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OEM pricing available

8 Inch Systems (formatted data)

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  • Operating systems available: Digital Research or Turbodos.
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Volume 3/Number 4

July/August 1982

Editor's Page .............................................. 4
Letters to the Editor .................................. 10
News & Views ............................................ 14
The CP/M Bus ............................................. 18
Software Directory ...................................... 89
New Products ............................................ 93
Advertiser Index ......................................... 96

In This Issue

System Development Software
D60 by DG Software .................................. 22
Fred L. Gohlke
RAID 8080 Interactive Emulator .................. 26
Andrew Bender
Three Macro Assemblers ............................. 30
Andrew Bender
PDS Assembly Language Development System 36
Mark Zeiger

Hardware Random Byte Generator .......... 44
John Gillespie
Error Detection & Correction Codes ........ 48
Robert Mackinnon
Getfile CP/M Utility Program .................. 52
Thomas W. Cage
A Review of Cer-Tek's UNIPROM Board ...... 54
Steve Leibson
CP/M Patches ............................................ 60
Technical Support Group/DR
CP/M Application Notes ............................ 64
Technical Support Group/DR
Old NorthStar Programs & The New DOS .... 69
D.J. Anderson
Cloning CP/M Disk Drives ......................... 70
Andrew Klossner
Low Cost Floppy Disk Power Supply ....... 73
Bob Zimmerer
Introduction to Computer Graphics .......... 74
Lawrence Hughes
Grafpak Plotting Software ....................... 84
J. Long & J. Simon

Departments

Editor's Page .............................................. 4
Letters to the Editor .................................. 10
News & Views ............................................ 14
The CP/M Bus ............................................. 18
Software Directory ...................................... 89
New Products ............................................ 93
Advertiser Index ......................................... 96
On May 17th, the Amateur Computer Group of New Jersey ran its seventh annual Trenton Computer Festival. Over 10,000 avid microcomputer users attended the event. One of the highlights of TCF-82 was a two-hour meeting of the CP/M-SIG/M user groups. Several hundred people attended this session. The featured speaker was Dr. Gary Kildall, President of Digital Research and creator of CP/M. Gary talked about DR's direction in operating systems and what DR is doing in the 8-and 16-bit areas. The following are the highlights of his talk.

Although CP/M is DR's best known product, DR has many other products including MP/M, CP/Net and Concurrent CP/M. CP/M, MP/M and CP/Net are available in both 8-bit (8080) and 16-bit versions (8086), while Concurrent CP/M is presently available only in 16-bit form. DR expects to release an 8-bit version later this year.

Operating systems in 8-bit environments face certain limitations; they are typically floppy disk based, have smaller and more restrictive instruction sets, and small memory space. However, these systems are low in cost and users have access to a very large, mature software base. The 8-bit operating systems are, of necessity, small in size, mostly single user, single stream, with no overlays and limited space for applications programs. Application space can be expanded via bank-switched memory. For example MP/M-II, in an 8-bit system creates a multi-user, multi-processing environment consisting of 48K memory spaces for each user. Hence, memory space for application programs is still limited, causing many programs to just limp along.

16-bit systems offer much more memory space. The 8086 offers 1 Megabyte of memory, making possible lots of 64K segments which can be packed one on top of the other so that application program space is effectively unlimited. Even
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Concurrent operation allows a single user to use his system as if it were several systems on which the user runs different applications concurrently. This is done via “virtual consoles” to which the user can easily switch back and forth. For example, a programmer can edit and compile a program on one virtual console, switch to another console to debug the program and on another virtual console print the program. The user can then switch back to the debugger and editor to make a patch to the program. Everything is managed via a multi-access file system with file and record lockout to prevent files from being corrupted.

Multi-user concurrency is well suited to on-line multi-user business systems such as one using a common

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Editor's Page, continued...

customer base for sales, invoicing and shipping. The key to successful operation of such a system is also the multi-access file system. Unix does not have a multi-access file system. Rather, system users are expected to stay away from one another in the file system. MP/M-I did not have a multi-access file system, and this turned out to be a problem. It took DR about a year and a half to work out their multi-access file system.

The conventional method of having a multi-access file system is use the file or record lockout. However, this has the disadvantage that if a given console has locked the record and then that console user leaves or the console goes down for some reason the record is locked against entry from other users. The usual practice is for a time limit to be placed on the lockout (e.g., 10 minutes). However, DR chose to use the technique used by IBM. DR calls it “test and write record.” When a console wishes to change a record it reads out the entire record, changes it and writes back the altered and original records to the system. The system then checks to see if the original record sent back is the same as the record currently in the data base. If it is, the record is updated. If it is not, it is assumed that the record has been changed in the meantime by some other terminal, and a notice is sent back that the file has been changed. The terminal now requests the altered record, makes its alterations and sends both records back again. Eventually the record will be updated properly. The record is locked between the time it reads the record and updates it. The feature must be coded into the application program. The application program can lockout a file, a record or a sequence of records and do a test-and-write record.

The 8-bit area is still a very active area for DR and they are working on new versions of the 8-bit software that will have many of the new features currently available for their 16-bit software. Versions of CBasic, Pascal/MT+ and CIS Cobol have already been released in 16-bit form. PL/I-86 is now in beta test and should be released in fall. They have also released XLT-86 which translates 8080 source programs into 8086 code with data analysis of the code to optimize it for the 16-bit environment.

DR is actively working on operating systems for the 68000. They are working on three levels of 68000 operating systems: CP/M and concurrent CP/M single user systems and an MP/M system with enhancements. They will have a totally new file system with a shell around it to make it look like either CP/M or MP/M or any system they wish. Like all other DR operating systems these will also have a user-configurable BIOS. CP/M-68K is currently running in house and should become available toward the later part of the summer.

Unfortunately, Gary felt that he could not talk about projects currently in R&D other than to say that they are being heavily influenced by the work that has been done with Smalltalk and the Xerox systems. He also said that DR is heavily involved with graphics. The emphasis is on user-friendly interfaces.

CP/M-3 is now in beta test. The BDOS (Version 4) file system will have the features introduced in MP/M-II (e.g., time and date stamps, etc.), with many speed enhancements and options for record caching. It will also have a greatly enhanced full screen editor.

In commenting on MS-DOS versus CP/M, Gary expressed the feeling that MS-DOS is “a CP/M clone” between CP/M V1.4 and V2. It is very similar to CP/M, but does not emulate it exactly.

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Looking For SOL-20 PC Boards

Dear Editor:

First, I would like to congratulate you on the quality of Microsystems. It certainly fills a need for those of us who are convinced that S-100 and CP/M are the way to go. I particularly like your choice of articles. Let's hope that Ziff-Davis does not have the same effect on you that McGraw-Hill has had on Byte.

As a suggestion, I would like to see more articles on modifying the CP/M BIOS and adapting it to various special requirements. I also need more information on the mechanics of the various CP/M utilities such as the debugger.

Finally, I need help. In addition to an S-100 system, I have a SOL-20 which is currently moribund. The problem appears to be either a broken trace on the PC board or a bad socket. Shortly after Processor Technology's demise, ASAP Computer Products was offering SOL-20 PC Boards for $50. When I tried to order one they were sold out. Some of these boards may be still around and available. Any ideas, suggestions or help that your readers may care to offer will be gratefully accepted.

Peter T.E. Nevius
2419 Brookshire Dr.
Schenectady, NY 12309

Interface To CalComp Model 114 Disk Drive

Dear Editor:

I'm writing to ask your readers' help in finding an S-100 interface card to a CalComp model 114 disk drive. These drives (which originally cost about $20,000 each) are very rugged mechanically and the removeable disk packs can each store about 30 Mbytes. This drive, unfortunately, does not have an SMD interface.

I thought I had found an electronic development company on the West Coast to build the interface, but the press of the other business has shelved the project for two years with no completion date in sight. Hence, I'm again looking for a supplier. There were thousands of these drives built and they are now being replaced by newer technology, so it seems there is a good market for an S-100 card. I have complete technical information (Manual and schematics) which I'll make available if needed.

Ron Tipton
P.O. Box 227
Greenwood, MO 64034

A Timestamp For CP/M

Dear Editor:

There is a potential problem with the circuit presented in the article "A Timestamp for CP/M" in the Mar/Apr 1982 issue. The register that controls the HOLD, READ and WRITE lines is not cleared when the system is powered up. If any of these lines end up in the active state, the data in the clock chip (MSM5832) can be modified or destroyed. There is an easy fix for this problem. A 74LS273 can be substituted for the command register chip (74LS374). It is pin compatible and functionally equivalent with the exception of pin one. Pin one on the 74LS273 is a master reset that can be connected to the power on clear signal from the IEEE-696 bus (pin 99). This will guarantee that the command register does not compromise the accuracy of the clock chip during power up. The 74LS273 does not have the ability to tri-state its outputs, but this is not required in this instance.

John S. Robison
Horsham, PA

Use Your Computer to Build A Computer

Dear Editor:

In regards to the article in the Jan/Feb 82 issue "Use Your Computer to build a Computer" I sent a disk as was requested in the article. The reply was very prompt.

In addition to the SORT program they offered, they provided a nice letter on the...
same disk plus three other listings, two of which are the best CP/M software programs I have.

One of them is a program directory that provides the following:
1) Alphabetical listing of files
2) Total space on disk
3) Total space used on disk
4) Total space remaining on disk
5) Number of extents used and available

The second program is called FIX. It is really good. Two of the most useful features are:
1) Erased File Directory
2) Recover Erased Files

There are about 15 programs included in FIX. All that is necessary to use FIX is type FIX. EFD and all of the erased files are listed.

Then to recover any of the erased files, type REF (FN.FT), and you are done.

William Harmon
Torrance, CA

ERRATA

Dear Editor:

This letter is promoted by your editorial comments in general, and those in the Volume 3, Number 1 issue in particular. I have noted and accepted your enthusiasm for the 8-100 standard. In fact, no such standard exists. What you have in mind is a proposed standard.

Unfortunately, you do err on simple factual matters also. And too frequently to inspire confidence, in my opinion.

A longstanding example, which you may say is mere semantics, while I say is a factual error, is your constant reference to the "S-100 bus standard." In fact, no such standard exists. What you have in mind is only a proposed standard. Until that proposal is formally adopted by the IEEE, it has no more standing than any other proposal.

Your more recent errors, one of which concerns me personally, are in the issue mentioned above. The SIG/M group has adopted a policy of supplying disks to groups rather than individuals. They have published this modus operandi infrequently in the ACGNJ newsletter. I have never seen anything that would lead me to believe that the CPMUG has done likewise. Certainly, nothing in LIFELINES has been said to that effect. I have as recently as six weeks ago received delivery of disks from them, on an individual basis.

Further, while I may be flattered to see my name in print under certain circumstances, it is totally inaccurate to say that I am a "SIG/M Software Distribution Group," as you did on page 12. I only own five SIG/M disks, purchased through the mail long ago, for my private use, before their group sales policy took effect. I never did anything to suggest that I wanted to distribute disks, nor was I ever asked to do so. In short, the subject never came up in my private transactions. It would be very interesting to me to learn how you or anyone else in the ACGNJ arrived at the conclusion that I am a "distribution group." Also, how many other names are incorrectly on that list?

I have spent many an hour working for various volunteer groups and would be the first to defend those who feel their work is usually unappreciated. What must be remembered by even the volunteer worker is to always "check your facts." This episode has reinforced my belief that much material in your column cannot be relied on until substantiated elsewhere. I trust that you will accept these comments in the spirit in which they are given, and that your future printed efforts will display factual correctness.

S.F. Rinkunas
Whitehall, PA

Dear Mr. Rinkunas: I have always tried to be careful to point out that the IEEE696/-S100 Standard is still being worked on and, although very close to adoption, is still a "proposed" standard. The standard was voted on by the committee members and approved in June, 1981. Three committee members assumed the responsibility for finalizing a few details, entering the proposed standard onto a word processor and submitting it to the IEEE Computer Standards committee. Regretfully, these individuals, all volunteers, have been very busy on other projects and have not yet completed this work. In the meantime, virtually every S-100 product manufacturer has declared his intention to bring new designs into conformance with the proposed standard.

Regarding the SIG/M software distribution list published in the Jan/Feb 1982 issue, note the following. This list was furnished to me by Bill Chin, the coordinator of SIG/M. You can be sure that I will get back to Bill and question him as to the validity of this list.

—Editor
Letters, continued...

Intro To The C Programming Language
Dear Editor:
I enjoyed the article "An Introduction to the C Programming Language" in your November/December issue. However, I noticed a few errors in your description of the C language.

The most significant difficulty is in your discussion of pointers. The statements

```c
char *pfeb[12]; *pfcb;
pfeb = fcb; /* not &fcb */ */
```

will set pfcb to point to the first element of the array fcb (fcb[0]). The name of the array without a subscript is a constant, and cannot have its address taken. This construction is valid for all arrays.

Another point not clearly explained is pointer arithmetic. A pointer that has been set to point to an element in an array will point to the next element in the array if it is incremented, and the i'th cell after the pointer if "+i" is added to it, even for arbitrarily complex arrays (including arrays of arrays or arrays of structures). The following statements

```c
float *fptr = fvar[3];
*fptr = *fptr + 4;
```

will set *fptr to point to fvar[9] and fptr1 to fvar[8].

Also, if two pointers, p1 and p2, point to the same array, p1 - p2 will result in the number of elements between p1 and p2 (negative if p1 < p2).

A number of other minor errors cropped up:

- In the first expression, x is only evaluated once, the second, twice. This feature is important when side effects occur, such as

  ```c
  x[++] = y;
  ```

  The bitwise inclusive or operator is |, exclusive or is ^, and the logical or is ||.

- Types were not fully described: unsigned declares an unsigned integer. Also, short and long can prefix any basic type (a long float is the same as double), with int being the default (short alone = short int).

- I was sorry not to see Aztec C mentioned.

Larry Hamelin
Albany, CA

Author's response:
I agree with Mr. Hamelin's description of pointers, and would like to point out that the statements:

```c
char fcb[12], *pfcb;
pfeb = &fcb[0]; /* erroneous */ should have been printed as:
pfeb = &fcb[0];
```

As Mr. Hamelin states. The variable fcb contains the address of the first element of the array.

Additionally, I felt that a very complex discussion of some of the more unclear features of pointer arithmetic was unnecessary in a first introduction to the language features.

In the same manner, the statement

```c
x op= y
```

is similar to

```c
x = x op y
```

in most cases. In the case of Mr. Hamelin's example:

```c
x[++] += y;
```

this is not so. That statement would be seen as:

```c
x[1] = x[1] + y;
```

In the normal implementation of C. What happens is that expression 2 is evaluated prior to expression 1. The variable "i" is incremented and y is then added to the value of x[i] (after "i" is incremented). That sum is then assigned x[i], also after "i" has been incremented. If the expression was identical:

```c
x[1] = x[1] + y
```

the sum would be placed in the element following.

Mr. Hamelin's observations of the missing bitwise operators is correct. They must have vanished at some time during the publication process.

As for the Aztec C Compiler, I received it after the article had been sent to press. I will be evaluating it in a future article. At this point, it would be unfair to say whether it is better or worse than any of the other implementations.

—David A. Gewirtz
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CIRCLE 12 ON READER SERVICE CARD
Rumors
Digital Research and Microsoft are reportedly working on upgrades of their languages to utilize the 8087. Introductions are expected shortly. Godbout has also disclosed that they are working on CPU cards for the 68000 and National 16032. Introduction is expected in 1983. Godbout expects to furnish CP/M-68K with their 68000 CPU card. Digital Research is also rumored readying a relocating macroassembler for CP/M-86. This may be released as early as this month.

Godbout News
Mark Garetz, newly appointed General Manager of CompuPro, a division of Godbout Electronics, announced that CompuPro will be changing their marketing approach from selling just boards to selling complete systems. Their first system will be the MP/M-8/16 containing dual 8085/8088 processors and running the G&G Engineering implementation of MP/M that allows up to eight users to run any combination of CP/M-80 and CP/M-86 software. Mark Garetz, incidentally, personally designed many of the system's components. Mark has also taken over as chairman of the IEEE S-100/696 Bus Standard Committee.

Digital Research News
Digital Research has announced two new products. Pascal/MT+86 and Concurrent CP/M-86. All applications programs written in Pascal/MT+ can be recompiled with Pascal/MT+86 and executed under CP/M-86 and MP/M-86. It is a complete implementation of the International Standards Organization (ISO) Pascal standard, and also supports the Intel 8087 coprocessor.

Concurrent CP/M-86 allows a single user to perform several jobs simultaneously, permitting the user to interact with the computer as if it were several computers in one. The first implementation is for the IBM Displaywriter, with versions for other systems to follow.

OASIS News
Phase One Systems Inc, supplier of the Oasis operating system has released a new applications software directory. It lists over 400 packages for the OASIS system. Free copies can be obtained from: Phase One Systems, 7700 Edgewater Drive, Suite 830, Oakland CA 94621-3051; (415)562-8085, TWX 910-366-7139.

Video Recorder Winchester Backup Introduced
Alpha Micro (17881 Sky Park North, Box 18347, Irvine, CA 92713) appears to be the first company to introduce an S-100 controller card which allows a video cassette recorder to be used to back up a Winchester drive. It allows a standard VHS or Beta recorder to be used. It provides file-oriented backup and a directory allowing selection and retrieval of random and sequential files. One tape can typically be used to backup 100MB of data, although this varies with length of tape, type of files and amount of recording redundancy desired.

Other CP/M-Oriented Magazines
Microsystems was the first magazine introduced to cover the CP/M area in depth. However, it is no longer the only one. There are now two others which also emphasize CP/M and are worth your attention.

Lifelines magazine is published by Lifeboat Associates (actually Life-lines Publishing Corp.) 1651 Third
Toughest Boards in Town... IEEE696/S-100. Systems too!

256 Kb Dynamic Memory
Available now from Dual Systems: DMEM/256 memory boards. Put the most density of memory ever available on your IEEE/S-100 bus. Get industrial-grade quality with this ruggedly built board: it's been burned-in for 168 hours.
- FULL 256 Kb on a single board.
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DMEM/256KP (Parity) ... S1495

Static Non-Volatile Memory
The Dual Systems CMEM memory boards combine high speed CMOS memories with new 3-10 year lithium batteries to give you the non-volatility of an EPROM board while retaining the instant writability of a high-speed read/write RAM.
- Runs at 6 MHz (no wait states).
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CMEM/32K $995
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Non-Stop Clock
Keeps time with power off. Our industrial clock utilizes a new lithium battery for 3-8 years use. Easiest clock to program you’ll ever see. Runs in all S-100 systems.
- Year, date, hrs., mins., and secs.
- Uses new LSI CMOS chip.

A/D Converter
IEEE696/S-100 AIM-12 industrial standard module designed for industrial analog-to-digital use.
- Runs in all S-100 systems.
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- BASIC program provided.
- AIM-12 w/1-1000 gain transducer amplifier... $785.
- AIM-12B... $695.

D/A Converter
AOM-12 IEEE696/S-100 industrial level digital-to-analog (D/A) converter.
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- Outputs 0–10, ±5, or ±10 volts.
- Short circuit protection, all outputs.
- Switch-programmable for multiple boards.

VIC 4-20
Standard output for industrial control 4-20 mA D/A converter. Used in conjunction with the D/A board.

DMA Serial I/O
The SIO-4/DMA is an intelligent, DMA, high performance S100 four port serial input/output board. It conforms to the IEEE-696 specification and is designed to work with older S100 machines. The board is intended to be used with asynchronous terminals or printers in a multi-user system.
- Program selectable baud rate.
- DMA transfers for output.
- 24-bits of address supported with no restrictions on boundaries.
- Can be connected to RS-232 terminals or modems.
- 256-bytes of FIFO buffer for input characters.
- RS-232 drivers and receivers conform fully to specification.
- Control-S/Control-Q protocol supported.
- Printers with ‘Buffer full’ signal lines supported.
- Limited synchronous mode capability.
- Occupies only 16 I/O addresses.
News & Views, continued...

Ave, New York, NY 10028. Published monthly, it is nearly 60 pages in size and carries very little advertising. It covers the CP/M software area in depth. Each issue carries regular articles by Ward Christensen (author of some of the best utility software in the CPMUG library), Carl Warren, Kelley Smith and Mike Karas, and other CP/M authorities. The magazine is definitely aimed at the more sophisticated software user. Also Lifelines publicizes the releases of CPMUG (also an adjunct of Lifeboat) and bugs and release information on software carried by Lifeboat and others. The editorial content of the magazine has improved tremendously since Ed Currie took over as editor about a year ago. Subscriptions are $18/yr (US, Canada, Mexico) or $40 (elsewhere). Single copies are $2.50.

Datacast magazine is published by Wireless Digital Inc, 333 Swett Rd, Woodside, CA 94062. The magazine emphasizes "software and telecommunications for users." However, about 60% of the first three issues published emphasize CP/M topics. The articles are mostly of the tutorial type (lists of CP/M suppliers) and survey type (lists of CP/M suppliers) and hence the magazine appears intended for the beginning CP/M user. Each issue is typically 64 pages in size. Although not specified, a yearly subscription appears to include six issues. Cost is $18/yr domestic (no foreign rate is specified). This makes Datacast the most expensive of the microcomputer-oriented magazines.

Unix Where Art Thou?

Last fall I had promised that this issue of Microsystems would highlight Unix-like systems. It is obvious that it does not. What happened?

At that time I had made arrangements with five vendors who were advertising "Unix-type" systems to loan us multi-user systems for review. They promised that we would receive the systems in December, and I arranged with authors to review the systems for this issue. I regret to report that as of mid-May we had not received a single system and that the suppliers were promising delivery in June or July. Although some of these vendors have started shipping single-user systems, to date none are shipping multi-user systems. I have therefore rescheduled the "Unix" issue for January 1983, and am keeping my fingers crossed.

In speaking to these suppliers, the problem appears to be two-fold. First, the task of transporting Unix from its DEC PDP-11 environment to that of a 16-bit micro is a formidable task — much more difficult than they had first thought. Secondly, once they had their Unix-like operating systems running they were disappointed with the response times and therefore are investing a considerable amount of time in tuning the software. Furthermore, suppliers who have developed CP/M emulators which run as a task under their Unix-like systems have encountered problems of speed and applications programs whose authors have not adhered to CP/M's rules, causing unexpected results.

User Groups News

SIG/M: The SIG/M has announced five more volumes of public domain...
software, bringing their total up to 60 volumes. The contents of the new volumes are:

56 - Musicraft Software System
57 - Musicraft Selections
58 - Musicraft System Source
59 - PISTOL: Portably Implemented Stack Oriented Language
60 - Miscellaneous CP/M Utilities


CPMUG: The CP/M User's Group has announced three new volumes of public domain software, bringing their total up to 80 volumes. The new volumes are:

78 - Miscellaneous CP/M Utilities
79 - Modem programs for PMMI and DH Hayes Smartmodem
80 - Cromemco Structured Basic Programs

The CPMUG disks are $8/disk-

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JRT is a Digital Research trademark. A 52K CP/M system is required.

CIRCLE 11 ON READER SERVICE CARD
SUPERSUB

To use SUBMIT, it is necessary to prepare a command file using an editor (e.g., ED, Wordstar, etc). SUPERSUB provides two optional modes which allow batch processes to be prepared without the use of a text editor. Also, nesting of batch processes is supported. These and other new features will be discussed in turn.

Summary Mode

Summary mode provides a way to enter a short batch job directly on the SUPERSUB command line. The mode is invoked by placing a "/" character as the first item on the command line. Batch process lines then appear following the division-sign and are delimited by semi-colons. A simple example is:

```
A>SUPERSUB / STAT A:; STAT B:
```

Interactively

It is sometimes convenient to enter longer batch jobs in an interactive fashion. SUPERSUB supports such an interactive mode. It is invoked by the command sequence "SUPERSUB /". The mode is invoked by placing a "/" character as the first item on the command line. Batch process lines then appear following the division-sign and are delimited by semi-colons. A simple example is:

```
A>SUPERSUB / STAT A:; STAT B:
```

As shown in the above examples, the summary mode makes entry of short batch jobs much less time consuming than with SUBMIT.
Supersub provides an interactive command summary, should this be needed. It is activated by executing SUPERSUB with no arguments.

Nesting

Under submit, batch lines do not normally themselves contain submit calls. Any existing batch file ($$$.SUB) is deleted when submit is invoked. Hence, undesirable results occur if the submit command is placed within a series of batch lines as illustrated here:

```c
$$.SUB

DIR B:
RUN.SUB is a special submit function
SUBMIT RUN
A:
DIR
: WE ARE DONE
```

All lines after the fourth would never get executed. SUPERSUB avoids this problem, and thus permits nesting of batch processes as illustrated above.

Nesting can be quite useful. For example, it permits a complicated batch process to be made up of several modular ones. In connection with SUPERSUB's summary and interactive modes, complicated command sequences can be requested with minimal typing. Some nesting examples follow.

Imagine that we wish to compile a set of C programs under the BCS C compiler. Each must be compiled and then linked. This could be done through a submit command called CCC.SUB:

```c
: CCC.SUB -- compile and link BCS code
: $1 file name we add .C
CC "$1.C
CLINK "$1 (any other standard type libraries)
```

To compile and link a set of C programs would then require an additional batch file to call CCC several times:

```c
: COMPIL -- compile several C programs & link them
SUPERSUB CCC FILE1
SUPERSUB CCC FILE3
... SUPERSUB CCC FILEN
: done
```

If CCC were a more complicated operation, it might also include its own SUPERSUB calls.

We could also imagine using the batch process as a shorthand during interactive or summary mode. An interactive mode session might take the following form:

```c
A> SUPERSUB
*A> SUPERSUB CCC ALPHA
*A> SUPERSUB CCC BETA
```

where ALPHA.C and BETA.C are C programs to be compiled.

In order to allow nesting, SUPERSUB appends to the current $$$.SUB and does not delete any current $$$.SUB file. SUPERSUB's documentation states that there is a limit of 128 nesting levels which is set by the CCP.

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static double pi = 3.1415926535898;
C = 2.0*pi*r;

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CIRCLE 19 ON READER SERVICE CARD

CP/M Bus, continued...

Where to obtain SUPERSUB
SUPERSUB is available through several of the CBBS systems nationwide at no cost. These systems have been discussed at length in Microsystems Vol.2/No.3. The program is supplied in source code (8080 assembly language) and hence may be modified and/or improved by end users.

RST Mods for DDT
Some 8080/80 computer systems preempt the RST 7 vector for a hardware interrupt of some kind. This makes DDT unusable since DDT needs a RST vector for its debugging modes. The choice of RST 7 is not special and it is quite straightforward to alter DDT to use another RST instruction/location (i.e., one of RST 1 to RST 6).

Some type of monitor program will be required for making these changes to DDT since it probably won’t be functional if a given system needs the patches in the first place. Five locations need to be changed. To begin, enter the following command line at the CCP level:

A>DDT "<char>

where ^<char> is a control character such as control-A. This trick will cause the CCP to load DDT and then discover an error so DDT won’t get executed. After the error message (“?”) is displayed, exit CP/M and enter whatever monitor facility is available for modifying memory locations. Below we illustrate the changes and include addresses for DDT versions 1.4 and 2.2. Parenthetical values are included for the change to RST 5:

<table>
<thead>
<tr>
<th>Address</th>
<th>Old Value</th>
<th>New Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1.4, 2.2)</td>
<td>0BE7H</td>
<td>3B6H</td>
</tr>
<tr>
<td></td>
<td>0BE7H</td>
<td>3B6H</td>
</tr>
<tr>
<td></td>
<td>08FBH</td>
<td>0B5DH</td>
</tr>
<tr>
<td></td>
<td>OBE6H</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>OBE4H</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>0B5DA</td>
<td>0FFH</td>
</tr>
<tr>
<td></td>
<td>0B5D9</td>
<td>0FFH</td>
</tr>
<tr>
<td></td>
<td>0B5D4</td>
<td>0FFH</td>
</tr>
<tr>
<td></td>
<td>O8FBH</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>OBE4H</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>OBE4H</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>OBE4H</td>
<td>00FH</td>
</tr>
<tr>
<td></td>
<td>OBE4H</td>
<td>00FH</td>
</tr>
</tbody>
</table>

With these changes, DDT should work on any CP/M system with at least one free RST vector other than RST 0.

The Z800 and CP/M Systems
A new user community is growing around the 8086 family of microprocessors and the CP/M-86 operating system. Because of programs like Digital Research’s XLT86 which translate 8080 assembler code into 8086 code, the transition from the 8-bit world may be less painful than one could otherwise imagine. However, it seems that users currently switching from the 8080 or Z80 to the 8086/8 could more easily switch to a better Z80 and hence retain most if not all of their software investments (including programs which don’t come with source code). Zilog will eventually release the Z800 which will be a considerably improved Z80. Such a microprocessor would have a tremendous software base immediately available and could eventually replace 8080/Z80 processors on most S-100 systems. This means that CP/M-80 programs and software will be directly useful for many years to come (with enhanced performance). I think that 8080/Z80 users should look forward to seeing the release of the Z800 or a similar device.
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Software Review

D80 by DG Software
by Fred L. Gohlke

An 8080/8085/Z80 machine code disassembler.

Disassemblers are tools. The size and shape tool you want depends on the job you want to do. Most CP/M users have used DDT for their small jobs, but DDT has its shortcomings.

DG Software has provided a new tool—D80—which has considerable power for large disassembly jobs. It is quick and, within limits, does an excellent job.

Probably the biggest problem in disassembling machine code is divining the logic of the programmer who wrote the original code. That's a task I dislike, even when I have the source code available, and is one I'll avoid like the plague except in a dire emergency.

Close behind deciphering the logic, in terms of big disassembly problems, is the difficulty of separating actual machine instructions from tables and storage areas. I know of no machine with the ability to handle either of these problems without human intervention.

The point of D80 is to make the solution of these problems as painless as possible (something like a dentist who says it won't hurt).

To use D80, give it the name of the .COM file you want to disassemble. On command, it dumps a small portion of the code to your monitor. By examining this code you decide whether it represents instructions or data. If it looks like instructions, you tell D80 to disassemble it.

Like the obedient servant it is, D80 disassembles the code beginning with the start of the segment you just examined, and continues until it reaches either an illegal instruction, an unconditional jump, an unconditional return, or a jump to the contents of the HL register pair. When it reaches one of these conditions, D80 stops, leaving the most recently disassembled statements on your monitor, and dumps the code which follows to your screen. You again decide whether or not the succeeding bytes are machine instructions and, if so, continue as above.

If the succeeding bytes don't look like instructions, you tell D80 whether you think they represent tables or storage, and continue. While this is going on, D80 is building a system map showing the beginning and ending addresses of each segment of machine code; of each table area; and of each storage area; and is building a symbol table containing all addresses referenced or jumped to by the disassembled machine code.

The system map and a list of all values which D80 hasn't been able to resolve is immediately available to the user, on command. By referring to this map frequently, it is possible to eliminate unresolved addresses within the program (but not external references, obviously). However, since addresses can be computed at run time and absolute values can be computed at assembly time and loaded into registers, the chances that the INITIAL disassembly of a complex program will re-assemble and run properly are slim.

The entire process just described takes place on the first pass through the code to be disassembled. The first pass is highly interactive. D80 displays the code, and the user interprets its meaning. Meanwhile D80 reads the .COM file, disassembles, builds the symbol table, and writes the source code file as appropriate.

The second pass is all D80. When the user has eliminated the unresolved entries in the symbol table to his own satisfaction, and tells D80 to start the second pass, it does. Quicker than a wink, D80 writes a disk file with the full system map, the full symbol table, and the disassembled source code.

But it isn't all peaches and cream. Disassembly of unknown code, even with the help of D80, is hard work. Fairly trivial programs can require a great deal of effort—complex ones are a formidable task. I found the best approach was to go through a program and mark only the obvious table and storage locations, let D80 do the second pass on this partially disassembled code, and then list the disassembly. After careful study of this partial disassembly, it's usually possible to get a general idea of what the code (at least part of it) is doing. Then by making notes on this preliminary listing, start D80 from scratch again and do a more thorough job.

The User's Manual

I find it difficult to rate the D80 User's Manual. The problem centers around who you are rating it for—the novice or the professional. For the novice, it is probably a complete disaster. But, on the other hand, disassembly of complex code hardly rates as a novice task. Personally, I'd suggest the novice stay with DDT.

For the professional, the manual is adequate. In all probability it was written by the author of D80, since it tends to present the features of D80 in a subjective manner. All of the features and commands are explained in detail, but usually by reference to other D80 features or commands. Thus, you must be familiar with the system.
to understand the manual, and you must understand the manual to become familiar with the system.

There are a couple of nit-picking errors in the manual which English language purists will find annoying. But then, it wasn’t written for English language purists. This is a work document, produced by a worker, to work with. The first time through (the time you’d like to digest the whole system so you can get on with your work) you will find fault with the manual. Later on, though, when you become more familiar with the system, it’s not really too bad.

While this type of manual is, as I said, adequate, it’s a shame that many of the neat features of D80 are hidden from the user the first time through. I, for one, tend to read a user’s manual once and thereafter refer to it only for an explanation of specific commands I’m using. With the D80 User’s Manual, it pays to read it a number of times after you’ve started using the system, to get the full flavor of D80.

Some D80 Features

Speed: D80 is fast. After a little practice I was able to do an INITIAL disassembly of a 4K program which produced 1500+ lines of source code and a 22K source file in 35 minutes. That seems good, but it’s not a fraction of the whole story, because when the INITIAL disassembly is finished the real work starts. (Just incidentally, INITIAL disassembly is my term, not D80’s. What I’m trying to tell you is that you’ll disassemble the same program a number of times before you get a complete disassembly.)

Analyzing and understanding those 1500 lines of code is no trivial matter. D80 has done its job quickly and well. Your job may be something else again.

The System: D80 is designed to run under CP/M or MP/M, but is not limited to those systems. The technical information for using D80 in a non-CP/M environment is included in the manual. It will run in systems as small as 24K (it overwrites the CCP in a 24K system).

D80 is a disk disassembler. It reads the .COM file from disk and writes the source code to disk as you go along. It maintains the symbol table and system map in memory. This means you can disassemble almost any size program as long as you have enough memory to handle the table and map.

You can save the system map to disk at any time, which means you can disassemble part of the code, save the map, stop, and pick up later where you left off.

D80 will disassemble code for the 8080, 8085, and the Z80 processors. Intel disassemblies are placed in .ASM files, and Zilog disassemblies are placed in .MAC files. The system comes up in the Z80 mode, and the other options are simply entered as commands if desired. The default mode can be easily changed if the user wants the system to come up on one of the other two modes, but it isn’t worth the bother unless you have an unusually heavy workload.

The system contains readily accessible “HELP” commands which are always a nice feature.

Evaluation

In general, I have the impression that D80 is well written. I found no systemic errors. If one did have problems, though, it would take some time to correct them since the author (distributor?) doesn’t provide a phone number. All requests for support must be submitted by mail. I have no idea whether such requests would be honored.

Within the constraints mentioned in the text of this report, I would rate D80:

Functionality 5
Ease of Use 4
Speed 5
Manual 3

(Scale 1 to 5 where 1 is poor and 5 is excellent)

D80 costs $85.00 and may be ordered from DG Software, P. O. Box 1035, Iowa City, IA 52244.

CIRCLE 104 ON READER SERVICE CARD

D80 Help Commands

HLP 1

FIRST PASS DISASSEMBLY COMMANDS:

<table>
<thead>
<tr>
<th>ADD SEGMENT TO MAP</th>
<th>DELETE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPLAY no DISPLAY</td>
<td>GLOBAL</td>
</tr>
<tr>
<td>SEGMENT TYPE</td>
<td></td>
</tr>
</tbody>
</table>

HLP 2

MAP AND SYMBOL TABLE COMMANDS:

<table>
<thead>
<tr>
<th>NEW -- CLEAR ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP -- DISPLAY MAP LISTS</td>
</tr>
<tr>
<td>SYM -- DISPLAY ENTIRE SYMBOL TABLE</td>
</tr>
<tr>
<td>REP -- REFORM SYM TABLE</td>
</tr>
<tr>
<td>SVM -- SAVE MAP ON DISK FILE</td>
</tr>
<tr>
<td>LDN -- LOAD MAP FROM DISK FILE</td>
</tr>
</tbody>
</table>

HLP 3

FILE DEFINITION COMMANDS:

| DSK -- DEFINE DISK SOURCE FILE |
| OUT -- OUTPUT DRIVE SPECIFICATION |
| EXC -- FILE EXECUTION ADDRESS |
| LOC -- ACTUAL FILE LOCATION |
| ADR -- DISPLAY INPUT FILE ADDRESSES |

HLP 4

FORMAT COMMANDS:

| D80 -- SELECT 8080 CODES |
| D85 -- SELECT 8085 CODES |
| Z80 -- SELECT Z80 CODES |
| LIN -- CONSOLE CHARACTERS PER LINE IN HEX |
| DEL -- CONSOLE INPUT DELETE CHARACTER IN HEX |
| EBC -- CONSOLE OUTPUT BACKSPACE CHARACTER IN HEX |

HLP 5

SPECIAL FUNCTION COMMANDS:

| END -- RETURN TO CP/M |
| CONTROL-C -- RETURN TO CP/M |
| SAV -- SAVE ALL THAT FOLLOWS TO(CR) |
| CONTROL-R -- RESTORE "SAVED" LINE |
| CONTROL-S -- STOP LISTING, START WITH ANY KEY |
| CONTROL-X -- TERMINATE/CLEAR LINE |
| (ESCAPE) -- PERFORM "DAS" COMMAND |
| DUM -- DUMP FILE DATA |
| (CR) -- DUMP POINTER AND DO "DUM" COMMAND |
| CONTROL-F -- TOGGLE LIST DEVICE |

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Debugging and program tracing facilities are perhaps the most difficult to evaluate objectively. First, a debugging program is invoked when there is an error or improper functioning of the program under test. This leads to a certain, usually negative, psychological condition when the debugger is invoked. Second, some of the most frustrating time in programming is spent in using debugging aids to find mistakes in programs and these aids are often inadequate in one or more ways, compounding the problem. Finally, once a particular debugger has been learned by the programmer, there is resistance to change — a sort of worn pair of shoes or familiar sweater effect. This resistance is greatly increased with time and becomes a function of how familiar you are with the commands and the effects of each command on the debugging process. Naturally, the more you use a debugging tool, like any tool, the less you think about it as a tool and the more you unconsciously incorporate it into your thought process.

I start the subject of this product review with this introduction because I feel that the review of an unfamiliar debugger is subject to a great degree of personal bias. I will try to keep my bias to a minimum to give as accurate and objective a review as possible.

RAID is a debugging aid which incorporates many desirable features. The acronym RAID stands for “Real-Time Assembler Interactive Debugger.” It can emulate the 8080 by simulating the action, in software, of each 8080 instruction. It can selectively trace certain selected segments of the program under test, using a variety of conditions to discontinue the trace or to initiate other debugging actions. Most importantly, it can be used in a real-time environment to allow debugging of programs operating under time constraints or with interrupt hardware. The manual starts out with the sentence: “The many unique and sophisticated features embodied in RAID make it the most powerful assembly language debugging system ever devised for a micro-computer.” This is immediately followed by the statement that RAID was designed to be easy to use and very forgiving to the inexperienced user. I do not always agree with this statement.

Documentation

The manual is a printed, 45-page loose leaf book. It is poorly written — despite the admonition to the user “only with a fluent understanding of the characteristics and features of RAID can its full potential be utilized.” The manual is organized by the type of command, with a description of each one. The descriptions seem quite terse although examples for each command are given. The commands are a confusing collection of single- and double-letter codes which, I agree, need to be fully mastered before you can use RAID in an intelligent fashion. Nonetheless, the notion of presenting a subset of all of the commands as a nucleus on which you can logically learn the other commands seems to have escaped the designer. This psychological impediment was the biggest problem I had with RAID. I just couldn’t learn all of those jumbled letters in the order in which they were presented. After a few days I began to perceive the manual as a sort of alphabet soup which I was going to sit down to eat. As I blew on the hot soup the alphabet noodles swirled around in random fashion in an incomprehensible set of unpronounceables, a freshly opened box of anagrams. It was difficult to get going with the manual. I like to learn new things and know that it does require some effort, but the stiff, formal style of presentation made the material hard to learn.

After an introduction to RAID by means of the manual, I found that the program itself is supplied in different sizes. I have a 60K system, but the nearest size RAID on the disk was 56K. I wasted 4K. Installing RAID was simple — just copy it onto the disk where it resides like any other program. Wait, what was this... another program SMBMAK? What does that do? Well, it seems RAID is written for ISIS and uses the symbol table generated by the ISIS assemblers. Since you
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and I are probably not using ISIS, we need SMBMAK to make an ISIS appearing symbol table from Digital Research's MAC or ASM assemblers. This is done by letting SMBMAK run through the print file of the MAC or ASM program. This creates problems if you used another assembler like MACRO-80 or CDL's MACRO2. SMBMAK might not like the file format of these assemblers. RAID will use the symbol table so that you can be at home with your debugging task. You can use the labels in RAID commands that you used in the assembly language program. You can use them the same way too! For example, if you equate NEXT to START+7 in your assembly language program then using NEXT as an address in a RAID command will be the same as using START+7. If you desire, RAID contains powerful features for defining and redefining symbols so that symbols can be defined during debugging as required and with the assembly language feature, actual assembly language code can be inserted into a program with RAID. It is then only necessary to enter these changes in your original assembly language program. This is a very useful feature which is well integrated into the structure of RAID.

Because RAID is designed to debug programs assembled with absolute assemblers (an absolute assembler is an assembler which generates non-relocatable instructions at fixed memory addresses), its use with modular relocatable programs with the assembly language/symbol table feature is questionable. First, there is no means for specifying relocation bases for symbol tables. Also, in a more complex situation where several relocatable programs are being tested there is no method for specifying which modules contain not only which addresses but the more difficult task of which duplicated symbols belong to which modules, and which of those modules the debugging patch is being assembled for. This deficiency makes these RAID features, which the RAID designers seem most proud of, almost useless in certain situations. While many programmers are still using absolute assemblers, the overwhelming number of serious assembly language programmers would not use such an assembler unless dictated by the situation. These situations are few — to wit, assembling CP/M's BOOT or CBIOS. Even the new MP/M uses a relocatable assembler.

I found the symbol table feature relatively worthless because of the use of relocatable assemblers in most of my work. However, there might be ways to update the feature to a useful adjunct. When debugging relocated programs one always has to add the relocation base of a module to the addresses in that module. The relocation base is the address in memory where that module is loaded. This problem is then compounded because programs can be assembled relative to more than one relocation base. As an example, a program can have its instructions located in a CSEG (control segment), its “local data” located in a DSEG (data segment) and its global data located in COMMON. There may be more than one common storage area so that certain coroutines share certain areas of memory. In these cases there is a different relocation base for each common area as well as for the DSEG and CSEG areas. Each of these area addresses needs to be added to the operand address or to the instruction address, resulting in the programmer doing a considerable amount of arithmetic in hex or octal. This was probably the force behind the introduction of the TI-59 Programmer calculator. I use mine quite heavily during debugging. RAID does not address itself to this problem.

The debugging commands in RAID are fairly standard. For example, the B command sets a breakpoint, while R removes a breakpoint. After this there are many variations possible. You can loop past a breakpoint address a specified number of times and then stop or you can set up a series of conditions which will interrupt execution and return control to you. If certain limits are exceeded or if an address limit is reached, you can obtain control. In this mode, RAID can be made to stop simulation and return control to the console. It is this area of RAID which is so powerful yet so difficult to commit to memory. Because of its great flexibility, there are a confusing array of flags and indicators which must be manipulated to set up the set of conditions on which execution is to be interrupted.

For those situations in which timing is critical, the ability to execute a subroutine or group of subroutines in real time is present. This means that simulation is turned off and that the program executes the instructions in real time. The user is cautioned that these areas of the program must be thoroughly checked first. This is very useful in resolving areas in which a program has or seems to have timing problems. Certain programs seem to misbehave because of what is incorrectly diagnosed as a timing error. Investigation of these errors with RAID sometimes disclose that the error is elsewhere in the program and
has nothing to do with timing. Because this type of error is expensive to trace, RAID can literally pay for itself with the diagnosis of a single timing bug.

There are other areas of less glamour where tracing down bugs is a simply boring, clerical task. One such error is in programs which have large numbers of stack operations. Any experienced programmer can tell you that sooner or later you will push too much or pop too much. RAID diagnoses this error and saves hours of looking at memory dumps of stack areas. If you have done this, you know what this means — shuffling the address bytes to get the location of which subroutines are stacked where, and where the registers are saved. RAID even tells you about these stack problems without being asked. Similarly, I am sure that at least once in your life you stored an item in an area you didn’t want to store it in. RAID detects this if you set protect mode and reports back that you have jumped to a bad address or written to a protected zone of memory.

Now, these features are all nice features and without the symbol table/assembly mode features they are certainly worth having, but how big is RAID? It is really quite small. It only needs 13K, but remember what it does. It resides in upper memory, overlaying the CCP and the upper portion of the TPA. And, if all of the features which RAID seems to have are not quite enough, RAID allows you to define memory structures in the form of linked lists. This is explained rather poorly in the manual under the operations which deal with this feature. Since many programs which are non-trivial use linked storage lists, this is a very important feature. It should be explained more clearly in the manual.

Conclusion

In summary, RAID is an expensive but useful tool which finds its major application in the debugging of non-trivial assembly language 8080 programs. Its symbolic features are geared to an earlier generation of assemblers and its manual needs some serious, well thought-out psychological engineering. Despite these drawbacks, if you need such a program it’s really a powerful addition to your library. You will need time to read the manual, to unlearn your present debugger and to wear-in the shoes and sweater of RAID. After a few weeks you will be quite adept at using it. I suggest that the RAID vendor, Southern Systems of Birmingham, make three minor changes. First, add Z-80 capabilities to RAID. Second, hire a psychological consulting firm which specializes in computer manual preparation to truly rewrite the manual. Finally, add capabilities to directly read the symbol table of RMAC, MAC and MACRO 80 to allow for relocation of at least one symbol table. This will allow one program to be debugged in a complex without unduly increasing the size of the resident debugger. RAID is a technically well thought-out product but the lack of relocation abilities and Z-80 operations limit it.

RAID is available from: Southern Computer Systems, PO Box 3373A, Birmingham, AL 35255. The cost is $250.
Three Macro Assemblers Compared

by Andrew L. Bender

A comparison of CDL’s Macro-2, Digital Research’s MAC and Microsoft’s Macro 80. All three are high-powered assemblers designed for serious program development.

Reviewing software is a far more tedious job than I had expected. I have tried to bring together the features of the software in a comparative manner, but readers should keep in mind that this isn’t a tutorial on Assemblers and linking loaders.

The three Assemblers are: MACRO-2, written by Computer Design Labs (CDL); MACRO-80 (Version 3.31), written by Microsoft and MAC (Version 2.0), written by Digital Research. All of these Assemblers were tested by assembling real programs (programs written to do other tasks than testing Assemblers) from the CPMUG library and from my system. Test conditions were provided by an Ithaca Intersystems 2MHz Z-80 CPU, 60K of Memory (TDL Z-16), Micromotion doubler/Megabox disk system and MITS 2SIO/2 serial I/O board. This hardware was contained in an IMSAI-8080 mainframe. All disk operations were in double density. Speed tests, without an accurate way of measuring time (a real-time clock on a computer system that locks out interrupts isn’t accurate), are of little value. Later, I will show that “speed of assembly” is not what you are really interested in.

Prices ranged from $85 to $175. However, it should be noted that MACRO-80 includes a linking loader, library manager and cross reference symbol table generator. MACRO-2 did not include any other companion programs. MAC does not generate relocatable code so that no linking loader is necessary.

Documentation

The Microsoft MACRO-80 Assembler came with a poorly documented 30 page manual. In all fairness to Microsoft, they do make clear that the manual “...is designed to serve as a reference guide to the MACRO-80 package.” They do not say it is a learning guide. However, later in the same paragraph they have the audacity to state that if you know Assembly language programming you will know enough to program using the manual, your ideas and MACRO-80. Despite the terse, specification style language there are annoying ambiguities in the manual. For example, there is confusion between the terms “label,” “symbol” and “name.” Looking at the general specification for a statement, one could code every EQU, SET and MACRO instruction incorrectly based on this ambiguity.

There are other annoying problems with the documentation. Items which should have been logically grouped together were scattered all over the manual. The quality of reproduction of the manual is poor; it appeared to have been produced by xerographic printing. The manual is often in disagreement with the program it documents—perhaps these are program bugs. Definitions made by the manual are not used later in defining how items are to be coded, and there are no coding examples. Since I have been using Assemblers for more than twenty years, I felt that with very little additional information, I should be able to write a MACRO-80 program. I was wrong. Perhaps I need more time and experience, or perhaps the manual needs more depth.

The CDL MACRO-2 manual, on the other hand, is somewhat better written. The manual is 74 pages long, and gives a good introduction to the Assembler facilities. However, it is not a tutorial and there are only a few examples given. Had the writers spent more time on the manual no one would be using any other Z-80 Assembler. Unfortunately, most of the features of this superb product are “sleepers”; they are undocumented or poorly documented in the manual and are
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<thead>
<tr>
<th></th>
<th>KIT</th>
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</thead>
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Macro Assemblers, continued...

waiting for the user to discover them either by accident or by experimentation. Also, there is no
guidance on how to use these features to their best
advantage. I experimented with this Assembler for
some 17 days and was surprised what could be done
with it. If you think that the tricks were not designed
into the Assembler you are very wrong. It is obvious
that the designers spent a great deal of time putting all
of these extras in. Too bad they did not document
them better.

Many of the concepts introduced in the COL MACRO-2
manual could use an example to illustrate them. This is
especially true of certain specialized operators which
are not commonly used in today's assemblers. The
shorthand style of the language adds to the confusion
rather than aiding understanding. Some of the pseudo
operations were well documented but the language
tended to be somewhat terse and explanations were
fuzzy in spots. The use of some pseudo-ops were
unclear at best. The manual's reproduction was on a
par with Microsoft's MACRO-80's, namely xerographic
printing—ugh!

The Digital Research MAC manual was by far the
best. Each reading seemed to add more to my
understanding of the facilities of the Assembler.
There are multiple examples of the use of MAC
facilities including several system designs with MAC. If
you decide on the Microsoft MACRO-80 Assembler, I
strongly recommend you buy the Digital Research
MAC manual. More about this later.

Using The Assemblers

Using the documentation to MACRO-80 as a guide, I
tried to assemble a few old MITS DOS Assembler
programs (a "non-macro" dialect of MACRO-80) and
found that there were some problems with definitions.
Aside from these trivial problems, the results were
perfect. Later, I assembled programs which used the
macro facility to some degree—and problems occurred.
The mechanism for inserting prestored macro libraries
did not work. The SET directive blew up and generated
one byte of object code each time it was invoked.
Finally an "X" error occurred in the listing, a great
surprise because the error code was not documented
anywhere in the manual. Hoping this was a problem
with the source code and ever mindful of the fact that it
can happen with a Macro Assembler, I checked the
code by assembling it with another Intel compatible
Macro Assembler (not reviewed here) and found that
there were no problems. I know that many, if not all of
these quirks have been fixed in later versions (Version
3.4) of Microsoft's MACRO-80.

The CDL MACRO-2 performed well, with no hitches
in assembling any relocatable program. Because the
manual was unclear, there were problems when I tried
to make an Intel hex file suitable for loading with DDT
or LOAD. Evidently, saying .PABS isn't enough.
Although not explained in the manual you also need
.PHEX and .XLINK pseudo ops to produce a hex file
which contains no linkage information. (.PABS is a
pseudo op which forces MACRO-2 to generate an
absolute object code file.) I did not like the CDL
mnemonics until I tried to make a Z-80 version of my
CBIOS. Then I liked them because it was not necessary
to change all my op codes to Zilog mnemonics.

The Digital Research MAC worked perfectly. It is
reliable, fast and a bargain if you only want a macro
assembler for 8080 code. There was not one feature
which offered any unpleasant surprises. Because of
the superb documentation which contains an excellent
tutorial on Macro Assemblers, I got used to this
Assembler and became very fond of the manual.
Unlike the other manuals it is printed and bound.
Pages do not stick together, and the printing is sharp.
If MAC could produce relocatable code it would be up-
to-date and very much a competitor for the other
Assemblers. Digital Research has announced a re-
locatable assembler (RMAC) as part of their PL/I-80
package. I am certain that this will meet the high
standards we have all come to expect from Digital
Research.

CDL's LINKER, the linkage editor
for MACRO-2, is by far the most
flexible linkage editor I have
come across.

Operating Speed

Since Assemblers, like editors and debuggers, are
program development tools they become an extention
of the programmer in the programming process and
figure into the important EDIT->ASSEMBLE->DEBUG
cycle. If the Assembler or any other item in the
process is too slow, it causes mental fatigue and
decreases the efficiency of the process. MAC, which
does not generate relocatable code, and therefore
has none of the overhead associated with this task,
was faster than MACRO-80. MACRO-2 and MACRO-
80 were quite different when it came to speed. The
MACRO-2 Assembler was at least 30% faster than
MACRO-80. MACRO-80 also always needs to use its
linkage editor since it, unlike MACRO-2, cannot
generate Intel Hex format absolute code directly as
Table 1. Macro Assembler Comparative Features.

<table>
<thead>
<tr>
<th>Features</th>
<th>Digital Research MAC</th>
<th>CDL MACRO-2</th>
<th>Microsoft MACRO-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Radix of evaluation</td>
<td>no</td>
<td>yes³</td>
<td>yes</td>
</tr>
<tr>
<td>Trace macro expansion</td>
<td>yes</td>
<td>yes¹</td>
<td>yes</td>
</tr>
<tr>
<td>Label rules: Op code as a label</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Terminating colon</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Maximum label size</td>
<td>16 charac.</td>
<td>any length</td>
<td>any length</td>
</tr>
<tr>
<td>Significant characters</td>
<td>16</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Direct renaming of pseudo-operations</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Define symbol value at assembly time</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Op code used as an operand</td>
<td>yes</td>
<td>yes</td>
<td>yes²</td>
</tr>
<tr>
<td>Inclusion of prestored code</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>String length operator</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Local and global symbols (outside macro)</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Symbol type operator</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Temporary variables</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Host processor</td>
<td>8080/Z80</td>
<td>Z80</td>
<td>8080/Z80</td>
</tr>
<tr>
<td>Cross reference listing</td>
<td>no</td>
<td>no</td>
<td>yes³</td>
</tr>
<tr>
<td>Documentation</td>
<td>excellent</td>
<td>fair</td>
<td>poor</td>
</tr>
<tr>
<td>Output object file format</td>
<td>Intel hex</td>
<td>Intel hex or CDL relocatable</td>
<td>Microsoft relocatable</td>
</tr>
<tr>
<td>Initial mode of assembly⁵</td>
<td>8080-abs.</td>
<td>Z80-reloc.</td>
<td>8080-reloc.</td>
</tr>
<tr>
<td>Input file format</td>
<td>not</td>
<td>not</td>
<td>not</td>
</tr>
<tr>
<td>Printed and/or saved symbol table</td>
<td>special⁶</td>
<td>special</td>
<td>special⁶</td>
</tr>
<tr>
<td>List Price</td>
<td>macro-assembler</td>
<td>$99.95</td>
<td>$149</td>
</tr>
<tr>
<td></td>
<td>linking editor</td>
<td>$79.95</td>
<td>included with assembler</td>
</tr>
</tbody>
</table>

Footnotes:
1. MACRO-2 can trace at different levels in a multi-level expansion with selectivity.
2. 8080 only.
3. Both a pseudo-op and operator exist for this purpose.
4. As a separate program. Refer to article.
5. Expected initial processor and format of object file.
6. MAC tolerates a line number, MACRO-80 needs special format line number, if present, generated by the EDIT-80 program.

Comparing Features
Some of the areas in which all three Assemblers are the same are the ability to trace MACRO expansions, the inclusion of prestored library code, generation of a symbol table display, and the ability to handle the input text of most editors.

Areas where the three Assemblers differ are many (see Table 1 for comparisons). The CDL MACRO-2 Assembler only runs on a Z-80 system, while the others run on both Z80 and 8080 systems.

LINK-80, the linkage editor for MACRO-80, is flexible and includes many features. There are a few things I would have liked to see, such as an ENTRY command allowing the programmer to define the starting address of the program at link edit time.

The commands for the Microsoft LINK-80 linkage editor were such that they could be placed in a "SUBMIT" file with only a parameter or two necessary in the call to SUBMIT to link a complex of programs.
Macro Assemblers, continued...

which might, under ordinary circumstances, require
typing in many names of files. Microsoft's LINK-80 ran
very quickly and produced a storage map containing
the actual, relocated memory addresses in a highly
readable, useful form. I was impressed with the
valuable information contained in this storage map.

CDL's LINKER, the linkage editor for MACRO-2 is, by
far, the most flexible linkage editor I have come
across. It includes many of the features of LINK-80,
and much more. The first few pages of LINKER's
manual contain an overview of link editor operations,
a description of the terms used in the manual and a
guide to the operation of LINKER. It is not only able to
prepare HEX and COM FILES, but can also generate
relocatable files in which certain of the symbol defini-
tions are resolved and others are left unresolved.
Hence you can not only generate libraries in a single
relocatable file (you can also do this with Microsoft's
LIB library manager) but can also, during testing and
checkout, generate working modules linked up with
their external suitably resolved references. Those
programs which are still on the "test bench" can be
rapidly linked because most of the symbol resolution
is done previously with their support modules "pre-
linked." LINKER can also put the commands for link
ing in a file and control the placement of programs.

I tested LINKER (Version 2.01) on a set of programs
which were translated to CDL MACRO-2 format by a
general purpose macro generator. There were no
problems. Unlike the MACRO-2 manual, which I
mentioned earlier, LINKER's manual is clear and well
written. The input format of LINKER does not cor-
respond to the relocatable format adopted by Microsoft
and, more recently, Digital Research. This means that
the relocatable elements produced by MACRO-80
and RMAC cannot be linked by LINKER, and those
relocatable elements produced by MACRO-2 cannot
be linked by LINKER. It should be possible to write a
program to convert the different relocatable formats.

LINKER reads the relocatable text of each module it
is linking twice. This results in a slower linkage editing
step for most very large programs, except in those
cases where a large group of relocatable elements
have been collected and prelinked. LINKER compares
favorably with the UNIVAC 1100 Series "Collector"
and the IBM 370 Linkage Editor in its scope and
design.

A cross reference table was available only on the
MACRO-80. It was very slow—but not as slow as a
similar task program running under a Basic interpreter.
MACRO-80 and MACRO-2 are fuzzy about finding a
colon at the end of a label. MAC doesn't care. MAC
won't let you use an op code as a label, but MACRO-80
and MACRO-2 both will.

There were some areas where the differences
seemed to matter more. The fact that MACRO-80
could be used to assemble either Zilog Z-80 mnemonic
code or 8080 Intel mnemonic code is important if your
mainframe CPU card can be swapped to either a Z-80
or 8080 and you have both kinds of program around.
MACRO-2 can also assemble both 8080 and Z-80
programs, but only when the Z-80 programs are in
CDL's unique mnemonic dialect rather than the Zilog
mnemonics. CDL (previously TDL—Technical Design
Labs) uses Intel mnemonics for all instructions which
are common to the 8080/8085 and Z-80. The extended
Z-80 op code mnemonics are logical extensions of the
Intel mnemonics. Hence, programs written using CDL
mnemonics cannot be directly assembled with
MACRO-80 or MAC and programs written with Zilog
mnemonics cannot be assembled with MACRO-2 or
MAC. The CDL op codes seem to make much more
sense because the entire program doesn't look like a
series of "LD" instructions. Intel uses store instruc-
tions when data is stored in memory, and move or load
instructions when data is moved between registers or
brought to or from memory. If you are brought up on the
Zilog mnemonics they may make a lot of sense.

However, when you are converting a program written
for the 8080 to the Z-80, Zilog mnemonics are
cumbersome. With CDL mnemonics, every line does
not have to be rewritten. With Zilog mnemonics,
every line must be recoded.

---

If you will not be preparing system
programs or assembly coded
production/application programs,
then the ASM Assembler included
with CP/M is excellent and will
meet your needs without spending
money for one of these high-
powered assemblers.

The CDL mnemonics conform closely to the IEEE
standard on microcomputer Assemblers. Rumor has it
that the creators of MACRO-2 are developing an even
more powerful assembler which allows the use of
Zilog Z-80 op codes and even greater speed.

One really strong point for the CDL MACRO-2
Assembler is its ability to request assignment of
variables at assembly time. This feature is very useful
in preparing different versions of the same program
without changing the parameters with a text editor.
A prime example of this is changing "MSIZE" in your
CBIOS without having to go back to your editor.
Another advanced feature which helps in the support
of good macro generation facilities is the string length
operator which allows you to determine in a macro, or
anywhere for that matter, how long a string argument
is.

None of these assemblers will directly assemble the
Intel 8085 RIM and SIM instructions. This is no real
problem since a simple macro can handle this.

The macro facility in MAC and MACRO-80 are virtually
identical. They work well but offer no special virtues.
The MACRO-2 macro definition differs from the Intel
definitions but is much more "powerful" in scope than
the Intel macro language. This means, however, that
the MACRO-2 Assembler could not use the Intel
macro definitions. This is no problem unless your
program happens to start with many pages of macro definitions which would require recoding.

Documentation being what it is, the assembler must produce its own documentation of the program being assembled. MACRO-80 can produce an octal or hex listing of the object code. Its pseudo-ops and listing formats are also nice and useful. Unfortunately, the page count is always incorrect and the title of the listing appears on the second page of the listing. The manual writer states that there are “sub page counts” as well as page counts. It seems to me that an assembly of a single program doesn’t need two page ones. The instructions written by the programmer are standard Intel or Zilog mnemonics. In Z-80 mode even the pseudo operations can be Zilog pseudo-operation instructions. That is very desirable.

MACRO-2 produces a nice appearing hex listing which is subject to an extensive set of listing controls, with even the width and length of the page being adjustable—a nice feature for publication. For ease in coding, MACRO-2 seems to be more human oriented. One doesn’t write :CM, “BDOS EQU 5”. Rather, the programmer writes “BDOS == 5” which is easier to write and is more meaningful.

In Conclusion

Now you make your choice and pay your money. If you will not be preparing system programs or assembly coded production/application programs, then the ASM Assembler included with CP/M is excellent and will meet your needs without spending money for one of these high-powered assemblers. Your investment in one of these assemblers should be dictated by your needs and programming habits. If you write functional subroutines, dealing with relocatable programs and doing some hex arithmetic during debugging then I strongly recommend the purchase of MACRO-2 or MACRO-80 (also buy the MAC manual as a text on how to use all of the MACRO features which are available). If you have a Z-80 system, the MACRO-80 Assembler can be switched to handle Intel or Zilog op codes and pseudo operations which are different. If you don’t mind the unconventional CDL mnemonics, the different (but more powerful) macro structure and being able to run only on a Z-80 machine, then MACRO-2 is what you would want to use. I’m not sure that I could recommend MAC at this point as a stand-alone development tool because it seems to be supplanted by the new Assembler which Digital Research is supplying with PL/1. MAC is still used by many people and its inability to generate relocatable code seriously hampers its utility in today’s programming climate.

Keep in mind that many of the programs in the CP/M and SIG/M User Group Libraries have been assembled with MAC. For this reason alone, MAC may represent a wise investment. Add MAC’s reasonable cost and great utility in handling the CP/M and SIG/M User Libraries you might be wise to invest in MAC. In addition, Digital Research’s CP/M 2.x CB IOS is assembled best with MAC.
The PDS Assembly Language Development System

by Mark Zeiger

If you are looking for a full-featured 8080/Z-80 assembly language development system at a reasonable price, Allen Ashley's PDS is the thing for you. Versions are available for CP/M, North Star, or Micropolis disk operating systems. For $99 you get the following:

1. ASMB—An assembler/editor
2. MAKRO—A macro assembler
3. EDIT—A character oriented text editor
4. DEBUG—A debugger
   (also HEXBUG, LINKBUG, COMBUG for CP/M)
5. LINKED—A linker (North Star only)
6. KWIK—A relocating loader (North Star)

All of the above programs will run on an 8080 system, but both assemblers will handle Z-80 code, as well as the debuggers. This is the most comprehensive set of programs I have seen for the North Star system, and while you can buy a better editor that will run under CP/M and probably a more sophisticated macro assembler, you will wind up paying at least twice the money that you would pay for PDS.

When I first started writing this review, I was using a North Star system and was therefore able to examine both the North Star and CP/M versions of PDS that Mr. Ashley has written. Since I do not have access to Micropolis drives, I can not describe any differences that may exist between the Micropolis version and the other two. What follows is a description of the assemblers, debuggers, and editor as well as the linkage protocols needed for assembly of library files.

ASMB: The Interactive Assembler/Editor

An assembler/editor is a single package which allows a programmer to write a line-oriented assembly language program and then assemble it. This is similar to a Basic interpreter which allows instructions to be entered into memory and then executes those instructions. Thus it is not necessary to use a separate editor to create source code, then invoke an assembler to create a hex or rel file, and finally use a loader or linker to make an object or “com” file. Small to medium sized programs may be written quickly and assembled in a very short time. If syntax errors are discovered, re-editing and re-assembly will take a matter of seconds instead of minutes.

ASMB seems very convenient, and you might wonder why anybody would want to use the separate programs instead of this integrated system. There are some drawbacks. The first is that the entire source file must reside in memory before it can be assembled; therefore this system can not be used to create a large program, since a well-commented source file is usually six to ten times larger than the object file it produces. Also a system such as this usually requires that text be formatted in a specific manner and use labels of a specific length. I like to create my own formats to improve the structure and readability of source code. I also like long labels that are descriptive. But for small program development, the conveniences offered by a program such as ASMB outweigh its disadvantages.

One of the first software packages written for the 8080 was Processor Tech's SP1, which later evolved into ALS-8. The program was modified by others to work on various disk systems, but it was essentially SP1 with a few extra I/O commands. PDS has all the features of those assemblers and many more. First, it will assemble Z-80 code using mnemonics which are similar to the widely used Intel mnemonics. There are even op codes for the recently discovered undocumented Z-80 instructions which allow you to treat the index registers as eight-bit registers.

ASMB has other advanced features that you would not expect to find in an editor/assembler. It has conditional assembly (using IF <exp> ... ENDIF), the SET operand (which allows the value of a label to be changed dynamically) and a DB expression which allows multibyte assignments (including ASCII strings). It also has a USE operand which will let a programmer

Mark Zeiger, 198-01 67th St., Flushing, NY 11365.
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NEW! System/6 Package
Computer Design Labs

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"Carl Galletti and Roger Amidon, owners.

Software with Manual/Manual Alone

All of the software below is available on any of the following media for operation with a Z80 CPU using the CP/M or similar type disk operating system (such as TDL's CP/M):

for TRS-80® CP/M (Model I or II)
for 8" CP/M (soft sectored single density)
for 5¼" CP/M (soft sectored single density)
for 8" North Star CP/M (single density)
for 5¼" North Star CP/M (double density)

BASIC I
A powerful and fast Z80 Basic interpreter with EDIT, RENUMBER, TRACE, PRINT USING, assembly language subroutine CALLs, LOADGO for "chaining", GOSUB to move text, EXCHANGE, KILL, LINE INPUT, error intercept, sequential file handing in both ASCII and binary formats, and much, much more. It runs in a little over 12K. An excellent choice for games where the precision was limited to 7 digits in order to make it one of the fastest around. $49.95/$15.

BASIC II
Basic I but with 12 digit precision to make its power available to the business world with only a slight sacrifice in speed over Basic I. It's more powerful than almost any other Basic (less than 10 digits will not function). $99.95/$15.

BUSINESS BASIC
The most powerful Basic for business applications. It applies to Basic II with random or sequential disk files in either fixed or variable record lengths, simultaneous access to multiple disk files, PRIVACY command to protect sensitive data, source code, global editing, added math functions, and disk file maintenance capability without leaving Basic (list, rename, or delete). $179.95/$20.

ZEDIT
A character oriented text editor with 26 commands and "macro" capability for stringing commands together and are a complete array of character move, add, delete, and display function. $49.95/$15.

ZTEL
Z80 Text Editing Language - Not just a text editor. Actually a language which allows you to edit text and also save, save, and recall programs which manipulate text. Commands include conditional branching, subroutine calls, iteration, block move, expression evaluation, and much more. Contains 36 value registers and 10 text registers. Be creative! Manipulate text with commands you write using Ztel. $79.95/$25.

TOP
A Z80 Text Output Processor which will do text formatting for manuals, documents, and other word processing output with any text editor. Does justification, page numbering and headings, spacing, centering, and much more. $79.95/$25.

MACRO I
A macro assembler which will generate relocatable or absolute code for the 8000 or Z80 using standard Intel mnemonics plus TDL/280 extensions. Functions include 14 conditionals, 16 listing controls, 54 pseudo-ops, 11 arithmetic/logical operations, loop delay and global symbols. Linking capability is provided with optional linker. Global editing, and recursive/reiterative macros. This assembler is so powerful you'll think it is doing all the work for you. You actually do assembly language programming much less of an effort and more creative. $79.95/$20.

MACRO II
Expands upon Macro I's linking capability (which is useful but somewhat limited) thereby being able to take full advantage of the optional Linker. Also a time and date function has been added and the listing capability improved. $99.95/$25.

LINKER
How many times have you written the same subroutine in each new program? Top notch professional programmers compile a library of these subroutines and use a Linker to tie them together at assembly time. Development time is thus drastically reduced and you are able to write in a high level language but with all the speed of assembly language. So, get the new CDL Linker and start writing programs in a fraction of the time it took before. Linker is compatible with Macro I & II as well as TDL/280 disk operating systems version 2.0 or later. $79.95/$20.

DEBUG I
Many programmers give up on writing in assembly language even though they know their programs would be faster and more powerful. To them assembly language seems difficult to understand and follow; as well as being a nightmare to debug. Well, not with proper tools like Debug I. With Debug you can easily follow the flow of any Z80 or 8080 program. Trace the program one step at a time or 10 steps or whatever you like. At each step you will be able to see the instruction executed and what it did. If desired, modifications can then be made before continuing. It's all under your control. You can even split displaying a subroutine call and up to seven breakpoints can be set during execution. Use of Debug I can pay for itself many times over by saving you valuable debugging time. $79.95/$20.

DEBUG II
This is an expanded debugger which includes all of the features of Debug I plus many more. You can "trap" (i.e. trace a program until a set of register, flag, and/or memory conditions occur). Also, instructions may be entered and executed immediately. This makes it easy to learn new instructions by examining registers/memory before and after. Add a READY function which allows changing between ASCII, binary, decimal, hex, octal, signed, decimal, or split octal. All these features and more add up to give you a very powerful development tool. Both Debug I and II must run on a Z80 but will work both Z80 and 8080 code. $99.95/$20.

ZAPPLE
A Z80 executive and debug monitor. Capable of seeing, ASCII put and display, read and write to I/O ports, hex math, breakpoint, execute, move, fill, display, read and write in Intel or binary format tape, and more on disk. $39.95/$15.

APPLE
8080 version of Zapple $34.95/$15.

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SYSTEM MONITOR BOARD (SMB II)
A complete I/O board for 80-100 systems. 2 serial ports, 2 parallel ports, 1200/2400 baud cassette tape interface, sockets for 2K of RAM, 3-2708/2716 EPROM's or ROM, jump on and read circuitry. Bare board $49.95/$20.

ROM FOR SMB II
2KXS masked ROM of Zapple monitor. Includes source listing $34.95/$15.

PAYROLL (source code only)
The Osborne package, Requires C Basic 2. 5 disks $124.95 (manual included)
8 disks $99.95 (manual included) Manual $20.00

ACCOUNTS PAYABLE/RECEIVABLE (source code only)
By Osborne, Requires C Basic 2. 5 disks $99.95 (manual not included)
8 disks $99.95 (manual not included) Manual $20.00

GENERAL LEDGER (source code only)
By Osborne, Requires C Basic 2. 5 disks $99.95 (manual not included)
8 disks $99.95 (manual not included) Manual $20.00

C BASIC 2
Required for Osborne software. $99.95/$20.

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* TPM is a trademark of Digital Research

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DEALER INQUIRIES INVITED.
PDS Review, continued...

use multiple location counters in a single program. All of these features are documented in the user manual.

The command set used by ASMB is similar to the command sets of the assemblers after which it is patterned. You may create an internal file space at any location in memory (which should be above 2500H to avoid overwriting the program). Source files may be read from or written to the disk and may be appended to source already existing in memory. The code may be assembled at any memory location or it may be assembled for one location while actually being stored at another. The source code may be listed either formatted with line numbers, or unformatted and the scrolling can be stopped by pressing the spacebar.

Finally, there is a mini-editor that allows the user to correct errors in a line without retyping the entire line.

ASMB is very convenient and versatile to use on all but the most complex of assembles. There are, however, a few annoying features. On the North Star package any reference to PSW (i.e., PUSH PSW) causes any error unless the PSW is first equated to 6. This error did not occur on the CP/M version. On both versions, combination of the USE and SET instructions generates an error even though the instructions perform exactly as the author specified they should, and do produce correct object code. When working under the North Star operating system you must first create a file on the disk before you start using ASMB. If you forget to do so, you will have to re-enter DOS, create the file, then go back to ASMB and save the file. You will have the same problem if you have enlarged the source of a file that has already been written and it becomes larger than the disk file. These problems do not exist on the CP/M version. And as stated before and seems to be a problem with most editor/assemblers, labels may have a maximum of five characters. In a long program you are really going to have to use you imagination to make up meaningful labels. Despite these few criticisms, ASMB is a fine program and by itself is almost worth $99... but wait—there's more to come!

EDIT: A Character-Oriented Text Editor

Edit is a character-oriented text editor similar to many other CP/M text editors. I like it better than CP/M's ED for two reasons. In CP/M's ED, if you accidentally press Control-C (which is easy to do since it is next to Control-Z) you will reboot the system and probably lose everything that was entered during the editing session. This will not happen with PDS Edit. The other nice feature of Edit is the ability to use an ASCII character to indicate the location of the "current activity pointer." This makes Edit much easier to use than other editors, since one of the biggest problems in using such an editor is to keep track of the pointer position. I found Edit easy to get used to because of the second feature, even though I had been using a screen editor up until this point.

If you are working under the North Star operating system, you don't really have a choice as to which editor you want to use. There just aren't that many available for the North Star environment; therefore Edit fills a big software gap and becomes a necessity.
The only difference between the CP/M and North Star versions is again in file creation. Using the North Star DOS, it is necessary to create the file in the operating system, then evoke Edit, type the file, and save it using Edit's "E" command. If you didn't guess right at the beginning and created a file that was too small, you will have to leave Edit, create a new file that is big enough, re-enter Edit and save the program. CP/M, with its dynamic file allocation, does not have that problem.

The Edit command set will allow you to create "macro" commands which can be repeated any number of times. It also has the capability of using multiple input files, thereby allowing you to read from many files and merge them.

Edit has all of the commands that are commonly found in character editors. The pointer may be moved forwards or backwards a given amount of characters or lines, and a given amount of characters or lines may be deleted from the buffer. It is possible to search for a string of characters and to substitute one string for another. One of the nice features of the search and substitute is the use of wildcards. The command SPGM@SS will find the first occurrence of either PGMA, PBMB, PGMC, ... PGMZ, PGM1, PGM2, etc. since the character "@" means "match any character." There are other wildcards that have meanings other than "any character." Note that the "S" is the echo of the "escape" character (1BH) which is used as a command terminator as well as a string separator.

The Edit command set will allow you to create "macro" commands which can be repeated any number of times. One of the strong points of the macro feature is the ability to put a pause instruction in the command and allow the operator to decide on a course of action as the macro command is being performed. Edit also has the capability of using multiple input files, thereby allowing the user to read from many files and merge them. It has only one text buffer, which is a drawback, but you are able to define a block of text and then either move or delete the block. One last command that is unique to the PDS system is Edit's "N" command. This allows a file that is created by ASMB to be formatted into an ASCII file without line numbers. The file may then be assembled by Makro.

If you are using North Star DOS, then Edit is a necessity. With CP/M you might want to stay with the editor you are using, but if you don't like your current editor and do not feel like spending money for a screen editor, then give Edit a try. It's easy to use, small, fast, and comes with the package.
PDS Review, continued...

MAKRO: The PDS Macro Assembler

Remember that for your $99 you have already purchased an excellent Z-80 Editor/Assembler and a good text editor. For that same money you’re going to get a relocating macro assembler. Macros are very useful in advanced program design because they can be used to make source code smaller and more readable. And if you are really good at it, you can use macros to do some very fancy assemblies.

A macro is a “template” of some code that you might wish to repeat a few times throughout the program in a slightly different manner (thus eliminating the use of a subroutine). To take what Mr. Ashley calls a trivial use of a macro (the only kind I really use), suppose you need a sequence of instructions that loads a register pair with an immediate value, adds the contents of that register pair to the HL registers, and stores the result in a memory location. The macro definition to generate such code would be:

```
RPADD: MACRO
  LXI PAIR,VALUE
  DAD PAIR
  SHLD DEST
```

The first line of the macro definition names the macro (RPADD) and the parameters (PAIR, VALUE, and DEST). The next three lines are the instructions and the last line signifies the end of the macro definition. Somewhere in the program you might use the macro call “RPADD B,2571H,START+5”. During the assembly the “B” will be substituted for “PAIR”, “2571H” for “VALUE”, and “START+5” for “DEST”. The resulting code would be:

```
LXI B,2571H
DAD B
SHLD START+5
```

Notice that not only does one line of code (the macro call) generate many lines of code, but the same call can generate code that is slightly different (we could have used the DE or HL pairs). Macro processors have other features that give the programmer a great deal of power and flexibility in creating code. In his documentation, Mr. Ashley points out that an entire macro processor is necessary (RPADD) and the parameters (PAIR, VALUE, and DEST).

The Macro package is a necessity if you’re working in North Star dos, there is nothing that is comparable to the PDS macro assembler. I wish Mr. Ashley had written his assemblers so that they would create files instead of leaving it for the programmer to do in DOS, but the package is a necessity if you’re writing assembly language programs to be used by North Star system. However, if you normally use CP/M, then the relocating macro assemblers sold by Microsoft, CDL, or Digital Research are, in my opinion, more powerful.

As has been mentioned before, if you’re working in North Star DOS, there is nothing that is comparable to the PDS macro assembler. I wish Mr. Ashley had written his assemblers so that they would create files instead of leaving it for the programmer to do in DOS, but the package is a necessity if you’re writing assembly language programs to be used by North Star system. If you normally use CP/M, then the relocating macro assemblers sold by either Microsoft or Digital Research are, in my opinion, more powerful. You get those assemblers “free” if you buy any of the Microsoft compilers (Basic, Cobol, or Fortran) or PL/I from Digital Research, but those compilers will cost from three hundred to eight hundred dollars.

DEBUG: An 8080/Z-80 Debugger and Disassembler

That’s right—there’s more! Debug is a program similar to CP/M’s DDT but with more features. In fact, the only feature of DDT that is missing from Debug is the “assemble” command. Using Debug, one may examine blocks of memory in either hex or ASCII, move bytes from one memory location to another, fill memory with a constant, examine and modify memory, and disassemble a program. Debug has two other
features that are not in DDT. It is possible to compare
two areas of storage and to search memory for a
specific string of bytes.

The importance of any debugger lies in its ability to
trace execution of a program. Debug has a single step
feature, the ability to set breakpoints, and the ability to
view all registers (including the Z-60 registers) in
single step mode. There are a few commands that
make it very easy to trace through loops and sub-
routines, and there is one invaluable command that

Debug has a single step feature, the ability to set breakpoints, and
the ability to view all registers (including the Z-80 registers) in
single step mode.

allows the program to execute normally until a register
pair has reached a value specified by the operator. As
Mr. Ashley states, the single step function of Debug
will be the programmer's most valuable development
tool.

Conclusions

If you are going to be doing any assembly language
development for the North Star operating system, get
the PDS package. It is a fantastic buy at $99 and
there's really nothing comparable to it at any price.
Remember that this package is also available to
operate under the Micropolis system, and I think I have
gone into enough detail so that those people with
Micropolis drives can compare PDS to other packages
on the market (if there are any).

If you usually work with CP/M, then your decision is
slightly more difficult. I feel that the Microsoft and
Digital Research packages are slightly more sophisti-
cated and easier to use, but I have been using them
longer and am more familiar with them. They do cost
more and do not come with an editor or debugger, but
if you use CP/M, you already have those tools. The one
thing you do not have is the interactive editor/assembler,
and this alone is almost worth the entire price of the
package.

The documentation for all the programs is very good
and straightforward. Each program is described in its
own section and all the commands are listed together
for easy reference. The non-standard commands are
explained in detail and examples are usually given
(this is especially true in the section describing Makro). I
encountered very few mistakes, and those that were
present were corrected on a diskfile. Mr. Ashley also
provides you with his phone number so that you may
contact him if you are encountering problems with any
of his programs.

The PDS Assembly Language Development System
may be purchased from Allen Ashley, 395 Sierra
Madre Villa, Pasadena, CA 91107; (213) 793-5748.

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ly collecting them in a "garbage" file. All errors are reported to printer and/or console. Reduces
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A Hardware Random Byte Generator

by John H. Gillespie

There are many occasions when large numbers of random numbers are required for simulations or Monte Carlo procedures. In the population genetics simulations that I am involved with, it is not unusual to use tens of billions of random numbers in a single run. Such simulations require a fast and a "very random" random number generator. The pseudo-random number generators supplied with most languages often fail on both counts. The most spectacular recent failure is the random number generator supplied with the Microsoft Basic compiler. If you use this generator to produce two random integers between one and six, then the sum of these two integers will never equal seven (see Lifelines Vol. 1/No. 7). While good software random number generators of adequate speed can be written for large computers, on micros it is usually preferable to construct hardware generators when speed is critical. In this article, plans will be presented for a pseudo-random byte generator which latches a random byte onto the S-100 bus whenever an input instruction is executed for the appropriate port.

The random byte generator is based on the maximal-length feedback shift register (MLFSR) technique. The basic idea of a MLFSR is illustrated in Figure 1. If the number of registers is large and if the tap register is cleverly chosen, then this generator will produce a pseudo-random sequence of bits which passes most criteria of randomness. A good place to read the basic ideas about these generators and their construction using TTL circuitry is the TTL Cookbook.

The mathematical properties of the sequence of bits generated by a MLFSR are well known. The books by Gill or Golomb give most of the details. For our purposes, the relevant fact is that the tap register may be chosen in such a way as to guarantee that the sequence of bits will be maximal length before the cycle repeats. There are usually quite a few different tap registers that will generate a maximal length sequence for a given total number of registers. Finding one such tap register can be hairy since it involves factoring polynomials over Galois Fields Modulo 2. Fortunately, there are extensive tables of tap registers which generate maximal length sequences. A particularly useful table is presented in the paper by Arvillias and Maritsas.

Figure 1: A Maximum-Length Feedback Shift Register.

Given that the total number of registers, p, and the tap register have been settled on, the mathematical theory tells us that the length of the sequence will be $2^p - 1$ before it repeats. For example, the generator described in this article uses a 63 stage generator, so it will generate $2^{63} - 1$ or approximately $9 \times 10^{18}$ bits before it repeats.
repeats. The generator is clocked at 10 MHz so the sequence will run for about 30,000 years before repeating.

Implementing one of these generators on the S-100 bus is very simple. A wiring diagram for a 63-stage generator is given in Figure 2. The dip switch allows the generator to be addressed at any of 16 port addresses of the form XF hex, X=0,1,...,F. The momentary switch S1 is necessary if the generator should contain zeros in each stage on power-up, it will continue to generate only zeros. By momentarily closing S1 some high bits are introduced. Once the generator has at least one high bit it can never return to a state where each register contains a zero. The generator is clocked at 10 MHz, in part to assure that two successive calls will provide bytes from widely separated regions of the sequence. A second reason concerns the bus timing. Some circuitry must be provided to protect against latching onto the bus while the generator is in transition. This is accomplished by the D-flip flop. The latching occurs on the first trailing edge of the generator’s clock after the RD signal goes low. Since the shift registers are clocked on the leading edge, the contents of the shift registers will always be stable when latched onto the bus. This circuit causes a delay of up to 100 nanoseconds from the time that RD goes low until the latching occurs. This delay causes no problems with 2-MHz 8080’s or 8085’s, or with 4-MHz Z-80’s because of the wait status that is internally inserted in the Z-80 during input instructions. However, this interface definitely does not meet the IEEE timing standards. It will meet the standard on a 4 MHz bus if a 20-MHz crystal is substituted, giving a maximal delay of 50 nanoseconds. This equals the 25±0.01 tcy maximum allowed by the standard. Alternatively, a simple circuit to generate a wait state can be included.

The entire generator can be wire-wrapped on a small portion of a prototype board in a few hours. The basic design can be embellished by adding a 74LS374 Octal latch to latch the generated bytes onto an 8-LED display which can be attached to the board by a jumper and placed outside of the computer enclosure. This is useful for debugging to make sure that the generated bytes are the same as those being read by the computer.

Once constructed, the random byte generator should be thoroughly tested for randomness. There are two reasons for this. The first is simply to make sure that no errors were made in the wiring. The second is more complicated. It turns out that all of the mathematical demonstrations of the randomness properties of these
A program to test the performance of the hardware random number generator.

#include <stdio.h>

static double mean = 0.0;
static double variance = 0.0;
static unsigned int n = 0;
static unsigned char *base = NULL;

main()
{
    double bit_prob[8], runs_t[8], chiSquared();
    int i;

    putfmt("Test of the hardware random number generator\n");
    putfmt("How many random bytes? \n");
    n = getint(10); // get decimal integer from stdin
    ranfill(base = alloc(n, NULL), n);
    bit_pattern(bit_prob);

    puts("Test of the hardware random number generator\n");
    for (i = 0; i < 7; i++)
    {
        bit_prob[i] = (double) n / 256.0;
    }

    for (i = 0; i <= n; i++)
    {
        rbyte = *p++;
        total += rbyte * rbyte;
    }

    mean = (double) total / n;
    variance = (double) total / n - mean * mean;
    for (i = 0; i <= 7; i++)
    {
        bit_prob[i] = (double) a[i] / n;
    }

    puts("normalized chiSquared = \n");
    chiSquared();
}

bit_pattern(bit_prob)
double *bit_prob
{
    unsigned char *p;
    unsigned int a[8], total, rbyte, i, j;
    unsigned long m = 0, v = 0;

    for (i = 0; i < 7; i++)
    {
        a[i] = 0;
    }
    p = base;

    for (i = 0; i <= n; i++)
    {
        rbyte = *p++;
        total += rbyte * rbyte;
    }

    mean = (double) total / n;
    variance = (double) total / n - mean * mean;
    for (i = 0; i <= 7; i++)
    {
        bit_prob[i] = (double) a[i] / n;
    }
}

ranfill(base, n)
public ranfill
ext clent, c$ret
rng equ 0b0h ;port address of random no. gen.
rnfill: ; call clent ;save c environment
    pop hl ;inc sp by 2
    pop hl ;hl = base
    pop bc ;bc = n
    in a, (rng) ;get random byte
    ld (hl), a ;stash it
    inc hl ;kick pointer
    dec bc ;decrement counter
    ld a, b ;check counter
    jr nz, loop ;jump if counter > 0
    jp c$ret ;return to c

Figure 4. Typical outputs of rantest program.

<table>
<thead>
<tr>
<th>Test of the hardware random number generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many random bytes? 30000</td>
</tr>
<tr>
<td>bit</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

mean number of one bits per byte = 3.9914, variance = 1.9858 normalized chisquared = -0.9890

Test of the pli-80 function rand

<table>
<thead>
<tr>
<th>How many random bytes? 30000</th>
</tr>
</thead>
<tbody>
<tr>
<td>bit</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
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<td>3</td>
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<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

mean number of one bits per byte = 4.0011, variance = 2.0022 normalized chisquared = -0.0942

Generators are based on averages taken over the entire sequence. In general, one is only using a very small fraction of the total sequence so the available mathematics is not entirely relevant. This necessitates that the generator be thoroughly examined with a series of statistical tests. In Figure 3 I have included a C listing of a program which examines several properties of the generators. The program starts off by calling the assembly language subroutine ranfill which places n random bytes in memory beginning at base for later testing. It is best to generate the random bytes as quickly as possible, since if correlations are to appear they will most likely involve bytes relatively close together in the sequence. The bytes are then examined in sequence by three C functions:

**Bit pattern.** This procedure calculates three quantities: 1) the fraction of one bits in each position in the generated bytes; 2) the mean number of one bits per byte; and 3) the variance in the number of one bits per byte. If everything is working we would expect about half of the bits to be ones and half to be zeros for each of the 8 bit positions among the n bytes. If this fraction lies outside of the range 0.5± 1/4n then there is reason to suspect the generator. If the fraction exceeds 0.5 then a good place to look for problems is with the interface to the bus. If the timing isn't correct the result is usually to read FFhex, which causes the inflation in the fraction of one bits. The mean number of one bits per byte should be about 4.0, while the variance should be about 2.0. If there are correlations between neighboring bits within a byte, this should cause the variance to be other than 2.0.

**Chisquared.** This procedure tests to see if all 256 bytes are generated with equal frequency. If the normalized chisquared lies outside of the range ± 1.96 more often than 1 time in 20, something is amiss. In earlier versions I found this to be another good indicator of interface problems. The normalized chisquared is used because the degrees of freedom (255) are so large.

<table>
<thead>
<tr>
<th>References</th>
</tr>
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</table>

**Runs test.** This test examines the number of runs of zeros and ones for each bit throughout the entire n bytes. This is a very good test for randomness between successive bytes. If the t-values lie outside of the range ± 1.96 more often than 1 time in 20, something is wrong. Details of this test may be found in an elementary statistics book.

Figure 4 gives a typical output from this program. As is evident, the generator checks out quite well.

If the rantest program is modified to examine the high order eight bits of the random number generator supplied with PL/I-80 the results are as in Figure 4. The runs test shows that the lowest two bits are not at all random in their behavior. This is a property of multiplicative generators that is of no concern for simple applications, but can obviously cause serious problems in more sophisticated programs, particularly those requiring truly random bytes and not uniform random variates.

JUL/AUG 1982
Error Detection And Correction Codes

by Robert B. MacKinnon

A summary of the techniques used to detect transmission errors and the means of automatic correction.

Principles

Digital computers, especially those involved in data communications, are susceptible to extraneous noise sources that introduce transmission errors. Although the effects from noise sources can be minimized, they can't be totally eliminated; as a result, errors can creep in. However, through the use of error detection hardware and algorithms, it is possible for transient errors to be detected and corrected. For years, digital communications systems, unattended data gathering equipment and digital computers have used special codes to perform the correction process. These codes range from the simple parity checking process to complex polynomial codes such as the Bosi-Chaudhri code. No matter which system is chosen, all error correction codes must adhere to certain principles of redundancy and efficiency.

After detecting an error, the system has to do one of the following three operations:

1. Ignore it.
2. Flag the error and ask for retransmission of the information.
3. Correct the error upon detection without asking for retransmission.

Each level of detection involves increasing complexity of implementation and redundancy. Redundant information is extraneous data to the original meaning of the data. It is added to help reduce the chance of an undetected error occurring during the transmission of data. Redundant information is defined as:

\[ R = 1 - \left( \frac{\text{no. of info. bits}}{\text{total no. of bits}} \right) \]

For example, assume a simple parity check bit is added to an eight bit digital word. The redundancy resulting from adding this bit is:

\[ 1 - \left( \frac{8}{9} \right) = 0.111 \text{ or } 11.1\% \]

This means that 11.1 percent of that digital word is totally unnecessary to the original meaning of the data.

We can see that as more bits are used as error checking bits, the digital word becomes longer and less efficient. Efficiency is the converse of redundancy and is defined as:

\[ E = 1 - R \]

For the above example, the efficiency of the simple parity check is:

\[ 1 - 0.111 = 0.889 \text{ or } 88.9\% \]

Code Distance

When an error occurs in a digital transmission, the receiving station does one of three operations—(1) ignore the error, (2) ask for a retransmission or (3) correct the error. Each level of error detection implies an increase in redundancy.

The first level—to ignore the error—has a redundancy of zero and an efficiency of 100%. In some cases (ie. telegrams via TTY), the errors can be ignored and the human operator can interpolate between the errors. However, such a system would be totally unacceptable for digital transmission. For most simple digital transmission systems, the second level of error detection—asking for retransmission of the information—is used. The receiving station uses a simple M-out-of-N code, parity check or checksum to detect a single bit deviation and then asks for retransmission of the errored data block.

As the detection scheme becomes more complex, a measurement of the effectiveness of the code is required. The measurement is arbitrary and is called the code distance (ie. the minimum separation between code words). If the minimum distance between code words is one, the code cannot detect any errors. When the code distance is two, the code cannot correct any errors but can detect single bit errors. A code distance of three implies detection of double bit errors and correction of single bit errors. This distance is often referred to as the hamming distance.
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Error Detection, continued...

Figure 1 presents the first seven code distances. Each level increase involves a decrease in efficiency but an increase in reliability of the code. Usually the adoption of a particular error correction code involves trading off some reliability for ease of implementation or speed.

<table>
<thead>
<tr>
<th>Distance</th>
<th>Detection</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>or 1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>plus 1</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>plus 2</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>plus 2</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>plus 3</td>
</tr>
</tbody>
</table>

Fixed Weight Codes
The Fixed Weight or M-out-of-N code is an integral character representation code which detects single bit errors. Each character that the code will represent must contain 'M' number of ones out of a possible 'N' information bits. This code differs from most because there are no extraneous redundant bits; rather, the content of the information determines whether an error has occurred. The possible number of character representations is severely limited by such an encoding scheme. The total number of legal combinations possible with this code is given by:

\[ Q = \frac{N!}{(M!)(N-M)!} \]

For example, a 4-out-of-8 code provides:

\[ Q = \frac{8!}{(4!)(8-4)!} = 70 \text{ characters} \]

and the usable number of information bits is given by the equation

\[ D = \log(\text{total no. of bits}) \]

which means, for the above example, the usable number of information bits contained in the code is:

\[ D = \log(70) = 6.13 \text{ bits} \]

\[ R = 1 - (6.13 / 8) = 0.233 \text{ or } 23.3\% \]

Another limitation of this code is its inability to resolve double-bit errors.

Parity
The most common form of error detection is the parity code. Parity can exist in two forms, even or odd. Even parity adds on a one bit to the digital word when the total number of ones in the word is even. It adds a zero bit if the number is odd. Conversely, odd parity adds on a one bit when the total number of ones is odd. Parity is easy to generate and to detect and has a low redundancy. However, it is limited to detection of only single-bit errors (code distance is two). It can be shown that approximately 30% of the time, simple parity checking will fail to detect most errors that occur to an eight bit word when transmitted. Noise pulses usually last long enough to destroy the integrity of at least two of the bits. Other methods using polynomial checks have been devised to detect these double-bit errors.

Polynomial Codes
As mentioned above, codes containing simple parity checks permit the detection of errors but offer no means of correction. If sufficient redundancy is added to the original information in the correct patterns, codes can be constructed so the errors can be corrected at the receiving station, without the need to retransmit the block in error. Such forward acting codes are discussed below.

Matrix Sum
In the matrix sum correction code, each character of the set to be encoded is arbitrarily assigned a number. For instance, assume A=1, B=2, C=3, and so on for the entire alphabet. Next, the letters are grouped in threes, the numbers assigned and arranged in rows to form a square matrix. The sums of all the rows and columns are taken and the total of the row and column sums taken (Figure 2).

The sums are converted back to corresponding characters and transmitted serially as below:

\[ A B C D E F G H I L O R F O X S \]

If any letter or letters were to be garbled when transmitted, the decoding process is a simple substitution process for the received character information: add vertically and horizontally to see where the error occurred and subtract vertically to determine the correct character. This system has been used by the U.S. Navy when transmitting RTTY messages. It is apparent that the system of encoding and decoding is tedious—but particularly suited to computer applications with one way transmissions since the code does not utilize any form of feedback. The 3 x 3 matrix will correct 90% of all single-bit errors and a 9 x 9 matrix will correct 99.9% of all errors with only a 23.4% overhead in message length. The redundancy of this method is 0.19 or nineteen percent.

Hamming Code
The most popular EDC code in use in digital computers today is the Hamming Code. This system introduces a code distance of 3: sufficient enough to correct single-bit
errors and detect double-bit errors. This is done by associating even parity check bits with unique combinations of information bits. Each check bit is responsible for checking the parity of its particular combination of information bits; for example, in the case of an eight bit word (as tabulated in figure 3) C1 checks \(13, 15, 17, 19\) and \(111\); C2 checks parity for \(13, 16, 17, 110\) and \(111\); C4 checks \(15, 16, 17\) and \(112\); and C8 checks \(19, 110, 111\) and \(112\). By gating the check bits into appropriate holding registers, the receiving device can determine the validity of the received character, determine the position of the bit in error, correct it (by reversing it), remove the parity bits and deliver the corrected words. The Hamming Code determines the position of the bit in error by first detecting an even parity error, then using the C1, C2, C4 and C8 output as a binary value pointing to the position of the bit in error.

**Figure 3. Hamming Chart and Resulting Boolean Equations**

<table>
<thead>
<tr>
<th>Check Bit Register Output</th>
<th>Error Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 C4 C2 C1</td>
<td></td>
</tr>
<tr>
<td>0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>0 0 1 0</td>
<td>1</td>
</tr>
<tr>
<td>0 1 1 0</td>
<td>13</td>
</tr>
<tr>
<td>0 1 1 1</td>
<td>13, 16</td>
</tr>
<tr>
<td>1 0 0 0</td>
<td>15</td>
</tr>
<tr>
<td>1 0 1 0</td>
<td>15, 16</td>
</tr>
<tr>
<td>1 1 0 0</td>
<td>15, 16, 17</td>
</tr>
<tr>
<td>1 1 1 0</td>
<td>19</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>19, 110</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>19, 110, 111</td>
</tr>
</tbody>
</table>

**Note:** The subscripts for the Error Bits above indicate the absolute bit positions (i.e. the indices of the bits being checked). The 'I' prefix indicates the actual data bits and the 'C' prefix indicates the check bits. As the example shows the machine requires twelve bits to check a single byte of data.

Boolean Equations for the Hamming Check Bits

- \(C1 = (C1 + 13 + 17 + 19 + 111)\)
- \(C2 = (C2 + 13 + 16 + 17 + 110 + 111)\)
- \(C4 = (C4 + 15 + 16 + 17 + 112)\)
- \(C8 = (C8 + 19 + 110 + 111 + 112)\)

For a single byte word, four Hamming bits are required, increasing the redundancy of the code to 0.667. This inefficiency is offset by the forward acting characteristic inherent in the code. That is, the correction occurs at the receiving station and retransmission of the data is eliminated.

---

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Example:
A GETFILE FILENAME.EXT 5000
Enter Execution Address in HEX: 5000
A non HEX number, CR, or a number less than 0100H will return to the CP/M system. Loading a dummy file of 0 length will allow you to not alter memory and directly jump to a chosen address.

Example:
A GETFILE DUMMY.DMB 0100
Enter Execution Address in HEX:XXYY
A valid address must follow the dummy file name but the execution address can be any valid four digit hex number.

When the GETFILE program is loaded into the TPA, it reads address 0005H to obtain the DOS entry point. It then subtracts the difference for the beginning of the CCP minus 0100H, stores this in the DE register and relocates itself to the calculated address.

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CIRCLE 38 ON READER SERVICE CARD
UNIPROM: State-Of-The-Art

EPROM Programming

by Steve Leibson

A short tutorial on EPROM’s and a review of
the Cer-Tek S-100 UNIPROM board.

EPROM’s are useful; erasable, programmable read-only memories (EPROM’s) can be used to store programs and data for uses ranging from simple peripheral drivers to entire languages. I use an EPROM in my North Star Horizon to store the routines which transform my memory-mapped video S-100 board into a Soroc IQ-120 terminal emulator. My big problem in using EPROM’s has been programming them. This article tells you how I solved that problem.

Introduction to EPROM’s

The EPROM and the microprocessor were both born in the early 1970’s. As early semiconductor devices, neither had much capability. The 4004 and 8008 were primitive processors and the 1702 EPROM could only store 256 bytes.

Improved processing technology has brought us a rapid evolution in EPROM capacity. The 2708 quadrupled storage to 1024 bytes. The introduction of the 2508 and 2758 five-volt only EPROM’s acknowledged that microprocessor systems were headed toward single, five-volt power supplies. Currently, there is a wide range of capacities available from 1024 bytes in the 2508 and 2758 parts to 8192 bytes in the 2764. The 2528 promises to double this limit again to 16384 bytes of storage.

Manufacturers of EPROM’s, in their race to supply us with greater capacities, have also given us a few problems to deal with. Newer EPROM technologies sometimes require different programming techniques. Sometimes, two manufacturers producing the next bigger part will select incompatible pinouts. These problems can make it very difficult to select an EPROM programmer that can program a wide range of devices.

EPROM Programmers

An EPROM can be thought of as a vast array of field-effect transistors (FET’s). Normally, the FET is off, current does not flow between the source and drain. If a charge is placed on the gate of the FET however, it will turn on and allow current to flow.

In EPROM FET’s, there is a “floating gate” which is isolated from the rest of the FET by an insulating material. A high gate-to-source voltage will drive electrons through the insulator and deposit them in the floating gate. When the voltage is removed, the electrons no longer have the energy to cross the insulating barrier and the FET is permanently on.

The high voltage is the programming voltage. Each type of EPROM has precise requirements for how much voltage is to be applied and for how long. Not enough voltage or too little time and the FET will not be programmed. Too much voltage or time may result in a damaged part.

EPROM’s may also be erased, that is what the “E” stands for. Until recently, the only way to erase an EPROM was with ultraviolet light. This required that EPROM’s be packaged with quartz windows to allow light to strike the chip. The ultraviolet light energizes the electrons trapped in the floating gate and allows them to cross the insulating barrier. This drains the gate of electrons and turns the FET off.

Newer parts, electrically erasable programmable read-only memories (EEPROM’s) can be erased with a...
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The Cer-Tek UNIPROM that is needed is the proper connections to the flexibility than that because of the consulting work that I do. One EPROM type cannot cover all applications.

Industrial programmers such as those available from Pro-Log and Data I/O can program a vast array of EPROM's and PROM's. They are based on microprocessors which are programmed with the various EPROM programming requirements. They also cost several thousand dollars.

Our microcomputers are a good basis for programming EPROM's. They can be programmed for the precise timing required by several different parts. All that is needed is the proper connections to the EPROM and the necessary programming voltages.

Several S-100 boards are available which allow a system to program EPROM's. Most can only program one or two types of EPROM. I felt that I needed more flexibility than that because of the consulting work that I do. One EPROM type cannot cover all applications.

The Cer-Tek UNIPROM

The UNIPROM, a new board from Cer-Tek (6020 Doniphan Drive, El Paso, TX 79932) can program a wide range of devices. With software available from Cer-Tek, the UNIPROM can program the following devices:

2704, 2708, 2508, 2758, 2516, 2716, 2532, 2732, 6755, 2564

This list represents a range of EPROM capacity from 512 bytes to 8192 bytes. The 8755 is a combination ROM and I/O chip made by Intel.

The reason that the UNIPROM has this flexibility is that most of the programming characteristics are determined in software. Ten switches on the UNIPROM board route board signals to a 24-pin zero-insertion-force (ZIF) programming socket. These switches allow the UNIPROM to accommodate the different EPROM pinouts. The on-board ZIF socket can accommodate all the EPROM's listed above except the three-supply TMS2716, the Intel 2732, and the 2564. These three devices will be supported by a programming console which attaches to the UNIPROM with a cable. You may also wire cable adapters for these devices. The UNIPROM manuals show you how.

The TMS2716 requires three power supplies, unlike the Intel 2716, so Cer-Tek chose to support the more popular single-supply part on the board. The Intel 2732 has a different pin-out than the T12532. Cer-Tek decided that they could only support one pin-out with the on-board ZIF socket and chose the TMS2532 as the more popular device. The 2564 is supplied in a 28-pin package and simply won't fit into the on-board programming socket. These devices are supported in the disk-based software.

All of the signals routed to the EPROM are controlled through an 8255A Programmable Peripheral Interface (PPI). This chip has three eight-bit parallel ports which are used to drive the address and data pins of the EPROM. One bit of one of the PPI ports is used to turn the programming voltage on and off. A second bit is used to drive the Chip Select. Eight bits drive the data lines. This leaves 14 bits for address bits accommodating EPROM sizes up to 16K.

One key feature of the UNIPROM is that it is I/O mapped instead of memory mapped. The UNIPROM takes up only four I/O addresses. It is preset at the factory to reside at locations D0 through D3 (hex) but can be relocated by cutting some traces and soldering jumpers.

This board can be left in the system since it isn't likely to conflict with other boards. Many S-100 EPROM programmers place the EPROM to be programmed in the memory space of the computer, meaning that 16K of memory space are lost to the programmer. Usually, you cannot afford to leave a board like that in your system—but the UNIPROM does not have this problem.

Besides the PPI and the circuits needed to interface it to the S-100 bus, there is a DC-DC converter on the UNIPROM board which generates the 24.5 volt programming voltage from 12 volts. That is all there is to the UNIPROM. The board is an elegant, simple approach to EPROM programming.

Cer-Tek charges $199 for the assembled and tested UNIPROM board with manual. An EPROM Programming System manual explains the theory behind the UNIPROM, how to use it and includes schematics and explanations of how the hardware works.

UNIPROM Software

Also included in this manual is a source listing for the software required to control the UNIPROM. This software may be purchased for $55 on a 2716 EPROM. The software is written to load and execute from location 100 (hex), the start of the CP/M transient program area (TPA). You can also purchase software reassembled to run at other locations on EPROM for $80.
The EPROM-based software will run on 8080, 8085 and Z80 processors and can be installed in your computer two ways. If you have a socket in your system that can accommodate a 2716 (the five-volt kind), you may plug the EPROM in and use a monitor system that can accommodate a 2716 (the five-volt computer two ways. If you have a socket in your need it. This method has the disadvantage of using up 2048 bytes of your computer's address space.

Cer-Tek has a nice solution to this waste of address space. You can load the UNIPROM software through the UNIPROM board using a short routine you key in. The routine will read the EPROM placed in the programming socket and load the code starting at the proper location.

I did not purchase the EPROM version of the UNIPROM software because a disk version of the software is available which has more capability for less money. This software is written for the CDOS and CP/M operating systems and costs $38. Included is a manual with a source listing. There is also a source file on the disk, intended to be assembled by the SD Systems Z80 assembler.

The disk software is available on 8" single-sided, single-density CP/M or CDOS disks, 5.25" CDOS disks and 5.25" North Star single-sided, single-density CP/M disks. The disk version of the UNIPROM software will run on 8080, 8085 and Z80 processors. I bought the North Star version which ran immediately. All of the EPROM's mentioned above are supported by the disk-based version of the software. The EPROM-based software does not support programming of 2564's and three-supply Texas Instruments 27616's. UNIPROM software commands include:

- B - Burn EPROM from memory image
- D - Display memory
- F - File name specifier for disk I/O
- L - Load a disk file into memory
- M - Move a block of memory
- P - Program (change) RAM memory
- R - Read an EPROM from UNIPROM to memory
- S - Save memory to a disk file
- T - Change EPROM type
- V - Verify (compare) two blocks of memory

All commands are available in the disk version, as is a command menu which is obtained by typing a question mark. The EPROM version does not have the disk commands F, L or S since it is designed to be independent of a disk operating system. These commands can be replaced with others available from the disk operating software of your system. If you have a tape-based system, your tape commands will do nicely.

Other Accessories
Unfortunately, the programmer and the software don't quite prepare you to program EPROM's. There are two other accessories I feel you will need to take full advantage of the UNIPROM. The programming socket
UNIPROM Review, continued...

is a bit hard to get at when the board is in the system. I bought a Mullen S-100 board extender to cure this.

If you don't buy an extender, you may have to plug the EPROM into the UNIPROM before installing the board in your computer. Since you should always install the board when the power is off, you will be turning the computer on with the EPROM in place. That is a bad idea. Cer-Tek says that the programming voltage may come on at power-up. This could damage the EPROM depending on the state of the other signals to the EPROM. It could also program a location in the EPROM with bad data.

Another way to solve this problem is to build an extension cable that extends the programming socket. This way, you can put the UNIPROM in the computer, route the cable through a convenient opening in the back, and replace the computer's cover. This is also what the programming consoles from Cer-Tek will do for you, when they are available.

The Programmer Giveth/The Eraser Taketh Away

Unless you are very rich and don't mind throwing out EPROM's after one programming cycle, you will eventually need to erase some of the EPROM's that you program. One way to do this is to leave the EPROM's in the sun for a week or two. Intel says this will erase them. A faster method is to purchase an EPROM eraser. The least expensive eraser I could find was the U/V-1 which is made by LS Engineering (Canoga Park, CA). It is sold by Jade Computer Products (4901 W. Rosecrans, Hawthorne, CA, 90250) for $39.95. Jade's part number is XME-3200.

The U/V-1 came with no instructions, and it took me a half hour to figure out how to turn it on. I kept pushing the switch and nothing would happen. After a few minutes with an ohm meter and an old article on building EPROM erasers, I finally figured it out. To save you some time, I'll tell you how to start it up. A push button on the side of the U/V-1 is both an on/off switch and a starter. To turn the lamp on, push and hold the switch in until you can see a glow. Then release the switch and the light will stay on. It's always the simple things that get you!

Using the UNIPROM

After all this, we are finally ready to program some EPROM's. The first order of business is to set those ten switches on the board. Cer-Tek's manuals are good, but they are rather vague about setting the switches. The switches are grouped into two sets, one with two switches and the other with eight. The smaller set differentiates between 2532/2732's and all other EPROM's. The larger set differentiates between 2704/2708's and all other EPROM's.

The problem was that several switches are marked "O" and the others are marked "C". The markings were not explained in the manual. Some simple-minded observation of the circuit board showed a large marking stating that "O" stands for "open" and "C" is for "closed." (I told you it's the simple things that get you.) I feel Cer-Tek needs to improve this part of the manual. If the switches are set incorrectly, the EPROM may be damaged.

After setting the switches, plug the board into your extender and turn the computer on. Bring up the software and you are ready for a "burn." Before you install the EPROM for programming however; make sure the "VPP ON!" LED is off! If the LED is on, the programming voltage is switched on and inserting the EPROM into the live socket may damage it. The LED should be off when the programming software is initialized. If it is on, something is wrong with the software. Check that the board is located at the address the software believes it to be.

Cer-Tek's UNIPROM came out of the box, plugged into my system and worked the first time. The software is very easy to use and seems bug-free. If you are considering an EPROM programmer, the UNIPROM deserves serious consideration.

My First Burn

I tested the UNIPROM with 2758 and 2716 EPROM's. Those are the devices I use most of the time. After setting the switches on the UNIPROM, I booted the software, told the program that my system ran at 4 MHz, and that I would be programming 2758's. I placed the 2758 in the ZIF socket and requested a burn using the information at F000 (hex). That is where the terminal emulation software resides in my system.

In a little over 52 seconds, the EPROM had been checked for complete erase, programmed and verified. The theoretical minimum programming time for a 2758 is 51.2 seconds. One interesting side note about the UNIPROM is that it sings while it is programming. Varying loads on the 25-volt switching supply during programming cause the step-up transformer to "chirp."

Next I tried a 2716. This merely required that I use the T(type) command to specify the part. Again, I used the software at F000 (hex) for the source. The EPROM was checked, programmed and verified in a little less than 103 seconds. The theoretical minimum time required to program a 2716 is 102.4 seconds.

Finally, I found an old 2708 in my parts box that I had received as part of the IEEE MicroMouse contest. Since the UNIPROM can also program 2708's, I decided to try programming this part. After resetting the board switches for the 2708 and setting the EPROM type with the "T" command, I started the burn.

The first thing I noticed was the sound coming from the board was different. While 2716's and 2758's require 50 millisecond programming pulses, the
2708 requires pulses between 100 microseconds and 1 millisecond. A program pulse has to be applied to each location until 100 milliseconds worth of pulses have been applied to each location. The shorter pulses are barely audible. The theoretical minimum programming time for a 2708 is 102.4 seconds.

After 201 seconds, the terminal beeped and "verify error" was displayed. "Oh no," I thought, "problems." After reading the UNIPROM documentation carefully, one of three explanations was possible. One, the board might not be able to program 2708's. This wasn't likely. Two, the EPROM might have only been partially erased and "phantom" bits might have appeared during the programming. Three, the EPROM might not be any good. How much trust can you put in a part that you got for free in a mouse contest?

I temporarily ignored the first possibility and tried to verify the second by erasing the EPROM for an hour. I carefully placed an opaque label over the erase window on the EPROM. The UNIPROM manual states that stray light on the EPROM during programming might cause a faulty burn. Another programming attempt reproduced the first results and "verify error" sadly stared back at me from the screen.

"Time for possibility number three," I decided. Checking with the local electronics shops, I found another 2708, purchased it and fired up the UNIPROM once again. After a very long 201 seconds, "completed" was displayed. A perfect burn!

**Further Software Explorations**

Experimenting further with the disk-based software was very enlightening. The software is really a very good monitor for loading, patching and saving binary files. All commands are self-prompting. This differs from CP/M's DDT which requires you to remember command syntax. The only thing that takes some memory with the UNIPROM software is that spaces are used for delimiters instead of carriage returns.

One thing I did not like about the software is that the common "control P" function in many CP/M utilities is missing. This command turns on the printer port so that anything displayed on the console is also copied to the printer. I think this would be a useful feature to use in conjunction with the D(ump) command.

Another small problem with the software is error checking. When given an illegal response to the question of system clock speed, the program accepts the bogus input and merrily continues. Also, when illegal characters are typed during input, they cause the command to be immediately aborted before you can backspace and fix your mistake.

**Conclusions**

I am quite impressed with Cer-Tek's UNIPROM. It came out of the box, plugged into my system and worked the first time. The software is very easy to use and seems to be bug-free. The people at Cer-Tek have been most responsive to me and I feel they have a real commitment to supporting this product. If you are considering an EPROM programmer, the UNIPROM deserves serious consideration.
CP/M V2.2 Patches
by Technical Support Group
Digital Research

MOVCPM.COM
Error Description(Patch 01, 3/31/81):
The following modification affects only CP/M systems
that use the optional blocking and deblocking algorithms
listed in Appendix G of the CP/M Alteration Guide.
When updating a file under systems using the algorithms
with no data added to the file, the last block of updated
records is not written to that file. Contact Digital
Research or your CP/M distributor if you are not certain
that this patch applies to your system.

Patch Procedure:
Make sure that you have a back-up copy of MOVCPM.COM
before using DDT to make the following changes. Use
the Assemble command (A) and the Set command (S).
After making the changes, return to the console
command processor using the GO command and save
the modified memory image on disk. Be sure to update
the memory image on tracks 0 and 1 by executing the
new MOVCPM program as described in the CP/M
Alteration Guide and by integrating your customized I/O
system.

A>ddt movcpm.com
DDT VERS 2.0
NEXT PC
2900 0190
-alcd2
1CD2 nop
1CD3 nop
1CD4 1xi h,0
1CD7
-G0

(Instructions were
DCR C
DCR C
JNZ 12DF)
-G0

(Number of pages to save
is determined from value
displayed under next.)

A>save 38 movcpm.com

Remember to install this patch to all CP/M systems
that use the blocking/deblocking algorithms listed in
Appendix G of the CP/M Alteration Guide.

Error Description(Patch 01-DD, 3/31/81): The following modification affects only CP/M systems
that use the optional blocking and deblocking algorithms
listed in Appendix G of the CP/M Alteration Guide.
When updating a file under systems using the algorithms
with no data added to the file, the last block of updated
records is not written to that file. Contact Digital
Research or your CP/M distributor if you are not certain
that this patch applies to your system.

Patch Procedure:
Make sure you have a back-up copy of MOVCPM.COM
before using DDT to make the following changes. Use
the Assemble command (A) and the Set command (S).
After making the changes, return to the console command processor using the GO command and save
the modified memory image on disk. Be sure to update
the memory image on tracks 0 and 1 by executing the new
MOVCPM program as described in the CP/M Alteration Guide and by integrating your customized I/O system.

A>ddt movcpm.com
DDT VERS 2.0
NEXT PC
2800 0100
-alcd2
1CD2 nop
1CD3 nop
1CD4 1xi h,0
1CD7
-G0

(Instructions were
DCR C
DCR C
JNZ 12DF)
-G0

(Number of pages to save
is determined from value
displayed under next.)

A>save 39 movcpm.com

Remember to install this patch to all CP/M systems
that use the blocking/deblocking algorithms listed in
Appendix G of the CP/M Alteration Guide.
**Error Description** (Patch 01-4200H, 3/31/81)
The following modification affects only CP/M systems that use the optional blocking and de-blocking algorithms listed in Appendix G of the CP/M Alteration Guide. When updating a file under systems using the algorithms with no data added to the file, the last block of updated records is not written to that file. Contact Digital Research or your CP/M distributor if you are not certain that this patch applies to your system.

**Patch Procedure:**
Make sure you have a back-up copy of MOVCPM.COM before using DDT to make the following changes. Use the Assemble command (A) and the Set command (S). After making the changes, return to the console command processor using the "G" command and save the modified memory image on disk. Be sure to update the memory image on tracks 0 and 1 by executing the new MOVCPM program as described in the CP/M Alteration Guide and by integrating your customized I/O system.

```
A>ddt movcpm.com
DDT VERS 2.0
NEXT PC
0600 0100
-0441
0441 SUI 61
0443 SYA 007D
0446 MOV C A
0447 MVI A 19
0449 CMP C
044A JNC 0456
044B JNC 0456
044D LXI B 019D
0450 CALL 02A7
0453 JMP 045E
0456 LDA 087D
0459 INR A
-0442
0442 61 41
0443 32
-A>save 38 movcpm.com
```

Remember to install this patch to all CP/M systems that use the blocking/deblocking algorithms listed in Appendix G of the CP/M Alteration Guide

**ASM.COM**
**Error Description** (Patch 02, 3/16/81):
ASM occasionally generates an erroneous phase error when the identifier in a SET statement appears within an expression from another statement.

For example:
```
    X SET 1
    Y FOR X
    END
```

This patch also applies to CP/M V1.4

**Patch Procedure:**
Make sure you have a back-up copy of ASM.COM before using DDT to make the following changes.

```
A>ddt asm.com
DDT VERS 2.2
NEXT PC
2100 0100
-04AD
04AD CALL 1352
04B1 CPI 05
04B2 CNC 200D
-Aldad
1DAD CALL 1352
1DB9 CPI 05
1DBE CNC 200D
-Aldad
1DAD call 1b8d
1DB9 .
-1b8d
```

**SUBMIT.COM**
**Error Description** (Patch 03, 6/27/80):
SUBMIT does not accept control characters in .SUB files. SUBMIT recognizes certain control characters when preceded by an up arrow. SUBMIT should interpret the two characters ^z as "control Z."

**Patch Procedure:**
Make sure you have a back-up copy of SUBMIT.COM before using DDT to make the following changes.

```
A>ddt submit.com
DDT V2.2
NEXT PC
0600 0100
-04A4
04A4 SUI 61
04A6 MVI D 07D
04A9 MOV C A
04AC MVI A 19
04AE CMP C
04AF JNC 050C
050D LDA 087D
050F JMP 0512
-0442
0442 61 41
0443 32
-A>save 5 submit.com
```

**Error Description** (Patch 04, 6/27/81):
If drive A is not the default drive when running the SUBMIT program, the $$$ .sub file is created on the currently logged in disk. Therefore, you can not run a SUBMIT job from any drive other than A. After making the following changes, the system will always create the $$$ .sub file on drive A.

**Patch Procedure:**
Make sure you have a back-up copy of SUBMIT.COM before using DDT to make the following changes.

```
A>ddt submit.com
DDT V2.2
NEXT PC
0600 0100
-04A4
04A4 SUI 61
04A6 MVI D 07D
04A9 MOV C A
04AC MVI A 19
04AE CMP C
04AF JNC 050C
050D LDA 087D
050F JMP 0512
-0442
0442 61 41
0443 32
-A>save 5 submit.com
```

**PIP.COM**
**Error Description** (Patch 05, 8/28/81):
A problem occurs with the PIP Start and Quit options when the Start and Quit strings are the same length.
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CP/M Patches, continued...

Patch Procedure:
Make sure you have a back-up copy of PIP.COM before using DDT to make the following changes.

A>ddt pip.com
DDT V2.2
NEXT PC
1EO0 0100
-1168
1168 lda 1F62
1168 sta 1DF7
1168 lxi h,1F62
1171 mvi h,00
1173 lda 1DF9
1176 inr a
1177 sta 1DF8
-1168
1168 lxi h,1F62
1168 mov a,h
116C sta 1F62
116F mvi m,0
1170 lxi h,lE04
1174 mov a,n
1175 mvi m,0
1177 inr a
1178 dcx h
1179 mov m,a
117A -0
A>save 29 pip.com

Error Description (Patch 06, 11/10/81):
A problem occurs with the PIP object file transfer options when copying file to file.

Patch Procedure:
Make sure you have a back-up copy of PIP.COM before using DDT to make the following changes.

A>ddt pip.com
DDT V2.2
NEXT PC
1EO0 0100
-10713
0713 lda 1F50
0716 lxi h,1E00
0719 ora m
-0713
0713 lda 1e04
0716 lxi h,lf5e
0719 -11099
1099 lda 1E04
109C RAR
109D JNC 1082
-11099
1099 lda 1f5e
109C .
-11640
1640 lda 1E04
1643 RAR
1644 JNC 1652
-11640
1640 lda 1f5e
1643 .
-00
A>save 29 pip.com

Error Description (Patch 07, 1/21/82):
When using PIP to copy to the PRN logical device, the LPT physical device is automatically selected. This patch disables the selection of the LPT device and allows the PRN logical device to be used without affecting the current IOBYTE setting.

Patch Procedure:
Make a back-up copy of PIP.COM before making any changes. The program DDT is required to make the changes. The changes are made by the following sequence of commands.

OA>DDT PIP.COM
DDT VERS 2.2
NEXT PC
1EO0 0100
-104F
054F CPI 00
0551 JNC 055E
0554 LDD 1DFC
-1A54F
054F CPI 2
0551 JNC 55E
0554 -G0
A>save 29 PIP.COM

DEBLOCK.ASM

Error Description (Patch 09, 2/11/82)
The following modification affects only CP/M systems that use the optional blocking and deblocking algorithms listed in Appendix G of the CP/M Alteration Guide. The sector blocking and deblocking algorithms provided in the guide work improperly in certain circumstances.

Patch Procedure:
Use the CP/M text editor to insert the following changes:

Following the comment on line 111 of Appendix G:
"read the selected CP/M sector"
Insert the following two lines:
  xra a
  sta unacnt ;racum = 0
The next source lines remain as shown:
  mvi a,l
  sta readop ;read operation
Insert the following code in your BIOS Home routine:
  home:
    lda hstwct ;check for pending write
    ora a
    jnz homed
  homed:
    sta hstact ;clear host active flag
Continue with the rest of the home routine.
The CCP Auto-Load Feature

(Applicable products and version numbers: CP/M V1.4, V2.0, and V2.2)

Program: CCP (Console Command Processor)

Normally, you interact with the CP/M CCP following the sign-on prompt. Utilizing the CCP Auto Load feature however, CP/M will execute an initial program immediately after loading the operating system.

Under normal operation, the CCP receives control from the BIOS upon a warm or cold boot. The beginning of the CCP module contains a two element jump vector and a command line that takes the following form.

```
JMP CCPSTART ;START THE CONSOLE PROCESSOR
JMP CCPCLEAR ;CLEAR THE INITIAL COMMAND
DB 127 ;MAXIMUM COMMAND LENGTH
DB 0 ;COMMAND LENGTH
DB * ;8 BLANK CHARACTERS
DB "COPYRIGHT..." ;COPYRIGHT NOTICE
```

If control is transferred to location CCP (address 3400H in a 20K CP/M), the console processor examines the command length at location CL (3407H in a 20K CP/M). If the command length byte is zero, then you receive the sign-on prompt and the CCP waits for console input. If the command length byte is not zero, the CCP assumes an initial command has already been entered. The CCP will execute the command on each cold or warm boot if control is transferred to location CCP. However, if control is transferred to location CCP+3 (JMP CCPCLEAR), the initial command is cleared and the program enters the CCP at the command line level displaying the default drive prompt.

Specify the length of the initial command using a non-zero CL byte. The command must be followed by a terminating zero. CP/M will execute the command following that CL byte. Although only 16 blank spaces are provided, you can move the Digital Research copyright notice for more spaces.

You can initialize the command line of the CCP on the operating system tracks or in the relocatable image within the MOVCPM data area. The initial command will execute in distributed or reconfigured CP/M systems.

In MOVCPM.COM or following SYSGEN and SAVE commands, the CP/M memory image is saved above the cold boot loader code starting at location (980H). If the system boot routines require more than 80H bytes, the CCP code may begin at location 0A00H.

Modifying MOVCPM.COM is similar to modifying the CCP. The difference is that the CCP starts at location 0980HH or 0A00H for systems requiring more than 80H bytes after DDT reads the CCP into memory.

The following procedure uses DDT to modify the CCP, allowing execution of the initial command "DIR" after each warm or cold boot.

```
>movcpm *
CONSTRUCTING 64K CP/M Vers. 2.2
READY FOR "SYSGEN" OR "SAVE 35 CP/M64.COM"
>ddt cpms64.com
DDT VERS 2.2
NEXT PC
```
Reversing The Backspace And Rubout Key Functions And Making Rubout Identical To Backspace

(AN-2, 6/25/81)

Applicable products and version numbers: CP/M V2.1 and V2.2

Program: BDOS

In the following code segment procedures, addresses given are hexadecimal offsets from the base of the CP/M system. The CCP is normally located at 98dH but may be located at A00H if a two sector boot is used.

You can assemble the patch for your size memory system. The cpmbase will equal the BDOS entry point address at locations 6 and 7 in the base page of memory minus 806H. Be careful because this entry point address is changed when DDT or SID is loaded. Under DDT or SID you must follow the jump at location 5 until an address is found with a significant digit of at least 6. In the following example, the cpmbase would be E506H-806H or D000H.

Procedure to reverse the backspace and rubout key functions

Patch into the SYSGEN or MOVCPM image exactly as you would patch-in a new version of your BIOS using the DDT “i” command followed by the DDT “r” command. Use the same offset as your custom BIOS and install the following code.

Alternatively, the above procedure can be installed directly into MOVCPM if you have MOVCPM.COM on your systems disk. The patch will be installed automatically in any size system that you build using MOVCPM. Make sure you have a back-up copy of MOVCPM.COM before using DDT to make the following changes.

The new program MOVCPM.COM is used in place of MOVCPM.COM. The backspace and rubout key functions will be reversed for any CP/M system generated with MOVCPM.COM.

Procedure to make RUBOUT identical to BACKSPACE

Before installing this patch, the code at cpmbase + 0A1Bh should read:

```
 mov a,b
 ora a
 je ('J
 mov a,m
 dec b
 dec h
 jmp cpmbase + 0A18h
```

Patch into the SYSGEN or MOVCPM image exactly as you would patch-in a new version of your BIOS using the DDT “i” command followed by the DDT “r” command. Use the same offset as your custom BIOS and install the following code.

```
 cpmbase equ 7
 ; subtract 806h from address at location 6
 org cpmbase + 0A02h
 cpi 806h:was cpi 00h
 org cpmbase + 0A16h
 cpi 00h:was cpi 7f
```

Alternatively, you can install the above procedure directly into MOVCPM if you have MOVCPM.COM on your system disk. The patch will be applied automatically to any size system that you build using MOVCPM. Make sure you have a back-up copy of MOVCPM.COM before using DDT to make the following changes.

```
 A>ddt movcpm.com
 DDT VERS 2.2
 NEXT PC
 2700 0100
 -11402
 1402 CPI 08
 1404 JNZ OA16
 1407 MOV A,B
 1408 ORA A
 1409 JZ 09EF
 140C DCR B
 140D LDA 000C
 1410 STA 000A
 1413 JMP 0A70
 1416 CPI 7F
 1418 JNZ 0A26
 -11403
 1402 08 0F
 1404 C2
 -a1417
 1417 7F 08
 1418 C2
 guards 38 movcpm.com
```

JUL/AUG 1982
Application Notes, continued...

The new program MOVCPM1.COM is used in place of MOVCPM.COM. The rubout and backspace key functions will be identical in any CP/M system generated with MOVCPM1.COM.

Sample BIOS For A Serial Printer Device
(AN-3, 6/25/81)

Applicable products and version numbers: CP/M V1.4, V2.0, V2.1 and V2.2
Program: BIOS

The following code fragment will drive Diablo serial interface printers or other serial devices that use the X-ON/X-OFF protocol for synchronization. A device that uses this protocol receives data faster that it can print. The device transmits a control-S character when its buffer becomes full and a control-Q to receive more data after the buffer is emptied.

```
MOVE A,C ! OUT LISTDATA
RET

LISTSTAT EQU 00H
LISTDATA EQU 01H
INSMASK EQU 02H
OUTMASK EQU 03H

LIST: CALL LISTST ! JS LIST

LISTST

B: RETURN LIST STATUS (0 IF NOT READY, FF IF READY)

LXI H, LISTFLAG
IN LISTSTAT ! ANI INSMASK ! JS NOINPUT

IN LISTDATA ! ANI 7FH ! CPI 'Q'-Z' ! JNZ 9?

MOV M, 0FH

9?: CPI 'S'-W' ! JNS NOINPUT

NOINPUT:

IN LISTSTAT ! ANI OUTMASK ! ANA M ! EA

OVI 255

NET

LISTFLAG OE 255: MUST BE 25, INITIALLY.
```

BIOS Error Return Code Options
(AN-4, 6/25/81)

Applicable products and version numbers: CP/M V2.2
Program: BIOS

Normally, CP/M responds only to a zero or non-zero value as the return code from the BIOS READ and WRITE entry points. If the value in register A is zero, CP/M assumes that the disk operation was completed successfully. If a non-zero value is in register A, the BDOS returns the message "BDOS ERR ON x: BAD SECTOR." You then have the option of typing <CR> to ignore the error or ctrl-C to abort.

This modification interjects three additional return codes for the BIOS READ and WRITE routines in register A as shown below.

0 - The disk read or write operation was successful
1 - Bad Sector - indicates permanent disk error
2 - Select Error - indicates the drive is not ready
3 - R/O - the disk is Read Only (used by WRITE)
4 - File R/O - (not normally used)

In the following code segment, addresses given are hexadecimal offsets from the base of the CP/M system. The CCP is normally located at 980H but may be located at A00H if a two sector boot is used.

You can assemble the patch for your size memory system. The cpmbase will equal the BDOS entry point address at locations 6 and 7 in the base page of memory minus 806H. Be careful because this entry point address is changed when DDT or SID is loaded. Under DDT or SID you must follow the jump at location 5 until an address is found with a least significant digit of 6. In the following example, the cpmbase would be E506H-806H or DD00H.

```
0005 JMP C000
2000 JMP D34H
D34H XTHL
D35H ADDL 8452
D34H XTHL
D34H JMP E506
```

Patch into the SYSGEN or MOVCPM image exactly as you would patch-in a new version of your BIOS using the DDT "i" command followed by the DDT "r" command. Use the same offset as your custom BIOS.

Before installing this patch the code at the cpmbase + BBDH should read:

```
LXI H, cpmbase + 609H
JMP cpmbase + R40H
```

The above code is replaced by the following code.

```
cpmbase equ ?

LXI H, cpmbase + 609H
JMP cpmbase + R40H
```

Alternatively, you can install the above procedure directly into MOVCPM if you have MOVCPM.COM on your system disk. The patch will be installed in any size system that you build using MOVCPM. Make sure you have a back-up copy of MOVCPM.COM before using DDT to install the following procedure.

```
A:ddt movcpm.com
```

The new program MOVCPM1.COM is used in place of MOVCPM.COM. Additional error return codes for the BIOS READ and WRITE routines are supported in any CP/M system generated with MOVCPM1.COM.

Improving The ^S Function
(AN-5, 6/25/81)

Applicable products and version numbers: CP/M V2.2
Program: BDOS

The ^S function controls screen scrolling during CRT output. However, the system does not recognize ^S if another character is typed before it.

In the following code segment procedures, addresses given are hexadecimal offsets from the base of the CP/M system. The CCP is normally located at 980H but may be located at A00H if a two sector boot is used.

You can assemble the patch for your size memory system. The cpmbase will equal the BDOS entry point address at locations 6 and 7 in the base page of memory
minus 806H. Be careful because this entry point address is changed when DDT or SID is loaded. Under DDT or SID you must follow the jump at location 5 until an address is found with a least significant digit of 6. In the following example, the cpmbase would be E506H-806H or DD00H.

```
0005 JMP C000
C000 JMP D3A4
D3A4 THIL
D3A5 SHLD 452
D1A8 THIL
D1A9 JMP E506
```

Patch into the SYSGEN or MOVCPM image exactly as you would patch-in a new version of your BIOS using the DDT "i" command followed by the DDT "r" command. Use the same offset as your custom BIOS. The call at cpmbase + 950H should be cpmbase + 923H before installing the following code.

```
cpmbase equ ?
org cpmbase + 950h
```

Alternatively, you can install the above procedure directly into MOVCPM if you have MOVCPM.COM on your system disk. The patch will be applied automatically to any size system that you build using MOVCPM. Make sure you have a back-up copy of MOVCPM.COM before using DDT to make the following changes.

```
A>ddt movcpm.com
```

The new program MOVCPM1.COM is used in place of MOVCPM.COM. Any CP/M system generated with MOVCPM1.COM will have the improved AS function.

**Changing The Lines Per Page (AN-6, 6/25/81)**

**Applicable products and version numbers:** CP/M V2.2

**Program:** ED.COM

This modification changes the number of lines scrolled by the "P" command in ED.COM from 23 to 14. Add 4200H to each address shown below for 4200H based systems. Make sure you have a back-up copy of ED.COM before using DDT to make the following changes.

```
A>ddt ed.com
```

The new program MOVCPM1.COM is used in place of MOVCPM.COM. Any CP/M system generated with MOVCPM1.COM will have the improved AS function.

**Changing The Restart Number In DDT (AN-7, 6/25/81)**

**Applicable products and version numbers:** CP/M V1.4, V2.0, V2.1, and V2.2

**Program:** DDT.COM

DDT uses RST 7 (machine instruction OFFH) to set break points. To change the restart number, modify the three bytes indicated by "??" in the following procedure for a new restart instruction and location. The restart instruction uses the bit pattern 11XXX111 where XXX is the restart number you will use. (AFH is RST 1, B7H is RST 2, BFH is RST 3, etc.) The restart location is usually the restart number times 8. Do not use RST 0 because it is reserved for CP/M.

The following procedure applies to DDT supplied with CP/M V2.1 and V2.2. For V1.4 and V2.0 change the instructions at 19B and 19E to:

```
0198 STA F04
019E STA 10F4
```

Make sure you have a back-up copy of DDT.COM before using DDT to make the following changes.

```
A>ddt ddt.com
```

To change the restart number for DDT in the future, you have to modify only the three bytes 1EBH, 1ECH and 1EDH.

**Nested Submit Files (AN-8, 6/25/81)**

**Applicable products and version numbers:** CP/M V2.1 and V2.2

**Program:** SUBMIT.COM

The CP/M submit program allows another submit command to be embedded within a submit file. However, control does not return to the original submit file after executing the nested submit command. Use any standard editor to type the following procedure into a file named SUBPATCH.ASM.

```
; ; subfch: equ 5bbh
bdatos: equ 5
open: equ 211h
; org 22dh :submit erase subroutine
```
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CIRCLE 44 ON READER SERVICE CARD

Application Notes, continued...

| ops: | ldx h,subfcb+12 ; try next extent
|      | rrc
| ops: | lxi d,subfcb+15 ; open extent
|      | jmp create
|      | org 25dh ; submit create subroutine
|      | create: call open
|      | inr a
|      | jmp ops1 ; loop if open ok
|      | lxi d,subfcb
|      | mvi c,22
|      | call bdos
|      |ADI 1
|      | ret
|      | ; the following code calls the above routines
|      | ; org 4feh
|      | ; call ops ; open the $$$.sub file
|      | ; jmp if not opened ok
|      | lda subfcb+15 ; set current record to end
|      | jmp 51dh ; jmp if open ok
|      | org subfcb
|      | db 1 ; force $$$.sub file to A:
|      | ;

Assemble SUBPATCH.ASM to create the file SUBPATCH.HEX. Then, use DDT to insert SUBPATCH.HEX into the SUBMIT.COM program as shown below.

A>ddt submit.com
DDT VERS 2.2
NEXT PC
0600 0100
-subpatch.hex
-r
-g0
A>save 5 submit.com

Configuring CP/M For Page Boundaries
(AN-9, 9/29/81)

Applicable products and version numbers: CP/M V2.2
Program: MOVCPM.COM
Patch MOVCPM.COM to configure CP/M V2.2 for page boundaries (256 bytes) instead of kilobyte boundaries.
Make sure you have a back-up copy of MOVCPM.COM before using DDT to make the following changes. Changes are saved in a new file named PGMOV.COM. The first argument designates the size of the system in pages that PGMOV is to construct. The first argument is optional but must range between 64 and 255 (decimal) if used.

A>ddt movcpm.com
DDT VERS 2.2
NEXT PC
2700 0100
-1165
0165 CPI 10
0167 JC 0172
016A MVI L,00
016C MOV H,A
016D DAD H
-6166
0166 10 40
0167 DA
-a164
0165 nop
0166 nop
016F -
-11a2
01A2 ANI FC
01A4 MOV H,A
01A5 PUSH H
01A6 LHLX 0006
-a1a2
01A2 ani fe
01A4 -
-g0
A>save 38 pgmov.com
Running Old NorthStar Programs With The New DOS

by D.J. Anderson

Recently, NorthStar released a new version of their DOS, Release 5.2, which fixes several bugs with Basic. This is the first standard release that uses the lower part of the computer’s memory: the DOS now starts at 0100H instead of 2000H.

This means that most users who have RAM from 0000 up will gain an extra 8K of usable memory (previously the DOS ignored this area). However, it will cause a problem if you have software that was purchased for a previous release.

If you have the source for purchased software, you can recompile it for the new location—user programs now start at 0E00H, instead of 2A00H or 2D00H. But what can you do if all you have is the object code? No one wants to go to the trouble of disassembling large programs, and simple relocating utilities that have appeared occasionally in various magazines require you to distinguish between data areas and instructions—nearly an impossible task, in many cases.

The answer is to write an interface program that will sit at 2000H, where the DOS used to be, and transfer calls to the new DOS at 0100H. In this way, the old program need not be modified at all.

The short program shown at right does just that. It contains all the information an application program expects to find in the DOS, and passes calls to the old DOS routines to the equivalent routine in the new DOS. With the exception of the directory lookup (DLOOK) routine, these are all just simple jumps. The DLOOK routine, however, sets the density flag (in double density systems), and so this must be done in the interface program as well.

To use this interface program, compile it and place it on disk with a go address of 2000H. Then, when you want to execute a program compiled for the old DOS, first execute the interface program:

```assembly
+GO D0S2000
+GO program

D. J. Anderson, 755 Southmore Drive West, Ottawa, Ontario, Canada K1V 6Z0

JUL/AUG 1982
```
Cloning CP/M Disk Drives

by Andrew Klossner

To the basement hacker scrimping for additions for a microcomputer, just buying one floppy disk drive can devastate a hardware budget. However, there are quite a few functions which are difficult or impossible to perform on a single-disk system. The orientation of CP/M is toward a plurality of on-line disks, and many of the commonly available programs are useless without at least two drives.

The utilities supplied with CP/M illustrate this point. While PIP can be used to copy a file between disks when there are multiple drives, the procedure to copy files with a single drive is to invoke DDT to load a file, switch disks, then use the SAVE command to write it out. This requires both disks to be bootable, and can result in a new file longer than the original, since SAVE only understands half of the possible file lengths. In order to copy several files between disks, as when backing up a disk, it is necessary to repeat this procedure once for each file. Interrogating or changing the attributes of a data file requires that the STAT program reside on the data disk.

One way around this problem is to modify each CP/M program so that it can optionally pause and allow the operator to swap disks before it attempts to access a file on a new volume. For example, a modified PIP program, when presented with the command "B:DATA =A:DATA", would read file A:DATA into memory, then print the message "MOUNT DISK B" and wait for the operator to strike a key. This done, PIP would assume that the second disk had been mounted on the drive, and could proceed to write the file B:DATA. Before exiting, PIP would ask the operator to "MOUNT DISK A" so as to restore the originally booted disk.

The obvious problems with this solution are that modifying every application program involves quite a bit of work, and many programs are not available in source code and so cannot be tampered with. Fortunately, the effect of modifying every application program can be achieved by changing the code within CP/M itself.

This article presents two methods of modifying a custom BIOS to provide several "virtual" disk drives on a system with only one real drive. The first is easy to understand and implement; it will work in many but not all cases. The second is more difficult to implement, but will work in all cases and provides more efficient operation than the first. The reader is assumed to be a proficient 8080 assembly language programmer, fluent in CP/M commands and system calls, and familiar with the manual, CP/M 2.0 Alteration Guide.

The First Method of Modification

The first method involves redefining the semantics of the operation "select disk." In a vanilla BIOS, the SELDSK entry point is used to specify the disk drive to be used in the next I/O operation. On a one-drive system, only drive 0 will ever be active, so this entry point can be used to specify the actual disk volume for the next operation.

The following code fragment replaces the SELDSK code in the MDS BIOS, presented on page 45 of the Alteration Guide:

```
seldsk: ; select disk given by register c
        lxi h,0000h ;return 0000 if error
        mov a,c
        cpi ndisks ;too large?
        rnc ;leave hl = 0000
        lda curdsk ;get current disk number
        cmp c ;is this the same disk as last time?
        je setdrive;if so, don't ask operator to swap
        mov a,c ;set CURDSK to new drive number
        sta curdsk
        adi "x", curdsk
        jmp setdrive
setdrive:
        lxi h,0 ;hl=disk number
        lda curdsk
        sta d,dpbase
        lxi h,0 ;hl=disk header table address
        lxi h,1
        jmp prmsg
        msg1: db 'MOUNT DISK ',0
        msg2: db '"x", HIT CARRIAGE RETURN',0
        msg3: db 'MOUNT DISK ',0
        curdsk: db 0 ;current disk: 0 is disk A
```

Andrew Klossner, P.O. Box 283, Wilsonville, OR 97070.
In addition, the following lines must be inserted after the label "wboot:" and before the first instruction of that routine:

```assembly
mvi c,0 ; warm boot, select disk A
call seldisk
```

With a BIOS incorporating this change, the command "STAT B:" might result in the following interaction:

```
MOUNT DISK B, HIT CARRIAGE RETURN:
Bytes remaining on B: 166k
MOUNT DISK A, HIT CARRIAGE RETURN:
```

Here, the operator was asked to insert a second disk; after this was done, STAT reported the free space on the disk, then returned to CP/M.

Now PIP can be used to back up a disk, with the command "PIPB:=A:*.*". A series of "MOUNT DISK:" messages will result, requiring a sequence of fast shuffles by the operator. Because of the algorithms within PIP, each file copy requires four mounts, since the procedure is to: 1) Find the next file on disk A, 2) Create the file on disk B, 3) Read from the file on disk A, and 4) Write out and close the file to disk B. Files larger than available memory require additional mounts.

Any CP/M program that uses multiple disk drives can now be run, provided that the operator is willing to spend the necessary time swapping volumes. The number of "virtual" disk drives is the same as the number of Disk Parameter Blocks (DPB's) in the BIOS. There are four in the MDS BIOS, and so disks A, B, C, and D can be accessed.

When running a multiple-volume program, it can be disastrous to mount a disk other than the one called for. A good practice is to temporarily label the disks with their letter codes.

**Deficiencies of the first method.** This simple modification will work fine when dealing only with single-density floppy disks. However, when double-density disks are to be handled, complications creep into the picture. When the physical sector size is greater than 128, CP/M buffers several 128-byte records, writing them to disk only when a full physical sector has been filled. For example, if the physical disk sector size is 512, then four calls to the "write sector" entry point may result in just one disk operation.

Now consider this scenario: A program writes three logical records to a file on disk A, then "selects" disk B, causing the operator to remove disk A and mount disk B. The three records may have been stored in an internal buffer, waiting for the fourth record to be added before a 512-byte sector write is initiated. Next, the program writes a record to a file on disk B. CP/M notes that the fourth record for the disk A file is not forthcoming, and so proceeds to "flush" or write out the internal buffer in order to finish writing the first three records. However, since disk B is mounted instead of disk A, the new sector lands in a random and probably disastrous position on disk B, wiping out whatever data was in its place.

Even when dealing only with 128-byte physical sectors, the first method suffers because many programs issue "selects" without following up with disk I/O. For example, the keyboard command "B:STAT", used to run the program from the file "B:STAT.COM", causes the following sequence of calls to the BIOS:

```
Select disk B
Select track
Select sector
Select address
Read a sector
Select disk A
Select disk B
Select track
Select sector
Select address
Read a sector
Select disk A
Select disk B
```

The problem is that, after each record of "B:STAT.COM" is read, disk A is selected, then disk B is selected. The net result is that the operator has to swap disks dozens of times to execute a single program.

**The Second Method of Modification**

The second method circumvents both these problems. It is implemented as follows:

- Leave the "select disk:" code as it was originally; that is, don't apply the modification of the first method.
- Reserve a byte of data, initially zero, labeled "CURDSK". This byte contains the number of the disk which is actually mounted on the drive, where number 0 is disk A, number 1 is disk B, etc.
Cloning Drives, continued...

- Add a subroutine (call it "DSKMNT") to the BIOS. This routine will check to see whether the currently mounted disk is the one upon which the next operation is to occur. It is called with the new disk number in register A. If the contents of A and CURDSK are the same, it quietly returns; otherwise it stores the new disk number into CURDSK and asks the operator to mount the new disk, in a manner similar to the first method.

- Isolate every segment of code in the BIOS which performs actual disk I/O. In a well designed but tricky sequence that redefines the number of disk drives, the warm boot code includes a subroutine which is given total responsibility for disk operations. Modify each such segment to call the DSKMNT subroutine with the number of the disk in register C. In addition, the I/O code so that actual disk I/O is always directed to drive 0, instead of going to any of several drives.

- Be sure to check the "warm boot" routine for virtual disk drives using one of these techniques. A sophisticated BIOS, the warm boot code includes a single, nonobvious OUT instruction. Before issuing this instruction, it should call DSKMNT to re-mount disk A.

Advantages/disadvantage of the second method. Using the second method of modification does have its drawbacks, the greatest being that it requires a large effort to seek out and modify every disk I/O operation in the BIOS. The advantages are that it will not clash with the buffering scheme, and useless "select disk" operations won't both the operator because the mount request is not issued until an actual disk read or write is scheduled.

Existing "Virtual Drive" Software

Several hardware vendors and software houses offer customized CP/M systems whose BIOS supports virtual disk drives using one of these techniques. A particularly good implementation, for the TRS-80 model I, is available from a company with the unlikely name of Pickles & Trout, in Goleta, CA. Their manual contains an excellent discussion of the consequences involved in using virtual drives.

Utility software packages are beginning to appear which run particularly well on virtual drive systems. For example, the Unica, a set of software tools from Knowlogy in Wilsonville, OR, includes a program which copies selected sets of files from one disk to another, using the minimum possible number of disk swaps. It does this by reading as many records as possible, from as many files as possible, into main memory before switching disks and writing them out. This software incorporates special code to eliminate extraneous disk selects when run under a BIOS using the first virtual disk method.
Low Cost Floppy Disk Power Supply

by Bob Zimmerer

Are you planning to buy a floppy disk? I bought one last summer and saved a little money by using this simple power supply. The two transformers are readily available, and by using them in the unconventional interconnection shown, provide the required and -5 volt regulated supply and the 26 volt unregulated supply for the stepper motor. My REMEX RFO 1000 requires about 1.5 amps at +5 volts, 1.2 amps at 26 volts when stepping, and a few milliamps at -5 volts. The voltages shown are measured while the disk is running. There is no need for regulating the 26 volts for the stepper motor.

The parts listed are the components I used. The exact value of the three filter capacitors is not critical; almost any large capacitors will do. The two bridge rectifiers are also not critical. Just be sure that they are at least 50V and can handle the current you need. The two +5V regulators are for the two disks I will eventually have. The single -5V regulator and 26 volt supply will handle two disk drives. With a little shopping around, you should be able to buy these parts for about $25.

Bob Zimmerer, 131 Second St., Port Angeles, WA 98362.
Introduction to Computer Graphics

by Lawrence E. Hughes

A brief survey of graphics displays, plotters and software.

Since a number of peripherals suitable for general purpose, high resolution graphics have appeared on the market, I felt that it was time for an article describing some of the details involved in using them, from a software viewpoint. Let me begin by describing two important hardware characteristics necessary for supporting "general purpose" graphics.

First, there must be an absolute minimum of 300 x 200 addressable points, preferably 600 x 400 or more. Second, the peripheral must have the ability to draw a straight line (or contiguous series of dots, etc.) from any addressable point to any other addressable point, without affecting the rest of the display.

Capabilities such as erasing part or all of previously drawn lines, or reading the display memory can be useful, but are not essential. Capabilities such as character generation and curve or circle drawing generally are not worth the extra cost, as they can be done in software easily, inexpensively, and in more general ways.

Lawrence E. Hughes, Mycroft Labs, Inc., Box 6045, Tallahassee, FL 32301.
SCION's Microangelo

The SCION Microangelo MA512 (monochrome version) is a single S-100 board with an onboard Z80 and 32K of memory, in addition to the video generation circuitry. Firmware

more for color or multiple gray levels) per "pixel." This tends to require a large amount of memory (e.g., 32K for 512 x 512), but with the increasing density and decreasing cost of RAM chips, this is becoming less of a problem.

VIDEO GRAPHICS DISPLAYS

Several high resolution video displays are currently available for the S-100 bus, in the $1000 to $1500 range (including monitor). Three of these are: the SCION Microangelo, the CDC Dynamic Blackboard and the CAT 100. All three have at least one resolution setting in the 300 x 200 range that are reasonably suitable, especially for preview applications, such as the Retrographics board for the Lear Siegler ADM-3A.

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Computer Graphics, continued...

is included to support vector and character generation. There are 512 x 480 pixels, with a roughly 5:4 aspect ratio (i.e., squares that are “n” pixels on a side appear as rectangles), but this is typically accounted for in software. The board appears to the primary microprocessor as a data port with handshaking on a separate status port, much like a serial I/O port would appear. Unlike the CDL, full character generation and dumb terminal emulation is supported, which makes this board suitable as a primary console display. The list price is $1095 (for the board itself, with the basic firmware). A reasonable monitor can be had for $150 to $300, with a slow (P31) phosphor highly recommended. Color versions are a great deal more expensive. A high-quality monitor and keyboard are also available from SCION, as well as a light-pen.

CDL's Dynamic Blackboard

The Cambridge Development Labs (CDL) Dynamic Blackboard (monochrome version) is a three board set (S-100) with direct hardware access to the display memory, via several I/O ports. No firmware is included, but a number of support routines are supplied on disk. There are 640 x 512 addressable pixels, but only 480 horizontal lines are visible at any given time. One unusual feature of the CDL board is hardware scrolling. The aspect ratio is exactly 1:1. The access speed is very high, with rates of up to 500,000 pixels per second claimed. No general purpose high level software could begin to keep up with this, hence the display would not be a bottleneck for some time to come. Cost for the basic board set is $1200, with a monitor once again running about $150 to $300. Color versions are available at much higher prices.

Digital Graphics Systems' CAT-100

The CAT-100 is a slightly different animal than the previous two boards. It has a mechanism for capturing images from an analog TV signal, complete with 16 gray levels. It can, however, be configured for 512 x 480 monochrome display. It is a two board set (S-100 again), and the 32K of onboard memory can be accessed via a 2K window in the main processor's address space. The standard version is $1525, but a complete kit is available for $875. Once again, a $150 to $300 monitor is required. Color versions are somewhat more expensive.

![TEST OF MULTI-LINE EZPLOT](image)
GRAPHICS PLOTTERS

Several pen plotters currently available in the $500 to $1000 range are quite suitable for general purpose graphics. The Houston Instruments HIPLOT DMP-2, the Mauro PROAC, and the STROBE are three of these.

Houston Instruments HIPLOT Plotter
The Houston Instruments HIPLOT (DMP-2) is a “flatbed” plotter, where the pen can move in both X and Y directions over a fixed (10” x 7”) area. Plotting speed is about 3” per second, and resolution is 200 points per inch (hence the addressable space is 2000 x 1400). Both serial and parallel interfaces are included in the standard unit. The list price is $1085. Larger and/or more intelligent versions are available at somewhat higher prices. This is an exceedingly well designed and well built unit.

Mauro PROAC Plotter
The Mauro MP-250B PROAC plotter allows the pen to move back and forth in one direction, while the paper (11” wide) is moved back and forth through a channel under the pen axis (by wheels with shallow teeth) for the other direction. Resolution is 200 points per inch, for a total addressable space of 2000 x 1400 on a 10” by 7” page. The list price of the PROAC is $775, with a serial interface (strongly recommended) for an additional $195.

STROBE 100 Plotter
The STROBE model 100 is a “drum” plotter, where the pen is moved back and forth in one direction, while the 8.5” x 11” page (mounted on a cylindrical drum) is rotated underneath that axis for the other direction. Resolution is 500 points per inch on the newer units, older ones have 250 points per inch, with a total addressable space of 5000 x 3500 on a 10” x 7” page. The cost of the basic unit is $785, with a parallel interface. STROBE markets interfaces for a variety of machines, including an S-100 board for $145. A semi-intelligent serial interface will be available soon for about $300.00.

On any of the above plotters, through various combinations of small steps (increments) in one or both axes, lines of any length can be drawn in any direction (within the constraints of page size). From a software viewpoint, there are no major advantages to any of these designs, and they may be considered to be functionally identical.

---

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CIRCLE 49 ON READER SERVICE CARD
DOT MATRIX PRINTERS

Dot matrix printers that offer access to each individual dot, such as the DataSouth DS180, offer yet another possible output device. Typically, with devices like this, a bit map of the final plot will be produced on a random access disk file, then pulled off sequentially, one line of dots at a time, and written to the dot addressable printer. This approach is necessary for two reasons: 1) since a line has been printed, it is not possible to back the paper up to add more dots (hence all dots for a given line must be plotted at once), and 2) the number of dots on a typical page exceeds central memory size (using one bit per dot), hence disk files must be used.

GRAPHICS SOFTWARE

Some plotters (e.g., any Tektronix compatible device, or the PROAC with its serial interface) understand how to draw, or move without drawing, from the current position to any new position in the addressable range. These are called "vector" devices. Other plotters only support access to raster scan pixels or very short vectors (e.g., .005 inches) in eight directions (incremental). The very lowest level of support software is only required for the latter variety, to make them simulate the vector type devices. The algorithms involved are relatively simple, and can be done with all integer arithmetic, with a minimum of multiplications and/or divisions. This is important because of speed considerations.

This level is often done in assembly language. Typical routines at this level allow drawing—or moving—from current position to any new position (expressed in integer raster point coordinates). In the case of a vector plotter such as the Tektronix, this might be as simple as encoding two 10-bit coordinates into a maximum of 4 ASCII characters, and sending them to the plotter. Such routines are called "hardware drivers." This level of software hides most of the differences in hardware characteristics.

The next level of software hides differences in coordinate systems, by translating coordinates from inches (relative to the lower left hand corner, or some user defined origin), into whatever absolute raster point coordinate system that the actual hardware uses. Such things as "windowing" and simple transformations in the plane are also implemented at this level. Windowing, or "clipping," is a technique that allows the user to specify a particular region (usually rectangular) on the plotting page, such that only those line segments, or portions thereof, that fall inside the window are actually drawn. Typical transformations implemented at this level might include magnification (in either or both axes), translation (ditto) and/or rotation about a given point. This is typically the lowest level accessible to the end user. An example would be the PLOT subroutine from the standard CALCOMP package.

If a set of higher level routines that draw characters, axes, grids, etc., are implemented in terms of such a routine, it is relatively easy to transport such a package to a new device by

AT LAST

A new book dealing with assembly language for CP/M system users entitled:

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simply re-writing that one routine and any lower level drivers used by it. One major advantage of doing this is the ability to preview several plots, or versions of a single plot, on a video device such as the CDL board, and then actually draw selected ones on a pen plotter such as a HIPLOT, using essentially the same user code (just substituting drivers).

There are several standard, high level packages currently in widespread use on mainframes and minicomputers, such as the CALCOMP basic package (from California Computer Products, Inc., originally designed for their very expensive, large pen plotters). Tektronix also has a basic package called PLOT-10, which was originally developed for their 40xx series terminals. These packages typically include routines that can draw line segments, alphanumeric characters, linear and/or log axes, linear, semi-log and/or log grids, etc. Routines to map user's coordinate systems into inches are also included, as may be routines for curve fitting, smoothing, etc.

Such routines are typically designed in quite generalized manners, such that they can perform their function in a wide variety of ways (e.g., draw any character string, anywhere on the page, any size, and at any angle), by passing parameters. Languages such as Fortran and PL/I are particularly well suited to modular, parameterized routines. Pascal is not sufficiently modular, and is too strongly typed, while Basic is not at all modular, has no parameters on its subroutines, and is usually about 10 to 100 times slower than a good compiled language (which can be a serious problem with graphics). Note that the standard CALCOMP package, the PLOT-10 package, and the Mycroft Labs package are all available only for Fortran, although we will be releasing a version of our package for PL/I later. We have no plans at all for supporting Basic, Pascal or Cobol directly.

This kind of package is typically available to the user in the form of a pre-compiled "object library" of subroutines (callable from Fortran) that simply re-writing that one routine and any lower level drivers used by it. One major advantage of doing this is the ability to preview several plots, or versions of a single plot, on a video device such as the CDL board, and then actually draw selected ones on a pen plotter such as a HIPLOT, using essentially the same user code (just substituting drivers).
Computer Graphics, continued...

can be searched by a linkage editor for just those routines which a particular user's program has called (along with lower level routines called by those routines, etc).

As an example of this kind of subroutine, the SYMBOL routine from the CALCOMP basic package allows the drawing of one or more alphanumeric (or special) characters. The calling sequence is:

```
CALL SYMBOL(XO,YO,H,STRING,ANGLE,NCHAR)
```

where the parameters have the following meaning:

- \(XO, YO\) — x,y coordinates, in inches, relative to the current origin, of the lower left corner of the first character position (before rotation). The special value 999.0 can be used for either or both parameters to pick up (in that axis) where the last call to SYMBOL left off.

- \(H\) — the height, in inches, of the characters, which also determines the width of each character, hence the length of the total string.

- \(STRING\) — character string to be drawn, either in an array or a literal (e.g., "Hello").

- \(ANGLE\) — angle of rotation, in degrees counterclockwise from 3 o'clock, about the point XO,YO, of the baseline of the character string.

- \(NCHAR\) — the number of characters to draw.

Note that there are certain other cases than the ones described, for drawing special symbols.

It is usually quite simple for a Fortran programmer to produce Cartesian graphs of data, using a package such as this. Often, other routines that support log, semi-log and/or polar graphs will be included. Yet other routines may be present to support the drawing of bar charts (histograms), pie charts, etc.

The highest level of support typically provided by a complete graphics package would include one or more generalized interactive programs that would allow the user to enter data (or read it from disk files), enter titles, axis labels, and so on, then produce complete, annotated graphs on one or more actual plotters. Even non-programmers can readily learn to use such utility programs, although they give up much of the flexibility available to a programmer using the package directly from Fortran Programmers that prefer working in other languages can also make use of such utilities by writing data files to disk, which can then be read by the interactive utility.

Mycroft Labs offers a graphics package, called GRAFFPAK, which is based on the standard CALCOMP basic routines. The package includes virtually all of the capabilities described in this article, and supports the following devices: Tektronix 40xx series terminals (or equivalent), Tektronix 4662 pen plotter, Houston Instruments HIPLOT DMP-2 pen plotter, CDL high resolution video board, and the SCION Microangelo high resolution video board. The following devices will be supported in the very near future: Mauro PROAC pen plotter, STROBE pen plotter, and DataSouth DS-180 dot addressable matrix printer. The price is $200.

For further information on the companies mentioned in this article, refer to the following list.

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CIRCLE 18 ON READER SERVICE CARD
We have assembled a package of plotter software (PLOTS) which is proving to be very useful for our scientific and engineering plotting applications. The package is menu-driven and allows generation of linear, semi-log and log-log plots with straight line curve fitting, on the basis of data points entered by the operator, or from data stored in an existing data file. The heart of the package is Mycroft Lab's "Grafpak" plotting package, which will be discussed in considerable detail later on. This software represents a beautiful example of Microsystem's software bus concept, in that we have simply taken commercially available software, added a few extras and have come up with a very powerful, easy-to-use, easily modified plotting package. PLOTS should be usable on any system running CP/M that has the necessary hardware and software (see Figure 1). PLOTS consists of two programs, a data editor and a plotter executive. The basic operation of PLOTS is very simple—the editor program prompts the operator for data points, axis labels, titles, etc. Upon completion of editing, this information is stored in a disk data file. The plotting executive is then automatically loaded, which accesses the data file and does the plotting, mostly by subroutine calls to Grafpak. Basic was used for the editor because program development is so easy in Basic, because the speed penalty for using it is of no consequence for data entry and, finally, because the string handling capabilities of Basic make it much easier to write the code for entry of string data (titles, axis labels, etc.). On the other hand, the fact that the plotting executive is all in Fortran results in very fast plotting and makes for compact plotting code, since it largely consists of subroutine calls to Grafpak.

The editor program has features one would expect: data points may be entered, deleted, changed, or reviewed, or data may be loaded from another disk file, then edited. Since the editor is written in Basic, changes of any desired sort are very easy to make. Our primary application for the package involves plotting of laboratory data. The example plots were produced by taking data directly from a student's laboratory notebook, using the editor. A very useful feature of the package is that the same data may be quickly plotted on any or all of the three axis types: linear, semi-log or log-log. This is often done in scientific or engineering plotting where one is looking for a straight line relationship in the data. If any semblance of a straight line can be found, the editor includes a routine which will calculate and plot a least squares fit for the points.

Although we have not done it, it would be very simple to write a program to allow any algebraic function to be plotted. All that would be required is a program to calculate a set of x, y values over the range of interest, then store the values in a data file. PLOTS could then be used to load and plot the points.

The Grafpak package is a very powerful set of plotting subroutines which allows one to plot linear, semi-log and log-log plots, with labeled axes and files. Automatic scaling of data is provided, as well as scaling of the overall size of the plots.
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Figure 1. Sample outputs from PLOTS programs.

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Some comments on Grafpak are in order here, inasmuch as it is the whole basis of PLOTS. The Grafpak package is a very powerful set of Fortran plotting subroutines which allows one to plot linear, semi-log and log-log plots, with labeled axes and files. Automatic scaling of data is provided, as well as scaling of the overall size of the plots. A single Fortran statement will enlarge or reduce the overall size of a plot. The pen location is monitored, so it is impossible to drive the pen on the HI plot against the stops, a very desirable feature! Grafpak has other features too numerous to mention here.

The documentation in Grafpak is for the most part excellent, as are the example plotting programs. Careful study will allow you to use all of the features of the package. The only area where the documentation is sketchy (and perhaps rightly so) is on getting the output of the package directed to the plotter. As supplied by Mycroft Labs, Grafpak sends all plotting information to the CP/M PUN: device. Initially, we were able to redirect the PUN: output to our second serial port by using DDT to modify the CP/M device driver dispatch table. We simply changed the jump table in the CP/M BIOS user area to cause PUN: to jump to the second serial port routine. Later, we added a new serial port, and then simply overwritten the PUN: code with a serial output routine for the new port. Again, the convenience of the software bus concept shows—very little patching is required to interface Grafpak to CP/M systems. The other ambiguity of the documentation was the absence of an example taking you through a sample session of preparing, compiling, and linking a plotting program. The listing in Figure 2 is an example of the steps, using a sample Fortran program (LOG.FOR) which comes with Grafpak. This probably should have been obvious to us, but it was not, so it took a good bit of guessing to get it right.

Grafpak has another feature which makes it an attractive piece of software. The software is modular enough that drivers may be written for it to use other plotting devices. Grafpak comes with drivers for both the HI-plot plotter, and the Tektronix 4010 family of graphics terminals. We have retrographics-equipped ADM 3 terminals which are equivalent to the TEK 4010, which makes it possible to direct plots to the video display. It is also possible to write drivers for other hardware. Mycroft Labs could provide assistance here, as they have written drivers for other plotters and would probably help with problems programmers might have in writing their own. Larry Hughes of Mycroft Labs proved very helpful in a number of telephone conversations when we were having trouble getting the TEK 4010 software working.

We will supply source listing for PLOTS, for three dollars, to cover handling and postage. (Make check payable to Joseph W. Long.) We can also supply the source on your disk (NorthStar 5” double density format only) for no charge; please include an SASE for the return of your disk.

Grafpak is available from Mycroft Labs, P.O. Box 6045, Tallahasseee, FL 32301; phone: (904)385-2708. The price of the package is $200.00, or $1,000.00 with all source code included. It is available on 8” single density soft-sectored format only.

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**Grafpak**

The documentation in Grafpak is for the most part excellent, as are the example plotting programs. Careful study will allow you to use all of the features of the package. The only area where the documentation is sketchy (and perhaps rightly so) is on getting the output of the package directed to the plotter. As supplied by Mycroft Labs, Grafpak sends all plotting information to the CP/M PUN: device. Initially, we were able to redirect the PUN: output to our second serial port by using DDT to modify the CP/M device driver dispatch table. We simply changed the jump table in the CP/M BIOS user area to cause PUN: to jump to the second serial port routine. Later, we added a new serial port, and then simply overwritten the PUN: code with a serial output routine for the new port. Again, the convenience of the software bus concept shows—very little patching is required to interface Grafpak to CP/M systems. The other ambiguity of the documentation was the absence of an example taking you through a sample session of preparing, compiling, and linking a plotting program. The listing in Figure 2 is an example of the steps, using a sample Fortran program (LOG.FOR) which comes with Grafpak. This probably should have been obvious to us, but it was not, so it took a good bit of guessing to get it right.

Grafpak has another feature which makes it an attractive piece of software. The software is modular enough that drivers may be written for it to use other plotting devices. Grafpak comes with drivers for both the HI-plot plotter, and the Tektronix 4010 family of graphics terminals. We have retrographics-equipped ADM 3 terminals which are equivalent to the TEK 4010, which makes it possible to direct plots to the video display. It is also possible to write drivers for other hardware. Mycroft Labs could provide assistance here, as they have written drivers for other plotters and would probably help with problems programmers might have in writing their own. Larry Hughes of Mycroft Labs proved very helpful in a number of telephone conversations when we were having trouble getting the TEK 4010 software working.

We will supply source listing for PLOTS, for three dollars, to cover handling and postage. (Make check payable to Joseph W. Long.) We can also supply the source on your disk (NorthStar 5” double density format only) for no charge; please include an SASE for the return of your disk.

Grafpak is available from Mycroft Labs, P.O. Box 6045, Tallahasseee, FL 32301; phone: (904)385-2708. The price of the package is $200.00, or $1,000.00 with all source code included. It is available on 8” single density soft-sectored format only.

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GET THE GUIDE!
Program Name: Spellbinder
Hardware System: CP/M + OASIS
Minimum Memory Size: 28K + Op System
Language: Assembly
Description: A full feature word processor with Office Management capabilities, integrated editing and printing sections. Special features include on-screen indents for outline creation, horizontal scrolling, user definable one-stroke function keys, and extremely flexible print formatting. Integrated print formatter includes bidirectional printing, true proportional spacing, print to and from screen, two column print, etc. The office management capabilities include both standard office procedures (forms handling, mail merge, cuesorting, alphanumeric selection and sorting, boiler plating, columnar manipulations such as removal, insertion, addition etc.) and a powerful macro capability which allows features to be added for the unique requirements of each user.

Release: June 1978
Price: $495
Included with price: Program, tutorial, reference and technical manual.
Where to purchase it: Lexisoft
P.O. Box 267
Davis, CA 95616
(916)758-3630

Program Name: C/80 C-Compiler Version 2.0
Hardware System: CP/M or Osborne 1 or Heath/Zenith (CP/M or HDOs)
Language: 8080 object code
Description: C Compiler supporting full C data structures, pointers and multidimensional arrays. Supports major C language features with the exception of floats, longs and argument to macros. Includes data initialization and all C storage classes, and compiles all C arithmetic and logical operators and control statements, generating 8080 assembly language code for Macro-80, or for the included absolute assembler. A useful software development aid is the runtime profile facility, which can print execution time and frequency for each subroutine.

Release: March 1982
Price: $49.95 + $3 shipping ($2 for 5" disks); $10 for owners of previous version.
Included with price: Disk and manual.
Where to purchase it: The Software Toolworks
14478 Glorietta Drive
Sherman Oaks, CA 91423
(213)986-4885

Program Name: INTROL-C for 6809
Hardware System: CP/M
Minimum Memory Size: 56K
Language: 8080 machine code
Description: A set of software development tools that allow C programs for 6809-based microprocessor systems to be created on 8080/Z80 development systems. Includes C compiler, 6809 assembler, object code linker, complete standard runtime library (with source code, in C) and library manager. Compiler supports all standard C except long, floating, and enumeration data types, initializers, bitfields, and structures as function parameters. All preprocessor directives are supported except #line and #if (#ifdef and #ifndef are supported, however). Compiled code is efficient, position independent, re-entrant, and ROMable. Price includes unlimited rights to distribute object code produced by compiler.

Release: February 1982
Price: $350.00
Included with price: 8" CP/M disk with object code, users manual.
Where to purchase it: Introl Corp.
647 W. Virginia St.
Milwaukee, WI 53204
(414)276-2937

Program Name: Crosstalk Version 2.0
Hardware System: All CP/M systems
Minimum Memory Size: 32K
Language: 8080 Assembly language
Description: Allows microcomputer system to access almost any ASCII dial-up computer system, capture and store received data, send pre-edited files to a remote computer system, and exchange virtually any type and size of file with another Crosstalk system, regardless of disk format incompatibilities. Crosstalk can automatically dial up a system, establish access through passwords, and loan in data at full modem speed for off-line editing later.

Release: January 1982
Price: $150.00
Included with price: Diskette and 60 page manual.
Where to purchase it: Available at computer stores, Dealer end user information is available from:
Microstuf, Inc.
1900 Leland Dr., Suite 12
Marietta, GA 30067
(404)985-0267

JUL/AUG 1982
Software Directory, continued...

Program Name: Plink(TM), RCPMLINK-TM
Hardware System: Osborne 01
Minimum Memory Size: 64K
Description: Allows communications via modem. User friendly PLINK asks for Drive A or B, then file name, to quickly save file to disk. To send a file, a simple control T + PLINK asks for Drive A or B + file name. RCPMLINK is a multi-function communications program. Its primary function is the transfer of files between remote CP/M systems or other Osborne 01 computers. The transfer is accomplished via a block mode, with headers and checksums (or optionally CRC checking) to ensure data validity. Automatic retry (up to ten times) is attempted for every sector of data transmitted or received when parity, framing, or overrun errors are encountered on a data byte, or on blocks of data that have checksum or CRC (cyclic redundancy check) errors. The user is given an option to quit, or retry after ten consecutive errors occur.
Release: March 1982
Where to purchase it: Allen Ashley
395 Sierra Madre Villa
Pasadena, CA 91107
(213)793-5748
CIRCLE 112 ON READER SERVICE CARD

Program Name: SYSTEM-70
Hardware System: CP/M 8" SO, 5-1/4" NorthStar
Minimum Memory Size: 16K
Language: Assembler
Description: Development software that enables a CP/M system to serve as a development station for Texas Instruments TMS7000 series microprocessors. With minor exceptions, assemblers feature instruction mnemonics and syntax as defined by processor manufacturer. Macro assembler includes full macro and conditional assembly features as well as ability to chain a series of source files together during a single assembly. Programs developed under this system must be off-loaded to target processor for test. Facilities are provided to implement off-loading mechanism as a direct transfer from memory, via a byte stream over a CPU port, or via .COM or .HEX disk files.
Release: October 1981
Price: $150.00
Where to purchase it: Allen Ashley
395 Sierra Madre Villa
Pasadena, CA 91107
(213)793-5748
CIRCLE 115 ON READER SERVICE CARD

Program Name: EPSET(tm)
Hardware System: CP/M 8" CP/M system or 5-1/4" NorthStar
Minimum Memory Size: 32K
Language: Object code
Description: "EPSET" contains nine files, eight of which are for testing EPSON-MX80's accuracy in printing its entire set of ASCII characters. The ninth file provides a menu for instantaneous selection and configuration of the EPSON-MX80 for combinations of characters per inch, single-, double-, and emphasized-strike, and line-spacing. The program is written in PL/I-80 for speed and precision.
Release: March 1982
Price: $39.95
Where to purchase it: Success Analysis Corporation
743 Holly Oak Drive
Palo Alto, CA 94303
(415)494-2613
CIRCLE 114 ON READER SERVICE CARD

Program Name: SYSTEM-TMS7
Hardware System: CP/M 8" SD 5-1/4" NorthStar & Micropolis Mod II
Minimum Memory Size: 16K
Language: Assembler
Description: Development software that enables a CP/M system to serve as a development station for Intel 8051/8751 single-chip processor. With minor exceptions, the assemblers feature instruction mnemonics and syntax as defined by Intel. The macro-assembler includes full macro and conditional assembly features as well as ability to chain a series of source files together during a single assembly. Programs developed under this system must be off-loaded to target processor for test. Facilities are provided to implement off-loading mechanism as a direct transfer from memory, via a byte stream over a CPU port, or via .COM or .HEX disk files.
Where to purchase it: Success Analysis Corporation
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Palo Alto, CA 94303
(415)494-2613
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Program Name: SYSTEM-70
Hardware System: CP/M 8" SD
Minimum Memory Size: 16K
Language: Assembler
Description: Development system software for National Semiconductor 70-Series microprocessors. With minor exceptions, assemblers feature instruction mnemonics and syntax as defined by the processor manufacturer. The macro-assembler includes full macro and conditional assembly features as well as the ability to chain a series of source files together during a single assembly. Programs developed under this system must be off-loaded to target processor for test. Facilities are provided to implement off-loading mechanism as a direct transfer from memory, via a byte stream over a CPU port, or via .COM or .HEX disk files.
Release: March 1982
Price: $150.00
Included with price: Macro assembler, interactive editor/assembler, text editor. Complete documentation is included and full user support is provided.
Where to purchase it: Allen Ashley
395 Sierra Madre Villa
Pasadena, CA 91107
(213)793-5748
CIRCLE 113 ON READER SERVICE CARD

Program Name: SYSTEM-51
Hardware System: CP/M 8" SD 5-1/4" NorthStar & Micropolis Mod II
Minimum Memory Size: 16K
Language: Assembler
Description: Development software that enables a CP/M system to serve as a development station for Intel 8051/8751 single-chip processor. With minor exceptions, the assemblers feature instruction mnemonics and syntax as defined by Intel. The macro-assembler includes full macro and conditional assembly features as well as ability to chain a series of source files together during a single assembly. Programs developed under this system must be off-loaded to target processor for test. Facilities are provided to implement off-loading mechanism as a direct transfer from memory, via a byte stream over a CPU port, or via .COM or .HEX disk files.
Release: March 1982
Price: $150.00
Included with price: Macro assembler, interactive editor/assembler, text editor. Complete documentation is included and full user support is provided.
Where to purchase it: Allen Ashley
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Pasadena, CA 91107
(213)793-5748
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Program Name: S-100-MBASE
Hardware System: S-100 MBASIC subroutines supplied; no BIOS mods required
Description: Industrial quality; burned in and tested.
Release: February 1981
Price: $375
Included with price: 15-1/4" disk and manual.
Where to purchase it: C&N
904 California Avenue
Palo Alto, CA 94306
(415)494-2613
CIRCLE 57 ON READER SERVICE CARD

Program Name: DIGITAL
Hardware System: S-100 MBASIC subroutines supplied; no BIOS mods required
Description: Industrial quality; burned in and tested.
Release: October 1981
Price: $375
Included with price: 15-1/4" disk and manual.
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1524 REDWOOD DRIVE
LOS ALTOS, CA 94022
(415) 966-1460
CIRCLE 57 ON READER SERVICE CARD
Program Name: JRT Pascal version 2
Hardware System: CP/M compatible systems.
Minimum Memory Size: 52K
Language: Assembly Language
Description: Full Pascal compiler and runtime system. Supports double precision (14-digit) floating point arithmetic, 64K strings, virtual storage for external procedures, separate compilation. True dynamic storage with automatic compression totally eliminates storage waste due to fragmentation. Procedures are not limited in size, recursion, nesting. I/O system supports binary and ASCII files, random disk files by record number or by relative byte address for variable length records. JRT Pascal optimizes programmer time with one-step compile—no assembly or link needed—verbal error messages, dynamic trace control. Advanced assembly language interface. The activity analyzer monitors programs and prints a histogram of execution frequency by line number. A utility is included to convert Microsoft format REL files to JRT format.
Release: January 1982
Price: $295 (manual only $30)
Included with price: Disk (available in most formats), user’s guide, 3-ring binder, user manual & report.
Where to purchase it:
JRT Systems
P.O. Box 22365
San Francisco, CA 94122
(415)888-4240
CIRCLE 117 ON READER SERVICE CARD

Program Name: Multi/OS (multi-user operating system)
Hardware System: Z80/6800/8085 incl. Altrons, Superbrain, TRS-80 MOD II
Minimum Memory Size: 64K memory board each user, 8K shared partition.
Language: Assembly "C"
Description: Allows simultaneous use by up to 16 users of one microcomputer. Configuration library contains over 70 devices and 20 disk drivers. Features are: mixing 5 and 8 floppy disks and hard disks; multiple printers with automatic spooling; 56K bytes program, full range of languages available; CP/M, CDO, SDSO, compatible; turnkey system features; interactive dialogue; record/lock using FMM; full single-user compatibility; "file mapped" messages for inter-user communications using high level languages; 15 disk units of 65 megabytes each; up to 975 megabytes on-line; user assignable subdirectories allow 65,504 files per unit; and many more.
Release: January 1981
Price: $900.00 end user. Call for OEM and dealer pricing.
Included with price: User manual and three month subscriber service for updates.
Where to purchase it:
InfoSoft Systems Inc.
25 Sylvan Road South
Westport, CT 06880
(203)226-8937
CIRCLE 118 ON READER SERVICE CARD

Program Name: DDUP
Hardware System: Any system running CP/M 2.x
Minimum Memory Size: 32K
Language: 8080 machine code
Description: DDUP (Disk Duplication) provides a convenient way to duplicate a diskette and/or to verify that two diskettes are identical. DDUP is made to be independent of disk controller, type of drive, disk size and format. Automatically adapts to actual number of tracks and sectors per track for the disks used. Requires that source and destination disk be of same format and density. It will replace bad

CIRCLE 119 ON READER SERVICE CARD
Where to purchase it: Electroconsult Inc. Konnerudgt. 3 N-3000 Drammen Norway CIRCLE 120 ON READER SERVICE CARD

Program Name: MR EDit
Hardware System: CP/M or MP/M with st'd CRT
Minimum Memory Size: 24K Transient
Language: Assembler
Description: Full screen-oriented text editor. Commands given by text or command key. User defines own command block (or 'group') numbers.

Price: $29.95 + $8 shipping/handling. Included with price: Disk and 13 page user's guide.

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The BIOS includes automatic density and single- or double-sided operation. System utilities such as FORMAT, BAKUP, SYSGEN, and CONSYS are included in the BIOS in addition to the standard CP/M utilities. The BIOS will support 5-1/4" and 8" drives simultaneously. Single-user, multi-user, and multi-processing software is available through Teletek from Digital Research, Turbodos, and Infosoft.

Price: $895; available from Teletek, 9767F Business Park Drive, Sacramento, CA 95827; (916)361-1777.

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by Steve Rogowski

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Some of the problems are not new like the one asking how much the $24 th Indians were paid for Manhattan would be worth today had it been deposited in bank. However, this problem was revised to have a variable interest rate so it would be a challenge to program. Of course many of the problems are new and have never been in print before.

The students edition has 265 pages includes all 90 problems (with variations 7 appendices and a complete bibliography. Cost is $4.95.

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**Slim DS/DD Disk System**

The ISA's F2P and F2 are floppy disk subsystems using two 8" ultra-slim, doublesided, dual-density floppy disk drives. The F2P drives are fully signal-compatible with the Persci 299B drive so that they can be configured into any Cromemco system. The F2 is intended for use in general system configurations and has an interface which is fully compatible with the Shugart SA801R and SA850R drives. Their major features are the following:

- DC direct-drive motor, special cam for high reliability, 3 msec seek time, free space inside the cabinet for an interface board (F2), and power supply unit. Noise filter and blower are also provided. For more information, contact International Systems & Automation, Heian Bldg., 2-6-16 Okubo, Shinjuku-ku, Tokyo 160, Japan.

**Cromemco 68000 Board Family With Error Correcting Memory**

Cromemco has announced a new Dual Processor Unit (DPU) which incorporates both 68000 and Z-80A processors on a single S-100 board.

Also offered are a Memory Controller Unit (MCU), a 256K RAM board (256MSU), and a 512K RAM board (512MSU).

The 256MSU and 512MSU memory boards provide built-in error checking and correction (ECC). Each board uses 22 bits to encode each 16-bit word to provide ECC via a modified Hamming code, allowing transparent detection and correction of single and double bit errors.

The Memory Controller Unit (MCU) can control up to eight memory boards. Each MSU supports either byte or word width memory operations. For use with the error detection/correction MCU's, there is an error-logging feature which stores the location of errors encountered, identifying which MSU and particular RAM chip on the MSU had the error.

**80 Character Video Board—S-100**

- Keyboard port with TYPE-AHEAD buffer
- 625 CRT controller with light pen port
- Two 2716's—program & character RAMs
- Optional 2716 for CHARACTER GRAPHICS
- All screen & keyboard ram
- Uses only EAST-TO-GET parts
- Use in any S-100 system
- 696 Bus Compliance: D8 M16 I8 T200

Build for less than $200. AT last—an affordable video board.

**Introducing The VDB-A**

Bare board with Documentation: $49.50 + $2 s&h (Ill. res. add 6% tax)

**Simpliway PRODUCTS CO.**
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Dealer Inquiries Invited
312/359-7337
CIRCLE 67 ON READER SERVICE CARD

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**Advertiser Index**

<table>
<thead>
<tr>
<th>Readers Service</th>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>ABM Products</td>
<td>16</td>
</tr>
<tr>
<td>49</td>
<td>Ackerman Digital Systems</td>
<td>77</td>
</tr>
<tr>
<td>64</td>
<td>Advanced Micro</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>Alpha Data Services</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>Avocet Systems Inc</td>
<td>78</td>
</tr>
<tr>
<td>26</td>
<td>Blat &amp; R&amp;D Corp</td>
<td>35</td>
</tr>
<tr>
<td>61</td>
<td>Bower-Stewart &amp; Assoc.</td>
<td>92</td>
</tr>
<tr>
<td>8</td>
<td>BPS</td>
<td>95</td>
</tr>
<tr>
<td>39</td>
<td>Budget Info</td>
<td>55</td>
</tr>
<tr>
<td>66</td>
<td>California Digital Eng.</td>
<td>85</td>
</tr>
<tr>
<td>40</td>
<td>Cer-Tek Inc.</td>
<td>57</td>
</tr>
<tr>
<td>65</td>
<td>Chromod Associates</td>
<td>92</td>
</tr>
<tr>
<td>65</td>
<td>CompUPro Systems</td>
<td>Cover 4</td>
</tr>
<tr>
<td>28</td>
<td>Computer Design Labs</td>
<td>37</td>
</tr>
<tr>
<td>32</td>
<td>Computer Dynamics</td>
<td>41</td>
</tr>
<tr>
<td>55</td>
<td>Computer Innovations Inc</td>
<td>78</td>
</tr>
<tr>
<td>7</td>
<td>Daman</td>
<td>15</td>
</tr>
<tr>
<td>38</td>
<td>Deiphic Systems</td>
<td>53</td>
</tr>
<tr>
<td>5</td>
<td>Diamond Software</td>
<td>6</td>
</tr>
<tr>
<td>21</td>
<td>Digital Research</td>
<td>24-25</td>
</tr>
<tr>
<td>48</td>
<td>Discount Software Group</td>
<td>75</td>
</tr>
<tr>
<td>13</td>
<td>Dual Systems Control Corp</td>
<td>15</td>
</tr>
<tr>
<td>24</td>
<td>Dupre Enterprises Inc</td>
<td>29</td>
</tr>
<tr>
<td>57</td>
<td>D&amp;W Digital</td>
<td>90</td>
</tr>
<tr>
<td>29</td>
<td>Ecosoft Inc</td>
<td>36</td>
</tr>
<tr>
<td>20</td>
<td>Electronic Control Technology</td>
<td>21</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Readers Service</th>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Elektroconsult AS</td>
<td>41</td>
</tr>
<tr>
<td>62</td>
<td>ET Software Services</td>
<td>95</td>
</tr>
<tr>
<td>54</td>
<td>Executive Computer</td>
<td>78</td>
</tr>
<tr>
<td>43</td>
<td>Executive Data Systems</td>
<td>68</td>
</tr>
<tr>
<td>9</td>
<td>G&amp;G Engineering</td>
<td>9</td>
</tr>
<tr>
<td>46</td>
<td>Hawkeye Grafix</td>
<td>72</td>
</tr>
<tr>
<td>59</td>
<td>IMSAI</td>
<td>91</td>
</tr>
<tr>
<td>22</td>
<td>Infosoft Systems Inc</td>
<td>27</td>
</tr>
<tr>
<td>19</td>
<td>Jade Computer</td>
<td>81,82,83</td>
</tr>
<tr>
<td>18</td>
<td>Products</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>JRT Systems</td>
<td>17</td>
</tr>
<tr>
<td>47</td>
<td>Key Microsystems</td>
<td>Knowology</td>
</tr>
<tr>
<td>45</td>
<td>Laboratory Computer Systems</td>
<td>71</td>
</tr>
<tr>
<td>30</td>
<td>Logical Devices Inc</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>Macrotech international Systems</td>
<td>5</td>
</tr>
<tr>
<td>19</td>
<td>Manx Software Systems</td>
<td>20</td>
</tr>
<tr>
<td>56</td>
<td>MicroTech Exports Inc</td>
<td>91</td>
</tr>
<tr>
<td>67</td>
<td>Midwest Micro Warehouse</td>
<td>79</td>
</tr>
<tr>
<td>1</td>
<td>Morrow Design</td>
<td>Cover 2</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Readers Service</th>
<th>Advertiser</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Musys Corp</td>
<td>39</td>
</tr>
<tr>
<td>35</td>
<td>McClintock Corp</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>North Star Computers Inc</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Picoen</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>Potomac Micro-Magic Inc</td>
<td>11</td>
</tr>
<tr>
<td>34</td>
<td>Priority One Electronics</td>
<td>42-43</td>
</tr>
<tr>
<td>60</td>
<td>Processor Interfaces Inc</td>
<td>92</td>
</tr>
<tr>
<td>42</td>
<td>RD Software</td>
<td>59</td>
</tr>
<tr>
<td>16</td>
<td>Rosetta Stone</td>
<td>12</td>
</tr>
<tr>
<td>27</td>
<td>S-100 Inc</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Sierra Data Sciences</td>
<td>1</td>
</tr>
<tr>
<td>67</td>
<td>Simpliway Products Co</td>
<td>96</td>
</tr>
<tr>
<td>36</td>
<td>SoftwareBanc</td>
<td>49</td>
</tr>
<tr>
<td>37</td>
<td>Software Connection</td>
<td>51</td>
</tr>
<tr>
<td>23</td>
<td>Southern Computer Systems</td>
<td>29</td>
</tr>
<tr>
<td>51</td>
<td>Southern Computer Systems</td>
<td>67</td>
</tr>
<tr>
<td>52</td>
<td>SPC Technologies Inc</td>
<td>80</td>
</tr>
<tr>
<td>25</td>
<td>Static Memory Systems Inc</td>
<td>31</td>
</tr>
<tr>
<td>56</td>
<td>Stok Computer Interface</td>
<td>79</td>
</tr>
<tr>
<td>12</td>
<td>Tecmar Inc</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Teletek</td>
<td>2</td>
</tr>
<tr>
<td>44</td>
<td>The Code Works</td>
<td>68</td>
</tr>
<tr>
<td>41</td>
<td>Theta Labs Inc</td>
<td>59</td>
</tr>
</tbody>
</table>

---

**MICROSYSTEMS**
Advanced Micro Digital has been producing the SUPER QUAD for some time now and it's truly one of a kind. Just plug this board into any S-100 mother board and hook-up your disk drives to it. It flies. Runs with CP/M, MP/M, and turbo-DOS. You can also plug in additional boards, I/O, hard disk controllers, etc. SUPER QUAD is a BUS master. The cost of this board is one third to one half of what you have been paying for the three board set. Just take a look at these features:

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MULTIPLE CHOICE
FOR MULTIPLE USERS.

CompuPro, the company which pioneered active termination, dual processing for microcomputers, M-Drive (the first “solid-state” disk), and DMA soft/hard disk controllers, has now created the 8/16 bit multi-user operating system for the 80s.

MP/M 8·6 lists for $1000. System requirements include CompuPro dual processor (CPU 8085/88) based system with appropriate interfacing, memory, and disk capabilities, as well as the System Support 1 and MPX 1 boards. MP/M 8-16 is used under license from Digital Research.

MP/M® 8-16, CompuPro’s proprietary edition of Digital Research’s MP/M 86 V2.X, unleashes the power of dual processing for unprecedented multi-user performance. Run the extensive library of 8 bit CP/M 2.2 software, and the latest 16 bit CP/M-86 software, simultaneously—even run different software packages at different stations. There’s also over 60K of temporary program area for each station; and, since both 8 and 16 bit software run under a true 16 bit operating system, speed and performance increases for any software run under MP/M 8-16.

To experience the state of the art in multi-user business, industrial, and scientific microcomputing, visit your authorized CompuPro Systems Center.