- A new dimension is added to laboratory computer technology—a two-color display at a low cost.
- Utilizes the PDP-11 central processor; the world's most popular 16-bit computer.
- Its award-winning UNIBUS architecture provides flexible and dynamic system growth.
- System can be custom tailored to include analog-to-digital converters, a real time clock with a Schmitt Trigger, color display, and many other options.
- Powerful expandable software to match all hardware configurations.

LAB11

digital

H945 Laboratory Data Panel

- Low cost general purpose Laboratory Cabinet
- Extremely modular; implement only the required options
- NIM-dimensionally compatible
- Table top or rack mounted versions
- All parameter knobs, A/D connectors, real time clock and Schmitt Trigger knobs easily accessible at the front panel
- Mobile around the Laboratory

LAB11

The Lab 11 is the newest member of Digital Equipment Corporation's expanding family of computer systems for laboratory applications. The Lab 11 incorporates Digital's award winning 16-bit PDP-11 processor into a complete laboratory data system including processor, analog-to-digital converter, real-time clock, color display and high speed paper tape reader and punch. The development of the Lab 11 complements Digital's highly successful PDP-12 and Lab 8/e, small scale computers for laboratory applications.

All computer system components and peripherals communicate with one another on a single high-speed data bus known as the UNIBUS™. Communication on the UNIBUS is bidirectional and asynchronous—devices can send, receive and exchange data independently without processor intervention. For example, a CRT display can refresh itself from a disk file while the CPU attends to other tasks.

Devices on the UNIBUS are addressed in the same manner as core memory. Because of this device and memory similarity, special I/O instructions are not required. This not only greatly simplifies programming, but adds a new dimension by allowing the entire PDP-11 instruction set to be used relative to I/O operations.

The asynchronous character of the UNIBUS makes it compatible with devices operating over a wide range of speeds. No matter how much processor or memory speeds may vary in the future, the interface built today will operate on tomorrow's PDP-11's. And, because bus-data handling speed is much greater than memory, techniques permit device-to-device data transfers at 2,500,000 words per second, without the need for special multiplexers.

Any number of external devices may be attached to the UNIBUS. The PDP-11 is infinitely expandable and infinitely variable. Standard interfacing modules are available, making the addition of peripherals "plug-in simple". PDP-11 flexibility lets the user design a system exactly tailored to his needs—from a small single-application, dedicated machine to a large, multi-user system with big computer power. Turnkey or timeshare, all are possible with the PDP-11. In addition to providing the ultimate in computer flexibility, Digital can furnish a complete line of compatible I/O devices for any laboratory application.

Hardware

```
PDP-11/20        MM11            KW11-P
                 CORE MEMORY     REAL
                                 TIME CLOCK
```
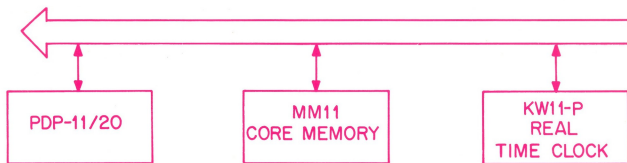
ASYNCHRONOUS DATA BUS
Unique UNIBUS construction
eliminates timing problems; no clocks,
pulse widths, transit times, or rise times
to worry about; makes expansion plug-
in simple.

EIGHT GENERAL-PURPOSE
REGISTERS
Greater programming flexibility;
registers can serve as accumulators,
address pointers, autodecrement or
increment pointers and as index
registers.

HARDWARE STACKS
Previously available only in large-scale
computers; stacks (Last-In, First-Out
Lists) permit reentrant subroutines and
automatic nesting of subroutines and
interrupts; convenient storage of
temporary data; improved speeds and
efficiencies.

BIT/BYTE/WORD/MULTI-WORD
HANDLING CAPABILITY
Bits and bytes handled as easily as
words; allows dramatic savings in
memory. Efficient double-and-triple-
precision arithmetic capability.

MULTI-LEVEL HARDWARE INTERRUPT
WITH UNLIMITED SUBLEVELS
Fully vectored interrupts; no device
polling required. Many devices can be
attached on each line; permits low-cost
system expansion. Lets the UNIBUS
act as a multiplexer. Devices may
interrupt other devices.

DIRECT MEMORY-TO-MEMORY AND
MEMORY-TO-I/O DEVICE
OPERATIONS
Operations can be performed between
peripherals and memory without
accumulators; more efficient I/O—no
need for separate I/O transfer
instructions; all instructions can be
used with I/O devices.

MM11 CORE MEMORY
The asynchronous nature of the PDP-11
system allows any speed of core
memory to be directly interfaced to the
UNIBUS. Any number of memories
each with its own speed can run with
the PDP-11 simultaneously. System can
start with 4K and grow to 32K in
increments of 4K. With special options
the PDP-11 can grow to 132K.

All instructions can directly address the
full 32K word memory and I/O space.
No pages, no special memory extension
hardware or software.

KW11-P REAL TIME CLOCK
The KW11-P provides real-time interval
interrupts and interval counting in
several modes of operation. Major
elements of the KW11-P are a 16-bit
synchronous binary Counter Register,
a 16-bit Data Buffer, a 9-bit Control
Register, and four program selectable
count ranges. The selectable counting
rates include two crystal controlled
rates (100 kilohertz and 10 kilohertz),
line frequency, and 1 external Schmitt
Trigger input.

The counter is a 16-bit synchronous
binary counter clock with one of four
program selectable rates. The counter
operates in either a count-up or count-
down mode. The count-down mode is
used to count down from a specified
count to zero underflow. Underflow
initiates the clock interrupt sequence.
Count-up mode is designed for external
event counting with no interrupts.

The count set buffer is a 16-bit register
used for the storage of the interval
count. This allows for the automatic
loading of the counter register. The
buffer is set or cleared by the
programmed initialization command.

The entire operation of the clock is set
by the programmed 9-bit Control-and-
Status Register which provides signals
to control the following: • Count Rate
• Mode Selection • Start Counter
• Interrupt Enable • Count Up/Down
• Count Error • Count Done
• Maintenance Clock

The KW11-P has three modes of
operation: • Single Interrupt
• Repeated Interrupt • External Event
Counter utilizing Schmitt Trigger

BUS →

```
┌──────────────┐        ┌──────────────┐        ┌ ─ ─ ─ ─ ─ ─ ┐
│   ADO1-D     │        │    VR20      │               ?
│    A/D       │        │ COLOR DISPLAY│        │             │
│  CONVERTER   │        │              │         ─ ─ ─ ─ ─ ─ ─
└──────────────┘        └──────────────┘
```

ADO1-D A/D CONVERTER

The standard ADO1-D consists of an expandable solid-state input multiplexer, programmable input range selector, control, and bus interface.

The multiplexer can be expanded by adding 4-channel modules up to a maximum of 32 channels.

The ADO1-D features: • Four Program Selectable Input Ranges • Up to 32 Channels • 10-bit Unipolar Resolution • Computer or External Clock Control • Overload Protection

By providing a program selectable input range, the sub-system can save the cost of separate signal condition equipment and/or the cost of providing a higher resolution A/D converter. For example, under computer control, the system can accurately digitize the moderate frequency signals spanning the equivalent of 14-bits of dynamic range.

The sub-system is well suited for a variety of tasks—testing, monitoring, and logging and analytical instrumentation data reduction—in both laboratory and manufacturing environments.

VR20 COLOR DISPLAY

The Lab 11 features as standard equipment a unique two-color display system which offers the user direct interaction with the computer in a way previously unobtainable at a reasonable price.

The VR20 is a two-color (Red and Green) point plotting display offering an 11″ diagonal viewing surface (7″ x 9″ or 58.5 square inches). The very bright dual-energy phosphor allows for crisp image viewing under normal ambient lighting conditions. The scope control produces two energy levels for exciting the phosphor to emit either red or green light.

The VR20 receives analog X and Y position information with an intensity pulse from the processor to generate sharp, bright, point-plot displays. The unit utilizes high speed magnetic deflection to enhance brightness and resolution.

The construction is all modular for ease of maintenance. Any sub-assembly or major component may be replaced in minutes with just a screwdriver.

The display is extremely easy to program; the programmer specifies "Red" or "Green" and the display controller does the rest.

PERIPHERALS AND OPTIONS

User can choose from many standard Lab peripherals and options to custom-build his system. Any number of devices can be interfaced to the PDP-11 UNIBUS. • DEC Tapes • MAG Tapes • Disks • Disk Cartridges • Card Readers • Line Printers • Communication Devices • User Devices

Software

Software for the Lab 11 is extensive and growing. The larger the Lab 11 configuration, the larger and more comprehensive is the software package that comes with it.

BASIC/LAB 11

BASIC/LAB 11 is a powerful laboratory oriented version of the BASIC language. In addition to normal BASIC computational features, BASIC/LAB 11 incorporates new command structures for servicing the Lab 11's analog-to-digital converter (AD01-D), real-time clock (KW11-P), and point-plotting color CRT Display (VR20).

The BASIC instructions for handling the A/D converter, real-time clock, and CRT Display permit the user to perform real-time data acquisition and reduction tasks in an easy to use high level language. The BASIC/LAB 11 software requires a minimum of 8,192 words of core memory.

Paper Tape Editor (ED-11)

Editor allows the user to enter portions of a source program from a teleprinter or paper tape and make corrections or additions to text.

PAL-11 Relocatable Assembler

The Relocatable Assembler translates the user's assembly language program into a relocatable object module. This two-or-three-pass assembler can be used on small systems; it runs with 8K words of core memory and an ASR-33 Teletype.

FORTRAN IV

The PDP-11 FORTRAN IV is available for those in need of a standardized mathematical language. Fully compatible with both ANSI FORTRAN IV and IBM 1130 FORTRAN, the language runs under an 8K disk operating system.

Those who wish to do numerical processing in PDP-11 assembly language will be aided by the Floating Point Package. Available in either a 32 or 64 bit format, it provides more than 17 decimal digits of accuracy.

Text Editor

The Editor allows on-line creation and editing of programs via the Teletype keyboard. It will handle both FORTRAN and assembler instructions, or it may be used to prepare any text file.

MACRO Assembler (MACRO-11)

MACRO-11 translates symbolic assembly language programs, which may include macro definitions, into relocatable binary object modules.

PDP-11 LINK (LINK-11)

LINK-11 combines the outputs of several assemblies and/or FORTRAN compilations into one load module. It is a powerful tool when constructing large software systems.

Some additional software packages:
• PDP-11 Linker • ODT-11 On-Line Debugging • PIP Peripheral Interchanging Program • Absolute Loader • FPP-11 Floating Point Math Package

DECUS

As new programs and routines are developed they will become available to LAB 11 users through the LAB 11 Program Library or from DECUS, the Digital Equipment Computer Users Society.

APPLICATIONS

Analytical Instrumentation

The Lab 11 can be used to acquire and analyze from one or more instruments typically used in chemical or physical analyses. Mass spectrometers, gas chromatographs, chemical analyzers, NMR spectrometers and various particle-size counters are a few of the instruments that may be automated through the use of the Lab 11. This application speeds up the process of obtaining a more thorough and accurate analysis than is possible when computations are done manually. The Lab 11, with its analog input capabilities for handling the instrumentation signals, helps eliminate the need for complex special interfaces to several classes of instruments. The two-color cathode ray tube display, with its graphic capability, allows for the effective presentation of data.

Life Science

Life Science research is an application to which the Lab 11 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 reinforcement studies. In experiments where humans or animals are presented stimuli to which they respond by pushing buttons and/or levels, the computer can be used to analyze these results on-line, using standard statistical techniques.

In physiological studies, the Lab 11 has the capability of handling analog signals, providing real-time analysis of the information and control of the experiment from which the data is being derived.

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 Lab 11 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.

Education

It has been 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 Lab 11 makes it particularly well suited for this type of environment. The use of a graphics display through which the machine and operator can communicate, coupled with the ease of operation inherent in its design, has put the Lab 11 in the foreground of computer extended instruction.
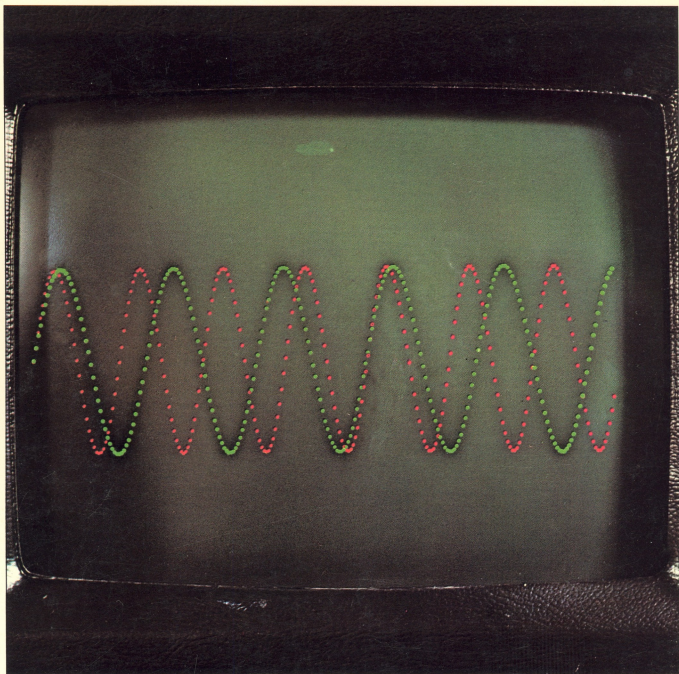
VR20 Color Display • DEC, the mini-computer leader, introduces another "first" in the laboratory—a two color CRT (Red and Green) display • Large 7" x 9" Viewing area • High Resolution Point Plot Display • Easy to program; programmer specifies "Red" or "Green" and the display controller does the rest