

**SA600
Rigid Disk Drive**

P/N 39026-3

**OEM Manual
August 1983**

Shugart

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ABBREVIATIONS / MNEMONICS

AM	Address Mark	I_{in}	In Line
BPI	Bits Per Inch	PCB	Printed Circuit Board
CRC	Cyclic Redundancy Check	TPI	Tracks Per Inch
FCI	Flux Changes Per Inch	TRK	Track
ID	Index		

ABOUT THIS MANUAL

This manual supersedes both previous manuals (P/N 39026-1 and 39026-2) and incorporates Publication Change Notices A, B and C, dated 2/11/82, 3/4/82 and 5/7/82 respectively.

While every effort has been made to ensure that the information provided herein is correct, please notify us in the event of an error or inconsistency. Direct any comments to:

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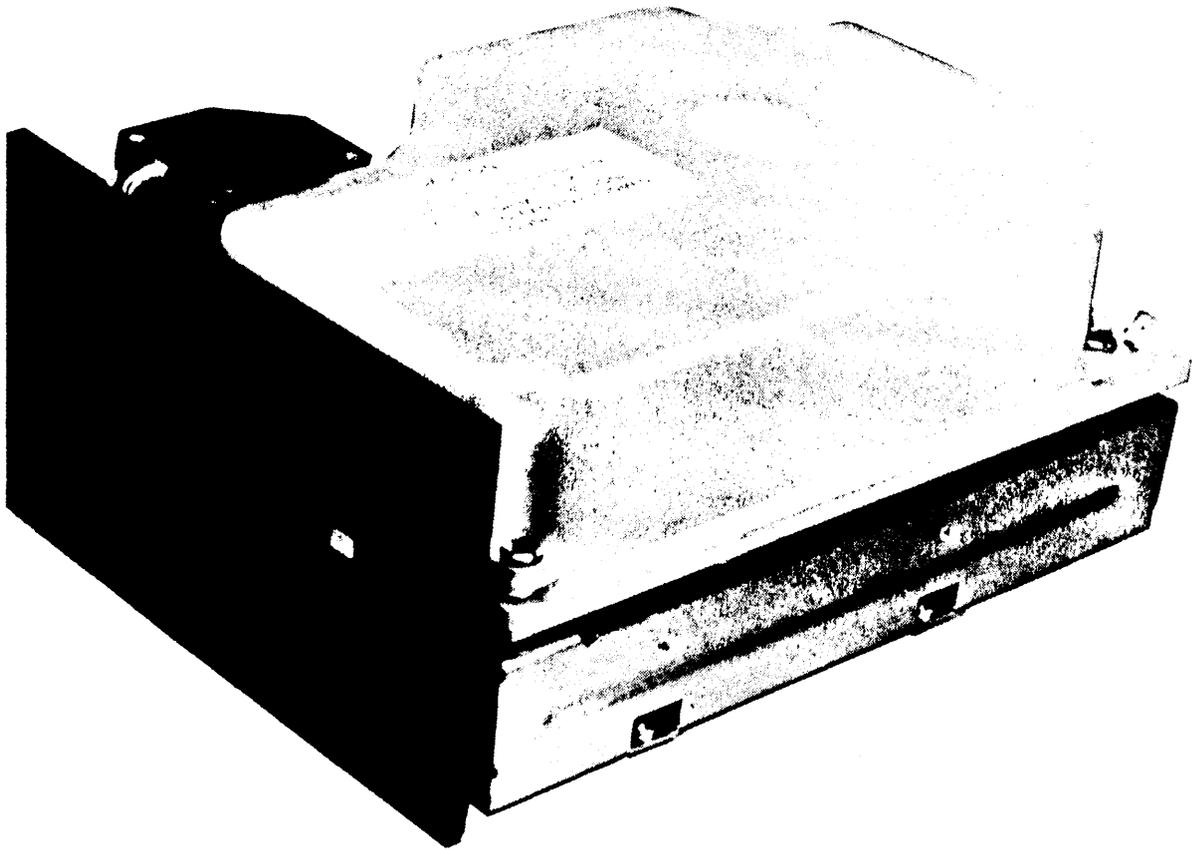


FIGURE 1-1. SA600 FIXED DISK DRIVE

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SECTION I INTRODUCTION

1.1 GENERAL DESCRIPTION

The Shugart SA600 series disk drives are random access storage devices with one, two, or three non-removable 130 mm disks as storage media. Each disk surface employs one moveable head to service 160/311 data tracks. The four models of the SA600 series are the SA604/606 and the SA607/612. The SA604/606 provides 6.66/10.00 megabytes accessed by 4/6 moveable heads over 160 data cylinders. The SA607/612 provides 6.47/12.95 megabytes accessed by 2/4 moveable heads over 311 data cylinders.

Low cost and unit reliability are achieved through the use of a unique rotary band actuator design. The inherent simplicity of mechanical construction and electronic controls allows maintenance-free operation throughout the life of the drive.

Mechanical and contamination protection for the heads, actuator, and disks are provided by an aluminum enclosure. A self contained recirculating system supplies clean air through a 0.3 micron filter. Another absolute filter allows pressure equalization with ambient air while maintaining contamination free environment.

The interface of an SA600 fixed disk drive is ST506 compatible and is designed to fit into the same physical space as the Shugart SA400 series 5.25 inch Minifloppy™.

Key Features:

- a. Storage Capacity of 6.66/10.0 or 6.47/12.95 megabytes
- b. Winchester design reliability
- c. Same physical size and identical mounting configuration as the SA4XX minifloppies
- d. Uses the same dc voltages as the SA4XX minifloppies
- e. Proprietary Fasflex IV™ rotary band actuator
- f. Normal and buffered seek
- g. 5 Mbits/second transfer rate
- h. Landing and shipping zone at track 182/340
- i. Brushless dc spindle motor
- j. Automatic spindle and actuator lock
- k. Electronic damping
- l. Microprocessor-based electronics

1.2 SPECIFICATION SUMMARY

1.2.1 Physical Specifications

Environmental Limits:

Ambient Temperature:

Operating — 40° to 122°F (4° to 50°C) *

Non-operating — 40° to +140°F (-40° to +60°C)

Temperature Gradient:

Operating — 10°F per ½ hr (5.5°C per ½ hr) non-condensing

Non-operating — non-condensing

*Maximum temperature change between write updates and subsequent read operations is limited to 65°F.

Relative Humidity:
 Operating — 8% to 80%
 Non-operating — 1% to 95%

Relative Humidity Variance:
 Operating — 20% per hr
 Non-operating — Below that can cause condensation

Maximum Wet Bulb — 78°F (25.6°C)

Elevation:
 Operating — 0 to 10,000 ft. (0 to 3048 meters)
 Non-operating — -1,000 to 30,000 ft. (-305 to 9144 meters)

Acoustical: 55 dBA at 1m

Vibration	Frequency Hz	
Operating	2 - 10	.2 in double amplitude 0.5 G Peak
	10 - 500	
Non-operating	2 - 10	.4 in double amplitude 2 G Peak
	10 - 500	

Shock
 Operating — 1 g maximum — no soft errors
 10 g maximum — no physical damage
 Non-operating — 30 g maximum — heads over landing zone

The following specifications will be furnished at a later date:

Ambient Magnetic Field
 Electro-magnetic Interference Susceptibility

DC Voltage Requirements:
 +12 Vdc ± 5% 1.8 A typical (12 V ± 10%, 4.0 A max starting for 6 sec)
 +5 Vdc ± 5% 1.2 A typical (2.0 A max)

Heat Dissipation = 86 BTU/hr typical (25 watts)

Mechanical Dimensions without Faceplate (Nominal):
 Height = 3.28 in. (83.3 mm)
 Width = 5.75 in. (146.1 mm)
 Depth = 8.00 in. (203.2 mm)
 Weight (incl. faceplate) = 5.2 lbs (2.4 kg)

1.2.2 Reliability Specifications

Mean Time Between Failure: 11,500 power on hours typical usage
 Preventive Maintenance: None required
 Mean Time to Repair: 30 minutes
 Component Life: 5 years

Error Rates:
 Soft Read Errors: 1 per 10¹⁰ bits read
 Hard Read Errors: 1 per 10¹² bits read
 Seek Errors: 1 per 10⁶ seeks

1.2.3 Performance Specifications

	SA604/SA606	SA607/SA612
Capacity		
Unformatted		
Per Drive	6.66/10.0 Mbytes	6.47/12.95 Mbytes
Per Surface	1.66 Mbytes	3.24 Mbytes
Per Track	10,416 bytes	10,416 bytes
Formatted (33 sectors/track)		
Per Drive	5.40/8.11 Mbytes	5.25/10.50 Mbytes
Per Surface	1.35 Mbytes	2.62 Mbytes
Per Track	8.45 kbytes	8.45 kbytes
Per Sector	256 bytes	256 bytes
Transfer Rate	5.0 Mbits/sec	5.0 Mbits/sec
	SA604/606	SA607/612
Access Time (includes settling time)		
Track to Track	16.2 msec	16.2 msec
Average	99 msec	92 msec
Maximum	215 msec	216 msec
Average Latency	8.33 msec	8.33 msec
Start Up Time (Typical)	12 sec	12 sec

1.2.4 Functional Specifications

Rotational Speed	3,600 (+0,-72) rpm	3,600 (+0,-72) rpm
Recording Density	7,900 bpi	9,300 bpi
Flux Density	7,900 fci	9,300 fci
Track Density	256 tpi	345 tpi
Cylinders	*160	**311
Data Tracks	640/960	622/1244
Read/Write Heads	4/6	2/4
Disks	2/3	1/2
Index	1	1

*Shipping zone at cylinder 182

**Shipping zone at cylinder 340

1.3 FUNCTIONAL CHARACTERISTICS

1.3.1 General Operation

The SA600 fixed disk drives consist of read/write and control electronics, read/write heads, track positioning mechanism, media, and air filtration system. These components perform the following functions:

- a. Interpret and generate control signals.
- b. Position the heads over the selected track.
- c. Read and write data.
- d. Provide a contamination free environment.

1.3.2 Read/Write and Control Electronics

The standard microprocessor and electronics are packaged on two printed circuit boards containing the following circuits:

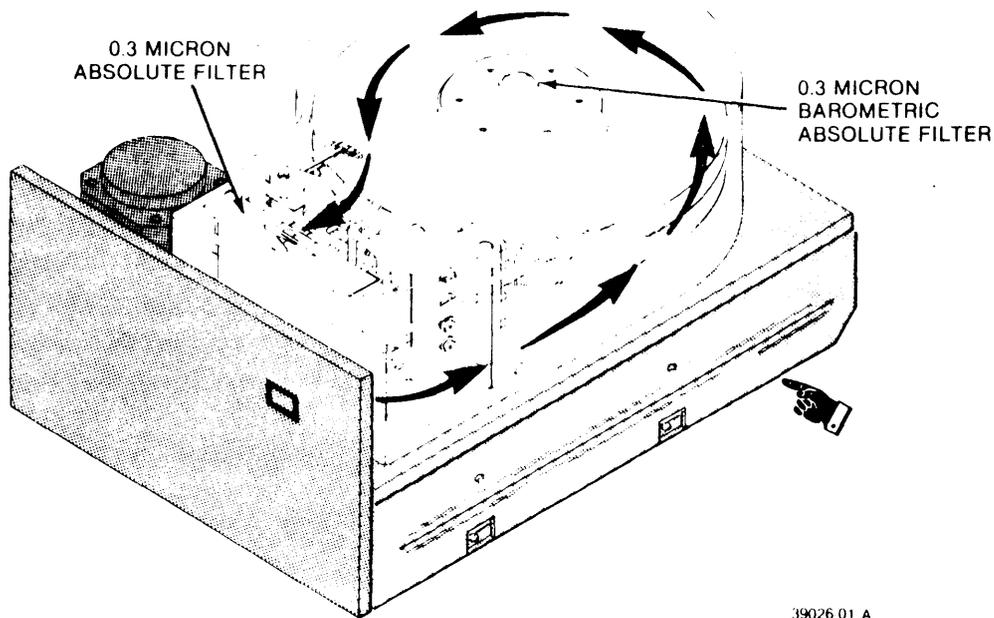
- a. Index Generator Circuit
- b. Head Position Actuator Drivers
- c. Read/Write Amplifiers
- d. Drive (READY) up to Speed Circuit
- e. Drive Select Circuit
- f. Write Fault Detection Circuit
- g. Read/Write Head Select Circuit
- h. Ramped (Buffered) Stepper Circuit
- i. Track 00 Indicator
- j. Brushless Spindle Motor Control Circuits
- k. Electronic Damping Circuit

1.3.3 Drive Mechanism

The brushless dc drive motor rotates the spindle at 3,600 (+0,-72) rpm.

1.3.4 Air Filtration System

The disk(s) and read/write heads are fully enclosed in a module using an integral recirculating air system with an absolute filter which maintains a clean environment. A separate absolute breather filter permits pressure equalization with the ambient air without contamination. See figure 1-2.

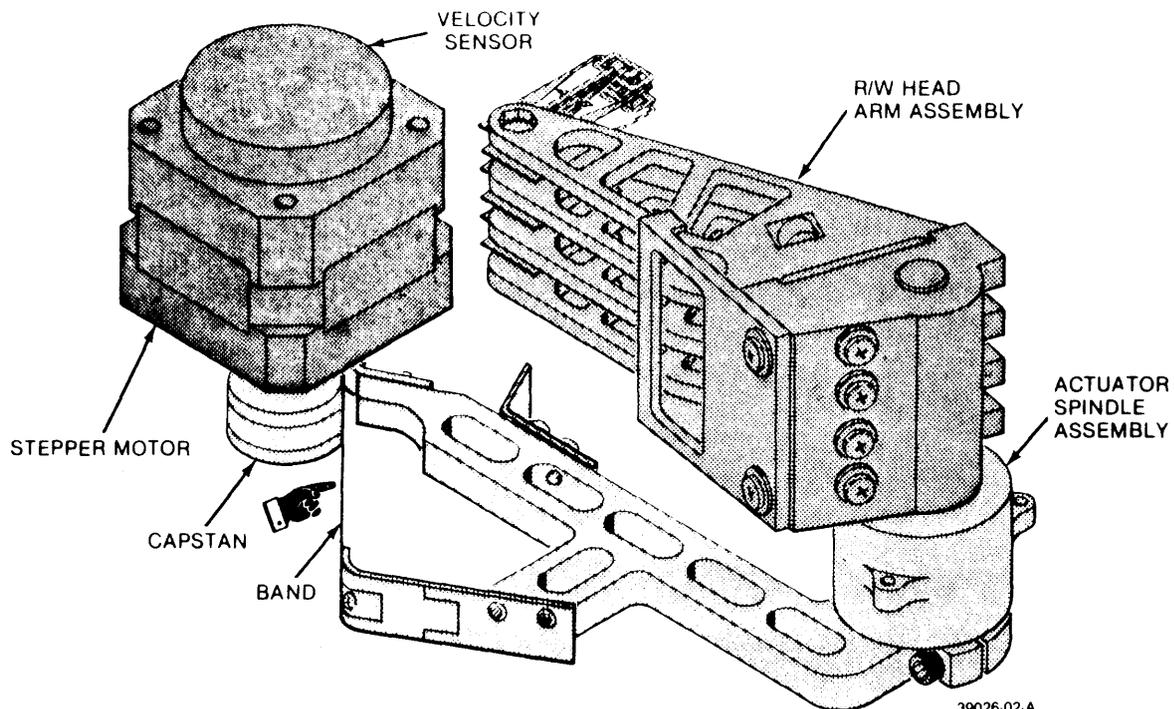


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FIGURE 1-2. AIR FILTRATION SYSTEM

1.3.5 Positioning Mechanism

The read/write heads are mounted on an arm which is positioned by the Fasflex IV™ rotary actuator. A stepper motor is used to position the rotary actuator precisely, utilizing a unique metal band/capstan concept. Figure 1-3 illustrates the read/write head positioning mechanism.



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FIGURE 1-3. READ/WRITE HEAD POSITIONING MECHANISM

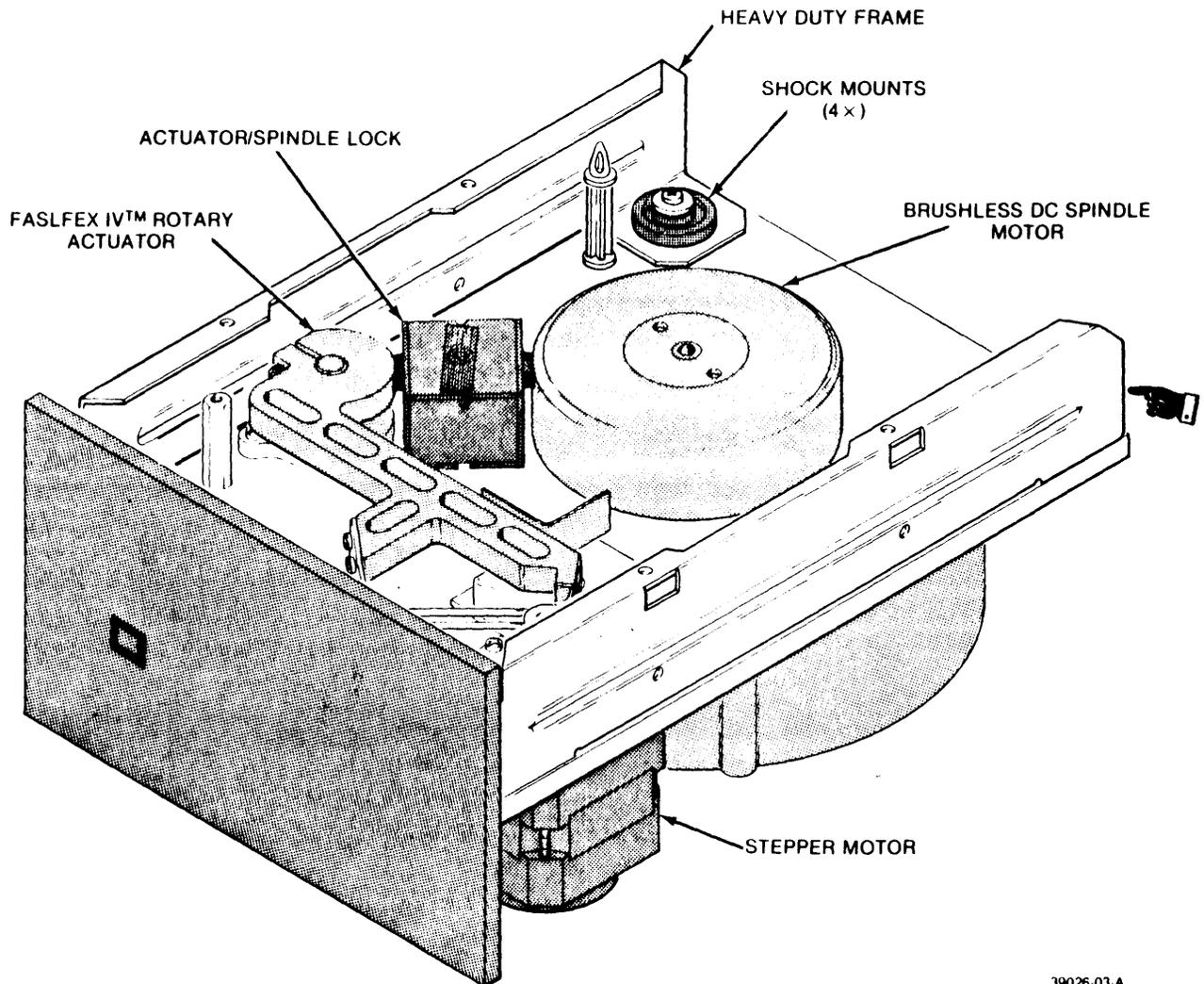
1.3.6 Read/Write Heads and Disk(s)

The recording media consists of a thin, lubricated, magnetic oxide coating on a 130 mm diameter aluminum substrate. This coating formulation, together with the low load force/low mass Winchester-type flying heads, permits reliable contact start/stop operation.

Data on each disk surface is read by one read/write head, each of which accesses 160/311 tracks. The drive is available in three basic configurations: one disk with two read/write heads, two disks with four read/write heads, or three disks with six read/write heads. The heads may be positioned to track 182/340 prior to shutdown in order to minimize the potential for damage to the recorded data on portable systems. Refer to paragraph 1.3.8.

1.3.7 Actuator/Spindle Lock

The SA600's are provided with an integral fail-safe actuator and spindle lock. This solenoid operated, dual mechanical brake is actuated when dc power is applied to the drive allowing the spindle to rotate and the heads to be accessed. When the drive is powered off, the solenoid is de-activated allowing the brake to decelerate the spindle and lock the actuator. This prevents possibility of head or disk movement during shipping or movement of the drive. See figure 1-4.



39026-03 A

FIGURE 1-4. SA600 ACTUATOR LOCK

1.3.8 Read/Write Head Shipping Zone

The unused area of the disk surface, inside the data bands, is designated as a "shipping zone." The heads can be accessed to this area before the drive is powered off, prior to moving or shipping the drive. This ensures that if the drive is exposed to severe handling (shock), the data storage area of the disk surface will not be damaged by the heads bouncing on the disks. See figure 1-5.

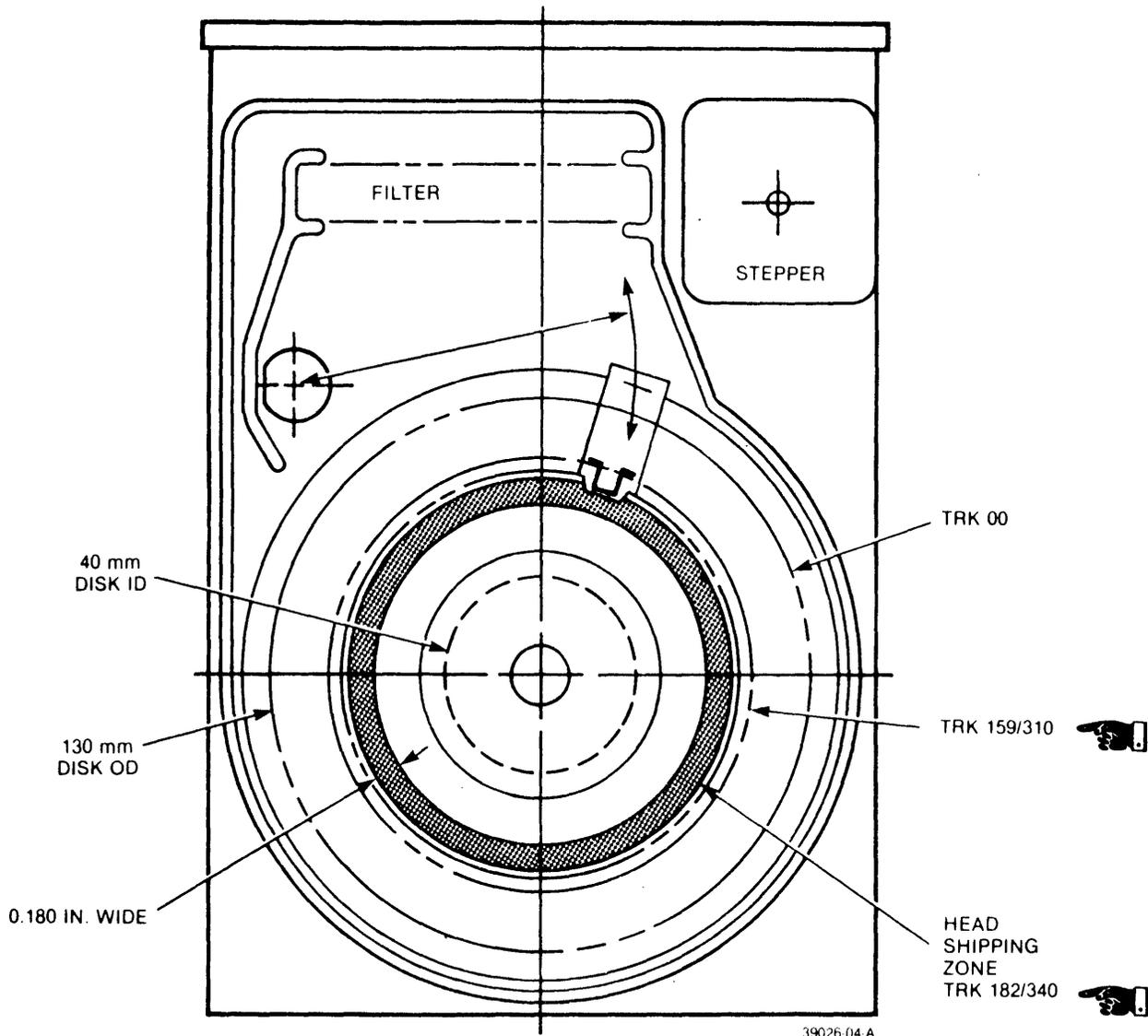


FIGURE 1-5. SA600 SHIPPING ZONE

1.4 FUNCTIONAL OPERATIONS

1.4.1 Power Sequencing

Since the SA600's have a speed sense circuit to prevent stepping until the disk is rotating at the proper speed (3,600 rpm), no power-on sequence is required. A READY signal will be presented to the controller interface once the disk is up to 95% of its normal rotational speed (3420 rpm). At READY time, after an initial power up, the drive will recalibrate itself to track 00. After an 18 msec head settle time, SEEK COMPLETE will go true. Normal seek and read functions can now begin. An additional 2 minute warm-up should be allowed prior to performing a write operation. Refer to paragraph 2.7.

1.4.2 Drive Selection

Drive selection occurs when one of the DRIVE SELECT lines is activated. Only the drive appropriately jumpered will respond to the input signals, and the output signals of that drive are then gated to the controller.

1.4.3 Track Accessing

Read/write head positioning is accomplished by:

- a. Deactivating WRITE GATE.
- b. Activating appropriate DRIVE SELECT line.
- c. Being in READY condition with SEEK COMPLETE true.
- d. Selecting appropriate direction.
- e. Pulsing STEP line.

Stepping can occur either at the normal or the buffered rate. During normal stepping, the heads are repositioned at the rate of incoming step pulses. In the case of buffered stepping, incoming step pulses are received at a high rate and are buffered into counters. When all of the steps have been received, they are issued to the stepper drivers at a ramped stepping rate.

Each pulse will cause the heads to move either one track in or one track out, depending on the level of the DIRECTION IN line. A true on the DIRECTION IN line will cause an inward seek; a false on the DIRECTION IN line will result in an outward seek toward track 00.

1.4.4 Head Selection

Any of the two to six possible heads can be selected by placing the binary address of that head on the three HEAD SELECT lines.

1.4.5 Read Operation

Reading data from the disk is accomplished by:

- a. Deactivating the WRITE GATE line.
- b. Activating the appropriate DRIVE SELECT line.
- c. Assuring that the drive is READY.
- d. Selecting the appropriate head.

1.4.6 Write Operation

Writing data onto the disk is accomplished by:

- a. Activating the appropriate DRIVE SELECT line.
- b. Assuring that the drive is READY.
- c. Clearing any write fault conditions (if they exist), by reselecting the drive.
- d. Selecting the proper head.
- e. Activating WRITE GATE and placing data on the WRITE DATA line.

SECTION II ELECTRICAL INTERFACE

2.1 ELECTRICAL INTERFACE

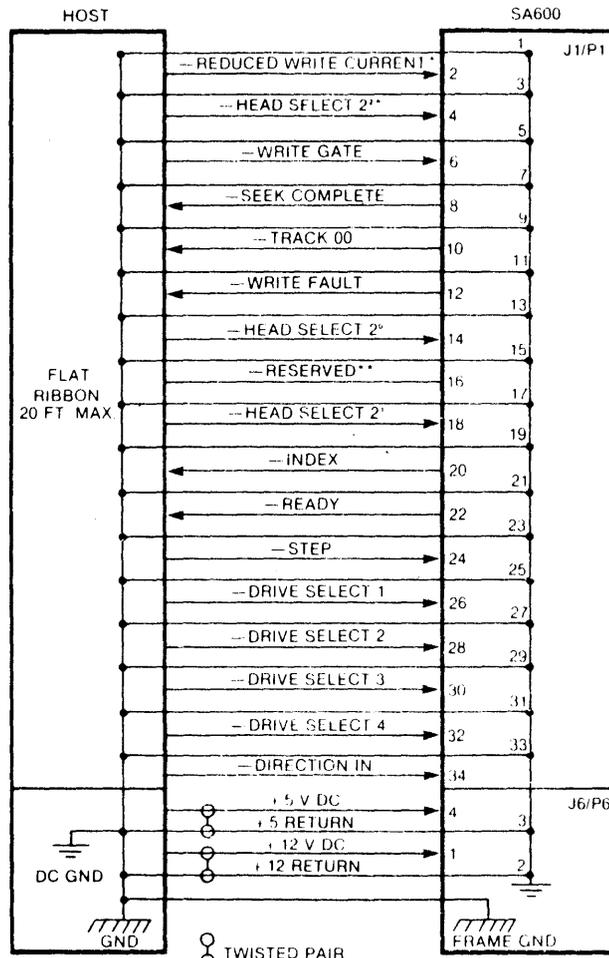
The interface of an SA600 drive can be divided into two categories:

- a. Signal Interface
- b. DC Power Interface

The following paragraphs provide the electrical definition for each line.

2.2 SIGNAL INTERFACE

The interface for an SA600 has drive control signal pin assignments per industry standards. See figure 2-1 for the pin assignments.



*RESERVED ON SA607/612.

**RESERVED TO J2 PIN 7 ON SA607/612.

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FIGURE 2-1. J1 INTERFACE AND J6 POWER CONNECTIONS

The signal interface consists of three categories.

- a. Control Input Lines
- b. Control Output Lines
- c. Data Transfer Lines

All control lines are digital in nature and either provide signals to the drive (input) or provide signals to the host (output) via the interface connector J1/P1. The data transfer signals are differential in nature. They provide data either to or from the drive, via J2/P2. See figure 2-10 for the J2/P2 pin assignments.

2.3 CONTROL INPUT LINES

The control input signals are of two types: those intended to be multiplexed in a multiple drive system and those intended to control the multiplexing. The control input signals to be multiplexed are STEP; DIRECTION SELECT; HEAD SELECT 2^0 , 2^1 , and 2^2 ; WRITE GATE, and REDUCED WRITE CURRENT. The signals which are intended to do the multiplexing are DRIVE SELECT 1, DRIVE SELECT 2, DRIVE SELECT 3, and DRIVE SELECT 4.

The control input lines have the following electrical specifications. See figure 2-2 for the recommended circuit.

Only one drive in the system should be terminated, and it should be physically located at the end of the cable and terminated by the removable 220/330 ohm resistor pack located near the P1 connector.

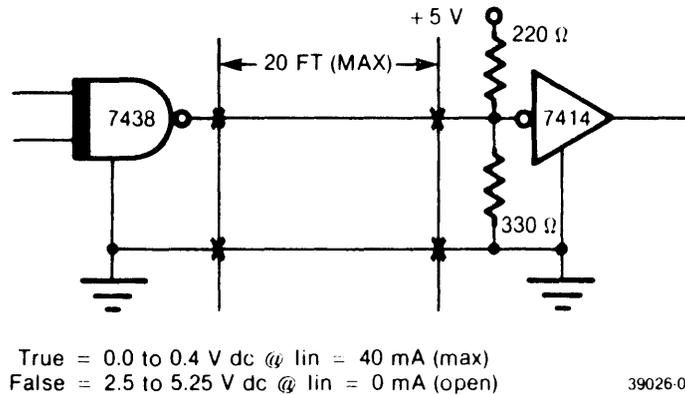


FIGURE 2-2. CONTROL INPUT DRIVER/RECEIVER COMBINATION

2.3.1 Drive Select 1-4

DRIVE SELECT, when logically true, connects the drive to the control lines. Only one DRIVE SELECT line may be active at a time.

Jumper options DS1, DS2, DS3, and DS4 are used to select which DRIVE SELECT line will activate the interface for that unique drive. See figure 2-3 for the jumper location.

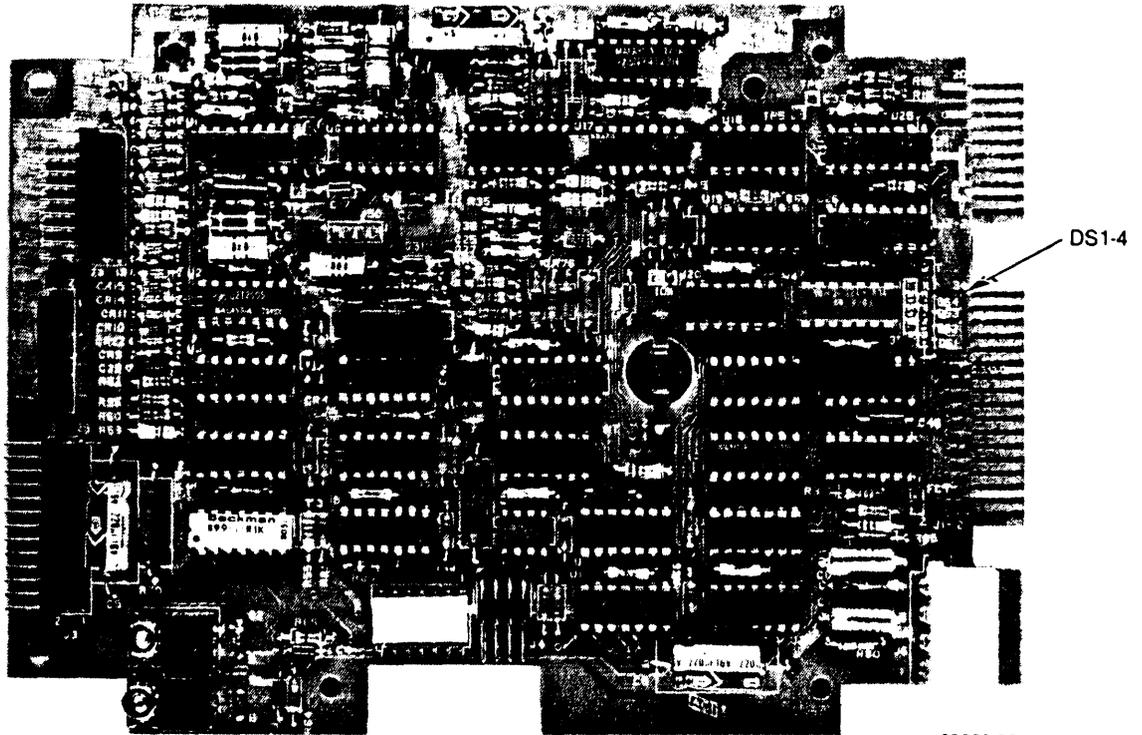
2.3.2 Direction In

This signal defines the direction of motion of the read/write heads when the STEP line is pulsed. An open circuit, or logical false, defines the direction as "out" and if a pulse is applied to the STEP line, the read/write head will move away from the center of the disk. If the input is shorted to ground, or logical true, the direction of motion is defined as "in" and if a pulse is applied to the STEP line, the read/write heads will move towards the center of the disk.

A removable 220/330 ohm resistor pack, located near the P1 connector, provides input line termination.

2.3.3 Step

This line causes the read/write heads to move in the direction defined by the DIRECTION IN line. The motion is initiated at each logical true-to-false transition. Any change in the DIRECTION IN line before the leading edge of the step pulse must be made at least 10 μ s for the SA604/606 and 0 ns for the SA607/612. Stepping can be performed in either the normal or buffered mode:

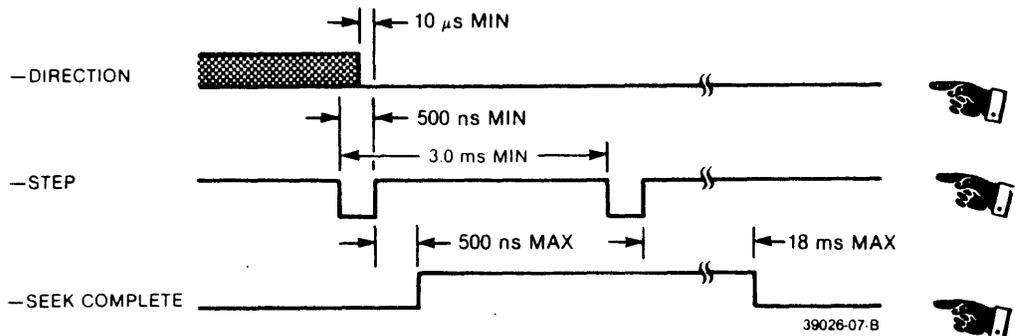


39026-25

FIGURE 2-3 READ/WRITE PCB

Normal Step Mode

In this mode, the read/write heads will move at the rate of the incoming step pulses. The minimum time between the successive steps is 3.0 ms with a minimum pulse width of 500 ns. See figure 2-4.



39026-07-B

FIGURE 2-4. NORMAL STEP MODE

Buffered Step Mode

In this mode, the step pulses are received at a high rate and buffered into a counter. After the last step pulse, the read/write heads will begin stepping the desired number of cylinders and SEEK COMPLETE (refer to paragraph 2.4.5) will go true after the read/write heads settle on the cylinders. This mode of operation is automatically selected when the time between step pulses is less than 200 μ sec.

The DRIVE SELECT line may be dropped and a different drive selected 500 ns after the last step pulse has been sent to the drive.

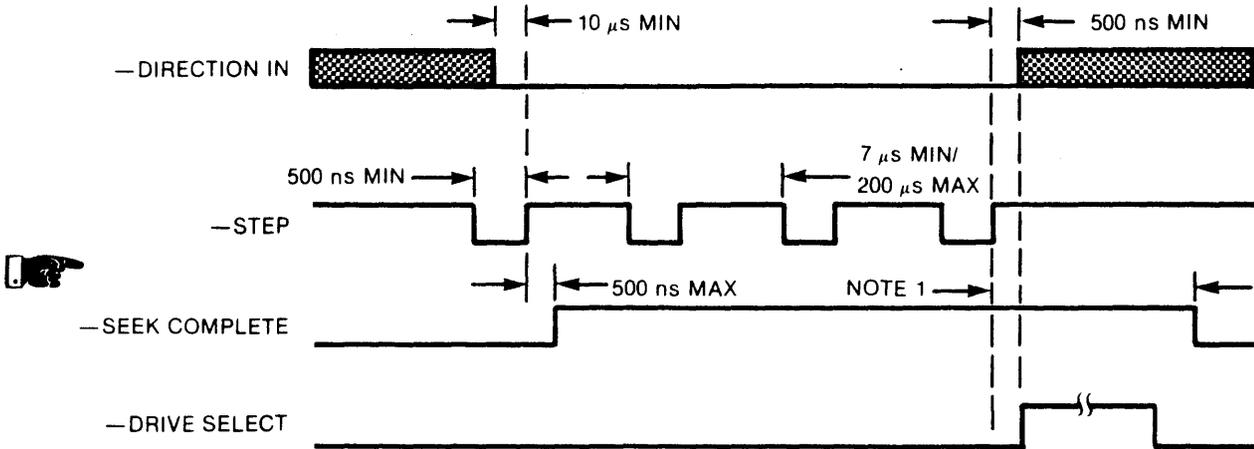
The maximum time between steps is 200 μ s with a minimum pulse width of 500 ns (see figure 2-5).

Shipping Zone

The read/write heads can be accessed to the shipping zone by doing a seek to track 182/340.

NOTES

- Step pulses with periods between 200 μs and 3.0 ms are not permitted. Seek accuracy is not guaranteed if this timing requirement is violated.
- A removable 220/330 ohm resistor pack (located near the P1 connector) allows for STEP line termination.



NOTES	SA604/606	SA607/612
1	205 ms MAX	216 ms MAX

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FIGURE 2-5. BUFFERED STEP MODE

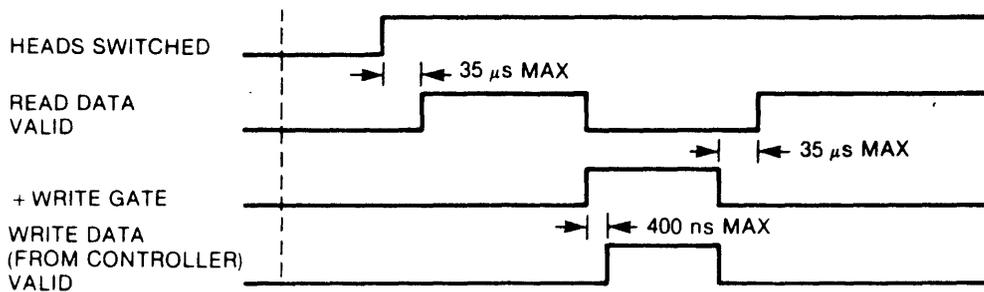
2.3.4 Head Select 2⁰, 2¹, and 2²

These three lines provide for the selection of each individual read/write head in a binary coded sequence. HEAD SELECT 2⁰ is the least significant line. When all HEAD SELECT lines are false, head 0 will be selected. Table 2-1 shows the HEAD SELECT sequence and model variations for the HEAD SELECT lines. See figure 2-6 for the timing sequences.

TABLE 2-1. HEAD SELECT (1 = False, 0 = True)

HEAD SELECT LINE			HEAD SELECTED	HEAD SELECTED	HEAD SELECTED
2 ⁰	2 ¹	2 ²	SA607	SA604/SA612	SA606
1	1	1	0	0	0
0	1	1	1	1	1
1	0	1	—	2	2
0	0	1	—	3	3
1	1	0	—	—	4
0	1	0	—	—	5

39026-09



39026-10

FIGURE 2-6. HEAD SELECTION TIMING

2.3.5 Write Gate

The active state of this signal (logical 0 level) enables WRITE DATA to be written onto the disk. The inactive state of the signal (logical 1 level) enables data to be transferred from the drive and enables STEP pulses to reposition the head arm. See figure 2-6 for the timing sequences.

A removable 220/330 ohm resistor pack (located near the P1 connector) allows for termination of this line.

2.3.6 Reduced Write Current and Precompensation

When this interface signal is low (true), the lower value of WRITE CURRENT is selected (for writing on cylinders 128 through 159). When this signal is high (false), the higher value of WRITE CURRENT is selected (for writing on cylinders 0 through 127). The SA607/SA612 provides for automatic reduced write current switching. A removable 220/330 ohm resistor pack, located near the P1 connector, allows for line termination. Optimum precompensation is 12 ns and should be used on cylinders 128 through 159/311.

2.4 CONTROL OUTPUT LINES

The control output signals are driven with an open collector output stage, capable of sinking a maximum of 40 mA at logical 0 (true), with a maximum voltage of 0.4 V measured at the driver. When the line driver is at logical 1 (false), the driver transistor is off and the collector cut off current is a maximum of 250 μ A.

All J1 output lines are enabled by their respective DRIVE SELECT lines.

Figure 2-7 shows the recommended control signal driver/receiver combination.

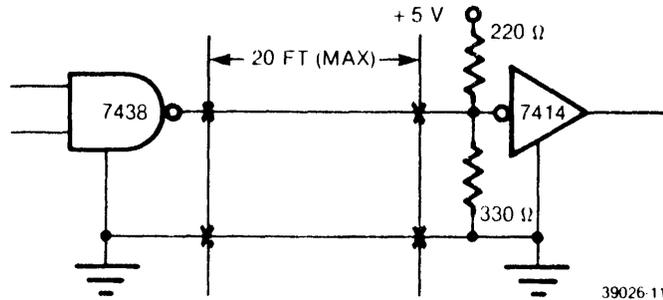


FIGURE 2-7. CONTROL OUTPUT DRIVER/RECEIVER COMBINATION

2.4.1 Track 00

This interface signal indicates a true state (logical 0) only when the read/write heads of the selected drive are at track 00 (the outermost track) and the access circuitry is driving current through phase one of the stepper motor. This signal is false (logical 1) when the read/write heads of the selected drive are not at track 00.

2.4.2 Index

The drive provides this interface signal once each revolution (16.67 ms) to indicate the beginning of the track. Normally, this signal is a logical 1 (false) and makes the transition to logical 0 (true) for a period of approximately 10 μ s once each revolution (see figure 2-8).

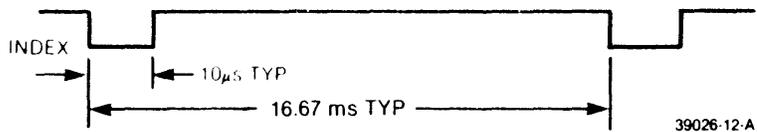


FIGURE 2-8. INDEX TIMING

2.4.3 Ready

This interface signal when true (logical 0), together with SEEK COMPLETE, indicates that the drive is ready to read, write, or seek, and that the signals are valid. When this line is false (logical 1), all seeking and writing to the disk is inhibited at the drive.

READY will be true after the drive is $95 \pm 2\%$ up to speed (3348 - 3492 rpm). The typical time for READY to become true is after the power is on for 12 seconds. It is now safe to seek the drive, but an additional 2 minutes should be allowed for thermal expansion to stabilize before any write operations are performed.

2.4.4 Write Fault

This signal, when active (logical 0), is issued to indicate that a condition exists at the drive that could cause improper writing on the disk. A WRITE FAULT occurs whenever one of four conditions occurs:

- a. WRITE CURRENT in the Read/Write head without WRITE GATE active.
- b. Multiple Read/Write heads selected.
- c. WRITE GATE and NO WRITE CURRENT to Read/Write heads.
- d. Microprocessor sequence error.

To reset the WRITE FAULT line, deselect the drive for at least 500 ns. A fault condition caused by a microprocessor sequence error cannot be reset by deselection. A dc power-on is necessary to restart the microprocessor.

2.4.5 Seek Complete

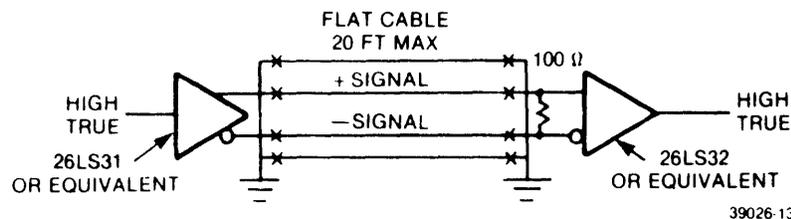
SEEK COMPLETE will go true (logical 0) when the read/write heads have settled on the final track at the completion of a seek. Reading or writing should not be attempted until SEEK COMPLETE is true. See figure 2-4 and 2-5.

SEEK COMPLETE will go false in two cases:

- a. A recalibration sequence is initiated (by the drive logic) at power-on if the read/write heads are not over track 00. Refer to paragraph 2.7.
- b. 500 ns typical, after the trailing edge of a STEP pulse (or the first of a series of step pulses).

2.5 DATA TRANSFER LINES

All lines associated with the transfer of data between the drive and the host are differential in nature and may not be multiplexed. These two pairs of balanced signals are: MFM WRITE DATA and MFM READ DATA, and are provided at the J2/P2 connector on all drives. Figure 2-9 illustrates the driver/receiver combination. Refer to figure 2-10 for the J2/P2 interface connection.



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FIGURE 2-9. DATA TRANSFER LINE DRIVER/RECEIVER COMBINATION

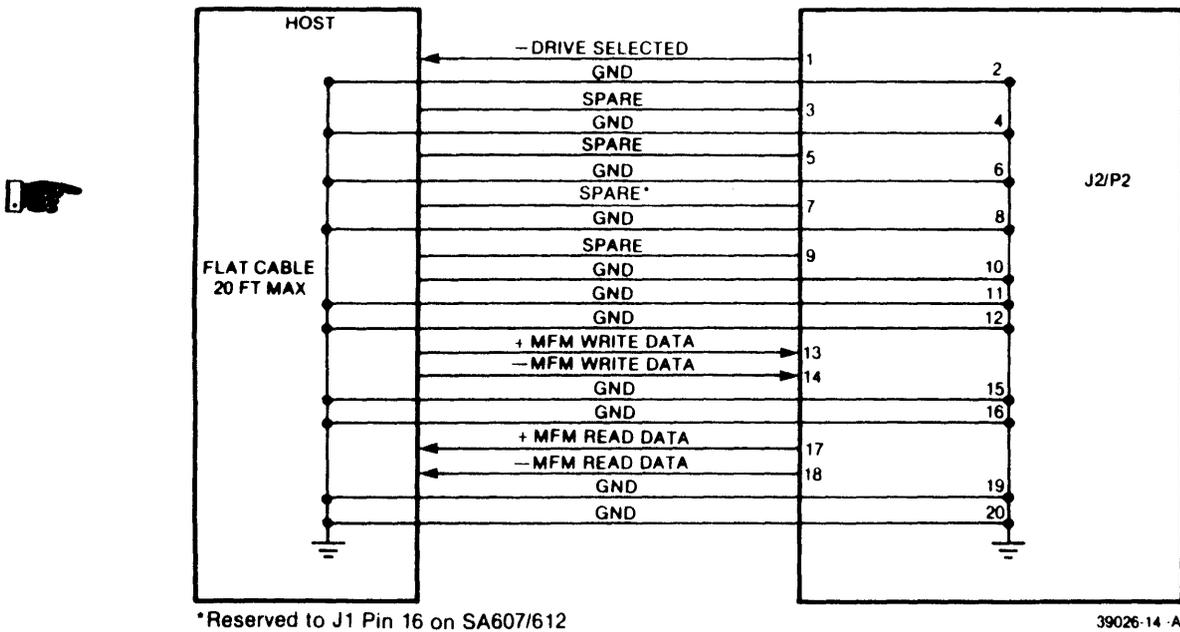


FIGURE 2-10. J2 INTERFACE CONNECTION

2.5.1 MFM Write Data

This pair of signals defines the transitions (bits) to be written on the disk. +MFM WRITE DATA going more positive than -MFM WRITE DATA will cause a flux reversal on the track under the selected head providing WRITE GATE is active. This signal must be driven to an inactive state (+MFM WRITE DATA more negative than -MFM WRITE DATA) by the host system when in the read mode. Figure 2-11 shows the timing for MFM WRITE DATA.

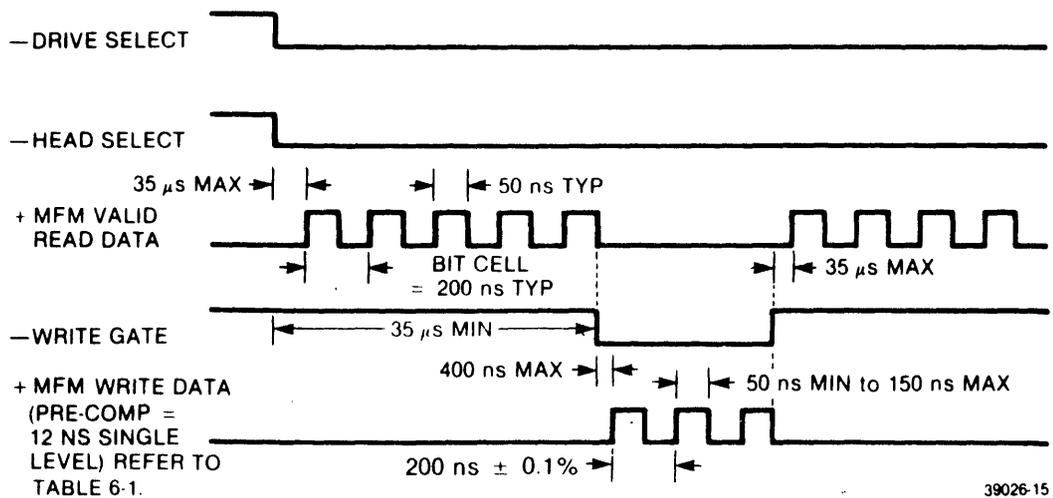


FIGURE 2-11. MFM READ/WRITE DATA TIMING

2.5.2 MFM Read Data

The data recovered by reading a pre-recorded track is transmitted to the host system via the differential pair of MFM READ DATA lines. This transition of the +MFM READ DATA line going more positive than -MFM READ DATA lines represents a flux reversal on the track of the selected head while WRITE GATE is inactive. Refer to figure 2-11.

2.6 SELECT STATUS

A status line is provided at the J2/P2 connector to inform the host system of the selection status of the drive.

The DRIVE SELECT line is driven by a TTL open collector driver as shown in figure 2-7. This signal will go active only when the drive is programmed as drive X (X = 1, 2, 3, and 4) by proper placement of the shorting plug in the vicinity of J1, and DRIVE SELECT X line at J1/P1 is activated by the host system.

2.7 GENERAL TIMING REQUIREMENTS

The timing diagram shown in figure 2-12 illustrates the necessary sequence of events (with associated timing restrictions) for proper operation of the drive.

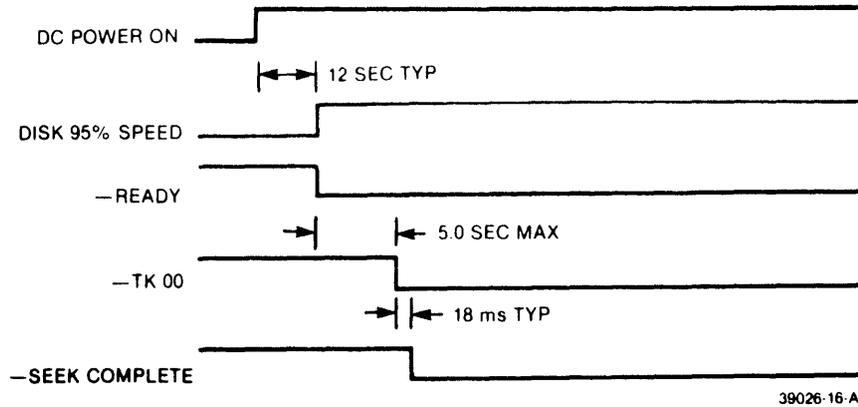


FIGURE 2-12. GENERAL CONTROL TIMING REQUIREMENT

Note that a recalibrate to track 00 sequence is initiated automatically at every dc power on. For this auto-recall sequence to function, the following conditions must be met:

- a. STEP input at J1 P1 is held inactive
- b. Spindle is spinning at regular speed.

2.8 POWER INTERFACE

The SA600's require only dc power for operation.

DC power to an SA600 drive is via connector J6 P6 located on the solder side of the PCB. The two dc voltages and their specifications along with their J6 P6 pin designations, are outlined in table 2-2.

TABLE 2-2. DC REQUIREMENTS

P6 PIN	DC VOLTAGE	TOLERANCE	CURRENT	MAX RIPPLE (p to p)
1	+ 12 VDC	± 0.6 VDC ± 1.2 V STARTING*	1.8 A TYPICAL 4.0 A MAX STARTING*	250 mV MAX ALLOWABLE
2	+ 12 RETURN			
3	+ 5 RETURN			
4	+ 5 VDC	± 0.25 VDC	0.9 A TYPICAL 1.5 A MAX	50 mV MAX ALLOWABLE

* 10 sec max.

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SECTION III PHYSICAL INTERFACE

3.1 PHYSICAL INTERFACE

The electrical interface between an SA600 and the host system is via three connectors. The first connector, J1, provides control signals for the drive; the second connector, J2, provides for the radial connection of the read/write signals; and the third connector, J6, provides dc power. See figure 3-1 for the connector locations.

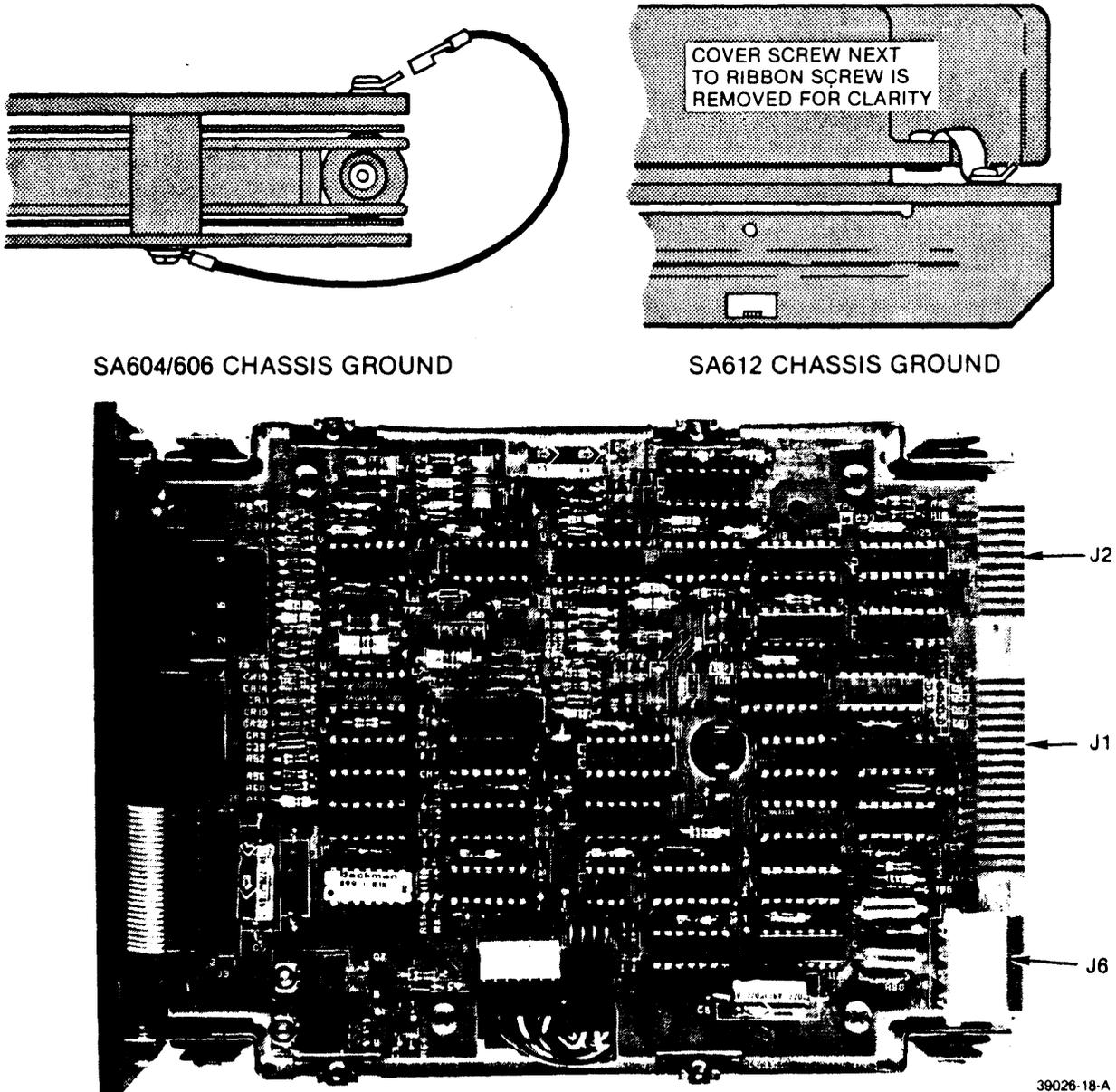


FIGURE 3-1. INTERFACE CONNECTOR LOCATIONS

3.2 J1/P1 CONNECTOR

Connection to J1 is through a 34 pin PCB edge connector. The dimensions for this connector are shown in figure 3-2. The pins are numbered 1 through 34 with the even numbered pins located on the component side of the PCB and odd pins located on the non-component side of the PCB. Pin 2 is located at the end of the PCB connector closest to the J2 connector and is labeled. A key slot is provided between pins 4 and 6. The recommended mating connector for P1 is a Scotchflex ribbon connector P/N 3463-0001.

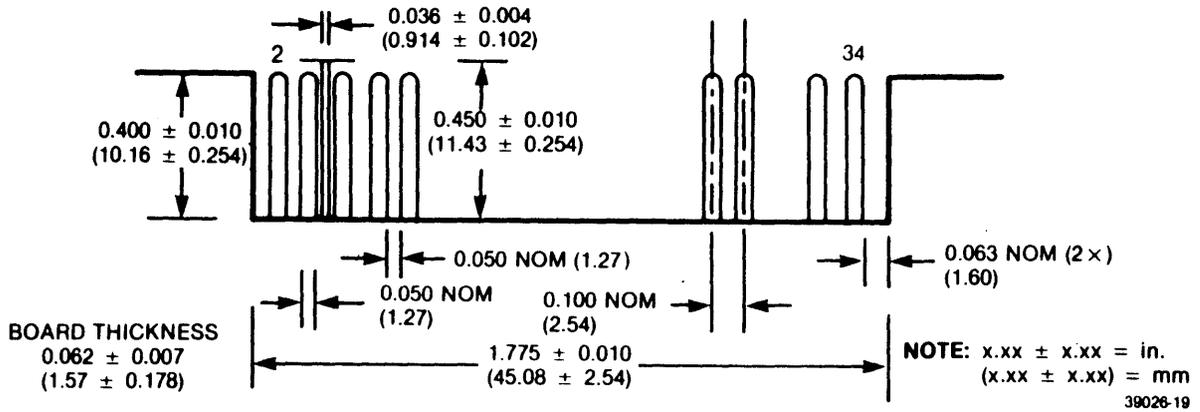


FIGURE 3-2. J1 CONNECTOR DIMENSIONS

3.3 J2/P2

Connection to J2 is through a 20 pin PCB edge connector. The pins are numbered 1 through 20 with the even numbered pins located on the component side of the PCB. The recommended mating connector for P2 is a Scotchflex ribbon connector P/N 3461-0001. A key slot is provided between pins 4 and 6. Figure 3-3 shows the dimensions for the connector.

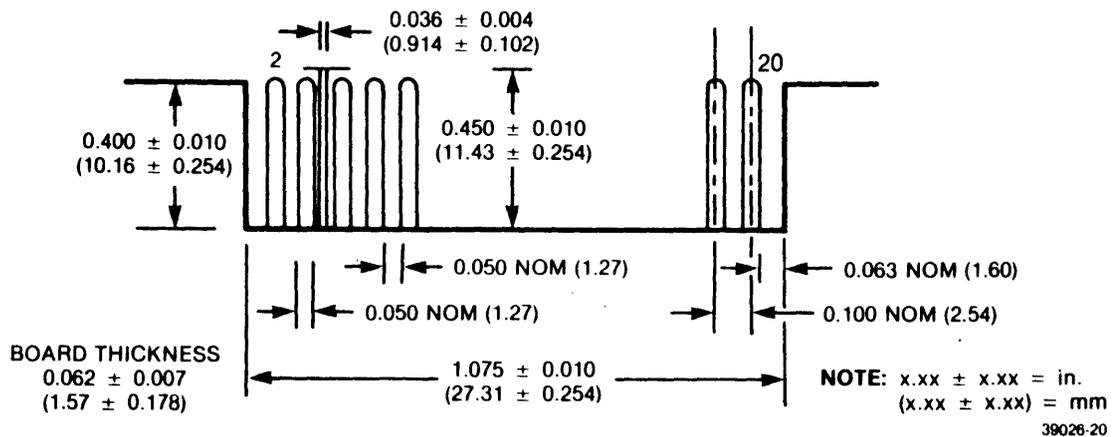
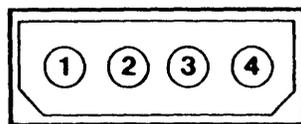


FIGURE 3-3. J2 CONNECTOR DIMENSIONS

3.4 J6/P6

The dc power connector, J6, is mounted on the non-component side of the PCB. J6 is a 4 pin AMP Mate-N-Lok connector P/N 350211-1. The recommended mating connector is AMP P/N 1-480424-0 utilizing AMP pins P/N 61473-1. J6, pin 1, is labeled on the component side of the PCB. Wire used should be #18 AWG. Figure 3-4 illustrates the J6 connector as seen on the drive PCB from the non-component side.



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FIGURE 3-4. J6 CONNECTOR

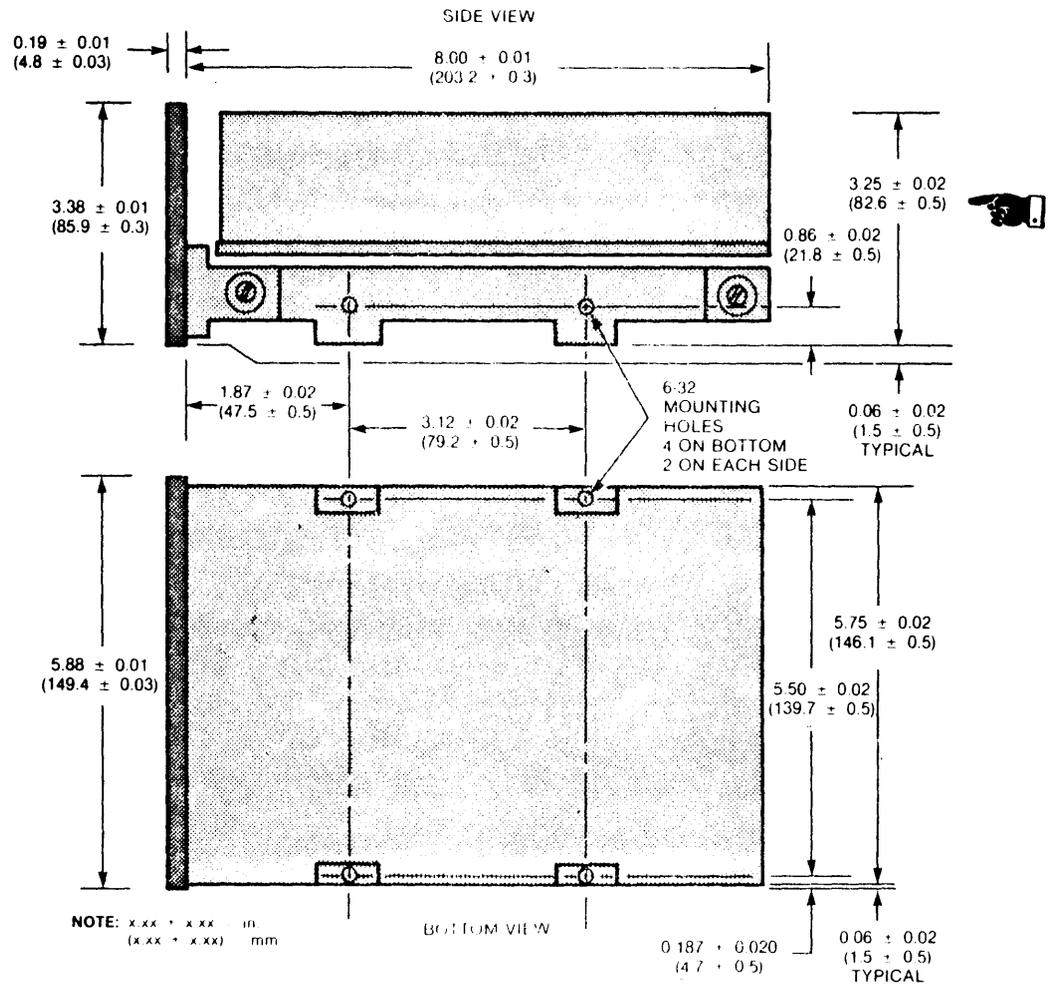
SECTION IV PHYSICAL SPECIFICATIONS

4.1 MECHANICAL DIMENSIONS

See figure 4-1 for the dimensions of the SA600 series drives.

NOTE

SA612 mounting brackets may look different from illustration, mounting hole dimensions are the same.



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FIGURE 4-1. MOUNTING DIMENSIONS

4.2 MOUNTING

The SA600's are capable of being mounted in either of the following positions:

- a. Vertically on either side.
- b. Horizontally with PCB down.

SECTION V

MEDIA DEFECTS AND ERRORS

5.1 ERROR MAPPING AND QUALIFICATION

In high density digital recording storage systems, reliability and operational performance are very important. This is done by providing an error detection and correction scheme. For disk storage systems, the predominant error pattern is a burst of errors occurring in one or more tracks. These errors are drop outs (absent bits), drop ins (added bits), or bits shifted from their nominal position beyond the tolerance of the data separator.

5.1.1 Causes of Errors

The following conditions may result in errors:

- a. Marginal signal to noise ratio of read/write circuits
- b. Marginal characteristics of the media and read/write heads
- c. Mispositioning of read/write heads on the disk
- d. Defects or imperfections in the disk media

5.1.2 Error Definition

An error is a discrepancy between recovered data and original data. There can be an extra bit or a missing bit, i.e., a "0" can be transformed into a "1" or a "1" can be changed to a "0."

Errors fall into two categories: "hard" or "soft." Hard errors are usually the result of media defects and will be repeatable. Soft errors are often caused by items (a) through (c) under paragraph 5.1.1 and will normally not be repeatable.

5.1.3 Media Defect Definition

Most errors resulting from media defects are classified as hard errors. They are attributable to small imperfections in the oxide coating of the disk, such as an impurity within the oxide itself, or a scratch on the surface of the oxide coating.

As the storage size and density of information increases, these defects become more apparent to the system. Winchester technology utilizes a higher bit packing ratio than older types of drives and is therefore more susceptible to this type of error.

5.1.4 Error Map

All drives will be scanned by a special scanning device during the manufacturing process. This device will test the drive in extreme marginal conditions by measuring the amplitude of a unique signal recorded on every track of every disk surface. All hard errors (media defects) will be logged and an error map attached to each drive. Each defect will be listed on the error map and will contain the following information:

- a. Track number
- b. Head number
- c. Byte count - Accurate to \pm TBD bytes (indicates the defective bytes as a location from physical index)
- d. Length of defect in bits

The error map accompanying each drive will typically provide the locations of more hard errors than will be detected by the user system. There are situations, however, where a magnetic anomaly or extra defects caused by improper handling may cause an error that is unique to a particular format or bit pattern. This flaw may present itself as a hard error, in addition to those reported on the error map. In the event that this situation occurs, it is recommended that this defect be added to the error map and mapped out.

5.1.5 User Error Mapping

The user system should be capable of mapping the defects as listed on the error map. These include any additional hard errors found during the user's functional test. The recommended method of mapping is to create a defect directory at cylinder 00. This directory would contain the locations of all defective areas, as well as alternate track assignments for those areas.

Under normal conditions, many defects which have been mapped will work without causing any problems. The main reason is that the media surface exceeds the minimum requirements and the chances of the error are very low. The amplitude loss due to the defect may only reduce the signal only to a fractional value. It still ensures trouble-free operation for longer time under full range of specified temperature conditions.

5.2 ERROR ACCEPTANCE CRITERIA

The drive, as received from the factory will meet the following error criteria:

- a. No more than 5 defective tracks.
- b. No more than 15 additional single track errors (32 good sectors).
- c. A single defect is defined as an error less than 10 bits long. A multiple defect is defined as an error greater than 10 bits long. A defective track has more than one defect location.

5.3 SYSTEM GENERATED ERRORS

It should be noted that errors may also be present as a result of system electrical noise, marginal timing conditions, ground loops in the dc power distribution cables, electro-magnetic interference, and radio frequency interference, etc.

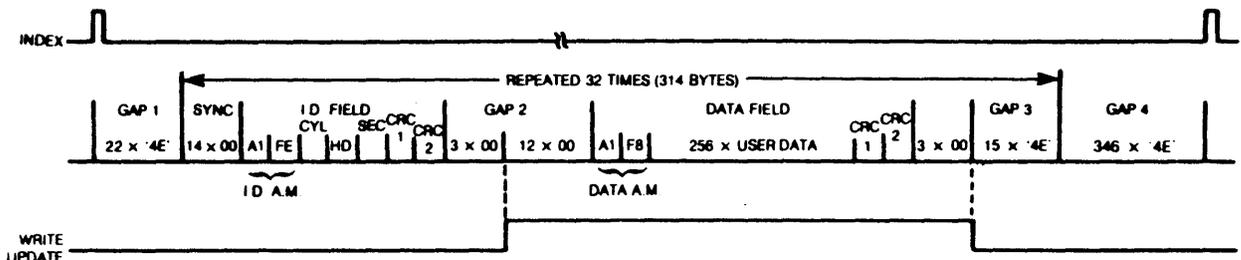
SECTION VI RECORDING FORMAT

6.1 SA600 SERIES TRACK FORMAT

The purpose of a format is to organize a data track into smaller and sequentially numbered blocks of data called sectors. The SA600 format is a soft sector type, which means that the beginning of each sector is defined by a prewritten identification (ID) field, which contains the physical sector address, plus cylinder and head information. The ID field is then followed by a user data field.

The soft sector format is a slightly modified version of the IBM system 34 double density format commonly used on 8-inch floppy disk drives. The encoding method used here is called modified frequency modulation (MFM).

Figure 6-1 shows each track divided into 32 sectors. Each sector has a data field of 256 bytes in length. However, if sector interleaving is used, Gap 4 can be reduced to 32 bytes minimum to accommodate 32 sectors per track. If sector interleaving is not used, Gap 3 is 25 bytes and Gap 4 becomes 26 bytes minimum.



NOTES:

1. MINIMUM TRACK CAPACITY — 10416 BYTES.
2. WRITE TO READ RECOVERY TIME = 35 MICROSECONDS.
3. HEAD SWITCHING TIME = 35 MICROSECONDS.

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FIGURE 6-1. TRACK FORMAT

The beginnings of both the ID field and the data field are flagged by unique characters called address marks.

An address mark is two bytes in length. The first byte is always an "A1" data pattern. This is followed by either an "FE" pattern which is the pattern used to define an ID address mark, or an "F8" which is a data address mark pattern.

The "A1" pattern violates the encode rules of MFM by omitting one clock transition between bits 4 and 5. This makes the address mark pattern unique to any other serial bit combination.

All ID and data fields are followed by a 16 bit cyclic redundancy check (CRC) character used for data verification. Each CRC polynomial is unique for a particular data pattern.

Surrounding the ID and data fields are gaps called Interrecord gaps.

6.2 GAP LENGTH CALCULATIONS

6.2.1 Gap 1

The purpose of gap 1 is to provide a head switching recovery period so that when switching from one track to another, sequential sectors may be read without waiting the rotational latency time. Gap 1 should be at least 22 bytes (30 bytes recommended) long to correspond with the head switching time of 35 microseconds. Gap 1 is immediately followed by a sync field for the ID field of the first sector.

6.2.2 Gap 2

Following the ID field, and separating the ID field from the data field, is gap 2. Gap 2 provides a known area for the data field write update splice to occur. The remainder of this gap also serves as the sync-up area for the data field address mark. The length of gap 2 is determined by the data separator lock up performance.

6.2.3 Gap 3

Gap 3, following the data field is a speed variation tolerance area. This allows for a situation where a track has been formatted while the disk is running 2% slower (3528 rpm) and write updated with the disk running at highest speed (3600 rpm).

Gap 3 should be at least 15 bytes in length (this includes 2 bytes for write turn off).

NOTE

To operate properly in non-interleaved formats, Gap 3 should be at least 25 bytes to allow for 35 μ s read recovery. In this format, a drive can only support 32 sectors per track.

6.2.4 Gap 4

Gap 4 is a speed tolerance buffer for the entire track. This allows the disk to rotate at the highest rated speed without overflowing the track during the format operation. The format operation which writes the ID fields, begins with the first encountered index and continues to the next index.

6.3 WRITE PRECOMPENSATION

Whenever two bits are written in close proximity to each other, a phenomenon called pulse superposition occurs, which tends to cause the two bits to move away from each other. This is a large factor contributing to bit shift. Other phenomenon such as random noise, speed variation, etc., will also cause bit shift, but to a lesser degree.

The effect of bit shift can be reduced by a technique called precompensation, which, by detecting which bits will occur early and which bits will occur late, can effectively minimize the shift by writing these bits in the opposite direction of the expected shift. Bit shift is more apparent on the innermost data tracks due to pulse crowding. Therefore, precompensation should only be at track numbers greater than or equal to 128. The optimum amount of precompensation for an SA600 is 12 ns for both early and late written bits. Table 6-1 shows various bit patterns for precompensation. Precompensation pattern detection bits are shifted through a four bit shift register. The bit is written out of the third position.

TABLE 6-1. WRITE PRECOMPENSATION

WRITE POSITION	DIRECTION OF SHIFT
0 0 0 0	= On Time Clock
0 0 0 1	= Late Clock
0 0 1 0	= On Time Data
0 0 1 1	= Early Data
0 1 0 0	=
0 1 0 1	=
0 1 1 0	= Late Data
0 1 1 1	= On Time Data
1 0 0 0	= Early Clock
1 0 0 1	= On Time Clock
1 0 1 0	= On Time Data
1 1 0 0	=
1 1 0 1	=
1 1 1 0	= Late Data
1 1 1 1	= On Time Data

SECTION VII CUSTOMER INSTALLABLE OPTIONS

The SA600 series drives have no customer installable options.

SECTION VIII DRIVE INTERCONNECT

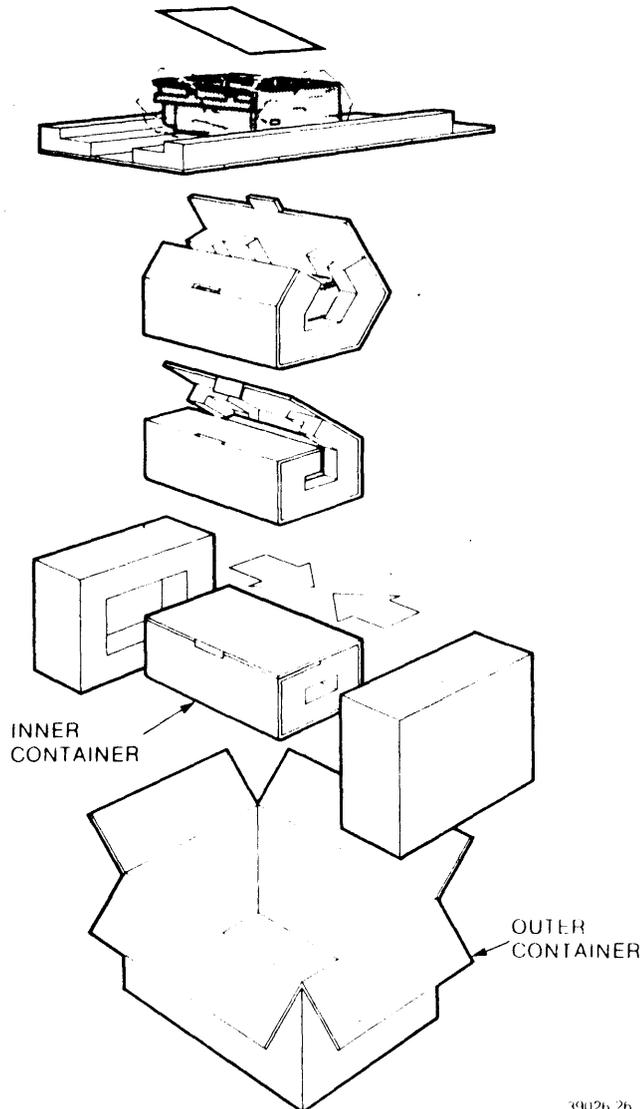
This section is not applicable to the SA600 drives.

SECTION IX PACKAGING INSTRUCTIONS

Due to the integral spindle brake/actuator lock, no special packaging instructions are required for these drives.

NOTE

It is suggested that packing material be kept in case the unit must be returned to Shugart for repair. Regardless, the unit must be individually packaged in comparable packing as shipped to preclude damage in shipping and handling. **Damage to the unit as a result of inadequate packaging will void the warranty on the unit.**



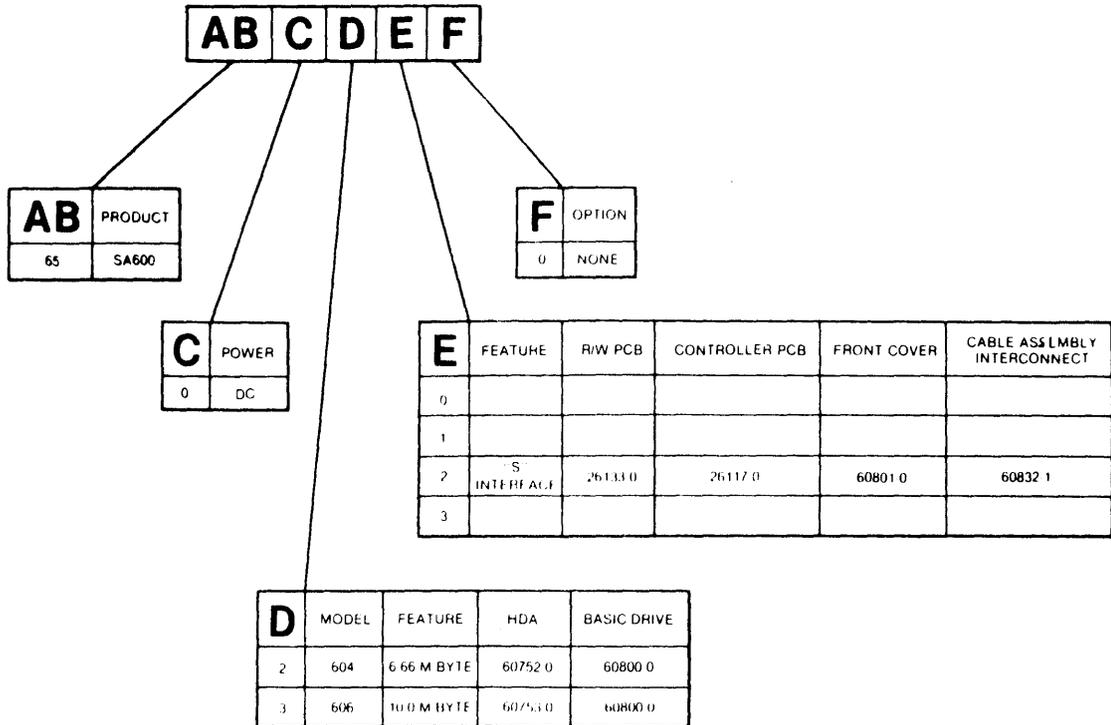
39026 26

FIGURE 9-1. SA600 PACKAGING

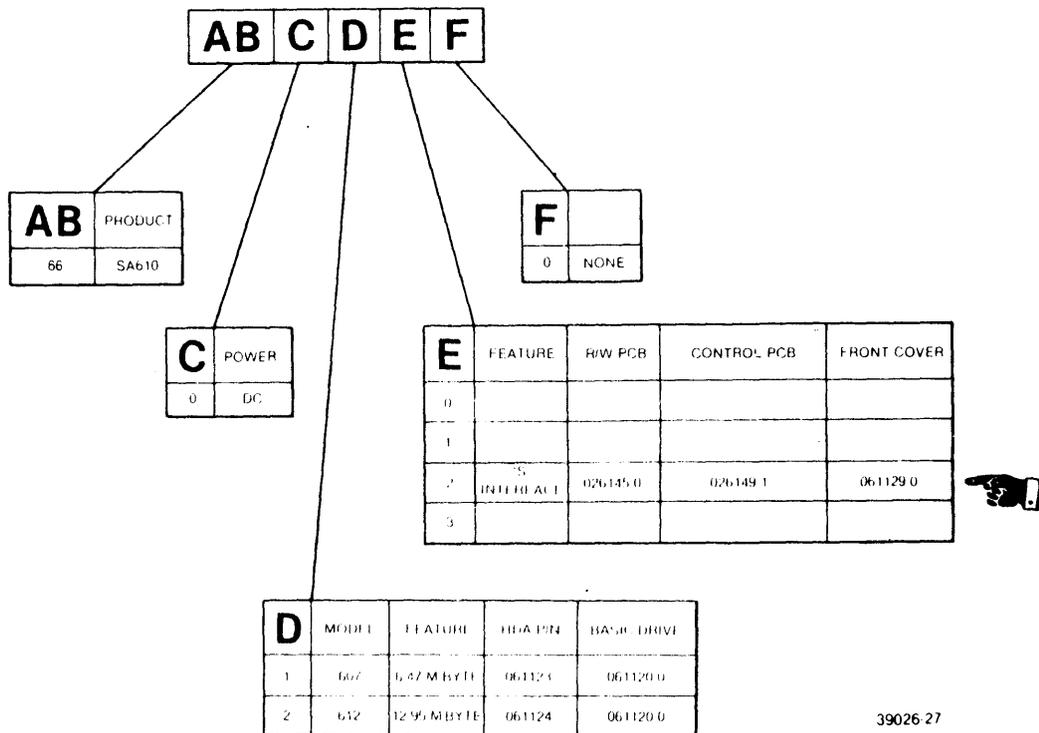
APPENDIX A ORDERING INFORMATION

TABLE A-1. SA600 ORDERING INFORMATION

SA604/606



SA607/612



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