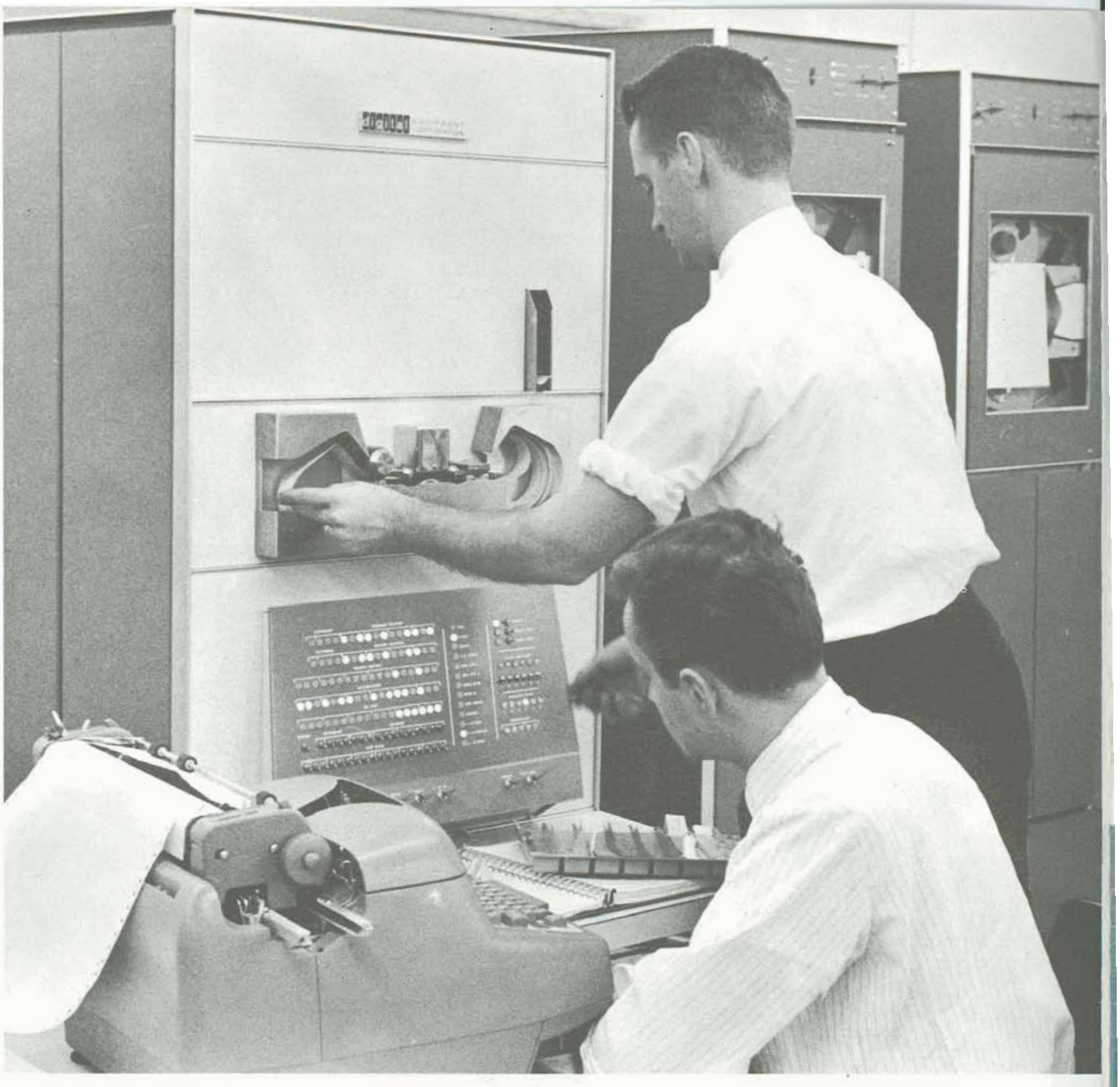
F-11B

PROGRAMMED DATA PROCESSOR 1

digital



PDP 1

Programmed Data Processor, Model One (PDP-1) is a general purpose, high speed, solid state computer. It can operate with many kinds of input-output equipment and has powerful program features. PDP-1 has proven itself to be a reliable and versatile computer in a variety of installations.

SPEED: Fully parallel processing and a 5-microsecond memory cycle time give the PDP-1 a computation rate of 100,000 additions per second and the ability to control simultaneously a large variety of peripheral devices operating at their maximum speeds.

APPLICATIONS: Uses of PDP-1 range from scientific experimentation to real-time process control. Typical applications in existing installations are: on-line data collection, format conversion, wave-form analysis, psychological experiment control. In each case, standard and optional input-output equipment designed and manufactured by Digital greatly increases the usefulness of the computer.

PROGRAM FEATURES: PDP-1 is a single address, single instruction, stored program computer operating on 18-bit, 1's complement binary numbers. Powerful program features include: multiple-step indirect addressing, Boolean operations, 12 variations of arithmetic and logical shifting, 15 basic conditional skip instructions, and a unique micro-instruction feature which shortens program running time.

STANDARD PDP-1

The Central Processor contains the Control Element, the Memory Buffer Register, the Arithmetic Element, and the Memory Addressing Element. The Operator Console provides switches and buttons for manual inputs and indicator lights for all active registers. Basic Core Memory capacity is 4096 words. Standard input-output equipment consists of a Perforated Tape Reader, Perforated Tape Punch, On-Line Typewriter, and Single Channel Sequence Break (automatic interrupt).

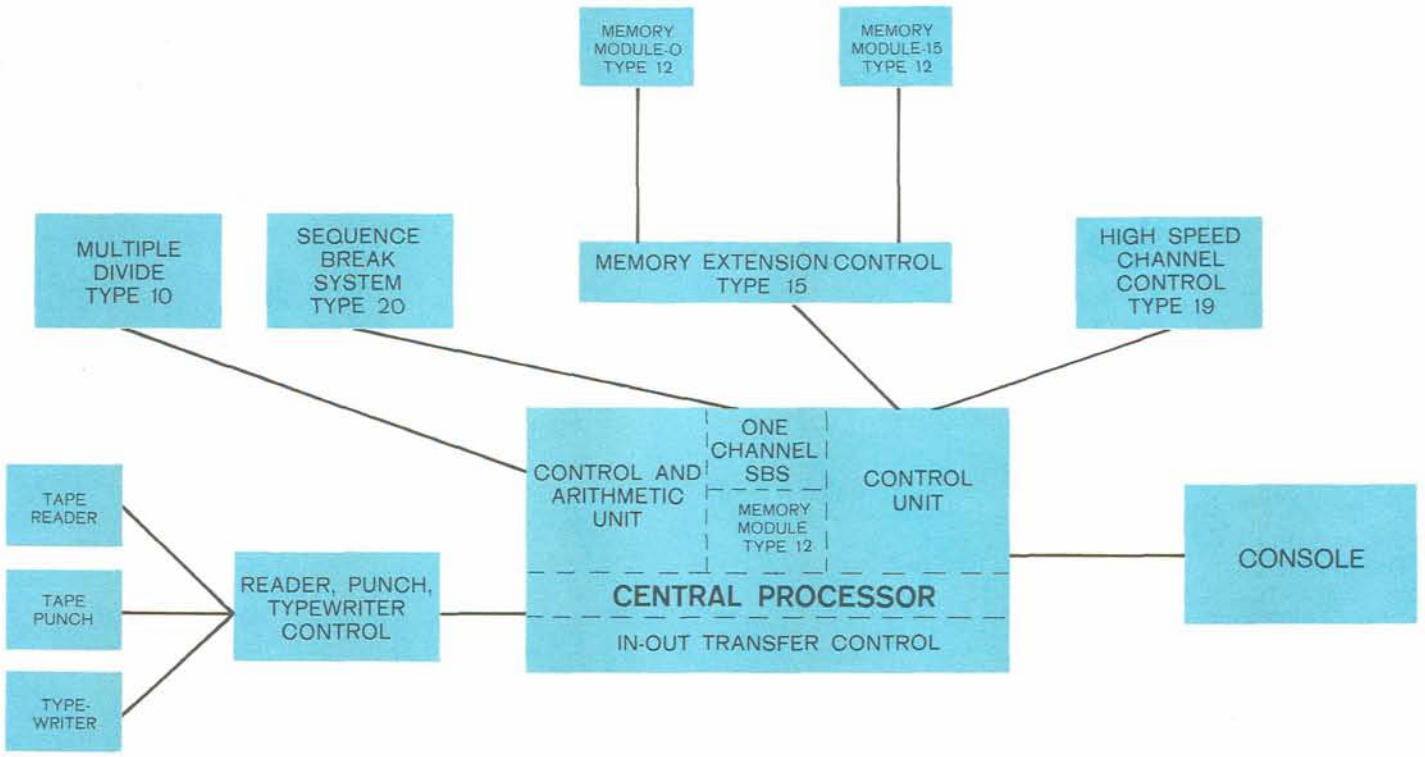
CENTRAL PROCESSOR OPTIONS

AUTOMATIC MULTIPLY AND DIVIDE, TYPE 10 shortens the average time required for multiplication and division to 19 and 35 microseconds, respectively, including instruction and operand access.

MEMORY MODULE, TYPE 12 consists of 4096 words. When the **MEMORY EXTENSION CONTROL,** Type 15 is used, up to 15 additional Type 12 Memory Modules can be added to PDP-1.

HIGH SPEED CHANNEL CONTROL, TYPE 19 contains internal control and signal paths for direct memory access devices such as the Automatic Magnetic Tape Control, Type 52 and the **HIGH SPEED DATA CHANNEL, TYPE 23.** With the Type 19 and Type 23, variable length blocks of data can be transferred between PDP-1 and input-output devices at rates of up to 200,000 (18-bit) words per second. The Type 23 Control counts the data words for a block transfer, buffers either incoming or outgoing data until the transfer is made, and signals the completion of the block.

MULTIPLE CHANNEL SEQUENCE BREAK, TYPE 20 allows the concurrent operation of the main program sequence and several input-output devices. Sixteen automatic interrupt channels are arranged in a priority chain. An interrupt can be initiated by an external device at any time. When a break occurs, the states of the Arithmetic and Control Elements are automatically stored in memory and program control is transferred to a routine which services the interrupting device.



PROGRAMMING PDP-1

The PDP-1 instruction format includes 5 bits for the instruction code, 1 bit for indirect addressing, and 12 bits for memory address. Operating times of instructions are multiples of the 5-microsecond memory cycle time. Shift, Rotate, Skip, and Operate take 5 microseconds. Add, Subtract, Deposit, and Load are two-cycle instructions completed in 10 microseconds. Multiplication by subroutine takes 325 microseconds on the average, and division requires about 440. Optional Automatic Multiply and Divide shortens these operations to an average of 19 and 35 microseconds, respectively. Floating point operations and number base conversion are performed by subroutines.

A memory reference instruction which is to use an indirect address will have a 1 in bit 5 of the instruction word. The original address of the instruction is then used to locate a memory register which contains the address to be used in carrying out the instruction. If this register also has a 1 in bit 5, the indirect addressing procedure is repeated and a third address is located. There is no limit to the number of times this process can be repeated.

PDP-1 INSTRUCTIONS

BASIC INSTRUCTIONS

INSTR.	CODE	EXPLANATION	OPER. TIME (μsec)
add Y	40	Add C(Y) to C(AC)	10
and Y	02	Logical AND C(Y) with C(AC)	10
cal Y	16	Equals jda 100	10
dac Y	24	Deposit C(AC) in Y	10
dap Y	26	Deposit contents of address part of AC in Y	10
dio Y	32	Deposit C(IO) in Y	10
dip Y	30	Deposit contents of instruction part of AC in Y	10
dis Y	56	Divide step	10
dzm Y	34	Deposit zero in Y	10
idx Y	44	Index (add one) C(Y), leave in Y & AC	10
ior Y	04	Inclusive OR C(Y) with C(AC)	10
iot Y	72	In-out transfer, see below	
isp Y	46	Index and skip if result is positive	10
jda Y	17	Equals dac Y and jsp Y+1	10
jmp Y	60	Take next instruction from Y	5
jsp Y	62	Jump to Y and save program counter in AC	5
lac Y	20	Load the AC with C(Y)	10
law N	70	Load the AC with the number N	5
law-N	71	Load the AC with the number -N	5
lio Y	22	Load IO with C(Y)	10
mus Y	54	Multiply step	10
opr	76	Operate, see below	5
sad Y	50	Skip next instruction if C(AC) $\neq$ C(Y)	10
sas Y	52	Skip next instruction if C(AC) = C(Y)	10
sft	66	Shift, see below	5
skp	64	Skip, see below	5
sub Y	42	Subtract C(Y) from C(AC)	10
xct Y	10	Execute instruction in Y	5+
xor Y	06	Exclusive OR C(Y) with C(AC)	10

OPERATE GROUP

cla	760200	Clear AC	5
clf	76000f	Clear selected Program Flag (f = flag #)	5
cli	764000	Clear IO	5
cma	761000	Complement AC	5
hlt	760400	Halt	5
lap	760100	Load AC with Program Counter	5
lat	762200	Load AC from Test Word switches	5
nop	760000	No operation	5
stf	76001f	Set selected Program Flag (f = flag #)	5

IN-OUT TRANSFER GROUP

INSTR.	CODE	EXPLANATION
cks	720033	Check Status
		CLOCK
rdk	720037	Read Clock into IO
rsk	720047	Reset Clock
		PERFORATED TAPE READER
rpa	720001	Read Perforated Tape Alpha
rpb	720002	Read Perforated Tape Binary
rrb	720030	Read Reader Buffer
		PERFORATED TAPE PUNCH
ppa	720005	Punch Perforated Tape Alpha
ppb	720006	Punch Perforated Tape Binary
		ON-LINE TYPEWRITER
tyi	720004	Type in
tyo	720003	Type out
		CRT DISPLAYS
dpy	720007	Display point on Precision CRT
dpp	720407	Display point on Ultra-Precision CRT
		MAGNETIC TAPE
mcb	720070	Magnetic Tape Clear Buffer
mcs	720034	Magnetic Tape Check Status
mel	72u036	Magnetic Tape Examine Location
mes	72u035	Magnetic Tape Examine States
mic	72uc75	Magnetic Tape Initial and Command
mrc	720072	Magnetic Tape Read Character
mrf	72u067	Magnetic Tape Reset Final
mri	72ug66	Magnetic Tape Reset Initial
msm	720073	Magnetic Tape Select Mode
muf	72ue76	Magnetic Tape Unit and Final
mwc	720071	Magnetic Tape Write Character

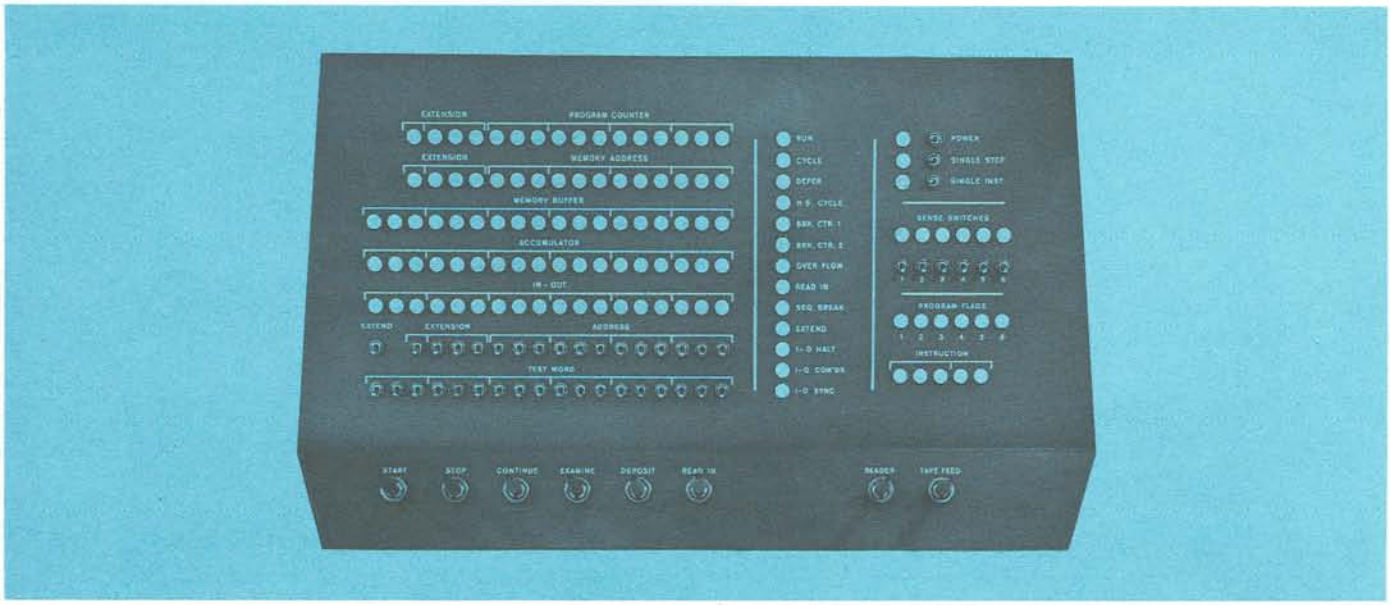
INSTR.	CODE	EXPLANATION
		LINE PRINTER
flb	721045	Fill Line Buffer
prl	720045	Print a Line
slp	722f45	Space Line Printer (f=format)
		SINGLE CHANNEL SEQUENCE BREAK
esm	720055	Enter Sequence Break Mode
lsm	720054	Leave Sequence Break Mode
cbs	720056	Clear Sequence Break System
		MULTIPLE CHANNEL SEQUENCE BREAK
dsc	72kn50	Deactivate Sequence Break Channel
asc	72kn51	Activate Sequence Break Channel
isb	72kn52	Initiate Sequence Break
cac	720053	Clear All Channels
		HIGH SPEED DATA CHANNEL
scw	72c057	Set Channel Word Counter
sci	72c157	Set Channel Initial Location
inr	72ur67	Initiate HSC Request
		MEMORY EXTENSION CONTROL
eem	724074	Enter Extend Mode
lem	720074	Leave Extend Mode

SKIP GROUP

INSTR.	CODE	EXPLANATION	OPER. TIME (μsec)
sma	640400	Skip on minus AC	5
spa	640200	Skip on plus AC	5
spi	642000	Skip on plus IO	5
sza	640100	Skip on ZERO (+0) AC	5
szf	64000f	Skip on ZERO flag (f = flag #)	5
szo	641000	Skip on ZERO overflow (and clear overflow)	5
szs	6400s0	Skip on ZERO sense switch (s = switch #)	5

SHIFT/ROTATE GROUP

ral	661	Rotate AC left	5
rar	671	Rotate AC right	5
rcl	663	Rotate combined AC & IO left	5
rcr	673	Rotate combined AC & IO right	5
ril	662	Rotate IO left	5
rir	672	Rotate IO right	5
sal	665	Shift AC left	5
sar	675	Shift AC right	5
scl	667	Shift combined AC & IO left	5
scr	677	Shift combined AC & IO right	5
sil	666	Shift IO left	5
sir	676	Shift IO right	5



PROGRAMMING AIDS

MACRO is a two-pass assembly program which produces a self-loading, machine language version of a program written in MACRO symbolic language. The package includes a complete symbolic program listing, an operations manual, and the necessary English and self-loading binary tapes.

The utility program includes multiply and divide subroutines for 18 bits, a random number generation subroutine for 18 bits, a single precision floating point package for arithmetic using an 18-bit fraction and an 18-bit exponent, and other routines.

DDT (Digital Debugging Tape) — an integral part of this programming system — is a complete symbolic-octal debugging program controlled from the typewriter. The symbols defined during assembly with MACRO can be punched out, read by DDT, and used during debugging.

A symbolic tape editor also translates from tape to tape, tape to typewriter, and typewriter to tape.

A complete set of standard test tapes, with descriptions and instructions for use, is delivered with each PDP-1.

INPUT-OUTPUT LOGIC

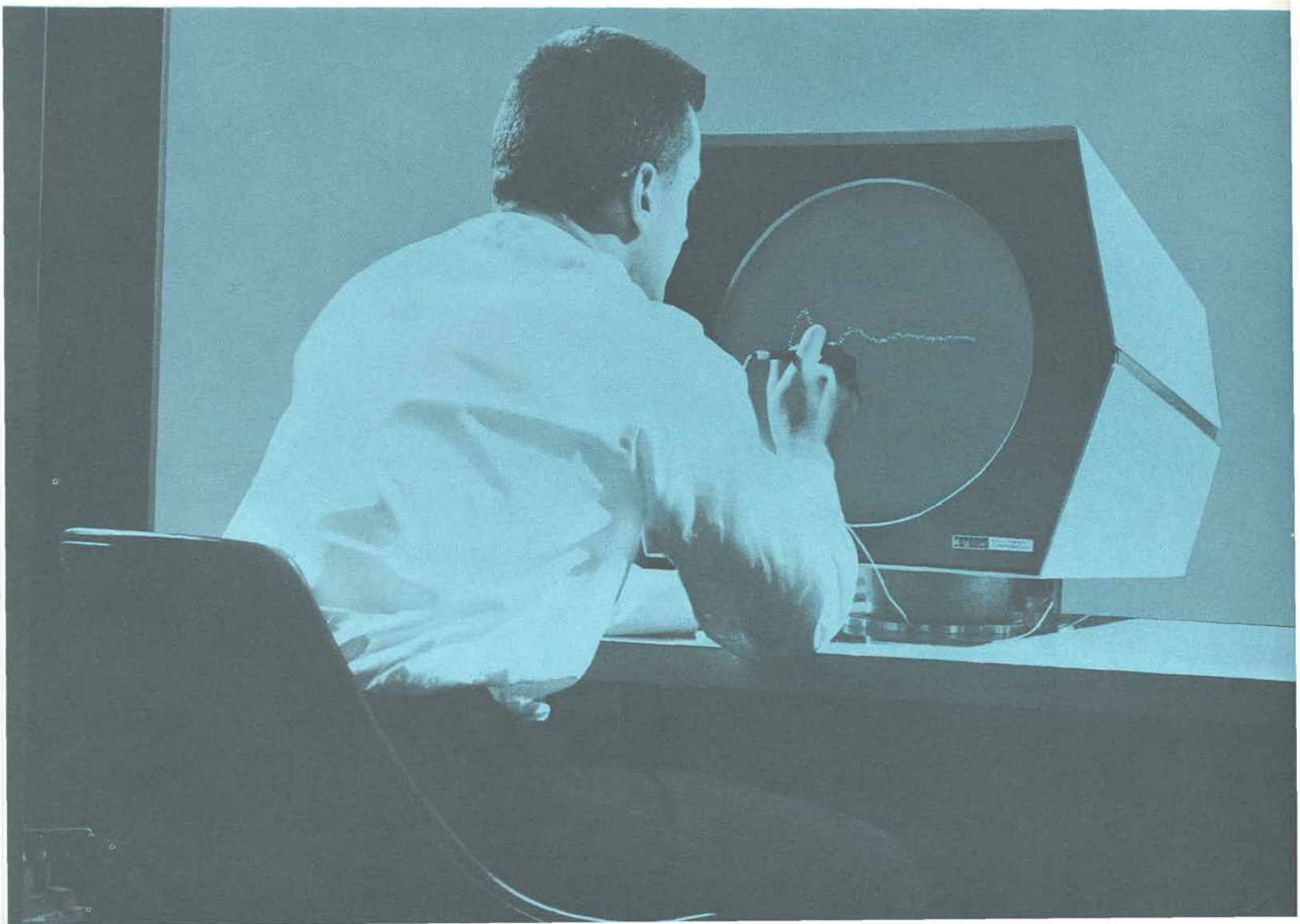
The input-output section of PDP-1 is specifically designed to accommodate the standard options described on the next page and unique in-out devices. New input-output transfer instructions can be implemented by making simple taper-pin connections, many more by adding standard Digital plug-in circuit modules. Both facilities are standard on PDP-1.

In medium speed applications (25,000 to 66,000 18-bit words per second), word-by-word transfers can be made under program control through the IO Register. In high speed applications (up to 200,000 18-bit words per second), transfers can be made through the optional High Speed Data Channel in variable length blocks.

In order to minimize the program time required to monitor the status of in-out devices, it is often desirable for them to interrupt the computer program. Single Channel Sequence Break allows program interrupts on a first-come, first-served basis. Multiple Channel Sequence Break provides 16 interrupt channels, arranged by priority, and permits an interrupt while another interrupt is in process. In either case, computer time is used efficiently and many external devices can be operated simultaneously.

The status of each in-out device can be determined by programmed interrogation of the Status Register and sensing of Program Flags. Status conditions can be specified by the customer and quickly wired in before or after installation. Typical conditions are: device ready or busy, parity error found, power on or off.

When an in-out device is instructed to carry out a relatively long operation, it is useful to synchronize the operation of the computer with the device at some point in the program. For this purpose, bits 5 and 6 of the instruction can be used to specify three types of synchronization: (1) Computer starts device, awaits completion signal before continuing; (2) Computer starts device, continues computation for a time, stops, awaits completion signal before continuing; (3) Computer starts device, does not request completion signal, continues computation. In this last case, synchronization is provided by program interrupt or by status examination.



INPUT-OUTPUT OPTIONS

PRECISION CRT DISPLAY, TYPE 30

A 16-inch display with control for use as an on-line output device. It converts stored digital data and presents it in the form of graphs, diagrams, and alphanumeric information. Points are plotted at a 20 kc rate.

LIGHT PEN, TYPE 32

A direct input, photosensitive device that greatly extends the usefulness of the Type 30 Display. Upon sensing a displayed point, the Light Pen sends a signal to the computer that causes branching of the program. Typical results are: the existing display is modified, new displays are generated, stored information is read out on another output device.

ULTRA-PRECISION CRT DISPLAY TYPE 31

A high resolution, five-inch display similar in operation to the Type 30. Its accuracy and stability make it suitable for precise photographic recording or reading of data. A mounting bezel for camera or photomultiplier is furnished.

MAGNETIC TAPE TRANSPORT, TYPE 50

Reads and writes IBM formats with a recording density of 200 7-bit characters per inch at a tape speed of 75 ips, or 15,000 characters per second. Read, write, and drive electronics are included in the cabinet.

PROGRAMMED MAGNETIC TAPE CONTROL, TYPE 51

Transfers information between computer and tape one character at a time. All transfer operations, including error checking and assembly of characters into computer words, are performed by routines. The Type 51 allows a choice of tape format.

AUTOMATIC MAGNETIC TAPE CONTROL, TYPE 52

A high speed control that automatically transfers information to and from computer in variable length blocks. Computation can continue while transfers are in progress. The Type 52 detects errors automatically during reading and writing: it checks parity and compares bit for bit with core memory. For rapid tape searching, a preselected number of blocks may be skipped. Tape format is IBM.

AUTOMATIC LINE PRINTER AND CONTROL, TYPE 62

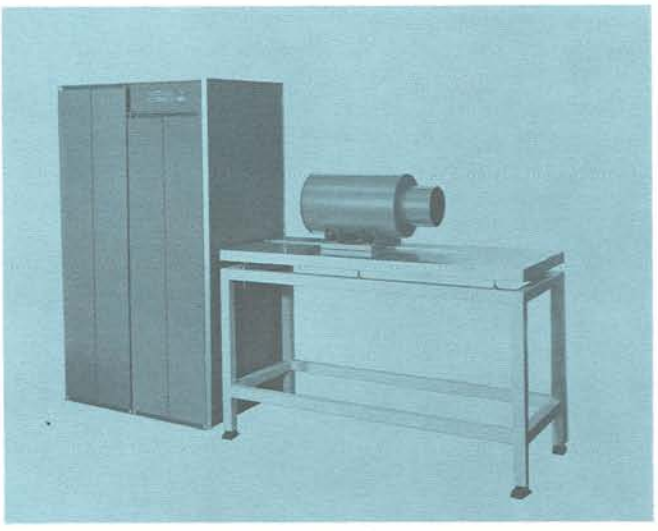
An on-line printing station capable of operating at 1000 lines per minute (120 columns per line, 64 characters per column). Eight spacing formats are available.

CARD READER AND CONTROL, TYPE 41

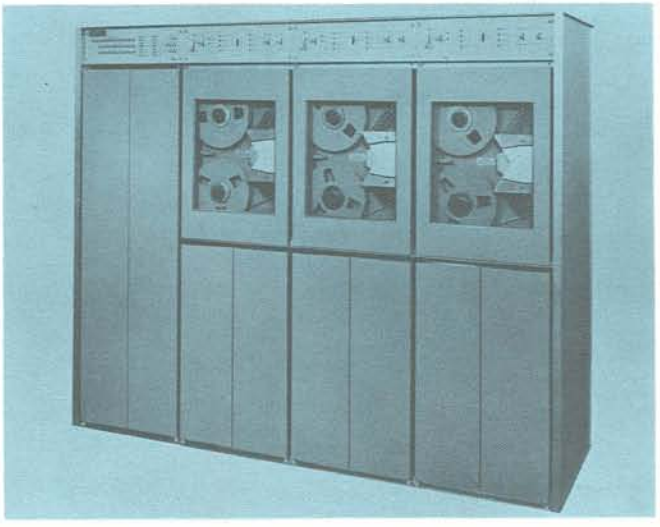
Provides on-line reading of standard punched cards. Cards are read column by column in alphanumeric or binary mode at rates up to 200 cards per minute. The alphanumeric mode converts the 12-bit Hollerith code of one column into the six-bit binary-coded decimal code with code validity checking. Binary mode reads a 12-bit column directly into the computer.

CARD PUNCH CONTROL, TYPE 40

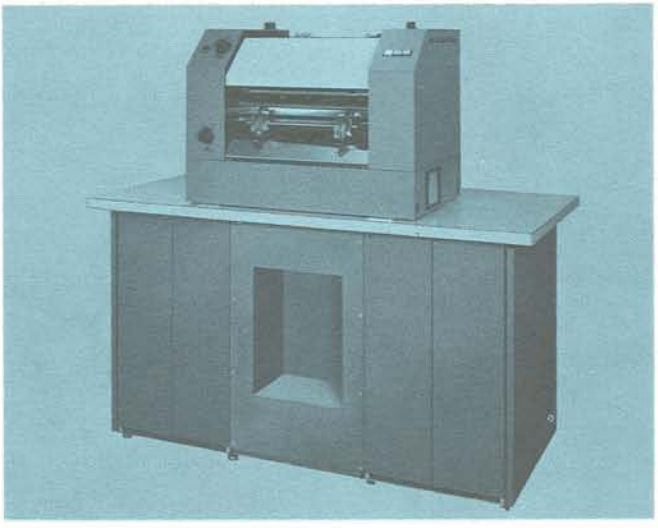
Controls the operation of a standard IBM Summary Punch. Cards are punched row by row at 100 cards per minute.



Ultra-Precision CRT Display



Magnetic Tape Transports and Control



High Speed Line Printer

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