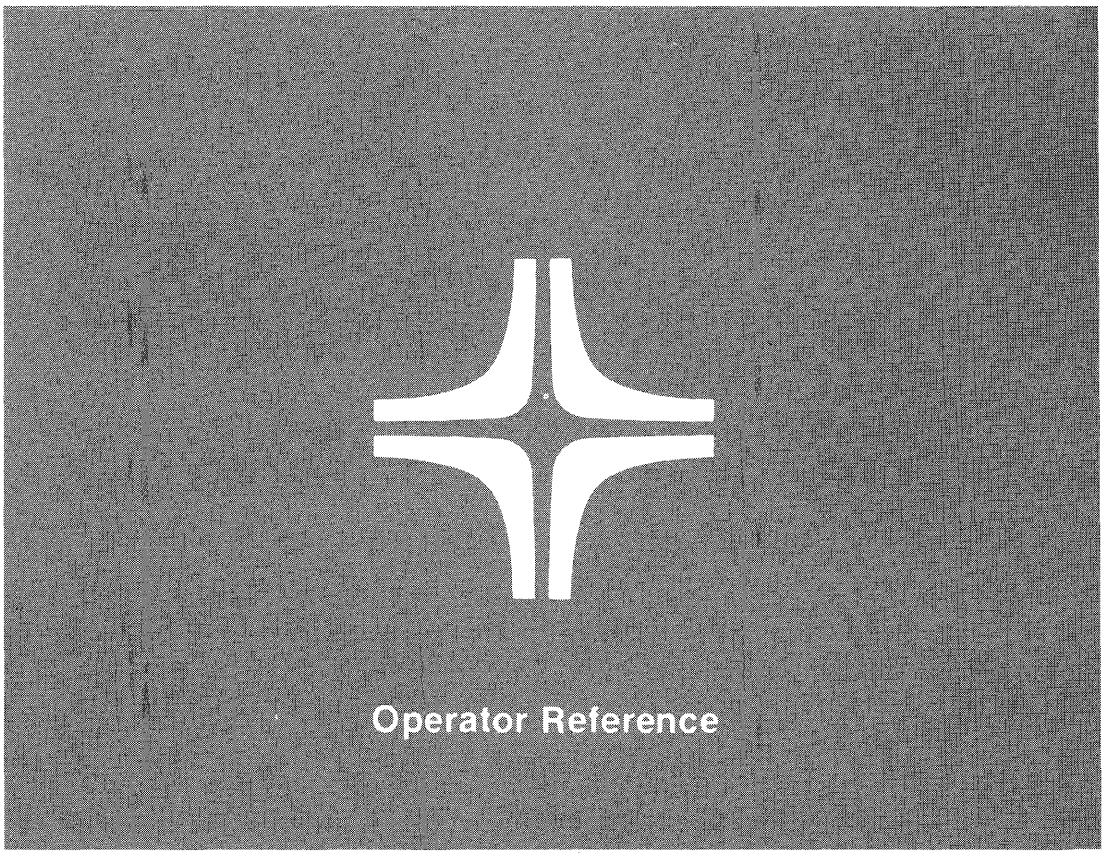
3766 Fixed Disk Storage Controller



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1. Introduction

1.1. OPERATING CAPABILITIES

This manual provides information for operating the SPERRY 3766 Fixed Disk Storage Controller (Figure 1-1). The disk controller is housed in a freestanding cabinet containing a printed circuit card module with eight printed circuit boards, a fixed disk drive, and power supply. Up to three additional disk drives may be included in a subsystem, with each drive capable of storing up to 100 megabytes of data for a host processor.

The fixed disk drive controller has the following capabilities:

- Multidrive control
- Dual-host operation
- Operation with fixed heads in the disk drives
- Dual-port drive
- Unattended operation
- Power-on confidence tests

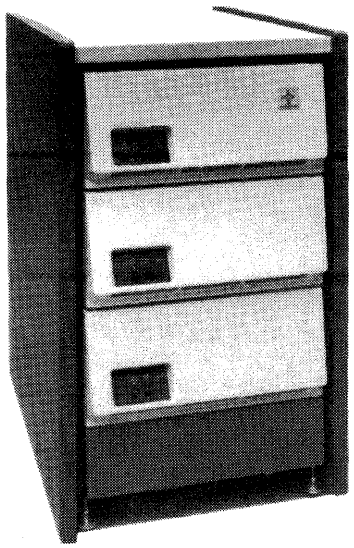


Figure 1-1. 3766 Fixed Disk Storage Controller

1.1.1. Multidrive Control

The basic controller operation supports a single disk drive; however, three additional disk drives can also be controlled. With optional features for additional disk drives, configuration switches on an internal printed circuit board are set for the particular controller configuration and operation. In addition to other controls, an internal timer determines the approximate power-up time required for the number of drives used.

1.1.2. Dual-Host Operation

A second host processor may be connected to the fixed disk drive controller (with an optional feature) to provide dual-access operation. The second controller interface controls data transfers and command interaction within the controller. Polling continues until either host signals for selection. The controller for that host is then reserved for the duration of a particular function and the controller does not honor a signal for selection from the opposite host. When the function is complete, the controller can again accept data from either host. Also, the controller can be cleared from either host.

1.1.3. Operation with Fixed Heads

With the fixed heads optional feature, the disk drive has rapid access to data stored on disks, without delays resulting from movement of access arms. There are 60 heads operating with 60 tracks that are organized into four 14-track cylinders and one 4-track cylinder. This 4-track cylinder is used for alternate track assignment. The fixed heads access unique tracks located on the servo platter surface, which is the bottom surface of the lowest of the four sealed disk platters.

1.1.4. Dual-Port Disk Drive

With dual-port capability, two controllers can access the same disk drive via two sets of disk drive ports. With this method of operation, all disk drives in the subsystem have dual ports.

1.1.5. Unattended Operation

Two modes of operation may be included to control power for the controller and disk drives. In local mode, primary power is supplied to the controller and disk drives when the power switch on the fixed disk controller operator control panel is turned on. In remote mode, this switch is left on and power is controlled from the host processor power-on control function.

1.1.6. Confidence Testing

Diagnostic routines perform extensive tests that thoroughly check operation of the entire subsystem. These tests are performed when:

- power is turned on;
- a host processor clears the subsystem; or
- the operator selects testing from the operator control panel.

1.2. COMPONENT DESCRIPTION

Two major components of interest to the operator are the controller and disk drive.

1.2.1. Controller

The controller performs the following basic functions. (See Figure 1–2.)

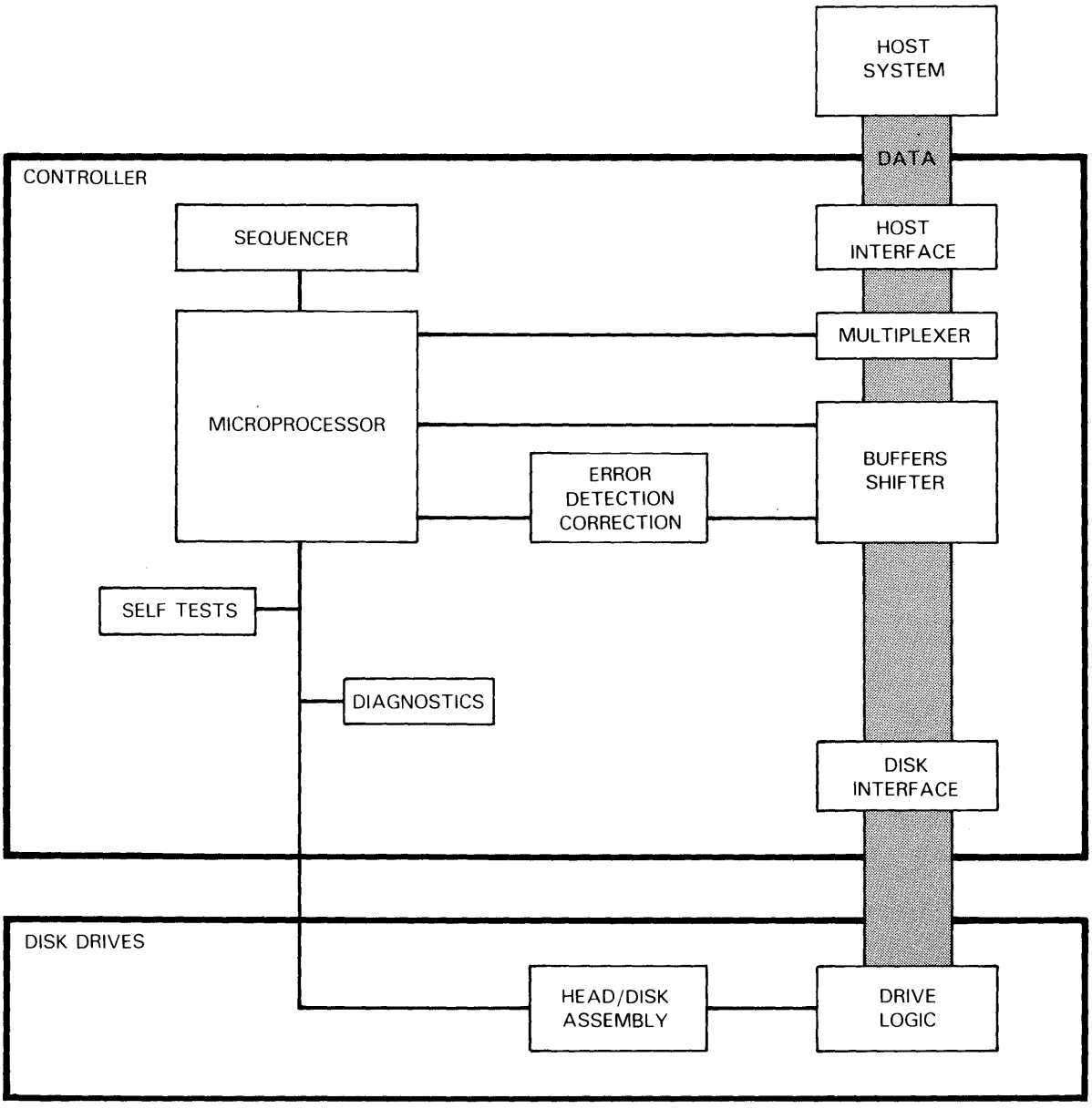


Figure 1–2. Controller Functions

- It interfaces the disk drives with control and status signals, and read/write and clock signals.
- It provides the host processor with a compatible 8-bit bidirectional byte interface and sustains data transfers of up to 1.2 megabytes per second.
- It transfers data internally, checks parity when writing data, multiplexes data from any of four inputs, and converts serial disk data to parallel form for reading or converts parallel data to serial form for writing.
- It controls operation of the subsystem with microinstructions from control storage by sequencing a microprocessor to address up to 4K of 48-bit words in control storage.
- It performs tests on the subsystem under microprocessor control, diagnoses faults, and displays the results on the controller control panel. Tests are made on:

  1. Control store stack to define microaddresses
  2. Scratch storage within the microprocessor with 256-bit data patterns
  3. Scratch storage external to the microprocessor with 256-bit data patterns
  4. All sources, operations, and destinations of the arithmetic logic unit (ALU)
  5. Quad data buffer in two 512-byte segments
  6. Branch field instructions
  7. Set, then clear all flags and tags
  8. Internal loopback and error correction code (ECC) generation capabilities
  9. Capability of the disk drives to seek, write, and read correctly

1.2.2. Disk Drive

Each disk drive used with the controller contains four disk platters of media (each is 14 inches (35.6 cm) in diameter) mounted on a single spindle and enclosed in a metal case (Figure 1–3). The fixed disks are not accessible; therefore, they cannot be changed by the operator. Data is stored on disk media for the host system in modified frequency modulation (MFM) code.

With the fixed heads capability, there are 60 read/write heads for 60 tracks on the disk. The tracks are organized into four 14-track cylinders and one 4-track cylinder for alternate track assignments. The fixed heads allow rapid access to disk data without accessor arm movement.

The disk drive contains a single head/disk assembly (HDA), which includes four disk platters, four movable data head/arm assemblies, and one servo head/arm assembly. Two movable data heads are used for each disk surface, with each head covering its own separate band of 561 tracks. An inner and outer band each have 561 tracks on a single disk surface.

Data is stored on seven disk surfaces, which may contain up to 100 megabytes of fixed storage for each disk drive. Two tracks are accessible on each disk surface – and each track is accessible in any one of 561 distinct positions (cylinders). With seven track surfaces, there is a total of 14 tracks accessible at each cylinder.

Servo tracks are located on the eighth disk surface to direct accessor arms and accommodate requests by programming commands. The entire head and disk assembly is enclosed in its own container to protect its operating environment.

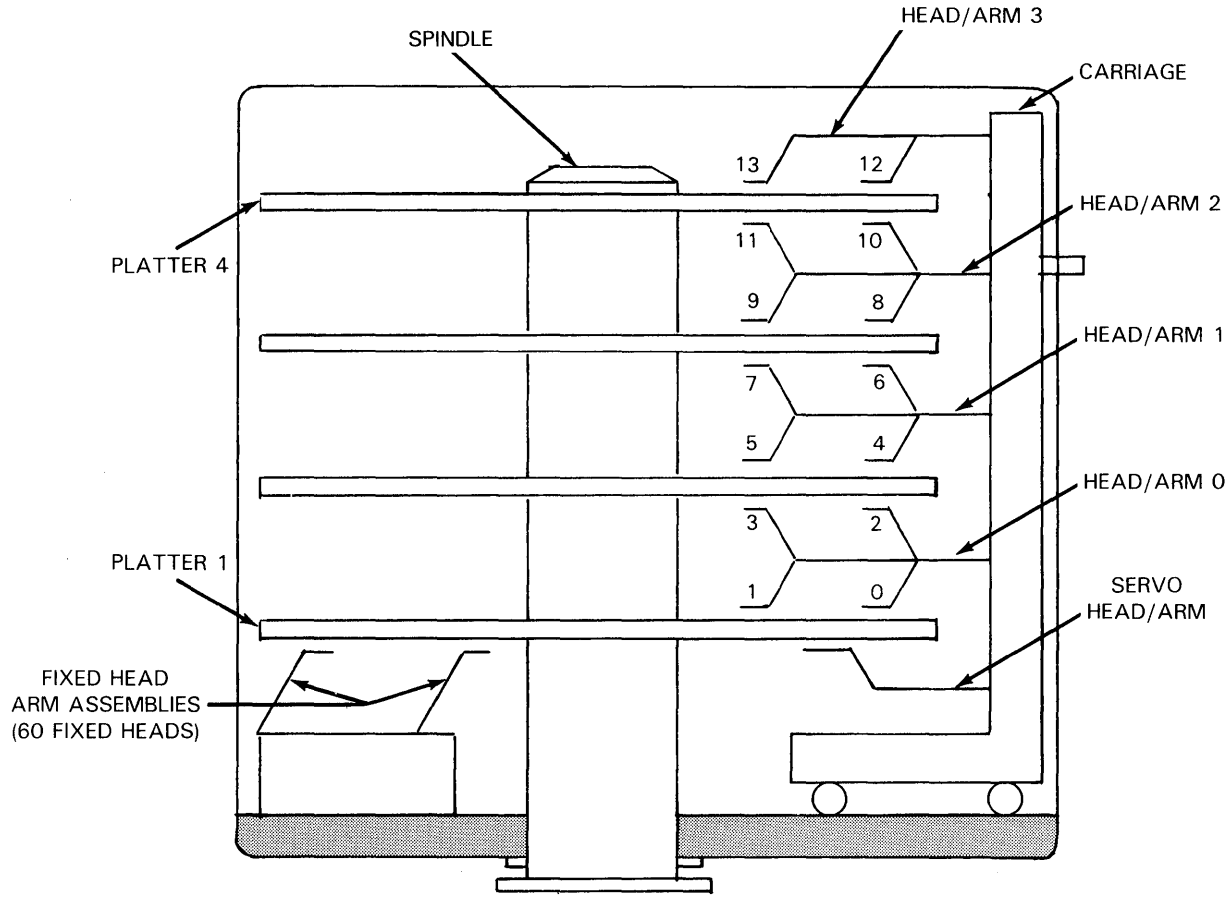


Figure 1-3. Head/Disk Assembly

1.2.3. Interface

The fixed disk controller is compatible with a SPERRY 8-bit bidirectional byte interface. If the dual host capability is included, the controller is connected to two host systems.

Two connectors for each host are included on the rear panel for attachment to interface cables. A terminator plug is connected to the output connector if this cabinet is the last peripheral in a chain.

A quad sector buffer is included in the interface to queue data being transferred between host and disk drive. The quad buffer is organized as two 512-byte segments, with two sectors (256 bytes each) contained in each segment. An expanded 16K-byte buffer may be included in your subsystem.

Data transfer sequence may be specified to operate in burst or byte mode, as defined by programming.

1.3. OPERATOR RESPONSIBILITIES

Operation of the fixed disk controller is greatly simplified because the disk media are not removable.

Self tests of the entire subsystem ensure correct operation; however, the operator must be familiar with operating indications presented on the operator control panel. The operator must:

- be thoroughly familiar with operator power control for local and remote operation;
- identify operational faults from indicators on the controller control panel; and
- perform self-test routines to reduce equipment down time by isolating a faulty component prior to contacting a Sperry customer engineer.

2. Controls and Indicators

The fixed disk controller is mounted in a cabinet with one or two disk drives in the same cabinet or two additional disk drives in an adjoining cabinet. The controller and all disk drives are equipped with individual control panels. In addition, a power control panel is located at the rear of the cabinet. No operator controls are located inside the cabinet; therefore, the cabinets must remain closed.

2.1. CONTROLLER CONTROL PANEL

The controller control panel contains switches and indicators used during normal operation or for diagnostic tests. A switch and circuit breaker are located behind the control panel and are accessible to the operator by snapping off the front panel. However, once set, these switches need not be disturbed. The switches and indicators are illustrated in Figure 2–1 and listed and described in Table 2–1.

2.2. DIAGNOSTIC INDICATORS

Four indicators are provided on the controller control panel that operate with the DIAG MODE switch to isolate faulty components. The type of fault is indicated by a combination of lit and extinguished indicators. The variable combinations of lit/extinguished indicators are listed with their meanings in Figure 3–2 to assist the operator in operation of the fixed disk controller.

2.3. DISK DRIVE CONTROL PANEL

Each disk drive contains an operator control panel to operate the drive at its location. The disk drive operator control panel is illustrated in Figure 2–2. The switches and indicators are listed and described in Table 2–2.

2.4. POWER CONTROL PANEL

A power control panel located at the lower rear of the fixed disk controller cabinet (Figure 2–3) contains the MAIN POWER circuit breaker to control primary power to the subsystem. After the circuit breaker is initially turned on, it should remain in the ON or 1 (up) position, except in an emergency. If the circuit breaker trips to the OFF or 0 position, contact the Sperry customer engineer.

CAUTION

If the fixed disk controller is to be relocated, contact the Sperry customer engineer so that a mechanical restraining rod can be installed to lock the head positioner to a fixed position before primary power is turned off. Otherwise, mechanical damage may result.

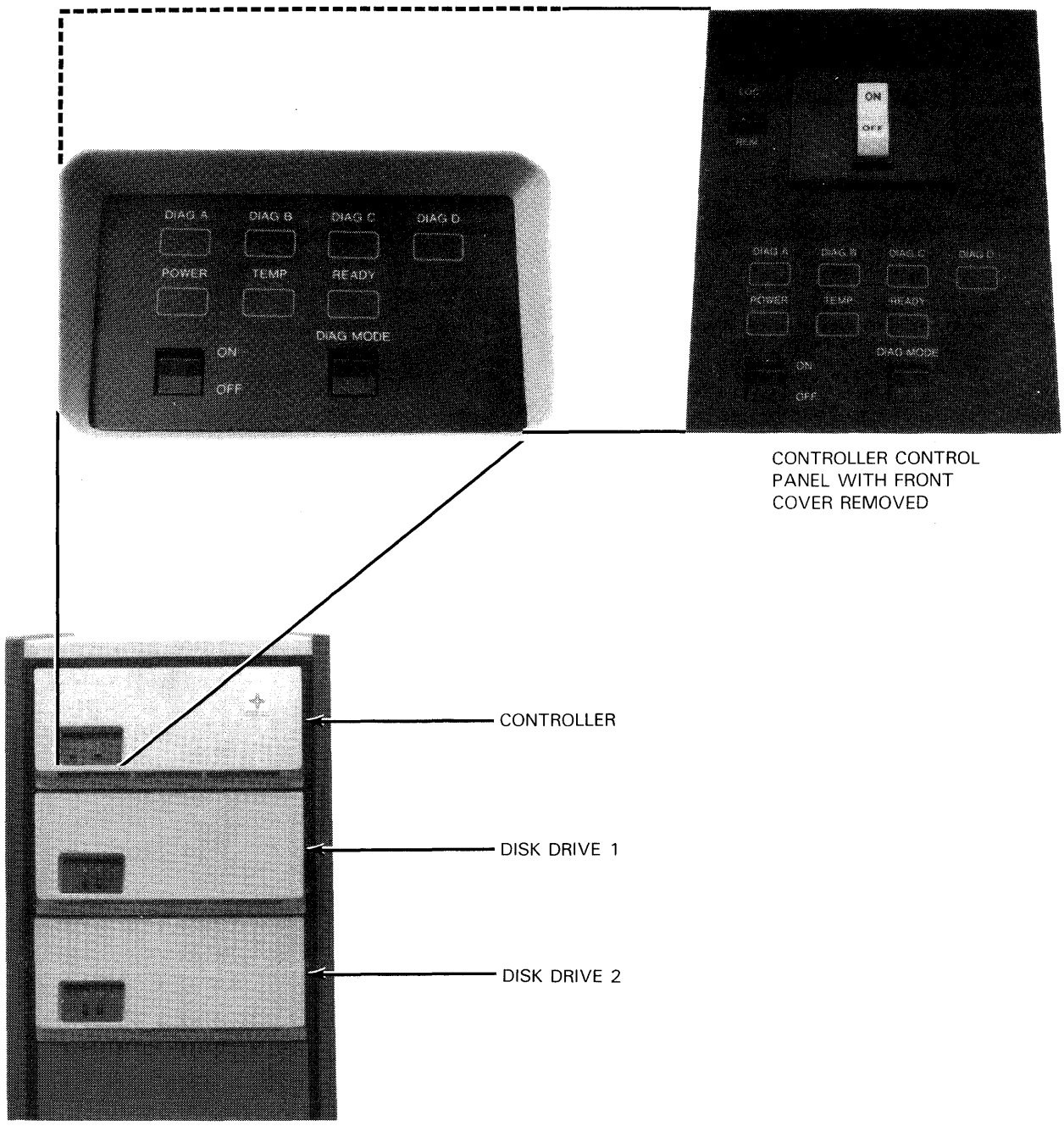


Figure 2–1. Controller Control Panel

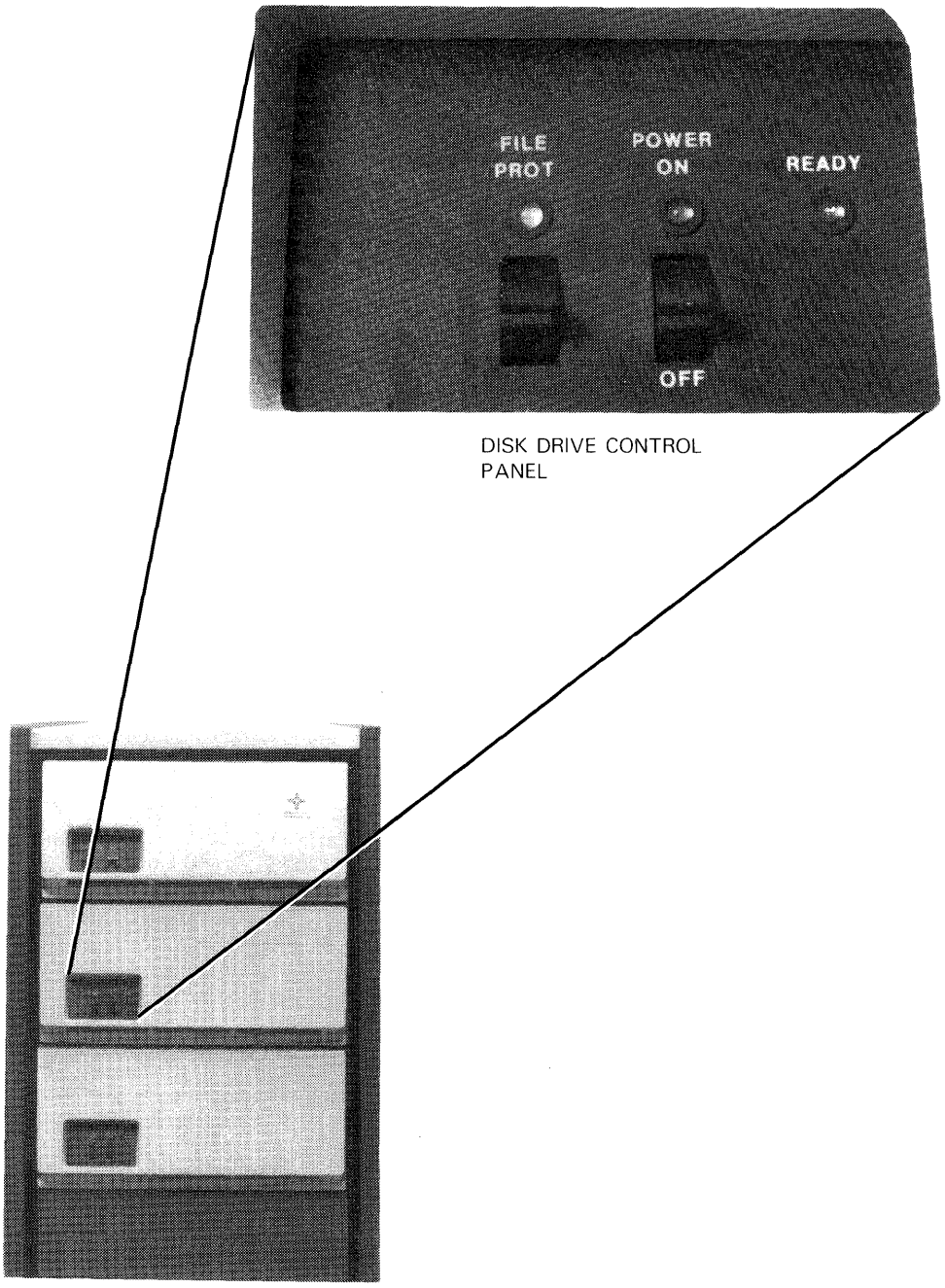
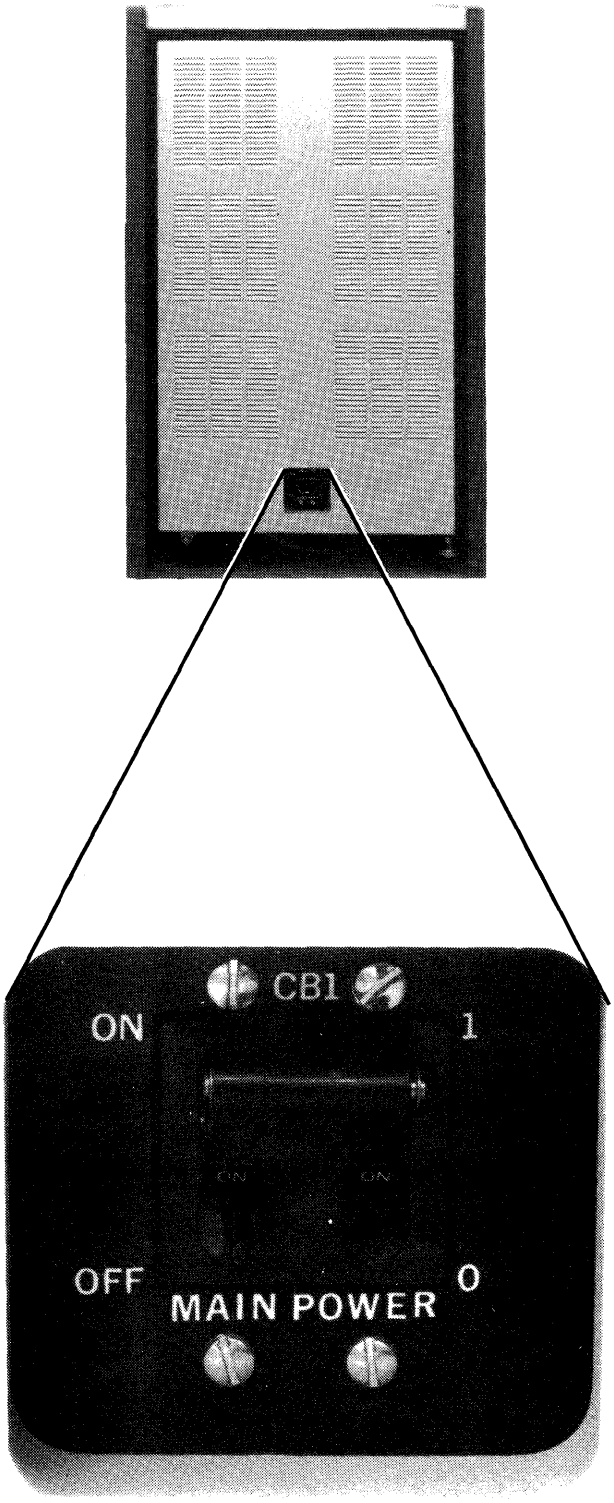


Figure 2–2. Disk Drive Control Panel



POWER CONTROL PANEL

NOTE:

Rear cabinet design may vary depending on model.

Figure 2–3. Power Control Panel

Table 2–1. Controller Control Panel, Switches and Indicators

Switch/Indicator	Function
LOC/REM switch (behind front panel)	Functions as part of unattended operation capability LOC position bypasses unattended operation capability, and power is controlled at the controller control panel. REM position allows control of operating power to be accomplished by a signal from the host system. Power must remain in ON position for this function.
Power ON/OFF circuit breaker (behind front panel)	Controls primary power to the controller power supply. Normally remains in the ON position
DIAG A through DIAG D indicators	Display the diagnostic status condition indicated by light combinations. See Figure 3–2 for operational recovery.
POWER indicator	Lit when primary power is applied to the controller power supply (ON/OFF switch set to ON)
TEMP indicator	Early warning indication that internal temperature in the controller is higher than normal. If temperature continues to rise, the power ON/OFF circuit breaker (behind the front panel) trips and power is turned off. A sense indication is presented to the host system when power is turned off.
READY indicator	The fixed disk controller subsystem is ready for operation and can execute commands from the host system.
Power ON/OFF switch	Controls operating power for the subsystem. In the OFF position, low current continues to be supplied to keep the head positioner in place and prevent read/write head damage.
DIAG MODE switch	Momentary action switch initiates diagnostic tests when pressed. All indicators light (except TEMP) when the switch is pressed; when released, diagnostic tests begin.

Table 2–2. Disk Drive Control Panel, Switches and Indicators

Switch/Indicator	Function
FILE PROT switch and indicator	In the up position with indicator lit, the disk drive is in read-only mode.
POWER ON/OFF switch and indicator	Turns power on for the disk drive. The power ON/OFF switch on the controller must be turned on before power can be applied to the disk drive. The indicator lights when power is on.
READY indicator	The disk drive is operating at normal speed and is ready to receive commands from the controller. The indicator should light after approximately 25 seconds have elapsed since the POWER ON/OFF switch was set to ON.

3. Operation

Operation of the fixed disk controller subsystem is confined to turning power on or off, protecting recorded data, performing diagnostic tests, and observing and responding to fault indications.

3.1. POWER TURN ON/OFF

Power is normally turned on or off at the controller control panel. If the unattended operation capability is included, power is turned on or off remotely at the host system.

CAUTION

Do not move the fixed disk controller cabinet without first contacting the Sperry customer engineer. An internal supporting rod must first be installed to prevent read/write head damage.

3.1.1. MAIN POWER Circuit Breaker

The MAIN POWER circuit breaker, located at the lower rear of the cabinet, is turned on at the time of installation and must remain on at all times except in an emergency.

NOTE:

The operator must ensure that power from the wall outlet is maintained, and that the fixed disk storage controller cabinet is not moved without first contacting the Sperry customer engineer.

3.1.2. Controller and Disk Drive Power Turn On/Off

Power is turned on for the controller and disk drive after primary power is applied with the MAIN POWER circuit breaker. Follow turn-on procedures as directed in subsequent paragraphs.

3.1.2.1. Power On

To turn on power, proceed as follows:

1. On each disk drive control panel, set the POWER ON/OFF switch to the ON (up) position.

2. After power is turned on for each disk drive, set the FILE PROT switch on each disk drive control panel to the down position if writing data on the disks is required, or to the up position if writing is not allowed.

3. Set the power ON/OFF switch on the controller control panel to ON (up) position. Note that the POWER indicator above the switch is lit.

NOTE:

Allow approximately 25 seconds after controller power is turned on for each disk drive to reach operating speed, then note that the READY indicator lights on each disk drive control panel and on the controller control panel. If any of the DIAG indicators light, refer to Figure 3–2.

3.1.2.2. Power Off

To turn off power, proceed as follows:

1. Set the power ON/OFF switch on the controller control panel to the OFF (down) position. Note that the POWER indicator (and all other indicators) extinguish on the controller and disk drives.

2. If any disk drive does not power-off, then set the POWER ON/OFF switch on the disk drive to the OFF (down) position. Note that the indicator extinguishes.

3.1.2.3. Emergency Power Turn Off

In an emergency, the operator may turn off power to the subsystem by setting the MAIN POWER circuit breaker on the rear of the cabinet to the OFF (0) position.

3.2. UNATTENDED OPERATION

The fixed disk controller and disk drives are designed for ease of operation. Disk packs inside the disk drive cabinet are part of the head/disk assembly (HDA) and can be replaced only by the Sperry customer engineer.

With the unattended operation capability, power to the controller and disk drives is controlled from the host system. If two host systems are connected to the controller for dual input, either host can control power on/off for the subsystem.

With remote power control from the host, power is first turned on at the controller, then the disk drives are turned on in sequence. When disk drive voltages reach their proper level and the disks are spinning at approximately 95 percent of normal speed, the next disk drive in the daisy chain is turned on. This sequence repeats until all disk drives are turned on.

If a disk drive fails to reach the required speed within 30 seconds, power is inhibited to that drive, and power-up control is propagated to the next disk drive. Power-on confidence tests, which are executed when voltages stabilize, indicate if a disk drive failed to reach normal speed.

To set the controller and disk drives for unattended operation from the host system, proceed as follows:

1. Remove the controller front panel cover by pulling it by its access openings on the bottom (Figure 3–1).

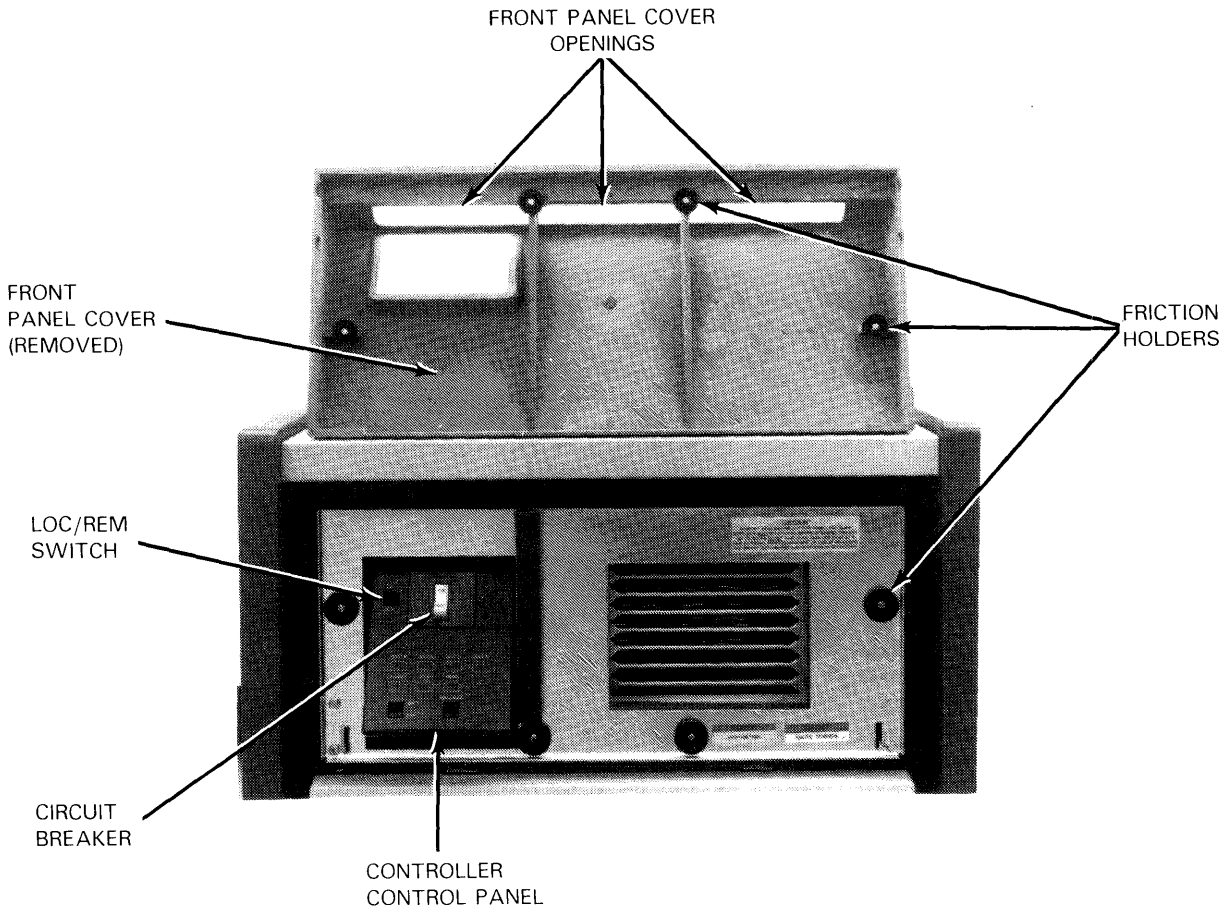


Figure 3–1. LOC/REM Switch on Controller Control Panel

2. Set the LOC/REM switch on the controller control panel to REM position.

3. Replace the front panel cover by setting it in place and pressing it against the controller to engage the friction holders.

4. Turn on power for the subsystem as directed in 3.1.2.1. The controller and disk drives are now ready to operate by power control from the host system.

3.3. OPERATOR MAINTENANCE

Maintenance by the operator is limited and required for:

- performing diagnostic tests if a failure occurs and reporting the results of the tests to the Sperry customer engineer; and
- performing a minor cleaning routine.

CAUTION

There are no operator controls or adjustments inside the cabinet; therefore, do not attempt to open the disk drive cabinet and slide the drawers out because improper conditions will result in a head crash and damage the equipment. The drawers should NOT be opened by the operator, especially with power off.

3.3.1. Diagnostics

The controller is equipped with firmware diagnostic routines that thoroughly check operation of the entire subsystem. The diagnostic routines are performed when:

- power is turned on either at the subsystem or remotely from the host system;
- a CLEAR signal is received from either host system; or
- the operator initiates tests with the DIAG switch on the controller panel.

During diagnostics, the controller is offline to the host system and does not respond to any request except when the CLEAR signal is sent. In addition, the DIAG indicators on the controller control panel light to indicate the tests are in progress, and the READY indicator remains extinguished.

Diagnostics are divided into two parts. The first part requires approximately 2 seconds and includes the following functions:

1. The controller and disk drives are cleared of any current error conditions.
2. The controller and disk drives are initialized to a starting condition.
3. Controller diagnostics are executed. The diagnostics:
   a. test operation of the sequencer and various sequencer controlled registers;
   b. check the integrity of the data path;
   c. check the RAM buffers with various test patterns; and
   d. perform internal controller loopback operations.
4. A buffer expansion diagnostic is executed. It writes, reads, and checks a test pattern.

The second part of diagnostics is disk drive testing.

Extensive tests on the disk drives are performed when power is turned on. Each disk drive requires 25 seconds, after power is turned on, to become fully operational and light its own READY indicator, then initiate power on for the next disk drive.

After this waiting period, each disk drive is polled to determine whether it is available for extensive testing. Each disk drive that has power off, is busy, or is protected from writing is then skipped and not tested further. If a disk drive has failed to meet the test requirements, it is also not tested further.

Each disk drive requires approximately 5 seconds for extensive tests. If diagnostic tests are performed with the DIAG MODE switch or from a host system shortly after power has been turned on, or the subsystem had recently been tested for power-on confidence tests, then disk drive diagnostics consist only of polling each disk drive.

The controller waits for all disk drives to be operational and tested before allowing the entire subsystem to go online to the host. If a fault occurs in the controller or buffer expansion, operation stops and waits for intervention by the operator or host system to restart from power on.

To initiate a diagnostic test, proceed as follows:

1. Press the DIAG MODE on the controller control panel and keep it pressed for a lamp test. Note that DIAG A, DIAG B, DIAG C, DIAG D, and POWER indicators remain lit while the DIAG MODE switch is pressed. This is a lamp test.

2. Release the DIAG MODE switch to execute the diagnostic routine. Note that the DIAG indicators are lit while tests are being performed.

3. After approximately 5 seconds for each operational disk drive, the tests are complete and all DIAG indicators should extinguish. If any are lit, refer to Figure 3–2 for an indication of the problem. If none are lit, the READY indicator lights and the subsystem may resume operation.

NOTE:

Contact the Sperry customer engineer if any DIAG indicators remain lit after tests are complete. Explain the indication presented by the DIAG indicators.

DIAG D	DIAG C	DIAG B	DIAG A	
○	○	○	○	Test completed successfully
○	○	○	●	Microprocessor 1 PCA failure
○	○	●	○	Microprocessor 2 PCA failure
○	○	●	●	Expansion I/O PCA failure (XIO)
○	●	○	○	Control storage parity error
○	●	○	●	DMA PCA failure
○	●	●	○	I/O PCA failure
○	●	●	●	Not used
●	○	○	○	Drive 0 read/write failure*
●	○	○	●	Drive 1 read/write failure*
●	○	●	○	Drive 2 read/write failure*
●	○	●	●	Drive 3 read/write failure*
●	●	○	○	Control storage parity error
●	●	○	●	Not used
●	●	●	○	Buffer expansion PCA failure**
●	●	●	●	Test in progress

* The controller is operational. This display indicates at least one disk drive failed in read/write power-on confidence tests.

** The controller can operate by using only the local buffer.

LEGEND:

● Indicator lit

○ Indicator extinguished

Figure 3–2. Operator Diagnostic Indications

3.3.2. Cleaning

Cleaning requires only that the operator maintain an unobstructed cooling airflow through the cabinet. Remove any obstructions to the air outlet at the rear of the cabinet (Figure 3–3). Air filters are maintained by the Sperry customer engineer.

CAUTION

Do not move the fixed disk drive controller cabinet without first contacting the Sperry customer engineer to install a mechanical restraining rod to prevent damage to the recording mechanism.

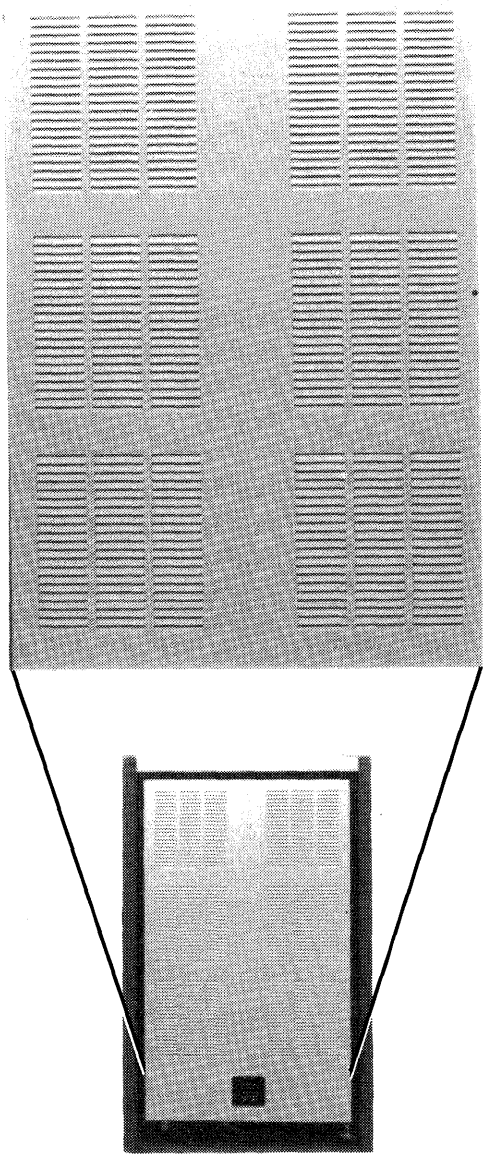


Figure 3–3. Cooling Air Outlet

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