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COMPUTER SYSTEMS

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PUBLICATIONS REVISION

General

8417 Disk Subsystem

General Description

UP-8916 Rev. 1

This Library Memo announces the release and availability of "SPERRY UNIVAC® 8417 Disk Subsystem General Description", UP-8916 Rev. 1.

This revision updates the 8417 Disk Subsystem description and characteristics to exactly reflect its operational characteristics.

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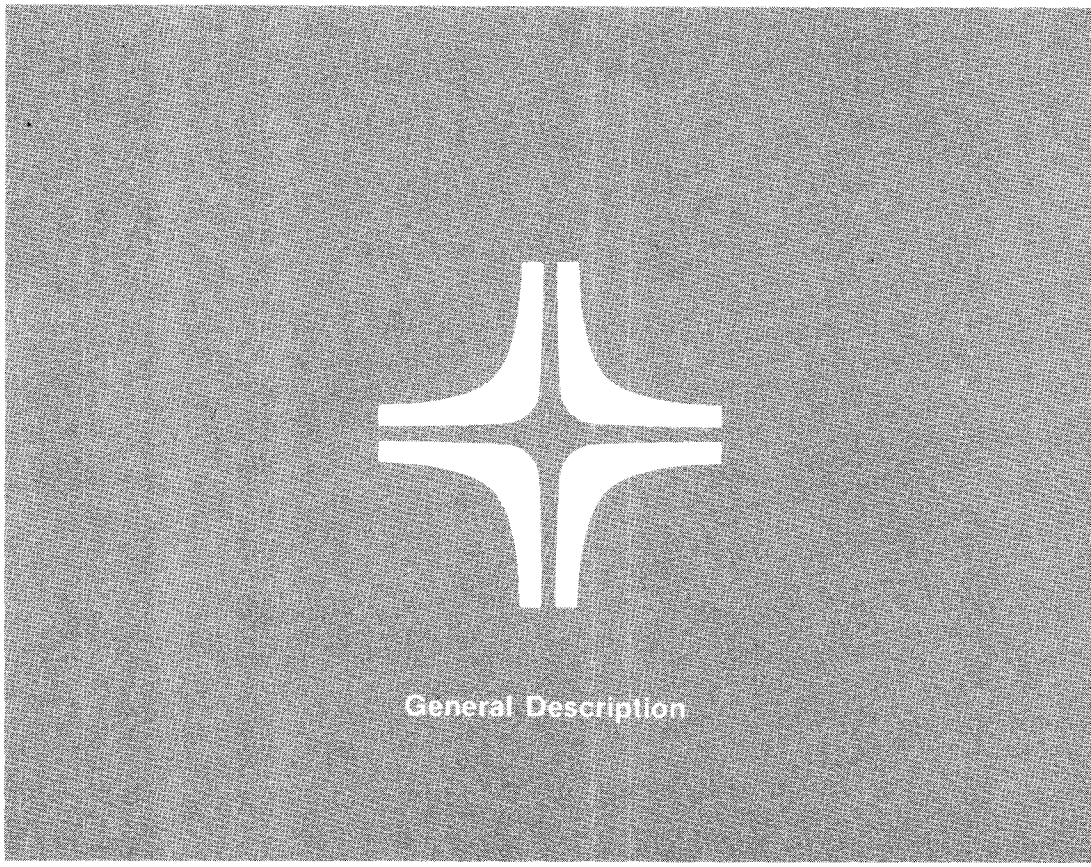
8417 Disk Subsystem



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1. Introduction

The SPERRY UNIVAC 8417 Disk Subsystem is a random access device having a formatted capacity of up to 119 megabytes with fixed-head storage on a permanently affixed disk platter assembly. Up to three disk drives may be mounted in a stand-alone cabinet (Figure 1-1), which also contains the disk drive power supply, interface cables, and operator control panel. The disk drive controller is part of the disk channel/controller located inside the system processor cabinet.

The 8417 disk drive has the same characteristics as the system resident disk drive located within the processor cabinet.

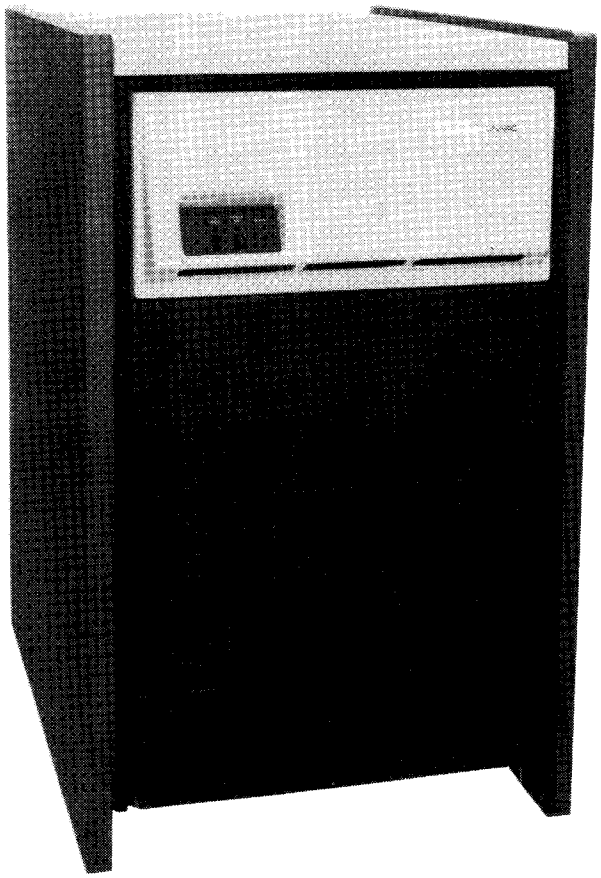

Figure 1—1. SPERRY UNIVAC 8417 Disk Drive

2. Functional Description

2.1. GENERAL PERFORMANCE

The 8417 disk drive uses fixed disk media, which means the operator is not required to replace disks in the drive assembly at any time. Operation is simply confined to two switches and three indicators on the operator control panel of each disk drive.

2.1.1. Disk Organization

Four disk platters, 14 inches (35.56 centimeters) in diameter, are used in each disk drive. Up to three disk drives may be included in one 8417 disk drive cabinet. Each disk drive has a single head/disk assembly (HDA) that includes four movable data head/arm assemblies. The data head/arm assemblies position the read/write heads according to directions from the disk controller. An optional feature permits a fixed head/arm assembly that eliminates head access time delay and offers an additional 860 kilobytes of user storage.

Each moving head data surface is divided into two data bands (outer and inner). Each data band contains 561 tracks (550 data tracks, 9 alternate tracks, 1 defect map and 1 maintenance cylinder) and a read/write head. Hence, there are 550 cylinders for the moving heads on seven data surfaces. The 560th cylinder (address 559) contains the head/disk assembly (HDA) error map and is not available for customer data. The bottom surface contains 560 servo tracks and 60 data tracks (56 plus 4 alternates) for the operational fixed read/write heads. The 561st cylinder (address 560) is used for maintenance testing only.

2.1.2. Recording Method

Disk recording is according to the modified frequency modulation (MFM) scheme. Recording is performed while the disk is rotating at a nominal speed of 3400 revolutions per minute (rpm), at the basic recording rate of 1.13 megabytes per second. The data separator of the disk controller generates the MFM write data, which is synchronized with the phase lock oscillator (PLO) located in the disk drive cabinet.

The address mark format is used to identify record boundaries since no sector pulses are used in the drive. Write and detect mark functions are performed by the controller data separator located on the disk channel/controller in the processor cabinet.

2.1.3. Accessor Arms

Data access is made with an access mechanism consisting of 14 data heads and one servo head mounted inside the head/disk assembly on a support tower. The uppermost data head/arm assembly has two read/write down sliders to service the upper surface of the top disk. Its counterpart data head/arm assembly contains two up and two down read/write sliders to service two disk surfaces (Figure 2-1).

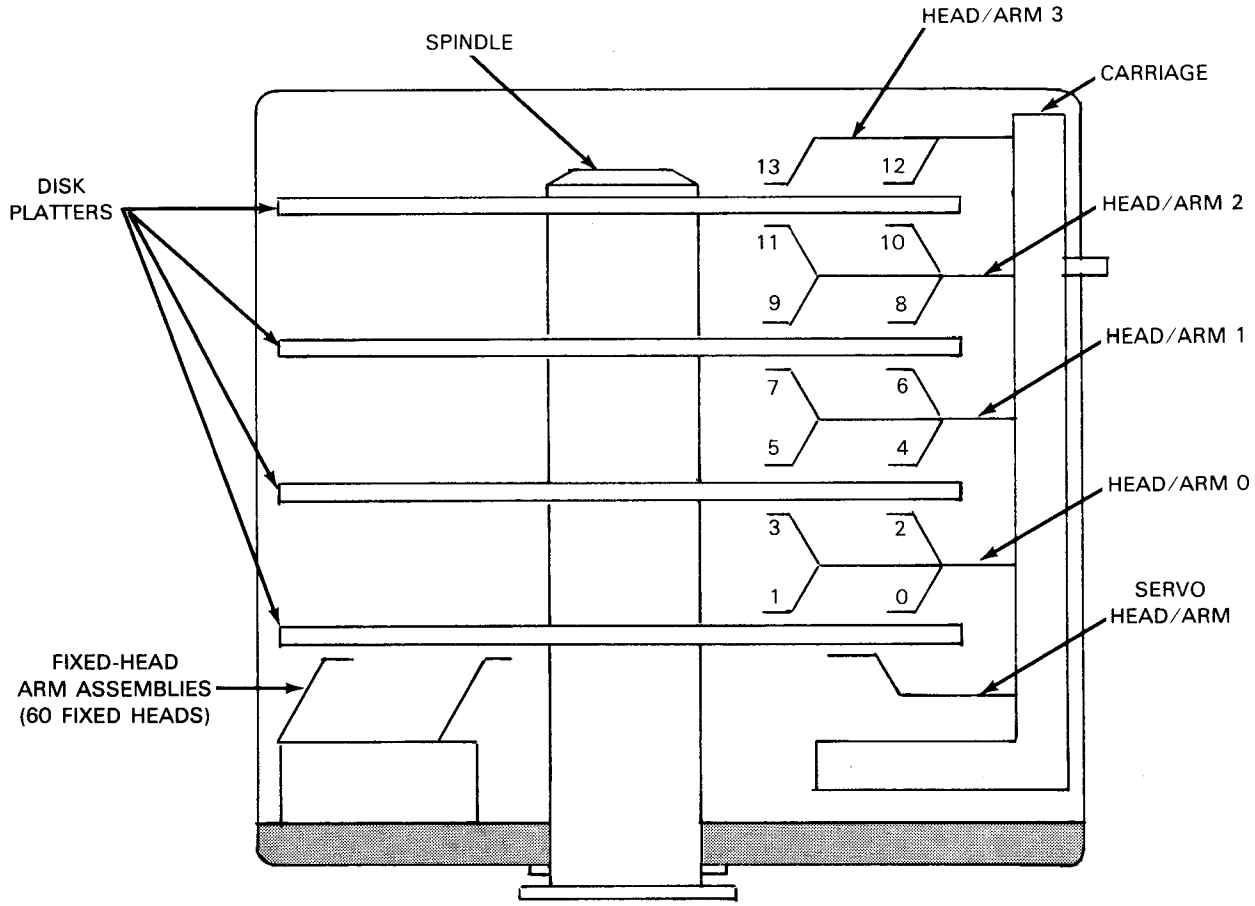

Figure 2—1. Head/Disk Assembly in 8417 Disk Drive, Schematic Diagram

The support tower holding the arms is moved to any selected cylinder by an electromagnetically controlled closed loop servo positioning system. The access mechanism moves the head directly from one cylinder to any other without requiring a return to home position.

Servo offset commands recover marginal data resulting from minor defects on the disk surface or inaccuracies in servo positioning. The servo offset command moves the accessor from its designated track location by a single increment of ±350 microinches (0.89 micron).

2.1.4. Disk Channel/Controller

A microprocessor-based disk channel/controller manages transfer of data to and from the channel, accepts commands from the channel, and sends status and sense information about the disk drive to the channel. The controller is resident in the processor cabinet.

The disk channel/control and all attached disk drives make up a disk subsystem. Up to eight disk drives may be connected to the disk channel/controller, including the disk drive resident in the processor cabinet. Commands specified by software, such as read, write, and search data on the disk surface are initiated at the disk channel/controller and transmitted to the disk drive during operation.

2.2. SAFETY CIRCUITS

Detection of unsafe conditions in the disk drive operation and reset function has been included to enhance subsystem reliability.

2.2.1. Disk Drive Safety Checks

A disk drive unsafe condition activates the drive unsafe status, which must be cleared by an automatic reset or by a Sperry Univac customer engineer before normal operation resumes. The disk drive safety checks are made when:

- Loss of any dc voltage occurs in the disk drive power supply.
- Disk pack rotation speed drops more than 20 percent of the normal operating speed.
- The phase lock oscillator (PLO) is not synchronized with the servo clock.
- During disk writing, a write transition is not detected when the write gate is active and address mark writing is inactive, or excess current is detected in either the write-select or +6 Vdc monitor circuits.

2.2.2. Reset Safety Check

Detection of an unsafe operating condition causes the disk drive to terminate its current operation. An automatic unsafe reset occurs when the controller deselects, then reselects, the disk drive. The disk channel/controller then informs system software of the unsafe condition, after which software may transmit a reset to the disk drive in an attempt to clear the unsafe condition.

Only unsafe conditions such as unsynchronization of the PLO or a disk writing condition (2.2.1) are reset by the automatic unsafe reset. Other conditions, such as dc power loss or disk rotation speed loss, are not automatically reset.

If the unsafe status condition remains after an automatic reset is made, a FAULT CLEAR will be signaled to attempt to reset the unsafe condition. If this also fails and the unsafe condition persists, operator intervention is then required.

2.3. CONFIGURATION

The 8417 disk drive cabinet can contain up to three disk drives. A single resident disk drive is contained within the processor cabinet. The disk channel/controller controls the resident disk drive and all disk drives in the stand-alone 8417 disk drive cabinet. Figure 2-2 illustrates the configuration.

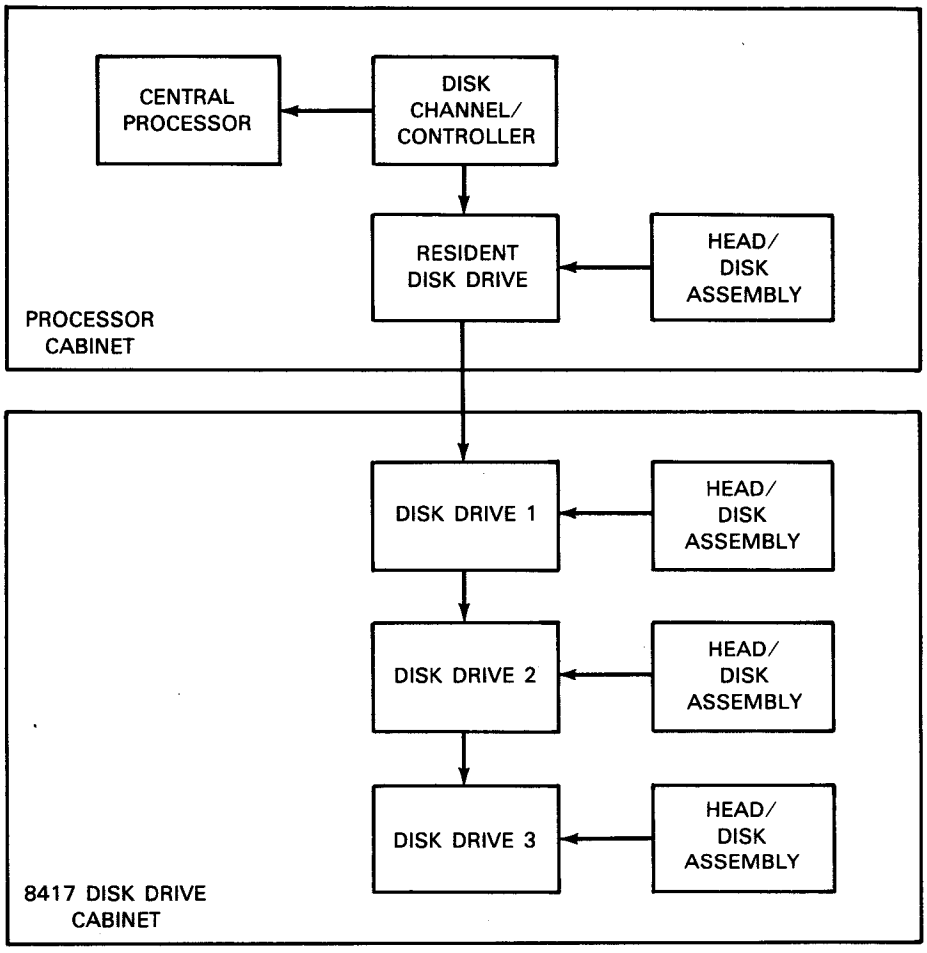

Figure 2—2. 8417 Disk Subsystem Configuration

2.4. OPTIONAL FEATURES

Table 2-1 lists the disk drive types and optional features.

Table 2—1. Disk Drive Types and Optional Features (Part 1 of 2)

Item	Description
Resident disk drive (60 Hz)	Disk drive located inside processor cabinet with nonremovable disk media and a movable head positioner assembly. Disk drive requires head/disk assembly without fixed-head assembly or head/disk assembly with fixed-head assembly. Disk drive with a fixed-head assembly provides formatted storage capacity up to 119.13 megabytes (118.27 megabytes for movable heads and 0.86 megabyte for fixed heads). Disk drive without a fixed-head assembly provides formatted storage capacity up to 118.27 megabytes. Data rate is 1.13 megabytes per second at 3400 rpm. The resident disk drive does not include a power supply, operator control panel, and interface cables. Operates in 200- to 240-volt power range.
Resident disk drive (50 Hz)	Same as resident disk drive, except operates with 50-Hz power source
8417 stand-alone disk drive with cabinet (60 Hz) (optional feature)	Disk drive located in its own cabinet with nonremovable disk media and a head positioner assembly. Disk drive requires head/disk assembly without fixed-head assembly or head/disk with fixed-head assembly. Disk drive with fixed-head assembly provides formatted storage capacity up to 119.13 megabytes (118.27 megabytes for movable heads and 0.86 megabyte for fixed heads). Disk drive without a fixed-head assembly provides storage capacity up to 118.27 megabytes. Data rate is 1.13 megabytes per second at 3400 rpm. The drive includes a power supply, operator control panel, and interface cables. Up to three disk drives may be included in the cabinet. Operates in 200- to 240-volt power range. One of the HDA optional features must be selected.
8417 stand-alone disk drive with cabinet (50 Hz) (optional feature)	Same as 8417 stand-alone disk drive, except operates with 50-Hz power source
Head/disk assembly (HDA), 4 disks with fixed-head assembly (optional feature)	HDA contains 4 disk platters, a movable head/arm, 14 read/write heads, and 1 servo head. Sixty fixed read/write head elements are included, in addition to movable heads, to provide 60 fixed-head tracks. Formatted storage capacity is 119.13 megabytes.
HDA, 4 disks without fixed-head assembly (optional feature)	Same as HDA with four disk platters except without a fixed-head assembly and formatted storage is 118.27 megabytes
Field replacement HDA, 4 disks with fixed-head assembly (optional feature)	Field replacement HDA contains 4 disk platters, a movable head/arm assembly with 14 read/write heads, and 1 servo head. Sixty fixed read/write head elements are included, in addition to movable heads, to provide 60 fixed-head tracks. Formatted storage capacity is 118.27 megabytes for movable heads and 0.86 megabyte for fixed heads. The HDA is prepped to conform with the system format.

Table 2—1. Disk Drive Types and Optional Features (Part 2 of 2)

Item	Description
Field replacement HDA, 4 disks without fixed-head assembly (optional feature)	Same as field replacement HDA with four disk platters, except without a fixed-head assembly
8417 disk drive cabinet (60 Hz) (optional feature)	Cabinet capable of housing one, two, or three 8417 stand-alone disk drives. Operates with 60-Hz power source, in 200- to 240-volt power range.
8417 disk drive cabinet (50 Hz) (optional feature)	Same as 8417 disk drive cabinet, except operates with 50-Hz power source

2.5. CONTROLS AND INDICATORS

Design of the 8417 disk drive has eliminated the need for complex operating procedures. The operator simply turns power on at the operator control panel, and operation commences under programmed control.

2.5.1. Operator Control Panel

Controls and indicators used by the operator are located on the operator control panel of each disk drive at the front of the cabinet. Figure 2-3 illustrates an 8417 disk drive cabinet with a single disk drive. The two panels below the illustrated control panel are locations for two additional disk drives, each with its own operator control panel, when the installation requires additional drives. Table 2-2 lists the controls and indicators with a brief description of each.

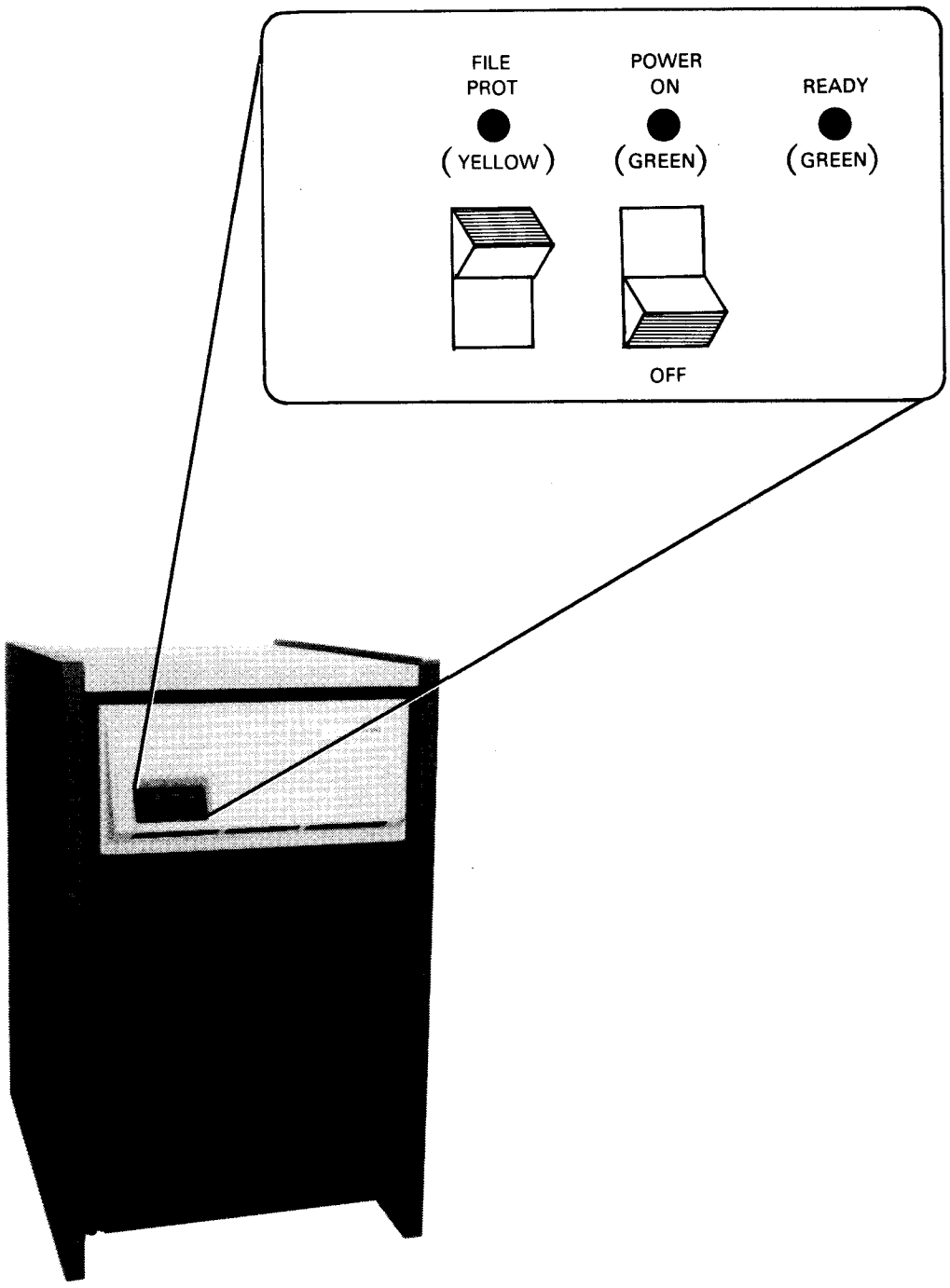

Figure 2—3. Operator Controls and Indicators

Table 2—2. Operator Controls and Indicators

Control/Indicator	Function
FILE PROT switch and indicator	■ ON position – Write-protect status is generated and write circuits in the drive are disabled. If a write command is received, an unsafe condition is generated along with the write-protect status. – Yellow indicator is illuminated. ■ OFF position – Write protect status is disabled, and write circuits may be activated with a write command. – Indicator is extinguished.
POWER ON/OFF switch and indicator	■ ON position, off line – The ac power is applied to the power supply and dc voltages are turned on. When all dc voltages are present and within required limits, a dc-power-OK status is generated to release the disk motor brake and turn on the motor. – A power-on reset is generated, and all counters and control flip-flops are initialized. – When disk speed reaches within 80 percent of required operating speed, the read/write heads are positioned to cylinder 0, and online status occurs. – Indicator lamp is illuminated. ■ OFF position, on line – When the disk subsystem is on line, power was previously applied to permit system control power sequencing. ■ OFF position – Read/write heads are returned to the disk landing zone. – The motor brake is applied to stop disk rotation. – POWER ON indicator is extinguished. – READY indicator is extinguished.
READY indicator	When lit, indicates that disk drive has reached online status (refer to POWER ON/OFF switch function) and the disk drive is ready for operation

2.5.2. MAIN POWER Circuit Breaker

The MAIN POWER circuit breaker is located on the lower rear of the 8417 disk drive cabinet. Power to all disk drives in the cabinet is turned off if the circuit breaker trips due to detection of an excess current condition in the power circuits. Normally, the circuit breaker is left in the ON (up) position, and power is controlled for each disk drive at its respective operator control panel. In an emergency, however, the operator may set the circuit breaker to OFF and contact the Sperry Univac customer engineer with information on the emergency situation.

2.6. CHARACTERISTICS

Up to three disk drives may be installed in the 8417 disk drive cabinet. The first drive is mounted in the uppermost position for ease of operator control and servicing. The second drive is in the middle and the third drive at the bottom. Any empty drive position has a front panel filler.

Each disk drive in the cabinet plugs into a power distribution box installed in the bottom rear of the cabinet. A single power cable comes out of the cabinet for connection to a power source.

2.6.1. Functional Characteristics

Each disk drive in the 8417 disk drive cabinet has the same operating capabilities. These capabilities and functional characteristics are listed in Table 2-3 for a disk drive using movable heads and one having the optional fixed-head feature.

Table 2—3. Functional Characteristics (Part 1 of 2)

Parameter	Characteristics	
	Movable Heads	**Fixed Heads**
Data capacity:		
Track capacity	15,360 bytes (formatted)	15,360 bytes (formatted)
Drive capacity,		
formatted (60 records/track)	118.27 megabytes	0.86 megabytes
Bit density	6366 bits per inch (251 bits per centimeter)	6366 bits per inch (251 bits per centimeter)
Access time:*		
Minimum seek**	7 milliseconds	0
Average seek†	37.8 milliseconds	0
Maximum seek**	70 milliseconds	0
Storage media:		
Type	Fixed disk	Fixed disk
Diameter	14 inches (356 mm)	14 inches (356 mm)
Data surfaces (4 disks)	7	1
Track density	476 tracks per inch (18.7 tracks per mm)	-

Table 2—3. Functional Characteristics (Part 2 of 2)

Parameter	Characteristics	
	Movable Heads	**Fixed Heads**
Recording techniques:		
Method	Modified frequency modulation (MFM)	MFM
Data heads per surface	2	60
Data heads per drive	14	60
Tracks per cylinder	14	-
Cylinders per drive	550 + 9 alternates + 1 maintenance	2 (equivalent cylinders)
Tracks per drive	7700 + 126 alternates	60
Data transfer rate:		
Data bit rate	9.05 X 10^6 bits per second	9.05 X 10^6 bits per second
Data byte rate	1.13 X 16^6 bytes per second	1.13 x 10^6 bytes per second
Disk rotational speed	3400 ± 136 rpm	3400 ± 136 rpm
Latency time:		
Average	8.82 ± 0.35 ms	8.82 ± 0.35 ms
Maximum	17.65 ± 0.71 ms	17.65 ± 0.71 ms
Start-up time (maximum)	25 seconds	25 seconds
Stop time (maximum)	60 seconds	60 seconds

* Access time is the time interval from issue of seek start command to drive generation of gated attention.

**Maximum access time for minimum seek length is the average of at least 1024 seeks.

† Average access time is the sum of the required time to perform all possible seek combinations divided by the number of such seeks.

2.6.2. Physical Characteristics

The approximate size of the 8417 disk drive cabinet is illustrated in Figure 2–4. The size and weight are listed in Table 2–4.

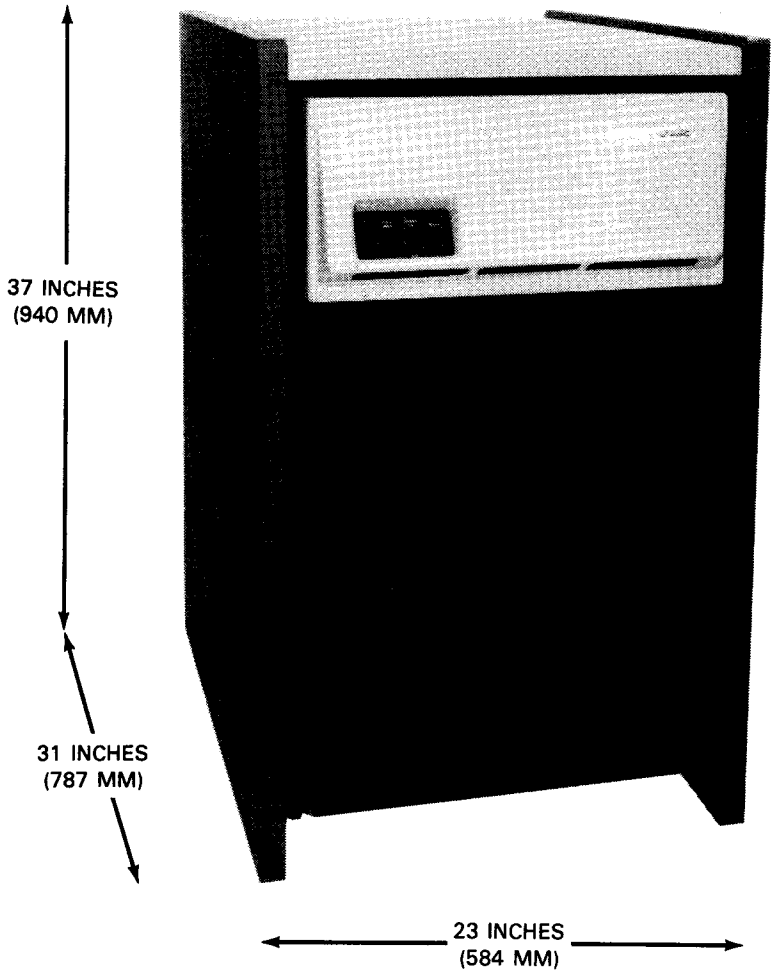

Figure 2—4. 8417 Disk Drive Cabinet Dimensions

Table 2—4. Physical Characteristics

Parameter	Characteristic
Width	23 inches (584 mm)
Height	37 inches (940 mm)
Depth	31 inches (787 mm)
Weight:	
Single drive	Approximately 125 pounds (56.7 kilograms) with power supply; 85 pounds (38.5 kilograms) without power supply
Three drives	Approximately 375 pounds (170.1 kilograms) with power supply, plus cabinet weight
HDA	Approximately 28 pounds (12.7 kilograms)

2.6.3. Heat Dissipation

Nominal heat dissipation within each 8417 disk drive cabinet is 3200 Btu/hr. During normal operation, heat dissipation does not reach 4000 Btu/hr.

2.6.4. Environmental Characteristics

The 8417 disk drive operates within the temperature range of 50° F (10° C) to 105° F (40.56° C) inside the cabinet, with a maximum gradient of 19.8° F (-7.2° C) per hour.

The temperature inside the cabinet is less than 105° F (40.56° C) during operation.

2.7. POWER REQUIREMENTS

The resident and stand-alone disk drives operate at the following voltages and line frequencies:

- 60-Hz AC Power

  Line voltage range may be within 208 Vac (+6, -12 percent) to 240 Vac (+6, -12 percent) at 60-Hz (± 2 percent), single-phase power.

  The starting current surge is less than 18 amperes. Running current is 5.0 amperes nominal at 208 Vac.

- 50-Hz AC Power

  The line voltage range and starting current surge are the same as for 60-Hz ac power. Running current is 5.0 amperes nominal at 220 Vac.

- AC Power Requirement

  The nominal ac power requirement is 1.1 kVA, at a maximum of 1.4 kVA.

3. Commands, Status, and Sense

3.1. COMMAND REPERTOIRE

Operation of the 8417 disk drive is directed by a set of commands. The disk drive commands are listed and briefly described in Table 3-1.

Table 3—1. Commands (Part 1 of 3)

Command	Function
Fixed/Moving Head Select	Selects the head type (fixed or movable), head location (inner or outer), and the sense command. Fixed heads are mounted on both sides of the servo tracks; those close to the spindle are inner fixed heads, and those close to the disk perimeter are outer fixed heads. Bit assignments for head selection are as follows: Bit — Assignment Value 0 — 0 = moving head, 1 = fixed head 1 — 0 = outer fixed head, 1 = inner fixed head 2-6 — Not used 7 — 0 = head select, 1 = sense command
Sense	Enables disk drive to transmit status byte 2 (Table 3-3) to the disk channel/controller. The sense command is not active during status byte 1 (Table 3-2) transmission.

Table 3—1. Commands (Part 2 of 3)

<table>
<tr><th>Command</th><th>Function</th></tr>
<tr><td>Set Head, Direction and Difference Most Significant Bit (MSB)</td><td>Selects head address, MSB of difference magnitude of head addresses, and direction of accessor movement. Controller selects 1 of 14 moving read/write heads if moving head assembly is selected, or 1 of 32 fixed-head addresses if a fixed head is selected. When the bit is set to 1, the assignments are as follows:

Bit — Function
0 — Accessor reverse direction (away from spindle)
1 — Difference magnitude 512
2 — Difference magnitude 256
3 — Head address 16
4 — Head address 8
5 — Head address 4
6 — Head address 2
7 — Head address 1</td></tr>
<tr><td>Set Difference</td><td>Indicates head positioning information, which is the difference between the current cylinder address and desired cylinder address. The MSB of difference magnitude is included with the set-head and direction command. When the bit is set to 1, the assignments are as follows:

Bit — Difference Magnitude
0 — 128
1 — 64
2 — 32
3 — 16
4 — 8
5 — 4
6 — 2
7 — 1</td></tr>
</table>

Table 3—1. Commands (Part 3 of 3)

Command	Function
Control	Control information is transmitted to the disk drive. When the bits is set to 1, the assignments are as follows: Bit — Control Command 0 — Write gate - enables write drivers 1 — Read gate - enables digital read-data line and resets interrupt latches 2 — Seek start - initiates seek in direction and magnitude previously selected by set-head/direction/magnitude and set difference commands 3 — Not used 4 — Offset direction - offset is toward disk perimeter 5 — Head select - head, indicated by head address register, can write or read 6 — Restore - initiates positioning to cylinder 0 and clears stored offsets 7 — Offset control - enables direction of offset specified by bit 4 to be performed. Bit 2 is also required.
Fault Clear	Resets all control flip-flops and unsafe latches
Module Select	Selects the disk drive for operation
Address Mark Write/Search	Disable no-write-transition unsafe detection during a write-address-mark operation

For a more detailed description of the commands, as well as the status conditions and sense data, see the System 80 I/O integrated controller programmer reference, UP-8742 (current version).

3.2. STATUS CONDITIONS

Status of the disk drive is indicated by the status bytes. Conditions indicated by the status bytes are listed in Tables 3–2 and 3–3.

Table 3—2. Status Byte 1

Bit	Function
0	Selected index – indicates beginning of a track, which occurs once per stack revolution
1	Selected online – indicates disk drive is ready for operation and following conditions are met: 1. Disk drive is selected. 2. No unsafe condition exists. 3. Disk drive completed a successful servo initialization (power-up sequence) or recovery from a seek-incomplete function. 4. Read/write heads are on cylinder.
2	Selected drive unsafe – indicates an unsafe condition in disk drive (2.2), which will: 1. Generate selected-drive-unsafe condition 2. Disable write drive circuits 3. Disable head selection The unsafe condition may be cleared by fault-clear, power-up reset, or automatic unsafe reset (2.2).
3	Write protect/offset unsafe – indicates selected disk drive is commanded to write during track-offset mode or to write in file-protect mode.
4	Selected seek incomplete – disk drive was unable to complete a seek operation or has failed to return a gated attention level to the controller within 230 milliseconds after beginning a seek. A restore command clears the seek error condition and returns the heads to cylinder 0.
5	Selected write protect – the FILE PROT switch is turned on and the write function is inhibited.
6	Selected fixed-head installed – the fixed-head assembly optional feature installed in the HDA of the disk drive
7	Not used

3.3. SENSE DATA

A sense command is generated when a command is issued to select a fixed or moving head, or when the disk drive is commanded to transmit status byte 2 across the interface. In normal operation, a sense command is not issued and the disk drive transmits status byte 1.

When the disk channel/controller detects a drive-unsafe or seek-incomplete status from the disk drive, status byte 2 (having the sense data) is examined and an automatic-reset, fault-clear, or restore command may be sent to the disk drive. The fault-clear command attempts to reset all unsafe conditions. The restore command reinitiates access control logic and resets a servo unsafe condition. The sense data, consisting of status byte 2, is listed in Table 3-3.

Table 3—3. Status Byte 2

Bit	Function
0	PLO unsafe - loss of PLO synchronization during write operation
1	Write unsafe - one or more of the following conditions exist: 1. Read and write gates are active simultaneously. 2. Multiple head/arm circuit is selected. 3. No write current, or transitions, or an illegal head address was detected with an active write gate. 4. Write current exceeds 120 milliamperes. 5. Write current terminal voltage of head/arm circuit dropped below -4.5 volts.
2	No write current or no-transition unsafe - an unsafe condition in which no write current, transition, or illegal head address is detected.
3	Speed unsafe - disk speed below 80 percent of nominal speed. Heads are positioned over the landing zone.
4	PLO sync unsafe - loss of PLO synchronization due to missing servo data
5	Seek too long - seek operation not completed within 230 milliseconds
6	Guard band detected - guard band 1 or 2 detected during seek or when access-ready function is active
7	The dc power unsafe - dc voltages not within tolerances or dc power not present