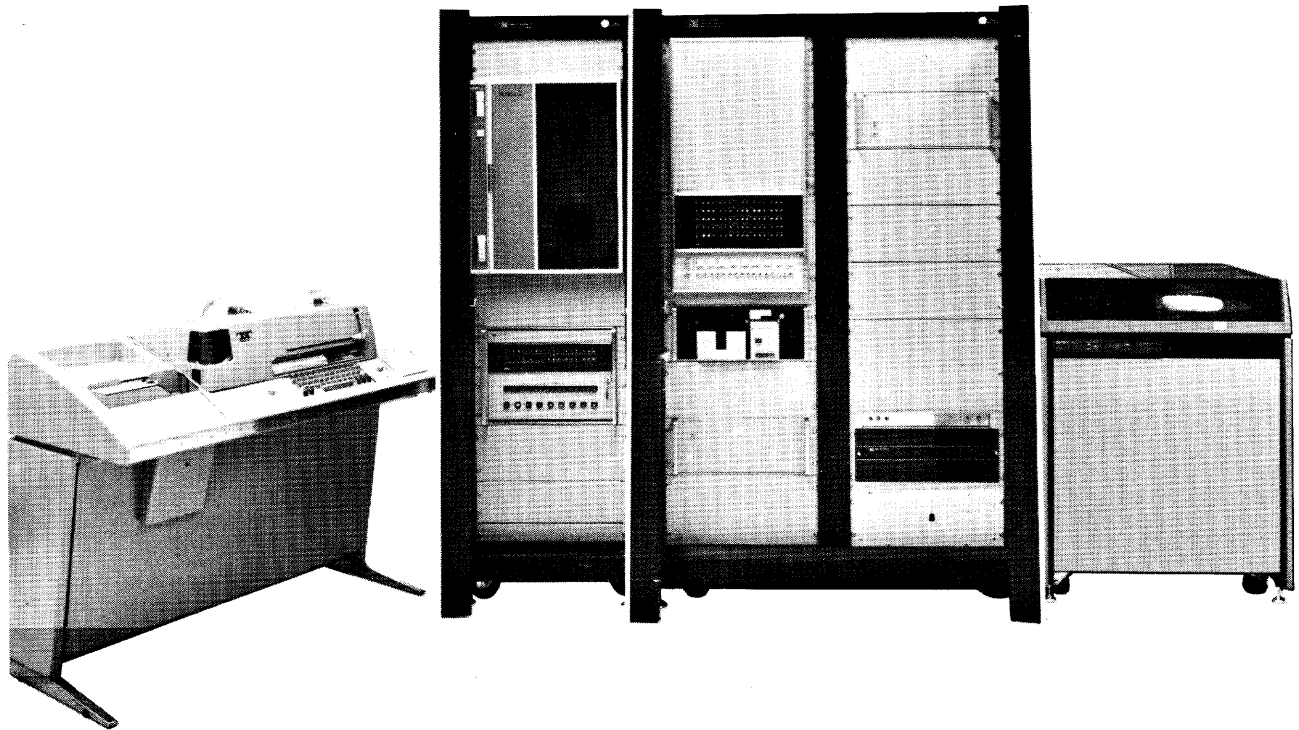


OPERATOR'S SYSTEM REFERENCE MANUAL

2000C TIME-SHARED BASIC SYSTEM



HEWLETT  PACKARD

**OPERATOR'S
SYSTEM REFERENCE MANUAL**

2000C

TIME-SHARED BASIC SYSTEM

—SYSTEM DESCRIPTION—

—PRINCIPLES OF OPERATION—

—PREVENTIVE MAINTENANCE—

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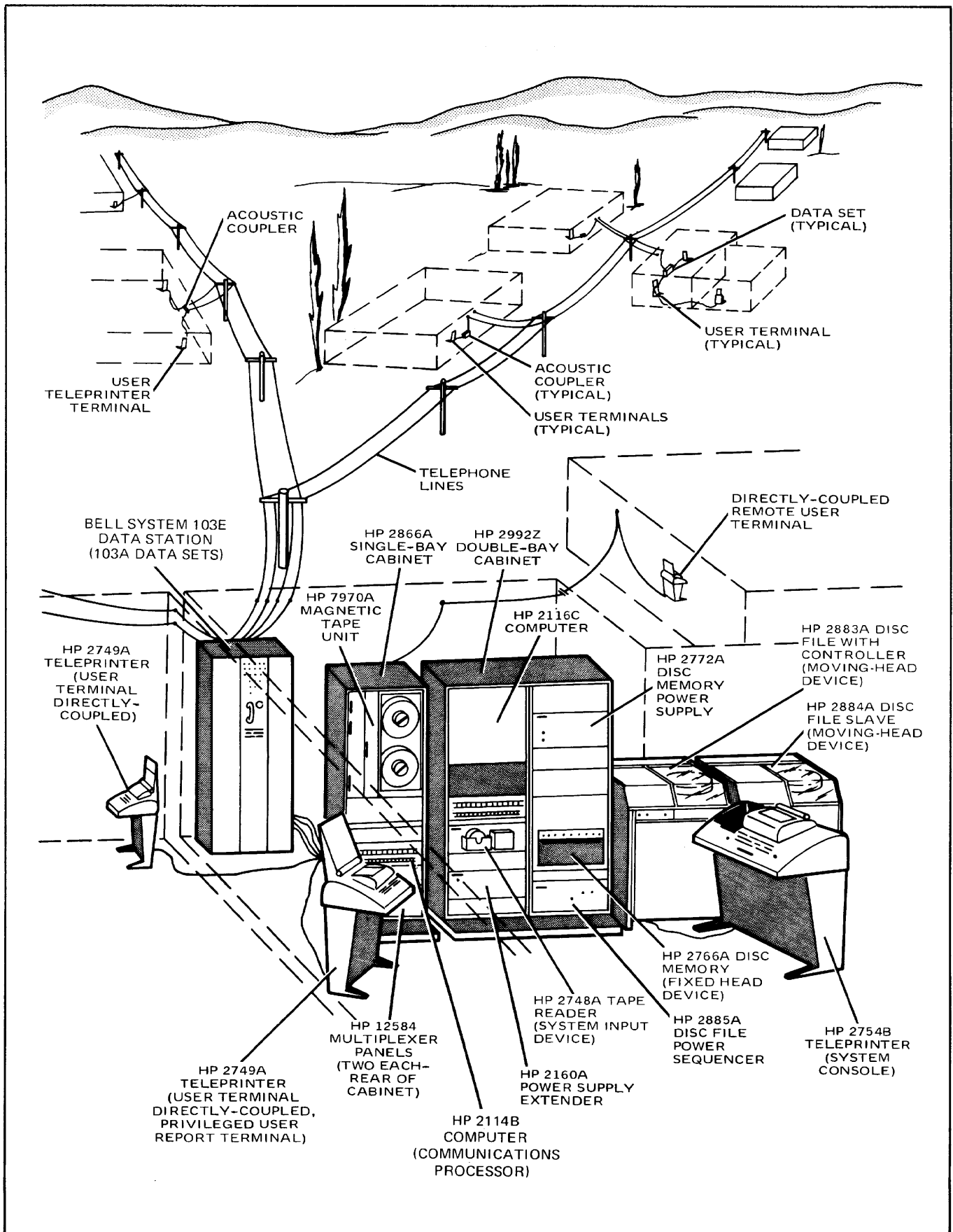
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Figure 1-0. Characteristic Hewlett-Packard 2000C Time-Shared BASIC System

SECTION I

SYSTEM DESCRIPTION

1-1. INTRODUCTION.

1-2. This reference manual provides system operators with a hardware oriented guide for the Hewlett-Packard 2000C Time-Shared BASIC System. Section I describes a representative 2000C system and its units. Section II provides a functional description of the time-shared system. Section III provides system preventive maintenance information.

1-3. Specific operating instructions for the system are provided in the "HP 2000C: Time-Shared BASIC System Operator's Guide" (part no. 02000-90017). An understanding of information in the operator's guide is essential in order to operate the system. An understanding of information in the user's guide "HP 2000C: A Guide to Time-Shared BASIC" (part no. 02000-90016) is also necessary to operate the system.

1-4. Any specific HP 2000C System will consist of the minimum configuration of equipment (operating in the time-shared mode) and will often include a number of customer-chosen options. Since the resulting total equipment configuration is usually unique for a given site, the minimum configuration equipment is emphasized throughout this manual. Alternate units that may be used in the minimum configuration are mentioned where applicable and optional additional equipment is also mentioned. Emphasis on any specific equipment in order to describe the minimum configuration or a functional concept is not intended to imply that the unit or units described are the only items of equipment that can be installed. Other units may be directly interchangeable or adaptable for use in fulfilling system intent unless otherwise indicated.

1-5. SYSTEM DESCRIPTION.

1-6. The HP 2000C System, shown in figure 1-0, and system software provide multiple-user access to a general purpose Hewlett-Packard computer. The BASIC (Beginners All-purpose Symbolic Instruction Code) language has been modified and extended by Hewlett-Packard to provide the programming tool used with the system. Table 1-1 is a consolidated list of the system equipment. The time-shared mode of operation for the equipment provides users with almost simultaneous use of the computer. Response time to any user is usually 0.3 second. Actual response time depends on the programs in use and the operating modes used within the programs. Connections to the system multiplexer facilities can be made through direct connections or through data sets. Acoustically coupled or hardwired devices may be employed for the data set at the user terminal end of the communications link. Up to 3,072 users may be accounted for in the system user-identification table (IDT) at any given time. Users, however, are served on

a first-call first-served basis up to the maximum number of system connections at any one time (16 for a minimum system).

1-7. Mass storage facilities for the system include a fixed-head device (FHD), moving-head device (MHD), and magnetic tape unit. The FHD is a rotating disc or drum memory unit used to retain programs and data tables for system operation, provide the user program swapping area, and provide storage for "sanctified" user programs and files. "Sanctified" programs and files are those user programs and files transferred from the MHD to the FHD to gain faster access time. The MHD is a rotating cartridge disc or disc file memory unit that is employed to store the bulk of user programs, libraries, and data files. The magnetic tape unit is used to obtain backup records of system and user programs and data (HIBernate and SLEep). (These commands, and others mentioned throughout the manual are described in the operator's guide.) The magnetic tape unit is also used to save and reload selected user programs and files (DUMp and LOAd).

1-8. The minimum FHD requirement for the system is generally filled by an HP 2766A-002 Magnetic Disc Memory unit with its power supply and interface kit. This requirement may alternately be filled with the HP 2773A-003 Drum Memory unit with its power supply and interface kit. The minimum MHD requirement for the system is filled by the HP 2870A Cartridge Disc with its controller, power supply, cabinet, and interface kit. Alternately the MHD requirement is filled with the HP 2883A Disc File with Controller, power unit, and interface kit. Either cartridge disc drives or disc files with their supporting units may be employed. The cartridge and file types of MHDs may not be intermixed however. The magnetic tape unit requirement is generally filled with the HP 7970A-202 Magnetic Tape Unit. The HP 3030G Magnetic Tape Unit may be used as an alternate. Mass storage may be increased by making expansions to the FHDs or additions to the MHDs. Generally the MHD capability is increased. Paragraphs 1-9 through 1-11 outline minimum and maximum storage capacities for the FHD and MHD units used in the system. The 32,768 word central processor and 8,192 word communications processor core memory capacities remain the same for increased mass storage configurations.

1-9. The primary FHD, minimum configuration for the system, is designated logical DRUM 0. The designation "drum" is used even though the FHD may physically be a disc memory device. Increases in FHD capacity may be made as shown in table 1-1. Absolute maximum FHD storage for the system is four logical disc units (i.e., DRUM 0 through DRUM 3). Additional information on logical unit designations for FHDs is contained in the operator's guide.

Table 1-1. HP 2000C Time-Shared BASIC System Configurations

MINIMUM HARDWARE CONFIGURATION TO SUPPORT 16 TERMINALS

1. Central Processor including the following:
 - 32,768-Word Memory
 - Direct Memory Access (DMA)
 - Extended Arithmetic Unit (EAU)
 - Memory Parity Check
 - Power Failure Interrupt with Automatic Restart
 - Time Base Generator
2. Communications Processor including the following:
 - 8,192-Word Memory
 - Power Failure Interrupt/Auto Restart
 - Memory Parity Check
 - Teleprinter Multiplexer with Telephone Auto-Disconnect for 16 Terminals
3. Processor Interconnect Hardware
4. High-Speed Tape Reader and Interface
5. System Console (HP 2754B Teleprinter) and Interface
6. Fixed-Head Mass Storage Device (1,048,576 bytes, expandable), Power Supply, and Interface
7. Moving-Head Mass Storage Cartridge Disc (2,494,464 bytes), Power Supply, Cabinet, and Interface
8. Magnetic Tape Unit (9-channel, 30,000 character-per-second) and Interface
9. Double-Bay Cabinet with Doors (208V, 3-phase, 60-hertz power)
10. Single-Bay Cabinet with Door
11. System Software and Accessories

SYSTEM OPTIONS*

- 001 1,572,864 Byte, Fixed-Head Mass Storage Device (16 terminal system only)
- 002 2,097,152 Byte, Fixed-Head Mass Storage Device (16 terminal system only)
- 003 32 Terminal Capability, including:
 - Additional HP 12584
Teleprinter Multiplexer with Telephone
Auto-Disconnect for 16 Additional Terminals
 - 1,572,864 Byte Fixed-Head Mass Storage Device
- 004 32 Terminal Capability, Expanded Fixed Head Mass Storage:
 - Additional HP 12584
Teleprinter Multiplexer with Telephone
Auto-Disconnect for 16 Additional Terminals
 - 2,097,152 Byte Fixed-Head Mass Storage Device
- 005 Moving-Head Mass Storage Device, Disc File (23,905,280 bytes), Controller, Power Supply and Interface. Delete Cartridge disc
- 015 230V, 50 Hz Operation

Table 1-1. HP 2000C Time-Shared BASIC System Configurations (Continued)

OPTIONAL PERIPHERAL EQUIPMENT

1. Additional Moving-Head Mass Storage Devices, Cartridge Discs (2,494,464 bytes each, system must not include Option -005)
 - 2nd, 4th, 6th, or 8th Drive
 - 3rd or 7th Drive with Power Supply and Cabinet
 - 5th Drive with Power Supply, Cabinet, Controller, and Interface
2. Additional Disc Cartridge (HP 12563A)
3. Additional Moving-Head Mass Storage Devices, Disc Files (23,905,280 bytes each, system must contain Option -005)
 - 2nd, 4th, 6th, or 8th Drive
 - 3rd, 5th**, or 7th** Drive with Controller and Interface
4. Additional HP 12868A Disc Pack
5. Teleprinter Terminal consisting of:
 - HP 2749A Teleprinter (with X-ON/X-OFF reader control option), plug compatible with a Bell System 103A Data Set and/or the 16 Terminal, Teleprinter Multiplexer
6. Keyboard-Display Terminal consisting of:
 - HP 2600A (CRT) Keyboard-Display, plug compatible with a Bell System 103A Data Set and/or the 16 Terminal, Teleprinter Multiplexer
7. Teleprinter Extender Cable, 25 foot (minimum) to 500 foot lengths
8. Data Set Cable, 25 feet, (HP part no. 12584-6006)

NOTES:

- * Either Option -001, -002, -003, or -004 may be used, but no more than one of these four options may be entered on any one system.
- ** Addition of 5th or 7th Drive may require I/O extension of the central processor. Factory consultation is necessary when adding maximum configuration of drives.

A discussion of physical FHD characteristics is contained in paragraphs 1-24 through 1-33. Criteria for expanding FHD capacity in the system is contained in paragraphs 1-44 through 1-52. FHD storage limits for the system are as follows:

- a. Minimum FHD capacity allowable in the system is 1,048,576 bytes (524,288 words).
- b. Maximum FHD capacity allowable in the system is 4,194,304 bytes (2,097,152 words).

1-10. The first MHD in the system is designated logical DISc 0. MHD capacity may be increased in increments equal to the first MHD as designated in table 1-1. The maximum MHD capacity in the system is eight drives (DISc 0 through DISc 7). The minimum configuration HP 2000C System utilizes a cartridge disc as the first MHD (as shown in table 1-1). MHD storage limits using the cartridge disc units in the system are as follows:

- a. Minimum MHD capacity allowable in the system using the cartridge disc as the first MHD (DISc 0) is 2,494,464 bytes (1,247,232 words).
- b. Maximum MHD capacity in the system using eight cartridge discs (DISc 0 through DISc 7) is 19,955,712 bytes (9,977,856 words).

1-11. Logical designations for the disc file units are the same as those for the cartridge disc units described in paragraph 1-10. Further information on logical unit designations for the MHDs is contained in the operator's guide. A discussion of physical MHD characteristics is contained in paragraphs 1-27 through 1-30. Information related to additional MHDs in the system is contained in paragraphs 1-47 through 1-50. MHD storage limits when using disc file units in the system are as follows:

- a. Minimum MHD capacity when using a disc file as the first MHD (DISc 0) is 23,905,280 bytes (11,952,640 words).

- b. Maximum MHD capacity when using eight disc files (DISc 0 through DISc 7) is 191,242,240 bytes (95,621,120 words).

1-12. Control programs for the system are input through the system high-speed paper tape reader. The system console, and user terminals accessed by ID codes A000 or Z999, are used for system control and monitoring.

1-13. MAJOR UNITS.

1-14. The minimum hardware configuration for the system consists of the equipment specified in table 1-1 mounted in an HP 2992Z Double-Bay Cabinet and one HP 2866A-001 Single-Bay Cabinet. The two cabinets, the HP 2754B Teleprinter (system console), and one free-standing MHD mass storage unit comprise the four major units of the minimum configuration system.

Note: Data sets and possibly an HP 2749A Teleprinter may be located at the computer site.

1-15. The central processor, high-speed tape reader input device, and central processor power supply extender are usually located in the left bay of the double-bay (main) cabinet. The primary fixed-head mass storage device, and its power supply usually mount in the right bay of the main cabinet. If the HP 2883A Disc File with Controller is used as the first system MHD, its power sequencer also mounts in the right bay. The communications processor usually mounts below the magnetic tape unit in the single-bay (extender) cabinet. The teleprinter multiplexer panel mounts in the rear of the extender cabinet. Option 001 for the HP 2866A Single-Bay Cabinet furnishes a power module and ac power control separate from that present in the main cabinet. Systems updated from an HP 2000B configuration usually require two HP 2866A Single-Bay Cabinets because of a requirement for the HP 2150B-002,-003 I/O and Memory Extender to upgrade the central processor to a 32,768 word core memory for the HP 2000C System. (A second double-bay cabinet could be used in lieu of two single-bay units.) One single-bay cabinet holds the communications processor and multiplexer panel. The second single-bay cabinet holds the magnetic tape unit mounted above the HP 2150B-002,-003 Memory and I/O Extender. The HP 2150B must be used if the central processor is an HP 2116B-005 Computer. Other equipment configurations may exist that meet system requirements.

Note: Two multiplexer panels may be mounted in the rear of the single-bay cabinet holding the communications processor. Expanded system configurations are discussed in paragraph 1-42.

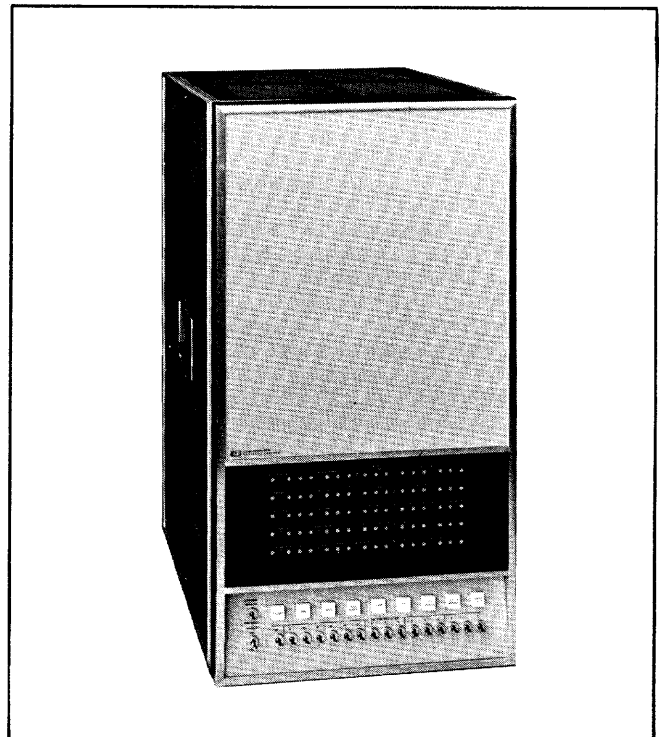
1-16. Remote user terminals directly connected to the multiplexer panel through cables can be located within a one-mile (1609-meter) radius. User terminals communicating with the system through data sets and the Bell System type 103E Data Station (equivalent sets can be

used), can be any distance from the central location. Further details are outlined in the following paragraphs on units that fill the requirements for:

- a. Central processor.
- b. Central processor power supply extender.
- c. System input device.
- d. Primary FHD.
- e. First MHD.
- f. Magnetic tape unit.
- g. Communications processor.
- h. Multiplexer facilities.
- i. System console.
- j. Terminals.

1-17. Refer to the operating and service manuals on the devices and interface kits discussed for specific equipment details. Optional additional equipment is described in paragraph 1-42.

1-18. **CENTRAL PROCESSOR.** The central processor unit for the HP 2000C System requires a 32,786-word core memory. This unit is generally an HP 2116C Computer with option 007 (see figure 1-1). The central processor unit with required options and accessories forms the central processor "group". System control programs, driver routines, and the BASIC language interpreter program are retained in the central processor core memory. This group controls all system functions and user program processing and interpretive execution except for terminal communications control. The communications processor, described in paragraph 1-34, accomplishes the user terminal input/output control functions.



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Figure 1-1. Representative Central Processor, HP 2116C Computer

1-19. Accessories needed for the HP 2116C-007 or HP 2116B-005 (with HP 2150B-002,-003) are listed below. All accessories mount in the card cage of the central processor.

- a. Direct Memory Access (DMA), HP 12578A (5 cards).
- b. Extended Arithmetic Unit (EAU), HP 12579A (2 cards).
- c. Power Failure Interrupt with Automatic Restart, HP 12588A (1 card).

Note: The "halt-restart" switch on the power-failure/automatic-restart card must be in the up (restart) position for time-shared operation.

- d. Memory Parity Check with Interrupt, HP 12591A, (1 card).

Note: The "interrupt-halt" switch on the memory parity check card must be in the up (halt) position for time-shared operation.

- e. Time Base Generator, HP 12539A or B (1 card, select code 16).

1-20 The cards contained in the following interface kits also mount in the central processor card cage and connect to peripheral devices via interface cables. This list generally represents the interfaces to "facilities" of the system (i.e., mass storage facilities, system input/output and control facilities). Variations and details of interfaces are discussed under the applicable peripheral device paragraphs that follow.

- a. Disc Memory Interface Kit (primary FHD), HP 12610C (2 cards, select codes 14 and 15).

Note: The "track protect" switch on the FHD data channel interface card must be in the down position to allow read/write operation on all tracks of the FHD.

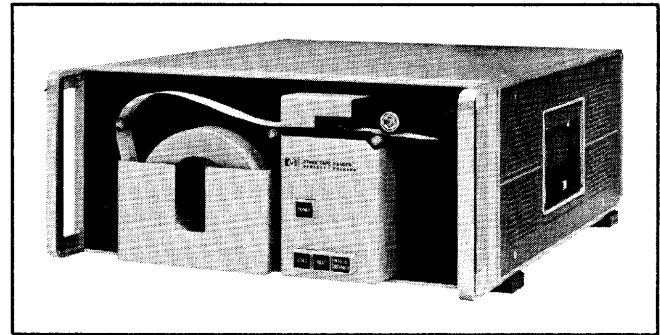
- b. Disc File Interface Kit (first MDH), HP 12565A (2 cards, select codes 17 and 20).
- c. 9-Channel Magnetic Tape Input/Output Interface Kit, HP 13181A (2 cards, select codes 21 and 22).

Note: Additional mass storage device interface cards should always be higher in select-code priority than the magnetic tape unit. See paragraph 1-42 on expanded system configurations.

- d. High-Speed Tape Reader Interface Kit (system input device), HP 12597A-002 (1 card, select code 13).
- e. Teleprinter Input/Output Interface Kit (system console), HP 12531B or C (1 card, select code 12).

1-21. The central processor group and the communications processor are connected together by the HP 12875A Processor Interconnect Kit. Two cards of the kit mount in the central processor card cage in select codes 10 and 11 and two cards mount in the communications processor card cage in select codes 12 and 13. The card in select code 10 must connect to the card in select code 13 in the communications processor. The card in select code 11 must connect to the card in select code 12 in the communications processor. If optional additional equipment is added in the system, the interface kit cards mount in the central processor card cage. When maximum configuration systems are installed, an I/O extender unit is needed for the magnetic tape unit interface, (see paragraph 1-42 on expanded systems).

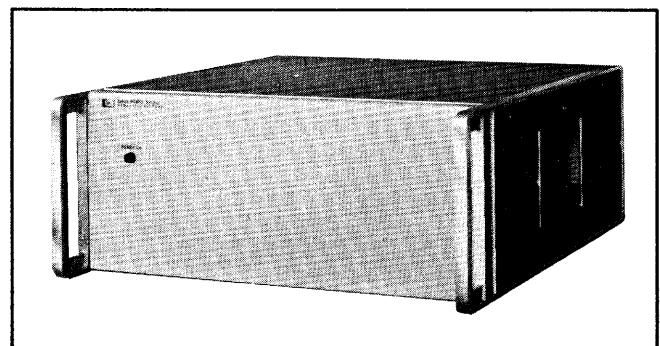
1-22. SYSTEM INPUT DEVICE. The primary input device for initial loading of system software is the high-speed paper tape reader. Other types of input devices for the system, such as teleprinters and the magnetic tape unit, are described later. The HP 2748A Tape Reader shown in figure 1-2 is the unit used in the HP 2000C System. The unit usually mounts just below the central processor. The HP 12597A-002 High-Speed Tape Reader Interface Kit is used with the HP 2748A.



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Figure 1-2. System Input Device, HP 2748A Tape Reader

1-23. CENTRAL PROCESSOR POWER SUPPLY EXTENDER. The HP 2160A Power Supply Extender, shown in figure 1-3, provides additional current for the central processor -2-volt and +4.5-volt internal power supplies. A dc power cable and a control cable connect the power supply extender directly to the central processor.

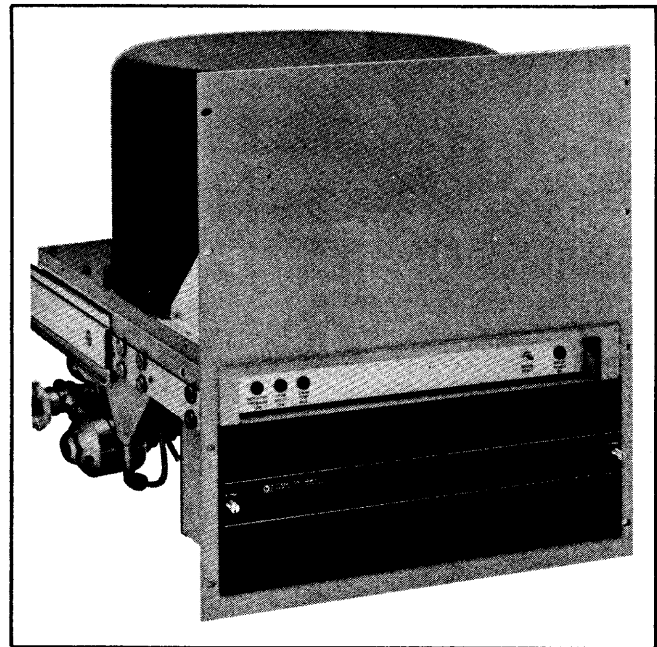


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Figure 1-3. HP 2160A Power Supply Extender

1-24. **FIXED-HEAD MASS STORAGE DEVICES.** The primary fixed-head device (FHD) for the minimum configuration system is the HP 2766A-002 Magnetic Disc Memory Unit (see figure 1-4). Option 002 for the HP 2766A designates the 524,288 word (1,048,576 byte) storage capacity (minimum requirement for the system primary FHD). The HP 2773A-003 Drum Memory Unit (same storage capacity) may be used in some system installations. Either unit usually mounts below the required power supply in the right bay of the main cabinet. Power supplies for the primary FHDs are discussed in paragraph 1-26. Connection to the central processor is made from the HP 2766A-002 through the cable and the command and data cards of the HP 12610C Disc Memory Interface Kit. (The HP 12610B Drum Memory Interface Kit is used if an HP 2773A-003 is the primary FHD.) Operation of the FHD requires the computer to be equipped with DMA to permit data transfer directly to or from core. Definitions and characteristics described below are applicable to either type of FHD when used in the system.

- a. Storage words are considered 16-bit words.
- b. Each sector on FHD tracks comprises 64 words.
- c. To make the distinction clear, physical tracks in mass storage devices are referred to as "physical tracks" whereas tracks referred to for system programming are called "logical tracks". Logical tracks are usually discussed.
- d. There are 32 sectors per FHD physical track.
- e. Logical tracks in the FHD comprise four physical tracks (128 sectors).
- f. System software is designed to transfer data with FHD units comprised of 64 logical track multiples. Each 64 logical tracks in a given FHD are called one "drum" unit in the HP 2000C even though the physical unit might be a disc (see the operator's guide).



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Figure 1-4. Commonly Used Fixed-Head Mass Storage Device, HP 2766A Magnetic Disc Memory Unit

1-25. Since the FHDs are defined as logical "drum" units of 64 logical tracks, certain precautions must be taken with units that do not have 64 logical track multiples when using expanded configuration units. Refer to the operator's guide for instructions on using the LOCK and UNLOCK commands at the system console to control the FHD. Table 1-2 summarizes characteristics of FHDs that may be used as the primary FHD in the system. The minimum system FHD (1,048,576 bytes) equals one "drum" unit (DRUM 0). See paragraph 1-42 for a discussion of expanded system requirements. Logical unit 0 in each case comprises logical tracks 0 through 63. Logical unit 1 in the 96 logical track units comprises logical tracks 64 through 95 while the 128 logical track units have logical tracks 64 through 127.

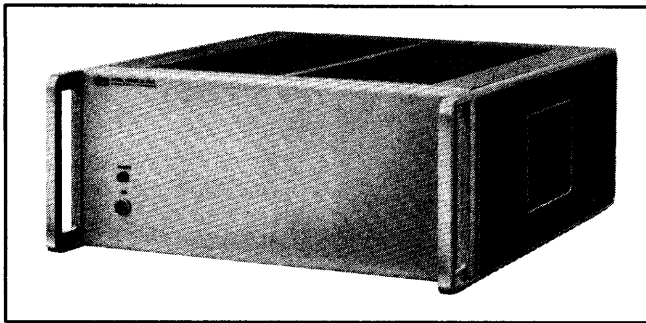
Table 1-2. Fixed-Head Mass Storage Devices

HP FHD MEMORY UNIT MODEL NUMBER/OPTION	NUMBER OF LOGICAL TRACKS	FHD CAPACITY (BYTES)	LOGICAL DISC UNITS	HP INTERFACE KIT USED	HP POWER SUPPLY USED
2766A-002 Disc	64	1,048,576	0	12610C	2772A
2766A-003 Disc	96	1,572,864	0,1*	12610C	2772A
2766A-004 Disc	128	2,097,152	0,1	12610C	2772A
2773A-003 Drum	64	1,048,576	0	12610B	2776A
2774A Drum	96	1,572,864	0,1*	12610B	2776A
2774A-003 Drum	128	2,097,152	0,1	12610B	2776A

NOTES:

- 1. Logical DISC 0 is always assumed to be in the system.
- 2. *Indicates tracks 32 through 63 must be locked in unit 1.

1-26. **FIXED-HEAD DEVICE POWER UNITS.** The HP 2766A Magnetic Disc Memory requires the HP 2772A Power Supply for ac and dc power. The HP 2772A is the FHD power unit commonly used (see figure 1-5) since the HP 2766A is usually used as the system primary FHD. If the HP 2773A or HP 2774A Drum Memory is used, it requires the HP 2776A Power Supply. Either unit mounts above the memory device in the right bay of the main cabinet. Either unit is controlled by and provides power to its respective FHD through power and control cables connected directly between the units.



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Figure 1-5. Fixed-Head Device Power Unit, HP 2772A Disc Memory Power Supply

1-27. **MOVING-HEAD MASS STORAGE DEVICES.** The first moving-head device (MHD) requirement for the system is filled by the HP 2870A Cartridge Disc Drive. The HP 2883A Disc File with Controller (see figure 1-6) may also be used as an alternate. The MHD is used to store user programs, libraries, and data files. It may also be used to store all system and user programs and files while the system is shut down for maintenance.

1-28. Either MHD (with required support units) is a free-standing unit, except that the HP 2883A requires the HP 2885A Disc File Power Sequencer. Power units for the MHDs are described in paragraph 1-31. The controller for the HP 2883A mounts inside the free-standing cabinet. The HP 2870A Cartridge Disc Drive, HP 2871A Cartridge Disc Controller (and Channel Adapter), and power supply all mount in an HP 2882A Cartridge Disc Cabinet. As previously mentioned, the two types of MHDs cannot be intermixed.

1-29. Connection to the central processor is made from the controller in the HP 2883A through the cable and the command and data cards of the HP 12565A Disc File Interface Kit. The HP 12557A Cartridge Disc Interface Kit is used in a similar manner for connection to the central processor from the HP 2871A if the HP 2870A Cartridge Disc Drive is used. Operation of either type MHD requires the computer be equipped with DMA.

1-30. The removable, 11-disc HP 12868A Disc Pack for the HP 2883A MHD is installed from the top of the disc file. The HP 12563A Cartridge Disc for the HP 2870A is a single disc installed from the front of the unit. The HP 2870A also contains one fixed disc. The fixed disc of the HP 2870A must not be disturbed if the time shared system

is to be reloaded from the disc. If new HP 12868A Disc Packs or HP 12563A Cartridge Discs are installed in the system they must be checked and formatted in accordance with procedures in the operator's guide before operation. Recording heads in either unit move between the rotating disc surfaces, thus the name "moving-head device" (MHD). Definitions and characteristics described below are applicable to either type MHD unless otherwise stated.

- a. Words are composed of 16 bits.
- b. Sectors are composed of 128 words.
- c. Blocks equal 256 words (2 sectors).
- d. In the HP 2883A MHD there are 23 sectors per physical track, while there are 12 sectors per physical track in the HP 2870A MHD.
- e. In the HP 2883A and HP 2870A there are 203 cylinders within the disc pack or disc cartridge, respectively.
- f. In the HP 2870A (minimum configuration unit), each cylinder contains four physical tracks. In the HP 2883A, each cylinder contains 20 physical tracks. The number of tracks available in a cylinder correspond to the number of read/write heads used.
- g. In the HP 2000C, "blocks" are the primary storage measurements, not sectors or tracks.
- h. The first MHD contains 46,690 blocks of storage (11,952,640 words) if it is an HP 2883A. If the first MHD is an HP 2870A, it contains 4,872 blocks (1,247,232 words) of storage.

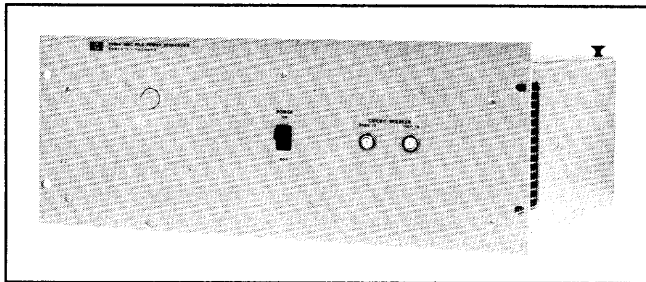


2093-111

Figure 1-6. Moving-Head Mass Storage Device, HP 2883A Disc File with Controller

- i. The First MHD for the system is defined as DISC 0. It must always be in the system. (See the operator's guide for hardware configuration commands.)

1-31. **MOVING-HEAD DEVICE POWER UNITS.** The HP 2885A Disc File Power Sequencer shown in figure 1-7 furnishes filtered ac power to the HP 2883A Disc File with Controller. The unit sequences turn-on power to the disc file controller, and provides ac voltage to the drive units. The HP 2885A mounts in the right bay of the main system cabinet below the primary FHD. If the HP 2870A Cartridge Disc Drive is used as the first FHD, its HP 2881A Cartridge Disc Power Supply mounts in the HP 2882A cabinet with other support units. Cables connect the power unit directly to associated MHD units.



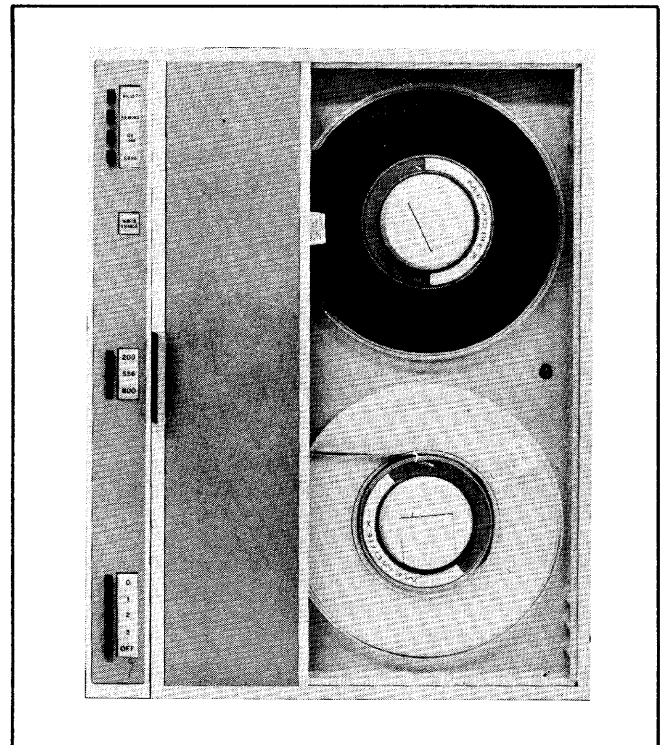
2093-112

Figure 1-7. Moving-Head Device Power Unit, HP 2885A Disc File Power Sequencer

1-32. **MAGNETIC TAPE MASS STORAGE DEVICES.** The unit used to fill the magnetic tape storage requirement in the minimum configuration system is the HP 7970A-202 Magnetic Tape Unit (see figure 1-8). The 30,000 character-per-second, 9-channel device provides storage for system programs and tables, and for users programs and files. (See the operator's guide for instructions on using the HIBernate and SLEep commands.) The device is also used to DUMp or LOAd selected programs and files. The HP 7970A-202 usually mounts in the system extender cabinet above the communications processor. Connection to the central processor is made through the cable, and the command and data cards of the HP 13181A 9-Channel Magnetic Tape Input/Output Interface Kit.

1-33. In some installations, the HP (H01) 3030G Magnetic Tape Unit with HP 12559A 9-Channel Magnetic Tape Input/Output Interface Kit may be used in lieu of the HP 7970A model. The 60,000 character-per-second HP 3030G is a free-standing unit. The interface kit for this last magnetic tape unit connects to the central processor in the same manner as mentioned for the HP 7970A-202 model. Power requirements for these units are satisfied by power supplies within the device itself.

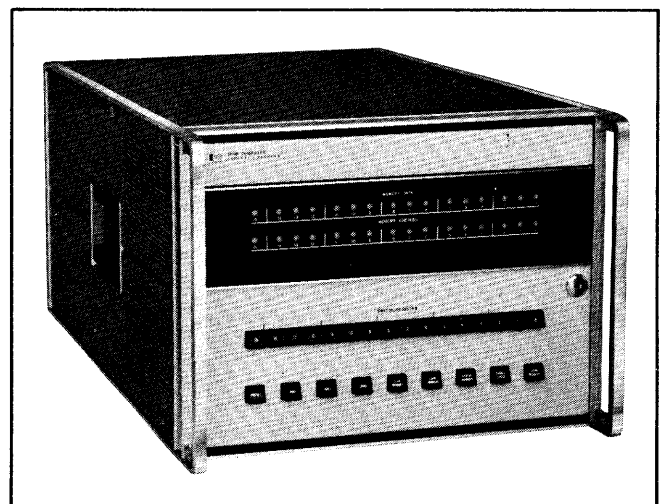
1-34. **COMMUNICATIONS PROCESSOR.** The HP 2114B Computer (see figure 1-9) is the commonly used unit used to control user communications with the system through the multiplexer facilities. The computer processes input/output programs for up to 32 user terminals, connected through the HP 12584 series Teleprinter Multiplexer Interface, in what appears to be a simultaneous manner. (The minimum system configuration consists of 16 termi-



2093-27

Figure 1-8. Mass Storage Device, HP 7970A Magnetic Tape Unit

nals.) All user input/output is passed to and received from the central processor via the processor interconnect facilities. The multiplexer driver program, control routines, teleprinter tables, and I/O buffer storage areas for up to 32 terminals have assigned locations in the 8,192-word core memory provided by option 004 to the HP 2114B Computer. (Other computers satisfying the 8,192-word requirement and other requirements outlined below may be used.) Option 008, Power Failure Interrupt/Automatic Restart, and the HP 12598A Memory Parity Check Accessory are also required with the computer. The HP 12598A card mounts in a pre-designated location in the HP 2114B Com-



2093-64

Figure 1-9. Communications Processor, HP 2114B Computer

puter card cage. Two cards of the HP 12584 series Teleprinter Multiplexer Interface Kit (for the 16 terminal minimum configuration system) also mount in the computer card cage. Additional information on the multiplexer cards is contained in paragraph 1-35. Information on expanded (32 terminal) configurations is covered in paragraph 1-42. Two interprocessor communication channels are provided by the four cards of the HP 12875A Processor Interconnect Kit. Two of the cards mount in the communications processor card cage in select codes 12 and 13. The other two cards of the kit mount in the central processor card cage in select codes 10 and 11. The card in select code 12 must connect to the card in select code 11 in the central processor. The card in select code 13 must connect to the card in select code 10 in the central processor.

1-35. **MULTIPLEXER FACILITIES.** The multiplexer facilities provide an interface between multiple user terminals and the communications processor. One HP 12584C Teleprinter Multiplexer Interface Kit is usually used for the minimum configuration HP 2000C System. (The HP 12584B Teleprinter Multiplexer Kit may also be used. Two multiplexer interface kits provide connection points for 32 ports (maximum connection configuration for the system).

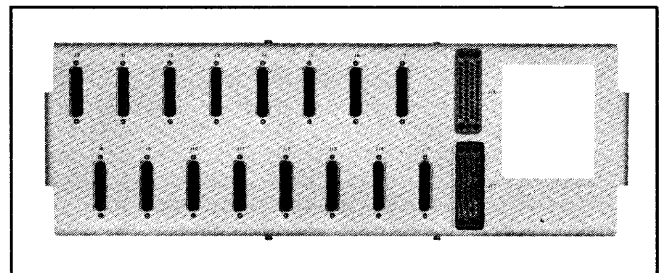
Note: Receptacle connectors on the multiplexer panel used to connect user terminals are referred to as ports of the system.

Each multiplexer kit provides connection points for 16 user terminals. When 32 port capability is used, the FHD for the system must have a 786,432-word (1,572,864 byte) capacity. (Additional information on expanded systems is contained in paragraph 1-42.) Where operation is fixed at 220 baud (20 characters per second) for all terminals rather than at 110 baud (10 characters per second), a maximum of 16 terminals can be serviced (even though two multiplexer kits are used). This situation will occur, for example, where all user terminals are HP 2600A Keyboard-Displays operating at the higher data transfer rate. Refer to the operator's guide for the use of the FAST and SLOW commands to control these rates. Where all user terminals are HP 2749A Teleprinters operating at 10 characters per second, two multiplexer kits can provide the total 32 terminal capability.

1-36. When HP 2749A Teleprinter terminals are located out of the local area, (cable length more than a mile, or 1609 meters, maximum) telephone line service (private or commercial) is required to communicate with the system. In this case, each port on the multiplexer panel used for remote service must connect directly to a data set. A Bell System type 103E Data Station (or equivalent) may be used where multiple data sets are employed. The PHONES command is used by the system operator to time disconnects during data set operation.

1-37. In a 32 port system, both panels for the multiplexer interface kits mount on the rear vertical Unistrut channels in the cabinet containing the communications processor. A representative panel, the connection point for 16 user terminals, is shown in figure 1-10. The ring carrier

card (one per panel) mounts on the opposite side of the panel from that shown in figure 1-10. With a 16 port system, (minimum connection configuration) one panel is used and the multiplexer interface card of the HP 12584 series Teleprinter Multiplexer Kit is installed in select code 10 in the communications processor. The auto-disconnect card of the first multiplexer kit mounts in select code 14. A priority jumper is used in select code 11 in this case. In a 32 port system the multiplexer card for the second panel replaces the priority jumper card in select code 11 and the auto-disconnect card for the second panel mounts in select code 15. In the 32 (maximum) terminal configuration system, four interface cables connect from the panels to the communications processor.



2069-11

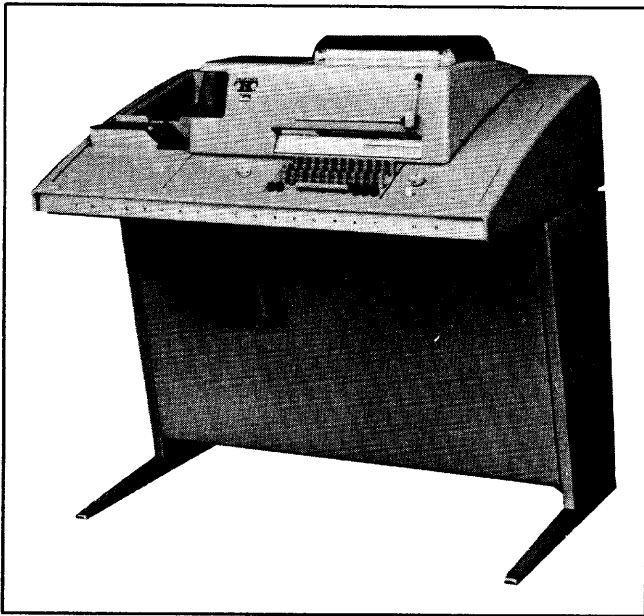
Figure 1-10. Multiplexer Facilities, HP 12584 Series Teleprinter Multiplexer Panel

CAUTION

The multiplexer and auto-disconnect cables from the panels to the cards in the communications processor must remain as installed in order to have the system operate in the time-shared mode. The cables cannot be interchanged. (Refer to the HP 12584 series Teleprinter Multiplexer Interface Kit Operating and Service Manual for further information.)

1-38. **SYSTEM CONSOLE.** The system operator monitors and controls user access to the HP 2000C System through the system console. The operator controls system configuration, obtains reports, and communicates with user terminals using the heavy duty HP 2754B Teleprinter (see figure 1-11). Certain system reports may also be obtained from the A000 user terminal which connects to the system through the multiplexer facilities. Refer to the operator's guide for complete details on system commands and operation. The system console is located in the immediate area with the system cabinets and connects to the central processor through the cable and interface card of the HP 12531B or C Teleprinter Interface Kit. The card mounts in the central processor card cage in select code 12.

1-39. **USER TERMINALS.** Any of the user terminals connected to the system allow the programmer to communicate with the central processor using the extended time-shared BASIC language. The total HP 2000C Time-Shared BASIC System exists to provide individual users at multiple terminals with a means to enter and execute programs.



2069-8

Figure 1-11. System Console, HP 2754B Teleprinter

1-40. The most commonly used terminal is the 10 character-per-second teleprinter shown in figure 1-12. This unit provides a keyboard for data entry, and a printer assembly to record input/output data exchanged with the system. A paper tape punch and paper tape reader are also located on the unit. All programming generated by users is originated on the user's terminal keyboard but may be read into the system through the terminal paper tape reader using the X-ON, X-OFF feature of the teleprinter. The publication "HP 2000C: A Guide to Time-Shared BASIC" (part no 02000-90016) outlines procedures for programming and for operation of the unit. The 20 character-per-second HP 2600A Keyboard-Display Terminal uses a CRT display for readout. It may be used as a direct replacement for the teleprinters. (Tape reader and punch are not included in the HP 2600A, however.)

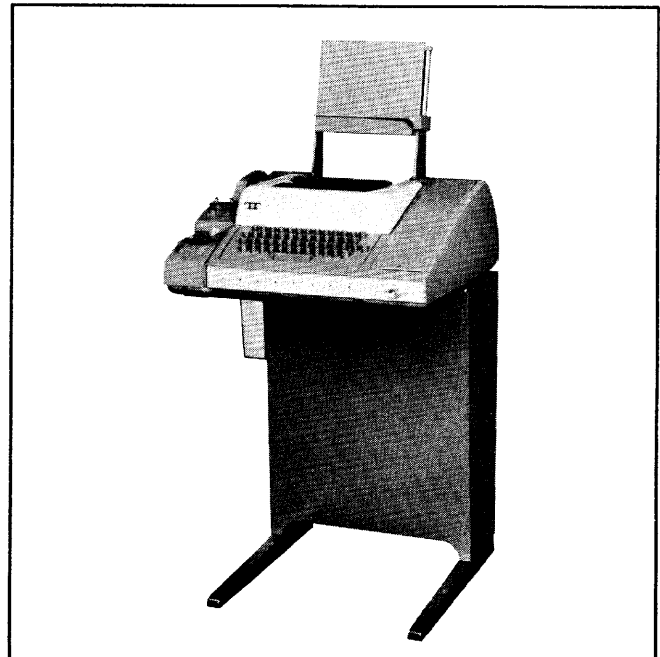
1-41. User terminals may be located any distance from the main system equipment. Terminals directly coupled to the multiplexer panel may be located within a one-mile (1609-meter) radius (cable distance) from the system. User terminals outside this local area connect with the multiplexer panel via data sets that are acoustically coupled or hardwired to the telephone facilities. Connection to multiplexer ports through data sets can be made for terminals in the local area to avoid long cable runs. Several classifications for operating terminals exist. These classifications are determined by the identification codes assigned (i.e., A000, BX00, Z999, etc.). See the system operator's guide for ID code assignment and use instructions.

1-42. OPTIONAL ADDITIONAL EQUIPMENT.

1-43. Preceding paragraphs describe a typical minimum configuration of system equipment. The following paragraphs discuss equipment that may be added to the HP 2000C Time-Shared BASIC System to increase operational

capability. While line printers, card readers, or other devices may be associated with the system for use in other operating modes, only equipment that is added for the purpose of extending the time-shared operating mode capability is mentioned. Equipment additions usually occur in one or both of the following areas; mass storage facilities, or user terminals. Mass storage facility additions in the fixed-head device (FHD), and moving-head device (MHD) categories may be made subject to restrictions outlined in the following paragraphs.

1-44. **FIXED-HEAD DEVICE ADDITIONS.** Some applications of the time-shared system (i.e., CAI-Math) may require the use of more FHD storage because of a rapid access time requirement. System option-001 provides a 786,432 word (1,572,864 byte) FHD with the 16 terminal system. System option -002 provides a 1,048,576 word (2,097,152 byte) FHD within the 16 terminal system. (See tabel 1-1.) A total of four fixed-head mass storage devices of 64 logical tracks each may be used in the system (maximum of 256 logical tracks). Logical unit 0 (DRUM 0) is always considered to be in the system. This means that up through logical unit 3 may be added by various physical combinations of FHDs. Characteristics of the HP 2766A, HP 2773A, or HP 2774A are discussed in paragraphs 1-24 and 1-25 and shown in table 1-2. A review of these characteristics will show that optimum equipment for maximum FHD storage will comprise two 1,048,576 word FHDs. It should be noted that the maximum allowable FHD storage (256 tracks) is available only if the FHDs are exact multiples of 64 logical tracks. Unit and track declarations on the system console can vary considerably if mixtures of HP 2766A-003 and HP 2766A-004 (HP 2773A-003, or HP 2774A and HP 2774A-003) units are used. Refer to the operator's guide for instructions on FHD ("drum") logical unit and logical track commands.



2069-9

Figure 1-12. Common User Terminal, HP 2749A Teleprinter

1-45. When the second physical FHD is added in the system, an additional FHD power unit is also required. This will be an HP 2772A for the HP 2766A FHDs, or HP 2776A if the HP 2773A or HP 2774A Drum Memory Unit is used. An additional cabinet is required to mount the FHD and its power unit. Two cards of an additional HP 12610C (or HP 12610B) Interface Kit for the HP 2766A (HP 2773A or HP 2774A) also mount in the central processor card cage.

1-46. The requirements for additional FHD storage may depend upon several factors other than those for having large numbers of programs "sanctified" (moved from the MHD to the FHD). For example, the minimum 524,288 word (1,048,576 byte) capacity FHD must be increased to 786,432 words (1,572,864 bytes) if a 32 port configuration system is used (option -003 for the system). Other factors that may govern increased FHD capacity are the number of user swap tracks allocated, or the number of directory tracks allocated for MHD control, or the number of IDT (identification table) tracks allocated, or whether or not the maximum MHD configuration is used, or a combination of the above factors. Refer to paragraph 1-51 for overall considerations involved when adding FHD equipment to the system.

1-47. MOVING-HEAD DEVICE ADDITIONS. Expanded storage for user programs, libraries, and files may be obtained by having up to eight MHD units on-line. The first moving-head device (DISC 0) is required in the system. This moving-head device (MHD) may be an HP 2870A Cartridge Disc Drive (minimum system) or an HP 2883A Disc File with Controller (system option -005). Requirements for making additions using the disc files (with disc packs) are discussed first in the following paragraphs. Requirements for making MHD additions using cartridge discs are discussed second. Recall that the two types of equipment cannot be mixed. Refer to paragraph 1-51 for overall considerations involved when adding either type of MHD to the system.

1-48. Moving-head devices in the system are considered as a linear sequence of 256-word blocks of storage. Disc file units (using the HP 12868A Disc Packs) each comprise 46,690 blocks of storage. Total on-line MHD storage obtainable with disc packs is therefore 326,830 blocks (95,621,120 words of 191,242,240 bytes), using DISC 0 through DISC 7.

Note: When adding disc files in the system it is necessary to format the new disc packs and isolate any defective sectors in accordance with procedures outlined in the operator's guide.

Each HP 2883A Disc File unit contains a controller that serves to drive the HP 2883A Disc File and one HP 2884A Disc File Slave unit. Each controller requires connection to the central processor through the command and data cards of an HP 12565A Disc File Interface Kit. The sequence for adding units in the system one at a time is:

a. Add an HP 2884A Disc File Slave. (Driven by the first HP 2883A Controller.)

- b. Add the second HP 2883A and interface kit.
- c. Add an HP 2884A Disc File Slave. (Driven by the second HP 2883A Controller.)
- d. Add the third HP 2883A and interface kit.
- e. Add an HP 2884A Disc File Slave. (Driven by the third HP 2883A Controller.)
- f. Add the fourth HP 2883A and interface kit.
- g. Add the fourth HP 2884A Disc File Slave. (Driven by the fourth HP 2883A Controller.)

Note: When more than six disc file units are added in the system, (i.e. the fourth HP 2883A and HP 2884A) factory consultation is required.

1-49. One HP 2885A Disc File Power Sequencer, mounted in the main cabinet, will drive four HP 2883A FHDs with controllers and their HP 2884A Disc File Slave units (see the second note in paragraph 1-48, however). All HP 2883A and HP 2884A Units are free-standing. Characteristics applicable to all disc file units are outlined in paragraph 1-30. Refer to the operator's guide for information on commands to be used to control additional disc file units.

1-50. The HP 2870A Cartridge Disc Drive is employed as the MHD in minimum configuration HP 2000C Systems. These units are also considered as a linear sequence of storage blocks in the system. Each HP 2870A comprises 4,872 256-word blocks of storage. Total on-line MHD storage obtainable with the fixed and removable cartridge disc (HP 12563A) of the HP 2870A is 38,976 blocks (9,977,856 words or 19,955,712 bytes), using DISC 0 through DISC 7.

Note: When adding cartridge discs in the system it is necessary to format the new cartridge units and isolate any defective sectors using procedures outlined in the operator's guide.

As described in paragraph 1-28, the first HP 2870A for the system mounts in the HP 2882A Cabinet with an HP 2871A Cartridge Disc Controller (and Channel Adapter), and HP 2881A Power Supply as a free-standing unit. One additional HP 2870A (DISC 1) with cable assemblies can be mounted in the existing HP 2882A Cabinet. Table 1-3 simplifies the explanation of additional equipment requirements. Refer to paragraph 1-30 for characteristics of the HP 2870A, and to the operator's guide for information on commands used to control the additional cartridge disc units.

1-51. OVERALL MASS STORAGE DEVICE CONSIDERATIONS. In general, the units that appear as addi-

Table 1-3. Cartridge Disc MHD Equipment Configurations

HP 2870A DRIVE	HP 2871A CONTROLLER	HP 2881A POWER SUPPLY	HP 2882A CABINET	HP 12557A INTERFACE
1	1	1	1	1
2	1	1	1	1
3	1	2	2	1
4	1	2	2	1
5	2	3	3	2
6	2	3	3	2
7	2	4	4	2
8	2	4	4	2

tions in most installations are the HP 2883A and HP 2884A Disc File units. These and other equipment additions to the system mean that consideration must be given to site space, power, and cooling requirements. Where maximum FHD and MHD unit configurations are installed (with storage capacities as outlined in paragraphs 1-8 through 1-11), several extra single-bay or double-bay cabinets, or free-standing units may be involved. Refer to the Site Preparation Manual (part no. 5950-9285) for information on calculations and preparations that must be made before adding equipment at the site.

1-52. All FHD and MHD interfaces added should be high priority in the central processor interrupt system than the magnetic tape unit. With a full complement of FHDs, MDH disc files and the magnetic tape unit, interface cards for the on-line devices fill the HP 2116 card cage and the HP 2151A I/O Extender is needed. I/O slots in the HP 2150B-002, -003 I/O and Memory Extender may be used if the HP 2000C is an updated system. Since DMA is required for FHD and MHD operation, interface cards for these devices must be installed in the central processor card cage. The magnetic tape unit does not require DMA for operation so interface cards for this device will appear in the extender. DC power required for the additional cards mounted in the I/O extender is supplied by the I/O extender power supply.

1-53. **TERMINALS.** The minimum configuration system (see table 1-1) provides 16 user terminal connections. Expanded systems with 32 terminals (option -003 for the system) require a FHD with a 786,432 word (1,572,864 byte) capacity. Option -004 to the system provides 32 terminals and a FHD with a 1,048,576 word (2,097,152 byte) capacity. Refer to paragraphs 1-35 through 1-37 for

additional information on the multiplexer facilities for 32 terminal systems. Refer to paragraph 1-44 through 1-46 for information on FHD capacities.

1-54. Any of the user terminals can be equipped with selected additional units. These units may be added over and above data set equipment mentioned in paragraphs 1-36, 1-37, and 1-41. For example, a user terminal with an HP 2749A Teleprinter or HP 2600A Keyboard-Display Terminal may also have an HP 2761B Optical Mark Reader connected for reading marked or punched cards. The HP 2570A Coupler/Controller can be used as a user terminal to interface up to seven devices through plug-in interface cards. Counters, voltmeters, digital thermometers, frequency synthesizers, tape punches, graphic plotters, teleprinters, or other instruments can be used for special terminal configurations. Refer to paragraphs 1-35 through 1-37 for a discussion of user terminal telephone options installed in the computer area.

1-55. EQUIPMENT IDENTIFICATION.

1-56. Information on model and serial identification numbers for individual units of equipment in a specific system should be obtained by referencing the manuals on the equipment in question. In general, however, eight (or ten, depending upon the production year) digit serial numbers are used to identify the individual units. These serial numbers, with appropriate prefixes, are usually located on the rear panel of the unit. Printed circuit cards for system units are usually identified by a letter and date code stamped on the applicable card. A record of all model and serial numbers must be kept at the central computer site. Manuals must be kept current with appropriate updating supplements and intact for use by service personnel.

SECTION II

PRINCIPLES OF OPERATION

2.1. INTRODUCTION.

2.2. This section provides an overall description of HP 2000C Time-Shared BASIC System hardware element operation. The discussion is limited to system operation in the time-shared mode. The principle function of the equipment and the control programs is to ensure that the asynchronous inputs from all users are accepted from the terminals, checked through the central processor, and stored on the rotating memory devices for later processing and computation. This "later processing and computation" takes place in the central processor at periodic intervals determined by the executive routine (scheduler) of the system. Processing intervals determined by the scheduler are dependent upon priority levels of current programs, the effects of additional inputs received, and timed interrupts from the system clock. Upon receipt of appropriate commands, the system outputs requested data.

2-3. On-line fixed-head and moving-head mass storage devices retain user programs, library routines, and files to aid users in compiling and recalling data. Certain system program and library data is also retained on rotating memory devices. This is in addition to system data that is resident in the central processor, and communications processor core memories. Appropriate system information is

loaded from the rotating memory devices to the central processor core and back to the rotating memory devices as needed to control and process data.

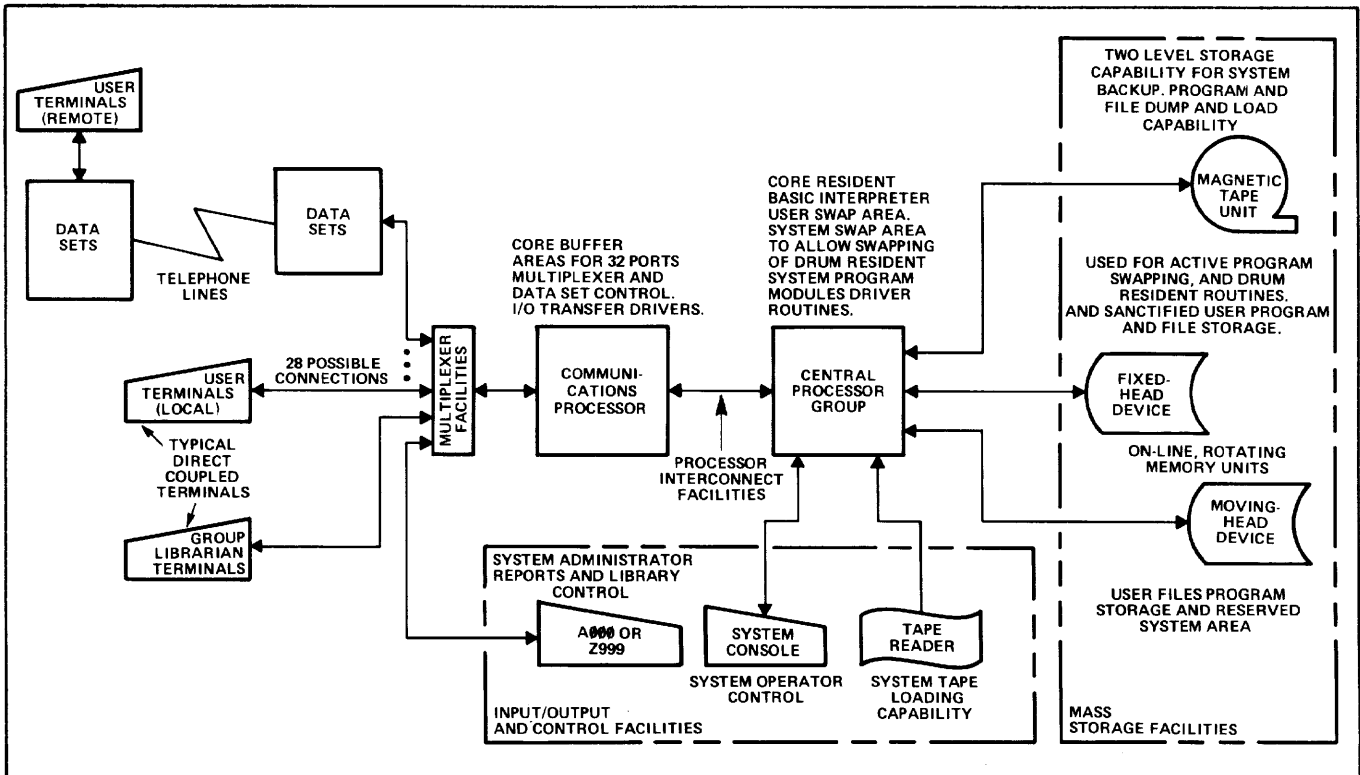
2-4. The magnetic tape unit can be used to store selected user program, file, and library data (or system data) as commanded by the system operator from the system console. Commands are entered on the system console to control access to the system, to obtain reports of system use and status, and to control the hardware resources of the system.

2-5. Details of the operation for individual system commands, or of BASIC commands and statements, and of internal control processes are not included in this discussion. Refer to operating and service manuals on individual units for specific principles of operation for the unit in question.

2-6. ELEMENTS OF THE HP 2000C SYSTEM.

2-7. Figure 2-1 shows seven major functional groups and facilities of the system that accomplish the above-mentioned tasks. These functional groups and facilities are:

a. The central processor group.



2155-3

Figure 2-1. Typical HP 2000C Time-Shared BASIC System, Simplified Block Diagram

- b. The mass storage facilities.
- c. Processor interconnect facilities.
- d. Communications processor.
- e. Multiplexer facilities.
- f. Terminals.
- g. Systems input/output and control facilities.

2-8. Each group and facility is described below. Accessories are considered an integral part of the central processor or communications processor, as applicable. Interface kits are discussed as part of the facilities to which they are connected.

2-9. CENTRAL PROCESSOR GROUP.

2-10. The central processor group performs the primary control functions for the system. It controls communications with each of the other hardware elements. It processes all user programs through software programs stored in core. The group consists of the memory, control, arithmetic, input/output, and power supply sections. The direct memory access, memory parity check, extended arithmetic unit, time base generator, and power failure interrupt with automatic restart accessories give the above listed sections additional control and processing capabilities.

2-11. MEMORY SECTION. The 32,768-word core of the memory section retains the following swapping areas and program modules.

- a. A system software module (control routine) overlay area.
- b. A user program swapping area (that allows users to be swapped in and out of core).

Note: Swapping is defined as loading a specific user program into core, then moving it back to a rotating memory device to make room for another user program in the same core area.

- c. Driver routines for the mass storage devices, system console, and processor inter-communications.
- d. The BASIC language interpreter.
- e. Utility routines for failure control and program re-entry.
- f. Tables for use by the central processor. Tables keyed to locating additional tables or routines stored on rotating memory devices.
- g. The scheduler (the executive program for system control).
- h. System library subroutines and programs.

2-12. CONTROL SECTION. The control section accomplishes overall control of central processor functions as directed by instructions in the system programs and by internal timing.

2-13. ARITHMETIC SECTION. The arithmetic section performs mathematical and data manipulation as directed by system software routines and by user BASIC programs.

2-14. INPUT/OUTPUT SECTION. The input/output section provides the interface between the central processor group and the mass storage facilities, the processor interconnect facilities, and portions of the input/output and control facilities. Input/output control, device addressing, and device interrupt processing take place within this section.

2-15. POWER SUPPLY SECTION. The power supply section in the central processor group supplies all controlled dc power to the group. The power supply extender operates in conjunction with this section to provide additional -2 volt and +4.5 volt power. The power failure interrupt with automatic restart accessory is used to monitor the performance of this section.

2-16. DIRECT MEMORY ACCESS. The five cards of direct memory access (DMA) work in conjunction with the control, and input/output sections of the central processor group to allow high-speed swapping of system and user data. Swapping occurs between the core memory and on-line storage devices as selected by system control programs. Appropriate driver routines for transfers are retained in core to effect swapping using the DMA channels. Commands to DMA are issued from the drivers in core through the control section. DMA in turn controls transfers between the central processor group and mass storage facilities with commands to the control section and input/output section.

2-17. MEMORY PARITY CHECK. The memory parity check accessory monitors data transferred from the memory section. An odd parity (17th bit) check is used. An error detected by this accessory causes the computer to halt.

2-18. EXTENDED ARITHMETIC UNIT. The EAU timing and EAU logic cards of the extended arithmetic unit work in conjunction with the control and arithmetic sections of the central processor group. They accomplish mathematical (multiplication and division) and data manipulation functions as directed by system control routines and user BASIC programs.

2-19. TIME BASE GENERATOR. The time base generator (TBG) is the HP 2000C System Clock. The system clock provides 100-millisecond interrupts through the input/output section for use by the scheduler program in controlling system functions on a real-time basis. It is also used by the system accounting program to keep track of user terminal time. Users have access to time information from the system clock.

2-20. POWER FAILURE INTERRUPT WITH AUTOMATIC RESTART. Power failure interrupt with automatic

restart monitors the power supply section and provides an interrupt signal in the event of power failure or shutdown. The interrupt signal causes the power failure software routine to issue instructions which result in the orderly shutdown of the central processor group. Upon restoration of power, the power failure software routine controls orderly restart of the system.

2-21. MASS STORAGE FACILITIES.

2-22. The mass storage facilities interface directly with the central processor group to provide storage for system and user data. On-line facilities consist of a fixed-head device (FHD) and a moving-head device (MHD). The backup storage device is a magnetic tape unit.

2-23. The FHD and MHD work in conjunction with DMA through command and data interfacing channels in the central processor input/output section. DMA effects high-speed swapping of system library routines and user programs, files, and libraries to and from the FHD and MHD. The magnetic tape unit (which does not require DMA for its operation) works through its command and data channels in the central processor input/output section to provide backup storage for system and user data.

2-24. **FIXED-HEAD DEVICE.** The FHD allows random high-speed access to system library commands and tables stored in its memory. The FHD also provides temporary storage for user programs that are currently active, but not actually running in core. Selected user programs and files may be stored on the FHD to speed user-program execution times.

2-25. The FHD is a permanently installed rotating memory device. The device has electronically switched heads which provide an average random access time of 8.7 milliseconds. The data transfer rate between the FHD and core, using DMA, is approximately 120,000 words per second. The data channel of the interface accomplishes bit-parallel/bit-serial transformations. Addressing and transfer instructions are passed via the command channel of the interface. Figure 2-2 illustrates the relationship between bytes, words, sectors, physical and logical tracks, logical "drum" units, and FHDs.

2-26. **MOVING-HEAD DEVICE.** The MHD uses removable disc packs to store user programs and files. Seldom used system programs (such as the loader) are also stored on the MHD. All data in the central processor core and on two logical "drum" FHD units may be stored on a little less than 10 percent of the disc pack. (The HP 2883A Disc File with Controller uses the 20-surface HP 12868A Disc Pack.) The removable disc pack also allows transfer of the complete time-shared system software from one set of hardware to another.

2-27. Head movement is required to access tracks, thus access time to data is slower than for the FHD. Average access time is 44 milliseconds (including rotational latency) and the data transfer rate is approximately 156,000 words

per second for the HP 2883A. The data channel of the interface transfers bit-parallel data between the central processor and MHD. Addressing and transfer instructions are also passed via the data channel of the interface. Figure 2-3 illustrates the relationship between bytes, words, sectors, blocks, and an overall logical "disc" unit. Blocks of 256 words are used to measure data storage in the MHD mass storage device.

2-28. **MAGNETIC TAPE UNIT.** The magnetic tape unit stores system programs, libraries, tables, user programs, and files in response to the SLEep or HIBernate commands issued from the system console. System backup information is thus retained. Selected user data may also be stored on magnetic tape using the DUMp command or loaded into the system using the LOAd command. All data is transferred in 8-bit parallel format. Parity checking is accomplished in the magnetic tape unit. The data channel of the magnetic tape unit interface transfers data between the central processor input/output section and magnetic tape device. The command channel transfers drive and status signals. DMA is not used in operating this unit.

2-29. PROCESSOR INTERCONNECT FACILITIES.

2-30. The processor interconnect facilities interface the central processor group and the communications processor. One send and one receive channel in each direction are available to pass user data and programs between the two processors and to exchange inter-processor commands and responses.

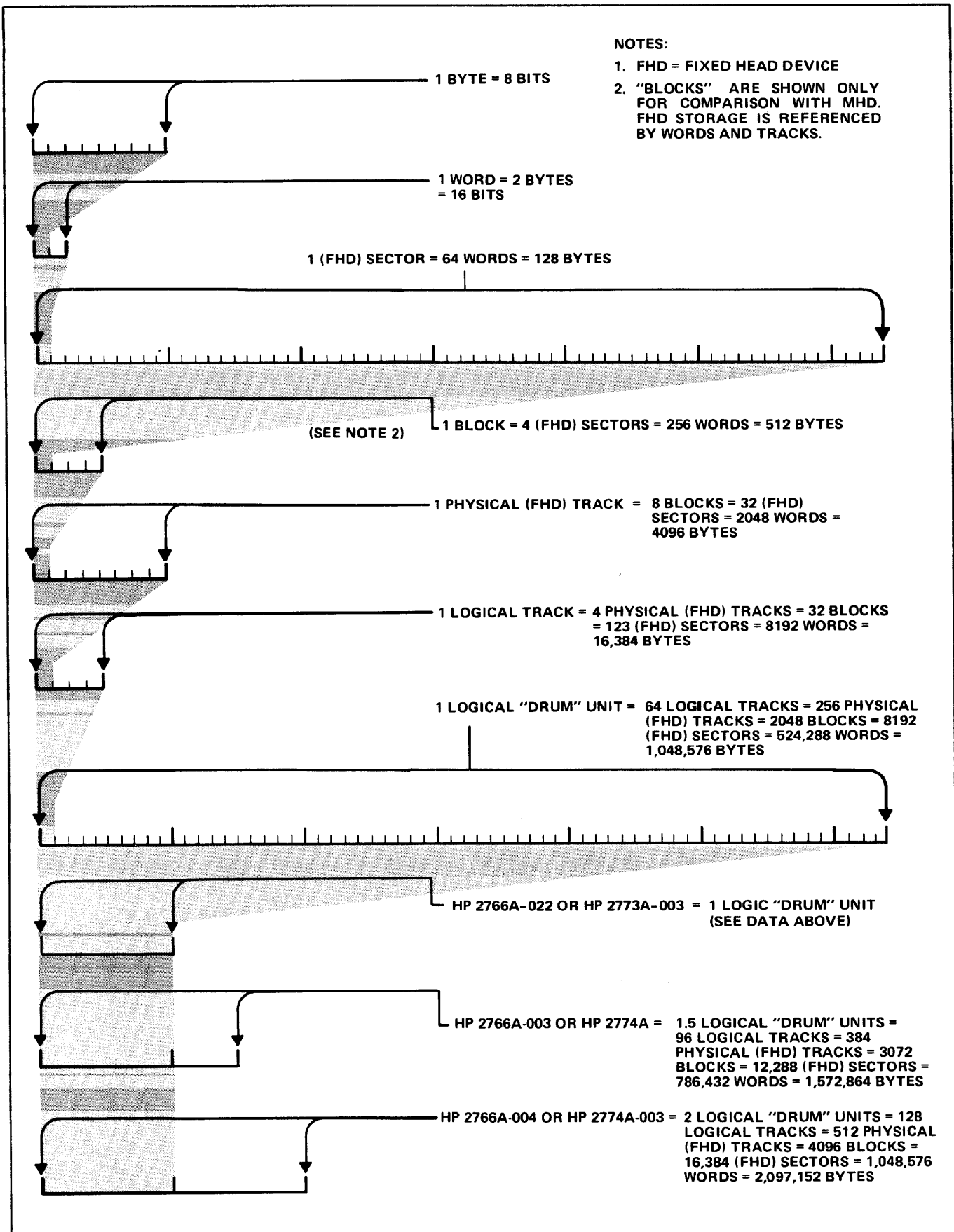
2-31. COMMUNICATIONS PROCESSOR.

2-32. The primary function of the communications processor is to process communications to and from user terminals. Interface with all terminals is through the multiplexer facilities. Interface with the central processor group is through the processor interconnect facilities.

2-33. The communications processor monitors the status of each terminal. It simultaneously receives inputs from, or transmits outputs to all user terminals at a total rate of 320 characters-per-second. This means 32 terminals may be served at 10 characters per second each, or 16 terminals at 20 characters per second each. User input data from terminals is formatted for system processing and passed to the central processor. User output data received from the central processor is sent to each terminal.

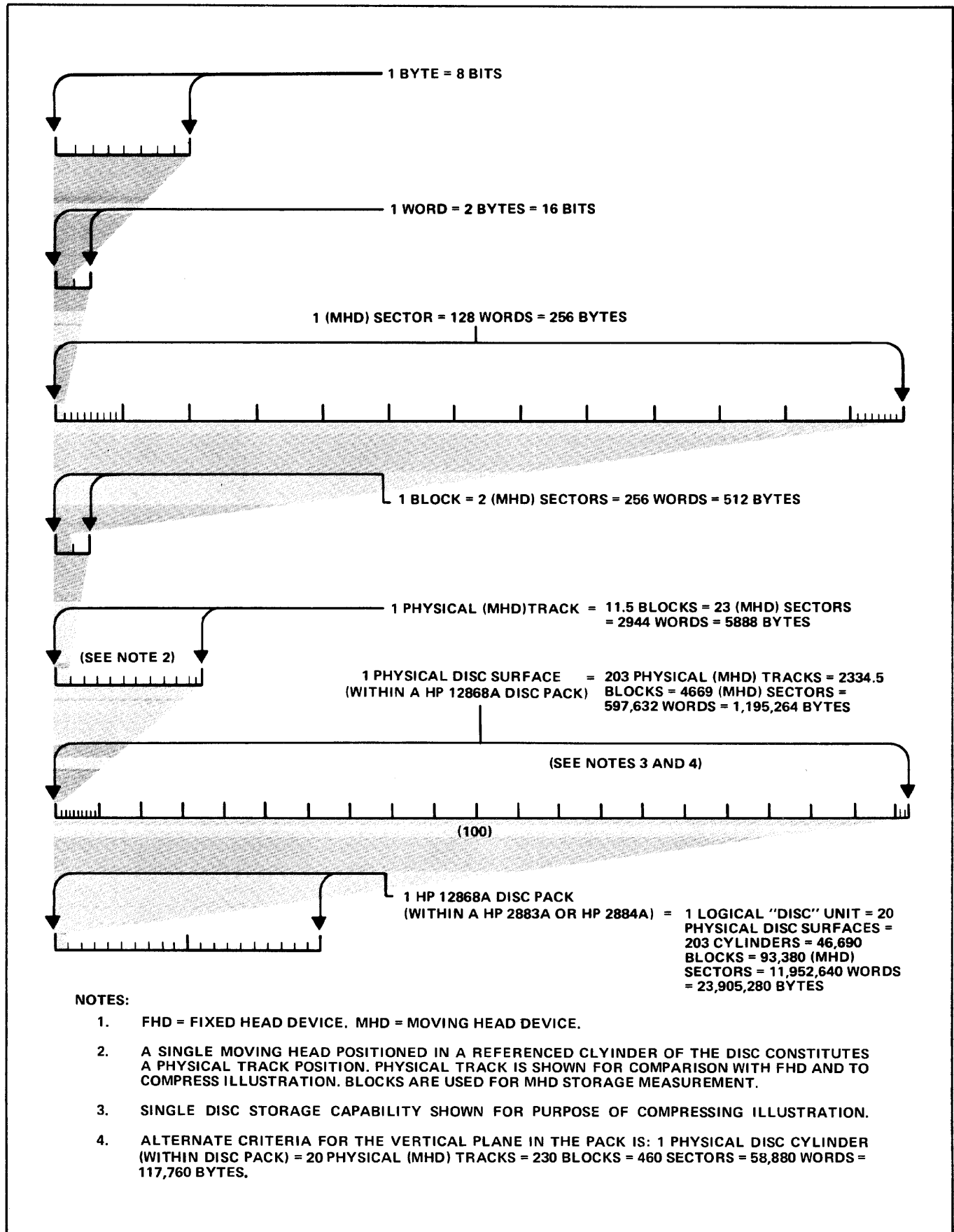
2-34. The communications processor is functionally similar to the central processor in that it is comprised of memory, control, arithmetic, input/output, and power supply sections. The memory parity check accessory and power failure interrupt with automatic restart option, aid the above sections in accomplishing their functions.

2-35. **MEMORY SECTION.** The 8,192 word core of the communications processor memory section retains the following program modules and dedicated core areas.



2155-7

Figure 2-2. HP 2000C Mass Storage Facilities, Fixed-Head Device Definitions



2155-8

Figure 2-3. HP 2000C Mass Storage Facilities, Moving-Head Device Definitions

- a. Interprocessor service routines and the interprocessor communications driver.
- b. A teleprinter table for each of the 32 terminals to keep track of parameters and status. (The tables are generally used in conjunction with the multiplexer routine to collect bits, form characters, then collect characters to fill the I/O buffer zone for each terminal.)
- c. The multiplexer driver routine (a program for terminal control).
- d. The telephone control routine.
- e. The communications processor initialization routine and the power failure/automatic restart routine.
- f. A 300-character buffer zone for each of the 32 terminals to store input and output data.
- g. Loader routines.

2-36. CONTROL SECTION. The control section accomplishes overall control of the communications processor. Internal programs and timing control its operation.

2-37. ARITHMETIC SECTION. This section performs all data manipulation as directed by internal software routines.

2-38. INPUT/OUTPUT SECTION. The input/output section interfaces the communications processor with the processor interconnect facilities and multiplexer facilities. Input/output control, addressing, and interrupt functions all take place within the input/output section. This section also accomplishes power supply section monitoring for the power failure/automatic restart routine.

2-39. POWER SUPPLY SECTION. This section provides all controlled dc power for the communications processor. The section is monitored by the power failure interrupt /auto restart option in the input/output section.

2-40. MEMORY PARITY CHECK. The memory parity check accessory for the communications processor works in conjunction with the control section to monitor data transferred from the memory section. An odd parity check (17 bit) is used in the same manner as in the central processor.

2-41. MULTIPLEXER FACILITIES.

2-42. The multiplexer facilities interface all user terminals with the communications processor. The software for the facilities performs a serial/parallel data conversion function (11-bit serial data is used for terminals, 16-bit parallel data is used for the communications processor). Essentially, two physical sections make up the facilities. These are the panel and interface cards in the input/output section of the communications processor. The software control program is contained in the communications processor core memory.

2-43. PANELS. Each of the two panels (maximum system configuration) provides connection ports for 16 terminals or data sets, or a combination of terminals and data sets. Each panel is also capable of processing data set control signals.

2-44. INTERFACE CARDS. The interface cards perform the bit-serial transfer of data. The software performs the serial/parallel conversion function. The "phones" cards process the data set control signals. The data set control signals allow the communications processor "phones" software routine to control "answering" and "hanging-up" of data sets. Software control routines time asynchronous input data from the terminals, using interrupts from the first interface card, and build each pulse chain into characters, then lines for storage in terminal I/O buffer zones located in core.

2-45. TERMINALS.

2-46. All terminals interface with the time-shared system through the multiplexer facilities. Direct connection or connection through data sets may be made to the multiplexer ports. Terminals such as the HP 2749A Teleprinter operate at a 10 character-per-second (110 baud) rate. The HP 2600A Keyboard-Display operates at a 10 or 20 character-per-second (110 or 220 baud) rate and may also be used. Users may log any authorized ID code and password into any terminal. Classifications of privileged user, semi-privileged user, group librarian and general user are described in the operator's guide. Applicable teleprinter characteristics are described first in the following paragraphs followed by a brief description of data sets.

2-47. TELEPRINTERS. The HP 2749A Teleprinter is the terminal that is usually used, and is described here. The teleprinter terminal consists of the printer, keyboard, tape reader, and tape punch assemblies. The keyboard and printer are the primary assemblies necessary for communication with the time-shared system. Each time a key is actuated on the keyboard a pulse chain (consisting of 11-bit serial pulses) is transmitted to the time-shared system. Conversely, pulse-chains received at the terminal actuate the printing mechanism. Each pulse chain is comprised of an 8-bit ASCII code character, a start bit and two stop bits.

Note: The start and stop bits are masked off by software control routines in the communications processor.

2-48. The "echo" feature for terminals ensures that data transmitted from the terminals is received properly by the time-shared system. When a character is sent from the keyboard to the multiplexer facilities the pulses are "turned around" and sent back to actuate the printer assembly in the terminal. In addition, the character is entered, bit-by-bit, in the communications processor. A printing of the character selected at the keyboard verifies proper receipt at the system.

2-49. Bit sampling, character building, and loading into the communications processor through the multiplexer facilities is accomplished by the communications processor software routines. The receipt of a line feed after the carriage return signifies that the central processor has checked the line entry for syntax and accepted the data. Refer to the users' guide for instruction on BASIC programming from a terminal.

2-50. DATA SETS. Data sets are used as an interface between the time-shared system and remote terminals to allow 11-bit data transmission over voice-grade telephone lines. They are not considered terminals in themselves. Terminal and time-shared system operation is essentially unchanged from that described in paragraphs 2-47 through 2-49. The principle differences are that the pulse chain for each character modulates an audio frequency carrier, and that data set control facilities are needed at the time-shared system. The auto-disconnect function of the multiplexer facilities enables software control of the data sets.

2-51. Data sets of the terminal end of the communications link may be hardwired or acoustically coupled to the telephone facilities. The acoustically coupled data sets provide the interface between the teleprinter and telephone facilities using standard telephone handsets.

2-52. If a time-shared user calls into the system through a data set, the automatic answer feature makes the telephone line connection to the multiplexer port. If the user does not log into the system properly within a nominal 120 seconds (variable with the PHOnes command) the phone's software control routine disconnects the data set.

2-53. SYSTEM INPUT/OUTPUT AND CONTROL FACILITIES.

2-54. The system input/output and control facilities include the system console and high-speed paper tape reader. These are the devices normally used for routine system control and loading. ID code A000 is used to obtain system reports and to control the public libraries. ID code Z999 controls the system HELLO library program. Refer to the operator's and users' guides for report and library command use.

2-55. SYSTEM CONSOLE. The system console is used to control access to the system, issue system commands, log system information, and to communicate with remote user terminals. The system console is essentially a heavy duty teleprinter. It connects directly to the central processor through the teleprinter interface in the central processor group input/output section. Eleven-bit serial data is used by the console, 8-bit parallel data is used at the central processor. Refer to the operator's guide for system control commands used at the console.

2-56. TAPE READER. The system high-speed paper tape reader is initially used to load system programs, and to reload system programs in event restart is necessary. Control programs resident in the communications processor core are loaded through the paper tape reader and interfaces in the central processor. The tape reader reads 8-bit data at a 500 character-per-second rate. Refer to the operator's guide for system loading procedures.

SECTION III

PREVENTIVE MAINTENANCE

3-1. INTRODUCTION.

3-2. This section outlines duties the system operator is to perform for preventive maintenance on HP 2000C Time-Shared BASIC System equipment.

3-3. PREVENTIVE MAINTENANCE.

3-4. The system operator is expected to clean cabinet filters on the HP 2992Z and HP 2866A Cabinets each week. Cabinet filters are located at the rear lower panels

over cabinet fans. Use care when removing dirty filters so as not to jar accumulated dust loose so that it is drawn into the cabinets and equipment. General outside cleanliness of cabinet and free-standing equipment should also be maintained. Refer to the operator's guide for normal operating duties (e.g. loading paper tapes, loading magnetic tapes, emptying the teleprinter chad bucket, etc.). All other preventive maintenance, as well as remedial service, can be performed by trained Hewlett-Packard Service Engineers under the terms of a Service Contract. Contact your local HP Sales and Service Office for Service Contract information.