Seagate

ENGINEERING SPECIFICATION

TWIN CITY OPERATIONS

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PRODUCT SPECIFICATION

FOR

97289-21G SABRE DISC DRIVE
2.1 GB, 8 HEAD PARALLEL
IPI-2 INTERFACE, ENHANCED

AND

97299-24G SABRE DISC DRIVE
2.4 GB, 9 HEAD PARALLEL
IPI-2 INTERFACE, ENCHANCED

SEAGATE PRE-RELEASE

This is a proposed document meant for review only within Twin City Operations.
It contains preliminary and incomplete information and is subject to change without notice or ECO.

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1.0 SCOPE

This document describes the Seagate 97289-21G (2.105 GB) Sabre Disc Drive with the IPI-2 I/O (8 Head Parallel), the 97299-24G (2.368 GB) Sabre Disc Drive with the IPI-2 I/O (9 Head Parallel), and their available configurations.

2.0 APPLICABLE DOCUMENTS

SPEC 64731600 - IPI-2 Intelligent Peripheral Interface
SPEC 64400300 - Synchronized Spindle System for Sabre Disc Drives
PUBL 83327350 - User's Manual
PUBL 83327370 - Maintenance Manual
PUBL 83327360 - Parts Data Manual
PUBL 83325000 - Reference Card
CSA 22.2 220 - Information Process and Business Equipment
IEC 950 - Safety of Information Technology Equipment
UL 478 - Electronic Data Processing Units and Systems
VDE 0806 - Regulations for Electric Motor Operated Appliances
VDE 0871 - Radio Frequency Interference
ANSI X3.129-1986 - Intelligent Peripheral Interface - Physical Level
ANSI X3.130-1986 - Intelligent Peripheral Interface - Device Specific Command Set for Magnetic Disc Drives
ANSI X3T9/88-82 Rev 2.1 - Enhanced Physical Interface

3.0 GENERAL DESCRIPTION

3.1 Equipment Definitions

The Sabre 8 head parallel disc drive (8 HP) is a high transfer rate 8 inch disc drive with an unformatted capacity of 2.105 GB. A high transfer rate of 24 MB/s is achieved by utilizing eight 3 MB/s read/write channels. The drive uses the industry standard Enhanced IPI-2 interface and can be operated with either single or dual port.

The Sabre 9 head parallel disc drive (9 HP) is a high transfer rate 8 inch disc drive with an unformatted capacity of 2.368 GB. A high transfer rate of 27 MB/s is achieved by utilizing nine 3 MB/s read/write channels. The drive uses the high performance Enhanced IPI-2 interface and can be operated with either single or dual port. The high performance IPI-2 interface differs from the Standard IPI-2 interface in that on information transfers the interface parity bits from Bus A and Bus B are checked, recorded and read from the media.

In the recording scheme for either drive, a bit from Bus A (bit 0 for example) is written followed by the corresponding bit 0 from Bus B on given recording surface; Bit 1 from Bus A is written followed by bit 1 from Bus B on the next surface; bits 2 on the next surface; bits 3 on the next surface; and so on until all bits are written.

Each drive has an integral power supply and is cabinet or rack mountable. The fixed, sealed, head disc assembly uses thin film media, thin film heads, a rotary actuator with an advanced digitally controlled positioning system, and a direct current spindle motor which may be synchronized with other Sabre drives. The spindle rotates at 3600 rpm.

The Sabre 8 HP disc drive and the Sabre 9HP disc drive are equipped with the capablility to micro-position each Read/Write head arm within its track space independently of carriage positioning circuitry.

Figure 1 illustrates the placement of major components, Figure 2 the available accessories, Figure 3 the plan view, and Figure 4 the head-disc scheme.

3.2 Accessories

Accessories are not included with the drive units but must be purchased separately. See Figure 2 and Table 1.

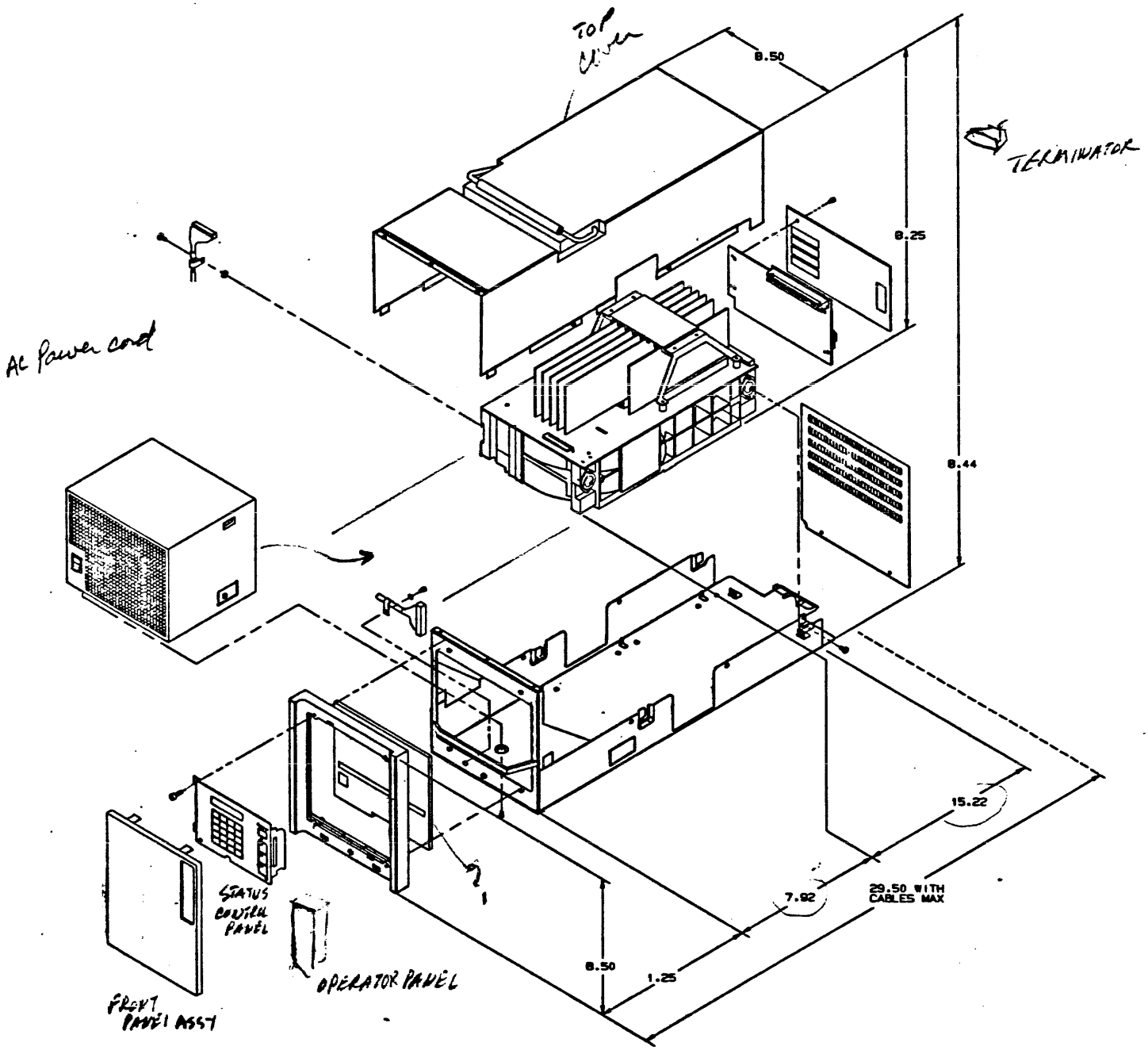
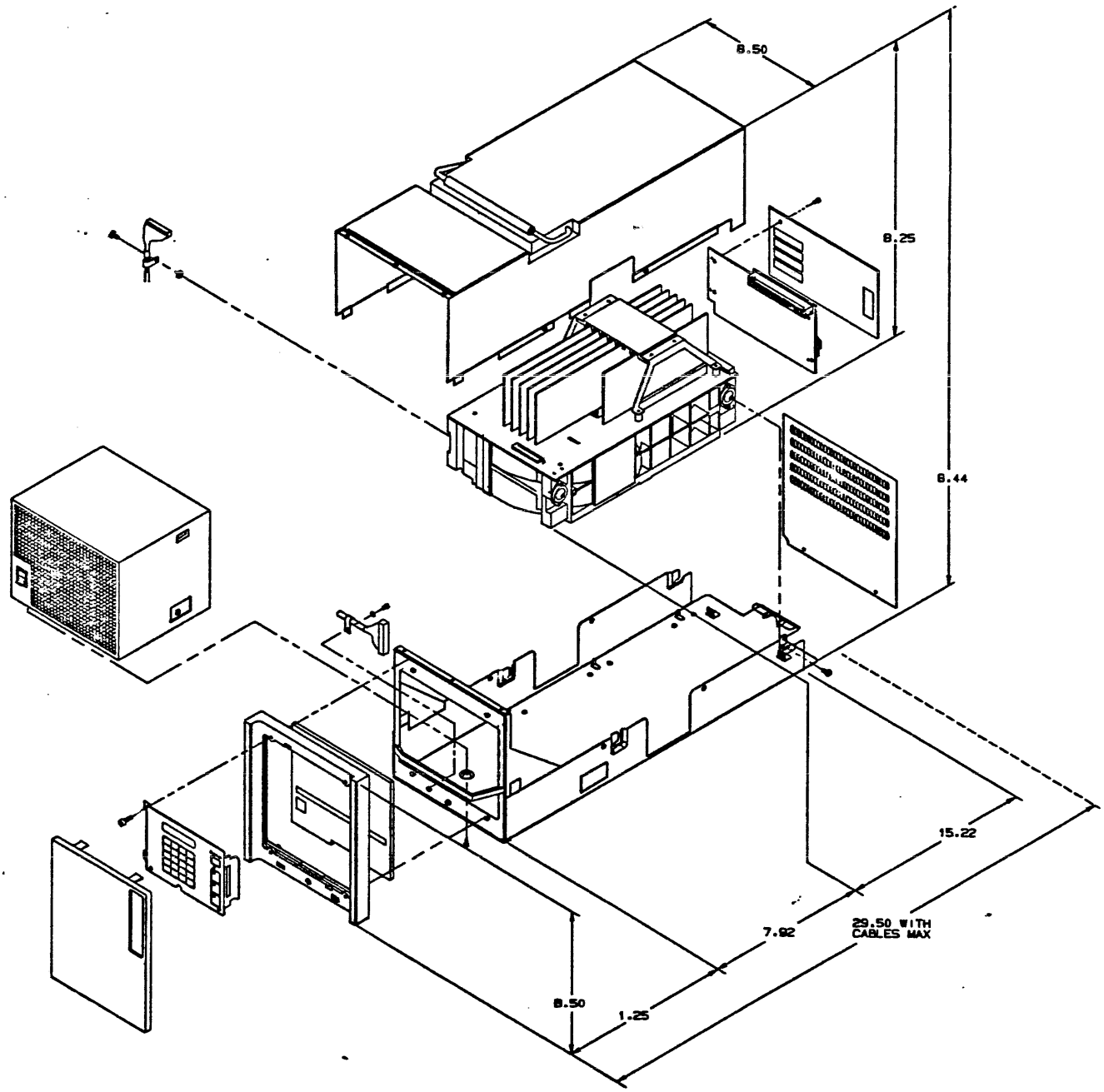


FIGURE 1. MAJOR COMPONENT PLACEMENT

FIGURE 2. SABRE AND ACCESSORIES



DIMENSIONS ARE NOMINAL AND INTENDED FOR SITE PLANNING USE ONLY

FIGURE 3. PLAN VIEWS

READ WRITE CHANNEL	HEAD ADDRESS 0	HEAD ADDRESS 1
0	6	7
1	5	4
2	2	3
3	1	0
4	17	16
5	14	15
6	13	12
7	10	11
8*	9*	8*

* Not used for 8 HP

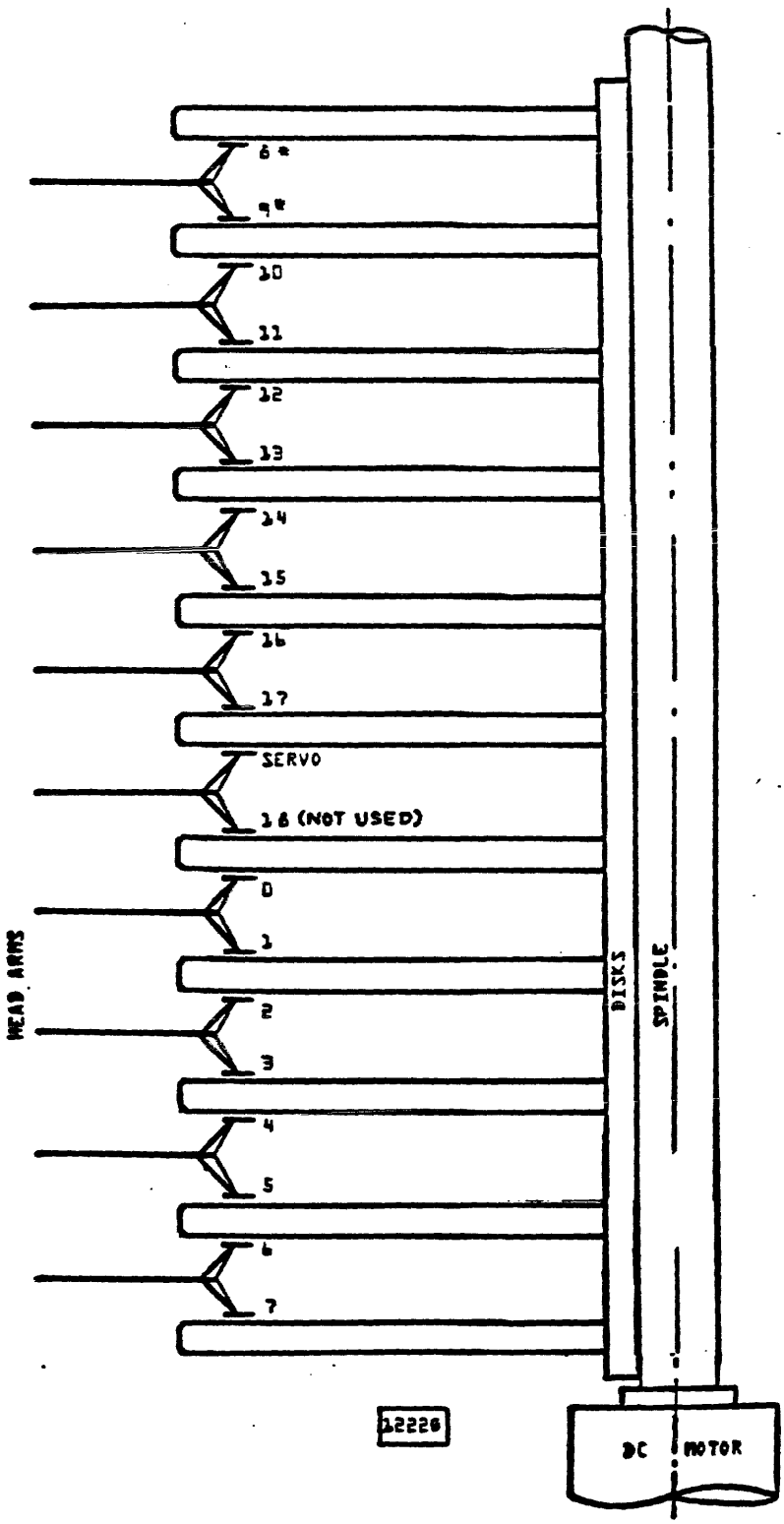


FIGURE 4. HEAD DISK SCHEME

TABLE 1. ACCESSORY AND SUPPLY ITEMS

DESCRIPTION	QUANTITY REQUIRED	NOTE	PART NO
AC Short Power Cord Set	One per Drive	1,2	47188871
AC Short Power Cord Set	One per Drive	1,3	47188872
AC Power Cord Set 5-15P (60Hz)	One per Drive	1	75168331
AC Power Cord Set 6-15P (60Hz)	One per Drive	1	75168346
AC Power Cord Set (50Hz)	One per Drive	1	15165427
Operator Panel Kit	One per drive	4	470318XX
Status/Control Panel Kit	One per drive	4	932389XX
Front Panel Assembly	One per drive	5	70522900
Rack Mounting Kit (for 2 drives mounted side by side in a 19 in. horizontal rack)	One per 2 drives		70527403
I/O Terminator Assembly	One per multi-drive installation in Daisy Chain	6	15458851
IPI I/O Cable	One per drive	6,7	708830XX
Spindle Synchronization Cable	One per slave synchronized drive	8	708827XX
Spindle Synchronization Terminator	Two per master synchronized drive		70882711

NOTES:
1. See Figures 12, 13 and 14 for ac power cord set detail.
2. Power cord set necessary to meet FCC and CSA emission requirements.
3. Power cord set necessary to meet VDE emission requirements.
4. Kits are tabulated according to the length of the cable in the kit. Last two digits of the kit part number denote the cable length. See Table 2. See 7.0 for panel functions.
5. Front Panel Assembly includes; Front Panel, Front Panel Insert, Filler Plate, and Filter. Standard Color: Light Grey with Imperial Blue Insert.
6. Twice the number of cables and terminators are required for dual port operation.
7. Last two digits denote cable length. See Table 3.
8. Last two digits denote cable length. See Table 4.

TABLE 2. OPERATOR PANEL, STATUS/CONTROL PANEL KIT TABS

CABLE LENGTH IN INCHES	22	48	96
OPERATOR PANEL KIT 470318XX	04	05	06
STATUS/CONTROL PANEL KIT 932389XX	03	04	05

TABLE 3. I/O CABLE LENGTHS AND TABS

CABLE LENGTH IN FEET	1½	10	80	3	6	25	50			
CABLE TABS PN 708830XX	11	12	13	14	15	16	17			

TABLE 4. SYNCHRONIZATION CABLES AND TABS

CABLE LENGTH IN FEET	1½	3	6	10	25	50				
CABLE TABS PN 708827XX	21	22	23	24	25	26				

3.3 Reliability, Availability, Maintainability (RAM) Features

1. Reliability

   - Whitney type technology with contact start/stop operations given a dedicated landing zone separate from the data recording area.
   - Heads, media and actuator are contained within a sealed module assembly with its own closed loop air filtration system.
   - An optional embedded sweep cycle (head movement) routine that insures head to disc interface time is normalized across the recording surface.
   - Automatic Head micro-positioning.

2. Availability

   - High performance access to data: 22.33 ms average (average seek + average latency).
   - Automatic drive recovery after ac power loss without operator intervention.
   - Accepts I/O commands for carriage offsets and read recovery circuit timing offsets (Strobe Offset).

3. Maintainability

   - No preventive maintenance required.
   - Built-in self test on dc power application. Firmware internal to the control MPU will test all MPU ROM + RAM memory, drive MPU bus, bus communications with IPI I/O circuits. Firmware resident to the IPI I/O processor can test integrity of the read and write channels using a dedicated diagnostic cylinder.
   - With Status/Control panel accessory, off line diagnostics can be run that vigorously test the actuator and its associated logic.
   - With the IPI-2 I/O, a servo test/recalibrate routine can be initiated over the interface.
   - With Status/Control panel accessory, drive internal machine/fault status can be made available for problem diagnosis.

- Automatic carriage lock/unlock on power down/up.
- Access to configuration switches is possible without removing logic covers.
- All I/O and dc cable connectors have key/polarizing hardware.

4.0 PERFORMANCE

4.1 Access-to-Data Characteristics

4.1.1 Data Transfer Rate

The nominal burst transfer rate is:

8 HEAD PARALLEL	9 HEAD PARALLEL
194.4 Mb/s (24.3 MB/s)	218.7 Mb/s (27.3 MB/s)

4.1.2 Positioning Times

Zero Cylinder Seek - 300 µs nominal. (Measured from Load Cylinder command Slave End state to Command Completion Interrupt available.)

Random (average) Seek - 13 ms nominal.
This is defined as the time to make all possible seeks divided by the number of possible seeks (see Figure 5).

Single Cylinder Seek - $\leq$ 3 ms average, 5.1 ms maximum.
This is defined as a seek between any pair of adjacent cylinders.

Maximum Seek - 28 ms.
This is defined as a seek from cylinder 0 to cylinder 2610.

Maximum RTZ - 1 s.

4.1.3 Latency Time

The average latency time is 8.33 ms, based on a nominal disc speed of 3600 rpm.

The maximum latency time is 16.83 ms, based on a minimum disc speed of 3564 rpm (see 5.4).

Latency time is defined as the time required to reach a particular track location after positioning is complete.

4.1.4 Head Switching Time - 2µs

4.1.5 Write or Read Recovery Time - 7µs

TBD

FIGURE 5. TYPICAL SEEK PROFILE

4.2 Data Capacity

The data capacity specified is based on the number of 8-bit Bytes that are recorded on a track. The unsectored capacity below does not include an allowance for tolerance gaps.

	8 HEAD PARALLEL	9 HEAD PARALLEL
Heads:	16	18
Cylinders Per Unit:	2611	2611
Bytes Per Physical Track:	50,400	50,400
Bytes Per Cylinder:	806,400	907,200
Bytes Per Spindle:	2,105,510,400	2,368,699,200

4.3 Error Rates

The following error rates assume that the drive is being operated within its specification. Errors caused by media defects or equipment failures are excluded.

4.3.1 Read Errors

Read error rates are based on the fact that all data has been verified as written correctly and all media defects have been flagged.

- Recoverable Error Rate $\leq$ 10 in 10^{11}

  The recoverable read error rate is the number of errors encountered which are recoverable within 27 retries as a function of the number of bits transferred (3 retries at each data strobe and carriage offset).

- Unrecoverable Error Rate $\leq$ 10 in 10^{13}

  The unrecoverable read error rate is the number of errors encountered which cannot be read correctly within 27 retries (3 retries at each combination of data strobe and carriage offset).

4.3.2 Write Errors

Unrecoverable write errors are those which cannot be corrected within 3 attempts at writing the record with a read verify after each attempt.

Write errors can occur as a result of the following:

- write data not being presented correctly
- media defects
- equipment malfunction

As such, write errors are not predictable as a function of the number of bits passed.

An unrecoverable write error that occurs because of a drive equipment malfunction is classified as a failure affecting drive MTBF.

4.3.3 Environmental Errors

When operating a low effective data transfer rate; e.g., random access of single short records, the effective error rate may be expected to exceed the limits of 4.3.1 due to external environmental interference. The resulting recoverable read error rate is less than 1 error in 8 hours of operation.

4.3.4 Access Errors

There are no more than 10 positioning errors in 10^8 seeks.

4.4 Data Security

Under normal controller I/O operation, the drive will write only that pattern present on the write data lines. Both drive Selected and On Cylinder must be true before a valid write operation can be completed. Data is protected by inhibiting Write Gate in all fault conditions including a loss of On Cylinder, Seek Error or low dc voltage. This is accomplished by switching off the voltage required to write and/or performing an emergency retract of the Read/Write heads.

Under an ac power failure while performing a write operation, the data will be valid on all tracks except the sector/record on which the read/write heads were writing at the time of the ac power failure.

4.5 Stop Time

The time to stop the spindle after the START/STOP switch has been turned off is 60 s maximum.

4.6 Start Time

The time for the drive to be in the Ready state after the START/STOP switch has been depressed is 90 s maximum.

4.7 Power Sequencing

The length of delay of the drive power-up sequence is determined by the logical unit number assignment in increments of 5 s; e.g., a logical unit "0" drive has no delay; a logical unit "4" drive delays power up by 20 s.

NOTE: Sabre will start its delay to power up sequence upon receiving a drive function code "spin-up" with the START switch on.

4.8 Spindle Synchronization

Within a system, each drive synchronizes its spindle with a master sync reference signal which is provided by one drive designated as the master, a controller, or an oscillator signal source. If the reference signal is not present, the drives in the system continue to operate in a non-synchronous mode.

Spindle synchronization is achieved within 10 s after (1) the spindle reaches full speed (3600 ±3.6 rpm) during a motor start routine provided a reference signal is present, or (2) the unit is running at full speed and a reference signal not previously detected, is detected.

The tolerance of the spindle lock is ±10 µs.

Only 1 device in a daisy-chain may provide the master sync reference signal. If a drive is chosen to provide this signal, all other devices become slaves and the selected drive is designated as a master in 1 of 2 ways:

1. The Master Sync Switch on the I/O board establishes the drive as a master or slave.

2. A drive with the Master Sync Switch inactive can be designated as a master via Bus Controls issued on the IPI-2 interface. Bus Control 01 (Load Drive Function) with Function Code 2F (Enable Master Sync) causes the drive to become a master. If the Enable Master Sync function is presented to a drive whose Master Sync Switch is active, the function is rejected and Bus Control Exception status is returned.

A drive designated as a master may be disabled in 1 of 2 ways:

1. The Master Sync Switch on the I/O board may be placed in the inactive position prior to power-up.

2. A Bus Control 01 (Load Drive Function) with Function Code 2E (Disable Master Sync) causes a drive to cease being a master. This function causes bit 5 in octet 3 (Spindle Sync Master) of the Extended Status Block to be reset. If the drive was designated as a master via the Master Sync Switch being active, the drive rejects the Disable Master Sync function and provides Slave Ending status Bus Control Exception. This condition causes bit 5 in octet 0 (Bus Control Exception) and bit 6 in octet 2 (Invalid Parameter) of the Status Response Block (Table 6) to be set.

See Table 1 for spindle synchronization cabling accessories. See SPEC 64400300 for additional interfacing and timing information.

4.9 Head Micro-positioning

The Sabre 8HP/9HP disc drive is equipped with the capability to micro-position each read/write head arm within its track space independent of the carriage positioning circuitry.

To accomplish this reliability enhancement, a 288 byte End-of-Track micro-positioning field exists just prior to the index mark. Servo information is recorded in this field. Overwrite protection circuitry prevents this information from being destroyed.

- Unformatted track capacity remains at 50,400 bytes.

- The transfer rate reflects the gross capacity (including the micro-positioning field) of 50,688 bytes per revolution for each physical head. The rate is calculated by multiplying the number of physical heads per logical head times the 3.041280 MB/s rate of each physical head.

5.0 RECORDING CHARACTERISTICS

5.1 Recording

Mode:	2,7 Code
Density (Inner Track):	24,200 bpi nominal

5.2 Disc

	8 HEAD PARALLEL	9 HEAD PARALLEL
Total number:	11	11
Servo surface:	1	1
Data surfaces:	16	18
Data tracks per surface:	2611*	2611*
Tracks per inch:	1880	1880

*Cylinder 2610 is reserved for the defect map.
*Cylinder 2609 is reserved for drive diagnostic use.

5.3 Heads

	8 HEAD PARALLEL	9 HEAD PARALLEL
Servo head:	1	1
Recording heads:	16	18

5.4 Spindle

The spindle speed is 3600 ±36 rpm. These limits represent ±1% of nominal.

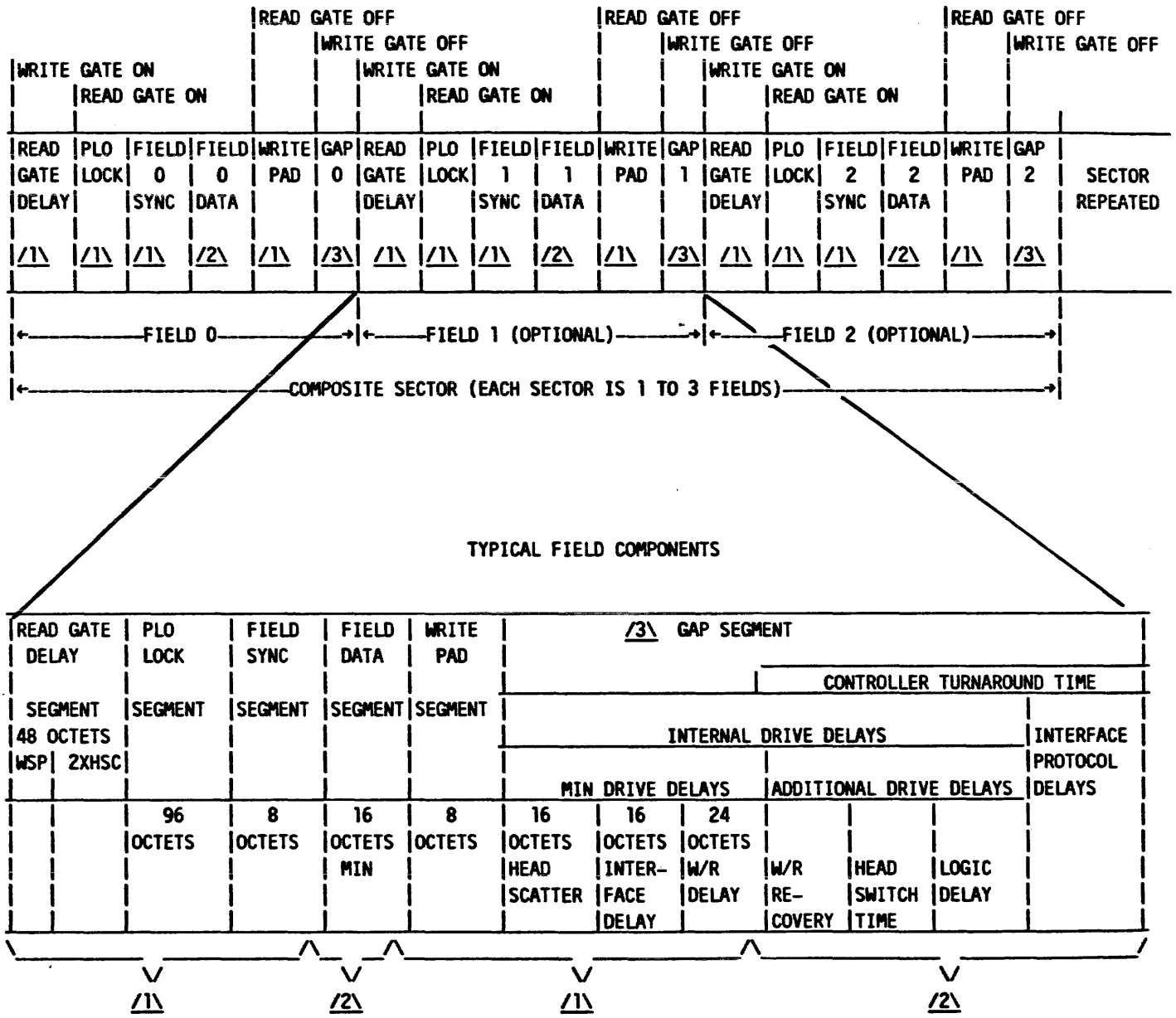
5.5 Disc Format

A fixed block hard sector format is used on the Sabre 8HP/9HP. Every sector is of the same length and organization but the length and organization is programmable. The Sabre 8HP/9HP does not support a soft sector format (address mark) or variable block format.

The Sabre 8HP/9HP retains the format specification in non-volatile memory. Consequently there is no need to re-initialize the format specification when the drive is powered on if the same format specification last used is still applicable.

5.5.1 User Cylinder Sector Format

The standard format allows a variable number of composite sectors per track. The total number of octets per composite sector is less than or equal to 65,536. Each composite sector has 1 to 3 fields. The standard hard sector format and typical field components are illustrated in Figure 6.



/1\ FIXED BY DRIVE
/2\ CONTROLLER DEFINED
/3\ CONTROLLER/DRIVE DEFINED

NOTE: The octet counts listed above are for a logical field which is comprised of eight (for 8HP) or nine (for 9HP) physical fields. The actual physical field length is determined by dividing the logical field length by eight.

FIGURE 6. HARD SECTOR DISC FORMAT

5.5.2 Defect Map

The drive maintains a defect map containing a list of defects found by the manufacturer. This defect map is for use by the controller to reallocate, map, or mask out defects when formatting the drive. The tracks used for the defect map are formatted with the manufacturer's format specifications (see table 5). All defects from all cylinders are recorded in sequential order CHP. The length of a defect is in bits +1, -0 bits.

5.5.2.1 Defect Map Contents

Each sector in the defect map is self identifying. A defect map set consists of 3 identical sectors (triplicates) plus any unreadable sectors, with each sector identified as to whether it is the first, second, third, or an unreadable sector of a set. An unreadable sector is identified with byte 3 of the data field (field 1) set to FF_{Hex}. See figure 7.

5.5.2.2 Defect Map Location

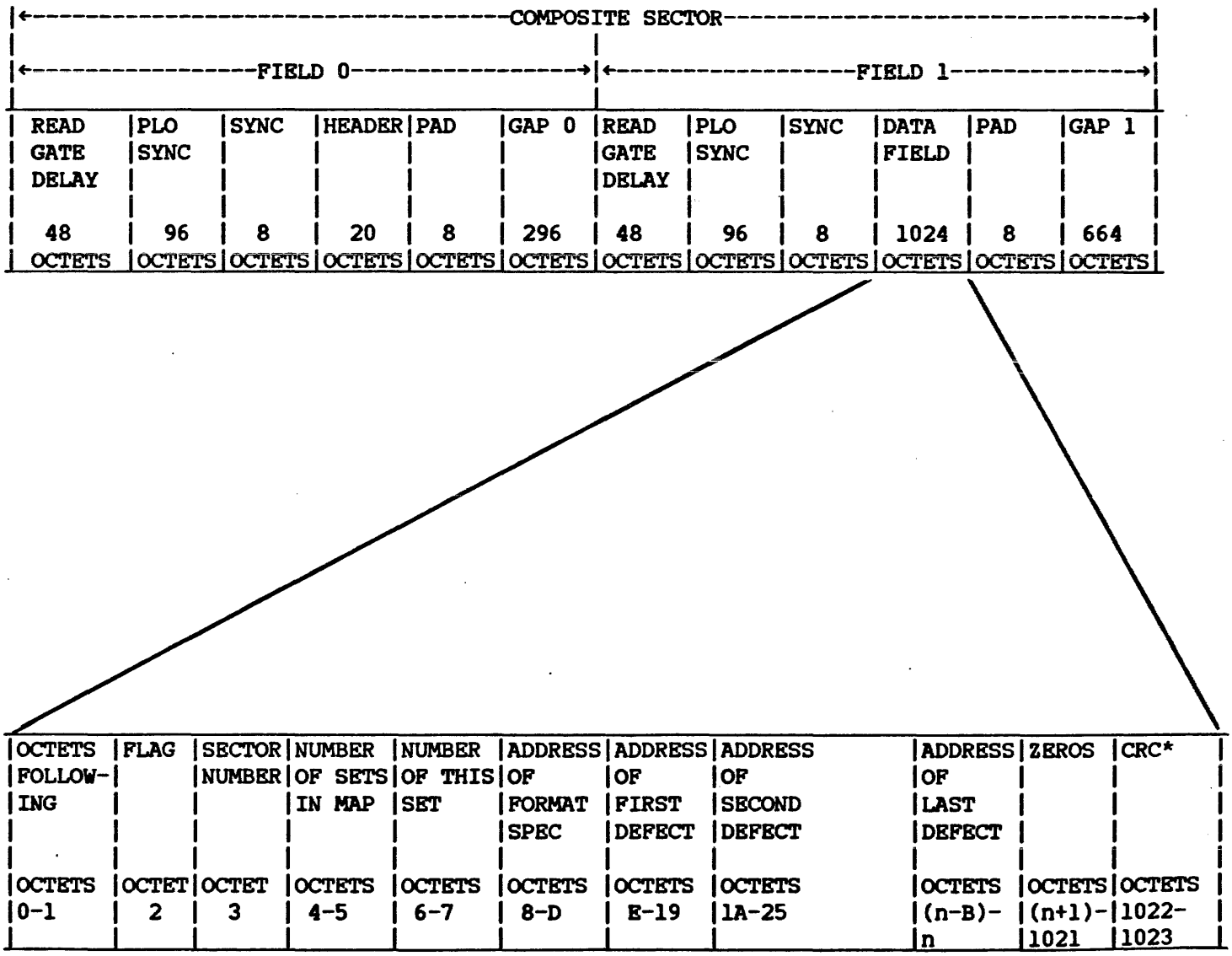
The factory written defect map is recorded on cylinder 2610 and has a composite sector of 2 fields and 23 sectors per track. It begins on the first sector of track 1 and continues on track 0, if necessary.

5.5.2.3 Defect Map Format

The drive has a built-in manufacturer's format specification that is used primarily to write and read the defect map on the last cylinder. The format provides for 2-field sectors (see figure 7). Field 0 contains the header and Field 1 contains the data.

Each defect entry in the map is 12 bytes in length. The defects in the defect map are stored in order of increasing physical addresses. An exception is made for defects that are detected after the initial map is recorded. These are added at the end of the defect map during final manufacturing test. Any additions that are made out of sequence are indicated by setting bit 3 of the Flag byte within that sector's data field. See Figure 7.

The Offset of Defect From Index field (see figure 7) is an offset value that specifies the physical location of a defect with respect to Index and the ordered head that the data is read/written to. Any offset value less than the physical track length per physical head specifies the physical distance in octets from Index for that defect for the first ordered physical head of a logical head (ordered head zero). For those slaves having more than one physical head per logical head, the defects for those heads (other than the first ordered head) are identified by specifying an offset equal to the physical distance in octets from Index for the defect plus the ordered head number times the physical track length per physical head.



* CRC - CYCLIC REDUNDANCY CODE - TWO OCTETS OF PARITY INFORMATION APPENDED TO THE DATA FIELD TO VERIFY ITS ACCURACY.

FIGURE 7. DEFECT MAP FORMAT

TABLE 5. DEFECT MAP FORMAT (FOR EACH SECTOR DATA FIELD) *

BYTE	BIT	DESCRIPTION
0-1		Number of bytes following: equals n-2
2		Flag byte
	7	1= Last sector of defect map
	6	1= Defect map continues on next lower cylinder
	5	= 0
	4	= 0
	3	1= Defect Entries in this sector out of sequence
	2-0	= 0 (Reserved)
3		Number of this sector within a set 00 = First 01 = Second 02 = Third 03-FE = Illegal FF = Ignore
4-5		Number of sets in defect map
6-7		Number of this set in the defect map
8-B		Cylinder address of format specification storage
C-D		Head address of format specification storage
E-11	↑	Cylinder address of defect
12-13	1st	Head address of defect
14-17	defect	Offset of defect from Index (bytes)
18-19	↓	Length of defect (bits)
	"	"
	"	"
	"	"
	"	"
	"	"
(n-B)-(n-8)	↑	Cylinder address of defect
(n-7)-(n-6)	Last	Head address of defect
(n-5)-(n-2)	defect	Offset of defect from Index (bytes)
(n-1)-n	↓	Length of defect (bits)
(n+1)-(1021)		Zero fill any bytes not filled by defect entries
1022-1023		CRC-16

* See following page for Notes for Table 5

TABLE 5. (Notes)

BYTES:	NOTES:
0-1	NUMBER OF BYTES Each data field of the map starts with a 2-byte count of the number of bytes used in the field, not including itself, n-2, where n is the last byte of the last defect entry.
2	FLAG BYTE The Flag Byte describes the attributes of the sector.
3	SECTOR NUMBER WITHIN THE SET All sectors within the defect map are identified by their sector number within a set or are set to x"FF" to be ignored.
4-5	NUMBER OF SETS The number of sets in the entire Defect Map.
6-7	NUMBER OF THIS SET The number of this particular sector set. Each sector in the set has this number.
8-D	ADDRESS OF FORMAT SPECIFICATION STORAGE These six bytes provide the address of the first track at which the Controller may store the Format Specification and attributes in the defect format. The address is initialized to the next available track following the Defect Map.
E→19 and (n-8)→n	DEFECT ENTRY These bytes are used to describe the defect itself. The last 12-byte defect entry cannot be split; therefore, any remainder of less than 12 bytes will be zeros. Similarly, the remainder following the last defect entry will be padded with zeros.
)22-1023	CRC-16 The 2-byte CRC-16 ($X^{16} + X^{15} + X^2 + 1$) is the last two bytes in the data field, and is considered part of the data field area. It is the Controller's responsibility to check the CRC. To calculate the CRC, the initial value of the CRC shall be set to all ones ($FFFF_H$).

5.5.3 Diagnostic Format

Cylinder address 2609 is formatted for use by the internal diagnostics.

5.6 Media Defects

A media defect is a physical characteristic of the media which results in a repetitive read error when a unit is operated within specified operating conditions. Valid data must not be written over known media defects; therefore, sector/track deallocation or skip displacement techniques must be utilized.

Media Defect Characteristics

- The maximum number of media defects in the module is TBD.
- The maximum number of defects on any cylinder is TBD.
- The maximum number of tracks with more than 1 but less than 11 defects is TBD.
- The maximum defect length (in bits per physical defect) is TBD.

Media Defect Free Areas are as follows:

- The first 2048 Bytes from index of diagnostic cylinder 2609.

6.0 INTERFACE

6.1 Interface Definition

Physical level interface requirements are defined in the ANSI specification ANSI X3T9/88-82 - Enhanced Intelligent Peripheral Interface-Physical Level (IPI-P).

The maximum cumulative cable length in a daisy chain is 80 feet. This length of cable may be used when the timing and transmission system meets the specifications of the Enhanced IPI-P Interface (ANSI X3T9/88-82).

IPI-2 Intelligent Peripheral Interface requirements are defined in ANSI specification ANSI X3.130-1986.

Unique commands, configuration information, format information, and drive specific information is as follows:

6.2 IPI-2 Device Dependent Specifications

6.2.1 Load Drive Function (01)

The following optional drive functions are not supported:

24 Load Heads

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set. Heads are automatically loaded as part of the Spin Up sequence.

25 Unload Heads

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set. Heads are automatically unloaded as part of the Spin Down sequence.

26 Lock Carriage

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set. The carriage is automatically locked as part of the Spin Down sequence.

27 Unlock Carriage

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set. The carriage is automatically unlocked as part of the Spin Up sequence.

2B Perform Sector Marking

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set. This drive does not support soft sector format (address mark).

2C Disable Drive ECC

If this unsupported command is received, Ending Status will indicate an Operation Exception has occured. When status is read the unsupported command bit will be set.

2D Enable Drive ECC

If this unsupported command is received, Ending Status will indicate an operation exception has occurred. When status is read the unsupported command bit will be set.

The following slave specific functions are supported:

2E Disable Master Sync

This command causes the selected drive to cease generation of the master sync reference signal. If the drive has been designated a master via the Master Sync Switch, the function will be rejected and ending status will report a Bus Control exception. See 4.8 for a description of spindle synchronization.

2F Enable Master Sync

This command causes the selected drive to generate a master sync reference signal. If the drive has been designated as a master via the Master Sync Switch, the function will be rejected and Bus Control Exception status returned. See 4.8 for a description of spindle synchronization.

81 Disable Read/Write Diagnostic Tests

This function causes the drive to disable its internal read/write disc diagnostics. The read/write diagnostic tests are enabled at power-on and by an appropriate reset unless disabled by manual switch settings.

84 Reserved for Factory Test

85 Reserved for Factory Test

86 Enable Reserve and Release Bus Controls

This function causes the drive to accept Bus Controls 30 and 31 as Reserve and Release respectively.

87 Disable Reserve and Release Bus Controls

This function causes the drive to reject Bus Controls 30 and 31. This is the default at power-on.

6.2.2 Load Drive Specific Information (03)

Reserved for Factory Test (0081)

6.2.3 Load RPS Target Sector Address (06)

The drive supports extended RPS parameters (see section 7.1.6 of ANSI X3.130-1986). The Master may terminate the transfer at the end of any parameter field after the RPS Target Sector (see ANSI X3.130-1986 for a description of master termination of an information transfer).

6.2.4 Load Position (07)

The drive supports extended RPS parameters. (see section 7.1.7 of ANSI X3.130-1986). The master may terminate the transfer at the end of any parameter field after the Head Address (see ANSI X3.130-1986 for a description of master termination of an information transfer).

6.2.5 Reserve (30)

The Reserve control causes the drive to be reserved to this port until released, until a Priority Select is executed by the alternate port, or until cleared by an appropriate reset. A Load Drive function code 86 "Enable Reserve and Release" must be issued prior to this command or it will be rejected.

6.2.6 Release (31)

The Release control causes the drive to be released from this port and occurs when the master deselects from this port. A Load Drive function code 86 "Enable and Release" must be issued prior to this command or it will be rejected.

6.2.7 Read Configuration (Code 41)

Drive configuration may be read with the read configuration control as described in Specification ANSI X3.130-1986 section 7.1.8.

6.2.7.1 Manufacturer's Identification (Octets 2E-31)

This 4 octet parameter contains the drive manufacturer's identification in ASCII.

DRIVE	ASCII
8 HP	SEAG
9 HP	SEAG

6.2.7.2 Model Number (Octets 32-39)

This 8 octet parameter contains the drive model number in ASCII.

DRIVE	ASCII
8 HP	8HP_S6L8
9 HP	9HP_S6L9

6.2.7.3 Revision Number (Octets 3A-3D)

This 4 octet parameter contains the drive revision number in ASCII.

DRIVE	ASCII
8 HP	PA8Y
9 HP	PA8Y

6.2.7.4 Switch Settings (Octets 46 and 47)

This 2 octet parameter contains the value of switch settings the drive reports via the configuration response.

6.2.7.4.1 Most Significant Octet (Octet 46)

This octet always contains the value of 00.

6.2.7.4.2 Least Significant Octet (Octet 47)

6.2.7.4.2.1 Local/Remote Switch (Bit 7)

This is a customer select switch which allows disc spin-up in local mode (without issuance of spin-up function) or in remote mode. This switch (labeled "1") is factory set to the remote position (closed).

6.2.7.4.2.2 Port Disable Switches

These are 2 switches used to disable Port A or Port B. These switches (labeled "2" and "3" respectively) are factory set to enable both ports (both switches open).

6.2.7.4.2.3 Disable Read/Write Diagnostics

This switch is used to inhibit the drive's internal diagnostic program from doing read/write operations. This switch (labeled "4") is factory set to enable read/write diagnostics (open).

6.2.7.4.2.4 ID Microcode Switches 2^3-2^0

	SWITCH SETTINGS			
DRIVE TYPE	2^3	2^2	2^1	2^0
9HP without parity checking	OPEN	OPEN	OPEN	OPEN
9HP with parity checking	OPEN	OPEN	OPEN	CLOSED
8HP	CLOSED	OPEN	OPEN	OPEN

6.2.8 Read Drive Specific Information (Code 43)

Drive dependent diagnostic status may be read with the read drive specific information bus control as described in ANSI X3.130-1986 section 7.1.10.

6.2.8.1 Native Controlled Internal Diagnostic Status Codes (Octets 02-11)

STATUS CODE	STATUS DESCRIPTION
80	Ready and On Cylinder
82	Motor Stopping
83	Motor Stopped
84	First Load/Calibrate
85	Sequence Delay
86	Waiting For (Hold + Local)
87	Starting Motor
88	Motor Up-to-Speed
89	I/O Self Test Passed
8A	Sweep Segment In Progress
8B	Heads Left On Last Cylinder Of Sweep
C6	Seek Time Out
CB	Off-Track Seek Error
CD	Illegal Cylinder Address
CF	Seek Error on Settle-in
D4	First Seek Fault on Retract
D5	First Seek Fault on Load
D6	First Seek Fault on RTZ
D7	First Seek Fault on Calibrate
D8	Speed Loss
D9	Motor Can't Start
DA	Emergency Retract
E0	Motor MPU Failure
E1	Servo MPU Failure
E2	I/O Status Transfer Failed
EE	I/O Self Diagnostic Test Failed

6.2.8.2 Native Controlled Internal Diagnostic FRU Codes (Octets 12-15)

In the event of equipment failure, the drives internal diagnostics will provide up to 4 codes indicating the FRU most probably at fault in order of likelihood.

FRU CODE	FRU DESCRIPTION
81	Control Board
82	Module (HDA)
83	Power Supply
84	I/O Board
85	Control Board
86	Module (HDA)
87	Not used
88	Not used
89	Not used
8A	R/W Channel 0,7 board
8B	R/W Channel 1,6 board
8C	R/W Channel 2,5 board
8D	R/W Channel 3,4 board
8E	R/W Channel 8 board

6.2.8.3 Native Controlled Internal Diagnostic Fault Codes (Octets 16-1D)

FAULT CODE	FAULT DESCRIPTION
80	Good Status
81	Read and Write Fault
82	Read or Write and Not On Cylinder Fault
84	First Seek Fault
88	Write Fault
90	Write and Write Protected Fault
A0	Head Select Fault
C0	Voltage Fault

6.2.8.4 IPI Controlled Internal Diagnostic Status Codes (Octets 1E-1F)

STATUS CODE	STATUS DESCRIPTION
Write/read tests	
00	Good Status
01	Failed during seek to diagnostic cylinder
02	Failed during RTZ seek from diagnostic cylinder
03	Spare
04	Spare
05	Failed during head select test
06	Failed during read header test
07	Failed during write data test
08	Failed during read data test
09	Sync byte error during read header test
0A	Data error during read header test
0B	Sync byte error during read data test
0C	Data error during read data test
Access tests	
13	Failed during servo test
14	Failed during random seek test
15	Failed during access RTZ test
Read slave specific tests	
20	Failed during read up diag status/error code log test
21	Failed during read up field replaceable unit log test
22	Failed during read up display fault log test

6.2.8.5 IPI Controlled Internal Diagnostic FRU Codes (Octets 20-21)

FRU CODE	FRU DESCRIPTION
01	Control Board
02	Module (HDA)
03	Power Supply
04	I/O Board
05	Control Board
06	Module (HDA)
OA	R/W Channel 0,7 board
OB	R/W Channel 1,6 board
OC	R/W Channel 2,5 board
OD	R/W Channel 3,4 board
OE	R/W Channel 8 board

6.2.8.6 IPI Controlled Internal Diagnostic Fault Codes (Octets 22-23)

FAULT CODE	FAULT DESCRIPTION
00	Good Status
01	Read and Write Fault
02	Read or Write and Not On Cylinder Fault
04	First Seek Fault
08	Write Fault
10	Write and Write Protected Fault
20	Head Select Fault
40	Voltage Fault

6.2.9 Read Status (Code 44)

The status bit definitions are shown in Table 6.

6.2.10 Read Correction Vectors (Code 45)

The drive does not support this code.

6.2.11 Read Extended Status (Code 48)

The extended status bit definitions are shown in Table 5.

TABLE 6. STATUS RESPONSE BLOCK

BIT / OCTET	7	6	5	4	3	2	1	0
0 EXCEPTION STATUS	STATUS RESPONSE	UNSOLICITED EXCEPTION	BUS CNTL EXCEPTION	READ FAULT	WRITE FAULT	SEEK FAULT	SPINDLE FAULT	EXECUTION FAULT
1 UNSOLICITED EXCEPTIONS	RESET COMPLETE	ALTER PORT PRIOR SEL	ALTER PORT FMT CHG	ALTER PORT FMT CMPLT	RESERVED	NOT READY TRANSITION	READY TRANSITION	MEDIA CHANGE
2 BUS CONTROL EXCEPTIONS	INVALID BUS CNTL	INVALID PARAMETER	UNSUPPORTED BUS CNTL	BUS CNTL CONTEXT	DATA BUS CNTL LATE	RESERVED	RESERVED	RESERVED
3 DRIVE EXCEPTIONS	SPEED FAULT	OFF CYL FAULT	HEAD SEL FAULT	RESERVED	RESERVED	VOLTAGE FAULT	RESERVED	RESERVED
4 DRIVE EXCEPTIONS	WRITE PROT FAULT	RESERVED	WRITE TRANS FAULT	HEAD OFFSET FAULT	DATA STROBE FAULT	RESERVED	RESERVED	RESERVED
5 DRIVE EXCEPTIONS	DIAG STAT VALID	DIAG TEST INCOMPLETE	W/R DIAG TEST DISABLE	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
6 DRIVE EXCEPTIONS	HEADS 7,8 ERROR	HEAD 6 ERROR	HEAD 5 ERROR	HEAD 4 ERROR	HEAD 3 ERROR	HEAD 2 ERROR	HEAD 1 ERROR	HEAD 0 ERROR
7 DRIVE /1\ EXCEPTIONS	DATA CONT. REJECT 1	DATA CONT. REJECT 0	DATA CONT. LATE	OPERATION FAULT	TRACK OVERRUN	SECTOR OVERRUN	FIELD OVERRUN	RESERVED

Data Control Reject Coding

0 - Normal Status
1 - Invalid Data Control
2 - Context Error (Data Control received while Serdes/Format Control (SFC) disabled)
3 - Illegal Bus Control (Data Contrtol received while Rotational Position Sensing (RPS) disabled)

TABLE 7. EXTENDED STATUS RESPONSE BLOCK

BIT / OCTET	7	6	5	4	3	2	1	0
0 INTERFACE FLAGS	EXTENDED STATUS	PORT NUMBER	ALTER PORT ENABLED	RESERVE ACTIVE	CMD CMPT INT EBLD	RPS INT EBLD	STAT PEND INT EBLD	FMT SPEC PRESENT
1 DATA RECV FLAGS	OFFSET DIRECTION	OFFSET MSB	OFFSET LSB	EARLY DATA STROBE	LATE DATA STROBE	RESERVED	HEADER ECC ENABLED	DATA ECC ENABLED
2 DRIVE FLAGS	WRITE PROTECTED	SPINDLE POWER ON	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
3 DRIVE STATUS	SPEED	ON CYLINDER	SPINDLE SYNC MASTER	SYNC LOCKED	RESERVED	RESERVED	HDA READY	MEDIA PRESENT
4 DRIVE ALARMS	RESERVED	RESERVED	ILLEGAL HD SELECT	RESERVED	RESERVED	VOLTAGE RANGE ERROR	LOGIC OVER TEMP	RESERVED
5 VENDOR DEFINED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
6 VENDOR DEFINED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED	1 = 8HP 0 = 9HP
7 HEAD SKEW	HEAD SKEW BIT 7	HEAD SKEW BIT 6	HEAD SKEW BIT 5	HEAD SKEW BIT 4	HEAD SKEW BIT 3	HEAD SKEW BIT 2	HEAD SKEW BIT 1	HEAD SKEW BIT 0

7.0 CONTROLS AND INDICATORS

7.1 Operator Panel, Status/Control Panel Accessories
See Figures 8 and 9.

Either of these 2 panels can be installed behind the drive front panel or remote to the unit. See User's Manual for details.

7.1.1 Operator Panel

The Operator Panel provides a LOGIC ADDRESS SELECT switch, START/STOP switch/indicator, FAULT/CLEAR switch/indicator, a WRITE PROTECT switch/indicator, and a Unit Selected indicator.

NAME	TYPE		FUNCTION
	LIGHT	SW	
LOGIC ADDRESS SELECT	X	X	Establishes Logical Address of the device and displays binary value 0-7 using 4 Green LEDs.
START/STOP	X	X	Green LED indicates when the drive is Ready. Indicator flashes rapidly when START is activated until drive is Ready (Local or Remote Spin Up Enabled, see 6.2.1.1). Indicator flashes slowly when STOP is depressed until disk rotation is stopped.
FAULT/CLEAR	X	X	Red LED indicates any Fault condition. The switch clears the Fault indication if the problem that caused the Fault is no longer present.
WRITE PROTECT	X	X	Red LED indicator is on when the drive's write circuits are disabled. Write Protect is activated by a switch located on the Control Board assembly or on this control panel.
UNIT SELECTED	X		Green LED indicates when the unit is selected.

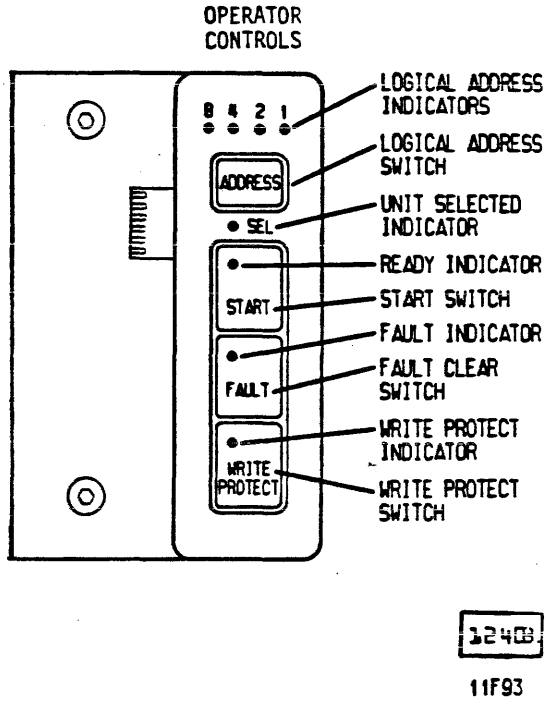


FIGURE 8. OPERATOR PANEL

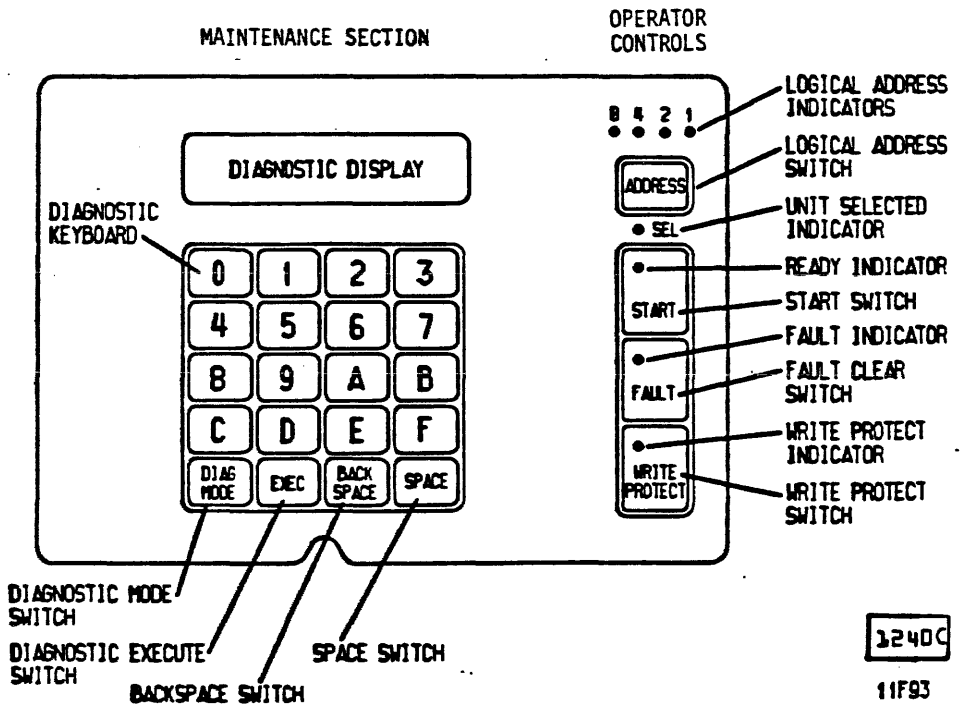


FIGURE 9. STATUS/CONTROL PANEL

7.1.2 Status/Control Panel

The Status/Control Panel combines the above described Operator Panel functions with a Maintenance section. The Maintenance section adds a maintenance keyboard and a liquid crystal display.

The following are the additional functions available from this panel:

- CH 1/2 Selected and/or Reserved Status
- Current Cylinder Address
- Fault Indication - Type and history of occurrence
- Internal Machine Status - Type and history of occurrence
- Off-line Diagnostic control and display

7.2 I/O Board Switches

The switches on the I/O board at the rear of the drive are accessible through a hole in the rear panel as shown in Figure 10. Switches are factory set as described in Table 7.

FIGURE 10. I/O BOARD SWITCHES

7.2.1 Unit Select Address Switches

If neither an operator panel or a status/control panel is cabled to the drive, the unit select address is determined by the three unit select address switches located on the back of the drive. See figure 10.

7.2.2 Write Protect Switch

Write protection can be accomplished by setting the write protect switch on the back of the drive.

7.2.3 Sweep Cycle Enable Switch

When this switch is in the "enabled" position, the drive will undertake procedures designed to enhance media life. This procedure will increase the maximum required time for a seek. This "sweep cycle seek" will require approximately 200ms and will occur less often than once every 12 minutes. It will occur upon a load position or a load cylinder command and will preface the commanded action.

7.2.4 Local/Remote Motor Start

In the Local Mode the drive spins up when DC power is applied or when the Start switch is pressed if the drive has an optional operator or status/control panel. In the remote mode, a load function command with modifier 22 or 23 is used to spin up or spin down the drive, respectively.

7.2.5 Enable Port A

Use of Port A is allowed when enabled.

7.2.6 Enable Port B

Use of Port B is allowed when enabled.

7.2.7 Microcode ID

The Microcode ID assigns a unique device type that is interpreted by the internal microcode. Switches ID0 and ID3 are factory set to OPEN and switches ID1 and ID2 are factory set to CLOSED. THESE SWITCHES MUST BE IN FACTORY SET POSTION FOR PROPER OPERATION.

7.2.8 Spindle Sync Reference Generation

When enabled, the drive generates a spindle sync time reference signal to which it phase locks its index signal. Other drives in the same spindle sync network will do likewise.
When disabled, the drive will operate independently, lock to an externally generated spindle sync signal or accept sync reference generation commands from the IPI-2 interface. See 4.8.

8.0 PHYSICAL SPECIFICATIONS

Nominal dimensions of the drive and power supply are shown on the plan views of Figure 3.

The drive weighs approximately 55 lbs.

For additional detail needed to mechanically integrate the Sabre into a user's system or subsystem cabinet see Appendix A.

9.0 RELIABILITY AND SERVICE GOALS

9.1 Mean Time Between Failure

The Mature Design MTBF for the drive operating within normal ambient environment is 64,000 hours. The MTBF will exceed 45,000 hours for units manufactured in the first 6 months of production, or 58,000 hours for units manufactured in the following 12 months of production.

The following expression defines MTBF:

$$\text{MTBF} = \frac{\text{Estimated Operating Hours (Power On)}}{\text{Number of Equipment Failures}}$$

Estimated operating hours means total hours less any maintenance time. Equipment failures mean any stoppage or substandard performance of the equipment because of equipment malfunction, excluding stoppages or substandard performance caused by operator error, adverse environment, power failure, controller failure, cable failure, or other failure not caused by the equipment. To establish a meaningful MTBF, operating hours must be greater than 6000 hours per drive and must include field performance data from representative sites.

For the purpose of this specification, equipment failures are defined as those failures necessitating repairs, adjustments or replacement on an unscheduled basis.

9.2 Mean Time to Repair

The mean time to repair does not exceed 0.5 hours. This is defined as the time for an adequately trained and competent service person to diagnose and correct a malfunction.

9.3 Preventive Maintenance Time

No scheduled PM is required.

9.4 Service Life

The drive is designed and constructed to provide a useful life of 5 years before factory refurbishment is required. Repair or replacement of major parts will be permitted during the lifetime. Operation in excess of this is permissible, but may result in a reduction of mature MTBF.

10.0 INSTALLATION AND MAINTENANCE

Required connections to the drive are ac power, I/O cables, and a system ground consistent with the User's Manual.

10.1 Power Requirements

10.1.1 Primary Power Requirements

The Sabre power supply has input parameters as shown in Table 8. The 2 voltage ranges shown are switch selectable by the user. The range switch is factory set for 208 thru 240 V. See 10.1.3 for variations of the ac power cords.

TABLE 8. PRIMARY FREQUENCY, VOLTAGE, AND POWER REQUIREMENTS

FREQUENCY			VOLTAGE			DISCS AND CARRIAGE IN MOTION TYPICAL VALUE			
						LINE CURRENT	ENERGY CONSUMPTION	HEAT DISSIPATION	POWER FACTOR
NOM	MIN	MAX	NOM	MIN	MAX	AMPS	KW	BTU/H	
50 THRU 60	48	62	100 THRU 120	85	132	TBD	TBD	TBD	TBD
			208 THRU 240	177	264	TBD	TBD	TBD	TBD

Start-up current is shown in Figure 11. Peak inrush current for 1/2 cycle will not exceed 50 A for the 100/120 V range or 35 A at the 208/240 V range.

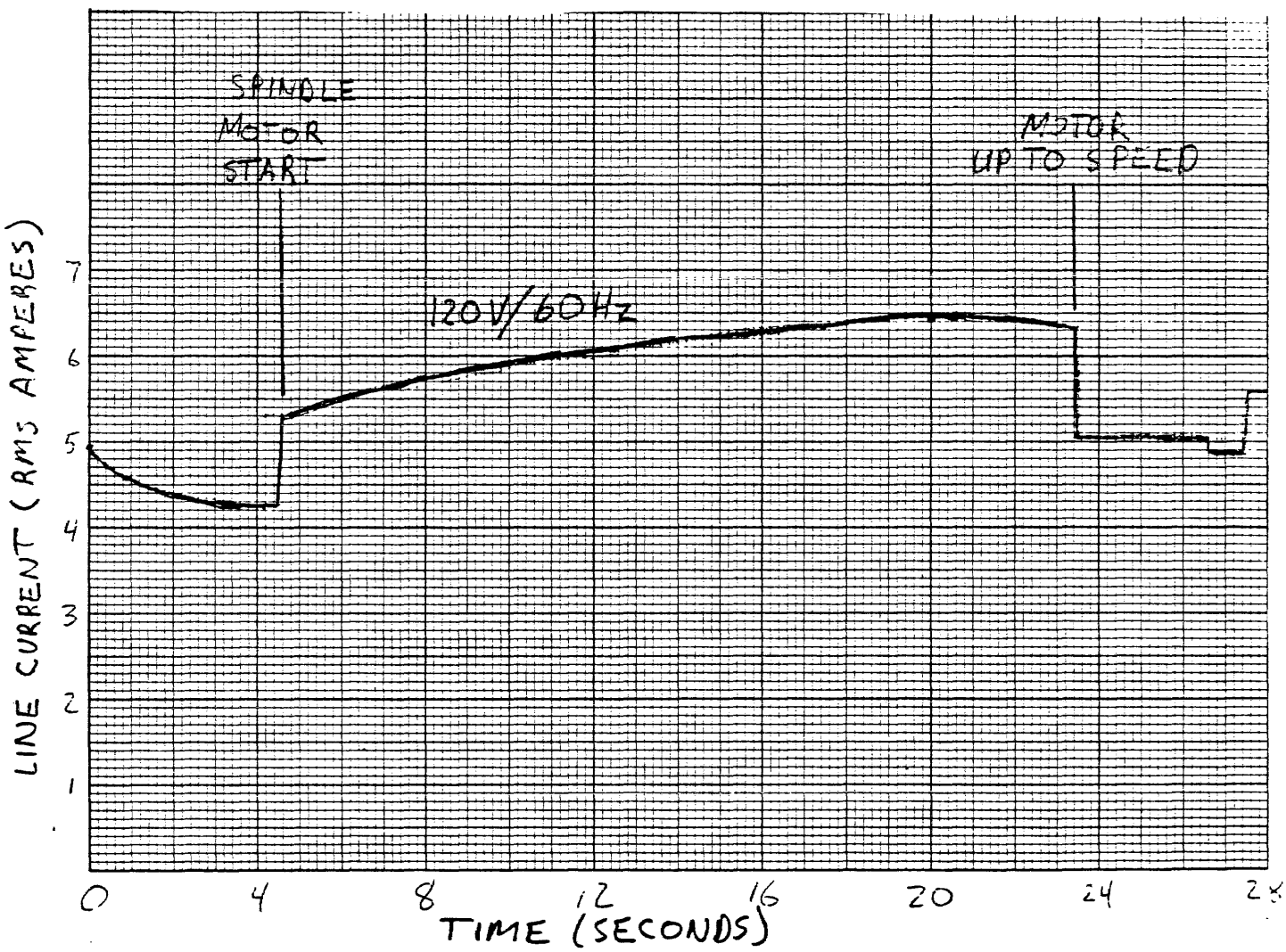
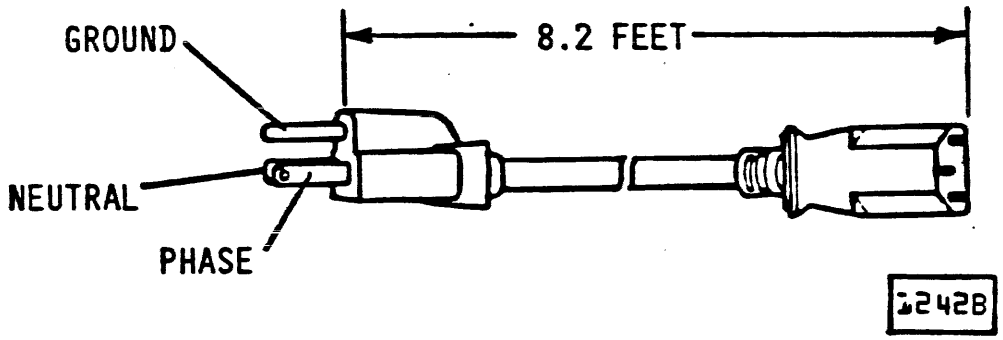


FIGURE 11. TYPICAL LINE CURRENT VERSUS START-UP TIME

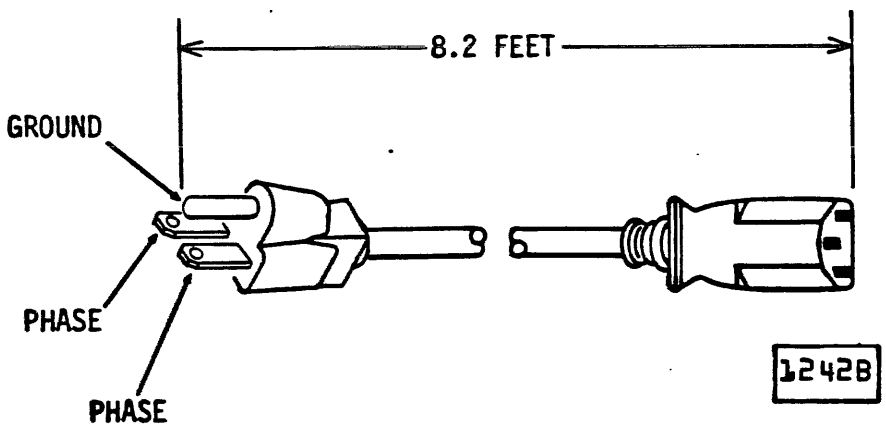
10.1.3 AC Power Connectors

10.1.3.1 60 Hz

A connector/cord assembly is available with each 60 Hz power supply in the configuration of Figure 12. A NEMA type 5-15P connector plug is provided on the 120 V Power Cord and a type 6-15P for the 208/220/240 V Power Cord.



A. 120 V POWER CORD



B. 208/220/240 V POWER CORD

FIGURE 12. 60 HZ POWER CONNECTORS

10.1.3.2 50 Hz

A connector/cord assembly is available with each 50 Hz power supply in the configuration of Figure 13. A European type connector plug is provided on each cord.

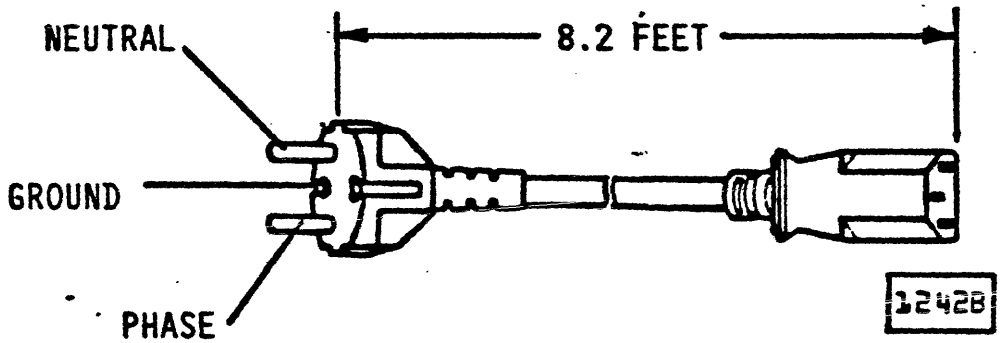


FIGURE 13. 50 HZ POWER CONNECTOR

10.1.3.3 Short Power Cord Set

An ac short power cord set is available with each power supply in the configuration of Figure 14. This cord mates with the power cords shown in Figures 12 and 13.

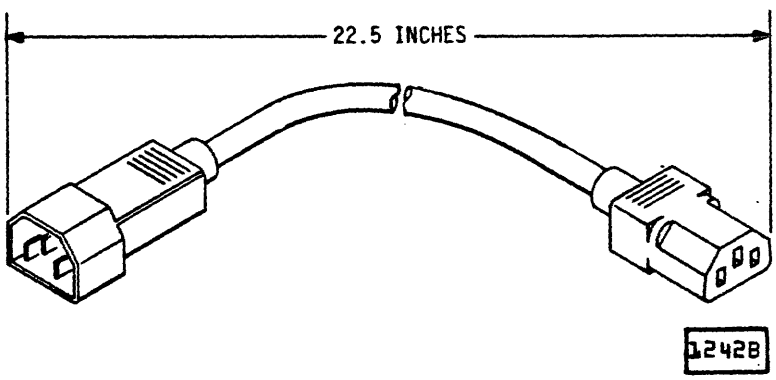


FIGURE 14. AC SHORT POWER CORD SET

10.2 Environmental Limits (Drive and Accessories) - Power Dissipation

The Sabre Disc Drive was tested and meets FCC and VDE emission requirements when properly grounded per 10.2 and configured with the power cord set and shielded data cables listed in Table 1. For any other configuration, FCC and VDE compliance is the responsibility of the end user.

10.2.1 Operating Environment

The unit will operate to Specifications when subjected to the following environmental conditions. Shock and vibration input must be thru the drive shock mount isolators:

Temperature	10°C to 45°C (50°F to 113°F) with a maximum change of 15°C (27°F) per hour.
Humidity	20% to 80% relative. A maximum wet bulb temperature of 26°C (79°F). No condensation allowed.
Barometric Pressure	104 kPa to 69 kPa (-1000 ft to 10,000 ft)
Shock	3 g's for 10 ms, half sign wave, any axis. No more than 2 shocks per second.
Vibration	Sinusoidal vibration of 0.2 g's from 5 to 50 Hz, 1 g from 50 to 500 Hz, any axis.

During operation, shock and/or vibration caused system errors which are recoverable/resettable via the interface controlled signals, are allowed.

10.2.2 Non-Operating Environment (Unpackaged)

The unit, in the unpacked condition, with power off, will withstand the following environmental conditions without damage. Shock and vibration input must be thru the drive shock mount isolators:

Temperature	10°C to 45°C (50°F to 113°F) with a maximum change of 15°C (27°F) per hour.
Humidity	20% to 80% relative. A maximum wet bulb temperature of 26°C (79°F). No condensation allowed.
Barometric Pressure	104 kPa to 69 kPa (-1000 ft to 10,000 ft)

Shock	20 g's for 10 ms, half sign wave, any axis, with no less than 5 seconds between shocks.
Vibration	Sinusoidal vibration of 0.5 g's from 5 to 50 Hz, 1 g from 50 to 500 Hz, any axis.

10.2.3 Storage Environment (Packaged)

In its shipping container as packaged by MPI, the unit will withstand the following without damage while in storage for periods up to 3 years:

Temperature	-10°C to 50°C (14°F to 122°F) with a maximum change of 15°C (27°F) per hour.
Humidity	5% to 95% relative.
Barometric Pressure	104 kPa to 69 kPa (-1000 ft to 10,000 ft)
Shock	Packaged units will withstand 30 inch drop. See 10.3.5.
Vibration	Resonance - 4 Hz to 100 Hz at 0.5 g's.

10.2.4 Transit Environment (Packaged)

In its shipping container as packaged by MPI, the unit will withstand the following without damage while in transit in common carriers:

Temperature	-40°C to 60°C (-40°F to 140°F) with a maximum change of 20°C (36°F) per hour.
Humidity	5% to 95% relative.
Barometric Pressure	104 kPa to 19 kPa (-1000 ft to 40,000 ft)
Shock	Packaged units will withstand 30 in. drops. See 10.3.5.
Vibration	Resonance - 4 Hz to 100 Hz at 0.5 g's.

10.2.5 Multiple Equipment Packaging

When the Sabre Disc Drive is packaged with accessory items chosen from Table 1, the total packaged weight will vary according to the accessories included and the package configuration. Packaged units with a gross weight of 50 lbs. to 100 lbs. will withstand 30 in. drops. Packaged units with a gross weight of 101 lbs. to 175 lbs. will withstand 24 in. drops.

APPENDIX A

MECHANICAL INTERFACE

A1.0 SCOPE

This Appendix defines the mechanical interfaces for the Sabre, accessories, center of gravity, and cooling air flow.

A2.0 APPLICABLE DOCUMENTS

None

A3.0 MOUNTING CRITERIA

TBD

A4.0 CENTER OF GRAVITY

TBD

A5.0 AIR FLOW

Sabre 8HP/9HP is a complete drive with head disc assembly. Power supply, module, and electronics are in an enclosure system consisting of a chassis, top cover, rear cover and optional front panel kit. All the components are cooled with fan driven airflow. The fan is housed inside the power supply (see Figure). An opening of 11 square inches for each drive can be used as a minimum design requirement for inlet and outlet openings for each drive.

Eight of the eleven square inches for the exaust should be directly beind the drive for which it is exhausting. Eight of the eleven square inches of the inlet should be directly in front of the drive for which it is supplying air. It is critical that the exhaust path blockage be kept to a minimum.

To confirm that required cooling for the drive electronics is being provided, place the drive in a random seek mode and measure the case tempertures of all the components listed below when they stabilize. The case temperatures shown in the list are maximum temperatures based on inlet air of 25°C and 45°C. All case temperatures must be at or below these temperatures.

COMPONENT	ASSY (PWA)	POSITION X-Y	MAX CASE 25°C AIR
Spindle Motor Driver PFET Trans.	AYDX	Q28	TBD
Spindle Motor Driver NFET Trans.	AYDX	Q27	TBD
Actuator Motor Driver NPN Trans.	AYDX	Q20	TBD
Write PLO IC	AYDX	U34	TBD
ECL/TTL Translator	AYDX	U17	TBD
TMS 320E 1525 Processor	AYDX	U41	TBD
*EN/DEC	U16-DYDX	C127	TBD
*Write Comp.	U18-DYDX	C323	TBD
*Read Comp.	U5 -DYDX	A201	TBD
*EN/DEC	U25-DYDX	J522	TBD

* Measure on the DYDX in the J43 connector.