Digital's PDP-12 is a complete computer system. It is designed as a simple-to-operate tool for a wide variety of research and real-time data-handling applications.

Performance characteristics of the PDP-12 have been optimized around a complete hardware/software system, rather than around an expandable minimum processor and memory. The PDP-12 system concept works to the advantage of users at all levels of programming sophistication. By simplifying program tasks, the PDP-12 frees users from the mechanics of program preparation to concentrate on more creative aspects of their work.

The following is a brief list of some of the PDP-12's features:

- All new, unified display-based programming system
- Automatic program loading from magnetic tape
- Program debugging hardware
- Seven by nine inch CRT display with graphic and alphanumeric capability
- Large existing library of applications programs
- TTL integrated circuit modules throughout
- LINCTape (addressable bi-directional magnetic tape) for program and data storage
- Free-standing cabinet and console table
Analytical Instrumentation
The PDP-12 can be used to acquire and analyze data from one or more instruments typically used in chemical or physical analysis. Mass spectrometers, gas chromato-graphs, chemical analyzers, NMR spectrometers, and various particle-size counters are a few of the instruments that may be automated through the use of the PDP-12. This application speeds up the process of obtaining the final data, reduces the number of errors, and performs a more thorough and accurate analysis than is possible when computations are done manually. The PDP-12, with its digital and analog input capabilities for handling the instrumentation signals and its relay outputs for instrument control or range switching, helps eliminate the need for complex special interfaces to several classes of instruments. The cathode ray tube display, with its graphic and alphanumeric capability, allows for the effective presentation of not only data and results but operating instructions which make the PDP-12 easy to use, even by the unskilled operator. The establishment of a question and answer dialogue between the computer and operator allows for an interaction not permitted by most small general purpose computers.

Signal Processing
Typical signal processing requirements within the general laboratory involve the manipulation of data through the use of such mathematical tools as averaging, time interval measurements, frequency analysis, and correlation techniques. The PDP-12 is well suited for this type of data acquisition and analysis for many reasons. It has a buffered analog-to-digital converter which allows analog-to-digital conversion to be initiated by an external source, such as a clock, and does not require any intervention on the part of the processor during the actual conversion of the analog signal. The results are then immediately available to the processor within one machine cycle (1½ microseconds). This feature allows the processor to continue doing useful work while the actual analog-to-digital conversion process is independently taking place. The data that is being acquired and processed may be transferred to digital magnetic tape, the operation of which is also completely buffered from the central processor. This allows the program to continue doing its computation while the tape units search for the proper block number and accomplish the transfer of data directly from memory onto magnetic tape, thereby freeing the processor of any tape handling routines. While the buffered CRT display is plotting data on its screen, the processor is free to continue with other tasks.

All these PDP-12 features enhance the machine's throughput capabilities (acquiring and transferring data to some intermediate storage device, such as digital magnetic tape). Throughput rates as high as 75 thousand words per second are possible with burst handling capability up to a maximum of 50,000 words per second. This high throughput capability allows the PDP-12 to handle the majority of signal processing chores encountered in real-time laboratory situations.

A library of programs is available to handle a wide variety of typical signal processing applications, such as data averaging, Fourier analysis, time interval histograms, general data acquisition, as well as programs for scanning data already acquired and placed on magnetic tape.

Education
It has become apparent to educators over the past several years that no discipline remains untouched by the revolution in the computer sciences. The use of computers as problem solving tools (computer extended instruction) is being adopted by universities, junior colleges, and high schools throughout the country. In technical curricula, computer usage is being taught as part of process control courses for chemical engineers, computer science courses for electrical engineers, instrumentation courses for medical students, and laboratory courses for speech students, just to name a few. The computer in these applications is a new and powerful tool to assist in problem solving. The hands-on interactive concept of the PDP-12 makes it particularly well suited for this type of environment. The use of a graphics display through which the machine and operator can communicate, combined with the ease of operation inherent in its design, has put the
PDP-12 and its predecessors, LINC-8 and LINC computers, in the forefront of computer extended instruction in many universities and technical schools around the world. Extending the computer concept slightly further, to such things as computer mediated instruction and guidance testing, brings into focus another ideal application for the PDP-12. Author-like languages and learning programs have already been written on predecessor machines and are available for experimental work in this field. These software packages, plus inexpensive bulk storage via LINCtape, and ease of programming, make the PDP-12 a highly flexible tool for the innovative researcher.

Bio-Medicine

Bio-medical research is an application to which the PDP-12 is ideally suited. In psychological research, operant behavior and related fields it can control experiments, record events, and analyze results. It has the capability of handling data inputs and outputs for such things as reinforcements studies. In experiments where humans or animals are presented stimuli to which they respond by pushing buttons or levers, the computer can be used to analyze these results on-line, using standard statistical techniques. The relay contact outputs, digital signal inputs, and manual sense switch branching capabilities from the console make the PDP-12 a powerful and flexible tool for the psychological researcher. The use of inexpensive magnetic tape storage (LINCtape) for both data and programs, coupled with an existing library of statistical packages, graph plotting packages, as well as interviewing programs, provides an excellent starting point from which other programs may be written, to suit the specific needs of the individual researcher.

In physiological studies, the PDP-12 has the capability of handling both analog and digital signals, providing real-time analysis of the information and control of the experiment from which the data is being derived. Programs for handling EKG, EEG, and evoked potentials have already been written for predecessor machines and exist both within the DEC program library and the Digital Equipment Corporation User's Society Library.

Hospital Systems

In the clinical chemistry laboratory the PDP-12's turn-key system provides better patient care, reduces costs, helps relieve the load on the limited number of technicians, handles more tests, and provides better and faster information to the medical staff. This system interprets and processes data simultaneously from up to 15 analytical instruments. It gives automatic readouts, allows continuous monitoring of the process, files and stores results, and does all of the result calculations. A patient filing system allows an accumulative patient summary to be maintained. The computer is able to keep detailed records on each patient, print out periodic summaries, print out summaries on a particular patient on demand, even while it is logging data. At regular intervals the computer is capable of forwarding billing information based upon the tests performed to the accounting department's computer. This will allow the increased work load and record keeping to be performed without imposing a staggering task on the billing department or cause the hiring of additional personnel. The PDP-12 Clinical Laboratory System pays for itself in time otherwise spent in tedious and time-consuming calculations. Also, the operator needs no special training in computer programming. All interfaces and software are supplied by Digital in one easy-to-use turn-key system.

The PDP-12, with its inherent ease of operation, is an ideal tool for use in patient monitoring and patient interviewing. In the patient monitoring situation, EKG, EEG, respiration, etc. can all be handled by the PDP-12 A/D converter and multiplexer. In patient interviewing, the CRT display allows a question and answer dialogue to be established between the patient and the computer while allowing summary printouts via the Teletype. Programs have already been written on predecessor machines for general medical histories and are actually in use in clinical environments. Many new clinical diagnosis systems are being planned and designed. Cytology, multi-phasic screening, and many other systems will benefit from the flexibility and ease of operation of the new PDP-12, with its inherent data gathering capabilities, utilizing digital and analog inputs, as well as its alphanumeric and graphic display capabilities.
Due to the unique capability of the PDP-12 to execute two complete instruction sets (the LINC instructions and the PDP-8 family of instructions), a substantial amount of field-proven software is immediately available for use on this system. This software consists of the entire library of PDP-8 programs (both systems programs and applications programs). It is also compatible with the LINC and LINC-8 software, especially in regards to their application programs. To simplify the general programming task and to optimize the advantages of a dual order-code system, a special operating system has been developed. This operating system—a unified, display-based system—represents an ultra-powerful, general-purpose assembler, editor, and monitor for both PDP-8 and LINC programming.

Unified Display-Based Operating System
This sophisticated operating system assumes the use of two tape transports and a display as integral parts of the system. The operating system is composed of an editor, an assembler, a monitor, and data-handling routines for performing the typical functions required in program development.

The operating system is normally in the editor mode, awaiting input information that may be entered via the Teletype, magnetic tape, or paper tape. The command structure of the operating system allows simple and straightforward commands to perform operations such as manipulation (adding, changing, or deleting) of manuscripts, filing of information, copying of manuscripts and data, editing, listing, searching, and assembling.

The editor allows editing on a line-by-line or on a character basis by the use of a controllable cursor on the display. The editor allows random access to any character or line being edited in the text, without resorting to any scheme using paging techniques. The assembler is a two-pass program that is called directly via the monitor. The display-based operating system assumes the use of two tape transports and a display as integral parts of the system. The operating system is composed of an editor, an assembler, a monitor, and data-handling routines for performing the typical functions required in program development.

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4K FORTRAN Compiler
The 4K FORTRAN compiler lets the user express problems in a mixture of English words and mathematical statements. It reduces the time needed for program preparation and enables users with little or no knowledge of the computer's organization and operating language to write effective programs. FORTRAN language consists of four general types of statements: arithmetic, logic, control, and input/output. FORTRAN functions include addition, subtraction, multiplication, division, sine, cosine, arctangent, square root, natural logarithm, and exponentiation.

8K FORTRAN Compiler
(requires 8K of memory and high-speed paper tape)
The 8K FORTRAN compiler translates a source program into a symbolic language, and then the symbolic version of the program is translated into relocatable binary code, the language of the computer. The binary code is punched onto paper tape and then reloaded into the computer for running the program. The 8K FORTRAN system features USA Standard FORTRAN syntax; subroutines; two levels of subscripting; function subprograms; input/output
supervisors; relocatable output loaded by the Linking Loader; COMMON statements; I, F, E, A, X, and H format specifications; and arithmetic and trigonometric library subroutines.

The 8K FORTRAN system consists of the two-pass FORTRAN compiler, Linking Loader, Run-Time Monitor, and a library of subprograms. The system requires 8K of core memory, an ASR33 Teletype, and a high-speed paper tape reader and punch. The compiler utilizes all available core to 32K and is page transparent.

FOCAL

FOCAL (FORMula CALculator) is a new conversational JOSS-like calculator and programming language developed by Digital. FOCAL has proven to be a powerful tool for solving complex calculations. Of equal importance is FOCAL's role as a teaching aid. A computer novice can begin doing useful work within a few hours using straightforward, simple English commands. Programs can be checked and modified as they are prepared, and FOCAL will tell what went wrong if an error is made. FOCAL features 14 functions, automatic error tracing, character editing, and the power to solve six-level simultaneous equations. FOCAL is available in three versions — 4K, 8K, and 8K Four User. 4K FOCAL uses field zero to store the FOCAL program, the user's program, and the user's variables. 8K FOCAL uses field zero to store the FOCAL program and the user's variables, and uses field one to store the user's program. This allows for storage of much larger user programs. Four User 8K FOCAL, with the proper hardware to connect four Tele- types, gives four users each the power of 4K FOCAL from one computer.

Signal Averaging Program

Signal Averaging Program (requires DW12 and AX08 peripherals) allows for handling of up to 1024 data points per epoch (sweep) and the averaging of this data over a maximum of 4096 sweeps, thus providing a technique for obtaining a valid signal from a noisy environment. Computation of standard deviation, confidence levels, and trend, plus calibration and plotting routines, are included. A dialog is established between the user and the set-up program with the system CRT display and Teletype.

Floating Point Packages

Floating point packages permit the PDP-12 to perform arithmetic operations that could not otherwise be done without the addition of costly hardware. In addition to increasing accuracy, floating point operations relieve the programmer of scaling problems common in fixed-point operations. This is a particular advantage to the inexperienced programmer. The floating point subroutines and interpreters permit the programmer to encode arithmetic operations to either 6 or 10 decimal digits of precision as easily as though the machine had floating point hardware. The operations implemented by the floating point packages include addition, subtraction, multiplication, and division. Other functions in the package are sine, cosine, square root, logarithms, arctangent, and exponentiation.

Signal Averaging Program — simulates a simplified model of the basilar membrane in the inner ear.
Fixed-Point Mathematical Routines
The PDP-12 program library maintains a set of mathematical function routines which perform the following operations in both single and double precision: addition, subtraction, multiplication, division, square root, sine, cosine, arctangent, natural logarithm, and exponentiation. A library of analytic procedures is available which makes readily programmable trigonometric functions, logarithm operations, and procedures such as analysis of variance or fast Fourier transform.

DATA PROGRAMS
(require PDP-12A LINC system)
DATA-12 — This program retrieves, displays, and stores individual data blocks from magnetic tape and provides the user with a repertoire of mathematical operations for manipulating this data. These operations include high and low pass filtration, differentiation and integration, attenuation and amplification, inversion, addition of a constant, and plotting of a bar graph. The data or resulting waveforms are continuously displayed.

FRQANA — This program performs a frequency analysis of 512 points of data and resolves the resulting spectrum into 64 components. The sine, cosine, and rms spectra are subsequently displayed and can be scaled. A resynthesis from the spectra can then be performed to provide a comparative display of the original data and the resynthesized waveform.

CURSOR — This program will display on the scope the signal samples from a designated analog input channel or data read into core memory from magnetic tape. Two data files, each 256 points in length, can be handled by CURSOR. A movable cursor, controllable from the front panel, is used to examine the data and display the absolute value of the amplitude.

GRAPHA — This program allows data to be retrieved from magnetic tape and displayed, as well as a graph to

FRQANA Data Program
CURSOR Data Program
be composed for this data with appropriate lettering and axes. The graph is assembled on the display and the finished product may be photographed, plotted on an incremental plotter, or saved on magnetic tape for future reference.

MAGSPY — This program provides a moving window for scanning data stored on digital magnetic tape. The data is displayed on the scope and can be scanned at a rate determined by a potentiometer setting. The data can be interpreted either as binary numbers or packed characters.

Utility Programs
A number of utility programs are supplied with the PDP-12. They include programs to provide printouts or punchouts of core memory content in octal, decimal, or binary forms, as specified by the user. Subroutines are provided for octal or decimal data transfer and binary-to-decimal, decimal-to-binary, and Teletype tape conversion. Other utility packages include:

Isometric Plot Subroutine — These programs provide for plotting a function of two variables, f(x, y), isometrically on a digital plotter.

Message Display Subroutine — This is a basic subroutine for displaying lines of text on the scope. It is self-contained, with matrices for all digits, letters, and special characters.

Question and Answer Subroutine — This is a general subroutine used to display a page of text on the scope. Question marks may be displayed and replaced with responses from the keyboard. The information entered in this manner may be recovered by a subsequent portion of the user’s program.

Maintenance Programs
A complete set of standard diagnostic programs simplifies and expedites system maintenance. Program descriptions permit the user to test effectively the operation of the computer for proper core memory functioning and proper execution of instructions. Diagnostic programs are provided to check the performance of standard and optional peripheral devices.
The PDP-12 is a single processor computer system which executes instructions from either of two order codes. The PDP-12 directly executes programs written for the PDP-8 or LINC computer systems.

The PDP-12 combines a totally new hardware organization with advanced system software to make optimal use of its hardware capabilities. Processor control is switched between modes by a single instruction or by console action. All instructions or console functions are directly executed by hardware.

The PDP-12 is a faster, more powerful, and less expensive successor to the LINC-8. Its totally redesigned tape units, display, analog-to-digital converter, and prewired real-time clock offer many new benefits while maintaining program compatibility with previous systems. The input/output bus is compatible with most integrated circuit levels. It operates directly from either processor mode and is identical to those on the PDP-8/L and PDP-8/1.

**PDP-12 features:**
- 4096 words, 12-bit core memory with 1.6 microsecond cycle time
- Full power processor prewired for the addition of a large number of options and peripherals
- Low-cost core memory expansion to 32,768 words, low-cost mass storage with DECdisks, and IBM-compatible synchronous and incremental magnetic tape
- Worldwide, dependable field service
- Over 4,000 compatible PDP-8, LINC, and LINC-8 family computers in use for sharing programs through Digital’s users group (DECUS)
- Single cycle and three cycle direct memory data break facilities, standard
- All active registers continually displayed
- Signed multiple instruction, standard
- Fifteen auto-index registers, standard
- LINC feature to facilitate multiple precision arithmetic
- Both two’s complement and one’s complement arithmetic
- 24-bit console switch register
- Six sense switches
- Complete with thirty inch free-standing cabinet, console table, ASR33 teleprinter including paper tape reader and punch
- Twelve digital sense line inputs, standard
- Six single-pole double-throw relay outputs

**ELECTRICAL**
- Power requirements:
  - 15 amperes, average, at 115 volts, 60 cycles single phase.
  - (Other line voltage and frequency ratings are available)
- Power requirements:
  - Under 2 kilowatts
- I/O bus levels:
  - Ground and +3 volts

**PHYSICAL**
- Standard cabinet size:
  - 71" high, 33" wide, 35" deep (including console)
- Table:
  - 30" wide, 20" deep
- Teletype size:
  - 33" high to top of console, 22 1/4" wide, 18 1/2" deep
- Weight:
  - 700 lbs.

**ENVIRONMENTAL**
- Temperature:
  - 40°F to 105°F ambient
- Humidity:
  - 20-80%
### LINC INSTRUCTION FORMATS

#### LOGICAL OPERATIONS

<table>
<thead>
<tr>
<th>Code</th>
<th>Mnemonic</th>
<th>Function</th>
<th>Time (μsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1540</td>
<td>BCL</td>
<td>Bit clear (any combination of 12-bits, logical AND)</td>
<td>3.2</td>
</tr>
<tr>
<td>1600</td>
<td>BSE</td>
<td>Bit clear (any combination of 12-bits, inclusive OR)</td>
<td>3.2</td>
</tr>
<tr>
<td>1640</td>
<td>BCO</td>
<td>Bit complement (any combination of 12-bits, exclusive OR)</td>
<td>3.2</td>
</tr>
<tr>
<td>0017</td>
<td>COM</td>
<td>Complement AC</td>
<td>3.2</td>
</tr>
</tbody>
</table>

#### SKIP

Skip next instruction if:

<table>
<thead>
<tr>
<th>Code</th>
<th>Mnemonic</th>
<th>Function</th>
<th>Time (μsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1440</td>
<td>SAE</td>
<td>AC equals memory register Y</td>
<td>3.2</td>
</tr>
<tr>
<td>1400</td>
<td>SNS</td>
<td>Right half AC unequal to specified half of memory register Y</td>
<td>3.2</td>
</tr>
<tr>
<td>0440</td>
<td>N SNS</td>
<td>Sense switch N is set</td>
<td>3.2</td>
</tr>
<tr>
<td>0590</td>
<td>AZF</td>
<td>AC equals block on tape</td>
<td>3.2</td>
</tr>
<tr>
<td>0451</td>
<td>APO</td>
<td>AC contains positive number</td>
<td>3.2</td>
</tr>
<tr>
<td>0452</td>
<td>LZE</td>
<td>Link bit equals 0</td>
<td>3.2</td>
</tr>
<tr>
<td>0400</td>
<td>SXL</td>
<td>External level N is present</td>
<td>3.2</td>
</tr>
<tr>
<td>0415</td>
<td>KST</td>
<td>Keyboard has been struck</td>
<td>3.2</td>
</tr>
<tr>
<td>0454</td>
<td>FLO</td>
<td>Add overflow is set</td>
<td>3.2</td>
</tr>
<tr>
<td>0405</td>
<td>QLZ</td>
<td>Bit 11 of MQ register equals 1</td>
<td>3.2</td>
</tr>
<tr>
<td>1500</td>
<td>SRO</td>
<td>Rotate memory register right one place, then if bit 11 of Y equals 0 skip next instruction</td>
<td>3.2</td>
</tr>
<tr>
<td>0453</td>
<td>IBZ</td>
<td>Between blocks on mag tape</td>
<td>3.2</td>
</tr>
<tr>
<td>0446</td>
<td>SKP</td>
<td>Unconditional skip</td>
<td>3.2</td>
</tr>
<tr>
<td>0200</td>
<td>XSK</td>
<td>Index memory register Y, skip when contents of Y equal 1777</td>
<td>3.2</td>
</tr>
<tr>
<td>0416</td>
<td>STD</td>
<td>Tape instruction done</td>
<td>3.2</td>
</tr>
<tr>
<td>0417</td>
<td>TWI</td>
<td>Tape word completed</td>
<td>3.2</td>
</tr>
</tbody>
</table>

#### INPUT-OUPUT

<table>
<thead>
<tr>
<th>Code</th>
<th>Mnemonic</th>
<th>Function</th>
<th>Time (μsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0014</td>
<td>ATR</td>
<td>AC to relay buffer</td>
<td>1.6</td>
</tr>
<tr>
<td>0015</td>
<td>RDC</td>
<td>Relay buffer to AC</td>
<td>1.6</td>
</tr>
<tr>
<td>0109</td>
<td>SAM</td>
<td>Sample analog channel N</td>
<td>1.6</td>
</tr>
<tr>
<td>0140</td>
<td>DIS</td>
<td>Display point on oscilloscope</td>
<td>1.6</td>
</tr>
<tr>
<td>1740</td>
<td>DSC</td>
<td>Display character on oscilloscope</td>
<td>1.6</td>
</tr>
<tr>
<td>0516</td>
<td>RSW</td>
<td>Right switch register to AC</td>
<td>1.6</td>
</tr>
<tr>
<td>0517</td>
<td>LSW</td>
<td>Left switch register to AC</td>
<td>1.6</td>
</tr>
<tr>
<td>0520</td>
<td>POP</td>
<td>Transfer to PDP-8 program control</td>
<td>1.6</td>
</tr>
<tr>
<td>0600</td>
<td>IOB</td>
<td>Execute input-output Bus xfer</td>
<td>1.6</td>
</tr>
</tbody>
</table>

#### MEMORY

<table>
<thead>
<tr>
<th>Code</th>
<th>Mnemonic</th>
<th>Function</th>
<th>Time (μsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0702</td>
<td>RDE</td>
<td>Read one block into memory</td>
<td>3.2</td>
</tr>
<tr>
<td>0703</td>
<td>RDC</td>
<td>Read and check one block</td>
<td>3.2</td>
</tr>
<tr>
<td>0704</td>
<td>RCG</td>
<td>Read and check N consecutive blocks</td>
<td>3.2</td>
</tr>
<tr>
<td>0705</td>
<td>WRC</td>
<td>Write and check one block</td>
<td>3.2</td>
</tr>
<tr>
<td>0706</td>
<td>WCI</td>
<td>Write and check N blocks</td>
<td>3.2</td>
</tr>
<tr>
<td>0707</td>
<td>CHK</td>
<td>Check one block of tape</td>
<td>3.2</td>
</tr>
<tr>
<td>0708</td>
<td>MBM</td>
<td>Move tape toward selected block</td>
<td>3.2</td>
</tr>
<tr>
<td>0001</td>
<td>AXO</td>
<td>AC to Ext. operations buffer</td>
<td>1.6</td>
</tr>
<tr>
<td>0002</td>
<td>XQA</td>
<td>Ext. operations buffer to AC</td>
<td>1.6</td>
</tr>
<tr>
<td>0003</td>
<td>TAC</td>
<td>Tape AC register to AC</td>
<td>1.6</td>
</tr>
<tr>
<td>0023</td>
<td>TMA</td>
<td>AC to tape control register</td>
<td>1.6</td>
</tr>
</tbody>
</table>

#### LINC TAPE

<table>
<thead>
<tr>
<th>Code</th>
<th>Mnemonic</th>
<th>Function</th>
<th>Time (μsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>HLT</td>
<td>Halt</td>
<td>1.6</td>
</tr>
<tr>
<td>0016</td>
<td>NOP</td>
<td>No operation</td>
<td>1.6</td>
</tr>
<tr>
<td>0011</td>
<td>CLR</td>
<td>Clear AC and Link</td>
<td>1.6</td>
</tr>
<tr>
<td>0040</td>
<td>SET</td>
<td>Set register N to contents of register Y</td>
<td>1.6</td>
</tr>
<tr>
<td>0001</td>
<td>JMP</td>
<td>Jump to register Y (IK address)</td>
<td>1.6</td>
</tr>
<tr>
<td>0006</td>
<td>DJR</td>
<td>Disable JMP return</td>
<td>1.6</td>
</tr>
<tr>
<td>0004</td>
<td>ESF</td>
<td>AC to spec. fctn. register</td>
<td>1.6</td>
</tr>
<tr>
<td>0024</td>
<td>SFA</td>
<td>Spec. fctns. register to AC</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The following instructions are used in the LINC mode. The LINC Order Code is built on eleven basic functions as shown in the list that follows.
The concept of a useful computer system as embodied by the PDP-12 means the optimization of the systems hardware and software around a specific set of input/output devices. These devices include two magnetic tape transports, a large screen CRT display, an analog-to-digital converter and multiplexer, as well as relay closure outputs and sense line inputs. The ability to handle this specific set of input/output devices is designed into the basic instruction set of the PDP-12 and is not considered part of the general I/O bus facility, but rather an integral part of the system. This allows more efficient handling of information to and from the user devices.

LINCTape Control TC12 and TU55 Transports

Digital's PDP-12 LINCTape control is a totally independent tape processor which operates directly into memory on a cycle-stealing basis with the central processor. This system provides an addressable magnetic tape facility for high-speed loading, read-out, and program updating. A maximum LINCTape configuration with eight TU55 transports, each carrying a tape of standard format to take 131,000 words, can provide over one million words of rapidly accessible storage to the PDP-12. All LINCTape instructions are directly executed by the TC12 control. The user may choose to have programming proceed or pause during tape transfers, which occur at the rate of one 12-bit word every 100 microseconds.

The LINCTape instruction set includes instructions to read, write, and check individual blocks or groups of tape blocks. Each instruction is complete. The tape control does all searching, as well as actual data transfers, without program intervention or the use of memory locations for word count and current address counters.

In addition to the defined LINCTape instructions, an extended addressing mode is provided which allows up to 2048 blocks of any length to be transferred, beginning with any program specified core location. This provides for a maximum of over 200,000 12-bit words per reel of tape.
A controller option TC12-8 is available which allows the PDP-12 to read or write DECtape. This allows for the transfer of data for the purposes of moving information from DECtape to LINCtape, and vice versa, to provide compatibility with other DECtape units on other machines.

**LINC Scope Control VC12 and VR12 Display**

The PDP-12 display system offers the user direct interaction with a small computer in a way previously unobtainable at a reasonable price.

The VR12 point plotting display offers an 11” diagonal viewing surface (58.5 square inches). The very bright P31 Phosphor allows viewing under normal ambient lighting conditions.

The VC12 buffered display control makes optimal use of the features of the VR12 display scope. The character display instruction (DSC) allows up to 400 characters to be displayed flicker-free in two preset sizes. The display control has its own buffer registers and allows the computer program to continue after initiating the display instruction.

The D/A converter outputs of the display control are buffered, and are capable of driving cables up to 200 feet in length. Two independent intensity channels allow two simultaneous displays to be driven from the same computer on two separate scopes.

**Analog-to-Digital Converter and Multiplexer, AD12**

The analog-to-digital converter (AD12) includes 16 channels of input through an FET-switched multiplexer which drives a sample and hold circuit. The sample and hold output is converted by the 10-bit A/D converter which is controlled by the LINC mode SAM instruction. Eight of the 16 input channels go directly to the potentiometers which are used by numerous programs as parameter inputs. The remaining eight channels go to differential preamplifiers which provide an input range of ±1 volt and an input impedance of 70K ohms. The common mode rejection of the preamplifiers is nominally 50 and will pass signals up to 60 KHz. The preamplifiers provide 10,000 per cent overload protection with microsecond recovery speeds.
The convert time, including multiplexer selection, sample and hold, and conversion, is approximately 19 microseconds. There are two programmed modes of operation in which the converter gives the user the option of pausing until conversion is complete or continuing on with programming.

The multiplexer and preamplifier can be expanded to a total of 32 channels with the addition of the AM12 multiplexer switches and AG12 preamplifiers.

Relay Buffer KD12
The KD12 relay buffer contains a 6-bit register connected to six SPDT relays located on the data terminal panel. These relays can be used for controlling experiments or external equipment. The relay buffer is loaded from the accumulator and may be interrogated in a similar fashion. The contact rating is two amperes at 28 VDC. One ampere at 110 VAC is also acceptable. Contact closure time is approximately 20 milliseconds.
The PDP-12 has a complete line of peripherals identical to those offered for Digital Equipment Corporation's PDP-8/I and PDP-8/L. Included are two random access DECdisks, a high-speed paper tape reader and punch, synchronous and incremental IBM-compatible magnetic tape, incremental plotter, data communications equipment, and card readers. All of these are easily interfaced to the PDP-12 in the factory or in the field.

Extended Memory, MC12 and MM8/I
Core memory for the PDP-12 is expanded inexpensively by the addition of up to seven memory modules of 4096 words each. The first memory expansion, MC12, is designed for mounting within the PDP-12 central processor. It requires no additional rack space, and up to six additional 4096-work memory modules (MM8/I's) can be added to the PDP-12, external to the central processor. The memory cycle time is nominally 1.6 microseconds.

Real-Time Clock, KW12
The KW12 real-time clock is designed to solve a wide range of programming requirements. The clock consists of a crystal time base which delivers pulses from a 400 KHz source at the rate of 400 KHz, 100 KHz, 10 KHz, 1 KHz, or 100 Hz. One of these five time bases, or an external signal, can be used to count the 12-bit clock register. A second clock buffer register is used in conjunction with the clock register to provide the following three methods of operation:

- **Time of day** — the clock register counts at the time base rate. Upon a computer signal, the clock is transferred to its buffer and read into the accumulator. The clock register also provides an overflow flag.
- **Preset counter** — the buffer is loaded with a preset number from the accumulator. When a clock overflow occurs, the overflow flag is set, the buffer is transferred to preset the clock, and the clock continues to count.

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**peripherals**

1. TU20 Industry Compatible Magnetic Tape Transports
2. Calcomp Plotter
3. KS935 Teletype
4. CRT Card Reader and Control
5. Interface Modules
6. PC12 High Speed Perforated Tape Reader and Punch
7. DF32 DECdisk Random Access Disk File
8. Bell Dataphone (interfaced by a DP12B)
9. PDP-12 Single Processor Computer System
10. TU55 Transport
11. ASR33 Console Teletype
12. AF01 A/D Converter System
13. TR02 Point Plotting Display
14. TR02 Incremental Tape Control
15. AX08
16. LP12 High-Speed Line Printer
17. Houston Complot
External event timer — the clock counts as in the time-of-day mode. On an external event, the clock is transferred to the buffer and the flag is set. The program can then pick up the time of event from the buffer while the counter continues to run. External signals can also be used to clear the counter. There are three such input channels.

Incremental Plotter Control, XY12
Incremental plotter control XY12 operates one of four models of incremental plotters for 30 inch, 12 inch, or 11 inch paper, and for step sizes of .01 inch or .005 inches. All recording (discrete points, continuous curves, or symbols) is accomplished by the incremental stepping action of the X and Y axes in any one of eight directions. Instructions are used to raise or lower the pen carriage. XY12 plugs directly into the PDP-12, requires no external mounting hardware, and provides a connector that is compatible with either Houston Complot or Calcomp Plotters.

DECdisk Random Access Disk File, DF32
The DECdisk type DF32 is a low-cost, random-access, bulk-storage device and control with a capacity of 32,000 words. Average access time is 16.7 microseconds for 60 cycle operation and the transfer rate is 66 microseconds per word. The DF32 can economically expand the memory capacity of the PDP-12 by providing up to 131,072 words of additional storage using three expander DS32 disks. Data is transferred through the three-cycle data break system and uses the DW08A I/O conversion panel option of the PDP-12.

Disk, RS08 and Controller, RF08
Each RS08 Disk and RF08 Controller combination provides storage of 262,144 13-bit words (12 bits plus parity). Four RS08 Disks can be driven by one controller, for a maximum capacity of 1,048,576 words. Data transfer rate on 60-cycle power is 16.7 microseconds per word, and 20 microseconds per word on 50-cycle. Data is transferred through the 3-cycle data break system and I/O conversion panel of the PDP-12. Average access time with a 60-cycle disk is 16.7 milliseconds or 20 milliseconds at 50-cycle power. The RF08 requires the DW08A I/O conversion panel.

Incremental Tape Control, TR02 and Transports
The TR02 control unit transfers data under program control, between the PDP-12 and incremental tape transports. Transports are available for incremental write only or for incremental write and synchronous read. IBM-compatible 7 or 9-channel formats are available with densities of 200, 556, and 800 bpi. The interface requires no operator control and is expandable to control two tape transports. The tape transport's reading speed is 25 inches per second. The incremental writing rate operates at up to 700 steps per second. Tape reels are 8½ inches in diameter. The TR02 interfaces directly to the positive I/O bus of the PDP-12.

Card Reader and Control, CR12
The CR12 card reader handles standard 12-row, 80-column punched cards at 200 cards per minute, in either alphanumeric or binary mode. Cards are read by column beginning with column one. The CR12 requires the BA12 option expander panel.

High Speed Perforated Tape Reader and Punch, PC12
The PC12 includes the PR12 high speed reader and PP12 paper tape punch. It requires the BA12 option expander panel. The high speed reader is valuable as a program-
ming aid or data input device because of its rapid read-in
of perforated tapes. It photoelectrically senses 8-channel,
fanfold, perforated tape at 300 characters per second. The
companion paper tape punch operates at 50 cps. Both
include hoppers for handling fanfold tape, and both the
reader and punch are available separately.

AX08
The AX08 integrates in one piece of electronic hardware
a 9-bit analog-to-digital converter, preamplifiers, multi-
plexer, sample-and-hold, converter, timing error flag, Schmitt
triggers, crystal-controlled and RC clocks, two
12-bit registers, display control, and power supply. To-
gether with a special programming package, the AX08 is
intended to enhance the signal averaging capability of the
PDP-12 general purpose computer system. It requires
the DW12 I/O expander panel.

Other peripherals include:
- Industry Compatible Magnetic Tape Transports TU20
  and Automatic Magnetic Tape Control TC58
- High-Speed Line Printer LP12 — 300 LPM, 132 columns
- General Purpose A/D Converter Systems
  AF01 — selectable accuracy 6-12 bits with up to 64
  multiplexed channels
  AF04 — guarded, scanning IDVM, 5uv resolution and
  auto-ranging features. 140 db CMR
  AM08 — analog multiplexer for up to 1024 channels
- Digital-to-Analog Converter AA01 and Control AA05
- Data Communications Systems
  IBM 360 Data Link DX36
  Additional Serial Line (TTY) Interface DP12
  Multiple Teletype System DC02
- Interface Modules
- Special Systems
- Peripheral Expander Panel
- I/O Bus Converter
- Power Failure and Turn-on Detection
- Teletypes

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The Digital Equipment Computer Users Society (DECUS)
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NEW YORK OFFICE: Suite 21-71 Grand Avenue, Palisades Park, New Jersey 07650 Telephone: (201) 841-2016 or (212) 594-5065 TWX: 710-992-9314
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PRINCETON OFFICE: Route One and Emmos Drive, Princeton, New Jersey 08540 Telephone: (609) 262-5940 TWX: 510-695-2337
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PHILADELPHIA OFFICE: 1100 West Valley Road, Wayne, Pennsylvania 19087 Telephone: (215) 887-1405 TWX: 510-988-4461
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CHAPEL HILL OFFICE: P.O. Box 1158, Chapel Hill, North Carolina 27514 Telephone: (919) 929-4065
HUNTSVILLE OFFICE: Suite 41 - Holiday Office Center 3022 Memorial Parkway S.W., Huntsville, Ala., 35801 Telephone: (205) 881-7730 TWX: 810-726-2122
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ATLANTA OFFICE: Suite 116, 1700 Commerce Drive, N.W., Atlanta, Georgia 30318 Telephone: (404) 351-2822 TWX: 910-751-3351
KNOXVILLE OFFICE: Digital Equipment Corporation 531 Lyons View Dr. S.W., Knoxville, Tenn. 37919 Telephone: (615) 559-6571 TWX: 910-887-0123

CENTRAL

ANN ARBOR OFFICE: 3633 Research Park Drive, Ann Arbor, Michigan 48105 Telephone: (313) 761-1159 TWX: 810-222-6853
MINNEAPOLIS OFFICE: Digital Equipment Corporation 15016 Minnetonka Industrial Road Minnetonka, Minnesota 55343 Telephone: (612) 465-1744 TWX: 910-676-2618
CLEVELAND OFFICE: Park Hill Bldg., 3104 Euclid Ave. Willoughby, Ohio 44094 Telephone: (216) 494-8000 TWX: 810-427-2608
ST. LOUIS OFFICE: Suite 110, 115 Progress Parkway, Maryland Heights St. Louis, Missouri 63042

ENGLAND

READING OFFICE: Digital Equipment Co., Ltd. Ardwight Road, Reading, Berkshire, England Telephone: Reading 65131 Telex: 84307
MANCHESTER OFFICE: 13/15 Upper Precinct, Walkden Manchester, England M8 5AZ Telephone: 081-700-4515/2 Telex: 689808
LONDON OFFICE: Digital Equipment Co. Ltd. Hill House, Uttridge Road, Ealing, London, W.5 Telephone: Reading 65131 Telex: 843227
FRANCE

PARIS OFFICE: 255 Rue de Charenton, Paris 12, France Telephone: 344-70-46 TWX: 21330

BELGIUM

THE HAGUE OFFICE: Digital Equipment N.V. Koninginneplein 65, The Hague, Netherlands Telephone: 639660 Telex: 93263

SWEDEN

STOCKHOLM OFFICE: Digital Equipment Norden AB Vetenmägg 2, Sollna 1, Stockholm, Sweden Telephone: 8 13 90 Telex: Digital Stockholm 17650 Cable: Digital Stockholm

INTERNATIONAL

AUSTRALIA

MELBOURNE OFFICE: Digital Equipment Australia Pty. Ltd., 56 Park Street, South Melbourne, Victoria, 3205 Telephone: 656-142 Cable: A93073
WESTERN AUSTRALIA OFFICE: 60 Quinlan Street, West Perth, Western Australia 6005 Telephone: 23-2191 Telex: A92140

BRISBANE OFFICE: Digital Equipment Australia Pty. Ltd., 136 Morocco Street, South Brisbane, Queensland 4000, Australia Telephone: 44947 Telex: A9055316

JAPAN

TOKYO OFFICE: Rika Trading Co., Ltd. (sales only) Kozat-Sakaikidai Bldg. No. 16-14, Nishishimbashi 1-chome Mibuku, Tokyo, Japan Telephone: 5912426 Telex: B14200

KOBE OFFICE: Digital Equipment Corporation International (engineering and services) Fukuysashi Building, No. 2-6, Roppongi 2-Chome, Minato-ku, Tokyo Telephone: 585-8624 Telex No.: 0242-2050

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