

**SYSTEM
DESCRIPTION**



PDP-6

PROGRAMMED DATA PROCESSOR — 6

36-bit word length

15 index registers and/or 16 accumulators

FORTRAN II — Macro assembler — utility programming library

memory protection and program relocation for multiprogramming and time sharing

asynchronous operation — modular construction

262,144-word directly addressable memory (2 μ sec and 0.4 μ sec)

memory overlap

363 instructions

fast floating point arithmetic: floating multiply average 14 μ sec

program-assignable operation codes

seven-channel priority interrupt system

byte manipulation — half-word — block transmission

128 input/output devices

programmed input/output transfers require no data channels

multiple processors

remote input/output

mass memory

Micro Tape

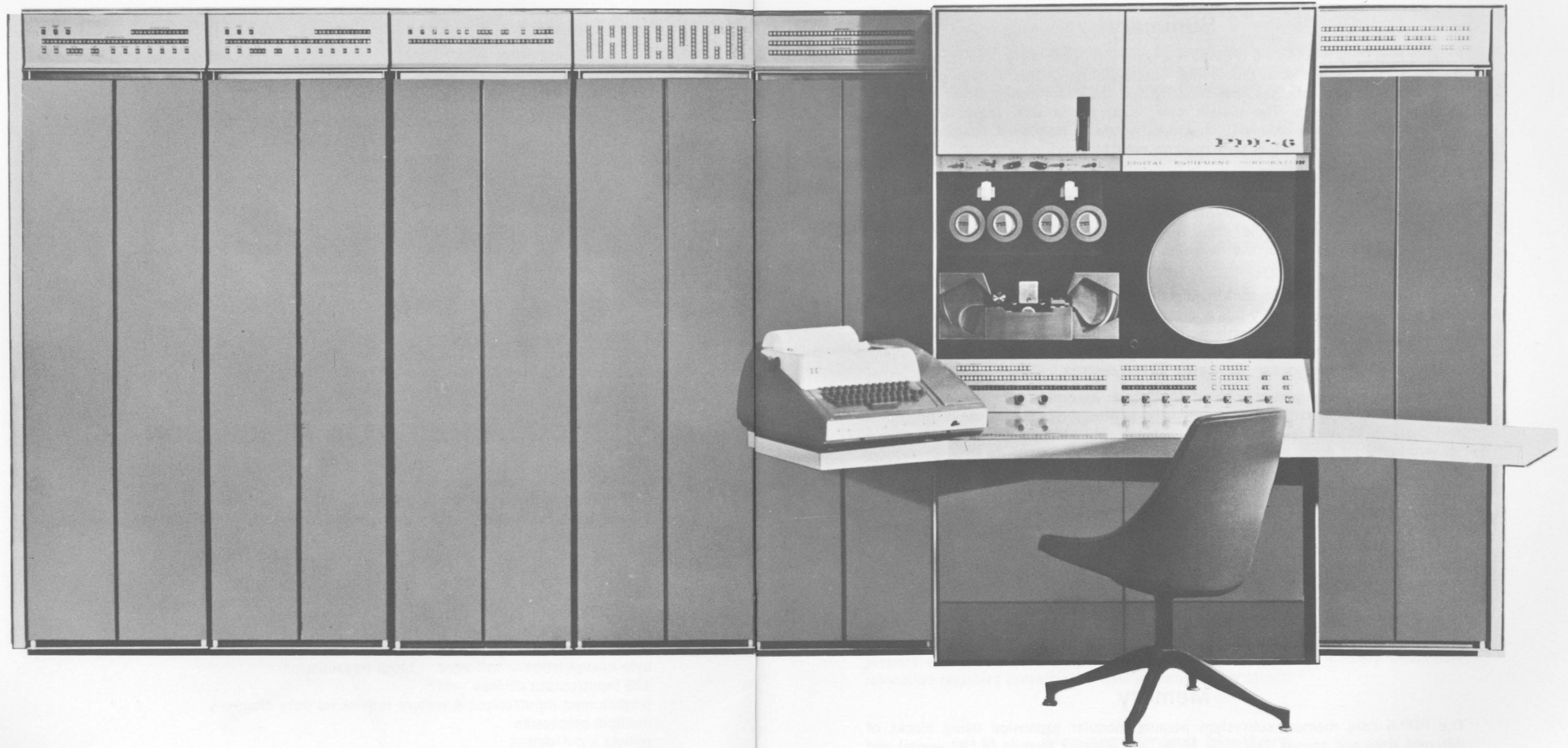


Figure 1 Programmed Data Processor-6

PDP-6 SYSTEM DESCRIPTION

Summary

Programmed Data Processor-6 (PDP-6) is a general-purpose digital computing system designed for scientific data processing. The flexibility of this system permits the user to specify the data handling capacity and the exact configuration needed to meet his requirements. The system can be expanded with presently available equipment or, at a later date, with equipment yet to be developed. Faster memories, for example, can be added as they become available.

The PDP-6 system consists of processors, memories, and input/output devices. Since each is autonomous (no device is dependent upon another for its timing), a system configuration can include memory modules of different speeds, processors of different types sharing the same memory modules, and standard or unique input/output devices. All of the hardware necessary for time-sharing is built into PDP-6.

For maximum flexibility in system configurations, the PDP-6 system is built around two busses: processor-memory bus and processor-input/output bus. The memory bus permits each processor to directly address 262,144 words of core memory, automatically permits overlapping, and simplifies multiprocessor operation. An input/output bus of a processor can service up to 128 devices.

Programming systems include a Monitor, Symbolic Assembler and Macro Processor, FORTRAN II Compiler, Debugging Aids, and a library of general utility programs.

Processors

A PDP-6 system can include any number of processors of the same or different types. The Type 166 is a 36-bit arithmetic processor with many powerful features, including 16 accumulators, 15 index registers, built in floating point arithmetic, and byte operations capability. Memory protection and relocation registers are included for time-sharing operations.

The Type 167 Drum Processor transfers data directly between mass memory and core memory, the arithmetic processor supplying only block or job control information. The characteristics of the drum system include a transfer rate of one 36-bit word in 6.4 microseconds and a total storage of 4,194,304 words on four drums.

Memory

The PDP-6 core memory subsystem permits modular expansion using blocks of different sizes and speeds. The Type 163B Core Memory Module (8,192 words) and the Type 163C Core Memory Module (16,384 words) have a word length of 36 bits, a cycle time of 2 microseconds, and an access time of 0.8 microseconds. The Type 162 Fast Memory Module contains 16 words with a 0.4-microsecond cycle.

The memory processor bus permits memory cycle overlap, gives all processors direct access to memory simultaneously, and permits easy expansion and modification of the memory subsystem. Memory modules are time-independent of processors, per-

mitting a processor to put a word on the bus and resume operations without waiting for memory to write the word. When reading a word, the processor takes the information from the bus and operates on it immediately, without waiting for the memory to rewrite.

Maximum system efficiency is achieved when sequential memory references address alternate memory modules. The addressed module places data on the bus as soon as it is available in the memory buffer and disconnects itself from the bus while rewriting, freeing the processor to store the result or seek the next instruction in a second memory module before the first one has completed rewriting. Utilizing such overlapping memory references, PDP-6 users can effectively cut in half the time required for average random accesses. Multiple connections between the bus and each memory module permit module sharing on a priority basis for multi-processor operations.

Input/Output

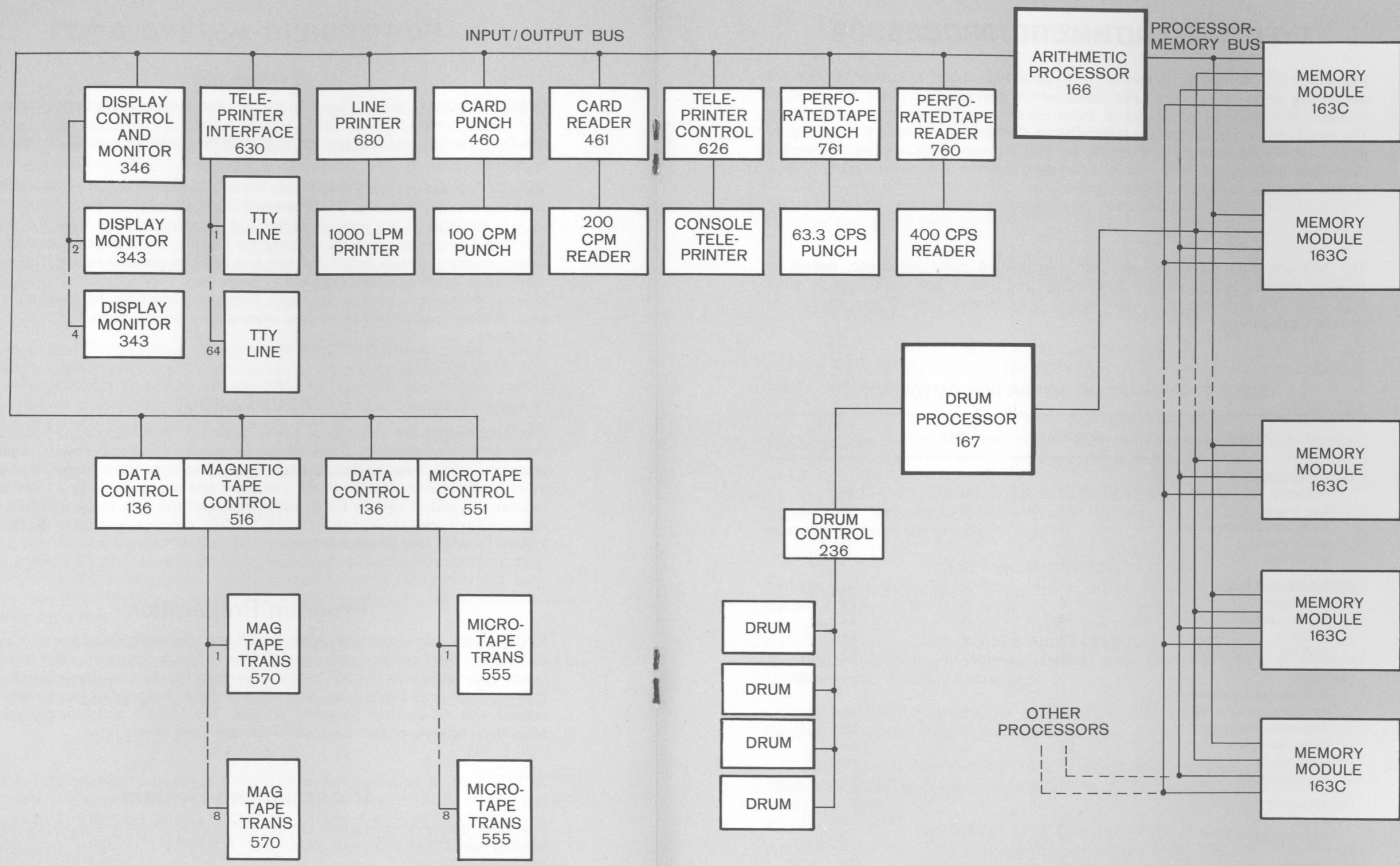
The input/output bus consists of device selection, data, control, and status sense lines. A seven-channel program-assignable priority interrupt system signals the processor when input/output devices require service. Word count and memory address registers are located in the processor and are available to all devices. This reduces the cost of various input/output controls, and data block transfers may be performed between tapes, card readers, printers, displays, and other devices where a block transfer may be advantageous.

Program Preparation

PDP-6 design eliminates the need for off-line conversion equipment. Conversion of programs from cards or paper tape to Micro Tape is done within the Monitor (see below) concurrent with normal program running. The Monitor also controls outputs to line printer from Micro Tape. Users at peripheral Teleprinters can simultaneously prepare and debug their programs on line. The Monitor and memory protection-relocation registers protect each user's storage from others.

Programming System

The basic programming system for the PDP-6 consists of a Monitor, Symbolic Assembler and Macro Processor (MACRO-6), FORTRAN II Compiler, Debugging Aids, and Library. The entire system is designed to run on any PDP-6 with 16,384 words of memory and a Micro Tape Dual Transport and Control. The programming system is designed to take full advantage of whatever features are available in larger systems.



TYPE 166 ARITHMETIC PROCESSOR

The Type 166 Arithmetic Processor is a general purpose processor capable of performing arithmetic, logical and input/output operations. It uses the first 16 locations in memory as accumulators, index registers, or ordinary memory locations. The results of each operation are transmitted automatically to one of these registers at the end of each instruction; thus the accumulator resides in memory. Instruction times vary, depending on the memory subsystem selected. Use of the Type 162 Fast Memory reduces instruction times significantly.

The 363 operation codes include fixed and floating point arithmetic, logical or Boolean, memory or accumulator modification and testing, half word, variable sized byte, block transmission, and input/output instructions. Table 1 summarizes instruction categories.

TABLE 1 SUMMARY OF INSTRUCTION CATEGORIES

Category	Operations	Modes	Total Instructions
Data Transmission			87
full word	4	4	16
half word	16	4	64
byte manipulation	5		5
block transfer	1		1
exchange	1		1
Arithmetic and Logic			127
fixed-point	6	4	24
floating-point	8, 1	4	33
Boolean	16	4	64
shifting	6		6
Executive			137
memory and accumulator modification and testing	6	8	48
arithmetic compare	2	8	16
logical compare	16	4	64
jumping	8		8
miscellaneous	1		1
Input/Output			8
basic	4		4
augmented	4		4
Push Down	4		4
			363

INPUT/OUTPUT EQUIPMENT

Digital offers a large selection of optional equipment for full utilization of the extensive input/output capacity of the system.

MICRO TAPE TRANSPORT TYPE 555

A fixed address magnetic tape facility for high speed loading, readout, and on-line program debugging. Read, write, and search speed is 80 inches a second. Density is 375 bits an inch. Total storage is three million bits. Features phase recording, rather than amplitude recording; redundant, nonadjacent data tracks, and a pre-recorded timing and mark track.

MICRO TAPE CONTROL TYPE 551

Controls up to eight Type 555 Micro Tape Transports. Searches in either direction for specified block numbers, then reads or writes data. Uses the Type 136 Data Control to assemble data and buffer transfers to the processor.

DATA CONTROL TYPE 136

Provides for assembly of 6, 12, 18, or 36-bit characters; six input/output devices can be controlled.

TELEPRINTER AND CONTROL TYPE 626

Permits on-line programming and debugging. Provides hardcopy outputs. Is standard Teletype equipment, operating at ten characters a second.

TELEPRINTER INTERFACE TYPE 630

Automatically scans up to 64 teleprinter (TTY) lines. Signals a program interrupt when teleprinter needs service.

CARD PUNCH CONTROL TYPE 460

Permits on-line punching of cards in any format, including IBM, at 100 or 300 cards a minute.

CARD READER AND CONTROL TYPE 461

Provides on-line reading of standard punched cards at 200 or 800 cards a minute in alphanumeric or binary codes.

HIGH SPEED PERFORATED TAPE PUNCH AND CONTROL TYPE 761

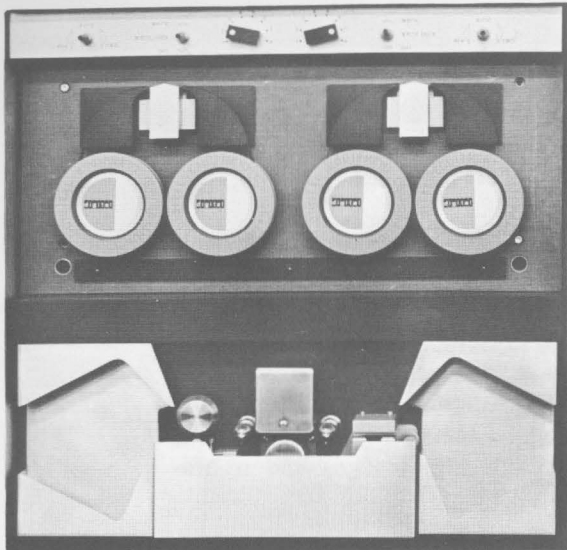
Punches 8-hole tape at 63.3 characters a second.

HIGH SPEED PERFORATED TAPE READER AND CONTROL TYPE 760

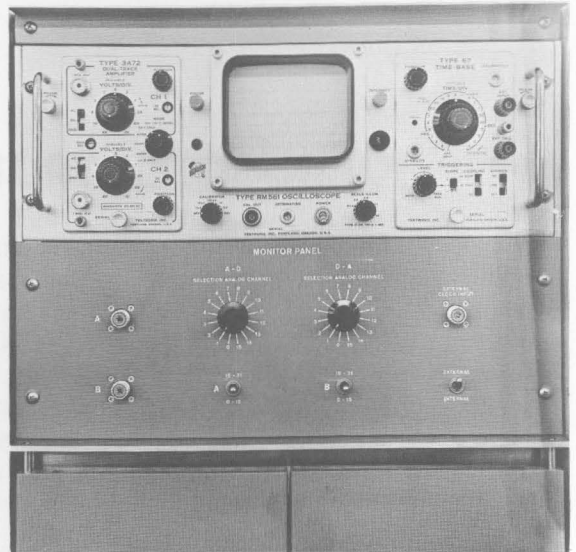
Reads perforated paper tape photo-electrically at 400 characters a second.

MAGNETIC TAPE CONTROL TYPE 516

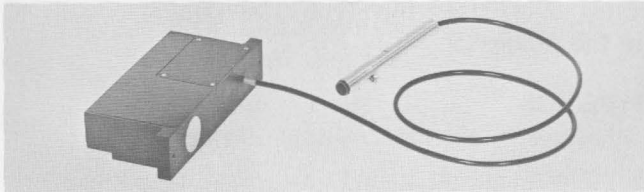
Automatically controls up to eight tape transports Type 570 or IBM 729 series. Permits reading, writing, forward/backward spacing, rewind and unload, and rewind. Uses a Type 136 Data Control to assemble data and buffer transfers to the processor. Longitudinal and lateral parity is checked.



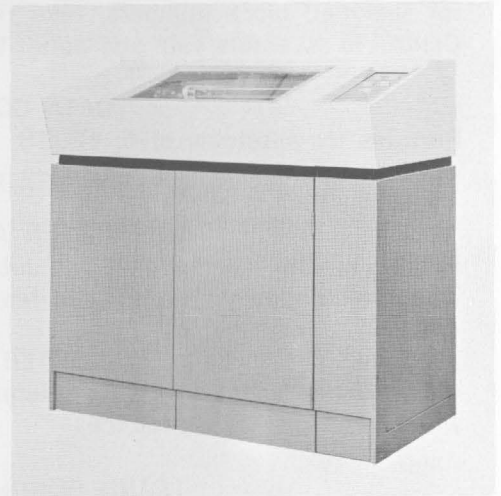
Micro Tape and Tape Reader



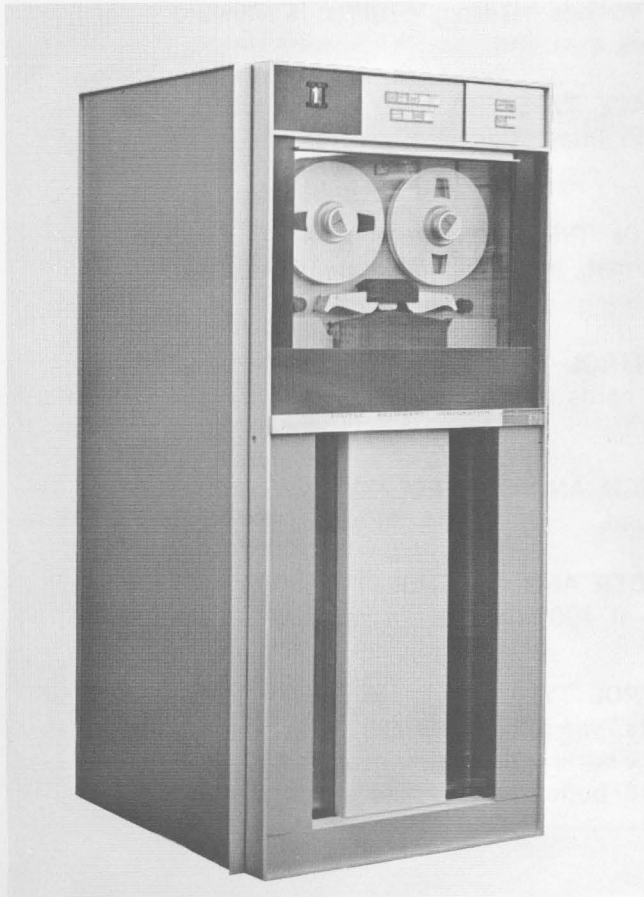
Analog-Digital-Analog Converter



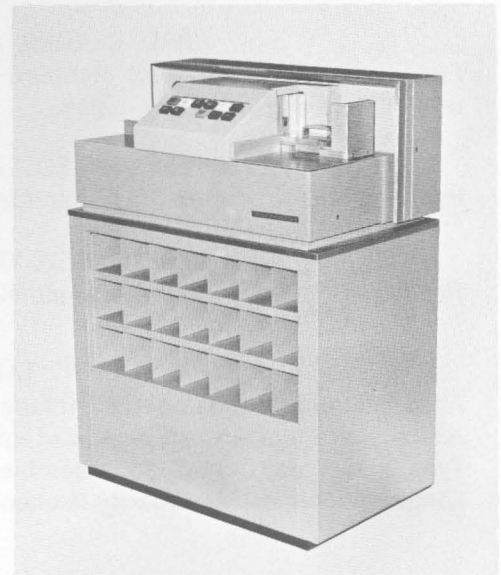
High Speed Light Pen



Automatic Line Printer



Magnetic Tape Transport



Card Reader and Control

MAGNETIC TAPE TRANSPORT TYPE 570

Tape motion is controlled by pneumatic capstans and brakes, eliminating conventional pinch rollers, clamps, and mechanical arms. Tape speed is either 75 or 112.5 inches a second. Track density, program-selectable, is 200 and 556 bits an inch. Tape width is one-half inch, with six data tracks and one for parity. Format (200 and 556-bit densities) is compatible with the IBM 727 and 729 series. Dual heads permit read checking while writing.

DRUM PROCESSOR TYPE 167

Establishes a data transmission path between main memory and the drum(s). Up to four drums can be connected to the drum processor.

MAGNETIC DRUM AND CONTROL TYPE 236

Drum stores 1,048,576 36-bit words organized into 128 tracks, each with 8192 words consisting of 64 128-word blocks. A word is transferred in 6.4 microseconds, and the drum revolution time is 52 milliseconds.

DISPLAY CONTROL AND MONITOR TYPE 346

Plots points, lines, vectors, and characters on a 9 $\frac{3}{8}$ -inch-square raster of 1024 points along each axis. Time between points plotted is 1.5 microseconds in the vector, increment, and character modes. In random point plotting, a time of about 35 microseconds is required per point.

DISPLAY MONITOR TYPE 343

Provides additional cathode ray tube display for multiple consoles.

HIGH SPEED LIGHT PEN TYPE 370

Detects data displayed by the Types 346 and 343 and inputs identifying signal to the computer.

AUTOMATIC LINE PRINTER AND CONTROL TYPE 680

Prints 1000 lines a minute, 120 columns a line, any one of 64 characters a column.

AUTOMATIC LINE PRINTER AND CONTROL TYPE 64

Prints 300 lines a minute, 120 columns a line, any one of 64 characters a column.

ANALOG-TO-DIGITAL CONVERTER TYPE 138

Transforms an analog voltage to a binary number, selectable from six to eleven bits. Conversion time varies, depending on the number of bits and the accuracy required. Twenty-one combinations of switching point accuracy and number of bits can be selected on the front panel.

MULTIPLEXED ANALOG-TO-DIGITAL CONVERTER TYPE 138/139

The Type 139 Multiplexer Control permits up to 64 channels of analog information to be applied singly to the input of the Type 138 Analog-to-Digital Converter. Channels can be selected in sequence or by individual addresses.

HIGH-SPEED ANALOG-TO-DIGITAL CONVERTER TYPE 142

Transforms an analog voltage to a signed, 10-bit binary number in 6 microseconds. Conversion accuracy is $\pm 0.15\% \pm 1/2$ least significant bit.

ANALOG-DIGITAL-ANALOG CONVERTER SYSTEM TYPE ADA-1

Performs fast, real-time data conversion between digital and analog computers. Maximum sample rate for D/A conversion is 200 kc; for A/D and interlaced conversions, 100 kc. Digital word length is 10 bits. Actual conversion times are 5 microseconds for A/D and 2 microseconds for D/A. Semiautomatic features enable the converter system to perform many of the functions that a computer normally performs for other converter interfaces.

INSTRUCTION TIMES

Table 2 summarizes instruction times for each group of instructions. Two times are given, a fast time and a slow time. The fast times are based on starting with instruction and data in fast memory. The slow times are based on starting with both instruction and data in the same core memory and allow for one index reference. The fast times are not necessarily minimum, since instructions in the immediate mode may run faster. Nor are the slow times maximum times, since an instruction may take considerably longer if there are several levels of indirect addressing. Exact times depend on the program context in which the instructions occur and on other factors. Therefore the figures should not be used to calculate program running time.

TABLE 2 SUMMARY OF INSTRUCTION TIMES

Instructions	Fast	Slow
Full and half word moves	1.9	4.0
Full and half word immediate	1.5	2.7
Byte manipulation	5.7	8.0
Byte manipulation and increment	7.2	8.0
Block transfer	$1.5+0.8n$	$2.4+1.2n$
Exchange	2.8	4.0
Fixed point add	2.7	4.3
Fixed point subtract	2.9	4.5
Fixed point multiply	14.5	16.1
Fixed point divide	23.4	25.0
Floating point add	5.8	8.0
Floating point subtract	6.0	8.2
Floating point multiply	12.4	14.5
Floating point divide	18.4	20.5
Boolean	2.7	4.3
Shifting (18 bits)	4.7	5.9
Memory, AC modification and testing	2.6	3.9
Arithmetic compare	2.7	4.4
Logical compare	2.7	4.4
Jumping	1.8	3.0
I/O		
basic	3.0	6.2
augmented	3.8	7.0
Push down	3.1	6.4

digital