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## SHUGART DISK SYSTEM

This bulletin contains general information describing the Shugart Disk System that is used in WCS (Wang Computer Systems) as the primary storage device and a detailed reference manual published by Shugart Associates and reprinted herein on the Model 901 disk drive.

The WCS documentation is published in a different bulletin.

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## 1. DESCRIPTION

### 1.1 GENERAL

The Shugart Disk System used in the WCS follows the same basic design as our previous disk systems with many improvements to make this system more reliable and easier to service.

The Shugart Disk System consists of a Wang microprocessor controller and power supply mounted on one printed circuit board with one to three Shugart disk drives contained in the unit.

### 1.2 DESIGN FEATURES

The processor and regulator are combined on one PCB (6718) which mounts to the chassis, component side down. The power supply, which includes the transformer filter capacitors and heat sink, is mounted on a removable brace between the microprocessor and the disk drives.

The microprocessor is a condensed version of the same microprocessor used in our other disk systems and the 9 track tape drive (2209). Refer to the Microprocessor Manual for the microprocessor description and operation.

### 1.3 MECHANICAL AND ELECTRONIC DIFFERENCES BETWEEN WCS AND SERIES 40 DISK SYSTEMS

The only shipping clamp on the WCS disk system is a piece of foam taped in the door opening to keep the door open protecting cartridge guide adjustment.

The WCS incorporates one to three Shugart Model 901 disk drives which use an IBM compatible disk cartridge. However, a sectorized format is used rather than the index format used by IBM. This enables the disk

system hardware configuration to remain basically the same as the Memorex series 40 disk systems.

The Shugart Model 901 disk drives use a multiplex option which allows all input and output lines to be parallel. The disk select lines DK1, DK2, and DK3 determine which drive is using these lines.

The stepper motors in the Shugart drive are turned off when the head is unloaded from the disk. This allows the drives to operate much cooler than the Memorex drives. In order to load the head in the Shugart drive, both the drive select and the head load lines must be low or true. The head load line fires a one shot which keeps the head loaded for a time even after the drive select line goes high. This allows the unit to be reselected without waiting for the head to settle to read or write.

Sector and index marks from each drive are monitored individually because they are present at the output of each drive as long as there is a disk cartridge in the drive; these signals are independent of the drive select lines.

The microprocessor PC board has provisions for masked EA chips to be used in place of the 1702As when the microcode has been finalized.

The power supply does not provide a -9V to the 1702As. It is derived from -12V supplied by the 2200. A modification of the I/O controller board is necessary to bring the -12V to the amphenol connector of the I/O cable.

The RAM is 512 x 8 rather than 1024 x 8; this is accomplished by using 2102-2 RAM ICs which are 256 x 4 having 4 bit parallel input/output as opposed to the 1024 x 1 serial input/output.

The only input path to memory in this processor is the C Bus. Data from the disk is sent through the ALU via this bus using an A to M, PC=1 instruction from the ROM.

A newly developed light board has been designed for this processor and special connectors have been incorporated in the processor PC board to monitor the ROM, RAM and the REGISTERS.

St0 and St1 are strictly inputs on the WCS floppy except for one bit, the carry bit which is input and output but cannot be used by the ALU as a bit included in the next result. The carry bit can just be sampled to check its state by the ALU.

The microprogram in the WCS floppy is contained in four (4) 1702 PROM chips and do not require changing if a disk drive is added to the customer's WCS. The PROM numbers and locations are listed below.

L111	L112	L113	L114
378-0452R1	378-0454R1	378-0453R1	378-0455R1

Two 2200 error codes have other possible meanings in the WCS:  
Error 64 is "sector not on disk" but can also mean "no cartridge in the drive, the drive door is open or that the drive is not ready". Error 71 is "cannot find sector" but can also mean "disk is write protected".

## 2. INSTALLATION

The Shugart disk system is shipped completely assembled inside the WCS cabinet. The only shipping clamp is a piece of foam in the door of each drive and a piece of masking tape to hold the foam in place.

The disk system should be disassembled before the unit is powered on to check that the plug-in connectors and components have not shaken loose during shipment. The voltages should also be checked while system is removed from the cabinet.

To remove the disk system from the WCS cabinet follow these instructions.

- 1) Unplug disk system from power strip.
- 2) Unplug I/O cable from CPU.
- 3) Remove the six wing nuts on the bottom of the cabinet.
- 4) An access hole has been provided in the rear of the cabinet so that the disk system can be pushed out toward the front of the cabinet far enough to enable a serviceman to grasp the sides of the unit and pull it out the rest of the way.

### NOTE:

On later Shugart disk systems hand holds are provided on the sides of the chassis.

- 5) If three disk drives are loaded in the unit, it may be beneficial to remove the disk drives before removing the disk system. To remove the disk drive, slide it toward the front of the WCS system until it stops. Tilt the front of the drive down until it can be removed completely from the chassis.
- 6) To remove the processor PC board remove the 6 Phillips head mounting screws on the perimeter of the PC board.

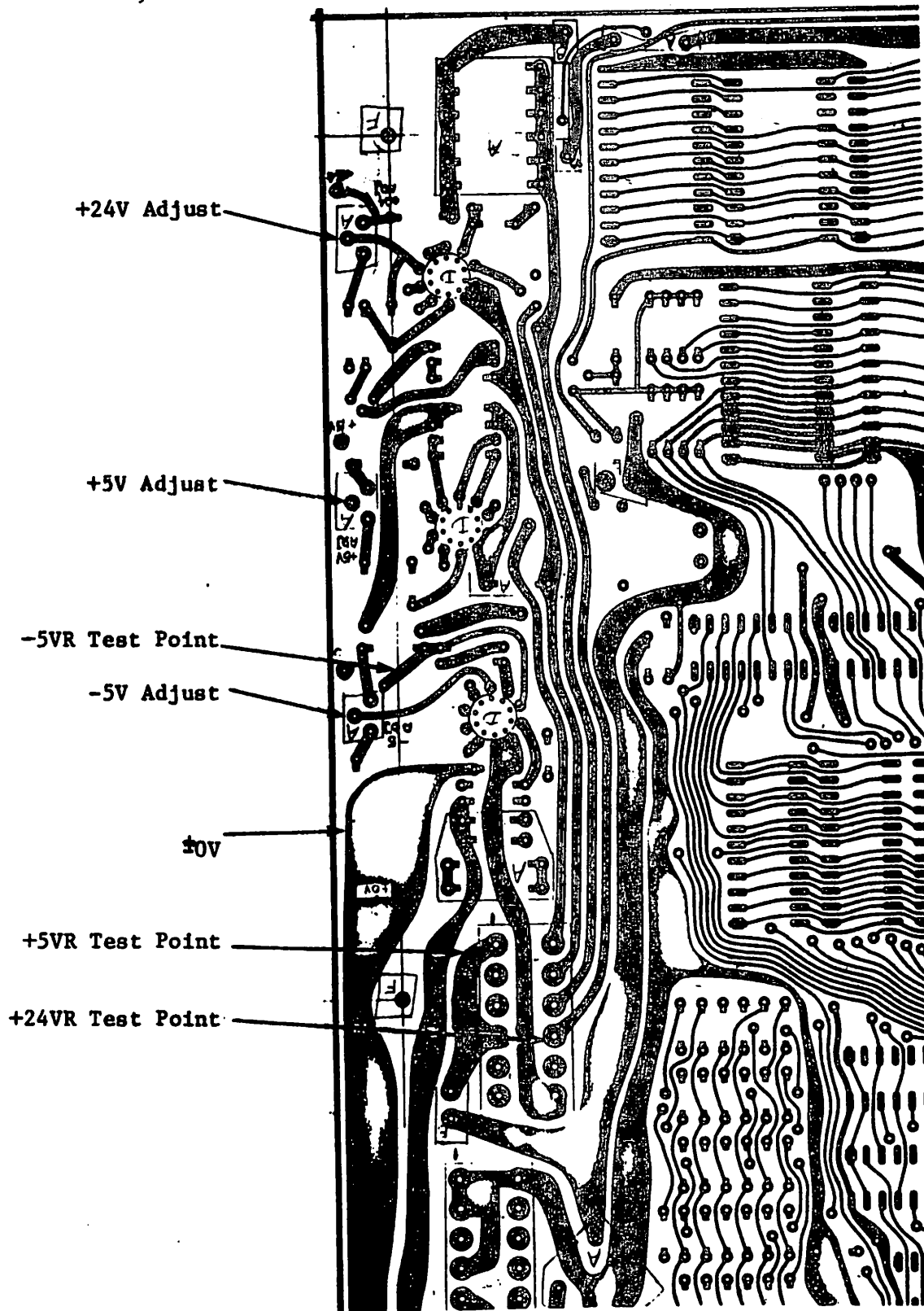
### CAUTION:

Reinstall the nylon washers on each screw. They protect the screws from shorting the PCB art work.

At this time the PC board should be able to be turned 180° toward the front of the cabinet and set down on the rubber grommets with a piece of foam between the PC board and the chassis. The cable strain will keep the PC board from falling forward (test position).

The PC board can be removed by turning it 90° toward the front and removing all the connectors.

- 7) The voltages can be checked from the wire side of the board by following the diagram below and with the I/O and power cable plugged in and the cabinet power switch ON.





The PROM Voltage -9V can be checked on Pin 24 of any one of four PROMS.

The reverse procedure of steps 1-6 can be used to reassemble the Shugart disk system.

NOTE:

Early microprocessor PC boards were not equipped with 90° adjustment pots due to a lack of stock. These should be changed on a service call basis to facilitate the voltage adjustment procedure.

### 3. OPERATION

The front panel of the WCS floppy disk system has three disk select lights, a format pushbutton with a shroud to protect it from accidental formatting and a power light.

There is no format switch to protect static electricity from formatting the disk, but rather an electronic format protect which rejects any attempt to format the disk which does not last for at least 100 ms.

Formatting on the disk system is done on Disk #1 only. This is a hard wired function of Disk #1 and can be initiated by installing a Model 901 diskette in Drive #1 and pushing the format pushbutton. If the diskette or disk drive is faulty and it does not complete the format operation within four attempts the Drive Select Light #1 will flash indicating an error during format.

All operations and addressing of this disk system is the same as the Series 40 disk systems (2242, 2240-2, 2243). Refer to "System 2200 Disk Memory Reference Manual" (WL #700-3159D) for operation codes.

### 4. DIAGNOSTICS

Refer to Service Bulletin #68 (WCS).

### 5. MAINTENANCE

#### 5.1 MICROPROCESSOR

The voltage adjustments covered in Section 2, step 7 should be the only maintenance requirements required in the microprocessor section of the Shugart disk system. The microprocessor PC board at present should be fixed at an area level office.

The Wang power supply is a modular type which is mounted to a removable support bracket and can be replaced in this manner if necessary. The heat sink assembly can also be removed from the support bracket so that component replacement on the heat sink can be made in customer's office.

#### 5.2 DISK DRIVE MAINTENANCE MANUAL

Due to the detailed reference manual published by Shugart Associates, it is reproduced in this bulletin as a reference manual for the Shugart Model 901 disk drive.

## 1.0 INTRODUCTION

### 1.0.1 General Description

The SA900/901 are low cost, highly reliable, direct access, removable Diskette Drives, providing storage for 3.1 million bits of data with a data rate of 250,000 bits/sec.

The SA900 Diskette Storage Drive can read and write data for input or output from the IBM 3740 Data Entry System. Any Shugart Associates, IBM, or equivalent diskette can be read or written on an SA900, IBM 3741, 3742, 3747 or 3540 and be subsequently updated on any of these devices.

The SA901 provides additional flexibility to the system designer who has other requirements that preclude IBM compatibility.

SA900/901 Diskette Storage Drives provide the system designer solutions to his applications requirements with greater performance and reliability than cassette or cartridge drives, and lower cost with increased function over card I/O and reel to reel tape drives.

Applications for the SA900/901 Diskette Storage Drive are key entry systems, point of sale recording systems, batch terminal data storage, microprogram load and error logging, minicomputer program and auxiliary data storage, word processing systems and data storage for small business systems.

The SA900/901 is composed of drive mechanism, read/write head, track positioning mechanism and associated electronics.

The SA100 Diskette, IBM Diskette or equivalent, can be read and written interchangeably between any SA900 and IBM 3751/42, 3747 and 3540. The SA101 Diskette can be read or written interchangeably on any SA901.

### 1.0.2 Specification Summary

#### 1.0.2.1 Performance Specifications

Capacity (Unformatted)	Per Disk	3.1 megabits
	Per Track	41 kilobits
Data Transfer Rate		250 kilobits/second
Access Time	Track to Track	10 ms
	Setting Time	10 ms
Average Access Time		260 ms
Rotational Speed		360 RPM
Average Latency		83 ms
Recording Mode		Frequency Modulation

### 1.0.2.2 Media Characteristics

Cartridge Required	SA900	SA100 or IBM "Diskette"
	SA901	SA101
Physical Sectors	SA900	0
	SA901	32
Index		1
Tracks		77
Density	Recording	3200 bpi (approx. inside track)
	Track	48 TPI

### 1.0.2.3 Additional Features for SA900/901

50 Hz 110 VAC, single phase  
60 Hz 208/230 VAC, single phase  
50 Hz 208/230 VAC, single phase

Write Protect (Optional SA900-Standard SA901)

- 12 to -15V to replace -5VDC

User Installed Features:

- Multiplex Interface
- Radial Interrupt
- Radial Rotational Sensing
- Radial Head Load
- Radial DC Power Connector

## 1.1 FUNCTIONAL CHARACTERISTICS

### 1.1.1 General Operation

The SA900/901 Diskette Drive consists of read/write and control electronics, drive mechanism, read/write head, track positioning mechanism, and the removable Diskette. These components perform the following functions:

- Interpret and generate control signals.
- Move read/write head to the selected track.
- Read and write data.

The relationship and interface signals for the internal functions of the SA900/901 are shown in Figures 1.1 and 1.2 respectively.

The Head Positioning Actuator positions the read/write head to the desired track on the Diskette. The Head Load Actuator loads the Diskette against the read/write head and data may then be recorded or read from the Diskette.

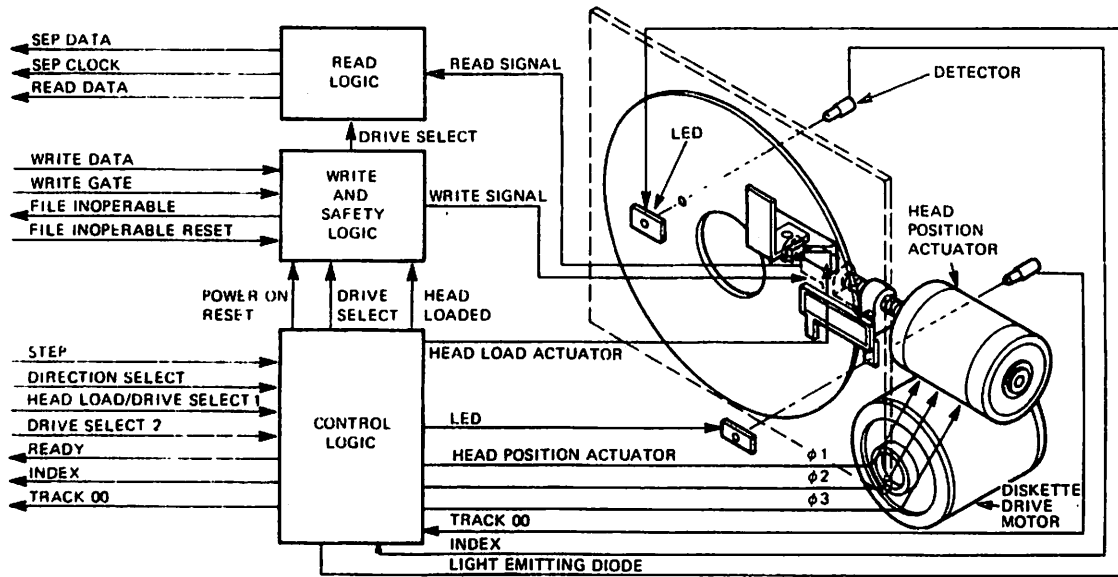


Figure 1.1 SA900 Functional Diagram, One Sector Hole

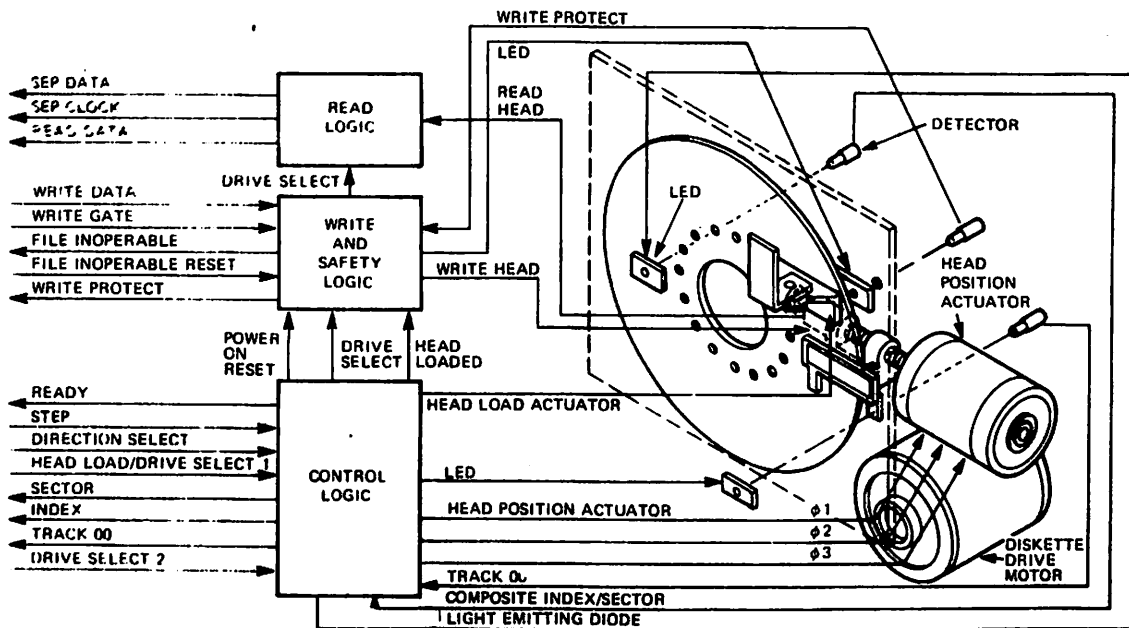


Figure 1.2 SA901 Functional Diagram, 32 Sector Holes

The electronics are packaged on one PCB. The PCB contains:

1. Index Detector Circuits (Sector/Index for 901).
2. Head Position Actuator Driver
3. Head Load Actuator Driver
4. Read/Write Amplifier and Transition Detector
5. Data/Clock Separation Circuits
6. Safety Sensing Circuits
7. Write Protect
8. Drive Ready Detector Circuit
9. Drive Select Circuits

An electrical stepping motor (Head Position Actuator) and lead screw positions the read/write head. The stepping motor rotates the lead screw clockwise or counterclockwise in  $15^\circ$  increments. A  $15^\circ$  rotation of the lead screw moves the read/write head one track position. The using system increments the stepping motor to the desired track.

The Diskette drive motor rotates the spindle at 360 rpm through a belt-drive system. 50 or 60 Hz power is accommodated by changing the drive pulley. A registration hub, centered on the face of the spindle, positions the Diskette. A clamp that moves in conjunction with the latch handle fixes the Diskette to the registration hub.

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

The SA900/901 head is a single element read/write head with straddle erase elements to provide erased areas between data tracks. Thus normal tolerance between media and drives will not degrade the signal to noise ratio and insures Diskette interchangeability.

The read/write head is mounted on a carriage which is located on the Head Position Actuator lead screw. (See Figure 1.3.) The Diskette is held in a plane perpendicular to the read/write head by a platen located on the base casting. This precise registration assures perfect compliance with the read/write head. The Diskette is loaded against the head with a load pad actuated by the head load solenoid.

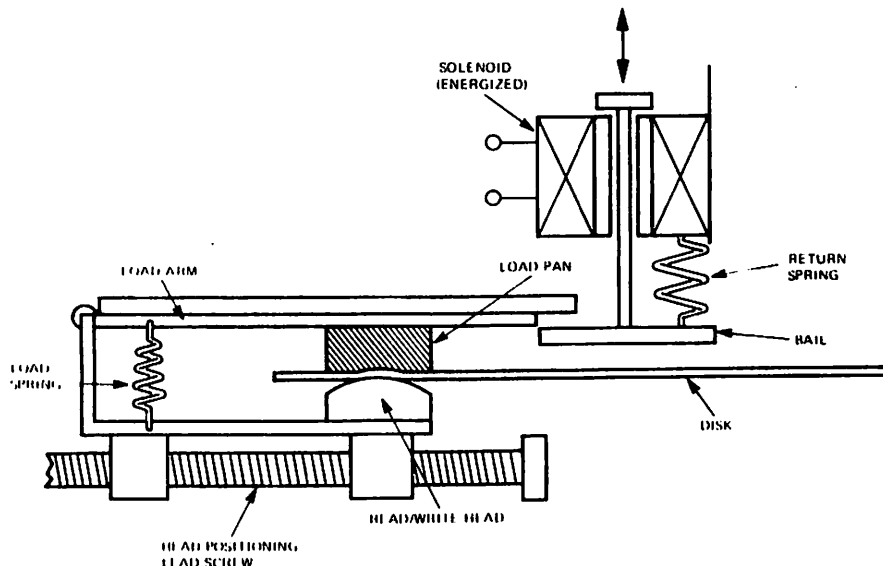


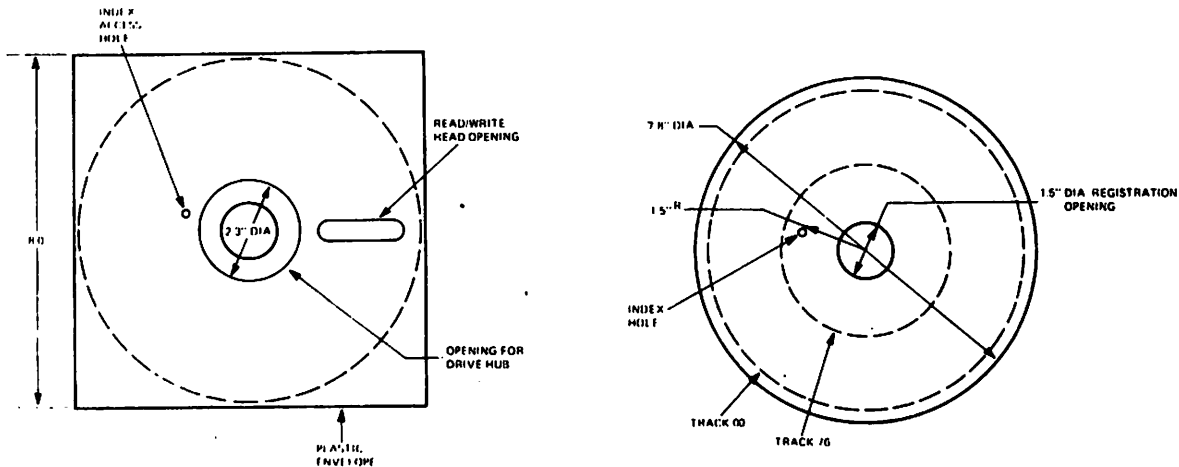
Figure 1.3 Head Load and Carriage Assembly

### 1.1.2 Diskette

The recording media used in the SA900 diskette Storage Drive is a Mylar\* disk enclosed in a plastic envelope. The characteristics of the disk and envelope are:

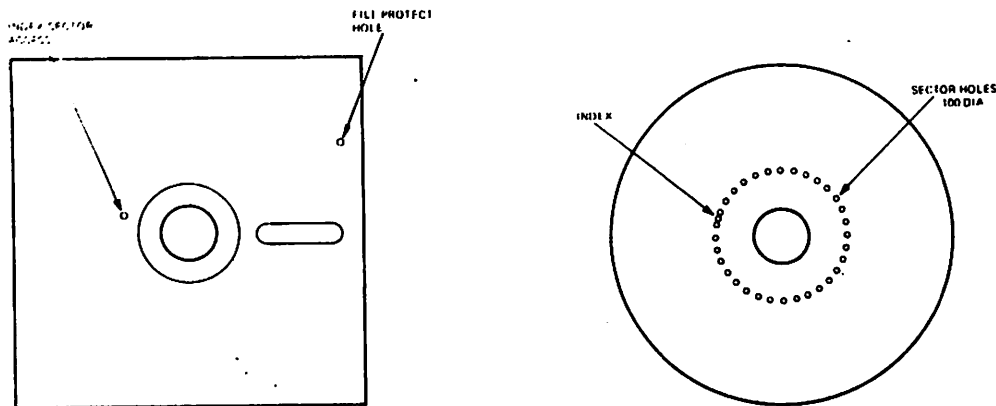
Disk Diameter	7.875 inches
Envelope Size	8 inches x 8 inches
Rotational Speed	360 RPM
Rotational Period	166.67 ms
Average Latency	83.33 ms
Number of Tracks	77
Bit Density Inside Track	3200 bpi approx.

The SA100 Diskette media is IBM compatible and can be used in the SA900 or the IBM 3740 Data Entry System. (See Figure 1.4).



**Figure 1.4 SA100 Diskette and Cartridge Layout**

The SA101 Diskette is used with the SA901 and differs from the SA100 in that there are 32 sector holes and a write protect hole. (See Figure 1.5).



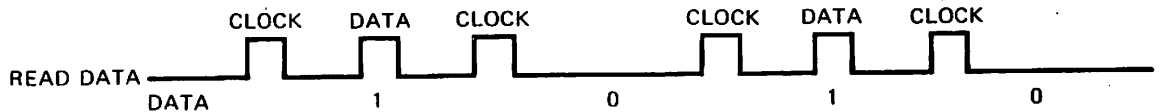
**Figure 1.5 SA101 Diskette and Cartridge Layout**

\*Trademark of Dupont Corp.

### 1.1.3 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 users application to best take advantage of the total available bits that can be written on any one track. The data written on the disk is recorded using a frequency modulation technique as shown in Figure 1.6.

For detailed discussion of IBM 3740 compatibility, the system designer should read Shugart Associates Guide to IBM 3740 Compatibility (Publication number SA 0006-3).

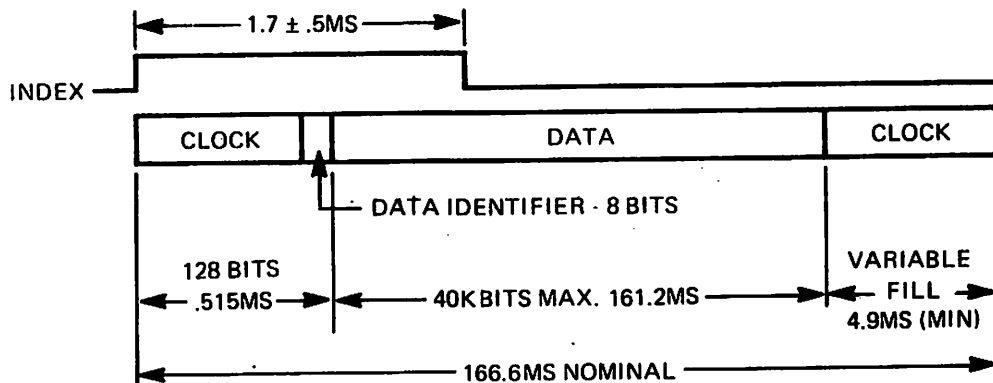


DATA PATTERN ILLUSTRATED = 1010

BASIC TRACK CHARACTERISTICS:

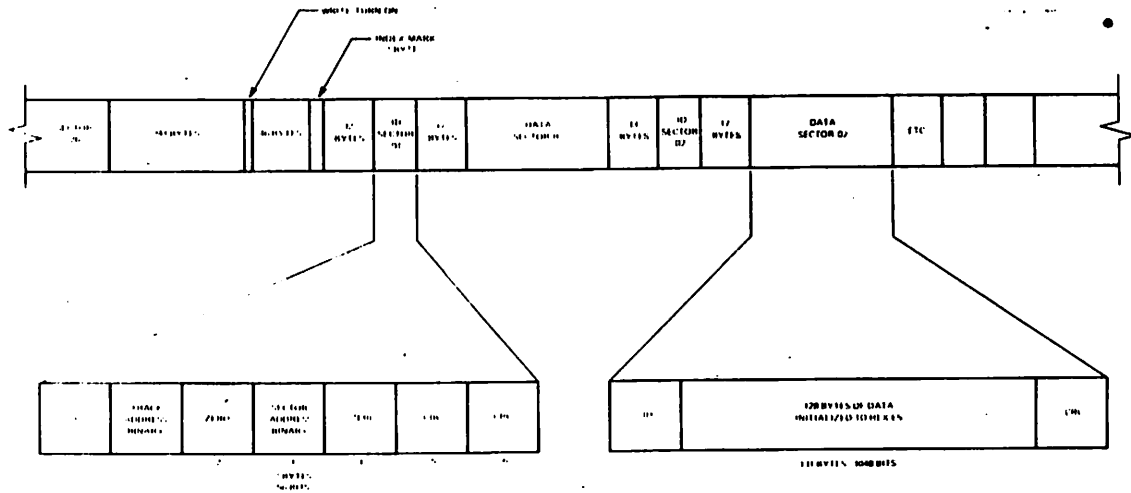
NUMBER OF BITS/TRACK	41,300 BITS
INDEX PULSE WIDTH	1.7 MS
SECTOR PULSE WIDTH (SA901) ONLY	.4 MS

Figure 1.6 Data Format



SA900 RECORDING FORMAT USING INDEX RECORDING

Figure 1.7 Index Recording Format



IBM TRACK FORMAT USED WITH THE SA900

Figure 1.8 IBM Track Format

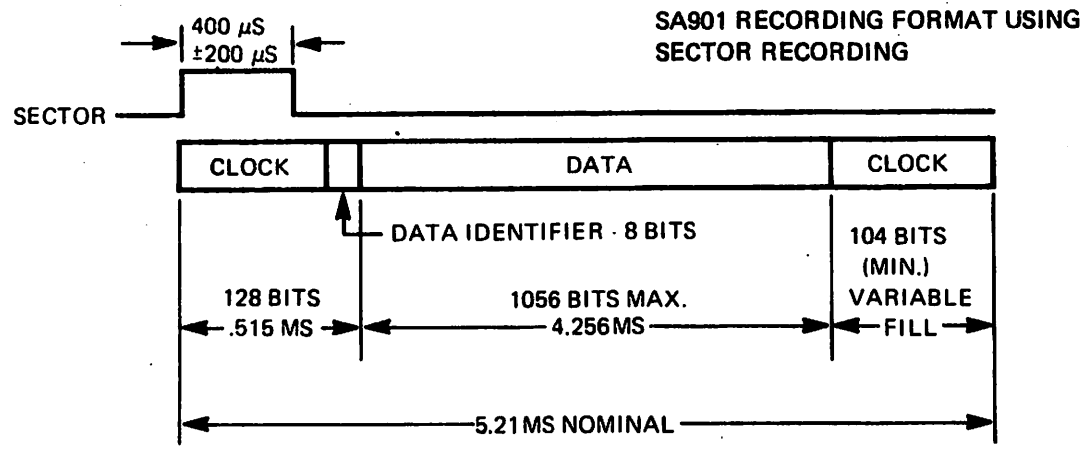


Figure 1.9 Sector Recording Format (SA 901 Only)

1.1.4 Track Accessing

Seeking the R/W head from one track to another is accomplished by selecting the desired direction utilizing the Direction Select interface line and then pulsing the Step line. Multiple track accessing is accomplished by repeated pulsing of the Step line until the desired track has been reached. Each pulse on the Step line will cause the R/W head to move one track either in or out depending on the Direction Select line.

The head load line must be active (logical 0 level) in order to activate the stepper. When not Accessing, Reading or Writing it is not necessary to have power to the stepper, therefore, the head load line controls the 24 volts to the stepper motor which allows it to remain cooler. This function can be crippled by cutting a trace which has been provided on the PCB. This trace has been labeled "R" for easy identification.



#### 1.1.4.1 Step Out

With the Direction Select line at a plus logic level (2.5V to 5.5V) a pulse on the Step line will cause the R/W 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 1.10.

#### 1.1.4.2 Step In

With the Direction Select line at a minus logic level (0V to .4V), a pulse on the Step line will cause the R/W 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 1.10.

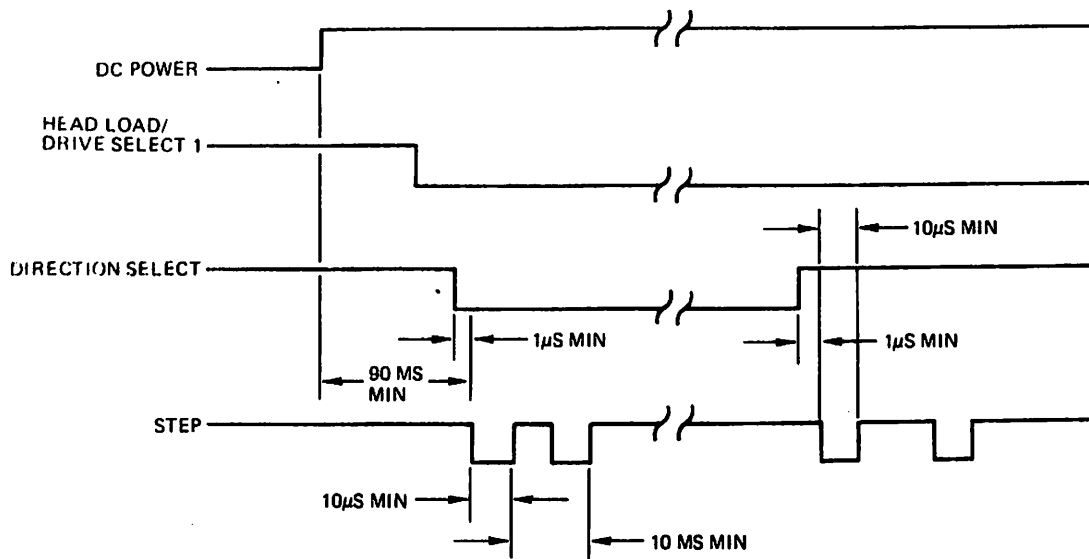


Figure 1.10 Track Access Timing

#### 1.1.5 Read Operation

Reading data from the SA900/901 Diskette Storage drive is accomplished by activating the interface line, "Head Load" and "Write Gate" is not active. The timing relationships required to initiate a read sequenced are shown in Figure 1.11.

These timing specifications are required in order to guarantee that the R/W head position has stabilized prior to reading.

Once reading has commenced, the two interface lines, Separated Data and Separated Clock provide the read data. The timing of the read signals, Separated Data, and Separated Clock are shown in Figure 1.12.

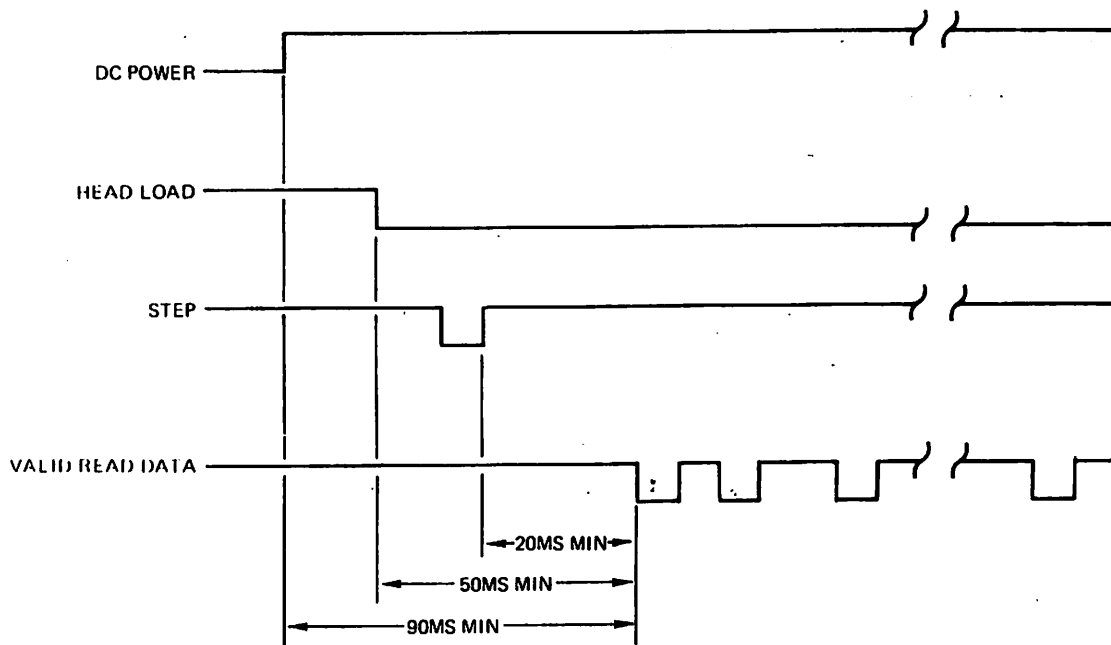


Figure 1.11 Read Initiate Timing

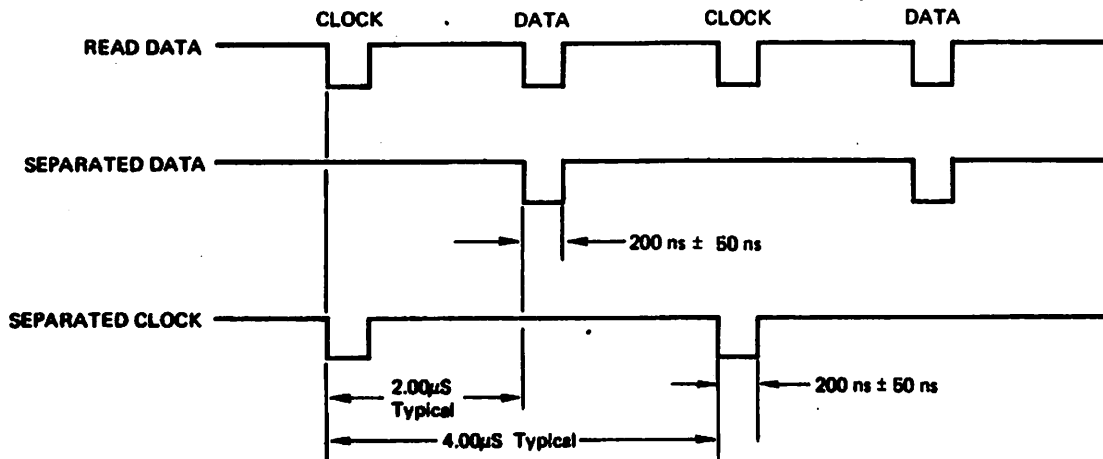


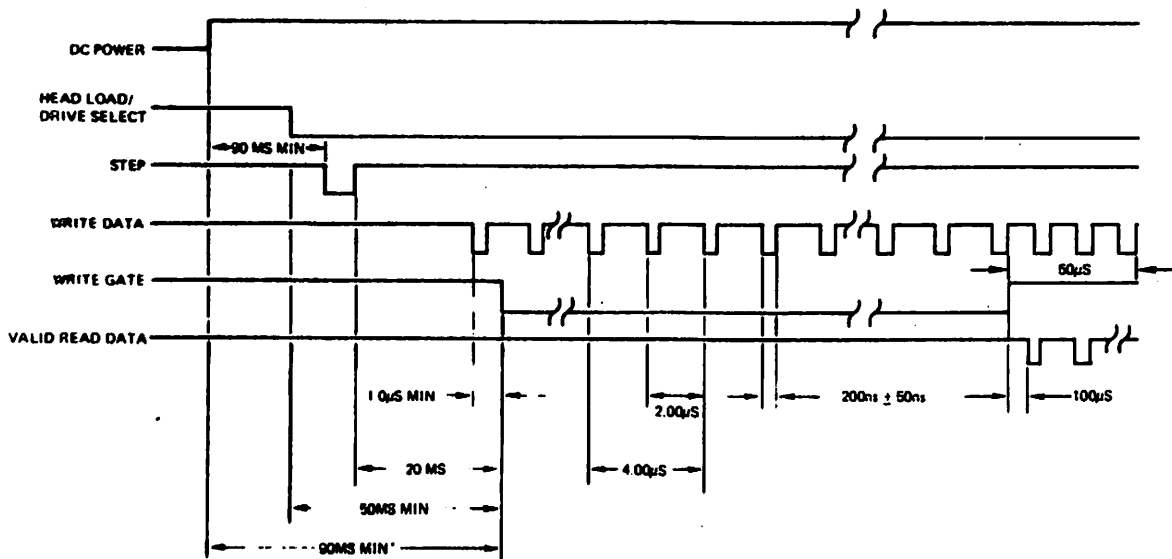
Figure 1.12 Read Signal Timing

### 1.1.6 Write Operation

In order to write data on the SA900/901 Diskette Storage drive, certain timing relationships must be assured. These timing requirements are required to:

1. Avoid destroying data due to a hardware failure or the position of the R/W head has not stabilized.

These timing requirements are defined in Figure 1.13.



\*2 SECONDS IF AC AND DC POWER ARE APPLIED AT SAME TIME

**Figure 1.13 Write Initiate Timing**

In order to ensure that a hardware failure or operator interference does not cause the unintentional loss of data, data safety circuitry is provided. If the data safety circuitry detects an undesirable condition within the drive a latch is set, writing is inhibited, and the signal File Inoperable is sent to the user. File Inoperable is defined by:

$$\begin{aligned} \text{File Inoperable} = & \text{(Write Gate)} \quad \overline{\text{Write I Sense}} \\ & + (\text{Write Gate}) \quad \overline{\text{Write I Sense}} \\ & + (\text{Write Gate}) \quad \overline{\text{Head Load}} \\ & + (\text{Write Gate}) \quad \overline{\text{Write Data}} \\ & + (\text{Write Gate}) \quad \overline{\text{Door Closed}} \end{aligned}$$

### 1.1.7 Power Sequencing

Applying AC and DC power to the SA900/901 can be done in any sequence, however, once AC power has been applied, a 2 second delay must be introduced before any Read or Write operation is attempted. This delay is for stabilization of the Diskette rotational speed. Also, initial position of the R/W head with respect to data tracks is indeterminant immediately after application of DC power. In order to assure proper positioning of the R/W head prior to any read/write operation, a Step Out operation should be performed until the Track 00 indicator becomes active.

The Head Load signal can be applied any time after DC power has been applied, however, the signal must be true for a minimum of 50 ms prior to a read or write operation.

## 1.2 ELECTRICAL INTERFACE

The interface of the SA900/901 Diskette drive can be divided into two categories: Signal and Power. The following sections provide the electrical definition for each line.

### 1.2.1 Signal Interface

The signal interface consists of the lines required to control the SA900/901 Diskette Storage drive and transfer data to and from the unit. All lines in the signal interface are digital in nature and either provide signals to the drive (input) or provide signals to the user (output).

There are seven (7) input signal lines to the SA900/901 Diskette Storage drive; each line has the following input specifications, except as noted.

$V_{in} = 0V-.4V = \text{logical zero} = \text{true} = \text{active}$

$V_{in} = 2.5V-5.5V = \text{logical one} = \text{false} = \text{inactive}$

Input Impedence =  $150\Omega$

There are seven (7) output signal lines from the SA900 Disk Storage Drive, and nine (9) from the SA901. Each line has the following output specifications:

$V_{out} = 0V-.4 = \text{logical zero} = \text{true} = \text{active}$

Each output line appears as an open circuit (transistor in cut-off) for the logical one level. (False = inactive).

Maximum sink current = 48 ma., except as noted.

#### 1.2.1.1 Direction Select

This interface signal defines the direction of motion of the R/W head when the Step line is pulsed. An open circuit or logical one level defines the direction as out and if a pulse is applied to the Step line the R/W head will move away from the center of the disk. Conversely, if this input is shorted to ground or a logical zero level is applied the direction of motion is defined as in and if a pulse is applied to the Step line the R/W head will move towards the center of the disk.

#### 1.2.1.2 Step

This interface line is a control signal which causes the R/W head to move with the direction of motion defined by the Direction Select line. The access motion is initiated on each logical zero to logical one transition of this signal. The timing restrictions on this signal are shown in Figure 1.10.

#### 1.2.1.3 Head Load/Drive Select 1

This interface line performs two functions on all machines at or above E.C. level 45. (The EC level can be found in the rear upper corner of the PCB). One function is to remove the 24 volts from the stepper motor which will allow the motor to run cooler. This means that in order to step, the Head Load line must be a logical 0 level. This function can be disabled by cutting a trace on the PCB. Then 24 volts will be applied to the stepper at all times. This trace has been labeled "R" for easy identification.

It also is a control signal to an actuator that allows the disk to be moved into contact with the R/W head before a Read/Write operation. An open circuit or logical one deactivates the head load actuator and causes a bail to lift the pressure pad from the disk, which removes the load from the disk and R/W head. A logical zero level on this signal activates the head load actuator and allows the pressure pad to bring the disk into contact with the R/W head with the proper contact pressure. Also, see Multiplex Interface, for Drive Select 1 usage.

#### 1.2.1.4 File Inoperable Reset

This interface line provides a direct reset on the File Inoperable latch. The inactive level for this signal is a logical one. The File Inoperable condition is reset with a logical zero level applied to this line.

#### NOTE:

Under no circumstances should the drive be operated with this signal at a constant logical zero level since all data safety circuitry will be defeated.

#### 1.2.1.5 Write Gate

Write Gate is an interface line which controls the writing of data on the disk. A logical one level on this interface line turns off the current source to the write drivers along with the current sinks for the write current. A logical zero level on this line enables the write current source and current sinks, and disables the stepping circuitry.

#### 1.2.1.6 Write Data

This interface line provides the data to be written on the disk and each transition from the logical one level to logical zero level causes the current through the R/W head to be reversed. Input impedance for Write Data = 100Ω.

#### 1.2.1.7 Drive Select 2

For this line, see Multiplex Interface, paragraph 1.2.3

### 1.2.1.8 Index

This interface signal is provided by the disk drive once each revolution (166.67 ms) to indicate the beginning of the track. Normally, this signal is a logical one level and makes the transition to the logical zero level for a period of 1.7 ms (.4 ms SA901) once each revolution. The timing of this signal is shown in Figure 1.14

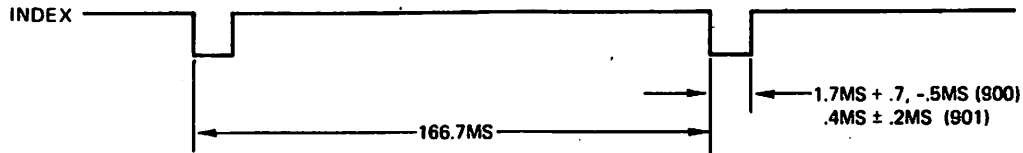


Figure 1.14 Index Timing

### 1.2.1.9 Track 00

The Track 00 interface signal indicates when the R/W head is positioned at track zero (the outer most data track) and the access circuitry is driving current through phase one of the stepping motor (Head Load signal true). This signal is at a logical one level when the R/W head is not at track zero and is at a logical zero level when the R/W head is at track zero.

### 1.2.1.10 File Inoperable

File Inoperable is the output of the data safety circuitry and is at a logical zero level when a condition which jeopardizes data integrity has occurred. Logically, the signal is defined as follows:

$$\begin{aligned} \text{File Inoperable} = & \overline{(\text{Write Gate} \ \underline{\text{Write I Sense}})} \\ & + (\text{Write Gate} \ \underline{\text{Write I Sense}}) \\ & + (\text{Write Gate} \ \underline{\text{Head Load}}) \\ & + (\text{Write Gate} \ \underline{\text{Write Data}}) \\ & + (\text{Write Gate} \ \underline{\text{Door Closed}}) \end{aligned}$$

### 1.2.1.11 Sector (SA901 Only)

This interface signal is provided by the disk drive 32 times each revolution. Normally, this signal is a logical one level and makes the transition to the logical zero level for a period of .4 ms 32 times each revolution. The timing of this signal is shown in Figure 1.15.

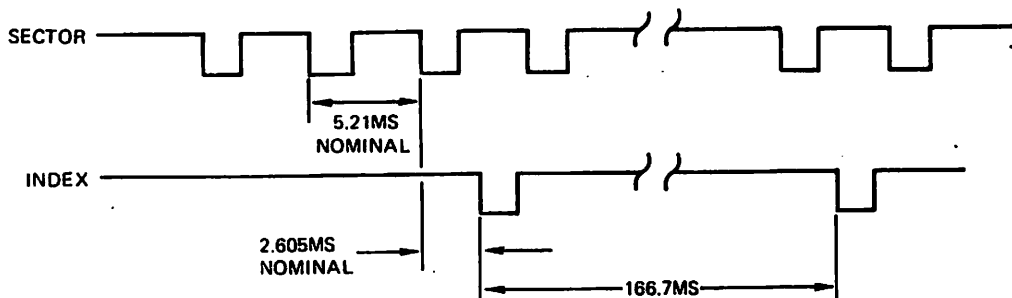


Figure 1.15 Index/Sector Timing

#### 1.2.1.12 Write Protect

(Standard on 901 - Optional on 900)

This interface signal is provided by the disk drive to allow the user an indication when a write protected diskette is installed. The signal is a logical one level when the diskette is not protected and a logical zero when it is protected.

#### 1.2.1.13 Separated Data

Separated Data is the interface line over which read data is sent to the using system. The frequency modulated signal written on the disk is demodulated by the drive electronics and the data pulses are sent to the using system over this interface line. Normally, this signal is a logical one level and each data bit recorded on the disc causes a transition to the logical zero level for 200 ns. The timing for this signal is shown in Figure 1.12. Maximum sink current = 100 ma.

#### 1.2.1.14 Separated Clock

The Separated Clock interface line provides the using system the clock bits recorded on the disk in frequency modulation recording. The levels and timing are identical to the Separated Data line except that a separated clock pulse occurs each  $4\mu\text{s}$ , instead of in multiples of  $4\mu\text{s}$ . Maximum sink current = 100 ma.

#### 1.2.1.15 Read Data

The Unseparated Read Data interface line provides raw data (clock and data bits together) to the using system that requires it. The levels and timing for this signal are shown in Figure 1.12. Maximum sink current = 100 ma.

#### NOTE:

The "Separated Data," Separated Clock and "Unseparated Read Data" signals are not valid for  $100\mu\text{s}$  following turnoff of "Write Gate." See Figure 1.13.

#### 1.2.1.16 Ready

This interface signal is provided to indicate to the user that a diskette is installed properly, the door is closed, and that two index or sector pulses have been detected (diskette is turning). This signal is at a logical one level when not ready and is at a logical zero level when ready.

#### 1.2.2 Power Interface

The SA900/901 Diskette Storage Drive requires both AC and DC power for operation; the AC power is used for the drive motor while the DC power is used for the electronics and stepping motor. The power requirements are defined in the following sections.

### 1.2.2.1 AC Power

110  $\pm$  10% VAC @ .75A  
50/60  $\pm$  .5 Hz single phase

### 1.2.2.2 DC Power

+5  $\pm$  0.25 VDC @ 1.5A max. 50 mV ripple  
-5  $\pm$  0.25 VDC @ .20A max. 50 mV ripple  
+24  $\pm$  1.20 VDC @ 2.0A max. 100 mV ripple

### 1.2.2.3 DC Power Options (-5 VDC Replacement)

-12 to -15 VDC  $\pm$  1V @ .20A. max. 50 mV ripple (Cut trace "L").

The PCB has been designed to accept a six circuit amp printed circuit board pin header assembly Amp P/N 1-380999-0 which mates with socket housing Amp P/N 1-480270-0 and socket P/N 60619-1. This connector will allow the user to bring the DC power to the drive in a cable separate from the signal cable. Both connectors are user installed.

### 1.2.3 Multiplex Interface

The multiplex interface is a user installed feature of the SA900/901. This feature gives the design engineer the capability of interfacing two or more drives together on one interface cable.

There is a point on the PCB that if jumpered (Jumper "E") converts the Head Load line, pin L18, into Drive Select 1 line. With this jumper installed, only the drive with a low level on pin L18 will respond or output to the Control Unit (Interface lines). This will allow all interface lines to be wire "ORED" on the cable from drive to drive with the exception of Drive Select 1 (Head Load, L18). Each drive should have its own Drive Select 1 line from the Control Unit. Since the inputs to the PCB's are all terminated, traces have been provided that will remove the terminations if cut. The traces are labeled as follows:

Trace "F"	Write Data Termination
Trace "G"	File Inop Reset Termination
Trace "H"	Write Gate Termination
Trace "J"	Direction Select Termination
Trace "K"	Step Termination

The last drive on the interface must be terminated or the user may elect to terminate the five affected lines externally, thereby maintaining uniformity in the drive PCB's, i.e. all traces cut the same.

For the user who is using only two drives "Drive Select 2" pin L13 has been provided. There are two ways to use this line.

1. As shipped from the factory it is open and makes no connection. Pin L18 "Head Load" or "Drive Select 1," goes through trace "A" and selects the drive. If trace "A" is cut and jumper "B" is installed pin L13 "Drive Select 2" does the function of drive select. This will allow the user to have a one to one cable from the control unit to drive one to drive two.

CU	Drive 1	Drive 2
Drive Select 1	L18	L18
Drive Select 2	L13	L13



Traces cut or jumpers installed for each drive would be as follows:

	Drive 1	Drive 2
Trace "A"	shorted	cut
Jumper "B"	open	installed
Jumper "E"	installed	installed
Trace "F"	cut	shorted*
Trace "G"	cut	shorted*
Trace "H"	cut	shorted*
Trace "J"	cut	shorted*
Trace "K"	cut	shorted

\*If external termination is provided this trace can be cut.

2. If a one to one cable is not required, the drive select lines could rotate as they go from drive to drive.

CU	Drive 1	Drive 2
Drive Select 1	L18	L18
Drive Select 2	L13	L13

This would allow both drives to be alike except one is terminated and the other one is not. If the user provided his own termination for the five interface lines, then both drives would be identical.

Traces cut or jumpers installed for each drive would be as follows:

	Drive 1	Drive 2
Trace "A"	shorted	shorted
Jumper "B"	open	open
Jumper "E"	installed	installed
Trace "F"	cut	shorted*
Trace "G"	cut	shorted*
Trace "H"	cut	shorted*
Trace "I"	cut	shorted*
Trace "J"	cut	shorted*
Trace "K"	cut	shorted*

\*If external termination is provided this trace can be cut.

A typical multiplexed system is illustrated in Figure 1.16.

### 1.2.3.1 Radial Interrupt Feature

When utilizing the Multiplex Interface feature (Jumper "E" installed), the Radial Interrupt feature will allow the user to monitor the Ready state of each drive on the interface. This can be used to detect when an operator has removed or installed a diskette in any drive. Cutting Trace "M" on the PCB will activate this feature by allowing the Ready line to be present on the interface at all times; i.e. normally, Ready is only presented when the drive is selected. This feature requires a Ready line from each drive to the control unit.

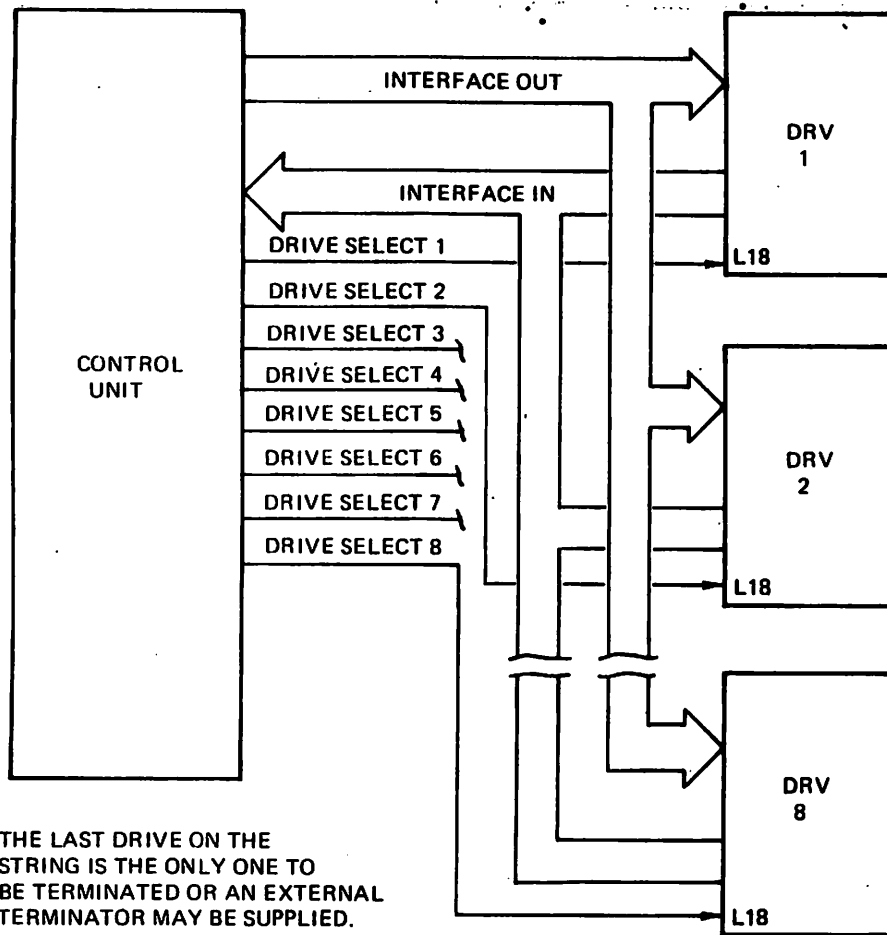


Figure 1.16 Typical Multiplexed System

### 1.2.3.2 Radial Rotational Position Sensing Feature

When the Multiplex feature is active (Jumper "E" installed) on the SA901 the user may find it desirable to monitor sector and index at all times so that he may select the drive just prior to the sector which he wishes to process. To do this, Trace "S" on the PCB must be cut and a line from each drive to the control unit for both sector and index. Used properly, this feature can reduce average latency time to about 55 Msec.

### 1.2.3.3 Radial Head Load Feature

When the Multiplex feature is active (Jumper "E" installed), the head is loaded when the drive is selected, pin L18 active. The Radial Head Load feature allows the user to load the head without selecting the drive. This is accomplished by connecting Jumper "B", cutting Trace "C" and connecting Jumper "D". The Head Load (L18) and Drive Select (L13) interface lines must come to each drive from the control unit. The drive will only be selected if both Head Load (L18) and Drive Select (L13) are active (low level). Use of this feature will eliminate the 50 Msec head settling delay in disk to disk copy operations.

### 1.3 PHYSICAL SPECIFICATIONS

#### 1.3.1 Dimensions

The overall dimensions of the SA900/901 Disk Storage drive are:  
(See Figure 1.18).

Height:	10.0 or 11.0 inches
Width:	5 1/4 inches
Depth:	14 1/4 inches
Weight:	15 pounds

#### 1.3.2 Environment

Temperature:	60°F to 100°F
Relative Humidity:	20% to 80% with maximum wet bulb temperature of 78°F
Heat Dissipation:	275 BTU/Hour

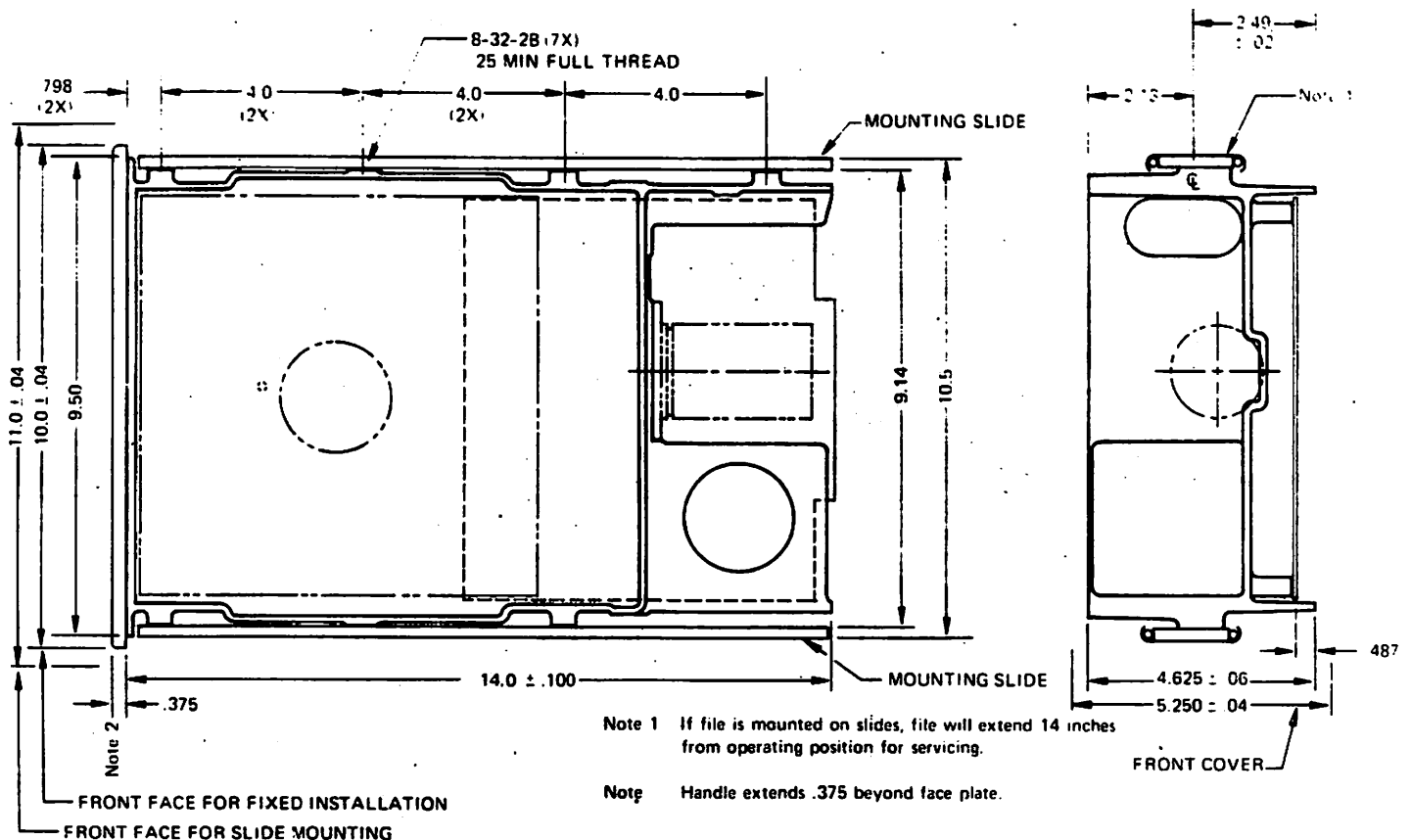


Figure 1.18 SA 900/901 Diskette Storage Drive Dimensions

## 1.4 RELIABILITY SPECIFICATIONS

### 1.4.1 Read Error Rate

$1 \times 10^9$  bits read/soft error (nominal)  
 $1 \times 10^{12}$  bits read/hard error (nominal)

### 1.4.2 Seek Error Rate

1 seek error in  $10^6$  seeks

## 1.5 INTERFACE DESCRIPTION

The electrical interface between the SA900/901 and the host system is via two connectors - the first connector (P1) provides for all signals and DC power for the diskette while the second connector (P4) provides for AC power and frame ground.

Connection to P1 is through a PCB edge card connector. The dimensions for this connector are shown in Figure 1.19. The pins are labeled L1 through L22 on one side of the PCB and R1 through R22 on the other side. Pin L1 is located on the component side of the PCB closest to the AC capacitor and is labeled L1. A key slot is provided between pins 6 and 7 to insure proper connector positioning.

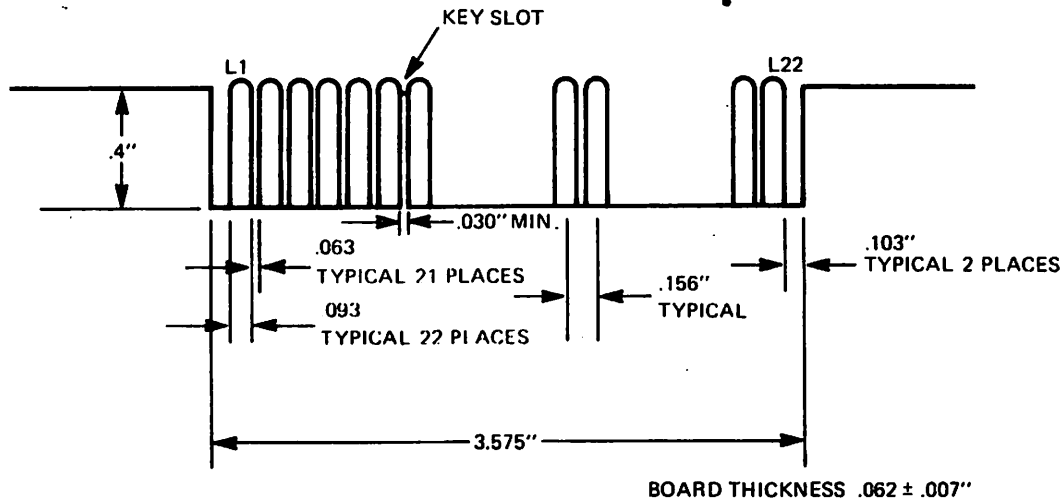


Figure 1.19 Connector Dimensions

The recommended connector for P1 is AMP Twin Leaf Printed Circuit Edge connector P/N583859-3 utilizing AMP contacts P/N1-583616-1 and intercontact plug P/N583274-1. AC power and frame ground is provided for through a 3-circuit panel mount connector. The pin housing for the connector is mounted in the SA900/901 and is AMP P/N 1-480305-0 with AMP pins P/N 60620-1. The user should use AMP socket P/N 1-480304-0 with AMP pins P/N 60619-1.

Figure 1.20 shows the total interconnection of the SA900/901 with the host system.

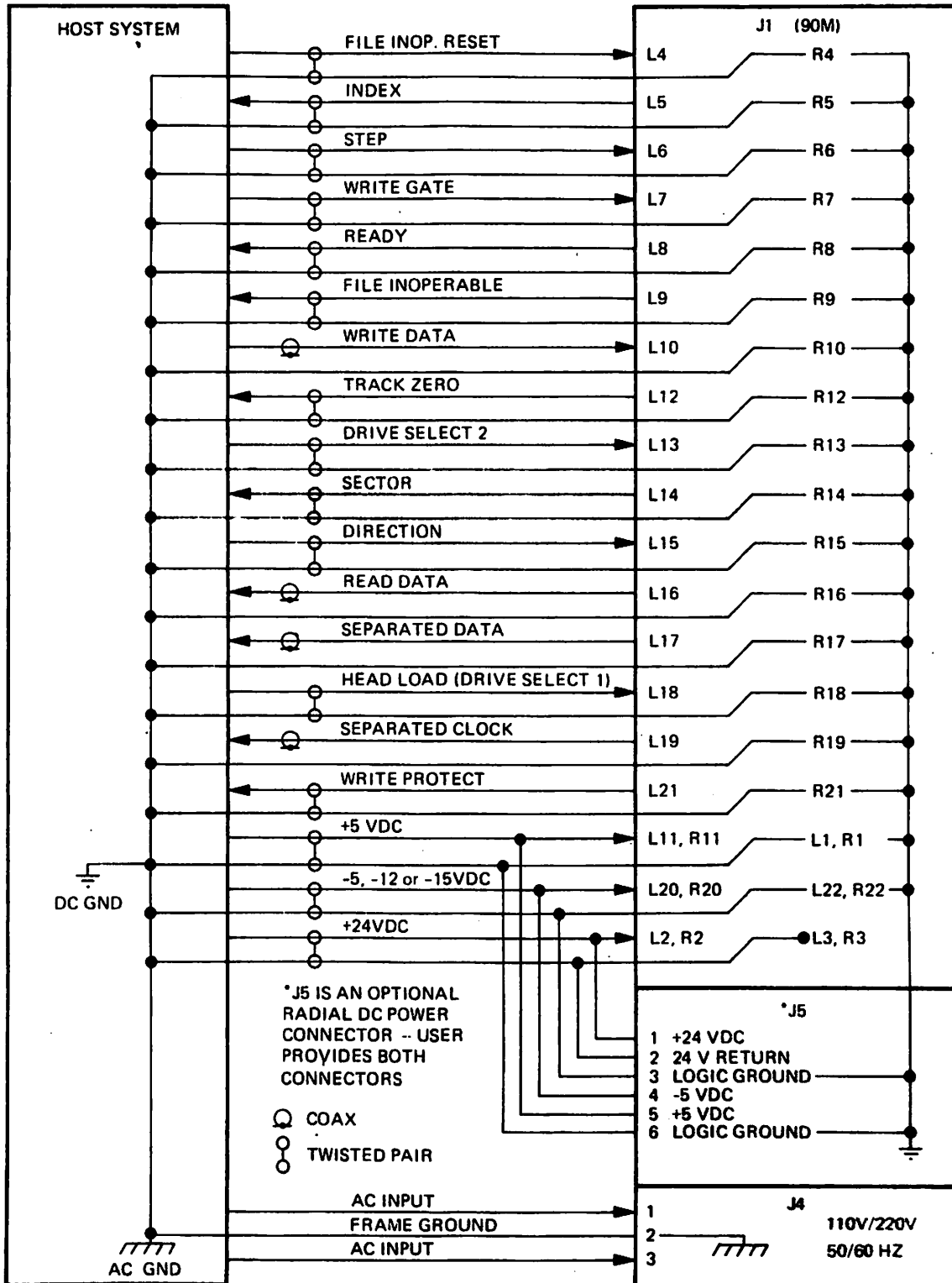


Figure 1.20 Interface Lines

## 1.6 INTERFACE CIRCUITRY

Shugart Associates provides interface circuitry to connect the SA900/901 with the host system via lines with 150 ohms characteristic impedance. For control signals, and 100 ohms characteristic impedance for data signals. The drivers and receivers are divided into two categories - those lines carrying data and those lines carrying control information.

The following two sections describe the circuitry recommended for interfacing the SA900/901 with the host system.

### 1.6.1 Data Line Driver

The line drivers for these interface signals must be capable of sinking 55 ma. in the logical true state with the maximum voltage in this state no greater than .3 volts with respect to logic ground. When the line driver is in the logical false state, the driver transistor is in cutoff and the voltage at the output of the driver should be no less than 3.0 volts with respect to logic ground.

### 1.6.2 Data Line Receiver

The line receiver for the four interface lines is basically a Schmitt trigger with the switching threshold at 1.7 volts to enhance the noise immunity on these signal lines. The signal line is terminated in  $100\Omega$  (+5%) for use with 93 to  $100\Omega$  coaxial cable.

Figure 1.21 shows the interface circuitry for the Read Data, Separated Data, Separated Clock, and Write Data interface lines.

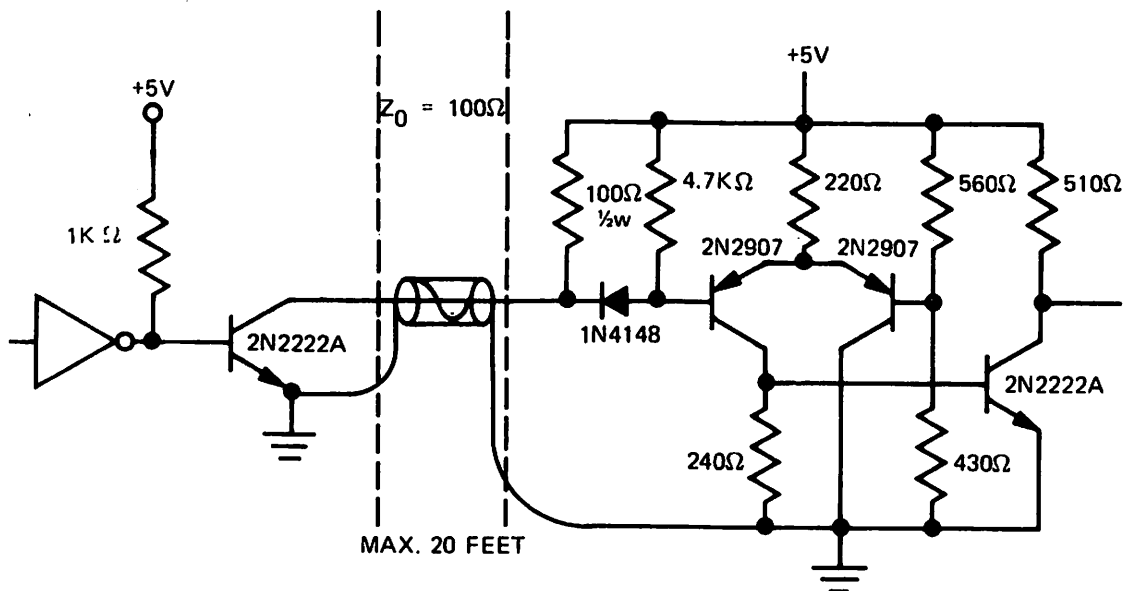


Figure 1.21 Data Line Driver/Receiver Combination

### 1.6.3 Control Line Driver

The line Driver for these signals consist of TTL 7438 devices. The driver must be able to sink a maximum of 48 ma. in the logical true state with a maximum voltage of .3 volts with respect to logic ground. When the line driver is in the logical false state the driver transistor is in cutoff and the collector cutoff current should be not greater than 10 nanoamperes.

### 1.6.4 Control Line Receiver

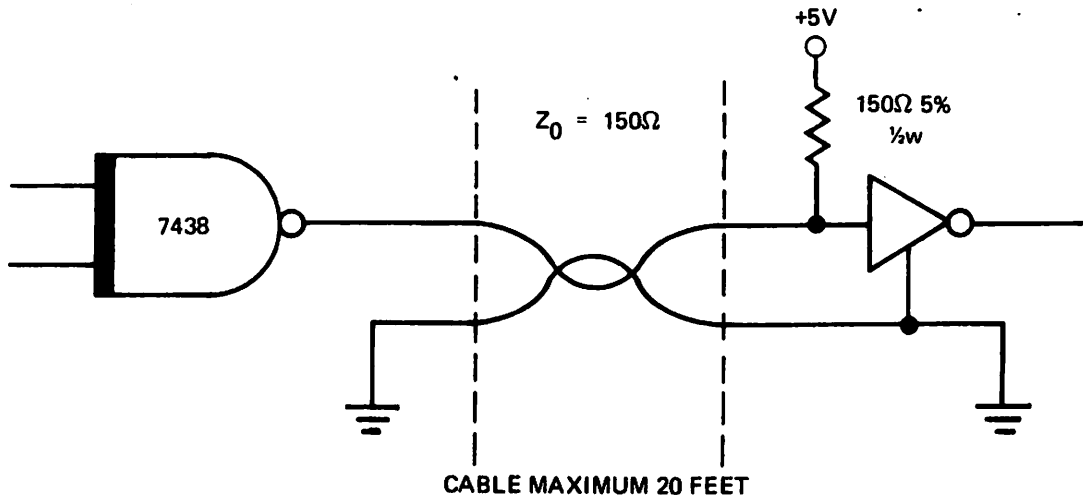
The line receiver consists of a standard 7400 family TTL gate with a termination resistor of  $150\Omega$  (+5%) to +5 volts. The input characteristics for this receiver are:

Maximum logical true state voltage = .8V.  
Minimum logical false state voltage = 2.0V.

**NOTE:**

These are measured at the input to the receiver.

Figure 1.22 shows the interface circuitry for the control lines between the SA900/901 and the host system.



**Figure 1.22 Control Signal Driver/Receiver Combination**

## 1.7 OPERATION PROCEDURES

The SA900/901 was designed for ease of operator use to facilitate a wide range of operator oriented applications. The following section is a guide for the handling and error recovery procedures on the diskette and diskette drive.

### 1.7.1 Diskette Loading and Handling

The diskette is a flexible disk enclosed in a plastic jacket. The interior of the jacket is lined with a wiping material to clean the disk of foreign material. Figure 1.26 shows the proper method of loading a diskette in the SA900/901 Diskette Storage Drive. To load the diskette, depress latch, insert the diskette with the label facing out. (See Figure 1.26). Move the latch handle to the left to lock diskette on drive spindle. The diskette can be loaded or unloaded with all power on and drive spindle rotating.

When removed from the drive, the diskette is stored in an envelope. To protect the diskette, the same care and handling procedures specified for computer magnetic tape apply. These precautionary procedures are as follows:

1. Return the diskette to its storage envelope whenever it is removed from file.
2. Keep cartridges away from magnetic fields and from ferromagnetic materials which might become magnetized. Strong magnetic fields can distort recorded data on the disk.
3. Replace storage envelopes when they become worn, cracked or distorted. Envelopes are designed to protect the disk.
4. Do not write on the plastic jacket with a lead pencil or ball-point pen. Use a felt tip pen.
5. Heat and contamination from a carelessly dropped ash can damage the disk.
6. Do not expose diskette to heat or sunlight.
7. Do not touch or attempt to clean the disk surface. Abrasions may cause loss of stored data.

### 1.7.2 SA101 Write Protect

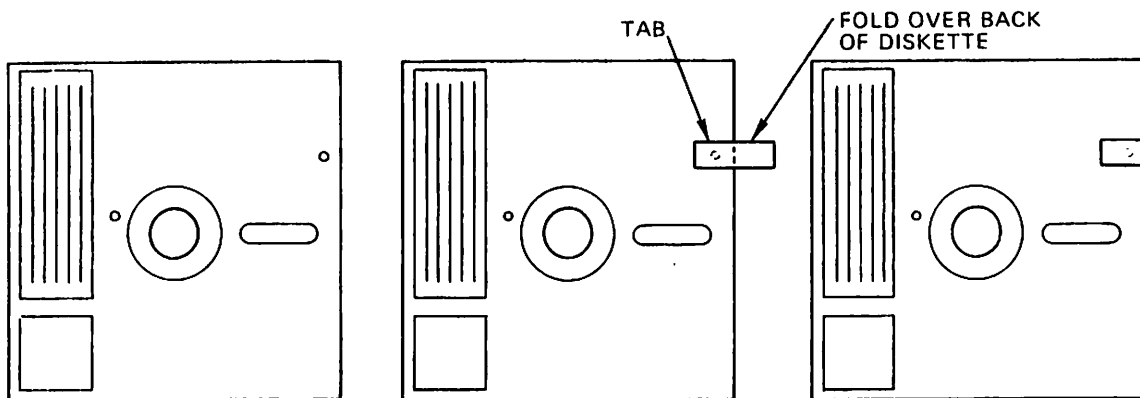
The SA101 has the capability of being write protected. The write protect feature is selected by the hole in the SA101. When the hole is open it is protected; when covered, writing is allowed. The hole is closed by placing a tab over the front of the hole, and the tab folded over covering the rear of the hole. The Diskette can then be write protected by removing the tab. See figure 1.24.

#### 1.7.2.1 SA900 Write Protect (Optional)

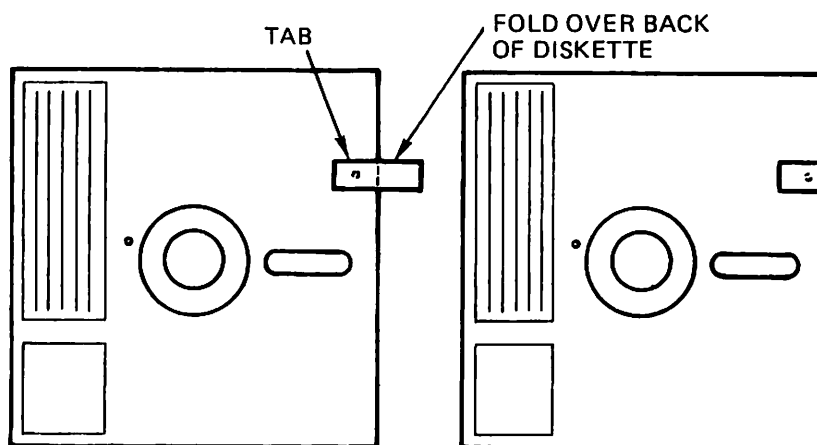
The SA100 or IBM Diskettes are not manufactured with a write protect hole punched out as are the SA101 Diskettes. To Write-Protect one of these diskettes, a hole must be punched out as specified in Figure 1.25. The operation of the write protect is that which is outlined in paragraph 1.7.2.

### 1.7.3 Error Detection and Correction





**Figure 1.23 Diskette Write Protected**



**Figure 1.24 Disabling of Write Protect Hole**

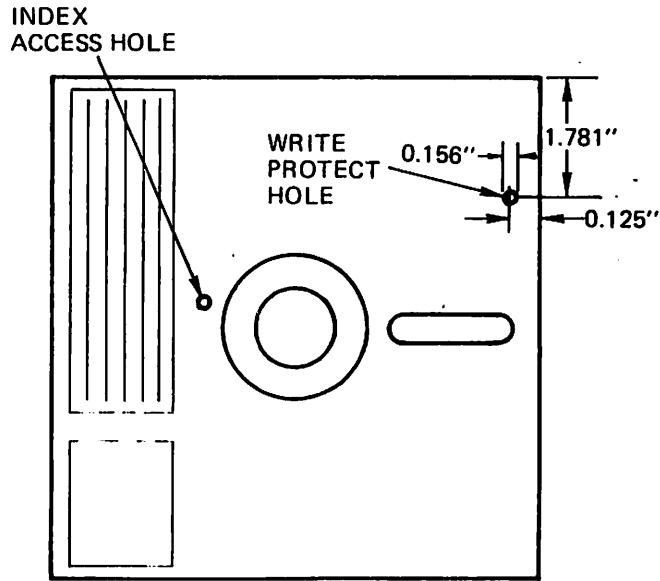


Figure 1.25 Write Protect Hole Specifications

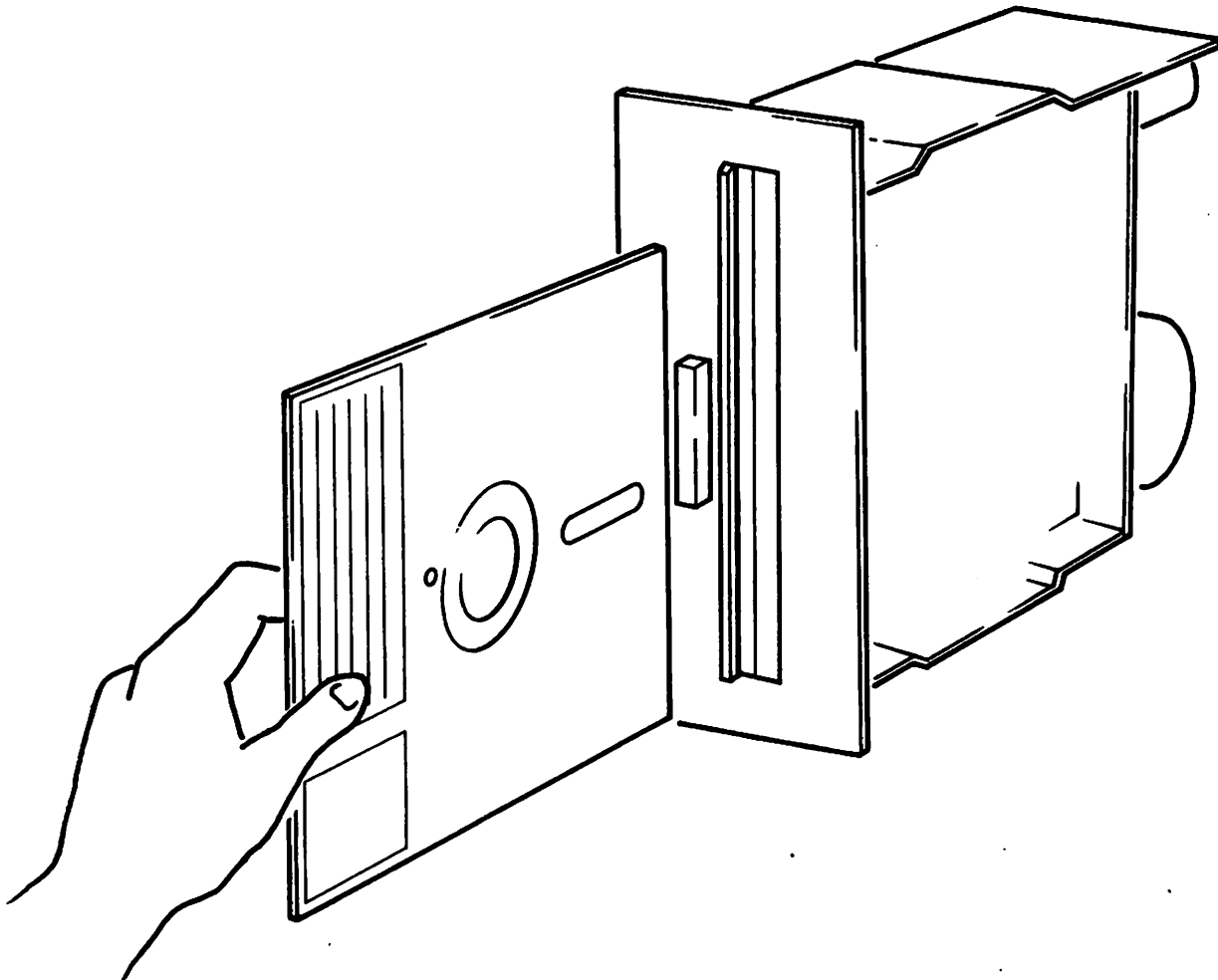


Figure 1.26 Loading SA900/901

### 1.7.3.1 Write Error

If an error occurs during a write operation, it 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 ten (10) attempts have been made, a read operation should be attempted on another track to determine if the media or the drive is failing. If the error still persists, the disk should be considered defective and discarded.

### 1.7.3.2 Read Error

Most errors that occur will be "soft" errors; that is, by performing an error recovery procedure the data will be recovered.

Soft errors are usually caused by:

1. Airborne contaminants that pass between the read/write head and the disk. These contaminants will generally be removed by the cartridge self-cleaning wiper.
2. Random electrical noise which usually lasts for a few  $\mu$  sec.
3. 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 procedures are recommended to recover from the above mentioned soft errors:

1. Reread the track ten (10) times or until such time as the data is recovered.
2. If data is not recovered after using step 1, access the head to the adjacent track in the same direction previously moved, then return to the desired track.
3. Repeat step 1.
4. If data is not recovered, the error is not recoverable.

## 2.1 General Operations

The SA900/901 Diskette Drive consists of read/write and control electronics, drive mechanism, read/write head, track positioning mechanism, and the removable Diskette. These components perform the following functions:

Interpret and generate control signals.  
Move read/write head to the desired track.  
Read and write data.

The relationship and interface signals for the internal functions of the SA900/901 are shown in Figure 2.1.

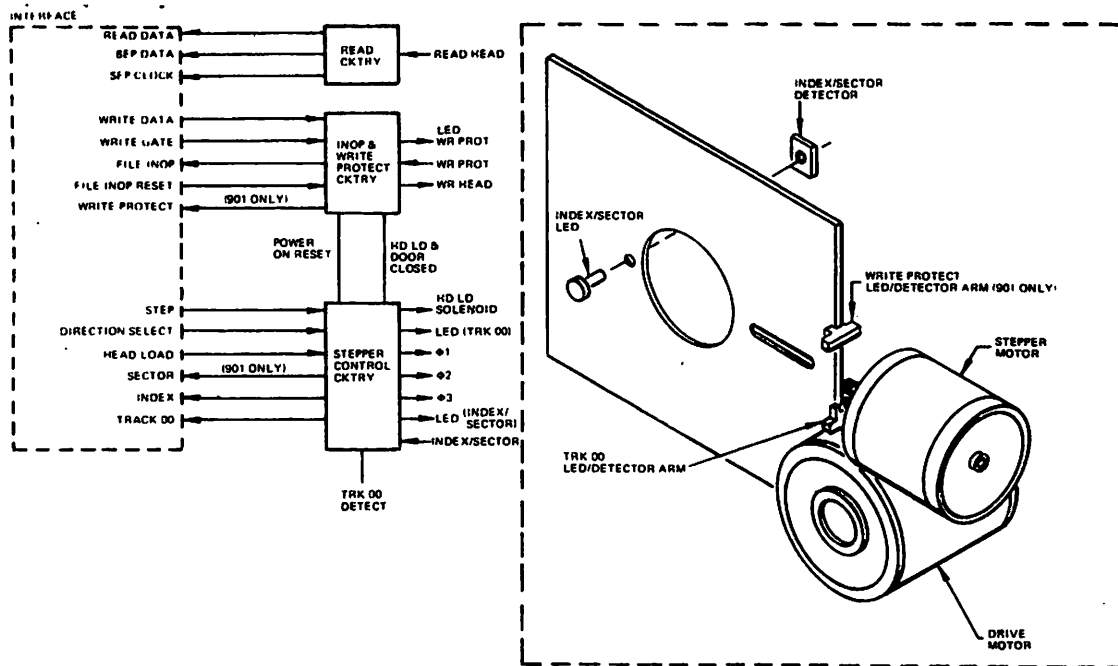


Figure 2.1 SA900/901 Functional Diagram

The Head Positioning Actuator positions the read/write head to the desired track on the Diskette. The Head Load Actuator loads the Diskette against the read/write head and data may then be recorded or read from the Diskette.

The electronics are packaged on one PCB. The PCB contains:

1. Index Detector Circuits (Sector/Index for 901).
2. Head Position Actuator Driver
3. Head Load Actuator Driver
4. Read/Write Amplifier and Transition Detector.
5. Data/Clock Separation Circuits.
6. Safety Sensing Circuits.
7. Write Protect (SA901 only).

### 2.1.1 Head Positioning

An electrical stepping motor (Head Position Actuator) and lead screw positions the read/write head. The stepping motor rotates the lead screw clockwise or counter-clockwise in  $15^\circ$  increments. A  $15^\circ$  rotation of the lead screw moves the read/write head one track position. The using system increments the stepping motor to the desired track.

### 2.1.2 Diskette Drive Spindle

The Diskette drive motor rotates the spindle at 360 rpm through a belt-drive system. 50 or 60 Hz power is accommodated by changing the drive pulley. A registration hub, centered on the face of the spindle, positions the Diskette. A clamp that moves in conjunction with the latch handle fixes the Diskette to the registration hub.

### 2.1.3 Read/Write Head

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

The SA900/901 head is a single element read/write head with straddle erase elements to provide erased areas between data tracks. Thus normal tolerance between media and drives will not degrade the signal to noise ratio and insures Diskette interchangeability.

The read/write head is mounted on a carriage which is located on the Head Position Actuator lead screw. The Diskette is held in a place perpendicular to the read/write head by one platen located on the base casting. The Diskette is loaded against the head with a load pad actuated by the head load solenoid.

## 2.2 Recording Format

### 2.2.1

The format of the data recorded on the Diskette is totally a function of the host system. Data is recorded on the diskette using frequency modulation as the recording mode, i.e., each data bit recorded on the diskette has an associated clock bit recorded with it. Data written on and read back from the diskette takes the form as shown in Figure 2.2.1. The binary data pattern shown represents a 101.

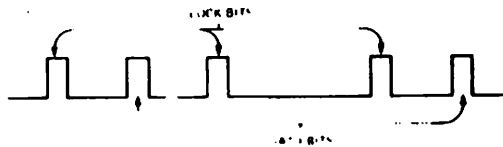


Figure 2.2.1 Data Pattern

### 2.2.2 Bit Cell

As shown in Figure 2.2.2, the clock bits and data bits (if present) are interleaved. By definition, a Bit Cell is the period between the leading edge of one clock bit and the leading edge of the next clock bit.

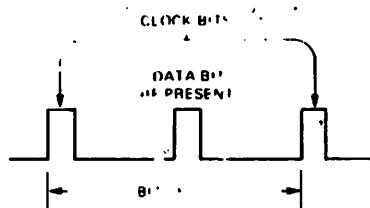


Figure 2.2.2 Bit Cell

### 2.2.3 Byte

A Byte, when referring to serial data (being written onto or read from the disc drive), is defined as eight (8) consecutive bit cells. The most significant bit cell is defined as bit cell 0 and 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 disc drive first with bit cell 7 being transferred last. Correspondingly, the most significant byte of data is transferred to the disc 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 2.2.3 illustrates the relationship of the bits within a byte and Figure 2.2.4 illustrates the relationship of the bytes for read and write data.

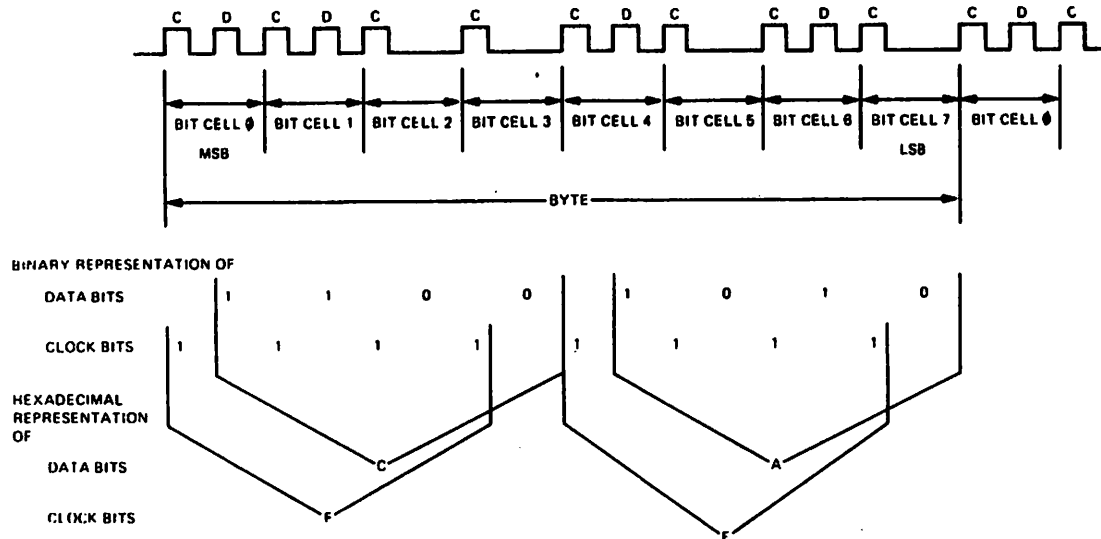


Figure 2.2.3 Byte

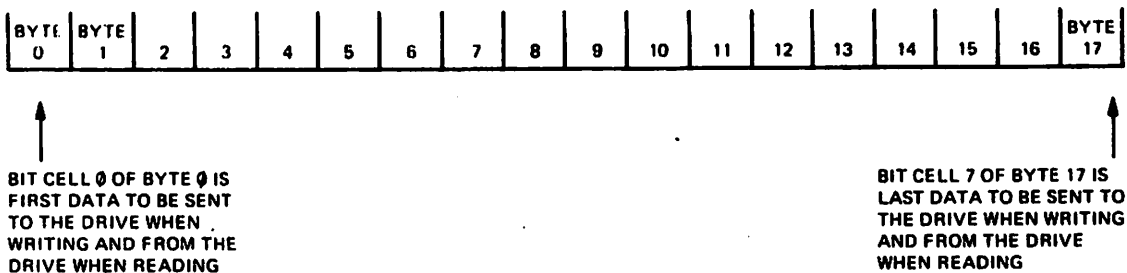


Figure 2.2.4 Data Bytes

## 2.2.4 Tracks

The SA900/901 is capable of recording up to 77 tracks of data. The tracks are numbered 0 - 76. Each track is made available to the R/W Head by accessing the head with a stepper motor and carriage assembly. Track accessing will be covered in Section 2.3.

### Basic Track Characteristics:

Number of bits/track	41,300 bits
Index Pulse Width	$1.7 \pm .5$ ms
Index/Sector Pulse Width (SA901 only)	$.4 \pm .2$ ms

## 2.2.5 Track Format

Tracks may be formatted in numerous ways and is dependent on the using system. The SA900/901 use index and sector recording formats respectively.

### 2.2.5.1 Index Recording Format

In this Format, the using system may record one long record or several smaller records. Each track is started by a physical index pulse and then each record is preceded by a unique recorded identifier. This type of recording is called soft sectoring. Figure 2.2.5 shows a typical Index Recording Format.

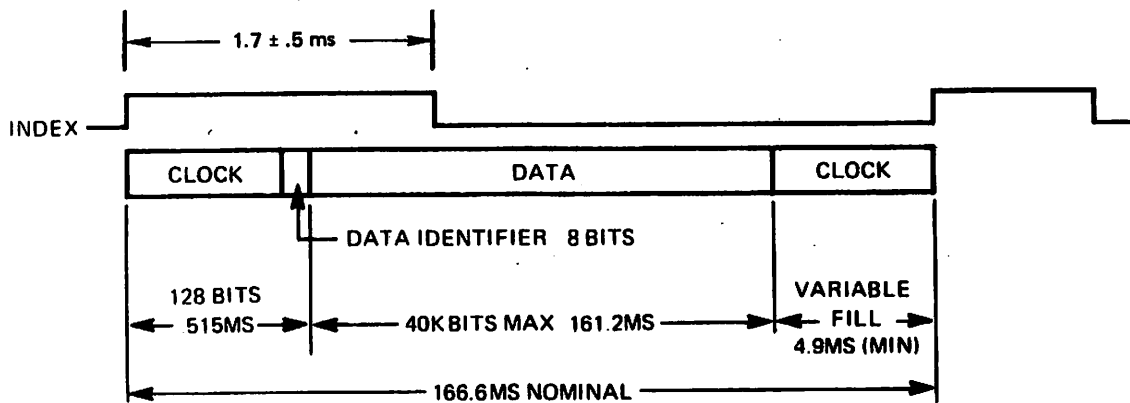


Figure 2.2.5 Index Recording Format

### 2.2.5.2 Sector Recording Format

In this Format, the using system may record up to 32 sectors (records) per track. Each track is started by a physical index pulse and each sector is started by a physical sector pulse. This type of recording is called hard sectoring. Figure 2.2.6 shows a typical Sector Recording Format.

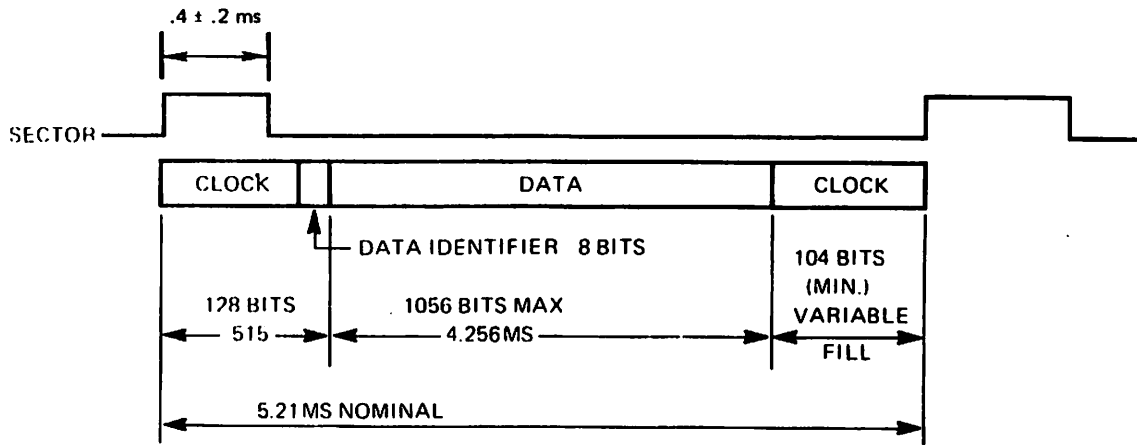


Figure 2.2.6 Sector Recording Format

### 2.2.6 Typical Track Index Format

Figure 2.2.7 shows a track format, which is IBM compatible, using Index Recording Format with soft sectoring.

#### 2.2.6.1 Gaps (Ref. Figure 2.2.7)

Each field on a track is separated from adjacent fields by a number of bytes containing no data bits. These areas are referred to as gaps and are provided to allow the updating of one field without affecting adjacent fields. As can be seen from Figure 2.2.7, there are four different types of gaps on each track.

##### Gap 1 Post-Index Gap

This gap is defined as the 32 bytes between Index Address Mark and the ID Address Mark for Sector one (excluding the address mark bytes). This gap is always 32 bytes in length and is not affected by any updating process.

##### Gap 2 ID Gap

The seventeen bytes between the ID Field and the Data Field is defined as Gap 2 (ID Gap). This gap may vary in size slightly after the Data Field has been updated.



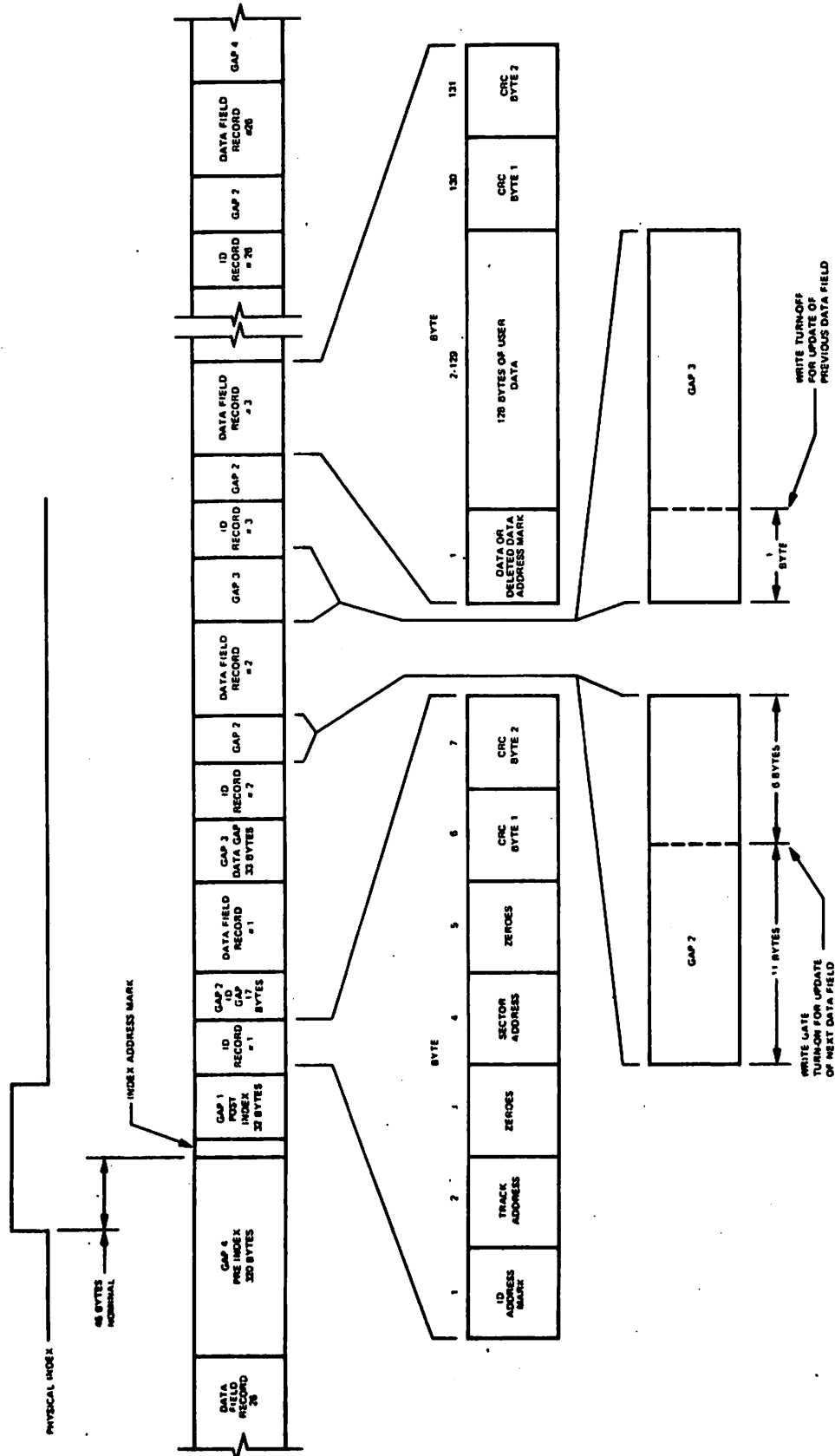


Figure 2.2.7 Track Format

### Gap 3 Data Gap

The thirty-three bytes between the Data Field and the next ID Field is defined as Gap 3 (Data Gap). As with the ID Gap, the Data Gap may vary slightly in length after the adjacent Data Field has been updated.

### Gap 4 Pre-Index Gap

The three hundred and twenty bytes between the last Data Field on a track and the Index Address Mark is defined as Gap 4 (Pre-Index Gap). Initially, this gap is nominally 320 bytes in length, however, due to write frequency tolerances and disc speed tolerances this gap may vary slightly in length. Also, after the data field of record 26 has been updated, this gap may again change slightly in length.

#### 2.2.6.2 Address Marks

Address Marks are unique bit patterns one byte in length which are used in this typical recording format to identify the beginning of ID and Data Fields and to synchronize the deserializing circuitry with the first byte of each field. Address Mark bytes are unique from all other data bytes in that certain bit cells do not contain a clock bit (all other data bytes have clock bits in every bit cell). There are four different types of Address Marks used. Each of these used to identify different types of fields.

#### Index Address Mark

The Index Address Mark is located at the beginning of each track and is a fixed number of bytes in front of the first record. The bit configuration for the Index Address Mark is shown in Figure 2.2.8.

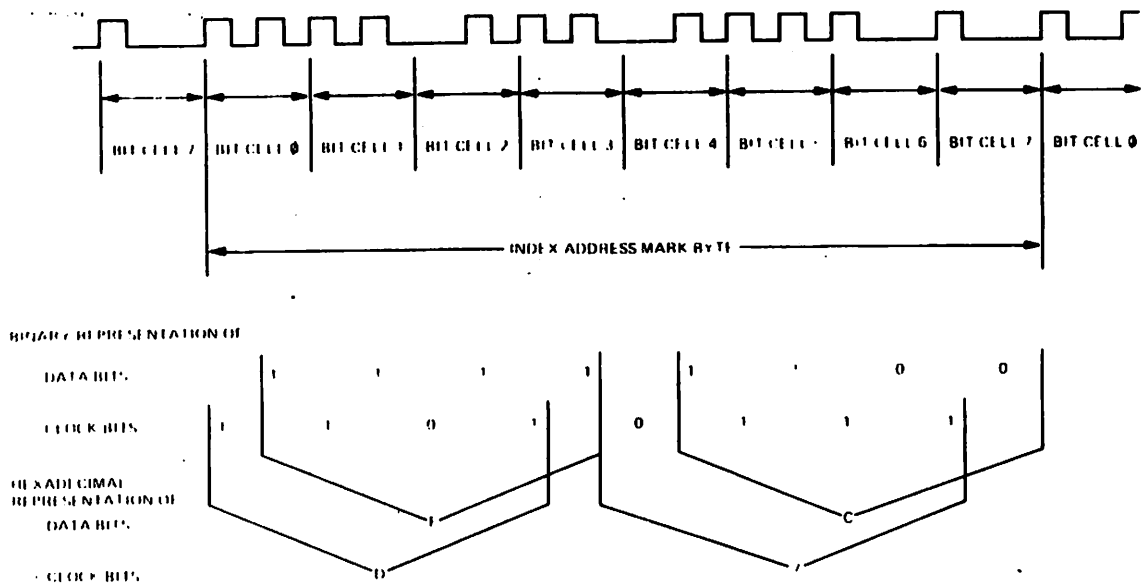


Figure 2.2.8 Index Address Mark

### ID Address Mark

The ID Address Mark byte is located at the beginning of each ID Field on the diskette. The bit configuration for this Address Mark is shown in Figure 2.2.9.

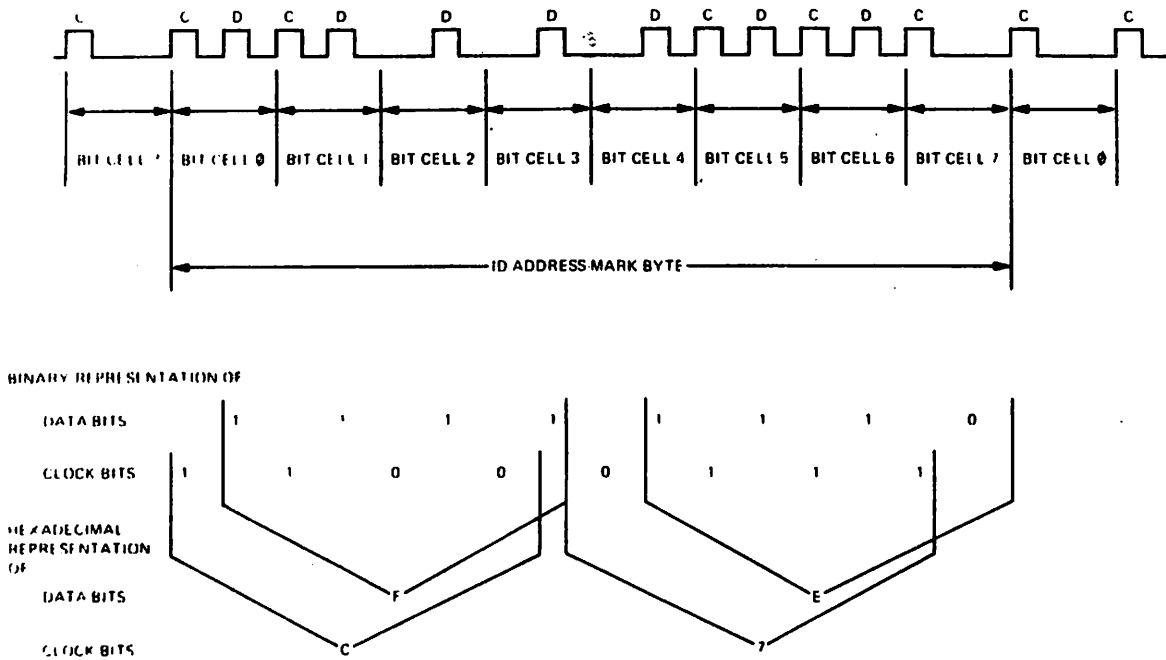


Figure 2.2.9 ID Address Mark

### Data Address Mark

The Data Address Mark byte is located at the beginning of each nondeleted Data Field on the diskette. The bit configuration for this Address Mark is shown in Figure 2.2.10.

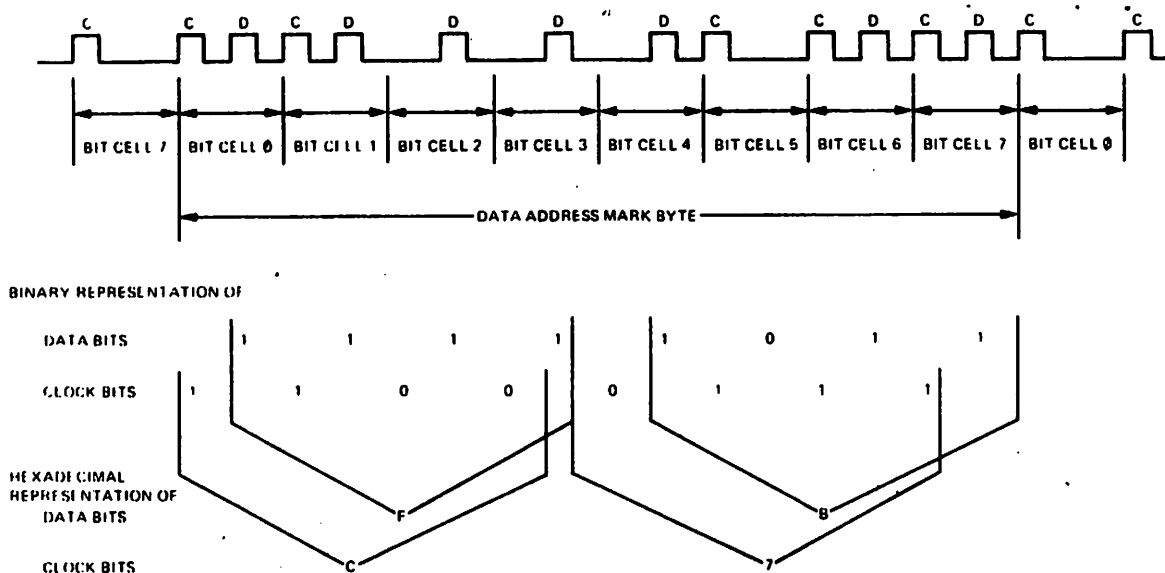


Figure 2.2.10 Data Address Mark

## Deleted Data Address Mark

The Deleted Data Address Mark byte is located at the beginning of each deleted Data Field on the diskette. The bit configuration for this Address Mark is shown in Figure 2.2.11.

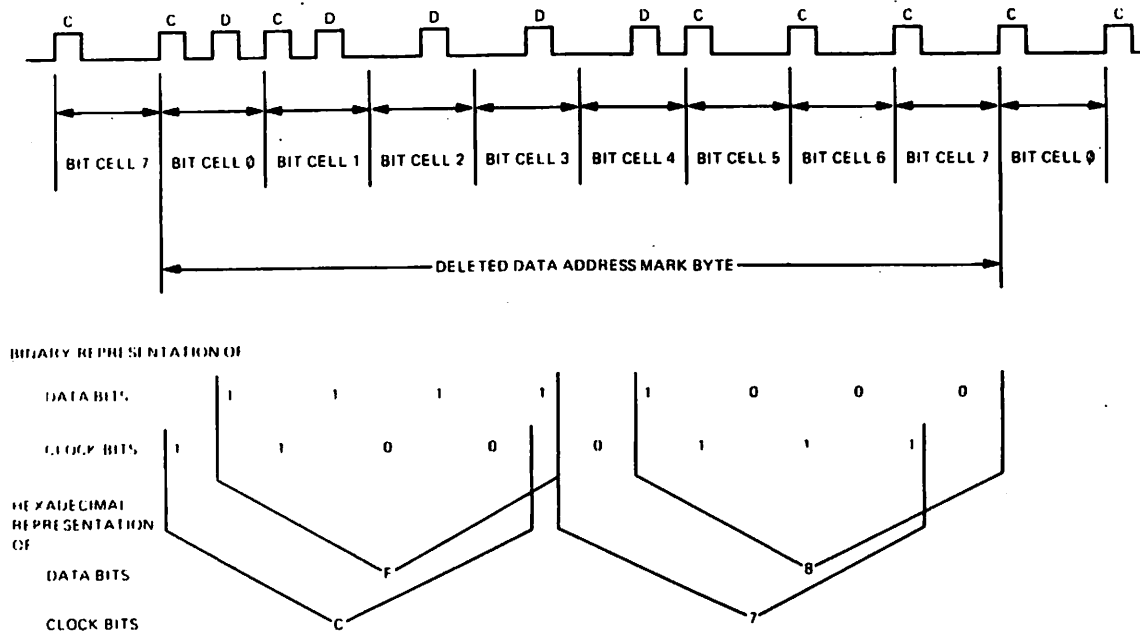


Figure 2.2.11 Deleted Data Address Mark

### 2.2.6.3 CRC

Each field written on the diskette is appended with two Cyclic Redundancy Check (CRC) bytes. These two CRC bytes are generated from a cyclic permutation of the data bits starting with bit zero of the address mark and ending with bit seven of the last byte within a field (excluding the CRC bytes). When a field is read back from a diskette, the data bits (from bit zero of the address mark to bit seven of the second CRC byte) are divided by the same generator polynomial. A non-zero remainder indicates an error within the data read back from the drive while a remainder of zero indicates the data has been read back correctly from the disk.

## 2.3 Track Accessing

- Stepper Motor
- Stepper Control Logic
- Reverse Seek
- Forward Seek
- Track 00 Flag

### 2.3.1

Seeking the R/W head from one track to another is accomplished by selecting the desired direction utilizing the Direction Select interface line, loading the R/W head, and then pulsing the Step line. Multiple track accessing is accomplished by repeated pulsing of the Step line until the desired track has been reached. Each pulse on the Step line will cause the R/W head to move one track either in or out depending on the Direction Select line.

### 2.3.2

The stepper motor used on the SA900/901 is a three-phase, fifteen degree, variable reluctance stepper motor. Figure 2.3.1 shows the logic diagram of the motor.

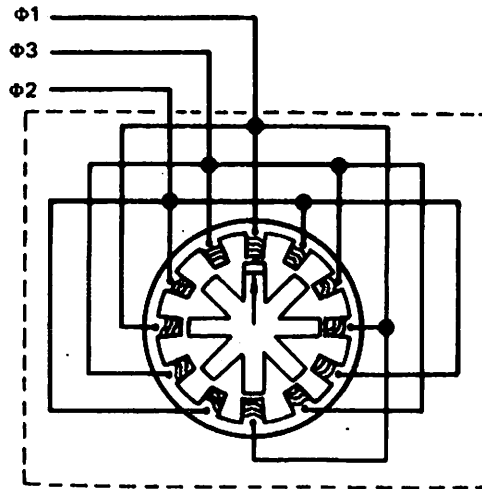


Figure 2.3.1 Stepper Motor

#### 2.3.2.1

The stepper motor has 12 stator windings and a rotor with 8 teeth. The 12 stator windings are wired together in groups of four, 90 degrees apart. Each group of four stator windings is wired to one phase of the stepper control logic. The rotor has its eight teeth spaced 45 degrees apart.

#### 2.3.2.2

Figure 2.3.2(a) shows the stepper motor (rear view) with phase 1 of the stepper control logic active. Phase 1 is applied to the four stator windings at 0°, 90°, 180° and 270°. This causes the four rotor teeth closest to those windings to move and line up with the stator windings.

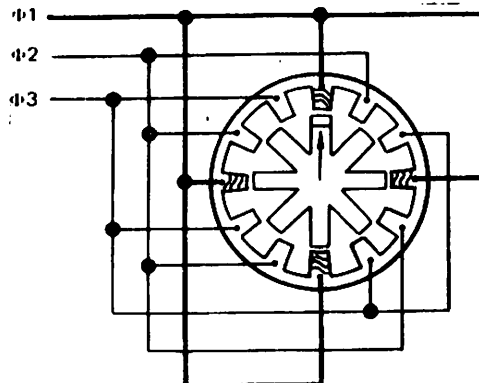


Figure 2.3.2 (a) Position 1 (Trk 00)

### 2.3.2.3

Figure 2.3.2(b) shows the stepper motor with phase 2 of the stepper control logic active. Phase 2 is applied to the stator windings at 30°, 120°, 210°, and 300°. This causes the four rotor teeth closest to those windings to move and line up with the stator windings. The result is a 15° turn of the stepper motor lead screw.

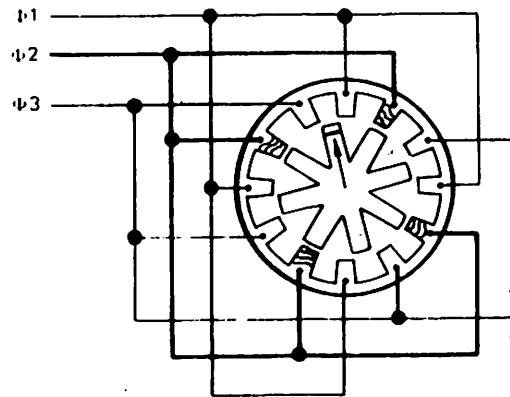


Figure 2.3.2 (b) Position 2 (Trk 01)

### 2.3.2.4

Figure 2.3.2(c) shows the stepper motor with phase 3 of the stepper control logic active. Result is another 15° turn of the stepper motor lead screw.

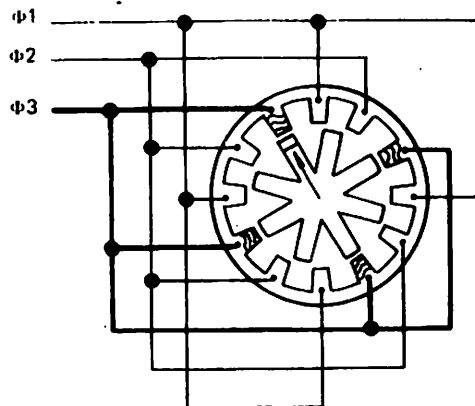


Figure 2.3.2 (c) Position 3 (Trk 02)

## 2.3.3 Stepper Control Logic (Figure 2.3.3)

### 2.3.3.1 Power on Reset

At power on, FF1 and FF2 are reset and the not outputs activate  $\Phi 1$  driver. With the  $\Phi 1$  driver active, the position 1 windings in the stepper motor are excited and cause the rotor in the stepper motor to align as in Figure 2.3.2(a).

### 2.3.3.2 Forward Seek

Seek in a forward direction five tracks

Assume: Present position of R/W head to be Track 00.

Direction select at a minus level (from using system).

Write gate is inactive.

Head is loaded and door is closed.

Five step pulses to be received (from using system)

FF1 and FF2 are reset phase 1 driver active.

Figure 2.3.3 and 2.3.4 show stepper control logic and timing diagram respectively. Minus Direction Select is inverted and becomes +Forward, this enables A2 and A3 of FF1 and FF2. Since both FF1 and FF2 are reset at this point, the FF1 line further enables A3.

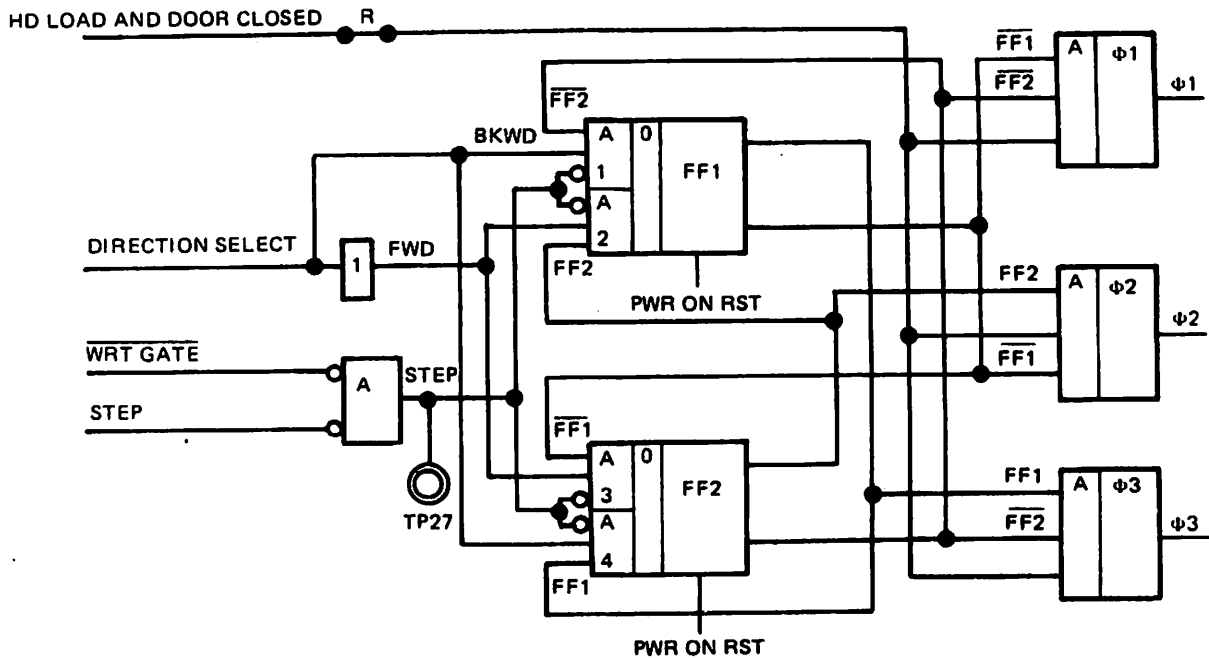


Figure 2.3.3 Track Accessing (Stepper Control Logic)

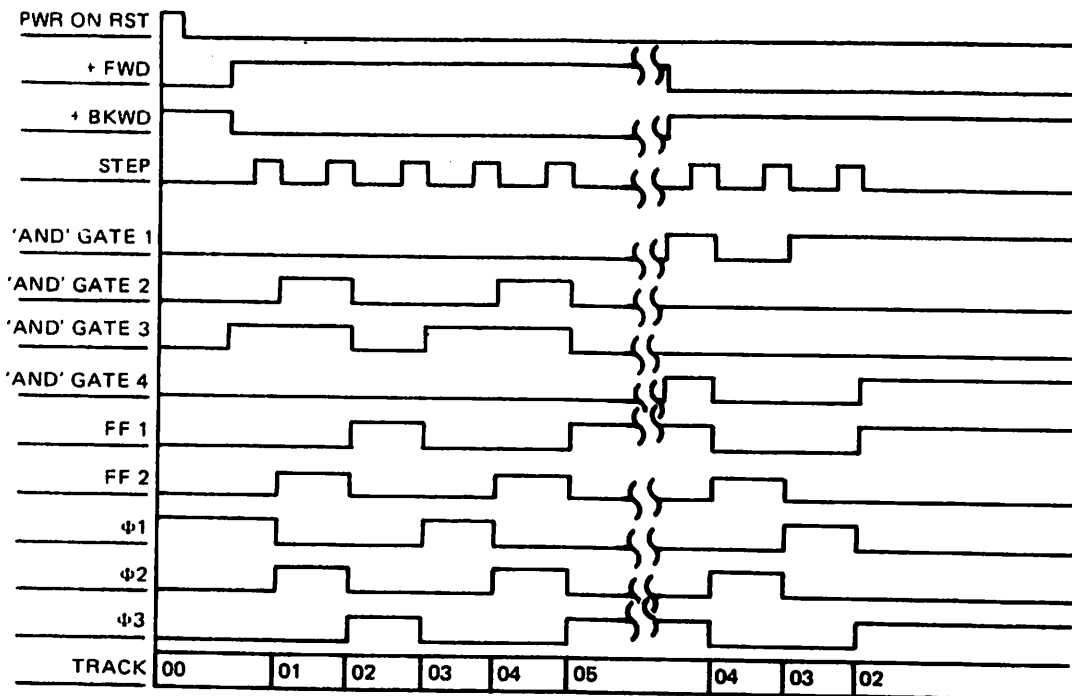


Figure 2.3.4 Track Accessing

When the first step pulse is sent to the control logic, it is anded with not write gate and then the step pulse clocks FF2 on. With FF2 on and FF1 off, phase 2 driver is activated and the Stepper Motor moves 15° in a counter-clockwise direction moving the carriage assembly one track towards the center of the diskette (track 01).

With FF2 on and FF1 off, AND blocks A2 and A3 are enabled. Upon receipt of the next step pulse, FF1 is clocked on and FF2 is clocked off. With FF1 on and FF2 on, phase 3 driver is activated and the stepper motor moves 15° in a counter-clockwise direction moving the carriage assembly one more track towards the center (track 02).

With FF1 on and FF2 off, AND blocks A2 and A3 are disabled. Upon receipt of the next step pulse, FF1 is clocked off and FF2 remains off. This causes phase 1 driver to be activated, turning the stepper motor an additional 15° in the counter-clockwise direction moving the carriage assembly one more track closer to the center (track 03).

The above process is continued until the host system stops sending step pulses, i.e., Track 05. At that time, FF1 is on and FF2 is off leaving phase 3 driver active. Figure 2.3.5 shows the stepper motor at this position.



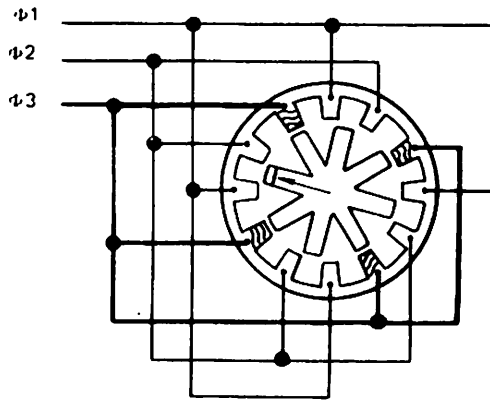


Figure 2.3.5 Stepper Motor at TRK 05

### 2.3.3.3 Reverse Seek (Fig. 2.3.3 and 2.3.4)

Seek in a Reverse Direction three tracks

Assume: Present position of R/W head to be Track 05.

Direction Select at a positive level

Write gate is inactive

Head is loaded and door closed

3 step pulses to be received

FF1 is on, FF2 is off, phase 3 driver active

Direction Select line, being positive, enables AND gates A1 and A4. With FF1 on and FF2 off, the first step pulse received is going to clock FF1 off and clock FF2 on. Phase 2 driver is activated by FF1 off and FF2 on, moving the stepper motor in a clockwise direction 15° or moving the carriage in a reverse direction one track.

The next step pulse received is going to clock FF2 off and leave FF1 off. This will cause phase 1 driver to become active and move the stepper motor an additional 15° in the clockwise direction moving the R/W head one more track in the reverse direction.

With FF1 off and FF2 off AND gate A1 is enabled. The next step pulse received is going to clock FF1 on which in turn will activate phase 3 driver. This will again move the stepper motor in a clockwise direction 15° and the R/W head back to Track 0.2. The stepper motor will end up in the position as shown in Figure 2.3.6.

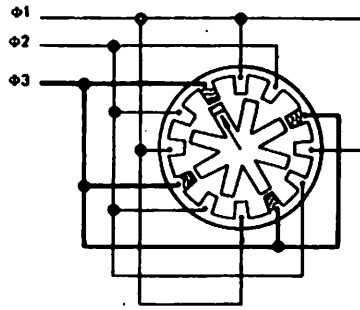


Figure 2.3.6 Stepper Motor at TRK 02

### 2.3.4 Track Zero Indicator

Track Zero Flag (P1L12) is provided to the using system to indicate when the R/W head is at track zero.

Figures 2.3.7 and 2.3.8 show the logic and timing for track Zero indication. The Track zero flag on the carriage assembly is adjusted so that the flag covers the photo transistor at track one. When the FF1 and FF2 are set off and the stepper moves to track zero, phase 1 is anded with Track Zero detect and Track Zero indication is sent to the using system.

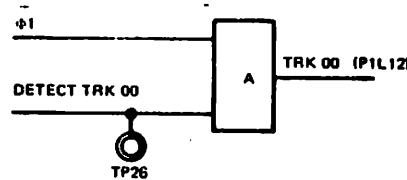


Figure 2.3.7 Track 00 Flag

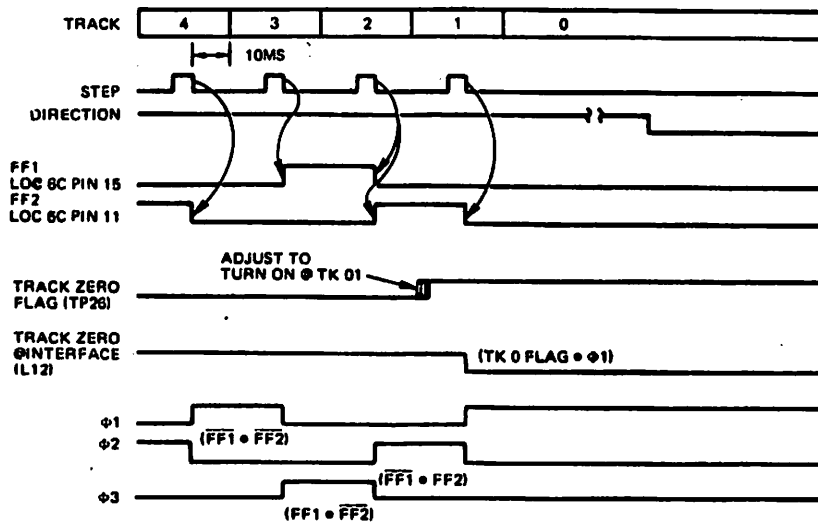


Figure 2.3.8 Track Zero Timing

## 2.4 READ-WRITE OPERATIONS

SA900/901 uses double frequency NRZI recording method.

The R/W Head, in general, is a ring with a gap and a coil wound at some point on the ring.

During a write operation, a bit is recorded when the flux direction in the ring is reversed by rapidly reversing the current in the coil.

During a read operation, a bit is read when the flux direction in the ring is reversed as a result of a flux reversal on the diskette surface.

### 2.4.1

The SA900/901 uses the double-frequency (2F) horizontal non return to zero (NRZI) method of recording. Double frequency is the term given to the recording system that inserts a clock bit at the beginning of each bit cell time thereby doubling the frequency of recorded bits. This clock bit, as well as the data bit, are provided by the using system. See Figure 2.4.1.

### 2.4.2

The R/W head is a ring with a gap and a coil wound some point on the ring. When current flows through the coil, the flux induced in the ring fringes at the gap. As the diskette recording surface passes by the gap, the fringe flux magnetizes the surface in a horizontal direction. See Figure 2.4.2.

### 2.4.3

During a write operation, a bit is recorded when the flux direction in the ring is reversed by rapidly reversing the current in the coil. The fringe flux is reversed in the gap and hence the portion of the flux flowing through the oxide recording surface is reversed. If the flux reversal is instantaneous in comparison to the motion of the diskette, it can be seen that the portion of the diskette surface that just passed under the gap is magnetized in one direction while the portion under the gap is magnetized in the opposite direction. This flux reversal represents a bit. See Figure 2.4.3.

### 2.4.4

During a read operation, a bit is read when the flux direction in the ring is reversed as a result of a flux reversal on the diskette surface. The gap first passes over an area that is magnetized in one direction, and a constant flux flows through the ring and coil. The coil registers no output voltage at this point. When a recorded bit passes under the gap, the flux flowing through the ring and coil will make a 180° reversal. This means that the flux reversal in the coil will cause a voltage output pulse. See Figure 2.4.4.

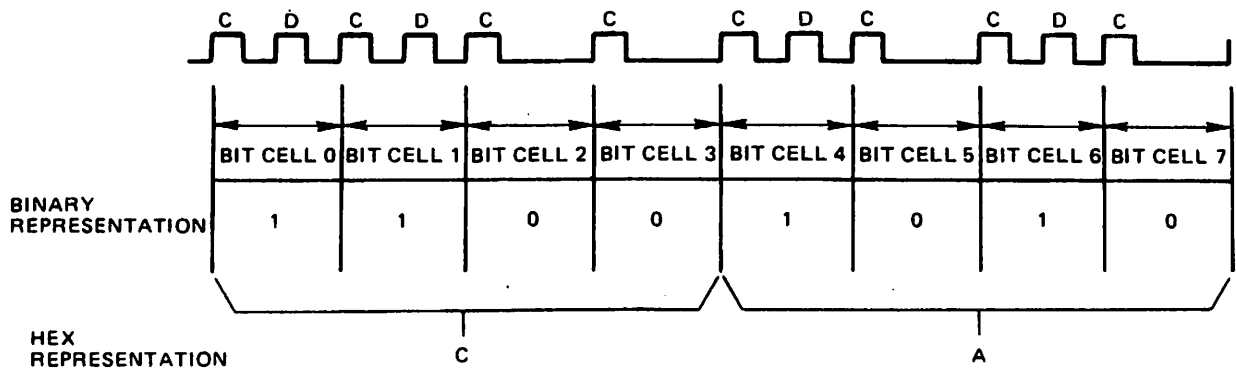


Figure 2.4.1 Bit Cell

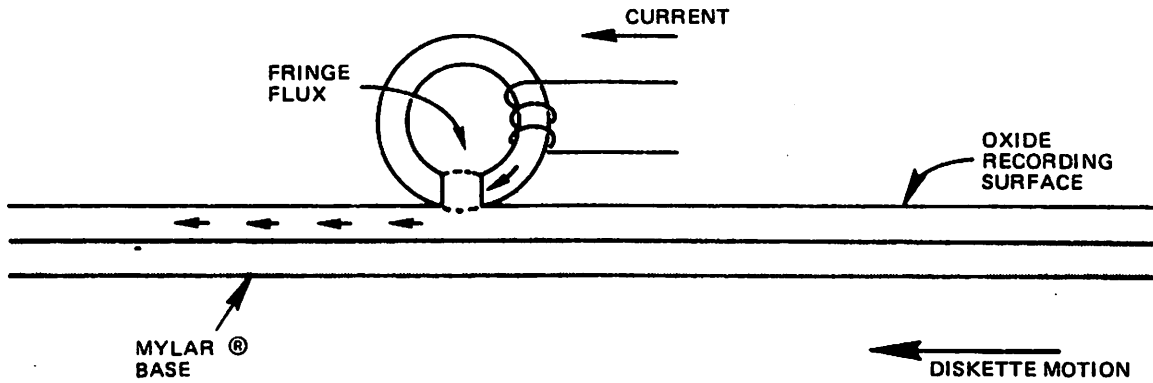


Figure 2.4.2 Basic R/W Head

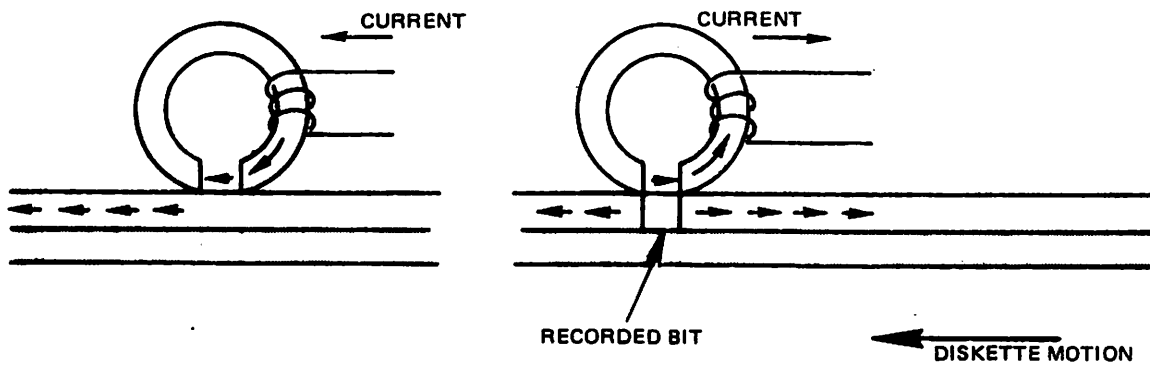


Figure 2.4.3 Recorded Bit

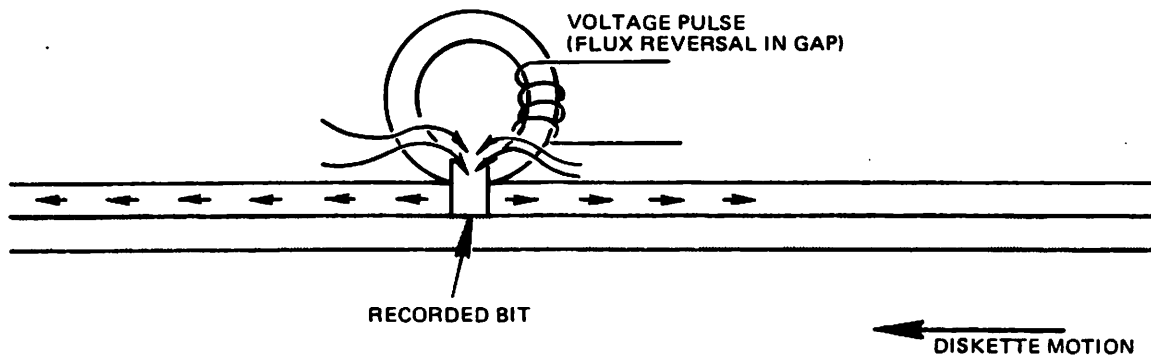


Figure 2.4.4 Reading a Bit

2.4.5 Figure 2.4.5 shows the 1F and 2F recording flux transitions with pulse relationship.

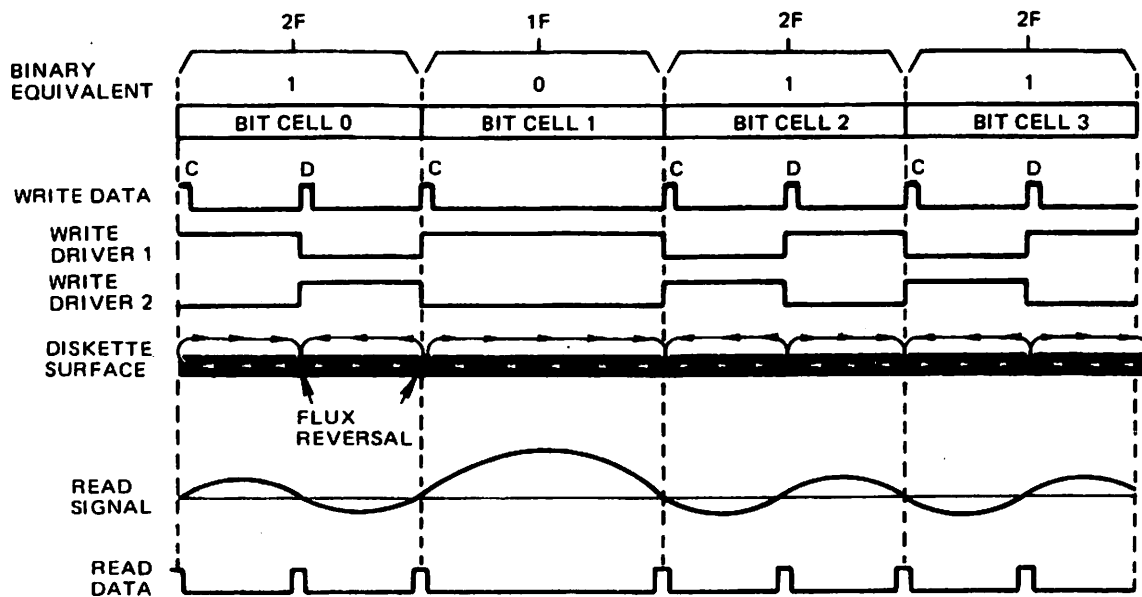


Figure 2.4.5 1F and 2F Recording Flux and Pulse Relationship

## 2.5 READ/WRITE HEAD

The R/W head contains three coils.

When writing, the head erases the outer edges of the track to insure data recorded will not exceed the .012 track width.

### 2.5.1

The R/W head contains three coils. Two read-write coils are wound on a single core, center tapped and one erase coil is wound on a yoke that spans the track being written. The read-write and erase coils are connected as shown on Figure 2.5.1.

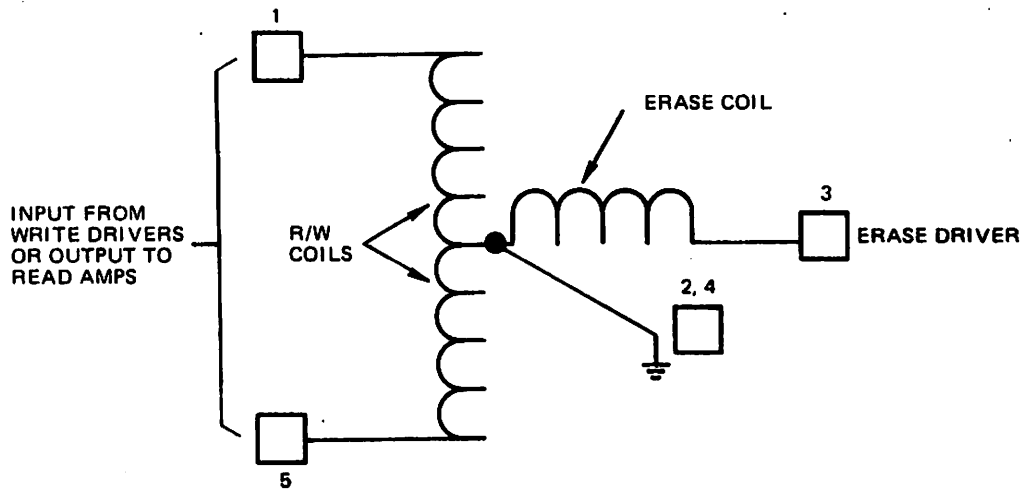


Figure 2.5.1 R/W Head

### 2.5.2

On a write operation, the erase coil is energized. This causes the outer edges of the track to be trim erased so as the track being recorded will not exceed the .012" track width. The trim erasing allows for minor deviations in R/W head current so as one track is recorded, it will not "splash over" to adjacent tracks.

### 2.5.3

Each bit written will be directed to alternate read/write coils, thus causing a change in the direction of current flow through the read/write head. This will cause a change in the flux pattern for each bit. The current through either of the R/W coils will cause the old data to be erased as new data is recorded.

### 2.5.4

On a read operation, as the direction of flux changes on the diskette surface as it passes under the gap, current will be induced into one of the windings of the R/W head. This will result in a voltage output pulse. When the next data bit passes under the gap, another flux change in the recording surface takes place. This will cause current to be induced in the other coil causing another voltage output pulse.

## 2.6 WRITE CIRCUIT OPERATION (FIGURE 2.6.1)

The binary connected Write Data Trigger flips with each pulse on the Write Data Line.

The Write Data Trigger alternately drives one or the other of the Write Drivers.

Write Gate allows write current to flow to the Write Driver circuits.

Write Current sensed and delayed allows Erase Coil current.

### 2.6.1

Write data pulses (clock & data bits) are supplied by the using system. The Write Trigger "flips" with each pulse. The Q and Q outputs are fed to alternate Write Drivers.

### 2.6.2

Write Gate, from using system, and not File Inop, internally generated, are anded together to provide write current.

### 2.6.3

The output of one of the Write Drivers allows write current to flow through one half of the read/write coil. When the Write Trigger "flips", the other Write Driver provided write current to the other half of the read/write coil.

### 2.6.4

When write current is sensed flowing to the Write Drivers, a signal is generated and delayed by 196 microseconds to provide erase coil current.

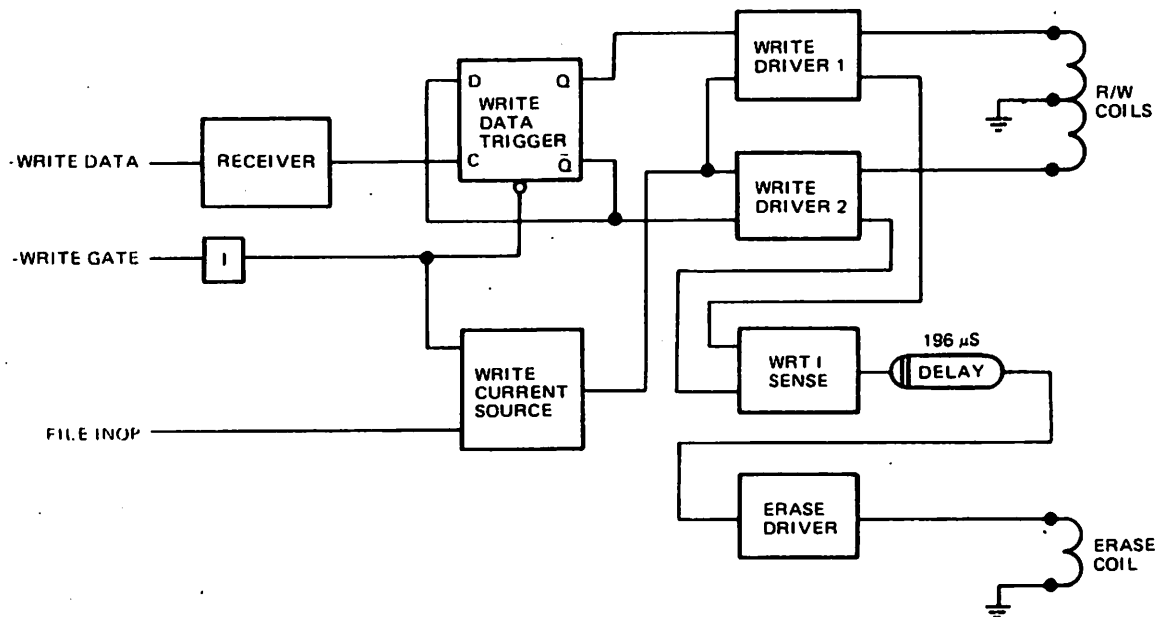


Figure 2.6.1 Write Circuit Functional Diagram

## 2.7 READ CIRCUIT OPERATION (FIGURE 2.7.1)

Duration of all read operations is under control of the using system.

When the head is loaded, the read signal amplitude becomes active and is fed to the amplifier.

As long as the head is loaded and write gate is not active, the read signal is amplified and shaped, the square wave signals are sent to the data separator.

The data separator separates the read data into clock pulses and data pulses.

### 2.7.1

When the using system requires data from the diskette drive, the using system must first load the head. With loading of the head and write gate being inactive, the read signal is fed to the amplifier section of the read circuit. After the amplification, the read signal is fed to a filter where the noise spikes are removed. The read signal is then fed to the differential amplifier.

### 2.7.2

Since a pulse occurs at least once every 4  $\mu$ s and when data bits are present once every 2  $\mu$ s, the frequency of the read data varies. The read signal amplitude decreases as the frequency increases. Note the signals on Figure 2.7.1. The differential amplifier will amplify the read signals to even levels and make square waves out of the read signals (sine waves).

### 2.7.3

The data separator is a two time constant separator, that is, the clock and data pulses must fall within pre-specified time frames or windows. The clock and data windows are developed in the data separation circuit. Figure 2.7.2 shows the functional diagram and Figure 2.7.3 shows the timing diagram of the circuit.

#### 2.7.3.1

Two data windows are supplied. The short window, 2.9  $\mu$ s, is used when the previous bit cell has a data pulse in it. The long window, 3.1  $\mu$ s, is used when the previous bit cell had no data pulse.

#### 2.7.3.2

If the data pulse initially falls in the data window, -separated data is sent back to the OR block that generates the data window to assure that the full data pulse is allowed through before the window falls.

#### 2.7.3.3

The clock window will take up the remainder of the bit cell time, either 1.1  $\mu$ s or 0.9  $\mu$ s.

### 2.7.4

In discussing the data separator circuit, Figure 2.7.2, initially assume all circuits are reset (inactive) and that the +READ DATA line contains what is shown in Figure 2.7.3.



#### 2.7.4.1

With both SS1 and SS2 off, +Clk Window is active. The first Read Data pulse will be allowed through AND A2 and out as -Sep. Clk. -Sep. Clk. is sent out onto the interface line and to L1, SS1 and SS2. Since FF1 is off, SS1 will be held reset. The -Sep. Clk. pulse will trigger SS2. The output of SS2 is sent to the OR block which in turn becomes +Data Window enabling AND A1. The next pulse on +Read Data will be allowed through A1 becoming -Separated Data. -Separated Data sets L1 which in turn enables FF1. FF1 is clocked on by SS2 timing out (3.1  $\mu$ s) and +Clk Window becoming active. The  $\bar{Q}$  output of FF1 will hold SS2 reset and allow SS1 to trigger with receipt of the next clock pulse.

#### 2.7.4.2

The next clock pulse, bit cell 1, is anded with +Clk Window and becomes the next -Sep. Clk. -Sep Clk will reset L1 and Trigger SS1 on. When SS1 becomes active, +Data Window becomes active enabling AND A1. Since bit cell 1 has no data bit in it, L1 will remain reset which will enable FF1 to be clocked off when +Data Window falls (2.9  $\mu$ s). When FF1 is clocked off the Q output will hold SS1 reset and allow SS2 to be triggered.

#### 2.7.4.3

The next clock pulse, bit cell 2, is anded with +Clk Window and becomes -Sep Clk. -Sep Clk will further reset L1, which was off, and trigger SS2 on. When SS2 becomes active, -Long Data Window, and enables AND A1 allowing the data pulse in bit cell 2 to become -Sep Data. -Sep Data will set L1 which enables FF1 to be clocked on when +Data Window falls. When +Data Window falls, the  $\bar{Q}$  output will hold SS2 reset and allow SS1 to trigger.

#### 2.7.4.4

This procedure continues until the using system terminates the Read Operation by unloading the head.

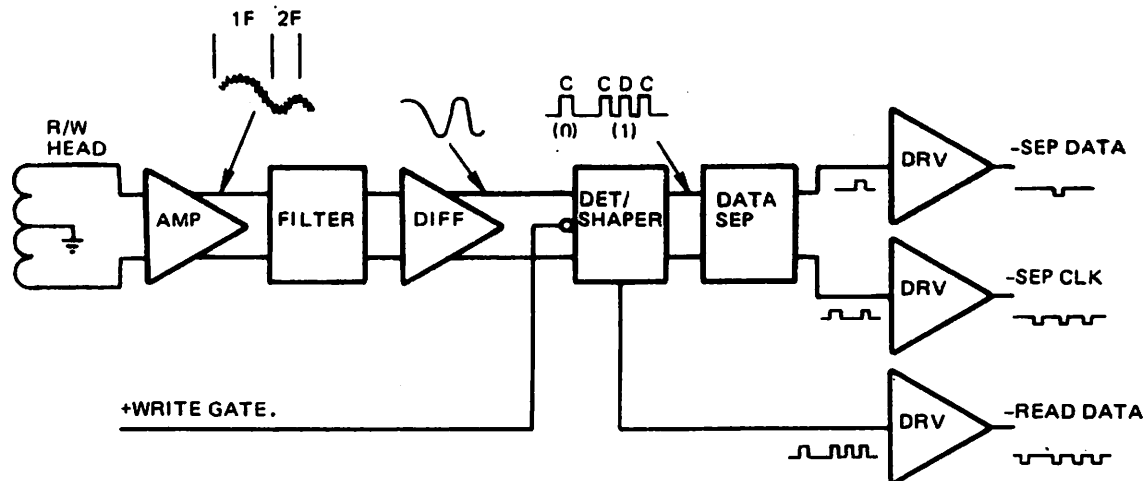


Figure 2.7.1 Read Circuit Functional Diagram

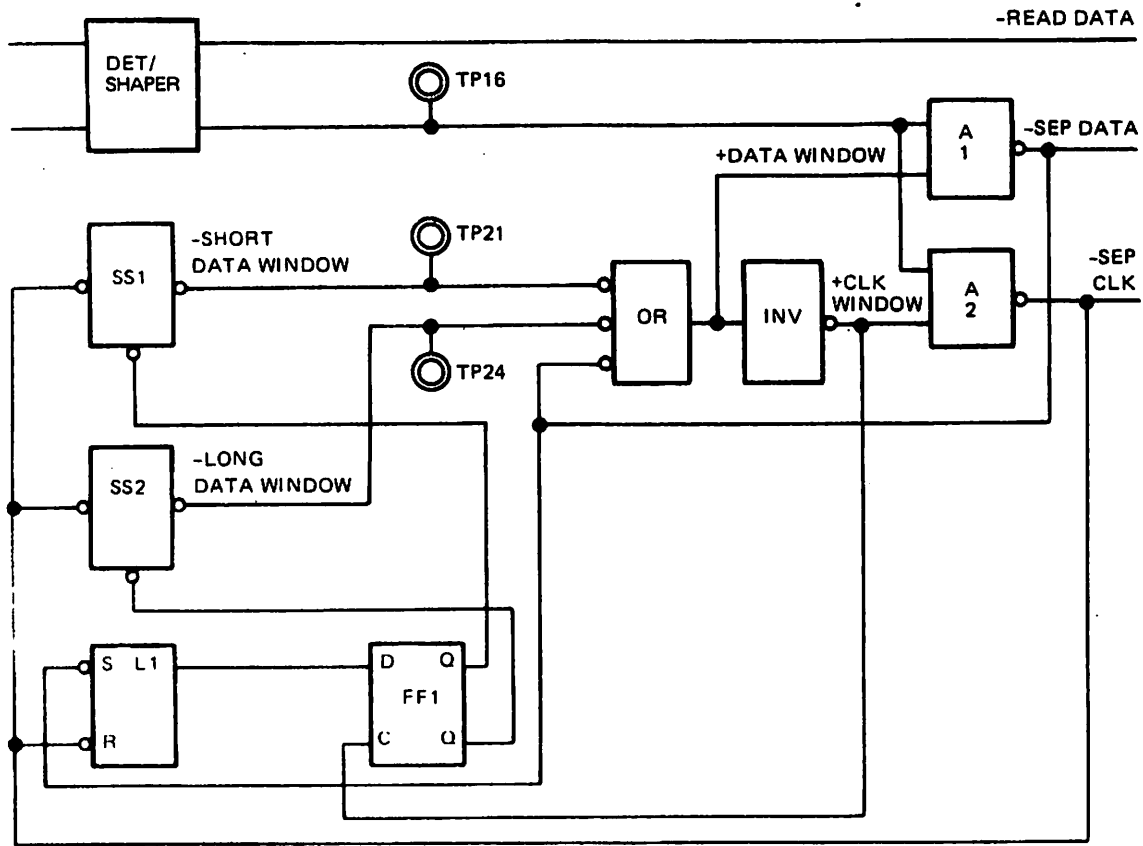


Figure 2.7.2 Data Separator Functional Diagram

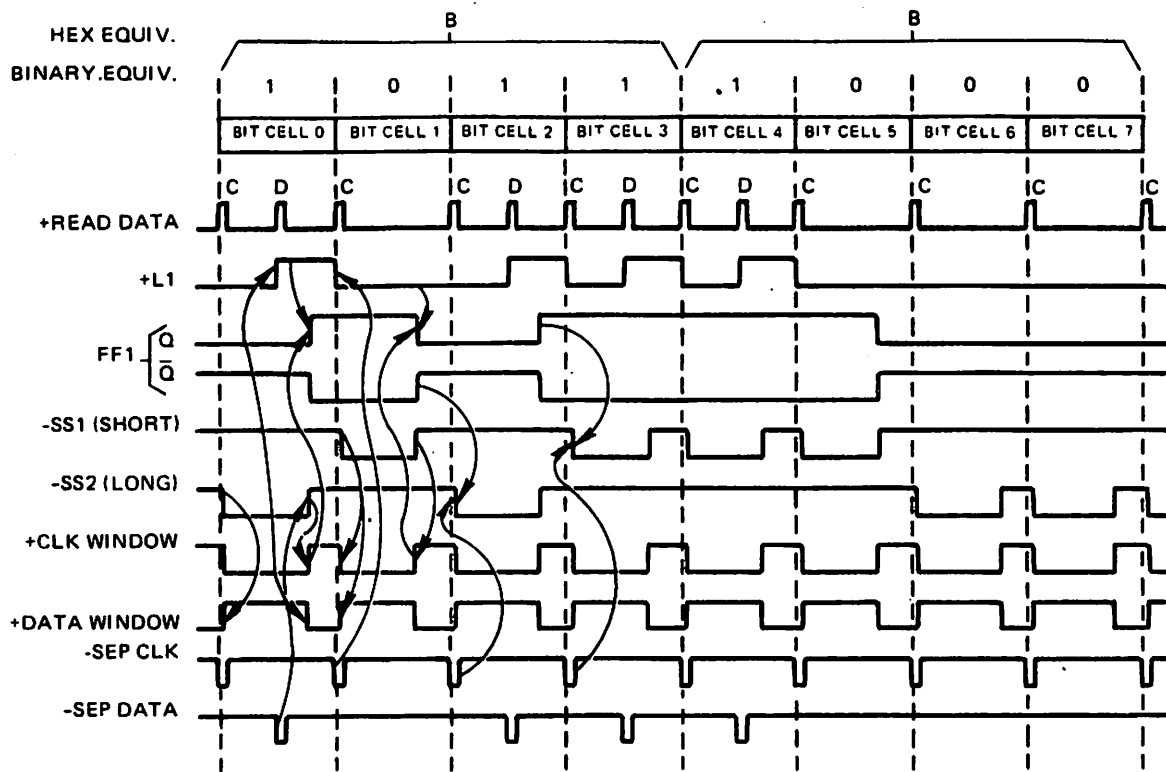


Figure 2.7.3 Data Separation Timing Diagram

## 2.8 SAFETY CIRCUITS

Safety Circuits check for component failures, using system operational errors, and operator errors.

### 2.8.1

The safety circuit, File Inop, in the SA900/901 is designed to check for the following:

1. Write gate with no write current sense.
2. No write gate with write current sense.
3. Write gate without the head loaded.
4. Write gate with not write data.
5. Write gate with the door opened.

### 2.8.2

Figure 2.8.1 shows the functional diagram of the File Inop circuit. It is the responsibility of the using system to test the -File Inop interface line. Upon detection of -File Inop, the using system should activate -File Inop Reset and retry the operation.

### 2.8.3

When -File Inop becomes active, the SA900/901 will inhibit any further write operations until the fault is corrected, and File Inop Reset or Power on reset is presented.

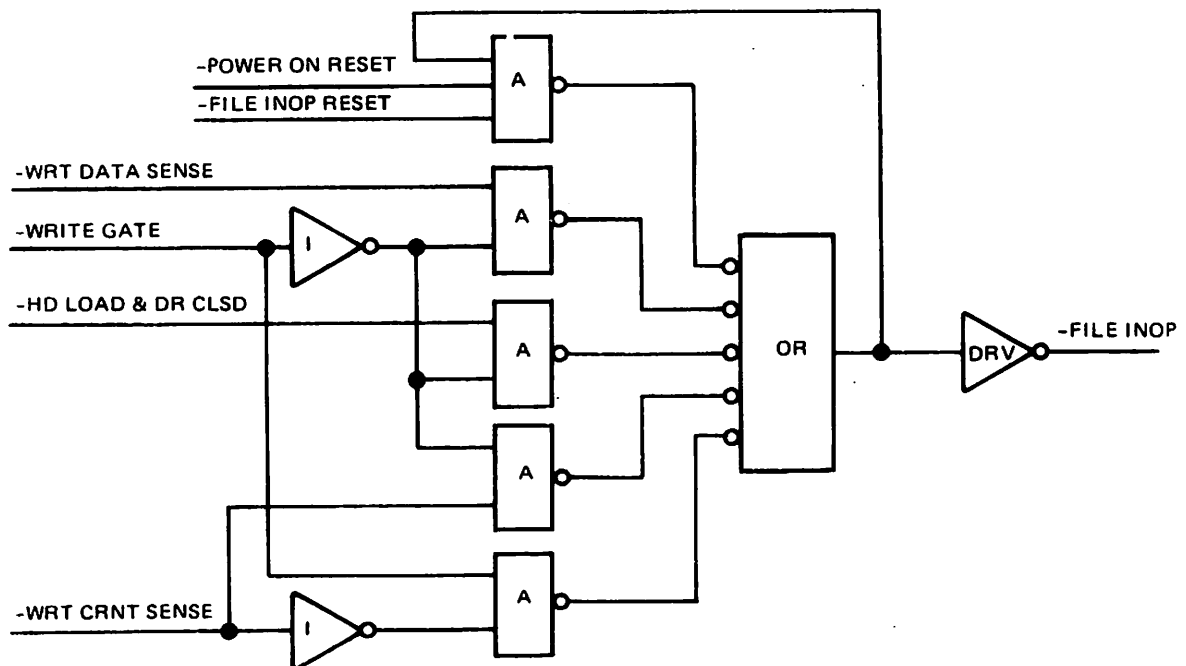


Figure 2.8.1 File Inop Circuit

## 2.9 INTERFACE

The electrical interface between the SA900/901 and the using system is via two connectors; one carries signals and DC power, the other carries AC power and frame ground.

The interface circuits are divided into two categories, lines carrying data and those lines carrying control information.

### 2.9.1

The electrical interface, Figure 2.9.1, connects the SA900/901 to the using system. P1, PCB edge card connector, provides all signals and DC power. P4, a 3-circuit panel mount connector, provides AC power and frame ground.

### 2.9.2

The AC power is used for the drive motor while the DC power is used for the electronics and stepping motor. The power requirements are defined below.

#### AC POWER

110  $\pm$  10% VAC @ .75A  
50/60  $\pm$  .5 Hz single phase

#### DC POWER

+5  $\pm$  0.25 VDC @ 1.5A max. 50 mV ripple  
-5  $\pm$  0.25 VDC @ .20A max. 50 mV ripple  
+24  $\pm$  1.20 VDC @ 2.0A max. 100 mV ripple

### 2.9.3

The interface circuits, drivers and receivers are divided into two categories - those lines carrying data and those lines carrying control information.

#### 2.9.3.1

The line receiver for -Write Data in the SA900/901 is basically a Schmitt trigger. The line drivers for -Read Data, -Sep. Clk. and -Sep. Data are 2N2222A transistor circuits. All data handling interface lines are terminated with 100 ohms and are designed for use with 100 ohm coaxial cable. Figure 2.9.2 is a typical data line receiver and driver circuit.

#### 2.9.3.2

The control line drivers consist of open collector circuits. The control line receivers consist of standard 7400 TTL gates with termination resistors of 150 ohms. Figure 2.9.3 shows a typical control signal driver and receiver.

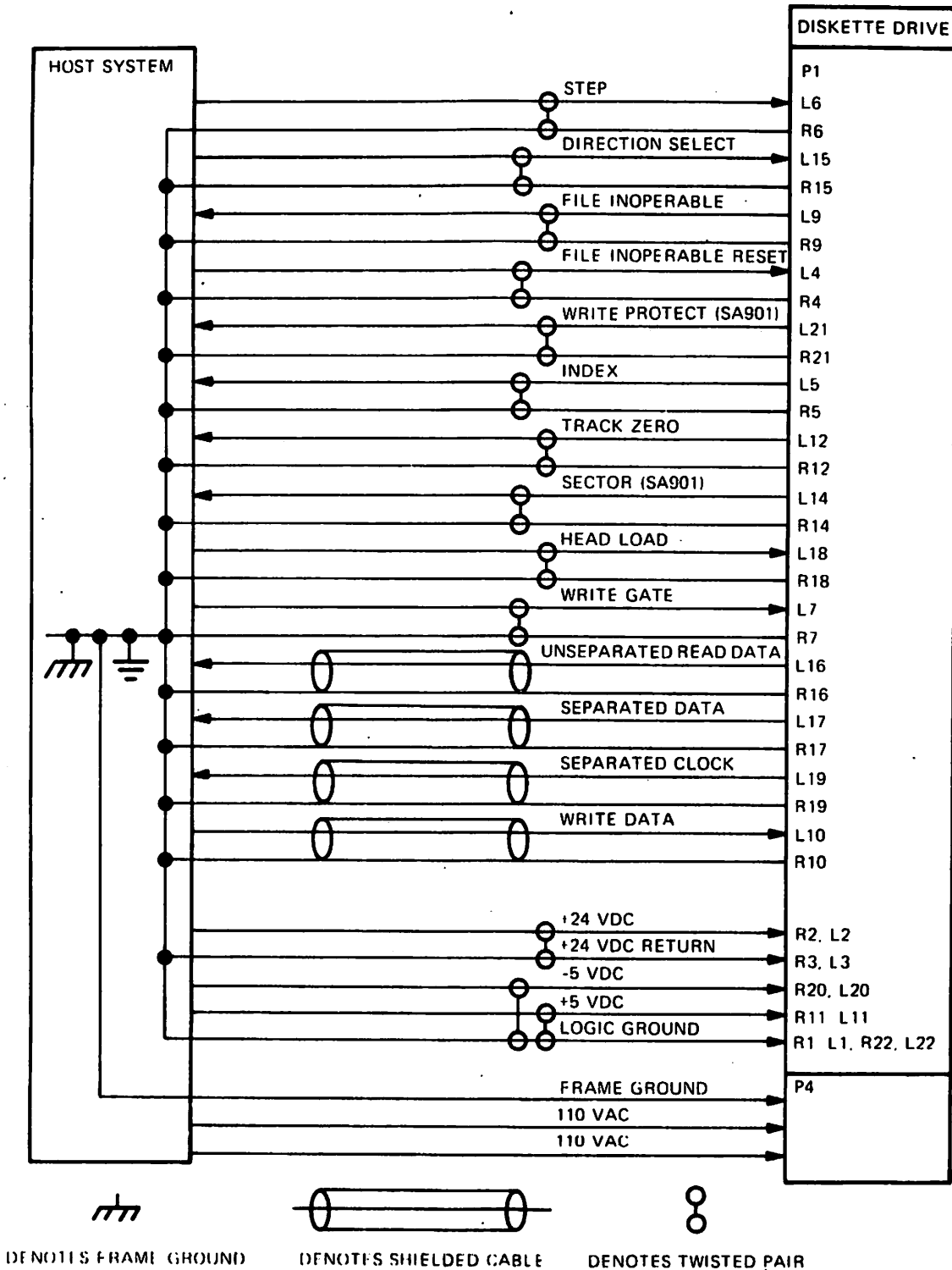


Figure 2.9.1 Interface Lines

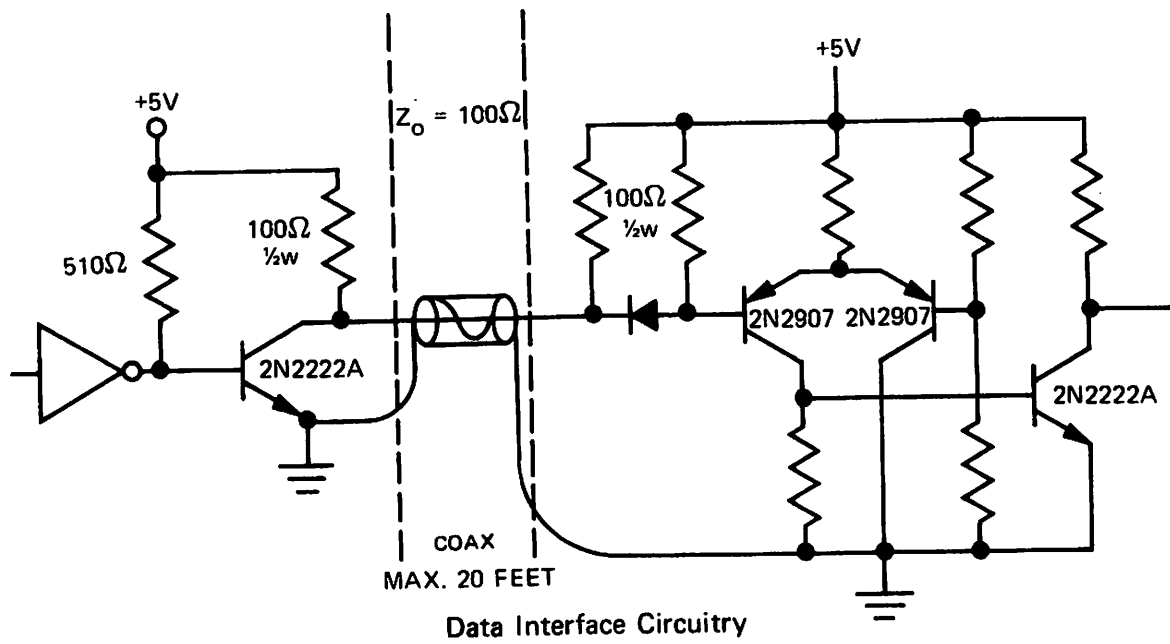


Figure 2.9.2 Data Line Driver/Receiver Combination

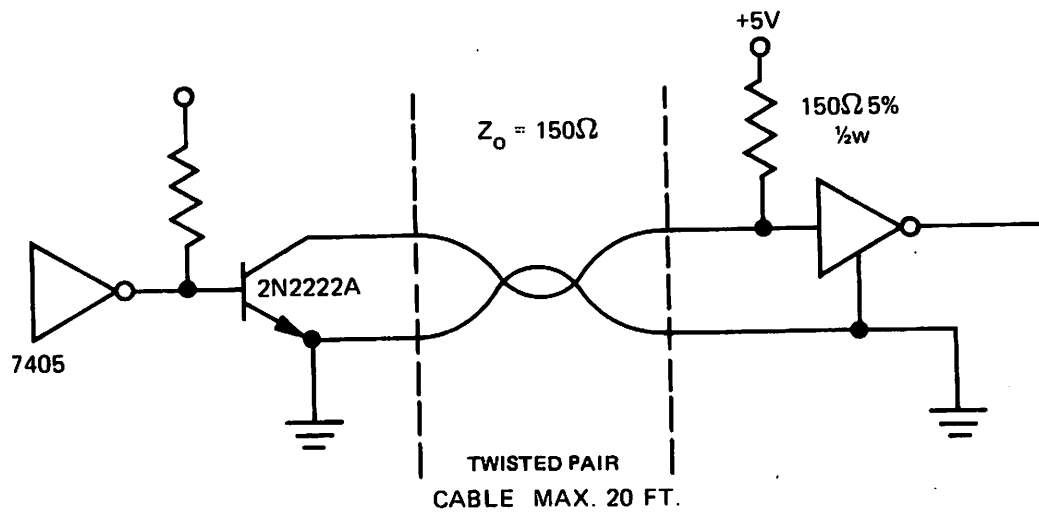


Figure 2.9.3 Control Signal Driver/Receiver Combination

### 3.1 MAINTENANCE FEATURES

#### 3.1.1 Alignment Diskette

The SA120 Alignment Diskette is used for alignment of the SA900/901. The following adjustments can be made using the SA120.

1. R/W Head radial alignment using track 38.
2. Index Photo-transistor alignment using tracks 01 and 76.
3. Track 00 is recorded with standard IBM 3740 format.

Caution should be exercised in using the SA120 Alignment Diskette. Tracks 00, 01, 36, 37, 38, 39, 40, and 76 should not be written on. To do so will destroy pre-recorded tests.

#### 3.1.2 SA909 Exerciser

The SA909 Exerciser was designed as a piece of test equipment for the SA900/901 Diskette Drive. The Exerciser is capable of performing the following functions:

1. Seek - Incremental or alternate tracks
2. Read
3. Write - 1F or 2F
4. Load Head
5. Recalibrate to track zero

The exerciser is provided with switches and indicators to perform the listed functions.

#### 3.1.3 Special Tools

The following special tools are available for performing maintenance on the SA900/901.

Description	Part Number
Alignment Diskette	SA120
Cartridge Guide Adj. Tool	50377-0
Head Penetration Gauge	50380-0
Head Load Bail Gauge (old)	50383-0
Load Bail Gauge (new)	50391-0
Load Button Pliers	50933-0

### 3.2 DIAGNOSTIC TECHNIQUES

#### 3.2.1 Introduction

Incorrect operating procedures, faulty programming, damaged diskettes, and "soft errors" created by airborne contaminants, random electrical noise, and other external causes can produce errors falsely attributed to drive failure or misadjustment.

Unless visual inspection of the drive discloses an obvious misalignment or broken part, attempt to repeat the fault with the original diskette, then attempt to duplicate fault on second diskette.

### 3.2.2 "Soft Error" Detection and Correction

Soft errors are usually caused by:

1. Airborne contaminants that pass between the read/write head and the disk. Usually these contaminants can be removed by the cartridge self-cleaning wiper.
2. Random electrical noise that usually lasts for a few  $\mu$  sec.
3. Small defects in the written data and/or track not detected during the write operation that may cause a soft error during a read.

The following procedures are recommended to recover from the above mentioned soft errors:

1. Reread the track ten (10) times or until such time as the data is recovered.
2. If data is not recovered after using step 1, access the head to the adjacent track in the same direction previously moved, then return to the desired track.
3. Repeat step 1.
4. If data is not recovered, the error is not recoverable.

### 3.2.3 Write Error (Reference Figure 1B)

If an error occurs during a write operation, it 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 ten (10) attempts have been made, a read operation should be attempted on another track to determine if the media or the drive is failing. If the error still persists the Diskette should be swapped and the above procedure repeated. If the failure still exists, consider the drive defective. If the failure disappears, consider the original diskette defective and discard it.

### 3.2.4 Read Error (Reference Figure 1A)

Most errors that occur will be "soft" errors. In these cases, performing an error recovery procedure will recover the data.

### 3.2.5 Seek Error (Reference Figure 1C)

Stepper malfunction.

### 3.2.6 Index/Sector Error (Not Ready) (Reference Figure 1D)

Initial indication is usually a not ready.



### 3.2.7 Test Points

- TP 0 +Door Closed
- 1 Read Data Signal
- 2 Read Data Signal
- 3 Read Data
- 4 Read Data
- 5 Ground
  
- TP 6 Ground
- 7 + Power On Reset
- 9 [(Head Load + Door Closed) Write Gate] +  
Write Data Write Gate
- 11 -Load Head
- 12 -Index and 901 Sector Pulses
- 13 +File Inop
- 15 +Write Gate Write Protect
- 16 +Read Data
- 20 +Write Data
- 21 -2.9  $\mu$ s Window S.S.
- 24 -3.1 $\mu$ s Window S.S.
- 26 +TRK  $\emptyset$
- 27 -STEP WRITE GATE
- 35 -Write Gate File Inop

# CAUTION

TURN POWER OFF  
BEFORE REMOVING DISKETTE  
DRIVE FROM USING SYSTEM  
AND/OR WHEN REMOVING PCB

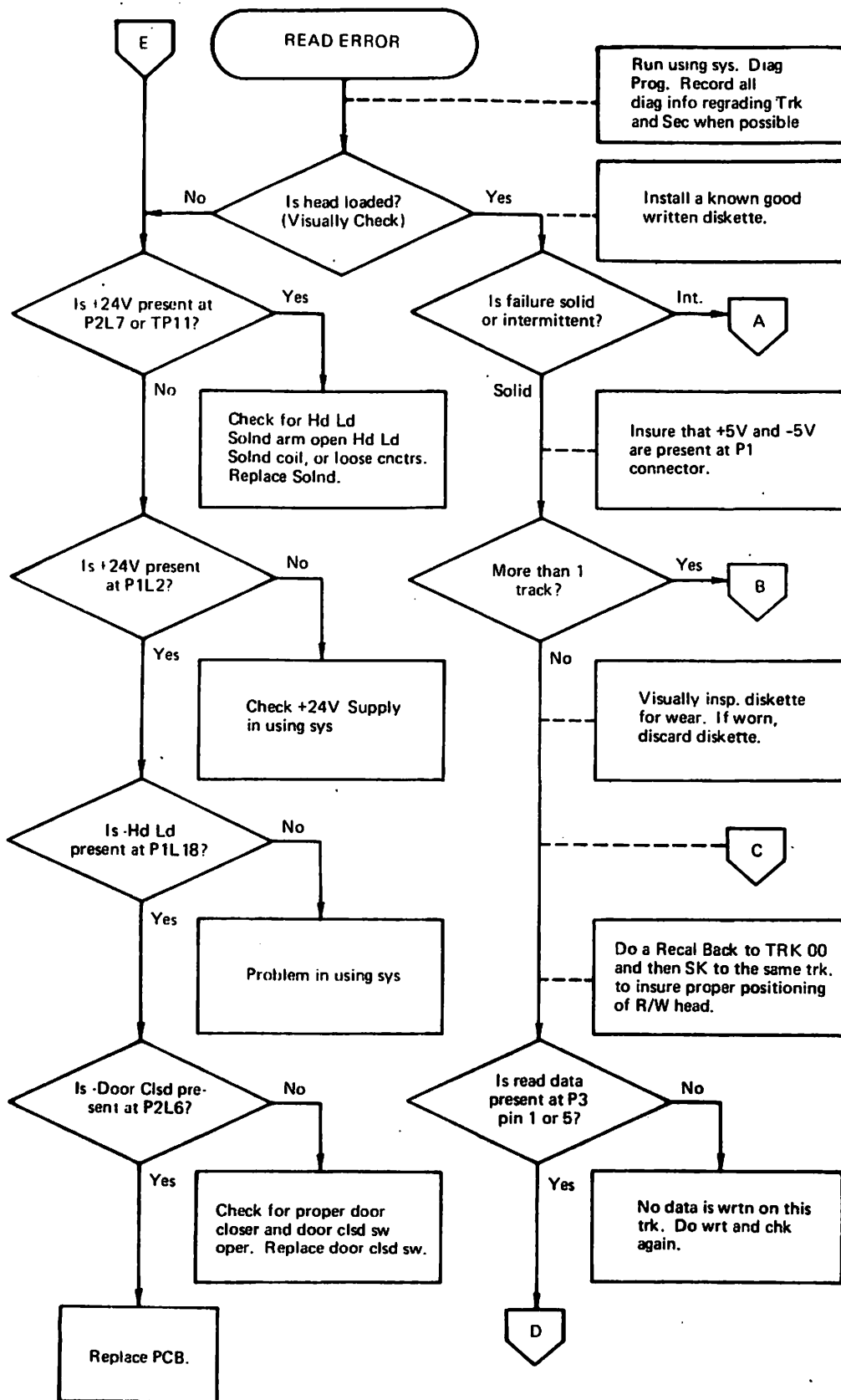


Figure 1A

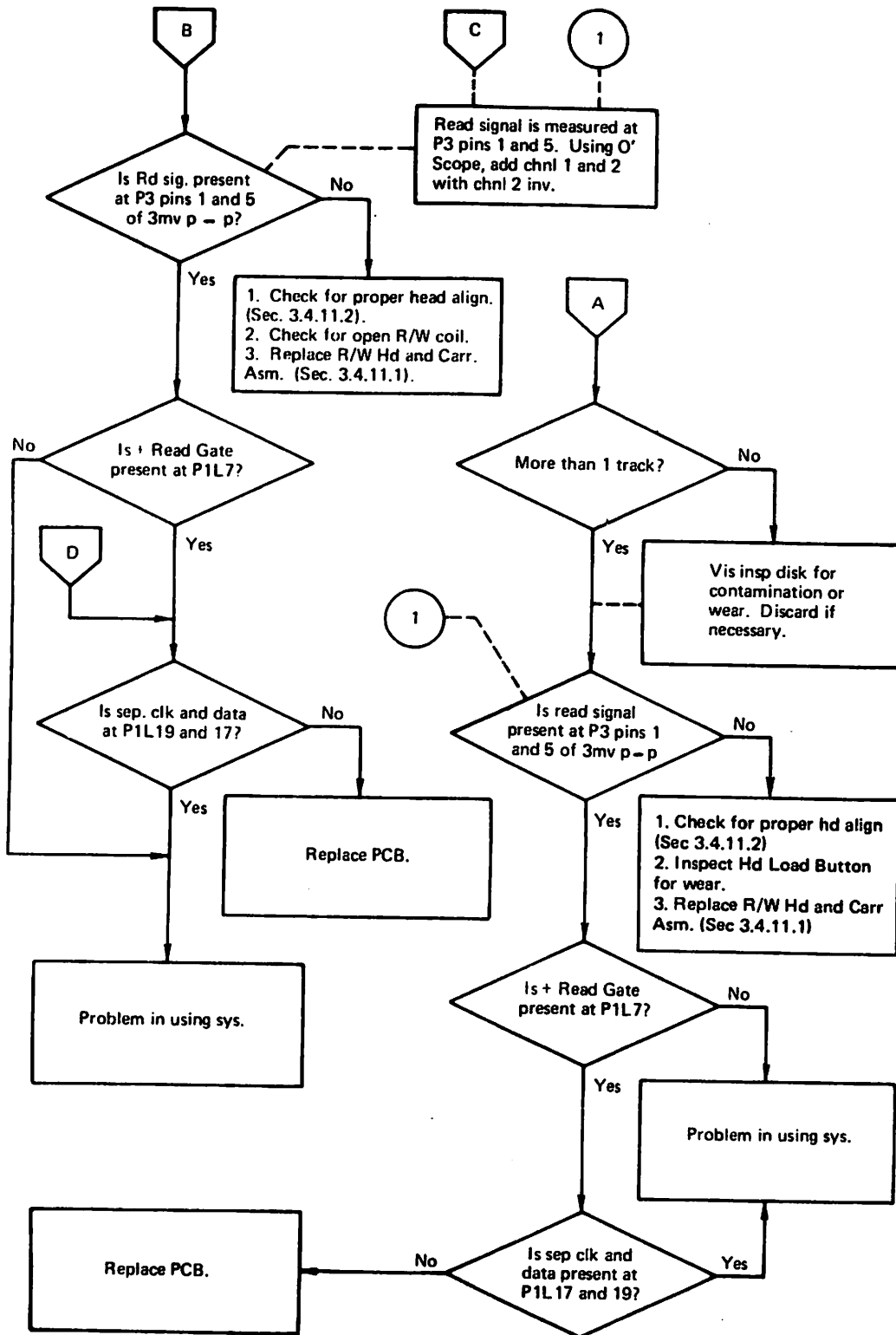


Figure 1A (Continued)

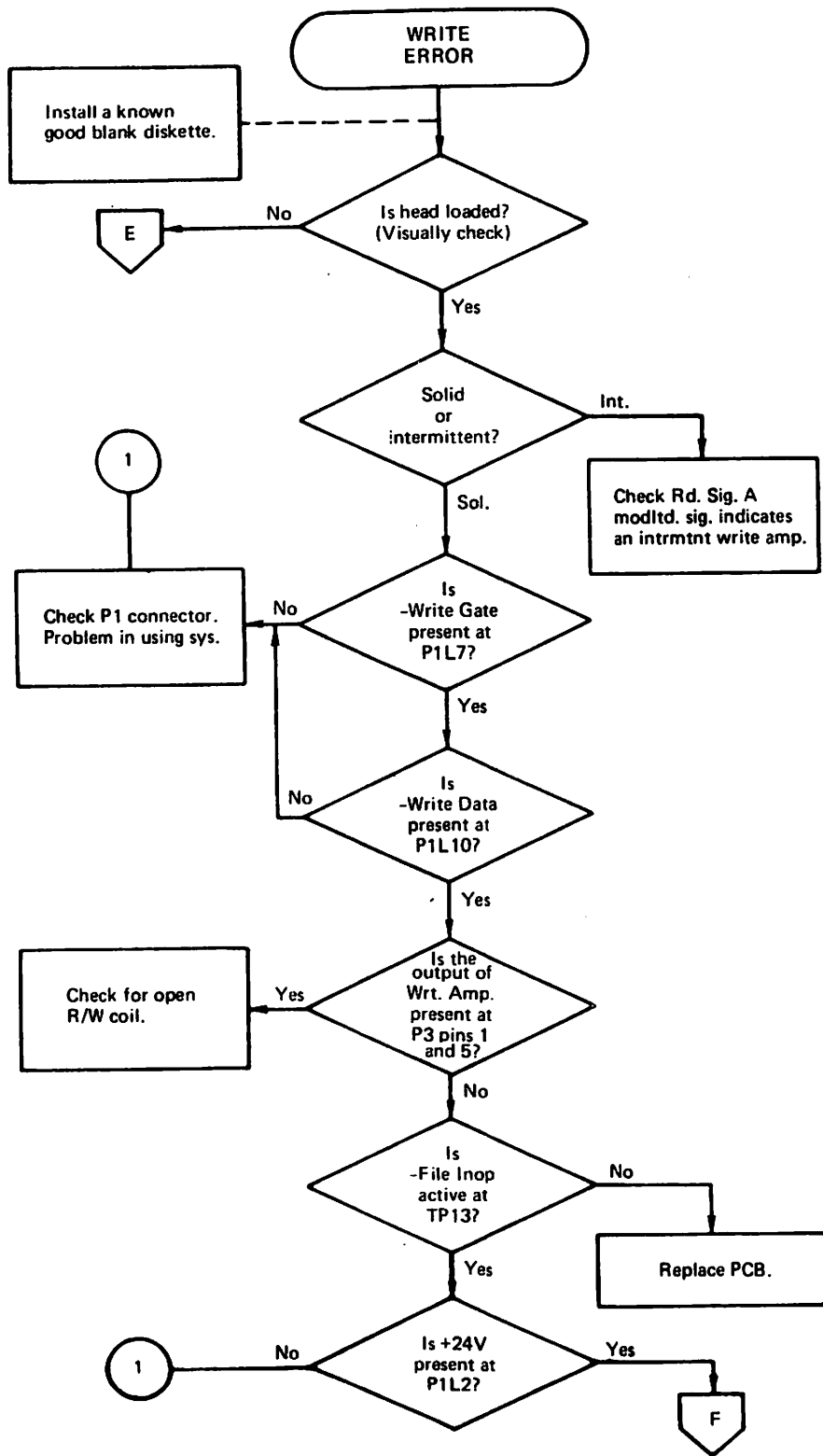


Figure 1B

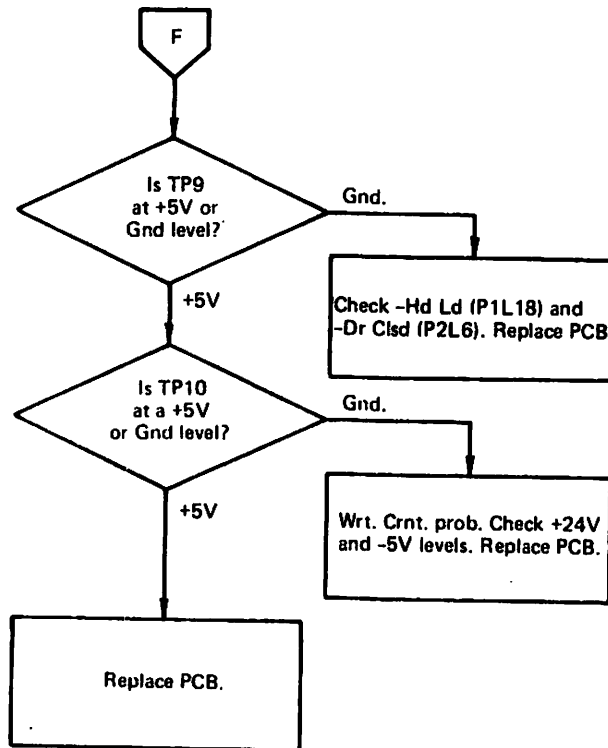


Figure 1B (Continued)

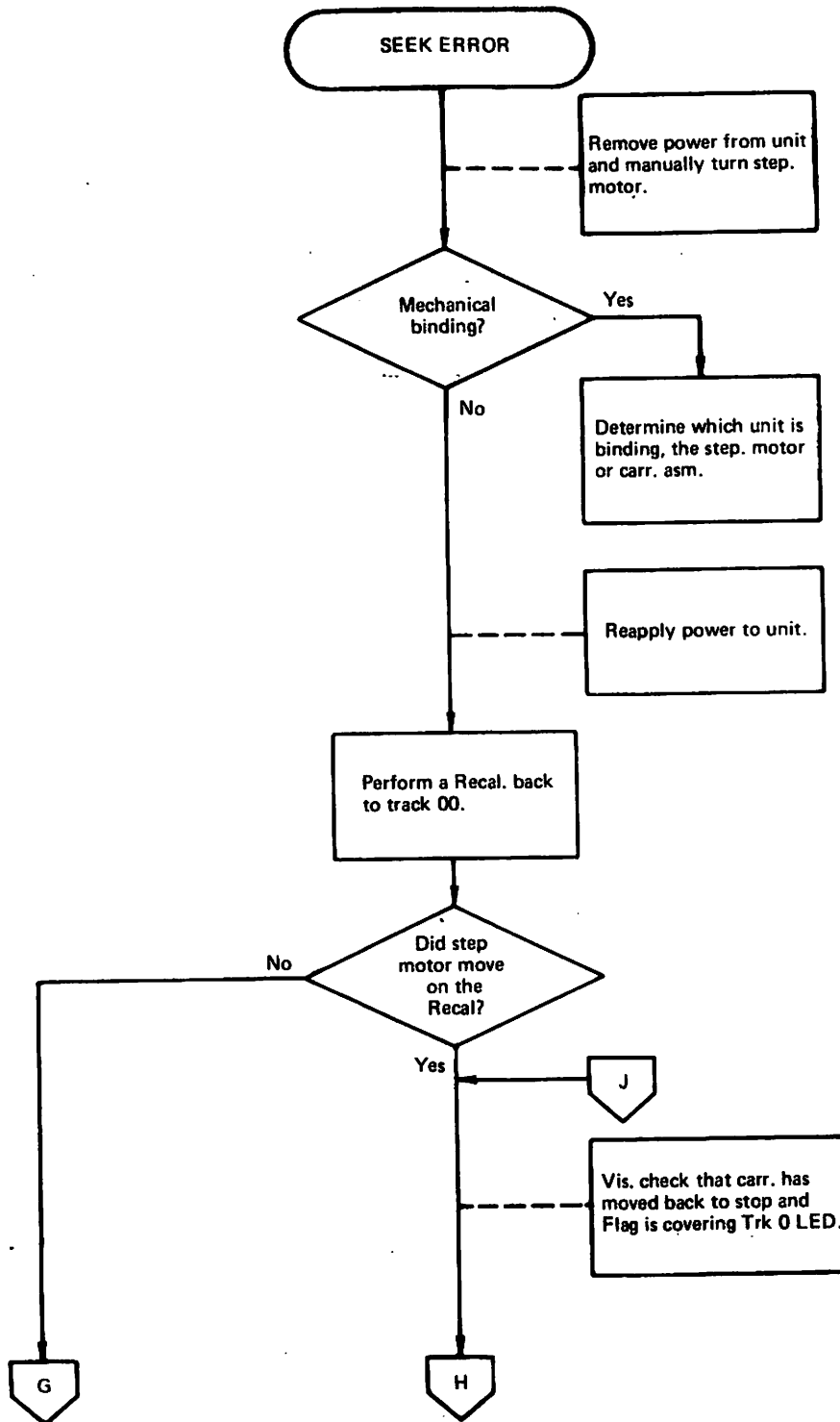


Figure 1C

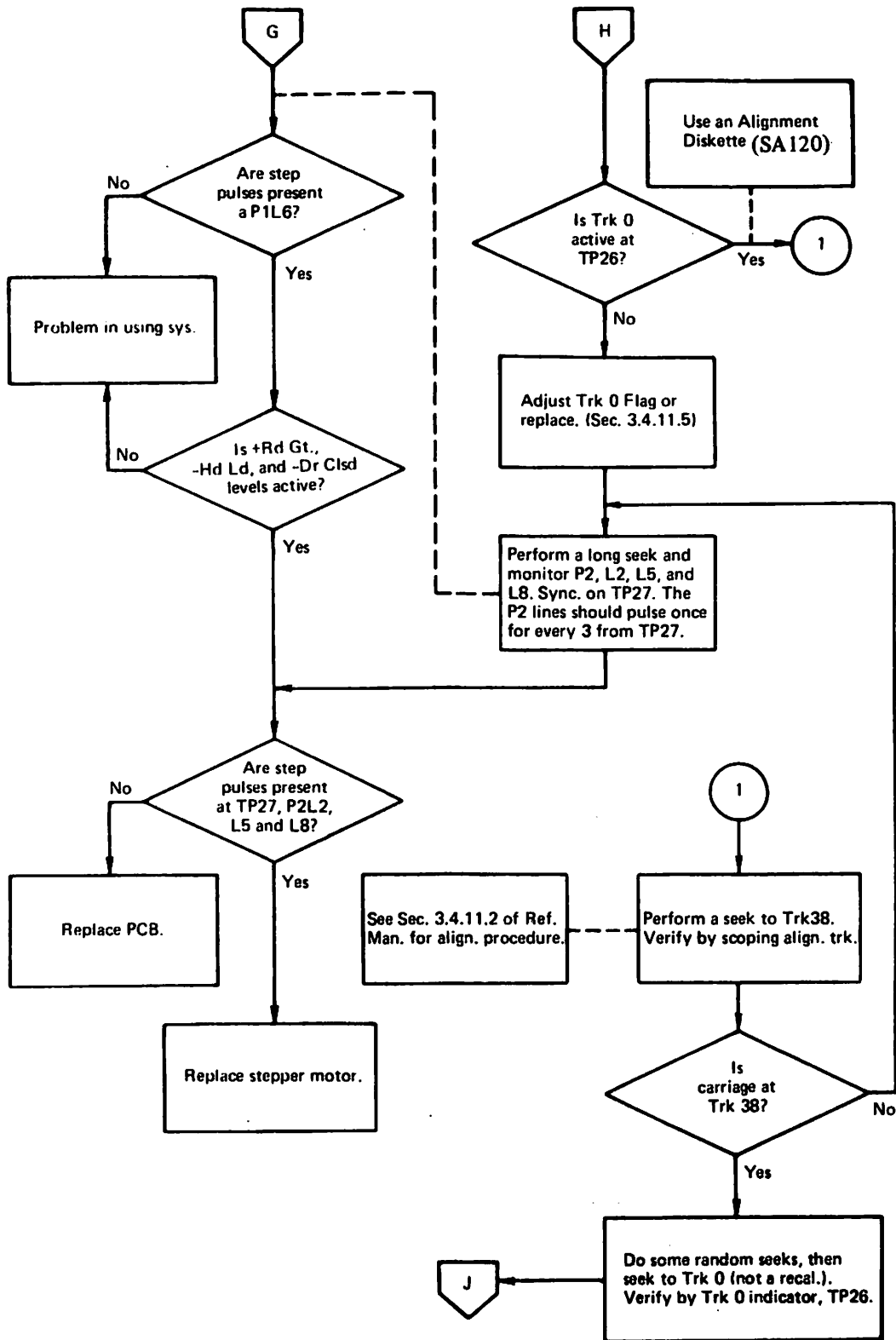


Figure 1C (Continued)

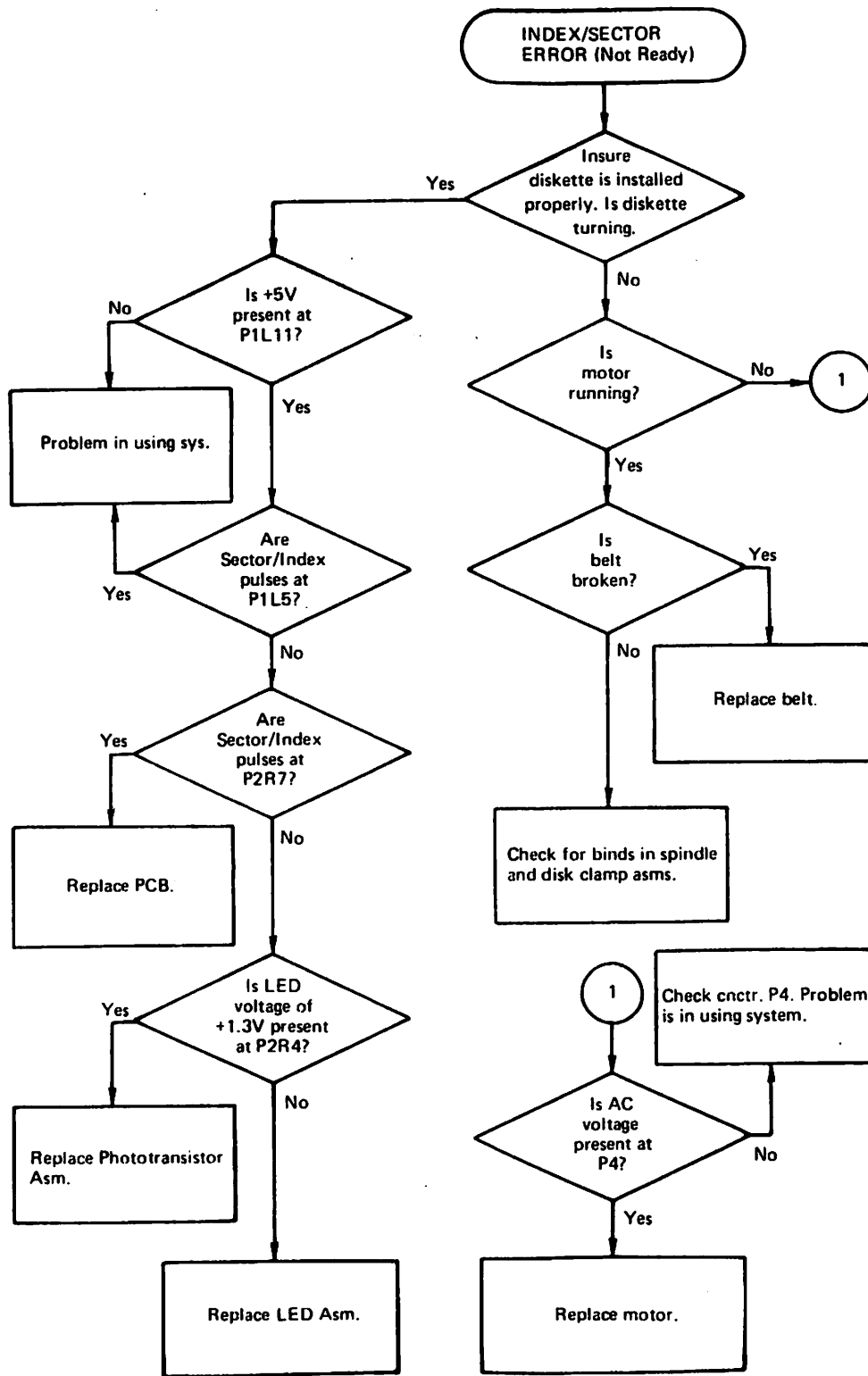


Figure 1D



### 3.3 PREVENTIVE MAINTENANCE

#### 3.3.1 Introduction

The prime objective of any preventive maintenance activity is to provide maximum machine availability to the user. Every preventive maintenance operation should assist in realizing this objective. Unless a preventive maintenance operation cuts machine downtime, it is unnecessary.

Visual inspection is the first step in every scheduled maintenance operation. Always look for corrosion, dirt, wear, binds, and loose connections. Noticing these items during PM may save downtime later.

Remember, do not do more than recommended preventive maintenance on equipment that is operating satisfactorily.

#### 3.3.2 Preventive Maintenance Procedures

Details of preventive maintenance operations are listed in Figure 2. During normal preventive maintenance, perform only those operations listed on the chart for that preventive maintenance period. Details on adjustments and service checks are found on the pages listed in the chart. Observe all safety procedures.

UNIT	FREQ MONTHS	CLEAN	OBSERVE
Read/Write Head	12	Clean Read/Write Head <b>ONLY IF NECESSARY</b>	Oxide build up and scratches
R/W Head Load Button		Replace	
Stepper Motor and Lead Screw		Clean off all oil, dust, and dirt	Inspect for nicks and burrs
Belt			Frayed or weakened areas
Base		Clean base	Inspect for loose screws, connectors, and switches
Read/Write Head			Check for proper alignment

Fig 2 PM Procedures

#### 3.3.3 Cleanliness

Cleanliness cannot be overemphasized in maintaining the SA900/901. Do not lubricate the SA900/901; oil will allow dust and dirt to accumulate. The read/write head should be cleaned but only when signs of oxide build up are present.

## 3.4 REMOVALS, ADJUSTMENTS

### 3.4.1 Motor Drive

#### 3.4.1.1 Drive Motor Assembly: Removal and Installation

- a. Extract 3 contacts to disconnect motor from AC connector.
- b. Loosen two screws holding capacitor clamp to the base. Remove rubber boot and disconnect motor leads from capacitor.
- c. Remove connectors from PCB and remove PCB.
- d. Remove belt from drive pulley.
- e. Remove 4 screws holding the motor to the base casting and remove motor.
- f. Reverse the procedure for installation.

NOTE:

Insure ground lead is installed between clamp and base.

#### 3.4.1.2 Motor Drive Pulley

- a. Loosen set screw and remove pulley.
- b. Reverse procedure for installation.

NOTE:

When installing a new pulley, the drive pulley must be aligned with the spindle pulley so that the belt tracks correctly.

#### 3.4.2 Side Cover: Removal

- a. Retract screw from upper casting wall sufficiently to allow the side cover to be rocked out.
- b. Lift cover off screw in lower casting wall.

#### 3.4.3 Cartridge Guide Access

- a. Remove side cover (Section 3.4.2).
- b. Position head to approximate center of head load bail (to prevent load arm tab from slipping off end of bail).
- c. Loosen 2 screws holding cartridge guide to door latch plate.
- d. Swing cartridge guide out.
- e. When the guide is swung in, it must be adjusted as per Section 3.4.9.2.

#### 3.4.4 Light Emitting Diode Assembly: Removal and Installation

- a. Remove side cover (Section 3.4.2).
- b. Disconnect the wires to the LED terminals (solder joints).
- c. Swing out the cartridge guide assembly (Section 3.4.3).
- d. Remove the screw, nut, and washer holding the LED assembly to the cartridge guide.
- e. Reverse the procedure for installation.
- f. Check index timing and readjust if necessary.

### 3.4.5 Write Protect Detector

- a. Remove side cover (Section 3.4.2).
- b. Swing out the cartridge guide assembly (Section 3.4.3).
- c. Remove the screw holding the detector bracket and remove the assembly.
- d. Remove the 2 screws holding the detector to the bracket and remove the detector.
- e. Disconnect the wires to the detector (solder joints).
- f. Reverse the procedure for installation.

**NOTE:**

Mount should be slipped over cable before soldering detector on.

### 3.4.6 Head Load Actuator

#### 3.4.6.1 Head Load Actuator: Removal and Installation

- a. Remove side cover (Section 3.4.2).
- b. Disconnect the wires to the actuator terminals (solder joints).
- c. Swing out the cartridge to guide assembly (Section 3.4.3).
- d. Remove Screw holding the actuator to the cartridge guide.  
**CAUTION:** Restrain the head load arm to prevent its impact with the head.
- e. Reverse the procedure for installation.

#### 3.4.6.2 Head Load Actuator Physical Adjustment (old style)

- a. Remove side cover.
- b. Step carriage to Track 00.
- c. Energize coil either using tester or manually grounding pin L18 on connector P1.
- d. Loosen bail screw on Head Load Bail.
- e. Using Bail Gauge (p/n 50383), adjust bail so that Head Load Arm just touches shim. Tighten screw until just snug. Insure that load arm is over bail when carriage is at Track 00.
- f. Step carriage to Track 76 and check that arm still just touches shim. (This will result in Head Load Bail to Head Load Arm clearance of .020"). Insure that load arm is over bail when carriage is at Track 76. Reference figures below.
- g. Tighten Head Load Bail screw.
- h. Replace side cover.

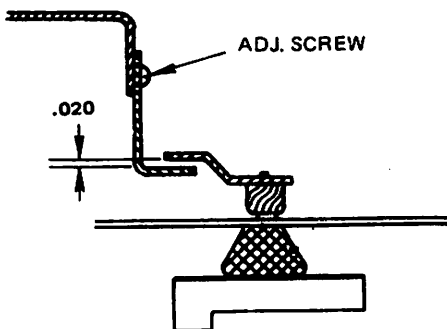


FIGURE 3 HEAD LOAD BAIL TO HEAD LOAD ARM ADJUSTMENT (OLD STYLE)

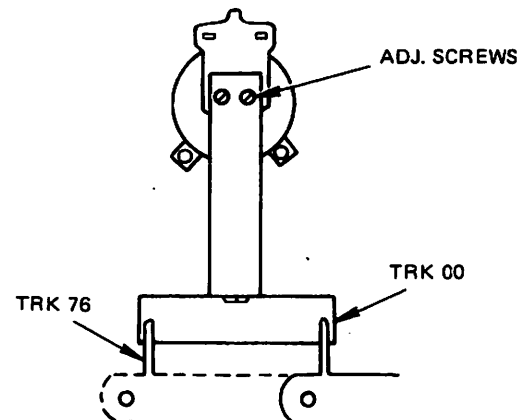


FIGURE 4 HEAD LOAD ACTUATOR LATERAL ALIGNMENT (OLD STYLE)

②

### 3.4.6.2(a) Head Load Actuator Physical Adjustment (new style)

- a. Remove side cover.
- b. Step carriage to Track 38.
- c. Place Head Load Actuator adjustment tool, P/N 50391, on R/W head and place load button in cup of tool.
- d. Adjust up stop on Actuator so that bail just touches head load arm.
- e. Energize Head Load coil by grounding TP11.
- f. Place adjustment tool on platen.
- g. Adjust down stop on coil so as the top of Head Load bail is flush with top of tool.
- h. Step carriage between tracks 00 and 76 insuring that there is clearance between Head Load Bail and Head Load Arm.
- i. Replace side cover.

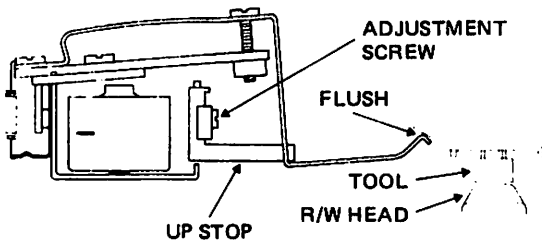


FIGURE 5 HEAD LOAD ACTUATOR UPSTOP ADJUSTMENT

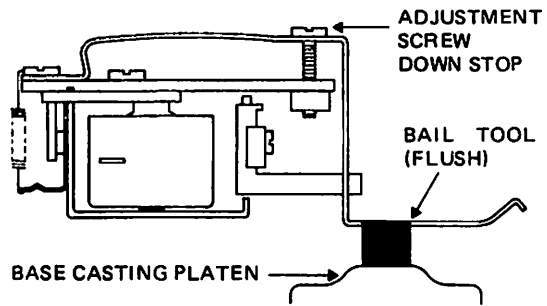


FIGURE 6 HEAD LOAD ACTUATOR DOWN STOP ADJUSTMENT

### 3.4.6.3 Head Load Actuator Timing

- a. Insert Alignment Diskette (SA120).
- b. Step carriage to Track 0.
- c. Sync oscilloscope on TP11 (-Load Head). Set time base to 10MSEC/division.
- d. Connect one probe to TP1 and the other to TP2. Ground probes to the PCB. Set the inputs to Add and invert one input.
- e. Energize the Head Load solenoid and observe the read signal on the oscilloscope. The signal must be at 50% of full amplitude by 50Msec. Reference Figure 7.
- f. If this is not met, continue on with the procedure.
- g. Loosen the screws holding the armature up stop.
- h. Move stop down toward the solenoid coil. Tighten screws.
- i. Repeat step c.

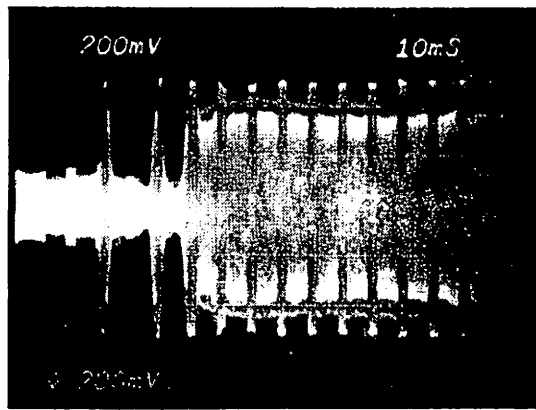


FIGURE 7 HEAD LOAD ACTUATOR TIMING

### 3.4.7 Index/Sector Photo Transistor Assembly

#### 3.4.7.1 Index/Sector Photo Transistor Assembly: Removal and Installation

- a. Disconnect wires from the terminals (solder joints).
- b. Remove 1 screw and remove photo transistor assembly from baseplate.
- c. Reverse the procedure for installation.

**NOTE:**

If replacing old style phototransistor assembly with new style (potentiometer on assembly) use Field Kit P/N 50928.

#### 3.4.7.2 Index Sector Photo Transistor Potentiometer Adjustment

- a. Insert Alignment Diskette (SA120).
- b. Using oscilloscope monitor TP-12 (-Index), sync internal negative, DC coupled, set vertical scale to 2 V/cm.
- DON'T TOUCH* → c. Adjust the potentiometer on the Sector/Index Phototransistor to obtain a pulse of 1.7 msec.  $\pm$  .5 msec. duration.
- d. Continue adjustment in section 3.4.7.3.

#### 3.4.7.3 Index/Sector Adjustment

- a. Insert Alignment Diskette (SA120).
- b. Step carriage to Track 1.
- c. Sync oscilloscope on TP 12 (-Index). Set time base to 50  $\mu$ sec/division.
- d. Connect one probe to TP 1 and the other to TP 2. Ground probes to the PCB. Set the inputs to AC, Add and invert one channel. Set vertical deflection to 500 MV/division.
- e. Channels 1 and 2 should be added and one of the channels inverted.
- f. Observe the timing between the start of the sweep and the first data pulse. This should be 200  $\mu$ sec  $\pm$  50  $\mu$ sec. If the timing is not within tolerance, continue on with the adjustment. Reference Figure 8.

*SHOULD HAVE  
300mV PP MIN.*

- g. Loosen the holding screw in the Index Transducer until the Transducer is just able to be moved.
- h. Observing the timing, adjust the Transducer until the timing is correct. Insure that the Transducer Assembly is against the registration surface on the base casting.
- i. Tighten the holding screw.
- j. Recheck the timing.
- k. Seek to Track 76 and reverifiy the timing.

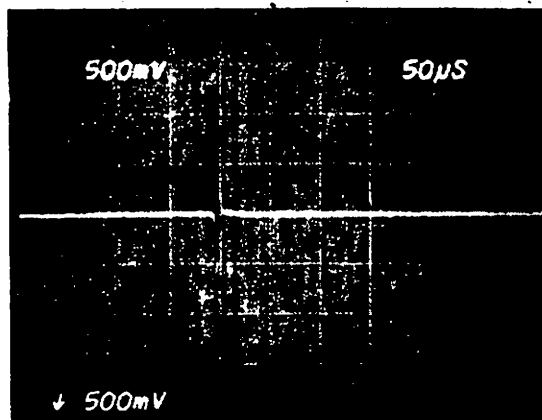


FIGURE 8 INDEX TIMING

### 3.4.8 Spindle Assembly

- a. Remove side cover (Section 3.4.2).
- b. Swing out cartridge guide (Section 3.4.3).
- c. Remove the nut and washer holding the spindle pulley.  
CAUTION: The pre-loaded rear bearing may fly out when spindle pulley is removed.
- d. Withdraw spindle hub from opposite side of baseplate.
- e. Reverse the procedure for installation.

### 3.4.9 Cartridge Guide

#### 3.4.9.1 Cartridge Guide Removal

- a. Perform steps 3.4.3 through 3.4.6.
- b. Pull up on the upper pivot cap screw until the shoulder contacts the base casting. Push up on the cartridge guide until the lower pivot clears the casting. Reference Figure 9.
- c. Tilt the cartridge guide slightly, and remove it from the upper pivot.
- d. To install the cartridge guide, reverse the procedure.

#### NOTE:

When swinging cartridge guide in, insert a small screwdriver through the access slot and load the torsion spring. (Force the torsion spring roller toward the rear of the spring).

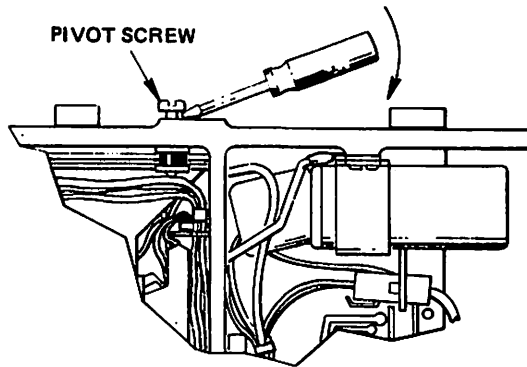


FIGURE 9 CARTRIDGE GUIDE REMOVAL

① DOOR LATCH ADJ: 726-9612

3.4.9.2 Cartridge Guide Adjustment

- a. Insert the shoulder screw (tool p/n 50377) through the adjustment hole in the cartridge guide and screw completely into the base casting (hand tight). Reference Figure 10.

NOTE:

Starting with drives manufactured in Dec. '73 the base casting has been machined in the adjustment hole area. This can be easily seen. On the machined castings the long shoulder (#2) should be used. On files where the casting was not machined the short shoulder (#1) should be used.

- b. Move the handle into the latched position and hold it lightly against the latch.
- c. Tighten two screws holding the cartridge guide to the latch plate.
- d. Depress push bar on front panel and check that door stays in latched position. If door latch was released by step d, repeat adjustment.
- e. Check index alignment per Section 3.4.7.3.

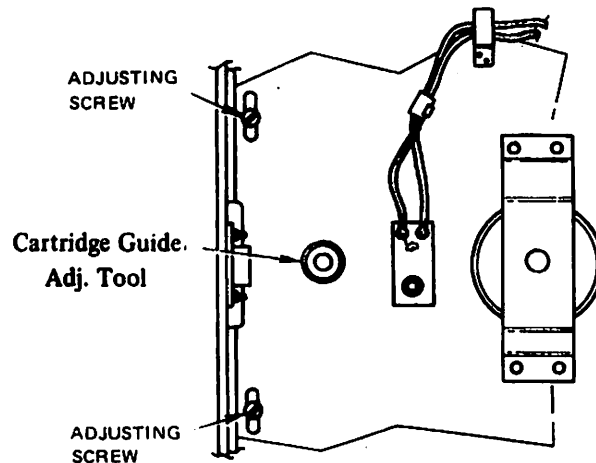


FIGURE 10 CARTRIDGE GUIDE ADJUSTMENT

### 3.4.10 Front Plate Assembly: Removal

- a. Remove side cover (Section 3.4.2).
- b. Swing out the cartridge guide assembly (Section 3.4.3).
- c. Remove 4 screws holding the front plate assembly to the base casting.
- d. Reverse the procedure for installation.
- e. Insert the cartridge guide assembly per Sections 3.4.9.1 and .2.

### 3.4.11 Stepper/Carriage

#### 3.4.11.1 Stepper/Carriage Assembly: Removal and Installation

- a. Disconnect the connectors from the PCB and remove the PCB.
- b. Remove side cover (Section 3.4.2).
- c. Swing out cartridge guide (Section 3.4.3).
- d. Extract stepper cable contacts from PCB connector.
- e. Loosen (3) motor clamp screws and rotate clamps to allow withdrawal of motor.  
CAUTION: DO NOT LOOSEN THREE SCREWS COATED WITH GLYPTOL.
- f. Manually rotate the lead screw to run the carriage assembly off the end while retracting the stepper motor.
- g. To install stepper/carriage assembly, reverse the procedure.
- h. Adjust index (Section 3.4.7.3).
- i. Adjust radial head alignment (Section 3.4.11.2).
- j. Adjust Track 0 limit stop (Section 3.4.11.8).
- k. Adjust Track 00 Detector (Section 3.4.11.9).

#### TR-393.4.11.2 Head Radial Alignment

##### NOTE:

Head radial alignment should be checked prior to adjusting index/sector Track 00 flag or carriage stop.

- a. Load Alignment diskette (SA120). (Note: Alignment diskette should be at room conditions for at least twenty minutes before alignment.)
- b. Step the carriage to Track 38.
- c. Sync the oscilloscope on TP 12 (-CE Index). Set the time base to 20 Msec per division. This will display over one revolution.
- d. Connect one probe to TP 1 and the other to TP 2. Ground the probes on the PCB. Set the inputs to AC, Add and invert one channel. Set the vertical deflection to 200 MV/dev.
- e. The two lobes must be within 80% amplitude of each other. If the lobes do not fall within the specification, continue on with the procedure.
- f. Loosen the three mounting screws which hold the motor to the mounting plate.  
CAUTION: DO NOT LOOSEN THREE SCREWS COATED WITH GLYPTOL.



- g. Rotate the stepper motor to radially move the head in or out. If the left lobe is less than 80% of the right, turn the stepper motor clockwise. If the right lobe is less than 80% of the left lobe, turn the stepper motor counterclockwise.
- h. When the lobes are of equal amplitude, tighten the motor mounting screws. Reference Figure 11.
- i. Check the adjustment by stepping off track and returning. Check in both directions.
- j. Whenever the Head Radial Alignment has been adjusted, the Track 00 detector adjustment (Section 3.4.11.9) and Track 00 stop must be checked (Section 3.4.11.8).

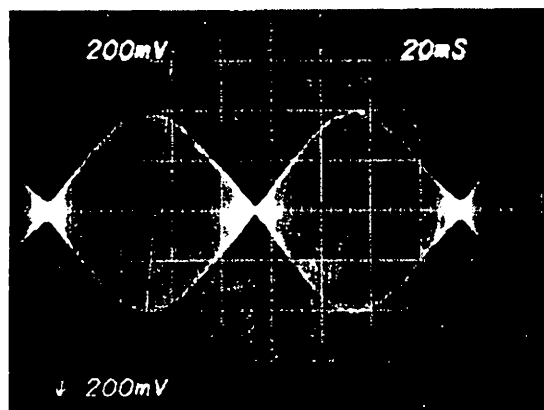


FIGURE 11 HEAD RADIAL ALIGNMENT

#### 3.4.11.3 Read/Write Head Load Button: Removal and Installation

- a. Remove side cover.
- b. To remove the old button if glued, open the arm, grasp the button with a pair of pliers and rotate the button. This breaks loose the button, and the button can be removed. Remove any glue that may remain by scraping.
- c. To remove the old button, if attached with a clip and washer, grasp the button with pliers and rock the button back and forth while pulling.
- d. Place the new button on the arm. On the back of the arm place the rubber washer (red side up). Holding the button, push the clip over the plastic stud until it is tight against the rubber washer. Reference Figure 12.
- e. Adjust according to Section 3.4.11.4.

**NOTE:**

The load arm should never be opened over 90° from carriage assembly to prevent possible damage to torsion spring.

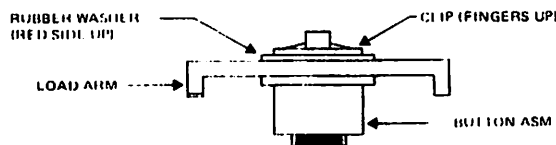


FIGURE 12

#### 3.4.11.4 Read/Write Head Load Button Adjustment

- a. Insert Alignment Diskette (SA120).
- b. Connect oscilloscope to TP 1 and 2, added differentially and sync negative external on TP 12 (-INDEX).
- c. Step carriage to Track 75.
- d. Observing read signal on oscilloscope, rotate the load button CCW in small increments (10°) until maximum amplitude is obtained.

#### 3.4.11.5 Head Penetration Adjustment

NOTE:

This adjustment is not normally done in the field. The only time that this adjustment need be done is when the stepper mounting plate has been loosened or removed.

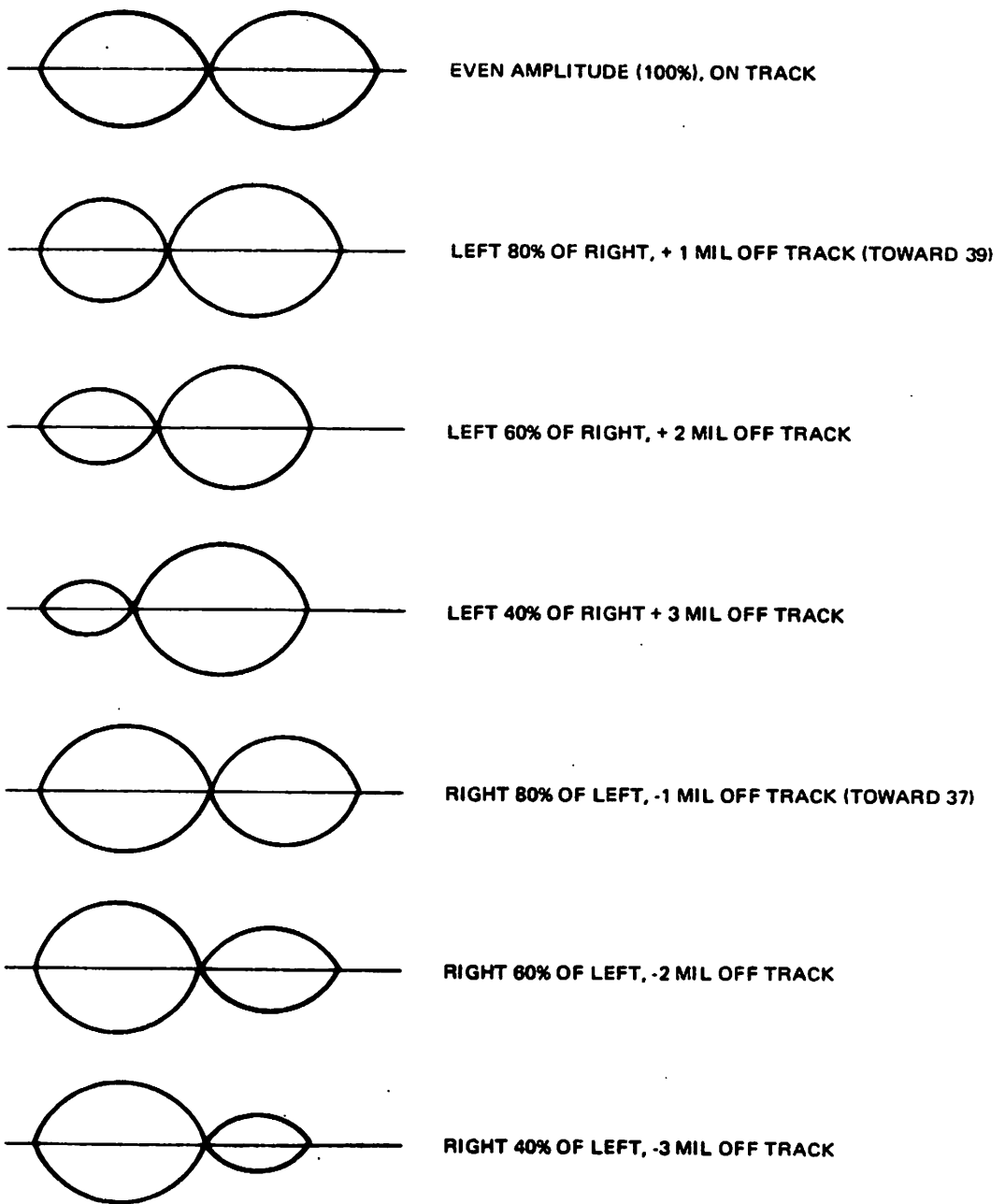
- a. Place the penetration tool (P/N 50380) on the gauge block and insure that the gauge reads .03 (3 on the small hand) and zero the dial for the large hand. This results in a reading of .030".
- b. Swing open the cartridge as per Section 3.4.3.
- c. Place the penetration tool on the base assembly with the short leg on the platen, the long leg on the carriage guide bar, and the plastic tip in the center of the R/W head.
- d. The head penetration should be  $.030" \pm .002"$  read on the gage.
- e. If the head does not meet this adjustment, move the stepper plate laterally until the gage reads .030".
- f. Tighten the screws and recheck the adjustment.
- g. Return cartridge guide and adjust as per Section 3.4.9.2.

#### 3.4.11.6 Track 0 Detector: Removal and Installation

- a. Remove side cover (Section 3.4.2).
- b. Swing carriage guide open (Section 3.4.3).
- c. Manually rotate stepper shaft and move carriage all the way in.
- d. Remove 2 screws holding bracket to base casting and remove bracket and detector.
- e. Remove 2 screws holding detector to bracket and remove detector.
- f. Unsolder four wires to detector.
- g. Reverse the procedure for installation.
- h. Adjust according to Section 3.4.11.9.

#### 3.4.11.7 Track 0 Flag

- a. Remove side cover (Section 3.4.2).
- b. Swing carriage guide open (Section 3.4.3).
- c. Hold head load arm back from head.
- d. Remove screw holding flag.
- e. Remove flag.
- f. Reverse procedure for installation.
- g. Adjust Track 0 Flag according to Section 3.4.11.9.



**Figure 13 R/W Head Radial Alignment**

#### 3.4.11.8 Track 00 Stop Adjustment (Old Style)

- a. Remove side cover (Section 3.4.2).
- b. Step carriage to Track 00. Verify that carriage is at 00 by checking P1L12 is minus (ground).
- c. Check that stop is  $.005'' (+.005'' -.000'')$  clearance between the carriage and the stop.
- d. If clearance is not within tolerance, continue on with the adjustment procedure.
- e. Loosen the screw in the Track 00 stop.
- f. Place a  $.005''$  feeler gage between the carriage and the stop. Position the stop against the feeler gage. Tighten the stop screw.
- g. Turn off AC and DC power.
- h. Manually rotate the lead screw clockwise to insure no interference between the carriage and the stop screw.
- i. If interference occurs, loosen screw and rotate stop to avoid the interference.
- j. Replace side cover.

#### 3.4.11.8 Track 00 Stop Adjustment (New Style)

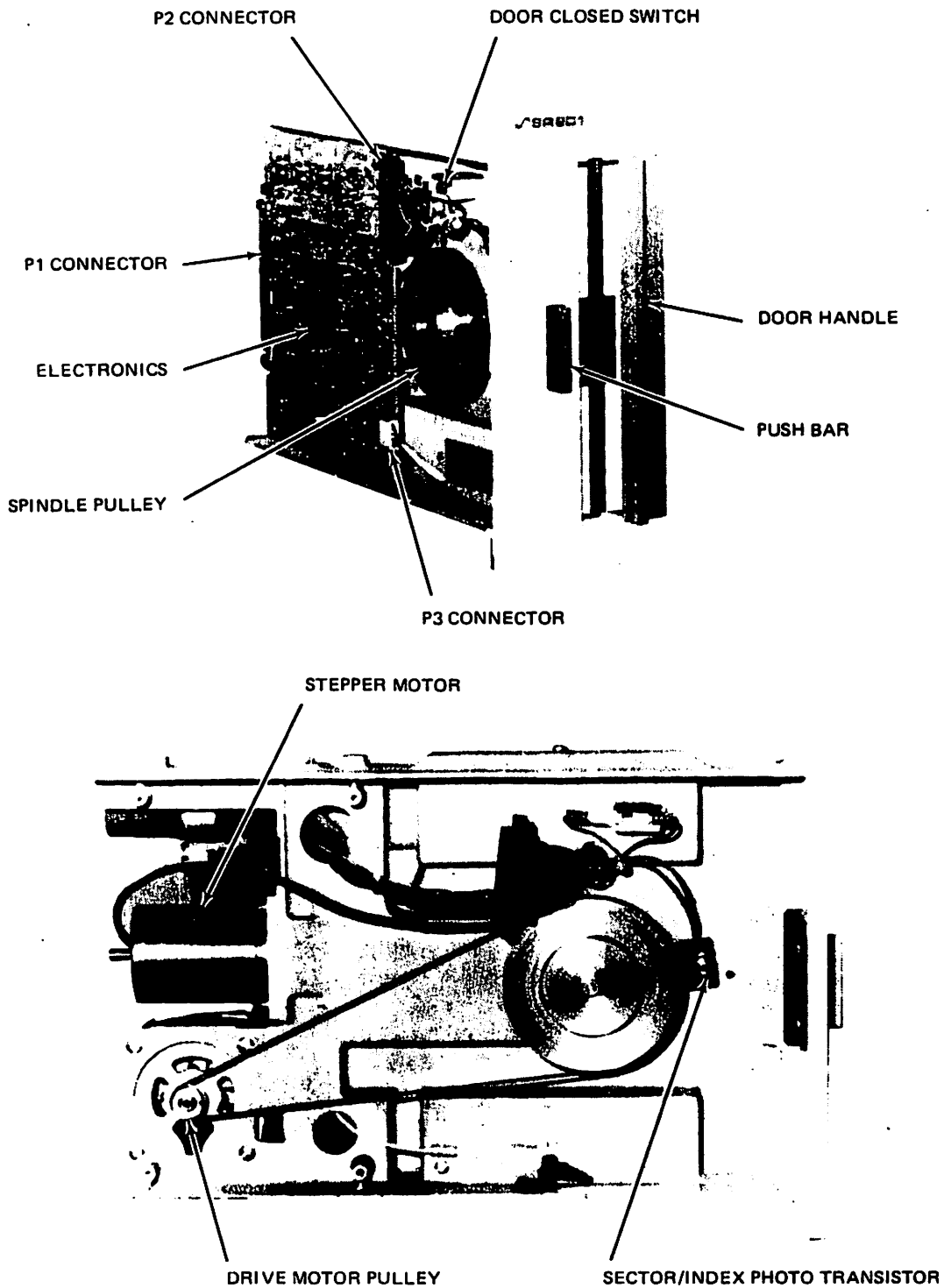
- a. Remove side cover (Section 3.4.2).
- b. Step carriage to Track 00. Verify that carriage is at 00 by checking P1L12 is minus (ground).
- c. Check that stop is  $.030'' \pm .010''$  between collar and carriage. Turn DC power OFF, and manually rotate lead screw CW until carriage stops. Check that stop is  $.020'' \pm .010''$  between collar and carriage.
- d. If clearances are not within tolerance, continue on with adjustment procedure.
- e. Turn DC power ON.
- f. Step carriage to Track 02.
- g. Loosen Track 00 stop collar.
- h. Grasp end of lead screw in back of stepper motor, with pair of pliers and manually turn lead screw CW to the Track 01 position. (Next detent position on stepper motor.)
- i. Position the stop collar axially along lead screw so there is  $.020'' \pm .010''$  between collar and carriage. Rotate the collar toward inside until the pin on the collar contacts the carriage stop surface. Tighten screw.
- j. Turn DC Power OFF and back ON. Carriage should move to Track 00. Verify that there is data at Track 00.
- k. Step carriage between Track 00 and 76 and check for any binding or interference between the carriage, lead screw, stop and head cable.

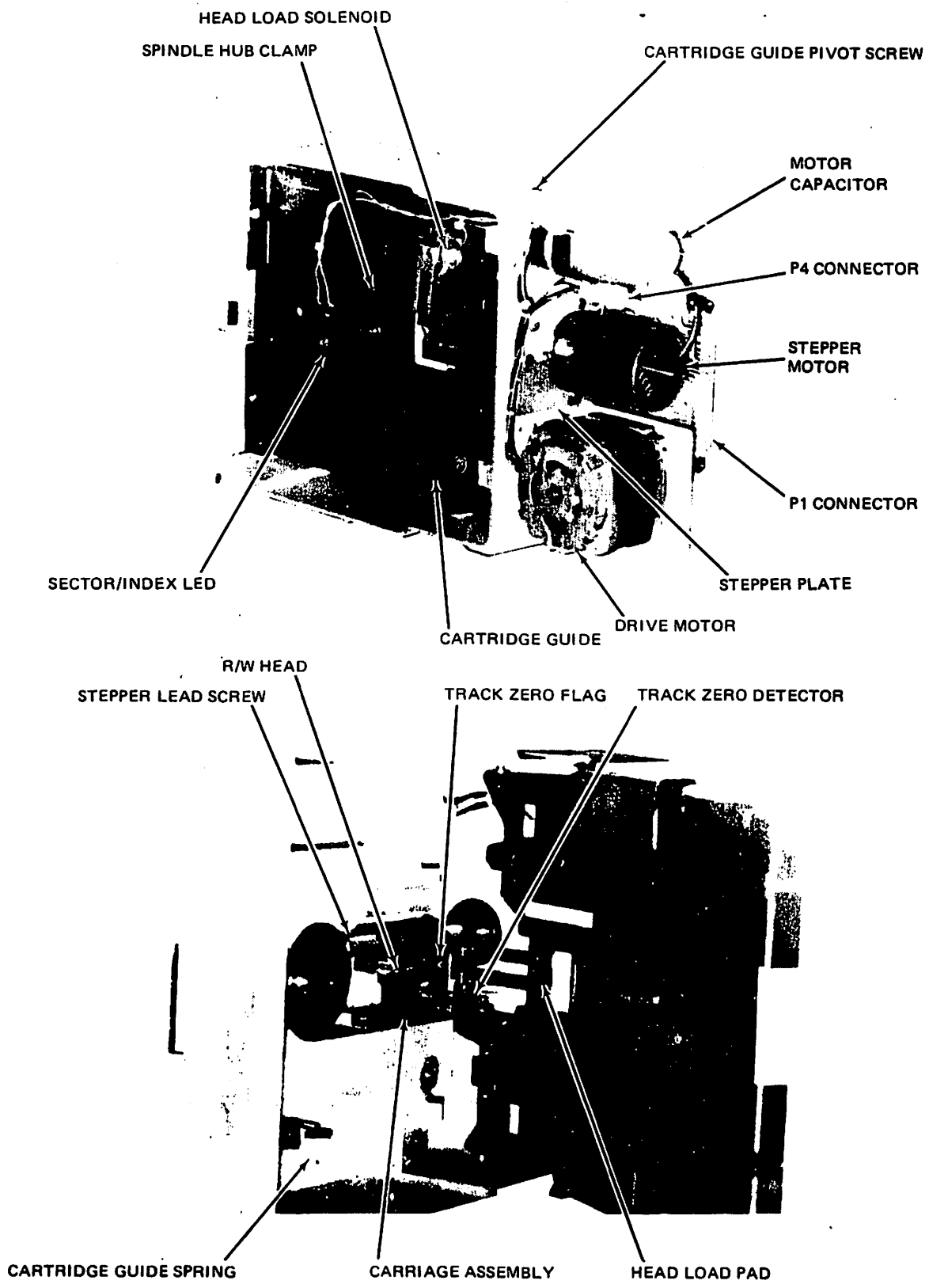
#### 3.4.11.9 Track 00 Detector Adjustment

- a. Remove side cover (Section 3.4.2).
- b. Check head radial alignment and adjust if necessary before making this adjustment.
- c. Connect oscilloscope probe to TP 26. Set vertical deflection to 1 v/division and sweep to continuous.
- d. Step carriage to Track 01. TP 26 should be high (+5 volts).
- e. If TP 26 is not high, loosen screw on Track 0 plug and rotate flag counter clockwise until TP 26 just goes high.

- f. Step carriage to Track 2. TP 26 should go low. Adjust flag clockwise if not low.
- g. Check adjustment by stepping carriage in and returning Track 00, observing that TP 26 is low at Track 02 and high at Tracks 01 and 00.
- h. Replace side cover.

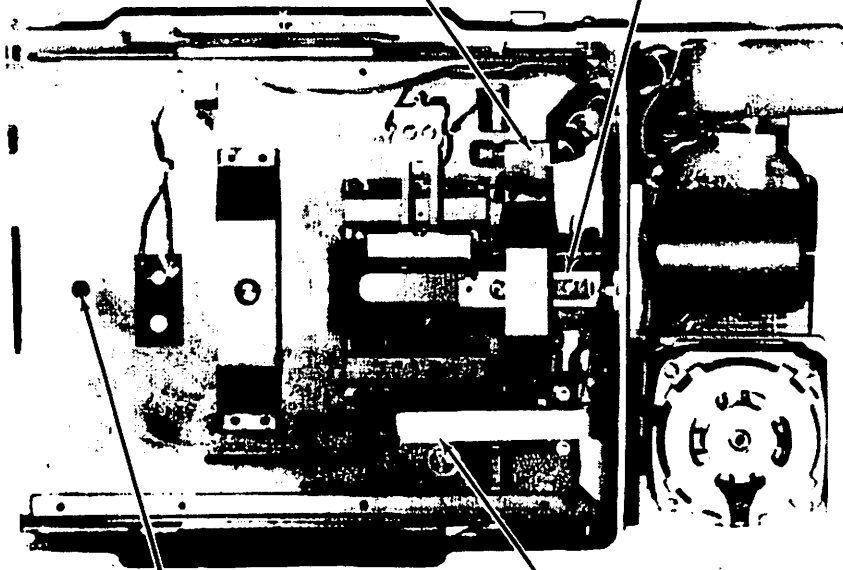
### 3.5 PHYSICAL LOCATIONS





WRITE PROTECT DETECTOR

HEAD LOAD ARM



CARTRIDGE GUIDE ADJ. SLOT

EJECT MECHANISM

## 4.1 SA 900 CHECK OUT PROCEDURES

### 4.1.1 Preliminary Checks

- a. Unpack the drive as per the unpacking instructions.
- b. Check drive for loose screws.
- c. Check the drive for AC Ground to DC Ground resistance of greater than two megohms. This can be checked at pin 2 of the AC connector and pin R-1 of the interface connector of the PCB.
- d. Connect AC and interface cables to the drive. Turn AC or DC power on.
- e. Turn on DC power.
- f. Connect the scope probe to test point 12 (-Index). Set the vertical scale to two volts per centimeter, DC coupled.
- g. Open the door and install the alignment disc (SA120). Close the door and verify the disc is turning.  
CAUTION: Do not write on the alignment disc.
- h. Sync the scope internal negative and verify a negative pulse occurs every 166.6 Msec. plus or minus 3.3 Msec.
- j. Load the head and verify that the index timing at test point 12 is still within specifications and that the head is loaded.
- k. Verify that there is .020" to .040" clearance between the head load actuator bail and the load arm throughout the travel of the carriage on the lead screw.
- l. Step to track 00 and monitor the read signal differentially at test points 1 and 2 AC coupled at 200 millivolts per centimeter added with one channel inverted. Sync scope externally at test point 12 (-Index). Verify that read data is present at this time.
- m. Slowly open the door and verify that the head load bail unloads the head before the ejector releases.
- n. Remove the alignment disc.

### 4.1.2 Functional Tests

- a. Install a scratch diskette.
- b. The drive tester or robot should now be programmed to perform the following functions:
  1. Write a hex pattern of CA for the complete track.
  2. Read back the data and verify that the data was written correctly.
  3. Step incrementally plus 1 track.
  4. This program should write and verify all tracks from 00 through 76.
  5. After reaching track 76, the drive should step to 0 and start the test all over again.
  6. Allow the drive to make five passes in the write, read, step mode error free.
- c. After completion of this test, the drive has now been completely functionally checked out and is ready for installation.



## DESCRIPTION

### General

The Illustrated Parts Catalog is arranged so that the figures will always precede the parts listings and when possible be on the opposite page.

The first number in the list will always refer to the figure and the second number to the reference number of the part within the figure.

When an assembly is referred to within a figure and a further breakdown is shown on another figure then the reference figure will be called out.

### Indented Level

The parts list is indented to show the levels of assembly within a figure. The major assembly will always be level 1, all parts or assemblies that attach to that assembly will be level 2 and assemblies within level 2 will have their attaching parts level 3 and so on.

### Quantity Per Assembly

The quantity listed is the quantity used on the major assembly. Major Assemblies will never have a quantity listed.

### Numerical Index

The numerical index lists all parts in part number sequence and is cross referenced to the figure and reference number.

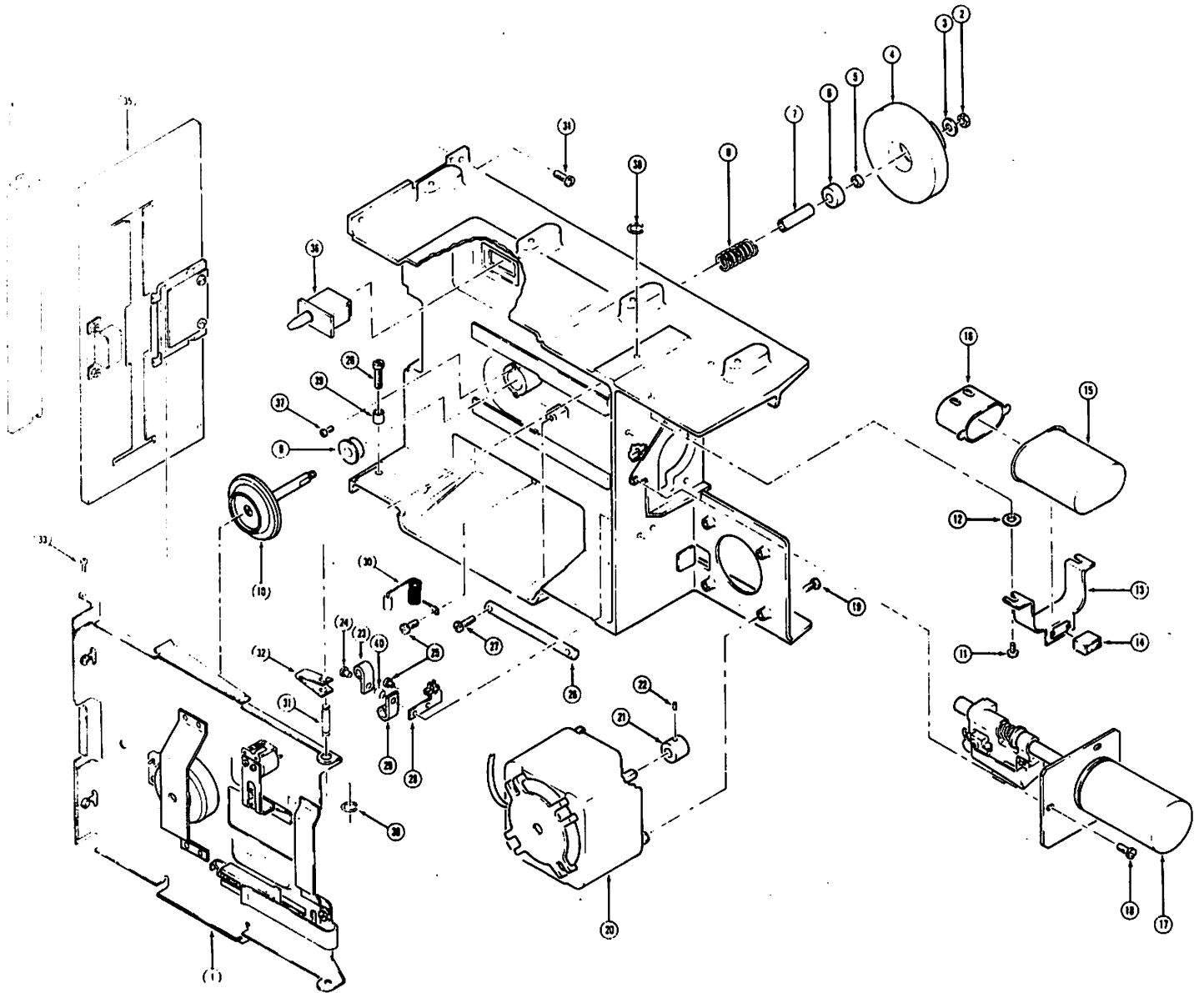


Figure 1 (1 of 2)

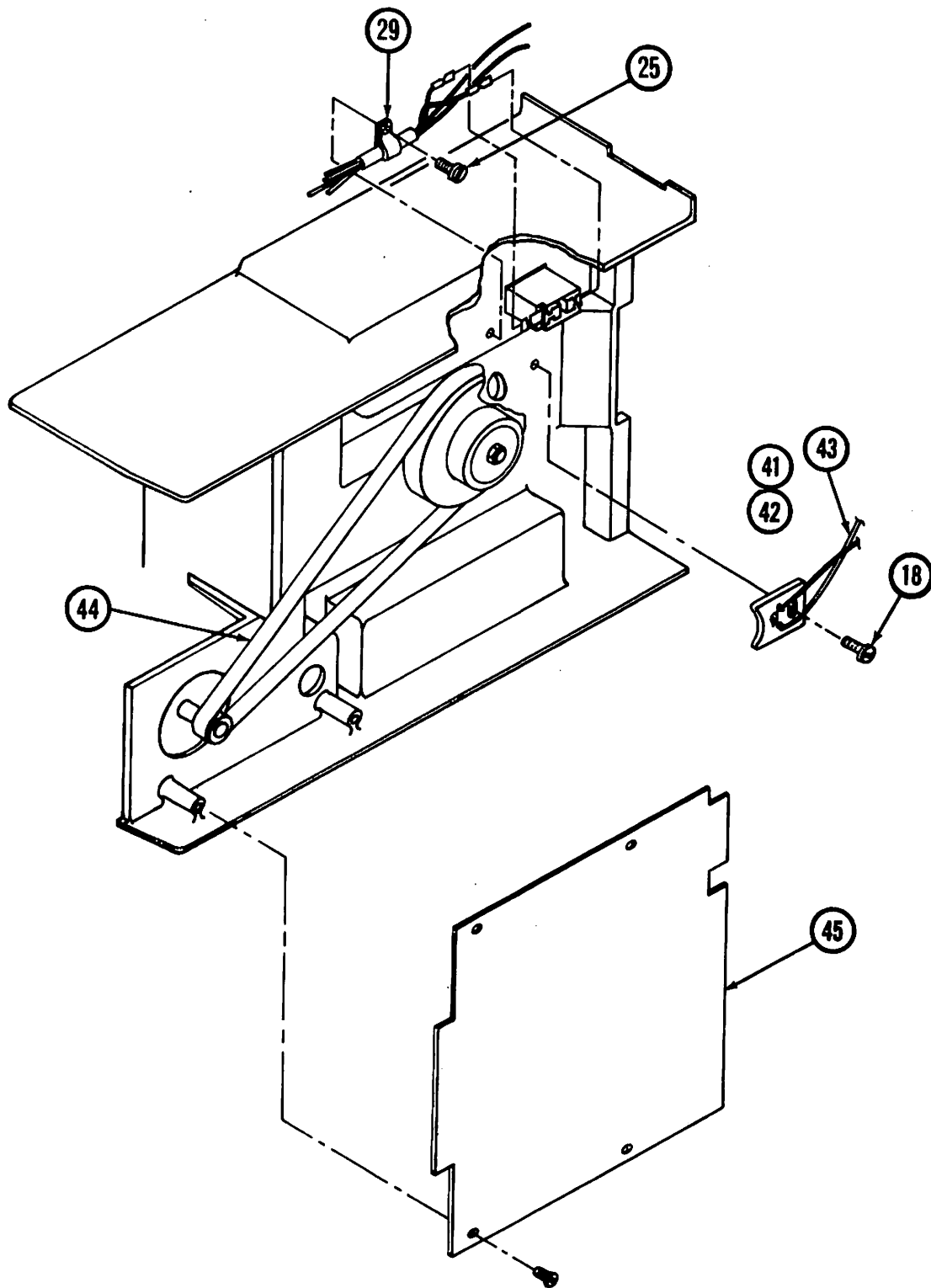


Figure 1 (2 of 2)

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
1	50010	BASIC ASSEMBLY, SA 900/901				
- 1	50030	. CARTIAGE GUIDE ASSEMBLY (SEE FIGURE 4 FOR BREAKDOWN)				1
- 2	10025	. NUT, 8-32				1
- 3	10014	. WASHER, #8				1
- 4	50016	. PULLEY ASSEMBLY, SPINDLE				1
- 5	50019	. SPACER, SPINDLE-SHORT				1
- 6	10800	. BEARING, SPINDLE				1
- 7	50018	. SPACER, SPINDLE—LONG				1
- 8	50166	. SPRING, SPINDLE				1
- 9	10801	. FLANGED BEARING, SPINDLE				1
- 10	50013	. HUB ASSEMBLY, SPINDLE				1
- 11	10203	. SCREW, B.H. 8-32x.250				2
- 12	12500	. WASHER				1
- 13	50098	. BRACKET				1
- 14	10150	. HOUSING, 3 PIN CONNECTOR				1
- 15	10095	. CAPACITOR, 110 VOLT 50/60 HZ				1
	15004	. CAPACITOR, 208/230/220 VOLT 50/60 HZ				1
- 16	10148	. RUBBER BOOT				1
17	50122	. STEPPER/CARRIAGE ASSEMBLY (SEE FIGURE 3 FOR BREAKDOWN)				1
- 18	10189	. SCREW, B.H. 6-32x.375				4
- 19	10207	. SCREW, B.H. 8-32x.500				4
- 20	50123	. MOTOR, 110 VOLT 50/60 HZ				1
	50301	. MOTOR, 208/230/220 VOLT 50/60 HZ				1
- 21	50358	. PULLEY, 60 HZ				1
	50357	. PULLEY, 50 HZ				1
- 22	11904	. SCREW, SET 6-32x.125				1
- 23	10262	. CABLE CLAMP, 1/8 INCH				2
- 24	10192	. SCREW				1
- 25	10187	. SCREW, B.H. 6-32x.250				9
- 26	50007	. GUIDE, CARRIAGE				1
- 27	10174	. SCREW, B.H. 4-40x.375				4
- 28	50121	. DETECTOR ASSEMBLY, TRACK 0 (SEE FIGURE 2 FOR BREAKDOWN)				1
- 29	10263	. CABLE CLAMP, 1/4 INCH				2
- 30	50186	. SPRING ASSEMBLY				1
- 31	50167	. PIVOT TOP				1
- 32	50168	. SPRING, BIAS				1
- 33	11905	. SCREW, B.V.				2
- 34	50142	. HANDLE				1
- 35	50097	. FRONT PLATE ASSEMBLY (SEE FIGURE 5 FOR BREAKDOWN)				1
- 36	17200	. SWITCH, DOOR OPEN				1
- 37	10172	. SCREW, B.H. 4-40x.250				6
- 38	11305	. CLIP				2
- 39	50049	. DEFLECTOR				1
- 40	50479	. SPACER				1

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
-18	10189	.	SCREW, B.H. 6-32 x .375			1
-41	*50128	.	PHOTOTANSITOR CABLE ASSEMBLY			1
-42	50329	.	PHOTOTRANSITOR ASSEMBLY			1
-43	50126	.	CABLE ASSEMBLY			1
-44	50356	.	BELT (60 HZ)			1
	50355	.	BELT (50 HZ)			1
-45	25002	.	PCB (SA 900, -5V, NO DATA SEP)			1
	25003	.	PCB (SA 900, -12/-15V, NO DATA SEP)			
	25004	.	PCB (SA 900, -5V, WITH DATA SEP)			
	25005	.	PCB (SA 900, -12/-15V, WITH DATA SEP)			
	25006	.	PCB (SA 901, -5V)			
	25007	.	PCB (SA 901, -12/-15V)			

\* WHEN ORDERING A REPLACEMENT PHOTOTRANSISTOR ASSEMBLY, IF OLD ASSEMBLY HAS ONLY TWO (2) LEADS COMING FROM IT, ORDER FIELD KIT, P/N 50928.

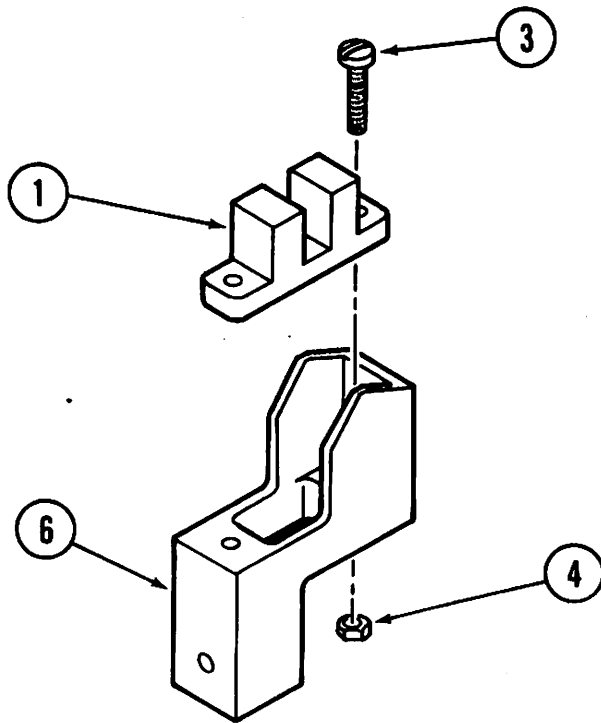
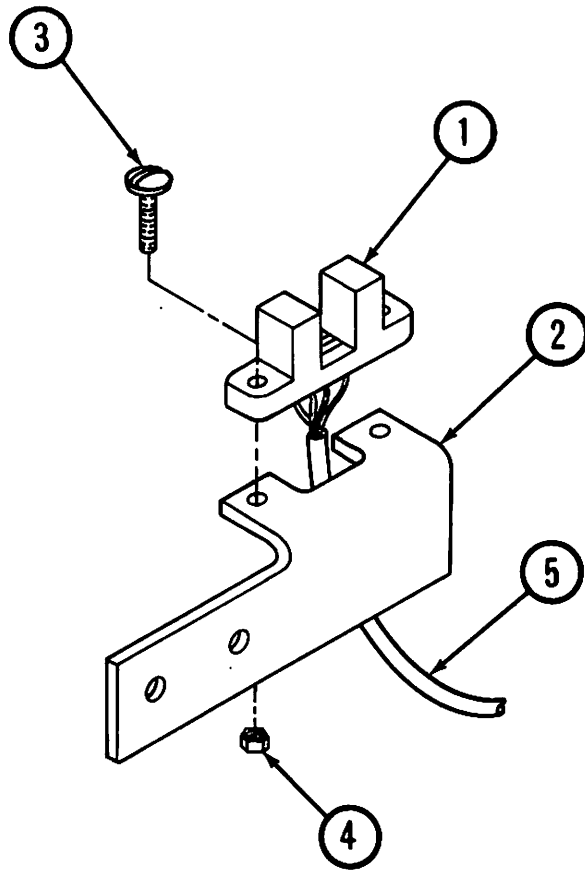


Figure 2

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
2 -	50121	DETECTOR ASSEMBLY SA900				
	50313	DETECTOR ASSEMBLY SA901				
- 1	10067	.	DETECTOR			2
- 2	50111	.	BRACKET, DETECTOR			1
- 3	10172	.	SCREW, B.H. 4-40x.250			4
- 4	10023	.	NUT, 4-40			4
- 5	50125	CABLE ASSEMBLY SA900				1
	50315	CABLE ASSEMBLY SA901				1
- 6	50161	.	MOUNT, WRITE PROTECT			1

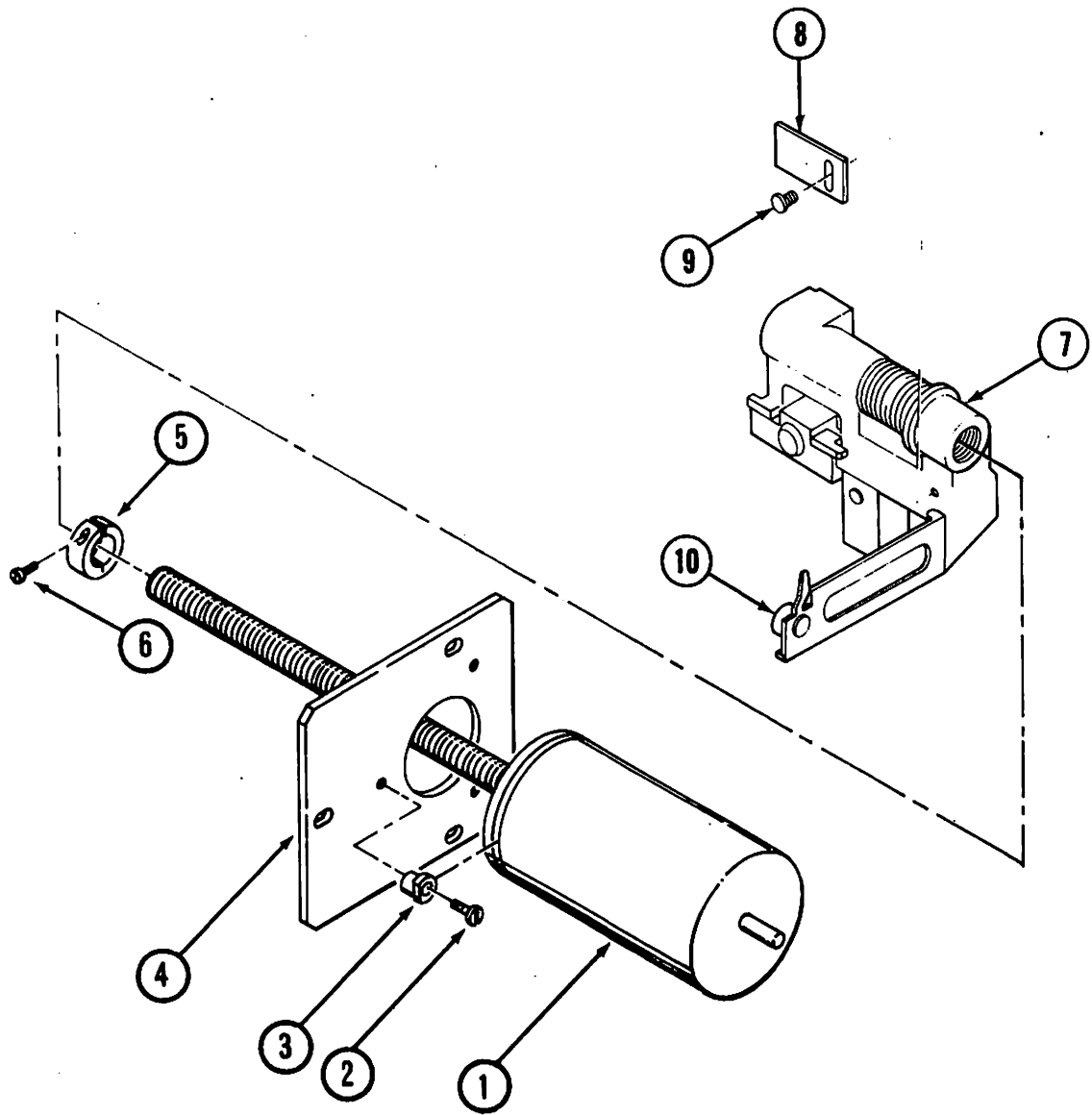


Figure 3



FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
3 -	50122	STEPPER/CARRIAGE ASSEMBLY				
- 1	50130	.	STEPPER MOTOR ASSEMBLY			1
- 2	11910	.	SCREW, B.H. 4-40x.250			3
- 3	50113	.	CLEAT, MOTOR MOUNT			3
- 4	50112	.	PLATE, STEPPER MOTOR			1
- 5	50114	.	STOP, LIMIT - LEAD SCREW			1
- 6	11903	.	SCREW, CAP 2-56x.250			1
- 7	50080	.	CARRIAGE ASSEMBLY			1
- 8	50081	.	.	FLAG, TRACK 0		1
- 9	10170	.	.	SCREW 6-32x.125		1
- 10	50929	.	.	LOAD BUTTON KIT		1

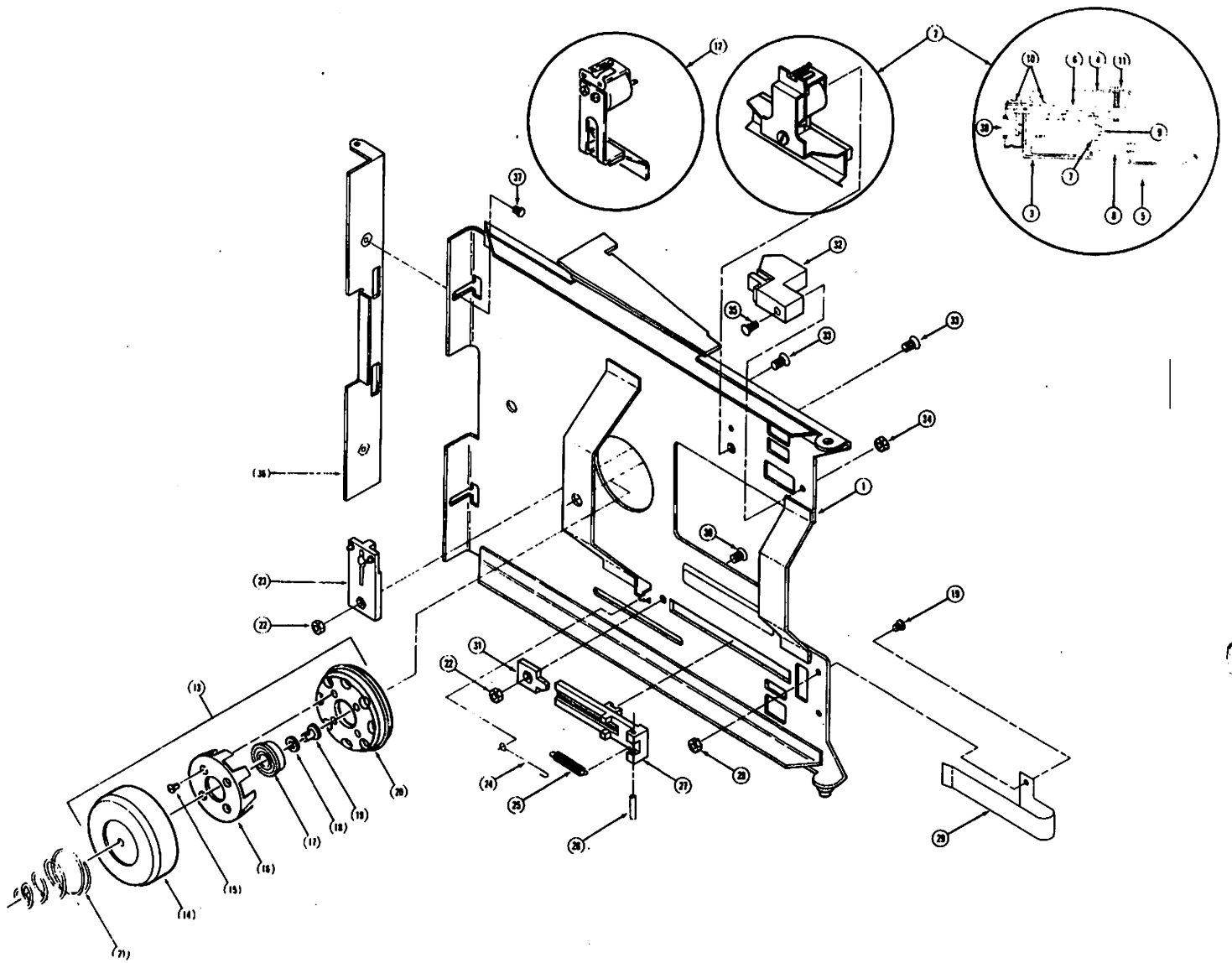


Figure 4

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
4 -						
-	50030					
- 1	50034					1
- 2	50253					1
- 3	10002					1
- 4	50365					1
- 5	50043					1
- 6	50364					1
- 7	50265					1
- 8	50363					1
- 9	11916					1
-10	10170					4
-11	10174					1
-12	50139					1
-13	50254					1
-14	50252					1
-15	11911					4
-16	50251					1
-17	10801					1
-18	12503					1
-19	10172					3
-20	50000					1
-21	50031					1
-22	10024					2
-23	50032					1
-24	50359					1
-25	50146					1
-26	11800					1
-27	50140					1
-28	10023					2
-29	50141					1
-30	11900					1
-31	50412					1
-32	50313					1
-33	11906					2
-34	11700					1
-35	10177					1
-36	50151					1
-37	10186					2
-38	50256					1

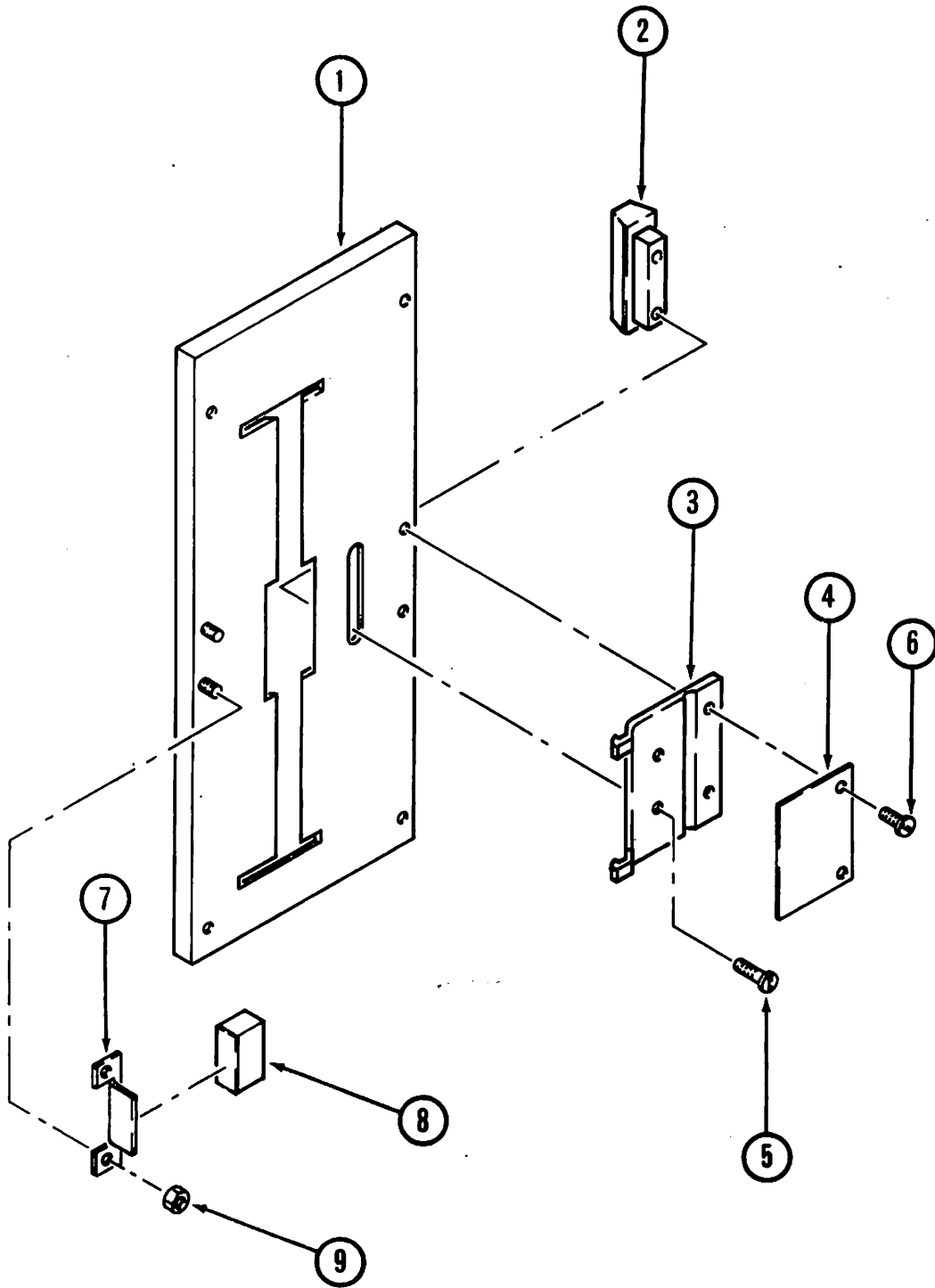


Figure 5

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
5 -	50097	FRONT PLATE ASSEMBLY	4 5/8" x 10 1/2"	TAN		
-	50244	FRONT PLATE ASSEMBLY	4 5/8" x 10 1/2"	WHITE		
	50387	FRONT PLATE ASSEMBLY	5 1/4" x 10"	TAN		
	50242	FRONT PLATE ASSEMBLY	5 1/4" x 10"	WHITE		
	50393	FRONT PLATE ASSEMBLY	5 1/4" x 10"	BROWN		
	50388	FRONT PLATE ASSEMBLY	5 1/4" x 11"	TAN		
	50238	FRONT PLATE ASSEMBLY	5 1/4" x 11"	WHITE		
	50269	FRONT PLATE ASSEMBLY	4 5/8" x 10 1/2"	BEIGE		
- 1	50144	. PLATE, FRONT	4 5/8" x 10 1/2"	TAN	1	
	50243	. PLATE, FRONT	4 5/8" x 10 1/2"	WHITE	1	
	50386	. PLATE, FRONT	5 1/4" x 10"	TAN	1	
	50241	. PLATE, FRONT	5 1/4" x 10"	WHITE	1	
	50394	. PLATE, FRONT	5 1/4" x 10"	BROWN	1	
	50360	. PLATE, FRONT	5 1/4" x 11"	TAN	1	
	50361	. PLATE, FRONT	5 1/4" x 11"	WHITE	1	
	50266	. PLATE, FRONT	4 5/8" x 10 1/2"	BEIGE	1	
- 2	50143	. PUSH BAR			1	
- 3	50156	. LATCH 726-1045			1	
- 4	50157	. SPRING, LATCH			1	
- 5	10172	. SCREW, B.H. 4-40 x .250			2	
- 6	10188	. SCREW, B.H. 6-32 x .312			2	
- 7	50182	. STOP			1	
- 8	50183	. BUMPER			1	
- 9	10023	. NUT, 4-40			2	

PART NUMBER	FIG. REF.
10002	4-3
10014	1-3
10023	2-4
	4-28
	5-9
10024	4-22
10025	1-2
10067	2-1
10095	1-15
10148	1-16
10150	1-14
10170	3-9
	4-10
10172	1-37
	2-3
	4-19
	5-5
10174	1-27
	4-11
10177	4-35
10186	4-37
10187	1-25
10188	5-6
10189	1-18
10192	1-24
10203	1-11
10207	1-19
10262	1-23
10263	1-29
10800	1-6
10801	1-9
	4-17
11305	1-38
11700	4-34
11800	4-26
11900	4-30
11903	3-6
11904	1-22
11905	1-33
11906	4-33
11910	3-2
11911	4-15
11916	4-9
12500	1-12
12503	4-18
15004	1-15
17200	1-36
25002	1-45
25003	1-45

PART NUMBER	FIG. REF.
25004	1-45
25005	1-45
25006	1-45
25007	1-45
50000	1-26
50007	1-26
50010	1-
50013	1-10
50016	1-4
50018	1-7
50019	1-5
50030	1-1
	4-
50031	4-21
50032	4-23
50034	4-1
50043	4-5
50049	1-39
50080	3-7
50081	3-8
50097	5-
50098	1-13
50111	2-2
50112	3-4
50113	3-3
50114	3-5
50121	1-28
	2
50122	1-17
	3-
50123	1-20
50125	2-5
50126	1-43
50128	1-41
50130	3-1
50139	4-12
50140	4-27
50141	4-29
50142	1-34
50143	5-2
50144	5-1
50146	4-25
50151	4-36
50156	5-3
50157	5-4
50161	2-6
50166	1-8
50167	1-31
50168	1-32
50182	5-7

PART NUMBER	FIG. REF.
50183	5-8
50186	1-30
50238	5-
50241	5-1
50242	5-
50243	5-1
50244	5-
50251	4-16
50252	4-14
50253	4-2
50254	4-13
50256	4-38
50265	4-7
50266	5-1
50269	5-
50301	1-20
50313	2-
	4-32
50315	2-5
50329	1-42
50355	1-43
50356	1-43
50357	1-21
50358	1-21
50359	4-24
50360	5-1
50361	5-1
50363	4-8
50364	4-6
50365	4-4
50386	5-1
50387	5-
50388	5-
50393	5-
50394	5-1
50412	4-31
50479	1-40
50928	1-41
50929	3-10

EDITED BY CUSTOMER ENGINEERING DIVISION

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December 5, 1977

## MODEL 2270 SA901 MAINTENANCE INFORMATION

### 1. INTRODUCTION

This bulletin covers all the maintenance information and procedures that may be required to repair an SA901 floppy in a WCS or 2270 system. It is a corrected reprint of procedures found in Service Bulletin 46.2. These new procedures apply specifically to Wang's application of the SA901 Drive and reflect the correct depot-level maintenance techniques. Section 2 deals with removal and installation procedures for the associated assemblies of the SA901. Section 3 is a list of special tools that are required to adjust and align the drive. Section 4 gives a description of the SA120 alignment diskette. Section 5 explains the need for test PROMs. Section 6 is a list of test points on the SA901 PCB for easy reference, and Section 7 is the adjustment and alignment procedure itself.

### 2. REMOVAL AND INSTALLATION PROCEDURES

#### 2.1 DRIVE MOTOR

- a. Extract 3 contacts to disconnect motor from AC connector.
- b. Loosen 2 screws holding capacitor clamp to the base. Remove rubber boot and disconnect motor leads from capacitor.
- c. Remove 4 screws holding PCB to base and swing PCB out.
- d. Remove belt from drive pulley.
- e. Remove 4 screws holding the motor to the base casting and remove motor.
- f. Reverse the procedure for installation.

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13-210A

NOTE:

Insure ground lead is installed between capacitor for clamp and base.

2.2 CARTRIDGE GUIDE ACCESS

- a. Position head to approximate center of head load bail (to prevent load arm tab from slipping off end of bail).
- b. Loosen 2 screws holding cartridge guide to door latch plate.
- c. Swing cartridge guide out.
- d. When guide is swung in, it must be adjusted as per section 7.2.

2.3 LIGHT EMITTING DIODE ASSEMBLY

- a. Disconnect the wires to the LED terminals (solder joints).
- b. Swing out the cartridge guide assembly (Ref. Section 2.2).

NOTE:

This step is not necessary if the drive has a new style (cast) cartridge guide.

- c. Remove the screw, nut, and washer holding the LED assembly to the cartridge guide.
- d. Reverse the procedure for installation.

2.4 WRITE PROTECT DETECTOR

- a. Remove connectors from PCB and remove PCB.
- b. Extract wires from P2 connector, pins 3 (Red), 4 (Grey), E (Black), and J (White).
- c. Remove cable clamp.
- d. Swing out cartridge guide assembly (Ref. section 2.2).
- e. Remove screw holding the detector bracket and remove assembly.
- f. Reverse the procedure for installation.



## 2.5 HEAD LOAD ACTUATOR

- a. Disconnect the wires to the actuator terminals (solder joints).
- b. Swing out the cartridge guide assembly (Ref. section 2.2).
- c. Remove screw holding the actuator to the cartridge guide.

### CAUTION:

Restrain the head load arm to prevent its impact with the head.

- d. Reverse the procedure for installation.

## 2.6 TRACK 0 DETECTOR

- a. Remove connectors from PCB and remove PCB.
- b. Extract wires from P2 connector, pins A (Brown), C (Black), F (Red), and K (Orange).
- c. Remove cable clamp.
- d. Swing out the cartridge guide assembly (Ref. section 2.2).

### NOTE:

This step may not be useful if the drive has an old style (black) cartridge guide.

- e. Manually rotate stepper shaft and move carriage away from the detector assembly.
- f. Remove cable clamp, and R/W head cable from bracket.
- g. Remove 2 screws holding detector assembly bracket to base casting and remove assembly.
- h. Reverse procedure for installation.

## 2.7 INDEX/SECTOR PHOTOTRANSISTOR ASSEMBLY

- a. Disconnect the wires to the terminals (solder joints).

### NOTE:

The spindle pulley may be removed for easier access.

- b. Remove screw holding transistor assembly to base.
- c. Reverse the procedure for installation.

## 2.8 CARTRIDGE GUIDE REMOVAL

- a. Swing out the cartridge guide assembly (Ref. section 2.2).
- b. Remove the LED assembly, the head load actuator and write protect detector assembly (Ref. sections 2.3, 2.4 and 2.5).
- c. Pull up on the upper pivot cap screw until the shoulder contacts the base casting (Ref. Figure 1). Push up on the cartridge guide until the lower pivot clears the casting.

### NOTE:

For new style cartridge guide, remove C-clamp on upper pivot post and push up on cartridge guide.

- d. Tilt the cartridge guide slightly, and remove it from the upper pivot.
- e. Reverse the procedure for installation.

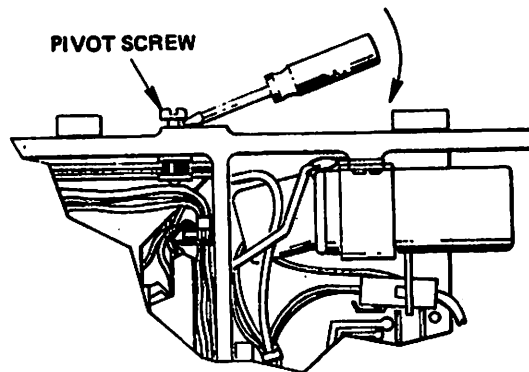


FIGURE 1 CARTRIDGE GUIDE REMOVAL

## 2.9 SPINDLE ASSEMBLY

- a. Swing out the cartridge guide (Ref. section 2.2).
- b. Remove the nut and washers holding the spindle pulley.

### CAUTION:

The pre-loaded rear bearing and spacer may fly out when spindle pulley is removed.

- c. Withdraw spindle hub from opposite side of base casting.
- d. Reverse the procedure for installation.

## 2.10 FRONT PLATE ASSEMBLY

- a. Swing out the cartridge guide assembly (Ref. section 2.2).
- b. Remove 4 screws holding the front plate assembly to the casting.
- c. Reverse the procedure for installation.

## 2.11 STEPPER/CARRIAGE ASSEMBLY

- a. Remove the connectors from the PCB and remove the PCB.
- b. Remove cable clamp holding R/W head cable.
- c. Extract wires from P2 connector, pins 2 (Red), 5 (Brown), 8 (Orange), and 10 (Black).

### NOTE:

This step is only necessary if the stepper motor is to be replaced.

- d. Loosen 3 motor clamp screws and rotate clamps to allow withdrawal of motor. On new units with redesigned stepper mounting clamp, loosen 2 screws and swing clamp down to allow withdrawal of motor.

### CAUTION:

Do not loosen 3 screws coated with Glyptol.

- e. Swing out the cartridge guide assembly (Ref. section 2.2).
- f. Remove cable clamp and spacer holding R/W head cable to track 0 detector bracket. On new units a grommet on the cable is inserted into a slot on the bracket.
- g. Manually rotate the lead screw to run the carriage assembly off the lead screw while withdrawing the stepper motor.
- h. To install stepper/carriage assembly reverse procedure. Note steps i. and j.
- i. When installing the carriage, set the pre-load nut in the #3 notch (Ref. Figure 2).
- j. When threading lead screw into carriage assembly, push the pre-load nut slightly against the spring in order to start thread. After threading, insure there is a gap between pre-load nut and rear of carriage.

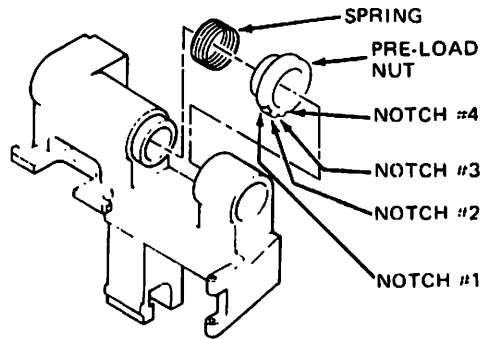


FIGURE 2

## 2.12 READ/WRITE HEAD LOAD BUTTON

- a. To remove the old style button (attached with a clip and washer), grasp the button with pliers and rock the button back and forth while pulling.
- b. To remove the new style button, hold the load arm out away from head, squeeze the locking tabs together with a pair of needle nose pliers and press forward.

- c. To install old style button, place button in head load arm and press rubber washer onto button stem. Press clip onto stem and insure button does not move.
- d. To install new style button, press the button into the head load arm and it will snap into place.

### 3. SPECIAL TOOLS

The following special tools are available for performing maintenance on the SA901.

<u>Description</u>	<u>OEM Part #</u>	<u>Wang Part #</u>
SA120 Alignment Diskette	SA120	726-9611
Cartridge Guide Adj. Tool	50377	726-9612
Head Load Bail Gauge	50391	726-9613
SA901 Alignment Program	N/A	701-0372
WCS Test PROMs	N/A	378-0510, 378-0511, 378-0512, 378-0513

### 4. ALIGNMENT DISKETTE

The SA120 alignment diskette is used for alignment of the SA901. The following adjustments can be made using the SA120.

1. Read/Write head radial alignment using track 38.
2. Index/Sector phototransistor adjustment using tracks 01 and 76.
3. Track 00 is recorded with standard IBM 3740 format.

Caution should be used in order not to destroy pre-recorded alignment tracks. The write protect notch should always be left open on the SA120 to prevent accidental loss of data.

#### NOTE:

The alignment diskette should be at room conditions for at least 20 minutes before using.

## 5. WCS TEST PROMS

The Index/Sector timing adjustment on an SA901 is performed at track 01 and track 76. The normal set of WCS PROMs allows access up to track 63. Because of this, a special set of PROMs has to be installed in the microprocessor to allow access to track 76. The PROMs can be installed on a 6718 or on a 7018. Refer to the Variation Chart on the 210-7018 schematic for the procedure to install PROMs on a 7018 PCB. Locations for the PROMs are as follows:

<u>Location</u>	<u>PROM #</u>
L111	378-0510
L112	378-0512
L113	378-0511
L114	378-0513

## 6. TEST POINTS ON 25006 PCB (Reference Figure 3)

TP0 +Door Closed  
TP1 Read Data Signal 1  
TP2 Read Data Signal 2  
TP3 Read Data 1 (Differentiated)  
TP4 Read Data 2 (Differentiated)  
TP5 Ground  
TP6 Ground  
TP7 +Power On Reset  
TP8 Ground  
TP9 -Write Data • +Write Gate  
TP11 -Load Head  
TP12 +Index/Sector  
TP13 +File Inop.  
TP14 Ground  
TP15 +Write Gate • -Write Protect  
TP16 +Read Data  
TP20 -Write Data

TP21 -2.9  $\mu$ sec window S.S.  
 TP24 -3.1  $\mu$ sec window S.S.  
 TP26 +Track 0  
 TP27 -Step  $\cdot$  -Read Gate  
 TP35 -Write Gate  $\cdot$  -File Inop.

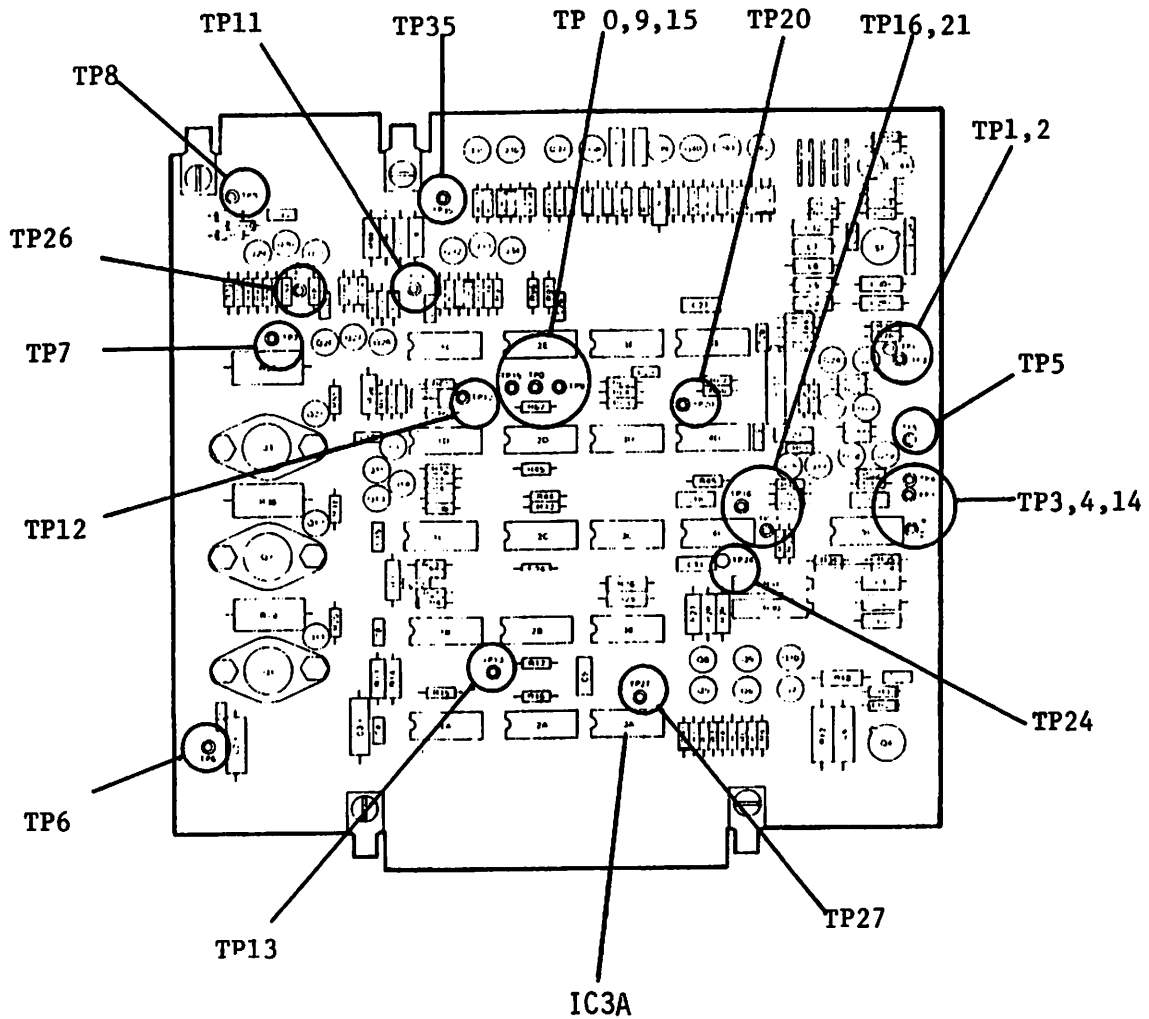


FIGURE 3

## 7. ALIGNMENT AND ADJUSTMENT PROCEDURE

### NOTE:

This procedure along with the alignment program cassette is designed to allow for repair of the SA901 on the fixed drive only. It is a sequential procedure that should be followed from beginning to end to insure complete operation of the SA901.

### 7.1 HEAD CLEANING PROCEDURE

Inspect head load pad and head for dirt and/or damage. (Refer to section 2.12 for head load pad removal procedure.) The head should ONLY be cleaned if it has an oxide build-up that is visible to the naked eye. Cleaning methods and materials other than those listed can permanently damage the head and should be avoided.

- a. Lightly dampen a piece of clean lintless tissue with Isopropyl alcohol (use sparingly).
- b. Lift the load arm off the head, being careful not to touch the load button.
- c. Gently wipe the head with the moistened portion of the tissue.
- d. After the alcohol has evaporated, gently polish the head with a clean dry piece of lintless tissue.
- e. Lower the load arm onto the head. Do not let it snap back.

### 7.2 CARTRIDGE GUIDE ADJUSTMENT

- a. Insert the adjustment tool (726-9612) through the hole in the cartridge guide and screw completely into the casting (hand tight). Reference Figure 4.
- b. Loosen 2 screws holding the cartridge guide to the latch plate.
- c. Move the handle into the latched position and hold it lightly against the latch fingers.



- d. Tighten 2 screws holding the cartridge guide to the latch plate.
- e. Depress push bar on front panel and check that door stays in latched position. If door latch was released, repeat adjustment.
- f. Insert diskette, close and open door, checking for proper operation.
- g. When complete, install known good PCB and continue.

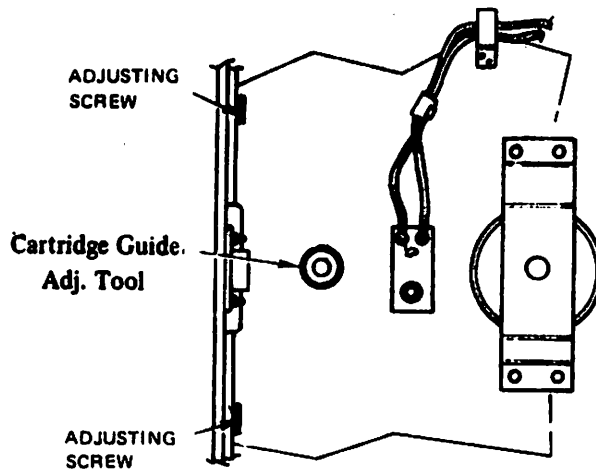


FIGURE 4 CARTRIDGE GUIDE ADJUSTMENT

### 7.3 HEAD LOAD ACTUATOR ADJUSTMENT

- a. Turn stepping motor lead screw until head carriage is approximately at track 00.
- b. Place bail adjustment tool (726-9613) on R/W head and place load button in cup of tool.
- c. Adjust up stop on actuator so that bail just touches head load arm (Ref. Figure 5).
- d. Remove adjustment tool.
- e. Energize head load coil by grounding TP11.
- f. Adjust down stop on actuator so there is  $.020 \pm .010$  clearance between head load bail and head load arm (Ref. Figure 6).
- g. Turn stepping motor lead screw until head carriage is approximately at track 76. Insure  $.020$  clearance is still maintained. If not, readjust down stop.

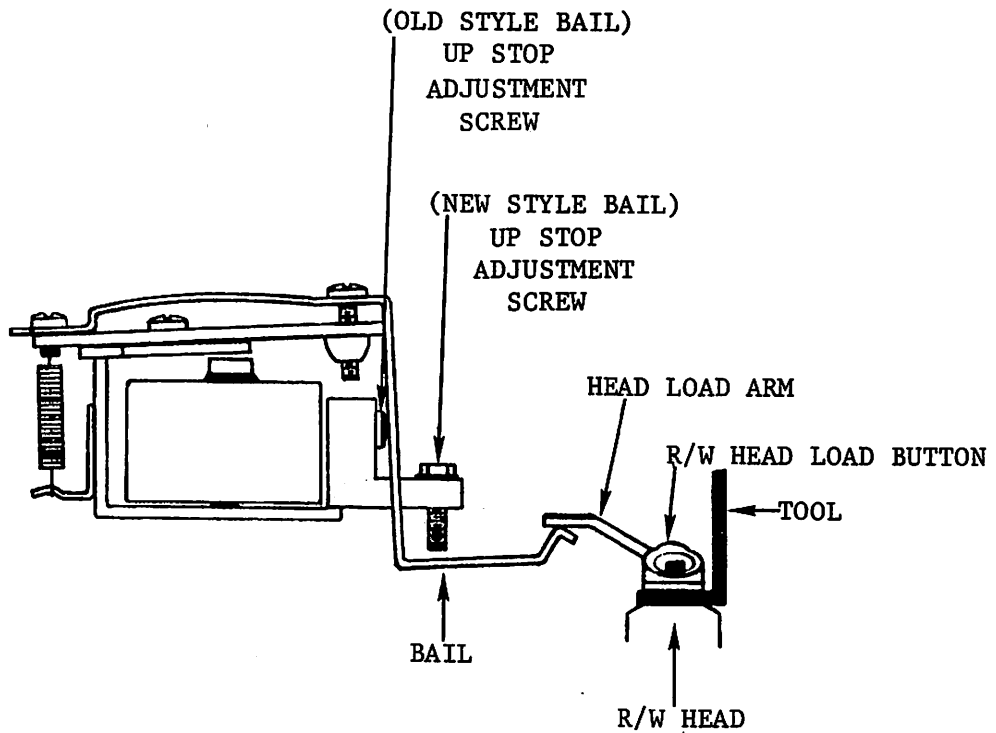


FIGURE 5  
HEAD LOAD ACTUATOR UP STOP ADJUSTMENT

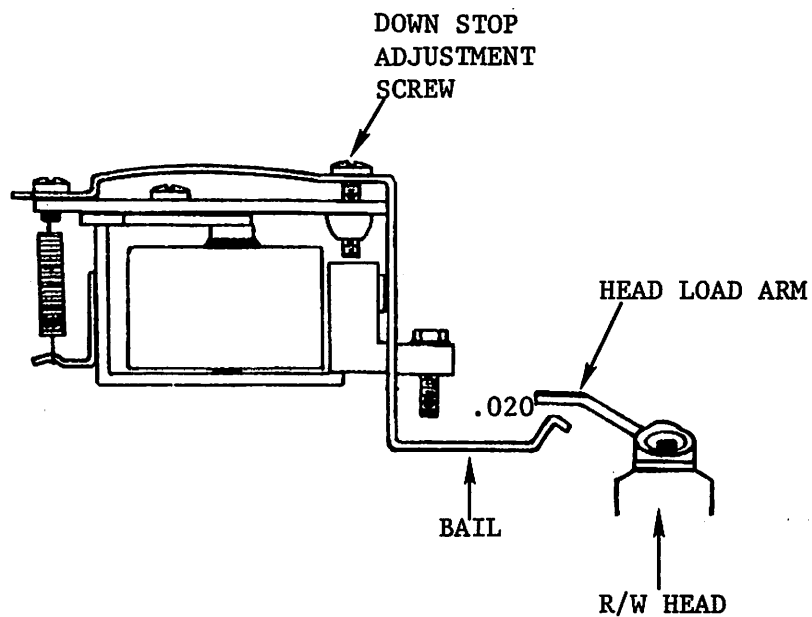


FIGURE 6  
HEAD LOAD ACTUATOR DOWN STOP ADJUSTMENT

NOTE:

At this time, insert the alignment program cassette into a tape drive and load the program. Key RUN, EXEC to start the program, then continue with this procedure.

7.4 INDEX/SECTOR PHOTOTRANSISTOR POTENTIOMETER ADJUSTMENT

- a. Insert SA120 alignment diskette.
- b. Connect oscilloscope probe to TP12. Set oscilloscope as follows:

TIME/DIV	0.5 MSEC.
VERT SENS	2V/DIV.
VERT MODE	DC COUPLED
TRIGGER SOURCE	INT
TRIGGER MODE	NORM
SLOPE	NEG

- c. Adjust the potentiometer on the Index/Sector phototransistor to obtain a pulse of 1.7 msec.  $\pm$  .5 msec. duration.

7.5 HEAD RADIAL ALIGNMENT

NOTE:

If either the head alignment or the track zero adjustment is incorrect, the track 00 stop could possibly interfere with the following two adjustments. It is recommended that the stop be loosened and moved toward the stepping motor until it no longer inhibits correct head positioning.

- a. Jumper pins 5 & 6 of IC 1A (Shugart PCB) to ground ( $\leftarrow$ Head Load and  $-$ Drive Select).
- b. Connect Channel 1 probe to TP1 and Channel 2 probe to TP2. Connect ext. trigger to TP12. Set the oscilloscope as follows:

TIME/DIV	20 MSEC.
VERT SENS	0.2 V/DIV.
VERT MODE	ADD, CHAN. 2 INVERTED, AC COUPLED
TRIGGER SOURCE	EXT.
TRIGGER MODE	NORM.
SLOPE	NEG.

- c. Depress SF key '3 (this accesses track 38).

NOTE:

Because the alignment diskette does not have sector holes and is not formatted, an error condition will exist when a track is read. This will initiate one reseek.

- d. A cat's eye pattern should be observed (Ref. Figure 7).
- e. The two lobes must be within 80% amplitude of each other (Ref. Figure 8). If the lobes do not fall within the specification, continue on with this procedure. If correct proceed to Section 7.6.
- f. Loosen 2 or 3 mounting screws which hold the motor to the mounting plate.

CAUTION:

DO NOT LOOSEN 3 SCREWS HOLDING MOUNTING PLATE TO CASTING. THESE ARE COATED WITH GLYPTOL.

- g. Rotate the stepping motor to radially move the head in or out. If the left lobe is less than 80% of the right, turn the stepping motor counterclockwise as viewed from rear of drive. If the right lobe is less than 80% of the left lobe, turn the stepping motor clockwise as viewed from the rear of the drive.
- h. When the lobes are of equal amplitude, tighten the motor mounting screws.
- i. Check the adjustment by doing a reseek (key RESET, then depress SF key '3) and readjust as required.

NOTE:

If the cat's eye pattern is not observed at all after the reseek, the track 00 detector is set incorrectly and must be adjusted prior to performing the head alignment. Proceed to Section 7.6 to perform the track 00 detector adjustment.

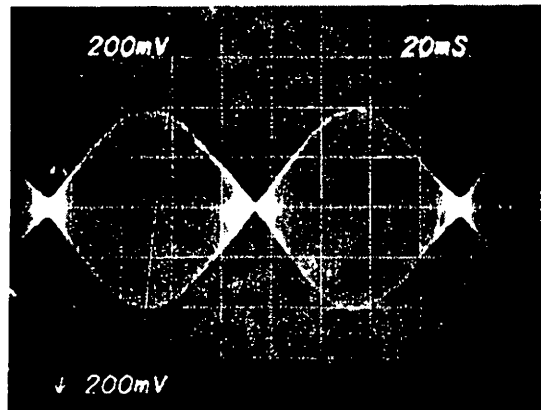


FIGURE 7 HEAD RADIAL ALIGNMENT

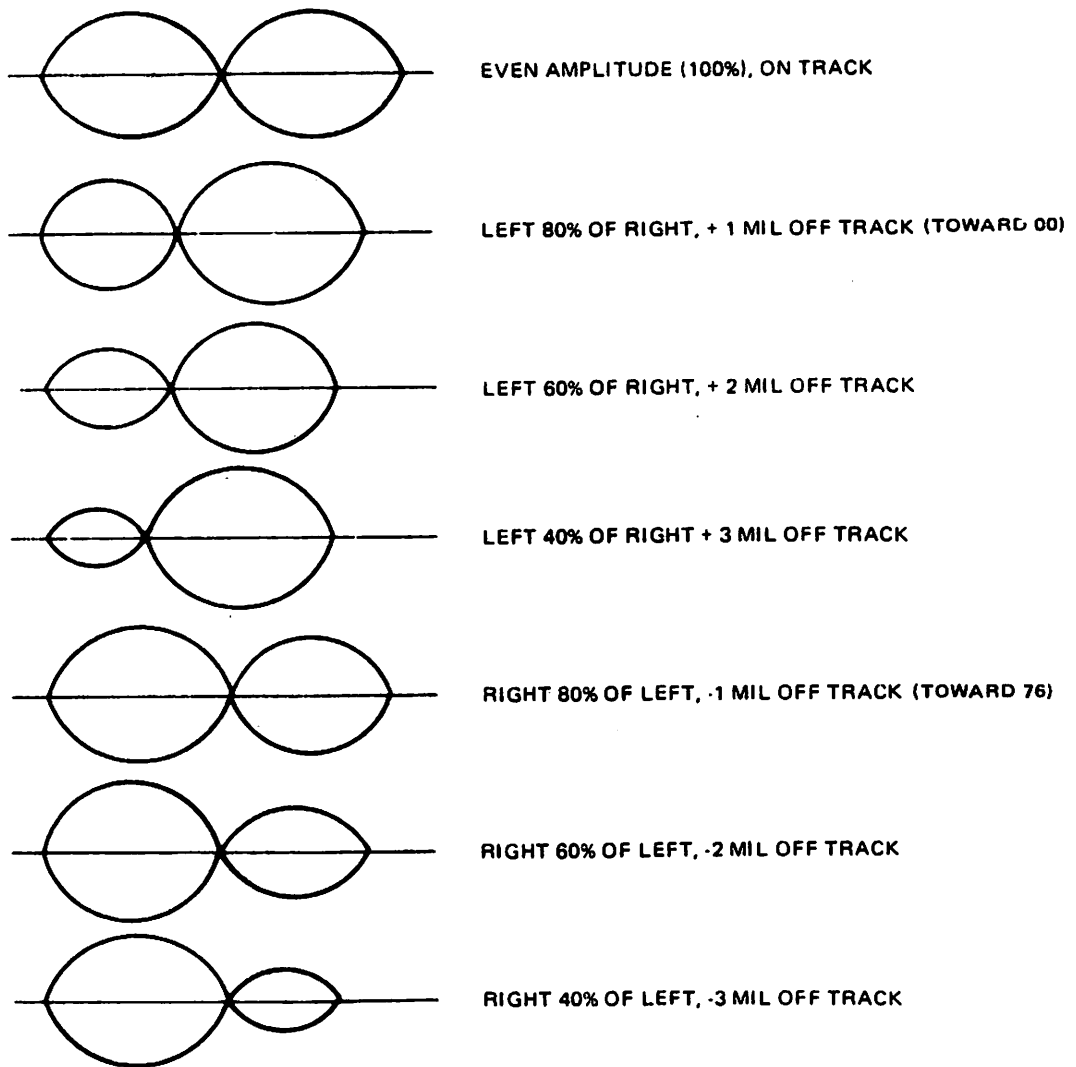


FIGURE 8 R/W HEAD RADIAL ALIGNMENT

#### 7.6 TRACK 00 DETECTOR ADJUSTMENT

**NOTE:**

If, when performing the head radial alignment, the cat's eye pattern was observed after the reseek and the adjustment was performed with no problem, the Track 00 detector adjustment is approximately correct. Therefore, only steps A and E-I of this procedure will have to be performed.

- a. Remove ground from pins 5 & 6 of IC 1A (Shugart PCB). Connect Channel 1 probe to TP1 and Channel 2 probe to TP2. Connect ext. trigger to TP12. Set oscilloscope as follows:

TIME/DIV	50 USEC.
VERT SENS	0.2 V/DIV
VERT MODE	ADD. CHAN. 2 INVERTED, AC COUPLED
TRIGGER SOURCE	EXT.
TRIGGER MODE	NORM.
SLOPE	NEG.

- b. Load the head by grounding TP11.
- c. Manually turn the stepping motor lead screw slowly to Track 01 and observe the Index/Sector timing waveform shown in Figure 10. Adjust for maximum amplitude (middle of track) above and below reference.

NOTE:

- 1) The IBM 3740 format that is recorded on Track 00 can be used as a reference point to find Track 01.
  - 2) If the Index/Sector timing adjustment is incorrect by a large margin, the horizontal sweep time will have to be increased so the waveform can be observed.
  - 3) Once Track 01 has been found, caution must be taken not to move the head assembly or the lead screw.
- d. Remove the probes from TP1 and TP2.
- e. Connect a probe to TP26. Set oscilloscope to observe a 5V DC level.
- f. TP26 should be at a +5V level when at Track 01.
- g. If TP26 is not high, loosen screw on Track 00 flag and move flag in or out of photosensor until TP26 just goes high.

- h. Key Reset, then depress SF'2. This steps head carriage to Track 02. TP26 should go low. Adjust flag if not low.
- i. Check adjustment by keying Reset and depressing SF'1 (this accesses Track 01). Insure TP26 goes high at Track 01.

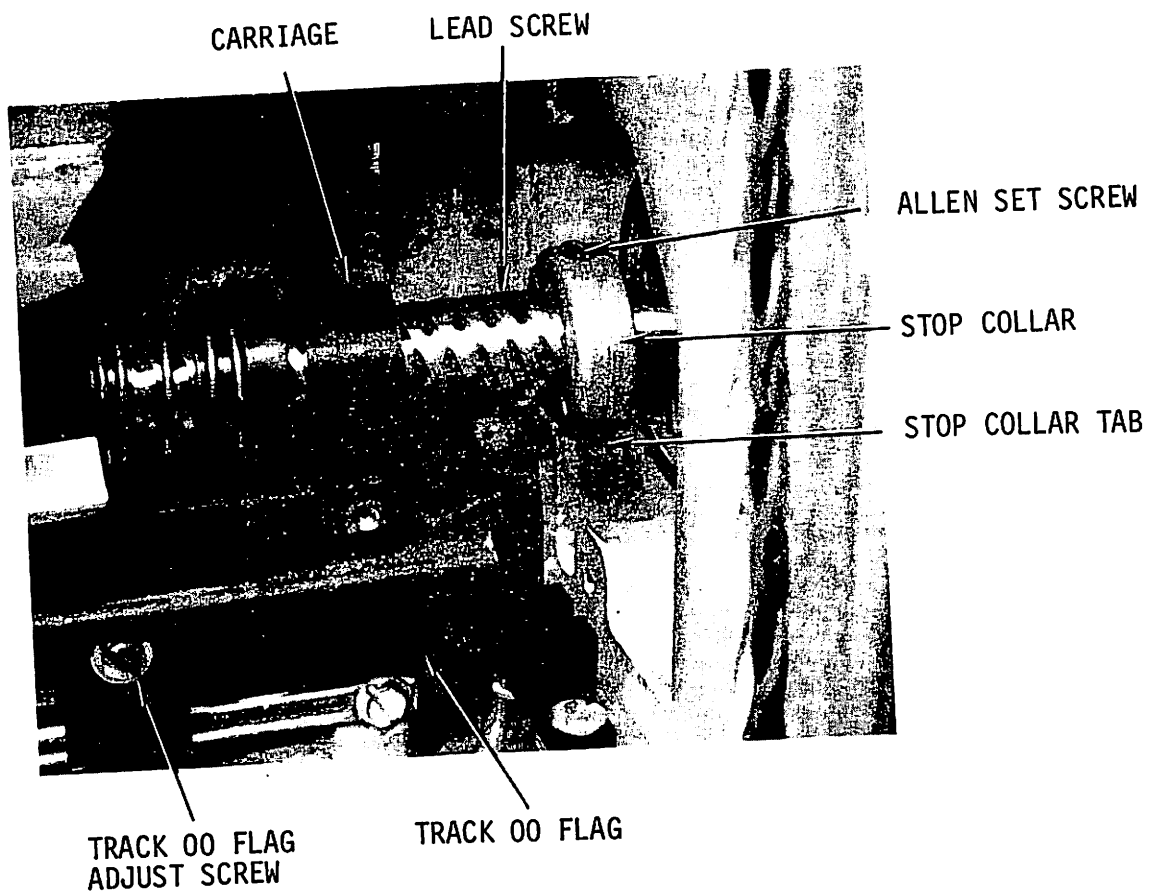


FIGURE 9



## 7.7 TRACK 00 STOP ADJUSTMENT

- a. Key Reset then depress SF'0 (this accesses Track 00).
- b. Check that there is  $.030 \pm .010$  clearance between stop and carriage. Manually rotate lead screw moving the carriage toward the stop collar until it stops. Insure there is  $.020 \pm .010$  clearance between collar and carriage.
- c. If clearances are within tolerance, proceed to section 7.8.
- d. Ground pins 5 & 6 of IC 1A (Shugart PCB).
- e. Key Reset then depress SF'2 (this accesses Track 02).
- f. Loosen Track 00 stop collar.
- h. Grasp end of lead screw in back of stepping motor with pair of pliers and manually turn lead screw CW (from rear of drive) to the Track 01 position. (Next detent position on stepping motor.)
- i. Position the stop collar axially along lead screw so there is  $.020 \pm .010$  between collar and carriage. Rotate the collar toward the inside of the drive until the tab on the collar contacts the carriage stop surface. Tighten stop collar set screw.
- j. Turn power OFF and back ON. Carriage should move to Track 00. Verify that there is data at Track 00.

## 7.8 INDEX/SECTOR TIMING ADJUSTMENT

- a. Key RESET, then depress S.F. key '1 (this accesses track 01).
- b. Connect Channel 1 probe to TP1 and Channel 2 probe to TP2. Connect ext. trigger to TP12. Set oscilloscope as follows:

TIME/DIV	50 USEC.
VERT SENS	0.2 V/DIV.
VERT MODE	ADD, CHAN. 2 INVERTED, AC COUPLED
TRIGGER SOURCE	EXT.
TRIGGER MODE	NORM.
SLOPE	NEG.

- c. Observe the timing between the start of the sweep and the first data pulse. This should be  $200 \mu\text{sec} \pm 50 \mu\text{sec}$  (Ref. Figure 10). If the timing is not within tolerance, continue on with this procedure. If correct, proceed to Section 7.9.
- d. Loosen the screw holding the index detector assembly to the casting until the assembly is just able to move.
- e. Observing the timing, adjust the detector until the timing is correct. Insure that the detector assembly is against the registration surface on the casting.
- f. Tighten the screw and recheck the timing.
- g. Key RESET, then depress S.F. key '4 (this accesses track 76).
- h. Observe the timing and insure it is within tolerance. If not, readjust, then recheck the timing at track 01 (S.F. key '1).

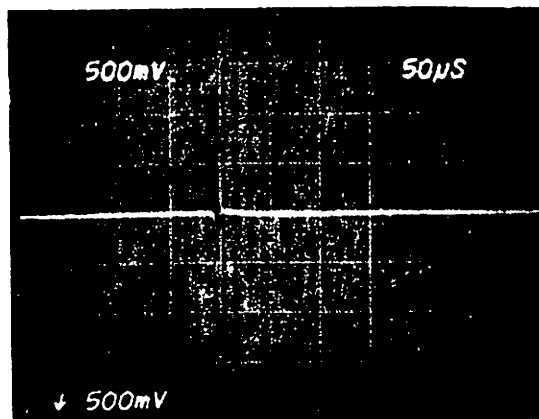


FIGURE 10 INDEX TIMING

#### 7.9 WRITE PROTECT DETECTOR ADJUSTMENT

- a. Set oscilloscope to observe a DC level and monitor P2L4.
- b. Loosen screw on detector assembly and adjust until maximum amplitude is achieved. Tighten screw.

#### NOTE:

After adjustment, insure the detector assembly does not interfere with the inserting of a diskette. If it does, the ejector will not catch and the diskette will pop out when door is being closed.

## 7.10 PCB POTENTIOMETER ADJUSTMENTS

- Insert a scratch platter and format.
- Key RESET, then depress S.F. key '4 (this accesses track 76).
- Connect oscilloscope probe to TP21. Set oscilloscope as follows:

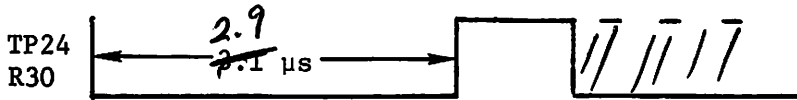
TIME/DIV	0.5 USEC.
VERT SENS	2V/DIV.
VERT MODE	DC COUPLED
TRIGGER SOURCE	INT.
TRIGGER MODE	NORM.
SLOPE	NEG.

- Adjust R31 until a negative pulse of 2.9  $\mu$ sec duration is obtained.
- Connect oscilloscope probe to TP24.
- Adjust R30 until a negative pulse of 3.1  $\mu$ sec duration is obtained.
- While observing the trailing edge of the positive pulse that is also displayed, adjust R127 until the trailing edge is one solid transition (Ref. Figure 11).

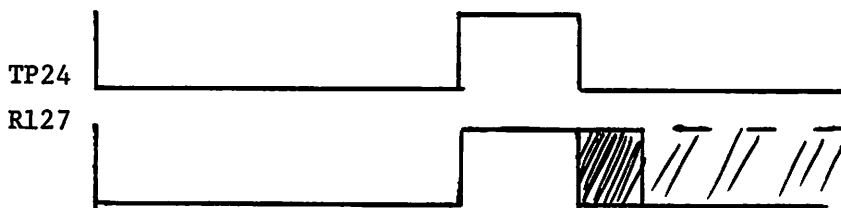
46.3



RIGHT VERT POT



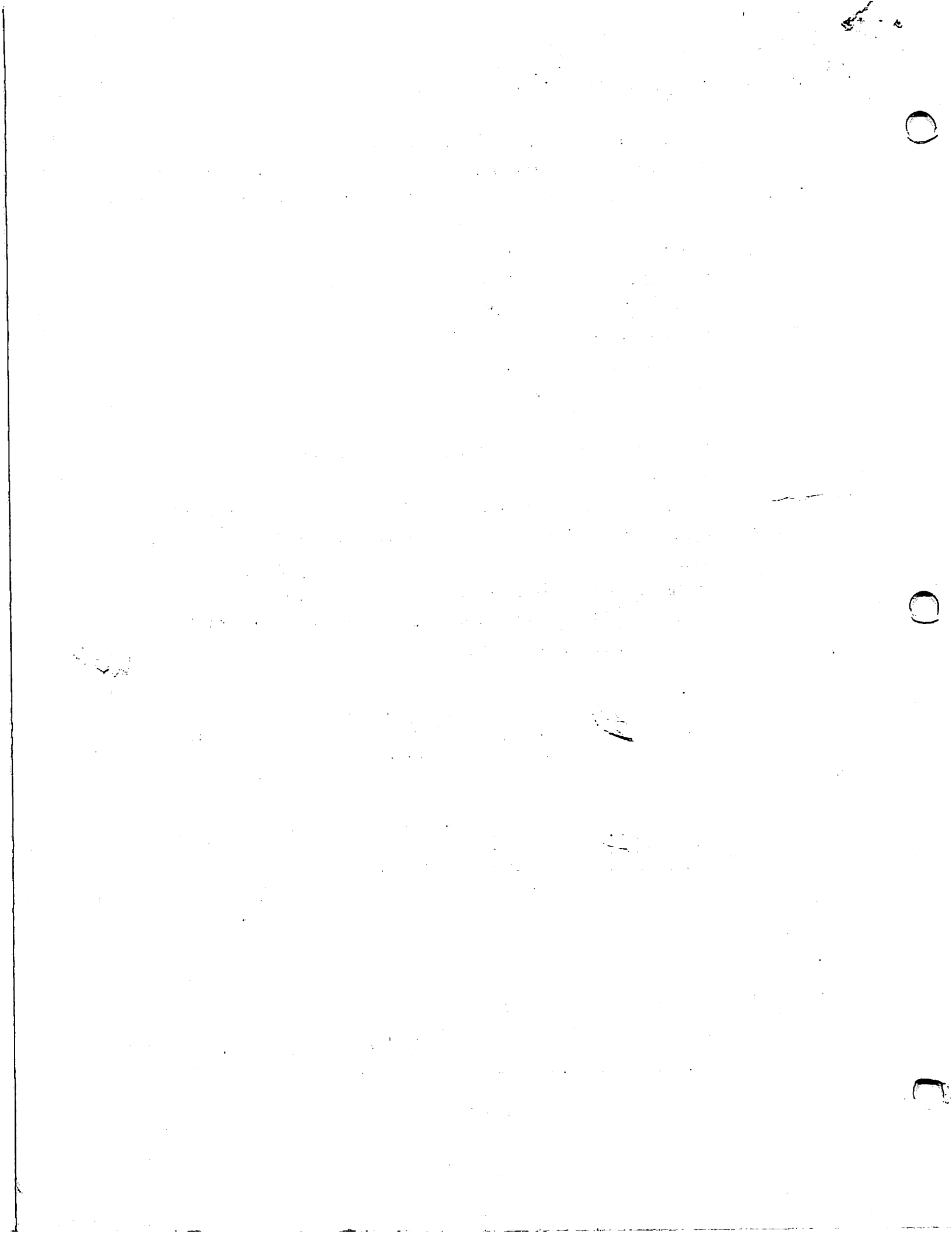
LEFT VERT POT



CORRECT

INCORRECT HORIZ POT

FIGURE 11



EDITED BY CUSTOMER ENGINEERING DIVISION

CORRECTION TO SERVICE BULLETIN NO. 46.3      March 10, 1978  
SHUGART SA901 PCB POTENTIOMETER ADJUSTMENTS

It has been brought to our attention that the adjustment specifications for the data/clock separator circuit on the Shugart SA901 PCB as stated in Service Bulletin 46.3 (Section 7.10 PCB POTENTIOMETER ADJUSTMENTS) produce intermittent failures. The correct specifications are as follows:

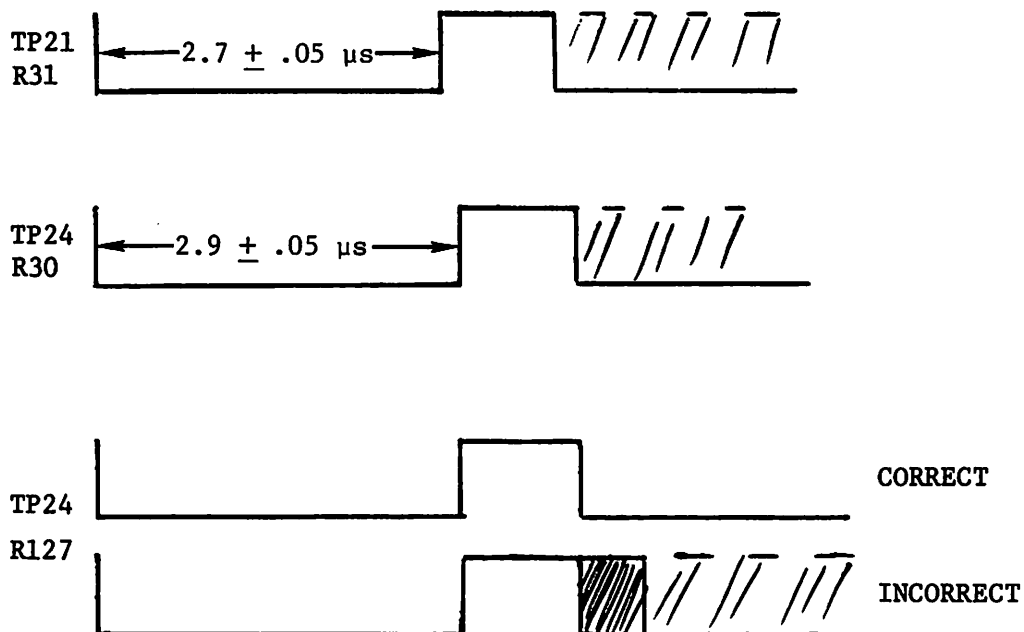


FIGURE 11

Thanks goes to Malcolm Keech of Australia.

**NOTICE:**

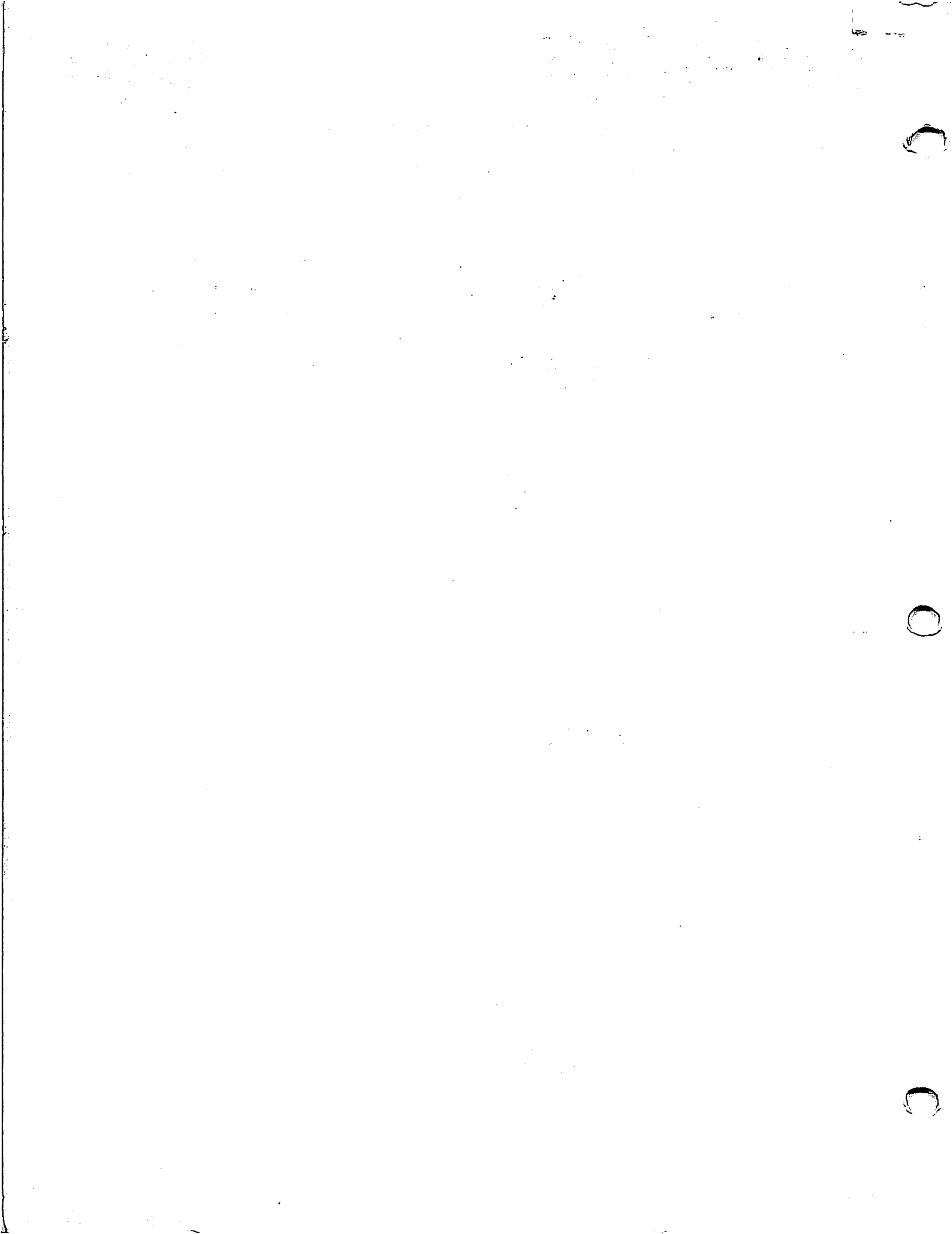
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December 15, 1977

## MODEL 2270A IBM COMPATIBLE SHUGART DISK SYSTEM

This bulletin contains preliminary information describing the 2270A IBM compatible diskette system, which is usable on Wang 2200T, 2200VP, or 2200S with Option 24 as the primary storage device. More detailed information will be forthcoming in future publications.

**NOTE:**

In order to function properly, ribbon cable connectors must be at, or updated to, E-Rev 2:

210-6767.....ECN 6976

210-6766.....ECN 6977

The 7218 board be at E-REV 3 to avoid Phase Lock Loop sync problems (ECN 7821).

These ECN's are included in the appendix.

**NOTICE:**

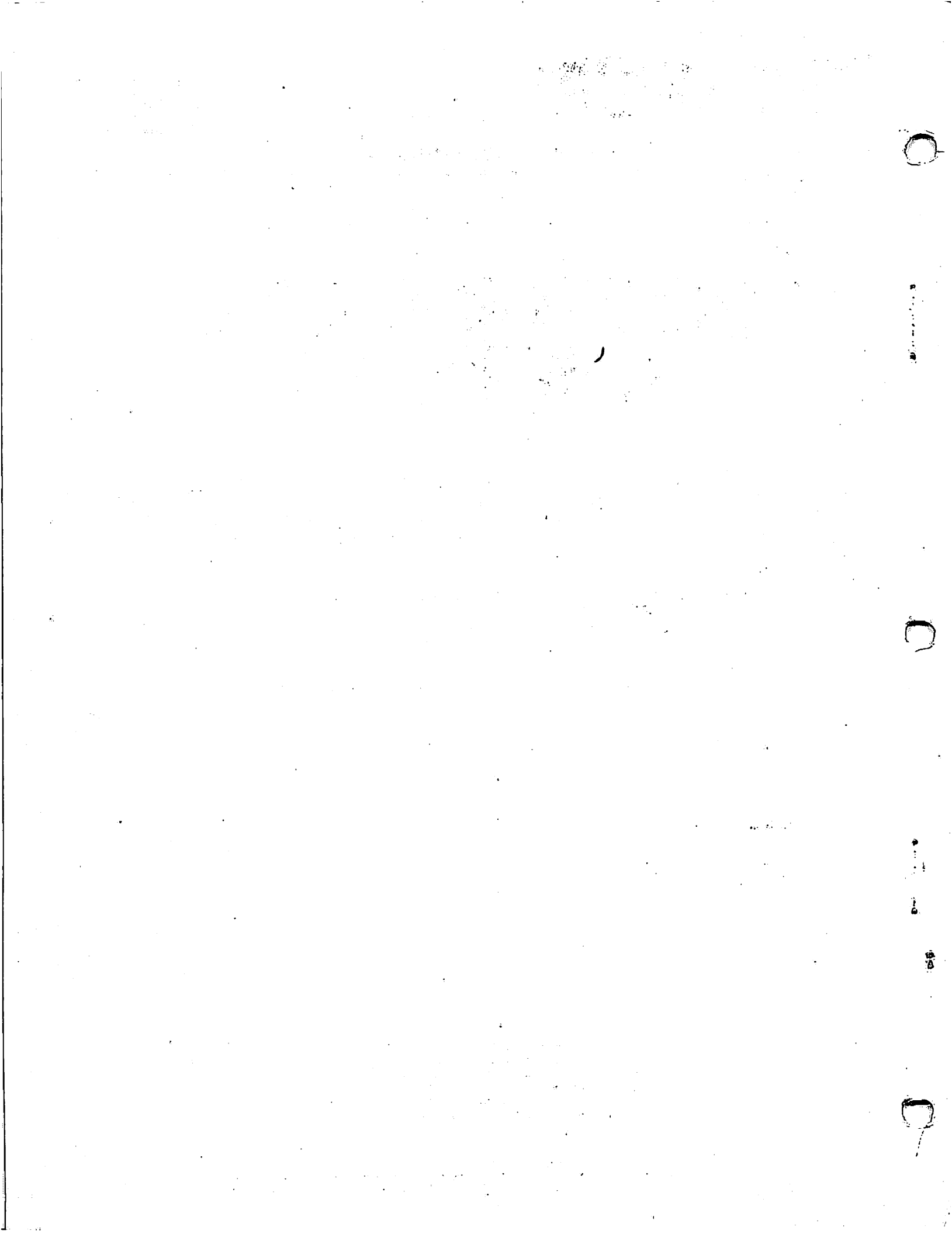
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## 1. MODEL 2270A IBM-COMPATIBLE DISKETTE DRIVE

### 1.1 OVERVIEW

The Wang Model 2270A IBM-Compatible Diskette Drive is physically and functionally identical to the Wang Model 2270, except that the controller in each diskette drive has been modified to automatically handle both IBM 3740 Series diskettes and Wang diskettes. IBM 3740 diskettes, of course, must be previously formatted (initialized) by IBM prior to use on the 2270A. IBM timing mark conventions are followed by the modified controller, and allow supplied 2270A Software to access, modify and create 3740 Series diskette data files. Thus the user can read and process directly from 3740 diskettes. More important, however, are the supplied utility programs which allow all or selected files on an IBM 3740 diskette to be converted to Wang hard disks or diskettes as files in 2200 format, or vice versa. A Wang 2200T or 2200VP is required (or 2200S with Option 24).

Once converted to Wang diskettes, the files can be processed by Wang 2200 computers instead of the IBM computers which presently handle the preprocessing and processing tasks for the IBM 3740 family of Data Entry Stations.

The Wang 2270A is available in one, two, or three drive versions, namely, the 2270A-1, the 2270A-2 and the 2270A-3. One diskette drive must be reserved for 2270A software storage, unless a hard disk is available for the required on-line software storage. This IBM Compatibility feature is field-upgradable on existing 2270's.

### 1.2 AUTOMATIC HARDWARE COMPATIBILITY

Physically, IBM and Wang diskettes have different sector timing marks. To provide compatibility, Model 2270A Controller hardware analyzes the timing marks to sense whether an IBM 3740 diskette or a Wang 2200 diskette has been placed in the diskette drive. Once the

type of diskette is determined, hardware microcode reacts accordingly to provide automatic timing mark compatibility, as if the timing mark difference did not exist.

When a 3740 diskette must be converted or otherwise accessed, the diskette drive used automatically handles the 3740 diskette under the control of supplied 2270A software. In addition, 3740 files previously converted to a Wang diskette may be accessed and processed by simply loading other Wang 2200 software into memory. In this case, the diskette drives of the 2270A handle the Wang diskette as would any 2270, including formatting in the first (fixed) drive. Once the Wang processing operations have been completed, the processed files can be converted back to 3740 diskettes, if necessary, using supplied utility software. Automatic safeguards prevent a 3740 diskette operation from occurring on a Wang diskette, or a Wang operation on a 3740 diskette.

NOTE:

User-programming of the 2270A with 3740 diskettes, other than using supplied 3740 subroutines, is strictly not supported by Wang Laboratories, Inc. This restriction is necessary due to the complexity of handling microcode, the difficulties and dangers of handling the 3740 VTOC entries, and the recording differences in 3740 and 2200 diskettes.

### 1.3 2270A SOFTWARE

The 2270A software provided with each 2270A consists of a comprehensive set of utility programs and subroutines. Conversion functions include the ability to convert (copy) a selected file or all files on a 3740 diskette to a Wang disk or diskette in Wang 2200 format. Similarly, Wang disk or diskette files may also be converted to 3740 diskette files. In addition, subroutines allow the user to access, modify, and create 3740 diskette files.

Thus, the software package allows the user to process 3740 files directly from 3740 diskettes, or process converted 3740 files from Wang diskettes.

### File Maintenance Group

File Maintenance DEFFN' Subroutines provide the means by which existing 3740 diskette data files may be accessed/maintained and also includes the capacity to create new data files in 3740 format. File Maintenance Group software consists of the following functions:

1. Read a sector
2. Write a sector
3. Backspace n sector(s)
4. Skip n sector(s)
5. Reread the last read/written sector
6. Write-end
7. Open (an existing new file)
8. Open new (create a new file)
9. Close a file

These functions are available to the user either directly through the console with operator prompts or indirectly via insertion of statements in the user's BASIC program.

### Diskette Utilities Group

A comprehensive set of Diskette Utility Programs provide the means by which the user may directly (via console) invoke the following utility functions:

1. Convert the data file(s) on an IBM 3740 diskette to Wang 2200 format data files, or vice versa. All or selected files may be copied, and input and output disk addresses are also selected.
2. List the catalog (index) of a 3740 diskette.

3. Read and display on the CRT selected 3740 diskette sector(s).
4. Display on the CRT each sector of a specific 3740 data file which has been converted via the above utility function to a Wang diskette.
5. Copy 2270A Software, which is issued on a diskette, to a selectable hard disk.

#### Diskette Initialization Group

This software was developed for program testing purposes. It creates an image of an initialized 3740 diskette on a 2200 diskette, which mainly consists of the 3740 Volume Table of Contents (VTOC).

#### 1.4 DISKETTE CONVERSION

IBM 3740 diskettes, like the Wang diskettes they resemble, are recorded on one side and require fixed length records within a file; however, that's where the similarities end. Differences in sector timing marks, as previously mentioned, are made compatible by hardware controller microcode. Software handles all file management functions including cataloging and sector allocation.

IBM 3740 diskettes can accommodate up to 19 files (IBM calls files "data sets"). Maximum 3740 diskette record length is 128 bytes, with one and only one record in each 128-byte sector. Each 3740 diskette contains 1,898 available sectors (73 tracks, 26 sectors per track).

When converting all files on a diskette, the Wang 2270A Conversion Utility Program adds converted files to the output disk or diskette until either all diskette files are converted or insufficient output diskette space exists to convert the next file. In the latter case, another output diskette is requested to contain the remaining files. In addition, selected files may be converted.

Within a file, the conversion process occurs as sector per sector copy. Wang records are equal in length to their 3740 diskette counterparts. As with 3740 diskettes, only one record resides in each sector. Character code translation between EBCDIC and ASCII is performed internally by the Conversion Utility Program.

### 1.5 THE IBM 3740 DATA ENTRY STATIONS

The IBM 3740 Series are low cost, key-to-diskette, source data entry devices. Over 50,000 have been installed, 95% of which are the non-programmable Data Stations used solely for data entry. The four 3741 Models vary in whether they (1) are programmable in a language called ACL, or (2) have communication capabilities. The table below summarizes the four 3741 models and the dual-operator 3742.

<u>MODEL</u>	<u>PROGRAMMABLE</u>	<u>COMMUNICATION</u>
3741, Model 1	No	No
3741, Model 2	No	Yes
3741, Model 3	Yes	No
3741, Model 4	Yes	Yes
3742 (Two Operators)	No	No

### 1.6 PHYSICAL CHARACTERISTICS OF THE DISKETTES

The magnetic recording surface is arranged in concentric circular recording tracks, with each track being further segmented into units called sectors. Each IBM 3740 diskette (WLI #177-0067) contains 73 tracks with 26 sectors per track, or 1,898 sectors per diskette. 3740 sector length is 128 bytes (characters), which is also the maximum record length for 3740 diskette files (referred to as "data sets" by IBM). The Wang diskette (2270A only) consists of 77 tracks with 16 sectors per track, or 1,231 sectors per diskette (minus at least two sectors for the Wang diskette index). Wang disk or diskette sector length is 256 bytes; however, maximum record length for Wang 2200 files that will be converted to 3740 diskettes

diskettes, record length restriction do not apply. With all disk or diskette storage devices, each sector is individually numbered and randomly accessible; thus access to records stored anywhere on the disk or diskette is fast and direct. Data is read or recorded (written) in one-sector blocks. As previously mentioned, the differences between Wang and 3740 diskettes are automatically handled by the hardware.

A conversion process is required to access an IBM diskette, and is performed as follows:

IBM address = Wang address + 16384

### Sector Formatting

The left-most drive of the 2270A may be used to "format" a Wang diskette (not 3740 diskettes). Formatting is required before a Wang diskette can be used. Depression of the format button begins the formatting procedure, which defines each sector's control and user bytes. IBM 3740 diskettes are preformatted, or "initialized" before delivery by IBM.

### Track Format (IBM)

Tracks may be formatted in numerous ways and is dependent on the using system. The SA900/901 use index and sector recording formats respectively.

### Index Recording Format

In this Format, the using system may record one long record or several smaller records. Each track is started by a physical index pulse and then each record is preceded by a unique recorded identifier. This type of recording is called soft sectoring. Figure 1-1 shows a typical Index Recording Format.



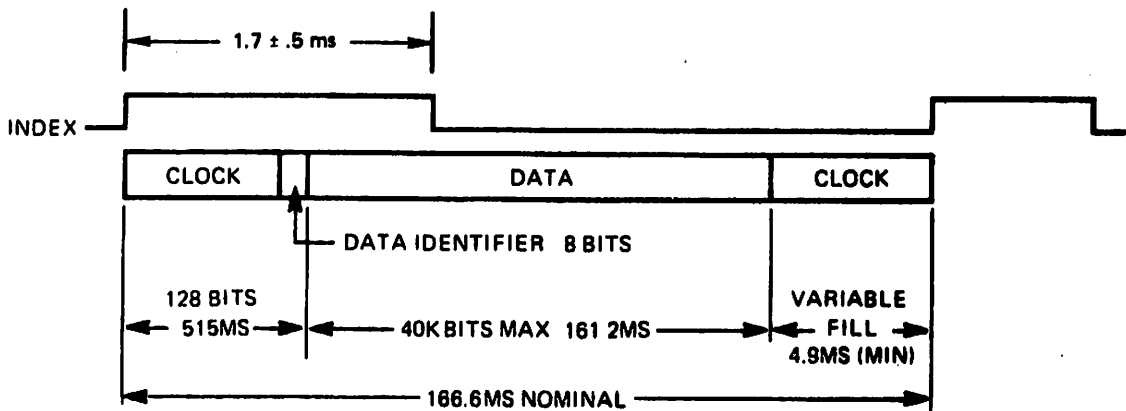


Figure 1-1 Index Recording Format

Typical Track Index Format

Figure 1-2 shows a track format, which is IBM compatible, using Index Recording Format with soft sectoring.

Gaps (Ref. Figure 1-2)

Each field on a track is separated from adjacent fields by a number of bytes containing no data bits. These areas are referred to as gaps and are provided to allow the updating of one field without affecting adjacent fields. As can be seen from Figure 1-2, there are four different types of gaps on each track.

Gap 1 Post-Index Gap

This gap is defined as the 32 bytes between Index Address Mark and the ID Address Mark for Sector one (excluding the address mark bytes). This gap is always 32 bytes in length and is not affected by any updating process.

Gap 2 ID Gap

The seventeen bytes between the ID Field and the Data Field is defined as Gap 2 (ID Gap). This gap may vary in size slightly after the Data Field has been updated.

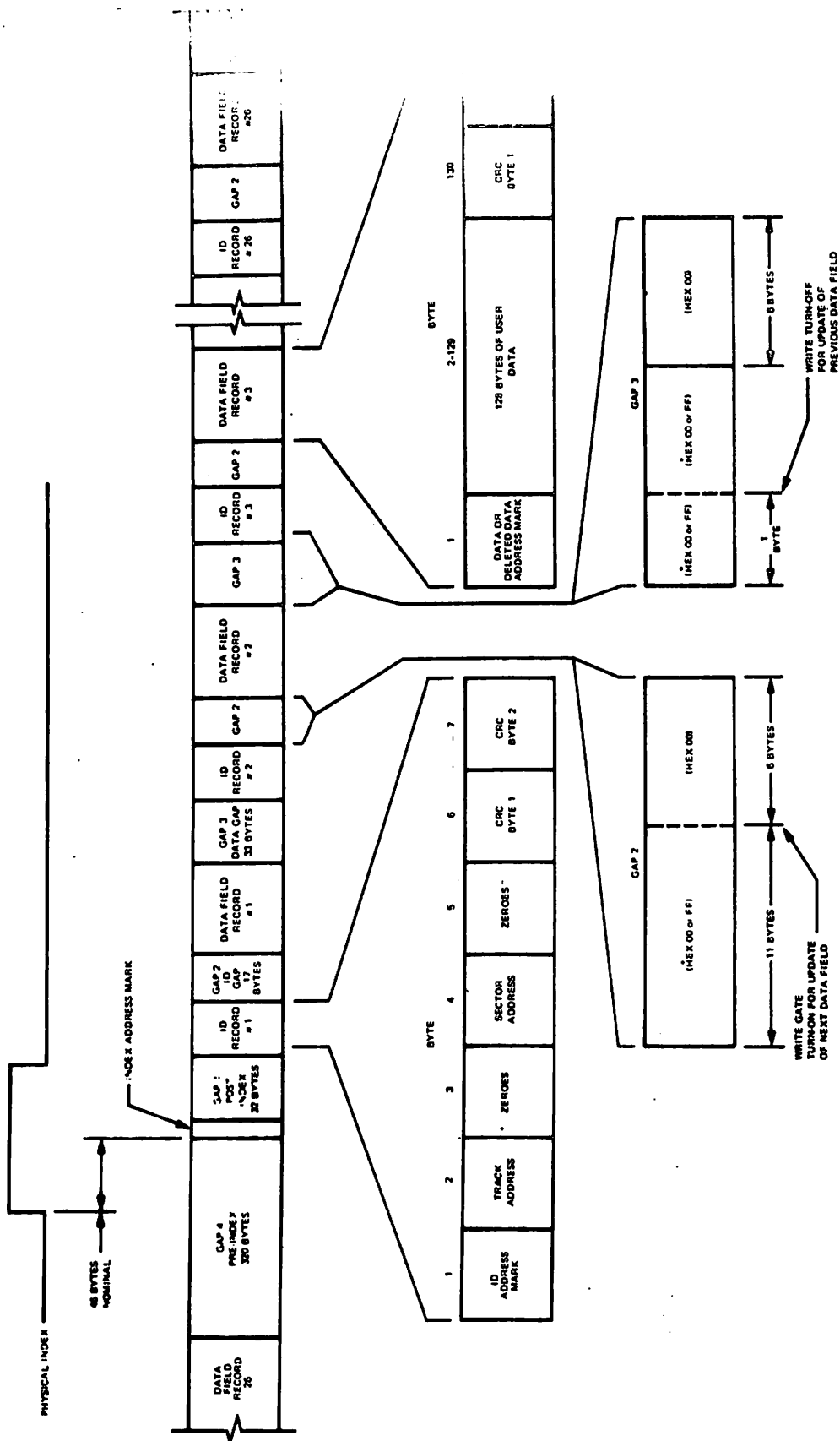


Figure 1-2 Track Format

### Gap 3 Data Gap

The thirty-three bytes between the Data Field and the next ID Field is defined as Gap 3 (Data Gap). As with the ID Gap, the Data Gap may vary slightly in length after the adjacent Data Field has been updated.

### Gap 4 Pre-Index Gap

The three hundred and twenty bytes between the last Data Field on a track and the Index Address Mark is defined as Gap 4 (Pre-Index Gap). Initially, this gap is nominally 320 bytes in length, however, due to write frequency tolerances and disc speed tolerances, this gap may vary slightly in length. Also, after the data field of record 26 has been updated, this gap may again change slightly in length.

### Address Marks

Address Marks are unique bit patterns one byte in length which are used in this typical recording format to identify the beginning of ID and Data Fields and to synchronize the deserializing circuitry with the first byte of each field. Address Mark bytes are unique from all other data bytes in that certain bit cells do not contain a clock bit (all other data bytes have clock bits in every bit cell). There are four different types of Address Marks used. Each of these is used to identify different types of fields.

### Index Address Mark

The Index Address Mark is located at the beginning of each track and is a fixed number of bytes in front of the first record. The bit configuration for the Index Address Mark is shown in Figure 1-3.

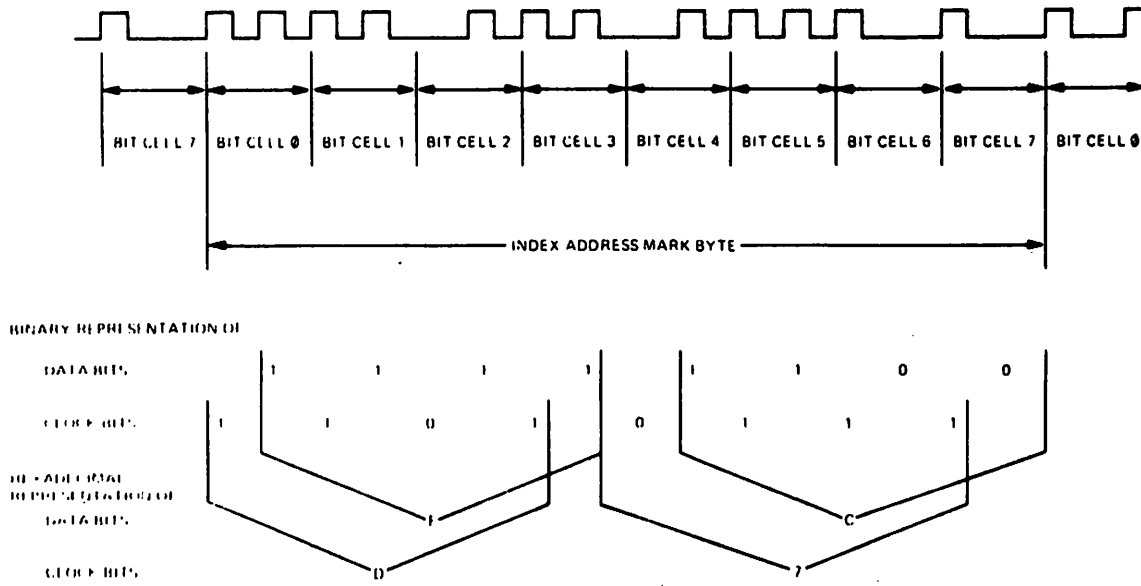


Figure 1-3 Index Address Mark

ID Address Mark

The ID Address Mark byte is located at the beginning of each ID Field on the diskette. The bit configuration for this Address Mark is shown in Figure 1-4.

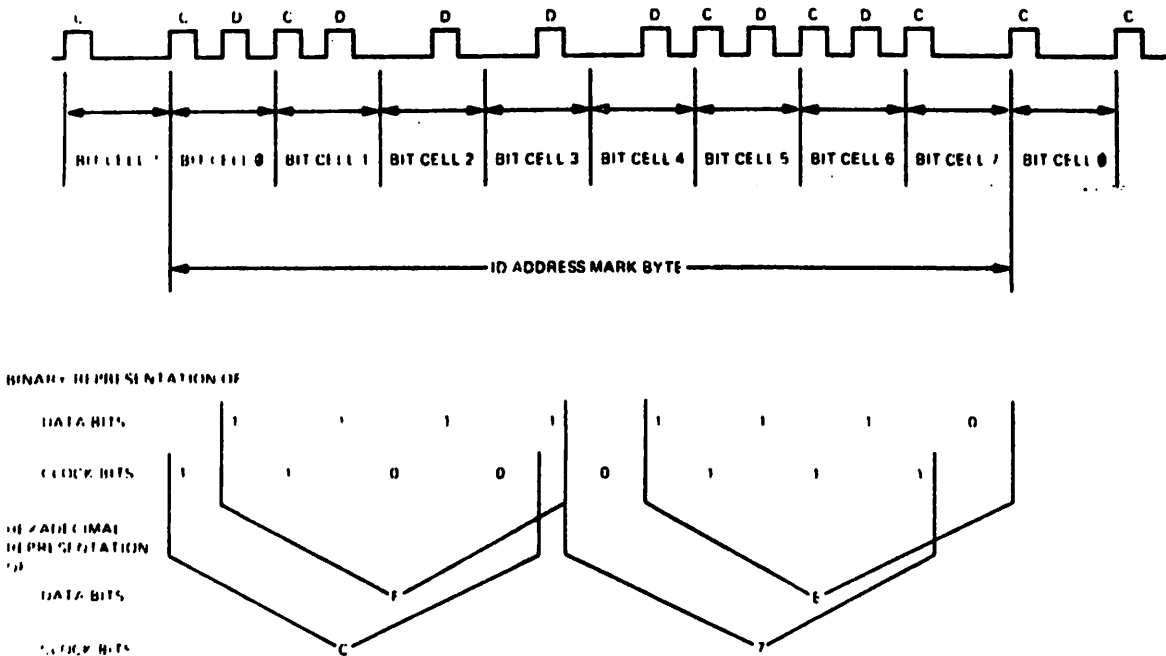


Figure 1-4 ID Address Mark

## Data Address Mark

The Data Address Mark byte is located at the beginning of each nondeleted Data Field on the diskette. The bit configuration for this Address Mark is shown in Figure 1-5.

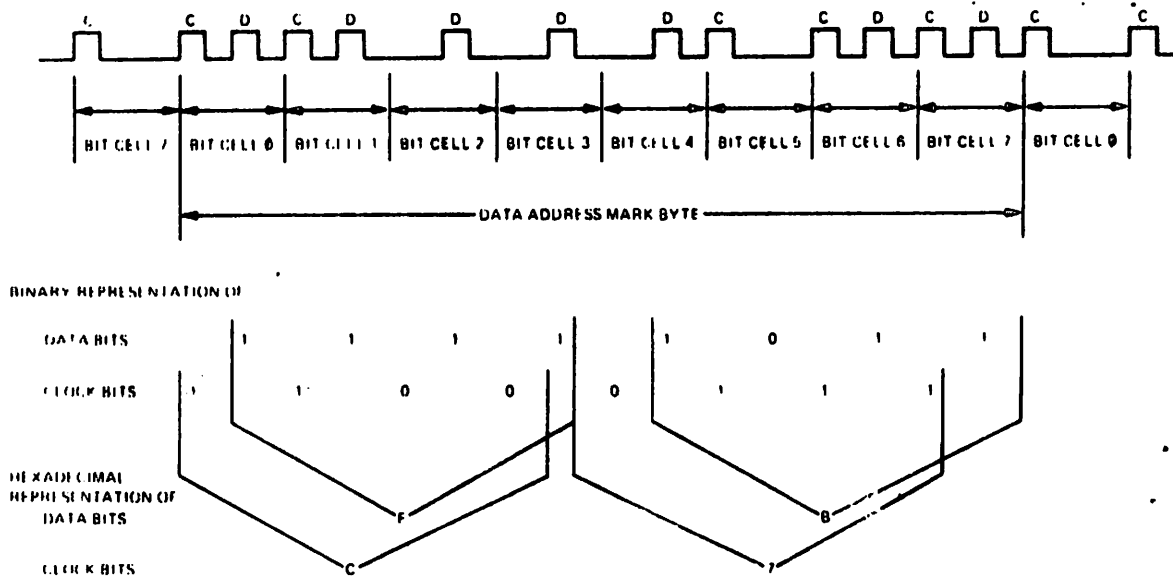


Figure 1-5 **Data Address Mark**

## Deleted Data Address Mark

The Deleted Data Address Mark byte is located at the beginning of each deleted Data Field on the diskette. The bit configuration for this Address Mark is shown in Figure 1-6.

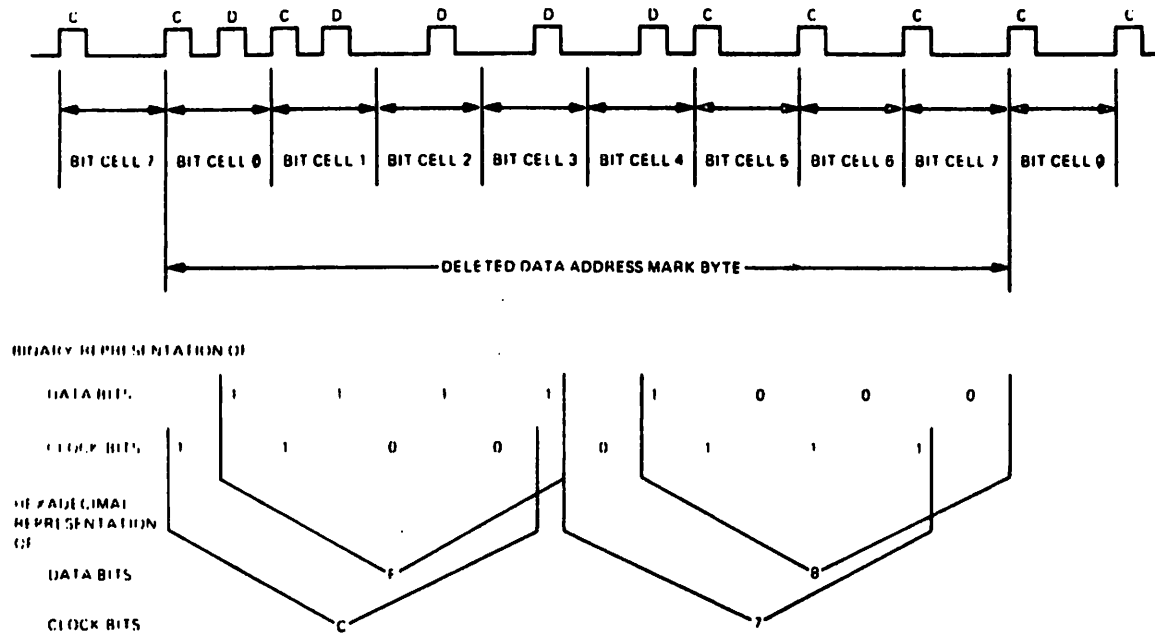


Figure 1-6 Deleted Data Address Mark

### CRC

Each field written on the diskette is appended with two Cyclic Redundancy Check (CRC) bytes. These two CRC bytes are generated from a cyclic permutation of the data bits starting with bit zero of the address mark and ending with bit seven of the last byte within a field (excluding the CRC bytes). When a field is read back from a diskette, the data bits (from bit zero of the address mark to bit seven of the second CRC byte) are divided by the same generator polynomial. A non-zero remainder indicates an error within the data read back from the drive while a remainder of zero indicates the data has been read back correctly from the disk.

## 2. DESCRIPTION (HARDWARE)

### 2.1 GENERAL

The Shugart Disk System used in the WCS follows the same basic design as our previous disk systems with many improvements to make this system more reliable and easier to service.

The Shugart Disk System consists of a Wang microprocessor controller and power supply, mounted on one printed circuit board, with up to three Shugart disk drives contained in the unit.

### 2.2 DESIGN FEATURES

The processor and regulator are comined on one PC (7218) which mounts to the chassis, component side down. The power supply, which includes the transformer filter capacitors and heat sink, is mounted on a removable brace between the microprocessor and the disk drives.

The microprocessor is a condensed version of the same microprocessor used in our other disk systems and the 9 track tape drive (2209). Refer to the Microprocessor Manual for the microprocessor description and operation.

### 2.3 MECHANICAL AND ELECTRONIC DIFFERENCES BETWEEN WCS AND SERIES 40 DISK SYSTEMS

The only shipping clamp on the WCS disk system is a piece of foam taped in the door opening to keep the door open protecting cartridge guide adjustment.

The WCS incorporates one to three Shugart Model 901 disk drives which use an IBM compatible disk cartridge.

The Shugart Model 901 disk drives use a multiplex option which allows all input and output lines to be parallel. The disk select lines DK1, DK2, and DK3 determine which drive is using these lines.

The stepper motors in the Shugart drive are turned off when the head is unloaded from the disk. This allows the drives to operate much cooler than the Memorex drives. In order to load the head in the Shugart drive, both the drive select and the head load lines must be low or true. The head load line fires a one shot which keeps the head loaded for a time after the drive select line goes high. This allows the unit to be reselected without waiting for the head to settle to read or write.

Sector and index marks from each drive are monitored individually because they are present at the output of each drive as long as there is a disk cartridge in the drive; these signals are independent of the drive select lines.

The RAM is 512 x 8 rather than 1024 x 8; this is accomplished by using 2102-2 RAM ICs which are 256 x 4 having 4 bit parallel input/output as opposed to the 1024 x 1 serial input/output.

The only input path to memory in this processor is the C Bus. Data from the disk is sent through the ALU via this bus using an A to M, PC=1 instruction from the ROM.

St0 and St1 are strictly inputs on the WCS floppy except for one bit, the carry bit which is input and output but cannot be used by the ALU as a bit included in the next result. The carry bit can only be sampled by the ALU to check its state.

The microprogram in the WCS floppy is contained in two (2) 2708 PROM chips and does not require changing if a disk drive is added to the customer's WCS. The PROM numbers and locations are listed below.

378-2058

378-2059

Two 2200 error codes have other possible meanings in the WCS: Error 64 is "sector not on disk" but can also mean "no cartridge in the drive, the drive door is open or that the drive is not ready." Error 71 is "cannot find sector" but can also mean "disk is write protected."



### 3. INSTALLATION

The 2270A Shugart disk system is shipped completely assembled inside as a stand-alone 2270A. The only shipping clamp is a piece of foam in the door of each drive and a piece of masking tape to hold the foam in place.

The disk system should be disassembled before the unit is powered on to check that the plug-in connectors and components have not been loosened during shipment. The voltages should also be checked while the system is removed from the cabinet.

1. Remove the unit cover.
2. To remove the processor PC board, and the 6 Phillips head mounting screws on the perimeter of the PC board.

#### CAUTION:

Reinstall the nylon washers on each screw. They protect the screws from shorting the PCB art work.

At this time the PC board should be turned 180 toward the front of the cabinet, and set down on the rubber grommets, with a piece of foam between the PC board and the chassis. The cable strain will keep the PC board from falling forward (test position).

The PC board can be removed by turning it 90 toward the front and removing all the connectors.

3. The voltages can be checked from the wire side of the board by following the diagram below and with the I/O and power cable plugged in and the power switch ON. (See Figure 3-1).

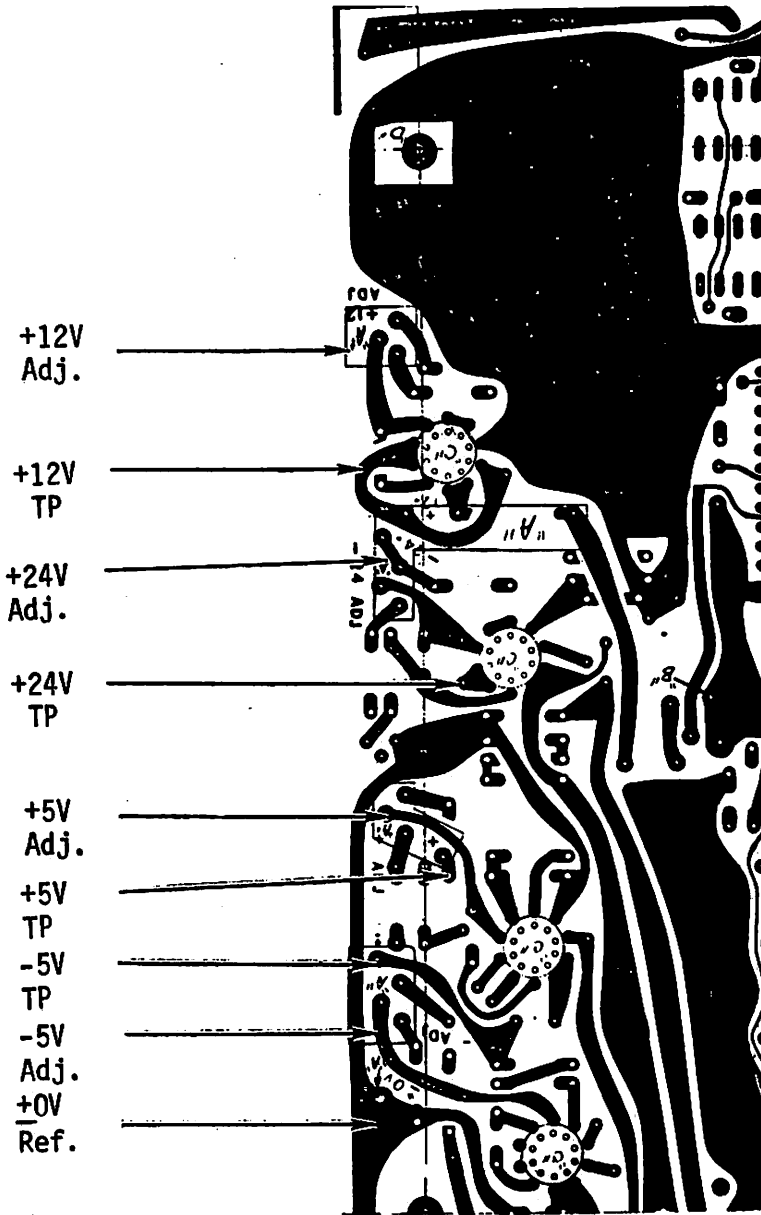


Figure 3-1 Regulated Voltages

Insure that the I/O cable (WLI #220-0066-4) has pin 11 open. This is necessary for proper system operation. The 7218 PCB has +5V connected to pin 11 of the I/O cable connector J1. This was done to allow the 2270A to be used in conjunction with a 7169 pcb in WCS-15 applications.

#### 5. Voltage Controlled Oscillator (VCO) Adjustment

**NOTE:**

+5V must be adjusted prior to performing this adjustment.

- A. Attach the channel 1 (oscilloscope) probe to L110 pin 3. Vertical deflection 2v/cm, Sweep rate .5us/div, Trigger internal positive slope on channel 1, Display channel 1 only. With the system reading sector 17385\*, adjust R86 until a period of 2us is acquired (See figure 3-2).

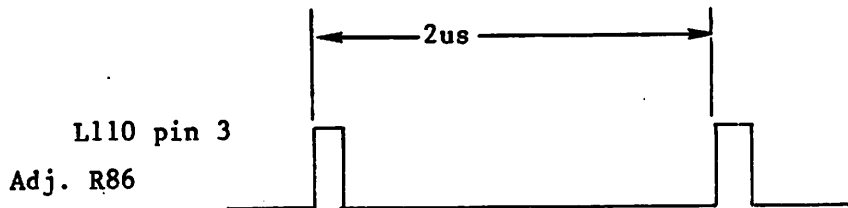


Figure 3-2

\*This can be accomplished by this short program: 10 Verify F (17385, 17385): GOTO 10.

- B. Attach the channel 2 oscilloscope probe to L110 pin 1. Vertical deflection 2v/cm, Sweep rate, .5us/div. Trigger internal positive on channel 1, add mode. Adjust R86 until the channel 1, channel 2 signals are coincident (See Figure 3-3).

NOTE:

THIS IS A TEMPERATURE SENSITIVE CIRCUIT AND MAY GO OUT OF SYNC. IF THE SYNC IS LOST, THEN EGN 7821 MUST BE INSTALLED AND THE ADJUSTMENT PERFORMED AGAIN.

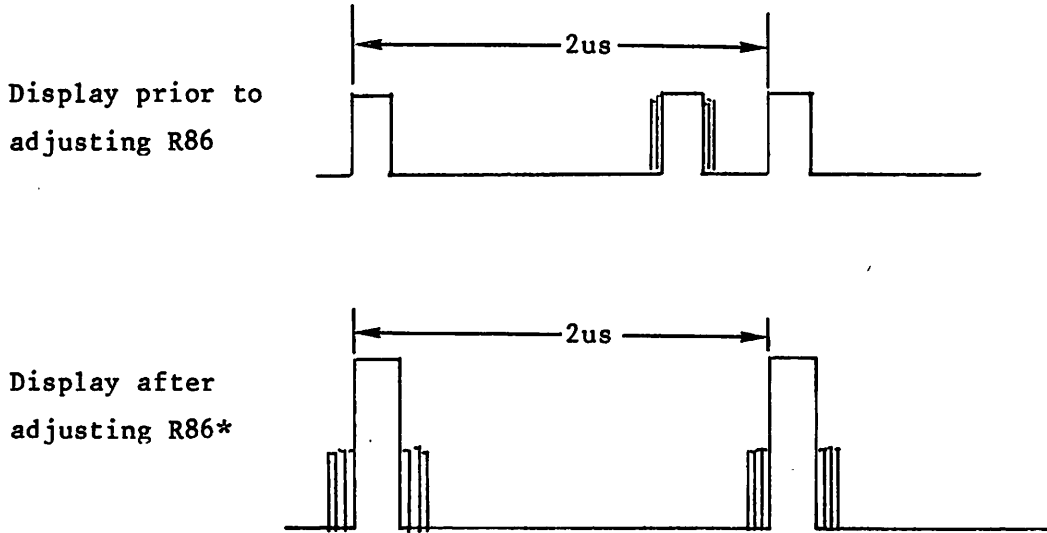
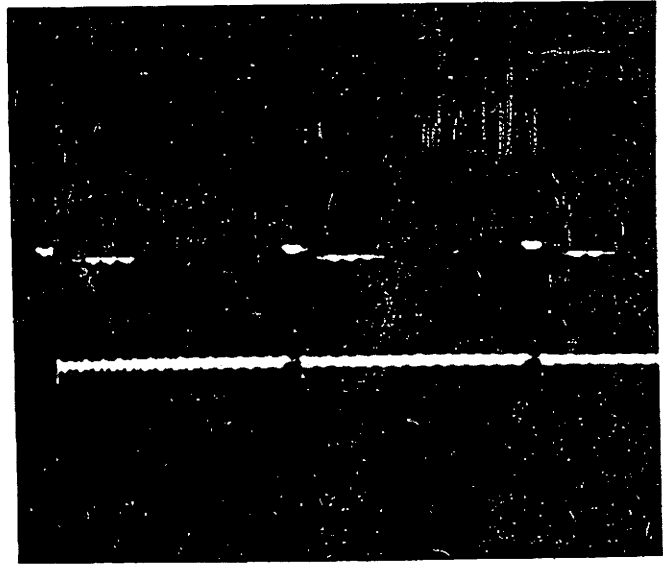
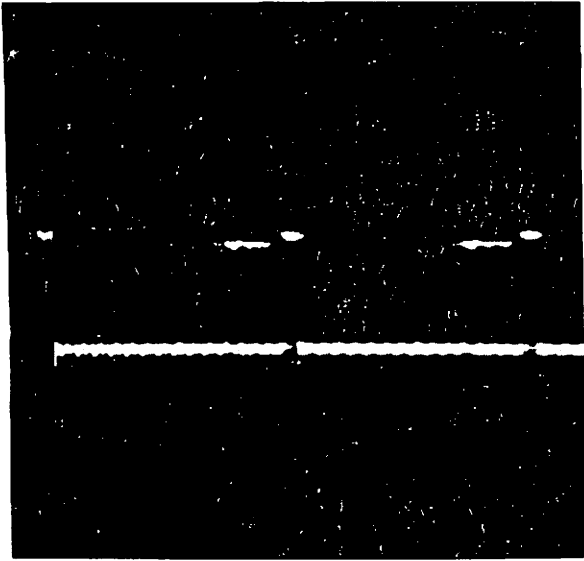


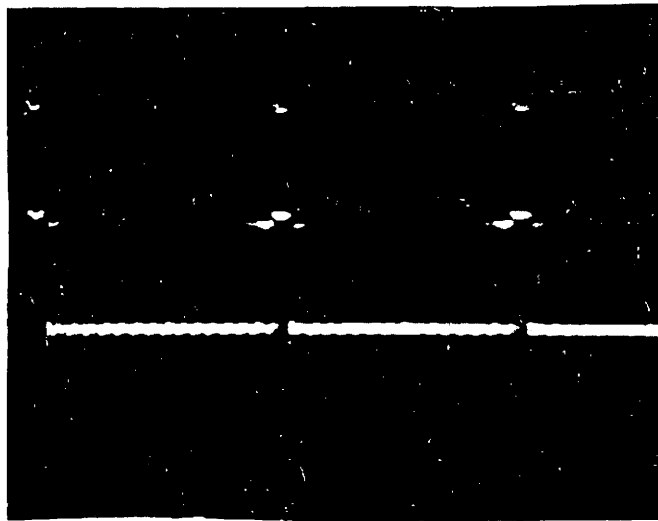
Figure 3-3

\*NOTE:

When the channel 1, channel 2 signals are coincident, the display amplitude will double. The pulse jitter seen in the photographs is due to the continuous compensation that takes place as the Phase Locked Loop (PLL) locks onto the incoming data. (See Figure 3-4)



Possible Displays if the PLL Requires Adjustment



Display with the PLL Properly Adjusted

Figure 3-4

NOTES

#### 4. OPERATION

The front panel of the 2270A floppy disk system has three disk select lights, and a format pushbutton with a shroud to protect it from accidental formatting and a power light.

There is no format switch to protect static electricity from formatting the disk, but rather an electronic format project which rejects any attempt to format the disk which does not last for at least 100 ms.

Formatting on the disk system is done on Disk #1 only. This is a hard wired function of Disk #1 and can be initiated by installing a Model 901 diskette in Drive #1 and pushing the format pushbutton. If the diskette or disk drive is faulty and it does not complete the format operation within four attempts the Drive Select Light #1 will flash indicating an error during format.

This writes Wang format on the Diskette. This will NOT format an IBM diskette--they are preformatted.

**NOTES:**



## 5. DIAGNOSTICS

The following is a step by step description, concerning operating the program for "2270A Production Test," and the CRT display.

- Step 1.           Rewind cassette (if needed) and press:
- Step 2.           : LOAD "START" (EXEC)  
                  after the "START" program has been loaded, press:
- Step 3.           : RUN (EXEC)  
                  Two lines should be displayed, of which the second  
                  line will be:
- Step 4.           "ENTER 1 FOR WANG PLATTER, 2 FOR IBM PLATTER?"  
                  Enter 1 or 2 and Press (EXEC), depending on kind of  
                  platter to be used.

NOTE: An IBM platter can be used only on  
2270A diskette drive.

Now "WANG DISK" or "IBM DISK" will be displayed in  
the top line, and the second line will be replaced  
by:

- Step 5.           "ENTER TEST #: 1. MICROCODE 2. MICROCODE-HARDWARE  
                  3. HARDWARE ?"  
                  Enter 1 for Disk Microcode test, 2 for Disk  
                  Microcode and Hardware test or 3 for Disk Hardware  
                  test. After pressing (EXEC), the selected test  
                  name will be displayed in the top line, and the  
                  second line will be replaced by:

Step 6.

"ENTER DRIVE(S) ADDRESS(S), 0 TO STOP: 1. 310  
2. B10 3. 350"?

The number by the Disk drive addresses on which the test will operate should be entered here. Any combination of Disk drives is allowed. Upon selecting a disk address, an asterisk will be displayed by the selected address. Selecting all three drives or selecting 0, will cause line to be erased, and the selected disk-drives to be displayed on the right hand side of second line. If Hardware test was selected in Step 5, proceed to Step 8.

Step 7.

The following lines will be displayed if 1 or 2 were entered in Step 5.

"ENTER INSTRUCTION NUMBER TO BE TESTED, 0 TO STOP?" This line will be followed by a list of all the instructions available for testing, depending on the selected disk-drives, and the type of platter. You may select 1, if you wish to test all the instructions. Or, enter any combination of instructions (an asterisk will be displayed by the selected instruction). Selecting 1 or 0 causes to stop the instructions selection and "ALL MICROCODE", or "PART MICROCODE" to be displayed in the left hand side of line 2, the third line will be replaced by: "THE SELECTED INSTRUCTIONS": and the bottom line will be:

Step 8.

"ENTER 1 TO RESELECT, 0 TO CONTINUE?"

The screen now displays all of the information as you have selected it. If you wish to change any detail, press 1, and entering information will start again, (back to Step 4), otherwise, enter 0 and the screen will be erased except the top two lines, and the third line will be displayed as:

Step 9. "MOUNT SCRATCH PLATTERS IN ALL TEST DRIVES AND KEY (EXEC)"

NOTE:

Be sure to mount the correct scratch platters in all of the test drives (as indicated by the top two lines).

After mounting platter(s), and (EXEC) the proper testing program will be loaded from the cassette, and the actual testing starts. While the test is progressing, information concerning the current status of the test is being displayed on the screen.

Step 10. Each test will be repeated over and over until one of the following actions is taken:

- 10.1 Pressing SF'15 (special function 15). That will cause the test status report to be displayed (proceed to Step 11).
- 10.2 Pressing "HALT/STEP", Once the ":" is displayed pressing SF'15 will display the test status report. (Step 11)
- 10.3 Pressing "RESET", That will cause the screen to be erased. Pressing SF'15 is possible.

Step 11. After pressing SF'15, the test status report will be displayed; information, such as number of runs of each test, test "RUN" or "NOT RUN", "COMPLETED" or "NOT COMPLETED", "ERRORS FOUND" in Microcode, or Hardware tests. "OK" or "NG" or, "NOT TESTED" will be displayed next to the instruction, with the exception of "VERIFY" which will have "TESTED" in its field (whether errors were found or not). At the bottom of the screen, the following line will be displayed:

Step 12. "ENTER 0 TO RUN AGAIN, 1 TO STOP"

0 will start the whole process from the beginning (Step 4). 1 will stop the program, however, since "START" is still stored in memory; pressing "RUN" will start the program execution again (Step 4).

NOTES

## 6. MAINTENANCE

### 6.1 MICROPROCESSOR

The voltage adjustments covered in Section 3 and the VCO adjustment should be the only maintenance requirements required in the microprocessor section of the Shugart disk system. The microprocessor PC board at present should be fixed at an area level office.

The Wang power supply is a modular type which is mounted to a removable support bracket and can be replaced in this manner if necessary. The heat sink assembly can also be removed from the support bracket so that component replacement on the heat sink can be made in the customer's office.

### 6.2 SA901 PREVENTIVE MAINTENANCE

#### 6.2.1 INTRODUCTION

The prime objective of any preventive maintenance activity is to provide maximum machine availability to the user. Every preventive maintenance operation should support this objective. Unless a preventive maintenance operation reduces machine downtime, it is unnecessary.

Visual inspection is the first step in every scheduled maintenance operation. Always look for corrosion, dirt, wear, binds, and loose connections. Noticing these items during PM may prevent downtime later.

Remember, do not do more than recommended preventive maintenance on equipment that is operating satisfactorily.

### 6.2.2 PREVENTIVE MAINTENANCE PROCEDURES

Details of preventive maintenance operations are listed in Table 6-1. During normal preventive maintenance, perform only those operations listed on the chart for that preventive maintenance period. Details on adjustments and service checks are found listed in the chart. Observe all safety procedures.

UNIT	FREQ MONTHS	CLEAN	OBSERVE
Read/Write Head	12	Clean Read/Write Head ONLY IF NECESSARY	Oxide build-up and scratches
R/W Head Load Button		Replace	
Stepper Motor and Lead Screw		Clean off all oil, dust and dirt	Inspect for nicks and burrs
Base		Clean base	Inspect for loose screws, connectors, and switches
Belt			Inspect for worn, weakened or frayed areas
Read/Write Head	Initially 3 Thereafter 12		Check for proper alignment

Table 6-1 PM Procedures

### 6.2.3 CLEANLINESS

Cleanliness cannot be overemphasized in maintaining the SA900/901. Do not lubricate the SA900/901; oil will allow dust and dirt to accumulate. The read/write head should be cleaned, but only when signs of oxide build-up are present.

### 6.3 TROUBLESHOOTING FLOW CHARTS

See Figure 6-2(A thru D)

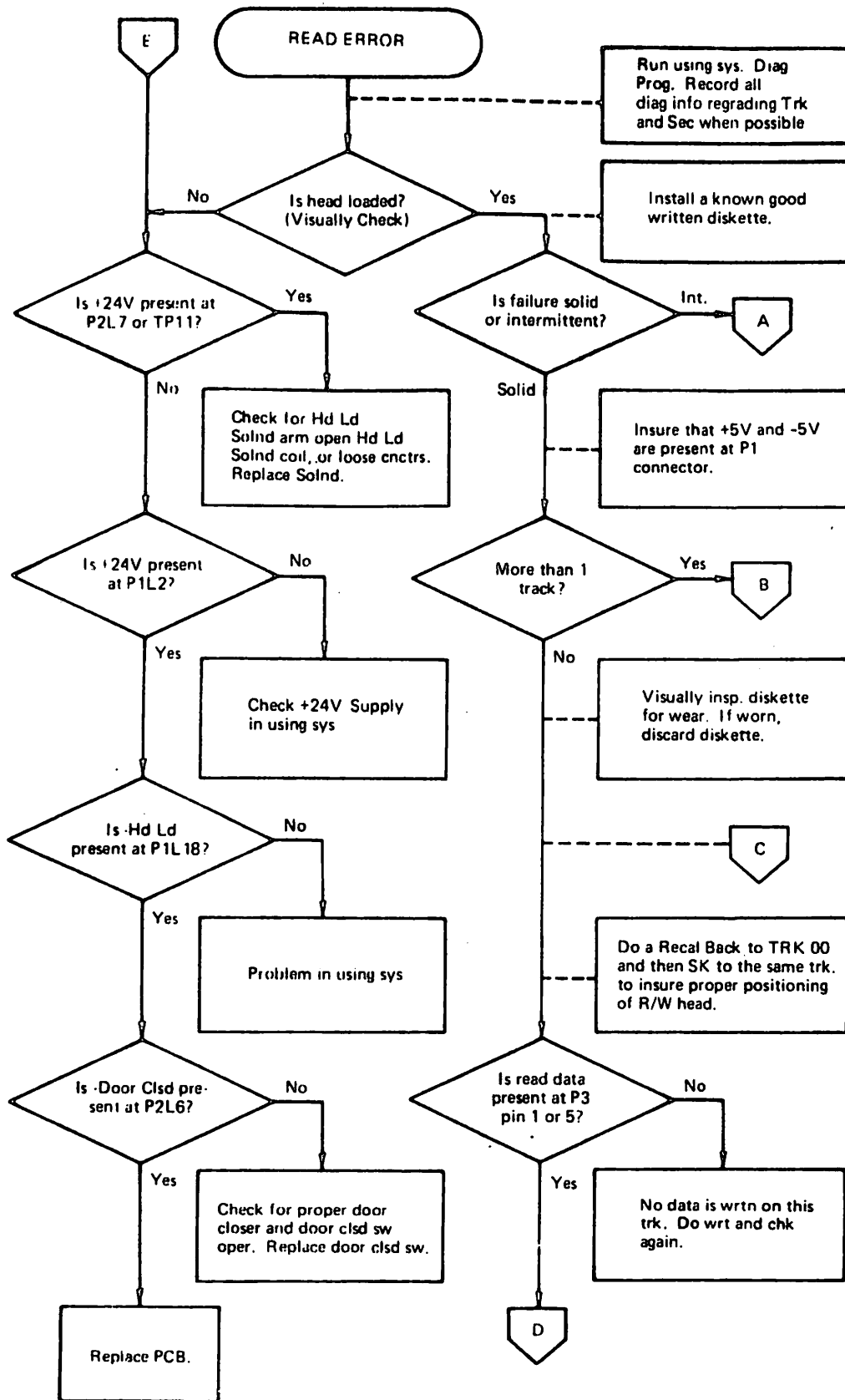


Figure 6-2A

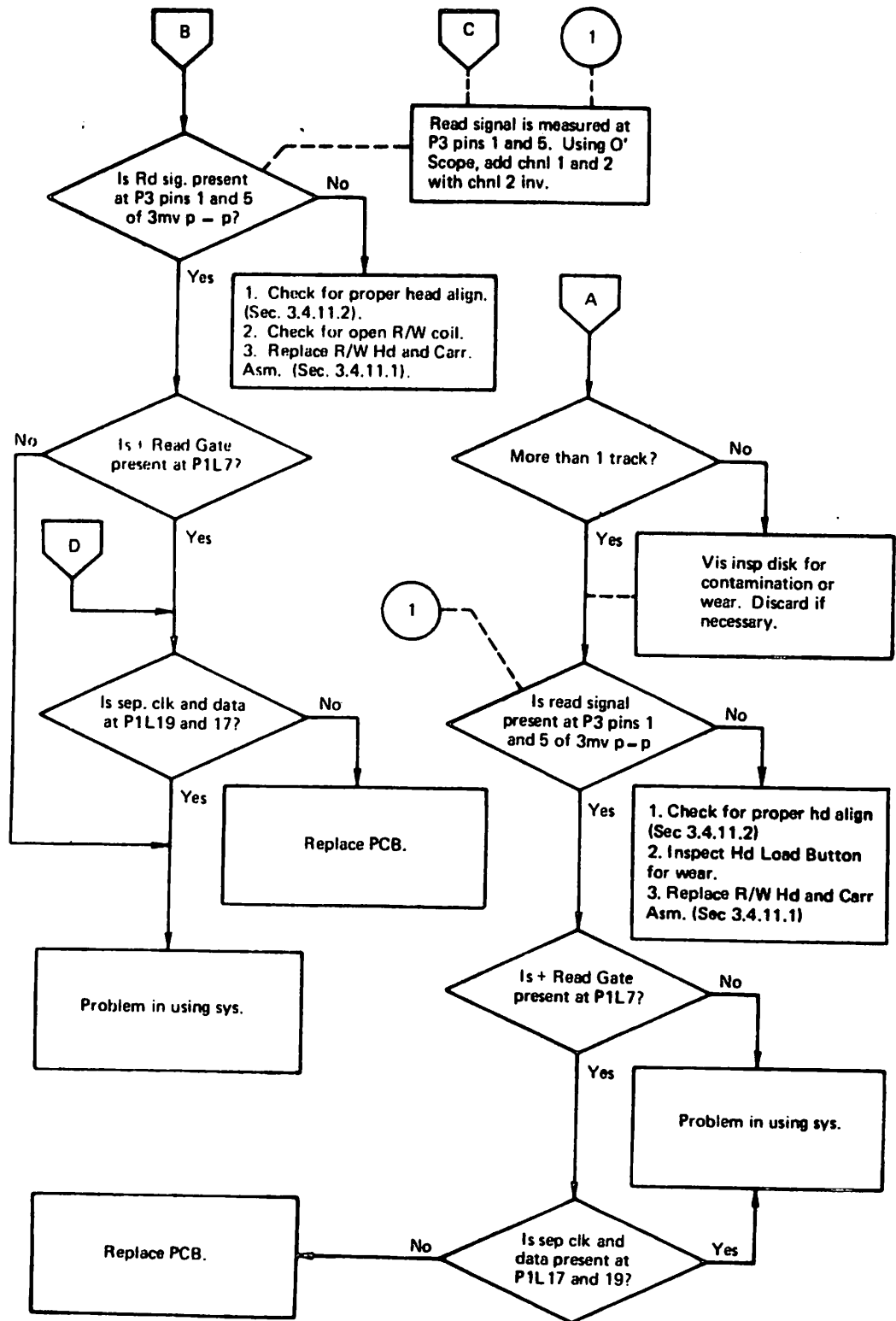


Figure 6-2A(Continued)



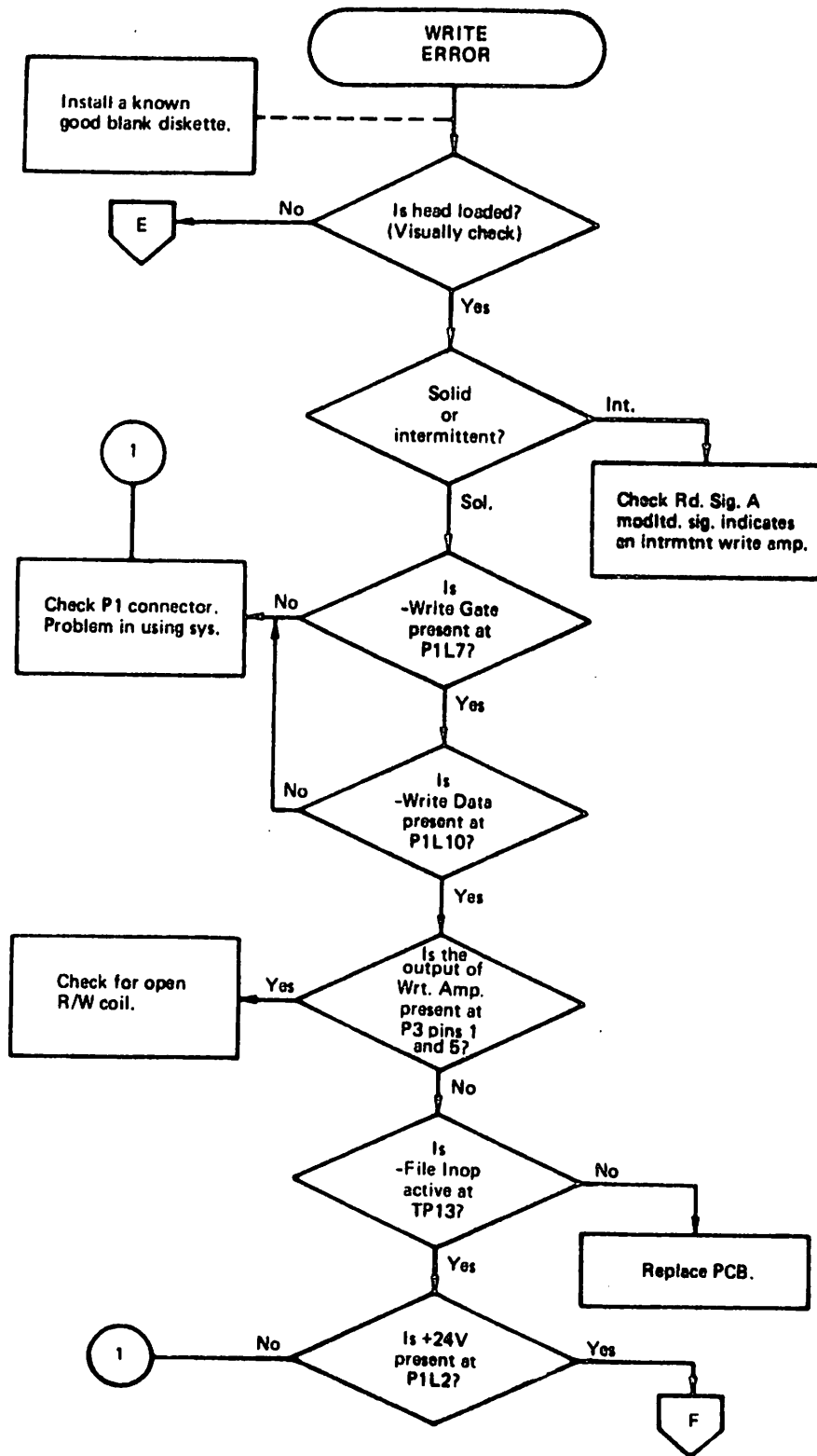


Figure 6-2B

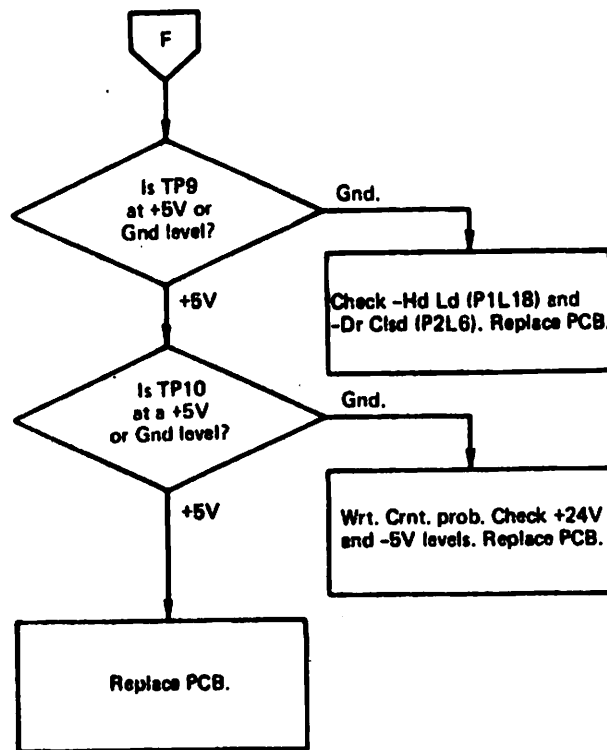


Figure 6-2B (Continued)

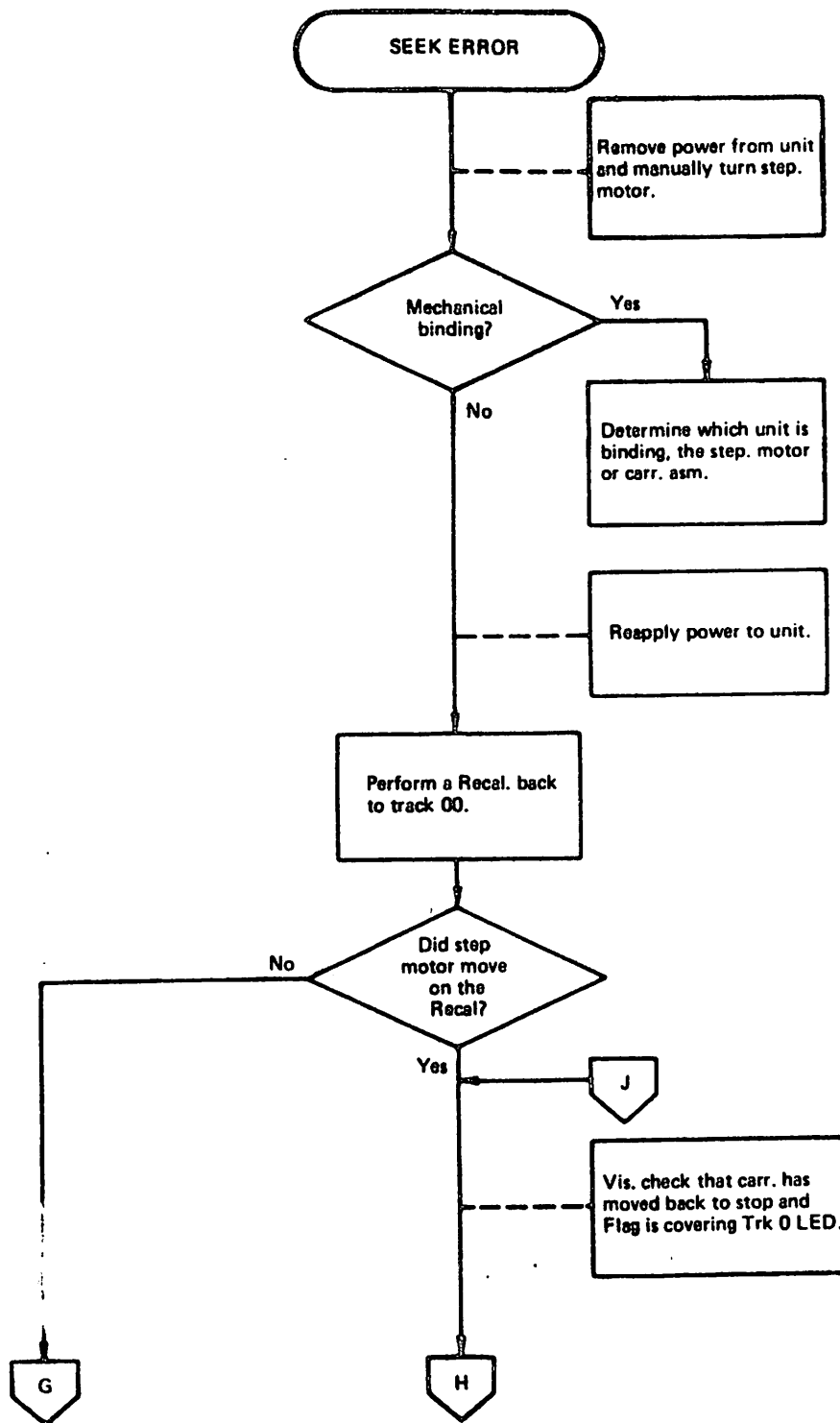


Figure 6-2C

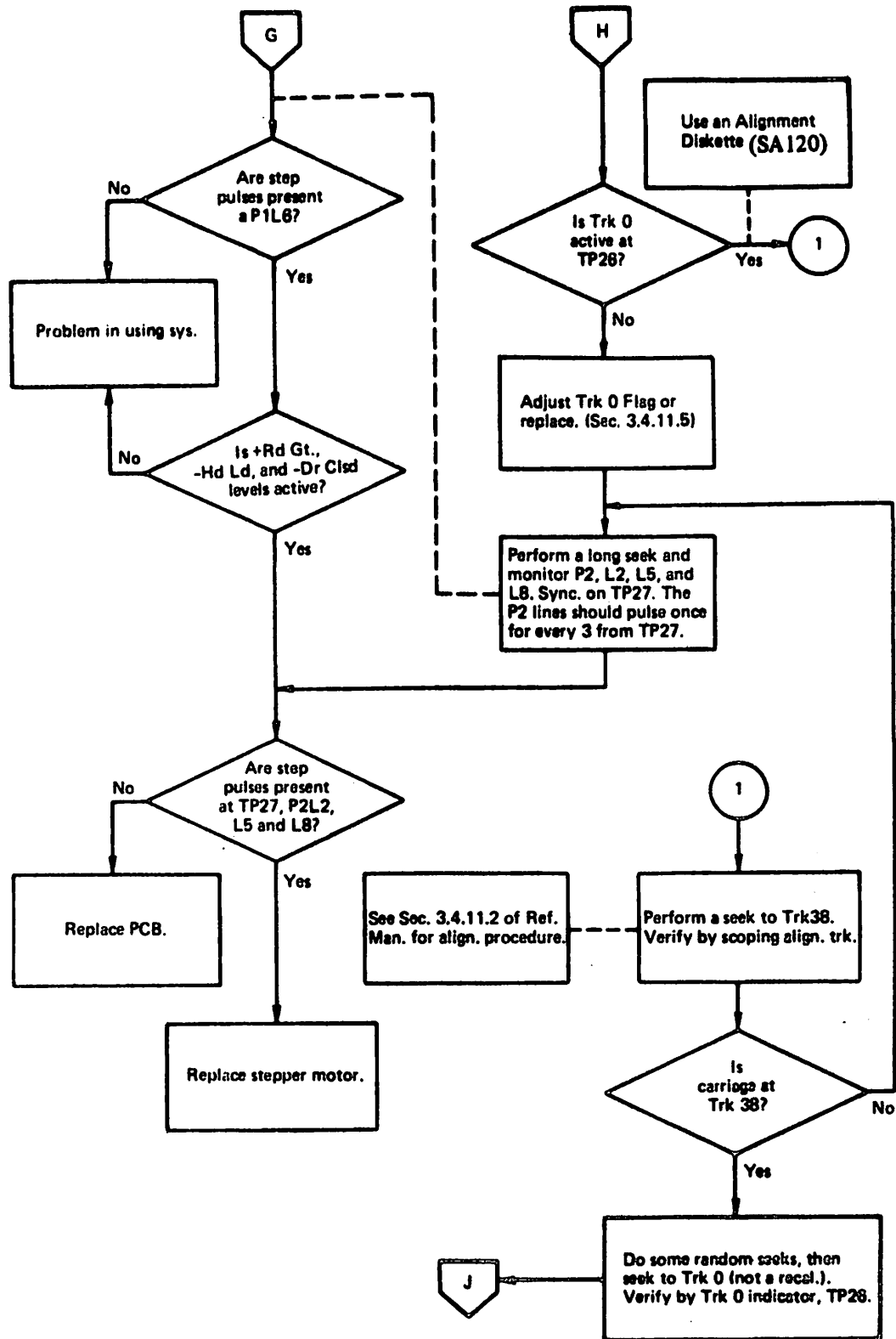


Figure 6-2C (Continued)

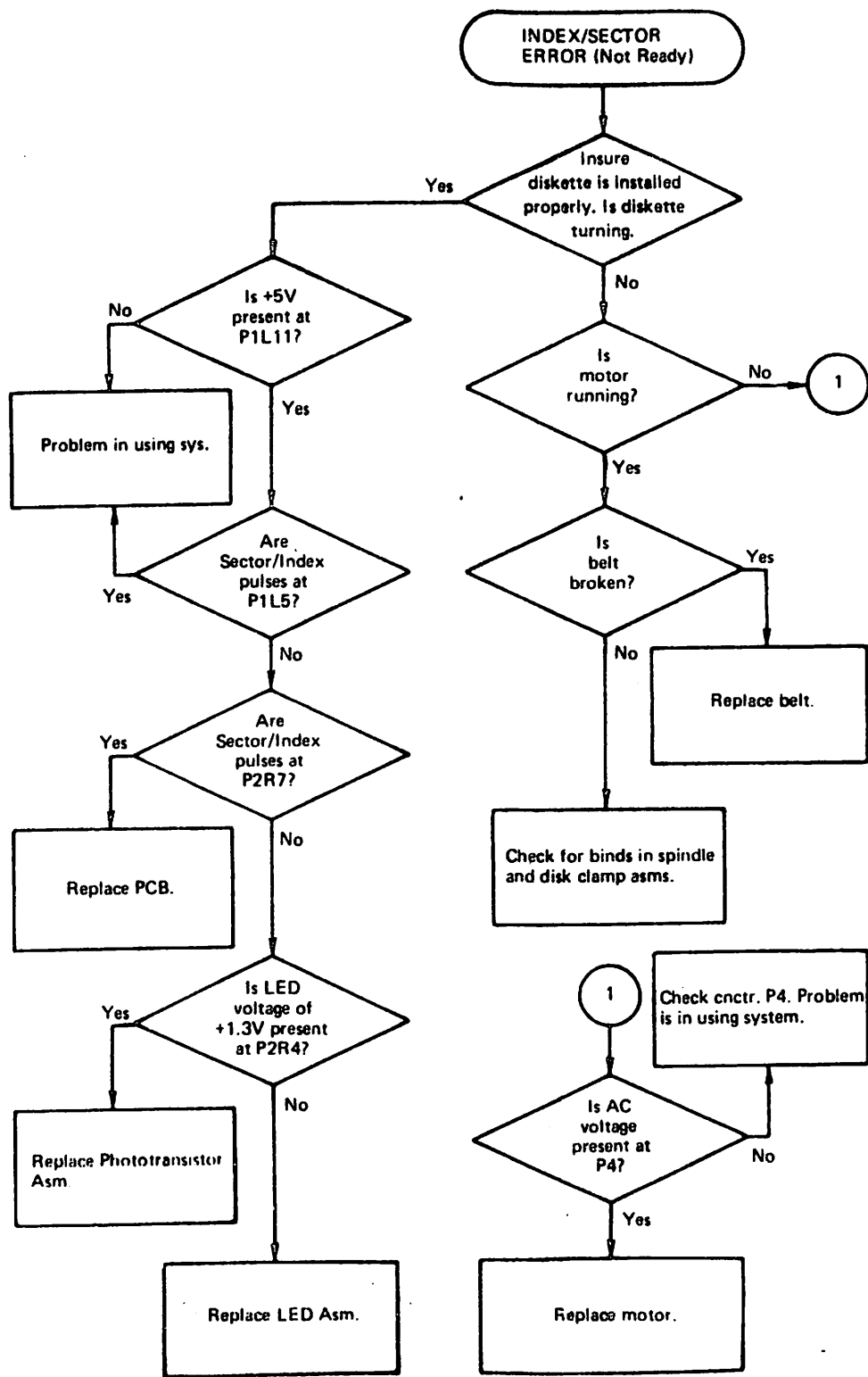


Figure 6-2D

**NOTES**

## 7. REMOVAL AND INSTALLATION PROCEDURES

### 7.1 DRIVE MOTOR

- a. Extract 3 contacts to disconnect motor from AC connector.
- b. Loosen 2 screws holding capacitor clamp to the base.  
Remove rubber boot and disconnect motor leads from capacitor.
- c. Remove 4 screws holding PCB to base and swing PCB out.
- d. Remove belt from drive pulley.
- e. Remove 4 screws holding the motor to the base casting and remove motor.
- f. Reverse the procedure for installation.

#### NOTE:

Insure ground lead is installed between capacitor for clamp and base.

### 7.2 CARTRIDGE GUIDE ACCESS

- a. Position head to approximate center of head load bail (to prevent load arm tab from slipping off end of bail).
- b. Loosen 2 screws holding cartridge guide to door latch plate.
- c. Swing cartridge guide out.
- d. When guide is swung in, it must be adjusted as per section 7.13.

### 7.3 LIGHT EMITTING DIODE ASSEMBLY

- a. Disconnect the wires to the LED terminals (solder joints).
- b. Swing out the cartridge guide assembly (Ref. Section 7.2).

NOTE:

This step is not necessary if the drive has a new style (cast) cartridge guide.

- c. Remove the screw, nut, and washer holding the LED assembly to the cartridge guide.
- d. Reverse the procedure for installation.

### 7.4 WRITE PROTECT DETECTOR

- a. Remove connectors from PCB and remove PCB.
- b. Extract wires from P2 connector, pins 3 (Red), 4 (Gray), E (Black), and J (White).
- c. Remove cable clamp.
- d. Swing out cartridge guide assembly (Ref. section 7.2).
- e. Remove screw holding the detector bracket and remove assembly.
- f. Reverse the procedure for installation.

### 7.5 HEAD LOAD ACTUATOR

- a. Disconnect the wires to the actuator terminals (solder joints).



- b. Swing out the cartridge guide assembly (Ref. section 7.2).
- c. Remove screw holding the actuator to the cartridge guide.

CAUTION:

Restrain the head load arm to prevent its impact with the head.

- d. Reverse the procedure for installation.

## 7.6 TRACK 0 DETECTOR

- a. Remove connectors from PCB and remove PCB.
- b. Extract wires from P2 connectors, pins A (Brown), C (Black), F (Red), and K (Orange).
- c. Remove cable clamp.
- d. Swing out the cartridge guide assembly (Ref. section 7.2).

NOTE:

This step may not be useful if the drive has an old style (black) cartridge guide.

- e. Manually rotate stepper shaft and move carriage away from the detector assembly.
- f. Remove cable clamp, and R/W head cable from bracket.
- g. Remove 2 screws holding detector assembly bracket to base casting and remove assembly.
- h. Reverse procedure for installation.

## 7.7 INDEX/SECTOR PHOTOTRANSISTOR ASSEMBLY

- a. Disconnect the wires to the terminals (solder joints).

### NOTE:

The spindle pulley may be removed for easier access.

- b. Remove screw holding transistor assembly to base.
- c. Reverse the procedure for installation.

## 7.8 CARTRIDGE GUIDE REMOVAL

- a. Swing out the cartridge guide assembly (Ref. section 7.2).
- b. Remove the LED assembly, write protect detector assembly and the head load actuator (Ref. sections 7.3, 7.4 and 7.5).
- c. Pull up on the upper pivot cap screw until the shoulder contacts the base casting (Ref. Figure 7-1). Push up on the cartridge guide until the lower pivot clears the casting.

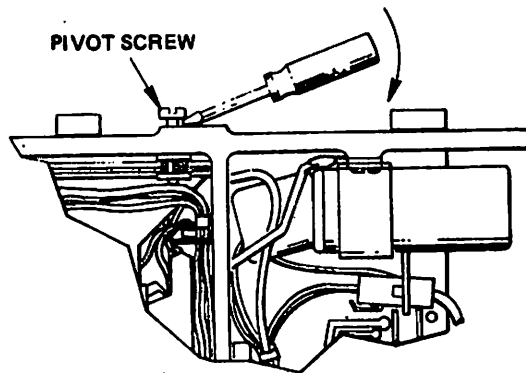


Figure 7-1 Cartridge Guide Removal

### NOTE:

For new style cartridge guide, remove C-clamp on upper pivot post and push up on cartridge guide.

- d. Tilt the cartridge guide slightly, and remove it from the upper pivot.
- e. Reverse the procedure for installation.

## 7.9 SPINDLE ASSEMBLY

- a. Swing out the cartridge guide (Ref. section 7.2).
- b. Remove the nut and washers holding the spindle pulley.

### CAUTION:

The pre-loaded rear bearing and spacer may fly out when spindle pulley is removed.

- c. Withdraw spindle hub from opposite side of base casting.
- d. Reverse the procedure for installation.

## 7.10 FRONT PLATE ASSEMBLY

- a. Swing out the cartridge guide assembly (Ref. section 7.2).
- b. Remove 4 screws holding the front plate assembly to the casting.
- c. Reverse the procedure for installation.

## 7.11 STEPPER/CARRIAGE ASSEMBLY

- a. Remove the connectors from the PCB and remove the PCB.
- b. Remove cable clamp holding R/W head cable.
- c. Extract wires from P2 connector, pins 2 (Red), 5 (Brown), 8 (Orange), and 10 (Black).

### NOTE:

This step is only necessary if the stepper motor is to be replaced.

- d. Loosen 3 motor clamp screws and rotate clamps to allow withdrawal of motor. One new units with redesigned stepper mounting clamp, loosen 2 screws and swing clamp down to allow withdrawal of motor.

**CAUTION:**

Do not loosen 3 screws coated with Glyptol.

- e. Swing out the cartridge guide assembly (Ref. section 7.2).
- f. Remove cable clamp and spacer holding R/W head cable to track 0 detector bracket. On new units, a grommet on the cable is inserted into a slot on the bracket.
- g. Manually rotate the lead screw to run the carriage assembly off the lead screw while withdrawing the stepper motor.
- h. To install stepper/carriage assembly, reverse procedure. Note steps i. and j.
- i. When installing the carriage, set the pre-load nut in the #3 notch (Ref. Figure 7-2).
- j. When threading lead screw into carriage assembly, push the pre-load nut slightly against the spring to start the thread. After threading, insure that there is a gap between the pre-load nut and the rear of the carriage.

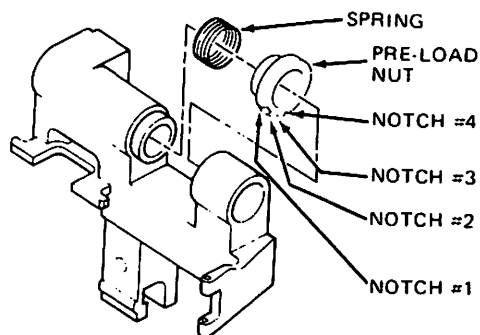


Figure 7-2 Pre-Load Setting

## 7.12 READ/WRITE HEAD LOAD BUTTON

- a. To remove the old style button (attached with a clip and washer), grasp the button with pliers and rock the button back and forth while pulling.
- b. To remove the new style button, hold the load arm out away from head, squeeze the locking tabs together with a pair of needle nose pliers and press forward.
- c. To install old style button, place button in head load arm and press rubber washer onto button stem. Press clip onto stem and insure button does not move.
- d. To install new style button, press the button into the head load arm and it will snap into place.

## 7.13 Cartridge Guide Adjustment

- a. Insert the adjustment tool (726-9612) through the hole in the cartridge guide and screw completely into the casting (hand tight).
- b. Loosen 2 screws holding the cartridge guide to the latch plate.
- c. Move the handle into the latched position and hold it lightly against the latch fingers.
- d. Tighten 2 screws holding the cartridge guide to the latch plate.
- e. Depress push bar on front panel and check that door stays in latched position. If door latch was released, repeat adjustment.
- f. Insert diskette, close and open door, checking for proper operation.

**NOTES**

## 8. PARTS DIAGRAMS

### General

The Illustrated Parts Catalog is arranged so that the figures will always precede the parts listings and when possible be on the opposite page.

The first number in the list will always refer to the figure and the second number to the reference number of the part within the figure.

When an assembly is referred to within a figure and a further breakdown is shown on another figure then the reference figure will be called out.

### Indented Level

The parts list is indented to show the levels of assembly within a figure. The major assembly will always be level 1, all parts or assemblies that attach to that assembly will be level 2 and assemblies within level 2 will have their attaching parts level 3 and so on.

### Quantity Per Assembly

The quantity listed is the quantity used on the major assembly. Major Assemblies will never have a quantity listed.

### Numerical Index

The numerical index lists all parts in part number sequence and is cross-referenced to the figure and reference number.

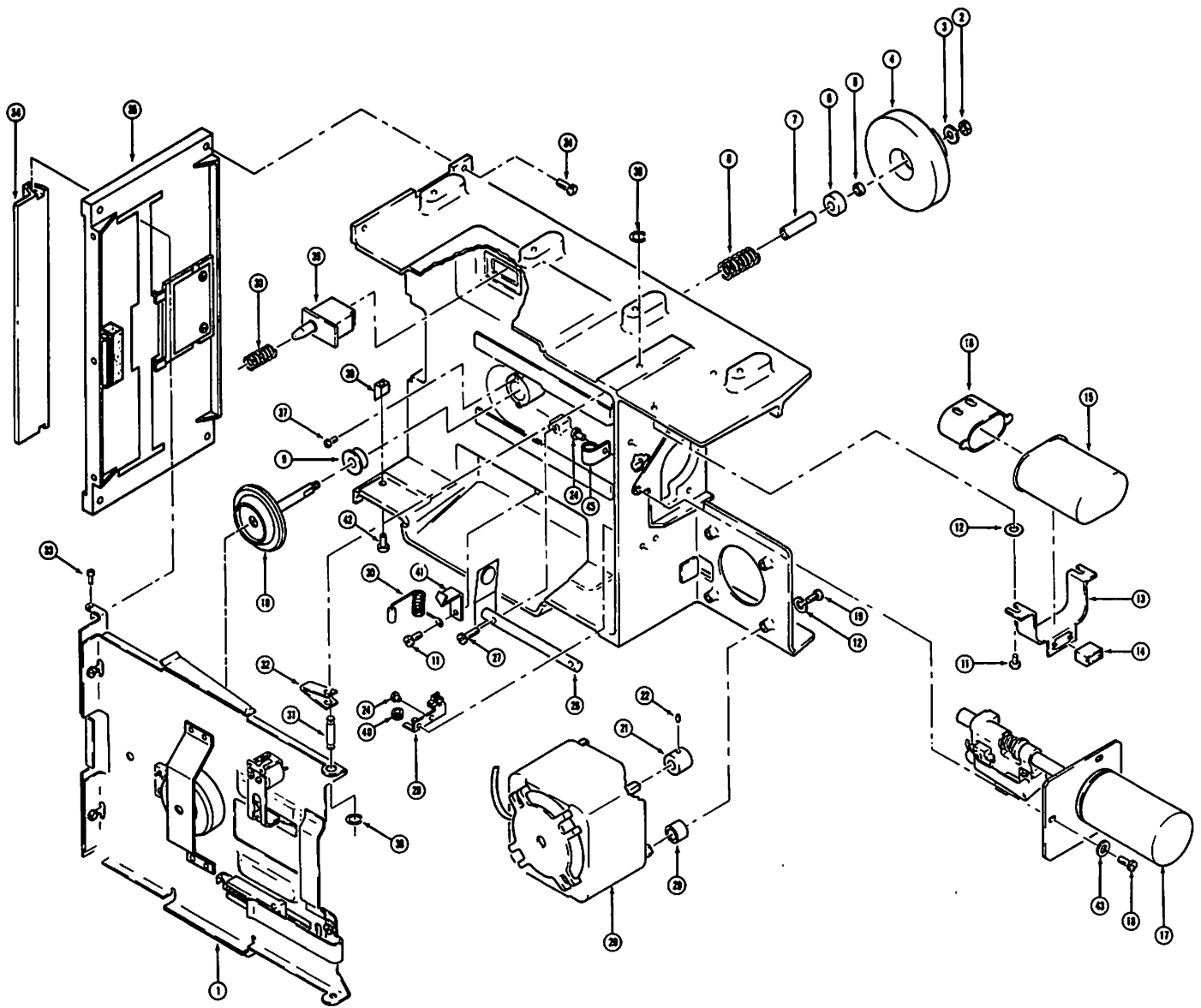


Figure 8-1 (1 of 2)



FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM
		1	2	3	4	
1	50010	BASIC ASSEMBLY, SA 900/901				
- 1	50030	. CARTRIDGE GUIDE ASSEMBLY (OLD, See Fig. 3)				1
	50550	. CARTRIDGE GUIDE ASSEMBLY (NEW, See Fig. 6)				
- 2	10025	. NUT, 8-32				1
- 3	12509	. WASHER, #8 SPRING				2
- 4	50016	. PULLEY ASSEMBLY, SPINDLE				1
- 5	50019	. SPACER, SPINDLE-SHORT				1
- 6	10800	. BEARING, SPINDLE				1
- 7	50018	. SPACER, SPINDLE—LONG				1
- 8	50166	. SPRING, SPINDLE				1
- 9	10801	. FLANGED BEARING, SPINDLE				1
- 10	50561	. HUB ASSEMBLY, SPINDLE				1
- 11	12015	. SCREW, 8-32x.312				6
- 12	12500	. WASHER, LOCK #8				2
- 13	50098	. BRACKET				1
- 14	10150	. HOUSING, 3 PIN CONNECTOR				1
- 15	10095	. CAPACITOR, 110 V 50/60 HZ (BODINE MTR ONLY)				1
	15004	. CAPACITOR, 220 V 50/60 HZ or 110 V ORIENTAL MTR				1
- 16	10148	. RUBBER BOOT				1
- 17		. STEPPER/CARRIAGE ASSEMBLY (SEE FIGURE 2 FOR BREAKDOWN)				1
- 18	12027	. SCREW, 6-32x.500				3
- 19	12028	. SCREW, 8-32x.500				4
- 20	50423	. MOTOR, 110 VOLT 50/60 HZ KIT				1
	50301	. MOTOR, 208/230/220 VOLT 50/60 HZ				1
- 21	50358	. PULLEY, 60 HZ				1
	50357	. PULLEY, 50 HZ				1
- 22	11904	. SCREW, SET 6-32x.125				1
- 23	10378	. CABLE CLAMP, 1/8 INCH				1
- 24	12013	. SCREW 6-32x.312 (12014 FOR ZINC FACE PLATE)				7
- 25	12016	. SCREW 8-32x.375				1
- 26	50522	. SPRING/GUIDE ASM				1
- 27	12012	. SCREW, 4-40x.375				4
- 28	50121	. DETECTOR ASSEMBLY, TRACK 0				1
- 29	50602	. SPACER				4
- 30	50186	. SPRING ASSEMBLY, DOOR OPEN (OLD STYLE)				1
	50582	. SPRING ASSEMBLY, DOOR OPEN (NEW STYLE)				1
	50583	. SPRING ASSEMBLY, DOOR OPEN (HORZ. MNT. PCB DOWN)				
- 31	50167	. PIVOT TOP				1
- 32	50168	. SPRING, BIAS				1
- 33	11905	. SCREW, B.V.				2
- 34	50142	. HANDLE				1
- 35	50527	. FRONT PLATE ASSEMBLY (SEE FIGURE 4 FOR BREAKDOWN)				1
- 36	17200	. SWITCH, DOOR OPEN				1
- 37	12011	. SCREW, 4-40x.250				2
- 38	11305	. CLIP				2
- 39	50487	. DEFLECTOR				2
- 40	50578	. GROMMET				1
- 41	50523	. LOCATOR				1
- 42	12020	. SCREW 8-32x.500				2
- 43	10013	. WASHER, #6 FLAT				3

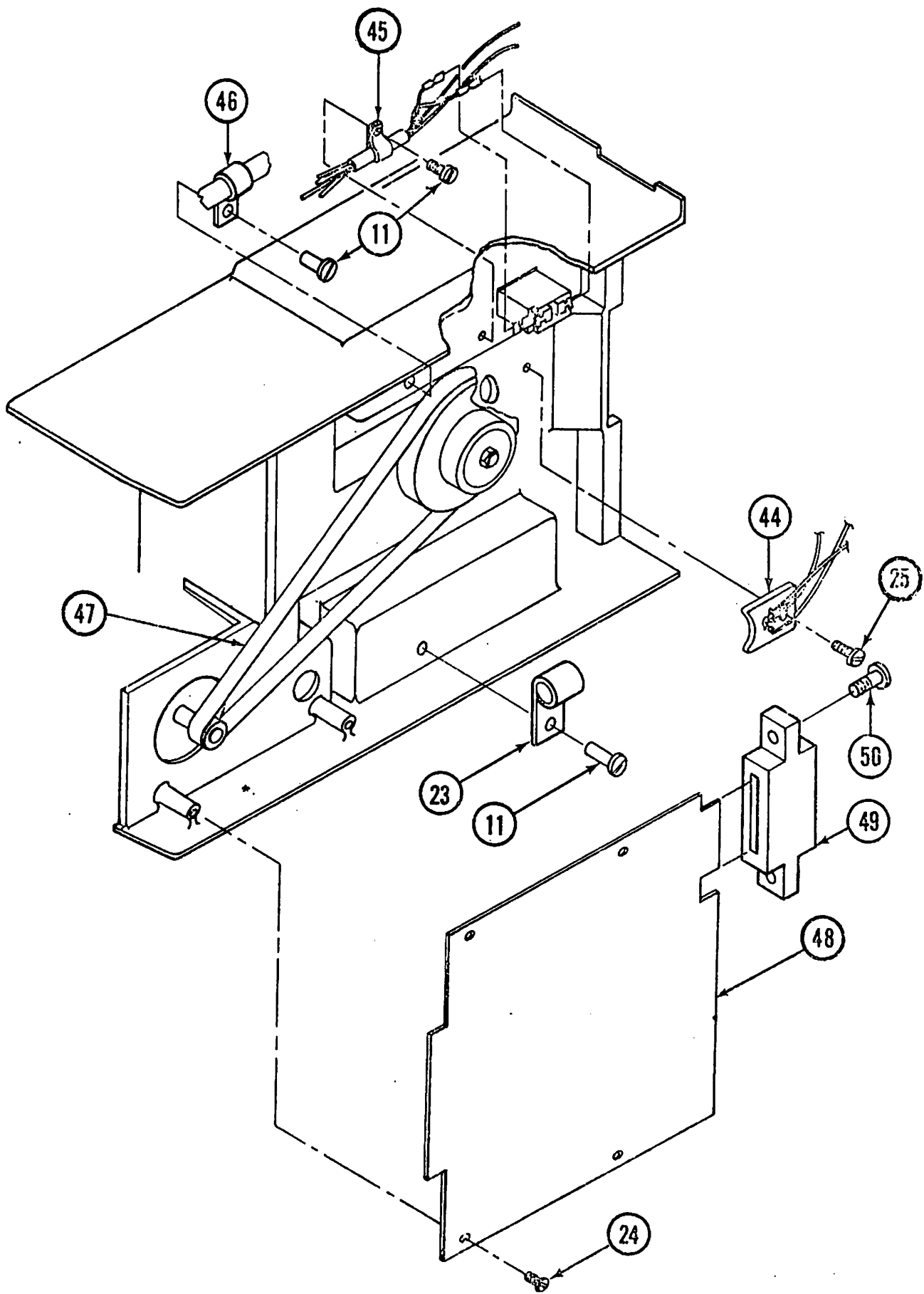


Figure 8-1(2 of 2)

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
1 -44	*50128	.	.	.	.	1
-45	10375	.	.	.	.	2
-46	10264	.	.	.	.	1
-47	50356	.	.	.	.	1
	50355	.	.	.	.	1
-48	25002	.	.	.	.	1
	25003	.	.	.	.	
	25004	.	.	.	.	
	25005	.	.	.	.	
	25006	.	.	.	.	
	25007	.	.	.	.	
-49	10140	.	.	.	.	1
-50	10176	.	.	.	.	2

\* WHEN ORDERING A REPLACEMENT PHOTOTRANSISTOR ASSEMBLY, IF OLD ASSEMBLY HAS ONLY TWO (2) LEADS COMING FROM IT, ORDER FIELD KIT, P/N 50928.

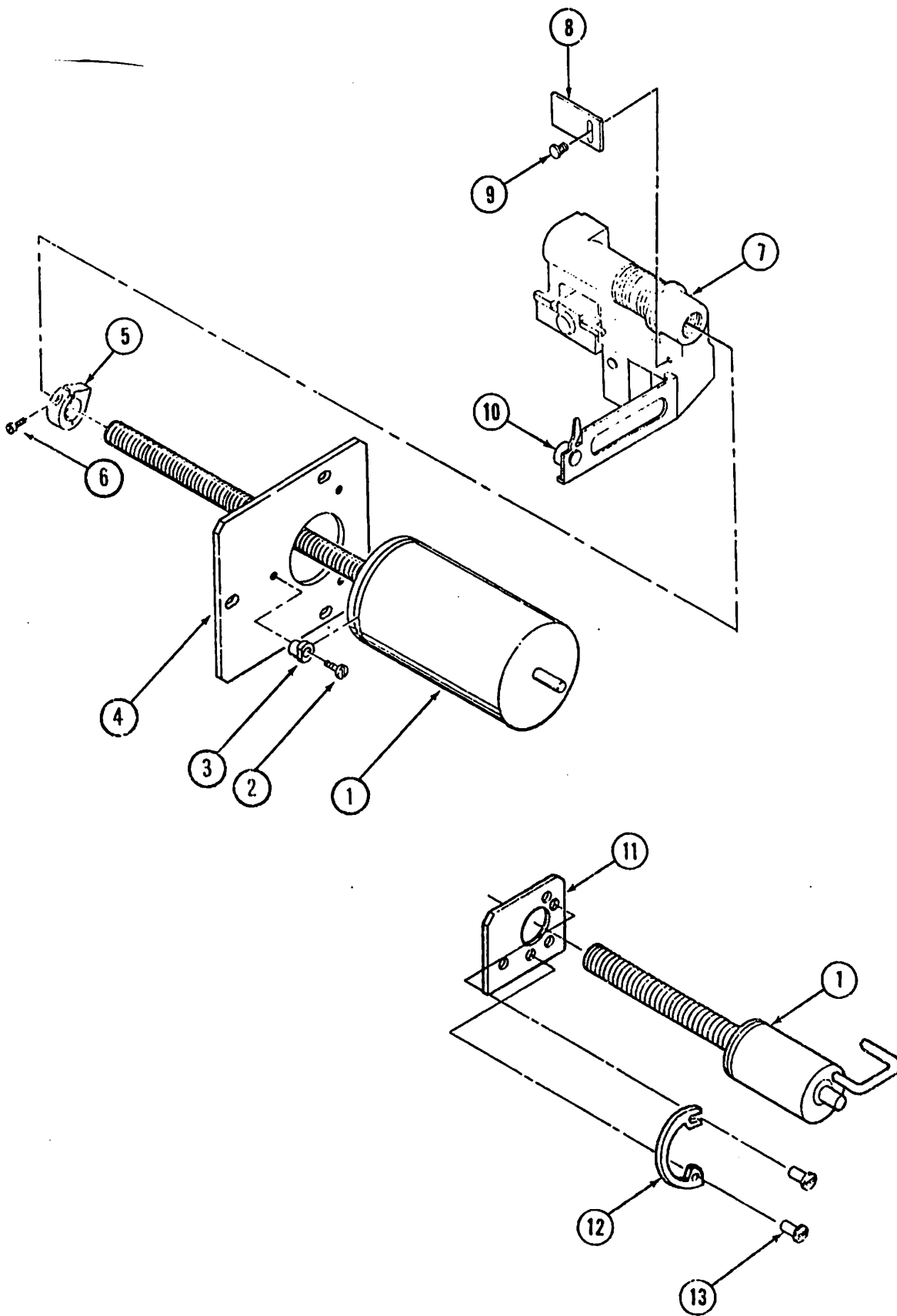


Figure 8-2

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
2-		STEPPER/CARRIAGE ASSEMBLY				
- 1	50130	.	STEPPER MOTOR ASSEMBLY			1
- 2	11910	.	SCREW, B.H. 4-40x.250			3
- 3	50113	.	CLEAT, MOTOR MOUNT			3
- 4	50112-0	.	PLATE, STEPPER MOTOR (OLD STYLE)			1
- 5	50245	.	STOP, LIMIT-LEAD SCREW			1
- 6	11903	.	SCREW, CAP 2-56x.250			1
- 7	50562	.	CARRIAGE ASSEMBLY (CERAMIC HEAD)			1
- 8	50529	.	FLAG, TRACK 0			1
- 9	11910	.	SCREW 4-40x.250			1
- 10	50929	.	LOAD BUTTON KIT (METAL LOAD ARM)			1
	50542	.	LOAD BUTTON (PLASTIC LOAD ARM)			
- 11	50112-1	.	PLATE, STEPPER MOTOR (NEW STYLE)			1
- 12	50584	.	MOUNTING CLAMP			1
- 13	10205	.	SCREW, 8-32x.375			2

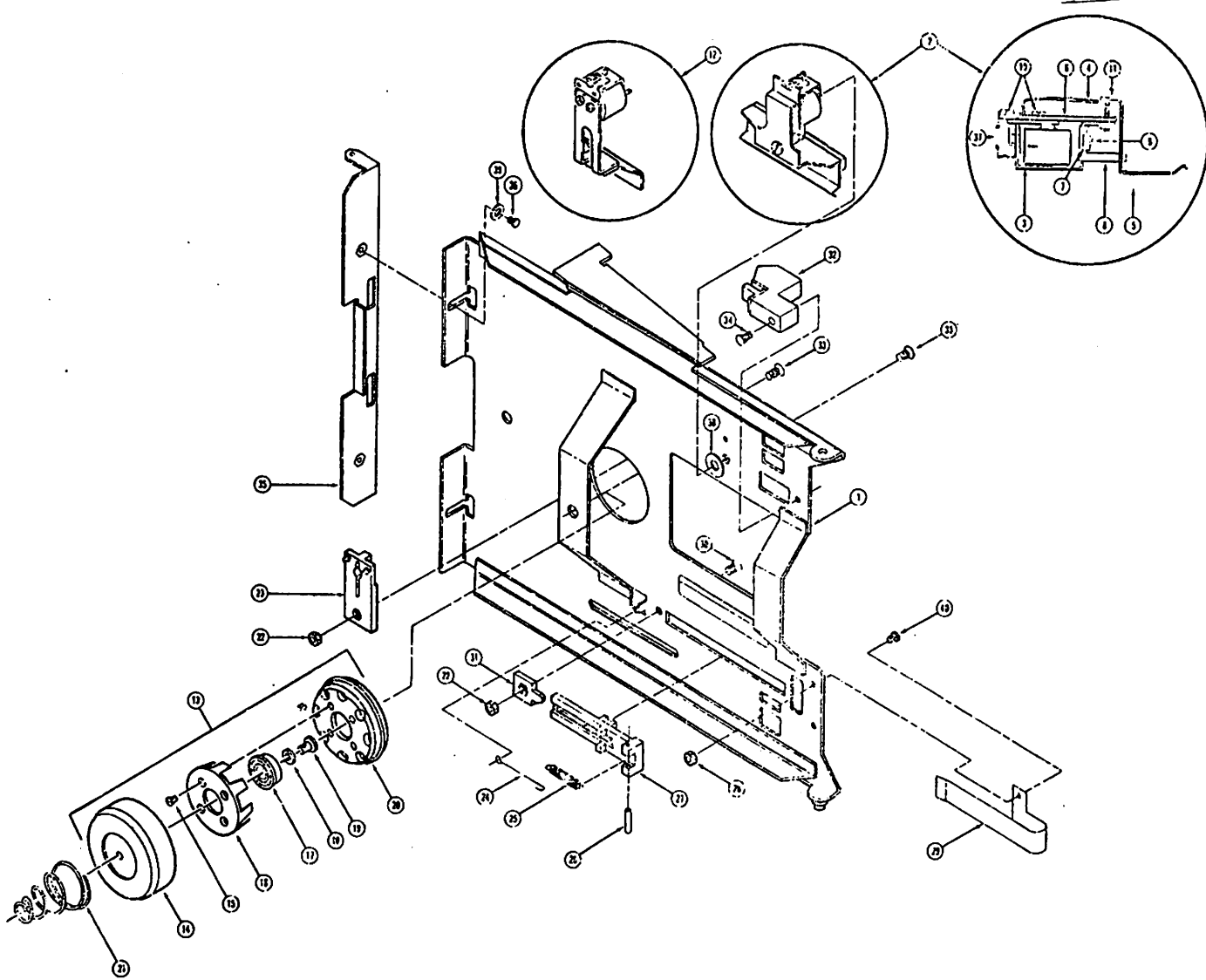


Figure 8-3

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
3 -						
-	50030					
- 1	50034					1
- 2	50253					1
- 3	10002					1
- 4	50365					1
- 5	50043					1
- 6	50364					1
- 7	50265					1
- 8	50363					1
- 9	11916					1
-10	10170					4
-11	10174					1
-12	50139					1
-13	50254					1
-14	50252					1
-15	11307					4
-16	50251					1
-17	10801					1
-18	12503					1
-19	12011					1
-20	50000					1
-21	50031					1
-22	10024					2
-23	50032					1
-24	50359					1
-25	50146					1
-26	11800					1
-27	50140					1
-28	10023					2
-29	50141					1
-30	11900					1
-31	50412					1
-32	50313					1
-33	11906					
-34	10177					2
-35	50151					1
-36	10186					1
-37	50256					1
-38	50282					1
-39	10013					2
-40	10172					2

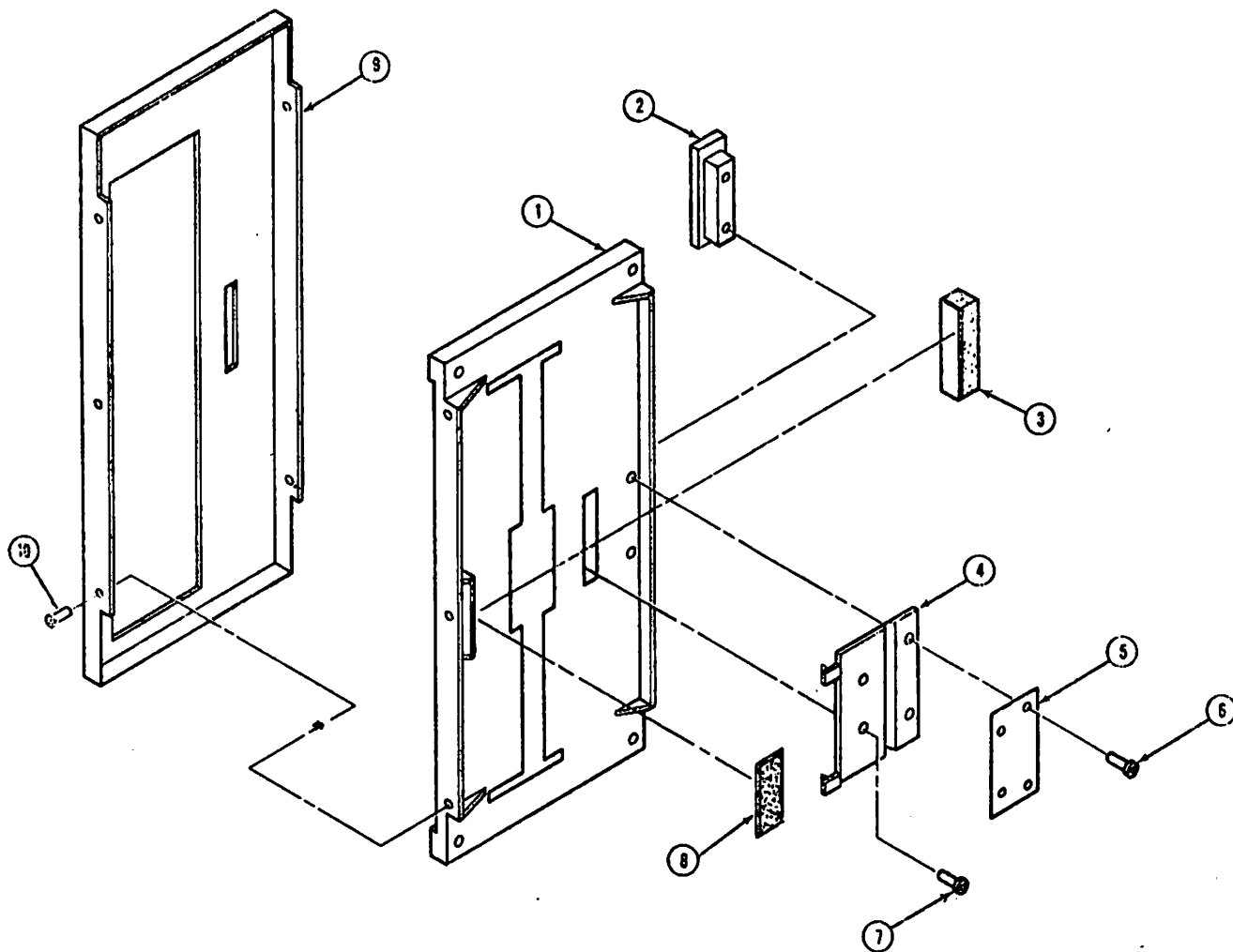


Figure 8-4



FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
4-	50527	FRONT PLATE ASSEMBLY (WITHOUT LITE)				
	50610	FRONT PLATE ASSEMBLY (WITH LITE)				
-1	50349	.	FRONT PLATE			1
-2	50143	.	PUSH BUTTON (WITHOUT LITE)			1
	50586	.	PUSH BUTTON (WITH LITE)			1
-3	50183	.	BUMPER			1
-4	50156	.	LATCH			1
-5	50157	.	SPRING PLATE			1
-6	10188	.	SCREW B.H. 6-32x.312			2
-7	11905	.	SCREW B.V.			2
-8	50580	.	SNATCH			1
-9	50257	COVER, FRONT 5-1/4 x 11 WHITE				1
	50258	COVER, FRONT 5-1/4 x 11 TAN				1
	50260	COVER, FRONT 5-1/4 x 10 WHITE				1
	50261	COVER, FRONT 5-1/4 x 10 TAN				1
	50263	COVER, FRONT 4-5/8 x 10-1/2 WHITE				1
	50264	COVER, FRONT 4-5/8 x 10-1/2 TAN				1
-10	10261	SCREW, FL. HD. 4-40x.250				5

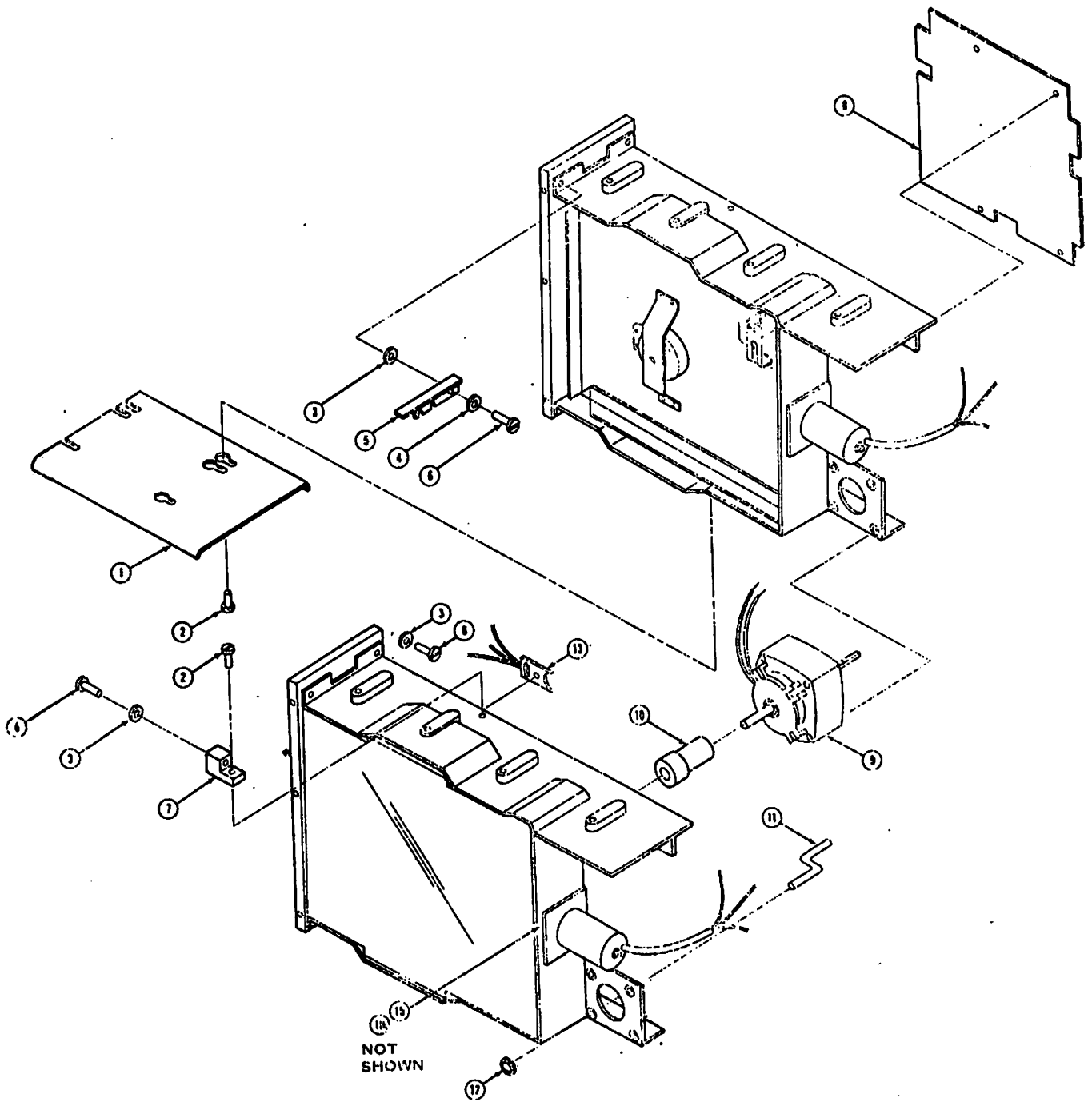


Figure 8-5

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
5-	50410	BASIC DRIVE ASSEMBLY, 902 RIGHT DRIVE				1
- 1	50431	. PLATE, JUNCTION				2
- 2	10204	. SCREW, 8-32x.312				9
- 3	50453	. SPACER				3
- 4	10013	. WASHER				1
- 5	50455	. CLIP, LOCKING				1
- 6	10191	. SCREW, 6-32x.500				3
- 7	50452	. BLOCK, LOCKING CLIP				1
- 8	25037	. PCB R/W -5V				1
	25038	. PCB R/W -15V				1
	25039	. PCB R/W WITH DATA SEP -5V				1
	25040	. PCB R/W WITH DATA SEP -15V				1
- 9	50458	. MOTOR 110VAC				1
	50459	. MOTOR 220VAC				1
-10	50432	. PULLEY 60Hz				1
	50451	. PULLEY 50Hz				1
-11	50465	. HOOK, BELT				1
-12	11306	. GRIP RING				1
-13	50484	. PHOTO TRANSISTOR ASSEMBLY RIGHT DRIVE				1
-14	50463	. TRACK 00 DETECTOR ASSEMBLY (RT DRV)				1
-15	50462	. WRITE PROTECT ASSEMBLY (RT DRV)				1

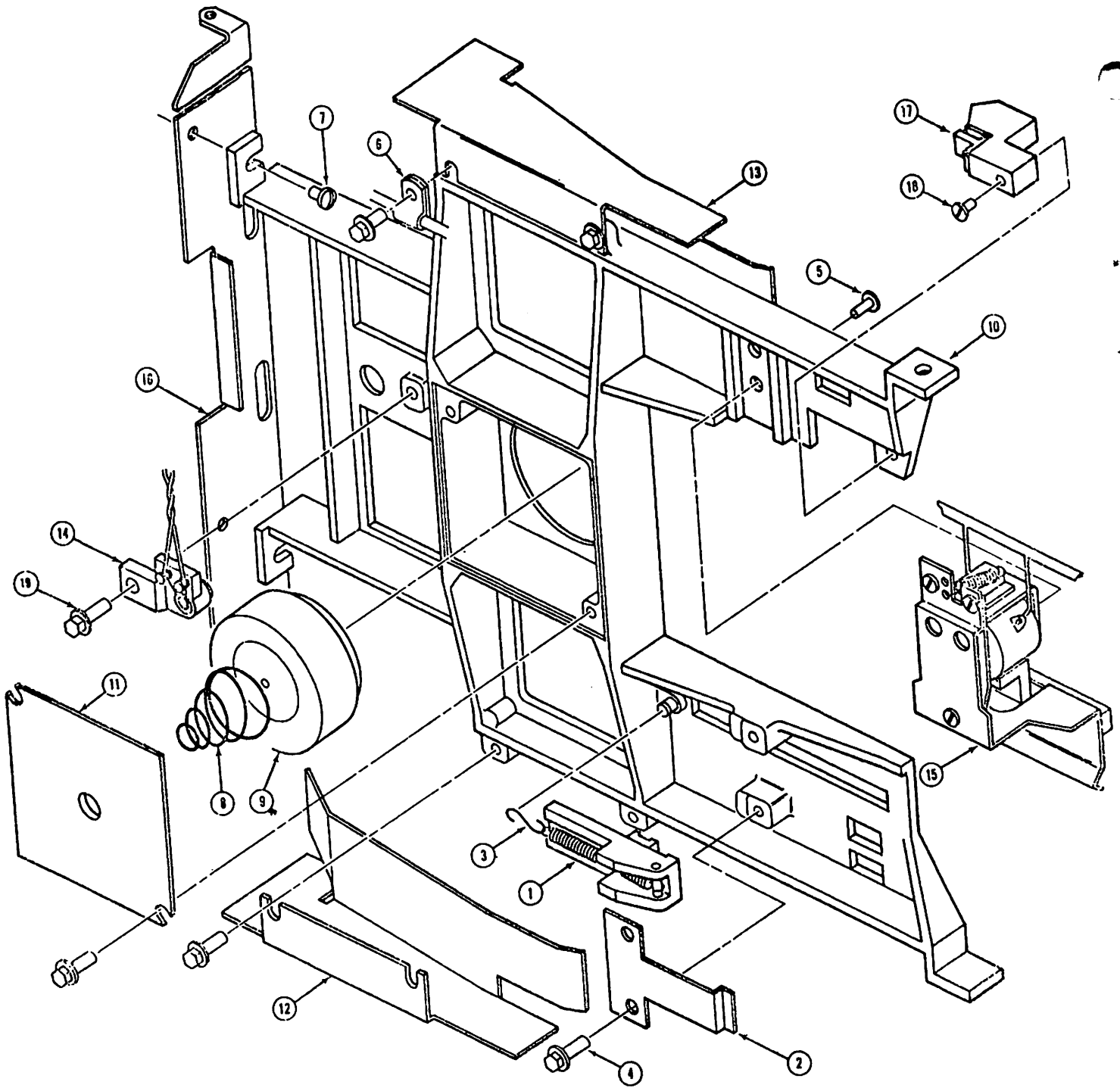


Figure 8-6

FIGURE & REF. NUMBER	PART NUMBER	DESCRIPTION				QTY PER ASM.
		1	2	3	4	
6 -	50550	CARTRIDGE GUIDE ASSEMBLY (BASIC)				
	50603	CARTRIDGE GUIDE ASSEMBLY (902 RIGHT)				
1	50609	.	EJECTOR ASSEMBLY			1
2	50555	.	SPRING, CLAMP, EJECTOR			1
3	50556	.	HOOK, SPRING			1
4	12015	.	SCREW 8-32 x .312			9
5	12013	.	SCREW 6-32 x .312			1
6	10378	.	CLAMP, CABLE			1
7	10187	.	SCREW 6-32 x .250			2
8	50031	.	SPRING, HUB CLAMP			1
9	50254	.	HUB CLAMP ASSEMBLY			1
10	50544	.	GUIDE			1
11	50546	.	PLATE, HUB CLAMP			1
12	50547	.	STRIPPER, BOTTOM			1
13	50548	.	STRIPPER, TOP			1
14	50557	.	L.E.D. ASSEMBLY			1
15	50558	.	HEAD LOAD ACTUATOR ASSEMBLY			1
16	50579	.	LATCH PLATE			1
17	50313	.	WRITE PROTECT DETECTOR ASSEMBLY			1
18	12026	.	SCREW 4-40 x .625			1
19	12016	.	SCREW			2

PART NUMBER	FIG. REF.
10002	3-3
10013	1-43
	3-39
	5-4
10023	3-28
10024	3-22
10025	1-2
10095	1-15
10140	1-49
10148	1-16
10150	1-14
10170	3-10
	3-40
10172	2-9
10174	3-11
10176	1-50
10177	3-34
10186	3-36
10187	6-7
10188	1-29
	4-6
10191	5-6
10204	5-2
10205	2-13
10261	4-10
10264	1-46
10375	1-45
10378	1-23
	6-6
10800	1-6
10801	1-9
	3-17
11305	1-38
11306	5-12
11307	3-15
11800	3-26
11900	3-30
11903	2-6
11904	1-22
11905	1-33
	4-7
11906	5-33
11910	2-9
11916	3-9
12011	1-37
	3-19
12012	1-27
12013	1-24
	6-5

PART NUMBER	FIG. REF.
12015	1-11
	6-4
12016	1-25
	6-19
	2-2
12020	1-42
12026	6-18
12027	1-18
12028	1-19
12501	1-12
12503	3-18
12509	1-3
15004	1-15
17200	1-36
25002	1-48
25003	1-48
25004	1-48
25005	1-48
25006	1-48
25007	1-48
25037	5-8
25038	5-8
25039	5-8
25040	5-8
50000	3-20
50010	1
50016	1-4
50018	1-7
50019	1-5
50030	1-1
	3
50031	3-21
	6-8
50032	3-23
50034	3-1
50043	3-5
50098	1-13
50112-0	2-4
50112-1	2-11
50113	2-3
50121	1-28
50128	1-44
50130	2-1
50139	3-12
50140	3-27
50141	3-29
50142	1-34
50143	4-2

PART NUMBER	FIG. REF.
50146	3-25
50151	3-35
50156	4-4
50157	4-5
50166	1-8
50167	1-31
50168	1-32
50183	4-3
50186	1-30
50245	2-5
50251	3-16
50252	3-14
50253	3-2
50254	3-13
	6-9
50256	3-37
50257	4-9
50258	4-9
50260	4-9
50261	4-9
50263	4-9
50264	4-9
50265	3-7
50282	3-38
50301	1-20
50313	3-32
	6-17
50349	4-1
50355	1-47
50356	1-47
50357	1-21
50358	1-21
50359	3-24
50363	3-8
50364	3-6
50365	3-4
50410	5
50412	3-31
50423	1-20
50431	5-1
50432	5-10
50451	5-10
50452	5-7
50453	5-3
50455	5-5
50458	5-9
50459	5-9
50462	5-15

PART NUMBER	FIG. REF.
50463	5-14
50465	5-11
50484	5-13
50487	1-39
50522	1-26
50523	1-41
50527	1-35
	4
50529	2-8
50542	2-10
50544	6-10
50546	6-11
50547	6-12
50548	6-13
50550	1-1
	6
50555	6-2
50556	6-3
50557	6-14
50558	6-15
50562	2-7
50578	1-46
50579	6-16
50580	4-8
50582	1-36
50583	1-30
50584	2-12
50586	4-2
50602	1-44
50603	6
50610	4
50609	6-1
50928	1-44
50929	2-10

CUSTOMER ENGINEERING PRICE CATALOG EFFECTIVE 10/01/77

PART NO	VC	VENDOR	PART NO	DESCRIPTION	RETAIL(\$US)	EXCHANGE
725-1000	80			DIODE 1V5231	4.00	
725-1001	80			XSTOR 2N3054	3.00	
725-1002	80			XSTOR 2N4013	7.00	
725-1003	80			XSTOR 40406	5.00	
725-1004	80	50929		LOAD BUTTON KIT-OLD	3.00	
725-1005	80	50542		LOAD BUTTON - NEW	3.00	
725-1006	80	50377		REPL BY 725-9612	10.00	
725-1007	80	50391		REPL BY 726-9613	10.00	
725-1008	80	SA120		REPL BY 726-9611	50.00	
725-1009	80	25005-4		PCB (SA901 -5V)	540.00	179.00
725-1010	80	50557		LED ASSY NEW TYPE	15.00	
725-1011	80	50558		ACTUATOR HEAD LOAD	24.00	
725-1012	80	50929		REPL BY 726-1020	26.00	
725-1013	80	17200		SWITCH DOOR OPEN	7.00	
725-1014	80	50121		REPL BY 726-1022	3.00	
725-1015	80	50355		REPL BY 656-0224	3.00	
725-1016	80			IC 74163	14.00	
725-1017	80	10109		REPL BY 330-3011	1.00	
725-1018	80	10375		REPL BY 654-1251	1.00	
725-1019	80	10105		RES 430 OHM 1/4W	3.00	
725-1020	80	50129-1		XSTOR PHOTO&CBL ASSY	26.00	
725-1021	80	50254		HUB CLAMP ASSY	20.00	
725-1022	80	10057		REPL BY 375-2103	3.00	
725-1023	80	50313		REPL BY 726-1022	3.00	
725-1024	80	50032		LED ASSY OLD STYLE	15.00	
725-1025	80	50130		STEPPER MTR ASSY	193.00	
725-1026	80	50443-2		MOTOR 110V 50/60HZ	143.00	
725-1027	80	50356		BELT 60HZ	10.00	
725-1028	80	50146		SPRING EJECTOR	2.00	
725-1029	80	50253		REPL BY 726-1011	24.00	
725-1030	80			POT 20K 3389S BOURNS	4.00	
725-1031	80			XSTOR PHOTO TIL 81	5.00	
725-1032	80			LED TIL31	9.00	
725-1033	80	50562		HEAD CARRIAGE ASSY	220.00	99.00
725-1034	80	10801		REPL BY 726-0914	4.00	
725-1035	80	50019		SPACER SPINDLE LONG	2.00	
725-1036	80	10800		REPL BY 465-0012	2.00	
725-1037	80	12509-0		WASHER SPRING	1.00	
725-1038	80	50141		CLAMP SPRING	3.00	
725-1039	80	ORDER 465-0012		BEARING SM:STPG MTR	4.00	
725-1040	80			BEARING LG:STPG MTR	9.00	
725-1041	80	50142		HANDLE DOOR	3.00	
725-1042	80	50349		PLATE FRONT	14.00	
725-1043	80	50143		PUSHBUTTON	3.00	
725-1044	80	50183		BUMPER FRONT PLATE	1.00	
725-1045	80	50156		LATCH FRONT PLATE	2.00	
725-1046	80	50157		SPRING PLATE	3.00	
725-1047	80	10188		SCREW BH 6-32X.312	1.00	
725-1048	80	11905		SCREW BV	1.00	
725-1049	80	50257		REPL BY 725-0053-91	10.00	

REVISION DATE  
09/29/77

REV. NO.  
3

VENDOR  
SHUGART

PAGE  
(VC=80) 5C-34

CUSTOMER ENGINEERING PRICE CATALOG EFFECTIVE 10/01/77

PART NO	VC	VENDOR	PART NO	DESCRIPTION	RETAIL (\$US)	EXCHANGE
725-1050	80	50151		DOOR PLATE LATCH	6.00	
725-1051	80	17212		REPL BY 325-2307	2.00	
725-1052	80	17211		SW TRACK-M	5.00	
725-1053	80	54048		BELT DRIVE-M	10.00	
725-1054	80	54047		MOTOR DRIVE-M	57.00	
725-1055	80	54068		MOTOR STEPPING-M	54.00	
725-1056	80	54145		LOAD BUTTON ASSY-M	3.00	
725-1057	80	54066		HUB COLLET-M	13.00	
725-1058	80	54055		HEAD CARR ASSY-M	183.00	90.00
725-1059	80	54064		HEAD LOAD SOL ASSY-M	22.00	
725-1060	80	54136		INDEX DETECTOR ASSY-	11.00	
725-1061	80	54137		INDEX LED ASSY-M	12.00	
725-1062	80	25060		PCB LOGIC-M	250.00	107.00
725-1063	80	25053		PCB MOTOR CONTROL-M	44.00	
725-1064	80	54097		REPL BY 726-9614	50.00	
725-1065	80	50684		HUB POST	10.00	
725-1066	80	54122-0		NOT NORMALLY STOCKED	12.00	
725-1067	80	54123-0		NOT NORMALLY STOCKED	8.00	
725-1068	80	54135		BAIL LOAD -M	4.00	
725-1069	80	11312		LAMP ASSY ACTIVITY-M	20.00	
725-1070	80	50561		HUB ASSY SPINDLE	19.00	

REVISION DATE  
09/29/77

REV. NO.  
3

VENDOR  
SHUGART

PAGE  
(VC=80) 5C-35



APPENDIX A  
SOFTWARE COMPATIBILITY

The following information was reprinted  
from 700-4369A, 3740 Diskette Compatibility  
Software Users Manual.

CHAPTER 1  
GENERAL INFORMATION

1.1 SOFTWARE OVERVIEW

Wang's 3740 Diskette Compatibility Software, designed for use with Wang's IBM 3740 Compatible Diskette Drive, provides a set of utility programs which implement operations such as the following:

- . displaying a 3740 diskette catalog, thereby providing the names of stored files and the addresses of each file's reserved and used sectors,
- . displaying 3740 sector dumps for the sectors in a specified address range,
- . performing media conversion of Wang disk/diskette files\* to 3740 diskette files, or vice versa, and
- . producing hardcopy of a specified 3740 diskette file, or a Wang diskette file previously converted from a 3740 diskette.

The software also provides utility subroutines which can be integrated with user-written BASIC language application programs where 3740 diskettes are to be accessed directly for file creation or maintenance. The subroutines handle the following types of operations:

- . opening a new or existing file,
- . reading, rereading, or writing a sector,
- . skipping or backspacing a specified number of sectors,
- . writing or updating an "end of data" pointer position, and
- . closing a file.

-----  
\* The 3740 Diskette Compatibility Software processes TC formatted Wang files (maximum record length 128 bytes).

Wang's Model 2270A (IBM 3740 Compatible) single, dual, or triple diskette units (unlike the Model 2270 units) have the necessary hardware and firmware to sense whether an IBM 3740 or a Wang diskette is currently mounted at a disk location where a read or write operation is to be executed; however, compatibility software is needed when data is to be stored on, retrieved from, or converted to a 3740 diskette by a Wang system. The software is not needed for normal operations with Wang diskettes.

## 1.2 MEDIA DIFFERENCES

IBM's 3740 Data Entry System encompasses such equipment as the single operator 3741 Data Station and the 3742 Dual Data Station. These "key to diskette" data stations store data on diskettes resembling the diskettes used in Wang systems.

A "diskette" is a thin, flexible disk platter 7.5 inches (19 cm) in diameter, about the size of a 45 rpm phonograph record, enclosed in an 8 by 8 inch (20 by 20 cm) semi-rigid protective plastic jacket. The diskette turns freely within the jacket, and is coated on one side with magnetic material arranged in concentric circular tracks. When formatted (initialized), the tracks are divided into "sectors" with unique, randomly accessible addresses, thereby providing a rapid, direct access method for data storage and retrieval. Although these general facts apply to both Wang and IBM diskettes, important differences usually preclude exchange of diskette files between Wang and IBM systems; however, with Wang's IBM 3740 Compatible Diskette Drive and the software described in this manual, 3740 diskette files can be read into a Wang system for subsequent processing. Also, data processed in a Wang system can be stored on 3740 diskettes and used as input to any system equipped to read 3740 diskette files.

### Visual Differences and Mounting Instructions

A permanent label with the name "Wang Diskette" and part number WLI No. 177-0063 identifies a diskette used in Wang Model 2270 or 2270A type drives. The elongated label has arrows marked "Insert" and "Up" showing how to position a diskette before mounting in a drive (see Figure 1-1); a third arrow points to the "write protect" hole. As indicated by instructions on the label, the write protect hole prevents writing when uncovered, and permits writing when covered by a tab.

A small, square, permanent label with the name "IBM Diskette" and Part No. 2305830 (Record Length 128 Bytes) identifies a standard diskette used by 3741 and 3742 data station operators. No arrows show how to position a 3740 diskette before mounting in a drive. To mount a 3740 diskette in one of Wang's IBM 3740 compatible drives, the diskette is held edgewise with the label on the right side, in the lower corner away from the drive door, as shown in Figure 1-2.

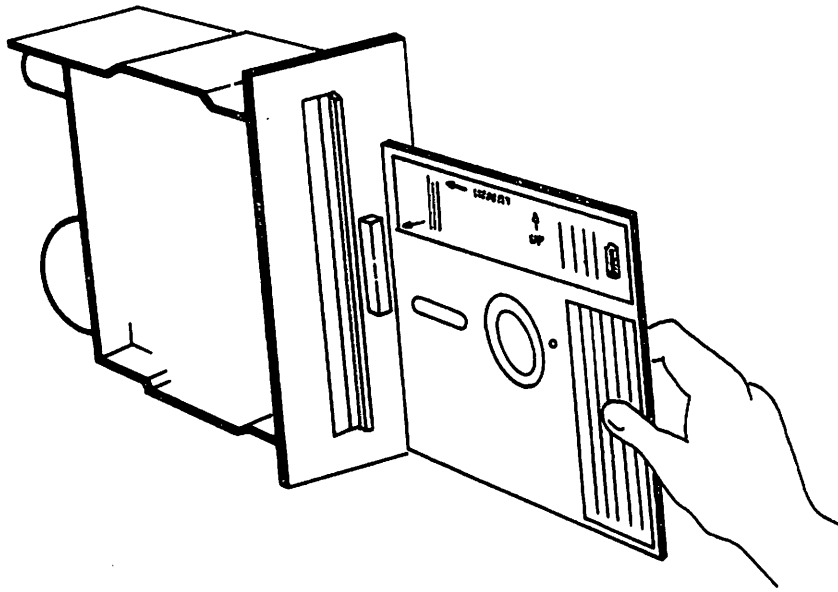


Figure 1-1. Mounting a Wang Diskette

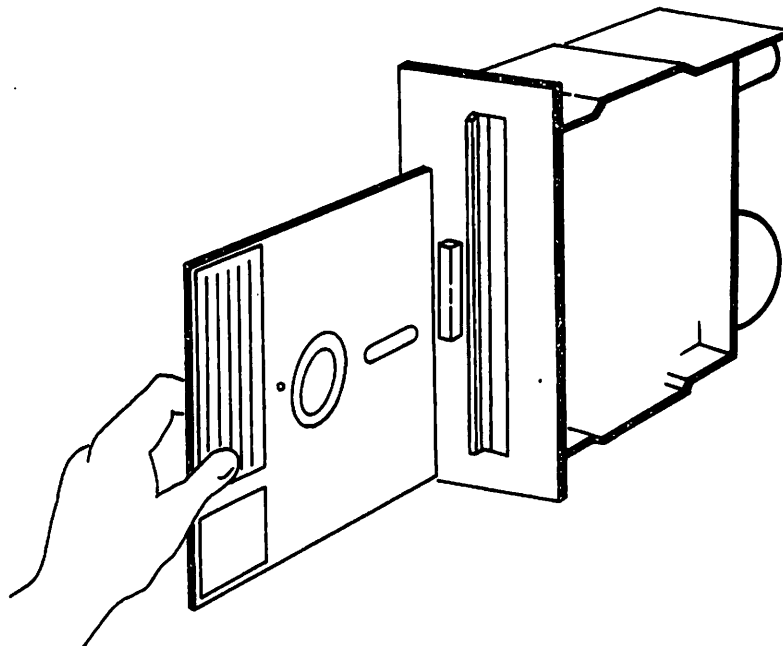


Figure 1-2. Mounting a 3740 Diskette

Other Significant Differences

For background information, other differences between IBM 3740 and Wang diskettes are summarized here:

- . A Wang diskette has 32 small index holes around its central mounting hole; a 3740 diskette has only one index hole.
- . The tracks on Wang diskettes are divided into 16 equal sectors per track, with a 256-byte capacity per sector; the tracks on 3740 diskettes are divided into 26 equal sectors per track, with a 128-byte capacity per sector.
- . Sector addressing notation differs. On Wang diskettes, the first sector has address zero. On 3740 diskettes, the first sector has address 16,384 in Wang notation; the second sector has address 16,385, etc. The sectors are arranged and numbered consecutively on 3740 diskettes, but a staggered (interlaced) arrangement of the sequentially numbered sectors on Wang diskettes increases performance during multi-sector read/write operations.
- . Catalog index layouts differ.
- . Timing mark conventions, used to identify stored data files, differ.
- . Data is recorded in different code sets--Wang uses USASCII (United States of America Standard Code for Information Interchange) while IBM uses EBCDIC (Extended Binary Coded Decimal Interchange Code).
- . Valuable data stored on a Wang diskette can be protected against accidental overwriting by uncovering the write protect hole; no such feature exists on 3740 diskettes.
- . A Wang diskette can be formatted (initialized) in the leftmost drive by pressing the recessed format button; a 3740 diskette must be purchased preformatted or be formatted by an IBM 3740 system if the diskette is to be used for data storage or retrieval in a Wang system.

Programming Differences

For Wang diskettes, read and write operations can be controlled via the disk statements described in the Disk Reference Manual provided with a Wang system, or any available disk utility software can be used. All information pertaining to the Model 2270 single, dual, or triple diskette units can be applied unchanged to comparable units of Wang's 3740 Compatible Diskette Drive when using Wang diskettes to store or retrieve diskette files.

By contrast, if a 3740 diskette is mounted in one of Wang's IBM 3740 Compatible Diskette Drives, none of the Automatic File Cataloging Mode disk statements can be used to control read and write operations on 3740 diskettes. Only five of the Absolute Sector Addressing Mode disk statements can accommodate the 3740 sector addresses; the statements are:

DATALOAD BA	DATALOAD DA	COPY.
DATASAVE BA	DATASAVE DA	

Furthermore, since Wang's disk statements are designed to read and write information in 256-byte sectors rather than the 128-byte sectors formatted on 3740 diskettes, special programming techniques must be employed to prevent loss of 128 bytes of valid data when information is transferred from the CPU to the disk controller for storage in a 3740 sector. Similarly, since the disk controller automatically supplies zero fill information after reading a 128-byte 3740 sector, programming techniques must recognize that valid data can lie only in the first 128 bytes of information resulting from the reading of a 3740 sector. Also, since the disk controller supplies a non-zero value in the 129th byte if a deleted or bad 3740 sector is read, the 129th byte position should be checked before processing the first 128 bytes of information. During a writing operation to a 3740 diskette, the 129th byte should be set to zero as a preferred technique.

Because the differences between Wang and IBM 3740 diskettes impose programming constraints of considerable magnitude, Wang Laboratories recommends use of its 3740 Compatibility Software to simplify application programming requirements associated with data storage or retrieval using 3740 diskettes. With the compatibility software, differences between 3740 and Wang diskettes become essentially transparent to the programmer.

### 1.3 DISKETTE STORAGE CONSIDERATIONS

On 3740 diskettes, there are 77 tracks numbered from 0 through 76, beginning with the outermost track; each track is divided into 26 sectors with a storage capacity of 128 bytes per sector. Track 0, called the index track, is reserved for information describing the diskette's contents, and the last two tracks (75 and 76) are reserved for use as replacements for defective tracks. Thus, the maximum space utilized for storage of data files (called data sets by IBM) is 74 by 26 by 128 or 246,272 bytes.

The "extent" of each data set is given in the 3740 index track in the form of three addresses associated with each named data set. See Figure 1-3 and Appendix B.

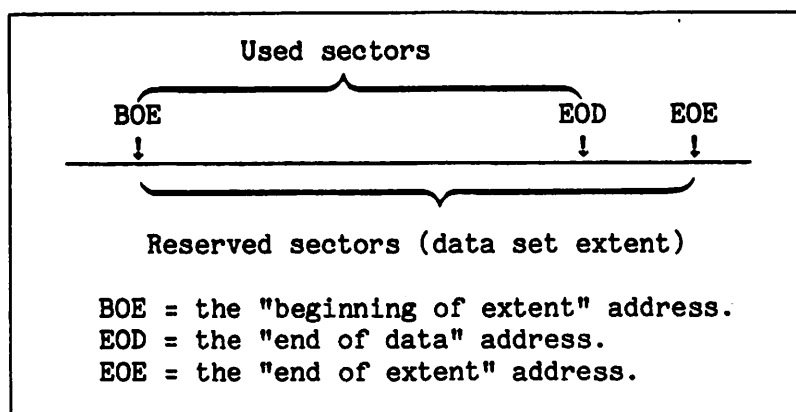


Figure 1-3. Storage Addresses for 3740 Files

On Wang diskettes, there are 77 tracks numbered from 0 through 76, and each track is divided into 16 sectors with a storage capacity of 256 bytes per sector. Only 64 tracks are accessible for disk operations via Model 2270 type diskette units, but all 77 tracks are accessible via Model 2270A type diskette units if the SCRATCH DISK statement parameter END is set to 1231 instead of 1023 when initializing a diskette.

The reserved catalog index space on a Wang diskette, user-selectable via the value assigned to the parameter LS in the SCRATCH DISK statement used to initialize the diskette, can be any number of sectors from 1 to 255 (24 is the default value). Thus, the maximum space available for storage of files on Wang diskettes varies, but the capacity in bytes can be calculated as follows:

$$\begin{aligned} A &= 262144 - 256 * n && \text{(for Model 2270 units)} \\ &= 315392 - 256 * n && \text{(for Model 2270A units)} \end{aligned}$$

where  $n$  = the value assigned to LS when scratching a diskette.

For media conversion from a 3740 diskette to a Wang diskette, only two sectors need be reserved for the catalog index since the 3740 index track accommodates a maximum of 19 file entries. The first sector in the Wang diskette catalog index can hold 15 file entries; the other sectors can hold 16 file entries each.

**NOTE:**

All Wang diskettes formatted in Model 2270 diskette units are "upward" compatible with Model 2270A units. If "downward" compatibility between Model 2270A and 2270 units is desired, do not take advantage of the 77 track read/write feature when scratching a diskette in a Model 2270A drive, i.e., set END = 1023, not 1231.

**1.4 MIXED MEDIA ERROR CONDITIONS**

The disk controller in Wang's 3740 Compatible Diskette Drive determines whether a disk read or write operation applies to a Wang or a 3740 diskette by the sector address (i.e., whether the address is less than 16,384 or not). The disk controller also senses which type of diskette (Wang or 3740) is mounted in a drive by the number of index holes on the diskette.

Accordingly, if either one of the following conditions occurs, an error code (ERR 64) interrupts a disk operation:

- a) a Wang diskette operation (sector address less than 16,384) is attempted on a 3740 diskette (only one index hole), or
- b) a 3740 diskette operation (sector address equal to or greater than 16,384) is attempted on a Wang diskette (32 index holes).

Then, corrective action can be taken.

## 1.5 CPU AND PERIPHERAL REQUIREMENTS

Two disk drives (minimum) are required to use Wang's 3740 Diskette Compatibility Software. One Model 2270A (IBM 3740 Compatible) drive is needed for mounting a 3740 diskette to be used for data storage or retrieval. Another 2270A drive, or any other disk/diskette drive in the system, is needed for mounting a platter containing the software or a user-written program. If a system has an IBM 3740 compatible single diskette unit, the unit must be used in conjunction with a fixed/removable disk drive, or must be upgraded to a dual diskette drive unit.

The central processor of the Wang system must be a 2200T, a 2200VP, or any Wang CPU which provides the full BASIC or BASIC-2 instruction set. A 12K-byte minimum memory size is sufficient for the software system. The subroutines, if appended to a user-written application program, require only 4.5K bytes of memory.

A printer is needed for those operations where hardcopy output of a 3740 diskette file or a Wang file (converted from a 3740 diskette) is desired.

## 1.6 SOFTWARE BACKUP

The software system on the master diskette obtained from Wang Laboratories should be kept in reserve, as a backup system, after copying the software to another diskette or a fixed/removable disk platter (depending upon the available peripherals in the system being used). The software can be copied using Wang's Integrated Support System (ISS) utilities, if available. Also, the software can be copied using the COPY statement if the diskette drive is a dual or triple unit. (See the general form of the COPY statement in the Disk Reference Manual.)

If a fixed/removable disk drive is available in addition to a single, dual, or triple 3740 Compatible Diskette Drive, the software system can be stored on the fixed disk or a removable disk platter without using ISS by repeating the following three-step procedure until every file listed in the master diskette catalog has been copied (all files are program files):

```
:CLEAR      EXEC

:LOAD DC { F } [xyz,] "name" EXEC
          { R }

:SAVE DC { F } [xyz,] "name" EXEC
          { R }
```

Keep in mind, however, that only unique file names can be stored on a particular platter; therefore, it may be necessary to use a different name when saving the START file.

CHAPTER 2  
OPERATING INSTRUCTIONS

2.1 LOADING THE SOFTWARE SYSTEM

Mount the disk or diskette containing the 3740 software; then, key the following sequence:

```
CLEAR EXEC
SELECT DISK xyy EXEC (replacing xyy by the proper address)
LOAD DC T "START" EXEC
RUN EXEC
```

If the software is mounted at a default disk location (310/B10), the SELECT statement may be omitted; then, F or R should replace T in the LOAD statement, depending upon whether the left or right drive is used. (Also, if the name START has been changed for the reason discussed in Section 1.6, use the appropriate name.)

The software system first provides displays indicating that the loading operation is in progress. No operator action is required until a prompt requests the addresses to be used for program loading, Wang TC formatted files, and 3740 (3741) files. No addresses need be supplied if the displayed default addresses are acceptable; however, if addresses other than the default values are desired, keep in mind that the program loading and TC formatted files addresses may be the same, but the 3740 files address must be unique.

After the disk addresses have been supplied (or the default addresses accepted), the system menu appears on the CRT. (See Figure 2-1.)



PRESS DESIRED FUNCTION KEY _			
3741-2200 UTILITY SYSTEM			
FN KEY	DESCRIPTION	FN KEY	DESCRIPTION
01	CONVERT 3741 TO TC FORMAT	05	LIST 3741 CATALOG
02	CONVERT TC FORMAT TO 3741	06	DUMP 3741 SECTOR(S)
03	LIST 3741 FILE	07	APPLICATION/SUBROUTINES
04	LIST TC FORMAT FILE (CONVERTED 3741 FILE)	08	CHANGE DISK ADDRESSES
		31	RETURN TO 'START'

Figure 2-1. The System Menu

## 2.2 THE UTILITY PROGRAMS

The system menu displays the available utility programs and the special function keys by which they are accessed. After a special function key is depressed to access a particular program, operating instructions (prompts) appear on the CRT indicating when disk platters are to be mounted, and when input is required. No operational difficulties should arise if the prompts are followed carefully. For convenience, a summary of each program is given here, and the required input is indicated.

CONVERT 3741 TO TC FORMAT--converts a 3740 (3741) file to a Wang TC formatted file, and provides an option to rerun the program before returning to the system menu. The system creates fixed length records in the converted file by adding space characters, if necessary, to satisfy the record length specified in the 3740 index track. During file conversion, the display indicates the record currently being processed. Required information: (1) the input (3741) file name, (2) the output (Wang) file name, and (3) where to stop the conversion, i.e., 'EOD' (End Of Data) or 'EOE' (End Of Extent).

CONVERT TC FORMAT TO 3741--converts a Wang TC formatted file to a 3740 (3741) file, and provides an option to rerun the program before returning to the system menu. During file conversion, the display indicates the record currently being processed; records longer than 128 bytes are truncated. Required information: (1) the input (Wang) file name and (2) the output (3741) file name.

LIST 3741 FILE--provides hardcopy of a 3741 file on a printer (address 215). Records are read and dumped with no attempt to format the data; nonprintable characters are printed as question marks (?). The 3741 file is listed from BOE to EOE, i.e., from the beginning to the end of the reserved sectors. An end of data record, if encountered, is listed also and looks like the index entry with the name blanked. Required information: only the input (3741) file name.

**LIST TC FORMAT FILE**--provides hardcopy of a Wang TC formatted file on a printer (address 215). Records are read and dumped with no attempt to format the data; nonprintable characters are printed as question marks (?). Note: Records longer than 128 bytes are truncated, if encountered; however, truncation is not effective when listing a converted 3741 file since the maximum record length of such files is 128 bytes; truncation occurs on the hardcopy only, not on a disk or diskette. Required information: only the input (Wang) file name.

**LIST 3741 CATALOG (Index Sectors)**--displays a list of the files on the currently mounted 3741 diskette. In addition to the names of the files, the numbers under the headings 'BOE', 'EOE', and 'EOD' indicate the sector addresses corresponding to the beginning of extent (the first sector in the file), the end of extent (the last sector reserved for the file), and the end of data (the next unused sector within the file); numbers in parentheses under each heading indicate the respective 3741 track and the sector position within the track. Any blank lines within the list correspond to deleted entries in the 3741 catalog. Note: The numbers given without parentheses are appropriate for use with the software system when dumping sectors in a particular file (see Figure 2-2). Required information: none.

NAME	'BOE'	'EOE'	'EOD'
SAMPLE	26 (01/01)	113 (04/10)	35 (01/10)
FILE010A	114 (04/11)	243 (09/10)	237 (09/04)
FILE030A	244 (09/11)	1056 (40/17)	1023 (39/10)
#####	##### (##/##)	##### (##/##)	##### (##/##)

(Note: The print format, shown in the last line, does not appear in an actual display.)

Figure 2-2. A Sample 3740 Catalog Listing

**DUMP 3741 SECTOR(S)**--displays a specified set of 3741 sectors with no attempt to format the data; nonprintable characters appear as question marks (?). Three sectors at a time are displayed; then, the system waits until the operator keys RETURN(EXEC) before displaying three more sectors. Required information: any pair of numbers between 1 and 1950 (maximum), where a suitable range of sector addresses for a particular file may be obtained from the "list 3741 catalog" display.

**APPLICATION/SUBROUTINES**--provides access to a sample application program if the file name 3741090A is the operator's response to the system's request for the name of the application program; then, via a new menu (see Figure 3-1) and prompts, the sample program demonstrates the file maintenance capabilities of the utility subroutines which simulate several Wang disk operations while compensating for the differences between Wang and 3740 diskettes. Note: See Chapter 3 for a description of each subroutine, and the requirements for integrating the subroutines with user-written application programs. Required information: The name of an application program stored on the platter with the 3740 software.

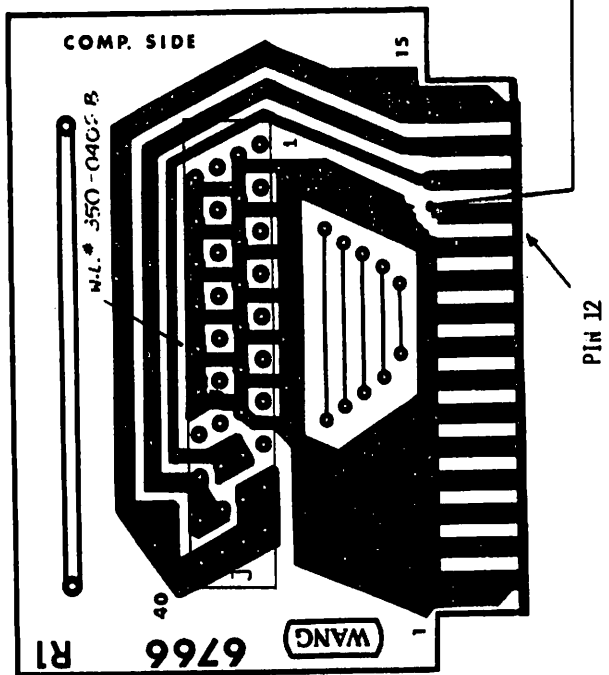
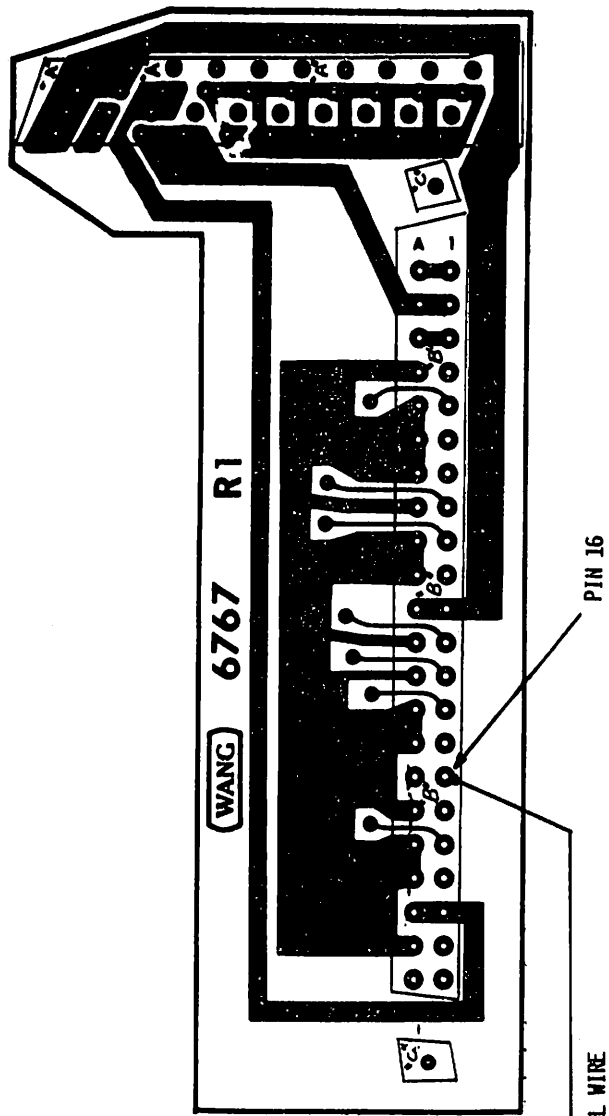
CHANGE DEFAULT ADDRESSES--allows the user to change the software's preset default addresses. If three disk drives are available, the program loading address and the Wang files mounting address should be different to eliminate the necessity of removing the software system platter each time a Wang platter is to be mounted. Required information: Any new addresses to replace the current default values.

RETURN TO 'START'--returns the system menu to the CRT if S. F. '31 is depressed after accessing one of the system programs.

APPENDIX B  
RIBBON CABLE CONVERSION, R1 to R2

The system is shipped with one ribbon cable; however, two cables will be necessary when processing two 3740 diskettes. If this is the case, an additional cable should be ordered, WLI# 220-3011-R2. In the event that a cable is required immediately, and the site has an R1 cable, then it may be modified to function as an R2 until the ordered cable arrives. The modification is accomplished as follows (refer to figure on following page):

1. Isolate pin 12 on the 6766 connector by cutting the etch as shown in the figure.
2. Solder one end of a 32 inch length of wire to pin 12 and route the wire through the hole in the 6766 board and parallel to the ribbon cable to pin 16 of the 6767 connector.
3. Tape the wire neatly along the ribbon cable to avoid transient noise pick-up or snagging of the wire.
4. Trim the wire to the exact length and solder to pin 16, as shown in the figure.
5. Replace the modified cable with the new cable when it arrives.



BREAK ETCH TO ISOLATE  
 PIN 12 AND CORRECT PIN  
 12 TO PIN 16 USING AN  
 EXTERNAL WIRE RUN  
 BETWEEN CONNECTORS.

EMERGENCY CONVERSION OF RIBBON CABLE FROM R1 TO R2

NOTES

**APPENDIX C**  
**SHUGART LOGIC DIAGRAMS**

The diagrams in this section are listed in the following order:

50501-0	Logic Manual Index
50502-0	Functional Diagram
50503-0	Read/Write/Inop Ckts.
50504-0	Stepper Control
50505-0	Detectors
50506-0	Motors/Solonioid/Switch
50507-0	Interface Inputs
50508-0	Interface Outputs
25000-0	Schematic Diagram, Diskette
6472-61	I/O CABLE ASSY.
7218	IBM 3741 SHUGART BOARD

LOGIC MANUAL DRIVE SN

INDEX

AA001	INDEX
AB010	FUNCTIONAL DIAGRAM
DA010	READ/WRITE/INOP CKTRY
DA020	STEPPER CONTROL
DA030	DETECTORS
DA040	MOTORS/SOLENOID/SWITCH
VA010	INTERFACE INPUT (J1, J4, AND J5)
VA020	INTERFACE OUTPUT (J1)

TABLE I  
OPTIONAL  
FEATURES

PCB ASM NO.	OPTIONAL FEATURES		
	-5V	-12V TO -15V	DATA SEP
25002	X		
25003		X	
25004	X		X
25005		X	X
25006	X		X
25007		X	X

WRITE PROTECT CAN BE ORDERED WITH ANY OF THE ABOVE.

TABLE III

CUSTOMER CUT TRACE OPTIONS AND HISTORY CHART

DESIGNATOR	DESCRIPTION	OPEN	SHORT
A	DRIVE SELECT I OR HEAD LOAD	<input type="checkbox"/>	<input type="checkbox"/>
B	ALTERNATE DRIVE SELECT PATH	<input type="checkbox"/>	<input type="checkbox"/>
C	RADIAL HEAD LOAD	<input type="checkbox"/>	<input type="checkbox"/>
D	DRIVE SELECT TERMINATION WITH RADIAL HEAD LOAD	<input type="checkbox"/>	<input type="checkbox"/>
E	MULTIPLEX OR DRIVE SELECT FEATURE	<input type="checkbox"/>	<input type="checkbox"/>
F	TERMINATION FOR "WRITE DATA"	<input type="checkbox"/>	<input type="checkbox"/>
G	TERMINATION FOR "FILE INOP RESET"	<input type="checkbox"/>	<input type="checkbox"/>
H	TERMINATION FOR "WRITE GATE"	<input type="checkbox"/>	<input type="checkbox"/>
J	TERMINATION FOR "DIRECTION SELECT"	<input type="checkbox"/>	<input type="checkbox"/>
K	TERMINATION FOR "STEP"	<input type="checkbox"/>	<input type="checkbox"/>
M	RADIAL/READY INTERRUPT	<input type="checkbox"/>	<input type="checkbox"/>
R	STEP WITH HEAD UNLOADED	<input type="checkbox"/>	<input type="checkbox"/>
S	R.P.S. (RADIAL SECTOR AND INDEX)	<input type="checkbox"/>	<input type="checkbox"/>

FACTORY CUT TRACE OPTIONS AND HISTORY CHART

L	-5 OR -12 TO -15V	SEE TABLE II
N	INDEX ONLY (500)	SEE TABLE II
P	INDEX AND SECTOR (501)	SEE TABLE II

AS SHIPPED FROM FACTORY

TABLE II

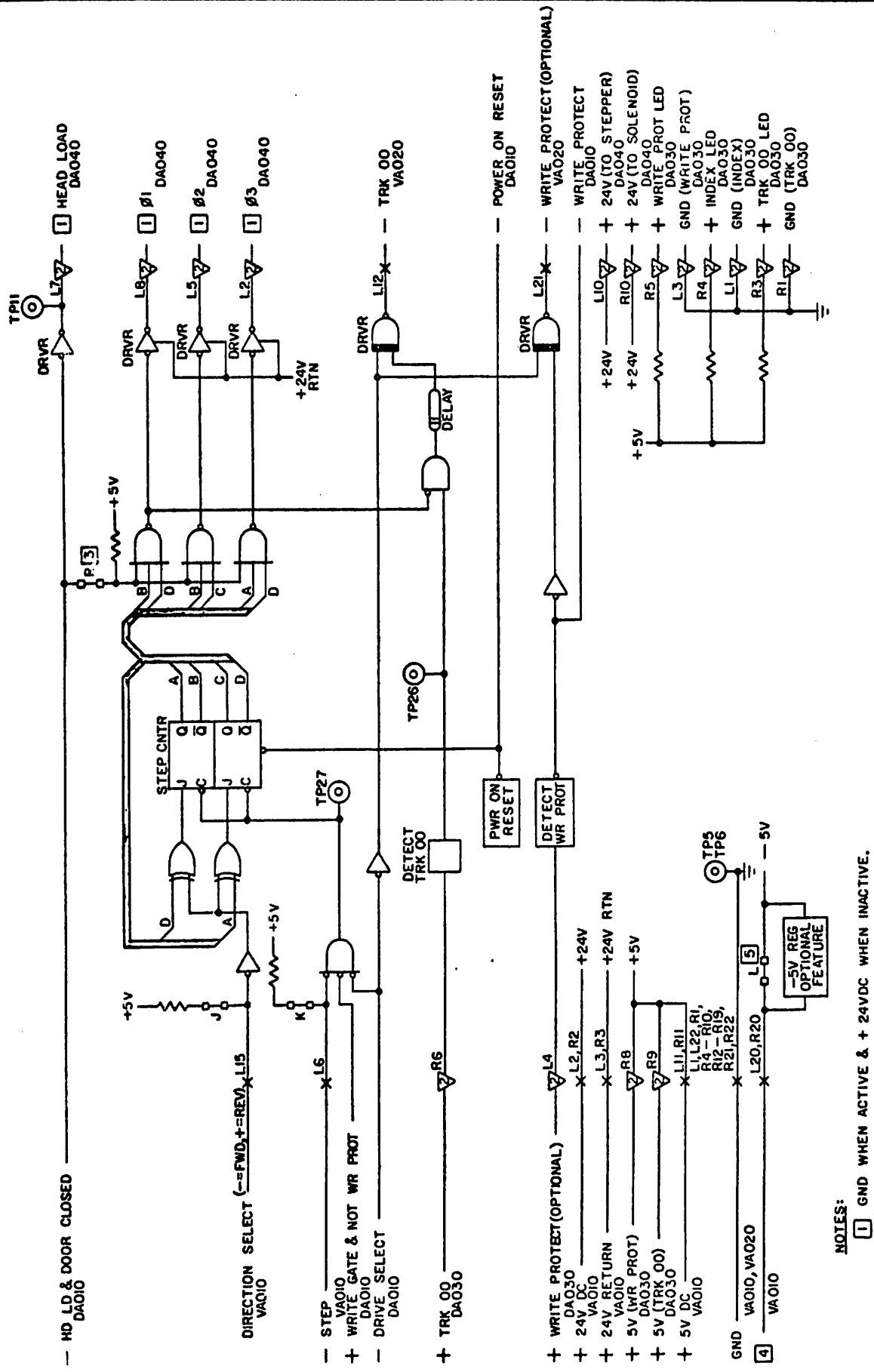
PCB ASM NO.	FACTORY CUT TRACE OPTIONS			
	TRACE L <sub>N</sub>	TRACE W <sub>N</sub>	TRACE V <sub>N</sub>	TRACE P <sub>N</sub>
25002	SHORTED	OPEN	SHORTED	SHORTED
25003	OPEN	SHORTED	OPEN	SHORTED
25004	SHORTED	OPEN	SHORTED	SHORTED
25005	OPEN	SHORTED	OPEN	SHORTED
25006	SHORTED	SHORTED	SHORTED	OPEN
25007	OPEN	SHORTED	SHORTED	OPEN

MUST CONFORM TO ENGINEERING SPEC. ES 3000-0		EC HISTORY	
MATERIAL	TOLERANCE UNITS OTHERWISE NOTED	DATE	NO.
DATE ORDERED	URBAN	3-16-74	0114
PARTS/LIST	INDUSTRIAL	3-16-74	0274
TITLES		LOGIC MANUAL	INDEX
ASSEMBLY		3/74	3/74
REVISIONS		1/00	2/1
APPROVED		LG	50501-0
DRAWN		1	OF 1





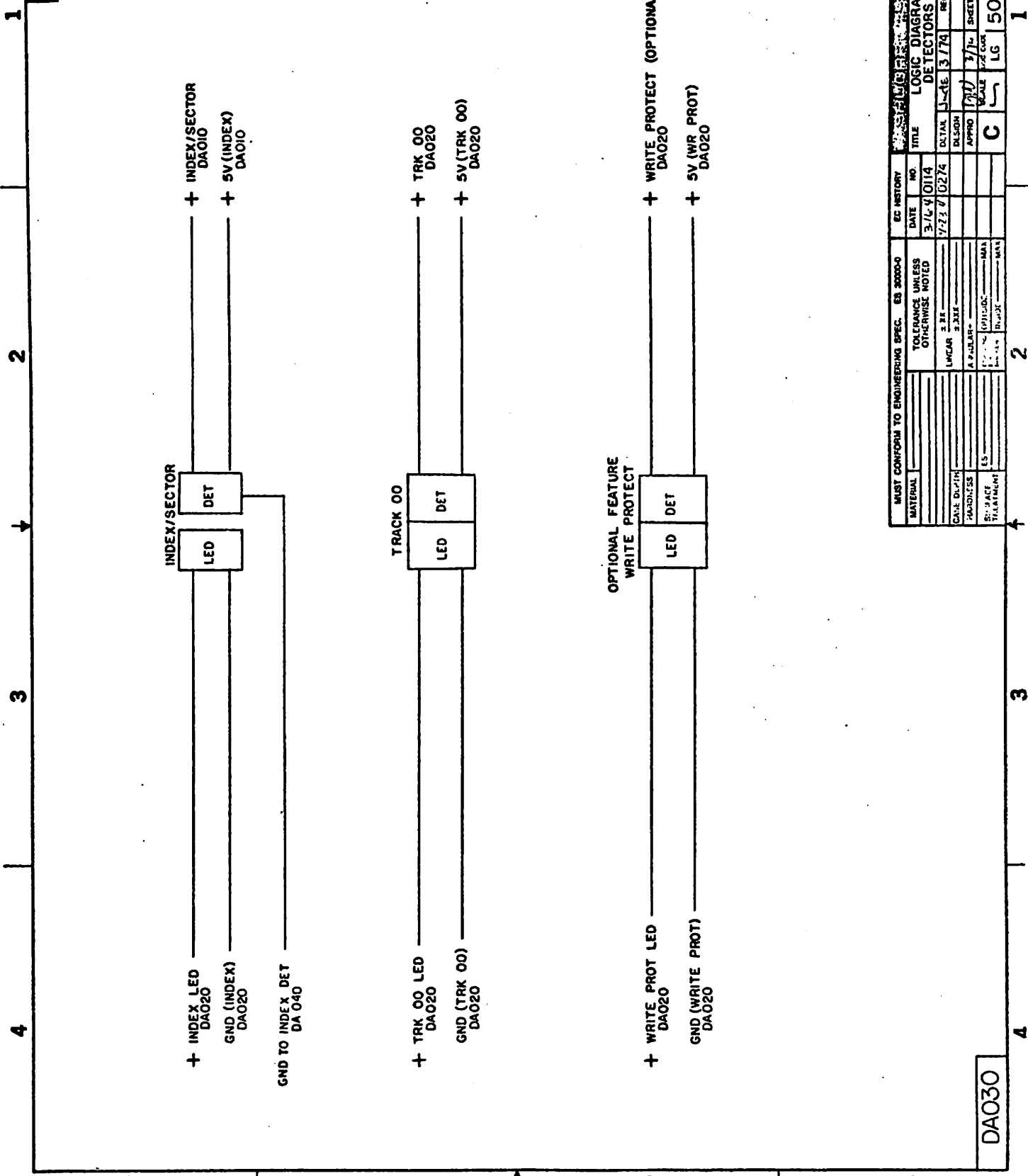




MATERIAL		EC HISTORY		MUST CONFORM TO ENGINEERING SPEC. ES 30000-0	
DATE	NO	DATE	NO	TOLERANCE UNLESS OTHERWISE NOTED	3-7L-4 0114
DETAIL	3/74	DESIGN	3/74	LINEAR	3-74
APPRO	3/74	APPRO	3/74	ANGULAR	3-74
SCALE	1	SCALE	1	MAXIMUM SURFACE FINISH	MAX
SHEET	1	SHEET	1	MAXIMUM SURFACE FINISH	MAX
OF	1	OF	1		
50504-0		50504-0		50504-0	
LG		LG		LG	

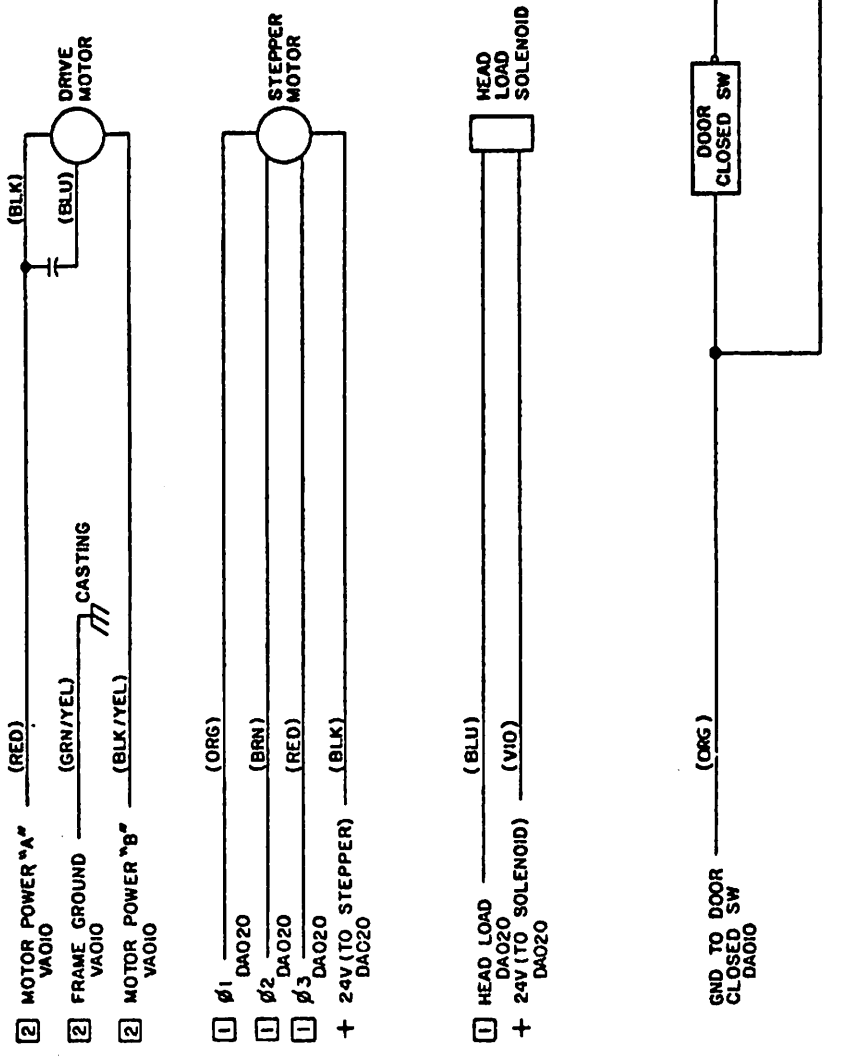
**NOTES:**

- 1 GND WHEN ACTIVE & +24VDC WHEN INACTIVE.
- 2 CONNECTOR SYMBOL REFERENCE: X = J1, ▽ = J2
- 3 CUT TRACE(R) TO ALLOW STEPPING WITH HEAD NOT LOADED OR DOOR OPEN.
- 4 -5V OR -12V TO -15V SELECTABLE FEATURE. SEE PAGE A4001
- 5 CUT TRACE(L) FOR -12V TO -15V INPUT AT L20, R20. SEE PAGE A4001, TABLE II.



MATERIAL		MUST CONFORM TO ENGINEERING SPEC. ES 3000-0		EC HISTORY		DATE		NO.		TITLE	
		TOLERANCE UNLESS OTHERWISE NOTED		3-7-4		0114				LOGIC DIAGRAM	
CASE D-714		LIMITS		3.25		3.25		3.774		RELEASED FOR ASSEMBLY	
FINISHES		A FINISH		OPTI-DIC		MARA		APPROD		SCALE	
SURFACE TREATMENT		ES		INDEX		MATERIAL		3/74		50500	
								SHEET		OF	
								1		1	
								C		50505-0	
								LG		p274	

DAO30

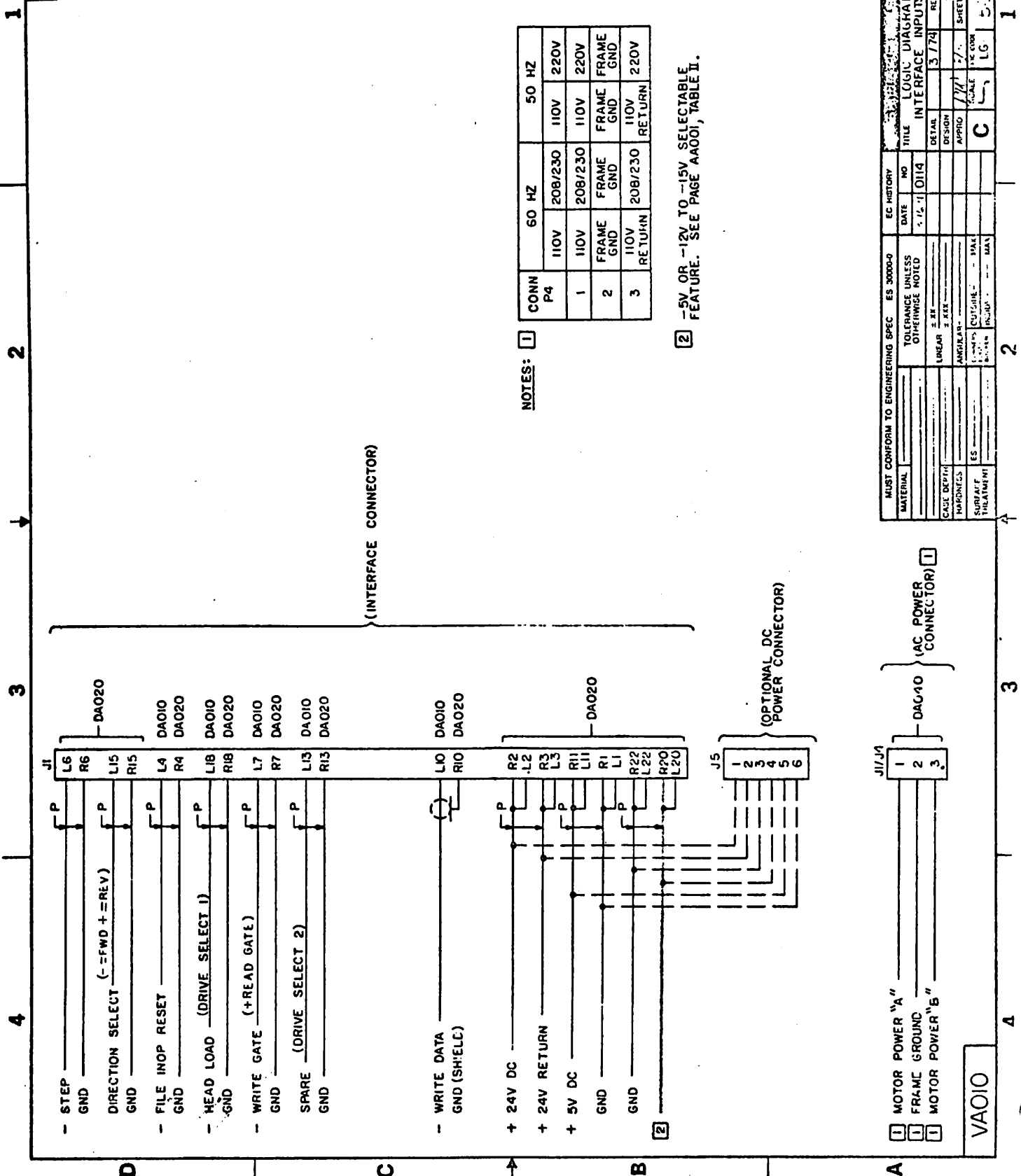


**NOTES:**

- 1 GND WHEN ACTIVE & +24V WHEN INACTIVE.
- 2 SEE PAGE VADIO (NOTE 1) FOR AC VOLTAGES.

MATERIAL		SC HISTORY		TITLE	
MUST CONFORM TO ENGINEERING SPEC. ES 3000-0		DATE	NO.	LOGIC DIAGRAM	
TOLERANCE UNLESS OTHERWISE NOTED		3-1-74	0114	MOTORS/SOLENOID/SWITCH	
URGAN		7-7-74	0274	DETAIL	3-1-74 3/74
CALC. CHECKED				DESIGN	3/74
HAND-DESIGNED				APPROD	3/74
SCALE				SHEET	1 OF 1
DATE				SCALE	50506-0
TIME				SCALE	50506-0
TIME				SCALE	50506-0

50507-0



NOTES: [1]

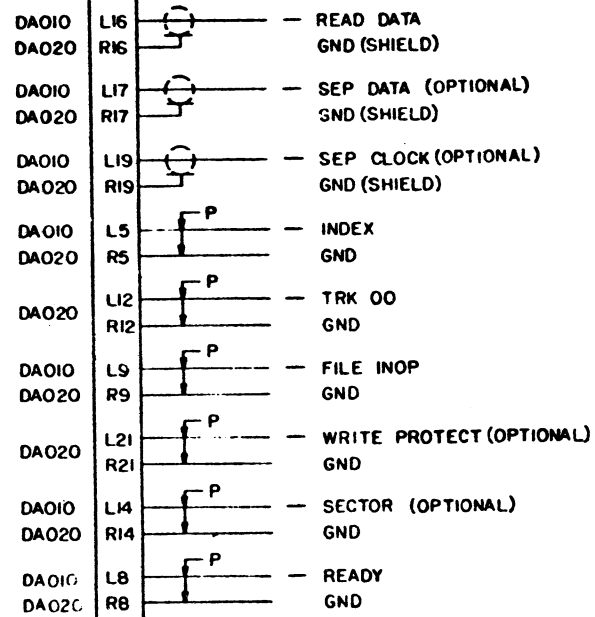
CONN	60 HZ		50 HZ	
	110V	208/230	110V	220V
P4				
1	110V	208/230	110V	220V
2	FRAME GND	FRAME GND	FRAME GND	FRAME GND
3	110V RETURN	208/230 RETURN	110V RETURN	220V RETURN

[2] -5V OR -12V TO -15V SELECTABLE FEATURE. SEE PAGE AA001, TABLE II.

MUST CONFORM TO ENGINEERING SPEC		ES 30000-0	EC HISTORY	LOGIC DIAGRAM	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED		DATE	NO	TITLE
			12-11	0114	INTERFACE INPUTS (J1, J1 ANE J5)
CASE DEPTH	LINEAR ± .005		DESIGN	3/74	RELEASED FOR ASSEMBLY
FINISHES	ANGULAR ± .005		APPRO	7/71	50500
SURFACE TREATMENT	ES ± .005		SCALE	1:1	SHEET 1 OF 1
					50507-0
					LG

(INTERFACE CONNECTOR)

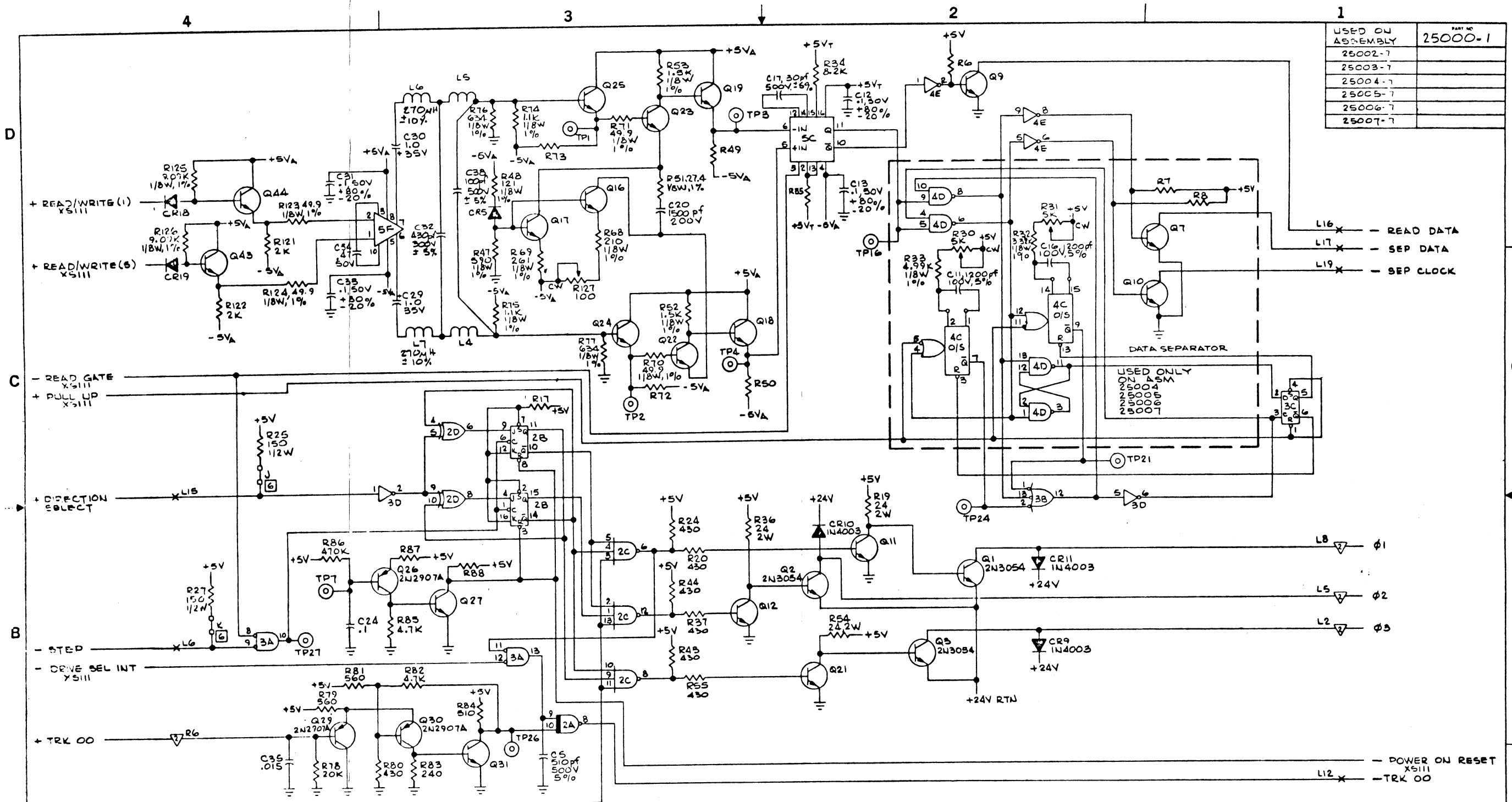
J1



89

VA020

MUST CONFORM TO ENGINEERING SPEC. ES 30000-0		EC HISTORY		SHUGART ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO.	TITLE	
	LINEAR ± .XX	1/24/68	0114	LOGIC DIAGRAM	
	ANGULAR ± .XXX		0274	INTERFACE OUTPUTS (J1)	
CASE DEPTH				DETAIL	3/74
HARDNESS				DESIGN	50500
SURFACE TREATMENT				APPRO	SHEET 1 OF 1
				SCALE	REV. NO.
				LG	50508-0
					1274



USED ON ASSEMBLY	PART NO
25002-7	
25003-7	
25004-7	
25005-7	
25006-7	
25007-7	

USED ONLY ON ASM  
 25004  
 25005  
 25006  
 25007

- NOTES: UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE 1/2, 1/4W, 5%.
  2. ALL CAPACITORS ARE IN MICROFARADS, 100V, 10%.
  3. ALL CHOKE ARE 100UH, 10%.
  4. ALL DIODES ARE 1N4148.
  5. ALL TRANSISTORS ARE 2N2222A.
  6. SYMBOL:  $\text{---} \text{---} \text{---}$  = TRACE CUT CAPABILITY.
  7. SYMBOL:  $\text{---} \text{---} \text{---}$  = JUMPER CAPABILITY.
  8. CONNECTOR SYMBOL REFERENCES:  
 (X) = J1 (V) = J2 (V) = J3 (V) = J5

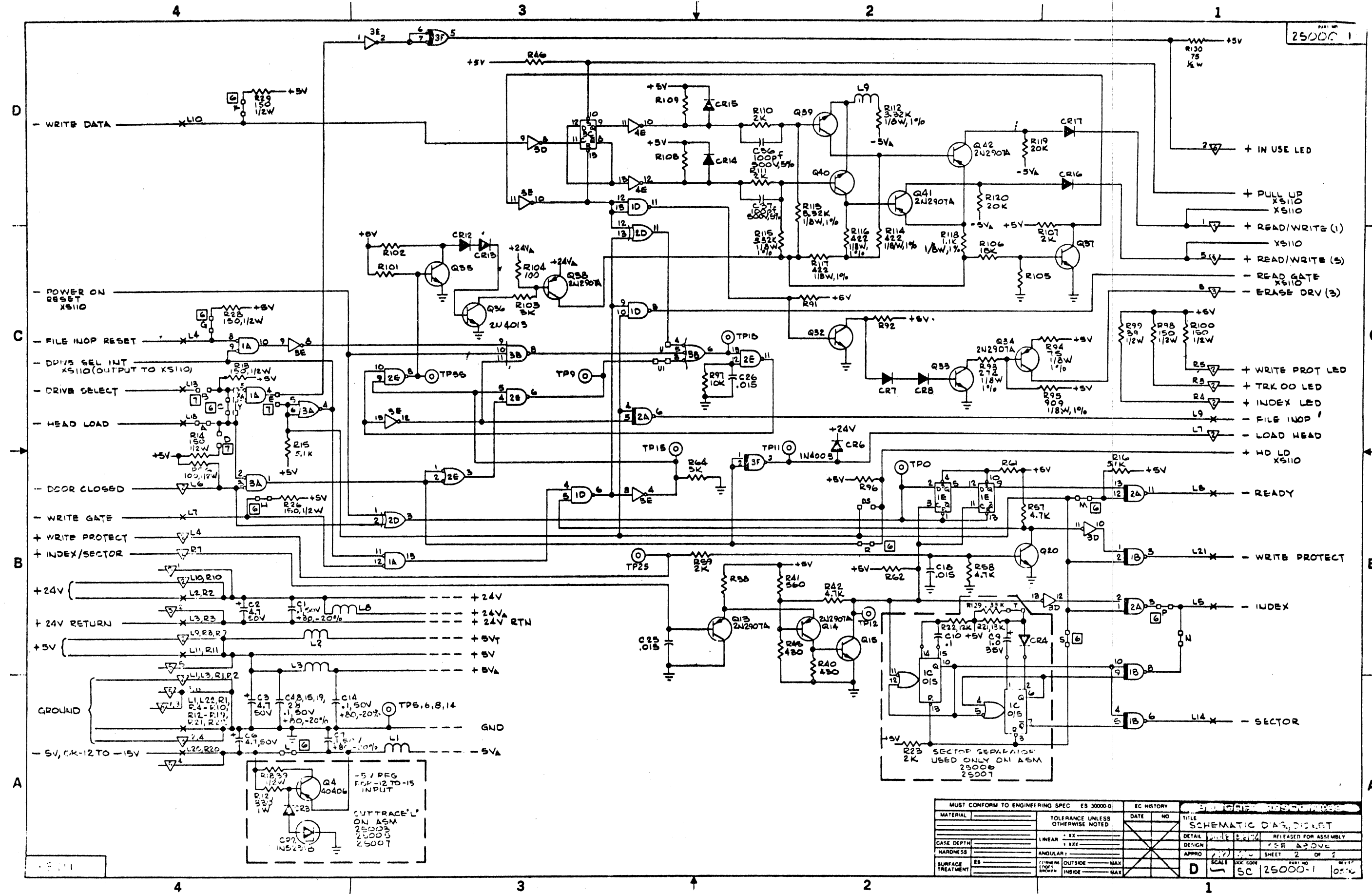
TYPE	POSITION	UNUSED ELEMENTS	+5V (PIN)	GND (PIN)
7400	1D, 4D, 2E	1D1	14	7
7402	1A, 3A	1A1		
7404	3D, 3E	3E3, 3D2		
7406	4E	4E2		
7410	3B, 2C			
7438	2A, 1B	1B4		
7474	1E, 3C		14	7
7476	2B		5	13
7486	2D		14	7
UAT33	5F			
BT20	5C			8
9602	1C, 4C		16	8
75452P	3F		8	4

REF DESIGNATION LAST USED	REF DESIGNATION NOT USED
C30	C21, 22, 23, 27
CR19	CR1
L9	
Q44	Q5, 6, 8, 28
R30	R1, 5, 9, 11, 39, 60, 63, 65, 47, 49, 50
TP86	TP10, 17, 18, 19, 22, 23, 20, 28, 29, 30, 31, 32, 33, 34

MUST CONFORM TO ENGINEERING SPEC ES 30000-0		EC HISTORY		SHAW-WALKER ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	RELEASED FOR ASSEMBLY
	LINEAR - .XX -	5-78	0396	SCHEMATIC DIAG, DIC, ET	SEE ABOVE
CASE DEPTH	ANGULAR -	8-78	0396	DESIGN	2.5, 24
HARDNESS		7-76	0396	APPRO	1
SURFACE TREATMENT	OUTSIDE - MAX	8-76	0396	SCALE	1 OF 2
	INSIDE - MAX	10-76	0396	SCALE	1 OF 2

X5110

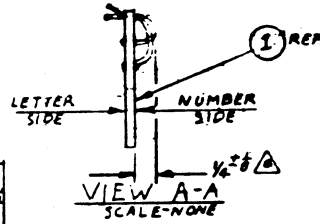




MUST CONFORM TO ENGINEERING SPEC ES 30000-0		EC HISTORY		REVISIONS	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	BY
				SCHEMATIC DIAG, DISC 1	
CASE DEPTH	LINEAR .XX			DETAIL	RELEASED FOR ASSEMBLY
HARDNESS	ANGULAR			DESIGN	SEE ABOVE
SURFACE TREATMENT	CORNER RADIUS			APPRO	SHEET 2 OF 2
	OUTSIDE MAX			SCALE	SEE CON
	INSIDE MAX			D	SC 25000-1

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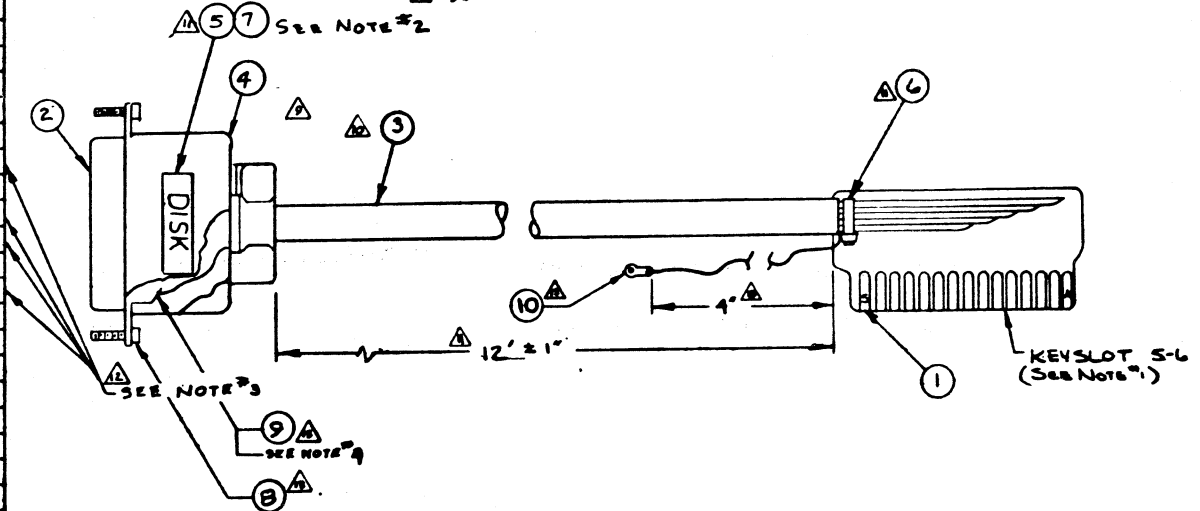
HOLE LEGEND		
DRAILED OR PUNCHED HOLE	HOLE DIA.	TOL.
	Ø125 to 125	+0.005
	126 to 250	+0.005
	251 to 500	+0.005
IDENT	DESCRIPTION	QTY.
A		



NOTES:

- 1) KEY SLOT BETWEEN 5 & 6 NEEDED ON 220-0066-3 ONLY.
- 2) ITEM #5 LABEL USED ON 220-0066-1 220-0066-3 ONLY, ITEM #7 LABEL USED ON 220-0066-2 ONLY.
- 3) ADD JUMPERS BETWEEN POSITIONS B,10,11 & 13 ON FINGER BOARD 5223C FOR 220-0066-1 ONLY.
- 4) SOLDER DRAIN WIRE TO ITEM 9.
- 5) CUT WIRE #11 AT FINGER BOARD AND CUT BACK.

WIRING RUN LIST						
FINGER BOARD	WIRE NO.	220-0066 2230/2240 2240/2242 2243 350-2067	220-0066 630/730 640/140	220-0066-2 2209	220-0066-3 WCS	220-0066-4 2210/2270A
1	1	6	7	6	6	6
2	2	7	6	7	7	7
3	3	1	1	1	1	1
4	4	3	3	3	3	3
5	5	5	5	5	5	5
6	6	2	2	2	2	2
7	7	4	4	4	4	4
8	8	9	9	9	9	9
9	9	12	12	16	12	12
10	10	11	13	19	11	11
11	11	7	13	11	13	13*
12	12	36	36	36	36	36
13	13	33	33	33	33	33
14	14	34	34	34	34	34
15	15	35	35	35	35	35
A	16	8	8	8	8	8
B	17	20	20	20	20	20
C	18	21	21	21	21	21
D	19	22	22	22	22	22
E	20	23	23	23	23	23
F	21	24	24	24	24	24
H	22	25	25	25	25	25
J	23	26	26	26	26	26
K	24	10	10	10	10	10
L	25	31	31	31	31	31
M	26	32	32	32	32	32
N	27	30	30	30	30	30
P	28	27	27	27	27	27
R	29	28	28	28	28	28
S	30	29	29	29	15	15



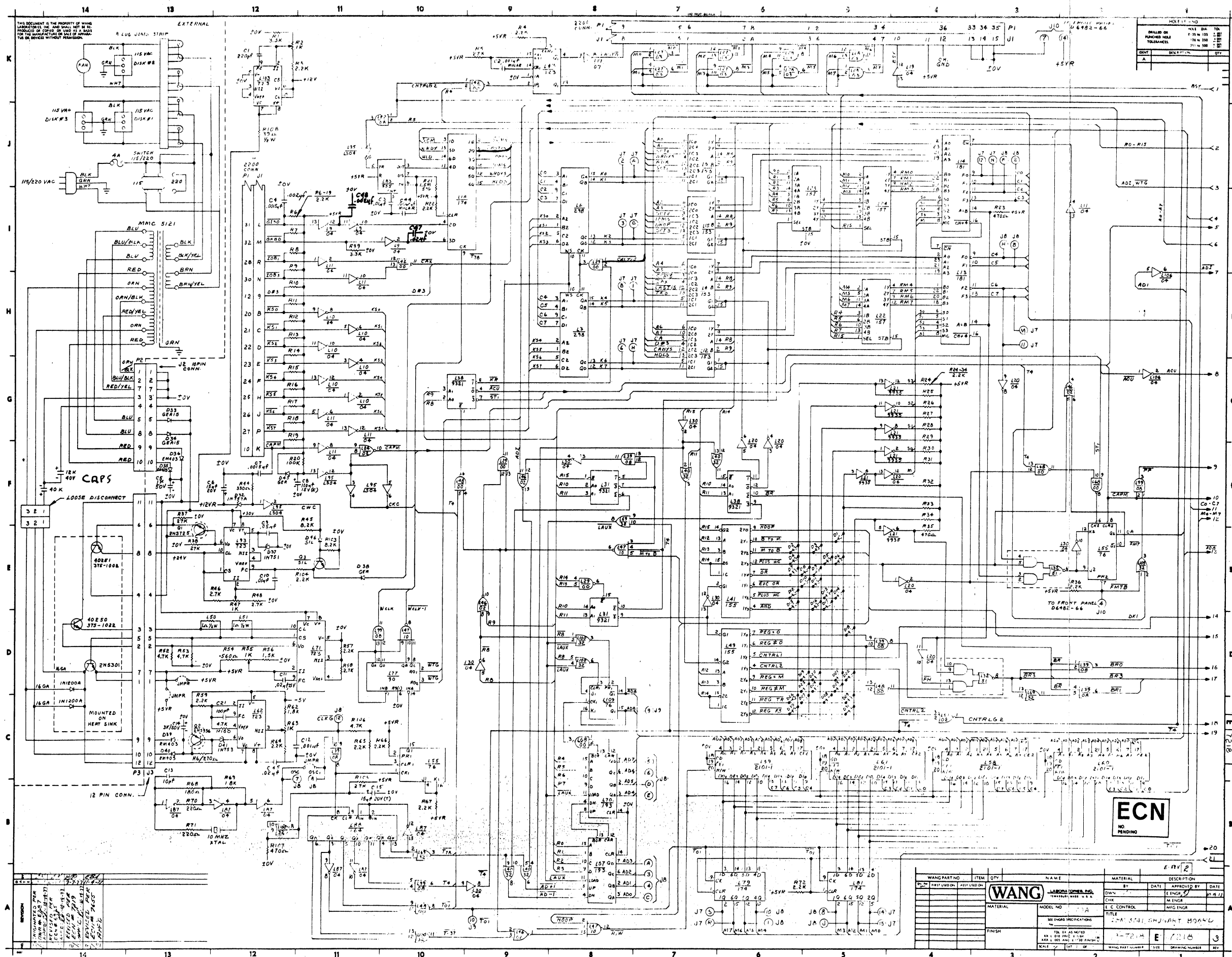
654-1006	10	1	GROUND LUG		#6
458-0361	9	1	GROUND STRAP		C6815-28
350-4234	8	2	CAPTIVE SCREW		1-40 X 3/8
615-1268-50	7	1/2	2250 CONN. LABEL		
605-1004	6	1	TV-RAP		
615-1298	5	1/2	DISK CONN. LABEL		
350-4228	4	1	180° STRAIN RELIEF COVER		3/6 POS.
420-0055	3	1/4	CABLE 30 COND. TOP		#26 GA. SHIELDED
350-2082	2	1	3/6 POS. PLUG ASSY.		SCREW MT.
510-5223C	1	1	30PIN FINGER BOARD		

WANG PART NO	ITEM	QTY	NAME	MATERIAL	DESCRIPTION
1	14-0935				
			<b>WANG</b> LABORATORIES, INC. TOWERSBURT MADE U.S.A.	BY	DATE
MATERIAL	MODEL NO DISKS		CHK	E ENGR	
FINISH	SEE ENGR SPECIFICATIONS No. ES-1-01		E C CONTROL	M ENGR	
TOL EX AS NOTED XX ± 0.10 FRAC ± 1/64 XXX ± 0.05 ANG ± 1°30' FINISH ✓			TITLE I.O. CABLE ASSY. (WAL DISK C-ES-14-0866-3)		
SCALE N.T.S.	SHT 1 OF 1	WANG PART NUMBER	SIZE	DRAWING NUMBER	REV
		C 6472-61		C 6472-61	1.4

REVISION	DATE	BY	DESCRIPTION
4	3-25-74	RFA	REVISED PER RFA 0744 3-5-74
5	4-15-74	R.F.A.	REVISED PER R.F.A. #0847. APPD BY 4-5-74
6	5-20-74	RFA	REVISED PER RFA #0959 5-28-74
7	6-10-74	RFA	REV. PER ECN 4195 6-10-74
8	7-11-74	RFA	REV. PER ECN 4195 7-11-74
9	8-1-75	RFA	REV. PER ECN 4257 8-1-75
10	9-10-75	RFA	REV. PER ECN 4309 9-10-75
11	10-10-75	RFA	REV. PER ECN 4316 10-10-75
12	11-17-75	RFA	REV. PER ECN 4317 11-17-75
13	12-17-75	RFA	REV. PER ECN 4317 12-17-75
14	1-16-76	RFA	REV. PER ECN 4317 1-16-76

92

C 6472-61

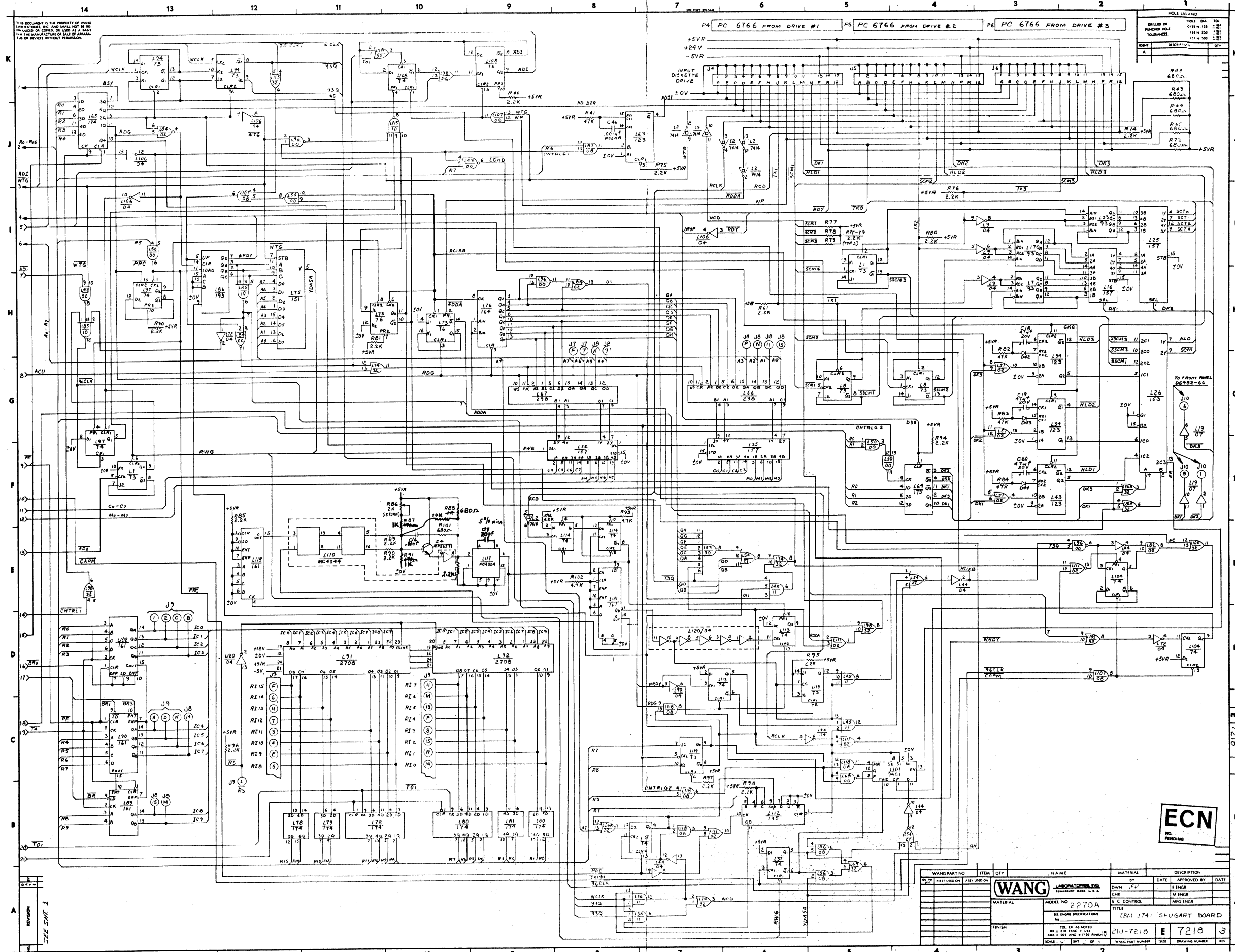


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REV	DESCRIPTION	DATE
1	INITIAL REV	10-27-66
2	REVISED FOR	11-15-66
3	REVISED FOR	11-15-66
4	REVISED FOR	11-15-66
5	REVISED FOR	11-15-66
6	REVISED FOR	11-15-66
7	REVISED FOR	11-15-66
8	REVISED FOR	11-15-66
9	REVISED FOR	11-15-66
10	REVISED FOR	11-15-66
11	REVISED FOR	11-15-66
12	REVISED FOR	11-15-66
13	REVISED FOR	11-15-66
14	REVISED FOR	11-15-66

WANG PART NO.	ITEM	QTY	NAME	MATERIAL	DESCRIPTION
100-100000	1	1	RESISTOR	100-100000	RESISTOR
100-100001	1	1	RESISTOR	100-100001	RESISTOR
100-100002	1	1	RESISTOR	100-100002	RESISTOR
100-100003	1	1	RESISTOR	100-100003	RESISTOR
100-100004	1	1	RESISTOR	100-100004	RESISTOR
100-100005	1	1	RESISTOR	100-100005	RESISTOR
100-100006	1	1	RESISTOR	100-100006	RESISTOR
100-100007	1	1	RESISTOR	100-100007	RESISTOR
100-100008	1	1	RESISTOR	100-100008	RESISTOR
100-100009	1	1	RESISTOR	100-100009	RESISTOR
100-100010	1	1	RESISTOR	100-100010	RESISTOR

**ECN**  
NO PENDING



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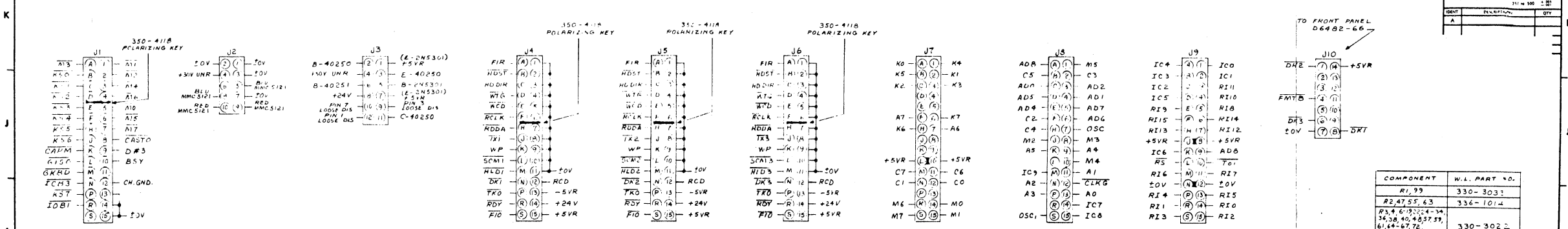
REV	DESCRIPTION	DATE	BY
A			

**ECN**  
 NO. PENDING

WANG PART NO.	ITEM	QTY	NAME	MATERIAL	DESCRIPTION	DATE	APPROVED BY
			<b>WANG</b>	LABORATORIES, INC.			
			MODEL NO.	2270A			
			TITLE	1571 3741 SHUGART BOARD			
			DATE	11-11-71			
			SCALE	1:1			
			WANG PART NUMBER	210-7218			
			SIZE	E 7218			
			DRAWING NUMBER	3			

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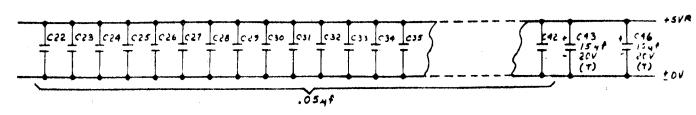
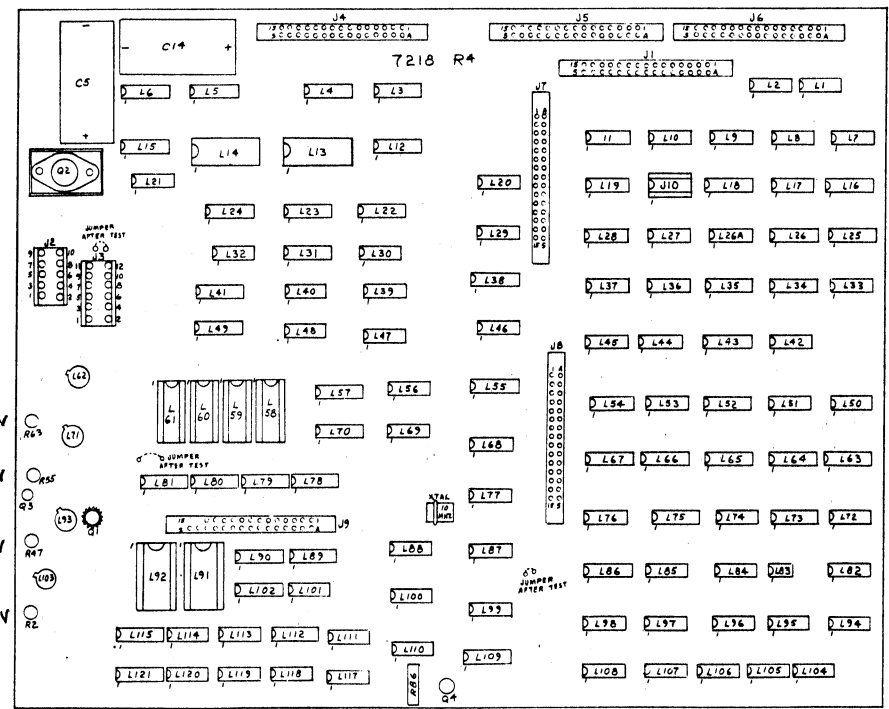
14 13 12 11 10 9 8 7 6 5 4 3 2 1



COMPONENT	W.L. PART NO.
R1, 99	330-3031
R2, 47, 55, 63	336-1014
R3, 4, 6, 19, 24, 34, 36, 38, 40, 48, 57, 59, 61, 64, 67, 72, 74, 81, 85, 89, 90, 92, 94-98	330-3022
R5, 37, 105	330-4027
R20	330-5011
R21	330-6014
R23, 35, 87, 91, 107	330-2047
R39	330-2021
R41, 82-84	330-4047
R24, 49, 60, 73, 101	330-2061
R44	330-2013
R45, 103	330-3021
R46, 58	330-3021
R50, 51	331-0011
R52, 53, 93, 100, 102, 106	330-3047
R54	330-2054
R56	330-3015
R62, 69	330-3015
R68	330-2021
R70, 71	330-2021
R86	336-1022
R88	330-3011
R108	330-2033
C1	300-1022
C2, 46	300-2011
C3, 10	300-1903
C4, 7	300-1917
C5	300-3055
C6, 15, 43, 46	300-4022
C8	300-3011
C9, 22-42	300-1911
C11, 45, 47	300-1914
C12	300-1916
C13	300-1010
C14	300-3054
C16	300-1901
C17	300-5016
C18-20	300-4034
C21	300-1100
C44	300-2025
XTAL	321-0008
D1-31, 42-44, 46	380-1001
D32	380-2091
D33, 34	380-3008
D35, 36, 39, 40	380-4000
D37	380-2051
D38, 45	380-0000
D41	380-2042
Q1	375-1027
Q2	375-1031
Q3	375-1006
Q4	375-1061
J2	654-1172
J3	654-1188
J10 14 PIN SOCKET	376-9012
24 PIN SOCKET	376-9003
22 PIN SOCKET	376-9010
J1, 4-9	350-0011
C48	300-1913

LOCATION	W.L. PART NO.	QTY	REMARKS
L1, 8, 94, 119	376-0005	11	4
L9-11, 20, 30, 44, 72, 87, 106, 120	376-0010	7	14
L3, 6, 67, 6	376-0138	8	16
L4, 5, 12, 15, 26	376-0048	8	16
L7, 17, 33	376-0011	10	5
L13, 14	376-0099	12	24
L16, 22-25, 35, 52	376-0082	8	16
L18, 65, 78, 79, 80, 81	376-0090	8	16
L19	376-0005	7	14
L21	376-0005	7	14
L27, 28	376-0008	7	14
L29, 42, 48, 50, 68, 96	376-0002	7	14
L31, 38	376-0006	8	16
L32	376-0012	7	14
L34, 43, 63	376-0009	8	16
L36, 45	376-0194	7	14
L37, 37, 104, 108, 113, 114	376-0002	7	14
L39, 56, 82, 99, 107, 118	376-0001	7	14
L24, 40, 69, 74, 98, 100, 105	376-0003	7	14
L41, 49	376-0009	8	16
L46, 51, 64, 111	376-0016	7	14
L47, 85	376-0003	7	14
L53	376-0001	7	14
L54	376-0125	7	14
L55, 73, 109	376-0007	13	5
L57, 70, 86	376-0003	8	16
L58, 59, 60, 61	377-1108	8	24
L62, 71, 93, 103	376-0066	8	16
L64	376-0119	8	16
L75	376-0047	8	16
L77	376-0073	10	5
L76, 88	376-0102	7	14
L83	376-0126	1	8
L89, 90, 102, 115, 121	376-0094	8	16
L71, 72	377-0317	12	24
L101	376-0264	7	14
L110	376-0097	8	16
L112	376-0263	7	14
L117	376-0139	7	14
L95	376-0180	7	14
L116	NOT USED		

LOCATION	TYPE	SPARES
L19	7407	1
L26A	7432	1
L29	7400	1
L36	7411	1
L48	7400	1
L56	7408	2
L63	74123	1
L72	7404	3
L74	7432	1
L82	7408	1
L95	741504	1
L96	7400	1
L107	7408	1
L109	7416	1



ECN  
NO. PENDING

WANG PART NO.	ITEM	QTY	NAME	MATERIAL	DESCRIPTION
376-0005	11	4			
376-0010	7	14			
376-0138	8	16			
376-0048	8	16			
376-0011	10	5			
376-0099	12	24			
376-0082	8	16			
376-0090	8	16			
376-0005	7	14			
376-0005	7	14			
376-0008	7	14			
376-0002	7	14			
376-0006	8	16			
376-0012	7	14			
376-0009	8	16			
376-0194	7	14			
376-0002	7	14			
376-0003	7	14			
376-0009	8	16			
376-0016	7	14			
376-0003	7	14			
376-0001	7	14			
376-0125	7	14			
376-0007	13	5			
376-0003	8	16			
377-1108	8	24			
376-0066	8	16			
376-0119	8	16			
376-0047	8	16			
376-0073	10	5			
376-0102	7	14			
376-0126	1	8			
376-0094	8	16			
377-0317	12	24			
376-0264	7	14			
376-0097	8	16			
376-0263	7	14			
376-0139	7	14			
376-0180	7	14			
NOT USED					

## APPENDIX D

### 2270 TO 2270A CONVERSION

The 2270A-1, 2270A-2, and 2270A-3 are improved versions of the Model 2270 Shugart Floppy Disk Chassis. While the 2270 accommodates only Wang formatted diskettes, the 2270A can accommodate Wang diskettes and the IBM 3740 diskettes as well. However, before the IBM 3740 diskettes can be used in the 2270A, they must be formatted by IBM.

The older 2270 may be upgraded to the 2270A by a conversion kit. This kit (WLI #200-0270) contains the 210-7218 Microprocessor Board (IBM Format Compatible) and the ribbon cables for connecting this board to the Shugart Diskette Drives. These ribbon cables are R2 versions of the old cables used in the 2270; the R1 cables cannot be used with the IBM diskettes unless they are first modified (See appendix B).

The I/O cable assembly (WLI #220-0066-4) supplied with newly manufactured 2270A's is compatible with both the 2270 and the new 2270A. This I/O cable is not contained in the conversion kit.

The older 2270 I/O cable assembly (WLI #220-0066-3) may be upgraded for use with the 2270A by cutting and tying back pin 11 on the cable fingerboard. Pin 11 is +5V.

#### CAUTION:

Do not use the 2270 I/O cable with the 2270A unless it is first upgraded by disconnecting pin 11. Failure to regard this warning may result in damage to the I/O controller in the 2200 CPU.

APPENDIX E

ECN's, 7218 BOARD

The 7218 is currently at E-REV 3.

The two latest ECN's will be listed.

ECN #7655:

7218 P.C.

1. Add a .02  $\mu$ f 25V +80-20% Ceramic Cap WLI #300-1904  
From: L18 pin 4  
To: Ground
2. Add a .002  $\mu$ f 200V 20% Ceramic Cap WLI #300-1913  
From: L9 pin 12  
To: Ground
3. Cut the etch (or remove the jumper) leading from L18  
pin 4 to L29 pin 1.
4. Add a jumper from L29 pin 1 to L18 pin 5.

REASON FOR CHANGE:

To eliminate intermittent errors 61 and 85.

This ECN increments the Electronic Revision Level to  
E-REV 2.

ECN #7821:

7218 P.C.

1. Add 10 K $\Omega$  1/4 W 10% Resistor WLI #330-4010  
From: The junction of R88 and R101  
To: The junction of C16 and R89 (see figure)
2. Add a 2.2 K $\Omega$  1/4 W 10% Resistor WLI #330-3022  
From: L117 pin 2  
To: L117 pin 1
3. Change R87  
From: 470 $\Omega$  1/4 W 10% Resistor WLI #330-2047  
To: 1 K $\Omega$  1/4 W 10% Resistor WLI #330-3010
4. Change R88  
From: 1 K $\Omega$  1/4 W 10% Resistor WLI #330-3010  
To: 680 $\Omega$  1/4 W 10% Resistor WLI #330-2068
5. Change R91  
From: 470 $\Omega$  1/4 W 10% Resistor WLI #330-2047  
To: 1 K $\Omega$  1/4 W 10% Resistor WLI #330-3010
6. Change C16  
From: 1  $\mu$ f 10V 20% Ceramic Cap WLI #300-1901  
To: .01  $\mu$ f 25V +80-20% Ceramic Cap WLI #300-1903
7. Change C17  
From: 33 pf 5% 500V Mica Cap WLI #300-5016  
To: 20 pf 5% 500V Mica Cap WLI #300-5018

REASON FOR CHANGE:

To eliminate temporary drift of phase lock loop circuit.

This ECN increments the Electronic Revision Level to E-REV 3.



