DEC DECstation 78 and 88

MANAGEMENT SUMMARY

The DECstation 78 and 88 are similar to the Datasystem 308 and 310 in that both smaller models are based on the VT78 processor and the larger models use PDP-8/A's. Both series offer the COS 310 operating system and similar memory capacities. The DECstations feature stronger high-level languages than the Datasystem's 308 and 310, and additional general-purpose and real-time operating systems are included.

The DECstation 78, announced in May 1977, includes a non-expandable LSI processor with 16K 12-bit words of main memory. Its storage capacity is limited to two million 8-bit bytes or one million 12-bit words. Two serial asynchronous interface ports are provided for data communications.

The DECstation 78 employs Digital's LSI-based PDP-8 video data processor, the VT78, which features a software self-diagnostic capability and single-button program loading capability. The minimum DECstation 78 package also includes a double density dual-diskette subsystem, desk hardware, the OS/78 and RTS/8 operating systems, the COS-310 operating system with file management capacilities, and the OS/78 BASIC and OS/78 FORTRAN IV programming languages. The price of this minimum system is $7,995.

The DECstation 78 can be augmented with a second dual-diskette subsystem, priced at $4,300, and either a 180-cps LA78 Serial Printer priced at $3,300, or a 45-cps, letter-quality LQP78 Daisy-Wheel Printer, priced at $3,995. Both of these printers have a 96-ASCII character set and 132 positions per line of print. ▷

The DECstation 78 and 88 are packaged entry-level versions of DEC's reliable and successful PDP-8. The 78 is an integrated LSI version of a 16K PDP-8 with simple no-bus architecture. The 88 uses a PDP-8/A processor with a 10- or 20-slot Omnibus. The 78 is a single-user system while the 88 supports multiple users, and real-time and data base operations. Prices for the 78 range from $7,995 to $15,400. The 88 costs from $11,500 to $22,200.

CHARACTERISTICS

MANUFACTURER: Digital Equipment Corporation, 146 Main Street, Maynard, Massachusetts 01754. Telephone (617) 897-5111.

Digital Equipment Corporation (DEC) is the world's largest manufacturer of minicomputer systems. DEC's product lines include general-purpose computing systems, laboratory monitoring and control systems, process control systems, industrial control systems, editing and typesetting systems, and business computing systems. DEC maintains 125 sales and service offices in over 30 countries and has manufacturing facilities in Puerto Rico, Mexico, Canada, Ireland, Scotland, Hong Kong, and Taiwan in addition to six facilities in the U.S. The company employs 45,000 persons worldwide and has installed more than 100,000 computer systems.

MODELS: DECstation 78, Models 40, 50, 70; DECstation 88, Models 50, 70, 80, 90, 92, 97. ▶

The DECstation 88/50 shown here is one of the business-oriented DEC-station systems that range from an LSI-based 16K word video data processor version with one mega-byte of floppy disk storage to a 32K word PDP-8/A version with ten megabytes of disk-pack storage. Software for business and general-purpose program development is available. DECstations range in price from $8,250 to $25,100 with quantity discounts available at all levels.

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▷ The basic DECstation 88 configuration includes a PDP-8/A CPU with 32K words of 1.5-microsecond core memory and bootstrap loader; a double-density dual floppy disk drive subsystem, with each drive capable of storing up to 512,572 bytes or 256K 12-bit words; a 1920-character CRT display/keyboard; and a desk. Also included in the $11,500 purchase price is a license for the COS-310 and OS/78 operating systems. Memory can be expanded to 128K words, and floppy disk storage can be increased to a maximum of four drives (two dual-drive units), for a total of 2 million bytes on-line.

Up to four RK05 or RL01 cartridge disk drives can also be added to the DECstation 88, providing an extra 20.4 million bytes of storage.

Three types of printers are also offered as options with the 88: the DEC-manufactured LA180 printer, the 300-lpm LE8 line printer, and a letter-quality printer that prints at up to 45 cps with a 96-character set.

The DECstations can be employed as remote entry terminals to a host system through the IBM 2780/3780 Emulation package. This package includes a synchronous line controller and the necessary software to communicate with other DEC DECsystem 10's or DECsystem 20's, or any IBM 360/370 computer system. The communications software package provides automatic answering, automatic retransmission of data in error, and double buffering of disk and line printer files. The data transmission rate is 4800 bps.

The DECstation systems, including the cartridge disk drives and line printers, plug into standard three-prong wall sockets. No special flooring is required, and any normal office environment is suitable for the systems.

DEC sells both systems to end users and OEM's alike. The company makes the units available to volume purchasers at quantity-discount prices. Even more substantial discounts are available to OEM buyers, and about 100 of these are committed to making tailored and/or turnkey business applications systems available to customers at negotiated prices.□

▶ **DATE ANNOUNCED:** DECstation 78, May 1977; DECstation 88, August 1977.

DATE OF FIRST DELIVERY: DECstation 78, September 1978; DECstation 88, March 1978.

NUMBER INSTALLED TO DATE: Over 20,000.

DATA FORMATS

BASIC UNIT: 12-bit word.

FIXED-POINT OPERANDS: 12-bit words standard, with optional 24-bit double-precision operands. Half-word (6-bit) byte swaps can also be handled.

FLOATING-POINT OPERANDS: 36-bit single-precision operands with a 24-bit signed fraction and signed 12-bit exponent or 72-bit operand with a 60-bit signed fraction and signed 12-bit exponent for double precision. Floating-point processor hardware is optional on all models; software subroutines are also available.

INSTRUCTIONS: One-word instructions. Memory reference instructions use the first three bits to specify the instruction and the last nine bits to specify the operand address. In order for memory reference instructions to access memory directly, each 4K memory module is logically divided into 32 pages of 128 addresses each for page addressing. Seven of the nine bits are used to specify relative address within page; one bit is used to specify current page or page zero within the module, and one bit is used to specify whether direct or indirect addressing is used.

For manipulation and/or testing of data, a group of "Operate" instructions is available that specify shift, clear, complement, and test (and skip) operations on the accumulator and its associated link bit. The first three bits specify an Operator-type instruction, the fourth bit specifies one of two groups of commands, and bits 5 through 11 are predefined by position to indicate particular functions. These seven 1-bit indicators can be turned on in each Operate instruction, with each 1-bit flag referred to as a "microinstruction" (not to be confused with microprogramming).

INTERNAL CODE: Binary.

MAIN STORAGE

TYPE: Core and static MOS RAM, ROM, and PROM.

CYCLE TIME: Core—3.6 microseconds for the DECstation 78; 1.5 microseconds for the DECstation 88.

CAPACITY: The capacity of the basic DECstations is 32K words.

CHECKING: None.

STORAGE PROTECTION: None.

CENTRAL PROCESSORS

GENERAL: All of the DECstation processors are single-address, fixed-word length, parallel machines using two's-complement arithmetic on 12-bit binary numbers with an accumulator and multiplier-quotient architecture and direct accumulator-to-device and device-to-accumulator I/O transfers.

There are two distinct processor versions of the same fundamental architecture. The VT78, an LSI version of the PDP-8A is the DECstation 78 processor. The DECstation 88's processor is the familiar PDP-8A.

The optional Extended Arithmetic Element (EAE) permits double-precision fixed-point operations plus hardware fixed-point multiply/divide. The EAE contains extension hardware that can operate on 24-bit signed numbers rather than the conventional 12-bit operands. The EAE adds 26 instructions to the basic repertoire.

The FPP8-A Floating Point Processor (FPP) provides the capability of operating with 24-bit fixed-point, 36-bit floating-point (24-bit mantissa and 12-bit exponent), or operands (60-bit mantissa and 12-bit exponent).

Two types of real-time clocks are offered for the DECstations. These units vary in the timing source, using a selected crystal frequency, or programmable intervals.

Power failure/auto restart, bootstrap loader, and memory extension control are combined on a single board in systems. In addition, the memory extension control, which permits addressing memory locations above 4K, also contains a time- ▶

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	MANUFACTURER
PRINTERS		
LA78	DECprinter, 132 positions, 96 ASCII characters, variable forms width, top-of-form control; parallel 180 cps	DEC
LE8	Line printer; drum, 132 positions, 64 ASCII characters, top-of-form control; 300 lpm	Dataproducts
LQP8	Letter-quality daisy-wheel printer; 132 positions, 96 ASCII characters; 45 cps characters; 45 cps	Diablo
TERMINALS		
VT100	DECscope CRT; 132 characters by 14 lines (24 optional), or 80 character by 24 lines; 3 character sizes selectable on a line basis; standard underline or reverse video, split screen, and optional bold and blink display; 18-key auxiliary keypad; up to 19,200 bps	DEC
VT55	DECgraphic video terminal, 96 characters, direct cursor addressing, 19-key keypad, graphics mode supports & 512-point linegraphs or histograms	DEC
LA36	DECwriter II; printer/keyboard, 132 positions, 96 characters, 7 x 7 dot matrix; 300 bps; asynchronous; 30 cps print speed, 50 cps positioning speed	DEC
LA38	DECwriter IV; tabletop, 4 character sizes, variable line spacing 3" to 14.8" forms width, 18-key numeric auxiliary keypad	DEC
LA120	DECwriter III; bidirectional, 8 font sizes, variable form width, variable line spacing; 180 cps	DEC
LA180	DECprinter I; serial, variable form width, 128 ASCII characters, 7 x 7 dot matrix; top-of-form control; 180 cps	DEC

➤ share control which provides monitor and user modes for time-shared operations, plus background/foreground real-time operations. Under the time-shared mode, certain instructions that would seriously hamper time-shared operation are inhibited and cause an interrupt.

REGISTERS: All models of the DECstation have eight major registers. Six are 12-bit registers: one accumulator (AC); one general-purpose register (MA) for use as temporary storage or an extension of the accumulator if the Extended Arithmetic Element is employed; a program counter (PC); memory address (MA) register; a switch register (SR) to manually load memory or another register from a programmer's console; and a memory buffer (MB) register to transfer data between other registers and memory.

ADDRESSING: All PDP-8's have four addressing modes; direct (128 locations); indirect (one level); indirect indexed, using the auto-index registers in memory; and program-relative.

INSTRUCTION REPERTOIRE: All processors have 6 memory reference instructions, 4 interrupt system control instructions, 3 flag processing instructions, and 41 operate instructions for logic control, etc. The optional Extended Arithmetic Element provides six additional shift instructions, four arithmetic instructions (including multiply/divide, and six double-precision instructions.

INTERRUPTS: A single-line interrupt structure is provided, with software polling of I/O devices required to determine the origin and priority of each interrupt.

Two operating modes, user and executive, are available. User mode is the standard mode of operation. In executive mode, full access is available to all programmable machine functions. In user mode, (invoked for time-sharing or foreground/background multiprogramming), direct I/O access is denied to unauthorized user programs.

Automatic push-down stacks are implemented in software to facilitate sharable (re-entrant) routines. The size of the push-down stacks is limited only by the size of available memory.

PHYSICAL SPECIFICATIONS: The DECstation 78 chassis is 14.4 inches high, 20.9 inches wide, and 27.2 inches deep. The DECstation 88 chassis is 41.75 inches high, 21.25 inches wide, and 30 inches deep. The 78 weighs 42 pounds, while the 88 weighs 225 pounds. Power consumption for the 78 is 110 watts, for the 88 it is 500 watts. Environmental requirements for the DECstation 78 are 59°F to 90°F and 20% to 80% humidity while those for the DECstation 88 are 41°F to 122°F and 10% to 90% humidity.

INPUT/OUTPUT CONTROL

OMNIBUS: A synchronous bus is provided with each processor. (One is standard in the PDP-8/A, with a second Omnibus as an option.) The Omnibus permits plugging memory/processor options or I/O devices into any available slot location, eliminating the need for special back-panel wiring. The maximum programmed data transfer rate is 50,000 words/second.

DIRECT MEMORY ACCESS: A standard 12-channel DMA (data break) feature is provided for high-speed block data transfers between memory and higher-speed peripheral/terminal devices on a cycle-stealing basis, and is an integral part of the Omnibus. Any peripheral controller with a DMA interface can operate directly to memory. In conjunction with the DMA feature, multiple external devices can directly increment multiple memory locations, and external data can be combined (add/subtract) direct to memory locations with processor intervention. The maximum DMA data transfer rate is 833,000 words/second.

CONFIGURATION RULES: The key to configuring the DECstations is the Omnibus, which consists of prewired ➤

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➤ slots that permit physical attachment of I/O devices and/or memory/processor options, and the capacity of the power supply included with each configuration. Neither the number of Omnibus slots nor the capacity of the power supply can be exceeded.

The DECstation 88/92 and 88/97 system include 20-slot Omnibus's while the smaller systems are 10-slot models.

MASS STORAGE

RX28 FLOPPY DISK: The RX28 is a double-density flexible disk drive with a capacity of 256K 12-bit words per drive. Up to two drives per controller can be configured. Average access time is 263 milliseconds; rotational speed is 360 rpm, yielding an average rotational delay of 83 milliseconds. A track-to-track move takes at least 10 milliseconds. The surface of the diskette is divided in 77 tracks, each with 26 sectors. The RX28 floppy disk drive is manufactured by DEC.

RK8 CARTRIDGE DISK SUBSYSTEM: Includes an RK05J cartridge disk drive with one removable IBM 5440-type cartridge and a controller for up to eight drives. The RK05J drive records data at 256 words per sector, 16 sectors per track, and 203 tracks per surface. Formatted capacity is 1.6 million 12-bit words. Average rotational delay is 20 milliseconds, and average head-positioning time is 50 milliseconds. Data transfer rate is 120K words per second. The RK05J cartridge disk drive can be intermixed with the RK05F double-density drive on the same controller. The RK05J disk drive is manufactured by DEC.

RK05F CARTRIDGE DISK DRIVE: A double-density version of the RK05J cartridge disk drive having 406 tracks per surface. It uses a nonremovable cartridge and has a capacity of 3.2 million words. The RK05F drives can be intermixed with the RK05J drives on the same controller, although there must be at least one RK05J drive in the subsystem. To the operating software, one RK05F appears as two logical RK05J's. Hence, a maximum subsystem using RK05F's has three RK05F drives and one RK05J drive. The RK05F disk drive is manufactured by DEC.

RL8A SUBSYSTEM: Includes an RL01 5.2-megabyte cartridge disk drive. The RL01 is a top-loading drive employing a removable cartridge. Features provided include an embedded servo, allowing control information to be dispersed on each data track for data integrity. Disk rotational speed is 2400 rpm, and average rotational delay is 12.5 milliseconds. Average head positioning time is 55 milliseconds. Data transfer rate is 512K bytes per second. The drive is manufactured by DEC.

In addition to the disk products offered by DEC, more than 15 manufacturers currently supply DEC-compatible disk drives. These units are either DEC-equivalent units or IBM 2315, 5440, or 3470 equivalents. A detailed summary of these products is presented in Report M13-100-201, *Minicomputer Disk Storage*, and Report M13-100-251, *Minicomputer Floppy Disk Storage*.

INPUT/OUTPUT UNITS

See Peripherals/Terminals table on the third page of this report. Also, a number of vendors manufacture direct replacement line printers for the PDP-8 series, as outlined in Report M13-100-401, *Minicomputer Printers*. Non-DEC punched card and punched tape units can be located in Reports M13-100-501 and M13-100-601, *Minicomputer Punched Card Units* and *Minicomputer Punched Tape Units*.

COMMUNICATIONS CONTROL

The following units are provided to control various communication interfaces.

The KL8-JA Asynchronous Serial Line Interface provides full- or half-duplex control of one local line with switch-selectable rates of from 110 to 9600 bits per second.

The KL8-A Four-Channel Asynchronous Interface provides partial modem controls on three channels and full modem controls on the fourth. The unit features 15 switch-selectable data rates from 50 to 9600 bps.

The DP8-EA Synchronous Modem Interface controls Bell 201 or equivalent modems. Character length is strap-selectable for six-, seven-, or eight-bit characters. The interface operates in full- or half-duplex modes on data break (DMA) channels. Data rates are strap-selectable to 71K bits per second.

The KG8-E Redundancy Check Unit provides hardware-generated LRC, VRC, and industry-compatible CRC characters to multiple output data streams. It also checks the same data on multiple input streams. The unit occupies one slot.

SOFTWARE

OPERATING SYSTEMS: There are three operating systems available for use with the DECstations: OS/78, RTS/8, and COS 310.

OS/78 is a comprehensive single user system for batch and interactive operation on an 8K-word (or larger) DECstation, with a minimum of 64K words of disk storage. OS/78 provides standard dynamic I/O handling for a maximum of 15 I/O devices, as well as modular program development support for FORTRAN IV, BASIC, six different levels of assembly language, and PIP (Peripheral Interchange Program). Modules in more than one language can be combined to form a composite programming system. Also supported under OS/78 are a symbolic editor, dynamic debug programs, file manipulation modules, an absolute loader, and program chaining.

OS/78 contains I/O handlers for RL08 disk drives, an LQP printer, an LA78 printer, and two asynchronous serial line units. User-written symbionts can run communications or printing, and monitor real-time jobs in parallel with normal OS/78 processing.

Minimum system requirements are a DECstation 78 or 88. Only 256 words of main memory are required for OS/78. Non-resident modules are swapped in and out as required.

RTS/8 (Real-Time System for PDP-8 family) allows concurrent running of up to 127 fixed-priority tasks in the foreground and either batch processing or program development in the background. The RTS monitor controls scheduling, startup and suspension of tasks, task execution, and intertask communications. RTS/8 is oriented toward I/O and data collection involving real-time operations. As such, it supports time-driven operations (clocks), power-fail features and most standard I/O and process interfaces. RTS/8 exists as a small run-time module, whose tasks are created at development time using OS/78.

RTS/8 supports only PAL8 assembly language modules in the foreground, but BASIC modules can be run under OS/78 in the foreground, and OS/78 BATCH, FDITOR, and TECO can be run in the background.

The monitor occupies less than 700 words in main memory, and tasks require an additional 10 words each. The RTS/8 system modules support most standard DEC peripherals. ➤

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▶ Minimum system requirements are an 8K DECstation 78 or 88, without OS/78 background support, or a 16K DEC-station 88 with OS/78 background support, with a console terminal and an input medium.

A monitor console routine (MCR) in the RTS/8 system permits the user to exercise on-line control, inspect, and debug the system. Functions that can be performed through the MCR include: request task execution, suspend task execution, execute task at a specified time, examine memory, enter value into memory, enter date, enter time, print task status, and return to OS/78. Single functions or strings of functions can be entered and performed.

Drivers for the RX8 and RX28 diskette drives and for the RK8-E and RL8-A cartridge disk drives accept uniform request message formats for reading and writing disk record blocks.

DECNET/8 extends the capabilities of RTS/8 to permit PDP-8 systems to interconnect with other DECNET systems. Under this system, tasks running in the RTS/8 environment can exchange data with other tasks executing on remote systems in the DECNET system. DECNET/8 supports the DDCMP protocol in full-duplex, point-to-point mode, over asynchronous and synchronous lines. Network Services Protocol (NSP) allows tasks on DECNET systems to establish logical links to other tasks executing on other systems. Variable-length messages of up to 528 bytes can be transferred over logical channels on a message basis through multiplexed physical links.

DECNET/8 is implemented as a special task in the RTS/8 environment and requires a minimum of 4K words of main memory for its own operation. The software package supports one asynchronous communications line at data rates up to 9600 bps, full-duplex. Also required is either a KL8-E or KL8-J asynchronous interface.

COS-310 is a modified version (not a proper subset) of CTS 300 for DEC's larger Datasystems. COS-310 functions to make the CPU appear as "black box," control I/O operations, and handle the operator interface. The operating system requires about 4K words of memory and resides, with numerous utility programs, on about one-third of a diskette.

COS-310 supports named I/O devices in the packaged systems. It supports batch and interactive processing as well as interactive program development. It manages direct access to diskette data through user file directories. It provides direct printing or spooling for an optional line printer, cursor control for the CRT, and a buffer for the keyboard. It allows programs to be chained. COS-310 supports multiple-volume data files on diskette. The operating system also contains fixed-point decimal arithmetic routines.

The COS-310 MONITOR is split into a core-resident and a diskette-resident segment; it includes interactive job control and editor functions, and maintains a directory of all programs stored within the system. The EDITOR is an interactive, line-oriented program that also accepts input from the keyboard and accepts and stores batch-mode commands or control files for SORT, BUILD, or other programs. The COS-310 MONITOR and one or two key utilities occupy about one-fifth of a diskette.

LANGUAGES: The following are DECstation-supported languages.

PAL8 is an 8K two-pass assembler designed to run under the OS/78 operating system. The first pass reads the input file and sets up the symbol table. The second pass reads the input file and uses the symbol table to generate the object file in binary. The binary file is an absolute binary tape that can

be loaded into memory via either the Absolute Loader or the Binary Loader. An optional third pass produces octal and symbolic listings and a listing of the symbol table. PAL8 can handle I/O from any OS/78 devices supporting ASCII text, and has pseudo-operations and options not available in the other PDP-8 assemblers. It is loaded and saved via the OS/78 Monitor and Absolute Loader. It will accept input generated by the Editor and generates output acceptable to the Absolute Loader and CREF.

OS/78 BASIC is implemented as a compiler language including an editor, compiler, and run-time system. It provides for interactive program development, and batch and inter-active processing. Three data formats are accommodated: alphanumeric, decimal with 15-digit precision, and floating point. Formatted numeric string printing capability and record-oriented random access are also included.

OS/78 FORTRAN IV provides full standard ANSI FORTRAN IV under the OS/78 operating system. The compiler accepts a single FORTRAN source-language program or subroutine as input, examines each FORTRAN statement for validity, and produces a list of error diagnostics plus a RALF assembly-language version of the source program, along with an optional annotated source listing. A job of one or more subroutines is executed by compiling and assembling the main program and each subroutine separately, then combining them with the loader.

OS/78 FORTRAN IV requires a minimum hardware configuration of a DECstation with 8K words of mainframe memory, a console terminal, and at least 128K of mass storage. Additional equipment that can be utilized when present includes an extended arithmetic element, a floating point processor, a double-precision option up to 32K words of mainframe memory, peripherals, and any I/O device supported by the PDP-8 series.

UTILITIES: The following are PDP-8 utility programs.

CREF (Cross Reference Program) assists the programmer in writing, debugging, and maintaining assembly-language programs by providing the ability to pinpoint all references to a given symbol. CREF operates on output from the PAL8 and RALF assemblers.

PIP (Peripherals Interchange Program) is the OS/8 system program that is used to transfer files between devices, to merge and delete files, and to list, zero, and compress directories. PIP accepts up to nine input files and performs output to a single file. Since PIP performs file transfers for all types of files (ASCII, Image or SAVE format, or binary) there are no assumed extensions. All extensions for either input or output files must be explicitly specified in the commands to PIP.

The *Symbolic Editor* (EDIT) allows users to create and modify symbolic source program tapes from the teletypewriter keyboard. As the program is typed on the keyboard, it is entered into memory, where it can be checked, corrected, and modified. When modification is complete, the Editor will produce a source program tape suitable for assembling or compiling into an object binary tape.

DIRECT is an OS/78 program that produces listings of OS/8 device directories. These directories can be of several types, depending upon the options specified in the DIRECT command line. The standard directory listing consists of file name, file name extension, length (decimal) in blocks written, and creation date.

The *On-Line Debugging Technique* (ODT) aids users in debugging programs that have been assembled/compiled and built into tasks. From the keyboard, the user can 1) print the contents of any location in the task for his examination or ▶

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alteration; 2) run the entire program or any portion of it, using the breakpoint feature to halt its execution at specified points; 3) search the object program for specific bit patterns, words, or references to a particular address; 4) calculate offsets for relative addresses; and 5) fill a block of words or bytes with a designated value.

Load, map, duplicate, and copy utilities are also included.

PRICING

POLICY: PDP-8 systems, purchased as end-user equipment on a package basis, include installation and set-up charges in the package prices. In addition, these systems are generally covered by a 90-day warranty. Maintenance contracts are negotiated separately. Any modifications to the system (additional I/O, memory, etc.) are subject to DEC's OEM policies. Discounts of up to 20 percent on both unit volume and dollar volume are available to end users.

Systems purchased for OEM purposes do not include warranty or installation. These must be purchased separately under one of three plans:

● System installation and 30-day on-site warranty priced at the greater of $300 or 3 percent of list price.

● System installation and 30-day on-site warranty priced at the greater of $500 or 5 percent of list price.

● Installation and 30-day on-site warranty for certain specified units, priced at the standard field installation charge plus maintenance for one month.

PDP-8/A modules are warranted on a return-to-factory basis for three months from the date of delivery.

For OEM customers, discounts of up to 35 percent for most electronic subassemblies and up to 28 percent on other hardware items are available, while discounts for software products can go as high as 56 percent.

Prices for field installation of options are the sum of all the individual field installation charges (FIC's), or $75 minimum, plus a one-time travel charge from the nearest DEC Service Center if the straight-line distance exceeds 100 miles. Installation prices for areas considered remote (not normally serviced by DEC or its subsidiaries) must be quoted individually.

Return-to-factory warranties and services can be obtained from seven locations in the United States and Canada. These locations are: Chicago, Illinois; Sunnyvale, California; Kanata, Ontario; Maynard, Massachusetts; Houston, Texas; Santa Ana, California; and Princeton, New Jersey.

Software prices usually include a one-time licensing fee that also includes one of two support plans. The first plan includes installation and testing of software packages, on-site remedial services for problems detected within 90 days of installation, and one-year coverage under DEC's Software Performance Report system, in which customers submit descriptions of their problems and remedies or emergency bypasses are supplied through a periodical maintenance document. The second plan provides only the one-year Software Performance Report coverage.■

EQUIPMENT PRICES

SYSTEMS

DECstation 78's include a VT78 CPU with a 3.6-microsecond cycle time, 16K words of MOS memory, memory extension control, automatic program loader, dual drive RX28 (RX02) floppy disk subsystem, 24 x 80 CRT and keyboard, 12-bit parallel I/O port, internal diagnostic, OS/78 operating system and Extended Instruction Set.

		Purchase Price	Monthly Maint.
DECstation 78 series			
78/40-B	Table-top model with COS-310 license, single-density RX02	$ 7,995	68
78/40-D	Same as 78/40-B except minidesk mounting	8,245	68
78/50-B	Same as 78/40-B except double-density RX02	8,250	80
78/50-C	Same as 78/50-B except full software support	11,250	80
78/50-D	Same as 78/50-B except minidesk mounting	8,500	80
78/50-F	Same as 78/50-D except full software support	11,500	80
78/50-L	Same as 78/50-D except includes LA180 printer	11,400	130
78/50-M	Same as 78/50-L except full software support	14,400	130
78/60-D	Same as 78/40-B except a single density RX02's COS	12,545	101
78/70-D	Minidesk mounting, 2 RX02's, and OS/78 and COS 310 license only	12,400	125
78/70-F	Same as 78/70-D with full software support	15,400	125
78/70-L	Same as 78/70-D with LA180 printer	15,300	175
78/80-M	Same as 78/70-L with full software support	18,300	175

DECstation 88's include all basic DECstation 78 features plus a PDP-8A CPU, a VT100 console device, and a 12-slot OMNIBUS.

88/50-D	With 32K words of MOS memory, OS/78 and COS 310 license only	11,500	129
88/50-F	Same as 88/50-D except full software support	14,500	129
88/50-L	Same as 88/50-D plus LA180 printer	14,400	184
88/50-M	Same as 88/50-L except full software support	17,400	184
88/70-D	Same as 88/50-D except 2 RX28 subsystems	15,900	174
88/70-F	Same as 88/70-D except full software support	18,900	174
88/70-L	Same as 88/70-D plus LA180 printer	18,800	229
88/70-M	Same as 88/70-L except full software support	21,800	229

DECstation 88/80's include all basic 88/70 features plus an RL8A cartridge disk subsystem.

88/80-D	With OS/78 and COS 310 license only	17,200	187
88/80-F	Same as 88/80-D except full software support	22,200	187
88/80-L	Same as 88/80-D plus LA180 printer	20,100	242
88/80-M	Same as 88/80-L except full software support	23,100	242

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		Purchase Price	Monthly Maint.

DECstation 88/90's include all basic 88/80 features plus an add-on RL01 drive for the RL8A subsystem.

		Purchase Price	Monthly Maint.
88/90-D	With full support for OS/78 only	17,500	192
88/90-L	Same as 88/90-D plus LA180 printer	20,400	247

DECstation 88/92's include all basic 88/90 features plus a 20-slot OMNIBUS.

88/92-D	With full support for OS/78 only	19,700	197
88/92-L	Same as 88/92-D plus LA180 printer	22,600	252

DECstation 88/97's include all basic 88/92 features plus 64K words of memory.

88/97-D	With full support for OS/78 only	22,200	232
88/97-L	Same as 88/97-D plus LA180 printer	25,100	287

PROCESSOR OPTIONS

KC8-AA	Programmer console; includes cables; requires DKC8-AA option board	550	8
KC8-AB	Remote programmer/console; includes cables; requires DKC8-AA option board	750	8
KE8-E	Extended Arithmetic Element; includes hardware divide, registers and extended instruction set; requires 2 slots	1,400	55
FPP8-A	Floating-Point Processor; provides 24-bit fixed-point, and 36-bit or 72-bit floating-point arithmetic operations; requires 2 slots	3,000	16
FPP8-AB	FORTRAN IV accelerator package; includes FPP, OS/8 operating system, and OS/8 FORTRAN IV paper tape binaries	2,500	16
KM8-AA	Extended Option Board; includes memory expansion control for systems greater than 4K words, time-share control, power fail/restart and bootstrap loader for paper tape, cartridge disk, floppy disk, and cassette tape; requires 1 slot	500	8
KT8-AA	Memory management and control for up to 128K words		
DKC8-AA	I/O Option Board; includes 100-Hertz real-time clock, programmer console control, 12-bit parallel I/O interface asynchronous serial line unit; 110 to 9600 bps; requires 1 slot	500	8
DK8-EC	Fixed-Interval Real-Time Clock, 1, 50, 500, or 5000 interrupts per second; requires 1 slot	350	2
	Programmable Real-Time Clock for all PDP-8's, 100-Hertz to 1M-Hertz base, 12-bit counter; requires 2 slots	740	3

MEMORY

MM8-AA	8K words, 1.5-microsecond cycle time; requires KM8-E or KM8-AA expansion control; requires 2 slots	1,500	10
MM8-AB	16K words of core memory, same specifications as MM8-AA above; requires 2 slots	2,500	15

MASS STORAGE

RL8-AK	Cartridge Disk Drive and Controller with removable 5-megabyte RL01 cartridge; maximum of 4 drives per controller; 88 only	5,100	58
RX28/78-AA	Dual Floppy Disk Drive and Controller, one RX02 dual drive per controller; maximum 8 per system; requires 1 slot	4,300	33

LINE PRINTERS/PLOTTERS

LA8-P	Printer and Controller; 132 columns, 96-character set, variable form width; requires 1 slot, for all PDP-8's, 180 cps	3,585	53
LE8-V	Printer and Controller; 132 columns, 64-character set; requires 1 slot, 300 lpm	11,235	72
LQP-78	Letter Quality Printer; 96-character set, 45 cps	3,995	47
LA78-PA	LA180 Printer and Controller; 96-character set, 180 cps; requires 1 slot	3,300	50

TERMINALS

LA36-CE	DECwriter II Printer; 132 columns, 96-character set; requires synchronous serial line unit; 10, 15, or 30 cps	2,100	19
LA38-GA	DECwriter IV; 96-character set, upper/lower case keyboard; up to 30 cps	1,600	16
LA120-BA	EIA interactive hardcopy terminal; 7 x 7 dot matrix; up to 180 cps	2,600	25
LA180-EA	DECprinter I; 132 columns, character set; 180 cps serial printer	3,770	55
VT100-AA	DECscope; 80 character x 24 lines or 132 characters by 14 lines; 96-character ASCII keyboard plus 14-key keypad; up to 19,200 bps	1,900	17
VT55-EA	DECgraphic scope; 96 characters; 2 512-point graphs	3,025	25

DATA COMMUNICATIONS

DS3-CB	2780 Communications Package; includes DP8 synchronous interface, 2780 Emulator license and software installation; requires 3 slots	4,730	16
KL8-JA	Asynchronous Interface; 20-milliampere or EIA interface, double-buffered, full-duplex, maximum 17 per system; requires 1 slot; 110 to 9600 bps	500	11
KL8-M	Modem Control for KL8-JA interface; for Bell 103A, E, F, G, and H, 113B, 202C and 202D, or equivalent modems; requires 1 slot	450	5
KL8-A	4-Channel Asynchronous Interface; partial modem controls on 3 channels and full modem controls on 1-channel, 20-milliampere or EIA interface; requires 1 slot; 50 to 9600 bps	995	18
H312-A	Null Modem Adapter for local EIA devices connected directly to EIA devices	95	2
H313-A	20-Milliampere to EIA Adapter, for all PDP-8's	300	5
DP8-EA	Synchronous Interface; bipolar (EIA) or TTL levels, DMA transfer; requires 2 slots, for Bell 200 series or equivalent modems, maximum of 4 per system; up to 71,000 bps	1,250	11
DP8-EB	Synchronous Interface; similar to DP8-EA above, for Bell 300 series or equivalent modems	2,600	11
KG8-EA	Redundancy Check Option for use with DP8 interfaces; provides VRC, LRC, and CRC checks; requires 1 slot	220	5