

**WANG**

**Shugart Winchester Disk Drive**

**Model: SA 1000**

**Customer Engineering Reprint  
Product Maintenance Manual**

**741-0898**

## PREFACE

The purpose of this manual is to provide the Wang-trained Customer Engineer (CE) with instructions to operate, troubleshoot and repair the Shugart SA 1000.

Three Product Service Notices (PSN's), 729-0915, 729-0992 and 729-1049 are located at the back of the manual.

Second Edition (August 1984)

This reprint edition is the converted number for and obsoletes document no. 729-0898. It also incorporates Product Service Notices (PSN's), 729-0915, 729-0992 and 729-1049. The material in this document may be used only for the purpose stated in the Preface. Updates and/or changes to this document will be published as Publications Update Bulletins (PUB's) or subsequent editions.

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SA 1000 INSTALLATION AND SHIPPING INSTRUCTIONS  
SA 1000 OPERATING PRECAUTIONS

CAUTION:

The disk drive will be severely damaged if the following installation and shipping instructions are not observed. Read the instructions before applying system power.

A. INSTALLATION INSTRUCTIONS

The SA1000 contains the following two shipping locks that must be removed before power is applied to the system:

SPINDLE LOCK: Remove the system cover, making the disk drive accessible. Remove the spindle lock (WL #726-1902) that prevents the spindle drive motor from rotating.

HEAD ACTUATOR LOCK: Remove the spring clip that prevents the head actuator from rotating. The spring clip fastens the tab on the actuator to the track 00 photocell. The damper can be readily identified because a yellow caution label is attached to it.

B. SHIPPING INSTRUCTIONS

Prior to shipping the SA1000, attach the spindle lock and head actuator lock, using the following procedure:

- a. Set system power on, and verify that the spindle drive motor is running.
- b. Wait two minutes to allow the media to get up to operating speed, then rotate the actuator damper until the tab on the actuator lines up with the track 00 photocell.
- c. Shut off system power. Attach the spring clip to the tab and photocell, preventing the head actuator damper from rotating.
- d. Attach the spindle lock (WL #726-1902) that prevents the spindle drive motor from rotating.
- e. Pack the drive in the original shipping carton. If it is not available, consult Customer Engineering for shipping instructions.

C. OPERATING PRECAUTIONS

1. Never rotate the head actuator damper when system power is off.
2. Do not rotate the drive motor spindle unnecessarily. If it must be rotated manually, always turn it clockwise (as viewed from the hub or belt side of the drive).
3. After drive power is shut off, do not move the drive until the disk has stopped rotating.
4. When moving the drive from one location to another, always place a foam pad under the drive to prevent damage to the unit. Always handle the drive gently, and do not subject it to mechanical shock.

Wang Customer Engineering 8/7/80

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**1**

**INTRO-  
DUCTION**

## 1.0 INTRODUCTION

### 1.1 GENERAL DESCRIPTION

The Shugart Model 1000 series disk drive is a random access storage device with one or two non-removable 8" disks as storage media. Each disk surface employs one movable head to service 256 data tracks. The two models of the SA1000 series are the 1002 and the 1004 with single and double platters respectively. The SA1002 provides 5 megabytes accessed by 2 movable heads and the SA1004 provides 10 megabytes accessed by 4 movable heads. Up to 4 SA1000 drives may be connected in one system.

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

Mechanical and contamination protection for the head, actuator and disks are provided by an impact resistant plastic and aluminum enclosure. A self contained recirculating system supplies clean air through a .3 micron filter. Another absolute filter allows pressure equalization with ambient air without chance of contamination.

The optional SA1200 Data Separator PCB provides MFM encoding/decoding, write precompensation, a crystal write oscillator and address mark writing and detection. Each Data Separator can accommodate 4 disk drives.

The SA1000 fixed disk drive's interface is similar to the Shugart 8" family of floppy disk drives. The SA1000 is designed to fit into the same physical space and utilize the same mounting hardware as the 8" floppies.

#### Key Features:

- Storage Capacity of 5.33 or 10.67 megabytes.
- Double density recording with encoding, write precompensation, and data separation done by the optional Data Separator PCB.
- Winchester design reliability.

- Same physical size and identical mounting configuration as the SA800/850 floppies
- Uses the same D.C. voltages as the SA800/850 floppies
- Lowest Cost/Megabyte in its capacity range
- Proprietary Fast Flex III band actuator.
- 4.34 Mbits/second transfer rate
- Simple interface similar to the floppy.

## 1.2.1 Specification Summary

### 1.2.1 Physical Specifications

#### Environmental Limits

Ambient Temperature = 50° to 115°F (10° to 46°C)  
 Relative Humidity = 8% to 80%  
 Maximum Wet Bulb = 78° non-condensing

#### AC Power Requirements

50/60 Hz  $\pm$  0.5Hz  
 100/115 VAC Installations = 90-127V at 1.1A typical  
 200/230 VAC Installations = 180-253V at 0.6A typical

#### DC Voltage Requirements

+24VDC  $\pm$  10% 2.8A typical during stepping  
 (0.2A typical steady state, non stepping)  
 +5VDC  $\pm$  5% 3.6A typical  
 -5VDC  $\pm$  5% (-7 to -16VDC optional) .2A typical

#### Mechanical Dimensions

	Rack Mount	Standard Mount
Height =	4.62 in. (117.3mm)	4.62 in. (117.3mm)
Width =	8.55 in. (217.2mm)	9.50 in. (241.3mm)
Depth =	14.25 in. (362.0mm)	14.25 in. (362.0mm)
Weight =	17 lbs. (7.7Kg)	17 lbs. (7.7Kg)

Heat Dissipation = 511 BTU/Hr. typical (150 Watts)

### 1.2.2 Reliability Specifications

MTBF: 8,000 POH typical usage  
 PM: None Required  
 MTTR: 30 minutes  
 Component Life: 5 years

#### Error Rates:

Soft Read Errors: 1 per 10<sup>10</sup> bits read  
 Hard Read Errors: 1 per 10<sup>12</sup> bits read  
 Seek Errors: 1 per 10<sup>6</sup> seeks

### 1.2.3 Performance Specifications

	SA1002	SA1004
Capacity		
Unformatted		
Per Drive	5.33 Mbytes	10.67 Mbytes
Per Surface	2.67 Mbytes	2.67 Mbytes
Per Track	10.4 Kbytes	10.4 Kbytes
Formatted		
Per Drive	4.2 Mbytes	8.4 Mbytes
Per Surface	2.1 Mbytes	2.1 Mbytes
Per Track	8.2 Kbytes	8.2 Kbytes
Per Sector	256 bytes	256 bytes
Sectors/Track	32	32
Transfer Rate	4.34 Mbits/sec	4.34 Mbits/sec
Access Time		
Track to Track	19 msec	19 msec
Average	70 msec	70 msec
Maximum	150 msec	150 msec
Average Latency	9.6 msec	9.6 msec

### 1.2.4 Functional Specifications

Rotational Speed	3125 rpm	3125 rpm
Recording Density	6270 bpi	6270 bpi
Flux Density	6270 fci	6270 fci
Track Density	172 tpi	172 tpi
Cylinders	256	256
Tracks	512	1024
R/W Heads	2	4
Disks	1	2
Index	1	1



**2**

**FUNC-**

**TIONAL**

**CHARAC-**

**TERISTICS**

## **2.0 FUNCTIONAL CHARACTERISTICS**

### **2.1 GENERAL OPERATION**

The SA1000 fixed disk drive consists of read/write and control electronics, read/write heads, track positioning mechanism, media, air filtration system, and optional data separator circuit. These components perform the following functions:

Interpret and Generate control signals.

Position the heads over the selected track.

Read and Write data.

### **2.2 READ/WRITE AND CONTROL ELECTRONICS**

The standard electronics are packaged on a single printed circuit board containing the following:

1. Index Detector Circuit
2. Head Position Actuator Drivers
3. Read/Write Amplifiers
4. Drive Ready Timer
5. Drive Select Circuit
6. Write Fault Detection Circuit
7. Read/Write Head Select Circuit
8. Step Buffers with Ramped Stepper Circuit
9. Track 000 indicator

The optional SA1200 Data Separator PCB contains the following:

1. Data Encode Circuit
2. Write Precompensation Circuit
3. Start Logic
4. Address Mark Detector
5. Data Separator Circuit

### **2.3 Drive Mechanism**

The AC drive motor rotates the spindle at 3125 RPM through a belt-drive system. Either 50 or 60 Hz power is accommodated by changing the drive pulley and belt.

### **2.4 Air Filtration System (Figure 1)**

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.

### **2.5 Positioning Mechanism (Figure 2)**

The read/write heads are mounted on a ball bearing supported carriage which is positioned by the Fastflex III<sup>TM</sup> actuator. A stepper motor is used to precisely position the carriage assembly utilizing a unique metal band/capstan concept.

### **2.6 Read/Write Heads and Disk(s)**

The recording media consists of a lubricated thin magnetic oxide coating on a 200mm dia. aluminum substrate. This coating formulation, together with the low load force/low mass Winchester type flying heads, permit reliable contact start/stop operation.

Data on each disk surface is read by one read/write head, each of which accesses 256 tracks. The drive is available in two basic configurations: one disk with two read/write heads, or two disks with four read/write heads.

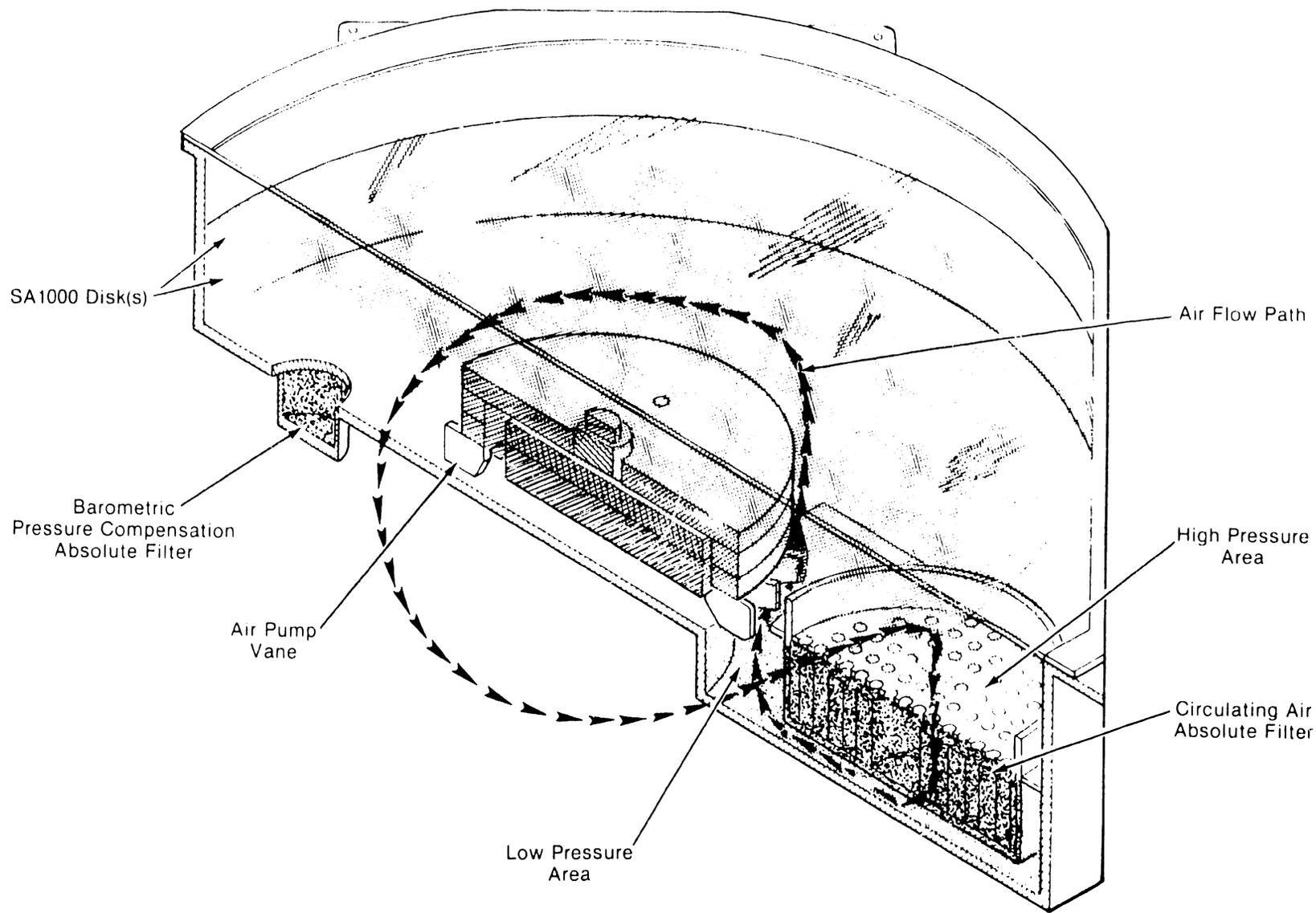


Figure 1 Air Filtration System

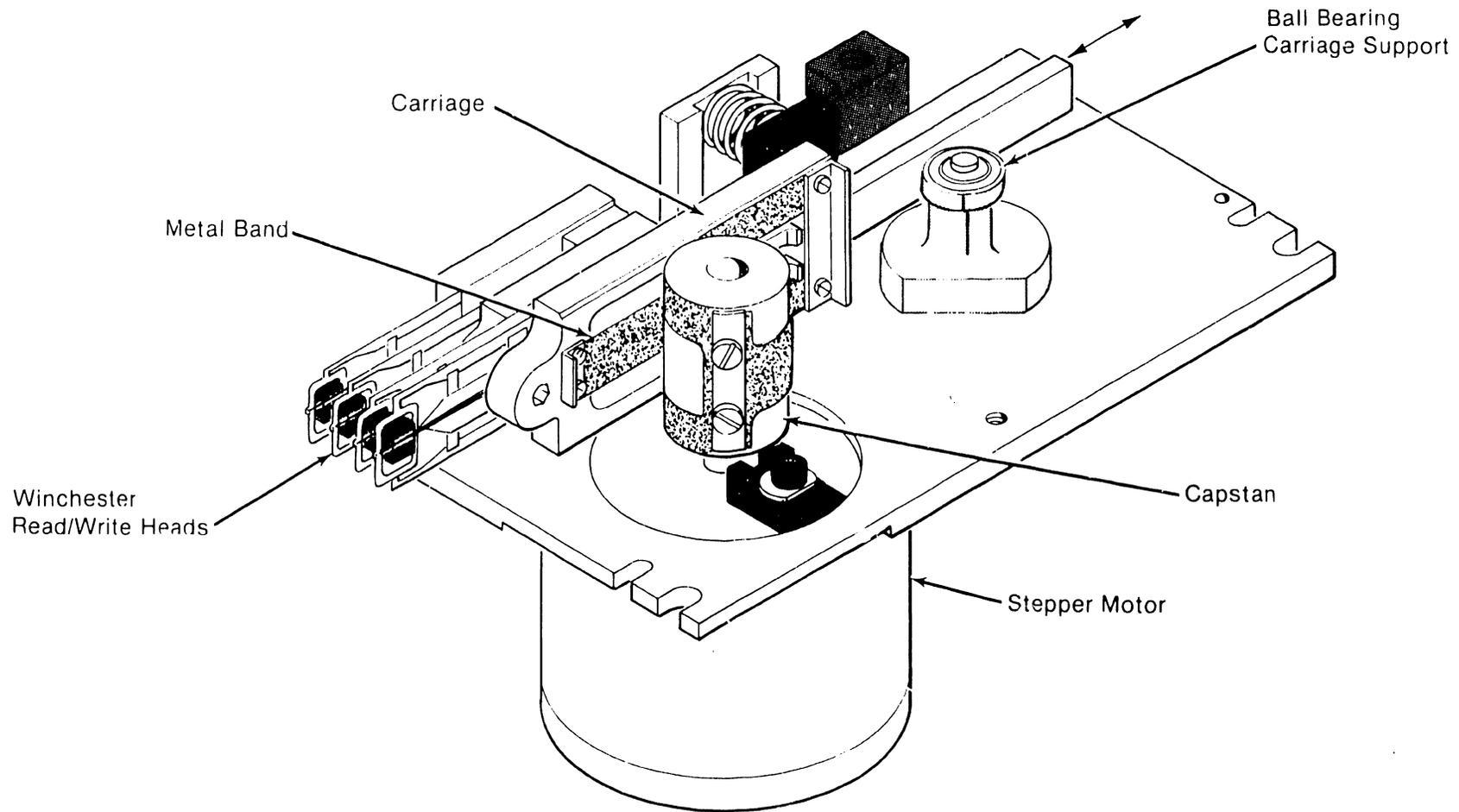


Figure 2 Positioning Mechanism

**3**

**FUNC-  
TIONAL  
OPERA-  
TION**

## **3.0 FUNCTIONAL OPERATIONS**

### **3.1 POWER SEQUENCING**

Since the SA1000 has a speed sense circuit that prevents stepping until the disk is rotating at the proper speed, no power on sequence is required. Once D.C. power is applied, an internal timer allows for speed stabilization. Following this period, a READY signal will be presented to the controller interface. At READY time, after an initial power up, the drive will recalibrate itself to TK000. After a 17 msec head settle time, SEEK COMPLETE will go true. Normal seek and read/write functions can now begin. Refer to Figure 3.

### **3.2 DRIVE SELECTION**

Drive selection occurs when an SA1000 Drive Select line is activated. Only the disk appropriately jumpered will respond to the input signals, and that drive's output signals are then valid.

### **3.3 TRACK ACCESSING**

Read/Write Head positioning is accomplished by:

- a. Activating the appropriate Drive Select Line.
- b. Deactivating Write Gate.
- c. Being in the READY condition with SEEK COMPLETE true.
- d. Selecting the appropriate Direction.
- e. Pulsing the Step Line.

Stepping can occur at either the Normal or 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 at a ramped stepping rate, to the stepper drivers.

Each pulse will cause the heads to move either 1 track in or 1 track out, depending on the level of the Direction In line. A high will cause an inward seek; a low will result in an outward seek toward TK000.

Head movement is initiated on the leading edge of the low going step pulse.

### 3.4 HEAD SELECTION

Any of the 4 possible heads can be selected by placing that head's binary address on the two head select lines.

### 3.5 READ OPERATION

Reading data from the disk is accomplished by:

- a. Activating the appropriate Drive Select Line.
- b. Assuring that the drive is Ready.
- c. Selecting the appropriate head.
- d. Inactivating the Write Gate Line.

Necessary timing relationships are shown in Figure 4.

### 3.6 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.
- d. Selecting the proper head.
- e. Activating Write Gate.
- f. Placing data on the Write Data line.

Necessary timing relationships are shown in Figure 4.

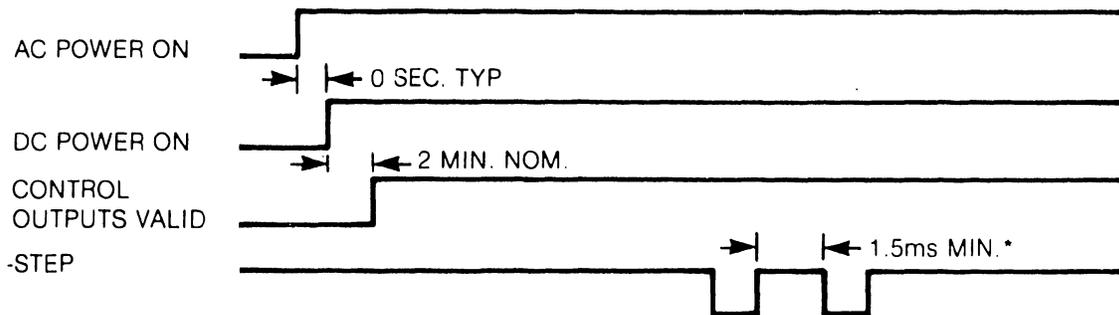


Figure 3 Power Sequencing

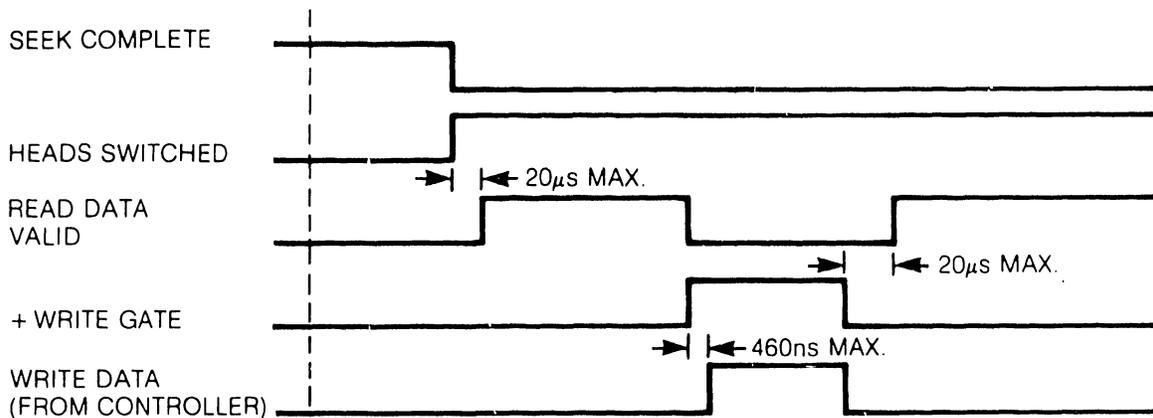


Figure 4 Read/Write Timing

**4**

**ELEC-  
TRICAL  
INTER-  
FACE**

## 4.0 ELECTRICAL INTERFACE

The interface of the SA1000 can be divided into three categories:

1. Signal
2. DC Power
3. AC Power

The following sections provide the electrical definition for each line.

### 4.1 SIGNAL INTERFACE

The signal interface consists of three categories:

1. Control Input lines
2. Control Output lines
3. 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 and clocking, either to or from the drive, via J2/P2.

**NOTE:** Refer to Figure 5. Those signal lines marked *SPARE* are uncommitted. They may be used as alternate lines to carry SA1000 signals if the user prefers to do his own modification. **Those signal lines marked NA are uncommitted for the SA1000, but are assigned for the SA850/851.** Therefore, these signals should not be used as alternate signals if a controller having an SA850/851 interface is used.

#### 4.1.1 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, HEAD SELECT  $2^0$  and  $2^1$ , WRITE GATE and REDUCED WRITE CURRENT. The signal which is intended to do the multiplexing is DRIVE SELECT 1, DRIVE SELECT 2, DRIVE SELECT 3, DRIVE SELECT 4.

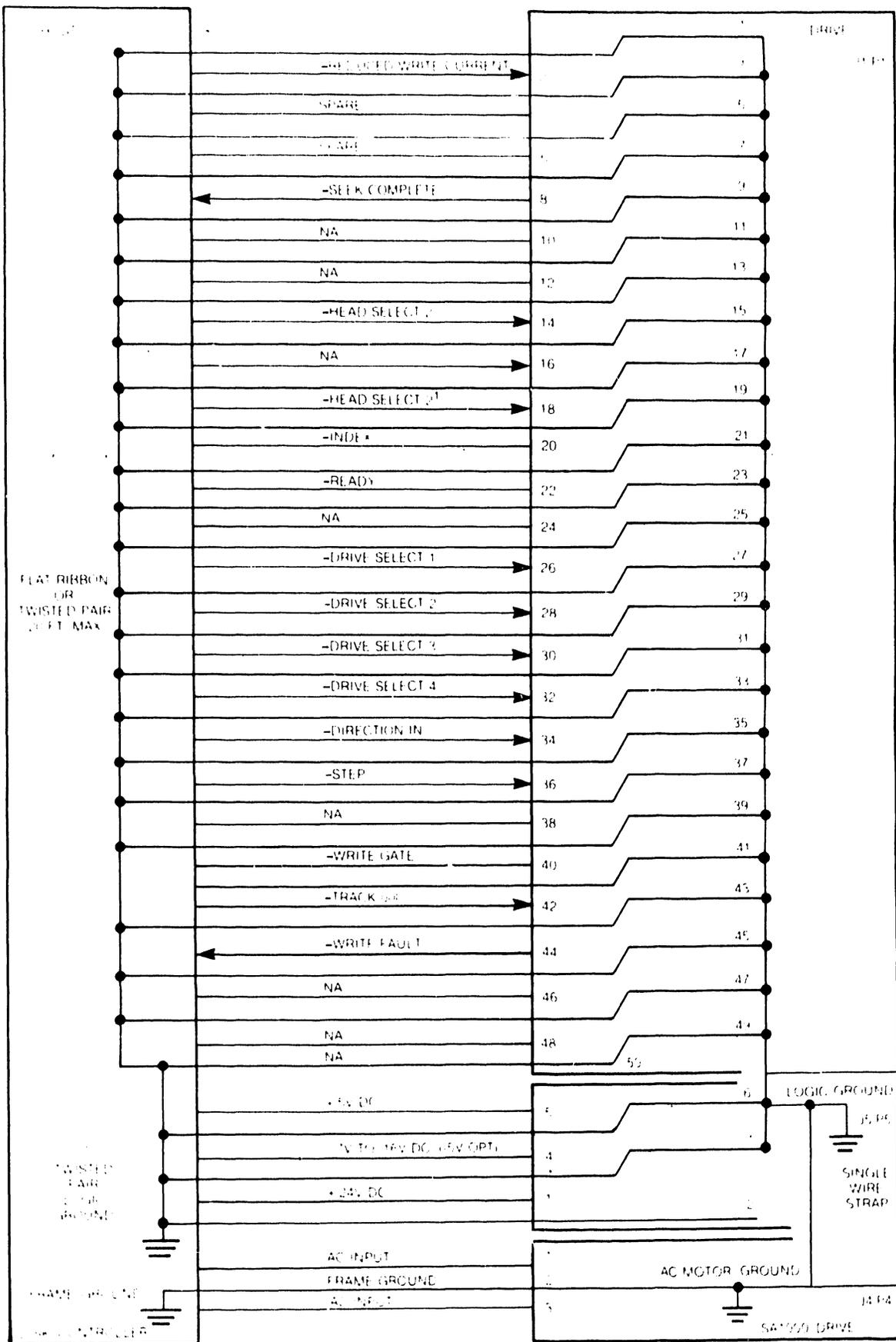
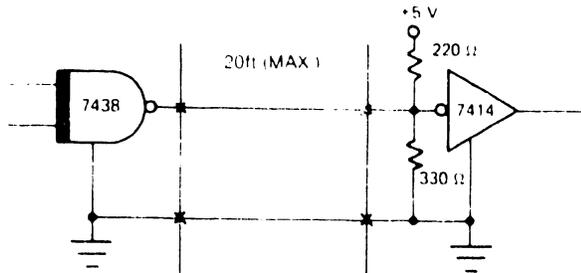


Figure 5 J1 Interface and Power Connections

The input lines have the following electrical specifications. Refer to Figure 6 for the recommended circuit

True = 0.0VDC to 0.4VDC @  $I_{in} = 40 \text{ ma(max)}$   
False = 2.5VDC to 5.25 VDC @  $I_{in} = 0 \text{ ma}$  (open)



**Figure 6 Control Input Driver/Receiver**

#### 4.1.1.1 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.

#### 4.1.1.2 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 one, 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 zero, 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 220/330 $\Omega$  resistor pack, located at IC location 8C, provides input line termination.

#### 4.1.1.3 STEP

This line causes the read/write heads to move in the direction as defined by the DIRECTION IN line. The motion is initiated at each logical zero to one transition (the trailing edge of the pulse). Any change in the DIRECTION IN line must be made at least 100 ns before the trailing edge of the step pulse. Stepping can be performed in either the Normal or Buffered mode:

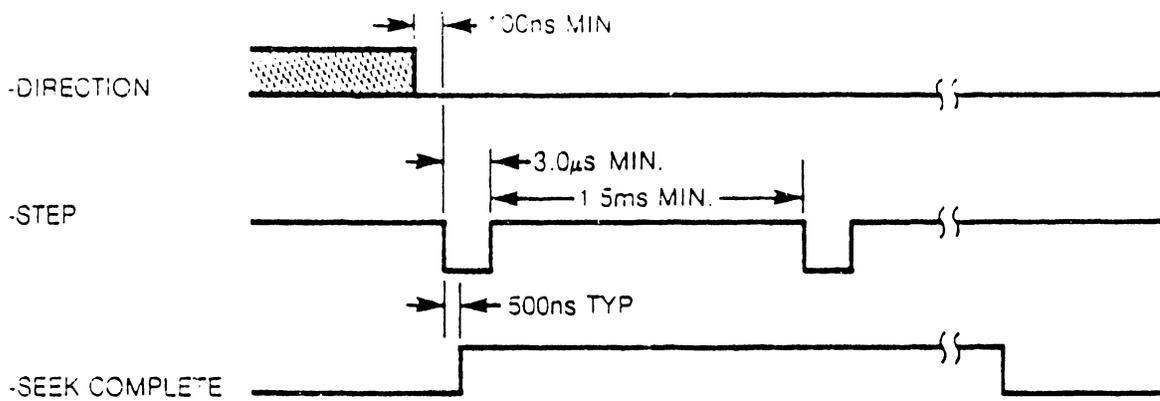


Figure 7 Normal Step Mode

- Normal Step Mode-In this mode, the read/write heads will move at the rate of the incoming step pulses. The minimum time between successive steps is 1.5ms, with a minimum pulse width of 3.0μs. Refer to Figure 7.
- 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 Section 4.1.2.5) will go true after the read/write heads settle at the cylinder. *This mode of operation is automatically selected when the time between step pulses is less than 200μsec.*

100 ns after the last step pulses have been sent to the drive, the DRIVE SELECT line may be dropped and a different drive selected.

The minimum time between steps is 3.0μs with a minimum pulse width of 200μs. (Refer to Figure 8).

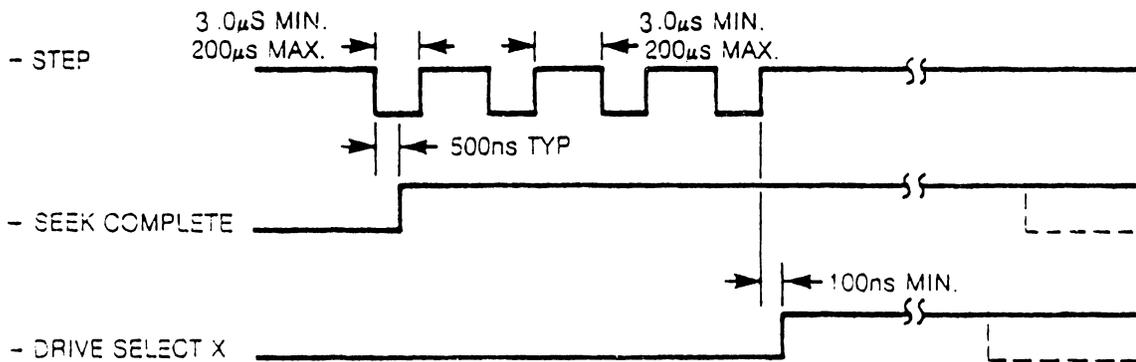


Figure 8 Buffered Step Mode

NOTES: 1. Step pulses with periods between 200 $\mu$ s and 1.5ms are not permitted. Seek accuracy is not guaranteed if this timing requirement is violated.

2. A 220/330 $\Omega$  resistor pack, located at IC location 8C, allows for Step line termination.

#### 4.1.1.4 HEAD SELECT 2<sup>0</sup> and 2<sup>1</sup>

These two lines provide for the selection of each individual read/write head in a binary coded sequence. HEAD SELECT 2<sup>0</sup> is the least significant line. When all HEAD SELECT lines are false, head 0 will be selected. Table 1 shows the HEAD SELECT SEQUENCE and model variations for the HEAD SELECT lines. (Refer to Figure 9 for the timing sequences).

A 220/330 $\Omega$  resistor pack, located at IC location 8C, allows for input line termination.

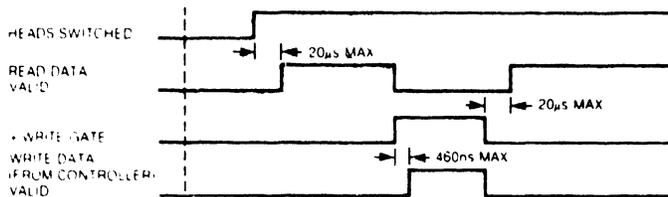


Figure 9 Head Selection Timing

#### 4.1.1.5 WRITE GATE

The active state of this signal (logical zero level) enables WRITE DATA to be written onto the disk. The inactive state of this signal (logical one level) enables data to be transferred from the drive and enables STEP pulses to reposition the head arm.

HEAD SELECT LINE		HEAD# SELECTED SA1002	HEAD# SELECTED SA1004
2	1		
0	0	0	0
0	1	1	1
1	0	-	2
1	1	-	3

Table 1. Head Select (0 = False, 1 = True)

A 220/330 $\Omega$  resistor pack, located at IC location 8C, allows for termination of this line.

#### 4.1.1.6 REDUCED WRITE CURRENT

When this interface signal is low (true) the lower value of Write Current is selected for writing on cylinders 128 through 255. When this signal is high (false), the higher value of Write Current is selected for writing on cylinders 0 through 127. A 220/330 $\Omega$  resistor pack, located at IC location 8C, allows for line termination.

#### 4.1.2 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 zero (true), with a maximum voltage of 0.4V measured at the driver. When the line driver is at logical one (false) the driver transistor is off and the collector cut off current is a maximum of 250 microamperes.

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

Figure 10 shows the recommended control signal driver/receiver combination.

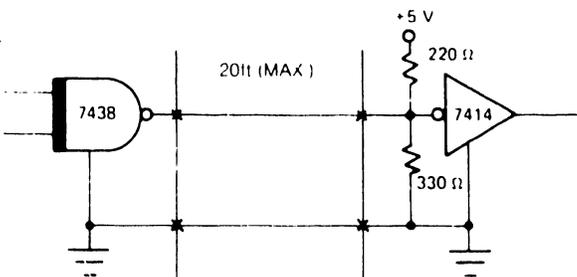


Figure 10 Control Output Driver/Receiver

##### 4.1.2.1 TRACK 000

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

#### 4.1.2.2 INDEX

The drive provides this interface signal once each revolution (19.2ms) to indicate the beginning of the track. Normally, this signal is a logical one and makes the transition to logical zero for a period of approximately  $10\mu\text{s}$  once each revolution. The leading edge of this pulse must be used for all timing requirements. Refer to Figure 11.

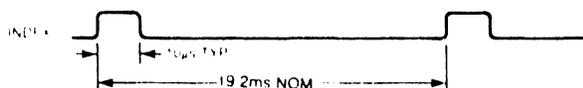


Figure 11 Index Timing

#### 4.1.2.3 READY

This interface signal (when true), 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, all writing to the disk and seeking is inhibited at the drive.

Ready will be true after the drive is  $95 \pm 2\%$  up to speed. The typical time for READY to become true after power on is 20 seconds.

#### 4.1.2.4 WRITE FAULT

This signal is used to indicate that a condition exists at the drive that could cause improper writing on the disk. A WRITE FAULT occurs whenever one of the two below listed conditions occur:

- WRITE CURRENT in the head without WRITE GATE active.
- Multiple heads selected.

Either of these two conditions will deselect all heads, thus preventing writing onto the disk. To reset the WRITE FAULT line, deselect the drive for at least 500 ns.

#### 4.1.2.5 SEEK COMPLETE

SEEK COMPLETE will go true 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.

SEEK COMPLETE will go false in two cases:

- A recalibration sequence is initiated (by the drive logic) at power on because the read/write heads are not over track zero.
- 500 NS typical, after the leading edge of a STEP pulse (or the first of a series of step pulses).

### 4.1.3 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 three pairs of balanced signals are: MFM WRITE DATA, MFM READ DATA, and TIMING CLOCK and are provided at the J2/P2 connectors on all drives. Figure 12 illustrates the driver/receiver combination.

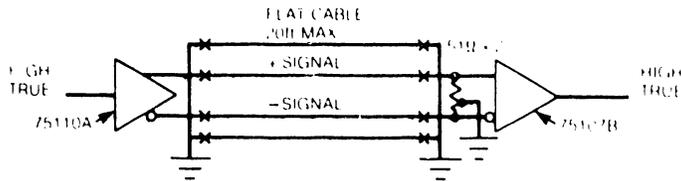


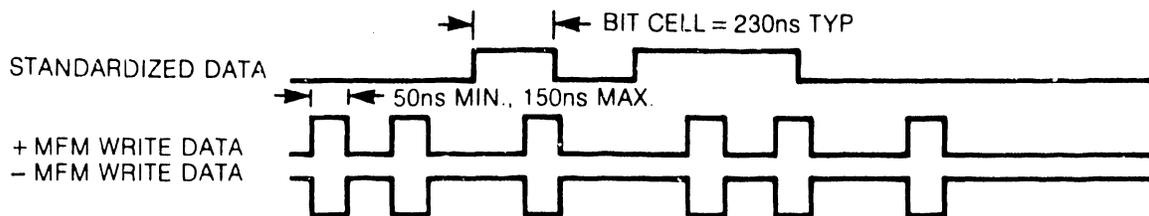
Figure 12 Data Transfer Line Driver/Receiver

#### 4.1.3.1 MFM WRITE DATA

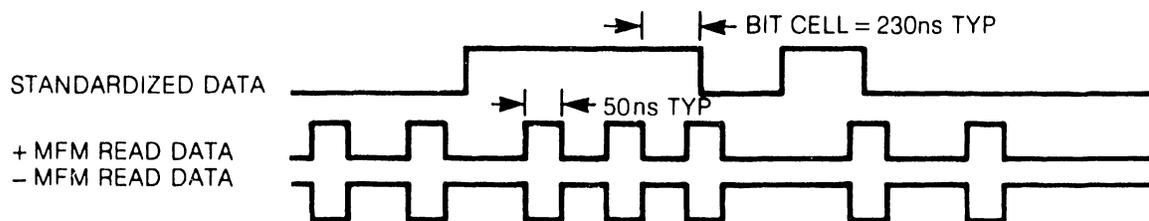
This pair defines the transitions (bits) to be written on disk. +MFM WRITE DATA going more positive than -MFM WRITE DATA will cause a flux reversal on the track under the selected head providing WRITE GATE is active. This signal must be driven to an inactive state (+MFM WRITE DATA more negative than -MFM WRITE DATA) by the host system when in the read mode. Figure 13 shows the timing for MFM WRITE DATA.

#### 4.1.3.2 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 line represents a flux reversal on the track of the selected head while WRITE GATE is inactive. Refer to Figure 14.



**Figure 13 MFM Write Data Timing**



**Figure 14 MFM Read Data Timing**

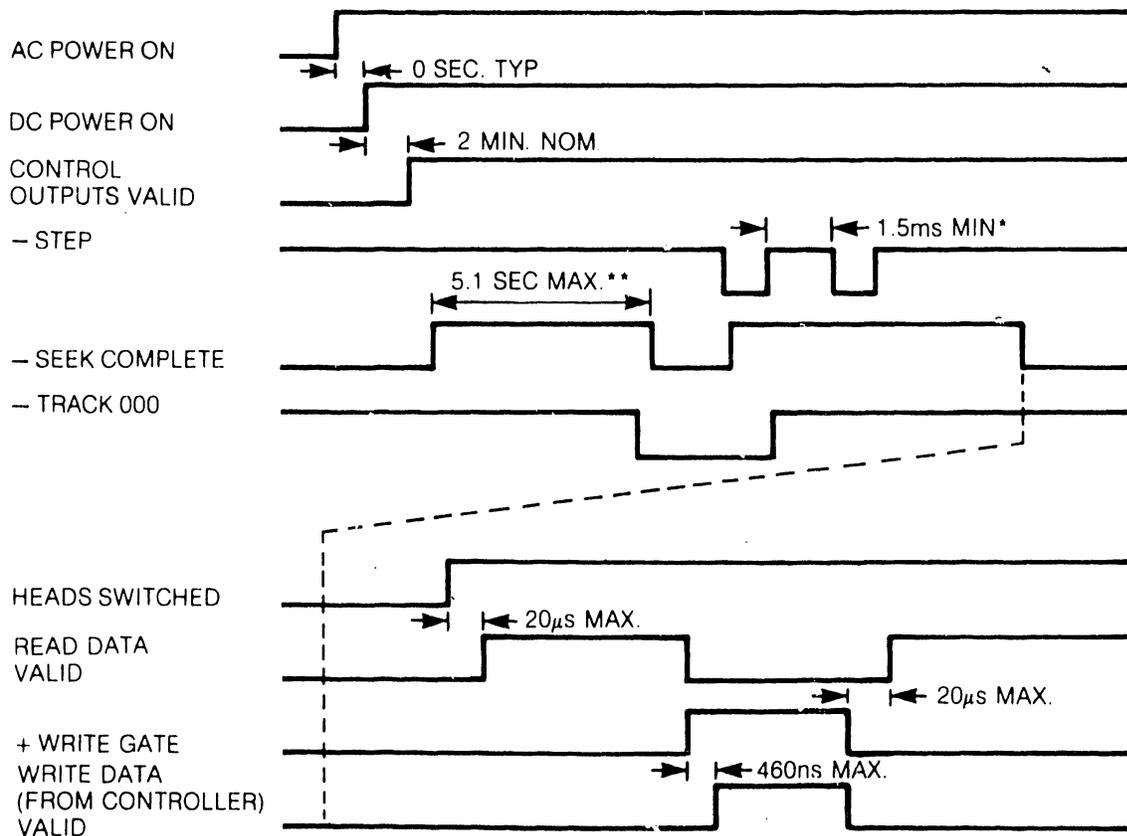
#### 4.1.3.3 TIMING CLOCK

This is a differential pair of clock signals (provided by the host) has a 50% (nominal) duty cycle and a  $3.6866 \mu\text{s} \pm .1\%$  period. The frequency of this clock is exactly 1/16 times the bit frequency for the standardized write data. Phase relationship between TIMING CLOCK and MFM WRITE DATA need not be maintained by the host for the SA1000 interface. The TIMING CLOCK is used by the drive logic for clocking and timing purposes.

#### 4.1.4 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 SELECTED line is driven by a TTL open collector driven as shown in Figure 10. 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 at the vicinity of J1, and the DRIVE SELECT X line at J1/P1 is activated by the host system.



\*FOR NORMAL STEP MODE  
 \*\*TIME FOR RECALIBRATION IS DEPENDENT ON POSITION OF RW HEADS AT AC AND DC POWER ON.

**Figure 15 General Control Timing Requirements**

**4.1.5 GENERAL TIMING REQUIREMENTS**

The timing diagram as shown in Figure 15 shows the necessary sequence of events (with associated timing restrictions) for proper operation of the drive.

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

- TIMING CLOCK is supplied to the drive (via J2/P2).
- STEP Input at J1/P1 is held inactive.
- Spindle is spinning at regular speed (if AC and DC are switched on at the same time, stepping action will not occur until spindle is up to speed).

CONN P4	60HZ		50HZ	
	110V (STANDARD)	203/230V	100V	220V
1	90-127V	180-253V	90-127V	180-253V
2	FRAME GND	FRAME GND	FRAME GND	FRAME GND
3	90-127V RTN	180-253V	90-127V RETURN	180-253V
MAX INRUSH CURRENT (3 SEC)	4.0A	TBS	TBS	TBS
MAX RUN CURRENT	1.0A	0.5A	1.1A	0.6A
FREQ TOL	± 0.5 HZ		± 0.5 HZ	

Table 2. AC Power Requirements

## 4.2 POWER INTERFACE

The SA1000 requires both AC and DC power for operation. The AC power is used for the drive motor and the DC power is used for the electronics and the stepper motor.

### 4.2.1 AC POWER

The AC power is via the connector J4 mounted at the center rear of the drive. Table 2 shows a listing of the AC power requirements.

### 4.2.2 DC POWER

DC power to the drive is via connector J3/P3 located on the solder side of the PCB. The three DC voltages and their specifications along with their J3/P3 pin designations, are outlined in Table 3.

**NOTE:** The SA1000 is shipped with DC (base casting) and AC ground (drive motor) connected together with a ground strap located on the drive motor. If the system configuration requires the separation of these grounds, remove the strap.

DC VOLTAGE	CURRENT			
	STEADY STATE		STEPPING	
	MAX.	TYP	MAX.	TYP
+24 ± 2.4V 1V P-P MAX. Ripple	0.25A	0.20A	3.3A	2.8A
+5 ± 0.25V 50mV P-P MAX. Ripple	4.1A	3.6A	2.5A	2.0A
-7 TO -16V (-5 ± 0.25V OPT) 50mV P-P MAX. Ripple	0.25A	0.20A	0.25A	0.20A

Table 3 DC Power Requirements

**5**

**PHYSI-  
CAL  
INTER-  
FACE**

## 5.0 PHYSICAL INTERFACE

The electrical interface between the SA4000 and the host system is via four 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; the third connector, J3, provides DC power; and the fourth connector, J4, provides AC power and frame ground. Refer to Figure 16 for the connector locations.

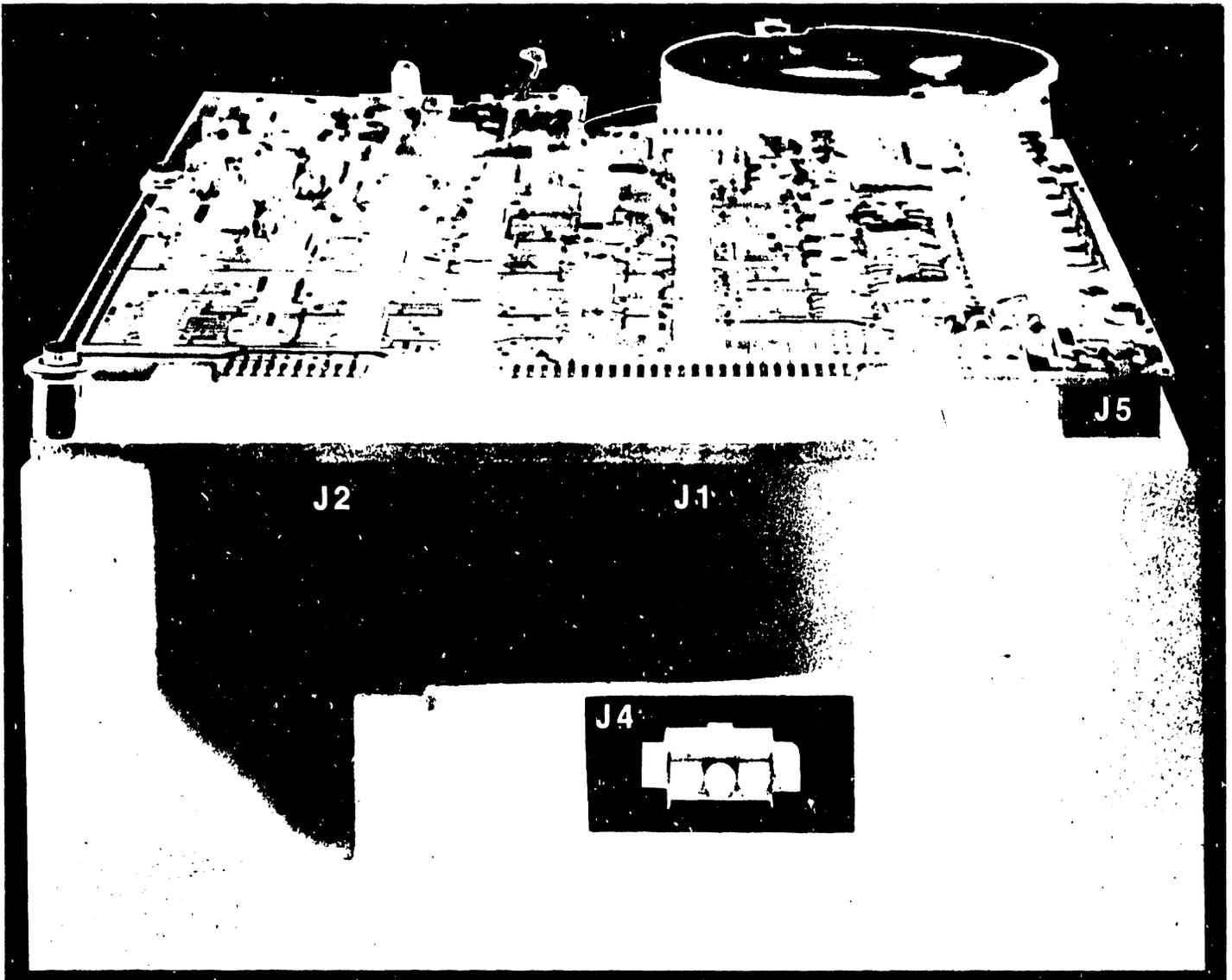


Figure 16 Connector Locations

### 5.1 J1/P1 CONNECTOR

Connection to J1 is through a 50 pin PCB edge connector. The dimensions for this connector are shown in Figure 17. The pins are numbered 1 through 50 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 on the end of the PCB connector closest to the AC connector and is labeled. A Key Slot is provided between pins 6 and 8. The *recommended mating connector* for P1 is Scotchflex ribbon connector P/N 3415-0001 or AMP Thinleaf printed circuit connector P/N 1-583717-1 utilizing AMP contacts P/N 583616-1.

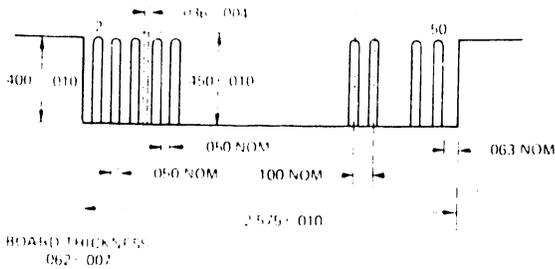


Figure 17 J1 Connector Dimensions

### 5.2 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 or AMP P/N 583717-1 with AMP contacts P/N 1-583616-1. Figure 18 shows the dimensions for the connector.

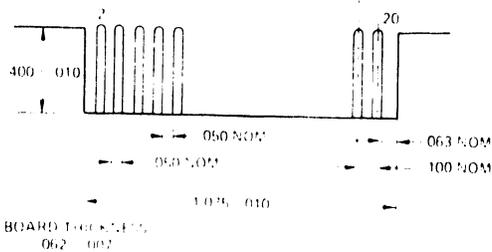


Figure 18 J2 Connector Locations

### 5.3 J3/P3

The DC power connector, J3, is a 6 pin AMP Mate-N-Lok connector P/N 1-380999-0, mounted on the component side of the Driver/Actuator PCB. The *recommended mating connector*, P3, is an AMP P/N 1-480270-0 utilizing AMP pins P/N 60619-1. The J3 pins are labeled on the connector. Refer to Figure 19.

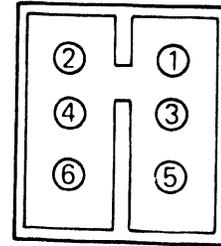


Figure 19 J3 Connector

### 5.4 J4/P4

AC power and frame ground are interfaced through a 3 pin connector, J4, located on the PCB side of the drive near the AC motor capacitor. The AMP part number for J4 is 1-480701-0 with pins AMP P/N 35087-1 and 350654-1 (ground pin), refer to Figure 20. The *recommended mating connector*, P4, is AMP socket P/N 1-480700-0 with AMP pins P/N 350536-1.

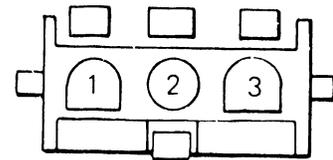
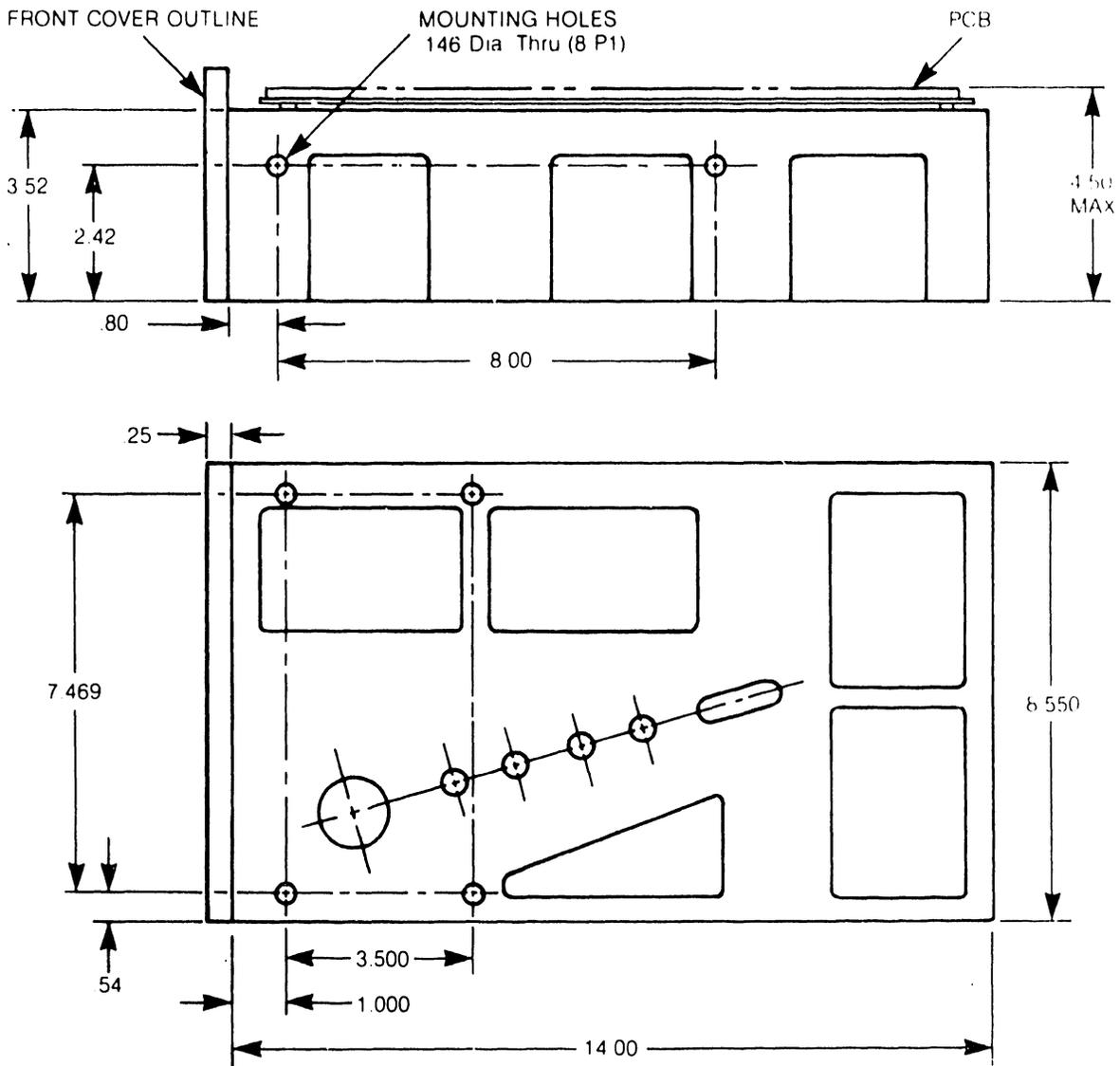


Figure 20 J4 Connector

**6**

**PHYSI-  
CAL  
SPECIFI-  
CATIONS**

All dimensions in inches



SA1000 MECHANICAL OUTLINE  
BOTTOM AND SIDE VIEW (RACK MOUNT)

**Figure 21 Drive Physical Dimensions**

## 6.0 PHYSICAL SPECIFICATIONS

This section describes the mechanical dimensions and mounting recommendations for the SA1000. Refer to Figure 21 for the dimensions.

The SA1000 is capable of being mounted in either one of the following positions

- Vertical -
- Horizontal - PCB Up.



**7**

**MEDIA  
DEFECT  
&  
ERRORS**

## **7.0 MEDIA DEFECT & ERRORS**

### **Introduction**

In high density digital recording storage systems it is necessary to increase the reliability or improve the operational performance 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 which are drop outs (absent bits) or shifted bits from their nominal position more than the data separator can tolerate them to shift. These errors are due to defects in the media as well as signal to noise ratio contributing to probability of error occurrence. The error rate is dependent upon noise and phase characteristics of media, Read/Write circuits, head and mispositioning of actuator.

### **What Is The Definition Of An Error?**

An error is any discrepancy between a recovered data and true correct recorded data. There can be an extra bit or a missing bit, i.e., a "zero" can be transformed into "one" or a "one" can be changed to zero. Errors can be classified into soft or hard errors. Soft errors are generally related to signal to noise ratio of the system and represent marginal conditions of head, media, and Read/Write circuits.

If an error is repeatable with a high probability, it is due to media defect and is termed a hard error. Some hard errors may be ignored if they reside in unused area of the format.

For those areas that contain media defects, alternate track/sector areas must be allocated or the area can simply be avoided. Media defects are addressed per level of controller and software sophistication, i.e., skip and/or reassignment or bad sector(s), or skip and/or reassignment of bad tracks(s).

### **How Will Shugart Find the Errors?**

The errors will be identified prior to shipment and information incorporated in a usable format to enable the user to skip those defective locations per his system capability. Shugart has a unique

media test system which exercises the drive in extreme marginal conditions and measure the amplitude and phase distortion of each bit recorded on the disk storage. Thus, drives shipped will be accompanied by an error map reporting any media defects.

### **Error Reporting**

A map will be provided with each drive showing defective bytes as a location from index identified by cylinder and head address. Additionally, an error free track at track 0 for each head will be guaranteed.

### **Error Acceptance Criteria**

There will be no more than 12 tracks with defects per head of which no more than 4 tracks will contain multiple defects.

A single defect is defined as an error less than 2 bytes long. A multiple defect is defined as an error greater than 2 bytes long, or a single error in several sectors.

As the defects are on an unformatted drive, the affected location may fall on an unused area when in the customer's optional format.

**8**

**SA1000**

**TRACK**

**FORMAT**

## **8.0 SA1000 TRACK FORMAT**

The purpose of a format is to organize a data track into smaller, sequentially numbered, blocks of data called sectors. The SA1000 format is a soft sectored type which means that the beginning of each sector is defined by a prewritten identification (I.D.) field which contains the physical sector address, plus cylinder and head information. The I.D. field is then followed by a user data field.

The soft sectored format is a slightly modified version of the I.B.M. system 34 double density, which is commonly used on 8 inch floppy disk drives. The encoding method used here is modified frequency modulation (MFM).

In the example shown (Figure 21), each track is divided into 32 sectors. Each sector has an adjacent data field of 256 bytes in length.

The beginning of both the I.D. field and the data field are flagged by unique characters called address marks.

An address mark is 2 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 I.D. address mark, or an "F8" which is a data address mark pattern.

The "A1" pattern is made unique by violating the encode rules of MFM by omitting one clock bit. This makes the address mark pattern unique to any other serial bit combination.

Each I.D. and data field 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 I.D. and data field are gaps called Interrecord gaps.

### **8.1 GAP LENGTH CALCULATIONS**

#### **8.1.1 GAP 1**

Gap 1's purpose 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 11 bytes long which corresponds to the head switching time of 20 microseconds. Gap 1 is immediately followed by a sync field for the I.D. field of the first sector.

### 8.1.2 GAP 2

Following the I.D. field, and separating the I.D. 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.

### 8.1.3 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 3% slower than nominal, then write updated with the disk running 3% faster than nominal (power line variations).

Gap 3 should be at least 15 bytes in length.

### 8.1.4 GAP 4

Gap 4 is a speed tolerance buffer for the entire track. This allows the disk to rotate at least 3% faster than normal without overflowing the track during the format operation. The format operation which writes the I.D. fields, begins with the first encountered index and continues to the next index.

## 8.2 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 of 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 be done 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 number greater than 128.

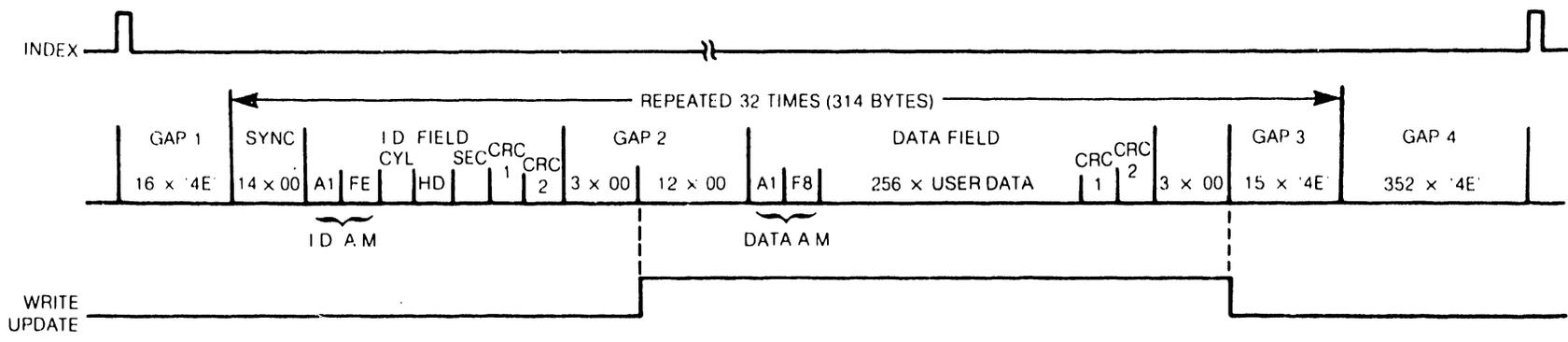
The optimum amount of pre-compensation for the SA1000 is 10 nanoseconds for both early and late written bits.

TABLE 4 shows various bit patterns for pre-compensation.

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

Precompensation Pattern Detection bits are shifted through a 4 bit shift register. Bit is written out of the the third position.

TABLE IV

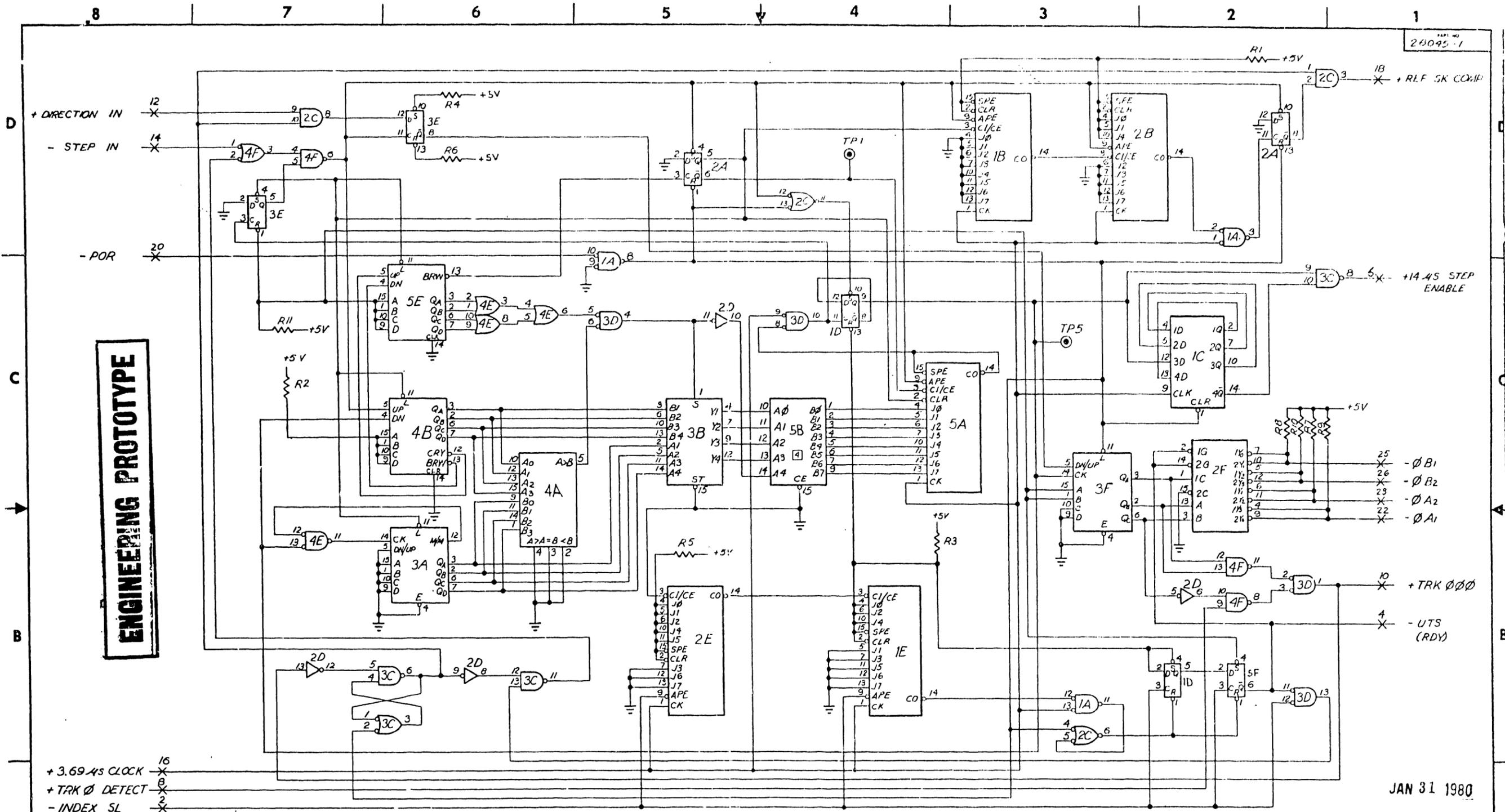


NOTES:

1. NOMINAL TRACK CAPACITY - 10416 BYTES.
2. MINIMUM TRACK CAPACITY - (NOMINAL - 3% SPEED VARIANCE) 10102 BYTES.
3. WRITE TO READ RECOVERY TIME = 20 MICROSECONDS.
4. HEAD SWITCHING TIME = 20 MICROSECONDS.

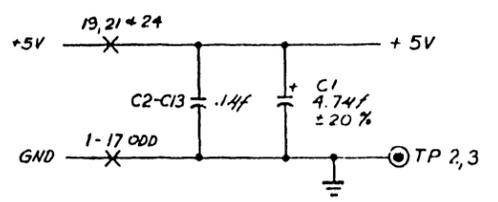
Figure 22 Track Format

**ENGINEERING PROTOTYPE**



+ 3.6945 CLOCK 16  
 + TRK Ø DETECT 8  
 - INDEX SL 2

JAN 31 1980



REFERENCE DESIGNATION	TYPE	POSITION	UNUSED ELEMENTS	VCC (PIN)	GRD (PIN)
C13					
R11					
TP5					

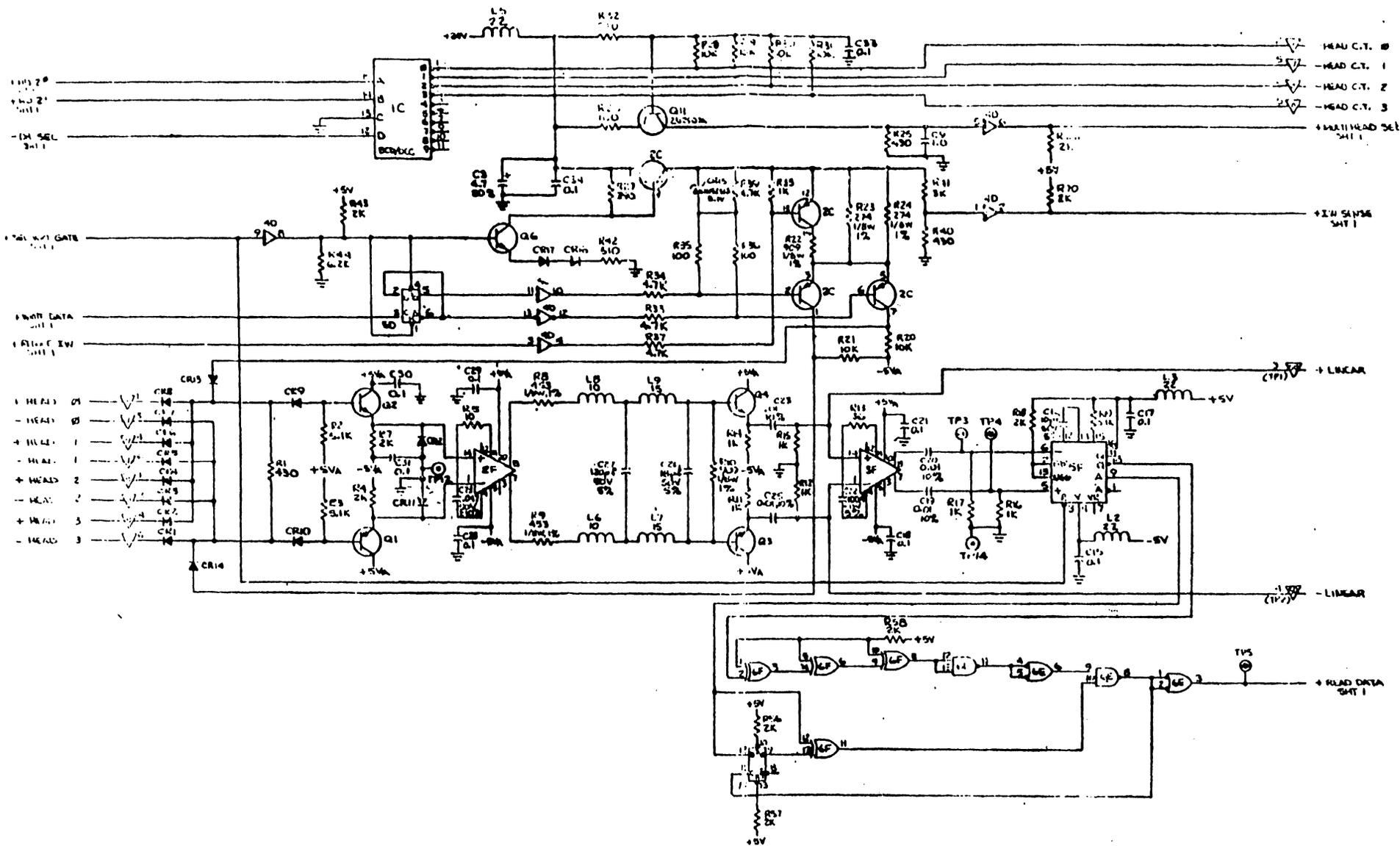
REFERENCE DESIGNATION	LAST USED	NOT USED
C13		
R11		
TP5		

NOTES:  
 UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTOR VALUES ARE 2K OHMS.  
 2. ALL CAPACITORS ARE AXIAL LEAD, 0.1µF, 50V, ±20%.  
 3. 74 LS SERIES IC'S MAY BE USED.  
 [X] IC, PROM, RAMP CNTL.

FEB 15 1980  
 CHECK & VERIFIED

MUST CONFORM TO ENGINEERING SPEC ES 30000-0		CD HISTORY		SHUBERT ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	NO
CASE DEPTH	LINEAR ±XX			DIAGRAM	
HARDNESS	ANGULAR ±XX			STEPPER LOGIC (CA 1000)	
SURFACE TREATMENT	FINISH ±XX			RELEASED FOR ASSEMBLY	
	SCALE			SHEET 1 OF 1	
				SCALE	
				PART NO	
				28095-1	





SHUGART ASSOCIATES  
 SCHEMATIC DIAGRAM  
 SA 1000 CONTROL (sheet 2 of 3)



**PSN**

**III A12-1**

# PRODUCT SERVICE NOTICE

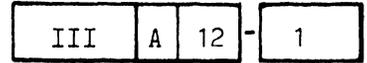
DATE : 1/19/81

CLASSIFICATION PERIPHERALS

CATEGORY DISK DRIVES

PRODUCT/APPL. SHUGART SA1000 WINCHESTER DRIVES

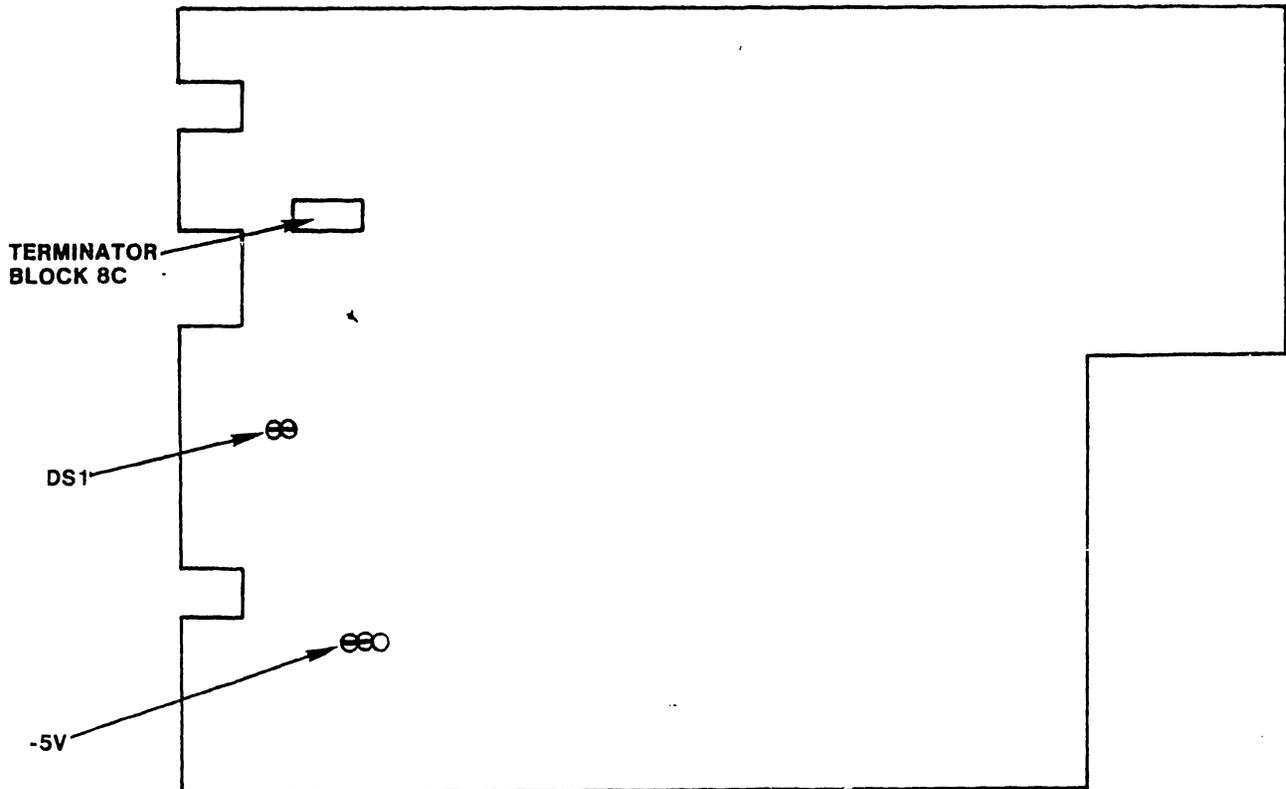
SEQUENCE # 1



TITLE:

2200LVP/SVP APPLICATIONS:  
CIRCUIT BOARD JUMPER CONFIGURATION

For operation with 2200LVP/SVP systems, jumper plugs (WL# 350-4506) must be installed at two locations on the Control circuit board. These jumper locations are referred to as DS1 and -5V (see figure). Also, a terminator block must be installed at location 8C (see figure).

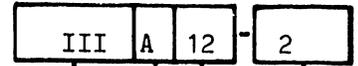


**PSN**

**III A12-2**

# PRODUCT SERVICE NOTICE

DATE : 07/24/81



CLASSIFICATION PERIPHERALS

CATEGORY DISK DRIVES

PRODUCT/APPL. SHUGART SA1000

SEQUENCE # 2

TITLE:

SHUGART SA1000 FIXED DISK DRIVE DAMPER REPLACEMENT

## PURPOSE

Certain Shugart SA1000 Fixed Disk Drives used in Wang Systems may contain dampers having defective seals that result in damper fluid leakage. This PSN provides instructions to identify and replace those dampers.

## URGENCY

Perform the following procedures on a "next service call" basis.

## DAMPER IDENTIFICATION

At present, three types of dampers are installed in Shugart SA1000 Fixed Disk Drives used in Wang system installations. Each type is identified by a specific "CAUTION" label as follows:

TRANSPARENT LABEL: This identifies a new damper (with a new design seal) that does not have to be replaced.

YELLOW LABEL WITH COLORED DOT IN CENTER: This is a remanufactured damper with the new design seal, and does not have to be replaced.

YELLOW LABEL: This damper contains the old design seal. It must be removed and replaced with a new damper having a transparent label.



## REMOVAL OF DISK DRIVE FOR DAMPER REPLACEMENT

Do not perform this procedure at the customer site; instead, bring the defective drive to the Wang Service Office (Branch, Area, or District). Make arrangements beforehand with the customer to schedule drive removal, installation of a "loaner" if necessary, or full swapout of the defective drive with a modified one.

### ITEMS REQUIRED

The following items are required in the performance of this procedure:

1. Damper Assembly (P/N 726-1927)
2. Allen wrench (0.05 in.)
3. Screwdriver (medium blade)
4. Wiping cloth
5. Damper Spacing Tool, 0.01-inch (P/N 726-9750) or feeler gage.

### DAMPER REMOVAL PROCEDURE

#### CAUTION

DO NOT TOUCH DAMPER OR ALLOW IT TO BE MOVED  
WITHOUT APPLICATION OF AC MOTOR POWER AND DC  
POWER TO DISK DRIVE, OTHERWISE READ/WRITE  
HEAD DAMAGE MAY RESULT.

1. Remove the three screws that secure the small printed circuit board to the disk-drive chassis. Do not disconnect the board; just move it out of the way enough to provide access to damper assembly.
2. Apply motor ac power and circuit dc power to disk drive.
3. Position damper to provide access to filler screw (figure 1). Since the motor is energized, some resistance will be felt approximately every 1/8-inch of motor rotation while turning damper.
4. Remove filler screw (and rubber seal) from damper using 0.05-inch Allen wrench.
5. Hold track 000 clamp steady and rotate damper until Allen screws are positioned as shown in figure 2.
6. Slowly turn damper until filler hole is lined up with one of the Allen screws (NOTE - old style dampers have two Allen screws).
7. Insert 0.05-inch Allen wrench through filler hole into Allen screw. Loosen Allen screw and remove wrench.
8. On old style dampers, slowly turn damper to line up second Allen screw, insert wrench, loosen screw, and remove wrench.

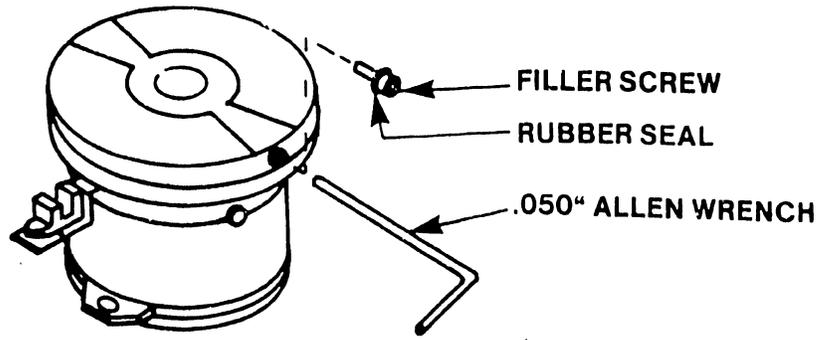


FIGURE 1. DAMPER REMOVAL

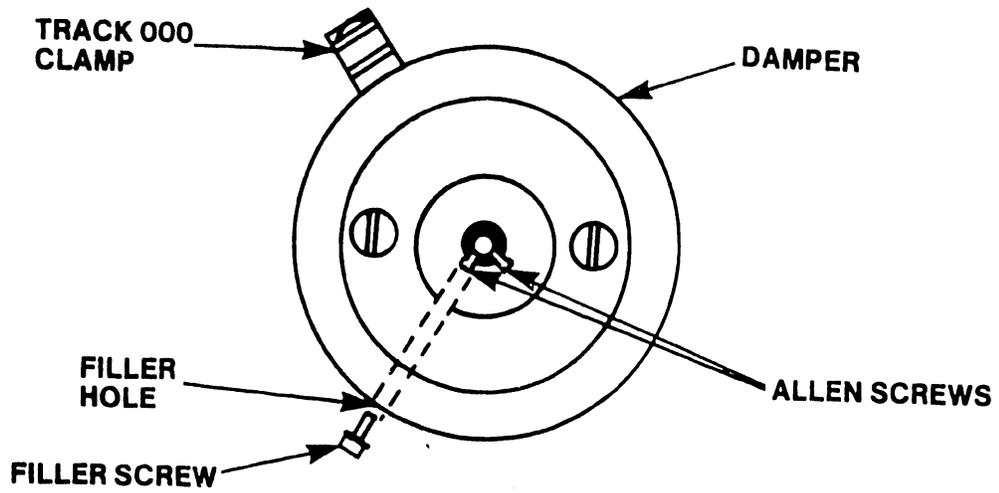


FIGURE 2 ALLEN SCREW LOCATIONS

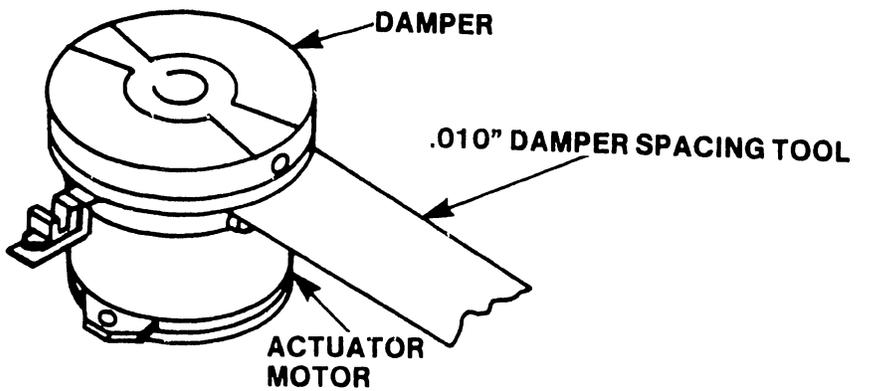


FIGURE 3. DAMPER INSTALLATION

9. Gently remove old damper assembly by lifting upwards.

NOTE

KEEP THE DAMPER ASSEMBLY UPRIGHT  
AT ALL TIMES TO PREVENT FLUID LOSS

10. Make sure old seal is also removed from stepper motor shaft along with old damper. Wipe stepper shaft clean of any remaining fluid.
11. Re-install filler screw (and rubber seal) into old damper. Carefully package and return old damper to:

WANG Laboratories Inc.  
RDB 3933  
437 S. Union Street  
Lawrence, MA 01843

NEW DAMPER INSTALLATION PROCEDURE

1. Remove filler screw (and rubber seal) from new damper.
2. Insert Allen wrench through cover screw hole and loosen screw just enough to slide new damper onto stepper motor shaft.
3. Place damper spacing tool (or 0.01-inch feeler gage) between damper and track 000 clamp (figure 3). Slide damper up against tool and tighten Allen screw.
4. Reinstall filler screw (and rubber seal).
5. Remove spacing tool and wipe damper clean.
6. Turn off ac power and re-install printed circuit board.

**PSN**

**III A12-3**

# PRODUCT SERVICE NOTICE

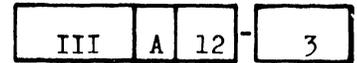
DATE : 1/14/82

CLASSIFICATION PERHIPERALS

CATEGORY DISK DRIVES

PRODUCT/APPL. SHUGART SA1000 WINCHESTER DRIVES

SEQUENCE # 3



TITLE:

SHUGART SA1000 DISK DRIVE OPTIONS JUMPERS

Some SA1000 "Winchester" disk drives are being received at the Lawrence stock room from Shugart Associates with the options jumpers installed incorrectly. These jumpers are on the 26051 Control PCB (WLI #726-1907). It is vital that these options jumpers be verified when a replacement drive is installed in the field. Remove or install the jumpers as described below. Refer to Figure 1 for jumper locations.

1. Fault - When removed, enables the Fault Detection logic. This jumper should be REMOVED.
2. Ready - When removed, enables the Ready signal at the interface. This jumper should be REMOVED.
3. Drive Selection - Selects the disk drive number 1 through 4. INSTALL this jumper for the correct drive number as shown in figure 2.
4. Interface Voltage Selection - Selects the correct interface voltage. INSTALL this jumper for the -5 Volt dc configuration for Wang systems as shown in figure 3.

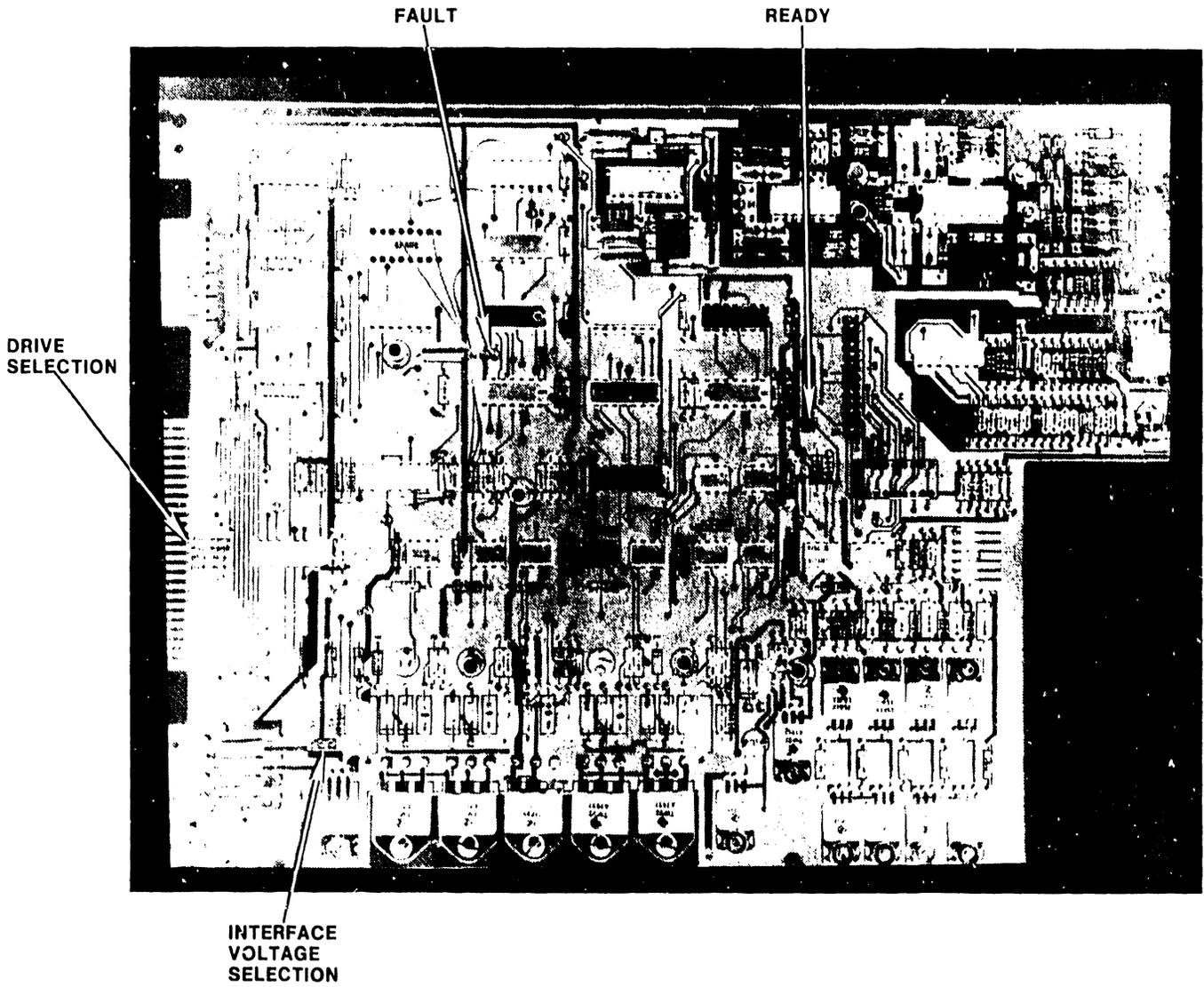


FIGURE 1  
26051 CONTROL BOARD

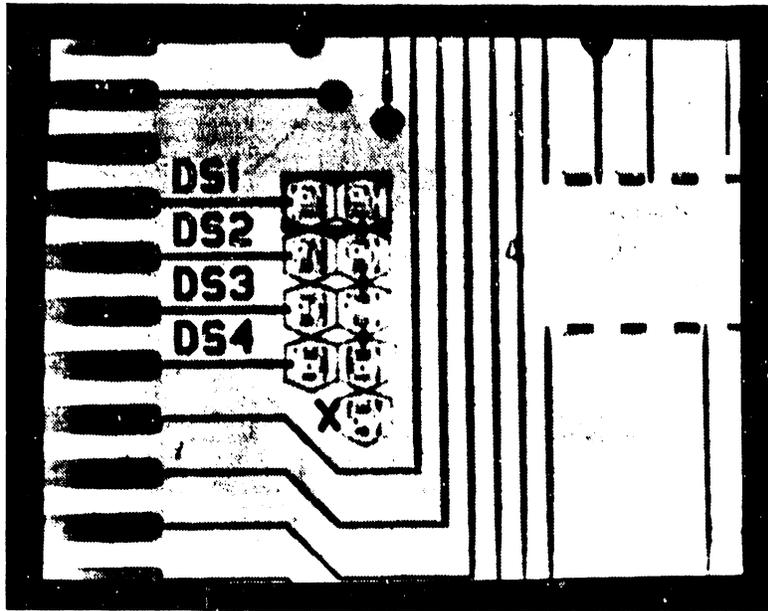


FIGURE 2  
DRIVE SELECTION (DS1-4)

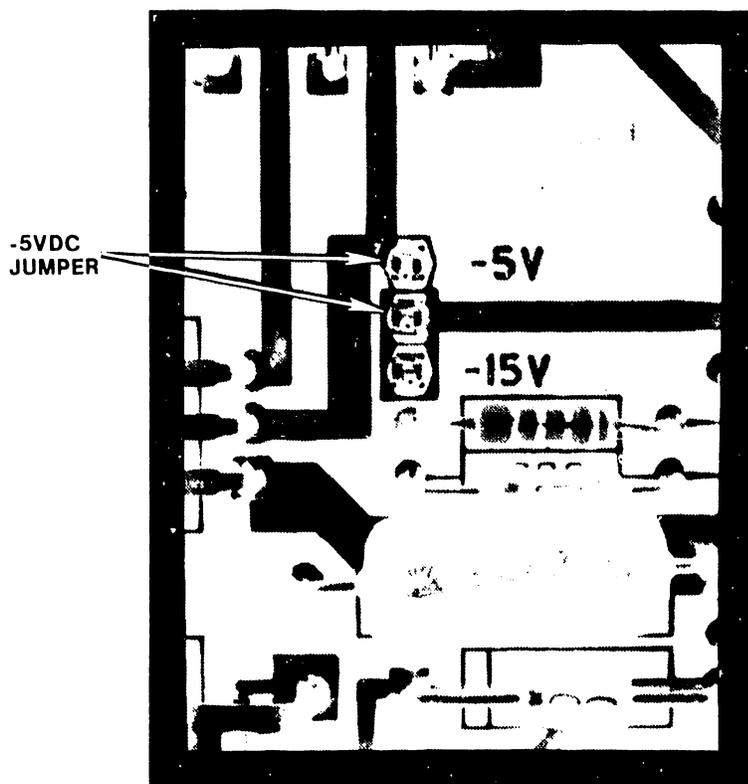


FIGURE 3  
-5 VOLT INTERFACE VOLTAGE SELECTION

**END**