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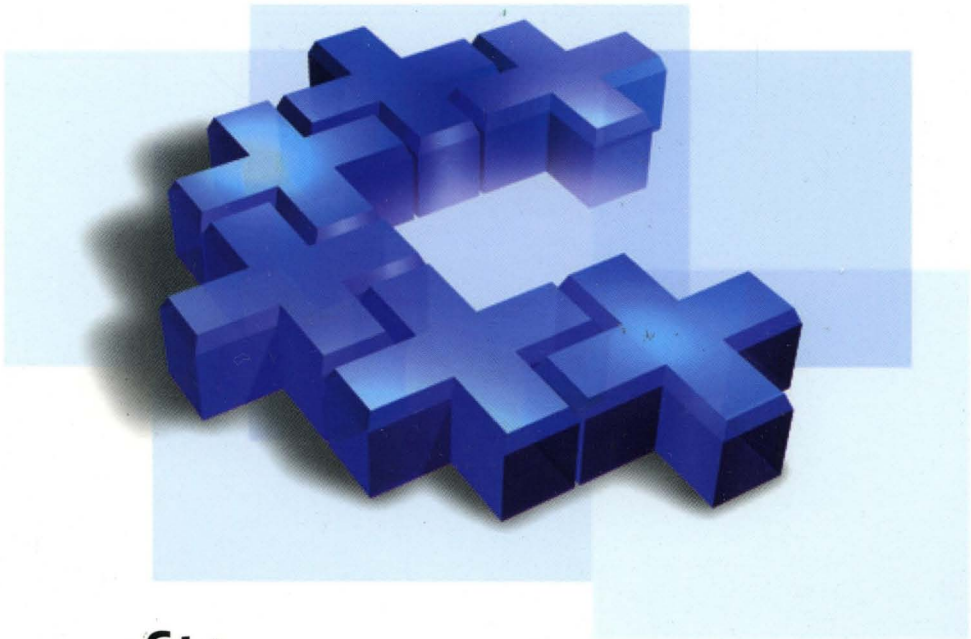
Microsoft Visual C++ 5.0
Programmer's Reference Set

Complete documentation for
Microsoft Visual C++ version 5.0



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Introduction

Microsoft Visual C++® contains the C++ iostream class library, which supports object-oriented input and output. This library follows the syntax that the authors of the C++ language originally established and thus represents a de facto standard for C++ input and output.

About This Book

Chapter 1, iostream Programming, provides information you need to get started using iostream classes. After reading this material, you will begin to understand how to write programs that process formatted text character streams and binary disk files and how to customize the library in limited ways. The chapter includes advanced information on how to derive iostream classes and create custom multiparameter "manipulators." These topics will get you started on extending the library and doing specialized formatting. You will also learn about the relationship between the iostream classes and their subsidiary buffer classes. You can then apply some of the iostream library design principles to your own class libraries.

Chapter 2, Alphabetic Microsoft iostream Class Library Reference, begins with a detailed class hierarchy diagram. The iostream class library reference follows, arranged by classes in alphabetic order. Each class description includes a summary of each member, arranged by category, followed by alphabetical listings of member functions (public and protected), overloaded operators, data members, and manipulators.

Public and protected class members are documented only when they are normally used in application programs or derived classes. See the class header files for a complete listing of class members.

CHAPTER 1

iostream Programming

This chapter begins with a general description of the iostream classes and then describes output streams, input streams, and input/output streams. The end of the chapter provides information about advanced iostream programming.

What a Stream Is

Like C, C++ does not have built-in input/output capability. All C++ compilers, however, come bundled with a systematic, object-oriented I/O package, known as the iostream classes. The "stream" is the central concept of the iostream classes. You can think of a stream object as a "smart file" that acts as a source and destination for bytes. A stream's characteristics are determined by its class and by customized insertion and extraction operators.

Through device drivers, the disk operating system deals with the keyboard, screen, printer, and communication ports as extended files. The iostream classes interact with these extended files. Built-in classes support reading from and writing to memory with syntax identical to that for disk I/O, which makes it easy to derive stream classes.

Input/Output Alternatives

This product provides several options for I/O programming:

- C run-time library direct, unbuffered I/O
- ANSI C run-time library stream I/O
- Console and port direct I/O
- The Microsoft Foundation Class Library
- The Microsoft iostream Class Library

The iostream classes are useful for buffered, formatted text I/O. They are also useful for unbuffered or binary I/O if you need a C++ programming interface and decide not to use the Microsoft Foundation classes. The iostream classes are an object-oriented I/O alternative to the C run-time functions.

You can use iostream classes with the Microsoft® Windows® operating system. String and file streams work without restrictions, but the character-mode stream objects **cin**, **cout**, **cerr**, and **clog** are inconsistent with the Windows graphical user interface. You can also derive custom stream classes that interact directly with the Windows environment. If you link with the QuickWin library, however, the **cin**, **cout**, **cerr**, and **clog** objects are assigned to special windows because they are connected to the predefined files **stdin**, **stdout**, and **stderr**.

You cannot use iostream classes in tiny-model programs because tiny-model programs cannot contain static objects such as **cin** and **cout**.

The iostream Class Hierarchy

The class hierarchy diagram at the beginning of Chapter 2 shows some relationships between iostream classes. There are additional "member" relationships between the **ios** and **streambuf** families. Use the diagram to locate base classes that provide inherited member functions for derived classes.

Output Streams

An output stream object is a destination for bytes. The three most important output stream classes are **ostream**, **ofstream**, and **ostrstream**.

The **ostream** class, through the derived class **ostream_withassign**, supports the predefined stream objects:

- **cout** standard output
- **cerr** standard error with limited buffering
- **clog** similar to **cerr** but with full buffering

Objects are rarely constructed from **ostream** or **ostream_withassign**; predefined objects are generally used. In some cases, you can reassign predefined objects after program startup. The **ostream** class, which can be configured for buffered or unbuffered operation, is best suited to sequential text-mode output. All functionality of the base class, **ios**, is included in **ostream**. If you construct an object of class **ostream**, you must specify a **streambuf** object to the constructor.

The **ofstream** class supports disk file output. If you need an output-only disk, construct an object of class **ofstream**. You can specify whether **ofstream** objects accept binary or text-mode data before or after opening the file. Many formatting options and member functions apply to **ofstream** objects, and all functionality of the base classes **ios** and **ostream** is included.

If you specify a filename in the constructor, that file is automatically opened when the object is constructed. Otherwise, you can use the **open** member function after invoking the default constructor, or you can construct an **ofstream** object based on an open file that is identified by a file descriptor.

Like the run-time function **sprintf**, the **ostrstream** class supports output to in-memory strings. To create a string in memory using I/O stream formatting, construct an object of class **ostrstream**. Because **ostrstream** objects are write-only, your program must access the resulting string through a pointer to **char**.

Constructing Output Stream Objects

If you use only the predefined **cout**, **cerr**, or **clog** objects, you don't need to construct an output stream. You must use constructors for:

- File streams
- String streams

Output File Stream Constructors

You can construct an output file stream in one of three ways:

- Use the default constructor, then call the **open** member function.

```
ofstream myFile; // Static or on the stack
myFile.open( "filename", iosmode );

ofstream* pmyFile = new ofstream; // On the heap
pmyFile->open( "filename", iosmode );
```

- Specify a filename and mode flags in the constructor call.

```
ofstream myFile( "filename", iosmode );
```

- Specify an integer file descriptor for a file already open for output. You can specify unbuffered output or a pointer to your own buffer.

```
int fd = _open( "filename", dosmode );
ofstream myFile1( fd );  // Buffered mode (default)
ofstream myFile2( fd, NULL, 0 );  // Unbuffered mode ofstream
myFile3( fd, pch, buflen);  // User-supplied buffer
```

Output String Stream Constructors

To construct an output string stream, you can use one of two **ostrstream** constructors. One dynamically allocates its own storage, and the other requires the address and size of a preallocated buffer.

- The dynamic constructor is used like this:

```
char* sp;
ostrstream myString;
mystring << "this is a test" << ends;
sp = myString.str();  // Get a pointer to the string
```

  The **ends** "manipulator" adds the necessary terminating null character to the string.

- The constructor that requires the preallocated buffer is used like this:

```
char s[32];
ostrstream myString( s, sizeof( s ) );
myString << "this is a test" << ends; // Text stored in s
```

Using Insertion Operators and Controlling Format

This section shows how to control format and how to create insertion operators for your own classes. The insertion (<<) operator, which is preprogrammed for all standard C++ data types, sends bytes to an output stream object. Insertion operators work with predefined "manipulators," which are elements that change the default format of integer arguments.

Output Width

To align output, you specify the output width for each item by placing the **setw** manipulator in the stream or by calling the **width** member function. This example right aligns the values in a column at least 10 characters wide:

```
#include <iostream.h>

void main()
{
   double values[] = { 1.23, 35.36, 653.7, 4358.24 };
   for( int i = 0; i < 4; i++ )
   {
      cout.width(10);
      cout << values[i] << '\n';
   }
}
```

The output looks like this:

```
      1.23
     35.36
     653.7
   4358.24
```

Leading blanks are added to any value fewer than 10 characters wide.

To pad a field, use the **fill** member function, which sets the value of the padding character for fields that have a specified width. The default is a blank. To pad the column of numbers with asterisks, modify the previous **for** loop as follows:

```
for( int i = 0; i < 4; i++ )
{
   cout.width( 10 );
   cout.fill( '*' );
   cout << values[i] << endl
}
```

The **endl** manipulator replaces the newline character (`'\n'`). The output looks like this:

```
******1.23
*****35.36
*****653.7
***4358.24
```

To specify widths for data elements in the same line, use the **setw** manipulator:

```
#include <iostream.h>
#include <iomanip.h>

void main()
{
   double values[] = { 1.23, 35.36, 653.7, 4358.24 };
   char *names[] = { "Zoot", "Jimmy", "Al", "Stan" };
   for( int i = 0; i < 4; i++ )
      cout << setw( 6 )  << names[i]
         << setw( 10 ) << values[i] << endl;
}
```

The **width** member function is declared in IOSTREAM.H. If you use **setw** or any other manipulator *with arguments*, you must include IOMANIP.H. In the output, strings are printed in a field of width 6 and integers in a field of width 10:

```
 Zoot       1.23
Jimmy      35.36
   Al      653.7
 Stan    4358.24
```

Neither **setw** nor **width** truncates values. If formatted output exceeds the width, the entire value prints, subject to the stream's precision setting. Both **setw** and **width** affect the following field only. Field width reverts to its default behavior (the necessary width) after one field has been printed. However, the other stream format options remain in effect until changed.

Alignment

Output streams default to right-aligned text. To left align the names in the previous example and right align the numbers, replace the **for** loop as follows:

```
for ( int i = 0; i < 4; i++ )
   cout << setiosflags( ios::left )
      << setw( 6 )  << names[i]
      << resetiosflags( ios::left )
      << setw( 10 ) << values[i] << endl;
```

The output looks like this:

```
Zoot       1.23
Jimmy      35.36
Al         653.7
Stan     4358.24
```

The left-align flag is set by using the **setiosflags** manipulator with the **ios::left** enumerator. This enumerator is defined in the **ios** class, so its reference must include the **ios::** prefix. The **resetiosflags** manipulator turns off the left-align flag. Unlike **width** and **setw**, the effect of **setiosflags** and **resetiosflags** is permanent.

Precision

The default value for floating-point precision is six. For example, the number 3466.9768 prints as 3466.98. To change the way this value prints, use the **setprecision** manipulator. The manipulator has two flags, **ios::fixed** and **ios::scientific**. If **ios::fixed** is set, the number prints as 3466.976800. If **ios::scientific** is set, it prints as 3.4669773+003.

To display the floating-point numbers shown in Alignment with one significant digit, replace the **for** loop as follows:

```
for ( int i = 0; i < 4; i++ )
   cout << setiosflags( ios::left )
      << setw( 6 )
      << names[i]
      << resetiosflags( ios::left )
      << setw( 10 )
      << setprecision( 1 )
      << values[i]
      << endl;
```

The program prints this list:

```
Zoot          1
Jimmy      4e+001
Al         7e+002
Stan       4e+003
```

To eliminate scientific notation, insert this statement before the **for** loop:

```
cout << setiosflags( ios::fixed );
```

With fixed notation, the program prints with one digit after the decimal point.

```
Zoot         1.2
Jimmy       35.4
Al         653.7
Stan      4358.2
```

If you change the **ios::fixed** flag to **ios::scientific**, the program prints this:

```
Zoot     1.2e+000
Jimmy    3.5e+001
Al       6.5e+002
Stan     4.4e+003
```

Again, the program prints one digit after the decimal point. If *either* **ios::fixed** or **ios::scientific** is set, the precision value determines the number of digits after the decimal point. If neither flag is set, the precision value determines the total number of significant digits. The **resetiosflags** manipulator clears these flags.

Radix

The **dec**, **oct**, and **hex** manipulators set the default radix for input and output. For example, if you insert the **hex** manipulator into the output stream, the object correctly translates the internal data representation of integers into a hexadecimal output format. The numbers are displayed with digits a through f in lowercase if the **ios::uppercase** flag is clear (the default); otherwise, they are displayed in uppercase. The default radix is **dec** (decimal).

Output File Stream Member Functions

Output stream member functions have three types: those that are equivalent to manipulators, those that perform unformatted write operations, and those that otherwise modify the stream state and have no equivalent manipulator or insertion operator. For sequential, formatted output, you might use only insertion operators and manipulators. For random-access binary disk output, you use other member functions, with or without insertion operators.

The open Function for Output Streams

To use an output file stream (**ofstream**), you must associate that stream with a specific disk file in the constructor or the **open** function. If you use the **open** function, you can reuse the same stream object with a series of files. In either case, the arguments describing the file are the same.

When you open the file associated with an output stream, you generally specify an **open_mode** flag. You can combine these flags, which are defined as enumerators in the **ios** class, with the bitwise OR (|) operator.

Flag	Function
ios::app	Opens an output file for appending.
ios::ate	Opens an existing file (either input or output) and seeks the end.
ios::in	Opens an input file. Use **ios::in** as an **open_mode** for an **ofstream** file to prevent truncating an existing file.
ios::out	Opens an output file. When you use **ios::out** for an **ofstream** object without **ios::app**, **ios::ate**, or **ios::in**, **ios::trunc** is implied.
ios::nocreate	Opens a file only if it already exists; otherwise the operation fails.
ios::noreplace	Opens a file only if it does not exist; otherwise the operation fails.
ios::trunc	Opens a file and deletes the old file (if it already exists).
ios::binary	Opens a file in binary mode (default is text mode).

Three common output stream situations involve mode options:

- Creating a file. If the file already exists, the old version is deleted.

```
ostream ofile( "FILENAME" );  // Default is ios::out
ofstream ofile( "FILENAME", ios::out ); // Equivalent to above
```

- Appending records to an existing file or creating one if it does not exist.

```
ofstream ofile( "FILENAME", ios::app );
```

- Opening two files, one at a time, on the same stream.

```
ofstream ofile();
ofile.open( "FILE1", ios::in );
// Do some output
ofile.close(); // FILE1 closed
ofile.open( "FILE2", ios::in );
// Do some more output
ofile.close(); // FILE2 closed
// When ofile goes out of scope it is destroyed.
```

The put Function

The **put** function writes one character to the output stream. The following two statements are the same by default, but the second is affected by the stream's format arguments:

```
cout.put( 'A' ); // Exactly one character written
cout << 'A'; // Format arguments 'width' and 'fill' apply
```

The write Function

The **write** function writes a block of memory to an output file stream. The length argument specifies the number of bytes written. This example creates an output file stream and writes the binary value of the `Date` structure to it:

```
#include <fstream.h>

struct Date
{
   int mo, da, yr;
};

void main()
{
   Date dt = { 6, 10, 92 };
   ofstream tfile( "date.dat" , ios::binary );
   tfile.write( (char *) &dt, sizeof dt );
}
```

The **write** function does not stop when it reaches a null character, so the complete class structure is written. The function takes two arguments: a **char** pointer and a count of characters to write. Note the required cast to **char*** before the address of the structure object.

The seekp and tellp Functions

An output file stream keeps an internal pointer that points to the position where data is to be written next. The **seekp** member function sets this pointer and thus provides random-access disk file output. The **tellp** member function returns the file position. For examples that use the input stream equivalants to **seekp** and **tellp**, see "The seekg and tellg Functions" on page 17.

The close Function for Output Streams

The **close** member function closes the disk file associated with an output file stream. The file must be closed to complete all disk output. If necessary, the **ofstream** destructor closes the file for you, but you can use the **close** function if you need to open another file for the same stream object.

The output stream destructor automatically closes a stream's file only if the constructor or the **open** member function opened the file. If you pass the constructor a file descriptor for an already-open file or use the **attach** member function, you must close the file explicitly.

Error Processing Functions

Use these member functions to test for errors while writing to a stream:

Function	Return value
bad	Returns **TRUE** if there is an unrecoverable error.
fail	Returns **TRUE** if there is an unrecoverable error or an "expected" condition, such as a conversion error, or if the file is not found. Processing can often resume after a call to **clear** with a zero argument.
good	Returns **TRUE** if there is no error condition (unrecoverable or otherwise) and the end-of-file flag is not set.
eof	Returns **TRUE** on the end-of-file condition.
clear	Sets the internal error state. If called with the default arguments, it clears all error bits.
rdstate	Returns the current error state. For a complete description of error bits, see the *Microsoft Foundation Class Library Reference*.

The **!** operator is overloaded to perform the same function as the **fail** function. Thus the expression

```
if( !cout)...
```

is equivalent to

```
if( cout.fail() )...
```

The **void***() operator is overloaded to be the opposite of the **!** operator; thus the expression

```
if( cout)...
```

is equal to

```
if( !cout.fail() )...
```

The **void***() operator is not equivalent to **good** because it doesn't test for the end of file.

The Effects of Buffering

The following example shows the effects of buffering. You might expect the program to print `please wait`, wait 5 seconds, and then proceed. It won't necessarily work this way, however, because the output is buffered.

```
#include <iostream.h>
#include <time.h>

void main()
{
   time_t tm = time( NULL ) + 5;
   cout << "Please wait...";
   while ( time( NULL ) < tm )
      ;
   cout << "\nAll done" << endl;
}
```

To make the program work logically, the **cout** object must empty itself when the message is to appear. To flush an **ostream** object, send it the **flush** manipulator:

```
cout << "Please wait..." << flush;
```

This step flushes the buffer, ensuring the message prints before the wait. You can also use the **endl** manipulator, which flushes the buffer and outputs a carriage return/line feed, or you can use the **cin** object. This object (with the **cerr** or **clog** objects) is usually tied to the **cout** object. Thus, any use of **cin** (or of the **cerr** or **clog** objects) flushes the **cout** object.

Binary Output Files

Streams were originally designed for text, so the default output mode is text. In text mode, the newline character (hexadecimal 10) expands to a carriage return/line feed (16-bit only). The expansion can cause problems, as shown here:

```
#include <fstream.h>
int iarray[2] = { 99, 10 };
void main()
{
   ofstream os( "test.dat" );
   os.write( (char *) iarray, sizeof( iarray ) );
}
```

You might expect this program to output the byte sequence { 99, 0, 10, 0 }; instead, it outputs { 99, 0, 13, 10, 0 }, which causes problems for a program expecting binary input. If you need true binary output, in which characters are written untranslated, you have several choices:

- Construct a stream as usual, then use the **setmode** member function, which changes the mode after the file is opened:

```
ofstream ofs ( "test.dat" );
ofs.setmode( filebuf::binary );
ofs.write( char*iarray, 4 ); // Exactly 4 bytes written
```

- Specify binary output by using the **ofstream** constuctor mode argument:

```
#include <fstream.h>
#include <fcntl.h>
#include <io.h>
int iarray[2] = { 99, 10 };
void main()
{
    ofstream os( "test.dat", ios::binary );
    ofs.write( iarray, 4 ); // Exactly 4 bytes written
}
```

- Use the **binary** manipulator instead of the **setmode** member function:

```
ofs << binary;
```

  Use the **text** manipulator to switch the stream to text translation mode.

- Open the file using the run-time **_open** function with a binary mode flag:

```
filedesc fd = _open( "test.dat",
              _O_BINARY | _O_CREAT | _O_WRONLY );
ofstream ofs( fd );
ofs.write( ( char* ) iarray, 4 ); // Exactly 4 bytes written
```

Overloading the << Operator for Your Own Classes

Output streams use the insertion (<<) operator for standard types. You can also overload the << operator for your own classes.

The **write** function example showed the use of a `Date` structure. A date is an ideal candidate for a C++ class in which the data members (month, day, and year) are hidden from view. An output stream is the logical destination for displaying such a structure. This code displays a date using the **cout** object:

```
Date dt( 1, 2, 92 );
cout << dt;
```

To get **cout** to accept a `Date` object after the insertion operator, overload the insertion operator to recognize an **ostream** object on the left and a `Date` on the right. The overloaded << operator function must then be declared as a friend of class `Date` so it can access the private data within a `Date` object.

```
#include <iostream.h>

class Date
{
   int mo, da, yr;
public:
   Date( int m, int d, int y )
   {
      mo = m; da = d; yr = y;
   }
   friend ostream& operator<< ( ostream& os, Date& dt );
};

ostream& operator<< ( ostream& os, Date& dt )
{
   os << dt.mo << '/' << dt.da << '/' << dt.yr;
   return os;
}

void main()
{
   Date dt( 5, 6, 92 );
   cout << dt;
}
```

When you run this program, it prints the date:

```
5/6/92
```

The overloaded operator returns a reference to the original **ostream** object, which means you can combine insertions:

```
cout << "The date is" << dt << flush;
```

Writing Your Own Manipulators Without Arguments

Writing manipulators that don't use arguments requires neither class derivation nor use of complex macros. Suppose your printer requires the pair <ESC>[to enter bold mode. You can insert this pair directly into the stream:

```
cout << "regular " << '\033' << '[' << "boldface" << endl;
```

Or you can define the `bold` manipulator, which inserts the characters:

```
ostream& bold( ostream& os ) {
   return os << '\033' << '[';
}
cout << "regular " << bold << "boldface" << endl;
```

The globally defined `bold` function takes an **ostream** reference argument and returns the **ostream** reference. It is not a member function or a friend because it doesn't need access to any private class elements. The `bold` function connects to the stream because the stream's << operator is overloaded to accept that type of function, using a declaration that looks something like this:

```
ostream& ostream::operator<< ( ostream& (*_f)( ostream& ) ); {
   (*_f)( *this );
   return *this;
}
```

You can use this feature to extend other overloaded operators. In this case, it is incidental that `bold` inserts characters into the stream. The function is called when it is inserted into the stream, not necessarily when the adjacent characters are printed. Thus, printing could be delayed because of the stream's buffering.

Input Streams

An input stream object is a source of bytes. The three most important input stream classes are **istream**, **ifstream**, and **istrstream**.

The **istream** class is best used for sequential text-mode input. You can configure objects of class **istream** for buffered or unbuffered operation. All functionality of the base class, **ios**, is included in **istream**. You will rarely construct objects from class **istream**. Instead, you will generally use the predefined **cin** object, which is actually an object of class **istream_withassign**. In some cases, you can assign **cin** to other stream objects after program startup.

The **ifstream** class supports disk file input. If you need an input-only disk file, construct an object of class **ifstream**. You can specify binary or text-mode data. If you specify a filename in the constructor, the file is automatically opened when the object is constructed. Otherwise, you can use the **open** function after invoking the default constructor. Many formatting options and member functions apply to **ifstream** objects. All functionality of the base classes **ios** and **istream** is included in **ifstream**.

Like the library function **sscanf**, the **istrstream** class supports input from in-memory strings. To extract data from a character array that has a null terminator, allocate and initialize the string, then construct an object of class **istrstream**.

Constructing Input Stream Objects

If you use only the **cin** object, you don't need to construct an input stream. You must construct an input stream if you use:

- File stream
- String stream

Input File Stream Constructors

There are three ways to create an input file stream:

- Use the **void**-argument constructor, then call the **open** member function:

```
ifstream myFile; // On the stack
myFile.open( "filename", iosmode );

ifstream* pmyFile = new ifstream; // On the heap
pmyFile->open( "filename", iosmode );
```

- Specify a filename and mode flags in the constructor invocation, thereby opening the file during the construction process:

```
ifstream myFile( "filename", iosmode );
```

- Specify an integer file descriptor for a file already open for input. In this case you can specify unbuffered input or a pointer to your own buffer:

```
int fd = _open( "filename", dosmode );
ifstream myFile1( fd );  // Buffered mode (default)
ifstream myFile2( fd, NULL, 0 );  // Unbuffered mode
ifstream myFile3( fd, pch, buflen );  // User-supplied buffer
```

Input String Stream Constructors

Input string stream constructors require the address of preallocated, preinitialized storage:

```
char s[] = "123.45";
double amt;
istrstream myString( s );
myString >> amt; // Amt should contain 123.45
```

Using Extraction Operators

The extraction operator (>>), which is preprogrammed for all standard C++ data types, is the easiest way to get bytes from an input stream object.

Formatted text input extraction operators depend on white space to separate incoming data values. This is inconvenient when a text field contains multiple words or when commas separate numbers. In such a case, one alternative is to use the unformatted input member function **getline** to read a block of text with white space included, then parse the block with special functions. Another method is to derive an input stream class with a member function such as `GetNextToken`, which can call **istream** members to extract and format character data.

Testing for Extraction Errors

Output error processing functions, discussed in "Error Processing Functions" on page 9, apply to input streams. Testing for errors during extraction is important. Consider this statement:

```
cin >> n;
```

If n is a signed integer, a value greater than 32,767 (the maximum allowed value, or MAX_INT) sets the stream's **fail** bit, and the **cin** object becomes unusable. All subsequent extractions result in an immediate return with no value stored.

Input Stream Manipulators

Many manipulators, such as **setprecision**, are defined for the **ios** class and thus apply to input streams. Few manipulators, however, actually affect input stream objects. Of those that do, the most important are the radix manipulators, **dec**, **oct**, and **hex**, which determine the conversion base used with numbers from the input stream.

On extraction, the **hex** manipulator enables processing of various input formats. For example, c, C, 0xc, 0xC, 0Xc, and 0XC are all interpreted as the decimal integer 12. Any character other than 0 through 9, A through F, a through f, x, and X terminates the numeric conversion. Thus the sequence `"124n5"` is converted to the number 124 with the **ios::fail** bit set.

Input Stream Member Functions

Input stream member functions are used for disk input. The member functions include:

- The open Function
- The get Function
- The getline Function
- The read Function
- The seekg and tellg Functions
- The close Function

The open Function for Input Streams

If you are using an input file stream (**ifstream**), you must associate that stream with a specific disk file. You can do this in the constructor, or you can use the **open** function. In either case, the arguments are the same.

You generally specify an **open_mode** flag when you open the file associated with an input stream (the default mode is **ios::in**). For a list of the **open_mode** flags, see "The open Function for Output Streams" on page 70. The flags can be combined with the bitwise OR (|) operator.

To read a file, first use the **fail** member function to determine whether it exists:

```
istream ifile( "FILENAME", ios::nocreate );
if ( ifile.fail() )
// The file does not exist ...
```

The get Function

The unformatted **get** member function works like the >> operator with two exceptions. First, the **get** function includes white-space characters, whereas the extractor excludes white space when the **ios::skipws** flag is set (the default). Second, the **get** function is less likely to cause a tied output stream (**cout**, for example) to be flushed.

A variation of the **get** function specifies a buffer address and the maximum number of characters to read. This is useful for limiting the number of characters sent to a specific variable, as this example shows:

```
#include <iostream.h>

void main()
{
   char line[25];
   cout << " Type a line terminated by carriage return\n>";
   cin.get( line, 25 );
   cout << ' ' << line;
}
```

In this example, you can type up to 24 characters and a terminating character. Any remaining characters can be extracted later.

The getline Function

The **getline** member function is similar to the **get** function. Both functions allow a third argument that specifies the terminating character for input. The default value is the newline character. Both functions reserve one character for the required terminating character. However, **get** leaves the terminating character in the stream and **getline** removes the terminating character.

The following example specifies a terminating character for the input stream:

```
#include <iostream.h>

void main()
{
   char line[100];
   cout << " Type a line terminated by 't'" << endl;
   cin.getline( line, 100, 't' );
   cout << line;
}
```

The read Function

The **read** member function reads bytes from a file to a specified area of memory. The length argument determines the number of bytes read. If you do not include that argument, reading stops when the physical end of file is reached or, in the case of a text-mode file, when an embedded **EOF** character is read.

This example reads a binary record from a payroll file into a structure:

```
#include <fstream.h>
#include <fcntl.h>
#include <io.h>

void main()
{
   struct
   {
      double salary;
      char name[23];
   } employee;

   ifstream is( "payroll", ios::binary | ios::nocreate );
   if( is ) {  // ios::operator void*()
      is.read( (char *) &employee, sizeof( employee ) );
      cout << employee.name << ' ' << employee.salary << endl;
   }
   else {
      cout << "ERROR: Cannot open file 'payroll'." << endl;
   }
}
```

The program assumes that the data records are formatted exactly as specified by the structure with no terminating carriage return or line feed characters.

The seekg and tellg Functions

Input file streams keep an internal pointer to the position in the file where data is to be read next. You set this pointer with the **seekg** function, as shown here:

```
#include <fstream.h>

void main()
{
   char ch;

   ifstream tfile( "payroll", ios::binary | ios::nocreate );
   if( tfile ) {
      tfile.seekg( 8 );       // Seek 8 bytes in (past salary)
      while ( tfile.good() ) { // EOF or failure stops the reading
         tfile.get( ch );
         if( !ch ) break; // quit on null
         cout << ch;
      }
   }
   else {
      cout << "ERROR: Cannot open file 'payroll'." << endl;
   }
}
```

To use **seekg** to implement record-oriented data management systems, multiply the fixed-length record size by the record number to obtain the byte position relative to the end of the file, then use the **get** object to read the record.

The **tellg** member function returns the current file position for reading. This value is of type **streampos**, a **typedef** defined in IOSTREAM.H. The following example reads a file and displays messages showing the positions of spaces.

```
#include <fstream.h>

void main()
{
   char ch;
ifstream tfile( "payroll", ios::binary | ios::nocreate );
   if( tfile ) {
      while ( tfile.good() ) {
         streampos here = tfile.tellg();
         tfile.get( ch );
         if ( ch == ' ' )
            cout << "\nPosition " << here << " is a space";
      }
   }
   else {
      cout << "ERROR: Cannot open file 'payroll'." << endl;
   }
}
```

The close Function for Input Streams

The **close** member function closes the disk file associated with an input file stream and frees the operating system file handle. The **ifstream** destructor closes the file for you (unless you called the **attach** function or passed your own file descriptor to the constructor), but you can use the **close** function if you need to open another file for the same stream object.

Overloading the >> Operator for Your Own Classes

Input streams use the extraction (>>) operator for the standard types. You can write similar extraction operators for your own types; your success depends on using white space precisely.

Here is an example of an extraction operator for the `Date` class presented earlier:

```
istream& operator>> ( istream& is, Date& dt )
{
   is >> dt.mo >> dt.da >> dt.yr;
   return is;
}
```

Input/Output Streams

An **iostream** object is a source and/or a destination for bytes. The two most important I/O stream classes, both derived from **iostream**, are **fstream** and **strstream**. These classes inherit the functionality of the **istream** and **ostream** classes described previously.

The **fstream** class supports disk file input and output. If you need to read from and write to a particular disk file in the same program, construct an **fstream** object. An **fstream** object is a single stream with two logical substreams, one for input and one for output. Although the underlying buffer contains separately designated positions for reading and writing, those positions are tied together.

The **strstream** class supports input and output of in-memory strings.

Custom Manipulators with Arguments

This section describes how to create output stream manipulators with one or more arguments, and how to use manipulators for non-output streams.

- Output Stream Manipulators with One Argument (int or long)
- Other One-Argument Output Stream Manipulators
- Output Stream Manipulators with More Than One Argument
- Custom Manipulators for Input and Input/Output Streams
- Using Manipulators with Derived Stream Classes

Output Stream Manipulators with One Argument (int or long)

The iostream class library provides a set of macros for creating parameterized manipulators. Manipulators with a single **int** or **long** argument are a special case. To create an output stream manipulator that accepts a single **int** or **long** argument (like **setw**), you must use the **OMANIP** macro, which is defined in IOMANIP.H. This example defines a `fillblank` manipulator that inserts a specified number of blanks into the stream:

```
#include <iostream.h>
#include <iomanip.h>

ostream& fb( ostream& os, int l )
{
   for( int i=0; i < l; i++ )
         os << ' ';
   return os;
}

OMANIP(int) fillblank( int l )
{
   return OMANIP(int) ( fb, l );
}

void main()
{
   cout << "10 blanks follow" << fillblank( 10 ) << ".\n";
}
```

The IOMANIP.H header file contains a macro that expands **OMANIP(int)** into a class, **__OMANIP_int**, which includes a constructor and an overloaded **ostream** insertion operator for an object of the class. In the previous example, the `fillblank` function calls the **__OMANIP_int** constructor to return an object of class **__OMANIP_int**. Thus, `fillblank` can be used with an **ostream** insertion operator. The constructor calls the `fb` function. The expression **OMANIP(long)** expands to another built-in class, **__OMANIP_long**, which accommodates functions with a long integer argument.

Other One-Argument Output Stream Manipulators

To create manipulators that take arguments other than **int** and **long**, you must use the **IOMANIPdeclare** macro, which declares the classes for your new type, as well as the **OMANIP** macro.

The following example uses a class `money`, which is a **long** type. The `setpic` manipulator attaches a formatting "picture" string to the class that can be used by the overloaded stream insertion operator of the class `money`. The picture string is stored as a static variable in the `money` class rather than as data member of a stream class, so you do not have to derive a new output stream class.

```
#include <iostream.h>
#include <iomanip.h>
#include <string.h>

typedef char* charp;
IOMANIPdeclare( charp );

class money {
private:
   long value;
   static char *szCurrentPic;
public:
   money( long val ) { value = val; }
   friend ostream& operator << ( ostream& os, money m ) {
      // A more complete function would merge the picture
      // with the value rather than simply appending it
      os << m.value << '[' << money::szCurrentPic << ']';
      return os;
   }
   friend ostream& setpic( ostream& os, char* szPic ) {
      money::szCurrentPic = new char[strlen( szPic ) + 1];
      strcpy( money::szCurrentPic, szPic );
      return os;
   }
};
char *money::szCurrentPic;  // Static pointer to picture
```

```
OMANIP(charp) setpic(charp c)
{
   return OMANIP(charp) (setpic, c);
}

void main()
{
   money amt = 35235.22;
   cout << setiosflags( ios::fixed );
   cout << setpic( "###,###,###.##" ) << "amount = " << amt << endl;
}
```

Output Stream Manipulators with More Than One Argument

The following example shows how to write a manipulator, `fill`, to insert a specific number of a particular character. The manipulator, which takes two arguments, is similar to `setpic` in the previous example. The difference is that the character pointer type declaration is replaced by a structure declaration.

```
#include <iostream.h>
#include <iomanip.h>

struct fillpair {
       char ch;
      int  cch;
};

IOMANIPdeclare( fillpair );

ostream& fp( ostream& os, fillpair pair )
{
   for ( int c = 0; c < pair.cch; c++ ) {
      os << pair.ch;
   }
   return os;
}

OMANIP(fillpair) fill( char ch, int cch )
{
   fillpair pair;

   pair.cch = cch;
   pair.ch  = ch;
   return OMANIP (fillpair)( fp, pair );
}

void main()
{
   cout << "10 dots coming" << fill( '.', 10 ) << "done" << endl;
}
```

This example can be rewritten so that the manipulator definition is in a separate program file. In this case, the header file must contain these declarations:

```
struct fillpair {
      char ch;
      int  cch;
};
IOMANIPdeclare( fillpair );
ostream& fp( ostream& o, fillpair pair );
OMANIP(fillpair) fill( char ch, int cch );
```

Custom Manipulators for Input and Input/Output Streams

The **OMANIP** macro works with **ostream** and its derived classes. The **SMANIP**, **IMANIP**, and **IOMANIP** macros work with the classes **ios**, **istream**, and **iostream**, respectively.

Using Manipulators with Derived Stream Classes

Suppose you define a manipulator, `xstream`, that works with the **ostream** class. The manipulator will work with all classes derived from **ostream**. Further suppose you need manipulators that work only with `xstream`. In this case, you must add an overloaded insertion operator that is not a member of **ostream**:

```
xstream& operator<< ( xstream& xs, xstream& (*_f)( xstream& ) ) {
   (*_f)( xs );
   return xs;
}
```

The manipulator code looks like this:

```
xstream& bold( xstream& xs ) {
   return xs << '\033' << '[';
}
```

If the manipulator needs to access `xstream` protected data member functions, you can declare the `bold` function as a friend of the `xstream` class.

Deriving Your Own Stream Classes

Like any C++ class, a stream class can be derived to add new member functions, data members, or manipulators. If you need an input file stream that tokenizes its input data, for example, you can derive from the **ifstream** class. This derived class can include a member function that returns the next token by calling its base class's public member functions or extractors. You may need new data members to hold the stream object's state between operations, but you probably won't need to use the base class's protected member functions or data members.

For the straightforward stream class derivation, you need only write the necessary constructors and the new member functions.

The streambuf Class

Unless you plan to make major changes to the iostream library, you do not need to work much with the **streambuf** class, which does most of the work for the other stream classes. In most cases, you will create a modified output stream by deriving only a new **streambuf** class and connecting it to the **ostream** class.

Why Derive a Custom streambuf Class?

Existing output streams communicate to the file system and to in-memory strings. You can create streams that address a memory-mapped video screen, a window as defined by Microsoft Windows, a new physical device, and so on. A simpler method is to alter the byte stream as it goes to a file system device.

A streambuf Derivation Example

The following example modifies the **cout** object to print in two-column landscape (horizontal) mode on a printer that uses the PCL control language (for example, Hewlett-Packard LaserJet printer). As the test driver program shows, all member functions and manipulators that work with the original **cout** object work with the special version. The application programming interface is the same.

The example is divided into three source files:

- HSTREAM.H—the LaserJet class declaration that must be included in the implementation file and application file
- HSTREAM.CPP—the LaserJet class implementation that must be linked with the application
- EXIOS204.CPP—the test driver program that sends output to a LaserJet printer

HSTREAM.H contains only the class declaration for `hstreambuf`, which is derived from the **filebuf** class and overrides the appropriate **filebuf** virtual functions.

```
// hstream.h - HP LaserJet output stream header
#include <fstream.h> // Accesses filebuf class
#include <string.h>
#include <stdio.h> // for sprintf

class hstreambuf : public filebuf
{
public:
   hstreambuf( int filed );
   virtual int sync();
   virtual int overflow( int ch );
   ~hstreambuf();
```

```
private:
   int column, line, page;
   char* buffer;
   void convert( long cnt );
   void newline( char*& pd, int& jj );
   void heading( char*& pd, int& jj );
   void pstring( char* ph, char*& pd, int& jj );
};
ostream& und( ostream& os );
ostream& reg( ostream& os );
```

HSTREAM.CPP contains the `hstreambuf` class implementation.

```
// hstream.cpp  - HP LaserJet output stream
#include "hstream.h"

const int REG  = 0x01;   // Regular font code
const int UND  = 0x02;   // Underline font code
const int CR   = 0x0d;   // Carriage return character
const int NL   = 0x0a;   // Newline character
const int FF   = 0x0c;   // Formfeed character
const int TAB  = 0x09;   // Tab character
const int LPP  = 57;     // Lines per page
const int TABW = 5;      // Tab width

// Prolog defines printer initialization (font, orientation, etc.
char prolog[] =
{ 0x1B, 0x45,                          // Reset printer
  0x1B, 0x28, 0x31, 0x30, 0x55,                    // IBM PC char set
  0x1B, 0x26, 0x6C, 0x31, 0x4F,                    // Landscape
  0x1B, 0x26, 0x6C, 0x38, 0x44,       // 8 lines per inch
  0x1B, 0x26, 0x6B, 0x32, 0x53};           // Lineprinter font

// Epilog prints the final page and terminates the output
char epilog[] = { 0x0C, 0x1B, 0x45 };   // Formfeed, reset

char uon[] = { 0x1B, 0x26, 0x64, 0x44, 0 }; // Underline on
char uoff[] = { 0x1B, 0x26, 0x64, 0x40, 0 };// Underline off

hstreambuf::hstreambuf( int filed ) : filebuf( filed )
{
   column = line = page = 0;
   int size = sizeof( prolog );
   setp( prolog, prolog + size );
   pbump( size );   // Puts the prolog in the put area
   filebuf::sync(); // Sends the prolog to the output file
   buffer = new char[1024]; // Allocates destination buffer
}
```

```
hstreambuf::~hstreambuf()
{

   sync(); // Makes sure the current buffer is empty
   delete buffer; // Frees the memory
   int size = sizeof( epilog );
   setp( epilog, epilog + size );
   pbump( size );   // Puts the epilog in the put area
   filebuf::sync(); // Sends the epilog to the output file
}
int hstreambuf::sync()
{
   long count = out_waiting();
   if ( count ) {
      convert( count );
   }
   return filebuf::sync();
}

int hstreambuf::overflow( int ch )
{
   long count = out_waiting();
   if ( count ) {
      convert( count );
   }
   return filebuf::overflow( ch );
}
// The following code is specific to the HP LaserJet printer

// Converts a buffer to HP, then writes it
void hstreambuf::convert( long cnt )
{
   char *bufs, *bufd; // Source, destination pointers
   int j = 0;

   bufs = pbase();
   bufd = buffer;
   if( page == 0 ) {
      newline( bufd, j );
   }
   for( int i = 0; i < cnt; i++ ) {
      char c = *( bufs++ );  // Gets character from source buffer
      if( c >= ' ' ) {       // Character is printable
         * ( bufd++ ) = c;
         j++;
         column++;
      }
```

```
else if( c == NL ) {            // Moves down one line
         *( bufd++ ) = c;    // Passes character through
         j++;
         line++;
         newline( bufd, j ); // Checks for page break, etc.
      }
      else if( c == FF ) {    // Ejects paper on formfeed
         line = line - line % LPP + LPP;
         newline( bufd, j ); // Checks for page break, etc.
      }
      else if( c == TAB ) {   // Expands tabs
         do {
            *( bufd++ ) = ' ';
            j++;
            column++;
         } while ( column % TABW );
      }
      else if( c == UND ) { // Responds to und manipulator
         pstring( uon, bufd, j );
      }
      else if( c == REG ) { // Responds to reg manipulator
         pstring( uoff, bufd, j );
      }
   }
   setp( buffer, buffer + 1024 ); // Sets new put area
   pbump( j ); // Tells number of characters in the dest buffer
}

// simple manipulators - apply to all ostream classes
ostream& und( ostream& os ) // Turns on underscore mode
{
   os << (char) UND; return os;
}

ostream& reg( ostream& os ) // Turns off underscore mode
{
   os << (char) REG; return os;
}

void hstreambuf::newline( char*& pd, int& jj ) {
// Called for each newline character
   column = 0;
   if ( ( line % ( LPP*2 ) ) == 0 ) { // Even page
      page++;
      pstring( "\033&a+0L", pd, jj );  // Set left margin to zero
      heading( pd, jj );              // Print heading
      pstring( "\033*p0x77Y", pd, jj );// Cursor to (0,77) dots
   }
   if ( ( ( line % LPP ) == 0 ) && ( line % ( LPP*2 ) ) != 0 ) {
   //  Odd page; prepare to move to right column
      page++;
      pstring( "\033*p0x77Y", pd, jj ); // Cursor to (0,77) dots
      pstring( "\033&a+88L", pd, jj );  // Left margin to col 88
   }
}
```

```
void hstreambuf::heading( char*& pd, int& jj ) // Prints heading
{
   char hdg[20];
   int i;

   if( page > 1 ) {
      *( pd++ ) = FF;
      jj++;
   }
   pstring( "\033*p0x0Y", pd, jj ); // Top of page
   pstring( uon, pd, jj );          // Underline on
   sprintf( hdg, "Page %-3d", page );
   pstring( hdg, pd, jj );
   for( i=0; i < 80; i++ ) {        // Pads with blanks
      *( pd++ ) = ' ';
      jj++;
   }
   sprintf( hdg, "Page %-3d", page+1 ) ;
   pstring( hdg, pd, jj );
   for( i=0; i < 80; i++ ) {        // Pads with blanks
      *( pd++ ) = ' ';
      jj++;
   }
   pstring( uoff, pd, jj ); // Underline off
}
// Outputs a string to the buffer
void hstreambuf::pstring( char* ph, char*& pd, int& jj )
{
   int len = strlen( ph );
   strncpy( pd, ph, len );
   pd += len;
   jj += len;
}
```

EXIOS204.CPP reads text lines from the **cin** object and writes them to the modified **cout** object.

```
// exios204.cpp
// hstream Driver program copies cin to cout until end of file
#include "hstream.h"

hstreambuf hsb( 4 ); // 4=stdprn

void main()
{
   char line[200];
   cout = &hsb; // Associates the HP LaserJet streambuf to cout
   while( 1 ) {
      cin.getline( line, 200 );
      if( !cin.good() ) break;
      cout << line << endl;
   }
}
```

Here are the main points in the preceding code:

- The new class `hstreambuf` is derived from **filebuf**, which is the buffer class for disk file I/O. The **filebuf** class writes to disk in response to commands from its associated **ostream** class. The `hstreambuf` constructor takes an argument that corresponds to the operating system file number, in this case 1, for **stdout**. This constructor is invoked by this line:

  ```
  hstreambuf hsb( 1 );
  ```

- The **ostream_withassign** assignment operator associates the `hstreambuf` object with the **cout** object:

  ```
  ostream& operator =( streambuf* sbp );
  ```

  This statement in EXIOS204.CPP executes the assignment:

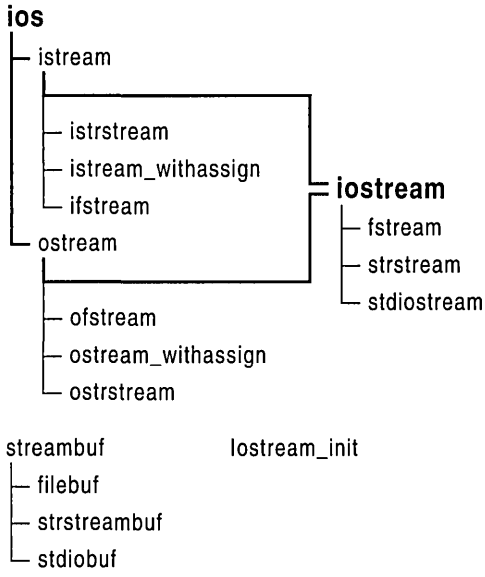
  ```
  cout = &hsb;
  ```

- The `hstreambuf` constructor prints the prolog that sets up the laser printer, then allocates a temporary print buffer.
- The destructor outputs the epilog text and frees the print buffer when the object goes out of scope, which happens after the exit from **main**.
- The **streambuf** virtual **overflow** and **sync** functions do the low-level output. The `hstreambuf` class overrides these functions to gain control of the byte stream. The functions call the private `convert` member function.
- The `convert` function processes the characters in the `hstreambuf` buffer and stores them in the object's temporary buffer. The **filebuf** functions process the temporary buffer.
- The details of `convert` relate more to the PCL language than to the iostream library. Private data members keep track of column, line, and page numbers.
- The `und` and `reg` manipulators control the underscore print attribute by inserting codes 0x02 and 0x03 into the stream. The `convert` function later translates these codes into printer-specific sequences.
- The program can be extended easily to embellish the heading, add more formatting features, and so forth.
- In a more general program, the `hstreambuf` class could be derived from the **streambuf** class rather than the **filebuf** class. The **filebuf** derivation shown gets the most leverage from existing iostream library code, but it makes assumptions about the implementation of **filebuf**, particularly the **overflow** and **sync** functions. Thus you cannot necessarily expect this example to work with other derived **streambuf** classes or with **filebuf** classes provided by other software publishers.

CHAPTER 2

Alphabetic Microsoft iostream Class Library Reference

iostream Class Hierarchy Diagram



iostream Class List

Abstract Stream Base Class

ios	Stream base class.

Input Stream Classes

istream	General-purpose input stream class and base class for other input streams.
ifstream	Input file stream class.
istream_withassign	Input stream class for **cin**.
istrstream	Input string stream class.

Output Stream Classes

ostream	General-purpose output stream class and base class for other output streams.
ofstream	Output file stream class.
ostream_withassign	Output stream class for **cout**, **cerr**, and **clog**.
ostrstream	Output string stream class.

Input/Output Stream Classes

iostream	General-purpose input/output stream class and base class for other input/output streams.
fstream	Input/output file stream class.
strstream	Input/output string stream class.
stdiostream	Input/output class for standard I/O files.

Stream Buffer Classes

streambuf	Abstract stream buffer base class.
filebuf	Stream buffer class for disk files.
strstreambuf	Stream buffer class for strings.
stdiobuf	Stream buffer class for standard I/O files.

Predefined Stream Initializer Class

Iostream_init	Predefined stream initializer class.

class filebuf

#include <fstream.h>

The **filebuf** class is a derived class of **streambuf** that is specialized for buffered disk file I/O. The buffering is managed entirely within the Microsoft iostream Class Library. **filebuf** member functions call the run-time low-level I/O routines (the functions declared in IO.H) such as **_sopen**, **_read**, and **_write**.

The file stream classes, **ofstream**, **ifstream**, and **fstream**, use **filebuf** member functions to fetch and store characters. Some of these member functions are virtual functions of the **streambuf** class.

The reserve area, put area, and get area are introduced in the **streambuf** class description. The put area and the get area are always the same for **filebuf** objects. Also, the get pointer and put pointers are tied; when one moves, so does the other.

Construction/Destruction—Public Members

filebuf Constructs a **filebuf** object.

~filebuf Destroys a **filebuf** object.

Operations—Public Members

open Opens a file and attaches it to the **filebuf** object.

close Flushes any waiting output and closes the attached file.

setmode Sets the file's mode to binary or text.

attach Attaches the **filebuf** object to an open file.

Status/Information—Public Members

fd Returns the stream's file descriptor.

is_open Tests whether the file is open.

See Also: **ifstream, ofstream, streambuf, strstreambuf, stdiobuf**

Member Functions

filebuf::attach

filebuf* attach(filedesc *fd* **);**

Attaches this **filebuf** object to the open file specified by *fd*.

Return Value

The function returns **NULL** when the stream is already attached to a file; otherwise it returns the address of the **filebuf** object.

Parameter

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**. **filedesc** is a **typedef** equivalent to **int**.

---

filebuf::close

filebuf* close();

Flushes any waiting output, closes the file, and disconnects the file from the **filebuf** object.

Return Value

If an error occurs, the function returns **NULL** and leaves the **filebuf** object in a closed state. If there is no error, the function returns the address of the **filebuf** object and clears its error state.

See Also: filebuf::open

---

filebuf::fd

filedesc fd() const;

Returns the file descriptor associated with the **filebuf** object; **filedesc** is a **typedef** equivalent to **int**.

Return Value

The value is supplied by the underlying file system. The function returns **EOF** if the object is not attached to a file.

See Also: filebuf::attach

---

filebuf::filebuf

filebuf();

filebuf(filedesc *fd* **);**

filebuf(filedesc *fd*, **char* pr, int** *nLength* **);**

Parameters

fd A file descriptor as returned by a call to the run-time function **_sopen**. **filedesc** is a **typedef** equivalent to **int**.

pr Pointer to a previously allocated reserve area of length *nLength*.

nLength The length (in bytes) of the reserve area.

Remarks

The three filebuf constructors are described as follows:

filebuf() Constructs a **filebuf** object without attaching it to a file.

filebuf(filedesc) Constructs a **filebuf** object and attaches it to an open file.

filebuf(filedesc, char*, int) Constructs a **filebuf** object, attaches it to an open file, and initializes it to use a specified reserve area.

---

filebuf::~filebuf

~filebuf();

Remarks

Closes the attached file only if that file was opened by the **open** member function.

---

filebuf::is_open

int is_open() const;

Return Value

Returns a nonzero value if this **filebuf** object is attached to an open disk file identified by a file descriptor; otherwise 0.

See Also: filebuf::open

---

filebuf::open

filebuf* open(const char* *szName*, **int** *nMode*, **int** *nProt* = **filebuf::openprot);**

Opens a disk file and attaches it with this **filebuf** object.

Return Value

If the file is already open, or if there is an error while opening the file, the function returns **NULL**; otherwise it returns the **filebuf** address.

Parameters

szName The name of the file to be opened during construction.

nMode An integer containing mode bits defined as **ios** enumerators that can be combined with the OR (|) operator. See the **ofstream** constructor for a list of the enumerators.

nProt The file protection specification; defaults to the static integer **filebuf::openprot**, which is equivalent to the operating system default (**filebuf::sh_compat** for MS-DOS). The possible values of *nProt* are:

- **filebuf::sh_compat** Compatibility share mode (MS-DOS only).
- **filebuf::sh_none** Exclusive mode—no sharing.
- **filebuf::sh_read** Read sharing allowed.
- **filebuf::sh_write** Write sharing allowed.

You can combine the **filebuf::sh_read** and **filebuf::sh_write** modes with the logical OR (||) operator.

See Also: **filebuf::is_open, filebuf::close, filebuf::~filebuf**

filebuf::setmode

int setmode(int *nMode* **= filebuf::text);**

Parameter

nMode An integer that must be one of the static **filebuf** constants. The *nMode* parameter must have one of the following values:

- **filebuf::text** Text mode (newline characters translated to and from carriage return/line feed pairs under MS-DOS).
- **filebuf::binary** Binary mode (no translation).

Return Value

The previous mode if there is no error; otherwise 0.

Remarks

Sets the binary/text mode of the stream's **filebuf** object.

See Also: **ios binary manipulator, ios text manipulator**

class fstream

#include <fstream.h>

The **fstream** class is an **iostream** derivative specialized for combined disk file input and output. Its constructors automatically create and attach a **filebuf** buffer object.

See **filebuf** class for information on the get and put areas and their associated pointers. Although the **filebuf** object's get and put pointers are theoretically independent, the get area and the put area are not active at the same time. When the stream's mode changes from input to output, the get area is emptied and the put area is reinitialized. When the mode changes from output to input, the put area is flushed and the get area is reinitialized. Thus, either the get pointer or the put pointer is null at all times.

Construction/Destruction—Public Members

fstream Constructs an **fstream** object.

~fstream Destroys an **fstream** object.

Operations—Public Members

open Opens a file and attaches it to the **filebuf** object and thus to the stream.

close Flushes any waiting output and closes the stream's file.

setbuf Attaches the specified reserve area to the stream's **filebuf** object.

setmode Sets the stream's mode to binary or text.

attach Attaches the stream (through the **filebuf** object) to an open file.

Status/Information—Public Members

rdbuf Gets the stream's **filebuf** object.

fd Returns the file descriptor associated with the stream.

is_open Tests whether the stream's file is open.

See Also: ifstream, ofstream, strstream, stdiostream, filebuf

---

Member Functions

fstream::attach

void attach(filedesc *fd* **);**

Attaches this stream to the open file specified by *fd*.

Parameter

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**; **filedesc** is a **typedef** equivalent to **int**.

Remarks

The function fails when the stream is already attached to a file. In that case, the function sets **ios::failbit** in the stream's error state.

See Also: filebuf::attach, fstream::fd

fstream::close

void close();

Remarks

Calls the **close** member function for the associated **filebuf** object. This function, in turn, flushes any waiting output, closes the file, and disconnects the file from the **filebuf** object. The **filebuf** object is not destroyed.

The stream's error state is cleared unless the call to **filebuf::close** fails.

See Also: filebuf::close, fstream::open, fstream::is_open

---

fstream::fd

filedesc fd() const;

Remarks

Returns the file descriptor associated with the stream. **filedesc** is a **typedef** equivalent to **int**. Its value is supplied by the underlying file system.

See Also: filebuf::fd, fstream::attach

---

fstream::fstream

fstream();

fstream(const char* *szName*, **int** *nMode*, **int** *nProt* **= filebuf::openprot);**

fstream(filedesc *fd* **);**

fstream(filedesc *fd*, **char*** *pch*, **int** *nLength* **);**

Parameters

szName The name of the file to be opened during construction.

nMode An integer that contains mode bits defined as **ios** enumerators that can be combined with the bitwise OR (|) operator. The *nMode* parameter must have one of the following values:

- **ios::app** The function performs a seek to the end of file. When new bytes are written to the file, they are always appended to the end, even if the position is moved with the **ostream::seekp** function.
- **ios::ate** The function performs a seek to the end of file. When the first new byte is written to the file, it is appended to the end, but when subsequent bytes are written, they are written to the current position.

- **ios::in** The file is opened for input. The original file (if it exists) will not be truncated.
- **ios::out** The file is opened for output.
- **ios::trunc** If the file already exists, its contents are discarded. This mode is implied if **ios::out** is specified, and **ios::ate**, **ios::app**, and **ios:in** are not specified.
- **ios::nocreate** If the file does not already exist, the function fails.
- **ios::noreplace** If the file already exists, the function fails.
- **ios::binary** Opens the file in binary mode (the default is text mode).

Note that there is no **ios::in** or **ios::out** default mode for **fstream** objects. You must specify both modes if your **fstream** object must both read and write files.

nProt The file protection specification; defaults to the static integer **filebuf::openprot**, which is equivalent to the operating system default, **filebuf::sh_compat**, under MS-DOS. The possible *nProt* values are as follows:

- **filebuf::sh_compat** Compatibility share mode (MS-DOS only).
- **filebuf::sh_none** Exclusive mode—no sharing.
- **filebuf::sh_read** Read sharing allowed.
- **filebuf::sh_write** Write sharing allowed.

The **filebuf::sh_read** and **filebuf::sh_write** modes can be combined with the logical OR (||) operator.

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**. **filedesc** is a **typedef** equivalent to **int**.

pch Pointer to a previously allocated reserve area of length *nLength*. A **NULL** value (or *nLength* = 0) indicates that the stream will be unbuffered.

nLength The length (in bytes) of the reserve area (0 = unbuffered).

Remarks

The four **fstream** constructors are:

- **fstream()** Constructs an **fstream** object without opening a file.
- **fstream(const char*, int, int)** Contructs an **fstream** object, opening the specified file.
- **fstream(filedesc)** Constructs an **fstream** object that is attached to an open file.
- **fstream(filedesc, char*, int)** Constructs an **fstream** object that is associated with a **filebuf** object. The **filebuf** object is attached to an open file and to a specified reserve area.

All **fstream** constructors construct a **filebuf** object. The first three use an internally allocated reserve area, but the fourth uses a user-allocated area. The user-allocated area is not automatically released during destruction.

fstream::~fstream

~fstream();

Remarks

Flushes the buffer, then destroys an **fstream** object, along with its associated **filebuf** object. The file is closed only if it was opened by the constructor or by the **open** member function.

The **filebuf** destructor releases the reserve buffer only if it was internally allocated.

fstream::is_open

int is_open() const;

Return Value

Returns a nonzero value if this stream is attached to an open disk file identified by a file descriptor; otherwise 0.

See Also: filebuf::is_open, fstream::open, fstream::close

fstream::open

void open(const char* *szName*, **int** *nMode*, **int** *nProt* = **filebuf::openprot);**

Opens a disk file and attaches it to the stream's **filebuf** object.

Parameters

szName The name of the file to be opened during construction.

nMode An integer containing mode bits defined as **ios** enumerators that can be combined with the OR (|) operator. See the **fstream** constructor for a list of the enumerators. There is no default; a valid mode must be specified.

nProt The file protection specification; defaults to the static integer **filebuf::openprot**. See the **fstream** constructor for a list of the other allowed values.

Remarks

If the **filebuf** object is already attached to an open file, or if a **filebuf** call fails, the **ios::failbit** is set. If the file is not found, then the **ios::failbit** is set only if the **ios::nocreate** mode was used.

See Also: filebuf::open, fstream::fstream, fstream::close, fstream::is_open

fstream::rdbuf

filebuf* rdbuf() const;

Remarks

Returns a pointer to the **filebuf** buffer object that is associated with this stream. (This is not the character buffer; the **filebuf** object contains a pointer to the character area.)

---

fstream::setbuf

streambuf* setbuf(char* *pch*, **int** *nLength* **);**

Attaches the specified reserve area to the stream's **filebuf** object.

Return Value

If the file is open and a buffer has already been allocated, the function returns **NULL**; otherwise it returns a pointer to the **filebuf** cast as a **streambuf**. The reserve area will not be released by the destructor.

Parameters

pch A pointer to a previously allocated reserve area of length *nLength*. A **NULL** value indicates an unbuffered stream.

nLength The length (in bytes) of the reserve area. A length of 0 indicates an unbuffered stream.

---

fstream::setmode

int setmode(int *nMode* **= filebuf::text);**

Sets the binary/text mode of the stream's **filebuf** object. It can be called only after the file is opened.

Return Value

The previous mode; –1 if the parameter is invalid, the file is not open, or the mode cannot be changed.

Parameter

nMode An integer that must be one of the following static **filebuf** constants:

- **filebuf::text** Text mode (newline characters translated to and from carriage return/line feed pairs).
- **filebuf::binary** Binary mode (no translation).

See Also: ios binary manipulator, ios text manipulator

class ifstream

#include <fstream.h>

The **ifstream** class is an **istream** derivative specialized for disk file input. Its constructors automatically create and attach a **filebuf** buffer object.

The **filebuf** class documentation describes the get and put areas and their associated pointers. Only the get area and the get pointer are active for the **ifstream** class.

Construction/Destruction—Public Members

ifstream Constructs an **ifstream** object.

~ifstream Destroys an **ifstream** object.

Operations—Public Members

open Opens a file and attaches it to the **filebuf** object and thus to the stream.

close Closes the stream's file.

setbuf Associates the specified reserve area to the stream's **filebuf** object.

setmode Sets the stream's mode to binary or text.

attach Attaches the stream (through the **filebuf** object) to an open file.

Status/Information—Public Members

rdbuf Gets the stream's **filebuf** object.

fd Returns the file descriptor associated with the stream.

is_open Tests whether the stream's file is open.

See Also: filebuf, streambuf, ofstream, fstream

Member Functions

ifstream::attach

void attach(filedesc *fd* **);**

Attaches this stream to the open file specified by *fd*.

Parameter

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**; **filedesc** is a **typedef** equivalent to **int**.

Remarks

The function fails when the stream is already attached to a file. In that case, the function sets **ios::failbit** in the stream's error state.

See Also: **filebuf::attach**, **ifstream::fd**

---

ifstream::close

void close();

Remarks

Calls the **close** member function for the associated **filebuf** object. This function, in turn, closes the file and disconnects the file from the **filebuf** object. The **filebuf** object is not destroyed.

The stream's error state is cleared unless the call to **filebuf::close** fails.

See Also: **filebuf::close**, **ifstream::open**, **ifstream::is_open**

---

ifstream::fd

filedesc fd() const;

Return Value

Returns the file descriptor associated with the stream; **filedesc** is a **typedef** equivalent to **int**. Its value is supplied by the underlying file system.

See Also: **filebuf::fd**, **ifstream::attach**

---

ifstream::ifstream

ifstream();

ifstream(const char* *szName*, **int** *nMode* **= ios::in, int** *nProt* **= filebuf::openprot);**

ifstream(filedesc *fd* **);**

ifstream(filedesc *fd*, **char*** *pch*, **int** *nLength* **);**

Parameters

szName The name of the file to be opened during construction.

nMode An integer that contains mode bits defined as **ios** enumerators that can be combined with the bitwise OR (|) operator. The *nMode* parameter must have one of the following values:

- **ios::in** The file is opened for input (default).
- **ios::nocreate** If the file does not already exist, the function fails.

- **ios::binary** Opens the file in binary mode (the default is text mode).

Note that the **ios::nocreate** flag is necessary if you intend to test for the file's existence (the usual case).

nProt The file protection specification; defaults to the static integer **filebuf::openprot** that is equivalent to **filebuf::sh_compat**. The possible *nProt* values are:

- **filebuf::sh_compat** Compatibility share mode.
- **filebuf::sh_none** Exclusive mode—no sharing.
- **filebuf::sh_read** Read sharing allowed.
- **filebuf::sh_write** Write sharing allowed.

To combine the **filebuf::sh_read** and **filebuf::sh_write** modes, use the logical OR (||) operator.

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**; **filedesc** is a **typedef** equivalent to **int**.

pch Pointer to a previously allocated reserve area of length *nLength*. A **NULL** value (or *nLength* = 0) indicates that the stream will be unbuffered.

nLength The length (in bytes) of the reserve area (0 = unbuffered).

Remarks

The four **ifstream** constructors are:

- **ifstream()** Constructs an **ifstream** object without opening a file.
- **ifstream(const char*, int, int)** Contructs an **ifstream** object, opening the specified file.
- **ifstream(filedesc)** Constructs an **ifstream** object that is attached to an open file.
- **ifstream(filedesc, char*, int)** Constructs an **ifstream** object that is associated with a **filebuf** object. The **filebuf** object is attached to an open file and to a specified reserve area.

All **ifstream** constructors construct a **filebuf** object. The first three use an internally allocated reserve area, but the fourth uses a user-allocated area.

---

ifstream::~ifstream

~ifstream();

Remarks

Destroys an **ifstream** object along with its associated **filebuf** object. The file is closed only if it was opened by the constructor or by the **open** member function.

The **filebuf** destructor releases the reserve buffer only if it was internally allocated.

ifstream::is_open

int is_open() const;

Return Value

Returns a nonzero value if this stream is attached to an open disk file identified by a file descriptor; otherwise 0.

See Also: **filebuf::is_open, ifstream::open, ifstream::close**

---

ifstream::open

void open(const char* *szName*, **int** *nMode* **= ios::in, int** *nProt* **= filebuf::openprot);**

Parameters

szName The name of the file to be opened during construction.

nMode An integer containing bits defined as **ios** enumerators that can be combined with the OR (|) operator. See the **ifstream constructor** for a list of the enumerators. The **ios::in** mode is implied.

nProt The file protection specification; defaults to the static integer **filebuf::openprot**. See the **ifstream** constructor for a list of the other allowed values.

Remarks

Opens a disk file and attaches it to the stream's **filebuf** object. If the **filebuf** object is already attached to an open file, or if a **filebuf** call fails, the **ios::failbit** is set. If the file is not found, then the **ios::failbit** is set only if the **ios::nocreate** mode was used.

See Also: **filebuf::open, ifstream::ifstream, ifstream::close, ifstream::is_open, ios::flags**

---

ifstream::rdbuf

filebuf* rdbuf() const;

Return Value

Returns a pointer to the **filebuf** buffer object that is associated with this stream. (This is not the character buffer; the **filebuf** object contains a pointer to the character area.)

---

ifstream::setbuf

streambuf* setbuf(char* *pch*, **int** *nLength* **);**

Attaches the specified reserve area to the stream's **filebuf** object.

Return Value

If the file is open and a buffer has already been allocated, the function returns **NULL**; otherwise it returns a pointer to the **filebuf**, which is cast as a **streambuf**. The reserve area will not be released by the destructor.

Parameters

pch A pointer to a previously allocated reserve area of length *nLength*. A **NULL** value indicates an unbuffered stream.

nLength The length (in bytes) of the reserve area. A length of 0 indicates an unbuffered stream.

---

ifstream::setmode

int setmode(int *nMode* = filebuf::text);

Return Value

The previous mode; –1 if the parameter is invalid, the file is not open, or the mode cannnot be changed.

Parameters

nMode An integer that must be one of the following static **filebuf** constants:

- **filebuf::text** Text mode (newline characters translated to and from carriage return/line feed pairs).
- **filebuf::binary** Binary mode (no translation).

Remarks

This function sets the binary/text mode of the stream's **filebuf** object. It may be called only after the file is opened.

See Also: ios binary manipulator, ios text manipulator

---

class ios

#include <iostream.h>

As the **iostream class hierarchy diagram** shows, **ios** is the base class for all the input/output stream classes. While **ios** is not technically an abstract base class, you will not usually construct **ios** objects, nor will you derive classes directly from **ios**. Instead, you will use the derived classes **istream** and **ostream** or other derived classes.

Even though you will not use **ios** directly, you will be using many of the inherited member functions and data members described here. Remember that these inherited member function descriptions are not duplicated for derived classes.

Data Members (static)—Public Members

basefield Mask for obtaining the conversion base flags (**dec**, **oct**, or **hex**).

adjustfield Mask for obtaining the field padding flags (**left**, **right**, or **internal**).

floatfield Mask for obtaining the numeric format (**scientific** or **fixed**).

Construction/Destruction—Public Members

ios Constructor for use in derived classes.

~ios Virtual destructor.

Flag and Format Access Functions—Public Members

flags Sets or reads the stream's format flags.

setf Manipulates the stream's format flags.

unsetf Clears the stream's format flags.

fill Sets or reads the stream's fill character.

precision Sets or reads the stream's floating-point format display precision.

width Sets or reads the stream's output field width.

Status-Testing Functions—Public Members

good Indicates good stream status.

bad Indicates a serious I/O error.

eof Indicates end of file.

fail Indicates a serious I/O error or a possibly recoverable I/O formatting error.

rdstate Returns the stream's error flags.

clear Sets or clears the stream's error flags.

User-Defined Format Flags—Public Members

bitalloc Provides a mask for an unused format bit in the stream's private flags variable (static function).

xalloc Provides an index to an unused word in an array reserved for special-purpose stream state variables (static function).

iword Converts the index provided by **xalloc** to a reference (valid only until the next **xalloc**).

pword Converts the index provided by **xalloc** to a pointer (valid only until the next **xalloc**).

Other Functions—Public Members

delbuf Controls the connection of **streambuf** deletion with **ios** destruction.

rdbuf Gets the stream's **streambuf** object.

sync_with_stdio Synchronizes the predefined objects **cin**, **cout**, **cerr**, and **clog** with the standard I/O system.

tie Ties a specified **ostream** to this stream.

Operators—Public Members

operator void* Converts a stream to a pointer that can be used only for error checking.

operator ! Returns a nonzero value if a stream I/O error occurs.

ios Manipulators

dec Causes the interpretation of subsequent fields in decimal format (the default mode).

hex Causes the interpretation of subsequent fields in hexadecimal format.

oct Causes the interpretation of subsequent fields in octal format.

binary Sets the stream's mode to binary (stream must have an associated **filebuf** buffer).

text Sets the stream's mode to text, the default mode (stream must have an associated **filebuf** buffer).

Parameterized Manipulators

(**#include <iomanip.h>** required)

setiosflags Sets the stream's format flags.

resetiosflags Resets the stream's format flags.

setfill Sets the stream's fill character.

setprecision Sets the stream's floating-point display precision.

setw Sets the stream's field width (for the next field only).

See Also: istream, ostream

Member Functions

ios::bad

int bad() const;

Return Value

Returns a nonzero value to indicate a serious I/O error. This is the same as setting the **badbit** error state. Do not continue I/O operations on the stream in this situation.

See Also: ios::good, ios::fail, ios::rdstate

ios::bitalloc

static long bitalloc();

Remarks

Provides a mask for an unused format bit in the stream's private flags variable (static function). The **ios** class currently defines 15 format flag bits accessible through **flags** and other member functions. These bits reside in a 32-bit private **ios** data member and are accessed through enumerators such as **ios::left** and **ios::hex**.

The **bitalloc** member function provides a mask for a previously unused bit in the data member. Once you obtain the mask, you can use it to set or test the corresponding custom flag bit in conjunction with the **ios** member functions and manipulators listed under "See Also."

See Also: ios::flags, ios::setf, ios::unsetf, ios setiosflags manipulator, ios resetiosflags manipulator

---

ios::clear

void clear(int *nState* **= 0);**

Parameter

nState If 0, all error bits are cleared; otherwise bits are set according to the following masks (**ios** enumerators) that can be combined using the bitwise OR (|) operator. The *nState* parameter must have one of the following values:

- **ios::goodbit** No error condition (no bits set).
- **ios::eofbit** End of file reached.
- **ios::failbit** A possibly recoverable formatting or conversion error.
- **ios::badbit** A severe I/O error.

Remarks

Sets or clears the error-state flags. The **rdstate** function can be used to read the current error state.

See Also: ios::rdstate, ios::good, ios::bad, ios::eof

---

ios::delbuf

void delbuf(int *nDelFlag* **);**

int delbuf() const;

Parameter

nDelFlag A nonzero value indicates that **~ios** should delete the stream's attached **streambuf** object. A 0 value prevents deletion.

Remarks

The first overloaded **delbuf** function assigns a value to the stream's buffer-deletion flag. The second function returns the current value of the flag.

This function is public only because it is accessed by the **Iostream_init** class. Treat it as protected.

See Also: ios::rdbuf, ios::~ios

---

ios::eof

int eof() const;

Return Value

Returns a nonzero value if end of file has been reached. This is the same as setting the **eofbit** error flag.

---

ios::fail

int fail() const;

Return Value

Returns a nonzero value if any I/O error (not end of file) has occurred. This condition corresponds to either the **badbit** or **failbit** error flag being set. If a call to **bad** returns 0, you can assume that the error condition is nonfatal and that you can probably continue processing after you clear the flags.

See Also: ios::bad, ios::clear

---

ios::fill

char fill(char *cFill* **);**

char fill() const;

Return Value

The first overloaded function sets the stream's internal fill character variable to *cFill* and returns the previous value. The default fill character is a space.

The second **fill** function returns the stream's fill character.

Parameter

cFill The new fill character to be used as padding between fields.

See Also: ios setfill manipulator

---

ios::flags

long flags(long *lFlags*);

long flags() const;

Return Value

The first overloaded **flags** function sets the stream's internal flags variable to *lFlags* and returns the previous value.

The second function returns the stream's current flags.

Parameter

lFlags The new format flag values for the stream. The values are specified by the following bit masks (**ios** enumerators) that can be combined using the bitwise OR (|) operator. The *lFlags* parameter must have one of the following values:

- **ios::skipws** Skip white space on input.
- **ios::left** Left-align values; pad on the right with the fill character.
- **ios::right** Right-align values; pad on the left with the fill character (default alignment).
- **ios::internal** Add fill characters after any leading sign or base indication, but before the value.
- **ios::dec** Format numeric values as base 10 (decimal) (default radix).
- **ios::oct** Format numeric values as base 8 (octal).
- **ios::hex** Format numeric values as base 16 (hexadecimal).
- **ios::showbase** Display numeric constants in a format that can be read by the C++ compiler.
- **ios::showpoint** Show decimal point and trailing zeros for floating-point values.
- **ios::uppercase** Display uppercase A through F for hexadecimal values and E for scientific values.
- **ios::showpos** Show plus signs (+) for positive values.
- **ios::scientific** Display floating-point numbers in scientific format.

- **ios::fixed** Display floating-point numbers in fixed format.
- **ios::unitbuf** Cause **ostream::osfx** to flush the stream after each insertion. By default, **cerr** is unit buffered.
- **ios::stdio** Cause **ostream::osfx** to flush stdout and stderr after each insertion.

See Also: ios::setf, ios::unsetf, ios setiosflags manipulator, ios resetiosflags manipulator, ios::adjustfield, ios::basefield, ios::floatfield

---

ios::good

int good() const;

Return Value

Returns a nonzero value if all error bits are clear. Note that the **good** member function is not simply the inverse of the **bad** function.

See Also: ios::bad, ios::fail, ios::rdstate

---

ios::init

Protected →

void init(streambuf* *psb* **);**

END Protected

Parameter

psb A pointer to an existing streambuf object.

Remarks

Associates an object of a **streambuf**-derived class with this stream and, if necessary, deletes a dynamically created stream buffer object that was previously associated. The **init** function is useful in derived classes in conjunction with the protected default **istream**, **ostream**, and **iostream** constructors. Thus, an **ios**-derived class constructor can construct and attach its own predetermined stream buffer object.

See Also: istream::istream, ostream::ostream, iostream::iostream

---

ios::ios

ios(streambuf* *psb* **);**

Parameter

psb A pointer to an existing streambuf object.

Remarks

Constructor for **ios**. You will seldom need to invoke this constructor except in derived classes. Generally, you will be deriving classes not from **ios** but from **istream**, **ostream**, and **iostream**.

---

ios::~ios

virtual ~ios();

Remarks

Virtual destructor for **ios**.

---

ios::iword

long& iword(int *nIndex* **) const;**

Parameters

nIndex An index to a table of words that are associated with the **ios** object.

Remarks

The **xalloc** member function provides the index to the table of special-purpose words. The **pword** function converts that index to a reference to a 32-bit word.

See Also: ios::xalloc, ios::pword

---

ios::precision

int precision(int *np* **);**

int precision() const;

Return Value

The first overloaded **precision** function sets the stream's internal floating-point precision variable to *np* and returns the previous value. The default precision is six digits. If the display format is scientific or fixed, the precision indicates the number of digits after the decimal point. If the format is automatic (neither floating point nor fixed), the precision indicates the total number of significant digits.

The second function returns the stream's current precision value.

Parameter

np An integer that indicates the number of significant digits or significant decimal digits to be used for floating-point display.

See Also: ios setprecision manipulator

ios::pword

void*& pword(int *nIndex* **) const;**

Parameter

nIndex An index to a table of words that are associated with the **ios** object.

Remarks

The **xalloc** member function provides the index to the table of special-purpose words. The **pword** function converts that index to a reference to a pointer to a 32-bit word.

See Also: ios::xalloc, ios::iword

---

ios::rdbuf

streambuf* rdbuf() const;

Return Value

Returns a pointer to the **streambuf** object that is associated with this stream. The **rdbuf** function is useful when you need to call **streambuf** member functions.

---

ios::rdstate

int rdstate() const;

Return Value

Returns the current error state as specified by the following masks (**ios** enumerators):

- **ios::goodbit** No error condition.
- **ios::eofbit** End of file reached.
- **ios::failbit** A possibly recoverable formatting or conversion error.
- **ios::badbit** A severe I/O error or unknown state.

The returned value can be tested against a mask with the AND (**&**) operator.

See Also: ios::clear

---

ios::setf

long setf(long *lFlags* **);**

long setf(long *lFlags*, **long** *lMask* **);**

Return Value

The first overloaded **setf** function turns on only those format bits that are specified by 1s in *lFlags*. It returns a **long** that contains the previous value of all the flags.

The second function alters those format bits specified by 1s in *lMask*. The new values of those format bits are determined by the corresponding bits in *lFlags*. It returns a **long** that contains the previous value of all the flags.

Parameters

lFlags Format flag bit values. See the **flags** member function for a list of format flags. To combine these flags, use the bitwise OR (|) operator.

lMask Format flag bit mask.

See Also: ios::flags, ios::unsetf, ios setiosflags manipulator

---

ios::sync_with_stdio

static void sync_with_stdio();

Remarks

Synchronizes the C++ streams with the standard I/O system. The first time this function is called, it resets the predefined streams (**cin**, **cout**, **cerr**, **clog**) to use a **stdiobuf** object rather than a **filebuf** object. After that, you can mix I/O using these streams with I/O using **stdin**, **stdout**, and **stderr**. Expect some performance decrease because there is buffering both in the stream class and in the standard I/O file system.

After the call to **sync_with_stdio**, the **ios::stdio** bit is set for all affected predefined stream objects, and **cout** is set to unit buffered mode.

---

ios::tie

ostream* tie(ostream* *pos* **);**

ostream* tie() const;

Return Value

The first overloaded **tie** function ties this stream to the specified **ostream** and returns the value of the previous tie pointer or **NULL** if this stream was not previously tied. A stream tie enables automatic flushing of the **ostream** when more characters are needed, or there are characters to be consumed.

By default, **cin** is initially tied to **cout** so that attempts to get more characters from standard input may result in flushing standard output. In addition, **cerr** and **clog** are tied to **cout** by default.

The second function returns the value of the previous tie pointer or **NULL** if this stream was not previously tied.

Parameter

pos A pointer to an **ostream** object.

---

ios::unsetf

long unsetf(long *lFlags* **);**

Return Value

Clears the format flags specified by 1s in *lFlags*. It returns a **long** that contains the previous value of all the flags.

Parameter

lFlags Format flag bit values. See the **flags** member function for a list of format flags.

See Also: ios::flags, ios::setf, ios resetiosflags manipulator

---

ios::width

int width(int *nw* **);**

int width() const;

Return Value

The first overloaded **width** function sets the stream's internal field width variable to *nw*. When the width is 0 (the default), inserters insert only the number of characters necessary to represent the inserted value. When the width is not 0, the inserters pad the field with the stream's fill character, up to *nw*. If the unpadded representation of the field is larger than *nw*, the field is not truncated. Thus, *nw* is a minimum field width.

The internal width value is reset to 0 after each insertion or extraction.

The second overloaded **width** function returns the current value of the stream's width variable.

Parameter

nw The minimum field width in characters.

See Also: ios setw manipulator

ios::xalloc

static int xalloc();

Return Value

Provides extra **ios** object state variables without the need for class derivation. It does so by returning an index to an unused 32-bit word in an internal array. This index can subsequently be converted into a reference or pointer by using the **iword** or **pword** member functions.

Any call to **xalloc** invalidates values returned by previous calls to **iword** and **pword**.

ios::iword, ios::pword

Operators

ios::operator void*

operator void* () const;

An operator that converts a stream to a pointer that can be compared to 0.

Return Value

The conversion returns 0 if either **failbit** or **badbit** is set in the stream's error state.See **rdstate** for a description of the error state masks. A nonzero pointer is not meant to be dereferenced.

See Also: ios::good, ios::fail

---

ios::operator !

int operator !() const;

Return Value

Returns a nonzero value if either **failbit** or **badbit** is set in the stream's error state. See **rdstate** for a description of the error state masks.

See Also: ios::good, ios::fail

---

ios::adjustfield

static const long adjustfield;

Remarks

A mask for obtaining the padding flag bits (**left, right,** or **internal**).

Example

```
extern ostream os;
if( ( os.flags() & ios::adjustfield ) == ios::left ) .....
```

See Also: **ios::flags**

---

ios::basefield

static const long basefield;

Remarks

A mask for obtaining the current radix flag bits (**dec**, **oct**, or **hex**).

Example

```
extern ostream os;
if( ( os.flags() & ios::basefield ) == ios::hex ) .....
```

See Also: **ios::flags**

---

ios::floatfield

static const long floatfield;

Remarks

A mask for obtaining floating-point format flag bits (**scientific** or **fixed**).

Example

```
extern ostream os;
if( ( os.flags() & ios::floatfield ) == ios::scientific ) .....
```

See Also: **ios::flags**

Manipulators

ios& binary

binary

Remarks

Sets the stream's mode to binary. The default mode is text.

The stream must have an associated **filebuf** buffer.

See Also: **ios text manipulator**, **ofstream::setmode**, **ifstream::setmode**, **filebuf::setmode**

ios& dec

dec

Remarks

Sets the format conversion base to 10 (decimal).

See Also: ios hex manipulator, ios oct manipulator

---

ios& hex

hex

Remarks

Sets the format conversion base to 16 (hexadecimal).

See Also: ios dec manipulator, ios oct manipulator

---

ios& oct

oct

Remarks

Sets the format conversion base to 8 (octal).

See Also: ios dec manipulator, ios hex manipulator

---

resetiosflags

SMANIP(long) resetiosflags(long *lFlags* **);**

#include <iomanip.h>

Parameter

lFlags Format flag bit values. See the **flags** member function for a list of format flags. To combine these flags, use the OR (|) operator.

Remarks

This parameterized manipulator clears only the specified format flags. This setting remains in effect until you change it.

---

setfill

SMANIP(int) setfill(int *nFill* **);**

#include <iomanip.h>

Parameter

nFill The new fill character to be used as padding between fields.

Remarks

This parameterized manipulator sets the stream's fill character. The default is a space. This setting remains in effect until the next change.

---

setiosflags

SMANIP(long) setiosflags(long *lFlags* **);**

#include <iomanip.h>

Parameter

lFlags Format flag bit values. See the **flags** member function for a list of format flags. To combine these flags, use the OR (|) operator.

Remarks

This parameterized manipulator sets only the specified format flags. This setting remains in effect until the next change.

---

setprecision

SMANIP(int) setprecision(int *np* **);**

#include <iomanip.h>

Parameter

np An integer that indicates the number of significant digits or significant decimal digits to be used for floating-point display.

Remarks

This parameterized manipulator sets the stream's internal floating-point precision variable to *np*. The default precision is six digits. If the display format is scientific or fixed, then the precision indicates the number of digits after the decimal point. If the format is automatic (neither floating point nor fixed), then the precision indicates the total number of significant digits. This setting remains in effect until the next change.

---

setw

SMANIP(int) setw(int *nw* **);**

#include <iomanip.h>

Parameter

nw The field width in characters.

Remarks

This parameterized manipulator sets the stream's internal field width parameter. See the **width** member function for more information. This setting remains in effect only for the next insertion.

---

ios& text

text

Sets the stream's mode to text (the default mode).

Remarks

The stream must have an associated **filebuf** buffer.

See Also: ios binary manipulator, ofstream::setmode, ifstream::setmode, filebuf::setmode

---

class iostream

#include <iostream.h>

The **iostream** class provides the basic capability for sequential and random-access I/O. It inherits functionality from the **istream** and **ostream** classes.

The **iostream** class works in conjunction with classes derived from **streambuf** (for example, **filebuf**). In fact, most of the **iostream** "personality" comes from its attached **streambuf** class. You can use **iostream** objects for sequential disk I/O if you first construct an appropriate **filebuf** object. More often, you will use objects of classes **fstream** and **strstream**.

Derivation

For derivation suggestions, see the **istream** and **ostream** classes.

Public Members

iostream Constructs an **iostream** object that is attached to an existing **streambuf** object.

~iostream Destroys an **iostream** object.

Protected Members

iostream Acts as a **void**-argument **iostream** constructor.

See Also: istream, ostream, fstream, strstream, stdiostream

Member Functions

iostream::iostream

Public →

iostream(streambuf* *psb* **);**

END Public

Protected →

iostream( );

END Protected

Parameter

psb A pointer to an existing **streambuf** object (or an object of a derived class).

Remarks

Constructs an object of type **iostream**.

See Also: ios::init

---

iostream::~iostream

virtual ~iostream();

Remarks

Virtual destructor for the **iostream** class.

---

class Iostream_init

#include <iostream.h>

The **Iostream_init** class is a static class that initializes the predefined stream objects **cin**, **cout**, **cerr**, and **clog**. A single object of this class is constructed "invisibly" in response to any reference to the predefined objects. The class is documented for completeness only. You will not normally construct objects of this class.

Public Members

Iostream_init A constructor that initializes **cin**, **cout**, **cerr**, and **clog**.

~Iostream_init The destructor for the **Iostream_init** class.

Member Functions

Iostream_init::Iostream_init

Iostream_init();

Remarks

Iostream_init constructor that initializes **cin**, **cout**, **cerr**, and **clog**. For internal use only.

Iostream_init::~Iostream_init

~Iostream_init();

Remarks

Iostream_init destructor. For internal use only.

---

class istream

#include <iostream.h>

The **istream** class provides the basic capability for sequential and random-access input. An **istream** object has a **streambuf**-derived object attached, and the two classes work together; the **istream** class does the formatting, and the **streambuf** class does the low-level buffered input.

You can use **istream** objects for sequential disk input if you first construct an appropriate **filebuf** object. More often, you will use the predefined stream object **cin** (which is actually an object of class **istream_withassign**), or you will use objects of classes **ifstream** (disk file streams) and **istrstream** (string streams).

Derivation

It is not always necessary to derive from **istream** to add functionality to a stream; consider deriving from **streambuf** instead, as illustrated in "Deriving Your Own Stream Classes" on page 22. The **ifstream** and **istrstream** classes are examples of **istream**-derived classes that construct member objects of predetermined derived **streambuf** classes. You can add manipulators without deriving a new class.

If you add new extraction operators for a derived **istream** class, then the rules of C++ dictate that you must reimplement all the base class extraction operators. See the "Derivation" section of class **ostream** for an efficient reimplementation technique.

Construction/Destruction — Public Members

istream Constructs an **istream** object attached to an existing object of a **streambuf**-derived class.

~istream Destroys an **istream** object.

Prefix/Suffix Functions — Public Members

ipfx Check for error conditions prior to extraction operations (input prefix function).

isfx Called after extraction operations (input suffix function).

Input Functions — Public Members

get Extracts characters from the stream up to, but not including, delimiters.

getline Extracts characters from the stream (extracts and discards delimiters).

read Extracts data from the stream.

ignore Extracts and discards characters.

peek Returns a character without extracting it from the stream.

gcount Counts the characters extracted in the last unformatted operation.

eatwhite Extracts leading white space.

Other Functions — Public Members

putback Puts characters back to the stream.

sync Synchronizes the stream buffer with the external source of characters.

seekg Changes the stream's get pointer.

tellg Gets the value of the stream's get pointer.

Operators — Public Members

operator >> Extraction operator for various types.

Protected Members

istream Constructs an **istream** object.

Manipulators

ws Extracts leading white space.

See Also: streambuf, ifstream, istrstream, istream_withassign

---

Member Functions

istream::eatwhite

void eatwhite();

Remarks

Extracts white space from the stream by advancing the get pointer past spaces and tabs.

See Also: istream ws manipulator

---

istream::gcount

int gcount() const;

Remarks

Returns the number of characters extracted by the last unformatted input function. Formatted extraction operators may call unformatted input functions and thus reset this number.

See Also: istream::get, istream::getline, istream::ignore, istream::read

---

istream::get

int get();&

istream& get(char* *pch*, **int** *nCount*, **char** *delim* = **'\n');**

istream& get(unsigned char* *puch*, **int** *nCount*, **char** *delim* = **'\n');**

istream& get(signed char* *psch*, **int** *nCount*, **char** *delim* = **'\n');**

istream& get(char& *rch* **);**

istream& get(unsigned char& *ruch* **);**

istream& get(signed char& *rsch* **);**

istream& get(streambuf& *rsb*, **char** *delim* = **'\n');**

Parameters

pch, puch, psch A pointer to a character array.

nCount The maximum number of characters to store, including the terminating **NULL**.

delim The delimiter character (defaults to newline).

rch, ruch, rsch A reference to a character.

rsb A reference to an object of a **streambuf**-derived class.

Remarks

These functions extract data from an input stream as follows:

Variation	Description
get();	Extracts a single character from the stream and returns it.
get(char*, int, char);	Extracts characters from the stream until either *delim* is found, the limit *nCount* is reached, or the end of file is reached. The characters are stored in the array followed by a null terminator.
get(char&);	Extracts a single character from the stream and stores it as specified by the reference argument.
get(streambuf&, char);	Gets characters from the stream and stores them in a **streambuf** object until the delimiter is found or the end of the file is reached. The **ios::failbit** flag is set if the **streambuf** output operation fails.

In all cases, the delimiter is neither extracted from the stream nor returned by the function. The **getline** function, in contrast, extracts but does not store the delimiter.

See Also: istream::getline, istream::read, istream::ignore, istream::gcount

istream::getline

istream& getline(char* *pch*, **int** *nCount*, **char** *delim* = **'\n');**

istream& getline(unsigned char* *puch*, **int** *nCount*, **char** *delim* = **'\n');**

istream& getline(signed char* *psch*, **int** *nCount*, **char** *delim* = **'\n');**

Parameters

pch, puch, psch A pointer to a character array.

nCount The maximum number of characters to store, including the terminating **NULL**.

delim The delimiter character (defaults to newline).

Remarks

Extracts characters from the stream until either the delimiter *delim* is found, the limit *nCount*–1 is reached, or end of file is reached. The characters are stored in the specified array followed by a null terminator. If the delimiter is found, it is extracted but not stored.

The **get** function, in contrast, neither extracts nor stores the delimiter.

See Also: istream::get, istream::read

istream::ignore

istream& ignore(int *nCount* **= 1, int** *delim* **= EOF);**

Parameters

nCount The maximum number of characters to extract.

delim The delimiter character (defaults to **EOF**).

Remarks

Extracts and discards up to *nCount* characters. Extraction stops if the delimiter *delim* is extracted or the end of file is reached. If *delim* = **EOF** (the default), then only the end of file condition causes termination. The delimiter character is extracted.

---

istream::ipfx

int ipfx(int *need* **= 0);**

Return Value

A nonzero return value if the operation was successful; 0 if the stream's error state is nonzero, in which case the function does nothing.

Parameter

need Zero if called from formatted input functions; otherwise the minimum number of characters needed.

Remarks

This input prefix function is called by input functions prior to extracting data from the stream. Formatted input functions call **ipfx(0)**, while unformatted input functions usually call **ipfx(1)**.

Any **ios** object tied to this stream is flushed if *need* = 0 or if there are fewer than *need* characters in the input buffer. Also, **ipfx** extracts leading white space if **ios::skipws** is set.

See Also: istream::isfx

---

istream::isfx

void isfx();

Remarks

This input suffix function is called at the end of every extraction operation.

istream::istream

Public →

istream(streambuf* *psb* **);**

END Public

Protected →

istream( );

END Protected

Parameter

psb A pointer to an existing object of a **streambuf**-derived class.

Remarks

Constructs an object of type **istream**.

See Also: ios::init

---

istream::~istream

virtual ~istream();

Remarks

Virtual destructor for the **istream** class.

---

istream::peek

int peek();

Return Value

Returns the next character without extracting it from the stream. Returns **EOF** if the stream is at end of file or if the **ipfx** function indicates an error.

---

istream::putback

istream& putback(char *ch* **);**

Parameter

ch The character to put back; must be the character previously extracted.

Remarks

Puts a character back into the input stream. The **putback** function may fail and set the error state. If *ch* does not match the character that was previously extracted, the result is undefined.

istream::read

istream& read(char* *pch*, **int** *nCount* **);**

istream& read(unsigned char* *puch*, **int** *nCount* **);**

istream& read(signed char* *psch*, **int** *nCount* **);**

Parameters

pch, puch, psch A pointer to a character array.

nCount The maximum number of characters to read.

Remarks

Extracts bytes from the stream until the limit *nCount* is reached or until the end of file is reached. The **read** function is useful for binary stream input.

See Also: istream::get, istream::getline, istream::gcount, istream::ignore

---

istream::seekg

istream& seekg(streampos *pos* **);**

istream& seekg(streamoff *off*, **ios::seek_dir** *dir* **);**

Parameters

pos The new position value; **streampos** is a **typedef** equivalent to **long**.

off The new offset value; **streamoff** is a **typedef** equivalent to **long**.

dir The seek direction. Must be one of the following enumerators:

- **ios::beg** Seek from the beginning of the stream.
- **ios::cur** Seek from the current position in the stream.
- **ios::end** Seek from the end of the stream.

Remarks

Changes the get pointer for the stream. Not all derived classes of **istream** need support positioning; it is most often used with file-based streams.

See Also: istream::tellg, ostream::seekp, ostream::tellp

---

istream::sync

int sync();

Synchronizes the stream's internal buffer with the external source of characters.

Return Value

EOF to indicate errors.

Remarks

Synchronizes the stream's internal buffer with the external source of characters. This function calls the virtual **streambuf::sync** function so you can customize its implementation by deriving a new class from **streambuf**.

See Also: **streambuf::sync**

---

istream::tellg

streampos tellg();

Gets the value for the stream's **get** pointer.

Return Value

A **streampos** type, corresponding to a **long**.

See Also: **istream::seekg, ostream::tellp, ostream::seekp**

Operators

istream::operator >>

istream& operator >>(char* *psz* **);**

istream& operator >>(unsigned char* *pusz* **);**

istream& operator >>(signed char* *pssz* **);**

istream& operator >>(char& *rch* **);**

istream& operator >>(unsigned char& *ruch* **);**

istream& operator >>(signed char& *rsch* **);**

istream& operator >>(short& *s* **);**

istream& operator >>(unsigned short& *us* **);**

istream& operator >>(int& *n* **);**

istream& operator >>(unsigned int& *un* **);**

istream& operator >>(long& *l* **);**

istream& operator >>(unsigned long& *ul* **);**

istream& operator >>(float& *f* **);**

istream& operator >>(double& *d* **);**

istream& operator >>(long double& *ld* **);** (16-bit only)

istream& operator >>(streambuf* *psb* **);**

istream& operator >>(istream& (***fcn*****)(istream&));**

istream& operator >>(ios& (***fcn*****)(ios&));**

Remarks

These overloaded operators extract their argument from the stream. With the last two variations, you can use manipulators that are defined for both **istream** and **ios**.

Manipulators

istream& ws

ws

Remarks

Extracts leading white space from the stream by calling the **eatwhite** function.

See Also: istream::eatwhite

---

class istream_withassign

#include <iostream.h>

The **istream_withassign** class is a variant of **istream** that allows object assignment. The predefined object **cin** is an object of this class and thus may be reassigned at run time to a different **istream** object. For example, a program that normally expects input from **stdin** could be temporarily directed to accept its input from a disk file.

Predefined Objects

The **cin** object is a predefined object of class **ostream_withassign**. It is connected to **stdin** (standard input, file descriptor 0).

The objects **cin**, **cerr**, and **clog** are tied to **cout** so that use of any of these may cause **cout** to be flushed.

Construction/Destruction—Public Members

istream_withassign Constructs an **istream_withassign** object.

~istream_withassign Destroys an **istream_withassign** object.

Operators—Public Members

operator = Indicates an assignment operator.

See Also: **ostream_withassign**

Member Functions

istream_withassign::istream_withassign

istream_withassign(streambuf* *psb* **);**

istream_withassign();

Parameter

psb A pointer to an existing object of a **streambuf**-derived class.

Remarks

The first constructor creates a ready-to-use object of type **istream_withassign**, complete with attached **streambuf** object.

The second constructor creates an object but does not initialize it. You must subsequently use the second variation of the **istream_withassign** assignment operator to attach the **streambuf** object, or use the first variation to initialize this object to match the specified **istream** object.

See Also: **istream_withassign::operator =**

---

istream_withassign::~istream_withassign

~istream_withassign();

Remarks

Destructor for the **istream_withassign** class.

Operators

istream_withassign::operator =

istream& operator =(const istream& *ris* **);**

istream& operator =(streambuf* *psb* **);**

Remarks

The first overloaded assignment operator assigns the specified **istream** object to this **istream_withassign** object.

The second operator attaches a **streambuf** object to an existing **istream_withassign** object, and it initializes the state of the **istream_withassign** object. This operator is often used in conjunction with the **void**-argument constructor.

Example

```
char buffer[100];
class xistream; // A special-purpose class derived from istream
extern xistream xin; // An xistream object constructed elsewhere

cin = xin; // cin is reassigned to xin
cin >> buffer; // xin used instead of cin
```

Example

```
char buffer[100];
extern filedesc fd; // A file descriptor for an open file
filebuf fb( fd ); // Construct a filebuf attached to fd

cin = &fb;      // fb associated with cin
cin >> buffer; // cin now gets its intput from the fb file
```

See Also: **istream_withassign::istream_withassign**

class istrstream

#include <strstrea.h>

The **istrstream** class supports input streams that have character arrays as a source. You must allocate a character array before constructing an **istrstream** object. You can use **istream** operators and functions on this character data. A get pointer, working in the attached **strstreambuf** class, advances as you extract fields from the stream's array. Use **istream::seekg** to go backwards. If the get pointer reaches the end of the string (and sets the **ios::eof** flag), you must call **clear** before **seekg**.

Construction/Destruction—Public Members

istrstream Constructs an **istrstream** object.

~istrstream Destroys an **istrstream** object.

Other Functions—Public Members

rdbuf Returns a pointer to the stream's associated **strstreambuf** object.

str Returns a character array pointer to the string stream's contents.

See Also: **strstreambuf, streambuf, strstream, ostrstream**

Member Functions

istrstream::istrstream

istrstream(char* *psz* **);**

istrstream(char* *pch*, **int** *nLength* **);**

Parameters

psz A null-terminated character array (string).

pch A character array that is not necessarily null terminated.

nLength Size (in characters) of *pch*. If 0, then *pch* is assumed to point to a null-terminated array; if less than 0, then the array length is assumed to be unlimited.

Remarks

The first constructor uses the specified *psz* buffer to make an **istrstream** object with length corresponding to the string length.

The second constructor makes an **istrstream** object out of the first *nLength* characters of the *pch* buffer.

Both constructors automatically construct a **strstreambuf** object that manages the specified character buffer.

---

istrstream::~istrstream

~istrstream();

Remarks

Destroys an **istrstream** object and its associated **strstreambuf** object. The character buffer is not released because it was allocated by the user prior to **istrstream** construction.

---

istrstream::rdbuf

strstreambuf* rdbuf() const;

Return Value

Returns a pointer to the **strstreambuf** buffer object that is associated with this stream. Note that this is not the character buffer itself; the **strstreambuf** object contains a pointer to the character area.

See Also: istrstream::str

istrstream::str

char* str();

Return Value

Returns a pointer to the string stream's character array. This pointer corresponds to the array used to construct the **istrstream** object.

See Also: istrstream::istrstream

---

class ofstream

#include <fstream.h>

The **ofstream** class is an **ostream** derivative specialized for disk file output. All of its constructors automatically create and associate a **filebuf** buffer object.

The **filebuf** class documentation describes the get and put areas and their associated pointers. Only the put area and the put pointer are active for the **ofstream** class.

Construction/Destruction—Public Members

ofstream Constructs an **ofstream** object.

~ofstream Destroys an **ofstream** object.

Operations—Public Members

open Opens a file and attaches it to the **filebuf** object and thus to the stream.

close Flushes any waiting output and closes the stream's file.

setbuf Associates the specified reserve area to the stream's **filebuf** object.

setmode Sets the stream's mode to binary or text.

attach Attaches the stream (through the **filebuf** object) to an open file.

Status/Information—Public Members

rdbuf Gets the stream's **filebuf** object.

fd Returns the file descriptor associated with the stream.

is_open Tests whether the stream's file is open.

See Also: filebuf, streambuf, ifstream, fstream

Member Functions

ofstream::attach

void attach(filedesc *fd* **);**

Parameter

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**; **filedesc** is a **typedef** equivalent to **int**.

Remarks

Attaches this stream to the open file specified by *fd*. The function fails when the stream is already attached to a file. In that case, the function sets **ios::failbit** in the stream's error state.

See Also: filebuf::attach, ofstream::fd

---

ofstream::close

void close();

Remarks

Calls the **close** member function for the associated **filebuf** object. This function, in turn, flushes any waiting output, closes the file, and disconnects the file from the **filebuf** object. The **filebuf** object is not destroyed.

The stream's error state is cleared unless the call to **filebuf::close** fails.

See Also: filebuf::close, ofstream::open, ofstream::is_open

---

ofstream::fd

filedesc fd() const;

Return Value

Returns the file descriptor associated with the stream. **filedesc** is a **typedef** equivalent to **int**. Its value is supplied by the underlying file system.

See Also: filebuf::fd, ofstream::attach

ofstream::is_open

int is_open() const;

Return Value

Returns a nonzero value if this stream is attached to an open disk file identified by a file descriptor; otherwise 0.

See Also: filebuf::is_open, ofstream::open, ofstream::close

---

ofstream::ofstream

ofstream();

ofstream(const char* *szName*, **int** *nMode* **= ios::out, int** *nProt* **= filebuf::openprot);**

ofstream(filedesc *fd* **);**

ofstream(filedesc *fd*, **char*** *pch*, **int** *nLength* **);**

Parameters

szName The name of the file to be opened during construction.

nMode An integer that contains mode bits defined as **ios** enumerators that can be combined with the bitwise OR (|) operator. The *nMode* parameter must have one of the following values:

- **ios::app** The function performs a seek to the end of file. When new bytes are written to the file, they are always appended to the end, even if the position is moved with the **ostream::seekp** function.
- **ios::ate** The function performs a seek to the end of file. When the first new byte is written to the file, it is appended to the end, but when subsequent bytes are written, they are written to the current position.
- **ios::in** If this mode is specified, then the original file (if it exists) will not be truncated.
- **ios::out** The file is opened for output (implied for all **ofstream** objects).
- **ios::trunc** If the file already exists, its contents are discarded. This mode is implied if **ios::out** is specified and **ios::ate**, **ios::app**, and **ios:in** are not specified.
- **ios::nocreate** If the file does not already exist, the function fails.
- **ios::noreplace** If the file already exists, the function fails.
- **ios::binary** Opens the file in binary mode (the default is text mode).

nProt The file protection specification; defaults to the static integer **filebuf::openprot** that is equivalent to **filebuf::sh_compat**. The possible *nProt* values are:

- **filebuf::sh_compat** Compatibility share mode.
- **filebuf::sh_none** Exclusive mode; no sharing.
- **filebuf::sh_read** Read sharing allowed.
- **filebuf::sh_write** Write sharing allowed.

To combine the **filebuf::sh_read** and **filebuf::sh_write** modes, use the logical OR (||) operator.

fd A file descriptor as returned by a call to the run-time function **_open** or **_sopen**; **filedesc** is a **typedef** equivalent to **int**.

pch Pointer to a previously allocated reserve area of length *nLength*. A **NULL** value (or *nLength* = 0) indicates that the stream will be unbuffered.

nLength The length (in bytes) of the reserve area (0 = unbuffered).

Remarks

The four **ofstream** constructors are:

Constructor	Description
ofstream()	Constructs an **ofstream** object without opening a file.
ofstream(const char*, int, int)	Contructs an **ofstream** object, opening the specified file.
ofstream(filedesc)	Constructs an **ofstream** object that is attached to an open file.
ofstream(filedesc, char*, int)	Constructs an **ofstream** object that is associated with a **filebuf** object. The **filebuf** object is attached to an open file and to a specified reserve area.

All **ofstream** constructors construct a **filebuf** object. The first three use an internally allocated reserve area, but the fourth uses a user-allocated area. The user-allocated area is not automatically released during destruction.

---

ofstream::~ofstream

~ofstream();

Remarks

Flushes the buffer, then destroys an **ofstream** object along with its associated **filebuf** object. The file is closed only if was opened by the constructor or by the **open** member function.

The **filebuf** destructor releases the reserve buffer only if it was internally allocated.

ofstream::open

void open(const char* *szName*, **int** *nMode* **= ios::out, int** *nProt* **= filebuf::openprot);**

Parameters

szName The name of the file to be opened during construction.

nMode An integer containing mode bits defined as **ios** enumerators that can be combined with the OR (|) operator. See the **ofstream** constructor for a list of the enumerators. The **ios::out** mode is implied.

nProt The file protection specification; defaults to the static integer **filebuf::openprot**. See the **ofstream** constructor for a list of the other allowed values.

Remarks

Opens a disk file and attaches it to the stream's **filebuf** object. If the **filebuf** object is already attached to an open file, or if a **filebuf** call fails, the **ios::failbit** is set. If the file is not found, the **ios::failbit** is set only if the **ios::nocreate** mode was used.

See Also: filebuf::open, ofstream::ofstream, ofstream::close, ofstream::is_open

---

ofstream::rdbuf

filebuf* rdbuf() const;

Return Value

Returns a pointer to the **filebuf** buffer object that is associated with this stream. (Note that this is not the character buffer; the **filebuf** object contains a pointer to the character area.)

Example

```
extern ofstream ofs;
int fd = ofs.rdbuf()->fd(); // Get the file descriptor for ofs
```

---

ofstream::setbuf

streambuf* **setbuf(char*** *pch*, **int** *nLength* **);**

Attaches the specified reserve area to the stream's **filebuf** object.

Return Value

If the file is open and a buffer has already been allocated, the function returns **NULL**; otherwise it returns a pointer to the **filebuf** cast as a **streambuf**. The reserve area will not be released by the destructor.

Parameters

pch A pointer to a previously allocated reserve area of length *nLength*. A **NULL** value indicates an unbuffered stream.

nLength The length (in bytes) of the reserve area. A length of 0 indicates an unbuffered stream.

---

ofstream::setmode

int setmode(int *nMode* **= filebuf::text);**

Return Value

The previous mode; –1 if the parameter is invalid, the file is not open, or the mode cannot be changed.

Parameter

nMode An integer that must be one of the following static **filebuf** constants:

- **filebuf::text** Text mode (newline characters translated to and from carriage return/line feed pairs).
- **filebuf::binary** Binary mode (no translation).

Remarks

This function sets the binary/text mode of the stream's **filebuf** object. It may be called only after the file is opened.

See Also: ios binary manipulator, ios text manipulator

---

class ostream

#include <iostream.h>

The **ostream** class provides the basic capability for sequential and random-access output. An **ostream** object has a **streambuf**-derived object attached, and the two classes work together; the **ostream** class does the formatting, and the **streambuf** class does the low-level buffered output.

You can use **ostream** objects for sequential disk output if you first construct an appropriate **filebuf** object. (The **filebuf** class is derived from **streambuf**.) More often, you will use the predefined stream objects **cout**, **cerr**, and **clog** (actually objects of class **ostream_withassign**), or you will use objects of classes **ofstream** (disk file streams) and **ostrstream** (string streams).

All of the **ostream** member functions write unformatted data; formatted output is handled by the insertion operators.

Derivation

It is not always necessary to derive from **ostream** to add functionality to a stream; consider deriving from **streambuf** instead, as illustrated on page 22 in "Deriving Your Own Stream Classes." The **ofstream** and **ostrstream** classes are examples of **ostream**-derived classes that construct member objects of predetermined derived **streambuf** classes. You can add manipulators without deriving a new class.

If you add new insertion operators for a derived **ostream** class, then the rules of C++ dictate that you must reimplement all the base class insertion operators. If, however, you reimplement the operators through inline equivalence, no extra code will be generated.

Construction/Destruction—Public Members

ostream Constructs an **ostream** object that is attached to an existing **streambuf** object.

~ostream Destroys an **ostream** object.

Prefix/Suffix Functions—Public Members

opfx Output prefix function, called prior to insertion operations to check for error conditions, and so forth.

osfx Output suffix function, called after insertion operations; flushes the stream's buffer if it is unit buffered.

Unformatted Output—Public Members

put Inserts a single byte into the stream.

write Inserts a series of bytes into the stream.

Other Functions—Public Members

flush Flushes the buffer associated with this stream.

seekp Changes the stream's put pointer.

tellp Gets the value of the stream's put pointer.

Operators—Public Members

operator << Insertion operator for various types.

Manipulators

endl Inserts a newline sequence and flushes the buffer.

ends Inserts a null character to terminate a string.

flush Flushes the stream's buffer.

See Also: streambuf, ofstream, ostrstream, cout, cerr, clog

Example

```
class xstream : public ostream
{
public:
   // Constructors, etc.
   // ........
   inline xstream& operator << ( char ch ) // insertion for char
   {
      return (xstream&)ostream::operator << ( ch );
   }
   // ........
   // Insertions for other types
};
```

Member Functions

ostream::flush

ostream& flush();

Remarks

Flushes the buffer associated with this stream. The **flush** function calls the **sync** function of the associated **streambuf**.

See Also: ostream flush manipulator, streambuf::sync

ostream::opfx

int opfx();

Return Value

If the **ostream** object's error state is not 0, **opfx** returns 0 immediately; otherwise it returns a nonzero value.

Remarks

This output prefix function is called before every insertion operation. If another **ostream** object is tied to this stream, the **opfx** function flushes that stream.

ostream::osfx

void osfx();

Remarks

This output suffix function is called after every insertion operation. It flushes the **ostream** object if **ios::unitbuf** is set, or **stdout** and **stderr** if **ios::stdio** is set.

ostream::ostream

Public →

ostream(streambuf* *psb* **);**

END Public

Protected →

ostream( );

END Protected

Parameter

psb A pointer to an existing object of a **streambuf**-derived class.

Remarks

Constructs an object of type **ostream**.

See Also: ios::init

---

ostream::~ostream

virtual ~ostream();

Remarks

Destroys an **ostream** object. The output buffer is flushed as appropriate. The attached **streambuf** object is destroyed only if it was allocated internally within the **ostream** constructor.

---

ostream::put

ostream& put(char *ch* **);**

Parameter

ch The character to insert.

Remarks

This function inserts a single character into the output stream.

---

ostream::seekp

ostream& seekp(streampos *pos* **);**

ostream& seekp(streamoff *off*, **ios::seek_dir** *dir* **);**

Parameters

pos The new position value; **streampos** is a **typedef** equivalent to **long**.

off The new offset value; **streamoff** is a **typedef** equivalent to **long**.

dir The seek direction specified by the enumerated type **ios::seek_dir**, with values including:

- **ios::beg** Seek from the beginning of the stream.
- **ios::cur** Seek from the current position in the stream.
- **ios::end** Seek from the end of the stream.

Remarks

Changes the position value for the stream. Not all derived classes of **ostream** need support positioning. For file streams, the position is the byte offset from the beginning of the file; for string streams, it is the byte offset from the beginning of the string.

See Also: ostream::tellp, istream::seekg, istream::tellg

---

ostream::tellp

streampos tellp();

Return Value

A **streampos** type that corresponds to a **long**.

Remarks

Gets the position value for the stream. Not all derived classes of **ostream** need support positioning. For file streams, the position is the byte offset from the beginning of the file; for string streams, it is the byte offset from the beginning of the string. Gets the value for the stream's put pointer.

See Also: ostream::seekp, istream::tellg, istream::seekg

---

ostream::write

ostream& write(const char* *pch*, **int** *nCount* **);**

ostream& write(const unsigned char* *puch*, **int** *nCount* **);**

ostream& write(const signed char* *psch*, **int** *nCount* **);**

Parameters

pch, puch, psch A pointer to a character array.

nCount The number of characters to be written.

Remarks

Inserts a specified number of bytes from a buffer into the stream. If the underlying file was opened in text mode, additional carriage return characters may be inserted. The **write** function is useful for binary stream output.

Operators

ostream::operator <<

ostream& operator <<(char *ch* **);**

ostream& operator <<(unsigned char *uch* **);**

ostream& operator <<(signed char *sch* **);**

ostream& operator <<(const char* *psz* **);**

ostream& operator <<(const unsigned char* *pusz* **);**

ostream& operator <<(const signed char* *pssz* **);**

ostream& operator <<(short *s* **);**

ostream& operator <<(unsigned short *us* **);**

ostream& operator <<(int *n* **);**

ostream& operator <<(unsigned int *un* **);**

ostream& operator <<(long *l* **);**

ostream& operator <<(unsigned long *ul* **);**

ostream& operator <<(float *f* **);**

ostream& operator <<(double *d* **);**

ostream& operator <<(long double *ld* **);** (16-bit only)

ostream& operator <<(const void* *pv* **);**

ostream& operator <<(streambuf* *psb* **);**

ostream& operator <<(ostream& (* *fcn* **)(ostream&));**

ostream& operator <<(ios& (* *fcn* **)(ios&));**

Remarks

These overloaded operators insert their argument into the stream. With the last two variations, you can use manipulators that are defined for both **ostream** and **ios**.

Manipulators

ostream& endl

endl

Remarks

This manipulator, when inserted into an output stream, inserts a newline character and then flushes the buffer.

---

ostream& ends

ends

Remarks

This manipulator, when inserted into an output stream, inserts a null-terminator character. It is particularly useful for **ostrstream** objects.

---

ostream& flush

flush

Remarks

This manipulator, when inserted into an output stream, flushes the output buffer by calling the **streambuf::sync** member function.

See Also: **ostream::flush**, **streambuf::sync**

---

class ostream_withassign

#include <iostream.h>

The **ostream_withassign** class is a variant of **ostream** that allows object assignment. The predefined objects **cout**, **cerr**, and **clog** are objects of this class and thus may be reassigned at run time to a different **ostream** object. For example, a program that normally sends output to **stdout** could be temporarily directed to send its output to a disk file.

Predefined Objects

The three predefined objects of class **ostream_withassign** are connected as follows:

cout Standard output (file descriptor 1).

cerr Unit buffered standard error (file descriptor 2).

clog Fully buffered standard error (file descriptor 2).

Unit buffering, as used by **cerr**, means that characters are flushed after each insertion operation. The objects **cin**, **cerr**, and **clog** are tied to **cout** so that use of any of these will cause **cout** to be flushed.

Construction/Destruction — Public Members

ostream_withassign Constructs an **ostream_withassign** object.

~ostream_withassign Destroys an **ostream_withassign** object.

Operators — Public Members

operator = Assignment operator.

See Also: **istream_withassign**

Member Functions

ostream_withassign::ostream_withassign

ostream_withassign(streambuf* *psb* **);**

ostream_withassign();

Parameter

psb A pointer to an existing object of a **streambuf**-derived class.

Remarks

The first constructor makes a ready-to-use object of type **ostream_withassign**, with an attached **streambuf** object.

The second constructor makes an object but does not initialize it. You must subsequently use the **streambuf** assignment operator to attach the **streambuf** object, or use the **ostream** assignment operator to initialize this object to match the specified object.

See Also: **ostream_withassign::operator =**

---

ostream_withassign::~ostream_withassign

~ostream_withassign();

Remarks

Destructor for the **ostream_withassign** class.

Operators

ostream_withassign::operator =

ostream& operator =(const ostream&_os);

ostream& operator =(streambuf*_*sp*);

Remarks

The first overloaded assignment operator assigns the specified **ostream** object to this **ostream_withassign** object.

The second operator attaches a **streambuf** object to an existing **ostream_withassign** object, and initializes the state of the **ostream_withassign** object. This operator is often used in conjunction with the **void**-argument constructor.

Example

```
filebuf fb( "test.dat" ); // Filebuf object attached to "test.dat"
cout = &fb;          // fb associated with cout
cout << "testing"; // Message goes to "test.dat" instead of stdout
```

See Also: ostream_withassign::ostream_withassign, cout

---

class ostrstream

#include <strstrea.h>

The **ostrstream** class supports output streams that have character arrays as a destination. You can allocate a character array prior to construction, or the constructor can internally allocate an expandable array. You can then use all the **ostream** operators and functions to fill the array.

Be aware that there is a put pointer working behind the scenes in the attached **strstreambuf** class. This pointer advances as you insert fields into the stream's array. The only way you can make it go backward is to use the **ostream::seekp** function. If the put pointer reaches the end of user-allocated memory (and sets the **ios::eof** flag), you must call **clear** before **seekp**.

Construction/Destruction—Public Members

ostrstream Constructs an **ostrstream** object.

~ostrstream Destroys an **ostrstream** object.

Other Functions—Public Members

pcount Returns the number of bytes that have been stored in the stream's buffer.

rdbuf Returns a pointer to the stream's associated **strstreambuf** object.

str Returns a character array pointer to the string stream's contents and freezes the array.

See Also: **strstreambuf, streambuf, strstream, istrstream**

Member Functions

ostrstream::ostrstream

ostrstream();

ostrstream(char* *pch*, **int** *nLength*, **int** *nMode* **= ios::out);**

Parameters

pch A character array that is large enough to accommodate future output stream activity.

nLength The size (in characters) of *pch*. If 0, then *pch* is assumed to point to a null-terminated array and **strlen(** *pch* **)** is used as the length; if less than 0, the array is assumed to have infinite length.

nMode The stream-creation mode, which must be one of the following enumerators as defined in class **ios**:

- **ios::out** Default; storing begins at *pch*.
- **ios::ate** The *pch* parameter is assumed to be a null-terminated array; storing begins at the **NULL** character.
- **ios::app** Same as **ios::ate**.

Remarks

The first constructor makes an **ostrstream** object that uses an internal, dynamic buffer.

The second constructor makes an **ostrstream** object out of the first *nLength* characters of the *pch* buffer. The stream will not accept characters once the length reaches *nLength*.

---

ostrstream::~ostrstream

~ostrstream();

Remarks

Destroys an **ostrstream** object and its associated **strstreambuf** object, thus releasing all internally allocated memory. If you used the **void**-argument constructor, the internally allocated character buffer is released; otherwise, you must release it.

An internally allocated character buffer will not be released if it was previously frozen by an **str** or **strstreambuf::freeze** function call.

See Also: **ostrstream::str, strstreambuf::freeze**

ostrstream::pcount

int pcount() const;

Return Value

Returns the number of bytes stored in the buffer. This information is especially useful when you have stored binary data in the object.

---

ostrstream::rdbuf

strstreambuf* rdbuf() const;

Return Value

Returns a pointer to the **strstreambuf** buffer object that is associated with this stream. This is not the character buffer; the **strstreambuf** object contains a pointer to the character area.

See Also: ostrstream::str

---

ostrstream::str

char* str();

Return Value

Returns a pointer to the internal character array. If the stream was built with the **void**-argument constructor, **str** freezes the array. You must not send characters to a frozen stream, and you are responsible for deleting the array. You can, however, subsequently unfreeze the array by calling **rdbuf->freeze(0)**.

If the stream was built with the constructor that specified the buffer, the pointer contains the same address as the array used to construct the **ostrstream** object.

See Also: ostrstream::ostrstream, ostrstream::rdbuf, strstreambuf::freeze

---

class stdiobuf

#include <stdiostr.h>

The run-time library supports three conceptual sets of I/O functions: iostreams (C++ only), standard I/O (the functions declared in STDIO.H), and low-level I/O (the functions declared in IO.H). The **stdiobuf** class is a derived class of **streambuf** that is specialized for buffering to and from the standard I/O system.

Because the standard I/O system does its own internal buffering, the extra buffering level provided by **stdiobuf** may reduce overall input/output efficiency. The **stdiobuf** class is useful when you need to mix iostream I/O with standard I/O (**printf** and so forth).

You can avoid use of the **stdiobuf** class if you use the **filebuf** class. You must also use the stream class's **ios::flags** member function to set the **ios::stdio** format flag value.

Construction/Destruction—Public Members

stdiobuf Constructs a **stdiobuf** object from a **FILE** pointer.

~stdiobuf Destroys a **stdiobuf** object.

Other Functions—Public Members

stdiofile Gets the file that is attached to the **stdiofile** object.

See Also: **stdiostream**, **filebuf**, **strstreambuf**, **ios::flags**

Member Functions

stdiobuf::stdiobuf

stdiobuf(**FILE*** *fp* **);**

Parameter

fp A standard I/O file pointer (can be obtained through an **fopen** or **_fsopen** call).

Remarks

Objects of class **stdiobuf** are constructed from open standard I/O files, including **stdin**, **stdout**, and **stderr**. The object is unbuffered by default.

---

stdiobuf::~stdiobuf

~stdiobuf();

Remarks

Destroys a **stdiobuf** object and, in the process, flushes the put area. The destructor does not close the attached file.

---

stdiobuf::stdiofile

FILE* stdiofile();

Remarks

Returns the standard I/O file pointer associated with a **stdiobuf** object.

class stdiostream

#include <stdiostr.h>

The **stdiostream** class makes I/O calls (through the **stdiobuf** class) to the standard I/O system, which does its own internal buffering. Calls to the functions declared in STDIO.H, such as **printf**, can be mixed with **stdiostream** I/O calls.

This class is included for compatibility with earlier stream libraries. You can avoid use of the **stdiostream** class if you use the **ostream** or **istream** class with an associated **filebuf** class. You must also use the stream class's **ios::flags** member function to set the **ios::stdio** format flag value.

The use of the **stdiobuf** class may reduce efficiency because it imposes an extra level of buffering. Do not use this feature unless you need to mix iostream library calls with standard I/O calls for the same file.

Construction/Destruction—Public Members

stdiostream Constructs a **stdiostream** object that is associated with a standard I/O **FILE** pointer.

~stdiostream Destroys a **stdiostream** object (virtual).

Other Functions—Public Members

rdbuf Gets the stream's **stdiobuf** object.

See Also: stdiobuf, ios::flags

Member Functions

stdiostream::rdbuf

stdiobuf* rdbuf() const;

Return Value

Returns a pointer to the **stdiobuf** buffer object that is associated with this stream. The **rdbuf** function is useful when you need to call **stdiobuf** member functions.

stdiostream::stdiostream

stdiostream(FILE* *fp*);

Parameter

fp A standard I/O file pointer (can be obtained through an **fopen** or **_fsopen** call). Could be **stdin**, **stdout**, or **stderr**.

Remarks

Objects of class **stdiostream** are constructed from open standard I/O files. An unbuffered **stdiobuf** object is automatically associated, but the standard I/O system provides its own buffering.

Example

```
stdiostream myStream( stdout );
```

---

stdiostream::~stdiostream

~stdiostream();

Remarks

This destructor destroys the **stdiobuf** object associated with this stream; however, the attached file is not closed.

---

class streambuf

#include <iostream.h>

All the iostream classes in the **ios** hierarchy depend on an attached **streambuf** class for the actual I/O processing. This class is an abstract class, but the iostream class library contains the following derived buffer classes for use with streams:

- **filebuf** Buffered disk file I/O.
- **strstreambuf** Stream data held entirely within an in-memory byte array.
- **stdiobuf** Disk I/O with buffering done by the underlying standard I/O system.

All **streambuf** objects, when configured for buffered processing, maintain a fixed memory buffer, called a reserve area, that can be dynamically partitioned into a get area for input, and a put area for output. These areas may or may not overlap. With the protected member functions, you can access and manipulate a get pointer for character retrieval and a put pointer for character storage. The exact behavior of the buffers and pointers depends on the implementation of the derived class.

The capabilities of the iostream classes can be extended significantly through the derivation of new **streambuf** classes. The **ios** class tree supplies the programming interface and all formatting features, but the **streambuf** class does the real work. The **ios** classes call the **streambuf** public members, including a set of virtual functions.

The **streambuf** class provides a default implementation of certain virtual member functions. The "Default Implementation" section for each such function suggests function behavior for the derived class.

Character Input Functions—Public Members

in_avail Returns the number of characters in the get area.

sgetc Returns the character at the get pointer, but does not move the pointer.

snextc Advances the get pointer, then returns the next character.

sbumpc Returns the current character, and then advances the get pointer.

stossc Moves the get pointer forward one position, but does not return a character.

sputbackc Attempts to move the get pointer back one position.

sgetn Gets a sequence of characters from the **streambuf** object's buffer.

Character Output Functions—Public Members

out_waiting Returns the number of characters in the put area.

sputc Stores a character in the put area and advances the put pointer.

sputn Stores a sequence of characters in the **streambuf** object's buffer and advances the put pointer.

Construction/Destruction—Public Members

~streambuf Virtual destructor.

Diagnostic Functions—Public Members

dbp Prints buffer statistics and pointer values.

Virtual Functions—Public Members

sync Empties the get area and the put area.

setbuf Attempts to attach a reserve area to the **streambuf** object.

seekoff Seeks to a specified offset.

seekpos Seeks to a specified position.

overflow Empties the put area.

underflow Fills the get area if necessary.

pbackfail Augments the **sputbackc** function.

Construction/Destruction—Protected Members

streambuf Constructors for use in derived classes.

Other Protected Member Functions—Protected Members

base Returns a pointer to the start of the reserve area.

ebuf Returns a pointer to the end of the reserve area.

blen Returns the size of the reserve area.

pbase Returns a pointer to the start of the put area.

pptr Returns the put pointer.

epptr Returns a pointer to the end of the put area.

eback Returns the lower bound of the get area.

gptr Returns the get pointer.

egptr Returns a pointer to the end of the get area.

setp Sets all the put area pointers.

setg Sets all the get area pointers.

pbump Increments the put pointer.

gbump Increments the get pointer.

setb Sets up the reserve area.

unbuffered Tests or sets the **streambuf** buffer state variable.

allocate Allocates a buffer, if needed, by calling **doalloc**.

doallocate Allocates a reserve area (virtual function).

See Also: **streambuf::doallocate**, **streambuf::unbuffered**

Member Functions

streambuf::allocate

Protected →

int allocate();

END Protected

Return Value

Calls the virtual function **doallocate** to set up a reserve area. If a reserve area already exists or if the **streambuf** object is unbuffered, **allocate** returns 0. If the space allocation fails, **allocate** returns **EOF**.

See Also: **streambuf::doallocate**, **streambuf::unbuffered**

---

streambuf::base

Protected →

char* base() const

END Protected

Return Value

Returns a pointer to the first byte of the reserve area. The reserve area consists of space between the pointers returned by **base** and **ebuf**.

See Also: streambuf::ebuf, streambuf::setb, streambuf::blen

streambuf::blen

Protected →

int blen() const;

END Protected

Return Value

Returns the size, in bytes, of the reserve area.

See Also: streambuf::base, streambuf::ebuf, streambuf::setb

streambuf::dbp

void dbp();

Remarks

Writes ASCII debugging information directly on **stdout**. Treat this function as part of the protected interface.

Example

```
STREAMBUF DEBUG INFO: this = 00E7:09DC
base()=00E7:0A0C, ebuf()=00E7:0C0C,  blen()=512
eback()=0000:0000, gptr()=0000:0000, egptr()=0000:0000
pbase()=00E7:0A0C, pptr()=00E7:0A22, epptr()=00E7:0C0C
```

streambuf::doallocate

Protected →

virtual int doallocate();

END Protected

Return Value

Called by **allocate** when space is needed. The **doallocate** function must allocate a reserve area, then call **setb** to attach the reserve area to the **streambuf** object. If the reserve area allocation fails, **doallocate** returns **EOF**.

Remarks

By default, this function attempts to allocate a reserve area using operator **new**.

See Also: streambuf::allocate, streambuf::setb

streambuf::eback

Protected →

char* eback() const;

END Protected

Return Value

Returns the lower bound of the get area. Space between the **eback** and **gptr** pointers is available for putting a character back into the stream.

See Also: streambuf::sputbackc, streambuf::gptr

---

streambuf::ebuf

Protected →

char* ebuf() const;

END Protected

Return Value

Returns a pointer to the byte after the last byte of the reserve area. The reserve area consists of space between the pointers returned by **base** and **ebuf**.

See Also: streambuf::base, streambuf::setb, streambuf::blen

---

streambuf::egptr

Protected →

char* egptr() const;

END Protected

Return Value

Returns a pointer to the byte after the last byte of the get area.

See Also: streambuf::setg, streambuf::eback, streambuf::gptr

---

streambuf::epptr

Protected →

char* epptr() const;

END Protected

Return Value

Returns a pointer to the byte after the last byte of the put area.

See Also: streambuf::setp, streambuf::pbase, streambuf::pptr

streambuf::gbump

Protected →

void gbump(int *nCount* **);**

END Protected

Parameter

Count The number of bytes to increment the get pointer. May be positive or negative.

Remarks

Increments the get pointer. No bounds checks are made on the result.

See Also: streambuf::pbump

---

streambuf::gptr

Protected →

char* gptr() const;

END Protected

Return Value

Returns a pointer to the next character to be fetched from the **streambuf** buffer. This pointer is known as the get pointer.

See Also: streambuf::setg, streambuf::eback, streambuf::egptr

---

streambuf::in_avail

int in_avail() const;

Return Value

Returns the number of characters in the get area that are available for fetching. These characters are between the **gptr** and **egptr** pointers and may be fetched with a guarantee of no errors.

---

streambuf::out_waiting

int out_waiting() const;

Return Value

Returns the number of characters in the put area that have not been sent to the final output destination. These characters are between the **pbase** and **pptr** pointers.

streambuf::overflow

virtual int overflow(int *nCh* **= EOF) = 0;**

Return Value

EOF to indicate an error.

Parameter

nCh **EOF** or the character to output.

Remarks

The virtual **overflow** function, together with the **sync** and **underflow** functions, defines the characteristics of the **streambuf**-derived class. Each derived class might implement **overflow** differently, but the interface with the calling stream class is the same.

The **overflow** function is most frequently called by public **streambuf** functions like **sputc** and **sputn** when the put area is full, but other classes, including the stream classes, can call **overflow** anytime.

The function "consumes" the characters in the put area between the **pbase** and **pptr** pointers and then reinitializes the put area. The **overflow** function must also consume *nCh* (if *nCh* is not **EOF**), or it might choose to put that character in the new put area so that it will be consumed on the next call.

The definition of "consume" varies among derived classes. For example, the **filebuf** class writes its characters to a file, while the **strsteambuf** class keeps them in its buffer and (if the buffer is designated as dynamic) expands the buffer in response to a call to **overflow**. This expansion is achieved by freeing the old buffer and replacing it with a new, larger one. The pointers are adjusted as necessary.

Default Implementation

No default implementation. Derived classes must define this function.

See Also: streambuf::pbase, streambuf::pptr, streambuf::setp, streambuf::sync, streambuf::underflow

---

streambuf::pbackfail

virtual int pbackfail(int *nCh* **);**

Return Value

The *nCh* parameter if successful; otherwise **EOF**.

Parameter

nCh The character used in a previous **sputbackc** call.

Remarks

This function is called by **sputbackc** if it fails, usually because the **eback** pointer equals the **gptr** pointer. The **pbackfail** function should deal with the situation, if possible, by such means as repositioning the external file pointer.

Default implementation

Returns EOF.

See Also: streambuf::sputbackc

---

streambuf::pbase

Protected →

char* pbase() const;

END Protected

Return Value

Returns a pointer to the start of the put area. Characters between the **pbase** pointer and the **pptr** pointer have been stored in the buffer but not flushed to the final output destination.

See Also: streambuf::pptr, streambuf::setp, streambuf::out_waiting

---

streambuf::pbump

Protected →

void pbump(int *nCount* **);**

END Protected

Parameter

nCount The number of bytes to increment the put pointer. May be positive or negative.

Remarks

Increments the put pointer. No bounds checks are made on the result.

See Also: streambuf::gbump, streambuf::setp

---

streambuf::pptr

Protected →

char* pptr() const;

END Protected

Return Value

Returns a pointer to the first byte of the put area. This pointer is known as the put pointer and is the destination for the next character(s) sent to the **streambuf** object.

See Also: **streambuf::epptr**, **streambuf::pbase**, **streambuf::setp**

---

streambuf::sbumpc

int sbumpc();

Return Value

Returns the current character, then advances the get pointer. Returns **EOF** if the get pointer is currently at the end of the sequence (equal to the **egptr** pointer).

See Also: **streambuf::epptr**, **streambuf::gbump**

---

streambuf::seekoff

virtual streampos seekoff(streamoff *off*, **ios::seek_dir** *dir*, **int** *nMode* **= ios::in | ios::out);**

Return Value

The new position value. This is the byte offset from the start of the file (or string). If both **ios::in** and **ios::out** are specified, the function returns the output position. If the derived class does not support positioning, the function returns **EOF**.

Parameters

off The new offset value; **streamoff** is a **typedef** equivalent to **long**.

dir One of the following seek directions specified by the enumerated type **seek_dir**:

- **ios::beg** Seek from the beginning of the stream.
- **ios::cur** Seek from the current position in the stream.
- **ios::end** Seek from the end of the stream.

nMode An integer that contains a bitwise OR (|) combination of the enumerators **ios::in** and **ios::out**.

Remarks

Changes the position for the **streambuf** object. Not all derived classes of **streambuf** need to support positioning; however, the **filebuf**, **strstreambuf**, and **stdiobuf** classes do support positioning.

Classes derived from **streambuf** often support independent input and output position values. The *nMode* parameter determines which value(s) is set.

Default Implementation

Returns EOF.

See Also: **streambuf::seekpos**

---

streambuf::seekpos

virtual streampos seekpos(streampos *pos*, **int** *nMode* **= ios::in | ios::out);**

Return Value

The new position value. If both **ios::in** and **ios::out** are specified, the function returns the output position. If the derived class does not support positioning, the function returns **EOF**.

Parameters

pos The new position value; **streampos** is a **typedef** equivalent to **long**.

nMode An integer that contains mode bits defined as **ios** enumerators that can be combined with the OR (|) operator. See **ofstream::ofstream** for a listing of the enumerators.

Remarks

Changes the position, relative to the beginning of the stream, for the **streambuf** object. Not all derived classes of **streambuf** need to support positioning; however, the **filebuf**, **strstreambuf**, and **stdiobuf** classes do support positioning.

Classes derived from **streambuf** often support independent input and output position values. The *nMode* parameter determines which value(s) is set.

Default Implementation

Calls **seekoff((streamoff)** *pos*, **ios::beg,** *nMode*). Thus, to define seeking in a derived class, it is usually necessary to redefine only **seekoff**.

See Also: **streambuf::seekoff**

---

streambuf::setb

Protected →

void setb(char* *pb*, **char*** *peb*, **int** *nDelete* **= 0);**

END Protected

Parameters

pb The new value for the base pointer.

peb The new value for the **ebuf** pointer.

nDelete Flag that controls automatic deletion. If *nDelete* is not 0, the reserve area will be deleted when: (1) the base pointer is changed by another **setb** call, or (2) the **streambuf** destructor is called.

Remarks

Sets the values of the reserve area pointers. If both *pb* and *peb* are **NULL**, there is no reserve area. If *pb* is not **NULL** and *peb* is **NULL**, the reserve area has a length of 0.

See Also: **streambuf::base**, **streambuf::ebuf**

---

streambuf::setbuf

virtual streambuf* setbuf(char* *pr*, int *nLength*);

Return Value

A **streambuf** pointer if the buffer is accepted; otherwise **NULL**.

Parameters

pr A pointer to a previously allocated reserve area of length *nLength*. A **NULL** value indicates an unbuffered stream.

nLength The length (in bytes) of the reserve area. A length of 0 indicates an unbuffered stream.

Remarks

Attaches the specified reserve area to the **streambuf** object. Derived classes may or may not use this area.

Default Implementation

Accepts the request if there is not a reserved area already.

---

streambuf::setg

Protected →

void setg(char* *peb*, char* *pg*, char* *peg*);

END Protected

Parameters

peb The new value for the **eback** pointer.

pg The new value for the **gptr** pointer.

peg The new value for the **egptr** pointer.

Remarks

Sets the values for the get area pointers.

See Also: **streambuf::eback**, **streambuf::gptr**, **streambuf::egptr**

streambuf::setp

Protected →

void setp(char* *pp*, **char*** *pep* **);**

END Protected

Parameters

pp The new value for the **pbase** and **pptr** pointers.

pep The new value for the **epptr** pointer.

Remarks

Sets the values for the put area pointers.

See Also: streambuf::pptr, streambuf::pbase, streambuf::epptr

---

streambuf::sgetc

int sgetc();

Remarks

Returns the character at the get pointer. The **sgetc** function does not move the get pointer. Returns **EOF** if there is no character available.

See Also: streambuf::sbumpc, streambuf::sgetn, streambuf::snextc, streambuf::stossc

---

streambuf::sgetn

int sgetn(char* *pch*, **int** *nCount* **);**

Return Value

The number of characters fetched.

Parameters

pch A pointer to a buffer that will receive characters from the **streambuf** object.

nCount The number of characters to get.

Remarks

Gets the *nCount* characters that follow the get pointer and stores them in the area starting at *pch*. When fewer than *nCount* characters remain in the **streambuf** object, **sgetn** fetches whatever characters remain. The function repositions the get pointer to follow the fetched characters.

See Also: streambuf::sbumpc, streambuf::sgetc, streambuf::snextc, streambuf::stossc

streambuf::snextc

int snextc();

Return Value

First tests the get pointer, then returns **EOF** if it is already at the end of the get area. Otherwise, it moves the get pointer forward one character and returns the character that follows the new position. It returns **EOF** if the pointer has been moved to the end of the get area.

See Also: streambuf::sbumpc, streambuf::sgetc, streambuf::sgetn, streambuf::stossc

---

streambuf::sputbackc

int sputbackc(char *ch* **);**

Return Value

EOF on failure.

Parameter

ch The character to be put back to the **streambuf** object.

Remarks

Moves the get pointer back one character. The *ch* character must match the character just before the get pointer.

See Also: streambuf::sbumpc, streambuf::pbackfail

---

streambuf::sputc

int sputc(int *nCh* **);**

Return Value

The number of characters successfully stored; **EOF** on error.

Parameter

nCh The character to store in the **streambuf** object.

Remarks

Stores a character in the put area and advances the put pointer.

This public function is available to code outside the class, including the classes derived from **ios**. A derived **streambuf** class can gain access to its buffer directly by using protected member functions.

See Also: streambuf::sputn

streambuf::sputn

int sputn(const char* *pch*, **int** *nCount* **);**

Return Value

The number of characters stored. This number is usually *nCount* but could be less if an error occurs.

Parameters

pch A pointer to a buffer that contains data to be copied to the **streambuf** object.

nCount The number of characters in the buffer.

Remarks

Copies *nCount* characters from *pch* to the **streambuf** buffer following the put pointer. The function repositions the put pointer to follow the stored characters.

See Also: streambuf::sputc

---

streambuf::stossc

void stossc();

Remarks

Moves the get pointer forward one character. If the pointer is already at the end of the get area, the function has no effect.

See Also: streambuf::sbumpc, streambuf::sgetn, streambuf::snextc, streambuf::sgetc

---

streambuf::streambuf

Protected →

streambuf();
streambuf(char* *pr*, **int** *nLength* **);**

END Protected

Parameters

pr A pointer to a previously allocated reserve area of length *nLength*. A **NULL** value indicates an unbuffered stream.

nLength The length (in bytes) of the reserve area. A length of 0 indicates an unbuffered stream.

Remarks

The first constructor makes an uninitialized **streambuf** object. This object is not suitable for use until a **setbuf** call is made. A derived class constructor usually calls **setbuf** or uses the second constructor.

The second constructor initializes the **streambuf** object with the specified reserve area or marks it as unbuffered.

See Also: streambuf::setbuf

---

streambuf::~streambuf

Protected →

virtual ~streambuf();

END Protected

Remarks

The **streambuf** destructor flushes the buffer if the stream is being used for output.

---

streambuf::sync

virtual int sync();

Return Value

EOF if an error occurs.

Remarks

The virtual **sync** function, with the **overflow** and **underflow** functions, defines the characteristics of the **streambuf**-derived class. Each derived class might implement **sync** differently, but the interface with the calling stream class is the same.

The **sync** function flushes the put area. It also empties the get area and, in the process, sends any unprocessed characters back to the source, if necessary.

Default Implementation

Returns 0 if the get area is empty and there are no more characters to output; otherwise, it returns **EOF**.

See Also: streambuf::overflow

---

streambuf::unbuffered

Protected →

void unbuffered(int *nState* **);**
int unbuffered() const;

END Protected

Parameter

nState The value of the buffering state variable; 0 = buffered, nonzero = unbuffered.

Remarks

The first overloaded **unbuffered** function sets the value of the **streambuf** object's buffering state. This variable's primary purpose is to control whether the **allocate** function automatically allocates a reserve area.

The second function returns the current buffering state variable.

See Also: streambuf::allocate, streambuf::doallocate

---

streambuf::underflow

mfvirtual int underflow() = 0;

Remarks

The virtual **underflow** function, with the **sync** and **overflow** functions, defines the characteristics of the **streambuf**-derived class. Each derived class might implement **underflow** differently, but the interface with the calling stream class is the same.

The **underflow** function is most frequently called by public **streambuf** functions like **sgetc** and **sgetn** when the get area is empty, but other classes, including the stream classes, can call **underflow** anytime.

The **underflow** function supplies the get area with characters from the input source. If the get area contains characters, **underflow** returns the first character. If the get area is empty, it fills the get area and returns the next character (which it leaves in the get area). If there are no more characters available, then **underflow** returns **EOF** and leaves the get area empty.

In the **strstreambuf** class, **underflow** adjusts the **egptr** pointer to access storage that was dynamically allocated by a call to **overflow**.

Default Implementation

No default implementation. Derived classes must define this function.

---

class strstream

#include <strstrea.h>

The **strstream** class supports I/O streams that have character arrays as a source and destination. You can allocate a character array prior to construction, or the constructor can internally allocate a dynamic array. You can then use all the input and output stream operators and functions to fill the array.

Be aware that a put pointer and a get pointer are working independently behind the scenes in the attached **strstreambuf** class. The put pointer advances as you insert fields into the stream's array, and the get pointer advances as you extract fields. The **ostream::seekp** function moves the put pointer, and the **istream::seekg** function moves the get pointer. If either pointer reaches the end of the string (and sets the **ios::eof** flag), you must call **clear** before seeking.

Construction/Destruction—Public Members

strstream Constructs a **strstream** object.

~strstream Destroys a **strstream** object.

Other Functions—Public Members

pcount Returns the number of bytes that have been stored in the stream's buffer.

rdbuf Returns a pointer to the stream's associated **strstreambuf** object.

str Returns a pointer to the string stream's character buffer and freezes it.

See Also: **strstreambuf, streambuf, istrstream, ostrstream**

Member Functions

strstream::pcount

int pcount() const;

Return Value

Returns the number of bytes stored in the buffer. This information is especially useful when you have stored binary data in the object.

---

strstream::rdbuf

strstreambuf* rdbuf() const;

Return Value

Returns a pointer to the **strstreambuf** buffer object that is associated with this stream. This is not the character buffer; the **strstreambuf** object contains a pointer to the character area.

See Also: **strstream::str**

strstream::str

char* str();

Return Value

Returns a pointer to the internal character array. If the stream was built with the **void**-argument constructor, then **str** freezes the array. You must not send characters to a frozen stream, and you are responsible for deleting the array. You can unfreeze the the stream by calling **rdbuf->freeze(0)**.

If the stream was built with the constructor that specified the buffer, the pointer contains the same address as the array used to construct the **ostrstream** object.

See Also: strstreambuf::freeze, strstream::rdbuf

---

strstream::strstream

strstream();

strstream(char* *pch*, **int** *nLength*, **int** *nMode* **);**

Parameters

pch A character array that is large enough to accommodate future output stream activity.

nLength The size (in characters) of *pch*. If 0, *pch* is assumed to point to a null-terminated array; if less than 0, the array is assumed to have infinite length.

nMode The stream creation mode, which must be one of the following enumerators as defined in class **ios**:

- **ios::in** Retrieval begins at the beginning of the array.
- **ios::out** By default, storing begins at *pch*.
- **ios::ate** The *pch* parameter is assumed to be a null-terminated array; storing begins at the **NULL** character.
- **ios::app** Same as **ios::ate**.

The use of the **ios::in** and **ios::out** flags is optional for this class; both input and output are implied.

Remarks

The first constructor makes an **strstream** object that uses an internal, dynamic buffer that is initially empty.

The second constructor makes an **strstream** object out of the first *nLength* characters of the *psc* buffer. The stream will not accept characters once the length reaches *nLength*.

strstream::~strstream

~strstream();

Remarks

Destroys a **strstream** object and its associated **strstreambuf** object, thus releasing all internally allocated memory. If you used the **void**-argument constructor, the internally allocated character buffer is released; otherwise, you must release it.

An internally allocated character buffer will not be released if it was previously frozen by calling **rdbuf->freeze(0)**.

See Also: **strstream::rdbuf**

class strstreambuf

#include <strstrea.h>

The **strstreambuf** class is a derived class of **streambuf** that manages an in-memory character array.

The file stream classes, **ostrstream**, **istrstream**, and **strstream**, use **strstreambuf** member functions to fetch and store characters. Some of these member functions are virtual functions defined for the **streambuf** class.

The reserve area, put area, and get area were introduced in the **streambuf** class description. For **strsteambuf** objects, the put area is the same as the get area, but the **get** pointer and the **put** pointer move independently.

Construction/Destruction—Public Members

strstreambuf Constructs a **strstreambuf** object.

~strstreambuf Destroys a strstreambuf object.

Other Functions—Public Members

freeze Freezes a stream.

str Returns a pointer to the string.

See Also: **istrstream, ostrstream, filebuf, stdiobuf**

Member Functions

strstreambuf::freeze

void freeze(int *n* **= 1);**

Parameter

n A 0 value permits automatic deletion of the current array and its automatic growth (if it is dynamic); a nonzero value prevents deletion.

Remarks

If a **strstreambuf** object has a dynamic array, memory is usually deleted on destruction and size adjustment. The **freeze** function provides a way to prevent that automatic deletion. Once an array is frozen, no further input or output is permitted. The results of such operations are undefined.

The **freeze** function can also unfreeze a frozen buffer.

See Also: strstreambuf::str

---

strstreambuf::str

char* str();

Return Value

Returns a pointer to the object's internal character array. If the **strstreambuf** object was constructed with a user-supplied buffer, that buffer address is returned. If the object has a dynamic array, **str** freezes the array. You must not send characters to a frozen **strstreambuf** object, and you are responsible for deleting the array. If a dynamic array is empty, then **str** returns **NULL**.

Use the **freeze** function with a 0 parameter to unfreeze a **strstreambuf** object.

See Also: strstreambuf::freeze

---

strstreambuf::strstreambuf

strstreambuf();

strstreambuf(int *nBytes* **);**

strstreambuf(char* *pch*, **int** *n*, **char*** *pstart* **= 0);**

strstreambuf(unsigned char* *puch*, **int n, unsigned char*** *pustart* **= 0);**

strstreambuf(signed char* *psch*, **int** *n*, **signed char*** *psstart* **= 0);**

strstreambuf(void* (* *falloc*)(**long), void (*** *ffree*)(**void***));**

Parameters

nBytes The initial length of a dynamic stream buffer.

pch, puch, psch A pointer to a character buffer that will be attached to the object. The **get** pointer is initialized to this value.

n One of the following integer parameters:

- positive *n* bytes, starting at *pch*, is used as a fixed-length stream buffer.
- 0 The *pch* parameter points to the start of a null-terminated string that constitutes the stream buffer (terminator excluded).
- negative The *pch* parameter points to a stream buffer that continues indefinitely.
- *pstart, pustart, psstart* The initial value of the **put** pointer.

falloc A memory-allocation function with the prototype **void*** **falloc(long)**. The default is **new**.

ffree A function that frees allocated memory with the prototype **void ffree(void*)**. The default is **delete**.

Remarks

The four **streambuf** constructors are described as follows:

Constructor	Description
strstreambuf()	Constructs an empty **strstreambuf** object with dynamic buffering. The buffer is allocated internally by the class and grows as needed, unless it is frozen.
strstreambuf(int)	Constructs an empty **strstreambuf** object with a dynamic buffer *n* bytes long to start with. The buffer is allocated internally by the class and grows as needed, unless it is frozen.
strstreambuf(char*, int, char*)	Constructs a **strstreambuf** object from already-allocated memory as specified by the arguments. There are constructor variations for both unsigned and signed character arrays.
strstreambuf(void*(*), void(*))	Constructs an empty **strstreambuf** object with dynamic buffering. The *falloc* function is called for allocation. The **long** parameter specifies the buffer length and the function returns the buffer address. If the *falloc* pointer is **NULL**, operator **new** is used. The *ffree* function frees memory allocated by *falloc*. If the *ffree* pointer is **NULL**, the operator **delete** is used.

strstreambuf::~strstreambuf

~strstreambuf();

Remarks

Destroys a **strstreambuf** object and releases internally allocated dynamic memory unless the object is frozen. The destructor does not release user-allocated memory.

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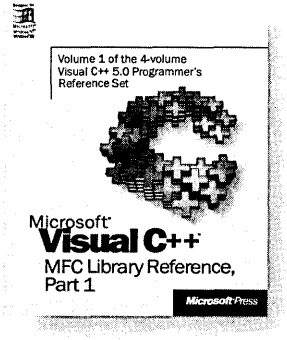

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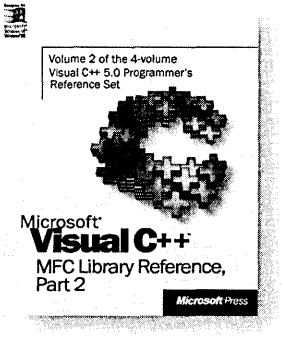

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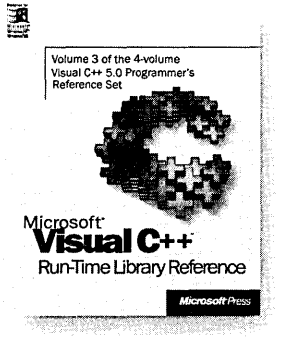

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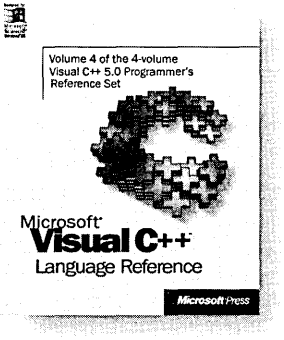

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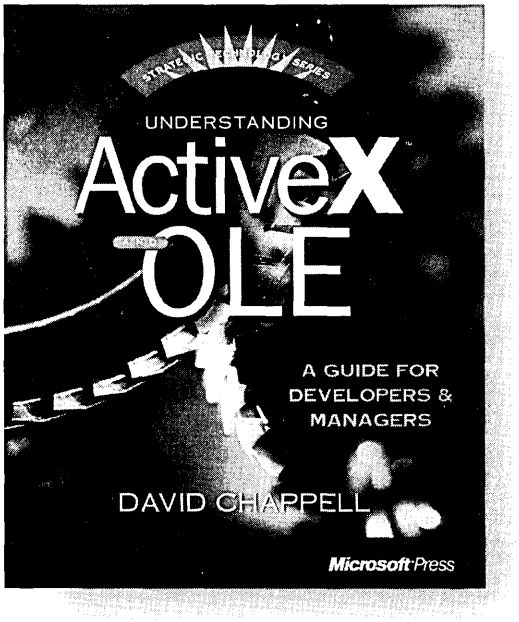

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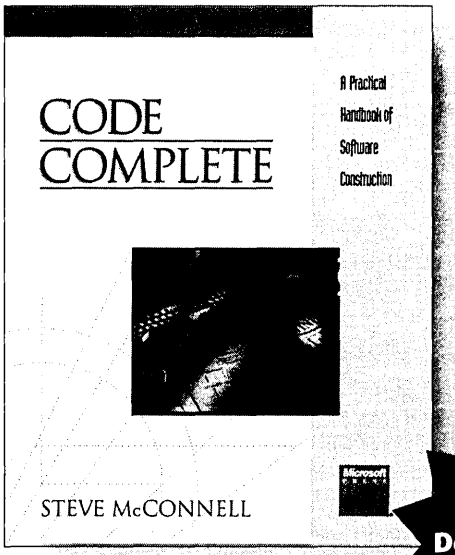

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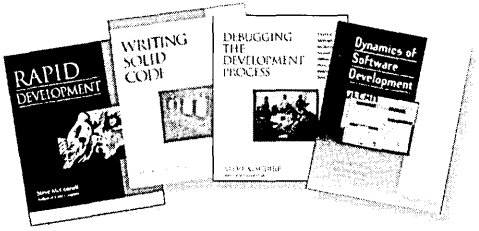

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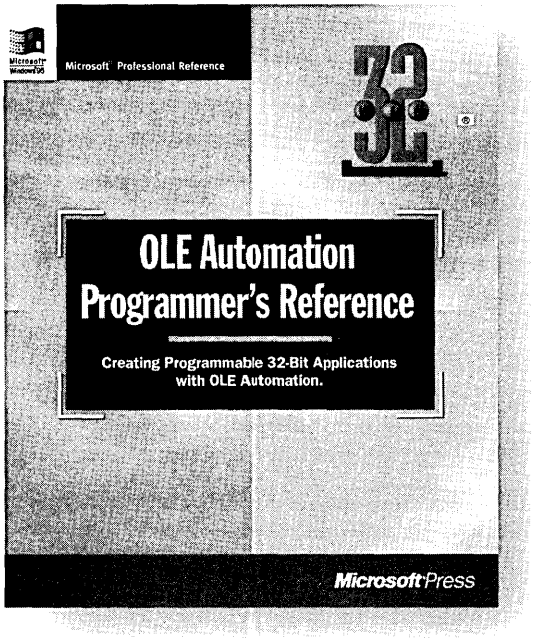

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Introduction

The Microsoft run-time library provides routines for programming for the Microsoft Windows NT and Windows 95 operating systems. These routines automate many common programming tasks that are not provided by the C and C++ languages.

C Run-Time Libraries

The following table lists the release versions of the C run-time library files, along with their associated compiler options and environment variables. Prior to Visual C++ 4.2, the C run-time libraries contained the iostream library functions. In Visual C++ 4.2, the old iostream library functions have been removed from LIBC.LIB, LIBCMT.LIB, and MSVCRT.LIB. (This change was made because the Standard C++ library has been added to Visual C++, and it contains a new set of iostream libraries. Thus, two sets of iostream functions are now included in Visual C++.) The old iostream functions now exist in their own libraries: LIBCI.LIB, LIBCIMT.LIB, and MSVCIRT.LIB. The new iostream functions, as well as many other new functions, exist in the Standard C++ libraries: LIBCP.LIB, LIBCPMT.LIB, and MSVCPRT.LIB.

The Standard C++ library and the old iostream library are incompatible, and only one of them can be linked with your project. See "Port to the Standard C++ Library" and the "Standard C++ Library Overview" for details.

When you build a release version of your project, one of the basic C run-time libraries (LIBC.LIB, LIBCMT.LIB, and MSVCRT.LIB) is linked by default, depending on the compiler option you choose (single-threaded, multithreaded, or DLL). Depending on the headers you use in your code, a library from the Standard C++ libraries or one from the old iostream libraries may also be linked:

- If you include a "Standard C++ library header" in your code, a Standard C++ library will be linked in automatically by Visual C++ at compile time. For example:

```
#include <ios>
```

- If you include an "old iostream library header" an old iostream library will be linked in automatically by Visual C++ at compile time. For example:

```
#include <ios.h>
```

Note that headers from the Standard C++ library and the old iostream library cannot be mixed.

Headers determine whether a Standard C++ library, an old iostream library, or neither will be linked. Compiler options determine which of the libraries to be linked is the default (single-threaded, multithreaded, or DLL). When a specific library compiler option is defined, that library is considered to be the default and its environment variables are automatically defined.

C Run-Time Library (without iostream)	Characteristics	Option	Defined
LIBC.LIB	Single threaded, static link	/ML	
LIBCMT.LIB	Multithreaded, static link	/MT	_MT
MSVCRT.LIB	Multithreaded, dynamic link (import library for MSVCRT.DLL)	/MD	_MT, _DLL
Standard C++ Library	**Characteristics**	**Option**	**Defined**
LIBCP.LIB	Single threaded, static link	/ML	
LIBCPMT.LIB	Multithreaded, static link	/MT	_MT
MSVCPRT.LIB	Multithreaded, dynamic link (import library for MSVCRT.DLL)	/MD	_MT, _DLL
Old Iostream Library	**Characteristics**	**Option**	**Defined**
LIBCI.LIB	Single threaded, static link	/ML	
LIBCIMT.LIB	Multithreaded, static link	/MT	_MT
MSVCIRT.LIB	Multithreaded, dynamic link (import library for MSVCIRT.DLL)	/MD	_MT, _DLL

To build a debug version of your application, the **_DEBUG** flag must be defined and the application must be linked with a debug version of one of these libraries. For more information about using the debug versions of the library files, see "C Run-Time Debug Libraries."

Building the Run-Time Libraries

There are two batch files provided for building the C run-time libraries from the source code included with Visual C++:

- \Program Files\DevStudio\Vc\CRT\SRC\BLDWIN95.BAT, used when building on Windows 95
- \Program Files\DevStudio\Vc\CRT\SRC\BLDNT.CMD, used when building on Windows NT

When using either BLDNT.CMD or BLDWIN95.BAT, set the V5TOOLS environment variable to the root of the Visual C++ installation (such as C:\Program Files\DevStudio \Vc\Bin). If this environment variable is not set, an error message will be displayed and the batch file will exit.

Compatibility

The Microsoft run-time library supports American National Standards Institute (ANSI) C and UNIX C. In this book, references to UNIX include XENIX, other UNIX-like systems, and the POSIX subsystem in Windows NT and Windows 95. The description of each run-time library routine in this book includes a compatibility section for these targets: ANSI, Windows 95 (listed as Win 95), and Windows NT (Win NT). All run-time library routines included with this product are compatible with the Win 32 API.

ANSI C Compliance

The naming convention for all Microsoft-specific identifiers in the run-time system (such as functions, macros, constants, variables, and type definitions) is ANSI-compliant. In this book, any run-time function that follows the ANSI/ISO C standards is noted as being ANSI compatible. ANSI-compliant applications should only use these ANSI compatible functions.

The names of Microsoft-specific functions and global variables begin with a single underscore. These names can be overridden only locally, within the scope of your code. For example, when you include Microsoft run-time header files, you can still locally override the Microsoft-specific function named **_open** by declaring a local variable of the same name. However, you cannot use this name for your own global function or global variable.

The names of Microsoft-specific macros and manifest constants begin with two underscores, or with a single leading underscore immediately followed by an uppercase letter. The scope of these identifiers is absolute. For example, you cannot use the Microsoft-specific identifier **_UPPER** for this reason.

UNIX

If you plan to transport your programs to UNIX, follow these guidelines:

- Do not remove header files from the SYS subdirectory. You can place the SYS header files elsewhere only if you do not plan to transport your programs to UNIX.
- Use the UNIX-compatible path delimiter in routines that take strings representing paths and filenames as arguments. UNIX supports only the forward slash (/) for this purpose, whereas Win 32 operating systems support both the backslash (\) and the forward slash (/). Thus this book uses UNIX-compatible forward slashes as path delimiters in **#include** statements, for example. (However, the Windows NT and Windows 95 command shell, CMD.EXE, does not support the forward slash in commands entered at the command prompt.)
- Use paths and filenames that work correctly in UNIX, which is case sensitive. The file allocation table (FAT) file system in Win 32 operating systems is not case sensitive; the installable Windows NT file system (NTFS) of Windows NT preserves case for directory listings but ignores case in file searches and other system operations.

Note In this version of Visual C++, UNIX compatibility information has been removed from the function descriptions.

Win32 Platforms

The C run-time libraries support Windows 95 and Windows NT, but not Win 32s. Windows 95 and Windows NT support the Win32 Application Programming Interface (API), but only Windows NT provides full Unicode support. In addition, any Win 32 application can use a multibyte character set (MBCS).

Backward Compatibility

The compiler views a structure that has both an old name and a new name as two different types. You cannot copy from an old structure type to a new structure type. Old prototypes that take **struct** pointers use the old **struct** names in the prototype.

For compatibility with Microsoft C professional development system version 6.0 and earlier Microsoft C versions, the library OLDNAMES.LIB maps old names to new names. For instance, **open** maps to **_open**. You must explicitly link with OLDNAMES.LIB only when you compile with the following combinations of command-line options:

- /Zl (omit default library name from object file) and /Ze (the default—use Microsoft extensions)

- /link (linker-control), /NOD (no default-library search), and /Ze

For more information about compiler command-line options, see "Compiler Reference" in the *Visual C++ Programmer's Guide*.

Required and Optional Header Files

The description of each run-time routine in this book includes a list of the required and optional include, or header (.H), files for that routine. Required header files need to be included to obtain the function declaration for the routine or a definition used by another routine called internally. Optional header files are usually included to take advantage of predefined constants, type definitions, or inline macros. The following table lists some examples of optional header file contents:

Definition	Example
Macro definition	If a library routine is implemented as a macro, the macro definition may be in a header file other than the header file for the original routine. For instance, the **toupper** macro is defined in the header file CTYPE.H, while the function **toupper** is declared in STDLIB.H.
Manifest constant	Many library routines refer to constants that are defined in header files. For instance, the **_open** routine uses constants such as **_O_CREAT**, which is defined in the header file FCNTL.H.
Type definition	Some library routines return a structure or take a structure as an argument. For example, stream input/output routines use a structure of type **FILE**, which is defined in STDIO.H.

The run-time library header files provide function declarations in the ANSI/ISO C standard recommended style. The compiler performs "type checking" on any routine reference that occurs after its associated function declaration. Function declarations are especially important for routines that return a value of some type other than **int**, which is the default. Routines that do not specify their appropriate return value in their declaration will be considered by the compiler to return an **int**, which can cause unexpected results. See "Type Checking" for more information.

Choosing Between Functions and Macros

Most Microsoft run-time library routines are compiled or assembled functions, but some routines are implemented as macros. When a header file declares both a function and a macro version of a routine, the macro definition takes precedence, because it always appears after the function declaration. When you invoke a routine that is implemented as both a function and a macro, you can force the compiler to use the function version in two ways:

- Enclose the routine name in parentheses.

```
#include <ctype.h>
a = toupper(a);     //use macro version of toupper
a = (toupper)(a);   //force compiler to use function version of toupper
```

- "Undefine" the macro definition with the **#undef** directive:

```
#include <ctype.h>
#undef toupper
```

If you need to choose between a function and a macro implementation of a library routine, consider the following trade-offs:

- Speed versus size. The main benefit of using macros is faster execution time. During preprocessing, a macro is expanded (replaced by its definition) inline each time it is used. A function definition occurs only once regardless of how many times it is called. Macros may increase code size but do not have the overhead associated with function calls.
- Function evaluation. A function evaluates to an address; a macro does not. Thus you cannot use a macro name in contexts requiring a pointer. For instance, you can declare a pointer to a function, but not a pointer to a macro.
- Macro side effects. A macro may treat arguments incorrectly when the macro evaluates its arguments more than once. For instance, the **toupper** macro is defined as:

```
#define toupper(c) ( (islower(c)) ? _toupper(c) :  (c) )
```

  In the following example, the **toupper** macro produces a side effect:

```
#include <ctype.h>

int a = 'm';
a = toupper(a++);
```

  The example code increments `a` when passing it to **toupper**. The macro evaluates the argument `a++` twice, once to check case and again for the result, therefore increasing `a` by 2 instead of 1. As a result, the value operated on by **islower** differs from the value operated on by **toupper**.
- Type-checking. When you declare a function, the compiler can check the argument types. Because you cannot declare a macro, the compiler cannot check macro argument types, although it can check the number of arguments you pass to a macro.

Type Checking

The compiler performs limited type checking on functions that can take a variable number of arguments, as follows:

Function Call	Type-Checked Arguments
_cprintf, _cscanf, printf, scanf	First argument (format string)
fprintf, fscanf, sprintf, sscanf	First two arguments (file or buffer and format string)
_snprintf	First three arguments (file or buffer, count, and format string)
_open	First two arguments (path and **_open** flag)
_sopen	First three arguments (path, **_open** flag, and sharing mode)
_execl, _execle, _execlp, _execlpe	First two arguments (path and first argument pointer)
_spawnl, _spawnle, _spawnlp, _spawnlpe	First three arguments (mode flag, path, and first argument pointer)

The compiler performs the same limited type checking on the wide-character counterparts of these functions.

CHAPTER 1

Run-Time Routines by Category

This chapter lists and describes Microsoft run-time library routines by category. For reference convenience, some routines are listed in more than one category. Multibyte-character routines and wide-character routines are grouped with single-byte-character counterparts, where they exist.

The main categories of Microsoft run-time library routines are:

Argument access
Buffer manipulation
Byte classification
Character classification
Data conversion
Debug
Directory control
Error handling
Exception handling
File handling
Floating-point support
Input and output
Internationalization
Memory allocation
Process and environment control
Searching and sorting
String manipulation
System calls
Time management

Argument Access

The **va_arg**, **va_end**, and **va_start** macros provide access to function arguments when the number of arguments is variable. These macros are defined in STDARG.H for ANSI C compatibility, and in VARARGS.H for compatibility with UNIX System V.

Argument-Access Macros

Macro	Use
va_arg	Retrieve argument from list
va_end	Reset pointer
va_start	Set pointer to beginning of argument list

Buffer Manipulation

Use these routines to work with areas of memory on a byte-by-byte basis.

Buffer-Manipulation Routines

Routine	Use
_memccpy	Copy characters from one buffer to another until given character or given number of characters has been copied
memchr	Return pointer to first occurrence, within specified number of characters, of given character in buffer
memcmp	Compare specified number of characters from two buffers
memcpy	Copy specified number of characters from one buffer to another
_memicmp	Compare specified number of characters from two buffers without regard to case
memmove	Copy specified number of characters from one buffer to another
memset	Use given character to initialize specified number of bytes in the buffer
_swab	Swap bytes of data and store them at specified location

When the source and target areas overlap, only **memmove** is guaranteed to copy the full source properly.

Byte Classification

Each of these routines tests a specified byte of a multibyte character for satisfaction of a condition. Except where specified otherwise, the test result depends on the multibyte code page currently in use.

Note By definition, the ASCII character set is a subset of all multibyte-character sets. For example, the Japanese katakana character set includes ASCII as well as non-ASCII characters.

The manifest constants in the following table are defined in CTYPE.H:

Multibyte-Character Byte-Classification Routines

Routine	Byte Test Condition
isleadbyte	Lead byte; test result depends on **LC_CTYPE** category setting of current locale
_ismbbalnum	**isalnum** || **_ismbbkalnum**
_ismbbalpha	**isalpha** || **_ismbbkalnum**
_ismbbgraph	Same as **_ismbbprint**, but **_ismbbgraph** does not include the space character (0x20)
_ismbbkalnum	Non-ASCII text symbol other than punctuation. For example, in code page 932 only, **_ismbbkalnum** tests for katakana alphanumeric
_ismbbkana	Katakana (0xA1–0xDF), code page 932 only
_ismbbkprint	Non-ASCII text or non-ASCII punctuation symbol. For example, in code page 932 only, **_ismbbkprint** tests for katakana alphanumeric or katakana punctuation (range: 0xA1– 0xDF).
_ismbbkpunct	Non-ASCII punctuation. For example, in code page 932 only, **_ismbbkpunct** tests for katakana punctuation.
_ismbblead	First byte of multibyte character. For example, in code page 932 only, valid ranges are 0x81–0x9F, 0xE0–0xFC.
_ismbbprint	**isprint** || **_ismbbkprint**. **ismbbprint** includes the space character (0x20)
_ismbbpunct	**ispunct** || **_ismbbkpunct**
_ismbbtrail	Second byte of multibyte character. For example, in code page 932 only, valid ranges are 0x40–0x7E, 0x80–0xEC.
_ismbslead	Lead byte (in string context)
_ismbstrail	Trail byte (in string context)
_mbbtype	Return byte type based on previous byte
_mbsbtype	Return type of byte within string

The **MB_LEN_MAX** macro, defined in LIMITS.H, expands to the maximum length in bytes that any multibyte character can have. **MB_CUR_MAX**, defined in STDLIB.H, expands to the maximum length in bytes of any multibyte character in the current locale.

Character Classification

Each of these routines tests a specified single-byte character, wide character, or multibyte character for satisfaction of a condition. (By definition, the ASCII character set is a subset of all multibyte-character sets. For example, Japanese katakana includes ASCII as well as non-ASCII characters.) Generally these routines execute faster than tests you might write. For example, the following code executes slower than a call to **isalpha**(*c*):

```
if ((c >= 'A') && (c <= 'Z')) || ((c >= 'a') && (c <= 'z'))
   return TRUE;
```

Character-Classification Routines

Routine	Character Test Condition
isalnum, iswalnum, _ismbcalnum	Alphanumeric
isalpha, iswalpha, _ismbcalpha	Alphabetic
__isascii, iswascii	ASCII
iscntrl, iswcntrl	Control
__iscsym	Letter, underscore, or digit
__iscsymf	Letter or underscore
isdigit, iswdigit, _ismbcdigit	Decimal digit
isgraph, iswgraph, _ismbcgraph	Printable other than space
islower, iswlower, _ismbclower	Lowercase
_ismbchira	Hiragana
_ismbckata	Katakana
_ismbclegal	Legal multibyte character
_ismbcl0	Japan-level 0 multibyte character
_ismbcl1	Japan-level 1 multibyte character
_ismbcl2	Japan-level 2 multibyte character
_ismbcsymbol	Non-alphanumeric multibyte character
isprint, iswprint, _ismbcprint	Printable
ispunct, iswpunct, _ismbcpunct	Punctuation
isspace, iswspace, _ismbcspace	White-space
isupper, iswupper, _ismbcupper	Uppercase
iswctype	Property specified by *desc* argument
isxdigit, iswxdigit	Hexadecimal digit
mblen	Return length of valid multibyte character; result depends on **LC_CTYPE** category setting of current locale

Data Conversion

These routines convert data from one form to another. Generally these routines execute faster than conversions you might write. Each routine that begins with a **to** prefix is implemented as a function and as a macro. See "Choosing Between Functions and Macros" on page xiii for information about choosing an implementation.

Data-Conversion Routines

Routine	Use
abs	Find absolute value of integer
atof	Convert string to **float**

Data-Conversion Routines *(continued)*

Routine	Use
atoi, _atoi64	Convert string to **int**
atol	Convert string to **long**
_ecvt	Convert **double** to string of specified length
_fcvt	Convert **double** to string with specified number of digits following decimal point
_gcvt	Convert **double** number to string; store string in buffer
_itoa, _i64toa, _itow, _i64tow	Convert **int** to string
labs	Find absolute value of **long** integer
_ltoa, _ltow	Convert **long** to string
_mbbtombc	Convert 1-byte multibyte character to corresponding 2-byte multibyte character
_mbcjistojms	Convert Japan Industry Standard (JIS) character to Japan Microsoft (JMS) character
_mbcjmstojis	Convert JMS character to JIS character
_mbctohira	Convert multibyte character to 1-byte hiragana code
_mbctokata	Convert multibyte character to 1-byte katakana code
_mbctombb	Convert 2-byte multibyte character to corresponding 1-byte multibyte character
mbstowcs	Convert sequence of multibyte characters to corresponding sequence of wide characters
mbtowc	Convert multibyte character to corresponding wide character
strtod, wcstod	Convert string to **double**
strtol, wcstol	Convert string to **long** integer
strtoul, wcstoul	Convert string to **unsigned long** integer
strxfrm, wcsxfrm	Transform string into collated form based on locale-specific information
__toascii	Convert character to ASCII code
tolower, towlower, _mbctolower	Test character and convert to lowercase if currently uppercase
_tolower	Convert character to lowercase unconditionally
toupper, towupper, _mbctoupper	Test character and convert to uppercase if currently lowercase
_toupper	Convert character to uppercase unconditionally
_ultoa, _ultow	Convert **unsigned long** to string
wcstombs	Convert sequence of wide characters to corresponding sequence of multibyte characters

(continued)

Data-Conversion Routines *(continued)*

Routine	Use
wctomb	Convert wide character to corresponding multibyte character
_wtoi	Convert wide-character string to **int**
_wtol	Convert wide-character string to **long**

Debug Routines

With this version, Visual C++ introduces debug support for the C run-time library. The new debug version of the library supplies many diagnostic services that make debugging programs easier and allow developers to:

- Step directly into run-time functions during debugging
- Resolve assertions, errors, and exceptions
- Trace heap allocations and prevent memory leaks
- Report debug messages to the user

To use these routines, the **_DEBUG** flag must be defined. All of these routines do nothing in a retail build of an application.

Debug Versions of the C Run-time Library Routines

Routine	Use
_ASSERT	Evaluate an expression and generates a debug report when the result is FALSE
_ASSERTE	Similar to **_ASSERT**, but includes the failed expression in the generated report
_CrtCheckMemory	Confirm the integrity of the memory blocks allocated on the debug heap
_CrtDbgReport	Generate a debug report with a user message and send the report to three possible destinations
_CrtDoForAllClientObjects	Call an application-supplied function for all **_CLIENT_BLOCK** types on the heap
_CrtDumpMemoryLeaks	Dump all of the memory blocks on the debug heap when a significant memory leak has occurred
_CrtIsValidHeapPointer	Verify that a specified pointer is in the local heap
_CrtIsMemoryBlock	Verify that a specified memory block is located within the local heap and that it has a valid debug heap block type identifier

Debug Versions of the C Run-time Library Routines ***(continued)***

Routine	Use
_CrtIsValidPointer	Verify that a specified memory range is valid for reading and writing
_CrtMemCheckpoint	Obtain the current state of the debug heap and store it in an application-supplied **_CrtMemState** structure
_CrtMemDifference	Compare two memory states for significant differences and return the results
_CrtMemDumpAllObjectsSince	Dump information about objects on the heap since a specified checkpoint was taken or from the start of program execution
_CrtMemDumpStatistics	Dump the debug header information for a specified memory state in a user-readable form
_CrtSetAllocHook	Install a client-defined allocation function by hooking it into the C run-time debug memory allocation process
_CrtSetBreakAlloc	Set a breakpoint on a specified object allocation order number
_CrtSetDbgFlag	Retrieve or modify the state of the **_crtDbgFlag** flag to control the allocation behavior of the debug heap manager
_CrtSetDumpClient	Install an application-defined function that is called every time a debug dump function is called to dump **_CLIENT_BLOCK** type memory blocks
_CrtSetReportFile	Identify the file or stream to be used as a destination for a specific report type by **_CrtDbgReport**
_CrtSetReportHook	Install a client-defined reporting function by hooking it into the C run-time debug reporting process
_CrtSetReportMode	Specify the general destination(s) for a specific report type generated by **_CrtDbgReport**
_RPT[0,1,2,3,4]	Track the application's progress by generating a debug report by calling **_CrtDbgReport** with a format string and a variable number of arguments. Provides no source file and line number information.
_RPTF[0,1,2,3,4]	Similar to the **_RPT*n*** macros, but provides the source file name and line number where the report request originated
_calloc_dbg	Allocate a specified number of memory blocks on the heap with additional space for a debugging header and overwrite buffers
_expand_dbg	Resize a specified block of memory on the heap by expanding or contracting the block

(continued)

Debug Versions of the C Run-time Library Routines *(continued)*

Routine	Use
_free_dbg	Free a block of memory on the heap
_malloc_dbg	Allocate a block of memory on the heap with additional space for a debugging header and overwrite buffers
_msize_dbg	Calculate the size of a block of memory on the heap
_realloc_dbg	Reallocate a specified block of memory on the heap by moving and/or resizing the block

The debug routines can be used to step through the source code for most of the other C run-time routines during the debugging process. However, Microsoft considers some technology to be proprietary and, therefore, does not provide the source code for these routines. Most of these routines belong to either the exception handling or floating-point processing groups, but a few others are included as well. The following table lists these routines:

C Run-time Routines that are Not Available in Source Code Form

acos	**_fpclass**	**_nextafter**
asin	**_fpieee_flt**	**pow**
atan, atan2	**_fpreset**	**printf, wprintf**[1]
_cabs	**frexp**	**_scalb**
ceil	**_hypot**	**scanf, wscanf**[1]
_chgsign	**_isnan**	**setjmp**
_clear87, _clearfp	**_j0**	**sin**
_control87, _controlfp	**_j1**	**sinh**
_copysign	**_jn**	**sqrt**
cos	**ldexp**	**_status87, _statusfp**
cosh	**log**	**tan**
exp	**log10**	**tanh**
fabs	**_logb**	**_y0**
_finite	**longjmp**	**_y1**
floor	**_matherr**	**_yn**
fmod	**modf**	

[1] Although source code is available for most of this routine, it makes an internal call to another routine for which source code is not provided.

Some C run-time functions and C++ operators behave differently when called from a debug build of an application. (Note that a debug build of an application can be done by either defining the **_DEBUG** flag or by linking with a debug version of the C run-time library.) The behavioral differences usually consist of extra features or information provided by the routine to support the debugging process. The following table lists these routines:

Routines that Behave Differently in a Debug Build of an Application

C **abort** routine	C++ **delete** operator
C **assert** routine	C++ **new** operator

For more information about using the debug versions of the C++ operators in the preceding table, see "Using the Debug Heap from C++."

Directory Control

These routines access, modify, and obtain information about the directory structure.

Directory-Control Routines

Routine	Use
_chdir, _wchdir	Change current working directory
_chdrive	Change current drive
_getcwd, _wgetcwd	Get current working directory for default drive
_getdcwd, _wgetdcwd	Get current working directory for specified drive
_getdrive	Get current (default) drive
_mkdir, _wmkdir	Make new directory
_rmdir, _wrmdir	Remove directory
_searchenv, _wsearchenv	Search for given file on specified paths

Error Handling

Use these routines to handle program errors.

Error-Handling Routines

Routine	Use
assert macro	Test for programming logic errors; available in both the release and debug versions of the run-time library
_ASSERT, _ASSERTE macros	Similar to **assert**, but only available in the debug versions of the run-time library
clearerr	Reset error indicator. Calling **rewind** or closing a stream also resets the error indicator.
_eof	Check for end of file in low-level I/O
feof	Test for end of file. End of file is also indicated when **_read** returns 0.
ferror	Test for stream I/O errors
_RPT, _RPTF macros	Generate a report similar to **printf**, but only available in the debug versions of the run-time library

Exception Handling Routines

Use the C++ exception-handling functions to recover from unexpected events during program execution.

Exception-Handling Functions

Function	Use
_set_se_translator	Handle Win32 exceptions (C structured exceptions) as C++ typed exceptions
set_terminate	Install your own termination routine to be called by **terminate**
set_unexpected	Install your own termination function to be called by **unexpected**
terminate	Called automatically under certain circumstances after exception is thrown. The **terminate** function calls **abort** or a function you specify using **set_terminate**
unexpected	Calls **terminate** or a function you specify using **set_unexpected**. The **unexpected** function is not used in current Microsoft C++ exception-handling implementation

File Handling

Use these routines to create, delete, and manipulate files and to set and check file-access permissions.

The C run-time libraries have a preset limit for the number of files that can be open at any one time. The limit for applications that link with the single-thread static library (LIBC.LIB) is 64 file handles or 20 file streams. Applications that link with either the static or dynamic multithread library (LIBCMT.LIB or MSVCRT.LIB and MSVCRT.DLL), have a limit of 256 file handles or 40 file streams. Attempting to open more than the maximum number of file handles or file streams causes program failure.

The following routines operate on files designated by a file handle:

File-Handling Routines (File Handle)

Routine	Use
_chsize	Change file size
_filelength	Get file length
_fstat, _fstati64	Get file-status information on handle
_isatty	Check for character device
_locking	Lock areas of file
_setmode	Set file-translation mode

The following routines operate on files specified by a path or filename:

File-Handling Routines (Path or Filename)

Routine	Use
_access, _waccess	Check file-permission setting
_chmod, _wchmod	Change file-permission setting
_fullpath, _wfullpath	Expand a relative path to its absolute path name
_get_osfhandle	Return operating-system file handle associated with existing stream **FILE** pointer
_makepath, _wmakepath	Merge path components into single, full path
_mktemp, _wmktemp	Create unique filename
_open_osfhandle	Associate C run-time file handle with existing operating-system file handle
remove, _wremove	Delete file
rename, _wrename	Rename file
_splitpath, _wsplitpath	Parse path into components
_stat, _stati64, _wstat, _wstati64	Get file-status information on named file
_umask	Set default permission mask for new files created by program
_unlink, _wunlink	Delete file

Floating-Point Support

Many Microsoft run-time library functions require floating-point support from a math coprocessor or from the floating-point libraries that accompany the compiler. Floating-point support functions are loaded only if required.

When you use a floating-point type specifier in the format string of a call to a function in the **printf** or **scanf** family, you must specify a floating-point value or a pointer to a floating-point value in the argument list to tell the compiler that floating-point support is required. The math functions in the Microsoft run-time library handle exceptions the same way that the UNIX V math functions do.

The Microsoft run-time library sets the default internal precision of the math coprocessor (or emulator) to 64 bits. This default applies only to the internal precision at which all intermediate calculations are performed; it does not apply to the size of arguments, return values, or variables. You can override this default and set the chip (or emulator) back to 80-bit precision by linking your program with LIB/FP10.OBJ. On the linker command line, FP10.OBJ must appear before LIBC.LIB, LIBCMT.LIB, or MSVCRT.LIB.

Floating-Point Functions

Routine	Use
abs	Return absolute value of **int**
acos	Calculate arccosine
asin	Calculate arcsine
atan, atan2	Calculate arctangent
atof	Convert character string to double-precision floating-point value
Bessel functions	Calculate Bessel functions **_j0, _j1, _jn, _y0, _y1, _yn**
_cabs	Find absolute value of complex number
ceil	Find integer ceiling
_chgsign	Reverse sign of double-precision floating-point argument
_clear87, _clearfp	Get and clear floating-point status word
_control87, _controlfp	Get old floating-point control word and set new control-word value
_copysign	Return one value with sign of another
cos	Calculate cosine
cosh	Calculate hyperbolic cosine
difftime	Compute difference between two specified time values
div	Divide one integer by another, returning quotient and remainder
_ecvt	Convert **double** to character string of specified length
exp	Calculate exponential function
fabs	Find absolute value
_fcvt	Convert **double** to string with specified number of digits following decimal point
_finite	Determine whether given double-precision floating-point value is finite
floor	Find largest integer less than or equal to argument
fmod	Find floating-point remainder
_fpclass	Return status word containing information on floating-point class
_fpieee_flt	Invoke user-defined trap handler for IEEE floating-point exceptions
_fpreset	Reinitialize floating-point math package
frexp	Calculate exponential value
_gcvt	Convert floating-point value to character string
_hypot	Calculate hypotenuse of right triangle
_isnan	Check given double-precision floating-point value for not a number (NaN)
labs	Return absolute value of **long**
ldexp	Calculate product of argument and 2 to specified power

Floating-Point Functions ***(continued)***

Routine	Use
ldiv	Divide one **long** integer by another, returning quotient and remainder
log	Calculate natural logarithm
log10	Calculate base-10 logarithm
_logb	Extract exponential value of double-precision floating-point argument
_lrotl, _lrotr	Shift **unsigned long int** left (**_lrotl**) or right (**_lrotr**)
_matherr	Handle math errors
__max	Return larger of two values
__min	Return smaller of two values
modf	Split argument into integer and fractional parts
_nextafter	Return next representable neighbor
pow	Calculate value raised to a power
printf, wprintf	Write data to **stdout** according to specified format
rand	Get pseudorandom number
_rotl, _rotr	Shift **unsigned int** left (**_rotl**) or right (**_rotr**)
_scalb	Scale argument by power of 2
scanf, wscanf	Read data from **stdin** according to specified format and write data to specified location
sin	Calculate sine
sinh	Calculate hyperbolic sine
sqrt	Find square root
srand	Initialize pseudorandom series
_status87, _statusfp	Get floating-point status word
strtod	Convert character string to double-precision value
tan	Calculate tangent
tanh	Calculate hyperbolic tangent

Long Double

Previous 16-bit versions of Microsoft C/C++ and Microsoft Visual C++ supported the **long double**, 80-bit precision data type. In Win32 programming, however, the **long double** data type maps to the **double**, 64-bit precision data type. The Microsoft run-time library provides **long double** versions of the math functions only for backward compatibility. The **long double** function prototypes are identical to the prototypes for their **double** counterparts, except that the **long double** data type replaces the **double** data type. The **long double** versions of these functions should not be used in new code.

Double Functions and Their Long Double Counterparts

Function	Long Double Counterpart	Function	Long Double Counterpart
acos	acosl	frexp	frexpl
asin	asinl	_hypot	_hypotl
atan	atanl	ldexp	ldexpl
atan2	atan2l	log	logl
atof	_atold	log10	log10l
Bessel functions j0, j1, jn	j0l, j1l, jnl	_matherr	_matherrl
Bessel functions y0, y1, yn	y0l, y1l, ynl	modf	modfl
_cabs	_cabsl	pow	powl
ceil	ceill	sin	sinl
cos	cosl	sinh	sinhl
cosh	coshl	sqrt	sqrtl
exp	expl	strtod	_strtold
fabs	fabsl	tan	tanl
floor	floorl	tanh	tanhl
fmod	fmodl		

Input and Output

The I/O functions read and write data to and from files and devices. File I/O operations take place in text mode or binary mode. The Microsoft run-time library has three types of I/O functions:

- **Stream I/O** functions treat data as a stream of individual characters.
- **Low-level I/O** functions invoke the operating system directly for lower-level operation than that provided by stream I/O.
- **Console and port I/O** functions read or write directly to a console (keyboard and screen) or an I/O port (such as a printer port).

Warning Because stream functions are buffered and low-level functions are not, these two types of functions are generally incompatible. For processing a particular file, use either stream or low-level functions exclusively.

Text and Binary Mode File I/O

File I/O operations take place in one of two translation modes, text or binary, depending on the mode in which the file is opened. Data files are usually processed in text mode. To control the file translation mode, you can:

- Retain the current default setting and specify the alternative mode only when you open selected files.
- Change the default translation mode directly by setting the global variable **_fmode** in your program. The initial default setting of **_fmode** is **_O_TEXT**, for text mode.

When you call a file-open function such as **_open**, **fopen**, **freopen**, or **_fsopen**, you can override the current default setting of **_fmode** by specifying the appropriate argument to the function. The **stdin**, **stdout**, and **stderr** streams always open in text mode by default; you can also override this default when opening any of these files. Use **_setmode** to change the translation mode using the file handle after the file is open.

Unicode™ Stream I/O in Text and Binary Modes

When a Unicode stream I/O routine (such as **fwprintf**, **fwscanf**, **fgetwc**, **fputwc**, **fgetws**, or **fputws**) operates on a file that is open in text mode (the default), two kinds of character conversions take place:

- Unicode-to-MBCS or MBCS-to-Unicode conversion. When a Unicode stream-I/O function operates in text mode, the source or destination stream is assumed to be a sequence of multibyte characters. Therefore, the Unicode stream-input functions convert multibyte characters to wide characters (as if by a call to the **mbtowc** function). For the same reason, the Unicode stream-output functions convert wide characters to multibyte characters (as if by a call to the **wctomb** function).
- Carriage return–linefeed (CR-LF) translation. This translation occurs before the MBCS–Unicode conversion (for Unicode stream input functions) and after the Unicode–MBCS conversion (for Unicode stream output functions). During input, each carriage return–linefeed combination is translated into a single linefeed character. During output, each linefeed character is translated into a carriage return –linefeed combination.

However, when a Unicode stream-I/O function operates in binary mode, the file is assumed to be Unicode, and no CR-LF translation or character conversion occurs during input or output.

Stream I/O

These functions process data in different sizes and formats, from single characters to large data structures. They also provide buffering, which can improve performance. The default size of a stream buffer is 4K. These routines affect only buffers created by the run-time library routines, and have no effect on buffers created by the operating system.

Stream I/O Routines

Routine	Use
clearerr	Clear error indicator for stream
fclose	Close stream
_fcloseall	Close all open streams except **stdin**, **stdout**, and **stderr**
_fdopen, wfdopen	Associate stream with handle to open file
feof	Test for end of file on stream
ferror	Test for error on stream
fflush	Flush stream to buffer or storage device
fgetc, fgetwc	Read character from stream (function versions of **getc** and **getwc**)
_fgetchar, _fgetwchar	Read character from **stdin** (function versions of **getchar** and **getwchar**)
fgetpos	Get position indicator of stream
fgets, fgetws	Read string from stream
_fileno	Get file handle associated with stream
_flushall	Flush all streams to buffer or storage device
fopen, _wfopen	Open stream
fprintf, fwprintf	Write formatted data to stream
fputc, fputwc	Write a character to a stream (function versions of **putc** and **putwc**)
_fputchar, _fputwchar	Write character to **stdout** (function versions of **putchar** and **putwchar**)
fputs, fputws	Write string to stream
fread	Read unformatted data from stream
freopen, _wfreopen	Reassign **FILE** stream pointer to new file or device
fscanf, fwscanf	Read formatted data from stream
fseek	Move file position to given location
fsetpos	Set position indicator of stream
_fsopen, _wfsopen	Open stream with file sharing
ftell	Get current file position
fwrite	Write unformatted data items to stream

Stream I/O Routines ***(continued)***

Routine	Use
getc, getwc	Read character from stream (macro versions of **fgetc** and **fgetwc**)
getchar, getwchar	Read character from **stdin** (macro versions of **fgetchar** and **fgetwchar**)
gets, getws	Read line from **stdin**
_getw	Read binary **int** from stream
printf, wprintf	Write formatted data to **stdout**
putc, putwc	Write character to a stream (macro versions of **fputc** and **fputwc**)
putchar, putwchar	Write character to **stdout** (macro versions of **fputchar** and **fputwchar**)
puts, _putws	Write line to stream
_putw	Write binary **int** to stream
rewind	Move file position to beginning of stream
_rmtmp	Remove temporary files created by **tmpfile**
scanf, wscanf	Read formatted data from **stdin**
setbuf	Control stream buffering
_setmaxstdio	Set a maximum for the number of simultaneously open files at the stream I/O level.
setvbuf	Control stream buffering and buffer size
_snprintf, _snwprintf	Write formatted data of specified length to string
sprintf, swprintf	Write formatted data to string
sscanf, swscanf	Read formatted data from string
_tempnam, _wtempnam	Generate temporary filename in given directory
tmpfile	Create temporary file
tmpnam, _wtmpnam	Generate temporary filename
ungetc, ungetwc	Push character back onto stream
vfprintf, vfwprintf	Write formatted data to stream
vprintf, vwprintf	Write formatted data to **stdout**
_vsnprintf, _vsnwprintf	Write formatted data of specified length to buffer
vsprintf, vswprintf	Write formatted data to buffer

When a program begins execution, the startup code automatically opens several streams: standard input (pointed to by **stdin**), standard output (pointed to by **stdout**), and standard error (pointed to by **stderr**). These streams are directed to the console (keyboard and screen) by default. Use **freopen** to redirect **stdin**, **stdout**, or **stderr** to a disk file or a device.

Files opened using the stream routines are buffered by default. The **stdout** and **stderr** functions are flushed whenever they are full or, if you are writing to a character device, after each library call. If a program terminates abnormally, output buffers may not be flushed, resulting in loss of data. Use **fflush** or **_flushall** to ensure that the buffer associated with a specified file or all open buffers are flushed to the operating system, which can cache data before writing it to disk. The commit-to-disk feature ensures that the flushed buffer contents are not lost in the event of a system failure.

There are two ways to commit buffer contents to disk:

- Link with the file COMMODE.OBJ to set a global commit flag. The default setting of the global flag is **n**, for "no-commit."
- Set the mode flag to **c** with **fopen** or **_fdopen**.

Any file specifically opened with either the **c** or the **n** flag behaves according to the flag, regardless of the state of the global commit/no-commit flag.

If your program does not explicitly close a stream, the stream is automatically closed when the program terminates. However, you should close a stream when your program finishes with it, as the number of streams that can be open at one time is limited. See **_setmaxstdio** for information on this limit.

Input can follow output directly only with an intervening call to **fflush** or to a file-positioning function (**fseek**, **fsetpos**, or **rewind**). Output can follow input without an intervening call to a file-positioning function if the input operation encounters the end of the file.

Low-level I/O

These functions invoke the operating system directly for lower-level operation than that provided by stream I/O. Low-level input and output calls do not buffer or format data.

Low-level routines can access the standard streams opened at program startup using the following predefined handles:

Stream	Handle
stdin	0
stdout	1
stderr	2

Low-level I/O routines set the **errno** global variable when an error occurs. You must include STDIO.H when you use low-level functions only if your program requires a constant that is defined in STDIO.H, such as the end-of-file indicator (**EOF**).

Low-Level I/O Functions

Function	Use
_close	Close file
_commit	Flush file to disk
_creat, _wcreat	Create file
_dup	Return next available file handle for given file
_dup2	Create second handle for given file
_eof	Test for end of file
_lseek, _lseeki64	Reposition file pointer to given location
_open, _wopen	Open file
_read	Read data from file
_sopen, _wsopen	Open file for file sharing
_tell, _telli64	Get current file-pointer position
_umask	Set file-permission mask
_write	Write data to file

_dup and **_dup2** are typically used to associate the predefined file handles with different files.

Console and Port I/O

These routines read and write on your console or on the specified port. The console I/O routines are not compatible with stream I/O or low-level I/O library routines. The console or port does not have to be opened or closed before I/O is performed, so there are no open or close routines in this category. In Windows NT and Windows 95, the output from these functions is always directed to the console and cannot be redirected.

Console and Port I/O Routines

Routine	Use
_cgets	Read string from console
_cprintf	Write formatted data to console
_cputs	Write string to console
_cscanf	Read formatted data from console
_getch	Read character from console
_getche	Read character from console and echo it
_inp	Read one byte from specified I/O port
_inpd	Read double word from specified I/O port
_inpw	Read 2-byte word from specified I/O port
_kbhit	Check for keystroke at console; use before attempting to read from console

(continued)

Console and Port I/O Routines ***(continued)***

Routine	Use
_outp	Write one byte to specified I/O port
_outpd	Write double word to specified I/O port
_outpw	Write word to specified I/O port
_putch	Write character to console
_ungetch	"Unget" last character read from console so it becomes next character read

Internationalization

The Microsoft run-time library provides many routines that are useful for creating different versions of a program for international markets. This includes **locale-related routines**, wide-character routines, multibyte-character routines, and generic-text routines. For convenience, most locale-related routines are also categorized in this reference according to the operations they perform. In this chapter and in this book's alphabetic reference, multibyte-character routines and wide-character routines are described with single-byte-character counterparts, where they exist.

Locale

Use the **setlocale** function to change or query some or all of the current program locale information. "Locale" refers to the locality (the country and language) for which you can customize certain aspects of your program. Some locale-dependent categories include the formatting of dates and the display format for monetary values. For more information, see "Locale Categories" on page 61 in Chapter 3.

Locale-Dependent Routines

Routine	Use	setlocale Category Setting Dependence
atof, atoi, atol	Convert character to floating-point, integer, or long integer value, respectively	**LC_NUMERIC**
is Routines	Test given integer for particular condition.	**LC_CTYPE**
isleadbyte	Test for lead byte ()	**LC_CTYPE**
localeconv	Read appropriate values for formatting numeric quantities	**LC_MONETARY, LC_NUMERIC**
MB_CUR_MAX	Maximum length in bytes of any multibyte character in current locale (macro defined in STDLIB.H)	**LC_CTYPE**
_mbccpy	Copy one multibyte character	**LC_CTYPE**

Locale-Dependent Routines ***(continued)***

Routine	Use	setlocale Category Setting Dependence
_mbclen	Return length, in bytes, of given multibyte character	**LC_CTYPE**
mblen	Validate and return number of bytes in multibyte character	**LC_CTYPE**
_mbstrlen	For multibyte-character strings: validate each character in string; return string length	**LC_CTYPE**
mbstowcs	Convert sequence of multibyte characters to corresponding sequence of wide characters	**LC_CTYPE**
mbtowc	Convert multibyte character to corresponding wide character	**LC_CTYPE**
printf functions	Write formatted output	**LC_NUMERIC** (determines radix character output)
scanf functions	Read formatted input	**LC_NUMERIC** (determines radix character recognition)
setlocale, _wsetlocale	Select locale for program	Not applicable
strcoll, wcscoll	Compare characters of two strings	**LC_COLLATE**
_stricoll, _wcsicoll	Compare characters of two strings (case insensitive)	**LC_COLLATE**
_strncoll, _wcsncoll	Compare first *n* characters of two strings	**LC_COLLATE**
_strnicoll, _wcsnicoll	Compare first *n* characters of two strings (case insensitive)	**LC_COLLATE**
strftime, wcsftime	Format date and time value according to supplied *format* argument	**LC_TIME**
_strlwr	Convert, in place, each uppercase letter in given string to lowercase	**LC_CTYPE**
strtod, wcstod, strtol, wcstol, strtoul, wcstoul	Convert character string to double, long, or unsigned long value	**LC_NUMERIC** (determines radix character recognition)
_strupr	Convert, in place, each lowercase letter in string to uppercase	**LC_CTYPE**
strxfrm, wcsxfrm	Transform string into collated form according to locale	**LC_COLLATE**
tolower, towlower	Convert given character to corresponding lowercase character	**LC_CTYPE**

(continued)

Locale-Dependent Routines ***(continued)***

Routine	Use	setlocale Category Setting Dependence
toupper, towupper	Convert given character to corresponding uppercase letter	**LC_CTYPE**
wcstombs	Convert sequence of wide characters to corresponding sequence of multibyte characters	**LC_CTYPE**
wctomb	Convert wide character to corresponding multibyte character	**LC_CTYPE**
_wtoi, _wtol	Convert wide-character string to **int** or **long**	**LC_NUMERIC**

Code Pages

A *code page* is a character set, which can include numbers, punctuation marks, and other glyphs. Different languages and locales may use different code pages. For example, ANSI code page 1252 is used for American English and most European languages; OEM code page 932 is used for Japanese Kanji.

A code page can be represented in a table as a mapping of characters to single-byte values or multibyte values. Many code pages share the ASCII character set for characters in the range 0x00–0x7F.

The Microsoft run-time library uses the following types of code pages:

- System-default ANSI code page. By default, at startup the run-time system automatically sets the multibyte code page to the system-default ANSI code page, which is obtained from the operating system. The call

  ```
  setlocale ( LC_ALL, "" );
  ```

  also sets the locale to the system-default ANSI code page.
- Locale code page. The behavior of a number of run-time routines is dependent on the current locale setting, which includes the locale code page. (For more information, see "Locale-Dependent Routines.") By default, all locale-dependent routines in the Microsoft run-time library use the code page that corresponds to the "C" locale. At run-time you can change or query the locale code page in use with a call to **setlocale**.
- Multibyte code page. The behavior of most of the multibyte-character routines in the run-time library depends on the current multibyte code page setting. By default, these routines use the system-default ANSI code page. At run-time you can query and change the multibyte code page with **_getmbcp** and **_setmbcp**, respectively.

- The "C" locale is defined by ANSI to correspond to the locale in which C programs have traditionally executed. The code page for the "C" locale ("C" code page) corresponds to the ASCII character set. For example, in the "C" locale, **islower** returns true for the values 0x61–0x7A only. In another locale, **islower** may return true for these as well as other values, as defined by that locale.

Interpretation of Multibyte-Character Sequences

Most multibyte-character routines in the Microsoft run-time library recognize multibyte-character sequences according to the current multibyte code page setting. The following multibyte-character routines depend instead on the locale code page (specifically, on the **LC_CTYPE** category setting of the current locale):

Locale-Dependent Multibyte Routines

Routine	Use
mblen	Validate and return number of bytes in multibyte character
_mbstrlen	For multibyte-character strings: validate each character in string; return string length
mbstowcs	Convert sequence of multibyte characters to corresponding sequence of wide characters
mbtowc	Convert multibyte character to corresponding wide character
wcstombs	Convert sequence of wide characters to corresponding sequence of multibyte characters
wctomb	Convert wide character to corresponding multibyte character

Single-byte and Multibyte Character Sets

The ASCII character set defines characters in the range 0x00–0x7F. There are a number of other character sets, primarily European, that define the characters within the range 0x00–0x7F identically to the ASCII character set and also define an extended character set from 0x80–0xFF. Thus an 8-bit, single-byte-character set (SBCS) is sufficient to represent the ASCII character set as well as the character sets for many European languages. However, some non-European character sets, such as Japanese Kanji, include many more characters than can be represented in a single-byte coding scheme, and therefore require multibyte-character set (MBCS) encoding.

Note Many SBCS routines in the Microsoft run-time library handle multibyte bytes, characters, and strings as appropriate. Many multibyte-character sets define the ASCII character set as a subset. In many multibyte character sets, each character in the range 0x00–0x7F is identical to the character that has the same value in the ASCII character set. For example, in both ASCII and MBCS character strings, the one-byte **NULL** character ('\0') has value 0x00 and indicates the terminating null character.

A multibyte character set may consist of both one-byte and two-byte characters. Thus a multibyte-character string may contain a mixture of single-byte and double-byte characters. A two-byte multibyte character has a lead byte and a trail byte. In a particular multibyte-character set, the lead bytes fall within a certain range, as do the trail bytes. When these ranges overlap, it may be necessary to evaluate the context to determine whether a given byte is functioning as a lead byte or a trail byte.

SBCS and MBCS Data Types

Any Microsoft MBCS run-time library routine that handles only one multibyte character or one byte of a multibyte character expects an unsigned **int** argument (where 0x00 <= character value <= 0xFFFF and 0x00 <= byte value <= 0xFF). An MBCS routine that handles multibyte bytes or characters in a string context expects a multibyte-character string to be represented as an unsigned **char** pointer.

Caution Each byte of a multibyte character can be represented in an 8-bit **char**. However, an SBCS or MBCS single-byte character of type **char** with a value greater than 0x7F is negative. When such a character is converted directly to an **int** or a **long**, the result is sign-extended by the compiler and can therefore yield unexpected results.

Therefore it is best to represent a byte of a multibyte character as an 8-bit **unsigned char**. Or, to avoid a negative result, simply convert a single-byte character of type **char** to an **unsigned char** before converting it to an **int** or a **long**.

Because some SBCS string-handling functions take (signed) **char*** parameters, a type mismatch compiler warning will result when **_MBCS** is defined. There are three ways to avoid this warning, listed in order of efficiency:

1. Use the "type-safe" inline function thunks in TCHAR.H. This is the default behavior.
2. Use the "direct" macros in TCHAR.H by defining **_MB_MAP_DIRECT** on the command line. If you do this, you must manually match types. This is the fastest method, but is not type-safe.
3. Use the "type-safe" statically linked library function thunks in TCHAR.H. To do so, define the constant **_NO_INLINING** on the command line. This is the slowest method, but the most type-safe.

Unicode: The Wide-Character Set

A wide character is a 2-byte multilingual character code. Any character in use in modern computing worldwide, including technical symbols and special publishing characters, can be represented according to the Unicode specification as a wide character. Developed and maintained by a large consortium that includes Microsoft,

the Unicode standard is now widely accepted. Because every wide character is always represented in a fixed size of 16 bits, using wide characters simplifies programming with international character sets.

A wide character is of type **wchar_t**. A wide-character string is represented as a **wchar_t[]** array and is pointed to by a **wchar_t*** pointer. You can represent any ASCII character as a wide character by prefixing the letter L to the character. For example, L'\0' is the terminating wide (16-bit) **NULL** character. Similarly, you can represent any ASCII string literal as a wide-character string literal simply by prefixing the letter L to the ASCII literal (L"Hello").

Generally, wide characters take up more space in memory than multibyte characters but are faster to process. In addition, only one locale can be represented at a time in multibyte encoding, whereas all character sets in the world are represented simultaneously by the Unicode representation.

Using Generic-Text Mappings

Microsoft Specific →

To simplify code development for various international markets, the Microsoft run-time library provides Microsoft-specific "generic-text" mappings for many data types, routines, and other objects. These mappings are defined in TCHAR.H. You can use these name mappings to write generic code that can be compiled for any of the three kinds of character sets: ASCII (SBCS), MBCS, or Unicode, depending on a manifest constant you define using a **#define** statement. Generic-text mappings are Microsoft extensions that are not ANSI compatible.

Preprocessor Directives for Generic-Text Mappings

#define	Compiled Version	Example
_UNICODE	Unicode (wide-character)	**_tcsrev** maps to **_wcsrev**
_MBCS	Multibyte-character	**_tcsrev** maps to **_mbsrev**
None (the default: neither **_UNICODE** nor **_MBCS** defined)	SBCS (ASCII)	**_tcsrev** maps to **strrev**

For example, the generic-text function **_tcsrev**, defined in TCHAR.H, maps to **mbsrev** if **MBCS** has been defined in your program, or to **_wcsrev** if **_UNICODE** has been defined. Otherwise **_tcsrev** maps to **strrev**.

The generic-text data type **_TCHAR**, also defined in TCHAR.H, maps to type **char** if **_MBCS** is defined, to type **wchar_t** if **_UNICODE** is defined, and to type **char** if neither constant is defined. Other data type mappings are provided in TCHAR.H for programming convenience, but **_TCHAR** is the type that is most useful.

Generic-Text Data Type Mappings

Generic-Text Data Type Name	SBCS (_UNICODE, _MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_TCHAR	**char**	**char**	**wchar_t**
_TINT	**int**	**int**	**wint_t**
_TSCHAR	**signed char**	**signed char**	**wchar_t**
_TUCHAR	**unsigned char**	**unsigned char**	**wchar_t**
_TXCHAR	**char**	**unsigned char**	**wchar_t**
_T or **_TEXT**	No effect (removed by preprocessor)	No effect (removed by preprocessor)	**L** (converts following character or string to its Unicode counterpart)

For a complete list of generic-text mappings of routines, variables, and other objects, see Appendix B, "Generic-Text Mappings," on page 677.

The following code fragments illustrate the use of **_TCHAR** and **_tcsrev** for mapping to the MBCS, Unicode, and SBCS models.

```
_TCHAR *RetVal, *szString;
RetVal = _tcsrev(szString);
```

If **MBCS** has been defined, the preprocessor maps the preceding fragment to the following code:

```
char *RetVal, *szString;
RetVal = _mbsrev(szString);
```

If **_UNICODE** has been defined, the preprocessor maps the same fragment to the following code:

```
wchar_t *RetVal, *szString;
RetVal = _wcsrev(szString);
```

If neither **_MBCS** nor **_UNICODE** has been defined, the preprocessor maps the fragment to single-byte ASCII code, as follows:

```
char *RetVal, *szString;
RetVal = strrev(szString);
```

Thus you can write, maintain, and compile a single source code file to run with routines that are specific to any of the three kinds of character sets.

See Also: A Sample Generic-Text Program

A Sample Generic-Text Program

The following program, GENTEXT.C, provides a more detailed illustration of the use of generic-text mappings defined in TCHAR.H:

```
/*
 * GENTEXT.C: use of generic-text mappings defined in TCHAR.H
 *       Generic-Text-Mapping example program
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <direct.h>
#include <errno.h>
#include <tchar.h>

int __cdecl _tmain(int argc, _TCHAR **argv, _TCHAR **envp)
{
   _TCHAR buff[_MAX_PATH];
   _TCHAR *str = _T("Astring");
   char *amsg = "Reversed";
   wchar_t *wmsg = L"Is";

#ifdef _UNICODE
   printf("Unicode version\n");
#else /* _UNICODE */
#ifdef _MBCS
   printf("MBCS version\n");
#else
   printf("SBCS version\n");
#endif
#endif /* _UNICODE */

   if (_tgetcwd(buff, _MAX_PATH) == NULL)
      printf("Can't Get Current Directory - errno=%d\n", errno);
   else
      _tprintf(_T("Current Directory is '%s'\n"), buff);
   _tprintf(_T("'%s' %hs %ls:\n"), str, amsg, wmsg);
   _tprintf(_T("'%s'\n"), _tcsrev(str));
   return 0;
}
```

If **_MBCS** has been defined, GENTEXT.C maps to the following MBCS program:

```
/*
 * MBCSGTXT.C: use of generic-text mappings defined in TCHAR.H
 *       Generic-Text-Mapping example program
 *       MBCS version of GENTEXT.C
 */

#include <stdlib.h>
#include <direct.h>
```

```
int __cdecl main(int argc, char **argv, char **envp)
{
   char buff[_MAX_PATH];
   char *str = "Astring";
   char *amsg = "Reversed";
   wchar_t *wmsg = L"Is";

   printf("MBCS version\n");

   if (_getcwd(buff, _MAX_PATH) == NULL) {
      printf("Can't Get Current Directory - errno=%d\n", errno);
   }
   else {
      printf("Current Directory is '%s'\n", buff);
   }

   printf("'%s' %hs %ls:\n", str, amsg, wmsg);
   printf("'%s'\n", _mbsrev(str));
   return 0;
}
```

If **_UNICODE** has been defined, GENTEXT.C maps to the following Unicode version of the program. For more information about using **wmain** in Unicode programs as a replacement for **main**, see "Using wmain" in *C Language Reference*.

```
/*
 * UNICGTXT.C: use of generic-text mappings defined in TCHAR.H
 *       Generic-Text-Mapping example program
 *       Unicode version of GENTEXT.C
 */

#include <stdlib.h>
#include <direct.h>

int __cdecl wmain(int argc, wchar_t **argv, wchar_t **envp)
{
   wchar_t buff[_MAX_PATH];
   wchar_t *str = L"Astring";
   char *amsg = "Reversed";
   wchar_t *wmsg = L"Is";

   printf("Unicode version\n");

   if (_wgetcwd(buff, _MAX_PATH) == NULL) {
      printf("Can't Get Current Directory - errno=%d\n", errno);
   }
   else {
      wprintf(L"Current Directory is '%s'\n", buff);
   }

   wprintf(L"'%s' %hs %ls:\n", str, amsg, wmsg);
   wprintf(L"'%s'\n", wcsrev(str));
   return 0;
}
```

If neither **_MBCS** nor **_UNICODE** has been defined, GENTEXT.C maps to single-byte ASCII code, as follows:

```
/*
 * SBCSGTXT.C: use of generic-text mappings defined in TCHAR.H
 *       Generic-Text-Mapping example program
 *       Single-byte (SBCS) Ascii version of GENTEXT.C
 */

#include <stdlib.h>
#include <direct.h>

int __cdecl main(int argc, char **argv, char **envp)
{
   char buff[_MAX_PATH];
   char *str = "Astring";
   char *amsg = "Reversed";
   wchar_t *wmsg = L"Is";

   printf("SBCS version\n");

   if (_getcwd(buff, _MAX_PATH) == NULL) {
      printf("Can't Get Current Directory - errno=%d\n", errno);
   }
   else {
      printf("Current Directory is '%s'\n", buff);
   }

   printf("'%s' %hs %ls:\n", str, amsg, wmsg);
   printf("'%s'\n", strrev(str));
   return 0;
}
```

See Also: Appendix B, Generic-Text Mappings; Using Generic-Text Mappings

Using TCHAR.H Data Types with _MBCS

As the table of generic-text routine mappings indicates (see Appendix B, "Generic-Text Mappings"), when the manifest constant **_MBCS** is defined, a given generic-text routine maps to one of the following kinds of routines:

- An SBCS routine that handles multibyte bytes, characters, and strings appropriately. In this case, the string arguments are expected to be of type **char***. For example, **_tprintf** maps to **printf**; the string arguments to **printf** are of type **char***. If you use the **_TCHAR** generic-text data type for your string types, the formal and actual parameter types for **printf** match because **_TCHAR*** maps to **char***.

- An MBCS-specific routine. In this case, the string arguments are expected to be of type **unsigned char***. For example, **_tcsrev** maps to **_mbsrev**, which expects and returns a string of type **unsigned char***. Again, if you use the **_TCHAR** generic-text data type for your string types, there is a potential type conflict because **_TCHAR** maps to type **char**.

Following are three solutions for preventing this type conflict (and the C compiler warnings or C++ compiler errors that would result):

- Use the default behavior. TCHAR.H provides generic-text routine prototypes for routines in the run-time libraries, as in the following example.

  ```
  char *_tcsrev(char *);
  ```

  In the default case, the prototype for **_tcsrev** maps to **_mbsrev** through a thunk in LIBC.LIB. This changes the types of the **_mbsrev** incoming parameters and outgoing return value from **_TCHAR** * (i.e., **char** *) to **unsigned char** *. This method ensures type matching when you are using **_TCHAR**, but it is relatively slow because of the function call overhead.

- Use function inlining by incorporating the following preprocessor statement in your code.

  ```
  #define _USE_INLINING
  ```

  This method causes an inline function thunk, provided in TCHAR.H, to map the generic-text routine directly to the appropriate MBCS routine. The following code excerpt from TCHAR.H provides an example of how this is done.

  ```
  __inline char *_tcsrev(char *_s1)
  {return (char *)_mbsrev((unsigned char *)_s1);}
  ```

  If you can use inlining, this is the best solution, because it guarantees type matching and has no additional time cost.

- Use "direct mapping" by incorporating the following preprocessor statement in your code.

  ```
  #define _MB_MAP_DIRECT
  ```

  This approach provides a fast alternative if you do not want to use the default behavior or cannot use inlining. It causes the generic-text routine to be mapped by a macro directly to the MBCS version of the routine, as in the following example from TCHAR.H.

  ```
  #define _tcschr _mbschr
  ```

When you take this approach, you must be careful to ensure that appropriate data types are used for string arguments and string return values. You can use type casting to ensure proper type matching or you can use the **_TXCHAR** generic-text data type. **_TXCHAR** maps to type **char** in SBCS code but maps to type **unsigned char** in MBCS code. For more information about generic-text macros, see Appendix B, "Generic-Text Mappings."

END Microsoft Specific

Memory Allocation

Use these routines to allocate, free, and reallocate memory.

Memory-Allocation Routines

Routine	Use
_alloca	Allocate memory from stack
calloc	Allocate storage for array, initializing every byte in allocated block to 0
_calloc_dbg	Debug version of **calloc**; only available in the debug versions of the run-time libraries
_expand	Expand or shrink block of memory without moving it
_expand_dbg	Debug version of **_expand**; only available in the debug versions of the run-time libraries
free	Free allocated block
_free_dbg	Debug version of **free**; only available in the debug versions of the run-time libraries
_get_sbh_threshold	Return the upper limit for the size of a memory allocation that will be supported by the small-block heap
_heapadd	Add memory to heap
_heapchk	Check heap for consistency
_heapmin	Release unused memory in heap
_heapset	Fill free heap entries with specified value
_heapwalk	Return information about each entry in heap
malloc	Allocate block of memory from heap
_malloc_dbg	Debug version of **malloc**; only available in the debug versions of the run-time libraries
_msize	Return size of allocated block
_msize_dbg	Debug version of **_msize**; only available in the debug versions of the run-time libraries
_query_new_handler	Return address of current new handler routine as set by **_set_new_handler**
_query_new_mode	Return integer indicating new handler mode set by **_set_new_mode** for **malloc**
realloc	Reallocate block to new size
_realloc_dbg	Debug version of **realloc**; only available in the debug versions of the run-time libraries
_set_new_handler	Enable error-handling mechanism when **new** operator fails (to allocate memory) and enable compilation of Standard Template Libraries (STL)
_set_new_mode	Set new handler mode for **malloc**
_set_sbh_threshold	Set the upper limit for the size of a memory allocation that will be supported by the small-block heap

Process and Environment Control

Use the process-control routines to start, stop, and manage processes from within a program. Use the environment-control routines to get and change information about the operating-system environment.

Process and Environment Control Functions

Routine	Use
abort	Abort process without flushing buffers or calling functions registered by **atexit** and **_onexit**
assert	Test for logic error
_ASSERT, _ASSERTE macros	Similar to **assert**, but only available in the debug versions of the run-time libraries
atexit	Schedule routines for execution at program termination
_beginthread, _beginthreadex	Create a new thread on a Windows NT or Windows 95 process
_cexit	Perform **exit** termination procedures (such as flushing buffers), then return control to calling program without terminating process
_c_exit	Perform **_exit** termination procedures, then return control to calling program without terminating process
_cwait	Wait until another process terminates
_endthread, _endthreadex	Terminate a Windows NT or Windows 95 thread
_execl, _wexecl	Execute new process with argument list
_execle, _wexecle	Execute new process with argument list and given environment
_execlp, _wexeclp	Execute new process using **PATH** variable and argument list
_execlpe, _wexeclpe	Execute new process using **PATH** variable, given environment, and argument list
_execv, _wexecv	Execute new process with argument array
_execve, _wexecve	Execute new process with argument array and given environment
_execvp, _wexecvp	Execute new process using **PATH** variable and argument array
_execvpe, _wexecvpe	Execute new process using **PATH** variable, given environment, and argument array
exit	Call functions registered by **atexit** and **_onexit**, flush all buffers, close all open files, and terminate process
_exit	Terminate process immediately without calling **atexit** or **_onexit** or flushing buffers
getenv, _wgetenv	Get value of environment variable
_getpid	Get process ID number

Process and Environment Control Functions *(continued)*

Routine	Use
longjmp	Restore saved stack environment; use it to execute a nonlocal **goto**
_onexit	Schedule routines for execution at program termination; use for compatibility with Microsoft C/C++ version 7.0 and earlier
_pclose	Wait for new command processor and close stream on associated pipe
perror, _wperror	Print error message
_pipe	Create pipe for reading and writing
_popen, _wpopen	Create pipe and execute command
_putenv, _wputenv	Add or change value of environment variable
raise	Send signal to calling process
setjmp	Save stack environment; use to execute nonlocal **goto**
signal	Handle interrupt signal
_spawnl, _wspawnl	Create and execute new process with specified argument list
_spawnle, _wspawnle	Create and execute new process with specified argument list and environment
_spawnlp, _wspawnlp	Create and execute new process using **PATH** variable and specified argument list
_spawnlpe, _wspawnlpe	Create and execute new process using **PATH** variable, specified environment, and argument list
_spawnv, _wspawnv	Create and execute new process with specified argument array
_spawnve, _wspawnve	Create and execute new process with specified environment and argument array
_spawnvp, _wspawnvp	Create and execute new process using **PATH** variable and specified argument array
_spawnvpe, _wspawnvpe	Create and execute new process using **PATH** variable, specified environment, and argument array
system, _wsystem	Execute operating-system command

In Windows NT and Windows 95, the spawned process is equivalent to the spawning process. Therefore, the OS/2® **wait** function, which allows a parent process to wait for its children to terminate, is not available. Instead, any process can use **_cwait** to wait for any other process for which the process ID is known.

The difference between the **_exec** and **_spawn** families is that a **_spawn** function can return control from the new process to the calling process. In a **_spawn** function, both the calling process and the new process are present in memory unless **_P_OVERLAY** is specified. In an **_exec** function, the new process overlays the calling process, so control cannot return to the calling process unless an error occurs in the attempt to start execution of the new process.

The differences among the functions in the **_exec** family, as well as among those in the **_spawn** family, involve the method of locating the file to be executed as the new process, the form in which arguments are passed to the new process, and the method of setting the environment, as shown in the following table. Use a function that passes an argument list when the number of arguments is constant or is known at compile time. Use a function that passes a pointer to an array containing the arguments when the number of arguments is to be determined at run time. The information in the following table also applies to the wide-character counterparts of the **_spawn** and **_exec** functions.

_spawn and _exec Function Families

Functions	Use PATH Variable to Locate File	Argument-Passing Convention	Environment Settings
_execl, _spawnl	No	List	Inherited from calling process
_execle, _spawnle	No	List	Pointer to environment table for new process passed as last argument
_execlp, _spawnlp	Yes	List	Inherited from calling process
_execlpe, _spawnlpe	Yes	List	Pointer to environment table for new process passed as last argument
_execv, _spawnv	No	Array	Inherited from calling process
_execve, _spawnve	No	Array	Pointer to environment table for new process passed as last argument
_execvp, _spawnvp	Yes	Array	Inherited from calling process
_execvpe, _spawnvpe	Yes	Array	Pointer to environment table for new process passed as last argument

Searching and Sorting

Use the following functions for searching and sorting:

Searching and Sorting Functions

Function	Search or Sort
bsearch	Binary search
_lfind	Linear search for given value
_lsearch	Linear search for given value, which is added to array if not found
qsort	Quick sort

String Manipulation

These routines operate on null-terminated single-byte character, wide-character, and multibyte-character strings. Use the buffer-manipulation routines, described in **Buffer Manipulation**, to work with character arrays that do not end with a null character.

String-Manipulation Routines

Routine	Use
_mbscoll, _mbsicoll, _mbsncoll, _mbsnicoll	Compare two multibyte-character strings using multibyte code page information (**_mbsicoll** and **_mbsnicoll** are case-insensitive)
_mbsdec, _strdec, _wcsdec	Move string pointer back one character
_mbsinc, _strinc, _wcsinc	Advance string pointer by one character
_mbslen	Get number of multibyte characters in multibyte-character string; dependent upon OEM code page
_mbsnbcat	Append, at most, first *n* bytes of one multibyte-character string to another
_mbsnbcmp	Compare first *n* bytes of two multibyte-character strings
_mbsnbcnt	Return number of multibyte-character bytes within supplied character count
_mbsnbcpy	Copy *n* bytes of string
_mbsnbicmp	Compare *n* bytes of two multibyte-character strings, ignoring case
_mbsnbset	Set first *n* bytes of multibyte-character string to specified character
_mbsnccnt	Return number of multibyte characters within supplied byte count
_mbsnextc, _strnextc, _wcsnextc	Find next character in string
_mbsninc. _strninc, _wcsninc	Advance string pointer by *n* characters
_mbsspnp, _strspnp, _wcsspnp	Return pointer to first character in given string that is not in another given string
_mbstrlen	Get number of multibyte characters in multibyte-character string; locale-dependent
strcat, wcscat, _mbscat	Append one string to another
strchr, wcschr, _mbschr	Find first occurrence of specified character in string
strcmp, wcscmp, _mbscmp	Compare two strings

(continued)

String-Manipulation Routines ***(continued)***

Routine	Use
strcoll, wcscoll, _stricoll, _wcsicoll, _strncoll, _wcsncoll, _strnicoll, _wcsnicoll	Compare two strings using current locale code page information (**_stricoll**, **_wcsicoll**, **_strnicoll**, and **_wcsnicoll** are case-insensitive)
strcpy, wcscpy, _mbscpy	Copy one string to another
strcspn, wcscspn, _mbscspn,	Find first occurrence of character from specified character set in string
_strdup, _wcsdup, _mbsdup	Duplicate string
strerror	Map error number to message string
_strerror	Map user-defined error message to string
strftime, wcsftime	Format date-and-time string
_stricmp, _wcsicmp, _mbsicmp	Compare two strings without regard to case
strlen, wcslen, _mbslen, _mbstrlen	Find length of string
_strlwr, _wcslwr, _mbslwr	Convert string to lowercase
strncat, wcsncat, _mbsncat	Append characters of string
strncmp, wcsncmp, _mbsncmp	Compare characters of two strings
strncpy, wcsncpy, _mbsncpy	Copy characters of one string to another
_strnicmp, _wcsnicmp, _mbsnicmp	Compare characters of two strings without regard to case
_strnset, _wcsnset, _mbsnset	Set first *n* characters of string to specified character
strpbrk, wcspbrk, _mbspbrk	Find first occurrence of character from one string in another string
strrchr, wcsrchr,_mbsrchr	Find last occurrence of given character in string
_strrev, _wcsrev,_mbsrev	Reverse string
_strset, _wcsset, _mbsset	Set all characters of string to specified character
strspn, wcsspn, _mbsspn	Find first substring from one string in another string
strstr, wcsstr, _mbsstr	Find first occurrence of specified string in another string
strtok, wcstok, _mbstok	Find next token in string
_strupr, _wcsupr, _mbsupr	Convert string to uppercase
strxfrm, wcsxfrm	Transform string into collated form based on locale-specific information

System Calls

The following functions are Windows NT and Windows 95 operating-system calls:

System Call Functions

Function	Use
_findclose	Release resources from previous find operations
_findfirst, _findfirsti64, _wfindfirst, _wfindfirsti64	Find file with specified attributes
_findnext, _findnexti64, _wfindnext, _wfindnexti64	Find next file with specified attributes

Time Management

Use these functions to get the current time and convert, adjust, and store it as necessary. The current time is the system time.

The **_ftime** and **localtime** routines use the **TZ** environment variable. If **TZ** is not set, the run-time library attempts to use the time-zone information specified by the operating system. If this information is unavailable, these functions use the default value of PST8PDT. For more information on **TZ**, see **_tzset**; also see **_daylight, timezone, and _tzname**.

Time Routines

Function	Use
asctime, _wasctime	Convert time from type **struct tm** to character string
clock	Return elapsed CPU time for process
ctime, _wctime	Convert time from type **time_t** to character string
difftime	Compute difference between two times
_ftime	Store current system time in variable of type **struct _timeb**
_futime	Set modification time on open file
gmtime	Convert time from type **time_t** to **struct tm**
localtime	Convert time from type **time_t** to **struct tm** with local correction
mktime	Convert time to calendar value

(continued)

Time Routines ***(continued)***

Function	Use
_strdate, _wstrdate	Return current system date as string
strftime, wcsftime	Format date-and-time string for international use
_strtime, _wstrtime	Return current system time as string
time	Get current system time as type **time_t**
_tzset	Set external time variables from environment time variable **TZ**
_utime, _wutime	Set modification time for specified file using either current time or time value stored in structure

Note In all versions of Microsoft C/C++ except Microsoft C/C++ version 7.0, and in all versions of Microsoft Visual C++, the **time** function returns the current time as the number of seconds elapsed since midnight on January 1, 1970. In Microsoft C/C++ version 7.0, **time** returned the current time as the number of seconds elapsed since midnight on December 31, 1899.

CHAPTER 2

Global Variables and Standard Types

The Microsoft run-time library contains definitions for global variables, control flags, and standard types used by library routines. Access these variables, flags, and types by declaring them in your program or by including the appropriate header files.

Global Variables

The Microsoft run-time library provides the following global variables:

Variable	Description
_amblksiz	Controls memory heap granularity
daylight, _timezone, _tzname	Adjust for local time; used in some date and time functions
_doserrno, errno, _sys_errlist, _sys_nerr	Store error codes and related information
_environ, _wenviron	Pointers to arrays of pointers to strings that constitute process environment
_fileinfo	Specifies whether information regarding open files of a process is passed to new processes
_fmode	Sets default file-translation mode
_osver, _winmajor, _winminor, _winver	Store build and version numbers of operating system
_pgmptr, _wpgmptr	Initialized at program startup to value such as program name, filename, relative path, or full path

_amblksiz

_amblksiz controls memory heap granularity. It is declared in MALLOC.H as

extern unsigned int _amblksiz;

The value of **_amblksiz** specifies the size of blocks allocated by the operating system for the heap. The initial requested size for a segment of heap memory is just enough to satisfy the current allocation request (for example, a call to **malloc**) plus memory required for heap manager overhead. The value of **_amblksiz** should represent a trade-off between the number of times the operating system is to be called to increase the heap to required size and the amount of memory potentially wasted (available but not used) at the end of the heap.

The default value of **_amblksiz** is 8K. You can change this value by direct assignment in your program. For example:

```
_amblksiz = 2045;
```

If you assign a value to **_amblksiz,** the actual value used internally by the heap manager is the assigned value rounded up to the nearest whole power of 2. Thus, in the previous example, the heap manager would reset the value of **_amblksize** to 2048.

_daylight, _timezone, and _tzname

_daylight, **_timezone**, and **_tzname** are used in some time and date routines to make local-time adjustments. They are declared in TIME.H as

extern int _daylight;
extern long _timezone;
extern char *_tzname[2];

On a call to **_ftime**, **localtime**, or **_tzset**, the values of **_daylight**, **_timezone**, and **_tzname** are determined from the value of the **TZ** environment variable. If you do not explicitly set the value of **TZ**, **_tzname[0]** and **_tzname[1]** contain empty strings, but the time-manipulation functions (**_tzset**, **_ftime**, and **localtime**) attempt to set the values of **_daylight** and **_timezone** by querying the operating system for the default value of each variable. The time-zone global variable values are as follows:

Variable	Value
_daylight	Nonzero if daylight-saving-time zone (DST) is specified in **TZ**; otherwise, 0. Default value is 1.
_timezone	Difference in seconds between coordinated universal time and local time. Default value is 28,800.
_tzname[0]	Three-letter time-zone name derived from **TZ** environment variable.
_tzname[1]	Three-letter DST zone name derived from **TZ** environment variable. Default value is PDT (Pacific daylight time). If DST zone is omitted from **TZ**, **_tzname[1]** is empty string.

_doserrno, errno, _sys_errlist, and _sys_nerr

These global variables hold error codes used by the **perror** and **strerror** functions for printing error messages. Manifest constants for these variables are declared in STDLIB.H as follows:

```
extern int _doserrno;
extern int errno;
extern char *_sys_errlist[ ];
extern int _sys_nerr;
```

errno is set on an error in a system-level call. Because **errno** holds the value for the last call that set it, this value may be changed by succeeding calls. Always check **errno** immediately before and after a call that may set it. All **errno** values, defined as manifest constants in ERRNO.H, are UNIX-compatible. The values valid for 32-bit Windows applications are a subset of these UNIX values.

On an error, **errno** is not necessarily set to the same value as the error code returned by a system call. For I/O operations only, use **_doserrno** to access the operating-system error-code equivalents of **errno** codes. For other operations the value of **_doserrno** is undefined.

Each **errno** value is associated with an error message that can be printed using **perror** or stored in a string using **strerror**. **perror** and **strerror** use the **_sys_errlist** array and **_sys_nerr**, the number of elements in **_sys_errlist**, to process error information.

Library math routines set **errno** by calling **_matherr**. To handle math errors differently, write your own routine according to the **_matherr** reference description and name it **_matherr**.

The following **errno** values are compatible with 32-bit Windows applications. Only **ERANGE** and **EDOM** are specified in the ANSI standard.

Constant	System Error Message	Value
E2BIG	Argument list too long	7
EACCES	Permission denied	13
EAGAIN	No more processes or not enough memory or maximum nesting level reached	11
EBADF	Bad file number	9
ECHILD	No spawned processes	10
EDEADLOCK	Resource deadlock would occur	36
EDOM	Math argument	33
EEXIST	File exists	17
EINVAL	Invalid argument	22
EMFILE	Too many open files	24

(continued)

(continued)

Constant	System Error Message	Value
ENOENT	No such file or directory	2
ENOEXEC	Exec format error	8
ENOMEM	Not enough memory	12
ENOSPC	No space left on device	28
ERANGE	Result too large	34
EXDEV	Cross-device link	18

_environ, _wenviron

The **_environ** variable is a pointer to an array of pointers to the multibyte-character strings that constitute the process environment. **_environ** is declared in STDLIB.H as

extern char **_environ;

In a program that uses the **main** function, **_environ** is initialized at program startup according to settings taken from the operating-system environment. The environment consists of one or more entries of the form

ENVVARNAME=*string*

getenv and **_putenv** use the **_environ** variable to access and modify the environment table. When **_putenv** is called to add or delete environment settings, the environment table changes size. Its location in memory may also change, depending on the program's memory requirements. The value of **_environ** is automatically adjusted accordingly.

The _wenviron variable, declared in STDLIB.H as **extern wchar_t **_wenviron;**, is a wide-character version of **_environ**. In a program that uses the **wmain** function, **_wenviron** is initialized at program startup according to settings taken from the operating-system environment.

In a program that uses **main**, **_wenviron** is initially **NULL**, because the environment is composed of multibyte-character strings. On the first call to **_wgetenv** or **_wputenv**, a corresponding wide-character string environment is created and is pointed to by **_wenviron**.

Similarly, in a program that uses **wmain**, **_environ** is initially **NULL** because the environment is composed of wide-character strings. On the first call to **_getenv** or **_putenv**, a corresponding wide-character string environment is created and is pointed to by **_environ**.

When two copies of the environment (MBCS and Unicode) exist simultaneously in a program, the run-time system must maintain both copies, resulting in slower execution time. For example, whenever you call **_putenv**, a call to **_wputenv** is also executed automatically, so that the two environment strings correspond.

Caution In rare instances, when the run-time system is maintaining both a Unicode version and a multibyte version of the environment, these two environment versions may not correspond exactly. This is because, although any unique multibyte-character string maps to a unique Unicode string, the mapping from a unique Unicode string to a multibyte-character string is not necessarily unique. Therefore, two distinct Unicode strings may map to the same multibyte string.

The following pseudocode illustrates how this can happen:

```
int i, j;
i = _wputenv( "env_var_x=string1" );  // results in the implicit call:
                                      // putenv ("env_var_z=string1")
j = _wputenv( "env_var_y=string2" );  // also results in implicit call:
                                      // putenv("env_var_z=string2")
```

In the notation used for this example, the character strings are not C string literals; rather, they are placeholders that represent Unicode environment string literals in the **_wputenv** call and multibyte environment strings in the **putenv** call. The character-placeholders '*x*' and '*y*' in the two distinct Unicode environment strings do not map uniquely to characters in the current MBCS. Instead, both map to some MBCS character '*z*' that is the default result of the attempt to convert the strings.

Thus in the multibyte environment the value of "*env_var_z*" after the first implicit call to **putenv** would be "*string1*", but this value would be overwritten on the second implicit call to **putenv**, when the value of "*env_var_z*" is set to "*string2*". The Unicode environment (in **_wenviron**) and the multibyte environment (in **_environ**) would therefore differ following this series of calls.

_fileinfo

The **_fileinfo** variable determines whether information about the open files of a process is passed to new processes by functions such as **_spawn**. **_fileinfo** is declared in STDLIB.H as

extern int _fileinfo;

If **_fileinfo** is 0 (the default), information about open files is not passed to new processes; otherwise the information is passed. You can modify the default value of **_fileinfo** by setting the **_fileinfo** variable to a nonzero value in your program.

_fmode

The **_fmode** variable sets the default file-translation mode for text or binary translation. It is declared in STDLIB.H as

extern int _fmode;

The default setting of **_fmode** is **_O_TEXT** for text-mode translation. **_O_BINARY** is the setting for binary mode.
You can change the value of **_fmode** in either of two ways:

- Link with BINMODE.OBJ. This changes the initial setting of **_fmode** to **_O_BINARY**, causing all files except **stdin**, **stdout**, and **stderr** to be opened in binary mode.
- Change the value of **_fmode** directly by setting it in your program.

_osver, _winmajor, _winminor, _winver

These variables store build and version numbers of the 32-bit Windows operating systems. Declarations for these variables in STDLIB.H are as follows:

extern unsigned int _osver;
extern unsigned int _winmajor;
extern unsigned int _winminor;
extern unsigned int _winver;

These variables are useful in programs that run in different versions of Windows NT or Windows 95.

Variable	Description
_osver	Current build number
_winmajor	Major version number
_winminor	Minor version number
_winver	Holds value of **_winmajor** in high byte and value of **_winminor** in low byte

_pgmptr, _wpgmptr

When a program is run from the command interpreter (CMD.EXE), **_pgmptr** is automatically initialized to the full path of the executable file. For example, if HELLO.EXE is in C:\BIN and C:\BIN is in the path, **_pgmptr** is set to C:\BIN\HELLO.EXE when you execute

```
C> hello
```

When a program is not run from the command line, **_pgmptr** may be initialized to the program name (the file's base name without the extension), or to a filename, a relative path, or a full path.

_wpgmptr is the wide-character counterpart of **_pgmptr** for use with programs that use **wmain. _pgmptr** and **_wpgmptr** are declared in STDLIB.H as

extern char *_pgmptr;
extern wchar_t *_pgmptr;

The following program demonstrates the use of **_pgmptr**.

```
/*
 * PGMPTR.C: The following program demonstrates the use of _pgmptr.
 */

#include <stdio.h>
#include <stdlib.h>
void main( void )
{
   printf("The full path of the executing program is : %Fs\n",
     _pgmptr);
}
```

Control Flags

The debug version of the Microsoft C run-time library uses the following flags to control the heap allocation and reporting process.

Flag	Description
_CRTDBG_MAP_ALLOC	Maps the base heap functions to their debug version counterparts
_DEBUG	Enables the use of the debugging versions of the run-time functions
_crtDbgFlag	Controls how the debug heap manager tracks allocations

These flags can be defined with a /D command-line option or with a **#define** directive. When the flag is defined with **#define**, the directive must appear before the header file include statement for the routine declarations.

_CRTDBG_MAP_ALLOC

When the **_CRTDBG_MAP_ALLOC** flag is defined in the debug version of an application, the base version of the heap functions are directly mapped to their debug versions. This flag is declared in CRTDBG.H. This flag is only available when the **_DEBUG** flag has been defined in the application.

_DEBUG

The compiler defines **_DEBUG** when you specify the /MTd or /Mdd option. These options specify debug versions of the C run-time library.

_crtDbgFlag

The **_crtDbgFlag** flag consists of five bit fields that control how memory allocations on the debug version of the heap are tracked, verified, reported, and dumped. The bit fields of the flag are set using the **_CrtSetDbgFlag** function. This flag and its bit fields are declared in CRTDBG.H. This flag is only available when the **_DEBUG** flag has been defined in the application.

Standard Types

The Microsoft run-time library defines the following standard types.

Type	Description	Declared In
clock_t structure	Stores time values; used by **clock**.	TIME.H
_complex structure	Stores real and imaginary parts of complex numbers; used by **_cabs**.	MATH.H
_dev_t short or unsigned integer	Represents device handles.	SYS\TYPES.H
div_t, ldiv_t structures	Store values returned by **div** and **ldiv**, respectively.	STDLIB.H
_exception structure	Stores error information for **_matherr**.	MATH.H
FILE structure	Stores information about current state of stream; used in all stream I/O operations.	STDIO.H
_finddata_t, _wfinddata_t, _wfinddatai64_t structures	**_finddata_t** stores file-attribute information returned by **_findfirst** and **_findnext**. **_wfinddata_t** stores file-attribute information returned by **_wfindfirst** and **_wfindnext**. **_wfinddatai64_t** stores file-attribute information returned by **_wfindfirsti64** and **_wfindnexti64**.	**_finddata_t**: IO.H **_wfinddata_t**: IO.H, WCHAR.H **_wfinddatai64_t**: IO.H, WCHAR.H

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Type	Description	Declared In
_FPIEEE_RECORD structure	Contains information pertaining to IEEE floating-point exception; passed to user-defined trap handler by **_fpieee_flt**.	FPIEEE.H
fpos_t (long integer, __int64, or structure, depending on the target platform)	Used by **fgetpos** and **fsetpos** to record information for uniquely specifying every position within a file.	STDIO.H
_HEAPINFO structure	Contains information about next heap entry for **_heapwalk**.	MALLOC.H
jmp_buf array	Used by **setjmp** and **longjmp** to save and restore program environment.	SETJMP.H
lconv structure	Contains formatting rules for numeric values in different countries.	LOCALE.H
_off_t long integer	Represents file-offset value.	SYS\TYPES.H
_onexit_t pointer	Returned by **_onexit**.	STDLIB.H
_PNH pointer to function	Type of argument to **_set_new_handler**.	NEW.H
ptrdiff_t integer	Result of subtraction of two pointers.	STDDEF.H
sig_atomic_t integer	Type of object that can be modified as atomic entity, even in presence of asynchronous interrupts; used with **signal**.	SIGNAL.H
size_t unsigned integer	Result of **sizeof** operator.	STDDEF.H and other include files
_stat structure	Contains file-status information returned by **_stat** and **_fstat**.	SYS\STAT.H
time_t long integer	Represents time values in **mktime** and **time**.	TIME.H
_timeb structure	Used by **_ftime** to store current system time.	SYS\TIMEB.H
tm structure	Used by **asctime**, **gmtime**, **localtime**, **mktime**, and **strftime** to store and retrieve time information.	TIME.H
_utimbuf structure	Stores file access and modification times used by **_utime** to change file-modification dates.	SYS\UTIME.H

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Type	Description	Declared In
va_list structure	Used to hold information needed by **va_arg** and **va_end** macros. Called function declares variable of type **va_list** that can be passed as argument to another function.	STDARG.H
wchar_t internal type of a wide character	Useful for writing portable programs for international markets.	STDDEF.H, STDLIB.H
wctrans_t integer	Represents locale-specific character mappings.	WCTYPE.H
wctype_t integer	Can represent all characters of any national character set.	WCHAR.H
wint_t integer	Type of data object that can hold any wide character or wide end-of-file value.	WCHAR.H

CHAPTER 3

Global Constants

The Microsoft run-time library contains definitions for global constants used by library routines. To use these constants, include the appropriate header files as indicated in the description for each constant. The global constants are listed in the following table:

BUFSIZ

CLOCKS_PER_SEC, CLK_TCK

Commit-To-Disk Constants

Data Type Constants

EOF, WEOF

errno

Exception-Handling Constants

EXIT_SUCCESS, EXIT_FAILURE

File Attribute Constants

File Constants

File Permission Constants

File Read/Write Access Constants

File Translation Constants

FILENAME_MAX

FOPEN_MAX, _SYS_OPEN

_FREEENTRY, _USEDENTRY

fseek, _lseek

Heap Constants

_HEAP_MAXREQ

HUGE_VAL

__LOCAL_SIZE

Locale Categories

_locking Constants

Math Error Constants

MB_CUR_MAX

NULL

Path Field Limits

RAND_MAX

setvbuf Constants

Sharing Constants

signal Constants

signal Action Constants

_spawn Constants

_stat Structure **st_mode** Field Constants

stdin, stdout, stderr

TMP_MAX, L_tmpnam

Translation Mode Constants

_WAIT_CHILD, _WAIT_GRANDCHILD

32-bit Windows Time/Date Formats

BUFSIZ

#include <stdio.h>

Remarks

BUFSIZ is the required user-allocated buffer for the **setvbuf** routine.

CLOCKS_PER_SEC, CLK_TCK

#include <time.h>

Remarks

The time in seconds is the value returned by the **clock** function, divided by **CLOCKS_PER_SEC**. **CLK_TCK** is equivalent, but considered obsolete.

See Also: clock

Commit-To-Disk Constants

Microsoft Specific →

#include <stdio.h>

Remarks

These Microsoft-specific constants specify whether the buffer associated with the open file is flushed to operating system buffers or to disk. The mode is included in the string specifying the type of read/write access (**"r"**, **"w"**, **"a"**, **"r+"**, **"w+"**, **"a+"**).

The commit-to-disk modes are as follows:

c Writes the unwritten contents of the specified buffer to disk. This commit-to-disk functionality only occurs at explicit calls to either the **fflush** or the **_flushall** function. This mode is useful when dealing with sensitive data. For example, if your program terminates after a call to **fflush** or **_flushall**, you can be sure that your data reached the operating system's buffers. However, unless a file is opened with the **c** option, the data might never make it to disk if the operating system also terminates.

n Writes the unwritten contents of the specified buffer to the operating system's buffers. The operating system can cache data and then determine an optimal time to write to disk. Under many conditions, this behavior makes for efficient program behavior. However, if the retention of data is critical (such as bank transactions or airline ticket information) consider using the **c** option. The **n** mode is the default.

Note The **c** and **n** options are not part of the ANSI standard for **fopen**, but are Microsoft extensions and should not be used where ANSI portability is desired.

Using the Commit-to-Disk Feature with Existing Code

By default, calls to the **fflush** or **_flushall** library functions write data to buffers maintained by the operating system. The operating system determines the optimal time to actually write the data to disk. The commit-to-disk feature of the run-time library lets you ensure that critical data is written directly to disk rather than to the operating system's buffers. You can give this capability to an existing program without rewriting it by linking its object files with COMMODE.OBJ.

In the resulting executable file, calls to **fflush** write the contents of the buffer directly to disk, and calls to **_flushall** write the contents of all buffers to disk. These two functions are the only ones affected by COMMODE.OBJ.

END Microsoft Specific

See Also: _fdopen, fopen

Data Type Constants

Remarks

Data type constants are implementation-dependent ranges of values allowed for integral data types. The constants listed below give the ranges for the integral data types and are defined in LIMITS.H.

Note The /J compiler option changes the default **char** type to **unsigned**.

Constant	Value	Meaning
SCHAR_MAX	127	Maximum signed **char** value
SCHAR_MIN	–128	Minimum signed **char** value
UCHAR_MAX	255 (0xff)	Maximum **unsigned char** value
CHAR_BIT	8	Number of bits in a **char**
USHRT_MAX	65535 (0xffff)	Maximum **unsigned short** value
SHRT_MAX	32767	Maximum (signed) **short** value
SHRT_MIN	–32768	Minimum (signed) **short** value
UINT_MAX	4294967295 (0xffffffff)	Maximum **unsigned int** value
ULONG_MAX	4294967295 (0xffffffff)	Maximum **unsigned long** value
INT_MAX	2147483647	Maximum (signed) **int** value
INT_MIN	–2147483647–1	Minimum (signed) **int** value
LONG_MAX	2147483647	Maximum (signed) **long** value

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Constant	Value	Meaning
LONG_MIN	–2147483647–1	Minimum (signed) **long** value
CHAR_MAX	127 (255 if /J option used)	Maximum **char** value
CHAR_MIN	–128 (0 if /J option used)	Minimum **char** value
MB_LEN_MAX	2	Maximum number of bytes in multibyte **char**

The following constants give the range and other characteristics of the **double** and **float** data types, and are defined in FLOAT.H:

Constant	Value	Description
DBL_DIG	15	# of decimal digits of precision
DBL_EPSILON	2.2204460492503131e–016	Smallest such that 1.0+**DBL_EPSILON** !=1.0
DBL_MANT_DIG	53	# of bits in mantissa
DBL_MAX	1.7976931348623158e+308	Maximum value
DBL_MAX_10_EXP	308	Maximum decimal exponent
DBL_MAX_EXP	1024	Maximum binary exponent
DBL_MIN	2.2250738585072014e–308	Minimum positive value
DBL_MIN_10_EXP	(–307)	Minimum decimal exponent
DBL_MIN_EXP	(–1021)	Minimum binary exponent
_DBL_RADIX	2	Exponent radix
_DBL_ROUNDS	1	Addition rounding: near
FLT_DIG	6	Number of decimal digits of precision
FLT_EPSILON	1.192092896e–07F	Smallest such that 1.0+**FLT_EPSILON** !=1.0
FLT_MANT_DIG	24	Number of bits in mantissa
FLT_MAX	3.402823466e+38F	Maximum value
FLT_MAX_10_EXP	38	Maximum decimal exponent
FLT_MAX_EXP	128	Maximum binary exponent
FLT_MIN	1.175494351e–38F	Minimum positive value
FLT_MIN_10_EXP	(–37)	Minimum decimal exponent
FLT_MIN_EXP	(–125)	Minimum binary exponent
FLT_RADIX	2	Exponent radix
FLT_ROUNDS	1	Addition rounding: near

EOF, WEOF

Remarks

EOF is returned by an I/O routine when the end-of-file (or in some cases, an error) is encountered.

WEOF yields the return value, of type **wint_t**, used to signal the end of a wide stream, or to report an error condition.

See Also: **putc**, **ungetc**, **scanf**, **fflush**, **_fcloseall**, **_ungetch**, **_putch**, **__isascii**

---

errno Constants

#include <errno.h>

Remarks

The **errno** values are constants assigned to **errno** in the event of various error conditions.

ERRNO.H contains the definitions of the **errno** values. However, not all the definitions given in ERRNO.H are used in 32-bit Windows operating systems. Some of the values in ERRNO.H are present to maintain compatibility with the UNIX family of operating systems.

The **errno** values in a 32-bit Windows operating system are a subset of the values for **errno** in XENIX systems. Thus, the **errno** value is not necessarily the same as the actual error code returned by a Windows NT or Windows 95 system call. To access the actual operating system error code, use the **_doserrno** variable, which contains this value.

The following **errno** values are supported:

ECHILD No spawned processes.

EAGAIN No more processes. An attempt to create a new process failed because there are no more process slots, or there is not enough memory, or the maximum nesting level has been reached.

E2BIG Argument list too long.

EACCES Permission denied. The file's permission setting does not allow the specified access. This error signifies that an attempt was made to access a file (or, in some cases, a directory) in a way that is incompatible with the file's attributes.

For example, the error can occur when an attempt is made to read from a file that is not open, to open an existing read-only file for writing, or to open a directory instead of a file. Under MS-DOS operating system versions 3.0 and later, **EACCES** may also indicate a locking or sharing violation.

The error can also occur in an attempt to rename a file or directory or to remove an existing directory.

EBADF Bad file number. There are two possible causes: 1) The specified file handle is not a valid file-handle value or does not refer to an open file. 2) An attempt was made to write to a file or device opened for read-only access.

EDEADLOCK Resource deadlock would occur. The argument to a math function is not in the domain of the function.

EDOM Math argument.

EEXIST Files exist. An attempt has been made to create a file that already exists. For example, the **_O_CREAT** and **_O_EXCL** flags are specified in an **_open** call, but the named file already exists.

EINVAL Invalid argument. An invalid value was given for one of the arguments to a function. For example, the value given for the origin when positioning a file pointer (by means of a call to **fseek**) is before the beginning of the file.

EMFILE Too many open files. No more file handles are available, so no more files can be opened.

ENOENT No such file or directory. The specified file or directory does not exist or cannot be found. This message can occur whenever a specified file does not exist or a component of a path does not specify an existing directory.

ENOEXEC Exec format error. An attempt was made to execute a file that is not executable or that has an invalid executable-file format.

ENOMEM Not enough core. Not enough memory is available for the attempted operator. For example, this message can occur when insufficient memory is available to execute a child process, or when the allocation request in a **_getcwd** call cannot be satisfied.

ENOSPC No space left on device. No more space for writing is available on the device (for example, when the disk is full).

ERANGE Result too large. An argument to a math function is too large, resulting in partial or total loss of significance in the result. This error can also occur in other functions when an argument is larger than expected (for example, when the *buffer* argument to **_getcwd** is longer than expected).

EXDEV Cross-device link. An attempt was made to move a file to a different device (using the **rename** function).

Exception-Handling Constants

Remarks

The constant **EXCEPTION_CONTINUE_SEARCH**, **EXCEPTION_CONTINUE_EXECUTION**, or **EXCEPTION_EXECUTE_HANDLER** is returned when an exception

occurs during execution of the guarded section of a **try-except** statement. The return value determines how the exception is handled. For more information, see "The Try-except Statement" in the C *Language Reference*.

EXIT_SUCCESS, EXIT_FAILURE

#include <stdlib.h>

Remarks

These are arguments for the **exit** and **_exit** functions and the return values for the **atexit** and **_onexit** functions.

See Also: atexit, exit, _onexit

File Attribute Constants

#include <io.h>

Remarks

These constants specify the current attributes of the file or directory specified by the function.

The attributes are represented by the following manifest constants:

_A_ARCH Archive. Set whenever the file is changed, and cleared by the BACKUP command. Value: 0x20

_A_HIDDEN Hidden file. Not normally seen with the DIR command, unless the /AH option is used. Returns information about normal files as well as files with this attribute. Value: 0x02

_A_NORMAL Normal. File can be read or written to without restriction. Value: 0x00

_A_RDONLY Read-only. File cannot be opened for writing, and a file with the same name cannot be created. Value: 0x01

_A_SUBDIR Subdirectory. Value: 0x10

_A_SYSTEM System file. Not normally seen with the DIR command, unless the /AS option is used. Value: 0x04

Multiple constants can be combined with the OR operator (|).

See Also: _find Functions

File Constants

#include <fcntl.h>

Remarks

The integer expression formed from one or more of these constants determines the type of reading or writing operations permitted. It is formed by combining one or more constants with a translation-mode constant.

The file constants are as follows:

_O_APPEND Repositions the file pointer to the end of the file before every write operation.

_O_CREAT Creates and opens a new file for writing; this has no effect if the file specified by *filename* exists.

_O_EXCL Returns an error value if the file specified by *filename* exists. Only applies when used with **_O_CREAT**.

_O_RDONLY Opens file for reading only; if this flag is given, neither **_O_RDWR** nor **_O_WRONLY** can be given.

_O_RDWR Opens file for both reading and writing; if this flag is given, neither **_O_RDONLY** nor **_O_WRONLY** can be given.

_O_TRUNC Opens and truncates an existing file to zero length; the file must have write permission. The contents of the file are destroyed. If this flag is given, you cannot specify **_O_RDONLY**.

_O_WRONLY Opens file for writing only; if this flag is given, neither **_O_RDONLY** nor **_O_RDWR** can be given.

See Also: _open, _sopen

File Permission Constants

#include <sys/stat.h>

Remarks

One of these constants is required when **_O_CREAT** (**_open**, **_sopen**) is specified.

The *pmode* argument specifies the file's permission settings as follows:

Constant	Meaning
_S_IREAD	Reading permitted
_S_IWRITE	Writing permitted
_S_IREAD | _S_IWRITE	Reading and writing permitted

When used as the *pmode* argument for **_umask**, the manifest constant sets the permission setting, as follows:

Constant	Meaning
_S_IREAD	Writing not permitted (file is read-only)
_S_IWRITE	Reading not permitted (file is write-only)
_S_IREAD | _S_IWRITE	Neither reading nor writing permitted

See Also: _open, _sopen, _umask, _stat structure

File Read/Write Access Constants

#include <stdio.h>

Remarks

These constants specify the access type ("a", "r", or "w") requested for the file. Both the translation mode ("b" or "t") and the commit-to-disk mode ("c" or "n") can be specified with the type of access.

The access types are described below.

"a" Opens for writing at the end of the file (appending); creates the file first if it does not exist. All write operations occur at the end of the file. Although the file pointer can be repositioned using **fseek** or **rewind**, it is always moved back to the end of the file before any write operation is carried out.

"a+" Same as above, but also allows reading.

"r" Opens for reading. If the file does not exist or cannot be found, the call to open the file will fail.

"r+" Opens for both reading and writing. If the file does not exist or cannot be found, the call to open the file will fail.

"w" Opens an empty file for writing. If the given file exists, its contents are destroyed.

"w+" Opens an empty file for both reading and writing. If the given file exists, its contents are destroyed.

When the "r+", "w+", or "a+" type is specified, both reading and writing are allowed (the file is said to be open for "update"). However, when you switch between reading and writing, there must be an intervening **fflush**, **fsetpos**, **fseek**, or **rewind** operation. The current position can be specified for the **fsetpos** or **fseek** operation.

See Also: _fdopen, fopen, freopen, _fsopen, _popen

File Translation Constants

#include <stdio.h>

Remarks

These constants specify the mode of translation (**"b"** or **"t"**). The mode is included in the string specifying the type of access (**"r"**, **"w"**, **"a"**, **"r+"**, **"w+"**, **"a+"**).

The translation modes are as follows:

t Opens in text (translated) mode. In this mode, carriage-return/linefeed (CR-LF) combinations are translated into single linefeeds (LF) on input, and LF characters are translated into CR-LF combinations on output. Also, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading or reading/writing, **fopen** checks for CTRL+Z at the end of the file and removes it, if possible. This is done because using the **fseek** and **ftell** functions to move within a file ending with CTRL+Z may cause **fseek** to behave improperly near the end of the file.

Note The **t** option is not part of the ANSI standard for **fopen** and **freopen**. It is a Microsoft extension and should not be used where ANSI portability is desired.

b Opens in binary (untranslated) mode. The above translations are suppressed.

If **t** or **b** is not given in *mode*, the translation mode is defined by the default-mode variable **_fmode**. For more information about using text and binary modes, see "Text and Binary Mode File I/O" on page 15 in Chapter 1.

See Also: **_fdopen**, **fopen**, **freopen**, **_fsopen**

FILENAME_MAX

#include <stdio.h>

Remarks

This is the maximum permissible length for *filename*.

See Also: Path Field Limits

FOPEN_MAX, _SYS_OPEN

#include <stdio.h>

Remarks

This is the maximum number of files that can be opened simultaneously. **FOPEN_MAX** is the ANSI-compatible name. **_SYS_OPEN** is provided for compatibility with existing code.

_FREEENTRY, _USEDENTRY

#include <malloc.h>

Remarks

These constants represent values assigned by the **_heapwalk** routines to the **_useflag** element of the **_HEAPINFO** structure. They indicate the status of the heap entry.

See Also: _heapwalk

fseek, _lseek Constants

#include <stdio.h>

Remarks

The *origin* argument specifies the initial position and can be one of the manifest constants shown below:

Constant	Meaning
SEEK_END	End of file
SEEK_CUR	Current position of file pointer
SEEK_SET	Beginning of file

See Also: fseek, _lseek, _lseeki64

Heap Constants

#include <malloc.h>

Remarks

These constants give the return value indicating status of the heap.

Constant	Meaning
_HEAPBADBEGIN	Initial header information was not found or was invalid.
_HEAPBADNODE	Bad node was found, or heap is damaged.
_HEAPBADPTR	**_pentry** field of **_HEAPINFO** structure does not contain valid pointer into heap (**_heapwalk** routine only).
_HEAPEMPTY	Heap has not been initialized.
_HEAPEND	End of heap was reached successfully (**_heapwalk** routine only).
_HEAPOK	Heap is consistent (**_heapset** and **_heapchk** routines only). No errors so far; **_HEAPINFO** structure contains information about next entry (**_heapwalk** routine only).

See Also: _heapchk, _heapset, _heapwalk

_HEAP_MAXREQ

#include <malloc.h>

Remarks

The maximum size of a user request for memory that can be granted.

See Also: malloc, calloc

HUGE_VAL

#include <math.h>

Remarks

HUGE_VAL is the largest representable double value. This value is returned by many run-time math functions when an error occurs. For some functions, **–HUGE_VAL** is returned.

__LOCAL_SIZE

Remarks

The compiler provides a symbol, **__LOCAL_SIZE**, for use in the inline assembler block of function prolog code. This symbol is used to allocate space for local variables on the stack frame in your custom prolog code.

The compiler determines the value of **__LOCAL_SIZE**. Its value is the total number of bytes of all user-defined locals as well as compiler-generated temporary variables. **__LOCAL_SIZE** can be used as an immediate operand; it cannot be used in an expression. You must not change or redefine the value of this symbol. For example:

```
mov     eax, __LOCAL_SIZE           ;Immediate operand
mov     eax, [ebp - __LOCAL_SIZE]   ;Expression
```

The following is a example of a naked function containing custom prolog and epilog sequences using the **__LOCAL_SIZE** symbol in the prolog sequence:

```
__declspec ( naked ) func()
{
   int i;
   int j;

   _asm       /* prolog */
      {
      push      ebp
      mov      ebp, esp
      sub      esp, __LOCAL_SIZE
      }
```

```
    /* Function body */

    __asm       /* epilog */
        {
        mov      esp, ebp
        pop      ebp
        ret
        }
}
```

For related information, see **naked** in the *Language Quick Reference*.

Locale Categories

#include <locale.h>

Remarks

Locale categories are manifest constants used by the localization routines to specify which portion of a program's locale information will be used. The locale refers to the locality (or country) for which certain aspects of your program can be customized. Locale-dependent areas include, for example, the formatting of dates or the display format for monetary values.

Locale Category	Parts of Program Affected
LC_ALL	All locale-specific behavior (all categories)
LC_COLLATE	Behavior of **strcoll** and **strxfrm** functions
LC_CTYPE	Behavior of character-handling functions (except **isdigit**, **isxdigit**, **mbstowcs**, and **mbtowc**, which are unaffected)
LC_MAX	Same as **LC_TIME**
LC_MIN	Same as **LC_ALL**
LC_MONETARY	Monetary formatting information returned by the **localeconv** function
LC_NUMERIC	Decimal-point character for formatted output routines (for example, **printf**), data conversion routines, and nonmonetary formatting information returned by **localeconv** function
LC_TIME	Behavior of **strftime** function

See Also: localeconv, setlocale, strcoll Functions, strftime, strxfrm

_locking Constants

#include <sys/locking.h>

Remarks

The *mode* argument in the call to the **_locking** function specifies the locking action to be performed.

The *mode* argument must be one of the following manifest constants:

_LK_LOCK Locks the specified bytes. If the bytes cannot be locked, the function tries again after one second. If, after ten attempts, the bytes cannot be locked, the function returns an error.

_LK_RLCK Same as **_LK_LOCK**.

_LK_NBLCK Locks the specified bytes. If bytes cannot be locked, the function returns an error.

_LK_NBRLCK Same as **_LK_NBLCK**.

_LK_UNLCK Unlocks the specified bytes. (The bytes must have been previously locked.)

See Also: **_locking**

Math Error Constants

#include <math.h>

Remarks

The math routines of the run-time library can generate math error constants.

These errors, described as follows, correspond to the exception types defined in MATH.H and are returned by the **_matherr** function when a math error occurs.

Constant	Meaning
_DOMAIN	Argument to function is outside domain of function.
_OVERFLOW	Result is too large to be represented in function's return type.
_PLOSS	Partial loss of significance occurred.
_SING	Argument singularity: argument to function has illegal value. (For example, value 0 is passed to function that requires nonzero value.)
_TLOSS	Total loss of significance occurred.
_UNDERFLOW	Result is too small to be represented.

See Also: **_matherr**

MB_CUR_MAX

#include <stdlib.h>

Context: ANSI multibyte- and wide-character conversion functions

Remarks

The value of **MB_CUR_MAX** is the maximum number of bytes in a multibyte character for the current locale.

See Also: **mblen**, **mbstowcs**, **mbtowc**, **wchar_t**, **wcstombs**, **wctomb**, Data Type Constants

---

NULL

Remarks

NULL is the null-pointer value used with many pointer operations and functions.

Path Field Limits

#include <stdlib.h>

Remarks

These constants define the maximum length for the path and for the individual fields within the path:

Constant	Meaning
_MAX_DIR	Maximum length of directory component
_MAX_DRIVE	Maximum length of drive component
_MAX_EXT	Maximum length of extension component
_MAX_FNAME	Maximum length of filename component
_MAX_PATH	Maximum length of full path

The sum of the fields should not exceed **_MAX_PATH**.

RAND_MAX

#include <stdlib.h>

Remarks

The constant **RAND_MAX** is the maximum value that can be returned by the **rand** function. **RAND_MAX** is defined as the value 0x7fff.

See Also: **rand**

setvbuf Constants

#include <stdio.h>

Remarks

These constants represent the type of buffer for **setvbuf**.

The possible values are given by the following manifest constants:

Constant	Meaning
_IOFBF	Full buffering: Buffer specified in call to **setvbuf** is used and its size is as specified in **setvbuf** call. If buffer pointer is **NULL**, automatically allocated buffer of specified size is used.
_IOLBF	Same as **_IOFBF**.
_IONBF	No buffer is used, regardless of arguments in call to **setvbuf**.

See Also: setbuf

Sharing Constants

#include <share.h>

Remarks

The *shflag* argument determines the sharing mode, which consists of one or more manifest constants. These can be combined with the *oflag* arguments (see "File Constants").

The constants and their meanings are listed below:

Constant	Meaning
_SH_COMPAT	Sets compatibility mode
_SH_DENYRW	Denies read and write access to file
_SH_DENYWR	Denies write access to file
_SH_DENYRD	Denies read access to file
_SH_DENYNO	Permits read and write access

See Also: _sopen, _fsopen

signal Constants

#include <signal.h>

Remarks

The *sig* argument must be one of the manifest constants listed below (defined in SIGNAL.H).

SIGABRT Abnormal termination. The default action terminates the calling program with exit code 3.

SIGFPE Floating-point error, such as overflow, division by zero, or invalid operation. The default action terminates the calling program.

SIGILL Illegal instruction. The default action terminates the calling program.

SIGINT CTRL+C interrupt. The default action issues **INT 23H**.

SIGSEGV Illegal storage access. The default action terminates the calling program.

SIGTERM Termination request sent to the program. The default action terminates the calling program.

See Also: signal, raise

signal Action Constants

#include <signal.h>

Remarks

The action taken when the interrupt signal is received depends on the value of *func*.

The *func* argument must be either a function address or one of the manifest constants listed below and defined in SIGNAL.H.

SIG_DFL Uses system-default response. If the calling program uses stream I/O, buffers created by the run-time library are not flushed.

SIG_IGN Ignores interrupt signal. This value should never be given for **SIGFPE**, since the floating-point state of the process is left undefined.

See Also: signal

_spawn Constants

#include <process.h>

Remarks

The *mode* argument determines the action taken by the calling process before and during a spawn operation. The following values for *mode* are possible:

Constant	Meaning
_P_OVERLAY	Overlays calling process with new process, destroying calling process (same effect as **_exec** calls).
_P_WAIT	Suspends calling thread until execution of new process is complete (synchronous **_spawn**).

(continued)

(continued)

Constant	Meaning
_P_NOWAIT or **_P_NOWAITO**	Continues to execute calling process concurrently with new process (asynchronous **_spawn**, valid only in 32-bit Windows applications).
_P_DETACH	Continues to execute calling process; new process is run in background with no access to console or keyboard. Calls to **_cwait** against new process will fail. This is an asynchronous **_spawn** and is valid only in 32-bit Windows applications.

See Also: **_spawn Functions**

_stat Structure st_mode Field Constants

#include <sys/stat.h>

Remarks

These constants are used to indicate file type in the **st_mode** field of the **_stat structure**.

The bit mask constants are described below:

Constant	Meaning
_S_IFMT	File type mask
_S_IFDIR	Directory
_S_IFCHR	Character special (indicates a device if set)
_S_IFREG	Regular
_S_IREAD	Read permission, owner
_S_IWRITE	Write permission, owner
_S_IEXEC	Execute/search permission, owner

See Also: **_stat**, **_fstat**, Standard Types

stdin, stdout, stderr

FILE *stdin;
FILE *stdout;
FILE *stderr;

#include <stdio.h>

Remarks

These are standard streams for input, output, and error output.

By default, standard input is read from the keyboard, while standard output and standard error are printed to the screen.

The following stream pointers are available to access the standard streams:

Pointer	Stream
stdin	Standard input
stdout	Standard output
stderr	Standard error

These pointers can be used as arguments to functions. Some functions, such as **getchar** and **putchar**, use **stdin** and **stdout** automatically.

These pointers are constants, and cannot be assigned new values. The **freopen** function can be used to redirect the streams to disk files or to other devices. The operating system allows you to redirect a program's standard input and output at the command level.

See Also: Stream I/O

TMP_MAX, L_tmpnam

#include <stdio.h>

Remarks

TMP_MAX is the maximum number of unique filenames that the **tmpnam** function can generate. **L_tmpnam** is the length of temporary filenames generated by **tmpnam**.

Translation Mode Constants

#include <fcntl.h>

Remarks

The **_O_BINARY** and **_O_TEXT** manifest constants determine the translation mode for files (**_open** and **_sopen**) or the translation mode for streams (**_setmode**).

The allowed values are:

_O_TEXT Opens file in text (translated) mode. Carriage return–linefeed (CR-LF) combinations are translated into a single linefeed (LF) on input. Linefeed characters are translated into CR-LF combinations on output. Also, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading and reading/writing, **fopen** checks for CTRL+Z at the end of the file and removes it, if possible. This is done because using the **fseek** and **ftell** functions to move within a file ending with CTRL+Z may cause **fseek** to behave improperly near the end of the file.

_O_BINARY Opens file in binary (untranslated) mode. The above translations are suppressed.

_O_RAW Same as **_O_BINARY**. Supported for C 2.0 compatibility.

For more information, see "Text and Binary Mode File I/O" and "File Translation."

See Also: _open, _pipe, _sopen, _setmode

_WAIT_CHILD, _WAIT_GRANDCHILD

#include <process.h>

Remarks

The **_cwait** function can be used by any process to wait for any other process (if the process ID is known). The action argument can be one of the following values:

Constant	Meaning
_WAIT_CHILD	Calling process waits until specified new process terminates.
_WAIT_GRANDCHILD	Calling process waits until specified new process, and all processes created by that new process, terminate.

See Also: _cwait

32-bit Windows Time/Date Formats

Remarks

The file time and the date are stored individually, using unsigned integers as bit fields. File time and date are packed as follows:

Time

Bit Position:	0 1 2 3 4	5 6 7 8 9 A	B C D E F
Length:	5	6	5
Contents:	hours	minutes	2-second increments
Value Range:	0–23	0–59	0–29 in 2-second intervals

Date

Bit Position:	0 1 2 3 4 5 6	7 8 9 A	B C D E F
Length:	7	4	5
Contents:	year	month	day
Value Range:	0–119 (relative to 1980)	1–12	1–31

CHAPTER 4

Debug Version of the C Run-Time Library

Visual C++ has extensive debug support for the C run-time library, letting you step directly into run-time functions when debugging an application. The library also provides a variety of tools to keep track of heap allocations, locate memory leaks, and track down other memory-related problems. This chapter is an alphabetic reference of the debug functions and macros available for these purposes.

_ASSERT, _ASSERTE Macros

Evaluate an expression and generate a debug report when the result is FALSE (debug version only).

_ASSERT(*booleanExpression* **);**
_ASSERTE(*booleanExpression* **);**

Macro	Required Header	Compatibility
_ASSERT	<crtdbg.h>	Win NT, Win 95
_ASSERTE	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Although **_ASSERT** and **_ASSERTE** are macros and are obtained by including CRTDBG.H, the application must link with one of the libraries listed above because these macros call other run-time functions.

Return Value

None

Parameter

booleanExpression Expression (including pointers) that evaluates to nonzero or 0.

Remarks

The **_ASSERT** and **_ASSERTE** macros provide an application with a clean and simple mechanism for checking assumptions during the debugging process. They are very flexible because they do not need to be enclosed in **#ifdef** statements to prevent them from being called in a retail build of an application. This flexibility is achieved by using the **_DEBUG** macro. **_ASSERT** and **_ASSERTE** are only available when **_DEBUG** is defined. When **_DEBUG** is not defined, calls to these macros are removed during preprocessing.

_ASSERT and **_ASSERTE** evaluate their *booleanExpression* argument and when the result is FALSE (0), they print a diagnostic message and call **_CrtDbgReport** to generate a debug report. The **_ASSERT** macro prints a simple diagnostic message, while **_ASSERTE** includes a string representation of the failed expression in the message. These macros do nothing when *booleanExpression* evaluates to nonzero.

Because the **_ASSERTE** macro specifies the failed expression in the generated report, it enables users to identify the problem without referring to the application source code. However, a disadvantage exists in that every expression evaluated by **_ASSERTE** must be included in the debug version of your application as a string constant. Therefore, if a large number of calls are made to **_ASSERTE**, these expressions can take up a significant amount of space.

_CrtDbgReport generates the debug report and determines its destination(s), based on the current report mode(s) and file defined for the **_CRT_ASSERT** report type. By default, assertion failures and errors are directed to a debug message window. The **_CrtSetReportMode** and **_CrtSetReportFile** functions are used to define the destination(s) for each report type.

When the destination is a debug message window and the user chooses the Retry button, **_CrtDbgReport** returns 1, causing the **_ASSERT** and **_ASSERTE** macros to start the debugger, provided that "just-in-time" (JIT) debugging is enabled. See "Debug Reporting Functions of the C Run-Time Library" for an example of an assert message box under Windows NT.

For more information about the reporting process, see the **_CrtDbgReport** function.

The **_RPT, _RPTF** debug macros are also available for generating a debug report, but they do not evaluate an expression. The **_RPT** macros generate a simple report and the **_RPTF** macros include the source file and line number where the report macro was called, in the generated report. In addition to the **_ASSERTE** macros, the ANSI **assert** routine can also be used to verify program logic. This routine is available in both the debug and release versions of the libraries.

Example

```
/*
 * DBGMACRO.C
 * In this program, calls are made to the _ASSERT and _ASSERTE
 * macros to test the condition 'string1 == string2'.  If the
 * condition fails, these macros print a diagnostic message.
 * The _RPTn and _RPTFn group of macros are also exercised in
 * this program, as an alternative to the printf function.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

int main()
{
   char *p1, *p2;

   /*
    * The Reporting Mode and File must be specified
    * before generating a debug report via an assert
    * or report macro.
    * This program sends all report types to STDOUT
    */
   _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

   /*
    * Allocate and assign the pointer variables
    */
   p1 = malloc(10);
   strcpy(p1, "I am p1");
   p2 = malloc(10);
   strcpy(p2, "I am p2");

   /*
    * Use the report macros as a debugging
    * warning mechanism, similar to printf.
    *
    * Use the assert macros to check if the
    * p1 and p2 variables are equivalent.
    *
    * If the expression fails, _ASSERTE will
    * include a string representation of the
```

```
     * failed expression in the report.
     * _ASSERT does not include the
     * expression in the generated report.
     */
    _RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the expression
    ➥ p1 == p2.\n");
    _RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
    _ASSERT(p1 == p2);

    _RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
    _ASSERTE(p1 == p2);

    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Use the assert macros to evaluate the expression p1 == p2.

dbgmacro.c(54) : Will _ASSERT find 'I am p1' == 'I am p2' ?
dbgmacro.c(55) : Assertion failed


dbgmacro.c(57) : Will _ASSERTE find 'I am p1' == 'I am p2' ?
dbgmacro.c(58) : Assertion failed: p1 == p2


'I am p1' != 'I am p2'
```

See Also: _RPT, _RPTF

_calloc_dbg

Allocates a number of memory blocks in the heap with additional space for a debugging header and overwrite buffers (debug version only).

void *__calloc_dbg(**size_t** *num*, **size_t** *size*, **int** *blockType*, **const char** **filename*, ➥ **int** *linenumber*);\

Routine	Required Header	Compatibility
_calloc_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, this function either returns a pointer to the user portion of the last allocated memory block, calls the new handler function, or returns NULL. See the following Remarks section for a complete description of the return behavior. See the **calloc** function for more information on how the new handler function is used.

Parameters

num Requested number of memory blocks

size Requested size of each memory block (bytes)

blockType Requested type of memory block: **_CLIENT_BLOCK** or **_NORMAL_BLOCK**

filename Pointer to name of source file that requested allocation operation or NULL

linenumber Line number in source file where allocation operation was requested or NULL

The *filename* and *linenumber* parameters are only available when **_calloc_dbg** has been called explicitly or the **_CRTDBG_MAP_ALLOC** environment variable has been defined.

Remarks

_calloc_dbg is a debug version of the **calloc** function. When **_DEBUG** is not defined, calls to **_calloc_dbg** are removed during preprocessing. Both **calloc** and **_calloc_dbg** allocate *num* memory blocks in the base heap, but **_calloc_dbg** offers several debugging features: buffers on either side of the user portion of the block to test for leaks, a block type parameter to track specific allocation types, and *filename/linenumber* information to determine the origin of allocation requests.

_calloc_dbg allocates each memory block with slightly more space than the requested *size*. The additional space is used by the debug heap manager to link the debug memory blocks together and to provide the application with debug header information and overwrite buffers. When the block is allocated, the user portion of the block is filled with the value 0xCD and each of the overwrite buffers are filled with 0xFD.

Example

```
/*
 * CALLOCD.C
 * This program uses _calloc_dbg to allocate space for
 * 40 long integers. It initializes each element to zero.
 */
#include <stdio.h>
#include <malloc.h>
#include <crtdbg.h>
```

```
void main( void )
{
      long *bufferN, *bufferC;

      /*
       * Call _calloc_dbg to include the filename and line number
       * of our allocation request in the header and also so we can
       * allocate CLIENT type blocks specifically
       */
      bufferN = (long *)_calloc_dbg( 40, sizeof(long), _NORMAL_BLOCK,
      ↪ __FILE__, __LINE__ );
      bufferC = (long *)_calloc_dbg( 40, sizeof(long), _CLIENT_BLOCK,
      ↪ __FILE__, __LINE__ );
      if( bufferN != NULL && bufferC != NULL )
           printf( "Allocated memory successfully\n" );
      else
           printf( "Problem allocating memory\n" );

      /*
       * _free_dbg must be called to free CLIENT type blocks
       */
      free( bufferN );
      _free_dbg( bufferC, _CLIENT_BLOCK );
}
```

Output

```
Allocated memory successfully
```

See Also: calloc, _malloc_dbg, _DEBUG

_CrtCheckMemory

Confirms the integrity of the memory blocks allocated in the debug heap (debug version only).

int _CrtCheckMemory(void);

Routine	Required Header	Compatibility
_CrtCheckMemory	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

If successful, **_CrtCheckMemory** returns TRUE; otherwise, the function returns FALSE.

Remarks

The **_CrtCheckMemory** function validates memory allocated by the debug heap manager by verifying the underlying base heap and inspecting every memory block. If an error or memory inconsistency is encountered in the underlying base heap, the debug header information, or the overwrite buffers, **_CrtCheckMemory** generates a debug report with information describing the error condition. When **_DEBUG** is not defined, calls to **_CrtCheckMemory** are removed during preprocessing.

The behavior of **_CrtCheckMemory** can be controlled by setting the bit fields of the **_crtDbgFlag** flag using the **_CrtSetDbgFlag** function. Turning the **_CRTDBG_CHECK_ALWAYS_DF** bit field ON results in **_CrtCheckMemory** being called every time a memory allocation operation is requested. Although this method slows down execution, it is useful for catching errors quickly. Turning the **_CRTDBG_ALLOC_MEM_DF** bit field OFF causes **_CrtCheckMemory** to not verify the heap and immediately return TRUE.

Because this function returns TRUE or FALSE, it can be passed to one of the **_ASSERT** macros to create a simple debugging error handling mechanism. The following example will cause an assertion failure if corruption is detected in the heap:

```
_ASSERTE( _CrtCheckMemory( ) );
```

Example

```
/*****************************************************************
 *  EXAMPLE  1                                                   *
 *  This simple program illustrates the basic debugging features *
 *  of the C runtime libraries, and the kind of debug output     *
 *  that these features generate.                                *
 *****************************************************************/

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

// This routine place comments at the head of a section of debug output
void OutputHeading( const char * explanation )
{
   _RPT1( _CRT_WARN, "\n\n%s:\n************************************\
**********************************\n", explanation );
}

// The following macros set and clear, respectively, given bits
// of the C runtime library debug flag, as specified by a bitmask.
#ifdef   _DEBUG
#define  SET_CRT_DEBUG_FIELD(a) \
            _CrtSetDbgFlag((a) | _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG))
#define  CLEAR_CRT_DEBUG_FIELD(a) \
            _CrtSetDbgFlag(~(a) & _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG))
```

```
#else
#define  SET_CRT_DEBUG_FIELD(a)   ((void) 0)
#define  CLEAR_CRT_DEBUG_FIELD(a) ((void) 0)
#endif


void main( )
{
   char *p1, *p2;
   _CrtMemState s1, s2, s3;

   // Send all reports to STDOUT
   _CrtSetReportMode( _CRT_WARN, _CRTDBG_MODE_FILE );
   _CrtSetReportFile( _CRT_WARN, _CRTDBG_FILE_STDOUT );
   _CrtSetReportMode( _CRT_ERROR, _CRTDBG_MODE_FILE );
   _CrtSetReportFile( _CRT_ERROR, _CRTDBG_FILE_STDOUT );
   _CrtSetReportMode( _CRT_ASSERT, _CRTDBG_MODE_FILE );
   _CrtSetReportFile( _CRT_ASSERT, _CRTDBG_FILE_STDOUT );

   // Allocate 2 memory blocks and store a string in each
   p1 = malloc( 34 );
   strcpy( p1, "This is the p1 string (34 bytes)." );

   p2 = malloc( 34 );
   strcpy( p2, "This is the p2 string (34 bytes)." );


   OutputHeading(
      "Use _ASSERTE to check that the two strings are identical" );
   _ASSERTE( strcmp( p1, p2 ) == 0 );

   OutputHeading(
      "Use a _RPT macro to report the string contents as a warning" );
   _RPT2( _CRT_WARN, "p1 points to '%s' and \np2 points to '%s'\n", p1, p2 );

   OutputHeading(
      "Use _CRTMemDumpAllObjectsSince to check the p1 and p2 allocations" );
   _CrtMemDumpAllObjectsSince( NULL );

   free( p2 );

   OutputHeading(
      "Having freed p2, dump allocation information about p1 only" );
   _CrtMemDumpAllObjectsSince( NULL );

   // Store a memory checkpoint in the s1 memory-state structure
   _CrtMemCheckpoint( &s1 );

   // Allocate another block, pointed to by p2
   p2 = malloc( 38 );
   strcpy( p2, "This new p2 string occupies 38 bytes.");

   // Store a 2nd memory checkpoint in s2
   _CrtMemCheckpoint( &s2 );
```

```
    OutputHeading(
       "Dump the changes that occurred between two memory checkpoints" );
    if ( _CrtMemDifference( &s3, &s1, &s2 ) )
       _CrtMemDumpStatistics( &s3 );

    // Free p2 again and store a new memory checkpoint in s2
    free( p2 );
    _CrtMemCheckpoint( &s2 );

    OutputHeading(
       "Now the memory state at the two checkpoints is the same" );
    if ( _CrtMemDifference( &s3, &s1, &s2 ) )
       _CrtMemDumpStatistics( &s3 );

    strcpy( p1, "This new p1 string is over 34 bytes" );
    OutputHeading( "Free p1 after overwriting the end of the allocation" );
    free( p1 );

    // Set the debug-heap flag so that freed blocks are kept on the
    // linked list, to catch any inadvertent use of freed memory
    SET_CRT_DEBUG_FIELD( _CRTDBG_DELAY_FREE_MEM_DF );

    p1 = malloc( 10 );
    free( p1 );
    strcpy( p1, "Oops" );

    OutputHeading( "Perform a memory check after corrupting freed memory" );
    _CrtCheckMemory( );

    // Use explicit calls to _malloc_dbg to save file name and line number
    // information, and also to allocate Client type blocks for tracking
    p1 = _malloc_dbg( 40, _NORMAL_BLOCK, __FILE__, __LINE__ );
    p2 = _malloc_dbg( 40, _CLIENT_BLOCK, __FILE__, __LINE__ );
    strcpy( p1, "p1 points to a Normal allocation block" );
    strcpy( p2, "p2 points to a Client allocation block" );

    // You must use _free_dbg to free a Client block
    OutputHeading(
       "Using free( ) to free a Client block causes an assertion failure" );
    free( p1 );
    free( p2 );

    p1 = malloc( 10 );
    OutputHeading( "Examine outstanding allocations (dump memory leaks)" );
    _CrtDumpMemoryLeaks( );

    // Set the debug-heap flag so that memory leaks are reported when
    // the process terminates. Then, exit.
    OutputHeading( "Program exits without freeing a memory block" );
    SET_CRT_DEBUG_FIELD( _CRTDBG_LEAK_CHECK_DF );
}
```

Output

```
Use _ASSERTE to check that the two strings are identical:
********************************************************************************
C:\DEV\EXAMPLE1.C(56) : Assertion failed: strcmp( p1, p2 ) == 0


Use a _RPT macro to report the string contents as a warning:
********************************************************************************
p1 points to 'This is the p1 string (34 bytes).' and
p2 points to 'This is the p2 string (34 bytes).'


Use _CRTMemDumpAllObjectsSince to check the p1 and p2 allocations:
********************************************************************************
Dumping objects ->
{13} normal block at 0x00660B5C, 34 bytes long
 Data: <This is the p2 s> 54 68 69 73 20 69 73 20 74 68 65 20 70 32 20 73
{12} normal block at 0x00660B10, 34 bytes long
 Data: <This is the p1 s> 54 68 69 73 20 69 73 20 74 68 65 20 70 31 20 73
Object dump complete.


Having freed p2, dump allocation information about p1 only:
********************************************************************************
Dumping objects ->
{12} normal block at 0x00660B10, 34 bytes long
 Data: <This is the p1 s> 54 68 69 73 20 69 73 20 74 68 65 20 70 31 20 73
Object dump complete.


Dump the changes that occurred between two memory checkpoints:
********************************************************************************
0 bytes in 0 Free Blocks.
38 bytes in 1 Normal Blocks.
0 bytes in 0 CRT Blocks.
0 bytes in 0 IgnoreClient Blocks.
0 bytes in 0 (null) Blocks.
Largest number used: 4 bytes.
Total allocations: 38 bytes.


Now the memory state at the two checkpoints is the same:
********************************************************************************


Free p1 after overwriting the end of the allocation:
********************************************************************************
memory check error at 0x00660B32 = 0x73, should be 0xFD.
memory check error at 0x00660B33 = 0x00, should be 0xFD.
DAMAGE: after Normal block (#12) at 0x00660B10.
```

```
Perform a memory check after corrupting freed memory:
*****************************************************************************
memory check error at 0x00660B10 = 0x4F, should be 0xDD.
memory check error at 0x00660B11 = 0x6F, should be 0xDD.
memory check error at 0x00660B12 = 0x70, should be 0xDD.
memory check error at 0x00660B13 = 0x73, should be 0xDD.
memory check error at 0x00660B14 = 0x00, should be 0xDD.
DAMAGE: on top of Free block at 0x00660B10.
DAMAGED located at 0x00660B10 is 10 bytes long.


Using free( ) to free a Client block causes an assertion failure:
*****************************************************************************
dbgheap.c(1039) : Assertion failed: pHead->nBlockUse == nBlockUse


Examine outstanding allocations (dump memory leaks):
*****************************************************************************
Detected memory leaks!
Dumping objects ->
{18} normal block at 0x00660BE4, 10 bytes long
 Data: <          > CD CD CD CD CD CD CD CD CD CD
Object dump complete.


Program exits without freeing a memory block:
*****************************************************************************
Detected memory leaks!
Dumping objects ->
{18} normal block at 0x00660BE4, 10 bytes long
 Data: <          > CD CD CD CD CD CD CD CD CD CD
Object dump complete.
```

See Also: **_crtDbgFlag, _CrtSetDbgFlag**

_CrtDbgReport

Generates a report with a debugging message and sends the report to three possible destinations (debug version only).

int _CrtDbgReport(int *reportType*, **const char** **filename*, **int** *linenumber*,
↪ **const char** **moduleName*, **const char** **format* [, *argument*] ... **);**

Routine	Required Header	Compatibility
_CrtDbgReport	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

For all report destinations, **_CrtDbgReport** returns –1 if an error occurs and 0 if no errors are encountered. However, when the report destination is a debug message window and the user chooses the Retry button, **_CrtDbgReport** returns 1. If the user chooses the Abort button in the debug message window, **_CrtDbgReport** immediately aborts and does not return a value.

The **_ASSERT[E]** and **_RPT, _RPTF** debug macros call **_CrtDbgReport** to generate their debug report. When **_CrtDbgReport** returns 1, these macros start the debugger, provided that "just-in-time" (JIT) debugging is enabled.

Parameters

reportType Report type: **_CRT_WARN, _CRT_ERROR, _CRT_ASSERT**

filename Pointer to name of source file where assert/report occurred or NULL

linenumber Line number in source file where assert/report occured or NULL

moduleName Pointer to name of module (.EXE or .DLL) where assert/report occurred

format Pointer to format-control string used to create the user message

argument Optional substitution arguments used by *format*

Remarks

The **_CrtDbgReport** function is similar to the **printf** function, as it can be used to report warnings, errors, and assert information to the user during the debugging process. However, this function is more flexible than **printf** because it does not need to be enclosed in **#ifdef** statements to prevent it from being called in a retail build of an application. This is achieved by using the **_DEBUG** flag: When **_DEBUG** is not defined, calls to **_CrtDbgReport** are removed during preprocessing.

_CrtDbgReport can send the debug report to three different destinations: a debug report file, a debug monitor (the Visual C++ debugger), or a debug message window. Two configuration functions, **_CrtSetReportMode** and **_CrtSetReportFile**, are used to specify the destination(s) for each report type. These functions allow the reporting destination(s) for each report type to be separately controlled. For example, it is possible to specify that a *reportType* of **_CRT_WARN** only be sent to the debug monitor, while a *reportType* of **_CRT_ASSERT** be sent to a debug message window and a user-defined report file.

_CrtDbgReport creates the user message for the debug report by substituting the *argument*[*n*] arguments into the *format* string, using the same rules defined by the

printf function. **_CrtDbgReport** then generates the debug report and determines the destination(s), based on the current report modes and file defined for *reportType*. When the report is sent to a debug message window, the *filename*, *lineNumber*, and *moduleName* are included in the information displayed in the window.

The following table lists the available choices for the report mode(s) and file and the resulting behavior of **_CrtDbgReport**. These options are defined as bit-flags in CRTDBG.H.

Report Mode	Report File	_CrtDbgReport Behavior
CRTDBG-MODE_DEBUG	Not applicable	Writes message to Windows **OutputDebugString** API.
CRTDBG-MODE_WNDW	Not applicable	Calls Windows **MessageBox** API to create message box to display the message along with Abort, Retry, and Ignore buttons. If user selects Abort, **_CrtDbgReport** immediately aborts. If user selects Retry, it returns 1. If user selects Ignore, execution continues and **_CrtDbgReport** returns 0. Note that choosing Ignore when an error condition exists often results in "undefined behavior."
CRTDBG-MODE_FILE	**__HFILE**	Writes message to user-supplied **HANDLE**, using the Windows **WriteFile** API, and does not verify validity of file handle; the application is responsible for opening the report file and passing a valid file handle.
CRTDBG-MODE_FILE	**_CRTDBG_-FILE_STDERR**	Writes message to **stderr**.
CRTDBG-MODE_FILE	**_CRTDBG_-FILE_STDOUT**	Writes message to **stdout**.

The report may be sent to one, two, or three destinations, or no destination at all. For more information about specifying the report mode(s) and report file, see the **_CrtSetReportMode** and **_CrtSetReportFile** functions.

If your application needs more flexibility than that provided by **_CrtDbgReport**, you can write your own reporting function and hook it into the C run-time library reporting mechanism by using the **_CrtSetReportHook** function.

Example

```
/*
 * REPORT.C:
 * In this program, calls are made to the _CrtSetReportMode,
 * _CrtSetReportFile, and _CrtSetReportHook functions.
 * The _ASSERT macros are called to evaluate their expression.
 * When the condition fails, these macros print a diagnostic message
 * and call _CrtDbgReport to generate a debug report and the
 * client-defined reporting function is called as well.
 * The _RPTn and _RPTFn group of macros are also exercised in
```

```
 * this program, as an alternative to the printf function.
 * When these macros are called, the client-defined reporting function
 * takes care of all the reporting - _CrtDbgReport won't be called.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

#define FALSE 0
#define TRUE !FALSE

/*
 * Define our own reporting function.
 * We'll hook it into the debug reporting
 * process later using _CrtSetReportHook.
 *
 * Define a global int to keep track of
 * how many assertion failures occur.
 */
int gl_num_asserts=0;
int OurReportingFunction( int reportType, char *userMessage, int *retVal )
{
   /*
    * Tell the user our reporting function is being called.
    * In other words - verify that the hook routine worked.
    */
   fprintf(stdout, "Inside the client-defined reporting function.\n");
   fflush(stdout);

   /*
    * When the report type is for an ASSERT,
    * we'll report some information, but we also
    * want _CrtDbgReport to get called -
    * so we'll return TRUE.
    *
    * When the report type is a WARNing or ERROR,
    * we'll take care of all of the reporting. We don't
    * want _CrtDbgReport to get called -
    * so we'll return FALSE.
    */
   if (reportType == _CRT_ASSERT)
   {
      gl_num_asserts++;
      fprintf(stdout, "This is the number of Assertion failures that
      ➥ have occurred: %d \n", gl_num_asserts);
      fflush(stdout);
      fprintf(stdout, "Returning TRUE from the client-defined reporting
      ➥ function.\n");
      fflush(stdout);
      return(TRUE);
   } else {
```

```
        fprintf(stdout, "This is the debug user message: %s \n", userMessage);
        fflush(stdout);
        fprintf(stdout, "Returning FALSE from the client-defined reporting
        ↪ function.\n");
        fflush(stdout);
        return(FALSE);
    }

    /*
     * By setting retVal to zero, we are instructing _CrtDbgReport
     * to continue with normal execution after generating the report.
     * If we wanted _CrtDbgReport to start the debugger, we would set
     * retVal to one.
     */
    retVal = 0;
}

int main()
{
        char *p1, *p2;

    /*
     * Hook in our client-defined reporting function.
     * Every time a _CrtDbgReport is called to generate
     * a debug report, our function will get called first.
     */
    _CrtSetReportHook( OurReportingFunction );

    /*
     * Define the report destination(s) for each type of report
     * we are going to generate.  In this case, we are going to
     * generate a report for every report type: _CRT_WARN,
     * _CRT_ERROR, and _CRT_ASSERT.
     * The destination(s) is defined by specifying the report mode(s)
     * and report file for each report type.
     * This program sends all report types to stdout.
     */
    _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);
    /*
     * Allocate and assign the pointer variables
     */
    p1 = malloc(10);
    strcpy(p1, "I am p1");
    p2 = malloc(10);
    strcpy(p2, "I am p2");
```

```
    /*
     * Use the report macros as a debugging
     * warning mechanism, similar to printf.
     *
     * Use the assert macros to check if the
     * p1 and p2 variables are equivalent.
     *
     * If the expression fails, _ASSERTE will
     * include a string representation of the
     * failed expression in the report.
     *
     *  _ASSERT does not include the
     * expression in the generated report.
     */
    _RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the expression
    ↪ p1 == p2.\n");
    _RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
    _ASSERT(p1 == p2);

    _RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
    _ASSERTE(p1 == p2);

    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Inside the client-defined reporting function.
This is the debug user message: Use the assert macros to evaluate
↪ the expression p1 == p2
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(54) : Will _ASSERT find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 1
Returning TRUE from the client-defined reporting function.
dbgmacro.c(55) : Assertion failed
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(57) : Will _ASSERTE find
↪ 'I am p1' == 'I am p2' ?
```

```
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 2
Returning TRUE from the client-defined reporting function.
dbgmacro.c(58) : Assertion failed: p1 == p2
Inside the client-defined reporting function.
This is the debug user message: 'I am p1' != 'I am p2'
Returning FALSE from the client-defined reporting function.
```

See Also: **_CrtSetReportMode, _CrtSetReportFile, printf, _DEBUG**

_CrtDoForAllClientObjects

Calls an application-supplied function for all **_CLIENT_BLOCK** types in the heap (debug version only).

void _CrtDoForAllClientObjects(void (*pfn)(void *, void *), void **context* **);**

Routine	Required Header	Compatibility
_CrtDoForAllClientObjects	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

None

Parameters

*void (*pfn)(void *, void *)* Pointer to the application-supplied function to call

context Pointer to the application-supplied context to pass to the application-supplied function

Remarks

The **_CrtDoForAllClientObjects** function searches the heap's linked list for memory blocks with the **_CLIENT_BLOCK** type and calls the application-supplied function when a block of this type is found. The found block and the *context* parameter are passed as arguments to the application-supplied function. During debugging, an application can track a specific group of allocations by explicitly calling the debug heap functions to allocate the memory and specifying that the blocks be assigned the **_CLIENT_BLOCK** block type. These blocks can then be tracked separately and reported on differently during leak detection and memory state reporting.

If the **_CRTDBG_ALLOC_MEM_DF** bit field of the **_crtDbgFlag** flag is not turned on, **_CrtDoForAllClientObjects** immediately returns. When **_DEBUG** is not defined, calls to **_CrtDoForAllClientObjects** are removed during preprocessing.

Example

```
/*
 * DFACOBJS.C
 * This program allocates some CLIENT type blocks of memory
 * and then calls _CrtDoForAllClientObjects to print out the contents
 * of each client block found on the heap.
 */

#include <crtdbg.h>
#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>

/*
 * My Memory Block linked-list data structure
 */
typedef struct MyMemoryBlockStruct
{
   struct MyMemoryBlockStruct *NextPtr;
   int blockType;
   int allocNum;
} aMemoryBlock;
aMemoryBlock *HeadPtr;
aMemoryBlock *TailPtr;

/*
 * CreateMemoryBlock
 * allocates a block of memory, fills in the data structure
 * and adds the new block to the linked list
 * Returns 1 if successful, otherwise 0
 */
int CreateMemoryBlock(
   int allocNum,
   int blockType
   )
{
   aMemoryBlock *blockPtr;
   size_t size;

   size = sizeof( struct MyMemoryBlockStruct );
   if ( blockType == _CLIENT_BLOCK )
      blockPtr = (aMemoryBlock *) _malloc_dbg( size, _CLIENT_BLOCK,
      ↪ __FILE__, __LINE__ );
   else
```

```
      blockPtr = (aMemoryBlock *) _malloc_dbg( size, _NORMAL_BLOCK,
      ↪ __FILE__, __LINE__ );

   if ( blockPtr == NULL )
      return(0);

   blockPtr->allocNum = allocNum;
   blockPtr->blockType = blockType;

   blockPtr->NextPtr = NULL;
   if ( HeadPtr == NULL )
      HeadPtr = blockPtr;
   else
      TailPtr->NextPtr = blockPtr;
   TailPtr = blockPtr;
   return(1);
}

/*
 * RestoreMemoryToHeap
 * restores all of the memory that we allocated on the heap
 */
void RestoreMemoryToHeap( )
{
   aMemoryBlock *blockPtr;

   if (!HeadPtr)
      return;

   while ( HeadPtr->NextPtr != NULL )
   {
      blockPtr = HeadPtr->NextPtr;
      if  ( HeadPtr->blockType == _CLIENT_BLOCK )
         _free_dbg( HeadPtr, _CLIENT_BLOCK );
      else
         _free_dbg( HeadPtr, _NORMAL_BLOCK );

      HeadPtr = blockPtr;
   }
}

/*
 * MyClientObjectHook
 * A hook function for performing some action on all
 * client blocks found on the heap - In this case, print
 * out the value stored at each memory address.
 */
void __cdecl MyClientObjectHook(
   void * pUserData,
   void * ignored
   )
{
```

```
    aMemoryBlock *blockPtr;
    long allocReqNum;
    int success;

    blockPtr = (aMemoryBlock *) pUserData;

    /*
     * Let's retrieve the actual object allocation order request number
     * and see if it's different from the allocation number we stored
     * in our data structure.
     */
    success = _CrtIsMemoryBlock((const void *) blockPtr,
          (unsigned int) sizeof( struct MyMemoryBlockStruct ),
          &allocReqNum, NULL, NULL );
    if ( success )
    printf( "Block #%d \t Type: %d \t Allocation Number: %d\n",
             blockPtr->allocNum, blockPtr->blockType, allocReqNum);
    else
    {
          printf("ERROR: not a valid memory block.\n");
          exit( 1 );
    }
}

void main( void )
{
    div_t div_result;
    int i, success, tmpFlag;

    /*
     * Set the _crtDbgFlag to turn debug type allocations.
     * This will enable us to specify that blocks of type
     * _CLIENT_BLOCK can be allocated and tracked separately.
     * Turn off checking for internal CRT blocks.
     */
    tmpFlag = _CrtSetDbgFlag( _CRTDBG_REPORT_FLAG );
    tmpFlag |= _CRTDBG_ALLOC_MEM_DF;
    tmpFlag &= _CRTDBG_CHECK_CRT_DF;
    _CrtSetDbgFlag( tmpFlag );

    /*
     * We're going to allocate 22 blocks and every other block is
     * going to be of type _CLIENT_BLOCK.
     * Blocks numbered 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22
     * should all be _CLIENT_BLOCKS.
     */
    HeadPtr = NULL;
    printf("Allocating the memory ");
    for (i=1; i < 23; i++)
    {
         div_result = div( i, 2);
    if ( div_result.rem > 0 )
       success = CreateMemoryBlock( i, _NORMAL_BLOCK );
```

```
    else
       success = CreateMemoryBlock( i, _CLIENT_BLOCK );

    if ( !success )
    {
          printf(" ERROR.\n");
             exit( 1 );
       }
    else
       printf(".");
    }
    printf(" done.\n");

    /*
     * We're going to call _CrtDoForAllClientObjects to make sure that
     * only blocks numbered 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22
     * got allocated as _CLIENT_BLOCKS.
     */
    _CrtDoForAllClientObjects( MyClientObjectHook, NULL );

    /*
     * Restore the memory to the heap
     */
    RestoreMemoryToHeap();
    exit( 0 );
}
```

Output

```
The instruction at "0x00401153" referenced memory at "0x00000004".
The memory could not be "read".
```

See Also: _CrtSetDbgFlag

_CrtDumpMemoryLeaks

Dumps all of the memory blocks in the debug heap when a memory leak has occurred (debug version only).

int _CrtDumpMemoryLeaks(void);

Routine	Required Header	Compatibility
_CrtDumpMemoryLeaks	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtDumpMemoryLeaks returns TRUE if a memory leak is found; otherwise, the function returns FALSE.

Remarks

The **_CrtDumpMemoryLeaks** function determines whether a memory leak has occurred since the start of program execution. When a leak is found, the debug header information for all of the objects in the heap is dumped in a user-readable form. When **_DEBUG** is not defined, calls to **_CrtDumpMemoryLeaks** are removed during preprocessing.

_CrtDumpMemoryLeaks is frequently called at the end of program execution to verify that all memory allocated by the application has been freed. The function can be called automatically at program termination by turning on the **_CRTDBG_LEAK_CHECK_DF** bit field of the **_crtDbgFlag** flag using the **_CrtSetDbgFlag** function.

_CrtDumpMemoryLeaks calls **_CrtMemCheckpoint** to obtain the current state of the heap and then scans the state for blocks that have not been freed. When an unfreed block is encountered, **_CrtDumpMemoryLeaks** calls **_CrtMemDumpAllObjectsSince** to dump information for all of the objects allocated in the heap from the start of program execution.

By default, internal C run-time blocks (**_CRT_BLOCK**) are not included in memory dump operations. The **_CrtSetDbgFlag** function can be used to turn on the **_CRTDBG_CHECK_CRT_DF** bit of **_crtDbgFlag** to include these blocks in the leak detection process.

Example

See Example 1 on page 75.

_CrtIsValidHeapPointer

Verifies that a specified pointer is in the local heap (debug version only).

int _CrtIsValidHeapPointer(const void **userData* **);**

Routine	Required Header	Compatibility
_CrtIsValidHeapPointer	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtIsValidHeapPointer returns TRUE if the specified pointer is in the local heap; otherwise, the function returns FALSE.

Parameter

userData Pointer to the beginning of an allocated memory block

Remarks

The **_CrtIsValidHeapPointer** function is used to ensure that a specific memory address is within the local heap. The "local" heap refers to the heap created and managed by a particular instance of the C run-time library. If a dynamically linked library (DLL) contains a static link to the run-time library, then it has its own instance of the run-time heap, and therefore its own heap, independent of the application's local heap. When **_DEBUG** is not defined, calls to **_CrtIsValidHeapPointer** are removed during preprocessing.

Because this function returns TRUE or FALSE, it can be passed to one of the **_ASSERT** macros to create a simple debugging error handling mechanism. The following example will cause an assertion failure if the specified address is not located within the local heap:

```
_ASSERTE( _CrtIsValidHeapPointer( userData ) );
```

Example

```
/*
 * ISVALID.C
 * This program allocates a block of memory using _malloc_dbg
 * and then tests the validity of this memory by calling _CrtIsMemoryBlock,
 * _CrtIsValidPointer, and _CrtIsValidHeapPointer.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

#define  TRUE   1
#define  FALSE  0

void main( void )
{
      char *my_pointer;

      /*
       * Call _malloc_dbg to include the filename and line number
       * of our allocation request in the header information
       */
      my_pointer = (char *)_malloc_dbg( sizeof(char) * 10, _NORMAL_BLOCK,
      ➥ __FILE__, __LINE__ );
```

```
        /*
         * Ensure that the memory got allocated correctly
         */
        _CrtIsMemoryBlock((const void *)my_pointer, sizeof(char) * 10,
        ↪ NULL, NULL, NULL );

        /*
         * Test for read/write accessibility
         */
        if (_CrtIsValidPointer((const void *)my_pointer, sizeof(char) * 10, TRUE))
              printf("my_pointer has read and write accessibility.\n");
        else
              printf("my_pointer only has read access.\n");

        /*
         * Make sure my_pointer is within the local heap
         */
        if (_CrtIsValidHeapPointer((const void *)my_pointer))
              printf("my_pointer is within the local heap.\n");
        else
              printf("my_pointer is not located within the local heap.\n");

        free(my_pointer);
}
```

Output

```
my_pointer has read and write accessibility.
my_pointer is within the local heap.
```

_CrtIsMemoryBlock

Verifies that a specified memory block is in the local heap and that it has a valid debug heap block type identifier (debug version only).

int _CrtIsMemoryBlock(const void **userData*, **unsigned int** *size*,
↪ **long** **requestNumber*, **char** ***filename*, **int** **linenumber* **);**

Routine	Required Header	Compatibility
_CrtIsMemoryBlock	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtIsMemoryBlock returns TRUE if the specified memory block is located within the local heap and has a valid debug heap block type identifier; otherwise, the function returns FALSE.

Parameter

userData Pointer to the beginning of the memory block to verify

size Size of the specified block (bytes)

requestNumber Pointer to the allocation number of the block or NULL

filename Pointer to name of source file that requested the block or NULL

linenumber Pointer to the line number in the source file or NULL

Remarks

The **_CrtIsMemoryBlock** function verifies that a specified memory block is located within the application's local heap and that it has a valid block type identifier. This function can also be used to obtain the object allocation order number and source file name/line number where the memory block allocation was originally requested. Passing non-NULL values for the *requestNumber*, *filename*, and/or *linenumber* parameters causes **_CrtIsMemoryBlock** to set these parameters to the values in the memory block's debug header, if it finds the block in the local heap. When **_DEBUG** is not defined, calls to **_CrtIsMemoryBlock** are removed during preprocessing.

Because this function returns TRUE or FALSE, it can be passed to one of the **_ASSERT** macros to create a simple debugging error handling mechanism. The following example will cause an assertion failure if the specified address is not located within the local heap:

```
_ASSERTE( _CrtIsMemoryBlock( userData, size, &requestNumber, &filename,
↪ &linenumber ) );
```

Example

```
/*
 * ISVALID.C
 * This program allocates a block of memory using _malloc_dbg
 * and then tests the validity of this memory by calling _CrtIsMemoryBlock,
 * _CrtIsValidPointer, and _CrtIsValidHeapPointer.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

#define  TRUE   1
#define  FALSE  0

void main( void )
{
      char *my_pointer;
```

```
        /*
         * Call _malloc_dbg to include the filename and line number
         * of our allocation request in the header information
         */
        my_pointer = (char *)_malloc_dbg( sizeof(char) * 10,
        ➥ _NORMAL_BLOCK, __FILE__, __LINE__ );

        /*
         * Ensure that the memory got allocated correctly
         */
        _CrtIsMemoryBlock((const void *)my_pointer, sizeof(char) * 10,
        ➥ NULL, NULL, NULL );

        /*
         * Test for read/write accessibility
         */
        if (_CrtIsValidPointer((const void *)my_pointer, sizeof(char) * 10, TRUE))
              printf("my_pointer has read and write accessibility.\n");
        else
              printf("my_pointer only has read access.\n");

        /*
         * Make sure my_pointer is within the local heap
         */
        if (_CrtIsValidHeapPointer((const void *)my_pointer))
              printf("my_pointer is within the local heap.\n");
        else
              printf("my_pointer is not located within the local heap.\n");

        free(my_pointer);
}
```

Output

```
my_pointer has read and write accessibility.
my_pointer is within the local heap.
```

_CrtIsValidPointer

Verifies that a specified memory range is valid for reading and writing (debug version only).

int _CrtIsValidPointer(const void **address*, **unsigned int** *size*, **int** *access* **);**

Routine	Required Header	Compatibility
_CrtIsValidPointer	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtIsValidPointer returns TRUE if the specified memory range is valid for the specified operation(s); otherwise, the function returns FALSE.

Parameter

address Points to the beginning of the memory range to test for validity

size Size of the specified memory range (bytes)

access Read/Write accessibility to determine for the memory range

Remarks

The **_CrtIsValidPointer** function verifies that the memory range beginning at *address* and extending for *size* bytes, is valid for the specified accessibility operation(s). When *access* is set to TRUE, the memory range is verified for both reading and writing. When *address* is FALSE, the memory range is only validated for reading. When **_DEBUG** is not defined, calls to **_CrtIsValidPointer** are removed during preprocessing.

Because this function returns TRUE or FALSE, it can be passed to one of the **_ASSERT** macros to create a simple debugging error handling mechanism. The following example will cause an assertion failure if the memory range is not valid for both reading and writing operations:

```
_ASSERTE( _CrtIsValidPointer( address, size, TRUE ) );
```

Example

```
/*
 * ISVALID.C
 * This program allocates a block of memory using _malloc_dbg
 * and then tests the validity of this memory by calling _CrtIsMemoryBlock,
 * _CrtIsValidPointer, and _CrtIsValidHeapPointer.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

#define  TRUE   1
#define  FALSE  0

void main( void )
{
      char *my_pointer;
```

```
        /*
         * Call _malloc_dbg to include the filename and line number
         * of our allocation request in the header information
         */
        my_pointer = (char *)_malloc_dbg( sizeof(char) * 10, _NORMAL_BLOCK,
        ➥ __FILE__, __LINE__ );

        /*
         * Ensure that the memory got allocated correctly
         */
        _CrtIsMemoryBlock((const void *)my_pointer, sizeof(char) * 10,
        ➥ NULL, NULL, NULL );

        /*
         * Test for read/write accessibility
         */
        if (_CrtIsValidPointer((const void *)my_pointer, sizeof(char) * 10, TRUE))
              printf("my_pointer has read and write accessibility.\n");
        else
              printf("my_pointer only has read access.\n");

        /*
         * Make sure my_pointer is within the local heap
         */
        if (_CrtIsValidHeapPointer((const void *)my_pointer))
              printf("my_pointer is within the local heap.\n");
        else
              printf("my_pointer is not located within the local heap.\n");

        free(my_pointer);
}
```

Output

```
my_pointer has read and write accessibility.
my_pointer is within the local heap.
```

_CrtMemCheckpoint

Obtains the current state of the debug heap and stores in an application-supplied **_CrtMemState** structure (debug version only).

void _CrtMemCheckpoint(_CrtMemState **state* **);**

Routine	Required Header	Compatibility
_CrtMemCheckpoint	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

None

Parameter

state Pointer to **_CrtMemState** structure to fill with the memory checkpoint

Remarks

The **_CrtMemCheckpoint** function creates a snapshot of the current state of the debug heap at any given moment, which can be used by other heap state functions to help detect memory leaks and other problems. When **_DEBUG** is not defined, calls to **_CrtMemState** are removed during preprocessing.

The application must pass a pointer to a previously allocated instance of the **_CrtMemState** structure, defined in CRTDBG.H, in the *state* parameter. If **_CrtMemCheckpoint** encounters an error during the checkpoint creation, the function generates a **_CRT_WARN** debug report describing the problem.

Example

See Example 1 on page 75.

_CrtMemDifference

Compares two memory states and returns their differences (debug version only).

int _CrtMemDifference(_CrtMemState **stateDiff*, **const _CrtMemState** **oldState*,
↪ **const _CrtMemState** **newState* **);**

Routine	Required Header	Compatibility
_CrtMemDifference	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

If the memory states are significantly different, **_CrtMemDifference** returns TRUE; otherwise, the function returns FALSE.

Parameters

stateDiff Pointer to a **_CrtMemState** structure that will be used to store the differences between the two memory states (returned)

oldState Pointer to an earlier memory state (**_CrtMemState** structure)

newState Pointer to a later memory state (**_CrtMemState** structure)

Remarks

The **_CrtMemDifference** function compares *oldState* and *newState* and stores their differences in *stateDiff*, which can then be used by the application to detect memory leaks and other memory problems. When **_DEBUG** is not defined, calls to **_CrtMemDifference** are removed during preprocessing.

newState and *oldState* must each be a valid pointer to a **_CrtMemState** structure, defined in CRTDBG.H, that has been filled in by **_CrtMemCheckpoint** before calling **_CrtMemDifference**. *stateDiff* must be a pointer to a previously allocated instance of the **_CrtMemState** structure.

_CrtMemDifference compares the **_CrtMemState** field values of the blocks in *oldState* to those in *newState* and stores the result in *stateDiff*. When the number of allocated block types or total number of allocated blocks for each type differs between the two memory states, the states are said to be significantly different. The difference between the two states' high water count and total allocations is also stored in *stateDiff*.

By default, internal C run-time blocks (**_CRT_BLOCK**) are not included in memory state operations. The **_CrtSetDbgFlag** function can be used to turn on the **_CRTDBG_CHECK_CRT_DF** bit of **_crtDbgFlag** to include these blocks in leak detection and other memory state operations. Freed memory blocks (**_FREE_BLOCK**) do not cause **_CrtMemDifference** to return TRUE.

Example

See Example 1 on page 75.

See Also: _crtDbgFlag

_CrtMemDumpAllObjectsSince

Dumps information about objects in the heap from the start of program execution or from a specified heap state (debug version only).

void _CrtMemDumpAllObjectsSince(const _CrtMemState **state* **);**

Routine	Required Header	Compatibility
_CrtMemDumpAll-ObjectsSince	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

None

Parameter

state Pointer to the heap state to begin dumping from or NULL

Remarks

The **_CrtMemDumpAllObjectsSince** function dumps the debug header information of objects allocated in the heap in a user-readable form. The dump information can be used by the application to track allocations and detect memory problems. When **_DEBUG** is not defined, calls to **_CrtMemDumpAllObjectsSince** are removed during preprocessing.

_CrtMemDumpAllObjectsSince uses the value of the *state* parameter to determine where to initiate the dump operation. To begin dumping from a specified heap state, the *state* parameter must be a pointer to a **_CrtMemState** structure that has been filled in by **_CrtMemCheckpoint** before **_CrtMemDumpAllObjectsSince** was called. When *state* is NULL, the function begins the dump from the start of program execution.

If the application has installed a dump hook function by calling **_CrtSetDumpClient**, then every time **_CrtMemDumpAllObjectsSince** dumps information about a **_CLIENT_BLOCK** type of block, it calls the application-supplied dump function as well. By default, internal C run-time blocks (**_CRT_BLOCK**) are not included in memory dump operations. The **_CrtSetDbgFlag** function can be used to turn on the **_CRTDBG_CHECK_CRT_DF** bit of **_crtDbgFlag** to include these blocks. In addition, blocks marked as freed or ignored (**_FREE_BLOCK**, **_IGNORE_BLOCK**) are not included in the memory dump.

Example

```
/*************************************************************
 *  EXAMPLE  2                                               *
 *  ----------                                               *
 *  This program illustrates several ways to use debugging hook  *
 *  functions with the new debug versions of the C runtime       *
 *  libraries. To add some realism, it has a few elements of an  *
 *  actual application, including two bugs.                      *
 *                                                               *
 *  The program stores birthdate information in a linked list    *
 *  of Client blocks. A Client-dump hook function validates the  *
 *  birthday data and reports the contents of the Client blocks. *
 *  An allocation hook function logs heap operations to a text   *
```

```
 *  file, and the report hook function logs reports to the same  *
 *  text file.                                                   *
 *                                                               *
 *  NOTE: The allocation hook function explicitly excludes CRT   *
 *        blocks (the memory allocated internally by the C       *
 *        runtime library) from its log. It is important to      *
 *        understand why! The hook function uses fprintf( ) to   *
 *        write to the log file, and fprintf( ) allocates a CRT  *
 *        block. If CRT blocks were not excluded in this case,   *
 *        an endless loop would be created in which fprintf( )   *
 *        would cause the hook function to be called, and the    *
 *        hook would in turn call fprintf( ), which would cause  *
 *        the hook to be called again, and so on. The moral is:  *
 *                                                               *
 *   -->  IF YOUR ALLOCATION HOOK USES ANY C RUNTIME FUNCTION    *
 *        THAT ALLOCATES MEMORY, THE HOOK MUST IGNORE CRT-TYPE   *
 *        ALLOCATION OPERATIONS!                                 *
 *                                                               *
 *  HINT: If you want to be able to report CRT-type blocks in    *
 *        your allocation hook, use Windows API functions for    *
 *        formatting and output, instead of C runtime functions. *
 *        Since the Windows APIs do not use the CRT heap, they   *
 *        will not trap your hook in an endless loop.            *
 *                                                               *
 *  BUGS: There are two bugs in the program below, which the     *
 *        debug heap features identify in several ways. One bug  *
 *        is that the birthDay.Name field is not large enough    *
 *        to hold several of the test names. The field should    *
 *        be larger, and strncpy( ) should be used in place of   *
 *        strcpy( ). The second bug is that the while( ) loop    *
 *        in the printRecords( ) function should not end until   *
 *        HeadPtr itself == NULL. This bug results not only in   *
 *        an incomplete display of birthdays, but also in a      *
 *        memory leak. In addition to these two bugs, Gauss'     *
 *        birthday data is out of range (April 30, not 32).      *
 *                                                               *
 *****************************************************************/

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <malloc.h>
#include <time.h>
#include <crtdbg.h>

/*****************************************************************
 *  DATA DECLARATIONS AND DEFINES                                *
 *****************************************************************/

// The following arrays provide test data for the example program:
const char * Names[] =
{
   "George Washington",
   "Thomas Jefferson",
```

```
   "Carl Friedrich Gauss",
   "Ludwig van Beethoven",
   "Thomas Carlyle"
} ;

const int Dates[] =
{
   1732,  2, 11,
   1743,  4, 13,
   1777,  4, 32,
   1795, 12,  4,
   1770, 12, 16
} ;

#define  TEST_RECS            5
// A generic sort of linked-list data structure, in this case for birthdays:
typedef struct BirthdayStruct
{
   struct BirthdayStruct * NextRec;
   int   Year;
   int   Month;
   int   Day;
   char  Name[20];
} birthDay;

birthDay * HeadPtr;
birthDay * TailPtr;

#define  FILE_IO_ERROR        0
#define  OUT_OF_MEMORY        1

#define  TRUE                 7
#define  FALSE                0

// Macros for setting or clearing bits in the CRT debug flag
#ifdef _DEBUG
#define  SET_CRT_DEBUG_FIELD(a)   _CrtSetDbgFlag((a) |
➥ _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG))
#define  CLEAR_CRT_DEBUG_FIELD(a) _CrtSetDbgFlag(~(a) &
➥ _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG))
#else
#define  SET_CRT_DEBUG_FIELD(a)   ((void) 0)
#define  CLEAR_CRT_DEBUG_FIELD(a) ((void) 0)
#endif


/*****************************************************************
 *  SPECIAL-PURPOSE ROUTINES                                     *
 *****************************************************************/

/* ERROR HANDLER
   -------------
   Handling serious errors gracefully is a real test of craftsmanship.
   This function is just a stub; it doesn't really handle errors.
```

```
*/
void FatalError( int ErrType )
{
   exit( 1 );
}


/* MEMORY ALLOCATION FUNCTION
   -------------------------
   The createRecord function allocates memory for a new birthday record,
   fills in the structure members, and then adds the record to a linked list.
   In debug builds, it makes these allocations in Client blocks. If memory
   is not available, it calls the error handler.
*/
void createRecord(
   const int    Year,
   const int    Month,
   const int    Day,
   const char * Name
#ifdef _DEBUG
,  const unsigned char * szFileName, int nLine
#endif
   )
{
   birthDay * ptr;
   size_t n;

   n = sizeof( struct BirthdayStruct );
   ptr = (birthDay *) _malloc_dbg( n, _CLIENT_BLOCK, szFileName, nLine );
   if( ptr == NULL )
      FatalError( OUT_OF_MEMORY );
   ptr->Year = Year;
   ptr->Month = Month;
   ptr->Day = Day;
   strcpy( ptr->Name, Name );
   ptr->NextRec = NULL;
   if ( HeadPtr == NULL )  // If this is the first record in the linked list
      HeadPtr = ptr;
   else
      TailPtr->NextRec = ptr;
   TailPtr = ptr;
}


/* BIRTHDAY DISPLAY FUNCTION
   ------------------------
   This function traverses the linked list, displays the birthday data,
   and then frees the memory blocks used to store the birthdays.
*/
void printRecords( )
{
   birthDay * ptr;
   char *months[] = {
      "", "January", "February", "March", "April", "May", "June", "July",
      "August", "September", "October", "November", "December" };
```

```
   if ( HeadPtr == NULL )        // Do nothing if list is empty
      return;

   printf( "\n\nThis is the birthday list:\n" );
   while ( HeadPtr->NextRec != NULL )
   {
      printf( "   %s was born on %s %d, %d.\n",
         HeadPtr->Name, months[HeadPtr->Month], HeadPtr->Day, HeadPtr->Year );
      ptr = HeadPtr->NextRec;
      _free_dbg( HeadPtr, _CLIENT_BLOCK );
      HeadPtr = ptr;
   }
}


/*****************************************************************
 *  DEBUG C RUNTIME LIBRARY HOOK FUNCTIONS AND DEFINES           *
 *****************************************************************/
#ifdef _DEBUG
#define  createRecord(a, b, c, d) \
       createRecord(a, b, c, d, __FILE__, __LINE__)
FILE *logFile;                // Used to log allocation information
const char lineStr[] = { "--------------------------------------\
--------------------------------------\n"  };

/* CLIENT DUMP HOOK FUNCTION
   -------------------------
   A hook function for dumping a Client block usually reports some
   or all of the contents of the block in question.  The function
   below also checks the data in several ways, and reports corruption
   or inconsistency as an assertion failure.
*/
void __cdecl MyDumpClientHook(
   void * pUserData,
   size_t nBytes
   )
{
   birthDay * bday;

   bday = (birthDay *) pUserData;

   _RPT4( _CRT_WARN, "   The birthday of %s is %d/%d/%d.\n",
          bday->Name, bday->Month, bday->Day, bday->Year );
   _ASSERTE( ( bday->Day > 0 ) && ( bday->Day < 32 ) );
   _ASSERTE( ( bday->Month > 0 ) && ( bday->Month < 13 ) );
   _ASSERTE( ( bday->Year > 0 ) && ( bday->Year < 1996 ) );
}


/* ALLOCATION HOOK FUNCTION
   ------------------------
   An allocation hook function can have many, many different
   uses. This one simply logs each allocation operation in a file.
*/
```

```
int __cdecl MyAllocHook(
   int      nAllocType,
   void   * pvData,
   size_t   nSize,
   int      nBlockUse,
   long     lRequest,
   const unsigned char * szFileName,
   int      nLine
   )
{
   char *operation[] = { "", "allocating", "re-allocating", "freeing" };
   char *blockType[] = { "Free", "Normal", "CRT", "Ignore", "Client" };

   if ( nBlockUse == _CRT_BLOCK )  // Ignore internal C runtime
   ↪ library allocations
      return( TRUE );

   _ASSERT( ( nAllocType > 0 ) && ( nAllocType < 4 ) );
   _ASSERT( ( nBlockUse >= 0 ) && ( nBlockUse < 5 ) );

   fprintf( logFile,
            "Memory operation in %s, line %d: %s a %d-byte
            ↪ '%s' block (# %ld)\n",
            szFileName, nLine, operation[nAllocType], nSize,
            blockType[nBlockUse], lRequest );
   if ( pvData != NULL )
      fprintf( logFile, " at %X", pvData );

   return( TRUE );     // Allow the memory operation to proceed
}


/* REPORT HOOK FUNCTION
   --------------------
   Again, report hook functions can serve a very wide variety of purposes.
   This one logs error and assertion failure debug reports in the
   log file, along with 'Damage' reports about overwritten memory.

   By setting the retVal parameter to zero, we are instructing _CrtDbgReport
   to return zero, which causes execution to continue. If we want the
   function to start the debugger, we should have _CrtDbgReport return one.
*/
int MyReportHook(
   int   nRptType,
   char *szMsg,
   int  *retVal
   )
{
   char *RptTypes[] = { "Warning", "Error", "Assert" };

   if ( ( nRptType > 0 ) || ( strstr( szMsg, "DAMAGE" ) ) )
      fprintf( logFile, "%s: %s", RptTypes[nRptType], szMsg );
```

```
   retVal = 0;

   return( TRUE );         // Allow the report to be made as usual

}
#endif                     // End of #ifdef _DEBUG



/*****************************************************************
 *  MAIN FUNCTION                                                *
 *****************************************************************/
void main( )
{
   int i, j;

#ifdef _DEBUG
   _CrtMemState checkPt1;
   char timeStr[10], dateStr[10];         // Used to set up log file

   // Send all reports to STDOUT, since this example is a console app
   _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

   // Set the debug heap to report memory leaks when the process terminates,
   // and to keep freed blocks in the linked list.
   SET_CRT_DEBUG_FIELD( _CRTDBG_LEAK_CHECK_DF | _CRTDBG_DELAY_FREE_MEM_DF );

   // Open a log file for the hook functions to use
   logFile = fopen( "MEM-LOG.TXT", "w" );
   if ( logFile == NULL )
      FatalError( FILE_IO_ERROR );
   _strtime( timeStr );
   _strdate( dateStr );
   fprintf( logFile,
            "Memory Allocation Log File for Example Program,
            run at %s on %s.\n", timeStr, dateStr );
   fputs( lineStr, logFile );

   // Install the hook functions
   _CrtSetDumpClient( MyDumpClientHook );
   _CrtSetAllocHook( MyAllocHook );
   _CrtSetReportHook( MyReportHook );

#endif                     // End of #ifdef _DEBUG

   HeadPtr = NULL;

   // Create a trial birthday record.
   createRecord( 1749, 3, 23, "Pierre de Laplace" );
```

```
    // Check the debug heap, and dump the new birthday record. --Note that
    // debug C runtime library functions such as _CrtCheckMemory( ) and
    // _CrtMemDumpAllObjectsSince( ) automatically disappear in a release build.
    _CrtMemDumpAllObjectsSince( NULL );
    _CrtCheckMemory( );
    _CrtMemCheckpoint( &checkPt1 );

    // Since everything has worked so far, create more records
    for ( i = 0, j = 0; i < TEST_RECS; i++, j+=3 )
       createRecord( Dates[j], Dates[j+1], Dates[j+2], Names[i] );

    // Examine the results
    _CrtMemDumpAllObjectsSince( &checkPt1 );
    _CrtMemCheckpoint( &checkPt1 );
    _CrtMemDumpStatistics( &checkPt1 );
    _CrtCheckMemory( );

    // This fflush needs to be removed...
    fflush( logFile );

    // Now try displaying the records, which frees the memory being used
    printRecords( );

    // OK, time to go. Did I forget to turn out any lights? I could
    // check explicitly using _CrtDumpMemoryLeaks( ), but I have set
    // _CRTDBG_LEAK_CHECK_DF, so the C runtime library debug heap will
    // automatically alert me at exit of any memory leaks.

#ifdef _DEBUG
    fclose( logFile );
#endif
}
```

Output

Screen output:

```
Dumping objects ->
C:\DEV\EXAMPLE2.C(327) : {13} client block at 0x00661B38, subtype 0,
➥ 36 bytes long:
    The birthday of Pierre de Laplace is 3/23/1749.
Object dump complete.
Dumping objects ->
C:\DEV\EXAMPLE2.C(338) : {18} client block at 0x00661CB4, subtype 0,
➥ 36 bytes long:
    The birthday of Thomas Carlyle is 12/16/1770.
C:\DEV\EXAMPLE2.C(338) : {17} client block at 0x00661C68, subtype 0,
➥ 36 bytes long:
    The birthday of Ludwig van Beethoven is 12/4/1795.
C:\DEV\EXAMPLE2.C(338) : {16} client block at 0x00661C1C, subtype 0,
➥ 36 bytes long:
    The birthday of Carl Friedrich Gauss is 4/32/1777.
C:\DEV\EXAMPLE2.C(219) : Assertion failed: ( bday->Day > 0 ) &&
➥ ( bday->Day < 32 )
C:\DEV\EXAMPLE2.C(338) : {15} client block at 0x00661BD0, subtype 0,
➥ 36 bytes long:
    The birthday of Thomas Jefferson is 4/13/1743.
```

```
C:\DEV\EXAMPLE2.C(338) : {14} client block at 0x00661B84, subtype 0,
↪ 36 bytes long:
   The birthday of George Washington is 2/11/1732.
Object dump complete.
0 bytes in 0 Free Blocks.
0 bytes in 0 Normal Blocks.
6442 bytes in 12 CRT Blocks.
0 bytes in 0 IgnoreClient Blocks.
216 bytes in 6 (null) Blocks.
Largest number used: 6658 bytes.
Total allocations: 6658 bytes.
memory check error at 0x00661C8C = 0x00, should be 0xFD.
DAMAGE: after (null) block (#17) at 0x00661C68.
(null) allocated at file C:\DEV\EXAMPLE2.C(338).
(null) located at 0x00661C68 is 36 bytes long.
memory check error at 0x00661C40 = 0x00, should be 0xFD.
DAMAGE: after (null) block (#16) at 0x00661C1C.
(null) allocated at file C:\DEV\EXAMPLE2.C(338).
(null) located at 0x00661C1C is 36 bytes long.
memory check error at 0x00661C40 = 0x00, should be 0xFD.
DAMAGE: after (null) block (#16) at 0x00661C1C.
memory check error at 0x00661C8C = 0x00, should be 0xFD.
DAMAGE: after (null) block (#17) at 0x00661C68.


This is the birthday list:
   Pierre de Laplace was born on March 23, 1749.
   George Washington was born on February 11, 1732.
   Thomas Jefferson was born on April 13, 1743.
   Carl Friedrich Gauss was born on April 32, 1777.
   Ludwig van Beethoven was born on December 4, 1795.
Detected memory leaks!
Dumping objects ->
C:\DEV\EXAMPLE2.C(338) : {18} client block at 0x00661CB4, subtype 0,
↪ 36 bytes long:
   The birthday of Thomas Carlyle is 12/16/1770.
Object dump complete.
```

Log file output:

```
Memory Allocation Log File for Example Program, run at 14:11:01 on 04/28/95.
------------------------------------------------------------------------------
Memory operation in C:\DEV\EXAMPLE2.C, line 327:
                  allocating a 36-byte 'Client' block (# 13)
Memory operation in C:\DEV\EXAMPLE2.C, line 338:
                  allocating a 36-byte 'Client' block (# 14)
Memory operation in C:\DEV\EXAMPLE2.C, line 338:
                  allocating a 36-byte 'Client' block (# 15)
Memory operation in C:\DEV\EXAMPLE2.C, line 338:
                  allocating a 36-byte 'Client' block (# 16)
Memory operation in C:\DEV\EXAMPLE2.C, line 338:
                  allocating a 36-byte 'Client' block (# 17)
Memory operation in C:\DEV\EXAMPLE2.C, line 338:
                  allocating a 36-byte 'Client' block (# 18)
```

```
Assert: C:\DEV\EXAMPLE2.C(219) : Assertion failed:
                  ( bday->Day > 0 ) && ( bday->Day < 32 )
Warning: DAMAGE: after (null) block (#17) at 0x00661C68.
Warning: DAMAGE: after (null) block (#16) at 0x00661C1C.
Memory operation in (null), line 0: freeing a 0-byte 'Client' block (# 0)
 at 661B38Memory operation in (null), line 0:
                  freeing a 0-byte 'Client' block (# 0)
 at 661B84Memory operation in (null), line 0:
                  freeing a 0-byte 'Client' block (# 0)
 at 661BD0Memory operation in (null), line 0:
                  freeing a 0-byte 'Client' block (# 0)
 at 661C1CError: DAMAGE: after (null) block (#16) at 0x00661C1C.
Memory operation in (null), line 0: freeing a 0-byte 'Client' block (# 0)
 at 661C68Error: DAMAGE: after (null) block (#17) at 0x00661C68.
```

See Also: **_crtDbgFlag**

_CrtMemDumpStatistics

Dumps the debug header information for a specified heap state in a user-readable form (debug version only).

void _CrtMemDumpStatistics(const _CrtMemState ***state*** **);**

Routine	Required Header	Compatibility
_CrtMemDumpStatistics	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

None

Parameter

state Pointer to the heap state to dump

Remarks

The **_CrtMemDumpStatistics** function dumps the debug header information for a specified state of the heap in a user-readable form. The dump statistics can be used by the application to track allocations and detect memory problems. The memory state may contain a specific heap state, or the difference between two states. When **_DEBUG** is not defined, calls to **_CrtMemDumpStatistics** are removed during preprocessing.

The *state* parameter must be a pointer to a **_CrtMemState** structure that has been filled in by **_CrtMemCheckpoint** or returned by **_CrtMemDifference** before **_CrtMemDumpStatistics** is called.

Example

See Example 1 on page 75.

_CrtSetAllocHook

Installs a client-defined allocation function by hooking it into the C run-time debug memory allocation process (debug version only).

_CRT_ALLOC_HOOK _CrtSetAllocHook(_CRT_ALLOC_HOOK *allocHook* **);**

Routine	Required Header	Compatibility
_CrtSetAllocHook	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtSetAllocHook returns the previously defined allocation hook function.

Parameter

allocHook New client-defined allocation function to hook into the C run-time debug memory allocation process

Remarks

_CrtSetAllocHook allows an application to hook its own allocation function into the C run-time debug library memory allocation process. As a result, every call to a debug allocation function to allocate, reallocate, or free a memory block triggers a call to the application's hook function. **_CrtSetAllocHook** provides an application with an easy method for testing how the application handles insufficient memory situations, the ability to examine allocation patterns, and the opportunity to log allocation information for later analysis. When **_DEBUG** is not defined, calls to **_CrtSetAllocHook** are removed during preprocessing.

The **_CrtSetAllocHook** function installs the new client-defined allocation function specified in *allocHook* and returns the previously defined hook function. The following example demonstrates how a client-defined allocation hook should be prototyped:

```
int YourAllocHook( int allocType, void *userData, size_t size, int blockType,
   long requestNumber, const unsigned char *filename, int lineNumber);
```

The `allocType` argument specifies the type of allocation operation (**_HOOK_ALLOC**, **_HOOK_REALLOC**, **_HOOK_FREE**) that triggered the call to the allocation's hook function. When the triggering allocation type is **_HOOK_FREE**, `userData` is a pointer to the user data section of the memory block about to be freed. However, when the triggering allocation type is **_HOOK_ALLOC** or **_HOOK_REALLOC**, `userData` is NULL because the memory block has not been allocated yet.

`size` specifies the size of the memory block in bytes, `blockType` indicates the type of the memory block, `requestNumber` is the object allocation order number of the memory block, and if available, `filename` and `lineNumber` specify the source file name and line number where the triggering allocation operation was initiated.

After the hook function has finished processing, it must return a Boolean value, which tells the main C run-time allocation process how to continue. When the hook function wants the main allocation process to continue as if the hook function had never been called, then the hook function should return TRUE. This causes the original triggering allocation operation to be executed. Using this implementation, the hook function can gather and save allocation information for later analysis, without interfering with the current allocation operation or state of the debug heap.

When the hook function wants the main allocation process to continue as if the triggering allocation operation was called and it failed, then the hook function should return FALSE. Using this implementation, the hook function can simulate a wide range of memory conditions and debug heap states to test how the application handles each situation.

Example

See Example 2 on page 99.

_CrtSetBreakAlloc

Sets a breakpoint on a specified object allocation order number (debug version only).

long _CrtSetBreakAlloc(long *lBreakAlloc* **);**

Routine	Required Header	Compatibility
_CrtSetBreakAlloc	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtSetBreakAlloc returns the previous object allocation order number that had a breakpoint set.

Parameter

lBreakAlloc Allocation order number, for which to set the breakpoint

Remarks

_CrtSetBreakAlloc allows an application to perform memory leak detection by breaking at a specific point of memory allocation and tracing back to the origin of the request. The function uses the sequential object allocation order number assigned to the memory block when it was allocated in the heap. When **_DEBUG** is not defined, calls to **_CrtSetBreakAlloc** are removed during preprocessing.

The object allocation order number is stored in the *lRequest* field of the **_CrtMemBlockHeader** structure, defined in CRTDBG.H. When information about a memory block is reported by one of the debug dump functions, this number is enclosed in curly brackets; for example, {36}.

Example

```
/*
 * SETBRKAL.C
 * In this program, a call is made to the _CrtSetBreakAlloc routine
 * to verify that the debugger halts program execution when it reaches
 * a specified allocation number.
 */

#include <malloc.h>
#include <crtdbg.h>

void main( )
{
      long allocReqNum;
      char *my_pointer;

      /*
       * Allocate "my_pointer" for the first
       * time and ensure that it gets allocated correctly
       */
      my_pointer = malloc(10);
      _CrtIsMemoryBlock(my_pointer, 10, &allocReqNum, NULL, NULL);
      /*
       * Set a breakpoint on the allocation request
       * number for "my_pointer"
       */
      _CrtSetBreakAlloc(allocReqNum+2);
      _crtBreakAlloc = allocReqNum+2;

      /*
       * Alternate freeing and reallocating "my_pointer"
       * to verify that the debugger halts program execution
       * when it reaches the allocation request
```

```
        */
        free(my_pointer);
        my_pointer = malloc(10);
        free(my_pointer);
        my_pointer = malloc(10);
        free(my_pointer);
}
```

Output

```
The exception Breakpoint
A breakpoint has been reached.
(0x0000003) occurred in the application at location 0x00401255.
```

_CrtSetDbgFlag

Retrieves and/or modifies the state of the **_crtDbgFlag** flag to control the allocation behavior of the debug heap manager (debug version only).

int _CrtSetDbgFlag(int *newFlag* **);**

Routine	Required Header	Compatibility
_CrtSetDbgFlag	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

_CrtSetDbgFlag returns the previous state of **_crtDbgFlag**.

Parameter

newFlag New state for the **_crtDbgFlag**

Remarks

The **_CrtSetDbgFlag** function allows the application to control how the debug heap manager tracks memory allocations by modifying the bit fields of the **_crtDbgFlag** flag. By setting the bits (turning on), the application can instruct the debug heap manager to perform special debugging operations, including checking for memory leaks when the application exits and reporting if any are found, simulating low memory conditions by specifying that freed memory blocks should remain in the heap's linked list, and verifying the integrity of the heap by inspecting each memory block at every allocation request. When **_DEBUG** is not defined, calls to **_CrtSetDbgFlag** are removed during preprocessing.

The following table lists the bit fields for **_crtDbgFlag** and describes their behavior. Because setting the bits results in increased diagnostic output and reduced program execution speed, most of the bits are not set (turned off) by default. For more information about these bit fields, see "Using the Debug Heap."

Bit field	Default	Description
_CRTDBG_ALLOC-_MEM_DF	ON	ON: Enable debug heap allocations and use of memory block type identifiers, such as **_CLIENT_BLOCK**. OFF: Add new allocations to heap's linked list, but set block type to **_IGNORE_BLOCK**.
_CRTDBG_CHECK-_ALWAYS_DF	OFF	ON: Call **_CrtCheckMemory** at every allocation and deallocation request. OFF: **_CrtCheckMemory** must be called explicitly.
_CRTDBG_CHECK-_CRT_DF	OFF	ON: Include **_CRT_BLOCK** types in leak detection and memory state difference operations. OFF: Memory used internally by the run-time library is ignored by these operations.
_CRTDBG_DELAY-_FREE_MEM_DF	OFF	ON: Keep freed memory blocks in the heap's linked list, assign them the **_FREE_BLOCK** type, and fill them with the byte value 0xDD. OFF: Do not keep freed blocks in the heap's linked list.
_CRTDBG_LEAK-_CHECK_DF	OFF	ON: Perform automatic leak checking at program exit via a call to **_CrtDumpMemoryLeaks** and generate an error report if the application failed to free all the memory it allocated. OFF: Do not automatically perform leak checking at program exit.

newFlag is the new state to apply to the **_crtDbgFlag** and is a combination of the values for each of the bit fields. To change one or more of these bit fields and create a new state for the flag, follow these steps:

1. Call **_CrtSetDbgFlag** with *newFlag* equal to **_CRTDBG_REPORT_FLAG** to obtain the current **_crtDbgFlag** state and store the returned value in a temporary variable.
2. Turn on any bits by OR-ing the temporary variable with the corresponding bitmasks (represented in the application code by manifest constants).
3. Turn off the other bits by AND-ing the variable with a bitwise NOT of the appropriate bitmasks.
4. Call **_CrtSetDbgFlag** with *newFlag* equal to the value stored in the temporary variable to set the new state for **_crtDbgFlag**.

The following lines of code demonstrate how to simulate low memory conditions by keeping freed memory blocks in the heap's linked list and prevent **_CrtCheckMemory** from being called at every allocation request:

```
// Get the current state of the flag
// and store it in a temporary variable
int tmpFlag = _CrtSetDbgFlag( _CRTDBG_REPORT_FLAG );

// Turn On (OR) - Keep freed memory blocks in the
// heap's linked list and mark them as freed
tmpFlag |= _CRTDBG_DELAY_FREE_MEM_DF;

// Turn Off (AND) - prevent _CrtCheckMemory from
// being called at every allocation request
tmpFlag &= ~_CRTDBG_CHECK_ALWAYS_DF;

// Set the new state for the flag
_CrtSetDbgFlag( tmpFlag );
```

Example

```
/*
 * SETDFLAG.C
 * This program concentrates on allocating and freeing memory
 * blocks to test the functionality of the _crtDbgFlag flag..
 */

#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

void main( )
{
      char *p1, *p2;
      int tmpDbgFlag;

      /*
       * Set the debug-heap flag to keep freed blocks in the
       * heap's linked list - This will allow us to catch any
       * inadvertent use of freed memory
       */
      tmpDbgFlag = _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG);
      tmpDbgFlag |= _CRTDBG_DELAY_FREE_MEM_DF;
      tmpDbgFlag |= _CRTDBG_LEAK_CHECK_DF;
      _CrtSetDbgFlag(tmpDbgFlag);

      /*
       * Allocate 2 memory blocks and store a string in each
       */
      p1 = (char *) malloc( 34 );
      p2 = (char *) malloc( 38 );
      strcpy( p1, "p1 points to a Normal allocation block" );
      strcpy( p2, "p2 points to a Client allocation block" );

      /*
       * Free both memory blocks
       */
      free( p2 );
      free( p1 );
```

```
        /*
         * Set the debug-heap flag to no longer keep freed blocks in the
         * heap's linked list and turn on Debug type allocations (CLIENT)
         */
        tmpDbgFlag = _CrtSetDbgFlag(_CRTDBG_REPORT_FLAG);
        tmpDbgFlag |= _CRTDBG_ALLOC_MEM_DF;
        tmpDbgFlag &= _CRTDBG_DELAY_FREE_MEM_DF;
        _CrtSetDbgFlag(tmpDbgFlag);

        /*
         * Explicitly call _malloc_dbg to obtain the filename and line number
         * of our allocation request and also so we can allocate CLIENT type
         * blocks specifically for tracking
         */
        p1 = (char *) _malloc_dbg( 40, _NORMAL_BLOCK, __FILE__, __LINE__ );
        p2 = (char *) _malloc_dbg( 40, _CLIENT_BLOCK, __FILE__, __LINE__ );
        strcpy( p1, "p1 points to a Normal allocation block" );
        strcpy( p2, "p2 points to a Client allocation block" );

        /*
         * _free_dbg must be called to free the CLIENT block
         */
        _free_dbg( p2, _CLIENT_BLOCK );
        free( p1 );

        /*
         * Allocate p1 again and then exit - this will leave unfreed
         * memory on the heap
         */
        p1 = (char *) malloc( 10 );
}
```

Output

```
Debug Error!
Program: C:\code\setdflag.exe
DAMAGE: after Normal block (#31) at 0x002D06A8.
Press Retry to debug the application.
```

See Also: _crtDbgFlag, _CrtCheckMemory

_CrtSetDumpClient

Installs an application-defined function to dump **_CLIENT_BLOCK** type memory blocks (debug version only).

_CRT_DUMP_CLIENT _CrtSetDumpClient(_CRT_DUMP_CLIENT *dumpClient* **);**

Routine	Required Header	Compatibility
_CrtSetDumpClient	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtSetDumpClient returns the previously defined client block dump function.

Parameter

dumpClient New client-defined memory dump function to hook into the C run-time debug memory dump process

Remarks

The **_CrtSetDumpClient** function allows the application to hook its own function to dump objects stored in **_CLIENT_BLOCK** memory blocks into the C run-time debug memory dump process. As a result, every time a debug dump function such as **_CrtMemDumpAllObjectsSince** or **_CrtDumpMemoryLeaks** dumps a **_CLIENT_BLOCK** memory block, the application's dump function will be called as well. **_CrtSetDumpClient** provides an application with an easy method for detecting memory leaks in and validating or reporting the contents of data stored in **_CLIENT_BLOCK** blocks. When **_DEBUG** is not defined, calls to **_CrtSetDumpClient** are removed during preprocessing.

The **_CrtSetDumpClient** function installs the new application-defined dump function specified in *dumpClient* and returns the previously defined dump function. An example of a client block dump function is as follows:

```
void DumpClientFunction( void *userPortion, size_t blockSize );
```

The `userPortion` argument is a pointer to the beginning of the user data portion of the memory block and `blockSize` specifies the size of the allocated memory block in bytes. The client block dump function must return **void**. The pointer to the client dump function that is passed to **_CrtSetDumpClient** is of type **_CRT_DUMP_CLIENT**, as defined in CRTDBG.H:

```
typedef void (__cdecl *_CRT_DUMP_CLIENT)( void *, size_t );
```

Example

See Example 2 on page 99.

_CrtSetReportFile

Identifies the file or stream to be used by **_CrtDbgReport** as a destination for a specific report type (debug version only).

_HFILE _CrtSetReportFile(int *reportType*, **_HFILE** *reportFile* **);**

Routine	Required Header	Compatibility
_CrtSetReportFile	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, **_CrtSetReportFile** returns the previous report file defined for the report type specified in *reportType*. If an error occurs, the report file for *reportType* is not modified and**_CrtSetReportFile** returns **_CRTDBG_HFILE_ERROR**.

Parameters

reportType Report type: **_CRT_WARN**, **_CRT_ERROR**, **_CRT_ASSERT**

reportFile New report file for *reportType*, see the following table

Remarks

_CrtSetReportFile is used in conjunction with the **_CrtSetReportMode** function to define the destination(s) for a specific report type generated by **_CrtDbgReport**. When **_CrtSetReportMode** has been called to assign the **_CRTDBG_MODE_FILE** reporting mode for a specific report type, **_CrtSetReportFile** should then be called to define the specific file or stream to use as the destination. When **_DEBUG** is not defined, calls to **_CrtSetReportFile** are removed during preprocessing.

The **_CrtSetReportFile** function assigns the new report file specified in *reportFile* to the report type specified in *reportType* and returns the previously defined report file for *reportType*. The following table lists the available choices for *reportFile* and the resulting behavior of **_CrtDbgReport**. These options are defined as bit-flags in CRTDBG.H.

Report File	_CrtDbgReport Behavior
_HFILE	**_CrtDbgReport** writes the message to a user-supplied **HANDLE** and does not verify the validity of the file handle. The application is responsible for opening and closing the report file and passing a valid file handle.
_CRTDBG_FILE_STDERR	**_CrtDbgReport** writes message to **stderr**.
_CRTDBG_FILE_STDOUT	**_CrtDbgReport** writes message to **stdout**.
_CRTDBG_REPORT_FILE	**_CrtDbgReport** is not called and the report file for *reportType* is not modified. **_CrtSetReportFile** simply returns the current report file for *reportType*.

When the report destination is a file, **_CrtSetReportMode** is called to set the file bit-flag and **_CrtSetReportFile** is called to define the specific file to use. The following code fragment demonstrates this configuration:

```
_CrtSetReportMode( _CRT_ASSERT, _CRTDBG_MODE_FILE );
_CrtSetReportFile( _CRT_ASSERT, _CRTDBG_FILE_STDERR );
```

The report file used by each report type can be separately controlled. For example, it is possible to specify that a *reportType* of **_CRT_ERROR** be reported to **stderr**, while a *reportType* of **_CRT_ASSERT** be reported to a user-defined file handle or stream.

Example

```
/*
 * REPORT.C:
 * In this program, calls are made to the _CrtSetReportMode,
 * _CrtSetReportFile, and _CrtSetReportHook functions.
 * The _ASSERT macros are called to evaluate their expression.
 * When the condition fails, these macros print a diagnostic message
 * and call _CrtDbgReport to generate a debug report and the
 * client-defined reporting function is called as well.
 * The _RPTn and _RPTFn group of macros are also exercised in
 * this program, as an alternative to the printf function.
 * When these macros are called, the client-defined reporting function
 * takes care of all the reporting - _CrtDbgReport won't be called.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

/*
 * Define our own reporting function.
 * We'll hook it into the debug reporting
 * process later using _CrtSetReportHook.
 *
 * Define a global int to keep track of
 * how many assertion failures occur.
 */
```

```
int gl_num_asserts=0;
int OurReportingFunction( int reportType, char *userMessage, int *retVal )
{
   /*
    * Tell the user our reporting function is being called.
    * In other words - verify that the hook routine worked.
    */
   fprintf("Inside the client-defined reporting function.\n", STDOUT);
   fflush(STDOUT);
   /*
    * When the report type is for an ASSERT,
    * we'll report some information, but we also
    * want _CrtDbgReport to get called -
    * so we'll return TRUE.
    *
    * When the report type is a WARNing or ERROR,
    * we'll take care of all of the reporting. We don't
    * want _CrtDbgReport to get called -
    * so we'll return FALSE.
    */
   if (reportType == _CRT_ASSERT)
   {
      gl_num_asserts++;
      fprintf("This is the number of Assertion failures that have occurred:
      ↪ %d \n", gl_num_asserts, STDOUT);
      fflush(STDOUT);
      fprintf("Returning TRUE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(TRUE);
   } else {
      fprintf("This is the debug user message: %s \n", userMessage, STDOUT);
      fflush(STDOUT);
      fprintf("Returning FALSE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(FALSE);
   }

   /*
    * By setting retVal to zero, we are instructing _CrtDbgReport
    * to continue with normal execution after generating the report.
    * If we wanted _CrtDbgReport to start the debugger, we would set
    * retVal to one.
    */
   retVal = 0;
}

int main()
{
      char *p1, *p2;
```

```
/*
 * Hook in our client-defined reporting function.
 * Every time a _CrtDbgReport is called to generate
 * a debug report, our function will get called first.
 */
_CrtSetReportHook( OurReportingFunction );

/*
 * Define the report destination(s) for each type of report
 * we are going to generate.  In this case, we are going to
 * generate a report for every report type: _CRT_WARN,
 * _CRT_ERROR, and _CRT_ASSERT.
 * The destination(s) is defined by specifying the report mode(s)
 * and report file for each report type.
 * This program sends all report types to STDOUT.
 */
_CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
_CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
_CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
_CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
_CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
_CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

/*
 * Allocate and assign the pointer variables
 */
p1 = malloc(10);
strcpy(p1, "I am p1");
p2 = malloc(10);
strcpy(p2, "I am p2");

/*
 * Use the report macros as a debugging
 * warning mechanism, similar to printf.
 *
 * Use the assert macros to check if the
 * p1 and p2 variables are equivalent.
 *
 * If the expression fails, _ASSERTE will
 * include a string representation of the
 * failed expression in the report.
 *
 *  _ASSERT does not include the
 * expression in the generated report.
 */
_RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the expression
↪ p1 == p2.\n");
_RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
_ASSERT(p1 == p2);

_RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
_ASSERTE(p1 == p2);
```

```
    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Inside the client-defined reporting function.
This is the debug user message: Use the assert macros to evaluate the
↪ expression p1 == p2
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(54) : Will _ASSERT find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 1
Returning TRUE from the client-defined reporting function.
dbgmacro.c(55) : Assertion failed
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(57) : Will _ASSERTE find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 2
Returning TRUE from the client-defined reporting function.
dbgmacro.c(58) : Assertion failed: p1 == p2
Inside the client-defined reporting function.
This is the debug user message: 'I am p1' != 'I am p2'
Returning FALSE from the client-defined reporting function.
```

See Also: _CrtDbgReport

_CrtSetReportHook

Installs a client-defined reporting function by hooking it into the C run-time debug reporting process (debug version only).

_CRT_REPORT_HOOK _CrtSetReportHook(_CRT_REPORT_HOOK *reportHook* **);**

Routine	Required Header	Compatibility
_CrtSetReportHook	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

_CrtSetReportHook returns the previous client-defined reporting function.

Parameter

reportHook New client-defined reporting function to hook into the C run-time debug reporting process

Remarks

_CrtSetReportHook allows an application to use its own reporting function into the C run-time debug library reporting process. As a result, whenever **_CrtDbgReport** is called to generate a debug report, the application's reporting function is called first. This functionality enables an application to perform operations such as filtering debug reports so it can focus on specific allocation types or send a report to destinations not available by using **_CrtDbgReport**. When **_DEBUG** is not defined, calls to **_CrtSetReportHook** are removed during preprocessing.

The **_CrtSetReportHook** function installs the new client-defined reporting function specified in *reportHook* and returns the previous client-defined hook. The following example demonstrates how a client-defined report hook should be prototyped:

```
int YourReportHook( int reportType, char *message, int *returnValue );
```

where `reportType` is the debug report type (**_CRT_WARN**, **_CRT_ERROR**, **_CRT_ASSERT**), `message` is the fully assembled debug user message to be contained in the report, and `returnValue` is the value specified by the client-defined reporting function that should be returned by **_CrtDbgReport**. See the **_CrtSetReportMode** function for a complete description of the available report types.

If the client-defined reporting function completely handles the debug message such that no further reporting is required, then the function should return **TRUE**. When the function returns **FALSE**, **_CrtDbgReport** will be called to generate the debug report using the current settings for the report type, mode, and file. In addition, by specifying the **_CrtDbgReport** return value in `returnValue`, the application can also control whether a debug break occurs. See **_CrtSetReportMode**, **_CrtSetReportFile**, and **_CrtDbgReport** for a complete description of how the debug report is configured and generated.

Example

```
/*
 * REPORT.C:
 * In this program, calls are made to the _CrtSetReportMode,
 * _CrtSetReportFile, and _CrtSetReportHook functions.
 * The _ASSERT macros are called to evaluate their expression.
 * When the condition fails, these macros print a diagnostic message
 * and call _CrtDbgReport to generate a debug report and the
 * client-defined reporting function is called as well.
 * The _RPTn and _RPTFn group of macros are also exercised in
 * this program, as an alternative to the printf function.
 * When these macros are called, the client-defined reporting function
 * takes care of all the reporting - _CrtDbgReport won't be called.
 */
```

```
#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

/*
 * Define our own reporting function.
 * We'll hook it into the debug reporting
 * process later using _CrtSetReportHook.
 *
 * Define a global int to keep track of
 * how many assertion failures occur.
 */
int gl_num_asserts=0;
int OurReportingFunction( int reportType, char *userMessage, int *retVal )
{
   /*
    * Tell the user our reporting function is being called.
    * In other words - verify that the hook routine worked.
    */
   fprintf("Inside the client-defined reporting function.\n", STDOUT);
   fflush(STDOUT);

   /*
    * When the report type is for an ASSERT,
    * we'll report some information, but we also
    * want _CrtDbgReport to get called -
    * so we'll return TRUE.
    *
    * When the report type is a WARNing or ERROR,
    * we'll take care of all of the reporting. We don't
    * want _CrtDbgReport to get called -
    * so we'll return FALSE.
    */
   if (reportType == _CRT_ASSERT)
   {
      gl_num_asserts++;
      fprintf("This is the number of Assertion failures that have
      ↪ occurred: %d \n", gl_num_asserts, STDOUT);
      fflush(STDOUT);
      fprintf("Returning TRUE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(TRUE);
   } else {
      fprintf("This is the debug user message: %s \n", userMessage, STDOUT);
      fflush(STDOUT);
      fprintf("Returning FALSE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(FALSE);
```

```
    }
    /*
     * By setting retVal to zero, we are instructing _CrtDbgReport
     * to continue with normal execution after generating the report.
     * If we wanted _CrtDbgReport to start the debugger, we would set
     * retVal to one.
     */
    retVal = 0;
}

int main()
{
      char *p1, *p2;

    /*
     * Hook in our client-defined reporting function.
     * Every time a _CrtDbgReport is called to generate
     * a debug report, our function will get called first.
     */
    _CrtSetReportHook( OurReportingFunction );

    /*
     * Define the report destination(s) for each type of report
     * we are going to generate.  In this case, we are going to
     * generate a report for every report type: _CRT_WARN,
     * _CRT_ERROR, and _CRT_ASSERT.
     * The destination(s) is defined by specifying the report mode(s)
     * and report file for each report type.
     * This program sends all report types to STDOUT.
     */
    _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

    /*
     * Allocate and assign the pointer variables
     */
    p1 = malloc(10);
    strcpy(p1, "I am p1");
    p2 = malloc(10);
    strcpy(p2, "I am p2");

    /*
     * Use the report macros as a debugging
     * warning mechanism, similar to printf.
     *
     * Use the assert macros to check if the
     * p1 and p2 variables are equivalent.
     *
```

```
     * If the expression fails, _ASSERTE will
     * include a string representation of the
     * failed expression in the report.
     *
     *  _ASSERT does not include the
     * expression in the generated report.
     */
    _RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the expression
    ↪ p1 == p2.\n");
    _RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
    _ASSERT(p1 == p2);

    _RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
    _ASSERTE(p1 == p2);

    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Inside the client-defined reporting function.
This is the debug user message: Use the assert macros to evaluate the
↪ expression p1 == p2
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(54) : Will _ASSERT find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 1
Returning TRUE from the client-defined reporting function.
dbgmacro.c(55) : Assertion failed
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(57) : Will _ASSERTE find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 2
Returning TRUE from the client-defined reporting function.
dbgmacro.c(58) : Assertion failed: p1 == p2
Inside the client-defined reporting function.
This is the debug user message: 'I am p1' != 'I am p2'
Returning FALSE from the client-defined reporting function.
```

_CrtSetReportMode

Specifies the general destination(s) for a specific report type generated by **_CrtDbgReport** (debug version only).

int _CrtSetReportMode(int *reportType*, **int** *reportMode* **);**

Routine	Required Header	Compatibility
_CrtSetReportMode	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, **_CrtSetReportMode** returns the previous report mode(s) for the report type specified in *reportType*. If an error occurs, the report mode(s) for *reportType* are not modified and**_CrtSetReportMode** returns –1.

Parameters

reportType Report type: **_CRT_WARN**, **_CRT_ERROR**, **_CRT_ASSERT**

reportMode New report mode(s) for *reportType*, see the table in the Remarks section

Remarks

_CrtSetReportMode is used in conjunction with the **_CrtSetReportFile** function to define the destination(s) for a specific report type generated by **_CrtDbgReport**. If **_CrtSetReportMode** and **_CrtSetReportFile** are not called to define the reporting method(s) for a specific report type, then **_CrtDbgReport** generates the report type using default destinations: Assertion failures and errors are directed to a debug message window, warnings from Windows applications are sent to the debugger, and warnings from console applications are directed to **stderr**. When **_DEBUG** is not defined, calls to **_CrtSetReportMode** are removed during preprocessing.

The following table lists the report types defined in CRTDBG.H.

Report Type	Description
_CRT_WARN	Warnings, messages, and information that does not need immediate attention.
_CRT_ERROR	Errors, unrecoverable problems, and issues that require immediate attention.
_CRT_ASSERT	Assertion failures (asserted expressions that evaluate to FALSE).

The **_CrtSetReportMode** function assigns the new report mode specified in *reportMode* to the report type specified in *reportType* and returns the previously defined report mode for *reportType*. The following table lists the available choices for *reportMode* and the resulting behavior of **_CrtDbgReport**. These options are defined as bit-flags in CRTDBG.H.

Report Mode	_CrtDbgReport Behavior
_CRTDBG_MODE_DEBUG	Writes the message to an output debug string.
_CRTDBG_MODE_FILE	Writes the message to a user-supplied file handle. **_CrtSetReportFile** should be called to define the specific file or stream to use as the destination.
_CRTDBG_MODE_WNDW	Creates a message box to display the message along with the Abort, Retry, and Ignore buttons.
_CRTDBG_REPORT_MODE	It is not called, and the report mode for *reportType* is not modified. **_CrtSetReportMode** simply returns the current report mode for *reportType*.

Each report type may be reported using one, two, or three modes, or no mode at all. Therefore, it is possible to have more than one destination defined for a single report type. For example, the following code fragment causes assertion failures to be sent to both a debug message window and to **stderr**:

```
_CrtSetReportMode( _CRT_ASSERT, _CRTDBG_MODE_FILE | _CRTDBG_MODE_WNDW );
_CrtSetReportFile( _CRT_ASSERT, _CRTDBG_FILE_STDERR );
```

In addition, the reporting mode(s) for each report type can be separately controlled. For example, it is possible to specify that a *reportType* of **_CRT_WARN** be sent to an output debug string, while **_CRT_ASSERT** be displayed using a a debug message window and sent to **stderr**, as illustrated above.

Example

```
/*
 * REPORT.C:
 * In this program, calls are made to the _CrtSetReportMode,
 * _CrtSetReportFile, and _CrtSetReportHook functions.
 * The _ASSERT macros are called to evaluate their expression.
 * When the condition fails, these macros print a diagnostic message
 * and call _CrtDbgReport to generate a debug report and the
 * client-defined reporting function is called as well.
 * The _RPTn and _RPTFn group of macros are also exercised in
 * this program, as an alternative to the printf function.
 * When these macros are called, the client-defined reporting function
 * takes care of all the reporting - _CrtDbgReport won't be called.
 */

#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>
```

```
/*
 * Define our own reporting function.
 * We'll hook it into the debug reporting
 * process later using _CrtSetReportHook.
 *
 * Define a global int to keep track of
 * how many assertion failures occur.
 */
int gl_num_asserts=0;
int OurReportingFunction( int reportType, char *userMessage, int *retVal )
{
   /*
    * Tell the user our reporting function is being called.
    * In other words - verify that the hook routine worked.
    */
   fprintf("Inside the client-defined reporting function.\n", STDOUT);
   fflush(STDOUT);

   /*
    * When the report type is for an ASSERT,
    * we'll report some information, but we also
    * want _CrtDbgReport to get called -
    * so we'll return TRUE.
    *
    * When the report type is a WARNing or ERROR,
    * we'll take care of all of the reporting. We don't
    * want _CrtDbgReport to get called -
    * so we'll return FALSE.
    */
   if (reportType == _CRT_ASSERT)
   {
      gl_num_asserts++;
      fprintf("This is the number of Assertion failures that have
      ↪ occurred: %d \n", gl_num_asserts, STDOUT);
      fflush(STDOUT);
      fprintf("Returning TRUE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(TRUE);
   } else {
      fprintf("This is the debug user message: %s \n", userMessage, STDOUT);
      fflush(STDOUT);
      fprintf("Returning FALSE from the client-defined reporting
      ↪ function.\n", STDOUT);
      fflush(STDOUT);
      return(FALSE);
   }

   /*
    * By setting retVal to zero, we are instructing _CrtDbgReport
    * to continue with normal execution after generating the report.
    * If we wanted _CrtDbgReport to start the debugger, we would set
    * retVal to one.
    */
```

```
    retVal = 0;
}

int main()
{
      char *p1, *p2;

    /*
     * Hook in our client-defined reporting function.
     * Every time a _CrtDbgReport is called to generate
     * a debug report, our function will get called first.
     */
    _CrtSetReportHook( OurReportingFunction );

    /*
     * Define the report destination(s) for each type of report
     * we are going to generate.  In this case, we are going to
     * generate a report for every report type: _CRT_WARN,
     * _CRT_ERROR, and _CRT_ASSERT.
     * The destination(s) is defined by specifying the report mode(s)
     * and report file for each report type.
     * This program sends all report types to STDOUT.
     */
    _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
    _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
    _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

    /*
     * Allocate and assign the pointer variables
     */
    p1 = malloc(10);
    strcpy(p1, "I am p1");
    p2 = malloc(10);
    strcpy(p2, "I am p2");

    /*
     * Use the report macros as a debugging
     * warning mechanism, similar to printf.
     *
     * Use the assert macros to check if the
     * p1 and p2 variables are equivalent.
     *
     * If the expression fails, _ASSERTE will
     * include a string representation of the
     * failed expression in the report.
     *
     *  _ASSERT does not include the
     * expression in the generated report.
     */
```

```
    _RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the
    ↪ expression p1 == p2.\n");
    _RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
    _ASSERT(p1 == p2);

    _RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
    _ASSERTE(p1 == p2);

    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Inside the client-defined reporting function.
This is the debug user message: Use the assert macros to evaluate the
↪ expression p1 == p2
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(54) : Will _ASSERT find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 1
Returning TRUE from the client-defined reporting function.
dbgmacro.c(55) : Assertion failed
Inside the client-defined reporting function.
This is the debug user message: dbgmacro.c(57) : Will _ASSERTE find
↪ 'I am p1' == 'I am p2' ?
Returning FALSE from the client-defined reporting function.
Inside the client-defined reporting function.
This is the number of Assertion failures that have occurred: 2
Returning TRUE from the client-defined reporting function.
dbgmacro.c(58) : Assertion failed: p1 == p2
Inside the client-defined reporting function.
This is the debug user message: 'I am p1' != 'I am p2'
Returning FALSE from the client-defined reporting function.
```

_expand_dbg

Resizes a specified block of memory in the heap by expanding or contracting the block (debug version only).

void *_expand_dbg(void **userData*, **size_t** *newSize*, **int** *blockType*,
↪ **const char** **filename*, **int** *linenumber* **);**

Routine	Required Header	Compatibility
_expand_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, **_expand_dbg** returns a pointer to the resized memory block, otherwise it returns NULL.

Parameters

userData Pointer to the previously allocated memory block

newSize Requested new size for block (bytes)

blockType Requested type for resized block: **_CLIENT_BLOCK** or **_NORMAL_BLOCK**

filename Pointer to name of source file that requested expand operation or NULL

linenumber Line number in source file where expand operation was requested or NULL

The *filename* and *linenumber* parameters are only available when **_expand_dbg** has been called explicitly or the **_CRTDBG_MAP_ALLOC** environment variable has been defined.

Remarks

The **_expand_dbg** function is a debug version of the **_expand** function. When **_DEBUG** is not defined, calls to **_expand_dbg** are removed during preprocessing. Both **_expand** and **_expand_dbg** resize a memory block in the base heap, but **_expand_dbg** accommodates several debugging features: buffers on either side of the user portion of the block to test for leaks, a block type parameter to track specific allocation types, and *filename*/*linenumber* information to determine the origin of allocation requests.

_expand_dbg resizes the specified memory block with slightly more space than the requested *newSize*. *newSize* may be greater or less than the size of the originally allocated memory block. The additional space is used by the debug heap manager to link the debug memory blocks together and to provide the application with debug header information and overwrite buffers. The resize is accomplished by either expanding or contracting the original memory block. **_expand_dbg** does *not* move the memory block, as does the **_realloc_dbg** function.

When *newSize* is greater than the original block size, the memory block is expanded. During an expansion, if the memory block cannot be expanded to accommodate the requested size, the block is expanded as much as possible. When *newSize* is less than the original block size, the memory block is contracted until the new size is obtained.

Example

```
/*
 * EXPANDD.C
 * This program allocates a block of memory using _malloc_dbg
 * and then calls _msize_dbg to display the size of that block.
 * Next, it uses _expand_dbg to expand the amount of
 * memory used by the buffer and then calls _msize_dbg again to
 * display the new amount of memory allocated to the buffer.
 */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>
#include <crtdbg.h>

void main( void )
{
      long *buffer;
      size_t size;

      /*
       * Call _malloc_dbg to include the filename and line number
       * of our allocation request in the header
       */
      buffer = (long *)_malloc_dbg( 40 * sizeof(long), _NORMAL_BLOCK,
      ➥ __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );

      /*
       * Get the size of the buffer by calling _msize_dbg
       */
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _malloc_dbg of 40 longs: %u\n", size );

      /*
       * Expand the buffer using _expand_dbg and show the new size
       */
      buffer = _expand_dbg( buffer, size + (40 * sizeof(long)), _NORMAL_BLOCK,
➥ __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _expand_dbg of 40 more longs: %u\n", size );

      free( buffer );
      exit( 0 );
}
```

Output

```
Size of block after _malloc_dbg of 40 longs: 160
Size of block after _expand_dbg of 40 more longs: 320
```

See Also: _malloc_dbg

_free_dbg

Frees a block of memory in the heap (debug version only).

void _free_dbg(void **userData*, **int** *blockType* **);**

Routine	Required Header	Compatibility
_free_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

None

Parameters

userData Pointer to the allocated memory block to be freed

blockType Type of allocated memory block to be freed: **_CLIENT_BLOCK**, **_NORMAL_BLOCK**, or **_IGNORE_BLOCK**

Remarks

The **_free_dbg** function is a debug version of the **free** function. When **_DEBUG** is not defined, calls to **_free_dbg** are removed during preprocessing. Both **free** and **_free_dbg** free a memory block in the base heap, but **_free_dbg** accommodates two debugging features: the ability to keep freed blocks in the heap's linked list to simulate low memory conditions and a block type parameter to free specific allocation types.

_free_dbg performs a validity check on all specified files and block locations before performing the free operation — the application is not expected to provide this information. When a memory block is freed, the debug heap manager automatically checks the integrity of the buffers on either side of the user portion and issues an error report if overwriting has occurred. If the **_CRTDBG_DELAY_FREE_MEM_DF** bit field of the **_crtDbgFlag** flag is set, the freed block is filled with the value 0xDD, assigned the **_FREE_BLOCK** block type, and kept in the heap's linked list of memory blocks.

Example

See Example 2 on page 99.

See Also: _malloc_dbg

_malloc_dbg

Allocates a block of memory in the heap with additional space for a debugging header and overwrite buffers (debug version only).

void *_**malloc_dbg**(**size_t** *size*, **int** *blockType*, **const char** **filename*, **int** *linenumber*);

Routine	Required Header	Compatibility
_malloc_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, this function either returns a pointer to the user portion of the allocated memory block, calls the new handler function, or returns NULL. See the following Remarks section for a complete description of the return behavior. See the **malloc** function for more information on how the new handler function is used.

Parameters

size Requested size of memory block (bytes)

blockType Requested type of memory block: **_CLIENT_BLOCK** or **_NORMAL_BLOCK**

filename Pointer to name of source file that requested allocation operation or NULL

linenumber Line number in source file where allocation operation was requested or NULL

The *filename* and *linenumber* parameters are only available when **_malloc_dbg** has been called explicitly or the **_CRTDBG_MAP_ALLOC** environment variable has been defined.

Remarks

_malloc_dbg is a debug version of the **malloc** function. When **_DEBUG** is not defined, calls to **_malloc_dbg** are removed during preprocessing. Both **malloc** and **_malloc_dbg** allocate a block of memory in the base heap, but **_malloc_dbg** offers several debugging features: buffers on either side of the user portion of the block to test for leaks, a block type parameter to track specific allocation types, and *filename*/*linenumber* information to determine the origin of allocation requests.

_malloc_dbg allocates the memory block with slightly more space than the requested *size*. The additional space is used by the debug heap manager to link the debug memory blocks together and to provide the application with debug header information and overwrite buffers. When the block is allocated, the user portion of the block is filled with the value 0xCD and each of the overwrite buffers are filled with 0xFD.

Example

See Example 1 on page 75.

_msize_dbg

Calculates the size of a block of memory in the heap (debug version only).

size_t _msize_dbg(void **userData*, **int** *blockType* **);**

Routine	Required Header	Compatibility
_msize_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, **_msize_dbg** returns the size (bytes) of the specified memory block, otherwise it returns NULL.

Parameters

userData Pointer to the memory block for which to determine the size

blockType Type of the specified memory block: **_CLIENT_BLOCK** or **_NORMAL_BLOCK**

Remarks

_msize_dbg is a debug version of the **_msize** function. When **_DEBUG** is not defined, calls to **_msize_dbg** are removed during preprocessing. Both **_msize** and **_msize_dbg** calculate the size of a memory block in the base heap, but **_msize_dbg** adds two debugging features: It includes the buffers on either side of the user portion of the memory block in the returned size, and it allows size calculations for specific block types.

Example

```
/*
 * REALLOCD.C
 * This program allocates a block of memory using _malloc_dbg
 * and then calls _msize_dbg to display the size of that block.
 * Next, it uses _realloc_dbg to expand the amount of
 * memory used by the buffer and then calls _msize_dbg again to
 * display the new amount of memory allocated to the buffer.
 */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>
#include <crtdbg.h>

void main( void )
{
      long *buffer;
      size_t size;

      /*
       * Call _malloc_dbg to include the filename and line number
       * of our allocation request in the header
       */
      buffer = (long *)_malloc_dbg( 40 * sizeof(long), _NORMAL_BLOCK,
      ➥ __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );
      /*
       * Get the size of the buffer by calling _msize_dbg
       */
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _malloc_dbg of 40 longs: %u\n", size );

      /*
       * Reallocate the buffer using _realloc_dbg and show the new size
       */
      buffer = _realloc_dbg( buffer, size + (40 * sizeof(long)),
      ➥ _NORMAL_BLOCK, __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _realloc_dbg of 40 more longs:
      ➥ %u\n", size );

      free( buffer );
      exit( 0 );
}
```

Output

```
Size of block after _malloc_dbg of 40 longs: 160
Size of block after _realloc_dbg of 40 more longs: 320
```

See Also: _malloc_dbg

_realloc_dbg

Reallocates a specified block of memory in the heap by moving and/or resizing the block (debug version only).

void *_**realloc_dbg**(**void** **userData*, **size_t** *newSize*, **int** *blockType*,
➥ **const char** **filename*, **int** *linenumber*);

Routine	Required Header	Compatibility
_realloc_dbg	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Return Value

Upon successful completion, this function either returns a pointer to the user portion of the reallocated memory block, calls the new handler function, or returns NULL. See the following Remarks section for a complete description of the return behavior. See the **realloc** function for more information on how the new handler function is used.

Parameters

userData Pointer to the previously allocated memory block

newSize Requested size for reallocated block (bytes)

blockType Requested type for reallocated block: **_CLIENT_BLOCK** or **_NORMAL_BLOCK**

filename Pointer to name of source file that requested **realloc** operation or NULL

linenumber Line number in source file where **realloc** operation was requested or NULL

The *filename* and *linenumber* parameters are only available when **_realloc_dbg** has been called explicitly or the **_CRTDBG_MAP_ALLOC** environment variable has been defined.

Remarks

_realloc_dbg is a debug version of the **realloc** function. When **_DEBUG** is not defined, calls to **_realloc_dbg** are removed during preprocessing. Both **realloc** and **_realloc_dbg** reallocate a memory block in the base heap, but **_realloc_dbg** accommodates several debugging features: buffers on either side of the user portion of the block to test for leaks, a block type parameter to track specific allocation types, and *filename*/*linenumber* information to determine the origin of allocation requests.

_realloc_dbg reallocates the specified memory block with slightly more space than the requested *newSize*. *newSize* may be greater or less than the size of the originally allocated memory block. The additional space is used by the debug heap manager to link the debug memory blocks together and to provide the application with debug header information and overwrite buffers. The reallocation may result in moving the original memory block to a different location in the heap, as well as changing the size of the memory block. If the memory block is moved, the contents of the original block are copied over.

Example

```
/*
 * REALLOCD.C
 * This program allocates a block of memory using _malloc_dbg
 * and then calls _msize_dbg to display the size of that block.
 * Next, it uses _realloc_dbg to expand the amount of
 * memory used by the buffer and then calls _msize_dbg again to
 * display the new amount of memory allocated to the buffer.
 */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>
#include <crtdbg.h>

void main( void )
{
      long *buffer;
      size_t size;
      /*
       * Call _malloc_dbg to include the filename and line number
       * of our allocation request in the header
       */
      buffer = (long *)_malloc_dbg( 40 * sizeof(long), _NORMAL_BLOCK,
      ↪ __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );

      /*
       * Get the size of the buffer by calling _msize_dbg
       */
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _malloc_dbg of 40 longs: %u\n", size );

      /*
       * Reallocate the buffer using _realloc_dbg and show the new size
       */
      buffer = _realloc_dbg( buffer, size + (40 * sizeof(long)),
      ↪ _NORMAL_BLOCK, __FILE__, __LINE__ );
      if( buffer == NULL )
            exit( 1 );
      size = _msize_dbg( buffer, _NORMAL_BLOCK );
      printf( "Size of block after _realloc_dbg of 40 more longs:
      ↪ %u\n", size );
```

```
        free( buffer );
        exit( 0 );
}
```

Output

```
Size of block after _malloc_dbg of 40 longs: 160
Size of block after _realloc_dbg of 40 more longs: 320
```

See Also: _malloc_dbg

_RPT, _RPTF Macros

Track an application's progress by generating a debug report (debug version only).

_RPT0(*reportType, format* **);**
_RPT1(*reportType, format, arg1* **);**
_RPT2(*reportType, format, arg1, arg2* **);**
_RPT3(*reportType, format, arg1, arg2, arg3* **);**
_RPT4(*reportType, format, arg1, arg2, arg3, arg4* **);**
_RPTF0(*reportType, format* **);**
_RPTF1(*reportType, format, arg1* **);**
_RPTF2(*reportType, format, arg1, arg2* **);**
_RPTF3(*reportType, format, arg1, arg2, arg3* **);**
_RPTF4(*reportType, format, arg1, arg2, arg3, arg4* **);**

Macro	Required Header	Compatibility
_RPT macros	<crtdbg.h>	Win NT, Win 95
_RPTF macros	<crtdbg.h>	Win NT, Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCD.LIB	Single thread static library, debug version
LIBCMTD.LIB	Multithread static library, debug version
MSVCRTD.LIB	Import library for MSVCRTD.DLL, debug version

Although these are macros and are obtained by including CRTDBG.H, the application must link with one of the libraries listed above because these macros call other run-time functions.

Return Value

None

Parameters

reportType Report type: **_CRT_WARN, _CRT_ERROR, _CRT_ASSERT**

format Format-control string used to create the user message

arg1 Name of first substitution argument used by *format*

arg2 Name of second substitution argument used by *format*

arg3 Name of third substitution argument used by *format*

arg4 Name of fourth substitution argument used by *format*

All of these macros take the *reportType* and *format* parameters. In addition, they might also take *arg1* through *arg4*, signified by the number appended to the macro name. For example, **_RPT0** and **_RPTF0** take no additional arguments, **_RPT1** and **_RPTF1** take *arg1*, **_RPT2** and **_RPTF2** take *arg1* and *arg2*, and so on.

Remarks

The **_RPT** and **_RPTF** macros are similar to the **printf** function, as they can be used to track an application's progress during the debugging process. However, these macros are more flexible than **printf** because they do not need to be enclosed in **#ifdef** statements to prevent them from being called in a retail build of an application. This flexibility is achieved by using the **_DEBUG** macro. The **_RPT** and **_RPTF** macros are only available when the **_DEBUG** flag is defined. When **_DEBUG** is not defined, calls to these macros are removed during preprocessing.

The **_RPT** macros call the **_CrtDbgReport** function to generate a debug report with a user message. The **_RPTF** macros create a debug report with the source file and line number where the report macro was called, in addition to the user message. The user message is created by substituting the *arg*[*n*] arguments into the *format* string, using the same rules defined by the **printf** function.

_CrtDbgReport generates the debug report and determines its destination(s), based on the current report modes and file defined for *reportType*. The **_CrtSetReportMode** and **_CrtSetReportFile** functions are used to define the destination(s) for each report type.

When the destination is a debug message window and the user chooses the Retry button, **_CrtDbgReport** returns 1, causing these macros to start the debugger, provided that "just-in-time" (JIT) debugging is enabled.

Two other macros exist that generate a debug report. The **_ASSERT** macro generates a report, but only when its expression argument evaluates to FALSE. **_ASSERTE** is exactly like **_ASSERT**, but includes the failed expression in the generated report.

Example

```
/*
 * DBGMACRO.C
 * In this program, calls are made to the _ASSERT and _ASSERTE
 * macros to test the condition 'string1 == string2'.  If the
 * condition fails, these macros print a diagnostic message.
 * The _RPTn and _RPTFn group of macros are also exercised in
 * this program, as an alternative to the printf function.
 */
```

```
#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <crtdbg.h>

int main()
{
   char *p1, *p2;

   /*
    * The Reporting Mode and File must be specified
    * before generating a debug report via an assert
    * or report macro.
    * This program sends all report types to STDOUT
    */
   _CrtSetReportMode(_CRT_WARN, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_WARN, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ERROR, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ERROR, _CRTDBG_FILE_STDOUT);
   _CrtSetReportMode(_CRT_ASSERT, _CRTDBG_MODE_FILE);
   _CrtSetReportFile(_CRT_ASSERT, _CRTDBG_FILE_STDOUT);

   /*
    * Allocate and assign the pointer variables
    */
   p1 = malloc(10);
   strcpy(p1, "I am p1");
   p2 = malloc(10);
   strcpy(p2, "I am p2");

   /*
    * Use the report macros as a debugging
    * warning mechanism, similar to printf.
    *
    * Use the assert macros to check if the
    * p1 and p2 variables are equivalent.
    *
    * If the expression fails, _ASSERTE will
    * include a string representation of the
    * failed expression in the report.
    * _ASSERT does not include the
    * expression in the generated report.
    */
   _RPT0(_CRT_WARN, "\n\n Use the assert macros to evaluate the expression
   ↪ p1 == p2.\n");
   _RPTF2(_CRT_WARN, "\n Will _ASSERT find '%s' == '%s' ?\n", p1, p2);
   _ASSERT(p1 == p2);

   _RPTF2(_CRT_WARN, "\n\n Will _ASSERTE find '%s' == '%s' ?\n", p1, p2);
   _ASSERTE(p1 == p2);
```

```
    _RPT2(_CRT_ERROR, "\n \n '%s' != '%s'\n", p1, p2);

    free(p2);
    free(p1);

    return 0;
}
```

Output

```
Use the assert macros to evaluate the expression p1 == p2.

dbgmacro.c(54) : Will _ASSERT find 'I am p1' == 'I am p2' ?
dbgmacro.c(55) : Assertion failed


dbgmacro.c(57) : Will _ASSERTE find 'I am p1' == 'I am p2' ?
dbgmacro.c(58) : Assertion failed: p1 == p2


'I am p1' != 'I am p2'
```

About the Alphabetic Reference

The following topics describe, in alphabetical order, the functions and macros in the Microsoft run-time library. In some cases, related routines are clustered in the same description. For example, the standard, wide-character, and multibyte versions of **strchr** are discussed in the same place, as are the various forms of the **exec** functions. Differences are noted where appropriate. To locate any function that does not appear in the expected position within the alphabetic reference, choose Search from the Help menu and type the name of the function you are looking for.

abort

Aborts the current process and returns an error code.

void abort(void);

Routine	Required Header	Compatibility
abort	<process.h> or <stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

abort does not return control to the calling process. By default, it terminates the current process and returns an exit code of 3.

Remarks

The **abort** routine prints the message "`abnormal program termination`" and then calls **raise(SIGABRT)**. The action taken in response to the **SIGABRT** signal depends on what action has been defined for that signal in a prior call to the **signal** function. The default **SIGABRT** action is for the calling process to terminate with exit code 3, returning control to the calling process or operating system. **abort** does not flush stream buffers or do **atexit/_onexit** processing.

abort determines the destination of the message based on the type of application that called the routine. Console applications always receive the message via **stderr**. In a single or multithreaded Windows application, **abort** calls the Windows **MessageBox** API to create a message box to display the message along with an OK button. When the user selects OK, the program aborts immediately.

When the application is linked with a debug version of the run-time libraries, **abort** creates a message box with three buttons: Abort, Retry, and Ignore. If the user selects Abort, the program aborts immediately. If the user selects Retry, the debugger is called and the user can debug the program if Just-In-Time (JIT) debugging is enabled. If the user selects Ignore, **abort** continues with its normal execution: creating the message box with the OK button.

Example

```
/* ABORT.C:  This program tries to open a
 * file and aborts if the attempt fails.
 */

#include  <stdio.h>
#include  <stdlib.h>

void main( void )
{
   FILE *stream;

   if( (stream = fopen( "NOSUCHF.ILE", "r" )) == NULL )
   {
      perror( "Couldn't open file" );
      abort();
   }
   else
      fclose( stream );
}
```

Output

```
Couldn't open file: No such file or directory

abnormal program termination
```

See Also: **_exec** Function Overview, **exit**, **raise**, **signal**, **_spawn** Function Overview, **_DEBUG**

abs

Calculates the absolute value.

int abs(int *n* **);**

Routine	Required Header	Compatibility
abs	<stdlib.h> or <math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **abs** function returns the absolute value of its parameter. There is no error return.

Parameter

n Integer value

Example

```
/* ABS.C: This program computes and displays
 * the absolute values of several numbers.
 */

#include  <stdio.h>
#include  <math.h>
#include  <stdlib.h>

void main( void )
{
   int    ix = -4, iy;
   long   lx = -41567L, ly;
   double dx = -3.141593, dy;

   iy = abs( ix );
   printf( "The absolute value of %d is %d\n", ix, iy);

   ly = labs( lx );
   printf( "The absolute value of %ld is %ld\n", lx, ly);

   dy = fabs( dx );
   printf( "The absolute value of %f is %f\n", dx, dy );
}
```

Output

```
The absolute value of -4 is 4
The absolute value of -41567 is 41567
The absolute value of -3.141593 is 3.141593
```

See Also: _cabs, fabs, labs

_access, _waccess

Determine file-access permission.

int _access(const char **path*, **int** *mode* **);**
int _waccess(const wchar_t **path*, **int** *mode* **);**

Routine	Required Header	Optional Headers	Compatibility
_access	<io.h>	<errno.h>	Win 95, Win NT
_waccess	<wchar.h> or <io.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the file has the given mode. The function returns –1 if the named file does not exist or is not accessible in the given mode; in this case, **errno** is set as follows:

EACCES Access denied: file's permission setting does not allow specified access.

ENOENT Filename or path not found.

Parameters

path File or directory path

mode Permission setting

Remarks

When used with files, the **_access** function determines whether the specified file exists and can be accessed as specified by the value of *mode*. When used with directories, **_access** determines only whether the specified directory exists; in Windows NT, all directories have read and write access.

mode Value	Checks File For
00	Existence only
02	Write permission
04	Read permission
06	Read and write permission

_waccess is a wide-character version of **_access**; the *path* argument to **_waccess** is a wide-character string. **_waccess** and **_access** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_taccess	_access	_access	_waccess

Example

```
/* ACCESS.C: This example uses _access to check the
 * file named "ACCESS.C" to see if it exists and if
 * writing is allowed.
 */

#include  <io.h>
#include  <stdio.h>
#include  <stdlib.h>

void main( void )
{
   /* Check for existence */
   if( (_access( "ACCESS.C", 0 )) != -1 )
   {
      printf( "File ACCESS.C exists\n" );
      /* Check for write permission */
      if( (_access( "ACCESS.C", 2 )) != -1 )
       printf( "File ACCESS.C has write permission\n" );
   }
}
```

Output

```
File ACCESS.C exists
File ACCESS.C has write permission
```

See Also: _chmod, _fstat, _open, _stat

acos

Calculates the arccosine.

double acos(double *x* **);**

Routine	Required Header	Optional Headers	Compatibility
acos	<math.h>	<errno.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **acos** function returns the arccosine of x in the range 0 to π radians. If x is less than –1 or greater than 1, **acos** returns an indefinite (same as a quiet NaN). You can modify error handling with the **_matherr** routine.

Parameter

x Value between –1 and 1 whose arccosine is to be calculated

Example

```
/* ASINCOS.C: This program prompts for a value in the range
 * -1 to 1. Input values outside this range will produce
 * _DOMAIN error messages.If a valid value is entered, the
 * program prints the arcsine and the arccosine of that value.
 */

#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

void main( void )
{
   double x, y;

   printf( "Enter a real number between -1 and 1: " );
   scanf( "%lf", &x );
   y = asin( x );
   printf( "Arcsine of %f = %f\n", x, y );
   y = acos( x );
   printf( "Arccosine of %f = %f\n", x, y );
}
```

Output

```
Enter a real number between -1 and 1: .32696
Arcsine of 0.326960 = 0.333085
Arccosine of 0.326960 = 1.237711
```

See Also: asin, atan, cos, _matherr, sin, tan

_alloca

Allocates memory on the stack.

void *_alloca(size_t *size* **);**

Routine	Required Header	Compatibility
_alloca	<malloc.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **_alloca** routine returns a **void** pointer to the allocated space, which is guaranteed to be suitably aligned for storage of any type of object. To get a pointer to a type other than **char**, use a type cast on the return value. A stack overflow exception is generated if the space cannot be allocated.

Parameter

size Bytes to be allocated from stack

Remarks

_alloca allocates *size* bytes from the program stack. The allocated space is automatically freed when the calling function exits. Therefore, do not pass the pointer value returned by **_alloca** as an argument to **free**.

There are restrictions to explicitly calling **_alloca** in an exception handler (EH). EH routines that run on x86-class processors operate in their own memory "frame": They perform their tasks in memory space that is not based on the current location of the stack pointer of the enclosing function. The most common implementations include Windows NT structured exception handling (SEH) and C++ catch clause expressions. Therefore, explicitly calling **_alloca** in any of the following scenarios results in program failure during the return to the calling EH routine:

- Windows NT SEH exception filter expression: **__except** (**alloca**())
- Windows NT SEH final exception handler: **__finally** { **alloca**() }
- C++ EH catch clause expression

However, **_alloca** can be called directly from within an EH routine or from an application-supplied callback that gets invoked by one of the EH scenarios listed above.

See Also: calloc, malloc, realloc

asctime, _wasctime

Converts a **tm** time structure to a character string.

char *asctime(const struct tm *_timeptr_);
wchar_t *_wasctime(const struct tm *_timeptr_);

Routine	Required Header	Compatibility
asctime	<time.h>	ANSI, Win 95, Win NT
_wasctime	<time.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

asctime returns a pointer to the character string result; **_wasctime** returns a pointer to the wide-character string result. There is no error return value.

Parameter

timeptr Time/date structure

Remarks

The **asctime** function converts a time stored as a structure to a character string. The *timeptr* value is usually obtained from a call to **gmtime** or **localtime**, which both return a pointer to a **tm** structure, defined in TIME.H.

timeptr Field	Value
tm_hour	Hours since midnight (0–23)
tm_isdst	Positive if daylight saving time is in effect; 0 if daylight saving time is not in effect; negative if status of daylight saving time is unknown. The C run-time library assumes the United States's rules for implementing the calculation of Daylight Saving Time (DST).
tm_mday	Day of month (1–31)
tm_min	Minutes after hour (0–59)
tm_mon	Month (0–11; January = 0)
tm_sec	Seconds after minute (0–59)
tm_wday	Day of week (0–6; Sunday = 0)
tm_yday	Day of year (0–365; January 1 = 0)
tm_year	Year (current year minus 1900)

The converted character string is also adjusted according to the local time zone settings. See the **time**, **_ftime**, and **localtime** functions for information on configuring the local time and the **_tzset** function for details about defining the time zone environment and global variables.

The string result produced by **asctime** contains exactly 26 characters and has the form `Wed Jan 02 02:03:55 1980\n\0`. A 24-hour clock is used. All fields have a constant width. The newline character and the null character occupy the last two positions of the string. **asctime** uses a single, statically allocated buffer to hold the return string. Each call to this function destroys the result of the previous call.

_wasctime is a wide-character version of **asctime**. **_wasctime** and **asctime** behave identically otherwise.

Generic-Text Routine Mapping:

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tasctime	asctime	asctime	_wasctime

Example

```
/* ASCTIME.C: This program places the system time
 * in the long integer aclock, translates it into the
 * structure newtime and then converts it to string
 * form for output, using the asctime function.
 */

#include <time.h>
#include <stdio.h>

struct tm *newtime;
time_t aclock;

void main( void )
{
   time( &aclock );                 /* Get time in seconds */

   newtime = localtime( &aclock );  /* Convert time to struct */
                                    /* tm form */

   /* Print local time as a string */
   printf( "The current date and time are: %s", asctime( newtime ) );
}
```

Output

```
The current date and time are: Sun May 01 20:27:01 1994
```

See Also: ctime, _ftime, gmtime, localtime, time, _tzset

asin

Calculates the arcsine.

double asin(double *x* **);**

Routine	Required Header	Compatibility
asin	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **asin** function returns the arcsine of *x* in the range $-\pi/2$ to $\pi/2$ radians. If *x* is less than –1 or greater than 1, **asin** returns an indefinite (same as a quiet NaN). You can modify error handling with the **_matherr** routine.

Parameter

x Value whose arcsine is to be calculated

Example

```
/* ASINCOS.C: This program prompts for a value in the range
 * -1 to 1. Input values outside this range will produce
 * _DOMAIN error messages.If a valid value is entered, the
 * program prints the arcsine and the arccosine of that value.
 */

#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

void main( void )
{
   double x, y;

   printf( "Enter a real number between -1 and 1: " );
   scanf( "%lf", &x );
   y = asin( x );
   printf( "Arcsine of %f = %f\n", x, y );
   y = acos( x );
   printf( "Arccosine of %f = %f\n", x, y );
}
```

Output

```
Enter a real number between -1 and 1: .32696
Arcsine of 0.326960 = 0.333085
Arccosine of 0.326960 = 1.237711
```

See Also: **acos, atan, cos, _matherr, sin, tan**

assert

Evaluates an expression and when the result is FALSE, prints a diagnostic message and aborts the program.

void assert(int *expression* **);**

Routine	Required Header	Compatibility
assert	<assert.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

expression Expression (including pointers) that evaluates to nonzero or 0

Remarks

The ANSI **assert** macro is typically used to identify logic errors during program development, by implementing the *expression* argument to evaluate to false only when the program is operating incorrectly. After debugging is complete, assertion checking can be turned off without modifying the source file by defining the identifier **NDEBUG**. **NDEBUG** can be defined with a /D command-line option or with a **#define** directive. If **NDEBUG** is defined with **#define**, the directive must appear before ASSERT.H is included.

assert prints a diagnostic message when *expression* evaluates to false (0) and calls **abort** to terminate program execution. No action is taken if *expression* is true (nonzero). The diagnostic message includes the failed expression and the name of the source file and line number where the assertion failed.

The destination of the diagnostic message depends on the type of application that called the routine. Console applications always receive the message via **stderr**. In a

single- or multithreaded Windows application, **assert** calls the Windows **MessageBox** API to create a message box to display the message along with an OK button. When the user chooses OK, the program aborts immediately.

When the application is linked with a debug version of the run-time libraries, **assert** creates a message box with three buttons: Abort, Retry, and Ignore. If the user selects Abort, the program aborts immediately. If the user selects Retry, the debugger is called and the user can debug the program if Just-In-Time (JIT) debugging is enabled. If the user selects Ignore, **assert** continues with its normal execution: creating the message box with the OK button. Note that choosing Ignore when an error condition exists can result in "undefined behavior."

The **assert** routine is available in both the release and debug versions of the C run-time libraries. Two other assertion macros, **_ASSERT** and **_ASSERTE**, are also available, but they only evaluate the expressions passed to them when the **_DEBUG** flag has been defined.

Example

```
/* ASSERT.C: In this program, the analyze_string function uses
 * the assert function to test several conditions related to
 * string and length. If any of the conditions fails, the program
 * prints a message indicating what caused the failure.
 */

#include <stdio.h>
#include <assert.h>
#include <string.h>

void analyze_string( char *string );   /* Prototype */

void main( void )
{
   char  test1[] = "abc", *test2 = NULL, test3[] = "";

   printf ( "Analyzing string '%s'\n", test1 );
   analyze_string( test1 );
   printf ( "Analyzing string '%s'\n", test2 );
   analyze_string( test2 );
   printf ( "Analyzing string '%s'\n", test3 );
   analyze_string( test3 );
}

/* Tests a string to see if it is NULL, */
/*   empty, or longer than 0 characters */
void analyze_string( char * string )
{
   assert( string != NULL );        /* Cannot be NULL */
   assert( *string != '\0' );       /* Cannot be empty */
   assert( strlen( string ) > 2 );  /* Length must exceed 2 */
}
```

Output

```
Analyzing string 'abc'
Analyzing string '(null)'
Assertion failed: string != NULL, file assert.c, line 24

abnormal program termination
```

See Also: **abort, raise, signal, _ASSERT, _ASSERTE, _DEBUG**

atan, atan2

Calculates the arctangent of x (**atan**) or the arctangent of y/x (**atan2**).

double atan(double x **);**
double atan2(double y**, double** x **);**

Routine	Required Header	Compatibility
atan	<math.h>	ANSI, Win 95, Win NT
atan2	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

atan returns the arctangent of x. **atan2** returns the arctangent of y/x. If x is 0, **atan** returns 0. If both parameters of **atan2** are 0, the function returns 0. You can modify error handling by using the **_matherr** routine. **atan** returns a value in the range $-\pi/2$ to $\pi/2$ radians; **atan2** returns a value in the range $-\pi$ to π radians, using the signs of both parameters to determine the quadrant of the return value.

Parameters

x, y Any numbers

Remarks

The **atan** function calculates the arctangent of x. **atan2** calculates the arctangent of y/x. **atan2** is well defined for every point other than the origin, even if x equals 0 and y does not equal 0.

Example

```
/* ATAN.C: This program calculates
 * the arctangent of 1 and -1.
 */

#include <math.h>
#include <stdio.h>
#include <errno.h>

void main( void )
{
   double x1, x2, y;

   printf( "Enter a real number: " );
   scanf( "%lf", &x1 );
   y = atan( x1 );
   printf( "Arctangent of %f: %f\n", x1, y );
   printf( "Enter a second real number: " );
   scanf( "%lf", &x2 );
   y = atan2( x1, x2 );
   printf( "Arctangent of %f / %f: %f\n", x1, x2, y );
}
```

Output

```
Enter a real number: -862.42
Arctangent of -862.420000: -1.569637
Enter a second real number: 78.5149
Arctangent of -862.420000 / 78.514900: -1.480006
```

See Also: **acos, asin, cos, _matherr, sin, tan**

---

atexit

Processes the specified function at exit.

int atexit(void (__cdecl *_func_)(void));

Routine	Required Header	Compatibility
atexit	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

To generate an ANSI-compliant application, use the ANSI-standard **atexit** function (rather than the similar **_onexit** function).

Return Value

atexit returns 0 if successful, or a nonzero value if an error occurs.

Parameter

func Function to be called

Remarks

The **atexit** function is passed the address of a function (*func*) to be called when the program terminates normally. Successive calls to **atexit** create a register of functions that are executed in LIFO (last-in-first-out) order. The functions passed to **atexit** cannot take parameters. **atexit** and **_onexit** use the heap to hold the register of functions. Thus, the number of functions that can be registered is limited only by heap memory.

Example

```
/* ATEXIT.C: This program pushes four functions onto
 * the stack of functions to be executed when atexit
 * is called. When the program exits, these programs
 * are executed on a "last in, first out" basis.
 */

#include <stdlib.h>
#include <stdio.h>

void fn1( void ), fn2( void ), fn3( void ), fn4( void );

void main( void )
{
   atexit( fn1 );
   atexit( fn2 );
   atexit( fn3 );
   atexit( fn4 );
   printf( "This is executed first.\n" );
}

void fn1()
{
   printf( "next.\n" );
}

void fn2()
{
   printf( "executed " );
}

void fn3()
{
   printf( "is " );
}
```

```
void fn4()
{
   printf( "This " );
}
```

Output

```
This is executed first.
This is executed next.
```

See Also: **abort, exit, _onexit**

---

atof, atoi, _atoi64, atol

Convert strings to double (**atof**), integer (**atoi, _atoi64**), or long (**atol**).

double atof(const char **string* **);**
int atoi(const char **string* **);**
__int64 _atoi64(const char **string* **);**
long atol(const char **string* **);**

Routine	Required Header	Compatibility
atof	<math.h> and <stdlib.h>	ANSI, Win 95, Win NT
atoi	<stdlib.h>	ANSI, Win 95, Win NT
_atoi64	<stdlib.h>	Win 95, Win NT
atol	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each function returns the **double**, **int**, **__int64** or **long** value produced by interpreting the input characters as a number. The return value is 0 (for **atoi** and **_atoi64**), 0L (for **atol**), or 0.0 (for **atof**) if the input cannot be converted to a value of that type. The return value is undefined in case of overflow.

Parameter

string String to be converted

Remarks

These functions convert a character string to a double-precision floating-point value (**atof**), an integer value (**atoi** and **_atoi64**), or a long integer value (**atol**). The input

string is a sequence of characters that can be interpreted as a numerical value of the specified type. The output value is affected by the setting of the **LC_NUMERIC** category in the current locale. For more information on the **LC_NUMERIC** category, see **setlocale**. The longest string size that **atof** can handle is 100 characters. The function stops reading the input string at the first character that it cannot recognize as part of a number. This character may be the null character ('\0') terminating the string.

The *string* argument to **atof** has the following form:

[*whitespace*] [*sign*] [*digits*] [*.digits*] [{**d** | **D** | **e** | **E** }[*sign*]*digits*]

A *whitespace* consists of space and/or tab characters, which are ignored; *sign* is either plus (+) or minus (–); and *digits* are one or more decimal digits. If no digits appear before the decimal point, at least one must appear after the decimal point. The decimal digits may be followed by an exponent, which consists of an introductory letter (**d**, **D**, **e**, or **E**) and an optionally signed decimal integer.

atoi, **_atoi64**, and **atol** do not recognize decimal points or exponents. The *string* argument for these functions has the form:

[*whitespace*] [*sign*]*digits*

where *whitespace*, *sign*, and *digits* are exactly as described above for **atof**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ttoi	atoi	atoi	_wtoi
_ttol	atol	atol	_wtol

Example

```
/* ATOF.C: This program shows how numbers stored
 * as strings can be converted to numeric values
 * using the atof, atoi, and atol functions.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char *s; double x; int i; long l;

   s = "  -2309.12E-15";    /* Test of atof */
   x = atof( s );
   printf( "atof test: ASCII string: %s\tfloat:  %e\n", s, x );

   s = "7.8912654773d210";  /* Test of atof */
   x = atof( s );
   printf( "atof test: ASCII string: %s\tfloat:  %e\n", s, x );
```

```
    s = "  -9885 pigs";      /* Test of atoi */
    i = atoi( s );
    printf( "atoi test: ASCII string: %s\t\tinteger: %d\n", s, i );

    s = "98854 dollars";     /* Test of atol */
    l = atol( s );
    printf( "atol test: ASCII string: %s\t\tlong: %ld\n", s, l );
}
```

Output

```
atof test: ASCII string:   -2309.12E-15      float:  -2.309120e-012
atof test: ASCII string: 7.8912654773d210    float:  7.891265e+210
atoi test: ASCII string:   -9885 pigs        integer: -9885
atol test: ASCII string: 98854 dollars       long: 98854
```

See Also: **_ecvt, _fcvt, _gcvt, setlocale, strtod, wcstol, strtoul**

_beginthread, _beginthreadex

Create a thread.

unsigned long _beginthread(void(__cdecl **start_address*)(void *),
↪ **unsigned** *stack_size*, **void** **arglist*);
unsigned long _beginthreadex(void **security*, **unsigned** *stack_size*,
↪ **unsigned (__stdcall** **start_address*)(**void** *), **void** **arglist*, **unsigned** *initflag*,
↪ **unsigned** **thrdaddr*);

Routine	Required Header	Compatibility
_beginthread	<process.h>	Win 95, Win NT
_beginthreadex	<process.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCMT.LIB	Multithread 3static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

To use **_beginthread** or **_beginthreadex**, the application must link with one of the multithreaded C run-time libraries.

Return Value

If successful, each of these functions returns a handle to the newly created thread. **_beginthread** returns –1 on an error, in which case **errno** is set to **EAGAIN** if there are too many threads, or to **EINVAL** if the argument is invalid or the stack size is incorrect. **_beginthreadex** returns 0 on an error, in which case **errno** and **doserrno** are set.

Parameters

start_address Start address of routine that begins execution of new thread

stack_size Stack size for new thread or 0

arglist Argument list to be passed to new thread or NULL

security Security descriptor for new thread; must be NULL for Windows 95 applications

initflag Initial state of new thread (running or suspended)

thrdaddr Address of new thread

Remarks

The **_beginthread** function creates a thread that begins execution of a routine at *start_address*. The routine at *start_address* must use the **__cdecl** calling convention and should have no return value. When the thread returns from that routine, it is terminated automatically.

_beginthreadex resembles the Win32 **CreateThread** API more closely than does **_beginthread**. **_beginthreadex** differs from **_beginthread** in the following ways:

- **_beginthreadex** has three additional parameters: *initflag, security, threadaddr*. The new thread can be created in a suspended state, with a specified security (Windows NT only), and can be accessed using *thrdaddr*, which is the thread identifier.
- The routine at *start_address* passed to **_beginthreadex** must use the **__stdcall** calling convention and must return a thread exit code.
- **_beginthreadex** returns 0 on failure, rather than –1.
- A thread created with **_beginthreadex** is terminated by a call to **_endthreadex.**

You can call **_endthread** or **_endthreadex** explicitly to terminate a thread; however, **_endthread** or **_endthreadex** is called automatically when the thread returns from the routine passed as a parameter. Terminating a thread with a call to **endthread** or **_endthreadex** helps to ensure proper recovery of resources allocated for the thread.

_endthread automatically closes the thread handle (whereas **_endthreadex** does not). Therefore, when using **_beginthread** and **_endthread**, do not explicitly close the thread handle by calling the Win32 **CloseHandle** API. This behavior differs from the Win32 **ExitThread** API.

Note For an executable file linked with LIBCMT.LIB, do not call the Win32 **ExitThread** API; this prevents the run-time system from reclaiming allocated resources. **_endthread** and **_endthreadex** reclaim allocated thread resources and then call **ExitThread**.

The operating system handles the allocation of the stack when either **_beginthread** or **_beginthreadex** is called; you do not need to pass the address of the thread stack to either of these functions. In addition, the *stack_size* argument can be 0, in which case the operating system uses the same value as the stack specified for the main thread.

arglist is a parameter to be passed to the newly created thread. Typically it is the address of a data item, such as a character string. *arglist* may be NULL if it is not needed, but **_beginthread** and **_beginthreadex** must be provided with some value to pass to the new thread. All threads are terminated if any thread calls **abort**, **exit**, **_exit**, or **ExitProcess**.

Example

```
/* BEGTHRD.C illustrates multiple threads using functions:
 *
 *      _beginthread            _endthread
 *
 *
 * This program requires the multithreaded library. For example,
 * compile with the following command line:
 *     CL /MT /D "_X86_" BEGTHRD.C
 *
 * If you are using the Visual C++ development environment, select the
 * Multi-Threaded runtime library in the compiler Project Settings
 * dialog box.
 *
 */

#include <windows.h>
#include <process.h>    /* _beginthread, _endthread */
#include <stddef.h>
#include <stdlib.h>
#include <conio.h>

void Bounce( void *ch );
void CheckKey( void *dummy );

/* GetRandom returns a random integer between min and max. */
#define GetRandom( min, max ) ((rand() % (int)(((max) + 1) - (min))) + (min))

BOOL repeat = TRUE;     /* Global repeat flag and video variable */
HANDLE hStdOut;         /* Handle for console window */
CONSOLE_SCREEN_BUFFER_INFO csbi;    /* Console information structure */

void main()
{
   CHAR    ch = 'A';

   hStdOut = GetStdHandle( STD_OUTPUT_HANDLE );

   /* Get display screen's text row and column information. */
   GetConsoleScreenBufferInfo( hStdOut, &csbi );

   /* Launch CheckKey thread to check for terminating keystroke. */
   _beginthread( CheckKey, 0, NULL );
```

```
   /* Loop until CheckKey terminates program. */
   while( repeat )
   {
      /* On first loops, launch character threads. */
      _beginthread( Bounce, 0, (void *) (ch++)  );

      /* Wait one second between loops. */
      Sleep( 1000L );
   }
}

/* CheckKey - Thread to wait for a keystroke, then clear repeat flag. */
void CheckKey( void *dummy )
{
   _getch();
   repeat = 0;     /* _endthread implied */

}

/* Bounce - Thread to create and and control a colored letter that moves
 * around on the screen.
 *
 * Params: ch - the letter to be moved
 */
void Bounce( void *ch )
{
   /* Generate letter and color attribute from thread argument. */
   char     blankcell = 0x20;
   char     blockcell = (char) ch;
   BOOL     first = TRUE;
  COORD    oldcoord, newcoord;
  DWORD    result;


   /* Seed random number generator and get initial location. */
   srand( _threadid );
   newcoord.X = GetRandom( 0, csbi.dwSize.X - 1 );
   newcoord.Y = GetRandom( 0, csbi.dwSize.Y - 1 );
   while( repeat )
   {
      /* Pause between loops. */
      Sleep( 100L );

      /* Blank out our old position on the screen, and draw new letter. */
      if( first )
         first = FALSE;
      else
      WriteConsoleOutputCharacter( hStdOut, &blankcell, 1, oldcoord, &result );
      WriteConsoleOutputCharacter( hStdOut, &blockcell, 1, newcoord, &result );
```

```
        /* Increment the coordinate for next placement of the block. */
        oldcoord.X = newcoord.X;
        oldcoord.Y = newcoord.Y;
        newcoord.X += GetRandom( -1, 1 );
        newcoord.Y += GetRandom( -1, 1 );

        /* Correct placement (and beep) if about to go off the screen. */
        if( newcoord.X < 0 )
           newcoord.X = 1;
        else if( newcoord.X == csbi.dwSize.X )
           newcoord.X = csbi.dwSize.X - 2;
        else if( newcoord.Y < 0 )
           newcoord.Y = 1;
        else if( newcoord.Y == csbi.dwSize.Y )
           newcoord.Y = csbi.dwSize.Y - 2;

        /* If not at a screen border, continue, otherwise beep. */
        else
           continue;
        Beep( ((char) ch - 'A') * 100, 175 );
     }
     /* _endthread given to terminate */
     _endthread();
}
```

See Also: _endthread, abort, exit

Bessel Functions

The Bessel functions are commonly used in the mathematics of electromagnetic wave theory.

_j0, _j1, _jn These routines return Bessel functions of the first kind: orders 0, 1, and *n*, respectively.

_y0, _y1, _yn These routines return Bessel functions of the second kind: orders 0, 1, and *n*, respectively.

Example

```
/* BESSEL.C: This program illustrates Bessel functions,
 * including:    _j0   _j1   _jn   _y0   _y1   _yn
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 2.387;
   int n = 3, c;
```

```
    printf( "Bessel functions for x = %f:\n", x );
    printf( " Kind\t\tOrder\tFunction\tResult\n\n" );
    printf( " First\t\t0\t_j0( x )\t%f\n", _j0( x ) );
    printf( " First\t\t1\t_j1( x )\t%f\n", _j1( x ) );
    for( c = 2; c < 5; c++ )
       printf( " First\t\t%d\t_jn( n, x )\t%f\n", c, _jn( c, x ) );
    printf( " Second\t0\t_y0( x )\t%f\n", _y0( x ) );
    printf( " Second\t1\t_y1( x )\t%f\n", _y1( x ) );
    for( c = 2; c < 5; c++ )
       printf( " Second\t%d\t_yn( n, x )\t%f\n", c, _yn( c, x ) );
}
```

Output

```
Bessel functions for x = 2.387000:
   Kind      Order   Function   Result

   First      0   _j0( x )   0.009288
   First      1   _j1( x )   0.522941
   First      2   _jn( n, x )   0.428870
   First      3   _jn( n, x )   0.195734
   First      4   _jn( n, x )   0.063131
   Second   0   _y0( x )   0.511681
   Second   1   _y1( x )   0.094374
   Second   2   _yn( n, x )   -0.432608
   Second   3   _yn( n, x )   -0.819314
   Second   4   _yn( n, x )   -1.626833
```

See Also: _matherr

Bessel Functions: _j0, _j1, _jn

Compute the Bessel function.

double _j0(double *x* **);**
double _j1(double *x* **);**
double _jn(int *n*, **double** *x* **);**

Routine	Required Header	Compatibility
_j0	<math.h>	Win 95, Win NT
_j1	<math.h>	Win 95, Win NT
_jn	<math.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a Bessel function of x. You can modify error handling by using **_matherr**.

Parameters

x Floating-point value

n Integer order of Bessel function

Remarks

The **_j0**, **_j1**, and **_jn** routines return Bessel functions of the first kind: orders 0, 1, and n, respectively.

Example

```
/* BESSEL.C: This program illustrates Bessel functions,
 * including:    _j0   _j1   _jn   _y0   _y1   _yn
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 2.387;
   int n = 3, c;

   printf( "Bessel functions for x = %f:\n", x );
   printf( " Kind\t\tOrder\tFunction\tResult\n\n" );
   printf( " First\t\t0\t_j0( x )\t%f\n", _j0( x ) );
   printf( " First\t\t1\t_j1( x )\t%f\n", _j1( x ) );
   for( c = 2; c < 5; c++ )
      printf( " First\t\t%d\t_jn( n, x )\t%f\n", c, _jn( c, x ) );
   printf( " Second\t0\t_y0( x )\t%f\n", _y0( x ) );
   printf( " Second\t1\t_y1( x )\t%f\n", _y1( x ) );
   for( c = 2; c < 5; c++ )
      printf( " Second\t%d\t_yn( n, x )\t%f\n", c, _yn( c, x ) );
}
```

Output

```
Bessel functions for x = 2.387000:
  Kind      Order   Function   Result

   First      0   _j0( x )   0.009288
   First      1   _j1( x )   0.522941
   First      2   _jn( n, x )   0.428870
   First      3   _jn( n, x )   0.195734
   First      4   _jn( n, x )   0.063131
   Second   0   _y0( x )   0.511681
   Second   1   _y1( x )   0.094374
   Second   2   _yn( n, x )   -0.432608
   Second   3   _yn( n, x )   -0.819314
   Second   4   _yn( n, x )   -1.626833
```

See Also: **_matherr**

Bessel Functions: _y0, _y1, _yn

Compute the Bessel function.

double _y0(double *x* **);**
double _y1(double *x* **);**
double _yn(int *n*, **double** *x* **);**

Routine	Required Header	Compatibility
_y0	<math.h>	Win 95, Win NT
_y1	<math.h>	Win 95, Win NT
_yn	<math.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a Bessel function of *x*. If *x* is negative, the routine sets **errno** to **EDOM**, prints a **_DOMAIN** error message to **stderr**, and returns **_HUGE_VAL**. You can modify error handling by using **_matherr**.

Parameters

x Floating-point value

n Integer order of Bessel function

Remarks

The **_y0**, **_y1**, and **_yn** routines return Bessel functions of the second kind: orders 0, 1, and n, respectively.

Example

```
/* BESSEL.C: This program illustrates Bessel functions,
 * including:    _j0   _j1   _jn   _y0   _y1   _yn
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 2.387;
   int n = 3, c;
```

```
   printf( "Bessel functions for x = %f:\n", x );
   printf( " Kind\t\tOrder\tFunction\tResult\n\n" );
   printf( " First\t\t0\t_j0( x )\t%f\n", _j0( x ) );
   printf( " First\t\t1\t_j1( x )\t%f\n", _j1( x ) );
   for( c = 2; c < 5; c++ )
      printf( " First\t\t%d\t_jn( n, x )\t%f\n", c, _jn( c, x ) );
   printf( " Second\t0\t_y0( x )\t%f\n", _y0( x ) );
   printf( " Second\t1\t_y1( x )\t%f\n", _y1( x ) );
   for( c = 2; c < 5; c++ )
      printf( " Second\t%d\t_yn( n, x )\t%f\n", c, _yn( c, x ) );
}
```

Output

```
Bessel functions for x = 2.387000:
   Kind      Order   Function   Result

   First      0   _j0( x )   0.009288
   First      1   _j1( x )   0.522941
   First      2   _jn( n, x )   0.428870
   First      3   _jn( n, x )   0.195734
   First      4   _jn( n, x )   0.063131
   Second   0   _y0( x )   0.511681
   Second   1   _y1( x )   0.094374
   Second   2   _yn( n, x )   -0.432608
   Second   3   _yn( n, x )   -0.819314
   Second   4   _yn( n, x )   -1.626833
```

See Also: _matherr

bsearch

Performs a binary search of a sorted array.

void *bsearch(const void *_key_, const void *_base_, size_t _num_, size_t _width_,
int (__cdecl *_compare_) (const void *_elem1_, const void *_elem2_));

Routine	Required Header	Compatibility
bsearch	<stdlib.h> and <search.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

bsearch returns a pointer to an occurrence of *key* in the array pointed to by *base*. If *key* is not found, the function returns **NULL**. If the array is not in ascending sort order or contains duplicate records with identical keys, the result is unpredictable.

Parameters

key Object to search for

base Pointer to base of search data

num Number of elements

width Width of elements

compare Function that compares two elements: *elem1* and *elem2*

elem1 Pointer to the key for the search

elem2 Pointer to the array element to be compared with the key

Remarks

The **bsearch** function performs a binary search of a sorted array of *num* elements, each of *width* bytes in size. The *base* value is a pointer to the base of the array to be searched, and *key* is the value being sought. The *compare* parameter is a pointer to a user-supplied routine that compares two array elements and returns a value specifying their relationship. **bsearch** calls the *compare* routine one or more times during the search, passing pointers to two array elements on each call. The *compare* routine compares the elements, then returns one of the following values:

Value Returned by *compare* Routine	Description
< 0	*elem1* less than *elem2*
0	*elem1* equal to *elem2*
> 0	*elem1* greater than *elem2*

Example

```
/* BSEARCH.C: This program reads the command-line
 * parameters, sorting them with qsort, and then
 * uses bsearch to find the word "cat."
 */

#include <search.h>
#include <string.h>
#include <stdio.h>

int compare( char **arg1, char **arg2 ); /* Declare a function for compare */

void main( int argc, char **argv )
{
   char **result;
   char *key = "cat";
   int i;

   /* Sort using Quicksort algorithm: */
   qsort( (void *)argv, (size_t)argc, sizeof( char * ), (int (*)(const
   void*, const void*))compare );

   for( i = 0; i < argc; ++i )    /* Output sorted list */
      printf( "%s ", argv[i] );
```

```
   /* Find the word "cat" using a binary search algorithm: */
   result = (char **)bsearch( (char *) &key, (char *)argv, argc,
         sizeof( char * ), (int (*)(const void*, const void*))compare );
   if( result )
      printf( "\n%s found at %Fp\n", *result, result );
   else
      printf( "\nCat not found!\n" );
}

int compare( char **arg1, char **arg2 )
{
   /* Compare all of both strings: */
   return _strcmpi( *arg1, *arg2 );
}
```

Output

```
[C:\work]bsearch dog pig horse cat human rat cow goat
bsearch cat cow dog goat horse human pig rat
cat found at 002D0008
```

See Also: _lfind, _lsearch, qsort

_cabs

Calculates the absolute value of a complex number.

double _cabs(struct _complex *z* **);**

Routine	Required Header	Compatibility
_cabs	<math.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_cabs returns the absolute value of its argument if successful. On overflow **_cabs** returns **HUGE_VAL** and sets **errno** to **ERANGE**. You can change error handling with **_matherr**.

Parameter

z Complex number

Remarks

The **_cabs** function calculates the absolute value of a complex number, which must be a structure of type **_complex**. The structure *z* is composed of a real component *x* and an imaginary component *y*. A call to **_cabs** produces a value equivalent to that of the expression **sqrt(** *z.x***z.x* + *z.y***z.y* **)**.

Example

```
/* CABS.C: Using _cabs, this program calculates
 * the absolute value of a complex number.
 */
#include <math.h>
#include <stdio.h>

void main( void )
{
   struct _complex number = { 3.0, 4.0 };
   double d;

   d = _cabs( number );
   printf( "The absolute value of %f + %fi is %f\n",
         number.x, number.y, d );
}
```

Output

```
The absolute value of 3.000000 + 4.000000i is 5.000000
```

See Also: **abs, fabs, labs**

calloc

Allocates an array in memory with elements initialized to 0.

void *calloc(size_t *num*, **size_t** *size* **);**

Routine	Required Header	Compatibility
calloc	<stdlib.h> and <malloc.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

calloc returns a pointer to the allocated space. The storage space pointed to by the return value is guaranteed to be suitably aligned for storage of any type of object. To get a pointer to a type other than **void**, use a type cast on the return value.

Parameters

num Number of elements

size Length in bytes of each element

Remarks

The **calloc** function allocates storage space for an array of *num* elements, each of length *size* bytes. Each element is initialized to 0.

calloc calls **malloc** in order to use the C++ **_set_new_mode** function to set the new handler mode. The new handler mode indicates whether, on failure, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure to allocate memory. You can override this default behavior so that, when **calloc** fails to allocate memory, **malloc** calls the new handler routine in the same way that the **new** operator does when it fails for the same reason. To override the default, call

```
_set_new_mode(1)
```

early in your program, or link with NEWMODE.OBJ.

When the application is linked with a debug version of the C run-time libraries, **calloc** resolves to **_calloc_dbg**.

Example

```
/* CALLOC.C: This program uses calloc to allocate space for
 * 40 long integers. It initializes each element to zero.
 */
#include <stdio.h>
#include <malloc.h>

void main( void )
{
   long *buffer;

   buffer = (long *)calloc( 40, sizeof( long ) );
   if( buffer != NULL )
      printf( "Allocated 40 long integers\n" );
   else
      printf( "Can't allocate memory\n" );
   free( buffer );
}
```

Output

```
Allocated 40 long integers
```

See Also: free, malloc, realloc

---

ceil

Calculates the ceiling of a value.

double ceil(double *x* **);**

Routine	Required Header	Compatibility
ceil	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **ceil** function returns a **double** value representing the smallest integer that is greater than or equal to *x*. There is no error return.

Parameter

x Floating-point value

Example

```
/* FLOOR.C: This example displays the largest integers
 * less than or equal to the floating-point values 2.8
 * and -2.8. It then shows the smallest integers greater
 * than or equal to 2.8 and -2.8.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double y;

   y = floor( 2.8 );
   printf( "The floor of 2.8 is %f\n", y );
   y = floor( -2.8 );
   printf( "The floor of -2.8 is %f\n", y );

   y = ceil( 2.8 );
   printf( "The ceil of 2.8 is %f\n", y );
   y = ceil( -2.8 );
   printf( "The ceil of -2.8 is %f\n", y );
}
```

Output

```
The floor of 2.8 is 2.000000
The floor of -2.8 is -3.000000
The ceil of 2.8 is 3.000000
The ceil of -2.8 is -2.000000
```

See Also: floor, fmod

_cexit, _c_exit

Perform cleanup operations and return without terminating the process.

void _cexit(void);
void _c_exit(void);

Routine	Required Header	Compatibility
_cexit	<process.h>	Win 95, Win NT
_c_exit	<process.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Remarks

The **_cexit** function calls, in last-in-first-out (LIFO) order, the functions registered by **atexit** and **_onexit**. Then **_cexit** flushes all I/O buffers and closes all open streams before returning. **_c_exit** is the same as **_exit** but returns to the calling process without processing **atexit** or **_onexit** or flushing stream buffers. The behavior of **exit, _exit, _cexit**, and **_c_exit** is as follows:

Function	Behavior
exit	Performs complete C library termination procedures, terminates process, and exits with supplied status code
_exit	Performs "quick" C library termination procedures, terminates process, and exits with supplied status code
_cexit	Performs complete C library termination procedures and returns to caller, but does not terminate process
_c_exit	Performs "quick" C library termination procedures and returns to caller, but does not terminate process

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_onexit**, **_spawn** Functions, **system**

_cgets

Gets a character string from the console.

char *_cgets(char *_buffer_);

Routine	Required Header	Compatibility
_cgets	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_cgets returns a pointer to the start of the string, at *buffer*[2]. There is no error return.

Parameter

buffer Storage location for data

Remarks

The **_cgets** function reads a string of characters from the console and stores the string and its length in the location pointed to by *buffer*. The *buffer* parameter must be a pointer to a character array. The first element of the array, *buffer*[0], must contain the maximum length (in characters) of the string to be read. The array must contain enough elements to hold the string, a terminating null character ('\0'), and two additional bytes. The function reads characters until a carriage-return–linefeed (CR-LF) combination or the specified number of characters is read. The string is stored starting at *buffer*[2]. If the function reads a CR-LF, it stores the null character ('\0'). **_cgets** then stores the actual length of the string in the second array element, *buffer* [1]. Because all editing keys are active when **_cgets** is called, pressing F3 repeats the last entry.

Example

```
/* CGETS.C: This program creates a buffer and initializes
 * the first byte to the size of the buffer: 2. Next, the
 * program accepts an input string using _cgets and displays
 * the size and text of that string.
 */

#include <conio.h>
#include <stdio.h>

void main( void )
{
   char buffer[82] = { 80 };  /* Maximum characters in 1st byte */
   char *result;

   printf( "Input line of text, followed by carriage return:\n");
   result = _cgets( buffer );  /* Input a line of text */
   printf( "\nLine length = %d\nText = %s\n", buffer[1], result );
}
```

Output

```
Input line of text, followed by carriage return:
This is a line of text

Line length = 22
Text = This is a line of text.
```

See Also: **_getch**

_chdir, _wchdir

Change the current working directory.

int _chdir(const char **dirname* **);**
int _wchdir(const wchar_t **dirname* **);**

Routine	Required Header	Optional Headers	Compatibility
_chdir	<direct.h>	<errno.h>	Win 95, Win NT
_wchdir	<direct.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a value of 0 if successful. A return value of –1 indicates that the specified path could not be found, in which case **errno** is set to **ENOENT**.

Parameter

dirname Path of new working directory

Remarks

The **_chdir** function changes the current working directory to the directory specified by *dirname*. The *dirname* parameter must refer to an existing directory. This function can change the current working directory on any drive and if a new drive letter is specified in *dirname*, the default drive letter will be changed as well. For example, if A is the default drive letter and \BIN is the current working directory, the following call changes the current working directory for drive C and establishes C as the new default drive:

```
_chdir("c:\\temp");
```

When you use the optional backslash character (\) in paths, you must place two backslashes (\\) in a C string literal to represent a single backslash (\).

_wchdir is a wide-character version of **_chdir**; the *dirname* argument to **_wchdir** is a wide-character string. **_wchdir** and **_chdir** behave identically otherwise.

Generic-Text Routine Mapping:

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tchdir	_chdir	_chdir	_wchdir

Example

```
/* CHGDIR.C: This program uses the _chdir function to verify
 * that a given directory exists.
 */

#include <direct.h>
#include <stdio.h>
#include <stdlib.h>

void main( int argc, char *argv[] )
{
   if( _chdir( argv[1] ))
      printf( "Unable to locate the directory: %s\n", argv[1] );
   else
      system( "dir *.wri");
}
```

Output

```
 Volume in drive C is CDRIVE
 Volume Serial Number is 0E17-1702

 Directory of C:\write

04/21/95  01:06p             3,200 ERRATA.WRI
04/21/95  01:06p             2,816 README.WRI
               2 File(s)      6,016 bytes
                         71,432,116 bytes free
```

See Also: **_mkdir, _rmdir, system**

_chdrive

Changes the current working drive.

int _chdrive(int *drive* **);**

Routine	Required Header	Compatibility
_chdrive	<direct.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_chdrive returns a value of 0 if the working drive is successfully changed. A return value of −1 indicates an error.

Parameter

drive Number of new working drive

Remarks

The **_chdrive** function changes the current working drive to the drive specified by *drive*. The *drive* parameter uses an integer to specify the new working drive (1=A, 2=B, and so forth). This function changes only the working drive; **_chdir** changes the working directory.

Example

```
/* GETDRIVE.C illustrates drive functions including:
 *    _getdrive      _chdrive        _getdcwd
 */

#include <stdio.h>
#include <conio.h>
#include <direct.h>
#include <stdlib.h>
#include <ctype.h>

void main( void )
{
   int ch, drive, curdrive;
   static char path[_MAX_PATH];

   /* Save current drive. */
   curdrive = _getdrive();

   printf( "Available drives are: \n" );

   /* If we can switch to the drive, it exists. */
   for( drive = 1; drive <= 26; drive++ )
      if( !_chdrive( drive ) )
         printf( "%c: ", drive + 'A' - 1 );

   while( 1 )
   {
      printf( "\nType drive letter to check or ESC to quit: " );
      ch = _getch();
      if( ch == 27 )
         break;
      if( isalpha( ch ) )
         _putch( ch );
      if( _getdcwd( toupper( ch ) - 'A' + 1, path, _MAX_PATH ) != NULL )
         printf( "\nCurrent directory on that drive is %s\n", path );
   }

   /* Restore original drive.*/
   _chdrive( curdrive );
   printf( "\n" );
}
```

Output

```
Available drives are:
A: B: C: L: M: O: U: V:
Type drive letter to check or ESC to quit: c
Current directory on that drive is C:\CODE

Type drive letter to check or ESC to quit: m
Current directory on that drive is M:\

Type drive letter to check or ESC to quit:
```

See Also: **_chdir, _fullpath, _getcwd, _getdrive, _mkdir, _rmdir, system**

_chgsign

Reverses the sign of a double-precision floating-point argument.

double _chgsign(double *x* **);**

Routine	Required Header	Compatibility
_chgsign	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_chgsign returns a value equal to its double-precision floating-point argument *x*, but with its sign reversed. There is no error return.

Parameter

x Double-precision floating-point value to be changed

See Also: **fabs, _copysign**

_chmod, _wchmod

Change the file-permission settings.

int _chmod(const char ***filename*, int** *pmode* **);**
int _wchmod(const wchar_t ***filename*, int** *pmode* **);**

Routine	Required Header	Optional Headers	Compatibility
_chmod	<io.h>	<sys/types.h>, <sys/stat.h>, <errno.h>	Win 95, Win NT
_wchmod	<io.h> or <wchar.h>	<sys/types.h>, <sys/stat.h>, <errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the permission setting is successfully changed. A return value of –1 indicates that the specified file could not be found, in which case **errno** is set to **ENOENT**.

Parameters

filename Name of existing file

pmode Permission setting for file

Remarks

The **_chmod** function changes the permission setting of the file specified by *filename*. The permission setting controls read and write access to the file. The integer expression *pmode* contains one or both of the following manifest constants, defined in SYS\STAT.H:

_S_IWRITE Writing permitted

_S_IREAD Reading permitted

_S_IREAD | _S_IWRITE Reading and writing permitted

Any other values for *pmode* are ignored. When both constants are given, they are joined with the bitwise-OR operator (|). If write permission is not given, the file is read-only. Note that all files are always readable; it is not possible to give write-only permission. Thus the modes **_S_IWRITE** and **_S_IREAD | _S_IWRITE** are equivalent.

_wchmod is a wide-character version of **_chmod**; the *filename* argument to **_wchmod** is a wide-character string. **_wchmod** and **_chmod** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tchmod	_chmod	_chmod	_wchmod

Example

```
/* CHMOD.C: This program uses _chmod to
 * change the mode of a file to read-only.
 * It then attempts to modify the file.
 */

#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   /* Make file read-only: */
   if( _chmod( "CHMOD.C", _S_IREAD ) == -1 )
      perror( "File not found\n" );
   else
      printf( "Mode changed to read-only\n" );
   system( "echo /* End of file */ >> CHMOD.C" );

   /* Change back to read/write: */
   if( _chmod( "CHMOD.C", _S_IWRITE ) == -1 )
      perror( "File not found\n" );
   else
      printf( "Mode changed to read/write\n" );
   system( "echo /* End of file */ >> CHMOD.C" );
}
```

Output

```
Mode changed to read-only
Access is denied
Mode changed to read/write
```

See Also: **_access, _creat, _fstat, _open, _stat**

_chsize

Changes the file size.

int _chsize(int *handle*, **long** *size* **);**

Routine	Required Header	Optional Headers	Compatibility
_chsize	<io.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_chsize returns the value 0 if the file size is successfully changed. A return value of −1 indicates an error: **errno** is set to **EACCES** if the specified file is locked against access, to **EBADF** if the specified file is read-only or the handle is invalid, or to **ENOSPC** if no space is left on the device.

Parameters

handle Handle referring to open file

size New length of file in bytes

Remarks

The **_chsize** function extends or truncates the file associated with *handle* to the length specified by *size*. The file must be open in a mode that permits writing. Null characters ('\0') are appended if the file is extended. If the file is truncated, all data from the end of the shortened file to the original length of the file is lost.

Example

```
/* CHSIZE.C: This program uses _filelength to report the size
 * of a file before and after modifying it with _chsize.
 */

#include <io.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <stdio.h>

void main( void )
{
   int fh, result;
   unsigned int nbytes = BUFSIZ;

   /* Open a file */
   if( (fh = _open( "data", _O_RDWR | _O_CREAT, _S_IREAD
               | _S_IWRITE ))  != -1 )
   {
      printf( "File length before: %ld\n", _filelength( fh ) );
      if( ( result = _chsize( fh, 329678 ) ) == 0 )
         printf( "Size successfully changed\n" );
      else
         printf( "Problem in changing the size\n" );
      printf( "File length after:  %ld\n", _filelength( fh ) );
      _close( fh );
   }
}
```

Output

```
File length before: 0
Size successfully changed
File length after:  329678
```

See Also: _close, _creat, _open

_clear87, _clearfp

Get and clear the floating-point status word.

unsigned int _clear87(void);
unsigned int _clearfp(void);

Routine	Required Header	Compatibility
_clear87	<float.h>	Win 95, Win NT
_clearfp	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The bits in the value returned indicate the floating-point status before the call to **_clear87** or **_clearfp**. See FLOAT.H for a complete definition of the bits returned by **_clear87**. Many of the math library functions modify the 8087/80287 status word, with unpredictable results. Return values from **_clear87** and **_status87** become more reliable as fewer floating-point operations are performed between known states of the floating-point status word.

Remarks

The **_clear87** function clears the exception flags in the floating-point status word, sets the busy bit to 0, and returns the status word. The floating-point status word is a combination of the 8087/80287 status word and other conditions detected by the 8087/80287 exception handler, such as floating-point stack overflow and underflow.

_clearfp is a platform-independent, portable version of the **_clear87** routine. It is identical to **_clear87** on Intel® (x86) platforms and is also supported by the MIPS® and ALPHA platforms. To ensure that your floating-point code is portable to MIPS or ALPHA, use **_clearfp**. If you are only targeting x86 platforms, you can use either **_clear87** or **_clearfp**.

Example

```
/* CLEAR87.C: This program creates various floating-point
 * problems, then uses _clear87 to report on these problems.
 * Compile this program with Optimizations disabled (/Od).
 * Otherwise the optimizer will remove the code associated with
 * the unused floating-point values.
 */

#include <stdio.h>
#include <float.h>
```

```
void main( void )
{
   double a = 1e-40, b;
   float x, y;

   printf( "Status: %.4x - clear\n", _clear87()  );

   /* Store into y is inexact and underflows: */
   y = a;
   printf( "Status: %.4x - inexact, underflow\n", _clear87() );

   /* y is denormal: */
   b = y;
   printf( "Status: %.4x - denormal\n", _clear87() );
}
```

Output

```
Status: 0000 - clear
Status: 0003 - inexact, underflow
Status: 80000 - denormal
```

See Also: _control87, _status87

clearerr

Resets the error indicator for a stream

void clearerr(FILE ***stream*);**

Routine	Required Header	Compatibility
clearerr	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

stream Pointer to **FILE** structure

Remarks

The **clearerr** function resets the error indicator and end-of-file indicator for *stream*. Error indicators are not automatically cleared; once the error indicator for a specified stream is set, operations on that stream continue to return an error value until **clearerr**, **fseek**, **fsetpos**, or **rewind** is called.

Example

```
/* CLEARERR.C: This program creates an error
 * on the standard input stream, then clears
 * it so that future reads won't fail.
 */

#include <stdio.h>

void main( void )
{
   int c;
   /* Create an error by writing to standard input. */
   putc( 'c', stdin );
   if( ferror( stdin ) )
   {
      perror( "Write error" );
      clearerr( stdin );
   }

   /* See if read causes an error. */
   printf( "Will input cause an error? " );
   c = getc( stdin );
   if( ferror( stdin ) )
   {
      perror( "Read error" );
      clearerr( stdin );
   }
}
```

Output

```
Write error: No error
Will input cause an error? n
```

See Also: _eof, feof, ferror, perror

---

clock

Calculates the processor time used by the calling process.

clock_t clock(void);

Routine	Required Header	Compatibility
clock	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

clock returns the number of clock ticks of elapsed processor time. The returned value is the product of the amount of time that has elapsed since the start of a process and the value of the **CLOCKS_PER_SEC** constant. If the amount of elapsed time is unavailable, the function returns –1, cast as a **clock_t**.

Remarks

The **clock** function tells how much processor time the calling process has used. The time in seconds is approximated by dividing the clock return value by the value of the **CLOCKS_PER_SEC** constant. In other words, **clock** returns the number of processor timer ticks that have elapsed. A timer tick is approximately equal to 1/**CLOCKS_PER_SEC** second. In versions of Microsoft C before 6.0, the **CLOCKS_PER_SEC** constant was called **CLK_TCK**.

Example

```
/* CLOCK.C: This example prompts for how long
 * the program is to run and then continuously
 * displays the elapsed time for that period.
 */

#include <stdio.h>
#include <stdlib.h>
#include <time.h>

void sleep( clock_t wait );

void main( void )
{
   long  i = 600000L;
   clock_t start, finish;
   double  duration;

   /* Delay for a specified time. */
   printf( "Delay for three seconds\n" );
   sleep( (clock_t)3 * CLOCKS_PER_SEC );
   printf( "Done!\n" );

   /* Measure the duration of an event. */
   printf( "Time to do %ld empty loops is ", i );
   start = clock();
   while( i-- )
      ;
   finish = clock();
   duration = (double)(finish - start) / CLOCKS_PER_SEC;
   printf( "%2.1f seconds\n", duration );
}
```

```
/* Pauses for a specified number of milliseconds. */
void sleep( clock_t wait )
{
   clock_t goal;
   goal = wait + clock();
   while( goal > clock() )
      ;
}
```

Output

```
Delay for three seconds
Done!
Time to do 600000 empty loops is 0.1 seconds
```

See Also: difftime, time

_close

Closes a file.

int _close(int *handle* **);**

Routine	Required Header	Optional Headers	Compatibility
_close	<io.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_close returns 0 if the file was successfully closed. A return value of –1 indicates an error, in which case **errno** is set to **EBADF**, indicating an invalid file-handle parameter.

Parameter

handle Handle referring to open file

Remarks

The **_close** function closes the file associated with *handle*.

Example

```
/* OPEN.C: This program uses _open to open a file
 * named OPEN.C for input and a file named OPEN.OUT
 * for output. The files are then closed.
 */
```

```
#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdio.h>

void main( void )
{
   int fh1, fh2;

   fh1 = _open( "OPEN.C", _O_RDONLY );
   if( fh1 == -1 )
      perror( "open failed on input file" );
   else
   {
      printf( "open succeeded on input file\n" );
      _close( fh1 );
   }

   fh2 = _open( "OPEN.OUT", _O_WRONLY | _O_CREAT, _S_IREAD |
                            _S_IWRITE );
   if( fh2 == -1 )
      perror( "Open failed on output file" );
   else
   {
      printf( "Open succeeded on output file\n" );
      _close( fh2 );
   }
}
```

Output

```
Open succeeded on input file
Open succeeded on output file
```

See Also: **_chsize, _creat, _dup, _open, _unlink**

_commit

Flushes a file directly to disk.

int _commit(int *handle* **);**

Routine	Required Header	Optional Headers	Compatibility
_commit	<io.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_commit returns 0 if the file was successfully flushed to disk. A return value of –1 indicates an error, and **errno** is set to **EBADF**, indicating an invalid file-handle parameter.

Parameter

handle Handle referring to open file

Remarks

The **_commit** function forces the operating system to write the file associated with *handle* to disk. This call ensures that the specified file is flushed immediately, not at the operating system's discretion.

Example

```
/* COMMIT.C illustrates low-level file I/O functions including:
 *
 *    _close_commit  memset_open     _write
 *
 * This is example code; to keep the code simple and readable
 * return values are not checked.
 */

#include <io.h>
#include <stdio.h>
#include <fcntl.h>
#include <memory.h>
#include <errno.h>

#define MAXBUF 32

int log_receivable( int );

void main( void )
{
   int fhandle;
   fhandle = _open( "TRANSACT.LOG", _O_APPEND | _O_CREAT |
                                    _O_BINARY | _O_RDWR );
   log_receivable( fhandle );
   _close( fhandle );
}

int log_receivable( int fhandle )
{
/* The log_receivable function prompts for a name and a monetary
 * amount and places both values into a buffer (buf). The _write
 * function writes the values to the operating system and the
 * _commit function ensures that they are written to a disk file.
 */

   int i;
   char  buf[MAXBUF];
```

```
    memset( buf, '\0', MAXBUF );
    /* Begin Transaction. */
    printf( "Enter name: " );
    gets( buf );
    for( i = 1; buf[i] != '\0'; i++ );
    /* Write the value as a '\0' terminated string. */
    _write( fhandle, buf, i+1 );
    printf( "\n" );

    memset( buf, '\0', MAXBUF );
    printf( "Enter amount: $" );
    gets( buf );
    for( i = 1; buf[i] != '\0'; i++ );
    /* Write the value as a '\0' terminated string. */
    _write( fhandle, buf, i+1 );
    printf( "\n" );

     /* The _commit function ensures that two important pieces of
      * data are safely written to disk. The return value of the
      * _commit function is returned to the calling function.
      */
    return _commit( fhandle );
}
```

See Also: **_creat, _open, _read, _write**

_control87, _controlfp

Get and set the floating-point control word.

unsigned int _control87(unsigned int *new*, **unsigned int** *mask* **);**
unsigned int _controlfp(unsigned int *new*, **unsigned int** *mask* **);**

Routine	Required Header	Compatibility
_control87	<float.h>	Win 95, Win NT
_controlfp	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The bits in the value returned indicate the floating-point control state. See FLOAT.H for a complete definition of the bits returned by **_control87**.

Parameters

new New control-word bit values

mask Mask for new control-word bits to set

Remarks

The **_control87** function gets and sets the floating-point control word. The floating-point control word allows the program to change the precision, rounding, and infinity modes in the floating-point math package. You can also mask or unmask floating-point exceptions using **_control87**. If the value for *mask* is equal to 0, **_control87** gets the floating-point control word. If *mask* is nonzero, a new value for the control word is set: For any bit that is on (equal to 1) in *mask*, the corresponding bit in *new* is used to update the control word. In other words, *fpcntrl* = (*fpcntrl* & ~**mask**) | (**new** & **mask**)) where *fpcntrl* is the floating-point control word.

Note The run-time libraries mask all floating-point exceptions by default.

_controlfp is a platform-independent, portable version of **_control87**. It is nearly identical to the **_control87** function on Intel (x86) platforms and is also supported by the MIPS and ALPHA platforms. To ensure that your floating-point code is portable to MIPS or ALPHA, use **_controlfp**. If you are targeting x86 platforms, use either **_control87** or **_controlfp**.

The only other difference between **_control87** and **_controlfp** is that **_controlfp** does not interfere with the DENORMAL OPERAND exception mask. The following example demonstrates the difference:

```
_control87( _EM_INVALID, _MCW_EM ); // DENORMAL is unmasked by this call
_controlfp( _EM_INVALID, _MCW_EM ); // DENORMAL exception mask remains unchanged
```

The possible values for the mask constant (*mask*) and new control values (*new*) are shown in Table R.1. Use the portable constants listed below (**_MCW_EM**, **_EM_INVALID**, and so forth) as arguments to these functions, rather than supplying the hexadecimal values explicitly.

Table R.1 Hexadecimal Values

Mask	Hex Value	Constant	Hex Value
_MCW_EM (Interrupt exception)	0x0008001F		
		_EM_INVALID	0x00000010
		_EM_DENORMAL	0x00080000
		_EM_ZERODIVIDE	0x00000008
		_EM_OVERFLOW	0x00000004
		_EM_UNDERFLOW	0x00000002
		_EM_INEXACT	0x00000001

(continued)

Table R.1 Hexadecimal Values *(continued)*

Mask	Hex Value	Constant	Hex Value
_MCW_IC (Infinity control)	0x00040000		
		_IC_AFFINE	0x00040000
		_IC_PROJECTIVE	0x00000000
_MCW_RC (Rounding control)	0x00000300		
		_RC_CHOP	0x00000300
		_RC_UP	0x00000200
		_RC_DOWN	0x00000100
		_RC_NEAR	0x00000000
_MCW_PC (Precision control)	0x00030000		
		_PC_24 (24 bits)	0x00020000
		_PC_53 (53 bits)	0x00010000
		_PC_64 (64 bits)	0x00000000

Example

```
/* CNTRL87.C: This program uses _control87 to output the control
 * word, set the precision to 24 bits, and reset the status to
 * the default.
 */

#include <stdio.h>
#include <float.h>

void main( void )
{
   double a = 0.1;

   /* Show original control word and do calculation. */
   printf( "Original: 0x%.4x\n", _control87( 0, 0 ) );
   printf( "%1.1f * %1.1f = %.15e\n", a, a, a * a );

   /* Set precision to 24 bits and recalculate. */
   printf( "24-bit:  0x%.4x\n", _control87( _PC_24, MCW_PC ) );
   printf( "%1.1f * %1.1f = %.15e\n", a, a, a * a );

   /* Restore to default and recalculate. */
   printf( "Default:  0x%.4x\n",
         _control87( _CW_DEFAULT, 0xfffff ) );
   printf( "%1.1f * %1.1f = %.15e\n", a, a, a * a );
}
```

Output

```
Original: 0x9001f
0.1 * 0.1 = 1.000000000000000e-002
24-bit:  0xa001f
0.1 * 0.1 = 9.999999776482582e-003
Default:  0x001f
0.1 * 0.1 = 1.000000000000000e-002
```

See Also: **_clear87**, **_status87**

_copysign

Return one value with the sign of another.

double _copysign(double *x*, **double** *y* **);**

Routine	Required Header	Compatibility
_copysign	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_copysign returns its double-precision floating point argument *x* with the same sign as its double-precision floating-point argument *y*. There is no error return.

Parameters

x Double-precision floating-point value to be changed

y Double-precision floating-point value

See Also: **fabs**, **_chgsign**

---

cos, cosh

Calculate the cosine (**cos**) or hyperbolic cosine (**cosh**).

double cos(double *x* **);**
double cosh(double *x* **);**

Routine	Required Header	Compatibility
cos	<math.h>	ANSI, Win 95, Win NT
cosh	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **cos** and **cosh** functions return the cosine and hyperbolic cosine, respectively, of x. If x is greater than or equal to 2^{63}, or less than or equal to -2^{63}, a loss of significance in the result of a call to **cos** occurs, in which case the function generates a **_TLOSS** error and returns an indefinite (same as a quiet NaN).

If the result is too large in a **cosh** call, the function returns **HUGE_VAL** and sets **errno** to **ERANGE**. You can modify error handling with **_matherr**.

Parameter

x Angle in radians

Example

```
/* SINCOS.C: This program displays the sine, hyperbolic
 * sine, cosine, and hyperbolic cosine of pi / 2.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double pi = 3.1415926535;
   double x, y;

   x = pi / 2;
   y = sin( x );
   printf( "sin( %f ) = %f\n", x, y );
   y = sinh( x );
   printf( "sinh( %f ) = %f\n",x, y );
   y = cos( x );
   printf( "cos( %f ) = %f\n", x, y );
   y = cosh( x );
   printf( "cosh( %f ) = %f\n",x, y );
}
```

Output

```
sin( 1.570796 ) = 1.000000
sinh( 1.570796 ) = 2.301299
cos( 1.570796 ) = 0.000000
cosh( 1.570796 ) = 2.509178
```

See Also: acos, asin, atan, _matherr, sin, tan

_cprintf

Formats and prints to the console.

int _cprintf(const char **format* [**,** *argument*] ... **);**

Routine	Required Header	Compatibility
_cprintf	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_cprintf returns the number of characters printed.

Parameters

format Format-control string

argument Optional parameters

Remarks

The **_cprintf** function formats and prints a series of characters and values directly to the console, using the **_putch** function to output characters. Each *argument* (if any) is converted and output according to the corresponding format specification in *format*. The format has the same form and function as the *format* parameter for the **printf** function. Unlike the **fprintf**, **printf**, and **sprintf** functions, **_cprintf** does not translate linefeed characters into carriage return–linefeed (CR-LF) combinations on output.

Example

```
/* CPRINTF.C: This program displays
 * some variables to the console.
 */

#include <conio.h>

void main( void )
{
   int      i = -16, h = 29;
   unsigned u = 62511;
   char     c = 'A';
   char     s[] = "Test";

   /* Note that console output does not translate \n as
    * standard output does. Use \r\n instead.
    */
   _cprintf( "%d  %.4x  %u  %c %s\r\n", i, h, u, c, s );
}
```

Output

```
-16  001d  62511  A Test
```

See Also: **_cscanf, fprintf, printf, sprintf, vfprintf**

_cputs

Puts a string to the console.

int _cputs(const char *_string_);

Routine	Required Header	Compatibility
_cputs	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_cputs** returns a 0. If the function fails, it returns a nonzero value.

Parameter

string Output string

Remarks

The **_cputs** function writes the null-terminated string pointed to by *string* directly to the console. A carriage return–linefeed (CR-LF) combination is not automatically appended to the string.

Example

```
/* CPUTS.C: This program first displays
 * a string to the console.
 */

#include <conio.h>

void main( void )
{
   /* String to print at console.
    * Note the \r (return) character.
    */
   char *buffer = "Hello world (courtesy of _cputs)!\r\n";

   _cputs( buffer );
}
```

Output

```
Hello world (courtesy of _cputs)!
```

See Also: **_putch**

_creat, _wcreat

Creates a new file.

int _creat(const char **filename*, **int** *pmode* **);**
int _wcreat(const wchar_t **filename*, **int** *pmode* **);**

Routine	Required Header	Optional Headers	Compatibility
_creat	<io.h>	<sys/types.h>, <sys/stat.h>, <errno.h>	Win 95, Win NT
_wcreat	<io.h> or <wchar.h>	<sys/types.h>, <sys/stat.h>, <errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions, if successful, returns a handle to the created file. Otherwise the function returns –1 and sets **errno** as follows:

errno Setting	Description
EACCES	Filename specifies an existing read-only file or specifies a directory instead of a file
EMFILE	No more file handles are available
ENOENT	The specified file could not be found

Parameters

filename Name of new file

pmode Permission setting

Remarks

The **_creat** function creates a new file or opens and truncates an existing one. **_wcreat** is a wide-character version of **_creat**; the *filename* argument to **_wcreat** is a wide-character string. **_wcreat** and **_creat** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcreat	_creat	_creat	_wcreat

If the file specified by *filename* does not exist, a new file is created with the given permission setting and is opened for writing. If the file already exists and its permission setting allows writing, **_creat** truncates the file to length 0, destroying the previous contents, and opens it for writing. The permission setting, *pmode*, applies to newly created files only. The new file receives the specified permission setting after it is closed for the first time. The integer expression *pmode* contains one or both of the manifest constants **_S_IWRITE** and **_S_IREAD**, defined in SYS\STAT.H. When both constants are given, they are joined with the bitwise-OR operator (|). The *pmode* parameter is set to one of the following values:

_S_IWRITE Writing permitted

_S_IREAD Reading permitted

_S_IREAD | _S_IWRITE Reading and writing permitted

If write permission is not given, the file is read-only. All files are always readable; it is impossible to give write-only permission. Thus the modes **_S_IWRITE** and **_S_IREAD | _S_IWRITE** are equivalent. Files opened using **_creat** are always opened in compatibility mode (see **_sopen**) with **_SH_DENYNO**.

_creat applies the current file-permission mask to *pmode* before setting the permissions (see **_umask**). **_creat** is provided primarily for compatibility with previous libraries. A call to **_open** with **_O_CREAT** and **_O_TRUNC** in the *oflag* parameter is equivalent to **_creat** and is preferable for new code.

Example

```
/* CREAT.C: This program uses _creat to create
 * the file (or truncate the existing file)
 * named data and open it for writing.
 */

#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int fh;
```

```
    fh = _creat( "data", _S_IREAD | _S_IWRITE );
    if( fh == -1 )
       perror( "Couldn't create data file" );
    else
    {
       printf( "Created data file.\n" );
       _close( fh );
    }
}
```

Output

```
Created data file.
```

See Also: **_chmod, _chsize, _close, _dup, _open, _sopen, _umask**

_cscanf

Reads formatted data from the console.

int _cscanf(const char **format* [**,** *argument*] ... **);**

Routine	Required Header	Compatibility
_cscanf	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_cscanf returns the number of fields that were successfully converted and assigned. The return value does not include fields that were read but not assigned. The return value is **EOF** for an attempt to read at end of file. This can occur when keyboard input is redirected at the operating-system command-line level. A return value of 0 means that no fields were assigned.

Parameters

format Format-control string

argument Optional parameters

Remarks

The **_cscanf** function reads data directly from the console into the locations given by *argument*. The **_getche** function is used to read characters. Each optional parameter must be a pointer to a variable with a type that corresponds to a type specifier in *format*. The format controls the interpretation of the input fields and has the same form and function as the *format* parameter for the **scanf** function. While **_cscanf** normally echoes the input character, it does not do so if the last call was to **_ungetch**.

Example

```
/* CSCANF.C: This program prompts for a string
 * and uses _cscanf to read in the response.
 * Then _cscanf returns the number of items
 * matched, and the program displays that number.
 */

#include <stdio.h>
#include <conio.h>

void main( void )
{
   int   result, i[3];

   _cprintf( "Enter three integers: ");
   result = _cscanf( "%i %i %i", &i[0], &i[1], &i[2] );
   _cprintf( "\r\nYou entered " );
   while( result-- )
      _cprintf( "%i ", i[result] );
   _cprintf( "\r\n" );
}
```

Output

```
Enter three integers: 1  2  3
You entered 3 2 1
```

See Also: **_cprintf, fscanf, scanf, sscanf**

---

ctime, _wctime

Convert a time value to a string and adjust for local time zone settings.

char *ctime(const time_t *_timer_);
wchar_t *_wctime(const time_t *_timer_);

Routine	Required Header	Compatibility
ctime	<time.h>	ANSI, Win 95, Win NT
_wctime	<time.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the character string result. If *time* represents a date before midnight, January 1, 1970, UTC, the function returns **NULL**.

Parameter

timer Pointer to stored time

Remarks

The **ctime** function converts a time value stored as a **time_t** structure into a character string. The *timer* value is usually obtained from a call to **time**, which returns the number of seconds elapsed since midnight (00:00:00), January 1, 1970, coordinated universal time (UTC). The string result produced by **ctime** contains exactly 26 characters and has the form:

```
Wed Jan 02 02:03:55 1980\n\0
```

A 24-hour clock is used. All fields have a constant width. The newline character ('\n') and the null character ('\0') occupy the last two positions of the string.

The converted character string is also adjusted according to the local time zone settings. See the **time**, **_ftime**, and **localtime** functions for information on configuring the local time and the **_tzset** function for details about defining the time zone environment and global variables.

A call to **ctime** modifies the single statically allocated buffer used by the **gmtime** and **localtime** functions. Each call to one of these routines destroys the result of the previous call. **ctime** shares a static buffer with the **asctime** function. Thus, a call to **ctime** destroys the results of any previous call to **asctime**, **localtime**, or **gmtime**.

_wctime is a wide-character version of **ctime**; **_wctime** returns a pointer to a wide-character string. **_wctime** and **ctime** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tctime	ctime	ctime	_wctime

Example

```
/* CTIME.C: This program gets the current
 * time in time_t form, then uses ctime to
 * display the time in string form.
 */

#include <time.h>
#include <stdio.h>

void main( void )
{
   time_t ltime;

   time( &ltime );
   printf( "The time is %s\n", ctime( &ltime ) );
}
```

Output

```
The time is Fri Apr 29 12:25:12 1994
```

See Also: **asctime, _ftime, gmtime, localtime, time**

_cwait

Waits until another process terminates.

int _cwait(int ***termstat*, int** ***procHandle*, int** ***action*);**

Routine	Required Header	Optional Headers	Compatibility
_cwait	<process.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

When the specified process has "successfully" completed, **_cwait** returns the handle of the specified process and sets *termstat* to the result code returned by the specified process. Otherwise, **_cwait** returns –1 and sets **errno** as follows:

Value	Description
ECHILD	No specified process exists, *procHandle* is invalid, or the call to the **GetExitCodeProcess** or **WaitForSingleObject** API failed
EINVAL	*action* is invalid

Parameters

termstat Pointer to a buffer where the result code of the specified process will be stored, or NULL

procHandle Handle to the current process or thread

action NULL: Ignored by Windows NT and Windows 95 applications; for other applications: action code to perform on *procHandle*

Remarks

The **_cwait** function waits for the termination of the process ID of the specified process that is provided by *procHandle*. The value of *procHandle* passed to **_cwait** should be the value returned by the call to the **_spawn** function that created the specified process. If the process ID terminates before **_cwait** is called, **_cwait** returns immediately. **_cwait** can be used by any process to wait for any other known process for which a valid handle (*procHandle*) exists.

termstat points to a buffer where the return code of the specified process will be stored. The value of *termstat* indicates whether the specified process terminated "normally" by calling the Windows NT **ExitProcess** API. **ExitProcess** is called internally if the specified process calls **exit** or **_exit**, returns from **main**, or reaches the end of **main**. See **GetExitCodeProcess** for more information regarding the value passed back through *termstat*. If **_cwait** is called with a NULL value for *termstat*, the return code of the specified process will not be stored.

The *action* parameter is ignored by Windows NT and Windows 95 because parent-child relationships are not implemented in these environments. Therefore, the OS/2 **wait** function, which allows a parent process to wait for any of its immediate children to terminate, is not available.

Example

```
/* CWAIT.C: This program launches several processes and waits
 * for a specified process to finish.
 */

#include <windows.h>
#include <process.h>
#include <stdlib.h>
#include <stdio.h>
#include <time.h>

/* Macro to get a random integer within a specified range */
#define getrandom( min, max ) (( rand() % (int)((( max ) + 1 )
➥ - ( min ))) + ( min ))

struct PROCESS
{

   int      nPid;
   char  name[40];
```

```
} process[4] = { { 0, "Ann" }, { 0, "Beth" }, { 0, "Carl" },
↪ { 0, "Dave" } };

void main( int argc, char *argv[] )
{

   int termstat, c;

   srand( (unsigned)time( NULL ) );  /* Seed randomizer */
   /* If no arguments, this is the calling process */
   if( argc == 1 )
   {

      /* Spawn processes in numeric order */
      for( c = 0; c < 4; c++ ){
         _flushall();
         process[c].nPid = spawnl( _P_NOWAIT, argv[0], argv[0],
                           process[c].name, NULL );
      }

      /* Wait for randomly specified process, and respond when done */
      c = getrandom( 0, 3 );
      printf( "Come here, %s.\n", process[c].name );
      _cwait( &termstat, process[c].nPid, _WAIT_CHILD );
      printf( "Thank you, %s.\n", process[c].name );

   }

   /* If there are arguments, this must be a spawned process */
   else
   {

      /* Delay for a period determined by process number */
      Sleep( (argv[1][0] - 'A' + 1) * 1000L );
      printf( "Hi, Dad. It's %s.\n", argv[1] );

   }

}
```

Output

```
Hi, Dad. It's Ann.
Come here, Ann.
Thank you, Ann.
Hi, Dad. It's Beth.
Hi, Dad. It's Carl.
Hi, Dad. It's Dave.
```

See Also: **_spawn Functions**

difftime

Finds the difference between two times.

double difftime(time_t *timer1*, **time_t** *timer0* **);**

Routine	Required Header	Compatibility
difftime	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

difftime returns the elapsed time in seconds, from *timer0* to *timer1*. The value returned is a double-precision floating-point number.

Parameters

timer1 Ending time

timer0 Beginning time

Remarks

The **difftime** function computes the difference between the two supplied time values *timer0* and *timer1*.

Example

```
/* DIFFTIME.C: This program calculates the amount of time
 * needed to do a floating-point multiply 10 million times.
 */

#include <stdio.h>
#include <stdlib.h>
#include <time.h>

void main( void )
{
   time_t   start, finish;
   long loop;
   double   result, elapsed_time;

   printf( "Multiplying 2 floating point numbers 10 million times...\n" );
```

```
    time( &start );
    for( loop = 0; loop < 10000000; loop++ )
       result = 3.63 * 5.27;
    time( &finish );

    elapsed_time = difftime( finish, start );
    printf( "\nProgram takes %6.0f seconds.\n", elapsed_time );
}
```

Output

```
Multiplying 2 floats 10 million times...

Program takes      2 seconds.
```

See Also: time

div

Computes the quotient and the remainder of two integer values.

div_t div(int *numer*, **int** *denom* **);**

Routine	Required Header	Compatibility
div	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

div returns a structure of type **div_t**, comprising the quotient and the remainder. The structure is defined in STDLIB.H.

Parameters

numer Numerator

denom Denominator

Remarks

The **div** function divides *numer* by *denom*, computing the quotient and the remainder. The **div_t** structure contains **int quot**, the quotient, and **int rem**, the remainder. The sign of the quotient is the same as that of the mathematical quotient. Its absolute value is the largest integer that is less than the absolute value of the mathematical quotient. If the denominator is 0, the program terminates with an error message.

Example

```
/* DIV.C: This example takes two integers as command-line
 * arguments and displays the results of the integer
 * division. This program accepts two arguments on the
 * command line following the program name, then calls
 * div to divide the first argument by the second.
 * Finally, it prints the structure members quot and rem.
 */

#include <stdlib.h>
#include <stdio.h>
#include <math.h>

void main( int argc, char *argv[] )
{
   int x,y;
   div_t div_result;

   x = atoi( argv[1] );
   y = atoi( argv[2] );

   printf( "x is %d, y is %d\n", x, y );
   div_result = div( x, y );
   printf( "The quotient is %d, and the remainder is %d\n",
         div_result.quot, div_result.rem );
}
```

Output

```
x is 876, y is 13
The quotient is 67, and the remainder is 5
```

See Also: **ldiv**

_dup, _dup2

Create a second handle for an open file (**_dup**), or reassign a file handle (**_dup2**).

int _dup(int *handle* **);**
int _dup2(int *handle1*, **int** *handle2* **);**

Routine	Required Header	Compatibility
_dup	<io.h>	Win 95, Win NT
_dup2	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_dup returns a new file handle. **_dup2** returns 0 to indicate success. If an error occurs, each function returns –1 and sets **errno** to **EBADF** if the file handle is invalid, or to **EMFILE** if no more file handles are available.

Parameters

handle, *handle1* Handles referring to open file

handle2 Any handle value

Remarks

The **_dup** and **_dup2** functions associate a second file handle with a currently open file. These functions can be used to associate a predefined file handle, such as that for **stdout**, with a different file. Operations on the file can be carried out using either file handle. The type of access allowed for the file is unaffected by the creation of a new handle. **_dup** returns the next available file handle for the given file#. **_dup2** forces *handle2* to refer to the same file as *handle1*. If *handle2* is associated with an open file at the time of the call, that file is closed.

Both **_dup** and **_dup2** accept file handles as parameters. To pass a stream **(FILE *)** to either of these functions, use **_fileno**. The **fileno** routine returns the file handle currently associated with the given stream. The following example shows how to associate **stderr** (defined as **FILE** * in STDIO.H) with a handle:

```
cstderr = _dup( _fileno( stderr ));
```

Example

```
/* DUP.C: This program uses the variable old to save the original
 * stdout. It then opens a new file named new and forces stdout to
 * refer to it. Finally, it restores stdout to its original state.
 */

#include <io.h>
#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int old;
   FILE *new;

   old = _dup( 1 );   /* "old" now refers to "stdout" */
                      /* Note:  file handle 1 == "stdout" */
   if( old == -1 )
   {
      perror( "_dup( 1 ) failure" );
      exit( 1 );
   }
   write( old, "This goes to stdout first\r\n", 27 );
   if( ( new = fopen( "data", "w" ) ) == NULL )
   {
      puts( "Can't open file 'data'\n" );
      exit( 1 );
   }
```

```
    /* stdout now refers to file "data" */
    if( -1 == _dup2( _fileno( new ), 1 ) )
    {
       perror( "Can't _dup2 stdout" );
       exit( 1 );
    }
    puts( "This goes to file 'data'\r\n" );

    /* Flush stdout stream buffer so it goes to correct file */
    fflush( stdout );
    fclose( new );

    /* Restore original stdout */
    _dup2( old, 1 );
    puts( "This goes to stdout\n" );
    puts( "The file 'data' contains:" );
    system( "type data" );
}
```

Output

```
This goes to stdout first
This goes to file 'data'

This goes to stdout

The file 'data' contains:

This goes to file 'data'
```

See Also: **_close, _creat, _open**

_ecvt

Converts a **double** number to a string.

char *_ecvt(double *value*, **int** *count*, **int** **dec*, **int** **sign* **);**

Function	Required Header	Compatibility
_ecvt	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ecvt returns a pointer to the string of digits. There is no error return.

Parameters

value Number to be converted

count Number of digits stored

dec Stored decimal-point position

sign Sign of converted number

Remarks

The **_ecvt** function converts a floating-point number to a character string. The *value* parameter is the floating-point number to be converted. This function stores up to *count* digits of *value* as a string and appends a null character ('\0'). If the number of digits in *value* exceeds *count,* the low-order digit is rounded. If there are fewer than *count* digits, the string is padded with zeros.

Only digits are stored in the string. The position of the decimal point and the sign of *value* can be obtained from *dec* and *sign* after the call. The *dec* parameter points to an integer value giving the position of the decimal point with respect to the beginning of the string. A 0 or negative integer value indicates that the decimal point lies to the left of the first digit. The *sign* parameter points to an integer that indicates the sign of the converted number. If the integer value is 0, the number is positive. Otherwise, the number is negative.

_ecvt and **_fcvt** use a single statically allocated buffer for the conversion. Each call to one of these routines destroys the result of the previous call.

Example

```
/* ECVT.C: This program uses _ecvt to convert a
 * floating-point number to a character string.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int     decimal,   sign;
   char    *buffer;
   int     precision = 10;
   double  source = 3.1415926535;

   buffer = _ecvt( source, precision, &decimal, &sign );
   printf( "source: %2.10f   buffer: '%s'  decimal: %d  sign: %d\n",
         source, buffer, decimal, sign );
}
```

Output

```
source: 3.1415926535   buffer: '3141592654'  decimal: 1   sign: 0
```

See Also: atof, _fcvt, _gcvt

_endthread, _endthreadex

void _endthread(void);
void _endthreadex(unsigned *retval* **);**

Function	Required Header	Compatibility
_endthread	<process.h>	Win 95, Win NT
_endthreadex	<process.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

retval Thread exit code

Remarks

The **_endthread** and **_endthreadex** functions terminate a thread created by **_beginthread** or **_beginthreadex**, respectively. You can call **_endthread** or **_endthreadex** explicitly to terminate a thread; however, **_endthread** or **_endthreadex** is called automatically when the thread returns from the routine passed as a parameter to **_beginthread** or **_beginthreadex**. Terminating a thread with a call to **endthread** or **_endthreadex** helps to ensure proper recovery of resources allocated for the thread.

Note For an executable file linked with LIBCMT.LIB, do not call the Win32 **ExitThread** API; this prevents the run-time system from reclaiming allocated resources. **_endthread** and **_endthreadex** reclaim allocated thread resources and then call **ExitThread.**

_endthread automatically closes the thread handle. (This behavior differs from the Win32 **ExitThread** API.) Therefore, when you use **_beginthread** and **_endthread**, do not explicitly close the thread handle by calling the Win32 **CloseHandle** API.

Like the Win32 **ExitThread** API, **_endthreadex** does not close the thread handle. Therefore, when you use **_beginthreadex** and **_endthreadex**, you must close the thread handle by calling the Win32 **CloseHandle** API.

Example

```
/* BEGTHRD.C illustrates multiple threads using functions:
 *
 *      _beginthread            _endthread
 *
 *
 * This program requires the multithreaded library. For example,
 * compile with the following command line:
 *     CL /MT /D "_X86_" BEGTHRD.C
 *                  .
 * If you are using the Visual C++ development environment, select the
 * Multi-Threaded runtime library in the compiler Project Options dialog
 * box.
 *
 */

#include <windows.h>
#include <process.h>    /* _beginthread, _endthread */
#include <stddef.h>
#include <stdlib.h>
#include <conio.h>

void Bounce( void *ch );
void CheckKey( void *dummy );

/* GetRandom returns a random integer between min and max. */
#define GetRandom( min, max ) ((rand() % (int)(((max) + 1) - (min))) + (min))

BOOL repeat = TRUE;     /* Global repeat flag and video variable */
HANDLE hStdOut;         /* Handle for console window */
CONSOLE_SCREEN_BUFFER_INFO csbi;    /* Console information structure */

void main()
{
   CHAR    ch = 'A';

   hStdOut = GetStdHandle( STD_OUTPUT_HANDLE );

   /* Get display screen's text row and column information. */
   GetConsoleScreenBufferInfo( hStdOut, &csbi );

   /* Launch CheckKey thread to check for terminating keystroke. */
   _beginthread( CheckKey, 0, NULL );

   /* Loop until CheckKey terminates program. */
   while( repeat )
   {
      /* On first loops, launch character threads. */
      _beginthread( Bounce, 0, (void *) (ch++)  );

      /* Wait one second between loops. */
      Sleep( 1000L );
   }
}
```

```
/* CheckKey - Thread to wait for a keystroke, then clear repeat flag. */
void CheckKey( void *dummy )
{
   _getch();
   repeat = 0;     /* _endthread implied */

}

/* Bounce - Thread to create and and control a colored letter that moves
 * around on the screen.
 *
 * Params: ch - the letter to be moved
 */
void Bounce( void *ch )
{
   /* Generate letter and color attribute from thread argument. */
   char     blankcell = 0x20;
   char     blockcell = (char) ch;
   BOOL     first = TRUE;
   COORD    oldcoord, newcoord;
   DWORD    result;


   /* Seed random number generator and get initial location. */
   srand( _threadid );
   newcoord.X = GetRandom( 0, csbi.dwSize.X - 1 );
   newcoord.Y = GetRandom( 0, csbi.dwSize.Y - 1 );
   while( repeat )
   {
      /* Pause between loops. */
      Sleep( 100L );

      /* Blank out our old position on the screen, and draw new letter. */
      if( first )
         first = FALSE;
      else
      WriteConsoleOutputCharacter( hStdOut, &blankcell, 1, oldcoord, &result );
      WriteConsoleOutputCharacter( hStdOut, &blockcell, 1, newcoord, &result );

      /* Increment the coordinate for next placement of the block. */
      oldcoord.X = newcoord.X;
      oldcoord.Y = newcoord.Y;
      newcoord.X += GetRandom( -1, 1 );
      newcoord.Y += GetRandom( -1, 1 );

      /* Correct placement (and beep) if about to go off the screen. */
      if( newcoord.X < 0 )
         newcoord.X = 1;
      else if( newcoord.X == csbi.dwSize.X )
         newcoord.X = csbi.dwSize.X - 2;
      else if( newcoord.Y < 0 )
         newcoord.Y = 1;
      else if( newcoord.Y == csbi.dwSize.Y )
         newcoord.Y = csbi.dwSize.Y - 2;
```

```
        /* If not at a screen border, continue, otherwise beep. */
        else
           continue;
        Beep( ((char) ch - 'A') * 100, 175 );
     }
     /* _endthread given to terminate */
     _endthread();
}
```

See Also: _beginthread

_eof

Tests for end-of-file.

int _eof(int *handle* **);**

Function	Required Header	Optional Headers	Compatibility
_eof	<io.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_eof returns 1 if the current position is end of file, or 0 if it is not. A return value of –1 indicates an error; in this case, **errno** is set to **EBADF**, which indicates an invalid file handle.

Parameter

handle Handle referring to open file

Remarks

The **_eof** function determines whether the end of the file associated with *handle* has been reached.

Example

```
/* EOF.C: This program reads data from a file
 * ten bytes at a time until the end of the
 * file is reached or an error is encountered.
 */
#include <io.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
void main( void )
```

```
{
   int  fh, count, total = 0;
   char buf[10];
   if( (fh = _open( "eof.c", _O_RDONLY )) == - 1 )
   {
      perror( "Open failed");
      exit( 1 );
   }
   /* Cycle until end of file reached: */
   while( !_eof( fh ) )
   {
      /* Attempt to read in 10 bytes: */
      if( (count = _read( fh, buf, 10 )) == -1 )
      {
      perror( "Read error" );
      break;
      }
      /* Total actual bytes read */
      total += count;
   }
   printf( "Number of bytes read = %d\n", total );
   _close( fh );
}
```

Output

```
Number of bytes read = 754
```

See Also: clearerr, feof, ferror, perror

_exec, _wexec Functions

Each of the functions in this family loads and executes a new process.

_execl, _wexecl	**_execv, _wexecv**
_execle, _wexecle	**_execve, _wexecve**
_execlp, _wexeclp	**_execvp, _wexecvp**
_execlpe, _wexeclpe	**_execvpe, _wexecvpe**

The letter(s) at the end of the function name determine the variation.

_exec Function Suffix	Description
e	*envp*, array of pointers to environment settings, is passed to new process.
l	Command-line arguments are passed individually to **_exec** function. Typically used when number of parameters to new process is known in advance.
p	**PATH** environment variable is used to find file to execute.
v	*argv*, array of pointers to command-line arguments, is passed to **_exec**. Typically used when number of parameters to new process is variable.

Remarks

Each of the **_exec** functions loads and execute a new process. All **_exec** functions use the same operating-system function. The **_exec** functions automatically handle multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use. The **_wexec** functions are wide-character versions of the **_exec** functions. The **_wexec** functions behave identically to their **_exec** family counterparts except that they do not handle multibyte-character strings.

Generic-Text Routine Mappings:

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_texecl	_execl	_execl	_wexecl
_texecle	_execle	_execle	_wexecle
_texeclp	_execlp	_execlp	_wexeclp
_texeclpe	_execlpe	_execlpe	_wexeclpe
_texecv	_execv	_execv	_wexecv
_texecve	_execve	_execve	_wexecve
_texecvp	_execvp	_execvp	_wexecvp
_texecvpe	_execvpe	_execvpe	_wexecvpe

When a call to an **_exec** function is successful, the new process is placed in the memory previously occupied by the calling process. Sufficient memory must be available for loading and executing the new process.

The *cmdname* parameter specifies the file to be executed as the new process. It can specify a full path (from the root), a partial path (from the current working directory), or a filename. If *cmdname* does not have a filename extension or does not end with a period (.), the **_exec** function searches for the named file. If the search is unsuccessful, it tries the same base name with the .COM extension and then with the .EXE, .BAT, and .CMD extensions. If *cmdname* has an extension, only that extension is used in the search. If *cmdname* ends with a period, the **_exec** function searches for *cmdname* with no extension. **_execlp**, **_execlpe**, **_execvp**, and **_execvpe** search for *cmdname* (using the same procedures) in the directories specified by the **PATH** environment variable. If *cmdname* contains a drive specifier or any slashes (that is, if it is a relative path), the **_exec** call searches only for the specified file; the path is not searched.

Parameters are passed to the new process by giving one or more pointers to character strings as parameters in the **_exec** call. These character strings form the parameter list for the new process. The combined length of the inherited environment settings and the strings forming the parameter list for the new process must not exceed 32K bytes. The terminating null character ('\0') for each string is not included in the count, but space characters (inserted automatically to separate the parameters) are counted.

The argument pointers can be passed as separate parameters (in **_execl**, **_execle**, **_execlp**, and **_execlpe**) or as an array of pointers (in **_execv**, **_execve**, **_execvp**, and **_execvpe**). At least one parameter, *arg0*, must be passed to the new process; this parameter is *argv*[0] of the new process. Usually, this parameter is a copy of *cmdname*. (A different value does not produce an error.)

The **_execl**, **_execle**, **_execlp**, and **_execlpe** calls are typically used when the number of parameters is known in advance. The parameter *arg0* is usually a pointer to *cmdname*. The parameters *arg1* through *argn* point to the character strings forming the new parameter list. A null pointer must follow *argn* to mark the end of the parameter list.

The **_execv**, **_execve**, **_execvp**, and **_execvpe** calls are useful when the number of parameters to the new process is variable. Pointers to the parameters are passed as an array, *argv*. The parameter *argv*[0] is usually a pointer to *cmdname*. The parameters *argv*[1] through *argv*[*n*] point to the character strings forming the new parameter list. The parameter *argv*[*n*+1] must be a **NULL** pointer to mark the end of the parameter list.

Files that are open when an **_exec** call is made remain open in the new process. In **_execl**, **_execlp**, **_execv**, and **_execvp** calls, the new process inherits the environment of the calling process. **_execle**, **_execlpe**, **_execve**, and **_execvpe** calls alter the environment for the new process by passing a list of environment settings through the *envp* parameter. *envp* is an array of character pointers, each element of which (except for the final element) points to a null-terminated string defining an environment variable. Such a string usually has the form *NAME=value* where *NAME* is the name of an environment variable and *value* is the string value to which that variable is set. (Note that *value* is not enclosed in double quotation marks.) The final element of the *envp* array should be **NULL**. When *envp* itself is **NULL**, the new process inherits the environment settings of the calling process.

A program executed with one of the **_exec** functions is always loaded into memory as if the "maximum allocation" field in the program's .EXE file header were set to the default value of 0xFFFFH. You can use the EXEHDR utility to change the maximum allocation field of a program; however, such a program invoked with one of the **_exec** functions may behave differently from a program invoked directly from the operating-system command line or with one of the **_spawn** functions.

The **_exec** calls do not preserve the translation modes of open files. If the new process must use files inherited from the calling process, use the **_setmode** routine to set the translation mode of these files to the desired mode. You must explicitly flush (using **fflush** or **_flushall**) or close any stream before the **_exec** function call. Signal settings are not preserved in new processes that are created by calls to **_exec** routines. The signal settings are reset to the default in the new process.

Example

```
/* EXEC.C illustrates the different versions of exec including:
 *      _execl          _execle          _execlp          _execlpe
 *      _execv          _execve          _execvp          _execvpe
 *
 * Although EXEC.C can exec any program, you can verify how
 * different versions handle arguments and environment by
 * compiling and specifying the sample program ARGS.C. See
 * SPAWN.C for examples of the similar spawn functions.
 */

#include <stdio.h>
#include <conio.h>
#include <process.h>

char *my_env[] =                /* Environment for exec?e */
{
   "THIS=environment will be",
   "PASSED=to new process by",
   "the EXEC=functions",
   NULL
};

void main()
{
   char *args[4], prog[80];
   int ch;

   printf( "Enter name of program to exec: " );
   gets( prog );
   printf( " 1. _execl  2. _execle  3. _execlp  4. _execlpe\n" );
   printf( " 5. _execv  6. _execve  7. _execvp  8. _execvpe\n" );
   printf( "Type a number from 1 to 8 (or 0 to quit): " );
   ch = _getche();
   if( (ch < '1') || (ch > '8') )
      exit( 1 );
   printf( "\n\n" );

   /* Arguments for _execv? */
   args[0] = prog;
   args[1] = "exec??";
   args[2] = "two";
   args[3] = NULL;

   switch( ch )
   {
   case '1':
      _execl( prog, prog, "_execl", "two", NULL );
      break;
   case '2':
      _execle( prog, prog, "_execle", "two", NULL, my_env );
      break;
   case '3':
      _execlp( prog, prog, "_execlp", "two", NULL );
      break;
```

```
    case '4':
       _execlpe( prog, prog, "_execlpe", "two", NULL, my_env );
       break;
    case '5':
       _execv( prog, args );
       break;
    case '6':
       _execve( prog, args, my_env );
       break;
    case '7':
       _execvp( prog, args );
       break;
    case '8':
       _execvpe( prog, args, my_env );
       break;
    default:
       break;
    }

    /* This point is reached only if exec fails. */
    printf( "\nProcess was not execed." );
    exit( 0 );
}
```

See Also: **abort, atexit, exit, _onexit, _spawn Function Overview, system**

_execl, _wexecl

Load and execute new child processes.

int _execl(const char *_cmdname_, const char *_arg0_, ... const char *_argn_, NULL);
int _wexecl(const wchar_t *_cmdname_, const wchar_t *_arg0_, ...
↪ const wchar_t *_argn_, NULL);

Function	Required Header	Optional Headers	Compatibility
_execl	<process.h>	<errno.h>	Win 95, Win NT
_wexecl	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to be executed

arg0, ... argn List of pointers to parameters

Remarks

Each of these functions loads and executes a new process, passing each command-line argument as a separate parameter.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execle, _wexecle

Load and execute new child processes.

int _execle(const char **cmdname*, **const char** **arg0*, ... **const char** **argn*,
↪ **NULL, const char *const** **envp* **);**
int _wexecle(const wchar_t **cmdname*, **const wchar_t** **arg0*, ...
↪ **const wchar_t** **argn*, **NULL, const char *const** **envp* **);**

Function	Required Header	Optional Headers	Compatibility
_execle	<process.h>	<errno.h>	Win 95, Win NT
_wexecle	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

arg0, ... argn List of pointers to parameters

envp Array of pointers to environment settings

Remarks

Each of these functions loads and executes a new process, passing each command-line argument as a separate parameter and also passing an array of pointers to environment settings.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execlp, _wexeclp

Load and execute new child processes.

int _execlp(const char *_cmdname_, const char *_arg0_, ... const char *_argn_, NULL);
int _wexeclp(const wchar_t *_cmdname_, const wchar_t *_arg0_, ...
↪ const wchar_t *_argn_, NULL);

Function	Required Header	Optional Headers	Compatibility
_execlp	<process.h>	<errno.h>	Win 95, Win NT
_wexeclp	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

arg0, ... argn List of pointers to parameters

Remarks

Each of these functions loads and executes a new process, passing each command-line argument as a separate parameter and using the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execlpe, _wexeclpe

Load and execute new child processes.

int _execlpe(const char *_cmdname_, const char *_arg0_, ... const char *_argn_,
↪ NULL, const char *const *_envp_);
int _wexeclpe(const wchar_t *_cmdname_, const wchar_t *_arg0_, ...
↪ const wchar_t *_argn_, NULL, const wchar_t *const *_envp_);

Function	Required Header	Optional Headers	Compatibility
_execlpe	<process.h>	<errno.h>	Win 95, Win NT
_wexeclpe	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

arg0, ... argn List of pointers to parameters

envp Array of pointers to environment settings

Remarks

Each of these functions loads and executes a new process, passing each command-line argument as a separate parameter and also passing an array of pointers to environment settings. These functions use the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execv, _wexecv

Load and execute new child processes.

int _execv(const char **cmdname*, const char *const **argv*);
int _wexecv(const wchar_t **cmdname*, const wchar_t *const **argv*);

Function	Required Header	Optional Headers	Compatibility
_execv	<process.h>	<errno.h>	Win 95, Win NT
_wexecv	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

argv Array of pointers to parameters

Remarks

Each of these functions loads and executes a new process, passing an array of pointers to command-line arguments.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execve, _wexecve

Load and execute new child processes.

int _execve(const char **cmdname*, const char *const **argv*, const char *const **envp*);
int _wexecve(const wchar_t **cmdname*, const wchar_t *const **argv*,
↪ const wchar_t *const **envp*);

Function	Required Header	Optional Headers	Compatibility
_execve	<process.h>	<errno.h>	Win 95, Win NT
_wexecve	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

argv Array of pointers to parameters

envp Array of pointers to environment settings

Remarks

Each of these functions loads and executes a new process, passing an array of pointers to command-line arguments and an array of pointers to environment settings.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execvp, _wexecvp

Load and execute new child processes.

int _execvp(const char *_cmdname_, const char *const *_argv_);
int _wexecvp(const wchar_t *_cmdname_, const wchar_t *const *_argv_);

Function	Required Header	Optional Headers	Compatibility
_execvp	<process.h>	<errno.h>	Win 95, Win NT
_wexecvp	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

argv Array of pointers to parameters

Remarks

Each of these functions loads and executes a new process, passing an array of pointers to command-line arguments and using the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

_execvpe, _wexecvpe

Load and execute new child processes.

int _execvpe(const char **cmdname*, const char *const **argv*, const char *const **envp*);
int _wexecvpe(const wchar_t **cmdname*, const wchar_t *const **argv*,
↪ const wchar_t *const **envp*);

Function	Required Header	Optional Headers	Compatibility
_execvpe	<process.h>	<errno.h>	Win 95, Win NT
_wexecvpe	<process.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, these functions do not return to the calling process. A return value of –1 indicates an error, in which case the **errno** global variable is set.

errno Value	Description
E2BIG	The space required for the arguments and environment settings exceeds 32K.
EACCES	The specified file has a locking or sharing violation.
EMFILE	Too many files open (the specified file must be opened to determine whether it is executable).
ENOENT	File or path not found.
ENOEXEC	The specified file is not executable or has an invalid executable-file format.
ENOMEM	Not enough memory is available to execute the new process; or the available memory has been corrupted; or an invalid block exists, indicating that the calling process was not allocated properly.

Parameters

cmdname Path of file to execute

argv Array of pointers to parameters

envp Array of pointers to environment settings

Remarks

Each of these functions loads and executes a new process, passing an array of pointers to command-line arguments and an array of pointers to environment settings. These functions use the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, exit, _onexit, _spawn Function Overview, system

Example

See Example on page 218.

---

exit, _exit

Terminate the calling process after cleanup (**exit**) or immediately (**_exit**).

void exit(int *status* **);**
void _exit(int *status* **);**

Function	Required Header	Compatibility
exit	<process.h> or <stdlib.h>	ANSI, Win 95, Win NT
_exit	<process.h> or <stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

status Exit status

Remarks

The **exit** and **_exit** functions terminate the calling process. **exit** calls, in last-in-first-out (LIFO) order, the functions registered by **atexit** and **_onexit**, then flushes all file buffers before terminating the process. **_exit** terminates the process without processing **atexit** or **_onexit** or flushing stream buffers. The *status* value is typically set to 0 to indicate a normal exit and set to some other value to indicate an error.

Although the **exit** and **_exit** calls do not return a value, the low-order byte of *status* is made available to the waiting calling process, if one exists, after the calling process exits. The *status* value is available to the operating-system batch command **ERRORLEVEL** and is represented by one of two constants: **EXIT_SUCCESS**, which represents a value of 0, or **EXIT_FAILURE**, which represents a value of 1. The behavior of **exit**, **_exit**, **_cexit**, and **_c_exit** is as follows:

Function	Description
exit	Performs complete C library termination procedures, terminates the process, and exits with the supplied status code.
_exit	Performs "quick" C library termination procedures, terminates the process, and exits with the supplied status code.
_cexit	Performs complete C library termination procedures and returns to the caller, but does not terminate the process.
_c_exit	Performs "quick" C library termination procedures and returns to the caller, but does not terminate the process.

Example

```
/* EXITER.C: This program prompts the user for a yes
 * or no and returns an exit code of 1 if the
 * user answers Y or y; otherwise it returns 0. The
 * error code could be tested in a batch file.
 */

#include <conio.h>
#include <stdlib.h>

void main( void )
{
   int ch;

   _cputs( "Yes or no? " );
   ch = _getch();
   _cputs( "\r\n" );
   if( toupper( ch ) == 'Y' )
      exit( 1 );
   else
      exit( 0 );
}
```

See Also: abort, atexit, _cexit, _exec Function Overview, _onexit, _spawn Function Overview, system

exp

Calculates the exponential.

double exp(double *x* **);**

Function	Required Header	Compatibility
exp	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **exp** function returns the exponential value of the floating-point parameter, *x*, if successful. On overflow, the function returns INF (infinite) and on underflow, **exp** returns 0.

Parameter

x Floating-point value

Example

```
/* EXP.C */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 2.302585093, y;

   y = exp( x );
   printf( "exp( %f ) = %f\n", x, y );
}
```

Output

```
exp( 2.302585 ) = 10.000000
```

See Also: log

_expand

Changes the size of a memory block.

void *_expand(void *_memblock_, size_t _size_);

Function	Required Header	Compatibility
_expand	<malloc.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_expand returns a void pointer to the reallocated memory block. **_expand**, unlike **realloc**, cannot move a block to change its size. Thus, if there is sufficient memory available to expand the block without moving it, the *memblock* parameter to **_expand** is the same as the return value.

_expand returns **NULL** if there is insufficient memory available to expand the block to the given size without moving it. The item pointed to by *memblock* is expanded as much as possible in its current location.

The return value points to a storage space that is guaranteed to be suitably aligned for storage of any type of object. To check the new size of the item, use **_msize**. To get a pointer to a type other than **void**, use a type cast on the return value.

Parameters

memblock Pointer to previously allocated memory block

size New size in bytes

Remarks

The **_expand** function changes the size of a previously allocated memory block by trying to expand or contract the block without moving its location in the heap. The *memblock* parameter points to the beginning of the block. The *size* parameter gives the new size of the block, in bytes. The contents of the block are unchanged up to the shorter of the new and old sizes. *memblock* can also point to a block that has been freed, as long as there has been no intervening call to **calloc**, **_expand**, **malloc**, or **realloc**. If *memblock* points to a freed block, the block remains free after a call to **_expand**.

When the application is linked with a debug version of the C run-time libraries, **_expand** resolves to **_expand_dbg**.

Example

```
/* EXPAND.C */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>

void main( void )
{
   char *bufchar;
   printf( "Allocate a 512 element buffer\n" );
   if( (bufchar = (char *)calloc( 512, sizeof( char ) )) == NULL )
      exit( 1 );
   printf( "Allocated %d bytes at %Fp\n",
      _msize( bufchar ), (void *)bufchar );
   if( (bufchar = (char *)_expand( bufchar, 1024 )) == NULL )
      printf( "Can't expand" );
   else
      printf( "Expanded block to %d bytes at %Fp\n",
         _msize( bufchar ), (void *)bufchar );
   /* Free memory */
   free( bufchar );
   exit( 0 );
}
```

Output

```
Allocate a 512 element buffer
Allocated 512 bytes at 002C12BC
Expanded block to 1024 bytes at 002C12BC
```

See Also: **calloc, free, malloc, _msize, realloc**

fabs

Calculates the absolute value of the floating-point argument.

double fabs(double *x* **);**

Function	Required Header	Compatibility
fabs	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fabs returns the absolute value of its argument. There is no error return.

Parameter

x Floating-point value

Example

```
/* ABS.C: This program computes and displays
 * the absolute values of several numbers.
 */

#include  <stdio.h>
#include  <math.h>
#include  <stdlib.h>

void main( void )
{
   int    ix = -4, iy;
   long   lx = -41567L, ly;
   double dx = -3.141593, dy;

   iy = abs( ix );
   printf( "The absolute value of %d is %d\n", ix, iy);

   ly = labs( lx );
   printf( "The absolute value of %ld is %ld\n", lx, ly);

   dy = fabs( dx );
   printf( "The absolute value of %f is %f\n", dx, dy );
}
```

Output

```
The absolute value of -4 is 4
The absolute value of -41567 is 41567
The absolute value of -3.141593 is 3.141593
```

See Also: **abs, _cabs, labs**

fclose, _fcloseall

Closes a stream (**fclose**) or closes all open streams (**_fcloseall**).

int fclose(FILE **stream* **);**
int _fcloseall(void);

Function	Required Header	Compatibility
fclose	<stdio.h>	ANSI, Win 95, Win NT
_fcloseall	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fclose returns 0 if the stream is successfully closed. **_fcloseall** returns the total number of streams closed. Both functions return **EOF** to indicate an error.

Parameter

stream Pointer to **FILE** structure

Remarks

The **fclose** function closes *stream*. **_fcloseall** closes all open streams except **stdin**, **stdout**, **stderr** (and, in MS-DOS®, **_stdaux** and **_stdprn**). It also closes and deletes any temporary files created by **tmpfile**. In both functions, all buffers associated with the stream are flushed prior to closing. System-allocated buffers are released when the stream is closed. Buffers assigned by the user with **setbuf** and **setvbuf** are not automatically released.

Example

```
/* FOPEN.C: This program opens files named "data"
 * and "data2".It  uses fclose to close "data" and
 * _fcloseall to close all remaining files.
 */

#include <stdio.h>

FILE *stream, *stream2;

void main( void )
{
   int numclosed;
```

```
    /* Open for read (will fail if file "data" does not exist) */
    if( (stream  = fopen( "data", "r" )) == NULL )
       printf( "The file 'data' was not opened\n" );
    else
       printf( "The file 'data' was opened\n" );

    /* Open for write */
    if( (stream2 = fopen( "data2", "w+" )) == NULL )
       printf( "The file 'data2' was not opened\n" );
    else
       printf( "The file 'data2' was opened\n" );

    /* Close stream */
    if( fclose( stream ) )
       printf( "The file 'data' was not closed\n" );

    /* All other files are closed: */
    numclosed = _fcloseall( );
    printf( "Number of files closed by _fcloseall: %u\n", numclosed );
}
```

Output

```
The file 'data' was opened
The file 'data2' was opened
Number of files closed by _fcloseall: 1
```

See Also: _close, _fdopen, fflush, fopen, freopen

_fcvt

Converts a floating-point number to a string.

char *_fcvt(double *value*, **int** *count*, **int** **dec*, **int** **sign* **);**

Function	Required Header	Compatibility
_fcvt	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_fcvt returns a pointer to the string of digits. There is no error return.

Parameters

value Number to be converted

count Number of digits after decimal point

dec Pointer to stored decimal-point position

sign Pointer to stored sign indicator

Remarks

The **_fcvt** function converts a floating-point number to a null-terminated character string. The *value* parameter is the floating-point number to be converted. **_fcvt** stores the digits of *value* as a string and appends a null character ('\0'). The *count* parameter specifies the number of digits to be stored after the decimal point. Excess digits are rounded off to *count* places. If there are fewer than *count* digits of precision, the string is padded with zeros.

Only digits are stored in the string. The position of the decimal point and the sign of *value* can be obtained from *dec* and *sign* after the call. The *dec* parameter points to an integer value; this integer value gives the position of the decimal point with respect to the beginning of the string. A zero or negative integer value indicates that the decimal point lies to the left of the first digit. The parameter *sign* points to an integer indicating the sign of *value*. The integer is set to 0 if *value* is positive and is set to a nonzero number if *value* is negative.

_ecvt and **_fcvt** use a single statically allocated buffer for the conversion. Each call to one of these routines destroys the results of the previous call.

Example

```
/* FCVT.C: This program converts the constant
 * 3.1415926535 to a string and sets the pointer
 * *buffer to point to that string.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int  decimal, sign;
   char *buffer;
   double source = 3.1415926535;

   buffer = _fcvt( source, 7, &decimal, &sign );
   printf( "source: %2.10f   buffer: '%s'   decimal: %d   sign: %d\n",
         source, buffer, decimal, sign );
}
```

Output

```
source: 3.1415926535   buffer: '31415927'   decimal: 1   sign: 0
```

See Also: atof, _ecvt, _gcvt

_fdopen, _wfdopen

Associate a stream with a file that was previously opened for low-level I/O.

FILE *_fdopen(int *handle*, **const char** **mode* **);**
FILE *_wfdopen(int *handle*, **const wchar_t** **mode* **);**

Function	Required Header	Compatibility
_fdopen	<stdio.h>	Win 95, Win NT
_wfdopen	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the open stream. A null pointer value indicates an error.

Parameters

handle Handle to open file

mode Type of file access

Remarks

The **_fdopen** function associates an I/O stream with the file identified by *handle*, thus allowing a file opened for low-level I/O to be buffered and formatted. **_wfdopen** is a wide-character version of **_fdopen**; the *mode* argument to **_wfdopen** is a wide-character string. **_wfdopen** and **_fdopen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfdopen	_fdopen	_fdopen	_wfdopen

The *mode* character string specifies the type of file and file access.

The character string *mode* specifies the type of access requested for the file, as follows:

"r" Opens for reading. If the file does not exist or cannot be found, the **fopen** call fails.

"w" Opens an empty file for writing. If the given file exists, its contents are destroyed.

"a" Opens for writing at the end of the file (appending); creates the file first if it doesn't exist.

"r+" Opens for both reading and writing. (The file must exist.)

"w+" Opens an empty file for both reading and writing. If the given file exists, its contents are destroyed.

"a+" Opens for reading and appending; creates the file first if it doesn't exist.

When a file is opened with the **"a"** or **"a+"** access type, all write operations occur at the end of the file. The file pointer can be repositioned using **fseek** or **rewind**, but is always moved back to the end of the file before any write operation is carried out. Thus, existing data cannot be overwritten. When the **"r+"**, **"w+"**, or **"a+"** access type is specified, both reading and writing are allowed (the file is said to be open for "update"). However, when you switch between reading and writing, there must be an intervening **fflush**, **fsetpos**, **fseek**, or **rewind** operation. The current position can be specified for the **fsetpos** or **fseek** operation, if desired.

In addition to the above values, the following characters can be included in *mode* to specify the translation mode for newline characters:

t Open in text (translated) mode. In this mode, carriage return–linefeed (CR-LF) combinations are translated into single linefeeds (LF) on input, and LF characters are translated to CR-LF combinations on output. Also, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading/writing, **fopen** checks for a CTRL+Z at the end of the file and removes it, if possible. This is done because using the **fseek** and **ftell** functions to move within a file that ends with a CTRL+Z may cause **fseek** to behave improperly near the end of the file.

b Open in binary (untranslated) mode; the above translations are suppressed.

c Enable the commit flag for the associated *filename* so that the contents of the file buffer are written directly to disk if either **fflush** or **_flushall** is called.

n Reset the commit flag for the associated *filename* to "no-commit." This is the default. It also overrides the global commit flag if you link your program with COMMODE.OBJ. The global commit flag default is "no-commit" unless you explicitly link your program with COMMODE.OBJ.

The **t**, **c**, and **n** *mode* options are Microsoft extensions for **fopen** and **_fdopen** and should not be used where ANSI portability is desired.

If **t** or **b** is not given in *mode*, the default translation mode is defined by the global variable **_fmode**. If **t** or **b** is prefixed to the argument, the function fails and returns **NULL**. For a discussion of text and binary modes, see "Text and Binary Mode File I/O."

Valid characters for the *mode* string used in **fopen** and **_fdopen** correspond to *oflag* arguments used in **_open** and **_sopen**, as follows:

Characters in *mode* String	Equivalent *oflag* Value for _open/_sopen
a	**_O_WRONLY** | **_O_APPEND** (usually **_O_WRONLY** | **_O_CREAT** | **_O_APPEND**)
a+	**_O_RDWR** | **_O_APPEND** (usually **_O_RDWR** | **_O_APPEND** | **_O_CREAT**)
r	**_O_RDONLY**
r+	**_O_RDWR**
w	**_O_WRONLY** (usually **_O_WRONLY** | **_O_CREAT** | **_O_TRUNC**)
w+	**_O_RDWR** (usually **_O_RDWR** | **_O_CREAT** | **_O_TRUNC**)
b	**_O_BINARY**
t	**_O_TEXT**
c	None
n	None

Example

```
/* _FDOPEN.C: This program opens a file using low-
 * level I/O, then uses _fdopen to switch to stream
 * access. It counts the lines in the file.
 */

#include <stdlib.h>
#include <stdio.h>
#include <fcntl.h>
#include <io.h>

void main( void )
{
   FILE *stream;
   int  fh, count = 0;
   char inbuf[128];

   /* Open a file handle. */
   if( (fh = _open( "_fdopen.c", _O_RDONLY )) == -1 )
      exit( 1 );

   /* Change handle access to stream access. */
   if( (stream = _fdopen( fh, "r" )) == NULL )
      exit( 1 );

   while( fgets( inbuf, 128, stream ) != NULL )
      count++;
```

```
    /* After _fdopen, close with fclose, not _close. */
    fclose( stream );
    printf( "Lines in file: %d\n", count );
}
```

Output

```
Lines in file: 32
```

See Also: **_dup, fclose, fopen, freopen, _open**

feof

Tests for end-of-file on a stream.

int feof(FILE **stream* **);**

Function	Required Header	Compatibility
feof	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **feof** function returns a nonzero value after the first read operation that attempts to read past the end of the file. It returns 0 if the current position is not end of file. There is no error return.

Parameter

stream Pointer to **FILE** structure

Remarks

The **feof** routine (implemented both as a function and as a macro) determines whether the end of *stream* has been reached. When end of file is reached, read operations return an end-of-file indicator until the stream is closed or until **rewind**, **fsetpos**, **fseek**, or **clearerr** is called against it.

Example

```
/* FEOF.C: This program uses feof to indicate when
 * it reaches the end of the file FEOF.C. It also
 * checks for errors with ferror.
 */

#include <stdio.h>
#include <stdlib.h>
```

```
void main( void )
{
   int  count, total = 0;
   char buffer[100];
   FILE *stream;
   if( (stream = fopen( "feof.c", "r" )) == NULL )
      exit( 1 );

   /* Cycle until end of file reached: */
   while( !feof( stream ) )
   {
      /* Attempt to read in 10 bytes: */
      count = fread( buffer, sizeof( char ), 100, stream );
      if( ferror( stream ) )      {
         perror( "Read error" );
         break;
      }

      /* Total up actual bytes read */
      total += count;
   }
   printf( "Number of bytes read = %d\n", total );
   fclose( stream );
}
```

Output

```
Number of bytes read = 745
```

See Also: clearerr, _eof, ferror, perror

ferror

Tests for an error on a stream.

int ferror(FILE ***stream*);**

Function	Required Header	Compatibility
ferror	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If no error has occurred on *stream*, **ferror** returns 0. Otherwise, it returns a nonzero value.

Parameter

stream Pointer to **FILE** structure

Remarks

The **ferror** routine (implemented both as a function and as a macro) tests for a reading or writing error on the file associated with *stream*. If an error has occurred, the error indicator for the stream remains set until the stream is closed or rewound, or until **clearerr** is called against it.

Example

```
/* FEOF.C: This program uses feof to indicate when
 * it reaches the end of the file FEOF.C. It also
 * checks for errors with ferror.
 */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int  count, total = 0;
   char buffer[100];
   FILE *stream;

   if( (stream = fopen( "feof.c", "r" )) == NULL )
      exit( 1 );

   /* Cycle until end of file reached: */
   while( !feof( stream ) )
   {
      /* Attempt to read in 10 bytes: */
      count = fread( buffer, sizeof( char ), 100, stream );
      if( ferror( stream ) )      {
         perror( "Read error" );
         break;
      }

      /* Total up actual bytes read */
      total += count;
   }
   printf( "Number of bytes read = %d\n", total );
   fclose( stream );
}
```

Output

```
Number of bytes read = 745
```

See Also: clearerr, _eof, feof, fopen, perror

fflush

Flushes a stream.

int fflush(FILE **stream* **);**

Function	Required Header	Compatibility
fflush	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fflush returns 0 if the buffer was successfully flushed. The value 0 is also returned in cases in which the specified stream has no buffer or is open for reading only. A return value of **EOF** indicates an error.

Note If **fflush** returns **EOF**, data may have been lost due to a write failure. When setting up a critical error handler, it is safest to turn buffering off with the **setvbuf** function or to use low-level I/O routines such as **_open**, **_close**, and **_write** instead of the stream I/O functions.

Parameter

stream Pointer to **FILE** structure

Remarks

The **fflush** function flushes a stream. If the file associated with *stream* is open for output, **fflush** writes to that file the contents of the buffer associated with the stream. If the stream is open for input, **fflush** clears the contents of the buffer. **fflush** negates the effect of any prior call to **ungetc** against *stream*. Also, **fflush(NULL)** flushes all streams opened for output. The stream remains open after the call. **fflush** has no effect on an unbuffered stream.

Buffers are normally maintained by the operating system, which determines the optimal time to write the data automatically to disk: when a buffer is full, when a stream is closed, or when a program terminates normally without closing the stream. The commit-to-disk feature of the run-time library lets you ensure that critical data is written directly to disk rather than to the operating-system buffers. Without rewriting an existing program, you can enable this feature by linking the program's object files with COMMODE.OBJ. In the resulting executable file, calls to **_flushall** write the contents of all buffers to disk. Only **_flushall** and **fflush** are affected by COMMODE.OBJ.

For information about controlling the commit-to-disk feature, see "Stream I/O" on page 16 in Chapter 1, **fopen**, and **_fdopen**.

Example

```
/* FFLUSH.C */

#include <stdio.h>
#include <conio.h>

void main( void )
{
   int integer;
   char string[81];

   /* Read each word as a string. */
   printf( "Enter a sentence of four words with scanf: " );
   for( integer = 0; integer < 4; integer++ )
   {
      scanf( "%s", string );
      printf( "%s\n", string );
   }

   /* You must flush the input buffer before using gets. */
   fflush( stdin );
   printf( "Enter the same sentence with gets: " );
   gets( string );
   printf( "%s\n", string );
}
```

Output

```
Enter a sentence of four words with scanf: This is a test
This
is
a
test
Enter the same sentence with gets: This is a test
This is a test
```

See Also: **fclose**, **_flushall**, **setvbuf**

fgetc, fgetwc, _fgetchar, _fgetwchar

Read a character from a stream (**fgetc**, **fgetwc**) or **stdin** (**_fgetchar**, **_fgetwchar**).

int fgetc(FILE *_stream_);
wint_t fgetwc(FILE *_stream_);
int _fgetchar(void);
wint_t _fgetwchar(void);

Function	Required Header	Compatibility
fgetc	<stdio.h>	ANSI, Win 95, Win NT
fgetwc	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT
_fgetchar	<stdio.h>	Win 95, Win NT
_fgetwchar	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fgetc and **_fgetchar** return the character read as an **int** or return **EOF** to indicate an error or end of file. **fgetwc** and **_fgetwchar** return, as a **wint_t**, the wide character that corresponds to the character read or return **WEOF** to indicate an error or end of file. For all four functions, use **feof** or **ferror** to distinguish between an error and an end-of-file condition. For **fgetc** and **fgetwc**, if a read error occurs, the error indicator for the stream is set.

Parameter

stream Pointer to **FILE** structure

Remarks

Each of these functions reads a single character from the current position of a file; in the case of **fgetc** and **fgetwc**, this is the file associated with *stream*. The function then increments the associated file pointer (if defined) to point to the next character. If the stream is at end of file, the end-of-file indicator for the stream is set. Routine-specific remarks follow.

Routine	Remarks
fgetc	Equivalent to **getc**, but implemented only as a function, rather than as a function and a macro.
fgetwc	Wide-character version of **fgetc**. Reads *c* as a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode.
_fgetchar	Equivalent to **fgetc(stdin)**. Also equivalent to **getchar**, but implemented only as a function, rather than as a function and a macro. Microsoft-specific; not ANSI-compatible.
_fgetwchar	Wide-character version of **_fgetchar**. Reads *c* as a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode. Microsoft-specific; not ANSI-compatible.

For more information about processing wide characters and multibyte characters in text and binary modes, see "Unicode Stream I/O in Text and Binary Modes" on page 15.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_fgettc	fgetc	fgetc	fgetwc
_fgettchar	fgetchar	fgetchar	_fgetwchar

Example

```
/* FGETC.C: This program uses getc to read the first
 * 80 input characters (or until the end of input)
 * and place them into a string named buffer.
 */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   FILE *stream;
   char buffer[81];
   int  i, ch;

   /* Open file to read line from: */
   if( (stream = fopen( "fgetc.c", "r" )) == NULL )
      exit( 0 );

   /* Read in first 80 characters and place them in "buffer": */
   ch = fgetc( stream );
   for( i=0; (i < 80 ) && ( feof( stream ) == 0 ); i++ )
   {
      buffer[i] = (char)ch;
      ch = fgetc( stream );
   }

   /* Add null to end string */
   buffer[i] = '\0';
   printf( "%s\n", buffer );
   fclose( stream );
}
```

Output

```
/* FGETC.C: This program uses getc to read the first
 * 80 input characters (or
```

See Also: **fputc, getc**

---

fgetpos

Gets a stream's file-position indicator.

int fgetpos(FILE ***stream*, fpos_t** ***pos*);**

Function	Required Header	Compatibility
fgetpos	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **fgetpos** returns 0. On failure, it returns a nonzero value and sets **errno** to one of the following manifest constants (defined in STDIO.H): **EBADF**, which means the specified stream is not a valid file handle or is not accessible, or **EINVAL**, which means the *stream* value is invalid.

Parameters

stream Target stream

pos Position-indicator storage

Remarks

The **fgetpos** function gets the current value of the *stream* argument's file-position indicator and stores it in the object pointed to by *pos*. The **fsetpos** function can later use information stored in *pos* to reset the *stream* argument's pointer to its position at the time **fgetpos** was called. The *pos* value is stored in an internal format and is intended for use only by **fgetpos** and **fsetpos**.

Example

```
/* FGETPOS.C: This program opens a file and reads
 * bytes at several different locations.
 */

#include <stdio.h>

void main( void )
{
   FILE   *stream;
   fpos_t pos;
   char   buffer[20];

   if( (stream = fopen( "fgetpos.c", "rb" )) == NULL )
      printf( "Trouble opening file\n" );
   else
   {
      /* Read some data and then check the position. */
      fread( buffer, sizeof( char ), 10, stream );
      if( fgetpos( stream, &pos ) != 0 )
         perror( "fgetpos error" );
      else
      {
         fread( buffer, sizeof( char ), 10, stream );
         printf( "10 bytes at byte %ld: %.10s\n", pos, buffer );
      }
```

```
   /* Set a new position and read more data */
   pos = 140;
   if( fsetpos( stream, &pos ) != 0 )
      perror( "fsetpos error" );

   fread( buffer, sizeof( char ), 10, stream );
   printf( "10 bytes at byte %ld: %.10s\n", pos, buffer );
   fclose( stream );
   }
}
```

Output

```
10 bytes at byte 10: .C: This p
10 bytes at byte 140:
{
   FIL
```

See Also: **fsetpos**

---

fgets, fgetws

Get a string from a stream.

char *fgets(char **string*, int *n*, FILE **stream*);
wchar_t *fgetws(wchar_t **string*, int *n*, FILE **stream*);

Function	Required Header	Compatibility
fgets	<stdio.h>	ANSI, Win 95, Win NT
fgetws	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns *string*. **NULL** is returned to indicate an error or an end-of-file condition. Use **feof** or **ferror** to determine whether an error occurred.

Parameters

string Storage location for data

n Maximum number of characters to read

stream Pointer to **FILE** structure

Remarks

The **fgets** function reads a string from the input *stream* argument and stores it in *string*. **fgets** reads characters from the current stream position to and including the first newline character, to the end of the stream, or until the number of characters read is equal to $n-1$, whichever comes first. The result stored in *string* is appended with a null character. The newline character, if read, is included in the string.

fgets is similar to the **gets** function; however, **gets** replaces the newline character with **NULL**. **fgetws** is a wide-character version of **fgets**.

fgetws reads the wide-character argument *string* as a multibyte-character string or a wide-character string according to whether *stream* is opened in text mode or binary mode, respectively. For more information about using text and binary modes in Unicode and multibyte stream-I/O, see "Text and Binary Mode File I/O" and "Unicode Stream I/O in Text and Binary Modes" on page 15.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_fgetts	fgets	fgets	fgetws

Example

```
/* FGETS.C: This program uses fgets to display
 * a line from a file on the screen.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char line[100];

   if( (stream = fopen( "fgets.c", "r" )) != NULL )
   {
      if( fgets( line, 100, stream ) == NULL)
         printf( "fgets error\n" );
      else
         printf( "%s", line);
      fclose( stream );
   }
}
```

Output

```
/* FGETS.C: This program uses fgets to display
```

See Also: **fputs, gets, puts**

_filelength, _filelengthi64

Get the length of a file.

long _filelength(**int** *handle* **);**
__int64 _filelengthi64(**int** *handle* **);**

Function	Required Header	Compatibility
_filelength	<io.h>	Win 95, Win NT
_filelengthi64	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Both **_filelength** and **_filelengthi64** return the file length, in bytes, of the target file associated with *handle*. Both functions return a value of –1L to indicate an error, and an invalid handle sets **errno** to **EBADF**.

Parameter

handle Target file handle

Example

```
/* CHSIZE.C: This program uses _filelength to report the size
 * of a file before and after modifying it with _chsize.
 */

#include <io.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <stdio.h>

void main( void )
{
   int fh, result;
   unsigned int nbytes = BUFSIZ;
```

```
    /* Open a file */
    if( (fh = _open( "data", _O_RDWR | _O_CREAT, _S_IREAD
                | _S_IWRITE ))  != -1 )
    {
       printf( "File length before: %ld\n", _filelength( fh ) );
       if( ( result = _chsize( fh, 329678 ) ) == 0 )
          printf( "Size successfully changed\n" );
       else
          printf( "Problem in changing the size\n" );
       printf( "File length after:  %ld\n", _filelength( fh ) );
       _close( fh );
    }
}
```

Output

```
File length before: 0
Size successfully changed
File length after:  329678
```

See Also: _chsize, _fileno, _fstat, _fstati64, _stat, _stati64

_fileno

Gets the file handle associated with a stream.

int _fileno(FILE *_stream_);

Function	Required Header	Compatibility
_fileno	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_fileno returns the file handle. There is no error return. The result is undefined if *stream* does not specify an open file.

Parameter

stream Pointer to **FILE** structure

Remarks

The **_fileno** routine returns the file handle currently associated with *stream*. This routine is implemented both as a function and as a macro. For details on choosing either implementation, see "Choosing Between Functions and Macros" on page xiii.

Example

```
/* FILENO.C: This program uses _fileno to obtain
 * the file handle for some standard C streams.
 */

#include <stdio.h>

void main( void )
{
   printf( "The file handle for stdin is %d\n", _fileno( stdin ) );
   printf( "The file handle for stdout is %d\n", _fileno( stdout ) );
   printf( "The file handle for stderr is %d\n", _fileno( stderr ) );
}
```

Output

```
The file handle for stdin is 0
The file handle for stdout is 1
The file handle for stderr is 2
```

See Also: _fdopen, _filelength, fopen, freopen

_find, _wfind Functions

These functions search for and close searches for specified filenames.

- **_findclose**
- **_findnext, _findnexti64, _wfindnext, _wfindnexti64**
- **_findfirst, _findfirsti64, _wfindfirst, _wfindfirsti64**

Remarks

The **_findfirst** function provides information about the first instance of a filename that matches the file specified in the *filespec* argument. Any wildcard combination supported by the host operating system can be used in *filespec*. File information is returned in a **_finddata_t** structure, defined in IO.H. The **_finddata_t** structure includes the following elements:

unsigned attrib File attribute

time_t time_create Time of file creation (–1L for FAT file systems)

time_t time_access Time of last file access (–1L for FAT file systems)

time_t time_write Time of last write to file

_fsize_t size Length of file in bytes

char name[_MAX_FNAME] Null-terminated name of matched file/directory, without the path

In file systems that do not support the creation and last access times of a file, such as the FAT system, the **time_create** and **time_access** fields are always –1L.

_MAX_FNAME is defined in STDLIB.H as 256 bytes.

You cannot specify target attributes (such as **_A_RDONLY**) by which to limit the find operation. This attribute is returned in the **attrib** field of the **_finddata_t** structure and can have the following values (defined in IO.H).

_A_ARCH Archive. Set whenever the file is changed, and cleared by the BACKUP command. Value: 0x20

_A_HIDDEN Hidden file. Not normally seen with the DIR command, unless the /AH option is used. Returns information about normal files as well as files with this attribute. Value: 0x02

_A_NORMAL Normal. File can be read or written to without restriction. Value: 0x00

_A_RDONLY Read-only. File cannot be opened for writing, and a file with the same name cannot be created. Value: 0x01

_A_SUBDIR Subdirectory. Value: 0x10

_A_SYSTEM System file. Not normally seen with the DIR command, unless the /A or /A:S option is used. Value: 0x04

_findnext finds the next name, if any, that matches the *filespec* argument specified in a prior call to **_findfirst**. The *fileinfo* argument should point to a structure initialized by a previous call to **_findfirst**. If a match is found, the *fileinfo* structure contents are altered as described above. **_findclose** closes the specified search handle and releases all associated resources. The handle returned by **_findfirst** must first be passed to **_findclose**, before modification operations such as deleting can be performed on the directories that form the path passed to **_findfirst**.

The **_find** functions allow nested calls. For example, if the file found by a call to **_findfirst** or **_findnext** is a subdirectory, a new search can be initiated with another call to **_findfirst** or **_findnext**.

_wfindfirst and **_wfindnext** are wide-character versions of **_findfirst** and **_findnext**. The structure argument of the wide-character versions has the **_wfinddata_t** data type, which is defined in IO.H and in WCHAR.H. The fields of this data type are the same as those of the **_finddata_t** data type, except that in **_wfinddata_t** the name field is of type **wchar_t** rather than type **char**. Otherwise **_wfindfirst** and **_wfindnext** behave identically to **_findfirst** and **_findnext**. Functions **_findfirsti64**, **_findnexti64**, **_wfindfirsti64**, and **_wfindnexti64** also behave identically except they use and return 64-bit file lengths.

Example

```
/* FFIND.C: This program uses the 32-bit _find functions to print
 * a list of all files (and their attributes) with a .C extension
 * in the current directory.
 */
```

```
#include <stdio.h>
#include <io.h>
#include <time.h>

void main( void )
{
   struct _finddata_t c_file;
   long hFile;

   /* Find first .c file in current directory */
   if( (hFile = _findfirst( "*.c", &c_file )) == -1L )
      printf( "No *.c files in current directory!\n" );
   else
   {
         printf( "Listing of .c files\n\n" );
         printf( "\nRDO HID SYS ARC  FILE         DATE %25c SIZE\n", ' ' );
         printf( "--- --- --- ---  ----         ---- %25c ----\n", ' ' );
         printf( ( c_file.attrib & _A_RDONLY ) ? " Y  " : " N  " );
         printf( ( c_file.attrib & _A_SYSTEM ) ? " Y  " : " N  " );
         printf( ( c_file.attrib & _A_HIDDEN ) ? " Y  " : " N  " );
         printf( ( c_file.attrib & _A_ARCH )   ? " Y  " : " N  " );
         printf( " %-12s %.24s  %9ld\n",
            c_file.name, ctime( &( c_file.time_write ) ), c_file.size );

         /* Find the rest of the .c files */
         while( _findnext( hFile, &c_file ) == 0 )
         {
            printf( ( c_file.attrib & _A_RDONLY ) ? " Y  " : " N  " );
            printf( ( c_file.attrib & _A_SYSTEM ) ? " Y  " : " N  " );
            printf( ( c_file.attrib & _A_HIDDEN ) ? " Y  " : " N  " );
            printf( ( c_file.attrib & _A_ARCH )   ? " Y  " : " N  " );
            printf( " %-12s %.24s  %9ld\n",
               c_file.name, ctime( &( c_file.time_write ) ), c_file.size );
         }

      _findclose( hFile );
   }
}
```

Output

```
Listing of .c files

RDO HID SYS ARC  FILE         DATE                          SIZE
--- --- --- ---  ----         ----                          ----
 N   N   N   Y   CWAIT.C      Tue Jun 01 04:07:26 1993      1611
 N   N   N   Y   SPRINTF.C    Thu May 27 04:59:18 1993       617
 N   N   N   Y   CABS.C       Thu May 27 04:58:46 1993       359
 N   N   N   Y   BEGTHRD.C    Tue Jun 01 04:00:48 1993      3726
```

_findclose

Closes the specified search handle and releases associated resources.

int _findclose(long *handle* **);**

Function	Required Header	Compatibility
_findclose	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_findclose** returns 0. Otherwise, it returns –1 and sets **errno** to **ENOENT**, indicating that no more matching files could be found.

Parameter

handle Search handle returned by a previous call to **_findfirst**

_findfirst, _findfirsti64, _wfindfirst, _wfindfirsti64

Provides information about the first instance of a filename that matches the file specified in the *filespec* argument.

long _findfirst(char ***filespec*, struct _finddata_t** ***fileinfo*);**
__int64 _findfirsti64(char ***filespec*, struct _finddata_t** ***fileinfo*);**
long _wfindfirst(wchar_t ***filespec*, struct _wfinddata_t** ***fileinfo*);**
__int64 _wfindfirsti64(wchar_t ***filespec*, struct _wfinddata_t** ***fileinfo*);**

Function	Required Header	Compatibility
_findfirst	<io.h>	Win 95, Win NT
_findfirsti64	<io.h>	Win 95, Win NT
_wfindfirst	<io.h> or <wchar.h>	Win NT
_wfindfirsti64	<io.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_findfirst** and **_wfindfirst** return a unique search handle identifying the file or group of files matching the *filespec* specification, which can be used in a subsequent call to **_findnext** or **_wfindnext**, respectively, or to **_findclose**. Otherwise, **_findfirst** and **_wfindfirst** return –1 and set **errno** to one of the following values:

ENOENT File specification that could not be matched

EINVAL Invalid filename specification

Parameters

filespec Target file specification (may include wildcards)

fileinfo File information buffer

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfindfirst	_findfirst	_findfirst	_wfindfirst
_tfindfirsti64	_findfirsti64	_findfirsti64	_wfindfirsti64

_findnext, _findnexti64, _wfindnext, _wfindnexti64

Find the next name, if any, that matches the *filespec* argument in a previous call to **_findfirst**, and then alters the *fileinfo* structure contents accordingly.

int _findnext(long *handle*, **struct _finddata_t** **fileinfo* **);**
__int64 _findnexti64(long *handle*, **struct _finddata_t** **fileinfo* **);**
int _wfindnext(long *handle*, **struct _wfinddata_t** **fileinfo* **);**
__int64 _wfindnexti64(long *handle*, **struct _wfinddata_t** **fileinfo* **);**

Function	Required Header	Compatibility
_findnext	<io.h>	Win 95, Win NT
_findnexti64	<io.h>	Win 95, Win NT
_wfindnext	<io.h> or <wchar.h>	Win NT
_wfindnexti64	<io.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_findnext** and **_wfindnext** return 0. Otherwise, they return –1 and set **errno** to **ENOENT**, indicating that no more matching files could be found.

Parameters

handle Search handle returned by a previous call to **_findfirst**

fileinfo File information buffer

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfindnext	_findnext	_findnext	_wfindnext
_tfindnexti64	_findnexti64	_findnexti64	_wfindnexti64

_finite

Determines whether given double-precision floating point value is finite.

int _finite(double *x* **);**

Function	Required Header	Compatibility
_finite	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_finite returns a nonzero value (TRUE) if its argument *x* is not infinite, that is, if –INF < *x* < +INF. It returns 0 (FALSE) if the argument is infinite or a NaN.

Parameter

x Double-precision floating-point value

See Also: _isnan, _fpclass

floor

Calculates the floor of a value.

double floor(double *x* **);**

Function	Required Header	Compatibility
floor	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **floor** function returns a floating-point value representing the largest integer that is less than or equal to *x*. There is no error return.

Parameter

x Floating-point value

Example

```
/* FLOOR.C: This example displays the largest integers
 * less than or equal to the floating-point values 2.8
 * and -2.8. It then shows the smallest integers greater
 * than or equal to 2.8 and -2.8.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double y;

   y = floor( 2.8 );
   printf( "The floor of 2.8 is %f\n", y );
   y = floor( -2.8 );
   printf( "The floor of -2.8 is %f\n", y );

   y = ceil( 2.8 );
   printf( "The ceil of 2.8 is %f\n", y );
   y = ceil( -2.8 );
   printf( "The ceil of -2.8 is %f\n", y );
}
```

Output

```
The floor of 2.8 is 2.000000
The floor of -2.8 is -3.000000
The ceil of 2.8 is 3.000000
The ceil of -2.8 is -2.000000
```

See Also: ceil, fmod

_flushall

Flushes all streams; clears all buffers.

int _flushall(void);

Function	Required Header	Compatibility
_flushall	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_flushall returns the number of open streams (input and output). There is no error return.

Remarks

By default, the **_flushall** function writes to appropriate files the contents of all buffers associated with open output streams. All buffers associated with open input streams are cleared of their current contents. (These buffers are normally maintained by the operating system, which determines the optimal time to write the data automatically to disk: when a buffer is full, when a stream is closed, or when a program terminates normally without closing streams.)

If a read follows a call to **_flushall**, new data is read from the input files into the buffers. All streams remain open after the call to **_flushall**.

The commit-to-disk feature of the run-time library lets you ensure that critical data is written directly to disk rather than to the operating system buffers. Without rewriting an existing program, you can enable this feature by linking the program's object files with COMMODE.OBJ. In the resulting executable file, calls to **_flushall** write the contents of all buffers to disk. Only **_flushall** and **fflush** are affected by COMMODE.OBJ.

For information about controlling the commit-to-disk feature, see "Stream I/O", **fopen**, and **_fdopen**.

Example

```
/* FLUSHALL.C: This program uses _flushall
 * to flush all open buffers.
 */

#include <stdio.h>
```

```
void main( void )
{
   int numflushed;

   numflushed = _flushall();
   printf( "There were %d streams flushed\n", numflushed );
}
```

Output

```
There were 3 streams flushed
```

See Also: **_commit, fclose, fflush, _flushall, setvbuf**

fmod

Calculates the floating-point remainder.

double fmod(double *x*, **double** *y* **);**

Function	Required Header	Compatibility
fmod	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fmod returns the floating-point remainder of *x* / *y*. If the value of *y* is 0.0, **fmod** returns a quiet NaN. For information about representation of a quiet NaN by the **printf** family, see **printf**.

Parameters

x, *y* Floating-point values

Remarks

The **fmod** function calculates the floating-point remainder *f* of *x* / *y* such that $x = i * y + f$, where *i* is an integer, *f* has the same sign as *x*, and the absolute value of *f* is less than the absolute value of *y*.

Example

```
/* FMOD.C: This program displays a
 * floating-point remainder.
 */

#include <math.h>
#include <stdio.h>
```

```
void main( void )
{
   double w = -10.0, x = 3.0, y = 0.0, z;

   z = fmod( x, y );
   printf( "The remainder of %.2f / %.2f is %f\n", w, x, z );
   printf( "The remainder of %.2f / %.2f is %f\n", x, y, z );

}
```

Output

```
The remainder of -10.00 / 3.00 is -1.000000
```

See Also: ceil, fabs, floor

fopen, _wfopen

Open a file.

FILE *fopen(const char **filename*, const char **mode*);
FILE *_wfopen(const wchar_t **filename*, const wchar_t **mode*);

Function	Required Header	Compatibility
fopen	<stdio.h>	ANSI, Win 95, Win NT
_wfopen	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

The **c**, **n**, and **t** *mode* options are Microsoft extensions for **fopen** and **_fdopen** and should not be used where ANSI portability is desired.

Return Value

Each of these functions returns a pointer to the open file. A null pointer value indicates an error.

Parameters

filename Filename

mode Type of access permitted

Remarks

The **fopen** function opens the file specified by *filename*. **_wfopen** is a wide-character version of **fopen**; the arguments to **_wfopen** are wide-character strings. **_wfopen** and **fopen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfopen	fopen	fopen	_wfopen

The character string *mode* specifies the type of access requested for the file, as follows:

"r" Opens for reading. If the file does not exist or cannot be found, the **fopen** call fails.

"w" Opens an empty file for writing. If the given file exists, its contents are destroyed.

"a" Opens for writing at the end of the file (appending) without removing the EOF marker before writing new data to the file; creates the file first if it doesn't exist.

"r+" Opens for both reading and writing. (The file must exist.)

"w+" Opens an empty file for both reading and writing. If the given file exists, its contents are destroyed.

"a+" Opens for reading and appending; the appending operation includes the removal of the EOF marker before new data is written to the file and the EOF marker is restored after writing is complete; creates the file first if it doesn't exist.

When a file is opened with the **"a"** or **"a+"** access type, all write operations occur at the end of the file. The file pointer can be repositioned using **fseek** or **rewind**, but is always moved back to the end of the file before any write operation is carried out. Thus, existing data cannot be overwritten.

The **"a"** mode does not remove the EOF marker before appending to the file. After appending has occurred, the MS-DOS TYPE command only shows data up to the original EOF marker and not any data appended to the file. The **"a+"** mode does remove the EOF marker before appending to the file. After appending, the MS-DOS TYPE command shows all data in the file. The **"a+"** mode is required for appending to a stream file that is terminated with the CTRL+Z EOF marker.

When the **"r+"**, **"w+"**, or **"a+"** access type is specified, both reading and writing are allowed (the file is said to be open for "update"). However, when you switch between reading and writing, there must be an intervening **fflush**, **fsetpos**, **fseek**, or **rewind** operation. The current position can be specified for the **fsetpos** or **fseek** operation, if desired.

In addition to the above values, the following characters can be included in *mode* to specify the translation mode for newline characters:

t Open in text (translated) mode. In this mode, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading/writing with **"a+"**, **fopen** checks for a CTRL+Z at the end of the file and removes it, if possible. This is done because

using **fseek** and **ftell** to move within a file that ends with a CTRL+Z, may cause **fseek** to behave improperly near the end of the file.

Also, in text mode, carriage return–linefeed combinations are translated into single linefeeds on input, and linefeed characters are translated to carriage return–linefeed combinations on output. When a Unicode stream-I/O function operates in text mode (the default), the source or destination stream is assumed to be a sequence of multibyte characters. Therefore, the Unicode stream-input functions convert multibyte characters to wide characters (as if by a call to the **mbtowc** function). For the same reason, the Unicode stream-output functions convert wide characters to multibyte characters (as if by a call to the **wctomb** function).

b Open in binary (untranslated) mode; translations involving carriage-return and linefeed characters are suppressed.

If **t** or **b** is not given in *mode*, the default translation mode is defined by the global variable **_fmode**. If **t** or **b** is prefixed to the argument, the function fails and returns **NULL**.

For more information about using text and binary modes in Unicode and multibyte stream-I/O, see "Text and Binary Mode File I/O" and "Unicode Stream I/O in Text and Binary Modes" on page 15.

c Enable the commit flag for the associated *filename* so that the contents of the file buffer are written directly to disk if either **fflush** or **_flushall** is called.

n Reset the commit flag for the associated *filename* to "no-commit." This is the default. It also overrides the global commit flag if you link your program with COMMODE.OBJ. The global commit flag default is "no-commit" unless you explicitly link your program with COMMODE.OBJ.

Valid characters for the *mode* string used in **fopen** and **_fdopen** correspond to *oflag* arguments used in **_open** and **_sopen**, as follows:

Characters in mode String	Equivalent *oflag* Value for _open/_sopen
a	**_O_WRONLY** | **_O_APPEND** (usually **_O_WRONLY** | **_O_CREAT** | **_O_APPEND**)
a+	**_O_RDWR** | **_O_APPEND** (usually **_O_RDWR** | **_O_APPEND** | **_O_CREAT**)
r	**_O_RDONLY**
r+	**_O_RDWR**
w	**_O_WRONLY** (usually **_O_WRONLY** | **_O_CREAT** | **_O_TRUNC**)
w+	**_O_RDWR** (usually **_O_RDWR** | **_O_CREAT** | **_O_TRUNC**)
b	**_O_BINARY**
t	**_O_TEXT**
c	None
n	None

Example

```
/* FOPEN.C: This program opens files named "data"
 * and "data2".It  uses fclose to close "data" and
 * _fcloseall to close all remaining files.
 */

#include <stdio.h>

FILE *stream, *stream2;

void main( void )
{
   int numclosed;

   /* Open for read (will fail if file "data" does not exist) */
   if( (stream  = fopen( "data", "r" )) == NULL )
      printf( "The file 'data' was not opened\n" );
   else
      printf( "The file 'data' was opened\n" );

   /* Open for write */
   if( (stream2 = fopen( "data2", "w+" )) == NULL )
      printf( "The file 'data2' was not opened\n" );
   else
      printf( "The file 'data2' was opened\n" );

   /* Close stream */
   if( fclose( stream ) )
      printf( "The file 'data' was not closed\n" );

   /* All other files are closed: */
   numclosed = _fcloseall( );
   printf( "Number of files closed by _fcloseall: %u\n", numclosed );
}
```

Output

```
The file 'data' was opened
The file 'data2' was opened
Number of files closed by _fcloseall: 1
```

See Also: **fclose, _fdopen, ferror, _fileno, freopen, _open, _setmode**

_fpclass

Returns status word containing information on floating-point class.

int _fpclass(double *x* **);**

Function	Required Header	Compatibility
_fpclass	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_fpclass returns an integer value that indicates the floating-point class of its argument *x*. The status word may have one of the following values, defined in FLOAT.H.

Value	Meaning
_FPCLASS_SNAN	Signaling NaN
_FPCLASS_QNAN	Quiet NaN
_FPCLASS_NINF	Negative infinity (–INF)
_FPCLASS_NN	Negative normalized non-zero
_FPCLASS_ND	Negative denormalized
_FPCLASS_NZ	Negative zero (–0)
_FPCLASS_PZ	Positive 0 (+0)
_FPCLASS_PD	Positive denormalized
_FPCLASS_PN	Positive normalized non-zero
_FPCLASS_PINF	Positive infinity (+INF)

Parameter

x Double-precision floating-point value

See Also: _isnan

_fpieee_flt

Invokes user-defined trap handler for IEEE floating-point exceptions.

int _fpieee_flt(unsigned long *exc_code*, **struct _EXCEPTION_POINTERS** **exc_info*,
↪ **int** *handler*(**_FPIEEE_RECORD** *));

Function	Required Header	Compatibility
_fpieee_flt	<fpieee.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value of **_fpieee_flt** is the value returned by *handler*. As such, the IEEE filter routine may be used in the except clause of a structured exception-handling (SEH) mechanism.

Parameters

exc_code Exception code

exc_info Pointer to the Windows NT exception information structure

handler Pointer to user's IEEE trap-handler routine

Remarks

The **_fpieee_flt** function invokes a user-defined trap handler for IEEE floating-point exceptions and provides it with all relevant information. This routine serves as an exception filter in the SEH mechanism, which invokes your own IEEE exception handler when necessary.

The **_FPIEEE_RECORD** structure, defined in FPIEEE.H, contains information pertaining to an IEEE floating-point exception. This structure is passed to the user-defined trap handler by **_fpieee_flt**.

_FPIEEE_RECORD Field	Description
unsigned int RoundingMode, unsigned int Precision	These fields contain information on the floating-point environment at the time the exception occurred.
unsigned int Operation	Indicates the type of operation that caused the trap. If the type is a comparison (**_FpCodeCompare**), you can supply one of the special **_FPIEEE_COMPARE_RESULT** values (as defined in FPIEEE.H) in the **Result.Value** field. The conversion type (**_FpCodeConvert**) indicates that the trap occurred during a floating-point conversion operation. You can look at the **Operand1** and **Result** types to determine the type of conversion being attempted.
_FPIEEE_VALUE Operand1, _FPIEEE_VALUE Operand2, _FPIEEE_VALUE Result	These structures indicate the types and values of the proposed result and operands: **OperandValid** Flag indicating whether the responding value is valid. **Format** Data type of the corresponding value. The format type may be returned even if the corresponding value is not valid. **Value** Result or operand data value.

Example

```
/* FPIEEE.C: This program demonstrates the implementation of
 * a user-defined floating-point exception handler using the
 * _fpieee_flt function.
 */

#include <fpieee.h>
#include <excpt.h>
#include <float.h>
int fpieee_handler( _FPIEEE_RECORD * );
```

```
int fpieee_handler( _FPIEEE_RECORD *pieee )
{
   // user-defined ieee trap handler routine:
   // there is one handler for all
   // IEEE exceptions

   // Assume the user wants all invalid
   // operations to return 0.

   if ((pieee->Cause.InvalidOperation) &&
      (pieee->Result.Format == _FpFormatFp32))
   {
      pieee->Result.Value.Fp32Value = 0.0F;

      return EXCEPTION_CONTINUE_EXECUTION;
   }
   else
      return EXCEPTION_EXECUTE_HANDLER;
}

#define _EXC_MASK    \
   _EM_UNDERFLOW  + \
   _EM_OVERFLOW   + \
   _EM_ZERODIVIDE + \
   _EM_INEXACT

void main( void )
{
   // ...

   __try {
      // unmask invalid operation exception
      _controlfp(_EXC_MASK, _MCW_EM);

      // code that may generate
      // fp exceptions goes here
   }
   __except ( _fpieee_flt( GetExceptionCode(),
            GetExceptionInformation(),
            fpieee_handler ) ){

      // code that gets control

      // if fpieee_handler returns
      // EXCEPTION_EXECUTE_HANDLER goes here

   }

   // ...
}
```

See Also: _control87

_fpreset

Resets the floating-point package.

void _fpreset(void);

Function	Required Header	Compatibility
_fpreset	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Remarks

The **_fpreset** function reinitializes the floating-point math package. **_fpreset** is usually used with **signal**, **system**, or the **_exec** or **_spawn** functions. If a program traps floating-point error signals (**SIGFPE**) with **signal**, it can safely recover from floating-point errors by invoking **_fpreset** and using **longjmp**.

Example

```
/* FPRESET.C: This program uses signal to set up a
 * routine for handling floating-point errors.
 */

#include <stdio.h>
#include <signal.h>
#include <setjmp.h>
#include <stdlib.h>
#include <float.h>
#include <math.h>
#include <string.h>

#pragma warning(disable : 4113) /* C4113 warning expected */

jmp_buf mark;              /* Address for long jump to jump to */
int     fperr;             /* Global error number */

void __cdecl fphandler( int sig, int num );   /* Prototypes */
void fpcheck( void );

void main( void )
{
   double n1, n2, r;
   int jmpret;
```

```
    /* Unmask all floating-point exceptions. */
     _control87( 0, _MCW_EM );
    /* Set up floating-point error handler. The compiler
     * will generate a warning because it expects
     * signal-handling functions to take only one argument.
     */
     if( signal( SIGFPE, fphandler ) == SIG_ERR )

    {
       fprintf( stderr, "Couldn't set SIGFPE\n" );
       abort();   }

    /* Save stack environment for return in case of error. First
     * time through, jmpret is 0, so true conditional is executed.
     * If an error occurs, jmpret will be set to -1 and false
     * conditional will be executed.
     */
    jmpret = setjmp( mark );
    if( jmpret == 0 )
    {
       printf( "Test for invalid operation - " );
       printf( "enter two numbers: " );
       scanf( "%lf %lf", &n1, &n2 );
       r = n1 / n2;
       /* This won't be reached if error occurs. */
       printf( "\n\n%4.3g / %4.3g = %4.3g\n", n1, n2, r );

       r = n1 * n2;
       /* This won't be reached if error occurs. */
       printf( "\n\n%4.3g * %4.3g = %4.3g\n", n1, n2, r );
    }
    else
       fpcheck();
}
/* fphandler handles SIGFPE (floating-point error) interrupt. Note
 * that this prototype accepts two arguments and that the
 * prototype for signal in the run-time library expects a signal
 * handler to have only one argument.
 *
 * The second argument in this signal handler allows processing of
 * _FPE_INVALID, _FPE_OVERFLOW, _FPE_UNDERFLOW, and
 * _FPE_ZERODIVIDE, all of which are Microsoft-specific symbols
 * that augment the information provided by SIGFPE. The compiler
 * will generate a warning, which is harmless and expected.
*/
void fphandler( int sig, int num )
{
   /* Set global for outside check since we don't want
    * to do I/O in the handler.
    */
```

```
    fperr = num;
    /* Initialize floating-point package. */
    _fpreset();
    /* Restore calling environment and jump back to setjmp. Return
     * -1 so that setjmp will return false for conditional test.
     */
    longjmp( mark, -1 );
}
void fpcheck( void )
{
    char fpstr[30];
    switch( fperr )
    {
    case _FPE_INVALID:
        strcpy( fpstr, "Invalid number" );
        break;
    case _FPE_OVERFLOW:
        strcpy( fpstr, "Overflow" );

        break;
    case _FPE_UNDERFLOW:
        strcpy( fpstr, "Underflow" );
        break;
    case _FPE_ZERODIVIDE:
        strcpy( fpstr, "Divide by zero" );
        break;
    default:
        strcpy( fpstr, "Other floating point error" );
        break;
    }
    printf( "Error %d: %s\n", fperr, fpstr );
}
```

Output

```
Test for invalid operation - enter two numbers: 5 0
Error 131: Divide by zero
```

See Also: **_exec** Function Overview, **signal**, **_spawn** Function Overview, **system**

fprintf, fwprintf

Print formatted data to a stream.

int fprintf(FILE ***stream*, const char** ****format*** [, *argument*]...**);**
int fwprintf(FILE ***stream*, const wchar_t** ****format*** [, *argument*]...**);**

Function	Required Header	Compatibility
fprintf	<stdio.h>	ANSI, Win 95, Win NT
fwprintf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fprintf returns the number of bytes written. **fwprintf** returns the number of wide characters written. Each of these functions returns a negative value instead when an output error occurs.

Parameters

stream Pointer to **FILE** structure

format Format-control string

argument Optional arguments

Remarks

fprintf formats and prints a series of characters and values to the output *stream.* Each function *argument* (if any) is converted and output according to the corresponding format specification in *format.* For **fprintf**, the *format* argument has the same syntax and use that it has in **printf.**

fwprintf is a wide-character version of **fprintf**; in **fwprintf**, *format* is a wide-character string. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ftprintf	fprintf	fprintf	fwprintf

For more information, see "Format Specifications" on page 463.

Example

```
/* FPRINTF.C: This program uses fprintf to format various
 * data and print it to the file named FPRINTF.OUT. It
 * then displays FPRINTF.OUT on the screen using the system
 * function to invoke the operating-system TYPE command.
 */

#include <stdio.h>
#include <process.h>

FILE *stream;

void main( void )
{
   int    i = 10;
   double fp = 1.5;
```

```
    char   s[] = "this is a string";
    char   c = '\n';

    stream = fopen( "fprintf.out", "w" );
    fprintf( stream, "%s%c", s, c );
    fprintf( stream, "%d\n", i );
    fprintf( stream, "%f\n", fp );
    fclose( stream );
    system( "type fprintf.out" );
}
```

Output

```
this is a string
10
1.500000
```

See Also: **_cprintf, fscanf, sprintf**

fputc, fputwc, _fputchar, _fputwchar

Writes a character to a stream (**fputc**, **fputwc**) or to **stdout** (**_fputchar**, **_fputwchar**).

int fputc(int *c*, **FILE** **stream* **);**
wint_t fputwc(wint_t *c*, **FILE** **stream* **);**
int _fputchar(int *c* **);**
wint_t _fputwchar(wint_t *c* **);**

Function	Required Header	Compatibility
fputc	<stdio.h>	ANSI, Win 95, Win NT
fputwc	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT
_fputchar	<stdio.h>	Win 95, Win NT
_fputwchar	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the character written. For **fputc** and **_fputchar**, a return value of **EOF** indicates an error. For **fputwc** and **_fputwchar**, a return value of **WEOF** indicates an error.

Parameters

c Character to be written

stream Pointer to **FILE** structure

Remarks

Each of these functions writes the single character *c* to a file at the position indicated by the associated file position indicator (if defined) and advances the indicator as appropriate. In the case of **fputc** and **fputwc**, the file is associated with *stream*. If the file cannot support positioning requests or was opened in append mode, the character is appended to the end of the stream. Routine-specific remarks follow.

Routine	Remarks
fputc	Equivalent to **putc**, but implemented only as a function, rather than as a function and a macro.
fputwc	Wide-character version of **fputc**. Writes *c* as a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode.
_fputchar	Equivalent to **fputc(stdout)**. Also equivalent to **putchar**, but implemented only as a function, rather than as a function and a macro. Microsoft-specific; not ANSI-compatible.
_fputwchar	Wide-character version of **_fputchar**. Writes *c* as a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode. Microsoft-specific; not ANSI-compatible.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_fputtc	fputc	fputc	fputwc
_fputtchar	_fputchar	_fputchar	_fputwchar

Example

```
/* FPUTC.C: This program uses fputc and _fputchar
 * to send a character array to stdout.
 */

#include <stdio.h>

void main( void )
{
   char strptr1[] = "This is a test of fputc!!\n";
   char strptr2[] = "This is a test of _fputchar!!\n";
   char *p;

   /* Print line to stream using fputc. */
   p = strptr1;
   while( (*p != '\0') && fputc( *(p++), stdout ) != EOF ) ;

   /* Print line to stream using _fputchar. */
   p = strptr2;
   while( (*p != '\0') && _fputchar( *(p++) ) != EOF )
      ;
}
```

See Also: **fgetc**, **putc**

fputs, fputws

Write a string to a stream.

int fputs(const char **string*, **FILE** **stream* **);**
int fputws(const wchar_t **string*, **FILE** **stream* **);**

Function	Required Header	Compatibility
fputs	<stdio.h>	ANSI, Win 95, Win NT
fputws	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a nonnegative value if it is successful. On an error, **fputs** returns **EOF**, and **fputws** returns **WEOF**.

Parameters

string Output string

stream Pointer to **FILE** structure

Remarks

Each of these functions copies *string* to the output *stream* at the current position. **fputws** copies the wide-character argument *string* to *stream* as a multibyte-character string or a wide-character string according to whether *stream* is opened in text mode or binary mode, respectively. Neither function copies the terminating null character.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_fputts	fputs	fputs	fputws

Example

```
/* FPUTS.C: This program uses fputs to write
 * a single line to the stdout stream.
 */

#include <stdio.h>

void main( void )
{
   fputs( "Hello world from fputs.\n", stdout );
}
```

Output

```
Hello world from fputs.
```

See Also: **fgets, gets, puts, _putws**

fread

Reads data from a stream.

size_t fread(void **buffer*, **size_t** *size*, **size_t** *count*, **FILE** **stream* **);**

Function	Required Header	Compatibility
fread	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fread returns the number of full items actually read, which may be less than *count* if an error occurs or if the end of the file is encountered before reaching *count.* Use the **feof** or **ferror** function to distinguish a read error from an end-of-file condition. If *size* or *count* is 0, **fread** returns 0 and the buffer contents are unchanged.

Parameters

buffer Storage location for data

size Item size in bytes

count Maximum number of items to be read

stream Pointer to **FILE** structure

Remarks

The **fread** function reads up to *count* items of *size* bytes from the input *stream* and stores them in *buffer.* The file pointer associated with *stream* (if there is one) is increased by the number of bytes actually read. If the given stream is opened in text mode, carriage return–linefeed pairs are replaced with single linefeed characters. The replacement has no effect on the file pointer or the return value. The file-pointer position is indeterminate if an error occurs. The value of a partially read item cannot be determined.

Example

```
/* FREAD.C: This program opens a file named FREAD.OUT and
 * writes 25 characters to the file. It then tries to open
 * FREAD.OUT and read in 25 characters. If the attempt succeeds,
 * the program displays the number of actual items read.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char list[30];
   int  i, numread, numwritten;

   /* Open file in text mode: */
   if( (stream = fopen( "fread.out", "w+t" )) != NULL )
   {
      for ( i = 0; i < 25; i++ )
         list[i] = (char)('z' - i);
      /* Write 25 characters to stream */
      numwritten = fwrite( list, sizeof( char ), 25, stream );
      printf( "Wrote %d items\n", numwritten );
      fclose( stream );

   }
   else
      printf( "Problem opening the file\n" );

   if( (stream = fopen( "fread.out", "r+t" )) != NULL )
   {
      /* Attempt to read in 25 characters */
      numread = fread( list, sizeof( char ), 25, stream );
      printf( "Number of items read = %d\n", numread );
      printf( "Contents of buffer = %.25s\n", list );
      fclose( stream );
   }
   else
      printf( "File could not be opened\n" );
}
```

Output

```
Wrote 25 items
Number of items read = 25
Contents of buffer = zyxwvutsrqponmlkjihgfedcb
```

See Also: **fwrite, _read**

free

Deallocates or frees a memory block.

void free(void **memblock* **);**

Function	Required Header	Compatibility
free	<stdlib.h> and <malloc.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

memblock Previously allocated memory block to be freed

Remarks

The **free** function deallocates a memory block (*memblock*) that was previously allocated by a call to **calloc**, **malloc**, or **realloc**. The number of freed bytes is equivalent to the number of bytes requested when the block was allocated (or reallocated, in the case of **realloc**). If *memblock* is **NULL**, the pointer is ignored and **free** immediately returns. Attempting to free an invalid pointer (a pointer to a memory block that was not allocated by **calloc**, **malloc**, or **realloc**) may affect subsequent allocation requests and cause errors.

After a memory block has been freed, **_heapmin** minimizes the amount of free memory on the heap by coalescing the unused regions and releasing them back to the operating system. Freed memory that is not released to the operating system is restored to the free pool and is available for allocation again.

When the application is linked with a debug version of the C run-time libraries, **free** resolves to **_free_dbg**. For more information about how the heap is managed during the debugging process, see "Using C Run-Time Library Debugging Support."

Example

```
/* MALLOC.C: This program allocates memory with
 * malloc, then frees the memory with free.
 */

#
```

```
include <stdlib.h>          /* For _MAX_PATH definition */
#include <stdio.h>
#include <malloc.h>
void main( void )
{
   char *string;

   /* Allocate space for a path name */
   string = malloc( _MAX_PATH );
   if( string == NULL )
      printf( "Insufficient memory available\n" );
   else
   {
      printf( "Memory space allocated for path name\n" );
      free( string );
      printf( "Memory freed\n" );
   }
}
```

Output

```
Memory space allocated for path name
Memory freed
```

See Also: **_alloca, calloc, malloc, realloc, _free_dbg, _heapmin**

freopen, _wfreopen

Reassign a file pointer.

FILE *freopen(const char *_path_, const char *_mode_, FILE *_stream_);
FILE *_wfreopen(const wchar_t *_path_, const wchar_t *_mode_, FILE *_stream_);

Function	Required Header	Compatibility
freopen	<stdio.h>	ANSI, Win 95, Win NT
_wfreopen	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the newly opened file. If an error occurs, the original file is closed and the function returns a **NULL** pointer value.

Parameters

path Path of new file

mode Type of access permitted

stream Pointer to **FILE** structure

Remarks

The **freopen** function closes the file currently associated with *stream* and reassigns *stream* to the file specified by *path*. **_wfreopen** is a wide-character version of **_freopen**; the *path* and *mode* arguments to **_wfreopen** are wide-character strings. **_wfreopen** and **_freopen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfreopen	freopen	freopen	_wfreopen

freopen is typically used to redirect the pre-opened files **stdin**, **stdout**, and **stderr** to files specified by the user. The new file associated with *stream* is opened with *mode,* which is a character string specifying the type of access requested for the file, as follows:

"r" Opens for reading. If the file does not exist or cannot be found, the **freopen** call fails.

"w" Opens an empty file for writing. If the given file exists, its contents are destroyed.

"a" Opens for writing at the end of the file (appending) without removing the EOF marker before writing new data to the file; creates the file first if it does not exist.

"r+" Opens for both reading and writing. (The file must exist.)

"w+" Opens an empty file for both reading and writing. If the given file exists, its contents are destroyed.

"a+" Opens for reading and appending; the appending operation includes the removal of the EOF marker before new data is written to the file and the EOF marker is restored after writing is complete; creates the file first if it does not exist.

Use the **"w"** and **"w+"** types with care, as they can destroy existing files.

When a file is opened with the **"a"** or **"a+"** access type, all write operations take place at the end of the file. Although the file pointer can be repositioned using **fseek** or **rewind**, the file pointer is always moved back to the end of the file before any write operation is carried out. Thus, existing data cannot be overwritten.

The **"a"** mode does not remove the EOF marker before appending to the file. After appending has occurred, the MS-DOS TYPE command only shows data up to the original EOF marker and not any data appended to the file. The **"a+"** mode does

remove the EOF marker before appending to the file. After appending, the MS-DOS TYPE command shows all data in the file. The **"a+"** mode is required for appending to a stream file that is terminated with the CTRL+Z EOF marker.

When the **"r+"**, **"w+"**, or **"a+"** access type is specified, both reading and writing are allowed (the file is said to be open for "update"). However, when you switch between reading and writing, there must be an intervening **fsetpos**, **fseek**, or **rewind** operation. The current position can be specified for the **fsetpos** or **fseek** operation, if desired. In addition to the above values, one of the following characters may be included in the *mode* string to specify the translation mode for new lines.

t Open in text (translated) mode; carriage return–linefeed (CR-LF) combinations are translated into single linefeed (LF) characters on input; LF characters are translated to CR-LF combinations on output. Also, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading or for writing and reading with **"a+"**, the run-time library checks for a CTRL+Z at the end of the file and removes it, if possible. This is done because using **fseek** and **ftell** to move within a file may cause **fseek** to behave improperly near the end of the file. The **t** option is a Microsoft extension that should not be used where ANSI portability is desired.

b Open in binary (untranslated) mode; the above translations are suppressed.

If **t** or **b** is not given in the *mode* string, the translation mode is defined by the default mode variable **_fmode**.

For a discussion of text and binary modes, see "Text and Binary Mode File I/O" on page 15 in Chapter 1.

Example

```
/* FREOPEN.C: This program reassigns stderr to the file
 * named FREOPEN.OUT and writes a line to that file.
 */

#include <stdio.h>
#include <stdlib.h>

FILE *stream;

void main( void )
{
   /* Reassign "stderr" to "freopen.out": */
   stream = freopen( "freopen.out", "w", stderr );

   if( stream == NULL )
      fprintf( stdout, "error on freopen\n" );
   else
   {
```

```
        fprintf( stream, "This will go to the file 'freopen.out'\n" );
        fprintf( stdout, "successfully reassigned\n" );
        fclose( stream );
    }
    system( "type freopen.out" );
}
```

Output

```
successfully reassigned
This will go to the file 'freopen.out'
```

See Also: **fclose, _fdopen, _fileno, fopen, _open, _setmode**

frexp

Gets the mantissa and exponent of a floating-point number.

double frexp(double *x*, **int** **expptr* **);**

Function	Required Header	Compatibility
frexp	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

frexp returns the mantissa. If *x* is 0, the function returns 0 for both the mantissa and the exponent. There is no error return.

Parameters

x Floating-point value

expptr Pointer to stored integer exponent

Remarks

The **frexp** function breaks down the floating-point value (*x*) into a mantissa (*m*) and an exponent (*n*), such that the absolute value of *m* is greater than or equal to 0.5 and less than 1.0, and $x = m*2n$. The integer exponent *n* is stored at the location pointed to by *expptr*.

Example

```
/* FREXP.C: This program calculates frexp( 16.4, &n )
 * then displays y and n.
 */

#include <math.h>
#include <stdio.h>
```

```
void main( void )
{
   double x, y;
   int n;

   x = 16.4;
   y = frexp( x, &n );
   printf( "frexp( %f, &n ) = %f, n = %d\n", x, y, n );
}
```

Output

```
frexp( 16.400000, &n ) = 0.512500, n = 5
```

See Also: **ldexp**, **modf**

fscanf, fwscanf

Read formatted data from a stream.

int fscanf(**FILE** **stream*, **const char** **format* [, *argument*]... **);**
int fwscanf(**FILE** **stream*, **const wchar_t** **format* [, *argument*]... **);**

Function	Required Header	Compatibility
fscanf	<stdio.h>	ANSI, Win 95, Win NT
fwscanf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the number of fields successfully converted and assigned; the return value does not include fields that were read but not assigned. A return value of 0 indicates that no fields were assigned. If an error occurs, or if the end of the file stream is reached before the first conversion, the return value is **EOF** for fscanf or **WEOF** for **fwscanf**.

Parameters

stream Pointer to **FILE** structure

format Format-control string

argument Optional arguments

Remarks

The **fscanf** function reads data from the current position of *stream* into the locations given by *argument* (if any). Each *argument* must be a pointer to a variable of a type that corresponds to a type specifier in *format*. *format* controls the interpretation of the input fields and has the same form and function as the *format* argument for **scanf**; see **scanf** for a description of *format*. If copying takes place between strings that overlap, the behavior is undefined.

fwscanf is a wide-character version of **fscanf**; the format argument to **fwscanf** is a wide-character string. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ftscanf	fscanf	fscanf	fwscanf

For more information, see "Format Specification Fields – **scanf** functions and **wscanf** functions" on page 495.

Example

```
/* FSCANF.C: This program writes formatted
 * data to a file. It then uses fscanf to
 * read the various data back from the file.
 */

#include <stdio.h>

FILE *stream;

void main( void )
{
   long l;
   float fp;
   char s[81];
   char c;

   stream = fopen( "fscanf.out", "w+" );
   if( stream == NULL )
      printf( "The file fscanf.out was not opened\n" );
   else
   {
      fprintf( stream, "%s %ld %f%c", "a-string",
               65000, 3.14159, 'x' );

      /* Set pointer to beginning of file: */
      fseek( stream, 0L, SEEK_SET );

      /* Read data back from file: */
      fscanf( stream, "%s", s );
      fscanf( stream, "%ld", &l );
```

```
        fscanf( stream, "%f", &fp );
        fscanf( stream, "%c", &c );
        /* Output data read: */
        printf( "%s\n", s );
        printf( "%ld\n", l );
        printf( "%f\n", fp );
        printf( "%c\n", c );

        fclose( stream );
    }
}
```

Output

```
a-string
65000
3.141590
x
```

See Also: **_cscanf, fprintf, scanf, sscanf**

fseek

Moves the file pointer to a specified location.

int fseek(FILE **stream*, **long** *offset*, **int** *origin* **);**

Function	Required Header	Compatibility
fseek	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **fseek** returns 0. Otherwise, it returns a nonzero value. On devices incapable of seeking, the return value is undefined.

Parameters

stream Pointer to **FILE** structure

offset Number of bytes from *origin*

origin Initial position

Remarks

The **fseek** function moves the file pointer (if any) associated with *stream* to a new location that is *offset* bytes from *origin*. The next operation on the stream takes place at the new location. On a stream open for update, the next operation can be either a read or a write. The argument origin must be one of the following constants, defined in STDIO.H:

SEEK_CUR Current position of file pointer

SEEK_END End of file

SEEK_SET Beginning of file

You can use **fseek** to reposition the pointer anywhere in a file. The pointer can also be positioned beyond the end of the file. **fseek** clears the end-of-file indicator and negates the effect of any prior **ungetc** calls against *stream*.

When a file is opened for appending data, the current file position is determined by the last I/O operation, not by where the next write would occur. If no I/O operation has yet occurred on a file opened for appending, the file position is the start of the file.

For streams opened in text mode, **fseek** has limited use, because carriage return–linefeed translations can cause **fseek** to produce unexpected results. The only **fseek** operations guaranteed to work on streams opened in text mode are:

- Seeking with an offset of 0 relative to any of the origin values.
- Seeking from the beginning of the file with an offset value returned from a call to **ftell**.

Also in text mode, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading/writing, **fopen** and all related routines check for a CTRL+Z at the end of the file and remove it if possible. This is done because using **fseek** and **ftell** to move within a file that ends with a CTRL+Z may cause **fseek** to behave improperly near the end of the file.

Example

```
/* FSEEK.C: This program opens the file FSEEK.OUT and
 * moves the pointer to the file's beginning.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char line[81];
   int  result;
```

```
   stream = fopen( "fseek.out", "w+" );
   if( stream == NULL )
      printf( "The file fseek.out was not opened\n" );
   else
      {
      fprintf( stream, "The fseek begins here: "
                       "This is the file 'fseek.out'.\n" );
      result = fseek( stream, 23L, SEEK_SET);
      if( result )
         perror( "Fseek failed" );
      else
      {
         printf( "File pointer is set to middle of first line.\n" );
         fgets( line, 80, stream );
         printf( "%s", line );

      }
      fclose( stream );
   }
}
```

Output

```
File pointer is set to middle of first line.
This is the file 'fseek.out'.
```

See Also: ftell, _lseek, rewind

fsetpos

Sets the stream-position indicator.

int fsetpos(FILE ***stream*****, const fpos_t** ***pos* **);**

Function	Required Header	Compatibility
fsetpos	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **fsetpos** returns 0. On failure, the function returns a nonzero value and sets **errno** to one of the following manifest constants (defined in ERRNO.H): **EBADF**, which means the file is not accessible or the object that *stream* points to is not a valid file handle; or **EINVAL**, which means an invalid stream value was passed.

Parameters

stream Pointer to **FILE** structure

pos Position-indicator storage

Remarks

The **fsetpos** function sets the file-position indicator for *stream* to the value of *pos,* which is obtained in a prior call to **fgetpos** against *stream.* The function clears the end-of-file indicator and undoes any effects of **ungetc** on *stream.* After calling **fsetpos**, the next operation on *stream* may be either input or output.

Example

```
/* FGETPOS.C: This program opens a file and reads
 * bytes at several different locations.
 */

#include <stdio.h>

void main( void )
{
   FILE   *stream;
   fpos_t pos;
   char   buffer[20];

   if( (stream = fopen( "fgetpos.c", "rb" )) == NULL )
      printf( "Trouble opening file\n" );
   else
   {
      /* Read some data and then check the position. */
      fread( buffer, sizeof( char ), 10, stream );
      if( fgetpos( stream, &pos ) != 0 )
         perror( "fgetpos error" );
      else
      {
         fread( buffer, sizeof( char ), 10, stream );
         printf( "10 bytes at byte %ld: %.10s\n", pos, buffer );
      }

   /* Set a new position and read more data */
   pos = 140;
   if( fsetpos( stream, &pos ) != 0 )
      perror( "fsetpos error" );

   fread( buffer, sizeof( char ), 10, stream );
   printf( "10 bytes at byte %ld: %.10s\n", pos, buffer );
   fclose( stream );
   }
}
```

Output

```
10 bytes at byte 10: .C: This p
10 bytes at byte 140:
{
   FIL
```

See Also: **fgetpos**

_fsopen, _wfsopen

Open a stream with file sharing.

FILE *_fsopen(const char *_filename_, const char *_mode_, int _shflag_);
FILE *_wfsopen(const wchar_t *_filename_, const wchar_t *_mode_, int _shflag_);

Function	Required Header	Optional Headers	Compatibility
_fsopen	<stdio.h>	<share.h>1	Win 95, Win NT
_wfsopen	<stdio.h> or <wchar.h>	<share.h>1	Win NT

1 For manifest constant for *shflag* parameter.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the stream. A **NULL** pointer value indicates an error.

Parameters

filename Name of file to open

mode Type of access permitted

shflag Type of sharing allowed

Remarks

The **_fsopen** function opens the file specified by *filename* as a stream and prepares the file for subsequent shared reading or writing, as defined by the mode and *shflag* arguments. **_wfsopen** is a wide-character version of **_fsopen**; the *filename* and *mode* arguments to **_wfsopen** are wide-character strings. **_wfsopen** and **_fsopen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfsopen	_fsopen	_fsopen	_wfsopen

The character string *mode* specifies the type of access requested for the file, as follows:

"r" Opens for reading. If the file does not exist or cannot be found, the **_fsopen** call fails.

"w" Opens an empty file for writing. If the given file exists, its contents are destroyed.

"a" Opens for writing at the end of the file (appending); creates the file first if it does not exist.

"r+" Opens for both reading and writing. (The file must exist.)

"w+" Opens an empty file for both reading and writing. If the given file exists, its contents are destroyed.

"a+" Opens for reading and appending; creates the file first if it does not exist.

Use the **"w"** and **"w+"** types with care, as they can destroy existing files.

When a file is opened with the **"a"** or **"a+"** access type, all write operations occur at the end of the file. The file pointer can be repositioned using **fseek** or **rewind**, but is always moved back to the end of the file before any write operation is carried out. Thus existing data cannot be overwritten. When the **"r+"**, **"w+"**, or **"a+"** access type is specified, both reading and writing are allowed (the file is said to be open for "update"). However, when switching between reading and writing, there must be an intervening **fsetpos**, **fseek**, or **rewind** operation. The current position can be specified for the **fsetpos** or **fseek** operation, if desired. In addition to the above values, one of the following characters can be included in *mode* to specify the translation mode for new lines:

t Opens a file in text (translated) mode. In this mode, carriage return–linefeed (CR-LF) combinations are translated into single linefeeds (LF) on input and LF characters are translated to CR-LF combinations on output. Also, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading or reading/writing, **_fsopen** checks for a CTRL+Z at the end of the file and removes it, if possible. This is done because using **fseek** and **ftell** to move within a file that ends with a CTRL+Z may cause **fseek** to behave improperly near the end of the file.

b Opens a file in binary (untranslated) mode; the above translations are suppressed.

If **t** or **b** is not given in *mode,* the translation mode is defined by the default-mode variable **_fmode**. If **t** or **b** is prefixed to the argument, the function fails and returns **NULL**. For a discussion of text and binary modes, see "Text and Binary Mode File I/O."

The argument *shflag* is a constant expression consisting of one of the following manifest constants, defined in SHARE.H:

_SH_COMPAT Sets Compatibility mode for 16-bit applications

_SH_DENYNO Permits read and write access

_SH_DENYRD Denies read access to file

_SH_DENYRW Denies read and write access to file

_SH_DENYWR Denies write access to file

Example

```
/* FSOPEN.C:
 */

#include <stdio.h>
#include <stdlib.h>
#include <share.h>

void main( void )
{
   FILE *stream;

   /* Open output file for writing. Using _fsopen allows us to
    * ensure that no one else writes to the file while we are
    * writing to it.
    */
   if( (stream = _fsopen( "outfile", "wt", _SH_DENYWR )) != NULL )
   {
      fprintf( stream, "No one else in the network can write "
                       "to this file until we are done.\n" );
      fclose( stream );
   }
   /* Now others can write to the file while we read it. */
   system( "type outfile" );
}
```

Output

```
No one else in the network can write to this file until we are done.
```

See Also: fclose, _fdopen, ferror, _fileno, fopen, freopen, _open, _setmode, _sopen

_fstat, _fstati64

Get information about an open file.

int _fstat(int *handle*, **struct _stat** **buffer* **);**
__int64 _fstati64(int *handle*, **struct _stat** **buffer* **);**

Function	Required Header	Compatibility
_fstat	<sys/stat.h> and <sys/types.h>	Win 95, Win NT
_fstati64	<sys/stat.h> and <sys/types.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_fstat and **_fstati64** return 0 if the file-status information is obtained. A return value of –1 indicates an error, in which case **errno** is set to **EBADF**, indicating an invalid file handle.

Parameters

handle Handle of open file

buffer Pointer to structure to store results

Remarks

The **_fstat** function obtains information about the open file associated with *handle* and stores it in the structure pointed to by *buffer*. The **_stat** structure, defined in SYS\STAT.H, contains the following fields:

st_atime Time of last file access.

st_ctime Time of creation of file.

st_dev If a device, *handle*; otherwise 0.

st_mode Bit mask for file-mode information. The **_S_IFCHR** bit is set if *handle* refers to a device. The **_S_IFREG** bit is set if *handle* refers to an ordinary file. The read/write bits are set according to the file's permission mode. **_S_IFCHR** and other constants are defined in SYS\STAT.H.

st_mtime Time of last modification of file.

st_nlink Always 1 on non-NTFS file systems.

st_rdev If a device, *handle*; otherwise 0.

st_size Size of the file in bytes.

If *handle* refers to a device, the **st_atime**, **st_ctime**, and **st_mtime** and **st_size** fields are not meaningful.

Because STAT.H uses the **_dev_t** type, which is defined in TYPES.H, you must include TYPES.H before STAT.H in your code.

Example

```
/* FSTAT.C: This program uses _fstat to report
 * the size of a file named F_STAT.OUT.
 */

#include <io.h>
#include <fcntl.h>
#include <time.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

void main( void )
{
   struct _stat buf;
   int fh, result;
   char buffer[] = "A line to output";

   if( (fh = _open( "f_stat.out", _O_CREAT | _O_WRONLY |
                                  _O_TRUNC )) ==  -1 )
   _write( fh, buffer, strlen( buffer ) );

   /* Get data associated with "fh": */
   result = _fstat( fh, &buf );
   /* Check if statistics are valid: */
   if( result != 0 )
      printf( "Bad file handle\n" );
   else
   {
      printf( "File size     : %ld\n", buf.st_size );

      printf( "Time modified : %s", ctime( &buf.st_ctime ) );
   }
   _close( fh );
}
```

Output

```
File size     : 0
Time modified : Tue Mar 21 15:23:08 1995
```

See Also: **_access**, **_chmod**, **_filelength**, **_stat**

ftell

Gets the current position of a file pointer.

long ftell(FILE **stream* **);**

Function	Required Header	Optional Headers	Compatibility
ftell	<stdio.h>	<errno.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

ftell returns the current file position. The value returned by **ftell** may not reflect the physical byte offset for streams opened in text mode, because text mode causes carriage return–linefeed translation. Use **ftell** with **fseek** to return to file locations correctly. On error, **ftell** returns –1L and **errno** is set to one of two constants, defined in ERRNO.H. The **EBADF** constant means the *stream* argument is not a valid file-handle value or does not refer to an open file. **EINVAL** means an invalid *stream* argument was passed to the function. On devices incapable of seeking (such as terminals and printers), or when *stream* does not refer to an open file, the return value is undefined.

Parameter

stream Target **FILE** structure

Remarks

The **ftell** function gets the current position of the file pointer (if any) associated with *stream.* The position is expressed as an offset relative to the beginning of the stream.

Note that when a file is opened for appending data, the current file position is determined by the last I/O operation, not by where the next write would occur. For example, if a file is opened for an append and the last operation was a read, the file position is the point where the next read operation would start, not where the next write would start. (When a file is opened for appending, the file position is moved to end of file before any write operation.) If no I/O operation has yet occurred on a file opened for appending, the file position is the beginning of the file.

In text mode, CTRL+Z is interpreted as an end-of-file character on input. In files opened for reading/writing, **fopen** and all related routines check for a CTRL+Z at the end of the file and remove it if possible. This is done because using **ftell** and **fseek** to move within a file that ends with a CTRL+Z may cause **ftell** to behave improperly near the end of the file.

Example

```
/* FTELL.C: This program opens a file named FTELL.C
 * for reading and tries to read 100 characters. It
 * then uses ftell to determine the position of the
 * file pointer and displays this position.
 */

#include <stdio.h>

FILE *stream;

void main( void )
{
   long position;
   char list[100];
   if( (stream = fopen( "ftell.c", "rb" )) != NULL )
   {
      /* Move the pointer by reading data: */
      fread( list, sizeof( char ), 100, stream );
      /* Get position after read: */
      position = ftell( stream );
      printf( "Position after trying to read 100 bytes: %ld\n",
              position );
      fclose( stream );
   }
}
```

Output

```
Position after trying to read 100 bytes: 100
```

See Also: **fgetpos, fseek, _lseek, _tell**

_ftime

Gets the current time.

void _ftime(struct _timeb ***timeptr*** **);**

Function	Required Header	Compatibility
_ftime	<sys/types.h> and <sys/timeb.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ftime does not return a value, but fills in the fields of the structure pointed to by *timeptr*.

Parameter

timeptr Pointer to **_timeb** structure

Remarks

The **_ftime** function gets the current local time and stores it in the structure pointed to by *timeptr.* The **_timeb** structure is defined in SYS\TIMEB.H. It contains four fields:

dstflag Nonzero if daylight savings time is currently in effect for the local time zone. (See **_tzset** for an explanation of how daylight savings time is determined.)

millitm Fraction of a second in milliseconds.

time Time in seconds since midnight (00:00:00), January 1, 1970, coordinated universal time (UTC).

timezone Difference in minutes, moving westward, between UTC and local time. The value of *timezone* is set from the value of the global variable **_timezone** (see **_tzset**).

Example

```
/* FTIME.C: This program uses _ftime to obtain the current
 * time and then stores this time in timebuffer.
 */

#include <stdio.h>
#include <sys/timeb.h>
#include <time.h>

void main( void )
{
   struct _timeb timebuffer;
   char *timeline;

   _ftime( &timebuffer );
   timeline = ctime( & ( timebuffer.time ) );

   printf( "The time is %.19s.%hu %s", timeline, timebuffer.millitm,
   ↪ &timeline[20] );
}
```

Output

```
The time is Tue Mar 21 15:26:41.341 1995
```

See Also: asctime, ctime, gmtime, localtime, time

_fullpath, _wfullpath

Create an absolute or full path name for the specified relative path name.

char *_fullpath(char **absPath*, const char **relPath*, size_t *maxLength*);
wchar_t *_wfullpath(wchar_t **absPath*, const wchar_t **relPath*, size_t *maxLength*);

Function	Required Header	Compatibility
_fullpath	<stdlib.h>	Win 95, Win NT
_wfullpath	<stdlib.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to a buffer containing the absolute path name (*absPath*). If there is an error (for example, if the value passed in *relPath* includes a drive letter that is not valid or cannot be found, or if the length of the created absolute path name (*absPath*) is greater than *maxLength*) the function returns **NULL**.

Parameters

absPath Pointer to a buffer containing the absolute or full path name

relPath Relative path name

maxLength Maximum length of the absolute path name buffer (*absPath*). This length is in bytes for **_fullpath** but in wide characters (**wchar_t**) for **_wfullpath**.

Remarks

The **_fullpath** function expands the relative path name in *relPath* to its fully qualified or "absolute" path, and stores this name in *absPath.* A relative path name specifies a path to another location from the current location (such as the current working directory: "."). An absolute path name is the expansion of a relative path name that states the entire path required to reach the desired location from the root of the filesystem. Unlike **_makepath**, **_fullpath** can be used to obtain the absolute path name for relative paths (*relPath*) that include "./" or "../" in their names.

For example, to use C run-time routines, the application must include the header files that contain the declarations for the routines. Each header file include statement references the location of the file in a relative manner (from the application's working directory):

```
#include <stdlib.h>
```

when the absolute path (actual file system location) of the file may be:

```
\\machine\shareName\msvcSrc\crt\headerFiles\stdlib.h
```

_fullpath automatically handles multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use. **_wfullpath** is a wide-character version of **_fullpath**; the string arguments to **_wfullpath** are wide-character strings. **_wfullpath** and **_fullpath** behave identically except that **_wfullpath** does not handle multibyte-character strings.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tfullpath	_fullpath	_fullpath	_wfullpath

If the *absPath* buffer is **NULL**, **_fullpath** calls **malloc** to allocate a buffer of size **_MAX_PATH** and ignores the *maxLength* argument. It is the caller's responsibility to deallocate this buffer (using **free**) as appropriate. If the *relPath* argument specifies a disk drive, the current directory of this drive is combined with the path.

Example

```
/* FULLPATH.C: This program demonstrates how _fullpath
 * creates a full path from a partial path.
 */

#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include <direct.h>

char full[_MAX_PATH], part[_MAX_PATH];

void main( void )
{
   while( 1 )
   {
      printf( "Enter partial path or ENTER to quit: " );
      gets( part );
      if( part[0] == 0 )
         break;

      if( _fullpath( full, part, _MAX_PATH ) != NULL )
         printf( "Full path is: %s\n", full );
      else
         printf( "Invalid path\n" );
   }
}
```

See Also: **_getcwd**, **_getdcwd**, **_makepath**, **_splitpath**

_futime

Sets modification time on an open file.

int _futime(int *handle*, **struct _utimbuf** **filetime* **);**

Function	Required Header	Optional Headers	Compatibility
_futime	<sys/utime.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_futime returns 0 if successful. If an error occurs, this function returns –1 and **errno** is set to **EBADF**, indicating an invalid file handle.

Parameters

handle Handle to open file

filetime Pointer to structure containing new modification date

Remarks

The **_futime** routine sets the modification date and the access time on the open file associated with *handle*. **_futime** is identical to **_utime**, except that its argument is the handle to an open file, rather than the name of a file or a path to a file. The **_utimbuf** structure contains fields for the new modification date and access time. Both fields must contain valid values.

Example

```
/* FUTIME.C: This program uses _futime to set the
 * file-modification time to the current time.
 */

#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>
#include <io.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <sys/utime.h>

void main( void )
{

   int hFile;
```

```
   /* Show file time before and after. */
   system( "dir futime.c" );

   hFile = _open("futime.c", _O_RDWR);

   if( _futime( hFile, NULL ) == -1 )
      perror( "_futime failed\n" );
   else
      printf( "File time modified\n" );

   close (hFile);

   system( "dir futime.c" );

}
```

Output

```
 Volume in drive C is CDRIVE
 Volume Serial Number is 1D37-7A7A

 Directory of C:\code

05/03/95  01:30p               601 futime.c
           1 File(s)           601 bytes
                         16,269,312 bytes free
 Volume in drive C is CDRIVE
 Volume Serial Number is 1D37-7A7A

 Directory of C:\code

05/03/95  01:36p               601 futime.c
           1 File(s)           601 bytes
                         16,269,312 bytes free
File time modified
```

fwrite

Writes data to a stream.

size_t fwrite(const void ***buffer*****, size_t** ***size*****, size_t** ***count*****, FILE** ****stream*** **);**

Function	Required Header	Compatibility
fwrite	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

fwrite returns the number of full items actually written, which may be less than *count* if an error occurs. Also, if an error occurs, the file-position indicator cannot be determined.

Parameters

buffer Pointer to data to be written

size Item size in bytes

count Maximum number of items to be written

stream Pointer to **FILE** structure

Remarks

The **fwrite** function writes up to *count* items, of *size* length each, from *buffer* to the output *stream*. The file pointer associated with *stream* (if there is one) is incremented by the number of bytes actually written. If *stream* is opened in text mode, each carriage return is replaced with a carriage-return–linefeed pair. The replacement has no effect on the return value.

Example

```
/* FREAD.C: This program opens a file named FREAD.OUT and
 * writes 25 characters to the file. It then tries to open
 * FREAD.OUT and read in 25 characters. If the attempt succeeds,
 * the program displays the number of actual items read.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char list[30];
   int  i, numread, numwritten;
   /* Open file in text mode: */
   if( (stream = fopen( "fread.out", "w+t" )) != NULL )
   {
      for ( i = 0; i < 25; i++ )
         list[i] = (char)('z' - i);
      /* Write 25 characters to stream */
      numwritten = fwrite( list, sizeof( char ), 25, stream );
      printf( "Wrote %d items\n", numwritten );
      fclose( stream );

   }
   else
      printf( "Problem opening the file\n" );
```

```
    if( (stream = fopen( "fread.out", "r+t" )) != NULL )
    {
       /* Attempt to read in 25 characters */
       numread = fread( list, sizeof( char ), 25, stream );
       printf( "Number of items read = %d\n", numread );
       printf( "Contents of buffer = %.25s\n", list );
       fclose( stream );
    }
    else
       printf( "File could not be opened\n" );
}
```

Output

```
Wrote 25 items
Number of items read = 25
Contents of buffer = zyxwvutsrqponmlkjihgfedcb
```

See Also: fread, _write

_gcvt

Converts a floating-point value to a string, which it stores in a buffer.

char *_gcvt(double *value*, **int** *digits*, **char** **buffer* **);**

Routine	Required Header	Compatibility
_gcvt	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_gcvt returns a pointer to the string of digits. There is no error return.

Parameters

value Value to be converted

digits Number of significant digits stored

buffer Storage location for result

Remarks

The **_gcvt** function converts a floating-point *value* to a character string (which includes a decimal point and a possible sign byte) and stores the string in *buffer*. The *buffer* should be large enough to accommodate the converted value plus a terminating null character, which is appended automatically. If a buffer size of *digits* + 1 is used,

the function overwrites the end of the buffer. This is because the converted string includes a decimal point and can contain sign and exponent information. There is no provision for overflow. **_gcvt** attempts to produce *digits* digits in decimal format. If it cannot, it produces *digits* digits in exponential format. Trailing zeros may be suppressed in the conversion.

Example

```
/* _GCVT.C: This program converts -3.1415e5
 * to its string representation.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char buffer[50];
   double source = -3.1415e5;
   _gcvt( source, 7, buffer );
   printf( "source: %f  buffer: '%s'\n", source, buffer );
   _gcvt( source, 7, buffer );
   printf( "source: %e  buffer: '%s'\n", source, buffer );
}
```

Output

```
source: -314150.000000  buffer: '-314150.'
source: -3.141500e+005  buffer: '-314150.'
```

See Also: **atof, _ecvt, _fcvt**

---

getc, getwc, getchar, getwchar

Read a character from a stream (**getc, getwc**), or get a character from **stdin** (**getchar, getwchar**).

int getc(FILE ***stream*);**
wint_t getwc(FILE ***stream*);**
int getchar(void);
wint_t getwchar(void);

Routine	Required Header	Compatibility
getc	<stdio.h>	ANSI, Win 95, Win NT
getwc	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT
getchar	<stdio.h>	ANSI, Win 95, Win NT
getwchar	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the character read. To indicate an read error or end-of-file condition, **getc** and **getchar** return **EOF**, and **getwc** and **getwchar** return **WEOF**. For **getc** and **getchar**, use **ferror** or **feof** to check for an error or for end of file.

Parameter

stream Input stream

Remarks

Each of these routines reads a single character from a file at the current position and increments the associated file pointer (if defined) to point to the next character. In the case of **getc** and **getwc**, the file is associated with *stream* (see "Choosing Between Functions and Macros" on page xiii). Routine-specific remarks follow.

Routine	Remarks
getc	Same as **fgetc**, but implemented as a function and as a macro.
getwc	Wide-character version of **getc**. Reads a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode.
getchar	Same as **_fgetchar**, but implemented as a function and as a macro.
getwchar	Wide-character version of **getchar**. Reads a multibyte character or a wide character according to whether *stream* is opened in text mode or binary mode.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_gettc	getc	getc	getwc
_gettchar	getchar	getchar	getwchar

Example

```
/* GETC.C: This program uses getchar to read a single line
 * of input from stdin, places this input in buffer, then
 * terminates the string before printing it to the screen.
 */

#include <stdio.h>

void main( void )
{
```

```
    char buffer[81];
    int i, ch;
    printf( "Enter a line: " );

    /* Read in single line from "stdin": */
    for( i = 0; (i < 80) &&  ((ch = getchar()) != EOF)
                         && (ch != '\n'); i++ )
       buffer[i] = (char)ch;

    /* Terminate string with null character: */
    buffer[i] = '\0';
    printf( "%s\n", buffer );
}
```

Output

```
Enter a line: This is a test
This is a test
```

See Also: **fgetc**, **_getch**, **putc**, **ungetc**

_getch, _getche

Get a character from the console without echo (**_getch**) or with echo (**_getche**).

int _getch(void);
int _getche(void);

Routine	Required Header	Compatibility
_getch	<conio.h>	Win 95, Win NT
_getche	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Both **_getch** and **_getche** return the character read. There is no error return.

Remarks

The **_getch** function reads a single character from the console without echoing. **_getche** reads a single character from the console and echoes the character read. Neither function can be used to read CTRL+C. When reading a function key or an arrow key, **_getch** and **_getche** must be called twice; the first call returns 0 or 0xE0, and the second call returns the actual key code.

Example

```
/* GETCH.C: This program reads characters from
 * the keyboard until it receives a 'Y' or 'y'.
 */

#include <conio.h>
#include <ctype.h>

void main( void )
{
   int ch;

   _cputs( "Type 'Y' when finished typing keys: " );
   do
   {
      ch = _getch();
      ch = toupper( ch );
   } while( ch != 'Y' );

   _putch( ch );
   _putch( '\r' );    /* Carriage return */
   _putch( '\n' );    /* Line feed       */
}
```

Output

```
Type 'Y' when finished typing keys: Y
```

See Also: **_cgets, getc, _ungetch**

_getcwd, _wgetcwd

Get the current working directory.

char *_getcwd(char ***buffer*****, int** ***maxlen*** **);**
wchar_t *_wgetcwd(wchar_t ***buffer*****, int** ***maxlen*** **);**

Routine	Required Header	Compatibility
_getcwd	<direct.h>	Win 95, Win NT
_wgetcwd	<direct.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to *buffer*. A **NULL** return value indicates an error, and **errno** is set either to **ENOMEM**, indicating that there is insufficient memory to allocate *maxlen* bytes (when a **NULL** argument is given as *buffer*), or to **ERANGE**, indicating that the path is longer than *maxlen* characters.

Parameters

buffer Storage location for path

maxlen Maximum length of path

Remarks

The **_getcwd** function gets the full path of the current working directory for the default drive and stores it at *buffer*. The integer argument *maxlen* specifies the maximum length for the path. An error occurs if the length of the path (including the terminating null character) exceeds *maxlen*. The *buffer* argument can be **NULL**; a buffer of at least size *maxlen* (more only if necessary) will automatically be allocated, using **malloc**, to store the path. This buffer can later be freed by calling **free** and passing it the **_getcwd** return value (a pointer to the allocated buffer).

_getcwd returns a string that represents the path of the current working directory. If the current working directory is the root, the string ends with a backslash (\). If the current working directory is a directory other than the root, the string ends with the directory name and not with a backslash.

_wgetcwd is a wide-character version of **_getcwd**; the *buffer* argument and return value of **_wgetcwd** are wide-character strings. **_wgetcwd** and **_getcwd** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tgetcwd	_getcwd	_getcwd	_wgetcwd

Example

```
// GETCWD.C
/* This program places the name of the current directory in the
 * buffer array, then displays the name of the current directory
 * on the screen. Specifying a length of _MAX_PATH leaves room
 * for the longest legal path name.
 */

#include <direct.h>
#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char buffer[_MAX_PATH];
```

```
    /* Get the current working directory: */
    if( _getcwd( buffer, _MAX_PATH ) == NULL )
        perror( "_getcwd error" );
    else
        printf( "%s\n", buffer );
}
```

Output

```
C:\code
```

See Also: **_chdir, _mkdir, _rmdir**

_getdcwd, _wgetdcwd

Get full path name of current working directory on the specified drive.

char *_getdcwd(int *drive*, **char *** *buffer*, **int** *maxlen* **);**
wchar_t *_wgetdcwd(int *drive*, **wchar_t *** *buffer*, **int** *maxlen* **);**

Routine	Required Header	Compatibility
_getdcwd	<direct.h>	Win 95, Win NT
_wgetdcwd	<direct.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns *buffer*. A **NULL** return value indicates an error, and **errno** is set either to **ENOMEM**, indicating that there is insufficient memory to allocate *maxlen* bytes (when a **NULL** argument is given as *buffer*), or to **ERANGE**, indicating that the path is longer than *maxlen* characters.

Parameters

drive Disk drive

buffer Storage location for path

maxlen Maximum length of path

Remarks

The **_getdcwd** function gets the full path of the current working directory on the specified drive and stores it at *buffer*. An error occurs if the length of the path (including the terminating null character) exceeds *maxlen*. The *drive* argument specifies the drive (0 = default drive, 1 = A, 2 = B, and so on). The *buffer* argument

can be **NULL**; a buffer of at least size *maxlen* (more only if necessary) will automatically be allocated, using **malloc**, to store the path. This buffer can later be freed by calling **free** and passing it the **_getdcwd** return value (a pointer to the allocated buffer).

_getdcwd returns a string that represents the path of the current working directory. If the current working directory is set to the root, the string ends with a backslash (\ ). If the current working directory is set to a directory other than the root, the string ends with the name of the directory and not with a backslash.

_wgetdcwd is a wide-character version of **_getdcwd**; the *buffer* argument and return value of **_wgetdcwd** are wide-character strings. **_wgetdcwd** and **_getdcwd** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tgetdcwd	_getdcwd	_getdcwd	_wgetdcwd

Example

```
/* GETDRIVE.C illustrates drive functions including:
 *      _getdrive       _chdrive        _getdcwd
 */

#include <stdio.h>
#include <conio.h>
#include <direct.h>
#include <stdlib.h>
#include <ctype.h>

void main( void )
{
   int ch, drive, curdrive;
   static char path[_MAX_PATH];

   /* Save current drive. */
   curdrive = _getdrive();

   printf( "Available drives are: \n" );

   /* If we can switch to the drive, it exists. */
   for( drive = 1; drive <= 26; drive++ )
      if( !_chdrive( drive ) )
         printf( "%c: ", drive + 'A' - 1 );

   while( 1 )
   {
      printf( "\nType drive letter to check or ESC to quit: " );
      ch = _getch();
      if( ch == 27 )
         break;
```

```
        if( isalpha( ch ) )
            _putch( ch );
        if( _getdcwd( toupper( ch ) - 'A' + 1, path, _MAX_PATH ) != NULL )
            printf( "\nCurrent directory on that drive is %s\n", path );
    }

    /* Restore original drive.*/
    _chdrive( curdrive );
    printf( "\n" );
}
```

Output

```
Available drives are:
A: B: C: L: M: O: U: V:
Type drive letter to check or ESC to quit: c
Current directory on that drive is C:\CODE

Type drive letter to check or ESC to quit: m
Current directory on that drive is M:\

Type drive letter to check or ESC to quit:
```

See Also: **_chdir, _getcwd, _getdrive, _mkdir, _rmdir**

_getdrive

Gets the current disk drive.

int _getdrive(void);

Routine	Required Header	Compatibility
_getdrive	<direct.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_getdrive returns the current (default) drive (1=A, 2=B, and so on). There is no error return.

Example

```
/* GETDRIVE.C illustrates drive functions including:
 *      _getdrive       _chdrive        _getdcwd
 */
```

```
#include <stdio.h>
#include <conio.h>
#include <direct.h>
#include <stdlib.h>
#include <ctype.h>

void main( void )
{
   int ch, drive, curdrive;
   static char path[_MAX_PATH];

   /* Save current drive. */
   curdrive = _getdrive();

   printf( "Available drives are: \n" );

   /* If we can switch to the drive, it exists. */
   for( drive = 1; drive <= 26; drive++ )
      if( !_chdrive( drive ) )
         printf( "%c: ", drive + 'A' - 1 );

   while( 1 )
   {
      printf( "\nType drive letter to check or ESC to quit: " );
      ch = _getch();
      if( ch == 27 )
         break;
      if( isalpha( ch ) )
         _putch( ch );
      if( _getdcwd( toupper( ch ) - 'A' + 1, path, _MAX_PATH ) != NULL )
         printf( "\nCurrent directory on that drive is %s\n", path );
   }

   /* Restore original drive.*/
   _chdrive( curdrive );
   printf( "\n" );
}
```

Output

```
Available drives are:
A: B: C: L: M: O: U: V:
Type drive letter to check or ESC to quit: c
Current directory on that drive is C:\CODE

Type drive letter to check or ESC to quit: m
Current directory on that drive is M:\

Type drive letter to check or ESC to quit:
```

See Also: **_chdrive, _getcwd, _getdcwd**

getenv, _wgetenv

Get a value from the current environment.

char *getenv(const char *_varname_);
wchar_t *_wgetenv(const wchar_t *_varname_);

Routine	Required Header	Compatibility
getenv	<stdlib.h>	ANSI, Win 95, Win NT
_wgetenv	<stdlib.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the environment table entry containing *varname*. It is not safe to modify the value of the environment variable using the returned pointer. Use the **_putenv** function to modify the value of an environment variable. The return value is **NULL** if *varname* is not found in the environment table.

Parameter

varname Environment variable name

Remarks

The **getenv** function searches the list of environment variables for *varname*. **getenv** is not case sensitive in Windows NT and Windows 95. **getenv** and **_putenv** use the copy of the environment pointed to by the global variable **_environ** to access the environment. **getenv** operates only on the data structures accessible to the run-time library and not on the environment "segment" created for the process by the operating system. Therefore, programs that use the *envp* argument to **main** or **wmain** may retrieve invalid information.

_wgetenv is a wide-character version of **getenv**; the argument and return value of **_wgetenv** are wide-character strings. The **_wenviron** global variable is a wide-character version of **_environ**.

In an MBCS program (for example, in an SBCS ASCII program), **_wenviron** is initially **NULL** because the environment is composed of multibyte-character strings. Then, on the first call to **_wputenv**, or on the first call to **_wgetenv** if an (MBCS) environment already exists, a corresponding wide-character string environment is created and is then pointed to by **_wenviron**.

Similarly in a Unicode (**_wmain**) program, **_environ** is initially **NULL** because the environment is composed of wide-character strings. Then, on the first call to **_putenv**, or on the first call to **getenv** if a (Unicode) environment already exists, a corresponding MBCS environment is created and is then pointed to by **_environ**.

When two copies of the environment (MBCS and Unicode) exist simultaneously in a program, the run-time system must maintain both copies, resulting in slower execution time. For example, whenever you call **_putenv**, a call to **_wputenv** is also executed automatically, so that the two environment strings correspond.

Caution In rare instances, when the run-time system is maintaining both a Unicode version and a multibyte version of the environment, these two environment versions may not correspond exactly. This is because, although any unique multibyte-character string maps to a unique Unicode string, the mapping from a unique Unicode string to a multibyte-character string is not necessarily unique. For more information, see "**_environ, _wenviron**."

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tgetenv	getenv	getenv	_wgetenv

To check or change the value of the **TZ** environment variable, use **getenv**, **_putenv** and **_tzset** as necessary. For more information about **TZ**, see **tzset** and see "**_daylight, timezone,** and **_tzname**."

Example

```
/* GETENV.C: This program uses getenv to retrieve
 * the LIB environment variable and then uses
 * _putenv to change it to a new value.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char *libvar;

   /* Get the value of the LIB environment variable. */
   libvar = getenv( "LIB" );

   if( libvar != NULL )
      printf( "Original LIB variable is: %s\n", libvar );

   /* Attempt to change path. Note that this only affects the environment
    * variable of the current process. The command processor's environment
    * is not changed.
    */
   _putenv( "LIB=c:\\mylib;c:\\yourlib" );
```

```
    /* Get new value. */
    libvar = getenv( "LIB" );

    if( libvar != NULL )
        printf( "New LIB variable is: %s\n", libvar );
}
```

Output

```
Original LIB variable is: C:\progra~1\devstu~1\vc\lib
New LIB variable is: c:\mylib;c:\yourlib
```

See Also: **_putenv**

_getmbcp

int _getmbcp(void);

Routine	Required Header	Compatibility
_getmbcp	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_getmbcp returns the current multibyte code page. A return value of 0 indicates that a single byte code page is in use.

See Also: **_setmbcp**

_get_osfhandle

Gets operating-system file handle associated with existing stream **FILE** pointer.

long _get_osfhandle(int *filehandle* **);**

Routine	Required Header	Compatibility
_get_osfhandle	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_get_osfhandle** returns an operating-system file handle corresponding to *filehandle*. Otherwise, it returns –1 and sets **errno** to **EBADF**, indicating an invalid file handle.

Parameter

filehandle User file handle

Remarks

The **_get_osfhandle** function returns *filehandle* if it is in range and if it is internally marked as free.

See Also: _close, _creat, _dup, _open

_getpid

Gets the process identification.

int _getpid(void);

Routine	Required Header	Compatibility
_getpid	<process.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_getpid returns the process ID obtained from the system. There is no error return.

Remarks

The **_getpid** function obtains the process ID from the system. The process ID uniquely identifies the calling process.

Example

```
/* GETPID.C: This program uses _getpid to obtain
 * the process ID and then prints the ID.
 */

#include <stdio.h>
#include <process.h>

void main( void )
{
   /* If run from command line, shows different ID for
    * command line than for operating system shell.
    */
   printf( "\nProcess id: %d\n", _getpid() );
}
```

Output

```
Process id: 193
```

See Also: _mktemp

_get_sbh_threshold

Returns the upper limit for the size of a memory allocation that will be supported by the small-block heap.

size_t _get_sbh_threshold(void);

Routine	Required Header	Compatibility
_get_sbh_threshold	<malloc.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

This function returns the upper limit for the size of a memory allocation that will be supported by the small-block heap.

Remarks

Call this function to get the current threshold value for the small-block heap. The default threshold size is 480 bytes for Windows 95 and all Windows NT platforms except the DEC Alpha platforms, and 896 bytes for DEC Alpha Platforms.

See Also: _set_sbh_threshold

gets, _getws

Get a line from the **stdin** stream.

char *gets(char *_buffer_);
wchar_t *_getws(wchar_t *_buffer_);

Routine	Required Header	Compatibility
gets	<stdio.h>	ANSI, Win 95, Win NT
_getws	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns its argument if successful. A **NULL** pointer indicates an error or end-of-file condition. Use **ferror** or **feof** to determine which one has occurred.

Parameter

buffer Storage location for input string

Remarks

The **gets** function reads a line from the standard input stream **stdin** and stores it in *buffer*. The line consists of all characters up to and including the first newline character ('\n'). **gets** then replaces the newline character with a null character ('\0') before returning the line. In contrast, the **fgets** function retains the newline character. **_getws** is a wide-character version of **gets**; its argument and return value are wide-character strings.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_getts	gets	gets	_getws

Example

```
/* GETS.C */

#include <stdio.h>

void main( void )
{
   char line[81];

   printf( "Input a string: " );
   gets( line );
   printf( "The line entered was: %s\n", line );
}
```

Output

```
Input a string: Hello!
The line entered was: Hello!
```

See Also: **fgets, fputs, puts**

_getw

Gets an integer from a stream.

int _getw(FILE **stream* **);**

Routine	Required Header	Compatibility
_getw	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_getw returns the integer value read. A return value of **EOF** indicates either an error or end of file. However, because the **EOF** value is also a legitimate integer value, use **feof** or **ferror** to verify an end-of-file or error condition.

Parameter

stream Pointer to **FILE** structure

Remarks

The **_getw** function reads the next binary value of type **int** from the file associated with *stream* and increments the associated file pointer (if there is one) to point to the next unread character. **_getw** does not assume any special alignment of items in the stream. Problems with porting may occur with **_getw** because the size of the **int** type and the ordering of bytes within the **int** type differ across systems.

Example

```
/* GETW.C: This program uses _getw to read a word
 * from a stream, then performs an error check.
 */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   FILE *stream;
   int i;

   if( (stream = fopen( "getw.c", "rb" )) == NULL )
      printf( "Couldn't open file\n" );
   else
   {
      /* Read a word from the stream: */
      i = _getw( stream );
```

```
        /* If there is an error... */
        if( ferror( stream ) )
        {
           printf( "_getw failed\n" );
           clearerr( stream );
        }
        else
           printf( "First data word in file: 0x%.4x\n", i );
        fclose( stream );
     }
}
```

Output

```
First data word in file: 0x47202a2f
```

See Also: **_putw**

gmtime

Converts a time value to a structure.

struct tm *gmtime(const time_t *_timer_);

Routine	Required Header	Compatibility
gmtime	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

gmtime returns a pointer to a structure of type **tm**. The fields of the returned structure hold the evaluated value of the *timer* argument in UTC rather than in local time. Each of the structure fields is of type **int**, as follows:

tm_sec Seconds after minute (0–59)

tm_min Minutes after hour (0–59)

tm_hour Hours since midnight (0–23)

tm_mday Day of month (1–31)

tm_mon Month (0–11; January = 0)

tm_year Year (current year minus 1900)

tm_wday Day of week (0–6; Sunday = 0)

tm_yday Day of year (0–365; January 1 = 0)

tm_isdst Always 0 for **gmtime**

The **gmtime**, **mktime**, and **localtime** functions use the same single, statically allocated structure to hold their results. Each call to one of these functions destroys the result of any previous call. If *timer* represents a date before midnight, January 1, 1970, **gmtime** returns **NULL**. There is no error return.

Parameter

timer Pointer to stored time. The time is represented as seconds elapsed since midnight (00:00:00), January 1, 1970, coordinated universal time (UTC).

Remarks

The **gmtime** function breaks down the *timer* value and stores it in a statically allocated structure of type **tm**, defined in TIME.H. The value of *timer* is usually obtained from a call to the **time** function.

Note The target environment should try to determine whether daylight savings time is in effect. The C run-time library assumes the United States's rules for implementing the calculation of Daylight Savings Time (DST).

Example

```
/* GMTIME.C: This program uses gmtime to convert a long-
 * integer representation of coordinated universal time
 * to a structure named newtime, then uses asctime to
 * convert this structure to an output string.
 */

#include <time.h>
#include <stdio.h>

void main( void )
{
   struct tm *newtime;
   long ltime;

   time( &ltime );

   /* Obtain coordinated universal time: */
   newtime = gmtime( &ltime );
   printf( "Coordinated universal time is %s\n",
                                asctime( newtime ) );
}
```

Output

```
Coordinated universal time is Tue Mar 23 02:00:56 1993
```

See Also: **asctime, ctime, _ftime, localtime, mktime, time**

_heapadd

Adds memory to the heap.

int _heapadd(void **memblock*, **size_t** *size* **);**

Routine	Required Header	Optional Headers	Compatibility
_heapadd	<malloc.h>	<errno.h>	None

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_heapadd** returns 0; otherwise, the function returns –1 and sets **errno** to **ENOSYS**.

Parameters

memblock Pointer to heap memory

size Size in bytes of memory to add

Remarks

Beginning with Visual C++ Version 4.0, the underlying heap structure was moved to the C run-time libraries to support the new debugging features. As a result, **_heapadd** is no longer supported on any Win32 platform and will immediately return –1 when called from an application of this type.

See Also: free, _heapchk, _heapmin, _heapset, _heapwalk, malloc, realloc

_heapchk

Runs consistency checks on the heap.

int _heapchk(void);

Routine	Required Header	Optional Headers	Compatibility
_heapchk	<malloc.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_heapchk returns one of the following integer manifest constants defined in MALLOC.H:

_HEAPBADBEGIN Initial header information is bad or cannot be found

_HEAPBADNODE Bad node has been found or heap is damaged

_HEAPBADPTR Pointer into heap is not valid

_HEAPEMPTY Heap has not been initialized

_HEAPOK Heap appears to be consistent

In addition, if an error occurs, **_heapchk** sets **errno** to **ENOSYS**.

Remarks

The **_heapchk** function helps debug heap-related problems by checking for minimal consistency of the heap.

Note In Visual C++ Version 4.0, the underlying heap structure was moved to the C run-time libraries to support the new debugging features. As a result, the only Win32 platform that is supported by **_heapchk** is Windows NT. The function returns **_HEAPOK** and sets **errno** to **ENOSYS**, when it is called by any other Win32 platform.

Example

```
/* HEAPCHK.C: This program checks the heap for
 * consistency and prints an appropriate message.
 */

#include <malloc.h>
#include <stdio.h>

void main( void )
{
   int  heapstatus;
   char *buffer;

   /* Allocate and deallocate some memory */
   if( (buffer = (char *)malloc( 100 )) != NULL )
      free( buffer );

   /* Check heap status */
   heapstatus = _heapchk();
   switch( heapstatus )
   {
```

```
        case _HEAPOK:
           printf(" OK - heap is fine\n" );
           break;
        case _HEAPEMPTY:
           printf(" OK - heap is empty\n" );
           break;
        case _HEAPBADBEGIN:
           printf( "ERROR - bad start of heap\n" );
           break;
        case _HEAPBADNODE:
           printf( "ERROR - bad node in heap\n" );
           break;
        }
     }
```

Output

```
OK - heap is fine
```

See Also: **_heapadd**, **_heapmin**, **_heapset**, **_heapwalk**

_heapmin

Releases unused heap memory to the operating system.

int _heapmin(void);

Routine	Required Header	Optional Headers	Compatibility
_heapmin	<malloc.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_heapmin** returns 0; otherwise, the function returns –1 and sets **errno** to **ENOSYS**.

Remarks

The **_heapmin** function minimizes the heap by releasing unused heap memory to the operating system.

Note In Visual C++ Version 4.0, the underlying heap structure was moved to the C run-time libraries to support the new debugging features. As a result, the only Win32 platform that is supported by **_heapmin** is Windows NT. The function returns –1 and sets **errno** to **ENOSYS**, when it is called by any other Win32 platform.

See Also: **free**, **_heapadd**, **_heapchk**, **_heapset**, **_heapwalk**, **malloc**

_heapset

Checks heaps for minimal consistency and sets the free entries to a specified value.

int _heapset(unsigned int *fill* **);**

Routine	Required Header	Optional Headers	Compatibility
_heapset	<malloc.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_heapset returns one of the following integer manifest constants defined in MALLOC.H:

_HEAPBADBEGIN Initial header information invalid or not found

_HEAPBADNODE Heap damaged or bad node found

_HEAPEMPTY Heap not initialized

_HEAPOK Heap appears to be consistent

In addition, if an error occurs, **_heapset** sets **errno** to **ENOSYS**.

Parameter

fill Fill character

Remarks

The **_heapset** function shows free memory locations or nodes that have been unintentionally overwritten.

_heapset checks for minimal consistency on the heap, then sets each byte of the heap's free entries to the *fill* value. This known value shows which memory locations of the heap contain free nodes and which contain data that were unintentionally written to freed memory.

Note In Visual C++ Version 4.0, the underlying heap structure was moved to the C run-time libraries to support the new debugging features. As a result, the only Win32 platform that is supported by **_heapset** is Windows NT. The function returns **_HEAPOK** and sets **errno** to **ENOSYS**, when it is called by any other Win32 platform.

Example

```
/* HEAPSET.C: This program checks the heap and
 * fills in free entries with the character 'Z'.
 */

#include <malloc.h>
#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int heapstatus;
   char *buffer;

   if( (buffer = malloc( 1 )) == NULL )  /* Make sure heap is */
      exit( 0 );                         /*    initialized    */
   heapstatus = _heapset( 'Z' );         /* Fill in free entries */
   switch( heapstatus )
   {
   case _HEAPOK:
      printf( "OK - heap is fine\n" );
      break;
   case _HEAPEMPTY:
      printf( "OK - heap is empty\n" );
      break;
   case _HEAPBADBEGIN:
      printf( "ERROR - bad start of heap\n" );
      break;
   case _HEAPBADNODE:
      printf( "ERROR - bad node in heap\n" );
      break;
   }
   free( buffer );
}
```

Output

```
OK - heap is fine
```

See Also: **_heapadd, _heapchk, _heapmin, _heapwalk**

_heapwalk

Traverses the heap and returns information about the next entry.

int _heapwalk(_HEAPINFO ***entryinfo*);**

Routine	Required Header	Optional Headers	Compatibility
_heapwalk	<malloc.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_heapwalk returns one of the following integer manifest constants defined in MALLOC.H:

_HEAPBADBEGIN Initial header information invalid or not found

_HEAPBADNODE Heap damaged or bad node found

_HEAPBADPTR **_pentry** field of **_HEAPINFO** structure does not contain valid pointer into heap

_HEAPEND End of heap reached successfully

_HEAPEMPTY Heap not initialized

_HEAPOK No errors so far; **_HEAPINFO** structure contains information about next entry.

In addition, if an error occurs, **_heapwalk** sets **errno** to **ENOSYS**.

Parameter

entryinfo Buffer to contain heap information

Remarks

The **_heapwalk** function helps debug heap-related problems in programs. The function walks through the heap, traversing one entry per call, and returns a pointer to a structure of type **_HEAPINFO** that contains information about the next heap entry. The **_HEAPINFO** type, defined in MALLOC.H, contains the following elements:

int *_pentry Heap entry pointer

size_t _size Size of heap entry

int _useflag Flag that indicates whether heap entry is in use

A call to **_heapwalk** that returns **_HEAPOK** stores the size of the entry in the **_size** field and sets the **_useflag** field to either **_FREEENTRY** or **_USEDENTRY** (both are constants defined in MALLOC.H). To obtain this information about the first entry in the heap, pass **_heapwalk** a pointer to a **_HEAPINFO** structure whose **_pentry** member is **NULL**.

Note Beginning with Visual C++ Version 4.0, the underlying heap structure was moved to the C run-time libraries to support the new debugging features. As a result, the only Win32 platform that is supported by **_heapwalk** is Windows NT. When it is called by any other Win32 platform, **_heapwalk** returns **_HEAPEND** and sets **errno** to **ENOSYS**.

Example

```
/* HEAPWALK.C: This program "walks" the heap, starting
 * at the beginning (_pentry = NULL). It prints out each
 * heap entry's use, location, and size. It also prints
 * out information about the overall state of the heap as
 * soon as _heapwalk returns a value other than _HEAPOK.
 */

#include <stdio.h>
#include <malloc.h>

void heapdump( void );

void main( void )
{
   char *buffer;

   heapdump();
   if( (buffer = malloc( 59 )) != NULL )
   {
      heapdump();
      free( buffer );
   }
   heapdump();
}

void heapdump( void )
{
   _HEAPINFO hinfo;
   int heapstatus;
   hinfo._pentry = NULL;
   while( ( heapstatus = _heapwalk( &hinfo ) ) == _HEAPOK )
   { printf( "%6s block at %Fp of size %4.4X\n",
        ( hinfo._useflag == _USEDENTRY ? "USED" : "FREE" ),
          hinfo._pentry, hinfo._size );
   }

   switch( heapstatus )
   {
   case _HEAPEMPTY:
      printf( "OK - empty heap\n" );
      break;
   case _HEAPEND:
      printf( "OK - end of heap\n" );
      break;
   case _HEAPBADPTR:
      printf( "ERROR - bad pointer to heap\n" );
      break;
   case _HEAPBADBEGIN:
      printf( "ERROR - bad start of heap\n" );
      break;
   case _HEAPBADNODE:
      printf( "ERROR - bad node in heap\n" );
      break;
   }
}
```

Output

```
  USED block at 002C0004 of size 0014
  USED block at 002C001C of size 0054
  USED block at 002C0074 of size 0024
  USED block at 002C009C of size 0010
  USED block at 002C00B0 of size 0018
  USED block at 002C00CC of size 000C
  USED block at 002C00DC of size 001C
  USED block at 002C00FC of size 0010
  USED block at 002C0110 of size 0014
  USED block at 002C0128 of size 0010
  USED block at 002C013C of size 0028
  USED block at 002C0168 of size 0088
  USED block at 002C01F4 of size 001C
  USED block at 002C0214 of size 0014
  USED block at 002C022C of size 0010
  USED block at 002C0240 of size 0014
  USED block at 002C0258 of size 0010
  USED block at 002C026C of size 000C
  USED block at 002C027C of size 0010
  USED block at 002C0290 of size 0014
  USED block at 002C02A8 of size 0010
  USED block at 002C02BC of size 0010
  USED block at 002C02D0 of size 1000
  FREE block at 002C12D4 of size ED2C
OK - end of heap
```

See Also: _heapadd, _heapchk, _heapmin, _heapset

_hypot

Calculates the hypotenuse.

double _hypot(double *x*, **double** *y* **);**

Routine	Required Header	Compatibility
_hypot	<math.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_hypot returns the length of the hypotenuse if successful or INF (infinity) on overflow. The **errno** variable is set to **ERANGE** on overflow. You can modify error handling with **_matherr**.

Parameters

x, *y* Floating-point values

Remarks

The **_hypot** function calculates the length of the hypotenuse of a right triangle, given the length of the two sides *x* and *y*. A call to **_hypot** is equivalent to the square root of *x*2 + *y*2.

Example

```
/* HYPOT.C: This program prints the
 * hypotenuse of a right triangle.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 3.0, y = 4.0;

   printf( "If a right triangle has sides %2.1f and %2.1f, "
           "its hypotenuse is %2.1f\n", x, y, _hypot( x, y ) );
}
```

Output

```
If a right triangle has sides 3.0 and 4.0, its hypotenuse is 5.0
```

See Also: **_cabs**, **_matherr**

_inp, _inpw, _inpd

Input a byte (**_inp**), a word (**_inpw**), or a double word (**_inpd**) from a port.

int _inp(unsigned short *port* **);**
unsigned short _inpw(unsigned short *port* **);**
unsigned long _inpd(unsigned short *port* **);**

Routine	Required Header	Compatibility
_inp	<conio.h>	Win 95
_inpw	<conio.h>	Win 95
_inpd	<conio.h>	Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The functions return the byte, word, or double word read from *port*. There is no error return.

Parameter

port Port number

Remarks

The **_inp**, **_inpw**, and **_inpd** functions read a byte, a word, and a double word, respectively, from the specified input port. The input value can be any unsigned short integer in the range 0–65,535.

See Also: _outp

---

is, isw Routines

isalnum, iswalnum
isalpha, iswalpha
__isascii, iswascii
iscntrl, iswcntrl
__iscsym, __iscsymf
isdigit, iswdigit
isgraph, iswgraph
islower, iswlower
isprint, iswprint
ispunct, iswpunct
isspace, iswspace
isupper, iswupper
isxdigit, iswxdigit
iswctype

Remarks

These routines test characters for specified conditions.

The **is** routines produce meaningful results for any integer argument from –1 (**EOF**) to **UCHAR_MAX** (0xFF), inclusive. The expected argument type is **int**.

Warning For the **is** routines, passing an argument of type **char** may yield unpredictable results. An SBCS or MBCS single-byte character of type **char** with a value greater than 0x7F is negative. If a **char** is passed, the compiler may convert the value to a signed **int** or a signed **long**. This value may be sign-extended by the compiler, with unexpected results.

The **isw** routines produce meaningful results for any integer value from –1 (**WEOF**) to 0xFFFF, inclusive. The **wint_t** data type is defined in WCHAR.H as an **unsigned short**; it can hold any wide character or the wide-character end-of-file (**WEOF**) value.

For each of the **is** routines, the result of the test for the specified condition depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. In the "C" locale, the test conditions for the **is** routines are as follows:

isalnum Alphanumeric (A–Z, a–z, or 0–9)

isalpha Alphabetic (A–Z or a–z)

__isascii ASCII character (0x00–0x7F)

iscntrl Control character (0x00–0x1F or 0x7F)

__iscsym Letter, underscore, or digit

__iscsymf Letter or underscore

isdigit Decimal digit (0–9)

isgraph Printable character except space ( )

islower Lowercase letter (a–z)

isprint Printable character including space (0x20–0x7E)

ispunct Punctuation character

isspace White-space character (0x09–0x0D or 0x20)

isupper Uppercase letter (A–Z)

isxdigit Hexadecimal digit (A–F, a–f, or 0–9)

For the **isw** routines, the result of the test for the specified condition is independent of locale. The test conditions for the **isw** functions are as follows:

iswalnum **iswalpha** or **iswdigit**

iswalpha Any wide character that is one of an implementation-defined set for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. **iswalpha** returns true only for wide characters for which **iswupper** or **iswlower** is true.

iswascii Wide-character representation of ASCII character (0x0000–0x007F).

iswcntrl Control wide character.

iswctype Character has property specified by the *desc* argument. For each valid value of the *desc* argument of **iswctype**, there is an equivalent wide-character classification routine, as shown in the following table:

Table R.2 Equivalence of iswctype(*c, desc*) to Other isw Testing Routines

Value of *desc* Argument	iswctype(*c, desc*) Equivalent
_ALPHA	**iswalpha**(*c*)
_ALPHA | _DIGIT	**iswalnum**(*c*)
_CONTROL	**iswcntrl**(*c*)
_DIGIT	**iswdigit**(*c*)
_ALPHA | _DIGIT | _PUNCT	**iswgraph**(*c*)
_LOWER	**iswlower**(*c*)
_ALPHA | _BLANK | _DIGIT | _PUNCT	**iswprint**(*c*)
_PUNCT	**iswpunct**(*c*)
_SPACE	**iswspace**(*c*)
_UPPER	**iswupper**(*c*)
_HEX	**iswxdigit**(*c*)

iswdigit Wide character corresponding to a decimal-digit character.

iswgraph Printable wide character except space wide character (L' ').

iswlower Lowercase letter, or one of implementation-defined set of wide characters for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. **iswlower** returns true only for wide characters that correspond to lowercase letters.

iswprint Printable wide character, including space wide character (L' ').

iswpunct Printable wide character that is neither space wide character (L' ') nor wide character for which **iswalnum** is true.

iswspace Wide character that corresponds to standard white-space character or is one of implementation-defined set of wide characters for which **iswalnum** is false. Standard white-space characters are: space (L' '), formfeed (L'\f'), newline (L'\n'), carriage return (L'\r'), horizontal tab (L'\t'), and vertical tab (L'\v').

iswupper Wide character that is uppercase or is one of an implementation-defined set of wide characters for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. **iswupper** returns true only for wide characters that correspond to uppercase characters.

iswxdigit Wide character that corresponds to a hexadecimal-digit character.

Example

```
/* ISFAM.C: This program tests all characters between 0x0
 * and 0x7F, then displays each character with abbreviations
 * for the character-type codes that apply.

 * Editor's note: the following output is significantly
 * shortened with the use of ellipses. This full output
 * is too long and repetitive.
 */

#include <stdio.h>
#include <ctype.h>

void main( void )
{
   int ch;
   for( ch = 0; ch <= 0x7F; ch++ )
   {
      printf( "%.2x  ", ch );
      printf( " %c", isprint( ch )  ? ch   : '\0' );
      printf( "%4s", isalnum( ch )  ? "AN" : "" );
      printf( "%3s", isalpha( ch )  ? "A"  : "" );
      printf( "%3s", __isascii( ch )  ? "AS" : "" );
      printf( "%3s", iscntrl( ch )  ? "C"  : "" );
      printf( "%3s", __iscsym( ch )  ? "CS "  : "" );
      printf( "%3s", __iscsymf( ch )  ? "CSF"  : "" );
      printf( "%3s", isdigit( ch )  ? "D"  : "" );
      printf( "%3s", isgraph( ch )  ? "G"  : "" );
      printf( "%3s", islower( ch )  ? "L"  : "" );
```

```
        printf( "%3s", ispunct( ch )  ? "PU" : "" );
        printf( "%3s", isspace( ch )  ? "S"  : "" );
        printf( "%3s", isprint( ch )  ? "PR" : "" );
        printf( "%3s", isupper( ch )  ? "U"  : "" );
        printf( "%3s", isxdigit( ch ) ? "X"  : "" );
        printf( "\n" );
    }
}
```

Output

```
00
01
02
03
04
05
06
07
08
09
0a
0b
0c
0d
0e
0f
10
11
12
13
14
15
16
17
18
19
1a
1b
1c
1d
1e
1f
20            AS                        S PR
21   !        AS              G    PU     PR
22   "        AS              G    PU     PR
23   #        AS              G    PU     PR
24   $        AS              G    PU     PR
25   %        AS              G    PU     PR
26   &        AS              G    PU     PR
27   '        AS              G    PU     PR
28   (        AS              G    PU     PR
29   )        AS              G    PU     PR
2a   *        AS              G    PU     PR
2b   +        AS              G    PU     PR
```

```
2c   ,          AS                  G    PU    PR
2d   -          AS                  G    PU    PR
2e   .          AS                  G    PU    PR
2f   /          AS                  G    PU    PR
30   0  AN      AS   CS        D    G          PR       X
31   1  AN      AS   CS        D    G          PR       X
32   2  AN      AS   CS        D    G          PR       X
33   3  AN      AS   CS        D    G          PR       X
34   4  AN      AS   CS        D    G          PR       X
35   5  AN      AS   CS        D    G          PR       X
36   6  AN      AS   CS        D    G          PR       X
37   7  AN      AS   CS        D    G          PR       X
38   8  AN      AS   CS        D    G          PR       X
.
.
.
39   9  AN      AS   CS        D    G          PR       X
3a   :          AS                  G    PU    PR
3b   ;          AS                  G    PU    PR
3c   <          AS                  G    PU    PR
3d   =          AS                  G    PU    PR
.
.
.
3e   >          AS                  G    PU    PR
3f   ?          AS                  G    PU    PR
40   @          AS                  G    PU    PR
41   A  AN   A  AS   CS CSF         G          PR   U   X
42   B  AN   A  AS   CS CSF         G          PR   U   X
43   C  AN   A  AS   CS CSF         G          PR   U   X
44   D  AN   A  AS   CS CSF         G          PR   U   X
45   E  AN   A  AS   CS CSF         G          PR   U   X
46   F  AN   A  AS   CS CSF         G          PR   U   X
47   G  AN   A  AS   CS CSF         G          PR   U
48   H  AN   A  AS   CS CSF         G          PR   U
49   I  AN   A  AS   CS CSF         G          PR   U
4a   J  AN   A  AS   CS CSF         G          PR   U
4b   K  AN   A  AS   CS CSF         G          PR   U
4c   L  AN   A  AS   CS CSF         G          PR   U
4d   M  AN   A  AS   CS CSF         G          PR   U
4e   N  AN   A  AS   CS CSF         G          PR   U
4f   O  AN   A  AS   CS CSF         G          PR   U
50   P  AN   A  AS   CS CSF         G          PR   U
51   Q  AN   A  AS   CS CSF         G          PR   U
52   R  AN   A  AS   CS CSF         G          PR   U
53   S  AN   A  AS   CS CSF         G          PR   U
54   T  AN   A  AS   CS CSF         G          PR   U
55   U  AN   A  AS   CS CSF         G          PR   U
56   V  AN   A  AS   CS CSF         G          PR   U
57   W  AN   A  AS   CS CSF         G          PR   U
58   X  AN   A  AS   CS CSF         G          PR   U
59   Y  AN   A  AS   CS CSF         G          PR   U
5a   Z  AN   A  AS   CS CSF         G          PR   U
5b   [          AS                  G    PU    PR
```

```
5c   \          AS                  G     PU    PR
5d   ]          AS                  G     PU    PR
5e   ^          AS                  G     PU    PR
5f   _          AS    CS CSF        G     PU    PR
60   `          AS                  G     PU    PR
61   a  AN  A AS    CS CSF        G  L        PR      X
62   b  AN  A AS    CS CSF        G  L        PR      X
63   c  AN  A AS    CS CSF        G  L        PR      X
64   d  AN  A AS    CS CSF        G  L        PR      X
65   e  AN  A AS    CS CSF        G  L        PR      X
66   f  AN  A AS    CS CSF        G  L        PR      X
67   g  AN  A AS    CS CSF        G  L        PR
68   h  AN  A AS    CS CSF        G  L        PR
69   i  AN  A AS    CS CSF        G  L        PR
6a   j  AN  A AS    CS CSF        G  L        PR
6b   k  AN  A AS    CS CSF        G  L        PR
6c   l  AN  A AS    CS CSF        G  L        PR
6d   m  AN  A AS    CS CSF        G  L        PR
6e   n  AN  A AS    CS CSF        G  L        PR
6f   o  AN  A AS    CS CSF        G  L        PR
70   p  AN  A AS    CS CSF        G  L        PR
71   q  AN  A AS    CS CSF        G  L        PR
72   r  AN  A AS    CS CSF        G  L        PR
73   s  AN  A AS    CS CSF        G  L        PR
74   t  AN  A AS    CS CSF        G  L        PR
75   u  AN  A AS    CS CSF        G  L        PR
76   v  AN  A AS    CS CSF        G  L        PR
77   w  AN  A AS    CS CSF        G  L        PR
78   x  AN  A AS    CS CSF        G  L        PR
79   y  AN  A AS    CS CSF        G  L        PR
7a   z  AN  A AS    CS CSF        G  L        PR
7b   {          AS                  G     PU    PR
7c   |          AS                  G     PU    PR
7d   }          AS                  G     PU    PR
7e   ~          AS                  G     PU    PR
7f
```

See Also: **setlocale, to** Function Overview

isalnum, iswalnum

int isalnum(int *c* **);**
int iswalnum(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of an alphanumeric character.

Routine	Required Header	Compatibility
isalnum	<ctype.h>	ANSI, Win 95, Win NT
iswalnum	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isalnum returns a non-zero value if either **isalpha** or **isdigit** is true for *c*, that is, if *c* is within the ranges A–Z, a–z, or 0–9. **iswalnum** returns a non-zero value if either **iswalpha** or **iswdigit** is true for *c*. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isalnum** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswalnum**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istalnum	isalnum	_ismbcalnum	iswalnum

isalpha, iswalpha

int isalpha(int *c* **);**
int iswalpha(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of an alphabetic character.

Routine	Required Header	Compatibility
isalpha	<ctype.h>	ANSI, Win 95, Win NT
iswalpha	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isalpha returns a non-zero value if *c* is within the ranges A–Z or a–z. **iswalpha** returns a non-zero value only for wide characters for which **iswupper** or **iswlower** is true, that is, for any wide character that is one of an implementation-defined set for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isalpha** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswalpha**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istalpha	isalpha	_ismbcalpha	iswalpha

__isascii, iswascii

int __isascii(int *c* **);**
int iswascii(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of an ASCII character.

Routine	Required Header	Compatibility
__isascii	<ctype.h>	Win 95, Win NT
iswascii	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

__isascii returns a non-zero value if *c* is an ASCII character (in the range 0x00–0x7F). **iswascii** returns a non-zero value if *c* is a wide-character representation of an ASCII character. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **__isascii** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswascii**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istascii	__isascii	__isascii	iswascii

iscntrl, iswcntrl

int iscntrl(int *c* **);**
int iswcntrl(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a control character.

Routine	Required Header	Compatibility
iscntrl	<ctype.h>	ANSI, Win 95, Win NT
iswcntrl	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

iscntrl returns a non-zero value if *c* is a control character (0x00–0x1F or 0x7F). **iswcntrl** returns a non-zero value if *c* is a control wide character. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **iscntrl** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswcntrl**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istcntrl	iscntrl	iscntrl	iswcntrl

__iscsym, __iscsymf

int __iscsym(int *c* **);**
int __iscsymf(int *c* **);**

Routine	Required Header	Compatibility
__iscsym	<ctype.h>	Win 95, Win NT
__iscsymf	<ctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

__iscsym returns a non-zero value if *c* is a letter, underscore, or digit. **__iscsymf** returns a non-zero value if *c* is a letter or an underscore. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **__iscsym** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **__iscsymf**, the result of the test condition is independent of locale.

Parameter

c Integer to test

isdigit, iswdigit

int isdigit(int *c* **);**
int iswdigit(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a decimal-digit character.

Routine	Required Header	Compatibility
isdigit	<ctype.h>	ANSI, Win 95, Win NT
iswdigit	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isdigit returns a non-zero value if *c* is a decimal digit (0–9). **iswdigit** returns a non-zero value if *c* is a wide character corresponding to a decimal-digit character. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isdigit** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswdigit**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istdigit	isdigit	_ismbcdigit	iswdigit

isgraph, iswgraph

int isgraph(int *c* **);**
int iswgraph(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a printable character other than a space.

Routine	Required Header	Compatibility
isgraph	<ctype.h>	ANSI, Win 95, Win NT
iswgraph	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isgraph returns a non-zero value if *c* is a printable character other than a space. **iswgraph** returns a non-zero value if *c* is a printable wide character other than a wide-character space. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isgraph** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswgraph**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istgraph	isgraph	_ismbcgraph	iswgraph

islower, iswlower

int islower(int *c* **);**
int iswlower(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a lowercase character.

Routine	Required Header	Compatibility
islower	<ctype.h>	ANSI, Win 95, Win NT
iswlower	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

islower returns a non-zero value if *c* is a lowercase character (a–z). **iswlower** returns a non-zero value if *c* is a wide character that corresponds to a lowercase letter, or if *c* is one of an implementation-defined set of wide characters for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **islower** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswlower**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istlower	islower	_ismbclower	iswlower

isprint, iswprint

int isprint(int *c* **);**
int iswprint(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a printable character.

Routine	Required Header	Compatibility
isprint	<ctype.h>	ANSI, Win 95, Win NT
iswprint	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isprint returns a nonzero value if *c* is a printable character, including the space character (0x20–0x7E). **iswprint** returns a nonzero value if *c* is a printable wide character, including the space wide character. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isprint** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswprint**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istprint	isprint	_ismbcprint	iswprint

ispunct, iswpunct

int ispunct(int *c* **);**
int iswpunct(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a punctuation character.

Routine	Required Header	Compatibility
ispunct	<ctype.h>	ANSI, Win 95, Win NT
iswpunct	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

ispunct returns a non-zero value for any printable character that is not a space character or a character for which **isalnum** is true. **iswpunct** returns a non-zero value for any printable wide character that is neither the space wide character nor a wide character for which **iswalnum** is true. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **ispunct** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswpunct**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istpunct	ispunct	_ismbcpunct	iswpunct

isspace, iswspace

int isspace(int *c* **);**
int iswspace(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a space character.

Routine	Required Header	Compatibility
isspace	<ctype.h>	ANSI, Win 95, Win NT
iswspace	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isspace returns a non-zero value if *c* is a white-space character (0x09–0x0D or 0x20). **iswspace** returns a non-zero value if *c* is a wide character that corresponds to a standard white-space character or is one of an implementation-defined set of wide characters for which **iswalnum** is false. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isspace** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswspace**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istspace	isspace	_ismbcspace	iswspace

isupper, iswupper

int isupper(int *c*);
int iswupper(wint_t *c*);

Each of these routines returns true if *c* is a particular representation of an uppercase letter.

Routine	Required Header	Compatibility
isupper	<ctype.h>	ANSI, Win 95, Win NT
iswupper	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isupper returns a non-zero value if *c* is an uppercase character (a–z). **iswupper** returns a non-zero value if *c* is a wide character that corresponds to an uppercase letter, or if *c* is one of an implementation-defined set of wide characters for which none of **iswcntrl**, **iswdigit**, **iswpunct**, or **iswspace** is true. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isupper** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For **iswupper**, the result of the test condition is independent of locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istupper	isupper	_ismbcupper	iswupper

iswctype

int iswctype(wint_t *c*, **wctype_t** *desc* **);**

iswctype tests *c* for the property specified by the *desc* argument. For each valid value of *desc*, there is an equivalent wide-character classification routine.

Routine	Required Header	Compatibility
iswctype	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

iswctype returns a nonzero value if *c* has the property specified by *desc*, or 0 if it does not. The result of the test condition is independent of locale.

Parameters

c Integer to test

desc Property to test for

isxdigit, iswxdigit

int isxdigit(int *c* **);**
int iswxdigit(wint_t *c* **);**

Each of these routines returns true if *c* is a particular representation of a hexadecimal digit.

Routine	Required Header	Compatibility
isxdigit	<ctype.h>	ANSI, Win 95, Win NT
iswxdigit	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isxdigit returns a non-zero value if *c* is a hexadecimal digit (A–F, a–f, or 0–9). **iswxdigit** returns a non-zero value if *c* is a wide character that corresponds to a hexadecimal digit character. Each of these routines returns 0 if *c* does not satisfy the test condition.

The result of the test condition for the **isxdigit** function depends on the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information. For the "C" locale, the **iswxdigit** function does not provide support for Unicode fullwidth hexadecimal characters. The result of the test condition for **iswxdigit** is independent of any other locale.

Parameter

c Integer to test

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istxdigit	isxdigit	isxdigit	iswxdigit

_isatty

int _isatty(int *handle* **);**

Routine	Required Header	Compatibility
_isatty	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_isatty returns a nonzero value handle is associated with a character device. Otherwise, **_isatty** returns 0.

Parameter

handle Handle referring to device to be tested

Remarks

The **_isatty** function determines whether *handle* is associated with a character device (a terminal, console, printer, or serial port).

Example

```
/* ISATTY.C: This program checks to see whether
 * stdout has been redirected to a file.
 */

#include <stdio.h>
#include <io.h>

void main( void )
{
   if( _isatty( _fileno( stdout ) ) )
      printf( "stdout has not been redirected to a file\n" );
   else
      printf( "stdout has been redirected to a file\n");
}
```

Output

```
stdout has been redirected to a file
```

isleadbyte

int isleadbyte(int *c* **);**

Routine	Required Header	Compatibility
isleadbyte	<ctype.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

isleadbyte returns a nonzero value if the argument satisfies the test condition or 0 if it does not. In the "C" locale and in single-byte–character set (SBCS) locales, **isleadbyte** always returns 0.

Parameter

c Integer to test

Remarks

The **isleadbyte** macro returns a nonzero value if its argument is the first byte of a multibyte character. **isleadbyte** produces a meaningful result for any integer argument from –1 (**EOF**) to **UCHAR_MAX** (0xFF), inclusive. The result of the test depends upon the **LC_CTYPE** category setting of the current locale; see **setlocale** for more information.

The expected argument type of **isleadbyte** is **int**; if a signed character is passed, the compiler may convert it to an integer by sign extension, yielding unpredictable results.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istleadbyte	Always returns false	_isleadbyte	Always returns false

See Also: **_ismbb** Routine Overview

_ismbb Routines

Each routine in the **_ismbb** family tests the given integer value *c* for a particular condition.

_ismbbalnum
_ismbbalpha
_ismbbgraph
_ismbbkalnum
_ismbbkana
_ismbbkprint
_ismbbkpunct
_ismbblead
_ismbbprint
_ismbbpunct
_ismbbtrail

Remarks

Each routine in the **_ismbb** family tests the given integer value *c* for a particular condition. The test result depends on the multibyte code page in effect. By default, the multibyte code page is set to the system-default ANSI code page obtained from the operating system at program startup. You can query or change the multibyte code page in use with **_getmbcp** or **_setmbcp**, respectively.

The routines in the **_ismbb** family test the given integer *c* as follows:

Routine	Byte Test Condition
_ismbbalnum	**isalnum** || **_ismbbkalnum**
_ismbbalpha	**isalpha** || **_ismbbkalnum**
_ismbbgraph	Same as **_ismbbprint**, but **_ismbbgraph** does not include the space character (0x20).
_ismbbkalnum	Non-ASCII text symbol other than punctuation. For example, in code page 932 only, **_ismbbkalnum** tests for katakana alphanumeric.
_ismbbkana	Katakana (0xA1–0xDF). Specific to code page 932.
_ismbbkprint	Non-ASCII text or non-ASCII punctuation symbol. For example, in code page 932 only, **_ismbbkprint** tests for katakana alphanumeric or katakana punctuation (range: 0xA1–0xDF).
_ismbbkpunct	Non-ASCII punctuation. For example, in code page 932 only, **_ismbbkpunct** tests for katakana punctuation.
_ismbblead	First byte of multibyte character. For example, in code page 932 only, valid ranges are 0x81–0x9F, 0xE0–0xFC.
_ismbbprint	**isprint** || **_ismbbkprint**. **ismbbprint** includes the space character (0x20).
_ismbbpunct	**ispunct** || **_ismbbkpunct**
_ismbbtrail	Second byte of multibyte character. For example, in code page 932 only, valid ranges are 0x40–0x7E, 0x80–0xEC.

The following table shows the ORed values that compose the test conditions for these routines. The manifest constants **_BLANK**, **_DIGIT**, **_LOWER**, **_PUNCT**, and **_UPPER** are defined in CTYPE.H.

Routine	_BLANK	_DIGIT	LOWER	_PUNCT	UPPER	Non-ASCII Text	Non-ASCII Punct
_ismbbalnum	—	x	x	—	x	x	—
_ismbbalpha	—	—	x	—	x	x	—
_ismbbgraph	—	x	x	x	x	x	x
_ismbbkalnum	—	—	—	—	—	x	—
_ismbbkprint	—	—	—	—	—	x	x
_ismbbkpunct	—	—	—	—	—	—	x
_ismbbprint	x	x	x	x	x	x	x
_ismbbpunct	—	—	—	x	—	—	x

The **_ismbb** routines are implemented both as functions and as macros. For details on choosing either implementation, see "Choosing Between Functions and Macros" on page xiii.

See Also: _mbbtombc, _mbctombb

_ismbbalnum

int _ismbbalnum(unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbalnum	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbalnum returns a nonzero value if the expression

```
isalnum || _ismbbkalnum
```

is true of *c*, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbalpha

int _ismbbalpha(unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbalpha	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbalpha returns a nonzero value if the expression

```
isalpha || _ismbbkalnum
```

is true of *c*, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbgraph

int _ismbbgraph (unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbgraph	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbgraph returns a nonzero value if the expression

```
( _PUNCT | _UPPER | _LOWER | _DIGIT ) || _ismbbkprint
```

is true of *c*, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbkalnum

int _ismbbkalnum(unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbkalnum	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbkalnum returns a nonzero value if the integer *c* is a non-ASCII text symbol other than punctuation, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbkana

int _ismbbkana(unsigned int *c*);

_ismbbkana tests for a katakana symbol and is specific to code page 932.

Routine	Required Header	Compatibility
_ismbbkana	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbkana returns a nonzero value if the integer *c* is a katakana symbol, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbkprint

int _ismbbkprint(unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbkprint	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbkprint returns a nonzero value if the integer *c* is a non-ASCII text or non-ASCII punctuation symbol, or 0 if it is not. For example, in code page 932 only, **_ismbbkprint** tests for katakana alphanumeric or katakana punctuation (range: 0xA1–0xDF).

Parameter

c Integer to be tested

_ismbbkpunct

int _ismbbkpunct(unsigned int *c*);

Routine	Required Header	Compatibility
_ismbbkpunct	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbkpunct returns a nonzero value if the integer *c* is a non-ASCII punctuation symbol, or 0 if it is not. For example, in code page 932 only, **_ismbbkpunct** tests for katakana punctuation.

Parameter

c Integer to be tested

_ismbblead

int _ismbblead(unsigned int *c*);

Routine	Required Header	Optional Headers	Compatibility
_ismbblead	<mbctype.h> or <mbstring.h>	<ctype.h>,[1] <limits.h>, <stdlib.h>	Win 95, Win NT

[1] For manifest constants for the test conditions.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbblead returns a nonzero value if the integer *c* is the first byte of a multibyte character. For example, in code page 932 only, valid ranges are 0x81–0x9F and 0xE0–0xFC.

Parameter

c Integer to be tested

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istlead	Always returns false	_ismbblead	Always returns false

_ismbbprint

int _ismbbprint(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbbprint	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbprint returns a nonzero value if the expression

```
isprint || _ismbbkprint
```

is true of *c*, or 0 if it is not.

Parameter

c Integer to be tested

_ismbbpunct

int _ismbbpunct(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbbpunct	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbpunct returns a nonzero value if the integer *c* is a non-ASCII punctuation symbol.

Parameter

c Integer to be tested

_ismbbtrail

int _ismbbtrail(unsigned int *c*);

Routine	Required Header	Optional Headers	Compatibility
_ismbbtrail	<mbctype.h> or <mbstring.h>	<ctype.h>,[1] <limits.h>, <stdlib.h>	Win 95, Win NT

[1] For manifest constants for the test conditions.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbbtrail returns a nonzero value if the integer *c* is the second byte of a multibyte character. For example, in code page 932 only, valid ranges are 0x40–0x7E and 0x80–0xEC.

Parameter

c Integer to be tested

_ismbc Routines

Each of the **_ismbc** routines tests a given multibyte character *c* for a particular condition.

_ismbcalnum, _ismbcalpha, _ismbcdigit

_ismbcgraph, _ismbcprint, _ismbcpunct, _ismbcspace

_ismbchira, _ismbckata

_ismbcl0, _ismbcl1, _ismbcl2

_ismbclegal, _ismbcsymbol

_ismbclower, _ismbcupper

Remarks

The test result of each of the **_ismbc** routines depends on the multibyte code page in effect. Multibyte code pages have single byte alphabetic characters. By default, the multibyte code page is set to the system-default ANSI code page obtained from the operating system at program startup. You can query or change the multibyte code page in use with **_getmbcp** or **_setmbcp**, respectively.

Routine	Test Condition	Code Page 932 Example
_ismbcalnum	Alphanumeric	Returns true if and only if *c* is a single-byte representation of an ASCII English letter: See examples for **_ismbcdigit** and **_ismbcalpha**.
_ismbcalpha	Alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII English letter: See examples for **_ismbcupper** and **_ismbclower**; or a Katakana letter: 0xA6<=*c*<=0xDF.
_ismbcdigit	Digit	Returns true if and only if *c* is a single-byte representation of an ASCII digit: 0x30<=*c*<=0x39.
_ismbcgraph	Graphic	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana printable character except a white space ( ). See examples for **_ismbcdigit**, **_ismbcalpha**, and **_ismbcpunct**.
_ismbclegal	Valid multibyte character	Returns true if and only if the first byte of *c* is within ranges 0x81–0x9F or 0xE0–0xFC, while the second byte is within ranges 0x40–0x7E or 0x80-FC.
_ismbclower	Lowercase alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII lowercase English letter: 0x61<=*c*<=0x7A.
_ismbcprint	Printable	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana printable character including a white space ( ): See examples for **_ismbcspace**, **_ismbcdigit**, **_ismbcalpha**, and **_ismbcpunct**.
_ismbcpunct	Punctuation	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana punctuation character.
_ismbcspace	Whitespace	Returns true if and only if *c* is a whitespace character: *c*=0x20 or 0x09<=*c*<=0x0D.
_ismbcsymbol	Multibyte symbol	Returns true if and only if 0x8141<=*c*<=0x81AC.
_ismbcupper	Uppercase alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII uppercase English letter: 0x41<=*c*<=0x5A.

Code Page 932 Specific →

The following routines are specific to code page 932.

Routine	Test Condition (Code Page 932 Only)
_ismbchira	Double-byte Hiragana: 0x829F<=*c*<=0x82F1.
_ismbckata	Double-byte Katakana: 0x8340<=*c*<=0x8396.
_ismbcl0	JIS non-Kanji: 0x8140<=*c*<=0x889E.
_ismbcl1	JIS level-1: 0x889F<=*c*<=0x9872.
_ismbcl2	JIS level-2: 0x989F<=*c*<=0xEA9E.

_ismbcl0, **_ismbcl1**, and **_ismbcl2** check that the specified value *c* matches the test conditions described in the preceding table, but do not check that *c* is a valid multibyte character. If the lower byte is in the ranges 0x00–0x3F, 0x7F, or 0xFD–0xFF, these functions return a nonzero value, indicating that the character satisfies the test condition. Use **_ismbbtrail** to test whether the multibyte character is defined.

END Code Page 932 Specific

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbcalnum, _ismbcalpha, _ismbcdigit

int _ismbcalnum(unsigned int *c* **);**
int _ismbcalpha(unsigned int *c* **);**
int _ismbcdigit(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbcalnum	<mbstring.h>	Win 95, Win NT
_ismbcalpha	<mbstring.h>	Win 95, Win NT
_ismbcdigit	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these routines tests a given multibyte character for a given condition.

Routine	Test Condition	Code Page 932 Example
_ismbcalnum	Alphanumeric	Returns true if and only if *c* is a single-byte representation of an ASCII English letter: See examples for **_ismbcdigit** and **_ismbcalpha**.
_ismbcalpha	Alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII English letter: 0x41<=*c*<=0x5A or 0x61<=*c*<=0x7A; or a Katakana letter: 0xA6<=*c*<=0xDF.
_ismbcdigit	Digit	Returns true if and only if *c* is a single-byte representation of an ASCII digit: 0x30<=*c*<=0x39.

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbcgraph, _ismbcprint, _ismbcpunct, _ismbcspace

int _ismbcgraph(unsigned int *c* **);**
int _ismbcprint(unsigned int *c* **);**
int _ismbcpunct(unsigned int *c* **);**
int _ismbcspace(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbcgraph	<mbstring.h>	Win 95, Win NT
_ismbcprint	<mbstring.h>	Win 95, Win NT
_ismbcpunct	<mbstring.h>	Win 95, Win NT
_ismbcspace	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these functions tests a given multibyte character for a given condition.

Routine	Test Condition	Code Page 932 Example
_ismbcgraph	Graphic	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana printable character except a white space ( ).
_ismbcprint	Printable	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana printable character including a white space ( ).
_ismbcpunct	Punctuation	Returns true if and only if *c* is a single-byte representation of any ASCII or Katakana punctuation character.
_ismbcspace	Whitespace	Returns true if and only if *c* is a whitespace character: *c*=0x20 or 0x09<=*c*<=0x0D.

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbchira, _ismbckata

Code Page 932 Specific →

int _ismbchira(unsigned int *c* **);**
int _ismbckata(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbchira	<mbstring.h>	Win 95, Win NT
_ismbckata	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these functions tests a given multibyte character for a given condition.

Routine	Test Condition (Code Page 932 Only)
_ismbchira	Double-byte Hiragana: 0x829F<=*c*<=0x82F1.
_ismbckata	Double-byte Katakana: 0x8340<=*c*<=0x8396.

End Code Page 932 Specific

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbcl0, _ismbcl1, _ismbcl2

Code Page 932 Specific→

int _ismbcl0(unsigned int *c* **);**
int _ismbcl1(unsigned int *c* **);**
int _ismbcl2(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbcl0	<mbstring.h>	Win 95, Win NT
_ismbcl1	<mbstring.h>	Win 95, Win NT
_ismbcl2	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these functions tests a given multibyte character for a given condition.

Routine	Test Condition (Code Page 932 Only)
_ismbcl0	JIS non-Kanji: 0x8140<=*c*<=0x889E.
_ismbcl1	JIS level-1: 0x889F<=*c*<=0x9872.
_ismbcl2	JIS level-2: 0x989F<=*c*<=0xEA9E.

_ismbcl0, **_ismbcl1**, and **_ismbcl2** check that the specified value *c* matches the test conditions described above, but do not check that *c* is a valid multibyte character. If the lower byte is in the ranges 0x00–0x3F, 0x7F, or 0xFD–0xFF, these functions return a nonzero value, indicating that the character satisfies the test condition. Use **_ismbbtrail** to test whether the multibyte character is defined.

End Code Page 932 Specific

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbclegal, _ismbcsymbol

int _ismbclegal(unsigned int *c* **);**
int _ismbcsymbol(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbclegal	<mbstring.h>	Win 95, Win NT
_ismbcsymbol	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these functions tests a given multibyte character for a given condition.

Routine	Test Condition	Code Page 932 Example
_ismbclegal	Valid multibyte	Returns true if and only if the first byte of *c* is within ranges 0x81–0x9F or 0xE0–0xFC, while the second byte is within ranges 0x40 -0x7E or 0x80-FC.
_ismbcsymbol	Multibyte symbol	Returns true if and only if 0x8141<=*c*<=0x81AC.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_istlegal	Always returns false	_ismbclegal	Always returns false

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbclower, _ismbcupper

int _ismbclower(unsigned int *c* **);**
int _ismbcupper(unsigned int *c* **);**

Routine	Required Header	Compatibility
_ismbclower	<mbstring.h>	Win 95, Win NT
_ismbcupper	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a nonzero value if the character satisfies the test condition or 0 if it does not. If *c*<= 255 and there is a corresponding **_ismbb** routine (for example, **_ismbcalnum** corresponds to **_ismbbalnum**), the result is the return value of the corresponding **_ismbb** routine.

Parameter

c Character to be tested

Remarks

Each of these functions tests a given multibyte character for a given condition.

Routine	Test Condition	Code Page 932 Example
_ismbclower	Lowercase alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII lowercase English letter: 0x61<=*c*<=0x7A.
_ismbcupper	Uppercase alphabetic	Returns true if and only if *c* is a single-byte representation of an ASCII uppercase English letter: 0x41<=*c*<=0x5A.

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_ismbslead, _ismbstrail

int _ismbslead(const unsigned char **string*, **const unsigned char** **current* **);**
int _ismbstrail(const unsigned char **string*, **const unsigned char** **current* **);**

Routine	Required Header	Optional Headers	Compatibility
_ismbslead	<mbctype.h> or <mbstring.h>	<ctype.h>,1 <limits.h>, <stdlib.h>	Win 95, Win NT
_ismbstrail	<mbctype.h> or <mbstring.h>	<ctype.h>,1 <limits.h>, <stdlib.h>	Win 95, Win NT

1 For manifest constants for the test conditions.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ismbslead and **_ismbstrail** return –1 if the character is a lead or trail byte, respectively. Otherwise they return zero.

Parameters

string Pointer to start of string or previous known lead byte

current Pointer to position in string to be tested

Remarks

The **_ismbslead** and **_ismbstrail** routines perform context-sensitive tests for multibyte-character string lead and trail bytes; they determine whether a given substring pointer points to a lead byte or a trail byte. **_ismbslead** and **_ismbstrail** are slower than their **_ismbblead** and **_ismbbtrail** counterparts because they take the string context into account.

See Also: **is, isw** Function Overview, **_ismbb** Function Overview

_isnan

Checks given double-precision floating-point value for not a number (NaN).

int _isnan(double *x* **);**

Routine	Required Header	Compatibility
_isnan	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_isnan returns a nonzero value (TRUE) if the argument *x* is a NaN; otherwise it returns 0 (FALSE).

Parameter

x Double-precision floating-point value

Remarks

The **_isnan** function tests a given double-precision floating-point value *x*, returning a nonzero value if *x* is a NaN. A NaN is generated when the result of a floating-point operation cannot be represented in Institute of Electrical and Electronics Engineers (IEEE) format. For information about how a NaN is represented for output, see **printf**.

See Also: _finite, _fpclass

_itoa, _i64toa, _ui64toa, _itow, _i64tow, _ui64tow

Convert an integer to a string.

char *_itoa(int *value*, **char** **string*, **int** *radix* **);**
char *_i64toa(__int64 *value*, **char** **string*, **int** *radix* **);**
char * _ui64toa(unsigned _int64 *value*, **char** **string*, **int** *radix* **);**
wchar_t * _itow(int *value*, **wchar_t** **string*, **int** *radix* **);**
wchar_t * _i64tow(__int64 *value*, **wchar_t** **string*, **int** *radix* **);**
wchar_t * _ui64tow(unsigned __int64 *value*, **wchar_t** **string*, **int** *radix* **);**

Routine	Required Header	Compatibility
_itoa	<stdlib.h>	Win 95, Win NT
_i64toa	<stdlib.h>	Win 95, Win NT
_ui64toa	<stdlib.h>	Win 95, Win NT
_itow	<stdlib.h>	Win 95, Win NT
_i64tow	<stdlib.h>	Win 95, Win NT
_ui64tow	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to *string*. There is no error return.

Parameters

value Number to be converted

string String result

radix Base of *value*; must be in the range 2–36

Remarks

The **_itoa**, **_i64toa**, and **_ui64toa** function convert the digits of the given *value* argument to a null-terminated character string and stores the result (up to 17 bytes) in *string*. If *radix* equals 10 and *value* is negative, the first character of the stored string is the minus sign (–). **_itow**, **_i64tow**, and **_ui64tow** are wide-character versions of **_itoa**, **_i64toa**, and **_ui64toa** respectively.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_itot	_itoa	_itoa	_itow

Example

```
/* ITOA.C: This program converts integers of various
 * sizes to strings in various radixes.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char buffer[20];
   int  i = 3445;
   long l = -344115L;
   unsigned long ul = 1234567890UL;

   _itoa( i, buffer, 10 );
   printf( "String of integer %d (radix 10): %s\n", i, buffer );
   _itoa( i, buffer, 16 );
   printf( "String of integer %d (radix 16): 0x%s\n", i, buffer );
   _itoa( i, buffer, 2  );
   printf( "String of integer %d (radix 2): %s\n", i, buffer );
```

```
    _ltoa( l, buffer, 16 );
    printf( "String of long int %ld (radix 16): 0x%s\n", l, buffer );

    _ultoa( ul, buffer, 16 );
    printf( "String of unsigned long %lu (radix 16): 0x%s\n", ul, buffer );
}
```

Output

```
String of integer 3445 (radix 10): 3445
String of integer 3445 (radix 16): 0xd75
String of integer 3445 (radix 2): 110101110101
String of long int -344115 (radix 16): 0xfffabfcd
String of unsigned long 1234567890 (radix 16): 0x499602d2
```

See Also: _ltoa, _ultoa

_kbhit

Checks the console for keyboard input.

int _kbhit(void);

Routine	Required Header	Compatibility
_kbhit	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_kbhit returns a nonzero value if a key has been pressed. Otherwise, it returns 0.

Remarks

The **_kbhit** function checks the console for a recent keystroke. If the function returns a nonzero value, a keystroke is waiting in the buffer. The program can then call **_getch** or **_getche** to get the keystroke.

Example

```
/* KBHIT.C: This program loops until the user
 * presses a key. If _kbhit returns nonzero, a
 * keystroke is waiting in the buffer. The program
 * can call _getch or _getche to get the keystroke.
 */

#include <conio.h>
#include <stdio.h>
```

```
void main( void )
{
   /* Display message until key is pressed. */
   while( !_kbhit() )
      _cputs( "Hit me!! " );

   /* Use _getch to throw key away. */
   printf( "\nKey struck was '%c'\n", _getch() );
   _getch();
}
```

Output

```
Hit me!! Hit me!! Hit me!! Hit me!! Hit me!! Hit me!! Hit me!!
Key struck was 'q'
```

labs

Calculates the absolute value of a long integer.

long labs(long *n* **);**

Routine	Required Header	Compatibility
labs	<stdlib.h> and <math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **labs** function returns the absolute value of its argument. There is no error return.

Parameter

n Long-integer value

Example

```
/* ABS.C: This program computes and displays
 * the absolute values of several numbers.
 */

#include  <stdio.h>
#include  <math.h>
#include  <stdlib.h>

void main( void )
{
   int    ix = -4, iy;
   long   lx = -41567L, ly;
   double dx = -3.141593, dy;
```

```
    iy = abs( ix );
    printf( "The absolute value of %d is %d\n", ix, iy);

    ly = labs( lx );
    printf( "The absolute value of %ld is %ld\n", lx, ly);

    dy = fabs( dx );
    printf( "The absolute value of %f is %f\n", dx, dy );
}
```

Output

```
The absolute value of -4 is 4
The absolute value of -41567 is 41567
The absolute value of -3.141593 is 3.141593
```

See Also: **abs, _cabs, fabs**

ldexp

Computes a real number from the mantissa and exponent.

double ldexp(double *x*, **int** *exp* **);**

Routine	Required Header	Compatibility
ldexp	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **ldexp** function returns the value of $x * 2^{exp}$ if successful. On overflow (depending on the sign of *x*), **ldexp** returns +/–**HUGE_VAL**; the **errno** variable is set to **ERANGE**.

Parameters

x Floating-point value

exp Integer exponent

Example

```
/* LDEXP.C */

#include <math.h>
#include <stdio.h>
```

```
void main( void )
{
   double x = 4.0, y;
   int p = 3;

   y = ldexp( x, p );
   printf( "%2.1f times two to the power of %d is %2.1f\n", x, p, y );
}
```

Output

```
4.0 times two to the power of 3 is 32.0
```

See Also: frexp, modf

ldiv

Computes the quotient and remainder of a long integer.

ldiv_t ldiv(long int *numer*, **long int** *denom* **);**

Routine	Required Header	Compatibility
ldiv	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

ldiv returns a structure of type **ldiv_t** that comprises both the quotient and the remainder.

Parameters

numer Numerator

denom Denominator

Remarks

The **ldiv** function divides *numer* by *denom*, computing the quotient and remainder. The sign of the quotient is the same as that of the mathematical quotient. The absolute value of the quotient is the largest integer that is less than the absolute value of the mathematical quotient. If the denominator is 0, the program terminates with an error message. **ldiv** is the same as **div**, except that the arguments of **ldiv** and the members of the returned structure are all of type **long int**.

The **ldiv_t** structure, defined in STDLIB.H, contains **long int quot**, the quotient, and **long int rem**, the remainder.

Example

```
/* LDIV.C: This program takes two long integers
 * as command-line arguments and displays the
 * results of the integer division.
 */

#include <stdlib.h>
#include <math.h>
#include <stdio.h>

void main( void )
{
   long x = 5149627, y = 234879;
   ldiv_t div_result;

   div_result = ldiv( x, y );
   printf( "For %ld / %ld, the quotient is ", x, y );
   printf( "%ld, and the remainder is %ld\n",
            div_result.quot, div_result.rem );
}
```

Output

```
For 5149627 / 234879, the quotient is 21, and the remainder is 217168
```

See Also: div

_lfind

Performs a linear search for the specified key.

void *_lfind(const void ****key*, const void ****base***, unsigned int ****num***, unsigned int** *width*,
↪ **int (__cdecl ****compare***)(const void ****elem1***, const void ****elem2***));**

Routine	Required Header	Compatibility
_lfind	<search.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If the key is found, **_lfind** returns a pointer to the element of the array at *base* that matches *key*. If the key is not found, **_lfind** returns **NULL**.

Parameters

key Object to search for

base Pointer to base of search data

num Number of array elements

width Width of array elements

compare Pointer to comparison routine

elem1 Pointer to key for search

elem2 Pointer to array element to be compared with key

Remarks

The **_lfind** function performs a linear search for the value *key* in an array of *num* elements, each of *width* bytes in size. Unlike **bsearch**, **_lfind** does not require the array to be sorted. The *base* argument is a pointer to the base of the array to be searched. The *compare* argument is a pointer to a user-supplied routine that compares two array elements and then returns a value specifying their relationship. **_lfind** calls the *compare* routine one or more times during the search, passing pointers to two array elements on each call. The *compare* routine must compare the elements then return nonzero, meaning the elements are different, or 0, meaning the elements are identical.

Example

```
/* LFIND.C: This program uses _lfind to search for
 * the word "hello" in the command-line arguments.
 */

#include <search.h>
#include <string.h>
#include <stdio.h>

int compare( const void *arg1, const void *arg2 );

void main( unsigned int argc, char **argv )
{
   char **result;
   char *key = "hello";

   result = (char **)_lfind( &key, argv,
                        &argc, sizeof(char *), compare );
   if( result )
      printf( "%s found\n", *result );
   else
      printf( "hello not found!\n" );
}

int compare(const void *arg1, const void *arg2 )
{
   return( _stricmp( * (char**)arg1, * (char**)arg2 ) );
}
```

Output

```
[C:\code]lfind Hello
Hello found
```

See Also: bsearch, _lsearch, qsort

localeconv

Gets detailed information on locale settings.

struct lconv *localeconv(void);

Routine	Required Header	Compatibility
localeconv	<locale.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

localeconv returns a pointer to a filled-in object of type **struct lconv**. The values contained in the object can be overwritten by subsequent calls to **localeconv** and do not directly modify the object. Calls to **setlocale** with *category* values of **LC_ALL**, **LC_MONETARY**, or **LC_NUMERIC** overwrite the contents of the structure.

Remarks

The **localeconv** function gets detailed information about numeric formatting for the current locale. This information is stored in a structure of type **lconv**. The **lconv** structure, defined in LOCALE.H, contains the following members:

char *decimal_point Decimal-point character for nonmonetary quantities.

char *thousands_sep Character that separates groups of digits to left of decimal point for nonmonetary quantities.

char *grouping Size of each group of digits in nonmonetary quantities.

char *int_curr_symbol International currency symbol for current locale. First three characters specify alphabetic international currency symbol as defined in the *ISO 4217 Codes for the Representation of Currency and Funds* standard. Fourth character (immediately preceding null character) separates international currency symbol from monetary quantity.

char *currency_symbol Local currency symbol for current locale.

char *mon_decimal_point Decimal-point character for monetary quantities.

char *mon_thousands_sep Separator for groups of digits to left of decimal place in monetary quantities.

char *mon_grouping Size of each group of digits in monetary quantities.

char *positive_sign String denoting sign for nonnegative monetary quantities.

char *negative_sign String denoting sign for negative monetary quantities.

char int_frac_digits Number of digits to right of decimal point in internationally formatted monetary quantities.

char frac_digits Number of digits to right of decimal point in formatted monetary quantities.

char p_cs_precedes Set to 1 if currency symbol precedes value for nonnegative formatted monetary quantity. Set to 0 if symbol follows value.

char p_sep_by_space Set to 1 if currency symbol is separated by space from value for nonnegative formatted monetary quantity. Set to 0 if there is no space separation.

char n_cs_precedes Set to 1 if currency symbol precedes value for negative formatted monetary quantity. Set to 0 if symbol succeeds value.

char n_sep_by_space Set to 1 if currency symbol is separated by space from value for negative formatted monetary quantity. Set to 0 if there is no space separation.

char p_sign_posn Position of positive sign in nonnegative formatted monetary quantities.

char n_sign_posn Position of positive sign in negative formatted monetary quantities.

The **char** * members of the structure are pointers to strings. Any of these (other than **char *decimal_point**) that equals "" is either of zero length or is not supported in the current locale. The **char** members of the structure are nonnegative numbers. Any of these that equals **CHAR_MAX** is not supported in the current locale.

The elements of **grouping** and **mon_grouping** are interpreted according to the following rules.

CHAR_MAX Do not perform any further grouping.

0 Use previous element for each of remaining digits.

n Number of digits that make up current group. Next element is examined to determine size of next group of digits before current group.

The values for **int_curr_symbol** are interpreted according to the following rules:

- The first three characters specify the alphabetic international currency symbol as defined in the *ISO 4217 Codes for the Representation of Currency and Funds* standard.
- The fourth character (immediately preceding the null character) separates the international currency symbol from the monetary quantity.

The values for **p_cs_precedes** and **n_cs_precedes** are interpreted according to the following rules (the **n_cs_precedes** rule is in parentheses):

0 Currency symbol follows value for nonnegative (negative) formatted monetary value.

1 Currency symbol precedes value for nonnegative (negative) formatted monetary value.

The values for **p_sep_by_space** and **n_sep_by_space** are interpreted according to the following rules (the **n_sep_by_space** rule is in parentheses):

0 Currency symbol is separated from value by space for nonnegative (negative) formatted monetary value.

1 There is no space separation between currency symbol and value for nonnegative (negative) formatted monetary value.

The values for **p_sign_posn** and **n_sign_posn** are interpreted according to the following rules:

0 Parentheses surround quantity and currency symbol

1 Sign string precedes quantity and currency symbol

2 Sign string follows quantity and currency symbol

3 Sign string immediately precedes currency symbol

4 Sign string immediately follows currency symbol

See Also: setlocale, strcoll Functions, strftime, strxfrm

localtime

Converts a time value and corrects for the local time zone.

struct tm *localtime(const time_t *_timer_);

Routine	Required Header	Compatibility
localtime	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

localtime returns a pointer to the structure result. If the value in *timer* represents a date before midnight, January 1, 1970, **localtime** returns **NULL**. The fields of the structure type **tm** store the following values, each of which is an **int**:

tm_sec Seconds after minute (0–59)

tm_min Minutes after hour (0–59)

tm_hour Hours after midnight (0–23)

tm_mday Day of month (1–31)

tm_mon Month (0–11; January = 0)

tm_year Year (current year minus 1900)

tm_wday Day of week (0–6; Sunday = 0)

tm_yday Day of year (0–365; January 1 = 0)

tm_isdst Positive value if daylight savings time is in effect; 0 if daylight savings time is not in effect; negative value if status of daylight savings time is unknown. The C run-time library assumes the United States's rules for implementing the calculation of Daylight Savings Time (DST).

Parameter

timer Pointer to stored time

Remarks

The **localtime** function converts a time stored as a **time_t** value and stores the result in a structure of type **tm**. The **long** value *timer* represents the seconds elapsed since midnight (00:00:00), January 1, 1970, coordinated universal time (UTC). This value is usually obtained from the **time** function.

gmtime, **mktime**, and **localtime** all use a single statically allocated **tm** structure for the conversion. Each call to one of these routines destroys the result of the previous call.

localtime corrects for the local time zone if the user first sets the global environment variable **TZ**. When **TZ** is set, three other environment variables (**_timezone**, **_daylight**, and **_tzname**) are automatically set as well. See **_tzset** for a description of these variables. **TZ** is a Microsoft extension and not part of the ANSI standard definition of **localtime**.

Note The target environment should try to determine whether daylight savings time is in effect.

Example

```
/* LOCALTIM.C: This program uses time to get the current time
 * and then uses localtime to convert this time to a structure
 * representing the local time. The program converts the result
 * from a 24-hour clock to a 12-hour clock and determines the
 * proper extension (AM or PM).
 */
```

```
#include <stdio.h>
#include <string.h>
#include <time.h>

void main( void )
{
      struct tm *newtime;
      char am_pm[] = "AM";
      time_t long_time;

      time( &long_time );                /* Get time as long integer. */
      newtime = localtime( &long_time ); /* Convert to local time. */

      if( newtime->tm_hour > 12 )        /* Set up extension. */
            strcpy( am_pm, "PM" );
      if( newtime->tm_hour > 12 )        /* Convert from 24-hour */
            newtime->tm_hour -= 12;      /*   to 12-hour clock.  */
      if( newtime->tm_hour == 0 )        /* Set hour to 12 if midnight. */
            newtime->tm_hour = 12;

      printf( "%.19s %s\n", asctime( newtime ), am_pm );
}
```

Output

```
Tue Mar 23 11:28:17 AM
```

See Also: asctime, ctime, _ftime, gmtime, time, _tzset

_locking

Locks or unlocks bytes of a file.

int _locking(int *handle*, **int** *mode*, **long** *nbytes* **);**

Routine	Required Header	Optional Headers	Compatibility
_locking	<io.h> and <sys/locking.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_locking returns 0 if successful. A return value of –1 indicates failure, in which case **errno** is set to one of the following values:

EACCES Locking violation (file already locked or unlocked).

EBADF Invalid file handle.

EDEADLOCK Locking violation. Returned when the **_LK_LOCK** or **_LK_RLCK** flag is specified and the file cannot be locked after 10 attempts.

EINVAL An invalid argument was given to **_locking**.

Parameters

handle File handle

mode Locking action to perform

nbytes Number of bytes to lock

Remarks

The **_locking** function locks or unlocks *nbytes* bytes of the file specified by *handle*. Locking bytes in a file prevents access to those bytes by other processes. All locking or unlocking begins at the current position of the file pointer and proceeds for the next *nbytes* bytes. It is possible to lock bytes past end of file.

mode must be one of the following manifest constants, which are defined in LOCKING.H:

_LK_LOCK Locks the specified bytes. If the bytes cannot be locked, the program immediately tries again after 1 second. If, after 10 attempts, the bytes cannot be locked, the constant returns an error.

_LK_NBLCK Locks the specified bytes. If the bytes cannot be locked, the constant returns an error.

_LK_NBRLCK Same as **_LK_NBLCK**.

_LK_RLCK Same as **_LK_LOCK**.

_LK_UNLCK Unlocks the specified bytes, which must have been previously locked.

Multiple regions of a file that do not overlap can be locked. A region being unlocked must have been previously locked. **_locking** does not merge adjacent regions; if two locked regions are adjacent, each region must be unlocked separately. Regions should be locked only briefly and should be unlocked before closing a file or exiting the program.

Example

```
/* LOCKING.C: This program opens a file with sharing. It locks
 * some bytes before reading them, then unlocks them. Note that the
 * program works correctly only if the file exists.
 */

#include <io.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <sys/locking.h>
#include <share.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
```

```
void main( void )
{
   int  fh, numread;
   char buffer[40];

   /* Quit if can't open file or system doesn't
    * support sharing.
    */
   fh = _sopen( "locking.c", _O_RDWR, _SH_DENYNO,
                  _S_IREAD | _S_IWRITE );
   if( fh == -1 )
      exit( 1 );

   /* Lock some bytes and read them. Then unlock. */
   if( _locking( fh, LK_NBLCK, 30L ) != -1 )
   {
      printf( "No one can change these bytes while I'm reading them\n" );
      numread = _read( fh, buffer, 30 );
      printf( "%d bytes read: %.30s\n", numread, buffer );
      lseek( fh, 0L, SEEK_SET );
      _locking( fh, LK_UNLCK, 30L );
      printf( "Now I'm done. Do what you will with them\n" );
   }
   else
      perror( "Locking failed\n" );

   _close( fh );
}
```

Output

```
No one can change these bytes while I'm reading them
30 bytes read: /* LOCKING.C: This program ope
Now I'm done. Do what you will with them
```

See Also: **_creat, _open**

log, log10

Calculates logarithms.

double log(double *x* **);**
double log10(double *x* **);**

Routine	Required Header	Compatibility
log	<math.h>	ANSI, Win 95, Win NT
log10	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **log** functions return the logarithm of *x* if successful. If *x* is negative, these functions return an indefinite (same as a quiet NaN). If *x* is 0, they return INF (infinite). You can modify error handling by using the **_matherr** routine.

Parameter

x Value whose logarithm is to be found

Example

```
/* LOG.C: This program uses log and log10
 * to calculate the natural logarithm and
 * the base-10 logarithm of 9,000.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 9000.0;
   double y;

   y = log( x );
   printf( "log( %.2f ) = %f\n", x, y );
   y = log10( x );
   printf( "log10( %.2f ) = %f\n", x, y );
}
```

Output

```
log( 9000.00 ) = 9.104980
log10( 9000.00 ) = 3.954243
```

See Also: exp, _matherr, pow

_logb

Extracts exponential value of double-precision floating-point argument.

double _logb(double *x* **);**

Routine	Required Header	Compatibility
_logb	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_logb returns the unbiased exponential value of *x*.

Parameter

x Double-precision floating-point value

Remarks

The **_logb** function extracts the exponential value of its double-precision floating-point argument *x*, as though *x* were represented with infinite range. If the argument *x* is denormalized, it is treated as if it were normalized.

See Also: **frexp**

longjmp

Restores stack environment and execution locale.

void longjmp(jmp_buf *env*, **int** *value* **);**

Routine	Required Header	Compatibility
longjmp	<setjmp.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

env Variable in which environment is stored

value Value to be returned to **setjmp** call

Remarks

The **longjmp** function restores a stack environment and execution locale previously saved in *env* by **setjmp**. **setjmp** and **longjmp** provide a way to execute a nonlocal **goto**; they are typically used to pass execution control to error-handling or recovery code in a previously called routine without using the normal call and return conventions.

A call to **setjmp** causes the current stack environment to be saved in *env*. A subsequent call to **longjmp** restores the saved environment and returns control to the point immediately following the corresponding **setjmp** call. Execution resumes as if *value* had just been returned by the **setjmp** call. The values of all variables (except register variables) that are accessible to the routine receiving control contain the values they had when **longjmp** was called. The values of register variables are unpredictable. The value returned by **setjmp** must be nonzero. If *value* is passed as 0, the value 1 is substituted in the actual return.

Call **longjmp** before the function that called **setjmp** returns; otherwise the results are unpredictable.

Observe the following restrictions when using **longjmp**:

- Do not assume that the values of the register variables will remain the same. The values of register variables in the routine calling **setjmp** may not be restored to the proper values after **longjmp** is executed.
- Do not use **longjmp** to transfer control out of an interrupt-handling routine unless the interrupt is caused by a floating-point exception. In this case, a program may return from an interrupt handler via **longjmp** if it first reinitializes the floating-point math package by calling **_fpreset**.
- Be careful when using **setjmp** and **longjmp** in C++ programs. Because these functions do not support C++ object semantics, it is safer to use the C++ exception-handling mechanism.

Example

```
/* FPRESET.C: This program uses signal to set up a
 * routine for handling floating-point errors.
 */

#include <stdio.h>
#include <signal.h>
#include <setjmp.h>
#include <stdlib.h>
#include <float.h>
#include <math.h>
#include <string.h>

jmp_buf mark;              /* Address for long jump to jump to */
int     fperr;             /* Global error number */

void __cdecl fphandler( int sig, int num );   /* Prototypes */
void fpcheck( void );

void main( void )
{
   double n1, n2, r;
   int jmpret;
```

```
    /* Unmask all floating-point exceptions. */
     _control87( 0, _MCW_EM );
    /* Set up floating-point error handler. The compiler
     * will generate a warning because it expects
     * signal-handling functions to take only one argument.
     */
     if( signal( SIGFPE, fphandler ) == SIG_ERR )

    {
       fprintf( stderr, "Couldn't set SIGFPE\n" );
       abort();   }

    /* Save stack environment for return in case of error. First
     * time through, jmpret is 0, so true conditional is executed.
     * If an error occurs, jmpret will be set to -1 and false
     * conditional will be executed.
     */
    jmpret = setjmp( mark );
    if( jmpret == 0 )
    {
       printf( "Test for invalid operation - " );
       printf( "enter two numbers: " );
       scanf( "%lf %lf", &n1, &n2 );
       r = n1 / n2;
       /* This won't be reached if error occurs. */
       printf( "\n\n%4.3g / %4.3g = %4.3g\n", n1, n2, r );

       r = n1 * n2;
       /* This won't be reached if error occurs. */
       printf( "\n\n%4.3g * %4.3g = %4.3g\n", n1, n2, r );
    }
    else
       fpcheck();
}
/* fphandler handles SIGFPE (floating-point error) interrupt. Note
 * that this prototype accepts two arguments and that the
 * prototype for signal in the run-time library expects a signal
 * handler to have only one argument.
 *
 * The second argument in this signal handler allows processing of
 * _FPE_INVALID, _FPE_OVERFLOW, _FPE_UNDERFLOW, and
 * _FPE_ZERODIVIDE, all of which are Microsoft-specific symbols
 * that augment the information provided by SIGFPE. The compiler
 * will generate a warning, which is harmless and expected.

 */
void fphandler( int sig, int num )
{
   /* Set global for outside check since we don't want
    * to do I/O in the handler.
    */
   fperr = num;
```

```
    /* Initialize floating-point package. */
    _fpreset();
    /* Restore calling environment and jump back to setjmp. Return
     * -1 so that setjmp will return false for conditional test.
     */
    longjmp( mark, -1 );
}
void fpcheck( void )
{
    char fpstr[30];
    switch( fperr )
    {
    case _FPE_INVALID:
        strcpy( fpstr, "Invalid number" );
        break;
    case _FPE_OVERFLOW:
        strcpy( fpstr, "Overflow" );

        break;
    case _FPE_UNDERFLOW:
        strcpy( fpstr, "Underflow" );
        break;
    case _FPE_ZERODIVIDE:
        strcpy( fpstr, "Divide by zero" );
        break;
    default:
        strcpy( fpstr, "Other floating point error" );
        break;
    }
    printf( "Error %d: %s\n", fperr, fpstr );
}
```

Output

```
Test for invalid operation - enter two numbers: 5 0
Error 131: Divide by zero
```

See Also: **setjmp**

_lrotl, _lrotr

Rotate bits to the left (**_lrotl**) or right (**_lrotr**).

unsigned long _lrotl(unsigned long *value*, **int** *shift* **);**
unsigned long _lrotr(unsigned long *value*, **int** *shift* **);**

Routine	Required Header	Compatibility
_lrotl	<stdlib.h>	Win 95, Win NT
_lrotr	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Both functions return the rotated value. There is no error return.

Parameters

value Value to be rotated

shift Number of bits to shift *value*

Remarks

The **_lrotl** and **_lrotr** functions rotate *value* by *shift* bits. **_lrotl** rotates the value left. **_lrotr** rotates the value right. Both functions "wrap" bits rotated off one end of *value* to the other end.

Example

```
/* LROT.C */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   unsigned long val = 0x0fac35791;

   printf( "0x%8.8lx rotated left eight times is 0x%8.8lx\n",
           val, _lrotl( val, 8 ) );
   printf( "0x%8.8lx rotated right four times is 0x%8.8lx\n",
           val, _lrotr( val, 4 ) );
}
```

Output

```
0xfac35791 rotated left eight times is 0xc35791fa
0xfac35791 rotated right four times is 0x1fac3579
```

See Also: _rotl, _rotr

_lsearch

Performs a linear search for a value; adds to end of list if not found.

void *_lsearch(const void *_key_, void *_base_, unsigned int *_num_, unsigned int _width_,
↪ int (__cdecl *_compare_)(const void *_elem1_, const void *_elem2_));

Routine	Required Header	Compatibility
_lsearch	<search.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If the key is found, **_lsearch** returns a pointer to the element of the array at *base* that matches *key*. If the key is not found, **_lsearch** returns a pointer to the newly added item at the end of the array.

Parameters

key Object to search for

base Pointer to base of array to be searched

num Number of elements

width Width of each array element

compare Pointer to comparison routine

elem1 Pointer to key for search

elem2 Pointer to array element to be compared with key

Remarks

The **_lsearch** function performs a linear search for the value *key* in an array of *num* elements, each of *width* bytes in size. Unlike **bsearch**, **_lsearch** does not require the array to be sorted. If *key* is not found, **_lsearch** adds it to the end of the array and increments *num*.

The *compare* argument is a pointer to a user-supplied routine that compares two array elements and returns a value specifying their relationship. **_lsearch** calls the *compare* routine one or more times during the search, passing pointers to two array elements on each call. *compare* must compare the elements, then return either nonzero, meaning the elements are different, or 0, meaning the elements are identical.

Example

```
/* LFIND.C: This program uses _lfind to search for
 * the word "hello" in the command-line arguments.
 */

#include <search.h>
#include <string.h>
#include <stdio.h>

int compare( const void *arg1, const void *arg2 );

void main( unsigned int argc, char **argv )
{
```

```
    char **result;
    char *key = "hello";

    result = (char **)_lfind( &key, argv,
                    &argc, sizeof(char *), compare );
    if( result )
       printf( "%s found\n", *result );
    else
       printf( "hello not found!\n" );
}

int compare(const void *arg1, const void *arg2 )
{
    return( _stricmp( * (char**)arg1, * (char**)arg2 ) );
}
```

Output

```
[C:\code]lfind Hello
Hello found
```

See Also: **bsearch, _lfind**

_lseek, _lseeki64

Move a file pointer to the specified location.

long _lseek(int *handle*, **long** *offset*, **int** *origin* **);**
__int64 _lseeki64(int *handle*, **__int64** *offset*, **int** *origin* **);**

Routine	Required Header	Compatibility
_lseek	<io.h>	Win 95, Win NT
_lseeki64	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_lseek returns the offset, in bytes, of the new position from the beginning of the file. **_lseeki64** returns the offset in a 64-bit integer. The function returns –1L to indicate an error and sets **errno** either to **EBADF**, meaning the file handle is invalid, or to **EINVAL**, meaning the value for *origin* is invalid or the position specified by *offset* is before the beginning of the file. On devices incapable of seeking (such as terminals and printers), the return value is undefined.

Parameters

handle Handle referring to open file

offset Number of bytes from *origin*

origin Initial position

Remarks

The **_lseek** function moves the file pointer associated with *handle* to a new location that is *offset* bytes from *origin*. The next operation on the file occurs at the new location. The *origin* argument must be one of the following constants, which are defined in STDIO.H:

SEEK_SET Beginning of file

SEEK_CUR Current position of file pointer

SEEK_END End of file

You can use **_lseek** to reposition the pointer anywhere in a file or beyond the end of the file.

Example

```
/* LSEEK.C: This program first opens a file named LSEEK.C.
 * It then uses _lseek to find the beginning of the file,
 * to find the current position in the file, and to find
 * the end of the file.
 */

#include <io.h>
#include <fcntl.h>
#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int fh;
   long pos;               /* Position of file pointer */
   char buffer[10];

   fh = _open( "lseek.c", _O_RDONLY );

   /* Seek the beginning of the file: */
   pos = _lseek( fh, 0L, SEEK_SET );
   if( pos == -1L )
      perror( "_lseek to beginning failed" );
   else
      printf( "Position for beginning of file seek = %ld\n", pos );

   /* Move file pointer a little */
   _read( fh, buffer, 10 );
```

```
    /* Find current position: */
    pos = _lseek( fh, 0L, SEEK_CUR );
    if( pos == -1L )
       perror( "_lseek to current position failed" );
    else
       printf( "Position for current position seek = %ld\n", pos );

    /* Set the end of the file: */
    pos = _lseek( fh, 0L, SEEK_END );
    if( pos == -1L )
       perror( "_lseek to end failed" );
       else
       printf( "Position for end of file seek = %ld\n", pos );

    _close( fh );
}
```

Output

```
Position for beginning of file seek = 0
Position for current position seek = 10
Position for end of file seek = 1207
```

See Also: **fseek, _tell**

_ltoa, _ltow

Convert a long integer to a string.

char *_ltoa(long *value*, **char** **string*, **int** *radix* **);**
wchar_t *_ltow(long *value*, **wchar_t** **string*, **int** *radix* **);**

Routine	Required Header	Compatibility
_ltoa	<stdlib.h>	Win 95, Win NT
_ltow	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to *string*. There is no error return.

Parameters

value Number to be converted

string String result

radix Base of *value*

Remarks

The **_ltoa** function converts the digits of *value* to a null-terminated character string and stores the result (up to 33 bytes) in *string*. The *radix* argument specifies the base of *value*, which must be in the range 2–36. If *radix* equals 10 and *value* is negative, the first character of the stored string is the minus sign (–). **_ltow** is a wide-character version of **_ltoa**; the second argument and return value of **_ltow** are wide-character strings. Each of these functions is Microsoft-specific.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ltot	_ltoa	_ltoa	_ltow

Example

```
/* ITOA.C: This program converts integers of various
 * sizes to strings in various radixes.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char buffer[20];
   int  i = 3445;
   long l = -344115L;
   unsigned long ul = 1234567890UL;

   _itoa( i, buffer, 10 );
   printf( "String of integer %d (radix 10): %s\n", i, buffer );
   _itoa( i, buffer, 16 );
   printf( "String of integer %d (radix 16): 0x%s\n", i, buffer );
   _itoa( i, buffer, 2  );
   printf( "String of integer %d (radix 2): %s\n", i, buffer );

   _ltoa( l, buffer, 16 );
   printf( "String of long int %ld (radix 16): 0x%s\n", l, buffer );

   _ultoa( ul, buffer, 16 );
   printf( "String of unsigned long %lu (radix 16): 0x%s\n", ul, buffer );
}
```

Output

```
String of integer 3445 (radix 10): 3445
String of integer 3445 (radix 16): 0xd75
String of integer 3445 (radix 2): 110101110101
String of long int -344115 (radix 16): 0xfffabfcd
String of unsigned long 1234567890 (radix 16): 0x499602d2
```

See Also: _itoa, _ultoa

_makepath, _wmakepath

Create a path name from components.

void _makepath(char **path*, **const char** **drive*, **const char** **dir*,
↪ **const char** **fname*, **const char** **ext* **);**
void _wmakepath(wchar_t **path*, **const wchar_t** **drive*, **const wchar_t** **dir*,
↪ **const wchar_t** **fname*, **const wchar_t** **ext* **);**

Routine	Required Header	Compatibility
_makepath	<stdlib.h>	Win 95, Win NT
_wmakepath	<stdlib.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

path Full path buffer

drive Drive letter

dir Directory path

fname Filename

ext File extension

Remarks

The **_makepath** function creates a single path and stores it in *path*. The path may include a drive letter, directory path, filename, and filename extension. **_wmakepath** is a wide-character version of **_makepath**; the arguments to **_wmakepath** are wide-character strings. **_wmakepath** and **_makepath** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tmakepath	_makepath	_makepath	_wmakepath

The following arguments point to buffers containing the path elements:

drive Contains a letter (A, B, and so on) corresponding to the desired drive and an optional trailing colon. **_makepath** inserts the colon automatically in the composite

path if it is missing. If *drive* is a null character or an empty string, no drive letter and colon appear in the composite *path* string.

dir Contains the path of directories, not including the drive designator or the actual filename. The trailing slash is optional, and either a forward slash (/) or a backslash (\) or both may be used in a single *dir* argument. If a trailing slash (/ or \) is not specified, it is inserted automatically. If *dir* is a null character or an empty string, no slash is inserted in the composite *path* string.

fname Contains the base filename without any extensions. If *fname* is **NULL** or points to an empty string, no filename is inserted in the composite *path* string.

ext Contains the actual filename extension, with or without a leading period (.). **_makepath** inserts the period automatically if it does not appear in *ext*. If *ext* is a null character or an empty string, no period is inserted in the composite *path* string.

The *path* argument must point to an empty buffer large enough to hold the complete path. Although there are no size limits on any of the fields that constitute *path*, the composite *path* must be no larger than the **_MAX_PATH** constant, defined in STDLIB.H. **_MAX_PATH** may be larger than the current operating-system version will handle.

Example

```
/* MAKEPATH.C */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char path_buffer[_MAX_PATH];
   char drive[_MAX_DRIVE];
   char dir[_MAX_DIR];
   char fname[_MAX_FNAME];
   char ext[_MAX_EXT];

   _makepath( path_buffer, "c", "\\sample\\crt\\", "makepath", "c" );
   printf( "Path created with _makepath: %s\n\n", path_buffer );
   _splitpath( path_buffer, drive, dir, fname, ext );
   printf( "Path extracted with _splitpath:\n" );
   printf( "  Drive: %s\n", drive );
   printf( "  Dir: %s\n", dir );
   printf( "  Filename: %s\n", fname );
   printf( "  Ext: %s\n", ext );
}
```

Output

```
Path created with _makepath: c:\sample\crt\makepath.c

Path extracted with _splitpath:
  Drive: c:
  Dir: \sample\crt\
  Filename: makepath
  Ext: .c
```

See Also: _fullpath, _splitpath

malloc

Allocates memory blocks.

void *malloc(size_t *size* **);**

Routine	Required Header	Compatibility
malloc	<stdlib.h> and <malloc.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

malloc returns a void pointer to the allocated space, or **NULL** if there is insufficient memory available. To return a pointer to a type other than **void**, use a type cast on the return value. The storage space pointed to by the return value is guaranteed to be suitably aligned for storage of any type of object. If size is 0, **malloc** allocates a zero-length item in the heap and returns a valid pointer to that item. Always check the return from **malloc**, even if the amount of memory requested is small.

Parameter

size Bytes to allocate

Remarks

The **malloc** function allocates a memory block of at least *size* bytes. The block may be larger than *size* bytes because of space required for alignment and maintenance information.

The startup code uses **malloc** to allocate storage for the **_environ**, **envp**, and **argv** variables. The following functions and their wide-character counterparts also call **malloc**:

calloc	**fscanf**	**_getw**	**setvbuf**
_exec functions	**fseek**	**_popen**	**_spawn** functions
fgetc	**fsetpos**	**printf**	**_strdup**
_fgetchar	**_fullpath**	**putc**	**system**
fgets	**fwrite**	**putchar**	**_tempnam**
fprintf	**getc**	**_putenv**	**ungetc**
fputc	**getchar**	**puts**	**vfprintf**
_fputchar	**_getcwd**	**_putw**	**vprintf**
fputs	**_getdcwd**	**scanf**	
fread	**gets**	**_searchenv**	

The C++ **_set_new_mode** function sets the new handler mode for **malloc**. The new handler mode indicates whether, on failure, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure to allocate memory. You can override this default behavior so that, when **malloc** fails to allocate memory, **malloc** calls the new handler routine in the same way that the **new** operator does when it fails for the same reason. To override the default, call

```
_set_new_mode(1)
```

early in your program, or link with NEWMODE.OBJ.

When the application is linked with a debug version of the C run-time libraries, **malloc** resolves to **_malloc_dbg**. For more information about how the heap is managed during the debugging process, see "Using C Run-Time Library Debugging Support."

Example

```
/* MALLOC.C: This program allocates memory with
 * malloc, then frees the memory with free.
 */

#include <stdlib.h>         /* For _MAX_PATH definition */
#include <stdio.h>
#include <malloc.h>

void main( void )
{
   char *string;

   /* Allocate space for a path name */
   string = malloc( _MAX_PATH );
   if( string == NULL )
      printf( "Insufficient memory available\n" );
   else
   {
      printf( "Memory space allocated for path name\n" );
      free( string );
      printf( "Memory freed\n" );
   }
}
```

Output

```
Memory space allocated for path name
Memory freed
```

See Also: calloc, free, realloc

_matherr

Handles math errors.

int _matherr(struct _exception *_except_);

Routine	Required Header	Compatibility
_matherr	<math.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_matherr returns 0 to indicate an error or a non-zero value to indicate success. If **_matherr** returns 0, an error message can be displayed, and **errno** is set to an appropriate error value. If **_matherr** returns a nonzero value, no error message is displayed, and **errno** remains unchanged.

Parameter

except Pointer to structure containing error information

Remarks

The **_matherr** function processes errors generated by the floating-point functions of the math library. These functions call **_matherr** when an error is detected.

For special error handling, you can provide a different definition of **_matherr**. If you use the dynamically linked version of the C run-time library (MSVCRT.DLL), you can replace the default **_matherr** routine in a client executable with a user-defined version. However, you cannot replace the default **_matherr** routine in a DLL client of MSVCRT.DLL.

When an error occurs in a math routine, **_matherr** is called with a pointer to an **_exception** type structure (defined in MATH.H) as an argument. The **_exception** structure contains the following elements:

int type Exception type

char *name Name of function where error occurred

double arg1, arg2 First and second (if any) arguments to function

double retval Value to be returned by function

The **type** specifies the type of math error. It is one of the following values, defined in MATH.H:

_DOMAIN Argument domain error.

_SING Argument singularity.

_OVERFLOW Overflow range error.

_PLOSS Partial loss of significance.

_TLOSS Total loss of significance.

_UNDERFLOW The result is too small to be represented. (This condition is not currently supported.)

The structure member **name** is a pointer to a null-terminated string containing the name of the function that caused the error. The structure members **arg1** and **arg2** specify the values that caused the error. (If only one argument is given, it is stored in **arg1**.)

The default return value for the given error is **retval**. If you change the return value, it must specify whether an error actually occurred.

Example

```
/* MATHERR.C illustrates writing an error routine for math
 * functions. The error function must be:
 *      _matherr
 */

#include <math.h>
#include <string.h>
#include <stdio.h>

void main()
{
   /* Do several math operations that cause errors. The _matherr
    * routine handles _DOMAIN errors, but lets the system handle
    * other errors normally.
    */
   printf( "log( -2.0 ) = %e\n", log( -2.0 ) );
   printf( "log10( -5.0 ) = %e\n", log10( -5.0 ) );
   printf( "log( 0.0 ) = %e\n", log( 0.0 ) );
}

/* Handle several math errors caused by passing a negative argument
 * to log or log10 (_DOMAIN errors). When this happens, _matherr
 * returns the natural or base-10 logarithm of the absolute value
 * of the argument and suppresses the usual error message.
 */
int _matherr( struct _exception *except )
{
   /* Handle _DOMAIN errors for log or log10. */
   if( except->type == _DOMAIN )
   {
      if( strcmp( except->name, "log" ) == 0 )
      {
         except->retval = log( -(except->arg1) );
         printf( "Special: using absolute value: %s: _DOMAIN "
                 "error\n", except->name );
         return 1;
      }
      else if( strcmp( except->name, "log10" ) == 0 )
      {
         except->retval = log10( -(except->arg1) );
         printf( "Special: using absolute value: %s: _DOMAIN "
                 "error\n", except->name );
         return 1;
      }
   }
```

```
    else
    {
        printf( "Normal: " );
        return 0;     /* Else use the default actions */
    }
}
```

Output

```
Special: using absolute value: log: _DOMAIN error
log( -2.0 ) = 6.931472e-001
Special: using absolute value: log10: _DOMAIN error
log10( -5.0 ) = 6.989700e-001
Normal: log( 0.0 ) = -1.#INF00e+000
```

__max

Returns the larger of two values.

type **__max**(*type a*, *type b*);

Routine	Required Header	Compatibility
_max	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

__max returns the larger of its arguments.

Parameters

type Any numeric data type

a, b Values of any numeric type to be compared

Remarks

The **__max** macro compares two values and returns the value of the larger one. The arguments can be of any numeric data type, signed or unsigned. Both arguments and the return value must be of the same data type.

Example

```
/* MINMAX.C */

#include <stdlib.h>
#include <stdio.h>
```

```
void main( void )
{
   int a = 10;
   int b = 21;

   printf( "The larger of %d and %d is %d\n",  a, b, __max( a, b ) );
   printf( "The smaller of %d and %d is %d\n", a, b, __min( a, b ) );
}
```

Output

```
The larger of 10 and 21 is 21
The smaller of 10 and 21 is 10
```

See Also: **__min**

_mbbtombc

unsigned short _mbbtombc(unsigned short *c* **);**

Routine	Required Header	Compatibility
_mbbtombc	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If **_mbbtombc** successfully converts *c*, it returns a multibyte character; otherwise it returns *c*.

Parameter

c Single-byte character to convert.

Remarks

The **_mbbtombc** function converts a given single-byte multibyte character to a corresponding double-byte multibyte character. Characters must be within the range 0x20–0x7E or 0xA1–0xDF to be converted.

In earlier versions, **_mbbtombc** was called **hantozen**. For new code, use **_mbbtombc** instead.

See Also: **_mbctombb**

_mbbtype

int _mbbtype(unsigned char *c*, **int** *type* **);**

Routine	Required Header	Optional Headers	Compatibility
_mbbtype	<mbstring.h>	<mbctype.h>[1]	Win 95, Win NT

[1] For definitions of manifest constants used as return values.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbbtype returns the type of byte within a string. This decision is context-sensitive as specified by the value of *type*, which provides the control test condition. *type* is the type of the previous byte in the string.The manifest constants in the following table are defined in MBCTYPE.H.

Value of *type*	_mbbtype Tests for	Return Value	*c*
Any value except 1	Valid single byte or lead byte	**_MBC_SINGLE** (0)	Single byte (0x20–0x7E, 0xA1–0xDF)
Any value except 1	Valid single byte or lead byte	**_MBC_LEAD** (1)	Lead byte of multibyte character (0x81–0x9F, 0xE0–0xFC)
Any value except 1	Valid single-byte or lead byte	**_MBC_ILLEGAL** (–1)	Invalid character (any value except 0x20–0x7E, 0xA1–0xDF, 0x81–0x9F, 0xE0–0xFC
1	Valid trail byte	**_MBC_TRAIL** (2)	Trailing byte of multibyte character (0x40–0x7E, 0x80–0xFC)
1	Valid trail byte	**_MBC_ILLEGAL** (–1)	Invalid character (any value except 0x20–0x7E, 0xA1–0xDF, 0x81–0x9F, 0xE0–0xFC

Parameters

c Character to test

type Type of byte to test for

Remarks

The **_mbbtype** function determines the type of a byte in a multibyte character. If the value of *type* is any value except 1, **_mbbtype** tests for a valid single-byte or lead byte of a multibyte character. If the value of *type* is 1, **_mbbtype** tests for a valid trail byte of a multibyte character.

In earlier versions, **_mbbtype** was called **chkctype**. For new code, **_mbbtype** use instead.

Byte Classification

_mbccpy

void _mbccpy(unsigned char *_dest_, const unsigned char *_src_);

Routine	Required Header	Compatibility
_mbccpy	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

dest Copy destination

src Multibyte character to copy

Remarks

The **_mbccpy** function copies one multibyte character from *src* to *dest*. If *src* does not point to the lead byte of a multibyte character as determined by an implicit call to **_ismbblead**, no copy is performed.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tccpy	Maps to macro or inline function	_mbccpy	Maps to macro or inline function

See Also: _mbclen

_mbcjistojms, _mbcjmstojis

unsigned int _mbcjistojms(unsigned int *c* **);**
unsigned int _mbcjmstojis(unsigned int *c* **);**

Routine	Required Header	Compatibility
_mbcjistojms	<mbstring.h>	Win 95, Win NT
_mbcjmstojis	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbcjistojms and **_mbcjmstojis** return a converted character. Otherwise they return 0.

Parameter

c Character to convert

Remarks

The **_mbcjistojms** function converts a Japan Industry Standard (JIS) character to a Microsoft Kanji (Shift JIS) character. The character is converted only if the lead and trail bytes are in the range 0x21–0x7E.

The **_mbcjmstojis** function converts a Shift JIS character to a JIS character. The character is converted only if the lead byte is in the range 0x81–0x9F or 0xE0–0xFC, and the trail byte is in the range 0x40–0x7E or 0x80–0xFC.

The value *c* should be a 16-bit value whose upper eight bits represent the lead byte of the character to convert and whose lower eight bits represent the trail byte.

In earlier versions, **_mbcjistojms** and **_mbcjmstojis** were called **jistojms** and **jmstojis**, repectively. **_mbcjistojms** and **_mbcjmstojis** should be used instead.

See Also: _ismbb Routines

_mbclen, mblen

Get the length and determine the validity of a multibyte character.

size_t _mbclen(const unsigned char ****c* **);
int mblen(const char ****mbstr*, **size_t *count* **);**

Routine	Required Header	Compatibility
_mbclen	<mbstring.h>	Win 95, Win NT
mblen	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbclen returns 1 or 2, according to whether the multibyte character *c* is one or two bytes long. There is no error return for **_mbclen**. If *mbstr* is not **NULL**, **mblen** returns the length, in bytes, of the multibyte character. If *mbstr* is **NULL**, or if it points to the wide-character null character, **mblen** returns 0. If the object that *mbstr* points to does not form a valid multibyte character within the first *count* characters, **mblen** returns –1.

Parameters

c Multibyte character

mbstr Address of multibyte-character byte sequence

count Number of bytes to check

Remarks

The **_mbclen** function returns the length, in bytes, of the multibyte character *c*. If *c* does not point to the lead byte of a multibyte character as determined by an implicit call to **_ismbblead**, the result of **_mbclen** is unpredictable.

mblen returns the length in bytes of *mbstr* if it is a valid multibyte character. It examines *count* or fewer bytes contained in *mbstr*, but not more than **MB_CUR_MAX** bytes. **mblen** determines multibyte-character validity according to the **LC_CTYPE** category setting of the current locale. For more information on the **LC_CTYPE** category, see **setlocale**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tclen	Maps to macro or inline function	_mbclen	Maps to macro or inline function

Example

```
/* MBLEN.C illustrates the behavior of the mblen function
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
```

```
    int      i;
    char    *pmbc = (char *)malloc( sizeof( char ) );
    wchar_t  wc   = L'a';

    printf( "Convert wide character to multibyte character:\n" );
    i = wctomb( pmbc, wc );
    printf( "\tCharacters converted: %u\n", i );
    printf( "\tMultibyte character: %x\n\n", pmbc );

    i = mblen( pmbc, MB_CUR_MAX );
    printf( "Length in bytes of multibyte character %x: %u\n", pmbc, i );

    pmbc = NULL;
    i = mblen( pmbc, MB_CUR_MAX );
    printf( "Length in bytes of NULL multibyte character %x: %u\n", pmbc, i );
}
```

Output

```
Convert wide character to multibyte character:
   Characters converted: 1
   Multibyte character: 2c02cc

Length in bytes of multibyte character 2c02cc: 1
Length in bytes of NULL multibyte character 0: 0
```

See Also: _mbccpy, _mbslen

_mbctohira, _mbctokata

unsigned int _mbctohira(unsigned int *c* **);**
unsigned int _mbctokata(unsigned int *c* **);**

Routine	Required Header	Compatibility
_mbctohira	<mbstring.h>	Win 95, Win NT
_mbctokata	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the converted character *c*, if possible. Otherwise it returns the character *c* unchanged.

Parameter

c Multibyte character to convert

Remarks

The **_mbctohira** and **_mbctohira** functions test a character *c* and, if possible, apply one of the following conversions.

Routine	Converts
_mbctohira	Multibyte katakana to multibyte hiragana
_mbctokata	Multibyte hiragana to multibyte katakana

In previous versions, **_mbctohira** was called **jtohira** and **_mbctokata** was called **jtokata**. For new code, use the new names instead.

See Also: _mbcjistojms, _mbctolower, _mbctombb

_mbctolower, _mbctoupper

unsigned int _mbctolower(unsigned int *c* **);**
unsigned int _mbctoupper(unsigned int *c* **);**

Routine	Required Header	Compatibility
_mbctolower	<mbstring.h>	Win 95, Win NT
_mbctoupper	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the converted character *c*, if possible. Otherwise it returns the character *c* unchanged.

Parameter

c Multibyte character to convert

Remarks

The **_mbctolower** and **_mbctoupper** functions test a character *c* and, if possible, apply one of the following conversions.

Routine	Converts
_mbctolower	Uppercase character to lowercase character
_mbctoupper	Lowercase character to uppercase character

In previous versions, **_mbctolower** was called **jtolower**, and **_mbctoupper** was called **jtoupper**. For new code, use the new names instead.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_totlower	tolower	_mbctolower	towlower
_totupper	toupper	_mbctoupper	towupper

See Also: _mbbtombc, _mbcjistojms, _mbctohira, _mbctombb

_mbctombb

unsigned int _mbctombb(unsigned int *c*);

Routine	Required Header	Compatibility
_mbctombb	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_mbctombb** returns the single-byte character that corresponds to *c*; otherwise it returns *c*.

Parameter

c Multibyte character to convert.

Remarks

The **_mbctombb** function converts a given multibyte character to a corresponding single-byte multibyte character. Characters must correspond to single-byte characters within the range 0x20–0x7E or 0xA1–0xDF to be converted.

In previous versions, **_mbctombb** was called **zentohan**. Use **_mbctombb** instead.

See Also: _mbbtombc, _mbcjistojms, _mbctohira, _mbctolower

_mbsbtype

int _mbsbtype(const unsigned char **mbstr*, size_t *count*);

Routine	Required Header	Optional Headers	Compatibility
_mbsbtype	<mbstring.h>	<mbctype.h>[1]	Win 95, Win NT

[1] For manifest constants used as return values.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbsbtype returns an integer value indicating the result of the test on the specified byte. The manifest constants in the following table are defined in MBCTYPE.H.

Return Value	Byte Type
_MBC_SINGLE (0)	Single-byte character. For example, in code page 932, **_mbsbtype** returns 0 if the specified byte is within the range 0x20–0x7E or 0xA1–0xDF.
_MBC_LEAD (1)	Lead byte of multibyte character. For example, in code page 932, **_mbsbtype** returns 1 if the specified byte is within the range 0x81–0x9F or 0xE0–0xFC.
_MBC_TRAIL (2)	Trailing byte of multibyte character. For example, in code page 932, **_mbsbtype** returns 2 if the specified byte is within the range 0x40–0x7E or 0x80–0xFC.
_MBC_ILLEGAL (–1)	Invalid character, or **NULL** byte found before the byte at offset *count* in *mbstr*.

Parameters

mbstr Address of a sequence of multibyte characters

count Byte offset from head of string

Remarks

The **_mbsbtype** function determines the type of a byte in a multibyte character string. The function examines only the byte at offset *count* in *mbstr*, ignoring invalid characters before the specified byte.

_mbsdec, _strdec, _wcsdec

unsigned char *_mbsdec(const unsigned char *_start_, const unsigned char *_current_);

Routine	Required Header	Optional Headers	Compatibility
_mbsdec	<mbstring.h>	<mbctype.h>	Win 95, Win NT
_strdec	<tchar.h>		Win 95, Win NT
_wcsdec	<tchar.h>		Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a pointer to the character that immediately precedes *current*, or **NULL** if the value of *start* is greater than or equal to that of *current*. The return value from **_tcsdec** is undefined; thus, when using **_tcsdec**, you must ensure that you do not decrement the string pointer beyond *start*.

Parameters

start Pointer to first byte of any multibyte character in the source string; *start* must precede *current* in the source string

current Pointer to first byte of any multibyte character in the source string; *current* must follow *start* in the source string

Remarks

The **_mbsdec** function returns a pointer to the first byte of the multibyte-character that immediately precedes *current* in the string that contains *start*. **_mbsdec** recognizes multibyte-character sequences according to the multibyte code page currently in use.

The generic-text function **_tcsdec**, defined in TCHAR.H, maps to **_mbsdec** if **_MBCS** has been defined, or to **_wcsdec** if **_UNICODE** has been defined. Otherwise **_tcsdec** maps to **_strdec**. **_strdec** and **_wcsdec** are single-byte character and wide-character versions of **_mbsdec**. **_strdec** and **_wcsdec** are provided only for this mapping and should not be used otherwise. For more information, see "Using Generic-Text Mappings" on page 25 and Appendix B, "Generic-Text Mappings."

See Also: _mbsinc, _mbsnextc, _mbsninc

_mbsinc, _strinc, _wcsinc

unsigned char *_mbsinc(const unsigned char *_current_);

Routine	Required Header	Compatibility
_mbsinc	<mbstring.h>	Win 95, Win NT
_strinc	<tchar.h>	Win 95, Win NT
_wcsinc	<tchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a pointer to the character that immediately follows *current*.

Parameter

current Character pointer

Remarks

The **_mbsinc** function returns a pointer to the first byte of the multibyte character that immediately follows *current*. **_mbsinc** recognizes multibyte-character sequences according to the multibyte code page currently in use.

The generic-text function **_tcsinc**, defined in TCHAR.H, maps to **_mbsinc** if **_MBCS** has been defined, or to **_wcsinc** if **_UNICODE** has been defined. Otherwise **_tcsinc** maps to **_strinc**. **_strinc** and **_wcsinc** are single-byte character and wide-character versions of **_mbsinc**. **_strinc** and **_wcsinc** are provided only for this mapping and should not be used otherwise. For more information, see "Using Generic-Text Mappings" on page 25 and Appendix B, "Generic-Text Mappings."

See Also: _mbsdec, _mbsnextc, _mbsninc

_mbsnbcat

unsigned char *_mbsnbcat(unsigned char **dest*, const unsigned char **src*, size_t *count*);

Routine	Required Header	Compatibility
_mbsnbcat	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbsnbcat returns a pointer to the destination string. No return value is reserved to indicate an error.

Parameters

dest Null-terminated multibyte-character destination string

src Null-terminated multibyte-character source string

count Number of bytes from *src* to append to *dest*

Remarks

The **_mbsnbcat** function appends, at most, the first *count* bytes of *src* to *dest*. If the byte immediately preceding the null character in *dest* is a lead byte, the initial byte of *src* overwrites this lead byte. Otherwise the initial byte of *src* overwrites the terminating null character of *dest*. If a null byte appears in *src* before *count* bytes are appended, **_mbsnbcat** appends all bytes from *src*, up to the null character. If *count* is greater than the length of *src*, the length of *src* is used in place of *count*. The resulting string is terminated with a null character. If copying takes place between strings that overlap, the behavior is undefined.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncat	strncat	_mbsnbcat	wcsncat

See Also: _mbsnbcmp, _mbsnbcnt, _mbsnccnt, _mbsnbcpy, _mbsnbicmp, _mbsnbset, strncat

_mbsnbcmp

int _mbsnbcmp(const unsigned char *_string1_, const unsigned char _string2_,
↪ size_t _count_);

Routine	Required Header	Compatibility
_mbsnbcmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relation of the substrings of *string1* and *string*.

Return Value	Description
< 0	*string1* substring less than *string2* substring
0	*string1* substring identical to *string2* substring
> 0	*string1* substring greater than *string2* substring

On an error, **_mbsnbcmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, *string2* Strings to compare

count Number of bytes to compare

Remarks

The **_mbsnbcmp** function lexicographically compares, at most, the first *count* bytes in *string1* and *string2* and returns a value indicating the relationship between the substrings. **_mbsnbcmp** is a case-sensitive version of **_mbsnbicmp**. Unlike **strcoll**, **_mbsnbcmp** is not affected by locale. **_mbsnbcmp** recognizes multibyte-character sequences according to the current multibyte code page.

_mbsnbcmp is similar to **_mbsncmp**, except that **_mbsnbcmp** compares strings by characters rather than by bytes.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncmp	strncmp	_mbsnbcmp	wcsncmp

Example

```
/* STRNBCMP.C */
#include <mbstring.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown fox jumps over the lazy dog";

void main( void )
{
   char tmp[20];
   int result;
   printf( "Compare strings:\n\t\t%s\n\t\t%s\n\n", string1, string2 );
   printf( "Function:\t_mbsnbcmp (first 10 characters only)\n" );
   result = _mbsncmp( string1, string2 , 10 );
   if( result > 0 )
      _mbscpy( tmp, "greater than" );
   else if( result < 0 )
      _mbscpy( tmp, "less than" );
   else
      _mbscpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
   printf( "Function:\t_mbsnicmp _mbsnicmp (first 10 characters only)\n" );
   result = _mbsnicmp( string1, string2, 10 );
   if( result > 0 )
      _mbscpy( tmp, "greater than" );
   else if( result < 0 )
      _mbscpy( tmp, "less than" );
   else
      _mbscpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
}
```

Output

```
Compare strings:
      The quick brown dog jumps over the lazy fox
      The QUICK brown fox jumps over the lazy dog

Function:_mbsnbcmp (first 10 characters only)
Result:     String 1 is greater than string 2

Function:_mbsnicmp (first 10 characters only)
Result:     String 1 is equal to string 2
```

See Also: _mbsnbcat, _mbsnbicmp, strncmp, _strnicmp

_mbsnbcnt, _mbsnccnt, _strncnt, _wcsncnt

Return number of characters or bytes within a supplied count

size_t _mbsnbcnt(const unsigned char *_string_, size_t _number_);
size_t _mbsnccnt(const unsigned char *_string_, size_t _number_);

Routine	Required Header	Compatibility
_mbsnbcnt	<mbstring.h>	Win 95, Win NT
_mbsnccnt	<mbstring.h>	Win 95, Win NT
_strncnt	<tchar.h>	Win 95, Win NT
_wcsncnt	<tchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbsnbcnt returns the number of bytes found in the first *number* of multibyte characters of *string*. **_mbsnccnt** returns the number of characters found in the first *number* of bytes of *string*. If a NULL character is encountered before the examination of *string* has completed, they return the number of bytes or characters found before the NULL character. If *string* consists of fewer than *number* characters or bytes, they return the number of characters or bytes in the string. If *number* is less than zero, they return 0. In previous versions, these functions had a return value of type **int** rather than **size_t**.

_strncnt returns the number of characters in the first *number* bytes of the single-byte string *string*. **_wcsncnt** returns the number of bytes in the first *number* wide characters of the wide-character string *string*.

Parameters

string String to be examined

number Number of characters or bytes to be examined in *string*

Remarks

_mbsnbcnt counts the number of bytes found in the first *number* of multibyte characters of *string*. **_mbsnbcnt** replaces **mtob**, and should be used in place of **mtob**.

_mbsnccnt counts the number of characters found in the first *number* of bytes of *string*. If **_mbsnccnt** encounters a NULL in the second byte of a double-byte character, the first byte is also considered to be NULL and is not included in the returned count value. **_mbsnccnt** replaces **btom**, and should be used in place of **btom**.

If **_MBCS** is defined, **_mbsnbcnt** is mapped to **_tcsnbcnt** and **_mbsnbcnt** is mapped to **_tcsnccnt**. These two mapping routines provide generic-text support and are defined in TCHAR.H. If **_UNICODE** is defined, both **_mbsnbcnt** and **_mbsnccnt** are mapped to the **_wcsncnt** macro. When **_MBCS** and **_UNICODE** are not defined, both **_tcsnbcnt** and **_tcsnccnt** are mapped to the **_strncnt** macro. **_strncnt** is the single-byte–character string version and **_wcsncnt** is the wide-character–string version of these mapping routines. **_strncnt** and **_wcsncnt** are provided only for generic-text mapping and should not be used otherwise. For more information, see "Using Generic-Text Mappings" on page 25 and see Appendix B, "Generic-Text Mappings."

Example

```
/* MBSNBCNT.C */

#include  <mbstring.h>
#include  <stdio.h>

void main( void )
{
   unsigned char str[] = "This is a multibyte-character string.";
   unsigned int char_count, byte_count;
   char_count = _mbsnccnt( str, 10 );
   byte_count = _mbsnbcnt( str, 10 );
   if ( byte_count - char_count )
      printf( "The first 10 characters contain %s multibyte characters",
      ↪ char_count );
   else
      printf( "The first 10 characters are single-byte.");
}
```

Output

```
The first 10 characters are single-byte.
```

See Also: _mbsnbcat

_mbsnbcoll, _mbsnbicoll

int _mbsnbcoll(const unsigned char *_string1_, const unsigned char _string2_, size_t _count_);
int _mbsnbicoll(const unsigned char *_string1_, const unsigned char _string2_, size_t _count_);

Routine	Required Header	Compatibility
_mbsnbcoll	<mbstring.h>	Win 95, Win NT
_mbsnbicoll	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relation of the substrings of *string1* and *string2*.

Return Value	Description
< 0	*string1* substring less than *string2* substring
0	*string1* substring identical to *string2* substring
> 0	*string1* substring greater than *string2* substring

Each of these functions returns **_NLSCMPERROR** on an error. To use **_NLSCMPERROR**, include either STRING.H or MBSTRING.H.

Parameters

string1, *string2* Strings to compare

count Number of bytes to compare

Remarks

Each of these functions collates, at most, the first *count* bytes in *string1* and *string2* and returns a value indicating the relationship between the resulting substrings of *string1* and *string2*. If the final byte in the substring of *string1* or *string2* is a lead byte, it is not included in the comparison; these functions compare only complete characters in the substrings. **_mbsnbicoll** is a case-insensitive version of **_mbsnbcoll**. Like **_mbsnbcmp** and **_mbsnbicmp**, **_mbsnbcoll** and **_mbsnbicoll** collate the two multibyte-character strings according to the lexicographic order specified by the multibyte code page currently in use.

For some code pages and corresponding character sets, the order of characters in the character set may differ from the lexicographic character order. In the "C" locale, this is not the case: the order of characters in the ASCII character set is the same as the lexicographic order of the characters. However, in certain European code pages, for

example, the character 'a' (value 0x61) precedes the character 'ä' (value 0xE4) in the character set, but the character 'ä' precedes the character 'a' lexicographically. To perform a lexicographic comparison of strings by bytes in such an instance, use **_mbsnbcoll** rather than **_mbsnbcmp**; to check only for string equality, use **_mbsnbcmp**.

Because the **coll** functions collate strings lexicographically for comparison, whereas the **cmp** functions simply test for string equality, the **coll** functions are much slower than the corresponding **cmp** versions. Therefore, the **coll** functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the comparison.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncoll	_strncoll	_mbsnbcoll	_wcsncoll
_tcsnicoll	_strnicoll	_mbsnbicoll	_wcsnicoll

See Also: _mbsnbcat, _mbsnbcmp, _mbsnbicmp, strcoll Functions, strncmp, _strnicmp

_mbsnbcpy

unsigned char * _mbsnbcpy(unsigned char *_dest_, const unsigned char *_src_, size_t _count_);

Routine	Required Header	Compatibility
_mbsnbcpy	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbsnbcpy returns a pointer to the character string that is to be copied.

Parameters

dest Destination for character string to be copied

src Character string to be copied

count Number of bytes to be copied

Remarks

The **_mbsnbcpy** function copies count bytes from *src* to *dest*. If *src* is shorter than *dest*, the string is padded with null characters. If *dest* is less than or equal to *count* it is not terminated with a null character.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncpy	strncpy	_mbsnbcpy	wcsncpy

See Also: _mbsnbcat, _mbsnbcmp, _mbsnbcnt, _mbsnccnt, _mbsnbicmp, _mbsnbset, _mbsncpy

_mbsnbicmp

int _mbsnbicmp(const unsigned char *_string1_, const unsigned char *_string2_,
↪ size_t _count_);

Routine	Required Header	Compatibility
_mbsnbicmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relationship between the substrings.

Return Value	Description
< 0	*string1* substring less than *string2* substring
0	*string1* substring identical to *string2* substring
> 0	*string1* substring greater than *string2* substring

On an error, **_mbsnbcmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, string2 Null-terminated strings to compare

count Number of bytes to compare

Remarks

The **_mbsnbicmp** function lexicographically compares, at most, the first *count* bytes of *string1* and *string2*. The comparison is performed without regard to case; **_mbsnbcmp** is a case-sensitive version of **_mbsnbicmp**. The comparison ends if a terminating null character is reached in either string before *count* characters are compared. If the strings are equal when a terminating null character is reached in either string before *count* characters are compared, the shorter string is lesser.

_mbsnbicmp is similar to **_mbsnicmp**, except that it compares strings by bytes instead of by characters.

Two strings containing characters located between 'Z' and 'a' in the ASCII table ('[', '\', ']', '^', '_', and '`') compare differently, depending on their case. For example, the two strings "ABCDE" and "ABCD^" compare one way if the comparison is lowercase ("abcde" > "abcd^") and the other way ("ABCDE" < "ABCD^") if it is uppercase.

_mbsnbicmp recognizes multibyte-character sequences according to the multibyte code page currently in use. It is not affected by the current locale setting.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsnicmp	_strnicmp	_mbsnbicmp	_wcsnicmp

Example

```
/* STRNBCMP.C */
#include <mbstring.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown fox jumps over the lazy dog";

void main( void )
{
   char tmp[20];
   int result;
   printf( "Compare strings:\n\t\t%s\n\t\t%s\n\n", string1, string2 );
   printf( "Function:\t_mbsnbcmp (first 10 characters only)\n" );
   result = _mbsncmp( string1, string2 , 10 );
   if( result > 0 )
      _mbscpy( tmp, "greater than" );
   else if( result < 0 )
      _mbscpy( tmp, "less than" );
   else
      _mbscpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
   printf( "Function:\t_mbsnicmp _mbsnicmp (first 10 characters only)\n" );
   result = _mbsnicmp( string1, string2, 10 );
   if( result > 0 )
      _mbscpy( tmp, "greater than" );
```

```
    else if( result < 0 )
        _mbscpy( tmp, "less than" );
    else
        _mbscpy( tmp, "equal to" );
    printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
}
```

Output

```
Compare strings:
      The quick brown dog jumps over the lazy fox
      The QUICK brown fox jumps over the lazy dog

Function:_mbsnbcmp (first 10 characters only)
Result:     String 1 is greater than string 2

Function:_mbsnicmp (first 10 characters only)
Result:     String 1 is equal to string 2
```

See Also: _mbsnbcat, _mbsnbcmp, _stricmp

_mbsnbset

unsigned char *_mbsnbset(unsigned char *_string_, unsigned int _c_, size_t _count_);

Routine	Required Header	Compatibility
_mbsnbset	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_mbsnbset returns a pointer to the altered string.

Parameters

string String to be altered

c Single-byte or multibyte character setting

count Number of bytes to be set

Remarks

The **_mbsnbset** function sets, at most, the first *count* bytes of *string* to *c*. If *count* is greater than the length of *string*, the length of *string* is used instead of *count*. If *c* is a multibyte character and cannot be set entirely into the last byte specified by *count*, then the last byte will be padded with a blank character. **_mbsnbset** does not place a terminating null at the end of *string*.

_mbsnbset is similar to **_mbsnset**, except that it sets *count* bytes rather than *count* characters of *c*.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsnset	_strnset	_mbsnbset	_wcsnset

Example

```
/* MBSNBSET.C */

#include <mbstring.h>
#include <stdio.h>

void main( void )
{
   char string[15] = "This is a test";
   /* Set not more than 4 bytes of string to be *'s */
   printf( "Before: %s\n", string );
   _mbsnbset( string, '*', 4 );
   printf( "After:  %s\n", string );
}
```

Output

```
Before: This is a test
After:  **** is a test
```

See Also: _mbsnbcat, _mbsnset, _mbsset

_mbsnextc, _strnextc, _wcsnextc

unsigned int _mbsnextc(const unsigned char *_string_);

Routine	Required Header	Compatibility
_mbsnextc	<mbstring.h>	Win 95, Win NT
_strnextc	<tchar.h>	Win 95, Win NT
_wcsnextc	<tchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the integer value of the next character in *string*.

Parameter

string Source string

Remarks

The **_mbsnextc** function returns the integer value of the next multibyte-character in *string*, without advancing the string pointer. **_mbsnextc** recognizes multibyte-character sequences according to the multibyte code page currently in use.

The generic-text function **_tcsnextc**, defined in TCHAR.H, maps to **_mbsnextc** if **_MBCS** has been defined, or to **_wcsnextc** if **_UNICODE** has been defined. Otherwise **_tcsnextc** maps to **_strnextc**. **_strnextc** and **_wcsnextc** are single-byte–character string and wide-character string versions of **_mbsnextc**. **_wcsnextc** returns the integer value of the next wide character in *string*; **_strnextc** returns the integer value of the next single-byte character in *string*. **_strnextc** and **_wcsnextc** are provided only for this mapping and should not be used otherwise. For more information, see "Using Generic-Text Mappings" on page 25 and Appendix B, "Generic-Text Mappings."

See Also: **_mbsdec, _mbsinc, _mbsninc**

_mbsninc, _strninc, _wcsninc

unsigned char *_mbsninc(const unsigned char *_string_, size_t _count_);

Routine	Required Header	Compatibility
_mbsninc	<mbstring.h>	Win 95, Win NT
_strninc	<tchar.h>	Win 95, Win NT
_wcsninc	<tchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines returns a pointer to *string* after *string* has been incremented by *count* characters, or **NULL** if the supplied pointer is **NULL**. If *count* is greater than or equal to the number of characters in *string*, the result is undefined.

Parameters

string Source string

count Number of characters to increment string pointer

Remarks

The **_mbsninc** function increments *string* by *count* multibyte characters. **_mbsninc** recognizes multibyte-character sequences according to the multibyte code page currently in use.

The generic-text function **_tcsninc**, defined in TCHAR.H, maps to **_mbsninc** if **_MBCS** has been defined, or to **_wcsninc** if **_UNICODE** has been defined. Otherwise **_tcsninc** maps to **_strninc**. **_strninc** and **_wcsninc** are single-byte–character string and wide-character string versions of **_mbsninc**. **_wcsninc** and **_strninc** are provided only for this mapping and should not be used otherwise. For more information, see "Using Generic-Text Mappings" on page 25 and Appendix B, "Generic-Text Mappings."

See Also: _mbsdec, _mbsinc, _mbsnextc

_mbsspnp, _strspnp, _wcsspnp

unsigned char *_mbsspnp(const unsigned char *_string1_, const unsigned char *_string2_);

Routine	Required Header	Compatibility
_mbsspnp	<mbstring.h>	Win 95, Win NT
_strspnp	<tchar.h>	Win 95, Win NT
_wcsspnp	<tchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_strspnp, **_wcsspnp**, and **_mbsspnp** return a pointer to the first character in *string1* that does not belong to the set of characters in *string2*. Each of these functions returns **NULL** if *string1* consists entirely of characters from *string2*. For each of these routines, no return value is reserved to indicate an error.

Parameters

string1 Null-terminated string to search

string2 Null-terminated character set

Remarks

The **_mbsspnp** function returns a pointer to the multibyte character that is the first character in *string1* that does not belong to the set of characters in *string2*. **_mbsspnp** recognizes multibyte-character sequences according to the multibyte code page currently in use. The search does not include terminating null characters.

The generic-text function **_tcsspnp**, defined in TCHAR.H, maps to **_mbsspnp** if **_MBCS** has been defined, or to **_wcsspnp** if **_UNICODE** has been defined. Otherwise **_tcsspnp** maps to **_strspnp**. **_strspnp** and **_wcsspnp** are single-byte character and wide-character versions of **_mbsspnp**. **_strspnp** and **_wcsspnp** behave identically to **_mbsspnp** otherwise; they are provided only for this mapping and should not be used for any other reason. For more information, see "Using Generic-Text Mappings" on page 25 and Appendix B, "Generic-Text Mappings."

Example

```
/* STRSPN.C: This program uses strspn to determine
 * the length of the segment in the string "cabbage"
 * consisting of a's, b's, and c's. In other words,
 * it finds the first non-abc letter.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[] = "cabbage";
   int  result;
   result = strspn( string, "abc" );
   printf( "The portion of '%s' containing only a, b, or c "
           "is %d bytes long\n", string, result );
}
```

Output

```
The portion of 'cabbage' containing only a, b, or c is 5 bytes long
```

See Also: strspn, strcspn, strncat, strncmp, strncpy, _strnicmp, strrchr

mbstowcs

Converts a sequence of multibyte characters to a corresponding sequence of wide characters.

size_t mbstowcs(wchar_t ***wcstr*****, const char** ***mbstr*****, size_t** ***count*** **);**

Routine	Required Header	Compatibility
mbstowcs	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If **mbstowcs** successfully converts the source string, it returns the number of converted multibyte characters. If the *wcstr* argument is **NULL**, the function returns the required size of the destination string. If **mbstowcs** encounters an invalid multibyte character, it returns –1. If the return value is *count*, the wide-character string is not null-terminated.

Parameters

wcstr The address of a sequence of wide characters

mbstr The address of a sequence of multibyte characters

count The number of multibyte characters to convert

Remarks

The **mbstowcs** function converts *count* or fewer multibyte characters pointed to by *mbstr* to a string of corresponding wide characters that are determined by the current locale. It stores the resulting wide-character string at the address represented by *wcstr.* The result is similiar to a series of calls to **mbtowc**. If **mbstowcs** encounters the single-byte null character ('\0') either before or when *count* occurs, it converts the null character to a wide-character null character (L'\0') and stops. Thus the wide-character string at *wcstr* is null-terminated only if a null character is encountered during conversion. If the sequences pointed to by *wcstr* and *mbstr* overlap, the behavior is undefined.

If the *wcstr* argument is **NULL**, **mbstowcs** returns the required size of the destination string.

Example

```
/* MBSTOWCS.CPP illustrates the behavior of the mbstowcs function
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int i;
   char    *pmbnull  = NULL;
   char    *pmbhello = (char *)malloc( MB_CUR_MAX );
   wchar_t *pwchello = L"Hi";
   wchar_t *pwc      = (wchar_t *)malloc( sizeof( wchar_t ));

   printf( "Convert to multibyte string:\n" );
   i = wcstombs( pmbhello, pwchello, MB_CUR_MAX );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tHex value of first" );
   printf( " multibyte character: %#.4x\n\n", pmbhello );

   printf( "Convert back to wide-character string:\n" );
   i = mbstowcs( pwc, pmbhello, MB_CUR_MAX );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tHex value of first" );
   printf( " wide character: %#.4x\n\n", pwc );
}
```

Output

```
Convert to multibyte string:
   Characters converted: 1
   Hex value of first multibyte character: 0x0e1a

Convert back to wide-character string:
   Characters converted: 1
   Hex value of first wide character: 0x0e1e
```

See Also: mblen, mbtowc, wcstombs, wctomb

mbtowc

Convert a multibyte character to a corresponding wide character.

int mbtowc(wchar_t **wchar*, **const char** **mbchar*, **size_t** *count* **);**

Routine	Required Header	Compatibility
mbtowc	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If **mbchar** is not **NULL** and if the object that *mbchar* points to forms a valid multibyte character, **mbtowc** returns the length in bytes of the multibyte character. If *mbchar* is **NULL** or the object that it points to is a wide-character null character (L'\0'), the function returns 0. If the object that *mbchar* points to does not form a valid multibyte character within the first *count* characters, it returns –1.

Parameters

wchar Address of a wide character (type **wchar_t**)

mbchar Address of a sequence of bytes (a multibyte character)

count Number of bytes to check

Remarks

The **mbtowc** function converts *count* or fewer bytes pointed to by *mbchar*, if *mbchar* is not **NULL**, to a corresponding wide character. **mbtowc** stores the resulting wide character at *wchar*, if *wchar* is not **NULL**. **mbtowc** does not examine more than **MB_CUR_MAX** bytes.

Example

```
/* MBTOWC.CPP illustrates the behavior of the mbtowc function
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int      i;
   char    *pmbc    = (char *)malloc( sizeof( char ) );
   wchar_t  wc      = L'a';
   wchar_t *pwcnull = NULL;
   wchar_t *pwc     = (wchar_t *)malloc( sizeof( wchar_t ) );
   printf( "Convert a wide character to multibyte character:\n" );
   i = wctomb( pmbc, wc );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tMultibyte character: %x\n\n", pmbc );

   printf( "Convert multibyte character back to a wide "
         "character:\n" );
   i = mbtowc( pwc, pmbc, MB_CUR_MAX );
   printf( "\tBytes converted: %u\n", i );
   printf( "\tWide character: %x\n\n", pwc );
   printf( "Attempt to convert when target is NULL\n" );
   printf( "  returns the length of the multibyte character:\n" );
   i = mbtowc( pwcnull, pmbc, MB_CUR_MAX );
   printf( "\tLength of multibyte character: %u\n\n", i );

   printf( "Attempt to convert a NULL pointer to a" );
   printf( " wide character:\n" );
   pmbc = NULL;
   i = mbtowc( pwc, pmbc, MB_CUR_MAX );
   printf( "\tBytes converted: %u\n", i );
}
```

Output

```
Convert a wide character to multibyte character:
   Characters converted: 1
   Multibyte character: 2d02d4

Convert multibyte character back to a wide character:
   Bytes converted: 1
   Wide character: 2d02dc

Attempt to convert when target is NULL
   returns the length of the multibyte character:
   Length of multibyte character: 1

Attempt to convert a NULL pointer to a wide character:
   Bytes converted: 0
```

See Also: mblen, wcstombs, wctomb

_memccpy

Copies characters from a buffer.

void *_memccpy(void *_dest_, const void *_src_, int _c_, unsigned int _count_);

Routine	Required Header	Compatibility
_memccpy	<memory.h> or <string.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If the character *c* is copied, **_memccpy** returns a pointer to the byte in *dest* that immediately follows the character. If *c* is not copied, it returns **NULL**.

Parameters

dest Pointer to destination

src Pointer to source

c Last character to copy

count Number of characters

Remarks

The **_memccpy** function copies 0 or more bytes of *src* to *dest*, halting when the character *c* has been copied or when *count* bytes have been copied, whichever comes first.

Example

```
/* MEMCCPY.C */

#include <memory.h>
#include <stdio.h>
#include <string.h>

char string1[60] = "The quick brown dog jumps over the lazy fox";

void main( void )
{
   char buffer[61];
   char *pdest;

   printf( "Function:\t_memccpy 60 characters or to character 's'\n" );
   printf( "Source:\t\t%s\n", string1 );
   pdest = _memccpy( buffer, string1, 's', 60 );
   *pdest = '\0';
   printf( "Result:\t\t%s\n", buffer );
   printf( "Length:\t\t%d characters\n\n", strlen( buffer ) );
}
```

Output

```
Function:   _memccpy 60 characters or to character 's'
Source:     The quick brown dog jumps over the lazy fox
Result:     The quick brown dog jumps
Length:     25 characters
```

See Also: **memchr, memcmp, memcpy, memset**

---

memchr

Finds characters in a buffer.

void *memchr(const void *_buf_, int _c_, size_t _count_);

Routine	Required Header	Compatibility
memchr	<memory.h> or <string.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **memchr** returns a pointer to the first location of *c* in *buf*. Otherwise it returns **NULL**.

Parameters

buf Pointer to buffer

c Character to look for

count Number of characters to check

Remarks

The **memchr** function looks for the first occurrence of *c* in the first *count* bytes of *buf*. It stops when it finds *c* or when it has checked the first *count* bytes.

Example

```
/* MEMCHR.C */

#include <memory.h>
#include <stdio.h>

int  ch = 'r';
char str[] =    "lazy";
char string[] = "The quick brown dog jumps over the lazy fox";
char fmt1[] =   "         1         2         3         4         5";
char fmt2[] =   "12345678901234567890123456789012345678901234567890";
```

```
void main( void )
{
   char *pdest;
   int result;
   printf( "String to be searched:\n\t\t%s\n", string );
   printf( "\t\t%s\n\t\t%s\n\n", fmt1, fmt2 );

   printf( "Search char:\t%c\n", ch );
   pdest = memchr( string, ch, sizeof( string ) );
   result = pdest - string + 1;
   if( pdest != NULL )
      printf( "Result:\t\t%c found at position %d\n\n", ch, result );
   else
      printf( "Result:\t\t%c not found\n" );
}
```

Output

```
String to be searched:
      The quick brown dog jumps over the lazy fox
            1         2         3         4         5
      123456789012345678901234567890123456789012345678901234567890

Search char:   r
Result:      r found at position 12
```

See Also: _memccpy, memcmp, memcpy, memset, strchr

---

memcmp

Compare characters in two buffers.

int memcmp(const void *_buf1_, const void *_buf2_, size_t _count_);

Routine	Required Header	Compatibility
memcmp	<memory.h> or <string.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relationship between the buffers.

Return Value	Relationship of First count Bytes of buf1 and buf2
< 0	*buf1* less than *buf2*
0	*buf1* identical to *buf2*
> 0	*buf1* greater than *buf2*

Parameters

buf1 First buffer

buf2 Second buffer

count Number of characters

Remarks

The **memcmp** function compares the first *count* bytes of *buf1* and *buf2* and returns a value indicating their relationship.

Example

```
/* MEMCMP.C: This program uses memcmp to compare
 * the strings named first and second. If the first
 * 19 bytes of the strings are equal, the program
 * considers the strings to be equal.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
    char first[]  = "12345678901234567890";
   char second[] = "12345678901234567891";
   int result;

   printf( "Compare '%.19s' to '%.19s':\n", first, second );
   result = memcmp( first, second, 19 );
   if( result < 0 )
      printf( "First is less than second.\n" );
   else if( result == 0 )
      printf( "First is equal to second.\n" );
   else if( result > 0 )
      printf( "First is greater than second.\n" );
   printf( "Compare '%.20s' to '%.20s':\n", first, second );
   result = memcmp( first, second, 20 );
   if( result < 0 )
      printf( "First is less than second.\n" );
   else if( result == 0 )
      printf( "First is equal to second.\n" );
   else if( result > 0 )
      printf( "First is greater than second.\n" );
}
```

Output

```
Compare '1234567890123456789' to '1234567890123456789':
First is equal to second.
Compare '12345678901234567890' to '12345678901234567891':
First is less than second.
```

See Also: _memccpy, memchr, memcpy, memset, strcmp, strncmp

memcpy

Copies characters between buffers.

void *memcpy(void *_dest_, const void *_src_, size_t _count_);

Routine	Required Header	Compatibility
memcpy	<memory.h> or <string.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

memcpy returns the value of *dest.*

Parameters

dest New buffer

src Buffer to copy from

count Number of characters to copy

Remarks

The **memcpy** function copies *count* bytes of *src* to *dest.* If the source and destination overlap, this function does not ensure that the original source bytes in the overlapping region are copied before being overwritten. Use **memmove** to handle overlapping regions.

Example

```
/* MEMCPY.C: Illustrate overlapping copy: memmove
 * handles it correctly; memcpy does not.
 */

#include <memory.h>
#include <string.h>
#include <stdio.h>

char string1[60] = "The quick brown dog jumps over the lazy fox";
char string2[60] = "The quick brown fox jumps over the lazy dog";
/*                          1         2         3         4         5
 *                 123456789012345678901234567890123456789012345678901234567890
 */

void main( void )
{
   printf( "Function:\tmemcpy without overlap\n" );
   printf( "Source:\t\t%s\n", string1 + 40 );
```

```
    printf( "Destination:\t%s\n", string1 + 16 );
    memcpy( string1 + 16, string1 + 40, 3 );
    printf( "Result:\t\t%s\n", string1 );
    printf( "Length:\t\t%d characters\n\n", strlen( string1 ) );

    /* Restore string1 to original contents */
    memcpy( string1 + 16, string2 + 40, 3 );

    printf( "Function:\tmemmove with overlap\n" );
    printf( "Source:\t\t%s\n", string2 + 4 );
    printf( "Destination:\t%s\n", string2 + 10 );
    memmove( string2 + 10, string2 + 4, 40 );
    printf( "Result:\t\t%s\n", string2 );
    printf( "Length:\t\t%d characters\n\n", strlen( string2 ) );

    printf( "Function:\tmemcpy with overlap\n" );
    printf( "Source:\t\t%s\n", string1 + 4 );
    printf( "Destination:\t%s\n", string1 + 10 );
    memcpy( string1 + 10, string1 + 4, 40 );
    printf( "Result:\t\t%s\n", string1 );
    printf( "Length:\t\t%d characters\n\n", strlen( string1 ) );
}
```

Output

```
Function:   memcpy without overlap
Source:      fox
Destination:   dog jumps over the lazy fox
Result:      The quick brown fox jumps over the lazy fox
Length:      43 characters

Function:   memmove with overlap
Source:      quick brown fox jumps over the lazy dog
Destination:   brown fox jumps over the lazy dog
Result:      The quick quick brown fox jumps over the lazy dog
Length:      49 characters

Function:   memcpy with overlap
Source:      quick brown dog jumps over the lazy fox
Destination:   brown dog jumps over the lazy fox
Result:      The quick quick brown dog jumps over the lazy fox
Length:      49 characters
```

See Also: _memccpy, memchr, memcmp, memmove, memset, strcpy, strncpy

_memicmp

Compares characters in two buffers (case-insensitive).

int _memicmp(const void *_buf1_, const void *_buf2_, unsigned int _count_);

Routine	Required Header	Compatibility
_memicmp	<memory.h> or <string.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relationship between the buffers.

Return Value	Relationship of First count Bytes of buf1 and buf2
< 0	*buf1* less than *buf2*
0	*buf1* identical to *buf2*
> 0	*buf1* greater than *buf2*

Parameters

buf1 First buffer

buf2 Second buffer

count Number of characters

Remarks

The **_memicmp** function compares the first *count* characters of the two buffers *buf1* and *buf2* byte by byte. The comparison is not case sensitive.

Example

```
/* MEMICMP.C: This program uses _memicmp to compare
 * the first 29 letters of the strings named first and
 * second without regard to the case of the letters.
 */

#include <memory.h>
#include <stdio.h>
#include <string.h>

void main( void )
{
   int result;
   char first[] = "Those Who Will Not Learn from History";
   char second[] = "THOSE WHO WILL NOT LEARN FROM their mistakes";
   /* Note that the 29th character is right here ^ */

   printf( "Compare '%.29s' to '%.29s'\n", first, second );
   result = _memicmp( first, second, 29 );
   if( result < 0 )
      printf( "First is less than second.\n" );
   else if( result == 0 )
      printf( "First is equal to second.\n" );}
   else if( result > 0 )
      printf( "First is greater than second.\n" );
}
```

Output

```
Compare 'Those Who Will Not Learn from' to 'THOSE WHO WILL NOT LEARN FROM'
First is equal to second.
```

See Also: _memccpy, memchr, memcmp, memcpy, memset, _stricmp, _strnicmp

memmove

Moves one buffer to another.

void *memmove(void **dest*, const void **src*, size_t *count*);

Routine	Required Header	Compatibility
memmove	<string.h> or <memory.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

memmove returns the value of *dest.*

Parameters

dest Destination object

src Source object

count Number of bytes of characters to copy

Remarks

The **memmove** function copies *count* bytes of characters from *src* to *dest.* If some regions of the source area and the destination overlap, **memmove** ensures that the original source bytes in the overlapping region are copied before being overwritten.

Example

```
/* MEMCPY.C: Illustrate overlapping copy: memmove
 * handles it correctly; memcpy does not.
 */

#include <memory.h>
#include <string.h>
#include <stdio.h>
```

```
char string1[60] = "The quick brown dog jumps over the lazy fox";
char string2[60] = "The quick brown fox jumps over the lazy dog";
/*                          1         2         3         4         5
 *                 123456789012345678901234567890123456789012345678901234567890
 */

void main( void )
{
   printf( "Function:\tmemcpy without overlap\n" );
   printf( "Source:\t\t%s\n", string1 + 40 );
   printf( "Destination:\t%s\n", string1 + 16 );
   memcpy( string1 + 16, string1 + 40, 3 );
   printf( "Result:\t\t%s\n", string1 );
   printf( "Length:\t\t%d characters\n\n", strlen( string1 ) );

   /* Restore string1 to original contents */
   memcpy( string1 + 16, string2 + 40, 3 );

   printf( "Function:\tmemmove with overlap\n" );
   printf( "Source:\t\t%s\n", string2 + 4 );
   printf( "Destination:\t%s\n", string2 + 10 );
   memmove( string2 + 10, string2 + 4, 40 );
   printf( "Result:\t\t%s\n", string2 );
   printf( "Length:\t\t%d characters\n\n", strlen( string2 ) );

   printf( "Function:\tmemcpy with overlap\n" );
   printf( "Source:\t\t%s\n", string1 + 4 );
   printf( "Destination:\t%s\n", string1 + 10 );
   memcpy( string1 + 10, string1 + 4, 40 );
   printf( "Result:\t\t%s\n", string1 );
   printf( "Length:\t\t%d characters\n\n", strlen( string1 ) );
}
```

Output

```
Function:   memcpy without overlap
Source:       fox
Destination:    dog jumps over the lazy fox
Result:       The quick brown fox jumps over the lazy fox
Length:       43 characters

Function:   memmove with overlap
Source:       quick brown fox jumps over the lazy dog
Destination:    brown fox jumps over the lazy dog
Result:       The quick quick brown fox jumps over the lazy dog
Length:       49 characters

Function:   memcpy with overlap
Source:       quick brown dog jumps over the lazy fox
Destination:    brown dog jumps over the lazy fox
Result:       The quick quick brown dog jumps over the lazy fox
Length:       49 characters
```

See Also: _memccpy, memcpy, strcpy, strncpy

memset

Sets buffers to a specified character.

void *memset(void **dest*, **int** *c*, **size_t** *count* **);**

Routine	Required Header	Compatibility
memset	<memory.h> or <string.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

memset returns the value of *dest.*

Parameters

dest Pointer to destination

c Character to set

count Number of characters

Remarks

The **memset** function sets the first *count* bytes of *dest* to the character *c.*

Example

```
/* MEMSET.C: This program uses memset to
 * set the first four bytes of buffer to "*".
 */

#include <memory.h>
#include <stdio.h>

void main( void )
{
   char buffer[] = "This is a test of the memset function";

   printf( "Before: %s\n", buffer );
   memset( buffer, '*', 4 );
   printf( "After:  %s\n", buffer );
}
```

Output

```
Before: This is a test of the memset function
After:  **** is a test of the memset function
```

See Also: _memccpy, memchr, memcmp, memcpy, _strnset

__min

Returns the smaller of two values.

type **__min(** *type a*, *type b* **);**

Routine	Required Header	Compatibility
__min	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The smaller of the two arguments

Parameters

type Any numeric data type

a, b Values of any numeric type to be compared

Remarks

The **__min** macro compares two values and returns the value of the smaller one. The arguments can be of any numeric data type, signed or unsigned. Both arguments and the return value must be of the same data type.

Example

```
/* MINMAX.C */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   int a = 10;
   int b = 21;

   printf( "The larger of %d and %d is %d\n",  a, b, __max( a, b ) );
   printf( "The smaller of %d and %d is %d\n", a, b, __min( a, b ) );
}
```

Output

```
The larger of 10 and 21 is 21
The smaller of 10 and 21 is 10
```

See Also: __max

_mkdir, _wmkdir

Create a new directory.

int _mkdir(const char **dirname* **);**
int _wmkdir(const wchar_t **dirname* **);**

Routine	Required Header	Compatibility
_mkdir	<direct.h>	Win 95, Win NT
_wmkdir	<direct.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the value 0 if the new directory was created. On an error the function returns –1 and sets **errno** as follows:

EACCES Directory was not created because *dirname* is the name of an existing file, directory, or device

ENOENT Path was not found

Parameter

dirname Path for new directory

Remarks

The **_mkdir** function creates a new directory with the specified *dirname*. **_mkdir** can create only one new directory per call, so only the last component of *dirname* can name a new directory. **_mkdir** does not translate path delimiters. In Windows NT, both the backslash (\) and the forward slash (/) are valid path delimiters in character strings in run-time routines.

_wmkdir is a wide-character version of **_mkdir**; the *dirname* argument to **_wmkdir** is a wide-character string. **_wmkdir** and **_mkdir** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tmkdir	_mkdir	_mkdir	_wmkdir

Example

```
/* MAKEDIR.C */

#include <direct.h>
#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   if( _mkdir( "\\testtmp" ) == 0 )
   {
      printf( "Directory '\\testtmp' was successfully created\n" );
      system( "dir \\testtmp" );
      if( _rmdir( "\\testtmp" ) == 0 )
         printf( "Directory '\\testtmp' was successfully removed\n"  );
      else
         printf( "Problem removing directory '\\testtmp'\n" );
   }
   else
      printf( "Problem creating directory '\\testtmp'\n" );
}
```

Output

```
Directory '\testtmp' was successfully created
 Volume in drive C is CDRIVE
 Volume Serial Number is 0E17-1702

 Directory of C:\testtmp

05/03/94  12:30p        <DIR>          .
05/03/94  12:30p        <DIR>          ..
               2 File(s)          0 bytes
                             17,358,848 bytes free
Directory '\testtmp' was successfully removed
```

See Also: _chdir, _rmdir

_mktemp, _wmktemp

Create a unique filename.

char *_mktemp(char *_template_);
wchar_t *_wmktemp(wchar_t *_template_);

Routine	Required Header	Compatibility
_mktemp	<io.h>	Win 95, Win NTv
_wmktemp	<io.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the modified template. The function returns **NULL** if *template* is badly formed or no more unique names can be created from the given template.

Parameter

template Filename pattern

Remarks

The **_mktemp** function creates a unique filename by modifying the *template* argument. **_mktemp** automatically handles multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use by the run-time system. **_wmktemp** is a wide-character version of **_mktemp**; the argument and return value of **_wmktemp** are wide-character strings. **_wmktemp** and **_mktemp** behave identically otherwise, except that **_wmktemp** does not handle multibyte-character strings.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tmktemp	_mktemp	_mktemp	_wmktemp

The *template* argument has the form *base*XXXXXX where *base* is the part of the new filename that you supply and each X is a placeholder for a character supplied by **_mktemp**. Each placeholder character in *template* must be an uppercase X. **_mktemp** preserves *base* and replaces the first trailing X with an alphabetic character. **_mktemp** replaces the following trailing X's with a five-digit value; this value is a unique number identifying the calling process, or in multi-threaded programs, the calling thread.

Each successful call to **_mktemp** modifies *template*. In each subsequent call from the same process or thread with the same *template* argument, **_mktemp** checks for filenames that match names returned by **_mktemp** in previous calls. If no file exists for a given name, **_mktemp** returns that name. If files exist for all previously returned names, **_mktemp** creates a new name by replacing the alphabetic character it used in the previously returned name with the next available lowercase letter, in order, from 'a' through 'z'. For example, if *base* is

```
fn
```

and the five-digit value supplied by **_mktemp** is 12345, the first name returned is

```
fna12345
```

If this name is used to create file FNA12345 and this file still exists, the next name returned on a call from the same process or thread with the same *base* for *template* will be

```
fnb12345
```

If FNA12345 does not exist, the next name returned will again be

```
fna12345
```

_mktemp can create a maximum of 27 unique filenames for any given combination of base and template values. Therefore, FNZ12345 is the last unique filename **_mktemp** can create for the *base* and *template* values used in this example.

Example

```
/* MKTEMP.C: The program uses _mktemp to create
 * five unique filenames. It opens each filename
 * to ensure that the next name is unique.
 */

#include <io.h>
#include <string.h>
#include <stdio.h>

char *template = "fnXXXXXX";
char *result;
char names[5][9];

void main( void )
{
   int i;
   FILE *fp;

   for( i = 0; i < 5; i++ )
   {
      strcpy( names[i], template );
      /* Attempt to find a unique filename: */
      result = _mktemp( names[i] );
      if( result == NULL )
         printf( "Problem creating the template" );
      else
      {
         if( (fp = fopen( result, "w" )) != NULL )
            printf( "Unique filename is %s\n", result );
         else
            printf( "Cannot open %s\n", result );
         fclose( fp );
      }
   }
}
```

Output

```
Unique filename is fna00141
Unique filename is fnb00141
Unique filename is fnc00141
Unique filename is fnd00141
Unique filename is fne00141
```

See Also: fopen, _getmbcp, _getpid, _open, _setmbcp, _tempnam, tmpfile

mktime

Converts the local time to a calendar value.

time_t mktime(struct tm *_timeptr_);

Routine	Required Header	Compatibility
mktime	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

mktime returns the specified calendar time encoded as a value of type **time_t**. If *timeptr* references a date before midnight, January 1, 1970, or if the calendar time cannot be represented, the function returns –1 cast to type **time_t**.

Parameter

timeptr Pointer to time structure

Remarks

The **mktime** function converts the supplied time structure (possibly incomplete) pointed to by *timeptr* into a fully defined structure with normalized values and then converts it to a **time_t** calendar time value. For description of **tm** structure fields, see **asctime**. The converted time has the same encoding as the values returned by the **time** function. The original values of the **tm_wday** and **tm_yday** components of the *timeptr* structure are ignored, and the original values of the other components are not restricted to their normal ranges.

mktime handles dates in any time zone from midnight, January 1, 1970, to midnight, February 5, 2036. If successful, **mktime** sets the values of **tm_wday** and **tm_yday** as appropriate and sets the other components to represent the specified calendar time, but with their values forced to the normal ranges; the final value of **tm_mday** is not set

until **tm_mon** and **tm_year** are determined. When specifying a **tm** structure time, set the **tm_isdst** field to 0 to indicate that standard time is in effect, or to a value greater than 0 to indicate that daylight savings time is in effect, or to a value less than zero to have the C run-time library code compute whether standard time or daylight savings time is in effect. (The C run-time library assumes the United States's rules for implementing the calculation of Daylight Savings Time). **tm_isdst** is a required field. If not set, its value is undefined and the return value from **mktime** is unpredictable. If *timeptr* points to a **tm** structure returned by a previous call to **asctime**, **gmtime**, or **localtime**, the **tm_isdst** field contains the correct value.

Note that **gmtime** and **localtime** use a single statically allocated buffer for the conversion. If you supply this buffer to **mktime**, the previous contents are destroyed.

Example

```
/* MKTIME.C: The example takes a number of days
 * as input and returns the time, the current
 * date, and the specified number of days.
 */

#include <time.h>
#include <stdio.h>

void main( void )
{
   struct tm when;
   time_t now, result;
   int    days;

   time( &now );
   when = *localtime( &now );
   printf( "Current time is %s\n", asctime( &when ) );
   printf( "How many days to look ahead: " );
   scanf( "%d", &days );

   when.tm_mday = when.tm_mday + days;
   if( (result = mktime( &when )) != (time_t)-1 )
      printf( "In %d days the time will be %s\n",
            days, asctime( &when ) );
   else
      perror( "mktime failed" );
}
```

Output

```
Current time is Tue May 03 12:45:47 1994

How many days to look ahead: 29
In 29 days the time will be Wed Jun 01 12:45:47 1994
```

See Also: asctime, gmtime, localtime, time

modf

Splits a floating-point value into fractional and integer parts.

double modf(double *x*, **double** **intptr* **);**

Routine	Required Header	Compatibility
modf	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

This function returns the signed fractional portion of *x*. There is no error return.

Parameters

x Floating-point value

intptr Pointer to stored integer portion

Remarks

The **modf** function breaks down the floating-point value *x* into fractional and integer parts, each of which has the same sign as *x*. The signed fractional portion of *x* is returned. The integer portion is stored as a floating-point value at *intptr*.

Example

```
/* MODF.C */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x, y, n;

   x = -14.87654321;      /* Divide x into its fractional */
   y = modf( x, &n );     /* and integer parts            */

   printf( "For %f, the fraction is %f and the integer is %.f\n",
            x, y, n );
}
```

Output

```
For -14.876543, the fraction is -0.876543 and the integer is -14
```

See Also: frexp, ldexp

_msize

Returns the size of a memory block allocated in the heap.

size_t _msize(void **memblock* **);**

Routine	Required Header	Compatibility
_msize	<malloc.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_msize returns the size (in bytes) as an unsigned integer.

Parameter

memblock Pointer to memory block

Remarks

The **_msize** function returns the size, in bytes, of the memory block allocated by a call to **calloc**, **malloc**, or **realloc**.

When the application is linked with a debug version of the C run-time libraries, **_msize** resolves to **_msize_dbg**.

Example

```
/* REALLOC.C: This program allocates a block of memory for
 * buffer and then uses _msize to display the size of that
 * block. Next, it uses realloc to expand the amount of
 * memory used by buffer and then calls _msize again to
 * display the new amount of memory allocated to buffer.
 */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>

void main( void )
{
   long *buffer;
   size_t size;

   if( (buffer = (long *)malloc( 1000 * sizeof( long ) )) == NULL )
      exit( 1 );
```

```
    size = _msize( buffer );
    printf( "Size of block after malloc of 1000 longs: %u\n", size );

    /* Reallocate and show new size: */
    if( (buffer = realloc( buffer, size + (1000 * sizeof( long )) ))
          == NULL )
       exit( 1 );
    size = _msize( buffer );
    printf( "Size of block after realloc of 1000 more longs: %u\n",
             size );

    free( buffer );
    exit( 0 );
}
```

Output

```
Size of block after malloc of 1000 longs: 4000
Size of block after realloc of 1000 more longs: 8000
```

See Also: **calloc, _expand, malloc, realloc**

_nextafter

Returns next representable neighbor.

double _nextafter(double *x*, **double** *y* **);**

Routine	Required Header	Compatibility
_nextafter	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If *x*=*y*, **_nextafter** returns *x*, with no exception triggered. If either *x* or *y* is a quiet NaN, then the return value is one or the other of the input NaNs.

Parameters

x, *y* Double-precision floating-point values

Remarks

The **_nextafter** function returns the closest representable neighbor of *x* in the direction toward *y*.

See Also: **_isnan**

offsetof

Retrieves the offset of a member from the beginning of its parent structure.

size_t offsetof(*structName*, *memberName* **);**

Routine	Required Header	Compatibility
offsetof	<stddef.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

offsetof returns the offset in bytes of the specified member from the beginning of its parent data structure. It is undefined for bit fields.

Parameters

structName Name of the parent data structure

memberName Name of the member in the parent data structure for which to determine the offset

Remarks

The **offsetof** macro returns the offset in bytes of *memberName* from the beginning of the structure specified by *structName*. You can specify types with the **struct** keyword.

Note **offsetof** is not a function and cannot be described using a C prototype.

_onexit

Registers a routine to be called at exit time.

_onexit_t _onexit(**_onexit_t** *func* **);**

Routine	Required Header	Compatibility
_onexit	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_onexit returns a pointer to the function if successful, or **NULL** if there is no space to store the function pointer.

Parameter

func Pointer to function to be called at exit

Remarks

The **_onexit** function is passed the address of a function (*func*) to be called when the program terminates normally. Successive calls to **_onexit** create a register of functions that are executed in LIFO (last-in-first-out) order. The functions passed to **_onexit** cannot take parameters.

_onexit is a Microsoft extension. For ANSI portability use **atexit**.

Example

```
/* ONEXIT.C */

#include <stdlib.h>
#include <stdio.h>

/* Prototypes */
int fn1(void), fn2(void), fn3(void), fn4 (void);

void main( void )
{
   _onexit( fn1 );
   _onexit( fn2 );
   _onexit( fn3 );
   _onexit( fn4 );
   printf( "This is executed first.\n" );
}

int fn1()
{
   printf( "next.\n" );
   return 0;
}

int fn2()
{
   printf( "executed " );
   return 0;
}

int fn3()
{
   printf( "is " );
   return 0;
}
```

```
int fn4()
{
   printf( "This " );
   return 0;
}
```

Output

```
This is executed first.
This is executed next.
```

See Also: atexit, exit

_open, _wopen

Open a file.

int _open(const char **filename*, **int** *oflag* [, **int** *pmode*] **);**
int _wopen(const wchar_t **filename*, **int** *oflag* [, **int** *pmode*] **);**

Routine	Required Header	Optional Headers	Compatibility
_open	<io.h>	<fcntl.h>, <sys/types.h>, <sys/stat.h>	Win 95, Win NT
_wopen	<io.h> or <wchar.h>	<fcntl.h>, <sys/types.h>, <sys/stat.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a file handle for the opened file. A return value of –1 indicates an error, in which case **errno** is set to one of the following values:

EACCES Tried to open read-only file for writing, or file's sharing mode does not allow specified operations, or given path is directory

EEXIST **_O_CREAT** and **_O_EXCL** flags specified, but *filename* already exists

EINVAL Invalid *oflag* or *pmode* argument

EMFILE No more file handles available (too many open files)

ENOENT File or path not found

Parameters

filename Filename

oflag Type of operations allowed

pmode Permission mode

Remarks

The **_open** function opens the file specified by *filename* and prepares the file for reading or writing, as specified by *oflag*. **_wopen** is a wide-character version of **_open**; the *filename* argument to **_wopen** is a wide-character string. **_wopen** and **_open** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_topen	_open	_open	_wopen

oflag is an integer expression formed from one or more of the following manifest constants or constant combinations defined in FCNTL.H:

_O_APPEND Moves file pointer to end of file before every write operation.

_O_BINARY Opens file in binary (untranslated) mode. (See **fopen** for a description of binary mode.)

_O_CREAT Creates and opens new file for writing. Has no effect if file specified by *filename* exists. *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_SHORT_LIVED Create file as temporary and if possible do not flush to disk. *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_TEMPORARY Create file as temporary; file is deleted when last file handle is closed. *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_EXCL Returns error value if file specified by *filename* exists. Applies only when used with **_O_CREAT**.

_O_RANDOM Specifies primarily random access from disk

_O_RDONLY Opens file for reading only; cannot be specified with **_O_RDWR** or **_O_WRONLY**.

_O_RDWR Opens file for both reading and writing; you cannot specify this flag with **_O_RDONLY** or **_O_WRONLY**.

_O_SEQUENTIAL Specifies primarily sequential access from disk

_O_TEXT Opens file in text (translated) mode. (For more information, see "Text and Binary Mode File I/O" on page 15 and **fopen**.)

_O_TRUNC Opens file and truncates it to zero length; file must have write permission. You cannot specify this flag with **_O_RDONLY**. **_O_TRUNC** used with **_O_CREAT** opens an existing file or creates a new file.

Warning The **_O_TRUNC** flag destroys the contents of the specified file.

_O_WRONLY Opens file for writing only; cannot be specified with **_O_RDONLY** or **_O_RDWR**.

To specify the file access mode, you must specify either **_O_RDONLY**, **_O_RDWR**, or **_O_WRONLY**. There is no default value for the access mode.

When two or more manifest constants are used to form the *oflag* argument, the constants are combined with the bitwise-OR operator (|). See "Text and Binary Mode File I/O" on page 15 for a discussion of binary and text modes.

The *pmode* argument is required only when **_O_CREAT** is specified. If the file already exists, *pmode* is ignored. Otherwise, *pmode* specifies the file permission settings, which are set when the new file is closed the first time. **_open** applies the current file-permission mask to *pmode* before setting the permissions (for more information, see **_umask**). *pmode* is an integer expression containing one or both of the following manifest constants, defined in SYS\STAT.H:

_S_IREAD Reading only permitted

_S_IWRITE Writing permitted (effectively permits reading and writing)

_S_IREAD | _S_IWRITE Reading and writing permitted

When both constants are given, they are joined with the bitwise-OR operator (|). In Windows NT, all files are readable, so write-only permission is not available; thus the modes **_S_IWRITE** and **_S_IREAD | _S_IWRITE** are equivalent.

Example

```
/* OPEN.C: This program uses _open to open a file
 * named OPEN.C for input and a file named OPEN.OUT
 * for output. The files are then closed.
 */

#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdio.h>

void main( void )
{
   int fh1, fh2;
```

```
    fh1 = _open( "OPEN.C", _O_RDONLY );
    if( fh1 == -1 )
       perror( "open failed on input file" );
    else
    {
       printf( "open succeeded on input file\n" );
       _close( fh1 );
    }

    fh2 = _open( "OPEN.OUT", _O_WRONLY | _O_CREAT, _S_IREAD |
                             _S_IWRITE );
    if( fh2 == -1 )
       perror( "Open failed on output file" );
    else
    {
       printf( "Open succeeded on output file\n" );
       _close( fh2 );
    }
}
```

Output

```
Open succeeded on input file
Open succeeded on output file
```

See Also: **_chmod**, **_close**, **_creat**, **_dup**, **fopen**, **_sopen**

_open_osfhandle

Associates a C run-time file handle with a existing operating-system file handle.

int _open_osfhandle (long *osfhandle*, **int** *flags* **);**

Routine	Required Header	Compatibility
_open_osfhandle	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_open_osfhandle** returns a C run-time file handle. Otherwise, it returns –1.

Parameters

osfhandle Operating-system file handle

flags Types of operations allowed

Remarks

The **_open_osfhandle** function allocates a C run-time file handle and sets it to point to the operating-system file handle specified by *osfhandle*. The *flags* argument is an integer expression formed from one or more of the manifest constants defined in FCNTL.H. When two or more manifest constants are used to form the *flags* argument, the constants are combined with the bitwise-OR operator (|).

The FCNTL.H file defines the following manifest constants:

_O_APPEND Positions file pointer to end of file before every write operation.

_O_RDONLY Opens file for reading only

_O_TEXT Opens file in text (translated) mode

_outp, _outpw, _outpd

Output a byte(**_outp**), a word(**_outpw**), or a double word (**_outpd**) at a port.

int _outp(unsigned short *port*, **int** *databyte* **);**
unsigned short _outpw(unsigned short *port*, **unsigned short** *dataword* **);**
unsigned long _outpd(unsigned short *port*, **unsigned long** *dataword* **);**

Routine	Required Header	Compatibility
_outp	<conio.h>	Win 95
_outpw	<conio.h>	Win 95
_outpd	<conio.h>	Win 95

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The functions return the data output. There is no error return.

Parameters

port Port number

databyte, dataword Output values

Remarks

The **_outp**, **_outpw**, and **_outpd** functions write a byte, a word, and a double word, respectively, to the specified output port. The *port* argument can be any unsigned integer in the range 0–65,535; *databyte* can be any integer in the range 0–255; and *dataword* can be any value in the range of an integer, an unsigned short integer, and an unsigned long integer, respectively.

See Also: **_inp**

_pclose

Waits for new command processor and closes stream on associated pipe.

int _pclose(FILE ***stream*);**

Routine	Required Header	Compatibility
_pclose	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_pclose returns the exit status of the terminating command processor, or –1 if an error occurs. The format of the return value is the same as that for **_cwait**, except the low-order and high-order bytes are swapped.

Parameter

stream Return value from previous call to **_popen**

Remarks

The **_pclose** function looks up the process ID of the command processor (CMD.EXE) started by the associated **_popen** call, executes a **_cwait** call on the new command processor, and closes the stream on the associated pipe.

See Also: **_pipe**, **_popen**

---

perror, _wperror

Print an error message.

void perror(const char ***string*);**
void _wperror(const wchar_t ***string*);**

Routine	Required Header	Compatibility
perror	<stdio.h> or <stdlib.h>	ANSI, Win 95, Win NT
_wperror	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

string String message to print

Remarks

The **perror** function prints an error message to **stderr**. **_wperror** is a wide-character version of **_perror**; the *string* argument to **_wperror** is a wide-character string. **_wperror** and **_perror** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tperror	perror	perror	_wperror

string is printed first, followed by a colon, then by the system error message for the last library call that produced the error, and finally by a newline character. If *string* is a null pointer or a pointer to a null string, **perror** prints only the system error message.

The error number is stored in the variable **errno** (defined in ERRNO.H). The system error messages are accessed through the variable **_sys_errlist**, which is an array of messages ordered by error number. **perror** prints the appropriate error message using the **errno** value as an index to **_sys_errlist**. The value of the variable **_sys_nerr** is defined as the maximum number of elements in the **_sys_errlist** array.

For accurate results, call **perror** immediately after a library routine returns with an error. Otherwise, subsequent calls can overwrite the **errno** value.

In Windows NT and Windows 95, some **errno** values listed in ERRNO.H are unused. These values are reserved for use by the UNIX operating system. See **_doserrno, errno, _sys_errlist,** and **_sys_nerr** for a listing of **errno** values used by Windows NT and Windows 95. **perror** prints an empty string for any **errno** value not used by these platforms.

Example

```
/* PERROR.C: This program attempts to open a file named
 * NOSUCHF.ILE. Because this file probably doesn't exist,
 * an error message is displayed. The same message is
 * created using perror, strerror, and _strerror.
 */

#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

void main( void )
{
   int  fh;

   if( (fh = _open( "NOSUCHF.ILE", _O_RDONLY )) == -1 )
   {
      /* Three ways to create error message: */
      perror( "perror says open failed" );
      printf( "strerror says open failed: %s\n", strerror( errno ) );
      printf( _strerror( "_strerror says open failed" ) );
   }
   else
   {
      printf( "open succeeded on input file\n" );
      _close( fh );
   }
}
```

Output

```
perror says open failed: No such file or directory

strerror says open failed: No such file or directory
_strerror says open failed: No such file or directory
```

See Also: clearerr, ferror, strerror

_pipe

Creates a pipe for reading and writing.

int _pipe(int ***phandles*, unsigned int** *psize*, **int** *textmode* **);**

Routine	Required Header	Optional Headers	Compatibility
_pipe	<io.h>	<fcntl.h>,[1] <errno.h>[2]	Win 95, Win NT

[1] For **_O_BINARY** and **_O_TEXT** definitions.
[2] **errno** definitions.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_pipe returns 0 if successful. It returns –1 to indicate an error, in which case **errno** is set to one of two values: **EMFILE**, which indicates no more file handles available, or **ENFILE**, which indicates a system file table overflow.

Parameters

phandles[2] Array to hold read and write handles

psize Amount of memory to reserve

textmode File mode

Remarks

The **_pipe** function creates a pipe. A *pipe* is an artificial I/O channel that a program uses to pass information to other programs. A pipe is similar to a file in that it has a file pointer, a file descriptor, or both, and can be read from or written to using the standard library's input and output functions. However, a pipe does not represent a specific file or device. Instead, it represents temporary storage in memory that is independent of the program's own memory and is controlled entirely by the operating system.

_pipe is similar to **_open** but opens the pipe for reading and writing, returning two file handles instead of one. The program can use both sides of the pipe or close the one it does not need. For example, the command processor in Windows NT creates a pipe when executing a command such as

```
PROGRAM1 | PROGRAM2
```

The standard output handle of PROGRAM1 is attached to the pipe's write handle. The standard input handle of PROGRAM2 is attached to the pipe's read handle. This eliminates the need for creating temporary files to pass information to other programs.

The **_pipe** function returns two handles to the pipe in the *phandles* argument. The element *phandles*[0] contains the read handle, and the element *phandles*[1] contains the write handle. Pipe file handles are used in the same way as other file handles. (The low-level input and output functions **_read** and **_write** can read from and write to a pipe.) To detect the end-of-pipe condition, check for a **_read** request that returns 0 as the number of bytes read.

The *psize* argument specifies the amount of memory, in bytes, to reserve for the pipe. The *textmode* argument specifies the translation mode for the pipe. The manifest constant **_O_TEXT** specifies a text translation, and the constant **_O_BINARY** specifies binary translation. (See **fopen** for a description of text and binary modes.)

If the *textmode* argument is 0, **_pipe** uses the default translation mode specified by the default-mode variable **_fmode**.

In multithreaded programs, no locking is performed. The handles returned are newly opened and should not be referenced by any thread until after the **_pipe** call is complete.

In order to use the **_pipe** function to communicate between a parent and a child process, each process must have only one handle open on the pipe. The handles must be opposites: if the parent has a read handle open, then the child must have a write handle open. The easiest way to do this is to **OR** (|) the **_O_NOINHERIT** flag with *textmode*. Then, use **_dup** or **_dup2** to create an inheritable copy of the pipe handle you wish to pass to the child. Close the original handle, and spawn the child process. Upon returning from the spawn call, close the "duplicate" handle in the parent process. See Example 2 below for more information.

In Windows NT and Windows 95, a pipe is destroyed when all of its handles have been closed. (If all read handles on the pipe have been closed, writing to the pipe causes an error.) All read and write operations on the pipe wait until there is enough data or enough buffer space to complete the I/O request.

Example 1

```
/* PIPE.C: This program uses the _pipe function to pass streams of
 * text to spawned processes.
 */

#include <stdlib.h>
#include <stdio.h>
#include <io.h>
#include <fcntl.h>
#include <process.h>
#include <math.h>

enum PIPES { READ, WRITE }; /* Constants 0 and 1 for READ and WRITE */
#define NUMPROBLEM 8

void main( int argc, char *argv[] )
{

   int hpipe[2];
   char hstr[20];
   int pid, problem, c;
   int termstat;

   /* If no arguments, this is the spawning process */
   if( argc == 1 )
   {

      setvbuf( stdout, NULL, _IONBF, 0 );
```

```
        /* Open a set of pipes */
        if( _pipe( hpipe, 256, O_BINARY ) == -1 )
            exit( 1 );


        /* Convert pipe read handle to string and pass as argument
         * to spawned program. Program spawns itself (argv[0]).
         */
        itoa( hpipe[READ], hstr, 10 );
        if( ( pid = spawnl( P_NOWAIT, argv[0], argv[0],
              hstr, NULL ) ) == -1 )
           printf( "Spawn failed" );

        /* Put problem in write pipe. Since spawned program is
         * running simultaneously, first solutions may be done
         * before last problem is given.
         */
        for( problem = 1000; problem <= NUMPROBLEM * 1000; problem += 1000)
        {

           printf( "Son, what is the square root of %d?\n", problem );
           write( hpipe[WRITE], (char *)&problem, sizeof( int ) );

        }

        /* Wait until spawned program is done processing. */
        _cwait( &termstat, pid, WAIT_CHILD );
        if( termstat & 0x0 )
           printf( "Child failed\n" );

        close( hpipe[READ] );
        close( hpipe[WRITE] );

    }

    /* If there is an argument, this must be the spawned process. */
    else
    {

        /* Convert passed string handle to integer handle. */
        hpipe[READ] = atoi( argv[1] );

        /* Read problem from pipe and calculate solution. */
        for( c = 0; c < NUMPROBLEM; c++ )
        {

           read( hpipe[READ], (char *)&problem, sizeof( int ) );
           printf( "Dad, the square root of %d is %3.2f.\n",
                   problem, sqrt( ( double )problem ) );

        }
    }
}
```

Output

```
Son, what is the square root of 1000?
Son, what is the square root of 2000?
Son, what is the square root of 3000?
Son, what is the square root of 4000?
Son, what is the square root of 5000?
Son, what is the square root of 6000?
Son, what is the square root of 7000?
Son, what is the square root of 8000?
Dad, the square root of 1000 is 31.62.
Dad, the square root of 2000 is 44.72.
Dad, the square root of 3000 is 54.77.
Dad, the square root of 4000 is 63.25.
Dad, the square root of 5000 is 70.71.
Dad, the square root of 6000 is 77.46.
Dad, the square root of 7000 is 83.67.
Dad, the square root of 8000 is 89.44.
```

Example 2

```
// This is a simple filter application.  It will spawn
// the application on  command line. But before spawning
// the application, it will create a pipe that will direct the
// spawned application's stdout to the filter.  The filter
// will remove ASCII 7 (beep) characters.

// Beeper.Cpp

/* Compile options needed: None */
#include <stdio.h>
#include <string.h>

int main()
{
   int   i;
   for(i=0;i<100;++i)
      {
         printf("\nThis is speaker beep number %d... \n\7", i+1);
      }
   return 0;
}


// BeepFilter.Cpp
/* Compile options needed: none
   Execute as: BeepFilter.exe <path>Beeper.exe
*/
#include <windows.h>
#include <process.h>
#include <memory.h>
#include <string.h>
#include <stdio.h>
#include <fcntl.h>
#include <io.h>
```

```
#define  OUT_BUFF_SIZE 512
#define  READ_HANDLE 0
#define  WRITE_HANDLE 1
#define  BEEP_CHAR 7

char szBuffer[OUT_BUFF_SIZE];

int Filter(char* szBuff, ULONG nSize, int nChar)
{
   char* szPos = szBuff + nSize -1;
   char* szEnd = szPos;
   int nRet = nSize;

   while (szPos > szBuff)
   {
      if (*szPos == nChar)
         {
            memmove(szPos, szPos+1, szEnd - szPos);
            --nRet;
         }
      --szPos;
   }
   return nRet;
}

int main(int argc, char** argv)
{
   int nExitCode = STILL_ACTIVE;
   if (argc >= 2)
   {
      HANDLE hProcess;
      int hStdOut;
      int hStdOutPipe[2];

      // Create the pipe
      if(_pipe(hStdOutPipe, 512, O_BINARY | O_NOINHERIT) == -1)
         return1;

      // Duplicate stdout handle (next line will close original)
      hStdOut = _dup(_fileno(stdout));

      // Duplicate write end of pipe to stdout handle
      if(_dup2(hStdOutPipe[WRITE_HANDLE], _fileno(stdout)) != 0)
         return2;

      // Close original write end of pipe
      close(hStdOutPipe[WRITE_HANDLE]);

      // Spawn process
      hProcess = (HANDLE)spawnvp(P_NOWAIT, argv[1],
      (const char* const*)&argv[1]);
```

```
      // Duplicate copy of original stdout back into stdout
      if(_dup2(hStdOut, _fileno(stdout)) != 0)
         return3;

      // Close duplicate copy of original stdout
      close(hStdOut);

      if(hProcess)
      {
         int nOutRead;
         while (nExitCode == STILL_ACTIVE)
         {
            nOutRead = read(hStdOutPipe[READ_HANDLE],
            szBuffer, OUT_BUFF_SIZE);
            if(nOutRead)
            {
               nOutRead = Filter(szBuffer, nOutRead, BEEP_CHAR);
               fwrite(szBuffer, 1, nOutRead, stdout);
            }

            if(!GetExitCodeProcess(hProcess,(unsigned long*)&nExitCode))
               return 4;
         }
      }
   }

   printf("\nPress \'ENTER\' key to continue... ");
   getchar();
   return nExitCode;
}
```

See Also: **_open**

_popen, _wpopen

Creates a pipe and executes a command.

FILE *_popen(const char *_command_, const char *_mode_);
FILE *_wpopen(const wchar_t *_command_, const wchar_t *_mode_);

Routine	Required Header	Compatibility
_popen	<stdio.h>	Win 95, Win NT
_wpopen	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a stream associated with one end of the created pipe. The other end of the pipe is associated with the spawned command's standard input or standard output. The functions return **NULL** on an error.

Parameters

command Command to be executed

mode Mode of returned stream

Remarks

The **_popen** function creates a pipe and asynchronously executes a spawned copy of the command processor with the specified string *command*. The character string *mode* specifies the type of access requested, as follows:

"r" The calling process can read the spawned command's standard output via the returned stream.

"w" The calling process can write to the spawned command's standard input via the returned stream.

"b" Open in binary mode.

"t" Open in text mode.

_wpopen is a wide-character version of **_popen**; the *path* argument to **_wpopen** is a wide-character string. **_wpopen** and **_popen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tpopen	_popen	_popen	_wpopen

Example

```
/* POPEN.C: This program uses _popen and _pclose to receive a
 * stream of text from a system process.
 */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{

   char   psBuffer[128];
   FILE   *chkdsk;

        /* Run DIR so that it writes its output to a pipe. Open this
    * pipe with read text attribute so that we can read it
         * like a text file.
    */
   if( (chkdsk = _popen( "dir *.c /on /p", "rt" )) == NULL )
      exit( 1 );
```

```
   /* Read pipe until end of file. End of file indicates that
    * CHKDSK closed its standard out (probably meaning it
        * terminated).
    */
   while( !feof( chkdsk ) )
   {
      if( fgets( psBuffer, 128, chkdsk ) != NULL )
         printf( psBuffer );
   }

   /* Close pipe and print return value of CHKDSK. */
   printf( "\nProcess returned %d\n", _pclose( chkdsk ) );
}
```

Output

```
 Volume in drive C is CDRIVE
 Volume Serial Number is 0E17-1702

 Directory of C:\dolphin\crt\code\pcode

05/02/94  01:05a                805 perror.c
05/02/94  01:05a              2,149 pipe.c
05/02/94  01:05a                882 popen.c
05/02/94  01:05a                206 pow.c
05/02/94  01:05a              1,514 printf.c
05/02/94  01:05a                454 putc.c
05/02/94  01:05a                162 puts.c
05/02/94  01:05a                654 putw.c
               8 File(s)        6,826 bytes
                           86,597,632 bytes free

Process returned 0
```

See Also: _pclose, _pipe

pow

Calculates *x* raised to the power of *y*.

double pow(double *x*, **double** *y* **);**

Routine	Required Header	Compatibility
pow	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

pow returns the value of xy. No error message is printed on overflow or underflow.

Values of x and y	Return Value of pow
$x <> 0$ and $y = 0.0$	1
$x = 0.0$ and $y = 0.0$	1
$x = 0.0$ and $y < 0$	INF

Parameters

x Base

y Exponent

Remarks

The **pow** function computes *x* raised to the power of *y*.

pow does not recognize integral floating-point values greater than 2^{64}, such as `1.0E100`.

Example

```
/* POW.C
 *
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double x = 2.0, y = 3.0, z;

   z = pow( x, y );
   printf( "%.1f to the power of %.1f is %.1f\n", x, y, z );
}
```

Output

```
2.0 to the power of 3.0 is 8.0
```

See Also: exp, log, sqrt

printf, wprintf

Print formatted output to the standard output stream.

int printf(const char ******format* **[,** *argument***]...);**
int wprintf(const wchar_t ******format* **[,** *argument***]...);**

Routine	Required Header	Compatibility
printf	<stdio.h>	ANSI, Win 95, Win NT
wprintf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the number of characters printed, or a negative value if an error occurs.

Parameters

format Format control

argument Optional arguments

Remarks

The **printf** function formats and prints a series of characters and values to the standard output stream, **stdout**. If arguments follow the *format* string, the *format* string must contain specifications that determine the output format for the arguments. **printf** and **fprintf** behave identically except that **printf** writes output to **stdout** rather than to a destination of type **FILE**.

wprintf is a wide-character version of **printf**; *format* is a wide-character string. **wprintf** and **printf** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tprintf	printf	printf	wprintf

The *format* argument consists of ordinary characters, escape sequences, and (if arguments follow *format*) format specifications. The ordinary characters and escape sequences are copied to **stdout** in order of their appearance. For example, the line

```
printf("Line one\n\t\tLine two\n");
```

produces the output

```
Line one
        Line two
```

Format specifications always begin with a percent sign (%) and are read left to right. When **printf** encounters the first format specification (if any), it converts the value of the first argument after *format* and outputs it accordingly. The second format specification causes the second argument to be converted and output, and so on. If there are more arguments than there are format specifications, the extra arguments are ignored. The results are undefined if there are not enough arguments for all the format specifications.

Example

```
/* PRINTF.C: This program uses the printf and wprintf functions
 * to produce formatted output.
 */

#include <stdio.h>

void main( void )
{
   char   ch = 'h', *string = "computer";
   int    count = -9234;
   double fp = 251.7366;
   wchar_t wch = L'w', *wstring = L"Unicode";

   /* Display integers. */
   printf( "Integer formats:\n"
           "\tDecimal: %d  Justified: %.6d  Unsigned: %u\n",
           count, count, count, count );

   printf( "Decimal %d as:\n\tHex: %Xh  C hex: 0x%x  Octal: %o\n",
            count, count, count, count );

   /* Display in different radixes. */
   printf( "Digits 10 equal:\n\tHex: %i  Octal: %i  Decimal: %i\n",
            0x10, 010, 10 );

   /* Display characters. */

   printf("Characters in field (1):\n%10c%5hc%5C%5lc\n", ch,
   ↪ ch, wch, wch);
   wprintf(L"Characters in field (2):\n%10C%5hc%5c%5lc\n", ch,
   ↪ ch, wch, wch);

   /* Display strings. */

   printf("Strings in field (1):\n%25s\n%25.4hs\n\t%S%25.3ls\n",
   string, string, wstring, wstring);
   wprintf(L"Strings in field (2):\n%25S\n%25.4hs\n\t%s%25.3ls\n",
      string, string, wstring, wstring);

   /* Display real numbers. */
   printf( "Real numbers:\n\t%f %.2f %e %E\n", fp, fp, fp, fp );

   /* Display pointer. */
   printf( "\nAddress as:\t%p\n", &count);

   /* Count characters printed. */
   printf( "\nDisplay to here:\n" );
   printf( "1234567890123456%n78901234567890\n", &count );
   printf( "\tNumber displayed: %d\n\n", count );
}
```

Output

```
Integer formats:
   Decimal: -9234  Justified: -009234  Unsigned: 4294958062
Decimal -9234 as:
   Hex: FFFFDBEEh  C hex: 0xffffdbee  Octal: 37777755756
Digits 10 equal:
   Hex: 16  Octal: 8  Decimal: 10
Characters in field (1):
         h    h    w    w
Characters in field (2):
         h    h    w    w
Strings in field (1):
                computer
                    comp
   Unicode                      Uni
Strings in field (2):
                computer
                    comp
   Unicode                      Uni
Real numbers:
   251.736600 251.74 2.517366e+002 2.517366E+002

Address as: 0012FFAC

Display to here:
12345678901234567890123456789O
   Number displayed: 16
```

See Also: fopen, fprintf, scanf, sprintf, vprintf Functions

Format Specification Fields: printf and wprintf Functions

A format specification, which consists of optional and required fields, has the following form:

%[flags] [width] [.precision] [{h | l | I64 | L}]type

Each field of the format specification is a single character or a number signifying a particular format option. The simplest format specification contains only the percent sign and a *type* character (for example, `%s`). If a percent sign is followed by a character that has no meaning as a format field, the character is copied to **stdout**. For example, to print a percent-sign character, use `%%`.

The optional fields, which appear before the *type* character, control other aspects of the formatting, as follows:

type Required character that determines whether the associated *argument* is interpreted as a character, a string, or a number (see Table R.3).

flags Optional character or characters that control justification of output and printing of signs, blanks, decimal points, and octal and hexadecimal prefixes (see Table R.4). More than one flag can appear in a format specification.

width Optional number that specifies the minimum number of characters output. (See "printf Width Specification.")

precision Optional number that specifies the maximum number of characters printed for all or part of the output field, or the minimum number of digits printed for integer values (see Table R.5).

h | l | I64 | L Optional prefixes to *type*-that specify the size of *argument* (see Table R.6).

printf Type Field Characters

The *type* character is the only required format field ; it appears after any optional format fields. The *type* character determines whether the associated argument is interpreted as a character, string, or number. The types **C** and **S**, and the behavior of **c** and **s** with **printf** functions, are Microsoft extensions and are not ANSI-compatible.

Table R.3 printf Type Field Characters

Character	Type	Output Format
c	**int** or **wint_t**	When used with **printf** functions, specifies a single-byte character; when used with **wprintf** functions, specifies a wide character.
C	**int** or **wint_t**	When used with **printf** functions, specifies a wide character; when used with **wprintf** functions, specifies a single-byte character.
d	**int**	Signed decimal integer.
i	**int**	Signed decimal integer.
o	**int**	Unsigned octal integer.
u	**int**	Unsigned decimal integer.
x	**int**	Unsigned hexadecimal integer, using "abcdef."
X	**int**	Unsigned hexadecimal integer, using "ABCDEF."
e	**double**	Signed value having the form [–]*d.dddd* **e** [*sign*]*ddd* where *d* is a single decimal digit, *dddd* is one or more decimal digits, *ddd* is exactly three decimal digits, and *sign* is + or –.
E	**double**	Identical to the **e** format except that **E** rather than **e** introduces the exponent.
f	**double**	Signed value having the form [–]*dddd.dddd*, where *dddd* is one or more decimal digits. The number of digits before the decimal point depends on the magnitude of the number, and the number of digits after the decimal point depends on the requested precision.

(continued)

Table R.3 printf Type Field Characters *(continued)*

Character	Type	Output Format
g	**double**	Signed value printed in **f** or **e** format, whichever is more compact for the given value and precision. The **e** format is used only when the exponent of the value is less than –4 or greater than or equal to the precision argument. Trailing zeros are truncated, and the decimal point appears only if one or more digits follow it.
G	**double**	Identical to the **g** format, except that **E**, rather than **e**, introduces the exponent (where appropriate).
n	Pointer to integer	Number of characters successfully written so far to the stream or buffer; this value is stored in the integer whose address is given as the argument.
p	Pointer to **void**	Prints the address pointed to by the argument in the form *xxxx*:*yyyy* where *xxxx* is the segment and *yyyy* is the offset, and the digits *x* and *y* are uppercase hexadecimal digits.
s	String	When used with **printf** functions, specifies a single-byte–character string; when used with **wprintf** functions, specifies a wide-character string. Characters are printed up to the first null character or until the *precision* value is reached.
S	String	When used with **printf** functions, specifies a wide-character string; when used with **wprintf** functions, specifies a single-byte–character string. Characters are printed up to the first null character or until the *precision* value is reached.

Flag Directives

The first optional field of the format specification is *flags*. A flag directive is a character that justifies output and prints signs, blanks, decimal points, and octal and hexadecimal prefixes. More than one flag directive may appear in a format specification.

Table R.4 Flag Characters

Flag	Meaning	Default
–	Left align the result within the given field width.	Right align.
+	Prefix the output value with a sign (+ or –) if the output value is of a signed type.	Sign appears only for negative signed values (–).
0	If *width* is prefixed with **0**, zeros are added until the minimum width is reached. If 0 and – appear, the **0** is ignored. If **0** is specified with an integer format (**i**, **u**, **x**, **X**, **o**, **d**) the **0** is ignored.	No padding.
blank (‘ ’)	Prefix the output value with a blank if the output value is signed and positive; the blank is ignored if both the blank and + flags appear.	No blank appears.

Table R.4 Flag Characters *(continued)*

Flag	Meaning	Default
#	When used with the **o**, **x**, or **X** format, the # flag prefixes any nonzero output value with 0, 0x, or 0X, respectively.	No blank appears.
	When used with the **e**, **E**, or **f** format, the # flag forces the output value to contain a decimal point in all cases.	Decimal point appears only if digits follow it.
	When used with the **g** or **G** format, the # flag forces the output value to contain a decimal point in all cases and prevents the truncation of trailing zeros. Ignored when used with **c**, **d**, **i**, **u**, or **s**.	Decimal point appears only if digits follow it. Trailing zeros are truncated.

printf Width Specification

The second optional field of the format specification is the width specification. The *width* argument is a nonnegative decimal integer controlling the minimum number of characters printed. If the number of characters in the output value is less than the specified width, blanks are added to the left or the right of the values—depending on whether the – flag (for left alignment) is specified—until the minimum width is reached. If *width* is prefixed with 0, zeros are added until the minimum width is reached (not useful for left-aligned numbers).

The width specification never causes a value to be truncated. If the number of characters in the output value is greater than the specified width, or if *width* is not given, all characters of the value are printed (subject to the precision specification).

If the width specification is an asterisk (*), an **int** argument from the argument list supplies the value. The *width* argument must precede the value being formatted in the argument list. A nonexistent or small field width does not cause the truncation of a field; if the result of a conversion is wider than the field width, the field expands to contain the conversion result.

Precision Specification

The third optional field of the format specification is the precision specification. It specifies a nonnegative decimal integer, preceded by a period (.), which specifies the number of characters to be printed, the number of decimal places, or the number of significant digits (see Table R.5). Unlike the width specification, the precision specification can cause either truncation of the output value or rounding of a floating-point value. If *precision* is specified as 0 and the value to be converted is 0, the result is no characters output, as shown below:

```
printf( "%.0d", 0 );      /* No characters output */
```

If the precision specification is an asterisk (*), an **int** argument from the argument list supplies the value. The *precision* argument must precede the value being formatted in the argument list.

The type determines the interpretation of *precision* and the default when *precision* is omitted, as shown in Table R.5.

Table R.5 How Precision Values Affect Type

Type	Meaning	Default
c, C	The precision has no effect.	Character is printed.
d, i, u, o, x, X	The precision specifies the minimum number of digits to be printed. If the number of digits in the argument is less than *precision*, the output value is padded on the left with zeros. The value is not truncated when the number of digits exceeds *precision*.	Default precision is 1.
e, E	The precision specifies the number of digits to be printed after the decimal point. The last printed digit is rounded.	Default precision is 6; if *precision* is 0 or the period (.) appears without a number following it, no decimal point is printed.
f	The precision value specifies the number of digits after the decimal point. If a decimal point appears, at least one digit appears before it. The value is rounded to the appropriate number of digits.	Default precision is 6; if *precision* is 0, or if the period (.) appears without a number following it, no decimal point is printed.
g, G	The precision specifies the maximum number of significant digits printed.	Six significant digits are printed, with any trailing zeros truncated.
s, S	The precision specifies the maximum number of characters to be printed. Characters in excess of *precision* are not printed.	Characters are printed until a null character is encountered.

If the argument corresponding to a floating-point specifier is infinite, indefinite, or NaN, **printf** gives the following output.

Value	Output
+ infinity	**1.#INF***random-digits*
– infinity	**–1.#INF***random-digits*
Indefinite (same as quiet NaN)	*digit.*#**IND***random-digits*
NAN	*digit.*#**NAN***random-digits*

Size and Distance Specification

The optional prefixes to *type*, **h**, **l**, and **L**, specify the "size" of *argument* (long or short, single-byte character or wide character, depending upon the type specifier that they modify). These type-specifier prefixes are used with type characters in **printf** functions or **wprintf** functions to specify interpretation of arguments, as shown in the following table. These prefixes are Microsoft extensions and are not ANSI-compatible.

Table R.6 Size Prefixes for printf and wprintf Format-Type Specifiers

To Specify	Use Prefix	With Type Specifier
long int	**l**	**d**, **i**, **o**, **x**, or **X**
long unsigned int	**l**	**u**
short int	**h**	**d**, **i**, **o**, **x**, or **X**
short unsigned int	**h**	**u**
__int64	**I64**	**d**, **i**, **o**, **u**, **x**, or **X**
Single-byte character with **printf** functions	**h**	**c** or **C**
Single-byte character with **wprintf** functions	**h**	**c** or **C**
Wide character with **printf** functions	**l**	**c** or **C**
Wide character with **wprintf** functions	**l**	**c** or **C**
Single-byte–character string with **printf** functions	**h**	**s** or **S**
Single-byte–character string with **wprintf** functions	**h**	**s** or **S**
Wide-character string with **printf** functions	**l**	**s** or **S**
Wide-character string with **wprintf** functions	**l**	**s** or **S**

Thus to print single-byte or wide-characters with **printf** functions and **wprintf** functions, use format specifiers as follows:

To Print Character As	Use Function	With Format Specifier
single byte	printf	**c**, **hc**, or **hC**
single byte	wprintf	**C**, **hc**, or **hC**
wide	wprintf	**c**, **lc**, or **lC**
wide	printf	**C**, **lc**, or **lC**

To print strings with **printf** functions and **wprintf** functions, use the prefixes **h** and **l** analogously with format type-specifiers **s** and **S**.

putc, putwc, putchar, putwchar

Writes a character to a stream (**putc**, **putwc**) or to **stdout** (**putchar**, **putwchar**).

int putc(int *c*, **FILE** **stream* **);**
wint_t putwc(wint_t *c*, **FILE** **stream* **);**
int putchar(int *c* **);**
wint_t putwchar(wint_t *c* **);**

Routine	Required Header	Compatibility
putc	<stdio.h>	ANSI, Win 95, Win NT
putwc	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT
putchar	<stdio.h>	ANSI, Win 95, Win NT
putwchar	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the character written. To indicate an error or end-of-file condition, **putc** and **putchar** return **EOF**; **putwc** and **putwchar** return **WEOF**. For all four routines, use **ferror** or **feof** to check for an error or end of file.

Parameters

c Character to be written

stream Pointer to **FILE** structure

Remarks

The **putc** routine writes the single character *c* to the output *stream* at the current position. Any integer can be passed to **putc**, but only the lower 8 bits are written. The **putchar** routine is identical to **putc(** *c*, **stdout)**. For each routine, if a read error occurs, the error indicator for the stream is set. **putc** and **putchar** are similar to **fputc** and **_fputchar**, respectively, but are implemented both as functions and as macros (see "Choosing Between Functions and Macros" on page xiii). **putwc** and **putwchar** are wide-character versions of **putc** and **putchar**, respectively.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_puttc	putc	putc	putwc
_puttchar	putchar	putchar	putwchar

Example

```
/* PUTC.C: This program uses putc to write buffer
 * to a stream. If an error occurs, the program
 * stops before writing the entire buffer.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char *p, buffer[] = "This is the line of output\n";
   int  ch;

   ch = 0;
   /* Make standard out the stream and write to it. */
   stream = stdout;
   for( p = buffer; (ch != EOF) && (*p != '\0'); p++ )
      ch = putc( *p, stream );
}
```

Output

```
This is the line of output
```

See Also: **fputc, getc**

_putch

Writes a character to the console.

int _putch(int *c* **);**

Routine	Required Header	Compatibility
_putch	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The function returns *c* if successful, and **EOF** if not.

Parameter

c Character to be output

Remarks

The **_putch** function writes the character *c* directly (without buffering) to the console.

Example

```
/* GETCH.C: This program reads characters from
 * the keyboard until it receives a 'Y' or 'y'.
 */

#include <conio.h>
#include <ctype.h>

void main( void )
{
   int ch;

   _cputs( "Type 'Y' when finished typing keys: " );
   do
   {
      ch = _getch();
      ch = toupper( ch );
   } while( ch != 'Y' );

   _putch( ch );
   _putch( '\r' );    /* Carriage return */
   _putch( '\n' );    /* Line feed       */
}
```

Output

```
Type 'Y' when finished typing keys: Y
```

See Also: _cprintf, _getch

_putenv, _wputenv

Creates new environment variables; modifies or removes existing ones.

int _putenv(const char *_*envstring* _);
int _wputenv(const wchar_t *_*envstring* _);

Routine	Required Header	Compatibility
_putenv	<stdlib.h>	Win 95, Win NT
_wputenv	<stdlib.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_putenv and **_wputenv** return 0 if successful, or –1 in the case of an error.

Parameter

envstring Environment-string definition

Remarks

The **_putenv** function adds new environment variables or modifies the values of existing environment variables. Environment variables define the environment in which a process executes (for example, the default search path for libraries to be linked with a program). **_wputenv** is a wide-character version of **_putenv**; the *envstring* argument to **_wputenv** is a wide-character string.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tputenv	_putenv	_putenv	_wputenv

The *envstring* argument must be a pointer to a string of the form *varname=string*, where *varname* is the name of the environment variable to be added or modified and *string* is the variable's value. If *varname* is already part of the environment, its value is replaced by *string*; otherwise, the new *varname* variable and its *string* value are added to the environment. You can remove a variable from the environment by specifying an empty *string*—in other words, by specifying only *varname=*.

_putenv and **_wputenv** affect only the environment that is local to the current process; you cannot use them to modify the command-level environment. That is, these functions operate only on data structures accessible to the run-time library and not on the environment "segment" created for a process by the operating system. When the current process terminates, the environment reverts to the level of the calling process (in most cases, the operating-system level). However, the modified environment can be passed to any new processes created by **_spawn**, **_exec**, or **system**, and these new processes get any new items added by **_putenv** and **_wputenv**.

With regard to environment entries, observe the following cautions:

- Do not change an environment entry directly; instead, use **_putenv** or **_wputenv** to change it. To modify the return value of **_putenv** or **_wputenv** without affecting the environment table, use **_strdup** or **strcpy** to make a copy of the string.
- Never free a pointer to an environment entry, because the environment variable will then point to freed space. A similar problem can occur if you pass **_putenv** or **_wputenv** a pointer to a local variable, then exit the function in which the variable is declared.

getenv and **_putenv** use the global variable **_environ** to access the environment table; **_wgetenv** and **_wputenv** use **_wenviron**. **_putenv** and **_wputenv** may change the value of **_environ** and **_wenviron**, thus invalidating the *envp* argument to **main** and the*_wenvp* argument to **wmain**. Therefore, it is safer to use **_environ** or **_wenviron** to access the environment information. For more information about the relation of **_putenv** and **_wputenv** to global variables, see **_environ, _wenviron**.

Example

```
/* GETENV.C: This program uses getenv to retrieve
 * the LIB environment variable and then uses
 * _putenv to change it to a new value.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char *libvar;

   /* Get the value of the LIB environment variable. */
   libvar = getenv( "LIB" );

   if( libvar != NULL )
      printf( "Original LIB variable is: %s\n", libvar );

   /* Attempt to change path. Note that this only affects the environment
    * variable of the current process. The command processor's environment
    * is not changed.
    */
   _putenv( "LIB=c:\\mylib;c:\\yourlib" );

   /* Get new value. */
   libvar = getenv( "LIB" );

   if( libvar != NULL )
      printf( "New LIB variable is: %s\n", libvar );
}
```

Output

```
Original LIB variable is: C:\progra~1\devstu~1\vc\lib
New LIB variable is: c:\mylib;c:\yourlib
```

See Also: **getenv**, **_searchenv**

---

puts, _putws

Write a string to **stdout**.

int puts(const char **string* **);**
int _putws(const wchar_t **string* **);**

Routine	Required Header	Compatibility
puts	<stdio.h>	ANSI, Win 95, Win NT
_putws	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these returns a nonnegative value if successful. If **puts** fails it returns **EOF**; if **_putws** fails it returns **WEOF**.

Parameter

string Output string

Remarks

The **puts** function writes *string* to the standard output stream **stdout**, replacing the string's terminating null character ('\0') with a newline character ('\n') in the output stream.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_putts	puts	puts	_putws

Example

```
/* PUTS.C: This program uses puts
 * to write a string to stdout.
 */

#include <stdio.h>

void main( void )
{
   puts( "Hello world from puts!" );
}
```

Output

```
Hello world from puts!
```

See Also: fputs, gets

_putw

Writes an integer to a stream.

int _putw(int *binint*, FILE **stream*);

Routine	Required Header	Compatibility
_putw	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_putw returns the value written. A return value of **EOF** may indicate an error. Because **EOF** is also a legitimate integer value, use **ferror** to verify an error.

Parameters

binint Binary integer to be output

stream Pointer to **FILE** structure

Remarks

The **_putw** function writes a binary value of type **int** to the current position of *stream*. **_putw** does not affect the alignment of items in the stream, nor does it assume any special alignment. **_putw** is primarily for compatibility with previous libraries. Portability problems may occur with **_putw** because the size of an **int** and the ordering of bytes within an **int** differ across systems.

Example

```
/* PUTW.C: This program uses _putw to write a
 * word to a stream, then performs an error check.
 */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   FILE *stream;
   unsigned u;
   if( (stream = fopen( "data.out", "wb" )) == NULL )
      exit( 1 );
   for( u = 0; u << 10; u++ )
   {
      _putw( u + 0x2132, stdout );
      _putw( u + 0x2132, stream );   /* Write word to stream. */
      if( ferror( stream ) )         /* Make error check. */
      {
         printf( "_putw failed" );
         clearerr( stream );
         exit( 1 );
      }
   }
   printf( "\nWrote ten words\n" );
   fclose( stream );
}
```

Output

```
Wrote ten words
```

See Also: _getw

---

qsort

Performs a quick sort.

void qsort(void **base*, **size_t** *num*, **size_t** *width*, **int (__cdecl** **compare* **)(const void** ↪ **elem1*, **const void** **elem2* **));**

Routine	Required Header	Compatibility
qsort	<stdlib.h> and <search.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

base Start of target array

num Array size in elements

width Element size in bytes

compare Comparison function

elem1 Pointer to the key for the search

elem2 Pointer to the array element to be compared with the key

Remarks

The **qsort** function implements a quick-sort algorithm to sort an array of *num* elements, each of *width* bytes. The argument *base* is a pointer to the base of the array to be sorted. **qsort** overwrites this array with the sorted elements. The argument *compare* is a pointer to a user-supplied routine that compares two array elements and returns a value specifying their relationship. **qsort** calls the *compare* routine one or more times during the sort, passing pointers to two array elements on each call:

compare(**(void *)** *elem1*, **(void *)** *elem2*);

The routine must compare the elements, then return one of the following values:

Return Value	Description
< 0	*elem1* less than *elem2*
0	*elem1* equivalent to *elem2*
> 0	*elem1* greater than *elem2*

The array is sorted in increasing order, as defined by the comparison function. To sort an array in decreasing order, reverse the sense of "greater than" and "less than" in the comparison function.

Example

```
/* QSORT.C: This program reads the command-line
 * parameters and uses qsort to sort them. It
 * then displays the sorted arguments.
 */

#include <stdlib.h>
#include <string.h>
#include <stdio.h>

int compare( const void *arg1, const void *arg2 );

void main( int argc, char **argv )
{
   int i;
   /* Eliminate argv[0] from sort: */
   argv++;
   argc--;

   /* Sort remaining args using Quicksort algorithm: */
   qsort( (void *)argv, (size_t)argc, sizeof( char * ), compare );

   /* Output sorted list: */
   for( i = 0; i < argc; ++i )
      printf( "%s ", argv[i] );
   printf( "\n" );
}

int compare( const void *arg1, const void *arg2 )
{
   /* Compare all of both strings: */
   return _stricmp( * ( char** ) arg1, * ( char** ) arg2 );
}
```

Output

```
[C:\code]qsort every good boy deserves favor
boy deserves every favor good
```

See Also: bsearch, _lsearch

_query_new_handler

Returns address of current new handler routine.

_PNH _query_new_handler(void);

Routine	Required Header	Compatibility
_query_new_handler	<new.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_query_new_handler returns the address of the current new handler routine as set by **_set_new_handler**.

Remarks

The C++ **_query_new_handler** function returns the address of the current exception-handling function set by the C++ **_set_new_handler** function. **_set_new_handler** is used to specify an exception-handling function that is to gain control if the **new** operator fails to allocate memory. For more information, see the discussions of the **operator new** and **operator delete** functions in *C++ Language Reference*.

See Also: **free**

_query_new_mode

Returns an integer indicating new handler mode set by **_set_new_mode** for **malloc**.

int _query_new_mode(void);

Routine	Required Header	Compatibility
_query_new_mode	<new.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_query_new_mode returns the current new handler mode, namely 0 or 1, for **malloc**. A return value of 1 indicates that, on failure to allocate memory, **malloc** calls the new handler routine; a return value of 0 indicates that it does not.

Remarks

The C++ **_query_new_mode** function returns an integer that indicates the new handler mode that is set by the C++ **_set_new_mode** function for **malloc**. The new handler mode indicates whether, on failure to allocate memory, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure. You can use **_set_new_mode** to override this behavior so that on failure **malloc** calls the new handler routine in the same way that the **new** operator does when it fails to allocate memory. For more information, see the **operator delete** and **operator new** functions in *C++ Language Reference*.

See Also: **calloc, free, realloc, _query_new_handler**

---

raise

Sends a signal to the executing program.

int raise(int *sig* **);**

Routine	Required Header	Compatibility
raise	<signal.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **raise** returns 0. Otherwise, it returns a nonzero value.

Parameter

sig Signal to be raised

Remarks

The **raise** function sends *sig* to the executing program. If a previous call to **signal** has installed a signal-handling function for *sig*, **raise** executes that function. If no handler function has been installed, the default action associated with the signal value *sig* is taken, as follows:

Signal	Meaning	Default
SIGABRT	Abnormal termination	Terminates the calling program with exit code 3
SIGFPE	Floating-point error	Terminates the calling program
SIGILL	Illegal instruction	Terminates the calling program
SIGINT	CTRL+C interrupt	Terminates the calling program
SIGSEGV	Illegal storage access	Terminates the calling program
SIGTERM	Termination request sent to the program	Ignores the signal

See Also: abort, signal

rand

Generates a pseudorandom number.

int rand(void);

Routine	Required Header	Compatibility
rand	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

rand returns a pseudorandom number, as described above. There is no error return.

Remarks

The **rand** function returns a pseudorandom integer in the range 0 to **RAND_MAX**. Use the **srand** function to seed the pseudorandom-number generator before calling **rand**.

Example

```
/* RAND.C: This program seeds the random-number generator
 * with the time, then displays 10 random integers.
 */

#include <stdlib.h>
#include <stdio.h>
#include <time.h>

void main( void )
{
   int i;
```

```
    /* Seed the random-number generator with current time so that
     * the numbers will be different every time we run.
     */
    srand( (unsigned)time( NULL ) );

    /* Display 10 numbers. */
    for( i = 0;   i < 10;i++ )
       printf( "  %6d\n", rand() );
}
```

Output

```
 6929
 8026
21987
30734
20587
 6699
22034
25051
 7988
10104
```

See Also: **srand**

_read

Reads data from a file.

int _read(int *handle*, **void** **buffer*, **unsigned int** *count* **);**

Routine	Required Header	Compatibility
_read	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_read returns the number of bytes read, which may be less than *count* if there are fewer than *count* bytes left in the file or if the file was opened in text mode, in which case each carriage return–linefeed (CR-LF) pair is replaced with a single linefeed character. Only the single linefeed character is counted in the return value. The replacement does not affect the file pointer.

If the function tries to read at end of file, it returns 0. If the *handle* is invalid, or the file is not open for reading, or the file is locked, the function returns –1 and sets **errno** to **EBADF**.

Parameters

handle Handle referring to open file

buffer Storage location for data

count Maximum number of bytes

Remarks

The **_read** function reads a maximum of *count* bytes into *buffer* from the file associated with *handle*. The read operation begins at the current position of the file pointer associated with the given file. After the read operation, the file pointer points to the next unread character.

If the file was opened in text mode, the read terminates when **_read** encounters a CTRL+Z character, which is treated as an end-of-file indicator. Use **_lseek** to clear the end-of-file indicator.

Example

```
/* READ.C: This program opens a file named
 * READ.C and tries to read 60,000 bytes from
 * that file using _read. It then displays the
 * actual number of bytes read from READ.C.
 */

#include <fcntl.h>      /* Needed only for _O_RDWR definition */
#include <io.h>
#include <stdlib.h>
#include <stdio.h>

char buffer[60000];

void main( void )
{
   int fh;
   unsigned int nbytes = 60000, bytesread;

   /* Open file for input: */
   if( (fh = _open( "read.c", _O_RDONLY )) == -1 )
   {
      perror( "open failed on input file" );
      exit( 1 );
   }

   /* Read in input: */
   if( ( bytesread = _read( fh, buffer, nbytes ) ) <= 0 )
      perror( "Problem reading file" );
     else
      printf( "Read %u bytes from file\n", bytesread );

   _close( fh );
}
```

Output

```
Read 775 bytes from file
```

See Also: _creat, fread, _open, _write

realloc

Reallocate memory blocks.

void *realloc(void **memblock*, **size_t** *size* **);**

Routine	Required Header	Compatibility
realloc	<stdlib.h> and <malloc.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

realloc returns a **void** pointer to the reallocated (and possibly moved) memory block. The return value is **NULL** if the size is zero and the buffer argument is not **NULL**, or if there is not enough available memory to expand the block to the given size. In the first case, the original block is freed. In the second, the original block is unchanged. The return value points to a storage space that is guaranteed to be suitably aligned for storage of any type of object. To get a pointer to a type other than **void**, use a type cast on the return value.

Parameters

memblock Pointer to previously allocated memory block

size New size in bytes

Remarks

The **realloc** function changes the size of an allocated memory block. The *memblock* argument points to the beginning of the memory block. If *memblock* is **NULL**, **realloc** behaves the same way as **malloc** and allocates a new block of *size* bytes. If *memblock* is not **NULL**, it should be a pointer returned by a previous call to **calloc**, **malloc**, or **realloc**.

The *size* argument gives the new size of the block, in bytes. The contents of the block are unchanged up to the shorter of the new and old sizes, although the new block can be in a different location. Because the new block can be in a new memory location, the pointer returned by **realloc** is not guaranteed to be the pointer passed through the *memblock* argument.

realloc calls **malloc** in order to use the C++ **_set_new_mode** function to set the new handler mode. The new handler mode indicates whether, on failure, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure to allocate memory. You can override this default

behavior so that, when **realloc** fails to allocate memory, **malloc** calls the new handler routine in the same way that the **new** operator does when it fails for the same reason. To override the default, call

```
_set_new_mode(1)
```

early in your program, or link with NEWMODE.OBJ.

When the application is linked with a debug version of the C run-time libraries, **realloc** resolves to **_realloc_dbg**.

Example

```
/* REALLOC.C: This program allocates a block of memory for
 * buffer and then uses _msize to display the size of that
 * block. Next, it uses realloc to expand the amount of
 * memory used by buffer and then calls _msize again to
 * display the new amount of memory allocated to buffer.
 */

#include <stdio.h>
#include <malloc.h>
#include <stdlib.h>

void main( void )
{
   long *buffer;
   size_t size;

   if( (buffer = (long *)malloc( 1000 * sizeof( long ) )) == NULL )
      exit( 1 );

   size = _msize( buffer );
   printf( "Size of block after malloc of 1000 longs: %u\n", size );

   /* Reallocate and show new size: */
   if( (buffer = realloc( buffer, size + (1000 * sizeof( long )) ))
      == NULL )
      exit( 1 );
   size = _msize( buffer );
   printf( "Size of block after realloc of 1000 more longs: %u\n",
            size );

   free( buffer );
   exit( 0 );
}
```

Output

```
Size of block after malloc of 1000 longs: 4000
Size of block after realloc of 1000 more longs: 8000
```

See Also: calloc, free, malloc

remove, _wremove

Delete a file.

int remove(const char **path* **);**
int _wremove(const wchar_t **path* **);**

Routine	Required Header	Compatibility
remove	<stdio.h> or <io.h>	ANSI, Win 95, Win NT
_wremove	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the file is successfully deleted. Otherwise, it returns –1 and sets **errno** either to **EACCES** to indicate that the path specifies a read-only file, or to **ENOENT** to indicate that the filename or path was not found or that the path specifies a directory.

Parameter

path Path of file to be removed

Remarks

The **remove** function deletes the file specified by *path.* **_wremove** is a wide-character version of **_remove**; the *path* argument to **_wremove** is a wide-character string. **_wremove** and **_remove** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tremove	remove	remove	_wremove

Example

```
/* REMOVE.C: This program uses remove to delete REMOVE.OBJ. */

#include <stdio.h>

void main( void )
{
   if( remove( "remove.obj" ) == -1 )
      perror( "Could not delete 'REMOVE.OBJ'" );
   else
      printf( "Deleted 'REMOVE.OBJ'\n" );
}
```

Output

```
Deleted 'REMOVE.OBJ'
```

See Also: _unlink

rename, _wrename

Rename a file or directory.

int rename(const char **oldname*, **const char** **newname* **);**
int _wrename(const wchar_t **oldname*, **const wchar_t** **newname* **);**

Routine	Required Header	Compatibility
rename	<io.h> or <stdio.h>	ANSI, Win 95, Win NT
_wrename	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if it is successful. On an error, the function returns a nonzero value and sets **errno** to one of the following values:

EACCES File or directory specified by *newname* already exists or could not be created (invalid path); or *oldname* is a directory and *newname* specifies a different path.

ENOENT File or path specified by *oldname* not found.

Parameters

oldname Pointer to old name

newname Pointer to new name

Remarks

The **rename** function renames the file or directory specified by *oldname* to the name given by *newname*. The old name must be the path of an existing file or directory. The new name must not be the name of an existing file or directory. You can use **rename** to move a file from one directory or device to another by giving a different path in the *newname* argument. However, you cannot use **rename** to move a directory. Directories can be renamed, but not moved.

_wrename is a wide-character version of **_rename**; the arguments to **_wrename** are wide-character strings. **_wrename** and **_rename** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_trename	rename	rename	_wrename

Example

```
/* RENAMER.C: This program attempts to rename a file
 * named RENAMER.OBJ to RENAMER.JBO. For this operation
 * to succeed, a file named RENAMER.OBJ must exist and
 * a file named RENAMER.JBO must not exist.
 */

#include <stdio.h>

void main( void )
{
   int  result;
   char old[] = "RENAMER.OBJ", new[] = "RENAMER.JBO";

   /* Attempt to rename file: */
   result = rename( old, new );
   if( result != 0 )
      printf( "Could not rename '%s'\n", old );
   else
      printf( "File '%s' renamed to '%s'\n", old, new );
}
```

Output

```
File 'RENAMER.OBJ' renamed to 'RENAMER.JBO'
```

rewind

Repositions the file pointer to the beginning of a file.

void rewind(FILE **stream* **);**

Routine	Required Header	Compatibility
rewind	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

stream Pointer to **FILE** structure

Remarks

The **rewind** function repositions the file pointer associated with *stream* to the beginning of the file. A call to **rewind** is similar to

(void) fseek(*stream*, **0L, SEEK_SET);**

However, unlike **fseek**, **rewind** clears the error indicators for the stream as well as the end-of-file indicator. Also, unlike **fseek**, **rewind** does not return a value to indicate whether the pointer was successfully moved.

To clear the keyboard buffer, use **rewind** with the stream **stdin**, which is associated with the keyboard by default.

Example

```
/* REWIND.C: This program first opens a file named
 * REWIND.OUT for input and output and writes two
 * integers to the file. Next, it uses rewind to
 * reposition the file pointer to the beginning of
 * the file and reads the data back in.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   int data1, data2;

   data1 = 1;
   data2 = -37;

   if( (stream = fopen( "rewind.out", "w+" )) != NULL )
   {
      fprintf( stream, "%d %d", data1, data2 );
      printf( "The values written are: %d and %d\n", data1, data2 );
      rewind( stream );
      fscanf( stream, "%d %d", &data1, &data2 );
      printf( "The values read are: %d and %d\n", data1, data2 );
      fclose( stream );
   }
}
```

Output

```
The values written are: 1 and -37
The values read are: 1 and -37
```

_rmdir, _wrmdir

Delete a directory.

int _rmdir(const char **dirname* **);**
int _wrmdir(const wchar_t **dirname* **);**

Routine	Required Header	Compatibility
_rmdir	<direct.h>	Win 95, Win NT
_wrmdir	<direct.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the directory is successfully deleted. A return value of –1 indicates an error, and **errno** is set to one of the following values:

ENOTEMPTY Given path is not a directory; directory is not empty; or directory is either current working directory or root directory.

ENOENT Path is invalid.

Parameter

dirname Path of directory to be removed

Remarks

The **_rmdir** function deletes the directory specified by *dirname*. The directory must be empty, and it must not be the current working directory or the root directory.

_wrmdir is a wide-character version of **_rmdir**; the *dirname* argument to **_wrmdir** is a wide-character string. **_wrmdir** and **_rmdir** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_trmdir	_rmdir	_rmdir	_wrmdir

Example

```
/* MAKEDIR.C */

#include <direct.h>
#include <stdlib.h>
#include <stdio.h>
```

```
void main( void )
{
   if( _mkdir( "\\testtmp" ) == 0 )
   {
      printf( "Directory '\\testtmp' was successfully created\n" );
      system( "dir \\testtmp" );
      if( _rmdir( "\\testtmp" ) == 0 )
         printf( "Directory '\\testtmp' was successfully removed\n"  );
      else
         printf( "Problem removing directory '\\testtmp'\n" );
   }
   else
      printf( "Problem creating directory '\\testtmp'\n" );
}
```

Output

```
Directory '\testtmp' was successfully created
 Volume in drive C is CDRIVE
 Volume Serial Number is 0E17-1702

 Directory of C:\testtmp

05/03/94  12:30p        <DIR>          .
05/03/94  12:30p        <DIR>          ..
               2 File(s)          0 bytes
                             17,358,848 bytes free
Directory '\testtmp' was successfully removed
```

See Also: _chdir, _mkdir

_rmtmp

Removes temporary files.

int _rmtmp(void);

Routine	Required Header	Compatibility
_rmtmp	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_rmtmp returns the number of temporary files closed and deleted.

Remarks

The **_rmtmp** function cleans up all temporary files in the current directory. The function removes only those files created by **tmpfile**; use it only in the same directory in which the temporary files were created.

Example

```
/* TMPFILE.C: This program uses tmpfile to create a
 * temporary file, then deletes this file with _rmtmp.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char tempstring[] = "String to be written";
   int  i;

   /* Create temporary files. */
   for( i = 1; i <= 3; i++ )
   {
      if( (stream = tmpfile()) == NULL )
         perror( "Could not open new temporary file\n" );
      else
         printf( "Temporary file %d was created\n", i );
   }

   /* Remove temporary files. */
   printf( "%d temporary files deleted\n", _rmtmp() );
}
```

Output

```
Temporary file 1 was created
Temporary file 2 was created
Temporary file 3 was created
3 temporary files deleted
```

See Also: _flushall, tmpfile, tmpnam

_rotl, _rotr

Rotate bits to the left (**_rotl**) or right (**_rotr**).

unsigned int _rotl(unsigned int *value*, **int** *shift* **);**
unsigned int _rotr(unsigned int *value*, **int** *shift* **);**

Routine	Required Header	Compatibility
_rotl	<stdlib.h>	Win 95, Win NT
_rotr	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Both functions return the rotated value. There is no error return.

Parameters

value Value to be rotated

shift Number of bits to shift

Remarks

The **_rotl** and **_rotr** functions rotate the unsigned *value* by *shift* bits. **_rotl** rotates the value left. **_rotr** rotates the value right. Both functions "wrap" bits rotated off one end of *value* to the other end.

Example

```
/* ROT.C: This program uses _rotr and _rotl with
 * different shift values to rotate an integer.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   unsigned val = 0x0fd93;
   printf( "0x%4.4x rotated left three times is 0x%4.4x\n",
           val, _rotl( val, 3 ) );
   printf( "0x%4.4x rotated right four times is 0x%4.4x\n",
           val, _rotr( val, 4 ) );
}
```

Output

```
0xfd93 rotated left three times is 0x7ec98
0xfd93 rotated right four times is 0x30000fd9
```

See Also: _lrotl

_scalb

Scales argument by a power of 2.

double _scalb(double *x*, **long** *exp* **);**

Routine	Required Header	Compatibility
_scalb	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_scalb returns an exponential value if successful. On overflow (depending on the sign of *x*), **_scalb** returns +/–**HUGE_VAL**; the **errno** variable is set to **ERANGE**.

Parameters

x Double-precision floating-point value

exp Long integer exponent

Remarks

The **_scalb** function calculates the value of $x * 2^{exp}$.

See Also: ldexp

scanf, wscanf

Read formatted data from the standard input stream.

int scanf(const char **format* [,*argument*]... **);**
int wscanf(const wchar_t **format* [,*argument*]... **);**

Routine	Required Header	Compatibility
scanf	<stdio.h>	ANSI, Win 95, Win NT
wscanf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Both **scanf** and **wscanf** return the number of fields successfully converted and assigned; the return value does not include fields that were read but not assigned. A return value of 0 indicates that no fields were assigned. The return value is **EOF** for an error or if the end-of-file character or the end-of-string character is encountered in the first attempt to read a character.

Parameters

format Format control string

argument Optional arguments

Remarks

The **scanf** function reads data from the standard input stream **stdin** and writes the data into the location given by *argument*. Each *argument* must be a pointer to a variable of a type that corresponds to a type specifier in *format*. If copying takes place between strings that overlap, the behavior is undefined.

wscanf is a wide-character version of **scanf**; the *format* argument to **wscanf** is a wide-character string. **wscanf** and **scanf** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tscanf	scanf	scanf	wscanf

For more information, see "Format Specification Fields—**scanf** functions and **wscanf** functions" on page 495.

Example

```
/* SCANF.C: This program uses the scanf and wscanf functions
 * to read formatted input.
 */

#include <stdio.h>

void main( void )
{
   int   i, result;
   float fp;
   char  c, s[81];
   wchar_t wc, ws[81];

   printf( "\n\nEnter an int, a float, two chars and two strings\n");

   result = scanf( "%d %f %c %C %s %S", &i, &fp, &c, &wc, s, ws );
   printf( "\nThe number of fields input is %d\n", result );
   printf( "The contents are: %d %f %c %C %s %S\n", i, fp, c, wc, s, ws);

   wprintf( L"\n\nEnter an int, a float, two chars and two strings\n");

   result = wscanf( L"%d %f %hc %lc %S %ls", &i, &fp, &c, &wc, s, ws );
   wprintf( L"\nThe number of fields input is %d\n", result );
   wprintf( L"The contents are: %d %f %C %c %hs %s\n", i, fp, c, wc, s, ws);
}
```

Output

```
Enter an int, a float, two chars and two strings
71
98.6
h
z
Byte characters

The number of fields input is 6
The contents are: 71 98.599998 h z Byte characters

Enter an int, a float, two chars and two strings
36
92.3
y
n
Wide characters

The number of fields input is 6
The contents are: 456 92.300003 y n Wide characters
```

See Also: fscanf, printf, sprintf, sscanf

Format Specification Fields: scanf and wscanf Functions

A format specification has the following form:

%[*] [*width*] [{**h** | **l** | **I64** | **L**}]*type*

The *format* argument specifies the interpretation of the input and can contain one or more of the following:

- White-space characters: blank (' '); tab ('\t'); or newline ('\n'). A white-space character causes **scanf** to read, but not store, all consecutive white-space characters in the input up to the next non–white-space character. One white-space character in the format matches any number (including 0) and combination of white-space characters in the input.
- Non–white-space characters, except for the percent sign (%). A non–white-space character causes **scanf** to read, but not store, a matching non–white-space character. If the next character in **stdin** does not match, **scanf** terminates.
- Format specifications, introduced by the percent sign (%). A format specification causes **scanf** to read and convert characters in the input into values of a specified type. The value is assigned to an argument in the argument list.

The format is read from left to right. Characters outside format specifications are expected to match the sequence of characters in **stdin**; the matching characters in **stdin** are scanned but not stored. If a character in **stdin** conflicts with the format specification, **scanf** terminates, and the character is left in **stdin** as if it had not been read.

When the first format specification is encountered, the value of the first input field is converted according to this specification and stored in the location that is specified by the first *argument*. The second format specification causes the second input field to be converted and stored in the second *argument*, and so on through the end of the format string.

An input field is defined as all characters up to the first white-space character (space, tab, or newline), or up to the first character that cannot be converted according to the format specification, or until the field width (if specified) is reached. If there are too many arguments for the given specifications, the extra arguments are evaluated but ignored. The results are unpredictable if there are not enough arguments for the format specification.

Each field of the format specification is a single character or a number signifying a particular format option. The *type* character, which appears after the last optional format field, determines whether the input field is interpreted as a character, a string, or a number.

The simplest format specification contains only the percent sign and a *type* character (for example, `%s`). If a percent sign (`%`) is followed by a character that has no meaning as a format-control character, that character and the following characters (up to the next percent sign) are treated as an ordinary sequence of characters, that is, a sequence of characters that must match the input. For example, to specify that a percent-sign character is to be input, use `%%`.

An asterisk (*) following the percent sign suppresses assignment of the next input field, which is interpreted as a field of the specified type. The field is scanned but not stored.

scanf Type Field Characters

The *type* character is the only required format field; it appears after any optional format fields. The *type* character determines whether the associated argument is interpreted as a character, string, or number.

Table R.7 Type Characters for scanf functions

Character	Type of Input Expected	Type of Argument
c	When used with **scanf** functions, specifies single-byte character; when used with **wscanf** functions, specifies wide character. White-space characters that are ordinarily skipped are read when **c** is specified. To read next non–white- space single-byte character, use **%1s**; to read next non–white-space wide character, use **%1ws**.	Pointer to **char** when used with **scanf** functions, pointer to **wchar_t** when used with **wscanf** functions.

(continued)

Table R.7 Type Characters for scanf functions *(continued)*

Character	Type of Input Expected	Type of Argument
C	When used with **scanf** functions, specifies wide character; when used with **wscanf** functions, specifies single-byte character. White-space characters that are ordinarily skipped are read when **C** is specified. To read next non–white-space single-byte character, use **%1s**; to read next non–white-space wide character, use **%1ws**.	Pointer to **wchar_t** when used with **scanf** functions, pointer to **char** when used with **wscanf** functions.
d	Decimal integer.	Pointer to **int**.
i	Decimal, hexadecimal, or octal integer.	Pointer to **int**.
o	Octal integer.	Pointer to **int**.
u	Unsigned decimal integer.	Pointer to **unsigned int**.
x	Hexadecimal integer.	Pointer to **int**.
e, E, f, g, G	Floating-point value consisting of optional sign (+ or –), series of one or more decimal digits containing decimal point, and optional exponent ("e" or "E") followed by an optionally signed integer value.	Pointer to **float**.
n	No input read from stream or buffer.	Pointer to **int**, into which is stored number of characters successfully read from stream or buffer up to that point in current call to **scanf** functions or **wscanf** functions.
s	String, up to first white-space character (space, tab or newline). To read strings not delimited by space characters, use set of square brackets ([ ]), as discussed following Table R.8.	When used with **scanf** functions, signifies single-byte character array; when used with **wscanf** functions, signifies wide-character array. In either case, character array must be large enough for input field plus terminating null character, which is automatically appended.
S	String, up to first white-space character (space, tab or newline). To read strings not delimited by space characters, use set of square brackets ([ ]), as discussed preceding this table.	When used with **scanf** functions, signifies wide-character array; when used with **wscanf** functions, signifies single-byte–character array. In either case, character array must be large enough for input field plus terminating null character, which is automatically appended.

The types **c**, **C**, **s**, and **S** are Microsoft extensions and are not ANSI-compatible.

Thus, to read single-byte or wide characters with **scanf** functions and **wscanf** functions, use format specifiers as follows:

To Read Character As	Use This Function	With These Format Specifiers
single byte	**scanf** functions	**c**, **hc**, or **hC**
single byte	**wscanf** functions	**C**, **hc**, or **hC**
wide	**wscanf** functions	**c**, **lc**, or **lC**
wide	**scanf** functions	**C**, **lc**, or **lC**

To scan strings with **scanf** functions, and **wscanf** functions, use the prefixes **h** and **l** analogously with format type-specifiers **s** and **S**.

scanf Width Specification

width is a positive decimal integer controlling the maximum number of characters to be read from **stdin**. No more than *width* characters are converted and stored at the corresponding *argument*. Fewer than *width* characters may be read if a white-space character (space, tab, or newline) or a character that cannot be converted according to the given format occurs before *width* is reached.

The optional prefixes **h**, **l**, **I64**, and **L** indicate the "size" of the *argument* (long or short, single-byte character or wide character, depending upon the type character that they modify). These format-specification characters are used with type characters in **scanf** or **wscanf** functions to specify interpretation of arguments as shown in the Table R.8. The type prefixes **h**, **l**, **I64**, and **L** are Microsoft extensions and are not ANSI-compatible. The type characters and their meanings are described in Table R.7.

Table R.8 Size Prefixes for scanf and wscanf Format-Type Specifiers

To Specify	Use Prefix	With Type Specifier
double	**l**	**e**, **E**, **f**, **g**, or **G**
long int	**l**	**d**, **i**, **o**, **x**, or **X**
long unsigned int	**l**	**u**
short int	**h**	**d**, **i**, **o**, **x**, or **X**
short unsigned int	**h**	**u**
__int64	**I64**	**d**, **i**, **o**, **u**, **x**, or **X**
Single-byte character with **scanf**	**h**	**c** or **C**
Single-byte character with **wscanf**	**h**	**c** or **C**
Wide character with **scanf**	**l**	**c** or **C**
Wide character with **wscanf**	**l**	**c**, or **C**
Single-byte–character string with **scanf**	**h**	**s** or **S**
Single-byte–character string with **wscanf**	**h**	**s** or **S**
Wide-character string with **scanf**	**l**	**s** or **S**
Wide-character string with **wscanf**	**l**	**s** or **S**

Following are examples of the use of **h** and **l** with **scanf** functions and **wscanf** functions:

```
scanf( "%ls", &x );    // Read a wide-character string
wscanf( "%lC", &x );    // Read a single-byte character
```

To read strings not delimited by space characters, a set of characters in brackets ([ ]) can be substituted for the **s** (string) type character. The corresponding input field is read up to the first character that does not appear in the bracketed character set. If the first character in the set is a caret (^), the effect is reversed: The input field is read up to the first character that does appear in the rest of the character set.

Note that **%[a-z]** and **%[z-a]** are interpreted as equivalent to **%[abcde...z]**. This is a common **scanf** function extension, but note that the ANSI standard does not require it.

To store a string without storing a terminating null character ('\0'), use the specification *%n***c** where *n* is a decimal integer. In this case, the **c** type character indicates that the argument is a pointer to a character array. The next *n* characters are read from the input stream into the specified location, and no null character ('\0') is appended. If *n* is not specified, its default value is 1.

The **scanf** function scans each input field, character by character. It may stop reading a particular input field before it reaches a space character for a variety of reasons:

- The specified width has been reached.
- The next character cannot be converted as specified.
- The next character conflicts with a character in the control string that it is supposed to match.
- The next character fails to appear in a given character set.

For whatever reason, when the **scanf** function stops reading an input field, the next input field is considered to begin at the first unread character. The conflicting character, if there is one, is considered unread and is the first character of the next input field or the first character in subsequent read operations on **stdin**.

_searchenv, _wsearchenv

Searches for a file using environment paths.

void _searchenv(const char **filename*, **const char** **varname*, **char** **pathname* **);**
void _wsearchenv(const wchar_t **filename*, **const wchar_t** **varname*, **wchar_t** **pathname* **);**

Routine	Required Header	Compatibility
_searchenv	<stdlib.h>	Win 95, Win NT
_wsearchenv	<stdlib.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

filename Name of file to search for

varname Environment to search

pathname Buffer to store complete path

Remarks

The **_searchenv** routine searches for the target file in the specified domain. The *varname* variable can be any environment or user-defined variable that specifies a list of directory paths, such as **PATH**, **LIB**, and **INCLUDE**.**_searchenv** is case sensitive, so *varname* should match the case of the environment variable.

The routine searches first for the file in the current working directory. If it does not find the file, it looks next through the directories specified by the environment variable. If the target file is in one of those directories, the newly created path is copied into *pathname*. If the *filename* file is not found, *pathname* contains an empty, null-terminated string.

The *pathname* buffer must be large enough to accommodate the full length of the constructed path name. Otherwise, **_searchenv** will overwite the *pathname* buffer resulting in unexpected behavior. This condition can be avoided by ensuring that the length of the constructed path name does not exceed the size of the *pathname* buffer, by calculating the maximum sum of the *filename* and *varname* lengths before calling **_searchenv**.

_wsearchenv is a wide-character version of **_searchenv**; the arguments to **_wsearchenv** are wide-character strings. **_wsearchenv** and **_searchenv** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tsearchenv	_searchenv	_searchenv	_wsearchenv

Example

```
/* SEARCHEN.C: This program searches for a file in
 * a directory specified by an environment variable.
 */

#include <stdlib.h>
#include <stdio.h>
```

```
void main( void )
{
   char pathbuffer[_MAX_PATH];
   char searchfile[] = "CL.EXE";
   char envvar[] = "PATH";

   /* Search for file in PATH environment variable: */
   _searchenv( searchfile, envvar, pathbuffer );
   if( *pathbuffer != '\0' )
      printf( "Path for %s: %s\n", searchfile, pathbuffer );
   else
      printf( "%s not found\n", searchfile );
}
```

Output

```
Path for CL.EXE: C:\msvcnt\c32\bin\CL.EXE
```

See Also: **getenv**, **_putenv**

setbuf

Controls stream buffering.

void setbuf(FILE **stream*, **char** **buffer* **);**

Routine	Required Header	Compatibility
setbuf	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

stream Pointer to **FILE** structure

buffer User-allocated buffer

Remarks

The **setbuf** function controls buffering for *stream*. The *stream* argument must refer to an open file that has not been read or written. If the *buffer* argument is **NULL**, the stream is unbuffered. If not, the buffer must point to a character array of length **BUFSIZ**, where **BUFSIZ** is the buffer size as defined in STDIO.H. The user-specified buffer, instead of the default system-allocated buffer for the given stream, is used for I/O buffering. The **stderr** stream is unbuffered by default, but you can use **setbuf** to assign buffers to **stderr**.

setbuf has been replaced by **setvbuf**, which is the preferred routine for new code. **setbuf** is retained for compatibility with existing code.

Example

```
/* SETBUF.C: This program first opens files named DATA1 and
 * DATA2. Then it uses setbuf to give DATA1 a user-assigned
 * buffer and to change DATA2 so that it has no buffer.
 */

#include <stdio.h>

void main( void )
{
   char buf[BUFSIZ];
   FILE *stream1, *stream2;

   if( ((stream1 = fopen( "data1", "a" )) != NULL) &&
      ((stream2 = fopen( "data2", "w" )) != NULL) )
   {
      /* "stream1" uses user-assigned buffer: */
      setbuf( stream1, buf );
      printf( "stream1 set to user-defined buffer at: %Fp\n", buf );

      /* "stream2" is unbuffered                */
      setbuf( stream2, NULL );
      printf( "stream2 buffering disabled\n" );
      _fcloseall();
   }
}
```

Output

```
stream1 set to user-defined buffer at: 0013FDA0
stream2 buffering disabled
```

See Also: fclose, fflush, fopen, setvbuf

---

setjmp

Saves the current state of the program.

int setjmp(jmp_buf *env* **);**

Routine	Required Header	Compatibility
setjmp	<setjmp.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

setjmp returns 0 after saving the stack environment. If **setjmp** returns as a result of a **longjmp** call, it returns the *value* argument of **longjmp**, or if the *value* argument of **longjmp** is 0, **setjmp** returns 1. There is no error return.

Parameter

env Variable in which environment is stored

Remarks

The **setjmp** function saves a stack environment, which you can subsequently restore using **longjmp**. When used together, **setjmp** and **longjmp** provide a way to execute a "non-local goto." They are typically used to pass execution control to error-handling or recovery code in a previously called routine without using the normal calling or return conventions.

A call to **setjmp** saves the current stack environment in *env*. A subsequent call to **longjmp** restores the saved environment and returns control to the point just after the corresponding **setjmp** call. All variables (except register variables) accessible to the routine receiving control contain the values they had when **longjmp** was called.

setjmp and **longjmp** do not support C++ object semantics. In C++ programs, use the C++ exception-handling mechanism.

Example

```
/* FPRESET.C: This program uses signal to set up a
 * routine for handling floating-point errors.
 */

#include <stdio.h>
#include <signal.h>
#include <setjmp.h>
#include <stdlib.h>
#include <float.h>
#include <math.h>
#include <string.h>

jmp_buf mark;              /* Address for long jump to jump to */
int     fperr;             /* Global error number */

void __cdecl fphandler( int sig, int num );   /* Prototypes */
void fpcheck( void );

void main( void )
{
   double n1, n2, r;
   int jmpret;
   /* Unmask all floating-point exceptions. */
   _control87( 0, _MCW_EM );
   /* Set up floating-point error handler. The compiler
    * will generate a warning because it expects
    * signal-handling functions to take only one argument.
    */
   if( signal( SIGFPE, fphandler ) == SIG_ERR )
```

```
    {
       fprintf( stderr, "Couldn't set SIGFPE\n" );
       abort();   }

 /* Save stack environment for return in case of error. First
  * time through, jmpret is 0, so true conditional is executed.
  * If an error occurs, jmpret will be set to -1 and false
  * conditional will be executed.
  */
   jmpret = setjmp( mark );
   if( jmpret == 0 )
   {
      printf( "Test for invalid operation - " );
      printf( "enter two numbers: " );
      scanf( "%lf %lf", &n1, &n2 );
      r = n1 / n2;
      /* This won't be reached if error occurs. */
      printf( "\n\n%4.3g / %4.3g = %4.3g\n", n1, n2, r );

      r = n1 * n2;
      /* This won't be reached if error occurs. */
      printf( "\n\n%4.3g * %4.3g = %4.3g\n", n1, n2, r );
   }
   else
      fpcheck();
}
/* fphandler handles SIGFPE (floating-point error) interrupt. Note
 * that this prototype accepts two arguments and that the
 * prototype for signal in the run-time library expects a signal
 * handler to have only one argument.
 *
 * The second argument in this signal handler allows processing of
 * _FPE_INVALID, _FPE_OVERFLOW, _FPE_UNDERFLOW, and
 * _FPE_ZERODIVIDE, all of which are Microsoft-specific symbols
 * that augment the information provided by SIGFPE. The compiler
 * will generate a warning, which is harmless and expected.

 */
void fphandler( int sig, int num )
{
   /* Set global for outside check since we don't want
    * to do I/O in the handler.
    */
   fperr = num;
   /* Initialize floating-point package. */
   _fpreset();
   /* Restore calling environment and jump back to setjmp. Return
    * -1 so that setjmp will return false for conditional test.
    */
   longjmp( mark, -1 );
}
```

```
void fpcheck( void )
{
   char fpstr[30];
   switch( fperr )
   {
   case _FPE_INVALID:
      strcpy( fpstr, "Invalid number" );
      break;
   case _FPE_OVERFLOW:
      strcpy( fpstr, "Overflow" );

      break;
   case _FPE_UNDERFLOW:
      strcpy( fpstr, "Underflow" );
      break;
   case _FPE_ZERODIVIDE:
      strcpy( fpstr, "Divide by zero" );
      break;
   default:
      strcpy( fpstr, "Other floating point error" );
      break;
   }
   printf( "Error %d: %s\n", fperr, fpstr );
}
```

Output

```
Test for invalid operation - enter two numbers: 5 0
Error 131: Divide by zero
```

See Also: longjmp

setlocale, _wsetlocale

Define the locale.

char *setlocale(int *category*, **const char** **locale* **);**
wchar_t *_wsetlocale(int *category*, **const wchar_t** **locale* **);**

Routine	Required Header	Compatibility
setlocale	<locale.h>	ANSI, Win 95, Win NT
_wsetlocale	<locale.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If a valid locale and category are given, the function returns a pointer to the string associated with the specified locale and category. If the locale or category is invalid, the function returns a null pointer and the current locale settings of the program are not changed.

For example, the call

```
setlocale( LC_ALL, "English" );
```

sets all categories, returning only the string `English_USA.1252`. If all categories are not explicitly set by a call to **setlocale**, the function returns a string indicating the current setting of each of the categories, separated by semicolons. If the *locale* argument is a null pointer, **setlocale** returns a pointer to the string associated with the *category* of the program's locale; the program's current locale setting is not changed.

The null pointer is a special directive that tells **setlocale** to query rather than set the international environment. For example, the sequence of calls

```
// Set all categories and return "English_USA.1252"
setlocale( LC_ALL, "English" );
// Set only the LC_MONETARY category and return "French_France.1252"
setlocale( LC_MONETARY, "French" );
setlocale( LC_ALL, NULL );
```

returns

```
LC_COLLATE=English_USA.1252;
LC_CTYPE=English_USA.1252;
LC_MONETARY=French_France.1252;
LC_NUMERIC=English_USA.1252;
LC_TIME=English_USA.1252
```

which is the string associated with the **LC_ALL** category.

You can use the string pointer returned by **setlocale** in subsequent calls to restore that part of the program's locale information, assuming that your program does not alter the pointer or the string. Later calls to **setlocale** overwrite the string; you can use **_strdup** to save a specific locale string.

Parameters

category Category affected by locale

locale Locale name

Remarks

Use the **setlocale** function to set, change, or query some or all of the current program locale information specified by *locale* and *category*. "Locale" refers to the locality (country and language) for which you can customize certain aspects of your program. Some locale-dependent categories include the formatting of dates and the display format for monetary values.

_wsetlocale is a wide-character version of **setlocale**; the *locale* argument and return value of **_wsetlocale** are wide-character strings. **_wsetlocale** and **setlocale** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tsetlocale	setlocale	setlocale	_wsetlocale

The *category* argument specifies the parts of a program's locale information that are affected. The macros used for *category* and the parts of the program they affect are as follows:

LC_ALL All categories, as listed below

LC_COLLATE The **strcoll, _stricoll, wcscoll, _wcsicoll,** and **strxfrm** functions

LC_CTYPE The character-handling functions (except **isdigit, isxdigit, mbstowcs,** and **mbtowc**, which are unaffected)

LC_MONETARY Monetary-formatting information returned by the **localeconv** function

LC_NUMERIC Decimal-point character for the formatted output routines (such as **printf**), for the data-conversion routines, and for the nonmonetary-formatting information returned by **localeconv**

LC_TIME The **strftime** and **wcsftime** functions

The *locale* argument is a pointer to a string that specifies the name of the locale. If *locale* points to an empty string, the locale is the implementation-defined native environment. A value of "C" specifies the minimal ANSI conforming environment for C translation. The "C" locale assumes that all **char** data types are 1 byte and that their value is always less than 256. The "C" locale is the only locale supported in Microsoft Visual C++ version 1.0 and earlier versions of Microsoft C/C++. Microsoft Visual C++ supports all the locales listed in Appendix A, "Language and Country Strings." At program startup, the equivalent of the following statement is executed:

```
setlocale( LC_ALL, "C" );
```

The *locale* argument takes the following form:

```
locale :: "lang[_country[.code_page]]"
        | ".code_page"
        | ""
        | NULL
```

The set of available languages, countries, and code pages includes all those supported by the Win32 NLS API. The set of language and country codes supported by **setlocale** is listed in Appendix A, "Language and Country Strings."

If *locale* is a null pointer, **setlocale** queries, rather than sets, the international environment, and returns a pointer to the string associated with the specified *category*. The program's current locale setting is not changed. For example,

```
setlocale( LC_ALL, NULL );
```

returns the string associated with *category*.

The following examples pertain to the **LC_ALL** category. Either of the strings ".OCP" and ".ACP" can be used in place of a code page number to specify use of the system default OEM code page and system-default ANSI code page, respectively.

`setlocale( LC_ALL, "" );` Sets the locale to the default, which is the system-default ANSI code page obtained from the operating system.

`setlocale( LC_ALL, ".OCP" );` Explicitly sets the locale to the current OEM code page obtained from the operating system.

`setlocale( LC_ALL, ".ACP" );` Sets the locale to the ANSI code page obtained from the operating system.

`setlocale( LC_ALL, "[lang_ctry]" );` Sets the locale to the language and country indicated, using the default code page obtained from the host operating system.

`setlocale( LC_ALL, "[lang_ctry.cp]" );` Sets the locale to the language, country, and code page indicated in the [*lang_ctry.cp*] string. You can use various combinations of language, country, and code page. For example:

```
setlocale( LC_ALL, "French_Canada.1252" );
// Set code page to French Canada ANSI default
setlocale( LC_ALL, "French_Canada.ACP" );
// Set code page to French Canada OEM default
setlocale( LC_ALL, "French_Canada.OCP" );
```

`setlocale( LC_ALL, "[lang]" );` Sets the locale to the country indicated, using the default country for the language specified, and the system-default ANSI code page for that country as obtained from the host operating system. For example, the following two calls to **setlocale** are functionally equivalent:

```
setlocale( LC_ALL, "English" );
setlocale( LC_ALL, "English_United States.1252" );
```

`setlocale( LC_ALL, "[.code_page]" );` Sets the code page to the value indicated, using the default country and language (as defined by the host operating system) for the specified code page.

The category must be either **LC_ALL** or **LC_CTYPE** to effect a change of code page. For example, if the default country and language of the host operating system are "United States" and "English," the following two calls to **setlocale** are functionally equivalent:

```
setlocale( LC_ALL, ".1252" );
setlocale( LC_ALL, "English_United States.1252");
```

For more information see the **setlocale** pragma in *Preprocessor Reference*.

Example

```
/* LOCALE.C: Sets the current locale to "Germany" using the
 * setlocale function and demonstrates its effect on the strftime
 * function.
 */

#include <stdio.h>
#include <locale.h>
#include <time.h>

void main(void)
{
      time_t ltime;
      struct tm *thetime;
      unsigned char str[100];

      setlocale(LC_ALL, "German");
      time (&ltime);
      thetime = gmtime(&ltime);

      /* %#x is the long date representation, appropriate to
       * the current locale
       */
      if (!strftime((char *)str, 100, "%#x",
                  (const struct tm *)thetime))
            printf("strftime failed!\n");
      else
            printf("In German locale, strftime returns '%s'\n",
                  str);

      /* Set the locale back to the default environment */
      setlocale(LC_ALL, "C");
      time (&ltime);
      thetime = gmtime(&ltime);

      if (!strftime((char *)str, 100, "%#x",
                  (const struct tm *)thetime))
            printf("strftime failed!\n");
      else
            printf("In 'C' locale, strftime returns '%s'\n",
                  str);
}
```

Output

```
In German locale, strftime returns 'Donnerstag, 22. April 1993'
In 'C' locale, strftime returns 'Thursday, April 22, 1993'
```

See Also: **localeconv**, **mblen**, **_mbstrlen**, **mbstowcs**, **mbtowc**, **strcoll** Functions, **strftime**, **strxfrm**, **wcstombs**, **wctomb**

_setmaxstdio

Sets a maximum for the number of simultaneously open files at the **stdio** level.

int _setmaxstdio(int *newmax* **);**

Routine	Required Header	Compatibility
_setmaxstdio	<stdio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Returns *newmax* if successful; –1 otherwise.

Parameter

newmax New maximum for number of simultaneously open files at the **stdio** level

Remarks

The **_setmaxstdio** function changes the maximum value for the number of files which may be simultaneously open at the stdio level.

C run-time I/O now supports many more open files on Win32 platforms than in previous versions. Up to 2,048 files may be open simultaneously at the lowio level (that is, opened and accessed by means of the **_open**, **_read**, **_write**, and so forth family of I/O functions). Up to 512 files may be open simultaneously at the stdio level (that is, opened and accessed by means of the **fopen**, **fgetc**, **fputc**, and so forth family of functions). The limit of 512 open files at the stdio level may be increased to a maximum of 2,048 by means of the **_setmaxstdio** function.

Since stdio level functions, such as **fopen**, are built on top of the lowio functions, the maximum of 2,048 is a hard upper limit for the number of simultaneously open files accessed through the C run-time library.

Note This upper limit may be beyond what is supported by a particular Win32 platform and configuration. For example, Win32s only supports 255 open files.

_setmbcp

Sets a new multibyte code page.

int _setmbcp(int *codepage* **);**

Routine	Required Header	Compatibility
_setmbcp	<mbctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_setmbcp returns 0 if the code page is set successfully. If an invalid code page value is supplied for *codepage*, the function returns –1 and the code page setting is unchanged.

Parameter

codepage New code page setting for locale-independent multibyte routines

Remarks

The **_setmbcp** function specifies a new multibyte code page. By default, the run-time system automatically sets the multibyte code page to the system-default ANSI code page. The multibyte code page setting affects all multibyte routines that are not locale-dependent. However, it is possible to instruct **_setmbcp** to use the code page defined for the current locale (see the following list of manifest constants and associated behavior results). For a list of the multibyte routines that are dependent on the locale code page rather than the multibyte code page, see "Interpretation of Multibyte-Character Sequences."

The multibyte code page also affects multibyte-character processing by the following run-time library routines:

_exec functions	**_mktemp**	**_stat**
_fullpath	**_spawn functions**	**_tempnam**
_makepath	**_splitpath**	**tmpnam**

In addition, all run-time library routines that receive multibyte-character *argv* or *envp* program arguments as parameters (such as the **_exec** and **_spawn** families) process these strings according to the multibyte code page. Hence these routines are also affected by a call to **_setmbcp** that changes the multibyte code page.

The *codepage* argument can be set to any of the following values:

- **_MB_CP_ANSI** Use ANSI code page obtained from operating system at program startup
- **_MB_CP_LOCALE** Use the current locale's code page obtained from a previous call to **setlocale**
- **_MB_CP_OEM** Use OEM code page obtained from operating system at program startup
- **_MB_CP_SBCS** Use single-byte code page. When the code page is set to **_MB_CP_SBCS**, a routine such as **_ismbblead** always returns false.
- Any other valid code page value, regardless of whether the value is an ANSI, OEM, or other operating-sytem–supported code page.

See Also: _getmbcp, setlocale

_setmode

Sets the file translation mode.

int _setmode (int *handle*, **int** *mode* **);**

Routine	Required Header	Optional Headers	Compatibility
_setmode	<io.h>	<fcntl.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_setmode** returns the previous translation mode. A return value of –1 indicates an error, in which case **errno** is set to either **EBADF**, indicating an invalid file handle, or **EINVAL**, indicating an invalid *mode* argument (neither **_O_TEXT** nor **_O_BINARY**).

Parameters

handle File handle

mode New translation mode

Remarks

The **_setmode** function sets to *mode* the translation mode of the file given by *handle*. The mode must be one of two manifest constants, **_O_TEXT** or **_O_BINARY**. **_O_TEXT** sets text (translated) mode. Carriage return–linefeed (CR-LF) combinations

are translated into a single linefeed character on input. Linefeed characters are translated into CR-LF combinations on output. **_O_BINARY** sets binary (untranslated) mode, in which these translations are suppressed.

_setmode is typically used to modify the default translation mode of **stdin** and **stdout**, but you can use it on any file. If you apply **_setmode** to the file handle for a stream, call **_setmode** before performing any input or output operations on the stream.

Example

```
/* SETMODE.C: This program uses _setmode to change
 * stdin from text mode to binary mode.
 */

#include <stdio.h>
#include <fcntl.h>
#include <io.h>

void main( void )
{
   int result;

/* Set "stdin" to have binary mode: */
   result = _setmode( _fileno( stdin ), _O_BINARY );
   if( result == -1 )
      perror( "Cannot set mode" );
   else
      printf( "'stdin' successfully changed to binary mode\n" );
}
```

Output

```
'stdin' successfully changed to binary mode
```

See Also: **_creat, fopen, _open**

_set_new_handler

Transfer control to your error-handling mechanism if the **new** operator fails to allocate memory.

_PNH _set_new_handler(_PNH *pNewHandler* **);**

Routine	Required Header	Compatibility
_set_new_handler	<new.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_set_new_handler returns a pointer to the previous exception handling function registered by **_set_new_handler**, so that the previous function can be restored later. If no previous function has been set, the return value may be used to restore the default behavior; this value may be NULL.

Parameter

pNewHandler Pointer to the application-supplied memory handling function

Remarks

Call the C++ **_set_new_handler** function to specify an exception-handling function that is to gain control if the **new** operator fails to allocate memory. If **new** fails, the run-time system automatically calls the exception-handling function that was passed as an argument to **_set_new_handler**. **_PNH**, defined in NEW.H, is a pointer to a function that returns type **int** and takes an argument of type **size_t**. Use **size_t** to specify the amount of space to be allocated.

_set_new_handler is essentially a garbage-collection scheme. The run-time system retries allocation each time your function returns a nonzero value and fails if your function returns 0.

An occurrence of one of the **_set_new_handler** functions in a program registers the exception-handling function specified in the argument list with the run-time system:

```
#include <new.h>
int handle_program_memory_depletion( size_t )
{
   // Your code
}
void main( void )
{
   _set_new_handler( handle_program_memory_depletion );
   int *pi = new int[BIG_NUMBER];
}
```

You can save the function address that was last passed to the **_set_new_handler** function and reinstate it later:

```
_PNH old_handler = _set_new_handler( my_handler );
   // Code that requires my_handler
   _set_new_handler( old_handler )
   // Code that requires old_handler
```

In a multithreaded environment, handlers are maintained separately for each process and thread. Each new process lacks installed handlers. Each new thread gets a copy of the new handlers of the calling thread. Thus, each process and thread is in charge of its own free-store error handling.

The C++ **_set_new_mode** function sets the new handler mode for **malloc**. The new handler mode indicates whether, on failure, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure to allocate memory. You can override this default behavior so that, when **malloc**

fails to allocate memory, **malloc** calls the new handler routine in the same way that the **new** operator does when it fails for the same reason. To override the default, call

```
_set_new_mode(1)
```

early in your program, or link with NEWMODE.OBJ.

Example

```
/* HANDLER.CPP: This program uses _set_new_handler to
 * print an error message if the new operator fails.
 */

#include <stdio.h>
#include <new.h>

/* Allocate memory in chunks of size MemBlock. */
const size_t MemBlock = 1024;

/* Allocate a memory block for the printf function to use in case
 * of memory allocation failure; the printf function uses malloc.
 * The failsafe memory block must be visible globally because the
 * handle_program_memory_depletion function can take one
 * argument only.
 */
char * failsafe = new char[128];

/* Declare a customized function to handle memory-allocation failure.
 * Pass this function as an argument to _set_new_handler.
 */
int handle_program_memory_depletion( size_t );

void main( void )
{
   // Register existence of a new memory handler.
   _set_new_handler( handle_program_memory_depletion );
   size_t *pmemdump = new size_t[MemBlock];
   for( ; pmemdump != 0; pmemdump = new size_t[MemBlock] );
}

int handle_program_memory_depletion( size_t size )
{
   // Release character buffer memory.
   delete failsafe;
   printf( "Allocation failed, " );
   printf( "%u bytes not available.\n", size );
   // Tell new to stop allocation attempts.
   return 0;
}
```

Output

```
Allocation failed %0 bytes not available.
```

See Also: calloc, free, realloc

_set_new_mode

Sets a new handler mode for **malloc**.

int _set_new_mode(int *newhandlermode* **);**

Routine	Required Header	Compatibility
_set_new_mode	<new.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_set_new_mode returns the previous handler mode set for **malloc**. A return value of 1 indicates that, on failure to allocate memory, **malloc** previously called the new handler routine; a return value of 0 indicates that it did not. If the *newhandlermode* argument does not equal 0 or 1, **_set_new_mode** returns –1.

Parameter

newhandlermode New handler mode for **malloc**; valid value is 0 or 1

Remarks

The C++ **_set_new_mode** function sets the new handler mode for **malloc**. The new handler mode indicates whether, on failure, **malloc** is to call the new handler routine as set by **_set_new_handler**. By default, **malloc** does not call the new handler routine on failure to allocate memory. You can override this default behavior so that, when **malloc** fails to allocate memory, **malloc** calls the new handler routine in the same way that the **new** operator does when it fails for the same reason. To override the default, call

```
_set_new_mode(1)
```

early in your program, or link with NEWMODE.OBJ.

See Also: calloc, free, realloc, _query_new_handler, _query_new_mode

_set_sbh_threshold

Sets the upper limit for the size of a memory allocation that will be supported by the small-block heap.

int _set_sbh_threshold(size_t *size* **);**

Routine	Required Header	Compatibility
_set_sbh_threshold	<malloc.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_set_sbh_threshold returns 1 if the operation of setting the small-block threshold size is successful. It returns 0 if the input threshold size is too big.

Parameter

size the new small-block threshold size to be set

Remarks

This function takes a user specified small-block threshold size as input, and sets the current small-block threshold size to that value. The small-block heap threshold size can be set to any multiples of 16, from 0 to 1920 bytes for Windows 95 and all Windows NT platforms except the DEC Alpha, and from 0 to 3616 bytes for DEC Alpha platforms.

See Also: **_get_sbh_thresold**

_set_se_translator

Handles Win32 exceptions (C structured exceptions) as C++ typed exceptions.

typedef void (*_se_translator_function)(unsigned int, struct _EXCEPTION_POINTERS*);
_se_translator_function _set_se_translator(_se_translator_function *se_trans_func* **);**

Routine	Required Header	Compatibility
_set_se_translator	<eh.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_set_se_translator returns a pointer to the previous translator function registered by **_set_se_translator**, so that the previous function can be restored later. If no previous function has been set, the return value may be used to restore the default behavior; this value may be NULL.

Parameter

se_trans_func Pointer to a C structured exception translator function that you write

Remarks

The **_set_se_translator** function provides a way to handle Win32 exceptions (C structured exceptions) as C++ typed exceptions. To allow each C exception to be handled by a C++ **catch** handler, first define a C exception "wrapper" class that can be used, or derived from, in order to attribute a specific class type to a C exception. To use this class, install a custom C exception translator function that is called by the internal exception-handling mechanism each time a C exception is raised. Within your translator function, you can throw any typed exception that can be caught by a matching C++ **catch** handler.

To specify a custom translation function, call **_set_se_translator** with the name of your translation function as its argument. The translator function that you write is called once for each function invocation on the stack that has **try** blocks. There is no default translator function.

In a multithreaded environment, translator functions are maintained separately for each thread. Each new thread gets a copy of the new translator function of the calling thread. Thus, each thread is in charge of its own translation handling.

The *se_trans_func* function that you write must take an unsigned integer and a pointer to a Win32 **_EXCEPTION_POINTERS** structure as arguments. The arguments are the return values of calls to the Win32 API **GetExceptionCode** and **GetExceptionInformation** functions, respectively.

Example

```
/*  SETRANS.CPP
 */

#include <stdio.h>
#include <windows.h>
#include <eh.h>

void SEFunc();
void trans_func( unsigned int, EXCEPTION_POINTERS* );

class SE_Exception
{
private:
   unsigned int nSE;
public:
   SE_Exception() {}
   SE_Exception( unsigned int n ) : nSE( n ) {}
```

```
    ~SE_Exception() {}
    unsigned int getSeNumber() { return nSE; }
};
void main( void )
{
    try
    {
        _set_se_translator( trans_func );
        SEFunc();
    }
    catch( SE_Exception e )
    {
        printf( "Caught a __try exception with SE_Exception.\n" );
    }
}
void SEFunc()
{
    __try
    {
        int x, y=0;
        x = 5 / y;
    }
    __finally
    {
        printf( "In finally\n" );
    }
}
void trans_func( unsigned int u, EXCEPTION_POINTERS* pExp )
{
    printf( "In trans_func.\n" );
    throw SE_Exception();
}
```

Output

```
In finally.
In trans_func.
Caught a __try exception with SE_Exception.
```

See Also: **set_terminate, set_unexpected, terminate, unexpected**

set_terminate

Installs your own termination routine to be called by **terminate**.

typedef void (*terminate_function)();
terminate_function set_terminate(terminate_function *term_func* **);**

Routine	Required Header	Compatibility
set_terminate	<eh.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

set_terminate returns a pointer to the previous function registered by **set_terminate**, so that the previous function can be restored later. If no previous function has been set, the return value may be used to restore the default behavior; this value may be NULL.

Parameter

term_func Pointer to a terminate function that you write

Remarks

The **set_terminate** function installs *term_func* as the function called by **terminate**. **set_terminate** is used with C++ exception handling and may be called at any point in your program before the exception is thrown. **terminate** calls **abort** by default. You can change this default by writing your own termination function and calling **set_terminate** with the name of your function as its argument. **terminate** calls the last function given as an argument to **set_terminate**. After performing any desired cleanup tasks, *term_func* should exit the program. If it does not exit (if it returns to its caller), **abort** is called.

In a multithreaded environment, termination functions are maintained separately for each thread. Each new thread gets a copy of the new termination function of the calling thread. Thus, each thread is in charge of its own termination handling.

The **terminate_function** type is defined in EH.H as a pointer to a user-defined termination function, *term_func*, that returns **void**. Your custom function *term_func* can take no arguments and should not return to its caller. If it does, **abort** is called. An exception may not be thrown from within *term_func*.

Example

```
/* TERMINAT.CPP:
 */
#include <eh.h>
#include <process.h>
#include <iostream.h>

void term_func();

void main()
{
```

```
    int i = 10, j = 0, result;
    set_terminate( term_func );
    try
    {
       if( j == 0 )
          throw "Divide by zero!";
       else
          result = i/j;

    }
    catch( int )
    {
       cout << "Caught some integer exception.\n";
    }
    cout << "This should never print.\n";

}
void term_func()
{
    cout << "term_func() was called by terminate().\n";

    // ... cleanup tasks performed here

    // If this function does not exit, abort is called.

    exit(-1);
}
```

Output

```
term_func() was called by terminate().
```

See Also: **abort**, **set_unexpected**, **terminate**, **unexpected**

set_unexpected

Installs your own termination function to be called by **unexpected**.

typedef void (*unexpected_function)();
unexpected_function set_unexpected(unexpected_function *unexp_func* **);**

Routine	Required Header	Compatibility
set_unexpected	<eh.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_set_unexpected returns a pointer to the previous termination function registered by **_set_unexpected**, so that the previous function can be restored later. If no previous function has been set, the return value may be used to restore the default behavior; this value may be NULL.

Parameter

unexp_func Pointer to a function that you write to replace the **unexpected** function

Remarks

The **set_unexpected** function installs *unexp_func* as the function called by **unexpected**. **unexpected** is not used in the current C++ exception-handling implementation. The **unexpected_function** type is defined in EH.H as a pointer to a user-defined unexpected function, *unexp_func*, that returns **void**. Your custom *unexp_func* function should not return to its caller.

By default, **unexpected** calls **terminate**. You can change this default behavior by writing your own termination function and calling **set_unexpected** with the name of your function as its argument. **unexpected** calls the last function given as an argument to **set_unexpected**.

Unlike the custom termination function installed by a call to **set_terminate**, an exception can be thrown from within *unexp_func*.

In a multithreaded environment, termination functions are maintained separately for each thread. Each new thread gets a copy of the new termination function of the calling thread. Thus, each thread is in charge of its own unexpected termination handling.

In the current Microsoft implementation of C++ exception handling, **unexpected** calls **terminate** by default and is never called by the exception-handling run-time library. There is no particular advantage to calling **unexpected** rather than **terminate**.

See Also: **abort**, **set_terminate**, **terminate**, **unexpected**

setvbuf

Controls stream buffering and buffer size.

int setvbuf(FILE ***stream*, char** ***buffer*, int** *mode*, **size_t** *size* **);**

Routine	Required Header	Compatibility
setvbuf	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

setvbuf returns 0 if successful, or a nonzero value if an illegal type or buffer size is specified.

Parameters

stream Pointer to **FILE** structure

buffer User-allocated buffer

mode Mode of buffering

size Buffer size in bytes. Allowable range: 2 < *size* < 32768. Internally, the value supplied for *size* is rounded down to the nearest multiple of 2.

Remarks

The **setvbuf** function allows the program to control both buffering and buffer size for *stream*. *stream* must refer to an open file that has not undergone an I/O operation since it was opened. The array pointed to by *buffer* is used as the buffer, unless it is **NULL**, in which case **setvbuf** uses an automatically allocated buffer of length *size*/2 * 2 bytes.

The mode must be **_IOFBF**, **_IOLBF**, or **_IONBF**. If *mode* is **_IOFBF** or **_IOLBF**, then *size* is used as the size of the buffer. If *mode* is **_IONBF**, the stream is unbuffered and *size* and *buffer* are ignored. Values for *mode* and their meanings are:

_IOFBF Full buffering; that is, *buffer* is used as the buffer and *size* is used as the size of the buffer. If *buffer* is **NULL**, an automatically allocated buffer *size* bytes long is used.

_IOLBF With MS-DOS, the same as **_IOFBF**.

_IONBF No buffer is used, regardless of *buffer* or *size*.

Example

```
/* SETVBUF.C: This program opens two streams: stream1
 * and stream2. It then uses setvbuf to give stream1 a
 * user-defined buffer of 1024 bytes and stream2 no buffer.
 */

#include <stdio.h>

void main( void )
{
   char buf[1024];
   FILE *stream1, *stream2;

   if( ((stream1 = fopen( "data1", "a" )) != NULL) &&
      ((stream2 = fopen( "data2", "w" )) != NULL) )
   {
      if( setvbuf( stream1, buf, _IOFBF, sizeof( buf ) ) != 0 )
         printf( "Incorrect type or size of buffer for stream1\n" );
      else
         printf( "'stream1' now has a buffer of 1024 bytes\n" );
```

```
        if( setvbuf( stream2, NULL, _IONBF, 0 ) != 0 )
           printf( "Incorrect type or size of buffer for stream2\n" );
        else
           printf( "'stream2' now has no buffer\n" );
        _fcloseall();
     }
}
```

Output

```
'stream1' now has a buffer of 1024 bytes
'stream2' now has no buffer
```

See Also: fclose, fflush, fopen, setbuf

---

signal

Sets interrupt signal handling.

void (*signal(int *sig*, **void (__cdecl** **func*) **(int** *sig* [, **int** *subcode*]))) **(int** *sig* **);**

Routine	Required Header	Compatibility
signal	<signal.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

signal returns the previous value of *func* associated with the given signal. For example, if the previous value of *func* was **SIG_IGN**, the return value is also **SIG_IGN**. A return value of **SIG_ERR** indicates an error, in which case **errno** is set to **EINVAL**.

Parameters

sig Signal value

func Function to be executed

subcode Optional subcode to the signal number

Remarks

The **signal** function allows a process to choose one of several ways to handle an interrupt signal from the operating system. The *sig* argument is the interrupt to which **signal** responds; it must be one of the following manifest constants, defined in SIGNAL.H.

sig Value	Description
SIGABRT	Abnormal termination
SIGFPE	Floating-point error
SIGILL	Illegal instruction
SIGINT	CTRL+C signal
SIGSEGV	Illegal storage access
SIGTERM	Termination request

By default, **signal** terminates the calling program with exit code 3, regardless of the value of *sig*.

Note **SIGINT** is not supported for any Win32 application including Windows NT and Windows 95. When a CTRL+C interrupt occurs, Win32 operating systems generate a new thread to specifically handle that interrupt. This can cause a single-thread application such as UNIX, to become multithreaded, resulting in unexpected behavior.

The *func* argument is an address to a signal handler that you write, or one of the manifest constants **SIG_DFL** or **SIG_IGN**, also defined in SIGNAL.H. If *func* is a function, it is installed as the signal handler for the given signal. The signal handler's prototype requires one formal argument, *sig*, of type **int**. The operating system provides the actual argument through *sig* when an interrupt occurs; the argument is the signal that generated the interrupt. Thus you can use the six manifest constants (listed in the preceding table) inside your signal handler to determine which interrupt occurred and take appropriate action. For example, you can call **signal** twice to assign the same handler to two different signals, then test the *sig* argument inside the handler to take different actions based on the signal received.

If you are testing for floating-point exceptions (**SIGFPE**), *func* points to a function that takes an optional second argument that is one of several manifest constants defined in FLOAT.H of the form **FPE_***xxx*. When a **SIGFPE** signal occurs, you can test the value of the second argument to determine the type of floating-point exception and then take appropriate action. This argument and its possible values are Microsoft extensions.

For floating-point exceptions, the value of *func* is not reset upon receiving the signal. To recover from floating-point exceptions, use **setjmp** with **longjmp**. If the function returns, the calling process resumes execution with the floating-point state of the process left undefined.

If the signal handler returns, the calling process resumes execution immediately following the point at which it received the interrupt signal. This is true regardless of the type of signal or operating mode.

Before the specified function is executed, the value of *func* is set to **SIG_DFL**. The next interrupt signal is treated as described for **SIG_DFL**, unless an intervening call to **signal** specifies otherwise. This feature lets you reset signals in the called function.

Because signal-handler routines are usually called asynchronously when an interrupt occurs, your signal-handler function may get control when a run-time operation is incomplete and in an unknown state. The list below summarizes restrictions that determine which functions you can use in your signal-handler routine.

- Do not issue low-level or STDIO.H I/O routines (such as **printf** and **fread**).
- Do not call heap routines or any routine that uses the heap routines (such as **malloc**, **_strdup**, and **_putenv**). See **malloc** for more information.
- Do not use any function that generates a system call (e.g., **_getcwd**, **time**).
- Do not use **longjmp** unless the interrupt is caused by a floating-point exception (i.e., *sig* is **SIGFPE**). In this case, first reinitialize the floating-point package with a call to **_fpreset**.
- Do not use any overlay routines.

A program must contain floating-point code if it is to trap the **SIGFPE** exception with the function. If your program does not have floating-point code and requires the run-time library's signal-handling code, simply declare a volatile double and initialize it to zero:

```
volatile double d = 0.0f;
```

The **SIGILL**, **SIGSEGV**, and **SIGTERM** signals are not generated under Windows NT. They are included for ANSI compatibility. Thus you can set signal handlers for these signals with **signal**, and you can also explicitly generate these signals by calling **raise**.

Signal settings are not preserved in spawned processes created by calls to **_exec** or **_spawn** functions. The signal settings are reset to the default in the new process.

See Also: **abort**, **_exec** Functions, **exit**, **_fpreset**, **_spawn** Functions

sin, sinh

Calculate sines and hyperbolic sines.

double sin(double *x* **);**
double sinh(double *x* **);**

Routine	Required Header	Compatibility
sin	<math.h>	ANSI, Win 95, Win NT
sinh	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

sin returns the sine of x. If x is greater than or equal to 2^{63}, or less than or equal to -2^{63}, a loss of significance in the result occurs, in which case the function generates a **_TLOSS** error and returns an indefinite (same as a quiet NaN).

sinh returns the hyperbolic sine of x. If the result is too large, **sinh** sets **errno** to **ERANGE** and returns **±HUGE_VAL**. You can modify error handling with **_matherr**.

Parameter

x Angle in radians

Example

```
/* SINCOS.C: This program displays the sine, hyperbolic
 * sine, cosine, and hyperbolic cosine of pi / 2.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double pi = 3.1415926535;
   double x, y;

   x = pi / 2;
   y = sin( x );
   printf( "sin( %f ) = %f\n", x, y );
   y = sinh( x );
   printf( "sinh( %f ) = %f\n",x, y );
   y = cos( x );
   printf( "cos( %f ) = %f\n", x, y );
   y = cosh( x );
   printf( "cosh( %f ) = %f\n",x, y );
}
```

Output

```
sin( 1.570796 ) = 1.000000
sinh( 1.570796 ) = 2.301299
cos( 1.570796 ) = 0.000000
cosh( 1.570796 ) = 2.509178
```

See Also: acos, asin, atan, cos, tan

_snprintf, _snwprintf

Write formatted data to a string.

int _snprintf(char **buffer*, **size_t** *count*, **const char** **format* [, *argument*] ...);
int _snwprintf(wchar_t **buffer*, **size_t** *count*, **const wchar_t** **format* [, *argument*] ...);

Routine	Required Header	Compatibility
_snprintf	<stdio.h>	Win 95, Win NT
_snwprintf	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_snprintf returns the number of bytes stored in *buffer*, not counting the terminating null character. If the number of bytes required to store the data exceeds *count*, then *count* bytes of data are stored in *buffer* and a negative value is returned. **_snwprintf** returns the number of wide characters stored in *buffer*, not counting the terminating null wide character. If the storage required to store the data exceeds *count* wide characters, then *count* wide characters are stored in *buffer* and a negative value is returned.

Parameters

buffer Storage location for output

count Maximum number of characters to store

format Format-control string

argument Optional arguments

Remarks

The **_snprintf** function formats and stores *count* or fewer characters and values (including a terminating null character that is always appended unless *count* is zero or the formatted string length is greater than or equal to *count* characters) in *buffer*. Each *argument* (if any) is converted and output according to the corresponding format specification in *format*. The format consists of ordinary characters and has the same form and function as the *format* argument for **printf**. If copying occurs between strings that overlap, the behavior is undefined.

_snwprintf is a wide-character version of **_snprintf**; the pointer arguments to **_snwprintf** are wide-character strings. Detection of encoding errors in **_snwprintf** may differ from that in **_snprintf**. **_snwprintf**, like **swprintf**, writes output to a string rather than to a destination of type **FILE**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_sntprintf	_snprintf	_snprintf	_snwprintf

Example

```
/* SPRINTF.C: This program uses sprintf to format various
 * data and place them in the string named buffer.
 */

#include <stdio.h>

void main( void )
{
   char  buffer[200], s[] = "computer", c = 'l';
   int   i = 35, j;
   float fp = 1.7320534f;

   /* Format and print various data: */
   j  = sprintf( buffer,     "\tString:    %s\n", s );
   j += sprintf( buffer + j, "\tCharacter: %c\n", c );
   j += sprintf( buffer + j, "\tInteger:   %d\n", i );
   j += sprintf( buffer + j, "\tReal:      %f\n", fp );

   printf( "Output:\n%s\ncharacter count = %d\n", buffer, j );
}
```

Output

```
Output:
   String:    computer
   Character: l
   Integer:   35
   Real:      1.732053

character count = 71
```

See Also: **sprintf**, **fprintf**, **printf**, **scanf**, **sscanf**, **vprintf** Functions

_sopen, _wsopen

Open a file for sharing.

int _sopen(const char **filename*, **int** *oflag*, **int** *shflag* [, **int** *pmode*]);
int _wsopen(const wchar_t **filename*, **int** *oflag*, **int** *shflag* [, **int** *pmode*]);

Routine	Required Header	Optional Headers	Compatibility
_sopen	<io.h>	<fcntl.h>, <sys/types.h>, <sys/stat.h>, <share.h>	Win 95, Win NT
_wsopen	<io.h> or <wchar.h>	<fcntl.h>, <sys/types.h>, <sys/stat.h>, <share.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a file handle for the opened file. A return value of –1 indicates an error, in which case **errno** is set to one of the following values:

EACCES Given path is a directory, or file is read-only, but an open-for-writing operation was attempted.

EEXIST **_O_CREAT** and **_O_EXCL** flags were specified, but *filename* already exists.

EINVAL Invalid *oflag* or *shflag* argument.

EMFILE No more file handles available.

ENOENT File or path not found.

Parameters

filename Filename

oflag Type of operations allowed

shflag Type of sharing allowed

pmode Permission setting

Remarks

The **_sopen** function opens the file specified by *filename* and prepares the file for shared reading or writing, as defined by *oflag* and *shflag*. **_wsopen** is a wide-character version of **_sopen**; the *filename* argument to **_wsopen** is a wide-character string. **_wsopen** and **_sopen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tsopen	_sopen	_sopen	_wsopen

The integer expression *oflag* is formed by combining one or more of the following manifest constants, defined in the file FCNTL.H. When two or more constants form the argument *oflag*, they are combined with the bitwise-OR operator (|).

_O_APPEND Repositions file pointer to end of file before every write operation.

_O_BINARY Opens file in binary (untranslated) mode. (See **fopen** for a description of binary mode.)

_O_CREAT Creates and opens new file for writing. Has no effect if file specified by *filename* exists. The *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_SHORT_LIVED Create file as temporary and if possible do not flush to disk. The *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_TEMPORARY Create file as temporary; file is deleted when last file handle is closed. The *pmode* argument is required when **_O_CREAT** is specified.

_O_CREAT | _O_EXCL Returns error value if file specified by *filename* exists. Applies only when used with **_O_CREAT**.

_O_NOINHERIT Prevents creation of a shared file handle.

_O_RANDOM Specifies primarily random access from disk.

_O_RDONLY Opens file for reading only; cannot be specified with **_O_RDWR** or **_O_WRONLY**.

_O_RDWR Opens file for both reading and writing; cannot be specified with **_O_RDONLY** or **_O_WRONLY**.

_O_SEQUENTIAL Specifies primarily sequential access from disk

_O_TEXT Opens file in text (translated) mode. (For more information, see "Text and Binary Mode File I/O" and **fopen**.)

_O_TRUNC Opens file and truncates it to zero length; the file must have write permission. You cannot specify this flag with **_O_RDONLY**. **_O_TRUNC** used with **_O_CREAT** opens an existing file or creates a new file.

Warning The **_O_TRUNC** flag destroys the contents of the specified file.

_O_WRONLY Opens file for writing only; cannot be specified with **_O_RDONLY** or **_O_RDWR**.

To specify the file access mode, you must specify either **_O_RDONLY**, **_O_RDWR**, or **_O_WRONLY**. There is no default value for the access mode.

The argument *shflag* is a constant expression consisting of one of the following manifest constants, defined in SHARE.H.

_SH_DENYRW Denies read and write access to file

_SH_DENYWR Denies write access to file

_SH_DENYRD Denies read access to file

_SH_DENYNO Permits read and write access

The *pmode* argument is required only when you specify **_O_CREAT**. If the file does not exist, *pmode* specifies the file's permission settings, which are set when the

new file is closed the first time. Otherwise *pmode* is ignored. *pmode* is an integer expression that contains one or both of the manifest constants **_S_IWRITE** and **_S_IREAD**, defined in SYS\STAT.H. When both constants are given, they are combined with the bitwise-OR operator. The meaning of *pmode* is as follows:

_S_IWRITE Writing permitted

_S_IREAD Reading permitted

_S_IREAD | _S_IWRITE Reading and writing permitted

If write permission is not given, the file is read-only. Under Windows NT and Windows 95, all files are readable; it is not possible to give write-only permission. Thus the modes **_S_IWRITE** and **_S_IREAD | _S_IWRITE** are equivalent.

_sopen applies the current file-permission mask to *pmode* before setting the permissions (see **_umask**).

Example

```
/* LOCKING.C: This program opens a file with sharing. It locks
 * some bytes before reading them, then unlocks them. Note that the
 * program works correctly only if the file exists.
 */

#include <io.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <sys/locking.h>
#include <share.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int  fh, numread;
   char buffer[40];

   /* Quit if can't open file or system doesn't
    * support sharing.
    */
   fh = _sopen( "locking.c", _O_RDWR, _SH_DENYNO,
                _S_IREAD | _S_IWRITE );
   if( fh == -1 )
      exit( 1 );

   /* Lock some bytes and read them. Then unlock. */
   if( _locking( fh, LK_NBLCK, 30L ) != -1 )
   {
      printf( "No one can change these bytes while I'm reading them\n" );
      numread = _read( fh, buffer, 30 );
      printf( "%d bytes read: %.30s\n", numread, buffer );
```

```
        lseek( fh, 0L, SEEK_SET );
       _locking( fh, LK_UNLCK, 30L );
        printf( "Now I'm done. Do what you will with them\n" );
    }
    else
        perror( "Locking failed\n" );

    _close( fh );
}
```

Output

```
No one can change these bytes while I'm reading them
30 bytes read: /* LOCKING.C: This program ope
Now I'm done. Do what you will with them
```

See Also: **_close**, **_creat**, **fopen**, **_fsopen**, **_open**

_spawn, _wspawn Functions

Each of the **_spawn** functions creates and executes a new process.

_spawnl, _wspawnl	**_spawnv, _wspawnv**
_spawnle, _wspawnle	**_spawnve, _wspawnve**
_spawnlp, _wspawnlp	**_spawnvp, _wspawnvp**
_spawnlpe, _wspawnlpe	**_spawnvpe, _wspawnvpe**

The letter(s) at the end of the function name determine the variation.

_spawn Function Suffix	**Description**
e	*envp*, array of pointers to environment settings, is passed to new process.
l	Command-line arguments are passed individually to **_spawn** function. This suffix is typically used when number of parameters to new process is known in advance
p	**PATH** environment variable is used to find file to execute.
v	*argv*, array of pointers to command-line arguments, is passed to **_spawn** function. This suffix is typically used when number of parameters to new process is variable.

Remarks

The **_spawn** functions each create and execute a new process. They automatically handle multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use. The **_wspawn** functions are wide-character versions of the **_spawn** functions; they do not handle multibyte-character strings. Otherwise, the **_wspawn** functions behave identically to their **_spawn** counterparts.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tspawnl	_spawnl	_spawnl	_wspawnl
_tspawnle	_spawnle	_spawnle	_wspawnle
_tspawnlp	_spawnlp	_spawnlp	_wspawnlp
_tspawnlpe	_spawnlpe	_spawnlpe	_wspawnlpe
_tspawnv	_spawnv	_spawnv	_wspawnv
_tspawnve	_spawnve	_spawnve	_wspawnve
_tspawnvp	_spawnvp	_spawnvp	_wspawnvp
_tspawnvpe	_spawnvpe	_spawnvpe	_wspawnvpe

Enough memory must be available for loading and executing the new process. The *mode* argument determines the action taken by the calling process before and during **_spawn**. The following values for *mode* are defined in PROCESS.H:

_P_OVERLAY Overlays calling process with new process, destroying the calling process (same effect as **_exec** calls).

_P_WAIT Suspends calling thread until execution of new process is complete (synchronous **_spawn**).

_P_NOWAIT or **_P_NOWAITO** Continues to execute calling process concurrently with new process (asynchronous **_spawn**).

_P_DETACH Continues to execute the calling process; new process is run in the background with no access to the console or keyboard. Calls to **_cwait** against the new process will fail (asynchronous **_spawn**).

The *cmdname* argument specifies the file that is executed as the new process and can specify a full path (from the root), a partial path (from the current working directory), or just a filename. If *cmdname* does not have a filename extension or does not end with a period (.), the **_spawn** function first tries the .COM extension, then the .EXE extension, the .BAT extension, and finally the .CMD extension.

If *cmdname* has an extension, only that extension is used. If *cmdname* ends with a period, the **_spawn** call searches for *cmdname* with no extension. The **_spawnlp**, **_spawnlpe**, **_spawnvp**, and **_spawnvpe** functions search for *cmdname* (using the same procedures) in the directories specified by the **PATH** environment variable.

If *cmdname* contains a drive specifier or any slashes (that is, if it is a relative path), the **_spawn** call searches only for the specified file; no path searching is done.

Note To ensure proper overlay initialization and termination, do not use the **setjmp** or **longjmp** function to enter or leave an overlay routine.

Arguments for the Spawned Process

To pass arguments to the new process, give one or more pointers to character strings as arguments in the **_spawn** call. These character strings form the argument list for the spawned process. The combined length of the strings forming the argument list for the new process must not exceed 1024 bytes. The terminating null character ('\0') for each string is not included in the count, but space characters (automatically inserted to separate arguments) are included.

You can pass argument pointers as separate arguments (in **_spawnl**, **_spawnle**, **_spawnlp**, and **_spawnlpe**) or as an array of pointers (in **_spawnv**, **_spawnve**, **_spawnvp**, and **_spawnvpe**). You must pass at least one argument, *arg0* or *argv*[0], to the spawned process. By convention, this argument is the name of the program as you would type it on the command line. A different value does not produce an error.

The **_spawnl**, **_spawnle**, **_spawnlp**, and **_spawnlpe** calls are typically used in cases where the number of arguments is known in advance. The *arg0* argument is usually a pointer to *cmdname*. The arguments *arg1* through *argn* are pointers to the character strings forming the new argument list. Following *argn*, there must be a **NULL** pointer to mark the end of the argument list.

The **_spawnv**, **_spawnve**, **_spawnvp**, and **_spawnvpe** calls are useful when there is a variable number of arguments to the new process. Pointers to the arguments are passed as an array, *argv*. The argument *argv*[0] is usually a pointer to a path in real mode or to the program name in protected mode, and *argv*[1] through *argv*[*n*] are pointers to the character strings forming the new argument list. The argument *argv*[*n* +1] must be a **NULL** pointer to mark the end of the argument list.

Environment of the Spawned Process

Files that are open when a **_spawn** call is made remain open in the new process. In the **_spawnl**, **_spawnlp**, **_spawnv**, and **_spawnvp** calls, the new process inherits the environment of the calling process. You can use the **_spawnle**, **_spawnlpe**, **_spawnve**, and **_spawnvpe** calls to alter the environment for the new process by passing a list of environment settings through the *envp* argument. The argument *envp* is an array of character pointers, each element (except the final element) of which points to a null-terminated string defining an environment variable. Such a string usually has the form *NAME=value* where *NAME* is the name of an environment variable and *value* is the string value to which that variable is set. (Note that *value* is not enclosed in double quotation marks.) The final element of the *envp* array should be **NULL**. When *envp* itself is **NULL**, the spawned process inherits the environment settings of the parent process.

The **_spawn** functions can pass all information about open files, including the translation mode, to the new process. This information is passed in real mode through

the **C_FILE_INFO** entry in the environment. The startup code normally processes this entry and then deletes it from the environment. However, if a **_spawn** function spawns a non-C process, this entry remains in the environment. Printing the environment shows graphics characters in the definition string for this entry because the environment information is passed in binary form in real mode. It should not have any other effect on normal operations. In protected mode, the environment information is passed in text form and therefore contains no graphics characters.

You must explicitly flush (using **fflush** or **_flushall**) or close any stream before calling a **_spawn** function.

You can control whether the open file information of a process is passed to its spawned processes. The external variable **_fileinfo** (declared in STDLIB.H) controls the passing of **C_FILE_INFO** information. If **_fileinfo** is 0 (the default), the **C_FILE_INFO** information is not passed to the new processes. If **_fileinfo** is not 0, **C_FILE_INFO** is passed to new processes. You can modify the default value of **_fileinfo** in one of two ways: link the supplied object file, FILEINFO.OBJ, into the program, or set the **_fileinfo** variable to a nonzero value directly in the C program.

New processes created by calls to **_spawn** routines do not preserve signal settings. Instead, the spawned process resets signal settings to the default.

Example

```
/* SPAWN.C: This program accepts a number in the range
 * 1-8 from the command line. Based on the number it receives,
 * it executes one of the eight different procedures that
 * spawn the process named child. For some of these procedures,
 * the CHILD.EXE file must be in the same directory; for
 * others, it only has to be in the same path.
 */

#include <stdio.h>
#include <process.h>

char *my_env[] =
{
   "THIS=environment will be",
   "PASSED=to child.exe by the",
   "_SPAWNLE=and",
   "_SPAWNLPE=and",
   "_SPAWNVE=and",
   "_SPAWNVPE=functions",
   NULL
};

void main( int argc, char *argv[] )
{
   char *args[4];
```

```
    /* Set up parameters to be sent: */
    args[0] = "child";
    args[1] = "spawn??";
    args[2] = "two";
    args[3] = NULL;

    if (argc <= 2)
    {
       printf( "SYNTAX: SPAWN <1-8> <childprogram>\n" );
       exit( 1 );
    }

    switch (argv[1][0])   /* Based on first letter of argument */
    {
    case '1':
       _spawnl( _P_WAIT, argv[2], argv[2], "_spawnl", "two", NULL );
       break;
    case '2':
       _spawnle( _P_WAIT, argv[2], argv[2], "_spawnle", "two",
                 NULL, my_env );
       break;
    case '3':
       _spawnlp( _P_WAIT, argv[2], argv[2], "_spawnlp", "two", NULL );
       break;
    case '4':
       _spawnlpe( _P_WAIT, argv[2], argv[2], "_spawnlpe", "two",
                  NULL, my_env );
       break;
    case '5':
       _spawnv( _P_OVERLAY, argv[2], args );
       break;
    case '6':
       _spawnve( _P_OVERLAY, argv[2], args, my_env );
       break;
    case '7':
       _spawnvp( _P_OVERLAY, argv[2], args );
       break;
    case '8':
       _spawnvpe( _P_OVERLAY, argv[2], args, my_env );
       break;
    default:
       printf( "SYNTAX: SPAWN <1-8> <childprogram>\n" );
       exit( 1 );
    }
    printf( "from SPAWN!\n" );
}
```

Output

```
SYNTAX: SPAWN <1-8> <childprogram>
```

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_flushall**, **_getmbcp**, **_onexit**, **_setmbcp**, **system**

_spawnl, _wspawnl

Create and execute a new process.

int _spawnl(int *mode*, **const char** **cmdname*, **const char** **arg0*,
↪ **const char** **arg1*, ... **const char** **argn*, **NULL);**
int _wspawnl(int *mode*, **const wchar_t** **cmdname*, **const wchar_t** **arg0*,
↪ **const wchar_t** **arg1*, ... **const wchar_t** **argn*, **NULL);**

Routine	Required Header	Compatibility
_spawnl	<process.h>	Win 95, Win NT
_wspawnl	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnl** or **_wspawnl** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnl** or **_wspawnl** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

arg0, ... *argn* List of pointers to arguments

Remarks

Each of these functions creates and executes a new process, passing each command-line argument as a separate parameter.

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_flushall**, **_getmbcp**, **_onexit**, **_setmbcp**, **system**

Example

See Example on page 536.

_spawnle, _wspawnle

Create and execute a new process.

int _spawnle(int *mode*, **const char** **cmdname*, **const char** **arg0*,
↪ **const char** **arg1*, ... **const char** **argn*, **NULL, const char *const** **envp*);
int _wspawnle(int *mode*, **const wchar_t** **cmdname*, **const wchar_t** **arg0*,
↪ **const wchar_t** **arg1*, ... **const wchar_t** **argn*, **NULL,**
↪ **const wchar_t *const** **envp*);

Routine	Required Header	Compatibility
_spawnle	<process.h>	Win 95, Win NT
_wspawnle	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnle** or **_wspawnle** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnle** or **_wspawnle** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

arg0, ... argn List of pointers to arguments

envp Array of pointers to environment settings

Remarks

Each of these functions creates and executes a new process, passing each command-line argument as a separate parameter and also passing an array of pointers to environment settings.

See Also: **abort, atexit, _exec** Functions, **exit, _flushall, _getmbcp, _onexit, _setmbcp, system**

Example

See Example on page 536.

_spawnlp, _wspawnlp

Create and execute a new process.

int _spawnlp(int *mode*, **const char** **cmdname*, **const char** **arg0*,
↪ **const char** **arg1*, ... **const char** **argn*, **NULL);**
int _wspawnlp(int *mode*, **const wchar_t** **cmdname*, **const wchar_t** **arg0*,
↪ **const wchar_t** **arg1*, ... **const wchar_t** **argn*, **NULL);**

Routine	Required Header	Compatibility
_spawnlp	<process.h>	Win 95, Win NT
_wspawnlp	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnlp** or **_wspawnlp** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnlp** or **_wspawnlp** (**_P_NOWAIT** or **_P_NOWAITO** specified fo *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return

value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

arg0, ... argn List of pointers to arguments

Remarks

Each of these functions creates and executes a new process, passing each command-line argument as a separate parameter and using the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, _exec Functions, **exit, _flushall, _getmbcp, _onexit, _setmbcp, system**

Example

See Example on page 536.

_spawnlpe, _wspawnlpe

Create and execute a new process.

int _spawnlpe(int *mode*, **const char** **cmdname*, **const char** **arg0*,
↪ **const char** **arg1*, ... **const char** **argn*, **NULL, const char *const** **envp*);
int _wspawnlpe(int *mode*, **const wchar_t** **cmdname*, **const wchar_t** **arg0*,
↪ **const wchar_t** **arg1*, ... **const wchar_t** **argn*, **NULL, const wchar_t *const** **envp*);

Routine	Required Header	Compatibility
_spawnlpe	<process.h>	Win 95, Win NT
_wspawnlpe	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnlpe** or **_wspawnlpe** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnlpe** or **_wspawnlpe** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

arg0, ... argn List of pointers to arguments

envp Array of pointers to environment settings

Remarks

Each of these functions creates and executes a new process, passing each command-line argument as a separate parameter and also passing an array of pointers to environment settings. These functions use the **PATH** environment variable to find the file to execute.

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_flushall**, **_getmbcp**, **_onexit**, **_setmbcp**, **system**

Example

See Example on page 536.

_spawnv, _wspawnv

Create and execute a new process.

int _spawnv(int *mode*, **const char** **cmdname*, **const char *const** **argv* **);**
int _wspawnv(int *mode*, **const wchar_t** **cmdname*, **const wchar_t *const** **argv* **);**

Routine	Required Header	Compatibility
_spawnv	<stdio.h> or <process.h>	Win 95, Win NT
_wspawnv	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnv** or **_wspawnv** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnv** or **_wspawnv** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

argv Array of pointers to arguments

Remarks

Each of these functions creates and executes a new process, passing an array of pointers to command-line arguments.

See Also: abort, atexit, _exec Functions, **exit, _flushall, _getmbcp, _onexit, _setmbcp, system**

Example

See Example on page 536.

_spawnve, _wspawnve

Create and execute a new process.

int _spawnve(int *mode*, **const char** **cmdname*, **const char *const** **argv*,
↪ **const char *const** **envp*);
int _wspawnve(int *mode*, **const wchar_t** **cmdname*, **const wchar_t *const** **argv*,
↪ **const wchar_t *const** **envp*);

Routine	Required Header	Compatibility
_spawnve	<stdio.h> or <process.h>	Win 95, Win NT
_wspawnve	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnve** or **_wspawnve** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnve** or **_wspawnve** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

argv Array of pointers to arguments

envp Array of pointers to environment settings

Remarks

Each of these functions creates and executes a new process, passing an array of pointers to command-line arguments and an array of pointers to environment settings.

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_flushall**, **_getmbcp**, **_onexit**, **_setmbcp**, **system**

Example

See Example on page 536.

_spawnvp, _wspawnvp

Create and execute a new process.

int _spawnvp(int *mode*, **const char** **cmdname*, **const char *const** **argv*);
int _wspawnvp(int *mode*, **const wchar_t** **cmdname*, **const wchar_t *const** **argv*);

Routine	Required Header	Compatibility
_spawnvp	<stdio.h> or <process.h>	Win 95, Win NT
_wspawnvp	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnvp** or **_wspawnvp** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnvp** or **_wspawnvp** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

argv Array of pointers to arguments

Remarks

Each of these functions creates and executes a new process, passing an array of pointers to command-line arguments and using the the **PATH** environment variable to find the file to execute.

See Also: abort, atexit, _exec Functions, **exit, _flushall, _getmbcp, _onexit, _setmbcp, system**

Example

See Example on page 536.

_spawnvpe, _wspawnvpe

Create and execute a new process.

int _spawnvpe(int *mode*, **const char** **cmdname*, **const char *const** **argv*,
↪ **const char *const** **envp*);
int _wspawnvpe(int *mode*, **const wchar_t** **cmdname*, **const wchar_t *const** **argv*,
↪ **const wchar_t *const** **envp*);

Routine	Required Header	Compatibility
_spawnvpe	<stdio.h> or <process.h>	Win 95, Win NT
_wspawnvpe	<stdio.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value from a synchronous **_spawnvpe** or **_wspawnvpe** (**_P_WAIT** specified for *mode*) is the exit status of the new process. The return value from an asynchronous **_spawnvpe** or **_wspawnvpe** (**_P_NOWAIT** or **_P_NOWAITO** specified for *mode*) is the process handle. The exit status is 0 if the process terminated normally. You can set the exit status to a nonzero value if the spawned process specifically calls the **exit** routine with a nonzero argument. If the new process did not explicitly set a positive exit status, a positive exit status indicates an abnormal exit with an abort or an interrupt. A return value of –1 indicates an error (the new process is not started). In this case, **errno** is set to one of the following values:

E2BIG Argument list exceeds 1024 bytes

EINVAL *mode* argument is invalid

ENOENT File or path is not found

ENOEXEC Specified file is not executable or has invalid executable-file format

ENOMEM Not enough memory is available to execute new process

Parameters

mode Execution mode for calling process

cmdname Path of file to be executed

argv Array of pointers to arguments

envp Array of pointers to environment settings

Remarks

Each of these functions creates and executes a new process, passing an array of pointers to command-line arguments and an array of pointers to environment settings. These functions use the **PATH** environment variable to find the file to execute.

See Also: **abort**, **atexit**, **_exec** Functions, **exit**, **_flushall**, **_getmbcp**, **_onexit**, **_setmbcp**, **system**

Example

See Example on page 536.

_splitpath, _wsplitpath

Break a path name into components.

void _splitpath(const char ***path*, char** ***drive*, char** ***dir*, char** ***fname*, char** ***ext*);**
void _wsplitpath(const wchar_t ***path*, wchar_t** ***drive*, wchar_t** ***dir*,**
↪ **wchar_t** ***fname*, wchar_t** ***ext*);**

Routine	Required Header	Compatibility
_splitpath	<stdlib.h>	Win 95, Win NT
_wsplitpath	<stdlib.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

path Full path

drive Optional drive letter, followed by a colon (:)

dir Optional directory path, including trailing slash. Forward slashes (/), backslashes (\ ), or both may be used.

fname Base filename (no extension)

ext Optional filename extension, including leading period (.)

Remarks

The **_splitpath** function breaks a path into its four components. **_splitpath** automatically handles multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use. **_wsplitpath** is a wide-character version of **_splitpath**; the arguments to **_wsplitpath** are wide-character strings. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tsplitpath	_splitpath	_splitpath	_wsplitpath

Each argument is stored in a buffer; the manifest constants **_MAX_DRIVE**, **_MAX_DIR**, **_MAX_FNAME**, and **_MAX_EXT** (defined in STDLIB.H) specify the maximum size necessary for each buffer. The other arguments point to buffers used to store the path elements. After a call to **_splitpath** is executed, these arguments contain empty strings for components not found in *path*. You can pass a **NULL** pointer to **_splitpath** for any component you don't need.

Example

```
/* MAKEPATH.C */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char path_buffer[_MAX_PATH];
   char drive[_MAX_DRIVE];
   char dir[_MAX_DIR];
   char fname[_MAX_FNAME];
   char ext[_MAX_EXT];

   _makepath( path_buffer, "c", "\\sample\\crt\\", "makepath", "c" );
   printf( "Path created with _makepath: %s\n\n", path_buffer );
   _splitpath( path_buffer, drive, dir, fname, ext );
```

```
    printf( "Path extracted with _splitpath:\n" );
    printf( "  Drive: %s\n", drive );
    printf( "  Dir: %s\n", dir );
    printf( "  Filename: %s\n", fname );
    printf( "  Ext: %s\n", ext );
}
```

Output

```
Path created with _makepath: c:\sample\crt\makepath.c

Path extracted with _splitpath:
  Drive: c:
  Dir: \sample\crt\
  Filename: makepath
  Ext: .c
```

See Also: **_fullpath, _getmbcp, _makepath, _setmbcp**

sprintf, swprintf

Write formatted data to a string.

int sprintf(char **buffer*, **const char** **format* [, *argument*] ... **);**
int swprintf(wchar_t **buffer*, **const wchar_t** **format* [, *argument*] ... **);**

Routine	Required Header	Compatibility
sprintf	<stdio.h>	ANSI, Win 95, Win NT
swprintf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

sprintf returns the number of bytes stored in *buffer,* not counting the terminating null character. **swprintf** returns the number of wide characters stored in *buffer,* not counting the terminating null wide character.

Parameters

buffer Storage location for output

format Format-control string

argument Optional arguments

For more information, see "Format Specifications" on page 463.

Remarks

The **sprintf** function formats and stores a series of characters and values in *buffer*. Each *argument* (if any) is converted and output according to the corresponding format specification in *format*. The format consists of ordinary characters and has the same form and function as the *format* argument for **printf**. A null character is appended after the last character written. If copying occurs between strings that overlap, the behavior is undefined.

swprintf is a wide-character version of **sprintf**; the pointer arguments to **swprintf** are wide-character strings. Detection of encoding errors in **swprintf** may differ from that in **sprintf**. **swprintf** and **fwprintf** behave identically except that **swprintf** writes output to a string rather than to a destination of type **FILE**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_stprintf	sprintf	sprintf	swprintf

Example

```
/* SPRINTF.C: This program uses sprintf to format various
 * data and place them in the string named buffer.
 */

#include <stdio.h>

void main( void )
{
   char  buffer[200], s[] = "computer", c = 'l';
   int   i = 35, j;
   float fp = 1.7320534f;

   /* Format and print various data: */
   j  = sprintf( buffer,     "\tString:    %s\n", s );
   j += sprintf( buffer + j, "\tCharacter: %c\n", c );
   j += sprintf( buffer + j, "\tInteger:   %d\n", i );
   j += sprintf( buffer + j, "\tReal:      %f\n", fp );

   printf( "Output:\n%s\ncharacter count = %d\n", buffer, j );
}
```

Output

```
Output:
   String:    computer
   Character: l
   Integer:   35
   Real:      1.732053

character count = 71
```

See Also: **_snprintf**, **fprintf**, **printf**, **scanf**, **sscanf**, **vprintf** Functions

sqrt

Calculates the square root.

double sqrt(double *x* **);**

Routine	Required Header	Compatibility
sqrt	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The **sqrt** function returns the square-root of *x*. If *x* is negative, **sqrt** returns an indefinite (same as a quiet NaN). You can modify error handling with **_matherr**.

Parameter

x Nonnegative floating-point value

Example

```
/* SQRT.C: This program calculates a square root. */

#include <math.h>
#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   double question = 45.35, answer;

   answer = sqrt( question );
   if( question < 0 )
      printf( "Error: sqrt returns %.2f\n, answer" );
   else
      printf( "The square root of %.2f is %.2f\n", question, answer );
}
```

Output

```
The square root of 45.35 is 6.73
```

See Also: exp, log, pow

srand

Sets a random starting point.

void srand(unsigned int *seed* **);**

Routine	Required Header	Compatibility
srand	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameter

seed Seed for random-number generation

Remarks

The **srand** function sets the starting point for generating a series of pseudorandom integers. To reinitialize the generator, use 1 as the *seed* argument. Any other value for *seed* sets the generator to a random starting point. **rand** retrieves the pseudorandom numbers that are generated. Calling **rand** before any call to **srand** generates the same sequence as calling **srand** with *seed* passed as 1.

Example

```
/* RAND.C: This program seeds the random-number generator
 * with the time, then displays 10 random integers.
 */

#include <stdlib.h>
#include <stdio.h>
#include <time.h>

void main( void )
{
   int i;

   /* Seed the random-number generator with current time so that
    * the numbers will be different every time we run.
    */
   srand( (unsigned)time( NULL ) );

   /* Display 10 numbers. */
   for( i = 0;   i < 10;i++ )
      printf( "  %6d\n", rand() );
}
```

Output

```
 6929
 8026
21987
30734
20587
 6699
22034
25051
 7988
10104
```

See Also: **rand**

---

sscanf, swscanf

Read formatted data from a string.

int sscanf(const char **buffer*, **const char** **format* [, *argument*] ... **);**
int swscanf(const wchar_t **buffer*, **const wchar_t** **format* [, *argument*] ... **);**

Routine	Required Header	Compatibility
sscanf	<stdio.h>	ANSI, Win 95, Win NT
swscanf	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the number of fields successfully converted and assigned; the return value does not include fields that were read but not assigned. A return value of 0 indicates that no fields were assigned. The return value is **EOF** for an error or if the end of the string is reached before the first conversion.

Parameters

buffer Stored data

format Format-control string

argument Optional arguments

For more information, see "Format Specifications" on page 495.

Remarks

The **sscanf** function reads data from *buffer* into the location given by each *argument*. Every *argument* must be a pointer to a variable with a type that corresponds to a type specifier in *format*. The *format* argument controls the interpretation of the input fields and has the same form and function as the *format* argument for the **scanf** function; see **scanf** for a complete description of *format*. If copying takes place between strings that overlap, the behavior is undefined.

swscanf is a wide-character version of **sscanf**; the arguments to **swscanf** are wide-character strings. **sscanf** does not handle multibyte hexadecimal characters. **swscanf** does not handle Unicode fullwidth hexadecimal or "compatibility zone" characters. Otherwise, **swscanf** and **sscanf** behave identically.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_stscanf	sscanf	sscanf	swscanf

Example

```
/* SSCANF.C: This program uses sscanf to read data items
 * from a string named tokenstring, then displays them.
 */

#include <stdio.h>

void main( void )
{
   char  tokenstring[] = "15 12 14...";
   char  s[81];
   char  c;
   int   i;
   float fp;

   /* Input various data from tokenstring: */
   sscanf( tokenstring, "%s", s );
   sscanf( tokenstring, "%c", &c );
   sscanf( tokenstring, "%d", &i );
   sscanf( tokenstring, "%f", &fp );

   /* Output the data read */
   printf( "String    = %s\n", s );
   printf( "Character = %c\n", c );
   printf( "Integer:  = %d\n", i );
   printf( "Real:     = %f\n", fp );
}
```

Output

```
String    = 15
Character = 1
Integer:  = 15
Real:     = 15.000000
```

See Also: **fscanf, scanf, sprintf, _snprintf**

_stat, _wstat, _stati64, _wstati64

Get status information on a file.

int _stat(const char **path*, **struct _stat** **buffer* **);**
__int64 _stati64(const char **path*, **struct _stat** **buffer* **);**
int _wstat(const wchar_t **path*, **struct _stat** **buffer* **);**
__int64 _wstati64(const wchar_t **path*, **struct _stat** **buffer* **);**

Routine	Required Header	Optional Headers	Compatibility
_stat	<sys/types.h> followed by <sys/stat.h>	<errno.h>	Win 95, Win NT
_wstat	<sys/types.h> followed by <sys/stat.h> or <wchar.h>	<errno.h>	Win NT
_stati64	<sys/types.h> followed by <sys/stat.h>	<errno.h>	Win 95, Win NT
_wstati64	<sys/types.h> followed by <sys/stat.h> or <wchar.h>	<errno.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the file-status information is obtained. A return value of –1 indicates an error, in which case **errno** is set to **ENOENT**, indicating that the filename or path could not be found.

Parameters

path Path of existing file

buffer Pointer to structure that stores results

Remarks

The **_stat** function obtains information about the file or directory specified by *path* and stores it in the structure pointed to by *buffer*. **_stat** automatically handles multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the multibyte code page currently in use.

_wstat is a wide-character version of **_stat**; the *path* argument to **_wstat** is a wide-character string. **_wstat** and **_stat** behave identically except that **_wstat** does not handle multibyte-character strings.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tstat	_stat	_stat	_wstat
_tstati64	_stati64	_stati64	_wstati64

The **_stat** structure, defined in SYS\STAT.H, includes the following fields.

gid Numeric identifier of group that owns file (UNIX-specific)

st_atime Time of last access of file.

st_ctime Time of creation of file.

st_dev Drive number of the disk containing the file (same as **st_rdev**).

st_ino Number of the information node (the *inode*) for the file (UNIX-specific). On UNIX file systems, the inode describes the file date and time stamps, permissions, and content. When files are soft-linked to one another, they share the same inode. The inode, and therefore **st_ino**, has no meaning in the FAT, HPFS, or NTFS file systems.

st_mode Bit mask for file-mode information. The **_S_IFDIR** bit is set if *path* specifies a directory; the **_S_IFREG** bit is set if *path* specifies an ordinary file or a device. User read/write bits are set according to the file's permission mode; user execute bits are set according to the filename extension.

st_mtime Time of last modification of file.

st_nlink Always 1 on non-NTFS file systems.

st_rdev Drive number of the disk containing the file (same as **st_dev**).

st_size Size of the file in bytes; a 64-bit integer for **_stati64** and **_wstati64**

uid Numeric identifier of user who owns file (UNIX-specific)

If *path* refers to a device, the size, time, **_dev**, and **_rdev** fields in the **_stat** structure are meaningless. Because STAT.H uses the **_dev_t** type that is defined in TYPES.H, you must include TYPES.H before STAT.H in your code.

Example

```
/* STAT.C: This program uses the _stat function to
 * report information about the file named STAT.C.
 */

#include <time.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <stdio.h>
```

```
void main( void )
{
   struct _stat buf;
   int result;
   char buffer[] = "A line to output";

   /* Get data associated with "stat.c": */
   result = _stat( "stat.c", &buf );

   /* Check if statistics are valid: */
   if( result != 0 )
      perror( "Problem getting information" );
   else
   {
      /* Output some of the statistics: */
      printf( "File size     : %ld\n", buf.st_size );
      printf( "Drive         : %c:\n", buf.st_dev + 'A' );
      printf( "Time modified : %s", ctime( &buf.st_atime ) );
   }
}
```

Output

```
File size     : 745
Drive         : C:
Time modified : Tue May 03 00:00:00 1994
```

See Also: **_access, _fstat, _getmbcp, _setmbcp**

_status87, _statusfp

Get the floating point status word.

unsigned int _status87(void);
unsigned int _statusfp(void);

Routine	Required Header	Compatibility
_status87	<float.h>	Win 95, Win NT
_statusfp	<float.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The bits in the value returned indicate the floating-point status. See the FLOAT.H include file for a complete definition of the bits returned by **_status87**.

Many math library functions modify the 8087/80287 status word, with unpredictable results. Return values from **_clear87** and **_status87** are more reliable if fewer floating-point operations are performed between known states of the floating-point status word.

Remarks

The **_status87** function gets the floating-point status word. The status word is a combination of the 8087/80287/80387 status word and other conditions detected by the 8087/80287/80387 exception handler, such as floating-point stack overflow and underflow. Unmasked exceptions are checked for before returning the contents of the status word. This means that the caller is informed of pending exceptions.

_statusfp is a platform-independent, portable version of **_status87**. It is identical to **_status87** on Intel (x86) platforms and is also supported by the MIPS platform. To ensure that your floating-point code is portable to MIPS, use **_statusfp**. If you are only targeting x86 platforms, use either **_status87** or **_statusfp**.

Example

```
/* STATUS87.C: This program creates various floating-point errors and
 * then uses _status87 to display messages indicating these problems.
 * Compile this program with optimizations disabled (/Od). Otherwise,
 * the optimizer removes the code related to the unused floating-
 * point values.
 */

#include <stdio.h>
#include <float.h>

void main( void )
{
   double a = 1e-40, b;
   float  x, y;

   printf( "Status = %.4x - clear\n",_status87() );

   /* Assignment into y is inexact & underflows: */
   y = a;
   printf( "Status = %.4x - inexact, underflow\n", _status87() );

   /* y is denormal: */
   b = y;
   printf( "Status = %.4x - inexact underflow, denormal\n",
           _status87() );

   /* Clear user 8087: */
   _clear87();
}
```

Output

```
Status = 0000 - clear
Status = 0003 - inexact, underflow
Status = 80003 - inexact underflow, denormal
```

See Also: **_clear87, _control87**

strcat, wcscat, _mbscat

Append a string.

char *strcat(char ***strDestination*, const char** ***strSource*);**
wchar_t *wcscat(wchar_t ***strDestination*, const wchar_t** ***strSource*);**
unsigned char *_mbscat(unsigned char ***strDestination*,**
↪ **const unsigned char** ***strSource*);**

Routine	Required Header	Compatibility
strcat	<string.h>	ANSI, Win 95, Win NT
wcscat	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbscat	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the destination string (*strDestination*). No return value is reserved to indicate an error.

Parameters

strDestination Null-terminated destination string

strSource Null-terminated source string

Remarks

The **strcat** function appends *strSource* to *strDestination* and terminates the resulting string with a null character. The initial character of *strSource* overwrites the terminating null character of *strDestination*. No overflow checking is performed when strings are copied or appended. The behavior of **strcat** is undefined if the source and destination strings overlap.

wcscat and **_mbscat** are wide-character and multibyte-character versions of **strcat**. The arguments and return value of **wcscat** are wide-character strings; those of **_mbscat** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcscat	strcat	_mbscat	wcscat

Example

```
/* STRCPY.C: This program uses strcpy
 * and strcat to build a phrase.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[80];
   strcpy( string, "Hello world from " );
   strcat( string, "strcpy " );
   strcat( string, "and " );
   strcat( string, "strcat!" );
   printf( "String = %s\n", string );
}
```

Output

```
String = Hello world from strcpy and strcat!
```

See Also: strncat, strncmp, strncpy, _strnicmp, strrchr, strspn

strchr, wcschr, _mbschr

Find a character in a string.

char *strchr(const char *_string_, int _c_);
wchar_t *wcschr(const wchar_t *_string_, wint_t _c_);
unsigned char *_mbschr(const unsigned char *_string_, unsigned int _c_);

Routine	Required Header	Compatibility
strchr	<string.h>	ANSI, Win 95, Win NT
wcschr	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbschr	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the first occurrence of *c* in *string*, or **NULL** if *c* is not found.

Parameters

string Null-terminated source string

c Character to be located

Remarks

The **strchr** function finds the first occurrence of *c* in *string*, or it returns **NULL** if *c* is not found. The null-terminating character is included in the search.

wcschr and **_mbschr** are wide-character and multibyte-character versions of **strchr**. The arguments and return value of **wcschr** are wide-character strings; those of **_mbschr** are multibyte-character strings. **_mbschr** recognizes multibyte-character sequences according to the multibyte code page currently in use. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcschr	strchr	_mbschr	wcschr

Example

```
/* STRCHR.C: This program illustrates searching for a character
 * with strchr (search forward) or strrchr (search backward).
 */

#include <string.h>
#include <stdio.h>

int  ch = 'r';

char string[] = "The quick brown dog jumps over the lazy fox";
char fmt1[] =   "         1         2         3         4         5";
char fmt2[] =   "12345678901234567890123456789012345678901234567890";

void main( void )
{
   char *pdest;
   int result;

   printf( "String to be searched: \n\t\t%s\n", string );
   printf( "\t\t%s\n\t\t%s\n\n", fmt1, fmt2 );
   printf( "Search char:\t%c\n", ch );
```

```
    /* Search forward. */
    pdest = strchr( string, ch );
    result = pdest - string + 1;
    if( pdest != NULL )
       printf( "Result:\tfirst %c found at position %d\n\n",
               ch, result );
    else
       printf( "Result:\t%c not found\n" );

    /* Search backward. */
    pdest = strrchr( string, ch );
    result = pdest - string + 1;
    if( pdest != NULL )
       printf( "Result:\tlast %c found at position %d\n\n", ch, result );
    else
       printf( "Result:\t%c not found\n" );
}
```

Output

```
String to be searched:
      The quick brown dog jumps over the lazy fox
                1         2         3         4         5
      123456789012345678901234567890123456789012345678901234567890

Search char:   r
Result:   first r found at position 12

Result:   last r found at position 30
```

See Also: **strcspn, strncat, strncmp, strncpy, _strnicmp, strpbrk, strrchr, strstr**

strcmp, wcscmp, _mbscmp

Compare strings.

int strcmp(const char **string1*, **const char** **string2* **);**
int wcscmp(const wchar_t **string1*, **const wchar_t** **string2* **);**
int _mbscmp(const unsigned char **string1*, **const unsigned char** **string2* **);**

Routine	Required Header	Compatibility
strcmp	<string.h>	ANSI, Win 95, Win NT
wcscmp	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbscmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value for each of these functions indicates the lexicographic relation of *string1* to *string2*.

Value	Relationship of string1 to string2
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

On an error, **_mbscmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, string2 Null-terminated strings to compare

Remarks

The **strcmp** function compares *string1* and *string2* lexicographically and returns a value indicating their relationship. **wcscmp** and **_mbscmp** are wide-character and multibyte-character versions of **strcmp**. The arguments and return value of **wcscmp** are wide-character strings; those of **_mbscmp** are multibyte-character strings. **_mbscmp** recognizes multibyte-character sequences according to the current multibyte code page and returns **_NLSCMPERROR** on an error. (For more information, see "Code Pages" on page 22 in Chapter 1.) These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcscmp	strcmp	_mbscmp	wcscmp

The **strcmp** functions differ from the **strcoll** functions in that **strcmp** comparisons are not affected by locale, whereas the manner of **strcoll** comparisons is determined by the **LC_COLLATE** category of the current locale. For more information on the **LC_COLLATE** category, see **setlocale**.

In the "C" locale, the order of characters in the character set (ASCII character set) is the same as the lexicographic character order. However, in other locales, the order of characters in the character set may differ from the lexicographic order. For example, in certain European locales, the character 'a' (value 0x61) precedes the character 'ä' (value 0xE4) in the character set, but the character 'ä' precedes the character 'a' lexicographically.

In locales for which the character set and the lexicographic character order differ, use **strcoll** rather than **strcmp** for lexicographic comparison of strings according to the **LC_COLLATE** category setting of the current locale. Thus, to perform a lexicographic comparison of the locale in the above example, use **strcoll** rather than **strcmp**. Alternatively, you can use **strxfrm** on the original strings, then use **strcmp** on the resulting strings.

_stricmp, _wcsicmp, and **_mbsicmp** compare strings by first converting them to their lowercase forms.Two strings containing characters located between 'Z' and 'a' in the ASCII table ('[', '\', ']', '^', '_', and '`') compare differently, depending on their case. For example, the two strings "ABCDE" and "ABCD^" compare one way if the comparison is lowercase ("abcde" > "abcd^") and the other way ("ABCDE" < "ABCD^") if the comparison is uppercase.

Example

```
/* STRCMP.C */

#include <string.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown dog jumps over the lazy fox";

void main( void )
{
   char tmp[20];
   int result;
   /* Case sensitive */
   printf( "Compare strings:\n\t%s\n\t%s\n\n", string1, string2 );
   result = strcmp( string1, string2 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "\tstrcmp:   String 1 is %s string 2\n", tmp );
   /* Case insensitive (could use equivalent _stricmp) */
   result = _stricmp( string1, string2 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "\t_stricmp:  String 1 is %s string 2\n", tmp );
}
```

Output

```
Compare strings:
   The quick brown dog jumps over the lazy fox
   The QUICK brown dog jumps over the lazy fox

   strcmp:   String 1 is greater than string 2
   _stricmp:  String 1 is equal to string 2
```

See Also: memcmp, _memicmp, strcoll Functions, **_stricmp, strncmp, _strnicmp, strrchr, strspn, strxfrm**

strcoll Functions

Each of the **strcoll** and **wcscoll** functions compares two strings according to the **LC_COLLATE** category setting of the locale code page currently in use. Each of the **_mbscoll** functions compares two strings according to the multibyte code page currently in use. Use the **coll** functions for string comparisons when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the comparison. Use the corresponding **cmp** functions to test only for string equality.

strcoll Functions

SBCS	Unicode	MBCS	Description
strcoll	**wcscoll**	**_mbscoll**	Collate two strings
_stricoll	**_wcsicoll**	**_mbsicoll**	Collate two strings (case insensitive)
_strncoll	**_wcsncoll**	**_mbsncoll**	Collate first *count* characters of two strings
_strnicoll	**_wcsnicoll**	**_mbsnicoll**	Collate first *count* characters of two strings (case-insensitive)

Remarks

The single-byte character (SBCS) versions of these functions (**strcoll**, **stricoll**, **_strncoll**, and **_strnicoll**) compare *string1* and *string2* according to the **LC_COLLATE** category setting of the current locale. These functions differ from the corresponding **strcmp** functions in that the **strcoll** functions use locale code page information that provides collating sequences. For string comparisons in locales in which the character set order and the lexicographic character order differ, the **strcoll** functions should be used rather than the corresponding **strcmp** functions. For more information on **LC_COLLATE**, see **setlocale**.

For some code pages and corresponding character sets, the order of characters in the character set may differ from the lexicographic character order. In the "C" locale, this is not the case: the order of characters in the ASCII character set is the same as the lexicographic order of the characters. However, in certain European code pages, for example, the character 'a' (value 0x61) precedes the character 'ä' (value 0xE4) in the character set, but the character 'ä' precedes the character 'a' lexicographically. To perform a lexicographic comparison in such an instance, use **strcoll** rather than **strcmp**. Alternatively, you can use **strxfrm** on the original strings, then use **strcmp** on the resulting strings.

strcoll, **stricoll**, **_strncoll**, and **_strnicoll** automatically handle multibyte-character strings according to the locale code page currently in use, as do their wide-character (Unicode) counterparts. The multibyte-character (MBCS) versions of these functions, however, collate strings on a character basis according to the multibyte code page currently in use.

Because the **coll** functions collate strings lexicographically for comparison, whereas the **cmp** functions simply test for string equality, the **coll** functions are much slower than the corresponding **cmp** versions. Therefore, the **coll** functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the string comparison.

See Also: **localeconv, _mbsnbcoll, setlocale, strcmp, strncmp, _strnicmp, strxfrm**

strcoll, wcscoll, _mbscoll

Compare strings using locale-specific information.

int strcoll(const char **string1*, **const char** **string2* **);**
int wcscoll(const wchar_t **string1*, **const wchar_t** **string2* **);**
int _mbscoll(const unsigned char **string1*, **const unsigned char** **string2* **);**

Routine	Required Header	Compatibility
strcoll	<string.h>	ANSI, Win 95, Win NT
wcscoll	<wchar.h>, <string.h>	ANSI, Win 95, Win NT
_mbscoll	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a value indicating the relationship of *string1* to *string2*, as follows:

Return Value	Relationship of string1 to string2
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

Each of these functions returns **_NLSCMPERROR** on an error. To use **_NLSCMPERROR**, include either STRING.H or MBSTRING.H. **wcscoll** can fail if either *string1* or *string2* contains wide-character codes outside the domain of the collating sequence. When an error occurs, **wcscoll** may set **errno** to **EINVAL**. To check for an error on a call to **wcscoll**, set **errno** to 0 and then check **errno** after calling **wcscoll**.

Parameters

string1, string2 Null-terminated strings to compare

Remarks

Each of these functions performs a case-sensitive comparison of *string1* and *string2* according to the code page currently in use. These functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the string comparison.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcscoll	strcoll	_mbscoll	wcscoll

See Also: localeconv, _mbsnbcoll, setlocale, strcmp, _stricmp, strncmp, _strnicmp, strxfrm

_stricoll, _wcsicoll, _mbsicoll

Compare strings using locale-specific information.

int _stricoll(const char **string1*, const char **string2*);
int _wcsicoll(const wchar_t **string1*, const wchar_t **string2*);
int _mbsicoll(const unsigned char **string1*, const unsigned char **string2*);

Routine	Required Header	Compatibility
_stricoll	<string.h>	Win 95, Win NT
_wcsicoll	<wchar.h>, <string.h>	Win 95, Win NT
_mbsicoll	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a value indicating the relationship of *string1* to *string2,* as follows:

Return Value	Relationship of string1 to string2
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

Each of these functions returns **_NLSCMPERROR**. To use **_NLSCMPERROR**, include either STRING.H or MBSTRING.H. **_wcsicoll** can fail if either *string1* or *string2* contains wide-character codes outside the domain of the collating sequence. When an error occurs, **_wcsicoll** may set **errno** to **EINVAL**. To check for an error on a call to **_wcsicoll**, set **errno** to 0 and then check **errno** after calling **_wcsicoll**.

Parameters

string1, string2 Null-terminated strings to compare

Remarks

Each of these functions performs a case-insensitive comparison of *string1* and *string2* according to the code page currently in use. These functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the string comparison.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsicoll	_stricoll	_mbsicoll	_wcsicoll

See Also: localeconv, _mbsnbcoll, setlocale, strcmp, _stricmp, strncmp, _strnicmp, strxfrm

_strncoll, _wcsncoll, _mbsncoll

Compare strings using locale-specific information.

int _strncoll(const char **string1*, **const char** **string2*, **size_t** *count* **);**
int _wcsncoll(const wchar_t **string1*, **const wchar_t** **string2*, **size_t** *count* **);**
int _mbsncoll(const unsigned char **string1*, **const unsigned char** **string2*,
↪ **size_t** *count* **);**

Routine	Required Header	Compatibility
_strncoll	<string.h>	Win 95, Win NT
_wcsncoll	<wchar.h> or <string.h>	Win 95, Win NT
_mbsncoll	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a value indicating the relationship of the substrings of *string1* and *string2,* as follows:

Return Value	Relationship of string1 to string2
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

Each of these functions returns **_NLSCMPERROR**. To use **_NLSCMPERROR**, include either STRING.H or MBSTRING.H. **_wcsncoll** can fail if either *string1* or *string2* contains wide-character codes outside the domain of the collating sequence. When an error occurs, **_wcsncoll** may set **errno** to **EINVAL**. To check for an error on a call to **_wcsncoll**, set **errno** to 0 and then check **errno** after calling **_wcsncoll.**

Parameters

string1, string2 Null-terminated strings to compare

count Number of characters to compare

Remarks

Each of these functions performs a case-sensitive comparison of the first *count* characters in *string1* and *string2* according to the code page currently in use. These functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the string comparison.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsnccoll	_strncoll	_mbsncoll	_wcsncoll
_tcsncoll	_strncoll	_mbsnbcoll	_wcsncoll

See Also: localeconv, _mbsnbcoll, setlocale, strcmp, _stricmp, strncmp, _strnicmp, strxfrm

_strnicoll, _wcsnicoll, _mbsnicoll

Compare strings using locale-specific information.

int _strnicoll(const char **string1*, **const char** **string2*, **size_t** *count*);
int _wcsnicoll(const wchar_t **string1*, **const wchar_t** **string2* , **size_t** *count*);
int _mbsnicoll(const unsigned char **string1*, **const unsigned char** **string2*,
↪ **size_t** *count*);

Routine	Required Header	Compatibility
_strnicoll	<string.h>	Win 95, Win NT
_wcsnicoll	<wchar.h> or <string.h>	Win 95, Win NT
_mbsnicoll	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a value indicating the relationship of the substrings of *string1* and *string2,* as follows:

Return Value	Relationship of string1 to string2
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

Each of these functions returns **_NLSCMPERROR**. To use **_NLSCMPERROR**, include either STRING.H or MBSTRING.H. **_wcsnicoll** can fail if either *string1* or *string2* contains wide-character codes outside the domain of the collating sequence. When an error occurs, **_wcsnicoll** may set **errno** to **EINVAL**. To check for an error on a call to **_wcsnicoll**, set **errno** to 0 and then check **errno** after calling **_wcsnicoll.**

Parameters

string1, string2 Null-terminated strings to compare

count Number of characters to compare

Remarks

Each of these functions performs a case-insensitive comparison of the first *count* characters in *string1* and *string2* according to the code page currently in use. These functions should be used only when there is a difference between the character set order and the lexicographic character order in the current code page and this difference is of interest for the string comparison.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncicoll	_strnicoll	_mbsnicoll	_wcsnicoll
_tcsnicoll	_strnicoll	_mbsnbicoll	_wcsnicoll

See Also: localeconv, _mbsnbcoll, setlocale, strcmp, _stricmp, strncmp, _strnicmp, strxfrm

strcpy, wcscpy, _mbscpy

Copy a string.

char *strcpy(char **strDestination*, const char **strSource*);
wchar_t *wcscpy(wchar_t **strDestination*, const wchar_t **strSource*);
unsigned char *_mbscpy(unsigned char **strDestination*,
↪ const unsigned char **strSource*);

Routine	Required Header	Compatibility
strcpy	<string.h>	ANSI, Win 95, Win NT
wcscpy	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbscpy	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the destination string. No return value is reserved to indicate an error.

Parameters

strDestination Destination string

strSource Null-terminated source string

Remarks

The **strcpy** function copies *strSource*, including the terminating null character, to the location specified by *strDestination*. No overflow checking is performed when strings are copied or appended. The behavior of **strcpy** is undefined if the source and destination strings overlap.

wcscpy and **_mbscpy** are wide-character and multibyte-character versions of **strcpy**. The arguments and return value of **wcscpy** are wide-character strings; those of **_mbscpy** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcscpy	strcpy	_mbscpy	wcscpy

Example

```
/* STRCPY.C: This program uses strcpy
 * and strcat to build a phrase.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[80];
   strcpy( string, "Hello world from " );
   strcat( string, "strcpy " );
   strcat( string, "and " );
   strcat( string, "strcat!" );
   printf( "String = %s\n", string );
}
```

Output

```
String = Hello world from strcpy and strcat!
```

See Also: **strcat, strcmp, strncat, strncmp, strncpy, _strnicmp, strrchr, strspn**

strcspn, wcscspn, _mbscspn

Find a substring in a string.

size_t strcspn(const char **string*, **const char** **strCharSet* **);**
size_t wcscspn(const wchar_t **string*, **const wchar_t** **strCharSet* **);**
size_t _mbscspn(const unsigned char **string*, **const unsigned char** **strCharSet* **);**

Routine	Required Header	Compatibility
strcspn	<string.h>	ANSI, Win 95, Win NT
wcscspn	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbscspn	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns an integer value specifying the length of the initial segment of *string* that consists entirely of characters not in *strCharSet*. If *string* begins with a character that is in *strCharSet*, the function returns 0. No return value is reserved to indicate an error.

Parameters

string Null-terminated searched string

strCharSet Null-terminated character set

Remarks

The **strcspn** function returns the index of the first occurrence of a character in *string* that belongs to the set of characters in *strCharSet*. Terminating null characters are included in the search.

wcscspn and **_mbscspn** are wide-character and multibyte-character versions of **strcspn.** The arguments of **wcscspn** are wide-character strings; those of **_mbscspn** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcscspn	strcspn	_mbscspn	wcscspn

Example

```
/* STRCSPN.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[] = "xyzabc";
   int  pos;

   pos = strcspn( string, "abc" );
   printf( "First a, b or c in %s is at character %d\n",
           string, pos );
}
```

Output

```
First a, b or c in xyzabc is at character 3
```

See Also: **strncat, strncmp, strncpy, _strnicmp, strrchr, strspn**

_strdate, _wstrdate

Copy a date to a buffer.

char *_strdate(char **datestr* **);**
wchar_t *_wstrdate(wchar_t **datestr* **);**

Routine	Required Header	Compatibility
_strdate	<time.h>	Win 95, Win NT
_wstrdate	<time.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the resulting character string *datestr*.

Parameter

datestr A pointer to a buffer containing the formatted date string

Remarks

The **_strdate** function copies a date to the buffer pointed to by *datestr*, formatted *mm/dd/yy*, where *mm* is two digits representing the month, *dd* is two digits representing the day, and *yy* is the last two digits of the year. For example, the string `12/05/99` represents December 5, 1999. The buffer must be at least 9 bytes long.

_wstrdate is a wide-character version of **_strdate**; the argument and return value of **_wstrdate** are wide-character strings. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tstrdate	_strdate	_strdate	_wstrdate

Example

```
/* TIMES.C illustrates various time and date functions including:
 *      time            _ftime          ctime       asctime
 *      localtime       gmtime          mktime      _tzset
 *      _strtime        _strdate        strftime
 *
 * Also the global variable:
 *      _tzname
 */

#include <time.h>
#include <stdio.h>
#include <sys/types.h>
#include <sys/timeb.h>
#include <string.h>

void main()
{
   char tmpbuf[128], ampm[] = "AM";
   time_t ltime;
   struct _timeb tstruct;
   struct tm *today, *gmt, xmas = { 0, 0, 12, 25, 11, 93 };

   /* Set time zone from TZ environment variable. If TZ is not set,
    * the operating system is queried to obtain the default value
    * for the variable.
    */
   _tzset();

   /* Display operating system-style date and time. */
   _strtime( tmpbuf );
   printf( "OS time:\t\t\t\t%s\n", tmpbuf );
   _strdate( tmpbuf );
   printf( "OS date:\t\t\t\t%s\n", tmpbuf );

   /* Get UNIX-style time and display as number and string. */
   time( &ltime );
   printf( "Time in seconds since UTC 1/1/70:\t%ld\n", ltime );
   printf( "UNIX time and date:\t\t\t%s", ctime( &ltime ) );

   /* Display UTC. */
   gmt = gmtime( &ltime );
   printf( "Coordinated universal time:\t\t%s", asctime( gmt ) );

   /* Convert to time structure and adjust for PM if necessary. */
   today = localtime( &ltime );
   if( today->tm_hour > 12 )
```

```
    {
    strcpy( ampm, "PM" );
    today->tm_hour -= 12;
    }
    if( today->tm_hour == 0 )  /* Adjust if midnight hour. */
    today->tm_hour = 12;

    /* Note how pointer addition is used to skip the first 11
     * characters and printf is used to trim off terminating
     * characters.
     */
    printf( "12-hour time:\t\t\t\t%.8s %s\n",
       asctime( today ) + 11, ampm );

    /* Print additional time information. */
    _ftime( &tstruct );
    printf( "Plus milliseconds:\t\t\t%u\n", tstruct.millitm );
    printf( "Zone difference in seconds from UTC:\t%u\n",
           tstruct.timezone );
    printf( "Time zone name:\t\t\t\t%s\n", _tzname[0] );
    printf( "Daylight savings:\t\t\t%s\n",
           tstruct.dstflag ? "YES" : "NO" );

    /* Make time for noon on Christmas, 1993. */
    if( mktime( &xmas ) != (time_t)-1 )
    printf( "Christmas\t\t\t\t%s\n", asctime( &xmas ) );

    /* Use time structure to build a customized time string. */
    today = localtime( &ltime );

    /* Use strftime to build a customized time string. */
    strftime( tmpbuf, 128,
        "Today is %A, day %d of %B in the year %Y.\n", today );
    printf( tmpbuf );
}
```

Output

```
OS time:                                21:51:03
OS date:                                05/03/94
Time in seconds since UTC 1/1/70:       768027063
UNIX time and date:                     Tue May 03 21:51:03 1994
Coordinated universal time:             Wed May 04 04:51:03 1994
12-hour time:                           09:51:03 PM
Plus milliseconds:                      279
Zone difference in seconds from UTC:    480
Time zone name:
Daylight savings:                       YES
Christmas                               Sat Dec 25 12:00:00 1993

Today is Tuesday, day 03 of May in the year 1994.
```

See Also: asctime, ctime, gmtime, localtime, mktime, time, _tzset

_strdup, _wcsdup, _mbsdup

Duplicate strings.

char *_strdup(const char *_strSource_);
wchar_t *_wcsdup(const wchar_t *_strSource_);
unsigned char *_mbsdup(const unsigned char *_strSource_);

Routine	Required Header	Compatibility
_strdup	<string.h>	Win 95, Win NT
_wcsdup	<string.h> or <wchar.h>	Win 95, Win NT
_mbsdup	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the storage location for the copied string or **NULL** if storage cannot be allocated.

Parameter

strSource Null-terminated source string

Remarks

The **_strdup** function calls **malloc** to allocate storage space for a copy of *strSource* and then copies *strSource* to the allocated space.

_wcsdup and **_mbsdup** are wide-character and multibyte-character versions of **_strdup**. The arguments and return value of **_wcsdup** are wide-character strings; those of **_mbsdup** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsdup	_strdup	_mbsdup	_wcsdup

Because **_strdup** calls **malloc** to allocate storage space for the copy of *strSource*, it is good practice always to release this memory by calling the **free** routine on the pointer returned by the call to **_strdup**.

Example

```
/* STRDUP.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char buffer[] = "This is the buffer text";
   char *newstring;
   printf( "Original: %s\n", buffer );
   newstring = _strdup( buffer );
   printf( "Copy:     %s\n", newstring );
   free( newstring );
}
```

Output

```
Original: This is the buffer text
Copy:     This is the buffer text
```

See Also: **memset, strcat, strcmp, strncat, strncmp, strncpy, _strnicmp, strrchr, strspn**

---

strerror, _strerror

Get a system error message (**strerror**) or prints a user-supplied error message (**_strerror**).

char *strerror(int *errnum* **);**
char *_strerror(const char **strErrMsg* **);**

Routine	Required Header	Compatibility
strerror	<string.h>	ANSI, Win 95, Win NT
_strerror	<string.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strerror and **_strerror** return a pointer to the error-message string. Subsequent calls to **strerror** or **_strerror** can overwrite the string.

Parameters

errnum Error number

strErrMsg User-supplied message

Remarks

The **strerror** function maps *errnum* to an error-message string, returning a pointer to the string. Neither **strerror** nor **_strerror** actually prints the message: For that, you need to call an output function such as **fprintf**:

```
if (( _access( "datafile",2 )) == -1 )
   fprintf( stderr, strerror(NULL) );
```

If *strErrMsg* is passed as **NULL**, **_strerror** returns a pointer to a string containing the system error message for the last library call that produced an error. The error-message string is terminated by the newline character ('\n'). If *strErrMsg* is not equal to **NULL**, then **_strerror** returns a pointer to a string containing (in order) your string message, a colon, a space, the system error message for the last library call producing an error, and a newline character. Your string message can be, at most, 94 bytes long.

The actual error number for **_strerror** is stored in the variable **errno**. The system error messages are accessed through the variable **_sys_errlist**, which is an array of messages ordered by error number. **_strerror** accesses the appropriate error message by using the **errno** value as an index to the variable **_sys_errlist**. The value of the variable **_sys_nerr** is defined as the maximum number of elements in the **_sys_errlist** array. To produce accurate results, call **_strerror** immediately after a library routine returns with an error. Otherwise, subsequent calls to **strerror** or **_strerror** can overwrite the **errno** value.

_strerror is not part of the ANSI definition but is instead a Microsoft extension to it. Do not use it where portability is desired; for ANSI compatibility, use **strerror** instead.

Example

```
/* PERROR.C: This program attempts to open a file named
 * NOSUCHF.ILE. Because this file probably doesn't exist,
 * an error message is displayed. The same message is
 * created using perror, strerror, and _strerror.
 */

#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <io.h>
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

void main( void )
{
   int  fh;
```

```
    if( (fh = _open( "NOSUCHF.ILE", _O_RDONLY )) == -1 )
    {
       /* Three ways to create error message: */
       perror( "perror says open failed" );
       printf( "strerror says open failed: %s\n", strerror( errno ) );
       printf( _strerror( "_strerror says open failed" ) );
    }
    else
    {
       printf( "open succeeded on input file\n" );
       _close( fh );
    }
}
```

Output

```
perror says open failed: No such file or directory

strerror says open failed: No such file or directory
_strerror says open failed: No such file or directory
```

See Also: clearerr, ferror, perror

strftime, wcsftime

Format a time string.

size_t strftime(char **strDest*, **size_t** *maxsize*, **const char** **format*,
↪ **const struct tm** **timeptr* **);**
size_t wcsftime(wchar_t **strDest*, **size_t** *maxsize*, **const wchar_t** **format*,
↪ **const struct tm** **timeptr* **);**

Routine	Required Header	Compatibility
strftime	<time.h>	ANSI, Win 95, Win NT
wcsftime	<time.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strftime returns the number of characters placed in *strDest* if the total number of resulting characters, including the terminating null, is not more than *maxsize*. **wcsftime** returns the corresponding number of wide characters. Otherwise, the functions return 0, and the contents of *strDest* is indeterminate.

Parameters

strDest Output string

maxsize Maximum length of string

format Format-control string

timeptr **tm** data structure

Remarks

The **strftime** and **wcsftime** functions format the **tm** time value in *timeptr* according to the supplied *format* argument and store the result in the buffer *strDest.* At most, *maxsize* characters are placed in the string. For a description of the fields in the *timeptr* structure, see **asctime. wcsftime** is the wide-character equivalent of **strftime;** its string-pointer argument points to a wide-character string. These functions behave identically otherwise.

Note Prior to this version of Visual C++, the documentation described the *format* parameter of **wcsftime** as having the datatype **const wchar_t ***, but the actual implementation of the *format* datatype was **const char ***. In this version, the implementation of the *format* datatype has been updated to reflect the previous and current documentation, that is: **const wchar_t ***.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsftime	strftime	strftime	wcsftime

The *format* argument consists of one or more codes; as in **printf**, the formatting codes are preceded by a percent sign (%). Characters that do not begin with % are copied unchanged to *strDest.* The **LC_TIME** category of the current locale affects the output formatting of **strftime**.(For more information on **LC_TIME**, see **setlocale**.) The formatting codes for **strftime** are listed below:

%a Abbreviated weekday name

%A Full weekday name

%b Abbreviated month name

%B Full month name

%c Date and time representation appropriate for locale

%d Day of month as decimal number (01–31)

%H Hour in 24-hour format (00–23)

%I Hour in 12-hour format (01–12)

%j Day of year as decimal number (001–366)

%m Month as decimal number (01–12)

%M Minute as decimal number (00–59)

%p Current locale's A.M./P.M. indicator for 12-hour clock

%S Second as decimal number (00–59)

%U Week of year as decimal number, with Sunday as first day of week (00–51)

%w Weekday as decimal number (0–6; Sunday is 0)

%W Week of year as decimal number, with Monday as first day of week (00–51)

%x Date representation for current locale

%X Time representation for current locale

%y Year without century, as decimal number (00–99)

%Y Year with century, as decimal number

%z, %Z Time-zone name or abbreviation; no characters if time zone is unknown

%% Percent sign

As in the **printf** function, the # flag may prefix any formatting code. In that case, the meaning of the format code is changed as follows:

Format Code	Meaning
%#a, %#A, %#b, %#B, %#p, %#X, %#z, %#Z, %#%	# flag is ignored.
%#c	Long date and time representation, appropriate for current locale. For example: "Tuesday, March 14, 1995, 12:41:29."
%#x	Long date representation, appropriate to current locale. For example: "Tuesday, March 14, 1995."
%#d, %#H, %#I, %#j, %#m, %#M, %#S, %#U, %#w, %#W, %#y, %#Y	Remove leading zeros (if any).

Example

```
/* TIMES.C illustrates various time and date functions including:
 *      time            _ftime          ctime       asctime
 *      localtime       gmtime          mktime      _tzset
 *      _strtime        _strdate        strftime
 *
 * Also the global variable:
 *      _tzname
 */

#include <time.h>
#include <stdio.h>
#include <sys/types.h>
#include <sys/timeb.h>
#include <string.h>
```

```
void main()
{
   char tmpbuf[128], ampm[] = "AM";
   time_t ltime;
   struct _timeb tstruct;
   struct tm *today, *gmt, xmas = { 0, 0, 12, 25, 11, 93 };

   /* Set time zone from TZ environment variable. If TZ is not set,
    * the operating system is queried to obtain the default value
    * for the variable.
    */
   _tzset();

   /* Display operating system-style date and time. */
   _strtime( tmpbuf );
   printf( "OS time:\t\t\t\t%s\n", tmpbuf );
   _strdate( tmpbuf );
   printf( "OS date:\t\t\t\t%s\n", tmpbuf );

   /* Get UNIX-style time and display as number and string. */
   time( &ltime );
   printf( "Time in seconds since UTC 1/1/70:\t%ld\n", ltime );
   printf( "UNIX time and date:\t\t\t%s", ctime( &ltime ) );

   /* Display UTC. */
   gmt = gmtime( &ltime );
   printf( "Coordinated universal time:\t\t%s", asctime( gmt ) );

   /* Convert to time structure and adjust for PM if necessary. */
   today = localtime( &ltime );
   if( today->tm_hour > 12 )
   {
   strcpy( ampm, "PM" );
   today->tm_hour -= 12;
   }
   if( today->tm_hour == 0 )  /* Adjust if midnight hour. */
   today->tm_hour = 12;

   /* Note how pointer addition is used to skip the first 11
    * characters and printf is used to trim off terminating
    * characters.
    */
   printf( "12-hour time:\t\t\t\t%.8s %s\n",
      asctime( today ) + 11, ampm );

   /* Print additional time information. */
   _ftime( &tstruct );
   printf( "Plus milliseconds:\t\t\t%u\n", tstruct.millitm );
   printf( "Zone difference in seconds from UTC:\t%u\n",
          tstruct.timezone );
   printf( "Time zone name:\t\t\t\t%s\n", _tzname[0] );
   printf( "Daylight savings:\t\t\t%s\n",
          tstruct.dstflag ? "YES" : "NO" );
```

```
    /* Make time for noon on Christmas, 1993. */
    if( mktime( &xmas ) != (time_t)-1 )
    printf( "Christmas\t\t\t\t%s\n", asctime( &xmas ) );

    /* Use time structure to build a customized time string. */
    today = localtime( &ltime );

    /* Use strftime to build a customized time string. */
    strftime( tmpbuf, 128,
        "Today is %A, day %d of %B in the year %Y.\n", today );
    printf( tmpbuf );
}
```

Output

```
OS time:                                21:51:03
OS date:                                05/03/94
Time in seconds since UTC 1/1/70:       768027063
UNIX time and date:                     Tue May 03 21:51:03 1994
Coordinated universal time:             Wed May 04 04:51:03 1994
12-hour time:                           09:51:03 PM
Plus milliseconds:                      279
Zone difference in seconds from UTC:    480
Time zone name:
Daylight savings:                       YES
Christmas                               Sat Dec 25 12:00:00 1993

Today is Tuesday, day 03 of May in the year 1994.
```

See Also: **localeconv, setlocale, strcoll, _stricoll, strxfrm**

_stricmp, _wcsicmp, _mbsicmp

Perform a lowercase comparison of strings.

int _stricmp(const char *_string1_, const char *_string2_);
int _wcsicmp(const wchar_t *_string1_, const wchar_t *_string2_);
int _mbsicmp(const unsigned char *_string1_, const unsigned char_t *_string2_);

Routine	Required Header	Compatibility
_stricmp	<string.h>	Win 95, Win NT
_wcsicmp	<string.h> or <wchar.h>	Win 95, Win NT
_mbsicmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relation of *string1* to *string2* as follows:

Return Value	Description
< 0	*string1* less than *string2*
0	*string1* identical to *string2*
> 0	*string1* greater than *string2*

On an error, **_mbsicmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, *string2* Null-terminated strings to compare

Remarks

The **_stricmp** function lexicographically compares lowercase versions of *string1* and *string2* and returns a value indicating their relationship. **_stricmp** differs from **_stricoll** in that the **_stricmp** comparison is not affected by locale, whereas the **_stricoll** comparison is according to the **LC_COLLATE** category of the current locale. For more information on the **LC_COLLATE** category, see **setlocale**.

The **_strcmpi** function is equivalent to **_stricmp** and is provided for backward compatibility only.

_wcsicmp and **_mbsicmp** are wide-character and multibyte-character versions of **_stricmp**. The arguments and return value of **_wcsicmp** are wide-character strings; those of **_mbsicmp** are multibyte-character strings. **_mbsicmp** recognizes multibyte-character sequences according to the current multibyte code page and returns **_NLSCMPERROR** on an error. (For more information, see "Code Pages" on page 22 in Chapter 1.) These three functions behave identically otherwise.

_wcsicmp and **wcscmp** behave identically except that **wcscmp** does not convert its arguments to lowercase before comparing them. **_mbsicmp** and **_mbscmp** behave identically except that **_mbscmp** does not convert its arguments to lowercase before comparing them.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsicmp	_stricmp	_mbsicmp	_wcsicmp

Example

```
/* STRCMP.C */

#include <string.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown dog jumps over the lazy fox";
```

```
void main( void )
{
   char tmp[20];
   int result;
   /* Case sensitive */
   printf( "Compare strings:\n\t%s\n\t%s\n\n", string1, string2 );
   result = strcmp( string1, string2 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "\tstrcmp:String 1 is %s string 2\n", tmp );
   /* Case insensitive (could use equivalent _stricmp) */
   result = _stricmp( string1, string2 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "\t_stricmp:  String 1 is %s string 2\n", tmp );
}
```

Output

```
Compare strings:
   The quick brown dog jumps over the lazy fox
   The QUICK brown dog jumps over the lazy fox

   strcmp:   String 1 is greater than string 2
   _stricmp:  String 1 is equal to string 2
```

See Also: **memcmp**, **_memicmp**, **strcmp**, **strcoll** Functions, **strncmp**, **_strnicmp**, **strrchr**, **_strset**, **strspn**

strlen, wcslen, _mbslen, _mbstrlen

Get the length of a string.

size_t strlen(const char *_string_);
size_t wcslen(const wchar_t *_string_);
size_t _mbslen(const unsigned char *_string_);
size_t _mbstrlen(const char *_string_);

Routine	Required Header	Compatibility
strlen	<string.h>	ANSI, Win 95, Win NT
wcslen	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbslen	<mbstring.h>	Win 95, Win NT
_mbstrlen	<stdlib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the number of characters in *string*, excluding the terminal **NULL**. No return value is reserved to indicate an error.

Parameter

string Null-terminated string

Remarks

Each of these functions returns the number of characters in *string*, not including the terminating null character. **wcslen** is a wide-character version of **strlen**; the argument of **wcslen** is a wide-character string. **wcslen** and **strlen** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcslen	strlen	_mbslen	wcslen

_mbslen and **_mbstrlen** return the number of multibyte characters in a multibyte-character string. **_mbslen** recognizes multibyte-character sequences according to the multibyte code page currently in use; it does not test for multibyte-character validity. **_mbstrlen** tests for multibyte-character validity and recognizes multibyte-character sequences according to the **LC_CTYPE** category setting of the current locale. For more information about the **LC_CTYPE** category, see **setlocale**.

Example

```
/*  STRLEN.C */

#include <string.h>
#include <stdio.h>
#include <conio.h>
#include <dos.h>

void main( void )
{
   char buffer[61] = "How long am I?";
   int  len;
   len = strlen( buffer );
   printf( "'%s' is %d characters long\n", buffer, len );
}
```

Output

```
'How long am I?' is 14 characters long
```

See Also: **setlocale**, **strcat**, **strcmp**, **strcoll** Functions, **strcpy**, **strrchr**, **_strset**, **strspn**

_strlwr, _wcslwr, _mbslwr

Convert a string to lowercase.

char *_strlwr(char *_string_);
wchar_t *_wcslwr(wchar_t *_string_);
unsigned char *_mbslwr(unsigned char *_string_);

Routine	Required Header	Compatibility
_strlwr	<string.h>	Win 95, Win NT
_wcslwr	<string.h> or <wchar.h>	Win 95, Win NT
_mbslwr	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the converted string. Because the modification is done in place, the pointer returned is the same as the pointer passed as the input argument. No return value is reserved to indicate an error.

Parameter

string Null-terminated string to convert to lowercase

Remarks

The **_strlwr** function converts any uppercase letters in *string* to lowercase as determined by the **LC_CTYPE** category setting of the current locale. Other characters are not affected. For more information on **LC_CTYPE**, see **setlocale**.

The **_wcslwr** and **_mbslwr** functions are wide-character and multibyte-character versions of **_strlwr**. The argument and return value of **_wcslwr** are wide-character strings; those of **_mbslwr** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcslwr	_strlwr	_mbslwr	_wcslwr

Example

```
/* STRLWR.C: This program uses _strlwr and _strupr to create
 * uppercase and lowercase copies of a mixed-case string.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[100] = "The String to End All Strings!";
   char *copy1, *copy2;
   copy1 = _strlwr( _strdup( string ) );
   copy2 = _strupr( _strdup( string ) );
   printf( "Mixed: %s\n", string );
   printf( "Lower: %s\n", copy1 );
   printf( "Upper: %s\n", copy2 );
}
```

Output

```
Mixed: The String to End All Strings!
Lower: the string to end all strings!
Upper: THE STRING TO END ALL STRINGS!
```

See Also: _strupr

strncat, wcsncat, _mbsncat

Append characters of a string.

char *strncat(char **strDest*, **const char** **strSource*, **size_t** *count* **);**
wchar_t *wcsncat(wchar_t **strDest*, **const wchar_t** **strSource*, **size_t** *count* **);**
unsigned char *_mbsncat(unsigned char **strDest*,
↪ **const unsigned char** **strSource*, **size_t** *count*);

Routine	Required Header	Compatibility
strncat	<string.h>	ANSI, Win 95, Win NT
wcsncat	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsncat	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the destination string. No return value is reserved to indicate an error.

Parameters

strDest Null-terminated destination string

strSource Null-terminated source string

count Number of characters to append

Remarks

The **strncat** function appends, at most, the first *count* characters of *strSource* to *strDest*. The initial character of *strSource* overwrites the terminating null character of *strDest*. If a null character appears in *strSource* before *count* characters are appended, **strncat** appends all characters from *strSource*, up to the null character. If *count* is greater than the length of *strSource*, the length of *strSource* is used in place of *count*. The resulting string is terminated with a null character. If copying takes place between strings that overlap, the behavior is undefined.

wcsncat and **_mbsncat** are wide-character and multibyte-character versions of **strncat**. The string arguments and return value of **wcsncat** are wide-character strings; those of **_mbsncat** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncat	strncat	_mbsncat	wcsncat

Example

```
/* STRNCAT.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[80] = "This is the initial string!";
   char suffix[] = " extra text to add to the string...";
   /* Combine strings with no more than 19 characters of suffix: */
   printf( "Before: %s\n", string );
   strncat( string, suffix, 19 );
   printf( "After:  %s\n", string );
}
```

Output

```
Before: This is the initial string!
After:  This is the initial string! extra text to add
```

See Also: _mbsnbcat, strcat, strcmp, strcpy, strncmp, strncpy, _strnicmp, strrchr, _strset, strspn

strncmp, wcsncmp, _mbsncmp

Compare characters of two strings.

int strncmp(const char **string1*, **const char** **string2*, **size_t** *count* **);**
int wcsncmp(const wchar_t **string1*, **const wchar_t** **string2*, **size_t** *count* **);**
int _mbsncmp(const unsigned char **string1*, **const unsigned char** *string2*,
↪ **size_t** *count* **);**

Routine	Required Header	Compatibility
strncmp	<string.h>	ANSI, Win 95, Win NT
wcsncmp	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsncmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relation of the substrings of *string1* and *string2* as follows:

Return Value	Description
< 0	*string1* substring less than *string2* substring
0	*string1* substring identical to *string2* substring
> 0	*string1* substring greater than *string2* substring

On an error, **_mbsncmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, *string2* Strings to compare

count Number of characters to compare

Remarks

The **strncmp** function lexicographically compares, at most, the first *count* characters in *string1* and *string2* and returns a value indicating the relationship between the substrings. **strncmp** is a case-sensitive version of **_strnicmp**. Unlike **strcoll**, **strncmp** is not affected by locale. For more information on the **LC_COLLATE** category, see **setlocale**.

wcsncmp and **_mbsncmp** are wide-character and multibyte-character versions of **strncmp**. The arguments and return value of **wcsncmp** are wide-character strings; those of **_mbsncmp** are multibyte-character strings. **_mbsncmp** recognizes multibyte-character sequences according to the current multibyte code page and returns **_NLSCMPERROR** on an error. For more information, see "Code Pages" on page 22 in Chapter 1. These three functions behave identically otherwise. **wcsncmp** and **_mbsncmp** are case-sensitive versions of **_wcsnicmp** and **_mbsnicmp**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsnccmp	strncmp	_mbsncmp	wcsncmp
_tcsncmp	strncmp	_mbsnbcmp	wcsncmp

Example

```
/* STRNCMP.C */
#include <string.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown fox jumps over the lazy dog";

void main( void )
{
   char tmp[20];
   int result;
   printf( "Compare strings:\n\t\t%s\n\t\t%s\n\n", string1, string2 );
   printf( "Function:\tstrncmp (first 10 characters only)\n" );
   result = strncmp( string1, string2 , 10 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
   printf( "Function:\tstrnicmp _strnicmp (first 10 characters only)\n" );
   result = _strnicmp( string1, string2, 10 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
}
```

Output

```
Compare strings:
      The quick brown dog jumps over the lazy fox
      The QUICK brown fox jumps over the lazy dog

Function:   strncmp (first 10 characters only)
Result:      String 1 is greater than string 2

Function:   _strnicmp (first 10 characters only)
Result:      String 1 is equal to string 2
```

See Also: **_mbsnbcmp, _mbsnbicmp, strcmp, strcoll Functions, _strnicmp, strrchr, _strset, strspn**

---

strncpy, wcsncpy, _mbsncpy

Copy characters of one string to another.

char *strncpy(char ***strDest*****, const char** ***strSource*****, size_t** *count* **);**
wchar_t *wcsncpy(wchar_t ***strDest*****, const wchar_t** ***strSource*****, size_t** *count* **);**
unsigned char *_mbsncpy(unsigned char ***strDest*****, const unsigned char** ***strSource*****,**
↪ size_t *count* **);**

Routine	Required Header	Compatibility
strncpy	<string.h>	ANSI, Win 95, Win NT
wcsncpy	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsncpy	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns *strDest*. No return value is reserved to indicate an error.

Parameters

strDest Destination string

strSource Source string

count Number of characters to be copied

Remarks

The **strncpy** function copies the initial *count* characters of *strSource* to *strDest* and returns *strDest*. If *count* is less than or equal to the length of *strSource*, a null character is not appended automatically to the copied string. If *count* is greater than the length of

strSource, the destination string is padded with null characters up to length *count*. The behavior of **strncpy** is undefined if the source and destination strings overlap.

wcsncpy and **_mbsncpy** are wide-character and multibyte-character versions of **strncpy**. The arguments and return value of **wcsncpy** and **_mbsncpy** vary accordingly. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncpy	strncpy	_mbsncpy	wcsncpy

Example

```
/* STRNCPY.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[100] = "Cats are nice usually";
   printf ( "Before: %s\n", string );
   strncpy( string, "Dogs", 4 );
   strncpy( string + 9, "mean", 4 );
   printf ( "After:  %s\n", string );
}
```

Output

```
Before: Cats are nice usually
After:  Dogs are mean usually
```

See Also: **_mbsnbcpy**, **strcat**, **strcmp**, **strcpy**, **strncat**, **strncmp**, **_strnicmp**, **strrchr**, **_strset**, **strspn**

_strnicmp, _wcsnicmp, _mbsnicmp

Compare characters of two strings without regard to case.

int _strnicmp(const char **string1*, **const char** **string2*, **size_t** *count* **);**
int _wcsnicmp(const wchar_t **string1*, **const wchar_t** **string2*, **size_t** *count* **);**
int _mbsnicmp(const unsigned char **string1*, **const unsigned char** **string2*,
↪ **size_t** *count* **);**

Routine	Required Header	Compatibility
_strnicmp	<string.h>	Win 95, Win NT
_wcsnicmp	<string.h> or <wchar.h>	Win 95, Win NT
_mbsnicmp	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The return value indicates the relationship between the substrings as follows:

Return Value	Description
< 0	*string1* substring less than *string2* substring
0	*string1* substring identical to *string2* substring
> 0	*string1* substring greater than *string2* substring

On an error, **_mbsnicmp** returns **_NLSCMPERROR**, which is defined in STRING.H and MBSTRING.H.

Parameters

string1, *string2* Null-terminated strings to compare

count Number of characters to compare

Remarks

The **_strnicmp** function lexicographically compares, at most, the first *count* characters of *string1* and *string2*. The comparison is performed without regard to case; **_strnicmp** is a case-insensitive version of **strncmp**. The comparison ends if a terminating null character is reached in either string before *count* characters are compared. If the strings are equal when a terminating null character is reached in either string before *count* characters are compared, the shorter string is lesser.

Two strings containing characters located between 'Z' and 'a' in the ASCII table ('[', '\', ']', '^', '_', and '`') compare differently, depending on their case. For example, the two strings `"ABCDE"` and `"ABCD^"` compare one way if the comparison is lowercase (`"abcde" > "abcd^"`) and the other way (`"ABCDE" < "ABCD^"`) if it is uppercase.

_wcsnicmp and **_mbsnicmp** are wide-character and multibyte-character versions of **_strnicmp**. The arguments and return value of **_wcsnicmp** are wide-character strings; those of **_mbsnicmp** are multibyte-character strings. **_mbsnicmp** recognizes multibyte-character sequences according to the current multibyte code page and returns **_NLSCMPERROR** on an error. For more information, see "Code Pages" on page 22 in Chapter 1. These three functions behave identically otherwise. These functions are not affected by the current locale setting.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsncicmp	_strnicmp	_mbsnicmp	_wcsnicmp
_tcsnicmp	_strnicmp	_mbsnbicmp	_wcsnicmp

Example

```
/* STRNCMP.C */
#include <string.h>
#include <stdio.h>

char string1[] = "The quick brown dog jumps over the lazy fox";
char string2[] = "The QUICK brown fox jumps over the lazy dog";

void main( void )
{
   char tmp[20];
   int result;
   printf( "Compare strings:\n\t\t%s\n\t\t%s\n\n", string1, string2 );
   printf( "Function:\tstrncmp (first 10 characters only)\n" );
   result = strncmp( string1, string2 , 10 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
   printf( "Function:\tstrnicmp _strnicmp (first 10 characters only)\n" );
   result = _strnicmp( string1, string2, 10 );
   if( result > 0 )
      strcpy( tmp, "greater than" );
   else if( result < 0 )
      strcpy( tmp, "less than" );
   else
      strcpy( tmp, "equal to" );
   printf( "Result:\t\tString 1 is %s string 2\n\n", tmp );
}
```

Output

```
Compare strings:
      The quick brown dog jumps over the lazy fox
      The QUICK brown fox jumps over the lazy dog

Function:   strncmp (first 10 characters only)
Result:      String 1 is greater than string 2

Function:   _strnicmp (first 10 characters only)
Result:      String 1 is equal to string 2
```

See Also: strcat, strcmp, strcpy, strncat, strncmp, strncpy, strrchr, _strset, strspn

_strnset, _wcsnset, _mbsnset

Initialize characters of a string to a given format.

char *_strnset(char *_string_, int _c_, size_t _count_);
wchar_t *_wcsnset(wchar_t *_string_, wchar_t _c_, size_t _count_);
unsigned char *_mbsnset(unsigned char *_string_, unsigned int _c_, size_t _count_);

Routine	Required Header	Compatibility
_strnset	<string.h>	Win 95, Win NT
_wcsnset	<string.h> or <wchar.h>	Win 95, Win NT
_mbsnset	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the altered string.

Parameters

string String to be altered

c Character setting

count Number of characters to be set

Remarks

The **_strnset** function sets, at most, the first *count* characters of *string* to *c* (converted to **char**). If *count* is greater than the length of *string*, the length of *string* is used instead of *count*.

_wcsnset and **_mbsnset** are wide-character and multibyte-character versions of **_strnset**. The string arguments and return value of **_wcsnset** are wide-character strings; those of **_mbsnset** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsnset	_strnset	_mbsnset	_wcsnset

Example

```
/* STRNSET.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[15] = "This is a test";
   /* Set not more than 4 characters of string to be *'s */
   printf( "Before: %s\n", string );
   _strnset( string, '*', 4 );
   printf( "After:  %s\n", string );
}
```

Output

```
Before: This is a test
After:  **** is a test
```

See Also: strcat, strcmp, strcpy, _strset

strpbrk, wcspbrk, _mbspbrk

Scan strings for characters in specified character sets.

char *strpbrk(const char *_string_, const char *_strCharSet_);
wchar_t *wcspbrk(const wchar_t *_string_, const wchar_t *_strCharSet_);
unsigned char *_mbspbrk(const unsigned char*_string_,
↪ const unsigned char *_strCharSet_);

Routine	Required Header	Compatibility
strpbrk	<string.h>	ANSI, Win 95, Win NT
wcspbrk	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbspbrk	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the first occurrence of any character from *strCharSet* in *string*, or a **NULL** pointer if the two string arguments have no characters in common.

Parameters

string Null-terminated, searched string

strCharSet Null-terminated character set

Remarks

The **strpbrk** function returns a pointer to the first occurrence of a character in *string* that belongs to the set of characters in *strCharSet*. The search does not include the terminating null character.

wcspbrk and **_mbspbrk** are wide-character and multibyte-character versions of **strpbrk**. The arguments and return value of **wcspbrk** are wide-character strings; those of **_mbspbrk** are multibyte-character strings. These three functions behave identically otherwise. **_mbspbrk** is similar to **_mbscspn** except that **_mbspbrk** returns a pointer rather than a value of type **size_t**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcspbrk	strpbrk	_mbspbrk	wcspbrk

Example

```
/* STRPBRK.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[100] = "The 3 men and 2 boys ate 5 pigs\n";
   char *result;
   /* Return pointer to first 'a' or 'b' in "string" */
   printf( "1: %s\n", string );
   result = strpbrk( string, "0123456789" );
   printf( "2: %s\n", result++ );
   result = strpbrk( result, "0123456789" );
   printf( "3: %s\n", result++ );
   result = strpbrk( result, "0123456789" );
   printf( "4: %s\n", result );
}
```

Output

```
1: The 3 men and 2 boys ate 5 pigs

2: 3 men and 2 boys ate 5 pigs

3: 2 boys ate 5 pigs

4: 5 pigs
```

See Also: strcspn, strchr, strrchr

strrchr, wcsrchr, _mbsrchr

Scan a string for the last occurrence of a character.

char *strrchr(const char *_string_, int _c_);
char *wcsrchr(const wchar_t *_string_, int _c_);
int _mbsrchr(const unsigned char *_string_, unsigned int _c_);

Routine	Required Header	Compatibility
strrchr	<string.h>	ANSI, Win 95, Win NT
wcsrchr	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsrchr	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the last occurrence of *c* in *string*, or **NULL** if *c* is not found.

Parameters

string Null-terminated string to search

c Character to be located

Remarks

The **strrchr** function finds the last occurrence of *c* (converted to **char**) in *string*. The search includes the terminating null character.

wcsrchr and **_mbsrchr** are wide-character and multibyte-character versions of **strrchr**. The arguments and return value of **wcsrchr** are wide-character strings; those of **_mbsrchr** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsrchr	strrchr	_mbsrchr	wcsrchr

Example

```
/* STRCHR.C: This program illustrates searching for a character
 * with strchr (search forward) or strrchr (search backward).
 */

#include <string.h>
#include <stdio.h>

int  ch = 'r';

char string[] = "The quick brown dog jumps over the lazy fox";
char fmt1[] =   "         1         2         3         4         5";
char fmt2[] =   "12345678901234567890123456789012345678901234567890";

void main( void )
{
   char *pdest;
   int result;

   printf( "String to be searched: \n\t\t%s\n", string );
   printf( "\t\t%s\n\t\t%s\n\n", fmt1, fmt2 );
   printf( "Search char:\t%c\n", ch );

   /* Search forward. */
   pdest = strchr( string, ch );
   result = pdest - string + 1;
   if( pdest != NULL )
      printf( "Result:\tfirst %c found at position %d\n\n",
            ch, result );
   else
      printf( "Result:\t%c not found\n" );

   /* Search backward. */
   pdest = strrchr( string, ch );
   result = pdest - string + 1;
   if( pdest != NULL )
      printf( "Result:\tlast %c found at position %d\n\n", ch, result );
   else
      printf( "Result:\t%c not found\n" );
}
```

Output

```
String to be searched:
      The quick brown dog jumps over the lazy fox
                1         2         3         4         5
      123456789012345678901234567890123456789012345678901

Search char:   r
Result:   first r found at position 12

Result:   last r found at position 30
```

See Also: **strchr, strcspn, _strnicmp, strpbrk, strspn**

_strrev, _wcsrev, _mbsrev

Reverse characters of a string.

char *_strrev(char *_string_);
wchar_t *_wcsrev(wchar_t *_string_);
unsigned char *_mbsrev(unsigned char *_string_);

Routine	Required Header	Compatibility
_strrev	<string.h>	Win 95, Win NT
_wcsrev	<string.h> or <wchar.h>	Win 95, Win NT
_mbsrev	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the altered string. No return value is reserved to indicate an error.

Parameter

string Null-terminated string to reverse

Remarks

The **_strrev** function reverses the order of the characters in *string*. The terminating null character remains in place. **_wcsrev** and **_mbsrev** are wide-character and multibyte-character versions of **_strrev**. The arguments and return value of **_wcsrev** are wide-character strings; those of **_mbsrev** are multibyte-character strings. For **_mbsrev**, the order of bytes in each multibyte character in *string* is not changed. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsrev	_strrev	_mbsrev	_wcsrev

Example

```
/* STRREV.C: This program checks an input string to
 * see whether it is a palindrome: that is, whether
 * it reads the same forward and backward.
 */

#include <string.h>
#include <stdio.h>
```

```
void main( void )
{
   char string[100];
   int result;

   printf( "Input a string and I will tell you if it is a palindrome:\n" );
   gets( string );

   /* Reverse string and compare (ignore case): */
   result = _stricmp( string, _strrev( _strdup( string ) ) );
   if( result == 0 )
      printf( "The string \"%s\" is a palindrome\n\n", string );
   else
      printf( "The string \"%s\" is not a palindrome\n\n", string );
}
```

Output

```
Input a string and I will tell you if it is a palindrome:
Able was I ere I saw Elba
The string "Able was I ere I saw Elba" is a palindrome
```

See Also: **strcpy, _strset**

_strset, _wcsset, _mbsset

Set characters of a string to a character.

char *_strset(char *_string_, int _c_);
wchar_t *_wcsset(wchar_t *_string_, wchar_t _c_);
unsigned char *_mbsset(unsigned char *_string_, unsigned int _c_);

Routine	Required Header	Compatibility
_strset	<string.h>	Win 95, Win NT
_wcsset	<string.h> or <wchar.h>	Win 95, Win NT
_mbsset	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the altered string. No return value is reserved to indicate an error.

Parameters

string Null-terminated string to be set

c Character setting

Remarks

The **_strset** function sets all the characters of *string* to *c* (converted to **char**), except the terminating null character. **_wcsset** and **_mbsset** are wide-character and multibyte-character versions of **_strset**. The data types of the arguments and return values vary accordingly. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsset	_strset	_mbsset	_wcsset

Example

```
/* STRSET.C */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[] = "Fill the string with something";
   printf( "Before: %s\n", string );
   _strset( string, '*' );
   printf( "After:  %s\n", string );
}
```

Output

```
Before: Fill the string with something
After:  ****************************
```

See Also: **_mbsnbset, memset, strcat, strcmp, strcpy, _strnset**

strspn, wcsspn, _mbsspn

Find the first substring.

size_t strspn(const char *_string_, const char *_strCharSet_);
size_t wcsspn(const wchar_t *_string_, const wchar_t *_strCharSet_);
size_t _mbsspn(const unsigned char *_string_, const unsigned char *_strCharSet_);

Routine	Required Header	Compatibility
strspn	<string.h>	ANSI, Win 95, Win NT
wcsspn	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsspn	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strspn, **wcsspn**, and **_mbsspn** return an integer value specifying the length of the substring in *string* that consists entirely of characters in *strCharSet.* If *string* begins with a character not in *strCharSet,* the function returns 0. No return value is reserved to indicate an error. For each of these routines, no return value is reserved to indicate an error.

Parameters

string Null-terminated string to search

strCharSet Null-terminated character set

Remarks

The **strspn** function returns the index of the first character in *string* that does not belong to the set of characters in *strCharSet.* The search does not include terminating null characters.

wcsspn and **_mbsspn** are wide-character and multibyte-character versions of **strspn.** The arguments of **wcsspn** are wide-character strings; those of **_mbsspn** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsspn	strspn	_mbsspn	wcsspn

Example

```
/* STRSPN.C: This program uses strspn to determine
 * the length of the segment in the string "cabbage"
 * consisting of a's, b's, and c's. In other words,
 * it finds the first non-abc letter.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[] = "cabbage";
   int  result;
   result = strspn( string, "abc" );
   printf( "The portion of '%s' containing only a, b, or c "
         "is %d bytes long\n", string, result );
}
```

Output

```
The portion of 'cabbage' containing only a, b, or c is 5 bytes long
```

See Also: **_mbsspnp, strcspn, strncat, strncmp, strncpy, _strnicmp, strrchr**

strstr, wcsstr, _mbsstr

Find a substring.

char *strstr(const char *_string_, const char *_strCharSet_);
wchar_t *wcsstr(const wchar_t *_string_, const wchar_t *_strCharSet_);
unsigned char *_mbsstr(const unsigned char *_string_,
↪ const unsigned char *_strCharSet_);

Routine	Required Header	Compatibility
strstr	<string.h>	ANSI, Win 95, Win NT
wcsstr	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbsstr	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the first occurrence of *strCharSet* in *string*, or **NULL** if *strCharSet* does not appear in *string*. If *strCharSet* points to a string of zero length, the function returns *string*.

Parameters

string Null-terminated string to search

strCharSet Null-terminated string to search for

Remarks

The **strstr** function returns a pointer to the first occurrence of *strCharSet* in *string*. The search does not include terminating null characters. **wcsstr** and **_mbsstr** are wide-character and multibyte-character versions of **strstr**. The arguments and return value of **wcsstr** are wide-character strings; those of **_mbsstr** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsstr	strstr	_mbsstr	wcsstr

Example

```
/* STRSTR.C */

#include <string.h>
#include <stdio.h>

char str[] =    "lazy";
char string[] = "The quick brown dog jumps over the lazy fox";
char fmt1[] =   "         1         2         3         4         5";
char fmt2[] =   "12345678901234567890123456789012345678901234567890";

void main( void )
{
   char *pdest;
   int  result;
   printf( "String to be searched:\n\t%s\n", string );
   printf( "\t%s\n\t%s\n\n", fmt1, fmt2 );
   pdest = strstr( string, str );
   result = pdest - string + 1;
   if( pdest != NULL )
      printf( "%s found at position %d\n\n", str, result );
   else
      printf( "%s not found\n", str );
}
```

Output

```
String to be searched:
   The quick brown dog jumps over the lazy fox
            1         2         3         4         5
   12345678901234567890123456789012345678901234567890

lazy found at position 36
```

See Also: strcspn, strcmp, strpbrk, strrchr, strspn

_strtime, _wstrtime

Copy the time to a buffer.

char *_strtime(char **timestr*);
wchar_t *_wstrtime(wchar_t **timestr*);

Routine	Required Header	Compatibility
_strtime	<time.h>	Win 95, Win NT
_wstrtime	<time.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the resulting character string *timestr*.

Parameter

timestr Time string

Remarks

The **_strtime** function copies the current local time into the buffer pointed to by *timestr*. The time is formatted as *hh:mm:ss* where *hh* is two digits representing the hour in 24-hour notation, *mm* is two digits representing the minutes past the hour, and *ss* is two digits representing seconds. For example, the string `18:23:44` represents 23 minutes and 44 seconds past 6 P.M. The buffer must be at least 9 bytes long.

_wstrtime is a wide-character version of **_strtime**; the argument and return value of **_wstrtime** are wide-character strings. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tstrtime	_strtime	_strtime	_wstrtime

Example

```
/* STRTIME.C */

#include <time.h>
#include <stdio.h>

void main( void )
{
   char dbuffer [9];
   char tbuffer [9];
   _strdate( dbuffer );
   printf( "The current date is %s \n", dbuffer );
   _strtime( tbuffer );
   printf( "The current time is %s \n", tbuffer );
}
```

Output

```
The current date is 03/23/93
The current time is 13:40:40
```

See Also: asctime, ctime, gmtime, localtime, mktime, time, _tzset

strtod, strtol, strtoul Functions

strtod, wcstod

strtol, wcstol

strtoul, wcstoul

Return Value

strtod returns the value of the floating-point number, except when the representation would cause an overflow, in which case the function returns +/–**HUGE_VAL**. The sign of **HUGE_VAL** matches the sign of the value that cannot be represented. **strtod** returns 0 if no conversion can be performed or an underflow occurs.

strtol returns the value represented in the string *nptr*, except when the representation would cause an overflow, in which case it returns **LONG_MAX** or **LONG_MIN**. **strtoul** returns the converted value, if any, or **ULONG_MAX** on overflow. Each of these functions returns 0 if no conversion can be performed.

wcstod, **wcstol**, and **wcstoul** return values analogously to **strtod**, **strtol**, and **strtoul,** respectively.

For all six functions in this group, **errno** is set to **ERANGE** if overflow or underflow occurs.

Parameters

nptr Null-terminated string to convert

endptr Pointer to character that stops scan

base Number base to use

Remarks

The **strtod**, **strtol**, and **strtoul** functions convert *nptr* to a double-precision value, a long-integer value, or an unsigned long-integer value, respectively.

The input string *nptr* is a sequence of characters that can be interpreted as a numerical value of the specified type. Each function stops reading the string *nptr* at the first character it cannot recognize as part of a number. This may be the terminating null character. For **strtol** or **strtoul**, this terminating character can also be the first numeric character greater than or equal to *base*.

For all six functions in the **strtod** group, the current locale's **LC_NUMERIC** category setting determines recognition of the radix character in *nptr;* for more information, see **setlocale**. If *endptr* is not **NULL**, a pointer to the character that stopped the scan is stored at the location pointed to by *endptr*. If no conversion can be performed (no valid digits were found or an invalid base was specified), the value of *nptr* is stored at the location pointed to by *endptr*.

strtod expects *nptr* to point to a string of the following form:

[*whitespace*] [*sign*] [*digits*] [*.digits*] [{**d** | **D** | **e** | **E**}[*sign*]*digits*]

A *whitespace* may consist of space or tab characters, which are ignored; *sign* is either plus (+) or minus (–); and *digits* are one or more decimal digits. If no digits appear before the radix character, at least one must appear after the radix character. The decimal digits can be followed by an exponent, which consists of an introductory letter (**d**, **D**, **e**, or **E**) and an optionally signed integer. If neither an exponent part nor a radix character appears, a radix character is assumed to follow the last digit in the string. The first character that does not fit this form stops the scan.

The **strtol** and **strtoul** functions expect *nptr* to point to a string of the following form:

[*whitespace*] [{+ | –}] [**0** [{ **x** | **X** }]] [*digits*]

If *base* is between 2 and 36, then it is used as the base of the number. If *base* is 0, the initial characters of the string pointed to by *nptr* are used to determine the base. If the first character is 0 and the second character is not 'x' or 'X', the string is interpreted as an octal integer; otherwise, it is interpreted as a decimal number. If the first character is '0' and the second character is 'x' or 'X', the string is interpreted as a hexadecimal integer. If the first character is '1' through '9', the string is interpreted as a decimal integer. The letters 'a' through 'z' (or 'A' through 'Z') are assigned the values 10 through 35; only letters whose assigned values are less than *base* are permitted. **strtoul** allows a plus (+) or minus (–) sign prefix; a leading minus sign indicates that the return value is negated.

wcstod, **wcstol**, and **wcstoul** are wide-character versions of **strtod**, **strtol**, and **strtoul,** respectively; the *nptr* argument to each of these wide-character functions is a wide-character string. Otherwise, each of these wide-character functions behaves identically to its single-byte–character counterpart.

Example

```
/* STRTOD.C: This program uses strtod to convert a
 * string to a double-precision value; strtol to
 * convert a string to long integer values; and strtoul
 * to convert a string to unsigned long-integer values.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char   *string, *stopstring;
   double x;
   long   l;
   int    base;
   unsigned long ul;
   string = "3.1415926This stopped it";
   x = strtod( string, &stopstring );
```

```
   printf( "string = %s\n", string );
   printf("   strtod = %f\n", x );
   printf("   Stopped scan at: %s\n\n", stopstring );
   string = "-10110134932This stopped it";
   l = strtol( string, &stopstring, 10 );
   printf( "string = %s", string );
   printf("   strtol = %ld", l );
   printf("   Stopped scan at: %s", stopstring );
   string = "10110134932";
   printf( "string = %s\n", string );
   /* Convert string using base 2, 4, and 8: */
   for( base = 2; base <= 8; base *= 2 )
   {
      /* Convert the string: */
      ul = strtoul( string, &stopstring, base );
      printf( "   strtol = %ld (base %d)\n", ul, base );
      printf( "   Stopped scan at: %s\n", stopstring );
   }
}
```

Output

```
string = 3.1415926 This stopped it
   strtod = 3.141593
   Stopped scan at: This stopped it

string = -10110134932 This stopped it
   strtol = -2147483647
   Stopped scan at: This stopped it
string = 10110134932
   strtol = 45 (base 2)
   Stopped scan at: 34932
   strtol = 4423 (base 4)
   Stopped scan at: 4932
   strtol = 2134108 (base 8)
   Stopped scan at: 932
```

See Also: atof, localeconv, setlocale

strtod, wcstod

Convert strings to a double-precision value.

double strtod(const char *_nptr_, char **_endptr_);
double wcstod(const wchar_t *_nptr_, wchar_t **_endptr_);

Each of these functions converts the input string *nptr* to a **double**.

Routine	Required Header	Compatibility
strtod	<stdlib.h>	ANSI, Win 95, Win NT
wcstod	<stdlib.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strtod returns the value of the floating-point number, except when the representation would cause an overflow, in which case the function returns +/–**HUGE_VAL**. The sign of **HUGE_VAL** matches the sign of the value that cannot be represented. **strtod** returns 0 if no conversion can be performed or an underflow occurs.

wcstod returns values analogously to **strtod.** For both functions, **errno** is set to **ERANGE** if overflow or underflow occurs.

Parameters

nptr Null-terminated string to convert

endptr Pointer to character that stops scan

Remarks

The **strtod** function converts *nptr* to a double-precision value. **strtod** stops reading the string *nptr* at the first character it cannot recognize as part of a number. This may be the terminating null character. **wcstod** is a wide-character version of **strtod**; its *nptr* argument is a wide-character string. Otherwise these functions behave identically.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcstod	strtod	strtod	wcstod

The **LC_NUMERIC** category setting of the current locale determines recognition of the radix character in *nptr;* for more information, see **setlocale**. If *endptr* is not **NULL**, a pointer to the character that stopped the scan is stored at the location pointed to by *endptr*. If no conversion can be performed (no valid digits were found or an invalid base was specified), the value of *nptr* is stored at the location pointed to by *endptr*.

strtod expects *nptr* to point to a string of the following form:

[*whitespace*] [*sign*] [*digits*] [*.digits*] [{**d** | **D** | **e** | **E**}[*sign*]*digits*]

A *whitespace* may consist of space and tab characters, which are ignored; *sign* is either plus (+) or minus (–); and *digits* are one or more decimal digits. If no digits appear before the radix character, at least one must appear after the radix character. The decimal digits can be followed by an exponent, which consists of an introductory letter (**d**, **D**, **e**, or **E**) and an optionally signed integer. If neither an exponent part nor a radix character appears, a radix character is assumed to follow the last digit in the string. The first character that does not fit this form stops the scan.

Example

```
/* STRTOD.C: This program uses strtod to convert a
 * string to a double-precision value; strtol to
 * convert a string to long integer values; and strtoul
 * to convert a string to unsigned long-integer values.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char   *string, *stopstring;
   double x;
   long   l;
   int    base;
   unsigned long ul;
   string = "3.1415926This stopped it";
   x = strtod( string, &stopstring );
   printf( "string = %s\n", string );
   printf("   strtod = %f\n", x );
   printf("   Stopped scan at: %s\n\n", stopstring );
   string = "-10110134932This stopped it";
   l = strtol( string, &stopstring, 10 );
   printf( "string = %s", string );
   printf("   strtol = %ld", l );
   printf("   Stopped scan at: %s", stopstring );
   string = "10110134932";
   printf( "string = %s\n", string );
   /* Convert string using base 2, 4, and 8: */
   for( base = 2; base <= 8; base *= 2 )
   {
      /* Convert the string: */
      ul = strtoul( string, &stopstring, base );
      printf( "   strtol = %ld (base %d)\n", ul, base );
      printf( "   Stopped scan at: %s\n", stopstring );
   }
}
```

Output

```
string = 3.1415926 This stopped it
   strtod = 3.141593
   Stopped scan at: This stopped it

string = -10110134932 This stopped it
   strtol = -2147483647
   Stopped scan at: This stopped it
string = 10110134932
   strtol = 45 (base 2)
   Stopped scan at: 34932
   strtol = 4423 (base 4)
   Stopped scan at: 4932
   strtol = 2134108 (base 8)
   Stopped scan at: 932
```

See Also: strtol, strtoul, atof, localeconv, setlocale

strtok, wcstok, _mbstok

Find the next token in a string.

char *strtok(char *_strToken_, const char *_strDelimit_);
wchar_t *wcstok(wchar_t *_strToken_, const wchar_t *_strDelimit_);
unsigned char *_mbstok(unsigned char*_strToken_, const unsigned char *_strDelimit_);

Routine	Required Header	Compatibility
strtok	<string.h>	ANSI, Win 95, Win NT
wcstok	<string.h> or <wchar.h>	ANSI, Win 95, Win NT
_mbstok	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

All of these functions return a pointer to the next token found in *strToken*. They return **NULL** when no more tokens are found. Each call modifies *strToken* by substituting a NULL character for each delimiter that is encountered.

Parameters

strToken String containing token(s)

strDelimit Set of delimiter characters

Remarks

The **strtok** function finds the next token in *strToken*. The set of characters in *strDelimit* specifies possible delimiters of the token to be found in *strToken* on the current call. **wcstok** and **_mbstok** are wide-character and multibyte-character versions of **strtok**. The arguments and return value of **wcstok** are wide-character strings; those of **_mbstok** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcstok	strtok	_mbstok	wcstok

On the first call to **strtok**, the function skips leading delimiters and returns a pointer to the first token in *strToken*, terminating the token with a null character. More tokens can be broken out of the remainder of *strToken* by a series of calls to **strtok**. Each call to **strtok** modifies *strToken* by inserting a null character after the token returned by that call. To read the next token from *strToken*, call **strtok** with a **NULL** value for the

strToken argument. The **NULL** *strToken* argument causes **strtok** to search for the next token in the modified *strToken*. The *strDelimit* argument can take any value from one call to the next so that the set of delimiters may vary.

Warning Each of these functions uses a static variable for parsing the string into tokens. If multiple or simultaneous calls are made to the same function, a high potential for data corruption and inaccurate results exists. Therefore, do not attempt to call the same function simultaneously for different strings and be aware of calling one of these function from within a loop where another routine may be called that uses the same function. However, calling this function simultaneously from multiple threads does not have undesirable effects.

Example

```
/* STRTOK.C: In this program, a loop uses strtok
 * to print all the tokens (separated by commas
 * or blanks) in the string named "string".
 */

#include <string.h>
#include <stdio.h>

char string[] = "A string\tof ,,tokens\nand some  more tokens";
char seps[]   = " ,\t\n";
char *token;

void main( void )
{
   printf( "%s\n\nTokens:\n", string );
   /* Establish string and get the first token: */
   token = strtok( string, seps );
   while( token != NULL )
   {
      /* While there are tokens in "string" */
      printf( " %s\n", token );
      /* Get next token: */
      token = strtok( NULL, seps );
   }
}
```

Output

```
A string   of ,,tokens
and some  more tokens

Tokens:
 A
 string
 of
 tokens
 and
 some
 more
 tokens
```

See Also: strcspn, strspn, setlocale

strtol, wcstol

Convert strings to a long-integer value.

long strtol(const char **nptr*, **char ****_endptr_, **int** *base* **);**
long wcstol(const wchar_t **nptr*, **wchar_t ****_endptr_, **int** *base* **);**

Routine	Required Header	Compatibility
strtol	<stdlib.h>	ANSI, Win 95, Win NT
wcstol	<stdlib.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strtol returns the value represented in the string *nptr*, except when the representation would cause an overflow, in which case it returns **LONG_MAX** or **LONG_MIN**. **strtol** returns 0 if no conversion can be performed. **wcstol** returns values analogously to **strtol.** For both functions, **errno** is set to **ERANGE** if overflow or underflow occurs.

Parameters

nptr Null-terminated string to convert

endptr Pointer to character that stops scan

base Number base to use

Remarks

The **strtol** function converts *nptr* to a **long**. **strtol** stops reading the string *nptr* at the first character it cannot recognize as part of a number. This may be the terminating null character, or it may be the first numeric character greater than or equal to *base*.

wcstol is a wide-character version of **strtol**; its *nptr* argument is a wide-character string. Otherwise these functions behave identically.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcstol	strtol	strtol	wcstol

The current locale's **LC_NUMERIC** category setting determines recognition of the radix character in *nptr;* for more information, see **setlocale**. If *endptr* is not **NULL**, a pointer to the character that stopped the scan is stored at the location pointed to by *endptr*. If no conversion can be performed (no valid digits were found or an invalid base was specified), the value of *nptr* is stored at the location pointed to by *endptr*.

strtol expects *nptr* to point to a string of the following form:

[*whitespace*] [{+ | −}] [**0** [{ **x** | **X** }]] [*digits*]

A *whitespace* may consist of space and tab characters, which are ignored; *digits* are one or more decimal digits. The first character that does not fit this form stops the scan. If *base* is between 2 and 36, then it is used as the base of the number. If *base* is 0, the initial characters of the string pointed to by *nptr* are used to determine the base. If the first character is 0 and the second character is not 'x' or 'X', the string is interpreted as an octal integer; otherwise, it is interpreted as a decimal number. If the first character is '0' and the second character is 'x' or 'X', the string is interpreted as a hexadecimal integer. If the first character is '1' through '9', the string is interpreted as a decimal integer. The letters 'a' through 'z' (or 'A' through 'Z') are assigned the values 10 through 35; only letters whose assigned values are less than *base* are permitted.

Example

```
/* STRTOD.C: This program uses strtod to convert a
 * string to a double-precision value; strtol to
 * convert a string to long integer values; and strtoul
 * to convert a string to unsigned long-integer values.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char   *string, *stopstring;
   double x;
   long   l;
   int    base;
   unsigned long ul;
   string = "3.1415926This stopped it";
   x = strtod( string, &stopstring );
   printf( "string = %s\n", string );
   printf("   strtod = %f\n", x );
   printf("   Stopped scan at: %s\n\n", stopstring );
   string = "-10110134932This stopped it";
   l = strtol( string, &stopstring, 10 );
   printf( "string = %s", string );
   printf("   strtol = %ld", l );
   printf("   Stopped scan at: %s", stopstring );
   string = "10110134932";
   printf( "string = %s\n", string );
   /* Convert string using base 2, 4, and 8: */
   for( base = 2; base <= 8; base *= 2 )
```

```
    {
        /* Convert the string: */
        ul = strtoul( string, &stopstring, base );
        printf( "   strtol = %ld (base %d)\n", ul, base );
        printf( "   Stopped scan at: %s\n", stopstring );
    }
}
```

Output

```
string = 3.1415926 This stopped it
   strtod = 3.141593
   Stopped scan at: This stopped it

string = -10110134932 This stopped it
   strtol = -2147483647
   Stopped scan at: This stopped it
string = 10110134932
   strtol = 45 (base 2)
   Stopped scan at: 34932
   strtol = 4423 (base 4)
   Stopped scan at: 4932
   strtol = 2134108 (base 8)
   Stopped scan at: 932
```

See Also: **strtod, strtoul, atof, localeconv, setlocale**

---

strtoul, wcstoul

Convert strings to an unsigned long-integer value.

unsigned long strtoul(const char **nptr*, **char ****_endptr_, **int** *base* **);**
unsigned long wcstoul(const wchar_t **nptr*, **wchar_t ****_endptr_, **int** *base* **);**

Routine	Required Header	Compatibility
strtoul	<stdlib.h>	ANSI, Win 95, Win NT
wcstoul	<stdlib.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

strtoul returns the converted value, if any, or **ULONG_MAX** on overflow. **strtoul** returns 0 if no conversion can be performed. **wcstoul** returns values analogously to **strtoul.** For both functions, **errno** is set to **ERANGE** if overflow or underflow occurs.

Parameters

nptr Null-terminated string to convert

endptr Pointer to character that stops scan

base Number base to use

Remarks

Each of these functions converts the input string *nptr* to an **unsigned long**.

strtoul stops reading the string *nptr* at the first character it cannot recognize as part of a number. This may be the terminating null character, or it may be the first numeric character greater than or equal to *base*. The **LC_NUMERIC** category setting of the current locale determines recognition of the radix character in *nptr;* for more information, see **setlocale**. If *endptr* is not **NULL**, a pointer to the character that stopped the scan is stored at the location pointed to by *endptr*. If no conversion can be performed (no valid digits were found or an invalid base was specified), the value of *nptr* is stored at the location pointed to by *endptr*.

wcstoul is a wide-character version of **strtoul**; its *nptr* argument is a wide-character string. Otherwise these functions behave identically.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcstoul	strtoul	strtoul	wcstoul

strtoul expects *nptr* to point to a string of the following form:

[*whitespace*] [{+ | –}] [**0** [{ **x** | **X** }]] [*digits*]

A *whitespace* may consist of space and tab characters, which are ignored; *digits* are one or more decimal digits. The first character that does not fit this form stops the scan. If *base* is between 2 and 36, then it is used as the base of the number. If *base* is 0, the initial characters of the string pointed to by *nptr* are used to determine the base. If the first character is 0 and the second character is not 'x' or 'X', the string is interpreted as an octal integer; otherwise, it is interpreted as a decimal number. If the first character is '0' and the second character is 'x' or 'X', the string is interpreted as a hexadecimal integer. If the first character is '1' through '9', the string is interpreted as a decimal integer. The letters 'a' through 'z' (or 'A' through 'Z') are assigned the values 10 through 35; only letters whose assigned values are less than *base* are permitted. **strtoul** allows a plus (+) or minus (–) sign prefix; a leading minus sign indicates that the return value is negated.

Example

```
/* STRTOD.C: This program uses strtod to convert a
 * string to a double-precision value; strtol to
 * convert a string to long integer values; and strtoul
 * to convert a string to unsigned long-integer values.
 */
```

```
#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char   *string, *stopstring;
   double x;
   long   l;
   int    base;
   unsigned long ul;
   string = "3.1415926This stopped it";
   x = strtod( string, &stopstring );
   printf( "string = %s\n", string );
   printf("   strtod = %f\n", x );
   printf("   Stopped scan at: %s\n\n", stopstring );
   string = "-10110134932This stopped it";
   l = strtol( string, &stopstring, 10 );
   printf( "string = %s", string );
   printf("   strtol = %ld", l );
   printf("   Stopped scan at: %s", stopstring );
   string = "10110134932";
   printf( "string = %s\n", string );
   /* Convert string using base 2, 4, and 8: */
   for( base = 2; base <= 8; base *= 2 )
   {
      /* Convert the string: */
      ul = strtoul( string, &stopstring, base );
      printf( "   strtol = %ld (base %d)\n", ul, base );
      printf( "   Stopped scan at: %s\n", stopstring );
   }
}
```

Output

```
string = 3.1415926 This stopped it
   strtod = 3.141593
   Stopped scan at: This stopped it

string = -10110134932 This stopped it
   strtol = -2147483647
   Stopped scan at: This stopped it
string = 10110134932
   strtol = 45 (base 2)
   Stopped scan at: 34932
   strtol = 4423 (base 4)
   Stopped scan at: 4932
   strtol = 2134108 (base 8)
   Stopped scan at: 932
```

See Also: strtod, strtol, atof, localeconv, setlocale

_strupr, _wcsupr, _mbsupr

Convert a string to uppercase.

char *_strupr(char *_string_);
wchar_t *_wcsupr(wchar_t *_string_);
unsigned char *_mbsupr(unsigned char *_string_);

Routine	Required Header	Compatibility
_strupr	<string.h>	Win 95, Win NT
_wcsupr	<string.h> or <wchar.h>	Win 95, Win NT
_mbsupr	<mbstring.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

These functions return a pointer to the altered string. Because the modification is done in place, the pointer returned is the same as the pointer passed as the input argument. No return value is reserved to indicate an error.

Parameter

string String to capitalize

Remarks

The **_strupr** function converts, in place, each lowercase letter in *string* to uppercase. The conversion is determined by the **LC_CTYPE** category setting of the current locale. Other characters are not affected. For more information on **LC_CTYPE**, see **setlocale**.

_wcsupr and **_mbsupr** are wide-character and multibyte-character versions of **_strupr**. The argument and return value of **_wcsupr** are wide-character strings; those of **_mbsupr** are multibyte-character strings. These three functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsupr	_strupr	_mbsupr	_wcsupr

Example

```
/* STRLWR.C: This program uses _strlwr and _strupr to create
 * uppercase and lowercase copies of a mixed-case string.
 */

#include <string.h>
#include <stdio.h>

void main( void )
{
   char string[100] = "The String to End All Strings!";
   char *copy1, *copy2;
   copy1 = _strlwr( _strdup( string ) );
   copy2 = _strupr( _strdup( string ) );
   printf( "Mixed: %s\n", string );
   printf( "Lower: %s\n", copy1 );
   printf( "Upper: %s\n", copy2 );
}
```

Output

```
Mixed: The String to End All Strings!
Lower: the string to end all strings!
Upper: THE STRING TO END ALL STRINGS!
```

See Also: _strlwr

strxfrm, wcsxfrm

Transform a string based on locale-specific information.

size_t strxfrm(char **strDest*, **const char** **strSource*, **size_t** *count* **);**
size_t wcsxfrm(wchar_t **strDest*, **const wchar_t** **strSource*, **size_t** *count* **);**

Routine	Required Header	Compatibility
strxfrm	<string.h>	ANSI, Win 95, Win NT
wcsxfrm	<string.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns the length of the transformed string, not counting the terminating null character. If the return value is greater than or equal to *count*, the content of *strDest* is unpredictable. On an error, each of the functions sets **errno** and returns **(size_t)** –1.

Parameters

strDest Destination string

strSource Source string

count Maximum number of characters to place in *strDest*

Remarks

The **strxfrm** function transforms the string pointed to by *strSource* into a new collated form that is stored in *strDest*. No more than *count* characters, including the null character, are transformed and placed into the resulting string. The transformation is made using the current locale's **LC_COLLATE** category setting. For more information on **LC_COLLATE**, see **setlocale**.

After the transformation, a call to **strcmp** with the two transformed strings yields results identical to those of a call to **strcoll** applied to the original two strings. As with **strcoll** and **stricoll**, **strxfrm** automatically handles multibyte-character strings as appropriate.

wcsxfrm is a wide-character version of **strxfrm**; the string arguments of **wcsxfrm** are wide-character pointers. For **wcsxfrm**, after the string transformation, a call to **wcscmp** with the two transformed strings yields results identical to those of a call to **wcscoll** applied to the original two strings. **wcsxfrm** and **strxfrm** behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tcsxfrm	strxfrm	strxfrm	wcsxfrm

In the "C" locale, the order of the characters in the character set (ASCII character set) is the same as the lexicographic order of the characters. However, in other locales, the order of characters in the character set may differ from the lexicographic character order. For example, in certain European locales, the character 'a' (value 0x61) precedes the character 'ä' (value 0xE4) in the character set, but the character 'ä' precedes the character 'a' lexicographically.

In locales for which the character set and the lexicographic character order differ, use **strxfrm** on the original strings and then **strcmp** on the resulting strings to produce a lexicographic string comparison according to the current locale's **LC_COLLATE** category setting. Thus, to compare two strings lexicographically in the above locale, use **strxfrm** on the original strings, then **strcmp** on the resulting strings. Alternatively, you can use **strcoll** rather than **strcmp** on the original strings.

The value of the following expression is the size of the array needed to hold the **strxfrm** transformation of the source string:

```
1 + strxfrm( NULL, string, 0 )
```

In the "C" locale only, **strxfrm** is equivalent to the following:

```
strncpy( _string1, _string2, _count );
return( strlen( _string1 ) );
```

See Also: localeconv, setlocale, strcmp, strncmp

_swab

Swaps bytes.

void _swab(char *_src_, char *_dest_, int _n_);

Routine	Required Header	Compatibility
_swab	<stdiib.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Parameters

src Data to be copied and swapped

dest Storage location for swapped data

n Number of bytes to be copied and swapped

Remarks

The **_swab** function copies *n* bytes from *src*, swaps each pair of adjacent bytes, and stores the result at *dest*. The integer *n* should be an even number to allow for swapping. **_swab** is typically used to prepare binary data for transfer to a machine that uses a different byte order.

Example

```
/* SWAB.C illustrates:
 *      _swab
 */

#include <stdlib.h>
#include <stdio.h>

char from[] = "BADCFEHGJILKNMPORQTSVUXWZY";
char to[] =   ".........................";

void main()
{
   printf( "Before:\t%s\n\t%s\n\n", from, to );
   _swab( from, to, sizeof( from ) );
   printf( "After:\t%s\n\t%s\n\n", from, to );
}
```

Output

```
Before:   BADCFEHGJILKNMPORQTSVUXWZY
   ........................

After:    BADCFEHGJILKNMPORQTSVUXWZY
   ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

system, _wsystem

Execute a command.

int system(const char **command* **);**
int _wsystem(const wchar_t **command* **);**

Routine	Required Header	Compatibility
system	<process.h> or <stdlib.h>	ANSI, Win 95, Win NT
_wsystem	<process.h> or <stdlib.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If *command* is **NULL** and the command interpreter is found, the function returns a nonzero value. If the command interpreter is not found, it returns 0 and sets **errno** to **ENOENT**. If *command* is not **NULL**, **system** returns the value that is returned by the command interpreter. It returns the value 0 only if the command interpreter returns the value 0. A return value of –1 indicates an error, and **errno** is set to one of the following values:

E2BIG Argument list (which is system-dependent) is too big.

ENOENT Command interpreter cannot be found.

ENOEXEC Command-interpreter file has invalid format and is not executable.

ENOMEM Not enough memory is available to execute command; or available memory has been corrupted; or invalid block exists, indicating that process making call was not allocated properly.

Parameter

command Command to be executed

Remarks

The **system** function passes *command* to the command interpreter, which executes the string as an operating-system command. **system** refers to the **COMSPEC** and

PATH environment variables that locate the command-interpreter file (the file named CMD.EXE in Windows NT). If *command* is NULL, the function simply checks to see whether the command interpreter exists.

You must explicitly flush (using **fflush** or **_flushall**) or close any stream before calling **system**.

_wsystem is a wide-character version of **system**; the *command* argument to **_wsystem** is a wide-character string. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tsystem	system	system	_wsystem

Example

```
/* SYSTEM.C: This program uses
 * system to TYPE its source file.
 */

#include <process.h>

void main( void )
{
   system( "type system.c" );
}
```

Output

```
/* SYSTEM.C: This program uses
 * system to TYPE its source file.
 */
#include <process.h>
void main( void )
{
   system( "type system.c" );
}
```

See Also: **_exec** Functions, **exit**, **_flushall**, **_spawn** Functions

tan, tanh

Calculate the tangent (**tan**) or hyperbolic tangent (**tanh**).

double tan(double *x* **);**
double tanh(double *x* **);**

Routine	Required Header	Compatibility
tan	<math.h>	ANSI, Win 95, Win NT
tanh	<math.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

tan returns the tangent of *x*. If *x* is greater than or equal to 2^{63}, or less than or equal to -2^{63}, a loss of significance in the result occurs, in which case the function generates a **_TLOSS** error and returns an indefinite (same as a quiet NaN). You can modify error handling with **_matherr**.

tanh returns the hyperbolic tangent of *x*. There is no error return.

Parameter

x Angle in radians

Example

```
/* TAN.C:  This program displays the tangent of pi / 4
 * and the hyperbolic tangent of the result.
 */

#include <math.h>
#include <stdio.h>

void main( void )
{
   double pi = 3.1415926535;
   double x, y;

   x = tan( pi / 4 );
   y = tanh( x );
   printf( "tan( %f ) = %f\n", x, y );
   printf( "tanh( %f ) = %f\n", y, x );
}
```

Output

```
tan( 1.000000 ) = 0.761594
tanh( 0.761594 ) = 1.000000
```

See Also: **acos, asin, atan, cos, sin**

_tell, _telli64

Get the position of the file pointer.

long _tell(int *handle* **);**
__int64 _telli64(int *handle* **);**

Routine	Required Header	Compatibility
_tell	<io.h>	Win 95, Win NT
_telli64	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

A return value of –1L indicates an error, and **errno** is set to **EBADF** to indicate an invalid file-handle argument. On devices incapable of seeking, the return value is undefined.

Parameter

handle Handle referring to open file

Remarks

The **_tell** function gets the current position of the file pointer (if any) associated with the *handle* argument. The position is expressed as the number of bytes from the beginning of the file. For the **_telli64** function, this value is expressed as a 64-bit integer.

Example

```
/* TELL.C:  This program uses _tell to tell the
 * file pointer position after a file read.
 */

#include <io.h>
#include <stdio.h>
#include <fcntl.h>

void main( void )
{
   int  fh;
   char buffer[500];

   if( (fh = _open( "tell.c", _O_RDONLY )) != -1 )
   {
      if( _read( fh, buffer, 500 ) > 0 )
         printf( "Current file position is: %d\n", _tell( fh ) );
      _close( fh );
   }
}
```

Output

```
Current file position is: 434
```

See Also: ftell, _lseek

_tempnam, _wtempnam, tmpnam, _wtmpnam

Create temporary filenames.

char *_tempnam(char *_dir_, char *_prefix_);
wchar_t *_wtempnam(wchar_t *_dir_, wchar_t *_prefix_);
char *tmpnam(char *_string_);
wchar_t *_wtmpnam(wchar_t *_string_);

Routine	Required Header	Compatibility
_tempnam	<stdio.h>	Win 95, Win NT
_wtempnam	<stdio.h> or <wchar.h>	Win 95, Win NT
tmpnam	<stdio.h>	ANSI, Win 95, Win NT
_wtmpnam	<stdio.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to the name generated, unless it is impossible to create this name or the name is not unique. If the name cannot be created or if a file with that name already exists, **tmpnam** and **_tempnam** return **NULL**. **_tempnam** and **_wtempnam** also return **NULL** if the file search fails.

Note The pointer returned by **tmpnam** points to an internal static buffer. **free** does not need to be called to deallocate this pointer.

Parameters

prefix Filename prefix

dir Target directory to be used if TMP not defined

string Pointer to temporary name

Remarks

The **tmpnam** function generates a temporary filename that can be used to open a temporary file without overwriting an existing file.

This name is stored in *string*. If *string* is **NULL**, then **tmpnam** leaves the result in an internal static buffer. Thus any subsequent calls destroy this value. If *string* is not **NULL**, it is assumed to point to an array of at least **L_tmpnam** bytes (the value of

L_tmpnam is defined in STDIO.H). The function generates unique filenames for up to **TMP_MAX** calls.

The character string that **tmpnam** creates consists of the path prefix, defined by the entry **P_tmpdir** in the file STDIO.H, followed by a sequence consisting of the digit characters '0' through '9'; the numerical value of this string is in the range 1–65,535. Changing the definitions of **L_tmpnam** or **P_tmpdir** in STDIO.H does not change the operation of **tmpnam**.

_tempnam creates a temporary filename for use in another directory. This filename is different from that of any existing file. The *prefix* argument is the prefix to the filename. **_tempnam** uses **malloc** to allocate space for the filename; the program is responsible for freeing this space when it is no longer needed. **_tempnam** looks for the file with the given name in the following directories, listed in order of precedence.

Directory Used	Conditions
Directory specified by **TMP**	**TMP** environment variable is set, and directory specified by **TMP** exists.
dir argument to **_tempnam**	**TMP** environment variable is not set, or directory specified by **TMP** does not exist.
P_tmpdir in STDIO.H	*dir* argument is **NULL**, or *dir* is name of nonexistent directory.
Current working directory	**P_tmpdir** does not exist.

_tempnam and **tmpnam** automatically handle multibyte-character string arguments as appropriate, recognizing multibyte-character sequences according to the OEM code page obtained from the operating system. **_wtempnam** is a wide-character version of **_tempnam**; the arguments and return value of **_wtempnam** are wide-character strings. **_wtempnam** and **_tempnam** behave identically except that **_wtempnam** does not handle multibyte-character strings. **_wtmpnam** is a wide-character version of **tmpnam**; the argument and return value of **_wtmpnam** are wide-character strings. **_wtmpnam** and **tmpnam** behave identically except that **_wtmpnam** does not handle multibyte-character strings.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ttmpnam	tmpnam	tmpnam	_wtmpnam
_ttempnam	_tempnam	_tempnam	_wtempnam

Example

```
/* TEMPNAM.C: This program uses tmpnam to create a unique
 * filename in the current working directory, then uses
 * _tempnam to create a unique filename with a prefix of stq.
 */

#include <stdio.h>
```

```
void main( void )
{
   char *name1, *name2;

   /* Create a temporary filename for the current working directory: */
   if( ( name1 = tmpnam( NULL ) ) != NULL )
      printf( "%s is safe to use as a temporary file.\n", name1 );
   else
      printf( "Cannot create a unique filename\n" );

   /* Create a temporary filename in temporary directory with the
    * prefix "stq". The actual destination directory may vary
    * depending on the state of the TMP environment variable and
    * the global variable P_tmpdir.
    */
   if( ( name2 = _tempnam( "c:\\tmp", "stq" ) ) != NULL )
      printf( "%s is safe to use as a temporary file.\n", name2 );
   else
      printf( "Cannot create a unique filename\n" );
}
```

Output

```
\s5d. is safe to use as a temporary file.
C:\temp\stq2 is safe to use as a temporary file.
```

See Also: **_getmbcp, malloc, _setmbcp, tmpfile**

terminate

Calls **abort** or a function you specify using **set_terminate**.

void terminate(void);

Routine	Required Header	Compatibility
terminate	<eh.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Remarks

The **terminate** function is used with C++ exception handling and is called in the following cases:

- A matching catch handler cannot be found for a thrown C++ exception.

- An exception is thrown by a destructor function during stack unwind.
- The stack is corrupted after throwing an exception.

terminate calls **abort** by default. You can change this default by writing your own termination function and calling **set_terminate** with the name of your function as its argument. **terminate** calls the last function given as an argument to **set_terminate**.

Example

```
/* TERMINAT.CPP:
 */
#include <eh.h>
#include <process.h>
#include <iostream.h>

void term_func();

void main()
{

   int i = 10, j = 0, result;
   set_terminate( term_func );
   try
   {
      if( j == 0 )
         throw "Divide by zero!";
      else
         result = i/j;

   }
   catch( int )
   {
      cout << "Caught some integer exception.\n";
   }
   cout << "This should never print.\n";

}
void term_func()
{
   cout << "term_func() was called by terminate().\n";

   // ... cleanup tasks performed here

   // If this function does not exit, abort is called.

   exit(-1);
}
```

Output

```
term_func() was called by terminate().
```

See Also: **abort**, **_set_se_translator**, **set_terminate**, **set_unexpected**, **unexpected**

time

Gets the system time.

time_t time(time_t **timer* **);**

Routine	Required Header	Compatibility
time	<time.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

time returns the time in elapsed seconds. There is no error return.

Parameter

timer Storage location for time

Remarks

The **time** function returns the number of seconds elapsed since midnight (00:00:00), January 1, 1970, coordinated universal time, according to the system clock. The return value is stored in the location given by *timer*. This parameter may be **NULL**, in which case the return value is not stored.

Example

```
/* TIMES.C illustrates various time and date functions including:
 *      time            _ftime          ctime       asctime
 *      localtime       gmtime          mktime      _tzset
 *      _strtime        _strdate        strftime
 *
 * Also the global variable:
 *      _tzname
 */

#include <time.h>
#include <stdio.h>
#include <sys/types.h>
#include <sys/timeb.h>
#include <string.h>

void main()
{
   char tmpbuf[128], ampm[] = "AM";
   time_t ltime;
   struct _timeb tstruct;
   struct tm *today, *gmt, xmas = { 0, 0, 12, 25, 11, 93 };
```

```
/* Set time zone from TZ environment variable. If TZ is not set,
 * the operating system is queried to obtain the default value
 * for the variable.
 */
_tzset();

/* Display operating system-style date and time. */
_strtime( tmpbuf );
printf( "OS time:\t\t\t\t%s\n", tmpbuf );
_strdate( tmpbuf );
printf( "OS date:\t\t\t\t%s\n", tmpbuf );

/* Get UNIX-style time and display as number and string. */
time( &ltime );
printf( "Time in seconds since UTC 1/1/70:\t%ld\n", ltime );
printf( "UNIX time and date:\t\t\t%s", ctime( &ltime ) );

/* Display UTC. */
gmt = gmtime( &ltime );
printf( "Coordinated universal time:\t\t%s", asctime( gmt ) );

/* Convert to time structure and adjust for PM if necessary. */
today = localtime( &ltime );
if( today->tm_hour > 12 )
{
strcpy( ampm, "PM" );
today->tm_hour -= 12;
}
if( today->tm_hour == 0 )  /* Adjust if midnight hour. */
today->tm_hour = 12;

/* Note how pointer addition is used to skip the first 11
 * characters and printf is used to trim off terminating
 * characters.
 */
printf( "12-hour time:\t\t\t\t%.8s %s\n",
   asctime( today ) + 11, ampm );

/* Print additional time information. */
_ftime( &tstruct );
printf( "Plus milliseconds:\t\t\t%u\n", tstruct.millitm );
printf( "Zone difference in seconds from UTC:\t%u\n",
         tstruct.timezone );
printf( "Time zone name:\t\t\t\t%s\n", _tzname[0] );
printf( "Daylight savings:\t\t\t%s\n",
         tstruct.dstflag ? "YES" : "NO" );

/* Make time for noon on Christmas, 1993. */
if( mktime( &xmas ) != (time_t)-1 )
printf( "Christmas\t\t\t\t%s\n", asctime( &xmas ) );
```

```
    /* Use time structure to build a customized time string. */
    today = localtime( &ltime );

    /* Use strftime to build a customized time string. */
    strftime( tmpbuf, 128,
          "Today is %A, day %d of %B in the year %Y.\n", today );
    printf( tmpbuf );
}
```

Output

```
OS time:                                21:51:03
OS date:                                05/03/94
Time in seconds since UTC 1/1/70:       768027063
UNIX time and date:                     Tue May 03 21:51:03 1994
Coordinated universal time:             Wed May 04 04:51:03 1994
12-hour time:                           09:51:03 PM
Plus milliseconds:                      279
Zone difference in seconds from UTC:    480
Time zone name:
Daylight savings:                       YES
Christmas                               Sat Dec 25 12:00:00 1993

Today is Tuesday, day 03 of May in the year 1994.
```

See Also: **asctime**, **_ftime**, **gmtime**, **localtime**, **_utime**

tmpfile

Creates a temporary file.

FILE *tmpfile(void);

Routine	Required Header	Compatibility
tmpfile	<stdio.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **tmpfile** returns a stream pointer. Otherwise, it returns a **NULL** pointer.

Remarks

The **tmpfile** function creates a temporary file and returns a pointer to that stream. If the file cannot be opened, **tmpfile** returns a **NULL** pointer. This temporary file is automatically deleted when the file is closed, when the program terminates normally, or when **_rmtmp** is called, assuming that the current working directory does not change. The temporary file is opened in **w+b** (binary read/write) mode.

Example

```
/* TMPFILE.C: This program uses tmpfile to create a
 * temporary file, then deletes this file with _rmtmp.
 */

#include <stdio.h>

void main( void )
{
   FILE *stream;
   char tempstring[] = "String to be written";
   int  i;

   /* Create temporary files. */
   for( i = 1; i <= 3; i++ )
   {
      if( (stream = tmpfile()) == NULL )
         perror( "Could not open new temporary file\n" );
      else
         printf( "Temporary file %d was created\n", i );
   }

   /* Remove temporary files. */
   printf( "%d temporary files deleted\n", _rmtmp() );
}
```

Output

```
Temporary file 1 was created
Temporary file 2 was created
Temporary file 3 was created
3 temporary files deleted
```

See Also: _rmtmp, _tempnam

---

to Functions

Each of the **to** functions and its associated macro, if any, converts a single character to another character.

__toascii **toupper, _toupper, towupper**

tolower, _tolower, towlower

Remarks

The **to** functions and macro conversions are as follows:

Routine	Macro	Description
__toascii	**__toascii**	Converts *c* to ASCII character
tolower	**tolower**	Converts *c* to lowercase if appropriate
_tolower	**_tolower**	Converts *c* to lowercase
towlower	None	Converts *c* to corresponding wide-character lowercase letter
toupper	**toupper**	Converts *c* to uppercase if appropriate
_toupper	**_toupper**	Converts *c* to uppercase
towupper	None	Converts c to corresponding wide-character uppercase letter

To use the function versions of the **to** routines that are also defined as macros, either remove the macro definitions with **#undef** directives or do not include CTYPE.H. If you use the /Za compiler option, the compiler uses the function version of **toupper** or **tolower**. Declarations of the **toupper** and **tolower** functions are in STDLIB.H.

The **__toascii** routine sets all but the low-order 7 bits of *c* to 0, so that the converted value represents a character in the ASCII character set. If *c* already represents an ASCII character, *c* is unchanged.

The **tolower** and **toupper** routines:

- Are dependent on the **LC_CTYPE** category of the current locale (**tolower** calls **isupper** and **toupper** calls **islower**).
- Convert *c* if *c* represents a convertible letter of the appropriate case in the current locale and the opposite case exists for that locale. Otherwise, *c* is unchanged.

The **_tolower** and **_toupper** routines:

- Are locale-independent, much faster versions of **tolower** and **toupper.**
- Can be used only when **isascii**(*c*) and either **isupper**(*c*) or **islower**(*c*), respectively, are true.
- Have undefined results if *c* is not an ASCII letter of the appropriate case for converting.

The **towlower** and **towupper** functions return a converted copy of *c* if and only if both of the following conditions are true. Otherwise, *c* is unchanged.

- *c* is a wide character of the appropriate case (that is, for which **iswupper** or **iswlower,** respectively, is true).
- There is a corresponding wide character of the target case (that is, for which **iswlower** or **iswupper,** respectively, is true).

Example

```
/* TOUPPER.C: This program uses toupper and tolower to
 * analyze all characters between 0x0 and 0x7F. It also
 * applies _toupper and _tolower to any code in this
 * range for which these functions make sense.
 */

#include <conio.h>
#include <ctype.h>
#include <string.h>

char msg[] = "Some of THESE letters are Capitals\r\n";
char *p;

void main( void )
{
   _cputs( msg );

   /* Reverse case of message. */
   for( p = msg; p < msg + strlen( msg ); p++ )
   {
      if( islower( *p ) )
         _putch( _toupper( *p ) );
      else if( isupper( *p ) )
         _putch( _tolower( *p ) );
      else
         _putch( *p );
   }
}
```

Output

```
Some of THESE letters are Capitals
sOME OF these LETTERS ARE cAPITALS
```

See Also: **is** Routines

__toascii

Converts characters.

int __toascii(int *c* **);**

Routine	Required Header	Compatibility
__toascii	<ctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

__toascii converts a copy of *c* if possible, and returns the result. There is no return value reserved to indicate an error.

Parameter

c Character to convert

Remarks

The **__toascii** routine converts the given character to an ASCII character.

See Also: **is** Routines, **to** Functions Overview

Example

```
/* TOUPPER.C: This program uses toupper and tolower to
 * analyze all characters between 0x0 and 0x7F. It also
 * applies _toupper and _tolower to any code in this
 * range for which these functions make sense.
 */

#include <conio.h>
#include <ctype.h>
#include <string.h>

char msg[] = "Some of THESE letters are Capitals\r\n";
char *p;

void main( void )
{
   _cputs( msg );

   /* Reverse case of message. */
   for( p = msg; p < msg + strlen( msg ); p++ )
   {
      if( islower( *p ) )
         _putch( _toupper( *p ) );
      else if( isupper( *p ) )
         _putch( _tolower( *p ) );
      else
         _putch( *p );
   }
}
```

Output

```
Some of THESE letters are Capitals
sOME OF these LETTERS ARE cAPITALS
```

---

tolower, _tolower, towlower

Convert character to lowercase.

int tolower(int *c* **);**
int _tolower(int *c* **);**
int towlower(wint_t *c* **);**

Routine	Required Header	Compatibility
tolower	<stdlib.h> and <ctype.h>	ANSI, Win 95, Win NT
_tolower	<ctype.h>	Win 95, Win NT
towlower	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines converts a copy of *c,* if possible, and returns the result. There is no return value reserved to indicate an error.

Parameter

c Character to convert

Remarks

Each of these routines converts a given uppercase letter to a lowercase letter if possible and appropriate.

See Also: **is** Routines, **to** Functions Overview

Example

```
/* TOUPPER.C: This program uses toupper and tolower to
 * analyze all characters between 0x0 and 0x7F. It also
 * applies _toupper and _tolower to any code in this
 * range for which these functions make sense.
 */

#include <conio.h>
#include <ctype.h>
#include <string.h>

char msg[] = "Some of THESE letters are Capitals\r\n";
char *p;

void main( void )
{
   _cputs( msg );

   /* Reverse case of message. */
   for( p = msg; p < msg + strlen( msg ); p++ )
   {
      if( islower( *p ) )
         _putch( _toupper( *p ) );
```

```
        else if( isupper( *p ) )
            _putch( _tolower( *p ) );
        else
            _putch( *p );
    }
}
```

Output

```
Some of THESE letters are Capitals
sOME OF these LETTERS ARE cAPITALS
```

---

toupper _toupper, towupper

Convert character to uppercase.

int toupper(int *c* **);**
int _toupper(int *c* **);**
int towupper(wint_t *c* **);**

Routine	Required Header	Compatibility
toupper	<stdlib.h> and <ctype.h>	ANSI, Win 95, Win NT
_toupper	<ctype.h>	Win 95, Win NT
towupper	<ctype.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these routines converts a copy of *c*, if possible, and returns the result.

If *c* is a wide character for which **iswlower** is true and there is a corresponding wide character for which **iswupper** is true, **towupper** returns the corresponding wide character; otherwise, **towupper** returns *c* unchanged.

There is no return value reserved to indicate an error.

Parameter

c Character to convert

Remarks

Each of these routines converts a given lowercase letter to an uppercase letter if possible and appropriate.

See Also: **is** Routines, **to** Functions Overview

Example

```
/* TOUPPER.C: This program uses toupper and tolower to
 * analyze all characters between 0x0 and 0x7F. It also
 * applies _toupper and _tolower to any code in this
 * range for which these functions make sense.
 */

#include <conio.h>
#include <ctype.h>
#include <string.h>

char msg[] = "Some of THESE letters are Capitals\r\n";
char *p;

void main( void )
{
   _cputs( msg );

   /* Reverse case of message. */
   for( p = msg; p < msg + strlen( msg ); p++ )
   {
      if( islower( *p ) )
         _putch( _toupper( *p ) );
      else if( isupper( *p ) )
         _putch( _tolower( *p ) );
      else
         _putch( *p );
   }
}
```

Output

```
Some of THESE letters are Capitals
sOME OF these LETTERS ARE cAPITALS
```

towctrans

Transforms a wide character.

wint_t towctrans(wint_t c, **wctrans_t** category **);**

Routine	Required Header	Compatibility
towctrans	<wctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCP.LIB	Single thread static library, retail version
LIBCPMT.LIB	Multithread static library, retail version
MSVCPRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

The transformation of the character *c*, using the transform in *category*.

Remarks

The value of *category* must have been returned by an earlier successful call to **wctrans**.

_tzset

Sets time environment variables.

void _tzset(void);

Routine	Required Header	Compatibility
_tzset	<time.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Remarks

The **_tzset** function uses the current setting of the environment variable **TZ** to assign values to three global variables: **_daylight**, **_timezone**, and **_tzname**. These variables are used by the **_ftime** and **localtime** functions to make corrections from coordinated universal time (UTC) to local time, and by the **time** function to compute UTC from system time. Use the following syntax to set the **TZ** environment variable:

set TZ=*tzn*[+ | –]*hh*[**:***mm*[**:***ss*]][*dzn*]

tzn Three-letter time-zone name, such as PST. You must specify the correct offset from UTC.

hh Difference in hours between UTC and local time. Optionally signed.

mm Minutes. Separated from *hh* by a colon (**:**).

ss Seconds. Separated from *mm* by a colon (**:**).

dzn Three-letter daylight-saving-time zone such as PDT. If daylight savings time is never in effect in the locality, set **TZ** without a value for *dzn*. The C run-time library

assumes the United States's rules for implementing the calculation of Daylight Savings Time (DST).

For example, to set the **TZ** environment variable to correspond to the current time zone in Germany, you can use one of the following statements:

```
set TZ=GST1GDT
set TZ=GST+1GDT
```

These strings use GST to indicate German standard time, assume that Germany is one hour ahead of UTC, and assume that daylight savings time is in effect.

If the **TZ** value is not set, **_tzset** attempts to use the time zone information specified by the operating system. Under Windows NT and Windows 95, this information is specified in the Control Panel's Date/Time application. If **_tzset** cannot obtain this information, it uses PST8PDT by default, which signifies the Pacific time zone.

Based on the **TZ** environment variable value, the following values are assigned to the global variables **_daylight**, **_timezone**, and **_tzname** when **_tzset** is called:

Global Variable	Description	Default Value
_daylight	Nonzero value if a daylight-savings-time zone is specified in **TZ** setting; otherwise, 0	1
_timezone	Difference in seconds between UTC and local time.	28800 (28800 seconds equals 8 hours)
_tzname[0]	String value of time-zone name from **TZ** environmental variable; empty if **TZ** has not been set	PST
_tzname[1]	String value of daylight-saving-time zone; empty if daylight-saving-time zone is omitted from **TZ** environmental variable	PDT

The default values shown in the preceding table for **_daylight** and the **_tzname** array correspond to "PST8PDT." If the DST zone is omitted from the **TZ** environmental variable, the value of **_daylight** is 0 and the **_ftime**, **gmtime**, and **localtime** functions return 0 for their DST flags.

Example

```
/* TZSET.C: This program first sets up the time zone by
 * placing the variable named TZ=EST5 in the environment
 * table. It then uses _tzset to set the global variables
 * named _daylight, _timezone, and _tzname.
 */

#include <time.h>
#include <stdlib.h>
#include <stdio.h>
```

```
void main( void )
{
   if( _putenv( "TZ=EST5EDT" ) == -1 )
   {
      printf( "Unable to set TZ\n" );
      exit( 1 );
   }
   else
   {
      _tzset();
      printf( "_daylight = %d\n", _daylight );
      printf( "_timezone = %ld\n", _timezone );
      printf( "_tzname[0] = %s\n", _tzname[0] );
   }
   exit( 0 );
}
```

Output

```
_daylight = 1
_timezone = 18000
_tzname[0] = EST
```

See Also: **asctime, _ftime, gmtime, localtime, time, _utime**

_ultoa, _ultow

Convert an unsigned long integer to a string.

char *_ultoa(unsigned long *value*, **char** **string*, **int** *radix* **);**
wchar_t *_ultow(unsigned long *value*, **wchar_t** **string*, **int** *radix* **);**

Routine	Required Header	Compatibility
_ultoa	<stdlib.h>	Win 95, Win NT
_ultow	<stdlib.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns a pointer to *string*. There is no error return.

Parameters

value Number to be converted

string String result

radix Base of *value*

Remarks

The **_ultoa** function converts *value* to a null-terminated character string and stores the result (up to 33 bytes) in *string*. No overflow checking is performed. *radix* specifies the base of *value*; *radix* must be in the range 2–36. **_ultow** is a wide-character version of **_ultoa**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ultot	_ultoa	_ultoa	_ultow

Example

```
/* ITOA.C: This program converts integers of various
 * sizes to strings in various radixes.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char buffer[20];
   int  i = 3445;
   long l = -344115L;
   unsigned long ul = 1234567890UL;

   _itoa( i, buffer, 10 );
   printf( "String of integer %d (radix 10): %s\n", i, buffer );
   _itoa( i, buffer, 16 );
   printf( "String of integer %d (radix 16): 0x%s\n", i, buffer );
   _itoa( i, buffer, 2  );
   printf( "String of integer %d (radix 2): %s\n", i, buffer );

   _ltoa( l, buffer, 16 );
   printf( "String of long int %ld (radix 16): 0x%s\n", l, buffer );

   _ultoa( ul, buffer, 16 );
   printf( "String of unsigned long %lu (radix 16): 0x%s\n", ul, buffer );
}
```

Output

```
String of integer 3445 (radix 10): 3445
String of integer 3445 (radix 16): 0xd75
String of integer 3445 (radix 2): 110101110101
String of long int -344115 (radix 16): 0xfffabfcd
String of unsigned long 1234567890 (radix 16): 0x499602d2
```

See Also: **_itoa**, **_ltoa**

_umask

Sets the default file-permission mask.

int _umask(int *pmode* **);**

Routine	Required Header	Compatibility
_umask	<io.h> and <sys/stat.h> and <sys/types.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_umask returns the previous value of *pmode*. There is no error return.

Parameter

pmode Default permission setting

Remarks

The **_umask** function sets the file-permission mask of the current process to the mode specified by *pmode*. The file-permission mask modifies the permission setting of new files created by **_creat**, **_open**, or **_sopen**. If a bit in the mask is 1, the corresponding bit in the file's requested permission value is set to 0 (disallowed). If a bit in the mask is 0, the corresponding bit is left unchanged. The permission setting for a new file is not set until the file is closed for the first time.

The argument *pmode* is a constant expression containing one or both of the manifest constants **_S_IREAD** and **_S_IWRITE**, defined in SYS\STAT.H. When both constants are given, they are joined with the bitwise-OR operator (|). If the *pmode* argument is **_S_IREAD**, reading is not allowed (the file is write-only). If the *pmode* argument is **_S_IWRITE**, writing is not allowed (the file is read-only). For example, if the write bit is set in the mask, any new files will be read-only. Note that with MS-DOS, Windows NT, and Windows 95, all files are readable; it is not possible to give write-only permission. Therefore, setting the read bit with **_umask** has no effect on the file's modes.

Example

```
/* UMASK.C: This program uses _umask to set
 * the file-permission mask so that all future
 * files will be created as read-only files.
 * It also displays the old mask.
 */
```

```
#include <sys/stat.h>
#include <sys/types.h>
#include <io.h>
#include <stdio.h>

void main( void )
{
   int oldmask;

   /* Create read-only files: */
   oldmask = _umask( _S_IWRITE );
   printf( "Oldmask = 0x%.4x\n", oldmask );
}
```

Output

```
Oldmask = 0x0000
```

See Also: **_chmod**, **_creat**, **_mkdir**, **_open**

unexpected

Calls **terminate** or function you specify using **set_unexpected**.

void unexpected(void);

Routine	Required Header	Compatibility
unexpected	<eh.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

None

Remarks

The **unexpected** routine is not used with the current implemenation of C++ exception handling. **unexpected** calls **terminate** by default. You can change this default behavior by writing a custom termination function and calling **set_unexpected** with the name of your function as its argument. **unexpected** calls the last function given as an argument to **set_unexpected**.

See Also: **abort**, **_set_se_translator**, **set_terminate**, **set_unexpected**, **terminate**

ungetc, ungetwc

Pushes a character back onto the stream.

int ungetc(int *c*, **FILE** **stream* **);**
wint_t ungetwc(wint_t *c*, **FILE** **stream* **);**

Routine	Required Header	Compatibility
ungetc	<stdio.h>	ANSI, Win 95, Win NT
ungetwc	<stdio.h> or <wchar.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, each of these functions returns the character argument *c*. If *c* cannot be pushed back or if no character has been read, the input stream is unchanged and **ungetc** returns **EOF**; **ungetwc** returns **WEOF**.

Parameters

c Character to be pushed

stream Pointer to **FILE** structure

Remarks

The **ungetc** function pushes the character *c* back onto *stream* and clears the end-of-file indicator. The stream must be open for reading. A subsequent read operation on *stream* starts with *c*. An attempt to push **EOF** onto the stream using **ungetc** is ignored.

Characters placed on the stream by **ungetc** may be erased if **fflush**, **fseek**, **fsetpos**, or **rewind** is called before the character is read from the stream. The file-position indicator will have the value it had before the characters were pushed back. The external storage corresponding to the stream is unchanged. On a successful **ungetc** call against a text stream, the file-position indicator is unspecified until all the pushed-back characters are read or discarded. On each successful **ungetc** call against a binary stream, the file-position indicator is decremented; if its value was 0 before a call, the value is undefined after the call.

Results are unpredictable if **ungetc** is called twice without a read or file-positioning operation between the two calls. After a call to **fscanf**, a call to **ungetc** may fail unless another read operation (such as **getc**) has been performed. This is because **fscanf** itself calls **ungetc**.

ungetwc is a wide-character version of **ungetc**. However, on each successful **ungetwc** call against a text or binary stream, the value of the file-position indicator is unspecified until all pushed-back characters are read or discarded.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_ungettc	ungetc	ungetc	ungetwc

Example

```
/* UNGETC.C: This program first converts a character
 * representation of an unsigned integer to an integer. If
 * the program encounters a character that is not a digit,
 * the program uses ungetc to replace it in the  stream.
 */

#include <stdio.h>
#include <ctype.h>

void main( void )
{
   int ch;
   int result = 0;

   printf( "Enter an integer: " );

   /* Read in and convert number: */
   while( ((ch = getchar()) != EOF) && isdigit( ch ) )
      result = result * 10 + ch - '0';    /* Use digit. */
   if( ch != EOF )
      ungetc( ch, stdin );                /* Put nondigit back. */
   printf( "Number = %d\nNextcharacter in stream = '%c'",
         result, getchar() );
}
```

Output

```
Enter an integer: 521a
Number = 521
Nextcharacter in stream = 'a'
```

See Also: **getc**, **putc**

_ungetch

Pushes back the last charcter read from the console.

int _ungetch(int *c* **);**

Routine	Required Header	Compatibility
_ungetch	<conio.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_ungetch returns the character *c* if it is successful. A return value of **EOF** indicates an error.

Parameter

c Character to be pushed

Remarks

The **_ungetch** function pushes the character *c* back to the console, causing *c* to be the next character read by **_getch** or **_getche**. **_ungetch** fails if it is called more than once before the next read. The *c* argument may not be **EOF**.

Example

```
/* UNGETCH.C: In this program, a white-space delimited
 * token is read from the keyboard. When the program
 * encounters a delimiter, it uses _ungetch to replace
 * the character in the keyboard buffer.
 */

#include <conio.h>
#include <ctype.h>
#include <stdio.h>

void main( void )
{
   char buffer[100];
   int count = 0;
   int ch;
   ch = _getche();
   while( isspace( ch ) )      /* Skip preceding white space. */
      ch = _getche();
   while( count < 99 )         /* Gather token. */
   {
      if( isspace( ch ) )      /* End of token. */
         break;
      buffer[count++] = (char)ch;
      ch = _getche();
   }
   _ungetch( ch );             /* Put back delimiter. */
   buffer[count] = '\0';       /* Null terminate the token. */
   printf( "\ntoken = %s\n", buffer );
}
```

Output

```
White
token = White
```

See Also: _cscanf, _getch

_unlink, _wunlink

Delete a file.

int _unlink(const char **filename* **);**
int _wunlink(const wchar_t **filename* **);**

Routine	Required Header	Compatibility
_unlink	<io.h> and <stdio.h>	Win 95, Win NT
_wunlink	<io.h> or <wchar.h>	Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if successful. Otherwise, the function returns –1 and sets **errno** to **EACCES**, which means the path specifies a read-only file, or to **ENOENT**, which means the file or path is not found or the path specified a directory.

Parameter

filename Name of file to remove

Remarks

The **_unlink** function deletes the file specified by *filename*. **_wunlink** is a wide-character version of **_unlink**; the *filename* argument to **_wunlink** is a wide-character string. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tunlink	_unlink	_unlink	_wunlink

Example

```
/* UNLINK.C: This program uses _unlink to delete UNLINK.OBJ. */

#include <stdio.h>

void main( void )
{
   if( _unlink( "unlink.obj" ) == -1 )
      perror( "Could not delete 'UNLINK.OBJ'" );
   else
      printf( "Deleted 'UNLINK.OBJ'\n" );
}
```

Output

```
Deleted 'UNLINK.OBJ'
```

See Also: **_close, remove**

_utime, _wutime

Set the file modification time.

int _utime(unsigned char **filename*, **struct _utimbuf** **times* **);**
int _wutime(wchar_t **filename*, **struct _utimbuf** **times* **);**

Routine	Required Headers	Optional Headers	Compatibility
_utime	<sys/utime.h>	<errno.h>	Win 95, Win NT
_wutime	<utime.h> or <wchar.h>	<errno.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each of these functions returns 0 if the file-modification time was changed. A return value of –1 indicates an error, in which case **errno** is set to one of the following values:

EACCES Path specifies directory or read-only file

EINVAL Invalid *times* argument

EMFILE Too many open files (the file must be opened to change its modification time)

ENOENT Path or filename not found

Parameters

filename Path or filename

times Pointer to stored time values

Remarks

The **_utime** function sets the modification time for the file specified by *filename*. The process must have write access to the file in order to change the time. Under Windows NT and Windows 95, you can change the access time and the modication time in the **_utimbuf** structure. If *times* is a **NULL** pointer, the modification time is set to the current local time. Otherwise, *times* must point to a structure of type **_utimbuf**, defined in SYS\UTIME.H.

The **_utimbuf** structure stores file access and modification times used by **_utime** to change file-modification dates. The structure has the following fields, which are both of type **time_t**:

actime Time of file access

modtime Time of file modification

_utime is identical to **_futime** except that the *filename* argument of **_utime** is a filename or a path to a file, rather than a handle to an open file.

_wutime is a wide-character version of **_utime**; the *filename* argument to **_wutime** is a wide-character string. These functions behave identically otherwise.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_tutime	_utime	_utime	_wutime

Example

```
/* UTIME.C: This program uses _utime to set the
 * file-modification time to the current time.
 */

#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/utime.h>

void main( void )
{
   /* Show file time before and after. */
   system( "dir utime.c" );
   if( _utime( "utime.c", NULL ) == -1 )
      perror( "_utime failed\n" );
   else
      printf( "File time modified\n" );
   system( "dir utime.c" );
}
```

Output

```
 Volume in drive C is ALDONS
 Volume Serial Number is 0E17-1702

 Directory of C:\dolphin\crt\code

05/03/94  10:00p                   451 utime.c
            1 File(s)              451 bytes
                           83,320,832 bytes free
 Volume in drive C is ALDONS
 Volume Serial Number is 0E17-1702
```

```
 Directory of C:\dolphin\crt\code

05/03/94  10:00p                   451 utime.c
            1 File(s)              451 bytes
                            83,320,832 bytes free
File time modified
```

See Also: **asctime, ctime, _fstat, _ftime, _futime, gmtime, localtime, _stat, time**

va_arg, va_end, va_start

Access variable-argument lists.

type **va_arg(va_list** *arg_ptr*, *type* **);**
void va_end(va_list *arg_ptr* **);**
void va_start(va_list *arg_ptr* **);** (UNIX version)
void va_start(va_list *arg_ptr*, *prev_param* **);** (ANSI version)

Routine	Required Header	Optional Headers	Compatibility
va_arg	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT
va_end	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT
va_start	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT

[1] Required for UNIX V compatibility.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

va_arg returns the current argument; **va_start** and **va_end** do not return values.

Parameters

type Type of argument to be retrieved

arg_ptr Pointer to list of arguments

prev_param Parameter preceding first optional argument (ANSI only)

Remarks

The **va_arg**, **va_end**, and **va_start** macros provide a portable way to access the arguments to a function when the function takes a variable number of arguments. Two versions of the macros are available: The macros defined in STDARG.H conform to the ANSI C standard, and the macros defined in VARARGS.H are compatible with the UNIX System V definition. The macros are:

va_alist Name of parameter to called function (UNIX version only)

va_arg Macro to retrieve current argument

va_dcl Declaration of **va_alist** (UNIX version only)

va_end Macro to reset *arg_ptr*

va_list **typedef** for pointer to list of arguments defined in STDIO.H

va_start Macro to set *arg_ptr* to beginning of list of optional arguments (UNIX version only)

Both versions of the macros assume that the function takes a fixed number of required arguments, followed by a variable number of optional arguments. The required arguments are declared as ordinary parameters to the function and can be accessed through the parameter names. The optional arguments are accessed through the macros in STDARG.H or VARARGS.H, which set a pointer to the first optional argument in the argument list, retrieve arguments from the list, and reset the pointer when argument processing is completed.

The ANSI C standard macros, defined in STDARG.H, are used as follows:

- All required arguments to the function are declared as parameters in the usual way. **va_dcl** is not used with the STDARG.H macros.
- **va_start** sets *arg_ptr* to the first optional argument in the list of arguments passed to the function. The argument *arg_ptr* must have **va_list** type. The argument *prev_param* is the name of the required parameter immediately preceding the first optional argument in the argument list. If *prev_param* is declared with the register storage class, the macro's behavior is undefined. **va_start** must be used before **va_arg** is used for the first time.
- **va_arg** retrieves a value of *type* from the location given by *arg_ptr* and increments *arg_ptr* to point to the next argument in the list, using the size of *type* to determine where the next argument starts. **va_arg** can be used any number of times within the function to retrieve arguments from the list.
- After all arguments have been retrieved, **va_end** resets the pointer to **NULL**.

The UNIX System V macros, defined in VARARGS.H, operate somewhat differently:

- Any required arguments to the function can be declared as parameters in the usual way.
- The last (or only) parameter to the function represents the list of optional arguments. This parameter must be named **va_alist** (not to be confused with **va_list**, which is defined as the type of **va_alist**).
- **va_dcl** appears after the function definition and before the opening left brace of the function. This macro is defined as a complete declaration of the **va_alist** parameter, including the terminating semicolon; therefore, no semicolon should follow **va_dcl**.

- Within the function, **va_start** sets *arg_ptr* to the beginning of the list of optional arguments passed to the function. **va_start** must be used before **va_arg** is used for the first time. The argument *arg_ptr* must have **va_list** type.
- **va_arg** retrieves a value of *type* from the location given by *arg_ptr* and increments *arg_ptr* to point to the next argument in the list, using the size of *type* to determine where the next argument starts. **va_arg** can be used any number of times within the function to retrieve the arguments from the list.
- After all arguments have been retrieved, **va_end** resets the pointer to **NULL**.

Example

```
/* VA.C: The program below illustrates passing a variable
 * number of arguments using the following macros:
 *      va_start            va_arg              va_end
 *      va_list             va_dcl (UNIX only)
 */

#include <stdio.h>
#define ANSI            /* Comment out for UNIX version     */
#ifdef ANSI             /* ANSI compatible version          */
#include <stdarg.h>
int average( int first, ... );
#else                   /* UNIX compatible version          */
#include <varargs.h>
int average( va_list );
#endif

void main( void )
{
   /* Call with 3 integers (-1 is used as terminator). */
   printf( "Average is: %d\n", average( 2, 3, 4, -1 ) );

   /* Call with 4 integers. */
   printf( "Average is: %d\n", average( 5, 7, 9, 11, -1 ) );

   /* Call with just -1 terminator. */
   printf( "Average is: %d\n", average( -1 ) );
}

/* Returns the average of a variable list of integers. */
#ifdef ANSI             /* ANSI compatible version    */
int average( int first, ... )
{
   int count = 0, sum = 0, i = first;
   va_list marker;

   va_start( marker, first );     /* Initialize variable arguments. */
   while( i != -1 )
   {
      sum += i;
      count++;
      i = va_arg( marker, int);
   }
```

```
   va_end( marker );              /* Reset variable arguments.      */
   return( sum ? (sum / count) : 0 );
}
#else    /* UNIX compatible version must use old-style definition.  */
int average( va_alist )
va_dcl
{
   int i, count, sum;
   va_list marker;

   va_start( marker );            /* Initialize variable arguments. */
   for( sum = count = 0; (i = va_arg( marker, int)) != -1; count++ )
      sum += i;
   va_end( marker );              /* Reset variable arguments.      */
   return( sum ? (sum / count) : 0 );
}
#endif
```

Output

```
Average is: 3
Average is: 8
Average is: 0
```

See Also: vfprintf

vprintf Functions

Each of the **vprintf** functions takes a pointer to an argument list, then formats and writes the given data to a particular destination.

vfprintf, vfwprintf	**_vsnprintf, _vsnwprintf**
vprintf, vwprintf	**vsprintf, vswprintf**

Remarks

The **vprintf** functions are similar to their counterpart functions as listed in the following table. However, each **vprintf** function accepts a pointer to an argument list, whereas each of the counterpart functions accepts an argument list.

These functions format data for output to destinations as follows:

Function	Counterpart Function	Output Destination
vfprintf	**fprintf**	*stream*
vfwprintf	**fwprintf**	*stream*
vprintf	**printf**	**stdout**
vwprintf	**wprintf**	**stdout**
vsprintf	**sprintf**	memory pointed to by *buffer*
vswprintf	**swprintf**	memory pointed to by *buffer*
_vsnprintf	**_snprintf**	memory pointed to by *buffer*
_vsnwprintf	**_snwprintf**	memory pointed to by *buffer*

The *argptr* argument has type **va_list**, which is defined in VARARGS.H and STDARG.H. The *argptr* variable must be initialized by **va_start,** and may be reinitialized by subsequent **va_arg** calls; *argptr* then points to the beginning of a list of arguments that are converted and transmitted for output according to the corresponding specifications in the *format* argument. *format* has the same form and function as the *format* argument for **printf**. None of these functions invokes **va_end**. For a more complete description of each **vprintf** function, see the description of its counterpart function as listed in the preceding table.

_vsnprintf differs from **vsprintf** in that it writes no more than *count* bytes to *buffer*.

vfwprintf, **_vsnwprintf**, **vswprintf**, and **vwprintf** are wide-character versions of **vfprintf**, **_vsnprintf**, **vsprintf,** and **vprintf**, respectively; in each of these wide-character functions, *buffer* and *format* are wide-character strings. Otherwise, each wide-character function behaves identically to its SBCS counterpart function.

For **vsprintf**, **vswprintf**, **_vsnprintf** and **_vsnwprintf**, if copying occurs between strings that overlap, the behavior is undefined.

See Also: **fprintf**, **printf**, **sprintf**, **va_arg**

vfprintf, vfwprintf

Write formatted output using a pointer to a list of arguments.

int vfprintf(FILE ***stream*, const char** ***format*, va_list** *argptr* **);**
int vfwprintf(FILE ***stream*, const wchar_t** ***format*, va_list** *argptr* **);**

Routine	Required Header	Optional Headers	Compatibility
vfprintf	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95
vfwprintf	<stdio.h> or <wchar.h>, and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT

[1] Required for UNIX V compatibility.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

vfprintf and **vfwprintf** return the number of characters written, not including the terminating null character, or a negative value if an output error occurs.

Parameters

stream Pointer to **FILE** structure

format Format specification

argptr Pointer to list of arguments

For more information, see "Format Specifications."

Remarks

Each of these functions takes a pointer to an argument list, then formats and writes the given data to *stream*.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_vftprintf	vfprintf	vfprintf	vfwprintf

See Also: fprintf, printf, sprintf, va_arg

vprintf, vwprintf

Write formatted output using a pointer to a list of arguments.

int vprintf(const char **format*, **va_list** *argptr* **);**
int vwprintf(const wchar_t **format*, **va_list** *argptr* **);**

Routine	Required Header	Optional Headers	Compatibility
vprintf	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT
vwprintf	<stdio.h> or <wchar.h>, and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT

[1] Required for UNIX V compatibility.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

vprintf and **vwprintf** return the number of characters written, not including the terminating null character, or a negative value if an output error occurs.

Parameters

format Format specification

argptr Pointer to list of arguments

Remarks

Each of these functions takes a pointer to an argument list, then formats and writes the given data to **stdout**.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_vtprintf	vprintf	vprintf	vwprintf

See Also: **fprintf, printf, sprintf, va_arg**

_vsnprintf, _vsnwprintf

Write formatted output using a pointer to a list of arguments.

int _vsnprintf(char **buffer*, **size_t** *count*, **const char** **format*, **va_list** *argptr* **);**
int _vsnwprintf(wchar_t **buffer*, **size_t** *count*, **const wchar_t** **format*,
↪ **va_list** *argptr* **);**

Routine	Required Header	Optional Headers	Compatibility
_vsnprintf	<stdio.h> and <stdarg.h>	<varargs.h>[1]	Win 95, Win NT
_vsnwprintf	<stdio.h> or <wchar.h>, and <stdarg.h>	<varargs.h>[1]	Win 95, Win NT

[1] Required for UNIX V compatibility.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

_vsnprintf and **_vsnwprintf** return the number of characters written, not including the terminating null character, or a negative value if an output error occurs. For **_vsnprintf**, if the number of bytes to write exceeds *buffer,* then *count* bytes are written and –1 is returned.

Parameters

buffer Storage location for output

count Maximum number of bytes to write

format Format specification

argptr Pointer to list of arguments

Remarks

Each of these functions takes a pointer to an argument list, then formats and writes the given data to the memory pointed to by *buffer*.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_vsntprintf	_vsnprintf	_vsnprintf	_vsnwprintf

See Also: fprintf, printf, sprintf, va_arg

vsprintf, vswprintf

Write formatted output using a pointer to a list of arguments.

int vsprintf(char **buffer*, **const char** **format*, **va_list** *argptr* **);**
int vswprintf(wchar_t **buffer*, **const wchar_t** **format*, **va_list** *argptr* **);**

Routine	Required Header	Optional Headers	Compatibility
vsprintf	<stdio.h> and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT
vswprintf	<stdio.h> or <wchar.h>, and <stdarg.h>	<varargs.h>[1]	ANSI, Win 95, Win NT

[1] Required for UNIX V compatibility.

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

vsprintf and **vswprintf** return the number of characters written, not including the terminating null character, or a negative value if an output error occurs. For **vswprintf**, a negative value is also returned if *count* or more wide characters are requested to be written.

Parameters

buffer Storage location for output

format Format specification

argptr Pointer to list of arguments

count Maximum number of bytes to write

Remarks

Each of these functions takes a pointer to an argument list, then formats and writes the given data to the memory pointed to by *buffer*.

Generic-Text Routine Mappings

TCHAR.H Routine	_UNICODE & _MBCS Not Defined	_MBCS Defined	_UNICODE Defined
_vstprintf	vsprintf	vsprintf	vswprintf

See Also: **fprintf, printf, sprintf, va_arg**

wcstombs

Converts a sequence of wide characters to a corresponding sequence of multibyte characters.

size_t wcstombs(char ***mbstr*, const wchar_t** ***wcstr*, size_t** ***count*** **);**

Routine	Required Header	Compatibility
wcstombs	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If **wcstombs** successfully converts the multibyte string, it returns the number of bytes written into the multibyte output string, excluding the terminating **NULL** (if any). If the *mbstr* argument is **NULL**, **wcstombs** returns the required size of the destination string. If **wcstombs** encounters a wide character it cannot be convert to a multibyte character, it returns –1 cast to type **size_t**.

Parameters

mbstr The address of a sequence of multibyte characters

wcstr The address of a sequence of wide characters

count The maximum number of bytes that can be stored in the multibyte output string

Remarks

The **wcstombs** function converts the wide-character string pointed to by *wcstr* to the corresponding multibyte characters and stores the results in the *mbstr* array. The *count* parameter indicates the maximum number of bytes that can be stored in the multibyte

output string (that is, the size of *mbstr*). In general, it is not known how many bytes will be required when converting a wide-character string. Some wide characters will require only one byte in the output string; others require two. If there are two bytes in the multibyte output string for every wide character in the input string (including the wide character **NULL**), the result is guaranteed to fit.

If **wcstombs** encounters the wide-character null character (L'\0') either before or when *count* occurs, it converts it to an 8-bit 0 and stops. Thus, the multibyte character string at *mbstr* is null-terminated only if **wcstombs** encounters a wide-character null character during conversion. If the sequences pointed to by *wcstr* and *mbstr* overlap, the behavior of **wcstombs** is undefined.

If the *mbstr* argument is **NULL**, **wcstombs** returns the required size of the destination string.

Example

```
/* WCSTOMBS.C illustrates the behavior of the wcstombs function. */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int      i;
   char    *pmbbuf   = (char *)malloc( MB_CUR_MAX );
   wchar_t *pwchello = L"Hello, world.";

   printf( "Convert wide-character string:\n" );
   i = wcstombs( pmbbuf, pwchello, MB_CUR_MAX );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tMultibyte character: %s\n\n", pmbbuf );
}
```

Output

```
Convert wide-character string:
   Characters converted: 1
   Multibyte character: H
```

See Also: mblen, mbstowcs, mbtowc, wctomb

wctomb

Converts a wide character to the corresponding multibyte character.

int wctomb(char ***mbchar*, wchar_t** *wchar* **);**

Routine	Required Header	Compatibility
wctomb	<stdlib.h>	ANSI, Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If **wctomb** converts the wide character to a multibyte character, it returns the number of bytes (which is never greater than **MB_CUR_MAX**) in the wide character. If *wchar* is the wide-character null character (L'\0'), **wctomb** returns 1. If the conversion is not possible in the current locale, **wctomb** returns –1.

Parameters

mbchar The address of a multibyte character

wchar A wide character

Remarks

The **wctomb** function converts its *wchar* argument to the corresponding multibyte character and stores the result at *mbchar*. You can call the function from any point in any program.

Example

```
/* WCTOMB.CPP illustrates the behavior of the wctomb function */

#include <stdio.h>
#include <stdlib.h>

void main( void )
{
   int i;
   wchar_t wc = L'a';
   char *pmbnull = NULL;
   char *pmb = (char *)malloc( sizeof( char ) );

   printf( "Convert a wide character:\n" );
   i = wctomb( pmb, wc );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tMultibyte character: %.1s\n\n", pmb );

   printf( "Attempt to convert when target is NULL:\n" );
   i = wctomb( pmbnull, wc );
   printf( "\tCharacters converted: %u\n", i );
   printf( "\tMultibyte character: %.1s\n", pmbnull );
}
```

Output

```
Convert a wide character:
   Characters converted: 1
   Multibyte character: a

Attempt to convert when target is NULL:
   Characters converted: 0
   Multibyte character: (
```

See Also: mblen, mbstowcs, mbtowc, wcstombs

wctrans

Determines a mapping from one set of wide-character codes to another.

wctrans_t wctrans(const char *_property_);

Routine	Required Header	Compatibility
wctrans	<wctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCP.LIB	Single thread static library, retail version
LIBCPMT.LIB	Multithread static library, retail version
MSVCPRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If the LC_CTYPE category of the current locale does not define a mapping whose name matches the property string *property*, the function returns zero. Otherwise, it returns a nonzero value suitable for use as the second argument to a subsequent call to **towctrans**.

Parameters

property property string

Remarks

This function determines a mapping from one set of wide-character codes to another.

The following pairs of calls have the same behavior in all locales (but an implementation can define additional mappings even in the "C" locale):

tolower(*c* **)** same as **towctrans(** *c*, **wctrans("towlower"))**

towupper(*c* **)** same as **towctrans(** *c*, **wctrans("toupper"))**

See Also: **setlocale**

wctype

Determines a classification rule for wide-character codes.

wctype_t wctype(const char * _property_);

Routine	Required Header	Compatibility
wctype	<wctype.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBCP.LIB	Single thread static library, retail version
LIBCPMT.LIB	Multithread static library, retail version
MSVCPRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If the **LC_CTYPE** category of the current locale does not define a classification rule whose name matches the property string *property*, the function returns zero. Otherwise, it returns a nonzero value suitable for use as the second argument to a subsequent call to **towctrans**.

Parameters

property property string

Remarks

The function determines a classification rule for wide-character codes. The following pairs of calls have the same behavior in all locales (but an implementation can define additional classification rules even in the "C" locale):

iswalnum(*c* **)** same as **iswctype(** *c*, **wctype("alnum"))**

iswalpha(*c* **)** same as **iswctype(** *c*, **wctype("alpha"))**

iswcntrl(*c* **)** same as **iswctype(** *c*, **wctype("cntrl"))**

iswdigit(*c* **)** same as **iswctype(** *c*, **wctype("digit"))**

iswgraph(*c* **)** same as **iswctype(** *c*, **wctype("graph"))**

iswlower(*c* **)** same as **iswctype(** *c*, **wctype("lower"))**

iswprint(*c* **)** same as **iswctype(** *c*, **wctype("print"))**

iswpunct(*c* **)** same as **iswctype(** *c*, **wctype("punct"))**

iswspace(*c* **)** same as **iswctype(** *c*, **wctype("space"))**

iswupper(*c* **)** same as **iswctype(** *c*, **wctype("upper"))**

iswxdigit(*c* **)** same as **iswctype(** *c*, **wctype("xdigit"))**

See Also: setlocale

_write

Writes data to a file.

int _write(int *handle*, **const void ****buffer*, **unsigned int** *count* **);**

Routine	Required Header	Compatibility
_write	<io.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries

LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

If successful, **_write** returns the number of bytes actually written. If the actual space remaining on the disk is less than the size of the buffer the function is trying to write to the disk, **_write** fails and does not flush any of the buffer's contents to the disk. A return value of –1 indicates an error. In this case, **errno** is set to one of two values: **EBADF**, which means the file handle is invalid or the file is not opened for writing, or **ENOSPC**, which means there is not enough space left on the device for the operation.

If the file is opened in text mode, each linefeed character is replaced with a carriage return–linefeed pair in the output. The replacement does not affect the return value.

Parameters

handle Handle of file into which data is written

buffer Data to be written

count Number of bytes

Remarks

The **_write** function writes *count* bytes from *buffer* into the file associated with *handle*. The write operation begins at the current position of the file pointer (if any) associated with the given file. If the file is open for appending, the operation begins at the current end of the file. After the write operation, the file pointer is increased by the number of bytes actually written.

When writing to files opened in text mode, **_write** treats a CTRL+Z character as the logical end-of-file. When writing to a device, **_write** treats a CTRL+Z character in the buffer as an output terminator.

Example

```
/* WRITE.C: This program opens a file for output
 * and uses _write to write some bytes to the file.
 */

#include <io.h>
#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>

char buffer[] = "This is a test of '_write' function";
```

```
void main( void )
{
   int fh;
   unsigned byteswritten;

   if( (fh = _open( "write.o", _O_RDWR | _O_CREAT,
                              _S_IREAD | _S_IWRITE )) != -1 )
   {
      if(( byteswritten = _write( fh, buffer, sizeof( buffer ))) == -1 )
         perror( "Write failed" );
      else
         printf( "Wrote %u bytes to file\n", byteswritten );

      _close( fh );
   }
}
```

Output

```
Wrote 36 bytes to file
```

See Also: **fwrite, _open, _read**

_wtoi, _wtoi64, _wtol

Converts a wide-character string to an integer (**_wtoi** and **_wtoi64**) or to a long integer (**_wtol**).

int _wtoi(const wchar_t *_string_);
__int64 _wtoi64(wchar_t *_string_);
long _wtol(const wchar_t *_string_);

Routine	Required Header	Compatibility
_wtoi	<stdlib.h> or <wchar.h>	Win 95, Win NT
_wtoi64	<stdlib.h> or <wchar.h>	Win 95, Win NT
_wtol	<stdlib.h> or <wchar.h>	Win 95, Win NT

For additional compatibility information, see "Compatibility" in the Introduction.

Libraries	
LIBC.LIB	Single thread static library, retail version
LIBCMT.LIB	Multithread static library, retail version
MSVCRT.LIB	Import library for MSVCRT.DLL, retail version

Return Value

Each function returns the **int**, **__int64**, or **long** value produced by interpreting the input characters as a number. If the input cannot be converted to a value of the appropriate type, **_wtoi** and **_wtoi64** return 0 and **_wtol** returns 0L. The return value is undefined in case of overflow.

Parameter

string String to be converted

Remarks

The **_wtoi** and **_wtoi64** function converts a wide-character string to an integer value. **_wtol** converts a wide-character string to a long integer value. The input string is a sequence of characters that can be interpreted as a numerical value of the specified type. The output value is affected by the setting of the **LC_NUMERIC** category of the current locale. (For more information on the **LC_NUMERIC** category, see **setlocale**.The function stops reading the input string at the first character that it cannot recognize as part of a number. This character may be the null character (L'\0') terminating the string.

The *string* argument for these functions has the form

[*whitespace*] [*sign*]*digits*

A *whitespace* consists of space and/or tab characters, which are ignored. *sign* is either plus (+) or minus (–). *digits* is one or more decimal digits. **_wtoi**, **_wtoi64**, and **_wtol** do not recognize decimal points or exponents.

Example

```
/* ATOF.C: This program shows how numbers stored
 * as strings can be converted to numeric values
 * using the atof, atoi, and atol functions.
 */

#include <stdlib.h>
#include <stdio.h>

void main( void )
{
   char *s; double x; int i; long l;

   s = "  -2309.12E-15";    /* Test of atof */
   x = atof( s );
   printf( "atof test: ASCII string: %s\tfloat:  %e\n", s, x );

   s = "7.8912654773d210";  /* Test of atof */
   x = atof( s );
   printf( "atof test: ASCII string: %s\tfloat:  %e\n", s, x );

   s = "  -9885 pigs";      /* Test of atoi */
   i = atoi( s );
   printf( "atoi test: ASCII string: %s\t\tinteger: %d\n", s, i );

   s = "98854 dollars";     /* Test of atol */
   l = atol( s );
   printf( "atol test: ASCII string: %s\t\tlong: %ld\n", s, l );
}
```

Output

```
atof test: ASCII string:   -2309.12E-15      float:  -2.309120e-012
atof test: ASCII string: 7.8912654773d210    float:  7.891265e+210
atoi test: ASCII string:   -9885 pigs        integer: -9885
atol test: ASCII string: 98854 dollars       long: 98854
```

See Also: atoi, _ecvt, _fcvt, _gcvt

APPENDIX A

Language and Country Strings

Language and Country Strings

The *locale* argument to the **setlocale** function takes the following form:

```
locale  "lang[_country[.code_page]]"
            | ".code_page"
            | ""
            | NULL
```

This appendix lists the language strings and country strings available to **setlocale**. All country and language codes currently supported by the Win32 NLS API are supported by **setlocale**. For information on code pages, see "Code Pages" on page 22 in Chapter 1.

Language Strings

The following language strings are recognized by **setlocale**. Any language not supported by the operating system is not accepted by **setlocale**. The three-letter language-string codes are only valid in Windows NT and Windows 95.

Primary Language	Sublanguage	Language String
Chinese	Chinese	"chinese"
Chinese	Chinese (simplified)	"chinese-simplified" or "chs"
Chinese	Chinese (traditional)	"chinese-traditional" or "cht"
Czech	Czech	"csy" or "czech"
Danish	Danish	"dan"or "danish"
Dutch	Dutch (Belgian)	"belgian," "dutch-belgian," or "nlb"
Dutch	Dutch (default)	"dutch" or "nld"
English	English (Australian)	"australian," "ena," or "english-aus"
English	English (Canadian)	"canadian," "enc," or "english-can"

(continued)

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Primary Language	Sublanguage	Language String
English	English (default)	"english"
English	English (New Zealand)	"english-nz" or "enz"
English	English (UK)	"eng", "english-uk," or "uk"
English	English (USA)	"american," "american english," "american-english," "english-american," "english-us," "english-usa," "enu," "us," or "usa"
Finnish	Finnish	"fin" or "finnish"
French	French (Belgian)	"frb" or "french-belgian"
French	French (Canadian)	"frc" or "french-canadian"
French	French (default)	"fra"or "french"
French	French (Swiss)	"french-swiss" or "frs"
German	German (Austrian)	"dea" or "german-austrian"
German	German (default)	"deu" or "german"
German	German (Swiss)	"des," "german-swiss," or "swiss"
Greek	Greek	"ell" or "greek"
Hungarian	Hungarian	"hun" or "hungarian"
Icelandic	Icelandic	"icelandic" or "isl"
Italian	Italian (default)	"ita" or "italian"
Italian	Italian (Swiss)	"italian-swiss" or "its"
Japanese	Japanese	"japanese" or "jpn"
Korean	Korean	"kor" or "korean"
Norwegian	Norwegian (Bokmal)	"nor" or "norwegian-bokmal"
Norwegian	Norwegian (default)	"norwegian"
Norwegian	Norwegian (Nynorsk)	"non" or "norwegian-nynorsk"
Polish	Polish	"plk" or "polish"
Portuguese	Portuguese (Brazilian)	"portuguese-brazilian" or "ptb"
Portuguese	Portuguese (default)	"portuguese" or "ptg"
Russian	Russian (default)	"rus" or "russian"
Slovak	Slovak	"sky" or "slovak"
Spanish	Spanish (default)	"esp" or "spanish"
Spanish	Spanish (Mexican)	"esm" or "spanish-mexican"
Spanish	Spanish (Modern)	"esn" or "spanish-modern"
Swedish	Swedish	"sve" or "swedish"
Turkish	Turkish	"trk" or "turkish"

Country Strings

The following is a list of country strings recognized by **setlocale**. Strings for countries that are not supported by the operating system are not accepted by **setlocale**. Three-letter country-name codes are from ISO/IEC (International Organization for Standardization, International Electrotechnical Commission) specification 3166.

Country	Country String
Australia	"aus" or "australia"
Austria	"austria" or "aut"
Belgium	"bel" or "belgium"
Brazil	"bra" or "brazil"
Canada	"can" or "canada"
Czech Republic	"cze" or "czech"
Denmark	"denmark" or "dnk"
Finland	"fin" or "finland"
France	"fra" or "france"
Germany	"deu" or "germany"
Greece	"grc" or "greece"
Hong Kong	"hkg," "hong kong," or "hong-kong"
Hungary	"hun" or "hungary"
Iceland	"iceland" or "isl"
Ireland	"ireland" or "irl"
Italy	"ita" or "italy"
Japan	"japan" or "jpn"
Mexico	"mex" or "mexico"
Netherlands	"nld," "holland," or "netherlands"
New Zealand	"new zealand," "new-zealand," "nz," or "nzl"
Norway	"nor" or "norway"
People's Republic of China	"china," "chn," "pr china," or "pr-china"
Poland	"pol" or "poland"
Portugal	"prt" or "portugal"
Russia	"rus" or "russia"
Singapore	"sgp" or "singapore"
Slovak Repubic	"svk" or "slovak"
South Korea	"kor," "korea," "south korea," or "south-korea"

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Country	Country String
Spain	"esp" or "spain"
Sweden	"swe" or "sweden"
Switzerland	"che" or "switzerland"
Taiwan	"taiwan" or "twn"
Turkey	"tur" or "turkey"
United Kingdom	"britain," "england," "gbr," "great britain," "uk," "united kingdom," or "united-kingdom"
United States of America	"america," "united states," "united-states," "us," or "usa"

APPENDIX B

Generic-Text Mappings

To simplify writing code for international markets, generic-text mappings are defined in TCHAR.H for:

- Data types
- Constants and global variables
- Routine mappings

For more information, see "Using Generic-Text Mappings" in Chapter 1. Generic-text mappings are Microsoft extensions that are not ANSI-compatible.

Data Type Mappings

These data-type mappings are defined in TCHAR.H and depend on whether the constant **_UNICODE** or **_MBCS** has been defined in your program.

For related information, see "Using TCHAR.H Data Types with **_MBCS** Code" on page 29 in Chapter 1.

Generic-Text Data Type Mappings

Generic-Text Data Type Name	SBCS (_UNICODE, _MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_TCHAR	**char**	**char**	**wchar_t**
_TINT	**int**	**int**	**wint_t**
_TSCHAR	**signed char**	**signed char**	**wchar_t**
_TUCHAR	**unsigned char**	**unsigned char**	**wchar_t**
_TXCHAR	**char**	**unsigned char**	**wchar_t**
_T or **_TEXT**	No effect (removed by preprocessor)	No effect (removed by preprocessor)	**L** (converts following character or string to its Unicode counterpart)

Constant and Global Variable Mappings

These generic-text constant, global variable, and standard-type mappings are defined in TCHAR.H and depend on whether the constant **_UNICODE** or **_MBCS** has been defined in your program.

Generic-Text Constant and Global Variable Mappings

Generic-Text Object Name	SBCS (_UNICODE, _MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_TEOF	**EOF**	**EOF**	**WEOF**
_tenviron	**_environ**	**_environ**	**_wenviron**
_tfinddata_t	**_finddata_t**	**_finddata_t**	**_wfinddata_t**

Routine Mappings

The generic-text routine mappings are defined in TCHAR.H. **_tccpy** and **_tclen** map to functions in the MBCS model; they are mapped to macros or inline functions in the SBCS and Unicode models for completeness. For information on a generic text routine, see the help topic about the corresponding SBCS-, _MBCS-, or _UNICODE-related routine.

More specific information about individual routines listed in the left column below is not available in this documentation. However, you can easily look up the information on a corresponding SBCS-, _MBCS-, or _UNICODE-related routine. Use the Search command on the Help menu to look up any generic-text routine listed below.

Generic-Text Routine Mappings

Generic-Text Routine Name	SBCS (_UNICODE & MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_fgettc	**fgetc**	**fgetc**	**fgetwc**
_fgettchar	**fgetchar**	**fgetchar**	**_fgetwchar**
_fgetts	**fgets**	**fgets**	**fgetws**
_fputtc	**fputc**	**fputc**	**fputwc**
_fputtchar	**fputchar**	**fputchar**	**_fputwchar**
_fputts	**fputs**	**fputs**	**fputws**
_ftprintf	**fprintf**	**fprintf**	**fwprintf**
_ftscanf	**fscanf**	**fscanf**	**fwscanf**

Generic-Text Routine Mappings *(continued)*

Generic-Text Routine Name	SBCS (_UNICODE & MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_gettc	**getc**	**getc**	**getwc**
_gettchar	**getchar**	**getchar**	**getwchar**
_getts	**gets**	**gets**	**getws**
_istalnum	**isalnum**	**_ismbcalnum**	**iswalnum**
_istalpha	**isalpha**	**_ismbcalpha**	**iswalpha**
_istascii	**__isascii**	**__isascii**	**iswascii**
_istcntrl	**iscntrl**	**iscntrl**	**iswcntrl**
_istdigit	**isdigit**	**_ismbcdigit**	**iswdigit**
_istgraph	**isgraph**	**_ismbcgraph**	**iswgraph**
_istlead	Always returns false	**_ismbblead**	Always returns false
_istleadbyte	Always returns false	**isleadbyte**	Always returns false
_istlegal	Always returns true	**_ismbclegal**	Always returns true
_istlower	**islower**	**_ismbclower**	**iswlower**
_istprint	**isprint**	**_ismbcprint**	**iswprint**
_istpunct	**ispunct**	**_ismbcpunct**	**iswpunct**
_istspace	**isspace**	**_ismbcspace**	**iswspace**
_istupper	**isupper**	**_ismbcupper**	**iswupper**
_istxdigit	**isxdigit**	**isxdigit**	**iswxdigit**
_itot	**_itoa**	**_itoa**	**_itow**
_ltot	**_ltoa**	**_ltoa**	**_ltow**
_puttc	**putc**	**putc**	**putwc**
_puttchar	**putchar**	**putchar**	**putwchar**
_putts	**puts**	**puts**	**putws**
_tmain	**main**	**main**	**wmain**
_sntprintf	**_snprintf**	**_snprintf**	**_snwprintf**
_stprintf	**sprintf**	**sprintf**	**swprintf**
_stscanf	**sscanf**	**sscanf**	**swscanf**
_taccess	**_access**	**_access**	**_waccess**
_tasctime	**asctime**	**asctime**	**_wasctime**
_tccpy	Maps to macro or inline function	**_mbccpy**	Maps to macro or inline function
_tchdir	**_chdir**	**_chdir**	**_wchdir**
_tclen	Maps to macro or inline function	**_mbclen**	Maps to macro or inline function
_tchmod	**_chmod**	**_chmod**	**_wchmod**
_tcreat	**_creat**	**_creat**	**_wcreat**

(continued)

Generic-Text Routine Mappings *(continued)*

Generic-Text Routine Name	SBCS (_UNICODE & MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_tcscat	strcat	_mbscat	wcscat
_tcschr	strchr	_mbschr	wcschr
_tcsclen	strlen	_mbslen	wcslen
_tcscmp	strcmp	_mbscmp	wcscmp
_tcscoll	strcoll	_mbscoll	wcscoll
_tcscpy	strcpy	_mbscpy	wcscpy
_tcscspn	strcspn	_mbscspn	wcscspn
_tcsdec	_strdec	_mbsdec	_wcsdec
_tcsdup	_strdup	_mbsdup	_wcsdup
_tcsftime	strftime	strftime	wcsftime
_tcsicmp	_stricmp	_mbsicmp	_wcsicmp
_tcsicoll	_stricoll	_stricoll	_wcsicoll
_tcsinc	_strinc	_mbsinc	_wcsinc
_tcslen	strlen	strlen	wcslen
_tcslwr	_strlwr	_mbslwr	_wcslwr
_tcsnbcnt	_strncnt	_mbsnbcnt	_wcnscnt
_tcsncat	strncat	_mbsnbcat	wcsncat
_tcsnccat	strncat	_mbsncat	wcsncat
_tcsncmp	strncmp	_mbsnbcmp	wcsncmp
_tcsnccmp	strncmp	_mbsncmp	wcsncmp
_tcsnccnt	_strncnt	_mbsnccnt	_wcsncnt
_tcsnccpy	strncpy	_mbsncpy	wcsncpy
_tcsncicmp	_strnicmp	_mbsnicmp	_wcsnicmp
_tcsncpy	strncpy	_mbsnbcpy	wcsncpy
_tcsncset	_strnset	_mbsnset	_wcsnset
_tcsnextc	_strnextc	_mbsnextc	_wcsnextc
_tcsnicmp	_strnicmp	_mbsnicmp	_wcsnicmp
_tcsnicoll	_strnicoll	_strnicoll	_wcsnicoll
_tcsninc	_strninc	_mbsninc	_wcsninc
_tcsnccnt	_strncnt	_mbsnccnt	_wcsncnt
_tcsnset	_strnset	_mbsnbset	_wcsnset
_tcspbrk	strpbrk	_mbspbrk	wcspbrk
_tcsspnp	_strspnp	_mbsspnp	_wcsspnp
_tcsrchr	strrchr	_mbsrchr	wcsrchr
_tcsrev	_strrev	_mbsrev	_wcsrev
_tcsset	_strset	_mbsset	_wcsset

Generic-Text Routine Mappings *(continued)*

Generic-Text Routine Name	SBCS (_UNICODE & MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_tcsspn	strspn	_mbsspn	wcsspn
_tcsstr	strstr	_mbsstr	wcsstr
_tcstod	strtod	strtod	wcstod
_tcstok	strtok	_mbstok	wcstok
_tcstol	strtol	strtol	wcstol
_tcstoul	strtoul	strtoul	wcstoul
_tcsupr	_strupr	_mbsupr	_wcsupr
_tcsxfrm	strxfrm	strxfrm	wcsxfrm
_tctime	ctime	ctime	_wctime
_texecl	_execl	_execl	_wexecl
_texecle	_execle	_execle	_wexecle
_texeclp	_execlp	_execlp	_wexeclp
_texeclpe	_execlpe	_execlpe	_wexeclpe
_texecv	_execv	_execv	_wexecv
_texecve	_execve	_execve	_wexecve
_texecvp	_execvp	_execvp	_wexecvp
_texecvpe	_execvpe	_execvpe	_wexecvpe
_tfdopen	_fdopen	_fdopen	_wfdopen
_tfindfirst	_findfirst	_findfirst	_wfindfirst
_tfindnext	_findnext	_findnext	_wfindnext
_tfopen	fopen	fopen	_wfopen
_tfreopen	freopen	freopen	_wfreopen
_tfsopen	_fsopen	_fsopen	_wfsopen
_tfullpath	_fullpath	_fullpath	_wfullpath
_tgetcwd	_getcwd	_getcwd	_wgetcwd
_tgetenv	getenv	getenv	_wgetenv
_tmain	main	main	wmain
_tmakepath	_makepath	_makepath	_wmakepath
_tmkdir	_mkdir	_mkdir	_wmkdir
_tmktemp	_mktemp	_mktemp	_wmktemp
_tperror	perror	perror	_wperror
_topen	_open	_open	_wopen
_totlower	tolower	_mbctolower	towlower
_totupper	toupper	_mbctoupper	towupper
_tpopen	_popen	_popen	_wpopen

(continued)

Generic-Text Routine Mappings *(continued)*

Generic-Text Routine Name	SBCS (_UNICODE & MBCS Not Defined)	_MBCS Defined	_UNICODE Defined
_tprintf	printf	printf	wprintf
_tremove	remove	remove	_wremove
_trename	rename	rename	_wrename
_trmdir	_rmdir	_rmdir	_wrmdir
_tsearchenv	_searchenv	_searchenv	_wsearchenv
_tscanf	scanf	scanf	wscanf
_tsetlocale	setlocale	setlocale	_wsetlocale
_tsopen	_sopen	_sopen	_wsopen
_tspawnl	_spawnl	_spawnl	_wspawnl
_tspawnle	_spawnle	_spawnle	_wspawnle
_tspawnlp	_spawnlp	_spawnlp	_wspawnlp
_tspawnlpe	_spawnlpe	_spawnlpe	_wspawnlpe
_tspawnv	_spawnv	_spawnv	_wspawnv
_tspawnve	_spawnve	_spawnve	_wspawnve
_tspawnvp	_spawnvp	_spawnvp	_tspawnvp
_tspawnvpe	_spawnvpe	_spawnvpe	_tspawnvpe
_tsplitpath	_splitpath	_splitpath	_wsplitpath
_tstat	_stat	_stat	_wstat
_tstrdate	_strdate	_strdate	_wstrdate
_tstrtime	_strtime	_strtime	_wstrtime
_tsystem	system	system	_wsystem
_ttempnam	_tempnam	_tempnam	_wtempnam
_ttmpnam	tmpnam	tmpnam	_wtmpnam
_ttoi	atoi	atoi	_wtoi
_ttol	atol	atol	_wtol
_tutime	_utime	_utime	_wutime
_tWinMain	WinMain	WinMain	wWinMain
_ultot	_ultoa	_ultoa	_ultow
_ungettc	ungetc	ungetc	ungetwc
_vftprintf	vfprintf	vfprintf	vfwprintf
_vsntprintf	_vsnprintf	_vsnprintf	_vsnwprintf
_vstprintf	vsprintf	vsprintf	vswprintf
_vtprintf	vprintf	vprintf	vwprintf

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Active Template Library

Microsoft®
Visual C++®
Run-Time Library Reference

Microsoft® Press

Contents

PART 1

Active Template Library Articles

ATL Article Overview

Articles in the Active Template Library (ATL) consist of the following:

"Introduction to COM and ATL" introduces the major concepts behind the Component Object Model (COM). This article also briefly explains what ATL is and when you should use it.

"Creating an ATL Project" contains information on the ATL COM AppWizard and ATL Object Wizard.

"Fundamentals of ATL COM Objects" discusses the relationship among various ATL classes and how those classes get implemented.

"ATL Window Classes" describes how to create, superclass, and subclass windows in ATL.

"Connection Points" explains what connection points are and how ATL implements them.

"Enumerators" describes the implementation and creation of enumerators in ATL.

"The Proxy Generator" explains what the ATL proxy generator does and how to use it.

"Debugging Tips for ATL Objects" tells you how to use ATL's built-in support for debugging **QueryInterface**, **AddRef**, and **Release** calls.

"ATL Services" covers the series of events that occur when a service gets implemented. It also talks about some of the concepts related to developing a service.

"The ATL Registry Component (Registrar)" discusses ATL scripting syntax and replaceable parameters. It also explains how to set up a static link to the Registrar.

See Also: "ATL Class Overview"

Introduction to COM and ATL

This article provides a very brief introduction to COM and ATL. For more information on COM, see "The Component Object Model" in the *Win32 SDK* online. For more information on ATL, see the "ATL Article Overview" and the "ATL Class Overview."

Introduction to COM

COM is the fundamental "object model" on which ActiveX and OLE are built. COM allows an object to expose its functionality to other components and to host applications. It defines both how the object exposes itself and how this exposure works across processes and across networks. COM also defines the object's life cycle.

Fundamental to COM are these concepts:

- Interfaces—the mechanism through which an object exposes its functionality.
- **IUnknown**—the basic interface on which all others are based. It implements the reference counting and interface querying mechanisms running through COM.
- Reference counting—the technique by which an object (or, strictly, an interface) decides when it is no longer being used and is therefore free to remove itself.
- **QueryInterface**—the method used to query an object for a given interface.
- Marshaling—the mechanism that enables objects to be used across thread, process, and network boundaries, allowing for location independence.
- Aggregation—a way in which one object can make use of another.

See Also: "The Component Object Model" in the *Win32 SDK* online

Interfaces

An interface is the way in which an object exposes its functionality to the outside world. In COM, an interface is a table of pointers (like a C++ vtable) to functions implemented by the object. The table represents the interface, and the functions to which it points are the methods of that interface. An object can expose as many interfaces as it chooses.

Each interface is based on the fundamental COM interface, **IUnknown**. The methods of **IUnknown** allow navigation to other interfaces exposed by the object.

Also, each interface is given a unique interface ID (IID). This uniqueness makes it is easy to support interface versioning. A new version of an interface is simply a new interface, with a new IID.

Note IIDs for the standard COM, OLE, and ActiveX interfaces are pre-defined.

See Also: "COM Objects and Interfaces" in the *Win32 SDK* online

IUnknown

IUnknown is the base interface of every other COM interface. **IUnknown** defines three methods: **QueryInterface**, **AddRef**, and **Release**. **QueryInterface** allows an interface user to ask the object for a pointer to another of its interfaces. **AddRef** and **Release** implement reference counting on the interface.

See Also: "IUnknown and Interface Definition Inheritance" in the *Win32 SDK* online

Reference Counting

COM itself does not automatically try to remove an object from memory when it thinks the object is no longer being used. Instead, the object programmer must remove the unused object. The programmer determines whether an object can be removed based on a reference count.

COM uses the **IUnknown** methods, **AddRef** and **Release**, to manage the reference count of interfaces on an object. The general rules for calling these methods are:

- Whenever a client receives an interface pointer, **AddRef** must be called on the interface.
- Whenever the client has finished using the interface pointer, it must call **Release**.

In a simple implementation, each **AddRef** call increments and each **Release** call decrements a counter variable inside the object. When the count returns to zero, the interface no longer has any users and is free to remove itself from memory.

Reference counting can also be implemented so that each reference to the object (not to an individual interface) is counted. In this case, each **AddRef** and **Release** call delegates to a central implementation on the object, and **Release** frees the entire object when its reference count reaches zero.

See Also: "Managing Object Lifetimes through Reference Counting" in the *Win32 SDK* online

QueryInterface

Although there are mechanisms by which an object can express the functionality it provides statically (before it is instantiated), the fundamental COM mechanism is to use the **IUnknown** method called **QueryInterface**.

Every interface is derived from **IUnknown**, so every interface has an implementation of **QueryInterface**. Regardless of implementation, this method queries an object using the IID of the interface to which the caller wants a pointer. If the object supports that interface, **QueryInterface** retrieves a pointer to the interface, while also calling **AddRef**. Otherwise, it returns the **E_NOINTERFACE** error code.

See Also: "QueryInterface: Navigating in an Object" in the *Win32 SDK* online

Marshaling

The COM technique of marshaling allows interfaces exposed by an object in one process to be used in another process. In marshaling, COM provides code (or uses code provided by the interface implementor) both to pack a method's parameters into a format that can be moved across processes (as well as, across the wire to processes running on other machines) and to unpack those parameters at the other end. Likewise, COM must perform these same steps on the return from the call.

Note Marshaling is typically not necessary when an interface provided by an object is being used in the same process as the object. However, marshaling may be needed between threads.

See Also: "Marshaling Details" in the *Win32 SDK* online

Aggregation

There are times when an object's implementor would like to take advantage of the services offered by another, pre-built object. Furthermore, it would like this second object to appear as a natural part of the first. COM achieves both of these goals through containment and aggregation.

Aggregation means that the containing (outer) object creates the contained (inner) object as part of its creation process and the interfaces of the inner object are exposed by the outer. An object allows itself to be aggregatable or not. If it is, then it must follow certain rules for aggregation to work properly.

Primarily, all **IUnknown** method calls on the contained object must delegate to the containing object.

See Also: "Reusing Objects" in the *Win32 SDK* online

Introduction to ATL

ATL is the Active Template Library, a set of template-based C++ classes with which you can easily create small, fast Component Object Model (COM) objects. It has special support for key COM features including: stock implementations of **IUnknown**, **IClassFactory**, **IClassFactory2** and **IDispatch**; dual interfaces; standard COM enumerator interfaces; connection points; tear-off interfaces; and ActiveX controls.

ATL code can be used to create single-threaded objects, apartment-model objects, free-threaded model objects, or both free-threaded and apartment-model objects.

Topics covered in this section include:

- How a template library differs from a standard C++ library.
- What you can and cannot do with ATL.
- When to use ATL versus MFC.

Using a Template Library

A template is somewhat like a macro. As with a macro, invoking a template causes it to expand (with appropriate parameter substitution) to code you have written. However, a template goes further than this to allow the creation of new classes based on types that you pass as parameters. These new classes implement type-safe ways of performing the operation expressed in your template code.

Template libraries such as ATL differ from traditional C++ class libraries in that they are typically supplied only as source code (or as source code with a little, supporting run time) and are not inherently or necessarily hierarchical in nature. Rather than deriving from a class to get the functionality you desire, you instantiate a class from a template.

The Scope of ATL

ATL allows you to easily create COM objects, Automation server, and ActiveX controls. ATL provides built-in support for many of the fundamental COM interfaces.

ATL is shipped as source code which you include in your application. ATL also makes a DLL available (atl.dll), which contains code that may be shared across components. However, this DLL is not necessary.

See Also: "Creating an ATL Project"

Choosing When to Use ATL

When developing components and applications, you can choose between two approaches—ATL and MFC (the Microsoft Foundation Class Library).

Using ATL

ATL is a fast, easy way to both create a COM component in C++ and maintain a small footprint. Use ATL to create a control if you don't need all of the built-in functionality that MFC automatically provides.

Using MFC

MFC allows you to create full applications, ActiveX controls, and active documents. If you have already created a control with MFC, you may want to continue development in MFC. When creating a new control, consider using ATL if you don't need all of MFC's built-in functionality.

Creating an ATL Project

The easiest way to create an ATL project is to use the ATL COM AppWizard. You can then add objects or controls to your project using the ATL Object Wizard. Go through the "ATL Tutorial" to insert a control and add custom properties and events.

This article:

- Describes how to use the ATL COM AppWizard.
- Lists the files generated by the ATL COM AppWizard.
- Describes how to add an object or a control with the ATL Object Wizard.
- Describes how to add a new interface to an existing object or control.

Using the ATL COM AppWizard

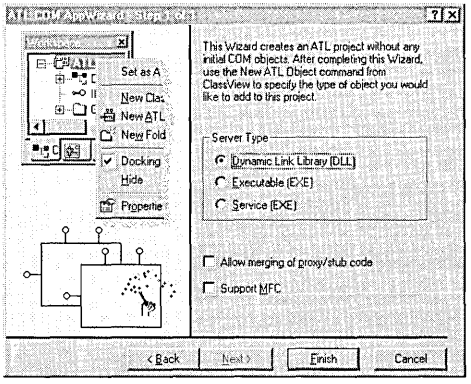
▶ **To create a project using the ATL COM AppWizard**

1 Open Developer Studio. Click **New** on the **File** menu and click the **Projects** tab.

2 Choose **ATL COM AppWizard** as your application type.

3 Enter a project name.

4 Click **OK**.



The ATL COM AppWizard displays a dialog box showing options that apply to your ATL project:

- Choose from one of three server types: **Dynamic Link Library (DLL)** for an in-process server, **Executable (EXE)** for a local out-of-process server, or **Service (EXE)**, a server is also a Windows NT service that runs in the background when NT starts up.

- Select **Allow merging of proxy/stub code** as a convenience when marshaling interfaces is required. This option places the MIDL generated proxy and stub code in the same DLL as the server.
- Click the **Support MFC** check box to use MFC functionality (such as **CString**) in your server.

Click **Finish** to generate the project. The AppWizard then displays information about the project that it is creating and then displays the newly created project in the Project Workspace.

Note When you build your project, you can choose a **MinSize** or **MinDependency** configuration. **MinSize** will generate a smaller component, since shared code will be used from atl.dll. In this case, you must distribute atl.dll with your component. **MinDependency** will generate a larger component, since all necessary code will be linked in with your component.

Note When building a Release version of a project, you can get the following link error:

```
LIBCMT.LIB(crt0.obj) : error LNK2001: unresolved external symbol _main
```

This error occurs if you are using CRT functions that require CRT startup code. The Release configurations define **_ATL_MIN_CRT**, which excludes CRT startup code from your EXE or DLL. To avoid this error, do one of the following:

- Remove **_ATL_MIN_CRT** from the list of preprocessor defines to allow CRT startup code to be included. On the **Project** menu, click **Settings**. In the **Settings For:** drop down list, choose **Multiple Configurations**. In the **Select project configuration(s) to modify** dialog box that appears, click the check boxes for all Release versions, and then click **OK**. On the **C/C++** tab, choose the **General** category, then remove **_ATL_MIN_CRT** from the **Preprocessor definitions** edit box.
- If possible, remove calls to CRT functions that require CRT startup code and use their Win32 equivalents. For example, use **lstrcmp** instead of **strcmp**. Known functions that require CRT startup code are some of the string and floating point functions.

Files Generated by the ATL COM AppWizard

Choose the **FileView** tab in the **Project Workspace** and expand by clicking + to see the files generated for your project:

File	Description
Test.cpp	Contains the implementation of your DLL's exports for an in-process server and the implementation of **WinMain** for a local server. For a service, this additionally implements all the service management functions.

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File	Description
Test.def	Typically, contains a list of your DLL's exports. Generated only for an in-process server.
Test.idl	Includes the definitions for all your interfaces. As an Interface Definition Language (.idl) file, it will be processed by the MIDL compiler to generate the Test.tlb type library and marshaling code.
Test.rc	Contains the resource information for your project.
Resource.h	The header file for the resource file.
StdAfx.cpp	Includes the files StdAfx.h and Atlimpl.cpp.
StdAfx.h	Includes the ATL header files.

Adding Objects and Controls

After generating a project with the ATL COM AppWizard, you can add an object or a control using the ATL Object Wizard. For each COM object or control you add, the wizard will generate .cpp and .h files, as well as an .rgs file for script-based registry support.

▶ **To add an object or a control using the ATL Object Wizard**

- With your ATL project open, select **New ATL Object** from the **Insert** menu. The ATL Object Wizard opens.

  - or -

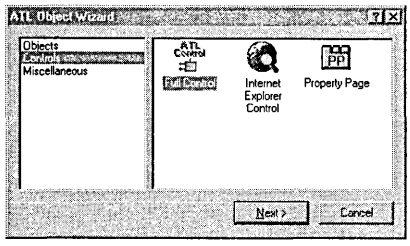
1. With your ATL project open, select the **Class View** tab in the project workspace.
2. Click the right mouse button on the top-most classes folder. A menu appears.
3. From the menu, choose **New ATL Object**. The ATL Object Wizard opens.

  - or -

- With your ATL project open and the WizardBar visible, click on the WizardBar Actions drop-down list and select **New ATL Object**.

  - or -

- With your ATL project open and the ATL ToolBar visible, select the **New ATL Object** button.



The ATL Object Wizard displays the categories of objects on the left and the icons of the objects in each category on the right. Choose a category, and the icons of the objects that category contains are displayed.

ATL Objects

- **Simple Object** adds a minimal COM object.
- **Internet Explorer Object** adds an object that supports the interfaces needed by Internet Explorer, but without support for a user interface.
- **Add-in Object** adds a COM object that extends the Developer Studio shell with your own toolbar button and event handling. This object offers the same functionality as the one added by the **DevStudio Add-in Wizard** on the Developer Studio **File\New Projects** tab.
- **ActiveX Server Component** adds an object that can be used by the Active Server Pages feature of Internet Information Server (IIS).
- **Microsoft Transaction Server Component** includes the header files needed by the Transaction Server and defines the object as nonaggregatable.
- **Component Registrar Object** adds an object that implements the **IComponentRegistrar** interface. This object can be used to register any objects in your in-process server that declare the **DECLARE_OBJECT_DESCRIPTION** macro. Using this object you can and register and/or unregister objects individually, unlike **DllRegisterServer** and **DllUnregisterServer** which register and unregister all objects in your server. It is also possible to get a list of objects in the server and their descriptions with the **IComponentRegistrar::GetComponents** method.

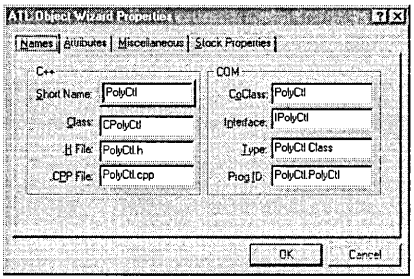
ATL Controls

- **Full Control** adds an object that supports the interfaces for all containers.
- **Internet Explorer Control** adds an object that supports the interfaces needed by Internet Explorer, including support for a user interface.
- **Property Page** adds an object that implements a property page.

ATL Miscellaneous

- **Dialog** adds an object that implements a dialog box.

Double-click the control or object you want to insert. The ATL Object Wizard displays a dialog box showing options that apply to your object or control.



Note Depending on the type of object or control you select, some of the pages and options described below may not be available.

In the **Names** page, enter class and file names. By default, the name you enter for **Short name** becomes the root for all other names in this page. You can enter your own names rather than accept these defaults.

- **Class** is the name of the class implementing your object.
- **CoClass** is the name of the component class that contains a list of interfaces supported by the object.
- **Interface** is the name of the interface you create for your object. This interface contains your custom methods. For Full Controls, Internet Explorer Controls, Simple Objects, Internet Explorer Objects, Add-in Objects, ActiveX Server Components, and Microsoft Transaction Server Components, the wizard creates an interface with the name you specify. For Property Page objects, no custom interface is created, and the wizard assigns **IUnknown** as the object interface. Dialog objects do not create an interface.
- **Type** is a description string for the object that goes into the registry.
- **ProgID** is a name that containers can use instead of the CLSID of the object.

In the **Attributes** page, select a threading model, interface type, and aggregation support:

- Choose **Dual Interfaces** if you want the object's interfaces to derive from **IDispatch** as well as support your custom functions (the vtable has custom interface functions plus late-binding **IDispatch** methods). This allows both COM clients and Automation controllers to access your object.
- Choose **Custom Interfaces** to derive the object's interfaces from **IUnknown** (the vtable has custom interface functions and not **IDispatch** methods). A custom interface can be faster than a dual interface, especially across process boundaries.
- Choose **Only** for aggregation if you want the object to be instantiated only if it is being aggregated.
- Check the **Support ISupportErrorInfo** checkbox to have your object implement the **ISupportErrorInfo** interface for error reporting.

- Check the **Support Connection Points** checkbox to add support for connection points to the object. The wizard will automatically derive the object's class from **IConnectionPointContainerImpl**.
- Check the **Free Threaded Marshaler** checkbox to create a free-threaded marshaler object to efficiently marshal interface pointers between threads in the same process.

In the **Miscellaneous** page, choose the features for the object.

- Choose **Opaque** to make your control completely opaque, so that none of the container shows behind the control boundaries. This helps the container draw the control more quickly. The entire control rectangle passed to your control class's **OnDraw** method. This option sets the **VIEWSTATUS_OPAQUE** bit in the **VIEWSTATUS** enumeration.
- Choose **Solid Background** to make the control's background a solid color and not a pattern. This option is meaningful only if the **Opaque** is option is also selected. This option sets the **VIEWSTATUS_SOLIDBKGND** bit in the **VIEWSTATUS** enumeration.
- Choose **Invisible at runtime** to make your control invisible at run time. You can use invisible controls to perform operations in the background, such as firing events at timed intervals.
- Choose **Acts like button** to enable your control to act like a button, in particular to display itself as the default button based on the ambient property **DisplayAsDefault**.
- Choose **Acts like label** to enable your control to replace the container's native label.
- Choose **Add control based on** to superclass one of the standard window classes. The drop-down list contains window class names defined by Windows. When you choose one of these, the wizard adds a **CContainedWindow** member variable to your control's class. **CContainedWindow::Create** will superclass the window class you specify.
- Choose **Normalize DC** to have your control create a normalized device context when it is called to draw itself. This standardizes the control's appearance, but is less efficient.
- Choose **Insertable** to have your control appear in the **Insert Object** dialog box of applications such as Microsoft Word and Microsoft Excel. Your control can then be inserted by any application that supports embedded objects through the **Insert Object** dialog box.
- Choose **Windowed Only** to force your control to be windowed, even in containers that support windowless objects. If you do not select this option, your control will automatically be windowless in containers that support windowless objects, and automatically be windowed in containers that do not support windowless objects.

In the **Stock Properties** page, select the stock properties you want the object to support, such as **Caption** or **Border Color**. You can select all the stock properties at once by clicking the >> button.

In the **Strings** page, enter names for the property page object.

- **Title** is the text that appears on the property page's tab.
- **Doc String** is a text string describing the page. The property frame could use the description in a status line or tool tip. The standard property frame currently does not use this string.
- **Helpfile** is the name of the associated help file. The help file name should be the simple name without a path. When the user presses Help, the frame opens the help file in the directory named in the value of the HelpDir key in the property page registry entries under its CLSID.

In the **Add-in** page, choose features for the Add-in object.

- **Provide Toolbar** creates a toolbar button the user can click to carry out a command added by your Add-in object.
- **Command Name** is the name of the command added by to Developer Studio by your Add-in object. This name appears in the list on the **Add-ins and Macro Files** tab of **Tools/Customize** menu option.
- **Method Name** is the name of the method that implements the command.
- **Toolbar Text** is the text you want to appear on the button you add to the toolbar to carry out your command.
- **Status bar Text** is the text you want to appear on the status line when your command is executing.
- **Tooltips Text** is the text you want to appear in the tooltip message for your toolbar button when the user's mouse hovers over the button.
- **Application Events** allows your Add-in object to catch application events.
- **Debugger Events** allows your Add-in object to catch debugger events.

In the **ASP** page, choose features for the ActiveX Server component.

- **OnStartPage/OnEndPage**, checked by default, adds the **OnStartPage** and **OnEndPage** methods to the object.
- If **OnStartPage/OnEndPage** is checked, you can choose which **Intrinsic Objects** you want to have available as member pointers in the object's class. By default, each intrinsic object is checked.

In the **MTX** page, choose features for the MS Transaction Server component. **Dual** and **Custom** choose the kind of interface implemented, and **Support Connection Points** adds support for connection points. These options are the same as the ones in

the **Attributes** page for other kinds of objects. In addition, the **MTX** page has two unique options:

- **Support IObjectControl** provides access to the three **IObjectControl** methods: **Activate, CanBePooled,** and **Deactivate**.
- **Can be pooled** tells the Transaction Server run-time environment that your object should be returned to an instance pool after deactivation, rather than destroyed. This option cannot be selected unless the **Support IObjectControl** option is also selected.

Adding a New Interface to an Existing Object or Control

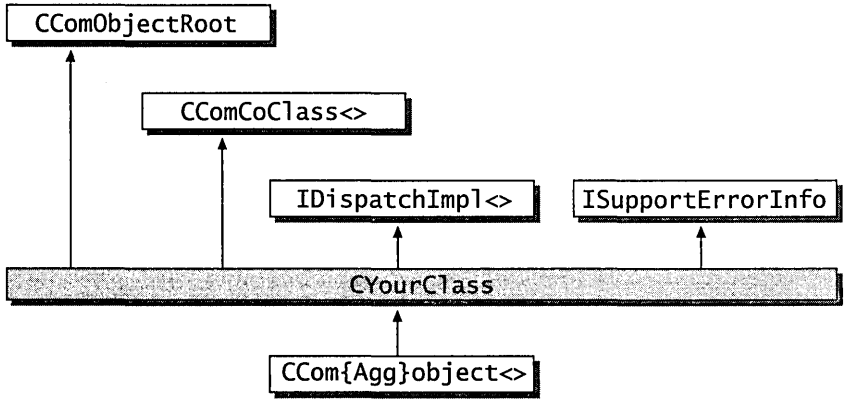
▶ **To add a new interface to an existing object**

1. Add the definition of your new interface to the .idl file.
2. Derive your object or control from the interface.
3. Create a new **COM_INTERFACE_ENTRY** for the interface.
4. Implement methods on the interface.

Fundamentals of ATL COM Objects

The following illustration depicts the relationship among the various classes and interfaces used in defining an ATL COM object.

ATL Structure



ATL implements **IUnknown** in two phases:

- **CComObject**, **CComAggObject**, or **CComPolyObject** implements the **IUnknown** methods.
- **CComObjectRoot** or **CComObjectRootEx** manages the reference count and outer pointers of **IUnknown**.

Other aspects of your ATL COM object are handled by other classes:

- **CComCoClass** defines the object's default class factory and aggregation model.
- **IDispatchImpl** provides a default implementation of the **IDispatch** portion of any dual interfaces on the object.

For more information, see the following sections in this article:

- Implementing **CComObjectRootEx**
- Implementing **CComObject**, **CComAggObject**, and **CComPolyObject**
- Supporting **IDispatch** and **IErrorInfo**
- Changing the Default Class Factory and Aggregation Model
- Creating an Aggregate

For information about creating an ATL COM object, see the article "Creating an ATL Project."

Implementing CComObjectRootEx

CComObjectRootEx is essential—all ATL objects must have one instance of **CComObjectRootEx** or **CComObjectRoot** in their inheritance. **CComObjectRootEx** provides the default **QueryInterface** mechanism based on COM map entries.

Through its COM map, an object's interfaces are exposed to a client when the client queries for an interface. The query is performed through **CComObjectRootEx::InternalQueryInterface**. **InternalQueryInterface** only handles interfaces in the COM map table.

You can enter interfaces into the COM map table with the **COM_INTERFACE_ENTRY** macro or one of its variants. For example, the following code from the BEEPER sample enters the interfaces **IDispatch**, **IBeeper**, and **ISupportErrorInfo** into the COM map table:

```
BEGIN_COM_MAP(CBeeper)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY(IBeeper)
   COM_INTERFACE_ENTRY_TEAR_OFF(IID_ISupportErrorInfo, CBeeper2)
END_COM_MAP( )
```

Implementing CComObject, CComAggObject, and CComPolyObject

The template classes, **CComObject**, **CComAggObject**, and **CComPolyObject** are always the most derived classes in the inheritance chain. It is their responsibility to handle all the methods in **IUnknown**: **QueryInterface**, **AddRef**, and **Release**. In addition, **CComAggObject** and **CComPolyObject** (when used for aggregated objects) provide the special reference counting and **QueryInterface** semantics required for the inner unknown.

Whether **CComObject**, **CComAggObject**, or **CComPolyObject** is used depends on whether you declare the **DECLARE_POLY_AGGREGATABLE** macro and on whether your object is being aggregated:

- If your class definition specifies the **DECLARE_POLY_AGGREGATABLE** macro, ATL creates an instance of **CComPolyObject<CYourClass>** when **IClassFactory::CreateInstance** is called. During creation, the value of the outer unknown is checked. If it is **NULL**, **IUnknown** is implemented for a non-aggregated object. If the outer unknown is not **NULL**, **IUnknown** is implemented for an aggregated object.
- If you do not specify the **DECLARE_POLY_AGGREGATABLE** macro in your class definition and the object is not aggregated, ATL creates an instance of **CComObject<CYourClass>** when **IClassFactory::CreateInstance** is called.
- If you do not specify the **DECLARE_POLY_AGGREGATABLE** macro in your class definition and the object is aggregated, ATL creates a **CComAggObject<CYourClass>** when **IClassFactory::CreateInstance** is called.

The advantage of using **CComAggObject** and **CComObject** is that the implementation of **IUnknown** is optimized for the kind of object being created. For instance, a nonaggregated object only needs a reference count, while an aggregated object needs both a reference count for the inner unknown and a pointer to the outer unknown.

The advantage of using **CComPolyObject** is that you avoid having both **CComAggObject** and **CComObject** in your module to handle the aggregated and nonaggregated cases. A single **CComPolyObject** object handles both cases. This means only one copy of the vtable and one copy of the functions exist in your module. If your vtable is large, this can substantially decrease your module size. However, if your vtable is small, using **CComPolyObject** can result in a slightly larger module size because it is not optimized for an aggregated or nonaggregated object, as are **CComAggObject** and **CComObject**.

The **DECLARE_POLY_AGGREGATABLE** macro is automatically added to your class definition by the ATL Object Wizard when you create a full control or Internet Explorer control. For more information about the wizard, see the article "Creating an ATL Project."

Supporting IDispatch and IErrorInfo

The template class **IDispatchImpl** can be used to provide a default implementation of the **IDispatch** portion of any dual interfaces on your object.

If your object uses the **IErrorInfo** interface to report errors back to the client, then your object must support the **ISupportErrorInfo** interface. The template class **ISupportErrorInfoImpl** provides an easy way to implement this if you only have a single interface that generates errors on your object.

Changing the Default Class Factory and Aggregation Model

ATL uses **CComCoClass** to define the default class factory and aggregation model for your object. **CComCoClass** specifies the following two macros:

- **DECLARE_CLASSFACTORY** Declares the class factory to be **CComClassFactory**.
- **DECLARE_AGGREGATABLE** Declares that your object can be aggregated.

You can override either of these defaults by specifying another macro in your class defintion. For example, to use **CComClassFactory2** instead of **CComClassFactory**, specify the **DECLARE_CLASSFACTORY2** macro:

```
class CMyClass : ...,
   public CComCoClass<CMyClass, &CLSID_CMyClass>
{
public:
   DECLARE_CLASSFACTORY2(CMyLicense)

   ...
};
```

Two other macros that define a class factory include **DECLARE_CLASSFACTORY_AUTO_THREAD** and **DECLARE_CLASSFACTORY_SINGLETON**.

ATL also uses the **typedef** mechanism to implement default behavior. For example, the **DECLARE_AGGREGATABLE** macro uses **typedef** to define a type called **_CreatorClass**, which is then reference throughout ATL. Note that in a derived class,

a **typedef** using the same name as the base class's **typedef** results in ATL using your definition and overriding the default behavior.

Creating an Aggregate

▶ **To create an aggregate**

1. Add an **IUnknown** pointer to your class object and initialize it to **NULL** in the constructor.
2. Override **FinalConstruct** to create the aggregate.
3. Use the **IUnknown** pointer you defined as the parameter to the **COM_INTERFACE_ENTRY_AGGREGATE** macros.
4. Override **FinalRelease** to release the **IUnknown** pointer.

Note If you use and release an interface from the aggregate during **FinalConstruct**, you should add the **DECLARE_PROTECT_FINAL_CONSTRUCT** macro to the definition of your class object.

ATL Window Classes

ATL contains several classes that allow you to use and implement windows. These classes, like other ATL classes, provide an efficient implementation that does not impose an overhead on your code.

- **CWindow** allows you to attach a window handle to the **CWindow** object. You then call **CWindow** methods to manipulate the window.
- **CWindowImpl** allows you to implement a new window and process messages with a message map. You can create a window based on a new Windows class, superclass an existing class, or subclass an existing window.
- **CDialogImpl** allows you to implement a modal or a modeless dialog box and process messages with a message map.
- **CContainedWindow** is a pre-built class that implements a window whose message map is contained in another class. Using **CContainedWindow** allows you to centralize message processing in one class.

This article explains how to use the ATL window classes. Topics covered include:

- Using a window
- Implementing a window
- Implementing a dialog box
- Using contained windows

Using a Window

Class **CWindow** allows you to use a window. Once you attach a window to a **CWindow** object, you can then call **CWindow** methods to manipulate the window. **CWindow** also contains an **HWND** operator to convert a **CWindow** object to an **HWND**. Thus you can pass a **CWindow** object to any function that requires a handle to a window. You can easily mix **CWindow** method calls and Win32 function calls, without creating any temporary objects.

Because **CWindow** has only one data member (a window handle), it does not impose an overhead on your code. In addition, many of the **CWindow** methods simply wrap corresponding Win32 API functions. By using **CWindow**, the **HWND** member is automatically passed to the Win32 function.

In addition to using **CWindow** directly, you can also derive from it to add data or code to your class. ATL itself derives three classes from **CWindow**: **CWindowImpl**, **CDialogImpl**, and **CContainedWindow**.

Implementing a Window

Class **CWindowImpl** allows you to implement a window and handle its messages. Message handing in ATL is based on a message map. This section explains:

- What message maps are and how to use them.
- How to implement a window with **CWindowImpl**.

Message Maps

A message map associates a handler function with a particular message, command, or notification. By using ATL's message map macros, you can specify a message map for a window. The window procedures in **CWindowImpl**, **CDialogImpl**, and **CContainedWindow** direct a window's messages to its message map.

The message handler functions accept an additional argument of type `BOOL&`. This argument indicates whether a message has been processed, and it is set to `TRUE` by default. A handler function can then set the argument to `FALSE` to indicate that it has not handled a message. In this case, ATL will continue to look for a handler function further in the message map. By setting this argument to `FALSE`, you can first perform some action in response to a message and then allow the default processing or another handler function to finish handling the message.

ATL also allows you to chain message maps, which directs the message handling to a message map defined in another class. For example, you can implement common message handling in a separate class to provide uniform behavior for all windows chaining to that class. You can chain to a base class or to a data member of your class.

ATL also supports dynamic chaining, which allows you to chain to another object's message map at run time. To implement dynamic chaining, you must derive your class from **CDynamicChain**. Then declare the **CHAIN_MSG_MAP_DYNAMIC** macro in your message map. **CHAIN_MSG_MAP_DYNAMIC** requires a unique number that identifies the object and the message map to which you are chaining. You must define this unique value through a call to **CDynamicChain::SetChainEntry**.

You can chain to any class that declares a message map, provided the class derives from **CMessageMap**. **CMessageMap** allows an object to expose its message maps to other objects. Note that **CWindowImpl** already derives from **CMessageMap**.

Finally, ATL supports alternate message maps, declared with the **ALT_MSG_MAP** macro. Each alternate message map is identified by a unique number, which you pass to **ALT_MSG_MAP**. Using alternate message maps, you can handle the messages of multiple windows in one map. Note that by default, **CWindowImpl** does not use alternate message maps. To add this support, override the **WindowProc** method in your **CWindowImpl**-derived class and call **ProcessWindowMessage** with the message map identifier.

Implementing a Window with CWindowImpl

To implement a window, derive a class from **CWindowImpl**. In your derived class, declare a message map and the message handler functions. You can now use your class in three different ways:

- Creating a window based on a new Windows class
- Superclassing an existing Windows class
- Subclassing an existing window

Creating a window based on a new Windows class

CWindowImpl contains the **DECLARE_WND_CLASS** macro to declare Windows class information. This macro implements the **GetWndClassInfo** function, which uses **CWndClassInfo** to define the information of a new Windows class. When **CWindowImpl::Create** is called, this Windows class is registered and a new window is created.

Note **CWindowImpl** passes **NULL** to the **DECLARE_WND_CLASS** macro, which means ATL will generate a Windows class name. To specify your own name, pass a string to **DECLARE_WND_CLASS** in your **CWindowImpl**-derived class.

Following is an example of a class that implements a window based on a new Windows class:

```
class CMyWindow : public CWindowImpl<CMyWindow>, ...
{
public:
   // Optionally specify name of the new Windows class
   DECLARE_WND_CLASS("MyName")
```

```
                // If this macro is not specified in your
                // class, ATL will generate a class name
    ...

    BEGIN_MSG_MAP(CMyWindow)
       MESSAGE_HANDLER(WM_PAINT, OnPaint)
    END_MSG_MAP()

    LRESULT OnPaint(UINT nMsg, WPARAM wParam,
                    LPARAM lParam, BOOL& bHandled)
    {
       // Do some painting code
       return 0;
    }
};
```

To create a window, create an instance of `CMyWindow` and then call the **Create** method.

Note To override the default Windows class information, implement the **GetWndClassInfo** method in your derived class by setting the **CWndClassInfo** members to the appropriate values.

Superclassing an existing Windows class

The **DECLARE_WND_SUPERCLASS** macro allows you to create a window that superclasses an existing Windows class. Specify this macro in your **CWindowImpl**-derived class. Like any other ATL window, messages are handled by a message map.

When you use **DECLARE_WND_SUPERCLASS**, a new Windows class will be registered. This new class will be the same as the existing class you specify, but will replace the window procedure with **CWindowImpl::WindowProc** (or with your function that overrides this method).

Following is an example of a class that superclasses the standard Edit class:

```
class CMyEdit : public CWindowImpl<CMyEdit>, ...
{
public:
   // "Edit" is the name of the standard Windows class.
   // "MyEdit" is the name of the new Windows class
   // that will be based on the Edit class.
   DECLARE_WND_SUPERCLASS("Edit", "MyEdit")

   ...
   BEGIN_MSG_MAP(CMyEdit)
      MESSAGE_HANDLER(WM_CHAR, OnChar)
   END_MSG_MAP()

   LRESULT OnChar(UINT nMsg, WPARAM wParam,
                  LPARAM lParam, BOOL& bHandled)
```

```
    {
        // Do some character handling code
    }
};
```

To create the superclassed Edit window, create an instance of `CMyEdit` and then call the **Create** method.

For more information about superclassing, see "Window Procedure Superclassing" in the *Win32 SDK* online.

Subclassing an existing window

To subclass an existing window, derive a class from **CWindowImpl** and declare a message map, as in the two previous cases. Note, however, that you do not specify any Windows class information, since you will subclass an already existing window.

Instead of calling **Create**, call **SubclassWindow** and pass it the handle to the existing window you want to subclass. Once the window is subclassed, it will use **CWindowImpl::WindowProc** (or your function that overrides this method) to direct messages to the message map. To detach a subclassed window from your object, call **UnsubclassWindow**. The window's original window procedure will then be restored.

For more information about subclassing, see "Window Procedure Subclassing" in the *Win32 SDK* online.

Implementing a Dialog Box

Implementing a dialog box is similar to implementing a window. You derive a class from **CDialogImpl** and declare a message map to handle messages. However, you must also specify a dialog template resource ID in your derived class. Your class must have a data member called `IDD` to hold this value.

Note When you create a dialog box using the ATL Object Wizard, the wizard automatically adds the `IDD` member as an **enum** type.

CDialogImpl allows you to implement a modal or a modeless dialog box. To create a modal dialog box, create an instance of your **CDialogImpl**-derived class and then call the **DoModal** method. To close a modal dialog box, call the **EndDialog** method from a message handler. To create a modeless dialog box, call the **Create** method instead of **DoModal**. To destroy a modeless dialog box, call **CWindow::DestroyWindow** instead of **EndDialog**.

Implement the dialog box's message handlers as you would the handlers in a **CWindowImpl**-derived class. If there is a message-specific return value, return it as an `LRESULT`. ATL maps the returned `LRESULT` values for proper handling by the Windows dialog manager. For details, see the source code for `CDialogImplBase::DialogProc` in atlwin.cpp.

Following is an example of a class that implements a dialog box:

```
class CMyDialog : public CDialogImpl<CMyDialog>, ...
{
public:
   enum { IDD = IDD_MYDIALOG };

   BEGIN_MSG_MAP(CMyDialog)
      MESSAGE_HANDLER(WM_INITDIALOG, OnInitDialog)
   END_MSG_MAP()

   LRESULT OnInitDialog(UINT uMsg, WPARAM wParam,
                        LPARAM lParam, BOOL& bHandled)
   {
      // Do some initialization code
      return 1;
   }
};
```

Using Contained Windows

ATL implements contained windows with **CContainedWindow**. A contained window represents a window that delegates its messages to a container object instead of handling them in its own class.

Note You do not need to derive a class from **CContainedWindow** in order to use contained windows.

With contained windows, you can either superclass an existing Windows class or subclass an existing window. To create a window that superclasses an existing Windows class, first specify the existing class name in the constructor for the **CContainedWindow** object. Then call **CContainedWindow::Create**. To subclass an existing window, you don't need to specify a Windows class name (pass **NULL** to the constructor). Simply call the **CContainedWindow::SubclassWindow** method with the handle to the window being subclassed.

You typically use contained windows as data members of a container class. The container does not need to be a window; however, it must derive from **CMessageMap**.

A contained window can use alternate message maps to handle its messages. If you have more than one contained window, you should declare several alternate message maps, each corresponding to a separate contained window.

Following is an example of a container class with two contained windows:

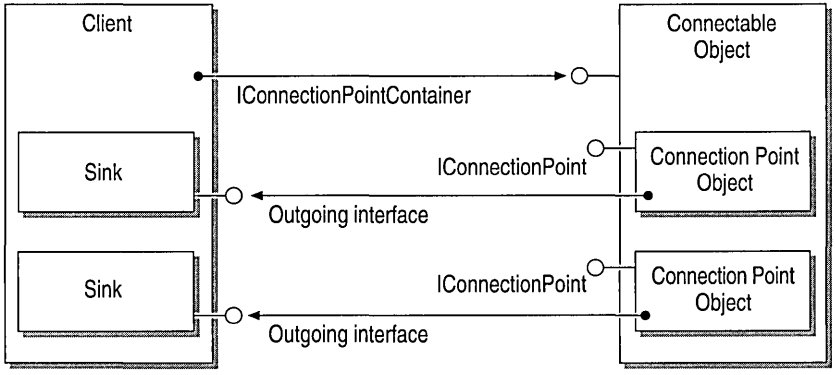
```
class CMyContainer : public CMessageMap, ...
{
public:
   CContainedWindow m_wndEdit;
   CContainedWindow m_wndList;
```

```
    CMyContainer() : m_wndEdit("Edit", this, 1),
                     m_wndList("List", this, 2)
    {
    }

    ...

    BEGIN_MSG_MAP(CMyContainer)
    ALT_MSG_MAP(1)
       // handlers for the Edit window go here
    ALT_MSG_MAP(2)
       // handlers for the List window go here
    END_MSG_MAP()

};
```

For more information about contained windows, see the SUBEDIT sample online. For more information about superclassing and subclassing, see "Window Procedure Superclassing" and "Window Procedure Subclassing" in the *Win32 SDK* online.

Connection Points

A connectable object is one that supports outgoing interfaces. An outgoing interface allows the object to communicate with a client. For each outgoing interface, the connectable object exposes a connection point. Each outgoing interface is implemented by a client on an object called a sink.



Each connection point supports the **IConnectionPoint** interface. The connectable object exposes its connection points to the client through the **IConnectionPointContainer** interface.

This article:

- Briefly describes the ATL classes that support connection points.
- Outlines the steps used to add connection points to an object.
- Provides an example of declaring a connection point.

See Also: "The Proxy Generator"

Connection Point Classes

ATL uses the following classes to support connection points:

- **IConnectionPointImpl** implements a connection point. The IID of the outgoing interface it represents is passed as a template parameter.
- **IConnectionPointContainerImpl** implements the connection point container and manages the list of **IConnectionPointImpl** objects.
- **IPropertyNotifySinkCP** implements a connection point representing the **IPropertyNotifySink** interface.
- **CComDynamicUnkArray** manages an arbitrary number of connections between the connection point and its sinks.
- **CComUnkArray** manages a predefined number of connections as specified by the template parameter.
- **CFirePropNotifyEvent** notifies a client's sink that an object's property has changed or is about to change.

Adding Connection Points to an Object

▶ To add a connection point to an object

1 Derive your class from **IConnectionPointContainerImpl** and from one or more instances of **IConnectionPointImpl**. Each instance of **IConnectionPointImpl** represents a separate connection point.

2 Use the **COM_INTERFACE_ENTRY_IMPL** macro to add an entry in the object's COM map to expose the **IConnectionPointContainer** interface:

```
BEGIN_COM_MAP(CMyClass)
  COM_INTERFACE_ENTRY_IMPL(IConnectionPointContainer)
END_COM_MAP()
```

3 Add a connection point map to your object declaration:

```
BEGIN_CONNECTION_POINT_MAP(CMyClass)
  CONNECTION_POINT_ENTRY(iid)
END_CONNECTION_POINT_MAP()
```

The parameter `iid` is the IID of the interface represented by the connection point.

Connection Point Example

This example shows an object that supports **IPropertyNotifySink** as an outgoing interface:

```
class CConnect :
   public CComObjectRootEx<CComObjectThreadModel>,
   public CComCoClass<CConnect, &CLSID_CConnect>,
   public IConnectionPointContainerImpl<CConnect>,
   public IConnectionPointImpl<CConnect,
            &IID_IPropertyNotifySink>
{
public:
   ...
   BEGIN_COM_MAP(CConnect)
      COM_INTERFACE_ENTRY_IMPL(IConnectionPointContainer)
   END_COM_MAP()

   BEGIN_CONNECTION_POINT_MAP(CConnect)
      CONNECTION_POINT_ENTRY(IID_IPropertyNotifySink)
   END_CONNECTION_POINT_MAP()

   ...
};
```

Note When specifying **IPropertyNotifySink** as an outgoing interface, you can use class **IPropertyNotifySinkCP** instead of **IConnectionPointImpl**. For example:

```
class CConnect :
   public CComObjectRootEx<CComObjectThreadModel>,
   public CComCoClass<CConnect, &CLSID_CConnect>,
   public IConnectionPointContainerImpl<CConnect>,
   public IPropertyNotifySinkCP<CConnect>
{
   ...
};
```

Enumerators

Enumerators provide a consistent way to iterate through a collection of objects. For example, you can define a simple enumerator to access strings in a collection. A complex enumerator can access records from a database.

This article describes:

- Implementing enumerators in ATL and COM.
- Using CComEnum, _Copy, CComIEnum, and CComIEnumImpl to create enumerators in ATL.

ATL does not define any standard objects for enumerators. However, it does provide you with the infrastructure for building them easily using the **CComEnum** and **_Copy** templates.

COM implements enumerators as separate objects that usually support a single interface, **IEnum***xxxx*, where *xxxx* is the type that is being enumerated. Standard enumerator types defined by COM include: **IEnumUnknown**, **IEnumMoniker**, **IEnumString**, **IEnumVARIANT**, **IEnumFORMATETC**, **IEnumSTATSTG**, **IEnumSTATDATA**, and **IEnumOLEVERB**.

Using CComEnum, _Copy, CComIEnum, and CComIEnumImpl to Create Enumerators in ATL

In ATL, **CComEnum<***Base*, *piid*, *T*, *Copy***>** defines an enumerator object that enumerates objects of type *T*. The parameter *Base* is the name of the interface that represents this enumerator (for example, **IEnumVARIANT**), and *piid* is a pointer to the IID of that interface. The parameter *Copy* is the name of a class used by **CComEnum** to implement copying the type and is typically used when cloning the enumerator.

A **_Copy<class** *T***>** class performs deep copy semantics for the particular type *T*. ATL predefines certain copy classes for your convenience: **_Copy<VARIANT>**, **_Copy<LPOLESTR>**, **_Copy<OLEVERB>**, **_Copy<CONNECTDATA>**, and **_CopyInterface<>**. These can be used to quickly build many of the standard enumerators.

CComIEnum is a pure virtual class that defines an enumeration interface.

CComIEnumImpl implements the methods on the enumeration interface: **Next**, **Skip**, **Reset**, and **Clone**. Generally, this class is only used internally by ATL during the implementation of **CComIEnum**.

The Proxy Generator

The ATL proxy generator automatically generates proxies for interfaces defined in a type library. Otherwise, hand coding these proxies would be very tedious.

Use the proxy generator when you want to support a connection point or a smart pointer. The proxy generator creates a class that represents a particular interface and its methods. For a connection point, the proxy generator also writes the code needed to broadcast a method call to all connected sinks.

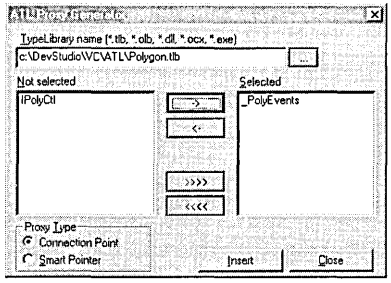
For a connection point proxy, the class created derives from **IConnectionPointImpl** and each method enumerates the connections (making calls on each one) inside a critical section.

For a smart pointer proxy, the class derives from **CComPtr**. Each method simply calls through to the underlying interface. When the target interface is a dispinterface, the methods automatically call **Invoke**.

The proxy generator generates the class derived from **IConnectionPointImpl** or **CComPtr** by reading the type library and implementing a function for each method. Before you can use the proxy generator you must generate the type library. To do this, either build your project or right click on the .idl file in **FileView**. On the submenu that appears, click **Compile** *thisproj.idl* where *thisproj* will be the name of your project.

▶ To generate a proxy for a connection point or a smart pointer

1. With your ATL project open, choose **Add To Project** from the **Project** menu. A pop-up menu appears.
2. Choose **Components and Controls** from the pop-up menu. The **Components and Controls Gallery** dialog box appears.
3. Double-click the **Developer Studio Components** folder.
4. Select the **ATL Proxy Generator** and click the **Insert** button.
5. You will be asked to confirm insertion of an ATL object. Click **OK**. The **ATL Proxy Generator** dialog box appears.



6. In the **TypeLibrary name** edit box, click the **...** button.
7. In the **Open** dialog box that appears, double-click the type library that contains the interfaces you want to wrap. A list of all the interfaces in the type library appears in the **Not Selected** list box.
8. Highlight the names of the interfaces that you want proxy generator to generate wrappers for.
9. Click the -> button to move the highlighted interfaces from the **Not Selected** list box to the **Selected** list box.
10. For the **Proxy Type**, click either **Connection Point** or **Smart Pointer**.

11 Click **Insert** and select a file name for the proxy header.

12 Select **Save**. The ATL proxy generator generates the header file.

For more information about using the ATL Proxy Generator, see the "ATL Tutorial."

See Also: "Connection Points"

Debugging Tips for ATL Objects

The debugging tips included in this article are:

- Setting breakpoints using DebugBreak
- Debugging QueryInterface calls
- Debugging AddRef and Release calls

See Also: "Debugging Tips" in "ATL Services"

Using DebugBreak

You can have your program call the **DebugBreak** Win32 function at the point in your code that you want debugging to start. Calling this function causes the program to display a dialog box as if it had crashed. Click **Cancel** to start the debugger and continue on in debug mode.

Enabling QueryInterface Debugging

ATL has built-in support for debugging **QueryInterface** calls. You enable this support using the following two-step process.

▶ **To enable QueryInterface debugging**

1 Run the FINDGUID program which comes with ATL and specify **-insert** as the command line parameter:

```
findguid -insert
```

This ensures all the common IIDs are in the interfaces section of your registry. You need to only do this once.

2 Add the following line before including atlcom.h:

```
#define _ATL_DEBUG_QI
```

Once you've enabled **QueryInterface** debugging, the debug output window of Developer Studio will display the name of each interface that is queried for on your object.

Enabling Reference Count Debugging

ATL has built-in support for debugging **AddRef** and **Release** calls. You enable this support using the following process.

▶ **To enable reference count debugging**

- Add the following line before including atlcom.h:

```
#define _ATL_DEBUG_REFCOUNT
```

With reference count debugging enabled, the debug output window of Developer Studio will display the corresponding interface name and its current reference count every time **AddRef** or **Release** is called on one of your interfaces.

ATL Services

To create your ATL COM object so that it runs in a service, simply select Service from the list of server options in the ATL COM AppWizard. The wizard will then create a **CServiceModule** class to implement the service.

The first four sections of this article discuss the actions that occur during execution of **CServiceModule** member functions. These topics appear in the same sequence as the functions are typically called. To improve your understanding of these topics, it is a good idea to use the source code generated by the ATL COM AppWizard as reference. These first four sections are:

- **CServiceModule::Start**
- **CServiceModule::ServiceMain**
- **CServiceModule::Run**
- **CServiceModule::Handler**

The last three sections of this article discuss concepts related to developing a service:

- Registry Entries for ATL services
- **DCOMCNFG**
- Debugging Tips for ATL services

CServiceModule::Start

The **WinMain** routine handles both registration and installation, as well as deregistration and uninstallation. When the service is run, **WinMain** calls **CServiceModule::Start**.

CServiceModule::Start sets up an array of **SERVICE_TABLE_ENTRY** structures that map each service to its startup function. This array is then passed to the Win32 API function, **StartServiceCtrlDispatcher**. In theory, one EXE could handle multiple services and the array could have multiple **SERVICE_TABLE_ENTRY** structures. Currently, however, an ATL-generated service supports only one service per EXE. Therefore, the array has a single entry that contains the service name and **_ServiceName** as the startup function. **_ServiceName** is a static member function of **CServiceModule** that calls the non-static member function, **ServiceName**.

Note Failure of **StartServiceCtrlDispatcher** to connect to the service control manager (SCM) probably means that the program is not running as a service. In this case, the program calls **CServiceModule::Run** directly so that the program can run as a local server. For more information about running the program as a local server, see Debugging Tips.

CServiceModule::ServiceMain

The SCM calls **ServiceMain** when you open the Services Control Panel application, select the service, and click **Start**.

After the SCM calls **ServiceMain**, a service must give the SCM a handler function. This function lets the SCM obtain the service's status and pass specific instructions (such as pausing or stopping). The SCM gets this function when the service passes **_Handler** to the Win32 API function, **RegisterServiceCtrlHandler**. (**_Handler** is a static member function that calls the non-static member function **Handler**.)

At startup, a service should also inform the SCM of its current status. It does this by passing **SERVICE_START_PENDING** to the Win32 API function, **SetServiceStatus**.

Now, **CServiceModule::Run** is called to perform the main work of the service. **Run** continues to execute until the service is stopped.

CServiceModule::Run

After being called, **Run** first stores the service's thread ID. The service will use this ID to close itself by sending a **WM_QUIT** message using the Win32 API function, **PostThreadMessage**.

Run then calls the Win32 API function, **CoInitializeEx**. By default, **Run** passes the **COINIT_MULTITHREADED** flag to the function. This flag indicates that the program is to be a free-threaded server.

Now you can specify security using **CSecurityDescriptor**. This class greatly simplifies the task of setting up and making changes to the discretionary access-control list (DACL)—a list of access-control entries (ACEs), where each ACE defines access to a Win32 object.

By default, the ATL COM AppWizard generates a call to the **InitializeFromThreadToken** member function of **CSecurityDescriptor**. This initializes the object's security descriptor to a null DACL, which means that any user has access to your object.

The easiest way to change user access is with the **Deny** and **Allow** member functions of **CSecurityDescriptor**. These functions add an ACE to the existing DACL. However, **Deny** always takes priority since **Deny** adds the ACE to the beginning of the DACL, while **Allow** adds it to the end. Both **Deny** and **Allow** pass the user name as the first parameter and the access rights (typically, **COM_RIGHTS_EXECUTE**) as the second.

Recall that the null DACL created by **InitializeFromThreadToken** grants all users access to the COM object. However, as soon as you call **Allow** to add an ACE, only that specified user will have access. The following code shows a call to **Allow**:

```
CSecurityDescriptor sd;
sd.InitializeFromThreadToken( );

if (bAllowOneUser)
{
   sd.Allow("MYDOMAIN\\myuser", COM_RIGHTS_EXECUTE);
}
CoInitializeSecurity(sd, -1, NULL, NULL,
                     RPC_C_AUTHN_LEVEL_PKT,
                     RPC_C_IMP_LEVEL_IMPERSONATE,
                     NULL, EOAC_NONE, NULL);
```

If the variable, `bAllowOneUser`, is **TRUE**, then only the one specified user has access because only that user's ACE is in the DACL. If `bAllowOneUser` is **FALSE**, then all users have access because the DACL is null.

If you do not want the service to specify its own security, remove the call to the Win32 API function, **CoInitializeSecurity**, and COM will then determine the security settings from the registry. A convenient way to configure registry settings is with the **DCOMCNFG** utility discussed later in this article.

Once security is specified, the object is registered with COM so that new clients can connect to the program. Finally, the program tells the SCM that it is running and the program enters a message loop. The program remains running until it posts a quit message upon service shutdown.

For more information about Windows NT security, see the MSDN article, "Windows NT Security in Theory and Practice" online.

CServiceModule::Handler

CServiceModule::Handler is the routine that the SCM calls to retrieve the status of the service and give it various instructions (such as stopping or pausing). The SCM passes an operation code to **Handler** to indicate what the service should do. A default

ATL-generated service only handles the stop instruction. If the SCM passes the stop instruction, the service tells the SCM that the program is about to stop. The service then calls **PostThreadMessage** to post a quit message to itself. This terminates the message loop and the service will ultimately close.

To handle more instructions, you need to change the **dwControlsAccepted** data member initialized in the **CServiceModule::Init** function. This data member tells the SCM which buttons to enable when the service is selected in the Services Control Panel application.

Registry Entries

DCOM introduced the concept of Application IDs (AppIDs), which group configuration options for one or more DCOM objects into a centralized location in the registry. You specify an AppID by indicating its value in the AppID named value under the object's CLSID.

By default, an ATL-generated service uses its CLSID as the GUID for its AppID. Under `HKEY_CLASSES_ROOT\AppID`, you can specify DCOM-specific entries. Initially, two entries exist:

- `LocalService`, with a value equal to the name of the service. If this value exists, it is used instead of the `LocalServer32` key under the CLSID.
- `ServiceParameters`, with a value equal to `-Service`. This value specifies parameters that will be passed to the service when it is started. Note that these parameters are passed to the service's **ServiceMain** function, not **WinMain**.

Any DCOM service also needs to create another key under `HKEY_CLASSES_ROOT\AppID`. This key is equal to the name of the EXE and acts as a cross-reference, as it contains an AppID value pointing back to the AppID entries.

DCOMCNFG

DCOMCNFG is a Windows NT 4.0 utility that allows you to configure various DCOM-specific settings in the registry. The **DCOMCNFG** window has three pages: Default Security, Default Properties, and Applications.

The Default Security Page

You can use the Default Security page to specify default permissions for objects on the system. The Default Security page has three sections: Access, Launch, and Configuration. To change a section's defaults, click on the corresponding **Edit Default** button. These Default Security settings are stored in the registry under `HKEY_LOCAL_MACHINE\Software\Microsoft\OLE`.

The Default Properties Page

On the Default Properties page, you must select the **Enable Distributed COM on this Computer** check box if you want clients on other machines to access COM objects running on this machine. Selecting this option sets the `HKEY_LOCAL_MACHINE\Software\Microsoft\OLE\EnableDCOM` value to `Y`.

The Applications Page

You change the settings for a particular object with the Applications page. Simply select the application from the list and click the **Properties** button. The Properties window has four pages:

- The General page confirms the application you are working with.
- The Location page allows you to specify where the application should run when a client calls **CoCreateInstance** on the relevant CLSID. If you select the **Run Application on the Following Computer** check box and enter a computer name, then a `RemoteServerName` value is added under the AppID for that application. Clearing the **Run Application on this Computer** check box renames the `LocalService` value to `_LocalService` and ,thereby, disables it.
- The Security page is similar to the Default Security page found in the **DCOMCNFG** window, except that these settings apply only to the current application. Again, the settings are stored under the AppID for that object.
- The Identify page identifies which user is used to run the application.

Debugging Tips

The following paragraphs outline some useful steps for debugging your service:

- Using Task Manager
- Displaying assertions
- Running the program as a local server

Using Task Manager

One of the simplest ways to debug a service is through the use of the Task Manager in Windows NT 4.0. While the service is running, start the Task Manager and click on the **Processes** tab. Use the right mouse button to click on the name of the EXE and then click **Debug**. This launches Developer Studio attached to that running process. Now, click **Break** on the **Debug** menu to allow you to set breakpoints in your code. Click **Run** to run to your selected breakpoints.

Displaying Assertions

If the client connected to your service appears to hang, the service may have asserted and displayed a message box that you are not able to see. You can confirm this by using Developer Studio's debugger to debug your code (see Using Task Manager earlier in this section).

If you determine that your service is displaying a message box that you cannot see, you may want to set the **Allow Service to Interact with Desktop** option before using the service again. This option is a startup parameter that permits any message boxes displayed by the service to appear on the desktop. To set this option, open the Services Control Panel application, select the service, click **Startup**, and then select the **Allow Service to Interact with Desktop** option.

Running the Program as a Local Server

If running the program as a service is inconvenient, you can temporarily change the registry so that the program is run as a normal local server. Simply rename the `LocalService` value under your AppID to `_LocalService` and ensure the `LocalServer32` key under your CLSID is set correctly. (Note that using **DCOMCNFG** to specify that your application should be run on a different computer renames your `LocalServer32` key to `_LocalServer32`.) Running your program as a local server takes a few more seconds on startup because the call to **StartServiceCtrlDispatcher** in **CServiceModule::Start** takes a few seconds before it fails.

The ATL Registry Component (Registrar)

The ATL 2.x Registrar provides optimized access to the system registry through a custom interface. The Registrar is free-threaded and allows static linking of code for C++ clients.

Note The ATL 2.x Registrar, provided in atl.dll, does not support Automation or the 1.1 methods that operated on a single key.

This article covers the following topics related to the Registrar:

- Creating Registrar Scripts, which includes:
  - Understanding Backus Nauer Form (BNF) Syntax
  - Understanding Parse Trees
  - Registry Scripting Examples

  - Using Replaceable Parameters (The Registrar's Preprocessor)
  - Invoking scripts
- Setting Up a Static Link to the Registrar Code (C++ only)

Note All of the source code for the 2.x Registrar ships with ATL. You can find the source code in atl\src\atliface.h.

Creating Registrar Scripts

A registrar script provides data-driven, rather than API-driven, access to the system registry. Data-driven access is typically more efficient since it takes only one or two lines in a script to add a key to the registry.

The ATL Object Wizard automatically generates a registrar script for your COM server. You can find this script in the .rgs file associated with your object.

The ATL Registrar's Script Engine processes your registrar script at run time. ATL automatically invokes the Script Engine during server setup.

Understanding Backus Nauer Form (BNF) Syntax

The scripts used by the ATL Registrar follow BNF syntax and use the notation shown in the next table.

Convention/Symbol	What It Means
`::=`	Equivalent
`|`	OR
`X+`	One or more `X`s.
`[X]`	`X` is optional. Optional delimiters are denoted by `[]`.
Any **bold** text	A string literal.
Any *italicized* text	How to construct the string literal.

As indicated in the preceding table, registrar scripts use string literals. These values are actual text that must appear in your script. The following table describes the string literals used in an ATL Registrar script.

String Literal	Description
ForceRemove	Completely remove the following key (if it exists) and then recreate it.
NoRemove	Do not remove the following key during Unregister.
val	The following `<Key Name>` is actually a named value.
Delete	Delete the following key during Register.
s	The following value is a string.
d	The following value is a **DWORD**.

BNF Syntax Examples

Here are a few syntax examples to help you understand how the notation and string literals work in an ATL Registrar script.

Syntax example 1

```
<registry expression> ::= <Add Key>
```

specifies that `registry expression` is equivalent to `Add Key`.

Syntax example 2

```
<registry expression> ::= <Add Key> | <Delete Key>
```

specifies that `registry expression` is equivalent to either `Add Key` or `Delete Key`.

Syntax example 3

```
<Key Name> ::= '<AlphaNumeric>+'
```

specifies that `Key Name` is equivalent to one or more `AlphaNumerics`.

Syntax example 4

```
<Add Key> ::= [ForceRemove | NoRemove | val]<Key Name>
```

specifies that `Add Key` is equivalent to `Key Name`, and that the string literals, `ForceRemove`, `NoRemove`, and `val`, are optional.

Syntax example 5

```
<AlphaNumeric> ::= any character not NULL, i.e. ASCII 0
```

specifies that `AlphaNumeric` is equivalent to any non-NULL character.

Understanding Parse Trees

Using BNF syntax, you define one or more parse trees in your script.

Each parse tree has the form:

```
<root key>{<registry expression>}+
```

where:

```
<root key> ::= HKEY_CLASSES_ROOT | HKEY_CURRENT_USER |
               HKEY_LOCAL_MACHINE | HKEY_USERS |
               HKEY_PERFORMANCE_DATA | HKEY_DYN_DATA |
               HKEY_CURRENT_CONFIG | HKCR | HKCU |
               HKLM | HKU | HKPD | HKDD | HKCC
<registry expression> ::= <Add Key> | <Delete Key>
<Add Key> ::= [ForceRemove | NoRemove | val]<Key Name>
              [<Key Value>][{< Add Key>}]
<Delete Key> ::= Delete<Key Name>
<Key Name> ::= '<AlphaNumeric>+'
```

```
<AlphaNumeric> ::= any character not NULL, i.e. ASCII 0
<Key Value> ::== <Key Type><Key Name>
<Key Type> ::= s | d
<Key Value> ::= '<AlphaNumeric>'
```

Note HKEY_CLASSES_ROOT and HKCR are equivalent; HKEY_CURRENT_USER and HKCU are equivalent; and so on.

A parse tree can add multiple keys and subkeys to the <root key>. In doing so, it keeps a subkey's handle open until the parser has completed parsing all its subkeys. This approach is more efficient than operating on a single key at a time, as seen in the following parse tree example:

```
HKEY_CLASSES_ROOT
{
   'MyVeryOwnKey'
   {
      'HasASubKey'
      {
         'PrettyCool?'
      }
   }
}
```

Here, the Registrar initially opens (creates) HKEY_CLASSES_ROOT\MyVeryOwnKey. It then sees that MyVeryOwnKey has a subkey. Rather than close the key to MyVeryOwnKey, the Registrar retains the handle and opens (creates) HasASubKey using this parent handle. (The system registry can be slower when no parent handle is open.) Thus, opening HKEY_CLASSES_ROOT\MyVeryOwnKey and then opening HasASubKey with MyVeryOwnKey as the parent is faster than opening MyVeryOwnKey, closing MyVeryOwnKey, and then opening MyVeryOwnKey\HasASubKey.

Registry Scripting Examples

The scripting examples in this article demonstrate how to add a key to the system registry; register the Registrar COM server; and specify multiple parse trees.

Add a Key to HKEY_CURRENT_USER

The following parse tree illustrates a simple script that adds a single key to the system registry. In particular, the script adds the key, MyVeryOwnKey, to HKEY_CURRENT_USER. It also assigns the default string value of HowGoesIt? to the new key:

```
HKEY_CURRENT_USER
{
   'MyVeryOwnKey' = s 'HowGoesIt?'
}
```

This script can easily be extended to define multiple subkeys as follows:

```
HKCU
{
   'MyVeryOwnKey' = s 'HowGoesIt?'
   {
      'HasASubkey'
      {
         'PrettyCool?' = d '55'
         val 'ANameValue' = s 'WithANamedValue'
      }
   }
}
```

Now, the script adds a subkey, `HasASubkey`, to `MyVeryOwnKey`. To this subkey, it adds both the `PrettyCool?` subkey (with a default **DWORD** value of 55) and the `ANameValue` named value (with a string value of `WithANamedValue`).

Register the Registrar COM Server

The following script registers the Registrar COM server itself.

```
HKCR
{
   ATL.Registrar = s 'ATL 2.0 Registrar Class'
   {
      CLSID = s '{44EC053A-400F-11D0-9DCD-00A0C90391D3}'
   }
   NoRemove CLSID
   {
      ForceRemove {44EC053A-400F-11D0-9DCD-00A0C90391D3} =
                  s 'ATL 2.0 Registrar Class'
      {
         ProgID = s 'ATL.Registrar'
         InprocServer32 = s '%MODULE%'
         {
            val ThreadingModel = s 'Apartment'
         }
      }
   }
}
```

At run time, this parse tree adds the `ATL.Registrar` key to `HKEY_CLASSES_ROOT`. To this new key, it then:

- Specifies `ATL Registrar 2.0 Class` as the key's default string value.
- Adds `CLSID` as a subkey.
- Specifies `{44EC053A-400F-11D0-9DCD-00A0C90391D3}` for `CLSID`. (This value is the Registrar's CLSID for use with **CoCreateInstance**.)

Since `CLSID` is shared, it should not be removed in Unregister mode. The statement, `NoRemove CLSID`, does this by indicating that `CLSID` should be opened in Register mode and ignored in Unregister mode.

The ForceRemove statement provides a housekeeping function by removing a key and all its subkeys before recreating the key. This can be useful if the names of the subkeys have changed. In this scripting example, ForceRemove checks to see if {44EC053A-400F-11D0-9DCD-00A0C90391D3} already exists. If it does, ForceRemove:

- Recursively deletes {44EC053A-400F-11D0-9DCD-00A0C90391D3} and all of its subkeys.
- Recreates {44EC053A-400F-11D0-9DCD-00A0C90391D3}.
- Adds ATL Registrar 2.0 Class as the default string value for {44EC053A-400F-11D0-9DCD-00A0C90391D3}.

The parse tree now adds two new subkeys to {44EC053A-400F-11D0-9DCD-00A0C90391D3}. The first key, ProgID, gets a default string value that is the ProgID. The second key, InprocServer32, gets a default string value, %MODULE%, that is a preprocessor value explained in the section, Using Replaceable Parameters (The Registrar's Preprocessor), of this article. InprocServer32 also gets a named value, ThreadingModel, with a string value of Apartment.

Specify Multiple Parse Trees

In order to specify more than one parse tree in a script, simply place one tree at the end of another. For example, the following script adds the key, MyVeryOwnKey, to the parse trees for both HKEY_CLASSES_ROOT and HKEY_CURRENT_USER:

```
HKCR
{
   'MyVeryOwnKey' = s 'HowGoesIt?'
}
HKEY_CURRENT_USER
{
   'MyVeryOwnKey' = s 'HowGoesIt?'
}
```

Note In a Registrar script, 4K is the maximum token size. (A token is any recognizable element in the syntax). In the previous scripting example, HKCR, HKEY_CURRENT_USER, 'MyVeryOwnKey', and 'HowGoesIt?' are all tokens.

Using Replaceable Parameters (The Registrar's Preprocessor)

Replaceable parameters allow a Registrar's client to specify run-time data. To do this, the Registrar maintains a replacement map into which it enters the values associated with the replaceable parameters in your script. The Registrar makes these entries at run time. The following section, Using %MODULE%, demonstrates these steps.

▶ **To specify run-time data using replaceable parameters**

1. In the location in the script where the data is to be placed, create a replacement variable name of the form `%VariableName%`.
2. Before calling one of the parsing methods, add a replacement value to the Registrar's replacement map by calling **AddReplacement(LPCOLESTR** *key*, **LPCOLESTR** *item*), where *key* is `"VariableName"` and *item* is the value that `VariableName` is to expand to at run time.

Besides adding entries to the map, you may also want to remove all entries from it. This is useful if more than one object wishes to use the same instance of the Registrar.

▶ **To remove all entries from the replacement map**

- Call **ClearReplacements( )**.

Using %MODULE%

The ATL Object Wizard automatically generates a script that uses `%MODULE%`. ATL uses this replaceable parameter for the actual location of your server's DLL or EXE.

Besides adding `%MODULE%` to the script, the ATL Object Wizard also adds the following line to the object's class declaration:

```
DECLARE_REGISTRY_RESOURCEID(IDR_MYCOMAPP)
```

This macro expands to:

```
static HRESULT WINAPI UpdateRegistry(BOOL bRegister)
{
   return _Module.UpdateRegistryFromResource(IDR_MYCOMAPP,
                                             bRegister);
}
```

where `_Module` refers to the global **CComModule**, which has the following method and **#define** statement:

```
UpdateRegistryFromResourceD(UINT nResID, BOOL bRegister,
        struct _ATL_REGMAP_ENTRY* pMapEntries = NULL);

#define UpdateRegistryFromResource
        UpdateRegistryFromResourceD
```

This method calls `AtlModuleUpdateRegistryFromResourceD`, which contains the following code:

```
ATLAPI AtlModuleUpdateRegistryFromResourceD(_ATL_MODULE*pM,
        LPCOLESTR lpszRes, BOOL bRegister,
        struct _ATL_REGMAP_ENTRY* pMapEntries,
        IRegistrar* pReg)
{
   USES_CONVERSION;
   ...
   CComPtr<IRegistrar> p;
   ...
```

```
    TCHAR szModule[_MAX_PATH];
    GetModuleFileName(pM->m_hInst, szModule, _MAX_PATH);
    p->AddReplacement(OLESTR("Module"), T2OLE(szModule));

    ...
}
```

Note You can find this code in atl\include\atlimpl.cpp.

CoCreateInstance acquires the pointer p, which points to the Registrar. Then, **AddReplacement** receives an **LPCOLESTR** containing the string "Module", as well as an **LPCOLESTR** containing the string acquired from the Win32 API function, **GetModuleFileName**. This code adds a replacement map entry for the Module variable that has a value associated with the result of **GetModuleFileName**. Now, when the preprocessor sees the %MODULE% in the script, it will replace it with the value from **GetModuleFileName**.

Concatenating run-time data with script data

Another use of the preprocessor is to concatenate run-time data with script data. For example, suppose we need an entry that contains a full path to a module with the string ", 1" appended at the end. First, define the following expansion:

```
'MyGoofyKey' = s '%MODULE%, 1'
```

Then, before calling one of the script processing methods, add a replacement to the map:

```
TCHAR szModule[_MAX_PATH]
GetModuleFileName(pM->m_hInst, szModule, _MAX_PATH);
p->AddReplacement(OLESTR("Module"), T2OLE(szModule));
```

During the parsing of the script, the Registrar expands '%MODULE%, 1' to c:\mycode\mydll.dll, 1.

Note In a Registrar script, 4K is the maximum token size. (A token is any recognizable element in the syntax.) This includes tokens that were created or expanded by the preprocessor.

Note To substitute replacement values at run time, do not specify the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro. Instead, create an array of **_ATL_REGMAP_ENTRIES** structures, where each entry contains a variable placeholder paired with a value to replace the placeholder at run time. Then call **CComModule::UpdateRegistryFromResourceD**, passing it the array. This method adds all the replacement values in the **_ATL_REGMAP_ENTRIES** structure to the Registrar's replacement map.

Invoking Scripts

The previous section, Using Replaceable Parameters (The Registrar's Preprocessor), discussed replacement maps and introduced two of the Registrar's methods, **AddReplacement** and **ClearReplacements**. The Registrar has eight other methods

specific to scripting. All eight of these methods are described in the following table and invoke the Registrar on a particular script.

Method	Syntax/Description
ResourceRegister	**HRESULT ResourceRegister(LPCOLESTR** *resFileName*, ↪ **UINT** *nID*, **LPCOLESTR** *szType* **);** Registers the script contained in a module's resource. *resFileName* indicates the UNC path to the module itself. *nID* and *szType* contain the resource's ID and type, respectively.
ResourceUnregister	**HRESULT ResourceUnregister(LPCOLESTR** *resFileName*, ↪ **UINT** *nID*, **LPCOLESTR** *szType* **);** Unregisters the script contained in a module's resource. *resFileName* indicates the UNC path to the module itself. *nID* and *szType* contain the resource's ID and type, respectively.
ResourceRegisterSz	**HRESULT ResourceRegisterSz(LPCOLESTR** *resFileName*, ↪ **LPCOLESTR** *szID*, **LPCOLESTR** *szType* **);** Registers the script contained in a module's resource. *resFileName* indicates the UNC path to the module itself. *szID* and *szType* contain the resource's string identifier and type, respectively.
ResourceUnregisterSz	**HRESULT ResourceUnregisterSz(LPCOLESTR** *resFileName*, ↪ **LPCOLESTR** *szID*, **LPCOLESTR** *szType* **);** Unregisters the script contained in a module's resource. *resFileName* indicates the UNC path to the module itself. *szID* and *szType* contain the resource's string identifier and type, respectively.
FileRegister	**HRESULT FileRegister(LPCOLESTR** *fileName* **);** Registers the script in a file. *fileName* is a UNC path to a file that contains (or is) a resource script.
FileUnregister	**HRESULT FileUnregister(LPCOLESTR** *fileName* **);** Unregisters the script in a file. *FileName* is a UNC path to a file that contains (or is) a resource script.
StringRegister	**HRESULT StringRegister(LPCOLESTR** *data* **);** Registers the script in a string. *data* contains the script itself.
StringUnregister	**HRESULT StringUnregister(LPCOLESTR** *data* **);** Unregisters the script in a string. *data* contains the script itself.

ATL uses the first two methods shown in the table (**ResourceRegister** and **ResourceUnregister**) in atlimpl.cpp:

```
LPCOLESTR szType = OLESTR("REGISTRY");
GetModuleFileName(pM->m_hInstResource, szModule, _MAX_PATH);
LPOLESTR pszModule = T2OLE(szModule);
```

```
if (HIWORD(lpszRes)==0)
{
   if (bRegister)
      hRes = p->ResourceRegister(pszModule,
               ((UINT)LOWORD((DWORD)lpszRes)), szType);
   else
      hRes = p->ResourceUnregister(pszModule,
               ((UINT)LOWORD((DWORD)lpszRes)), szType);
}
else
{
   if (bRegister)
      hRes = p->ResourceRegisterSz(pszModule, lpszRes, szType);
   else
      hRes = p->ResourceUnregisterSz(pszModule, lpszRes, szType);
}
```

Note that `szModule` contains the value acquired from **GetModuleFileName**.

The next two methods shown in the table, **ResourceRegisterSz** and **ResourceUnregisterSz**, are similar to **ResourceRegister** and **ResourceUnregister**, but allow you to specify a string identifier.

The methods **FileRegister** and **FileUnregister** are useful if you do not want the script in a resource or if you want the script in its own file. The methods **StringRegister** and **StringUnregister** allow the .rgs file to be stored in a dynamically-allocated string.

Setting Up a Static Link to the Registrar Code (C++ only)

C++ clients can create a static link to the Registrar's code. Static linking of the Registrar's parser adds approximately 5K to a release build.

The simplest way to set up static linking assumes you have specified **DECLARE_REGISTRY_RESOURCEID** in your object's declaration. (This is the default specification used by the ATL.)

▶ To create a static link using DECLARE_REGISTRY_RESOURCEID

1. At the top of stdafx.h, add the following **#define** statement: `#define _ATL_STATIC_REGISTRY`.
2. Recompile.

PART 2

Active Template Library Tutorial

ATL Tutorial

With ATL, you can create efficient, flexible, lightweight controls. This tutorial leads you through the creation of a control and demonstrates some ATL fundamentals in the process.

The ATL control that you create in this seven-step tutorial draws a circle and also draws a filled polygon inside the circle. You will add a control to your project, add a Sides property to indicate how many sides the polygon will have, and add drawing code to display your control when the property changes. Then, you will make your control respond to click events, add a property page to your control, and put your control on a Web page.

The tutorial is divided into seven steps. Do them in order because later steps depend on tasks you have completed in earlier steps.

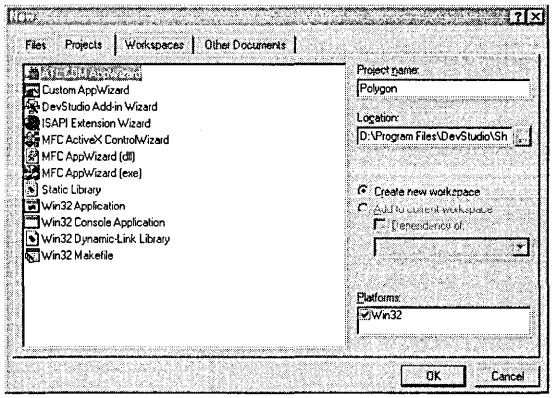
- Step 1: Creating the Project
- Step 2: Adding a Control to Your Project
- Step 3. Adding a Property to Your Control
- Step 4: Changing Your Control's Drawing Code
- Step 5: Adding an Event to Your Control
- Step 6: Adding a Property Page to Your Control
- Step 7: Putting Your Control on a Web Page
- ATL References
- Appendix (code generated by the ATL Object Wizard)

Step 1: Creating the Project

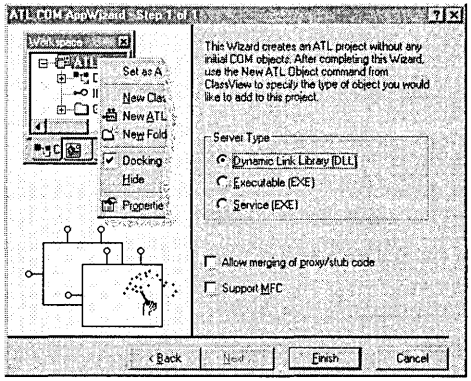
First you will create the initial ATL project using the ATL COM AppWizard.

1. In the Developer Studio environment, click **New** on the **File** menu, then choose the **Projects** tab.
2. Select the **ATL COM AppWizard**.
3. Type **Polygon** as the project name.

Your dialog box should look like this:



Click **OK** and the ATL COM AppWizard presents a dialog box offering several choices to configure the initial ATL project.



Because you are creating a control, leave the Server Type as a DLL, since a control must be an in-process server. All the default options are fine, so click **Finish**. A dialog box appears that lists the main files that will be created. These files are listed below, along with a description of each file that the ATL COM AppWizard generates.

File	Description
Polygon.cpp	Contains the implementation of DllMain, DllCanUnloadNow, DllGetClassObject, DllRegisterServer and DllUnregisterServer. Also contains the object map, which is a list of the ATL objects in your project. This is initially blank, since you haven't created an object yet.
Polygon.def	The standard Windows module definition file for the DLL.

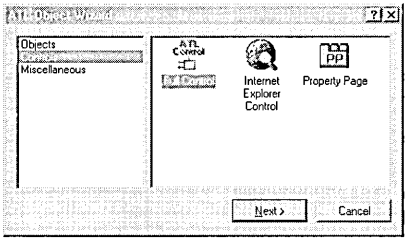
(continued)

File	Description
Polygon.dsw	The project workspace.
Polygon.dsp	The file that contains the project settings.
Polygon.idl	The interface definition language file, which describes the interfaces specific to your objects.
Polygon.rc	The resource file, which initially contains the version information and a string containing the project name.
Resource.h	The header file for the resource file.
Polygonps.mk	The make file that can be used to build a proxy/stub DLL. You will not need to use this.
Polygonps.def	The module definition file for the proxy/stub DLL.
StdAfx.cpp	The file that will #include the ATL implementation files.
StdAfx.h	The file that will #include the ATL header files.

To make the Polygon DLL useful, you need to add a control, using the ATL Object Wizard.

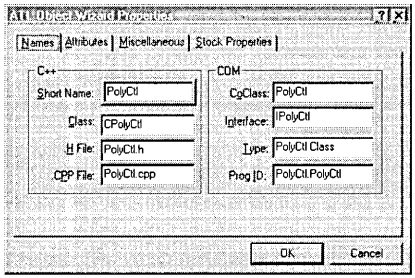
Step 2: Adding a Control

To add an object to an ATL project, you use the ATL Object Wizard. Click **New ATL Object** on the **Insert** menu, and the ATL Object Wizard appears.



In the first ATL Object Wizard dialog box, select the category of object you want to add to your current ATL project. Some of the options you can select are a basic COM object, a control tailored to work in Internet Explorer, and a property page. In this tutorial, you are going to create a standard control, so set the category as **Controls** on the left, then on the right select **Full Control**. Finally, click **Next**.

A set of property pages is displayed that allow you to configure the control you are inserting into your project. Type "PolyCtl" as the short name.



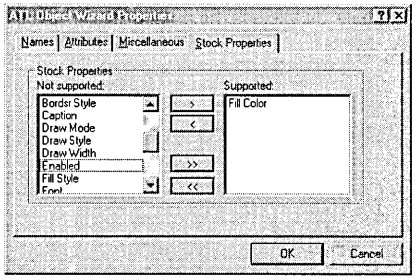
The **Class** field shows the C++ class name created to implement the control. The **.H File** and **.CPP File** show the files created containing the definition of the C++ class. The **CoClass** is the name of the component class for this control, and **Interface** is the name of the interface on which your control will implement its custom methods and properties. The **Type** is a description for the control, and the **ProgID** is the readable name that can be used to look up the CLSID of the control.

Now enable support for rich error information for your control:

1. Click on the **Attributes** tab.
2. Click the **Support ISupportErrorInfo** check box.

You're going to color in the polygon when you draw it, so add a Fill Color stock property:

1. Click on the **Stock Properties** tab.
   You see a list box with all the possible stock properties you can enter.
2. Scroll down the list, then double-click **Fill Color** to move it to the **Supported** list.



You are finished selecting options for your control. Click **OK**.

When you created your control, several code changes and additions were made. The following files were created:

File	Description
PolyCtl.h	Contains most of the implementation of the C++ class CPolyCtl.
PolyCtl.cpp	Contains the remaining parts of CPolyCtl.

(continued)

File	Description
PolyCtl.rgs	A text file that contains the registry script used to register the control.
PolyCtl.htm	An HTML file that contains the source of a Web page that contains a reference to the newly created control, so that you can try it out in Internet Explorer immediately.

The following code changes were also performed by the Wizard:

- A #include was added to the StdAfx.h and StdAfx.cpp files to include the ATL files necessary for controls.
- The registry script PolyCtl.rgs was added to the project resource.
- Polygon.idl was changed to include details of the new control.
- The new control was added to the object map in Polygon.cpp.

The file PolyCtl.h is the most interesting because it contains the main code that implements your control. The code for PolyCtl.h is described in the Appendix of this tutorial.

You are now ready to build your control:

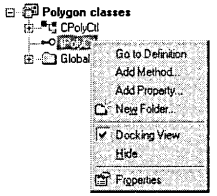
1. On the **Build** menu click **Build Polygon.dll**.
2. Once your control has finished building, click **ActiveX Control Test Container** on the **Tools** menu. The **Test Container** is launched.
3. In **Test Container**, choose **Insert Ole Control** from the **Edit** menu. The **Insert Ole Control** dialog box appears.
4. From the list of available controls in the **Insert Ole Control** dialog box, choose **PolyCtl class**.

   You should see a rectangle with the text "ATL 2.0" in the middle.
5. Close **Test Container**.

Next, you will add a custom property to the control.

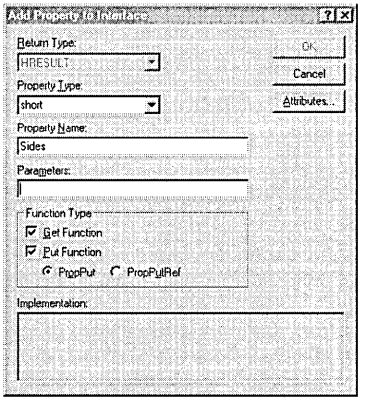
Step 3: Adding a Property to the Control

`IPolyCtl` is the interface that contains your custom methods and properties. The easiest way to add a property to this interface is to right click on it in the **Class View** and select **Add Property**.



The **Add Property to Interface** dialog box appears, allowing you to enter the details of the property you want to add:

1. On the drop-down list of property types, select **short**.
2. Type "Sides" as the **Property Name**. If you move to another field after editing the **Property Name** field, the **Implementation** box will show the lines that will be added to your .idl file.
3. Click **OK** to finish adding the property.



MIDL (the program that compiles .idl files) defines a **Get** method that retrieves the property and a **Put** method that sets the property. When MIDL compiles the file, it automatically defines those two methods in the interface by prepending `put_` and `get_` to the property name.

Along with adding the necessary lines to the .idl file, the **Add Property to Interface** dialog box also adds the **Get** and **Put** function prototypes to the class definition in PolyCtl.h and adds an empty implementation to PolyCtl.cpp.

To set and retrieve the property you need a place to store it. Open PolyCtl.h and add the following line at the end of the class definition after `m_clrFillColor` is defined:

```
short m_nSides;
```

Now you can implement the **Get** and **Put** methods. The `get_Sides` and `put_Sides` function definitions have been added to PolyCtl.cpp. You need to add code to match the following:

```
STDMETHODIMP CPolyCtl::get_Sides(short *pVal)
{
   *pVal = m_nSides;
   return S_OK;
}

STDMETHODIMP CPolyCtl::put_Sides(short newVal)
```

```
{
   if (newVal > 2 && newVal < 101)
   {
      m_nSides = newVal;
      return S_OK;
   }
   else
      return Error(_T("Shape must have between 3 and 100 sides"));
}
```

The `get_Sides` function simply returns the current value of the Sides property through the `pVal` pointer. In the `put_Sides` method, you make sure the user is setting the Sides property to an acceptable value. You need more than 2 sides, and since you will be storing an array of points for each side later on, 100 is a reasonable limit for a maximum value. If an invalid value is passed you use the ATL **Error** function to set the details in the **IErrorInfo** interface. This is useful if your container needs more information about the error than the returned **HRESULT**.

The last thing you need to do for the property is initialize `m_nSides`. Make a triangle the default shape by adding a line to the constructor in PolyCtl.h:

```
CPolyCtl()
{
   m_nSides = 3;
}
```

You now have a property called Sides. It's not much use until you do something with it, so next you will change the drawing code to use it.

Step 4: Changing the Drawing Code

In the drawing code you will use **sin** and **cos** functions to calculate the polygon points, so add include math.h at the top of PolyCtl.h:

```
#include <math.h>
#include "resource.h"       // main symbols
```

Note for Release builds only When the ATL COM AppWizard generates the default project, it defines the macro **_ATL_MIN_CRT**. This macro is defined so that you don't bring the C Run-Time Library into your code if you don't need it. The polygon control needs the C Run-Time Library start-up code to initialize the floating-point functions. Therefore, you need to remove the **_ATL_MIN_CRT** macro if you want to build a Release version. To remove the macro, click **Settings** on the **Project** menu. In the **Settings For:** drop-down list, choose **Multiple Configurations**. In the **Select project configuration(s) to modify** dialog box that appears, click the check boxes for all four Release versions, then click **OK**. On the **C/C++** tab, choose the **General** category, then remove **_ATL_MIN_CRT** from the **Preprocessor definitions** edit box.

Once the polygon points are calculated, you store the points by adding an array of type **POINT** to the end of the class definition in PolyCtl.h:

```
OLE_COLOR m_clrFillColor;
short m_nSides;
POINT m_arrPoint[100];
```

Now change the `OnDraw` function in PolyCtl.cpp to match the one below. Note that you remove the calls to the Rectangle and DrawText functions. You also explicitly get and select a black pen and white brush. You need to do this in case your control is running windowless. If you don't have your own window, you can't make assumptions about the device context you'll be drawing in.

The completed `OnDraw` looks like this:

```
HRESULT CPolyCtl::OnDraw(ATL_DRAWINFO& di)
{
   RECT& rc = *(RECT*)di.prcBounds;
   HDC hdc  = di.hdcDraw;
   COLORREF  colFore;
   HBRUSH    hOldBrush, hBrush;
   HPEN      hOldPen, hPen;

   // Translate m_colFore into a COLORREF type
   OleTranslateColor(m_clrFillColor, NULL, &colFore);

   //Create and select the colors to draw the circle
   hPen = (HPEN)GetStockObject(BLACK_PEN);
   hOldPen = (HPEN)SelectObject(hdc, hPen);
   hBrush = (HBRUSH)GetStockObject(WHITE_BRUSH);
   hOldBrush = (HBRUSH)SelectObject(hdc, hBrush);

   const double pi = 3.14159265358979;
   POINT  ptCenter;
   double dblRadiusx = (rc.right - rc.left) / 2;
   double dblRadiusy = (rc.bottom - rc.top) / 2;
   double dblAngle = 3 * pi / 2;         // Start at the top
   double dblDiff  = 2 * pi / m_nSides;  // Angle each side will make
   ptCenter.x = (rc.left + rc.right) / 2;
   ptCenter.y = (rc.top + rc.bottom) / 2;

   // Calculate the points for each side
   for (int i = 0; i < m_nSides; i++)
   {
      m_arrPoint[i].x = (long)(dblRadiusx * cos(dblAngle) + ptCenter.x + 0.5);
      m_arrPoint[i].y = (long)(dblRadiusy * sin(dblAngle) + ptCenter.y + 0.5);
      dblAngle += dblDiff;
   }
   Ellipse(hdc, rc.left, rc.top, rc.right, rc.bottom);

   // Create and select the brush that will be
   // used to fill the polygon
   hBrush  = CreateSolidBrush(colFore);
```

```
SelectObject(hdc, hBrush);
   Polygon(hdc, &m_arrPoint[0], m_nSides);

   // Select back the old pen and brush and delete
   // the brush we created
   SelectObject(hdc, hOldPen);
   SelectObject(hdc, hOldBrush);
   DeleteObject(hBrush);

   return S_OK;
}
```

Now, initialize `m_clrFillColor`. Choose green as the default color and add this line to the `CPolyCtl` constructor in PolyCtl.h:

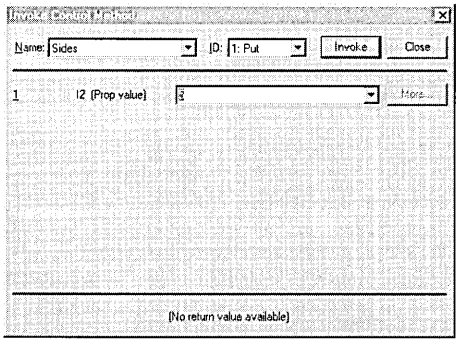
```
   m_clrFillColor = RGB(0, 0xFF, 0);
```

The constructor now looks like this:

```
CPolyCtl()
{
   m_nSides = 3;
   m_clrFillColor = RGB(0, 0xFF, 0);
}
```

Now rebuild the control and try it again. Open **ActiveX Control Test Container** and insert the control. You should see a green triangle within a circle. Try changing the number of sides. To modify properties on a dual interface from within **Test Container**, use **Invoke Methods**:

1. In **Test Container**, click **Invoke Methods** on the **Edit** menu.
   The **Invoke Control Method** dialog box is displayed.
2. Click **Sides** from the **Name** list box and click **1: Put** from the **ID** list box.
3. Type 5 in the **(Prop Value)** edit box and click **Invoke**.



Notice that the control doesn't change. What is wrong? Although you changed the number of sides internally by setting the `m_nSides` variable, you didn't cause the control to repaint. If you switch to another application and then switch back to

Test Container you will find that the control is repainted and now has the correct number of sides.

To correct this problem, you need to add a call to the **FireViewChange** function, which is defined in **IViewObjectExImpl**, after you set the number of sides. If the control is running in its own window, **FireViewChange** will call the **InvalidateRect** API directly. If the control is running windowless, the **InvalidateRect** method will be called on the container's site interface. This forces the control to repaint itself.

The new `put_Sides` method is as follows:

```
STDMETHODIMP CPolyCtl::put_Sides(short newVal)
{
   if (newVal > 2 && newVal < 101)
   {
      m_nSides = newVal;
      FireViewChange();
      return S_OK;
   }
   else
      return Error(_T("Shape must have between 3 and 100 sides"));
}
```

After you've added **FireViewChange**, rebuild and try the control again. This time when you change the number of sides and click **Invoke**, you should see the control change immediately.

Next, you will add an event to the control.

Step 5: Adding an Event

Now you will add a `ClickIn` and a `ClickOut` event to your ATL control. You will fire the `ClickIn` event if the user clicks within the polygon and fire `ClickOut` if the user clicks outside.

To be able to fire events, you must first specify an event interface. Add the code declaring this interface to the `library` section in the Polygon.idl file. The resulting .idl file should appear as shown in the following code. The code that you add is in **bold**. Note that the GUIDs in your file will differ from the ones below. Do not change the code that is not bold. In particular, be careful not to overwrite the second GUID in the code below.

```
library POLYGONLib
{
   importlib("stdole32.tlb");

   [
      uuid(4CBBC677-507F-11D0-B98B-000000000000),
      helpstring("Event interface for PolyCtl")
   ]
   dispinterface _PolyEvents
```

```
    {
        properties:
        methods:
        [id(1)] void ClickIn([in]long x, [in] long y);
        [id(2)] void ClickOut([in]long x, [in] long y);
    };
    [
        uuid(4CBBC676-507F-11D0-B98B-000000000000),
        helpstring("PolyCtl Class")
    ]
    coclass PolyCtl
    {
        [default] interface IPolyCtl;
        [default, source] dispinterface _PolyEvents;
    };
};
```

Note that you start the interface name with an underscore. This is a convention to indicate that the interface is an internal interface. Thus, programs that allow you to browse COM objects can choose not to display the interface to the user.

In the interface definition, you added the `ClickIn` and `ClickOut` methods that take the x and y coordinates of the clicked point as parameters. You also added a line to indicate that this is the default source interface. The source attribute indicates that the control is the source of the notifications, so it will call this interface on the container.

Now implement a connection point interface and a connection point container interface for your control. (In COM, events are implemented through the mechanism of connection points. To receive events from a COM object, a container establishes an advisory connection to the connection point that the COM object implements. Since a COM object can have multiple connection points, the COM object also implements a connection point container interface. Through this interface, the container can determine which connection points are supported.) The interface that implements a connection point is called **IConnectionPoint** and the interface that implements a connection point container is called **IConnectionPointContainer**.

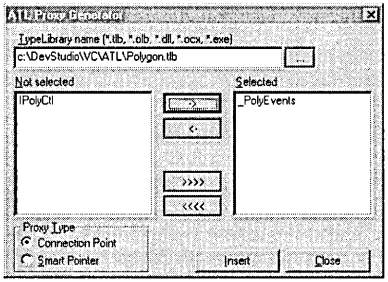
To help implement **IConnectionPoint**, ATL provides a proxy generator. This proxy generator generates the **IConnectionPoint** interface by reading your type library and implementing a function for each event that can be fired. But before you can use it, you must generate your type library. To do this you can either rebuild your project or right click on the .idl file in the **FileView** and click **Compile Polygon.idl**. This will create the Polygon.tlb file, which is your type library.

After compiling your type library, follow these steps:

1. Go to the **Components and Controls Gallery** (on the **Project** menu, click **Add to Project**, then click **Components and Controls**).
2. In **Components and Controls Gallery**, double-click the **Developer Studio Components** folder. Select the **ATL Proxy Generator** and click the **Insert** button.

You will be asked to confirm insertion. Click **OK**. The **ATL Proxy Generator** dialog box appears.

3. Click on the button labeled **...** and select the Polygon.tlb file.
   The type library will be read and the two interfaces that you implemented (`_PolyEvents` and `IPolyCtl`) will appear in the **Not selected** box.
4. To generate a connection point for the event interface, select `_PolyEvents` and click the **>** button to move `_PolyEvents` to the **Selected** box.
   You want a connection point, so leave the **Proxy Type** as **Connection Point**.
5. Click **Insert**.
6. A standard **Save** dialog box appears and suggests CPPolygon.h as the filename. Accept this name and click **Save**.
7. A message that the proxy has been successfully generated appears. Click **OK**.
8. Now click **Close**, then click **Close** again to close the **Components and Controls Gallery**.



If you look at the generated CPPolygon.h file, you see it has a class called `CProxy_PolyEvents` that derives from **IConnectionPointImpl**. CPPolygon.h also defines the two methods `Fire_ClickIn` and `Fire_ClickOut`, which take the two coordinate parameters. These are the methods you call when you want to fire an event from your control.

Now include the CPPolygon.h file at the top of PolyCtl.h:

```
#include <math.h>
#include "resource.h"       // main symbols
#include "CPPolygon.h"
```

Now add the `CProxy_PolyEvents` class to the `CPolyCtl` class inheritance list in PolyCtl.h. You also need to implement **IConnectionPointContainer**. ATL supplies an implementation of this interface in the class **IConnectionPointContainerImpl**. Therefore, add these two lines to `CPolyCtl` class inheritance list in PolyCtl.h:

```
public CProxy_PolyEvents<CPolyCtl>,
public IConnectionPointContainerImpl<CPolyCtl>
```

Also, you need to make the interface _PolyEvents the default outgoing interface, so supply it as the second parameter to **IProvideClassInfo2Impl** in the CPolyCtl class inheritance list in PolyCtl.h:

```
public IProvideClassInfo2Impl<&CLSID_PolyCtl, &DIID__PolyEvents,
                              &LIBID_POLYGONLib>,
```

The CPolyCtl class declaration now looks like this:

```
class ATL_NO_VTABLE CPolyCtl :
   public CComObjectRootEx<CComObjectThreadModel>,
   public CComCoClass<CPolyCtl, &CLSID_PolyCtl>,
   public CComControl<CPolyCtl>,
   public CStockPropImpl<CPolyCtl, IPolyCtl, &IID_IPolyCtl,
                                             &LIBID_POLYGONLib>,
   public IProvideClassInfo2Impl<&CLSID_PolyCtl, &DIID__PolyEvents,
                                 &LIBID_POLYGONLib>,
   public IPersistStreamInitImpl<CPolyCtl>,
   public IPersistStorageImpl<CPolyCtl>,
   public IQuickActivateImpl<CPolyCtl>,
   public IOleControlImpl<CPolyCtl>,
   public IOleObjectImpl<CPolyCtl>,
   public IOleInPlaceActiveObjectImpl<CPolyCtl>,
   public IViewObjectExImpl<CPolyCtl>,
   public IOleInPlaceObjectWindowlessImpl<CPolyCtl>,
   public IDataObjectImpl<CPolyCtl>,
   public ISupportErrorInfo,
   public ISpecifyPropertyPagesImpl<CPolyCtl>,
   public CProxy_PolyEvents<CPolyCtl>,
   public IConnectionPointContainerImpl<CPolyCtl>
```

Next expose **IConnectionPointContainer** through your **QueryInterface** function by adding it to your COM map. Note that you don't need to expose **IConnectionPoint** through **QueryInterface,** since the client obtains this interface through the use of **IConnectionPointContainer**. Add the following line to the end of the COM map in PolyCtl.h:

```
COM_INTERFACE_ENTRY_IMPL(IConnectionPointContainer)
```

The COM map now looks like this:

```
BEGIN_COM_MAP(CPolyCtl)
   COM_INTERFACE_ENTRY(IPolyCtl)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY_IMPL(IViewObjectEx)
   COM_INTERFACE_ENTRY_IMPL_IID(IID_IViewObject2, IViewObjectEx)
   COM_INTERFACE_ENTRY_IMPL_IID(IID_IViewObject, IViewObjectEx)
   COM_INTERFACE_ENTRY_IMPL(IOleInPlaceObjectWindowless)
   COM_INTERFACE_ENTRY_IMPL_IID(IID_IOleInPlaceObject,
                                IOleInPlaceObjectWindowless)
   COM_INTERFACE_ENTRY_IMPL_IID(IID_IOleWindow,
                                IOleInPlaceObjectWindowless)
   COM_INTERFACE_ENTRY_IMPL(IOleInPlaceActiveObject)
```

```
   COM_INTERFACE_ENTRY_IMPL(IOleControl)
   COM_INTERFACE_ENTRY_IMPL(IOleObject)
   COM_INTERFACE_ENTRY_IMPL(IQuickActivate)
   COM_INTERFACE_ENTRY_IMPL(IPersistStorage)
   COM_INTERFACE_ENTRY_IMPL(IPersistStreamInit)
   COM_INTERFACE_ENTRY_IMPL(ISpecifyPropertyPages)
   COM_INTERFACE_ENTRY_IMPL(IDataObject)
   COM_INTERFACE_ENTRY(IProvideClassInfo)
   COM_INTERFACE_ENTRY(IProvideClassInfo2)
   COM_INTERFACE_ENTRY(ISupportErrorInfo)
   COM_INTERFACE_ENTRY_IMPL(IConnectionPointContainer)
END_COM_MAP()
```

There is one more thing to do for connection points and that is to tell the ATL implementation of **IConnectionPointContainer** which connection points are available. You do this through the use of a connection point map, which is simply a list of the interface identifiers for each supported connection point. Add the following three lines after the COM map in PolyCtl.h. Note that there are two underscore characters in the identifier name for the interface, since MIDL prepends `DIID_` onto the interface name that you defined earlier, which starts with an underscore character.

```
BEGIN_CONNECTION_POINT_MAP(CPolyCtl)
   CONNECTION_POINT_ENTRY(DIID__PolyEvents)
END_CONNECTION_POINT_MAP()
```

You are done implementing the code to support events. Now, add some code to fire the events at the appropriate moment. Remember, you are going to fire a `ClickIn` or `ClickOut` event when the user clicks the left mouse button in the control. To find out when the user clicks the button, first add a handler for the **WM_LBUTTONDOWN** message. In PolyCtl.h, add the following line to the message map:

```
   MESSAGE_HANDLER(WM_LBUTTONDOWN, OnLButtonDown)
```

The message map now looks like this:

```
BEGIN_MSG_MAP(CPolyCtl)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
   MESSAGE_HANDLER(WM_GETDLGCODE, OnGetDlgCode)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
   MESSAGE_HANDLER(WM_KILLFOCUS, OnKillFocus)
   MESSAGE_HANDLER(WM_LBUTTONDOWN, OnLButtonDown)
END_MSG_MAP()
```

To supply the implementation of `OnLButtonDown`, add the following code after the `OnDraw` prototype in PolyCtl.h:

```
LRESULT OnLButtonDown(UINT uMsg, WPARAM wParam,
                      LPARAM lParam, BOOL& bHandled);
```

Next, add the following code after the OnDraw implementation in PolyCtl.cpp:

```
LRESULT CPolyCtl::OnLButtonDown(UINT uMsg, WPARAM wParam, LPARAM lParam,
                                BOOL& bHandled)
{
   HRGN hRgn;
   WORD xPos = LOWORD(lParam);  // horizontal position of cursor
   WORD yPos = HIWORD(lParam);  // vertical position of cursor

   // Create a region from our list of points
   hRgn = CreatePolygonRgn(&m_arrPoint[0], m_nSides, WINDING);

   // If the clicked point is in our polygon then fire the ClickIn
   // event otherwise we fire the ClickOut event
   if (PtInRegion(hRgn, xPos, yPos))
      Fire_ClickIn(xPos, yPos);
   else
      Fire_ClickOut(xPos, yPos);

   // Delete the region that we created
   DeleteObject(hRgn);
   return 0;
}
```

Since you have already calculated the points of the polygon in the OnDraw function, use them in OnLButtonDown to create a region. Then, use the **PtInRegion** API function to determine whether the clicked point is inside the polygon or not.

The uMsg parameter is the ID of the Windows message being handled. This allows you to have one function that handles a range of messages. The wParam and the lParam are the standard values for the message being handled. The parameter bHandled allows you to specify whether the function handled the message or not. By default, the value is set to **TRUE** to indicate that the function handled the message, but you can set it to **FALSE.** Doing so will cause ATL to continue looking for another message handler function to which to send the message.

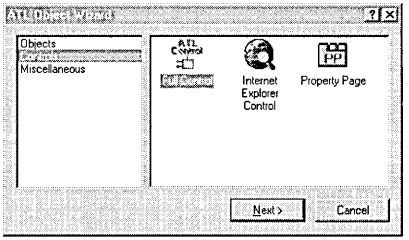
Now try out your events. Build the control and start **ActiveX Control Test Container** again. This time open the event log window by clicking **Event Log** on the **View** menu. Now insert the control and try clicking in the window. Notice that ClickIn is fired if you click within the filled polygon and ClickOut is fired when you click outside it.

Next you will add a property page.

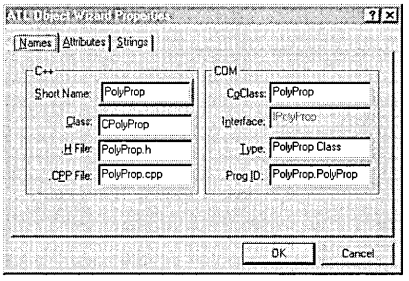
Step 6: Adding a Property Page

Property pages are implemented as separate COM objects, which allow property pages to be shared if required. To add a property page to your control you can use the ATL Object Wizard.

Start the ATL Object Wizard and select **Controls** as the category on the left. Select **Property Page** on the right, then click **Next**.

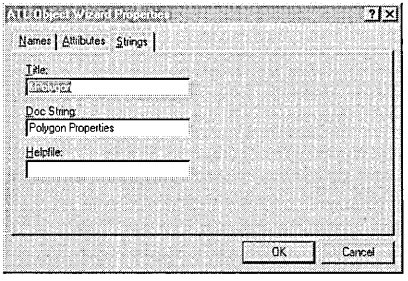


You again get the dialog box allowing you to enter the name of the new object. Call the object PolyProp and enter that name in the **Short Name** edit box.



Notice that the **Interface** edit box is grayed out. This is because a property page doesn't need a custom interface.

Click on the **Strings** tab to set the title of the property page. The title of the property page is the string that appears in the tab for that page. The **Doc String** is a description that a property frame could use to put in a status line or tool tip. Note that the standard property frame currently doesn't use this string, but you can set it anyway. You're not going to generate a **Helpfile** at the moment, so erase the entry in that text box. Click **OK** and the property page object will be created.



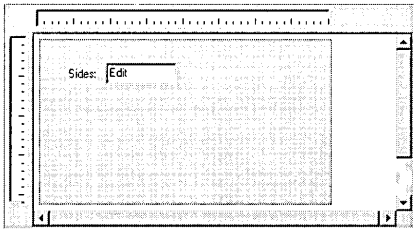
The following three files are created:

File	Description
PolyProp.h	Contains the C++ class `CPolyProp`, which implements the property page.
PolyProp.cpp	Includes the PolyProp.h file.
PolyProp.rgs	The registry script that registers the property page object.

The following code changes are also made:

- The new property page is added to the object entry map in Polygon.cpp.
- The `PolyProp` class is added to the Polygon.idl file.
- The new registry script file PolyProp.rgs is added to the project resource.
- A dialog box template is added to the project resource for the property page.
- The property strings you specified are added to the resource string table.

Now add the fields that you want to appear on the property page. Switch to **ResourceView**, then open the dialog `IDD_POLYPROP`. Notice that it is empty except for a label that tells you to put your property page controls here. Delete that label and add one that contains the text "Sides:". Next to the label add an edit box and give it an ID of `IDC_SIDES`.



Include Polygon.h at the top of the PolyProp.h file:

```
#include "Polygon.h" // definition of IPolyCtl
```

Now enable the `CPolyProp` class to set the number of sides in your object when the **Apply** button is pressed. Change the `Apply` function in PolyProp.h as follows.

```
STDMETHOD(Apply)(void)
{
   USES_CONVERSION;
   ATLTRACE(_T("CPolyProp::Apply\n"));
   for (UINT i = 0; i < m_nObjects; i++)
   {
      CComQIPtr<IPolyCtl, &IID_IPolyCtl> pPoly(m_ppUnk[i]);
      short nSides = (short)GetDlgItemInt(IDC_SIDES);
      if FAILED(pPoly->put_Sides(nSides))
```

```
        {
            CComPtr<IErrorInfo> pError;
            CComBSTR       strError;
            GetErrorInfo(0, &pError);
            pError->GetDescription(&strError);
            MessageBox(OLE2T(strError), _T("Error"), MB_ICONEXCLAMATION);
            return E_FAIL;
        }
    }
    m_bDirty = FALSE;
    return S_OK;
}
```

A property page could have more than one client attached to it at a time, so the `Apply` function loops around and calls `put_Sides` on each client with the value retrieved from the edit box. You are using the **CComQIPtr** class, which performs the **QueryInterface** on each object to obtain the `IPolyCtl` interface from the **IUnknown** (stored in the `m_ppUnk` array).

Check that setting the Sides property actually worked. If it fails, you get a message box displaying error details from the **IErrorInfo** interface. Typically, a container asks an object for the **ISupportErrorInfo** interface and calls **InterfaceSupportsErrorInfo** first, to determine whether the object supports setting error information. But since it's your control, you can forego that check.

CComPtr helps you by automatically handling the reference counting, so you don't need to call **Release** on the interface. **CComBSTR** helps you with **BSTR** processing, so you don't have to perform the final **SysFreeString** call. You also use one of the various string conversion classes, so you can convert the **BSTR** if necessary (this is why we add the **USES_CONVERSION** macro at the start of the function).

You also must set the property page's dirty flag to indicate that the **Apply** button should be enabled. This occurs when the user changes the value in the Sides edit box, so add this line to the message map in PolyProp.h:

```
COMMAND_HANDLER(IDC_SIDES, EN_CHANGE, OnSidesChange)
```

The property page message map now looks like this:

```
BEGIN_MSG_MAP(CPolyProp)
    COMMAND_HANDLER(IDC_SIDES, EN_CHANGE, OnSidesChange)
    CHAIN_MSG_MAP(IPropertyPageImpl<CPolyProp>)
END_MSG_MAP()
```

Now add the `OnSidesChange` function after the `Apply` function:

```
LRESULT OnSidesChange(WORD wNotify, WORD wID, HWND hWnd, BOOL& bHandled)
{
    SetDirty(TRUE);
    return 0;
}
```

`OnSidesChange` will be called when a **WM_COMMAND** message is sent with the **EN_CHANGE** notification for the `IDC_SIDES` control. `OnSidesChange` then calls

`SetDirty` and passes **TRUE** to indicate the property page is now dirty and the **Apply** button should be enabled.

Now, add the property page to your control. The ATL Object Wizard doesn't do this for you automatically, since there could be multiple controls in your project. Open PolyCtl.h and add this line to the property map:

```
PROP_ENTRY("Sides", 1, CLSID_PolyProp)
```

The control's property map now looks like this:

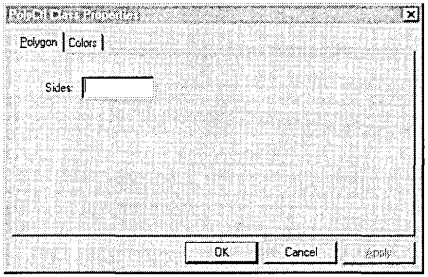
```
BEGIN_PROPERTY_MAP(CPolyCtl)
   //PROP_ENTRY("Description", dispid, clsid)
   PROP_ENTRY("Sides", 1, CLSID_PolyProp)
   PROP_PAGE(CLSID_StockColorPage)
END_PROPERTY_MAP()
```

You could have added a `PROP_PAGE` macro with the CLSID of your property page, but if you use the `PROP_ENTRY` macro as shown, the Sides property value is also saved when the control is saved. The three parameters to the macro are the property description, the DISPID of the property, and the CLSID of the property page that has the property on it. This is useful if, for example, you load the control into Visual Basic and set the number of Sides at design time. Since the number of Sides is saved, when you reload your Visual Basic project the number of Sides will be restored.

Now build that control and insert it into **ActiveX Control Test Container**. Then follow the steps below:

1. In **Test Container**, on the **Edit** menu click **Embedded Object Functions**.
2. Click **Properties** on the submenu.

The property page appears.



The **Apply** button is initially disabled. Start typing a value in the Sides edit box and the Apply button will become enabled. After you have finished entering the value, click the **Apply** button. The control display changes and the **Apply** button is again disabled. Try entering an invalid value and you should see a message box containing the error description that you set from the `put_Sides` function.

Next you'll put your control on a Web page.

Step 7: Putting the Control on a Web Page

Your control is now finished. To see your control work in a real-world situation, put it on a Web page. When the ATL Object Wizard creates the initial control it also creates an HTML file that contains the control. You can open up the PolyCtl.htm file in Internet Explorer and you see your control on a Web page.

The control doesn't do anything yet, so change the Web page to respond to the events that you send. Open PolyCtl.htm in Developer Studio and add the lines in **bold**.

```
<HTML>
<HEAD>
<TITLE>ATL 2.0 test page for object PolyCtl</TITLE>
</HEAD>
<BODY>
<OBJECT ID="PolyCtl" <
 CLASSID="CLSID:4CBBC676-507F-11D0-B98B-000000000000">
>
</OBJECT>
<SCRIPT LANGUAGE="VBScript">
<!--
Sub PolyCtl_ClickIn(x, y)
   PolyCtl.Sides = PolyCtl.Sides + 1
End Sub
Sub PolyCtl_ClickOut(x, y)
   PolyCtl.Sides = PolyCtl.Sides - 1
End Sub
-->
</SCRIPT>
</BODY>
</HTML>
```

You have added some VBScript code that gets the Sides property from the control, and increases the number of sides by one if you click inside the control. If you click outside the control you reduce the number of sides by one.

Start up Internet Explorer and make sure your **Security** settings are set to **Medium**:

1. Click **Options** on the **View** menu.
2. Select the **Security** tab and click **Safety Level**.
3. Set the security to medium if necessary, then click **OK**.
4. Click **OK** to close the **Options** dialog box.

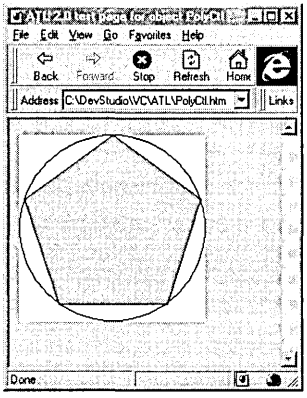
Now open PolyCtl.htm. A **Safety Violation** dialog box informs you that Internet Explorer doesn't know if the control is safe to script.

What does this mean? Imagine if you had a control that, for example, displayed a file, but also had a `Delete` method that deleted a file. The control would be safe if you

just viewed it on a page, but wouldn't be safe to script since someone could call the `Delete` method. This message is Internet Explorer's way of saying that it doesn't know if someone could do damage with this control so it is asking the user.

You know your control is safe, so click **Yes**. Now click inside the polygon; the number of sides increases by one. Click outside the polygon to reduce the number of sides. If you try to reduce the number of sides below three, you will see the error message that you set.

The following figure shows the control running in Internet Explorer after you have clicked inside the polygon twice.



Since you know your control is always safe to script, it would be good to let Internet Explorer know, so that it doesn't need to show the **Safety Violation** dialog box. You can do this through the **IObjectSafety** interface. ATL supplies an implementation of this interface in the class **IObjectSafetyImpl**.

To add the interface to your control, just add **IObjectSafetyImpl** to your list of inherited classes and add an entry for it in your COM map.

Add the following line to the end of the list of inherited classes in PolyCtl.h, remembering to add a comma to the previous line:

```
public IObjectSafetyImpl<CPolyCtl>
```

Then add the following line to the COM map in PolyCtl.h:

```
COM_INTERFACE_ENTRY_IMPL(IObjectSafety)
```

Now build the control. Once the build has finished, open PolyCtl.htm in Internet Explorer again. This time the Web page should be displayed directly without the **Safety Violation** dialog box. Click inside and outside the polygon to confirm that the scripting is working.

ATL References

This tutorial has demonstrated some basic concepts about using ATL.

To view the available ATL documentation, see:

- ATL Article Overview
- ATL Class Overview
- ATL Samples Index (online)

Appendix

This appendix contains the PolyCtl.h and Poly.cpp code created by the ATL Object Wizard when generating a full control with the **Support ISupportErrorInfo** option chosen on the **Attributes** tab.

PolyCtl.cpp implements the **InterfaceSupportsErrorInfo** function for the **ISupportErrorInfo** interface and the **OnDraw** function.

PolyCtl.h shows how ATL uses multiple inheritance to implement the necessary interfaces. This provides a flexible way of implementing a COM object, since it allows you to add and remove interfaces easily. The list of interfaces that will be exposed through **QueryInterface** are specified in the COM map.

The `DECLARE_REGISTRY_RESOURCEID` macro simply specifies the resource ID containing the registry script and is used to register and unregister the control.

The property map indicates which properties of the object will persist, meaning they can be loaded and saved. The property map also identifies the property pages used by the object.

The message map indicates which function will be called to handle the various Windows messages.

```
// PolyCtl.h : Declaration of the CPolyCtl

#ifndef __POLYCTL_H_
#define __POLYCTL_H_

#include "resource.h"       // main symbols

/////////////////////////////////////////////////////////////
// CPolyCtl
class ATL_NO_VTABLE CPolyCtl :
   public CComObjectRootEx<CComObjectThreadModel>,
   public CComCoClass<CPolyCtl, &CLSID_PolyCtl>,
   public CComControl<CPolyCtl>,
   public CStockPropImpl<CPolyCtl, IPolyCtl, &IID_IPolyCtl, &LIBID_TEMPLib>,
   public IProvideClassInfo2Impl<&CLSID_PolyCtl, NULL, &LIBID_TEMPLib>,
```

```
    public IPersistStreamInitImpl<CPolyCtl>,
    public IPersistStorageImpl<CPolyCtl>,
    public IQuickActivateImpl<CPolyCtl>,
    public IOleControlImpl<CPolyCtl>,
    public IOleObjectImpl<CPolyCtl>,
    public IOleInPlaceActiveObjectImpl<CPolyCtl>,
    public IViewObjectExImpl<CPolyCtl>,
    public IOleInPlaceObjectWindowlessImpl<CPolyCtl>,
    public IDataObjectImpl<CPolyCtl>,
    public ISupportErrorInfo,
    public ISpecifyPropertyPagesImpl<CPolyCtl>
{
public:
    CPolyCtl()
    {

    }

DECLARE_REGISTRY_RESOURCEID(IDR_PolyCtl)

DECLARE_POLY_AGGREGATABLE(CPolyCtl)

BEGIN_COM_MAP(CPolyCtl)
    COM_INTERFACE_ENTRY(IPolyCtl)
    COM_INTERFACE_ENTRY(IDispatch)
    COM_INTERFACE_ENTRY_IMPL(IViewObjectEx)
    COM_INTERFACE_ENTRY_IMPL_IID(IID_IViewObject2, IViewObjectEx)
    COM_INTERFACE_ENTRY_IMPL_IID(IID_IViewObject, IViewObjectEx)
    COM_INTERFACE_ENTRY_IMPL(IOleInPlaceObjectWindowless)
    COM_INTERFACE_ENTRY_IMPL_IID(IID_IOleInPlaceObject,
                                 IOleInPlaceObjectWindowless)
    COM_INTERFACE_ENTRY_IMPL_IID(IID_IOleWindow,
                                 IOleInPlaceObjectWindowless)
    COM_INTERFACE_ENTRY_IMPL(IOleInPlaceActiveObject)
    COM_INTERFACE_ENTRY_IMPL(IOleControl)
    COM_INTERFACE_ENTRY_IMPL(IOleObject)
    COM_INTERFACE_ENTRY_IMPL(IQuickActivate)
    COM_INTERFACE_ENTRY_IMPL(IPersistStorage)
    COM_INTERFACE_ENTRY_IMPL(IPersistStreamInit)
    COM_INTERFACE_ENTRY_IMPL(ISpecifyPropertyPages)
    COM_INTERFACE_ENTRY_IMPL(IDataObject)
    COM_INTERFACE_ENTRY(IProvideClassInfo)
    COM_INTERFACE_ENTRY(IProvideClassInfo2)
    COM_INTERFACE_ENTRY(ISupportErrorInfo)
END_COM_MAP()

BEGIN_PROPERTY_MAP(CPolyCtl)
    // PROP_ENTRY("Description", dispid, clsid)
    PROP_PAGE(CLSID_StockColorPage)
END_PROPERTY_MAP()

BEGIN_MSG_MAP(CPolyCtl)
    MESSAGE_HANDLER(WM_PAINT, OnPaint)
    MESSAGE_HANDLER(WM_GETDLGCODE, OnGetDlgCode)
```

```
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
   MESSAGE_HANDLER(WM_KILLFOCUS, OnKillFocus)
END_MSG_MAP()

// IViewObjectEx
   STDMETHOD(GetViewStatus)(DWORD* pdwStatus)
   {
      ATLTRACE(_T("IViewObjectExImpl::GetViewStatus\n"));
   *pdwStatus = VIEWSTATUS_SOLIDBKGND|VIEWSTATUS_OPAQUE;
   return S_OK;
   }

// IPolyCtl
public:
   HRESULT OnDraw(ATL_DRAWINFO& di);

};
#endif // __POLYCTL_H_
```

The following code is the PolyCtl.cpp file generated by the ATL Object Wizard when the **Support ISupportErrorInfo** option is chosen. You can see that the default drawing code simply draws a rectangle with the text "ATL 2.0" in the center.

```
// PolyCtl.cpp : Implementation of CPolyCtl
#include "stdafx.h"
#include "Polygon.h"
#include "PolyCtl.h"

/////////////////////////////////////////////////////////////////////////////
// CPolyCtl

STDMETHODIMP CPolyCtl::InterfaceSupportsErrorInfo(REFIID riid)
{
   static const IID* arr[] =
   {
      &IID_IPolyCtl,
   };
   for (int i=0;i<sizeof(arr)/sizeof(arr[0]);i++)
   {
      if (InlineIsEqualGUID(*arr[i],riid))
         return S_OK;
   }
   return S_FALSE;
}

HRESULT CPolyCtl::OnDraw(ATL_DRAWINFO& di)
{
   RECT& rc = *(RECT*)di.prcBounds;
   Rectangle(di.hdcDraw, rc.left, rc.top, rc.right, rc.bottom);
   DrawText(di.hdcDraw, _T("ATL 2.0"), -1, &rc,
            DT_CENTER | DT_VCENTER | DT_SINGLELINE);
   return S_OK;

}
```

PART 3

Active Template Library Reference

3ATL Class Overview

Classes in the Active Template Library (ATL) can be categorized as follows:

Class Factories
Class Information
COM Modules
Connection Points
Controls: General Support
Data Transfer
Data Types
Dual Interfaces
Error Information
Interface Pointers
IUnknown Implementation
Object Safety
Persistence
Properties and Property Pages
Registry Support
Running Objects
Site Information
Tear-Off Interfaces
Thread Pooling
Threading Models and Critical Sections
UI Support
Windows Support

See Also: "ATL Article Overview"

Class Factories

The following classes implement or support a class factory:

- **CComClassFactory** Provides a default class factory for object creation.
- **CComClassFactory2** Controls object creation through a license.
- **CComClassFactoryAutoThread** Allows objects to be created in multiple thread-pooled apartments.
- **CComClassFactorySingleton** Creates a single object.
- **CComCoClass** Defines the class factory for the object.

See Also: Aggregation and Class Factory Macros

Class Information

The following class provides support for retrieving class information:

- **IProvideClassInfo2Impl** Provides access to type information. Retrieves the outgoing IID for the object's default event set.

COM Modules

The following classes provide support for a COM module:

- **CComModule** Implements a DLL or EXE module.
- **CComAutoThreadModule** Implements an EXE module, with support for multiple thread-pooled apartments.

Connection Points

The following classes provide support for connection points:

- **IConnectionPointContainerImpl** Implements a connection point container.
- **IConnectionPointImpl** Implements a connection point.
- **IPropertyNotifySinkCP** Implements a connection point representing the **IPropertyNotifySink** interface.
- **CComDynamicUnkArray** Manages unlimited connections between a connection point and its sinks.
- **CComUnkArray** Manages a fixed number of connections between a connection point and its sinks.
- **CFirePropNotifyEvent** Notifies a client's sink that an object's property has changed or is about to change.

Related Articles "Connection Points"

See Also: Connection Point Macros and Global Functions

Controls: General Support

The following classes provide general support for ATL controls:

- **CComControl** Consists of helper functions and data members that are essential to ATL controls.
- **IOleControlImpl** Provides methods necessary for controls.
- **IOleObjectImpl** Provides the principal methods through which a container communicates with a control. Manages the activation and deactivation of in-place controls.
- **IQuickActivateImpl** Combines initialization into a single call to help containers avoid delays when loading controls.
- **IPointerInactiveImpl** Provides minimal mouse interaction for an otherwise inactive control.

Related Articles "ATL Tutorial"

Data Transfer

The following classes support various types of data transfer:

- **IDataObjectImpl** Supports Uniform Data Transfer by using standard formats to retrieve and set data. Handles data change notifications by managing connections to advise sinks.
- **CBindStatusCallback** Allows an asynchronous moniker to send and receive information about the asynchronous data transfer to and from your object.

Data Types

The following classes wrap C++ data types:

- **CComBSTR** Wraps the **BSTR** data type.
- **CComVariant** Wraps the **VARIANT** data type.

Dual Interfaces

The following class provides support for dual interfaces:

- **IDispatchImpl** Implements the **IDispatch** portion of a dual interface.

Error Information

The following class indicates how error information is handled:

- **ISupportErrorInfoImpl** Determines whether the object supports the **IErrorInfo** interface. **IErrorInfo** allows error information to be propagated back to the client.

Interface Pointers

The following classes manage a given interface pointer:

- **CComPtr** Performs automatic reference counting.
- **CComQIPtr** Similar to **CComPtr**, but also performs automatic querying of interfaces.

IUnknown Implementation

The following classes implement **IUnknown** and related methods:

- **CComObjectRootEx** Manages reference counting for both aggregated and nonaggregated objects. Allows you to specify a threading model.
- **CComObjectRoot** Manages reference counting for both aggregated and nonaggregated objects. Uses the default threading model of the server.
- **CComAggObject** Implements **IUnknown** for an aggregated object.
- **CComObject** Implements **IUnknown** for a nonaggregated object.
- **CComPolyObject** Implements **IUnknown** for aggregated and nonaggregated objects. Using **CComPolyObject** avoids having both **CComAggObject** and **CComObject** in your module. A single **CComPolyObject** object handles both aggregated and nonaggregated cases.
- **CComObjectNoLock** Implements **IUnknown** for a nonaggregated object, without modifying the module lock count.
- **CComTearOffObject** Implements **IUnknown** for a tear-off interface.
- **CComCachedTearOffObject** Implements **IUnknown** for a "cached" tear-off interface.
- **CComContainedObject** Implements **IUnknown** for the inner object of an aggregation or a tear-off interface.
- **CComObjectGlobal** Manages a reference count on the module to ensure your object won't be deleted.
- **CComObjectStack** Creates a temporary COM object, using a skeletal implementation of **IUnknown**.

Related Articles "Fundamentals of ATL COM Objects"

See Also: Aggregation and Class Factory Macros, COM Map Macros and Global Functions

Object Safety

The following class provides support for object safety:

- **IObjectSafetyImpl** Allows an object to be marked as safe for initialization or safe for scripting.

Related Articles "ATL Tutorial"

Persistence

The following classes implement object persistence:

- **IPersistStreamInitImpl** Allows a client to load and save an object's persistent data to a stream.
- **IPersistStorageImpl** Allows a client to load and save an object's persistent data to a storage.
- **IPersistPropertyBagImpl** Allows a client to load and save an object's properties to a property bag.

Related Articles "ATL Tutorial"

See Also: Property Map Macros

Properties and Property Pages

The following classes support properties and property pages:

- **IPropertyPageImpl** Manages a particular property page within a property sheet.
- **IPropertyPage2Impl** Similar to **IPropertyPageImpl**, but also allows a client to select a specific property in a property page.
- **IPerPropertyBrowsingImpl** Accesses the information in an object's property pages.
- **ISpecifyPropertyPagesImpl** Obtains the CLSIDs for the property pages supported by an object.
- **IPersistPropertyBagImpl** Stores an object's properties in a client-supplied property bag.
- **CComDispatchDriver** Retrieves or sets an object's properties through an **IDispatch** pointer.
- **CStockPropImpl** Implements the stock properties supported by ATL.

Related Articles "ATL Tutorial"

See Also: Property Map Macros, Stock Property Macros

Registry Support

The following class provides registry support:

- **CRegKey** Contains methods for manipulating values in the system registry.

Related Articles "The ATL Registry Component (Registrar)"

See Also: Registry Macros

Running Objects

The following class provides support for running objects:

- **IRunnableObjectImpl** Determines if an object is running, forces it to run, or locks it into the running state.

Related Articles "ATL Tutorial"

Site Information

The following classes allow an object to communicate with its site:

- **IObjectWithSiteImpl** Retrieves and sets a pointer to an object's site. Used for objects that are not controls.
- **IOleObjectImpl** Retrieves and sets a pointer to an object's site. Used for controls.

Tear-Off Interfaces

The following classes provide support for tear-off interfaces:

- **CComTearOffObject** Implements **IUnknown** for a tear-off interface.
- **CComCachedTearOffObject** Implements **IUnknown** for a "cached" tear-off interface.

Thread Pooling

The following classes support thread pooling:

- **CComAutoThreadModule** Implements an EXE module, with support for multiple thread-pooled apartments.
- **CComApartment** Manages an apartment in a thread-pooled EXE module.
- **CComSimpleThreadAllocator** Manages thread selection for an EXE module.

Threading Models and Critical Sections

The following classes define a threading model and critical section:

- **CComMultiThreadModel** Provides thread-safe methods for incrementing and decrementing a variable. Provides a critical section.
- **CComMultiThreadModelNoCS** Provides thread-safe methods for incrementing and decrementing a variable. Does not provide a critical section.

- **CComSingleThreadModel** Provides methods for incrementing and decrementing a variable. Does not provide a critical section.
- **CComObjectThreadModel** Determines the appropriate threading-model class for a single object class.
- **CComGlobalsThreadModel** Determines the appropriate threading-model class for an object that is globally available.
- **CComAutoCriticalSection** Contains methods for obtaining and releasing a critical section. The critical section is automatically initialized.
- **CComCriticalSection** Contains methods for obtaining and releasing a critical section. The critical section must be explicitly initialized.
- **CComFakeCriticalSection** Mirrors the methods in **CComCriticalSection** without providing a critical section. The methods in **CComFakeCriticalSection** do nothing.

UI Support

The following classes provide general UI support:

- **IOleObjectImpl** Provides the principal methods through which a container communicates with a control. Manages the activation and deactivation of in-place controls.
- **IOleInPlaceObjectWindowlessImpl** Manages the reactivation of in-place controls. Enables a windowless control to receive messages, as well as to participate in drag and drop operations.
- **IOleInPlaceActiveObjectImpl** Assists communication between an in-place control and its container.
- **IViewObjectExImpl** Enables a control to display itself directly and to notify the container of changes in its display. Provides support for flicker-free drawing, non-rectangular and transparent controls, and hit testing.

Related Articles "ATL Tutorial"

Windows Support

The following classes provide support for windows:

- **CWindow** Contains methods for manipulating a window. **CWindow** is the base class for **CWindowImpl**, **CDialogImpl**, and **CContainedWindow**.
- **CWindowImpl** Implements a window based on a new window class. Also allows you to subclass or superclass the window.
- **CDialogImpl** Implements a dialog box.

- **CContainedWindow** Implements a window contained within another object. Allows you to subclass or superclass the window.
- **CWndClassInfo** Manages the information of a new window class.
- **CDynamicChain** Supports dynamic chaining of message maps.
- **CMessageMap** Allows an object to expose its message maps to other objects.

Related Articles "ATL Window Classes," "ATL Tutorial"

See Also: Message Map Macros, Window Class Macros

CBindStatusCallback

template< class *T* >
class CBindStatusCallback :
public CComObjectRootEx<*T*::_ThreadModel::ThreadModelNoCS>,
public IBindStatusCallbackImpl<*T*>

Parameters

T Your class, derived from **IBindStatusCallbackImpl**.

The **CBindStatusCallback** class implements the **IBindStatusCallback** interface. **IBindStatusCallback** must be implemented by your application so it can receive notifications from an asynchronous data transfer. The asynchronous moniker provided by the system uses **IBindStatusCallback** methods to send and receive information about the asynchronous data transfer to and from your object.

Typically, the **CBindStatusCallback** object is associated with a specific bind operation. For example, in the ASYNC sample, when you set the URL property, it creates a **CBindStatusCallback** object in the call to **Download**:

```
STDMETHOD(put_URL)(BSTR strURL)
{
   ...
   m_bstrURL = strURL;
   CBindStatusCallback<CATLAsync>::Download(this,
      OnData, m_bstrURL, m_spClientSite, FALSE);
   return S_OK;
}
```

The asynchronous moniker uses the callback function `OnData` to call your application when it has data. The asynchronous moniker is provided by the system.

See the *ActiveX SDK* online for a description of **IBindStatusCallback**.

#include <atlctl.h>

IBindStatusCallback Methods

GetBindInfo	Called by the asynchronous moniker to request information on the type of bind to be created.
GetPriority	Called by the asynchronous moniker to get the priority of the bind operation. The ATL implementation returns **E_NOTIMPL**.
OnLowResource	Called when resources are low. The ATL implementation returns **S_OK**.
OnObjectAvailable	Called by the asynchronous moniker to pass an object interface pointer to your application. The ATL implementation returns **S_OK**.
OnProgress	Called to indicate the progress of a data downloading process. The ATL implementation returns **S_OK**.
OnStartBinding	Called when binding is started.
OnStopBinding	Called when the asynchronous data transfer is stopped.

Class Methods

CBindStatusCallback	Constructor.
Download	Starts the download process, creates a **CBindStatusCallback** object, and calls **StartAsyncDownload.**
OnDataAvailable	Called to provide data to your application as it becomes available. Reads the data, then calls the function passed to it to use the data.
StartAsyncDownload	Initializes the bytes available and bytes read to zero, creates a push-type stream object from a URL, and calls **OnDataAvailable** every time data is available.

Data Members

m_dwAvailableToRead	Number of bytes available to read.
m_dwTotalRead	Total number of bytes read.
m_pFunc	Pointer to the function called when data is available.
m_pT	Pointer to the object requesting the asynchronous data transfer.
m_spBindCtx	Pointer to the **IBindCtx** interface for the current bind operation.
m_spBinding	Pointer to the **IBinding** interface for the current bind operation. See the *ActiveX SDK* online for a description of **IBinding**.
m_spMoniker	Pointer to the **IMoniker** interface for the URL to use.
m_spStream	Pointer to the **IStream** interface for the data transfer.

Methods

CBindStatusCallback::CBindStatusCallback

CBindStatusCallback( );

Remarks

The constructor. Creates an object to receive notifications concerning the asynchronous data transfer. Typically, one object is created for each bind operation.

The constructor also initializes **m_pT** and **m_pFunc** to **NULL**.

See Also: CBindStatusCallback::StartAsyncDownload

CBindStatusCallback::Download

HRESULT Download(*T* pT*, **ATL_PDATAAVAILABLE** *pFunc*, **BSTR** *bstrURL*,
↪ **IUnknown*** *pUnkContainer* = **NULL**, **BOOL** *bRelative* = **FALSE);**

Return Value

One of the standard **HRESULT** values.

Parameters

pT [in] A pointer to the object requesting the asynchronous data transfer. The **CBindStatusCallback** object is templatized on this object's class.

pFunc [in] A pointer to the function that receives the data that is read. The function is a member of your object's class of type *T*. See **StartAsyncDownload** for syntax and an example.

bstrURL [in] The URL to obtain data from. Can be any valid URL or file name. Cannot be **NULL**. For example:

```
CComBSTR mybstr =_T("http://somesite/data.htm")
```

pUnkContainer [in] The **IUnknown** of the container. **NULL** by default.

bRelative [in] A flag indicating whether the URL is relative or absolute. **FALSE** by default, meaning the URL is absolute.

Remarks

Creates a **CBindStatusCallback** object and calls **StartAsyncDownload** to start downloading data asynchronously from the specified URL. Every time data is available it is sent to the object through **OnDataAvailable**. **OnDataAvailable** reads the data and calls the function pointed to by *pFunc* (for example, to store the data or print it to the screen).

See Also: CBindStatusCallback::StartAsyncDownload

CBindStatusCallback::GetBindInfo

HRESULT GetBindInfo(DWORD* *pgrfBSCF*, **BINDINFO*** *pbindinfo* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pgrfBSCF [out] A pointer to **BINDF** enumeration values indicating how the bind operation should occur. By default, set with the following enumeration values:

BINDF_ASYNCHRONOUS Asynchronous download.

BINDF_ASYNCSTORAGE **OnDataAvailable** returns **E_PENDING** when data is not yet available rather than blocking until data is available.

BINDF_GETNEWESTVERSION The bind operation should retrieve the newest version of the data.

BINDF_NOWRITECACHE The bind operation should not store retrieved data in the disk cache.

pbindinfo [in, out] A pointer to the **BINDINFO** structure giving more information about how the object wants binding to occur.

Remarks

Called to tell the moniker how to bind. The default implementation sets the binding to be asynchronous and to use the data-push model. In the data-push model, the moniker drives the asynchronous bind operation and continuously notifies the client whenever new data is available.

See **IBindStatusCallback::GetBindInfo** in the *ActiveX SDK* online.

CBindStatusCallback::GetPriority

HRESULT GetPriority(LONG* *pnPriority* **);**

See **IBindStatusCallback::GetPriority** in the *ActiveX SDK* online.

Remarks

Returns **E_NOTIMPL**.

CBindStatusCallback::OnDataAvailable

HRESULT OnDataAvailable(DWORD *grfBSCF*, **DWORD** *dwSize*,
➥ **FORMATETC*** *pformatetc*, **STGMEDIUM*** *pstgmed* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

grfBSCF [in] A **BSCF** enumeration value. One or more of the following: **BSCF_FIRSTDATANOTIFICATION**, **BSCF_INTERMEDIARYDATANOTIFICATION**, or **BSCF_LASTDATANOTIFICATION**.

dwSize [in] The cumulative amount (in bytes) of data available since the beginning of the binding. Can be zero, indicating that the amount of data is not relevant or that no specific amount became available.

pformatetc [in] Pointer to the **FORMATETC** structure that contains the format of the available data. If there is no format, can be **CF_NULL**.

pstgmed [in] Pointer to the **STGMEDIUM** structure that holds the actual data now available.

Remarks

The system-supplied asynchronous moniker calls **OnDataAvailable** to provide data to the object as it becomes available.

OnDataAvailable reads the data, then calls a method of your object's class (for example, to store the data or print it to the screen). See **CBindStatusCallback::StartAsyncDownload** for details.

See Also: CBindStatusCallback::StartAsyncDownload

CBindStatusCallback::OnLowResource

HRESULT OnLowResource(DWORD *dwReserved* **);**

See **IBindStatusCallback::OnLowResource** in the *ActiveX SDK* online.

Remarks

Returns **S_OK**.

CBindStatusCallback::OnObjectAvailable

HRESULT OnObjectAvailable(REFID *riid*, **IUnknown*** *punk* **);**

See **IBindStatusCallback::OnObjectAvailable** in the *ActiveX SDK* online.

Remarks

Returns **S_OK**.

CBindStatusCallback::OnProgress

HRESULT OnProgress(ULONG *ulProgress*, **ULONG** *ulProgressMax*,
↪ **ULONG** *ulStatusCode*, **LPCWSTRONG** *szStatusText* **);**

See **IBindStatusCallback::OnProgress** in the *ActiveX SDK* online.

Remarks

Returns **S_OK**.

CBindStatusCallback::OnStartBinding

HRESULT OnStartBinding(DWORD *dwReserved*, **IBinding*** *pBinding* **);**

See **IBindStatusCallback::OnStartBinding** in the *ActiveX SDK* online.

Remarks

Sets the data member **m_spBinding** to the **IBinding** pointer in *pBinding*.

See Also: CBindStatusCallback::OnStopBinding

CBindStatusCallback::OnStopBinding

HRESULT OnStopBinding(HRESULT *hresult*, **LPCWSTR** *szError* **);**

See **IBindStatusCallback::OnStopBinding** in the *ActiveX SDK* online.

Remarks

Releases the **IBinding** pointer in the data member **m_spBinding**. Called by the system-supplied asynchronous moniker to indicate the end of the bind operation.

See Also: CBindStatusCallback::OnStartBinding

CBindStatusCallback::StartAsyncDownload

HRESULT StartAsyncDownload(*T* pT*, **ATL_PDATAAVAILABLE** *pFunc*,
↪ **BSTR** *bstrURL*, **BOOL** *bRelative* = **FALSE);**

Return Value

One of the standard **HRESULT** values.

Parameters

pT [in] A pointer to the object requesting the asynchronous data transfer. The **CBindStatusCallback** object is templatized on this object's class.

pFunc [in] A pointer to the function that receives the data being read. The function is a member of your object's class of type *T*. See **Remarks** for syntax and an example.

bstrURL [in] The URL to obtain data from. Can be any valid URL or file name. Cannot be **NULL**. For example:

```
CComBSTR mybstr =_T("http://somesite/data.htm")
```

pUnkContainer [in] The **IUnknown** of the container. **NULL** by default.

bRelative [in] A flag indicating whether the URL is relative or absolute. **FALSE** by default, meaning the URL is absolute.

Remarks

Starts downloading data asynchronously from the specified URL. Every time data is available it is sent to the object through **OnDataAvailable**. **OnDataAvailable** reads the data and calls the function pointed to by *pFunc* (for example, to store the data or print it to the screen).

The function pointed to by *pFunc* is a member of your object's class and has the following syntax:

void Function_Name(CBindStatusCallback<*T***>*** *pbsc*, **BYTE*** *pBytes*,
↪ **DWORD** *dwSize* **);**

In the following example (taken from the ASYNC sample), the function `OnData` writes the received data into a text box:

```
void OnData(CBindStatusCallback<CATLAsync>* pbsc,
            BYTE* pBytes, DWORD dwSize)
{
   m_bstrText.Append= (LPCSTR)pBytes;
   if (::IsWindow(m_EditCtrl.m_hWnd))
   {
      USES_CONVERSION;
      ::SendMessage(m_EditCtrl.m_hWnd, WM_SETTEXT, 0,
            (LPARAM)OLE2CT((BSTR)m_bstrText));
   }
}
```

See Also: **CBindStatusCallback::OnDataAvailable**

Data Members

CBindStatusCallback::m_dwAvailableToRead

DWORD m_dwAvailableToRead;

Remarks

Can be used to store the number of bytes available to be read. Initialized to zero in **StartAsyncDownload**.

See Also: **CBindStatusCallback::StartAsyncDownload**

CBindStatusCallback::m_dwTotalRead

DWORD m_dwTotalRead;

Remarks

The cumulative total of bytes read in the asychronous data transfer. Incremented every time **OnDataAvailable** is called by the number of bytes actually read. Initialized to zero in **StartAsyncDownload**.

See Also: **CBindStatusCallback::StartAsyncDownload**, **CBindStatusCallback::OnDataAvailable**

CBindStatusCallback::m_pFunc

ATL_PDATAAVAILABLE m_pFunc;

Remarks

The function pointed to by **m_pFunc** is called by **OnDataAvailable** after it reads the available data (for example, to store the data or print it to the screen).

The function pointed to by **m_pFunc** is a member of your object's class and has the following syntax:

void Function_Name(CBindStatusCallback<*T*>* *pbsc*, BYTE* *pBytes*,
↪ DWORD *dwSize*);

See Also: CBindStatusCallback::StartAsyncDownload, CBindStatusCallback::OnDataAvailable

---

CBindStatusCallback::m_pT

***T** m_pT;**

Remarks

A pointer to the object requesting the asynchronous data transfer. The **CBindStatusCallback** object is templatized on this object's class.

See Also: CBindStatusCallback::StartAsyncDownload

CBindStatusCallback::m_spBindCtx

CComPtr<IBindCtx> m_spBindCtx;

Remarks

A pointer to an **IBindCtx** interface that provides access to the bind context (an object that stores information about a particular moniker binding operation). Initialized in **StartAsyncDownload**.

See Also: CBindStatusCallback::StartAsyncDownload, CComPtr

CBindStatusCallback::m_spBinding

CComPtr<IBinding> m_spBinding;

Remarks

A pointer to the **IBinding** interface of the current bind operation. Initialized in **OnStartBinding** and released in **OnStopBinding**.

See the *ActiveX SDK* online for a description of **IBinding**.

See Also: CBindStatusCallback::OnStartBinding, CBindStatusCallback::OnStopBinding, CComPtr

CBindStatusCallback::m_spMoniker

CComPtr<IMoniker> m_spMoniker;

Remarks

A pointer to the **IMoniker** interface for the URL to use. Initialized in **StartAsyncDownload**.

See Also: CBindStatusCallback::StartAsyncDownload, CComPtr

CBindStatusCallback::m_spStream

CComPtr<IStream> m_spStream;

Remarks

A pointer to the **IStream** interface of the current bind operation. Initialized in **OnDataAvailable** from the **STGMEDIUM** structure when the **BCSF** flag is **BCSF_FIRSTDATANOTIFICATION** and released when the **BCSF** flag is **BCSF_LASTDATANOTIFICATION**.

See Also: CBindStatusCallback::OnDataAvailable, CComPtr

CComAggObject

template< class *contained* **>**
class CComAggObject : public IUnknown,
public CComObjectRootEx< *contained*::_ThreadModel::ThreadModelNoCS >

Parameters

contained Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interfaces you want to support on the object.

CComAggObject implements **IUnknown** for an aggregated object. **CComAggObject** has its own **IUnknown**, separate from the outer object's **IUnknown**, and maintains its own reference count.

CComAggObject uses **CComContainedObject** to delegate to the outer unknown.

For more information about aggregation, see the article "Fundamentals of ATL COM Objects."

#include <atlcom.h>

See Also: CComObject, CComPolyObject, DECLARE_AGGREGATABLE, DECLARE_ONLY_AGGREGATABLE, DECLARE_NOT_AGGREGATABLE

Class Methods

CComAggObject	Constructor.
FinalConstruct	Performs final initialization of **m_contained**.
FinalRelease	Performs final destruction of **m_contained**.

IUnknown Methods

AddRef	Increments the reference count on the aggregated object.
QueryInterface	Retrieves a pointer to the requested interface.
Release	Decrements the reference count on the aggregated object.

Data Members

m_contained	Delegates **IUnknown** calls to the outer unknown.

Methods

CComAggObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Increments the reference count on the aggregated object.

See Also: **CComAggObject::Release**

CComAggObject::CComAggObject

CComAggObject(void* *pv* **);**

Parameters

pv [in] The outer unknown.

Remarks

The constructor. Initializes the **CComContainedObject** member, **m_contained**, and increments the module lock count.

The destructor decrements the module lock count.

See Also: **CComAggObject::FinalConstruct, CComAggObject::FinalRelease**

CComAggObject::FinalConstruct

HRESULT FinalConstruct( );

Return Value

A standard **HRESULT** value.

Remarks

Called during the final stages of object construction, this method performs any final initialization on the **m_contained** member.

See Also: **CComObjectRootEx::FinalConstruct, CComAggObject::FinalRelease**

CComAggObject::FinalRelease

void FinalRelease( );

Remarks

Called during object destruction, this method frees the **m_contained** member.

See Also: **CComObjectRootEx::FinalRelease, CComAggObject::FinalConstruct**

CComAggObject::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The identifier of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Retrieves a pointer to the requested interface. If the requested interface is **IUnknown**, **QueryInterface** returns a pointer to the aggregated object's own **IUnknown** and increments the reference count. Otherwise, this method queries for the interface through the **CComContainedObject** member, **m_contained**.

CComAggObject::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics or testing. In non-debug builds, **Release** always returns 0.

Remarks

Decrements the reference count on the aggregated object.

See Also: CComAggObject::AddRef

Data Members

CComAggObject::m_contained

CComContainedObject< *contained* **> m_contained;**

Parameters

contained [in] Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interfaces you want to support on the object.

Remarks

A **CComContainedObject** object derived from your class. All **IUnknown** calls through **m_contained** are delegated to the outer unknown.

CComApartment

class CComApartment

CComApartment is used by **CComAutoThreadModule** to manage an apartment in a thread-pooled EXE module. **CComApartment** provides methods for incrementing and decrementing the lock count on a thread.

#include <atlbase.h>

Methods	
Apartment	Marks the starting address of the thread.
GetLockCount	Returns the current lock count on the thread.
Lock	Increments the lock count on the thread.
Unlock	Decrements the lock count on the thread.

Data Members	
m_dwThreadID	Contains the identifier of the thread.
m_hThread	Contains the handle to the thread.
m_nLockCnt	Contains the current lock count on the thread.

Methods

CComApartment::Apartment

DWORD Apartment( );

Return Value

Always 0.

Remarks

The thread function marking the starting address of the thread. Automatically set during **CComAutoThreadModule::Init**.

CComApartment::GetLockCount

LONG GetLockCount( );

Return Value

The lock count on the thread.

Remarks

Returns the current lock count on the thread.

See Also: CComApartment::Lock, CComApartment::Unlock, CComApartment::m_nLockCnt

---

CComApartment::Lock

LONG Lock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic increment on the thread's lock count. Called by **CComAutoThreadModule::Lock**.

The lock count on the thread is used for statistical purposes.

See Also: CComApartment:Unlock, CComApartment::GetLockCount, CComApartment::m_nLockCnt

---

CComApartment::Unlock

LONG Unlock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic decrement on the thread's lock count. Called by **CComAutoThreadModule::Unlock**.

The lock count on the thread is used for statistical purposes.

See Also: CComApartment::Lock, CComApartment::GetLockCount, CComApartment::m_nLockCnt

---

Data Members

CComApartment::m_dwThreadID

DWORD m_dwThreadID;

Remarks

Contains the identifier of the thread.

CComApartment::m_hThread

HANDLE m_hThread;

Remarks

Contains the handle to the thread.

CComApartment::m_nLockCnt

LONG m_nLockCnt;

Remarks

Contains the current lock count on the thread.

See Also: CComApartment::Lock, CComApartment::Unlock

CComAutoCriticalSection

class CComAutoCriticalSection

CComAutoCriticalSection provides methods for obtaining and releasing ownership of a critical section object. **CComAutoCriticalSection** is similar to class **CComCriticalSection**, except **CComAutoCriticalSection** automatically initializes critical section objects in the constructor.

Typically, you use **CComAutoCriticalSection** through the **typedef** name **AutoCriticalSection**. This name references **CComAutoCriticalSection** when **CComMultiThreadModel** is being used.

You should not use **CComAutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code. In this case, use **CComCriticalSection**.

#include <atlbase.h>

See Also: CComFakeCriticalSection

Methods

CComAutoCriticalSection	Constructor.
Lock	Obtains ownership of the critical section object.
Unlock	Releases ownership of the critical section object.

Data Members

m_sec	A **CRITICAL_SECTION** object.

Methods

CComAutoCriticalSection::CComAutoCriticalSection

void CComAutoCriticalSection( );

Remarks

The constructor. Calls the Win32 function **InitializeCriticalSection**, which initializes the critical section object contained in the **m_sec** data member.

The destructor calls **DeleteCriticalSection**, which releases all system resources used by the critical section object.

CComAutoCriticalSection::Lock

void Lock( );

Remarks

Calls the Win32 function **EnterCriticalSection**, which waits until the thread can take ownership of the critical section object contained in the **m_sec** data member. When the protected code has finished executing, the thread must call **Unlock** to release ownership of the critical section.

CComAutoCriticalSection::Unlock

void Unlock( );

Remarks

Calls the Win32 function **LeaveCriticalSection**, which releases ownership of the critical section object contained in the **m_sec** data member. To first obtain ownership, the thread must call the **Lock** method. Each call to **Lock** then requires a corresponding call to **Unlock** to release ownership of the critical section.

Data Members

CComAutoCriticalSection::m_sec

CRITICAL_SECTION m_sec;

Remarks

Contains a critical section object that is used by all **CComAutoCriticalSection** methods.

See Also: CComAutoCriticalSection::CComAutoCriticalSection, CComAutoCriticalSection::Lock, CComAutoCriticalSection::Unlock

CComAutoThreadModule

template< class *ThreadAllocator* **= CComSimpleThreadAllocator >**
class CComAutoThreadModule : public CComModule

Parameters

ThreadAllocator [in] The class managing thread selection. The default value is **CComSimpleThreadAllocator**.

CComAutoThreadModule derives from **CComModule** to implement a thread-pooled, apartment-model COM server for EXEs and Windows NT services. **CComAutoThreadModule** uses **CComApartment** to manage an apartment for each thread in the module.

Derive your module from **CComAutoThreadModule** when you want to create objects in multiple apartments. You must also include the **DECLARE_CLASSFACTORY_AUTO_THREAD** macro in your object's class definition to specify **CComClassFactoryAutoThread** as the class factory.

By default, the ATL COM AppWizard will derive your module from **CComModule**. To use **CComAutoThreadModule**, modify the class definition. For example:

```
class CMyModule :
public CComAutoThreadModule<CComSimpleThreadAllocator>
{
public:
   LONG Unlock( )
   {
      LONG l = CComAutoThreadModule<ComSimpleThreadAllocator>::Unlock( );
      if (l == 0)
         PostThreadMessage(dwThreadID, WM_QUIT, 0, 0);
      return l;
   }

   DWORD dwThreadID;
};
```

For more information about the AppWizard, see the article "Creating an ATL Project."

#include <atlbase.h>

Methods

CreateInstance	Selects a thread and then creates an object in the associated apartment.
GetDefaultThreads	Dynamically calculates the number of threads for the module based on the number of processors.
Init	Creates the module's threads.
Lock	Increments the lock count on the module and on the current thread.
Unlock	Decrements the lock count on the module and on the current thread.

Data Members

dwThreadID	Contains the identifier of the current thread.
m_Allocator	Manages thread selection.
m_nThreads	Contains the number of threads in the module.
m_pApartments	Manages the module's apartments.

Methods

CComAutoThreadModule::CreateInstance

HRESULT CreateInstance(void* *pfnCreateInstance*,
↪ **REFIID** *riid*, **void**** *ppvObj*);

Return Value

A standard **HRESULT** value.

Parameters

pfnCreateInstance [in] A pointer to a creator function.

riid [in] The IID of the requested interface.

ppvObj [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppvObj* is set to **NULL**.

Remarks

Selects a thread and then creates an object in the associated apartment. Called by **CComClassFactoryAutoThread::CreateInstance**.

CComAutoThreadModule::GetDefaultThreads

static int GetDefaultThreads( );

Return Value

The number of threads to be created in the EXE module.

Remarks

This static method dynamically calculates the maximum number of threads for the EXE module, based on the number of processors. By default, this return value is passed to the **Init** method to create the threads.

CComAutoThreadModule::Init

void Init(_ATL_OBJMAP_ENTRY* *p*, **HINSTANCE** *h*,
↪ **int** *nThreads* = **GetDefaultThreads( ));**

Parameters

p [in] A pointer to an array of object map entries.

h [in] The **HINSTANCE** passed to **DLLMain** or **WinMain**.

nThreads [in] The number of threads to be created. By default, *nThreads* is the value returned by **GetDefaultThreads**.

Remarks

Initializes data members and creates the number of threads specified by *nThreads*.

See Also: CComAutoThreadModule::m_nThreads

CComAutoThreadModule::Lock

LONG Lock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic increment on the lock count for the module and for the current thread. **CComAutoThreadModule** uses the module lock count to determine whether any clients are accessing the module. The lock count on the current thread is used for statistical purposes.

See Also: CComAutoThreadModule::Unlock, CComModule::m_nLockCnt, CComApartment::m_nLockCnt

---

CComAutoThreadModule::Unlock

LONG Unlock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic decrement on the lock count for the module and for the current thread. **CComAutoThreadModule** uses the module lock count to determine whether any clients are accessing the module. The lock count on the current thread is used for statistical purposes.

When the module lock count reaches zero, the module can be unloaded.

See Also: CComAutoThreadModule::Lock, CComModule::m_nLockCnt, CComApartment::m_nLockCnt

---

Data Members

CComAutoThreadModule::dwThreadID

DWORD dwThreadID;

Remarks

Contains the identifier of the current thread.

CComAutoThreadModule::m_Allocator

ThreadAllocator **m_Allocator;**

Remarks

The object managing thread selection. By default, the *ThreadAllocator* class template parameter is **CComSimpleThreadAllocator**.

CComAutoThreadModule::m_nThreads

int m_nThreads;

Remarks

Contains the number of threads in the EXE module. When **Init** is called, **m_nThreads** is set to the *nThreads* parameter value. Each thread's associated apartment is managed by a **CComApartment** object.

See Also: CComAutoThreadModule::m_pApartments

CComAutoThreadModule::m_pApartments

CComApartment* m_pApartments;

Remarks

Points to an array of **CComApartment** objects, each of which manages an apartment in the module. The number of elements in the array is based on the **m_nThreads** member.

CComBSTR

class CComBSTR

The **CComBSTR** class is a wrapper for **BSTR**s, length-prefixed strings. The length is stored as an integer at the memory location preceding the data in the string.

A **BSTR** is null-terminated after the last counted character, but may also contain null characters embedded within the string. The string length is determined by the character count, not the first null character.

#include <atlbase.h>

Methods

Append	Appends a string to **m_str**.
AppendBSTR	Appends a **BSTR** to **m_str**.
Attach	Attaches a **BSTR** to the **CComBSTR** object.
CComBstr	Constructor.
Copy	Returns a copy of **m_str**.
Detach	Detaches **m_str** from the **CComBSTR** object.
Empty	Frees **m_str**.
Length	Returns the length of **m_str**.
ReadFromStream	Loads a **BSTR** object from a stream.
WriteToStream	Saves **m_str** to a stream.

Operators

operator BSTR	Converts a **CComBSTR** object to a **BSTR**.
operator =	Assigns a value to **m_str**.
operator +=	Appends a **CComBSTR** to the object.
operator &	Returns the address of **m_str**.
operator !	Returns **TRUE** or **FALSE**, depending on whether **m_str** is **NULL**.

Data Members

m_str	Contains the **BSTR** associated with the **CComBSTR** object.

Methods

CComBSTR::Append

void Append(const CComBSTR& *bstrSrc* **);**
void Append(LPCOLESTR *lpsz* **);**
void Append(LPCSTR *lpsz* **);**
void Append(LPCOLESTR *lpsz*, **int** *nLen* **);**

Parameters

bstrSrc [in] A **CComBSTR** object.

lpsz [in] A character string. The Unicode version specifies an **LPCOLESTR**; the ANSI version specifies an **LPCSTR**.

nLen [in] The number of characters from *lpsz* to append.

Remarks

Appends either *lpsz* or the **BSTR** member of *bstrSrc* to **m_str**.

See Also: CComBSTR::AppendBSTR, CComBSTR::operator +=

CComBSTR::AppendBSTR

void AppendBSTR(BSTR *p* **);**

Parameters

p [in] A **BSTR** to append.

Remarks

Appends the specified **BSTR** to **m_str**.

See Also: CComBSTR::Append, CComBSTR::operator +=

CComBSTR::Attach

void Attach(BSTR *src* **);**

Parameters

src [in] The **BSTR** to attach to the object.

Remarks

Attaches a **BSTR** to the **CComBSTR** object by setting the **m_str** member to *src*.

Note This method will assert if **m_str** is non-**NULL**.

See Also: CComBSTR::Detach, CComBSTR::operator =

CComBSTR::CComBSTR

CComBSTR( );
CComBSTR(int *nSize*, **LPCOLESTR** *sz* = **NULL);**
CComBSTR(int *nSize*, **LPCSTR** *sz* = **NULL);**
CComBSTR(LPCOLESTR *pSrc* **);**
CComBSTR(LPCSTR *pSrc* **);**
CComBSTR(const CComBSTR& *src* **);**

Parameters

nSize [in] The number of characters to copy from *sz*.

sz [in] A string to copy. The Unicode version specifies an **LPCOLESTR**; the ANSI version specifies an **LPCSTR**. Only *nSize* characters will be copied. The default value is **NULL**.

pSrc [in] A string to copy. The Unicode version specifies an **LPCOLESTR**; the ANSI version specifies an **LPCSTR**.

src [in] A **CComBSTR** object.

Remarks

The default constructor sets the **m_str** member to **NULL**. The copy constructor sets **m_str** to a copy of the **BSTR** member of *src*.

The other four constructors set **m_str** to a copy of the specified string; however, if you pass a value for *nSize*, then only *nSize* characters will be copied, followed by a terminating null character.

The destructor frees the string pointed to by **m_str**.

CComBSTR::Copy

BSTR Copy( ) const;

Return Value

A copy of the **m_str** member.

Remarks

Allocates and returns a copy of **m_str**.

See Also: CComBSTR::operator =

CComBSTR::Detach

BSTR Detach( );

Return Value

The **BSTR** associated with the **CComBSTR** object.

Remarks

Detaches **m_str** from the **CComBSTR** object and sets **m_str** to **NULL**.

See Also: CComBSTR::Attach

CComBSTR::Empty

void Empty( );

Remarks

Frees the **m_str** member.

CComBSTR::Length

unsigned int Length( ) const;

Return Value

The length of the **m_str** member.

Remarks

Returns the number of characters in **m_str**, excluding the terminating null character.

CComBSTR::ReadFromStream

HRESULT ReadFromStream(IStream* *pStream* **);**

Return Value

A standard **HRESULT** value.

Parameters

pStream [in] A pointer to the **IStream** interface on the stream containing the data.

Remarks

Sets the **m_str** member to the **BSTR** contained in the specified stream.
ReadToStream requires a previous call to **WriteToStream**.

CComBSTR::WriteToStream

HRESULT WriteToStream(IStream* *pStream* **);**

Return Value

A standard **HRESULT** value.

Parameters

pStream [in] A pointer to the **IStream** interface on a stream.

Remarks

Saves the **m_str** member to a stream.

See Also: CComBSTR::ReadFromStream

Operators

CComBSTR::operator BSTR

operator BSTR( ) const;

Remarks

Converts a **CComBSTR** object to a **BSTR**.

CComBSTR::operator =

CComBSTR& operator =(LPCOLESTR *pSrc* **);**
CComBSTR& operator =(LPCSTR *pSrc* **);**
CComBSTR& operator =(const CComBSTR& *src* **);**

Remarks

Sets the **m_str** member to a copy of *pSrc* or to a copy of the **BSTR** member of *src*. The *pSrc* parameter specifies either an **LPCOLESTR** for Unicode versions or **LPCSTR** for ANSI versions.

See Also: CComBSTR::Copy

CComBSTR::operator +=

CComBSTR& operator +=(const CComBSTR& *bstrSrc* **);**

Remarks

Appends the **BSTR** member of *bstrSrc* to **m_str**.

See Also: CComBSTR::Append, CComBSTR::AppendBSTR

CComBSTR::operator &

BSTR* operator &( );

Remarks

Returns the address of the **BSTR** stored in the **m_str** member.

CComBSTR::operator !

bool operator !( );

Remarks

Returns **true** if the **m_str** member is **NULL**; otherwise, **false**.

Data Members

CComBSTR::m_str

BSTR m_str;

Remarks

Contains the **BSTR** associated with the **CComBSTR** object.

CComCachedTearOffObject

template <class *contained***>**
class CComCachedTearOffObject : public IUnknown,
public CComObjectRootEx< *contained*::_ThreadModel::ThreadModelNoCS >

Parameters

contained Your tear-off class, derived from **CComTearOffObjectBase** and the interfaces you want your tear-off object to support.

CComCachedTearOffObject implements **IUnknown** for a tear-off interface. This class differs from **CComTearOffObject** in that **CComCachedTearOffObject** has its own **IUnknown**, separate from the owner object's **IUnknown** (the owner is the object for which the tear-off is being created). **CComCachedTearOffObject** maintains its own reference count on its **IUnknown** and deletes itself once its reference count is 0. Note, however, that querying for any of its tear-off interfaces increments the reference count of the owner object's **IUnknown**.

If the **CComCachedTearOffObject** object implementing the tear-off is already instantiated, and the tear-off interface is queried for again, the same **CComCachedTearOffObject** object is reused. In contrast, if a tear-off interface implemented by a **CComTearOffObject** is again queried for through the owner object, another **CComTearOffObject** will be instantiated.

The owner class must implement **FinalRelease** and call **Release** on the cached **IUnknown** for the **CComCachedTearOffObject**, which will decrement its reference count. This will cause **CComCachedTearOffObject**'s **FinalRelease** to be called and delete the tear-off.

#include <atlcom.h>

See Also: CComTearOffObject, CComObjectRootEx

Methods

AddRef	Increments the reference count for a **CComCachedTearOffObject** object.
CComCachedTearOffObject	Constructor.
FinalConstruct	Calls the **m_contained::FinalConstruct** (the tear-off class' method).
FinalRelease	Calls the **m_contained::FinalRelease** (the tear-off class' method).
QueryInterface	Returns a pointer to the **IUnknown** of the **CComCachedTearOffObject** object, or to the requested interface on your tear-off class (the class *contained*).
Release	Decrements the reference count for a **CComCachedTearOffObject** object and destroys it if the reference count is 0.

Data Members

m_contained	A **CComContainedObject** object derived from your tear-off class (the class *contained*).

Methods

CComCachedTearOffObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics and testing.

Remarks

Increments the reference count of the **CComCachedTearOffObject** object by 1.

See Also: CComCachedTearOffObject::Release

CComCachedTearOffObject::CComCachedTearOffObject

CComCachedTearOffObject(void* *pv* **);**

Parameters

pv [in] Pointer to the **IUnknown** of the **CComCachedTearOffObject**.

Remarks

The constructor. Initializes the **CComContainedObject** member, **m_contained**.

See Also: CComTearOffObject

CComCachedTearOffObject::FinalConstruct

HRESULT FinalConstruct( );

Return Value

A standard **HRESULT** value.

Remarks

Calls **m_contained::FinalConstruct** to create **m_contained**, the **CComContainedObject**<*contained*> object used to access the interface implemented by your tear-off class.

See Also: CComCachedTearOffObject::FinalRelease

CComCachedTearOffObject::FinalRelease

void FinalRelease( );

Remarks

Calls **m_contained::FinalRelease** to free **m_contained**, the **CComContainedObject**<*contained*> object.

See Also: CComCachedTearOffObject::FinalConstruct

CComCachedTearOffObject::QueryInterface

HRESULT QueryInterface(REFIID *iid* , **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The GUID of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface. If the requested interface is **IUnknown**, returns a pointer to the **CComCachedTearOffObject**'s own **IUnknown** and increments the reference count. Otherwise, queries for the interface on your tear-off class using the **InternalQueryInterface** method inherited from **CComObjectRootEx**.

See Also: CComCachedTearOffObject::AddRef, CComCachedTearOffObject::Release

---

CComCachedTearOffObject::Release

ULONG Release( );

Return Value

In non-debug builds, always returns 0. In debug builds, returns the a value that may be useful for diagnostics or testing.

Remarks

Decrements the reference count by 1 and, if the reference count is 0, deletes the **CComCachedTearOffObject** object.

See Also: CComCachedTearOffObject::AddRef

Data Members

CComCachedTearOffObject::m_contained

CComContainedObject<*contained*> m_contained;

Parameters

contained [in] Your tear-off class, derived from **CComTearOffObjectBase** and the interfaces you want your tear-off object to support.

Remarks

A **CComContainedObject** object derived from your tear-off class. The methods **m_contained** inherits are used to access the tear-off interface in your tear-off class through the cached tear-off object's **QueryInterface**, **FinalConstruct**, and **FinalRelease**.

See Also: **CComTearOffObject**

CComClassFactory

class CComClassFactory : public IClassFactory,
public CComObjectRootEx< CComGlobalsThreadModel >

CComClassFactory implements the **IClassFactory** interface, which contains methods for creating an object of a particular CLSID, as well as locking the class factory in memory to allow new objects to be created more quickly. **IClassFactory** must be implemented for every class that you register in the system registry and to which you assign a CLSID.

ATL objects normally acquire a class factory by deriving from **CComCoClass**. This class includes the macro **DECLARE_CLASSFACTORY**, which declares **CComClassFactory** as the default class factory. To override this default, specify one of the **DECLARE_CLASSFACTORY***XXX* macros in your class definition. For example, the **DECLARE_CLASSFACTORY_EX** macro uses the specified class for the class factory:

```
class CMyClass : ..., public CComCoClass< ... >
{
public:
   DECLARE_CLASSFACTORY_EX(CMyClassFactory)

   ...
};
```

The above class definition specifies that **CMyClassFactory** will be used as the object's default class factory. **CMyClassFactory** must derive from **CComClassFactory** and override **CreateInstance**.

ATL provides three other macros that declare a class factory:

- **DECLARE_CLASSFACTORY2** Uses **CComClassFactory2**, which controls creation through a license.
- **DECLARE_CLASSFACTORY_AUTO_THREAD** Uses **CComClassFactoryAutoThread**, which creates objects in multiple apartments.
- **DECLARE_CLASSFACTORY_SINGLETON** Uses **CComClassFactorySingleton**, which constructs a single **CComObjectGlobal** object.

#include <atlcom.h>

See Also: CComObjectRootEx, CComGlobalsThreadModel

IClassFactory Methods

CreateInstance	Creates an object of the specified CLSID.
LockServer	Locks the class factory in memory.

Methods

CComClassFactory::CreateInstance

HRESULT CreateInstance(LPUNKNOWN *pUnkOuter*, **REFIID** *riid*,
↪ **void**** *ppvObj*);

Return Value

A standard **HRESULT** value.

Parameters

pUnkOuter [in] If the object is being created as part of an aggregate, then *pUnkOuter* must be the outer unknown. Otherwise, *pUnkOuter* must be **NULL**.

riid [in] The IID of the requested interface. If *pUnkOuter* is non-**NULL**, *riid* must be **IID_IUnknown**.

ppvObj [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppvObj* is set to **NULL**.

Remarks

Creates an object of the specified CLSID and retrieves an interface pointer to this object.

See Also: CoCreateInstance, CoGetClassObject

CComClassFactory::LockServer

HRESULT LockServer(BOOL *fLock*);

Return Value

A standard **HRESULT** value.

Parameters

fLock [in] If **TRUE**, the lock count is incremented; otherwise, the lock count is decremented.

Remarks

Increments and decrements the module lock count by calling **_Module::Lock** and **_Module::Unlock**, respectively. **_Module** refers to the global instance of **CComModule** or a class derived from it.

Calling **LockServer** allows a client to hold onto a class factory so that multiple objects can be created quickly.

See Also: CComModule::Lock, CComModule::Unlock

CComClassFactory2

template< class *license* **>**
class CComClassFactory2 : public CComClassFactory2Base, *license*

Parameters

license A class that implements the following static functions:

- **static BOOL VerifyLicenseKey(BSTR** *bstr* **);**
- **static BOOL GetLicenseKey(DWORD** *dwReserved*, **BSTR*** *pBstr* **);**
- **static BOOL IsLicenseValid( );**

CComClassFactory2 implements the **IClassFactory2** interface, which is an extension of **IClassFactory**. **IClassFactory2** controls object creation through a license. A class factory executing on a licensed machine can provide a run-time license key. This license key allows an application to instantiate objects when a full machine license does not exist.

ATL objects normally acquire a class factory by deriving from **CComCoClass**. This class includes the macro **DECLARE_CLASSFACTORY**, which declares **CComClassFactory** as the default class factory. To use **CComClassFactory2**, specify the **DECLARE_CLASSFACTORY2** macro in your object's class definition. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
public:
   DECLARE_CLASSFACTORY2(CMyLicense)

   ...
};
```

CMyLicense, the template parameter to **CComClassFactory2**, must implement the static functions **VerifyLicenseKey**, **GetLicenseKey**, and **IsLicenseValid**. The following is an example of a simple license class:

```
class CMyLicense
{
protected:
   static BOOL VerifyLicenseKey(BSTR bstr)
   {
      USES_CONVERSION;
      return !lstrcmp(OLE2T(bstr), _T("My run-time license key"));
   }

   static BOOL GetLicenseKey(DWORD dwReserved, BSTR* pBstr)
   {
      USES_CONVERSION;
      *pBstr = SysAllocString( T2OLE(_T("My run-time license key")));
      return TRUE;
   }
```

```
   static BOOL IsLicenseValid() {  return TRUE; }
};
```

CComClassFactory2 derives from both **CComClassFactory2Base** and *license*. **CComClassFactory2Base**, in turn, derives from **IClassFactory2** and **CComObjectRootEx< CComGlobalsThreadModel >.**

#include <atlcom.h>

See Also: CComClassFactoryAutoThread, CComClassFactorySingleton, CComObjectRootEx, CComGlobalsThreadModel

IClassFactory Methods

CreateInstance	Creates an object of the specified CLSID.
LockServer	Locks the class factory in memory.

IClassFactory2 Methods

CreateInstanceLic	Given a license key, creates an object of the specified CLSID.
GetLicInfo	Retrieves information describing the licensing capabilities of the class factory.
RequestLicKey	Creates and returns a license key.

Methods

CComClassFactory2::CreateInstance

HRESULT CreateInstance(LPUNKNOWN *pUnkOuter*, **REFIID** *riid*, **void**** *ppvObj* **);**

Return Value

A standard **HRESULT** value.

Parameters

pUnkOuter [in] If the object is being created as part of an aggregate, then *pUnkOuter* must be the outer unknown. Otherwise, *pUnkOuter* must be **NULL.**

riid [in] The IID of the requested interface. If *pUnkOuter* is non-**NULL**, *riid* must be **IID_IUnknown.**

ppvObj [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppvObj* is set to **NULL.**

Remarks

Creates an object of the specified CLSID and retrieves an interface pointer to this object. Requires the machine to be fully licensed. If a full machine license does not exist, call **CreateInstanceLic.**

See Also: CoCreateInstance, CoGetClassObject

CComClassFactory2::CreateInstanceLic

HRESULT CreateInstanceLic(IUnknown* *pUnkOuter*, **IUnknown*** *pUnkReserved*, ↪ **REFIID** *riid*, **BSTR** *bstrKey*, **void**** *ppvObject*);

Return Value

A standard **HRESULT** value.

Parameters

pUnkOuter [in] If the object is being created as part of an aggregate, then *pUnkOuter* must be the outer unknown. Otherwise, *pUnkOuter* must be **NULL**.

pUnkReserved [in] Not used. Must be **NULL**.

riid [in] The IID of the requested interface. If *pUnkOuter* is non-**NULL**, *riid* must be **IID_IUnknown**.

bstrKey [in] The run-time license key previously obtained from a call to **RequestLicKey**. This key is required to create the object.

ppvObject [out] A pointer to the interface pointer specified by *riid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Similar to **CreateInstance**, except that **CreateInstanceLic** requires a license key. You can obtain a license key using **RequestLicKey**. In order to create an object on an unlicensed machine, you must call **CreateInstanceLic**.

See Also: CoCreateInstance, CoGetClassObject

CComClassFactory2::GetLicInfo

HRESULT GetLicInfo(LICINFO* *pLicInfo*)

Return Value

A standard **HRESULT** value.

Parameters

pLicInfo [out] Pointer to a **LICINFO** structure.

Remarks

Fills a **LICINFO** structure with information that describes the class factory's licensing capabilities. The *fRuntimeKeyAvail* member of this structure indicates whether, given a license key, the class factory allows objects to be created on an unlicensed machine. The *fLicVerified* member indicates whether a full machine license exists.

See Also: CComClassFactory2::RequestLicKey, CComClassFactory2::CreateInstanceLic

CComClassFactory2::LockServer

HRESULT LockServer(BOOL *fLock* **);**

Return Value

A standard **HRESULT** value.

Parameters

fLock [in] If **TRUE**, the lock count is incremented; otherwise, the lock count is decremented.

Remarks

Increments and decrements the module lock count by calling **_Module::Lock** and **_Module::Unlock**, respectively. **_Module** refers to the global instance of **CComModule** or a class derived from it.

Calling **LockServer** allows a client to hold onto a class factory so that multiple objects can be quickly created.

See Also: CComModule::Lock, CComModule::Unlock

CComClassFactory2::RequestLicKey

HRESULT RequestLicKey(DWORD *dwReserved*, **BSTR*** *pbstrKey* **);**

Return Value

A standard **HRESULT** value.

Parameters

dwReserved [in] Not used. Must be zero.

pbstrKey [out] Pointer to the license key.

Remarks

Creates and returns a license key, provided that the *fRuntimeKeyAvail* member of the **LICINFO** structure is **TRUE**. A license key is required for calling **CreateInstanceLic** to create an object on an unlicensed machine. If *fRuntimeKeyAvail* is **FALSE**, then objects can only be created on a fully licensed machine.

Call **GetLicInfo** to retrieve the value of *fRuntimeKeyAvail.*

CComClassFactoryAutoThread

class CComClassFactoryAutoThread : public IClassFactory,
public CComObjectRootEx< CComGlobalsThreadModel >

CComClassFactoryAutoThread is similar to **CComClassFactory**, but allows objects to be created in multiple apartments. To take advantage of this support, derive your EXE module from **CComAutoThreadModule**.

ATL objects normally acquire a class factory by deriving from **CComCoClass**. This class includes the macro **DECLARE_CLASSFACTORY**, which declares **CComClassFactory** as the default class factory. To use **CComClassFactoryAutoThread**, specify the **DECLARE_CLASSFACTORY_AUTO_THREAD** macro in your object's class definition. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
public:
   DECLARE_CLASSFACTORY_AUTO_THREAD( )

   ...
};
```

#include <atlcom.h>

See Also: IClassFactory, CComClassFactory2, CComClassFactorySingleton, CComObjectRootEx, CComGlobalsThreadModel

IClassFactory Methods

CreateInstance	Creates an object of the specified CLSID.
LockServer	Locks the class factory in memory.

Methods

CComClassFactoryAutoThread::CreateInstance

HRESULT CreateInstance(LPUNKNOWN *pUnkOuter*, **REFIID** *riid*,
↪ **void**** *ppvObj*);

Return Value

A standard **HRESULT** value.

Parameters

pUnkOuter [in] If the object is being created as part of an aggregate, then *pUnkOuter* must be the outer unknown. Otherwise, *pUnkOuter* must be **NULL**.

riid [in] The IID of the requested interface. If *pUnkOuter* is non-**NULL**, *riid* must be **IID_IUnknown**.

ppvObj [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppvObj* is set to **NULL**.

Remarks

Creates an object of the specified CLSID and retrieves an interface pointer to this object. If your module derives from **CComAutoThreadModule**, **CreateInstance** first selects a thread to create the object in the associated apartment.

See Also: CoCreateInstance, CoGetClassObject

CComClassFactoryAutoThread::LockServer

HRESULT LockServer(BOOL *fLock* **);**

Return Value

A standard **HRESULT** value.

Parameters

fLock [in] If **TRUE**, the lock count is incremented; otherwise, the lock count is decremented.

Remarks

Increments and decrements the module lock count by calling **_Module::Lock** and **_Module::Unlock**, respectively. When using **CComClassFactoryAutoThread**, **_Module** typically refers to the global instance of **CComAutoThreadModule**.

Calling **LockServer** allows a client to hold onto a class factory so that multiple objects can be quickly created.

See Also: CComAutoThreadModule::Lock, CComAutoThreadModule::Unlock

CComClassFactorySingleton

template< class *T* >
class CComClassFactorySingleton : public CComClassFactory

Parameters

T Your class.

CComClassFactorySingleton derives from **CComClassFactory** and uses **CComObjectGlobal** to construct a single object. Each call to the **CreateInstance** method simply queries this object for an interface pointer.

ATL objects normally acquire a class factory by deriving from **CComCoClass**. This class includes the macro **DECLARE_CLASSFACTORY**, which declares **CComClassFactory** as the default class factory. To use **CComClassFactorySingleton**, specify the **DECLARE_CLASSFACTORY_SINGLETON** macro in your object's class definition. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
public:
   DECLARE_CLASSFACTORY_SINGLETON(CMyClass)

   ...
};
```

#include <atlcom.h>

See Also: IClassFactory, CComClassFactory2, CComClassFactoryAutoThread, CComObjectRootEx, CComGlobalsThreadModel

IClassFactory Methods

CreateInstance	Queries **m_Obj** for an interface pointer.

Data Members

m_Obj	The **CComObjectGlobal** object constructed by **CComClassFactorySingleton.**

Methods

CComClassFactorySingleton::CreateInstance

HRESULT CreateInstance(LPUNKNOWN *pUnkOuter*, **REFIID** *riid*, **void**** *ppvObj* **);**

Return Value

A standard **HRESULT** value.

Parameters

pUnkOuter [in] If the object is being created as part of an aggregate, then *pUnkOuter* must be the outer unknown. Otherwise, *pUnkOuter* must be **NULL**.

riid [in] The IID of the requested interface. If *pUnkOuter* is non-**NULL**, *riid* must be **IID_IUnknown**.

ppvObj [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppvObj* is set to **NULL**.

Remarks

Calls **QueryInterface** through **m_Obj** to retrieve an interface pointer.

See Also: CoCreateInstance, CoGetClassObject

Data Members

CComClassFactorySingleton::m_Obj

CComObjectGlobal< *T* > m_Obj;

Remarks

The **CComObjectGlobal** object constructed by **CComClassFactorySingleton**, where *T* is the class template parameter. Each call to the **CreateInstance** method simply queries this object for an interface pointer.

CComCoClass

template< class *T*, const CLSID* *pclsid* >
class CComCoClass

Parameters

T Your class, derived from **CComCoClass**.

pclsid A pointer to the CLSID of the object.

CComCoClass provides methods for retrieving an object's CLSID and setting error information. Any class object that can be created externally should be derived from **CComCoClass**.

CComCoClass also defines the default class factory and aggregation model for your object. **CComCoClass** uses the following two macros:

- **DECLARE_CLASSFACTORY** Declares the class factory to be **CComClassFactory**.
- **DECLARE_AGGREGATABLE** Declares that your object can be aggregated.

You can override either of these defaults by specifying another macro in your class definition. For example, to use **CComClassFactory2** instead of **CComClassFactory**, specify the **DECLARE_CLASSFACTORY2** macro:

```
class CMyClass : ...,
   public CComCoClass<CMyClass, &CLSID_CMyClass>
{
public:
   DECLARE_CLASSFACTORY2(CMyLicense)

   ...
};
```

#include <atlcom.h>

Methods

Error	Returns rich error information to the client.
GetObjectCLSID	Returns the object's class identifier.
GetObjectDescription	Override to return the object's description.

Methods

CComCoClass::Error

static HRESULT Error(LPCOLESTR *lpszDesc*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0);**
static HRESULT Error(LPCOLESTR *lpszDesc*, **DWORD** *dwHelpID*,
↪ **LPCOLESTR** *lpszHelpFile*, **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0);**
static HRESULT Error(LPCSTR *lpszDesc*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0);**
static HRESULT Error(LPCSTR *lpszDesc*, **DWORD** *dwHelpID*,
↪ **LPCSTR** *lpszHelpFile*, **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0);**
static HRESULT Error(UINT *nID*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0, HINSTANCE** *hInst* **= _Module.GetResourceInstance( ));**
static HRESULT Error(UINT *nID*, **DWORD** *dwHelpID*, **LPCOLESTR** *lpszHelpFile*,
↪ **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0,**
↪ **HINSTANCE** *hInst* **= _Module.GetResourceInstance( ));**

Return Value

A standard **HRESULT** value. For details, see Remarks.

Parameters

lpszDesc [in] The string describing the error. The Unicode version of **Error** specifies that *lpszDesc* is of type **LPCOLESTR**; the ANSI version specifies a type of **LPCSTR**.

iid [in] The IID of the interface defining the error or **GUID_NULL** (the default value) if the error is defined by the operating system.

hRes [in] The **HRESULT** you want returned to the caller. The default value is 0. For more details about *hRes*, see Remarks.

nID [in] The resource identifier where the error description string is stored. This value should lie between 0x0200 and 0xFFFF, inclusively. In debug builds, an **ASSERT** will result if *nID* does not index a valid string. In release builds, the error description string will be set to "Unknown Error."

dwHelpID [in] The help context identifier for the error.

lpszHelpFile [in] The path and name of the help file describing the error.

hInst [in] The handle to the resource. By default, this parameter is **_Module::GetResourceInstance**, where **_Module** is the global instance of **CComModule** or a class derived from it.

Remarks

This static method sets up the **IErrorInfo** interface to provide error information to the client. In order to call **Error**, your object must implement the **ISupportErrorInfo** interface.

If the *hRes* parameter is nonzero, then **Error** returns the value of *hRes*. If *hRes* is zero, then the first four versions of **Error** return **DISP_E_EXCEPTION**. The last two versions return the result of the macro **MAKE_HRESULT(1, FACILITY_ITF,** *nID*).

See Also: ISupportErrorInfoImpl, MAKE_HRESULT

CComCoClass::GetObjectCLSID

static const CLSID& GetObjectCLSID( );

Return Value

The object's class identifier.

Remarks

Provides a consistent way of retrieving the object's CLSID.

CComCoClass::GetObjectDescription

static LPCTSTR WINAPI GetObjectDescription( );

Return Value

The class object's description.

Remarks

This static method retrieves the text description for your class object. The default implementation returns **NULL**. You can override this method with the **DECLARE_OBJECT_DESCRIPTION** macro. For example:

```
class CMyClass : public CComCoClass< ... >, ...
{
public:
   DECLARE_OBJECT_DESCRIPTION("Account Transfer Object 1.0")

   ...
};
```

GetObjectDescription is called by **IComponentRegistrar::GetComponents**. **IComponentRegistrar** is an Automation interface that allows you to register and unregister individual components in a DLL. When you create a Component Registrar object with the ATL Object Wizard, the wizard will automatically implement the **IComponentRegistrar** interface. **IComponentRegistrar** is typically used by Microsoft Transaction Server.

For more information about the ATL Object Wizard, see the article "Creating an ATL Project."

CComContainedObject

template< class *Base* **>**
class CComContainedObject : public *Base*

Parameters

Base Your class, derived from **CComObjectRoot** or **CComObjectRootEx**.

ATL uses **CComContainedObject** in classes **CComAggObject**, **CComPolyObject**, and **CComCachedTearOffObject**. **CComContainedObject** implements **IUnknown** by delegating to the owner object's **IUnknown**. (The owner is either the outer object of an aggregation, or the object for which a tear-off interface is being created.) **CComContainedObject** calls **CComObjectRootEx**'s **OuterQueryInterface**, **OuterAddRef**, and **OuterRelease**, all inherited through *Base*.

#include <atlcom.h>

Class Methods

CComContainedObject	Constructor. Initializes the member pointer to the owner object's **IUnknown**.
GetControllingUnknown	Retrieves the owner object's **IUnknown**.

IUnknown Methods

AddRef	Increments the reference count on the owner object.
QueryInterface	Retrieves a pointer to the interface requested on the owner object.
Release	Decrements the reference count on the owner object.

Methods

CComContainedObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Increments the reference count on the owner object.

See Also: CComContainedObject::Release

CComContainedObject::CComContainedObject

CComContainedObject(void* *pv* **);**

Parameters

pv [in] The owner object's **IUnknown**.

Remarks

The constructor. Sets the **m_pOuterUnknown** member pointer (inherited through the *Base* class) to *pv*.

See Also: CComObjectRootEx::m_pOuterUnknown

CComContainedObject::GetControllingUnknown

IUnknown* GetControllingUnknown( );

Return Value

The owner object's **IUnknown**.

Remarks

Returns the **m_pOuterUnknown** member pointer (inherited through the *Base* class) which holds the owner object's **IUnknown**. This method may be virtual if *Base* has declared the **DECLARE_GET_CONTROLLING_UNKNOWN** macro.

See Also: CComObjectRootEx::m_pOuterUnknown

CComContainedObject::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The identifier of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Retrieves a pointer to the interface requested on the owner object.

CComContainedObject::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics or testing. In non-debug builds, **Release** always returns 0.

Remarks

Decrements the reference count on the owner object.

See Also: CComContainedObject::AddRef

CComControl

template < class *T* >
class CComControl : public CComControlBase, public CWindowImpl< *T* >

Parameters

T The class implementing the control.

CComControl is a set of useful control helper functions and essential data members for ATL controls. When you create a full control or an Internet Explorer control using the ATL Object Wizard, the wizard will automatically derive your class from **CComControl**.

For more information about creating a control, see the "ATL Tutorial." For more information about the ATL Object Wizard, see the article "Creating an ATL Project."

For a demonstration of **CComControl** methods and data members, see the CIRC sample online.

#include <atlctl.h>

See Also: CWindowImpl

CComControl class members are divided into the following categories:

- Methods
- CComControlBase Methods
- GetAmbient Property Methods
- Data Members
- Stock Property Data Members

Methods

CComControl	Constructor.
ControlQueryInterface	Retrieves a pointer to the requested interface.
CreateControlWindow	Creates a window for the control.
FireOnChanged	Notifies the container's sink that a control property has changed.
FireOnRequestEdit	Notifies the container's sink that a control property is about to change.

CComControlBase Methods

CComControlBase	Constructor. Stores the window handle. Initializes the control data and sets a default control size.
DoesVerbActivate	Checks that the *iVerb* parameter used by **IOleObjectImpl::DoVerb** activates the control.
DoesVerbUIActivate	Checks that the *iVerb* parameter used by **IOleObjectImpl::DoVerb** causes the control's user interface to activate.
DoVerbProperties	Tells the control to display its property sheet.
FireViewChange	Tells the control to discard any undo the state it is maintaining.
GetDirty	Retrieves the value of the flag indicating whether the control's properties have changed since it was last saved.
GetZoomInfo	Retrieves the zoom factor and stores it in the **ATL_DRAWINFO** structure.
InPlaceActivate	Determines that the control can be in-place activated, informs the container the control is going in-place active, and activates the control.
OnDraw	Draws your control.
OnDrawAdvanced	Normalizes the device context, then calls your control class's **OnDraw** method.
OnGetDlgCode	Called in response to a **WM_GETDLGCODE** message. Override to have the control process TAB keys and arrow keys.
OnKillFocus	Informs the container the control has lost focus.
OnPaint	Prepares the container for painting, gets information about the control size, and calls your control class's **OnDraw** method.
OnSetFocus	Informs the container the control has gained focus.
SendOnClose	Called by the server to notify the control's advise sinks the control has changed from the running to the loaded state.
SendOnDataChange	Called by the server to notify the control's advise sinks that data in the control has changed.
SendOnRename	Called by the server to notify the control's advise sinks the control has been renamed.
SendOnSave	Called by the server to notify the control's advise sinks the control has been saved.
SendOnViewChange	Notifies the control's advise sinks its view has changed.
SetControlFocus	Sets or removes keyboard focus to or from the control.
SetDirty	Sets the value of the flag indicating that the control's properties have changed since it was last saved.

GetAmbient Property Methods

GetAmbientAppearance	Gets the container's APPEARANCE property.
GetAmbientAutoClip	Gets the container's AUTOCLIP property.
GetAmbientBackColor	Gets the container's BACKCOLOR property.
GetAmbientDisplayAsDefault	Gets the container's DISPLAYASDEFAULT property.
GetAmbientDisplayName	Gets the container's DISPLAYNAME property.
GetAmbientFont	Gets the container's FONT properties.
GetAmbientForeColor	Gets the container's FORECOLOR property.
GetAmbientLocaleID	Gets the container's LOCALEID property.
GetAmbientMessageReflect	Gets the container's MESSAGEREFLECT property.
GetAmbientPalette	Gets the container's PALETTE property.
GetAmbientProperty	Retrieves the specified container property.
GetAmbientScaleUnits	Gets the container's SCALEUNITS property.
GetAmbientShowGrabHandles	Gets the container's SHOWGRABHANDLES property.
GetAmbientShowHatching	Gets the container's SHOWHATCHING property.
GetAmbientSupportsMnemonics	Gets the container's SUPPORTSMNEMONICS property.
GetAmbientTextAlign	Gets the container's TEXTALIGN property.
GetAmbientUIDead	Gets the container's UIDEAD property.
GetAmbientUserMode	Gets the container's USERMODE property.

Data Members

m_bAutoSize	Flag indicating the control cannot be any other size, and **SetExtent** should fail.
m_bDrawFromNatural	Flag indicating that **GetData** should use the control's actual size and not its current extent when drawing.
m_bDrawGetDataInHimetric	Flag indicating that **GetData** should use HIMETRIC units and not pixels when drawing.
m_bInPlaceActive	Flag indicating the control is in-place active.
m_bInPlaceSiteEx	Flag indicating the container supports OCX96 control features, such as windowless and flicker-free controls.
m_bNegotiatedWnd	Flag indicating whether or not the control has negotiated with the container about being windowless or windowed.
m_bRecomposeOnResize	Flag indicating the control wants to recompose its presentation when the container changes the control's display size.
m_bRequiresSave	Flag indicating the control has changed since it was last saved.
m_bResizeNatural	Flag indicating the control wants to resize its natural extent (its unscaled physical size) when the container changes the control's display size.

(continued)

Data Members *(continued)*	
m_bUIActive	Flag indicating the control's user interface is active.
m_bUsingWindowRgn	Flag indicating the control is using the container-supplied window region.
m_bWasOnceWindowless	Flag indicating the control has been windowless, but may or may not be windowless now.
m_bWindowOnly	Flag indicating the control should be windowed even if the container supports windowless controls.
m_bWndless	Flag indicating the control is windowless.
m_hWndCD	A reference to the window handle associated with the control.
m_nFreezeEvents	A count of the number of times the container has refused to accept events (a freeze of events) without an intervening acceptance of events (a thaw of events).
m_phWndCD	A pointer to the window handle associated with the control.
m_rcPos	The **RECT** position of the control.
m_sizeExtent	The **SIZE** of the control on a particular display in HIMETRIC units (each logical unit is 0.01 millimeter). This size is scaled by the display.
m_sizeNatural	The fixed physical **SIZE** of the control in HIMETRIC units (each logical unit is 0.01 millimeter). This size is not scaled by the display.
m_spAdviseSink	A COM interface pointer of type **IAdviseSink**.
m_spAmbientDispatch	A **CComDispatchDriver** object used to set and get properties through **IDispatch**.
m_spClientSite	A COM interface pointer of type **IOleClientSite**.
m_spDataAdviseHolder	A COM interface pointer of type **IDataAdviseHolder**.
m_spInPlaceSite	A pointer to the container's **IOleInPlaceSite**, **IOleInPlaceSiteEX**, or **IOleInPlaceSiteWindowless** COM interface.
m_spOleAdviseHolder	A COM interface pointer of type **IOleAdviseHolder**.

Stock Property Data Members	
m_bAutoSize	Stores the AUTOSIZE stock property.
m_bBorderVisible	Stores the BORDERVISIBLE stock property.
m_bEnabled	Stores the ENABLED stock property.
m_bstrCaption	Stores the CAPTION stock property.
m_bstrText	Stores the TEXT stock property.
m_bTabStop	Stores the TABSTOP stock property.
m_bValid	Stores the VALID stock property.
m_clrBackColor	Stores the BACKCOLOR stock property.

Stock Property Data Members ***(continued)***

m_clrBorderColor	Stores the BORDERCOLOR stock property.
m_clrFillColor	Stores the FILLCOLOR stock property.
m_clrForeColor	Stores the FORECOLOR stock property.
m_nAppearance	Stores the APPEARANCE stock property.
m_nBackStyle	Stores the BACKSTYLE stock property.
m_nBorderStyle	Stores the BORDERSTYLE stock property.
m_nBorderWidth	Stores the BORDERWIDTH stock property.
m_nDrawMode	Stores the DRAWMODE stock property.
m_nDrawStyle	Stores the DRAWSTYLE stock property.
m_nDrawWidth	Stores the DRAWWIDTH stock property.
m_nFillStyle	Stores the FILLSTYLE stock property.
m_nMousePointer	Stores the MOUSEPOINTER stock property.
m_nReadyState	Stores the READYSTATE stock property.
m_pFont	Stores the FONT stock property.
m_pMouseIcon	Stores the MOUSEICON stock property.
m_pPicture	Stores the PICTURE stock property.

Methods

CComControl::CComControl

CComControl( );

Remarks

The constructor. Calls the **CComControlBase** constructor, passing the **m_hWnd** data member inherited through **CWindowImpl**.

See Also: CComControl::CComControlBase, CWindow::m_hWnd

CComControl::CComControlBase

CComControlBase(HWND *h* **);**

Parameters

h [in] The handle to the window associated with the control.

Remarks

The constructor. Stores a pointer to the window handle in the data member **m_phWndCD**. Initializes the control size to 5080X5080 HIMETRIC units (2"X2") and initializes the **CComControlBase** data member values to **NULL** or **FALSE**.

See Also: CComControl::m_sizeExtent, CComControl::m_phWndCD

CComControl::ControlQueryInterface

virtual HRESULT ControlQueryInterface(const IID& *iid*, void *ppv*);**

Parameters

iid [in] The GUID of the interface being requested.

ppv [out] A pointer to the interface pointer identified by *iid*, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface. Only handles interfaces in the COM map table.

See Also: CComObjectRootEx::InternalQueryInterface

CComControl::CreateControlWindow

virtual HWND CreateControlWindow(HWND *hWndParent*, RECT& *rcPos*);

Parameters

hWndParent [in] Handle to the parent or owner window. A valid window handle must be supplied. The control window is confined to the area of its parent window.

rcPos [in] The initial size and position of the window to be created.

Remarks

By default, creates a window for the control by calling **CWindowImpl::Create**. Override this method if you want to do something other than create a single window, for example, to create two windows, one of which becomes a toolbar for your control.

See Also: CWindowImpl::Create

CComControl::DoesVerbActivate

BOOL DoesVerbActivate(LONG *iVerb*);

Return Value

Returns **TRUE** if *iVerb* equals **OLEIVERB_UIACTIVATE**, **OLEIVERB_PRIMARY**, **OLEIVERB_SHOW**, or **OLEIVERB_INPLACEACTIVATE**; otherwise, returns **FALSE**.

Parameters

iVerb [in] Value indicating the action to be performed by **DoVerb**.

Remarks

Checks that the *iVerb* parameter used by **IOleObjectImpl::DoVerb** either activates the control's user interface (*iVerb* equals **OLEIVERB_UIACTIVATE**), defines the

action taken when the user double-clicks the control (*iVerb* equals **OLEIVERB_PRIMARY**), displays the control (*iVerb* equals **OLEIVERB_SHOW**), or activates the control (*iVerb* equals **OLEIVERB_INPLACEACTIVATE**). You can override this method to define your own activation verb.

See Also: IOleObjectImpl::DoVerb, CComControl::DoesVerbUIActivate

CComControl::DoesVerbUIActivate

BOOL DoesVerbUIActivate(LONG *iVerb* **);**

Return Value

Returns **TRUE** if *iVerb* equals **OLEIVERB_UIACTIVATE** or **OLEIVERB_PRIMARY**. Also returns **TRUE** if the control is not active and *iVerb* equals **OLEIVERB_UIACTIVATE**, **OLEIVERB_PRIMARY**, **OLEIVERB_SHOW**, or **OLEIVERB_INPLACEACTIVATE**. Otherwise, the method returns **FALSE**.

Parameters

iVerb [in] Value indicating the action to be performed by **DoVerb**.

Remarks

Checks that the *iVerb* parameter used by **IOleObjectImpl::DoVerb** causes the control's user interface to activate and returns **TRUE**.

DoesVerbUIActivate also checks whether the control is in-place active. If it is not and the value of *iVerb* causes the control to go active, **DoesVerbUIActivate** returns **TRUE**. This handles older containers that must activate the control and its user interface together.

See Also: IOleObjectImpl::DoVerb, CComControl::DoesVerbActivate

CComControl::DoVerbProperties

HRESULT DoVerbProperties(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control. Not used in the ATL implementation.

Remarks

Displays the control's property pages. By default, this is set as the action taken when the user double-clicks the control. You can change this to another action by overriding **IOleObjectImpl::DoVerbPrimary**.

See Also: IOleObjectImpl::DoVerbPrimary

CComControl::FireOnChanged

HRESULT FireOnChanged(DISPID *dispID* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dispID [in] Identifier of the property that has changed.

Remarks

If your control class derives from **IPropertyNotifySink**, this method calls **CFirePropNotifyEvent::FireOnChanged** to notify all connected **IPropertyNotifySink** interfaces that the specified control property has changed. If your control class does not derive from **IPropertyNotifySink**, this method returns **S_OK**.

This function is safe to call even if your control doesn't support connection points.

See Also: CComControl::FireOnRequestEdit

CComControl::FireOnRequestEdit

HRESULT FireOnRequestEdit(DISPID *dispID* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dispID [in] Identifier of the property about to change.

Remarks

If your control class derives from **IPropertyNotifySink**, this method calls **CFirePropNotifyEvent::FireOnRequestEdit** to notify all connected **IPropertyNotifySink** interfaces that the specified control property is about to change. If your control class does not derive from **IPropertyNotifySink**, this method returns **S_OK**.

This function is safe to call even if your control doesn't support connection points.

See Also: CComControl::FireOnChanged

CComControl::FireViewChange

HRESULT FireViewChange( );

Return Value

One of the standard **HRESULT** values.

Remarks

If the control is active (the control class data member **m_bInPlaceActive** is **TRUE**), notifies the container that you want to redraw the entire control. If the control is inactive, notifies the control's registered advise sinks (through the control class data member **m_spAdviseSink**) that the control's view has changed.

CComControl::GetAmbientAppearance

HRESULT GetAmbientAppearance(short& *nAppearance*);

Return Value

One of the standard **HRESULT** values.

Parameters

nAppearance [out] The property **DISPID_AMBIENT_APPEARANCE**.

Remarks

Retrieves **DISPID_AMBIENT_APPEARANCE**, the current appearance setting for the control: 0 for flat and 1 for 3D.

See Also: GetAmbient Property Methods

CComControl::GetAmbientAutoClip

HRESULT GetAmbientAutoClip(BOOL& *bAutoClip* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bAutoClip [out] The property **DISPID_AMBIENT_AUTOCLIP**.

Remarks

Retrieves **DISPID_AMBIENT_AUTOCLIP**, a flag indicating whether the container supports automatic clipping of the control display area.

See Also: GetAmbient Property Methods

CComControl::GetAmbientBackColor

HRESULT GetAmbientBackColor(OLE_COLOR& *BackColor* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

BackColor [out] The property **DISPID_AMBIENT_BACKCOLOR.**

Remarks

Retrieves **DISPID_AMBIENT_BACKCOLOR**, the ambient background color for all controls, defined by the container.

See Also: GetAmbient Property Methods

CComControl::GetAmbientDisplayAsDefault

HRESULT GetAmbientDisplayAsDefault(BOOL& *bDisplayAsDefault* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bDisplayAsDefault [out] The property **DISPID_AMBIENT_DISPLAYASDEFAULT.**

Remarks

Retrieves **DISPID_AMBIENT_DISPLAYASDEFAULT**, a flag that is **TRUE** if the container has marked the control in this site to be a default button, and therefore a button control should draw itself with a thicker frame.

See Also: GetAmbient Property Methods

CComControl::GetAmbientDisplayName

HRESULT GetAmbientDisplayName(BSTR& *bstrDisplayName* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bstrDisplayName [out] The property **DISPID_AMBIENT_DISPLAYNAME.**

Remarks

Retrieves **DISPID_AMBIENT_DISPLAYNAME**, the name the container has supplied to the control.

See Also: GetAmbient Property Methods

CComControl::GetAmbientFont

HRESULT GetAmbientFont(IFont *ppFont*);**

Return Value

One of the standard **HRESULT** values.

Parameters

ppFont [out] The property **DISPID_AMBIENT_FONT**.

Remarks

Retrieves **DISPID_AMBIENT_FONT**, a pointer to the container's ambient **IFont** dispatch interface. If the property is **NULL**, the pointer is **NULL**. If the pointer is not **NULL**, the caller must release the pointer.

See Also: GetAmbient Property Methods

CComControl::GetAmbientForeColor

HRESULT GetAmbientForeColor(OLE_COLOR& *ForeColor*);

Return Value

One of the standard **HRESULT** values.

Parameters

ForeColor [out] The property **DISPID_AMBIENT_FORECOLOR**.

Remarks

Retrieves **DISPID_AMBIENT_FORECOLOR**, the ambient foreground color for all controls, defined by the container.

See Also: GetAmbient Property Methods

CComControl::GetAmbientLocaleID

HRESULT GetAmbientLocaleID(LCID& *lcid*);

Return Value

One of the standard **HRESULT** values.

Parameters

lcid [out] The property **DISPID_AMBIENT_LOCALEID**.

Remarks

Retrieves **DISPID_AMBIENT_LOCALEID**, the identifier of the language used by the container. The control can use this identifier to adapt its user interface to different languages.

See Also: GetAmbient Property Methods

CComControl::GetAmbientMessageReflect

HRESULT GetAmbientMessageReflect(BOOL& *bMessageReflect* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bMessageReflect [out] The property **DISPID_AMBIENT_MESSAGEREFLECT**.

Remarks

Retrieves **DISPID_AMBIENT_MESSAGEREFLECT**, a flag indicating whether the container wants to receive window messages (such as **WM_DRAWITEM**) as events.

See Also: GetAmbient Property Methods

CComControl::GetAmbientPalette

HRESULT GetAmbientPalette(HPALETTE& *hPalette* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

hPalette [out] The property **DISPID_AMBIENT_PALETTE**.

Remarks

Retrieves **DISPID_AMBIENT_PALETTE**, used to access the container's **HPALETTE**.

See Also: GetAmbient Property Methods

CComControl::GetAmbientProperty

HRESULT GetAmbientProperty(DISPID *dispid*, **VARIANT&** *var* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dispid [in] Identifier of the container property to be retrieved.

var [in] Variable to receive the property.

Remarks

Retrieves the container property specified by *id*.

ATL has provided a set of helper functions to retrieve specific properties, for example, **GetAmbientBackColor**. These functions retrieve specific properties.

See Also: **CComControl::m_spClientSite**, GetAmbient Property Methods

CComControl::GetAmbientScaleUnits

HRESULT GetAmbientScaleUnits(BSTR& *bstrScaleUnits* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bstrScaleUnits [out] The property **DISPID_AMBIENT_SCALEUNITS**.

Remarks

Retrieves **DISPID_AMBIENT_SCALEUNITS**, the container's ambient units (such as inches or centimeters) for labeling displays.

See Also: GetAmbient Property Methods

CComControl::GetAmbientShowGrabHandles

HRESULT GetAmbientShowGrabHandles(BOOL& *bShowGrabHandles* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bShowGrabHandles [out] The property **DISPID_AMBIENT_SHOWGRABHANDLES**.

Remarks

Retrieves **DISPID_AMBIENT_SHOWGRABHANDLES**, a flag indicating whether the container allows the control to display grab handles for itself when active.

See Also: GetAmbient Property Methods

CComControl::GetAmbientShowHatching

HRESULT GetAmbientShowHatching(BOOL& *bShowHatching* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bShowHatching [out] The property **DISPID_AMBIENT_SHOWHATCHING**.

Remarks

Retrieves **DISPID_AMBIENT_SHOWHATCHING**, a flag indicating whether the container allows the control to display itself with a hatched pattern when UI active.

See Also: GetAmbient Property Methods

CComControl::GetAmbientSupportsMnemonics

HRESULT GetAmbientSupportsMnemonics(BOOL& *bSupportsMnemonics* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bSupportsMnemonics [out] The property **DISPID_AMBIENT_SUPPORTSMNEMONICS**.

Remarks

Retrieves **DISPID_AMBIENT_SUPPORTSMNEMONICS**, a flag indicating whether the container supports keyboard mnemonics.

See Also: GetAmbient Property Methods

CComControl::GetAmbientTextAlign

HRESULT GetAmbientTextAlign(short& *nTextAlign* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

nTextAlign [out] The property **DISPID_AMBIENT_TEXTALIGN**.

Remarks

Retrieves **DISPID_AMBIENT_TEXTALIGN**, the text alignment preferred by the container: 0 for general alignment (numbers right, text left), 1 for left alignment, 2 for center alignment, and 3 for right alignment.

See Also: GetAmbient Property Methods

CComControl::GetAmbientUIDead

HRESULT GetAmbientUIDead(BOOL& *bUIDead* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bUIDead [out] The property **DISPID_AMBIENT_UIDEAD**.

Remarks

Retrieves **DISPID_AMBIENT_UIDEAD**, a flag indicating whether the container wants the control to respond to user-interface actions. If **TRUE**, the control should not respond. This flag applies regardless of the **DISPID_AMBIENT_USERMODE** flag.

See Also: GetAmbient Property Methods

CComControl::GetAmbientUserMode

HRESULT GetAmbientUserMode(BOOL& *bUserMode* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

bUserMode [out] The property **DISPID_AMBIENT_USERMODE**.

Remarks

Retrieves **DISPID_AMBIENT_USERMODE**, a flag indicating whether the container is in run-mode (**TRUE**) or design-mode (**FALSE**).

See Also: GetAmbient Property Methods

CComControl::GetDirty

BOOL GetDirty( );

Return Value

Returns the value of data member **m_bRequiresSave**.

Remarks

Returns the value of data member **m_bRequiresSave**. This value is set in **SetDirty**.

See Also: **CComControl::SetDirty**

CComControl::GetZoomInfo

void GetZoomInfo(ATL_DRAWINFO& *di* **);**

Parameters

di [out] The structure that will hold the zoom factor's numerator and denominator.

Remarks

Retrieves the x and y values of the numerator and denominator of the zoom factor for a control activated for in-place editing. The zoom factor is the proportion of the control's natural size to its current extent.

See Also: CComControl::m_sizeNatural, CComControl::m_sizeExtent

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CComControl::InPlaceActivate

HRESULT InPlaceActivate(LONG *iVerb*, **const RECT*** *prcPosRect* = **NULL);**

Return Value

One of the standard **HRESULT** values.

Parameters

iVerb [in] Value indicating the action to be performed by **IOleObjectImpl::DoVerb.**

prcPosRect [in] Pointer to the position of the in-place control.

Remarks

Causes the control to transition from the inactive state to whatever state the verb in *iVerb* indicates. Before activation, this method checks that the control has a client site, checks how much of the control is visible, and gets the control's location in the parent window. After the control is activated, this method activates the control's user interface and tells the container to make the control visible.

This function also retrieves an **IOleInPlaceSite**, **IOleInPlaceSiteEx**, or **IOleInPlaceSiteWindowless** interface pointer for the control and stores it in the control class's data member **m_spInPlaceSite**. The control class data members **m_bInPlaceSiteEx**, **m_bWndless**, **m_bWasOnceWindowless**, and **m_bNegotiatedWnd** are set to **TRUE** as appropriate.

See Also: IOleInPlaceObjectWindowlessImpl::InPlaceDeactivate

CComControl::OnDraw

virtual HRESULT OnDraw(ATL_DRAWINFO& *di* **);**

Return Value

A standard **HRESULT** value.

Parameters

di [in] A reference to the **ATL_DRAWINFO** structure that contains drawing information such as the draw aspect, the control bounds, and whether the drawing is optimized or not.

Remarks

Override this method to draw your control.

The default **OnDraw** deletes or restores the device context or does nothing, depending on flags set in **OnDrawAdvanced**.

An **OnDraw** method is automatically added to your control class when you create your control with the ATL Object Wizard. The wizard's default **OnDraw** draws a rectangle with the label "ATL 2.0".

See Also: **CComControl::OnDrawAdvanced, IViewObjectExImpl::Draw**

CComControl::OnDrawAdvanced

virtual HRESULT OnDrawAdvanced(ATL_DRAWINFO& *di* **);**

Return Value

A standard **HRESULT** value.

Parameters

di [in] A reference to the **ATL_DRAWINFO** structure that contains drawing information such as the draw aspect, the control bounds, and whether the drawing is optimized or not.

Remarks

The default **OnDrawAdvanced** prepares a normalized device context for drawing, then calls your control class's **OnDraw** method. Override this method if you want to accept the device context passed by the container without normalizing it.

An **OnDraw** method is automatically added to your control class when you create your control with the ATL Object Wizard. The wizard's default **OnDraw** draws a rectangle with the label "ATL 2.0".

See Also: **CComControl::OnDraw, IViewObjectExImpl::Draw**

CComControl::OnGetDlgCode

LRESULT OnGetDlgCode(UINT *nMsg*, **WPARAM** *wParam*,
↪ **LPARAM** *lParam*, **BOOL&** *bHandled* **);**

Return Value

The result of message processing. 0 if successful.

Parameters

nMsg [in] The window message identifier. Not used in the default ATL implementation.

wParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

lParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

bHandled [in, out] Flag that indicates whether the window message was successfully handled. The default is **TRUE**.

Remarks

Called in response to a **WM_GETDLGCODE** window message. The message is sent to the dialog box associated with the control. Override this method to let the control process the input of arrow keys and TAB keys. The default ATL implementation simply returns 0.

See Also: **WM_GETDLGCODE**

CComControl::OnKillFocus

LRESULT OnKillFocus(UINT *nMsg*, **WPARAM** *wParam*,
↪ **LPARAM** *lParam*, **BOOL&** *bHandled* **);**

Return Value

Always returns 0.

Parameters

nMsg [in] The window message identifier. Not used in the default ATL implementation.

wParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

lParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

bHandled [in, out] Flag that indicates whether the window message was successfully handled. The default is **TRUE**.

Remarks

Checks that the control is in-place active and has a valid control site, then informs the container the control has lost focus.

See Also: **CComControl::m_bInPlaceActive**, **CComControl::m_spClientSite**

CComControl::OnPaint

LRESULT OnPaint(UINT *nMsg*, **WPARAM** *wParam*, **LPARAM** *lParam*,
↪ **BOOL&** *lResult* **);**

Return Value

Returns zero.

Parameters

nMsg [in] Specifies the message. Not used in the default ATL implementation.

wParam [in] Additional message-specific information. Not used in the default ATL implementation.

lParam [in] Additional message-specific information. Not used in the default ATL implementation.

lResult [in, out] A boolean value. Not used in the default ATL implementation. See **MESSAGE_HANDLER** for more information.

Remarks

Prepares the container for painting, gets the control's client area, then calls the control class's **OnDraw** method.

An **OnDraw** method is automatically added to your control class when you create your control with the ATL Object Wizard. The wizard's default **OnDraw** draws a rectangle with the label "ATL 2.0".

See Also: BeginPaint, EndPaint, IViewObjectExImpl::Draw

CComControl::OnSetFocus

LRESULT OnSetFocus(UINT *nMsg*, **WPARAM** *wParam*, **LPARAM** *lParam*,
↪ **BOOL&** *bHandled* **);**

Return Value

Always returns 0.

Parameters

nMsg [in] The window message identifier. Not used in the default ATL implementation.

wParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

lParam [in] A 32-bit message parameter. Not used in the default ATL implementation.

bHandled [in, out] Flag that indicates whether the window message was successfully handled. The default is **TRUE**.

Remarks

Checks that the control is in-place active and has a valid control site, then informs the container the control has gained focus.

See Also: CComControl::m_bInPlaceActive, CComControl::m_spClientSite

CComControl::SendOnClose

HRESULT SendOnClose( );

Return Value

One of the standard **HRESULT** values.

Remarks

Notifies all advisory sinks registered with the advise holder that the control has been closed.

See Also: CComControl::m_spOleAdviseHolder

CComControl::SendOnDataChange

HRESULT SendOnDataChange(DWORD *advf* **= 0);**

Return Value

One of the standard **HRESULT** values.

Parameters

advf [in] Advise flags that specify how the call to **IAdviseSink::OnDataChange** is made. Values are from the **ADVF** enumeration.

Remarks

Notifies all advisory sinks registered with the advise holder that the control data has changed.

See Also: CComControl::m_spDataAdviseHolder

CComControl::SendOnRename

HRESULT SendOnRename(IMoniker* *pmk* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pmk [in] Pointer to the new moniker of the control.

Remarks

Notifies all advisory sinks registered with the advise holder that the control has a new moniker.

See Also: CComControl::m_spOleAdviseHolder

CComControl::SendOnSave

HRESULT SendOnSave( );

Return Value

One of the standard **HRESULT** values.

Remarks

Notifies all advisory sinks registered with the advise holder that the control has been saved.

See Also: CComControl::m_spOleAdviseHolder

CComControl::SendOnViewChange

HRESULT SendOnViewChange(DWORD *dwAspect*, **LONG** *lindex* = −1 **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dwAspect [in] The aspect or view of the control.

lindex [in] The portion of the view that has changed. Only −1 is valid.

Remarks

Notifies all registered advisory sinks that the control's view has changed.

See Also: CComControl::m_spAdviseSink

CComControl::SetControlFocus

BOOL SetControlFocus(BOOL *bGrab* **);**

Return Value

Returns **TRUE** if the control successfully receives focus; otherwise, **FALSE**.

Parameters

bGrab [in] If **TRUE**, sets the keyboard focus to the calling control. If **FALSE**, removes the keyboard focus from the calling control, provided it has the focus.

Remarks

Sets or removes the keyboard focus to or from the control. For a windowed control, the Windows API function **SetFocus** is called. For a windowless control, **IOleInPlaceSiteWindowless::SetFocus** is called. Through this call, a windowless control obtains the keyboard focus and can respond to window messages.

CComControl::SetDirty

void SetDirty(BOOL *bDirty* **);**

Parameters

bDirty [in] Value of the data member **m_bRequiresSave**.

Remarks

Sets the data member **m_bRequiresSave** to the value in *bDirty*. You should call **SetDirty(TRUE)** to flag that the control has changed since it was last saved. The value of **m_bRequiresSave** is retrieved with **GetDirty**.

Data Members

CComControl::m_bAutoSize

unsigned m_bAutoSize:1;

Remarks

Flag indicating the control cannot be any other size. This flag is checked by **IOleObjectImpl::SetExtent** and, if **TRUE**, causes the function to return **E_FAIL**.

If you choose the AUTOSIZE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: IOleObjectImpl::SetExtent

CComControl::m_bBorderVisible

BOOL m_bBorderVisible;

Remarks

The data member in your control class that flags whether the control's border should be visible or not. If you choose the BORDERVISIBLE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_nBorderStyle, CComControl::m_clrBorderColor, CComControl::m_nBorderWidth

CComControl::m_bDrawFromNatural

unsigned m_bDrawFromNatural:1;

Remarks

Flag indicating that **IDataObjectImpl::GetData** should set the control size from **m_sizeNatural** rather than from **m_sizeExtent**.

See Also: IDataObjectImpl::GetData, CComControl::m_sizeNatural, CComControl::m_sizeExtent

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CComControl::m_bDrawGetDataInHimetric

unsigned m_bDrawGetDataInHimetric:1;

Remarks

Flag indicating that **IDataObjectImpl::GetData** should use HIMETRIC units and not pixels when drawing. Each logical HIMETRIC unit is 0.01 millimeter.

See Also: IDataObjectImpl::GetData

CComControl::m_bEnabled

BOOL m_bEnabled;

Remarks

The data member in your control class that flags whether the control is enabled. The **m_bInPlaceActive** flag indicates the control is in-place active, while the **m_bUIActive** flag indicates the control's user interface (menus and toolbars) is also active.

If you choose the ENABLED option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

CComControl::m_bInPlaceActive

unsigned m_bInPlaceActive:1;

Remarks

Flag indicating the control is in-place active. This means the control is visible and its window, if any, is visible, but its menus and toolbars may not be active. The **m_bUIActive** flag indicates the control's user interface, such as menus, is also active.

See Also: CComControl::m_bEnabled, CComControl::m_bUIActive

CComControl::m_bInPlaceSiteEx

unsigned m_bInPlaceSiteEx:1;

Remarks

Flag indicating the container supports the **IOleInPlaceSiteEx** interface and OCX96 control features, such as windowless and flicker-free controls.

The data member **m_spInPlaceSite** points to an **IOleInPlaceSite**, **IOleInPlaceSiteEx**, or **IOleInPlaceSiteWindowless** interface, depending on the value of the **m_bWndless** and **m_bInPlaceSiteEx** flags. (The data member **m_bNegotiatedWnd** must be **TRUE** for the **m_spInPlaceSite** pointer to be valid.)

If **m_bWndless** is **FALSE** and **m_bInPlaceSiteEx** is **TRUE**, **m_spInPlaceSite** is an **IOleInPlaceSiteEx** interface pointer. See **m_spInPlaceSite** for a table showing the relationship among these three data members.

See Also: CComControl::m_bWndless, CComControl::m_bNegotiatedWnd, CComControl::m_spInPlaceSite

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CComControl::m_bNegotiatedWnd

unsigned m_bNegotiatedWnd:1;

Remarks

Flag indicating whether or not the control has negotiated with the container about support for OCX96 control features (such as flicker-free and windowless controls), and whether the control is windowed or windowless. The **m_bNegotiatedWnd** flag must be **TRUE** for the **m_spInPlaceSite** pointer to be valid.

See Also: CComControl::m_bWndless, CComControl::m_spInPlaceSite

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CComControl::m_bRecomposeOnResize

unsigned m_bRecomposeOnResize:1;

Remarks

Flag indicating the control wants to recompose its presentation when the container changes the control's display size. This flag is checked by **IOleObjectImpl::SetExtent** and, if **TRUE**, **SetExtent** notifies the container of view changes. if this flag is set, the **OLEMISC_RECOMPOSEONRESIZE** bit in the **OLEMISC** enumeration should also be set.

See Also: IOleObjectImpl::SetExtent

CComControl::m_bRequiresSave

unsigned m_bRequiresSave:1;

Remarks

Flag indicating the control has changed since it was last saved. The value of **m_bRequiresSave** can be set with **SetDirty** and retrieved with **GetDirty**.

See Also: CComControl::SetDirty, CComControl::GetDirty

CComControl::m_bResizeNatural

unsigned m_bResizeNatural:1;

Remarks

Flag indicating the control wants to resize its natural extent (its unscaled physical size) when the container changes the control's display size. This flag is checked by **IOleObjectImpl::SetExtent** and, if **TRUE**, the size passed into **SetExtent** is assigned to **m_sizeNatural**.

The size passed into **SetExtent** is always assigned to **m_sizeExtent**, regardless of the value of **m_bResizeNatural**.

See Also: IOleObjectImpl::SetExtent, CComControl::m_sizeNatural, CComControl::m_sizeExtent

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CComControl::m_bstrCaption

BSTR m_bstrCaption;

Remarks

The data member in your control class that holds text to be displayed with the control. If you choose the CAPTION option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_bstrText

CComControl::m_bstrText

BSTR m_bstrCaption;

Remarks

The data member in your control class that holds text to be displayed with the control. If you choose the TEXT option from the Stock Properties tab in the ATL Object

Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_bstrCaption

CComControl::m_bTabStop

BOOL m_bTabStop;

Remarks

The data member in your control class that flags whether the control is a tab stop or not. If you choose the TABSTOP option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

CComControl::m_bUIActive

unsigned m_bUIActive:1;

Remarks

Flag indicating the control's user interface, such as menus and toolbars, is active. The **m_bInPlaceActive** flag indicates that the control is active, but not that its user interface is active.

See Also: CComControl::m_bEnabled, CComControl::m_bInPlaceActive

CComControl::m_bUsingWindowRgn

unsigned m_bUsingWindowRgn:1;

Remarks

Flag indicating the control is using the container-supplied window region.

CComControl::m_bValid

BOOL m_bValid;

Remarks

The data member in your control class that flags whether the control is a valid or not. If you choose the VALID option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class,

creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

CComControl::m_bWasOnceWindowless

unsigned m_bWasOnceWindowless:1;

Remarks

Flag indicating the control has been windowless, but may or may not be windowless now.

See Also: CComControl::m_bWndless

CComControl::m_bWindowOnly

unsigned m_bWindowOnly:1;

Remarks

Flag indicating the control should be windowed, even if the container supports windowless controls.

See Also: CComControl::m_bWndless

CComControl::m_bWndless

unsigned m_bWndless:1;

Remarks

Flag indicating the control is windowless.

The data member **m_spInPlaceSite** points to an **IOleInPlaceSite**, **IOleInPlaceSiteEx**, or **IOleInPlaceSiteWindowless** interface, depending on the value of the **m_bWndless** and **m_bInPlaceSiteEx** flags. (The data member **m_bNegotiatedWnd** must be **TRUE** for the **m_spInPlaceSite** pointer to be valid.)

If **m_bWndless** is **TRUE**, **m_spInPlaceSite** is an **IOleInPlaceSiteWindowless** interface pointer. See **m_spInPlaceSite** for a table showing the complete relationship between these data members.

See Also: CComControl::m_spInPlaceSite, CComControl::m_bInPlaceSiteEx, CComControl::m_bNegotiatedWnd, CComControl::m_bWindowOnly, CComControl::m_bWasOnceWindowless

CComControl::m_clrBackColor

OLE_COLOR m_clrBackColor;

Remarks

The data member in your control class that holds the control's background color. If you choose the BACKCOLOR option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_clrBorderColor, CComControl::m_clrFillColor, CComControl::m_clrForeColor

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CComControl::m_clrBorderColor

OLE_COLOR m_clrBorderColor;

Remarks

The data member in your control class that holds the control's border color. If you choose the BORDERCOLOR option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_clrBackColor, CComControl::m_clrFillColor, CComControl::m_clrForeColor

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CComControl::m_clrFillColor

OLE_COLOR m_clrFillColor;

Remarks

The data member in your control class that holds the control's fill color. If you choose the FILLCOLOR option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_clrBackColor, CComControl::m_clrBorderColor, CComControl::m_clrForeColor

CComControl::m_clrForeColor

OLE_COLOR m_clrForeColor;

Remarks

The data member in your control class that holds the control's foreground color. If you choose the FORECOLOR option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_clrBackColor, CComControl::m_clrBorderColor, CComControl::m_clrFillColor

---

CComControl::m_hWndCD

HWND& m_hWndCD;

Remarks

Contains a reference to the window handle associated with the control. Part of a union with **m_phWndCD**.

See Also: CComControl::CComControl, CComControl::m_phWndCD

CComControl::m_nAppearance

long m_nAppearance;

Remarks

The data member in your control class that stores the paint style used by the control, for example, flat or 3D. If you choose the APPEARANCE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_nDrawMode

CComControl::m_nBackStyle

long m_nBackStyle;

Remarks

The data member in your control class that stores the control's background style, either transparent or opaque. If you choose the BACKSTYLE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data

member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_nFillStyle**

CComControl::m_nBorderStyle

long m_nBorderStyle;

Remarks

The data member in your control class that stores the control's border style. If you choose the BORDERSTYLE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_bBorderVisible**, **CComControl::m_clrBorderColor**, **CComControl::m_nBorderWidth**

CComControl::m_nBorderWidth

long m_nBorderWidth;

Remarks

The data member in your control class that stores the control's border width. If you choose the BORDERWIDTH option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_bBorderVisible**, **CComControl::m_clrBorderColor**, **CComControl::m_nBorderStyle**

CComControl::m_nDrawMode

long m_nDrawMode;

Remarks

The data member in your control class that stores the appearance of output from the control's graphics methods, for example, XOR Pen or Invert Colors. If you choose the DRAWMODE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_nDrawWidth, CComControl::m_nDrawStyle**

CComControl::m_nDrawStyle

long m_nDrawStyle;

Remarks

The data member in your control class that stores the line style used by the control's drawing methods, for example, solid, dashed, or dotted. If you choose the DRAWSTYLE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_nDrawWidth, CComControl::m_nDrawMode**

CComControl::m_nDrawWidth

long m_nDrawWidth;

Remarks

The data member in your control class that stores the line width (in pixels) used by the control's drawing methods. If you choose the DRAWWIDTH option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_nDrawStyle, CComControl::m_nDrawMode**

CComControl::m_nFillStyle

long m_nFillStyle;

Remarks

The data member in your control class that stores the control's fill style, for example, solid, transparent, or cross-hatched. If you choose the FILLSTYLE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: **CComControl::m_nBackStyle**

CComControl::m_nFreezeEvents

short m_nFreezeEvents;

Remarks

A count of the number of times the container has frozen events (refused to accept events) without an intervening thaw of events (acceptance of events).

See Also: IOleControl::FreezeEvents

CComControl::m_nMousePointer

long m_nMousePointer;

Remarks

The data member in your control class that stores the type of mouse pointer displayed when the mouse is over the control, for example, arrow, cross, or hourglass. If you choose the MOUSEPOINTER option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_pMouseIcon

CComControl::m_nReadyState

long m_nReadyState;

Remarks

The data member in your control class that stores the control's readiness state, for example, loading or loaded. If you choose the READYSTATE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

CComControl::m_pFont

IFontDisp* m_pFont;

Remarks

The data member in your control class that stores a pointer to **IFontDisp** font properties. If you choose the FONT option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your

control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

CComControl::m_phWndCD

HWND* m_phWndCD;

Remarks

Contains a pointer to the window handle associated with the control. Initialized in the **CComControl** constructor. Part of a union with **m_hWndCD**.

See Also: CComControl::CComControl, CComControl::m_hWndCD

CComControl::m_pMouseIcon

IPictureDisp* m_pMouseIcon;

Remarks

The data member that stores a pointer to **IPictureDisp** picture properties of the graphic (icon, bitmap, or metafile) to be displayed when the mouse is over the control. The properties include the handle of the picture. If you choose the MOUSEICON option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_nMousePointer

CComControl::m_pPicture

IPictureDisp* m_pPicture;

Remarks

The data member that stores a pointer to **IPictureDisp** picture properties of a graphic (icon, bitmap, or metafile) to be displayed. The properties include the handle of the picture. If you choose the PICTURE option from the Stock Properties tab in the ATL Object Wizard, the wizard automatically creates this data member in your control class, creates **put** and **get** methods for the property, and supports **IPropertyNotifySink** to automatically notify the container when the property changes.

See Also: CComControl::m_pMouseIcon

CComControl::m_rcPos

RECT m_rcPos;

Remarks

The position in pixels of the control, expressed in the coordinates of the container.

See Also: **CComControl::m_sizeExtent, CComControl::m_sizeNatural, RECT**

CComControl::m_sizeExtent

SIZE m_sizeExtent;

Remarks

The extent of the control in HIMETRIC units (each unit is 0.01 millimeters) for a particular display. This size is scaled by the display. The control's physical size is specified in the **m_sizeNatural** data member and is fixed.

You can convert the size to pixels with the global function **AtlHiMetricToPixel**.

See Also: **CComControl::m_sizeNatural, CComControl::m_rcPos, SIZE**

CComControl::m_sizeNatural

SIZE m_sizeNatural;

Remarks

The physical size of the control in HIMETRIC units (each unit is 0.01 millimeters). This size is fixed, while the size in **m_sizeExtent** is scaled by the display.

You can convert the size to pixels with the global function **AtlHiMetricToPixel**.

See Also: **CComControl::m_sizeExtent, CComControl::m_rcPos, SIZE**

CComControl::m_spAdviseSink

CComPtr<IAdviseSink> m_spAdviseSink;

Remarks

A direct pointer to the advisory connection on the container (the container's **IAdviseSink**).

See Also: **CComPtr**

CComControl::m_spAmbientDispatch

CComDispatchDriver m_spAmbientDispatch;

Remarks

A **CComDispatchDriver** object that lets you retrieve and set an object's properties through an **IDispatch** pointer.

See Also: CComDispatchDriver

CComControl::m_spClientSite

CComPtr<IOleClientSite> m_spClientSite;

Remarks

A pointer to the control's client site within the container.

See Also: CComPtr, IOleClientSite

CComControl::m_spDataAdviseHolder

CComPtr<IDataAdviseHolder> m_spDataAdviseHolder;

Remarks

Provides a standard means to hold advisory connections between data objects and advise sinks. (A data object is a control that can transfer data and that implements **IDataObject**, whose methods specify the format and transfer medium of the data.)

The interface **m_spDataAdviseHolder** implements the **IDataObject::DAdvise** and **IDataObject::DUnadvise** methods to establish and delete advisory connections to the container. The control's container must implement an advise sink by supporting the **IAdviseSink** interface.

See Also: CComPtr

CComControl::m_spInPlaceSite

CComPtr<IOleInPlaceSiteWindowless> m_spInPlaceSite;

Remarks

A pointer to the container's **IOleInPlaceSite**, **IOleInPlaceSiteEx**, or **IOleInPlaceSiteWindowless** interface pointer.

The **m_spInPlaceSite** pointer is valid only if the **m_bNegotiatedWnd** flag is **TRUE**.

The following table shows how the **m_spInPlaceSite** pointer type depends on the **m_bWndless** and **m_bInPlaceSite** data member flags:

m_spInPlaceSite Type	m_bWndless Value	m_bInPlaceSite Value
IOleInPlaceSiteWindowless	**TRUE**	**TRUE** or **FALSE**
IOleInPlaceSiteEx	**FALSE**	**TRUE**
IOleInPlaceSite	**FALSE**	**FALSE**

See Also: **CComPtr**

CComControl::m_spOleAdviseHolder

CComPtr<IOleAdviseHolder> m_spOleAdviseHolder;

Remarks

Provides a standard implementation of a way to hold advisory connections. Implements the **IOleObject::Advise** and **IOleObject::Unadvise** methods to establish and delete advisory connections to the container. The control's container must implement an advise sink by supporting the **IAdviseSink** interface.

See Also: **CComPtr**

CComCriticalSection

class CComCriticalSection

CComCriticalSection provides methods for obtaining and releasing ownership of a critical section object. **CComCriticalSection** is similar to class **CComAutoCriticalSection**, except that you must explicitly initialize and release the critical section.

Typically, you use **CComCriticalSection** through the **typedef** name **CriticalSection**. This name references **CComCriticalSection** when **CComMultiThreadModel** is being used.

#include <atlbase.h>

See Also: CComFakeCriticalSection

Methods

Init	Creates and initializes a critical section object.
Lock	Obtains ownership of the critical section object.
Term	Releases system resources used by the critical section object.
Unlock	Releases ownership of the critical section object.

Data Members

m_sec	A **CRITICAL_SECTION** object.

Methods

CComCriticalSection::Init

void Init( );

Remarks

Calls the Win32 function **InitializeCriticalSection**, which initializes the critical section object contained in the **m_sec** data member.

CComCriticalSection::Lock

void Lock( );

Remarks

Calls the Win32 function **EnterCriticalSection**, which waits until the thread can take ownership of the critical section object contained in the **m_sec** data member. The critical section object must first be initialized with a call to the **Init** method. When

the protected code has finished executing, the thread must call **Unlock** to release ownership of the critical section.

CComCriticalSection::Term

void Term( );

Remarks

Calls the Win32 function **DeleteCriticalSection**, which releases all resources used by the critical section object contained in the **m_sec** data member. Once **Term** has been called, the critical section can no longer be used for synchronization.

CComCriticalSection::Unlock

void Unlock( );

Remarks

Calls the Win32 function **LeaveCriticalSection**, which releases ownership of the critical section object contained in the **m_sec** data member. To first obtain ownership, the thread must call the **Lock** method. Each call to **Lock** requires a corresponding call to **Unlock** to release ownership of the critical section.

Data Members

CComCriticalSection::m_sec

CRITICAL_SECTION m_sec;

Remarks

Contains a critical section object that is used by all **CComCriticalSection** methods.

See Also: CComCriticalSection::Lock, CComCriticalSection::Unlock, CComCriticalSection::Init, CComCriticalSection::Term

CComDispatchDriver

class CComDispatchDriver

CComDispatchDriver lets you retrieve or set an object's properties through an **IDispatch** pointer. For more information about adding properties to an object, see the "ATL Tutorial."

#include <atlctl.h>

Methods

CComDispatchDriver	Constructor. Initializes the data member **p** to **NULL**.
GetProperty	Gets the value of a property exposed by an object.
PutProperty	Sets the value of a property exposed by an object.
Release	Releases the **IDispatch** pointer and sets it to **NULL**.

Operators

operator IDispatch*	Converts a **ComDispatchDriver** object to an **IDispatch** pointer.
operator *	Returns the dereferenced value of the data member **p**.
operator &	Returns the address of data member **p**.
operator ->	Returns the data member **p**.
operator =	Sets the data member **p** to the specified **IDispatch** interface pointer.
operator !	Checks whether the data member **p** is **NULL** or not.

Data Members

p	Pointer to the **IDispatch** interface.

Methods

CComDispatchDriver::CComDispatchDriver

CComDispatchDriver( );
CComDispatchDriver(IDispatch* *lp* **);**
CComDispatchDriver(IUnknown* *lp* **));**

Parameters

lp [in] Pointer to an **IDispatch** or **IUnknown** interface.

Remarks

The constructor. If there is no *lp* parameter, the constructor initializes the data member **p** to **NULL**. If *lp* points to an **IDispatch** interface, the constructor sets **p** to that interface and calls **AddRef**. If *lp* points to an **IUnknown** interface, the constructor calls **QueryInterface** for the **IDispatch** interface and sets **p** to that interface.

The destructor calls **Release** on **p**, if necessary.

CComDispatchDriver::GetProperty

HRESULT GetProperty(DISPID *dwDispID*, **VARIANT*** *var* **);**
static HRESULT GetProperty(IDispatch* *pDisp*, **DISPID** *dwDispID*, **VARIANT*** *var* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dwDispID [in] The DISPID of the property to be retrieved. The DISPID can be obtained from **IDispatch::GetIDsOfNames**.

var [out] Pointer to where the property value is to be stored.

pDisp [in] Pointer to the **IDispatch** interface.

Remarks

Gets the value of the property identified by *dwDispID*. If you supply *pDisp*, that **IDispatch** pointer is used. If you do not, the **IDispatch** pointer contained in the data member **p** is used.

The following example shows a call to the static version of **GetProperty**. This code is used to implement **IPersistStreamInitImpl::Save**.

```
CComPtr<IDispatch> pDispatch;
const IID* piidOld = NULL;
for(int i = 0; pMap[i].pclsidPropPage != NULL; i++)
                // pMap is a pointer to an array of
                // ATL_PROPMAP_ENTRY structures
{
   if (pMap[i].szDesc == NULL)
      continue;
   CComVariant var;
   if(pMap[i].piidDispatch != piidOld)
   {
      if(FAILED(ControlQueryInterface(*pMap[i].piidDispatch,
                              (void**)&pDispatch)))
      {
         ATLTRACE(_T("Failed to get a dispatch pointer
                  for property #%i\n"), i);
         hr = E_FAIL;
         break;
      }
```

```
      piidOld = pMap[i].piidDispatch;
   }
   if (FAILED(CComDispatchDriver::GetProperty(pDispatch,
                              pMap[i].dispid, &var)))
   {
      ATLTRACE(_T("Invoked failed on DISPID %x\n"),
               pMap[i].dispid);
      hr = E_FAIL;
      break;
   }
   HRESULT hr = var.WriteToStream(pStm);
   if (FAILED(hr))
      break;
}
```

See Also: **CComDispatchDriver::PutProperty**

CComDispatchDriver::PutProperty

HRESULT PutProperty(DISPID *dwDispID*, **VARIANT*** *var* **);**
static HRESULT PutProperty(IDispatch* *pDisp*, **DISPID** *dwDispID*, **VARIANT*** *var* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

dwDispID [in] The DISPID of the property to be set. The DISPID can be obtained from **IDispatch::GetIDsOfNames**.

var [in] Pointer to the property value to be set.

pDisp [in] Pointer to the **IDispatch** interface.

Remarks

Sets the value of the property identified by *dwDispID* to the value in *var*. If you supply *pDisp*, that **IDispatch** pointer is used. If you do not, the **IDispatch** pointer contained in the data member **p** is used.

The following code illustrates **PutProperty**:

```
DISPID dwDispID;
VARIANT var;
HRESULT hRes;
OLECHAR *szMember = "ThisProperty";
VariantInit(&var)
...
hRes = pDisp->GetIDsOfNames(IID_NULL, szMember, 1,
                            LOCALE_USER_DEFAULT, &dwDispID);
hRes = CComDispatchDriver::PutProperty(pDisp, dwDispID, &var);
```

See Also: **CComDispatchDriver::GetProperty**

CComDispatchDriver::Release

void Release( );

Remarks

Checks whether data member **p** points to an **IDispatch** interface and, if it does, releases the interface and sets **p** to **NULL**.

Operators

CComDispatchDriver::operator IDispatch*

operator IDispatch*( ) ;

Remarks

Converts a **CComDispatchDriver** object to an **IDispatch** pointer by returning the data member **p**. Thus, if the **CComDispatchDriver** object is pDD, the following two statements are equivalent:

```
pMyDisp=(IDispatch*)(pDD)
pMyDisp= pDD.p
```

CComDispatchDriver::operator *

IDispatch& operator *( );

Remarks

Returns the dereferenced value of the **IDispatch** interface pointer stored in the data member **p**.

Note The operation will assert if **p** is **NULL**.

CComDispatchDriver::operator &

IDispatch operator &( );**

Remarks

Returns the address of the **IDispatch** interface pointer stored in the data member **p**. The operation will assert if **p** is non-**NULL**. This operator avoids memory leaks if you want to set **p** without releasing it first.

CComDispatchDriver::operator ->

IDispatch* operator ->( );

Remarks

Returns the **IDispatch** interface pointer stored in the data member **p**.

Note The operation will assert if **p** is **NULL**.

CComDispatchDriver::operator =

IDispatch* operator =(IDispatch* *lp*) ;
IDispatch* operator =(IUnknown* *lp*) ;

Remarks

Sets the data member **p** to an **IDispatch** interface pointer or to a pointer to an **IDispatch** interface obtained through an **IUnknown** pointer.

If **p** already points to an **IDispatch** interface, that interface is first released.

For example, if the **CComDispatchDriver** object is `pDD` and an **IDispatch** pointer is `pMyDisp`, `pDD=pMyDisp` sets `pDD.p` to `pMyDisp`. If an **IUnknown** pointer is `pMyUnk`, `pDD=pMyUnk` sets `pDD.p` to point to the **IDispatch** queried for on `pMyUnk`, that is:

```
pMyUnk->QueryInterface(IID_IDispatch, (void**)pDD.p);
```

CComDispatchDriver::operator !

BOOL operator !( );

Remarks

Returns **TRUE** if the data member **p** is **NULL**; otherwise, **FALSE**.

Data Members

CComDispatchDriver::p

IDispatch* p;

Remarks

The pointer to the **IDispatch** interface. This data member can be set to an existing **IDispatch** interface with **operator =**.

See Also: **CComDispatchDriver::operator =**

CComDynamicUnkArray

class CComDynamicUnkArray

CComDynamicUnkArray holds a dynamically allocated array of **IUnknown** pointers, each an interface on a connection point. **CComDynamicUnkArray** can be used as a parameter to the **IConnectionPointImpl** template class.

The **CComDynamicUnkArray** methods **begin** and **end** can be used to loop through all connection points (for example, when an event is fired).

See "The Proxy Generator" for details on automating creation of connection point proxies.

#include <atlcom.h>

See Also: CComUnkArray

Methods

begin	Returns a pointer to the first **IUnknown** pointer in the collection.
CComDynamicUnkArray	Constructor. Initializes the collection values to **NULL** and the collection size to zero.
end	Returns a pointer to one past the last **IUnknown** pointer in the collection.

Methods

CComDynamicUnkArray::begin

IUnknown begin( );**

Return Value

A pointer to an **IUnknown** interface pointer.

Remarks

Returns a pointer to the beginning of the collection of **IUnknown** interface pointers.

The collection contains pointers to interfaces stored locally as **IUnknown**. You cast each **IUnknown** interface to the real interface type and then call through it. You do not need to query for the interface first.

Before using the **IUnknown** interface, you should check that it is not **NULL**.

See Also: CComDynamicUnkArray::end, CComUnkArray::begin

CComDynamicUnkArray::CComDynamicUnkArray

CComDynamicUnkArray( );

Remarks

The constructor. Sets the collection size to zero and initializes the values to **NULL**.
The destructor frees the collection, if necessary.

CComDynamicUnkArray::end

IUnknown end( );**

Return Value

A pointer to an **IUnknown** interface pointer.

Remarks

Returns a pointer to one past the last **IUnknown** pointer in the collection.

See Also: CComDynamicUnkArray::begin, CComUnkArray::end

CComFakeCriticalSection

class CComFakeCriticalSection

CComFakeCriticalSection mirrors the methods found in **CComCriticalSection**. However, **CComFakeCriticalSection** does not provide a critical section; therefore, its methods do nothing.

Typically, you use **CComFakeCriticalSection** through a **typedef** name, either **AutoCriticalSection** or **CriticalSection**. When using **CComSingleThreadModel** or **CComMultiThreadModelNoCS**, both of these **typedef** names reference **CComFakeCriticalSection**. When using **CComMultiThreadModel**, they reference **CComAutoCriticalSection** and **CComCriticalSection** respectively.

#include <atlbase.h>

Methods

Init	Does nothing.
Lock	Does nothing.
Term	Does nothing.
Unlock	Does nothing.

Methods

CComFakeCriticalSection::Init

void Init( );

Remarks

Does nothing since there is no critical section.

See Also: CComCriticalSection::Init

CComFakeCriticalSection::Lock

void Lock( );

Remarks

Does nothing since there is no critical section.

See Also: CComCriticalSection::Lock

CComFakeCriticalSection::Term

void Term( );

Remarks

Does nothing since there is no critical section.

See Also: CComCriticalSection::Term

CComFakeCriticalSection::Unlock

void Unlock( );

Remarks

Does nothing since there is no critical section.

See Also: CComCriticalSection::Unlock

CComGlobalsThreadModel

```
#if defined( _ATL_SINGLE_THREADED )
   typedef CComSingleThreadModel CComGlobalsThreadModel;
#elif defined( _ATL_APARTMENT_THREADED )
   typedef CComMultiThreadModel CComGlobalsThreadModel;
#else
   typedef CComMultiThreadModel CComGlobalsThreadModel;
#endif
```

Depending on the threading model used by your application, the **typedef** name **CComGlobalsThreadModel** references either **CComSingleThreadModel** or **CComMultiThreadModel**. These classes provide additional **typedef** names to reference a critical section class.

Note **CComGlobalsThreadModel** does not reference class **CComMultiThreadModelNoCS**.

Using **CComGlobalsThreadModel** frees you from specifying a particular threading model class. Regardless of the threading model being used, the appropriate methods will be called.

In addition to **CComGlobalsThreadModel**, ATL provides the **typedef** name **CComObjectThreadModel**. The class referenced by each **typedef** depends on the threading model used, as shown in the following table:

	Threading Model		
typedef	Single	Apartment	Free
CComObjectThreadModel	S	S	M
CComGlobalsThreadModel	S	M	M

S=**CComSingleThreadModel**; M=**CComMultiThreadModel**

Use **CComObjectThreadModel** within a single object class. Use **CComGlobalsThreadModel** in an object that is globally available to your program, or when you wish to protect module resources across multiple threads.

#include <atlbase.h>

See Also: **CComObjectRootEx**

CComModule

class CComModule : public _ATL_MODULE

CComModule implements a COM server module, allowing a client to access the module's components. **CComModule** supports both DLL (in-process) and EXE (local) modules.

A **CComModule** instance uses an object map to maintain a set of class object definitions. This object map is implemented as an array of **_ATL_OBJMAP_ENTRY** structures, and contains information for:

- Entering and removing object descriptions in the system registry.
- Instantiating objects through a class factory.
- Establishing communication between a client and the root object in the component.
- Performing lifetime management of class objects.

When you run the ATL COM AppWizard, the wizard automatically generates **_Module**, a global instance of **CComModule** or a class derived from it. For more information about the ATL COM AppWizard, see the article "Creating an ATL Project."

In addition to **CComModule**, ATL provides **CComAutoThreadModule**, which implements an apartment-model module for EXEs and Windows NT services. Derive your module from **CComAutoThreadModule** when you want to create objects in multiple apartments.

#include <atlbase.h>

Methods

GetClassObject	Creates an object of a specified CLSID. For DLLs only.
GetLockCount	Returns the current lock count on the module.
GetModuleInstance	Returns **m_hInst**.
GetResourceInstance	Returns **m_hInstResource**.
GetTypeLibInstance	Returns **m_hInstTypeLib**.
Init	Initializes data members.
Lock	Increments the module lock count.
RegisterClassHelper	Enters an object's standard class registration in the system registry.
RegisterClassObjects	Registers the class factory in the Running Object Table. For EXEs only.
RegisterServer	Updates the system registry for each object in the object map.

(continued)

Methods *(continued)*	
RegisterTypeLib	Registers a type library.
RevokeClassObjects	Removes the class factory from the Running Object Table. For EXEs only.
Term	Releases data members.
Unlock	Decrements the module lock count.
UnregisterClassHelper	Removes an object's standard class registration from the system registry.
UnregisterServer	Unregisters each object in the object map.
UpdateRegistryClass	Registers or unregisters an object's standard class registration.
UpdateRegistryFromResourceD	Runs the script contained in a specified resource to register or unregister an object.
UpdateRegistryFromResourceS	Statically links to the ATL Registry Component. Runs the script contained in a specified resource to register or unregister an object.

Data Members	
m_csObjMap	Ensures synchronized access to the object map information.
m_csTypeInfoHolder	Ensures synchronized access to the type library information.
m_csWindowCreate	Ensures synchronized access to window class information and static data used during window creation.
m_hHeap	Contains the handle to the heap managed by the module.
m_hInst	Contains the handle to the module instance.
m_hInstResource	By default, contains the handle to the module instance.
m_hInstTypeLib	By default, contains the handle to the module instance.
m_nLockCnt	Contains the current lock count on the module.
m_pObjMap	Points to the object map maintained by the module instance.

Methods

CComModule::GetClassObject

HRESULT GetClassObject(REFCLSID *rclsid*, **REFIID** *riid*, **LPVOID*** *ppv* **);**

Return Value

A standard **HRESULT** value.

Parameters

rclsid [in] The CLSID of the object to be created.

riid [in] The IID of the requested interface.

ppv [out] A pointer to the interface pointer identified by *riid*. If the object does not support this interface, *ppv* is set to **NULL**.

Remarks

Creates an object of the specified CLSID and retrieves an interface pointer to this object.

Note **GetClassObject** is only available to DLLs.

CComModule::GetLockCount

LONG GetLockCount( );

Return Value

The lock count on the module.

Remarks

Returns the current lock count on the module. **CComModule** uses the lock count to determine whether any clients are accessing the module. When the lock count reaches zero, the module can be unloaded.

See Also: **CComModule::Lock**, **CComModule::Unlock**, **CComModule::m_nLockCnt**

CComModule::GetModuleInstance

HINSTANCE GetModuleInstance( );

Return Value

The **HINSTANCE** identifying this module.

Remarks

Returns the **m_hInst** data member.

See Also: **CComModule::GetResourceInstance**, **CComModule::GetTypeLibInstance**

CComModule::GetResourceInstance

HINSTANCE GetResourceInstance( );

Return Value

An **HINSTANCE**.

Remarks

Returns the **m_hInstResource** data member.

See Also: CComModule::GetModuleInstance, CComModule::GetTypeLibInstance

CComModule::GetTypeLibInstance

HINSTANCE GetTypeLibInstance( );

Return Value

An **HINSTANCE**.

Remarks

Returns the **m_hInstTypeLib** data member.

See Also: CComModule::GetModuleInstance, CComModule::GetResourceInstance

CComModule::Init

void Init(_ATL_OBJMAP_ENTRY* *p*, **HINSTANCE** *h* **);**

Parameters

p [in] A pointer to an array of object map entries.

h [in] The **HINSTANCE** passed to **DLLMain** or **WinMain**.

Remarks

Initializes all data members.

See Also: CComModule::Term

CComModule::Lock

LONG Lock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic increment on the module's lock count. **CComModule** uses the lock count to determine whether any clients are accessing the module.

See Also: CComModule::Unlock, CComModule::GetLockCount, CComModule::m_nLockCnt

CComModule::RegisterClassHelper

HRESULT RegisterClassHelper(const CLSID& *clsid*, LPCTSTR *lpszProgID*,
↪ LPCTSTR *lpszVerIndProgID*, UINT *nDescID*, DWORD *dwFlags*);

Return Value

A standard **HRESULT** value.

Parameters

clsid [in] The CLSID of the object to be registered.

lpszProgID [in] The ProgID associated with the object.

lpszVerIndProgID [in] The version-independent ProgID associated with the object.

nDescID [in] The identifier of a string resource for the object's description.

dwFlags [in] Specifies the threading model to enter in the registry. Possible values are **THREADFLAGS_APARTMENT**, **THREADFLAGS_BOTH**, or **AUTPRXFLAG**.

Remarks

Enters an object's standard class registration in the system registry. The **UpdateRegistryClass** method calls **RegisterClassHelper**.

See Also: CComModule::UnregisterClassHelper

CComModule::RegisterClassObjects

HRESULT RegisterClassObjects(DWORD *dwClsContext*, DWORD *dwFlags*);

Return Value

A standard **HRESULT** value.

Parameters

dwClsContext [in] Specifies the context in which the class object is to be run. Possible values are **CLSCTX_INPROC_SERVER**, **CLSCTX_INPROC_HANDLER**, or **CLSCTX_LOCAL_SERVER**. For a description of these values, see **CLSCTX** in the *Win32 SDK* online.

dwFlags [in] Determines the connection types to the class object. Possible values are **REGCLS_SINGLEUSE**, **REGCLS_MULTIPLEUSE**, or **REGCLS_MULTI_SEPARATE**. For a description of these values, see **REGCLS** in the *Win32 SDK* online.

Remarks

Registers the class factory in the Running Object Table.

Note **RegisterClassObjects** is only available to EXEs.

See Also: CComModule::RevokeClassObjects

CComModule::RegisterServer

HRESULT RegisterServer(BOOL *bRegTypeLib* **= FALSE,**
↳ **const CLSID*** *pCLSID* **= NULL);**

Return Value

A standard **HRESULT** value.

Parameters

bRegTypeLib [in] Indicates whether the type library will be registered. The default value is **FALSE**.

pCLSID [in] Points to the CLSID of the object to be registered. If **NULL** (the default value), all objects in the object map will be registered.

Remarks

Depending on the *pCLSID* parameter, updates the system registry for a single class object or for all objects in the object map. If *bRegTypeLib* is **TRUE**, the type library information will also be updated.

The **BEGIN_OBJECT_MAP** macro starts your object map definition.

RegisterServer will be called automatically by **DLLRegisterServer** for a DLL or by **WinMain** for an EXE run with the **/RegServer** command line option.

See Also: CComModule::UnregisterServer

CComModule::RegisterTypeLib

HRESULT RegisterTypeLib( );
HRESULT RegisterTypeLib(LPCTSTR *lpszIndex* **);**

Return Value

A standard **HRESULT** value.

Parameters

lpszIndex [in] Specifies the name of a type library resource.

Remarks

Adds information about a type library to the system registry. If the module instance contains multiple type libraries, use the second version of this method to specify which type library should be used.

CComModule::RevokeClassObjects

HRESULT RevokeClassObjects( );

Return Value

A standard **HRESULT** value.

Remarks

Removes the class factory from the Running Object Table.

Note **RevokeClassObjects** is only available to EXEs.

See Also: **CComModule::RegisterClassObjects**

CComModule::Term

void Term( );

Remarks

Releases all data members.

See Also: **CComModule::Init**

CComModule::Unlock

LONG Unlock( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Performs an atomic decrement on the module's lock count. **CComModule** uses the lock count to determine whether any clients are accessing the module. When the lock count reaches zero, the module can be unloaded.

See Also: **CComModule::Lock**, **CComModule::GetLockCount**, **CComModule::m_nLockCnt**

CComModule::UnregisterClassHelper

HRESULT UnregisterClassHelper(const CLSID& *clsid*, **LPCTSTR** *lpszProgID*, **LPCTSTR** *lpszVerIndProgID* **);**

Return Value

A standard **HRESULT** value.

Parameters

clsid [in] The CLSID of the object to be unregistered.

lpszProgID [in] The ProgID associated with the object.

lpszVerIndProgID [in] The version-independent ProgID associated with the object.

Remarks

Removes an object's standard class registration from the system registry. The **UpdateRegistryClass** method calls **UnregisterClassHelper**.

See Also: CComModule::RegisterClassHelper

CComModule::UnregisterServer

HRESULT UnregisterServer(const CLSID* *pCLSID* **= NULL);**

Return Value

A standard **HRESULT** value.

Parameters

pCLSID [in] Points to the CLSID of the object to be unregistered. If **NULL** (the default value), all objects in the object map will be unegistered.

Remarks

Depending on the *pCLSID* parameter, unregisters either a single class object or all objects in the object map. The **BEGIN_OBJECT_MAP** macro starts your object map definition.

UnregisterServer will be called automatically by **DLLUnregisterServer** for a DLL or by **WinMain** for an EXE run with the **/UnregServer** command line option.

See Also: CComModule::RegisterServer

CComModule::UpdateRegistryClass

HRESULT UpdateRegistryClass(const CLSID& *clsid*, **LPCTSTR** *lpszProgID*,
↪ **LPCTSTR** *lpszVerIndProgID*, **UINT** *nDescID*, **DWORD** *dwFlags*,
↪ **BOOL** *bRegister* **);**

Return Value

A standard **HRESULT** value.

Parameters

clsid [in] The CLSID of the object to be registered or unregistered.

lpszProgID [in] The ProgID associated with the object.

lpszVerIndProgID [in] The version-independent ProgID associated with the object.

nDescID [in] The identifier of the string resource for the object's description.

dwFlags [in] Specifies the threading model to enter in the registry. Possible values are **THREADFLAGS_APARTMENT**, **THREADFLAGS_BOTH**, or **AUTPRXFLAG**.

bRegister [in] Indicates whether the object should be registered.

Remarks

If *bRegister* is **TRUE**, this method enters the object's standard class registration in the system registry. If *bRegister* is **FALSE**, it removes the object's registration.

Depending on the value of *bRegister*, **UpdateRegistryClass** calls either **RegisterClassHelper** or **UnregisterClassHelper**.

By specifying the **DECLARE_REGISTRY** macro, **UpdateRegistryClass** will be invoked automatically when your object map is processed.

CComModule::UpdateRegistryFromResourceD

HRESULT UpdateRegistryFromResourceD(LPCTSTR *lpszRes*, **BOOL** *bRegister*,
↪ **struct _ATL_REGMAP_ENTRY*** *pMapEntries* = **NULL**);
HRESULT UpdateRegistryFromResourceD(UINT *nResID*, **BOOL** *bRegister*,
↪ **struct _ATL_REGMAP_ENTRY*** *pMapEntries* = **NULL**);

Return Value

A standard **HRESULT** value.

Parameters

lpszRes [in] A resource name.

nResID [in] A resource ID.

bRegister [in] Indicates whether the object should be registered.

pMapEntries [in] A pointer to the replacement map storing values associated with the script's replaceable parameters. ATL automatically uses `%MODULE%`. To use additional replaceable parameters, see Remarks for details. Otherwise, use the **NULL** default value.

Remarks

Runs the script contained in the resource specified by *lpszRes* or *nResID*. If *bRegister* is **TRUE**, this method registers the object in the system registry; otherwise, it unregisters the object.

By specifying the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro, **UpdateRegistryFromResourceD** will be invoked automatically when your object map is processed.

Note To substitute replacement values at run time, do not specify the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro. Instead, create an array of **_ATL_REGMAP_ENTRIES** structures, where each entry contains a variable placeholder paired with a value to replace the placeholder at run time. Then call **UpdateRegistryFromResourceD**, passing the array for the *pMapEntries* parameter. This adds all the replacement values in the **_ATL_REGMAP_ENTRIES** structures to the Registrar's replacement map.

Note To statically link to the ATL Registry Component (Registrar), see **UpdateRegistryFromResourceS.**

For more information about replaceable parameters and scripting, see the article "The ATL Registry Component (Registrar)."

See Also: **BEGIN_OBJECT_MAP**

CComModule::UpdateRegistryFromResourceS

HRESULT UpdateRegistryFromResourceS(LPCTSTR *lpszRes*, **BOOL** *bRegister*,
↪ **struct _ATL_REGMAP_ENTRY*** *pMapEntries* = **NULL);**
HRESULT UpdateRegistryFromResourceS(UINT *nResID*, **BOOL** *bRegister*,
↪ **struct _ATL_REGMAP_ENTRY*** *pMapEntries* = **NULL);**

Return Value

A standard **HRESULT** value.

Parameters

lpszRes [in] A resource name.

nResID [in] A resource ID.

bRegister [in] Indicates whether the resource script should be registered.

pMapEntries [in] A pointer to the replacement map storing values associated with the script's replaceable parameters. ATL automatically uses `%MODULE%`. To use additional replaceable parameters, see Remarks for details. Otherwise, use the **NULL** default value.

Remarks

Similar to **UpdateRegistryFromResourceD** except **UpdateRegistryFromResourceS** creates a static link to the ATL Registry Component (Registrar).

UpdateRegistryFromResourceS will be invoked automatically when your object map is processed, provided you add `#define _ATL_STATIC_REGISTRY` to your stdafx.h.

Note To substitute replacement values at run time, do not specify the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro. Instead, create an array of **_ATL_REGMAP_ENTRIES** structures, where each entry contains a variable placeholder paired with a value to replace the placeholder at run time. Then call **CComModule::UpdateRegistryFromResourceS**, passing the array for the *pMapEntries* parameter. This adds all the replacement values in the **_ATL_REGMAP_ENTRIES** structures to the Registrar's replacement map.

For more information about replaceable parameters and scripting, see the article "The ATL Registry Component (Registrar)."

See Also: **BEGIN_OBJECT_MAP**

Data Members

CComModule::m_csObjMap

CRITICAL_SECTION m_csObjMap;

Remarks

Ensures synchronized access to the object map.

CComModule::m_csTypeInfoHolder

CRITICAL_SECTION m_csTypeInfoHolder;

Remarks

Ensures synchronized access to the type library.

CComModule::m_csWindowCreate

CRITICAL_SECTION m_csWindowCreate;

Remarks

Ensures synchronized access to window class information and to static data used during window creation.

CComModule::m_hHeap

HANDLE m_hHeap;

Remarks

Contains the handle to the heap managed by the module.

CComModule::m_hInst

HINSTANCE m_hInst;

Remarks

Contains the handle to the module instance. The **Init** method sets **m_hInst** to the handle passed to **DLLMain** or **WinMain**.

CComModule::m_hInstResource

HINSTANCE m_hInstResource;

Remarks

By default, contains the handle to the module instance. The **Init** method sets **m_hInstResource** to the handle passed to **DLLMain** or **WinMain**. You can explicitly set **m_hInstResource** to the handle to a resource.

The **GetResourceInstance** method returns the handle stored in **m_hInstResource**.

CComModule::m_hInstTypeLib

HINSTANCE m_hInstTypeLib;

Remarks

By default, contains the handle to the module instance. The **Init** method sets **m_hInstTypeLib** to the handle passed to **DLLMain** or **WinMain**. You can explicitly set **m_hInstTypeLib** to the handle to a type library.

The **GetTypeLibInstance** method returns the handle stored in **m_hInstTypeLib**.

CComModule::m_nLockCnt

LONG m_nLockCnt;

Remarks

Contains the current lock count on the module. **CComModule** uses the lock count to determine whether any clients are accessing the module. When the lock count reached zero, the module can be unloaded.

See Also: CComModule::GetLockCount, CComModule::Lock, CComModule::Unlock

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CComModule::m_pObjMap

_ATL_OBJMAP_ENTRY* m_pObjMap;

Remarks

Points to the object map maintained by the module instance.

CComMultiThreadModel

class CComMultiThreadModel

CComMultiThreadModel provides thread-safe methods for incrementing and decrementing the value of a variable. Typically, you use **CComMultiThreadModel** through one of two **typedef** names, either **CComObjectThreadModel** or **CComGlobalsThreadModel**. The class referenced by each **typedef** depends on the threading model used, as shown in the following table:

	Threading Model		
typedef	**Single**	**Apartment**	**Free**
CComObjectThreadModel	S	S	M
CComGlobalsThreadModel	S	M	M

S=**CComSingleThreadModel**; M=**CComMultiThreadModel**

CComMultiThreadModel itself defines three **typedef** names. **AutoCriticalSection** and **CriticalSection** reference classes that provide methods for obtaining and releasing ownership of a critical section. **ThreadModelNoCS** references class **CComMultiThreadModelNoCS**.

#include <atlbase.h>

See Also: CComSingleThreadModel, CComAutoCriticalSection, CComCriticalSection

Methods

Decrement	Decrements the value of the specified variable in a thread-safe manner.
Increment	Increments the value of the specified variable in a thread-safe manner.

Typedefs

AutoCriticalSection	References class **CComAutoCriticalSection**.
CriticalSection	References class **CComCriticalSection**.
ThreadModelNoCS	References class **CComMultiThreadModelNoCS**.

Methods

CComMultiThreadModel::Decrement

static ULONG Decrement(LPLONG *p*);

Return Value

If the result of the decrement is 0, then **Decrement** returns 0. If the result of the decrement is nonzero, the return value is also nonzero but may not equal the result of the decrement.

Parameters

p [in] Pointer to the variable to be decremented.

Remarks

This static method calls the Win32 function **InterlockedDecrement**, which decrements the value of the variable pointed to by *p*. **InterlockedDecrement** prevents more than one thread from simultaneously using this variable.

See Also: CComMultiThreadModel::Increment

CComMultiThreadModel::Increment

static ULONG Increment(LPLONG *p*);

Return Value

If the result of the increment is 0, then **Increment** returns 0. If the result of the increment is nonzero, the return value is also nonzero but may not equal the result of the increment.

Parameters

p [in] Pointer to the variable to be incremented.

Remarks

This static method calls the Win32 function **InterlockedIncrement**, which increments the value of the variable pointed to by *p*. **InterlockedIncrement** prevents more than one thread from simultaneously using this variable.

See Also: CComMultiThreadModel::Decrement

Typedefs

CComMultiThreadModel::AutoCriticalSection

typedef CComAutoCriticalSection AutoCriticalSection;

Remarks

When using **CComMultiThreadModel**, the **typedef** name **AutoCriticalSection** references class **CComAutoCriticalSection**, which provides methods for obtaining and releasing ownership of a critical section object.

CComSingleThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **AutoCriticalSection**. The following table shows the relationship between the threading model class and the critical section class reference by **AutoCriticalSection**:

Class defined in	Class referenced
CComMultiThreadModel	**CComCriticalSection**
CComSingleThreadModel	**CComFakeCriticalSection**
CComMultiThreadModelNoCS	**CComFakeCriticalSection**

In addition to **AutoCriticalSection**, you can use the **typedef** name **CriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

The following code is taken from **CComObjectRootEx**.

```
template< class ThreadModel >
class CComObjectRootEx : public CComObjectRootBase
{
public:
   typedef ThreadModel _ThreadModel;
   typedef _ThreadModel::AutoCriticalSection _CritSec;

   ULONG InternalAddRef( )
   {
      ...
      return _ThreadModel::Increment(&m_dwRef);
   }
   ...
   void Lock( ) { m_critsec.Lock( ); }
   ...

private:
   _CritSec m_critsec;

};
```

The following tables show the results of the **InternalAddRef** and **Lock** methods, depending on the **ThreadModel** template parameter and the threading model used by the application:

ThreadModel = CComObjectThreadModel

	Single or **Apartment**	**Free**
InternalAddRef	The increment is not thread-safe.	The increment is thread-safe.
Lock	Does nothing; there is no critical section to lock.	The critical section is locked.

ThreadModel = CComObjectThreadModel::ThreadModelNoCS

	Single or **Apartment**	**Free**
InternalAddRef	The increment is not thread-safe.	The increment is thread-safe.
Lock	Does nothing; there is no critical section to lock.	Does nothing; there is no critical section to lock.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComMultiThreadModel::ThreadModelNoCS

CComMultiThreadModel::CriticalSection

typedef CComCriticalSection CriticalSection;

Remarks

When using **CComMultiThreadModel**, the **typedef** name **CriticalSection** references class **CComCriticalSection**, which provides methods for obtaining and releasing ownership of a critical section object.

CComSingleThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **CriticalSection**. The following table shows the relationship between the threading model class and the critical section class referenced by **CriticalSection**:

Class defined in	Class referenced
CComMultiThreadModel	**CComCriticalSection**
CComSingleThreadModel	**CComFakeCriticalSection**
CComMultiThreadModelNoCS	**CComFakeCriticalSection**

In addition to **CriticalSection**, you can use the **typedef** name **AutoCriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

See **AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComMultiThreadModel::ThreadModelNoCS

CComMultiThreadModel::ThreadModelNoCS

typedef CComMultiThreadModelNoCS ThreadModelNoCS;

Remarks

When using **CComMultiThreadModel**, the **typedef** name **ThreadModelNoCS** references class **CComMultiThreadModelNoCS**. **CComMultiThreadModelNoCS** provides thread-safe methods for incrementing and decrementing a variable; however, it does not provide a critical section.

CComSingleThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **ThreadModelNoCS**. The following table shows the relationship between the threading model class and the class referenced by **ThreadModelNoCS**:

Class defined in	Class referenced
CComMultiThreadModel	**CComMultiThreadModelNoCS**
CComSingleThreadModel	**CComSingleThreadModel**
CComMultiThreadModelNoCS	**CComMultiThreadModelNoCS**

Example

See **AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel

CComMultiThreadModelNoCS

class CComMultiThreadModelNoCS

CComMultiThreadModelNoCS is similar to **CComMultiThreadModel** in that it provides thread-safe methods for incrementing and decrementing a variable. However, when you reference a critical section class through **CComMultiThreadModelNoCS**, methods such as **Lock** and **Unlock** will do nothing.

Typically, you use **CComMultiThreadModelNoCS** through the **ThreadModelNoCS** **typedef** name. This **typedef** is defined in **CComMultiThreadModelNoCS**, **CComMultiThreadModel**, and **CComSingleThreadModel**.

Note The global **typedef** names **CComObjectThreadModel** and **CComGlobalsThreadModel** do not reference **CComMultiThreadModelNoCS**.

In addition to **ThreadModelNoCS**, **CComMultiThreadModelNoCS** defines **AutoCriticalSection** and **CriticalSection**. These latter two **typedef** names reference **CComFakeCriticalSection**, which provides empty methods associated with obtaining and releasing a critical section.

#include <atlbase.h>

Methods

Decrement	Decrements the value of the specified variable in a thread-safe manner.
Increment	Increments the value of the specified variable in a thread-safe manner.

Typedefs

AutoCriticalSection	References class **CComFakeCriticalSection**.
CriticalSection	References class **CComFakeCriticalSection**.
ThreadModelNoCS	References class **CComMultiThreadModelNoCS**.

Methods

CComMultiThreadModelNoCS::Decrement

static ULONG Decrement(LPLONG *p*);

Return Value

If the result of the decrement is 0, then **Decrement** returns 0. If the result of the decrement is nonzero, the return value is also nonzero but may not equal the result of the decrement.

Parameters

p [in] Pointer to the variable to be decremented.

Remarks

This static method calls the Win32 function **InterlockedDecrement**, which decrements the value of the variable pointed to by *p*. **InterlockedDecrement** prevents more than one thread from simultaneously using this variable.

See Also: CComMultiThreadModelNoCS::Increment

CComMultiThreadModelNoCS::Increment

static ULONG Increment(LPLONG *p*);

Return Value

If the result of the increment is 0, then **Increment** returns 0. If the result of the increment is nonzero, the return value is also nonzero but may not equal the result of the increment.

Parameters

p [in] Pointer to the variable to be incremented.

Remarks

This static method calls the Win32 function **InterlockedIncrement**, which increments the value of the variable pointed to by *p*. **InterlockedIncrement** prevents more than one thread from simultaneously using this variable.

See Also: CComMultiThreadModelNoCS::Decrement

Typedefs

CComMultiThreadModelNoCS::AutoCriticalSection

typedef CComFakeCriticalSection AutoCriticalSection;

Remarks

When using **CComMultiThreadModelNoCS**, the **typedef** name **AutoCriticalSection** references class **CComFakeCriticalSection**. Because **CComFakeCriticalSection** does not provide a critical section, its methods do nothing.

CComMultiThreadModel and **CComSingleThreadModel** also contain definitions for **AutoCriticalSection**. The following table shows the relationship

between the threading model class and the critical section class referenced by **AutoCriticalSection**:

Class defined in	Class referenced
CComMultiThreadModelNoCS	**CComFakeCriticalSection**
CComMultiThreadModel	**CComAutoCriticalSection**
CComSingleThreadModel	**CComFakeCriticalSection**

In addition to **AutoCriticalSection**, you can use the **typedef** name **CriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

See **CComMultiThreadModel::AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComMultiThreadModelNoCS::ThreadModelNoCS

CComMultiThreadModelNoCS::CriticalSection

typedef CComFakeCriticalSection CriticalSection;

Remarks

When using **CComMultiThreadModelNoCS**, the **typedef** name **CriticalSection** references class **CComFakeCriticalSection**. Because **CComFakeCriticalSection** does not provide a critical section, its methods do nothing.

CComMultiThreadModel and **CComSingleThreadModel** also contain definitions for **CriticalSection**. The following table shows the relationship between the threading model class and the critical section class referenced by **CriticalSection**:

Class defined in	Class referenced
CComMultiThreadModelNoCS	**CComFakeCriticalSection**
CComMultiThreadModel	**CComCriticalSection**
CComSingleThreadModel	**CComFakeCriticalSection**

In addition to **CriticalSection**, you can use the **typedef** name **AutoCriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

See **CComMultiThreadModel::AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComMultiThreadModelNoCS::ThreadModelNoCS

CComMultiThreadModelNoCS::ThreadModelNoCS

typedef CComMultiThreadModelNoCS ThreadModelNoCS;

Remarks

When using **CComMultiThreadModelNoCS**, the **typedef** name **ThreadModelNoCS** simply references **CComMultiThreadModelNoCS**.

CComMultiThreadModel and **CComSingleThreadModel** also contain definitions for **ThreadModelNoCS**. The following table shows the relationship between the threading model class and the class referenced by **ThreadModelNoCS**:

Class defined in	Class referenced
CComMultiThreadModelNoCS	**CComMultiThreadModelNoCS**
CComMultiThreadModel	**CComMultiThreadModelNoCS**
CComSingleThreadModel	**CComSingleThreadModel**

Example

See **CComMultiThreadModel::AutoCriticalSection**.

Note that the definition of **ThreadModelNoCS** in **CComMultiThreadModelNoCS** provides symmetry with **CComMultiThreadModel** and **CComSingleThreadModel**. For example, suppose the sample code in **CComMultiThreadModel::AutoCriticalSection** declared the following **typedef**:

```
typedef ThreadModel::ThreadModelNoCS _ThreadModel;
```

Regardless of the class specified for **ThreadModel** (such as **CComMultiThreadModelNoCS**), **_ThreadModel** resolves accordingly.

See Also: **CComObjectThreadModel**, **CComGlobalsThreadModel**

CComObject

template< class *Base* **>**
class CComObject : public *Base*

Parameters

Base Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interfaces you want to support on the object.

CComObject implements **IUnknown** for a nonaggregated object. However, calls to **QueryInterface**, **AddRef**, and **Release** are delegated to **CComObjectRootEx**.

For more information about using **CComObject**, see the article "Fundamentals of ATL COM Objects."

#include <atlcom.h>

See Also: CComAggObject, CComPolyObject, DECLARE_AGGREGATABLE, DECLARE_NOT_AGGREGATABLE

Methods

CComObject	Constructor.
CreateInstance	Creates a new **CComObject** object.

IUnknown Methods

AddRef	Increments the reference count on the object.
QueryInterface	Retrieves a pointer to the requested interface.
Release	Decrements the reference count on the object.

Methods

CComObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Increments the reference count on the object.

See Also: CComObject::Release

CComObject::CComObject

CComObject(void* = NULL);

Parameters

void* [in] This unnamed parameter is not used. It exists for symmetry with other **CCom***XXX***Object***XXX* constructors.

Remarks

The constructor increments the module lock count. The destructor decrements it.

CComObject::CreateInstance

static HRESULT CreateInstance(CComObject< *Base* **>**** *pp* **);**

Return Value

A standard **HRESULT** value.

Parameters

pp [out] A pointer to a **CComObject<***Base***>** pointer. If **CreateInstance** is unsuccessful, *pp* is set to **NULL**.

Remarks

This static method allows you to create a new **CComObject<***Base***>** object, without the overhead of **CoCreateInstance**.

CComObject::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The identifier of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Retrieves a pointer to the requested interface.

CComObject::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics or testing. In non-debug builds, **Release** always returns 0.

Remarks

Decrements the reference count on the object.

See Also: CComObject::AddRef

CComObjectGlobal

template< class *Base* **>**
class CComObjectGlobal : public *Base*

Parameters

Base Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interface you want to support on the object.

CComObjectGlobal manages a reference count on the module containing your *Base* object. **CComObjectGlobal** ensures your object will not be deleted as long as the module is not released. Your object will only be removed when the reference count on the entire module goes to zero.

For example, using **CComObjectGlobal**, a class factory can hold a common global object that is shared by all its clients.

#include <atlcom.h>

See Also: CComObjectStack, CComAggObject, CComObject

Class Methods

CComObjectGlobal	Constructor.

IUnknown Methods

AddRef	Implements a global **AddRef**.
QueryInterface	Implements a global **QueryInterface**.
Release	Implements a global **Release**.

Data Members

m_hResFinalConstruct	Contains the **HRESULT** returned during construction of the **CComObjectGlobal** object.

Methods

CComObjectGlobal::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics and testing.

Remarks

Increments the reference count of the object by 1. By default, **AddRef** calls **_Module::Lock**, where **_Module** is the global instance of **CComModule** or a class derived from it.

See Also: **CComObjectGlobal::Release, CComModule::Lock**

CComObjectGlobal::CComObjectGlobal

CComObjectGlobal( );

Remarks

The constructor. Calls **FinalConstruct** and then sets **m_hResFinalConstruct** to the **HRESULT** returned by **FinalConstruct**. If you have not derived your base class from **CComObjectRoot**, you must supply your own **FinalConstruct** method. The destructor calls **FinalRelease**.

See Also: **CComObjectRootEx::FinalConstruct**

CComObjectGlobal::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject*) ;

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The GUID of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by iid, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface pointer. **QueryInterface** only handles interfaces in the COM map table.

See Also: **CComObjectRootEx::InternalQueryInterface, BEGIN_COM_MAP**

CComObjectGlobal::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics and testing. In non-debug builds, **Release** always returns 0.

Remarks

Decrements the reference count of the object by 1. By default, **Release** calls **_Module::Unlock**, where **_Module** is the global instance of **CComModule** or a class derived from it.

See Also: **CComObjectGlobal::AddRef, CComModule::Unlock**

Data Members

CComObjectGlobal::m_hResFinalConstruct

HRESULT m_hResFinalConstruct( );

Remarks

Contains the **HRESULT** from calling **FinalConstruct** during construction of the **CComObjectGlobal** object.

See Also: CComObjectRootEx::FinalConstruct

CComObjectNoLock

template< class *Base* **>**
class CComObjectNoLock : public *Base*

Parameters

Base Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interface you want to support on the object.

CComObjectNoLock is similar to **CComObject** in that it implements **IUnknown** for a nonaggregated object; however, **CComObjectNoLock** does not increment the module lock count in the constructor.

ATL uses **CComObjectNoLock** internally for class factories. In general, you will not use this class directly.

#include <atlcom.h>

Class Methods

CComObjectNoLock	Constructor.

IUnknown Methods

AddRef	Increments the reference count on the object.
QueryInterface	Returns a pointer to the requested interface.
Release	Decrements the reference count on the object.

Methods

CComObjectNoLock::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Increments the reference count on the object.

See Also: CComObjectNoLock::Release

CComObjectNoLock::CComObjectNoLock

CComObjectNoLock(void* = NULL);

Parameters

void* [in] This unnamed parameter is not used. It exists for symmetry with other **CCom***XXX***Object***XXX* constructors.

Remarks

The constructor. Unlike **CComObject**, does not increment the module lock count.

CComObjectNoLock::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The identifier of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Retrieves a pointer to the requested interface.

CComObjectNoLock::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics or testing. In non-debug builds, **Release** always returns 0.

Remarks

Decrements the reference count on the object.

See Also: CComObjectNoLock::AddRef

CComObjectRoot

typedef CComObjectRootEx<CComObjectThreadModel> CComObjectRoot;

CComObjectRoot is a **typedef** of **CComObjectRootEx** templatized on the default threading model of the server. Thus **CComObjectThreadModel** will reference either **CComSingleThreadModel** or **CComMultiThreadModel**.

CComObjectRootEx handles object reference count management for both nonaggregated and aggregated objects. It holds the object reference count if your object is not being aggregated, and holds the pointer to the outer unknown if your object is being aggregated. For aggregated objects, **CComObjectRootEx** methods can be used to handle the failure of the inner object to construct, and to protect the outer object from deletion when inner interfaces are released or the inner object is deleted.

#include <atlcom.h>

See Also: CComObjectRootEx, CComAggObject, CComObject, CComPolyObject

CComObjectRootEx

template< class *ThreadModel* **>**
class CComObjectRootEx : public CComObjectRootBase

Parameters

ThreadModel The class whose methods implement the desired threading model. You can explicitly choose the threading model by setting *ThreadModel* to **CComSingleThreadModel**, **CComMultiThreadModel**, or **CComMultiThreadModelNoCS**. You can accept the server's default thread model by setting *ThreadModel* to **CComObjectThreadModel** or **CComGlobalsThreadModel**.

CComObjectRootEx handles object reference count management for both nonaggregated and aggregated objects. It holds the object reference count if your object is not being aggregated, and holds the pointer to the outer unknown if your object is being aggregated. For aggregated objects, **CComObjectRootEx** methods can be used to handle the failure of the inner object to construct, and to protect the outer object from deletion when inner interfaces are released or the inner object is deleted.

A class that implements a COM server must inherit from **CComObjectRootEx** or **CComObjectRoot**.

If your class definition specifies the **DECLARE_POLY_AGGREGATABLE** macro, ATL creates an instance of **CComPolyObject<CYourClass>** when **IClassFactory::CreateInstance** is called. During creation, the value of the outer unknown is checked. If it is **NULL**, **IUnknown** is implemented for a nonaggregated object. If the outer unknown is not **NULL**, **IUnknown** is implemented for an aggregated object.

If your class does not specify the **DECLARE_POLY_AGGREGATABLE** macro, ATL creates an instance of **CComObject<CYourClass>** for aggregated objects or an instance of **CComAggObject<CYourClass>** for nonaggregated objects.

The advantage of using **CComPolyObject** is that you avoid having both **CComAggObject** and **CComObject** in your module to handle the aggregated and nonaggregated cases. A single **CComPolyObject** object handles both cases. Therefore, only one copy of the vtable and one copy of the functions exist in your module. If your vtable is large, this can substantially decrease your module size. However, if your vtable is small, using **CComPolyObject** can result in a slightly larger module size because it is not optimized for an aggregated or nonaggregated object, as are **CComAggObject** and **CComObject**.

The **DECLARE_POLY_AGGREGATABLE** macro is automatically added to your class definition by the ATL Object Wizard when you create a full control or Internet Explorer control.

If your object is aggregated, **IUnknown** is implemented by **CComAggObject** or **CComPolyObject**. These classes delegate **QueryInterface**, **AddRef**, and **Release** calls to **CComObjectRootEx**'s **OuterQueryInterface**, **OuterAddRef**, and **OuterRelease** to forward to the outer unknown. Typically, you override **CComObjectRootEx::FinalConstruct** in your class to create any aggregated objects, and override **CComObjectRootEx::FinalRelease** to free any aggregated objects.

If your object is not aggregated, **IUnknown** is implemented by **CComObject** or **CComPolyObject**. In this case, calls to **QueryInterface**, **AddRef**, and **Release** are delegated to **CComObjectRootEx**'s **InternalQueryInterface**, **InternalAddRef**, and **InternalRelease** to perform the actual operations.

#include <atlcom.h>

See Also: CComAggObject, CComObject, CComPolyObject

Methods

CComObjectRootEx	Constructor.
InternalAddRef	Increments the reference count for a nonaggregated object.
InternalQueryInterface	Delegates to the **IUnknown** of a nonaggregated object.
InternalRelease	Decrements the reference count for a nonaggregated object.
Lock	If the thread model is multithreaded, obtains ownership of a critical section object.
Unlock	If the thread model is multithreaded, releases ownership of a critical section object.

CComObjectRootBase Methods

FinalConstruct	Override in your class to create any aggregated objects.
FinalRelease	Override in your class to release any aggregated objects.
OuterAddRef	Increments the reference count for an aggregated object.
OuterQueryInterface	Delegates to the outer **IUnknown** of an aggregated object.
OuterRelease	Decrements the reference count for an aggregated object.

Data Members

m_critsec	A **CComAutoCriticalSection** object or **CComFakeCriticalSection** object, depending on the thread model.
m_dwRef	With **m_pOuterUnknown**, part of a union. Used when the object is not aggregated to hold the reference count of **AddRef** and **Release**.
m_pOuterUnknown	With **m_dwRef**, part of a union. Used when the object is aggregated to hold a pointer to the outer unknown.

Methods

CComObjectRootEx::CComObjectRootEx

CComObjectRootEx( );

Remarks

The constructor initializes the reference count to 0.

CComObjectRootEx::FinalConstruct

HRESULT FinalConstruct( );

Return Value

One of the standard **HRESULT** values.

Remarks

Typically, override this method in the class derived from **CComObjectRootEx** to create any aggregated objects. For example:

```
class CMyAggObject : public CComObjectRootEx< ... >
{
   DECLARE_GET_CONTROLLING_UNKNOWN
   HRESULT FinalConstruct( )
   {
      return CoCreateInstance(CLSID_SomeServer,
               GetControllingUnknown(), CLSCTX_ALL,
               IID_ISomeServer, &m_pSomeServer);
   }
   ...
};
```

If the construction fails, you can return an error. You can also use the macro **DECLARE_PROTECT_FINAL_CONSTRUCT** to protect your outer object from being deleted if (during creation) the internal aggregated object increments the reference count then decrements the count to 0.

By default, **CComObjectRootEx::FinalConstruct** simply returns **S_OK**.

Here is a typical way to create an aggregate:

- Add an **IUnknown** pointer to your class object and initialize it to **NULL** in the constructor.
- Override **FinalConstruct** to create the aggregate.
- Use the **IUnknown** pointer you defined as the parameter to the **COM_INTERFACE_ENTRY_AGGREGATE** macro.
- Override **FinalRelease** to release the **IUnknown** pointer.

See Also: **CComObjectRootEx::FinalRelease,**
DECLARE_GET_CONTROLLING_UNKNOWN

CComObjectRootEx::FinalRelease

void FinalRelease( );

Remarks

Typically, override this method in the class derived from **CComObjectRootEx** to free any aggregated objects before deletion.

See Also: **CComObjectRootEx::FinalConstruct**

CComObjectRootEx::InternalAddRef

ULONG InternalAddRef( );

Return Value

A value that may be useful for diagnostics and testing.

Remarks

Increments the reference count of a nonaggregated object by 1. If the thread model is multithreaded, **InterlockedIncrement** is used to prevent more than one thread from changing the reference count at the same time.

See Also: **CComObjectRootEx::InternalRelease, InterlockedIncrement** in the *Win32 SDK* online

CComObjectRootEx::InternalQueryInterface

static HRESULT InternalQueryInterface(void* *pThis*,
↪ **const _ATL_INTMAP_ENTRY*** *pEntries*, **REFIID** *iid*, **void**** *ppvObject* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pThis [in] A pointer to the object that contains the COM map of interfaces exposed to **QueryInterface**.

pEntries [in] A pointer to the **_ATL_INTMAP_ENTRY** structure that accesses a map of available interfaces.

iid [in] The GUID of the interface being requested.

ppvObject [out] A pointer to the interface pointer specified in *iid*, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface.

InternalQueryInterface only handles interfaces in the COM map table. If your object is aggregated, **InternalQueryInterface** does not delegate to the outer unknown. You can enter interfaces into the COM map table with the macro **COM_INTERFACE_ENTRY** or one of its variants.

See Also: **CComObjectRootEx::InternalAddRef**, **CComObjectRootEx::InternalRelease**

CComObjectRootEx::InternalRelease

ULONG InternalRelease( );

Return Value

In non-debug builds, always returns 0. In debug builds, returns a value that may be useful for diagnostics or testing.

Remarks

Decrements the reference count of a nonaggregated object by 1. If the thread model is multithreaded, **InterlockedDecrement** is used to prevent more than one thread from changing the reference count at the same time.

See Also: **CComObjectRootEx::InternalAddRef**, **InterlockedDecrement** in the *Win32 SDK* online

---

CComObjectRootEx::Lock

void Lock( );

Remarks

If the thread model is multithreaded, this method calls the Win32 API function **EnterCriticalSection**, which waits until the thread can take ownership of the critical section object obtained through the **m_critsec** data member. When the protected code finishes executing, the thread must call **Unlock** to release ownership of the critical section.

If the thread model is single-threaded, this method does nothing.

See Also: **CComObjectRootEx::Unlock**, **CComObjectRootEx::m_critsec**

CComObjectRootEx::OuterAddRef

ULONG OuterAddRef( );

Return Value

A value that may be useful for diagnostics and testing.

Remarks

Increments the reference count of the outer unknown of an aggregation.

See Also: CComObjectRootEx::OuterRelease, CComObjectRootEx::OuterQueryInterface

---

CComObjectRootEx::OuterQueryInterface

HRESULT OuterQueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

iid [in] The GUID of the interface being requested.

ppvObject [out] A pointer to the interface pointer specified in *iid*, or **NULL** if the aggregation does not support the interface.

Remarks

Retrieves an indirect pointer to the requested interface.

See Also: CComObjectRootEx::OuterAddRef, CComObjectRootEx::OuterRelease

---

CComObjectRootEx::OuterRelease

ULONG OuterRelease( );

Return Value

In non-debug builds, always returns 0. In debug builds, returns a value that may be useful for diagnostics or testing.

Remarks

Decrements the reference count of the outer unknown of an aggregation.

See Also: CComObjectRootEx::OuterAddRef, CComObjectRootEx::OuterQueryInterface

CComObjectRootEx::Unlock

void Unlock( );

Remarks

If the thread model is multithreaded, this method calls the Win32 API function **LeaveCriticalSection**, which releases ownership of the critical section object obtained through the **m_critsec** data member. To obtain ownership, the thread must call **Lock**. Each call to **Lock** requires a corresponding call to **Unlock** to release ownership of the critical section.

If the thread model is single-threaded, this method does nothing.

See Also: **CComObjectRootEx::Lock, CComObjectRootEx::m_critsec**

Data Members

CComObjectRootEx::m_critsec

_CritSec m_critsec;

Remarks

A **CComAutoCriticalSection** or **CComFakeCriticalSection** object. The critical section class *_CritSec* is determined by the thread model: **CComAutoCriticalSection** if multithreaded, and **CComFakeCriticalSection** if single-threaded.

If the thread model is multithreaded, **m_critsec** is a **CComAutoCriticalSection** object and provides access to **CComAutoCriticalSection**'s methods and a **CRITICAL_SECTION** object.

If the thread model is single-threaded, a critical section is not needed and **m_critsec** is a **CComFakeCriticalSection** object.

See Also: **CComObjectRootEx::Lock, CComObjectRootEx::Unlock**

CComObjectRootEx::m_dwRef

long m_dwRef;

Remarks

Part of a **union** that accesses four bytes of memory.

```
union
{
   long m_dwRef;
   IUnknown* m_pOuterUnknown;
};
```

If the object is not aggregated, the reference count accessed by **AddRef** and **Release** is stored in **m_dwRef**. If the object is aggregated, the pointer to the outer unknown is stored in **m_pOuterUnknown**.

CComObjectRootEx::m_pOuterUnknown

IUnknown* m_pOuterUnknown;

Remarks

Part of a **union** that accesses four bytes of memory.

```
union
{
   long m_dwRef;
   IUnknown* m_pOuterUnknown;
};
```

If the object is aggregated, the pointer to the outer unknown is stored in **m_pOuterUnknown**. If the object is not aggregated, the reference count accessed by **AddRef** and **Release** is stored in **m_dwRef**.

CComObjectStack

template< class *Base* **>**
class CComObjectStack : public *Base*

Parameters

Base Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interface you want to support on the object.

CComObjectStack is used to create a temporary COM object and provide the object a skeletal implementation of **IUnknown**. Typically, the object is used as a local variable within one function (that is, pushed onto the stack). Since the object is destroyed when the function finishes, reference counting is not performed to increase efficiency.

The following example shows how to create a COM object used inside a function:

```
void MyFunc( )
{
   CComObjectStack<CMyObject> Tempobj;
   ...
}
```

The temporary object `Tempobj` is pushed onto the stack and automatically disappears when the function finishes.

#include <atlcom.h>

See Also: CComAggObject, CComObject, CComObjectGlobal

Class Methods

CComObjectStack	Constructor.

IUnknown Methods

AddRef	Returns zero. In debug mode, calls **_ASSERTE**.
QueryInterface	Returns **E_NOINTERFACE**. In debug mode, calls **_ASSERTE**.
Release	Returns zero. In debug mode, calls **_ASSERTE**.

Data Members

m_hResFinalConstruct	Contains the **HRESULT** returned during construction of the **CComObjectStack** object.

Methods

CComObjectStack::AddRef

ULONG AddRef( );

Return Value

Returns zero.

Remarks

Returns zero. In debug mode, calls **_ASSERTE**.

CComObjectStack::CComObjectStack

CComObjectStack( );

Remarks

The constructor. Calls **FinalConstruct** and then sets **m_hResFinalConstruct** to the **HRESULT** returned by **FinalConstruct**. If you have not derived your base class from **CComObjectRoot**, you must supply your own **FinalConstruct** method. The destructor calls **FinalRelease**.

See Also: CComObjectRootEx::FinalConstruct

CComObjectStack::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject*) ;

Return Value

Returns **E_NOINTERFACE**.

Parameters

iid [in] The IID of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*, or **NULL** if the interface is not found.

Remarks

Returns **E_NOINTERFACE**. In debug mode, calls **_ASSERTE**.

CComObjectStack::Release

ULONG Release( );

Return Value

Returns zero.

Remarks

Returns zero. In debug mode, calls **_ASSERTE**.

Data Members

CComObjectStack::m_hResFinalConstruct

HRESULT m_hResFinalConstruct( );

Remarks

Contains the **HRESULT** returned from calling **FinalConstruct** during construction of the **CComObjectStack** object.

See Also: CComObjectRootEx::FinalConstruct

CComObjectThreadModel

```
#if defined( _ATL_SINGLE_THREADED )
   typedef CComSingleThreadModel CComObjectThreadModel;
#elif defined( _ATL_APARTMENT_THREADED )
   typedef CComSingleThreadModel CComObjectThreadModel;
#else
   typedef CComMultiThreadModel CComObjectThreadModel;
#endif
```

Depending on the threading model used by your application, the **typedef** name **CComObjectThreadModel** references either **CComSingleThreadModel** or **CComMultiThreadModel**. These classes provide additional **typedef** names to reference a critical section class.

Note **CComObjectThreadModel** does not reference class **CComMultiThreadModelNoCS**.

Using **CComObjectThreadModel** frees you from specifying a particular threading model class. Regardless of the threading model being used, the appropriate methods will be called.

In addition to **CComObjectThreadModel**, ATL provides the **typedef** name **CComGlobalsThreadModel**. The class referenced by each **typedef** depends on the threading model used, as shown in the following table:

	Threading Model		
typedef	**Single**	**Apartment**	**Free**
CComObjectThreadModel	S	S	M
CComGlobalsThreadModel	S	M	M

S=**CComSingleThreadModel**; M=**CComMultiThreadModel**

Use **CComObjectThreadModel** within a single object class. Use **CComGlobalsThreadModel** in an object that is either globally available to your program, or when you wish to protect module resources across multiple threads.

#include <atlbase.h>

See Also: **CComObjectRootEx**

CComPolyObject

template< class *contained* **>**
class CComPolyObject : public IUnknown,
public CComObjectRootEx< *contained*::**_ThreadModel::ThreadModelNoCS >**

Parameters

contained Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interfaces you want to support on the object.

CComPolyObject implements **IUnknown** for an aggregated or nonaggregated object.

When an instance of **CComPolyObject** is created, the value of the outer unknown is checked. If it is **NULL**, **IUnknown** is implemented for a nonaggregated object. If the outer unknown is not **NULL**, **IUnknown** is implemented for an aggregated object.

The advantage of using **CComPolyObject** is that you avoid having both **CComAggObject** and **CComObject** in your module to handle the aggregated and nonaggregated cases. A single **CComPolyObject** object handles both cases. This means only one copy of the vtable and one copy of the functions exist in your module. If your vtable is large, this can substantially decrease your module size. However, if your vtable is small, using **CComPolyObject** can result in a slightly larger module size because it is not optimized for an aggregated or nonaggregated object, as are **CComAggObject** and **CComObject**.

If the **DECLARE_POLY_AGGREGATABLE** macro is specified in your object's class definition, **CComPolyObject** will be used to create your object. **DECLARE_POLY_AGGREGATABLE** will automatically be declared if you use the ATL Object Wizard to create a full control or Internet Explorer control.

If aggregated, the **CComPolyObject** object has its own **IUnknown**, separate from the outer object's **IUnknown**, and maintains its own reference count. **CComPolyObject** uses **CComContainedObject** to delegate to the outer unknown.

For more information about aggregation, see the article "Fundamentals of ATL COM Objects."

#include <atlcom.h>

See Also: CComObjectRootEx, DECLARE_POLY_AGGREGATABLE

Class Methods

CComPolyObject	Constructor.
FinalConstruct	Performs final initialization of **m_contained**.
FinalRelease	Performs final destruction of **m_contained**.

IUnknown Methods	
AddRef	Increments the reference count on the object.
QueryInterface	Retrieves a pointer to the requested interface.
Release	Decrements the reference count on the object.

Data Members	
m_contained	Delegates **IUnknown** calls to the outer unknown if the object is aggregated or to the **IUnknown** of the object if the object is not aggregated.

Methods

CComPolyObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics or testing.

Remarks

Increments the reference count on the object.

See Also: CComPolyObject::Release

CComPolyObject::CComPolyObject

CComPolyObject(void* *pv* **);**

Parameters

pv [in] A pointer to the outer unknown if the object is to be aggregated, or **NULL** if the object if the object is not aggregated.

Remarks

The constructor. Initializes the **CComContainedObject** data member, **m_contained**, and increments the module lock count.

The destructor decrements the module lock count.

See Also: CComPolyObject::FinalConstruct, CComPolyObject::FinalRelease

CComPolyObject::FinalConstruct

HRESULT FinalConstruct( );

Return Value

A standard **HRESULT** value.

Remarks

Called during the final stages of object construction, this method performs any final initialization on the **m_contained** data member.

See Also: CComObjectRootEx::FinalConstruct, CComPolyObject::FinalRelease

---

CComPolyObject::FinalRelease

void FinalRelease( );

Remarks

Called during object destruction, this method frees the **m_contained** data member.

See Also: CComObjectRootEx::FinalRelease, CComPolyObject::FinalConstruct

---

CComPolyObject::QueryInterface

HRESULT QueryInterface(REFIID *iid*, **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The identifier of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*. If the object does not support this interface, *ppvObject* is set to **NULL**.

Remarks

Retrieves a pointer to the requested interface.

For an aggregated object, if the requested interface is **IUnknown**, **QueryInterface** returns a pointer to the aggregated object's own **IUnknown** and increments the reference count. Otherwise, this method queries for the interface through the **CComContainedObject** data member, **m_contained**.

CComPolyObject::Release

ULONG Release( );

Return Value

In debug builds, **Release** returns a value that may be useful for diagnostics or testing. In nondebug builds, **Release** always returns 0.

Remarks

Decrements the reference count on the object.

See Also: CComPolyObject::AddRef

Data Members

CComPolyObject::m_contained

CComContainedObject< *contained* **> m_contained;**

Parameters

contained [in] Your class, derived from **CComObjectRoot** or **CComObjectRootEx**, as well as from any other interfaces you want to support on the object.

Remarks

A **CComContainedObject** object derived from your class. **IUnknown** calls through **m_contained** are delegated to the outer unknown if the object is aggregated, or to the **IUnknown** of this object if the object is not aggregated.

CComPtr

template< class *T* >
class CComPtr

Parameters

T A COM interface specifying the type of pointer to be stored.

ATL uses **CComPtr** and **CComQIPtr** to manage COM interface pointers. Both classes perform automatic reference counting through calls to **AddRef** and **Release**. Overloaded operators handle pointer operations. **CComQIPtr** additionally supports automatic querying of interfaces though **QueryInterface**.

The following code is from **CFirePropNotifyEvent::FireOnRequestEdit**:

```
static HRESULT FireOnRequestEdit(IUnknown* pUnk, DISPID dispID)
{
   CComQIPtr<IConnectionPointContainer,
            &IID_IConnectionPointContainer> pCPC(pUnk);
   if (!pCPC)
      return S_OK;

   CComPtr<IConnectionPoint> pCP;
   pCPC->FindConnectionPoint(IID_IPropertyNotifySink, &pCP);
   if (!pCP)
      return S_OK;

   ...
};
```

This example illustrates the following:

- The constructor for the **CComQIPtr** object, `pCPC`, calls **QueryInterface** on `pUnk` to obtain the **IConnectionPointContainer** pointer. The retrieved pointer is stored in `pCPC`.
- The function declares the **CComPtr** object, `pCP`, to hold an **IConnectionPoint** pointer.
- **IConnectionPointContainer::FindConnectionPoint** is called through `pCPC` to retrieve an **IConnectionPoint** pointer via `pCP`.

#include <atlbase.h>

See Also: CComPtr::CComPtr, CComQIPtr::CComQIPtr

Methods

CComPtr	Constructor. Initializes the member pointer.
Release	Decrements the reference count on the object pointed to by the member pointer.

Operators

operator *T**	Converts a **CComPtr** object to a *T**.
operator *	Returns the dereferenced value of the member pointer.
operator &	Returns the address of the member pointer.
operator ->	Returns the member pointer.
operator =	Assigns a pointer to the member pointer.
operator !	Returns **TRUE** or **FALSE**, depending on whether the member pointer is **NULL**.

Data Members

p	The managed COM interface pointer of type *T**.

Methods

CComPtr::CComPtr

CComPtr( );
CComPtr(*T** *lp* **);**
CComPtr (const CComPtr< *T* **>&** *lp* **);**

Parameters

lp [in] Used to initialize the interface pointer, **p**.

T [in] A COM interface.

Remarks

The default constructor sets **p** to **NULL**. The copy constructor sets **p** to the member pointer of *lp* and calls **AddRef** through **p**. If you pass a pointer type derived from *T*, the constructor sets **p** to the *T** parameter and calls **AddRef**.

The destructor calls **Release** through **p**.

CComPtr::Release

void Release( );

Remarks

Calls **IUnknown::Release** through **p** and sets **p** to **NULL**.

CComPtr::operator *T**

operator *T**( );

Remarks

Converts a **CComPtr** object to a *T**.

CComPtr::operator *

T& **operator** *( );

Remarks

Returns the dereferenced value of the interface pointer, **p**.

Note The operation will assert if **p** is **NULL**.

CComPtr::operator &

*T*** **operator &**( );

Remarks

Returns the address of the interface pointer, **p**.

Note The operation will assert if **p** is non-**NULL**.

CComPtr::operator ->

*T** **operator ->**( );

Remarks

Returns the interface pointer, **p**.

Note The operation will assert if **p** is **NULL**.

CComPtr::operator =

*T** **operator =(** *T** *lp* **);**
*T** **operator =(** **const CComPtr<** *T* **>&** *lp* **);**

Remarks

When assigning a pointer type derived from *T*, the operator sets **p** to the given *T**.
When assigning a **CComPtr**, the operator sets **p** to the member pointer of *lp*.

CComPtr::operator !

bool operator !( );

Remarks

Returns **true** if **p** is **NULL**; otherwise, **false**.

Data Members

CComPtr::p

*T** **p;**

Remarks

Points to the specified COM interface.

CComQIPtr

template< class *T*, const IID* *piid* >
class CComQIPtr

Parameters

T A COM interface specifying the type of pointer to be stored.

piid A pointer to the IID of *T*.

ATL uses **CComQIPtr** and **CComPtr** to manage COM interface pointers. Both classes perform automatic reference counting through calls to **AddRef** and **Release**. Overloaded operators handle pointer operations. **CComQIPtr** additionally supports automatic querying of interfaces though **QueryInterface**.

For an example of using **CComQIPtr** and **CComPtr**, see the **CComPtr** class overview.

Note Do not use **CComQIPtr<IUnknown, &IID_IUnknown>**. Rather, use **CComPtr<IUnknown>**.

#include <atlbase.h>

See Also: CComPtr::CComPtr, CComQIPtr::CComQIPtr

Methods

CComQIPtr	Constructor. Initializes the member pointer.
Release	Decrements the reference count on the object pointed to by the member pointer.

Operators

operator *T**	Converts a **CComQIPtr** object to a *T**.
operator *	Returns the dereferenced value of the member pointer.
operator &	Returns the address of the member pointer.
operator ->	Returns the member pointer.
operator =	Assigns a pointer to the member pointer.
operator !	Returns **TRUE** or **FALSE**, depending on whether the member pointer is **NULL**.

Data Members

p	The managed COM interface pointer of type *T**.

Methods

CComQIPtr::CComQIPtr

CComQIPtr( );
CComQIPtr(*T** *lp* **);**
CComQIPtr(const CComQIPtr< *T*, *piid* **>&** *lp* **);**
CComQIPtr(IUnknown* *lp* **);**

Parameters

lp [in] Used to initialize the interface pointer, **p**.

T [in] A COM interface.

piid [in] A pointer to the IID of *T*.

Remarks

The default constructor sets **p** to **NULL**. The copy constructor sets **p** to the member pointer of *lp* and calls **AddRef** through **p**.

If you pass a pointer type derived from *T*, the constructor sets **p** to the *T** parameter and calls **AddRef**. If you pass a pointer type not derived from *T*, the constructor calls **QueryInterface** to set **p** to an interface pointer corresponding to *piid*.

The destructor calls **Release** through **p**.

CComQIPtr::Release

void Release( );

Remarks

Calls **IUnknown::Release** through **p** and sets **p** to **NULL**.

Operators

CComQIPtr::operator *T**

operator *T**( );

Remarks

Converts a **CComQIPtr** object to a *T**.

CComQIPtr::operator *

***T*& operator *( );**

Remarks

Returns the dereferenced value of the interface pointer, **p**.

Note The operation will assert if **p** is **NULL**.

CComQIPtr::operator &

T operator &( );**

Remarks

Returns the address of the interface pointer, **p**.

Note The operation will assert if **p** is non-**NULL**.

CComQIPtr::operator ->

***T** operator ->( );**

Remarks

Returns the interface pointer, **p**.

Note The operation will assert if **p** is **NULL**.

CComQIPtr::operator =

***T** operator =(T* lp);**
***T** operator =(const CComQIPtr< T, piid >& lp);**
***T** operator =(IUnknown* lp);**

Remarks

When assigning a pointer type derived from *T*, the operator sets **p** to the given *T**. When assigning a **CComQIPtr**, the operator sets **p** to the member pointer of *lp*.

When assigning a pointer type not derived from *T*, the operator calls **QueryInterface** to set **p** to an interface pointer corresponding to *piid*. If **QueryInterface** fails, **p** is set to **NULL**.

CComQIPtr::operator !

bool operator !( );

Remarks

Returns **true** if **p** is **NULL**; otherwise, **false**.

Data Members

CComQIPtr::p

*T** **p;**

Remarks

Points to the specified COM interface.

CComSimpleThreadAllocator

class CComSimpleThreadAllocator

CComSimpleThreadAllocator manages thread selection for **CComAutoThreadModule**. **CComSimpleThreadAllocator::GetThread** simply cycles through each thread and returns the next one in the sequence.

#include <atlbase.h>

See Also: CComApartment

Methods

GetThread	Selects a thread.

Methods

CComSimpleThreadAllocator::GetThread

int GetThread(CComApartment* *pApt*, **int** *nThreads* **);**

Return Value

An integer between zero and *nThreads* – 1. Identifies one of the threads in the EXE module.

Parameters

pApt [in] Not used in ATL's default implementation.

nThreads [in] The maximum number of threads in the EXE module.

Remarks

Selects a thread by specifying the next thread in the sequence. You can override **GetThread** to provide a different method of selection or to make use of the *pApt* parameter.

GetThread is called by **CComAutoThreadModule::CreateInstance**.

See Also: CComApartment

CComSingleThreadModel

class CComSingleThreadModel

CComSingleThreadModel provides methods for incrementing and decrementing the value of a variable. Unlike **CComMultiThreadModel** and **CComMultiThreadModelNoCS**, these methods are not thread-safe.

Typically, you use **CComSingleThreadModel** through one of two **typedef** names, either **CComObjectThreadModel** or **CComGlobalsThreadModel**. The class referenced by each **typedef** depends on the threading model used, as shown in the following table:

	Threading Model		
typedef	**Single**	**Apartment**	**Free**
CComObjectThreadModel	S	S	M
CComGlobalsThreadModel	S	M	M

S=**CComSingleThreadModel**; M=**CComMultiThreadModel**

CComSingleThreadModel itself defines three **typedef** names. **ThreadModelNoCS** references **CComSingleThreadModel**. **AutoCriticalSection** and **CriticalSection** reference class **CComFakeCriticalSection**, which provides empty methods associated with obtaining and releasing ownership of a critical section.

#include <atlbase.h>

Methods	
Decrement	Decrements the value of the specified variable. This implementation is not thread-safe.
Increment	Increments the value of the specified variable. This implementation is not thread-safe.

Typedefs	
AutoCriticalSection	References class **CComFakeCriticalSection**.
CriticalSection	References class **CComFakeCriticalSection**.
ThreadModelNoCS	References **CComSingleThreadModel**.

Methods

CComSingleThreadModel::Decrement

static ULONG Decrement(LPLONG *p*);

Return Value

The result of the decrement.

Parameters

p [in] Pointer to the variable to be decremented.

Remarks

This static method decrements the value of the variable pointed to by *p*.

See Also: CComSingleThreadModel::Increment

CComSingleThreadModel::Increment

static ULONG Increment(LPLONG *p*);

Return Value

The result of the increment.

Parameters

p [in] Pointer to the variable to be incremented.

Remarks

This static method decrements the value of the variable pointed to by *p*.

See Also: CComSingleThreadModel::Decrement

Typedefs

CComSingleThreadModel::AutoCriticalSection

typedef CComFakeCriticalSection AutoCriticalSection;

Remarks

When using **CComSingleThreadModel**, the **typedef** name **AutoCriticalSection** references class **CComFakeCriticalSection**. Because **CComFakeCriticalSection** does not provide a critical section, its methods do nothing.

CComMultiThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **AutoCriticalSection**. The following table shows the relationship

between the threading model class and the critical section class referenced by **AutoCriticalSection**:

Class defined in	Class referenced
CComSingleThreadModel	**CComFakeCriticalSection**
CComMultiThreadModel	**CComAutoCriticalSection**
CComMultiThreadModelNoCS	**CComFakeCriticalSection**

In addition to **AutoCriticalSection**, you can use the **typedef** name **CriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

See **CComMultiThreadModel::AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComSingleThreadModel::ThreadModelNoCS

CComSingleThreadModel::CriticalSection

typedef CComFakeCriticalSection CriticalSection;

Remarks

When using **CComSingleThreadModel**, the **typedef** name **CriticalSection** references class **CComFakeCriticalSection**. Because **CComFakeCriticalSection** does not provide a critical section, its methods do nothing.

CComMultiThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **CriticalSection**. The following table shows the relationship between the threading model class and the critical section class referenced by **CriticalSection**:

Class defined in	Class referenced
CComSingleThreadModel	**CComFakeCriticalSection**
CComMultiThreadModel	**CComCriticalSection**
CComMultiThreadModelNoCS	**CComFakeCriticalSection**

In addition to **CriticalSection**, you can use the **typedef** name **AutoCriticalSection**. You should not specify **AutoCriticalSection** in global objects or static class members if you want to eliminate the CRT startup code.

Example

See **CComMultiThreadModel::AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel, CComSingleThreadModel::ThreadModelNoCS

CComSingleThreadModel::ThreadModelNoCS

typedef CComSingleThreadModel ThreadModelNoCS;

Remarks

When using **CComSingleThreadModel**, the **typedef** name **ThreadModelNoCS** simply references **CComSingleThreadModel**.

CComMultiThreadModel and **CComMultiThreadModelNoCS** also contain definitions for **ThreadModelNoCS**. The following table shows the relationship between the threading model class and the class referenced by **ThreadModelNoCS**:

Class defined in	Class referenced
CComSingleThreadModel	CComSingleThreadModel
CComMultiThreadModel	CComMultiThreadModelNoCS
CComMultiThreadModelNoCS	CComMultiThreadModelNoCS

Example

See **CComMultiThreadModel::AutoCriticalSection**.

See Also: CComObjectThreadModel, CComGlobalsThreadModel

CComTearOffObject

template< class *Base* **>**
class CComTearOffObject : public *Base*

Parameters

Base Your tear-off class, derived from **CComTearOffObjectBase** and the interfaces you want your tear-off object to support.

ATL implements its tear-off interfaces in two phases—the **CComTearOffObjectBase** methods handle the reference count and **QueryInterface**, while **CComTearOffObject** implements **IUnknown**.

CComTearOffObject implements a tear-off interface as a separate object that is instantiated only when that interface is queried for. The tear-off is deleted when its reference count becomes zero. Typically, you build a tear-off interface for an interface that is rarely used, since using a tear-off saves a vtable pointer in all the instances of your main object.

You should derive the class implementing the tear-off from **CComTearOffObjectBase** and from whichever interfaces you want your tear-off object to support. **CComTearOffObjectBase** is templatized on the owner class and the thread model. The owner class is the class of the object for which a tear-off is being implemented. If you do not specify a thread model, the default thread model is used.

You should create a COM map for your tear-off class. When ATL instantiates the tear-off, it will create **CComTearOffObject<CYourTearOffClass>** or **CComCachedTearOffObject<CYourTearOffClass>**.

For example, in the BEEPER sample, the `CBeeper2` class is the tear-off class and the `CBeeper` class is the owner class:

```
class CBeeper2 : public ISupportErrorInfo,
                 public CComTearOffObjectBase<CBeeper>
{
public:
   CBeeper2() {}
   STDMETHOD(InterfaceSupportsErrorInfo)(REFIID riid)
   {
      return (InlineIsEqualGUID(IID_IBeeper,riid)) ?
             S_OK : S_FALSE;
   }

   BEGIN_COM_MAP(CBeeper2)
      COM_INTERFACE_ENTRY(ISupportErrorInfo)
   END_COM_MAP()
};
```

```
class CBeeper :
   public IDispatchImpl<IBeeper, &IID_IBeeper,
                        &LIBID_BeeperLib>,
   public CComObjectRoot,
   public CComCoClass<CBeeper, &CLSID_Beeper>
{
public:
   CBeeper();
   BEGIN_COM_MAP(CBeeper)
      COM_INTERFACE_ENTRY(IDispatch)
      COM_INTERFACE_ENTRY(IBeeper)
      COM_INTERFACE_ENTRY_TEAR_OFF(IID_ISupportErrorInfo,
                                   CBeeper2)
   END_COM_MAP()
...
};
```

#include <atlcom.h>

See Also: CComCachedTearOffObject

Methods

AddRef	Increments the reference count for a **CComTearOffObject** object.
CComTearOffObject	Constructor.
QueryInterface	Returns a pointer to the requested interface on either your tear-off class or the owner class.
Release	Decrements the reference count for a **CComTearOffObject** object and destroys it.

CComTearOffObjectBase Methods

CComTearOffObjectBase	Constructor.

CComTearOffObjectBase Data Members

m_pOwner	A pointer to a **CComObject** derived from the owner class.

Methods

CComTearOffObject::AddRef

ULONG AddRef( );

Return Value

A value that may be useful for diagnostics and testing.

Remarks

Increments the reference count of the **CComTearOffObject** object by 1.

See Also: **CComTearOffObject::Release**

CComTearOffObject::CComTearOffObject

CComTearOffObject(**void*** *p* **);**

Parameters

p [in] Pointer that will be converted to a pointer to a **CComObject<Owner>** object.

Remarks

The constructor. Increments the owner's reference count by 1.

See Also: **CComCachedTearOffObject::CComCachedTearOffObject**

CComTearOffObject::CComTearOffObjectBase

CComTearOffObjectBase( );

Remarks

The constructor. Initializes the **m_pOwner** member to **NULL**.

See Also: **CComCachedTearOffObject::CComCachedTearOffObject**

CComTearOffObject::QueryInterface

HRESULT QueryInterface(**REFIID** *iid* , **void**** *ppvObject* **);**

Return Value

A standard **HRESULT** value.

Parameters

iid [in] The IID of the interface being requested.

ppvObject [out] A pointer to the interface pointer identified by *iid*, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface. Queries first for interfaces on your tear-off class. If the interface is not there, queries for the interface on the owner object. If the requested interface is **IUnknown**, returns the **IUnknown** of the owner.

See Also: **CComTearOffObject::AddRef**, **CComTearOffObject::Release**

CComTearOffObject::Release

ULONG Release( );

Return Value

In non-debug builds, always returns 0. In debug builds, returns a value that may be useful for diagnostics or testing.

Remarks

Decrements the reference count by 1 and, if the reference count is 0, deletes the **CComTearOffObject**.

See Also: CComTearOffObject::AddRef

Data Members

CComTearOffObject::m_pOwner

CComObject<*Owner*>* m_pOwner;

Parameters

Owner [in] The class for which a tear-off is being implemented.

Remarks

A pointer to a **CComObject** object derived from *Owner*. The pointer is initialized to **NULL** during construction.

See Also: CComTearOffObject::CComTearOffObjectBase

CComUnkArray

template< unsigned int *nMaxSize* **>**
class CComUnkArray

Parameters

nMaxSize The maximum number of **IUnknown** pointers that can be held in the static array.

CComUnkArray holds a fixed number of **IUnknown** pointers, each an interface on a connection point. **CComUnkArray** can be used as a parameter to the **IConnectionPointImpl** template class. **CComUnkArray<1>** is a template specialization of **CComUnkArray** that has been optimized for one connection point.

The **CComUnkArray** methods **begin** and **end** can be used to loop through all connection points (for example, when an event is fired).

See "The Proxy Generator" for details on automating creation of connection point proxies.

#include <atlcom.h>

See Also: CComDynamicUnkArray

Methods

begin	Returns a pointer to the first **IUnknown** pointer in the collection.
CComUnkArray	Constructor.
end	Returns a pointer to one past the last **IUnknown** pointer in the collection.

Methods

CComUnkArray::begin

IUnknown begin( );**

Return Value

A pointer to an **IUnknown** interface pointer.

Remarks

Returns a pointer to beginning of the collection of **IUnknown** interface pointers.

The collection contains pointers to interfaces stored locally as **IUnknown**. You cast each **IUnknown** interface to the real interface type and then call through it. You do not need to query for the interface first.

Before using the **IUnknown** interface, you should check that it is not **NULL**.

See Also: **CComUnkArray::end**, **CComDynamicUnkArray::begin**

CComUnkArray::CComUnkArray

CComUnkArray( );

Remarks

The constructor. Sets the collection to hold *nMaxSize* **IUnknown** pointers, and initializes the pointers to **NULL**.

CComUnkArray::end

IUnknown end( );**

Return Value

A pointer to an **IUnknown** interface pointer.

Remarks

Returns a pointer to one past the last **IUnknown** pointer in the collection.

The **CComUnkArray** methods **begin** and **end** can be used to loop through the all connection points, for example, when an event is fired.

```
IUnknown** p = m_vec.begin();
while(p != m_vec.end())
{
   // Do something with *p
   p++;
}
```

See Also: **CComUnkArray::begin**, **CComDynamicUnkArray::end**

CComVariant

class CComVariant : public tagVARIANT

CComVariant wraps the **VARIANT** type, which consists of a tagged union, as well as a member indicating the value type stored in the union. **VARIANT**s are typically used in Automation.

#include <atlbase.h>

Methods

Attach	Attaches a **VARIANT** to the **CComVariant** object.
CComVariant	Constructor.
ChangeType	Converts the **CComVariant** object to a new type.
Clear	Clears the **CComVariant** object.
Copy	Copies a **VARIANT** to the **CComVariant** object.
Detach	Detaches the underlying **VARIANT** from the **CComVariant** object.
ReadFromStream	Loads a **VARIANT** from a stream.
WriteToStream	Saves the underlying **VARIANT** to a stream.

Operators

operator =	Assigns a value to the **CComVariant** object.
operator ==	Indicates whether the **CComVariant** object equals the specified **VARIANT**.
operator !=	Indicates whether the **CComVariant** object does not equal the specified **VARIANT**.

Methods

CComVariant::Attach

HRESULT Attach(VARIANT* *pSrc* **);**

Return Value

A standard **HRESULT** value.

Parameters

pSrc [in] Points to the **VARIANT** to be attached to the object.

Remarks

Attaches the specified **VARIANT** to the **CComVariant** object. **Attach** sets the variant type of the object to **VT_EMPTY**.

See Also: CComVariant::Detach

CComVariant::CComVariant

CComVariant( );
CComVariant(const CComVariant& *varSrc* **);**
CComVariant(const VARIANT& *varSrc* **);**
CComVariant(LPCOLESTR *lpsz* **);**
CComVariant(LPCSTR *lpsz* **);**
CComVariant(BSTR *bstrSrc* **);**
CComVariant(bool *bSrc* **);**
CComVariant(int *nSrc* **);**
CComVariant(BYTE *nSrc* **);**
CComVariant(short *nSrc* **);**
CComVariant(long *nSrc*, **VARTYPE** *vtSrc* = **VT_I4** **);**
CComVariant(float *fltSrc* **);**
CComVariant(double *dblSrc* **);**
CComVariant(CY *cySrc* **);**
CComVariant(IDispatch* *pSrc* **);**
CComVariant(IUnknown* *pSrc* **);**

Parameters

varSrc [in] The **CComVariant** or **VARIANT** used to initialize the **CComVariant** object.

lpsz [in] The character string used to initialize the **CComVariant** object. The Unicode version specifies an **LPCOLESTR**; the ANSI version specifies an **LPCSTR**.

bstrSrc [in] The **BSTR** used to initialize the **CComVariant** object.

bSrc [in] The **bool** used to initialize the **CComVariant** object.

nSrc [in] The **int**, **BYTE**, **short**, or **long** used to initialize the **CComVariant** object.

vtSrc [in] The type for the **CComVariant** object. This parameter is available only when passing a **long** for *nSrc*. *vtSrc* can only be **VT_I4** (the default value) or **VT_ERROR**; otherwise, the constructor will assert.

fltSrc [in] The **float** used to initialize the **CComVariant** object.

dblSrc [in] The **double** used to initialize the **CComVariant** object.

cySrc [in] The **CY** used to initialize the **CComVariant** object.

pSrc [in] The **IDispatch** or **IUnknown** pointer used to initialize the **CComVariant** object.

Remarks

Each constructor initializes the object by calling the **VariantInit** Win32 function. If you pass a parameter value, the constructor sets the object's value and type accordingly.

The destructor manages cleanup by calling **CComVariant::Clear**.

CComVariant::ChangeType

HRESULT ChangeType(VARTYPE *vtNew*, **const VARIANT*** *pSrc* **= NULL);**

Return Value

A standard **HRESULT** value.

Parameters

vtNew [in] The new type for the **CComVariant** object.

pSrc [in] A pointer to the **VARIANT** whose value will be converted to the new type. The default value is **NULL**, meaning the **CComVariant** object will be converted in place.

Remarks

Converts the **CComVariant** object to a new type. If you pass a value for *pSrc*, **ChangeType** will use this **VARIANT** as the source for the conversion. Otherwise, the **CComVariant** object will be the source.

See Also: VariantChangeType

CComVariant::Clear

HRESULT Clear( );

Return Value

A standard **HRESULT** value.

Remarks

Clears the **CComVariant** object by calling the **VariantClear** API function.

The destructor automatically calls **Clear**.

CComVariant::Copy

HRESULT Copy(const VARIANT* *pSrc* **);**

Return Value

A standard **HRESULT** value.

Parameters

pSrc [in] A pointer to the **VARIANT** to be copied

Remarks

Frees the **CComVariant** object and then assigns it a copy of the specified **VARIANT**.

See Also: CComVariant::operator =, VariantCopy

CComVariant::Detach

HRESULT Detach(VARIANT* *pSrc* **);**

Return Value

A standard **HRESULT** value.

Parameters

pSrc [out] Returns the underlying **VARIANT** value of the object.

Remarks

Detaches the underlying **VARIANT** from the **CComVariant** object and sets the object's type to **VT_EMPTY**.

See Also: CComVariant::Attach

CComVariant::ReadFromStream

HRESULT ReadFromStream(IStream* *pStream* **);**

Return Value

A standard **HRESULT** value.

Parameters

pStream [in] A pointer to the **IStream** interface on the stream containing the data.

Remarks

Sets the underlying **VARIANT** to the **VARIANT** contained in the specified stream. **ReadToStream** requires a previous call to **WriteToStream**.

CComVariant::WriteToStream

HRESULT WriteToStream(IStream* *pStream* **);**

Return Value

A standard **HRESULT** value.

Parameters

pStream [in] A pointer to the **IStream** interface on a stream.

Remarks

Saves the underlying **VARIANT** to a stream.

See Also: CComVariant::ReadFromStream

Operators

CComVariant::operator =

CComVariant& operator =(const CComVariant& *varSrc* **);**
CComVariant& operator =(const VARIANT& *varSrc* **);**
CComVariant& operator =(LPCOLESTR *lpsz* **);**
CComVariant& operator =(LPCSTR *lpsz* **);**
CComVariant& operator =(BSTR *bstrSrc* **);**
CComVariant& operator =(bool *bSrc* **);**
CComVariant& operator =(int *nSrc* **);**
CComVariant& operator =(BYTE *nSrc* **);**
CComVariant& operator =(short *nSrc* **);**
CComVariant& operator =(long *nSrc* **);**
CComVariant& operator =(float *nSrc* **);**
CComVariant& operator =(double *nSrc* **);**
CComVariant& operator =(CY *cySrc* **);**
CComVariant& operator =(IDispatch* *pSrc* **);**
CComVariant& operator =(IUnknown* *pSrc* **);**

Remarks

Assigns a value and corresponding type to the **CComVariant** object.

See Also: CComVariant::Copy, VARIANT

CComVariant::operator ==

bool operator ==(const VARIANT& *varSrc* **);**

Remarks

Returns **true** if the value and type of *varSrc* are equal to the value and type, respectively, of the **CComVariant** object. Otherwise, **false**.

See Also: CComVariant::operator !=, VARIANT

CComVariant::operator !=

bool operator !=(const VARIANT& *varSrc* **);**

Remarks

Returns **true** if either the value or type of *varSrc* is not equal to the value or type, respectively, of the **CComVariant** object. Otherwise, **false**.

See Also: CComVariant::operator ==, VARIANT

CContainedWindow

class CContainedWindow : public CWindow

CContainedWindow implements a window contained within another object. **CContainedWindow**'s window procedure uses a message map in the containing object to direct messages to the appropriate handlers. When constructing a **CContainedWindow** object, you specify which message map should be used.

CContainedWindow allows you to create a new window by superclassing an existing window class. The **Create** method first registers a window class that is based on an existing class but uses **CContainedWindow::WindowProc**. **Create** then creates a window based on this new window class. Each instance of **CContainedWindow** can superclass a different window class.

CContainedWindow also supports window subclassing. The **SubclassWindow** method attaches an existing window to the **CContainedWindow** object and changes the window procedure to **CContainedWindow::WindowProc**. Each instance of **CContainedWindow** can subclass a different window.

Note For any given **CContainedWindow** object, call either **Create** or **SubclassWindow**. You should not invoke both methods on the same object.

When you use the **Add control based on** option in the ATL Object Wizard, the wizard will automatically add a **CContainedWindow** data member to the class implementing the control. The following example is taken from the SUBEDIT sample and shows how the contained window is declared:

```
class CAtlEdit : ...
{
public:
   // Declare a contained window data member
   CContainedWindow m_EditCtrl;

   // Initialize the contained window:
   // 1. Pass "EDIT" to specify that the contained
   //    window should be based on the standard
   //    Windows Edit box
   // 2. Pass 'this' pointer to specify that CAtlEdit
   //    contains the message map to be used for the
   //    contained window's message processing
   // 3. Pass the identifier of the message map. '1'
   //    identifies the alternate message map declared
   //    with ALT_MSG_MAP(1)
   CAtlEdit() : m_EditCtrl(_T("EDIT"), this, 1)
   {
      m_bWindowOnly = TRUE;
   }
```

```
    // Declare the default message map,
    // identified by '0'
    BEGIN_MSG_MAP(CAtlEdit)
       ...
       MESSAGE_HANDLER(WM_CREATE, OnCreate)
       ...
    // Declare an alternate message map,
    // identified by '1'
    ALT_MSG_MAP(1)
       MESSAGE_HANDLER(WM_CHAR, OnChar)
    END_MSG_MAP()

    // Define OnCreate handler
    // When the containing window receives a WM_CREATE
    // message, create the contained window by calling
    // CContainedWindow::Create
    LRESULT OnCreate(UINT uMsg, WPARAM wParam,
                     LPARAM lParam, BOOL& bHandled)
    {
       ...
       m_EditCtrl.Create(m_hWnd, rc, _T("hello"),
                         WS_CHILD | WS_VISIBLE |
                         ES_MULTILINE | ES_AUTOVSCROLL);
       return 0;
    }

    ...
};
```

For more information about	See
Creating controls	"ATL Tutorial"
Using windows in ATL	"ATL Window Classes"
ATL Object Wizard	"Creating an ATL Project"
Windows	"Windows" and subsequent topics in the *Win32 SDK* online
Subclassing	"Window Procedure Subclassing" in the *Win32 SDK* online
Superclassing	"Window Procedure Superclassing" in the *Win32 SDK* online

#include <atlwin.h>

See Also: CWindow, CWindowImpl, CMessageMap, BEGIN_MSG_MAP, ALT_MSG_MAP

Methods

CContainedWindow	Constructor. Initializes data members to specify which message map will process the contained window's messages.
Create	Creates a window.
DefWindowProc	Provides default message processing.
RegisterWndSuperclass	Registers the window class of the contained window.
SubclassWindow	Subclasses a window.

Methods *(continued)*	
SwitchMessageMap	Changes which message map is used to process the contained window's messages.
UnsubclassWindow	Restores a previously subclassed window.
WindowProc	Processes messages sent to the contained window.

Data Members	
m_dwMsgMapID	Identifies which message map will process the contained window's messages.
m_lpszClassName	Specifies the name of an existing window class on which a new window class will be based.
m_pfnSuperWindowProc	Points to the window class's original window procedure.
m_pObject	Points to the containing object.

Methods

CContainedWindow::CContainedWindow

CContainedWindow(LPTSTR *lpszClassName*, **CMessageMap*** *pObject*,
↪ **DWORD** *dwMsgMapID* **= 0);**

Parameters

lpszClassName [in] The name of an existing window class on which the contained window will be based.

pObject [in] A pointer to the containing object that declares the message map. This object's class must derive from **CMessageMap**.

dwMsgMapID [in] Identifies the message map that will process the contained window's messages. The default value, 0, specifies the default message map declared with **BEGIN_MSG_MAP**. To use an alternate message map declared with **ALT_MSG_MAP**(*msgMapID*), pass *msgMapID*.

Remarks

The constructor initializes data members. If you want to create a new window through **Create**, you must pass the name of an existing window class for the *lpszClassName* parameter. For an example, see the **CContainedWindow** overview.

If you subclass an existing window through **SubclassWindow**, the *lpszClassName* value will not be used. Therefore, you can pass **NULL** for this parameter.

See Also: CContainedWindow::m_lpszClassName,
CContainedWindow::m_pObject,
CContainedWindow::m_pfnSuperWindowProc,
CContainedWindow::SwitchMessageMap

CContainedWindow::Create

HWND Create(HWND *hWndParent*, **RECT&** *rcPos*,
↪ **LPCTSTR** *szWindowName* = **NULL**,
↪ **DWORD** *dwStyle* = **WS_CHILD | WS_VISIBLE**,
↪ **DWORD** *dwExStyle* = **0**, **UINT** *nID* = **0**);

Return Value

If successful, the handle to the newly created window. Otherwise, **NULL**.

Parameters

hWndParent [in] The handle to the parent or owner window.

rcPos [in] A **RECT** structure specifying the position of the window.

szWindowName [in] Specifies the name of the window. The default value is **NULL**.

dwStyle [in] The style of the window. The default value is **WS_CHILD | WS_VISIBLE**. For a list of possible values, see **CreateWindow** in the *Win32 SDK* online.

dwExStyle [in] The extended window style. The default value is 0, meaning no extended style. For a list of possible values, see **CreateWindowEx** in the *Win32 SDK* online.

nID [in] For a child window, the window identifier. For a top-level window, an **HWND** casted to a **UINT**. The default value is 0.

Remarks

Calls **RegisterWndSuperclass** to register a window class that is based on an existing class but uses **CContainedWindow::WindowProc**. The existing window class name is saved in **m_lpszClassName**. **Create** then creates a window based on this new class. The newly created window is automatically attached to the **CContainedWindow** object.

Note Do not call **Create** if you have already called **SubclassWindow**.

See Also: CWindow::m_hWnd

CContainedWindow::DefWindowProc

LRESULT DefWindowProc(UINT *uMsg*, **WPARAM** *wParam*, **LPARAM** *lParam*);

Return Value

The result of the message processing.

Parameters

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

Remarks

Called by **WindowProc** to process messages not handled by the message map. By default, **DefWindowProc** calls the **CallWindowProc** Win32 function to send the message information to the window procedure specified in **m_pfnSuperWindowProc**.

CContainedWindow::RegisterWndSuperclass

ATOM RegisterWndSuperClass( );

Return Value

If successful, an atom that uniquely identifies the window class being registered. Otherwise, 0.

Remarks

Called by **Create** to register the window class of the contained window. This window class is based on an existing class but uses **CContainedWindow::WindowProc**. The existing window class's name and window procedure are saved in **m_lpszClassName** and **m_pfnSuperWindowProc**, respectively.

See Also: CContainedWindow::CContainedWindow

CContainedWindow::SubclassWindow

BOOL SubclassWindow(HWND *hWnd* **);**

Return Value

TRUE if the window is successfully subclassed; otherwise, **FALSE**.

Parameters

hWnd [in] The handle to the window being subclassed.

Remarks

Subclasses the window identified by *hWnd* and attaches it to the **CContainedWindow** object. The subclassed window now uses **CContainedWindow::WindowProc**. The original window procedure is saved in **m_pfnSuperWindowProc**.

Note Do not call **SubclassWindow** if you have already called **Create**.

See Also: CContainedWindow::UnsubclassWindow

CContainedWindow::SwitchMessageMap

void SwitchMessageMap(DWORD *dwMsgMapID* **);**

Parameters

dwMsgMapID [in] The message map identifier. To use the default message map declared with **BEGIN_MSG_MAP**, pass 0. To use an alternate message map declared with **ALT_MSG_MAP(***msgMapID***)**, pass *msgMapID*.

Remarks

Changes which message map will be used to process the contained window's messages. The message map must be defined in the containing object.

You initially specify the message map identifier in the constructor.

See Also CContainedWindow::CContainedWindow, CContainedWindow::m_dwMsgMapID

CContainedWindow::UnsubclassWindow

HWND UnsubclassWindow( );

Return Value

The handle to the window previously subclassed.

Remarks

Detaches the subclassed window from the **CContainedWindow** object and restores the original window procedure, saved in **m_pfnSuperWindowProc**.

See Also: CContainedWindow::SubclassWindow

CContainedWindow::WindowProc

static LRESULT CALLBACK WindowProc(HWND *hWnd*, **UINT** *uMsg*,
↪ **WPARAM** *wParam*, **LPARAM** *lParam* **);**

Return Value

The result of the message processing.

Parameters

hWnd [in] The handle to the window.

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

Remarks

This static method implements the window procedure. **WindowProc** directs messages to the message map identified by **m_dwMsgMapID**. If necessary, **WindowProc** calls **DefWindowProc** for additional message processing.

See Also: **BEGIN_MSG_MAP**, **ALT_MSG_MAP**

Data Members

CContainedWindow::m_dwMsgMapID

DWORD m_dwMsgMapID;

Remarks

Holds the identifier of the message map currently being used for the contained window. This message map must be declared in the containing object.

The default message map, declared with **BEGIN_MSG_MAP**, is always identified by 0. An alternate message map, declared with **ALT_MSG_MAP**(*msgMapID*), is identified by *msgMapID*.

m_dwMsgMapID is first initialized by the constructor and can be changed by calling **SwitchMessageMap**. For an example, see the **CContainedWindow** overview.

See Also: **CContainedWindow::m_pObject**

CContainedWindow::m_lpszClassName

LPTSTR m_lpszClassName;

Remarks

Specifies the name of an existing window class. When you create a window, **Create** registers a new window class that is based on this existing class but uses **CContainedWindow::WindowProc**.

m_lpszClassName is initialized by the constructor. For an example, see the **CContainedWindow** overview.

CContainedWindow::m_pfnSuperWindowProc

WNDPROC m_pfnSuperWindowProc;

Remarks

If the contained window is subclassed, **m_pfnSuperWindowProc** points to the original window procedure of the window class. If the contained window is

superclassed, meaning it is based on a window class that modifies an existing class, **m_pfnSuperWindowProc** points to the existing window class's window procedure.

The **DefWindowProc** method sends message information to the window procedure saved in **m_pfnSuperWindowProc**.

See Also: **CContainedWindow::Create**, **CContainedWindow::SubclassWindow**

CContainedWindow::m_pObject

CMessageMap* m_pObject;

Remarks

Points to the object containing the **CContainedWindow** object. This container, whose class must derive from **CMessageMap**, declares the message map used by the contained window.

m_pObject is initialized by the constructor. For an example, see the **CContainedWindow** overview.

See Also: **CContainedWindow::m_dwMsgMapID**

CDialogImpl

template< class *T* >
class CDialogImpl : public CDialogImplBase

Parameters

T Your class, derived from **CDialogImpl**.

CDialogImpl allows you to create a modal or modeless dialog box. **CDialogImpl** provides the dialog box procedure, which uses the default message map to direct messages to the appropriate handlers.

CDialogImpl derives from **CDialogImplBase**, which in turn derives from **CWindow** and **CMessageMap**.

Note Your class must define an **IDD** member that specifies the dialog template resource ID. For example, the ATL Object Wizard automatically adds the following line to your class:

```
enum { IDD = IDD_MYDIALOG };
```

where `MyDialog` is the **Short name** entered in the wizard's **Names** page.

For more information about	See
Creating controls	"ATL Tutorial"
Using dialog boxes in ATL	"ATL Window Classes"
ATL Object Wizard	"Creating an ATL Project"
Dialog boxes	"Dialog Boxes" and subsequent topics in the *Win32 SDK* online

#include <atlwin.h>

See Also: BEGIN_MSG_MAP

Methods	
Create	Creates a modeless dialog box.
DoModal	Creates a modal dialog box.

CDialogImplBase Methods	
DialogProc	Processes messages sent to the dialog box.
EndDialog	Destroys a modal dialog box.

Methods

CDialogImpl::Create

HWND Create(HWND *hWndParent* **);**

Return Value

The handle to the newly created dialog box.

Parameters

hWndParent [in] The handle to the owner window.

Remarks

Creates a modeless dialog box. This dialog box is automatically attached to the **CDialogImpl** object.

To create a modal dialog box, call **DoModal**.

See Also: CWindow::m_hWnd

CDialogImpl::DialogProc

static BOOL CALLBACK DialogProc(HWND *hWnd*, **UINT** *uMsg*,
➥ **WPARAM** *wParam*, **LPARAM** *lParam* **);**

Return Value

TRUE if the message is processed; otherwise, **FALSE**.

Parameters

hWnd [in] The handle to the dialog box.

uMsg [in] The message sent to the dialog box.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

Remarks

This static method implements the dialog box procedure. **DialogProc** uses the default message map to direct messages to the appropriate handlers.

You can override **DialogProc** to provide a different mechanism for handling messages.

See Also: BEGIN_MSG_MAP

CDialogImpl::DoModal

int DoModal(HWND *hWndParent* **= ::GetActiveWindow( ));**

Return Value

If successful, the value of the *nRetCode* parameter specified in the call to **EndDialog**. Otherwise, -1.

Parameters

hWndParent [in] The handle to the owner window. The default value is the return value of the **GetActiveWindow** Win32 function.

Remarks

Creates a modal dialog box. This dialog box is automatically attached to the **CDialogImpl** object.

To create a modeless dialog box, call **Create**.

See Also: CWindow::m_hWnd

CDialogImpl::EndDialog

BOOL EndDialog(int *nRetCode* **);**

Return Value

TRUE if the dialog box is destroyed; otherwise, **FALSE**.

Parameters

nRetCode [in] The value to be returned by **CDialogImpl::DoModal**.

Remarks

Destroys a modal dialog box. **EndDialog** must be called through the dialog procedure. After the dialog box is destroyed, Windows uses the value of *nRetCode* as the return value for **DoModal**, which created the dialog box.

Note Do not call **EndDialog** to destroy a modeless dialog box. Call **CWindow::DestroyWindow** instead.

See Also: CDialogImpl::DialogProc

CDynamicChain

class CDynamicChain

CDynamicChain manages a collection of message maps, enabling a Windows message to be directed, at run time, to another object's message map.

To add support for dynamic chaining of message maps, do the following:

- Derive your class from **CDynamicChain**. In the message map, specify the **CHAIN_MSG_MAP_DYNAMIC** macro to chain to another object's default message map. Specify **CHAIN_MSG_MAP_ALT_DYNAMIC** to chain to an alternate message map.
- Derive every class you want to chain to from **CMessageMap**. **CMessageMap** allows an object to expose its message maps to other objects.
- Call **CDynamicChain::SetChainEntry** to identify which object and which message map you want to chain to.

For example, suppose your class is defined as follows:

```
class CMyWindow : public CDynamicChain, ...
{
public:
   ...

   BEGIN_MSG_MAP(CMyWindow)
      MESSAGE_HANDLER(WM_PAINT, OnPaint)
      MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
      // dynamically chain to the default
      // message map in another object
      CHAIN_MSG_MAP_DYNAMIC(1313)
               // '1313' identifies the object
               // and the message map that will be
               // chained to. '1313' is defined
               // through the SetChainEntry method
   END_MSG_MAP()

   LRESULT OnPaint(UINT uMsg, WPARAM wParam,
                   LPARAM lParam, BOOL& bHandled)
   { ... }

   LRESULT OnSetFocus(UINT uMsg, WPARAM wParam,
                      LPARAM lParam, BOOL& bHandled)
   { ... }

};
```

The client then calls `CMyWindow::SetChainEntry`:

```
// myCtl is a CMyWindow object
myCtl.SetChainEntry(1313, &chainedObj);
```

where `chainedObj` is the chained object and is an instance of a class derived from **CMessageMap**. Now, if `myCtl` receives a message that is not handled by `OnPaint` or `OnSetFocus`, the window procedure directs the message to `chainedObj`'s default message map.

For more information about message map chaining, see Message Maps in the article "ATL Window Classes."

#include <atlwin.h>

See Also: CWindowImpl

Methods

CallChain	Directs a Windows message to another object's message map.
RemoveChainEntry	Removes a message map entry from the collection.
SetChainEntry	Adds a message map entry to the collection or modifies an existing entry.

Methods

CDynamicChain::CallChain

BOOL CallChain(DWORD *dwChainID*, **HWND** *hWnd*, **UINT** *uMsg*,
↪ **WPARAM** *wParam*, **LPARAM** *lParam*, **LRESULT&** *lResult* **);**

Return Value

TRUE if the message is fully processed; otherwise, **FALSE**.

Parameters

dwChainID [in] The unique identifier associated with the chained object and its message map.

hWnd [in] The handle to the window receiving the message.

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

lResult [out] The result of the message processing.

Remarks

Directs the Windows message to another object's message map. In order for the window procedure to invoke **CallChain**, you must specify the **CHAIN_MSG_MAP_DYNAMIC** or **CHAIN_MSG_MAP_ALT_DYNAMIC** macro in your message map. For an example, see the **CDynamicChain** overview.

CallChain requires a previous call to **SetChainEntry** to associate the *dwChainID* value with an object and its message map.

CDynamicChain::RemoveChainEntry

BOOL RemoveChainEntry(DWORD *dwChainID* **);**

Return Value

TRUE if the message map is successfully removed from the collection. Otherwise, **FALSE**.

Parameters

dwChainID [in] The unique identifier associated with the chained object and its message map. You originally define this value through a call to **SetChainEntry**.

Remarks

Removes the specified message map from the collection.

CDynamicChain::SetChainEntry

BOOL SetChainEntry(DWORD *dwChainID*, **CMessageMap*** *pObject*,
↳ **DWORD** *dwMsgMapID* **= 0);**

Return Value

TRUE if the message map is successfully added to the collection. Otherwise, **FALSE**.

Parameters

dwChainID [in] The unique identifier associated with the chained object and its message map.

pObject [in] A pointer to the chained object declaring the message map. This object must derive from **CMessageMap**.

dwMsgMapID [in] The identifier of the message map in the chained object. The default value is 0, which identifies the default message map declared with **BEGIN_MSG_MAP**. To specify an alternate message map declared with **ALT_MSG_MAP**(*msgMapID*), pass *msgMapID*.

Remarks

Adds the specified message map to the collection. If the *dwChainID* value already exists in the collection, its associated object and message map are replaced by *pObject* and *dwMsgMapID*, respectively. Otherwise, a new entry is added.

See Also: CDynamicChain::CallChain, CDynamicChain::RemoveChainEntry, CHAIN_MSG_MAP_DYNAMIC, CHAIN_MSG_MAP_ALT_DYNAMIC

CFirePropNotifyEvent

class CFirePropNotifyEvent

CFirePropNotifyEvent has two methods that notify the container's sink that a control property has changed or is about to change.

If the class implementing your control is derived from **IPropertyNotifySink**, the **CFirePropNotifyEvent** methods are invoked when you call **FireOnRequestEdit** or **FireOnChanged**. If your control class is not derived from **IPropertyNotifySink**, calls to these functions return **S_OK**.

For more information about creating controls, see the "ATL Tutorial."

#include <atlctl.h>

Methods

FireOnChanged	Notifies the container's sink that a control property has changed.
FireOnRequestEdit	Notifies the container's sink that a control property is about to change.

Methods

CFirePropNotifyEvent::FireOnChanged

HRESULT FireOnChanged(IUnknown* *pUnk*, **DISPID** *dispID* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pUnk [in] Pointer to the **IUnknown** of the object sending the notification.

dispID [in] Identifier of the property that has changed.

Remarks

Notifies all connected **IPropertyNotifySink** interfaces (on every connection point of the object) that the specified object property has changed. This function is safe to call even if your control doesn't support connection points.

See Also: CFirePropNotifyEvent::FireOnRequestEdit, CComControl::FireOnChanged

CFirePropNotifyEvent::FireOnRequestEdit

HRESULT FireOnRequestEdit(IUnknown* *pUnk*, **DISPID** *dispID* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pUnk [in] Pointer to the **IUnknown** of the object sending the notification.

dispID [in] Identifier of the property about to change.

Remarks

Notifies all connected **IPropertyNotifySink** interfaces (on every connection point of the object) that the specified object property is about to change. This function is safe to call even if your control doesn't support connection points.

See Also: CFirePropNotifyEvent::FireOnChanged, CComControl::FireOnRequestEdit

CMessageMap

class CMessageMap

CMessageMap is an abstract base class that allows an object's message maps to be accessed by another object. In order for an object to expose its message maps, its class must derive from **CMessageMap**.

ATL uses **CMessageMap** to support contained windows and dynamic message map chaining. For example, any class containing a **CContainedWindow** object must derive from **CMessageMap**. The following code is taken from the SUBEDIT sample. Through **CComControl**, the `CAtlEdit` class automatically derives from **CMessageMap**.

```
class CAtlEdit : public CComControl<CAtlEdit>, ...
                 // CComControl derives from CWindowImpl,
                 // which derives from CMessageMap
{
public:
   // Declare a contained window data member
   CContainedWindow m_EditCtrl;

   // Initialize the contained window:
   // 1. Pass "EDIT" to specify that the contained
   //    window should be based on the standard
   //    Windows Edit box
   // 2. Pass 'this' pointer to specify that CAtlEdit
   //    contains the message map to be used for the
   //    contained window's message processing
   // 3. Pass the identifier of the message map. In
   //    this case, '1' identifies the message map
   //    declared with ALT_MSG_MAP(1)
   CAtlEdit() : m_EditCtrl(_T("EDIT"), this, 1)
   {
      m_bWindowOnly = TRUE;
   }

   // Declare the default message map
   BEGIN_MSG_MAP(CAtlEdit)
      MESSAGE_HANDLER(WM_PAINT, OnPaint)
      ...
   // Declare an alternate message map,
   // identified by '1'
   ALT_MSG_MAP(1)
      MESSAGE_HANDLER(WM_CHAR, OnChar)
   END_MSG_MAP()

   ...
};
```

Because the contained window, `m_EditCtrl`, will use a message map in the containing class, `CAtlEdit` derives from **CMessageMap**.

For more information about message maps, see Message Maps in the article "ATL Window Classes."

#include <atlwin.h>

See Also: CDynamicChain, BEGIN_MSG_MAP, ALT_MSG_MAP

Methods

ProcessWindowMessage	Accesses a message map in the **CMessageMap**-derived class.

Methods

CMessageMap::ProcessWindowMessage

virtual BOOL ProcessWindowMessage(HWND *hWnd*, **UINT** *uMsg*,
↳ **WPARAM** *wParam*, **LPARAM** *lParam*, **LRESULT&** *lResult*,
↳ **DWORD** *dwMsgMapID*) **= 0;**

Return Value

TRUE if the message is fully handled; otherwise, **FALSE**.

Parameters

hWnd [in] The handle to the window receiving the message.

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

lResult [out] The result of the message processing.

dwMsgMapID [in] The identifier of the message map that will process the message. The default message map, declared with **BEGIN_MSG_MAP**, is identified by 0. An alternate message map, declared with **ALT_MSG_MAP**(*msgMapID*), is identified by *msgMapID*.

Remarks

Accesses the message map identified by *dwMsgMapID* in a **CMessageMap**-derived class. Called by the window procedure of a **CContainedWindow** object or of an object that is dynamically chaining to the message map.

See Also: CHAIN_MSG_MAP_DYNAMIC, CHAIN_MSG_MAP_ALT_DYNAMIC

CRegKey

class CRegKey

CRegKey provides methods for manipulating values in the system registry. The registry contains an installation-specific set of definitions for system components, such as software version numbers, logical-to-physical mappings of installed hardware, and COM objects.

CRegKey provides a programming interface to the system registry for a given machine. For example, to open a particular registry key, call **CRegKey::Open**. To retrieve or modify a data value, call **CRegKey::QueryValue** or **CRegKey::SetValue**, respectively. To close a key, call **CRegKey::Close**.

When you close a key, its registry data is written (flushed) to the hard disk. This process may take several seconds. If your application must explicitly write registry data to the hard disk, you can call the **RegFlushKey** Win32 function. However, **RegFlushKey** uses many system resources and should be called only when absolutely necessary.

#include <atlbase.h>

Methods

Attach	Attaches a registry key handle to the **CRegKey** object.
Close	Releases **m_hKey**.
Create	Creates or opens the specified key.
CRegKey	Constructor.
DeleteSubKey	Deletes the specified key.
DeleteValue	Deletes a value field of the key identified by **m_hKey**.
Detach	Detaches **m_hKey** from the **CRegKey** object.
Open	Opens the specified key.
QueryValue	Retrieves the data for a specified value field.
RecurseDeleteKey	Deletes the specified key and explicitly deletes all subkeys.
SetKeyValue	Stores data in a specified value field of a specified key.
SetValue	Stores data in a specified value field.

Operators

operator HKEY	Converts a **CRegKey** object to an **HKEY**.

Data Members

m_hKey	Contains a handle of the registry key associated with the **CRegKey** object.

Methods

CRegKey::Attach

void Attach(HKEY *hKey* **);**

Parameters

hKey [in] The handle of a registry key.

Remarks

Attaches an **HKEY** to the **CRegKey** object by setting the **m_hKey** member handle to *hKey*.

Note **Attach** will assert if **m_hKey** is non-**NULL**.

See Also: CRegKey::Detach

CRegKey::Close

LONG Close( );

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Remarks

Releases the **m_hKey** member handle and sets it to **NULL**.

See Also: CRegKey::Open

CRegKey::Create

LONG Create(HKEY *hKeyParent*, **LPCTSTR** *lpszKeyName*,
↪ **LPTSTR** *lpszClass* = **REG_NONE,**
↪ **DWORD** *dwOptions* = **REG_OPTION_NON_VOLATILE,**
↪ **REGSAM** *samDesired* = **KEY_ALL_ACCESS,**
↪ **LPSECURITY_ATTRIBUTES** *lpSecAttr* = **NULL,**
↪ **LPDWORD** *lpdwDisposition* = **NULL);**

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

hKeyParent [in] The handle of an open key.

lpszKeyName [in] Specifies the name of a key to be created or opened. This name must be a subkey of *hKeyParent*.

lpszClass [in] Specifies the class of the key to be created or opened. The default value is **REG_NONE**.

dwOptions [in] Options for the key. The default value is **REG_OPTION_NON_VOLATILE**. For a list of possible values and descriptions, see **RegCreateKeyEx** in the *Win32 SDK* online.

samDesired [in] The security access for the key. The default value is **KEY_ALL_ACCESS**. For a list of possible values and descriptions, see **RegCreateKeyEx**.

lpSecAttr [in] A pointer to a **SECURITY_ATTRIBUTES** structure that indicates whether the handle of the key can be inherited by a child process. By default, this parameter is **NULL** (meaning the handle cannot be inherited).

lpdwDisposition [out] If non-**NULL**, retrieves either **REG_CREATED_NEW_KEY** (if the key did not exist and was created) or **REG_OPENED_EXISTING_KEY** (if the key existed and was opened).

Remarks

Creates the specified key if it does not exist as a subkey of *hKeyParent*. Otherwise, **Create** opens the key.

Create sets the **m_hKey** member to the handle of this key.

See Also: CRegKey::Open, CRegKey::Close

CRegKey::CRegKey

CRegKey( );

Remarks

The constructor. Sets the **m_hKey** member handle to **NULL**. The destructor releases **m_hKey**.

CRegKey::DeleteSubKey

LONG DeleteSubKey(LPCTSTR *lpszSubKey* **);**

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

lpszSubKey [in] Specifies the name of the key to delete. This name must be a subkey of **m_hKey**.

Remarks

Removes the specified key from the registry. Under Windows 95, **DeleteSubKey** deletes the key and all its subkeys. Under Windows NT, **DeleteSubKey** can only

delete a key that has no subkeys. If the key has subkeys, call **RecurseDeleteKey** instead.

See Also: CRegKey::DeleteValue

CRegKey::DeleteValue

LONG DeleteValue(LPCTSTR *lpszValue* **);**

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

lpszValue [in] Specifies the value field to remove.

Remarks

Removes a value field from **m_hKey**.

See Also: CRegKey::DeleteSubKey

CRegKey::Detach

HKEY Detach( );

Return Value

The **HKEY** associated with the **CRegKey** object.

Remarks

Detaches the **m_hKey** member handle from the **CRegKey** object and sets **m_hKey** to **NULL**.

See Also: CRegKey::Attach

CRegKey::Open

LONG Open(HKEY *hKeyParent*, **LPCTSTR** *lpszKeyName*,
↪ **REGSAM** *samDesired* = **KEY_ALL_ACCESS);**

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

hKeyParent [in] The handle of an open key.

lpszKeyName [in] Specifies the name of a key to be created or opened. This name must be a subkey of *hKeyParent*.

samDesired [in] The security access for the key. The default value is **KEY_ALL_ACCESS**. For a list of possible values and descriptions, see **RegCreateKeyEx** in the *Win32 SDK* online.

Remarks

Opens the specified key and sets **m_hKey** to the handle of this key. If the *lpszKeyName* parameter is **NULL** or points to an empty string, **Open** opens a new handle of the key identified by *hKeyParent*, but does not close any previously opened handle.

Unlike **CRegKey::Create**, **Open** will not create the specified key if it does not exist.

See Also: CRegKey::Close

CRegKey::QueryValue

LONG QueryValue(DWORD& *dwValue*, LPCTSTR *lpszValueName*);
LONG QueryValue(LPTSTR *szValue*, LPCTSTR *lpszValueName*,
↪ DWORD* *pdwCount*)

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

dwValue [out] The value field's numerical data.

lpszValueName [in] Specifies the value field to be queried.

szValue [out] The value field's string data.

pdwCount [out] The size of the string data.

Remarks

Retrieves the data for the specified value field of **m_hKey**. The first version of **QueryValue** allows you to retrieve numerical data. The second version allows you to retrieve string data.

CRegKey::RecurseDeleteKey

LONG RecurseDeleteKey(LPCTSTR *lpszKey*);

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

lpszKey [in] Specifies the name of the key to delete. This name must be a subkey of **m_hKey**.

Remarks

Removes the specified key from the registry and explicitly removes any subkeys. If the key has subkeys, you must call this method under Windows NT in order to delete the key. Under Windows 95, you can call **DeleteSubKey** to remove the key and any subkeys.

CRegKey::SetKeyValue

LONG SetKeyValue(LPCTSTR *lpszKeyName*, **LPCTSTR** *lpszValue*,
↪ **LPCTSTR** *lpszValueName* = **NULL**);

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

lpszKeyName [in] Specifies the name of the key to be created or opened. This name must be a subkey of **m_hKey**.

lpszValue [in] Specifies the data to be stored. This parameter must be non-**NULL**.

lpszValueName [in] Specifies the value field to be set. If a value field with this name does not already exist in the key, it is added.

Remarks

Creates or opens the *lpszKeyName* key and stores the *lpszValue* data in the *lpszValueName* value field.

See Also: CRegKey::SetValue

CRegKey::SetValue

LONG SetValue(DWORD *dwValue*, **LPCTSTR** *lpszValueName*);
LONG SetValue(LPCTSTR *lpszValue*, **LPCTSTR** *lpszValueName* = **NULL**);
LONG SetValue(HKEY *hKeyParent*, **LPCTSTR** *lpszKeyName*,
↪ **LPCTSTR** *lpszValue*, **LPCTSTR** *lpszValueName* = **NULL**);

Return Value

If successful, returns **ERROR_SUCCESS**; otherwise, an error value.

Parameters

dwValue [in] Specifies the data to be stored.

lpszValueName [in] Specifies the value field to be set. If a value field with this name does not already exist in the key, it is added.

lpszValue [in] Specifies the data to be stored. This parameter must be non-**NULL**.

hKeyParent [in] The handle of an open key.

lpszKeyName [in] Specifies the name of a key to be created or opened. This name must be a subkey of *hKeyParent*.

Remarks

Stores data in the specified value field of an open registry key. The first two versions of **SetValue** use **m_hKey** as the open key. The third version allows you to create or open a subkey of *hKeyParent*, and then set the value field of the subkey.

See Also: CRegKey::SetKeyValue

Operators

CRegKey::operator HKEY

operator HKEY( ) const;

Remarks

Converts a **CRegKey** object to an **HKEY**.

Data Members

CRegKey::m_hKey

HKEY m_hKey;

Remarks

Contains a handle of the registry key associated with the **CRegKey** object.

CStockPropImpl

template < class *T*, **class** *InterfaceName*, **const IID*** *piid*, **const GUID*** *plibid* **>**
class CStockPropImpl : IDispatchImpl< *InterfaceName*, *piid*, *plibid* **>**

Parameters

T The class implementing the control.

InterfaceName A dual interface.

piid A pointer to the IID of *InterfaceName*.

plibid A pointer to the identifier of GUID of the type library section of *InterfaceName*.

CStockPropImpl implements every stock property you can choose from the Stock Properties tab in the ATL Object Wizard. **CStockPropImpl** automatically creates a data member in your control class for each property, creates **put** and **get** methods for each property, and adds code to notify and synchronize with the container when any property changes.

The ATL Object Wizard can also be used to implement any or all of the stock properties in the same manner. For more information about adding stock properties to a control, see the "ATL Tutorial." For more information about the ATL Object Wizard, see the article "Creating an ATL Project."

CStockPropImpl implements **put** and **get** methods for the stock properties that are interface pointers, including FONT, MOUSEICON, and PICTURE. For all other stock properties, **CStockPropImpl** calls the macros **IMPLEMENT_STOCKPROP**, **IMPLEMENT_BOOL_STOCKPROP** , and **IMPLEMENT_BSTR_STOCKPROP**.

The following table lists the stock properties implemented and the data members created by **CStockPropImpl**. See the data members in **CComControl** for a description of each property, except HWND, whose data member is described in **CWindow**.

Stock Property	Data Member
APPEARANCE	**m_nAppearance**
AUTOSIZE	**m_bAutoSize**
BACKCOLOR	**m_clrBackColor**
BACKSTYLE	**m_nBackStyle**
BORDERCOLOR	**m_clrBorderColor**
BORDERSTYLE	**m_nBorderStyle**
BORDERVISIBLE	**m_bBorderVisible**
BORDERWIDTH	**m_nBorderWidth**
CAPTION	**m_bstrCaption**
DRAWMODE	**m_nDrawMode**
DRAWSTYLE	**m_nDrawStyle**
DRAWWIDTH	**m_nDrawWidth**
ENABLED	**m_bEnabled**
FILLCOLOR	**m_clrFillColor**
FILLSTYLE	**m_nFillStyle**
FONT	**m_pFont**
FORECOLOR	**m_clrForeColor**
HWND	**m_hWnd**
MOUSEICON	**m_pMouseIcon**
MOUSEPOINTER	**m_nMousePointer**
PICTURE	**m_pPicture**
READYSTATE	**m_nReadyState**
TABSTOP	**m_bTabStop**
TEXT	**m_bstrText**
VALID	**m_bValid**

#include <atlctl.h>

CWindow

class Cwindow

CWindow provides the base functionality for manipulating a window in ATL. Many of the **CWindow** methods simply wrap one of the Win32 API functions. For example, compare the prototypes for **CWindow::ShowWindow** and **::ShowWindow**:

CWindow method	Win32 function
BOOL ShowWindow(int *nCmdShow* **);**	**BOOL ShowWindow(HWND** *hWnd*, **int** *nCmdShow* **);**

CWindow::ShowWindow calls the Win32 function **ShowWindow** by passing **CWindow::m_hWnd** as the first parameter. Every **CWindow** method that directly wraps a Win32 function passes the **m_hWnd** member; therefore, much of the **CWindow** documentation will refer you to the *Win32 SDK* online documentation.

Note Not every window-related Win32 function is wrapped by **CWindow**, and not every **CWindow** method wraps a Win32 function.

CWindow::m_hWnd stores the **HWND** that identifies a window. An **HWND** is attached to your object when you:

- Specify an **HWND** in **CWindow**'s constructor.
- Call **CWindow::Attach**.
- Use **CWindow**'s **operator =**.
- Create or subclass a window, using one of the following classes derived from **CWindow**:

  CWindowImpl Allows you to create a new window or subclass an existing window.

  CContainedWindow Implements a window contained within another object. You can create a new window or subclass an existing window.

  CDialogImpl Allows you to create a modal or modeless dialog box.

For more information about windows, see "Windows" and subsequent topics in the *Win32 SDK* online. For more information about using windows in ATL, see the article "ATL Window Classes."

#include <atlwin.h>

Alert Methods

FlashWindow	Flashes the window once.
MessageBox	Displays a message box.

Attribute Methods

GetExStyle	Retrieves the extended window styles.
GetStyle	Retrieves the window styles.
GetWindowLong	Retrieves a 32-bit value at a specified offset into the extra window memory.
GetWindowWord	Retrieves a 16-bit value at a specified offset into the extra window memory.
ModifyStyle	Modifies the window styles.
ModifyStyleEx	Modifies the extended window styles.
SetWindowLong	Sets a 32-bit value at a specified offset into the extra window memory.
SetWindowWord	Sets a 16-bit value at a specified offset into the extra window memory.

Caret Methods

CreateCaret	Creates a new shape for the system caret.
CreateGrayCaret	Creates a gray rectangle for the system caret.
CreateSolidCaret	Creates a solid rectangle for the system caret.
HideCaret	Hides the system caret.
ShowCaret	Displays the system caret.

Clipboard Methods

ChangeClipboardChain	Removes the window from the chain of Clipboard viewers.
OpenClipboard	Opens the Clipboard.
SetClipboardViewer	Adds the window to the Clipboard viewer chain.

Construction, Destruction, and Initialization

Attach	Attaches a window to the **CWindow** object.
CWindow	Constructor.
DestroyWindow	Destroys the window associated with the **CWindow** object.
Detach	Detaches the window from the **CWindow** object.

Coordinate Mapping Methods

ClientToScreen	Converts client coordinates to screen coordinates.
MapWindowPoints	Converts a set of points from the window's coordinate space to the coordinate space of another window.
ScreenToClient	Converts screen coordinates to client coordinates.

Dialog Box Item Methods	
CheckDlgButton	Changes the check state of the specified button.
CheckRadioButton	Checks the specified radio button.
DlgDirList	Fills a list box with the names of all files matching a specified path or filename.
DlgDirListComboBox	Fills a combo box with the names of all files matching a specified path or filename.
DlgDirSelect	Retrieves the current selection from a list box.
DlgDirSelectComboBox	Retrieves the current selection from a combo box.
GetDlgItemInt	Translates a control's text to an integer.
GetDlgItemText	Retrieves a control's text.
GetNextDlgGroupItem	Retrieves the previous or next control within a group of controls.
GetNextDlgTabItem	Retrieves the previous or next control having the **WS_TABSTOP** style.
IsDlgButtonChecked	Determines the check state of the button.
SendDlgItemMessage	Sends a message to a control.
SetDlgItemInt	Changes a control's text to the string representation of an integer value.
SetDlgItemText	Changes a control's text.
Drag-Drop Methods	
DragAcceptFiles	Registers whether the window accepts dragged files.
Font Methods	
GetFont	Retrieves the window's current font.
SetFont	Changes the window's current font.
Help Methods	
GetWindowContextHelpId	Retrieves the window's help context identifier.
SetWindowContextHelpId	Sets the window's help context identifier.
WinHelp	Starts Windows Help.
Hot Key Methods	
GetHotKey	Determines the hot key associated with the window.
SetHotKey	Associates a hot key with the window.
Icon Methods	
GetIcon	Retrieves the window's large or small icon.
SetIcon	Changes the window's large or small icon.

Menu Methods	
DrawMenuBar	Redraws the window's menu bar.
GetMenu	Retrieves the window's menu.
GetSystemMenu	Creates a copy of the system menu for modification.
HiliteMenuItem	Highlights or removes the highlight from a top-level menu item.
SetMenu	Changes the window's current menu.

Message Methods	
PostMessage	Places a message in the message queue associated with the thread that created the window. Returns without waiting for the thread to process the message.
SendMessage	Sends a message to the window and does not return until the window procedure has processed the message.
SendNotifyMessage	Sends a message to the window. If the window was created by the calling thread, **SendNotifyMessage** does not return until the window procedure has processed the message. Otherwise, it returns immediately.

Scrolling Methods	
EnableScrollBar	Enables or disables the scroll bar arrows.
GetScrollPos	Retrieves the position of the scroll box.
GetScrollRange	Retrieves the scroll bar range.
ScrollWindow	Scrolls the specified client area.
ScrollWindowEx	Scrolls the specified client area with additional features.
SetScrollPos	Changes the position of the scroll box.
SetScrollRange	Changes the scroll bar range.
ShowScrollBar	Shows or hides a scroll bar.

Timer Methods	
KillTimer	Destroys a timer event.
SetTimer	Creates a timer event.

Update and Painting Methods	
BeginPaint	Prepares the window for painting.
EndPaint	Marks the end of painting.
GetDC	Retrieves a device context for the client area.
GetDCEx	Retrieves a device context for the client area and allows clipping options.
GetUpdateRect	Retrieves the coordinates of the smallest rectangle that completely encloses the update region.

(continued)

Update and Painting Methods *(continued)*	
GetUpdateRgn	Retrieves the update region and copies it into a specified region.
GetWindowDC	Retrieves a device context for the entire window.
Invalidate	Invalidates the entire client area.
InvalidateRect	Invalidates the client area within the specified rectangle.
InvalidateRgn	Invalidates the client area within the specified region.
IsWindowVisible	Determines the window's visibility state.
LockWindowUpdate	Disables or enables drawing in the window.
Print	Requests that the window be drawn in a specified device context.
PrintClient	Requests that the window's client area be drawn in a specified device context.
RedrawWindow	Updates a specified rectangle or region in the client area.
ReleaseDC	Releases a device context.
SetRedraw	Sets or clears the redraw flag.
ShowOwnedPopups	Shows or hides the pop-up windows owned by the window.
ShowWindow	Sets the window's show state.
UpdateWindow	Updates the client area.
ValidateRect	Validates the client area within the specified rectangle.
ValidateRgn	Validates the client area within the specified region.

Window Access Methods	
ChildWindowFromPoint	Retrieves the child window containing the specified point.
ChildWindowFromPointEx	Retrieves a particular type of child window containing the specified point.
GetLastActivePopup	Retrieves the most recently active pop-up window.
GetParent	Retrieves the immediate parent window.
GetTopLevelParent	Retrieves the top-level parent or owner window.
GetTopLevelWindow	Retrieves the top-level owner window.
GetTopWindow	Retrieves the top-level child window.
GetWindow	Retrieves the specified window.
IsChild	Determines whether the specified window is a child window.
SetParent	Changes the parent window.

Window Size and Position Methods

ArrangeIconicWindows	Arranges all minimized child windows.
BringWindowToTop	Brings the window to the top of the Z order.
CenterWindow	Centers the window against a given window.
GetClientRect	Retrieves the coordinates of the client area.
GetWindowPlacement	Retrieves the show state and positions.
GetWindowRect	Retrieves the window's bounding dimensions.
IsIconic	Determines whether the window is minimized.
IsZoomed	Determines whether the window is maximized.
MoveWindow	Changes the window's size and position.
SetWindowPlacement	Sets the show state and positions.
SetWindowPos	Sets the size, position, and Z order.

Window State Methods

EnableWindow	Enables or disables input.
IsWindowEnabled	Determines whether the window is enabled for input.
SetActiveWindow	Activates the window.
SetCapture	Sends all subsequent mouse input to the window.
SetFocus	Sets the input focus to the window.

Window Text Methods

GetWindowText	Retrieves the window's text.
GetWindowTextLength	Retrieves the length of the window's text.
SetWindowText	Changes the window's text.

Window Tree Access Methods

GetDescendantWindow	Retrieves the specified descendant window.
GetDlgCtrlID	Retrieves the window's identifier (for child windows only).
GetDlgItem	Retrieves the specified child window.
SendMessageToDescendants	Sends a message to the specified descendant windows.
SetDlgCtrlID	Changes the window's identifier.

Operators

operator HWND	Converts the **CWindow** object to an **HWND**.
operator =	Assigns an **HWND** to the **CWindow** object.

Data Members

m_hWnd	The handle to the window associated with the **CWindow** object.

Methods

CWindow::ArrangeIconicWindows

UINT ArrangeIconicWindows( );

See **ArrangeIconicWindows** in the *Win32 SDK* online.

Remarks

Arranges all minimized child windows.

CWindow::Attach

void Attach(HWND *hWndNew* **);**

Parameters

hWndNew [in] The handle to a window.

Remarks

Attaches the window identified by *hWndNew* to the **CWindow** object.

See Also: CWindow::Detach

CWindow::BeginPaint

HDC BeginPaint(LPPAINTSTRUCT *lpPaint* **);**

See **BeginPaint** in the *Win32 SDK* online.

Remarks

Prepares the window for painting.

See Also: CWindow::EndPaint

CWindow::BringWindowToTop

BOOL BringWindowToTop( );

See **BringWindowToTop** in the *Win32 SDK* online.

Remarks

Brings the window to the top of the Z order.

See Also: CWindow::MoveWindow, CWindow::SetWindowPos

CWindow::CenterWindow

BOOL CenterWindow(HWND *hWndCenter* **= NULL);**

Return Value

TRUE if the window is successfully centered; otherwise, **FALSE**.

Parameters

hWndCenter [in] The handle to the window against which to center. If this parameter is **NULL** (the default value), the method will set *hWndCenter* to the window's parent window if it is a child window. Otherwise, it will set *hWndCenter* to the window's owner window.

Remarks

Centers the window against a given window.

See Also: CWindow::MoveWindow, CWindow::SetWindowPos

CWindow::ChangeClipboardChain

BOOL ChangeClipboardChain(HWND *hWndNewNext* **);**

See **ChangeClipboardChain** in the *Win32 SDK* online.

Remarks

Removes the window from the chain of Clipboard viewers.

See Also: CWindow::SetClipboardViewer

CWindow::CheckDlgButton

BOOL CheckDlgButton(int *nIDButton*, **UINT** *nCheck* **);**

See **CheckDlgButton** in the *Win32 SDK* online.

Remarks

Changes the check state of the specified button.

See Also: CWindow::CheckRadioButton, CWindow::IsDlgButtonChecked

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CWindow::CheckRadioButton

BOOL CheckRadioButton(int *nIDFirstButton*, **int** *nIDLastButton*,
↪ **int** *nIDCheckButton* **);**

See **CheckRadioButton** in the *Win32 SDK* online.

Remarks

Checks the specified radio button.

See Also: CWindow::CheckDlgButton

CWindow::ChildWindowFromPoint

HWND ChildWindowFromPoint(POINT *point* **) const;**

See **ChildWindowFromPoint** in the *Win32 SDK* online.

Remarks

Retrieves the child window containing the specified point.

See Also: CWindow::ChildWindowFromPointEx, POINT

CWindow::ChildWindowFromPointEx

HWND ChildWindowFromPoint(POINT *point*, **UINT** *uFlags* **) const;**

See **ChildWindowFromPointEx** in the *Win32 SDK* online.

Remarks

Retrieves a particular type of child window containing the specified point.

See Also: CWindow::ChildWindowFromPoint, POINT

CWindow::ClientToScreen

BOOL ClientToScreen(LPPOINT *lpPoint* **) const;**
BOOL ClientToScreen(LPRECT *lpRect* **) const;**

See **ClientToScreen** in the *Win32 SDK* online.

Remarks

Converts client coordinates to screen coordinates. The second version of this method allows you to convert the coordinates of a **RECT** structure.

See Also: CWindow::ScreenToClient, POINT

CWindow::CreateCaret

BOOL CreateCaret(HBITMAP *pBitmap* **);**

See **CreateCaret** in the *Win32 SDK* online.

Remarks

Creates a new shape for the system caret.

See Also: **CWindow::CreateGrayCaret**, **CWindow::CreateSolidCaret**

CWindow::CreateGrayCaret

BOOL CreateGrayCaret(int *nWidth*, **int** *nHeight* **);**

See **CreateCaret** in the *Win32 SDK* online.

Remarks

Creates a gray rectangle for the system caret. Passes (HBITMAP) 1 for the bitmap handle parameter to the Win32 function.

See Also: **CWindow::CreateCaret**, **CWindow::CreateSolidCaret**

CWindow::CreateSolidCaret

BOOL CreateSolidCaret(int *nWidth*, **int** *nHeight* **);**

See **CreateCaret** in the *Win32 SDK* online.

Remarks

Creates a solid rectangle for the system caret. Passes (HBITMAP) 0 for the bitmap handle parameter to the Win32 function.

See Also: **CWindow::CreateCaret**, **CWindow::CreateGrayCaret**

CWindow::CWindow

CWindow(HWND *hWnd* **= NULL);**

Parameters

hWnd [in] The handle to a window.

Remarks

The constructor. Initializes the **m_hWnd** member to *hWnd*, which by default is **NULL**.

Note **CWindow::CWindow** does not create a window. Classes **CWindowImpl**, **CContainedWindow**, and **CDialogImpl** (all of which derive from **CWindow**) provide a method to create a window or dialog box, which is then assigned to **CWindow::m_hWnd**. You can also use the **CreateWindow** Win32 function.

CWindow::DestroyWindow

BOOL DestroyWindow( );

See **DestroyWindow** in the *Win32 SDK* online.

Remarks

Destroys the window associated with the **CWindow** object and sets **m_hWnd** to **NULL**. It does not destroy the **CWindow** object itself.

CWindow::Detach

HWND Detach( );

Return Value

The **HWND** associated with the **CWindow** object.

Remarks

Detaches **m_hWnd** from the **CWindow** object and sets **m_hWnd** to **NULL**.

See Also: CWindow::Attach

CWindow::DlgDirList

int DlgDirList(LPTSTR *lpPathSpec*, **int** *nIDListBox*, **int** *nIDStaticPath*,
↪ **UINT** *nFileType* **);**

See **DlgDirList** in the *Win32 SDK* online.

Remarks

Fills a list box with the names of all files matching a specified path or filename.

See Also: CWindow::DlgDirListComboBox, CWindow::DlgDirSelect, CWindow::DlgDirSelectComboBox

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CWindow::DlgDirListComboBox

int DlgDirListComboBox(LPTSTR *lpPathSpec*, **int** *nIDComboBox*,
↪ **int** *nIDStaticPath*, **UINT** *nFileType* **);**

See **DlgDirListComboBox** in the *Win32 SDK* online.

Remarks

Fills a combo box with the names of all files matching a specified path or filename.

See Also: CWindow::DlgDirList, CWindow::DlgDirSelect, CWindow::DlgDirSelectComboBox

CWindow::DlgDirSelect

BOOL DlgDirSelect(LPTSTR *lpString*, **int** *nCount*, **int** *nIDListBox* **);**

See **DlgDirSelectEx** in the *Win32 SDK* online.

Remarks

Retrieves the current selection from a list box.

See Also: CWindow::DlgDirSelectComboBox, CWindow::DlgDirList

CWindow::DlgDirSelectComboBox

BOOL DlgDirSelectComboBox(LPTSTR *lpString*, **int** *nCount*, **int** *nIDComboBox* **);**

See **DlgDirSelectComboBoxEx** in the *Win32 SDK* online.

Remarks

Retrieves the current selection from a combo box.

See Also: CWindow::DlgDirSelect, CWindow::DlgDirListComboBox

CWindow::DragAcceptFiles

void DragAcceptFiles(BOOL *bAccept* **= TRUE);**

See **DragAcceptFiles** in the *Win32 SDK* online.

Remarks

Registers whether the window accepts dragged files.

CWindow::DrawMenuBar

BOOL DrawMenuBar( );

See **DrawMenuBar** in the *Win32 SDK* online.

Remarks

Redraws the window's menu bar.

See Also: CWindow::GetMenu, CWindow::SetMenu

CWindow::EnableScrollBar

BOOL EnableScrollBar(UINT *uSBFlags*,
↪ **UINT** *uArrowFlags* **= ESB_ENABLE_BOTH);**

See **EnableScrollBar** in the *Win32 SDK* online.

Remarks

Enables or disables the scroll bar arrows.

See Also: CWindow::ShowScrollBar

CWindow::EnableWindow

BOOL EnableWindow(BOOL *bEnable* **= TRUE);**

See **EnableWindow** in the *Win32 SDK* online.

Remarks

Enables or disables input.

See Also: CWindow::IsWindowEnabled

CWindow::EndPaint

void EndPaint(LPPAINTSTRUCT *lpPaint* **);**

See **EndPaint** in the *Win32 SDK* online.

Remarks

Marks the end of painting.

See Also: CWindow::BeginPaint

CWindow::FlashWindow

BOOL FlashWindow(BOOL *bInvert* **);**

See **FlashWindow** in the *Win32 SDK* online.

Remarks

Flashes the window once.

See Also: CWindow::SetTimer

CWindow::GetClientRect

BOOL GetClientRect(LPRECT *lpRect* **) const;**

See **GetClientRect** in the *Win32 SDK* online.

Remarks

Retrieves the coordinates of the client area.

See Also: CWindow::GetWindowRect, RECT

CWindow::GetDC

HDC GetDC( );

See **GetDC** in the *Win32 SDK* online.

Remarks

Retrieves a device context for the client area.

See Also: CWindow::GetDCEx, CWindow::GetWindowDC, CWindow::ReleaseDC

CWindow::GetDCEx

HDC GetDCEx(HRGN *hRgnClip*, **DWORD** *flags* **);**

See **GetDCEx** in the *Win32 SDK* online.

Remarks

Retrieves a device context for the client area and allows clipping options.

See Also: CWindow::GetDC, CWindow::GetWindowDC, CWindow::ReleaseDC

CWindow::GetDescendantWindow

HWND GetDescendantWindow(int *nID* **) const;**

Return Value

The handle to a descendant window.

Parameters

nID [in] The identifier of the descendant window to be retrieved.

Remarks

Finds the descendant window specified by the given identifier. **GetDescendantWindow** searches the entire tree of child windows, not only the windows that are immediate children.

See Also: CWindow::GetDlgItem

CWindow::GetDlgCtrlID

int GetDlgCtrlID( ) const;

See **GetDlgCtrlID** in the *Win32 SDK* online.

Remarks

Retrieves the window's identifier (for child windows only).

See Also: CWindow::SetDlgCtrlID

CWindow::GetDlgItem

HWND GetDlgItem(int *nID* **) const;**

See **GetDlgItem** in the *Win32 SDK* online.

Remarks

Retrieves the specified child window.

See Also: CWindow::GetDescendantWindow

CWindow::GetDlgItemInt

UINT GetDlgItemInt(int *nID*, **BOOL*** *lpTrans* **= NULL,**
↪ **BOOL** *bSigned* **= TRUE) const;**

See **GetDlgItemInt** in the *Win32 SDK* online.

Remarks

Translates a control's text to an integer.

See Also: CWindow::SetDlgItemInt, CWindow::GetDlgItemText

CWindow::GetDlgItemText

UINT GetDlgItemText(int *nID*, **LPTSTR** *lpStr*, **int** *nMaxCount* **) const;**
BOOL GetDlgItemText(int *nID*, **BSTR&** *bstrText* **) const;**

See **GetDlgItemText** in the *Win32 SDK* online.

Remarks

Retrieves a control's text. The second version of this method allows you to copy the control's text to a **BSTR**. This version returns **TRUE** if the text is successfully copied; otherwise, **FALSE**.

See Also: CWindow::SetDlgItemText, CWindow::GetDlgItem

CWindow::GetExStyle

DWORD GetExStyle( ) const;

Return Value

The window's extended styles.

Remarks

Retrieves the extended window styles of the window.

To retrieve the regular window styles, call **GetStyle**.

See Also: CWindow::ModifyStyleEx

CWindow::GetFont

HFONT GetFont( ) const;

Return Value

A font handle.

Remarks

Retrieves the window's current font by sending a **WM_GETFONT** message to the window.

See Also: CWindow::SetFont

CWindow::GetHotKey

DWORD GetHotKey(WORD& *wVirtualKeyCode*, **WORD&** *wModifiers* **) const;**

Return Value

The virtual key code and modifiers for the hot key associated with the window. For a list of possible modifiers, see **WM_GETHOTKEY** in the *Win32 SDK* online.

Parameters

wVirtualKeyCode [in] Not used.

wModifiers [in] Not used.

Remarks

Determines the hot key associated with the window by sending a **WM_GETHOTKEY** message.

See Also: CWindow::SetHotKey

CWindow::GetIcon

HICON GetIcon(BOOL *bBigIcon* **= TRUE) const;**

Return Value

An icon handle.

Parameters

bBigIcon [in] If **TRUE** (the default value) the method returns the large icon. Otherwise, it returns the small icon.

Remarks

Retrieves the handle to the window's large or small icon. **GetIcon** sends a **WM_GETICON** message to the window.

See Also: CWindow::SetIcon

CWindow::GetLastActivePopup

HWND GetLastActivePopup( ) const;

See **GetLastActivePopup** in the *Win32 SDK* online.

Remarks

Retrieves the most recently active pop-up window.

CWindow::GetMenu

HMENU GetMenu( ) const;

See **GetMenu** in the *Win32 SDK* online.

Remarks

Retrieves the window's menu.

See Also: CWindow::SetMenu

CWindow::GetNextDlgGroupItem

HWND GetNextDlgGroupItem(HWND *hWndCtl*,
↪ **BOOL** *bPrevious* **= FALSE) const;**

See **GetNextDlgGroupItem** in the *Win32 SDK* online.

Remarks

Retrieves the previous or next control within a group of controls.

See Also: CWindow::GetNextDlgTabItem

CWindow::GetNextDlgTabItem

HWND GetNextDlgTabItem(HWND *hWndCtl*,
↪ **BOOL** *bPrevious* **= FALSE) const;**

See **GetNextDlgTabItem** in the *Win32 SDK* online.

Remarks

Retrieves the previous or next control having the **WS_TABSTOP** style.

See Also: CWindow::GetNextDlgGroupItem

CWindow::GetParent

HWND GetParent( ) const;

See **GetParent** in the *Win32 SDK* online.

Remarks

Retrieves the immediate parent window.

See Also: CWindow::SetParent

CWindow::GetScrollPos

int GetScrollPos(int *nBar* **) const;**

See **GetScrollPos** in the *Win32 SDK* online.

Remarks

Retrieves the position of the scroll box.

See Also: CWindow::SetScrollPos

CWindow::GetScrollRange

BOOL GetScrollRange(int *nBar*, **LPINT** *lpMinPos*, **LPINT** *lpMaxPos* **) const;**

See **GetScrollRange** in the *Win32 SDK* online.

Remarks

Retrieves the scroll bar range.

See Also: CWindow::SetScrollRange

CWindow::GetStyle

DWORD GetStyle( ) const;

Return Value

The window's styles.

Remarks

Retrieves the window styles of the window.

To retrieve the extended window styles, call **GetExStyle**.

See Also: CWindow::ModifyStyle

CWindow::GetSystemMenu

HMENU GetSystemMenu(BOOL *bRevert* **) const;**

See **GetSystemMenu** in the *Win32 SDK* online.

Remarks

Creates a copy of the system menu for modification.

See Also: CWindow::GetMenu

CWindow::GetTopLevelParent

HWND GetTopLevelParent( ) const;

Return Value

The handle to the top-level parent window.

Remarks

Retrieves the window's top-level parent window.

See Also: CWindow::GetParent, CWindow::GetTopLevelWindow, CWindow::GetWindow

CWindow::GetTopLevelWindow

HWND GetTopLevelWindow( ) const;

Return Value

The handle to the top-level owner window.

Remarks

Retrieves the window's top-level parent or owner window.

See Also: CWindow::GetTopLevelParent, CWindow::GetWindow

CWindow::GetTopWindow

HWND GetTopWindow( ) const;

See **GetTopWindow** in the *Win32 SDK* online.

Remarks

Retrieves the top-level child window.

See Also: **CWindow::GetWindow**

CWindow::GetUpdateRect

BOOL GetUpdateRect(LPRECT *lpRect*, **BOOL** *bErase* = **FALSE);**

See **GetUpdateRect** in the *Win32 SDK* online.

Remarks

Retrieves the coordinates of the smallest rectangle that completely encloses the update region.

See Also: **CWindow::GetUpdateRgn, RECT**

CWindow::GetUpdateRgn

int GetUpdateRgn(HRGN *hRgn*, **BOOL** *bErase* = **FALSE);**

See **GetUpdateRgn** in the *Win32 SDK* online.

Remarks

Retrieves the update region and copies it into a specified region.

See Also: **CWindow::GetUpdateRect**

CWindow::GetWindow

HWND GetWindow(UINT *nCmd* **) const;**

See **GetWindow** in the *Win32 SDK* online.

Remarks

Retrieves the specified window.

See Also: **CWindow::GetTopWindow, CWindow::GetTopLevelParent, CWindow::GetTopLevelWindow**

CWindow::GetWindowContextHelpId

DWORD GetWindowContextHelpId( ) const;

See **GetWindowContextHelpId** in the *Win32 SDK* online.

Remarks

Retrieves the window's help context identifier.

See Also: **CWindow::SetWindowContextHelpId**

CWindow::GetWindowDC

HDC GetWindowDC( );

See **GetWindowDC** in the *Win32 SDK* online.

Remarks

Retrieves a device context for the entire window.

See Also: CWindow::GetDC, CWindow::GetDCEx, CWindow::ReleaseDC

CWindow::GetWindowLong

LONG GetWindowLong(int *nIndex* **) const;**

See **GetWindowLong** in the *Win32 SDK* online.

Remarks

Retrieves a 32-bit value at a specified offset into the extra window memory.

See Also: CWindow::SetWindowLong, CWindow::GetWindowWord

CWindow::GetWindowPlacement

BOOL GetWindowPlacement(WINDOWPLACEMENT FAR* *lpwndpl* **) const;**

See **GetWindowPlacement** in the *Win32 SDK* online.

Remarks

Retrieves the show state and positions.

See Also: CWindow::SetWindowPlacement, WINDOWPLACEMENT

CWindow::GetWindowRect

BOOL GetWindowRect(LPRECT *lpRect* **) const;**

See **GetWindowRect** in the *Win32 SDK* online.

Remarks

Retrieves the window's bounding dimensions.

See Also: CWindow::GetClientRect, RECT

CWindow::GetWindowText

int GetWindowText(LPTSTR *lpszStringBuf*, **int** *nMaxCount*) **const;**
BOOL GetWindowText(BSTR& *bstrText* **);**

See **GetWindowText** in the *Win32 SDK* online.

Remarks

Retrieves the window's text. The second version of this method allows you to store the text in a **BSTR**. If the text is successfully copied, the return value is **TRUE**; otherwise, the return value is **FALSE**.

See Also: CWindow::GetWindowTextLength, CWindow::SetWindowText

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CWindow::GetWindowTextLength

int GetWindowTextLength( ) const;

See **GetWindowTextLength** in the *Win32 SDK* online.

Remarks

Retrieves the length of the window's text.

See Also: CWindow::GetWindowText

CWindow::GetWindowWord

WORD GetWindowWord(int *nIndex*) **const;**

See **GetWindowWord** in the *Win32 SDK* online.

Remarks

Retrieves a 16-bit value at a specified offset into the extra window memory.

See Also: CWindow::SetWindowWord, CWindow::GetWindowLong

CWindow::HideCaret

BOOL HideCaret( );

See **HideCaret** in the *Win32 SDK* online.

Remarks

Hides the system caret.

See Also: CWindow::ShowCaret

CWindow::HiliteMenuItem

BOOL HiliteMenuItem(HMENU *hMenu*, **UINT** *uHiliteItem*, **UINT** *uHilite* **);**

See **HiliteMenuItem** in the *Win32 SDK* online.

Remarks

Highlights or removes the highlight from a top-level menu item.

CWindow::Invalidate

BOOL Invalidate(BOOL *bErase* **= TRUE);**

See **InvalidateRect** in the *Win32 SDK* online.

Remarks

Invalidates the entire client area. Passes **NULL** for the **RECT** parameter to the **InvalidateRect** Win32 function.

See Also: CWindow::InvalidateRect, CWindow::InvalidateRgn, CWindow::ValidateRect, CWindow::ValidateRgn

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CWindow::InvalidateRect

BOOL InvalidateRect(LPCRECT *lpRect*, **BOOL** *bErase* **= TRUE);**

See **InvalidateRect** in the *Win32 SDK* online.

Remarks

Invalidates the client area within the specified rectangle.

See Also: CWindow::Invalidate, CWindow::InvalidateRgn, CWindow::ValidateRect, RECT

CWindow::InvalidateRgn

void InvalidateRgn(HRGN *hRgn*, **BOOL** *bErase* **= TRUE);**

See **InvalidateRgn** in the *Win32 SDK* online.

Remarks

Invalidates the client area within the specified region. Specifies a **void** return type, while the **InvalidateRgn** Win32 function always returns **TRUE**.

See Also: CWindow::Invalidate, CWindow::InvalidateRect, CWindow::ValidateRgn

CWindow::IsChild

BOOL IsChild(const HWND *hWnd*) const;

See **IsChild** in the *Win32 SDK* online.

Remarks

Determines whether the specified window is a child window.

CWindow::IsDlgButtonChecked

UINT IsDlgButtonChecked(int *nIDButton*) const;

See **IsDlgButtonChecked** in the *Win32 SDK* online.

Remarks

Determines the check state of the button.

See Also: CWindow::CheckDlgButton

CWindow::IsIconic

BOOL IsIconic( ) const;

See **IsIconic** in the *Win32 SDK* online.

Remarks

Determines whether the window is minimized.

See Also: CWindow::IsZoomed

CWindow::IsWindowEnabled

BOOL IsWindowEnabled( ) const;

See **IsWindowEnabled** in the *Win32 SDK* online.

Remarks

Determines whether the window is enabled for input.

See Also: CWindow::EnableWindow, CWindow::IsWindowVisible

CWindow::IsWindowVisible

BOOL IsWindowVisible( ) const;

See **IsWindowVisible** in the *Win32 SDK* online.

Remarks

Determines the window's visibility state.

CWindow::IsZoomed

BOOL IsZoomed( ) const;

See **IsZoomed** in the *Win32 SDK* online.

Remarks

Determines whether the window is maximized.

See Also: CWindow::IsIconic

CWindow::KillTimer

BOOL KillTimer(UINT *nIDEvent* **);**

See **KillTimer** in the *Win32 SDK* online.

Remarks

Destroys a timer event.

See Also: CWindow::SetTimer

CWindow::LockWindowUpdate

BOOL LockWindowUpdate(BOOL *bLock* **= TRUE);**

Return Value

TRUE if the window is successfully locked; otherwise, **FALSE**.

Parameters

bLock [in] If **TRUE** (the default value), the window will be locked. Otherwise, it will be unlocked.

Remarks

Disables or enables drawing in the window by calling the **LockWindowUpdate** Win32 function. If *bLock* is **TRUE**, this method passes **m_hWnd** to the Win32 function; otherwise, it passes **NULL**.

CWindow::MapWindowPoints

int MapWindowPoints(HWND *hWndTo*, **LPPOINT** *lpPoint*, **UINT** *nCount* **) const;**
int MapWindowPoints(HWND *hWndTo*, **LPRECT** *lpRect* **) const;**

See **MapWindowPoints** in the *Win32 SDK* online.

Remarks

Converts a set of points from the window's coordinate space to the coordinate space of another window. The second version of this method allows you to convert the coordinates of a **RECT** structure.

See Also: POINT

CWindow::MessageBox

int MessageBox(LPCTSTR *lpszText*, **LPCTSTR** *lpszCaption* **= NULL,**
↪ **UINT** *nType* **= MB_OK);**

See **MessageBox** in the *Win32 SDK* online.

Remarks

Displays a message box.

CWindow::ModifyStyle

BOOL ModifyStyle(DWORD *dwRemove*, **DWORD** *dwAdd*, **UINT** *nFlags* **= 0);**

Return Value

TRUE if the window styles are modified; otherwise, **FALSE**.

Parameters

dwRemove [in] Specifies the window styles to be removed during style modification.

dwAdd [in] Specifies the window styles to be added during style modification.

nFlags [in] Window-positioning flags. For a list of possible values, see the **SetWindowPos** function in the *Win32 SDK* online.

Remarks

Modifies the window styles of the **CWindow** object. Styles to be added or removed can be combined by using the bitwise OR (|) operator. See the **CreateWindow** function in the *Win32 SDK* online for information about the available window styles.

If *nFlags* is nonzero, **ModifyStyle** calls the Win32 function **SetWindowPos**, and redraws the window by combining *nFlags* with the following four flags:

- **SWP_NOSIZE** Retains the current size.
- **SWP_NOMOVE** Retains the current position.
- **SWP_NOZORDER** Retains the current Z order.
- **SWP_NOACTIVATE** Does not activate the window.

To modify a window's extended styles, call **ModifyStyleEx**.

See Also: CWindow::GetStyle

CWindow::ModifyStyleEx

BOOL ModifyStyleEx(DWORD *dwRemove*, **DWORD** *dwAdd*, **UINT** *nFlags* **= 0);**

Return Value

TRUE if the extended window styles are modified; otherwise, **FALSE**.

Parameters

dwRemove [in] Specifies the extended styles to be removed during style modification.

dwAdd [in] Specifies the extended styles to be added during style modification.

nFlags [in] Window-positioning flags. For a list of possible values, see the **SetWindowPos** function in the *Win32 SDK* online.

Remarks

Modifies the extended window styles of the **CWindow** object. Styles to be added or removed can be combined by using the bitwise OR (|) operator. See the **CreateWindowEx** function in the *Win32 SDK* online for information about the available extended styles.

If *nFlags* is nonzero, **ModifyStyleEx** calls the Win32 function **SetWindowPos**, and redraws the window by combining *nFlags* with the following four flags:

- **SWP_NOSIZE** Retains the current size.
- **SWP_NOMOVE** Retains the current position.
- **SWP_NOZORDER** Retains the current Z order.
- **SWP_NOACTIVATE** Does not activate the window.

To modify windows using regular window styles, call **ModifyStyle**.

See Also: CWindow::GetExStyle

CWindow::MoveWindow

BOOL MoveWindow(int *x*, **int** *y*, **int** *nWidth*, **int** *nHeight*, **BOOL** *bRepaint* **= TRUE);**
BOOL MoveWindow(LPCRECT *lpRect*, **BOOL** *bRepaint* **= TRUE);**

See **MoveWindow** in the *Win32 SDK* online.

Remarks

Changes the window's size and position. The second version of this method uses a **RECT** structure to determine the window's new position, width, and height.

See Also: CWindow::SetWindowPos

CWindow::OpenClipboard

BOOL OpenClipboard( );

See **OpenClipboard** in the *Win32 SDK* online.

Remarks

Opens the Clipboard.

CWindow::PostMessage

BOOL PostMessage(UINT *message*, **WPARAM** *wParam* **= 0,**
↪ **LPARAM** *lParam* **= 0);**

See **PostMessage** in the *Win32 SDK* online.

Remarks

Places a message in the message queue associated with the thread that created the window. Returns without waiting for the thread to process the message.

See Also: CWindow::SendMessage, CWindow::SendNotifyMessage

CWindow::Print

void Print(HDC *hDC*, **DWORD** *dwFlags* **) const;**

Parameters

hDC [in] The handle to a device context.

dwFlags [in] Specifies the drawing options. You can combine one or more of the following flags:

- **PRF_CHECKVISIBLE** Draw the window only if it is visible.
- **PRF_CHILDREN** Draw all visible child windows.
- **PRF_CLIENT** Draw the client area of the window.
- **PRF_ERASEBKGND** Erase the background before drawing the window.
- **PRF_NONCLIENT** Draw the nonclient area of the window.
- **PRF_OWNED** Draw all owned windows.

Remarks

Sends a **WM_PRINT** message to the window to request that it draw itself in the specified device context.

See Also: CWindow::PrintClient

CWindow::PrintClient

void PrintClient(HDC *hDC*, **DWORD** *dwFlags*) **const;**

Parameters

hDC [in] The handle to a device context.

dwFlags [in] Specifies drawing options. You can combine one or more of the following flags:

- **PRF_CHECKVISIBLE** Draw the window only if it is visible.
- **PRF_CHILDREN** Draw all visible child windows.
- **PRF_CLIENT** Draw the client area of the window.
- **PRF_ERASEBKGND** Erase the background before drawing the window.
- **PRF_NONCLIENT** Draw the nonclient area of the window.
- **PRF_OWNED** Draw all owned windows.

Remarks

Sends a **WM_PRINTCLIENT** message to the window to request that it draw its client area in the specified device context.

See Also: CWindow::Print

CWindow::RedrawWindow

BOOL RedrawWindow(LPCRECT *lpRectUpdate* **= NULL,**
↳ **HRGN** *hRgnUpdate* **= NULL,**
↳ **UINT** *flags* **= RDW_INVALIDATE | RDW_UPDATENOW | RDW_ERASE);**

See **RedrawWindow** in the *Win32 SDK* online.

Remarks

Updates a specified rectangle or region in the client area.

See Also: CWindow::UpdateWindow, RECT

CWindow::ReleaseDC

int ReleaseDC(HDC *hDC* **);**

See **ReleaseDC** in the *Win32 SDK* online.

Remarks

Releases a device context.

See Also: CWindow::GetDC, CWindow::GetDCEx, CWindow::GetWindowDC

CWindow::ScreenToClient

BOOL ScreenToClient(LPPOINT *lpPoint* **) const;**
BOOL ScreenToClient(LPRECT *lpRect* **) const;**

See **ScreenToClient** in the *Win32 SDK* online.

Remarks

Converts screen coordinates to client coordinates. The second version of this method allows you to convert the coordinates of a **RECT** structure.

See Also: CWindow::ClientToScreen, POINT

CWindow::ScrollWindow

BOOL ScrollWindow(int *xAmount*, **int** *yAmount*, **LPCRECT** *lpRect* **= NULL,**
↪ **LPCRECT** *lpClipRect* **= NULL);**

See **ScrollWindow** in the *Win32 SDK* online.

Remarks

Scrolls the specified client area.

See Also: CWindow::ScrollWindowEx, RECT

CWindow::ScrollWindowEx

int ScrollWindowEx(int *dx*, **int** *dy*, **LPCRECT** *lpRectScroll*, **LPCRECT** *lpRectClip*,
↪ **HRGN** *hRgnUpdate*, **LPRECT** *lpRectUpdate*, **UINT** *flags* **);**

See **ScrollWindowEx** in the *Win32 SDK* online.

Remarks

Scrolls the specified client area with additional features.

See Also: CWindow::ScrollWindow, RECT

CWindow::SendDlgItemMessage

LRESULT SendDlgItemMessage(int *nID*, **UINT** *message*, **WPARAM** *wParam* **= 0,**
↪ **LPARAM** *lParam* **= 0);**

See **SendDlgItemMessage** in the *Win32 SDK* online.

Remarks

Sends a message to a control.

See Also: CWindow::SendMessage

CWindow::SendMessage

LRESULT SendMessage(UINT *message*, **WPARAM** *wParam* **= 0,**
↪ **LPARAM** *lParam* **= 0);**

See **SendMessage** in the *Win32 SDK* online.

Remarks

Sends a message to the window and does not return until the window procedure has processed the message.

See Also: CWindow::PostMessage, CWindow::SendNotifyMessage, CWindow::SendMessageToDescendants

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Cwindow::SendMessageToDescendants

void SendMessageToDescendants(UINT *message*, **WPARAM** *wParam* **= 0,**
↪ **LPARAM** *lParam* **= 0, BOOL** *bDeep* **= TRUE);**

Parameters

message [in] The message to be sent.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

bDeep [in] If **TRUE** (the default value), the message will be sent to all descendant windows; otherwise, it will be sent only to the immediate child windows.

Remarks

Sends the specified message to all immediate children of the **CWindow** object. If *bDeep* is **TRUE**, the message is additionally sent to all other descendant windows.

See Also: CWindow::SendMessage, CWindow::SendNotifyMessage, CWindow::PostMessage

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CWindow::SendNotifyMessage

BOOL SendNotifyMessage(UINT *message*, **WPARAM** *wParam* **= 0,**
↪ **LPARAM** *lParam* **= 0);**

See **SendNotifyMessage** in the *Win32 SDK* online.

Remarks

Sends a message to the window. If the window was created by the calling thread, **SendNotifyMessage** does not return until the window procedure has processed the message. Otherwise, it returns immediately.

See Also: **CWindow::SendMessage, CWindow::SendMessageToDescendants, CWindow::PostMessage**

CWindow::SetActiveWindow

HWND SetActiveWindow( );

See **SetActiveWindow** in the *Win32 SDK* online.

Remarks

Activates the window.

CWindow::SetCapture

HWND SetCapture( );

See **SetCapture** in the *Win32 SDK* online.

Remarks

Sends all subsequent mouse input to the window.

CWindow::SetClipboardViewer

HWND SetClipboardViewer( );

See **SetClipboardViewer** in the *Win32 SDK* online.

Remarks

Adds the window to the Clipboard viewer chain.

See Also: **CWindow::ChangeClipboardChain**

CWindow::SetDlgCtrlID

int SetDlgCtrlID(int *nID* **);**

Return Value

If successful, the previous identifier of the window; otherwise 0.

Parameters

nID [in] The new value to set for the window's identifier.

Remarks

Sets the identifier of the window to the specified value.

See Also: **CWindow::GetDlgCtrlID**

CWindow::SetDlgItemInt

BOOL SetDlgItemInt(int *nID*, **UINT** *nValue*, **BOOL** *bSigned* = **TRUE);**

See **SetDlgItemInt** in the *Win32 SDK* online.

Remarks

Changes a control's text to the string representation of an integer value.

See Also: CWindow::GetDlgItemInt, CWindow::SetDlgItemText

CWindow::SetDlgItemText

BOOL SetDlgItemText(int *nID*, **LPCTSTR** *lpszString* **);**

See **SetDlgItemText** in the *Win32 SDK* online.

Remarks

Changes a control's text.

See Also: CWindow::GetDlgItemText, CWindow::SetDlgItemInt

CWindow::SetFocus

HWND SetFocus( );

See **SetFocus** in the *Win32 SDK* online.

Remarks

Sets the input focus to the window.

CWindow::SetFont

void SetFont(HFONT *hFont*, **BOOL** *bRedraw* = **TRUE);**

Parameters

hFont [in] The handle to the new font.

bRedraw [in] If **TRUE** (the default value), the window is redrawn. Otherwise, it is not.

Remarks

Changes the window's current font by sending a **WM_SETFONT** message to the window.

See Also: CWindow::GetFont

CWindow::SetHotKey

int SetHotKey(WORD *wVirtualKeyCode*, **WORD** *wModifiers* **);**

Return Value

For a list of possible return values, see **WM_SETHOTKEY** in the *Win32 SDK* online.

Parameters

wVirtualKeyCode [in] The virtual key code of the hot key.

wModifiers [in] The modifiers of the hot key. For a list of possible values, see **WM_SETHOTKEY** in the *Win32 SDK* online.

Remarks

Associates a hot key with the window by sending a **WM_SETHOTKEY** message.

See Also: CWindow::GetHotKey

CWindow::SetIcon

HICON SetIcon(HICON *hIcon*, **BOOL** *bBigIcon* **= TRUE);**

Return Value

The handle to the previous icon.

Parameters

hIcon [in] The handle to a new icon.

bBigIcon [in] If **TRUE** (the default value), the method sets a large icon. Otherwise, it sets a small icon.

Remarks

Sets the window's large or small icon to the icon identified by *hIcon*. **SetIcon** sends a **WM_SETICON** message to the window.

See Also: CWindow::GetIcon

CWindow::SetMenu

BOOL SetMenu(HMENU *hMenu* **);**

See **SetMenu** in the *Win32 SDK* online.

Remarks

Changes the window's current menu.

See Also: CWindow::GetMenu

CWindow::SetParent

HWND SetParent(HWND *hWndNewParent* **);**

See **SetParent** in the *Win32 SDK* online.

Remarks

Changes the parent window.

See Also: CWindow::GetParent

CWindow::SetRedraw

void SetRedraw(BOOL *bRedraw* **= TRUE);**

Parameters

bRedraw [in] Specifies the state of the redraw flag. If **TRUE** (the default value), the redraw flag is set; if **FALSE**, the flag is cleared.

Remarks

Sets or clears the redraw flag by sending a **WM_SETREDRAW** message to the window. Call **SetRedraw** to allow changes to be redrawn or to prevent changes from being redrawn.

CWindow::SetScrollPos

int SetScrollPos(int *nBar*, **int** *nPos*, **BOOL** *bRedraw* **= TRUE);**

See **SetScrollPos** in the *Win32 SDK* online.

Remarks

Changes the position of the scroll box.

See Also: CWindow::GetScrollPos

CWindow::SetScrollRange

BOOL SetScrollRange(int *nBar*, **int** *nMinPos*, **int** *nMaxPos*,
↪ **BOOL** *bRedraw* **= TRUE);**

See **SetScrollRange** in the *Win32 SDK* online.

Remarks

Changes the scroll bar range.

See Also: CWindow::GetScrollRange

CWindow::SetTimer

UINT SetTimer(UINT *nIDEvent*, **UINT** *nElapse*,
↪ **void (CALLBACK EXPORT*** *lpfnTimer* **)(HWND, UINT, UINT, DWORD));**

See **SetTimer** in the *Win32 SDK* online.

Remarks

Creates a timer event.

See Also: CWindow::KillTimer

CWindow::SetWindowContextHelpId

BOOL SetWindowContextHelpId(DWORD *dwContextHelpId* **);**

See **SetWindowContextHelpId** in the *Win32 SDK* online.

Remarks

Sets the window's help context identifier.

See Also: CWindow::GetWindowContextHelpId

CWindow::SetWindowLong

LONG SetWindowLong(int *nIndex*, **LONG** *dwNewLong* **);**

See **SetWindowLong** in the *Win32 SDK* online.

Remarks

Sets a 32-bit value at a specified offset into the extra window memory.

See Also: CWindow::GetWindowLong, CWindow::SetWindowWord

CWindow::SetWindowPlacement

BOOL SetWindowPlacement(const WINDOWPLACEMENT FAR*lpwndpl* **);**

See **SetWindowPlacement** in the *Win32 SDK* online.

Remarks

Sets the show state and positions.

See Also: CWindow::GetWindowPlacement, WINDOWPLACEMENT

CWindow::SetWindowPos

BOOL SetWindowPos(HWND *hWndInsertAfter*, **int** *x*, **int** *y*, **int** *cx*, **int** *cy*,
➥ **UINT** *nFlags* **);**
BOOL SetWindowPos(HWND *hWndInsertAfter*, **LPCRECT** *lpRect*, **UINT** *nFlags* **);**

See **SetWindowPos** in the *Win32 SDK* online.

Remarks

Sets the size, position, and Z order. The second version of this method uses a **RECT** structure to set the window's new position, width, and height.

See Also: CWindow::BringWindowToTop, CWindow::MoveWindow, RECT

CWindow::SetWindowText

BOOL SetWindowText(LPCTSTR *lpszString* **);**

See **SetWindowText** in the *Win32 SDK* online.

Remarks

Changes the window's text.

See Also: CWindow::GetWindowText

CWindow::SetWindowWord

WORD SetWindowLong(int *nIndex*, **WORD** *wNewWord* **);**

See **SetWindowWord** in the *Win32 SDK* online.

Remarks

Sets a 16-bit value at a specified offset into the extra window memory.

See Also: CWindow::GetWindowWord, CWindow::SetWindowLong

CWindow::ShowCaret

BOOL ShowCaret( );

See **ShowCaret** in the *Win32 SDK* online.

Remarks

Displays the system caret.

See Also: CWindow::HideCaret

CWindow::ShowOwnedPopups

BOOL ShowOwnedPopups(BOOL *bShow* **= TRUE);**

See **ShowOwnedPopups** in the *Win32 SDK* online.

Remarks

Shows or hides the pop-up windows owned by the window.

CWindow::ShowScrollBar

BOOL ShowScrollBar(UINT *nBar*, **BOOL** *bShow* **= TRUE);**

See **ShowScrollBar** in the *Win32 SDK* online.

Remarks

Shows or hides a scroll bar.

CWindow::ShowWindow

BOOL ShowWindow(int *nCmdShow* **);**

See **ShowWindow** in the *Win32 SDK* online.

Remarks

Sets the window's show state.

CWindow::UpdateWindow

BOOL UpdateWindow( );

See **UpdateWindow** in the *Win32 SDK* online.

Remarks

Updates the client area.

See Also: CWindow::RedrawWindow

CWindow::ValidateRect

BOOL ValidateRect(LPCRECT *lpRect* **);**

See **ValidateRect** in the *Win32 SDK* online.

Remarks

Validates the client area within the specified rectangle.

See Also: **CWindow::ValidateRgn, CWindow::InvalidateRect**

CWindow::ValidateRgn

BOOL ValidateRgn(HRGN *hRgn* **);**

See **ValidateRgn** in the *Win32 SDK* online.

Remarks

Validates the client area within the specified region.

See Also: **CWindow::ValidateRect, CWindow::InvalidateRgn**

CWindow::WinHelp

BOOL WinHelp(LPCTSTR *lpszHelp*, **UINT** *nCmd* **= HELP_CONTEXT,**
↪ **DWORD** *dwData* **= 0);**

See **WinHelp** in the *Win32 SDK* online.

Remarks

Starts Windows Help.

Operators

CWindow::operator HWND

operator HWND( ) const;

Remarks

Converts a **CWindow** object to an **HWND**.

CWindow::operator =

CWindow& operator =(HWND *hWnd* **);**

Remarks

Assigns an **HWND** to the **CWindow** object by setting the **m_hWnd** member to *hWnd*.

Data Members

CWindow::m_hWnd

HWND m_hWnd;

Remarks

Contains a handle to the window associated with the **CWindow** object.

See Also: **CWindow::CWindow**

CWindowImpl

template< class *T* >
class CWindowImpl : public CWindowImplBase

Parameters

T Your class, derived from **CWindowImpl**.

CWindowImpl allows you to create a new window or subclass an existing window. **CWindowImpl**'s window procedure uses a message map to direct messages to the appropriate handlers.

CWindowImpl::Create creates a new window based on the window class information managed by **CWndClassInfo**. **CWindowImpl** contains the **DECLARE_WND_CLASS** macro, which means **CWndClassInfo** will register a new window class. If you want to superclass an existing window class, derive your class from **CWindowImpl** and include the **DECLARE_WND_SUPERCLASS** macro. In this case, **CWndClassInfo** will register a window class that is based on an existing class but uses **CWindowImpl::WindowProc**. For example:

```
class CMyWindow : CComControl<CMyWindow>, ...
                // CComControl derives from CWindowImpl
{
public:
   // 1. The NULL parameter means ATL will generate a
   //    name for the superclass
   // 2. The "EDIT" parameter means the superclass is
   //    based on the standard Windows Edit box
   DECLARE_WND_SUPERCLASS(NULL, "EDIT")
   ...
};
```

Note Because **CWndClassInfo** manages the information for a single window class, each window created through an instance of **CWindowImpl** will be based on the same window class.

CWindowImpl also supports window subclassing. The **SubclassWindow** method attaches an existing window to the **CWindowImpl** object and changes the window procedure to **CWindowImpl::WindowProc**. Each instance of **CWindowImpl** can subclass a different window.

Note For any given **CWindowImpl** object, call either **Create** or **SubclassWindow**. You should not invoke both methods on the same object.

In addition to **CWindowImpl**, ATL provides **CContainedWindow** to create a window contained within another object.

CWindowImpl derives from **CWindowImplBase**, which in turn derives from **CWindow** and **CMessageMap**.

For more information about	See
Creating controls	"ATL Tutorial"
Using windows in ATL	"ATL Window Classes"
ATL Object Wizard	"Creating an ATL Project"
Windows	"Windows" and subsequent topics in the *Win32 SDK* online
Subclassing	"Window Procedure Subclassing" in the *Win32 SDK* online
Superclassing	"Window Procedure Superclassing" in the *Win32 SDK* online

#include <atlwin.h>

See Also: BEGIN_MSG_MAP, CComControl

Methods	
Create	Creates a window.

CWindowImplBase Methods	
DefWindowProc	Provides default message processing.
GetWndClassInfo	Returns a static instance of **CWndClassInfo**, which manages the window class information.
SubclassWindow	Subclasses a window.
UnsubclassWindow	Restores a previously subclassed window.
WindowProc	Processes messages sent to the window.

Data Members	
m_pfnSuperWindowProc	Points to the window class's original window procedure.

Methods

CWindowImpl::Create

HWND Create(HWND *hWndParent*, **RECT&** *rcPos*,
↪ **LPCTSTR** *szWindowName* = **NULL**,
↪ **DWORD** *dwStyle* = **WS_CHILD | WS_VISIBLE**,
↪ **DWORD** *dwExStyle* = **0**, **UINT** *nID* = **0**);

Return Value

If successful, the handle to the newly created window. Otherwise, **NULL**.

Parameters

hWndParent [in] The handle to the parent or owner window.

rcPos [in] A **RECT** structure specifying the position of the window.

szWindowName [in] Specifies the name of the window. The default value is **NULL**.

dwStyle [in] The style of the window. The default value is **WS_CHILD | WS_VISIBLE**. For a list of possible values, see **CreateWindow** in the *Win32 SDK* online.

dwExStyle [in] The extended window style. The default value is 0, meaning no extended style. For a list of possible values, see **CreateWindowEx** in the *Win32 SDK* online.

nID [in] For a child window, the window identifier. For a top-level window, an **HWND** casted to a **UINT**. The default value is 0.

Remarks

Creates a window based on a new window class. **Create** first registers the window class if it has not yet been registered. The newly created window is automatically attached to the **CWindowImpl** object.

To use a window class that is based on an existing window class, derive your class from **CWindowImpl** and include the **DECLARE_WND_SUPERCLASS** macro. The existing window class's window procedure is saved in **m_pfnSuperWindowProc**. For more information, see the **CWindowImpl** overview.

Note Do not call **Create** if you have already called **SubclassWindow**.

See Also: CWindowImpl::GetWndClassInfo, CWndClassInfo::Register, CWindow::m_hWnd

---

CWindowImpl::DefWindowProc

LRESULT DefWindowProc(UINT *uMsg*, **WPARAM** *wParam*, **LPARAM** *lParam* **);**

Return Value

The result of the message processing.

Parameters

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

Remarks

Called by **WindowProc** to process messages not handled by the message map. By default, **DefWindowProc** calls the **CallWindowProc** Win32 function to send the message information to the window procedure specified in **m_pfnSuperWindowProc**.

CWindowImpl::GetWndClassInfo

static CWndClassInfo& GetWndClassInfo( );

Return Value

A static instance of **CWndClassInfo**.

Remarks

Called by **Create** to access the window class information. By default, **CWindowImpl** obtains this method through the **DECLARE_WND_CLASS** macro, which specifies a new window class.

To superclass an existing window class, derive your class from **CWindowImpl** and include the **DECLARE_WND_SUPERCLASS** macro to override **GetWndClassInfo**. For more information, see the **CWindowImpl** overview.

Besides using the **DECLARE_WND_CLASS** and **DECLARE_WND_SUPERCLASS** macros, you can override **GetWndClassInfo** with your own implementation.

CWindowImpl::SubclassWindow

BOOL SubclassWindow(HWND *hWnd* **);**

Return Value

TRUE if the window is successfully subclassed; otherwise, **FALSE**.

Parameters

hWnd [in] The handle to the window being subclassed.

Remarks

Subclasses the window identified by *hWnd* and attaches it to the **CWindowImpl** object. The subclassed window now uses **CWindowImpl::WindowProc**. The original window procedure is saved in **m_pfnSuperWindowProc**.

Note Do not call **SubclassWindow** if you have already called **Create**.

See Also: CWindowImpl::UnsubclassWindow

CWindowImpl::UnsubclassWindow

HWND UnsubclassWindow( );

Return Value

The handle to the window previously subclassed.

Remarks

Detaches the subclassed window from the **CWindowImpl** object and restores the original window procedure, saved in **m_pfnSuperWindowProc**.

See Also: CWindowImpl::SubclassWindow

CWindowImpl::WindowProc

static LRESULT CALLBACK WindowProc(HWND *hWnd*, **UINT** *uMsg*,
↪ **WPARAM** *wParam*, **LPARAM** *lParam* **);**

Return Value

The result of the message processing.

Parameters

hWnd [in] The handle to the window.

uMsg [in] The message sent to the window.

wParam [in] Additional message-specific information.

lParam [in] Additional message-specific information.

Remarks

This static method implements the window procedure. **WindowProc** uses the default message map (declared with **BEGIN_MSG_MAP**) to direct messages to the appropriate handlers. If necessary, **WindowProc** calls **DefWindowProc** for additional message processing.

You can override **WindowProc** to provide a different mechanism for handling messages.

Data Members

CWindowImpl::m_pfnSuperWindowProc

WNDPROC m_pfnSuperWindowProc;

Remarks

Depending on the window, points to one of the following window procedures:

Type of window	Window procedure
A window based on a new window class, specified through the **DECLARE_WND_CLASS** macro.	The **DefWindowProc** Win32 function.
A window based on a window class that modifies an existing class, specified through the **DECLARE_WND_SUPERCLASS** macro.	The existing window class's window procedure.
A subclassed window.	The subclassed window's original window procedure.

CWindowImpl::DefWindowProc sends message information to the window procedure saved in **m_pfnSuperWindowProc**.

See Also: CWindowImpl::Create, CWindowImpl::SubclassWindow

CWndClassInfo

class CWndClassInfo

CWndClassInfo manages the information of a window class. You typically use **CWndClassInfo** through one of two macros, **DECLARE_WND_CLASS** or **DECLARE_WND_SUPERCLASS**, as described in the following table:

Macro	Description
DECLARE_WND_CLASS	**CWndClassInfo** registers information for a new window class.
DECLARE_WND_SUPERCLASS	**CWndClassInfo** registers information for a window class that is based on an existing class but uses a different window procedure. This technique is called superclassing.

By default, **CWindowImpl** includes the **DECLARE_WND_CLASS** macro to create a window based on a new window class. If you want to create a window based on an existing window class, derive your class from **CWindowImpl** and include the **DECLARE_WND_SUPERCLASS** macro in your class definition. For example:

```
class CMyWindow : CComControl<CMyWindow>, ...
                // CComControl derives from CWindowImpl
{
public:
   // 1. The NULL parameter means ATL will generate a
   //    name for the superclass
   // 2. The "EDIT" parameter means the superclass is
   //    based on the standard Windows Edit box
   DECLARE_WND_SUPERCLASS(NULL, "EDIT")
   ...
};
```

For more information about window classes and superclassing, see "Window Classes" and "Window Procedure Superclassing" in the *Win32 SDK* online.

For more information about using windows in ATL, see the article "ATL Window Classes."

#include <atlwin.h>

See Also: CComControl

Methods

Register	Registers the window class.

Data Members

m_atom	Uniquely identifies the registered window class.
m_bSystemCursor	Specifies whether the cursor resource refers to a system cursor or to a cursor contained in a module resource.

Methods ***(continued)***

m_lpszCursorID	Specifies the name of the cursor resource.
m_lpszOrigName	Contains the name of an existing window class.
m_szAutoName	Holds an ATL-generated name of the window class.
m_wc	Maintains window class information in a **WNDCLASSEX** structure.
pWndProc	Points to the window procedure of an existing window class.

Methods

CWndClassInfo::Register

ATOM Register(WNDPROC* *pProc* **);**

Return Value

If successful, an atom that uniquely identifies the window class being registered. Otherwise, 0.

Parameters

pProc [out] Specifies the original window procedure of an existing window class.

Remarks

Called by **CWindowImpl::Create** to register the window class if it has not yet been registered.

If you have specified the **DECLARE_WND_CLASS** macro (the default in **CWindowImpl**), **Register** registers a new window class. In this case, the *pProc* parameter is not used.

If you have specified the **DECLARE_WND_SUPERCLASS** macro, **Register** registers a superclass—a window class that is based on an existing class but uses a different window procedure. The existing window class's window procedure is returned in *pProc*.

See Also: CWndClassInfo::m_atom, CWndClassInfo::m_wc, CWndClassInfo::pWndProc

Data Members

CWndClassInfo::m_atom

ATOM m_atom;

Remarks

Contains the unique identifier for the registered window class.

See Also: **CWndClassInfo::Register**

CWndClassInfo::m_bSystemCursor

BOOL m_bSystemCursor;

Remarks

If **TRUE**, the system cursor resource will be loaded when the window class is registered. Otherwise, the cursor resource contained in your module will be loaded.

CWndClassInfo uses **m_bSystemCursor** only when the **DECLARE_WND_CLASS** macro is specified (the default in **CWindowImpl**). In this case, **m_bSystemCursor** is initialized to **TRUE**. For more information, see the **CWndClassInfo** overview.

See Also: **CWndClassInfo::m_lpszCursorID**

CWndClassInfo::m_lpszCursorID

LPCTSTR m_lpszCursorID;

Remarks

Specifies either the name of the cursor resource or the resource identifier in the low-order word and zero in the high-order word. When the window class is registered, the handle to the cursor identified by **m_lpszCursorID** is retrieved and stored by **m_wc**.

CWndClassInfo uses **m_lpszCursorID** only when the **DECLARE_WND_CLASS** macro is specified (the default in **CWindowImpl**). In this case, **m_lpszCursorID** is initialized to **IDC_ARROW**. For more information, see the **CWndClassInfo** overview.

See Also: **CWndClassInfo::m_bSystemCursor**

CWndClassInfo::m_lpszOrigName

LPCTSTR m_lpszOrigName;

Remarks

Contains the name of an existing window class. **CWndClassInfo** uses **m_lpszOrigName** only when you include the **DECLARE_WND_SUPERCLASS** macro in your class definition. In this case, **CWndClassInfo** registers a window class based on the class named by **m_lpszOrigName**. For more information, see the **CWndClassInfo** overview.

See Also: **CWndClassInfo::m_wc, CWndClassInfo::pWndProc**

CWndClassInfo::m_szAutoName

TCHAR m_szAutoName[13];

Remarks

Holds the name of the window class. **CWndClassInfo** uses **m_szAutoName** only if **NULL** is passed for the *WndClassName* parameter to **DECLARE_WND_CLASS** or **DECLARE_WND_SUPERCLASS**. ATL will construct a name when the window class is registered.

CWndClassInfo::m_wc

WNDCLASSEX m_wc;

Remarks

Maintains the window class information in a **WNDCLASSEX** structure.

If you have specified the **DECLARE_WND_CLASS** macro (the default in **CWindowImpl**), **m_wc** contains information about a new window class.

If you have specified the **DECLARE_WND_SUPERCLASS** macro, **m_wc** contains information about a superclass—a window class that is based on an existing class but uses a different window procedure. **m_lpszOrigName** and **pWndProc** save the existing window class's name and window procedure, respectively.

CWndClassInfo::pWndProc

WNDPROC pWndProc;

Remarks

Points to the window procedure of an existing window class. **CWndClassInfo** uses **pWndProc** only when you include the **DECLARE_WND_SUPERCLASS** macro in your class definition. In this case, **CWndClassInfo** registers a window class that is based on an existing class but uses a different window procedure. The existing window class's window procedure is saved in **pWndProc**. For more information, see the **CWndClassInfo** overview.

See Also: **CWndClassInfo::m_wc**, **CWndClassInfo::m_lpszOrigName**

IConnectionPointContainerImpl

template< class *T* >
class IConnectionPointContainerImpl

Parameters

T Your class, derived from **IConnectionPointContainerImpl**.

IConnectionPointContainerImpl implements a connection point container to manage a collection of **IConnectionPointImpl** objects. **IConnectionPointContainerImpl** provides two methods that a client can call to retrieve more information about a connectable object:

- **EnumConnectionPoints** allows the client to determine which outgoing interfaces the object supports.
- **FindConnectionPoint** allows the client to determine whether the object supports a specific outgoing interface.

For information about using connection points in ATL, see the article "Connection Points."

#include <atlcom.h>

See Also: IConnectionPointContainer

IConnectionPointContainer Methods

EnumConnectionPoints	Creates an enumerator to iterate through the connection points supported in the connectable object.
FindConnectionPoint	Retrieves an interface pointer to the connection point that supports the specified IID.

Methods

IConnectionPointContainerImpl::EnumConnectionPoints

HRESULT EnumConnectionPoints(IEnumConnectionPoints *****ppEnum* **);

See **IConnectionPointContainer::EnumConnectionPoints** in the *Win32 SDK* online.

Remarks

Creates an enumerator to iterate through the connection points supported in the connectable object.

See Also: IConnectionPointImpl, IEnumConnectionPoints

IConnectionPointContainerImpl::FindConnectionPoint

HRESULT FindConnectionPoint(REFIID *riid*, **IConnectionPoint**** *ppCP* **);**

See **IConnectionPointContainer::FindConnectionPoint** in the *Win32 SDK* online.

Remarks

Retrieves an interface pointer to the connection point that supports the specified IID.

See Also: IConnectionPointImpl

IConnectionPointImpl

template< class *T*, const IID* *piid*, class *CDV* = CComDynamicUnkArray >
class IConnectionPointImpl : public _ICPLocator< *piid* >

Parameters

T Your class, derived from **IConnectionPointImpl**.

piid A pointer to the IID of the interface represented by the connection point object.

CDV A class that manages the connections. The default value is **CComDynamicUnkArray**, which allows unlimited connections. You can also use **CComUnkArray**, which specifies a fixed number of connections.

IConnectionPointImpl implements a connection point, which allows an object to expose an outgoing interface to the client. The client implements this interface on an object called a sink.

ATL uses **IConnectionPointContainerImpl** to implement the connectable object. Each connection point within the connectable object represents an outgoing interface, identified by *piid*. Class *CDV* manages the connections between the connection point and a sink. Each connection is uniquely identified by a "cookie."

For more information about using connection points in ATL, see the article "Connection Points."

#include <atlcom.h>

See Also: IConnectionPoint

IConnectionPoint Methods

Advise	Establishes a connection between the connection point and a sink.
EnumConnections	Creates an enumerator to iterate through the connections for the connection point.
GetConnectionInterface	Retrieves the IID of the interface represented by the connection point.
GetConnectionPointContainer	Retrieves an interface pointer to the connectable object.
Unadvise	Terminates a connection previously established through **Advise**.

Data Members

m_vec	Manages the connections for the connection point.

Methods

IConnectionPointImpl::Advise

HRESULT Advise(IUnknown* *pUnkSink*, **DWORD*** *pdwCookie* **);**

See **IConnectionPoint::Advise** in the *Win32 SDK* online.

Remarks

Establishes a connection between the connection point and a sink.

To terminated the connection call, **Unadvise**.

IConnectionPointImpl::EnumConnections

HRESULT EnumConnections(IEnumConnections** *ppEnum* **);**

See **IConnectionPoint::EnumConnections** in the *Win32 SDK* online.

Remarks

Creates an enumerator to iterate through the connections for the connection point.

See Also: IEnumConnections

IConnectionPointImpl::GetConnectionInterface

HRESULT GetConnectionInterface(IID* *piid2* **);**

See **IConnectionPoint::GetConnectionInterface** in the *Win32 SDK* online.

Remarks

Retrieves the IID of the interface represented by the connection point.

IConnectionPointImpl::GetConnectionPointContainer

HRESULT GetConnectionPointContainer(IConnectionPointContainer** *ppCPC* **);**

See **IConnectionPoint::GetConnectionPointContainer** in the *Win32 SDK* online.

Remarks

Retrieves an interface pointer to the connectable object.

See Also: IConnectionPointContainerImpl

IConnectionPointImpl::Unadvise

HRESULT Unadvise(DWORD *dwCookie* **);**

See **IConnectionPoint::Unadvise** in the *Win32 SDK* online.

Remarks

Terminates a connection previously established through **Advise**.

Data Members

IConnectionPointImpl::m_vec

CDV **m_vec;**

Remarks

Manages the connections between the connection point object and a sink. By default, **m_vec** is of type **CComDynamicUnkArray**.

IDataObjectImpl

template< class *T* >
class IDataObjectImpl

Parameters

T Your class, derived from **IDataObjectImpl**.

The **IDataObject** interface provides methods to support Uniform Data Transfer. **IDataObject** uses the standard format structures **FORMATETC** and **STGMEDIUM** to retrieve and store data.

IDataObject also manages connections to advise sinks to handle data change notifications. In order for the client to receive data change notifications from the data object, the client must implement the **IAdviseSink** interface on an object called an advise sink. When the client then calls **IDataObject::DAdvise**, a connection is established between the data object and the advise sink.

Class **IDataObjectImpl** provides a default implementation of **IDataObject** and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

Class Methods

FireDataChange	Sends a change notification back to each advise sink.

IDataObject Methods

DAdvise	Establishes a connection between the data object and an advise sink. This enables the advise sink to receive notifications of changes in the object.
DUnadvise	Terminates a connection previously established through **DAdvise**.
EnumDAdvise	Creates an enumerator to iterate through the current advisory connections.
EnumFormatEtc	Creates an enumerator to iterate through the **FORMATETC** structures supported by the data object. The ATL implementation returns **E_NOTIMPL**.
GetCanonicalFormatEtc	Retrieves a logically equivalent **FORMATETC** structure to one that is more complex. The ATL implementation returns **E_NOTIMPL**.
GetData	Transfers data from the data object to the client. The data is described in a **FORMATETC** structure and is transferred through a **STGMEDIUM** structure.

(continued)

IDataObject Methods ***(continued)***

GetDataHere	Similar to **GetData**, except the client must allocate the **STGMEDIUM** structure. The ATL implementation returns **E_NOTIMPL**.
QueryGetData	Determines whether the data object supports a particular **FORMATETC** structure for transferring data. The ATL implementation returns **E_NOTIMPL**.
SetData	Transfers data from the client to the data object. The ATL implementation returns **E_NOTIMPL**.

Methods

IDataObjectImpl::DAdvise

HRESULT DAdvise(FORMATETC* *pformatetc*, **DWORD** *advf*,
↪ **IAdviseSink*** *pAdvSink*, **DWORD*** *pdwConnection*);

See **IDataObject::DAdvise** in the *Win32 SDK* online.

Remarks

Establishes a connection between the data object and an advise sink. This enables the advise sink to receive notifications of changes in the object.

To terminate the connection, call **DUnadvise**.

See Also: FORMATETC, IAdviseSink

IDataObjectImpl::DUnadvise

HRESULT DUnadvise(FORMATETC* *pformatetc*, **DWORD** *advf*,
↪ **IAdviseSink*** *pAdvSink*, **DWORD*** *pdwConnection*);

See **IDataObject::DUnadvise** in the *Win32 SDK* online.

Remarks

Terminates a connection previously established through **DAdvise**.

See Also: FORMATETC, IAdviseSink

IDataObjectImpl::EnumDAdvise

HRESULT DAdvise(FORMATETC* *pformatetc*, **DWORD** *advf*,
↪ **IAdviseSink*** *pAdvSink*, **DWORD*** *pdwConnection*);

See **IDataObject::EnumDAdvise** in the *Win32 SDK* online.

Remarks

Creates an enumerator to iterate through the current advisory connections.

See Also: **FORMATETC**, **IAdviseSink**

IDataObjectImpl::EnumFormatEtc

HRESULT EnumFormatEtc(DWORD *dwDirection*,
↪ **IEnumFORMATETC**** *ppenumFormatEtc* **);**

See **IDataObject::EnumFormatEtc** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

See Also: **IEnumFORMATETC**

IDataObjectImpl::FireDataChange

HRESULT FireDataChange( );

Return Value

A standard **HRESULT** value.

Remarks

Sends a change notification back to each advise sink that is currently being managed.

IDataObjectImpl::GetCanonicalFormatEtc

HRESULT GetCanonicalFormatEtc(FORMATETC* *pformatetcIn*,
↪ **FORMATETC*** *pformatetcOut* **);**

See **IDataObject::GetCanonicalFormatEtc** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

See Also: **FORMATETC**

IDataObjectImpl::GetData

HRESULT GetData(FORMATETC* *pformatetcIn*, **STGMEDIUM*** *pmedium* **);**

See **IDataObject::GetData** in the *Win32 SDK* online.

Remarks

Transfers data from the data object to the client. The *pformatetcIn* parameter must specify a storage medium type of **TYMED_MFPICT**.

See Also: IDataObjectImpl::GetDataHere, IDataObjectImpl::QueryGetData, IDataObjectImpl::SetData, FORMATETC, STGMEDIUM, TYMED

IDataObjectImpl::GetDataHere

HRESULT GetDataHere(FORMATETC* *pformatetc*, **STGMEDIUM*** *pmedium* **);**

See **IDataObject::GetDataHere** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

See Also: IDataObjectImpl::GetData, IDataObjectImpl::QueryGetData, IDataObjectImpl::SetData, FORMATETC, STGMEDIUM

IDataObjectImpl::QueryGetData

HRESULT QueryGetData(FORMATETC* *pformatetc* **);**

See **IDataObject::QueryGetData** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

See Also: IDataObjectImpl::GetData, IDataObjectImpl::GetDataHere, IDataObjectImpl::SetData, FORMATETC

IDataObjectImpl::SetData

HRESULT SetData(FORMATETC* *pformatetc*, **STGMEDIUM*** *pmedium*,
↪ **BOOL** *fRelease* **);**

See **IDataObject::SetData** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

See Also: IDataObjectImpl::GetData, IDataObjectImpl::GetDataHere, IDataObjectImpl::QueryGetData, FORMATETC, STGMEDIUM

IDispatchImpl

template< class *T*, **const IID*** *piid*, **const GUID*** *plibid*, **WORD** *wMajor* **= 1,**
↪ **WORD** *wMinor* **= 0, class** *tihclass* **= CComTypeInfoHolder >**
class IDispatchImpl : public *T*

Parameters

T A dual interface.

piid A pointer to the IID of *T*.

plibid A pointer to the identifier of *T*'s type library section.

wMajor The major version of the type library. The default value is 1.

wMinor The minor version of the type library. The default value is 0.

tihclass The class used to manage the type information for *T*. The default value is **CComTypeInfoHolder**.

IDispatchImpl provides a default implementation for the **IDispatch** portion of any dual interface on your object. A dual interface derives from **IDispatch** and uses only Automation-compatible types. Like a dispinterface, a dual interface supports early and late binding; however, a dual interface differs in that it also supports vtable binding.

The following example shows a typical implementation of **IDispatchImpl**:

```
class CBeeper :
      public IDispatchImpl< IBeeper, &IID_IBeeper,
         &LIBID_BeeperLib >,
      public CComObjectRoot,
      public CComCoClass< CBeeper, &CLSID_Beeper >
{
   ...
};
```

IDispatchImpl contains a static member of type **CComTypeInfoHolder** that manages the type information for the dual interface. If you have multiple objects implementing the same dual interface, only a single instance of **CComTypeInfoHolder** will be used.

#include <atlcom.h>

See Also: ITypeInfo

Class Methods

IDispatchImpl	Constructor.

IDispatch Methods	
GetIDsOfNames	Maps a set of names to a corresponding set of dispatch identifiers.
GetTypeInfo	Retrieves the type information for the dual interface.
GetTypeInfoCount	Determines whether there is type information available for the dual interface.
Invoke	Provides access to the methods and properties exposed by the dual interface.

Data Members	
_tih	Manages the type information for the dual interface.

Methods

IDispatchImpl::GetIDsOfNames

HRESULT GetIDsOfNames(REFIID *riid*, **LPOLESTR*** *rgszNames*,
↪ **UINT** *cNames*, **LCID** *lcid*, **DISPID*** *rgdispid* **);**

See **IDispatch::GetIDsOfNames** in the *Win32 SDK* online.

Remarks

Maps a set of names to a corresponding set of dispatch identifiers.

IDispatchImpl::GetTypeInfo

HRESULT GetTypeInfo(UINT *itinfo*, **LCID** *lcid*, **ITypeInfo**** *pptinfo* **);**

See **IDispatch::GetTypeInfo** in the *Win32 SDK* online.

Remarks

Retrieves the type information for the dual interface.

See Also: IDispatchImpl::GetTypeInfoCount

IDispatchImpl::GetTypeInfoCount

HRESULT GetTypeInfoCount(UINT* *pctinfo* **);**

See **IDispatch::GetTypeInfoCount** in the *Win32 SDK* online.

Remarks

Determines whether there is type information available for the dual interface.

See Also: IDispatchImpl::GetTypeInfo

IDispatchImpl::IDispatchImpl

IDispatchImpl( );

Remarks

The constructor. Calls **AddRef** on the **_tih** member. The destructor calls **Release**.

IDispatchImpl::Invoke

HRESULT Invoke(DISPID *dispidMember*, **REFIID** *riid*, **LCID** *lcid*,
↪ **WORD** *wFlags*, **DISPPARMS*** *pdispparams*, **VARIANT*** *pvarResult*,
↪ **EXCEPINFO*** *pexcepinfo*, **UINT*** *puArgErr* **);**

See **IDispatch::Invoke** in the *Win32 SDK* online.

Remarks

Provides access to the methods and properties exposed by the dual interface.

Data Members

IDispatchImpl::_tih

static *tihclass* **_tih;**

Remarks

This static data member is an instance of the class template parameter, *tihclass*, which by default is **CComTypeInfoHolder**. **_tih** manages the type information for the dual interface.

IObjectSafetyImpl

template< class *T* **>**
class IObjectSafetyImpl

Parameters

T Your class, derived from **IObjectSafetyImpl**.

The **IObjectSafety** interface allows a client to retrieve and set an object's safety levels. For example, a web browser may call **IObjectSafety::SetInterfaceSafetyOptions** to make a control safe for initialization or safe for scripting.

Class **IObjectSafetyImpl** provides a default implementation of **IObjectSafety** and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: **IObjectSafety** in the *ActiveX SDK* online

IObjectSafety Methods

GetInterfaceSafetyOptions	Retrieves the safety options supported by the object, as well as the safety options currently set for the object.
SetInterfaceSafetyOptions	Makes the object safe for initialization or scripting.

Data Members

m_dwSafety	Stores the object's current safety level.

IObjectSafetyImpl::GetInterfaceSafetyOptions

HRESULT GetInterfaceSafetyOptions(REFIID *riid*,
↳ **DWORD*** *pdwSupportedOptions*, **DWORD*** *pdwEnabledOptions* **);**

See **IObjectSafety::GetInterfaceSafetyOptions** in the *ActiveX SDK* online.

Remarks

Retrieves the safety options supported by the object, as well as the safety options currently set for the object. If the *riid* parameter is not **IID_IDispatch**, this method returns **E_NOINTERFACE**.

See Also: **IObjectSafetyImpl::SetInterfaceSafetyOptions**

IObjectSafetyImpl::SetInterfaceSafetyOptions

HRESULT SetInterfaceSafetyOptions(REFIID *riid*,
↪ **DWORD** *dwOptionsSetMask*, **DWORD** *dwEnabledOptions*);

See **IObjectSafety::SetInterfaceSafetyOptions** in the *ActiveX SDK* online.

Remarks

Makes the object safe for initialization or scripting. If the *riid* parameter is not **IID_IDispatch**, this method returns **E_NOINTERFACE**.

See Also: IObjectSafetyImpl::GetInterfaceSafetyOptions

Data Members

IObjectSafetyImpl::m_dwSafety

DWORD m_dwSafety;

Remarks

Stores the object's current safety level.

IObjectWithSiteImpl

template< class *T* >
class IObjectWithSiteImpl

Parameters

T Your class, derived from **IObjectWithSiteImpl**.

The **IObjectWithSite** interface allows an object to communicate with its site. Class **IObjectWithSiteImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

IObjectWithSiteImpl specifies two methods. The client first calls **SetSite**, passing the site's **IUnknown** pointer. This pointer is stored within the object, and can later be retrieved through a call to **GetSite**.

Typically, you derive your class from **IObjectWithSiteImpl** when you are creating an object that is not a control. For controls, derive your class from **IOleObjectImpl**, which also provides a site pointer. Do not derive your class from both **IObjectWithSiteImpl** and **IOleObjectImpl**.

#include <atlcom.h>

IObjectWithSite Methods	
GetSite	Queries the site for an interface pointer.
SetSite	Provides the object with the site's **IUnknown** pointer.

Data Members	
m_spUnkSite	Manages the site's **IUnknown** pointer.

Methods

IObjectWithSiteImpl::GetSite

HRESULT GetSite(REFIID *riid*, void ***ppvSite*);

See **IObjectWithSite::GetSite** in the *Win32 SDK* online.

Remarks

Queries the site for a pointer to the interface identified by *riid*. If the site supports this interface, the pointer is returned via *ppvSite*. Otherwise, *ppvSite* is set to **NULL**.

See Also: IObjectWithSiteImpl::SetSite

IObjectWithSiteImpl::SetSite

HRESULT SetSite(IUnknown* *pUnkSite* **);**

See **IObjectWithSite::SetSite** in the *Win32 SDK* online.

Remarks

Provides the object with the site's **IUnknown** pointer.

See Also: IObjectWithSiteImpl::GetSite

Data Members

IObjectWithSiteImpl::m_spUnkSite

CComPtr< IUnknown > m_spUnkSite;

Remarks

Manages the site's **IUnknown** pointer. **m_spUnkSite** initially receives this pointer through a call to **SetSite**.

See Also: CComPtr

IOleControlImpl

template< class *T* >
class IOleControlImpl

Parameters

T Your class, derived from **IOleControlImpl**.

Class **IOleControlImpl** provides a default implementation of the **IOleControl** interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: **IOleObjectImpl**, "ActiveX Controls Interfaces" in the *Win32 SDK* online

IOleControl Methods

FreezeEvents	Indicates whether or not the container ignores or accepts events from the control.
GetControlInfo	Fills in information about the control's keyboard behavior. The ATL implementation returns **E_NOTIMPL**.
OnAmbientPropertyChange	Informs a control that one or more of the container's ambient properties has changed. The ATL implementation returns **S_OK**.
OnMnemonic	Informs the control that a user has pressed a specified keystroke. The ATL implementation returns **E_NOTIMPL**.

Methods

IOleControlImpl::FreezeEvents

HRESULT FreezeEvents(BOOL *bFreeze* **);**

See **IOleControl::FreezeEvents** in the *Win32 SDK* online.

Remarks

In ATL's implementation, **FreezeEvents** increments the control class's **m_nFreezeEvents** data member if *bFreeze* is **TRUE**, and decrements **m_nFreezeEvents** if *bFreeze* is **FALSE**. **FreezeEvents** then returns **S_OK**.

See Also: **CComControl::m_nFreezeEvents**

IOleControlImpl::GetControlInfo

HRESULT GetControlInfo(LPCONTROLINFO *pCI* **);**

See **IOleControl:GetControlInfo** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleControlImpl::OnAmbientPropertyChange

HRESULT OnAmbientPropertyChange(DISPID *dispid* **);**

See **IOleControl::OnAmbientPropertyChange** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IOleControlImpl::OnMnemonic

HRESULT OnMnemonic(LPMSG *pMsg* **);**

See **IOleControl::OnMnemonic** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleInPlaceActiveObjectImpl

template< class *T* >
class IOleInPlaceActiveObjectImpl

Parameters

T Your class, derived from **IOleInPlaceActiveObjectImpl**.

The **IOleInPlaceActiveObject** interface assists communication between an in-place control and its container; for example, communicating the active state of the control and container, and informing the control it needs to resize itself. Class **IOleInPlaceActiveObjectImpl** provides a default implementation of **IOleInPlaceActiveObject** and supports **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: **CComControl**, "ActiveX Controls Interfaces" in the *Win32 SDK* online

IOleWindow Methods

ContextSensitiveHelp	Enables context-sensitive help. The ATL implementation returns **E_NOTIMPL**.
GetWindow	Gets a window handle.

IOleInPlaceActiveObject Methods

EnableModeless	Enables modeless dialog boxes. The ATL implementation returns **S_OK**.
OnDocWindowActivate	Notifies the control when the container's document window is activated or deactivated. The ATL implementation returns **S_OK**.
OnFrameWindowActivate	Notifies the control when the container's top-level frame window is activated or deactivated.
ResizeBorder	Informs the control it needs to resize its borders. The ATL implementation returns **S_OK**.
TranslateAccelerator	Processes menu accelerator-key messages from the container. The ATL implementation returns **E_NOTIMPL**.

Methods

IOleInPlaceActiveObjectImpl::ContextSensitiveHelp

HRESULT ContextSensitiveHelp(BOOL *fEnterMode* **);**

See **IOleWindow::ContextSensitiveHelp** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL.**

IOleInPlaceActiveObjectImpl::EnableModeless

HRESULT EnableModeless(BOOL *fEnable* **);**

See **IOleInPlaceActiveObject::EnableModeless** in the *Win32 SDK* online.

Remarks

Returns **S_OK.**

IOleInPlaceActiveObjectImpl::GetWindow

HRESULT GetWindow(HWND* *phwnd* **);**

See **IOleWindow::GetWindow** in the *Win32 SDK* online.

Remarks

The container calls this function to get the window handle of the control. Some containers will not work with a control that has been windowless, even if it is currently windowed. In ATL's implementation, if the **CComControl::m_bWasOnceWindowless** data member is **TRUE**, the function returns **E_FAIL**. Otherwise, if **phwnd* is not **NULL**, **GetWindow** assigns *phwnd* to the control class's data member **m_hWnd** and returns **S_OK.**

See Also: CComControl::m_bWasOnceWindowless

IOleInPlaceActiveObjectImpl::OnDocWindowActivate

HRESULT OnDocWindowActivate(BOOL *fActivate* **);**

See **IOleInPlaceActiveObject::OnDocWindowActivate** in the *Win32 SDK* online.

Remarks

Returns **S_OK.**

IOleInPlaceActiveObjectImpl::OnFrameWindowActivate

HRESULT OnFrameWindowActivate(BOOL *fActivate* **);**

See **IOleInPlaceActiveObject::OnFrameWindowActivate** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IOleInPlaceActiveObjectImpl::ResizeBorder

HRESULT ResizeBorder(LPRECT *prcBorder*,
↪ **IOleInPlaceUIWindow*** *pUIWindow*, **BOOL** *fFrameWindow* **);**

See **IOleInPlaceActiveObject::ResizeBorder** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IOleInPlaceActiveObjectImpl::TranslateAccelerator

HRESULT TranslateAccelerator(LPMSG *lpmsg* **);**

See **IOleInPlaceActiveObject::TranslateAccelerator** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleInPlaceObjectWindowlessImpl

template< class *T* >
class IOleInPlaceObjectWindowlessImpl

Parameters

T Your class, derived from **IOleInPlaceObjectWindowlessImpl**.

The **IOleInPlaceObject** interface manages the reactivation and deactivation of in-place controls and determines how much of the control should be visible. The **IOleInPlaceObjectWindowless** interface enables a windowless control to receive window messages and to participate in drag-and-drop operations. Class **IOleInPlaceObjectWindowlessImpl** provides a default implementation of **IOleInPlaceObject** and **IOleInPlaceObjectWindowless** and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: CComControl

IOleWindow Methods

ContextSensitiveHelp	Enables context-sensitive help. The ATL implementation returns **E_NOTIMPL**.
GetWindow	Gets a window handle.

IOleInPlaceObject Methods

InPlaceDeactivate	Deactivates an active in-place control.
ReactivateAndUndo	Reactivates a previously deactivated control. The ATL implementation returns **E_NOTIMPL**.
SetObjectRects	Indicates what part of the in-place control is visible.
UIDeactivate	Deactivates and removes the user interface that supports in-place activation.

IOleInPlaceObjectWindowless Methods

GetDropTarget	Supplies the **IDropTarget** interface for an in-place active, windowless object that supports drag and drop. The ATL implementation returns **E_NOTIMPL**.
OnWindowMessage	Dispatches a message from the container to a windowless control that is in-place active.

Methods

IOleInPlaceObjectWindowlessImpl::ContextSensitiveHelp

HRESULT ContextSensitiveHelp(BOOL *fEnterMode* **);**

See **IOleWindow::ContextSensitiveHelp** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleInPlaceObjectWindowlessImpl::GetDropTarget

HRESULT GetDropTarget(IDropTarget** *ppDropTarget* **);**

See **IOleInPlaceObjectWindowless::GetDropTarget** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleInPlaceObjectWindowlessImpl::GetWindow

HRESULT GetWindow(HWND* *phwnd* **);**

See **IOleWindow::GetWindow** in the *Win32 SDK* online.

Remarks

The container calls this function to get the window handle of the control. Some containers will not work with a control that has been windowless, even if it is currently windowed. In ATL's implementation, if the control class's data member **m_bWasOnceWindowless** is **TRUE**, the function returns **E_FAIL**. Otherwise, if *phwnd* is not **NULL**, **GetWindow** sets **phwnd* to the control class's data member **m_hWnd** and returns **S_OK**.

See Also: CComControl::m_bWasOnceWindowless

IOleInPlaceObjectWindowlessImpl::InPlaceDeactivate

HRESULT InPlaceDeactivate(HWND* *phwnd* **);**

See **IOleInPlaceObject::InPlaceDeactivate** in the *Win32 SDK* online.

Remarks

Called by the container to deactivate an in-place active control. This method performs a full or partial deactivation depending on the state of the control. If

necessary, the control's user interface is deactivated, and the control's window, if any, is destroyed. The container is notified that the control is no longer active in place. The **IOleInPlaceUIWindow** interface used by the container to negotiate menus and border space is released.

See Also: CComControl::InPlaceActivate

IOleInPlaceObjectWindowlessImpl::OnWindowMessage

HRESULT OnWindowMessage(UINT *msg*, **WPARAM** *WParam*,
↪ **LPARAM** *LParam*, **LRESULT** *plResultParam* **);**

See **IOleInPlaceObjectWindowless::OnWindowMessage** in the *Win32 SDK* online.

Remarks

Dispatches a message from a container to a windowless control that is in-place active.

IOleInPlaceObjectWindowlessImpl::ReactivateAndUndo

HRESULT ReactivateAndUndo( );

See **IOleInPlaceObject::ReactivateAndUndo** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleInPlaceObjectWindowlessImpl::SetObjectRects

HRESULT SetObjectRects(LPCRECT *prcPos*, **LPCRECT** *prcClip* **);**

See **IOleInPlaceObject::SetObjectRects** in the *Win32 SDK* online.

Remarks

Called by the container to inform the control that its size and/or position has changed. Updates the control's **m_rcPos** data member and the control display. Only the part of the control that intersects the clip region is displayed. If a control's display was previously clipped but the clipping has been removed, this function can be called to redraw a full view of the control.

See Also: CComControl::m_rcPos

IOleInPlaceObjectWindowlessImpl::UIDeactivate

HRESULT UIDeactivate( );

See **IOleInPlaceObject::UIDeactivate** in the *Win32 SDK* online.

Remarks

Deactivates and removes the control's user interface that supports in-place activation. Sets the control class's data member **m_bUIActive** to **FALSE**. The ATL implementation of this function always returns **S_OK**.

See Also: CComControl::m_bUIActive

IOleObjectImpl

template< class *T* >
class IOleObjectImpl

Parameters

T Your class, derived from **IOleObjectImpl**.

The **IOleObject** interface is the principle interface through which a container communicates with a control. Class **IOleObjectImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: **CComControl**, "ActiveX Controls Interfaces" in the *Win32 SDK* online

IOleObject Methods

Advise	Establishes an advisory connection with the control.
Close	Changes the control state from running to loaded.
DoVerb	Tells the control to perform one of its enumerated actions.
EnumAdvise	Enumerates the control's advisory connections.
EnumVerbs	Enumerates actions for the control.
GetClientSite	Retrieves the control's client site.
GetClipboardData	Retrieves data from the Clipboard. The ATL implementation returns **E_NOTIMPL**.
GetExtent	Retrieves the extent of the control's display area.
GetMiscStatus	Retrieves the status of the control.
GetMoniker	Retrieves the control's moniker. The ATL implementation returns **E_NOTIMPL**.
GetUserClassID	Retrieves the control's class identifier.
GetUserType	Retrieves the control's user-type name.
InitFromData	Initializes the control from selected data. The ATL implementation returns **E_NOTIMPL**.
IsUpToDate	Checks if the control is up to date. The ATL implementation returns **S_OK**.
SetClientSite	Tells the control about its client site in the container.
SetColorScheme	Recommends a color scheme to the control's application, if any. The ATL implementation returns **E_NOTIMPL**.
SetExtent	Sets the extent of the control's display area.
SetHostNames	Tells the control the names of the container application and container document.

(continued)

IOleObject Methods *(continued)*	
SetMoniker	Tells the control what its moniker is. The ATL implementation returns **E_NOTIMPL**.
Unadvise	Destroys an advisory connection with the control.
Update	Updates the control. The ATL implementation returns **S_OK**.

DoVerb Helper Methods	
DoVerbDiscardUndo	Tells the control to discard any undo state it is maintaining.
DoVerbHide	Tells the control to remove its user interface from view.
DoVerbInPlaceActivate	Runs the control and installs its window, but does not install the control's user interface.
DoVerbOpen	Causes the control to be open-edited in a separate window.
DoVerbPrimary	Performs the specified action when the user double-clicks the control. The control defines the action, usually to activate the control in-place.
DoVerbShow	Shows a newly inserted control to the user.
DoVerbUIActivate	Activates the control in-place and shows the control's user interface, such as menus and toolbars.

Methods

IOleObjectImpl::Advise

HRESULT Advise(IAdviseSink* *pAdvSink*, **DWORD*** *pdwConnection* **);**

See **IOleObject::Advise** in the *Win32 SDK* online.

Remarks

If successful, the **IAdviseSink** pointer is stored in the control class's **m_spOleAdviseHolder** data member.

See Also: CComControl::m_spOleAdviseHolder, IOleObjectImpl::Unadvise

IOleObjectImpl::Close

HRESULT Close(DWORD *dwSaveOption* **);**

See **IOleObject::Close** in the *Win32 SDK* online.

Remarks

Changes the control from the running to the loaded state. Deactivates the control and destroys the control window if it exists. If the control class data member **m_bRequiresSave** is **TRUE** and the *dwSaveOption* parameter is either

OLECLOSE_SAVEIFDIRTY or **OLECLOSE_PROMPTSAVE**, the control properties are saved before closing.

The pointers held in the control class data members **m_spInPlaceSite** and **m_spAdviseSink** are released, and the data members **m_bNegotiatedWnd**, **m_bWndless**, and **m_bInPlaceSiteEx** are set to **FALSE**.

IOleObjectImpl::DoVerb

HRESULT DoVerb(LONG *iVerb*, **LPMSG** *lpmsg*, **IOleClientSite*** *pActiveSite*, ↪ **LONG** *lindex*, **HWND** *hwndParent*, **LPCRECT** *lprcPosRect* **);**

See **IOleObject::DoVerb** in the *Win32 SDK* online.

Remarks

The ATL implementation of this function uses only the first parameter, *iVerb*. Depending on the value of *iVerb*, one of the ATL **DoVerb** helper functions is called as follows:

iVerb Value	DoVerb helper function called
OLEIVERB_DISCARDUNDOSTATE	DoVerbDiscardUndo
OLEIVERB_HIDE	DoVerbHide
OLEIVERB_INPLACEACTIVATE	DoVerbInPlaceActivate
OLEIVERB_OPEN	DoVerbOpen
OLEIVERB_PRIMARY	DoVerbPrimary
OLEIVERB_PROPERTIES	CComControl::DoVerbProperties
OLEIVERB_SHOW	DoVerbShow
OLEIVERB_UIACTIVATE	DoVerbUIActivate

See Also: IOleObject::EnumVerbs

IOleObjectImpl::DoVerbDiscardUndo

HRESULT DoVerbDiscardUndo(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

Returns **S_OK**.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control.

Remarks

The default implementation simply returns **S_OK**.

IOleObjectImpl::DoVerbHide

HRESULT DoVerbHide(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

Returns **S_OK**.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control. Not used in the ATL implementation.

Remarks

Deactivates and removes the control's user interface, and hides the control.

See Also: IOleObjectImpl::DoVerbShow

IOleObjectImpl::DoVerbInPlaceActivate

HRESULT DoVerbInPlaceActivate(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control. Not used in the ATL implementation.

Remarks

Activates the control in place by calling **CComControl::InPlaceActivate**. Unless the control class's data member **m_bWindowOnly** is **TRUE**, **DoVerbInPlaceActivate** first attempts to activate the control as a windowless control (possible only if the container supports **IOleInPlaceSiteWindowless**). If that fails, the function attempts to activate the control with extended features (possible only if the container supports **IOleInPlaceSiteEx**). If that fails, the function attempts to activate the control with no extended features (possible only if the container supports **IOleInPlaceSite**). If activation succeeds, the function notifies the container the control has been activated.

See Also: CComControl::InPlaceActivate, CComControl::m_bWindowOnly

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IOleObjectImpl::DoVerbOpen

HRESULT DoVerbOpen(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

Returns **S_OK**.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control.

Remarks

The default implementation simply returns **S_OK**.

IOleObjectImpl::DoVerbPrimary

HRESULT DoVerbPrimary(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control.

Remarks

Defines the action taken when the user double-clicks the control. By default, set to display the property pages. You can override this in your control class to invoke a different behavior on double-click; for example, play a video or go in-place active.

See Also: CComControl::DoVerbProperties

IOleObjectImpl::DoVerbShow

HRESULT DoVerbShow(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control. Not used in the ATL implementation.

Remarks

Tells the container to make the control visible.

See Also: IOleObjectImpl::DoVerbHide

IOleObjectImpl::DoVerbUIActivate

HRESULT DoVerbUIActivate(LPCRECT *prcPosRect*, **HWND** *hwndParent* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

prcPosRec [in] Pointer to the rectangle the container wants the control to draw into.

hwndParent [in] Handle of the window containing the control. Not used in the ATL implementation.

Remarks

Activates the control's user interface and notifies the container that its menus are being replaced by composite menus.

See Also: CComControl::InPlaceActivate, IOleObjectImpl::DoVerbInPlaceActivate

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IOleObjectImpl::EnumAdvise

HRESULT EnumAdvise(IEnumSTATDATA** *ppenumAdvise* **);**

See **IOleObject::EnumAdvise** in the *Win32 SDK* online.

Remarks

Supplies an enumeration of registered advisory connections for this control.

See Also: IOleObjectImpl::EnumVerbs

IOleObjectImpl::EnumVerbs

HRESULT EnumVerbs(IEnumOLEVERB** *ppEnumOleVerb* **);**

See **IOleObject::EnumVerbs** in the *Win32 SDK* online.

Remarks

Supplies an enumeration of registered actions (verbs) for this control by calling **OleRegEnumVerbs**. You can add verbs to your project's .rgs file. For example, see CIRCCTL.RGS in the CIRC sample.

See Also: OleRegEnumVerbs, IOleObjectImpl::EnumAdvise

IOleObjectImpl::GetClientSite

HRESULT GetClientSite(IOleClientSite *ppClientSite*);**

See **IOleObject::GetClientSite** in the *Win32 SDK* online.

Remarks

Puts the pointer in the control class data member **m_spClientSite** into *ppClientSite* and increments the reference count on the pointer.

See Also: IOleObjectImpl::SetClientSite

IOleObjectImpl::GetClipboardData

HRESULT GetClipboardData(DWORD *dwReserved*, IDataObject *ppDataObject*);**

See **IOleObject::GetClipboardData** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleObjectImpl::GetExtent

HRESULT GetExtent(DWORD *dwDrawAspect*, SIZEL* *psizel*);

See **IOleObject::GetExtent** in the *Win32 SDK* online.

Remarks

Retrieves a running control's display size in HIMETRIC units (0.01 millimeter per unit). The size is stored in the control class data member **m_sizeExtent**.

See Also: IOleObjectImpl::SetExtent

IOleObjectImpl::GetMiscStatus

HRESULT GetMiscStatus(DWORD *dwAspect*, DWORD* *pdwStatus*);

See **IOleObject::GetMiscStatus** in the *Win32 SDK* online.

Remarks

Returns a pointer to registered status information for the control by calling **OleRegGetMiscStatus**. The status information includes behaviors supported by the control and presentation data. You can add status information to your project's .rgs file.

See Also: OleRegGetMiscStatus, IOleObjectImpl::EnumVerbs, IOleObjectImpl::GetUserType

IOleObjectImpl::GetMoniker

HRESULT GetMoniker(DWORD *dwAssign*, **DWORD** *dwWhichMoniker*,
➥ **IMoniker**** *ppmk*);

See **IOleObject::GetMoniker** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleObjectImpl::GetUserClassID

HRESULT GetUserClassID(CLSID* *pClsid*);

See **IOleObject::GetUserClassID** in the *Win32 SDK* online.

Remarks

Returns the control's class identifier.

See Also: IOleObjectImpl::GetUserType

IOleObjectImpl::GetUserType

HRESULT GetUserType(DWORD *dwFormOfType*, **LPOLESTR*** *pszUserType*);

See **IOleObject::GetUserType** in the *Win32 SDK* online.

Remarks

Returns the control's user-type name by calling **OleRegGetUserType**. The user-type name is used for display in user-interfaces elements such as menus and dialog boxes. You can change the user-type name in your project's .rgs file.

See Also: OleRegGetUserType, IOleObjectImpl::GetUserClassID, IOleObjectImpl::GetMiscStatus, IOleObjectImpl::EnumVerbs

IOleObjectImpl::InitFromData

HRESULT InitFromData(IDataObject* *pDataObject*, **BOOL** *fCreation*,
➥ **DWORD** *dwReserved*);

See **IOleObject::InitFromData** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleObjectImpl::IsUpToDate

HRESULT IsUpToDate( );

See **IOleObject::IsUpToDate** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IOleObjectImpl::SetClientSite

HRESULT SetClientSite(IOleClientSite* *pClientSite* **);**

See **IOleObject::SetClientSite** in the *Win32 SDK* online.

Remarks

Uses *pClientSite* as the pointer to the control's client site and stores *pClientSite* in the control class data member **m_spClientSite**. The method then returns **S_OK**.

See Also: IOleObjectImpl::GetClientSite

IOleObjectImpl::SetColorScheme

HRESULT SetColorScheme(LOGPALETTE* *pLogPal* **);**

See **IOleObject::SetColorScheme** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleObjectImpl::SetExtent

HRESULT SetExtent(DWORD *dwDrawAspect*, **SIZEL*** *psizel* **);**

See **IOleObject::SetExtent** in the *Win32 SDK* online.

Remarks

If the control class data member **m_bAutoSize** is **TRUE**, this method returns **E_FAIL** because the control cannot be resized. Otherwise, **SetExtent** stores the value pointed to by *psizel* in the control class data member **m_sizeExtent**. This value is in HIMETRIC units (0.01 millimeter per unit).

If the control class data member **m_bResizeNatural** is **TRUE**, **SetExtent** also stores the value pointed to by *psizel* in the control class data member **m_sizeNatural**.

If the control class data member **m_bRecomposeOnResize** is **TRUE**, **SetExtent** calls **SendOnDataChange** and **SendOnViewChange** to notify all advisory sinks registered with the advise holder that the control size has changed.

See Also: **IOleObjectImpl::GetExtent**, **CComControl::SendOnDataChange**, **CComControl::SendOnViewChange**

IOleObjectImpl::SetHostNames

HRESULT SetHostNames(LPCOLESTR *szContainerApp*,
↪ **LPCOLESTR** *szContainerObj* **);**

See **IOleObject::SetHostNames** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IOleObjectImpl::SetMoniker

HRESULT SetMoniker(DWORD *dwAssign*, **DWORD** *dwWhichMoniker*,
↪ **IMoniker**** *ppmk* **);**

See **IOleObject::SetMoniker** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IOleObjectImpl::Unadvise

HRESULT Unadvise(DWORD *dwConnection* **);**

See **IOleObject::Unadvise** in the *Win32 SDK* online.

Remarks

Deletes the advisory connection stored in the control class's **m_spOleAdviseHolder** data member.

See Also: **CComControl::m_spOleAdviseHolder**, **IOleObjectImpl::Advise**

IOleObjectImpl::Update

HRESULT Update( );

See **IOleObject::Update** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IPerPropertyBrowsingImpl

template< class *T* >
class IPerPropertyBrowsingImpl

Parameters

T Your class, derived from **IPerPropertyBrowsingImpl**.

The **IPerPropertyBrowsing** interface allows a client to access the information in an object's property pages. Class **IPerPropertyBrowsingImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Note If you are using Microsoft Access as the container application, you must derive your class from **IPerPropertyBrowsingImpl**. Otherwise, Access will not load your control.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: IPropertyPageImpl, ISpecifyPropertyPagesImpl

IPerPropertyBrowsing Methods

GetDisplayString	Retrieves a string describing a given property.
GetPredefinedStrings	Retrieves an array of strings corresponding to the values that a given property can accept.
GetPredefinedValue	Retrieves a **VARIANT** containing the value of a property identified by a given DISPID. The DISPID is associated with the string name retrieved from **GetPredefinedStrings**. The ATL implementation returns **E_NOTIMPL**.
MapPropertyToPage	Retrieves the CLSID of the property page associated with a given property.

Methods

IPerPropertyBrowsingImpl::GetDisplayString

HRESULT GetDisplayString(DISPID *dispID*, BSTR* *pBstr*);

See **IPerPropertyBrowsing::GetDisplayString** in the *Win32 SDK* online.

Remarks

Retrieves a string describing a given property.

IPerPropertyBrowsingImpl::GetPredefinedStrings

HRESULT GetPredefinedStrings(DISPID *dispID*,
➥ **CALPOLESTR*** *pCaStringsOut*, **CADWORD*** *pCaCookiesOut*);

See **IPerPropertyBrowsing::GetPredefinedStrings** in the *Win32 SDK* online.

Remarks

Fills each array with zero items. ATL's implementation of **GetPredefinedValue** returns **E_NOTIMPL**.

See Also: **CADWORD, CALPOLESTR**

IPerPropertyBrowsingImpl::GetPredefinedValue

HRESULT GetPredefinedValue(DISPID *dispID*, **DWORD** *dwCookie*,
➥ **VARIANT*** *pVarOut*);

See **IPerPropertyBrowsing::GetPredefinedValue** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**. ATL's implementation of **GetPredefinedStrings** retrieves no corresponding strings.

IPerPropertyBrowsingImpl::MapPropertyToPage

HRESULT MapPropertyToPage(DISPID *dispID*, **CLSID*** *pClsid*);

See **IPerPropertyBrowsing::MapPropertyToPage** in the *Win32 SDK* online.

Remarks

Retrieves the CLSID of the property page associated with the specified property. ATL uses the object's property map to obtain this information.

See Also: **BEGIN_PROPERTY_MAP**

IPersistPropertyBagImpl

template< class *T* >
class IPersistPropertyBagImpl

Parameters

T Your class, derived from **IPersistPropertyBagImpl**.

The **IPersistPropertyBag** interface allows an object to save its properties to a client-supplied property bag. Class **IPersistPropertyBagImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

IPersistPropertyBag works in conjunction with **IPropertyBag** and **IErrorLog**. These latter two interfaces must be implemented by the client. Through **IPropertyBag**, the client saves and loads the object's individual properties. Through **IErrorLog**, both the object and the client can report any errors encountered.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: BEGIN_PROPERTY_MAP

IPersist Methods

GetClassID	Retrieves the object's CLSID.

IPersistPropertyBag Methods

InitNew	Initializes a newly created object. The ATL implementation returns **S_OK**.
Load	Loads the object's properties from a client-supplied property bag.
Save	Saves the object's properties into a client-supplied property bag.

Methods

IPersistPropertyBagImpl::GetClassID

HRESULT GetClassID(CLSID **pClassID*);

See **IPersist::GetClassID** in the *Win32 SDK* online.

Remarks

Retrieves the object's CLSID.

IPersistPropertyBagImpl::InitNew

HRESULT InitNew( );

See **IPersistPropertyBag::InitNew** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

IPersistPropertyBagImpl::Load

HRESULT Load(LPPROPERTYBAG *pPropBag*, **LPERRORLOG** *pErrorLog* **);**

See **IPersistPropertyBag::Load** in the *Win32 SDK* online.

Remarks

Loads the object's properties from a client-supplied property bag. ATL uses the object's property map to retrieve this information.

See Also: BEGIN_PROPERTY_MAP, IPersistPropertyBagImpl::Save, IPropertyBag, IErrorLog

---

IPersistPropertyBagImpl::Save

HRESULT Save(LPPROPERTYBAG *pPropBag*, **BOOL** *fClearDirty*,
↪ **BOOL** *fSaveAllProperties* **);**

See **IPersistPropertyBag::Save** in the *Win32 SDK* online.

Remarks

Saves the object's properties into a client-supplied property bag. ATL uses the object's property map to store this information. By default, this method saves all properties, regardless of the value of *fSaveAllProperties*.

See Also: BEGIN_PROPERTY_MAP, IPersistPropertyBagImpl::Load, IPropertyBag

IPersistStorageImpl

template< class *T* >
class IPersistStorageImpl

Parameters

T Your class, derived from **IPersistStorageImpl**.

The **IPersistStorage** interface allows a client to request that your object load and save its persistent data using a storage. Class **IPersistStorageImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: "Storages and Streams" in the *Win32 SDK* online

IPersist Methods

GetClassID	Retrieves the object's CLSID.

IPersistStorage Methods

HandsOffStorage	Instructs the object to release all storage objects and enter HandsOff mode. The ATL implementation returns **S_OK**.
InitNew	Initializes a new storage.
IsDirty	Checks whether the object's data has changed since it was last saved.
Load	Loads the object's properties from the specified storage.
Save	Saves the object's properties to the specified storage.
SaveCompleted	Notifies an object that it can return to Normal mode to write to its storage object. The ATL implementation returns **S_OK**.

Methods

IPersistStorageImpl::GetClassID

HRESULT GetClassID(CLSID **pClassID*);

See **IPersist::GetClassID** in the *Win32 SDK* online.

Remarks

Retrieves the object's CLSID.

IPersistStorageImpl::HandsOffStorage

HRESULT HandsOffStorage( );

See **IPersistStorage::HandsOffStorage** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

See Also: IPersistStorageImpl::SaveCompleted, IPersistStorageImpl::Save

---

IPersistStorageImpl::InitNew

HRESULT InitNew(IStorage* *pStorage*);

See **IPersistStorage:InitNew** in the *Win32 SDK* online.

Remarks

Initializes a new storage. The ATL implementation delegates to the **IPersistStreamInit** interface.

See Also: IStorage

IPersistStorageImpl::IsDirty

HRESULT IsDirty( );

See **IPersistStorage:IsDirty** in the *Win32 SDK* online.

Remarks

Checks whether the object's data has changed since it was last saved. The ATL implementation delegates to the **IPersistStreamInit** interface.

IPersistStorageImpl::Load

HRESULT Load(IStorage* *pStorage*);

See **IPersistStorage:Load** in the *Win32 SDK* online.

Remarks

Loads the object's properties. The ATL implementation delegates to the **IPersistStreamInit** interface. **Load** uses a stream named "Contents" to retrieve the object's data. The **Save** method originally creates this stream.

See Also: IStorage

IPersistStorageImpl::Save

HRESULT Save(IStorage* *pStorage*, **BOOL** *fSameAsLoad* **);**

See **IPersistStorage:Save** in the *Win32 SDK* online.

Remarks

Saves the object's properties. The ATL implementation delegates to the **IPersistStreamInit** interface. When **Save** is first called, it creates a stream named "Contents" on the specified storage. This stream is then used in later calls to **Save** and in calls to **Load**.

See Also: IPersistStorageImpl::SaveCompleted, IStorage

IPersistStorageImpl::SaveCompleted

HRESULT SaveCompleted(IStorage* *pStorage* **);**

See **IPersistStorage:SaveCompleted** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

See Also: IPersistStorageImpl::HandsOffStorage, IPersistStorageImpl::Save, IStorage

IPersistStreamInitImpl

template< class *T* >
class IPersistStreamInitImpl

Parameters

T Your class, derived from **IPersistStreamInitImpl**.

The **IPersistStreamInit** interface allows a client to request that your object load and save its persistent data to a single stream. Class **IPersistStreamInitImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: "Storages and Streams" in the *Win32 SDK* online

IPersist Methods

GetClassID	Retrieves the object's CLSID.

IPersistStreamInit Methods

GetSizeMax	Retrieves the size of the stream needed to save the object's data. The ATL implementation returns **E_NOTIMPL**.
InitNew	Initializes a newly created object.
IsDirty	Checks whether the object's data has changed since it was last saved.
Load	Loads the object's properties from the specified stream.
Save	Saves the object's properties to the specified stream.

Methods

IPersistStreamInitImpl::GetClassID

HRESULT GetClassID(CLSID **pClassID*);

See **IPersist::GetClassID** in the *Win32 SDK*.

Remarks

Retrieves the object's CLSID.

IPersistStreamInitImpl::GetSizeMax

HRESULT GetSizeMax(ULARGE_INTEGER FAR* *pcbSize*);

See **IPersistStreamInit::GetSizeMax** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IPersistStreamInitImpl::InitNew

HRESULT InitNew( );

See **IPersistStreamInit::InitNew** in the *Win32 SDK* online.

Remarks

Initializes a newly created object.

IPersistStreamInitImpl::IsDirty

HRESULT IsDirty( );

See **IPersistStreamInit::IsDirty** in the *Win32 SDK* online.

Remarks

Checks whether the object's data has changed since it was last saved.

IPersistStreamInitImpl::Load

HRESULT Load(LPSTREAM *pStm* **);**

See **IPersistStreamInit::Load** in the *Win32 SDK* online.

Remarks

Loads the object's properties from the specified stream. ATL uses the object's property map to retrieve this information.

See Also: BEGIN_PROPERTY_MAP, IPersistStreamInitImpl::Save, IStream

---

IPersistStreamInitImpl::Save

HRESULT Save(LPSTREAM *pStm*, **BOOL** *fClearDirty* **);**

See **IPersistStreamInit::Save** in the *Win32 SDK* online.

Remarks

Saves the object's properties to the specified stream. ATL uses the object's property map to store this information.

See Also: BEGIN_PROPERTY_MAP, IPersistStreamInitImpl::Load, IStream

IPointerInactiveImpl

template< class *T* >
class IPointerInactiveImpl

Parameters

T Your class, derived from **IPointerInactiveImpl**.

An inactive object is one that is simply loaded or running. Unlike an active object, an inactive object cannot receive Windows mouse and keyboard messages. Thus, inactive objects use fewer resources and are typically more efficient.

The **IPointerInactive** interface allows an object to support a minimal level of mouse interaction while remaining inactive. This functionality is particularly useful for controls.

Class **IPointerInactiveImpl** implements the **IPointerInactive** methods by simply returning **E_NOTIMPL**. However, it implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

IPointerInactive Methods

GetActivationPolicy	Retrieves the current activation policy for the object. The ATL implementation returns **E_NOTIMPL**.
OnInactiveMouseMove	Notifies the object that the mouse pointer has moved over it, indicating the object can fire mouse events. The ATL implementation returns **E_NOTIMPL**.
OnInactiveSetCursor	Sets the mouse pointer for the inactive object. The ATL implementation returns **E_NOTIMPL**.

Methods

IPointerInactiveImpl::GetActivationPolicy

HRESULT GetActivationPolicy(DWORD* *pdwPolicy* **);**

See **IPointerInactive::GetActivationPolicy** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IPointerInactiveImpl::OnInactiveMouseMove

HRESULT OnInactiveMouseMove(LPCRECT *pRectBounds*, **long** *x*, **long** *y*,
↪ **DWORD** *dwMouseMsg* **);**

See **IPointerInactive::OnInactiveMouseMove** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IPointerInactiveImpl::OnInactiveSetCursor

See **IPointerInactive::OnInactiveSetCursor** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IPropertyNotifySinkCP

template< class *T*, **class** *CDV* = **CComDynamicUnkArray >**
class IPropertyNotifySinkCP :
public IConnectionPointImpl< *T*, **&IID_IPropertyNotifySink,** *CDV* **>**

Parameters

T Your class, derived from **IPropertyNotifySinkCP**.

CDV A class that manages the connections between a connection point and its sinks. The default value is **CComDynamicUnkArray**, which allows unlimited connections. You can also use **CComUnkArray**, which specifies a fixed number of connections.

The **IPropertyNotifySink** interface allows a sink object to receive notifications about property changes. Class **IPropertyNotifySinkCP** exposes this interface as an outgoing interface on a connectable object. The client must implement the **IPropertyNotifySink** methods on the sink.

Derive your class from **IPropertyNotifySinkCP** when you want to create a connection point that represents the **IPropertyNotifySink** interface.

For more information about using connection points in ATL, see the article "Connection Points."

#include <atlctl.h>

See Also: IConnectionPointImpl, IConnectionPointContainerImpl

IPropertyNotifySinkCP inherits all methods through its base class, **IConnectionPointImpl**.

IPropertyPageImpl

template< class *T* >
class IPropertyPageImpl

Parameters

T Your class, derived from **IPropertyPageImpl.**

The **IPropertyPage** interface allows an object to manage a particular property page within a property sheet. Class **IPropertyPageImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: IPropertyPage2Impl, IPerPropertyBrowsingImpl, ISpecifyPropertyPagesImpl

Class Methods

IPropertyPageImpl	Constructor.
SetDirty	Flags the property page's state as changed or unchanged.

IPropertyPage Methods

Activate	Creates the dialog box window for the property page.
Apply	Applies current property page values to the underlying objects specified through **SetObjects**. The ATL implementation returns **S_OK**.
Deactivate	Destroys the window created with **Activate**.
GetPageInfo	Retrieves information about the property page.
Help	Invokes Windows help for the property page.
IsPageDirty	Indicates whether the property page has changed since it was activated.
Move	Positions and resizes the property page dialog box.
SetObjects	Provides an array of **IUnknown** pointers for the objects associated with the property page. These objects receive the current property page values through a call to **Apply**.
SetPageSite	Provides the property page with an **IPropertyPageSite** pointer, through which the property page communicates with the property frame.
Show	Makes the property page dialog box visible or invisible.
TranslateAccelerator	Processes a specified keystroke.

Data Members

m_bDirty	Specifies whether the property page's state has changed.
m_nObjects	Stores the number of objects associated with the property page.
m_dwHelpContext	Stores the context identifier for the help topic associated with the property page.
m_dwDocString	Stores the resource identifier associated with the text string describing the property page.
m_dwHelpFile	Stores the resource identifier associated with the name of the help file describing the property page.
m_dwTitle	Stores the resource identifier associated with the text string that appears in the tab for the property page.
m_pPageSite	Points to the **IPropertyPageSite** interface through which the property page communicates with the property frame.
m_ppUnk	Points to an array of **IUnknown** pointers to the objects associated with the property page.
m_size	Stores the height and width of the property page's dialog box, in pixels.

Methods

IPropertyPageImpl::Activate

HRESULT Activate(HWND *hWndParent*, **LPCRECT** *pRect*, **BOOL** *bModal* **);**

See **IPropertyPage::Activate** in the *Win32 SDK* online.

Remarks

Creates the dialog box window for the property page. By default, the dialog box is always modeless, regardless of the value of the *bModal* parameter.

See Also: IPropertyPageImpl::Deactivate

IPropertyPageImpl::Apply

HRESULT Apply( );

See **IPropertyPage::Apply** in the *Win32 SDK* online.

Remarks

Returns **S_OK**.

See Also: IPropertyPageImpl::SetObjects

IPropertyPageImpl::Deactivate

HRESULT Deactivate( );

See **IPropertyPage::Deactivate** in the *Win32 SDK* online.

Remarks

Destroys the dialog box window created with **Activate**.

IPropertyPageImpl::GetPageInfo

HRESULT GetPageInfo(PROPPAGEINFO* *pPageInfo* **);**

See **IPropertyPage::GetPageInfo** in the *Win32 SDK* online.

Remarks

Fills the *pPageInfo* structure with information contained in the data members. **GetPageInfo** loads the string resources associated with **m_dwDocString**, **m_dwHelpFile**, and **m_dwTitle**.

See Also: IPropertyPageImpl::m_dwHelpContext, IPropertyPageImpl::m_size, PROPPAGEINFO

IPropertyPageImpl::Help

HRESULT Help(PROPPAGEINFO* *pPageInfo* **);**

See **IPropertyPage::Help** in the *Win32 SDK* online.

Remarks

Invokes Windows help for the property page.

See Also: PROPPAGEINFO

IPropertyPageImpl::IPropertyPageImpl

IPropertyPageImpl( );

Remarks

The constructor. Initializes all data members.

IPropertyPageImpl::IsPageDirty

HRESULT Help(PROPPAGEINFO* *pPageInfo* **);**

See **IPropertyPage::Help** in the *Win32 SDK* online.

Remarks

Indicates whether the property page has changed since it was activated.

See Also: IPropertyPageImpl::SetDirty, IPropertyPageImpl::m_bDirty

---

IPropertyPageImpl::Move

HRESULT Move(LPCRECT *pRect* **);**

See **IPropertyPage::Move** in the *Win32 SDK* online.

Remarks

Positions and resizes the property page dialog box.

IPropertyPageImpl::SetDirty

void SetDirty(BOOL *bDirty* **);**

Parameters

bDirty [in] If **TRUE**, the property page's state is marked as changed. Otherwise, it is marked as unchanged.

Remarks

Flags the property page's state as changed or unchanged, depending on the value of *bDirty*. If necessary, **SetDirty** informs the frame that the property page has changed.

See Also: IPropertyPageImpl::IsPageDirty, IPropertyPageImpl::SetPageSite, IPropertyPageImpl::m_bDirty

---

IPropertyPageImpl::SetObjects

HRESULT SetObjects(ULONG *nObjects*, **IUnknown**** *ppUnk* **);**

See **IPropertyPage::SetObjects** in the *Win32 SDK* online.

Remarks

Provides an array of **IUnknown** pointers for the objects associated with the property page.

See Also: IPropertyPageImpl::Apply, IPropertyPageImpl::m_nObjects, IPropertyPageImpl::m_ppUnk

IPropertyPageImpl::SetPageSite

HRESULT SetPageSite(IPropertyPageSite* *pPageSite* **);**

See **IPropertyPage::SetPageSite** in the *Win32 SDK* online.

Remarks

Provides the property page with an **IPropertyPageSite** pointer, through which the property page communicates with the property frame.

See Also: IPropertyPageImpl::m_pPageSite, IPropertyPageSite

IPropertyPageImpl::Show

HRESULT Show(UINT *nCmdShow* **);**

See **IPropertyPage::Show** in the *Win32 SDK* online.

Remarks

Makes the property page dialog box visible or invisible.

IPropertyPageImpl::TranslateAccelerator

HRESULT TranslateAccelerator(MSG* *pMsg* **);**

See **IPropertyPage::TranslateAccelerator** in the *Win32 SDK* online.

Remarks

Processes the keystroke specified in *pMsg*.

See Also: MSG

Data Members

IPropertyPageImpl::m_bDirty

BOOL m_bDirty;

Remarks

Specifies whether the property page's state has changed.

See Also: IPropertyPageImpl::IsPageDirty, IPropertyPageImpl::SetDirty

IPropertyPageImpl::m_nObjects

ULONG m_nObjects;

Remarks

Stores the number of objects associated with the property page.

See Also: IPropertyPageImpl::SetObjects

IPropertyPageImpl::m_dwHelpContext

DWORD m_dwHelpContext;

Remarks

Stores the context identifier for the help topic associated with the property page.

See Also: IPropertyPageImpl::GetPageInfo

IPropertyPageImpl::m_dwDocString

UINT m_dwDocString;

Remarks

Stores the resource identifier associated with the text string describing the property page.

See Also: IPropertyPageImpl::GetPageInfo

IPropertyPageImpl::m_dwHelpFile

UINT m_dwHelpFile;

Remarks

Stores the resource identifier associated with the name of the help file describing the property page.

See Also: IPropertyPageImpl::GetPageInfo

IPropertyPageImpl::m_dwTitle

UINT m_dwTitle;

Remarks

Stores the resource identifier associated with the text string that appears in the tab for the property page.

See Also: IPropertyPageImpl::GetPageInfo

IPropertyPageImpl::m_pPageSite

IPropertyPageSite* m_pPageSite;

Remarks

Points to the **IPropertyPageSite** interface through which the property page communicates with the property frame.

See Also: IPropertyPageImpl::SetPageSite

IPropertyPageImpl::m_ppUnk

IUnknown m_ppUnk;**

Remarks

Points to an array of **IUnknown** pointers to the objects associated with the property page.

See Also: IPropertyPageImpl::SetObjects

IPropertyPageImpl::m_size

SIZE m_size;

Remarks

Stores the height and width of the property page's dialog box, in pixels.

See Also: IPropertyPageImpl::GetPageInfo, SIZE

IPropertyPage2Impl

template< class *T* >
class IPropertyPage2Impl : public IPropertyPageImpl< *T* >

Parameters

T Your class, derived from **IPropertyPage2Impl**.

The **IPropertyPage2** interface extends **IPropertyPage** by adding the **EditProperty** method. This method allows a client to select a specific property in a property page object.

Class **IPropertyPage2Impl** simply returns **E_NOTIMPL** for **IPropertyPage2::EditProperty**. However, it inherits the default implementation of **IPropertyPageImpl** and implements **IUnknown** by sending information to the dump device in debug builds.

When you create a property page, your class is typically derived from **IPropertyPageImpl**. To provide the extra support of **IPropertyPage2**, modify your class definition and override the **EditProperty** method.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: IPerPropertyBrowsingImpl, ISpecifyPropertyPagesImpl

IPropertyPage2 Methods

EditProperty	Specifies which property control will receive the focus when the property page is activated. The ATL implementation returns **E_NOTIMPL**.

Methods

IPropertyPage2Impl::EditProperty

HRESULT EditProperty(DISPID *dispID*);

See **IPropertyPage2::EditProperty** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IProvideClassInfo2Impl

template< const CLSID* *pcoclsid*, **const IID*** *psrcid*, **const GUID*** *plibid*,
↪ **WORD** *wMajor* = **1, WORD** *wMinor* = **0, class** *tihclass* = **CComTypeInfoHolder >**
class IProvideClassInfo2Impl : public IProvideClassInfo2

Parameters

pcoclsid A pointer to the coclass' identifier.

psrcid A pointer to the identifier for the coclass' default outgoing dispinterface.

plibid A pointer to the identifier of the coclass' type library.

wMajor The major version of the type library. The default value is 1.

wMinor The minor version of the type library. The default value is 0.

tihclass The class used to manage the coclass' type information. The default value is **CComTypeInfoHolder**.

The **IProvideClassInfo2** interface extends **IProvideClassInfo** by adding the **GetGUID** method. This method allows a client to retrieve an object's outgoing interface IID for its default event set. Class **IProvideClassInfo2Impl** provides a default implementation of the **IProvideClassInfo** and **IProvideClassInfo2** methods.

IProvideClassInfo2Impl contains a static member of type **CComTypeInfoHolder** that manages the type information for the coclass.

#include <atlcom.h>

Class Methods

IProvideClassInfo2Impl	Constructor.

IProvideClassInfo Methods

GetClassInfo	Retrieves an **ITypeInfo** pointer to the coclass' type information.

IProvideClassInfo2 Methods

GetGUID	Retrieves the GUID for the object's outgoing dispinterface.

Data Members

_tih	Manages the type information for the coclass.

Methods

IProvideClassInfo2Impl::GetClassInfo

HRESULT GetClassInfo(ITypeInfo** *pptinfo* **);**

See **IProvideClassInfo::GetClassInfo** in the *Win32 SDK* online.

Remarks

Retrieves an **ITypeInfo** pointer to the coclass' type information.

IProvideClassInfo2Impl::GetGUID

HRESULT GetGUID(DWORD *dwGuidKind*, **GUID*** *pGUID* **);**

See **IProvideClassInfo2::GetGUID** in the *Win32 SDK* online.

Remarks

Retrieves the GUID for the object's outgoing dispinterface.

IProvideClassInfo2Impl::IProvideClassInfo2Impl

IProvideClassInfo2Impl( );

Remarks

The constructor. Calls **AddRef** on the **_tih** member. The destructor calls **Release**.

Data Members

IProvideClassInfo2Impl::_tih

static *tihclass* **_tih;**

Remarks

This static data member is an instance of the class template parameter, *tihclass*, which by default is **CComTypeInfoHolder**. **_tih** manages the type information for the coclass.

IQuickActivateImpl

template< class *T* >
class IQuickActivateImpl

Parameters

T Your class, derived from **IQuickActivateImpl**.

The **IQuickActivate** interface helps containers avoid delays when loading controls by combining initialization in a single call. The **QuickActivate** method allows the container to pass a pointer to a **QACONTAINER** structure that holds pointers to all the interfaces the control needs. On return, the control passes back a pointer to a **QACONTROL** structure that holds pointers to its own interfaces, which are used by the container. Class **IQuickActivateImpl** provides a default implementation of **IQuickActivate** and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: CComControl

IQuickActivate Methods

GetContentExtent	Gets the extent of a full rendering of the control within the container.
QuickActivate	Performs quick initialization of controls being loaded.
SetContentExtent	Informs the control how much display space the container has assigned to it.

Methods

IQuickActivateImpl::GetContentExtent

HRESULT GetContentExtent(LPSIZEL *pSize* **);**

See **IQuickActivate::GetContentExtent** in the *Win32 SDK* online.

Remarks

Retrieves the current display size for a running control. The size is for a full rendering of the control and is specified in HIMETRIC units.

See Also: IQuickActivateImpl::SetContentExtent

IQuickActivateImpl::QuickActivate

HRESULT QuickActivate(QACONTAINER* *pQACont*, **QACONTROL*** *pQACtrl* **);**

See **IQuickActivate::QuickActivate** in the *Win32 SDK* online.

Remarks

With the **QuickActivate** method, the container passes a pointer to a **QACONTAINER** structure. The structure contains pointers to interfaces needed by the control and the values of some ambient properties. Upon return, the control passes a pointer to a **QACONTROL** structure that contains pointers to its own interfaces that the container requires, and additional status information.

IQuickActivateImpl::SetContentExtent

HRESULT SetContentExtent((LPSIZEL *pSize* **);**

See **IQuickActivate::SetContentExtent** in the *Win32 SDK* online.

Remarks

Informs a control of how much display space the container has assigned to it. The size is specified in HIMETRIC units.

See Also: IQuickActivateImpl::GetContentExtent

IRunnableObjectImpl

template< class *T* >
class IRunnableObjectImpl

Parameters

T Your class, derived from **IRunnableObjectImpl**.

The **IRunnableObject** interface enables a container to determine if a control is running, force it to run, or lock it into the running state. Class **IRunnableObjectImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: CComControl

IRunnable Object Methods

GetRunningClass	Returns the CLSID of the running control. The ATL implementation sets the CLSID to **GUID_NULL** and returns **E_UNEXPECTED**.
IsRunning	Determines if the control is running. The ATL implementation returns **TRUE**.
LockRunning	Locks the control into the running state. The ATL implementation returns **S_OK**.
Run	Forces the control to run. The ATL implementation returns **S_OK**.
SetContainedObject	Indicates that the control is embedded. The ATL implementation returns **S_OK**.

Methods

IRunnableObjectImpl::GetRunningClass

HRESULT GetRunningClass(LPCLSID *lpClsid*);

See **IRunnableObject::GetRunningClass** in the *Win32 SDK* online.

Remarks

The ATL implementation sets **lpClsid* to **GUID_NULL** and returns **E_UNEXPECTED**.

IRunnableObjectImpl::IsRunning

virtual BOOL IsRunning( );

See **IRunnableObject::IsRunning** in the *Win32 SDK* online.

Remarks

The ATL implementation returns **TRUE**.

IRunnableObjectImpl::LockRunning

HRESULT LockRunning(BOOL *fLock*, **BOOL** *fLastUnlockCloses* **);**

See **IRunnableObject::LockRunning** in the *Win32 SDK* online.

Remarks

The ATL implementation returns **S_OK**.

IRunnableObjectImpl::Run

HRESULT Run(LPBINDCTX);

See **IRunnableObject::Run** in the *Win32 SDK* online.

Remarks

The ATL implementation returns **S_OK**.

IRunnableObjectImpl::SetContainedObject

HRESULT SetContainedObject(BOOL *fContained* **);**

See **IRunnableObject::SetContainedObject** in the *Win32 SDK* online.

Remarks

The ATL implementation returns **S_OK**.

ISpecifyPropertyPagesImpl

template< class *T* >
class ISpecifyPropertyPagesImpl

Parameters

T Your class, derived from **ISpecifyPropertyPagesImpl**.

The **ISpecifyPropertyPages** interface allows a client to obtain a list of CLSIDs for the property pages supported by an object. Class **ISpecifyPropertyPagesImpl** provides a default implementation of this interface and implements **IUnknown** by sending information to the dump device in debug builds.

Note Do not expose the **ISpecifyPropertyPages** interface if your object does not support property pages.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: IPropertyPageImpl, IPerPropertyBrowsingImpl

ISpecifyPropertyPages Methods

GetPages	Fills a Counted Array of UUID values. Each UUID corresponds to the CLSID for one of the property pages that can be displayed in the object's property sheet.

Methods

ISpecifyPropertyPagesImpl::GetPages

HRESULT GetPages(CAUUID* *pPages* **);**

See **ISpecifyPropertyPages::GetPages** in the *Win32 SDK* online.

Remarks

Fills the array in the **CAUUID** structure with the CLSIDs for the property pages that can be displayed in the object's property sheet. ATL uses the object's property map to retrieve each CLSID.

See Also: BEGIN_PROPERTY_MAP

ISupportErrorInfoImpl

template< const IID* *piid* >
class ISupportErrorInfoImpl : public ISupportErrorInfo

Parameters

piid A pointer to the IID of an interface that supports **IErrorInfo**.

The **ISupportErrorInfo** interface ensures that error information can be returned to the client. Objects that use **IErrorInfo** must implement **ISupportErrorInfo**.

Class **ISupportErrorInfoImpl** provides a default implementation of **ISupportErrorInfo** and can be used when only a single interface generates errors on an object. For example:

```
class CMyClass :
   public IDispatchImpl< ... >,
   public CComObjectRoot,
   public CComCoClass< ... >
   public ISupportErrorInfoImpl< &IID_IMyClass >
{
   ...
};
```

#include <atlcom.h>

ISupportErrorInfo Methods

InterfaceSupportsErrorInfo	Indicates whether an interface supports the **IErrorInfo** interface.

Methods

ISupportErrorInfoImpl::InterfaceSupportsErrorInfo

HRESULT InterfaceSupportsErrorInfo(REFIID *riid*);

See **ISupportErrorInfo::InterfaceSupportsErrorInfo** in the *Win32 SDK* online.

Remarks

Indicates whether the interface identified by *riid* supports the **IErrorInfo** interface.

IViewObjectExImpl

template< class *T* >
class IViewObjectExImpl

Parameters

T Your class, derived from **IViewObjectExImpl**.

The **IViewObject**, **IViewObject2**, and **IViewObjectEx** interfaces enable a control to display itself directly, and to create and manage an advise sink to notify the container of changes in the control display. The **IViewObjectEx** interface provides support for extended control features such as flicker-free drawing, non-rectangular and transparent controls, and hit-testing (for example, how close a mouse click must be to be considered on the control). Class **IViewObjectExImpl** provides a default implementation of these interfaces and implements **IUnknown** by sending information to the dump device in debug builds.

Related Articles "ATL Tutorial," "Creating an ATL Project"

#include <atlctl.h>

See Also: **CComControl**, "ActiveX Controls Interfaces" in the *Win32 SDK* online

IViewObject Methods	
Draw	Draws a representation of the control onto a device context.
Freeze	Freezes the drawn representation of a control so that it won't change until an **Unfreeze**. The ATL implementation returns **E_NOTIMPL**.
GetAdvise	Returns information on the most recent **SetAdvise**.
GetColorSet	Returns the logical palette used by the control for drawing. The ATL implementation returns **E_NOTIMPL**.
SetAdvise	Sets up an advise sink to receive notifications of changes in the view of the control.
Unfreeze	Unfreezes the drawn representation of the control. The ATL implementation returns **E_NOTIMPL**.

IViewObject2 Methods	
GetExtent	Retrieves the size of the control from the cache.

IViewObjectEx Methods	
GetNaturalExtent	Provides sizing hints from the container for the object to use as the user resizes it. The ATL implementation returns **E_NOTIMPL**.
GetRect	Returns a rectangle describing a requested drawing aspect. The ATL implementation returns **E_NOTIMPL**.
GetViewStatus	Returns information about the opacity of the object, and what drawing aspects are supported.

(continued)

IViewObjectEx Methods *(continued)*	
QueryHitPoint	Indicates whether a point is within a given drawing aspect of an object.
QueryHitRect	Indicates whether any point in a rectangle is within a given drawing aspect of an object.

Methods

IViewObjectExImpl::Draw

HRESULT Draw(DWORD *dwDrawAspect*, **LONG** *lindex*, **void*** *pvAspect*,
↪ **DVTARGETDEVICE*** *ptd*, **HDC** *hicTargetDev*, **LPCRECTL** *prcBounds*,
↪ **LPCRECTL** *prcWBounds*, **BOOL(_stdcall *** *pfnContinue*) **(DWORD** *dwContinue*),
↪ **DWORD** *dwContinue* **);**

See **IViewObject::Draw** in the *Win32 SDK* online.

Remarks

This method calls **CComControl::OnDrawAdvanced** which in turn calls your control class's **OnDraw** method. An **OnDraw** method is automatically added to your control class when you create your control with the ATL Object Wizard. The Wizard's default **OnDraw** draws a rectangle with the label "ATL 2.0".

See Also: CComControl::OnDrawAdvanced, CComControl::OnDraw

IViewObjectExImpl::Freeze

HRESULT Freeze(DWORD *dwAspect*, **LONG** *lindex*, **void*** *pvAspect*,
↪ **DWORD*** *pdwFreeze* **);**

See **IViewObject::Freeze** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IViewObjectExImpl::GetAdvise

HRESULT GetAdvise(DWORD* *pAspects*, **DWORD*** *pAdvf*,
↪ **IAdviseSink**** *ppAdvSink* **);**

See **IViewObject::GetAdvise** in the *Win32 SDK* online.

Remarks

Retrieves an existing advisory sink connection on the control, if there is one. The advisory sink is stored in the control class data member **m_spAdviseSink**.

See Also: **IViewObjectExImpl::SetAdvise**

IViewObjectExImpl::GetColorSet

HRESULT GetColorSet(DWORD *dwAspect*, **LONG** *lindex*,
↪ **void*** *pvAspect*, **DVTARGETDEVICE*** *ptd*, **HDC** *hicTargetDevice*,
↪ **LOGPALETTE**** *ppColorSet* **);**

See **IViewObject::GetColorSet** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

IViewObjectExImpl::GetExtent

HRESULT GetExtent(DWORD *dwDrawAspect*, **LONG** *lindex*,
↪ **DVTARGETDEVICE*** *ptd*, **LPSIZEL*** *lpsizel* **);**

See **IViewObject2::GetExtent** in the *Win32 SDK* online.

Remarks

Retrieves the control's display size in HIMETRIC units (0.01 millimeter per unit) from the control class data member **m_sizeExtent**.

IViewObjectExImpl::GetNaturalExtent

HRESULT GetNaturalExtent(DWORD *dwAspect*, **LONG** *lindex*,
↪ **DVTARGETDEVICE*** *ptd*, **HDC** *hicTargetDevice*,
↪ **DVEXTENTINFO*** *pExtentInfo*, **LPSIZEL** *psizel* **);**

See **IViewObjectEx::GetNaturalExtent** in the *Win32 SDK* online.

Remarks

If *dwAspect* is **DVASPECT_CONTENT** and *pExtentInfo->dwExtentMode* is **DVEXTENT_CONTENT**, sets **psizel* to the control class's data member **m_sizeNatural**.

IViewObjectExImpl::GetRect

HRESULT GetRect(DWORD *dwAspect*, **LPRECTL** *pRect* **);**

See **IViewObjectEx::GetRect** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

ViewObjectExImpl::GetViewStatus

HRESULT GetViewStatus(DWORD* *pdwStatus* **);**

See **IViewObjectEx::GetViewStatus** in the *Win32 SDK* online.

Remarks

By default, ATL sets *pdwStatus* to indicate that the control supports **VIEWSTATUS_OPAQUE** (possible values are in the **VIEWSTATUS** enumeration).

IViewObjectExImpl::QueryHitPoint

HRESULT QueryHitPoint(DWORD *dwAspect*, **LPCRECT** *pRectBounds*,
↪ **POINT** *ptlLoc*, **LONG** *lCloseHit*, **DWORD*** *pHitResult* **);**

See **IViewObjectEx::QueryHitPoint** in the *Win32 SDK* online.

Remarks

Checks if the specified point is in the specified rectangle and returns a **HITRESULT** value in *pHitResult*. The value can be either **HITRESULT_HIT** or **HITRESULT_OUTSIDE**.

If *dwAspect* equals **DVASPECT_CONTENT**, the method returns **S_OK**. Otherwise, the method returns **E_FAIL**.

See Also: IViewObjectExImpl::QueryHitRect

IViewObjectExImpl::QueryHitRect

HRESULT QueryHitRect(DWORD *dwAspect*, **LPCRECT** *pRectBounds*,
↪ **LPRECT** *prcLoc*, **LONG** *lCloseHit*, **DWORD*** *pHitResult* **);**

See **IViewObjectEx::QueryHitRect** in the *Win32 SDK* online.

Remarks

Checks whether the control's display rectangle overlaps any point in the specified location rectangle and returns a **HITRESULT** value in *pHitResult*. The value can be either **HITRESULT_HIT** or **HITRESULT_OUTSIDE**.

If *dwAspect* equals **DVASPECT_CONTENT**, the method returns **S_OK**. Otherwise, the method returns **E_FAIL**.

See Also: IViewObjectExImpl::QueryHitPoint

IViewObjectExImpl::SetAdvise

HRESULT SetAdvise(DWORD *aspects*, **DWORD** *advf*, **IAdviseSink*** *pAdvSink* **);**

See **IViewObject::SetAdvise** in the *Win32 SDK* online.

Remarks

Sets up a connection between the control and an advise sink so that the sink can be notified about changes in the control's view. The pointer to the **IAdviseSink** interface on the advise sink is stored in the control class data member **m_spAdviseSink**.

See Also: IViewObjectExImpl::GetAdvise

IViewObjectExImpl::Unfreeze

HRESULT Unfreeze(DWORD *dwFreeze* **);**

See **IViewObject::Unfreeze** in the *Win32 SDK* online.

Remarks

Returns **E_NOTIMPL**.

ATL Macros and Global Functions

The ATL macros and global functions offer functionality in the following categories:

Aggregation and Class Factory Macros
COM Map Macros and Global Functions
Connection Point Macros and Global Functions
Debugging and Error Reporting Macros and Global Functions
Device Context Global Functions
Event Handling Global Functions
Marshaling Global Functions
Message Map Macros
Object Map Macros
Pixel/HIMETRIC Conversion Global Functions
Property Map Macros
Registry Macros
Stock Property Macros
String Conversion Macros
Window Class Macros

Aggregation and Class Factory Macros

DECLARE_AGGREGATABLE	Declares that your object can be aggregated (the default).
DECLARE_CLASSFACTORY	Declares the class factory to be **CComClassFactory**, the ATL default class factory.
DECLARE_CLASSFACTORY_EX	Declares your class factory object to be the class factory.
DECLARE_CLASSFACTORY2	Declares **CComClassFactory2** to be the class factory.
DECLARE_CLASSFACTORY_AUTO_THREAD	Declares **CComClassFactoryAutoThread** to be the class factory.
DECLARE_CLASSFACTORY_SINGLETON	Declares **CComClassFactorySingleton** to be the class factory.
DECLARE_GET_CONTROLLING_UNKNOWN	Declares a virtual **GetControllingUnknown** function.
DECLARE_NOT_AGGREGATABLE	Declares that your object cannot be aggregated.
DECLARE_ONLY_AGGREGATABLE	Declares that your object must be aggregated.
DECLARE_POLY_AGGREGATABLE	Checks the value of the outer unknown and declares your object aggregatable or not aggregatable, as appropriate.
DECLARE_PROTECT_FINAL_CONSTRUCT	Protects the outer object from deletion during construction of an inner object.

COM Map Macros and Global Functions

AtlInternalQueryInterface	Delegates to the **IUnknown** of a nonaggregated object.
BEGIN_COM_MAP	Marks the beginning of the COM interface map entries.
COM_INTERFACE_ENTRY	Enters interfaces into the COM interface map.
END_COM_MAP	Marks the end of the COM interface map entries.

Connection Point Macros and Global Functions

AtlAdvise	Creates a connection between an object's connection point and a client's sink.
AtlUnadvise	Terminates the connection established through **AtlAdvise**.
BEGIN_CONNECTION_POINT_MAP	Marks the beginning of the connection point map entries.
CONNECTION_POINT_ENTRY	Enters connection points into the map.
END_CONNECTION_POINT_MAP	Marks the end of the connection point map entries.

Debugging and Error Reporting Macros and Global Functions

AtlReportError	Sets up **IErrorInfo** to provide error details to a client.
AtlTrace	Global function that sends a formatted message and/or variable values to the dump device.
ATLTRACE	Sends a formatted message and/or variable values to the dump device.
ATLTRACENOTIMPL	Sends a message to the dump device that the specified function is not implemented.

Device Context Global Functions

AtlCreateTargetDC	Creates a device context.

Event Handling Global Functions

AtlWaitWithMessageLoop	Waits for an object to be signaled, meanwhile dispatching window messages as needed.

Marshaling Global Functions

AtlFreeMarshalStream	Releases the marshal data and the **IStream** pointer.
AtlMarshalPtrInProc	Creates a new stream object and marshals the specified interface pointer.
AtlUnmarshalPtr	Converts a stream's marshaling data into an interface pointer.

Message Map Macros

BEGIN_MSG_MAP	Marks the beginning of the default message map.
ALT_MSG_MAP	Marks the beginning of an alternate message map.
MESSAGE_HANDLER	Maps a Windows message to a handler function.
MESSAGE_RANGE_HANDLER	Maps a contiguous range of Windows messages to a handler function.
COMMAND_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the notification code and the identifier of the menu item, control, or accelerator.
COMMAND_ID_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the identifier of the menu item, control, or accelerator.
COMMAND_CODE_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the notification code.
COMMAND_RANGE_HANDLER	Maps a contiguous range of **WM_COMMAND** messages to a handler function.
NOTIFY_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the notification code and the control identifier.
NOTIFY_ID_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the control identifier.
NOTIFY_CODE_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the notification code.
NOTIFY_RANGE_HANDLER	Maps a contiguous range of **WM_NOTIFY** messages to a handler function.
CHAIN_MSG_MAP	Chains to the default message map in the base class.
CHAIN_MSG_MAP_MEMBER	Chains to the default message map in a data member of the class.
CHAIN_MSG_MAP_ALT	Chains to an alternate message map in the base class.
CHAIN_MSG_MAP_ALT_MEMBER	Chains to an alternate message map in a data member of the class.
CHAIN_MSG_MAP_DYNAMIC	Chains to the message map in another class at run time.
CHAIN_MSG_MAP_ALT_DYNAMIC	Chains to an alternate message map in another class at run time.
END_MSG_MAP	Marks the end of a message map.

Object Map Macros

BEGIN_OBJECT_MAP	Marks the beginning of the ATL object map and initializes the array of object descriptions.
OBJECT_ENTRY	Enters an ATL object into the object map, updates the registry, and creates an instance of the object.
END_OBJECT_MAP	Marks the end of the ATL object map.
DECLARE_OBJECT_DESCRIPTION	Allows you to specify a class object's text description, which will be entered into the object map.

Pixel/HIMETRIC Conversion Global Functions

AtlHiMetricToPixel	Converts HIMETRIC units (each unit is 0.01 millimeter) to pixels.
AtlPixelToHiMetric	Converts pixels to HIMETRIC units (each unit is 0.01 millimeter).

Property Map Macros

BEGIN_PROPERTY_MAP	Marks the beginning of the ATL property map.
PROP_ENTRY	Enters a property description, property DISPID, and property page CLSID into the property map.
PROP_ENTRY_EX	Enters a property description, property DISPID, property page CLSID, and **IDispatch** IID into the property map.
PROP_PAGE	Enters a property page CLSID into the property map.
END_PROPERTY_MAP	Marks the end of the ATL property map.

Registry Macros

DECLARE_NO_REGISTRY	Avoids default ATL registration.
DECLARE_REGISTRY	Enters or removes the main object's entry in the system registry.
DECLARE_REGISTRY_RESOURCE	Finds the named resource and runs the registry script within it.
DECLARE_REGISTRY_RESOURCEID	Finds the resource identified by an ID number and runs the registry script within it.

Stock Property Macros

IMPLEMENT_BOOL_STOCKPROP	Implements a boolean stock property for an ATL object.
IMPLEMENT_BSTR_STOCKPROP	Implements a text stock property for an ATL object.
IMPLEMENT_STOCKPROP	Implements a stock property for an ATL object.

String Conversion Macros	
String Conversion Macros	Set of macros that convert between string types.
DEVMODE and TEXTMETRIC String Conversion Macros	Set of macros that convert the strings within **DEVMODE** and **TEXTMETRIC** structures.

Window Class Macros	
DECLARE_WND_CLASS	Allows you to specify the name of a new window class.
DECLARE_WND_SUPERCLASS	Allows you to specify the name of an existing window class on which a new window class will be based.

ALT_MSG_MAP

ALT_MSG_MAP(*msgMapID* **)**

Parameters

msgMapID [in] The message map identifier.

Remarks

Marks the beginning of an alternate message map. ATL identifies each message map by a number. The default message map (declared with the **BEGIN_MSG_MAP** macro) is identified by 0. An alternate message map is identified by *msgMapID*.

Message maps are used to process messages sent to a window. For example, **CContainedWindow** allows you to specify the identifier of a message map in the containing object. **CContainedWindow::WindowProc** then uses this message map to direct the contained window's messages either to the appropriate handler function or to another message map. For a list of macros that declare handler functions, see **BEGIN_MSG_MAP**.

Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps. The following example shows the default message map and one alternate message map, each containing one handler function:

```
BEGIN_MSG_MAP(CMyClass)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
END_MSG_MAP
```

The next example shows two alternate message maps. The default message map is empty.

```
BEGIN_MSG_MAP(CMyClass)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
ALT_MSG_MAP(2)
   MESSAGE_HANDLER(WM_CREATE, OnCreate)
END_MSG_MAP
```

The **END_MSG_MAP** macro marks the end of the message map. Note that there is always exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **MESSAGE_HANDLER**, **CMessageMap**, **CDynamicChain**

AtlAdvise

HRESULT AtlAdvise(IUnknown* *pUnkCP*, **IUnknown*** *pUnk*,
↪ **const IID&** *iid*, **LPDWORD** *pdw* **);**

Return Value

A standard **HRESULT** value.

Parameters

pUnkCP [in] A pointer to the **IUnknown** of the object the client wants to connect with.

pUnk [in] A pointer to the client's **IUnknown**.

iid [in] The GUID of the connection point. Typically, this is the same as the outgoing interface managed by the connection point.

pdw [out] A pointer to the cookie that uniquely identifies the connection.

Remarks

Creates a connection between an object's connection point and a client's sink. The sink implements the outgoing interface supported by the connection point. The client uses the *pdw* cookie to remove the connection by passing it to **AtlUnadvise**.

AtlCreateTargetDC

HDC AtlCreateTargetDC(HDC *hdc*, **DVTARGETDEVICE*** *ptd* **);**

Return Value

Returns the handle to a device context for the device specified in the **DVTARGETDEVICE**. If no device is specified, returns the handle to the default display device.

Parameters

hdc [in] The existing handle of a device context, or **NULL**.

ptd [in] A pointer to the **DVTARGETDEVICE** structure that contains information about the target device.

Remarks

Creates a device context for the device specified in the **DVTARGETDEVICE** structure. If the structure is **NULL** and *hdc* is **NULL**, creates a device context for the default display device.

If *hdc* is not **NULL** and *ptd* is **NULL**, the function returns the existing *hdc*.

AtlFreeMarshalStream

void AtlFreeMarshalStream(IStream* *pStream* **);**

Parameters

pStream [in] A pointer to the **IStream** interface on the stream used for marshaling.

Remarks

Releases the marshal data in the stream, then releases the stream pointer.

See Also: AtlMarshalPtrInProc

AtlHiMetricToPixel

extern void AtlPixelToHiMetric(const SIZEL* *lpSizeInHiMetric*,
↪ **LPSIZEL** *lpSizeInPix* **);**

Parameters

lpSizeInHiMetric [in] Pointer to the size of the object in HIMETRIC units.

lpSizeInPix [out] Pointer to where the object's size in pixels is to be returned.

Remarks

Converts an object's size in HIMETRIC units (each unit is 0.01 millimeter) to a size in pixels on the screen device.

See Also: AtlPixelToHiMetric

AtlInternalQueryInterface

HRESULT AtlInternalQueryInterface(void* *pThis*,
↪ **const _ATL_INTMAP_ENTRY*** *pEntries*, **REFIID** *iid*, **void**** *ppvObject* **);**

Return Value

One of the standard **HRESULT** values.

Parameters

pThis [in] A pointer to the object that contains the COM map of interfaces exposed to **QueryInterface**.

pEntries [in] An array of **_ATL_INTMAP_ENTRY** structures that access a map of available interfaces.

iid [in] The GUID of the interface being requested.

ppvObject [out] A pointer to the interface pointer specified in *iid*, or **NULL** if the interface is not found.

Remarks

Retrieves a pointer to the requested interface.

AtlInternalQueryInterface only handles interfaces in the COM map table. If your object is aggregated, **AtlInternalQueryInterface** does not delegate to the outer unknown. You can enter interfaces into the COM map table with the macro **COM_INTERFACE_ENTRY** or one of its variants.

See Also: CComObjectRootEx::InternalAddRef, CComObjectRootEx::InternalRelease

---

AtlMarshalPtrInProc

HRESULT AtlMarshalPtrInProc(IUnknown* *pUnk*, **const IID&** *iid*,
↪ **IStream**** *ppStream*);

Return Value

A standard **HRESULT** value.

Parameters

pUnk [in] A pointer to the interface to be marshaled.

iid [in] The GUID of the interface being marshaled.

ppStream [out] A pointer to the **IStream** interface on the new stream object used for marshaling.

Remarks

Creates a new stream object, writes the CLSID of the proxy to the stream, and marshals the specified interface pointer by writing the data needed to initialize the proxy into the stream. The **MSHLFLAGS_TABLESTRONG** flag is set so the pointer can be marshaled to multiple streams. The pointer can also be unmarshaled multiple times.

If marshaling fails, the stream pointer is released.

AtlMarshalPtrInProc can only be used on a pointer to an in-process object.

See Also: AtlUnmarshalPtr, AtlFreeMarshalStream, MSHLFLAGS in the *Win32 SDK* online

AtlPixelToHiMetric

extern void AtlPixelToHiMetric(const SIZEL* *lpSizeInPix*,
↪ **LPSIZEL** *lpSizeInHiMetric* **);**

Parameters

lpSizeInPix [in] Pointer to the object's size in pixels.

lpSizeInHiMetric [out] Pointer to where the object's size in HIMETRIC units is to be returned.

Remarks

Converts an object's size in pixels on the screen device to a size in HIMETRIC units (each unit is 0.01 millimeter).

See Also: AtlHiMetricToPixel

AtlReportError

HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **LPCOLESTR** *lpszDesc*,
↪ **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0);**
HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **LPCOLESTR** *lpszDesc*,
↪ **DWORD** *dwHelpID*, **LPCOLESTR** *lpszHelpFile*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0);**
HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **LPCSTR** *lpszDesc*,
↪ **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0);**
HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **LPCSTR** *lpszDesc*,
↪ **DWORD** *dwHelpID*, **LPCSTR** *lpszHelpFile*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0);**
HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **UINT** *nID*,
↪ **const IID&** *iid* **= GUID_NULL, HRESULT** *hRes* **= 0,**
↪ **HINSTANCE** *hInst* **= _Module.GetResourceInstance( ));**
HRESULT WINAPI AtlReportError(const CLSID& *clsid*, **UINT** *nID*,
↪ **DWORD** *dwHelpID*, **LPCOLESTR** *lpszHelpFile*, **const IID&** *iid* **= GUID_NULL,**
↪ **HRESULT** *hRes* **= 0, HINSTANCE** *hInst* **= _Module.GetResourceInstance( ));**

Return Value

If the *hRes* parameter is nonzero, returns the value of *hRes*. If *hRes* is zero, then the first four versions of **AtlReportError** return **DISP_E_EXCEPTION**. The last two versions return the result of the macro **MAKE_HRESULT(1, FACILITY_ITF,** *nID*).

Parameters

clsid [in] The CLSID of the object reporting the error.

lpszDesc [in] The string describing the error. The Unicode version specifies that *lpszDesc* is of type **LPCOLESTR**; the ANSI version specifies a type of **LPCSTR**.

iid [in] The IID of the interface defining the error or **GUID_NULL** if the error is defined by the operating system.

hRes [in] The **HRESULT** you want returned to the caller.

nID [in] The resource identifier where the error description string is stored. This value should lie between 0x0200 and 0xFFFF, inclusively. In debug builds, an **ASSERT** will result if *nID* does not index a valid string. In release builds, the error description string will be set to "Unknown Error."

dwHelpID [in] The help context identifier for the error.

lpszHelpFile [in] The path and name of the help file describing the error.

hInst [in] The handle to the resource. By default, this parameter is **_Module::GetResourceInstance**, where **_Module** is the global instance of **CComModule** or a class derived from it.

Remarks

Sets up the **IErrorInfo** interface to provide error information to clients of the object. The string *lpszDesc* is used as the text description of the error. When the client receives the *hRes* you return from **AtlReportError**, the client can access the **IErrorInfo** structure for details about the error.

See Also: **MAKE_HRESULT**

AtlTrace

void _cdecl AtlTrace(LPCTSTR *lpszFormat*, **...);**

Parameters

lpszFormat [in] The format of the string and variables to send to the dump device.

Remarks

Sends the specified string to the dump device. **AtlTrace** is available in both debug and release builds.

For example:

```
AtlTrace(_T("The value of x is %d.\n"), x);
```

See Also: **ATLTRACE**

ATLTRACE

ATLTRACE(*exp* **)**

Parameters

exp [in] The formatted string and variables to send to the dump device.

Remarks

Sends the specified string to the dump device. The **ATLTRACE** macro performs the same as the global function **AtlTrace**, except that in release builds **ATLTRACE** compiles to `(void) 0`, while the function **AtlTrace** can still be used.

For example:

```
ATLTRACE(_T("The value of x is %d.\n"), x)
```

ATLTRACENOTIMPL

ATLTRACENOTIMPL(*funcname* **)**

Parameters

funcname [in] A string containing the name of the function that is not implemented.

Remarks

In debug builds of ATL, sends the string "*funcname* is not implemented" to the dump device and returns **E_NOTIMPL**. In release builds, simply returns **E_NOTIMPL**.

See Also: ATLTRACE

AtlUnadvise

HRESULT AtlUnadvise(IUnknown* *pUnkCP*, **const IID&** *iid*, **DWORD** *dw* **);**

Return Value

A standard **HRESULT** value.

Parameters

pUnkCP [in] A pointer to the **IUnknown** of the object that the client is connected with.

iid [in] The GUID of the connection point. Typically, this is the same as the outgoing interface managed by the connection point.

dw [in] The cookie that uniquely identifies the connection.

Remarks

Terminates the connection established through **AtlAdvise**.

AtlUnmarshalPtr

HRESULT AtlUnmarshalPtr(IStream* *pStream*, **const IID&** *iid*,
↪ **IUnknown**** *ppUnk* **);**

Return Value

A standard **HRESULT** value.

Parameters

pStream [in] A pointer to the stream being unmarshaled.

iid [in] The GUID of the interface being unmarshaled.

ppUnk [out] A pointer to the unmarshaled interface.

Remarks

Converts the stream's marshaling data into an interface pointer that can be used by the client.

See Also: AtlMarshalPtrInProc

AtlWaitWithMessageLoop

BOOL AtlWaitWithMessageLoop(HANDLE *hEvent* **);**

Return Value

Returns **TRUE** if the object has been signaled.

Parameters

hEvent [in] The handle of the object to wait for.

Remarks

Waits for the object to be signaled, meanwhile dispatching window messages as needed. This is useful if you want to wait for an object's event to happen and be notified of it happening, but allow window messages to be dispatched while waiting.

BEGIN_COM_MAP

BEGIN_COM_MAP(*x* **)**

Parameters

x [in] The name of the class object you are exposing interfaces on.

Remarks

The COM map is the mechanism that exposes interfaces on an object to a client through **QueryInterface**. **CComObjectRootEx::InternalQueryInterface** only returns pointers for interfaces in the COM map. Start your interface map with the **BEGIN_COM_MAP** macro, add entries for each of your interfaces with the **COM_INTERFACE_ENTRY** macro or one of its variants, and complete the map with the **END_COM_MAP** macro.

For example, from the ATL BEEPER sample:

```
BEGIN_COM_MAP(CBeeper)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY(IBeeper)
   COM_INTERFACE_ENTRY_TEAR_OFF(IID_ISupportErrorInfo, CBeeper2)
END_COM_MAP( )
```

See the ATL COMMAP sample for examples using the different types of COM map entry macros.

BEGIN_CONNECTION_POINT_MAP

BEGIN_CONNECTION_POINT_MAP(*x* **)**

Parameters

x [in] The name of the class containing the connection points.

Remarks

Marks the beginning of the connection point map entries. Start your connection point map with the **BEGIN_CONNECTION_POINT_MAP** macro, add entries for each of your connection points with the **CONNECTION_POINT_ENTRY** macro, and complete the map with the **END_CONNECTION_POINT_MAP** macro.

For example:

```
BEGIN_CONNECTION_POINT_MAP(CConnect)
   CONNECTION_POINT_ENTRY(m_cpInterfaceBeingExposed)
END_CONNECTION_POINT_MAP( )
```

For more information about connection points in ATL, see the article "Connection Points."

BEGIN_MSG_MAP

BEGIN_MSG_MAP(*theClass* **)**

Parameters

theClass [in] The name of the class containing the message map.

Remarks

Marks the beginning of the default message map. **CWindowImpl::WindowProc** uses the default message map to process messages sent to the window. The message map directs messages either to the appropriate handler function or to another message map.

The following macros map a message to a handler function. This function must be defined in *theClass*.

Macro	Description
MESSAGE_HANDLER	Maps a Windows message to a handler function.
MESSAGE_RANGE_HANDLER	Maps a contiguous range of Windows messages to a handler function.

(continued)

Macro	Description
COMMAND_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the notification code and the identifier of the menu item, control, or accelerator.
COMMAND_ID_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the identifier of the menu item, control, or accelerator.
COMMAND_CODE_HANDLER	Maps a **WM_COMMAND** message to a handler function, based on the notification code.
COMMAND_RANGE_HANDLER	Maps a contiguous range of **WM_COMMAND** messages to a handler function, based on the identifier of the menu item, control, or accelerator.
NOTIFY_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the notification code and the control identifier.
NOTIFY_ID_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the control identifier.
NOTIFY_CODE_HANDLER	Maps a **WM_NOTIFY** message to a handler function, based on the notification code.
NOTIFY_RANGE_HANDLER	Maps a contiguous range of **WM_NOTIFY** messages to a handler function, based on the control identifier.

The following macros direct a message to another message map. This process is called "chaining."

Macro	Description
CHAIN_MSG_MAP	Chains to the default message map in the base class.
CHAIN_MSG_MAP_MEMBER	Chains to the default message map in a data member of the class.
CHAIN_MSG_MAP_ALT	Chains to an alternate message map in the base class.
CHAIN_MSG_MAP_ALT_MEMBER	Chains to an alternate message map in a data member of the class.
CHAIN_MSG_MAP_DYNAMIC	Chains to the default message map in another class at run time.
CHAIN_MSG_MAP_ALT_DYNAMIC	Chains to an alternate message map in another class at run time.

Example

```
class CMyWindow : ...
{
public:
   ...

   BEGIN_MSG_MAP(CMyWindow)
      MESSAGE_HANDLER(WM_PAINT, OnPaint)
      MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
      CHAIN_MSG_MAP(CMyBaseWindow)
   END_MSG_MAP

   LRESULT OnPaint(UINT uMsg, WPARAM wParam,
                   LPARAM lParam, BOOL& bHandled)
   { ... }

   LRESULT OnSetFocus(UINT uMsg, WPARAM wParam,
                      LPARAM lParam, BOOL& bHandled)
   { ... }
};
```

When a `CMyWindow` object receives a `WM_PAINT` message, the message is directed to `CMyWindow::OnPaint` for the actual processing. If `OnPaint` indicates the message requires further processing, the message will then be directed to the default message map in `CMyBaseWindow`.

In addition to the default message map, you can define an alternate message map with **ALT_MSG_MAP**. Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps. The following example shows the default message map and one alternate message map, each containing one handler function:

```
BEGIN_MSG_MAP(CMyClass)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
END_MSG_MAP
```

The next example shows two alternate message maps. The default message map is empty.

```
BEGIN_MSG_MAP(CMyClass)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
ALT_MSG_MAP(2)
   MESSAGE_HANDLER(WM_CREATE, OnCreate)
END_MSG_MAP
```

The **END_MSG_MAP** macro marks the end of the message map. Note that there is always exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CMessageMap, CDynamicChain**

BEGIN_OBJECT_MAP

BEGIN_OBJECT_MAP(*x* **)**

Parameters

x [in] Array of ATL object definitions.

Remarks

Marks the beginning of the map of ATL objects. The parameter *x* is an array holding **_ATL_OBJMAP_ENTRY** structures that describe the objects.

Start your object map with the **BEGIN_OBJECT_MAP** macro, add entries for each object with the **OBJECT_ENTRY** macro, and complete the map with the **END_OBJECT_MAP** macro. When **CComModule::RegisterServer** is called, it updates the system registry for each object in the object map.

Typically, you follow an object map definition with **CComModule::Init** to initialize the instance. For example, from the CIRCCOLL sample:

```
BEGIN_OBJECT_MAP(ObjectMap)
   OBJECT_ENTRY(CLSID_MyCircleCollectionCreator, CMyCircleCollectionCreator)
END_OBJECT_MAP( )

//DLL Entry Point
extern "C"
BOOL WINAPI DllMain(HINSTANCE hInstance, DWORD dwReason, LPVOID /*lpReserved*/)
{
   if (dwReason == DLL_PROCESS_ATTACH)
   {
      _Module.Init(ObjectMap, hInstance);
      DisableThreadLibraryCalls(hInstance);
   }
   else if (dwReason == DLL_PROCESS_DETACH)
      _Module.Term();
   return TRUE;
}
```

BEGIN_PROPERTY_MAP

BEGIN_PROPERTY_MAP(*theClass* **)**

Parameters

theClass [in] The name of the class containing the property map.

Remarks

Marks the beginning of the object's property map. The property map stores property descriptions, property DISPIDs, property page CLSIDs, and **IDispatch** IIDs. Classes **IPerPropertyBrowsingImpl**, **IPersistPropertyBagImpl**, **IPersistStreamInitImpl**, and **ISpecifyPropertyPagesImpl** use the property map to retrieve and set this information.

When you create a control with the ATL Object Wizard, the wizard will create an empty property map by specifying **BEGIN_PROPERTY_MAP** followed by **END_PROPERTY_MAP**.

Example

From the CIRC sample:

```
BEGIN_PROPERTY_MAP( CCircCtl )
   PROP_ENTRY( "Caption", DISPID_CAPTION,
               CLSID_CCircProps )
   PROP_ENTRY( "Enabled", DISPID_ENABLED,
               CLSID_CCircProps )
   PROP_ENTRY( "Fore Color", DISPID_FORECOLOR,
               CLSID_StockColorPage )
   PROP_ENTRY( "Back Color", DISPID_BACKCOLOR,
               CLSID_StockColorPage )
   PROP_ENTRY( "Font", DISPID_FONT, CLSID_StockFontPage )
END_PROPERTY_MAP( )
```

See Also: **PROP_ENTRY**, **PROP_ENTRY_EX**, **PROP_PAGE**

CHAIN_MSG_MAP

CHAIN_MSG_MAP(*theChainClass*)

Parameters

theChainClass [in] The name of the base class containing the message map.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP** directs messages to a base class's default message map (declared with **BEGIN_MSG_MAP**). To direct messages to a base class's alternate message map (declared with **ALT_MSG_MAP**), use **CHAIN_MSG_MAP_ALT**.

For example:

```
class CMyClass : public CMyBaseClass, ...
{
public:
   ...

   BEGIN_MSG_MAP(CMyClass)
      MESSAGE_HANDLER(WM_PAINT, OnPaint)
```

```
      // chain to default message map in CMyBaseClass
      CHAIN_MSG_MAP(CMyBaseClass)
   ALT_MSG_MAP(1)
      // chain to default message map in CMyBaseClass
      CHAIN_MSG_MAP(CMyBaseClass)
   ALT_MSG_MAP(2)
      MESSAGE_HANDLER(WM_CHAR, OnChar)
      // chain to alternate message map in CMyBaseClass
      CHAIN_MSG_MAP_ALT(CMyBaseClass, 1)
   END_MSG_MAP

   ...
};
```

This example illustrates the following:

- If a window procedure is using `CMyClass`'s default message map and `OnPaint` does not handle a message, the message is directed to `CMyBaseClass`'s default message map for processing.
- If a window procedure is using the first alternate message map in `CMyClass`, all messages are directed to `CMyBaseClass`'s default message map.
- If a window procedure is using `CMyClass`'s second alternate message map and `OnChar` does not handle a message, the message is directed to the specified alternate message map in `CMyBaseClass`. `CMyBaseClass` must have declared this message map with `ALT_MSG_MAP(1)`.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CHAIN_MSG_MAP_MEMBER, CHAIN_MSG_MAP_DYNAMIC, MESSAGE_HANDLER**

CHAIN_MSG_MAP_ALT

CHAIN_MSG_MAP_ALT(*theChainClass*, *msgMapID* **)**

Parameters

theChainClass [in] The name of the base class containing the message map.

msgMapID [in] The message map identifier.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP_ALT** directs messages to an alternate message map in a base class. You must have declared this alternate

message map with **ALT_MSG_MAP(*msgMapID*)**. To direct messages to a base class's default message map (declared with **BEGIN_MSG_MAP**), use **CHAIN_MSG_MAP**. For an example, see **CHAIN_MSG_MAP**.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CHAIN_MSG_MAP_ALT_MEMBER**, **CHAIN_MSG_MAP_ALT_DYNAMIC**

CHAIN_MSG_MAP_ALT_DYNAMIC

CHAIN_MSG_MAP_ALT_DYNAMIC(*dynaChainID*, *msgMapID* **)**

Parameters

dynaChainID [in] The unique identifier for an object and its message map.

msgMapID [in] The message map identifier.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP_ALT_DYNAMIC** directs messages, at run time, to an alternate message map in another object. You must have declared this alternate message map with **ALT_MSG_MAP(*msgMapID*)**.

The chained object and its message map are associated with the *dynaChainID* value, which you define through **CDynamicChain::SetChainEntry**. You must derive your class from **CDynamicChain** in order to use **CHAIN_MSG_MAP_ALT_DYNAMIC**.

To direct messages at run time to another object's default message map (declared with **BEGIN_MSG_MAP**), use **CHAIN_MSG_MAP_DYNAMIC**. For an example, see the **CDynamicChain** overview.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CHAIN_MSG_MAP_ALT**, **CHAIN_MSG_MAP_ALT_MEMBER**

CHAIN_MSG_MAP_ALT_MEMBER

CHAIN_MSG_MAP_ALT_MEMBER(*theChainMember*, *msgMapID* **)**

Parameters

theChainMember [in] The name of the data member containing the message map.

msgMapID [in] The message map identifier.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP_ALT_MEMBER** directs messages to an alternate message map in a data member. You must have declared this alternate message map with **ALT_MSG_MAP**(*msgMapID*). To direct messages to a data member's default message map (declared with **BEGIN_MSG_MAP**), use **CHAIN_MSG_MAP_MEMBER**. For an example, see **CHAIN_MSG_MAP_MEMBER**.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CHAIN_MSG_MAP_ALT, CHAIN_MSG_MAP_ALT_DYNAMIC**

CHAIN_MSG_MAP_DYNAMIC

CHAIN_MSG_MAP_DYNAMIC(*dynaChainID* **)**

Parameters

dynaChainID [in] The unique identifier for an object's message map.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP_DYNAMIC** directs messages, at run time, to the default message map in another object. The object and its message map are associated with *dynaChainID*, which you define through **CDynamicChain::SetChainEntry**. You must derive your class from **CDynamicChain** in order to use **CHAIN_MSG_MAP_DYNAMIC**. For an example, see the **CDynamicChain** overview.

To direct messages at run time to another object's alternate message map (declared with **ALT_MSG_MAP**), use **CHAIN_MSG_MAP_ALT_DYNAMIC**.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro

marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **CHAIN_MSG_MAP, CHAIN_MSG_MAP_MEMBER**

CHAIN_MSG_MAP_MEMBER

CHAIN_MSG_MAP_MEMBER(*theChainMember* **)**

Parameters

theChainMember [in] The name of the data member containing the message map.

Remarks

Defines an entry in a message map. **CHAIN_MSG_MAP_MEMBER** directs messages to a data member's default message map (declared with **BEGIN_MSG_MAP**). To direct messages to a data member's alternate message map (declared with **ALT_MSG_MAP**), use **CHAIN_MSG_MAP_ALT_MEMBER**.

For example:

```
class CMyClass : ...
{
public:
   CMyContainedClass m_obj;
   ...

   BEGIN_MSG_MAP(CMyClass)
      MESSAGE_HANDLER(WM_PAINT, OnPaint)
      // chain to default message map of m_obj
      CHAIN_MSG_MAP_MEMBER(m_obj)
   ALT_MSG_MAP(1)
      // chain to default message map of m_obj
      CHAIN_MSG_MAP(m_obj)
   ALT_MSG_MAP(2)
      MESSAGE_HANDLER(WM_CHAR, OnChar)
      // chain to alternate message map of m_obj
      CHAIN_MSG_MAP_ALT(m_obj, 1)
   END_MSG_MAP

   ...
};
```

This example illustrates the following:

- If a window procedure is using `CMyClass`'s default message map and `OnPaint` does not handle a message, the message is directed to `m_obj`'s default message map for processing.

- If a window procedure is using the first alternate message map in `CMyClass`, all messages are directed to `m_obj`'s default message map.
- If a window procedure is using `CMyClass`'s second alternate message map and `OnChar` does not handle a message, the message is directed to the specified alternate message map of `m_obj`. Class `CMyContainedClass` must have declared this message map with `ALT_MSG_MAP(1)`.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: CHAIN_MSG_MAP, CHAIN_MSG_MAP_DYNAMIC, MESSAGE_HANDLER

COM_INTERFACE_ENTRY Macros

These macros enter an object's interfaces into its COM map so that they can be accessed by **QueryInterface**. The order of entries in the COM map is the order interfaces will be checked for a matching IID during **QueryInterface**.

Each object that wants to expose its interfaces via **QueryInterface** must have its own COM map. The COM map starts with the macro **BEGIN_COM_MAP**. Interface entries are added with one or more of the **COM_INTERFACE_ENTRY** macros, and the map is completed with the **END_COM_MAP** macro. For example:

```
BEGIN_COM_MAP(CMyObject)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY(IMyObject)
END_COM_MAP( )
```

See the ATL COMMAP sample online for examples using the different types of COM map entry macros.

Note that the first entry in the COM map must be an interface on the object containing the COM map. Thus, you cannot start your COM map entries with **COM_INTERFACE_ENTRY_CHAIN**, which causes the COM map of a different object to be searched at the point where **COM_INTERFACE_ENTRY_CHAIN**(*Chis*) appears in your object's COM map. If you want to search the COM map of another object first, add an interface entry for **IUnknown** to your COM map, then chain the other object's COM map. For example:

```
BEGIN_COM_MAP(CThisObject)
   COM_INTERFACE_ENTRY(IUnknown)
   COM_INTERFACE_ENTRY_CHAIN(COtherObject)
END_COM_MAP( )
```

The following are the available entry macros:

COM Map Entry Macros

COM_INTERFACE_ENTRY
COM_INTERFACE_ENTRY_IID
COM_INTERFACE_ENTRY2
COM_INTERFACE_ENTRY2_IID
COM_INTERFACE_ENTRY_IMPL
COM_INTERFACE_ENTRY_IMPL_IID
COM_INTERFACE_ENTRY_FUNC
COM_INTERFACE_ENTRY_FUNC_BLIND
COM_INTERFACE_ENTRY_TEAR_OFF
COM_INTERFACE_ENTRY_CACHED_TEAR_OFF
COM_INTERFACE_ENTRY_AGGREGATE
COM_INTERFACE_ENTRY_AGGREGATE_BLIND
COM_INTERFACE_ENTRY_AUTOAGGREGATE
COM_INTERFACE_ENTRY_AUTOAGGREGATE_BLIND
COM_INTERFACE_ENTRY_CHAIN
COM_INTERFACE_ENTRY_BREAK
COM_INTERFACE_ENTRY_NOINTERFACE

COM_INTERFACE_ENTRY

COM_INTERFACE_ENTRY(*x* **)**

Parameters

x [in] The name of an interface your class object derives from directly.

Remarks

Typically, this is the entry type you use most often.

For example:

```
BEGIN_COM_MAP(CThisExample)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY(IBaseThisExample)
   COM_INTERFACE_ENTRY(ISupportErrorInfo)
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY2

COM_INTERFACE_ENTRY2(*x, x2* **)**

Parameters

x [in] The name of an interface you want to expose from your object.

x2 [in] The name of the inheritance branch from which *x* is exposed.

Remarks

Use this macro to disambiguate two branches of inheritance. For example, if you derive your class object from two dual interfaces, you expose **IDispatch** using **COM_INTERFACE_ENTRY2** since **IDispatch** can be obtained from either one of the interfaces.

For example, from the ATL sample COMMAP:

```
class COuter :
   public CChainBase, // CChainBase derives from
                      // IDispatch
   public IDispatchImpl<IOuter, &IID_IOuter,
                        &LIBID_COMMAPLib)>,
   public CComCoClass<COuter, &CLSID_COuter>
{
public:
   COuter(){}
   ...

   BEGIN_COM_MAP(COuter)
      COM_INTERFACE_ENTRY2(IDispatch, IOuter)
   ...
   END_COM_MAP

};
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY2_IID

COM_INTERFACE_ENTRY2_IID(*iid, x, x2* **)**

Parameters

iid [in] The GUID you are specifying for the interface.

x [in] The name of an interface that your class object derives from directly.

x2 [in] The name of a second interface that your class object derives from directly.

Remarks

As **COM_INTERFACE_ENTRY2**, except you can specify a different IID.

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_AGGREGATE

COM_INTERFACE_ENTRY_AGGREGATE(*iid*, *punk* **)**

Parameters

iid [in] The GUID of the interface queried for.

punk [in] The name of an **IUnknown** pointer.

Remarks

When the interface identified by *iid* is queried for, **COM_INTERFACE_ENTRY_AGGREGATE** forwards to *punk*. The *punk* parameter is assumed to point to the inner unknown of an aggregate or to **NULL**, in which case the entry is ignored. Typically, you would **CoCreate** the aggregate in **FinalConstruct**.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   ...
   COM_INTERFACE_ENTRY_AGGREGATE(IID_IAgg, m_pUnkAgg.p)
   ...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_AGGREGATE_BLIND

COM_INTERFACE_ENTRY_AGGREGATE_BLIND(*punk* **)**

Parameters

punk [in] The name of an **IUnknown** pointer.

Remarks

Same as **COM_INTERFACE_ENTRY_AGGREGATE**, except that querying for any IID results in forwarding the query to *punk*. If the interface query fails, processing of the COM map continues.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   ...
   COM_INTERFACE_ENTRY_AGGREGATE_BLIND(m_pUnkAggBlind.p)
   ...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_AUTOAGGREGATE

COM_INTERFACE_ENTRY_AUTOAGGREGATE(*iid*, *punk*, *clsid* **)**

Parameters

iid [in] The GUID of the interface queried for.

punk [in] The name of an **IUnknown** pointer. Must be a member of the class containing the COM map.

clsid [in] The identifier of the aggregate that will be created if *punk* is **NULL**.

Remarks

Same as **COM_INTERFACE_ENTRY_AGGREGATE**, except if *punk* is **NULL**, it automatically creates the aggregate described by the *clsid*.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
...
   COM_INTERFACE_ENTRY_AUTOAGGREGATE(IID_IAutoAgg, m_pUnkAutoAgg.p, CLSID_CAutoAgg)
...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_AUTOAGGREGATE_BLIND

COM_INTERFACE_ENTRY_AUTOAGGREGATE_BLIND(*punk*, *clsid* **)**

Parameters

punk [in] The name of an **IUnknown** pointer. Must be a member of the class containing the COM map.

clsid [in] The identifier of the aggregate that will be created if *punk* is **NULL**.

Remarks

Same as **COM_INTERFACE_ENTRY_AUTOAGGREGATE**, except that querying for any IID results in forwarding the query to *punk*, and if *punk* is **NULL**, automatically creating the aggregate described by the *clsid*. If the interface query fails, processing of the COM map continues.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   ...
   COM_INTERFACE_ENTRY_AUTOAGGREGATE_BLIND(m_pUnkAutoAggB.p, CLSID_CAutoAggB)
   ...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_BREAK

COM_INTERFACE_ENTRY_BREAK(*x* **)**

Parameters

x [in] Text used to construct the interface identifier.

Remarks

Causes your program to call **DebugBreak** when the specified interface is queried for.

The interface IID will be constructed by appending *x* to `IID_`. For example, if *x* is `IPersistStorage`, the IID will be `IID_IPersistStorage`.

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_CACHED_TEAR_OFF

COM_INTERFACE_ENTRY_CACHED_TEAR_OFF(*iid*, *x*, *punk* **)**

Parameters

iid [in] The GUID of the tear-off interface.

x [in] The name of the class implementing the interface.

punk [in] The name of an **IUnknown** pointer. Must be a member of the class containing the COM map. Should be initialized to **NULL** in the class object's constructor.

Remarks

Saves the interface specific data for every instance. If the interface is not used, this lowers the overall instance size of your object.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   ...
   COM_INTERFACE_ENTRY_CACHED_TEAR_OFF(IID_ITearOff2,
      CTearOff2, m_pUnkTearOff2.p)
   ...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_CHAIN

COM_INTERFACE_ENTRY_CHAIN(*classname* **)**

Parameters

classname [in] A base class of the current object.

Remarks

Processes the COM map of the base class when the processing reaches this entry in the COM map.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   COM_INTERFACE_ENTRY2(IDispatch, IOuter)
   ...
   COM_INTERFACE_ENTRY_CHAIN(CChainBase)
   ...
END_COM_MAP()
```

Note that the first entry in the COM map must be an interface on the object containing the COM map. Thus, you cannot start your COM map entries with **COM_INTERFACE_ENTRY_CHAIN**, which causes the COM map of a different object to be searched at the point where **COM_INTERFACE_ENTRY_CHAIN(***CO*ther*Object*) appears in your object's COM map. If you want to search the COM map of another object first, add an interface entry for **IUnknown** to your COM map, then chain the other object's COM map. For example:

```
BEGIN_COM_MAP(CThisObject)
   COM_INTERFACE_ENTRY(IUnknown)
   COM_INTERFACE_ENTRY_CHAIN(COtherObject)
END_COM_MAP( )
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_FUNC

COM_INTERFACE_ENTRY_FUNC(*iid*, *dw*, *func* **)**

Parameters

iid [in] The GUID of the interface exposed.

dw [in] A parameter passed through to the *func*.

func [in] The function pointer that will return *iid*.

Remarks

A general mechanism for hooking into ATL's **QueryInterface** logic. If *iid* matches the IID of the interface queried for, then the function specified by *func* is called.

The declaration for the function should be:

```
HRESULT WINAPI func(void* pv, REFIID riid, LPVOID* ppv, DWORD dw);
```

When your function is called, *pv* points to your class object. The *riid* parameter refers to the interface being queried for, *ppv* is the pointer to the location where the function should store the pointer to the interface, and *dw* is the parameter you specified in the entry. The function should set **ppv* to **NULL** and return **E_NOINTERFACE** or **S_FALSE** if it chooses not to return an interface. With **E_NOINTERFACE**, COM map processing terminates. With **S_FALSE**, COM map processing continues, even though no interface pointer was returned. If the function returns an interface pointer, it should return **S_OK**.

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_FUNC_BLIND

COM_INTERFACE_ENTRY_FUNC_BLIND(*dw*, *func* **)**

Parameters

dw [in] A parameter passed through to the *func*.

func [in] The function that gets called when this entry in the COM map is processed.

Remarks

Same as **COM_INTERFACE_ENTRY_FUNC**, except that querying for any IID results in a call to *func*. Any failure will cause processing to continue on the COM map. If the function returns an interface pointer, it should return **S_OK**.

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_IID

COM_INTERFACE_ENTRY_IID(*iid*, *x* **)**

Parameters

iid [in] The GUID of the interface exposed.

x [in] The name of the class whose vtable will be exposed as the interface identified by *iid*.

Remarks

Use this macro to enter the interface into the COM map and specify its IID.

For example:

```
BEGIN_COM_MAP(CThisExample)
   COM_INTERFACE_ENTRY_IID(*piid, CThisExample)
   COM_INTERFACE_ENTRY(IDispatch)
   COM_INTERFACE_ENTRY(IBaseThisExample)
```

```
   COM_INTERFACE_ENTRY(ISupportErrorInfo)
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_IMPL

COM_INTERFACE_ENTRY_IMPL(*x* **)**

Parameters

x [in] Text used to construct the interface ID and to construct the name of the class whose vtable entries will be exposed.

Remarks

Use this macro to construct the interface ID (IID), construct the interface name, and enter the interface into the COM map.

The IID will be constructed by appending *x* to `IID_`. For example, if *x* is `IPersistStorage`, the IID will be `IID_IPersistStorage`.

The class name is constructed by prepending *x* to `Impl` and a templatization on the object exposing the class in its COM map. For example, if *x* is `IPersistStorage` and the object exposing the class is `CThisCtl`, the class will be `IPersistStorageImpl<CThisCtl>`.

Use **COM_INTERFACE_ENTRY_IMPL** to construct a class that has the same vtable as a needed interface but is templatized on the object exposing that interface through its COM map. While you can accomplish the same thing by coding `COM_INTERFACE_ENTRY_IID(IID_x, xImpl<CThisCtl>)`, **COM_INTERFACE_ENTRY_IMPL** is more convenient.

For example:

```
class CCircCtl :
   ...
   public IPersistStreamInitImpl<CCircCtl>,
   public IPersistStorageImpl<CCircCtl>,
   ...
{
public:
   ...
   BEGIN_COM_MAP(CCircCtl)
      ...
      COM_INTERFACE_ENTRY_IMPL(IPersistStorage)
      COM_INTERFACE_ENTRY_IMPL(IPersistStreamInit)
      ...
      END_COM_MAP()
      ...
};
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_IMPL_IID

COM_INTERFACE_ENTRY_IMPL_IID(*iid*, *x* **)**

Parameters

iid [in] The GUID of the interface exposed.

x [in] Text used to construct the name of the class whose vtable entries will be exposed.

Remarks

Use this macro to specify the interface IID, construct the interface name, and enter the interface into the COM map.

The class name is constructed by appending `Impl` to *x* and then appending a templatization on the object exposing the class in its COM map. For example, if *x* is `IPersistStorage` and the object exposing the class is `CThisCtl`, the class name will be `IPersistStorageImpl<CThisCtl>`.

Use **COM_INTERFACE_ENTRY_IMPL_IID** to construct a class that has the same vtable as a needed interface but is templatized on the object exposing that interface through its COM map. While you can accomplish the same thing by coding `COM_INTERFACE_ENTRY_IID(iid, xImpl<CThisCtl>)`, **COM_INTERFACE_ENTRY_IMPL_IID** is more convenient.

For example:

```
class CCircCtl :
   ...
   public IPersistPropertyBagImpl<CCircCtl>,
   ...
{
public:
   ...
   BEGIN_COM_MAP(CCircCtl)
      ...
      COM_INTERFACE_ENTRY_IMPL_IID(IID_IPersist,
         IPersistPropertyBag)
      ...
   END_COM_MAP()
   ...
};
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_NOINTERFACE

COM_INTERFACE_ENTRY_NOINTERFACE(*x* **)**

Parameters

x [in] Text used to construct the interface identifier.

Remarks

Returns **E_NOINTERFACE** and terminates COM map processing when the specified interface is queried for. You can use this macro to prevent an interface from being used in a particular case. For example, you can insert this macro into your COM map right before **COM_INTERFACE_ENTRY_AGGREGATE_BLIND** to prevent a query for the interface from being forwarded to the aggregate's inner unknown.

The interface IID will be constructed by appending *x* to `IID_`. For example, if *x* is `IPersistStorage`, the IID will be `IID_IPersistStorage`.

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COM_INTERFACE_ENTRY_TEAR_OFF

COM_INTERFACE_ENTRY_TEAR_OFF(*iid*, *x* **)**

Parameters

iid [in] The GUID of the tear-off interface.

x [in] The name of the class implementing the interface.

Remarks

Exposes your tear-off interfaces. A tear-off interface is implemented as a separate object that is instantiated every time the interface it represents is queried for. Typically, you build your interface as a tear-off if the interface is rarely used, since this saves a vtable pointer in every instance of your main object. The tear-off is deleted when its reference count becomes zero. The class implementing the tear-off should be derived from **CComTearOffObjectBase** and have its own COM map.

For example, from the ATL sample COMMAP:

```
BEGIN_COM_MAP(COuter)
   ...
   COM_INTERFACE_ENTRY_TEAR_OFF(IID_ITearOff1, CTearOff1)
   ...
END_COM_MAP()
```

See **COM_INTERFACE_ENTRY Macros** for remarks about COM map entries.

COMMAND_CODE_HANDLER

COMMAND_CODE_HANDLER(*code*, *func* **)**

Parameters

code [in] The notification code.

func [in] The name of the message-handler function.

Remarks

Similar to **COMMAND_HANDLER**, but maps a **WM_COMMAND** message based only on the notification code.

See Also: COMMAND_ID_HANDLER, COMMAND_RANGE_HANDLER, MESSAGE_HANDLER, NOTIFY_CODE_HANDLER

COMMAND_HANDLER

COMMAND_HANDLER(*id, code, func* **)**

Parameters

id [in] The identifier of the menu item, control, or accelerator.

code [in] The notification code.

func [in] The name of the message-handler function.

Remarks

Defines an entry in a message map. **COMMAND_HANDLER** maps a **WM_COMMAND** message to the specified handler function, based on the notification code and the control identifier. For example:

```
class CMyClass : ...
{
public:
   ...

   BEGIN_MSG_MAP(CMyClass)
      COMMAND_HANDLER(IDC_MYCTL, EN_CHANGE, OnChange)
      ...
   END_MSG_MAP()

   // When a CMyClass object receives a WM_COMMAND
   // message identified by IDC_MYCTL and EN_CHANGE,
   // the message is directed to CMyClass::OnChange
   // for the actual processing.
   LRESULT OnChange( ... )
   { ... }

};
```

Any function specified in a **COMMAND_HANDLER** macro must defined as follows:

```
LRESULT CommandHandler(WORD wNotifyCode, WORD wID, HWND hWndCtl,
                       BOOL& bHandled);
```

The message map sets `bHandled` to **TRUE** before `CommandHandler` is called. If `CommandHandler` does not fully handle the message, it should set `bHandled` to **FALSE** to indicate the message needs further processing.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

In addition to **COMMAND_HANDLER**, you can use **MESSAGE_HANDLER** to map a **WM_COMMAND** message without regard to an identifier or code. In this case, `MESSAGE_HANDLER(WM_COMMAND, OnHandlerFunction)` will direct all **WM_COMMAND** messages to `OnHandlerFunction`.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **COMMAND_ID_HANDLER**, **COMMAND_CODE_HANDLER**, **COMMAND_RANGE_HANDLER**, **NOTIFY_HANDLER**

COMMAND_ID_HANDLER

COMMAND_ID_HANDLER(*id*, *func* **)**

Parameters

id [in] The identifier of the menu item, control, or accelerator sending the message.

func [in] The name of the message-handler function.

Remarks

Similar to **COMMAND_HANDLER**, but maps a **WM_COMMAND** message based only on the identifier of the menu item, control, or accelerator.

See Also: **COMMAND_CODE_HANDLER**, **COMMAND_RANGE_HANDLER**, **MESSAGE_HANDLER**, **NOTIFY_ID_HANDLER**

COMMAND_RANGE_HANDLER

COMMAND_RANGE_HANDLER(*idFirst*, *idLast*, *func* **)**

Parameters

idFirst [in] Marks the beginning of a contiguous range of **WM_COMMAND** messages.

idLast [in] Marks the end of a contiguous range of **WM_COMMAND** messages.

func [in] The name of the message-handler function.

Remarks

Similar to **COMMAND_HANDLER**, but maps a range of **WM_COMMAND** messages to a single handler function. This range is based on the identifier of the menu item, control, or accelerator sending the message.

See Also: **COMMAND_ID_HANDLER, COMMAND_CODE_HANDLER, MESSAGE_RANGE_HANDLER, NOTIFY_RANGE_HANDLER**

CONNECTION_POINT_ENTRY

CONNECTION_POINT_ENTRY(*iid* **)**

Parameters

iid [in] The GUID of the interface being added to the connection point map.

Remarks

Enters a connection point for the specified interface into the connection point map so that it can be accessed. Connection point entries in the map are used by **IConnectionPointContainerImpl**. The class containing the connection point map must inherit from **IConnectionPointContainerImpl**. For example:

```
class CMyCPClass :
   public IConnectionPointContainerImpl,
   public IPropertyNotifySinkImpl<CMyCPClass>
{
public:
   ...
   BEGIN_CONNECTION_POINT_MAP(CMyCPClass)
      CONNECTION_POINT_ENTRY(IID_IPropertyNotifySink)
   END_CONNECTION_POINT_MAP( )
   ...
};
```

Start your connection point map with the **BEGIN_CONNECTION_POINT_MAP** macro, add entries for each of your connection points with the **CONNECTION_POINT_ENTRY** macro, and complete the map with the **END_CONNECTION_POINT_MAP** macro.

For more information about connection points in ATL, see the article "Connection Points."

DECLARE_AGGREGATABLE

DECLARE_AGGREGATABLE(*x* **)**

Parameters

x [in] The name of the class you are defining as aggregatable.

Remarks

Specifies that your object can be aggregated. **CComCoClass** contains this macro to specify the default aggregation model. To override this default, specify either the **DECLARE_NOT_AGGREGATABLE** or

DECLARE_ONLY_AGGREGATABLE macro in your class definition. For example:

```
class CMyClass : public CComCoClass< .. >, ...
{
public:
   DECLARE_NOT_AGGREGATABLE(CMyClass)
   ...
};
```

DECLARE_CLASSFACTORY

DECLARE_CLASSFACTORY( )

Remarks

Declares **CComClassFactory** to be the class factory. **CComCoClass** uses this macro to declare the default class factory for your object.

See Also: DECLARE_CLASSFACTORY_EX, DECLARE_CLASSFACTORY2, DECLARE_CLASSFACTORY_AUTO_THREAD, DECLARE_CLASSFACTORY_SINGLETON

DECLARE_CLASSFACTORY2

DECLARE_CLASSFACTORY2(*lic* **)**

Parameters

lic [in] A class that implements **VerifyLicenseKey**, **GetLicenseKey**, and **IsLicenseValid**.

Remarks

Declares **CComClassFactory2** to be the class factory. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
   ...
   DECLARE_CLASSFACTORY2(CMyLicense)
   ...
};
```

CComCoClass includes the **DECLARE_CLASSFACTORY** macro, which specifies **CComClassFactory** as the default class factory. However, by including the **DECLARE_CLASSFACTORY2** macro in your object's class definition, you override this default.

See Also: DECLARE_CLASSFACTORY_EX, DECLARE_CLASSFACTORY_AUTO_THREAD, DECLARE_CLASSFACTORY_SINGLETON

DECLARE_CLASSFACTORY_AUTO_THREAD

DECLARE_CLASSFACTORY_AUTO_THREAD( )

Remarks

Declares **CComClassFactoryAutoThread** to be the class factory. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
   ...
   DECLARE_CLASSFACTORY_AUTO_THREAD( )
   ...
};
```

CComCoClass includes the **DECLARE_CLASSFACTORY** macro, which specifies **CComClassFactory** as the default class factory. However, by including the **DECLARE_CLASSFACTORY_AUTO_THREAD** macro in your object's class definition, you override this default.

See Also: DECLARE_CLASSFACTORY_EX, DECLARE_CLASSFACTORY2, DECLARE_CLASSFACTORY_SINGLETON

DECLARE_CLASSFACTORY_EX

DECLARE_CLASSFACTORY_EX(*cf* **)**

Parameters

cf [in] The name of the class that implements your class factory object.

Remarks

Declares *cf* to be the class factory. *cf* must derive from **CComClassFactory** and override the **CreateInstance** method. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
   ...
   DECLARE_CLASSFACTORY_EX(CMyClassFactory)
   ...
};
```

CComCoClass includes the **DECLARE_CLASSFACTORY** macro, which specifies **CComClassFactory** as the default class factory. However, by including the **DECLARE_CLASSFACTORY_EX** macro in your object's class definition, you override this default.

See Also: DECLARE_CLASSFACTORY2, DECLARE_CLASSFACTORY_AUTO_THREAD, DECLARE_CLASSFACTORY_SINGLETON

DECLARE_CLASSFACTORY_SINGLETON

DECLARE_CLASSFACTORY_SINGLETON(*obj* **)**

Parameters

obj [in] The name of your class object.

Remarks

Declares **CComClassFactorySingleton** to be the class factory. For example:

```
class CMyClass : ..., public CComCoClass< ... >
{
   ...
   DECLARE_CLASSFACTORY_SINGLETON(CMyClass)
   ...
};
```

CComCoClass includes the **DECLARE_CLASSFACTORY** macro, which specifies **CComClassFactory** as the default class factory. However, by including the **DECLARE_CLASSFACTORY_SINGLETON** macro in your object's class definition, you override this default.

See Also: DECLARE_CLASSFACTORY2, DECLARE_CLASSFACTORY_EX, DECLARE_CLASSFACTORY_AUTO_THREAD

DECLARE_GET_CONTROLLING_UNKNOWN

DECLARE_GET_CONTROLLING_UNKNOWN( )

Remarks

Declares a virtual function **GetControllingUnknown**. Add this macro to your object if you get the compiler error message that **GetControllingUnknown** is undefined (for example, in **CComAggregateCreator**).

See Also: DECLARE_AGGREGATABLE

DECLARE_NO_REGISTRY

DECLARE_NO_REGISTRY( )

Remarks

Use **DECLARE_NO_REGISTRY** if you want to avoid any default ATL registration for the class in which this macro appears.

See Also: DECLARE_REGISTRY, DECLARE_REGISTRY_RESOURCE, DECLARE_REGISTRY_RESOURCEID

DECLARE_NOT_AGGREGATABLE

DECLARE_NOT_AGGREGATABLE(*x* **)**

Parameters

x [in] The name of the class object you are defining as not aggregatable.

Remarks

Specifies that your object cannot be aggregated.
DECLARE_NOT_AGGREGATABLE causes **CreateInstance** to return an error (**CLASS_E_NOAGGREGATION**) if an attempt is made to aggregate onto your object.

By default, **CComCoClass** contains the **DECLARE_AGGREGATABLE** macro, which specifies that your object can be aggregated. To override this default behavior, include **DECLARE_NOT_AGGREGATABLE** in your class definition. For example:

```
class CMyClass : public CComCoClass< .. >, ...
{
public:
   DECLARE_NOT_AGGREGATABLE(CMyClass)
   ...
};
```

See Also: **DECLARE_ONLY_AGGREGATABLE**

DECLARE_OBJECT_DESCRIPTION

DECLARE_OBJECT_DESCRIPTION(*x* **)**

Parameters

x [in] The class object's description.

Remarks

Allows you to specify a text description for your class object. ATL enters this description into the object map through the **OBJECT_ENTRY** macro.

DECLARE_OBJECT_DESCRIPTION implements a **GetObjectDescription** function, which you can use to override the **CComCoClass::GetObjectDescription** method. For example:

```
class CMyClass : public CComCoClass< ... >, ...
{
public:
   // Override CComCoClass::GetObjectDescription
   DECLARE_OBJECT_DESCRIPTION("Account Transfer Object 1.0")

   ...
};
```

The **GetObjectDescription** function is called by **IComponentRegistrar::GetComponents**. **IComponentRegistrar** is an Automation interface that allows you to register and unregister individual components in a DLL. When you create a Component Registrar object with the ATL Object Wizard, the wizard will automatically implement the **IComponentRegistrar** interface. **IComponentRegistrar** is typically used by Microsoft Transaction Server.

For more information about the ATL Object Wizard, see the article "Creating an ATL Project."

DECLARE_ONLY_AGGREGATABLE

DECLARE_ONLY_AGGREGATABLE(*x* **)**

Parameters

x [in] The name of the class object you are defining as only aggregatable.

Remarks

Specifies that your object must be aggregated. **DECLARE_ONLY_AGGREGATABLE** causes an error (**E_FAIL**) if an attempt is made to **CoCreate** your object as nonaggregated object.

By default, **CComCoClass** contains the **DECLARE_AGGREGATABLE** macro, which specifies that your object can be aggregated. To override this default behavior, include **DECLARE_ONLY_AGGREGATABLE** in your class definition. For example:

```
class CMyClass : public CComCoClass< .. >, ...
{
public:
   DECLARE_ONLY_AGGREGATABLE(CMyClass)
   ...
};
```

See Also: **DECLARE_NOT_AGGREGATABLE**

DECLARE_POLY_AGGREGATABLE

DECLARE_POLY_AGGREGATABLE(*x* **)**

Parameters

x [in] The name of the class object you are defining as aggregatable or not aggregatable.

Remarks

Specifies that an instance of **CComPolyObject** < *x* > is created when your object is created. During creation, the value of the outer unknown is checked. If it is **NULL**,

IUnknown is implemented for a nonaggregated object. If the outer unknown is not **NULL**, **IUnknown** is implemented for an aggregated object.

The advantage of using **DECLARE_POLY_AGGREGATABLE** is that you avoid having both **CComAggObject** and **CComObject** in your module to handle the aggregated and nonaggregated cases. A single **CComPolyObject** object handles both cases. This means only one copy of the vtable and one copy of the functions exist in your module. If your vtable is large, this can substantially decrease your module size. However, if your vtable is small, using **CComPolyObject** can result in a slightly larger module size because it is not optimized for an aggregated or nonaggregated object, as are **CComAggObject** and **CComObject**.

The **DECLARE_POLY_AGGREGATABLE** macro is automatically declared in your object if you use the ATL Object Wizard to create a full control or Internet Explorer control.

See Also: **CComPolyObject**, **CComAggObject**, **CComObject**

DECLARE_PROTECT_FINAL_CONSTRUCT

DECLARE_PROTECT_FINAL_CONSTRUCT( )

Remarks

Protects your object from being deleted if (during **FinalConstruct**) the internal aggregated object increments the reference count then decrements the count to 0.

DECLARE_REGISTRY

DECLARE_REGISTRY(*class*, *pid*, *vpid*, *nid*, *flags* **)**

Parameters

class [in] Included for backward compatibility.

pid [in] An **LPCTSTR** that is a version-specific program identifier.

vpid [in] An **LPCTSTR** that is a version-independent program identifier.

nid [in] A **UINT** that is an index of the resource string in the registry to use as the description of the program.

flags [in] A **DWORD** containing the program's threading model in the registry. Must be one of the following values: **THREADFLAGS_APARTMENT**, **THREADFLAGS_BOTH**, or **AUTPRXFLAG**.

Remarks

Enters the standard class registration into the system registry or removes it from the system registry. The standard registration consists of the CLSID, the program ID, the version-independent program ID, description string, and the thread model.

When you create an object or control using the ATL Object Wizard, the wizard automatically implements script-based registry support and adds the **DECLARE_REGISTRY_RESOURCEID** macro to your files. If you do not want script-based registry support, you need to replace this macro with **DECLARE_REGISTRY**. **DECLARE_REGISTRY** only inserts the five basic keys described above into the registry. You must manually write code to insert other keys into the registry.

See Also: **DECLARE_REGISTRY_RESOURCE**

DECLARE_REGISTRY_RESOURCE

DECLARE_REGISTRY_RESOURCE(*x*)

Parameters

x [in] String identifier of your resource.

Remarks

Gets the named resource containing the registry file and runs the script to either enter objects into the system registry or remove them from the system registry.

When you create an object or control using the ATL Object Wizard, the wizard will automatically implement script-based registry support and add the **DECLARE_REGISTRY_RESOURCEID** macro, which is similar to **DECLARE_REGISTRY_RESOURCE**, to your files.

You can statically link with the ATL Registry Component (Registrar) for optimized registry access. To statically link to the Registrar code, add `#define _ATL_STATIC_REGISTRY` to your stdafx.h.

If you want ATL to substitute replacement values at run time, do not specify the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro. Instead, create an array of **_ATL_REGMAP_ENTRIES** structures, where each entry contains a variable placeholder paired with a value to replace the placeholder at run time. Then call **CComModule::UpdateRegistryFromResourceD** or **CComModule::UpdateRegistryFromResourceS**, passing the array. This adds all the replacement values in the **_ATL_REGMAP_ENTRIES** structures to the Registrar's replacement map.

For more information about replaceable parameters and scripting, see the article "The ATL Registry Component (Registrar)."

See Also: **DECLARE_REGISTRY**

DECLARE_REGISTRY_RESOURCEID

DECLARE_REGISTRY_RESOURCEID(*x* **)**

Parameters

x [in] Wizard-generated identifier of your resource.

Remarks

Same as **DECLARE_REGISTRY_RESOURCE** except that it uses a Wizard-generated **UINT** to identify the resource, rather than a string name.

When you create an object or control using the ATL Object Wizard, the wizard will automatically implement script-based registry support and add the **DECLARE_REGISTRY_RESOURCEID** macro to your files.

You can statically link with the ATL Registry Component (Registrar) for optimized registry access. To statically link to the Registrar code, add `#define _ATL_STATIC_REGISTRY` to your stdafx.h.

If you want ATL to substitute replacement values at run time, do not specify the **DECLARE_REGISTRY_RESOURCE** or **DECLARE_REGISTRY_RESOURCEID** macro. Instead, create an array of **_ATL_REGMAP_ENTRIES** structures, where each entry contains a variable placeholder paired with a value to replace the placeholder at run time. Then call **CComModule::UpdateRegistryFromResourceD** or **CComModule::UpdateRegistryFromResourceS**, passing the array. This adds all the replacement values in the **_ATL_REGMAP_ENTRIES** structures to the Registrar's replacement map.

For more information about replaceable parameters and scripting, see the article "The ATL Registry Component (Registrar)."

See Also: **DECLARE_REGISTRY, DECLARE_REGISTRY_RESOURCE**

DECLARE_WND_CLASS

DECLARE_WND_CLASS(*WndClassName* **)**

Parameters

WndClassName [in] The name of the new window class. If **NULL**, ATL will generate a window class name.

Remarks

Allows you to specify the name of a new window class, whose information will be managed by **CWndClassInfo**. **DECLARE_WND_CLASS** defines the new window class by implementing the following static function:

```
static CWndClassInfo& GetWndClassInfo();
```

CWindowImpl uses the **DECLARE_WND_CLASS** macro to create a window based on a new window class. To override this behavior, use the **DECLARE_WND_SUPERCLASS** macro or provide your own implementation of the **GetWndClassInfo** function.

For more information about using windows in ATL, see the article "ATL Window Classes."

DECLARE_WND_SUPERCLASS

DECLARE_WND_SUPERCLASS(*WndClassName*, *OrigWndClassName* **)**

Parameters

WndClassName [in] The name of the window class that will superclass *OrigWndClassName*. If **NULL**, ATL will generate a window class name.

OrigWndClassName [in] The name of an existing window class.

Remarks

Allows you to specify the name of a window class that will superclass an existing window class. **CWndClassInfo** manages the information of the superclass.

DECLARE_WND_SUPERCLASS implements the following static function:

```
static CWndClassInfo& GetWndClassInfo();
```

By default, **CWindowImpl** uses the **DECLARE_WND_CLASS** macro to create a window based on a new window class. By specifying the **DECLARE_WND_SUPERCLASS** macro in a **CWindowImpl**-derived class, the window class will be based on an existing class but will use your window procedure. This technique is called superclassing.

Besides using the **DECLARE_WND_CLASS** and **DECLARE_WND_SUPERCLASS** macros, you can override the **GetWndClassInfo** function with your own implementation.

For more information about superclassing, see "Window Procedure Superclassing" in the *Win32 SDK* online. For more information about using windows in ATL, see the article "ATL Window Classes."

END_COM_MAP

END_COM_MAP( )

Remarks

Ends the definition of your COM interface map.

See Also: **BEGIN_COM_MAP**, **COM_INTERFACE_ENTRY**

END_CONNECTION_POINT_MAP

END_CONNECTION_POINT_MAP( )

Remarks

Marks the end of the connection point map entries. Start your connection point map with the **BEGIN_CONNECTION_POINT_MAP** macro, add entries for each of your connection points with the **CONNECTION_POINT_ENTRY** macro, and complete the map with the **END_CONNECTION_POINT_MAP** macro.

For example:

```
BEGIN_CONNECTION_POINT_MAP(CMyCPClass)
   CONNECTION_POINT_ENTRY(m_cpInterfaceBeingExposed)
END_CONNECTION_POINT_MAP( )
```

For more information about connection points in ATL, see the article "Connection Points."

END_MSG_MAP

END_MSG_MAP( )

Remarks

Marks the end of a message map. Always use the **BEGIN_MSG_MAP** macro to mark the beginning of a message map. Use **ALT_MSG_MAP** to declare subsequent alternate message maps. The following example shows the default message map and one alternate message map, each containing one handler function:

```
BEGIN_MSG_MAP(CMyClass)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
END_MSG_MAP
```

The next example shows two alternate message maps. The default message map is empty.

```
BEGIN_MSG_MAP(CMyClass)
ALT_MSG_MAP(1)
   MESSAGE_HANDLER(WM_PAINT, OnPaint)
   MESSAGE_HANDLER(WM_SETFOCUS, OnSetFocus)
ALT_MSG_MAP(2)
   MESSAGE_HANDLER(WM_CREATE, OnCreate)
END_MSG_MAP
```

Note that there is always exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

END_OBJECT_MAP

END_OBJECT_MAP( )

Remarks

Marks the end of the map of ATL objects. When **CComModule::RegisterServer** is called, it updates the system registry for each object in the object map.

Start your object map with the **BEGIN_OBJECT_MAP** macro, add entries for each object with the **OBJECT_ENTRY** macro, and complete the map with the **END_OBJECT_MAP** macro.

END_PROPERTY_MAP

END_PROPERTY_MAP( )

Remarks

Marks the end of the object's property map. When you create a control with the ATL Object Wizard, the wizard will create an empty property map by specifying **BEGIN_PROPERTY_MAP** followed by **END_PROPERTY_MAP**.

Example

See **BEGIN_PROPERTY_MAP**.

See Also: PROP_ENTRY, PROP_ENTRY_EX, PROP_PAGE

IMPLEMENT_BOOL_STOCKPROP

IMPLEMENT_BOOL_STOCKPROP(*fname*, *pname*, *dispid* **)**

Parameters

fname [in] Name used to create the names of the **put** and **get** methods.

pname [in] Name used to create the name of the data member that stores the property value.

dispid [in] The DISPID of the property.

Remarks

Implements stock properties that are boolean values. Same as the **IMPLEMENT_STOCKPROP** macro except that the **get** method tests the value of the data member containing the property and returns **VARIANT_TRUE** or **VARIANT_FALSE** rather than returning the value. This lets containers that do not interpret all non-zero values as **TRUE** to use the property. Standard stock properties that are boolean values are **Auto Size**, **Border Visible**, **Enabled**, **Tab Stop**, and **Valid**.

IMPLEMENT_BOOL_STOCKPROP creates a data member in your control class for a property, creates a **put** and **get** method for the property, and adds code to notify and synchronize with the container if the property changes.

The **put** and **get** method names are created by appending *fname* to `put_` and `get_`. For example, if *fname* is `Enabled`, the method names are `put_Enabled` and `get_Enabled`.

The data member name is created by appending *pname* to `m_`. For example, if *pname* is `bEnabled`, the data member is `m_bEnabled`.

See Also: CStockPropImpl, IMPLEMENT_BSTR_STOCKPROP, IMPLEMENT_STOCKPROP, CComControl::m_bEnabled, CComControl::m_bAutoSize, CComControl::m_bBorderVisible, CComControl::m_bTabStop, CComControl::m_bValid

IMPLEMENT_BSTR_STOCKPROP

IMPLEMENT_BSTR_STOCKPROP(*fname*, *pname*, *dispid* **)**

Parameters

fname [in] Name used to create the names of the **put** and **get** methods.

pname [in] Name used to create the name of the data member that stores the property value.

dispid [in] The DISPID of the property.

Remarks

Implements text stock properties. Allocates a **BSTR** data member in your control class and copies *pname* into the data member. Creates a **put** and **get** method for the property, and adds code to notify and synchronize with the container if the property changes. Standard **BSTR** stock properties are **Caption** and **Text**.

The **put** and **get** method names are created by appending *fname* to `put_` and `get_`. For example, if *fname* is `Caption`, the method names are `put_Caption` and `get_Caption`.

The data member name is created by appending *pname* to `m_`. For example, if *pname* is `bstrCaption`, the data member is `m_bstrCaption`.

See Also: CStockPropImpl, IMPLEMENT_STOCKPROP, IMPLEMENT_BOOL_STOCKPROP, CComControl::m_bstrCaption, CComControl::m_bstrText

IMPLEMENT_STOCKPROP

IMPLEMENT_STOCKPROP(*type*, *fname*, *pname*, *dispid* **)**

Parameters

type [in] The data type of the property.

fname [in] Name used to create the names of the **put** and **get** methods.

pname [in] Name used to create the name of the data member that stores the property value.

dispid [in] The DISPID of the property.

Remarks

Creates a data member in your control class for a property, creates a **put** and **get** method for the property, and adds code to notify and synchronize with the container if the property changes.

The **put** and **get** method names are created by appending *fname* to `put_` and `get_`. For example, if *fname* is `BorderWidth`, the method names are `put_BorderWidth` and `get_BorderWidth`.

The data member name is created by appending *pname* to `m_`. For example, if *pname* is `nBorderWidth`, the data member is `m_nBorderWidth`.

For text stock properties, use the **IMPLEMENT_BSTR_STOCKPROP** macro because it will automatically allocate a new string and copy the passed text into it. For boolean stock properties, use the **IMPLEMENT_BOOL_STOCKPROP** macro.

See Also: CStockPropImpl

MESSAGE_HANDLER

MESSAGE_HANDLER(*msg*, *func* **)**

Parameters

msg [in] The Windows message.

func [in] The name of the message-handler function.

Remarks

Defines an entry in a message map. **MESSAGE_HANDLER** maps a Windows message to the specified handler function. For example:

```
class CMyClass : ...
{
public:
   ...
```

```
    BEGIN_MSG_MAP(CMyClass)
       MESSAGE_HANDLER(WM_PAINT, OnPaint)
       ...
    END_MSG_MAP()

    // When a CMyClass object receives a WM_PAINT
    // message, the message is directed to
    // CMyClass::OnPaint for the actual processing.
    LRESULT OnPaint( ... )
    { ... }

};
```

Any function specified in a **MESSAGE_HANDLER** macro must defined as follows:

```
LRESULT MessageHandler(UINT uMsg, WPARAM wParam, LPARAM lParam,
                       BOOL& bHandled);
```

The message map sets `bHandled` to **TRUE** before `MessageHandler` is called. If `MessageHandler` does not fully handle the message, it should set `bHandled` to **FALSE** to indicate the message needs further processing.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

In addition to **MESSAGE_HANDLER**, you can use **COMMAND_HANDLER** and **NOTIFY_HANDLER** to map **WM_COMMAND** and **WM_NOTIFY** messages, respectively.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **MESSAGE_RANGE_HANDLER**

MESSAGE_RANGE_HANDLER

MESSAGE_RANGE_HANDLER(*msgFirst*, *msgLast*, *func*)

Parameters

msgFirst [in] Marks the beginning of a contiguous range of messages.

msgLast [in] Marks the end of a contiguous range of messages.

func [in] The name of the message-handler function.

Remarks

Similar to **MESSAGE_HANDLER**, but maps a range of Windows messages to a single handler function.

See Also: **COMMAND_RANGE_HANDLER**, **NOTIFY_RANGE_HANDLER**

NOTIFY_CODE_HANDLER

NOTIFY_CODE_HANDLER(*cd*, *func* **)**

Parameters

cd [in] The notification code.

func [in] The name of the message-handler function.

Remarks

Similar to **NOTIFY_HANDLER**, but maps a **WM_NOTIFY** message based only on the notification code.

See Also: NOTIFY_ID_HANDLER, NOTIFY_RANGE_HANDLER, COMMAND_CODE_HANDLER, MESSAGE_HANDLER

NOTIFY_HANDLER

NOTIFY_HANDLER(*id*, *cd*, *func* **)**

Parameters

id [in] The identifier of the control sending the message.

code [in] The notification code.

func [in] The name of the message-handler function.

Remarks

Defines an entry in a message map. **NOTIFY_HANDLER** maps a **WM_NOTIFY** message to the specified handler function, based on the notification code and the control identifier. For example:

```
class CMyClass : ...
{
public:
   ...

   BEGIN_MSG_MAP(CMyClass)
      NOTIFY_HANDLER(IDC_MYCTL, NM_CLICK, OnClick)
      ...
   END_MSG_MAP()

   // When a CMyClass object receives a WM_NOTIFY
   // message identified by IDC_MYCTL and NM_CLICK,
   // the message is directed to CMyClass::OnClick
   // for the actual processing.
   LRESULT OnClick( ... )
   { ... }

};
```

Any function specified in a **NOTIFY_HANDLER** macro must defined as follows:

```
LRESULT NotifyHandler(int idCtrl, LPNMHDR pnmh, BOOL& bHandled);
```

The message map sets `bHandled` to **TRUE** before `NotifyHandler` is called. If `NotifyHandler` does not fully handle the message, it should set `bHandled` to **FALSE** to indicate the message needs further processing.

Note Always begin a message map with **BEGIN_MSG_MAP**. You can then declare subsequent alternate message maps with **ALT_MSG_MAP**. The **END_MSG_MAP** macro marks the end of the message map. Every message map must have exactly one instance of **BEGIN_MSG_MAP** and **END_MSG_MAP**.

In addition to **NOTIFY_HANDLER**, you can use **MESSAGE_HANDLER** to map a **WM_NOTIFY** message without regard to an identifier or code. In this case, `MESSAGE_HANDLER(WM_NOTIFY, OnHandlerFunction)` will direct all **WM_NOTIFY** messages to `OnHandlerFunction`.

For more information about using message maps in ATL, see "Message Maps" in the article "ATL Window Classes."

See Also: **NOTIFY_ID_HANDLER, NOTIFY_CODE_HANDLER, NOTIFY_RANGE_HANDLER, COMMAND_HANDLER**

NOTIFY_ID_HANDLER

NOTIFY_ID_HANDLER(*id, func* **)**

Parameters

id [in] The identifier of the control sending the message.

func [in] The name of the message-handler function.

Remarks

Similar to **NOTIFY_HANDLER**, but maps a **WM_NOTIFY** message based only on the control identifier.

See Also: **NOTIFY_CODE_HANDLER, NOTIFY_RANGE_HANDLER, COMMAND_ID_HANDLER, MESSAGE_HANDLER**

NOTIFY_RANGE_HANDLER

NOTIFY_RANGE_HANDLER(*idFirst, idLast, func* **)**

Parameters

idFirst [in] Marks the beginning of a contiguous range of **WM_NOTIFY** messages.

idLast [in] Marks the end of a contiguous range of **WM_NOTIFY** messages.

func [in] The name of the message-handler function.

Remarks

Similar to **NOTIFY_HANDLER**, but maps a range of **WM_NOTIFY** messages to a single handler function. This range is based on the identifier of the control sending the message.

See Also: NOTIFY_ID_HANDLER, NOTIFY_CODE_HANDLER, COMMAND_RANGE_HANDLER, MESSAGE_RANGE_HANDLER

OBJECT_ENTRY

OBJECT_ENTRY(*clsid*, *class* **)**

Parameters

clsid [in] The CLSID of the ATL object to be entered into the object map.

class [in] The name of the class of the ATL object.

Remarks

Enters the function pointers of the creator class and class-factory creator class **CreateInstance** functions for this object into the ATL object map. When **CComModule::RegisterServer** is called, it updates the system registry for each object in the object map.

Start your object map with the **BEGIN_OBJECT_MAP** macro, add entries for each object with the **OBJECT_ENTRY** macro, and complete the map with the **END_OBJECT_MAP** macro.

See Also: DECLARE_OBJECT_DESCRIPTION

PROP_ENTRY

PROP_ENTRY(*szDesc*, *dispid*, *clsid* **)**

Parameters

szDesc [in] The property description.

dispid [in] The property's DISPID.

clsid [in] The CLSID of the associated property page.

Remarks

Use this macro to enter a property description, property DISPID, and property page CLSID into the object's property map. The **BEGIN_PROPERTY_MAP** macro marks the beginning of the property map; the **END_PROPERTY_MAP** macro marks the end.

Example

See **BEGIN_PROPERTY_MAP**.

See Also: PROP_ENTRY_EX, PROP_PAGE

PROP_ENTRY_EX

PROP_ENTRY_EX(*szDesc, dispid, clsid, iidDispatch* **)**

Parameters

szDesc [in] The property description.

dispid [in] The property's DISPID.

clsid [in] The CLSID of the associated property page.

iidDispatch [in] The IID of the dual interface defining the property.

Remarks

Similar to **PROP_ENTRY**, but allows you specify a particular IID if your object supports multiple dual interfaces.

The **BEGIN_PROPERTY_MAP** macro marks the beginning of the property map; the **END_PROPERTY_MAP** macro marks the end.

Example

The following example groups entries for `IMyDual1` followed by an entry for `IMyDual2`. Grouping by dual interface will improve performance.

```
BEGIN_PROPERTY_MAP( CMyClass )
   PROP_ENTRY_EX( "Caption", DISPID_CAPTION,
                  CLSID_CMyProps, IID_IMyDual1 )
   PROP_ENTRY_EX( "Enabled", DISPID_ENABLED,
                  CLSID_CMyProps, IID_IMyDual1 )
   PROP_ENTRY_EX( "Width", DISPID_WIDTH,
                  CLSID_CMyProps, IID_IMyDual2 )
END_PROPERTY_MAP( )
```

See Also: PROP_PAGE

PROP_PAGE

PROP_PAGE(*clsid* **)**

Parameters

clsid [in] The CLSID of a property page.

Remarks

Use this macro to enter a property page CLSID into the object's property map. **PROP_PAGE** is similar to **PROP_ENTRY**, but does not require a property description or DISPID.

Note If you have already entered a CLSID with **PROP_ENTRY** or **PROP_ENTRY_EX**, you do not need to make an additional entry with **PROP_PAGE**.

The **BEGIN_PROPERTY_MAP** macro marks the beginning of the property map; the **END_PROPERTY_MAP** macro marks the end.

Example

```
BEGIN_PROPERTY_MAP( CMyClass )
   PROP_PAGE( CLSID_CMyClassPropPage1 )
   PROP_PAGE( CLSID_CMyClassPropPage2 )
END_PROPERTY_MAP( )
```

String Conversion Macros

The syntax of the ATL string-conversion macros is:

MACRONAME(*string_address* **)**

For example:

A2W(*lpa***)**

In the macro names, the source string type is on the left (for example, **A**) and the destination string type is on the right (for example, **W**). **A** stands for **LPSTR**, **OLE** stands for **LPOLESTR**, **T** stands for **LPTSTR**, and **W** stands for **LPWSTR**.

Thus, **A2W** converts an **LPSTR** to an **LPWSTR**, **OLE2T** converts an **LPOLESTR** to an **LPTSTR**, and so on.

The destination string is created using **_alloca**, except when the destination type is **BSTR**. Using **_alloca** allocates memory off the stack, so that when your function returns, it is automatically cleaned up.

If there is a **C** in the macro name, the macro converts to a **const** string. For example, **W2CA** converts an **LPWSTR** to an **LPCSTR**.

Note When using an ATL string conversion macro, specify the **USES_CONVERSION** macro at the beginning of your function in order to avoid compiler errors. For example:

```
void func( LPSTR lpsz )
{
   USES_CONVERSION;
   ...
   LPWSTR x = A2W(lpsz)
   // Do something with x
   ...
}
```

The behavior of the ATL string conversion macros depends on the compiler directive in effect, if any. If the source and destination types are the same, no conversion takes place.

Compiler directives change **T** and **OLE** as follows:

Compiler directive in effect	T becomes	OLE becomes
none	**A**	**W**
_UNICODE	**W**	**W**
OLE2ANSI	**A**	**A**
_UNICODE and **OLE2ANSI**	**W**	**A**

The following table lists the ATL string conversion macros.

ATL String Conversion Macros

A2BSTR	**OLE2A**	**T2A**	**W2A**
A2COLE	**OLE2BSTR**	**T2BSTR**	**W2BSTR**
A2CT	**OLE2CA**	**T2CA**	**W2CA**
A2CW	**OLE2CT**	**T2COLE**	**W2COLE**
A2OLE	**OLE2CW**	**T2CW**	**W2CT**
A2T	**OLE2T**	**T2OLE**	**W2OLE**
A2W	**OLE2W**	**T2W**	**W2T**

See Also: DEVMODE and TEXTMETRIC String Conversion Macros

DEVMODE and TEXTMETRIC String Conversion Macros

These macros create a copy of a **DEVMODE** or **TEXTMETRIC** structure and convert the strings within the new structure to a new string type. The macros allocate memory on the stack for the new structure and return a pointer to the new structure.

The syntax is:

MACRONAME(*address_of_structure* **)**

For example:

DEVMODEA2W(*lpa***)**

and

TEXTMETRICA2W(*lptma***)**

In the macro names, the string type in the source structure is on the left (for example, **A**) and the string type in the destination structure is on the right (for example, **W**). **A** stands for **LPSTR**, **OLE** stands for **LPOLESTR**, **T** stands for **LPTSTR**, and **W** stands for **LPWSTR**.

Thus, **DEVMODEA2W** copies a **DEVMODE** structure with **LPSTR** strings into a **DEVMODE** structure with **LPWSTR** strings, **TEXTMETRICOLE2T** copies a **TEXTMETRIC** structure with **LPOLESTR** strings into a **TEXTMETRIC** structure with **LPTSTR** strings, and so on.

The two strings converted in the **DEVMODE** structure are the device name (**dmDeviceName**) and the form name (**dmFormName**). The **DEVMODE** string conversion macros also update the structure size (**dmSize**).

The four strings converted in the **TEXTMETRIC** structure are the first character (**tmFirstChar**), the last character (**tmLastChar**), the default character (**tmDefaultChar**), and the break character (**tmBreakChar**).

The behavior of the **DEVMODE** and **TEXTMETRIC** string conversion macros depends on the compiler directive in effect, if any. If the source and destination types are the same, no conversion takes place. Compiler directives change **T** and **OLE** as follows:

Compiler directive in effect	T becomes	OLE becomes
none	A	W
_UNICODE	W	W
OLE2ANSI	A	A
_UNICODE and OLE2ANSI	W	A

The following table lists the **DEVMODE** and **TEXTMETRIC** string conversion macros.

DEVMODE and TEXTMETRIC String Conversion Macros

DEVMODEA2W	TEXTMETRICA2W
DEVMODEOLE2T	TEXTMETRICOLE2T
DEVMODET2OLE	TEXTMETRICT2OLE
DEVMODEW2A	TEXTMETRICW2A

See Also: String Conversion Macros

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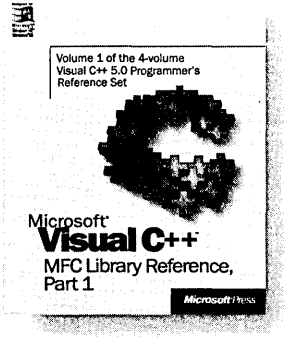

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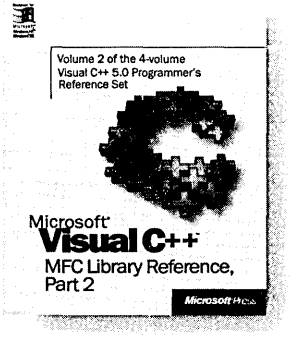

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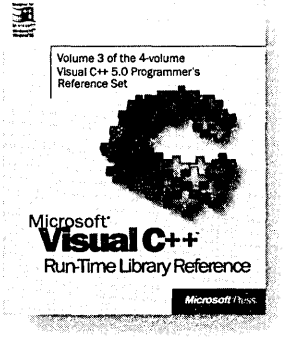

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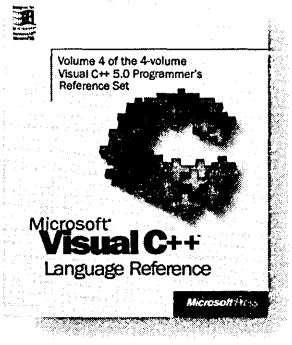

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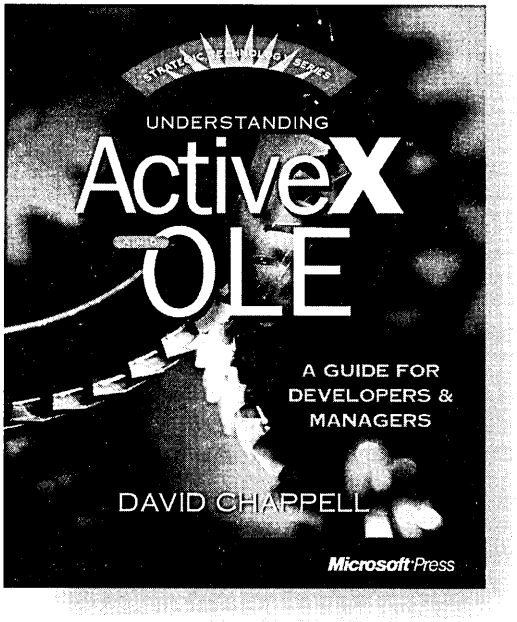

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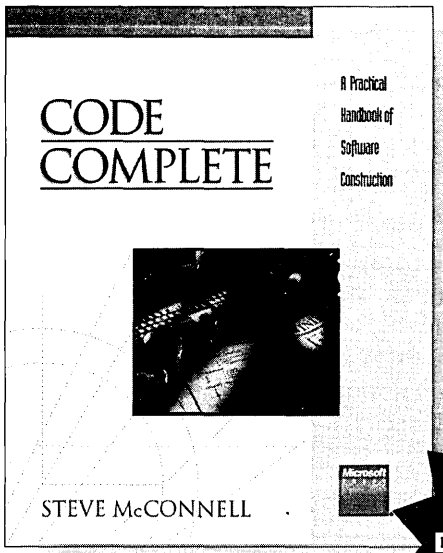

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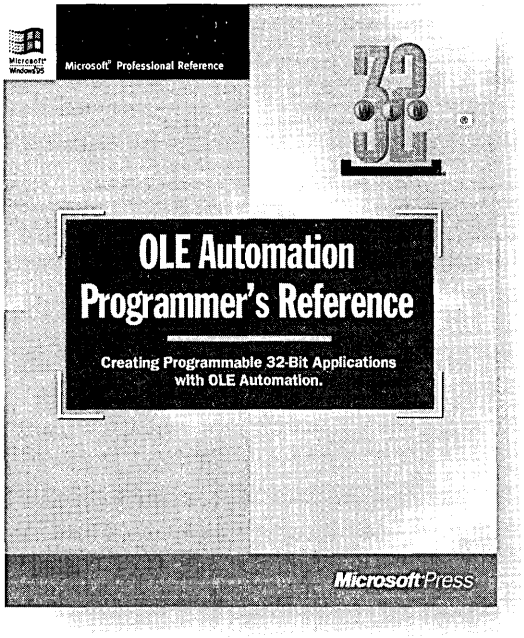

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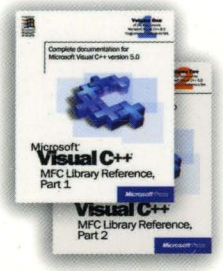

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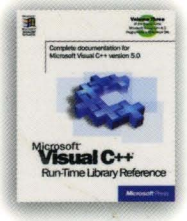

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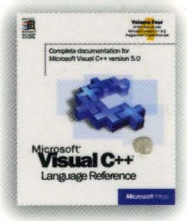

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