

SA400L
Minifloppy™
Diskette Storage Drive

OEM Manual

Shugart

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ABBREVIATIONS/MNEMONICS

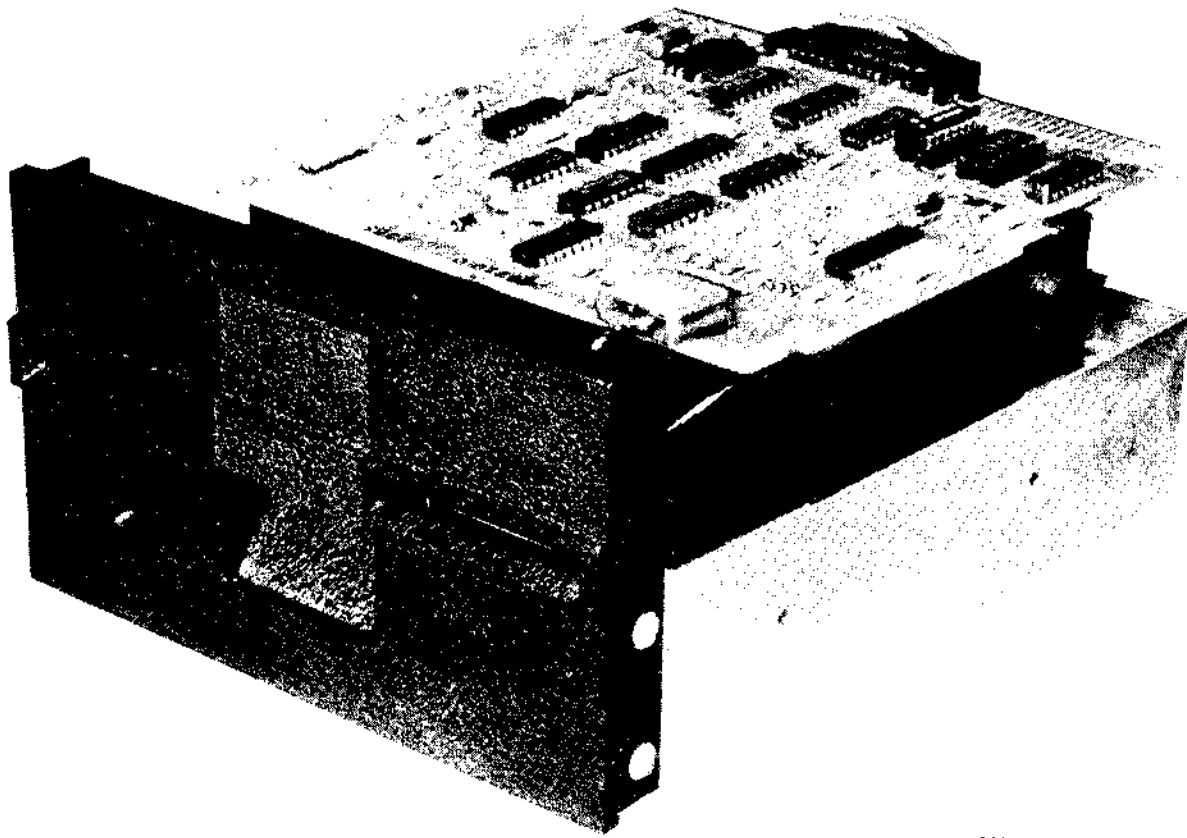
AM	Address Mark	MFM	Modified FM
bpi	Bits Per Inch	MTBF	Mean Time Between Failures
CRC	Cyclic Redundancy Check	MTTR	Mean Time to Repair
fci	Flux Changes Per Inch	PCB	Printed Circuit Board
FM	Frequency Modulation	PM	Preventive Maintenance
GND	Ground	POH	Power On Hours
ID	Identification	TRK	Track
LED	Light Emitting Diode	WG OFF	Write Gate Off

ABOUT THIS MANUAL

This manual supersedes manual P/N 39019-0 dated 11/80 and incorporates Publication Change Notice #1. All previous editions of this manual may be discarded.

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 on the form at the back of this manual to:

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FIGURE 1-1. SA400L MINIFLOPPY™ DISKETTE DRIVE

SECTION I INTRODUCTION

1.1 GENERAL DESCRIPTION

The SA400L Minifloppy™ drive offers the system designer the random access storage capacity of floppy disk drives in a package the size of most cassette tape units. It also provides superior data integrity and faster throughput of data when compared with cassette drives.

The SA400L is based on the proven floppy disk drive technology of the Shugart SA800 drive. It features a unique direct drive stepping motor actuator utilizing a spiral cam with a V-groove positive detent which assures precise location of the read/write head on a track. The drive employs the same proprietary glass-bonded ferrite/ceramic read/write head as the SA800. AC power requirements have been eliminated through the use of a dc servo-controlled spindle drive motor. The drive comes equipped with an interface which allows upward expansion of the units within the system and future system enhancements with the large floppy drive.

Applications for the minifloppy drive include word processing and text editing systems, mini and micro computer program storage, power typing systems, "intelligent" desktop calculators, and the microcomputer hobby market.

The SA104/105/107 Minidiskette™ media used with the SA400L is similar to the standard flexible disk, only smaller. It is available for soft (SA104) or hard (SA105/107) sectored formats. The minidiskette diameter is 5.125 inches (130.2 mm) and the jacket is a square 5.25 inches (133.4 mm).

1.2 SPECIFICATION SUMMARY

1.2.1 Performance Specifications

	Single Density (FM)	Double Density (MFM)
Capacity (in Bytes)		
Unformatted (Per Disk)		
35 Track	109,375	218,750
40 Track	125,000	250,000
Formatted (16 Records/Track)		
Per Disk		
35 Track	71,680	143,360
40 Track	81,920	163,840
Per Track	2,048	4,096
Per Sector	128	256
Formatted (10 Records/Track)		
Per Disk		
35 Track	89,600	179,200
40 Track	102,400	204,800
Per Track	2,560	5,120
Per Sector	256	512
Transfer Rate	125 K bytes/sec	250 K bytes/sec
Latency (avg.)	100 ms	
Access Time		
Track-to-Track	20 ms	
Average		
35 Track	248 ms	
40 Track	275 ms	
Settling Time	20 ms	

1.2.2 Functional Specifications

	Single Density (FM)	Double Density (MFM)
Rotational Speed	300 rpm	300 rpm
Recording Density		
35 Track	2581 bpi	5162 bpi
40 Track	2768 bpi	5536 bpi
Flux Density		
35 Track	5162 fci	5162 fci
40 Track	5536 fci	5536 fci
Track Density	48 tpi	48 tpi
Media Requirements		
SA104 (soft-sectored)		
SA105 (16 sectors, hard-sectored)		
SA107 (10 sectors, hard-sectored)		

Industry standard flexible diskette
 Oxide on 0.003 in. (0.08 mm) Mylar
 5.25 in. (133.4 mm) square jacket

1.2.3 Physical Specifications

Environmental Specifications	Operating	Shipping	Storage
Ambient Temperature	50° to 115°F (10° to 46.1°C)	-40° to 144°F (-40° to 62.2°C)	-8° to 117°F (-22.2° to 47.2°C)
Relative Humidity	20 to 80%	1 to 95%	1 to 95%
Maximum Wet Bulb	85° F (29.4°C)	No Condensation	No Condensation

DC Voltage Requirements
 +12 V ± 5% @ 1.80 A Maximum, 0.9 A Typical
 +5 V ± 5% @ 0.70 A Maximum, 0.5 A Typical

Mechanical Dimensions (exclusive of front panel)
 Width = 5.75 in. (146.1 mm)
 Height = 3.25 in. (82.6 mm)
 Depth = 8.0 in. (203.2 mm) Nominal
 Weight = 3 lbs. (1.36 kg) Nominal

Power Dissipation
 13.3 Watts (45.3 BTU/hr) Continuous (typical)
 7.3 Watts (24.9 BTU/hr) Standby (typical)

1.2.4 Reliability Specifications

MTBF: 8000 POH under typical usage
 PM: Not Required
 MTTR: 30 minutes

Error Rates:
 Soft Read Errors: 1 per 10⁹ bits read
 Hard Read Errors: 1 per 10¹² bits read
 Seek Errors: 1 per 10⁶ seeks

Media Life:
 Passes per Track: 3.0 x 10⁶
 Insertions: 30,000 +

1.3 FUNCTIONAL CHARACTERISTICS

1.3.1 General Operation

The SA400L Minidiskette Storage Drive consists of read/write, control and drive motor electronics, drive mechanism, read/write head and track positioning mechanism. These components perform the following functions:

- Interpret and generate control signals.
- Move the read/write head to the desired track.
- Read and write data.
- Control drive motor speed.

The interface signals and the relationship of the signals to the internal functions are shown in figure 1-2.

The head positioning actuator positions the read/write head to the desired track on the minidiskette. The head load actuator loads the minidiskette against the read/write head and data may then be recorded or read.

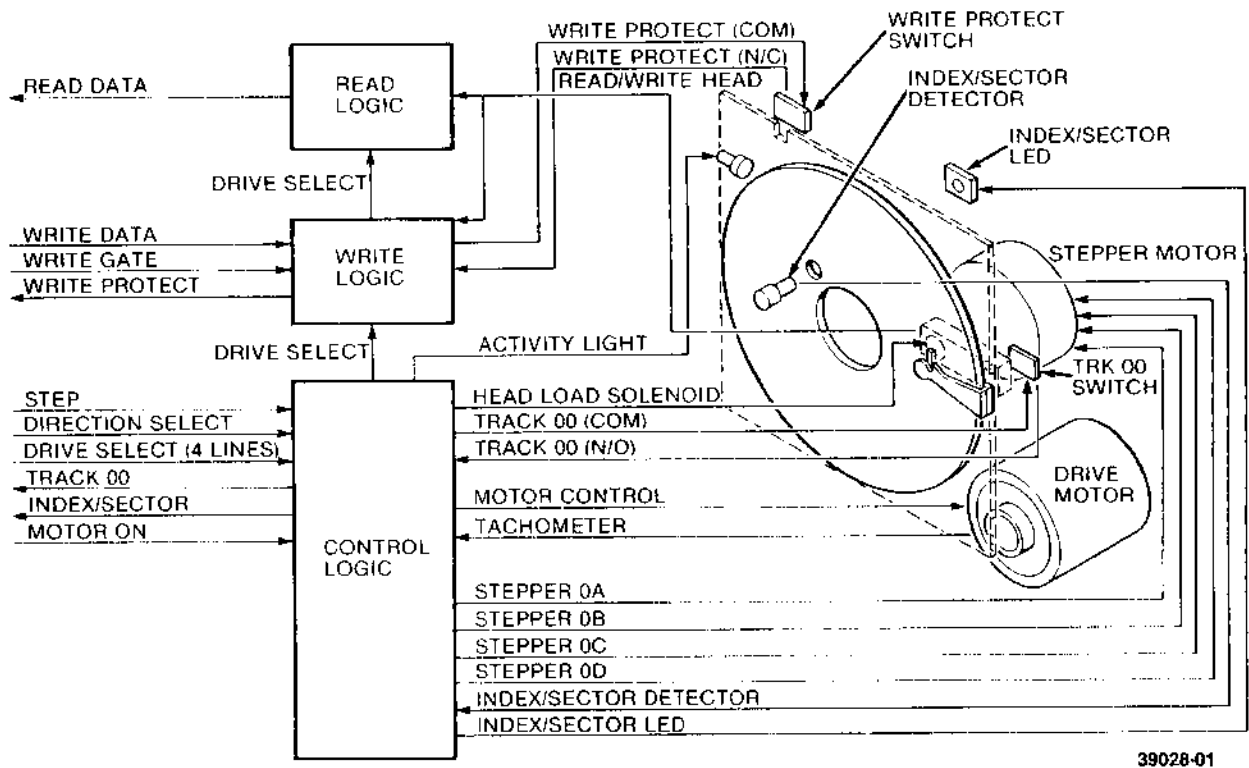


FIGURE 1-2. SA400L FUNCTIONAL DIAGRAM

1.3.2 Read/Write and Control Electronics

The electronics are packaged on one PCB which contains:

- Index/Sector detector.
- Read/write head position actuator drivers.
- Read/write head load actuator driver.
- Write current drivers (LSI logic).
- Read amplifier and transition detectors (LSI logic).
- Write protect detector.
- Drive select circuits.
- Drive motor control circuits.

1.3.3 Drive Mechanism

The minifloppy drive motor operates on 12 V dc and rotates the spindle at 300 rpm through a belt-drive system. The speed of the motor is controlled by feed-back from a tachometer internal to the motor. A registration hub clamp moving in conjunction with the door closure mechanism centers and clamps the minidiskette onto the spindle hub.

1.3.4 Read/Write Head Positioning Mechanism

An electrical stepping motor and a face cam position the read/write head. The stepping motor rotates the cam either clockwise or counterclockwise with two step increments per track. The using system increments the stepper motor to the desired track by selecting the proper direction and issuing one step pulse per track. The drive control electronics issue the second step pulse needed per track.

1.3.5 Read/Write Head

The SA400L read/write head is a single element glass-bonded ferrite/ceramic head with straddle erase elements to provide erased areas between data tracks. Thus, normal interchange tolerances between media and drives will not degrade the signal-to-noise ratio and minidiskette interchangeability is ensured.

The read/write head is mounted on a carriage assembly which moves on rails and is positioned by the cam. The minidiskette is held in a plane perpendicular to the read/write head by a platen located on the base casting. This precision registration assures perfect compliance with the read/write head. The minidiskette is loaded against the head with a load pad actuated by the head load solenoid.

The read/write head is in direct contact with the minidiskette. The head surface has been designed to obtain maximum signal transfer to and from the magnetic surface of the minidiskette with minimum head/diskette wear.

1.3.6 Recording Format

The format of the data recorded on the disk is totally a function of the host system, and can be designed around the user's application to take maximum advantage of the total available bits that can be written on any one track.

For a detailed discussion of various recording formats, refer to Section VI.

1.4 FUNCTIONAL OPERATIONS

1.4.1 Power Sequencing

Applying dc power to the SA400L can be done in any sequence; however, during power-up, the WRITE GATE line must be held inactive or at a high level. This will prevent possible "glitching" of the media. After application of dc power, a 100 ms delay should be introduced before any operation is performed. Also, after powering on, initial position of the read/write head with respect to the data tracks on the media is indeterminant. In order to assure proper positioning of the read/write head after powering on, a step out operation should be performed until the TRACK 00 line becomes active (recalibrate).

1.4.2 Drive Selection

Drive selection occurs when the DRIVE SELECT line is activated. Under normal operation, the DRIVE SELECT line will load the read/write head against the minidiskette, enabling contact of the read/write head with the media. It also lights an LED on the front plate.

1.4.3 Motor On

In order for the host system to read or write data, the dc drive motor must be turned on. This is accomplished by activating the MOTOR ON line. A 500 msec delay must be introduced after activating this line to allow the motor to come up to speed before reading or writing can be accomplished.

The motor must be turned off by the host system by deactivating the MOTOR ON line. This should be done if the drive has not received a new command within 2 seconds (10 revolutions of diskette) after completing the execution of a command. This ensures maximum motor and media life.

1.4.4 Track Accessing

Seeking the read/write head from one track to another is accomplished by:

- a. Activating the DRIVE SELECT line.
- b. Selecting the desired direction using the DIRECTION SELECT line.
- c. WRITE GATE being inactive.
- d. Pulsing the STEP line.

Multiple track accessing is accomplished by repeatedly pulsing the STEP line until the desired track has been reached. Each pulse on the STEP line will cause the read/write head to move one track either in or out, depending on the DIRECTION SELECT line. Head movement and direction latching is initiated on the trailing edge of the step pulse.

1.4.5 Step Out

With the DIRECTION SELECT line at a plus logic level (2.5 to 5.25 V), a pulse on the STEP line will cause the read/write head to move one track away from the center of the disk. The pulse(s) applied to the STEP line and the DIRECTION SELECT line must have the timing characteristics shown in figure 1-3.

1.4.6 Step In

With the DIRECTION SELECT line at a minus logic level (0 to 0.4 V), a pulse on the STEP line causes the read/write head to move one track closer to the center of the disk. The pulse(s) applied to the STEP line must have the timing characteristics shown in figure 1-3.

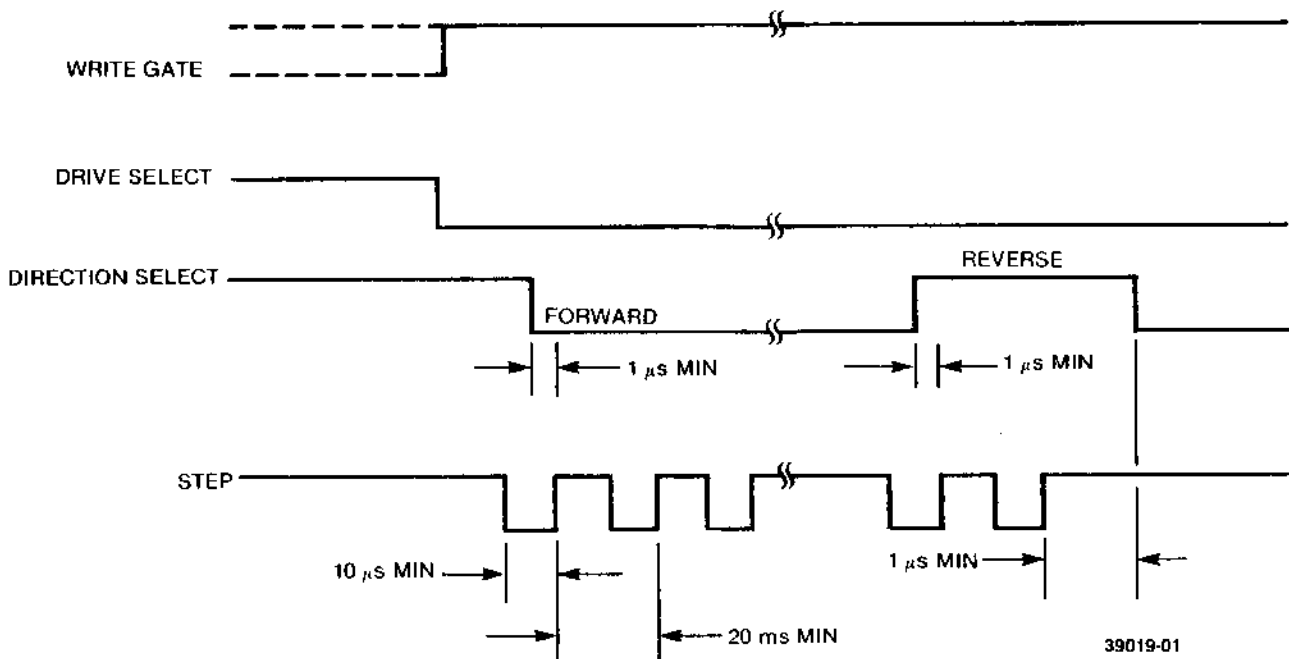


FIGURE 1-3. TRACK ACCESS TIMING

1.4.7 Read Operation

Reading data from the SA400L minifloppy drive is accomplished by:

- a. Activating DRIVE SELECT line.
- b. WRITE GATE being inactive.

The timing relationships required to initiate a read sequence are shown in figure 1-4. These timing specifications are required to guarantee that the read/write head position has stabilized prior to reading.

The timing of READ DATA is shown in figure 1-5.

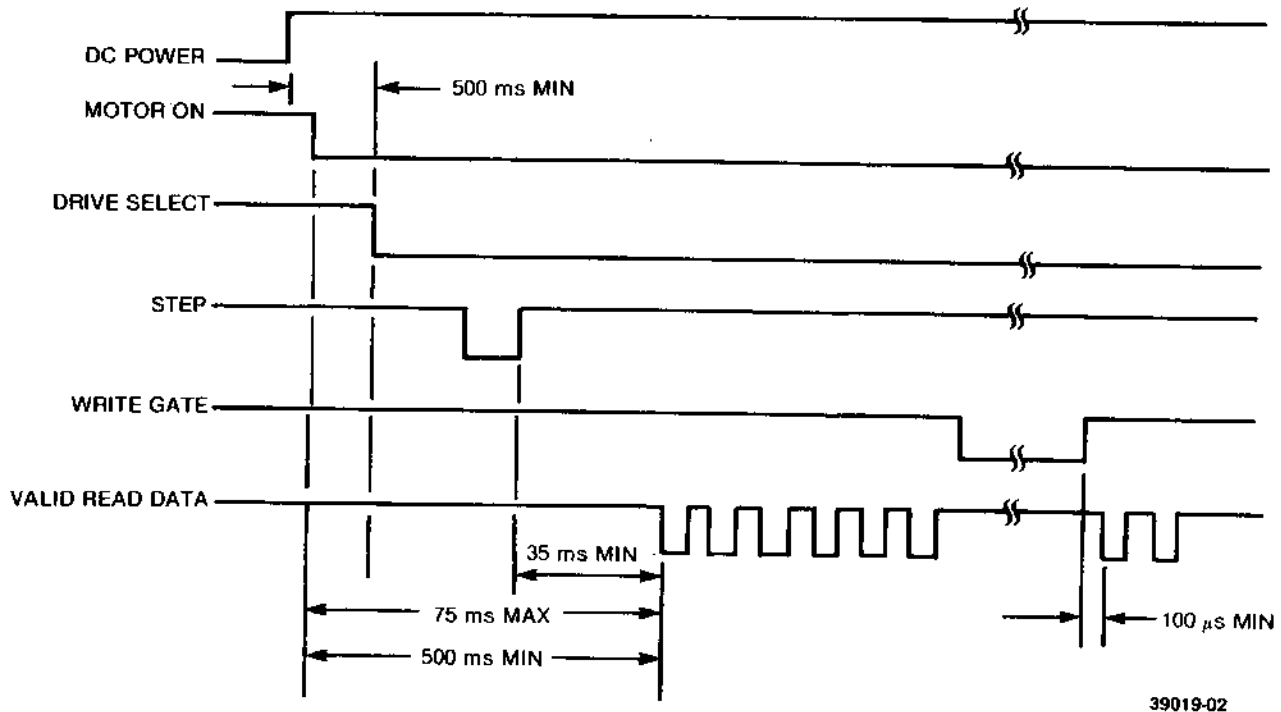


FIGURE 1-4. READ INITIATE TIMING

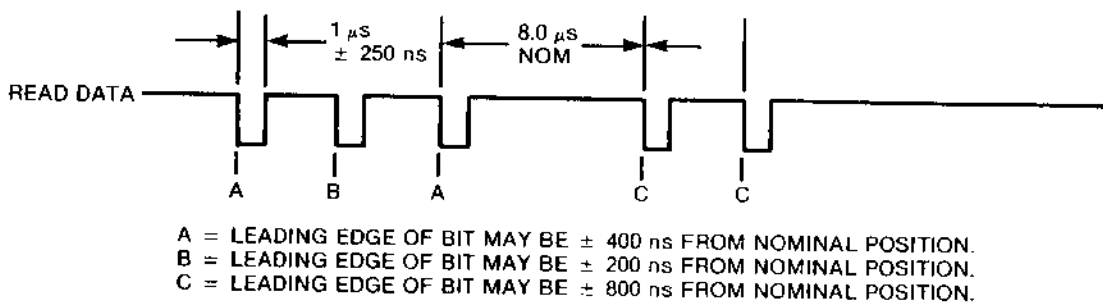


FIGURE 1-5. READ SIGNAL TIMING

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1.4.8 Write Operation

Writing data to the SA400L is accomplished by:

- a. Activating the DRIVE SELECT line.
- b. Activating the WRITE GATE line.
- c. Pulsing the WRITE DATA line with the data to be written.

The timing relationships required to initiate a write data sequence are shown in figure 1-6. These timing specifications are required to guarantee that the read/write head position has stabilized prior to writing.

The timing specifications for the WRITE DATA pulses are shown in figure 1-7.

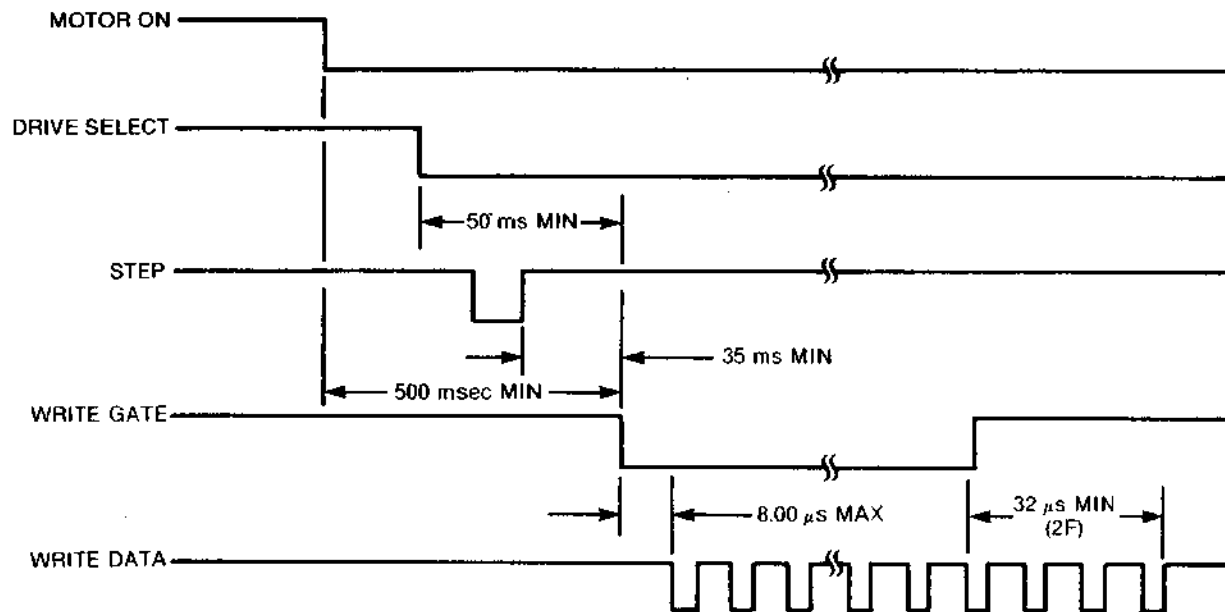


FIGURE 1-6. WRITE INITIATE TIMING

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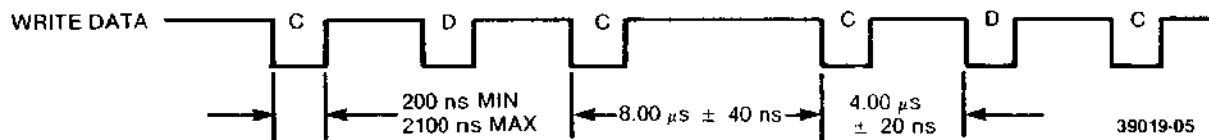
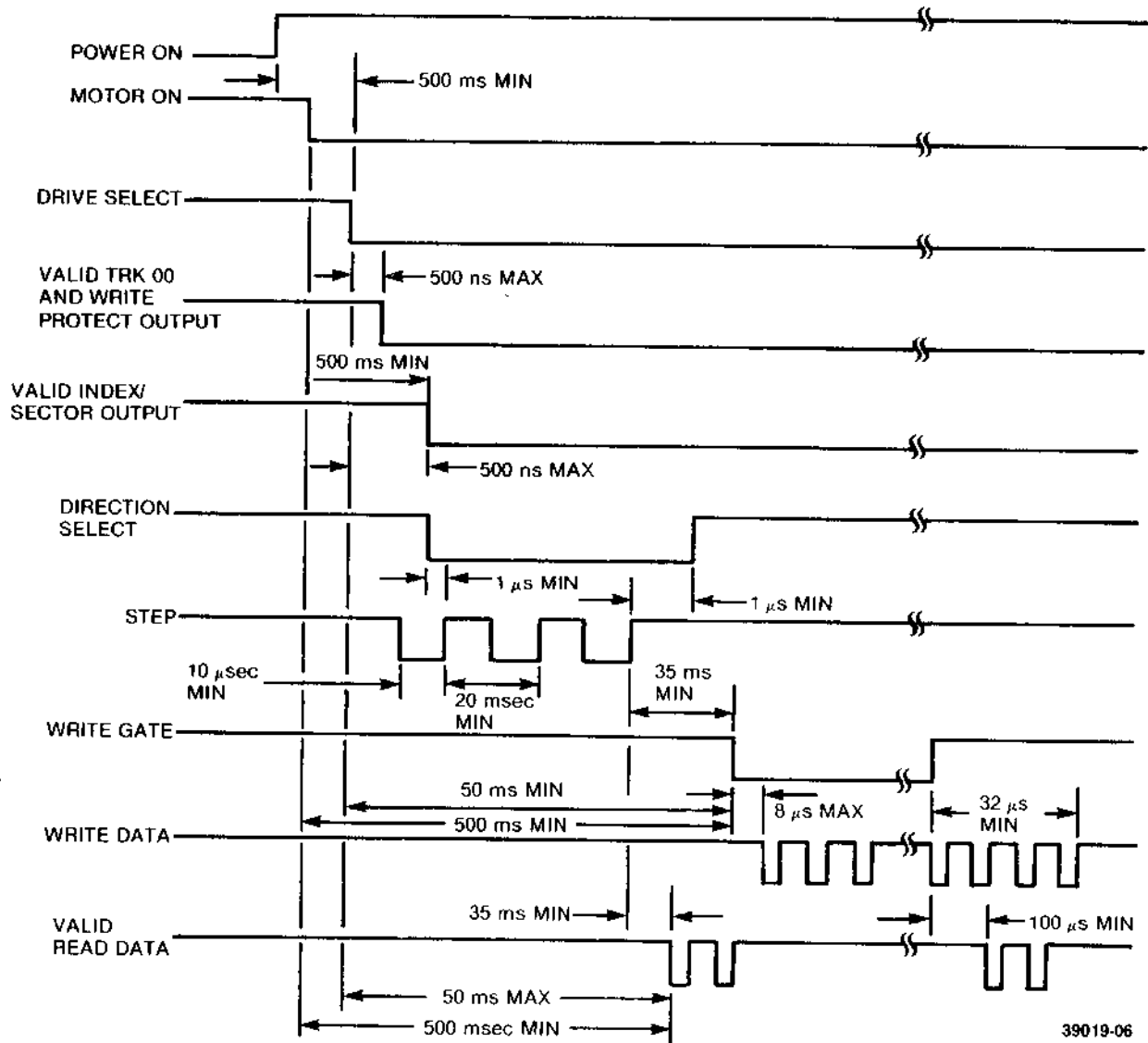


FIGURE 1-7. WRITE DATA TIMING

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1.4.9 Sequence of Events

The timing diagram shown in figure 1-8 illustrates the necessary sequence of events with associated timing restrictions for proper operation.



39019-06

FIGURE 1-8. GENERAL CONTROL AND DATA TIMING REQUIREMENTS

SECTION II ELECTRICAL INTERFACE

2.1 INTRODUCTION

The interface of the SA400L minidiskette drive can be divided into two categories:

- a. Signal Interface Lines
- b. Power Interface Lines

The following paragraphs provide the electrical definition for each line.

See figure 2-1 for all interface connections

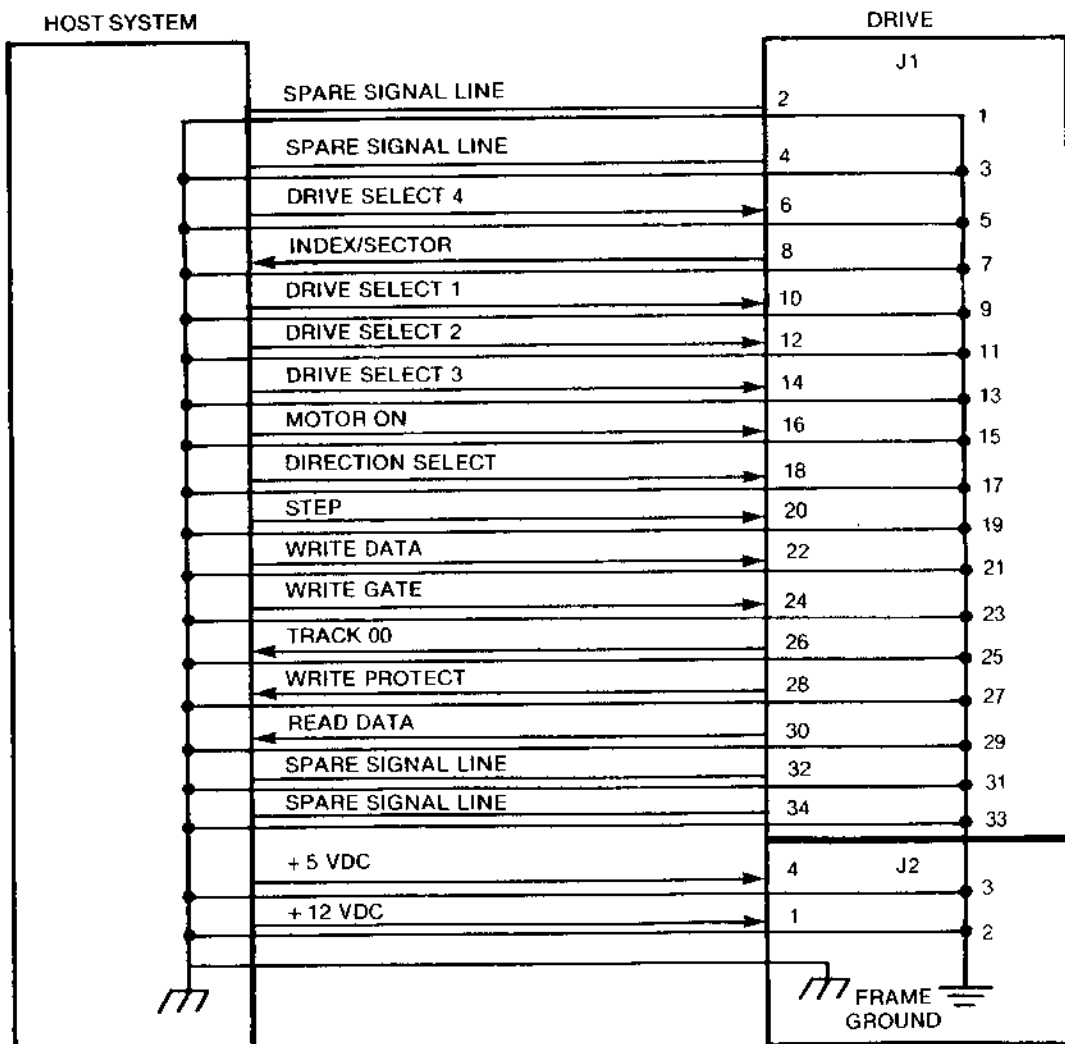


FIGURE 2-1. INTERFACE CONNECTIONS

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2.2 SIGNAL INTERFACE

The signal interface consists of two categories:

- a. Control Lines
- b. Data Transfer Lines

All lines in the signal interface are digital in nature and provide signals either to the drive (input) or to the host (output) via interface connector P1/J1.

2.2.1 Input Lines

The input signals are of three types: those intended to be multiplexed in a multiple drive system, those which will perform the multiplexing, and motor control.

The input signals to be multiplexed are:

- a. DIRECTION SELECT
- b. STEP
- c. WRITE DATA
- d. WRITE GATE
- e. HEAD LOAD

The input signals which are intended to do the multiplexing are:

- a. DRIVE SELECT 1
- b. DRIVE SELECT 2
- c. DRIVE SELECT 3
- d. DRIVE SELECT 4

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

True = Logical Zero = $V_{IN} \pm 0.0$ to $+ 0.4$ V @ $I_{IN} = 40$ mA (max)
False = Logical One = $V_{IN} + 2.5$ to $+ 5.25$ V @ $I_{IN} = 250$ μ A (open)
Input impedance = 150 ohms

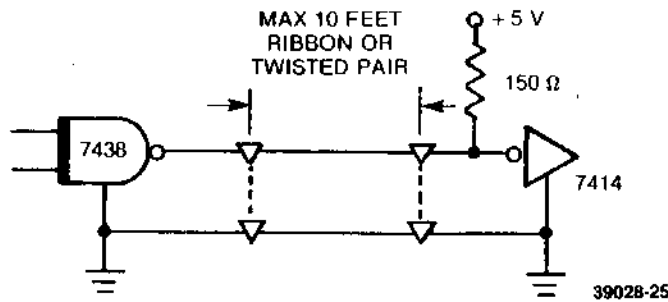


FIGURE 2-2. INTERFACE SIGNAL DRIVER/RECEIVER

2.2.2 Input Line Terminations

The SA400L has been provided with the capability of terminating the five input lines listed below:

- a. MOTOR ON
- b. DIRECTION SELECT
- c. STEP
- d. WRITE DATA
- e. WRITE GATE

These lines are terminated through a 150-ohm resistor pack installed in a dip socket located at IC location 3D.

In a single drive system, this resistor pack should be kept in place to provide the proper terminations.

In a multiple drive system (program shunt position "MX" open), only the last drive on the interface is to be terminated. All other drives on the interface must have the resistor pack removed. External terminations may also be used. But the user must provide the terminations beyond the last drive and each of the five lines must be terminated to +5 V dc through a 150-ohm, 1/4-watt resistor.

2.2.3 Drive Select 1-4

The SA400L, as shipped from the factory, is configured to operate in a single drive system. It can be easily modified by the user to operate with other drives in a multiplexed multiple-drive system. The user can activate the multiplex option by cutting the "MX" position of the programmable shunt located in IC location 2D. This allows the multiplexing of the I/O lines.

In a single drive system (program shunt position "MX" open), the four input lines (DRIVE SELECT 1, DRIVE SELECT 2, DRIVE SELECT 3, and DRIVE SELECT 4) are provided so that the using system may select which drive on the interface is to be used. In this mode of operation only the drive with the DRIVE SELECT line active will respond to the input lines and gate the output lines. In addition, the selected drive will load its read/write head if program shunt position "HL" is shorted.

The program shunt, IC location 2D, positions "DS1," "DS2," "DS3," and "DS4" are to be used to select which DRIVE SELECT line will activate the I/O lines for a unique drive. For example, if the user wants the first drive on the interface to be address 1, he must cut program shunt positions "DS2," "DS3," and "DS4," leaving "DS1" intact.

The program shunt is AMP P/N 435704-6. The shunt positions can be cut using AMP's tool P/N 435705. The shunt is installed in a dip socket and, at the user's option, can be removed and replaced by a dip switch (AMP P/N 4435626-4). The user may also choose to have the program shunts pre-programmed and/or color-coded by AMP. For this service, contact your local AMP representative.

2.2.4 Motor On

This input, when activated to a logical zero level, will turn on the drive motor. A 500 msec delay must be allowed before reading or writing after activating this line. This line should be deactivated for maximum media life if no commands have been issued to the drives within 2 seconds (10 revolutions of the media) after completion of a previous command.

2.2.5 Direction Select

This interface line is a control signal defining the direction of motion the read/write head will take 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. Conversely, if this input is shorted to ground or a logical zero level, the direction of motion is defined as "in" and if a pulse is applied to the STEP line, the read/write head will move towards the center of the disk.

2.2.6 Step

STEP is a control signal causing the read/write head to move with the direction of motion as defined by the DIRECTION SELECT line.

The access motion is initiated on each logical zero to logical one transition, or the trailing edge of the signal pulse. Any change in the DIRECTION SELECT line must be made at least 1 μ s before the trailing edge of the STEP pulse. DIRECTION SELECT logic level must be maintained 1 μ s after the trailing edge of the STEP pulse. See figure 1-4 for these timings.

2.2.7 Write Gate

The active state of this signal, or logical zero, enables write data to be written on the diskette. The inactive state, or logical one, enables the read data logic and stepper logic. See figure 1-6 for timings.

2.2.8 Write Data (FM)

The WRITE DATA line provides the data to be written on the diskette. Each transition from a logical one level to a logical zero level will cause the current through the read/write heads to be reversed, thereby writing a data bit. This line is enabled by WRITE GATE being active. WRITE DATA must be inactive during a read operation. A write data clamp is provided on the PCB at the interface which holds the WRITE DATA line at a logical zero level whenever WRITE GATE is inactive. See figure 1-7 for timings.

2.2.9 Output Lines

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

True = Logical Zero = $V_{OUT} + 0.0$ to $+0.4$ V @ $I_{OUT} = 48$ mA (max.)
False = Logical One = $V_{OUT} + 2.5$ to $+5.25$ V (open collector @ $I_{OUT} = 250$ μ A max.)

2.2.10 Track 00

The active, or logical zero, state of this interface signal indicates when the read/write head of the drive is positioned at track 00 (the outermost track) and the access circuitry is driving current through phase "A" of the stepper motor and DRIVE SELECT is enabled. This signal is at a logical one level, or inactive state, when the read/write head of the drive is **not** at track 00. When the read/write head is at track 00 and an additional step out pulse is issued to the drive, a mechanical stop will keep the read/write head at track 00 but the TRACK 00 signal will go inactive. This is because the stepper motor will go to phase "C" and not phase "A." One more step out pulse will put the stepper motor back into phase "A" and the TRACK 00 signal will go active again.

2.2.11 Index/Sector

INDEX/SECTOR is provided by the drive each time an index or sector hole is sensed at the index/sector photo detector. Normally, this signal is at a logical one level and makes the transition to the logical zero level each time a hole is sensed.

When using SA104 media (soft sectored), there will be one pulse on this interface signal per revolution of the diskette (200 ms). This pulse indicates the physical beginning of a track. See figure 2-3 for the timing.

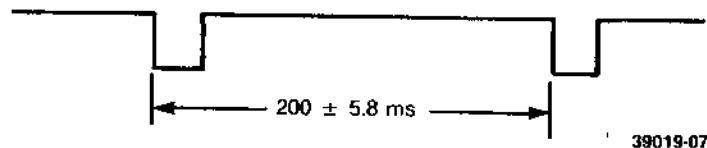


FIGURE 2-3. INDEX TIMING (SA104 MEDIA)

When using SA105 or SA107 media (hard sectored), there will be 17 or 11 pulses on this interface line per revolution (200 ms). To indicate the beginning of a track, once per revolution there is one index transition between 16 or 10 equally spaced sector transitions. The timing for this signal is shown in figure 2-4.

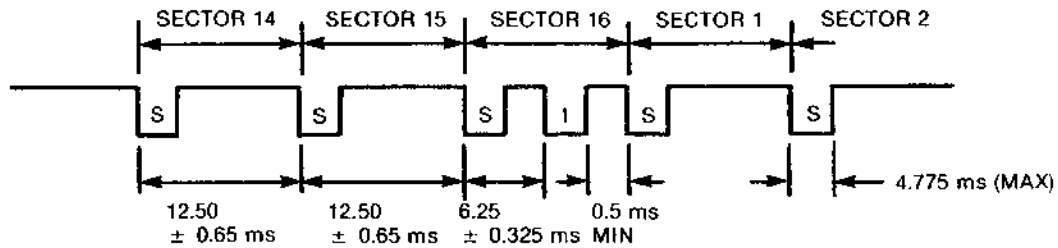
When using the Index/Sector signal, look for an edge or transition rather than a level to determine its status. With no diskette inserted, this signal remains active or at a logical zero level which is an erroneous status.

2.2.12 Read Data

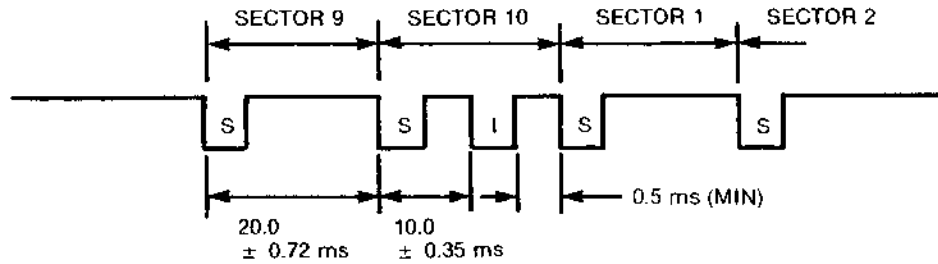
This interface line provides the "raw data" (clock and data together) as detected by the drive electronics. Normally, this signal is a logical one level and becomes a logical zero level for the active state. See figure 1-5 for the timing and bit shift tolerance within normal media variations.

2.2.13 Write Protect

WRITE PROTECT is provided by the drive to indicate to the user when a write protected diskette is installed. The signal is logical zero level when it is protected. Under normal operation, the drive will inhibit writing with a protected diskette installed in addition to notifying the interface. If the "WP" trace is cut, writing to the diskette is inhibited unless a write protect label is installed over the notch.



SA105 MEDIA



SA107 MEDIA

39019-16

FIGURE 2-4. INDEX/SECTOR TIMING (SA105/107 MEDIA)

2.3 POWER INTERFACE

The SA400L requires only dc power for operation. DC power to the drive is provided via P2/J2 located on the non-component side of the PCB near the drive motor. The two dc voltages, their specifications, and their P2/J2 pin designators are outlined below. The specifications outlined under current requirements are for one drive. For multiple drive systems, the current requirements are a multiple of the maximum current times the number of drives in the system.

2.4 FRAME GROUND

It is important that the drive be frame grounded to the host systems ac or frame ground. Failure to do so may result in drive noise susceptibility. Refer to paragraph 3.4 for the procedure.

TABLE 2-1. DC POWER REQUIREMENTS

P2 PIN	DC VOLTAGE	TOLERANCE	CURRENT	MAX RIPPLE (P TO P)
1	+ 12 VDC	± 0.6 VDC	*1.80 A MAX 0.90 A TYP	100 mV
2	+ 12 RETURN			
3	+ 5 RETURN			
4	+ 5 VDC	± 0.25 VDC	0.70 A MAX 0.50 A TYP	50 mV

*THE 12 V dc CURRENT IS COMPOSED OF THREE COMPONENTS; HEAD LOAD CURRENT, DISKETTE DRIVE MOTOR CURRENT, AND PCB FUNCTIONS. EACH OF THESE COMPONENTS HAS THE FOLLOWING CONTRIBUTION TO THE 12 Vdc CURRENT REQUIREMENTS.

1. PCB FUNCTIONS (DRIVE "STANDBY" CURRENT)—0.4 A TYP; 0.5 A MAX
2. HEAD LOAD (DRIVE SELECTED)—0.16 A TYP; 0.2 A MAX
3. DRIVE MOTOR: START (FOR 400 ms MAX)—1.0 A TYP; 1.1 A MAX
RUNNING 0.35 A TYP; 1.1 A MAX (MOTOR STALLED)

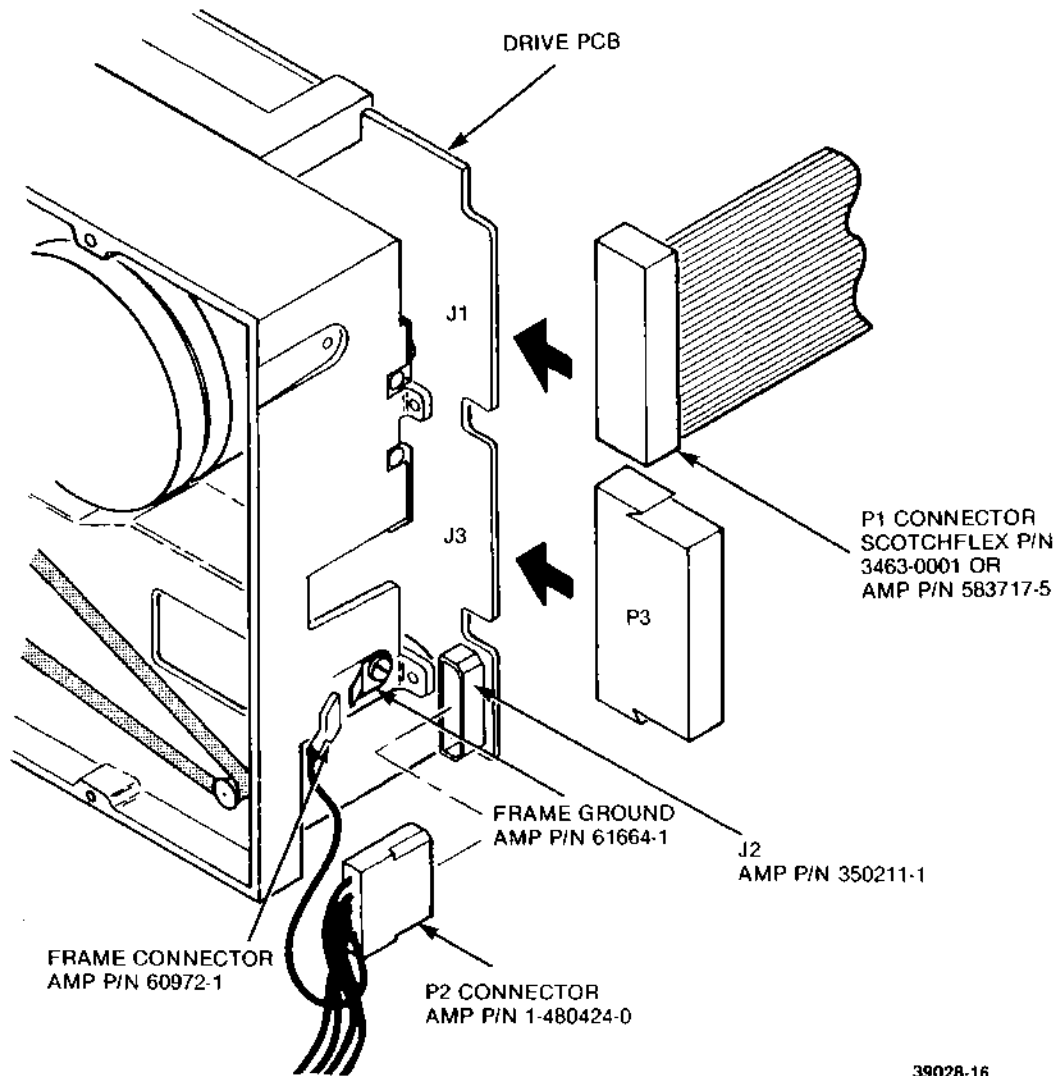
39028-17

SECTION III PHYSICAL INTERFACE

3.1 INTRODUCTION

The electrical interface between the SA400L and the host system is via two connectors. The first connector, J1, provides the signal interface, and the second connector, J2, provides the dc power.

This section describes the physical connectors used on the drive and the recommended connectors to be used with them. See figure 3-1 for connector locations.



39028-16

FIGURE 3-1. INTERFACE CONNECTORS - PHYSICAL LOCATIONS

3.2 J1/P1 CONNECTOR

Connection to J1 is through a 34-pin PCB edge card connector. The dimensions for this connector are shown in figure 3-2. The pins are numbered 1 through 34 with the even-numbered pins on the component side of the PCB and the odd-numbered pins on the non-component side. Pin 2 is located on the end of the PCB connector closest to the corner and is labeled 2. A key slot is provided between pins 4 and 6 for optional connector keying.

The recommended connectors for P1 are outlined in table 3-1.

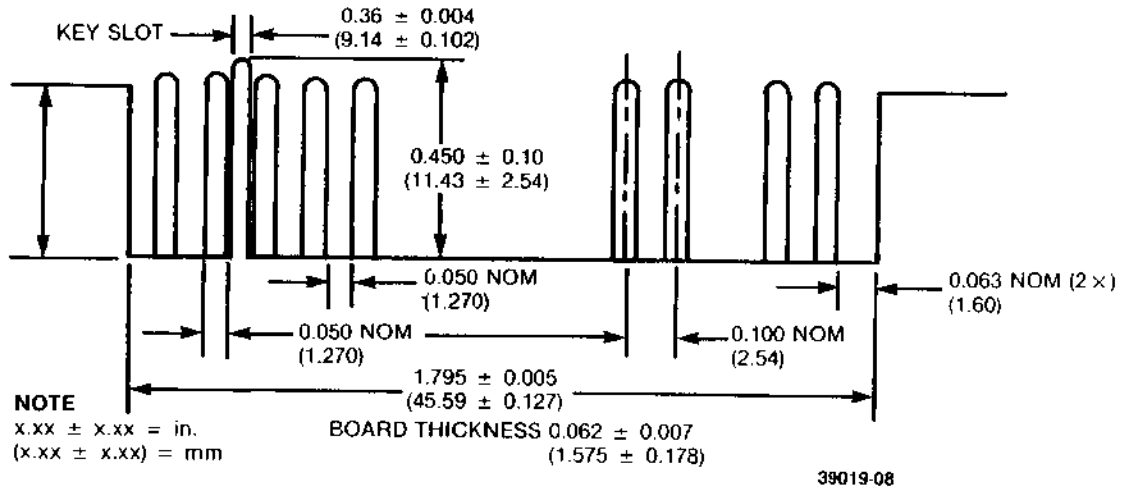


FIGURE 3-2. J1 CONNECTOR DIMENSIONS

TABLE 3-1. RECOMMENDED P1 CONNECTORS

TYPE OF CABLE	MANUFACTURER	CONNECTOR P/N	CONTACT P/N
TWISTED PAIR, #26	AMP	583717-5	1-583616-1
FLAT CABLE	3M "SCOTCHFLEX"	3463-0001	N/A

39019-09

3.3 J2/P2 CONNECTOR

The dc power connector, J2, is mounted on the non-component side of the PCB and is located near the drive motor. J2 is a 4-pin AMP Mate-N-Lok connector, P/N 350211-1. The recommended mating connector (P2) is AMP P/N 1-480424-0, utilizing AMP pins P/N 61473-1. J2, pin 1, is labeled on the component side of the PCB. Wire used should be #18 AWG. Figure 3-3 illustrates J2 connector as seen on the drive PCB from the non-component side.

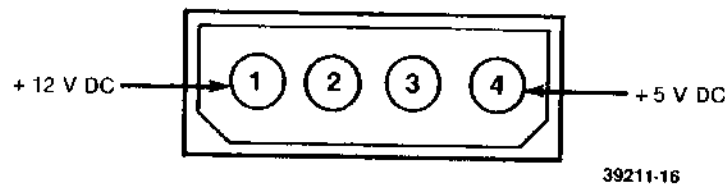


FIGURE 3-3. J2 CONNECTOR

3.4 FRAME GROUNDING

The SA400L must be frame-grounded to the host system to ensure proper operation. If the frame of the drive is not fastened directly to the frame of the host system with a good ac ground, a wire from the system ac frame ground must be connected to the SA400L. For this purpose, a faston tab is provided on the drive at the rear of the casting where a faston connector can be attached or soldered. The tab is AMP P/N 61664-1 and its mating connector is AMP P/N 60972-1. See figure 3-1 for the frame ground location.

SECTION IV PHYSICAL SPECIFICATIONS

4.1 MECHANICAL DIMENSIONS

See figure 4-1 for dimensions of the SA400L.

4.2 MOUNTING

As shipped from the factory, the SA400L is capable of being mounted in any of the following positions:

- a. Top Loading — mounted upright.
- b. Front Loading — mounted vertical with door opening left or right.
- c. Front Loading — mounted horizontal with PCB up.

DO NOT HORIZONTAL MOUNT WITH PCB DOWN.

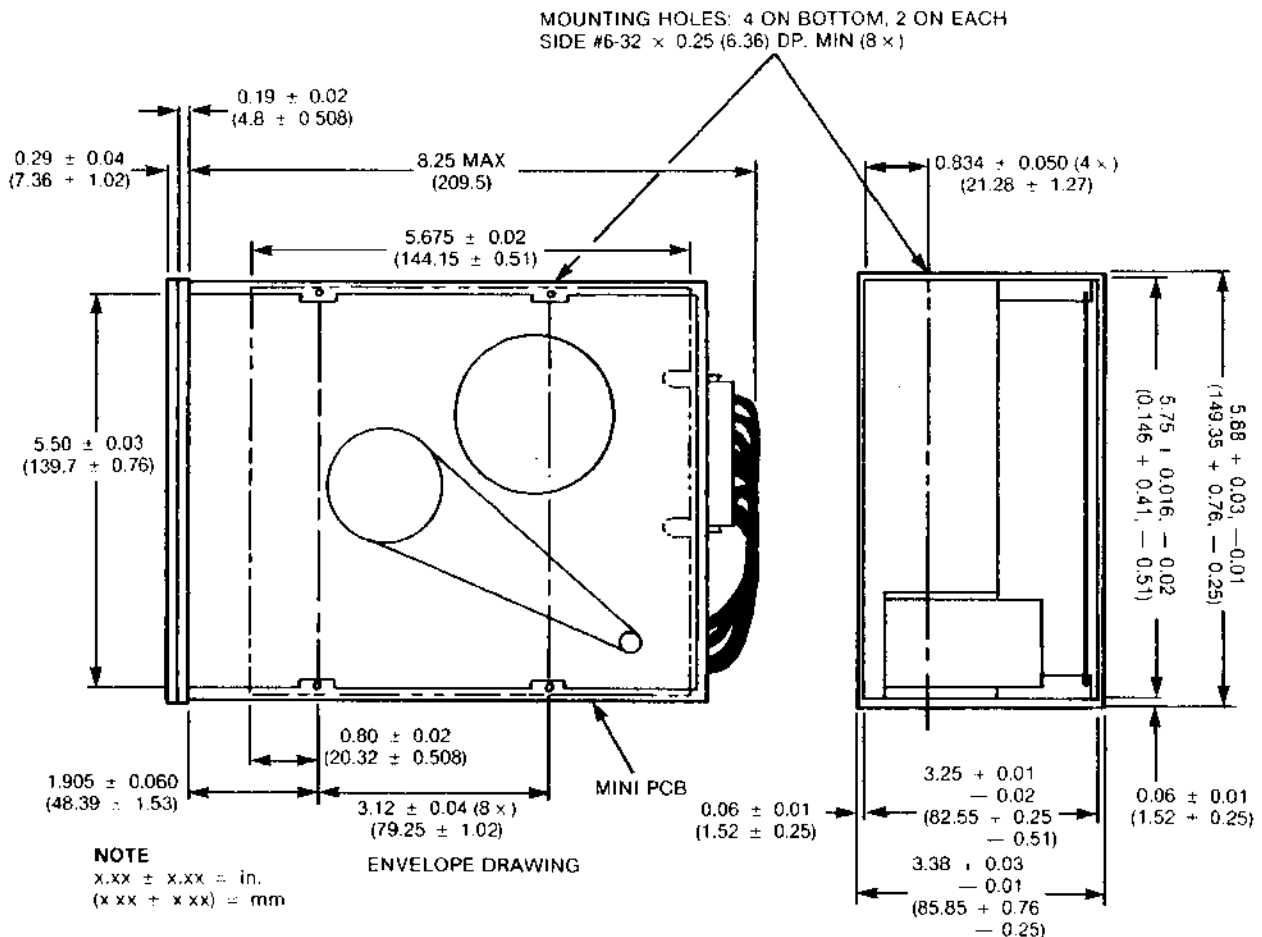


FIGURE 4-1. SA400L PHYSICAL DIMENSIONS

39019-10

SECTION V ERROR RECOVERY

5.1 WRITE ERROR

If an error occurs during a write operation, this error will be detected on the next revolution by doing a read operation (commonly called a "write check"). To correct the error, another write and write check operation must be done. If the write operation is not successful after 10 attempts have been made, a read operation should be attempted on another track. This is done to determine if the media or the drive is failing. If the error still persists, the disk should be considered defective and discarded.

5.2 READ ERROR

Most errors that occur will be "soft" errors. Soft errors are usually caused by the following:

- a. Airborne contaminants passing between the read/write head and the disk. The contaminants will generally be removed by the cartridge self-cleaning wiper.
- b. Random electrical noise which usually lasts for a few microseconds.
- c. Small defects in the written data and/or track not detected during the write operation which may cause a soft error during a read.

The following procedure is recommended to recover from errors:

- a. Reread the track 10 times or until such time as the data is recovered.
- b. If data is not recovered after using step (a), access the head to the adjacent track in the same direction previously moved. Return to the desired track.
- c. Repeat step (a).
- d. If data is not recovered, the error is not recoverable.

5.3 SEEK ERROR

Seek errors are detected by reading an ID field after the seek is completed. The ID field contains the track address. If a seek error is detected, the host system should issue a recalibrate operation (step out until TRACK 00 line goes active) and seek back to the original track.

SECTION VI RECORDING FORMAT

6.1 GENERAL INFORMATION

The format of the data recorded on the diskette is totally a function of the host system. As discussed in paragraph 1.4.8, data can be recorded on the diskette using FM or MFM encoding. In these encoding techniques, clock bits are written at the start of their respective bit cells and bits at the centers of their bit cells.

A byte, when referring to serial data (being written onto or read from the disk drive), is defined as eight consecutive bit cells. The most significant bit cell is defined as bit cell 0. The least significant bit cell is defined as bit cell 7. When reference is made to a specific data bit (i.e., data bit 3), it is with respect to the corresponding bit cell (bit cell 3).

During a write operation, bit cell 0 of each byte is transferred to the disk drive first with bit cell 7 being transferred last. Correspondingly, the most significant byte of data is transferred to the disk first and the least significant byte is transferred last.

When data is being read back from the drive, bit cell 0 of each byte will be transferred first with bit cell 7 last. As with reading, the most significant byte will be transferred first from the drive to the user.

Figure 6-1 illustrates the relationship of the bits within a byte. Figure 6-2 shows the relationship of the bytes for read and write data.

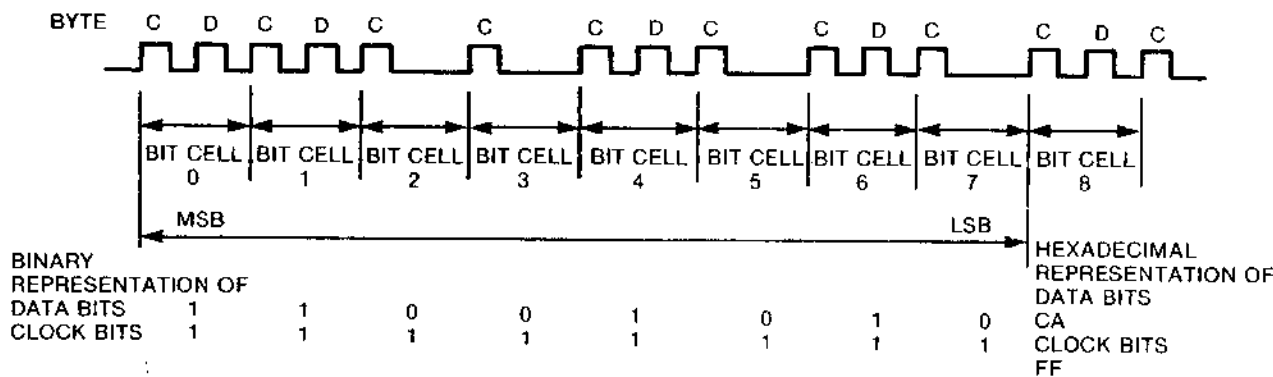


FIGURE 6-1. BYTE (FM ENCODING)

39028-02

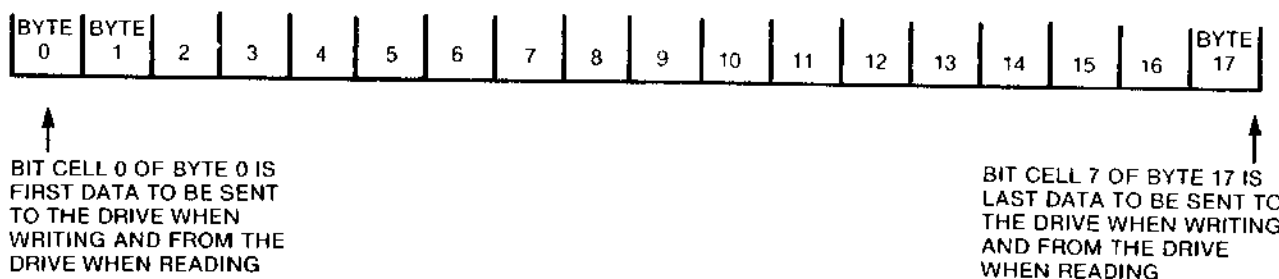


FIGURE 6-2. DATA BYTES

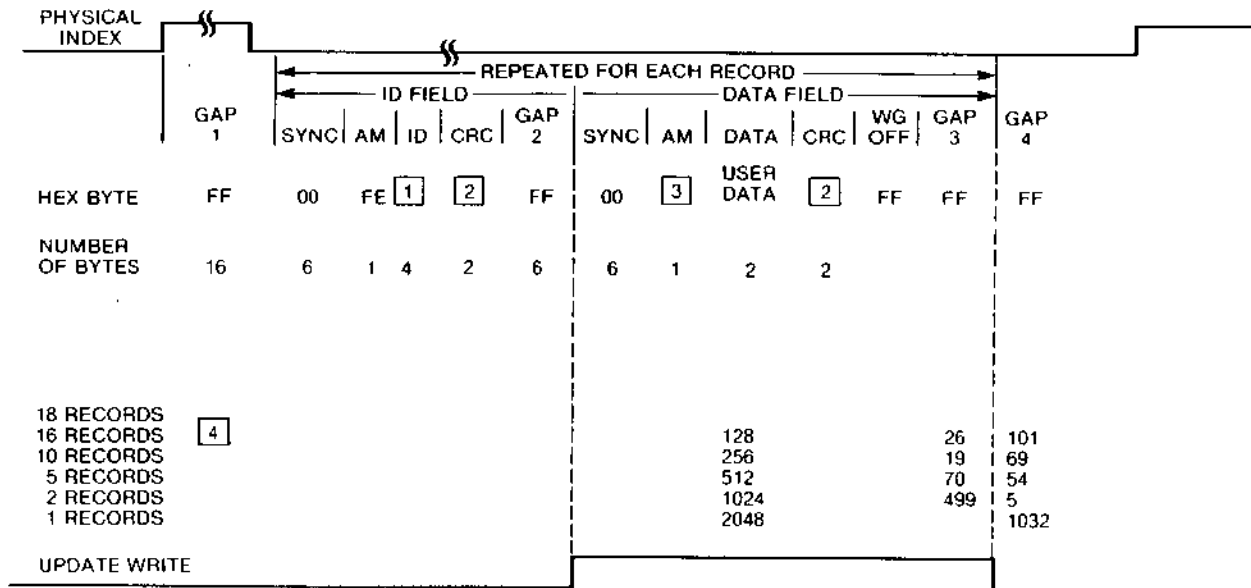
39019-17

6.2 FORMATS

Tracks may be formatted in numerous ways, depending on the using system. The SA400L uses either hard or soft sectored formats.

6.2.1 Soft Sectored Recording Format

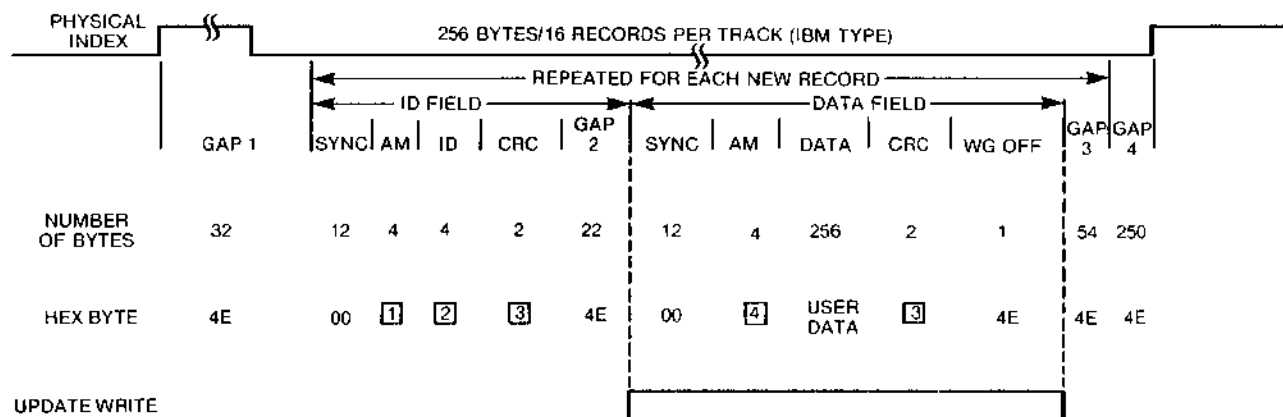
In this format, the using system may record one long record or several smaller records. Each track is started by physical index pulse and then each record is preceded by a unique recorded identifier. Figure 6-3 illustrates the recommended single density (FM) formats. Figure 6-4 shows the recommended double density (MFM) format.



- NOTES:**
1. Track Number, Head Number, Sector Number, Sector Length.
 2. IBM or Equivalent CRC Generator.
 3. FB for Data or FB for Deleted Data.
 4. 16 record format has a Gap 2 of 11 bytes.

39028-04

FIGURE 6-3. RECOMMENDED FM SOFT SECTOR DENSITY (EVEN BOUNDARIES)



- NOTES:**
1. First three bytes are Hex A1 with missing Clock Transitions between bits 4 and 5. Last byte is Hex FE.
 2. Track Number, Head Number, Sector Number, Sector Length (Hex 01)

3. IBM or Equivalent CRC Generator.
4. Same as Note 1, except last byte = Hex FB.

39028-05

FIGURE 6-4. MFM RECOMMENDED FORMAT

6.2.2 Track Layout

Index is the physical detector indicating one revolution of the media and is used to initiate format operations, generate the READY signal in the storage device, ensure one complete revolution of the media has been searched, and as a deselect storage signal after a certain number of revolutions.

- Gap 1 **Gap 1** is from the physical index mark to the ID field address mark sync and allows for physical index variation, speed variation, and interchange between storage devices.
- ID Field **Sync** is a fixed number of bytes for separator synchronization prior to the Address Mark (AM). Includes a minimum of two bytes plus worst case separator sync-up requirements.
- ID Pre-Address Mark** (MFM) is three bytes of A1 with unique clock bits and is not written per encode rules.
- ID Address Mark** (FM) is a unique byte to identify the ID field and is not written per the encode rules.
- ID Address Mark** (MFM) is one byte of FE written per the encode rules.
- ID** is a four byte address containing track number, head number, record number, and record length.
- CRC** is two bytes for cyclic redundancy check (CRC).
- Gap 2 **Gap 2** is from ID CRC to data AM sync and allows for speed variation, oscillator variation and erase core clearance of ID CRC bytes prior to WRITE GATE turn on for an update write.
- Data Field **Sync** is a fixed number of bytes for separator synchronization prior to the AM. Includes a minimum of two bytes plus worst case separator sync-up requirements.
- Pre-Data Address Mark** (MFM) is three bytes of A1 with unique clock bits not written per the encode rules.
- Data Address Mark** (FM) is a unique byte to identify the data field and is not written per the encode rules.
- Data Address Mark** (MFM) is one byte of FB or F8 and is written per the encode rules.
- Data** is the area for user data.
- CRC** is two bytes for cyclic redundancy check.
- Write Gate Off** (WG OFF) is one byte to allow for WRITE GATE turn-off after an update write.
- Gap 3 **Gap 3** is from WG OFF to the next ID AM sync and allows for the erase core to clear the data field CRC bytes, speed and write oscillator variation, read preamplifier recovery time, and system turn-around time to read the following ID field.
- Gap 4 **Gap 4** is the last gap prior to physical index and allows for speed and write oscillator variation during a format write and physical index variation.

6.2.3 Hard Sector Recording Format

In a hard sectored format, the using system may record up to 16 or 10 sectors (records) per track. Each track begins with a physical index pulse. Each sector is started by a physical sector pulse. Figure 6-5 illustrates the hard sectored formats. The SA105 or SA107 minidiskettes are used for these formats. All driver tolerances have been taken into account in developing these formats.

PHYSICAL SECTOR	G1	SYNC	AM	ID	DATA FIELD	CRC	G2
FM							
HEX BYTE	FF	00	FB	1	2	3	FF
NUMBER OF BYTES	16	6	1	4		2	
16 RECORDS					128		36
10 RECORDS					256		25
MFM							
HEX BYTE	AA	FF	0B	1	2	3	AA
NUMBER OF BYTES	16	6	1	4		2	
16 RECORDS					256		101
10 RECORDS					512		79
UPDATE WRITE							

- NOTES: 1. Track Number, Head Number, Record Number, Record Length.
2. User Data.
3. Generated by CRC Generator (IBM or Equivalent).

39028-06

FIGURE 6-5. RECOMMENDED HARD SECTOR FM AND MFM FORMATS

SECTION VII CUSTOMER INSTALLABLE OPTIONS

The 400L Minifloppy™ drive has no customer installable options.

SECTION VIII DRIVE OPERATION

8.1 MINIDISKETTE LOADING

The SA400L was designed for ease of operator use and to facilitate a wide range of operator-oriented applications. To load the diskette, open the door on the front panel, insert the diskette with label towards the door handle, and close handle.

8.2 MINIDISKETTE HANDLING

To protect the diskette, the same care and handling procedures specified for computer magnetic tape apply. These precautionary procedures are as follows:

- a. Return diskette to storage envelope whenever removed from drive. Replace storage envelopes when worn, cracked, or distorted. Envelopes are designed to protect disks.
- b. Do not bend or fold diskette.
- c. Diskettes not for immediate use should be stored in boxes.
- d. Keep diskettes away from magnetic fields and from ferromagnetic materials which might become magnetized. Strong magnetic fields can distort recorded data on disk.
- e. Place I.D. labels in correct location. Never use in layers.
- f. Do not write on plastic jacket with lead pencil or ball point pen. Use felt tip pen.
- g. Do not use erasers.
- h. Heat and contamination from carelessly dropped ashes can damage disk.
- i. Do not expose diskette to heat or sunlight.

8.3 WRITE PROTECT FEATURE

The SA104/105/107 minidiskettes have the capability of being write protected. A write protect notch is located on the diskette jacket. When the notch is open, writing is allowed. When the notch is covered with a tab, writing is inhibited and the interface signal will be activated. Figure 8-1 illustrates the SA104/105/107 minidiskette write protected and unprotected.

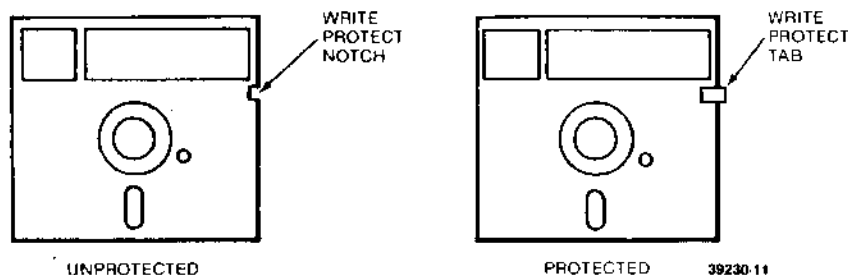


FIGURE 8-1. SA104/105/107 WRITE PROTECT

SECTION IX PACKAGING

9.1 INSTALLATION OF PACKAGING MATERIALS

All 400L's shipped from the factory and regional depots are equipped with carriage stops and door retainers. The carriage stop is designed to prevent head carriage movement while the drive is in transit (see figure 9-1). The door retainer eliminates the possibility of breakage resulting from the door opening during shipment (see figure 9-2).

Upon receipt of the drive, the door retainer and carriage stop should be removed and retained. They must be reinstalled prior to any further shipment of the drive.

9.2 PACKAGING FOR RESHIPMENT

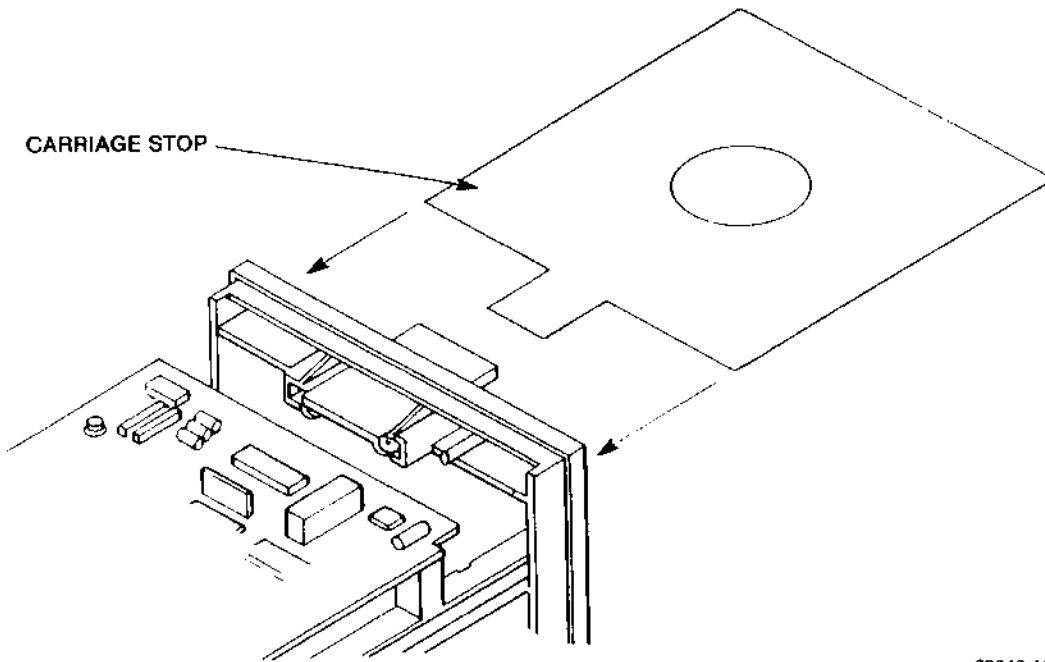
It is suggested that packing material be kept in case the unit must be returned to Shugart for repair. Regardless, the unit must be individually packaged in comparable packing as shipped to preclude damage in shipping and handling. **Damage to the unit as a result of inadequate packaging will void the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

To prepare a drive for shipment:

- a. Locate head carriage at track 00.
- b. Insert carriage stop as you would a diskette, with tab under head carriage (see figure 9-1).
- c. Install door retainer by sliding center section (with tabs nearest PCB), into door pin slots, and bending tabs down over hub frame (see figure 9-2).
- d. Place drive in packaging container.

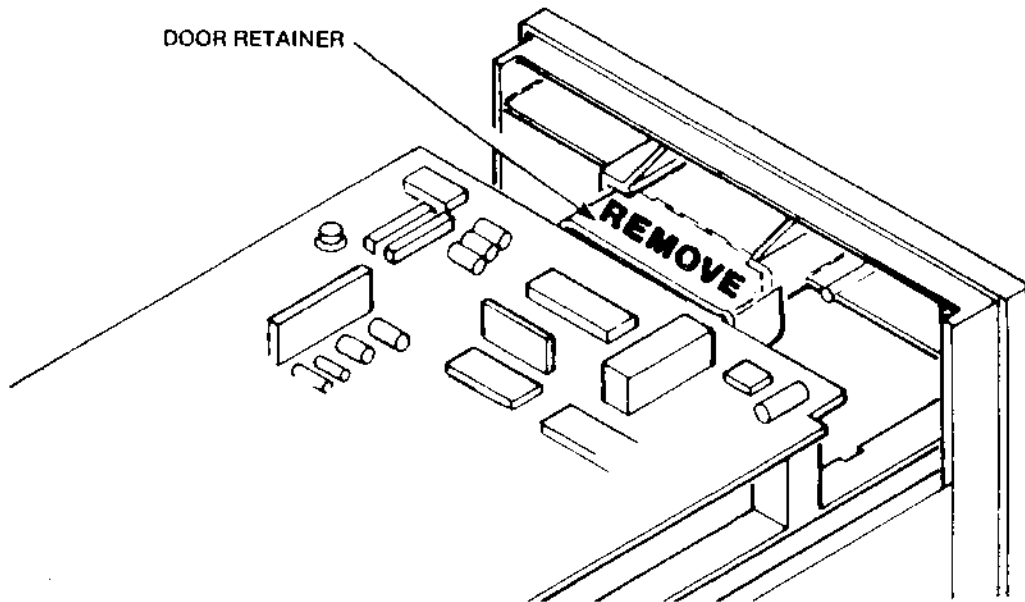
Failure to follow this procedure may result in damage to the drive.

Figures 9-3 and 9-4 show how to repackage the disk drive using original shipping containers.



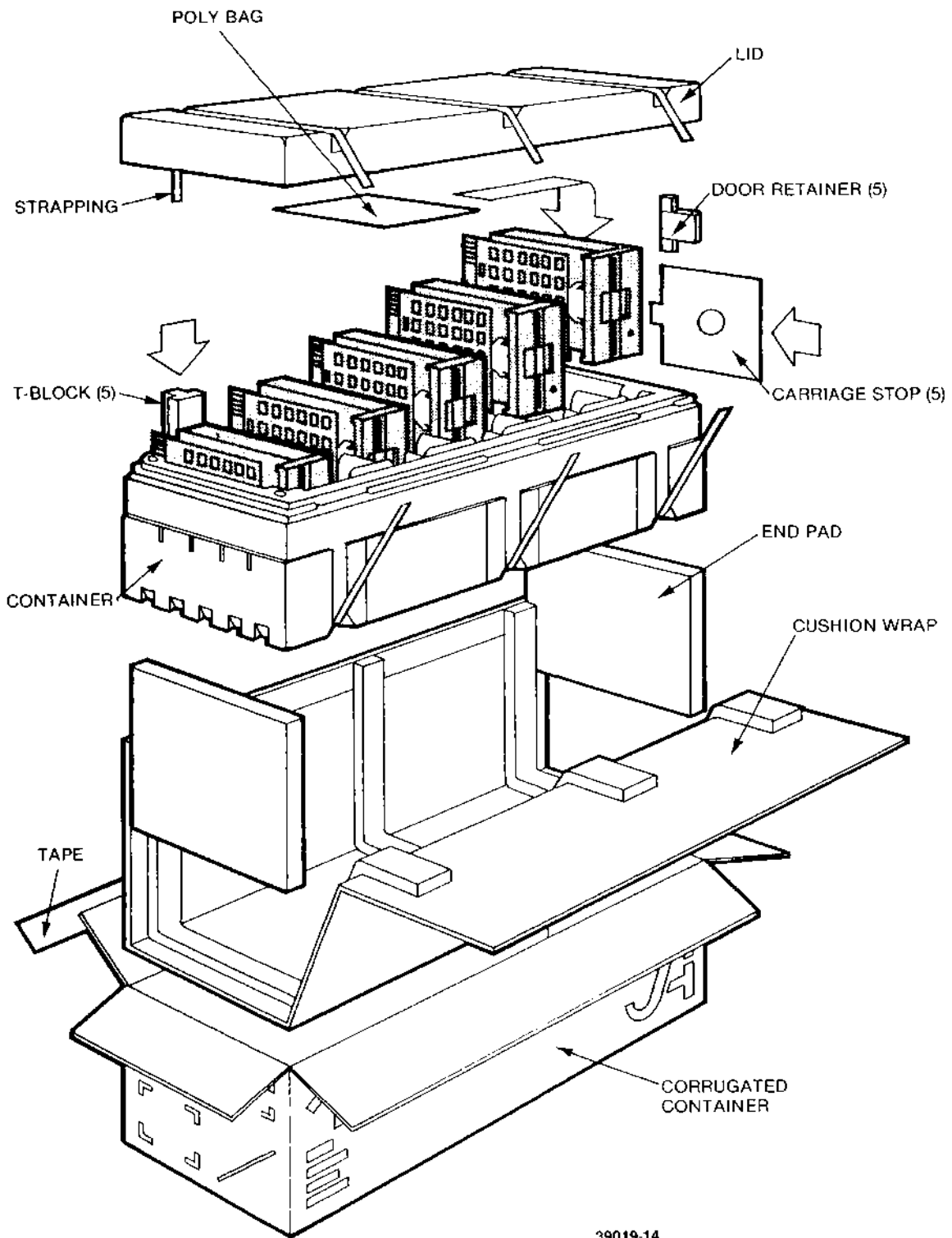
39019-12

FIGURE 9-1. CARRIAGE STOP



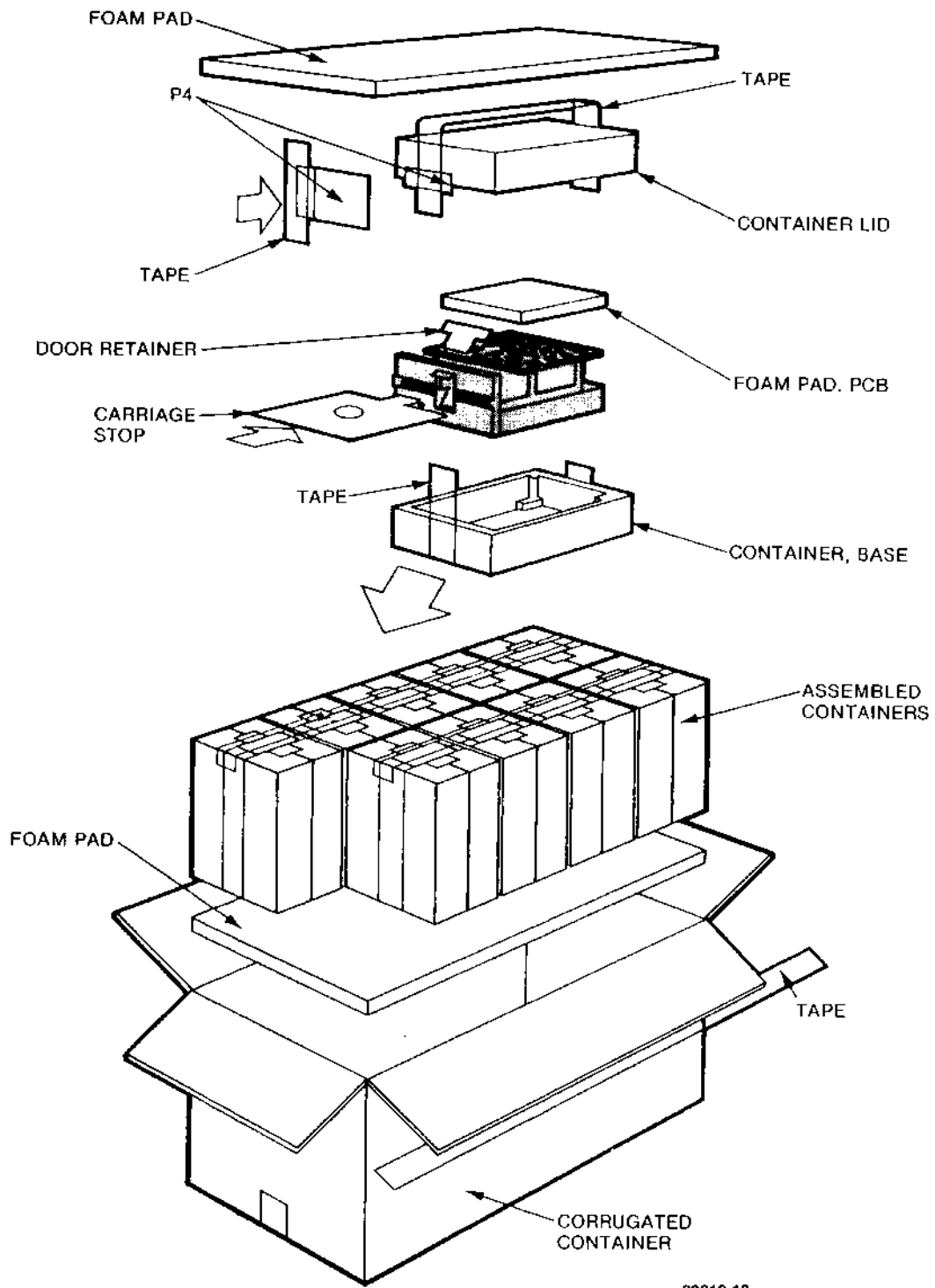
39019-13

FIGURE 9-2. DOOR RETAINER



39019-14

FIGURE 9-3. SA400L PACKAGING, 5-PACK



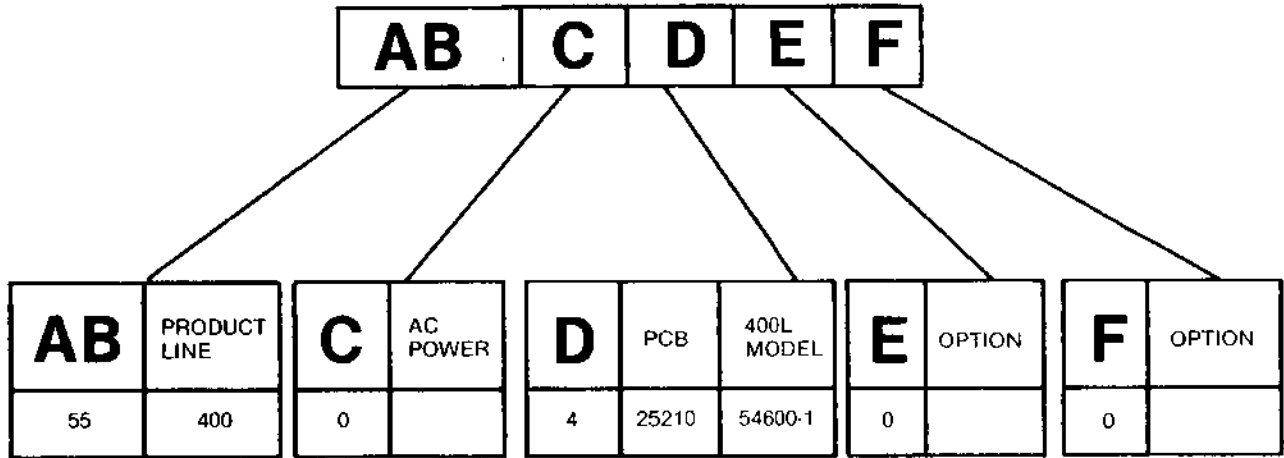
39019-18

FIGURE 9-4. SA400L PACKAGING, 10-PACK

APPENDIX A ORDERING INFORMATION

Table A-1 can be used to construct a unique drive configuration.

TABLE A-1. SA400L ORDERING INFORMATION



39019-15

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