

DIGITAL EQUIPMENT CORPORATION

OPTION BULLETIN

COMPONENTS GROUP

MAY 1976

LSI-11, PDP-11/03, and PDP-11V03 Microcomputers



digital

The use of large-scale integration (LSI) technology will take new and existing product designs past a series of traditional barriers—size, weight, packaging, reliability/maintainability and cost.

LSI technology enables DIGITAL to put an N-channel MOS central processor, 4096 (4K) word random-access memory (RAM), vectored automatic priority interrupt logic, real-time clock input, power failure/autorestart logic, and buffered parallel 16-bit input/output port on one 8.5-by-10-inch printed circuit board.

To these LSI-11 features are added an enclosure and power supply (including lights, switches and fan) to produce the PDP-11/03—the LSI-11 in a box.

Expansion of the LSI-11 or the PDP-11/03 is possible by choosing from any of six memory and I/O modules—RAM, PROM/ROM or core memories, serial and parallel I/O interfaces, printed-circuit backplane/card guide assembly—all interfaced to the LSI-11 bus.

LSI modularity means you buy only what you need. You are free to concentrate your expertise, and maximize your profitability, in applying DIGITAL's microcomputer capability to a whole new range of control and processing opportunities.

Choosing either LSI product enables you to offer the newest in the popular DIGITAL PDP-11 family of mini-computers, a family with unparalleled user acceptance. More than 17,000 PDP-11s are in use, the largest number in processing and control applications. Over four years of development and field experience are yours to profit from when you offer LSI microcomputers to your customers.

The wealth of tools available to help integrate the LSI-11 or PDP-11/03 into your product means that you can cut short your development cycle and get to market sooner.

Here's what is available:

- A large, flexible instruction repertoire, including the 400-plus instructions of the basic PDP-11/40.
- A simplified, application-oriented bus structure for maximum ease in handling I/O and memory operations.
- Off-the-shelf, plug-in expansion interfaces.
- Off-the-shelf, plug-in core, RAM, and/or PROM/ROM expansion memories.
- Resident firmware debugging techniques and ASCII console routines.
- Operating system development on standard PDP-11/35, 11/40 or LSI-11.
- Software and hardware training classes.
- Complete documentation, including user's programming and maintenance manuals, configuration and installation guides.
- The unmatched resources of the DECUS library for PDP-11 application programs.

LSI-11 HARDWARE AND FIRMWARE

Microcomputer Module KD11-F

The 16-bit central processor functions are contained in four silicon gate N-channel metal oxide semiconductor (MOS), large-scale integration (LSI), integrated circuit

chips. These chips provide all instructions, decoding, bus control, and arithmetic/logic unit (ALU) functions of the processor. The central processor contains eight general registers which can serve as accumulators, index registers, autoincrement/autodecrement registers, or stack pointers.

4096-by-16 read/write MOS semiconductor memory is contained on the microcomputer module. This memory is composed of LSI dynamic random-access memory (RAM) chips that require little operating power, provide fast access time, and are refreshed automatically by the processor's microcode, which is transparent to the user. A memory register on the KD11-F module addresses all on-board memory plus LSI-11 bus-compatible expansion memory up to 32K words or 64K bytes.

Multiplexed parallel I/O bus port-DMA operation. The LSI-11 bus is a high-speed, 38-line parallel bus containing data, address, control and synchronization lines. Sixteen lines are used for time multiplexing of data and addresses. All data and control lines are bidirectional, asynchronous, open-collector lines capable of providing a maximum parallel data transfer rate of 833K words per second under direct memory access operation.

Powerful PDP-11/40 basic instruction set. More than 400 powerful instructions make up the LSI-11's extensive basic instruction set. There are no separate memory, I/O or accumulator instructions. Thus the user can manipulate data in peripheral device registers as flexibly as in memory registers.

The basic operation code uses both single- and double-operand instructions for words or bytes, making it possible to perform such operations as adding, subtracting, or moving two operands in one step. This can reduce the number of instructions needed for many routines by as much as two-thirds. Much of the LSI-11's operating flexibility and processing power are derived from its wide variety of addressing techniques. Addressing can be direct, indirect, autoincrement, autodecrement, byte or word, indexing and stack-addressing. This flexibility means the LSI-11 can deal with data in the most efficient manner. The general registers can be used interchangeably as stack pointers, accumulators, and index registers. Address modification can be done directly in the general registers.

Extended instruction and floating-point instruction options provide fixed-point multiplication, division, and multiple shifting in single-precision arithmetic as well as floating-point addition, subtraction, multiplication and division.

Single-level, vectored, automatic priority interrupt provides for user-implementation of a priority-structured I/O interrupt system. Devices electrically closest to the microcomputer module receive highest priority, for either DMA or programmed I/O transfers. (DMA devices have a higher priority than programmed I/O devices.) This structure allows nesting of interrupts to as many levels as there are devices connected to the LSI-11 bus. Upon receipt of an interrupt grant, the device directs the processor to an interrupt vector location which contains the starting address of the device interrupt service routine and the new processor status word.

Real-time clock input signal line functions as an external interrupt line. When connected to a frequency source, it can serve as a real-time processor interrupt. A switch on the microcomputer module enables or disables this highest priority interrupt function.

Asynchronous operation of all system modules permits each to function at its highest possible speed.

Power fail/autorestart provides jumper-selective restart through a power-up vector, a defined location, or an octal debugging technique (ODT) microcode.

Power failure is one of a series of errors and programming conditions which will cause the central processor to trap to a set of fixed locations.

Whenever dc power sequencing signals indicate an impending ac power loss, a microcoded power-fail sequence is initiated. The microcomputer traps to location 24 to execute a user's power-down routine. This will make possible an orderly system shut-down.

When power is restored, the processor can execute one of four switched options:

1. The processor traps to location 24 and executes a user-defined power-up routine to restore the machine to its state prior to power failure.
2. Power-up to a defined location in memory.
3. Power-up to the ODT/console firmware routine (this assumes that an I/O interface that responds to the device address is present).
4. Power-up to a microcode bootstrap program (this assumes that the device corresponding to the bootstrap is present).

ODT/ASCII console routine/bootstrap all are resident in microcode to provide automatic entry into the debugging mode, replacement of conventional programmers' panel lights and switches with any terminal device generating standard ASCII codes, and the ability to automatically commence operation through resident bootstrap routines.

Word or byte processing provides very efficient handling of 8-bit characters without the need to rotate, swap, or mask.

8.5-by-10-inch board contains all of these features.

Expansion Memory Modules

4K dynamic random-access memory-MSV11-B is a dual-size (8.5-by-5-inch) read/write memory module utilizing dynamic MOS semiconductor memory devices. The module capacity is 4096 words of 16 bits, with memory-select circuitry for operation on 4K address boundaries. Dynamic memory refresh is performed automatically every 1.67 milliseconds by microcode on the microcomputer module.

4K programmable read-only memory-MRV11-AA is a dual-size (8.5-by-5-inch) field programmable, read-only module utilizing either 256 x 4 or 512 x 4 fusible-link semiconductor devices. The module's maximum capacity

is 2048 or 4096 words of 16 bits (depending upon which device is used), and is expandable in 256- or 512-word increments. This module is configured with 32 sockets for mounting memory IC devices of the user's choice. PROM chips can be supplied as an option. A pin-compatible masked ROM chip is available for volume applications so that the lowest possible cost can be achieved. Board-mounted jumpers enable selection of the module's address.

4K core memory module-MMV11-A is a quad-size (8.5-by-10-inch) core, read/write memory module containing 4096 words of 16 bits, with memory address selection circuitry for starting operation on any 4K boundary. Core memory provides nonvolatile read/write storage for applications requiring protection against power losses.

Interfacing Modules

Serial line unit-DLV11 is a universal asynchronous receiver/transmitter serial interface module for use between the LSI-11 bus and serial devices. It is a dual-size (8.5-by-5-inch) module with the following features:

- Either optically isolated 20mA current loop or EIA interface.
- Selectable baud rates: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600.
- Jumper-selectable stop bits and data bits.
- LSI-11 bus interface and control logic for interrupt processing and vectored addressing of interrupt service routines.
- Interrupt priority determined by electrical position along the LSI-11 bus.
- Control/status register (CSR) compatible with PDP-11 software routines. CSRs and receiver data buffer registers directly accessed via processor instructions.
- Plug, signal, and program compatible with PDP-11 DL 11-C.

Parallel line unit-DRV11 is a general-purpose, 16-bit parallel interface between the LSI-11 bus and the user's peripheral device. It is a dual-size (8.5-by-5-inch) module with the following features:

- 16 diode-clamped data input lines.
- 16 latched output lines.
- 16-bit word or 8-bit byte data transfers.
- Complete device address decoding user-assigned.
- LSI-11 bus interface and control logic for interrupt processing and vectored addressing of interrupt service routines.
- Interrupt priority determined by electrical position along the LSI-11 bus.
- Control/status registers (CSR) compatible with PDP-11 software routines. CSR and receiver data

buffer registers directly accessed via processor instructions.

- Plug, signal, and program compatible with PDP-11 DR11-C.
- Four control lines available to the peripheral device for output data ready, output data accepted, input data ready, and input data accepted logic operations.
- Can be used with TTL or DTL logic-compatible devices.
- Maximum data transfer rate of 90K words per second under program control.
- Maximum drive capability of 25 feet of cable

Backplane/card guide assembly H9270

The H9270 backplane/card guide assembly is a pre-wired LSI-11 structured backplane based on a standard DIGITAL four-by-four slot configuration. The H9270 has the following features:

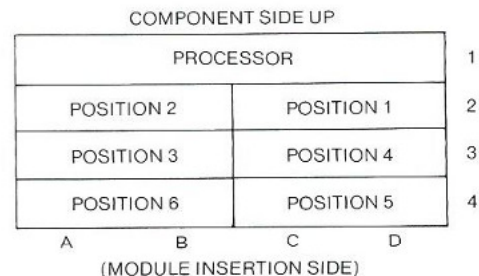
- Designed to accept one microcomputer and up to six I/O and memory modules.
- All LSI-11 bus data, control, and power connections are prewired on the printed circuit backplane to each module location.
- Easily implemented, priority-structured I/O bus system based upon electrical position along the LSI-11 bus. Device priority levels established by a daisy-chained grant signal arrangement for interrupt and DMA requests. Placement of modules into the backplane automatically passes the bus grant signal to the next lower-priority device.
- Backplane integral with card guide assembly.
- Mounting capability in all planes.
- Backplane size 11.15 by 2.8 by 11.0 inches.

LSI-11 BUS

The LSI-11 bus is a simple, fast, easy-to-use interface between LSI-11 modules. All LSI-11 modules connected to this common bidirectional bus structure receive the same interface signal lines. A typical system

application in which the processor module, memory modules, and peripheral device interface modules are connected to the bus is shown in the diagram.

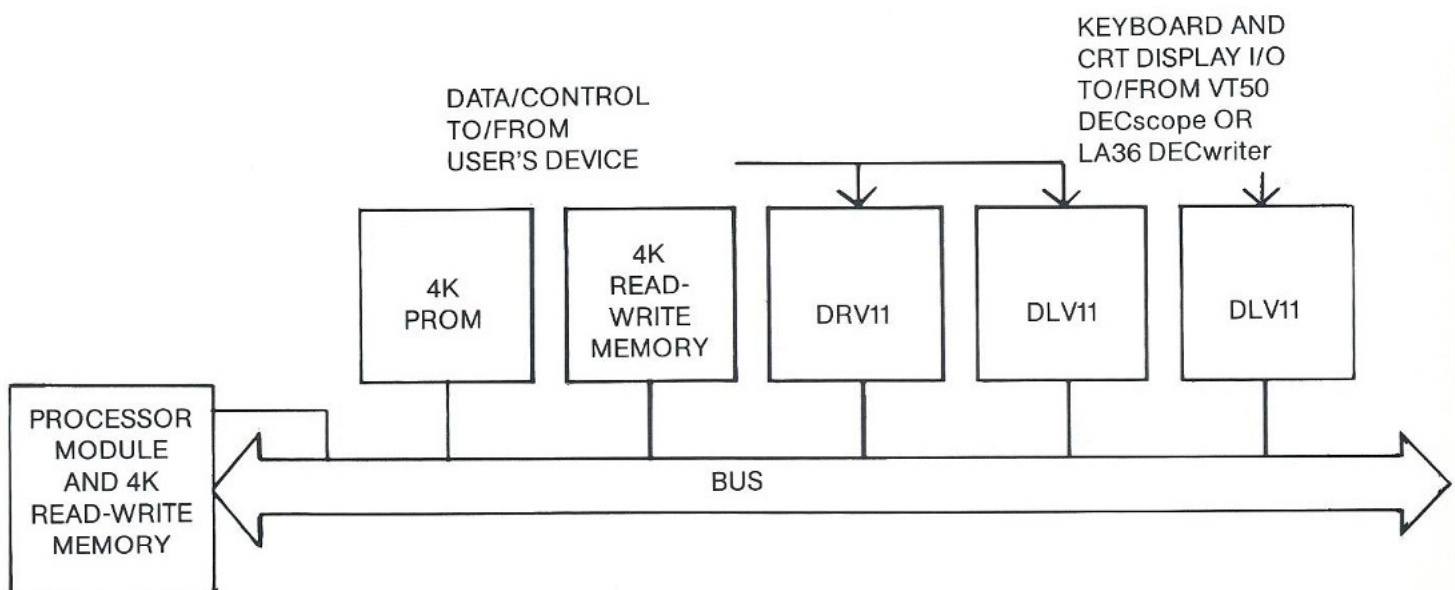
Bus data and control lines are bidirectional open-collector lines that are asserted low. The bus is comprised of 16 data/address lines (BDAL 0-15), and 16 control/synchronization signal lines, and system function lines.



The processor module is capable of driving six device slots (double-height) along the bus without additional termination, as provided with the H9270 backplane. Devices or memory can be installed in any location along this bus, as long as the desired priority order of the devices is maintained.

LSI-11 SOFTWARE

The LSI-11 software consists of a paper tape software (QJV10-AB) operating package available with the LSI-11 as a basic utility package and an Editor, which allows the user to create and modify ASCII source files to be used as input to other system programs; an Assembler, which allows the user to translate assembly language programs into executable machine-coded programs; a Loader, which allows the user to input programs and data from various media into the machine; an On-line Debugging Technique (ODT) Package, which allows the user to debug assembled and linked programs; an Input/Output Executive, which allows the user to control the flow of data to and from devices under program control.



Typical Bus Application

FEATURES

Expansion Memory Modules

4K-by-16 RAM

- ☐ Dynamic MOS devices
- ☐ Refreshed by microcode
- ☐ 4K address boundaries
- ☐ 8.5-by-5-inch PC board

4K-by-16 PROM/ROM

- ☐ Fusible-link devices
- ☐ Pin-compatible with masked ROM devices
- ☐ 256- or 512-word increments

- ☐ 8.5-by-5-inch PC board

4K-by-16 Core

- ☐ Nonvolatile storage
- ☐ 4K address boundaries
- ☐ 8.5-by-10-inch PC board

Backplane/Card Guide Assembly

- ☐ Provides bus structure
- ☐ Mounts microcomputer module and up to six memory and I/O modules
- ☐ PC board backplane
- ☐ Integral card guide assembly
- ☐ Mounts in any of three planes
- ☐ Screw terminal power and ground connections

Interface Modules

Serial Line Unit

- ☐ 20 mA current loop or EIA
- ☐ 13 user-selectable baud rates
- ☐ Jumper-selectable data and stop bits
- ☐ Device decoding and vectored interrupt addressing
- ☐ 8.5-by-5-inch PC board

Parallel Line Unit

- ☐ 16 diode-clamped input lines
- ☐ 16 latched output lines
- ☐ Device decoding and vectored interrupt addressing
- ☐ Transfer rates to 90K words per second
- ☐ 8.5-by-5-inch PC board

Microcomputer Module

- ☐ 16-bit central processor unit
- ☐ 4K-by-16 RAM memory
- ☐ Parallel I/O bus port
- ☐ PDP-11/40 instruction set
- ☐ Maximum rate of 833K words per second for direct memory access transfers
- ☐ Power-fail/autorestart
- ☐ Vectored interrupt
- ☐ Real-time clock input
- ☐ Microcode octal debugging technique routine
- ☐ Microcode ASCII console routine
- ☐ Microcode bootstrap routine
- ☐ Optional fixed- and floating-point arithmetic
- ☐ Word or byte processing
- ☐ 8.5-by-10-inch PC board

MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

LSI-11 Nomenclature	Module Description	Module Dimension	Power Requirements*	
			+5V $\pm 5\%$ **	+12V $\pm 3\%$ **
KD11-F	Microcomputer	10.436 x 8.50 x 0.5"	1.8A (Typ) 2.4A (Max)	0.8A (Typ) 1.1A (Max)
MSV-11B	4K x 16 RAM	5.187 x 8.50 x 0.5"	0.6A (Typ) 1.1A (Max)	0.3A (Typ) 0.6A (Max)
MRV-11AA	4K x 16 PROM/ROM (fully implemented) (4K implemented)	5.187 x 8.50 x 0.5"	0.2A (Typ) 0.4A (Max) 2.8A (Typ) 4.1A (Max)	
MMV-11A	4K x 16 Core	10.436 x 8.50 x 0.9"	3.0A (Stby) 7.0A (Optg)	0.2A (Stby) 0.6A (Optg)
DLV-11	Serial Line Unit	5.187 x 8.50 x 0.5"	1.0A (Typ) 1.6A (Max)	180 mA (Typ) 250 mA (Max)
DRV-11	Parallel Line Unit	5.187 x 8.50 x 0.5"	0.8A (Typ) 1.3A (Max)	

*Preliminary

**At the module connector

SPECIFICATIONS (CONT.)

For all Modules:

Electrical

Input Logic Levels

TTL Logical Low: 0.8Vdc max.

TTL Logical High: 2.0Vdc min.

Output Logic Levels

TTL Logical Low: 0.4Vdc max.

TTL Logical High: 2.4Vdc min.

Bus Receivers and Drivers

Logical Low: 1.1Vdc max. 0.7Vdc max.

Logical High: 1.7Vdc min. 2.7Vdc min.

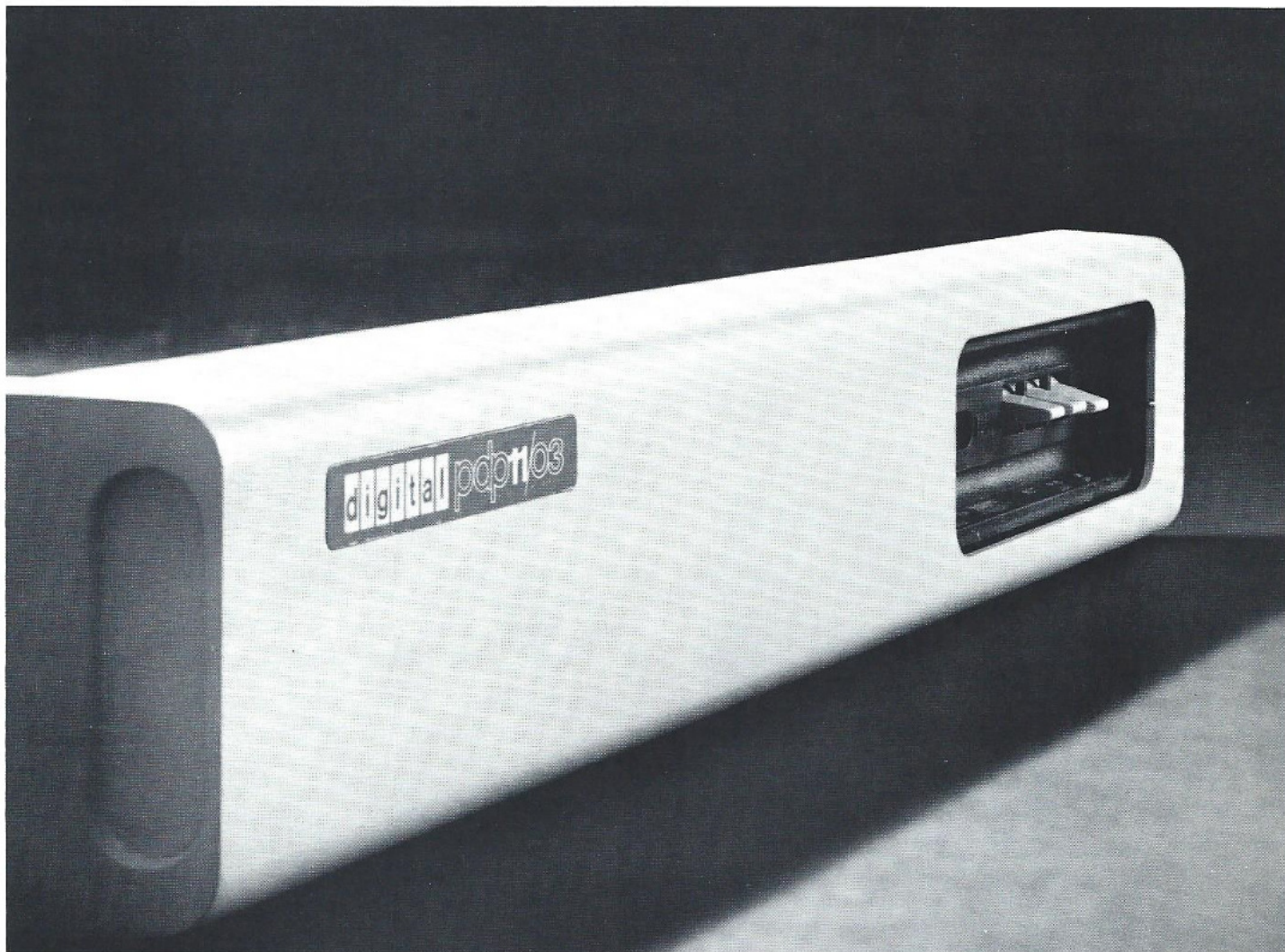
Environmental

Ambient Temperature

Operating: 0 to 50°C (32 to 122°F)

Non Operating: -40 to 66°C (-40 to +150°F)

Humidity: 10 to 95 percent, non-condensing



PDP-11/03

The PDP-11/03 is formed by adding the following elements to the basic LSI-11 microcomputer module: the power supply (including lights, switches and a dual fan assembly); standard rack mountable enclosure measuring 3½ by 19 by 13 inches; H9270 backplane/card guide assembly; DLV11 serial line interface. The 11/03 is available in 4K RAM (115 and 230 volt) and 4K Core (115 and 230 volt) versions. Each is expandable beyond the basic configuration by adding the options currently available as modules with the LSI-11.

The PDP-11/03 is designed with a removable front panel (pop panel). By removing this panel, you expose the LSI modules and cables for easy removal or replacement from the front. The power supply is located on the

right side and has lights and switches attached so that when the front panel is removed, the lights and switches remain functional.

PDP-11/03 Operating Specifications

Temperature	41°F to 122°F
Relative Humidity	10% to 95% (no condensation)
Input Voltage:	
PDP-11/03-AA, BA	90-132 Vac, 115 Vac nominal, 47-63 Hz
PDP-11/03-AB, BB	180-264 Vac, 230 Vac nominal, 47-63 Hz
Input Power:	
PDP-11/03-AA, AB, BA, BB	210 watts max at full load, 190 watts typical at full load



PDP-11V03

The PDP-11V03 is an integrated hardware-software system designed to offer powerful and flexible computation resources at a low price. Development of application-oriented software is a typical assignment for the system among original equipment manufacturers building the LSI-11 board set into their products. The PDP-11V03 consists of a PDP-11/03 with 8K of semiconductor read-write memory, dual-drive floppy disk system, terminator-bootstrap module with DMA refresh, a VT52 DECscope or LA36 DECwriter II input/output terminal, and a caster-mounted cabinet with power distribution panel.

PDP-11V03 Operating Specifications

Temperature	
Operating	15 to 32°C (59 to 90° F)
Nonoperating	-35 to 60° C (-30 to 140° F)
(diskettes, nonoperating)	-35° to 52° C (-30 to 125° F)
Relative Humidity	
Operating	20 to 80%
Nonoperating	5% to 98%, noncondensing
(diskettes)	10 to 80%, noncondensing
Magnetic Field	less than 50 oersteds
Mechanical	
Cabinet size	26" H x 28" D x 21½" W
Weight	205 pounds
Electrical	
Input Voltage	
PDP-11V03-AA	100 to 127 Vac, 60 Hz, ±1 Hz, with VT52
PDP-11V03-EA	100 to 127 Vac, 60 Hz, ±1 Hz, with LA36
PDP-11V03-AD	200 to 254 Vac, 50 Hz, ±1 Hz, with VT52
PDP-11V03-ED	200 to 254 Vac, 50 Hz, ±1 Hz, with LA36
Input Power	940 watts max at full load

MICROCOMPUTER APPLICATIONS

The LSI-11 and PDP-11/03 microcomputers join the remainder of the PDP-11 family's wide variety of applications:

Information Routing

PDP-11s are being utilized as remote data processing terminals reporting to a host computer. By implementing DIGITAL's extensive line of communication products and terminals, the PDP-11 has satisfied a large variety of applications including:

- Remote message transmission/reception
- Remote job entry
- Data processing
- Data concentration
- Fund transfer terminals

Textile Manufacturing

The PDP-11 is being applied to color computing systems. Colors can be matched by this system by spectrally determining the color of a sample and computing the required formula and cost of the matching color. This system is also used to store various color formulas for later retrieval, analyze quality of finished products, and provide inventory control.

Transportation

PDP-11s provide the monitoring and control functions for on-board ship operations. The computer compares actual events with required events (air conditioning, air pressure, water pressure, power, etc.), and performs the necessary closed-loop adjustments. In addition, logs are provided which summarize equipment operation to aid in immediate and preventive maintenance.

Spectral Analysis

The PDP-11 automates a data processing system which provides real-time analysis of narrow band signal spectrum. The system utilizes FOCAL 11 Software for solving complex equations and for interactive on-line or off-line operation.

Hospitals

PDP-11s are the central processors in patient monitoring systems. The computer continuously analyzes electrocardiograms for up to eight patients, displays critical life data for immediate analysis and provides historical patient records.

Utilities

PDP-11s are used in electrical stations to monitor kilowatt flow into the station and out to users and to provide management with peak load curves, line loss measurements, out-of-tolerance voltage/current conditions, and historic information necessary for future planning.

Engineering

PDP-11s control automated drafting systems which facilitate generation, correction, revision, and storage of engineering drawings. The designs are input through digitizers, sketch tables, or other computers. They can then be checked for accuracy and modified. The final print is stored on magnetic tape, plotted, or output to another computer.

Printing

PDP-11s are utilized in a newspaper communication and process control system. By use of a unique multi-tasking, multiprocessing scheme, this system performs a wide range of functions including data entry of editorial advertisements, data storage and editing, typesetting, credit control, and generation of management information.

SERVICE AND WARRANTY

LSI-11 microcomputers are warranted for 90 days.

Return any defective unit during this period and it will be repaired or replaced without charge.

Post-warranty service can be provided in a variety of ways, including complete repair through a local DIGITAL depot, a contract with DIGITAL's Field Service Group, or the purchaser's own service organization, with or without training at DIGITAL.

ORDERING INFORMATION

For further information on DIGITAL component products, contact:

Digital Equipment Corporation, Components Group,
One Iron Way, Marlborough, Massachusetts 01752. Call
800-225-9480 toll-free from 8:30 AM to 5:30 PM our
time*.

In Canada:

Digital Equipment of Canada Limited, P.O. Box 11500,
Ottawa, Ontario, K2H 8K8. Call (613) 592-5111, ext. 154.

In Europe:

Digital Equipment Corporation International (Europe),
81, route de l'Aire, C.P. 340, CH-1211 GENEVE 26.
Call (022) 42 79 50.

*U.S. only. Massachusetts residents please dial (617) 481-7400.



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