

Texas Instruments 990 Series

MANAGEMENT SUMMARY

The TI 990 Series features four upwardly compatible processors and nine packaged systems based on these four processors. The processors are easy to classify into two sets: the 990/4 and 990/5 microcomputers and the higher end 990/10 and 990/12 minicomputers. The 990/4 and 990/5 are LSI-based and each is packaged on a single circuit board. The 990/10 is a two-board unit implemented in Schottky TTL and conventional MSI components. The newest processor in the 990 family is the 990/12, with enhancements such as faster LSI devices and a 2K-byte workspace cache option.

Both the 990/4 and 990/10 have changed somewhat since their October 1975 introduction. The major changes are in memory packaging, withdrawal of availability as a board-only product, new packaging configurations, and expanded mass storage options. The 990/5 and 990/12 were announced in 1979.

The 990 family has highly compatible components and systems. TI has designed the family to allow ease of hardware upgrade from the DS990 Model 2 through the DS990 Model 30, the high-level languages are available, allowing flexibility and compatibility across multiple paths. This design compatibility and flexibility is inherent at the component level for the 990/4, 990/5, 990/10, and 990/12 processors.

The packaged DS990 systems include all necessary hardware with the necessary operating system software. Hardware is available with or without software (see Equipment Prices), and optional high-level industry-standard languages are offered for designing and implementing custom applications programs.

The DS990 Model 1 system includes a 1920-character video display unit with 96-ASCII-character set, typewriter- ➤

Texas Instruments' DS990 Series consists of four basic processors and nine packaged systems assembled around the four processors. The systems are available as hardware configurations only or with software included. Prices range from \$1,925 for the low-end processor with 8K bytes of dynamic RAM with parity, hardware multiply/divide, and a six-slot chassis to \$92,900 for the packaged hardware-only version of the Model 30, which includes 256K bytes of error-correcting memory, a 2K-byte cache controller, two video display terminals, and a dual disk system.

CHARACTERISTICS

MANUFACTURER: Texas Instruments Incorporated, Digital Systems Division, P.O. Box 1444, Mail Stop 784, Houston, Texas 77001. Telephone (512) 258-5121.

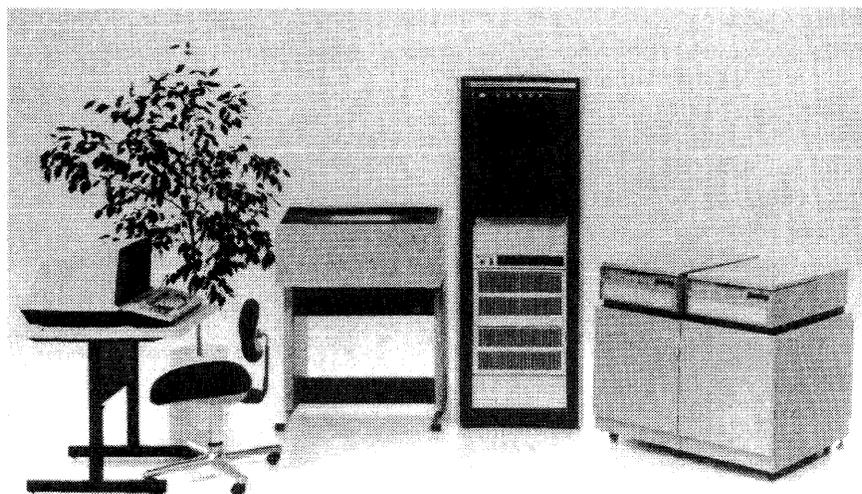
Texas Instruments is a leading supplier of semiconductor products to all branches of the electronics industry. In addition, the company is active in the fields of computer systems, process control, instrumentation, and computer peripheral equipment.

MODELS: 990/4, 990/5, 990/10, and 990/12 processors; DS990 Model 1, DS990 Model 2, DS990 Model 4, DS990 Model 6, DS990 Model 8, DS990 Model 20, DS990 Model 30; DS990 Model 4 Performance Package, DS990 Model 8 Performance Package.

DATE ANNOUNCED: 990/4 and 990/10, October 1975; 990/5, February 1979; 990/12, May 1979.

DATE OF FIRST DELIVERY: 990/4 and 990/10—March 1976; 990/5—April 1979; 990/12—June 1979.

NUMBER INSTALLED: Over 1000 pre-production models; production models—350 in U.S.A. and 150 elsewhere. ➤



The DS990 Model 20 shown consists of TI's most powerful 990 processor, the 990/12; an optional magnetic tape drive; two 50-megabyte disk drives; an optional 600-lpm printer; and a video display terminal. The Model 30 system is similar and uses 200-megabyte disk drives.

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▷ style keyboard with separate numeric pad, 16-bit TMS-9900 microprocessor, 64K bytes of random access memory (RAM) with parity and two communication ports in a self-contained module. Mass storage is provided by two, three, or four double-sided, double-density diskette drives in table-top enclosures with up to 5.2 megabytes of unformatted storage. An alternate configuration includes the addition of the Silent 700 30-character-per-second thermal printer built into the terminal. Optional hardware includes a special video display graphics set, TI OMNI 800 Series 810 printer, communications hardware, and a total of up to four diskette drives. The Model 1 uses either the TPL or TX5 Operating System. Languages supported are TX5 BASIC, TX5 FORTRAN, 990 Assembly Language, and TPL. The Model 1 also supports Pascal run-time and DX5 COBOL run-time interpreters. The languages supported are dependent on which operating system is chosen. The Model 1 has two ports for communication locally or over telephone networks. Hardware options include internal modems and interfaces to external modems with or without an auto-call unit. Communications software includes TTY (under TPL), IBM 3780/2780 (under TX5 or TPL), Burroughs Poll/Select (under TPL), and TI 742 (under TPL).

The Model 2 utilizes a 990/5 microcomputer with 64K bytes of memory, two on-board EIA asynchronous ports, two double-sided, double-density diskette drives (each with 1.15 megabytes of formatted storage), and a choice of either a Model 911 VDT or a Model 820 Keyboard Send/Receive (KSR) Terminal as the system workstation. Optional equipment includes additional diskette storage (up to 4.6 megabytes), a second workstation, an OMNI 800 Series 810 printer, 9.4-megabyte Model DS10 hard disk (4.7 fixed and 4.7 removable), an optional standby power supply, and a choice of hardware enclosures. The Model 2 is available in a table-top (6-slot) or cabinet (13-slot) enclosure with programmer's panel. The DS990 Model 2 supports program development in 990 Assembly Language, TX5 BASIC, and TX5 FORTRAN. Pascal run-time and DX5 COBOL run-time interpreters are also supported. Optional communication capability includes synchronous communication using a standard communications interface board with a choice of external modems with or without auto-call or with the appropriate user-supplied external modem. Communications software includes 3780/2780 emulation.

The DS990 Models 4, 6, and 8 with a minimum 128K bytes of memory utilize the 990/10 processor. All models include a 13-slot chassis with a programmer panel, 40A power supply, and disk loader ROM. Each system also includes appropriate documentation and a 1920-character Model 911 VDT with standard typewriter-like keyboard. The systems vary in the amounts of disk storage provided. The DS990 Model 4 system includes a DS10 disk drive with 5 megabytes of fixed disk-pack storage and 5 megabytes of removable disk-pack storage. The Model 4 system is designed to serve as a small-scale software development system or a medium-scale application system. The Model 6 system has two DS25 removable ▷

▶ DATA FORMATS

BASIC UNIT: 16-bit word is standard, although byte and bit addressing are possible in certain instructions. One parity bit per word is optional.

FIXED-POINT OPERANDS: 8 or 16 bits.

FLOATING-POINT OPERANDS: The 990/12 is the only one of the processors that has an instruction set which includes floating point operands.

INSTRUCTIONS: One-, two-, and three-word in nine formats. All memory reference instructions specify one or two addresses. Formation of each address is independent, and different addressing modes can be used with each.

The memory-reference format divides the 16-bit word into a 4-bit op code, a byte/word bit, two 4-bit general-purpose register designators, and two 2-bit addressing mode-selector bits, one for each general-purpose register designator. The register designators specify which of the current 16 workspace registers are to be used in forming both the operand source address and destination address. The two-bit mode-selectors determine which addressing modes are to be used to generate the effective source and destination addresses.

Most of the other instruction formats, including the register operate instructions, utilize a subset of the above control fields. Four formats require only the source designators.

Immediate-mode instructions require only a 12-bit op code and a 4-bit register designator. Jump instructions include an 8-bit op code and an 8-bit relative displacement. CRU instructions use a similar format except that the 8-bit displacement is used to develop a CRU bit address. Shift Instructions include a 4-bit register designator and a 4-bit shift count. Control instructions consist of a 16-bit op code.

INTERNAL CODE: Binary.

MAIN STORAGE

STORAGE TYPE: Dynamic MOS, EPROM.

CYCLE TIME: In the following table, times are in nanoseconds:

	Main Memory	Cache Memory
990/4	330	—
990/5	500	—
990/10	250	—
990/12	740	350

CAPACITY: For the 990/4, 8192 to 65,536 bytes of dynamic MOS memory and/or 2048 to 16,384 bytes of EPROM. The 990/4 CPU board contains 8192 bytes of dynamic RAM. Dynamic RAM can be extended by the addition of memory modules containing either 8192, 16,384, 24,576, 32,768, or 40,960 bytes composed of 4K-bit chips or 65,536 bytes composed of 16K-bit chips. Each module contains its own controller. On-board sockets on the 990/4 CPU board can accommodate up to 2048 bytes of PROM (SN74S287), ROM, or static RAM (TMS4043). An EPROM memory module consisting of a single full-size circuit board with 2048 bytes of TMS2708 EPROM memory and sockets for an additional 14,336 bytes is also available for the 990/4.

For the 990/5, either 32,768 or 65,536 bytes of on-board dynamic RAM memory. Either EPROM or ROM devices may be mounted on sockets to provide 2K bytes of on-board memory. The 990/5 CPU features a TILINE bus interface which is twenty bits long, describing a 1024K x 16 address space. ▶

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
MAGNETIC TAPE EQUIPMENT		
949008-0001	Transport Master Kit; master tape transport and controller for up to four transports; 9-track, 800 bpi, NRZI, 37.5 ips, vacuum columns, 10.5-inch reels, rack-mounted; add on transport is 949008-0006; 30 KBS	Texas Instruments 979A
948980-0001	Same as 949008-0001 but 1600 bpi, PE; add-on transport is either 949008-0006 or 948980-0006; 60 KBS	Texas Instruments 979A
PRINTERS		
938120-0001	Master Kit; serial impact printer and controller; 132 positions, 96 ASCII character set, 9 x 7 dot matrix, bidirectional, 3 to 15-inch wide paper, 256-character buffer, 6 or 8 lines per inch, 10 or 16.5 characters per inch; *--	Texas Instruments 810
2262090-0001	Master Kit; serial matrix printer/terminal and controller; 132 positions, 96-character set, 150 cps	Texas Instruments 820
937485-0001	Master Kit; drum line printer and controller; 132 positions, 64 ASCII character set, 5 to 16-inch wide paper, one-line buffer, 10 characters per inch, 6 or 8 lines per inch, 12-channel VFU; 300 lpm	Dataproducs 2230
937492-0001	Same as 937485-0001 but 600 lpm	Dataproducs 2260
PUNCHED CARD EQUIPMENT		
945083-0001	Master Kit; 80-column reader and controller; 1000-card input hopper, 500-card output stacker, fiber optic read station; 400 cpm	True Data 804
TERMINALS		
948977-0001	743 KSR Terminal Kit; controller and Silent 700 terminal; 80-position thermal printer with 64 ASCII character set, 10 characters per inch, 6 lines per inch, friction feed and 5 x 7 dot matrix; limited ASCII keyboard, EIA interface, full duplex; 30 cps	Texas Instruments 743
938849-0001	911 Video Display Terminal; 12-inch, 5 x 7 dot matrix, 96 ASCII character set, 24 lines by 80 characters, MOS refresh memory, 61-key keyboard including 10 programmable function keys and repeat key, 4-direction cursor control, 3 programmable intensity levels, EIA interface, switch-selectable data rates to 9600 bps	Texas Instruments 911

▷ disk-pack drives for a total storage capacity of 50 megabytes. The Model 8 system has two DS50 removable disk-pack drives for a total capacity of 100 megabytes. The Model 6 and Model 8 systems are particularly useful for medium- to large-scale software development and application systems.

In January 1980, Texas Instruments announced the DS990 Models 4 and 8 Performance Packages. The Models 4 and 8 Performance Packages achieve high performance through the combination of a 990/10 mini-computer and a cache memory subsystem. By acting as a buffer to main memory, the 2K-byte cache memory can improve 990/10 performance as much as 27 percent. The Performance Packages have the same disk storage as the Models 4 and 8 but standard memory is 256K bytes of ECC memory.

Main maximum memory on Models 4, 6, and 8 can be expanded up to 2048K bytes. A wide variety of disk storage units, diskette drives, magnetic tape units, dot matrix and impact line printers, card readers, additional Model 911 VDT's or 915 Remote Terminals, Silent 700 data terminals, and RS-232C communications interface modules for asynchronous and synchronous transmission at selectable rates from 75 to 9600 bits per second are also available. Software options available for DS990 Models 4, 6, and 8 and the Model 4 and 8 Performance Packages include COBOL, RPG II, DX10 990 BASIC, TI 990 Pascal, FORTRAN, DBMS 990, Query 990, TIFORM, ▷

► For the 990/10, 16,384 to 2,097,152 bytes of dynamic MOS memory and 2048 to 16,384 bytes of EPROM (same module as for the 990/4). Dynamic MOS may be either error-correcting or parity memory. Parity memory is available in increments of 16,384 bytes, 24,576 bytes, 32,768 bytes, or 40,960 bytes per module. The module includes an on-board controller. Error-correcting memory is available in 16,384, 32,768, or 49,152-byte increments. Each module must be paired with an error-correcting memory controller board, which contains a TILINE interface, 16,384 bytes of dynamic MOS, and refresh circuitry. Any of the different types may be intermixed on a 990 up to address and power limits of the CPU.

For the 990/12, 16,384 to 2,097,152 bytes of dynamic MOS memory. Error-correcting memory is available with a 2K-byte cache option which can increase system performance by about 30 percent on certain applications. The 990/12 CPU provides a TILINE bus interface.

CHECKING: Either parity or error checking and correcting systems are employed on the 990. Standard DS990 models 4 and above come with error checking and correcting. If parity checking is implemented, one parity bit is associated with each 16-bit word of parity memory. The parity bit is added by the parity controller to each 16-bit word written into parity memory and checked when read by the same controller.

The error checking and correcting system employs a 6-bit, modified Hamming code to identify erroneous bits. The memory controller generates a 6-bit code during a memory write operation and stores it, along with the 16-bit data word, in a 22-bit memory word. During a read operation, the controller retrieves the stored data, generates a new code, and compares that code with the stored code to determine whether an error has occurred. Single-bit errors in the word are ►

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➤ and Sort/Merge. Because certain languages, utilities, and applications, when used together, greatly increase productivity, TI has formed Integrated Software Packages (ISP). The COBOL ISP contains DX10, diagnostics, COBOL, TIFORM 990, an interactive forms package, and Sort/Merge. The DBMS ISP includes all the elements of the COBOL ISP plus the DBMS-990 data-base management system and the Query 990 inquiry/report language. IBM-compatible 3270 Interactive Communications Software (ICS) and 3780/2780 communications are also available.

The DS990 Models 20 and 30, introduced in May 1979, utilize the 990/12 processor with 256K bytes of memory with a 2K-cache controller. The standard systems include a 17-slot chassis with programmer panel, a DS50 (Model 20) or DS200 (Model 30) disk system master kit, two 911 VDTs, a 979A magnetic tape drive (800 or 1600 bpi) or a secondary disk drive, 70" cabinet enclosure, the DX10 Operating System, and applicable hardware and software documentation. Hardware-only versions can also be purchased. The Model 20 is expandable to 200 megabytes of disk storage and 2048K bytes of main memory, and the Model 30 is expandable to 800 megabytes of disk storage and 2048K bytes of main memory. COBOL, RPGII, DX10 990 BASIC, TI 990 Pascal, FORTRAN, DBMS 990, Query 990, TIFORM, COBOL ISP, DBMS ISP, and Sort/Merge packages are available as software options. Communications software includes IBM-compatible 3270 ICS and 3780/2780 emulation. Models 4, 6, 8, 20, and 30 and the two Performance Packages are software-compatible.

The microprocessor-based 990/4 can accommodate up to 10,240 bytes (5120 words) of memory on the CPU board, including up to 8192 bytes of dynamic RAM (random-access memory) and up to 2048 bytes of static RAM, ROM (read-only memory), or PROM (programmable read-only memory), in 512-byte (256-word) increments. The basic 990/4 includes seven external interrupts plus one internal interrupt, a real-time clock input, a CRU interface for programmed I/O functions, and optional parity control and self-test features.

Memory for the 990/4 is not limited to the 10K bytes that can be mounted on the CPU board. Separate RAM memory modules permit expansion to 64K bytes (32K words) using 8K-byte increments. EPROM (erasable programmable read-only memory) modules provide space for up to 32K bytes in 2K-byte increments. Memory write protection for 512-byte blocks is provided by two 7-bit registers which define the upper and lower boundaries of the write-protected area.

The Model 990/5 microcomputer's choice of memory begins at 34,816 bytes or 67,584 total on the CPU board, which includes 2048 bytes of PROM or EPROM. External and internal interrupts are increased to 13 and 3, respectively. Additional features include a real-time clock input, a CRU interface for programmed I/O functions, three on-board communications ports, station identifica-

➤ detected and corrected on the fly. If a multi-bit error occurs, the controller detects it and interrupts the CPU.

STORAGE PROTECTION: There are no storage protection features available for the 990/4 and the 990/5. Through the memory mapping options, which can be specified under program control, the 990/10 and the 990/12 have up to three 32K-word blocks to utilize a storage protection option. The 990/12 CPU generates a 16-bit address describing a 64K address space. Mapping scheme extends space to 2,048 bytes. A memory protection scheme permits users to specify read, write, and execute protected access.

RESERVED STORAGE: When using TI standard software, all models reserve the first 64 words of memory. Locations 0 to 31 are used to store interrupt trap addresses, and locations 32 to 63 store extended-operations trap addresses. In addition, in 990/10's with memory management, the high-order 1024 words are reserved for peripheral device drivers and the automatic bootstrap loader program after being transferred from ROM.

CENTRAL PROCESSOR

GENERAL: All models include an on-board real-time clock, a hardware multiply/divide, power fail/auto restart logic, and a command-driven communication register unit (CRU). The CRU defines a 4,096-bit input and 4,096-bit output register.

Models 990/4, 990/5, and 990/10 have a chassis option of a six-slot or a thirteen-slot unit. Only one slot is required by the CPU for the 990/4 and 990/5. Two slots are required for Models 990/10 and 990/12.

The 990/4 microcomputer has a cycle time of 330 nanoseconds and includes eight vectored interrupts. The 990/5 single circuit board microcomputer has a cycle time of 500 nanoseconds and implements sixteen interrupt levels, 15 of which are maskable under software control. Levels 1 and 2 are reserved for internal functions. Levels 3 to 15 are available at backplane wiring and may be used for external functions or for internal functions such as communication ports. The 990/5 also includes a TILINE bus interface which is twenty bits long, describing a 1024K x 16 address space. Either EPROM or ROM devices may be mounted on sockets to provide 2K bytes of on-board memory.

The 990/10 processor has a cycle time of 250 nanoseconds and features a TILINE multi-user bus, memory management, 16 interrupt levels, 16 extended operations, interface for operator/programmer panel, 1K bytes of PROM program loader with/without mapping memory error interrupt logic, and 13-slot chassis with self-contained power supply for CPU and standard interface cards. The 2K-byte cache controller is an optional feature on 990/10 systems.

The 990/12 processor has a cycle time of 740 nanoseconds if main memory is used. The 990/12 features a cache memory system. The 2K-byte cache controller has a cycle time of 350 nanoseconds. If the 990/12 executes code out of the cache instead of main memory, the cycle time of the processor approaches 380 nanoseconds. The 990/12 furnishes a 12-bit CRU address and 24 decoded module select signals to the chassis backplane. The chassis has been increased to 17-slot upgrading handling capabilities. The extended features of the 990/12 include a hardware floating point and stack operations. The 990/12 also employs a 143-instruction set (72 of which duplicate the 990/10).

A TILINE expansion is optional on the 990/5, 990/10, and the 990/12. There are three types of TILINE memory: an EPROM module, TILINE parity memory, and TILINE error-correcting memory.

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DS990 Hardware Overview

Model	1	2	4	6	8	20	30
TMS9900 CPU 990/5 CPU 990/10 CPU 990/12 CPU	X	X	X	X	X	X	X
FD1000 Diskettes DSSD FD800 Diskettes SSSD	X	X	X*	X*	X*	X*	X*
DS10 Disk DS25 Disk DS50 Disk DS200 Disk		X*	X	X*	X*	X*	X*
911 VDT 915 Remote Terminal Integral CRT	X	X**	X	X	X	X	X
Thermal Printer 810 Printer 820 KSR Printer 2230 Printer 2260 Printer	X*	X*	X*	X*	X*	X*	X*
979A Tape Drive Comm. Module 743 KSR	X*	X*	X*	X*	X*	X*	X*

*Optional.

**The Model 2 is available with one or two 911 VDT or AN820 KSR printer.

tion, a TILINE bus interface, parity control, and self-test features.

The 990/10 is a TTL version of the 990/4 and is mounted on two boards; an arithmetic unit and a memory controller. All 990/10 memories are on a separate module; memory can be expanded from 16K to 64K bytes (8K to 32K words) in the basic configurations, and up to 2048K bytes (1024K words) with the optional memory mapping feature. Memories for the 990/10 include 16K, 24K, 32K, and 40K-byte parity MOS modules, 2K-byte EPROM modules expandable to 16K bytes, and 16K, 32K, and 48K-byte error-correcting modules.

The 990/10 also has 16 interrupts and an asynchronous high-speed common I/O bus (TILINE) to which the CPU, memories, and peripheral controllers alike are interfaced to permit independent interleaved operations. The TILINE bus has a data transfer rate greater than 3 million words per second. In contrast, the data rate of the 990 CRU interface is about 100K words per second under programmed I/O.

Another option for the 990/10 is the availability of error-correcting memories like those available for the TI 980B. These are 22-bit memories that employ a 6-bit Hamming code to detect and correct I-bit errors on the fly. Multiple-bit errors are considered nonrecoverable and cause an interrupt.

The newest processor in the 990 family is the 990/12, which offers by far the highest performance of the 990 series. It matches the 990/10 in interrupt levels (16) but adds many more enhancements. In its minimum configuration, the 990/12 employs 262,144 bytes of error-correcting

CRU expansion is optional on all 990 models. CRU expansion creates a parity-line or common interrupt. Each CRU expansion card contains a 32-position interrupt scanner plus other circuitry to identify up to 128 interrupting devices. Up to 2048 interrupt lines can thus be implemented through the CRU.

CONTROL STORAGE: Control storage for the 990/4 is integral with the TMS9900 microprocessor chip. No control memory is employed on the 990/5, 990/10, and 990/12 models.

PHYSICAL SPECIFICATIONS: All modules, including CPU boards, are 10.8 inches by 14.25 inches wide.

Two chassis are offered for the 990/4, 990/5, and 990/10, a 6-slot chassis and a 13-slot chassis. Both the 6-slot chassis and the 13-slot chassis are 19 inches wide and 24 inches deep. The smaller unit is 7 inches high, while the larger is 12.25 inches high.

The 990/12 offers a 17-slot chassis only. The dimensions are 24.5 inches high, 19.5 inches wide, and 28.5 inches deep.

The CRU and TILINE expansion chassis are both 12.25 inches high, 19 inches wide, and 24 inches deep.

The single-bay equipment desk is 30 inches high, 30 inches deep, and 54 inches wide. Rack-mount space is 19 inches wide and 24.5 inches high. Service access to the rack-mount must be 23 inches by 30 inches wide. Convection cooling requires a 6-inch rear clearance and 12-inch clearance on the right side.

The double-bay equipment desk is 30 inches high, 30 inches deep, and 71.6 inches wide. Left or right rack-mount space and service access are the same as for the single-bay desk. Convection cooling requires a 5-inch rear clearance and 12-inch right and left side clearance.

The single-bay pedestal is 30 inches high, 30 inches deep, and 24 inches wide. Rack-mount space and service access are the same as for the single-bay desk. Convection cooling requires a 6-inch rear clearance and 12-inch left side clearance.

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▷ memory and a 2K-byte cache controller. The 990/12 uses TILINE memory modules, of which there are three types: an EPROM module, TILINE parity memory, and TILINE error-correcting memory. Error-correcting memory's improved system uptime makes it the preferred choice for large memory systems. It is also the error-correcting memory which is available with the cache option.

The cache controller has a cycle time of 350 nanoseconds whereas the main memory cycle times are 740 nanoseconds. The instruction set provides 143 instructions, 72 of which duplicate the 990/10. Some additional features of the 990/12 include floating point operations, byte string, stack operations, conversions, and extended precision.

The 990/10 and /12 are directed towards users who build complex systems, such as data collection, business data processing, message switching, or other real-time application systems.

One significant feature of all 990 Series models is the Communications Register Unit (CRU). The CRU is a unique I/O interface in which the I/O addressing space may be considered as two 4096-bit registers (one for input and one for output) instead of the separate 16-bit input/output device interfaces as implemented on other minicomputers. Each bit is individually addressable, and multiple-bit interfaces (6 bits, 8 bits, 16 bits, etc.) are formed by combining groups of bits. Hence, I/O devices can have unconventional data widths that can be as small as 1 and as large as 120 bits per data unit. This type of interface is found on no other manufacturer's computers and can be extremely useful in process control and monitoring applications, where interfaces of unconventional width are common.

Another noteworthy feature of the 990 Series computers is TI's "workspace concept." This arrangement is based on establishing the normal general-purpose register/accumulator sets as "virtual register" sets in memory. A register file, or workspace as TI calls it, is defined through a hardware workspace pointer register that retains the memory address of the first virtual register in a 16-register file. The next 15 locations are addressed by indexing the workspace base address with the register number.

The important advantage of this arrangement is that *any 16 contiguous memory locations can be designated as a workspace*. For real-time applications, a context switch is accomplished merely by changing the contents of the workspace pointer register. Further, any number of workspaces may be defined. There is a trade-off, however, in this arrangement. General-purpose registers implemented in main memory are slower than conventional hardware registers, resulting in diminished performance because each register access requires a memory access. However, for many real-time applications, the execution speed of the 990 Series computers will be sufficiently fast when combined with the ease and efficiency of performing context switches. ▷

▶ The rack-mount equipment cabinet is 70 inches high with interior dimensions 63 inches high, 19 inches wide, and 24 inches deep. Convection cooling requires a 6-inch rear clearance and 6-inch clearance above the exhaust fan. If the cabinet rear door is to be opened, 24 inches minimum clearance must be provided. This cabinet is capable of exhausting approximately 6826 BTU/hour.

Power requirements for all units are 115 VAC+10 percent, 48 to 62 Hz. Heat dissipation for a full 6-slot chassis including power supply is approximately 1600 BTU's per hour. For a full 13-slot chassis, heat dissipation is about 3000 BTU's per hour.

Recommended operating environment is 32 to 122 degrees F. and 0 to 95 percent relative humidity (noncondensing).

I/O CONTROL

I/O CHANNELS: All models feature a Communications Register Unit (CRU) that supports programmed I/O operations. The CRU provides an 8192-bit register (256 16-bit words for input and for output) that can interface directly with low-speed peripherals or sensors in place of a traditional I/O bus. This can be programmed directly, using the register addresses as storage locations. Addressing in the CRU can be done to the individual bit level with register-to-register type instructions capable of manipulating operands of 1 to 16 bits in length and beginning at any position in the CRU. This makes the CRU especially useful for A/D or D/A operations and also provides an effective means of handling multiple low-speed devices such as card readers, terminals, modems, paper tape readers and punches, etc. An extensive line of modular interfaces to the CRU is also provided for EIA RS-232 interfacing plus accumulators, interrupts, contacts, and blanks for custom-designed modules. The data rate of the 990/4 CRU is 1.5 million bits per second. The 990/10 rate is 4 million bits per second from the main chassis and 2 million bits per second from expansion chassis.

The 990/10 and the 990/12 have a 16-bit bidirectional asynchronous bus that can address up to 1024K locations. All CPU's, memories, and peripheral controllers are connected to the TILINE, permitting asynchronous, simultaneous operation of all devices, including direct memory access. The data transfer rate of the TILINE is 3 million words per second. Multiple systems can be interconnected via the TILINE, although multiple-processor systems are not supported by TI systems software at this time.

SIMULTANEOUS OPERATIONS: CPU's, memories, and peripherals in the same chassis compete for access to the 990/10 and the 990/12 TILINE bus. Units in separate chassis can be isolated by the TILINE couplers and, therefore, can operate independently of units on other TILINE segments. Peripheral operations via the CRU can proceed simultaneously within the limitations of programming.

CONFIGURATION RULES

The DS990 Model 1 may have one 810 printer, a Video Display Tube (VDT) graphics kit, and up to two additional FD1000 DSDD diskettes.

The DS990 Model 2 may have two 911 VDTs or two 820 KSR printers. In addition to the 911 or 820 terminals, it can have two 810 RO printers. A maximum of two DS10 disk drives and two DSDD diskette drives or four DSDD diskette drives may be connected.

A feature of the DS990 family, Models 4 through 30, is that any disk may be added to any system. The DS990 Model 4 is recommended for use with up to eight 911 VDTs, while the DS990 Models 6 and 8 are recommended with up to 16 VDTs. The DS990 Models 20 and 30 have a recommended ▶

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Characteristics of 990 Packaged Systems

Model	Processor	Memory (in bytes)	Terminals	Standard Disk Configuration
DS990/1	TMS 9900	64K	1	2.6 MB
DS990/2	990/5	64K	1-2	2.6 MB
DS990/4	990/10	128K-2048K	multiple	10 MB
DS990/6	990/10	128K-2048K	multiple	50 MB
DS990/8	990/10	128K-2048K	multiple	100 MB
DS990/20	990/12	256K-2048K	multiple	100 MB
DS990/30	990/12	256K-2048K	multiple	400 MB

➤ Competition for the 990 Series comes mainly from the Data General Commercial Systems and Nova line, the mid and lower DEC PDP-11 family, the DEC Datasystems, and the Hewlett-Packard HP 300 and HP 3000 Series 30.

Although TI has been heavily OEM-oriented in the past, they are currently striving to strike a more even balance between OEM and end-user business. The OEM discount reaches 38% while the end-user discount goes as high as 28%.

The 990 is offered on a purchase or lease basis with separately priced maintenance. In addition to standard maintenance service with various options for extended coverage, Texas Instruments offers on-call service, shop service, and fixed-price repair service. Shop service is available during normal working hours at TI service centers for customer-delivered parts. Fixed-price repair service is offered on standard electronic interface assemblies only and offers repair and/or exchange of parts. This service is normally for customers who perform their own equipment maintenance.

TI provides selected hardware or software training courses for fixed fees. Courses are conducted at the Digital Systems Division Education and Development Center in Austin, Texas; however, on-site courses are available on special request.

All software for the 990 is offered by license agreement with Texas Instruments. In addition to a one-time license fee, an annual subscription service is available for updates.

USER REACTION

Early returns from Datapro's 1980 user survey included responses from five end-users of Texas Instruments 990 series. Four were using one 990/10 each, and one had a 990/6. One system was being rented, while the other four had been purchased outright.

Applications reported by these users included engineering/scientific, circulation, accounting, word processing, statistical compilations of current music, distributed processing, inventory control, payroll/personnel, service bureau, transportation, retail, transaction processing, and on-line sales.

Two systems had been in use for two years, another for a year and a half, one for slightly over a year, and one for ➤

➤ maximum of 24 VDTs. The DS990 Model 4 will support one 979A Magnetic Tape Transport and the larger systems will support two. Additional peripherals which the Model 4 and larger systems can use are: 810/820 printing terminals, 733/743 data terminals, 2230/2260 line printers, 804 card reader, FD1000 DSDD diskette drive and communication modules.

The 990/4 and the 990/5 occupy one chassis slot. Models 990/10 and 990/12 occupy two slots. Memory modules require one slot, except those memory devices which mount directly on the 990/4 CPU board. Most CRU-interface modules occupy one half slot and use 16 input and 16 output bits.

The CRU can be expanded through addition of expansion chassis, a CRU expander card, and a CRU buffer card. Each card occupies one slot position. The CRU expander card requires one slot in the CPU chassis. The CRU buffer card requires one slot in the first expansion chassis, leaving 12 full or 24 half slots available in this chassis. The second expansion chassis provides 12 full or 24 half slots. One expander card can drive up to two expansion chassis.

The highest 128 bits of the CRU are reserved for use by the CPU for internal functions.

The TILINE expansion chassis adds 12 full slots on the 990/4 and the 990/5, 11 full slots for the 990/10, and 15 slots for the 990/12.

To use the expansion chassis, a TILINE coupler must be present in both the CPU and the expansion chassis. Each TILINE coupler requires one slot. TILINE couplers are also used to connect two 990 CPU's, (TILINE interface kit). In conjunction with the TILINE interface kit, the CRU expansion kit provides an expansion chassis with both CRU and TILINE buses.

All units require either one half slot or one full slot. Units requiring one half slot include the PROM programmer kit, the 743 KSR Data Terminal Controller, the 733 ASR Data Terminal Controller, the 810 Printer Controller, the 804 Card Reader Controller, the TTY/EIA Interface Module, the 990 Communications Interface, the 990 Asynchronous Modem, the 990 Synchronous Modem, and the 16 I/O EIA or TTL Data modules. The units requiring one slot each include the TMS 9900 Emulator, the Logic-State Trace Module, all memory modules, all dual-drive disk controllers, and the dual 911 VDT controller.

The 990/4 and 990/5, in the 6-slot chassis, have five vacant slots; in the 13-slot chassis, twelve vacant slots. The 990/10 in the 13-slot chassis has ten vacant slots. There are 14 vacant slots with the 990/12 using the 17-slot chassis.

In general, most modules may be plugged into any slot in the chassis. Exceptions include CPU boards, the CRU buffer board, and modules such as error-correcting memory controller and memory boards, which must be adjacent in the ➤

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➤ slightly less than a year. Eight, five, three, and two were the numbers of workstations reported, and main memory ranged from 128K to 256K bytes. All of the users had disk storage, which ranged from ten megabytes to 110 megabytes. Only one user did not report the presence of a printer, but the other four systems were supporting one, two, or three printers.

The DX10 Operating System was in use in all five installations, and programming languages included RPG II, COBOL, FORTRAN, and assembly language. In-house personnel, proprietary software packages, contract programming, and "ready-made" programs from the manufacturer were listed as sources of applications programs.

The following table summarizes the ratings given by these five 990 users.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	3	2	0	0	3.6
Reliability of mainframe	4	1	0	0	3.8
Reliability of peripherals	3	2	0	0	3.6
Maintenance service:					
Responsiveness	2	2	0	0	3.5
Effectiveness	0	3	1	0	2.8
Technical support:					
Trouble-shooting	0	4	0	1	2.6
Education	0	1	2	2	1.8
Documentation	0	1	2	2	1.8
Manufacturer's software:					
Operating system	3	2	0	0	3.6
Compilers and assemblers	3	2	0	0	3.6
Applications programs	0	2	0	0	3.0
Ease of programming	3	2	0	0	3.6
Ease of conversion	1	1	1	0	3.0
Overall satisfaction	4	1	0	0	3.8

*Weighted Average on a scale of 4.0 for Excellent.

Datapro feels it is worth noting that the only Poor ratings and two-thirds of the Fair ratings in the above chart are in the area of technical support. Texas Instruments has been primarily an OEM-oriented organization and is apparently not yet as aggressive in the customer support aspect of the business as these end-users feel TI should be. It also seems significant that the one user who was the source of three of the Poor ratings gave an Excellent rating to the overall satisfaction category and checked such complimentary comments as users are happy with response time, system is easy to expand/reconfigure, programs and data carried over from other systems are compatible as vendor promised, and delivery of equipment and required software was ahead of schedule. It is also significant to note that all five users said they would recommend the 990 to other users.

The only complaints voiced by the other four users were a long start-up time and difficulty in keeping up with the vendor's enhancements and changes to hardware and software.

It would appear from these ratings and the users' comments that Texas Instruments' hardware is well ahead of its customer support, a situation which should show ➤

➤ chassis. However, there are advantages in simplification of technical problems and time savings if the user's chassis layout follows the standard layouts, which follow, as closely as possible.

Standard chassis layout for the 990/4 in a 6-slot chassis includes the CPU, slot 1; memory expansion, slot 2; up to two 911 VDT's, slot 3; floppy disk controller, slot 4; printer and card reader controllers, slot 5; PROM programmer and 733 Terminal, 743 Terminal, or EIA terminal interface, slot 6.

Standard chassis layout for the 990/4 in a 13-slot chassis includes the CPU, slot 1; memory expansion, slots 2 and 3; controllers for up to six 911 VDT's, slots 8 through 10; floppy disk controller, slot 11; printer and card reader, slot 12; and PROM programmer and 733 Terminal, 743 Terminal, or EIA terminal interface, slot 13.

Devices in the CRU expansion chassis include: CRU buffer, slot 1; TILINE Coupler, slot 2; error control memory and controllers, slots 3 through 6; and TILINE controllers, slots 7 and 8. The TILINE expansion chassis includes controllers for up to six 911 VDT's, (slots 9, 10, and 12) and a floppy disk controller (slot 11).

MASS STORAGE

FD800 DISKETTE SUBSYSTEM: Consists of a controller capable of interfacing up to four single-sided, single-density diskette drives and one drive. The 945970-0001 FD800 Single Floppy Master Kit consists of one FD800 Diskette Drive and controller. The 945970-0003 is the same subsystem with two drives. The 945970-0004 is an add-on FD800 in a dual-drive chassis, while 945970-0005 provides two add-on drives.

The FD800 subsystem offers IBM 3740 compatibility with 26 sectors per track, 128 bytes (64 words) per sector, and 77 tracks. Capacity is 256K bytes (128K words) per floppy disk. Track-to-track and across-all-tracks head movement times are 10 and 260 milliseconds, respectively. Head settling time is 8 milliseconds, while head loading time is 35 milliseconds. Head loading is under program control. Average rotational delay is 83 milliseconds. Data transfer rate is 31,250 bytes (15,625 words) per second between the controller and the disk, with double-sector buffering for both read and write operations. Controller-to-CPU transfer rate averages 5000 bytes (2500 words) per second.

FD1000 DISKETTE SUBSYSTEM: Consists of a controller, one drive mounted in a dual-drive chassis, a blank double-sided, double-density diskette, interconnecting cables, and a Hardware Demonstration test. The FD1000 dual drive Master Kit includes all the items in the single drive Master Kit plus a second drive mounted in the chassis and a second blank diskette.

The FD1000 flexible disks operate with either double-sided, double-density diskettes or with IBM-compatible, single-sided, single-density diskettes. The FD1000 features automatic sensing of diskette type. The single-sided, single-density diskette stores 256K bytes of data formatted in 128-byte sectors, 26 sectors per track, and 77 tracks per diskette. Single-sided diskettes are directly interchangeable between the FD1000 and the FD800.

The double-sided, double-density diskette stores 1.1 megabytes of data formatted in 288-byte sectors, 26 sectors per track, 77 tracks per diskette, and two tracks per cylinder. Burst data transfer rate with the double-density diskette is 500K bits per second. With either diskette type, adjacent track seek time is three milliseconds, average seek time is 91 milliseconds, and average rotational latency is 83 milliseconds. ➤

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▷ improvement when TI becomes more accustomed to dealing with end-users than it has heretofore been. □

▶ **DS10 MAGNETIC DISK SUBSYSTEM:** Consists of one drive and a controller capable of interfacing up to two fixed and removable-cartridge disk drives. Each drive has a capacity of 9.4 million bytes (4.7 million 16-bit words), for a total system capacity of 18.8 million bytes (9.4 million words). The 937500-0001 DS10 Single Master Kit consists of a rack-mountable DS10 Cartridge Disk Drive and controller. The add-on drive is the 937500-0004.

Data is stored on four surfaces, each organized into 405 data tracks plus 3 spares per surface. There are 20 288-byte (144-word) selectors per track. Total track capacity is 7812 bytes unformatted and 5760 bytes formatted. Recording track density is 2200 bpi (inner track). There are 4 tracks per cylinder and 408 cylinders per drive. Total drive capacity is 9,400,320 bytes (4,700,160 words).

The drives rotate at 2400 rpm with an average rotational delay of 12.5 milliseconds. The data transfer rate is 312,500 bytes (156,250 words) per second. Track-to-track, average, and across-all-tracks head positioning times are 7, 35, and 60 milliseconds, respectively. The drives employ IBM 5440-type disk cartridges. The DS10 Cartridge Disk Drive is a CDC 9427H.

DS25, DS50, AND DS200 MAGNETIC DISK SUBSYSTEMS: The DS25, DS50, and DS200 provide storage for 22.33 million bytes (41.17 million words), 44.66 million bytes (22.33 million words), and 169.47 million bytes (84.74 million words), respectively. Up to four of the moving-head drives can be connected to a controller. DS25, DS50, and DS200 drives cannot be intermixed on the same controller. All master kits consist of a disk drive and controller; secondary kits consist of an add-on drive only. The DS25 and DS50 are cabinet-mounted for installation on a table top or pedestal, while the DS200 is a free-standing cabinet unit.

The DS25 and DS50 each utilize five recording surfaces per drive on 3330-technology removable disk packs. Three of the five platters are employed for recording, with five surfaces for data and the sixth for servo use. The remaining two platters, located on the top and bottom of the pack, provide protection. The DS50 contains 815 tracks per surface (808 active data cylinders per spindle), while the DS25 contains 408 tracks per surface (404 active data cylinders per spindle).

The DS200 contains 19 recording surfaces per drive on a 12-platter removable pack. The drive employs a technology similar to that of the IBM 3330 applied to the actuator and disk pack design. The top and bottom platters are designed to protect the pack. The bottom surface of the eleventh platter is for servo use, leaving platters 2 through 10 and the top surface of platter 11 for data storage. The DS200 contains 815 tracks per surface (808 active data cylinders per spindle).

Bit density for all drives is 4040 bpi, while track density is 185 tpi on the DS25 and 370 tpi on the DS50 and DS200. Unformatted track capacity and formatted track capacity for all drives are 13,440 bytes (6720 words) and 10,944 bytes (5472 words), respectively. All drives have 38 logically interlaced sectors per track and 288 bytes per sector. Actual storage capacities, including spare tracks, are 22,325,760 bytes (11,162,880 words) for the DS25, 44,546,800 bytes (22,273,400 words) for the DS50, and 168,277,840 bytes (84,138,920 words) for the DS200. The drives rotate at 3600 rpm, resulting in an average rotational delay of 8.3 microseconds. Track-to-track, average, and across-all-tracks head positioning times are 6, 30, and 55 milliseconds, respectively. Head positioning is performed by a closed-loop proportional servo system driving a voice-coil actuator. The drives have a data transfer rate of 806,000 bytes (403,000 words) per second. The DS25, DS50,

and DS200 are all Calcomp Trident drives (T-25, T-50, and T-200).

I/O UNITS

See Peripherals/Terminals table.

In addition to the devices listed in the Peripherals/Terminals table, the 990 CRU interface permits connection to any TI 960B controller or interface (see Report M11-840-101) through hardware adapters. In addition to the conventional peripherals, TI also offers a broad line of interface devices that are particularly useful in measurement and control applications. These include 14 models of A/D and D/A converters and 13 general-purpose interfaces.

COMMUNICATIONS CONTROL

Texas Instruments offers several communications modules which interface the CRU of all DS990 models.

990 COMMUNICATIONS MODULE: Provides an RS-232C interface to the CRU bus with full modem control signals for both asynchronous and synchronous modems. Selectable rates of 75, 110, 150, 200, 300, 1200, 2400, 4800, and 9600 bps are provided. Character size is selectable from 5 to 9 bits, with programmable parity that may be odd, even, or not used.

Other features include line break detection generation, 250-millisecond timer, programmable Sync/DLE stripping (stripping out "fill in" characters in the synchronous mode depending on the protocol system), false start bit detection, selection of 1, 1.5, or 2 stop bits, and programmable self-test.

BELL DATA SET INTERFACE KIT: Includes the 990 Communications Module and a cable that interfaces to certain Bell or equivalent data sets. These sets include the Bell 103A and F (300 bps, asynchronous), Bell 202 (1200 bps, asynchronous), Bell 201 (2400 bps, synchronous), and Bell 208 (4800 bps, synchronous).

ASYNCHRONOUS MODEM: Similar in characteristics to the Bell 202C 1200-bps data set with auto answer. The modem is capable of full-duplex operation over a 4-wire private line or half-duplex operation over the direct distance dial network. A loop-back is provided for test purposes. The modem requires the 990 Communications Module, which is interfaced to it, thus requiring adjacent slots in the chassis.

SYNCHRONOUS MODEM: Similar in characteristics to the Bell 201C 2400-bps data set and to the Asynchronous Modem. The modem provides an internal clock and loop-back for self-testing.

DATA MODULES: Provide either TTL or EIA 16-bit parallel input/output interfaces between the 990 and external devices. Jumper wire option cards provide options of 16 inputs and 16 outputs or 15 inputs, 14 outputs, and one maskable interrupt.

SOFTWARE

OPERATING SYSTEMS: Four operating systems and an enhanced executive are offered for use with the 990 Series computers: the Terminal-Executive Operating System (TX990); an enhanced TX990 executive called the Terminal-Executive Floppy Disk System (TXDS); the TX5 Operating System; the new DX5 Operating System; and the Disk-Based Operating System (DX10).

TX990 is a memory-resident real-time operating system for all 990 models that is intended for use in low-cost control applications with a minimum of supporting peripheral equipment. TX990 is modular, using linkable components, ▶

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► which permits only the required functions to be implemented. The primary functions performed by TX990 are task scheduling, interrupt handling, supervisor call interfacing, and I/O servicing. Task scheduling is on a priority basis with four priority levels. Each level can include any number of tasks. Within each priority level, tasks are scheduled on a first-in/first-out basis. A time-out feature prevents one task from monopolizing all of the CPU time.

The TX990 I/O supervisor processes all task I/O requirements. It accepts I/O requests from application tasks, initiates I/O operations, and manages the interface between application tasks and device service routines. System service routines that perform commonly used functions are accessible by the tasks through supervisor calls.

A TX990 system is generated by linking the applications tasks with system modules. Once generated, the resultant system is stored for subsequent loading and execution. A TX990 system can run dedicated assembly language or FORTRAN IV application programs developed with TXDS or DX10 software. Optional TX990 modules include additional supervisor calls, logical I/O, operator communications via the 733 ASR Data Terminal, and floppy disk file management for sequential and relative files.

The minimum configuration required for a TX990 system, after generation and linkage of applications software, includes an 8K-byte (4K-word) 990/4 or 990/10 CPU and a 733 ASR Data Terminal and associate ROM loader. Peripherals supported by TX990 include the 911 VDT, 733 ASR Data Terminal, 810 Printer, 2230 or 2260 Line Printer, FD800 Floppy Disk, and 804 Card Reader. System generation, however, must be performed on a 990 system under DX10 or TXDS.

TXDS is the TX990 Operating System combined with floppy disk file management for sequential and relative record files. TXDS provides support for a two-pass assembler, text editor, linker, debug package, system program, IBM floppy format conversion utility, PROM Programmer, BNPF/High-Low Dump, and Cross Reference utilities. FORTRAN IV is offered on an optional basis. TXDS and DX10 (see below) also provide the host system for the AMPL software.

TXDS requires a 990 with 48K bytes (24K words) of memory, a 911 VDT, dual FD800 Floppy Disk Drives, and a ROM loader. Up to 56K bytes (28K words) of memory can be supported. Peripherals supported include 911 VDT's (single user only for development), up to four floppy disk drives, an 810 Printer, a 2230 or 2260 Line Printer, a 733 ASR or 743 KSR Data Terminal, an 804 Card Reader, a PROM Programmer, and AMPL hardware.

The *TX5 Operating System* is a memory-resident, multitasking executive with double-density, flexible-disk and disk file management for sequential and relative records or DX10-compatible files. The TX5 task scheduling, interrupt handling, I/O processing, and utility support are compatible with the TXDS system. A TXDS to TX5 conversion utility is also included.

The TX5 operating system is designed to support small system applications based on the DS990 Model 1, DS990/5, or 990/10 computer, with TILINE and dual-density flexible disk. The TX5 supports development in assembly language, FORTRAN, and 990 Basic.

The TX5 includes all components of the TXDS operating system plus DX10-compatible, sequential, and relative record file management, and a screen-oriented text editor.

The TX5 operating system requires a DS990 Model 1, 990/5, or 990/10 computer with 64K bytes memory, 911 video display terminal or other I/O supported terminal, and a double-density flexible disk or DS10 disk.



The Texas Instruments DS990 Model 2 utilizes a 990/5 micro-computer with 64K bytes of memory. The configuration pictured includes two 911 video terminals and an 810 printer. The double-sided, double-density diskettes drives are housed in the cabinet (center) just below the printer.

The TX5 software is included as part of the DS990 Model 1 and 2 software versions.

DX10 is a disk-based, real-time, multi-tasking operating system for the 990/10 and 990/12 computer. Each task is allotted up to 32K words of address space, which may be divided into three segments. Up to eight terminals can be supported in an interactive program development mode. DX10 tasks may be self-contained or may include separately attached re-entrant procedures, re-entrant subroutine libraries, common areas for inter-task communication, and dynamically allocated memory, assigned at execution time. DX10 also has overlay support, permitting user programs larger than 64K bytes (32K words). Program development support is provided in both batch and interactive modes.

DX10 task scheduling is based on a four-level priority system using time-slicing. Tasks assigned to the same priority level are scheduled on a first-in/first-out basis. High-priority tasks are periodically skipped to prevent locking out lower-priority tasks.

Both memory-resident and disk-resident tasks are installed through the SCI package. Disk-resident tasks are relocated at installation time for faster response at execution time.

User tasks are isolated from each other by memory mapping hardware. Memory mapping also aids roll-in/roll-out procedures implemented by the scheduler.

The DX10 system command interpreter provides a high-level interactive language designed to perform prompting and verification functions. Over 160 system commands provide a range of functions from disk backup and restore to initializing time and date.

The DX10 file management package supports three types of disk files: sequential, relative record, and indexed. File organization may be specified as either contiguous and fixed-length or noncontiguous and dynamically allocated. Multiple logical records for both sequential and relative-record files can be blocked into single physical records to reduce access times. For security, there are two levels of file access: exclusive write access and shared access. File protection can also be attained through 8-bit keys which are specified at file creation time.

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► The SCI package provides the interface between users and the DS10 operating system. It supports both interactive and batch processing and performs such system functions as status checking and control of multiple tasks. Debugging and limited editing features are also provided by the package.

DX10 provides support for all 990/10 and 990/12 peripherals, including communications, plus a special minimum-overhead character-level routine for the 913 CRT terminals. Limited device independence is achieved through logical unit designations in I/O calls. Logic unit designators can be reassigned by users either through the OCP or through a supervisor call within the tasks. Designators assigned through the OCP are global assignments and are used as default values, while designators assigned by tasks are used only by the tasks and override the global assignments.

DX10 requires a minimum configuration of a 128K-byte (64K-word) 990/10 or 990/12 with memory mapping and ROM loader features, a 911 VDT or a 733 ASR Data Terminal, and one DS10 or dual DS25/DS50 disk drives. DX10 supports the FORTRAN IV, COBOL, PASCAL, Business BASIC, and Multi-user BASIC compilers and assembly language programs. DX10 also supports an interactive text editor, link editor, and sort/merge.

A new DX5 interactive software package was announced in December 1979. The package is an addition to the DX10 system software and consists of the DX5 Operating System and packages for a COBOL run-time interpreter, sort/merge, and 3780/2780 emulator communications. With DX5, COBOL development is accomplished on Models 4, 6, 8, 20, or 30 using DX10 COBOL. The code which is produced can then be linked with the DX5 COBOL run-time package and a disk or diskette copy can be made for use on the Model 1 or 2. The new product also allows existing DX10 COBOL programs to be modified for execution in the DX5 environment. TI claims that the DX5 and DX10 Operating Systems and user interfaces are compatible. User interface commands implemented in DX5 are identical to those employed with DX10.

DX5 features multi-key indexed and relative-record file support, interactive and batch execution, interactive debugging, file utilities, and text editing support. DX5 also includes two optional support packages: DX5 Sort/Merge and a DX5 3780/2780 Communications Emulator. The Sort/Merge is an interactive or batch utility for sorting data or merging files. The 3780/2780 emulator enables the user to emulate IBM 3780 or 2780 remote job entry packages. The DX5 software was developed to execute on DS990 Models 1 and 2. Both systems are configured with 64K bytes of memory and two double-sided and double-density diskettes drives.

LANGUAGES: Texas Instruments offers four higher-level languages for program development on the 990 systems: FORTRAN IV and TXDS FORTRAN IV, COBOL, PASCAL, DX10 BASIC, SBC BASIC, and RPG II. In addition, there are three assembler programs: a one-pass (prototyping system) or two-pass (TX990) assembler for the TI 733 ASR Data Terminal, a two-pass cross-assembler for IBM 360/370 systems, and the DX10 macro assembler (SDSMAC). Deciding that certain languages, applications, and utilities complement each other, TI has introduced the business-oriented Integrated Software Package (ISP).

FORTRAN IV conforms to ANSI Standard FORTRAN (X3.9-1966) and includes extensions recommended by the Instrument Society of America (ISA-S61.1, 1975 and ISA-S61.2-1976). TI has also implemented other enhancements, including direct-access I/O operations, overlapped I/O operations, overlay capability, free-form source input, double-precision integers, an IMPLICIT statement that declares data types for groups of data and relieves the user from the need to declare the type of each member of the data group, DATA

statement array names, a COPY directive, ACCEPT and DISPLAY directives designed specifically for the 911 VDT terminal, and an optional re-entrant subroutine library.

The FORTRAN IV compiler can optionally generate cross-reference listing during execution for each variable in the program and also provide a source program debug module. The run-time utility package and library perform format editing, data conversions, subprogram linking, floating-point arithmetic routines, and FORTRAN tracing to aid in debugging. The run-time library allows execution of compiled FORTRAN programs under DX10 and TXDS, limited stand-alone operations and operations with user-written operating systems.

DX10 FORTRAN IV requires a DS990 system, a 990/10, or a 990/12 disk system with 128K-byte (64K-word) memory and a 911 VDT.

TXDS FORTRAN IV conforms to ANSI Standard FORTRAN (X3.9-1966) with enhancements for optimization and program development and debug options. This version of FORTRAN requires a 990/4 or a 990/5 with 48K bytes (24K words) of memory, a 990/10 or a 990/12 with 64K bytes (32K words) of memory. Required peripherals include a 911 VDT and dual FD800 Floppy Disk Drives.

COBOL complies with ANSI Standard X3.23-1974 and operates under DX10 on a 990/10 or a 990/12 with at least 128K bytes (64K words) of memory and a 911 VDT. In addition to the COBOL Level 1 nucleus, TI's COBOL also includes Level 1 table handling capabilities, sequential I/O operations, the Level 1 library, program segmentation, and indexed I/O operations. Level 2 relative I/O features are also incorporated. Texas Instruments has also added a source program debug package and interprogram communication package, plus modules that provide re-entrant run-time subroutines for control, editing, binary and decimal arithmetic, logical I/O interfacing, segmentation, library, and interactive video display terminal I/O. TI's COBOL is interactive, with the compiler producing intermediate interpreter object code. A COBOL run-time interpreter is also available which runs under DX5. Development is accomplished on DS990 Models 4 and above under DX10.

PASCAL is a general-purpose, block-structured language noted for its ease of use and excellent maintainability. The version offered by TI is closely compatible with the standard PASCAL as originally defined. PASCAL executes only in the multi-user environment of DX10. Included in the PASCAL package with the software object license are the compiler and run-time library, a nester utility for standardized source indentation, a configuration processor to support separate compilation of nested program modules, and a reverse assembler that outputs PASCAL object modules in 990 assembly language source format. The minimum hardware requirement for PASCAL is the DS990 Model 4 packaged system.

SBC 990 BASIC exceeds the ANSI minimum standard (X3.4-1978) for the BASIC language. SBC 990 BASIC facilities include file management, program encryption, debugging tools, and file maintenance utilities. Its features include various data types, control statements, numeric and string operations, mathematical and chronological functions, virtual arrays, user-defined procedures, and an interface for assembly language routines. The two data types supported by SBC 990 BASIC are numeric and string. Within numeric type, decimal, integer, or real-type may be selected. Decimal data is an extension particularly useful in commercial data processing to represent monetary amounts, while string data type is used for noncomputational data. Variable names, both string and numeric, may contain over 30 characters. The control statements of SBC 990 BASIC support branching and looping within a program. Programmers are allowed to ►

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► develop special purpose procedures within programs by writing functions or subroutines. Both functions and subroutines may contain multiple BASIC statements. By using the subroutine capability, a library of programs can be used by different programs without the need for recoding to avoid variable name conflicts. SBC 990 BASIC runs only on the DS990 Model 1 and comes packaged on double-sided, double-density diskette media.

DX10 990 BASIC provides decimal data type, flexible report formatting, and extensive file support for business and such features as predefined mathematical functions and recursive constructs for more technical environments. The interpreter is designed to exceed the ANSI minimum standard (X3.4-1978) and runs under the DX10 Operating System. The BASIC language is supported across the entire DS990 family with DX10 BASIC designed for the larger systems (DS990 Model 4 through Model 30).

DX10 990 BASIC provides a program encryption feature which protects algorithms and techniques used in a program. Once encrypted, a DX10 990 BASIC program cannot be read nor modified by other programmers although the interpreter is equipped to execute such programs.

Data transfer in DX10 990 BASIC is supported for all peripherals compatible with the DX10 Operating System. Special commands simplify the use of a Model 911 Video Display Terminal for interactive data input and output, and special commands allow a programmer to prevent more than one terminal from accessing a given record while several terminals access the same relative record or keyed file. DX10 990 BASIC may be combined with the TI 2780/3780 emulator communications package to allow exchange of files with an IBM 360/370 host computer or another TI 990 computer equipped with a 2780/3780 package.

The minimum system requirements for DX10 990 BASIC consist of the TI DS990 Model 4 packaged system. DX10 990 BASIC operates as a re-entrant task under DX10. Only one copy of the BASIC interpreter need be memory-resident with DX10 for the support of multiple BASIC programs. Each user has available a maximum workspace of approximately 31K bytes for program development and execution.

The *990 RPG II* compiler is a one-pass compiler which operates in approximately 20K bytes of memory, with internal code being either ASCII or EBCDIC, and runs under the DX10 disk operating system on a TI 990/10. The 990 RPG II package object license includes the RPG II compiler, RPG II runtime, IBM RPG II floppy-disk conversion utility, and an RPG II text editor. The 990 RPG II is compatible with the IBM System/3 RPG II where the hardware and operating systems permit and is less restrictive than the IBM RPG II in a number of areas to allow for more flexibility in programming.

A utility program is available for copying and converting IBM-formatted diskette files (one-sided, 128 bytes per section only) to DX 10 format disk files. The 990 RPG II includes a trace option not available on the IBM System/3 version. This option, when enabled, prints each major item that occurs in RPG II execution.

Integrated Software Packages (ISP) contain language, utilities, and applications which have been found to greatly increase business productivity. There are two packages: COBOL ISP and DBMS ISP. The COBOL ISP is composed of the DX10 Operating System, DX10 diagnostics, COBOL, TIFORM 990, an interactive forms package, and Sort/Merge. The DBMS ISP includes all the elements of the COBOL ISP plus the DBMS-990 database management system and the Query 990 inquiry/report language.

PX9ASM is a basic one-pass assembler that can be run on any 990 model under control of the 990 Debug Monitor program

(PX990). It supports all 990 Series machine-language instructions and also incorporates several assembler directives. Output from PX9ASM can be either absolute or relocatable.

Cross Assembler is a part of the Cross Support System available on time-sharing networks. Users can assemble source programs on an IBM 360 or 370 system and produce absolute programs or linkable modules in the standard 990 Series object format. The cross assembler supports the instruction and directive set of the PX9ASM one-pass assembler and also has a directive for specifying output options. The cross assembler is a two-pass assembler. The symbol table listing can be optionally combined with the object code listing, and a cross-reference and object listing can also be produced.

SDSMAC is a two-pass macro assembler that operates under DX10 and combines all the features of the cross assembler with provisions for the extended instruction set recognized by 990/10 or 990/12 computers with memory mapping. In addition, SDSMAC supports logical and relational operators in expressions, macro instruction definitions, and tracking of the "current workspace" to identify memory addresses that are being used as register files.

APPLICATIONS PROGRAMS: Texas Instruments' TIFORM 990 forms package eliminates the usual disadvantages associated with interactive data entry application design. Under TIFORM 990, man-machine interface and the application's procedural logic are two separate and distinct activities. Normally, screen processing results in terminal-specific code being intermingled within application code. This makes an application difficult to modify and forces a major redesign if a different terminal is required.

TIFORM 990 allows the application procedural code to be written in a higher level language and to specify screen formats by means of TIFORM's Form Description Language. Form Description Language statements can be automatically generated using the Interactive Screen Generator and Editor (ISGE). ISGE prompts the user through a series of menus for field specifications and screen layouts. Because terminal-dependent commands are not intermingled with application code, applications are kept essentially terminal independent.

DBMS-990: TI's data base management system provides definition and data access and includes a high-level data definition language (DOL) and a data manipulation language (DML) which is accessible through COBOL. Data control is provided by restricted access, password security of data items, and logging. To minimize user overhead, optional DBMS 990 functions can be omitted if not required for the application.

The DDL provides the user with the means to define the data elements within the data base. A DDL operation must be performed before any processing can take place on the data base. Utilizing the DDL, the user defines file names, key names, number of keys, lines, groups, and fields. Physical file boundaries are also handled at the data definition level.

The data manipulation language (DML) enables users to read, write (update), add, and delete data. The DML is not actually a complete language but a set of function codes that get passed to DBMS-990 through the COBOL CALL statement. When initiating a data transfer, the user is required to provide the file name, key name, key value, line type, group of field names, and name of user data area.

There are three categories of DML functions: read, update, and file functions. In addition, section commands are provided by the DX10 Operating System and are not embedded in the DML host language. Read functions include READ FORWARD, READ BACKWARD, READ SERIAL, and READ KEY. Update functions include ADD AFTER, ADD BEFORE, WRITE, and DELETE. File functions include

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► **OPEN and CLOSE.** Section commands include OPEN a DBMS-990 Section for access and CLOSE a DBMS-990 section. A DBGEN command gives the DBMS-990 user the flexibility to configure his data base management system to meet his specific needs and memory requirements.

The number of interface buffers and buffer size determine the number of requests that may be pending for DBMS services at any particular time. The default (standard) value for the number of interface buffers is 10; the user may specify as few as one buffer or as many as available memory resources permit. The buffer size default is 384; the user must specify a size that will handle the longest DBMS line length plus the size of the largest DBMS call-parameter list.

The DBMS-990 data hierarchy consists of the following logical elements: file, record, line (a collection of fields or groups of fields), group, and field. Both primary and secondary keys can be employed (a field or a group in a line).

Security is optional in DBMS-990. A file and/or data base may be accessed only when the user's password is valid for the data base. Each password is associated with one or more files. Conceivably, there could be only one password for a data base, or there could be several passwords distributed between the related files of the data base.

Access authorization defines the type of access allowed on the data elements of a file for a particular password. Authorization must be assigned to each file associated with a password. The following access types are available: No Access, Read, Write (Replace), Add, and Delete. Authorization codes may be applied to all levels of data. In the absence of their own authorization codes, fields and lines assume the authorization code of the file. However, if this is not desired, a line or a field may be assigned less access authorization than the file.

The file-access checking option allows the DBMS-990 user to gain exclusive access to a particular DBMS file when desirable. When a YES response is given to the prompt, all application programs that access the DBMS are required to use the DML functions OF (OPEN FILE) and CF (CLOSE FILE) whether or not they need exclusive access.

DBMS-990 optionally performs automatic logging of update images to save a record image of the update. If a data base is damaged, restoration of the data base, from the log to the last successful transaction, is possible. In order to perform this restoration, logging saves the after-image of the update on write or add functions. Using the recovery utility provided in the DBMS-990 utility library fully or in part, a data base can be reestablished by specifying the appropriate parameters in the recover-utility menu.

The DBMS-990 utilities provide the user with the means to properly maintain a DBMS-990 installation. Eleven utility functions are provided:

- Print pages of a disk section.
- Print pages of a file.
- Inactivate a file within a section.
- Compress a disk section by eliminating inactivated files.
- Copy a file to a save file in order to make changes to the DDL description of the file.
- Reload a save file to the new DDL description.
- Back up a data base for restore and recovery purposes.
- Restore a data base from backup format.

- Recover a data base from backup format using logging data.
- List the DDL source information for a given file.
- Summarize the available space in a file.

The DBMS-990 utilities' user interface is implemented by means of a system command that, when invoked, queries the user for the utility function desired, which is identified by a six-character function code. Each procedure in turn prompts the user with a menu specific to that function.

A Primitive Query command provides the DBMS-990 user with a limited capability to retrieve and display information contained in the data base. Three functions, implemented by means of DML functions, are provided by the Primitive Query command. The Read Forward and Read Backward functions read data lines specified by the line-type ID associated with the key name and key value specified in the calling parameter. The Read Serial function reads data lines physically without reference to logical association. In either case, the number of lines to be retrieved, as well as the output file, are specified by the user in answer to command menu prompts. Other DBMS-990 information retrieval and display functions can be implemented by writing a COBOL program with the required DML.

DBMS-990 operates under the DX10 Disk System software. The minimum consists of a DS990 Model 6 or 8 system, which includes a 990/10 minicomputer with 160K bytes of memory, a 911 Video Display Terminal, and dual DS25 (Model 6) or DS50 (Model 8) disk drives.

Query 990 Inquiry/Report Language is a data processing tool which combines interactive data retrieval with reporting. Coupled with DBMS-990, Query 990 enhances both access to, and utilization of, a firm's data-base resources. Query 990 has two paths leading users to the fulfillment of their information requests: input query and guided query. Input query incorporates every feature of Query 990. Guided query, a subset of input query, interactively prompts users for the minimum information required to retrieve and format the desired output. Users outside the data processing department who are unfamiliar with programming languages can easily learn Query 990. The incorporation of concise and powerful English-like commands gives Query 990 its simplicity. Simplified access to data encourages greater use of data resources by authorized personnel. Outside users directly developing and satisfying many of their own information requests reduce reliance on the programming staff for reports and analysis. This reduced reliance can provide many of the following benefits:

1. Immediate access to data base information not currently provided by management reports;
2. Faster response to information requests;
3. Satisfaction of "one time" requests which were previously too costly or inconvenient to provide;
4. Control over escalating programmer costs;
5. Reduction of the communication problems (costs) which arise between users and programmers.

SORT/MERGE: Provides full, address, key, and summary sorts and full and summary merges on up to five input files. The user has the option of selecting sequence, record length, record selection, and reformatting criteria. Sort/Merge operates under DX10 and is accessible as a utility in interactive or batch mode. It can also be called from COBOL, FOR-►

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► **TRAN, BASIC, Business BASIC, or assembly-language programs.** Sort/Merge consists of a control statement compiler module, reformatting module, sort module, merge module, and summary module. The minimum configuration for Sort/Merge includes a DS990 system or a 990/10 disk system with 128K bytes (64K words) of memory and a 911 VDT. The FD800 Floppy Disk is not supported.

DIAGNOSTICS: Two categories of test routines are available. Stand-alone tests are repetitive and are not suited for operator intervention. All other tests are operator-interactive and utilize an operator-oriented test monitor. Diagnostics are available on cassettes, punched cards, floppy disks, disk cartridges, or disk packs.

Texas Instruments offers the TMS9900 Prototyping System software package (PX990), designed to aid in generating software for TMS9900 microprocessor systems including 990/4 microcomputers purchased without control memories. PX990 requires a minimum of a 990/4 with 8192 words of dynamic RAM, 512 words of ROM, 256 words of static RAM, and a 733 ASR Data Terminal and appropriate autoloader ROM. Software included in the package includes the Prototyping System Debug Monitor (PX9MTR), the PX9ASM one-pass assembler, and the 733 ASR-based ASCII Text Editor (PX9EDT).

The Debug Monitor (PX9MTR) is a modular control program that requires 4K words of memory for residence. Programs which run under PX9MTR also run under the TX990 and DX10 operating systems. PX9MTR consists of four basic modules: the operator interface, the program service call interface, the I/O executive, and a program debug module. The operator interface accepts user commands through a 733 ASR keyboard, decodes the commands, and passes control to the appropriate modules. The program service call interface accepts user program requests for monitor service; I/O requests are passed to the I/O executive, but non-I/O request such as data conversions are performed by the interface module. The I/O executive handles all I/O requests, including interrupts, and provides file and record-level I/O operations independently of the device type; I/O operations are status-driven. The program debug modules provide capabilities for program breakpoint insertion and deletion, formatted snapshots of memory and registers, memory protection, trace regions, and execute-single instructions; the module allows the user to examine and modify memory, workspace registers, and CRU lines. A PROM programming module transfers finished, debugged programs to a PROM device through a PROM programmer. A similar module is also provided with TX990.

PRICING

POLICY: Texas Instruments offers the 990 Series computers on a purchase or lease basis with separately priced maintenance. Monthly leasing charges are based on 9.1 to 2.46 percent of the purchase price for lease terms ranging from one to five years, respectively. OEM discounts up to 36 percent are allowed on quantities of 50 units or more.

Basic-coverage maintenance prices, as detailed in the Equipment Prices section of this report, apply for eight hours during the period from 8 a.m. to 5 p.m., Monday through Friday, excluding holidays. Extended-coverage service on equipment for 16 consecutive hours during the period from 8 a.m. to midnight each day, Monday through Friday, and during the period from 8 a.m. to 5 p.m. on Saturday, excluding holidays, is priced at 1.5 times the basic-coverage prices. For full 24-hour, 7-days-a-week coverage, including holidays, maintenance is priced at two times the basic monthly maintenance charges. In addition, a per-zone monthly surcharge of five percent of the basic monthly maintenance charge is assessed for travel beyond zone 0 (a 25-mile radius of the field service office).

Service on an on-call basis is provided for customers without a basic-coverage maintenance contract and for service performed outside the hours of agreement. On-call service is charged at \$40 per hour between 8 a.m. and 5 p.m., Monday through Friday, excluding holidays, and at \$50 per hour (4-hour emergency call-out minimum) for calls exceeding 8 hours during standard working hours, for calls made before 8 a.m. and after 5 p.m. Monday through Friday, and for calls made any time on Saturday. Double-time charges of \$60 per hour (4-hour emergency call-out minimum) are made for Sundays and holidays. The transportation charge for on-call service is 15 cents per mile plus commercial travel costs, if any.

Shop service is available at \$25 per man-hour or part thereof during normal working hours if the customer delivers the equipment in need of repair to a Texas Instruments service center.

A fixed-price repair service is offered on standard electronic interface assemblies for those customers who stock their own spares of standard 990 Series products and service their own equipment. The service offers a 14-day repair or exchange of most assemblies for the cost of labor and material. For an additional per-part charge of \$55, Texas Instruments will either repair and return to the user the same customer-modified serial-numbered assembly or replace a single standard part within 48 hours (subject to availability).

All 990 Series software is furnished to the user under program license agreement whereby Texas Instruments retains ownership of the software and licenses the right to use it on identified CPU's in accordance with specified terms and conditions. TI grants the purchaser a further license to make copies of the program and modified originals for installation and use on such additional CPU's provided the copies acknowledge TI's copyright and are installed and used only on the additional CPU.

Reproduction fees are charged for additional copies of compilers. Source software is not transferable and not sublicensable.

Licensed software for the 990 Series includes a one-year software subscription service providing software revisions on media supplied by Texas Instruments (except DS25, DS50, or DS200 disk packs, which are user-supplied). TI's "subscription service" provides an updated version of the software and a one-year subscription service. The subscription service is aimed at those who have allowed it to lapse. If DS25, DS50, or DS200 media are employed, the user has 60 days to supply Texas Instruments with a disk pack so that updates may be applied to the pack.

Support for noncurrent software releases is limited to correcting any deficiencies deemed necessary by Texas Instruments and will be available for only six months from the date of the most current release.

Training courses are separately purchasable items. Courses are conducted at the Digital Systems Division Education and Development Centers in Austin, Texas, and Chicago, Illinois. Courses include both classroom lectures and laboratory projects. Prices for special courses conducted at customer locations will be quoted upon request.

Training courses on the 990 computer family are divided between software, hardware, and audio-cassette self-study courses. Software courses include Introduction to 990 Assembly Language (990S1), \$600; Programming the DS990 Using the TX5 Operating System (990S2-5), \$600; Programming the DS990 Using DX10 (990S2-10), \$600; Programming the 990 Using Pascal (990 Pascal), \$600; Programming the 990 Using 990 COBOL, Sort/Merge, and TIFORM (990 COBOL I), \$600; Developing the 990 COBOL User Environment (990 COBOL II), \$600; 990 ►

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► **Assembly Language Programming for the COBOL Application Environment (990 COBOL III), \$600; and 990 Data Base Management System (990 DBMS), \$600. Hardware maintenance courses include DS990 Model 2 Maintenance (DS2M), \$1,680 (fourteen days); DS990 Model 4 Maintenance (DS4M), \$2,160 (eighteen days); and DS990 Models 6/8 Maintenance (DS6/8M), \$2,160 (eighteen days). Self-study courses include Introduction to the 990/9900 Computer Family, \$100; 990 Software Development Using the DS990 System, \$200; and Introduction to TI 990 BASIC, \$100.**

Prices shown in the Equipment Prices list are for single-unit quantities. The OEM discount schedule starts at quantity 5 to 6 with a 21% discount and continues to 38% discount for quantity 100.

EQUIPMENT: The following systems include all controllers and attachments.

DS990 MODEL 1 SYSTEM: Includes TMS 9900 microprocessor, 64K-byte RAM, keyboard, two to four DSDD diskette drives, 1920-character CRT. Available options include built-in thermal printer or external impact printer. Purchase price is \$9,450 (without software) with a monthly maintenance charge of \$100.

DS990 MODEL 2 SYSTEM: Includes a 990/5 microcomputer, two asynchronous ports, two diskette drives, plus a choice of a Model 911 video display terminal or an Omni 800 Model 820 KSR printing terminal, 990 assembly language, TX5, and

IBM 2780/3780 communications software. A basic Model 2 system with two diskettes and two Model 911 video display terminals is priced at \$13,200 with a monthly maintenance charge of \$160.

DS990 MODEL 4 SYSTEM: Includes basic Model 4 system plus an 810 printer, DX10, COBOL, Sort/Merge, and installation. Purchase price is \$35,400 with a monthly maintenance charge of \$282.

DS990 MODEL 8 SYSTEM: Includes basic Model 8 system plus 810 printer, DX10, COBOL, Sort/Merge, and installation. Purchase price is \$60,655 with a monthly maintenance charge of \$452.

DS990 MODEL 20 SYSTEM: Includes a 990/12 central processor with a new 17-slot enclosure, 256K bytes of error-correcting memory with a 2K-byte cache controller, two Model 911 video display terminals, a DS50 disk drive with 50 megabytes of storage, and a magnetic tape drive. Minimum configuration is priced at \$64,500 with a monthly maintenance charge of \$595.

DS990 MODEL 30 SYSTEM: Includes the 990/12 central processor with a new 17-slot system enclosure, 256K bytes of error-correcting memory with a 2K-byte cache controller, two Model 911 video display terminals, a DS200 disk drive with 200 megabytes of storage, and a magnetic tape drive. Purchase price is \$77,400 with a monthly maintenance charge of \$645.

EQUIPMENT PRICES

PROCESSORS

The 990/4 microcomputer includes on-board real-time clock, hardware multiply/divide, power fail/auto restart logic, eight vectored interrupts, and a command-driven CRU bus for up to 4096 input and 4096 output lines. The CPU board contains 8K bytes of dynamic RAM with parity. On-board sockets can accommodate up to 2K bytes of PROM, ROM, or static RAM.

		Purchase Price	Monthly Maint.
940069-0001	With 6-slot chassis and operator panel	\$1,925	\$41
940069-0002	With 6-slot chassis, operator panel, and standby power supply	2,275	46
940069-0003	With 13-slot chassis and operator panel	2,450	45
940069-0004	With 13-slot chassis, operator panel, and standby power supply	2,800	50
940069-0005	With 6-slot chassis and programmer panel	2,075	43
940069-0006	With 6-slot chassis, programmer panel and standby power supply	2,425	48
940069-0007	With 13-slot chassis and programmer panel	2,600	47
940069-0008	With 13-slot chassis, programmer panel, and standby power supply	2,950	52

The 990/5 microcomputer includes on-board real time clock, hardware multiply/divide, power fail/auto restart logic, 16 vectored interrupts, 16 extended operations, TILINE multi-user bus, command-driven CRU for up to 4096 input and 4096 output lines, interface for operator/programmer panel, 2K bytes of PROM/EPROM for boot-load and self-test operations, 32K bytes or 64K bytes of on-board dynamic RAM memory.

2261928-0001	With 32K bytes, 6-slot chassis, operator panel	\$3,400	\$55
2261928-0002	With 32K bytes, 6-slot chassis, operator panel, and standby power supply	3,750	60
2261928-0003	With 32K bytes, 13-slot chassis, operator panel	3,925	59
2261928-0004	With 32K bytes, 13-slot chassis, operator panel, and standby power supply	4,275	64
2261928-0005	With 32K bytes, 6-slot chassis, programmer panel	3,550	57
2261928-0006	With 32K bytes, 6-slot chassis, programmer panel, and standby power supply	3,900	62
2261928-0007	With 32K bytes, 13-slot chassis, programmer panel	4,075	61
2261928-0008	With 32K bytes, 13-slot chassis, programmer panel, and standby power supply	4,425	66
2261926-0001	With 64K bytes, 6-slot chassis, operator panel	4,150	67
2261926-0002	With 64K bytes, 6-slot chassis, operator panel, and standby power supply	4,500	72
2261926-0003	With 64K bytes, 13-slot chassis, operator panel	4,675	71
2261926-0004	With 64K bytes, 13-slot chassis, operator panel, and standby power supply	5,025	76
2261926-0005	With 64K bytes, 6-slot chassis, programmer panel	4,300	69
2261926-0006	With 64K bytes, 6-slot chassis, programmer panel, and standby power supply	4,650	74
2261926-0007	With 64K bytes, 13-slot chassis, programmer panel	4,825	73
2261926-0008	With 64K bytes, 13-slot chassis, programmer panel, and standby power supply	5,175	78

The 990/10 minicomputer includes on-board real-time clock, integer hardware multiply/divide, power fail/auto restart logic, 16 vectored interrupts, 16 extended operations, TILINE multi-user bus, command-driven CRU bus for up to 4096 input and 4096 output lines, interface for operator/programmer panel, 1K byte of PROM program loader with/without mapping, memory error interrupt logic, and self-contained power supply for CPU and standard interface cards.

2262200-0001	With 13-slot chassis, operator panel, 128K-byte error-correcting memory	14,675	103
2262200-0002	Same with 160K-byte error-correcting memory	15,425	117
2262200-0003	Same with 192K-byte error-correcting memory	16,175	131
2262200-0004	Same with 256K-byte error-correcting memory	17,675	159
2262200-0005	Same with 320K-byte error-correcting memory	19,175	187
2262200-0006	With 13-slot chassis, operator panel, standby power supply, 128K-byte error-correcting memory	15,025	108

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EQUIPMENT PRICES

PROCESSORS (Continued)		Purchase Price	Monthly Maint.
2262200-0007	Same with 160K-byte error-correcting memory	15,775	122
2262200-0008	Same with 192K-byte error-correcting memory	16,525	136
2262200-0009	Same with 256K-byte error-correcting memory	18,025	164
2262200-0010	Same with 320K-byte error-correcting memory	19,525	192
2262200-0011	With 13-slot chassis, programmer panel, 128K-byte error-correcting memory	14,825	105
2262200-0012	Same with 160K-byte error-correcting memory	15,575	119
2262200-0013	Same with 192K-byte error-correcting memory	16,325	133
2262200-0014	Same with 256K-byte error-correcting memory	17,825	161
2262200-0015	Same with 320K-byte error-correcting memory	19,325	189
2262200-0016	With 13-slot chassis, programmer panel, standby power supply, 128K-byte error-correcting memory	15,175	110
2262200-0017	Same with 160K-byte error-correcting memory	15,925	124
2262200-0018	Same with 192K-byte error-correcting memory	16,675	138
2262200-0019	Same with 256K-byte error-correcting memory	18,175	166
2262200-0020	Same with 320K-byte error-correcting memory	19,675	194
2262199-0001	With 17-slot chassis, mapping, programmer panel, 256K-byte error-correcting memory	21,100	211
2262199-0002	Same with 320K-byte error-correcting memory	22,600	239
2262199-0009	With 17-slot chassis, mapping, programmer panel, 256K-byte cache memory	26,100	231
2262199-0010	Same with 320K-byte cache memory	27,600	259

The 990/12 minicomputer includes on-board real-time clock, integer hardware multiply/divide, power fail/auto restart logic, 16 vectored interrupts, 16 extended operations, command-driven CRU bus for up to 4096 input and 4096 output lines, interface for operator/programmer panel, hardware floating point, 143-instruction set, 17-slot chassis, 12-bit CRU address, 24 decoded module select signals to the chassis backplane, TILINE multi-user bus, programmer panel, and mapping.

2262201-0001	With 256K-byte error-correcting memory	29,050	261
2262201-0002	With 320K-byte error-correcting memory	30,550	289
2262201-0009	With 256K-byte cache memory	34,050	281
2262201-0010	With 30K-byte cache memory	35,550	309

PACKAGED SYSTEMS

2267375-0001	DS990 Model 1 System, includes TMS 9900 microprocessor with 64K bytes of random-access memory, parity integrated into self-contained unit, 1920-character video display terminal with 96-ASCII-character set, two double-sided double-density (1.15M-byte) diskette drives, two communication ports, TX5 Operating System	9,450	111
2267375-0002	Same as 2267375-0001 with thermal printer	10,550	125
2267375-0005	Same as 2267375-0001 but with 3 drives	12,495	142
2267375-0006	Same as 2267375-0001 but with 3 drives and thermal printer	13,595	156
2267375-0007	Same as 2267375-0001 but with 4 drives	14,295	166
2267375-0008	Same as 2267375-0001 but with 4 drives and thermal printer	15,395	180
2267375-0009	Same as 2267375-0001 with software	11,150	111
2267375-0010	Same as 2267375-0002 with software	12,250	125
2267375-0013	Same as 2267375-0005 with software	14,195	142
2267375-0014	Same as 2267375-0006 with software	15,295	156
2267375-0015	Same as 2267375-0007 with software	15,995	166
2267375-0016	Same as 2267375-0008 with software	17,095	180
2268005-0001	DS990 Model 2 System, includes the 990/5 microcomputer with 64K bytes of parity memory, two asynchronous terminal interface ports, on-board Model 810 printer interface, either a 911 video display terminal (1920 characters) or an 820KSR printer terminal, two double-sided double-density flexible disk drives, each storing 1.15M bytes (2.3M bytes total), licensed copy of TX5 Operating System, one-year software subscription service, hardware enclosure either in a table-top or 762-mm (30-in.) cabinet. Price listed here is with the tabletop enclosure with the 911 VDT.	14,695	158
2268006-0001	Same as 2268005-0001 but with 820 KSR	15,695	162
2268007-0001	Same as 2268005-0001 but in 762mm cabinet	15,695	162
2268008-0001	Same as 2268005-0001 but in 762mm cabinet with 820 KSR	16,295	166
2268005-1001	Same as 2268005-0001 but without software	12,995	158
2268006-1001	Same as 2268005-0001 but with 820 KSR and without software	13,995	162
2268007-1001	Same as 2268005-0001 but in 762mm cabinet without software	13,595	162
2268008-1001	Same as 2268005-0001 but in 762mm cabinet with 820 KSR and without software	14,595	166
945062-0001	DS990 Model 4, includes 990/10 minicomputer with 128K bytes of error-correcting memory, memory mapping, hard-disk loader ROM, programmer panel, 13-slot chassis, Model 911 video display terminal, 9.4-megabyte fixed/removable DS10 cartridge disk drive, licensed copy of DS10 Operating System on a disk cartridge, one-year software subscription service, single-bay desk enclosure, and software	28,000	249
945062-2001	192K-byte version of 945062-0001	29,500	277
945062-4001	256K-byte version of 945062-0001	31,000	305
945062-6001	352K-byte version of 945062-0001	33,500	347
945062-0011	Same as 945062-0001 but with double-bay desk	28,000	249
945062-2011	192K-byte version of 945062-0011	29,500	277
945062-4011	256K-byte version of 945062-0011	31,000	305
945062-6011	352K-byte version of 945062-0011	33,500	347
945062-0021	Same as 945062-0001 but with 70-inch cabinet	27,500	249
945062-2021	192K-byte version of 945062-0021	29,000	277
945062-4021	256K-byte version of 945062-0021	30,500	305
945062-6021	352K-byte version of 945062-0021	33,000	347
945062-0031	Same as 945062-0001 but with 30-inch cabinet	27,500	249
945062-2031	192K-byte version of 945062-0031	29,000	277
945062-4031	256K-byte version of 945062-0031	30,500	305
945062-6031	352K-byte version of 945062-0031	33,000	347
945062-1001	Hardware-only version of 945062-0001	25,000	249
945062-3001	192K-byte version of 945062-1001	26,500	277
945062-5001	256K-byte version of 945062-1001	28,000	305
945062-7001	352K-byte version of 945062-1001	30,500	347
945062-1011	Hardware-only version of 945062-0011	25,000	249
945062-3011	192K-byte version of 945062-1011	26,500	277
945062-5011	256K-byte version of 945062-1011	28,000	305

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EQUIPMENT PRICES

PACKAGE SYSTEMS (Continued)		Purchase Price	Monthly Maint.
945062-7011	352K-byte version of 945062-1011	30,500	347
945062-1021	Hardware-only version of 945062-0021	24,500	249
945062-3021	192K-byte version of 945062-1021	26,000	277
945062-5021	256K-byte version of 945062-1021	27,500	305
945062-7021	352K-byte version of 945062-1021	30,000	347
945062-1031	Hardware-only version of 945062-0031	24,500	249
945062-3031	192K-byte version of 945062-1031	26,000	277
945062-5031	256K-byte version of 945062-1031	27,500	305
945062-7031	352K-byte version of 945062-1031	30,000	347
945081-0001	DS990 Model 6, same as 945062-0001 but with dual 22.33-megabyte DS25 disk pack drives on individual pedestals	48,250	369
945081-2001	192K-byte version of 945081-0001	49,750	397
945081-4001	256K-byte version of 945081-0001	51,250	425
985081-6001	352K-byte version of 945081-0001	53,750	467
945081-0021	Same as 945081-0001 but with 70-inch cabinet	47,750	369
945081-2021	192K-byte version of 945081-0021	49,250	397
945081-4021	256K-byte version of 945081-0021	50,750	425
945081-6021	352K-byte version of 945081-0021	53,250	467
945081-1001	Hardware-only version of 945081-0001	44,750	369
945081-3001	192K-byte version of 945081-1001	46,250	397
945081-5001	256K-byte version of 945081-1001	47,750	425
945081-7001	352K-byte version of 945081-1001	50,250	467
945081-1021	Hardware-only version of 945081-0021	44,250	369
945081-3021	192K-byte version of 945081-1021	45,750	397
945081-5021	256K-byte version of 945081-1021	47,250	425
945081-7021	352K-byte version of 945081-1021	49,750	467
945084-0001	DS990 Model 8, same as 945062-0001 but with dual 44.6-megabyte DS50 disk pack drives on individual pedestals	53,250	419
945084-2001	192K-byte version of 945084-0001	54,750	447
945084-4001	256K-byte version of 945084-0001	56,250	475
945084-6001	352K-byte version of 945084-0001	58,750	517
945084-0021	Same as 945084-0001 but with 70-inch cabinet	52,750	419
945084-2021	192K-byte version of 945084-0021	54,250	447
945084-4021	256K-byte version of 945084-0021	55,750	475
945084-6021	352K-byte version of 945084-0021	58,250	517
945084-1001	Hardware-only version of 945084-0001	49,750	419
945084-3001	192K-byte version of 945084-1001	51,250	447
945084-5001	256K-byte version of 945084-1001	52,750	475
945084-7001	352K-byte version of 945084-1001	55,250	517
945084-1021	Hardware-only version of 945084-0021	49,250	419
945084-3021	192K-byte version of 945084-1021	50,750	447
945084-5021	256K-byte version of 945084-1021	52,250	475
945084-7021	352K-byte version of 945084-1021	54,750	517
2268017-1028	DS990 Model 20 System, includes the 990/12 central processor. Minimum configuration includes 256K bytes of error-correcting (ECC) memory, 2K-byte cache controller, two Model 911 video display terminals, a DS50 disk with 50 megabytes of disk storage, choice of a magnetic tape data storage system or a second DS50 disk drive for backup.	64,500	595
2268017-0028	DS990 Model 20A, 800-bpi with software and installation	68,500	595
2268016-1028	DS990 Model 20A, 1600-bpi, hardware only	66,000	595
2268016-0028	DS990 Model 20A, 1600-bpi, with software and installation	70,000	595
2268015-1028	DS990 Model 20B, dual disk, hardware only	68,500	610
2268015-0028	DS990 Model 20B, dual disk with software and installation	72,500	610
2268021-1028	DS990 Model 30 system includes the 990/12 central processor. Minimum configuration includes 256K bytes of error-correcting (ECC) memory, 2K-byte cache controller, two Model 911 video display terminals, a DS200 disk drive with 200 megabytes of data storage, choice of a magnetic tape data system or a second DS200 disk drive for backup.	77,400	645
2268021-0028	DS990 Model 30A, 800 bpi, with software and installation	81,200	645
2268020-1028	DS990 Model 30A, 1600 bpi, hardware only	78,900	645
2268020-0028	DS990 Model 30A, 1600 bpi, with software and installation	82,700	645
2268019-1028	DS990 Model 30B, dual disk system, hardware only	92,900	710
2268019-0028	DS990 Model 30B, dual disk system with software and installation	96,900	710
PERFORMANCE PACKAGES			
2268032-5031	DS990 Model 4 Performance Package (Hardware System), 30-inch cabinet	33,750	340
2268032-5021	Same in a 70-inch cabinet	33,750	340
2268048-1038	DS990 Model 8 Performance Package (Hardware System), 30-inch cabinet	62,000	554
2268048-1028	Same in a 70-inch cabinet	62,000	554
PROCESSOR OPTIONS			
940071-0001	CRU expansion master kit, includes CRU expansion chassis, CRU expansion card, CRU buffer card and 12-foot cable	2,200	22
940071-0002	CRU expansion secondary kit, same as 940071-0001 but without CRU expansion card	1,975	19
940072-0001	TILINE expansion kit, includes expansion chassis, two TILINE coupler modules, and cable for 990/10	2,875	23
945091-0001	TILINE interface kit, includes two TILINE coupler modules and cable, for 990/10	1,400	7

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EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
MEMORY			
944935-0011	8K-byte parity memory module	700	17
944935-0012	16K-byte parity memory module	1,150	20
944935-0013	24K-byte parity memory module	1,600	23
944935-0014	32K-byte parity memory module	2,050	26
944935-0015	40K-byte parity memory module	2,500	29
945170-0001	EPR0M memory module	800	5
948955-0001	EC expansion memory, 64K bytes	1,750	28
948955-0002	EC expansion memory, 128K bytes	3,250	56
948955-0003	EC expansion memory, 192K bytes	4,750	84
948955-0004	EC expansion memory, 256K bytes	6,250	112
MASS STORAGE			
FD800 Rackmount Diskette Drives			
2269929-0001	Single-drive master kit	3,325	35
2269929-0003	Dual-drive master kit	4,725	42
2269929-0004	Single-drive secondary kit	2,375	27
2269929-0005	Dual-drive secondary kit	3,775	34
FD800 Table-top Diskette Drives			
2269929-0022	Single-drive master kit	3,400	35
2269929-0023	Dual-drive master kit	4,800	42
2269929-0024	Single-drive secondary kit	2,450	27
2269929-0025	Dual-drive secondary kit	3,850	34
2269929-0043	FD800 drive only	1,400	7
FD1000 Rackmount Diskette Drives			
2261685-1001	Single-drive master kit	4,790	41
2261685-1003	Dual-drive master kit	6,675	65
2261685-1004	Single-drive secondary kit	3,240	31
2261685-1005	Dual-drive secondary kit	5,125	55
FD1000 Table-top Diskette Drives			
2261685-1101	Single-drive master kit	4,790	41
2261685-1103	Dual-drive master kit	6,675	65
2261685-1104	Single-drive secondary kit	3,240	31
2261685-1105	Dual-drive secondary kit	5,125	55
2261685-1266	FD1000 drive only	1,890	24
DS10 Disks			
937500-0001	Single master kit (rackmount); includes a 9.4-megabyte DS10 cartridge disk drive, controller for up to two drives, rackmounting slides for drive, 5440-type cartridge, and a terminator	9,900	120
937500-0004	Secondary kit (rackmount); includes add-on disk drive, 5440-type cartridge, and rackmounting slides	7,800	100
937500-0011	Same as 937500-0001 with quietized pedestal cabinet	10,900	120
937500-0013	Same as 937500-0004 with quietized pedestal cabinet	8,600	100
937500-0002	Interface kit	4,500	20
DS25 Disks			
947521-1001	Single master kit with pedestal; includes a 22.33-megabyte DS25 disk pack drive, controller for up to four drives, disk pack, and a terminator	14,995	155
947521-1004	Secondary kit with pedestal; includes disk pack drive and disk pack	11,795	135
947521-0002	Interface kit	5,500	20
DS50 Disks			
947580-1001	Single master kit with pedestal; includes a 44.6-megabyte DS50 disk pack drive, controller for up to four drives, disk pack, and a terminator	17,200	155
947580-1004	Secondary kit with pedestal; includes disk pack drive and disk pack	14,600	135
947580-0002	Interface kit	5,500	20
DS200 Disks			
938140-0001	Single master kit with pedestal, includes a 169.47-megabyte DS200 disk pack drive, controller for up to four drives, disk pack, and a terminator	29,500	205
938140-0004	Secondary kit with pedestal; includes disk pack drive and disk pack	25,500	185
938140-0002	Interface kit	5,500	20
945965-0001	FD800 diskette (minimum order in multiples of 10)	10 each	—
2261687-0001	FD1000 diskette (minimum order in multiples of 10)	15 each	—

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EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
MASS STORAGE (Continued)			
937507-0001	DS10 disk cartridge	150	—
947533-0001	DS25/DS50 disk pack	600	—
948986-0002	DS200 error-free disk pack	1,200	—
MAGNETIC TAPE EQUIPMENT			
949008-0001	979A master kit; includes 9-track, 800 bpi, NRZI, 979A tape transport, controller for up to four 800-bpi tape transports, 200-foot reel of tape, and terminator	10,000	120
949008-0006	979A secondary kit; includes 800-bpi 979A tape transport and 200-foot reel of tape	8,000	95
948980-0001	979A master kit; same as 949008-0001 but transport is 1600 bpi and PE controller handles 800- or 1600-bpi drives in any mix	11,500	120
948980-0006	979A secondary kit, same as 949008-0006 but 1600-bpi, PE	8,000	95
PRINTERS			
938120-0001	810 master kit; includes 132-position, 96-character set, 150-cps 810 serial matrix printer and controller	2,655	33
2262090-0001	820 KSR master kit; includes 132-position, 96-character set, 150-cps 820 serial matrix printer/terminal and controller	2,895	35
937485-0001	2230 master kit; includes 132-position, 64-character set, 300-lpm 2230 drum printer and controller	13,500	105
937492-0001	2260 master kit; includes 132-position, 64-character set, 600-lpm 2260 drum printer and controller	18,250	160
PUNCHED CARD EQUIPMENT			
945083-0001	804 master kit; includes table-top, 400-cpm, 80-column 804 card reader and controller	5,200	55
TERMINALS			
948977-0001	743 KSR Silent 700 Printer Keyboard Data Terminal Kit; includes 743 Silent 700 Terminal, roll of paper, and controller	1,520	25
938849-0001	911 video display terminal (VDT) kit; includes 24-line by 80-character, 96-character set 911 VDT, keyboard, and controller	1,850	23
938849-0003	With dual controller	2,150	24
938849-0002	Dual controller and two 911 VDT's with keyboards	3,500	39
938850-0001	Add-on video display terminal and keyboard	1,350	15
I/O INTERFACES			
945099-0001	16-I/O-line EIA data module	335	7
945099-0005	16-I/O-line EIA data module with hi/lo interrupt	335	7
945099-0006	16-I/O-line EIA data module with lo/hi interrupt	335	7
945103-0001	16-I/O-line TTL data module	310	7
945103-0005	16-I/O-line TTL data module with hi/low interrupt	310	7
945103-0006	16-I/O-line TTL data module with lo/hi interrupt	310	7
945103-0004	16-I/O-line TTL data module with pull-up	310	7
938133-0001	D/A converter kit, 1 channel	925	22
938133-0002	D/A converter kit, 2 channel	1,345	28
938133-0003	D/A converter kit, 3 channel	1,680	36
938133-0004	D/A converter kit, 4 channel	2,015	52
938132-0001	A/D converter, 16 channels	1,625	25
938132-0002	A/D converter, 32 channels	1,905	26
938132-0003	A/D converter, 48 channels	2,130	27
938132-0004	A/D converter, 64 channels	2,350	28
940002-0001	32-bit input/transition detection kit	430	7
940001-0001	32-bit output data kit	315	7
940003-0001	Digital I/O termination panel kit, 3.1m (10 ft.) cable	280	N/C
940003-0002	Digital I/O termination panel kit, 4.6m (15 ft.) cable	335	N/C
940003-0003	Digital I/O termination panel kit, 6.1m (20 ft.) cable	365	N/C
940057-0001	990 5MT/6MT serial interface kit, 3.1m (10 ft.) cable	500	7
940057-0002	990 5MT/6MT serial interface kit, 4.6m (15 ft.) cable	500	7
940057-0003	990 5MT/6MT serial interface kit, 6.1m (20 ft.) cable	500	7
COMMUNICATIONS			
937527-0003	TTY/EIA terminal interface module	375	7
946104-0001	990 communications interface module; RS-232C interface for both synchronous and asynchronous modems	480	7
946104-0002	Bell data set interface kit; includes 946104-0001 and cable for Bell 103A, 201, 202, or 208 modems	530	7
945114-0002	990 asynchronous modem kit; provides Bell 202-equivalent modem with auto answer	600	8
945094-0003	990 synchronous modem kit; provides Bell 201C-equivalent modem	1,275	9
945163-0001	Autocall kit; provides for CPU calling via dial pulse or tone signals to telephone switching circuitry	450	10
HARDWARE			
945127-0001	990 computer chassis rack-mounting slide set	75	—
945126-0001	6-slot chassis table-top dustcover	150	—
936409-0001	13-slot chassis table-top dustcover	150	—

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EQUIPMENT PRICES

HARDWARE (Continued)		<u>Purchase Price</u>	<u>Monthly Maint.</u>
937498-0001	Single-bay equipment desk	750	—
946738-0001	Double-bay equipment desk	1,000	—
937528-0001	Single-bay pedestal	500	—
945080-0001	Rack-mount equipment cabinet	1,000	—
945130-0001	1.75-inch blank front panel	12	—
945130-0002	3.5-inch blank front panel	14	—
945130-0003	7-inch blank front panel	16	—
945130-0004	8.75-inch blank front panel	17	—
945130-0005	10.5-inch blank front panel	18	—
940045-0001	Chassis center card guide kit, includes center card guide and necessary hardware; allows a single full-size board to be subdivided into two half-size boards	5	—
975170-0001	Extender card, full size; allows operation of any card external to chassis	200	—
226851-0001	Half size	150	—
946712-0001	Tabletop programmer panel; facilitates in-house maintenance on systems with operator panels	250	5
974651-0001	Universal wire-wrap board, full size; 13 rows of 15 locations for mounting either 14- or 16-pin IC's and 2 rows for mounting 20-, 24-, 28-, or 40-pin IC's; wire-wrap pins on reverse side	600	—
974900-0001	Half size; 50 locations for 14- or 16-pin IC's; wire-wrap pins on reverse side	275	—
974901-0001	Free-matrix universal wire-wrap board, full size; 22 column pairs for IC's with 0.3-inch pin spacing; 2 column pairs for IC's with 0.4-inch pin spacing; 2 columns pairs for IC's with staggered pin patterns; wire-wrap pins on reverse side	875	—
974903-0001	Half size, 10 column pairs for IC's with 0.3-inch pin spacing; 2 column pairs for IC's with 0.4-inch pin spacing; 2 column pairs for IC's with staggered pin patterns; wire-wrap pins on reverse side	400	—

SOFTWARE PRICES

Each listed software package has a separate product number for one-time license, annual software subscription renewal, and update subscription service. Consult TI for complete list.

The One-Time License fee includes one-year subscription service.

Software is available on a variety of media (various disk packs, diskettes, and tape) at varying prices. This price list shows representative prices in each case.

	<u>One-Time License</u>	<u>Repeat Copy</u>	<u>Subscription/Support</u>
TX990	1,200	375	500
TXDS	1,500	200	500
TX 3780/2780 Emulator	500	200	500
TX5 Operating System	1,700	300	550
DX10 Disk System	3,000	325	750
DX 3780/2780 Emulator	1,400	1,100	650
DX 3270 ICS	1,650	1,100	600
TXDS FORTRAN	700	200	400
DX10 FORTRAN	3,000	1,100	750
DX10 COBOL	3,250	1,100	650
DX10 990 BASIC	2,700	1,100	550
DX10 Sort/Merge	2,500	325	625
990 Diagnostics	400	—	—
RPG II	2,000	325	500
TI 990 Pascal	1,500	325	500
DBMS-990	2,000	325	500
Query 990	1,500	325	500
TIFORM 990	1,500	325	500
TX5 BASIC (includes SBC BASIC)	800	325	400
TX5 FORTRAN	1,200	375	700
TX5 3780/2780	1,100	300	650
DX10 COBOL with DX5 COBOL Run-Time Package	4,450	1,100	900
DX 3780/2780 Emulator with DX5 3780/2780	2,600	1,100	750
COBOL ISP (Integrated Software Package)	9,250	*	*
DBMS ISP (Integrated Software Package)	12,250	*	*

*Repeat copy and subscription support are handled on an individual language basis, as is now done. DS25, DS50, or DS200 disk pack to be supplied by customer for subscription/support updates. ■