

MODEL 715DEC  
DISK STORAGE DRIVE  
OPERATION, SERVICE,  
AND DIAGRAMS

UD002341-2

**ITEL**  
CORPORATION  
FIELD ENGINEERING DIVISION

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# CHAPTER 1 GENERAL INFORMATION

## 1.1 INTRODUCTION

This manual provides installation, operation and service instructions, and parts information for the Model 715 DEC Disk Storage Drive (figure 1-1). The Model 715 DEC is a high-performance, direct-access, single head per surface drive which enables a data processing system to store or retrieve information at random from a rotating disk pack.

## 1.2 MANUAL CONTENT

The Model 715 DEC Operation and Service Manual is divided into nine chapters. The following paragraphs briefly describe the contents of each chapter.

### 1.2.1 Chapter 1, General Information

General information provides drive specifications, equipment description, introductory material, and a description of manual contents.

### 1.2.2 Chapter 2, Installation

Chapter 2 discusses unpacking, inspection, setup, and interconnection of the drive into a subsystem.

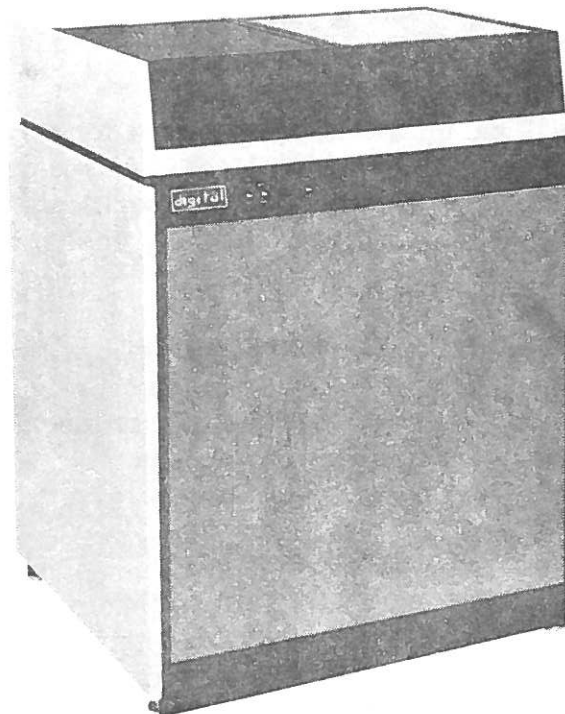


Figure 1-1. 715 DEC Disk Storage Drive

### **1.2.3 Chapter 3, Operation**

Chapter 3 discusses controls, indicators, and their functions. Installation and removal of the disk storage pack is included.

### **1.2.4 Chapter 4, Functional Description**

The drive functional description discusses the functional operations performed by the drive. In addition, an analysis of the generation of each signal in the drive is presented.

### **1.2.5 Chapter 5, Maintenance**

Chapter 5 presents maintenance philosophy, required special tools, test equipment, and a preventive maintenance schedule.

### **1.2.6 Chapter 6, Checks and Adjustments**

Electrical and mechanical checks and adjustments are contained in Chapter 6.

### **1.2.7 Chapter 7, Error Analysis**

This chapter contains procedures, tables and charts designed to assist in troubleshooting.

### **1.2.8 Chapter 8, Replacement Procedures**

Chapter 8 presents removal and installation procedures for two classes of items: first, those most likely to be removed and replaced and, second, those items the removal and replacement of which may be difficult or critical.

### **1.2.9 Chapter 9, Diagrams**

This chapter contains logic, schematic, and cable diagrams, a description of the logic symbols used, and sets of normal waveforms. Printed wiring assembly (PWA) locations in the electronic gate are also provided, as well as block diagrams, flow charts, and timing diagrams of each drive functional operation.

## **1.3 SYSTEM DESCRIPTION**

The Model 715 DEC operates as a satellite by responding to commands issued by a control unit (CU). Several drives can communicate with the same CU, depending on the customer facilities. All drives in a subsystem may be stopped or started from a central location via the CU, provided that the individual START/STOP switches at each drive are positioned to START. The operator can monitor and/or intervene at any time to stop and restart a drive, to interchange disk packs between drives, or to install a disk pack from the shelf.

- Up to eight 715 DEC drives may be connected to the control unit.
- All eight drives may be operational (on-line) at any one time.
- Interchangeable selected IBM 2316 disk packs (or equivalent) are used with each drive.
- Drive control panel lights indicate status condition which affect the drive performance.
- Self-checking logic verifies drive operational readiness each time it is started.
- Monitor circuits protect data integrity during each read/write operation.

### **1.3.1 Disk Pack Description**

The storage medium is a flat, rotating magnetic disk. Disks are packaged in a stack of 11, enclosed in a removable cover. The packs provide large amounts of on-line storage and virtually unlimited off-line storage. Figure 1-2 shows disk pack layout.

### **1.3.2 Basic Operations**

The Model 715 DEC drive positions the read/write heads over a selected cylinder and reads and writes data on the disk. The drive unit also provides status signals to enable the CU to monitor drive operations.

Twenty read/write head-arm assemblies are mounted vertically in ten pairs on a movable carriage to read or write on upper and lower disk surfaces. The carriage is driven horizontally by an electromagnetic actuator (EMA) in a forward or reverse direction to position all 20 heads at a particular cylinder position within the pack. Any one of the 20 heads can be selected to read or write on the 20 tracks contained within the cylinder.

The selection of a particular head to read or write on a track occurs in microseconds of switching time, whereas the horizontal motion to move from one cylinder to another requires milliseconds of access time.

## **1.4 SPECIFICATIONS**

Model 715 DEC Disk Storage Drive specifications are listed in Table 1-1.



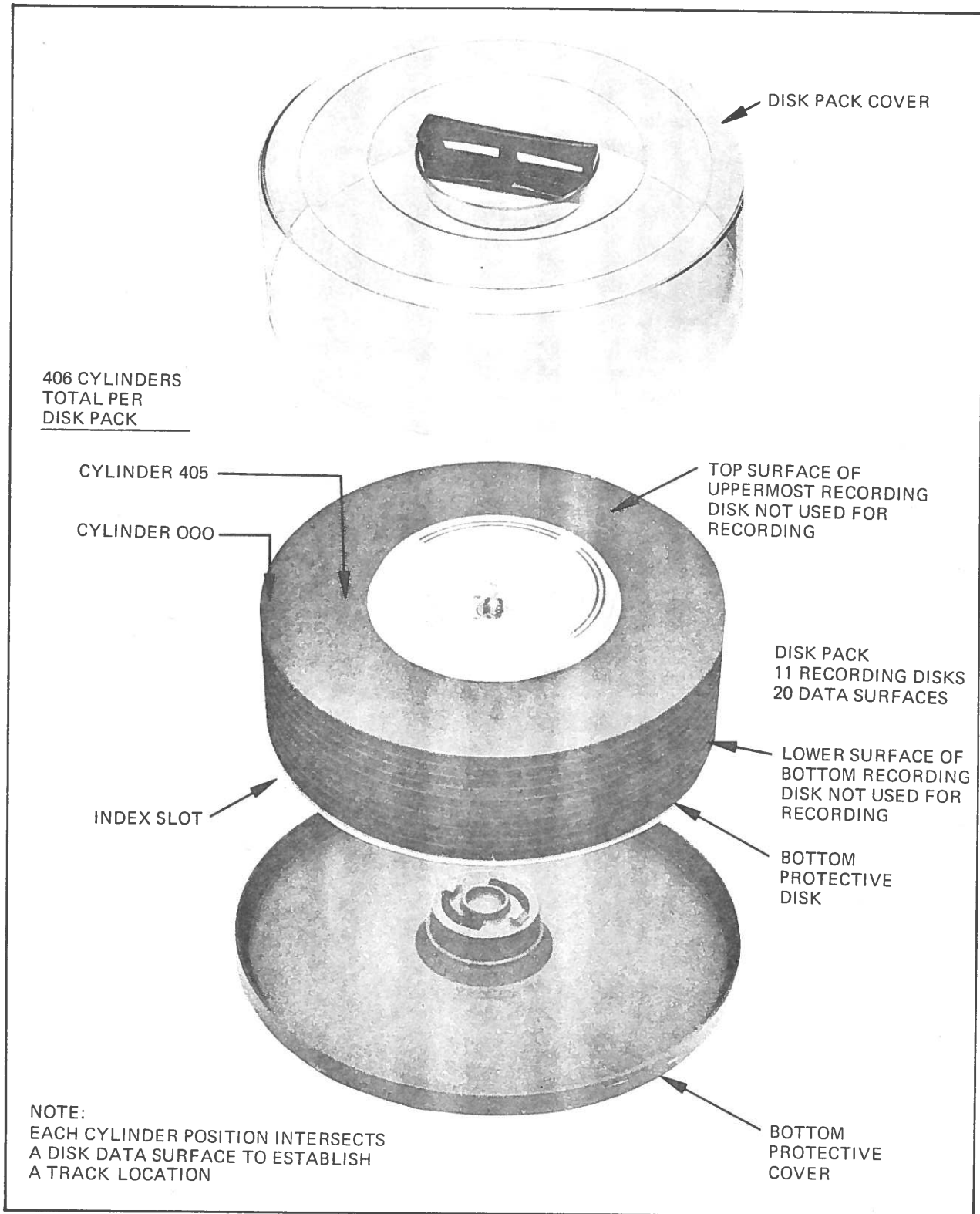


Figure 1-2. Disk Pack Layout

Table 1-1. Model 715 DEC Specifications

CHARACTERISTICS	SPECIFICATIONS
<b>ACCESSING:</b>	
Access drive motor	Electromagnetic actuator
Access control	Closed-loop electro-optical servo electronics
Direct access motion-	
Coarse positioning mode	Initially moves heads to desired cylinder region
Fine positioning linear mode	Locates head assembly in registration at the selected cylinder
Access timing-	
One cylinder seek	7.5 ms
Average seek	29 ms
Maximum seek	55 ms
Average rotational latency time	12.5 ms
<b>OPERATION:</b>	
Start-up time*	20.5 seconds
Disk rotational speed	2400 RPM $\pm$ 2% (counterclockwise)
Disk rotational period	25 ms
Disk pack stop time **	25 seconds
Disk drive motor	1/2 HP induction, 208/230 VAC
<b>READ/WRITE:</b>	
Storage device	Sectored IBM 2316 disk pack or equivalent
Disk diameter	14 inches
Number of disks	11
Number of magnetic recording surfaces	20 (uppermost recording surface is numbered zero)
Number of cylinders per disk pack	406 (includes 6 spare cylinders)
Number of tracks per cylinder	20
Total number of tracks	406 per disk surface (8120 per pack, includes 120 spare tracks)
Data bytes per track	7,294
Data bytes per cylinder	145,880
Data bytes per disk pack	58.352 Megabytes
Data rate (nominal)	312 Kilobytes/second

\* A unique temperature compensation system permits fast start-up. Time includes complete brush cycle, head load, and seek to position the read/write heads at cylinder 000.

\*\* The maximum time required for disk pack to stop rotating after setting START/STOP switch to STOP.

Table 1-1. Model 715 DEC Specifications (Continued)

CHARACTERISTICS	SPECIFICATIONS
<p>RECORDING DATA:</p> <p>Disk recording band</p> <p>Track numbering scheme</p> <p>Recording method</p> <p>Clock frequency</p> <p>Read back data-bit cell time</p> <p>Read data pulse width</p> <p>Write data pulse width</p> <p>Number of recording heads</p> <p>Data compatibility</p>	<p>2,030 inches (406 tracks)</p> <p>000-outer; 405-inner</p> <p>Double frequency</p> <p>2.50 MHz</p> <p>400 ns (nominal)</p> <p>70 ± 15 ns</p> <p>70 ± 15 ns</p> <p>20</p> <p>Model 715 DEC can read and alter 400-cylinder pack data written by other 715 DEC drives if same data format is used by both drives and appropriate software is implemented by its control unit.</p>
<p>OPERATING ENVIRONMENT:</p> <p>Temperature range</p> <p>Humidity range</p> <p>Drive cooling (internal)</p> <p>Air circulation (internal)</p> <p>Heat dissipation</p>	<p>60°F min. to 90°F max.</p> <p>8% min. to 80% max (maximum wet bulb temperature 83°F)</p> <p>Forced room air, ambient temperature</p> <p>Ducted 50-70 cfm, filtered (filter removes 0.3 micron particle size)</p> <p>3500 BTU/hr.</p>
<p>POWER:</p> <p>Primary power requirement (single-phase voltage used at each drive is rotated by individual drives for balanced loading)</p> <p>Dissipation</p> <p>DC supply voltages (developed by internal power supply)</p>	<p>208/230 VAC ± 10%, 3 phase, 60 Hz ± 1%. (50 Hz design option available) Starting current surge not to exceed five times the normal operational current of six amperes.</p> <p>1.1 KVA</p> <p>-47.5 V ± 8%</p> <p>+12.5 V ± 8%</p> <p>-12.5 V ± 8%</p> <p>+20.5 V ± 5%</p> <p>+5 V ± 5%</p> <p>+30 V ± 5%</p>

Table 1-1. Model 715 DEC Specifications (Continued)

CHARACTERISTICS	SPECIFICATIONS
<p><b>PHYSICAL CHARACTERISTICS:</b></p> <p>Height</p> <p>Width</p> <p>Depth</p> <p>Weight</p> <p>Mounting</p> <p>Connecting cables</p> <p>Installation clearances</p>	<p>40 inches</p> <p>30 inches</p> <p>24 inches</p> <p>415 pounds</p> <p>Casters and levelers</p> <p>One each: signal, DC, and AC power. Cable entry is between floor and bottom edge of rear service covers.</p> <p>3 feet minimum front and rear for service access; 1.5 feet minimum rear clearance for cooling air.</p>



## CHAPTER 2 INSTALLATION

### 2.1 INTRODUCTION

Follow these procedures to install a Model 715 DEC Disk Storage Drive in a subsystem. A checklist (table 2-1) is provided to check off each completed procedural step while installing a drive.

#### 2.1.1 Unpacking and Receiving Inspection

The Model 715 DEC may be crated, as for overseas shipment, or it may be packaged in a heavy, transparent protective plastic film, as for domestic and most air freight shipments. Because the Model 715 DEC weighs 415 pounds, a forklift or adequate manpower (a minimum of four men) must be employed to move or lift a crated drive.

#### CAUTION

Always grasp drive by frame structure to move or lift. Do not hold any portion of top cover or side panel.

#### CRA TED DRIVE

1. Disassemble wooden shipping crate. Retain packing parts for future use.
2. Remove cardboard sleeve and plastic covering from drive.
3. Visually inspect drive exterior for evidence of shipping damage. Retain original packing materials and receipts if claims are filed for shipping damage. All claims for damage should be filed promptly with the transportation company involved. Notify the manufacturer's representative of any claim.
4. Remove covers for inspection (figure 2-1). Remove front access panel, lower rear access panel, and top rear access panel by grasping upper edge of panel and pulling away from frame structure. Remove manual and strapping from inside front access panel. Remove package from inside rear area. Verify that contents include two kick strips, six screws, an installation report form, and an identification marking strip.
5. Raise operator cover and manually turn spindle to check the spindle hold brake. Spindle should lock to verify that it will hold the pack.
6. Remove top cover assembly by pushing rear retainer clamps forward to unlock mounting studs at rear of cover. Lift entire assembly from rear to free it from studs and slide forward to remove it from frame.
7. Visually inspect internal areas of unit above and below baseplate. Look for loose connections on such items as fuse holders, filters, and screws that may have occurred during shipment. Verify that all screw terminals are tight.

Table 2-1. Checklist of 715 DEC Installation Requirements

PARAGRAPH	ITEM	CHECKED
	UNPACKING AND INSPECTION	
2.1.1	Unpacking and Receiving Inspection	<input type="checkbox"/>
	OFF-LINE CHECKOUT	
2.2	Equipment Setup	<input type="checkbox"/>
2.3	Interconnection	<input type="checkbox"/>
2.4.1	Power Supply Voltage Check	<input type="checkbox"/>
2.4.2	Hold Reverse Current Check (See Note)	<input type="checkbox"/>
2.5.1	Head Load Check	<input type="checkbox"/>
2.5.2	Drive Motor Start-Inhibit Check	<input type="checkbox"/>
2.5.3	Access Velocity Check and Adjustment	<input type="checkbox"/>
2.5.4	Read/Write Head Alignment	<input type="checkbox"/>
	ON-LINE CHECKOUT	
2.6	Running Diagnostics	<input type="checkbox"/>

**NOTE:** Before performing a hold reverse current check, install a disk pack.

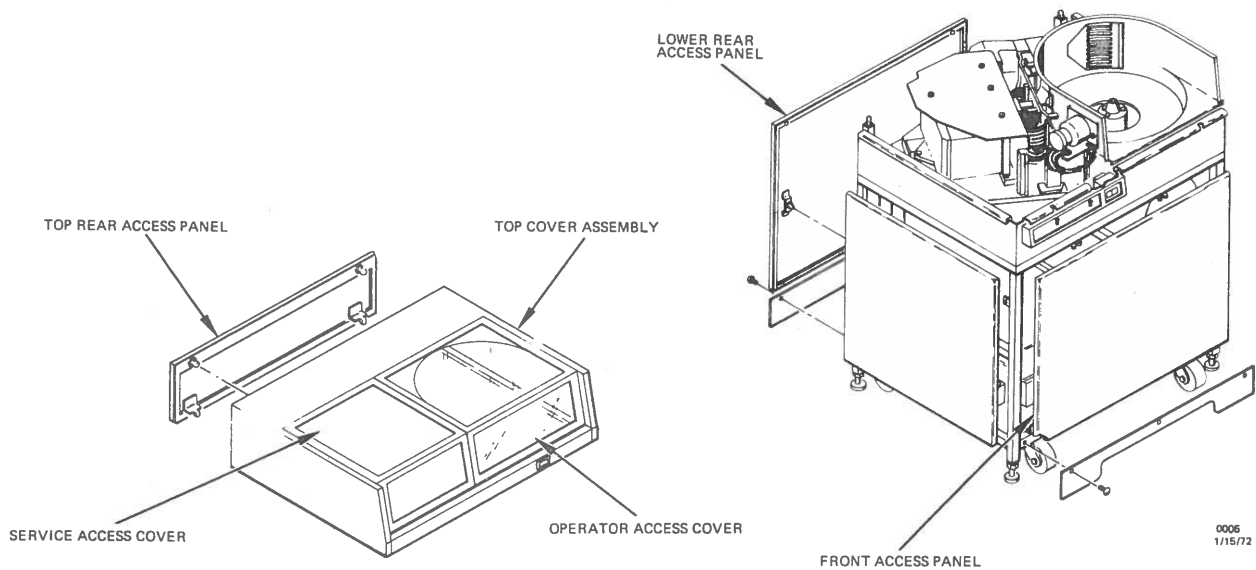


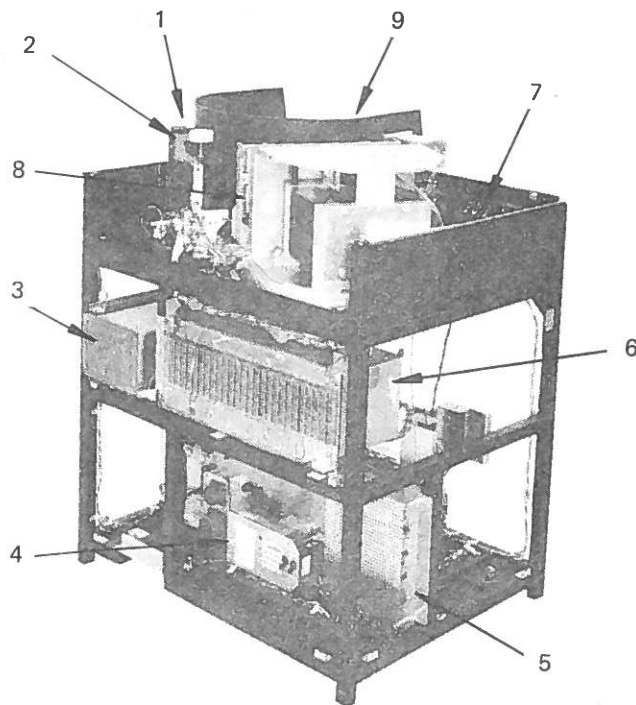
Figure 2-1. Model 715 DEC Disk Storage Drive,  
Service Access Covers

**NOTE:** The drive is transported with a carriage lock installed by the factory to prevent excessive carriage motion. The lock is mounted on the EMA shield at the top of the carriage assembly. Do not remove the lock at this time.

8. Open electronic gate (figure 2-2) and check all printed wiring assemblies (PWA's) and paddle boards to ensure that all are securely connected in their sockets.
9. Remove air deflector secured by three screws (figure 2-2) and visually check primary and secondary gratings on access transducer (below and behind read/write heads) for cracks, obstructions, or other irregularities.
10. Check positioning of matrix PWA's on cam tower for proper seating in sockets. Ensure that all head plugs are properly seated.
11. Visually check position of torsion rods on head-arm assemblies for proper contact with load button on read/write heads. Refer to Chapter 5 for unload and load procedure.
12. Visually check cam-follower surface of each head-arm assembly to verify that arms are properly engaged with cams on cam tower.
13. Check drive belt installation and spindle by manually turning the spindle to verify that it spins freely.



14. Check EMA coil resistance across terminals 15 and 16 of PD1 on rear of power driver to ensure that no shorts or opens exist and to verify that resistance is within 2.0 to 2.5 ohms.
15. Check pivot action of index transducer by pressing index transducer push rod and determine that transducer moves away from spindle.
16. Replace all covers if off-line checkout is not to be accomplished at this time.



ITEM	DESCRIPTION
1	BRUSH DRIVE
2	AIR DEFLECTOR
3	PREFILTER
4	SEQUENCE PANEL
5	POWER DRIVER
6	ELECTRONIC GATE
7	LAMPS
8	MATRIX CARD
9	SHROUD

Figure 2-2. Disk Storage Drive, Rear View, Covers Removed

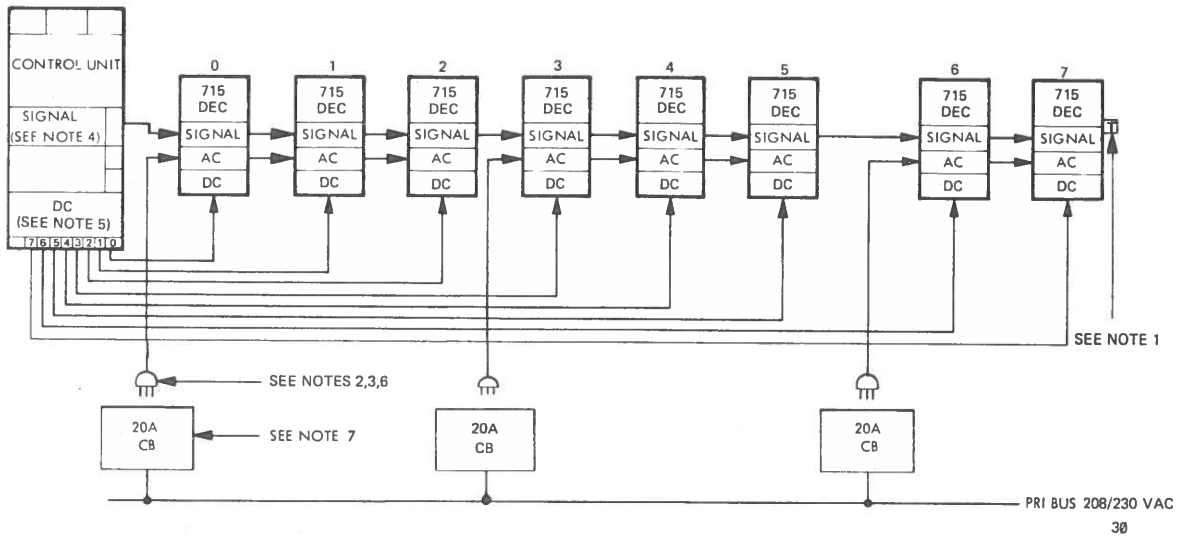
## 2.2 EQUIPMENT SET-UP

Roll the drive to its assigned location in the subsystem and position it in place. Level drive by lowering the four leveller jacks to remove all weight from casters. Jacks should be adjusted so that top of drive is even with tops of other drives in subsystem.

Wipe off all exterior covers using a lint-free wiper dampened with 90% isopropyl alcohol.

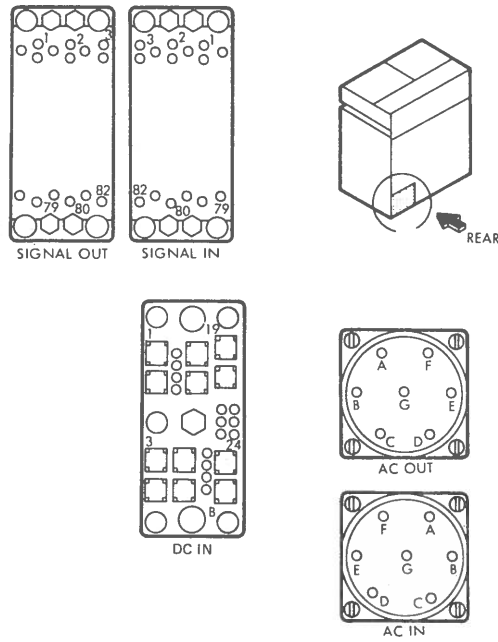
## 2.3 INTERCONNECTION

Input to each drive is effected by three cables: AC power cable, DC cable, and signal bus cable. Up to three Model 715 DEC drives may be connected to a single AC power cable string as shown in figure 2-3. A separate DC cable connection is made to each individual drive from the control unit. Only one signal bus cable is connected to the CU; additional drives obtain signal bus connections from the preceding drive.



NOTES:

1. Signal Terminator is installed on SIGNAL OUT connector of last drive in subsystem.
2. Three drives are jumper connected to one primary power outlet.
3. Total AC cable length from each primary power outlet must not exceed 100 feet.
4. Signal cable is jumper-connected from drive-to-drive and control unit inclusive (maximum accumulated cable length is 100 feet).
5. DC cable is connected one to each drive from control unit. Maximum length for each DC cable is 50 feet.
6. Primary power cable terminates at the wall power outlet or control unit power outlet.
7. Each facility PRI PWR outlet must be provided with a 20 A CB which is UL approved for branch circuit protection.



DETAIL OF 715DEC DRIVE RECEPTACLE ARRANGEMENT

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Figure 2-3. Drive/Control Unit Interface Connections

The maximum length of each DC cable is 50 feet. Both AC power cables and signal bus cables are limited to a maximum accumulated length of 100 feet. AC and signal bus cables are available in individual lengths from 5 to 50 feet, while DC cables are available in 10- to 50-foot lengths. The last drive in the subsystem must have a signal terminator connected to its signal output receptacle. Cable and terminator part numbers are found in the Parts Identification Manual, UP002341-2.

### 2.3.1 AC Power Connection

#### 60-Hz POWER

Check line voltage and verify that drive power transformer connections agree with the line voltage requirement for 208 or 230 VAC input. An adjustable primary tap is located on each of the two power transformers for selecting 208 or 230 VAC input power. The drive is shipped with connections arranged as specified by the label on the sequence panel. To change the input voltage level, it is necessary to rearrange the input power leads on terminal board PS2 (located on power transformer T1) and terminal board SP1 (located inside the sequence panel). See figure 2-4.

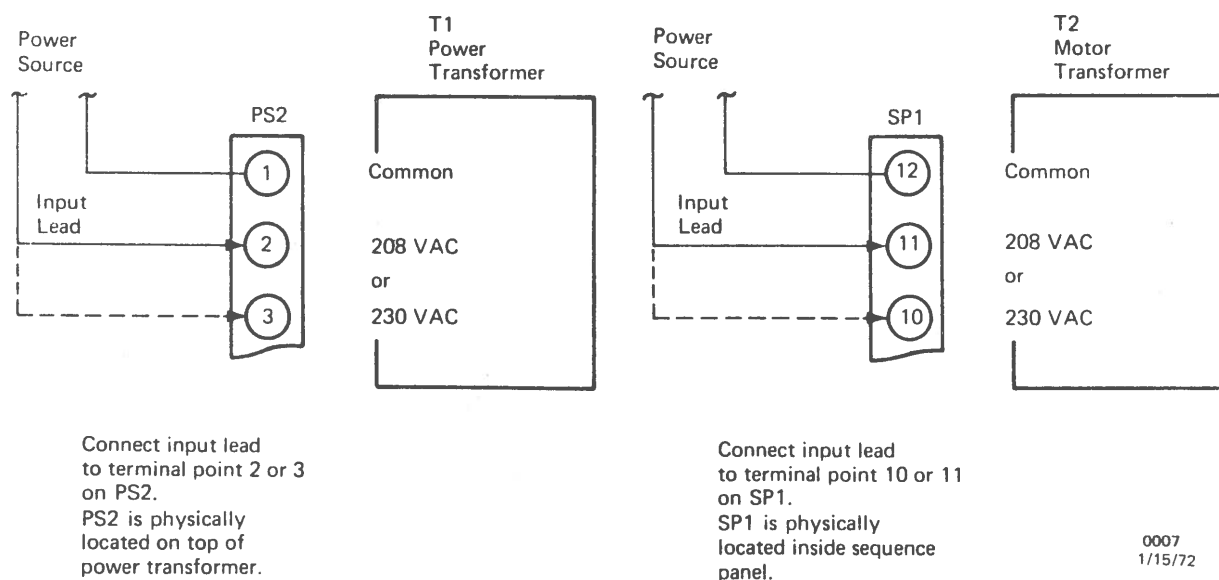


Figure 2-4. 208/230 VAC Input Power Connections

## 50-Hz POWER

The optional 50-Hz version of the Model 715 DEC includes special power transformers, brush motor, and associated components for use with 220V, 3-phase, 50-Hz, wye-or delta-connected primary power supplies. Appendix A describes 50-Hz power requirements, drive characteristics, and wiring connections.

### 2.3.2 Interconnection Procedure

1. Route AC, Signal, and DC cables through floor port in unit.
2. Place sequence panel circuit breaker CB1 to OFF and power driver circuit breakers CB2 and CB3 to OFF. See figure 2-5 for circuit breaker locations.
3. Connect AC power cable to drive AC IN receptacle and to AC OUT of another drive or the CU. If more than one drive is being connected in the system, connect last drive first, then work up drive string to connect first drive to the Primary Power receptacle. See figure 2-3.

**NOTE:** Up to three drives maximum can be connected to the Primary Power receptacle. Any Primary Power outlet may be used instead, if it is equipped with a 20A circuit breaker which is UL approved for branch circuit protection.

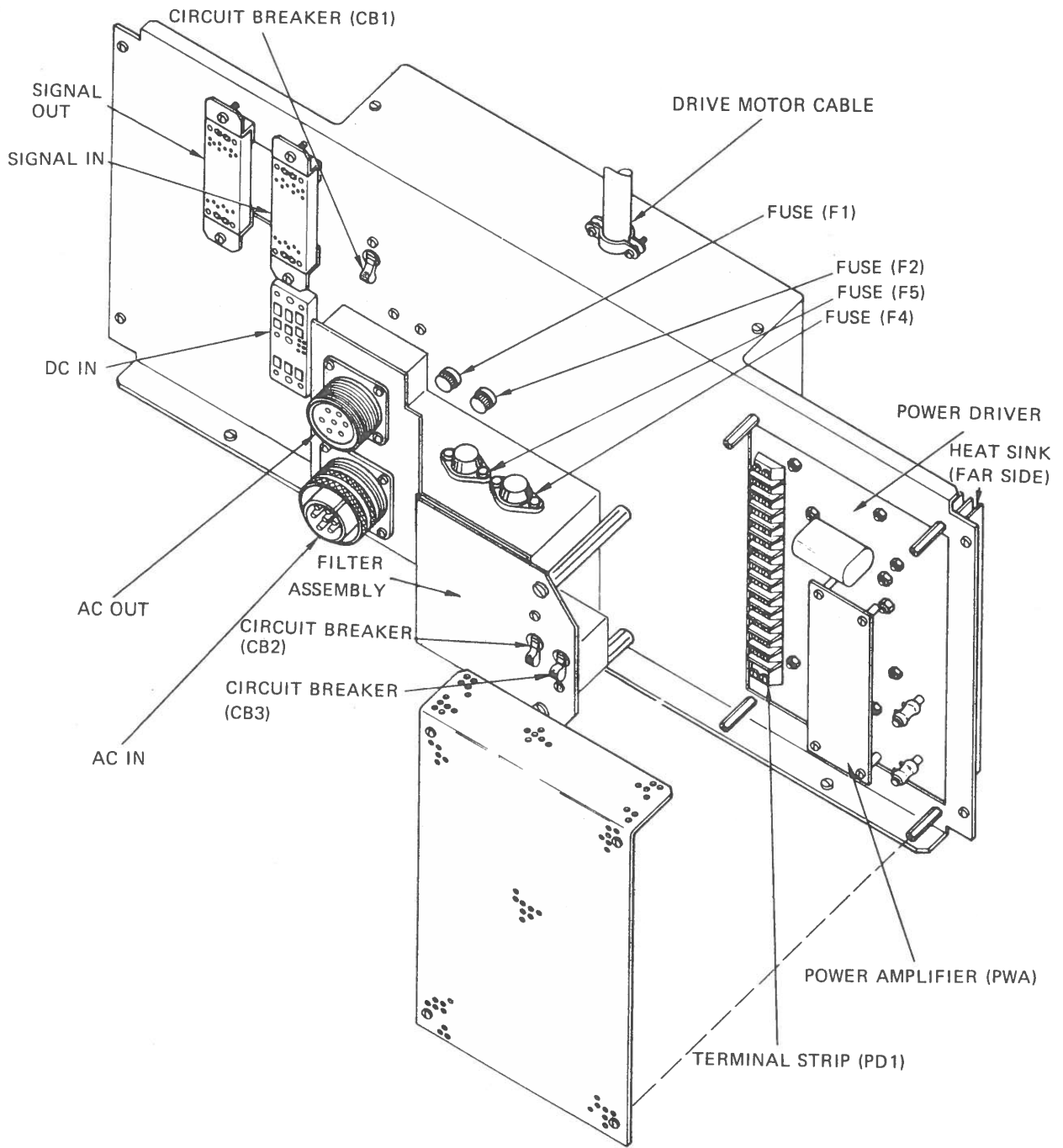
4. Connect one end of DC cable to drive DC receptacle and connect other end of cable to CU DC receptacle, as shown in figure 2-3.
5. Install signal terminator at last drive's SIGNAL OUT receptacle. Connect one end of signal cable to last drive's SIGNAL IN receptacle and connect other end to SIGNAL OUT receptacle of next drive in line. Repeat signal cable connections for all units being installed until first drive in line is connected to CU SIGNAL receptacle.
6. Operate CB1 at installed drive to verify that system power is present.

## 2.4 VOLTAGE AND CURRENT CHECKS

### 2.4.1 Power Supply Voltage Checks

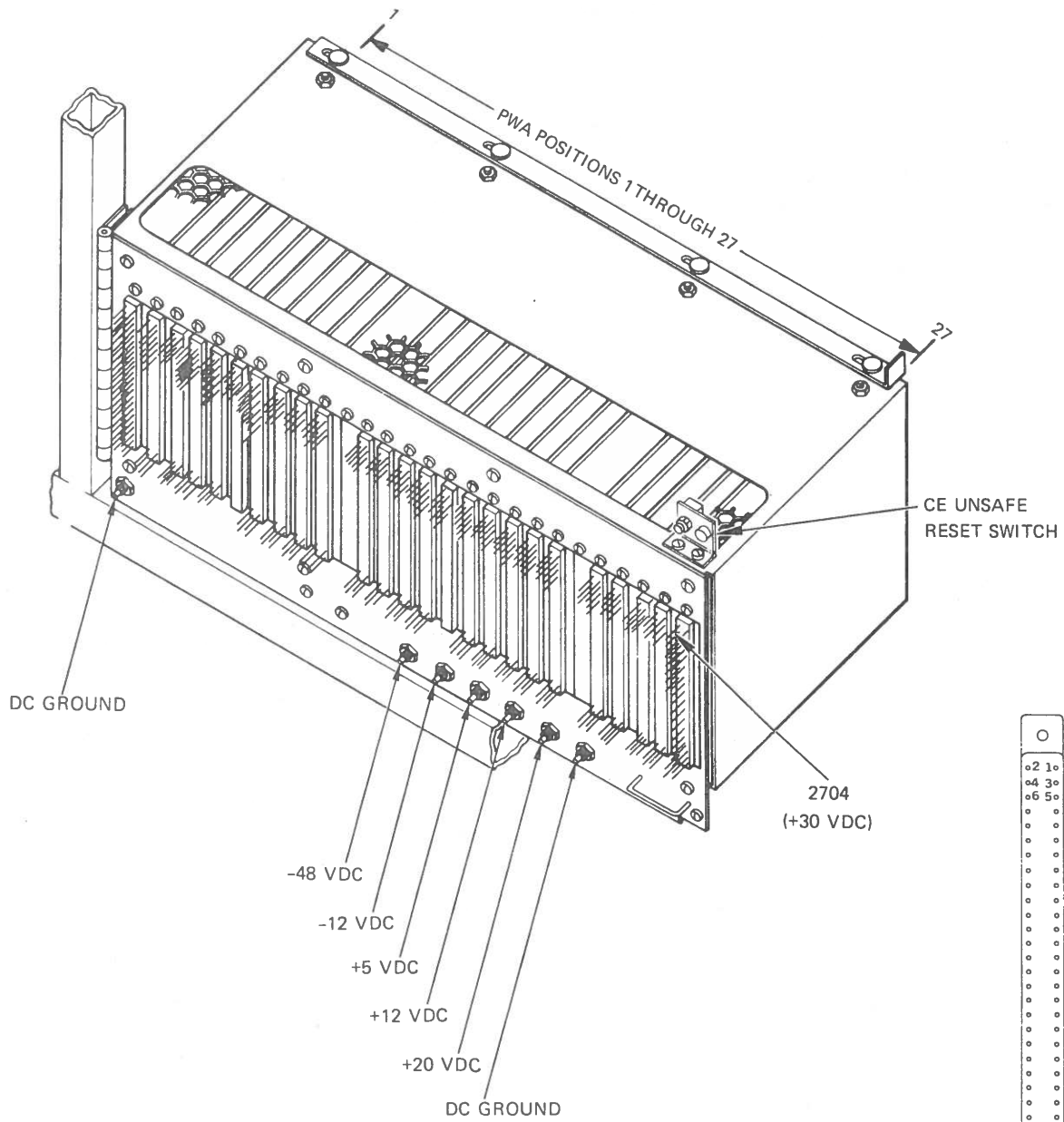
Power supply DC voltages must be within the required ranges. Place circuit breaker CB1 to ON (leave CB2 and CB3 off). Verify that both exhaust fans start up. Check DC voltage levels on rear of electronic gate at points shown in figure 2-6.

**NOTE:** Oscilloscopes or meters used in the field for maintenance of equipment must bear evidence of current calibration. Meter readings must be accurate within  $\pm 2\%$  of full scale deflection; oscilloscopes, within  $\pm 3\%$ . See Paragraph 5.3.2 for additional specifications.



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Figure 2-5. Sequence Panel and Power Driver Details



CONNECTOR PIN  
DETAIL 0623  
10/13/71

VOLTAGE LEVELS	
NOMINAL	RANGE
-48 VDC	-43.7 TO -51.3 VDC
-12 VDC	-11.5 TO -13.5 VDC
+12 VDC	+11.5 TO +13.5 VDC
+20 VDC	+19.5 TO +21.5 VDC
+5 VDC	+4.75 TO +5.25 VDC
+30 VDC SOCKET 27, PIN 4	+27.6 TO +32.4 VDC

Figure 2-6. Electronic Gate, Voltage Points

## 2.4.2 Hold Reverse Current Check

### CAUTION

Do not remove the carriage lock to perform this check.

The drive is shipped with a carriage lock that restricts forward carriage motion when the drive is transported. The carriage lock is fastened to the top front of the EMA cover. The Hold Reverse current check is to be accomplished with this lock installed.

**NOTE:** The lock should permit the carriage to retract sufficiently to actuate the HEADS EXTENDED switch. If it does not, CB3 will trip when step 4 of the procedure is accomplished.

Perform the check in accordance with the following procedure.

1. Install maintenance disk pack on drive.
2. Initially check carriage for reverse motion to determine that enough travel is possible to actuate HEADS EXTENDED switch.
3. Place CB1 to OFF. Ensure carriage lock is in place, then manually move carriage forward from retracted position to rest against carriage lock.
4. Place CB2 and CB3 to ON, then place CB1 to ON. Check for presence of Hold Reverse current by verifying that carriage moves backward against rear stop.
5. Place CB1, CB2, and CB3 to OFF after completing this check.
6. Remove carriage shipping lock to free carriage. The lock should be retained for reinstallation prior to future relocation or shipment of unit. A tapped hole is provided on the terminal board behind the control panel for carriage lock storage.

## 2.5 FUNCTIONAL CHECKS

Drive functional checks are accomplished with the drive disconnected from the control unit and operating modes controlled by the off-line testor.

If drive has been stored or exposed to extreme high or low temperatures just prior to positioning at the facility, allow drive to stand for six hours, or operate for two hours at facility environment to reach thermal equilibrium before accomplishing the following checks.

### 2.5.1 Head-Load Check

The head load check is performed during the power-on sequence to ensure that a file-ready operational status can be attained.

1. Install maintenance pack on drive and place CB2 and CB3 to ON, then place CB1 to on.
2. Place drive START/STOP switch to START. Look for the following functions as the drive cycles through the power-on sequence.
  - a. Drive motor starts.
  - b. Brushes cycle into and out of pack.
  - c. Carriage moves forward to load heads, then returns to cylinder 000.
  - d. FILE READY light illuminates.
3. Refer to chapter 7 for troubleshooting procedures if an unsafe condition occurs as indicated by the illumination of the UNSAFE lamp.
4. Set START/STOP switch to STOP to turn off drive and check operation of dynamic brake. Pack should stop rotating within 25 seconds. Refer to chapter 7 troubleshooting charts for defective braking.

### 2.5.2 Drive Motor Start-Inhibit Check

The drive motor start circuit is checked to ensure that the solid state relay (SSR) switch will operate to control start sequencing. Several conditions can disable motor power sequencing, one of which occurs when brushes are located in the pack.

1. Install disk pack on drive. Place CB2 and CB3 to ON, then place CB1 to ON.
2. Set START/STOP switch to START. As soon as brushes begin to enter pack, set START/STOP switch to STOP to remove drive motor power and then return switch to START position.
3. Observe action of brush cycling to determine that power to drive motor remains disabled until brushes return to stored position. Also, drive motor should start automatically when brushes are retracted to result in another brush cycle prior to loading heads.

### 2.5.3 Access Velocity Check

**NOTE:** Before performing the access velocity check, ensure that the access transducer position is within the requirements outlined in paragraph 6.2.

The access velocity is checked to determine the timing interval from the beginning of Seek-Start to occurrence of Access Ready. During this check, an UNSAFE condition may occur as a result of a velocity-too-great condition, indicating that an adjustment is required. If so, perform the access velocity check and adjustment as described in chapter 6.



## 2.5.4 Read/Write Head Alignment

Read/write heads are aligned when a drive is installed. Perform head alignment check and adjustment in accordance with procedures in chapter 6. Note that two hours warmup is required before adjustment can be performed.

## 2.6 RUNNING DIAGNOSTICS

### 2.6.1 On-Line Checkout Procedure

1. Interrupt system program and place CB1 to OFF.
2. Disconnect off-line testor from drive.
3. Connect DC and Signal cables to drive.
4. Set drive controls as follows:

ENABLE/DISABLE switch to ENABLE.  
READ-WRITE/READ ONLY switch to READ-WRITE.

5. Place CB1 to ON and replace all covers.
6. Set START/STOP switch to START and observe that file-ready condition is obtained.
7. Run the customer's diagnostic programs to determine that drive operates under system control.
8. Set START/STOP switch to STOP and check operation of the dynamic brake. Pack should stop rotating within 25 seconds.

### 2.6.2 Power-On/Drive-Start Sequence Check

This check is performed with the drive on-line to determine that the installed drive can be stopped and restarted along with other drives that are connected in the subsystem.

**NOTE:** The subsystem program must be interrupted to shut down CU power. Obtain permission from systems personnel to avoid creating a condition which could disrupt DP operations.

1. Verify that packs are installed on all drives in the subsystem and place all drive START/STOP switches to START so that all drive motors operate.

2. Power down the CU. The power off condition should disable the controlled ground lines to the drives and the drive motors should stop.

**NOTE:** If AC power to drives is obtained from either the CU or an external source independent of the CU, the drive motors will stop when the CU is powered down.

3. Check each drive to verify that the heads are retracted from the pack.
4. Verify that all drive START/STOP switches are in START position, and that CB1 is ON.
5. Restore power to the CU.

**NOTE:** All drive motors should start up in sequence (one at a time) according to drive position on the signal cable. The first drive on the signal cable starts first. When it has reached 70% of pack speed, the next drive should start. This sequence continues from drive to drive until the last drive in the system attains pack speed.

The system and drive(s) may now be turned over to the customer for his use.



# CHAPTER 3 OPERATION

## 3.1 OPERATOR CONTROLS AND INDICATORS

Arrangement of the control panel is shown in Figure 3-1.

### 3.1.1 START/STOP Switch

This toggle switch energizes the disk drive motor and initiates the power-on sequence when placed to START. The power-on sequence causes the brush cycle to start, disk pack to come up to speed, and heads to access into the pack. The heads move to the forward stop to perform an automatic check of drive circuits. After contacting the forward stop, the heads move in reverse and stop at cylinder 000. The FILE READY indicator is illuminated if an operational status is achieved. The UNSAFE indicator lights if a malfunction is present.

The STOP position shuts down the drive. This switch action removes AC power from the drive motor and initiates the power-off sequence. Read/write heads are retracted out of the disk pack and dynamic brake power is applied to stop disk rotation.

### 3.1.2 READ-WRITE/READ-ONLY Switch

This switch enables execution of write commands in the READ-WRITE position and prohibits execution of write commands in the READ-ONLY position.

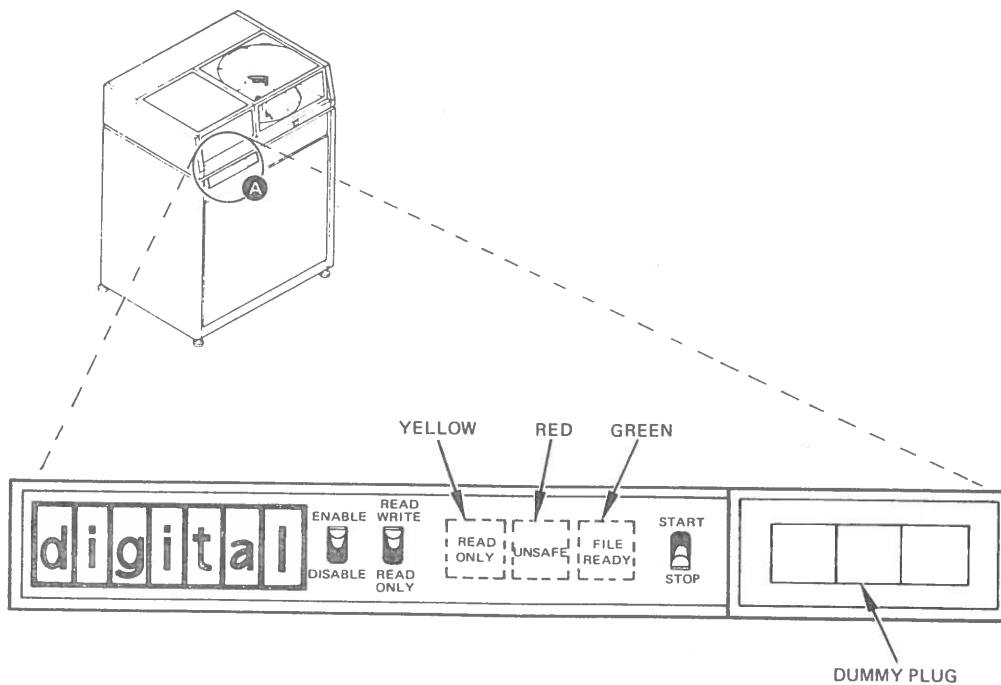


Figure 3-1. Control Panel Arrangement

### **3.1.3 ENABLE/DISABLE Switch**

The DISABLE position blocks the execution of commands from the control unit by placing the drive off-line and preventing usage meter operation. However, drive status may still be read by the control unit. The ENABLE position restores control unit-to-drive communications and enables the usage meter to operate.

### **3.1.4 FILE READY Indicator**

This green indicator is illuminated when the power-on sequence is completed and the drive is ready to accept commands from the CU. The lamp is extinguished if the drive is turned off, system power is dropped, a seek incomplete occurs, or an unsafe condition exists.

### **3.1.5 UNSAFE Indicator**

This red indicator is illuminated when an unsafe condition exists within the drive. It remains illuminated only when the heads do not unload in such conditions as Heads Unsafe, AC Write Unsafe, and DC Write Unsafe. Other unsafe conditions such as 30 VDC Unsafe, Velocity Unsafe, and Pack Speed Unsafe allow the indicator lamp to be extinguished immediately after the heads unload from the pack. Correcting the unsafe condition and turning the drive off and back on also extinguishes the indicator lamp.

### **3.1.6 READ ONLY Indicator**

This yellow indicator is illuminated when the write circuits are disabled by the READ-WRITE/READ-ONLY switch being placed in the READ ONLY position.

## **3.2 OPERATIONAL PROCEDURES**

### **3.2.1 Disk Pack Operating and Handling Procedures**

The instructions provided by the disk pack manufacturer should be used by the operator as a reference source. Disk packs are to be protected against improper handling and environmental abuse as specified by the disk pack manufacturer.

The disk pack is always carried by the built-in handle on the top cover. It is conditioned to room temperature before installation. A self-locking device in the handle permits removal of the top only when the disk pack is mounted on the drive.

#### **DISK PACK INSTALLATION**

Perform the following steps to install the disk pack:

1. Verify that drive is stopped, then raise operator cover to gain access to disk pack spindle.

2. Remove disk pack bottom cover by turning the bottom cover knob.
3. Place disk pack on spindle.

### CAUTION

Do not allow the disk pack or its cover to strike the shroud, heads, etc. as damage to these areas or the disk pack could result.

4. Turn top cover handle in a clockwise direction until it comes to a full stop. Continue to turn even though cover may disengage, to ensure that full stop point is reached and pack-in-place switch is closed.
5. Remove disk pack top cover.
6. Close and latch drive operator cover. Reassemble disk pack top and bottom covers and store in a designated area.

### DISK PACK REMOVAL

Perform the following steps to remove the disk pack:

1. Make certain that drive switch is positioned to STOP.
2. Wait for disk pack to come to a complete stop (about 20 seconds) before opening operator cover.

**NOTE:** Never raise the cover until the STOP switch is operated. Otherwise, dynamic braking of the spindle is overridden.

3. Open operator cover.
4. Position disk pack cover over top of pack.
5. Turn cover in a counterclockwise direction for two full turns so that cover becomes securely fastened to disk pack as an integral unit.
6. Remove disk pack by its top cover handle.

### CAUTION

Do not allow the disk pack or its cover to strike the shroud, heads, etc. as damage to these areas or the disk pack could result.

7. Immediately attach bottom cover to create a positive dust seal, and store in a designated area.
8. Close and latch operator cover.

### 3.2.2 Drive Operation

#### DRIVE START-UP

Perform the following steps to start the drive:

1. Check visually to determine that a disk pack is installed in drive, pack top cover is removed, and operator cover is closed and latched. Drive is now ready to be turned on.

**NOTE:** If the operator is charged with the responsibility of recording usage meter time before the drive is started, this task should be completed at this time.

2. Position START/STOP switch to START.
3. Observe that the drive motor starts and that green FILE READY indicator is illuminated about 20 seconds after drive start.
4. Ensure that the ENABLE/DISABLE switch is set to ENABLE. Drive is now ready to receive CU commands to seek and transfer data.

#### DRIVE SHUTDOWN

To stop the drive, set the START/STOP switch to STOP. In approximately 20 seconds the heads are retracted from the disk pack, the pack rotation is braked to a stop, and power to the drive motor circuits is interrupted.

For operator safety reasons, power to the drive is interrupted and the heads become retracted whenever the operator cover is unlatched/raised with the switch positioned to START. Pack rotation, however, is not electrically braked; consequently, it requires about 60 seconds to coast to a stop. Observe the following precautions:

1. For safety - wait for the pack to stop rotating before raising the operator cover (for any reason).
2. To save time - shut down the drive only by positioning the drive switch to STOP. Never raise the cover to stop the drive.
3. To avoid program interruption - never shut down the drive while it is operating unless permission is obtained from the center operations manager. (Such an operator error causes the heads to retract off the pack and will negate subsequent instruction from the control unit.)

#### RESPONDING TO MALFUNCTIONS

Drive malfunctions are serviced only by authorized maintenance personnel. Conditions which define drive malfunctions are as follows:

1. No green light 20 seconds after placing START/STOP switch to START.
2. Illumination of red light at any time.

Authorized responses to malfunctions observed by the operator are as follows:

1. Position the START/STOP switch to STOP.
2. Report the observed malfunction to the "supervising operator", the "computer center manager" or equivalent personnel.

#### UNSAFE DIAGNOSTIC PROCEDURES

If an unsafe condition exists and the drive is powered down by the START/STOP switch (and not restarted), the states of all latches and lines remain in the configuration which caused the unsafe condition.

**NOTE:** Do not destroy this logic state by restarting the drive or removing AC power, otherwise, additional time will be required to recreate the unsafe condition.

If the unsafe was caused by a read/write failure, it is best to obtain information from the customer regarding the type of instruction that was being executed at the drive when the failure occurred. Using this information, recreate the failure conditions by running an on-line system diagnostics test.





# CHAPTER 4

## FUNCTIONAL DESCRIPTION

### 4.1 INTRODUCTION

The Model 715DEC Disk Storage Drive has five main functions.

1. Rotate the disk pack.
2. Access the read/write heads to a desired cylinder.
3. Select the appropriate read/write head.
4. Transfer the digital data between the control unit and the disk pack.
5. Monitor the disk drive operation, generate status information, and transmit status information to the control unit.

### 4.2 DRIVE INTERFACE

Drive control unit interface connections are shown in figure 2-3. This section describes the interface line functions. Chapter 9 of this manual includes a schematic diagram of each interface cable.

#### 4.2.1 AC Cable

The ac power cable connects to the drive AC IN receptacle, and supplies ac power to the sequence panel and to the drive AC OUT receptacle. The 208/230-VAC 3-phase power to the AC OUT receptacle is rotated within the drive to balance line loading as additional drives are connected. From the sequence panel, ac power is supplied to fan and blower motors, the brush drive motor, the disk drive motor, the dc power supply, and power control circuits.

#### 4.2.2 DC Cable

A separate dc cable is required between each disk drive and the control unit. Both Read Data and Write Data coaxial cables are included in the dc cable. Composite Sector/Index pulses are supplied to the control unit to aid in determining record locations on the disk pack. Gated Attention is generated by the drive upon the completion of a seek or restore operation. Module Select is activated by the control unit to select a particular drive. Selected Module informs the control unit that the drive has been selected and that the Read Data and Write Data lines to this drive are to be used.

#### 4.2.3 Signal Cable

The signal cable is connected between the drive SIGNAL IN connector and the SIGNAL OUT connector of the preceding drive, or, if there is no preceding drive, to the control unit. The last drive in a system must have a terminator assembly installed on the SIGNAL OUT connector.

All drive commands are sent from the control unit on signal cable drive bus lines and tag lines. The module select line in the DC cable determines to which drive the commands are directed. The significance of the drive bus lines is determined by the tag

lines. When the control tag line is activated, the bus lines carry the eight control commands listed in table 4-1.

Table 4-1. Control Commands Carried on File Bus Lines

BUS LINE	COMMAND
256	Defect Detect
128	Write
64	Read
32	Seek Start
16	Reset Head
8	Not Used
4	Head Select
2	Restore
1	Head Advance

Table 4-2 lists addressing commands effective when the other two tag lines are active.

Table 4-2. Addressing Commands Carried on File Bus Lines

BUS LINE	SET CYLINDER	SET HEAD
256	CAR Bit 256	Not Used
128	CAR Bit 128	Not Used
64	CAR Bit 64	Not Used
32	CAR Bit 32	Not Used
16	CAR Bit 16	HAR Bit 16
8	CAR Bit 8	HAR Bit 8
4	CAR Bit 4	HAR Bit 4
2	CAR Bit 2	HAR Bit 2
1	CAR Bit 1	HAR Bit 1

In addition to the drive bus and tag lines, the signal cable includes lines which transmit information from the drive to the control unit. The cylinder address register 1-256 lines transmit present cylinder address information to the control unit. The balance of the signal cable lines consist of drive status information transmitted to the control unit, and control signals such as Pick Start.

### 4.3 DRIVE OPERATIONS

Disk drive operations may be considered as being two types: drive initiated and control unit commanded. Drive-initiated operations are performed when powering up, powering down, or recognizing an unsafe condition. Drive-initiated operations are as follows:

Power-On - This sequence checks all manually operated and interlocking switch conditions, then applies power to the motors within the drive. Safety

circuits, carriage velocity, and pack speed are checked before positioning the read/write heads at cylinder 000 (after entering the restore operation).

Restore - This operation, positioning the read/write heads to cylinder 000, is initiated by the disk drive as the latter part of the power-on operation, or when there is a seek incomplete condition. It may also be initiated by the control unit, as discussed in succeeding paragraphs.

Power-Off - This operation retracts the read/write heads from the disk pack. It is caused by:

1. A system level shutdown.
2. Placing the START/STOP switch in STOP position.
3. An ac unsafe condition detected, signifying interruption of the ac power.

Control unit commanded operations are performed in response to the commands listed in tables 4-1 and 4-2. These commands are:

Seek - This operation positions the read/write heads at a particular cylinder and selects the appropriate read/write head, preparatory to reading or writing data.

Read - This sequence senses data on the disk pack, amplifies signals, and transmits data to the control unit. Data may comprise either track or record identification information or recorded facts. Reading may be combined with defect detection for pack initialization.

Write - Records data from the control unit on the disk pack.

Restore - Positions the read/write heads at cylinder 000; performed to establish a cylinder-position reference.

A functional block diagram, a flowchart of events, and a timing diagram are provided in the chapter 9 of this manual for each drive operation.

#### **4.3.1 Power-On/Head-Load Sequence**

The purpose of the power-on/head-load sequence is to:

- a. Turn drives on in sequence to prevent heavy current surges.
- b. Satisfy certain essential conditions before positioning the read/write heads over the disk pack.
- c. Perform a check of safety circuits, carriage velocity, power supplies, and pack speed.

With power applied to the disk drive and CB1 set to ON, Power On Reset (socket 27) is

generated to condition control latches for drive start. The exhaust fans are energized. Pick Start is supplied from the control unit or the previous drive. With a disk pack installed, the Hold Reverse latch (socket 14) is set to retain the carriage at its rear stop, the Head Load latch (socket 14) presets the difference counter (socket 13) to 407, and, if all interlocks are closed and the START/STOP switch is at START, the drive motor and brush motor latches (socket 27) are set.

The blower, drive, and brush motors are then energized, the brush motor completing its cycle as the drive motor increases speed. The brush cycle is completed when the brushes return to the retracted position. When the drive motor has reached 70 percent of its final speed (2400 rpm), a pick start signal is sent to the next drive. Additionally, Sequence Start Pulse (socket 27) is generated.

The Sequence Start Pulse starts the head-load sequence, if no unsafe conditions exist, by resetting the Hold Reverse latch and setting the Head Load latch (socket 14). These signals then activate Drive Forward 5"/Sec (socket 15) and the carriage moves forward. As the carriage moves forward, signals from the access transducer decrement the difference counter. Simultaneously, a velocity safety sensor signal, also provided by the access transducer, is applied to the velocity safety circuit on socket 18 (see figure 4-1). During the start of the head load operation, the 800 usec delay circuit is enabled. Since the time between velocity sensor signals is greater than 800 microseconds, the safety circuit flip-flop will be reset before the occurrence of the next sensor signal pulse. When the difference counter decrements to a count of 127, Drive Forward 20"/Sec (socket 15) is activated and the carriage accelerates to 25"/second. Drive Forward 20"/Sec also enables the 3.2-millisecond delay circuit in the velocity safety circuit. Since the carriage moves at a velocity greater than that corresponding to 3.2 millisecond signal intervals, the safety circuit flip-flop is not reset before another sensor signal occurs. This generates Velocity Too Great which sets the Drive to Forward Stop flip-flop (socket 14), thus beginning the restore operation. It should be noted that when Head Load is true, the Velocity Unsafe flip-flop is blocked so that Velocity Too Great can be generated without setting the flip-flop.

As an extra safety feature to prevent carriage crash into the forward stop, Diff Equals One occurring before Velocity Too Great sets the Velocity Unsafe flip-flop. This will illuminate the UNSAFE lamp and cause the heads to retract.

#### 4.3.2 Restore Operation

The restore operation positions the read/write heads at cylinder 000. It is initiated:

- a. As part of the power-on/head-load operation, when Velocity Too Great is generated.
- b. When a seek incomplete condition exists.
- c. When the control tag line and bus line 2 are set (restore command from the control unit).

The restore operation begins by setting the Drive to Forward Stop flip-flop (socket 14)



which also sets the Seek In Process flip-latch. Drive Forward 5"/Sec (socket 15) is activated and the carriage moves at 5 inches per second forward motion. A count of 407 is set into the difference counter (socket 13) and held until the forward stop switch (socket 19) is closed. The forward stop signal resets the Drive to Forward Stop flip-flop, deactivating Drive Forward 5"/Sec, and activating Go Reverse (socket 15). Go Reverse enables gates which supply the curve generator shaper output signals to the summing amplifier and pulser, such that the carriage moves in reverse (away from the disk pack center). As the carriage moves, the access transducer produces position signals (socket 20) which decrement the difference counter (socket 13) each time a cylinder is crossed. The difference counter counts each odd and even cylinder by alternately setting and resetting the bit 1 latch. One-half cylinder before reaching cylinder 000, Diff Equals One (socket 13) and Cylinder Vicinity (socket 20) are both activated setting the Linear Mode latch (socket 14). In linear mode, the curve generator is inhibited and drive for the last half-cylinder is provided by the gated position signals (socket 25). Seek Complete latch (socket 14) is set by Cylinder and Vel Minus Pos Equals Zero (socket 24). Seek complete then resets the Seek In Process latch, activating Access Ready (socket 14).

#### 4.3.3 Power-Off/Head-Unload Sequence

The purpose of the Power-Off/Head-Unload sequence is to ensure that the read/write heads are retracted from the disk pack before the pack stops rotating so that no damage will occur to either the heads or pack surfaces. This operation is initiated in response to one of three conditions:

1. System level shutdown.
2. START/STOP switch to STOP.
3. AC Unsafe generated.

##### SYSTEM LEVEL SHUTDOWN

With drive power on and disk pack at speed, an operator-initiated shutdown at the system level deactivates Controlled Ground (socket 27) which deactivates Start and Controlled Ground. This sets the Hold Reverse latch (socket 14) and, because the heads are not yet retracted, generates Drive Reverse 5"/Sec (socket 15). The carriage moves in reverse, away from the center of the pack, until the Carriage Retract switch transfers to the retracted position. This action deactivates Heads Extended (socket 19), Drive Reverse 5"/Sec, Access on Line (socket 12), and Access Ready (socket 14), extinguishing the File Ready lamp (socket 19). The control unit then removes ac power from the drive and the disk pack coasts to a stop.

##### START/STOP SWITCH TO STOP

With drive power on and disk pack at speed, setting the drive START/STOP switch to STOP (socket 19) resets the Start/Stop latch and the Drive Motor latch (socket 27). This deactivates Start and Controlled Ground and removes AC power from the drive motor, blower motor (both from the sequence panel), and the AC voltage check circuit

(socket 14). The Brake Relay latch (socket 27) and the Hold Reverse latch (socket 14) are set, and a 25-second delay is initiated (socket 17) prior to generating Pack Stopped. The Brake Relay latch energizes a relay which provides dynamic braking of the drive motor. The Hold Reverse latch activates Drive Reverse 5"/Sec (socket 15) and the carriage moves in reverse until the Carriage Retract switch (socket 19) transfers. This deactivates Drive Reverse 5"/Sec and extinguishes the File Ready lamp (sockets 12 and 19). At the end of the 25-second delay, begun when Start and Controlled Ground was deactivated, Pack Stopped (socket 17) is generated, inhibiting the Brake Relay latch gate, and removing drive motor braking current.

#### AC UNSAFE CONDITION

When an ac unsafe condition is detected in the power supply, AC Unsafe generates Safety Unload (socket 18) which activates circuits in the Power Driver to provide both Reverse Drive and Pulsed Reverse, and to block Forward Drive and Pulse Forward. This retracts the carriage at approximately 15"/Sec which is controlled by the power driver circuit. If ac power is restored, the AC Unsafe will no longer be true, and the power returning will initiate a Power-On/Head-Load operation. If the ac power is not restored, the carriage will remain retracted and the pack will coast to a stop.

#### 4.3.4 Seek Operation

The seek operation changes the position of the read/write heads to a new cylinder position on the disk pack. The positioning mechanism is a carriage assembly which serves as a movable platform supporting the read/write head assemblies. The carriage is connected to an electromagnetic actuator (EMA) which converts electrical current to a physical force that moves the carriage and read/write heads, or holds them at a designated position. The direction of current flow in the EMA determines the direction of movement of the carriage, while the amount of current controls the speed.

The control unit begins a seek operation by selecting a particular drive by activating Mod Select in the DC cable. This generates Mod Select (socket 8) and allows the bus and tag lines to control drive operation. Mod Select gates the present cylinder address (socket 9) and presents file status (socket 12) to the control unit.

The control unit first resets the head address register (HAR) with Control tag and Bus Line 16 (socket 8). Next, the new cylinder address is sent to the drive on the bus lines with the Set Cylinder tag line activated to load the cylinder address register (CAR, socket 9). At the same time, the new cylinder address on the bus lines is furnished to the difference calculator (socket 16). There, the new address is compared with the present cylinder address and the binary difference between the two addresses is determined. In addition, the direction the carriage must move (forward or reverse) to reach the new cylinder address is also determined. The complement of the difference count is supplied to the difference counter (socket 13) where it is loaded in complement form by the Set Cylinder tag line which also sets or resets the Forward latch (socket 14) as determined by +Forward Sign from socket 16. As an example of a seek; if the present cylinder address is 000 and the new address is 104, bus lines 64, 32, and 8 are activated and loaded into CAR. These same bus lines will produce a difference count of



407, the complement of 104. The complement of the count is used since the output lines of the difference counter are negative true logic.

The control unit sends the new head address. For example, to select head 5, bus lines 1 and 4 together with Set Head, are sent to the drive. Bus lines 1 and 4 enable HAR bits 1 and 4 respectively, and the Set Head tag line gates the bus line data into the HAR. The head address register may be advanced one number by Bus Line 1 and Control tag line. This signal enables a drive to continue reading or writing in the same cylinder (different track) without reissuing a seek command.

The control and movement of the carriage and the ultimate positioning of the heads at a particular cylinder is determined by a servo system. The servo system operates in either coarse positioning or linear mode. The coarse positioning mode is used initially during a seek to move the carriage very quickly to 1/2 cylinder (0.0025 inch) away from its destination, where servo operation is shifted to the linear mode. Linear mode provides final carriage positioning and holds the carriage on cylinder. Servo operation is discussed in detail in 4.3.7.

Bus Line 32 and Control tag line are activated to make up Seek Start (socket 8). The Forward latch gates the curve generator outputs (socket 15) with Go Forward or Go Reverse, providing input signals through the summing amplifier (socket 24) to the power driver, causing the carriage assembly to move.

The access transducer produces Even Cylinder and Odd Cylinder signals (socket 20) as the heads move across cylinders. These signals alternately set and reset the difference counter bit 1 latch (socket 13), thus incrementing the counter, and decrementing the number of cylinders, to go. When the number of cylinders to go is reduced to one, the next Cylinder Vicinity signal (socket 20) sets the Linear Mode latch (socket 14), disabling the curve generator outputs and enabling Gated Position 1 and Gated Position 2 (socket 25) which now constitute the input to the summing amplifier. When the gated position signals are at zero and Velocity Minus Position Equals Zero (socket 24) is activated, the Seek In Process latch is reset to activate Access Ready (socket 14) and Gated Attention (socket 12), ending the operation.

#### 4.3.5 Read Operation

This sequence senses data on the disk pack, amplifies signals, and transmits data to the control unit. Reading may be combined with defect detection when running the disk pack initialization program.

In the same manner as for the seek operation previously discussed, the read operation begins with the control unit selecting a drive. The Control tag line and bus lines 4 and 64 are activated to select a read/write head and enable the read gate, respectively. Head Select (socket 8) gates the HAR (set during the seek) output to the head select circuits (sockets 2 and 3), enabling the selected head (sockets 28 or 29). Read Gate, also generated in socket 8, gates the read data from the amplifier (socket 5) to the control unit, which senses and controls the data by controlling bus line 64 (Read Gate).

When the record on the disk pack has been read and no other records are to be read, bus lines 4 and 64 and Control tag line are deactivated, terminating the read operation. The Module Select line may then be deactivated.

When the end of a record is reached and it is not the last record to be read, the start of a multi-track read operation is recognized, indicating data overflow to another track in the same cylinder. The control unit deactivates bus lines 4 and 64 and holds Control tag line active while waiting for program direction to stop or continue the read operation. If the program directs the control unit to stop the read operation, Module Select and Control are deactivated, terminating communications with the drive. If the program directs the operation to continue, Module Select and Control are held active and File Bus 1 is activated to initiate a head advance (socket 8). When the head advance is accomplished, a new read operation is started. If the drive responds to the head advance command with Sel Drive End of Cyl (socket 12), the control unit waits for the program decision to halt the read operation or continue with another seek. The read operation is terminated by deactivating Module Select and Control tag. Reading data with the defect detector enabled (disk pack initialization) is accomplished as an ordinary read operation, except that bus line 256 is activated to enable the defect detection circuit (socket 6). As long as no errors are detected, the read operation continues in the same manner as previously described. A detected error supplies a five microsecond signal to the control unit. If an error is detected, the track may be flagged as defective and an alternate track assigned in its place, or if the program directs, the track may be read again. When an alternate track has been assigned, the drive may read other tracks or halt, as directed by the program. The operation is halted by deactivating bus lines 4, 64, and 256, Control tag line, and Module Select.

#### 4.3.6 Write Operation

The write operation records data furnished by the CPU onto the disk pack. Because it is necessary to determine the correct write location, the write operation starts as did the read operation, with Module Select, bus lines 4 and 64, and Control tag line activated with a drive in File Ready condition. This selects a read/write head and enables Read Gate, sending read data to the control unit. When the desired area on the disk pack has been read and identified, the control unit deactivates bus line 64 (Read Gate) and activates Bus Line 128 (Write Gate, socket 8) to write data in the desired location. At the end of the last record, the control unit terminates the write operation by deactivating Control tag line, bus lines 4 and 128, and Module Select. If the end of the record is indicated before the last record is written, multi-track operation may be initiated as it was for the read operation.

#### 4.3.7 Servo Operation

The seek operation discussed in 4.3.4 referred in general terms to the head positioning servo system. More details are provided in the following paragraphs. For explanation simplicity and to avoid repetition, the following servo operation discussion assumes that a normal forward seek operation has progressed to the point where the difference counter bits are sent to the curve generator. Because coarse positioning mode servo

operation is used before linear mode in the seek operation, it is discussed first, followed by linear mode servo operation.

### COARSE POSITIONING

Coarse positioning mode begins when Seek Start sets the seek start latch and resets the linear mode latch (socket 14). The forward latch was previously set and now gates the curve generator output with Go Forward (socket 15). The curve generator output amplitude is determined by the difference counter signals. The output is maximum when the cylinder difference is greater than 64, and is proportional to cylinder difference when it is less than 64.

### INITIAL CARRIAGE MOTION

Curve generator outputs (Shaper Output 1 and 2) are applied to the summing amplifier (socket 24). Its output signals, Forward Drive and Pulse Forward, are gated to the power driver by Activate Servo and additional signals (Pack In Place and Pack At Speed) designed to prevent an unwanted head load and possible head or disk pack damage. The power driver provides EMA current to move the carriage forward by turning on Darlington pair transistors T5 and T6 with Forward Drive and Darlington pair transistors T3 and T4 with Pulsed Forward. This applies 48 volts across the EMA coil, as shown in figure 4-2 (also see power driver schematic diagram in chapter 9 of this manual). S1 in figure 4-2 corresponds to T5/T6, S2 to T3/T4. When current begins to flow through the coil, the EMA moves the entire carriage assembly (figure 4-3) forward.

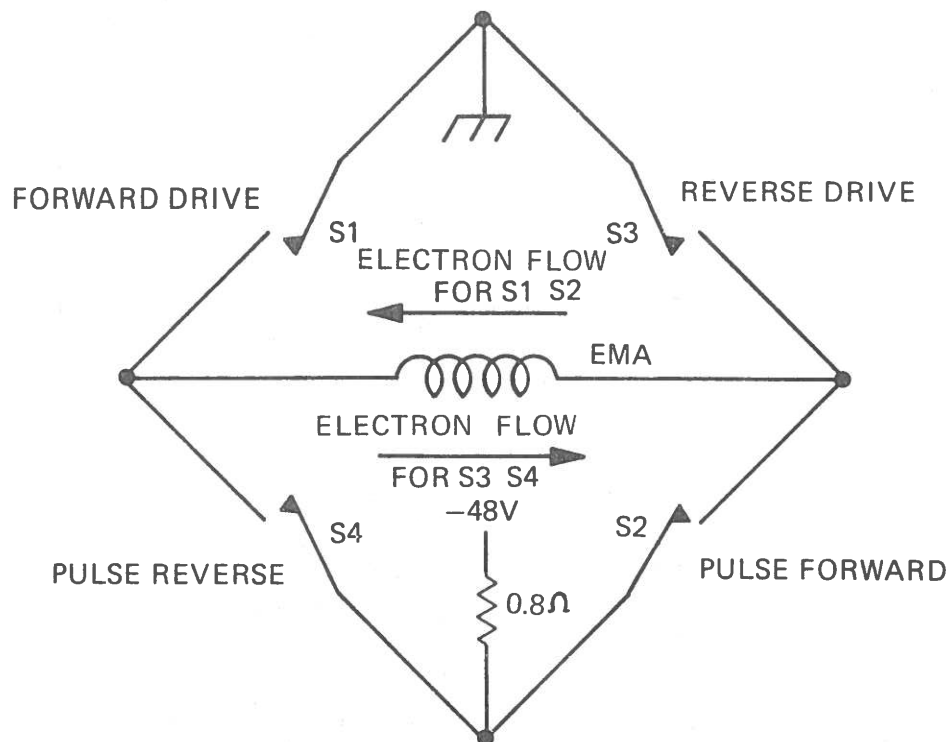


Figure 4-2. EMA Circuit

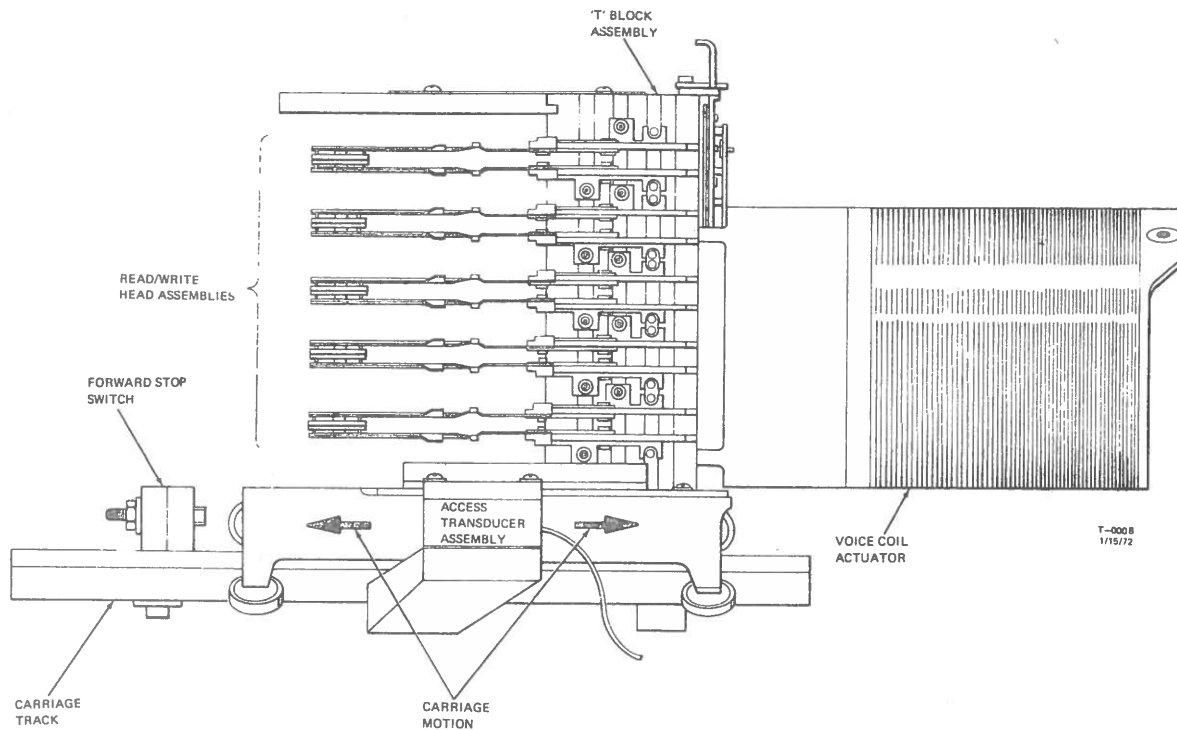


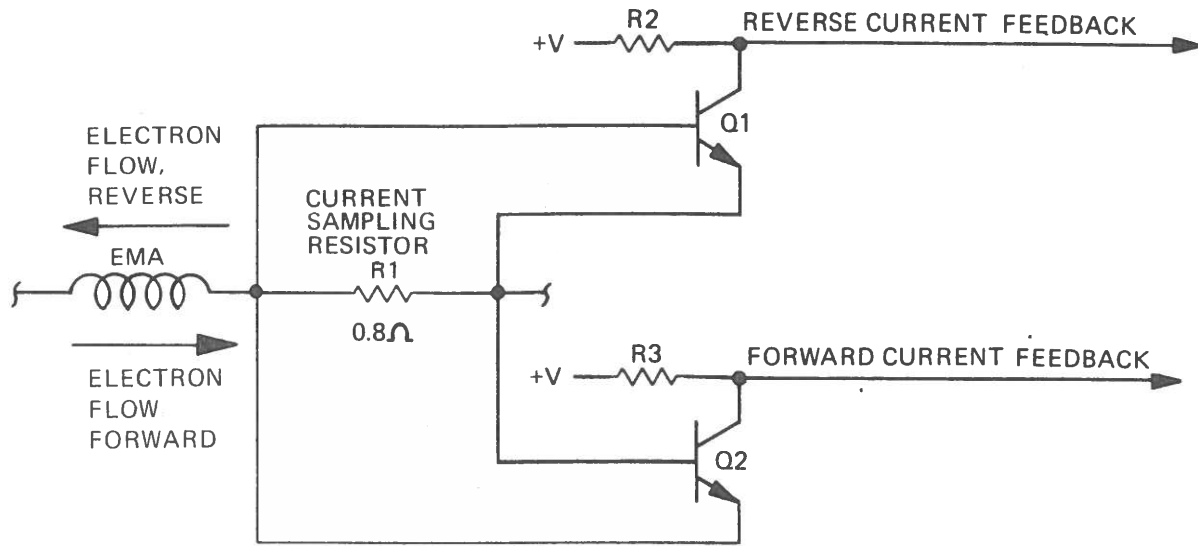
Figure 4-3. EMA and Carriage Assembly

### EMA CURRENT FEEDBACK

Current flowing through the EMA coil also flows through a current sampling resistor, developing a voltage which is applied to forward and reverse current feedback detectors on the power driver, as shown in figure 4-4. With forward current flowing, as shown, the voltage across R1 applies reverse bias to Q1 and forward bias to Q2. The voltage developed across R3 is then proportional to EMA current. This signal is applied to socket 24 where it is compared with the summing amplifier driving signal. It also is one of the inputs for the tachometer (socket 23). Current sampling and feedback occur in a similar manner when the EMA is moving in the reverse direction.

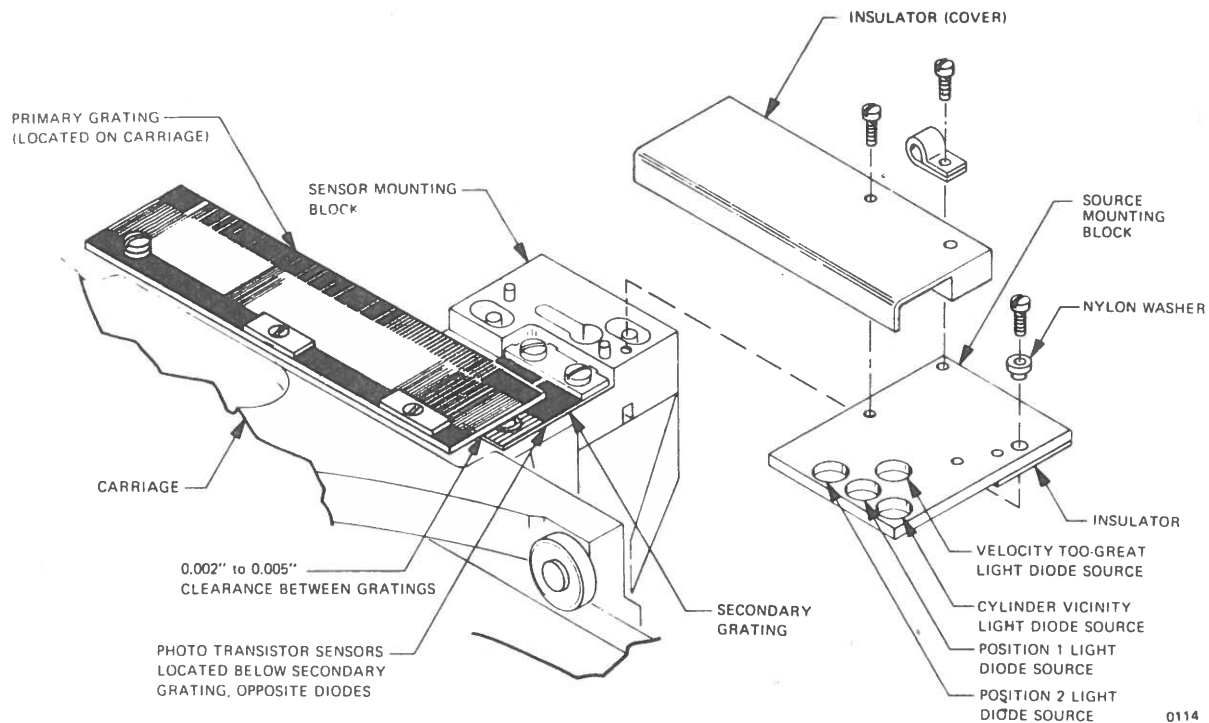
### ACCESS TRANSDUCER ASSEMBLY

The access transducer assembly (figure 4-5) monitors carriage movement and generates three signals that are related to carriage position and one signal related to velocity. A combination of three sets of light-emitting diodes (LED's) and photosensitive diodes (PSD's), together with the position grids on the primary and secondary gratings (figure 4-6), monitor carriage position and cylinder crossings. The current source for the two position signal LED's is the AGC circuit (socket 21). This circuit compensates for component aging of the LED's/PSD's. If compensation is required, the AGC circuit determines which LED/PSD needs it and determines the amount as well.



T-0022  
1/15/72

Figure 4-4. EMA Current Feedback



0114  
2/9/72

Figure 4-5. Access Transducer Assembly

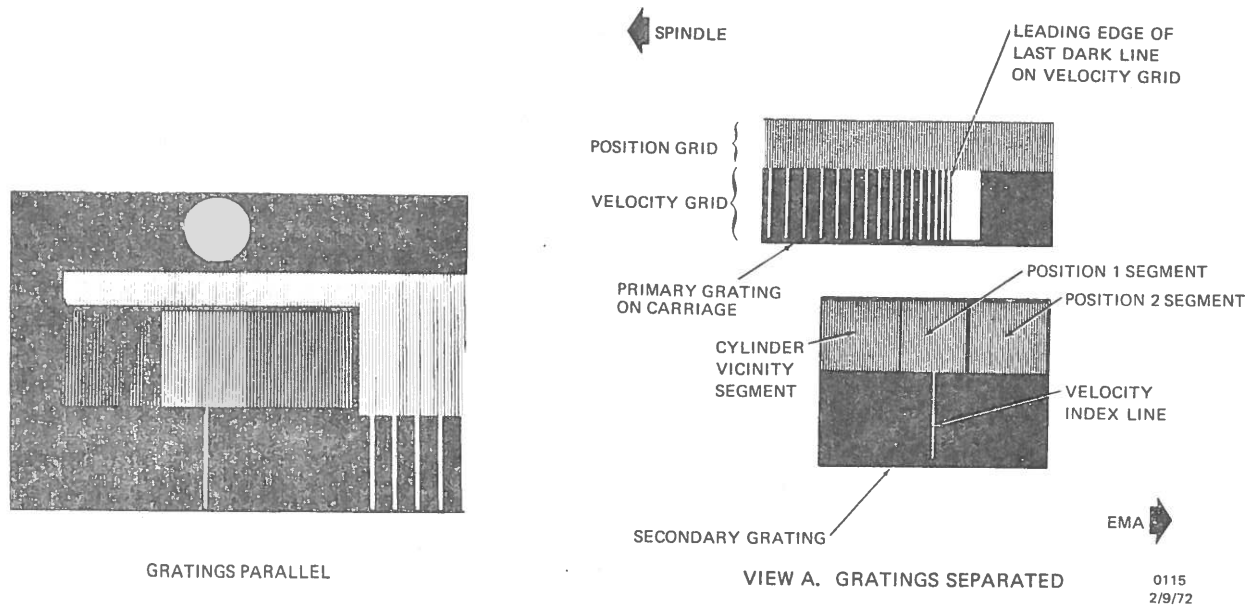


Figure 4-6. Primary and Secondary Gratings

The current source for the cylinder vicinity LED is a separate AGC circuit located on socket 20. Carriage velocity is monitored with a LED, a photosensitive transistor (PST), the primary grating velocity grid, and the secondary grating velocity index line. The velocity safety LED current source is on socket 18.

The glass gratings consist of opaque and clear lines, evenly spaced on the position grids and irregularly spaced on the velocity grid. The position of the read/write heads is determined directly from the arrangement and spacing of the lines on the grating position grids. The primary grating moves with the carriage. The variations of light passing through the combined primary and secondary gratings are sensed by the PSD and PST and are converted into electrical signals of an amplitude proportional to the transmitted light intensity.

The velocity grid pattern provides a physical relationship between the distance to the carriage stop and the allowable carriage speed. Carriage velocity is detected when the lines on the primary grating velocity grid move across the single transparent index line on the secondary grating. The occurrence of too many crossings within a given period causes generation of Velocity Too Great (socket 18), which in a normal seek will result in a safety unload of the read/write heads.

The secondary grating position grid is divided into three segments, each with a different phase relationship to the primary grating position grid. The phases are zero

degrees, 180 degrees, and 90 degrees. Therefore, only one segment permits the LED to transmit maximum light intensity to its sensor at any one time. When one position segment has maximum light transmission and maximum sensor current, the other position segment has minimum light transmission and a corresponding minimum sensor current. At this same time, the cylinder vicinity segment lines are so placed as to allow one-half the light to be transmitted, and a corresponding mid-point in output current is produced by its sensor. Position signal timing diagrams are shown in figure 4-7. Individual signals developed by each sensor are shown in views A, B, and C. The resulting composite signal is shown in view D.

## FEEDBACK SIGNALS

In addition to the curve generator drive signals (Shaper Output 1 and 2), negative feedback signals from the tachometer (socket 23) are applied to the summing amplifier (socket 24) to control the velocity of the carriage. As in any basic servo loop, the feedback signal (tachometer) opposes the input signal (curve generator) with the servo attempting to maintain a zero input to the summing amplifier. As the carriage assembly moves the access transducer primary grating over the secondary grating, position sensor signals are generated which are frequency modulated by carriage velocity. In figure 4-8, view A shows the lowest position signal frequency at the beginning of acceleration and at the end of deceleration, with maximum frequency occurring at maximum velocity, in the center portion of the waveform. For simplification, only one position signal is shown. Both position 1 and position 2 signals are applied via a differential amplifier (socket 20) to a differentiator (socket 23). The differentiated signal (view B of figure 4-8) is gated, biased, and added to the integrated motor current sample from the power driver. The amplitude of the final tachometer output signal shown in view C of figure 4-8 is representative of carriage velocity.

Figure 4-9 shows changes in EMA control signals during a seek. Seek Start enables the curve generator (socket 15) so that the shaper output rises sharply to its maximum amplitude as determined by the difference counter outputs. With Forward Drive and Pulsed Forward both activated, forward motor current flows through the EMA coil.

Carriage acceleration is determined by the curve generator outputs together with the motor current sample feedback and the tachometer feedback signal. Motor current sample feedback was previously discussed. This signal is compared with the summing amplifier outputs to determine if Pulsed Forward is activated or deactivated. When the motor current feedback signal equals or exceeds the input signal, Pulsed Forward is deactivated, causing the EMA coil current to decrease. This decreases the motor current feedback signal. When the feedback signal is less than the input signal, Pulsed Forward is again activated, increasing the EMA coil current. The effect of Pulsed Forward switching is to limit carriage acceleration.

As the carriage moves forward, the differentiated access transducer signals (tachometer feedback) are applied to the summing amplifier. When the tachometer feedback is equal and opposite to the curve generator input signal, the desired velocity is

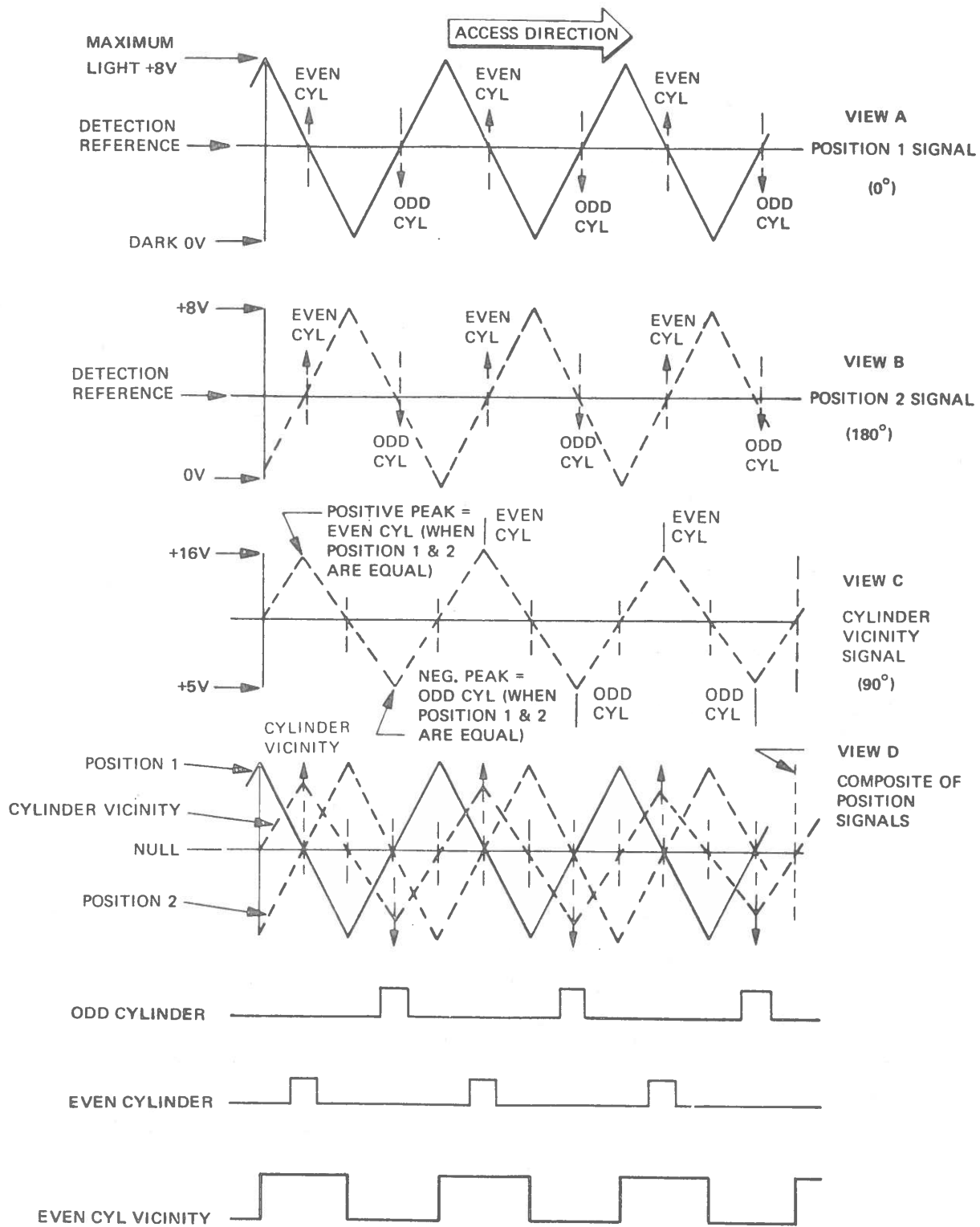


Figure 4-7. Even Cylinder, Odd Cylinder, and Cylinder Vicinity Detection



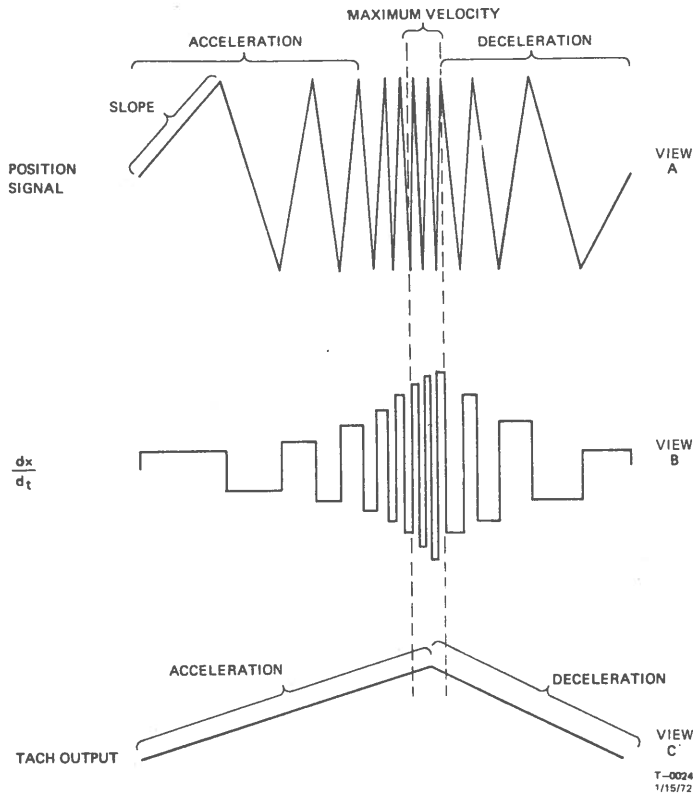


Figure 4-8. Tachometer Signal Generation

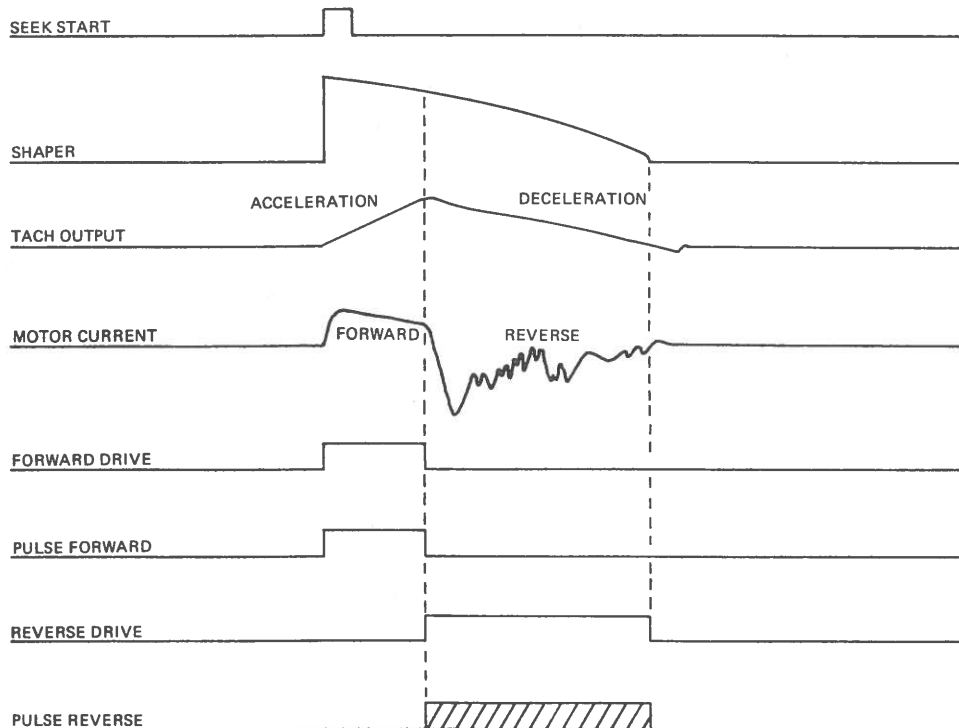


Figure 4-9. EMA Control Signals

attained and, momentarily, the summing amplifier output is zero. The carriage continues to move forward and the tachometer feedback signal exceeds the input signal to reverse the summing amplifier output polarity. This deactivates Forward Drive and Pulsed Forward and activates Reverse Drive and Pulsed Reverse. With the EMA coil current reversed, the carriage is decelerated. The polarity of the motor current sample signal is now reversed to forward bias the reverse current detector. This signal is integrated and added to the access transducer feedback signals to become the tachometer feedback signal. This signal, representing carriage velocity, is applied to the summing amplifier. When the tachometer feedback signal exceeds the curve generator signal, Pulsed Reverse is deactivated, reducing the EMA coil current, the deceleration, and the feedback signal. When the feedback signal is less than the input signal, Pulsed Reverse is again activated, increasing the motor current. Pulsed Reverse switching continues as the carriage is decelerated until both the curve generator signal and the tachometer signal are zero and the seek is complete.

#### LINEAR MODE

Linear positioning mode begins when the Linear Mode latch (socket 14) is set by Diff Equals One (socket 13) and Cylinder Vicinity (socket 20). This occurs when the read/write heads have moved past the last cylinder crossing before their destination and are one-half cylinder away from their final position. Linear mode continues while the heads are positioned to and held on the requested cylinder until an unsafe condition occurs, or a restore or a new seek operation is initiated. When the Linear Mode latch is set, the curve generator outputs (socket 15) are disabled and the summing amplifier (socket 24) inputs are now Gated Position 1 and 2 (socket 25) with Tach Output 1 and 2 (socket 23) still used as the servo feedback signals. To achieve more accurate head positioning, additional summing amplifier input signals are provided while in linear mode. These signals, Temperature Compensation, Balancer, and Wiggler are described in the following paragraphs.

#### TEMPERATURE COMPENSATION

The reference thermistor on the drive baseplate and the compensation thermistor on the index transducer (measures disk pack temperature) sense the temperature that exists at each location. The difference in thermistor outputs is amplified and applied to a variable gain amplifier which compensates for a temperature gradient across the surfaces of the disk pack. The temp comp outputs are fed to the summing amplifier, balancer and cylinder detector, and the AGC circuit. Because a temperature difference moves the radial location of a cylinder with respect to the read/write heads, temp comp moves the read/write heads, and changes the point at which cylinder detection occurs. In addition, temp comp is used by the balancer circuit in its operation (see next paragraph).

#### BALANCER

Balancer Output 1 and 2 are applied to the summing amplifier (socket 24) to compensate for dc drift in the servo system. Position signals and temp comp offset signals

are applied to the balancer circuit. These signals are subtracted from the summing amp output, leaving only the offset voltage (dc drift) to be averaged by the balancer.

#### WIGGLER

The index sensor signal (socket 17) is used to control a phase-locked oscillator. The oscillator output is Wiggler, a 40-Hz sine wave (socket 23). This signal is applied to the summing amplifier to create a "dither" signal which moves the carriage very slightly back and forth. This movement is detected by the access transducer and is used to maintain AGC while in linear mode. The movement is synchronized to the disk pack index slot, therefore, all disk packs dither movement is identical and causes no head tracking error. Because the dither movement is so small, its presence is not felt when a seek operation is in progress.

### 4.4 PWA CIRCUIT ANALYSIS

This section describes in detail, the generation of signals within the drive. Each description discusses the purpose and operation of the circuitry on the PWA. Refer to chapter 9 for the PWA logic diagrams.

#### 4.4.1 Socket 2, SELECT 0-9

##### PURPOSE

1. Generates head selected signals for heads 0 through 9 from the -Head Select control signal and head address register (HAR) bits.
2. Produces the -Heads Unsafe signal when multiple heads are selected or a not R/W Ready condition is detected.
3. Combines three cylinder address register (CAR) bits to produce two cylinder selection control signals for use in the READ and WRITE sockets.

##### OPERATION

Head Selected Signals (0-9). The head selected signals are generated from combinations of HAR bits. The + and - HAR Bits 1, 2, 4, and 8 and -HAR Bit 16 are gated together in various combinations through ten NAND gates. These gates, when enabled by the inverted -Head Select signal, decode the contents of the HAR for heads 0 through 9. The -HAR bit 16 is used in gates for heads 0 through 4 to ensure that heads 0 through 4 are disabled when heads 16 through 20 are selected, and vice versa. Depending upon the contents of the HAR (if it is between 0 and 9), one of the ten gating circuits will be enabled. The output of the enabled gate then goes active while the remaining nine are inhibited. The outputs of all ten gates are coupled to line drivers which invert and translate the voltage level of the Head Selected output signals. In addition, the outputs of gates for heads 1, 2, 5, 6, and 9 are ORed together to produce the -A Heads Selected signal. In like manner, the outputs of gates for heads 0, 3, 4, 7, and 8 are ORed together to produce the -B Heads Selected signal. These signals determine the side (or group) of the selected head.

Heads Unsafe Signal. Each Head Selected output signal is coupled through a diode to

a common point. The Head Selected signals from socket 3 are also coupled through diodes to a common point which is routed to socket 2, pin 54, as the Multiple Select signal. The common points of sockets 2 and 3 are connected together to form one input to the detector. The other input to the detector is supplied by a gating network controlled by the -R/W Ready signal from socket 14. The detector sets the Heads Unsafe flip-latch generating the -Heads Unsafe signal if either of the following conditions exist:

- a. Two or more heads selected.
- b. Any head is selected and the R/W Ready signal goes inactive.

Cylinder Selection Signals. The -CAR Bits 64, 128, and 256 are gated together to produce two cylinder selection control signals, the -CYLS 192-405 and -CYLS 320-405. These signals control gating circuits for write and read operations on sockets 4 and 5.

#### 4.4.2 Socket 3, SELECT 10-19

##### PURPOSE

Generates head selected signals for heads 10 through 19 from the -Head Select control signal and the head address register (HAR) bits.

##### OPERATION

Head Selected Signals (10-19). The head selected signals are generated from combinations of HAR bits. The + and - HAR bits 1, 2, 4, and +HAR bits 8 and 16 are gated together in various combinations through ten NAND gates. These gates, when enabled by the inverted -Head Select signal, decode the contents of the HAR for heads 10 through 19. Depending upon the contents of the HAR (if it is between 10 and 19), one of the ten gating circuits will be enabled. The output of the enabled gate then goes active while the remaining nine are inhibited. The outputs of all ten gates are coupled to line drivers which invert and translate the voltage level of the Head Selected output signals. In addition, the outputs of the gates for heads 11, 12, 15, 16, and 19 are ORed together to produce the -B Heads Selected signal. In like manner, the outputs of the gates for heads 10, 13, 14, 17, and 18 are ORed together to produce the -A Heads Selected signal. These signals determine the side (or group) of the selected head.

Multiple Select. Each Head Selected output signal is coupled through a diode to a common point. The common connection is routed to socket 2 as the Multiple Select signal where it is used to generate the Heads Unsafe signal.

#### 4.4.3 Socket 4, WRITE

##### PURPOSE

1. Generates write current and associated gating (pre-driver) signals for

both "A" and "B" heads.

2. Sends the +Write Current Sense signal to socket 12 (File Status).
3. Generates -AC Write Unsafe and -DC Write Unsafe status signals under a variety of unsafe conditions. The unsafe signals are used in socket 12 (File Status).

## OPERATION

Write Pre-Driver Signals. Input Write Data pulses from the control unit are inverted and applied to the clock input of a J-K flip-flop. The flip-flop is connected in a divide-by-two configuration. The two flip-flop outputs are connected to pre-driver circuits which supply the two Write Pre-Driver gate signals to the matrix sockets. The pre-driver signals are complementary and change state on each positive-going transition of the input Write Data signal.

Write Current Signals. Two discrete write current signals are generated, one for "A" heads and one for "B" heads. The -A Heads Selected and -B Heads Selected signals are used as gating signals for the write current gates. When the write mode is enabled, the -Write Gate input signal goes low; it is then inverted and NANDed with the read gate, delayed head selected (A or B), and a safety disable line. If the read gate and safety signals are inactive, the current source is enabled generating write current. The write current from the current source is applied to two gate circuits which are enabled by the heads selected signals. Depending upon which head selected signal is active (A or B), the write current is routed through one of the gate circuits. The outputs of the gate circuits are applied to the matrix sockets as -Write Current A and -Write Current B. The write current from the current source is reduced in two discrete increments by the -CYLS 192-405 and -CYLS 320-405 input signals. The write current requirement is lowered as the heads move toward the disk pack center due to the lower flying height of the heads and reduced velocity of the disk pack. The write gate, read gate, delayed head selected, and safety disable lines are also NORed together. The outputs of both the NAND and the NOR circuits are NORed together and coupled to the write unsafe circuits. The NOR circuit output is also clamped so that it cannot generate write current when active.

-AC Write Unsafe Signal. When the write mode is selected, the NORed output of the read gate/write gate circuit goes high. After being delayed 20 microseconds, it provides an enable level to the NAND gate at the input of the AC flip-latch. As the write current through the heads switches, the transitions are detected and coupled back into the WRITE socket. After buffering through a line receiver, the transitions are applied to a time interval detector. If the time interval between transitions is less than 600 nanoseconds, the detector output remains low and the flip latch remains reset. If the time interval between transitions exceeds 600 nanoseconds, the detector output goes high; this sets the flip-latch, generating an active -AC Write Unsafe signal.

-DC Write Unsafe Signal. The -DC Write Unsafe signal is generated by the DC flip-latch. The set input of the latch is derived from a wire-OR network combining current detectors and associated gating circuits. There are current detector networks for the

write gate current source and both write current gate circuits. There is also a monitoring circuit for the current clamp circuit.

The current detector circuits for the write current gate circuits are wire-ORed, inverted, and applied to the common (wire-OR) input line for the DC flip latch. The current detector for write current and the current clamp on monitor outputs are both NANDed with the -Write Gate input signal to supply the remaining signals to the common wire-OR line. The wire-OR input line to the DC flip latch goes low (active) under the following conditions:

- a. Both A and B heads selected.
- b. Write current present but no write gate.
- c. No write gate but write current detector active (write current sense).

When any of the above conditions occur, the wire-OR line to the DC flip-latch goes low. After a 30-microsecond delay, the DC flip-latch is set, generating an active -DC Write Unsafe signal.

+Write Current Sense Signal. The output of the write gate current detector is routed to socket 12 (File Status) as the +Write Current Sense signal.

#### 4.4.4 Socket 5, READ

##### PURPOSE

1. Produces the Read Data output pulse train which is sent to the control unit.
2. Generates the Read Signal 1 and Read Signal 2 waveforms for use in socket 6 (Defect Detector).

##### OPERATION

Read Data. The Pre-Amp 1 and 2 read signals from MATRIX socket 28 or 29 (depending upon selection of A or B heads) are applied to the input amplifier where the signal level is amplified by a factor of approximately 25.

The input signal level is reduced in two discrete increments by the -CYLS 192-405 and -CYLS 320-405 cylinder selection signals. This results in a lower signal level at the amplifier output. The read level is reduced as the heads move toward the disk pack center because the reduced velocity of the disk pack nearer the center causes the heads to ride closer to the disk surfaces.

The amplified signal is coupled through a bandpass filter network which removes frequency components above 4 MHz. The resultant filtered signal is applied to a differentiator circuit which produces an output signal proportional to the slope of the input waveform. The two outputs of the differentiator are routed to socket 6 (Defect Detector) as the Read Signal 1 and Read Signal 2 signals. The differentiator outputs are also

coupled to a clipper amplifier and pulse shaper circuit. The amplifier clips the applied signal converting it to a pulse train. The output stage of the shaper circuit consists of a limited differentiator which produces 80-nanosecond pulses (of both polarities) at each transition of the clipped waveform. Both outputs of the limited differentiator are applied to a NOR gate which is enabled by the +Read Gate signal. (When Read Gate is inactive, the -Read Gate signal disables the NOR gate output). The output of the NOR gate is coupled to a line driver which produces a train of positive-going pulses, occurring at each transition of the clipper amplifier signal. The line driver output is supplied to the control unit as the Read Data signal.

#### 4.4.5 Socket 6, DEFECT DETECTOR

##### PURPOSE

1. Generates the +Error Det to socket 9 (Cylinder Address Register) when surface defects are detected during the initialization of the disk pack.
2. Contains a test circuit for use during the head alignment procedure.

##### OPERATION

Error Det Signal. The error detector circuit is enabled when the Read Gate and File Bus 256 signals are active. These signals are gated together to enable the input gates; when this occurs, Read Signal 1 and Read Signal 2 from the READ PWA are applied to an amplifier. The amplified output signal is applied to a full-wave rectifier network to convert the signal to a pulsating dc configuration. The rectified signal is peak detected, divided down through a resistor network, and applied to one input of a comparator network. The second input to the comparator is the pulsating dc signal from the rectifier network. When the pulsating dc signal crosses the voltage threshold set by the peak-detected rectified signal, the comparator changes state. This produces a train of pulses which correspond to data transitions in the read signals. The comparator output is termed "Sense Pulse" and it is applied to the detector input. The detector produces an active output if the time interval between sense pulses exceeds 500 nanoseconds. This corresponds to dropping two consecutive bits of data or clock. The detector output is gated with the enable level from the Read Gate and File Bus 256. The Read Gate and File Bus 256 signals also trigger a 30-microsecond one-shot which initially inhibits the detector output during the amplifier circuit stabilization. The detector output (+Error Sense) triggers a 5-microsecond one-shot, the output of which is gated with the enable level from the Read Gate and File Bus 256 signals. The train of 5-microsecond pulses is inverted and routed to socket 9 as the +Error Det signal.

Head Alignment Test Circuit. During head alignment procedures, the read signal is jumpered from pin 1 to pin 19 of the socket. The read signal is amplified and sent through two demodulation networks. The demodulation removes 10 kHz and 40 Hz frequency components from the signal. The resulting signal is coupled through two differentiation circuits. The outputs of the differentiation circuits are monitored as test points during the alignment procedure.

#### 4.4.6 Socket 8, BUS AND TAG CONTROL, HEAD ADDRESS REGISTER

##### PURPOSE

1. Decodes the File Bus lines into Head Address Register (HAR) bits.
2. Decodes the File Bus lines into various operational control signals for use within the drive.

##### OPERATION

+File Bus Signals. The -Drive Bus 1 through 128 signals from the control unit are buffered and inverted through line receivers and sent to the drive circuits as the +File Bus 1 through 128 control signals. The +File Bus signals are also used internally within socket 8.

+Mod Select Signal. The -Mod Select signal from the control unit is buffered and inverted through a line driver to generate the +Mod Select signal.

+Set Cylinder Signal. The +Set Cylinder signal is generated from an AND combination of the following signals:

- a. The inverted and buffered -Set Cylinder signal from the control unit.
- b. The -Disable Interface signal.

The +Set Cylinder output signal is sent to socket 9 (Cylinder Address Register) and socket 13 (Difference Counter).

-Read Only Signal. The -Read Only signal is generated when the READ ONLY flip-latch is set. The latch is set by the NAND combination of -Mod Select and +Read Only signals. Thus, to enter the read only mode of operation, the front panel READ-WRITE/READ ONLY switch must be set to READ ONLY and the drive must not be selected. The -Read Only signal is sent to socket 9 and to socket 18 (Temperature Compensation and Safety).

-Write Gate Signal. The -Write Gate signal is generated by a NAND combination of the following signals:

- a. +File Bus 128.
- b. -Read Only.
- c. The AND combination of the following signals:
  1. -Unsafe.
  2. The inverted Control tag signal (-Control) from the control unit.
  3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

In effect, if the drive is not in the read only mode, +File Bus 128 is active, no unsafe



condition exists, and the Control tag line goes active, the -Write Gate signal is generated and sent to socket 4 (Write).

-Read Gate Signal. The -Read Gate signal is generated by a NAND combination of the following signals:

- a. +File Bus 64
- b. The AND combination of the following signals:
  1. -Unsafe.
  2. The inverted Control tag signal.
  3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

In effect, if no unsafe conditions exist, +File Bus 64 is active, and the Control tag line goes active, the -Read Gate signal is generated and sent to socket 5 (Read) and socket 6 (Defect Detector).

-Reset Attention Signal. The -Reset Attention signal is generated by the NAND combination of the following signals:

- a. The inverted Control tag signal.
- b. +File Bus 64.
- c. +Mod Select.

The -Reset Attention output signal is sent to socket 12 (File Status).

-Seek Start Signal. The -Seek Start signal indicates the start of a seek operation. It is generated by a NAND combination of the following signals:

- a. -Heads Retracted.
- b. +File Bus 32.
- c. The AND combination of the following signals:
  1. -Unsafe.
  2. The inverted Control tag signal.
  3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

The -Seek Start signal is used in socket 12, socket 13, socket 14 (Access Control), socket 15 (Curve Generator), and socket 16 (Difference Calculator).

-Head Select Signal. The -Head Select signal is generated from the NAND combination of the following signals:

- a. +File Bus 4.
- b. The AND combination of the following signals:
  1. -Unsafe.

2. The inverted Control tag signal.
3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

The -Head Select signal is sent to socket 2 (Select 0-9) and socket 3 (Select 10-19).

-CE Reset Unsafe Signal. The -CE Reset Unsafe signal is generated from the NAND combination of the following signals:

- a. +Reset Attention.
- b. +Index Pulse.
- c. +File Bus 16.

The -CE Reset Unsafe output signal is sent to socket 14.

-Restore Signal. The -Restore output signal initiates a restore operation. It is generated by the NAND combination of the following signals:

- a. +File Bus 2.
- b. -Heads Retracted.
- c. The AND combination of the following signals:
  1. -Unsafe.
  2. The inverted Control tag signal.
  3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

The -Restore output signal is sent to socket 12 and socket 14.

HAR Bit Signals. The HAR Bit signals are generated from a register comprised of five J-K flip-flops. The flip-flops are initially cleared by either the -Drive to Forward Stop signal during a restore operation or by the NAND combination of the following signals during a reset unsafe condition:

- a. +File Bus 16.
- b. The AND combination of the following signals:
  1. -Unsafe.
  2. The inverted Control tag signal.
  3. -Set Head and +Mod Select and -Set Cylinder and -Disable Interface.

After being cleared, the flip-flops can be loaded with the head address. This is accomplished by enabling Five two-input NAND circuits (one for each flip-flop) with the AND combination of +Mod Select and +Set Head. The +File Bus lines 1, 2, 4, 8, and 16 contain the head address; the contents of these lines are gated to the set direct inputs of the flip-flops through the enabled gates. This generates the + and - HAR Bit outputs. The Q output of each flip-flop is connected to the clock input of the following stage. This enables the heads to be selected in sequence by stepping the HAR in unit increments through the NAND combination of +File Bus 1 and the AND circuit

of (b.) above.

#### 4.4.7 Socket 9, CYLINDER ADDRESS REGISTER

##### PURPOSE

1. Generates CAR Bit and Cyl Addr Reg signals from the File Bus lines and Set Cylinder tag line.
2. Buffers the +Error Det and -Selected Index signals for transmission to the control unit.
3. Generates the -Sel Read Only signal for use by the control unit.

##### OPERATION

CAR Bit and Cyl Addr Reg Signals. Each of the nine +File Bus lines is applied to the data input of a D-type flip-flop. The +Mod Select, the +File Ready, and the +Set Cylinder signals are gated together to form the clock input for each of the flip-flops. When the +Set Cylinder signal goes active, each flip-flop will be clocked. The data on the File Bus lines then appears at the flip-flop outputs. The  $\bar{Q}$  output of each flip-flop is taken as a -CAR Bit signal. The -CAR Bit signals are used in the Difference Calculator, socket 16 and are routed to socket 10 for test purposes. In addition, -CAR Bits 64, 128, and 256 are used in socket 18 (Temperature Compensation and Safety) and socket 2 (Select 0-9). The Q output of the Bit 1 flip-flop is used in socket 13 (Difference Counter) and socket 25 (Cylinder Select): this signal is termed +CAR Bit 1. The Q outputs of all nine flip-flops are gated through AND circuits by +Mod Select. The outputs of the AND circuits are applied to line drivers. The resulting nine lines are the -Cyl Addr Reg bit signals which are routed to the control unit.

During a restore operation, the +Drive to Forward Stop signal goes active. It is inverted to a low and applied to the clear inputs of each of the flip-flops. This resets the flip-flops, removing any cylinder address information.

Selected 715 DEC Signal. The +Mod Select signal is buffered and inverted in a line driver and sent to the control unit as the -Selected 715DEC signal.

+Error Det Signal. The +Error Det signal from socket 6 is coupled through an AND circuit by the +Mod Select line. The signal is buffered and inverted by a line driver and routed to the control unit as the -Sel Error Detected signal.

-Selected Index Signal. The -Selected Index signal from socket 17 (Index Transducer) is buffered through two inverter stages (one inverter is the line driver) and routed to the control unit as the -Selected Index signal.

-Sel Read Only Signal. The -Read Only signal from socket 8 (Bus and Tag Control, Head Address Register) sets a flip-latch. The Q output of the latch is ANDed with the +Mod Select and the -30VDC Unsafe from socket 14 (Access Control). The output of the AND circuit is inverted by a line driver with the resulting output signal routed to

the control unit as the -Sel Read Only Signal.

#### 4.4.8 Socket 12, FILE STATUS

##### PURPOSE

Generates a variety of drive status signals for use by the drive and the control unit.

##### OPERATION

-Unsafe, File Unsafe Lamp, -Sel File Unsafe, and +Disable Interface Signals. The following unsafe control signals are NORed together in the UNSAFE gate:

- a. -Heads Unsafe
- b. -Pack Speed Unsafe
- c. -AC Write Unsafe
- d. -DC Write Unsafe
- e. -30 VDC Unsafe
- f. -Any Unsafe Except R/W
- g. -Velocity Unsafe

If any of the input unsafe signals goes active (low), the output of the NOR circuit goes high. The NOR circuit output is gated with the -Heads Retracted input signal to produce the -Unsafe output signal to socket 8 (Bus and Tag Control, Head Address Register). The -Unsafe signal is also coupled to a line driver generating the UNSAFE lamp drive. The output of the UNSAFE NOR circuit is also gated with the +Mod Select signal; the resulting signal is buffered and coupled through a line driver to form the -Sel File Unsafe signal to the control unit. The -Unsafe output signal is NORed with the Q output of the ON-LINE flip-latch generating the +Disable Interface signal to socket 8.

-Sel Write Cur Sense Signal. The +Mod Select signal is NANDed with the +Write Current Sense signal from socket 4; the resulting signal is buffered and coupled through a line driver to form the -Sel Write Cur Sense signal to the control unit.

-Sel Drive End of Cyl Signal. The +Mod Select signal is NANDed with the +HAR 4 and +HAR 16 bits from socket 8; the resulting output signal is buffered and coupled through a line driver to form the -Sel Drive End of Cyl signal to the control unit. When active, this signal informs the control unit that no more heads can be selected for the particular cylinder number selected.

-Selected Module Signal. The +Mod Select signal is inverted, buffered, and coupled through a line driver to form the -Selected Module signal to the control unit.

-Set Drive to Forward Stop Signal. The -Set Drive to Forward Stop signal is generated by a three-stage, divide-by-four counter. Initially, the three flip-flops in the counter are reset by an ORed combination of the following signals:

- a. -Seek Start
- b. -Drive to Forward Stop
- c. -Hold Reverse and -Heads Retracted

In normal operation, the -Seek Start signal resets the counter. The inverted -Seek in Process signal enables the first flip-flop in the counter and counting of index pulses begins. If the seek is not completed within 100 milliseconds, four index pulses will have been counted in the counter. When the fourth index pulse is counted, the  $\bar{Q}$  output of the third flip-flop goes low, generating the -Set Drive to Forward Stop signal. The signal is routed to socket 14 (Access Control). The +First Cylinder and +Linear Mode signals are NANDed together with the output wire ORed to the output of the third counter stage. This is done because it is necessary to generate a restore operation if a cylinder crossing occurs while the drive is in the linear mode.

+File Ready Signal. The +File Ready signal is generated by inverting the input -File Ready signal from socket 14. The +File Ready output signal is routed to socket 9 (Cylinder Address Register) and to socket 13 (Difference Counter).

-Sel Seek Incomplete Signal. If a seek operation cannot be performed and four index pulses are counted, the -Set Drive to Forward Stop signal sets the SEEK INCOMPLETE flip-latch. The Q output of the latch is NANDed with the +Mod Select signal; the resulting signal is buffered and coupled through a line driver to form the -Sel Seek Incomplete signal to the control unit.

Access Ready Lamp Signal. The Access Ready Lamp drive signal is generated by NANDing the following signals:

- a. -Unsafe (the inverted output of the UNSAFE NOR circuit)
- b. -Restore
- c. -Hold Reverse and  $\bar{Q}$ -Heads Retracted
- d. -Seek Incomplete (Q output of SEEK INCOMPLETE flip-latch)

If the above conditions are met, the output of the NAND circuit goes active. The resulting signal is coupled through a line driver to the front panel FILE READY lamp.

-Sel Drive Ready Signal. The -Sel Drive Ready signal is produced by NANDing the following signals:

- a. -Unsafe (the inverted output of the UNSAFE NOR circuit)
- b. -Seek Incomplete (Q output of the SEEK INCOMPLETE flip-latch)
- c. +Mod Select
- d. +File Ready and -Seek Start

When the above conditions are active (true), the output of the NAND circuit goes active. The resulting signal is buffered and coupled through a line driver to form the -Sel Drive Ready signal to the control unit.

-Sel Drive On Line Signal. The -Sel Drive On Line signal indicates that the selected drive is on line; that is, it is ready to receive commands from the control unit. The signal is generated from two sources, the ON-LINE flip-latch and the ENABLE/DISABLE flip-latch.

The ON-LINE flip-latch is set by the NORed combination of the -File Ready and the -Seek Incomplete (Q output of SEEK INCOMPLETE flip-latch) signals. Thus, the Q output of the ON-LINE flip-latch goes active when a seek has been successfully completed or the File Ready signal is active. The Q output of the ON-LINE latch is wire-ORed with the inverted Q output of the ENABLE/DISABLE latch. The ENABLE/DISABLE latch is set when the front panel ENABLE/DISABLE switch is set to ENABLE. Under this condition, the inverted Q output of the ENABLE/DISABLE latch enables the wire-OR connection and the ON-LINE flip-latch output is NANDed with the +Mod Select signal. The resulting output signal is buffered and coupled through a line driver to form the -Sel Drive On Line signal to the control unit.

If the ENABLE/DISABLE switch is set to DISABLE, the ENABLE SW TRANSFER flip-latch is reset, enabling one input of ENABLE/DISABLE flip latch reset gate. The other input to the reset gate is the -Mod Select signal. Therefore, the ENABLE/DISABLE flip-latch cannot be reset until the drive has completed its function and the control unit selects a different drive. When this occurs, the ENABLE/DISABLE flip-latch is reset, inhibiting the Q output of the ON-LINE flip-latch. The drive is then removed from on-line status by the -Sel Drive On Line signal.

-Gated Attention Signal. The -Gated Attention signal is generated when the drive has just completed a seek or restore operation. The signal is generated from a NANDed combination of the following signals:

- a. Attention (Q output of ATTENTION 2 flip-latch)
- b. -Restore
- c. -Seek Start
- d. Seek End (Output of SEEK END NOR gate)

Generation of each of the above inputs to the NAND circuit is discussed in the following paragraphs.

The output of the ON-LINE flip-latch is NORed with the -Restore signal from socket 8 to set the ATTENTION 1 flip-latch. The Q output of the ATTENTION 1 latch is NANDed with the output of the ON-LINE latch; the resulting signal is NORed with the -Seek Start input signal from socket 8 to set the ATTENTION 2 flip-latch. When the ATTENTION 2 latch is set by any combination of the gating signals, an active enabling signal is applied to one input of the -Gated Attention NAND circuit.

The -Restore input signal from socket 8 is applied directly to one input of the -Gated Attention NAND circuit.

The -Seek Start input signal from socket 8 is also applied directly to one input of the

-Gated Attention NAND circuit.

The final input to the -Gated Attention NAND circuit is supplied by the Seek End signal. This signal is a NORed combination of the following signals:

- a. -Seek Incomplete ( $\overline{Q}$  output of the SEEK INCOMPLETE flip-latch)
- b. -File Ready
- c. -Hold Reverse and -Heads Retracted

An active enable level is supplied to the -Gated Attention NAND circuit if a seek cannot be completed, the drive achieves file ready status, or if the heads are retracted from the pack.

When all inputs to the NAND circuit are active (high), the output goes active (low). The resulting signal is buffered and coupled through a line driver to form the -Gated Attention signal to the control unit.

#### 4.4.9 Socket 13, DIFFERENCE COUNTER

##### PURPOSE

1. Generates difference counter control bits and various combinations of the control bits for use in socket 15 (Curve Generator).
2. Generates Cylinder crossing signals, first cylinder crossing signals, and cylinder vicinity signals for use in controlling movement of the heads.

##### OPERATION

Difference Counter Bits. The difference counter is a nine-bit counter. The input to the counter is supplied by the -Difference signals from socket 16 (Difference Calculator). The input -Difference signals are the "ones complement" of the difference between the new and present cylinder address signals. During a restore, head load, or difference counter reset operation, the counter can be preset to the "ones complement" of 407 (104).

The counter consists of two four-bit counters which receive difference bits 2 through 256. The "ones" bit of the counter is the DIFF BIT 1 flip-flop. The counter is preset to 104 (407) by a NORed combination of the following signals:

- a. -Drive to Forward Stop
- b. -Reset Diff Counter
- c. -Head Load and -Heads Retracted

When this signal is active, it is inverted and sets the 64, 32, and 8 inputs to the counter. It also inhibits the remaining inputs to the counter. The output of the NOR circuit (+Set Difference to 407) also loads the preset input into the counter through another

NOR circuit. The clock input to the counter is the inverted Q output of the DIFF BIT 1 flip-flop which changes state at each cylinder crossing. The counter then counts the number of cylinder crossings, increasing the count (decreasing the difference) in unit increments. The counter will continue to count until the difference has reached zero (counter at 511).

In normal operation, the counter input is supplied from the difference calculator circuit on socket 16. The -Difference 1 input is applied to the D input of the DIFF BIT 1 flip-flop. The remaining -Difference input signals are buffered and, when enabled by the not +Set Diff to 407 signal, applied to the counter inputs. In this case, the -Difference input signals (including -Difference 1) are loaded into the counter by a 300-nanosecond pulse derived from the ANDed combination of the following signals:

- a. +Set Cylinder
- b. +Mod Select
- c. +File Ready

After the counter is loaded with the difference signals, it is again clocked by the inverted Q output of the DIFF BIT 1 flip-flop. Operation of the counter is the same as described for the preset condition; that is, it counts up in unit increments, decreasing the difference at each cylinder crossing. There are nine -Diff Counter Bit output signals which are applied to socket 15 for use in the shaper circuits and fed to socket 10 for testing purposes.

+Diff Less Than 64 Signal. The -Diff Counter Bits 64, 128, and 256 are ANDed together to form the +Diff Less Than 64 signal to socket 15.

-Diff CTR Bits 32 + 128 + 256 Signal. The -Diff Counter Bits 32, 128, and 256 are ORed together to form the -Diff Ctr Bits 32 + 128 + 256 signal to socket 15.

-Diff Equals One Signal. The following signals are NANDed together to form the -Diff Equals One signal:

- a. +Diff Counter Bit 1
- b. -Diff Counter Bit 2
- c. -Diff Counter Bit 4
- d. -Diff Counter Bit 8
- e. -Diff Counter Bit 16
- f. -Diff Counter Bit 32
- g. +Diff Less Than 64

The -Diff Equals One signal is sent to socket 10 for testing purposes; it is also inverted to form the +Diff Equals One signal to socket 14 (Access Control) and socket 18 (Temperature Compensation and Safety).



-Diff Equals Zero Signal. The following signals are Nanded together to form the -Diff Equals Zero signal:

- a. -Diff Counter Bit 1
- b. -Diff Counter Bit 2
- c. -Diff Counter Bit 4
- d. -Diff Counter Bit 8
- e. -Diff Counter Bit 16
- f. -Diff Counter Bit 32
- g. +Diff Less Than 64

The -Diff Equals Zero signal is sent to socket 10 for testing purposes it is also used in socket 14.

+Diff Less Than 16 Signal. The following signals are ANDed together to form the +Diff Less Than 16 signal:

- a. -Diff Counter Bit 16
- b. -Diff Counter Bit 32
- c. +Diff Less Than 64

The +Diff Less Than 16 signal is sent to socket 15.

+Diff Equal/Less Than 2 Signal. The following signals are ANDed together:

- a. +Diff Counter Bit 2
- b. -Diff Counter Bit 1
- c. -Diff Counter Bit 4
- d. -Diff Counter Bit 8
- e. -Diff Counter Bit 16
- f. -Diff Counter Bit 32
- g. +Diff Less Than 64

When active, the output of the AND circuit drives the output of a NOR circuit active. The output of the NOR circuit is NORed with the -Diff Equals One signal producing the +Diff Equal/Less Than 2 signal to socket 15.

-One Track Seek Signal. When the difference count of the counter is greater than 1, the inverted -Diff Equals One signal holds the ONE TRACK SEEK flip-latch in the reset state. When the heads are on the selected cylinder, the reset signal is removed from the latch. If the next seek is a single cylinder seek, the -Diff Equals One remains active, inhibiting the flip-latch reset line. When the seek is initiated, the -Seek Start signal from socket 8 sets the latch generating an active -One Track Seek signal to socket 15 and to socket 21 (AGC).

+Sel Set Diff Signal. The ANDed combination of +Set Cylinder, +Mod Select, and +File Ready which is used to generate the counter load signal is also routed to socket 14 as the +Sel Set Difference signal.

DIFF BIT 1 Flip-Flop Operation. The -Difference 1 input signal is applied to the D input of the DIFF BIT 1 flip-flop. The input signal is loaded into the flip-flop by the 300-nanosecond counter loading pulse. The state of the flip-flop is changed at each cylinder crossing through use of the direct set and direct clear inputs. The clear input is supplied by a NORed combination of the following signals:

- a. +Set Diff to 407
- b. +Odd Cylinder and -CAR Bit 1
- c. +Even Cylinder and +CAR Bit 1

The set input is supplied by a NORed combination of the following signals:

- a. +Even Cylinder and -CAR Bit 1
- b. +Odd Cylinder and +CAR Bit 1

Thus, the initial state of the flip-flop depends upon the state of CAR Bit 1 but when established, the flip-flop changes state each time a cylinder is crossed.

-Cylinder and +Cylinder Signals. The -Even Cylinder and -Odd Cylinder signals from socket 20 (Cylinder Detector) are NORed together to produce the +Cylinder output signal to socket 14. The +Cylinder signal is inverted to -Cylinder which is sent to socket 15, socket 24 (Summing and Pulser), and socket 25 (Cylinder Select). These signals go active at all cylinder crossings, odd and even.

+First Cylinder and -First Cylinder Signals. The CAR Bit 1 signal is applied to the D input of a flip-flop. When the drive goes to linear mode, the +Linear Mode signal loads the CAR Bit 1 level into the flip-flop. The Q and  $\bar{Q}$  outputs of the flip-flop are ANDed with the +Even Cylinder and +Odd Cylinder signals, respectively. When a new seek is initiated, one of the two AND circuit outputs goes active. The AND circuit outputs are NORed together to produce the -First Cylinder signal to socket 14. The -First Cylinder signal to socket 12 (File Status). These signals go active at the first cylinder crossing of a new seek.

-First Cylinder Vicinity Signal. The -First Cylinder Vicinity signal is generated from the First Cylinder flip-flop and the +Even Cylinder Vicinity input signal from socket 20. The +Even Cylinder Vicinity signal and its inverse are ANDed with the Q and  $\bar{Q}$  outputs of the First Cylinder flip-flop, respectively. The outputs of the AND circuits are NORed together to produce the -First Cylinder Vicinity output signal to socket 21. This signal indicates that the heads have moved one half cylinder in a new seek.

#### **4.4.10 Socket 14, ACCESS CONTROL**

##### **PURPOSE**

1. Processes cylinder access signals.
2. Produces a variety of control and status signals for both coarse and fine head positioning.

3. Monitors various safety signals to produce appropriate control signals.

## OPERATION

-Forward Signal. The -Forward signal is generated when the FORWARD flip-latch is set. The latch is set by the NAND combination of the +Forward Sign signal (from Difference Calculator, socket 16) and the +Sel Set Diff signal (from Difference Counter, socket 13). The latch is reset by either the NAND combination of the +Sel Set Diff and -Forward Sign or by the -Drive to Forward Stop signals. The -Forward output signal is sent to socket 15 (Curve Generator).

+Linear Mode and -Linear Mode Signals. The Linear Mode signals indicate that the drive has entered linear mode. This occurs when the heads are within one-half cylinder of the selected cylinder or if the heads are stopped on cylinder. The LINEAR MODE flip-latch is set by the -Diff Equals Zero signal if the heads are on cylinder or by the NAND combination of the following signals as the heads are approaching the selected cylinder:

- a. +Diff Equals One
- b. +Cylinder Vicinity

When set, the LINEAR MODE flip-latch generates the +Linear Mode and -Linear Mode signals at the Q and  $\bar{Q}$  outputs, respectively.

The LINEAR MODE latch is reset by the ORed combination of the following signals:

- a. -Hold Reverse
- b. -Drive to Forward Stop
- c. The NAND combination of the following signals:
  1. -Diff Equals Zero
  2. -Invalid Seek
  3. The Q output of the Seek Start flip-latch.
  4. The delayed  $\bar{Q}$  output of the SEEK COMPLETE flip-latch.

+First Cylinder Detected and -First Cylinder Detected Signals. The First Cylinder Detected signals are generated when the FIRST CYLINDER DETECTED flip-latch is set. The latch is set by the ORed combination of the -First Cylinder and -Hold Reverse signals. When set, the FIRST CYLINDER DETECTED flip-latch generates the +First Cylinder Detected and -First Cylinder Detected signals at the Q and  $\bar{Q}$  outputs, respectively. The latch is reset by the -Linear Mode signal when the drive enters linear mode.

+Hold Reverse and -Hold Reverse Signals. The Hold Reverse signals are generated when the HOLD REVERSE flip-latch is set. The latch is set by the ORed combination of the following input signals:

- a. +Start and Controlled Gnd
- b. -Any Unsafe Except R/W
- c. -Power On/Start Reset

When set, the HOLD REVERSE flip-latch generates the +Hold Reverse and -Hold Reverse signals at the Q and  $\bar{Q}$  outputs, respectively. The latch is reset by the -Sequence Start Pulse from socket 27 (Power Control).

-Reset Diff Counter Signal. The -Reset Diff Counter signal is generated by the ORed combination of the -Forward Stop signal and the -Hold Reverse signal. This signal resets the difference counter when the forward stop switch has been reached or when the heads are retracted from the pack by the -Hold Reverse signal.

+Drive to Forward Stop and -Drive to Forward Stop Signals. The Drive to Forward Stop signals are generated during a restore operation, an initial seek operation, or during a seek-incomplete condition. The two DRIVE TO FWD STOP flip-flops are initially cleared by the -Reset Diff Counter signal.

The output flip-flop is clocked by the ORed combination of the following signals:

- a. -Set Drive to Forward Stop
- b. -Restore
- c. +Velocity Too Great (generated when the +Velocity Too Great input signal clocks the first DRIVE TO FWD STOP flip-flop).

When clocked by any of the above signals, the output flip-flop generates the +Drive to Forward Stop and -Drive to Forward Stop signals at the Q and  $\bar{Q}$  outputs, respectively.

+Retracted Mode and -Retracted Mode Signals. The +Heads Retracted input signal is NANDed with the +Hold Reverse signal to generate the -Retracted Mode signal. This signal is inverted to produce the +Retracted Mode signal. These signals, when active, indicate that the heads are retracted from the pack.

The +Head Load and -Head Load Signal. The +Head Load and -Head Load signals are generated when the HEAD LOAD flip-latch is set. The latch is set when the -Hold Reverse signal goes active. When set, the HEAD LOAD flip-latch generates the +Head Load and -Head Load signals at the Q and  $\bar{Q}$  outputs, respectively. The latch is reset by the -Drive to Forward Stop signal.

-Use Fast AGC Signal. The -Use Fast AGC signal is used only during a head load operation. It is generated by the NAND combination of the +Head Load and -Retracted Mode signals. This signal is used to set initial AGC and Tachometer levels into the servo circuits.

-Reset Unsafe Signal. The -Reset Unsafe signal is used to clear all the unsafe conditions in the drive. It is generated by the ORed combination of the following signals:

- a. -CE Reset Unsafe

- b. -Power On/Start Reset
- c. The NAND combination of +Index and +Sel Set Diff

-Seek In Process Signal. The -Seek In Process signal is generated when the SEEK IN PROCESS flip-latch is set. The latch is set by the ORed combination of the following signals:

- a. -Drive to Forward Stop
- b. The NAND combination of the following signals:
  - 1. -Diff Equals Zero
  - 2. +Seek Start (generated when the -Seek Start input signal sets the Seek Start flip-latch).
  - 3. The delayed  $\bar{Q}$  output of the SEEK COMPLETE flip-latch.

When set, the SEEK IN PROCESS flip-latch generates the -Seek In Process signal at the  $\bar{Q}$  output.

The SEEK IN PROCESS latch is reset by either of two conditions. When the heads are retracted from the pack, the -Hold Reverse signal resets the latch. When a seek has been completed, the SEEK COMPLETE latch is set by the NAND combination of +Cylinder, +Vel Minus Pos Equals Zero, and +Linear Mode. When this occurs, the delayed  $\bar{Q}$  output of the SEEK COMPLETE latch resets the SEEK IN PROCESS latch.

+Access Ready and -Access Ready Signals. The -Seek In Process signal is Nanded with the +Linear Mode signal to produce the -Access Ready signal. The -Access Ready signal is inverted to form the +Access Ready signal.

-File Ready Signal. The -File Ready signal is generated from the NAND combination of the +Access Ready and the -Seek Start signal. The -Seek Start signal is obtained from the  $\bar{Q}$  output of the Seek Start flip-latch; the  $\bar{Q}$  output goes high when the -Seek Start input signal sets the latch.

-R/W Ready Signal. The -R/W Ready signal is generated from the NAND combination of the +Access Ready and +Cylinder signals. This signal indicates that the drive is on cylinder and that read/write operations can commence.

-AC Unsafe Signal. The -AC Unsafe signal is generated in the drive power supply. If the -AC Unsafe signal goes active while the heads are on the pack (-Retracted Mode is high), the -AC Unsafe signal will be held active by the latch until the heads are retracted from the pack (-Retracted Mode goes low).

-30VDC Unsafe Signal. The +30VDC supply voltage is supplied to the DC VOLTAGE CHECK circuit. This circuit is a threshold detector which generates the -30VDC Unsafe signal if the input voltage falls below the preset threshold level.

-Triac On Signal. The Motor Transformer Secondary signals are applied to the AC

VOLTAGE CHECK circuit which consists of a rectifier, filter, and transistor switch. When input ac is applied, the filter begins to charge. After several cycles, the charge on the filter is sufficient to turn on the transistor switch. When this occurs, the -Triac On signal is generated.

#### 4.4.11 Socket 15, CURVE GENERATOR

##### PURPOSE

1. Generates analog shaper signals to socket 24 (Summing and Pulser) for use in generating drive signals for the carriage assembly.
2. Generates speed and directional control signals for the carriage assembly.

##### OPERATION

Shaper Output 1 and Shaper Output 2 Signals. The shaper signals are analog signals which are generated from the difference counter signals from socket 13. The analog signals are generated in a digital-to-analog converter which receives the difference counter bits and various gating signals. The gating signals lower the gain of the digital-to-analog converter when the number of cylinders to be traversed is less than 64.

The following difference counter signals are applied to the reset terminals of their associated flip-latches:

- a. +Diff Equal/Less Than 2
- b. +Diff Less Than 64
- c. +Diff Less Than 16

If the difference count is equal to or less than 2, none of the three latches will be reset by their input signals. The -Seek Start signal sets the three latches at the start of the seek operation. Under these conditions, the Q outputs of the latches generate the following active signals:

- a. -Equal/Less Than 2
- b. -Less Than 64
- c. -Less Than 16

These signals are used to gate current sources which limit the gain of the digital-to-analog converter. If the difference count is greater than 2 but less than 16, the  $\leq 2$  flip-latch will be held reset and only the -Less Than 64 and -Less Than 16 signals will be active. In like manner, if the difference count is between 16 and 64, the  $\leq 2$  and  $< 16$  latches will be held reset and only the -Less Than 64 signal will be active.

The following difference counter signals are supplied as inputs to the digital-to-analog converter:

- a. -Diff Counter Bit 1
- b. -Diff Counter Bit 4
- c. -Diff Counter Bit 8
- d. -Diff Counter Bit 16
- e. -Diff Ctr Bits 32 + 128 +256
- f. +Equal/Less Than 2
- g. -Cylinder
- h. +Diff Less Than 64

The +Equal/Less Than 2 signal is taken from the Q output of the  $\leq 2$  flip-latch discussed in the preceding paragraph. The gain of the digital-to-analog converter is reduced by gating current sources into the circuit for difference counts less than 64. Three of the gating circuits are discussed in the preceding paragraph. The fourth is activated when a one track seek is selected. The -One Track Seek signal from socket 13 (Difference Counter) provides the gate signal to apply the current source to the converter circuit. The four current sources have a common gain adjustment before application to the converter circuit.

The output of the digital-to-analog converter is an analog signal proportional to the difference count up to 64. The output signal is at maximum (with slight variation) for difference counts above 64. As the difference counter counts up (decreasing the difference), the output of the digital-to-analog converter describes a curve. The converter output is directly coupled to two gate circuits, one for forward motion and one for reverse. The output is also inverted in a unity-gain amplifier. The amplifier output is also coupled to two gate circuits, one for forward motion and one for reverse motion.

The gate circuits for the shaper output signals are controlled by the -Go Forward and +Go Reverse signals. These signals are generated from the -Forward input signal from socket 14 (Access Control).

The -Forward signal is coupled directly to an AND circuit; it is also inverted and applied to a NAND circuit. If the NORed combination of -Head Load, -Drive to Forward Stop, and -Linear Mode is inactive (high), both the AND and NAND circuits are enabled. If forward motion is selected, the -Forward signal is low. This drives the NAND circuit output low; the NAND circuit is inverted to a high, enabling both FORWARD shaper output gate circuits. The differential shaper output signals are then sent to socket 24 (Summing and Pulser) through the FORWARD gates. In this case, the AND circuit is disabled, holding the REVERSE shaper output gate circuits off. If reverse motion is selected, the NAND circuit is disabled and the AND circuit is enabled. The shaper output signals are then gated through the REVERSE gate circuits and the FORWARD gate circuits are off.

Both shaper output signals can be disabled by gating a dc voltage to the output lines.

Each shaper output line is wire-ORed to one DISABLE gate circuit. If the NORed combination of -Head Load, -Drive to Forward Stop, and -Linear Mode goes active (low), both DISABLE gate circuits are enabled. A dc voltage is then coupled to both shaper output lines through the DISABLE gates. This inhibits the shaper outputs.

The -Go Forward and +Go Reverse gate signals are also routed to socket 10 for test purposes.

-Drive Reverse 5"/Sec Signal. The +Hold Reverse and -Heads Retracted input signals are NANDed to form the -Drive Reverse 5"/Sec signal fed to sockets 24 and 10.

-Drive Forward 20"/Sec Signal. The following signals are NANDed to form the -Drive Forward 20"/Sec signal:

- a. -Diff Counter Bit 128
- b. -Diff Counter Bit 256
- c. +Head Load

The -Drive Forward 20"/Sec signal is sent to sockets 24, 18 and 10.

-Drive Forward 5"/Sec Signal. The -Drive Forward 5"/Sec signal is generated from the NORed combination of the following signals:

- a. +Drive to Forward Stop
- b. +Head Load and -Hold Reverse

The -Drive Forward 5"/Sec signal is sent to sockets 24 and 10.

#### 4.4.12 Socket 16, DIFFERENCE CALCULATOR

##### PURPOSE

1. Calculates the difference between the new cylinder address appearing on the File Bus lines and the present address stored in the cylinder address register (CAR).
2. Generates the -Invalid Seek signal if a number equal to or greater than 406 appears in the CAR.
3. Provides buffering and line drive for the File Bus 256 line.

##### OPERATION

-Difference Signals. The difference calculator circuit consists of a 9-bit adder circuit. The "B" input of each adder segment is supplied by the inverted +File Bus input lines. These lines contain the new cylinder address in binary form. The inverter stages provide the complement of the new cylinder address as adder inputs. The -CAR Bits 1 through 9 are applied to the D inputs of their respective flip-flops. The clock input for the flip-flops is the NORed combination of the -Drive to Forward Stop



the +Index pulse triggers a 15-millisecond one-shot. The negative-going trailing edge of the Q output of the one-shot triggers a second 15-millisecond one-shot. The second one-shot generates a window from 15 to 30 milliseconds after incidence of the first +Index pulse. The Q output of the second one-shot is Nanded with the +Index pulse. If a second +Index pulse occurs between 15 and 30 milliseconds after the first, the NAND circuit output sets the PACK AT SPEED flip-latch. When the PACK AT SPEED latch is set, the -Pack At Speed signal (Q output) goes active. This signal is sent to socket 24 (Summing and Pulser) and socket 27 (Power Control). It indicates that the rotation velocity of the disk pack is within acceptable operating limits. If the +Index pulse does not fall within the window set by the second one-shot, the PACK AT SPEED flip-latch will be held reset by the +Index pulse. In this case, the +Index pulse is coupled through a NAND circuit which is enabled by the high level at the set input of the latch. The NAND circuit output is coupled through a NOR circuit to hold the flip-latch in the reset state. The flip latch is also reset by an active -Power On/Start Reset signal from socket 27. In the reset state, the -Pack At Speed signal is inactive (high). The -Pack At Speed signal is Nanded with the -Hold Reverse signal from socket 14. Thus, when the -Pack At Speed signal is inactive and the heads are on the disk pack (-Hold Reverse is high), the NAND circuit is enabled, setting the PACK SPEED UN-SAFE flip-latch. This generates an active -Pack Speed Unsafe signal to socket 12, socket 18 (Temperature Compensation and Safety), and socket 10 for test purposes. The PACK SPEED UNSAFE latch is reset by the -Reset Unsafe signal from socket 14.

Index Sensor Bias. The sensor bias for the index transducer is supplied by a -12-volt dc line coupled through a resistor. This level is sent to the transducer through socket 19.

Index Source Drive Signal. The Index Source Drive signal provides the current source for the index transducer. The current drive is supplied from the source AGC circuit. The input signal for the source AGC circuit is supplied from the amplified Index Sensor signal; the AGC circuit is enabled by the NORed combination of the +Pack At Speed signal and the +Start and Controlled Gnd signal from socket 27. The +Pack At Speed signal is used only to ensure that the PACK AT SPEED flip-latch is reset after the +Start and Controlled Gnd signal is removed.

+Pack Stopped Signal. Twenty-five seconds after the +Start and Controlled Gnd signal is removed (goes low), a NAND circuit is enabled generating the +Pack Stopped signal to socket 27.

#### **4.4.14 Socket 18, TEMPERATURE COMPENSATION & SAFETY**

##### **PURPOSE**

1. Generates a variety of status and control signals:
  - a. Temperature Compensation and Offset Signals
  - b. Unsafe Signals
  - c. Velocity Status Signals

- d. Activate Servo Signal
- e. Thermistor Drive Signals
- f. Cylinder Offset Signal
- g. Read Only Lamp Drive

## OPERATION

+Velocity Too Great Signal. The Velocity Safety Sensor signal from the photosensitive transistor (PST) mounted on the carriage is applied to an input amplifier. The amplifier output is a positive-going pulse which is applied to the clock input of a J-K flip-flop and to one input of an AND circuit. In normal operation, the flip-flop will be in the reset state. It is clocked to the set state at the trailing edge of the velocity sensor pulse. If the next velocity sensor pulse is received less than 800-microseconds from the first, the flip-flop will be in the set state and the sensor pulse will be coupled through the AND circuit to socket 14 (Access Control) as the +Velocity Too Great signal.

The reset circuit for the flip-flop operates in two different modes. In normal operation, the amplified velocity sensor pulse is inverted and used to set a flip-latch circuit. This removes the clear input from the J-K flip-flop, enabling it to be clocked to the set state. The inverted sensor pulse also enables two NAND circuits, one for the +Velocity Too Great signal and one for the signal from the 800-microsecond delay circuit. The outputs of the NAND circuits are wire-ORed to form the reset input of the flip-latch. When the flip-latch is in the set state (from the first velocity sensor pulse), the NAND combination of the Q output of the flip-latch and the inverted -Drive Forward 20"/Sec signal enables the 800-microsecond delay circuit. If another sensor pulse is received before the 800-microsecond delay is complete, the output of the NOR circuit goes active; this resets the flip-latch through the NAND combination of the NOR circuit output and the inverted sensor pulse. This clears the J-K flip-flop and inhibits generation of the +Velocity Too Great signal. If another sensor pulse is received within 800-microseconds, the flip-flop will be in the set state and an active +Velocity Too Great signal will be generated. In this case, the flip latch is reset by the NAND combination of the inverted sensor pulse and the trailing edge of the +Velocity Too Great signal.

During the head load operation, the -Drive Forward 20"/Sec signal goes active (low). This inhibits the 800-microsecond delay circuit and enables the 3.2-millisecond delay circuit. Under these conditions, an active +Velocity Too Great signal can be generated at a very low carriage speed (20"/Sec); in this manner, the velocity safety circuits can be checked with little danger of a damaging carriage crash.

-Velocity Unsafe Signal. The -Velocity Unsafe signal is generated in the VELOCITY UNSAFE flip-flop. The +Velocity Too Great signal and the -Head Load signal are NANDed together and connected in a wire-OR configuration with the NANDed combination of the +Head Load, +Odd Cylinder, and +Diff Equals One signals. The wire-OR line provides the clock input to the VELOCITY UNSAFE flip-flop. When the flip-flop is clocked, the -Velocity Unsafe signal is generated at the Q output. The -Velocity Unsafe signal is sent to socket 12 (File Status) and to socket 10 for test purposes.

Vel Safety Source Drive Signal. The Vel Safety Source Drive signal for the access transducer is generated from a gated current source. The gating signal for the current source is the +Retracted Mode signal from socket 14. The Vel Safety Source Drive signal is sent to the transducer through socket 19.

-Any Unsafe Except R/W and 0X-48 Safety Unload Signals. The following unsafe signals are NORed together to form a composite unsafe signal:

- a. -Velocity Unsafe
- b. -AC Unsafe
- c. -Pack Speed Unsafe
- d. -30VDC Unsafe
- e. -DC Unsafe

The composite unsafe signal from the NOR circuit is NANDed with the inverted and buffered -12X0 Heads Extended Sw. input signal to form the 0X-48 Safety Unload signal. The Safety Unload signal is sent to the Power Driver. The same two input signals are also combined together in another NAND circuit to form the -Any Unsafe Except R/W signal. This signal is sent to sockets 14, 12, and 10. Both of the output signals represent unsafe conditions which will cause the heads to be retracted from the pack.

0X-12 Activate Servo Signal. The activate Servo signal is generated from an AND combination of the following signals:

- a. +Pack In Place
- b. Inverted Safety Unload
- c. Inverted Interlock

The Activate Servo signal is sent to socket 24 (Summing and Pulser). The conditions required for the Activate Servo signal to be active are as follows:

- a. A disk pack installed on the drive.
- b. No unsafe conditions which cause the heads to be retracted.
- c. All circuit boards installed (interlock ground between sockets must be continuous).

Reference Thermistor Drive and Compensation Thermistor Drive Signals. The Compensation Thermistor Drive signal is supplied by +12V through a resistor network. The Reference Thermistor Drive signal is provided by an amplifier circuit which changes the polarity of the positive dc input voltage to a negative dc drive signal. Both thermistor drive signals are sent to the transducers through socket 19.

Temp Comp Output and Temp Comp Offset 1 Signals. The output signals from the compensation and reference thermistors are applied to a differential amplifier. The compensation thermistor signal is also measured against a temperature reference voltage in another differential amplifier. The outputs of the two differential amplifiers are

applied to a variable gain amplifier. The variable gain amplifier provides an output control signal proportional to the difference between ambient temperature and the reference temperature. The output of the variable gain amplifier is supplied to socket 20 (Cylinder Detector) and to socket 23 (Tachometer) as the Temp Comp Output signal. This signal is also coupled through a resistance network and sent to sockets 20 and 24 as the Temp Comp Offset 1 signal.

The gain of the variable gain amplifier is varied in linear mode by a gated gain control circuit. The gain control circuit is driven by -CAR Bits 64, 128, and 256. The output of the gain control circuit is gated by the -Linear Mode signal. The effect of the gain control circuit on the variable gain amplifier changes with head position because the compensation thermistor is located on the index transducer. Since there is a temperature gradient across the disk pack, the temperature compensation must change with head position. When the drive goes into linear mode, the -Linear Mode signal gates the gain control signal into the variable gain amplifier.

Cylinder Offset Signal. The Temp Comp Output signal is applied to two gate circuits. The gating signal for the gate circuits is the NAND combination of the -Linear Mode signal and the -Even Cyl Stop signal. Therefore, when the drive is in linear mode, the Temp Comp Output is gated through the P-Gate if the -Even Cyl Stop signal is active (low) and through the N-Gate if the -Even Cyl Stop signal is inactive (high). The outputs of the gate circuits are applied to a unity gain amplifier which generates the Cylinder Offset signal to socket 25 (Cylinder Select). The Cylinder Offset signal compensates the cylinder position signals for changes in cylinder location due to temperature variations.

Read Only Lamp Signal. The -Read Only signal from socket 8 is buffered and inverted through a line driver to provide current drive to the front panel READ ONLY lamp.

#### 4.4.15 Socket 20, CYLINDER DETECTOR

##### PURPOSE

1. Generates balancer output signals for the servo loop.
2. Generates cylinder position, vicinity, and even/odd signals.
3. Provides bias voltages for the sensor light-emitting diodes.
4. Generates the source drive for the cylinder vicinity source light-emitting diode.

##### OPERATION

Balancer Output 1 and Balancer Output 2 Signals. The following signals are applied to the input amplifier for the Balancer 1 circuit:

- a. Balancer P1 and P2 (Position) Signals
- b. Temp Comp Offset 1 and 2 Signals
- c. Summing Amp Output 1 and 2 Signals

The Summing Amp Output signals are compared with the composite Balancer and Temp Comp Offset signals in the amplifier to produce a difference signal. The amplifier output is gated to the input of a low pass amplifier by the ORed combination of the following signals:

- a. -Balancer Enable
- b. -Retracted Mode
- c. -Access Ready

The gated signal is coupled through the low pass amplifier circuit where all high frequency components are removed. The output of the amplifier is supplied to the summing amplifier on socket 24 (Summing and Pulser) as the Balancer Output 1 signal. The Balancer Output 2 signal is a dc reference voltage which is also supplied to the summing amplifier on socket 24. The Balancer Output signals compensate for any dc drift in the servo system; that is, they compensate for any change in summing amplifier output that is not due to position or temperature compensation signals.

Position Signal 1 and Position Signal 2. The Sensor 1 and Sensor 2 input signals from the access transducer are coupled to a differential amplifier. The two outputs of the differential amplifier are 180° out of phase with each other. These two signals are supplied to the following sockets as the Position Signal 1 and Position Signal 2 signals:

- a. Socket 21 (AGC)
- b. Socket 23 (Tachometer)
- c. Socket 24 (Summing and Pulser)
- d. Socket 25 (Cylinder Select)

+Even Cylinder Vicinity Signal. The Cylinder Vicinity Sensor signal from the access transducer is applied to an input amplifier. The amplifier output is compared to a dc reference voltage in a comparator; the comparator output is inverted and sent to socket 13 (Difference Counter) as the +Even Cylinder Vicinity signal.

+Cylinder Vicinity Signal. The output of the cylinder vicinity comparator circuit is ANDed with the -Even Cyl Stop input signal and the +Even Cylinder Vicinity signal is ANDed with the +Even Cyl Stop input signal. The outputs of the two AND circuits are ORed together to form the +Cylinder Vicinity signal. This signal goes active when approaching even cylinders if an even cylinder is selected; it goes active when approaching odd cylinders if an odd cylinder is selected.

+Odd Cylinder and -Odd Cylinder Signals. The 0.6 (P2-P1) signal is applied to an input detector (comparator). The output of the detector circuit is NANDed with the -Even Cylinder Vicinity signal and the output of the Even Cylinder detector. The output of the NAND circuit is routed to sockets 13 and as the -Odd Cylinder signal. The -Odd Cylinder signal is inverted to +Odd Cylinder and sent to sockets 18 (Temperature Compensation and Safety) and 23 (Tachometer). The detector output signals permit a finite width for the cylinder output signals rather than a narrow spike occurring at the detection point.

+Even Cylinder and -Even Cylinder Signals. The 0.6 (P1-P2) input signal is applied to an input detector (comparator). The output of the detector circuit is NANDed with the +Even Cylinder Vicinity signal and the output of the Odd Cylinder detector. The output of the NAND circuit is routed to sockets 13 and 10 as the -Even Cylinder signal. The -Even Cylinder signal is inverted to +Even Cylinder and sent to socket 23. As in the case of the Odd Cylinder signals, the detector output signals permit a finite width for the cylinder output signals rather than a narrow spike occurring at the detection point.

Cyl Vicinity Source Drive. The Cyl Vicinity Source Drive signal provides the drive for the cylinder vicinity light-emitting diode on the source block of the access transducer. The drive signal is provided by the AGC comparator circuit which is gated by the -Retracted Mode signal. Two separate compensation control inputs are supplied to the AGC COMPTR power source. If the light intensity received by the cylinder vicinity sensor diode is low, the amplified sensor signal provides additional bias to the AGC COMPTR circuit to increase the source drive. The  $\pm 1$  SIGN circuit receives the detected Temp Comp Output signal and supplies it as a control signal to the AGC COMPTR. If the selected cylinder is even, the Temp Comp signal is routed to the AGC COMPTR with no inversion; if the selected cylinder is odd, however, the  $\pm 1$  SIGN circuit inverts the Temp Comp signal before sending it to the AGC COMPTR circuit. This is accomplished by using the +Even Cyl Stop and -Even Cyl Stop input signals.

Sensor Bias Signal. The dc bias voltage for the sensor light-emitting diodes is supplied by the -6-volt line coupled through a resistor network. The bias voltage is applied to the sensor block of the access transducer.

#### 4.4.16 Socket 21, AGC

##### PURPOSE

1. Generates the Source 1 and 2 Drive signals which are used to drive two light-emitting diodes on the source block of the access transducer.
2. Generates the +Access Ready +70 MSec control signal.

##### OPERATION

Source 1 Drive and Source 2 Drive Signals. The Source Drive signals are derived from the input Position signals from socket 20 (Cylinder Detector). The position signals are amplified and then compared against a dc reference voltage. The comparison is made to determine if the light-emitting diodes require additional drive current. The comparison signal regulates the total current output of the current source. The position signals are also coupled to a series of three amplifier circuits. The first amplifier circuit output is gated by the Q output of the 1-1/2 CYLINDER DETECTED flip-latch. The flip-latch is set by the NANDed combination of the +First Cylinder Detected and -First Cylinder Vicinity signals. Thus, after the first 1-1/2 cylinders of a seek have been traversed, the flip-latch is set and the amplifier output is gated to the DIRECTION CONTROL output. The second amplifier circuit is the SUM AMPLIFIER.

In this circuit, the two position signals are summed and applied to the DEMOD (demodulation) circuit. The DEMOD circuit is enabled by the NANDed combination of the inverted 40 Hz Wiggler Pulse and the delayed +Access Ready signal. When the delayed +Access Ready signal goes active, the output of the DEMOD circuit is gated to the DIRECTION CONTROL output line. The third amplifier circuit is gated by the -One Track Seek signal. When a one track seek is selected, the output of the first amplifier circuit (gated by the 1-1/2 CYLINDER DETECTED flip-latch) is inhibited and the one track seek amplifier output is gated to the DIRECTION CONTROL output line. The outputs of all three amplifier circuits are wire-ORed together to form the DIRECTION CONTROL output. The DIRECTION CONTROL output determines which of the two Source Drive signals requires additional drive. This signal drives the current director circuit which adjusts the current source outputs accordingly. The Source 1 Drive and Source 2 Drive signals are applied to the light-emitting diodes on the source block of the access transducer.

During a head load operation, the -Use Fast AGC signal from socket 14 (Access Control) goes active. This charges capacitors in the SET TIME CONSTANT circuit which drive the current source circuit, producing the Source Drive signals during initial operation.

+Access Ready +70 MSec Signal. When the drive goes into linear mode, the +Access Ready signal from socket 14 goes active. This signal is then coupled through a 70-millisecond delay circuit. When the 70-millisecond delay has been completed, the seek should be complete and the +Access Ready +70 MSec signal goes active. The output signal is used to gate the DEMOD circuit and is also sent to socket 24 (Summing and Pulser).

#### 4.4.17 Socket 23, TACHOMETER

##### PURPOSE

1. Generates the Tach Output signals which comprise the feedback control for the servo system.
2. Generates the 40-Hz Wiggler signals from Index pulses.
3. Provides an amplification circuit to generate the Temp Comp Off-set 2 signal.

##### OPERATION

Tach Output 1 and Tach Output 2 Signals. The Tach Output signals are derived from the Position Signal inputs from socket 20 (Cylinder Detector). The Position Signals are applied to two differentiator circuits. Since the Position Signals are triangular in shape, the differentiator circuits yield square waves. The Position Signals change in amplitude and width as the carriage moves; this yields "staircase" waveform outputs of the differentiator circuits. The output of one of the differentiator circuits is inverted so that both differentiator outputs are in phase. The outputs of the differentiators are applied to gating circuits.

The gate circuit for the noninverting differentiator is enabled at each even cylinder crossing by the NORed combination of the following signals:

- a. +Retracted Mode
- b. +Even Cylinder
- c. +Even Cylinder Stop and +Linear Mode

The gate circuit for the inverting differentiator is enabled at each odd cylinder crossing by the NORed combination of the following signals:

- a. -Odd Cylinder Stop (generated by NANDing +Linear Mode and -Even Cylinder Stop)
- b. -Odd Cylinder and -Even Cylinder Gate (generated by NANDing +Odd Cylinder and the enable signal for the first differentiator).

Thus, during a seek, one differentiator output gate circuit is enabled while the other is inhibited. The switching sequence is determined by whether an even or odd cylinder is being crossed. The outputs of the two gate circuits are wire-ORed together. The resultant composite waveform from the two circuits is a staircase function with discrete amplitude increments representing cylinders crossed. As the waveform amplitude increases to maximum, the period between amplitude steps decreases, representing increased velocity. After the maximum amplitude has been reached, the waveform falls off in the opposite manner; that is, the velocity falls off rapidly as the number of cylinders traversed increases.

A third contribution to the wire-OR output line is made by the gated CURRENT INTEGRATOR circuit. Depending upon whether the drive is moving in the forward or reverse direction, the Forward Motor Current Sample or Reverse Motor Current Sample signal is applied to the CURRENT INTEGRATOR circuit. The applicable current signal is integrated with respect to time, yielding a continuous waveform similar to the composite differentiated position signals. The output of the CURRENT INTEGRATOR circuit is gated to the wire-OR point by the +Head Load signal. The wire-OR signal line is coupled to an amplifier circuit whose gain is set by a dc voltage obtained from a resistance network on the socket. The output of the amplifier circuit is sent to socket 24 (Summing and Pulser) as the Tach Output 1 signal. The Tach Output 1 signal is inverted in a second amplifier circuit and sent to socket 24 as the Tach Output 2 signal.

During a head load operation, the -Use Fast AGC input signal gates a dc voltage to the wire-OR point to set the Tach Output signals to some preset initial value.

40 Hz Wiggler Signals. The 40-Hz Wiggler Signals are generated from the +Index pulses, pulses. The +Index pulses are applied to a phase discriminator circuit which compares the phase of the 40-Hz output pulse with the input +Index pulse. Any phase difference (change in frequency of disk pack rotation) is detected and applied to an integrator in the form of a dc voltage. The integrator output supplies a dc control voltage to the voltage controlled oscillator (VCO), maintaining the output frequency at 40 Hz.



The clipped output of the VCO is inverted and supplied to socket 25 (Cylinder Select) as the 40 Hz Pulse. This signal also provides the comparison signal for the phase discriminator circuit. The clipped VCO output is also sent directly to socket 25 as the 40 Hz Pulse Inverted. The sinusoidal output of the VCO is amplified and sent to socket 24 as the Wiggler signal.

Temp Comp Offset 2 Signal. The Temp Comp Output signal from socket 18 (Temperature Compensation and Safety) is amplified and inverted and routed to sockets 20 and 24 as the Temp Comp Offset 2 signal.

#### **4.4.18 Socket 24, SUMMING AND PULSER**

##### PURPOSE

1. Generates Summing Amp Output signals which represent the sum of all servo control, drive, offset, and position signals.
2. Generates forward and reverse drive control signals to the Power Driver from the summing amplifier signals.
3. Generates motor current sample signals for use in the tachometer feedback circuit.
4. Provides +Vel Minus Pos Equals Zero and +Early V-P=0 status signals for use in completing a seek operation.

##### OPERATION

Summing Amp Output 1 and Summing Amp Output 2 Signals. The following servo control signals are applied to the FORWARD and REVERSE summing junctions of the SUMMING AMPLIFIER, respectively.

- a. -Drive Forward 5"/Sec and -Drive Reverse 5"/Sec
- b. -Drive Forward 20"/Sec (FORWARD only)
- c. Temp Comp Offset 1 and Temp Comp Offset 2
- d. Tach Output 1 and Tach Output 2
- e. Balancer Output 1 and Balancer Output 2
- f. Shaper Output 1 and Shaper Output 2
- g. Gated Position 2 and Gated Position 1
- h. Wiggler (FORWARD only)

The SUMMING AMPLIFIER is a differential amplifier which amplifies the difference between the signals appearing at the two summing junctions. The amplified difference signals are coupled to the Balancer circuit on socket 20 (Cylinder Detector) as the Summing Amp Output 1 and Summing Amp Output 2 signals. The Summing Amp Output signals are also applied to a two-stage operational amplifier circuit. The amplifier output signals are applied to a variety of comparator circuits.

0X-48 Forward Drive and 0X-48 Reverse Drive Signals. The two primary outputs of the AMPL circuit are coupled to the DIRECTION COMPARATOR circuit. The DIRECTION COMPARATOR circuit supplies two complementary output lines to gating circuits. The gate circuit for Reverse Drive is enabled by an active 0X-12 Activate

Servo input signal. In this case, the 0X-48 Reverse Drive signal is gated to the Power Driver. As long as the servo is activated, the Reverse Drive signal will be present at the Power Driver although it will only be active when reverse direction is indicated by the DIRECTION COMPARATOR circuit. The gate circuit for the Forward Drive is enabled by the ANDed combination of the following signals:

- a. 0X-12 Activate Servo
- b. +Pack At Speed and +Pack In Place and -Retracted Mode

When enabled, the gate circuit sends the 0X-48 Forward Drive signal to the Power Driver. As long as the servo is activated, the pack is in place and at speed, and the heads are on the pack, the Forward Drive signal will be present at the Power Driver although it will only be active when the forward direction is indicated by the DIRECTION COMPARATOR circuit.

-3X+0.5 Pulsed Forward and -3X0.5 Pulsed Reverse Signals. The comparator circuit for the Pulsed Forward signal receives the following input signals:

- a. The primary forward output of the AMPL circuit.
- b. The summed forward output of the AMPL circuit, Forward Current, and Chopper input.

The comparator output is applied to a gating circuit which is enabled by the same signal that gates the Forward Drive signal. When enabled, the -3X0.5 Pulsed Forward signal is gated to the Power Driver. The Chopper signal is only used after the seek has been completed; it prevents the servo from coming to rest after the selected cylinder is reached. The Chopper signal is generated by gating a 500 Hz oscillator circuit with the +Access Ready +70 MSec. The comparator circuit for the Pulsed Reverse signal receives the following input signals:

- a. The primary reverse output of the AMPL circuit.
- b. The summed reverse output of the AMPL circuit, Reverse Current, and Chopper input.

The comparator output is applied to a gating circuit which is enabled by the 0X-12 Activate Servo input signal. When enabled, the -3X0.5 Pulsed Reverse signal is gated to the Power Driver.

Forward Motor Current Sample and Reverse Motor Current Sample Signals. The Forward Current and Reverse Current signals from the Power Driver are coupled through resistor networks to provide the Forward Motor Current Sample and Reverse Motor Current Sample signals for use in the Tachometer, socket 23.

+Early V-P=0 Signal. The Forward Current and Reverse Current input signals are applied to the LEVEL DETECTOR circuit. If the two current levels are close to being equal, both LEVEL DETECTOR outputs go high. One of the outputs is supplied to socket 25 (Cylinder Select) as the +Early V-P=0 signal. This signal is used to enable

the balancer circuits after the drive has entered linear mode.

+Vel Minus Pos Equals Zero Signal. The +Vel Minus Pos Equals Zero signal goes active when the drive is almost stopped. The signal is generated by the ORed combination of the following three conditions:

- a. The drive has entered linear mode, the output of the differentiated Position signal LEVEL DETECTOR circuit is high, and the +Early V-P=0 signal is active. (The output of the Position signal LEVEL DETECTOR will only be high for a half cylinder at each crossing.)
- b. The drive has entered linear mode, the output of the differentiated Position signal LEVEL DETECTOR circuit is high, and the positive-going 100-microsecond one-shot pulse generated by the arrival at a cylinder.
- c. The +Early V-P=0 signal is active and the drive is not in linear mode. (This condition does not normally occur).

The +Vel Minus Pos Equals Zero signal is a positive-going pulse which is applied to socket 14 (Access Control).

#### 4.4.19 Socket 25, CYLINDER SELECT

##### PURPOSE

1. Generates the Even Cyl Stop Signals
2. Generates the following signals for use in the servo loop:
  - a. Balancer Position Signals
  - b. Gated Position Signals
  - c. Balancer Enable Signal
  - d. 40-Hz Wiggler Pulse
  - e. 0.6 (P1-P2) Signal
  - f. 0.6 (P2-P1) Signal
3. Generates -Loss of Cylinder signal

##### OPERATION

+Even Cyl Stop and -Even Cyl Stop Signals. The +CAR Bit 1 signal is applied to the data input of a D-type flip-flop. The flip-flop is initially cleared by the -Reset Diff Counter input signal. The level of the +CAR Bit 1 signal is clocked to the Q output of the flip-flop by the inverted -Seek In Process signal. The  $\bar{Q}$  output of the flip-flop is routed to sockets 20 (Cylinder Detector) and 23 (Tachometer) as the +Even Cyl Stop signal. The Q output is sent to sockets 18 (Temperature Compensation and Safety), 20 and 23 as the -Even Cyl Stop signal.

Balancer P1, Balancer P2, Gated Position 1, and Gated Position 2 Signals. The position Signal 1 and Position Signal 2 input signals are each applied to two gating circuits

with grounded inputs. The outputs of the gating circuits are wire-ORed in two groups of three. Each wire-OR configuration consists of gating circuits with inputs of Position Signal 1, Position Signal 2, and ground. Only one gating circuit of each set is enabled at a time. If the drive is not in the linear mode and the heads are not retracted, the AND combination of the -Linear Mode signal and the -Hold Reverse signal enables the gating circuits with the grounded inputs. This grounds the outputs of the gating circuits, disabling the Balancer Position and Gated Position signals. If the drive is in linear mode, the inverted -Linear Mode signal is ANDed with the +Even Cyl Stop and -Even Cyl Stop signals. The outputs of the AND circuits are coupled through line drivers and used to enable the gating circuits. If an even cylinder has been selected, the Position Signal 1 signal is gated to the resistance network for the Position 1 output signals and the Position Signal 2 is gated to the resistance network for the Position 2 output signals. If an odd cylinder has been selected, the Position Signal 2 is gated to the resistance network for the Position 1 output signals and the Position Signal 1 is gated to the resistance network for the Position 2 output signals. Two outputs are taken from each resistance network. The Balancer P1 and Balancer P2 signals are sent to the balancer amplifier on socket 20. The Gated Position 1 and Gated Position 2 signals are sent to the summing amplifier on socket 24 (Summing and Pulser).

-Balancer Enable Signal. When the linear mode is entered, the +Linear Mode signal goes high removing the direct set from a D-type flip-flop. When the +Early V-P=0 signal goes active, a low is clocked to the Q output generating the -Balancer Enable signal to socket 20.

40-Hz Wiggler Pulse. The 40-Hz Wiggler Pulse is generated from the NORed combination of the following signals:

- a. 40 Hz Pulse (from socket 23) and +Even Cyl Stop
- b. Inverted 40 Hz Pulse (from socket 23) and -Even Cyl Stop

The 40-Hz Wiggler Pulse output is sent to socket 21 (AGC).

0.6 (P1-P2) and 0.6 (P2-P1) Signals. The Position Signal 1 and Position Signal 2 inputs are applied to two differential amplifier circuits which generate complementary difference signals. The Cylinder Offset signal from socket 18 provides dc offset to generate the amplification factor of 0.6. The complementary 0.6 (P1-P2) and 0.6 (P2-P1) output signals are sent to socket 20 for use in detecting cylinder crossings.

-Loss of Cylinder Signal. The -Loss of Cylinder signal is generated when the LOSS OF CYLINDER flip-latch is set by the NAND combination of +Access Ready and -Cylinder. This signal indicates that the drive has moved off cylinder in linear mode. The -Loss of Cylinder signal is used as a monitoring point to indicate that a malfunction has occurred within the servo system.

#### 4.4.20 Socket 27, POWER CONTROL

##### PURPOSE

1. Generates power and motor controls, and status signals for the drive power-on sequence.

##### OPERATION

-Power On Reset Signal. When line power is applied to the drive (by placing CB1 to on), the +20V line is activated and the POWER ON RESET circuit is enabled. The low output of the POWER ON RESET circuit is sent to sockets 12 (File Status) and 20 (Cylinder Detector) as the -Power On Reset signal. The -Power On Reset signal also resets the PICK START flip-latch.

+Start and Controlled Gnd Signal. The +Start and Controlled Gnd signal is generated only when all of the following conditions have been fulfilled:

- a. Line power has been applied to the drive (CB1 is on).
- b. Pick Start is active.
- c. Drive START/STOP switch has been set to START.
- d. Drive cover has been closed.
- e. A disk pack has been properly installed.
- f. Controlled Ground is active.

The -Sequence Pick In signal from the control unit or preceding drive is fed through an input relay which is energized by the +5 VDC in the drive. Pick In applies a ground to one input of the enable gate for the 120-millisecond one-shot. The second input of the enable gate is enabled by the Q output of the PICK START flip-latch which was initially reset by the -Power Reset signal. Thus, the -Sequence Pick In signal triggers the one-shot producing a positive-going 120-millisecond pulse at the Q output. The one-shot output, the inverted -Sequence Pick In signal, and the inverted Controlled Gnd line from the control unit are NANDed together to set the PICK START flip-latch. The Q output of the PICK START flip-latch is applied to the output AND circuit for the +Start and Controlled Gnd signal and to one input of a four-input NAND circuit. When the drive START/STOP switch is set to START, the -Drive Switch On signal sets the START/STOP SW flip-latch, enabling a second input of the four-input NAND circuit.

When the drive covers have been closed, the -Covers Closed signal sets the COVER CLOSED flip-latch, enabling the third input of the four-input NAND circuit.

When the disk pack has been properly installed on the drive, the -Pack In Place signal sets the PACK IN PLACE flip-latch, enabling the fourth input of the four-input NAND circuit. When all four inputs of the NAND circuit are enabled, its output is inverted and applied to the output AND circuit for the +Start and Controlled Gnd signal. With both inputs of the AND circuit enabled, the +Start and Controlled Gnd signal goes active. This signal is sent to sockets 14 (Access Ready) and 17 (Index Transducer).

-Sequence Pick Out Signal. The inverted output of the four-input NAND circuit is NORed with the -Pack At Speed signal. The output of the NOR circuit is Nanded with the inverted Q output (Q output) of the PICK START flip-latch. The output of the NAND circuit is NORed with the normally closed contact of the input relay; the resulting signal is buffered and inverted through a line driver and supplied to the following drive as the -Sequence Pick Out signal. The -Sequence Pick Out signal goes active if Pick Start goes active and the disk pack attains speed. If the Pick Start signal goes active but the START/STOP switch is set to STOP, the disk pack is not in place, or the drive covers are open, the -Sequence Pick Out signal is sent to the following drive and the +Start and Controlled Gnd signal is disabled. If the drive does not have line power applied (CB1 is off), the -Sequence Pick Out signal is routed to the following drive through the normally closed contact of the input relay.

+5X-48 Brush Motor Reed Signal. When the drive START/STOP switch is set to START, the DRIVE MOTOR flip-latch is set sending the Q output high. The -Pack At Speed input signal is also initially high. The NAND combination of the -Pack At Speed signal and the Q output of the DRIVE MOTOR flip-latch enables the NOR circuit at the set input of the BRUSH MOTOR flip-latch. With the BRUSH MOTOR flip-latch set, the Q output goes low; this signal is then buffered and inverted through a line driver producing the +5X-48 Brush Motor Reed signal to the sequence panel. When the drive motor begins to move the disk pack, the -Brush In Pack signal from the BRUSH MOTOR SW goes active (low). This signal holds the set level on the BRUSH MOTOR flip-latch until the brush cycle has been completed.

-Sequence Start Pulse. When the brush cycle begins, the BRUSH IN PACK flip-latch is set by the -Brush In Pack signal. This drives the Q output low, setting a high at the output of the 15-microsecond delay circuit. When the brush cycle has been completed, the -Brush At Stop signal resets the BRUSH IN PACK flip-latch. This places a high at the Q output and the output of the delay circuit remains high for an additional 15 microseconds. Thus, the AND circuit is enabled, producing a positive-going 15-microsecond pulse. The 15-microsecond pulse is Nanded with the inverted -Pack At Speed signal. Therefore, if the pack has attained speed, the -Sequence Start Pulse is generated and sent to socket 14. An active -Sequence Start Pulse also resets the BRUSH MOTOR flip-latch through one input of a NOR circuit. The BRUSH MOTOR flip-latch can also be reset through the Nanded combination of the following signals:

- a. The 15-microsecond pulse from the BRUSH IN PACK circuit.
- b. The absence of the low output of the four-input NAND circuit used to generate the +Start and Controlled Gnd signal.

Thus, the BRUSH MOTOR flip-latch is reset if an active -Sequence Start Pulse is obtained or if the +Start and Controlled Gnd signal is inhibited.

+5X-48 SSR Control Signal. When line power is applied to the drive (by setting CB1 to on), the LINE CYCLE COUNTER is set by the -Power On/Start Reset signal. The 30V Secondary ac input signal is clipped and inverted by a line receiver and coupled to the clock input of the first counter stage. On the first clock pulse, the Q output of

the first stage goes high. This signal is Nanded with the inverted output of the four-input NAND circuit used to generate +Start and Controlled Gnd signal. The NAND circuit output resets the BRAKE RELAY flip-latch enabling one of five inputs of the NAND circuit at the set input of the DRIVE MOTOR flip-latch. At the third clock pulse input to the LINE CYCLE COUNTER, both  $\bar{Q}$  outputs go high enabling the output NAND circuit and locking up the counter. The low at the NAND circuit output is inverted to a high enabling the second of five inputs of the NAND circuit at the set input of the DRIVE MOTOR flip-latch.

The remaining three inputs to the DRIVE MOTOR input NAND circuit are supplied by the following signals:

- a. -Pack At Speed (which is high until the disk pack attains speed)
- b. -Brush At Stop (which is initially high until the brush cycle starts)
- c. +Heads Retracted

When all of the input signals are active, the DRIVE MOTOR flip latch is set. This drives the  $\bar{Q}$  output low; the low  $\bar{Q}$  output is inverted and coupled through a line driver to the sequence panel as the +5X-48 SSR Control signal. When the SSR Control signal causes the drive motor to start, the -Triac On signal from socket 14 goes active and clears the LINE CYCLE COUNTER. The DRIVE MOTOR flip-latch can be reset from the following two sources:

- a. The inverted output of the four-input NAND circuit used to generate the +Start and Controlled Gnd signal. This signal goes low to reset the DRIVE MOTOR flip-latch when the drive START/STOP switch is set to STOP.
- b. The -Power On/Start Reset signal.

+5X-48 Relay 1 Control Signal and +5X-48 Brake SCR Reed Signal. If the drive motor is not operating, the active reset signal at the BRAKE RELAY flip-latch is inhibited. The latch can then be set by the NORed combination of the following signals:

- a. -Power On/Start Reset
- b. The NAND combination of the  $\bar{Q}$  output of the first stage of the LINE CYCLE COUNTER and the output of the four-input NAND circuit used to generate the +Start and Controlled Gnd signal.

Thus, the BRAKE RELAY flip-latch is set when line power is applied or when the +Start and Controlled Gnd signal cannot be generated. When set, the Q output of the latch is buffered and inverted through a line driver and sent to the sequence panel as the +5X-48 Relay 1 Control signal. In this state, the Relay 1 Control signal inhibits operation of the drive motor. When the BRAKE RELAY latch is in the reset state, the Relay 1 Control signal enables operation of the drive motor.

The Q output of the BRAKE RELAY flip-latch is Nanded with the following signals:

- a. The output of the LINE CYCLE COUNTER.
- b. The output of the four-input NAND circuit used to generate the +Start and Controlled Gnd signal.
- c. Inverted +Pack Stopped (from socket 17).

Thus, if line power is applied, the disk pack is moving, and the +Start and Controlled Gnd is lost by placing the START/STOP switch to STOP, the NAND circuit output goes low. This signal is then buffered and inverted through a line driver and sent to the sequence panel as the +5X-48 Brake SCR Reed signal. This signal applies braking voltage to the drive motor under the above conditions. The +Pack Stopped signal removes the braking voltage approximately 25 seconds after it is applied.

#### 4.4.21 Sockets 28 and 29, MATRIX A and MATRIX B

##### PURPOSE

1. Generates the "Write Transitions" signals which are wire-ORed and sent to socket 4 (Write).
2. Generates the Preamp Out 1 and Preamp Out 2 signals which are wire-ORed and sent to socket 5 (Read).

##### OPERATION

Write Transitions. When the WRITE mode is selected, the Write Current input signal is applied to two gating circuits. The gating circuits are alternately enabled by the Write Pre-Driver 1 and Write Pre-Driver 2 signals from socket 4. The Write Current is then gated alternately to the two inputs of the enabled head. The gated Write Current signals are also coupled to a detector circuit which generates the 0X+0.8 Write Transitions signal applied to socket 4 through the socket 1 READ/WRITE Paddle card.

Preamp Out 1 and 2 Signals. When the READ mode is selected, the WRITE circuits are disabled. The read current signals from the selected head are buffered through an isolation circuit and applied to the READ PREAMPLIFIER. The two outputs of the READ PREAMPLIFIER are applied to gating circuits, both of which are enabled by the -A (socket 28) or -B (socket 29) Heads Selected signal. The resulting Preamp Out 1 and Preamp Out 2 signals from each socket are wire-ORed together and used as the input signals applied to socket 5 through the READ/WRITE paddle card.



## 4.5 ELECTRO-MECHANICAL FUNCTIONS

The descriptions that follow are organized by categories comprising electrical and mechanical functions. The main functional areas follow:

1. Air Circulating System
2. Disk Rotating Components
3. Read/Write Head Positioning Components
4. Head Loading and Read/Write Components
5. DC Power Supply
6. Operational Control Switches and Indicators

For the purposes of pointing out specific functional units, as applicable, references are made to illustrations in other chapters of this manual.

### 4.5.1 Air Circulating System

Figure 4-10 shows the airflow paths through the disk drive. Also, the air-circulating components and major units being cooled are shown. The numbers in some of the arrows indicate the sequence of air movement from one area to another from the entry to the exits. Air is pulled into the disk drive by the air system blower. An exterior foam filter and an absolute filter clean the air before it passes through the blower to the interior of the disk drive. The air circulates within the upper part of the disk drive first and then enters the area below the baseplate. Two exhaust fans are located at the bottom of the disk drive to expel the used cooling air through the bottom toward the lower front of the disk drive cabinet.

### 4.5.2 Disk Rotating Components

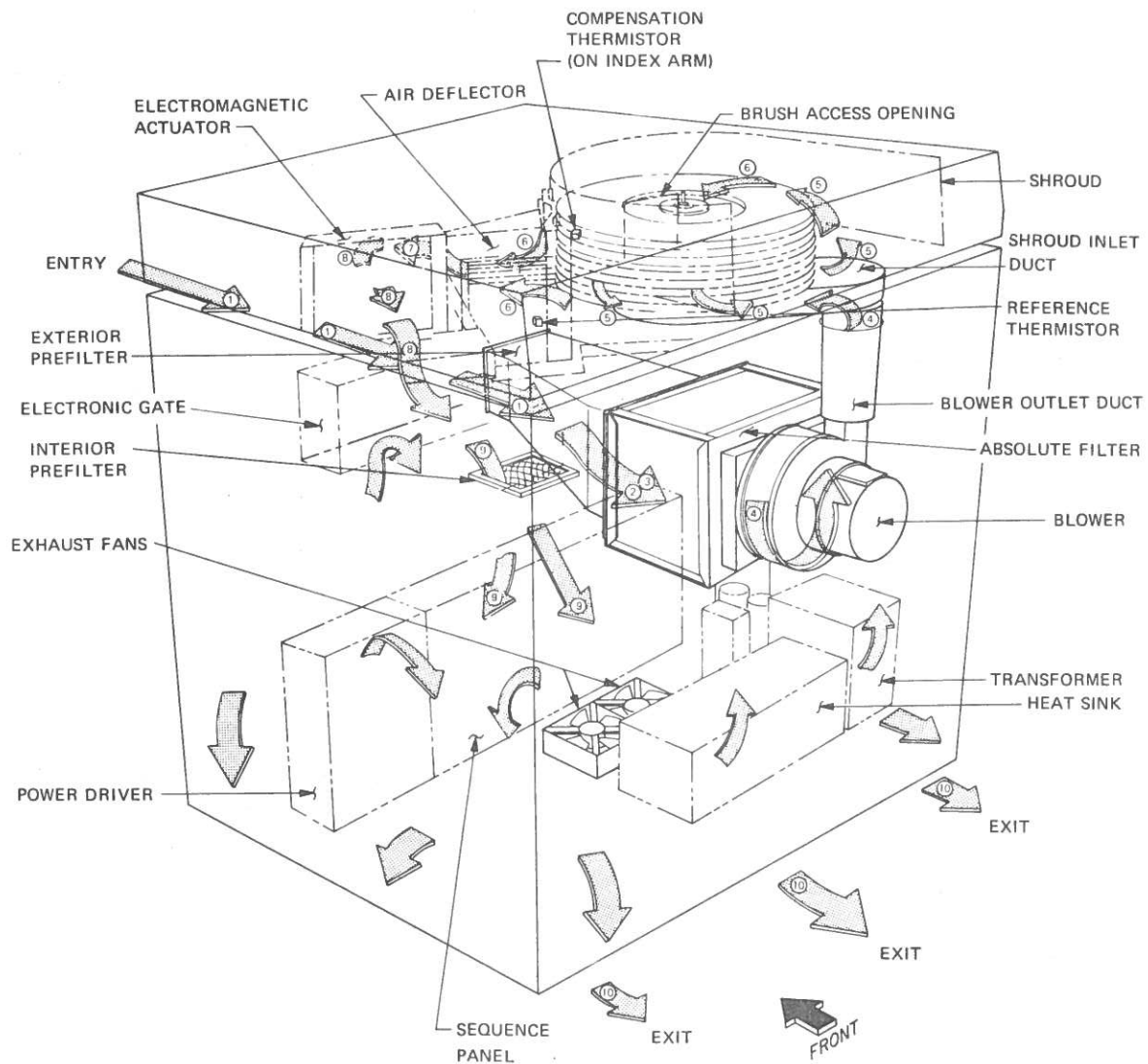
The disk rotating components comprise the following units:

1. Drive Motor
2. Spindle Assembly
3. Spindle-Hold Brake
4. Pack-on Switch
5. Index Block In-Place Switch
6. Brush Drive
7. Index Transducer

These components are shown in chapter 8 and are described in the following paragraphs.

#### DRIVE MOTOR

The drive motor torque is transmitted to the spindle assembly through a belt. The proper tension on the belt is maintained by a spring attached between the motor mounting plate and the baseplate. Power is supplied to the drive motor from the sequence



AIRFLOW DISTRIBUTION:

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>① ENTRY POINT AT PREFILTER</li> <li>② DUCTED FLOW TO ABSOLUTE FILTER</li> <li>③ FINE PARTICLES REMOVED AT ABSOLUTE FILTER</li> <li>④ DUCTED FLOW TO SHROUD INLET DUCT</li> <li>⑤ DISPLAYED OVER DISK PACK SHROUD</li> </ul> | <ul style="list-style-type: none"> <li>⑥ SHROUD OUTLET PATH VIA CAM-TOWER AND BRUSH ASSEMBLY GROUP</li> <li>⑦ DEFLECTED FLOW TO ELECTROMAGNETIC ACTUATOR</li> <li>⑧ ENTRY AND EXIT FLOW FROM ELECTROMAGNETIC ACTUATOR</li> <li>⑨ INTERIOR PREFILTER DIRECTS FLOW TO BOTTOM OF CABINET</li> <li>⑩ EXHAUST AT BOTTOM AND FRONT OF CABINET</li> </ul> |
|--|--|

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Figure 4-10. Air Circulating System

panel assembly contingent on the state of various interlocks. With CB1 on and all interlock circuits closed, the drive motor is energized by placing the START/STOP switch in the START position. In addition to driving the spindle assembly, the drive motor also functions as a dynamic brake to rapidly stop pack rotation after the drive is powered down. The dynamic braking control circuit (in the sequence panel assembly) applies braking current after the START/STOP switch is placed in the STOP position. The braking current is applied until the spindle stops rotating, after which it is automatically removed by a timing circuit.

The drive motor has the following characteristics:

208/230 VAC Power Input	Single Phase
60-Hz Frequency	25 Amps, Start Current
CCW Rotation	2.8 Amps, Run Current
0.5 Horsepower	3450 RPM (with load)

#### SPINDLE ASSEMBLY

The disk pack is mounted on the spindle, which rotates counterclockwise at 2400 + 48 RPM.

#### SPINDLE-HOLD BRAKE

The spindle-hold brake (figure 6-3) is a mechanical locking mechanism that is actuated when the operator cover is raised. The back edge of the cover presses downward on the brake actuating lever, causing the index transducer mounting to pivot away from the spindle. A link rod connected to the brake actuating lever is extended forward to compress a spring attached to the link rod and the spindle-holding pawl. The spring tension forces the pawl into one of the notches on the spindle-hold brake when the spindle is turned manually to change the disk pack. This spindle locking action holds the spindle stationary to permit the pack cover to be removed from or secured onto the pack.

Closing the operator cover pivots the index transducer to its operating position and retracts the link rod to disengage the pawl from its notched position. If the operator cover is raised while the drive is operating, the compression spring maintains a light force against the pawl. The rake angle on the pawl tooth prevents it from engaging notches on the brake when the spindle is rotated by the drive motor; the tooth is continuously cammed away from the brake notches while the spindle is rotated. This cam action produces an audible "clicking" noise when the disk pack is rotating with the operator cover raised.

#### PACK-ON-SWITCH

The pack-on switch (figure 6-2) is a safety interlock that provides continuity for the motor start logic. This interlock prevents the drive motor from operating without a disk pack being installed. A spring-loaded sliding shaft, threaded on the upper end,

is located inside the spindle. The shaft extends through the bottom of the spindle, where it rests on the lower contact arm of the pack-on switch. The switch is held open by the position of the sliding shaft resting on the lower contact arm.

Installation of the disk pack, and rotating the handle on the dust cover for its removal, causes the disk pack spindle lock to engage the threaded portion of the sliding shaft. The sliding shaft is thereby retracted upwards away from the switch contact arm so the pack-on switch is activated. Spring loading on the shaft engages a ball-lock mechanism in the disk pack spindle lock, thereby securing the disk pack to the spindle assembly, and simultaneously freeing the disk cover from the disk pack so it can be lifted away.

A reversal of these functions occurs when the disk pack is removed. Rotating the handle of the dust cover for installation on the disk pack frees the threads on the sliding shaft inside the spindle assembly. Spring-load action extends the shaft downward to engage and open the contacts of the pack-on switch. This action also disengages the ball-lock mechanism to free the disk pack from the spindle drive assembly, and simultaneously to lock the cover to the disk pack so it can be removed from the drive.

#### INDEX BLOCK IN-PLACE SWITCH

The index block in-place switch is mounted in front of and below the index transducer (figure 6-10). This switch is a safety interlock that provides continuity for the drive motor start logic when the disk pack cover is removed and the operator cover is closed. When the operator cover is raised, the index block is pivoted backward so the switch and index sensor clear the disk pack. Closing the operator cover with the pack cover removed causes the index block to pivot forward and position the sensor near the pack. The transducer mounting is spring-loaded against the switch so the switch transfers when the sensor is positioned to span the index disk.

If a disk pack is installed without removing the pack cover, an interference occurs between the transducer mounting and the pack cover to prevent the switch from transferring. This condition interrupts continuity in the drive start circuits and prevents the application of power to the drive motor.

#### BRUSH DRIVE ASSEMBLY

The brush drive assembly operates to clean the disk surfaces during the power-on sequence. The brush drive assembly is mounted on the baseplate adjacent to the disk pack. Ten brush arms on the assembly swing inside the disk pack. An eleventh arm spans the top disk surface to provide a visual indication of displacement. The arms are driven by an actuating lever that is linked with the brush motor to rotate at four RPM. Nylon brushes on the 10 arms sweep disk upper and lower surfaces and retract to a stop position at the mounting to operate a brush retract switch that generates a "brush at stop" signal to the sequence logic. The transfer of the brush retract switch de-energizes the brush motor, thereby terminating the brush cycle. The brush retract switch signal and the power-on sequencing logic also interact if a "pack-at-

speed" signal is not generated by the index transducer. In this case, operation of the brush motor and cycling of the brushes continue. The brush-motor logic also ensures that the brush arms are always retracted from the disk pack when the drive is powered down. If the drive is powered on with brush arms in the disk pack, the drive motor will not start until the arms are retracted.

## INDEX TRANSDUCER

The index transducer detects each of the sector slots and the index slot on the disk pack and generates a signal that is supplied to the index transducer logic circuit. This circuit develops index and sector pulses that are used in the control unit and in the drive, such as to ensure that disk pack rotation speed is within the required limits for drive operation. The index transducer employs a light emitting diode (LED) and a phototransistor sensor that span the outer edge of the index disk. The LED is located above the disk and the phototransistor sensor is located below the disk. As the slots on the disk rotate past the transducer, the light beam from the LED passes through the slot and a current is generated in the phototransistor. The disk rotational characteristics that establish timing conditions for speed detection and control logic are as follows:

Disk Rotation Speed	2400 $\pm$ 48 RPM
Disk Rotation Period (One Revolution)	25 ms

The index transducer logic circuits (socket 17) monitor the index and sector pulses and generate the following signals:

1. Pack at Speed: Used by the power control (socket 27); affects the power sequencing.
2. Pack Speed Unsafe: Detects slow pack speed; causes safety unload of read/write heads.
3. Selected Index: Generates the selected index signal transmitted to the control unit.
4. Selected Sector: Sent to control unit as disk rotation position information.
5. Composite Sector/Index: Same as for #4.

### 4.5.3 Read/Write Head Positioning Components

Components comprising the mechanism that positions the read/write heads consist of the following units:

1. Electromagnetic Actuator (EMA; functional description is given in 4.3.7).
  - a) Permanent magnet
  - b) Coil and cylinder

## 2. Carriage Assembly

- a) Carriage rail
- b) Carriage
- c) Cylinder Indicator

## 3. Access Transducer Assembly (functional description is given in 4.3.7).

- a) Light-emitting diodes
- b) Photosensitive transducers
- c) Primary and secondary gratings

## 4. Carriage-Retract Switch

The read/write heads are physically linked to the movable carriage, which is attached to the cylinder that supports the EMA coil. Application of electrical current to the EMA coil causes the cylinder, the carriage, and the read/write heads to move radially toward or away from the center of the spindle. The positioning of the read/write heads at a particular cylinder is physically indicated by the cylinder indicator and electronically indicated by the access transducer assembly.

## CARRIAGE ASSEMBLY

The carriage assembly (figure 6-4) consists of a stationary rail that is mounted on the baseplate and the carriage which serves as a movable platform and a support for the read/write head assemblies.

### Carriage Rail

The rail is a single casting on which the access transducer and the forward stop switch are mounted. The carriage assembly and the baseplate are electrically insulated from the disk drive frame but are referenced to their own DC ground. The forward stop (calibration) switch, mounted at the front of the rail, is insulated from the carriage rail. When the carriage contacts the stop, the stop is electrically connected to the carriage support, resulting in a very accurate position-oriented switch transfer. This switch transfer is used as the reference for all cylinder positioning.

### Carriage

The carriage, the T-block with the head-arm assemblies, and the drive coil comprise the moving mass. The carriage is constructed so it contacts the rail at three support points. Each point consists of two roller bearings, one contacting the top rail surface, the other contacting the side. The three support points produce a minimum of friction and side-play while the carriage is in motion.

The EMA ground coil spring is connected to the A side of the carriage frame to provide

electrical continuity between the carriage rail and the baseplate for an effective DC ground. Two conductive straps supply current to the drive coil. The moving mass is relatively light in weight so its inertia is held to a minimum for maximum acceleration.

### Cylinder Indicator

The cylinder indicator (figure 6-7) is located on top of the carriage assembly to provide a visual indication of seek displacements. The indicator consists of a stationary scale mounted on the cam tower and a movable vernier mounted on the carriage. The movable vernier functions as a marker that is aligned with calibrations on the stationary scale to indicate the cylinder position of the read/write heads.

### CARRIAGE RETRACT SWITCH

The carriage retract switch (figure 6-4) provides an electrical indication that the carriage assembly is retracted (the read/write heads removed from the disk pack) or extended (heads in the disk pack). The electrical signal is provided to circuits in the drive to enable or disable various functions. The signal is also supplied to the control unit to prevent its powering down as long as any drive has its read/write heads extended.

### 4.5.4 Read/Write Head Loading Components

Components that load the head array on the disk (figures 4-11, 6-4, and 6-9) are:

1. Read/Write Head Arm Assembly
2. Head Load Linkage
3. Cam Tower and Head Load Cams

These components accomplish the following functions:

1. Twenty head-arm assemblies holds the read/write heads close to the disk surfaces.
2. The head-load linkage maintains a constant force against the head assemblies to force the heads toward the disk surfaces.
3. Head-load cams on the cam tower assembly control the loading and unloading of the head-arm assemblies.

### HEAD-ARM ASSEMBLY

The head-arm assembly consists of a magnetic head attached to a flexible support arm, which suspends the head in the disk pack. Pack rotation causes the head to glide on an air cushion 70 to 100 microinches from the disk surface. The magnetic head contains an integral read/write coil element that is connected by a cable and plug fastened to the support arm. The magnetic head element, made of two pole pieces, is mounted in a gliding shoe, which has two air bleed holes. The gliding shoe is mounted to the sup-

port arm by a flexure spring that allows the head to pivot and thereby negotiate slight irregularities in the disk surface while gliding. The support-arm assembly contains a leaf spring which permits the arm to flex upward and downward while the heads are gliding. A cam-follower surface is formed on the arm adjacent to the head. This surface contacts spacers on the cam tower to raise and lower the arms as they are extended into or retracted from the disk pack.

## HEAD ARRAY

The head array contains 20-head-arm assemblies, one head for each disk data surface. The array is arranged in two stacks of 10 heads each. The arms are fastened to a T-block mount that holds the head-load linkage. Each head-arm can be adjusted individually, over a range of four cylinders, along the line of access motion. The T-block is fastened to and moves with the carriage so the array is a part of the moving mass. The head-to-disk arrangement provides for 18 head-arm assemblies to be grouped into nine pairs. A single head-arm is located at the top of one stack and at the bottom of the other stack.

The two stacks of heads are designated A side and B side. A point on the disk initially rotates past the A side first. See view B, figure 4-11. Each head is numbered as shown in view B: heads containing an odd number are loaded against the top surface of a disk, and heads with an even number are loaded against the bottom surface.

## HEAD LOADING

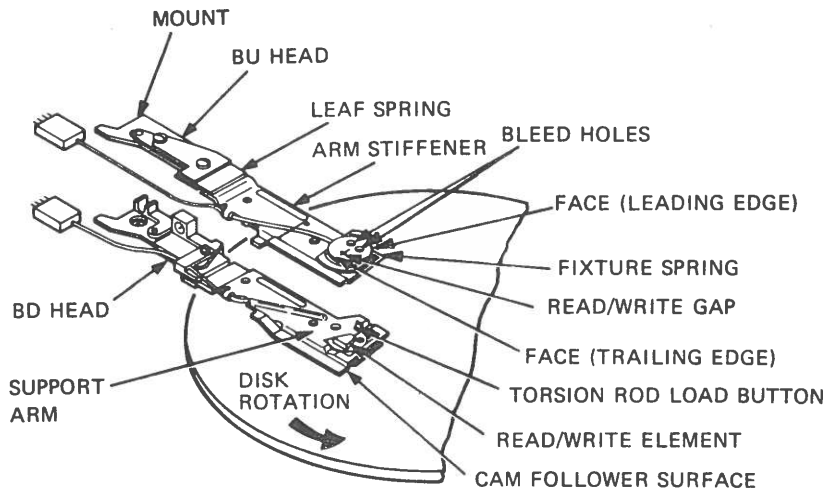
### Mechanical Linkage

A constant force is applied against the head-arm at all times. The force is applied by torsion rods (figure 4-12), which are twisted by a link-crank mechanism. Two offset links, one for each stack of head-arms, are depressed to apply force to the cranks. The cranks, in turn, rotate 10 torsion rods. Five of the rods are rotated in one direction and five in an opposite direction. This action causes the 20 heads to move upward or downward toward their respective disk surface. The links are held down by latches secured by machine screws. Spacers on the cam tower control the clearance between opposite pairs of heads to prevent them from contacting each other while the array is retracted from the pack.

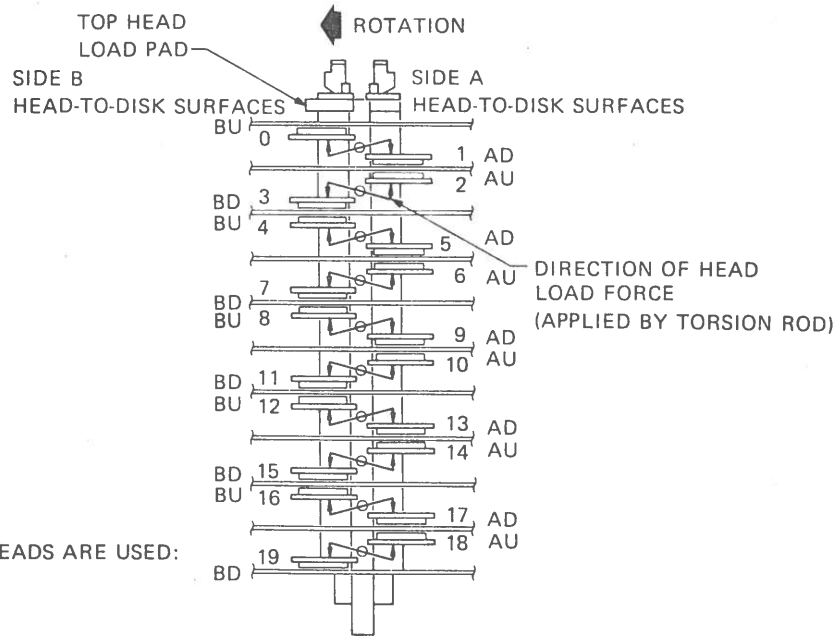
### Loading on Disk

Cam follower surfaces at the front of each head-arm assembly control the head motion toward the disk surfaces as the array is extended into the rotating pack. The cam surfaces allow loading to be applied gently to prevent an abrupt head motion at the disk. The heads are cammed away from the disk surfaces in a similar manner to accomplish unloading of heads as the array is retracted from the pack.





VIEW A. READ/WRITE HEAD DETAILS



NOTE:  
 FOUR TYPES OF HEADS ARE USED:  
 AD = A DOWN  
 AU = A UP  
 BD = B DOWN  
 BU = B UP  
 ONLY HEADS OF THE SAME TYPE  
 CAN BE INTERCHANGED FOR A  
 GIVEN NUMBER POSITION.

VIEW B. ARRANGEMENT OF READ/WRITE HEADS

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Figure 4-11. Read/Write Head Array

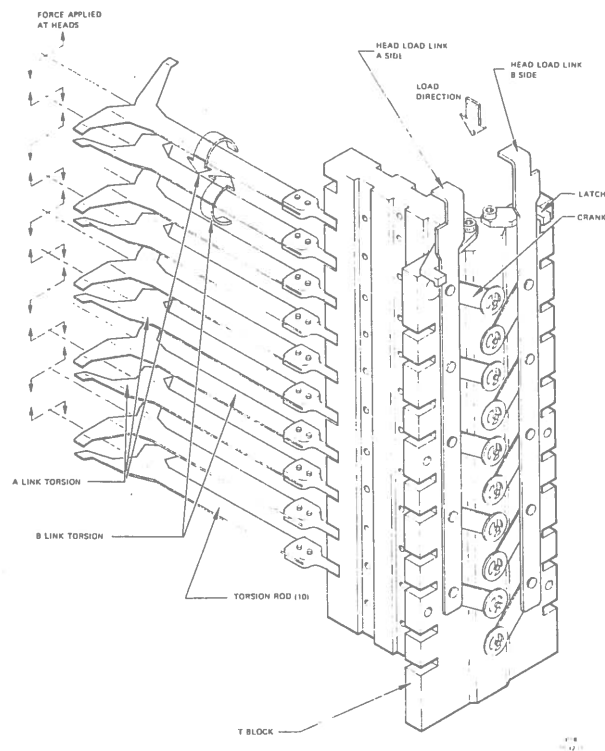


Figure 4-12. Head Load Linkage

### Flying the Heads

The gliding shoe, which retains the magnetic head element, floats on a thin film of air that rotates with the disk. This air layer separates the two surfaces so no wear or friction occurs. The head-load leverage placed on the shoe causes it to glide above or below the disk at a height that is proportional to the air velocity at the surface of the disk. Therefore, the gliding height is greater at the outside tracks (100 microinches) than it is at the inside (70 microinches). The gliding characteristics of the shoe are stabilized by the two bleed holes.

The read and write circuits compensate for variations in gliding height at the outer, middle, and inner surfaces of the disk: cylinders 000-191, 192-349, and 320-405, respectively. This adjusts the signal strength when bits are written on or read from the disk surface. As the head glides over the disk surface, the flexure spring allows the head to pitch and roll relative to the disk surface. The leaf spring on the support arm allows the head to deflect up and down. These conditions give the head freedom to compensate for irregularities in the disk surface and to maintain a constant glide height from the disk surface within a given radius from the spindle.

## MAGNETIC HEAD DESCRIPTION

The read/write head contains two coils wound on a ferrite core as shown in figure 4-13. The read/write coils are wound one on top of the other with their leads connected in series by a center tap.

The ferrite core is designed so bits are written at a track width of 0.0043 inch. Current applied to the write coils causes the existing data to be erased as bits are written.

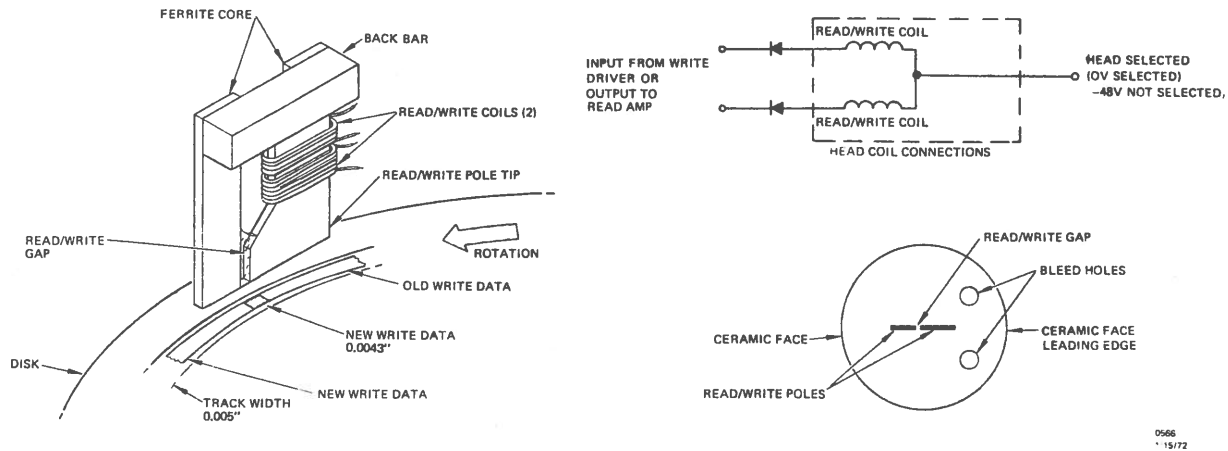


Figure 4-13. Head-to-Disk Relationship

### 4.5.5 DC Power Supply

The dc power supply in the drive produces all of the dc operating power for the disk drive circuits. This includes the braking current for the disk drive motor, power sources where from the EMA currents are generated in the power driver, and power used to produce logic and analog signals throughout the disk drive.

### 4.5.6 Operational Control Switches and Indicators

Arrangement of the control panel is shown in figure 3-1 and a schematic diagram of the various switches, indicators, and circuit breakers in figure 4-14.

#### CIRCUIT BREAKER (CB1)

Located on the power sequence panel, this circuit breaker controls all dc and ac power within the drive except that available at the convenience outlet. This CB permits service personnel to remove power from the drive without disconnecting cables.

#### CIRCUIT BREAKER (CB2)

Located on the sequence panel, this circuit breaker controls forward drive current from the power driver to the EMA drive coil.

### CIRCUIT BREAKER (CB3)

Located on the sequence panel, this circuit breaker controls reverse drive current from the power driver to the EMA drive coil.

### PACK-ON-SWITCH

Located below the spindle assembly, this switch is actuated by the installation of a disk pack and prevents the drive motor from operating if a pack is not installed.

### INDEX BLOCK IN-PLACE SWITCH

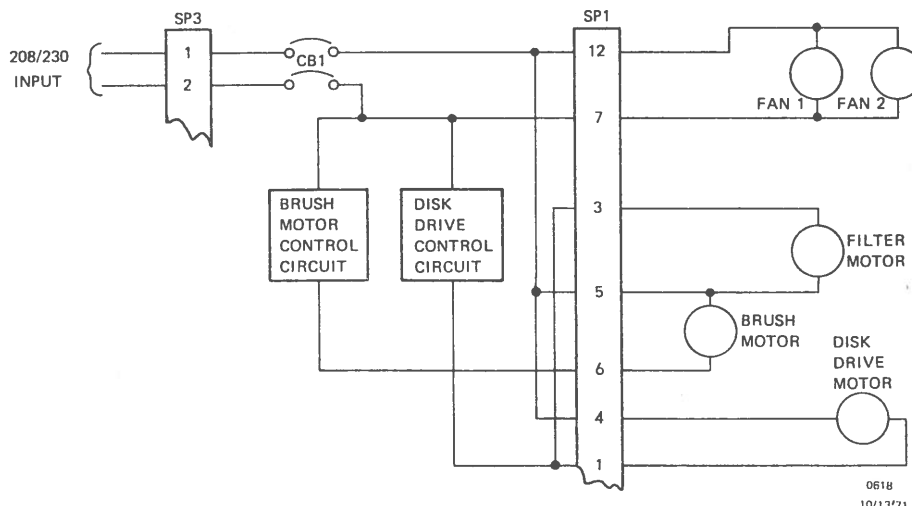
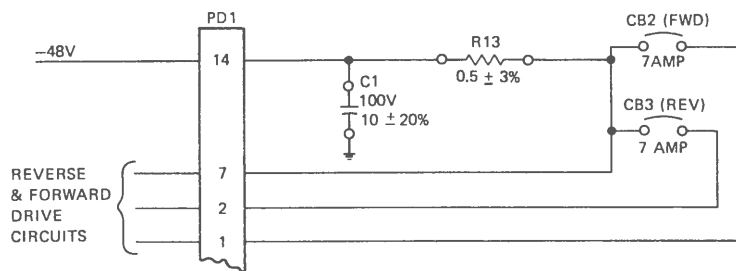
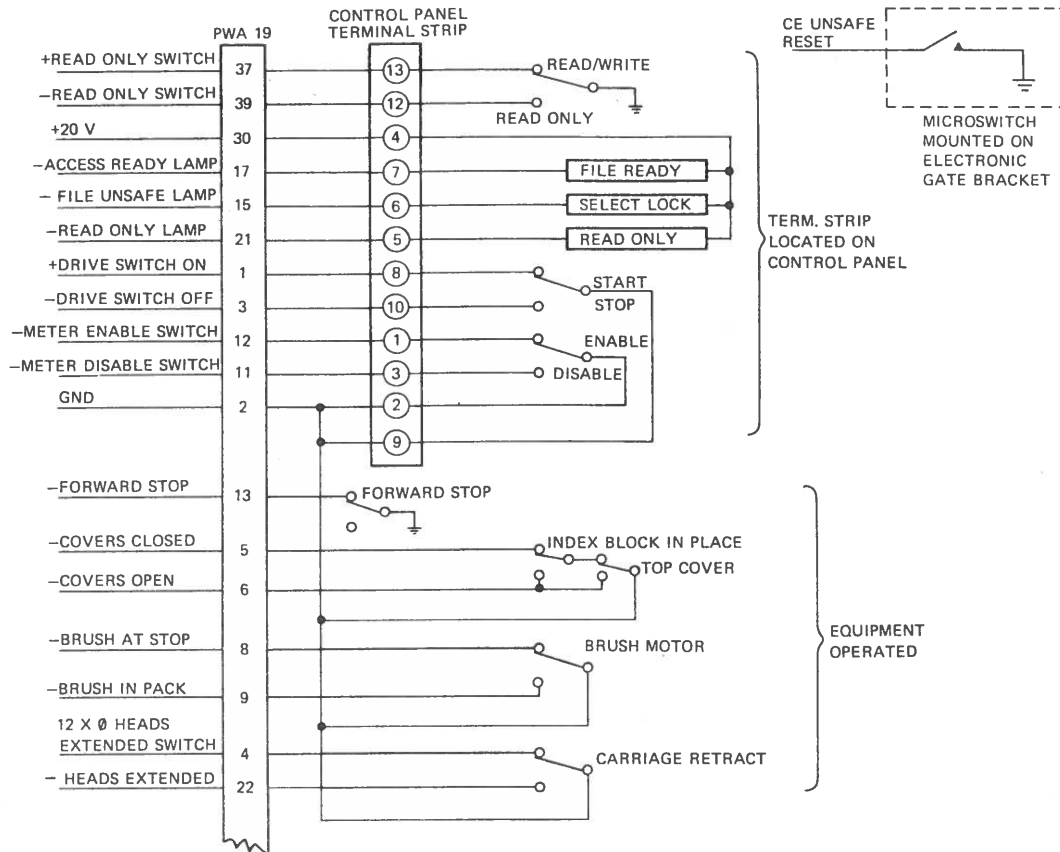
The index block in-place switch detects that the disk pack cover is removed and the operator cover is closed.

### OPERATOR COVER PUSH ROD

Located on the air deflector, the push rod must be operated manually when removing or installing a disk pack with the top cover assembly removed.

### TOP COVER ASSEMBLY INTERLOCK SWITCH

Located on top of the right side panel, this switch provides continuity to the START/STOP switch when the top cover assembly is in place. Removal of the top cover assembly opens the switch to interrupt power to the drive motor. The switch action can be overridden by pulling up the actuator to lock the switch in a closed position.



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Figure 4-14. Mechanical Switching and Indicators

## CHAPTER 5 MAINTENANCE

### 5.1 SAFETY PRECAUTIONS

Maintenance personnel should use the following safety practices to prevent injury to themselves or damage to the equipment:

1. Keep fingers and hands out of area between carriage and disk pack while drive is on.
2. Use care when working around a spinning disk pack. The index slot is sharp and can inflict serious cuts.
3. High potentials up to 230 VAC are present inside the sequence panel when drive is not operating. Always remove AC-IN connector when performing maintenance in this area.
4. The electromagnetic actuator (EMA) includes an extremely powerful magnet. Wrist watches should be removed when working around the EMA. Use only non-magnetic tools in this area.
5. Avoid touching or blowing breath on read/write heads. Acids from the skin can etch and ruin heads. Breath can cause condensation deposits which will disfigure the gliding surface.

#### CAUTION

If carriage is inadvertently moved forward with torsion rods loaded, damage can be avoided by unloading before returning carriage to its retracted position. Failure to observe this precaution will result in misaligned heads.

6. Never move carriage forward manually without first unloading torsion rods on read/write heads.
7. Ensure that carriage is fully retracted before loading torsion rods. Inspect each head to ensure that load button is in contact with tip of torsion rod.
8. Never disassemble a disk pack.
9. Serious damage to disk surfaces will result from servicing practices which introduce particles into the shroud area.
10. Do not write on the C. E. disk pack.
11. Operate push rod to hold index block assembly fully away from pack when installing or removing a disk pack while drive top cover assembly is removed.
12. Do not clean disk pack unless particle damage or oxide build-up is suspected.
13. When performing maintenance, always remove customer data pack, and if a test pack is required, install the maintenance pack.
14. Never remove or change PWA's without shutting down all internal drive power.

## 5.2 MAINTENANCE PHILOSOPHY

### 5.2.1 Objectives

The prime objective of the maintenance activity is to provide maximum equipment availability to the customer. A preventive maintenance program, properly applied, can assist greatly in achieving this objective.

### 5.2.2 Basic Considerations

The three fundamental considerations in preventive maintenance of mechanical or electromechanical equipment are: INSPECT - CLEAN - LUBRICATE.

Visual observation is the service technician's most valuable preventive maintenance tool. Most mechanical equipment failures will have given visual indication of their presence long before the actual failure occurs. It is, therefore, left to the awareness and perception of the service technician to detect these failures before they occur.

**NOTE:** Do not perform more than recommended preventive maintenance on equipment that is operating satisfactorily. Also, do not disassemble equipment in an attempt to locate a potential failure.

## 5.3 TOOLS AND SERVICING AIDS

This section describes the tools and test equipment that are used for servicing the Model 715 DEC Disk Storage Drive. An itemized description is provided for each tool. The special tools are required in addition to the maintenance pack (Item 14).

### 5.3.1 Tools

#### SPECIAL TOOLS

The following is a listing of all special tools required for servicing and maintenance:

1. Extracting Tool, Retaining Ring, 0012
2. Extracting Tool, Retaining Ring, 2204
3. Extracting Tool, Pin Type XII
4. Extracting Tool, Pin Type 3
5. Extracting Tool, Coax
6. Extractor, PWA (ISS P/N 70001154-1)
7. Head Alignment Tools (ISS P/N 70004055-1 and -2)
8. Disk & Head Cleaning Paddle
9. 2 & 5 Mil Gauge, Special
10. Tissue, Lint-Free
11. Alcohol, 90% Isopropyl (Freon TF solvent optional for cleaning heads)

12. Jumper Leads
13. Head Cleaning Brush (ISS P/N 70003631-1)
14. CE Pack, IBM P/N 2200100 or equivalent
15. Extender, PWA, ISS P/N 70003833-1
16. Torque Screwdriver Assembly.

MANUFACTURER-SUPPLIED TOOLS

1. Carriage Alignment Tool Kit (ISS P/N 70003911-1) is available from supplier of replacement parts. (Procedure for carriage alignment, check, and replacement is included in tool kit.)

5.3.2 Test Equipment

STANDARD ELECTRONIC TEST EQUIPMENT

Two items of standard test equipment are required for servicing and troubleshooting: an oscilloscope and a multimeter.

OSCILLOSCOPE

Read circuit troubleshooting requires an oscilloscope with delayed sweep capability, a minimum bandwidth of 25 MHz, and a 5 mv/cm vertical sensitivity. A Tektronix Model 453 is recommended.

MULTIMETER

Multimeter requirements are not critical, but the meter selected should be of sufficient quality to meet the following minimum range and accuracy specifications:

AC/DC Volts . . . . .	0 to 250, ± 2% FS accuracy
Resistance . . . . .	0 to 20 Megohms, ± 5% accuracy
Input Impedance DC. . . . .	20,000 Ohms/Volt
Input Impedance AC . . . . .	10,000 Ohms/Volt

A Triple #630 is recommended.

SPECIAL TEST EQUIPMENT

A special purpose test unit, the Off-Line Testor, is helpful as a troubleshooting and service aid. The test unit is used for off-line maintenance and has the capability of simulating the command set that is normally issued by the control unit. Control switches and indicators permit service personnel to manually activate and monitor internal drive functions.



## 5.4 PREVENTIVE MAINTENANCE

### 5.4.1 Maintenance Schedule and Procedures

Table 5-1 identifies the required preventive maintenance operations as well as the frequency at which they must be accomplished. Key items which should be given specific attention during each service call are also included. Refer to replacement procedures in chapter 8 when necessary.

**NOTE:** When called for, lubrication should always be applied sparingly, Excessive oil is not a substitute for regular application and will only provide a collection point for dust and dirt.

### 5.4.2 Shroud and Spindle Servicing

#### VISUAL INSPECTION AND CHECKS

Check carefully for metal particles in the shroud area or in the air plenum area. Very small particles are particularly dangerous. The airflow within the shroud is designed to flush most foreign matter out of the shroud area. Particles in the shroud, however, can be deposited on the spindle and in the disk pack.

Particle generation normally occurs with wear. Any two rubbing surfaces will generate particles. If particles are discovered, clean the shroud area, inspect the disk pack and heads for cleanliness, and check for the following conditions:

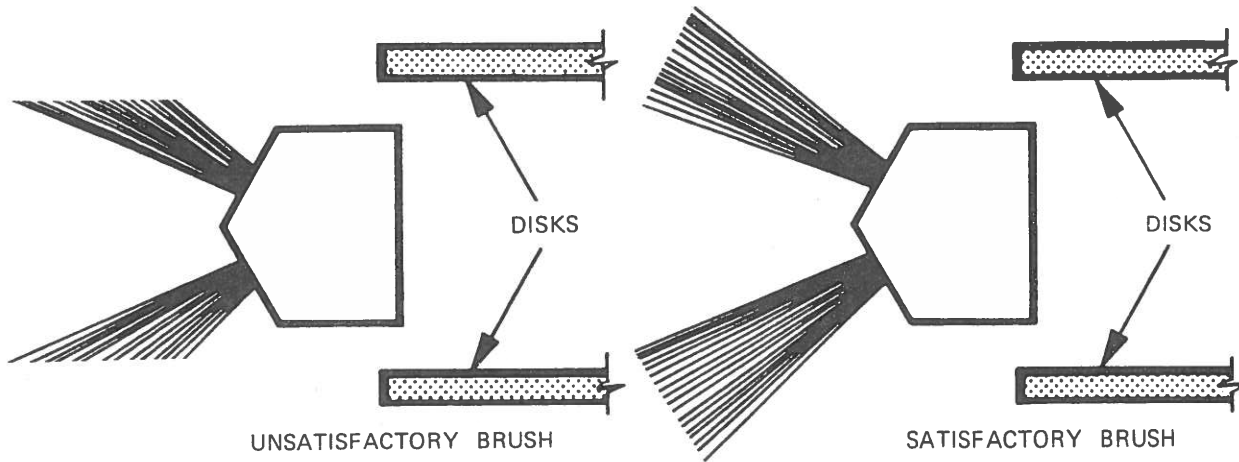
1. Proper operation of customer access cover (no binding or grinding when opening and closing).
2. Proper adjustment of index block pivot mechanism.
3. Proper operation of pack lock screw and handle insert.
4. Proper fit of pack cover and proper clearance between handle recess and pack hub when cover is placed on pack.

#### SHROUD AND SPINDLE CLEANING

Clean the shroud area by dampening a lint-free tissue very lightly with 90% isopropyl alcohol and wipe the shroud area to remove all dirt and smudges. Wipe spindle surfaces thoroughly. After wiping area with alcohol, pick up any remaining particles with a wad of adhesive tape turned adhesive side out. Ensure that all metal particles are removed. Apply one drop of oil to spindle cone and spread evenly to produce a light film on surface.

Table 5-1. 715 DEC Preventive Maintenance Schedule

INTERVAL (MONTHS)	ITEM	ACTION	REF. PARA.
3	Shroud	Clean with 90% isopropyl alcohol and lint-free wiper.	5.4.2
	Read/Write Heads	Inspect for oxide deposits.	5.4.15
	Carriage Rails	Clean with lint-free tissue lightly dampened with 90% isopropyl alcohol.	5.4.17
	Spindle Cone	Clean and oil with light petroleum oil (one drop spread on surface).	5.4.2
	Pre-filter (2 locations)	Replace with new filter.	
	Shroud Screws	Inspect for tightness. Tighten as required.	5.4.2
	Head Cables	Inspect cables and plugs for loose connectors and connector hold-downs	
	Disk Cleaning Brushes	Inspect brushes for excessive wear. Replace as required. Refer to Figure 5-1.	
6	Control Panel Indicator Lamps	Inspect for illumination. Replace as required.	
	Spindle Ground Contact	Inspect for excessive wear. Replace as required.	
	Absolute Filter	Replace with new filter.	
12	Read/Write Safety Circuits	Check for proper operation	
	Base and Covers	Clean with 90% isopropyl alcohol and lint-free wiper.	
As Req'd	Spindle Lock Screw	Lubricate with light grease.	
	Disk Pack	Clean with 90% isopropyl alcohol and lint-free wiper with paddle.	5.4.3
	Read/Write Heads	Clean heads with dry brush. For stubborn deposits, moisten head cleaning brush with Freon TF solvent, or 90% isopropyl alcohol. Shake off excess so that brush is dry. Support back of read/write head and thoroughly scrub face with rotary motion.	5.4.16



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Figure 5-1. Disk Pack Brush Wear Condition

### 5.4.3 Disk Pack Servicing

#### DISK PACK FILTERS

Disk packs are provided with a replaceable air filter located on the underside of the pack. Inspect filters occasionally by holding the pack upside-down with bottom cover removed. Clean or replace filters that appear clogged. A clean filter is white in color. A clogged filter can be recognized by the darkened surface condition of the mesh. Clean filters with warm water and a mild detergent soap. If a replacement filter is required, it should be ordered from the disk pack supplier or manufacturer.

#### DISK PACK CLEANING

Disk packs should be cleaned only when they appear to be dirty and contain a buildup of lint, or when read errors occur that appear to result from dirty surfaces. If particle damage or oxide buildup is suspected, refer to the description of Disk Pack Inspection (5.4.11), to evaluate pack condition. If the inspection reveals pack cleaning is required, clean the disk pack as follows:

1. Remove drive top cover assembly.
2. Remove shroud.

## 5.4.8 Visual Indications of Head-to-Disk Interference

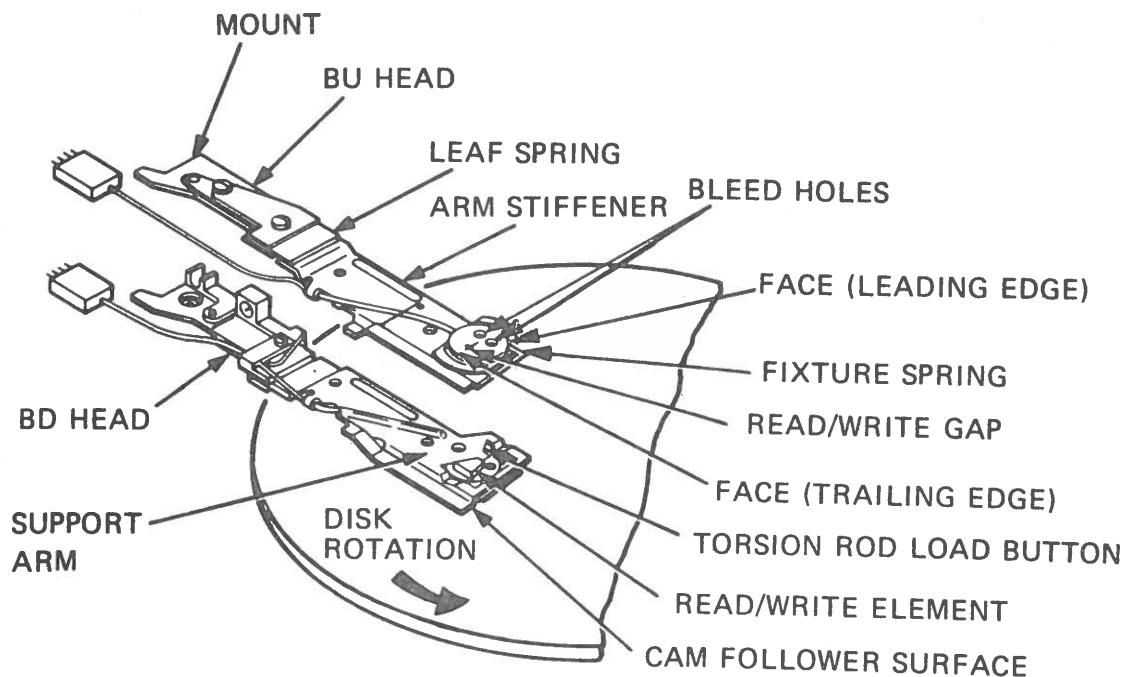
### SCRATCHES ON DISK SURFACES

Some types of scratches on disk surfaces are practically harmless while other types can result in damage to equipment. One type of harmful scratch is a typical comet-trail where the head of the comet is an embedded particle protruding out of the disk surface.

Some types of scratches indicate other problems. Scratches which are regularly spaced 0.005 inch apart indicate that a head with a protrusion on its shoe face, or an embedded particle in the head pole epoxy has been used on the disk.

### HYDROCARBON DEPOSIT ON HEADS

The accumulation of a black tar-like deposit in the bleed holes and on the leading edge of the shoe results from hydrocarbon contaminants which enter if the drive is not sealed or is operated extensively with top cover removed. Clean heads and check the operator cover and/or service cover for damaged seals.



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Figure 5-2. Read/Write Head Details

## SCRATCHES ON HEAD

If a head has a series of 0.005-inch spaced grooves or scratches across the face of the shoe, it has been gliding on a disk surface containing an embedded particle which could still be present on the disk. The presence of these grooves does not necessarily mean that a head is ruined. Heads become scratched during normal use but a damaged head will not read data properly, or it will glide with an audible tinkling.

## OXIDE DEPOSIT ON HEADS

The reddish-brown color of oxide deposit makes it easy to detect. Its presence on heads may mean that oxide is being scraped off a disk surface by head-to-disk interference. Inspect for conditions which would cause this type of interference. One or two heads may have small, light-brown streaks of oxide or a small deposit of oxide in bleed holes, or oxide on the trailing edge of the shoe. Heads with light-brown oxide streaks or oxide deposits can usually be cleaned and reused. A record should be kept in the machine of these heads that are cleaned to determine if a specific head is picking up excessive oxide at a frequent interval. Heads should be cleaned ONLY when necessary.

## AUDIBLE TINKLING FROM HEAD AND DISK INTERFERENCE

An audible tinkling or scratching sound is an indication of head-to-disk interference. This can be an initial symptom and may not continue if the particle is dislodged or is smashed flat. If allowed to continue, the noise could progress to a screech.

Examine the heads and disk surface for scratches and comet trails. The approximate radial position of the embedded particle can be determined by noting the cylinder positions of the carriage where the tinkling occurred. The head, disk surface, and spindle area must be thoroughly cleaned whenever this condition exists.

### 5.4.9 HDI Damage Effects on Read/Write Head

The extent of HDI damage effects on read/write heads will vary depending upon the length of time that the HDI condition has existed, and the type of condition which produced HDI. Generally, the HDI effects may be divided into three stages of damage.

1. Initial Stage: During this stage, the face of the read/write head has light-brown streaks of oxide. Usually the oxide can be cleaned off with Freon or alcohol and the head cleaning brush. Any head with a discolored epoxy "cross" at the read/write element, or oxide specks on the shoe face or epoxy "cross" after cleaning must be replaced.

**NOTE:** The epoxy "cross" is normally a light-gray color on a clean head. Contamination causes discoloration.

2. Intermediate Stage: During this stage, HDI has existed for a longer period of time. Oxide on the read/write head face becomes burned to a dark brown or black color. Do not use this head even if the dark streaks can be removed by cleaning. Heat developed by friction could soften the epoxy used to anchor the core and cause the core to become misaligned. Optical instruments are required to detect this type of damage. The head must be replaced.
3. Final Stage: During this stage, the HDI condition has progressed so that aluminum from the disk substrate is deposited on the read/write head. The flexure spring may be bent or broken, and the element and ceramic face may be supported only by the element wires. The head must be replaced.

#### **5.4.10 HDI Damage Effects on Disk Pack**

The extent of damage to a disk pack after HDI can be categorized into three types:

##### **CATEGORY 1:**

This type of damage is undetectable. The read/write heads may have light-brown streaks of oxide, but the disk pack has not been seriously damaged.

##### **CATEGORY 2:**

This type of damage is detectable, and is serious. Some disk pack damage is present, however, damage is slight. The disk analysis program can be run to locate the surface imperfections for flagging. Such disk surfaces are still smooth and clean and will not cause further HDI.

##### **CATEGORY 3:**

This type of damage is of a catastrophic nature. The pack can be cleaned up, however, the defects cause the disk analysis program to reject the pack. Attempts to reuse the pack will result in additional HDI. Packs subjected to this condition of HDI should be removed from service and not reused.

#### **5.4.11 Disk Pack Inspection**

Disk pack inspection is required when it is suspected that head-to-disk interference (HDI) has occurred, or when read errors occur that appear to result from dirty surfaces. HDI is caused by the presence of a foreign particle in the airstream between the head face and disk surface, or a protrusion on the head or disk which interferes with the air bearing as the head glides over the disk. If the problem is not corrected, it can cause damage from pack-to-pack or drive-to-drive. The propagated damage results when the operator does not recognize or understand head-crash symptoms so as to hold HDI damage propagation to a minimum.

The presence of fingerprints, films, or stains on the surface of either disk or heads leaves a deposit of oils and salts which may build up to a height greater than the gliding height of the head, causing head-to-disk interference.

An audible tinkling, zinging, or scratching sound is an indication of HDI. This can be an initial symptom and may not continue if the particle is dislodged or is smashed flat. If allowed to continue, the noise can become louder, and the damage becomes more serious. The approximate radial position of the embedded particle can be determined by noting the carriage cylinder positions where the sounds occurred. This requires thorough cleaning of the head, disk surface, and spindle area.

#### PACK INSPECTION

1. Remove drive top cover assembly.
2. Install suspected disk pack on drive.
3. Use a high-intensity light to illuminate each disk surface from front of drive.
4. Manually rotate the pack while searching for the following damage indications:
  - a. Deposits or smears that cannot be totally removed with alcohol and lint-free tissue.
  - b. Scratches in oxide which show the aluminum substrate. Aluminum visible on disk edge is not serious.
  - c. Scratches in oxide which are 0.005 inch apart, indicating that a head with an embedded particle or other protrusion has been used on the disk.
  - d. Embedded particle with a trailing scratch (comet trail).
  - e. Unacceptable bands, a concentric, circular ring or strip that is 1/32 inch or larger. Bands can be identified by color, texture, or reflective variations from the other disk surfaces.

Bands which are not black in color and possess a high degree of reflectivity, or which shine more than remaining disk surfaces are acceptable for use. Unacceptable bands are black in color and may be shiny or dull in comparison to other disk surfaces. Such areas have been damaged by HDI and could result in further HDI if pack is reused.

5. Check on the availability of CPU time and run customer diagnostic program.

**NOTE:** Ensure that routines used for check will not destroy customer data.

6. Perform evaluation as follows for a pack that is suspected of having imperfections other than those previously described.
  - a. Install pack on drive.
  - b. Clean disk surfaces suspected of having defects.
7. Examine the disk surface finish to determine if the pack can be used without causing damage to heads. Only small defects of the following types are permitted to enable the pack to be reused.
  - a. Small areas of light-colored stains or other discolorations which remain after the pack has been thoroughly cleaned are acceptable.
  - b. Small pin holes in the surface coating are permitted if the diameter does not exceed 1/16 inch. These areas will be flagged (bypassed) when the surface analysis program is run.

#### 5.4.12 Recovery From HDI Condition

1. Determine the cause of HDI by checking for the following conditions on disk pack and heads to prevent recurrent damages:
  - a. Isolate the particular head and disk surface affected by HDI.
  - b. Inspect read/write head according to procedures following in this chapter.
  - c. Inspect disk surface according to preceding procedures and clean the pack.
2. Clean and/or replace read/write head. Heads with light-brown oxide deposits can usually be cleaned and reused. The presence of dark-brown or black oxide deposits indicates heating has occurred and the head must be replaced.
3. Verify that operating personnel have not used a defective disk pack on other machines to propagate the problem.
4. Check heads and packs on other machines which have been exposed, and possibly impacted by this HDI condition. Look for oxide deposits on heads.
5. Replace contaminated pack cleaning brushes. (Do not wash and reuse because these brushes could produce another head crash.)
6. Install maintenance pack on suspected drive. Turn power on to obtain FILE READY condition. Turn power off and check for oxide buildup on heads. Inspect disk surfaces for signs of HDI.
7. Inspect heads again for oxide buildup. If no oxide is evident, the drive can be returned to service. If oxide is present, it may be necessary to clean and/or replace other heads on the drive, and also to clean the pack.
8. Examine all disk packs which have previously been used on the failing drive prior to the HDI problem. It may be necessary to check all customer library packs. Use the procedure of paragraph 5.4.11 to determine if a pack has been damaged.



9. Inspect all drives which were exposed to HDI propagation for presence of oxide after the drive has been subjected to four hours of operation. Oxide buildup may be caused by a damaged, or defective read/write head or a contaminated disk surface which must be corrected as described in steps 6, 7, and 8 above.
10. Monitor the drive operation for HDI effects. Check drive daily for a period of one week then check weekly for a period of one month.
11. Ensure that defective heads and disk packs detected by these procedures are not returned to service.

#### 5.4.13 Prevention of HDI Condition

1. Periodically inspect read/write heads. Perform read/write head servicing as described in the following paragraphs according to the PM schedule of Table 5-1.
2. Do not allow particles to accumulate in shroud area. Clean shroud as specified in PM schedule of Table 5-1.
3. Ensure that air filtering system does not leak and that functioning (clean) filters are used in the drive. Dirty filters cause contamination to accumulate and also produce heat in the drive.
4. Ensure that foreign particles are not being generated within the drive. Check disk pack for deformed or damaged filter which can rub against the spindle housing to create particles. Clean and oil spindle cone as specified in PM schedule of Table 5-1.
5. Avoid leaving the operator cover or top service cover open for long periods other than while performing maintenance.
6. Always use lint-free tissues for cleaning heads and disks to avoid introducing particles in the head/disk area.
7. Always replace worn or dirty disk pack brushes which could retain contaminants or fail to clean disk surfaces properly.

#### 5.4.14 Read/Write Head Servicing (Figure 5-2)

Read/write heads are to be inspected at one-month intervals or when diagnostic symptoms indicate that a head is causing errors. If inspection reveals imperfections, the head should be cleaned.

The heads are not to be cleaned as a scheduled maintenance requirement. Cleaning is accomplished only when visual checks indicate the presence of contaminants.

**NOTE:** If damage is found while inspecting the head, isolate the cause of damage by referring to the previous descriptions of head-to-disk interference before attempting to replace the head.

### 5.4.15 Read/Write Head Inspection

1. Position a dental mirror close to the head and use a high-intensity light to inspect the head. Do not place the dental mirror between the heads or allow it to touch the heads because damage could result.
2. Inspect all heads to ensure that torsion rods rest on load button and cam-follower surfaces on arms properly engage the cams (figure 5-3).
3. If torsion rods do not make proper contact, unload and reposition torsion rods as follows:
  - a. Loosen both hex-socket screws holding retainer links and latch interlock support to T-Block.
  - b. Disengage both link retainers from the torsion rod links.
  - c. Move torsion rod links A and B up and down several times to assure a bind-free movement.
  - d. Reload torsion rods, reposition link retainers A and B, and tighten both hex-socket screws.

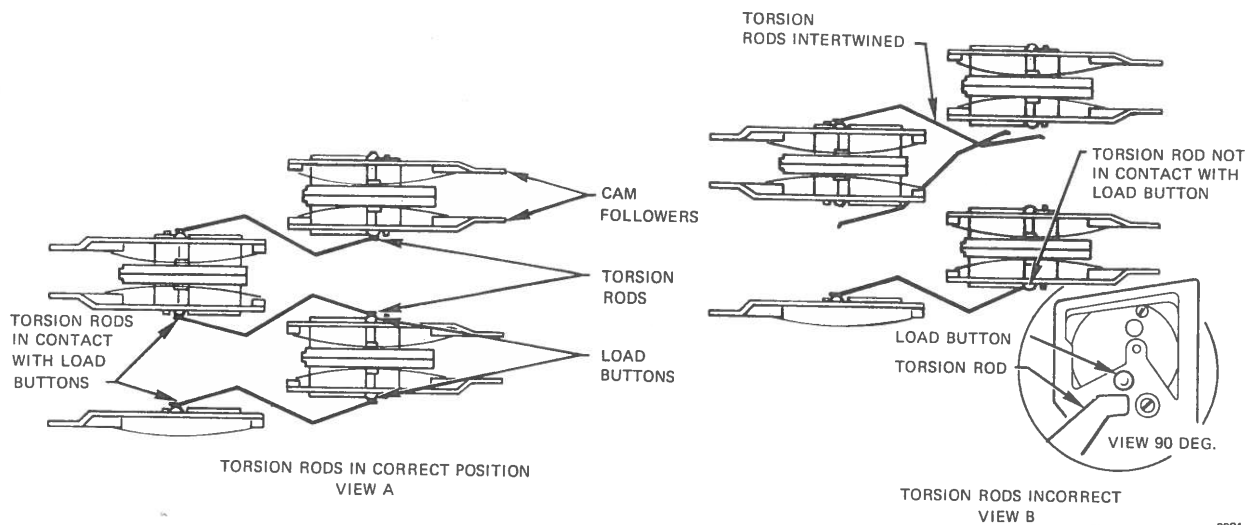


Figure 5-3. Torsion Rod Check

4. Look for the following types of contamination (or damage) on each head:
  - a. Light-brown streaks of oxide on face, in bleed holes, or on trailing edge of shoe. These can usually be cleaned and reused. A record should be kept in the machine of these cleaned heads to determine if a specific head is picking up excessive oxide at a frequent interval. Heads should be cleaned only when necessary.
  - b. Hydrocarbon tar-like substance in bleed holes and on leading edge of shoe. This indicates that the drive is not sealed, or has been operated extensively with the covers open. Check the covers for damaged seals.
  - c. Heavy oxide deposit on face of head.
  - d. Non-particle damage; stains, film, residue, lint, dust, etc., on flexure spring and face.
  - e. Particle damage; scratches, nicks, burrs, etc., on face. A succession of 0.005-inch grooves indicates an embedded particle in the disk surface, which could still be present on the disk. The presence of these grooves does not necessarily mean that a head is ruined.

### **CAUTION**

Do not touch the face of read/write head with fingers. Oil from the skin can cause deposits of foreign materials to build up. Do not leave any residue or lint on the head. Do not blow on the heads because moisture from breath will cause contamination.

5. Clean the head with Freon TF solvent or alcohol and the head cleaning brush if contaminants are present. If head is damaged, isolate the cause and replace head, as appropriate. Any head with a discolored epoxy cross at the read/write element, or oxide specks remaining after cleaning must be replaced. DO NOT clean heads which have dark brown or black oxide on the face, but replace the head.

#### **5.4.16 Read/Write Head Cleaning**

Read/write heads are to be cleaned only when inspection reveals that oxide deposits or other contaminants are present. Observe the CAUTION note of paragraph 5.4.15 and use head-cleaning brush.

- NOTES:**
1. Only the contaminated (dirty) head is to be cleaned. Do not attempt to clean a head that is operating satisfactorily.
  2. If wear is present in head cleaning brush, discard and replace with a new brush. Do not apply excessive pressure to the head while cleaning. Such action could alter the pitch attitude set by the manufacturer or could bend the arm stiffener.

#### 5.4.17 Carriage Rails Cleaning

1. Clean carriage rail surface with lint-free tissue lightly dampened with 90% isopropyl alcohol.

**NOTE:** Carriage rail surface must be immaculately clean. Any foreign material on this surface will adversely affect alignment. Do not apply too much alcohol to rails.

#### CAUTION

Do not oil the carriage rails.

### 5.5 POWER SUPPLY VOLTAGE

#### CAUTION

Use care when probing power circuits. AC voltage levels of 208/230 V are present in the sequence panel when drive is turned off.

#### 5.5.1 Voltage Levels

DC voltage level of +20V, +12V, -12V and +5V are used throughout the logic. A potential of -48 VDC is present in some logic circuits. These voltage values must be within the required ranges as shown in figure 2-3 when referenced to DC ground.

### 5.5.2 Logic Levels

High and low logic voltage levels used in the drive circuits are labeled plus (+) or minus (-) in front of the line name and represent the following voltage values for high-low states:

+ (H), High Level . . . . . +2.5 V to +5.0 V  
+3.5 V Nominal

- (L), Low Level . . . . . 0.0 V to 0.5 V  
0.0 V Nominal

Special logic voltages, other than those described above, are indicated on the diagrams for the affected line name. These lines will have logic levels listed as +5X-48, -3X+0.5, 0X-48, -31X+5, 0X+3, etc. The first value (+5, -3, 0) denotes the active state of the line. The second value (-48, +0.5) denotes the inactive state of the line. The "X" separates the two voltage values.

### 5.5.3 Use of Test Probes

When probing or using jumpers, ensure that logic modules are not overloaded. Avoid the use of high voltages which could damage or destroy semiconductor devices. For the majority of logic circuit testing, a properly placed ground will create the desired effect.

### 5.5.4 Power Input Connections for 208/230 VAC Source

The drive is shipped with power input connections arranged as specified by the label on the sequence panel. It may be necessary, however, to change the connections for a particular site requirement connecting the drive in a system. Refer to the installation instructions in chapter 2 of this manual before connecting the drive to an AC power source.

## CHAPTER 6

### CHECKS AND ADJUSTMENTS

#### 6.1 REQUIREMENTS FOR MAKING ADJUSTMENTS

Drive machine adjustments are factory set and normally should not require alteration. However, if an out-of-tolerance condition is detected or if parts are replaced, adjustments must be made.

The access velocity adjustment is electrical and all other adjustments are mechanical.

**NOTE:** Any time the CE pack is installed and the drive turned ON to achieve FILE READY status, a jumper must be installed from 1732 to 1702. Failure to connect this jumper will not allow the drive to achieve FILE READY status.

#### 6.2 ACCESS TRANSDUCER ADJUSTMENTS

Three adjustments are required after alteration or removal of the assembly or any of its components (Figures 6-1 and 6-2):

1. **Grating Proximity:** The grating proximity is adjusted so the distance between the bottom glass surface of the primary grating and the top glass surface of the secondary grating is between 0.002 and 0.005 inch (Figure 4-5). This distance is adjusted by placing shims under the sensor mounting block.

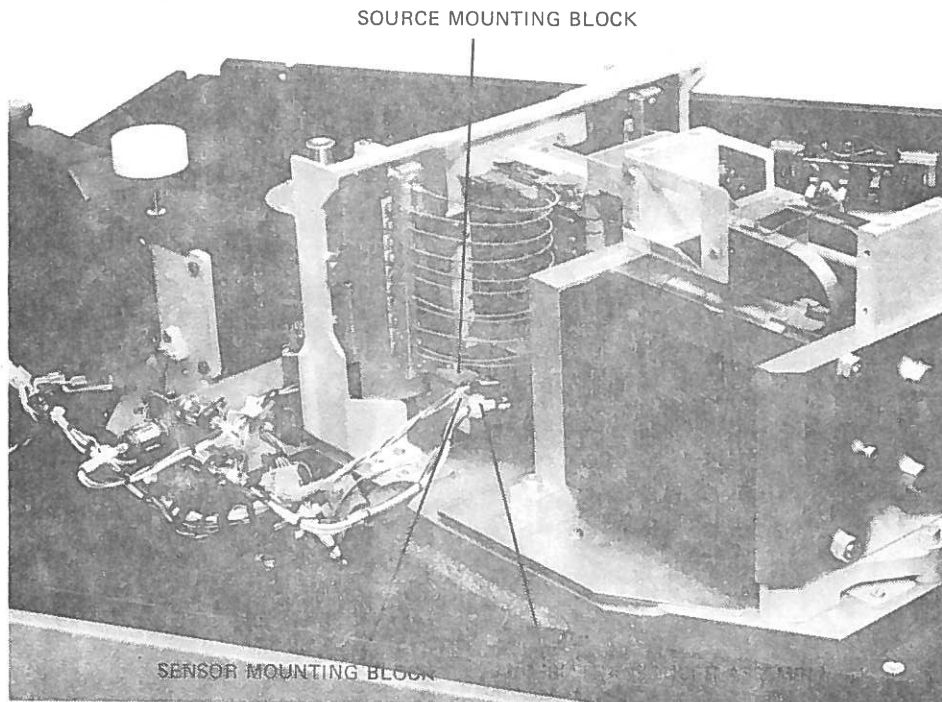
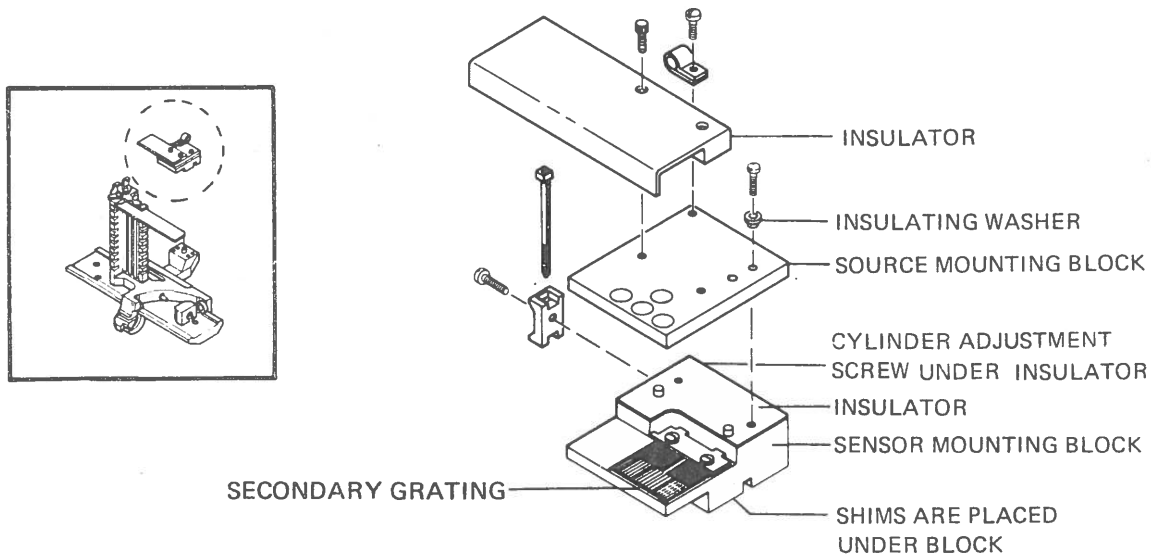


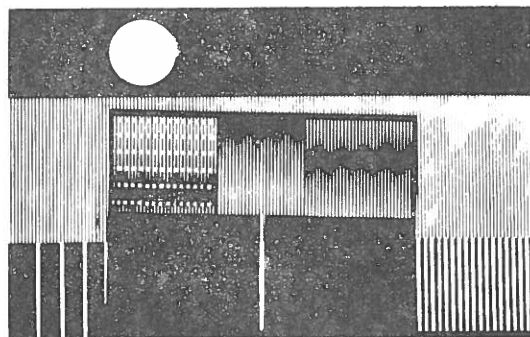
Figure 6-1. Access Transducer Assembly Locations



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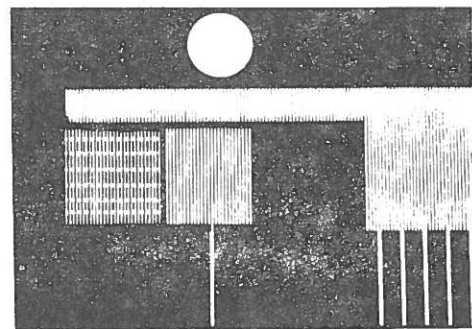
Figure 6-2. Access Transducer Assembly

2. Parallelism: The lines on the primary grating must be parallel with the lines on the secondary grating. This produces a pattern as shown in View B of figure 6-3. A lack of parallelism produces a moire pattern as shown in View A of figure 6-3. The parallelism adjustment is made by manually positioning the primary grating so its lines are parallel with the lines on the secondary grating.



GRATINGS NOT PARALLEL (MOIRE' PATTERN)

VIEW A



GRATINGS PARALLEL

VIEW B

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Figure 6-3. Grating Assembly Patterns

3. **Cylinder Position:** The cylinder positioning is checked by placing a 0.038-inch shim between the carriage and the calibration stop (figure 6-4). The shim is held in place by exerting a slight hand pressure against the carriage. Under these conditions, the last velocity line on the primary grating must fall within (not necessarily centered in) the index line on the secondary grating (figure 4-6).

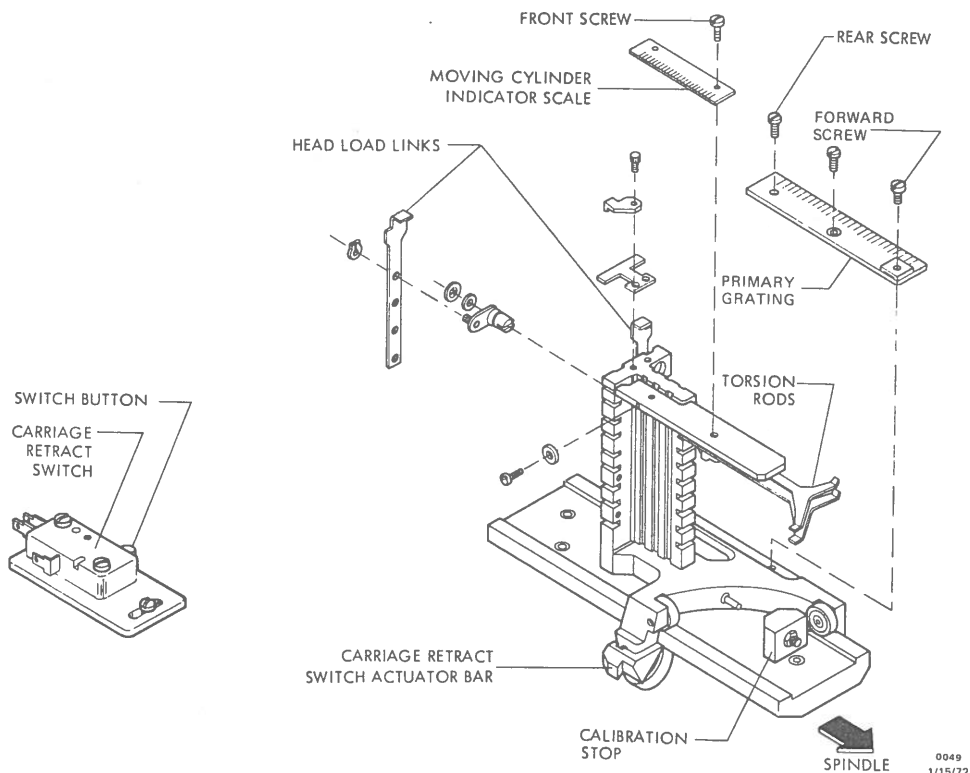


Figure 6-4. Carriage Assembly

### 6.2.1 Preparation

1. Place START/STOP switch to OFF.
2. Remove both rear access panels. Obtain permission to stop DP operations and place CB1 to OFF.
3. Remove disk pack if one is installed.
4. Remove entire top cover assembly.
5. Remove shroud, EMA shield, and air duct.



- Carefully move carriage forward until head load links just clear carriage interlock bracket (approximately 1-1/2 inches).

### CAUTION

Carriage must not be extended far enough for heads to start down cams. Extreme head damage will occur if heads leave cam surface without a pack in place, and rotating. If accidentally moved too far, heads must be carefully inspected before subsequent use.

- Unload torsion rods by loosening two screws on top of T-block.
- Remove head cable plug retainer from "A" side.
- Disconnect head cable plugs from "A" matrix and lay aside. (Tape placed around the entire set of cables will aid in keeping them out of the way).
- Remove two screws and insulator from source mounting block (Figure 6-2).
- Lift off source mounting block and lay aside. Remove insulator under source mounting block.

#### 6.2.2 Grating Proximity Adjustment

Perform an initial check to verify that a 0.002- to 0.005-inch clearance exists between primary and secondary gratings at the minimum clearance point.

**NOTE:** Use only nonmetallic shims for making this measurement.

The minimum clearance point is determined by moving the carriage through its full travel and noting the point location where clearance exists between gratings. If clearance is not within limits, adjust as follows:

- Ensure primary grating is secured in place and sensor mounting block mounting screws are tight. Observe clearance between gratings (see figure 4-5). Estimate thickness of shim required to bring gap into range. It may be necessary to use a combination of several nonmetallic shims to measure the gap.
- Place 0.002-inch measuring shim between gratings and loosen (don't remove) primary grating hold-down screws and two cap screws holding down sensor mount. These screws must be loosened enough to allow spacing shims to be slipped under sensor mount (see figure 6-2).
- Select several spacing shims to obtain required thickness determined from step 1. Initially, use at least 0.002-inch less than estimated because shims will vary slightly in thickness and may not be the exact value printed on them.

4. Retighten sensor mounting block screws, then lightly tighten primary grating screws. While tightening, check with 0.002-inch measuring shim to ensure gap is not less than 0.002-inch. Do not move carriage while tightening screws.
5. If more than 0.002-inch gap exists, check for 0.002- to 0.005-inch gap per original checking method. If less than 0.002-inch gap exists, go immediately to step 2 and remove required number of spacing shims to increase gap to 0.002-inch minimum. Repeat steps 1 through 5 until 0.002- to 0.005-inch gap exists between gratings at minimum clearance.

### 6.2.3 Parallelism Adjustment

**NOTE:** Use small penlight to eliminate shadows in transducer area.

1. Position carriage forward until primary grating is approximately centered over secondary grating.
2. Loosen three screws holding primary grating in place (figure 4-5).
3. While observing from directly above, position primary grating until exact parallelism of line is obtained. No moire patterns should remain.
4. Start with rear screw and successively tighten three screws holding down primary grating. Tighten screws in increments while equalizing torque to maintain a relatively level attitude of the primary grating. Tighten the rear screw (with raised shoulder) to 5 to 6 inch-pounds and the other two screws, to 4 to 5 inch-pounds.

#### **CAUTION**

Uneven tightening of primary grating screws may break glass on which the lines appear.

### 6.2.4 Cylinder Position Adjustment

1. Move carriage to calibration stop.
2. Place 0.038-inch feeler gauge between carriage and calibration stop (figure 6-4). Hold in place with slight hand pressure on carriage.
3. Insert 0.002-inch protective shim between gratings and loosen cap screws on sensor mounting block (see figure 6-2). Loosen screws just enough to allow block to be moved.
4. Rotate cylinder adjustment screw CCW approximately two turns while forcing sensor mounting block toward EMA. Do not allow adjustment screw to move block. Remove 0.002-inch shim from between gratings.
5. Adjust cylinder adjustment screw until leading edge of last dark line of the velocity grid on primary grating is within velocity index line on the

secondary grating (see figure 4-6).

**NOTE:** The adjustment must always be made by rotating cylinder adjustment screw CW. In event of adjustment overshoot, repeat steps 4 and 5.

6. Remove 0.038-inch shim between carriage and calibration stop.
7. Move carriage forward until it just makes contact with calibration stop. Hold in place with slight hand pressure.
8. While observing cylinder vicinity segment, carefully adjust cylinder adjustment screw until cylinder vicinity segment grid becomes gray, position 1 segment grid is black, and position 2 grid is white.

**NOTE:** Due to parallax, it is necessary to observe this condition from directly above, with only one eye.

9. Tighten mounting screws and verify that conditions established by step 8 are not disturbed.
10. Install 0.038-inch shim between carriage and calibration stop and ensure that leading edge of last dark line of velocity grid is within (not necessarily centered on) velocity index line on secondary grating. If not, repeat adjustment starting with step 1.

### 6.2.5 Equipment Close-Up

1. Install plastic insulator over sensor mounting block.
2. Install source mount with insulating washers and screws.
3. Replace head cable plugs and head plug retainers.
4. Move carriage back against interlock bracket and load torsion rods. Return carriage to fully retracted position after loading heads.

#### CAUTION

Use a dental mirror to inspect all heads to ensure that torsion rod tips are positioned against load buttons on heads and are not locked together. Incorrect torsion rod positioning may result in physical damage to heads.

5. Replace EMA shield, shroud, and air duct.
6. Install top cover and both rear access panels.

**NOTE:** Head alignment must always be checked after alteration of any component in access transducer.

7. Perform head alignment after completing access transducer adjustments.

### 6.3 ACCESS VELOCITY ADJUSTMENT

The access velocity is checked to determine the timing interval from the beginning of seek start to occurrence of access ready. During this check, an unsafe condition may occur as a result of a velocity-too-great condition. When this happens, adjustment is to be performed as follows:

1. Install maintenance disk pack.
2. Connect Off-Line Testor to the drive.
3. Ensure jumper is installed from 1732 to 1702.
4. Turn drive on and obtain access ready status.
5. Set up oscilloscope as follows:
  - a. Connect scope channel 1 input probe to 2733.
  - b. Set time base at 2 ms/div.
  - c. Set vertical deflection at 2v/div.
  - d. Set trigger mode switch to internal (INT) and slope switch to minus (-).
  - e. Adjust variable time base to obtain two complete AC cycles displayed over 10 divisions as shown in view A, figure 6-5.
  - f. Ground 1824.

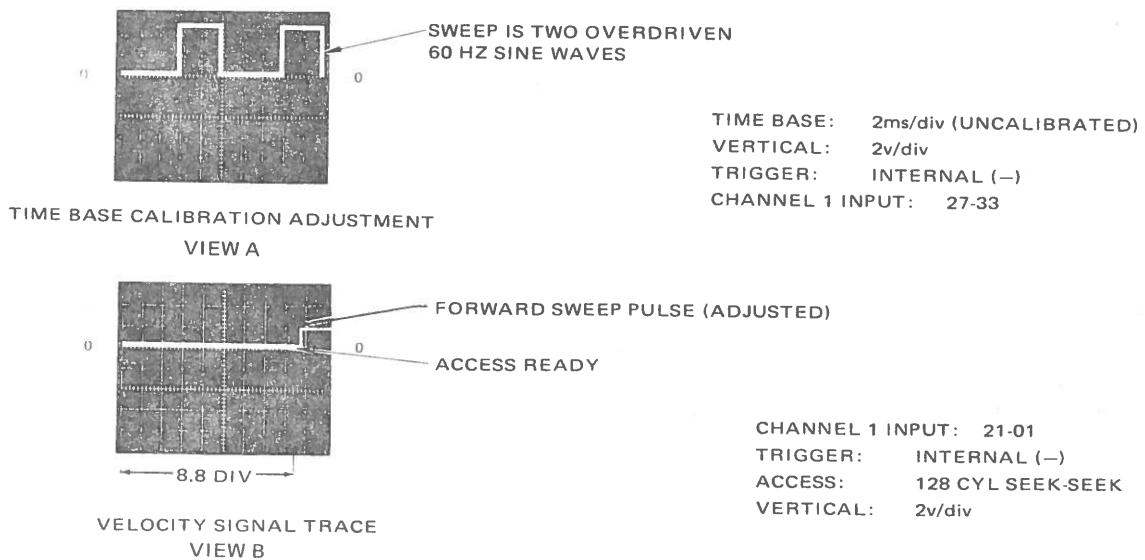


Figure 6-5. Scope Patterns for Access Velocity Safety Check/Adjustments

6. Set up Off-Line Testor to perform seek operations as follows:
  - a. Perform initial cylinder 000 recalibrate seek operation.
  - b. Perform 000-128 seek-seek operation.
7. Set up oscilloscope to read velocity signal by connecting channel 1 input probe to 2101 (+Access Ready).
8. Observe scope pattern. Look for pulse that is displaced 8.8 divisions from start of sweep (figure 6-5, view B). A different displacement is required for 50-Hz drives as discussed in Appendix A.

**NOTE:** Actually, two pulses will appear close together; one each for forward and reverse motion as shown in view B. The shorter pulse must not be less than 8.8 cm.
9. Adjust access velocity if 8.8 division pulse displacement is not present.
10. Return variable time base control to calibrated position. Leave scope channel 1 input at 2101. Set trigger SOURCE to external (EXT) and SLOPE to minus (-). Connect EXT TRIG INPUT to Seek Start (1303). Set up Off-Line Testor to perform 000-405 seek-seek operations. Seek time (from Seek Start to Access Ready) must be between 52 and 55 ms. Adjust access velocity if seek time is outside limits.
11. Check 405 cylinder seek, restore, and head load for a velocity unsafe condition.
12. Remove ground from 1824 and jumper from 1732 to 1702.

#### VELOCITY ADJUSTMENT

Adjustment is made at potentiometer 136R10, located on the curve generator, PWA 15. Adjustment is made to obtain scope pattern figure 6-5, view B.

1. Increase access velocity by rotating adjustment screw CCW. An increase in access speed causes pulse to appear early (which decreases number of divisions present from start of sweep).
2. Reduce access velocity by rotating adjustment screw CW. A decrease in access speed causes pulse to appear at a later time (which increases number of divisions present from start of sweep).

#### 6.4 BRUSH RETRACT SWITCH ADJUSTMENT

The brush retract switch is positioned so a clearance of 0.020 to 0.030 inch exists between the switch body and the actuating cam.

1. Turn off START/STOP switch.
2. Obtain permission to stop DP operations and then turn off CB1.
3. Remove air deflector.
4. Loosen two switch mounting screws.

5. Position switch cam arm and drive link parallel. This will place switch cam at its maximum extension.
6. Place 0.025-shim between cam and switch.
7. Hold switch tightly against shim and tighten screws.
8. Remove shim.
9. Replace air deflector.

#### 6.5 CARRIAGE RETRACT SWITCH ADJUSTMENT (Figure 6-4)

1. Turn off START/STOP switch.
2. Obtain permission to stop DP operation and turn off CB1.
3. Loosen screws holding switch.
4. Place 0.025-inch shim between switch and actuator bar with carriage in full retract position.
5. Hold switch tight against shim and actuator bar and tighten screws.
6. Remove shim.

#### 6.6 CYLINDER INDICATOR ADJUSTMENT (Figures 6-6, 6-7)

1. Turn off drive.
2. Open service cover.

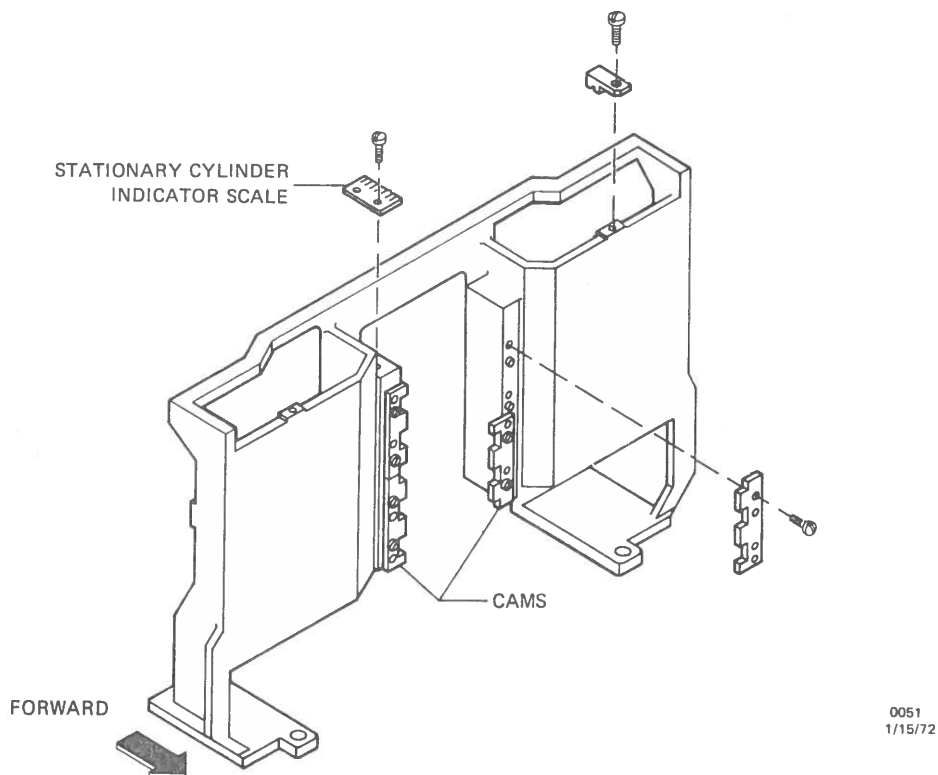
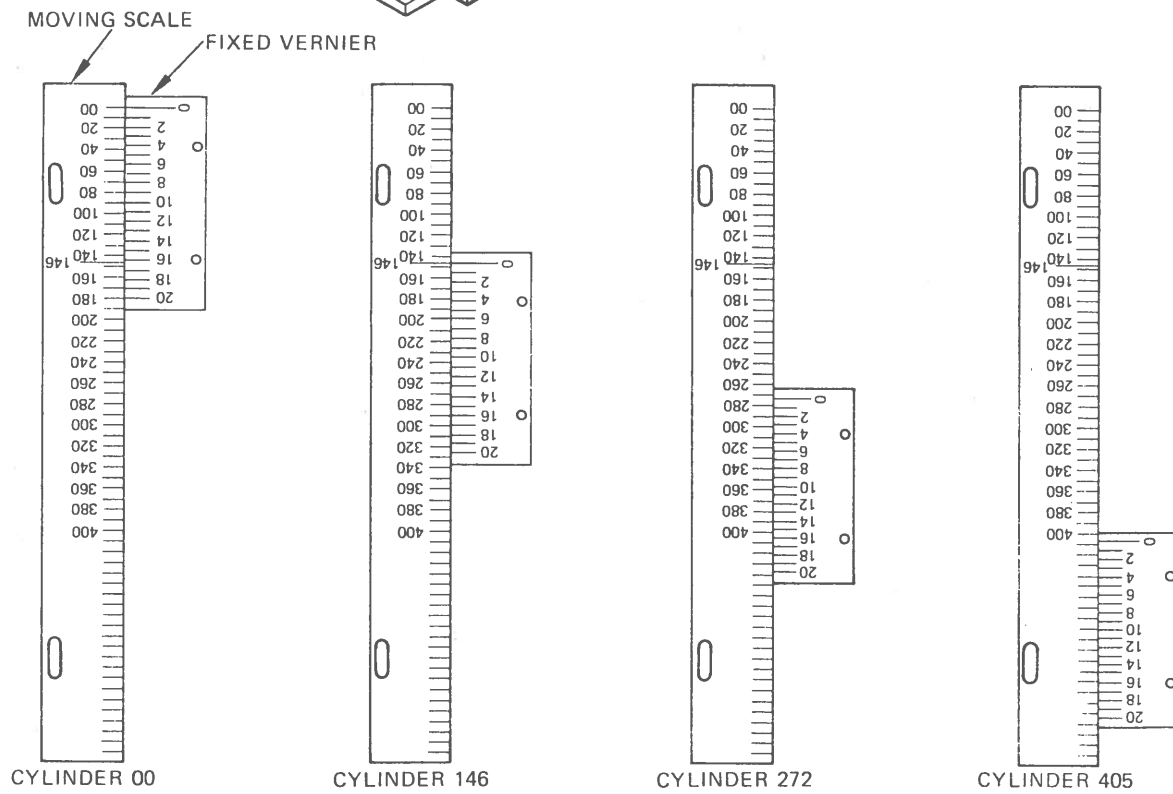
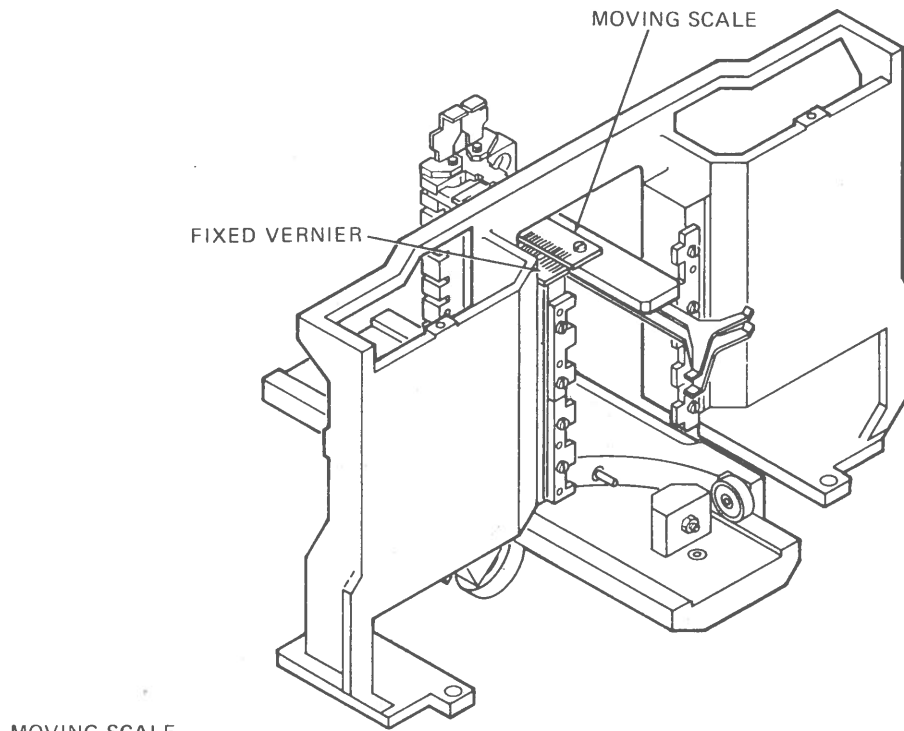


Figure 6-6. Cam Tower Assembly



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Figure 6-7. Cylinder Position Indicator

3. Loosen front screw on moving scale.
4. Install pack, turn on drive, and wait until heads are at track zero.
5. Loosen rear screw on moving scale.
6. Position moving scale for zero reading.
7. Tighten rear screw.
8. Turn drive off.
9. Tighten front screw.
10. Perform final check as follows:
  - a. Turn drive on.
  - b. Access to cylinder 146.
  - c. Check for position and interference.

## **6.7 READ/WRITE HEAD ADJUSTMENT**

### **6.7.1 Head Alignment Check and Adjustment Requirements**

Read/write heads are aligned initially when a drive is installed and after this only when any of the following conditions exist:

1. Read data errors occur.
2. Any read/write head is replaced.
3. Calibration stop is adjusted, replaced, or repaired.
4. Access transducer is adjusted, replaced, or repaired.
5. An alignment check reveals head out of alignment.
6. Temp Comp (PWA 18) is replaced.

The radial positioning of a read/write head during accessing must be precise to ensure disk pack interchangeability between drives. Head alignment checks are made to ensure that positioning is accurate. The CE disk pack is used as a standard for checking head positioning and also for aligning a read/write head. Master cylinder 146 is the reference for the positioning check and alignment.

Reading any track of cylinder 146 of the CE pack produces an oscilloscope signal that forms two envelopes (lobes) as shown in figure 6-8. These lobes are used to produce a pulse with the trailing edge falling at the crossover point of the envelopes (figure 6-8). Sync the scope to trigger on the positive-going transition of the sync pulse. Exact alignment is indicated when the trailing edges coincide.

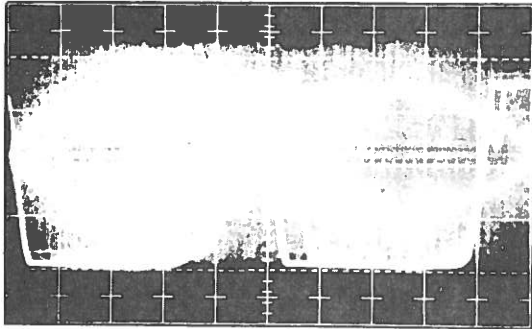
### **6.7.2 Head Alignment Check Procedure**

All 20 heads must be checked. The initial check is to be conducted following a 2-hour warmup to stabilize the drive. Use the following procedure to determine if head adjustment is required:

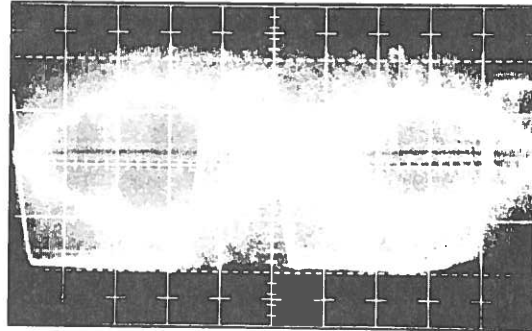
1. Connect oscilloscope to drive and install the CE disk pack.  
Refer to steps 1 through 6 of paragraph 6.7.3.



2. Use Off-Line Testor for accessing to cylinder 146 and for head selection (steps 7 through 10 of paragraph 6.7.3). Check heads consecutively 0 through 19.



VIEW A. HEAD OUT OF ALIGNMENT



VIEW B. HEAD CORRECTLY ALIGNED

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Figure 6-8. Waveform Pattern for Checking and Adjusting Heads

3. For each head, note the trailing edge of the pulses at the center cross-over point. Refer to figure 6-8.
4. Pulse trailing edges must be superimposed. Otherwise, misaligned head must be adjusted.

**NOTE:** Head adjustment is performed only on misaligned heads. After adjustment, however, all heads must be rechecked.

### 6.7.3 Head Alignment Adjustment Procedure

1. Install CE pack on drive.
2. Connect Off-Line Testor.
3. Ensure that the drive has been warmed up for two hours under the following conditions:
  - a. Top rear access cover removed.
  - b. Service access cover open.
  - c. Air duct removed.
  - d. All other mechanical components in place.

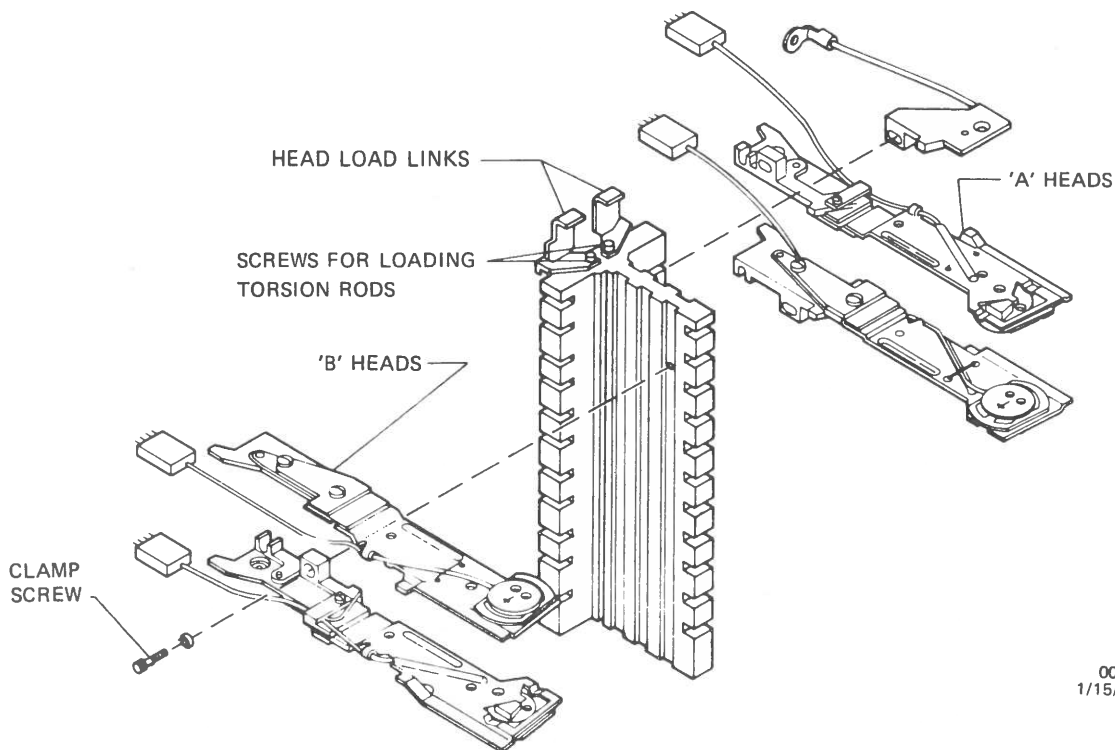
**NOTE:** When AC and DC power is removed for short periods of time during or just prior to head alignment, the drive should be restabilized for a period equal to twice the off time before continuing the procedure. In no case should the restabilization period be less than 5 minutes or greater than 2 hours.

4. Connect jumper between 0601 and 0619.
5. Connect oscilloscope as follows:
  - a. INPUT 1 to 0613 (Test Point).
  - b. INPUT 2 to 0501 (Test Point).
  - c. TRIG IN to 0614 (Test Point).
  - d. SYNC on external (EXT).
6. Set up oscilloscope controls for the following:
  - a. Channels 1 and 2 chopped. Both inputs AC coupled.
  - b. Sweep triggered on positive slope of external pulse.
  - c. A vertical amplitude setting of 5v/cm for CH1 and 0.5v/cm for CH2.
  - d. Sweep time as required for display of one disk pack revolution, approximately 25 ms (uncalibrated).

**NOTE:** Verify proper scope adjustment by gently pushing forward on the carriage and noting a change in the pulse pattern.
7. Perform seek to cylinder 146 with OFF-Line Testor.
8. Select head to be adjusted.

**NOTE:** Heads should be aligned from the bottom upward. Alignment should begin with head 18 and end with head 1 on side A; alignment should begin with head 19 and end with head 0 on side B.
9. Loosen clamp screw of applicable head. Tighten, using torque screwdriver (P/N 70004459-1), to between 4 and 5 inch-pounds. See figure 6-9 for head location.
10. Using the alignment tool (P/N 70004055-1), adjust head position so that the trailing edges of the displayed pulses coincide to within 0.1 cm.
11. Tighten head clamp screw to 7 inch-pounds. After removing the torque screwdriver, observe the oscilloscope display and proceed as follows:
  - a. If pulse coincidence pattern is more than 0.1 cm out of alignment, repeat steps 9 through 11.
  - b. If pulse coincidence pattern is out of alignment but less than 0.1 cm, proceed to step 12.
  - c. If pulse coincidence pattern has no observable offset, proceed to step 14.
12. Carefully press (forward and reverse) on carriage to determine direction of error in alignment. Then carefully insert the 70004055-2 alignment tool in head. This tool can be identified by the number 2 stamped on the handle.

**NOTE:** Do not allow the alignment tool camber to contact the head camming surfaces.



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Figure 6-9. Heads and T-Block

13. Gently rock the alignment tool in the same direction as the error observed by moving the carriage in step 12. Continue the alignment until there is no observable error in the pulse coincidence display.

**CAUTION**

Exercise extreme care in performing the fine alignment to avoid breaking the alignment tool indexing pin. In no case should the alignment procedure of steps 12 and 13 be used for an error of greater than 0.1 cm.

14. Repeat steps 8 through 13 for the remaining heads to be aligned.
15. Perform a post-adjustment check consisting of the following:
  - a. 100 restore operations
  - b. One unload-head load operation
16. Perform seek to cylinder 146 with Off-Line Testor.

17. Select each head in turn and verify its alignment. Heads exhibiting pulse coincidence display errors of greater than 0.1 cm should be realigned.

**NOTE:** If any heads require the realignment of step 17, repeat steps 15 through 17.

18. Remove jumper from between 0601 and 0619.

## 6.8 INDEX TRANSDUCER ADJUSTMENT

### 6.8.1 Radial Adjustment (Figure 6-10)

Two adjustments are required. One provides clearance between the pack and transducer. The other ensures that switch contacts open and close when transducer is pivoted for removing and installing the disk pack. Adjustment is made as follows:

1. Remove top cover.
2. Remove shroud.
3. Manually pivot index transducer back and install maintenance pack.
4. Carefully allow index transducer to pivot forward into its operating position (see figure 6-10).
5. Adjust pack clearance as follows:
  - a. Insert 0.50-inch feeler gauge between outer edge of pack and upper surface of index transducer assembly.
  - b. Rotate maintenance pack manually and locate the point of rotation at which maximum gap occurs between pack edge and upper surface of index transducer assembly.

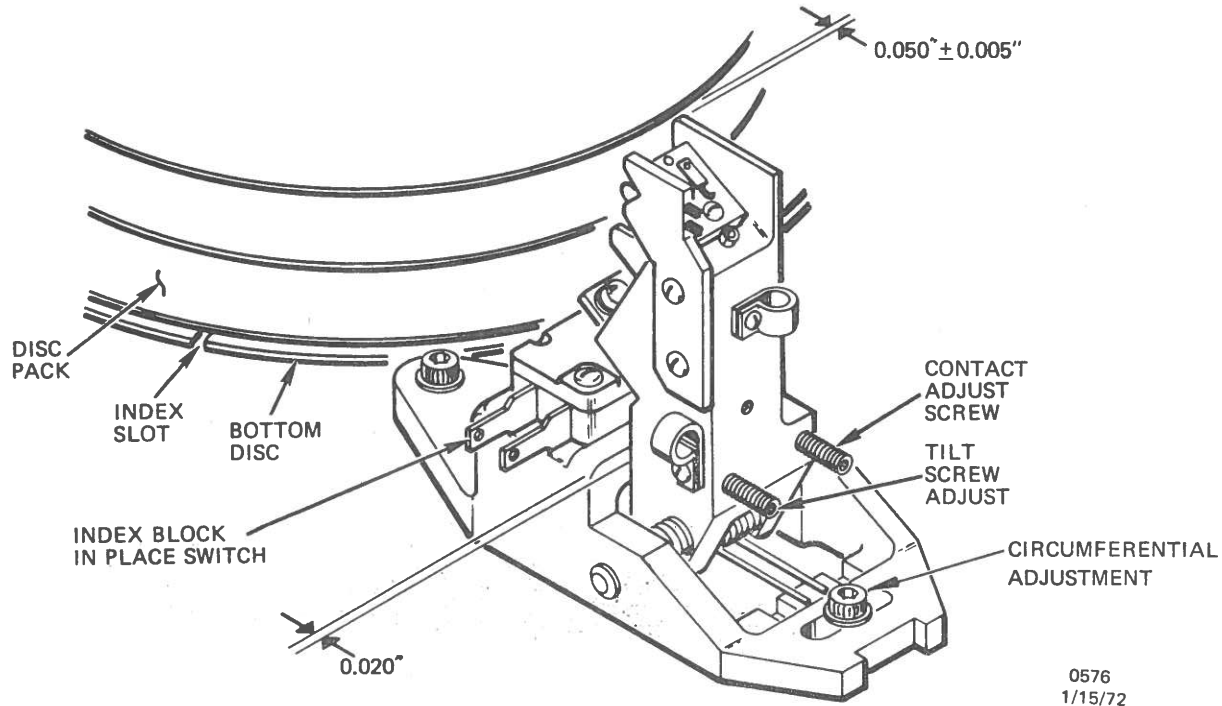
**NOTE:** Do not allow pack to turn against feeler gauge.

- c. Adjust tilt adjust screw until  $0.050 \pm 0.005$  inch pack clearance is obtained at gap between transducer mounting and edge of disk pack.
6. Adjust switch actuation as follows:
  - a. Insert 0.020-inch feeler gauge between tilt adjust screw and shoulder of transducer base to allow for proper overtravel.

**NOTE:** A continuity test light or ohmmeter may be used to detect switch operation. Also an audible click occurs when switch contacts make or break.

- b. Turn contact adjust screw inward (toward spindle) until switch transfers (closed), then back out screw (away from spindle) until switch transfers again (open).

7. Verify that spindle holding pawl adjustment has not been affected and return drive to service.



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Figure 6-10. Index Transducer Adjustment

### 6.8.2 Circumferential Adjustment

The index transducer is adjusted circumferentially while observing the pulse burst on cylinder 236 of the CE disk pack and monitoring the signal at read/write heads.

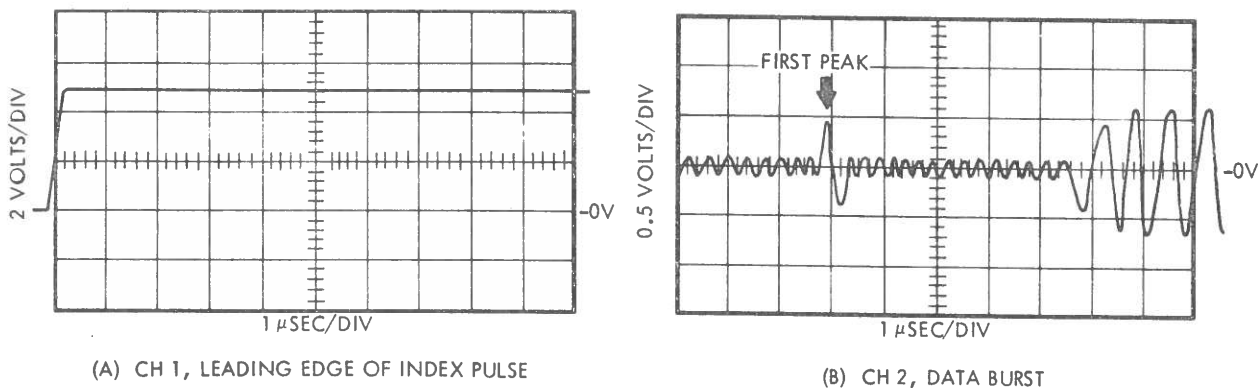
1. Connect Off-Line Testor to the drive and install CE pack.
2. Connect jumper from 1732 to 1702.
3. Turn drive on and obtain Access Ready status.
4. Perform seek to cylinder 236 with Off-Line Testor.
5. Set up oscilloscope as follows:
  - a. CH 1 INPUT to 1753 (DC coupled). Vertical sensitivity of 2 v/div.
  - b. CH 2 INPUT to 0501 (AC coupled). Vertical sensitivity of 0.5 v/div.
  - c. MODE to CH 1, Trigger to CH 1 only.
  - d. Sweep TIME/DIV to 1  $\mu$ sec/div.
  - e. Adjust triggering to observe positive-going leading edge of index pulse. See figure 6-11, view A.
  - f. Switch MODE to channel 2.
6. Select, in turn, heads 9 and 10, by using Off-Line Testor. Measure elapsed time between index pulse and first peak of data burst for each

- head. See figure 6-11, view B. The range of time for both heads (from index pulse to data burst) should be  $3 \pm 2 \mu\text{sec}$ .
7. If both of these times are  $3 \pm 2 \mu\text{sec}$ , no further adjustment is necessary. If not, proceed to step 8.
  8. Loosen screw at back of transducer index block and pivot block laterally until both times are  $3 \pm \mu\text{sec}$ .
  9. Tighten screw while viewing signal to ensure that adjustment is not disturbed.
  10. Verify that spindle holding pawl adjustment has not been affected.
  11. Remove jumper, from 1702 to 1732.

### 6.9 PACK-ON SWITCH ADJUSTMENT

The pack-on switch (figure 6-12) is adjusted by manually forming one of the switch components until a clearance of 0.020 inch to 0.040 inch exists between switch contacts without a disk pack installed.

1. Remove disk pack.
2. Obtain permission to stop DP operations and turn off CB1.
3. Using long-nose pliers, form stationary strap of the pack-on switch for a clearance of 0.020 to 0.040 inch between switch contacts. See figure 6-12.
4. Install disk pack and verify that switch contacts are made.

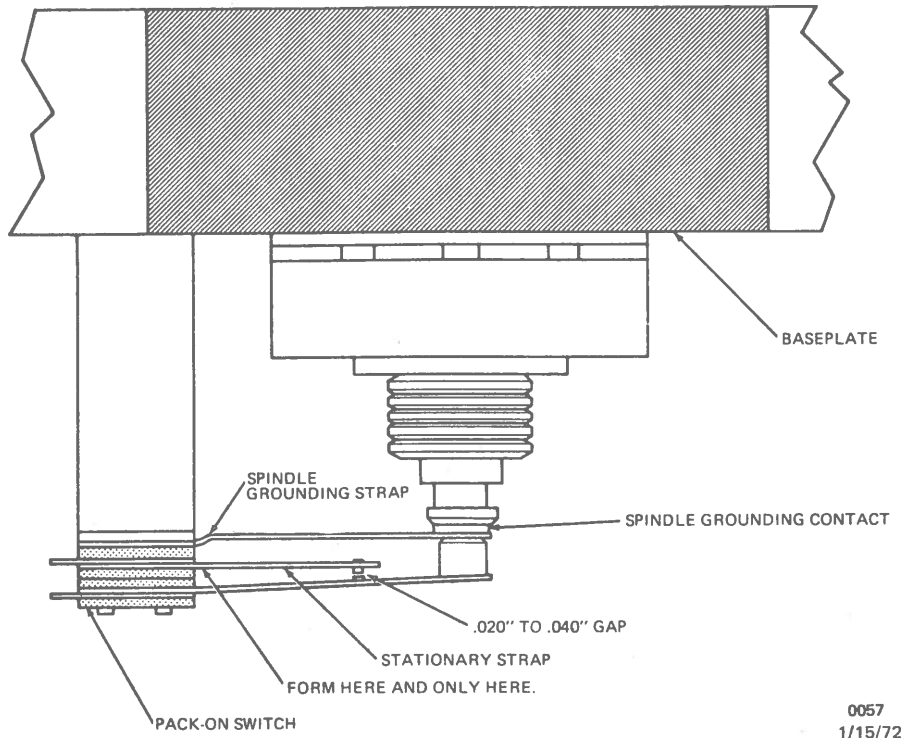


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Figure 6-11. Index Transducer Adjustment Waveforms

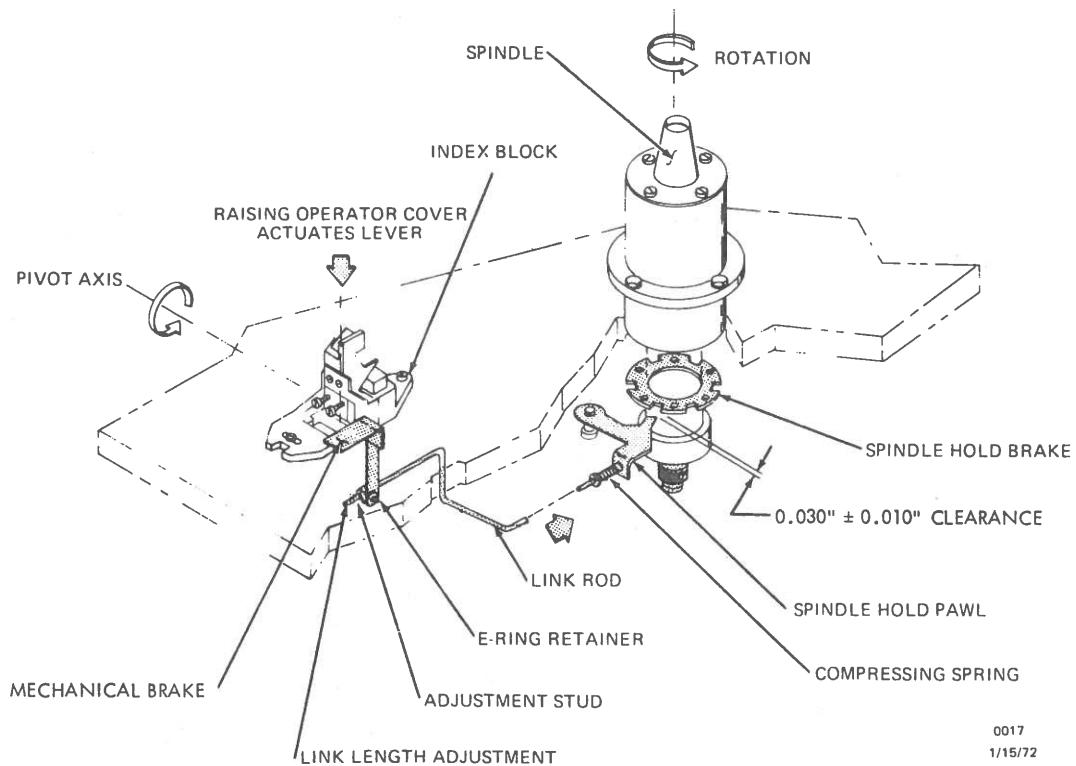
### 6.10 SPINDLE HOLDING PAWL ADJUSTMENT

The adjustable portion of the holding pawl linkage is located above the baseplate. Either the operator cover must be down, or the entire top cover assembly removed to make this adjustment. Access to adjustment linkage may be obtained by removing the top rear panel.



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Figure 6-12. Pack-On Switch Adjustment



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Figure 6-13. Spindle Holding Pawl Adjustment

1. Remove shroud.
2. Remove E-ring retainer holding adjustment stud to mechanical brake lever. See figure 6-13.
3. Remove stud from brake lever and adjust stud position on link as necessary to obtain 0.020- to 0.040-inch clearance between pawl and lock wheel (CW to increase clearance).
4. Replace stud and manually operate brake lever to verify pawl engages lock wheel when lever is depressed.
5. Replace top cover assembly and raise operator cover to ensure that mechanical brake is effective while cover is raised.

## 6.11 SERVO CHECKS AND ADJUSTMENTS

### 6.11.1 Access Velocity Check

The access velocity should be checked and if necessary, adjusted, according to paragraph 6.3, as part of a complete servo system check.

### 6.11.2 Magnitude Check of Position Signals, Cylinders 000 to 008 Seek-Seek

1. Set up oscilloscope for dual-trace chopped mode.
  - a. Connect channel 1 input to 2031 (Position 1 signal).
  - b. Connect channel 2 input to 2032 (Position 2 signal).
  - c. Set CH 1 and CH 2 VOLTS/DIV to 2, ground input, and adjust zero-volt reference so it coincides with first horizontal line above lowest line of graticule.
  - d. Position TRIGGER control to CH 1 ONLY.
  - f. Position A SWEEP MODE switch to NORM TRIG.
  - g. Place SLOPE to plus (+) and SOURCE to EXT.
  - h. Connect EXT TRIG INPUT to 1555 (-Go Forward).
2. Using Off-Line Testor, perform eight-cylinder seek-seek operations between cylinders 000 and 008.
3. By alternately grounding channels 2 and 1 (INPUT to GND), observe scope patterns for position 1 and 2 signals for following conditions. See figure 6-14.
  - a. The most negative positions of respective patterns should be displaced between 0.0 to 0.2 volts above zero-volt reference.
  - b. The most positive magnitude of each signal should be between 7.8 and 8.2 volts.

### 6.11.3 Magnitude Check of Position Signal, Cylinders 000 to 398 Single Seeks

1. Use oscilloscope setup of 6.11.2 (1) except for step d; position TIME/DIV to 1 ms (calibrated).
2. Ground 1824.



3. Using Off-Line Testor, perform single-cycle seeks from 000 to 398.
4. Observe scope patterns for position 1 and 2 signals. See figure 6-15.
  - a. The voltage between seeks in both views must be 3.75 to 4.25 volts from zero reference.
  - b. The most positive displacement in view A must be 7.8 to 8.2 volts.
  - c. The most negative displacement in view B must be 0.0 to 0.2 volts.
5. Remove ground from 1824.

#### 6.11.4 Magnitude Check of Positon Signals, Cylinders 000 to 405 Single Seek

1. Use oscilloscope setup of 6.11.2 (1) except for step d; position TIME/DIV to 20 ms (calibrated).
2. Using Off-Line Testor, perform seek-seek operation from cylinder 000 to 405.
3. Observe scope pattern for position 1 and 2 signals for following conditions. See figure 6-16.
  - a. The most negative positions of respective patterns should be displaced 0.0 to 0.2 volts above zero-volt reference.
  - b. The overall magnitude of each signal, peak-to-peak, should be between 7.8 and 8.3 volts.

#### 6.11.5 Magnitude Check of Combined (Added) Position 1 and 2 Signals

1. Set up oscilloscope for add mode.
  - a. Leave channel 1 input at 2031 (position 1 signal), channel 2 input at 2032 (position 2 signal), and EXT TRIG INPUT at 1555 (-GO FORWARD).
  - b. Pull out INVERT control so position 2 signal (2032) adds to position 1 signal (2031).
  - c. Set CH1 and CH2 VOLTS/DIV to 5 (calibrated), and adjust zero-volt reference so it coincides with first horizontal line above lowest line of graticule.
  - d. Position TIME/DIV to 0.5 ms.
  - e. Place channel 1 SLOPE to MINUS.
2. Using Off-Line Testor, position heads on cylinder 000. Wait minimum of 2 minutes; then, perform a cylinder 000-405 single seek.
3. Measure magnitude of combined position signal within first completed cycle. Magnitude should be between 15.6 and 16.4 volts. See figure 6-17.

**NOTE:** If seek is repeated, position head on cylinder 000 and wait at least 2 minutes before performing 000-405 seek.

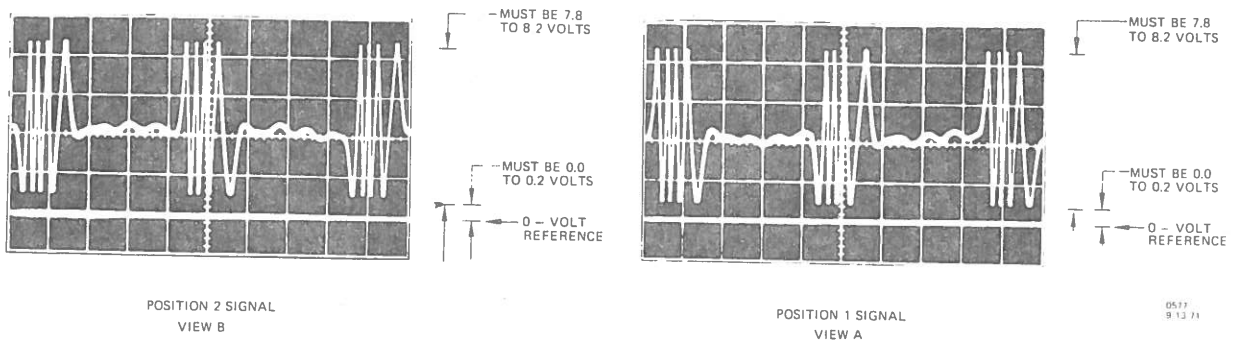


Figure 6-14. Position Signal Magnitude, Cylinders 000-008 Seek-Seek

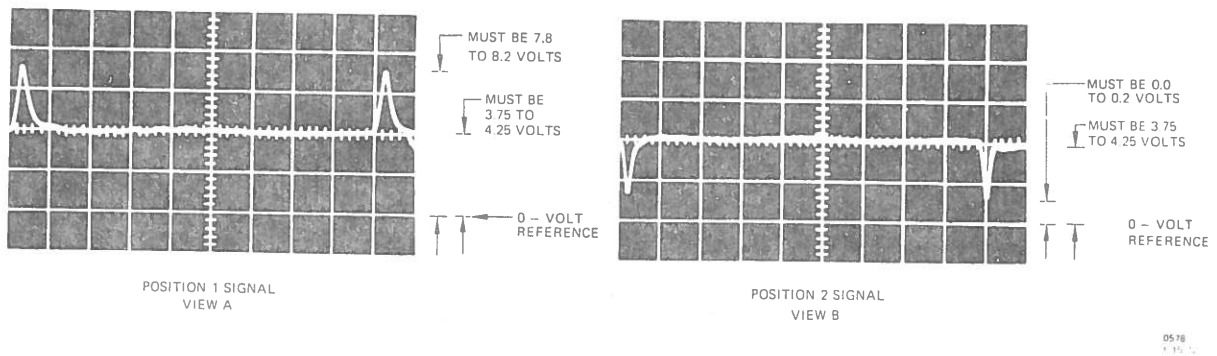


Figure 6-15. Position Signal Magnitude, Single Seek

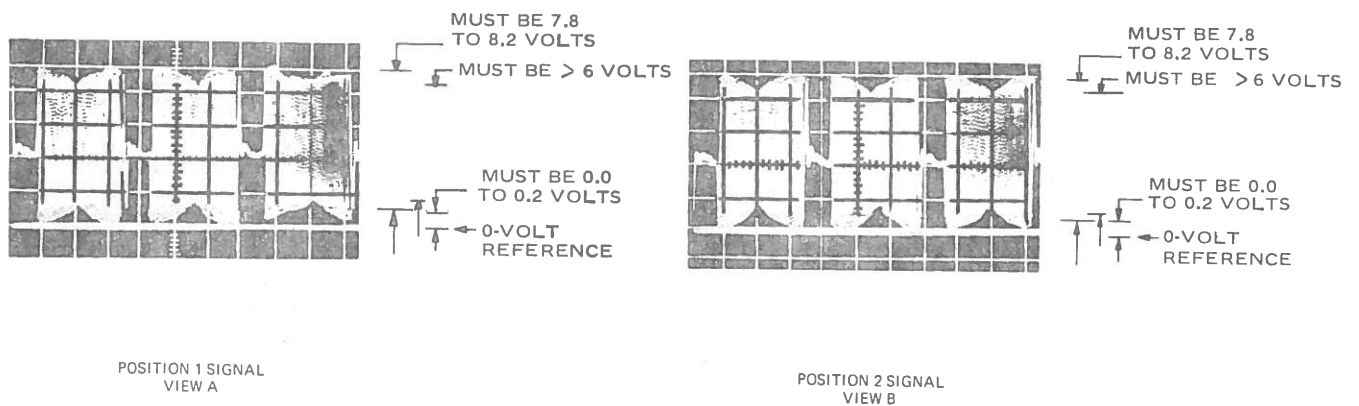


Figure 6-16. Position Signal Magnitude, Cylinders 000-405 Seek-Seek

### 6.11.6 Seek-Seek Versus Single-Seek Access Timing

1. Set up oscilloscope as follows:
  - a. Connect channel 1 input to 2101 (+Access Ready).
  - b. Connect EXT TRIG INPUT to 1447 (-Seek Start), and position A TRIGGERING SOURCE to EXT.
  - c. Position TIME/DIV control to 10 ms (calibrated).
  - d. Set CH 1 VOLTS/DIV to 2, and adjust zero-volt reference to coincide with graticule horizontal centerline.
2. Using Off-Line Testor, perform 000-405 cylinder seek-seek.
3. Note time required for 000-405 cylinder seek in each direction during seek-seek operation.
4. Using Off-Line Testor, perform 000-405 cylinder single seek. When repeating operation, allow at least 10-second interval between end of last single-seek operation and beginning of next single-seek operation.
5. Note time required for 000-405 seek-seek and single-seek operation should not be greater than 3.0 ms. Otherwise check cylinder position grating alignment or AGC (PWA 21).
6. Time difference between 000-405 seek-seek and single-seek operation should be not greater than 3.0 ms. Otherwise check cylinder position grating alignment or AGC (PWA 21).

### 6.11.7 Amplitude Check of Ringing Between Seeks

1. Set up oscilloscope for add mode, CH 2 inverted.
  - a. Connect channel 1 input to 2032 (position 2 signal).
  - b. Connect channel 2 input to 2031 (position 1 signal).
  - c. Ground 1824.
  - d. Set CH1 and CH2 VOLTS/DIV to 5, and adjust vertical positioning so trace between seeks coincides with horizontal centerline.
  - e. Position TIME/DIV control to 5 ms (calibrated).
  - f. Position MODE TRIGGER control to CH 1 ONLY.
  - g. Connect EXT TRIG INPUT to 1555 (-GO FORWARD).
  - h. Position A TRIGGERING SOURCE to EXT and SLOPE to plus (+).
2. Perform 2-cylinder seek-seek between cylinders 400 and 402 using Off-Line Testor.
3. Observe amplitude of any ringing between seeks. Position excursions of ringing should always be less than  $\pm 0.5$  volt from zero-volt reference. Figure 6-18, view A, shows no overshoot, whereas figure 6-18, view B, shows excessive overshoot
4. Remove ground from 1824.

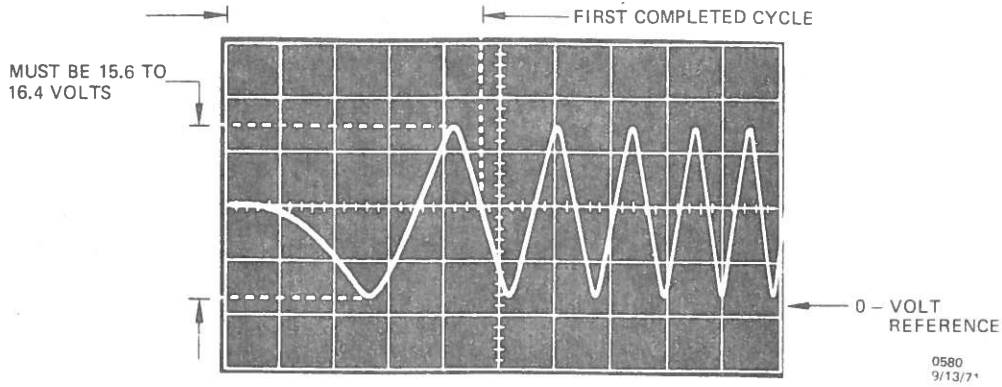


Figure 6-17. Added Positions 1 and 2 Signal, Cylinders 000-405 Seek-Seek

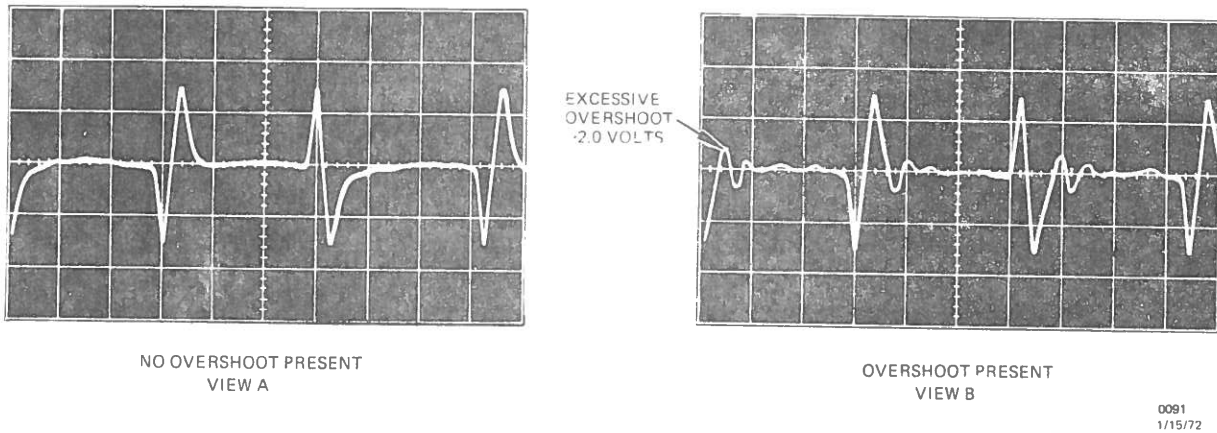


Figure 6-18. Overshoot and Ringing of Added Positions 1 and 2 Signals

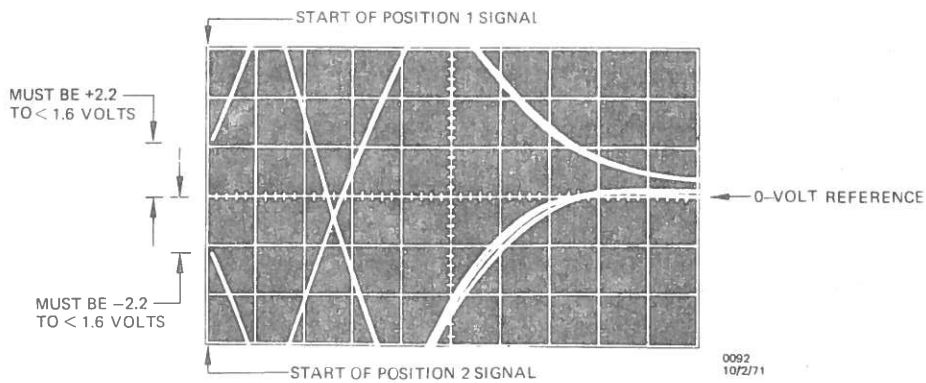


Figure 6-19. Cylinder Width Check, Positions 1 and 2 Signals

### 6.11.8 Cylinder Width Check as Heads Leave Cylinders

1. Set up oscilloscope for add mode, CH2 inverted.
  - a. Connect channel 1 input to 2032 (position 2 signal).
  - b. Connect channel 2 input to 2031 (position 1 signal).
  - c. Set CH1 and CH2 VOLTS/DIV to 2, and adjust vertical positioning of DC level between seeks so it coincides with horizontal centerline.
  - d. Position TIME/DIV control to 0.5 ms (calibrated).
  - e. Position TRIGGER CONTROL to CH1 ONLY.
  - f. Connect EXT TRIG INPUT to 2051 (+ Cylinder).
  - g. Position A TRIGGERING SOURCE to EXT and SLOPE to minus (-).
  - h. Ground 1824.
2. Perform 2-cylinder seek-seek between cylinders 400 and 402 using Off-Line Testor.
3. Observe start of combined position 1 and 2 signal for both access directions. Start of Position signal between cylinders should appear on scope at + 1.6 volts from horizontal centerline. See figure 6-19.

### 6.11.9 Wiggler Amplitude Check

1. Set up oscilloscope for add mode.
  - a. Connect channel 1 input to 2032 (position 2 signal).
  - b. Connect channel 2 input to 2031 (position 1 signal).
  - c. Connect EXT TRIG INPUT to 1753 (+ Index).
  - d. Position TIME/DIV control to 5 ms.
  - e. Position MODE control to ADD.
  - f. Position A TRIGGERING SOURCE to EXT and SLOPE to +.
  - g. Pull out INVERT control.
  - h. Set CH1 and 2 VOLTS/DIV to 0.1, AC coupled, and adjust zero-volt reference so it coincides with horizontal centerline.
2. With the drive operating on track, observe peak-to-peak amplitude of combined position 1 and 2 signal. Amplitude of ideal 40-Hz sine wave should be within range of 0.18 to 0.42 volts peak-to-peak. See figure 6-20.

**NOTE:** The signal observed may not approach an ideal sine-wave appearance as well as shown in figure 6-20, view A. Therefore, the observer must extrapolate and estimate a mean peak-to-peak amplitude.

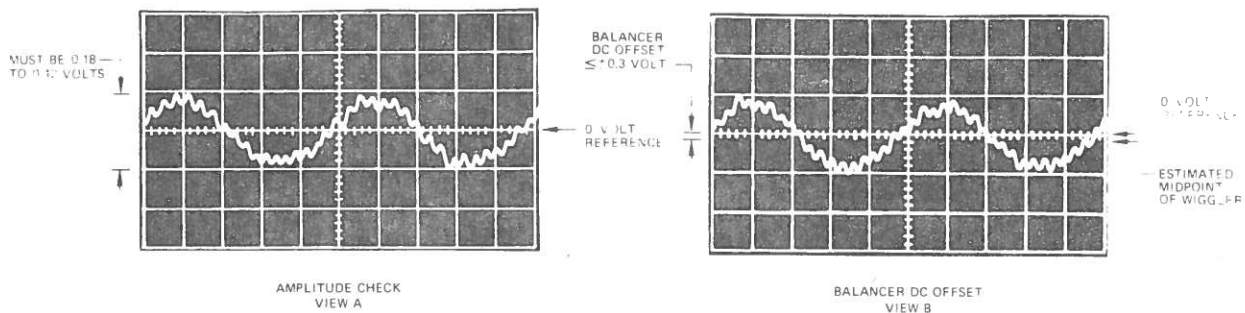


Figure 6-20. Wiggler Amplitude Check, Added Positions 1 and 2 Signal

### CAUTION

While performing the following steps, avoid accessing into the forward stop. Otherwise CB2 will open.

3. Using Off-Line Testor, access in forward direction from cylinder 000 to 008, from cylinder 008 to 016, and so on in successive 8-cylinder increments to cylinder 400. Immediately following each access, observe combined (added) position 1 and 2 signal while on track for condition described in step 4.
4. Look for very low frequency modulations of observed signal. If modulation is not present for more than 0.5 second, AGC circuit will malfunction.

#### 6.11.10 Balancer DC Offset Check

1. Use the same oscilloscope setup of 6.11.9.
2. Estimate location of midpoint of combined (added) position 1 and 2 signal (while on track) with respect to zero-volt reference as shown in figure 6-21, view B. DC offset must be less than  $\pm 0.3$  volt.

**NOTE:** The DC offset of the combined (added) position 1 and 2 signal while on track should be checked after drive has been warmed up for 5 minutes with covers and panels in place. Ground 1824 for this test.

### 6.11.11 Balancer Operational Check

1. Set up oscilloscope for differential operation.
  - a. Connect channel 1 input to 2452 (Summing Amp Output 1).
  - b. Connect Channel 2 input to 2455 (Summing Amp Output 2).
  - c. Set channels 1 and 2 VOLTS/DIV to 1.
  - d. Position TIME/DIV control to 5 ms.
  - e. Position MODE/TRIGGER controls to ADD/CH1 ONLY.
  - f. Pull out INVERT control on channel 2.
  - g. Position A TRIGGERING SOURCE to INT, and SLOPE to +.
  - h. Set INPUT switches for both channels to GND.
  - i. Adjust zero-volt reference so that it coincides with horizontal centerline.
  - j. Set INPUT switches to DC.
2. Connect 2420 (+ 12V) to a 560 Kohm resistor. Connect other end of resistor to 2444 (Balancer Output 2). Resulting waveform should resemble that of view A, figure 6-21, with negative deflection followed by rapid decay to zero.
3. Remove jumper from resistor to 2444. Resulting waveform should show positive deflection followed by rapid decay to zero, as in view B, figure 6-21.
4. Remove jumper between 2420 and 560 Kohm resistor.

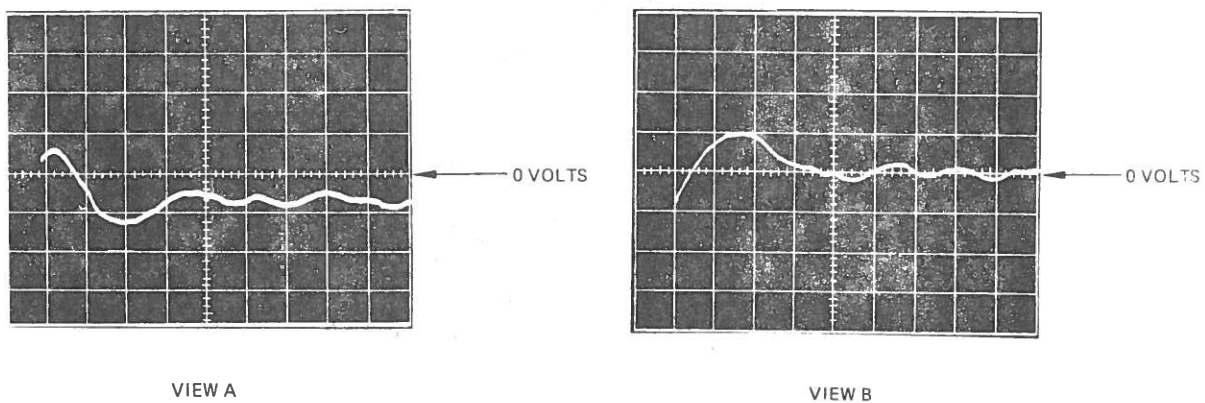


Figure 6-21. Balancer Waveforms

### 6.11.12 Temperature Compensation Action Check

The following procedure is used for checking the continuous temperature compensation system.

1. Set up oscilloscope for add mode.
  - a. Connect channel 1 input to 2031 (position 1 signal).
  - b. Connect channel 2 input to 2032 (position 2 signal), and EXT TRIG INPUT to 1741 (+Index).
  - c. Set channels 1 and 2 VOLTS/DIV to 2.
  - d. Position TIME/DIV control to 10 ms.
  - e. Position MODE/TRIGGER controls to ADD/CH 1 ONLY.
  - f. Position A TRIGGERING SOURCE to EXT, and SLOPE to plus (+).
  - g. Pull out INVERT control on channel 2.
  - h. Set INPUT switches for both channels to GND.
  - i. Adjust zero-volt reference so that it coincides with horizontal centerline.
  - j. Ground 1824.
  - k. Set INPUT switches to DC (waveform should appear like figure 6-22, view A).

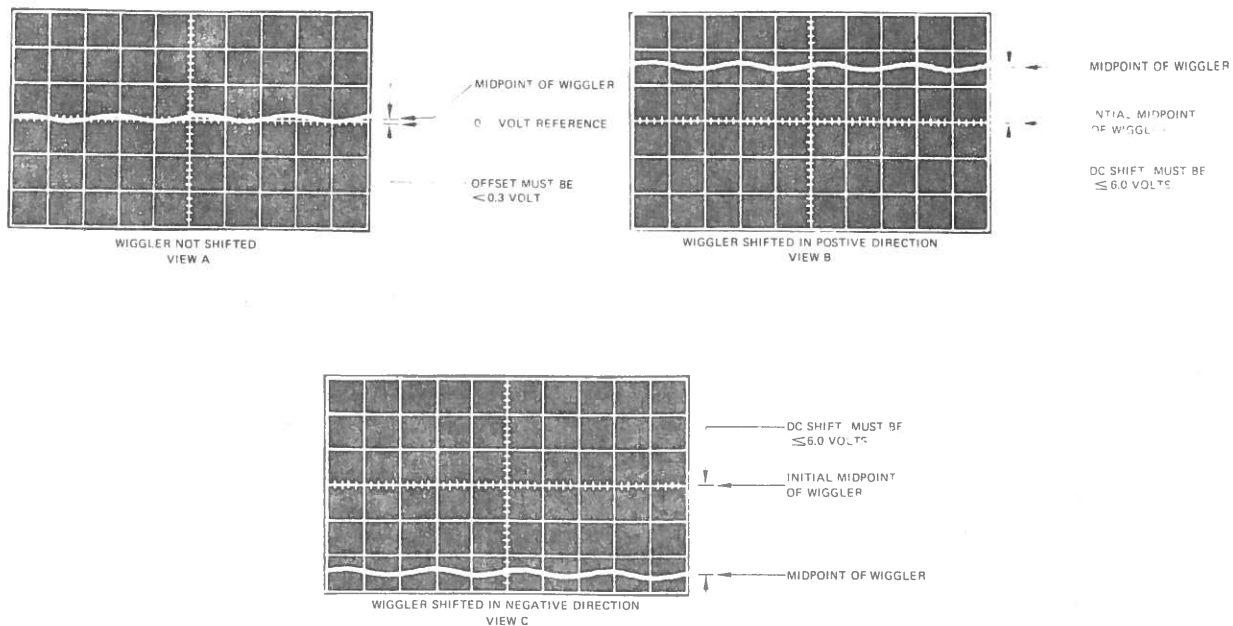


Figure 6-22. Temperature Compensation Effect on Added 1 and 2 Signal

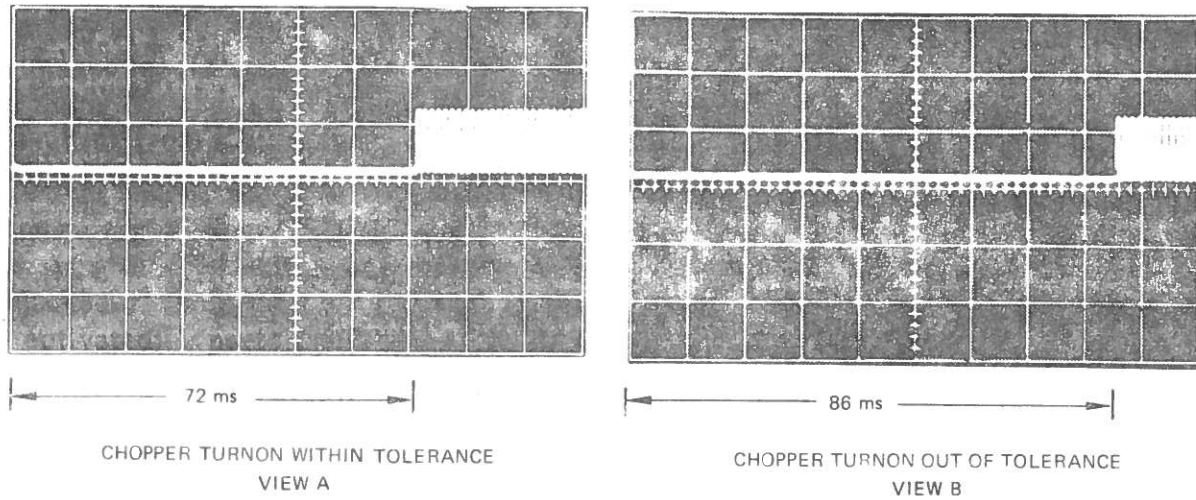


2. With disk pack installed on drive, using Off-Line Testor, access to track 000. Do not select head. Remove ground from 1824.
3. Connect jumper between 1820 (+ 12 volts) and 1818 (TP). Waveform should be positioned approximately 6 volts above center graticule, figure 6-22, view B).
4. Select head 0. Disk file must not display read/write unsafe condition.
5. Deselect head 0.
6. Connect jumper between 1802 (ground) and 1824. Waveform must return to 0-volt reference (figure 6-22, view A).
7. Remove jumper connected in step 6.
8. Remove end of jumper connected to 1820 (+ 12 volts) and connect to 1840 (-12 volts). Waveform should be positioned approximately 6 volts below center graticule (figure 6-22, view C).
10. Connect jumper between 1802 (ground) and 1824. Disk file must display a read/write unsafe condition.
11. Deselect head 0 and clear unsafe condition.

**NOTE:** The wiggler voltage may deviate from the voltage designated when tested for a positive or negative shift. This variation may be caused by insufficient stabilization time.

### 6.11.13 Chopper Operation Check

1. Set up oscilloscope for dual-trace chopped mode.
  - a. Connect channel 1 input to 2032 (position 2 signal).
  - b. Connect channel 2 input to 2454 (chopper signal).
  - c. Set CH1 VOLTS/DIV to 5, and position signal above horizontal centerline.
  - d. Set CH2 VOLTS/DIV to 2, and position signal below horizontal centerline.
  - e. Position TIME/DIV control to 10 ms/div.
  - f. Position MODE/TRIGGER controls to CHOP/CH1 ONLY.
  - g. Position A SWEEP MODE switch to NORM TRIG.
  - h. Place SLOPE to minus (-) and SOURCE to EXT.
  - i. Connect EXT TRIG INPUT to 1427 (-Linear Mode signal).
2. Using Off-Line Testor, perform 1-cylinder single seek, and observe that chopper turns on approximately 60-80 ms from start of linear mode. See figure 6-23.
3. Alter oscilloscope settings as follows:
  - a. Position B TRIGGERING SOURCE to INT.
  - b. Position MODE/TRIGGER controls to CH2/NORM.



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Figure 6-23. Chopper Signal Turnon

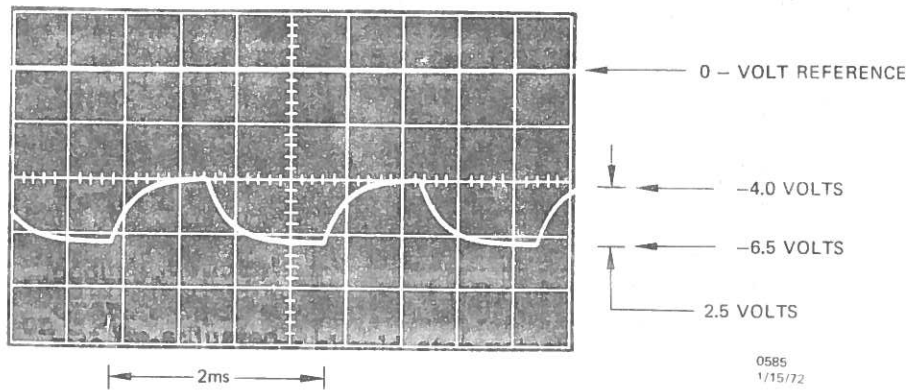


Figure 6-24. Chopper Signal

- c. Adjust zero-volt reference to coincide with first horizontal line below top of graticule.
  - d. Position TIME/DIV control to 0.5 ms.
4. Observe chopper signal trace. It should display an exponential waveform, approximately 500 Hz, with a peak-to-peak voltage range between -4.0 to -6.5 volts from zero-volt reference as shown in figure 6-24.

## 6.12 AGC SYMMETRY

1. Set up oscilloscope.
  - a. Connect scope channel 1 input to 2103 (40-Hz Wiggler Pulse).
  - b. Set TIME/DIV to 2.
  - c. Set CH1 VOLTS/DIV to 2.
  - d. Set A TRIGGERING SOURCE to INT.
  - e. Set A TRIGGERING SLOPE to +.
  - f. Set MODE TRIGGER to CH1.
  - g. Adjust A TRIGGERING LEVEL control to synchronize start of sweep on positive-going transition of 40 Hz Wiggler Pulse.
  - h. Adjust general operational and TIME/DIV controls to display exactly one cycle of 40-Hz Wiggler Pulse across scope graticule (10 divisions).
2. Observe negative-going transition of 40-Hz Wiggler Pulse. It should occur at 5 to 6 divisions after start of sweep. See figure 6-25.

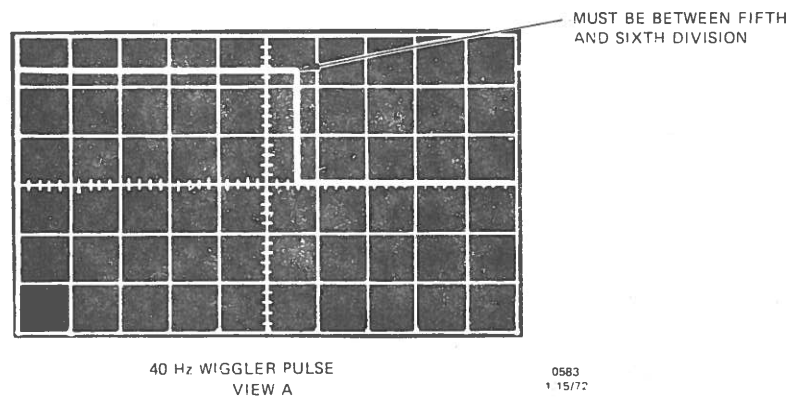


Figure 6-25. 40-Hz Wiggler Pulse

### 6.13 POWER SUPPLY VOLTAGE CHECK

DC voltages developed by the power supply must be within the required ranges. These voltages levels are to be checked as follows:

1. Place circuit breaker CB1 to ON (leave CB2 and CB3 OFF).
2. Place the START/STOP switch to STOP.
3. Verify that both exhaust fans start up but that the blower motor does not start up.
4. Check DC voltage levels on rear of electronic gate at points shown in Figure 2-6.

**NOTE:** All polarities shown are in reference to DC ground at points shown in Figure 2-6. These voltage values must be within the indicated ranges.

### 6.14 HEAD-LOAD FUNCTIONAL CHECK

The head-load functional check is performed during the power-on sequence to ensure that a file-ready operational status can be attained.

1. Install maintenance pack on drive and place CB1, CB2, and CB3 to ON.
2. Ensure that a jumper is installed from 1732 to 1702.
3. Place drive START/STOP switch to START. Look for following functions as drive cycles through power-on sequence:
  - a. Drive motor and blower motor start.
  - b. Brushes cycle into and out of pack.
  - c. Carriage moves forward to load heads then returns to cylinder 000.
  - d. FILE READY light should come on.
4. Perform this check for each unit being installed in subsystem.
5. Refer to chapter 7 for diagnostic procedures if an unsafe condition occurs.
6. Operate STOP switch to turn off crive and check operation of the dynamic brake. Pack should stop rotating within 20 seconds. Refer to chapter 7 troubleshooting charts for defective braking.

### DRIVE MOTOR-START INHIBIT CHECK

The drive motor start circuit is checked to ensure that the SSR switch operates to control start sequencing.

1. Install maintenance pack on drive and place CB1, CB2, and CB3 to ON.
2. Place the drive START/STOP switch to START. As the brushes enter the pack, place START/STOP switch to STOP to remove drive motor

- power and then return switch to START position.
3. Observe action of brush cycling. Power to drive motor should remain disabled until brushes return to stored position. Also, the drive motor should start automatically when stored position is reached causing another brush cycle to occur before loading heads.
  4. Place START/STOP switch to STOP after this check is completed.

### 6.15 POWER-ON, DRIVE RESTART, SEQUENCE CHECK

This check is accomplished with the drive on-line to determine that the drive can be stopped and restarted in a specific sequence with the other drives in the subsystem.

**NOTE:** In order to power-down the storage control unit which will interrupt the subsystem program, permission must first be obtained in order to avoid disrupting DP operations.

1. Verify that disk packs are installed on all drives in subsystem and place START/STOP switches to START so that all drive motors operate.
2. Power down control unit. This power off condition should disable the controlled ground line to the drives.

**NOTE:** If AC power to drives is obtained from control unit or an external source independent of the control unit, drive motors will stop when the control unit is powered down.

3. Check each drive to assure that heads are retracted from pack.
4. Check to see that drive START/STOP switch is in START position and verify that CB1 is on.
5. Restore power to control unit.

**NOTE:** All drive and blower motors should start up in sequence (one drive at a time) according to drive position on the signal cable. The first drive on the signal cable starts first. When its drive motor has reached 70% of pack speed, next drive should start until all drives in the subsystem operate at pack speed.

### 6.16 CARRIAGE CRASH TO FORWARD STOP CHECK

The disk drives are designed to withstand a maximum forward stop velocity of 30"/second. A malfunction termed Velocity Unsafe is required for this condition to exist. During the presence of this velocity unsafe condition, the carriage is decelerated through the power driver circuitry. The power driver is alerted from the velocity unsafe safety circuit. The velocity unsafe condition deactivates the servo system

circuits, activates the safety unload circuit and retracts the heads. The UNSAFE lamp will illuminate when the velocity unsafe is detected, and will extinguish when the heads have completed the retract operation.

The carriage is decelerated when velocity unsafe has been detected, to prevent movement of heads, glass, and/or damage to forward stop or other component parts. A variety of errors can cause a high velocity impact of up to 80"/second. In addition to damaged mechanical parts and broken glass, the carriage assembly may be moved out of alignment. In many instances, however, there is no visible indication of damage resulting from a high-speed carriage crash. If it is suspected that a high-speed carriage crash has occurred, perform the following checks:

1. Visually inspect primary grating glass for breakage, especially around mounting screw holes.
2. Inspect heads, torsion rods, forward stop switch, and other movable parts for damage.

**NOTE:** If head damage is found or if heads were loaded against a nonrotating disk, the disk surface must also be inspected for damage (refer to Chapter 5 for HDI damage information).

**NOTE:** Before proceeding to step 3, reinstall any components or assemblies removed to perform the inspection.

3. Install maintenance pack and perform several random seeks to check-out servo circuits, etc.
4. Remove maintenance pack; install CE pack and perform recalibration.
5. Verify by cylinder indicator scale that carriage is at zero. Record cylinder indicator scale reading. Do not readjust.
6. Seek to cylinder 146 and record cylinder indicator scale reading.
7. Observe head alignment signal of each head. Refer to 6.7 for head alignment setup.
  - a. Check to see if scale reads proper cylinder and heads are aligned.
  - b. If scale reads off cylinder but heads are aligned, then scale has moved and should be adjusted. Refer to 6.6 for Cylinder Indicator Adjustment.
  - c. If heads are not exactly aligned, then scale has moved and should be adjusted.
  - d. If scale reads proper cylinder but heads are all out of alignment, i.e., if heads are positioned in the vicinity of three cylinders beyond cylinder 146, seek to cylinders lower than 146 to recover signal. It is probable that complete carriage assembly has moved forward due to impact. If impact has caused carriage assembly movement, perform following steps:

- 1) Check for gap between the face of EMA and the end of carriage

rail. It should be zero. If a gap exists up to 0.003 inch, realign heads.

2) If gap is greater than 0.003 inch, major adjustments are required as follows:

- a) Power down drive.
- b) Remove EMA.
- c) Perform carriage alignment (refer to Carriage Alignment Procedure US002329-1).
- d) Check Primary glass grating.
- e) Reinstall EMA.
- f) Power on.
- g) Seek to cylinder 146.
- h) Align heads.

e. If scale does not read proper cylinder and heads are not properly aligned, a series of different problems could cause the condition.

- 1) Perform steps 1 and 2 of paragraph d if carriage and cylinder indicator scale have moved.
- 2) If carriage has not moved, it is possible that the primary glass grating has moved, forward stop has been moved or damaged, or forward stop pin is damaged.
- 3) Moved gratings: All heads will be approximately in line with one another but off-cylinder. Perform velocity safety, primary grating adjustments.
- 4) Moved or damaged forward stop or forward stop pin: head alignment will appear to be off by whole cylinders. Visually inspect forward stop and pin for damage. If damage is found, grating is properly adjusted, head alignment may be performed. Torsion rod must contact the "load button" on the head arm and must not touch the head capsule.

# CHAPTER 7 ERROR ANALYSIS

## 7.1 TYPES OF DIAGNOSTICS

### 7.1.1 On-Line System Diagnostics

On-line checkout is accomplished with the drive connected in the system. Previous or current computing operations must be completed or cleared up prior to application of the system on-line checkout.

### 7.1.2 Off-Line Service Operations

#### CAUTION

Do not operate CB1 to remove or restore power to the drive when in a system with the CPU running. This causes equipment checks which could disrupt the program. The CPU must be stopped whenever CB1 is operated.

Off-line operations are used to diagnose drive malfunctions when errors cannot be detected by the on-line system diagnostics.

Off-line checkout of drive operations is accomplished by powering down the failing drive, shutting down the CPU so that CB1 can be opened to remove power, and connecting the Off-Line Testor to the drive. After CB1 is closed and CPU power is restored, the drive can be powered on so all drive functions are controlled by switches on the Off-Line Testor. Refer to Chapter 6 for the off-line checks.

### 7.1.3 Connecting Off-Line Testor to On-Line Drive

Use the following procedure to connect the Off-Line Testor to an on-line 715DEC Drive:

1. Shut down drive by placing START/STOP switch to STOP and ENABLE/DISABLE switch to DISABLE.
2. Obtain permission to disrupt DP operations and press the STOP switch on CPU.
3. Place CB1 on drive to OFF.
4. Remove SIGNAL IN, SIGNAL OUT, and DC cables from drive.
5. Connect SIGNAL IN and DC cables from Off-Line Testor to drive and install indicator board in Socket 10 of the drive.
6. Place CB1 on drive to ON.
7. Press START switch on CPU to restore system operations.
8. Place START/STOP switch of drive to START.
9. Perform required exercises on drive with Off-Line Testor.



## 7.2 REMOVING AND INSTALLING DRIVE IN SYSTEM

### 7.2.1 Disconnecting Drive From System

The following procedures are used for disconnecting and removing a drive from the system.

1. Follow customer's system shut-down procedure to power-down the system.
2. Shut down drive by placing START/STOP switch to STOP and ENABLE/DISABLE switch to DISABLE.
3. Place CB1 on drive to OFF.
4. Remove SIGNAL IN and SIGNAL OUT cables from drive and connect together.
5. Remove AC IN and AC OUT cables from drive and connect together.
6. Remove DC IN cable.
7. Restore system power.

**NOTE:** If drive to be removed is last in line, proceed as follows and omit steps 4, 5, and 6.

- a. Remove terminator and connect to SIGNAL OUT connector of preceding drive.
  - b. Disconnect AC IN cable.
  - c. Disconnect DC IN cable.
  - d. Proceed to step 8.
8. Turn on remaining drives, as appropriate, and return to normal DP operation.

### 7.2.2 Connecting Drive In System

Connect the drive in system according to instructions in Chapter 2, Installation.

## 7.3 POWER SUPPLY VOLTAGE AND FUNCTIONAL CHECKS

Refer to Chapter 2, Installation, for detailed procedures for checking power supply voltages and for functional checks.

## 7.4 UNSAFE ERROR ANALYSIS

### 7.4.1 Unsafe Condition

The unsafe condition occurs at the drive. It may cause the heads to retract off the pack. An unsafe condition associated with reading or writing will not retract the heads from the pack. The UNSAFE indicator illuminates to inform the operator of an unsafe condition.

Operation of the START/STOP switch to turn off the drive and then restart it resets all latches to turn off the indicator. The unsafe condition returns if the circumstances which initially caused the failure are still present in the system or at the drive.

Most failures at the drive can be isolated to a particular circuit malfunction by use of system procedures. If the failure originates at the CPU or from the control unit interface, the problem must be corrected within these areas to reinstate drive operations.

The C. E. UNSAFE RESET switch is a microswitch located on the outer corner of the electronic gate. It is mounted on the L-shaped bracket with the drive ground strap terminal connection. When activated, the C. E. UNSAFE RESET switch enables the service engineer to clear an unsafe condition without operating the START/STOP switch, powering down, head loading, and brush cycling. This switch is wired to PWA 75004484-X, Socket 8, Pin 09. If the heads are off pack, the START/STOP switch must be activated.

**NOTE:** The C. E. UNSAFE RESET switch shall be activated ONLY when the machine is serviced for clearing a select lock condition and not as a convenient operator junction.

#### 7.4.2 Drive Failures Detected by Safety Circuits

The presence of an unsafe condition within the drive is detected by the File Status PWA (socket 12). Unsafe detection occurs at an OR gate circuit which activates the UNSAFE lamp and sends Selected File Unsafe signal to the control unit via the file status lines. Table 7-1 describes the types of drive failure which produce a file unsafe condition to illuminate the UNSAFE indicator.

Table 7-1. Drive Safety Circuits

*UNSAFE CONDITION (LINE NAME)	HEADS UNLOAD	LAMP REMAINS LIT	SIGNAL ORIGIN (SOCKET AND PIN)
-30VDC Unsafe	Yes	No	DC level detector on Access Control, 1403
-Velocity Unsafe	Yes	No	FL on Temp Comp, 1829
-AC Write Unsafe	No	Yes	FL on Write, 0435
-DC Write Unsafe	No	Yes	FL on Write, 0445
-Heads Unsafe	No	Yes	FL on 0-9 Select, 0247
-Pack Speed Unsafe	Yes	No	FL on Index Transducer, 1739
-Every Unsafe Except R/W	Yes	No	Gated Output on Temp Comp, 1841
*0V=Unsafe Condition Level, +3V=Safe Condition Level			

### 7.4.3 Unsafe Diagnostic

If the drive is powered down by the START/STOP switch (and not restarted), the set condition of all latches and lines remains active at the logic state which created the unsafe condition.

**NOTE:** Do not destroy this logic state by restarting the drive or removing AC power; otherwise, additional time will be required to recreate the unsafe condition.

If the unsafe condition was caused by a read/write failure, it is best to obtain information from the customer regarding the type of instruction that was being executed at the drive when the failure occurred. Using this information, recreate the failure conditions by running an on-line system diagnostics test.

An overall diagnostic procedure flowchart for isolating an unsafe condition is given in Figure 7-1.

## 7.5 TROUBLESHOOTING CHARTS

### 7.5.1 Description

Troubleshooting procedures are presented in the form of a flowchart for the unsafe condition error analysis, and in the form of tables that list discrepancies and probable causes for various accessing and on-line operations.

### 7.5.2 Power-On to Drive Forward 5"/Second

Table 7-2 describes various discrepancies that may occur during the power-on sequence preceding either a head load or carriage movement. Exhaust fans, blower motors, brush cycling, pack speed, and motor speed are checked during this time.

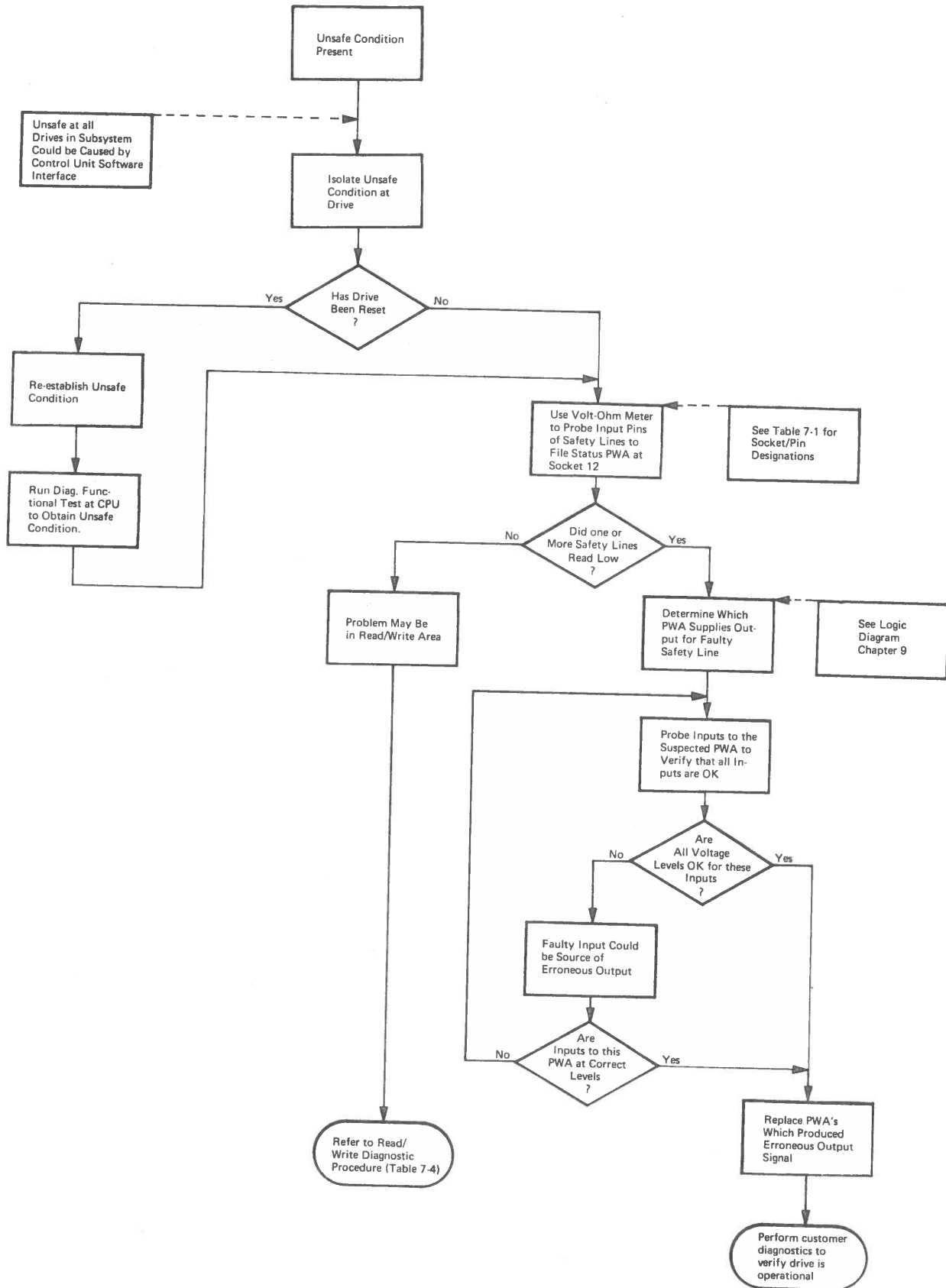


Figure 7-1. Unsafe Error Analysis

Table 7-2. Power On to Drive Forward 5"/Second

DISCREPANCY	PROBABLE CAUSE
<p>CB1 is on but neither fan motor operates.</p>	<p>No output power from 208 or 230 VAC supply.</p>
<p>CB1 is on but no hold reverse is present on EMA. When discrepancy is resolved, carriage can be pushed forward until the heads extended switch is open. At this time, the Drive Reverse 5"/Sec should be active.</p> <p><b>NOTE:</b> Hold reverse current is not present unless pack is installed.</p>	<ol style="list-style-type: none"> <li>1. CB3 is turned off.</li> <li>2. Card is removed from a socket and summing and pulser does not have activate servo line true at 2427.</li> <li>3. Summing and pulser card is defective. Reverse drive or pulsed reverse is not operating.</li> <li>4. Gated position on 2511 and 2512 does not have 1.3V differential offset in hold reverse mode. Replace cylinder selector card.</li> <li>5. Check DC power supply voltages. (See Chapter 2 for ranges.)</li> <li>6. Power driver defective or open coil on EMA.</li> </ol>
<p>START/STOP switch set to START but no brush cycle or drive motor and blower motor start.</p>	<ol style="list-style-type: none"> <li>1. Fuse 1 or fuse 3 is blown.</li> <li>2. Index block switch not closing.</li> <li>3. No pick start from preceding drive.</li> <li>4. EMA is in hold reverse by heads extended switch is not closed.</li> <li>5. Covers open switch or interlock load switch is open.</li> <li>6. Power control card in socket 27 is defective.</li> <li>7. SSR is leaky and causes Triac On 2717 to be true.</li> <li>8. Defective pack in-place switch.</li> </ol>
<p>START/STOP switch set to START and drive motor and blower motor turn on but no brush cycle occurs.</p>	<ol style="list-style-type: none"> <li>1. Brush motor or connector to motor is defective.</li> <li>2. Reed 3 switch is defective or diode across it is shorted.</li> <li>3. Power control card is defective.</li> <li>4. Check inputs to power control card, socket 27.</li> </ol>

Table 7-2. Power On to Drive Forward 5"/Second (continued)

DISCREPANCY	PROBABLE CAUSE
<p>START/STOP switch is positioned to START and brush cycle is good but drive motor and blower motor will not start.</p> <p><b>NOTE:</b> A leaky SSR will cause Triac On 2717 to be true with the START/STOP switch off.</p>	<ol style="list-style-type: none"> <li>1. Defective SSR or diode across SSR.</li> <li>2. Defective power control card, socket 27.</li> <li>3. Check inputs to power control card, socket 27.</li> </ol>
<p>Brush motor continues to cycle, drive motor and blower motor run but no head load occurs.</p>	<ol style="list-style-type: none"> <li>1. No Pack at Speed signal</li> <li>2. Index transducer or index transducer card, socket 17, is defective.</li> <li>3. No Controlled Ground signal at 2703.</li> </ol>
<p>Brush motor cycles and drive motor starts but does not continue to run. If START switch is left on, drive starts again but fails in same manner.</p> <p><b>NOTE:</b> If motor thermal switch is the problem, wait 5 minutes before restarting drive. This should allow the motor thermal switch to close and operate drive motor when START switch is activated.</p>	<ol style="list-style-type: none"> <li>1. Thermal switch inside drive motor has opened due to turning device on and off too many times within a short period. Test by positioning START/STOP switch to STOP and if drive motor brake does not operate, thermal switch is open.</li> <li>2. Defective DC power supply.</li> </ol> <p><b>NOTE:</b> Observe that EMA tries to head load by moving out approximately 1/4" and then goes to a retract mode. Also, a power-on reset occurs on pin 15. This condition turns drive motor off and starts brush cycle. When brush completes and motor has restarted, operation is repeated.</p>
<p>Drive motor does not come up to speed. No load occurs and index pulses are greater than 25 milliseconds apart. Multiple brush cycles occur.</p>	<ol style="list-style-type: none"> <li>1. SSR is defective.</li> <li>2. Spindle is binding.</li> <li>3. Belt is slipping because of broken spring on motor mount or broken motor mount belt.</li> <li>4. Motor pulley is worn.</li> </ol>

Table 7-2. Power On to Drive Forward 5"/Second (continued)

DISCREPANCY	PROBABLE CAUSE
Drive motor has been off for a long period, but when drive motor is turned on, thermal switch in the motor turns on.	<ol style="list-style-type: none"> <li>1. Brake did not turn off 20 seconds after pack stopped and caused motor to heat up. Check Pack Stopped line, 2705, or power control card in socket 27 is defective.</li> </ol>
Brake does not operate - takes longer than 20 seconds to stop pack.	<ol style="list-style-type: none"> <li>1. F2 is defective.</li> <li>2. Power control card, socket 27, is defective.</li> <li>3. Reed 2, or diode across reed 2 is shorted.</li> <li>4. SCR in DC supply to motor windings is not operating.</li> <li>5. Thermal switch is open.</li> </ol>

**7.5.3 Drive Forward 5"/Second to Access Ready**

Table 7-3 lists the possible discrepancies and probable causes during the time of carriage movement. Also, the servo system and safety circuits are checked during this time.

Table 7-3. Drive Forward 5"/Second to Access Ready

DISCREPANCY	PROBABLE CAUSE
Brush cycle complete, ready for load. Drive motor appears to be at speed but no head load. CB2 and CB3 are on.	<ol style="list-style-type: none"> <li>1. No Pack at Speed signal from index transducer card. Brush cycle does not stop.</li> <li>2. No sequence start pulse from power control card.</li> <li>3. Access control card is defective. File will not come out of hold reverse mode.</li> <li>4. Curve generator card will not generate Drive Forward 5"/Second.</li> <li>5. Activate servo line at 2427 is not true.</li> </ol>

Table 7-3. Drive Forward 5"/Second to Access Ready (continued)

DISCREPANCY	PROBABLE CAUSE
	<ol style="list-style-type: none"> <li>6. With Drive Forward 5"/Second into summing amplifier, 2452 and 2455 should be offset differentially by 12V. Forward Drive and Pulsed Forward should be operating. If above is not true, change pulser summing and summing and pulser in socket 24.</li> <li>7. If summing and pulser card is good but drive does not head load, power control or EMA is not operating.</li> </ol>
<p>On head load drive moves forward but slowly and has a low-frequency growl from EMA. Drive may also have two or three recalibrates before reaching access ready.</p>	<ol style="list-style-type: none"> <li>1. No "Use Fast AGC" output signal from access control card, socket 14.</li> <li>2. AGC card in socket 21 is defective.</li> </ol>
<p>Drive has many recalibrates after a head load and then reaches access ready, but this occurs only after a pack change.</p>	<ol style="list-style-type: none"> <li>1. Balancer on cylinder detector card is defective.</li> <li>2. Access control card which controls the sample time of the balancer is not operating correctly.</li> <li>3. Balancer output at 2047 should be approximately +3V. This voltage can change only at Access Ready, Motion Stopped, or Retracted Mode time. The voltage cannot change during access time.</li> </ol> <p><b>NOTE:</b> You may perform balancer check, see Chapter 6.</p> <ol style="list-style-type: none"> <li>4. Summing and pulser card may have DC offset on one of its inputs. <ol style="list-style-type: none"> <li>a) When drive stops recalibrating, measure output of summing amplifier at 2452 and 2455 differentially. Output should be zero volts.</li> </ol> </li> </ol>



Table 7-3. Drive Forward 5"/Second to Access Ready (continued)

DISCREPANCY	PROBABLE CAUSE
	<p>b) Measure "Gated Position" signal on cylinder select card at 2511 and 2512 differentially. This signal should be swinging plus and minus approximately 1 volt around zero volts, differentially. This is achieved by grounding 1824.</p> <p><b>NOTE:</b> This voltage will be zero volts differential after a pack change and temperature compensation into summing amplifier goes zero volts. If position voltage will not swing about zero volts differentially, then some other input voltage to the summing amplifier is present which has an offset for which position voltage is compensating.</p> <p>5. Check for offset with drive stopped at any track. Measure following voltages differentially and check for DC offset at socket 24:</p> <p>a) Pins 39 and 33 Temp Comp Offset.  b) Pins 43 and 35 Shaper Output.  c) Pin 41 Wiggler.  d) Pins 49 and 42 Tach Output.  e) Check that pins 43, 53, and 38 are at +5 vdc.</p> <p>Replace any card which feeds summing amplifier that has any offset when reading steps a, b, c, d, or e.</p> <p>6. Shorted thermistor.</p>
<p>Velocity unsafe while making a head load. Drive appeared to go to the forward stop but heads retracted from the pack and indicated a velocity unsafe condition,</p>	<p>1. Curve generator card in socket 15 could be defective.  2. Temperature comp and safety card is defective in socket 18.</p>

Table 7-3. Drive Forward 5"/Second to Access Ready (continued)

DISCREPANCY	PROBABLE CAUSE
	<ol style="list-style-type: none"> <li>3. No tach output from the tachometer card in socket 23.</li> <li>4. Low position signal due to defective AGC card in socket 21.</li> <li>5. Glass grating is not aligned properly.</li> <li>6. Access time adjustment is not correct and curve generator pot is turned to far CCW.</li> <li>7. Access control card is defective.</li> <li>8. Summing and pulser card in socket 24 loses drive to power driver.</li> <li>9. Position transducer is defective.</li> </ol>
<p>Drive goes to forward stop, bounces back approximately one inch, then oscillates into the forward stop at a low frequency or it may not oscillate but remain stationary near forward stop.</p>	<ol style="list-style-type: none"> <li>1. Reverse current circuit breaker CB3 is open.</li> <li>2. Reverse drive from summing and pulser card in socket 24 is defective but CB2 and CB3 do not open.</li> <li>3. Power driver is defective and will not supply reverse current.</li> <li>4. Curve generator card in socket 15 is defective. "Go Reverse" or "Shaper Output" signal is not present.</li> <li>5. Access control card in socket 14 is defective.</li> <li>6. Forward stop switch is not operating.</li> <li>7. Difference counter is not counting.</li> </ol>
<p>Carriage moves forward and CB2 opens (forward current). Carriage hits the forward stop when the velocity is not high.</p>	<ol style="list-style-type: none"> <li>1. Difference counter in socket 13 is not operating.</li> <li>2. Even cylinder or odd-cylinder signals are not present on cylinder detector, socket 20.</li> <li>3. AGC card is defective, socket 21.</li> <li>4. Carriage retract switch does not open during a head load.</li> <li>5. Cylinder address register in socket 9 is defective.</li> <li>6. Bus lines to head address register are true.</li> </ol>

Table 7-3. Drive Forward 5"/Second to Access Ready (continued)

DISCREPANCY	PROBABLE CAUSE
<p>Drive does not recalibrate to track 000 on a head or recalibrate. It goes to tracks 001, 002, or 003. Perform "Carriage Crash to Forward Stop" check, found in Chapter 6</p>	<ol style="list-style-type: none"> <li>1. Glass grating is not properly aligned; check glass alignment.</li> <li>2. Glass is loose or crash stop is moving or ruptured.</li> <li>3. Difference counter is not reset to 407 on a head load.</li> </ol>
<p>Drive head load but no access ready. (File Ready lamp not lit.)</p>	<ol style="list-style-type: none"> <li>1. Access Control card in socket 14 is defective or one of its inputs to access ready is not true.</li> <li>2. File status card is defective in socket 12.</li> <li>3. Seek incomplete is true on file status card.</li> <li>4. Difference counter in socket 13 is defective.</li> <li>5. Cylinder detector card in socket 20 is defective.</li> <li>6. AGC card in socket 21 is defective.</li> </ol>

#### 7.5.4 Head-Load Complete and Drive On-Line

Table 7-4 lists possible problems and probable causes which may occur while drive is on-line.

Table 7-4. Head Load Complete and Drive On Line

DISCREPANCY	PROBABLE CAUSE
<p>UNSAFE indicator illuminates and heads do not pull off pack.</p> <p>Above condition can be caused by any of the following:</p> <ol style="list-style-type: none"> <li>1. Servo problem</li> <li>2. Write problem</li> <li>3. Head select problem</li> <li>4. CPU or control unit (see paragraph 7.4.1)</li> </ol>	<ol style="list-style-type: none"> <li>1. Servo Problem                     <p>When drive receives heads unsafe condition and heads are still on pack, check "R/W Ready" signal on socket 14, pin 26. This signal results from minus cylinder and access ready condition. With these lines active and head selected, heads unsafe occurs. This is servo problem which was caused by movement of heads after head was selected. Perform servo check procedures given in Chapter 6. The most important servo checks are (1) Amplitude Check of Ringing Between Seeks where the overshoot during a 1-cylinder seek between cylinder 404 and 405 must never exceed 2.0 volts, and the ringing must be less than <math>\pm 0.5</math> volt from zero-volt reference and (2) Cylinder Width Check as heads leave cylinders to determine what position cylinder is lost due to position change of the heads. The following card(s) may be defective:</p> <ol style="list-style-type: none"> <li>a) Curve generator, PWA 15.</li> <li>b) AGC, PWA 21.</li> <li>c) Access control, PWA 14.</li> <li>d) Pulser and summing amplifier, PWA 24.</li> <li>e) Cylinder select, PWA 25.</li> </ol> </li> <li>2. Write Problem                     <p>Check the AC Write Unsafe and DC Write Unsafe signals at pins 35 and 45 of socket 4. If either signal is active, socket 4 is defective.</p> </li> <li>3. Head Select Problem                     <p>Check the Heads Unsafe signal at pin 47 of socket 2. If the signal is active, either socket 2 or socket 3 is defective.</p> </li> </ol>



## CHAPTER 8

### REPLACEMENT PROCEDURES

#### 8.1 INTRODUCTION

The removal and installation procedures that follow pertain to items most likely to be removed and replaced, and those items which are either difficult or critical to remove and replace. Location illustrations are presented at the end of this chapter.

Procedures are presented early in this chapter for service covers and certain other components that must be removed before other items. In no case is a general statement made to remove an item unless the detailed removal procedure has already been presented.

#### 8.2 SERVICE COVERS

Six removable service covers afford access for drive maintenance. Also, a small control panel cover, located on the upper front panel, must be removed to replace indicator holders (not indicators) and operating switches.

##### 8.2.1 Front, Upper Rear, and Lower Covers

###### REMOVAL

To remove covers, grasp upper edge and pull cover away from frame, lifting to disengage cover hangers from lower supports on frame.

###### INSTALLATION

Engage cover hangers in frame supports and push cover to engage friction latches.

##### 8.2.2 Right and Left-Hand Side Covers

The right- and left-hand covers are interchangeable. Either cover is removed and installed as follows:

###### REMOVAL

1. Remove front and lower rear covers.
2. Remove two screws that fasten side cover to drive frame near upper corners of cover.
3. Lift cover and pull away from frame.

###### INSTALLATION

1. Engage cover hangers in frame support and hold cover in place.
2. Fasten cover to drive frame with two screws.

### 8.2.3 Top Cover Assembly

The top cover assembly comprises both the operator and the service cover. When the top cover assembly is in place on the disk drive, it engages a switch that is interlocked with the START/STOP switch. The interlock switch must be overridden to operate the drive if the top cover assembly is removed.

#### REMOVAL

1. Remove upper rear cover.
2. Push rear retaining clamps on top cover assembly forward to release mounting studs.
3. Lift top cover assembly from rear to free it from studs.
4. Slide top cover assembly forward to separate it from apron flange at front of frame, and lift top cover assembly off frame.

#### INSTALLATION

1. Position top cover assembly so its front engages flange on upper front of drive frame.
2. Grasp rear of top cover assembly and slide it backwards to align its mounting holes above mounting studs at rear of drive frame.
3. Inspect lower front edge of cover to make sure that apron flange is seated properly inside of top cover assembly.
4. Push rear retaining clamps on the top cover assembly to the rear to engage mounting studs.

### 8.2.4 Operator Control Panel Cover (Figure 8-1)

The operator control panel cover is fastened to the upper front panel of the disk drive by adhesive tape around the inner periphery of the cover. To remove the cover, gently insert a screwdriver between the middle of right-hand edge of cover and panel and pry off cover. Be careful not to disfigure the panel or cover.

To install cover, position cover with left-hand edges of cover and panel recess exactly aligned. Push cover against panel recess and push all around cover periphery with thumb.

### 8.3 FILTERS

Three replaceable filters are used in the air circulating system: two foam filters (exterior and interior) trap the larger airborne particles, and an absolute filter traps the smaller airborne particles.

Do not attempt to clean and reuse these filters. They are not reclaimable and must be discarded after use. These filters are replaced as part of the preventive maintenance schedule of Table 5-1. These filters should also be replaced between schedule dates if they become dirty and excessively limit air flow.

The time between replacements of the absolute filter is dependent upon the environmental conditions (dust level) in which the equipment is operated.

### **8.3.1 Exterior Foam Filter (Figure 8-2)**

The exterior foam filter is located behind the lower rear cover in the inlet air duct.

#### **REMOVAL AND INSTALLATION**

1. Remove lower rear cover.
2. Locate and remove old filter by pulling it from duct opening. Discard old filter.
3. Install new filter by positioning it in recess at duct opening.
4. Replace lower rear cover.

### **8.3.2 Interior Foam Filter (Figure 8-5)**

The interior foam filter is located directly behind the operator control panel.

#### **REMOVAL AND INSTALLATION**

1. Raise top service cover.
2. Locate and remove interior prefilter by grasping plunger fastener knobs on filter retaining frame and pulling upward.
3. Remove old filter and discard.
4. Position new filter in filter retaining frame, making sure that fastener plungers are pulled out. Then push in plungers to secure frame.
5. Close service cover.

### **8.3.3 Absolute Filter**

#### **REMOVAL**

1. Place CB1 to OFF.
2. Remove front cover.
3. Disconnect blower power cable at quick-disconnect.
4. Loosen hose clamp that secures blower exit duct to blower plenum assembly and slide off duct.
5. While supporting blower by hand, remove filter locking rod that holds top of blower plenum to top of inlet filter duct.
6. Lift blower plenum assembly up and away from absolute filter, disengaging plenum ears from slots in bottom flange of air system support plate.
7. Pull absolute filter straight out from air inlet duct.
8. Discard used absolute filter.



## INSTALLATION

**NOTE:** Observe direction on side of new filter. Filter must be installed so arrow points toward blower and is at top or visible side of absolute filter.

1. Place absolute filter on flange of air system support plate and push against air inlet duct to expose slots in flange.
2. Engage blower plenum ears in flange slots and, pushing against blower, hold plenum against absolute filter.
3. Replace filter locking rod, fastening blower plenum to inlet filter duct.
4. Attach blower and tighten clamp.
5. Connect blower power cable at quick-disconnect.
6. Replace front cover.

## 8.4 INDICATOR LAMPS

Indicator lamps are located on the operator control panel (figures 8-2 and 8-4) and may be removed or replaced from inside the service cover. Lamp failures do not affect disk drive operations and, therefore, are replaced only after failure.

### REMOVAL AND INSTALLATION

1. Open service cover.
2. Locate indicator lamp to be replaced.
3. Pull out lamp and discard.
4. Push in new lamp.
5. Close service cover.

## 8.5 PRINTED WIRING ASSEMBLIES (PWA's)

Table 9-3 identifies the gate position, part number, and name for PWA's installed in the electronic gate.

### **CAUTION**

Always remove DC voltage by opening CB1 before removing or inserting PWA.

A PWA is individually packaged in a plastic bag and thus, is separated from other PWA's for protection from shock, moisture, and dust. Avoid dropping or stacking PWA's and unnecessary handling when the protective wrapping is removed.

## 8.5.1 PWA Replacement Procedure

### REMOVAL

PWA Extractor (ISS Part No. 88001154-1) is used for removing PWA's

1. Place START/STOP switch to STOP.
2. Remove lower rear cover and place CB1 to OFF.
3. Open electronic gate (figure 8-2) to gain access to PWA and slide PWA retaining latch to expose full edge of PWA for removal.
4. Attach prongs in PWA extractor tool to pull holes in PWA.
5. Remove PWA from gate by squeezing handle of tool, and moving the tool in a slight up-and-down motion to free the contact pins from sockets.

### CAUTION

Each PWA board is keyed (slotted) to fit into its location in electronic gate. A corresponding key is located at back of electronic gate socket. Occasionally a key sticks to PWA board when board is extracted. Watch for this condition, and, as appropriate, immediately replace key in back of socket to prevent inadvertently inserting wrong PWA in socket.

### INSTALLATION

1. Be sure that PWA selected has correct part number for particular gate location.

### CAUTION

Always check PWA socket in electronic gate for proper keying with PWA board to be inserted.

2. Insert PWA in gate and plug into receptacle. Make sure all contacts mate with their respective sockets; then push until PWA is aligned with other PWA's in gate.
3. Slide PWA retaining latch to lock position.
4. Close electronic gate.

## 8.5.2 Repair of Damaged PWA Socket Pins

1. Carefully remove wire wraps from affected pin.

**NOTE:** Longnose pliers may be used with extreme care, but pin removal tool, available from Winchester Manufacturing Company, is preferred for pin removal and installation.

2. Twist pin one-quarter turn (clockwise for odd-numbered pin, counterclockwise for even-numbered pin).
3. Push pin out of connector and remove from PWA side.
4. Install new pin from PWA side. Ensure that contact has seated properly.
5. Using the pin removal tool (or pliers), twist pin one-quarter turn (counterclockwise for odd-numbered pin, clockwise for even-numbered pin). Twist must occur at the point where pin enters connector block.
6. Reinstall wires to pin using wire-wrap tool.

## 8.6 FUSES

There are four fuses, F1, F2, F4, and F5, located on the sequence panel (figure 2-5) and one fuse, F3, on the power supply (figure 8-1). Any of these is readily replaced by unscrewing fuse holder, discarding used fuse, inserting new fuse in holder, and screwing holder back onto either sequence panel or power supply, as appropriate.

## 8.7 EMA AIR DUCT (Figure 8-2)

### REMOVAL

1. Remove top cover assembly and upper rear cover.
2. Remove screw fastening duct to EMA cover.
3. Loosen two screws fastening duct to air deflector support.
4. Lift off duct.

### INSTALLATION

1. Slide duct onto air deflector support.
2. Fasten EMA air duct with one screw to EMA cover and tighten two screws in air deflector support.
3. Replace upper rear cover and top cover assembly.

## 8.8 EMA COVER (Figure 8-1)

### CAUTION

Do not allow steel cover plate to be pulled against magnet during removal or installation of cover.

#### REMOVAL

1. Remove EMA air duct.
2. Remove two screws that fasten EMA cover to EMA frame: rear screw and middle front screw.
3. Lift cover straight up, being careful that cover does not bind in EMA cover guide.

#### INSTALLATION

Install EMA cover by reversing removal procedure.

## 8.9 AIR DEFLECTOR ASSEMBLY (Figure 8-2)

#### REMOVAL

1. Remove top cover assembly and upper rear cover.
2. Remove two screws fastening air deflector to brush drive assembly.
3. Loosen (do not remove) two screws fastening air deflector to its support bracket.
4. Slide air deflector, disengaging it from its support bracket, and lift out of disk drive.

**NOTE:** Index push rod is part of air deflector assembly and may be replaced by ensuing steps.

5. Remove screw at bottom of index push rod.
6. Pull rod upward and slide spring off rod.

#### INSTALLATION

Install index push rod and air deflector assembly by reversing removal procedure, but before replacing screw in index push rod, apply one drop of Loctite Sealant (#44001292-6) to screw threads.

## 8.10 USAGE METER

Usage meter is optional equipment.

There are two versions of support for the usage meter. One version attaches directly to the shroud, whereas the other version attaches to the shroud and has two spacers positioned between the usage meter flange and the shroud. In either case, the usage meter is supported by a bracket affixed to the baseplate.

#### REMOVAL

1. Place CB1 to OFF.
2. If usage meter is to be completely removed from disk drive, unsolder wires connecting to usage meter printed wiring board. However, if usage meter assembly is only being removed from shroud and baseplate, omit this step.
3. Remove two screws, spacers (as applicable), lockwashers, and nuts that fasten usage meter to shroud.
4. Remove one screw and lockwasher that fasten usage meter bracket to baseplate, if required.

#### INSTALLATION

Install usage meter by reversing removal procedure.

### 8.11 SHROUD (Figure 8-1)

#### REMOVAL

1. Turn off disk drive and wait until disk pack stops rotating.
2. Open operator cover and remove disk pack.
3. Remove top cover assembly.
4. Remove usage meter (if one is supplied with disk drive).
5. Remove four screws from top surface of bottom shroud. These screws fasten the shroud to standoffs that are screwed into the baseplate. The standoffs may also be removed.

#### INSTALLATION

Install shroud by reversing removal procedure.

### 8.12 CARRIAGE RETRACT SWITCH (Figure 8-5)

The carriage retract switch is located on the baseplate adjacent to the front of the electromagnetic actuator (EMA) cover, on the same side of the carriage rail as the EMA cover guide.

#### REMOVAL

1. Place CB1 to OFF.
2. Open service cover and operator cover.

3. Remove disk pack.

### CAUTION

Be careful when moving carriage in following procedure to keep read/write head sufficiently retracted so head cams always support head assembly.

4. Move carriage forward just enough to provide easy access to carriage retract switch.
5. Unclip three wires clipped to terminals on carriage retract switch.
6. Remove two screws that fasten switch to mounting plate and lift off switch.

## INSTALLATION

Install the carriage retract switch by reversing the removal procedure. However, after installation and before tightening switch screws, turning on CB1, and operating the disk drive, adjust carriage retract switch per 6.5.

### 8.13 DISK BRUSHES (Figure 8-5)

Figure 5-1 shows a satisfactory and an unsatisfactory brush condition. Brushes must be replaced when it is observed that they do not compress upon entering the disk pack.

#### REMOVAL AND INSTALLATION

1. Turn off disk drive and wait until disk stops rotating.
2. Open operator cover and remove disk pack.
3. Remove top cover assembly.
4. Loosen socket-head setscrew in brush retainer arm and pull out brush.
5. Insert new brush, align for proper brush action, and tighten setscrew. The shoulder of brush assembly must be flush against arm mount.

### 8.14 BRUSH DRIVE AND COMPONENTS

#### 8.14.1 Brush Drive Assembly

##### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly and air deflector.
3. Unplug brush drive motor cable.

4. Unclip three wires connected to the terminals on brush drive switch (snap action).
5. Remove three screws fastening brush drive assembly to baseplate.

#### INSTALLATION

Install brush drive assembly by reversing removal procedure.

#### 8.14.2 Brush Retract Switch

##### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly and air deflector.
3. Unclip three wires connected to terminals on brush drive switch.
4. Remove two screws threaded into nut plate below bracket and lift out switch.

##### INSTALLATION

1. Install brush retract switch by reversing the removal procedure.
2. Adjust brush retract switch according to paragraph 6.4.

#### 8.14.3 Brush Drive Motor

##### REMOVAL

1. Remove brush drive assembly.
2. Remove two nylon screws that fasten motor flange to drive brush mount. This also removes ground wire that is also secured with one of these screws and a lockwasher.
3. Rotate motor counterclockwise so setscrew that secures brush rod arm to motor drive shaft becomes accessible. Loosen setscrew and slide motor shaft out of brush rod arm.
4. Remove drive motor and insulator from base of brush drive mount.

#### 8.15 READ/WRITE HEADS (Figure 8-1)

##### REMOVAL

1. Remove top cover assembly, EMA duct, and EMA cover.

## CAUTION

When performing maintenance on the read/write heads, where unloading/loading is necessary, make certain that torsion rods are all properly positioned to avoid damage.

- a. Move head load links up and down several times. There should be no binding.
  - b. With a flashlight and dental mirror held close to the head(s) (do not touch heads), examine torsion rods for proper positioning (see figure 5-3). They must be in correct position, with rod tips resting on load buttons. All cam follower surfaces of the head assembly must move freely within the head load cam.
2. Unload torsion rods.
    - a. Loosen two socket-head screws that fasten torsion rod retainer support to T-block.
    - b. Push downward on each torsion rod link until it clears retainer lip and hold.
    - c. Pull retainers toward heads, then gradually release pressure on link. This unloads torsion rods and thus releases pressure on head assemblies.
  3. Remove plug retainer (two screws).
  4. Unplug read/write head to be replaced from matrix PWA connector.
  5. Remove screw and washer securing head to T-block.

## CAUTION

Protect read/write heads and torsion rods while performing steps 5 and 6.

6. Pull head from array carefully toward back and to side from rear of cam tower. Do not flex assembly unnecessarily; preset alignments may be altered.

## CAUTION

- a. Do not touch gliding surfaces; acids from skin will etch and disfigure surface.



- b. Do not touch face of head with fingers; oil from skin can cause build-up of deposits. Do not leave lint or residue on heads. Do not blow on heads; moisture from breath can cause contamination.
- c. Do not use volt-ohmmeter to verify continuity through head elements; VOM voltage is sufficient to burn out elements.
- d. Do not lay head on EMA; induced magnetism can affect read/write operations.
- e. Do not use a head if any distortions or abnormalities are evident; replacement is cheaper than lost data.
- f. Clean read/write heads only when inspection reveals presence of oxide deposits. Refer to Chapter 5, Maintenance, for cleaning instructions.

## INSTALLATION

**NOTE:** Four different read/write head configurations are used in the drive: BU, BD, AU, and AD. Each head configuration is assigned a different part number and is not interchangeable with other part numbers. Refer to figures 4-11 and 6-9 for further details.

1. Examine replacement head to ensure that it is same part as one removed. Clean gliding surface with lint-free tissue moistened with 90% isopropyl alcohol.

### CAUTION

Read/write heads are delicate. Use extreme care in handling new head arm assembly to position it in T-block slot. Ensure that torsion rod is correctly positioned against dimple on arm assembly. Avoid contact between head gimbal and cam.

2. Locate cam surface of replacement head in cam tower and position the tip of arm in T-block slot. Ensure that head assembly is seated properly before installing mounting screw.
3. Install single mounting screw and washer to secure head arm to T-block. Do not tighten at this time.

4. Manually move carriage back-and-forth while checking cam surfaces for correct mating action.
5. Plug read/write head into matrix PWA connector.
6. Replace plug retainer.
7. Manually retract carriage and load torsion rods by reversing procedure 8.15, REMOVAL, step 2.
8. Perform head alignment check and adjustment procedure of paragraph 6.7.

### 8.16 'A' MATRIX PWA'S (Figure 8-2)

#### REMOVAL

1. Turn off disk pack and wait until disk pack stops rotating.
2. Open operator cover and remove disk pack.
3. Remove top cover assembly and EMA duct.
4. Extract top screws and loosen lower screw securing head-plug retainers to cam tower and remove retainers.
5. Unplug all head plugs to matrix card connector. Also, for matrix card connecting to "A" side heads, remove ground strap.
6. Loosen matrix card retainer screw enough so retainer may be turned to allow matrix card to be extracted.
7. From shroud side of cam tower, unplug matrix card by applying upward force to bottom of both sides of card.
8. After card is unplugged, grasp top of card and pull upward and out of card tower.

#### INSTALLATION

Install matrix card by reversing removal procedure.

### 8.17 CAM TOWER (Figure 8-1)

#### REMOVAL

1. Remove top cover assembly, shroud, EMA duct, and both matrix cards.
2. Remove two matrix card sockets (two screws fastening each socket).
3. Unload torsion rods. See 8.15.
4. Remove four head-arm cams (two screws fastening each cam to cam tower).
5. Extract top screws and lower screw securing head plug retainers to cam tower, and remove retainers.
6. Unplug all heads to matrix card connector. Also, for matrix card connecting to "A" side heads, remove screw attaching topmost cable (carriage ground) from head assembly to "A" matrix card.
7. Remove four screws securing cam tower to baseplate.
8. Lift up cam tower enough to clear pins on baseplate, pull forward and away from baseplate.

## INSTALLATION

1. Position cam tower so two locating pins in baseplate protrude into corresponding location holes in cam tower feet.
2. Complete installation by reversing steps 1 through 7 of removal procedure.

**NOTE:** When attaching carriage ground cable to matrix card bracket, place attaching lockwasher between terminal lug and bracket.

### 8.18 EMA MAGNET (Figure 8-1)

#### REMOVAL

**NOTE:** Remove your wristwatch to keep the intense magnetic field from affecting watch regulation.

1. Place CB1 to OFF.
2. Remove top cover assembly, EMA duct, EMA cover, and rear skirt. Rear skirt is fastened with five screws and lockwashers.
3. Disconnect EMA cable clamp (one screw) and two wires to EMA flex conductor (one screw each).
4. Unload torsion rods per 8.15.
5. Remove four screws securing T-block to EMA coil cap.
6. Remove three bolts fastening EMA to baseplate.
7. Gently lift EMA while pulling away from T-block to disengage slot in EMA base from locating stud on baseplate.

#### INSTALLATION

1. Clean lower surface of EMA base and mating surface of baseplate with lint-free tissue dampened with 90% isopropyl alcohol.

**NOTE:** There must not be any particles between EMA base and baseplate. Otherwise, spurious noise effects may be present in critical signals during operation of disk drive.

2. Complete installation by reversing removal procedure.

### 8.19 EMA COIL (Figure 8-5)

#### REMOVAL

1. Remove EMA magnet (see paragraph 8.18).
2. Remove two screws, fasteners, and lower flexure supports from coil.
3. Pull coil out of front of EMA housing.

#### INSTALLATION

1. Install EMA coil by reversing removal procedure.

### 8.20 TORSION RODS (Figure 8-1)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly, EMA duct, and EMA cover.
3. Unload torsion rods per 8.15.
4. Remove four screws fastening T-block to EMA coil cap.
5. Move carriage away from EMA coil.
6. Remove the clip and washer which secure the torsion rod to the head load link (figure 4-12).
7. Remove the torsion rod by pulling it through the T-block.

### 8.21 ACCESS TRANSDUCER (Figure 8-5)

Three operational parts of the access transducer are replaceable: secondary grating, source mount, and sensor mount. Because the source and sensor mounts are matched for functional reasons, they must be replaced as a matched pair. Whenever any of these operational units are replaced or their positioning is disturbed, the access transducer adjustment described in paragraph 6.2 must be performed.

Replacement of the access transducer insulator, which functions as a protective cover and not as an operational part, does not necessitate adjustment.

#### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover, EMA duct, EMA cover, and shroud.

#### CAUTION

Protect read/write heads and torsion rods.

3. Unload torsion rods per 8.15, REMOVAL, step 2.

4. Remove "A" side plug retainer (two screws). Top screw requires removal; lower screw need only be loosened.
5. Disconnect "A" side head plugs and carriage ground assembly (latter is secured by one screw and washer).
6. Twist connector latch counterclockwise to disconnect source and sensor harness from plug bracket (on air deflector support).
7. Remove two screws and nylon washers securing source block to sensor mount, and lift source block disengaging from dowels on sensor mount.

### **CAUTION**

When handling primary and secondary gratings, avoid touching graticule.

8. Remove primary grating (three screws and two clamps).
9. Remove two corner screws securing sensor mount to mounting block. Loosen adjusting screw on sensor mount approximately six turns counterclockwise. Lift off source block, disengaging from dowels on mounting block.
10. Disassemble secondary grating from sensor mount (two screws).

### INSTALLATION

1. Assemble secondary grating to sensor mount, carefully tightening screws until they are snug.
2. Attach matched source and sensor mounts to mounting block, tightening screws until snug. It may be necessary to turn adjusting screw on sensor mount a couple of turns clockwise to get sensor mount to properly seat on mounting block. Do not force this seating. It is better to remove adjusting screw, replacing later after seating sensor mount.
3. Attach primary grating to carriage carefully and incrementally tighten screws in succession until fully tightened.
4. Connect source and sensor harnesses to plug bracket, twisting connector latch clockwise to engage.
5. Adjust clearance between primary and secondary gratings according to 6.2.
6. Perform parallelism adjustment, cylinder position adjustment, and equipment close-up according to 6.2.

**NOTE:** Head alignment must always be checked after alteration of any operational component in access transducer (see 6.7).

## 8.22 PRIMARY GRATING

### REMOVAL

1. Perform steps 1 through 5 of access transducer removal (8.21).

### CAUTION

When handling primary grating, avoid touching graticule.

2. Remove primary grating (three screws and two clamps).

### INSTALLATION

1. Attach primary grating to carriage.
2. Perform access transducer adjustments and equipment close-up according to paragraph 6.2.

## 8.23 SECONDARY GRATING

### REMOVAL

1. Perform steps 1 through 5 of access transducer removal (8.21).

### CAUTION

When handling primary and secondary gratings, avoid touching graticule.

2. Remove primary grating (three screws and two clamps).
3. Remove secondary grating from sensor mount (two screws).

### INSTALLATION

1. Replace secondary and primary gratings.
2. Perform access transducer adjustments and equipment close-up according to paragraph 6.2.

## 8.24 INDEX PIVOT ASSEMBLY (Figure 8-5)

### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly, front cover, air deflector, and shroud.
3. Remove retainer ring securing lever coupler to pivot shaft and disconnect coupler from shaft.

4. Remove four screws securing pivot assembly to baseplate, and remove pivot assembly.

## INSTALLATION

1. Secure pivot assembly to baseplate.
2. Adjust link stud position as described in paragraph 6.10.
3. Replace retainer ring to secure coupler to pivot shaft.
4. Replace shroud, air deflector, front cover, and top cover assembly.
5. Place CB1 to ON and replace lower rear cover.

## 8.25 INDEX TRANSDUCER

### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly, EMA duct, and shroud.
3. Unplug index transducer harness from bracket that holds air deflector to baseplate.
4. Unplug thermistor harness at connector behind air deflector support.
5. Disconnect three wires connected to switch on index transducer assembly.
6. Remove front screw and rear screw and washer securing index transducer assembly to baseplate.
7. Lift index transducer from baseplate.

### INSTALLATION

1. Clean mating surfaces on index transducer assembly and baseplate with lint-free tissue dampened in 90% isopropyl alcohol.
2. Replace index transducer assembly by reversing removal procedure.
3. Perform index transducer adjustment according to paragraph 6.8.

## 8.26 BRAKE-ACTUATING LINK (Figure 8-6)

### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly, front cover, air deflector, and shroud.
3. Remove retainer ring securing lever coupler to pivot shaft and disconnect coupler from shaft.
4. Remove retainer holding spindle brake link to spindle pawl. Spindle brake link may now be removed from spindle pawl along with spindle pawl return spring.

### INSTALLATION

1. Place pawl return spring on spindle brake link and position link through hole in pawl.

2. Secure spindle brake link to spindle pawl with retainer.
3. Replace lever coupler on pivot shaft and secure with retainer ring.
4. Make sure that there is 0.020- to 0.040-inch clearance between spindle brake pawl and spindle hold brake. If not, adjust as described in paragraph 6.10.
5. Replace shroud, air deflector, front cover, and top cover assembly.
6. Place CB1 to ON and replace lower rear cover.

## 8.27 DRIVE MOTOR BELT (Figure 8-6)

### REMOVAL

1. Place CB1 to OFF.
2. Unlatch and open rear gate.
3. Unclip terminals attaching two wires to pack-on switch.
4. Remove motor tension spring to motor tension plate.
5. Rotate motor clockwise enough to allow drive belt to be slipped up and off drive motor pulley.
6. Remove belt by dropping one side of it between pack-on switch and drive motor.

### INSTALLATION

Replace drive belt by reversing removal procedure.

## 8.28 DRIVE MOTOR AND PULLEY

### REMOVAL

1. Perform all steps for removal of drive motor belt.
2. Remove sequence panel cover by pulling out plunger fasteners and lifting off cover.
3. Disconnect motor cable wires to SP1 and to sequence panel chassis.
4. Remove nut that fastens drive motor cable to sequence panel and pull cable out of sequence panel.
5. Remove one bolt (to rear and right-hand side of motor) that holds motor mounting palte to bottom of baseplate.
6. Rotate drive motor clockwise to disengage motor mount from rear bolt, and, then, move motor to rear to disengage motor mounting plate from front bolt.
7. If drive motor is to be replaced, perform additional steps. (Omit these steps if pulley is being replaced.)
  - a. Separate drive motor from mounting plate (four bolts and washers).
  - b. Unscrew four shock mounts and adapters from drive motor.
  - c. Save these parts for use with replacement motor.



8. Remove pulley from motor shaft as follows:
  - a. Loosen three screws that secure pulley clamp to motor shaft.
  - b. Remove pulley with puller.

#### INSTALLATION

1. Replace pulley as follows:
  - a. Place key in slot in motor shaft.
  - b. Use hard rubber or plastic mallet and tap pulley onto motor shaft.
2. Fasten pulley to pulley clamp.
3. If four shock mounts and adapters were removed (as when the motor is being replaced), screw these onto drive motor housing.
4. Fasten mounting plate (if previously removed) to drive motor.
5. Measure distance from top of pulley to bottom of mounting plate. This distance must be  $0.176 \pm 0.010$  inch. If necessary, adjust as follows:
  - a. Loosen setscrew on pulley clamp.
  - b. Tap motor pulley assembly in appropriate direction to obtain proper distance.
  - c. Retighten pulley clamp setscrew.
6. Complete replacement by reversing steps 1 through 6 of removal procedure.

#### 8.29 BLOWER PLENUM ASSEMBLY (Figure 8-1)

##### REMOVAL

1. Place CB1 to OFF.
2. Remove front cover.
3. Disconnect blower cable from power source.
4. Loosen clamp securing blower exit duct to blower plenum and slide off duct.
5. While supporting blower and plenum by hand, remove filter-locking rod (at top of plenum) that attaches blower plenum to inlet filter duct.
6. Lift blower plenum assembly up and out, disengaging plenum ears from slots in air system support plate.

##### INSTALLATION

1. Before replacing blower plenum assembly, be sure that arrow on absolute filter housing is pointing in direction of air flow.
2. Replace blower plenum assembly by reversing removal procedure.

### 8.30 INLET FILTER DUCT (Figure 8-2)

#### REMOVAL

1. Perform all steps in removal procedure for blower plenum assembly.
2. Lift absolute filter off air support plate.
3. Unlatch and open PWA gate.
4. Extract three screws that fasten inlet filter duct to air system support plate and lift off inlet filter duct.

#### INSTALLATION

1. Place inlet filter duct on air system support plate and fasten with three screws.
2. Place absolute filter on air system support plate with arrow on filter housing pointing in direction of air flow.
3. Perform reversal of removal procedure for blower plenum assembly.

### 8.31 AIR SYSTEM SUPPORT PLATE AND SUPPORTED UNITS (Figure 8-1)

#### REMOVAL

1. Place CB1 to OFF.
2. Disconnect blower cable from power source.
3. Unlatch and open PWA gate.
4. Remove screw securing air system support plate to standoff on power supply plate.
5. Remove seven screws and washers fastening air system support plate to disk drive frame. Lift out air system support plate and attached units.

#### INSTALLATION

Replace air system support plate by reversing removal procedure.

### 8.32 SPINDLE HOLDING PAWL (Figure 8-6)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly, front cover, shroud, right-hand side cover, blower plenum assembly, and absolute filter.
3. Remove retaining ring securing lever coupler to pivot shaft and disconnect.
4. Remove socket-head screw, flat washer, and spring which hold spindle holding pawl to baseplate.
5. Remove spindle holding pawl (with link rod attached) and nylon washer between pawl and baseplate.

6. To disassemble spindle holding pawl assembly, remove retaining ring from brake actuating link. Extract link from pawl. Pawl return compression spring and second retaining ring on link are also freed by this action.

#### INSTALLATION

1. Replace spindle holding pawl by reversing removal procedure.
2. Check and adjust spindle holding pawl according to paragraph 6.10.

### 8.33 PACK-ON SWITCH ASSEMBLY (Figure 8-5)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove front cover.
3. Unclip terminals on two wires to pack-on switch.
4. Remove two screws fastening pack-on switch assembly by reversing removal procedure.

#### INSTALLATION

Replace pack-on switch assembly by reversing removal procedures.

### 8.34 SPINDLE GROUNDING CONTACT (Figure 8-6)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove one of the two screws securing pack-on switch bracket to baseplate and loosen other screw.
3. Rotate pack-on switch to provide clearance to grounding contact.
4. Pry off nylon contact retainer. Grounding contact will stay in retainer and may be removed with fingers.

#### INSTALLATION

1. Replace spindle grounding contacts by reversing removal procedure.
2. Check and adjust pack-on switch according to paragraph 6.9.

### 8.35 SPINDLE ASSEMBLY (Figure 8-1)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove top cover assembly and front cover.
3. Perform the following steps to facilitate removal of spindle holding pawl and drive motor belt.

- a. Loosen clamp on blower exit duct, and slide clamp up duct. Disengage blower exit from blower plenum.
  - b. Remove screws from shroud inlet duct, and lift it and the blower exit duct from baseplate.
4. Remove spindle holding pawl and drive motor belt.
  5. Extract three socket-head screws securing spindle to baseplate.

### CAUTION

Use extra care when removing spindle from baseplate to prevent binding. Spindle must be lifted straight up and must not be tilted.

6. Lift spindle straight up and away from baseplate.

### INSTALLATION

1. With 90% isopropyl alcohol, clean spindle and baseplate surface that contacts spindle. Use lint-free tissue.

### CAUTION

In performing step 2, do not tilt spindle when lowering into baseplate. Otherwise, binding may occur.

2. Lower spindle into baseplate, slowly and carefully to ensure proper alignment and to prevent binding.
3. Complete replacement by reversing steps 1 through 5 of removal procedure.
4. Perform read/write head check and adjustment procedure according to paragraph 6.7.

### 8.36 ELECTRONIC (PWA) GATE ASSEMBLY (Figure 8-2)

#### REMOVAL

1. Place CB1 to OFF.
2. Open PWA gate.
3. Release PWA gate card latch.
4. Cut cable ties securing cables to gate frame.
5. Extract paddle PWA's.
6. Disconnect ground strap attached to bottom of baseplate (by screw and lockwasher).

7. Unsolder wires from DC power supply connected to voltage terminals underneath PWA gate behind front panel.
8. Unsolder Read coax and ground wires from PWA 5 connector, pins 5 and 6.
9. Unsolder Write coax and ground wires from PWA 4 connector, pins 33 and 2.
10. Remove screw, washer, and nut gate stay to bracket on drive frame.
11. Support gate assembly so it will not fall and remove two screws securing gate hinge to hinge bracket on drive frame. Lift off PWA gate assembly.

## INSTALLATION

Replace PWA gate assembly by reversing removal procedure.

### 8.37 RESISTOR BRACKET ASSEMBLY (Figure 8-1)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove front cover and top cover assembly.
3. Remove EMA cover.
4. Disconnect two wires from EMA coil (two screws and nylon washers).
5. Disconnect clamp securing EMA coil wires to EMA frame and ties holding them to other wire harness.
6. Disconnect wires from resistor bracket assembly to power driver terminal board PD1 according to following table.

<u>Resistor Bracket Component/Terminal</u>	<u>Power Driver PD1 Terminal</u>
R13-1	14
R13-2	7
R15-1	15
R14-2	6
L1-1	16

7. Remove appropriate cable ties so wires disconnected from power driver PD1 may be removed.
8. Remove two screws that secure resistor bracket assembly to frame, and lift out assembly (including attached wires).

#### INSTALLATION

Replace resistor bracket assembly by reversing removal procedure, except perform step 7 after all wires have been reconnected.

### 8.38 POWER DRIVER ASSEMBLY (Figures 8-2 and 8-3)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove front and rear covers.
3. Remove power driver cover (four screws and lockwashers).
4. Disconnect all wires at input terminals of PD1.
5. Supporting power driver to prevent its falling over, remove five screws securing power driver to sequence panel.

#### INSTALLATION

Replace power driver by reversing removal procedure.

#### REMOVAL AND REPLACEMENT OF POWER DRIVER PWA

1. Perform steps 1 through 3 of power driver assembly removal.
2. Unsolder at PWA wires that connect to external destinations.
3. Remove four screws fastening PWA to standoffs on power driver support, and lift off PWA.

### 8.39 POWER SUPPLY ASSEMBLY (Figure 8-1)

#### REMOVAL

1. Place CB1 to OFF.
2. Remove front cover.
3. Remove long standoff that supports air system support plate. This standoff is located at rear of regulator assembly.
4. Disconnect two wires from power driver and one wire from DC in connector to power supply capacitor C1 (two screws). Reconnect other wires that connect to C1 to other power supply components.
5. Remove PS1 terminal board cover (three screws), and disconnect all wires that connect PS1 and adjacent ground bar to external connections.
6. Disconnect all wires that connect PS2 to units external to power supply.
7. Disconnect all wires that connect PS3 to units external to power supply.
8. Remove two screws that secure clamps, and also, in part, secure power supply mounting plate to disk drive frame.
9. Remove remaining six screws and lockwashers that secure power supply mounting plate to disk drive frame.
10. Lift out power supply assembly toward front of disk drive.

#### INSTALLATION

Replace power supply assembly by reversing removal procedure.

## 8.40 POWER SUPPLY COMPONENTS

The power supply components may be removed after first performing the removal procedures steps 1 and 2 of 8.39.

### CAPACITOR C1 REMOVAL AND REPLACEMENT

1. Disconnect all wires to capacitor C1 terminals.

**NOTE:** Two possible methods apply to removal of C1, depending on the accessibility of the screw head that tightens the capacitor bracket (clamp).

2. If accessible, loosen screw on C1 bracket. Then remove C1.
3. If C1 bracket screw is not accessible, perform following steps.
  - a. Remove three screws and lockwashers that fasten bracket to power supply mount.
  - b. Loosen bracket screw and remove C1 from bracket.
4. Replace C1 by reversing removal procedure.

### CAPACITOR C4 REMOVAL AND INSTALLATION

1. Slide protective cap away from C4 terminals and unsolder two wires to capacitor C4 terminals.
2. Loosen capacitor C4 bracket (clamp) screw and remove C4.
3. Replace C4 by reversing removal procedure.

### REGULATOR PWA REMOVAL AND INSTALLATION

1. Remove front regulator cover (four screws and lockwashers).
2. Unsolder wires to external destinations from PWA terminals.
3. Remove four screws fastening PWA to standoffs on regulator support plate and lift off PWA.
4. Replace PWA by reversing removal steps.

## 8.41 SEQUENCE PANEL ASSEMBLY (Figures 8-3 and 8-4)

### REMOVAL

1. Remove front, lower rear, and both side covers.
2. Place CB1 to OFF.
3. Disconnect following cables at sequence panel: AC IN, AC OUT, SIGNAL OUT. If subsystem is needed, mate removed cables together.

4. Remove power driver assembly (if required, as when the sequence panel is being replaced and power driver is not).
5. Unplug ground wire to DC IN connector (from rear of drive) and remove screw fastening wire to sequence panel.
6. Disengage (pull out) plunger fasteners securing sequence panel cover, and lift cover off.
7. Remove the following connectors:
  - a. SIGNAL OUT. Also remove cable clamp brackets.
  - b. SIGNAL IN. Also remove cable clamp brackets.
  - c. DC IN (four screws).
8. Disconnect wires connected externally from SP1, 2, and 3.
9. Remove nut fastening motor cable clamp to top of sequence panel and pull out motor cable.
10. Cut cable ties (as required) to release appropriate sequence panel harnesses tied together with other wires external to sequence panel.
11. Supporting sequence panel assembly, remove six screws and lockwashers that secure sequence panel to disk drive frame.
12. Lift and remove sequence panel assembly from drive frame to the rear or to either side.

## INSTALLATION

Replace sequence panel by reversing removal procedure.

### 8.42 SEQUENCE PANEL COMPONENTS

#### REMOVAL AND INSTALLATION OF CIRCUIT BREAKER CB2 OR CB3

1. Remove lower rear cover.
2. Remove top screw and lockwasher that secure circuit breaker cover to sequence panel.
3. Remove two screws and lockwashers that fasten circuit breaker to circuit breaker bracket.
4. Push circuit breaker to rear to clear switch toggle and move circuit breaker to side and out of bracket.
5. Remove two screws that fasten wire to circuit breaker.
6. Replace circuit breaker by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF CIRCUIT BREAKER CB1

1. Remove front and lower rear covers.
2. From rear of panel, remove two screws that fasten CB1 to sequence panel.
3. Pull out plunger fasteners on sequence panel cover and lift off cover.
4. From inside of sequence panel, pull CB1 away from panel.



5. Remove four screws that fasten wires to CB1 terminals.
6. Replace CB1 by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF MOTOR BRAKE CAPACITOR C1

1. Remove front cover.
2. Pull out plunger fasteners on sequence panel cover and lift off cover.
3. Release two cable ties that secure capacitor C1.
4. Tilt top of C1 and remove two screws that fasten wires to C1 terminals.
5. Replace C1 by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF MOTOR BRAKE ASSEMBLY

1. Remove front covers.
2. Pull out plunger fasteners on sequence panel cover and lift off cover.
3. Disconnect all externally destined wires on motor brake assembly.
4. Remove four screws that secure motor brake assembly to standoffs on sequence panel.
5. Replace motor brake assembly by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF TRANSFORMER T2

1. Remove front cover.
2. Pull out plunger fasteners on sequence panel cover and lift off cover.
3. Remove T2 wires from SP1.
4. Remove two screws and lockwashers that fasten T2 to sequence panel.
5. Replace T2 by reversing removal procedure.

#### REMOVAL AND REPLACEMENT OF SOLID STATE RELAY (SSR)

1. Remove front cover.
2. Pull out plunger fasteners on sequence panel cover and lift off cover.
3. Remove two nuts that fasten wires and diode lugs to upper terminals on solid state relay. Disengage wires and save diode for use in reassembly.
4. Remove two nuts that fasten wires to two lower terminals on solid state relay (SSR) and disengage wires.
5. Loosen left-hand screw and remove right-hand screw and washer that secure solid state relay to sequence panel.
6. To right-hand side, lift out solid state relay. Insulator will hang on remaining screw.
7. Replace solid state relay by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF RELAY 1

1. Remove front cover.
2. Pull out plunger fasteners on sequence panel and cover and lift off cover.

3. Unclip terminals 5 and 7, being careful not to break wires on capacitor connected between these terminals. Save capacitor for use in reassembly.
4. Unclip terminals A and B, being careful not to break wires on diode connected between these terminals. Save diode for reassembly.
5. Remove screw fastening relay 1 to sequence panel and lift out relay 1.
6. Replace relay 1 by reversing removal procedure.

#### REMOVAL AND INSTALLATION OF REED 3

1. Remove front cover.
2. Pull out plunger fasteners on sequence panel cover and lift off cover.
3. Remove two nuts and washers (at rear of sequence panel) that fasten reed 3 to sequence panel.
4. Gently pull reed 3 away from panel and tilt slightly to provide accessibility to terminals at top of reed 1.
5. Unsolder wires attached to four terminals on reed 1 and diode (between terminals 1 and 2). Save diode for reassembly.
6. Replace reed 3 by reversing removal procedure.

#### 8.43 EXHAUST FANS (Figure 8-1)

##### REMOVAL AND INSTALLATION

1. Remove front cover.
2. Unplug fan power cable (close to fan).
3. Remove four screws that fasten fan assembly (fan and guard) to fan mount.
4. Fan guard and fan will separate upon completion of step 3. Lift off fan guard and fan.
5. Replace fan by reversing removal procedure.

#### 8.44 TOP COVER INTERLOCK SWITCH (Figure 8-2)

##### REMOVAL AND INSTALLATION

1. Place CB1 to OFF.
2. Remove top cover assembly.
3. Unclip three wires to switch terminals.
4. Remove two screws that fasten switch bracket to front skirt.
5. Lift out bracket (with switch attached).
6. Remove two screws that fasten bracket to switch.
7. Replace top cover interlock switch by reversing removal procedure.

#### 8.45 THERMISTORS

The removal and installation of the various thermistors are individually described.

## REFERENCE THERMISTOR REMOVAL AND INSTALLATION (Figure 8-5)

**NOTE:** This thermistor is fastened to the baseplate behind the cam tower.

1. Remove top cover assembly.
2. Remove EMA duct.
3. Unsolder two wires to thermistor terminals.
4. Extract one screw securing thermistor block to baseplate, and lift thermistor.
5. Replace thermistor by reversing removal procedure.

## COMPENSATION THERMISTOR REMOVAL AND INSTALLATION (Figure 6-10)

**NOTE:** This thermistor is attached to the Index Transducer Assembly.

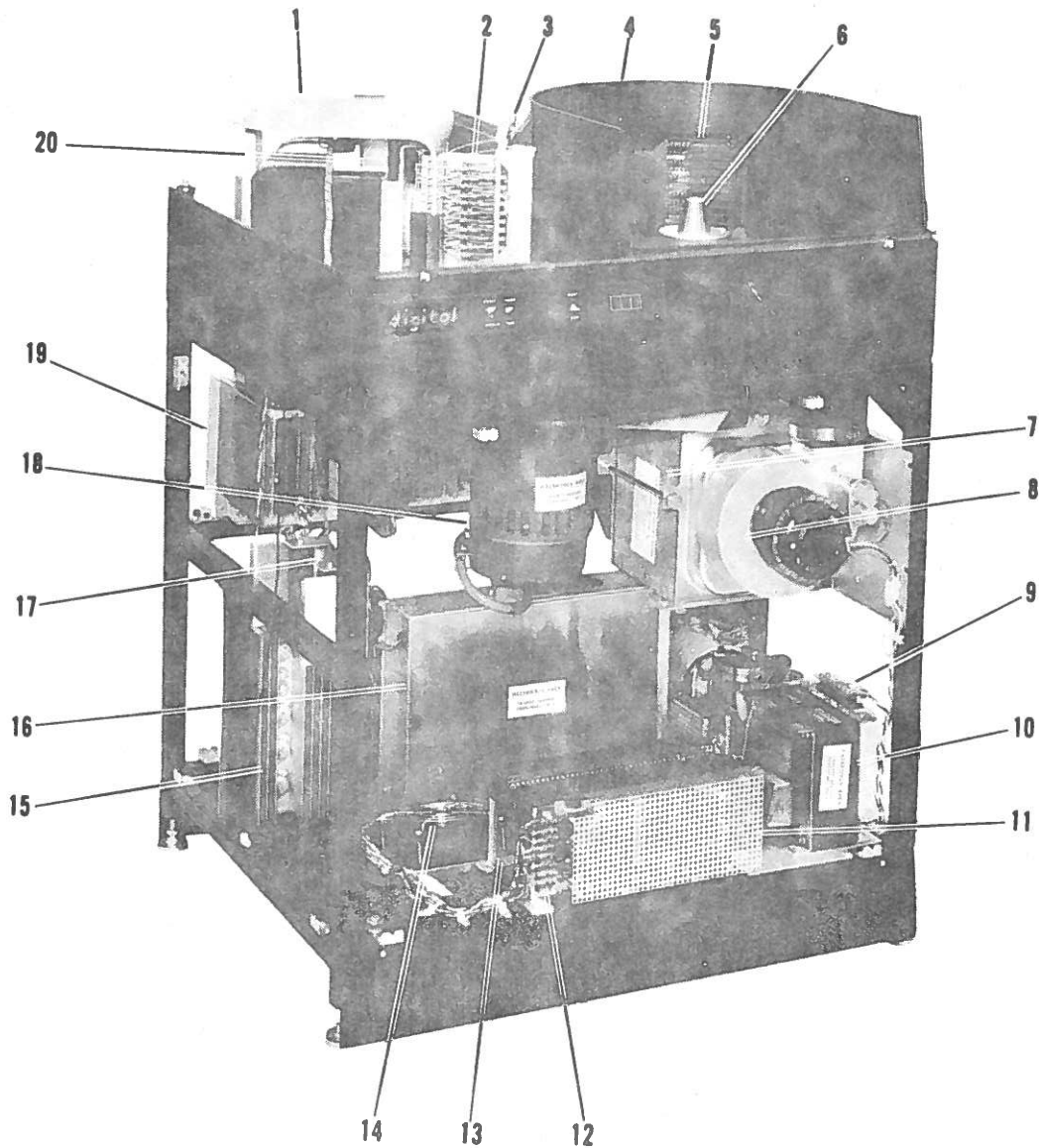
1. Remove top cover assembly and shroud.
2. Unsolder two wires to thermistor terminals.
3. Extract two screws fastening thermistor block to index transducer assembly, and remove thermistor.
4. Replace thermistor by reversing removal procedure.

### 8.46 CARRIAGE ASSEMBLY (Figure 8-1)

The carriage assembly must be aligned using a special carriage alignment tool kit. This alignment is extremely critical. Therefore, the carriage assembly positioning should not be altered, nor the carriage replaced, unless the carriage alignment tool (ISS Part Number 70003911-1) and procedure (ISS Document Number US002329) are available.

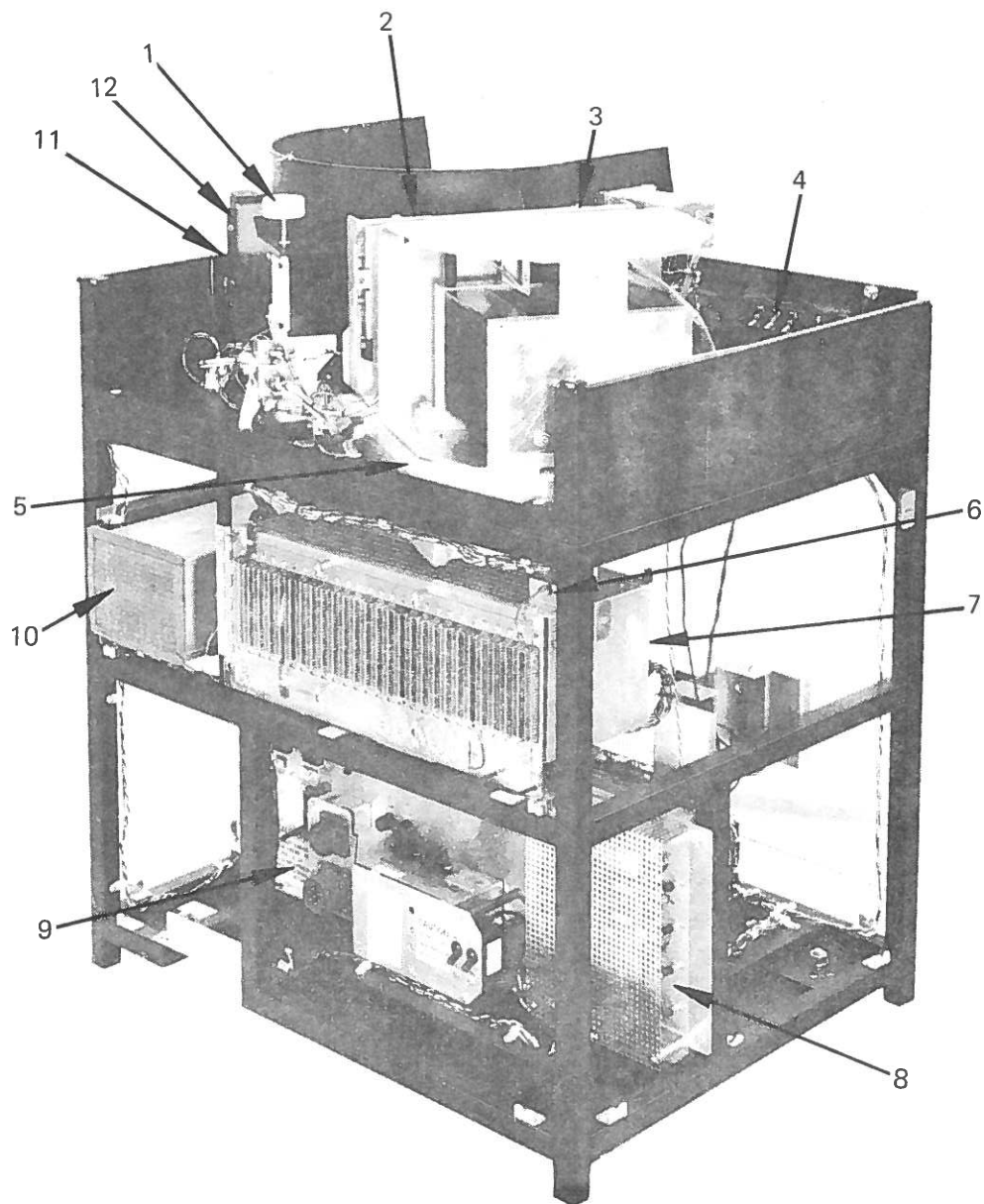
### 8.47 LOCATION DIAGRAMS

This section contains general arrangement illustrations of the 715DEC Disk Storage Drive and provides a quick reference for the location of components within the machine. These illustrations may be used as an aid by service personnel to support the maintenance procedures described in other chapters.



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	EMA COVER	11	POWER SUPPLY
2	READ/WRITE HEADS	12	TERMINAL BOARD PS-1
3	CAM TOWER	13	TERMINAL BOARD PS-3
4	SHROUD	14	EXHAUST FAN
5	BRUSH DRIVE	15	POWER DRIVER
6	SPINDLE	16	SEQUENCE PANEL (FRONT COVER)
7	ABSOLUTE FILTER	17	RESISTOR BRACKET
8	BLOWER	18	DRIVE MOTOR
9	TERMINAL BOARD PS-2	19	ELECTRONIC GATE
10	POWER TRANSFORMER	20	EMA

Figure 8-1. 715DEC Disk Storage Drive (Front View, Covers Removed)



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	INDEX TRANSDUCER PUSH ROD	7	ELECTRONIC GATE
2	A MATRIX PWA	8	POWER DRIVER
3	B MATRIX PWA	9	SEQUENCE PANEL
4	INDICATOR LAMPS	10	EXTERIOR PREFILTER
5	BASEPLATE	11	TOP COVER INTERLOCK SWITCH
6	C.E. UNSAFE RESET SWITCH	12	AIR DEFLECTOR

Figure 8-2. 715DEC Disk Storage Drive (Rear View, Covers Removed)

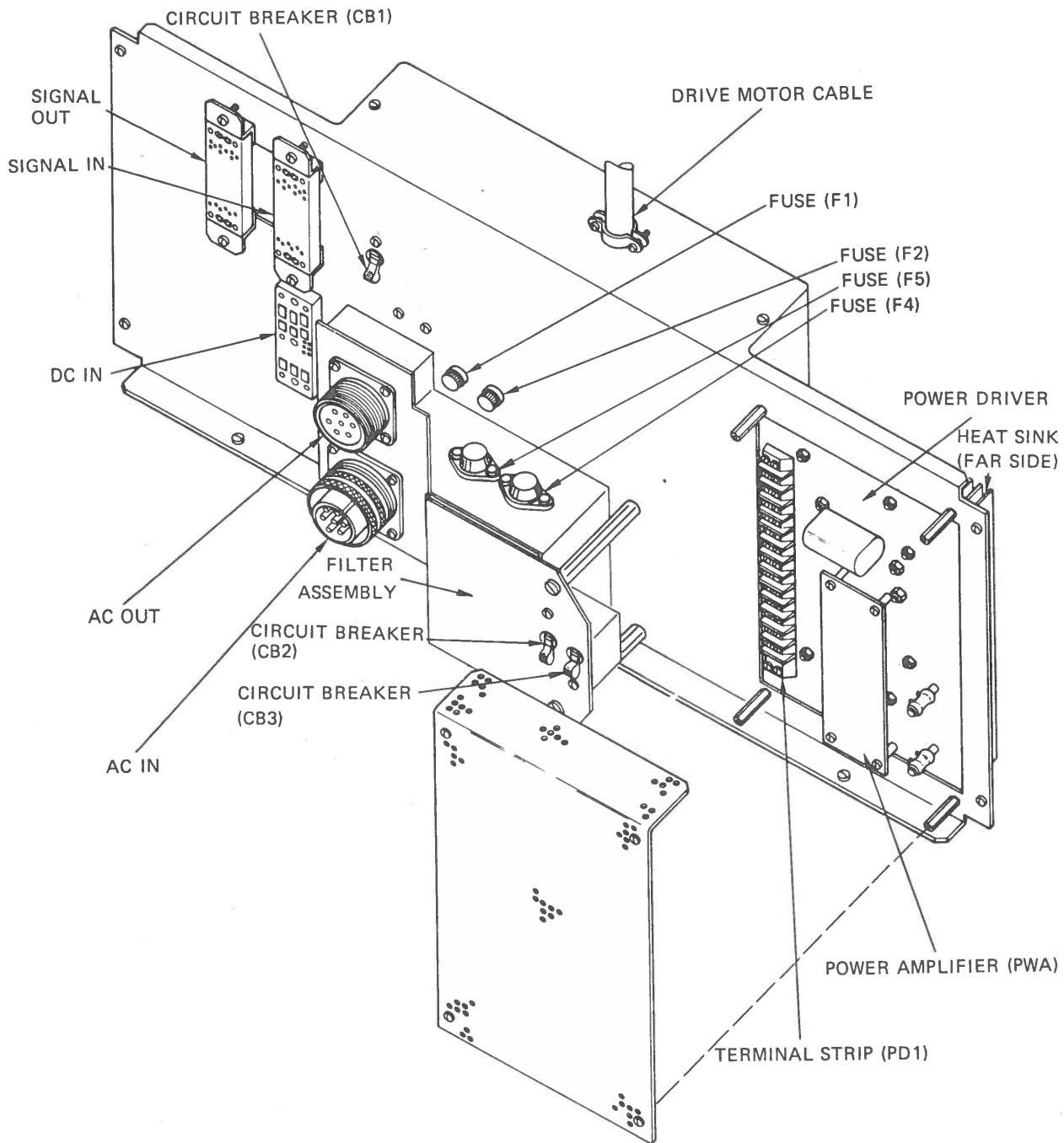
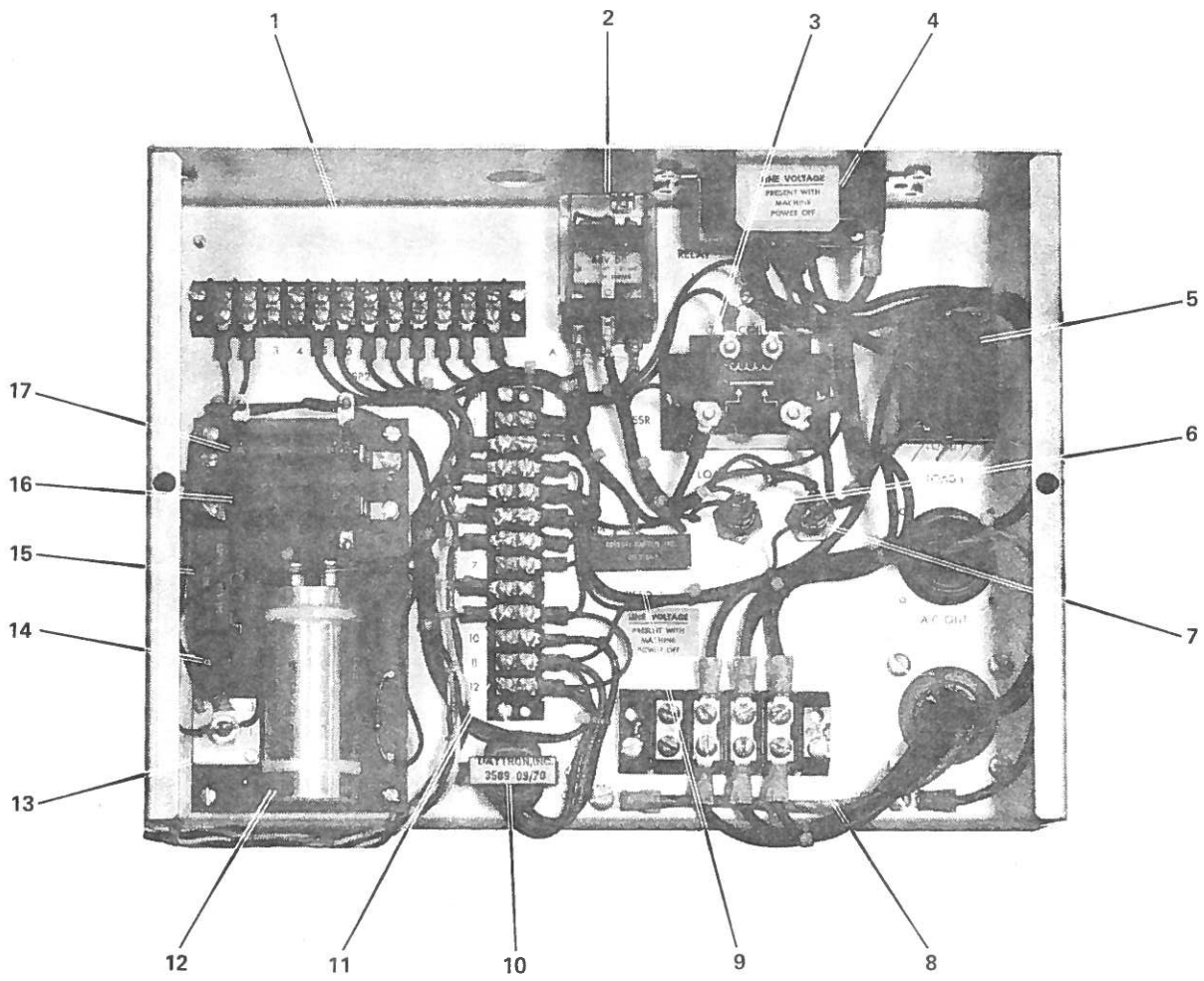
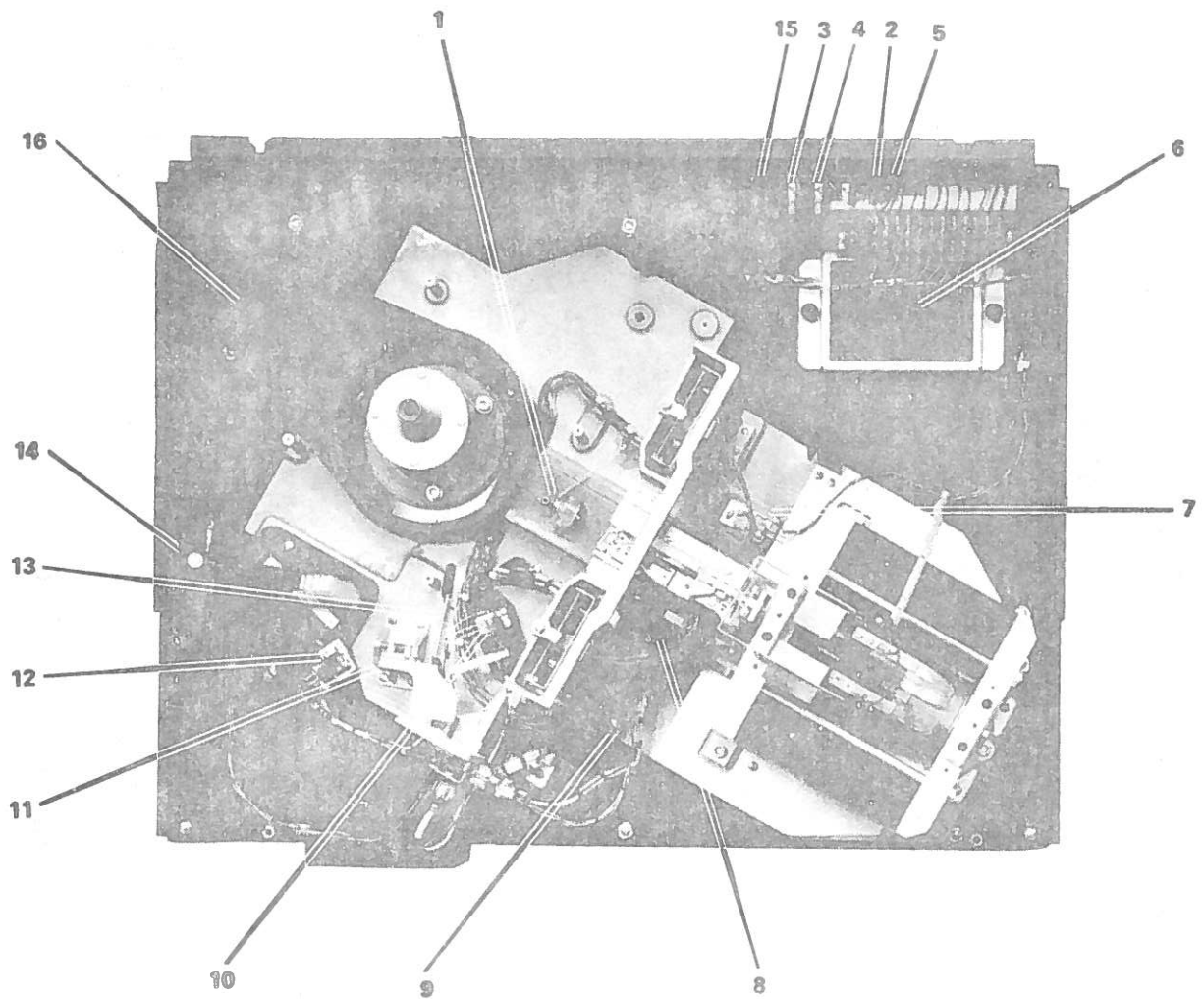


Figure 8-3. 715DEC Sequence Panel Details (Rear View)



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	TERMINAL BOARD SP-2	10	MOTOR TRANSFORMER T2
2	RELAY 1	11	TERMINAL BOARD SP-1
3	SOLID STATE RELAY (TRIAC)	12	CAPACITOR (C1)
4	115 VAC SERVICE OUTLET	13	SOLID STATE RECTIFIER (SCR)
5	CIRCUIT BREAKER CB1	14	MOTOR BRAKE CKT BOARD ASM
6	FUSE F2 (1 AMP)	15	REED SWITCH 2
7	FUSE F1 (1 AMP)	16	RESISTOR (R2)
8	TERMINAL BOARD SP-3	17	RESISTOR (R3)
9	REED SWITCH 3		

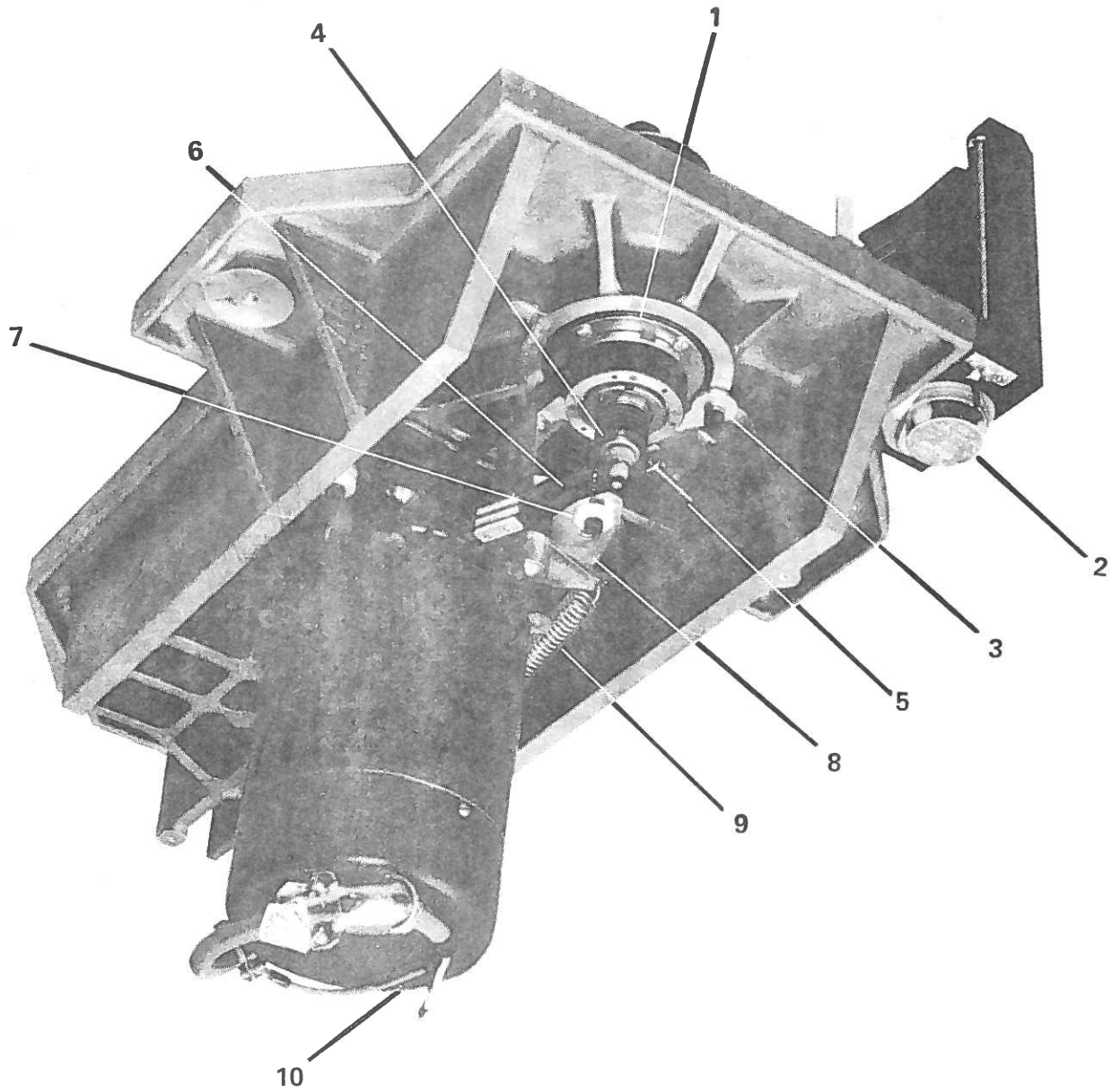
Figure 8-4. Sequence Panel Details (Front Cover Removed)



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	CALIBRATION STOP	9	REFERENCE THERMISTOR
2	READ ONLY/READ WRITE SWITCH	10	INDEX TRANSDUCER ASM
3	FILE READY INDICATOR LAMP	11	INDEX PIVOT ASM
4	UNSAFE INDICATOR LAMP	12	BRUSH RETRACT SWITCH
5	ENABLE/DISABLE SWITCH	13	SPINDLE RETRACT LINK ROD
6	INTERIOR PREFILTER	14	BRUSH DRIVE ASM
7	CARRIAGE RETRACT SWITCH	15	START/STOP SWITCH
8	ACCESS TRANSDUCER	16	SHROUD INLET DUCT

Figure 8-5. 715DEC Disk Storage Drive (Top View, Components Above Baseplate)





ITEM	DESCRIPTION
1	SPINDLE BRAKE
2	BRUSH DRIVE MOTOR
3	SPINDLE BRAKE PAWL
4	SPINDLE GROUNDING CONTACT
5	PAWL RETURN SPRING & ACTUATING LINK
6	PACK-ON SWITCH CONTACTS
7	MOTOR MOUNTING SCREW
8	MOTOR MOUNTING PLATE
9	BELT TENSION SPRING
10	DRIVE MOTOR

Figure 8-6. 715DEC Disk Storage Drive (Components Below Baseplate)

# CHAPTER 9

## DIAGRAMS

### 9.1 INTRODUCTION

Chapter 9 is arranged in the following order:

1. Description of Logic Symbols (9.2)
2. Operational Diagrams (9.3)
  - a. Functional Block Diagram
  - b. Flowchart
  - c. Timing Diagram
3. Waveforms (9.4)
  - a. 192-Cylinder Seek-Seek
  - b. 8-Cylinder Seek-Seek
4. Cable Diagram (9.5)
5. PWA Assignment (9.6)
6. Logic and Schematic Diagrams (9.7)

## 9.2 DESCRIPTION OF LOGIC SYMBOLS

Symbols and abbreviations used on diagrams in this chapter are defined in Tables 9-1 and 9-2.

Table 9-1. Abbreviations









AMPL	AMPLIFIER	OSC	OSCILLATOR
C	CLEAR, (RESET)	P	POSITIVE
CAP	CAPACITOR	Q	OUTPUT
CD	DIRECT CLEAR	$\bar{Q}$	COMPLEMENTARY OUTPUT
CKT	CIRCUIT	QL	QUAD LATCH
COMPTR	COMPARATOR	R	RESET
DET	DETECTOR	REF	REFERENCE
DIFF	DIFFERENTIAL	REG	REGISTER
DLY	DELAY	RES	RESISTOR
FF	FLIP FLOP	S	SET
FL	FLIP LATCH	SS	SINGLE SHOT
FREQ	FREQUENCY	SD	SET DIRECT
GND	GROUND	SSR	SOLID STATE RELAY
LD	LINE DRIVER	T	RESISTOR TERMINATOR
LED	LIGHT EMITTING DIODE	TP	TEST POINT
LR	LINE RECEIVER	VAC	VOLT, AC
N,NEG	NEGATIVE	VDC	VOLT, DC
NET,NTWK	NETWORK		

Table 9-2. Symbols

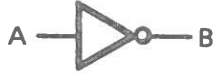

SYMBOL	INDICATES
	Circle on line means LOW (L) level, active state (input/output lines)
+(H)	HIGH logic level
-(L)	LOW logic level
•	AND function
+ , $\Omega$	OR function
$\oplus, \nabla$	EXCLUSIVE OR function
>	Is greater than
$\geq$	Is equal to or greater than
<	Is less than
$\leq$	Is equal to or less than
$\propto$	Is proportional to
$\bar{X}$	Bar indicates the opposite state of given function; where X is the name of the function, $\bar{X}$ is the not-condition of X.
(24)	Input/Output Pin
	Read/Write Head
	Oscilloscope Photograph Reference
P $\updownarrow$	Twisted Pair Wires

Table 9-2. Symbols (Cont.)

**GATE (MAY HAVE 2 OR MORE INPUTS)**

LOGIC LEVEL INPUTS		INPUT	OUTPUT	OUTPUT DESCRIPTION L = LOW      H = HIGH
POSITIVE	* NEGATIVE	A B	C	
<b>AND</b> 		L L H L L H H H	L L L H	OUTPUT IS LOW WHEN ANY INPUT IS LOW. OUTPUT IS HIGH WHEN ALL INPUTS ARE HIGH.
<b>NAND (AND INVERT)</b> 		L L H L L H H H	H H H L	OUTPUT IS LOW WHEN ALL INPUTS ARE HIGH. OUTPUT IS HIGH WHEN ANY INPUT IS LOW.
<b>OR</b> 		L L H L L H H H	L H H H	OUTPUT IS LOW WHEN ALL INPUTS ARE LOW. OUTPUT IS HIGH WHEN ANY INPUT IS HIGH.
<b>NOR (OR INVERT)</b> 		L L H L L H H H	H L L L	OUTPUT IS LOW WHEN ANY INPUT IS HIGH. OUTPUT IS HIGH WHEN ALL INPUTS ARE LOW.


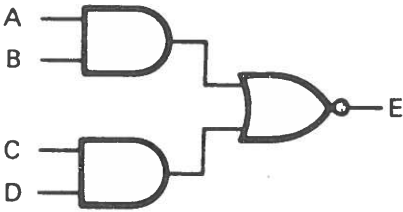
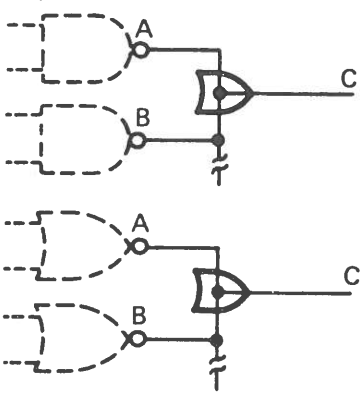
**INVERTER**

POSITIVE	* NEGATIVE	INPUT OUTPUT		OUTPUT DESCRIPTION L = LOW      H = HIGH
		A	B	
		H L	L H	OUTPUT IS INVERTED INPUT.

\* NEGATIVE INPUT SYMBOLS ARE FUNCTIONALLY EQUIVALENT TO POSITIVE INPUT SYMBOLS.

Table 9-2. Symbols (Cont.)

**SPECIAL PURPOSE GATES**

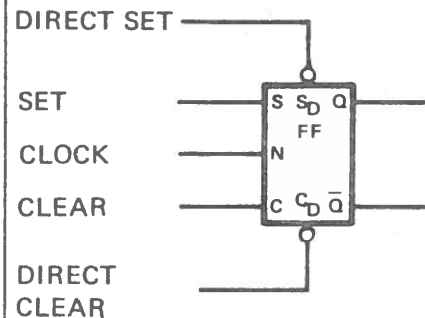
EXCLUSIVE OR	INPUT	OUTPUT	OUTPUT DESCRIPTION	
	A B	C	L = LOW	H = HIGH
	L L H L L H H H	L H H L	OUTPUT IS HIGH WHEN ONLY ONE INPUT IS HIGH AND ALL OTHER INPUTS ARE LOW.	
AND OR INVERT	INPUT	OUTPUT		
	A B C D	E		
	L L L L H L L L L H L L H H L L L L H L H L H L L H H L H H H L L L L H H L L H L H L H H H L H L L H H H L H H L H H H H H H H	H H H L H H H L H H L L L L L L	OUTPUT IS LOW WHEN ANY "AND GATE" HAS ALL OF ITS INPUTS HIGH.  OUTPUT IS HIGH WHEN NO "AND GATE" HAS ALL OF ITS INPUTS HIGH.	
DOT OR (WIRED OR) GATE	INPUT	OUTPUT		
	A B	C		
	L L H L L H H H	L L L H	OUTPUT IS LOW WHEN ANY INPUT TIED TO THIS POINT IS LOW.  OUTPUT IS HIGH WHEN ALL INPUTS TIED TO THIS POINT ARE HIGH.	

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Table 9-2. Symbols (Cont.)

**FLIP-FLOP**

WHEN ALL INPUTS ARE HIGH F/F WILL TOGGLE EACH TIME CLOCK GOES NEGATIVE. SD AND CD WILL OVERRIDE C, S, AND CLOCK INPUTS. FF WILL STAY LOCKED UP WHEN CD OR SD REMAINS LOW.

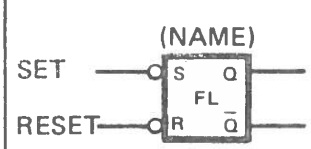


		$t_n$					$t_{n+1}$	
SD	CD	S	C	N	$\bar{Q}$	Q		
H	H	H	L	L	L	H		
H	H	L	H	L	H	L		
H	H	H	H	L				
H	H	L	L	L				
L	H	-	-	-	L	H		
H	L	-	-	-	H	L		
L	L	-	-	-	H	H		

$t_n$  = OUTPUT CONDITION BEFORE CLOCK PULSE.  
 $t_{n+1}$  = OUTPUT CONDITION AFTER CLOCK PULSE.

} TOGGLES  
 } NO CHANGE

**FLIP LATCH**

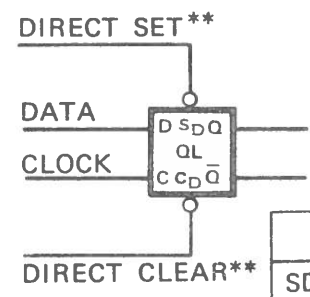


SET	RESET	Q	$\bar{Q}$
H	H	*	*
L	H	H	L
H	L	L	H
L	L	H	H

\*INDETERMINATE . . . DEPENDS UPON WHICH INPUT WAS LAST IN A LOW STATE.

**QUAD LATCH**

INFORMATION PRESENT AT THE DATA INPUT D IS TRANSFERRED TO THE Q OUTPUT WHEN CLOCK IS HIGH. LEVEL AT OUTPUT (Q) WILL FOLLOW THE D INPUT LEVEL AS LONG AS CLOCK REMAINS HIGH.



INFORMATION PRESENT AT OUTPUTS WILL BE RETAINED AS CLOCK GOES LOW UNTIL SUCH TIME THAT CLOCK IS PERMITTED TO GO HIGH AGAIN. SD AND CD INPUTS FUNCTION SAME AS FOR FLIP FLOP.

		$t_n$				$t_{n+1}$	
SD	CD	C	D	Q	$\bar{Q}$		
H	H	H	H	H	L		
H	H	H	L	L	H		
H	H	L	-	*	*		
L	H			H	L		
H	L			L	H		

$t_n$  = OUTPUT CONDITION BEFORE CLOCK PULSE.  
 $t_{n+1}$  = OUTPUT CONDITION AFTER CLOCK PULSE.

} D=Q (WHEN C IS HELD HIGH)  
 } \*WHEN C IS LOW:  
 Q AND  $\bar{Q}$  WILL REMAIN IN PREVIOUS STATE.

\*\* OPTIONAL INPUTS

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Table 9-2. Symbols (Cont.)

**SINGLE SHOT (POSITIVE INPUT)**

OUTPUT Q GOES HIGH WHEN "A" GOES POSITIVE (P). Q GOES LOW AT THE END OF TIME OUT ( $\mu$  sec or ms) PERIOD.

**SINGLE SHOT (NEGATIVE INPUT)**

OUTPUT Q GOES HIGH WHEN "A" GOES NEGATIVE (N). Q GOES LOW AT THE END OF TIME OUT ( $\mu$  sec or ms) PERIOD.

**LINE DRIVER**

TRANSLATES LOGIC LEVELS TO LINE LEVELS

A = LOGIC LEVEL  
B = A TRANSLATED TO LINE LEVELS

**LINE RECEIVER**

TRANSLATES LINE LEVELS TO LOGIC LEVELS.

C	D
H	L
L	H

A	B
H	H
L	L

**RESISTOR TERMINATOR**

PROVIDES LINE LOAD FOR THE LINE DRIVER.

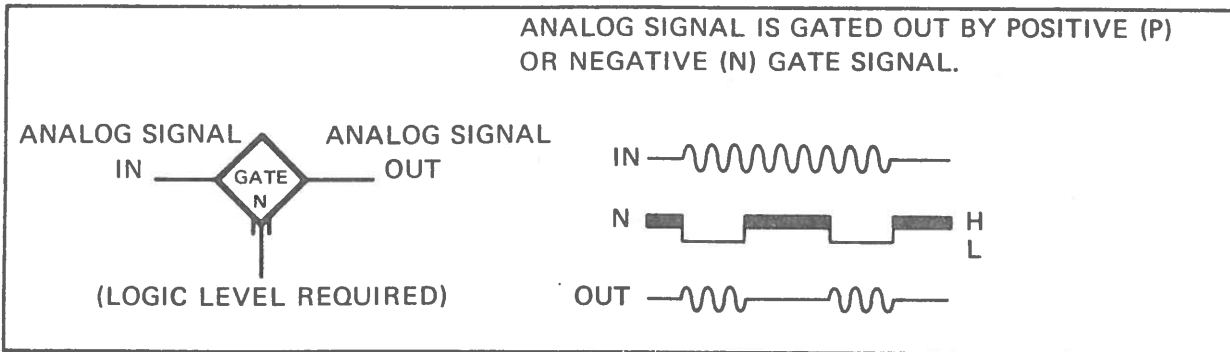
**RESISTOR TO VOLTAGE**

PROVIDES RESISTANCE TO VOLTAGE (V).

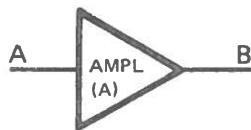
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Table 9-2. Symbols (Cont.)

**ANALOG GATE**



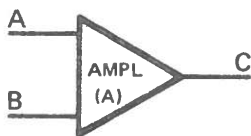
**AMPLIFIER (SINGLE INPUT)**



(A) INDICATES AMPLIFIER GAIN.

$B = A \text{ (INPUT)} \times \text{AMPLIFIER GAIN (A)}$

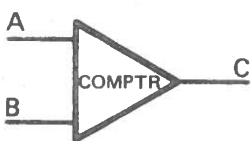
**AMPLIFIER (TWO INPUTS)**



(A) INDICATES AMPLIFIER GAIN. A AND B ARE USUALLY OPPOSITE POLARITY.

$C = (A \pm B) \times \text{AMPLIFIER GAIN (A)}$

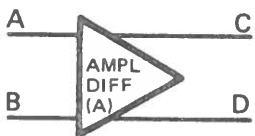
**COMPARATOR**



COMPARES LEVEL OF ONE INPUT SIGNAL AGAINST ANOTHER (WHERE A IS REFERENCE LEVEL).

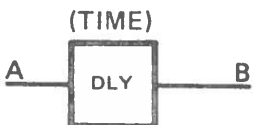
OUTPUT C IS HIGH IF  $B \geq A$   
OUTPUT C IS LOW IF  $B < A$

**DIFFERENTIAL AMPLIFIER**



SIGNAL AT C, D  $\propto$  TO SIGNAL AT A, B.  
(A) INDICATES NOMINAL GAIN.

**DELAY LINE**



(TIME) = DELAY TIME IN sec, ms, or  $\mu\text{sec}$ .

$B = A \text{ DELAYED BY (TIME)}$

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### 9.3 OPERATIONAL DIAGRAMS

A set of operational diagrams is provided for each of the following operations:

Power-On/Head-Load (Figures 9-1, 9-2, 9-3)

Power-Off/Head-Unload (Figures 9-4, 9-5, 9-6)

Recalibrate (Figures 9-7, 9-8, 9-9)

Seek (Figures 9-10, 9-11, 9-12)

Read (Figures 9-13, 9-14, 9-16)

Write (Figures 9-13, 9-15)

Except for the read and the write operations, a functional block diagram, a flowchart of events, and a timing diagram comprise the diagram set for each operation. A single functional block diagram shows both the read and the write operations, and there are no timing diagrams for reading and writing. A separate flowchart of events is presented for reading, writing, and reading with defect detector enabled.

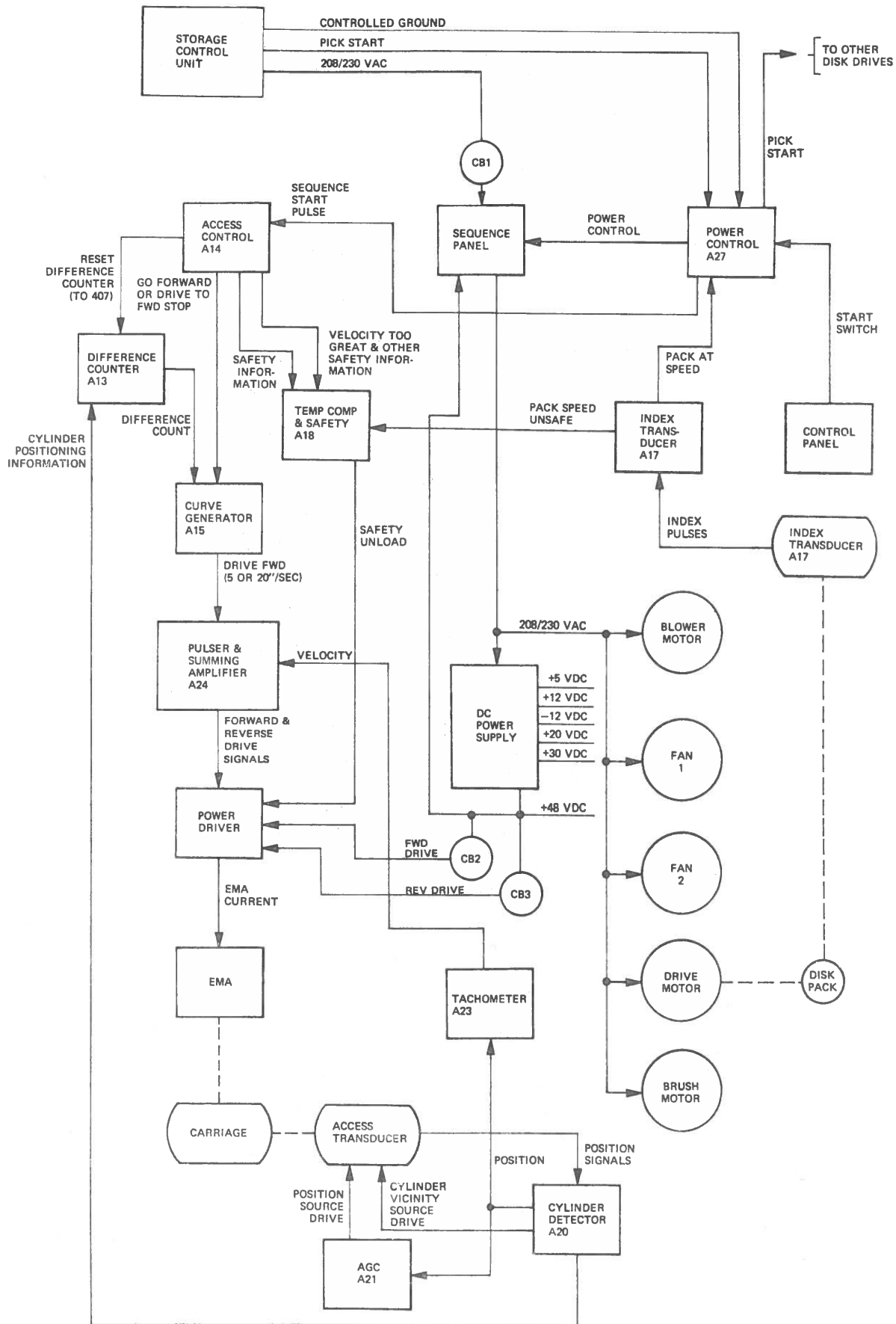
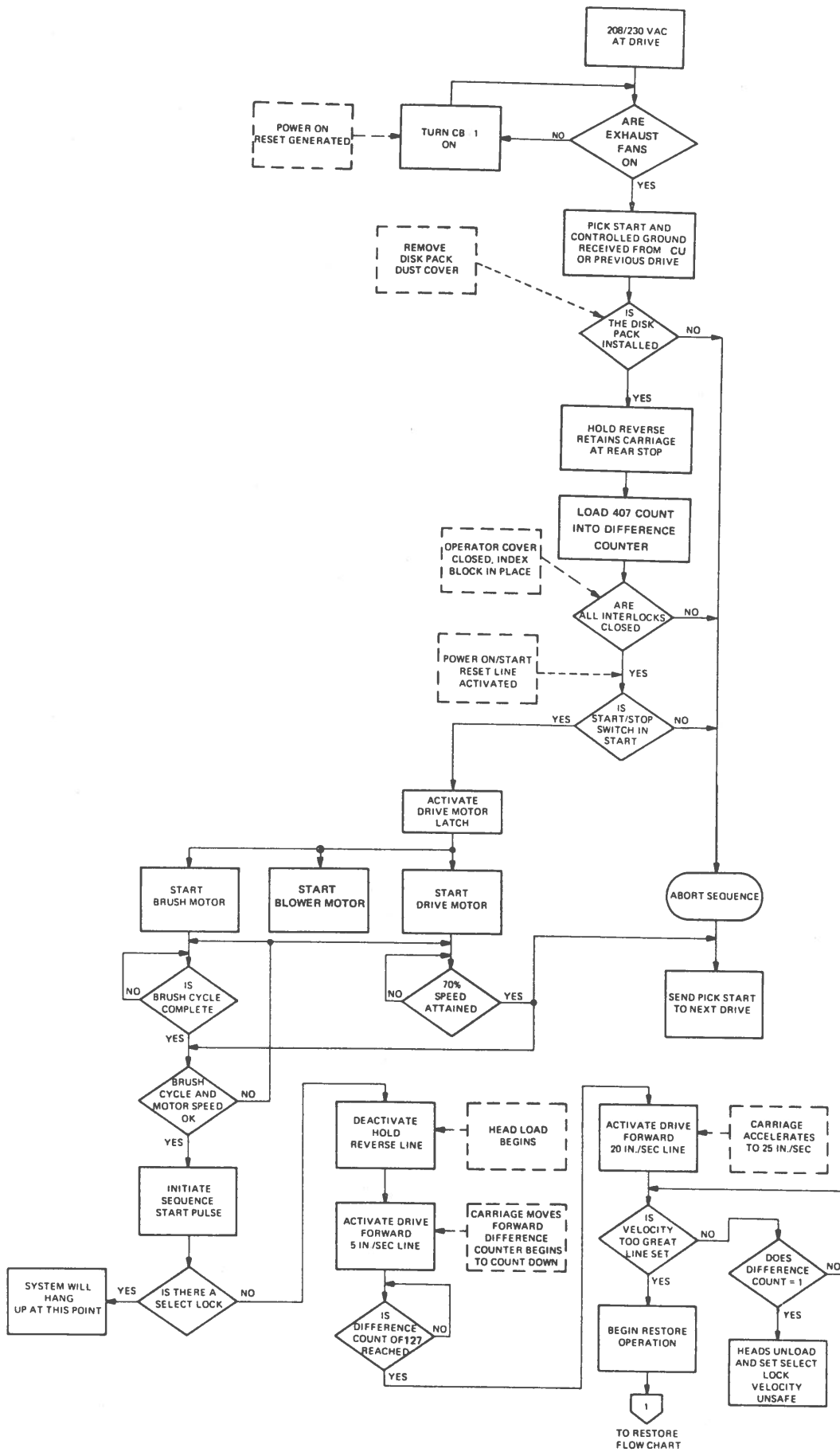


Figure 9-1. Power-On/Head-Load Operation

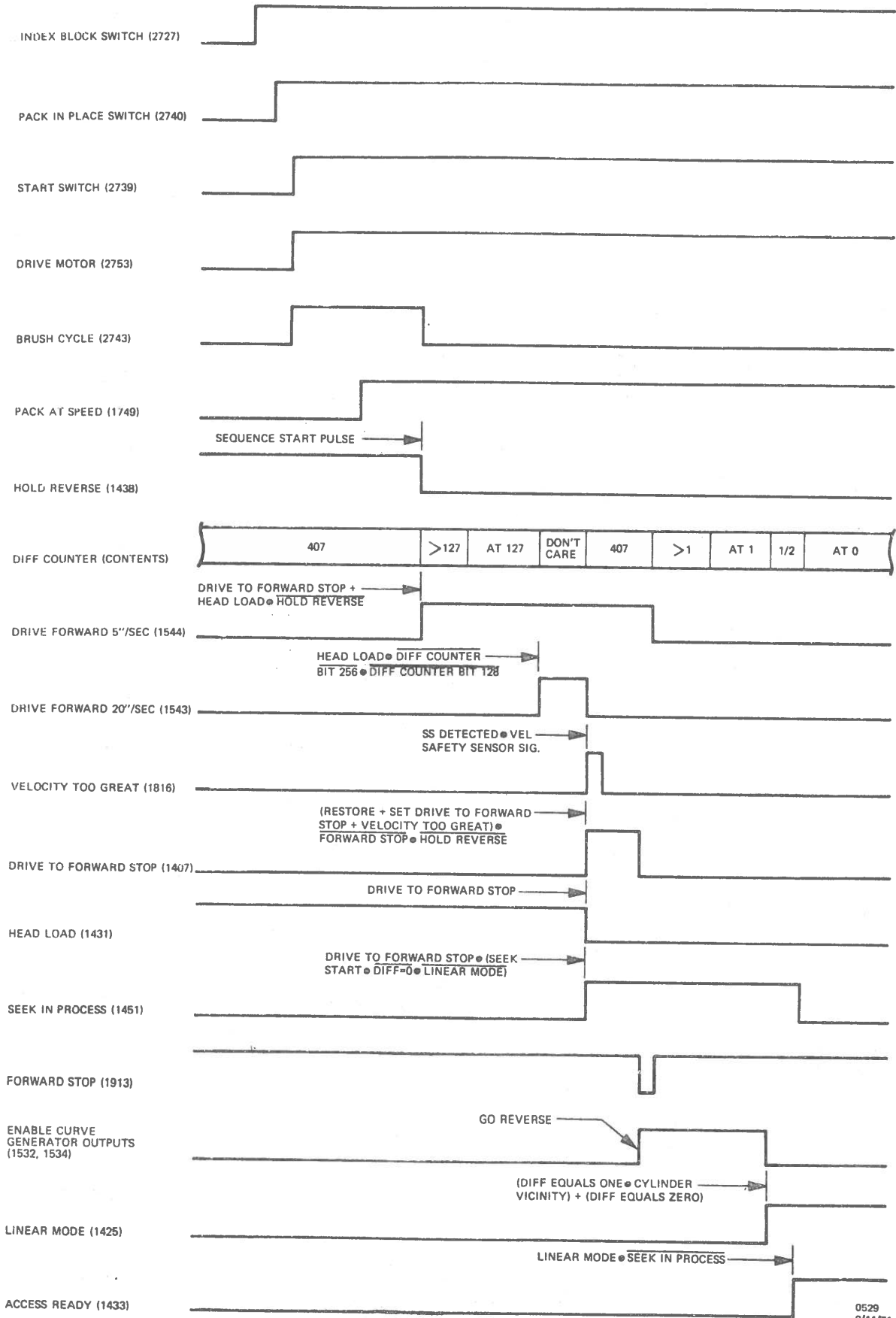
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A15/A24

0528  
9/11/71

Figure 9-2. Power-On/Head-Load Events



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9/11/71

Figure 9-3. Power-On/Head-Load Timing

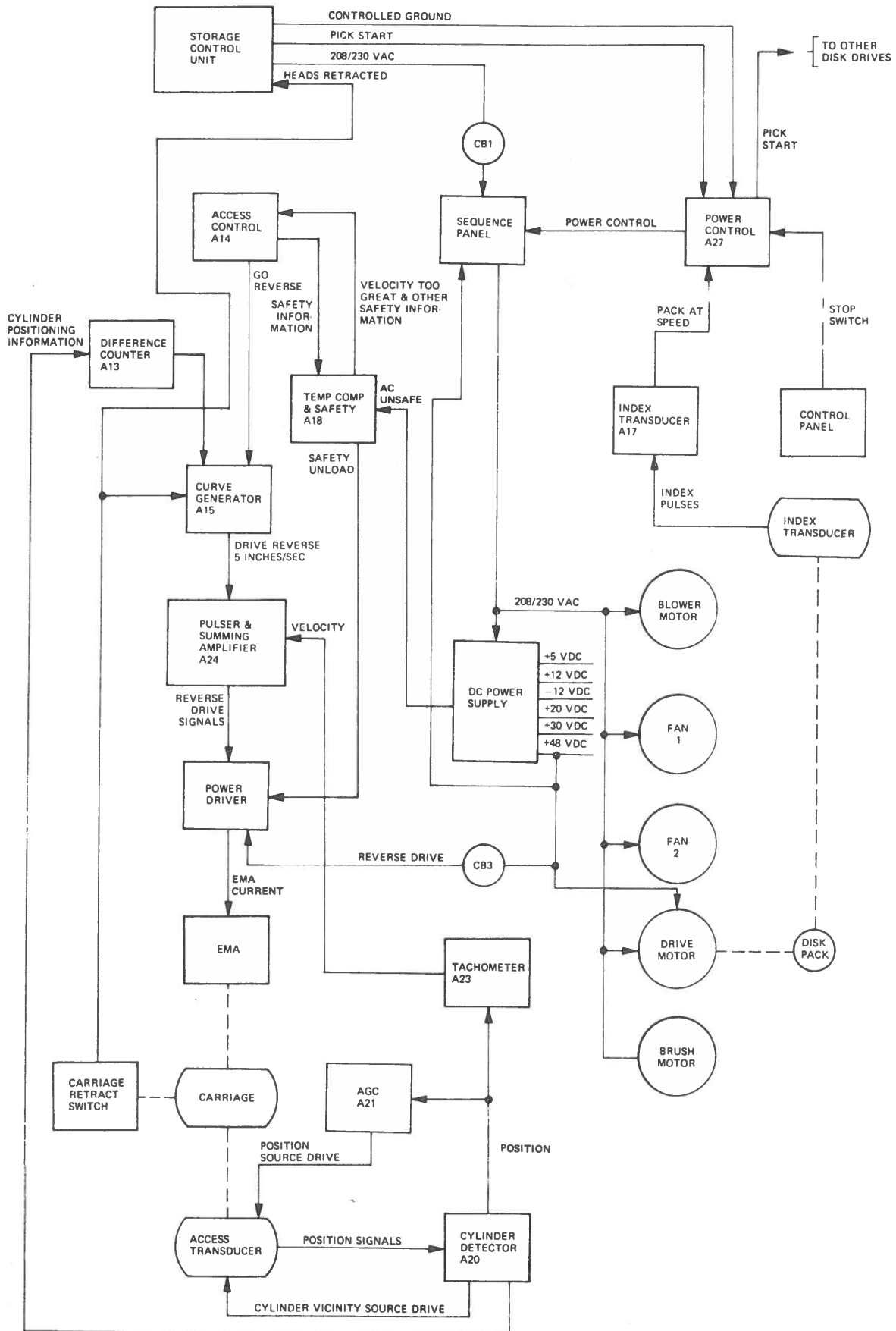
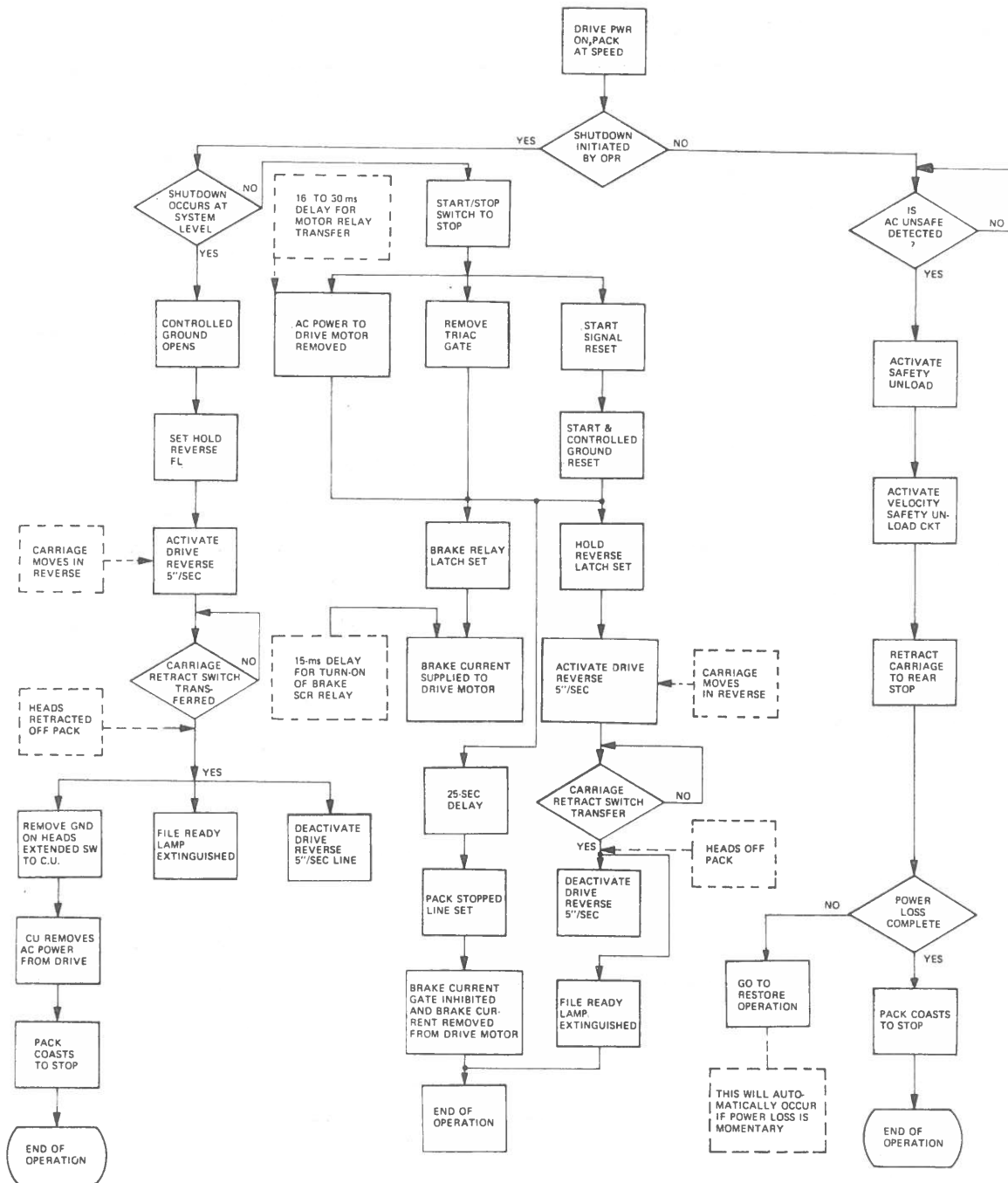


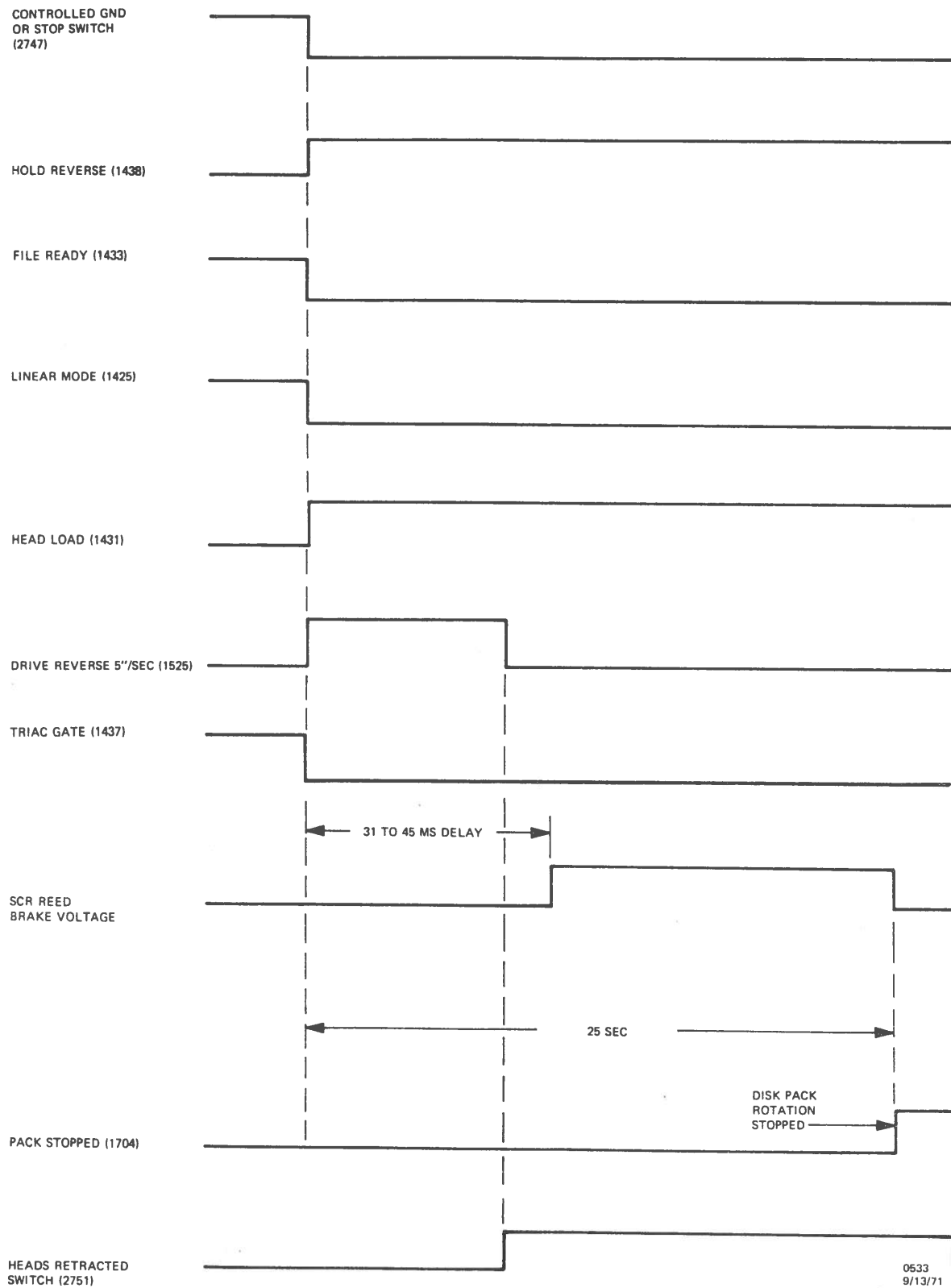
Figure 9-4. Power-Off/Head-Unload Operation

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Figure 9-5. Power-Off/Head-Unload Events



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Figure 9-6. Power-Off/Head-Unload Timing

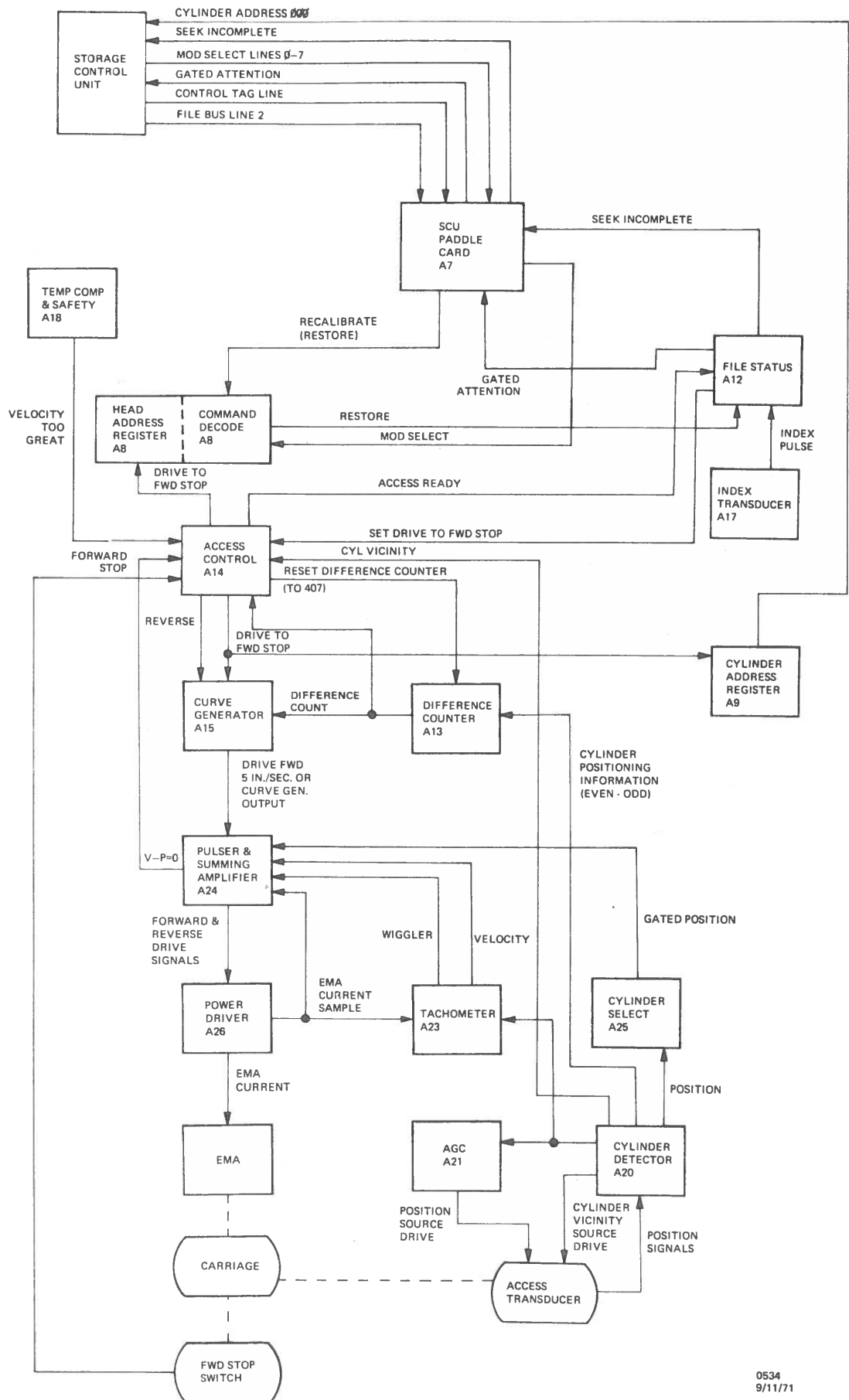
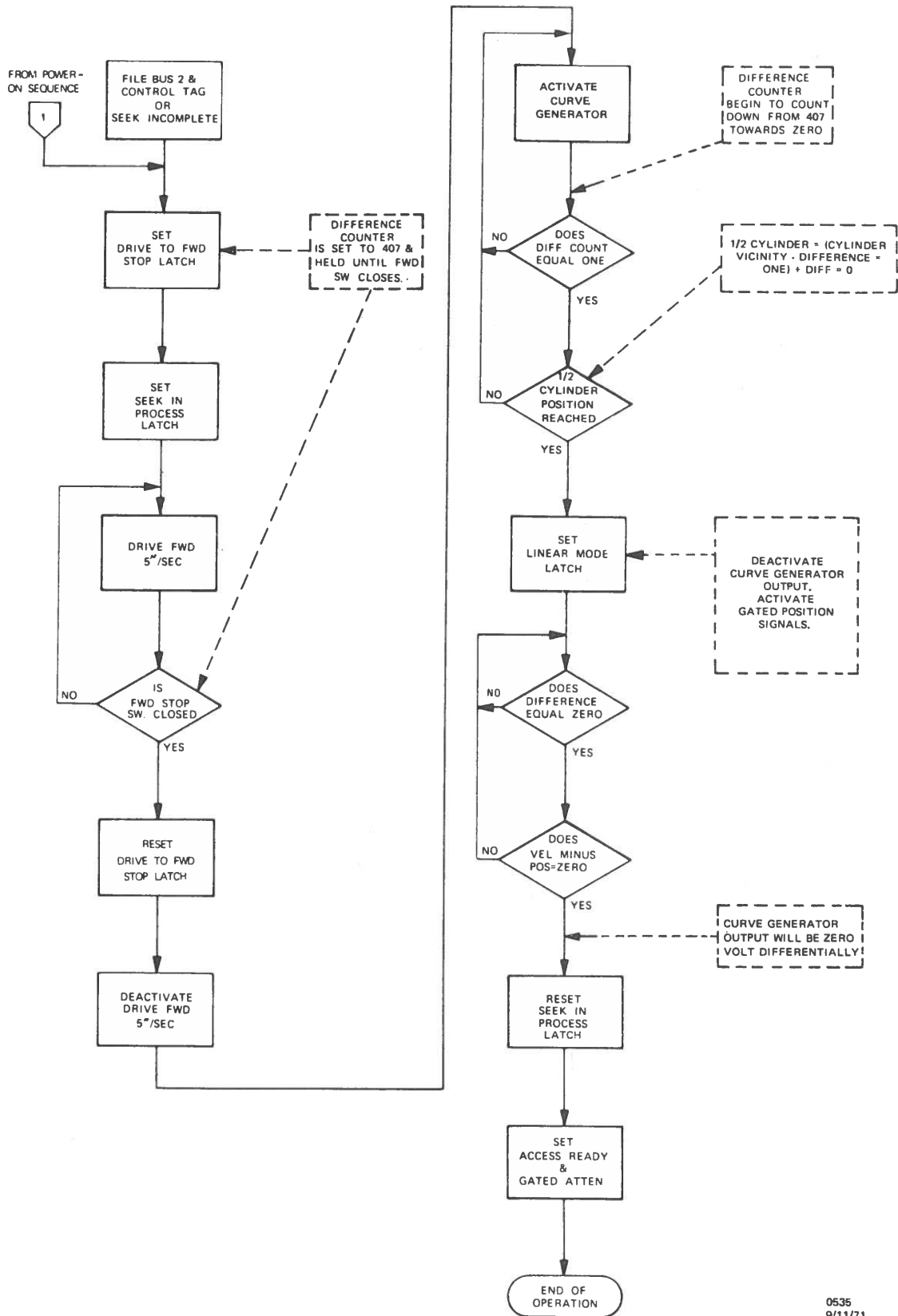


Figure 9-7. Recalibrate (Restore) Operation

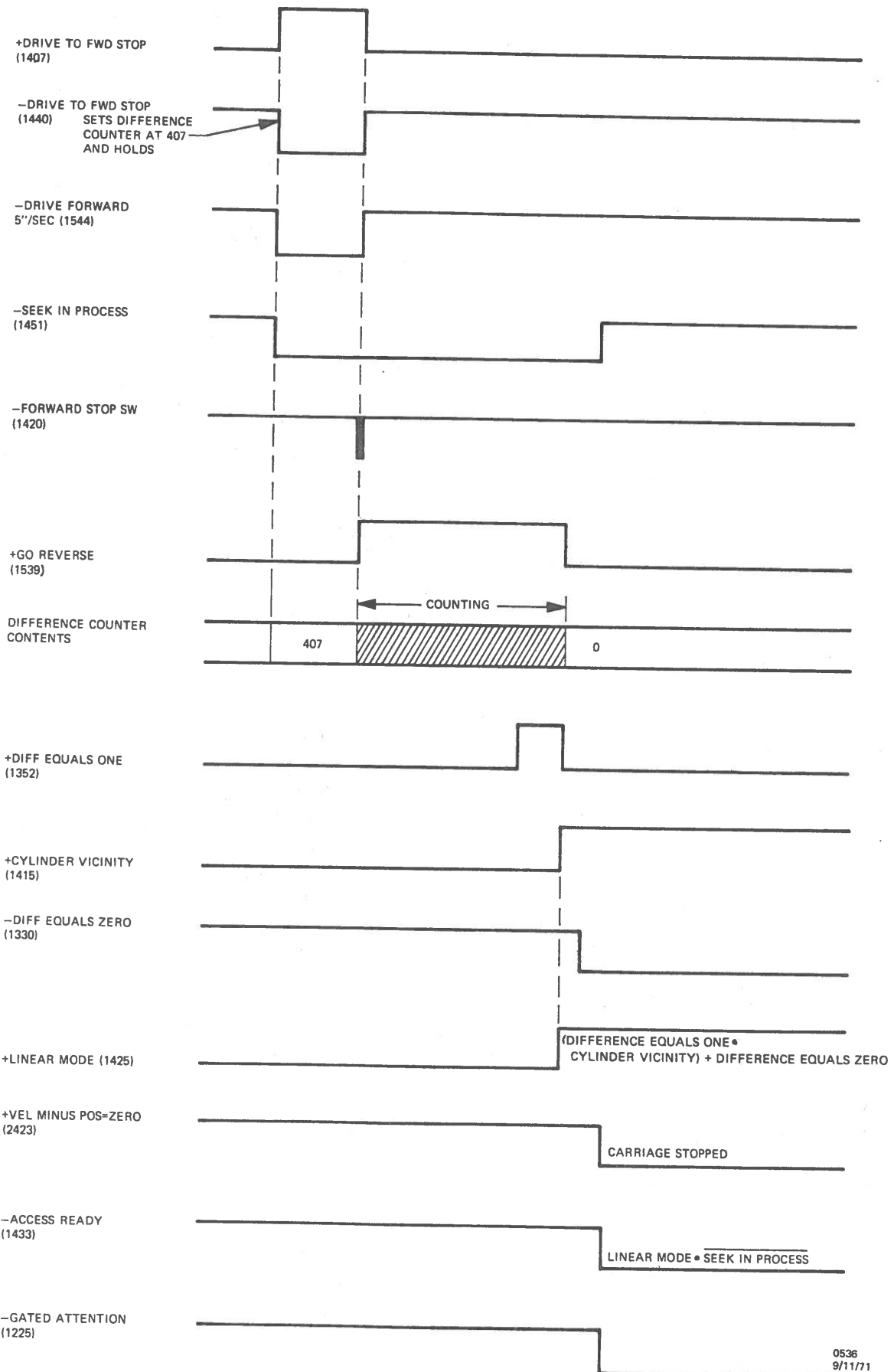
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Figure 9-8. Recalibrate (Restore) Events



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Figure 9-9. Recalibrate (Restore) Timing

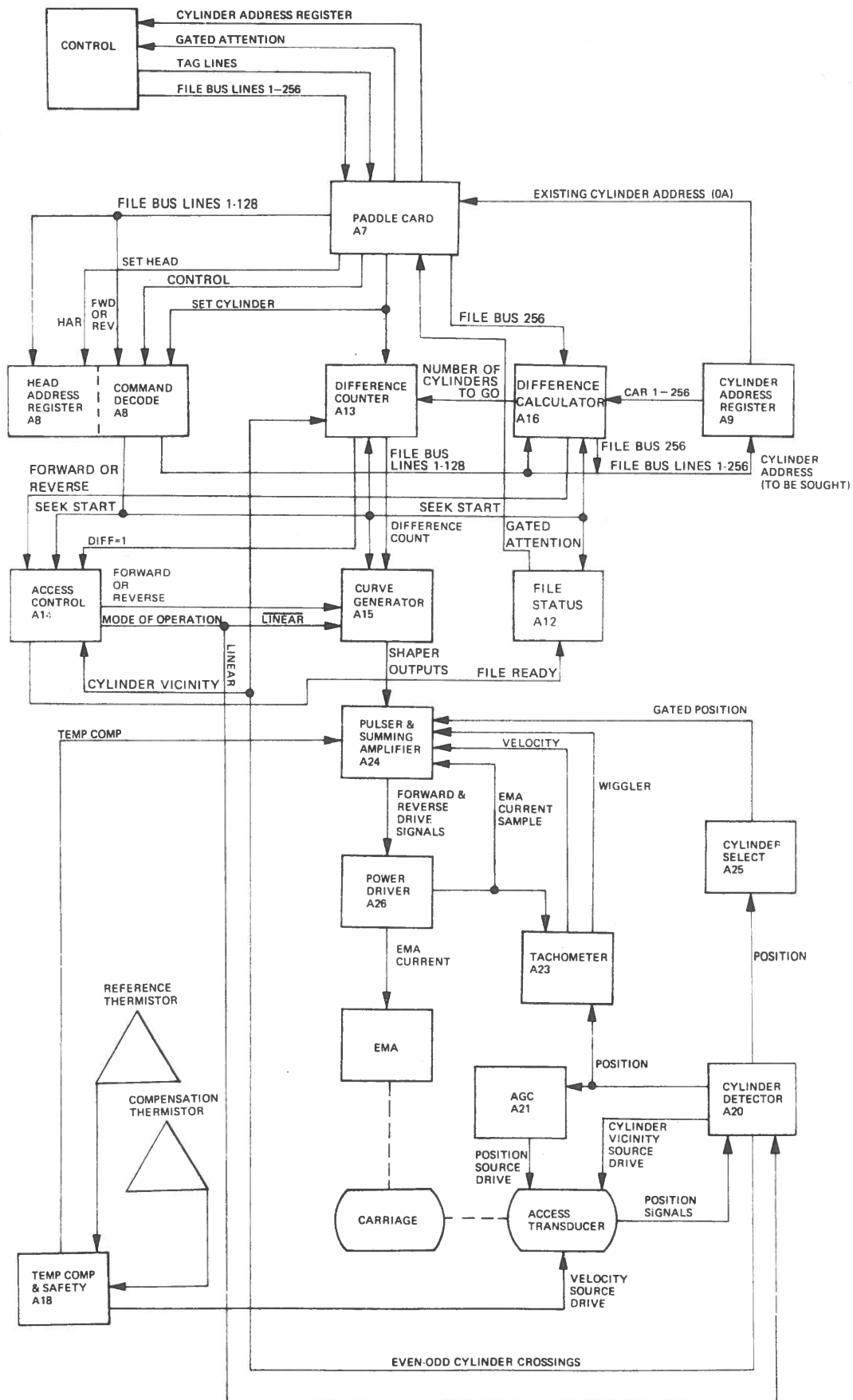


Figure 9-10. Seek Operation

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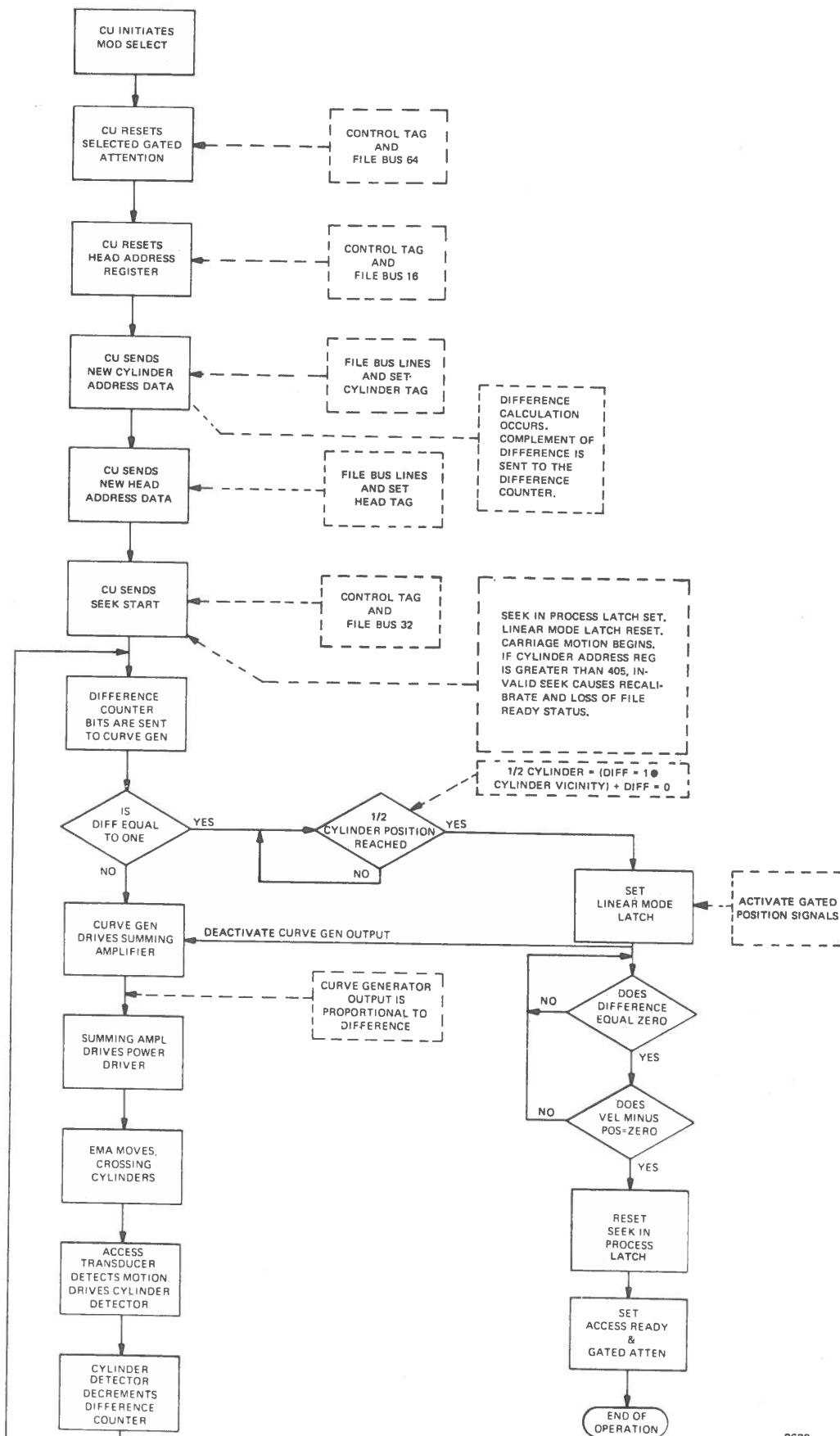


Figure 9-11. Seek Events

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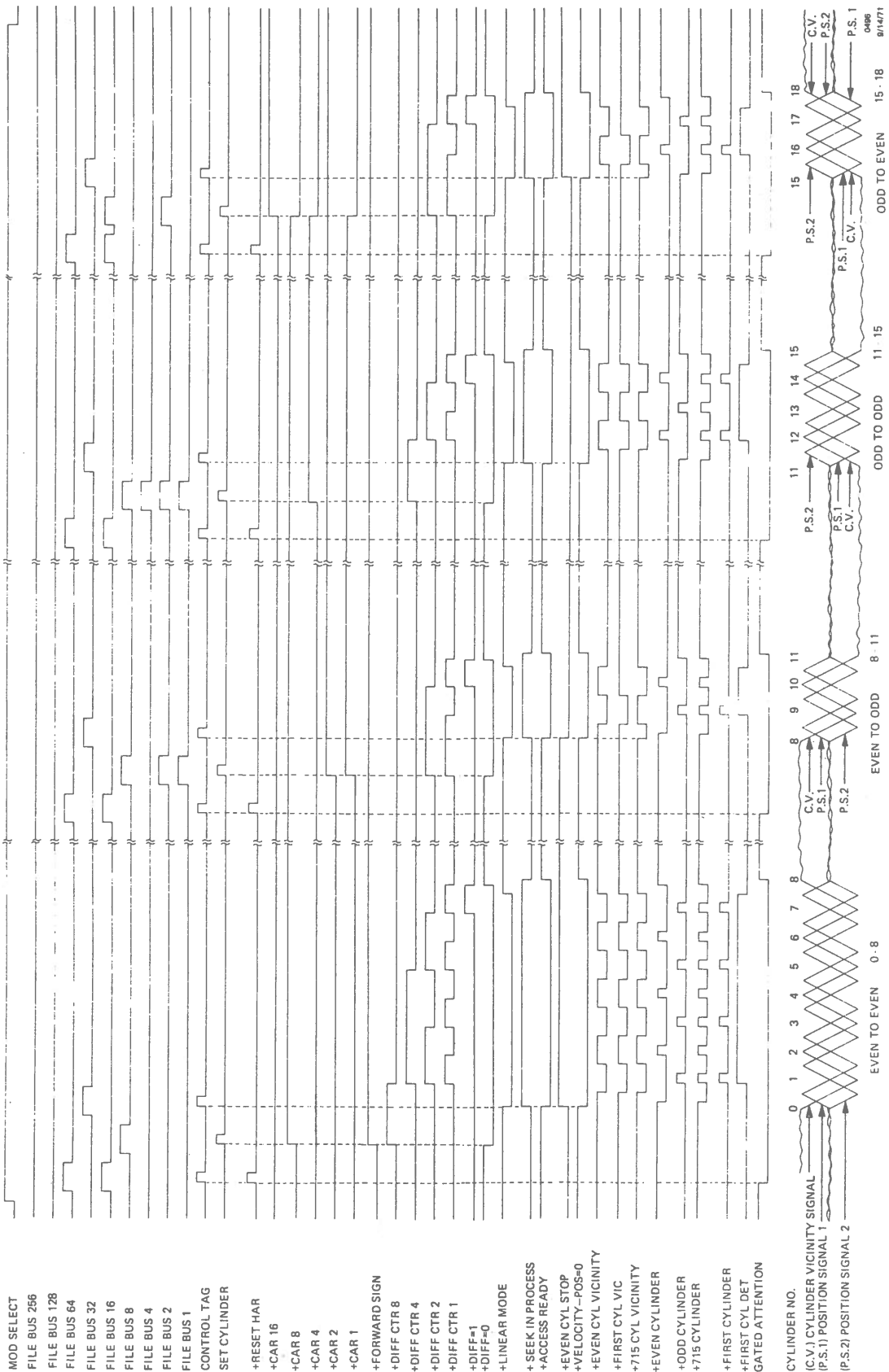
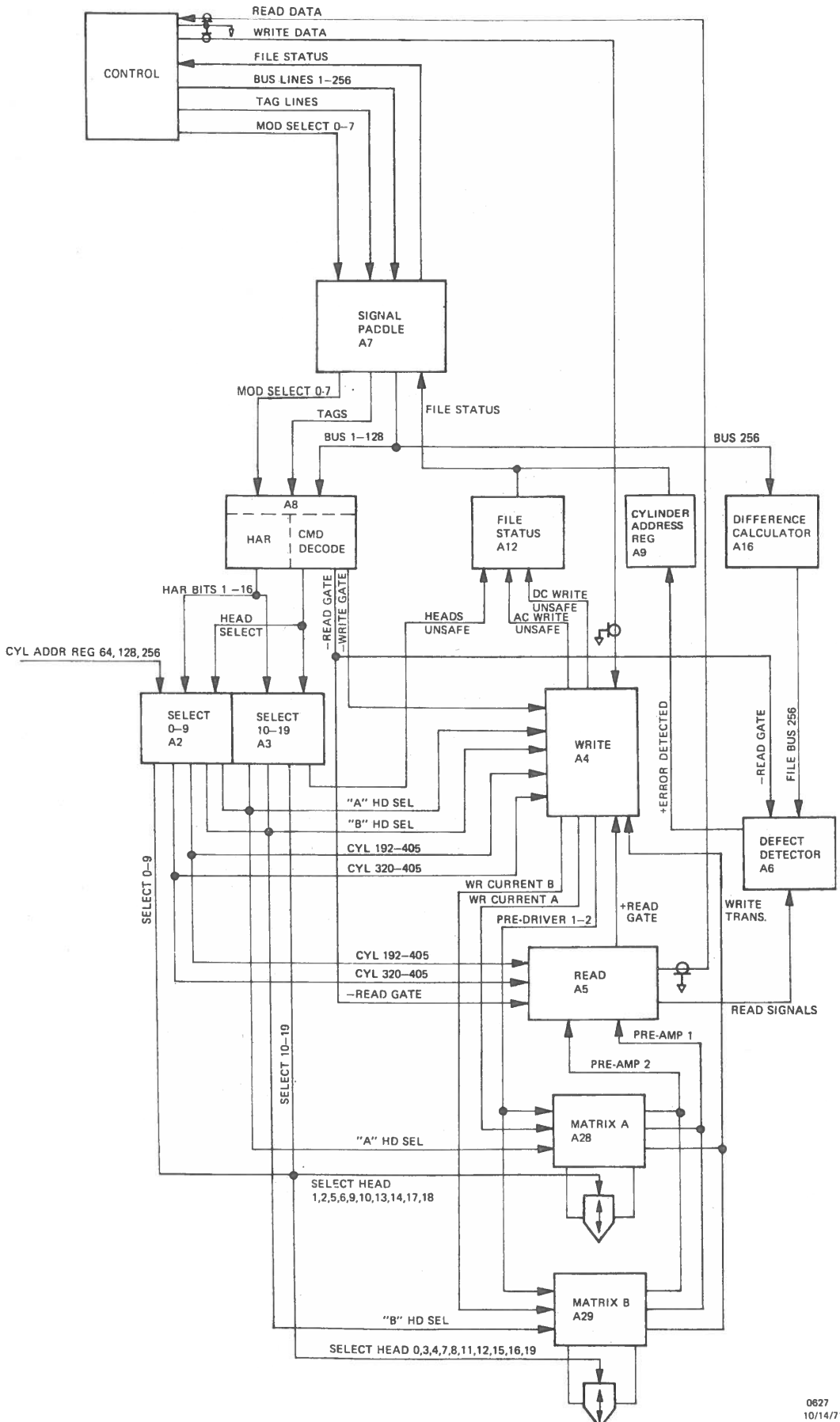


Figure 9-12. Seek Timing



0827  
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Figure 9-13. Read and Write Operations 715DEC

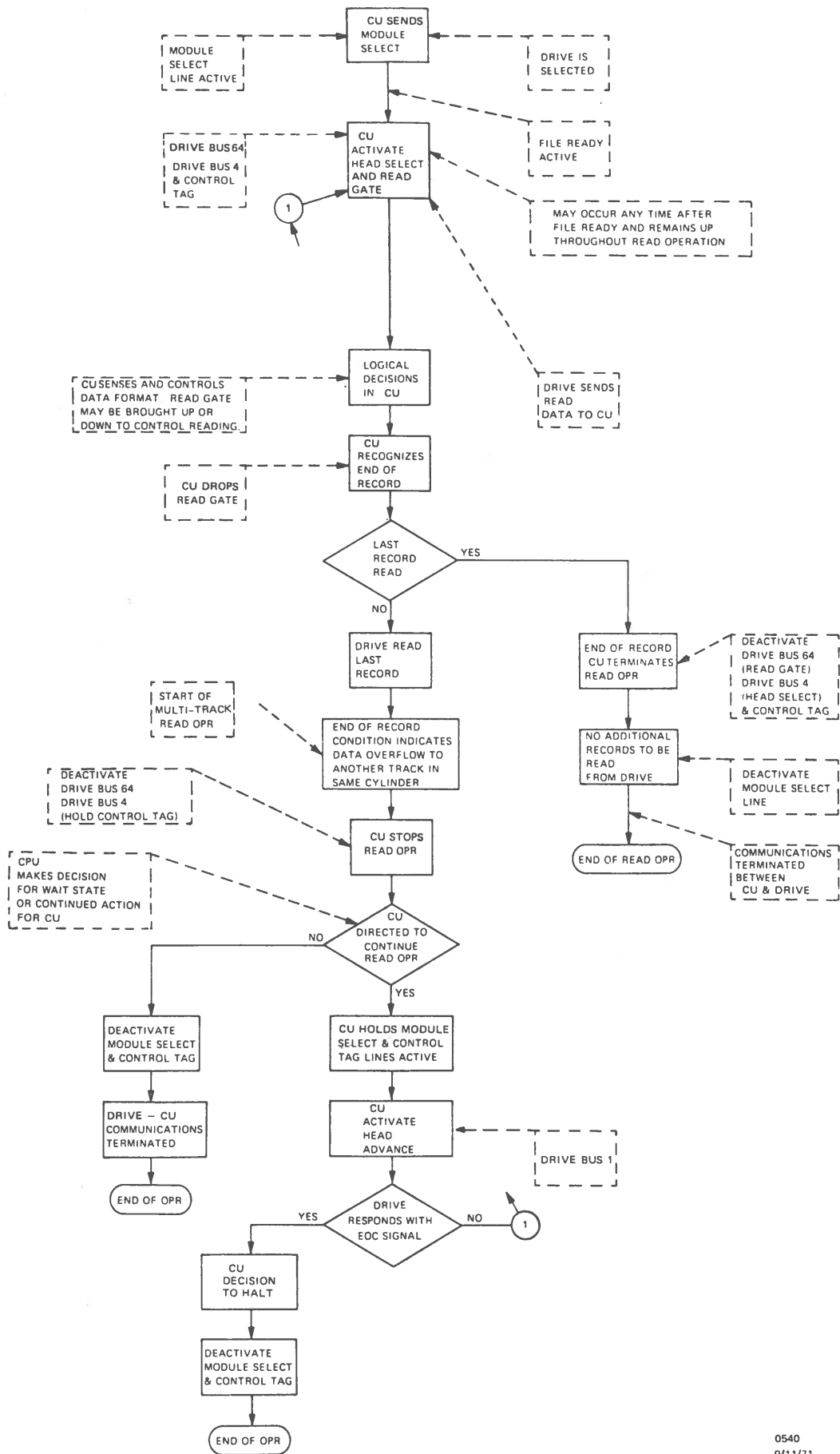


Figure 9-14. Typical Read Events

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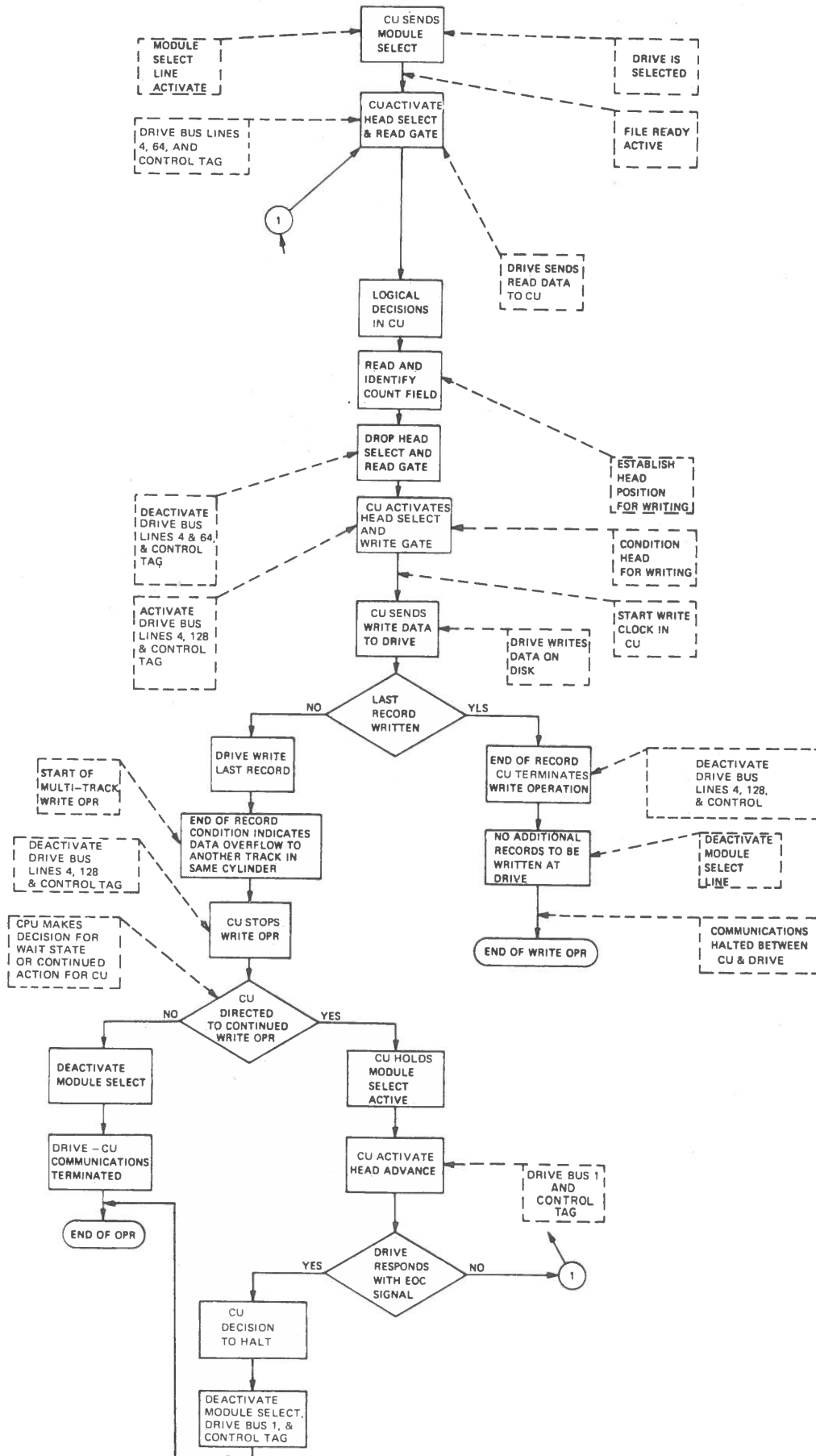


Figure 9-15. Typical Write Events



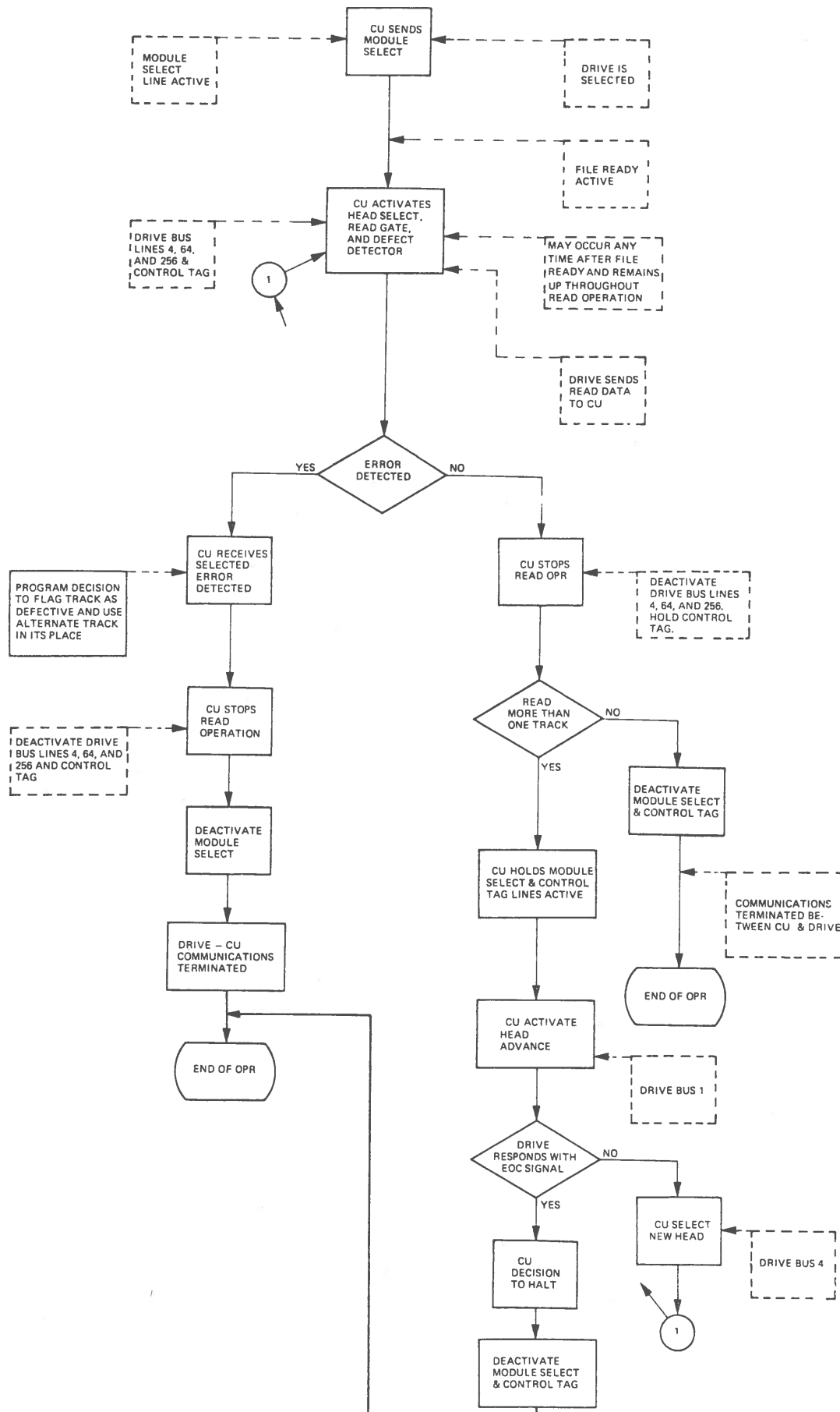


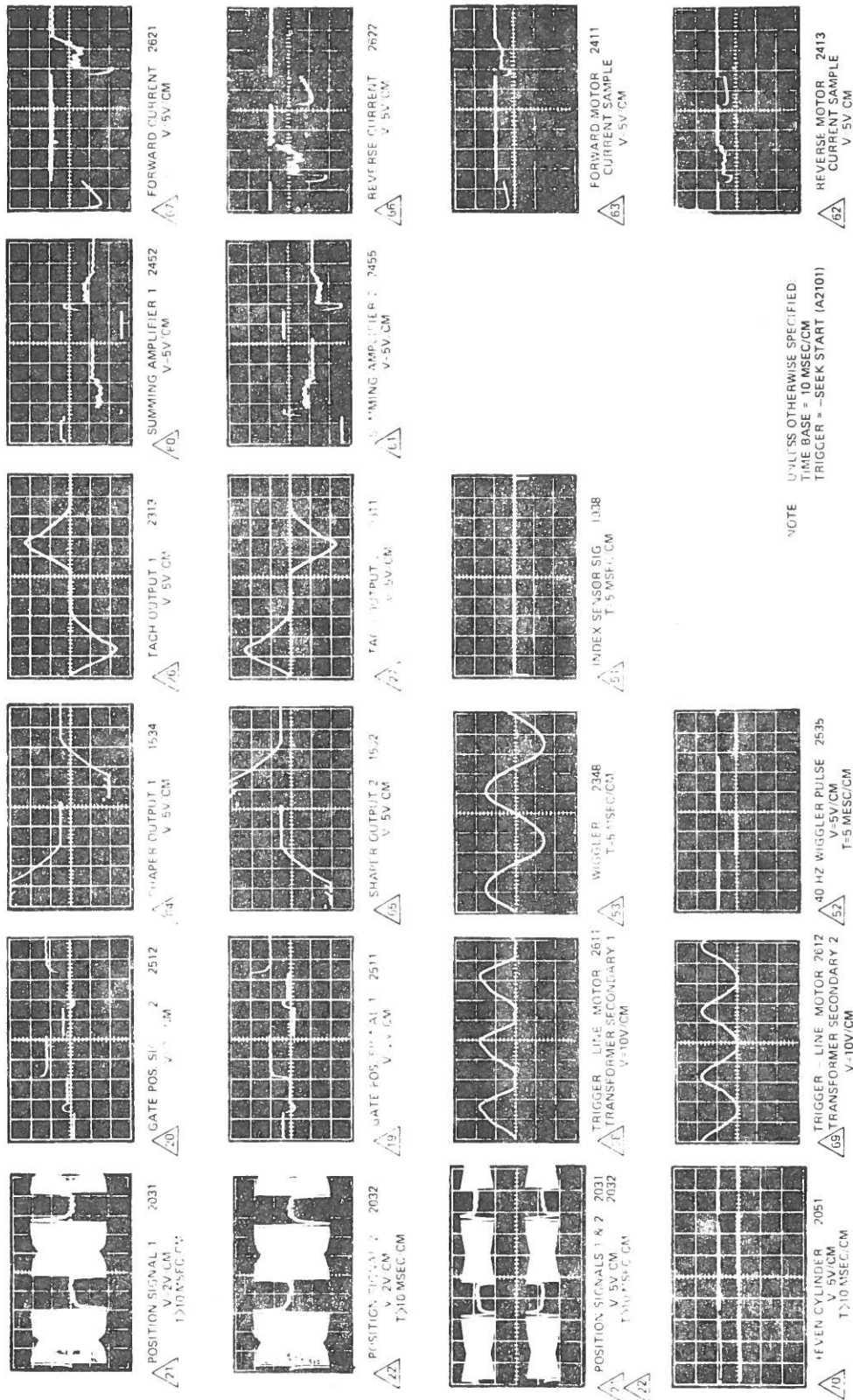
Figure 9-16. Read Events With Track Defect Detector Enabled

## 9.4 WAVEFORMS

Two set of waveforms are given:

1. For a 192-cylinder seek-seek operation.
2. For an 8-cylinder seek-seek operation.

Each waveform is identified by a number in a triangle, such as  $\triangle 15$ . The number in the triangle is also shown beside the signal that it represents on the appropriate logic diagram, presented later in this chapter. Also, identifying the signal are the socket and pin numbers shown below the waveform, such as 1532 (where 15 is the socket number and 32 is the pin number).



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Figure 9-17. Oscilloscope Traces of Signals: 192-Cylinder Seek-Seek Condition

# SIGNAL CABLE

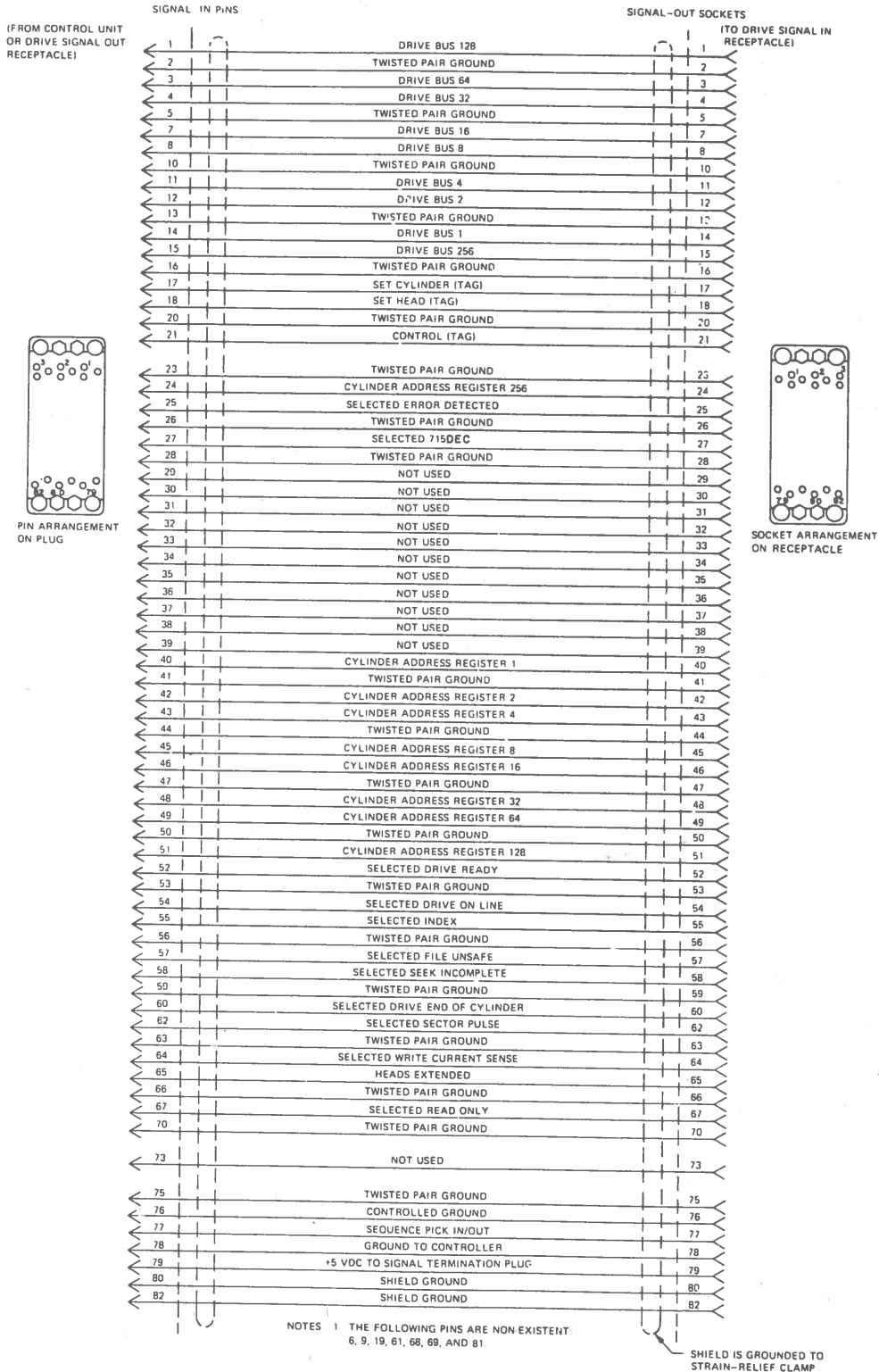


Figure 9-20. Signal Cable Diagram

## 9.6 PWA ASSIGNMENT

Table 9-3 lists the printed wiring assemblies located in the electronic gate (see Figure 9-21). The revision level of each part number is found in the Parts Catalog, UP 002341-2.

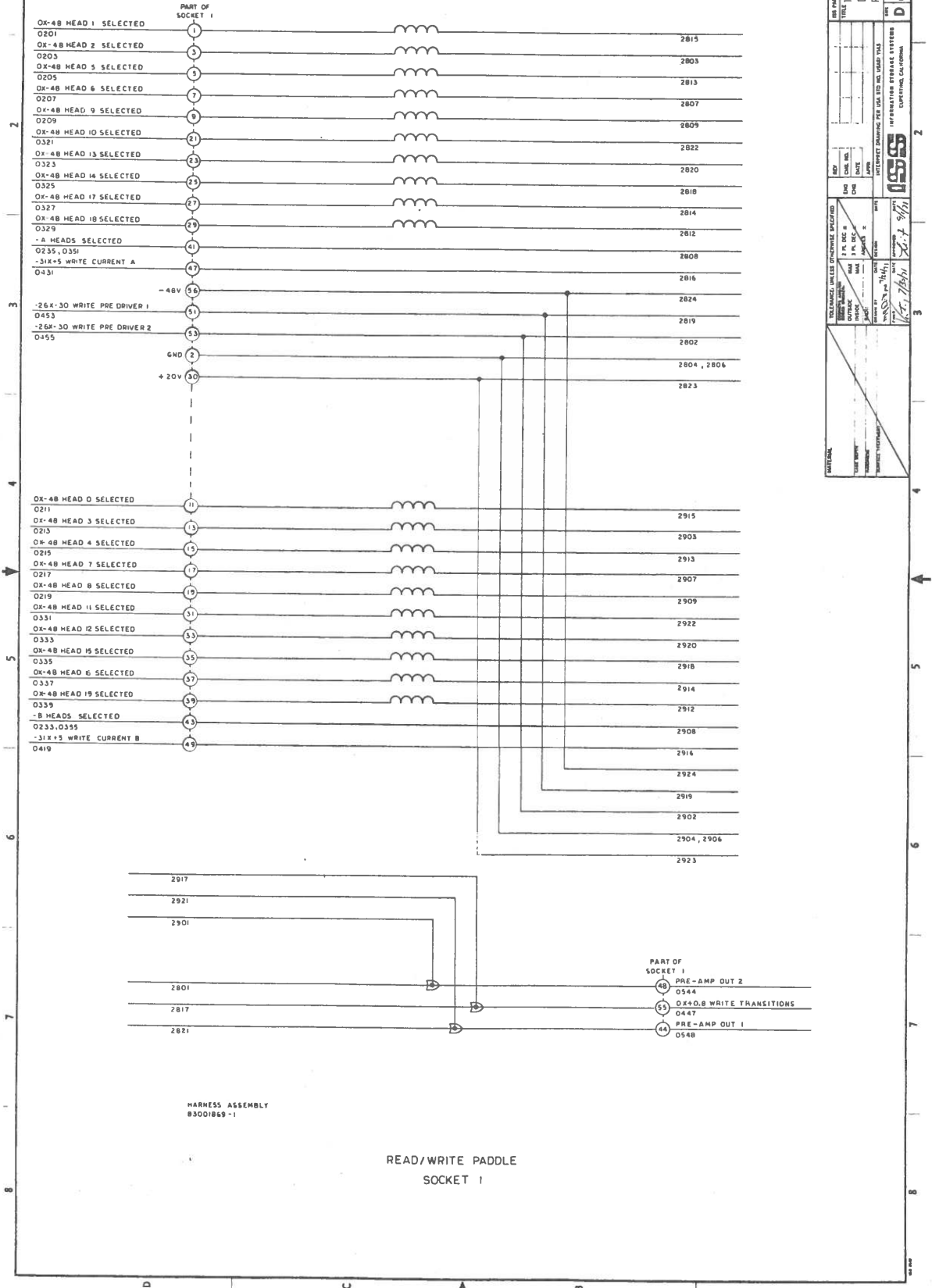
Table 9-3. PWA Assignments in Electronic Gate

GATE POS.	PART NUMBER	PWA TITLE
1	INTERFACE	READ/WRITE PADDLE
2	75000003-X	SELECT 0-9
3	75000068-X	SELECT 10-19
4	75004343-X	WRITE
5	75003548-X	READ
6	75003978-X	DEFECT DETECTOR
7	INTERFACE	SIGNAL PADDLE
8	75004484-X	HEAD ADDRESS REGISTER (HAR)
9	75003727-X	CYLINDER ADDRESS REGISTER (CAR)
10	TEST ONLY	
11	NOT USED	
12	75003461-X	FILE STATUS
13	75003728-X	DIFFERENCE COUNTER
14	75003370-X	ACCESS CONTROL
15	75002523-X	CURVE GENERATOR
16	75004293-X	DIFFERENCE CALCULATOR
17	75003462-X	INDEX TRANSDUCER
18	75004139-X	TEMPERATURE COMP & SAFETY
19	INTERFACE	TRANSDUCER PADDLE
20	75003713-X	CYLINDER DETECTOR
21	75002521-X	AUTOMATIC GAIN CONTROL (AGC)
22	NOT USED	
23	75003719-X	TACHOMETER
24	75003720-X	PULSER AND SUMMING AMP
25	75004138-X	CYLINDER SELECTOR
26	INTERFACE	PWR SEQ AND PULSER PADDLE
27	75003394-X	POWER CONTROL
* 28	75000065-X	MATRIX A
* 29	75000065-X	MATRIX B

\* These PWA'S located on CAM Tower

07001869-1A

07001869-1A  
 RELEASED FOR AMST. BY: [ ]  
 SKT 1



07001869-1A  
 THE INTERCONNECTION  
 DIAGRAM -  
 READ/WRITE PADDLE

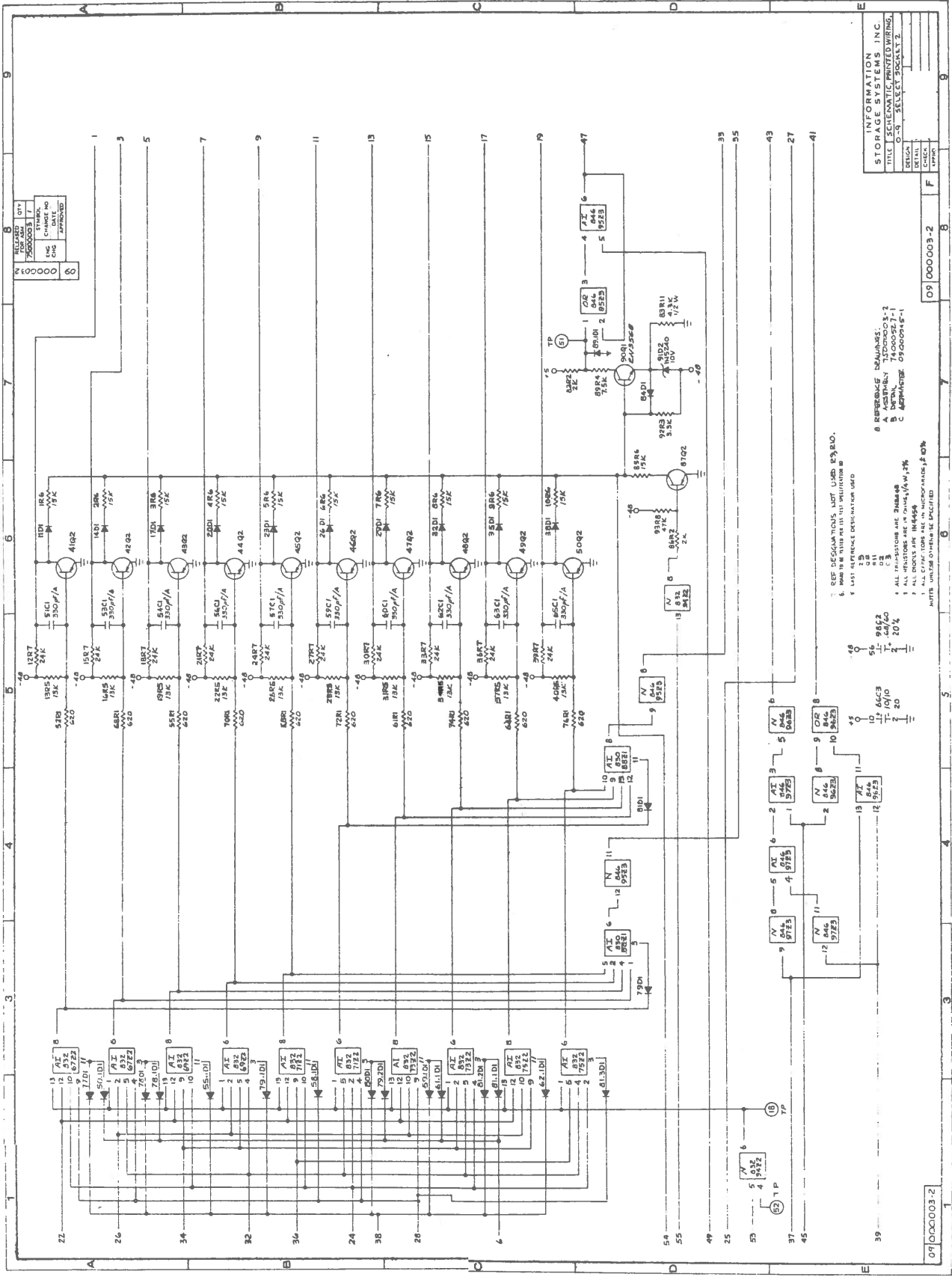
DATE: 8/21/71  
 DRAWING NO. D 07001869-1A  
 INFO: NONE

REVISIONS UNLESS OTHERWISE SPECIFIED:  
 1. P. DC & [ ]  
 2. [ ]  
 3. [ ]

DESIGNED BY: [ ]  
 CHECKED BY: [ ]  
 DATE: [ ]  
 DRAWN BY: [ ]  
 DATE: [ ]

INTERCONNECT DRAWING PER MIL-STD-883C, TEST METHOD 2000  
 INTERCONNECT DRAWING PER MIL-STD-883C, TEST METHOD 2000

WASSON SYSTEMS, INC.  
 1701 Alhambra Blvd., Alhambra, CA 91701

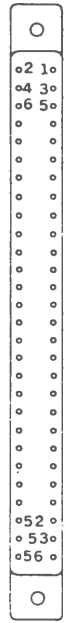
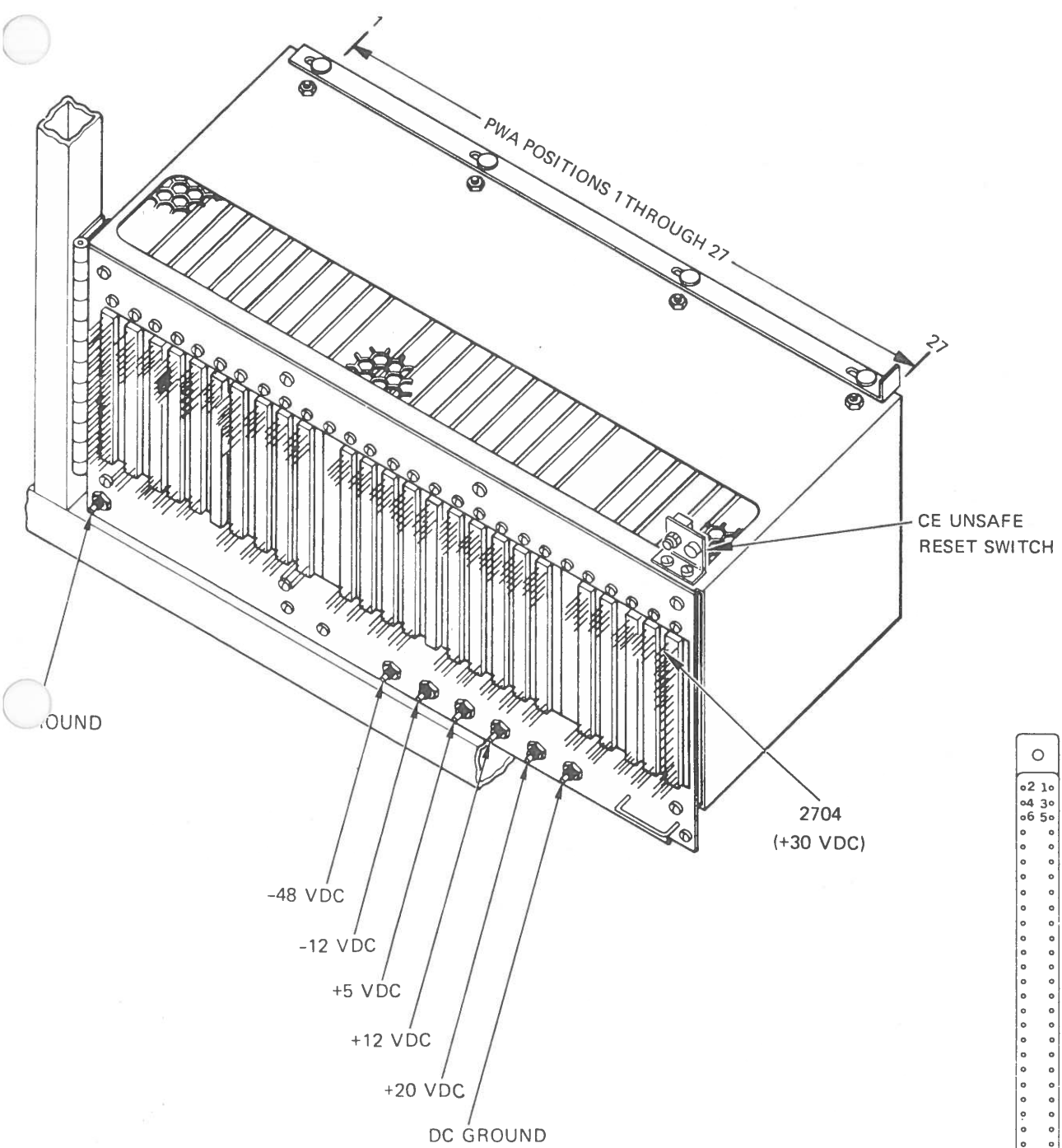


REV.	DATE	BY
1	7/20/52	STW
2	7/20/52	STW
3	7/20/52	STW
4	7/20/52	STW
5	7/20/52	STW
6	7/20/52	STW

INFORMATION	
STORIAN INC.	
TITLE	SOCKET 2
DESIGN	09 000003-2
DETAIL	
APPR.	

- 1. KEEP DESIGNATIONS, NOT USED, IN BLOC.
- 2. ALL TRANSISTORS ARE 2N2484.
- 3. ALL RESISTORS ARE IN OHMS, UNLESS OTHERWISE SPECIFIED.
- 4. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
- 5. LAST REFERENCE DESIGNATION USED.
- 6. REFERENCE NUMBERS:
  - A. ASSEMBLY 7400003-2
  - B. DETAIL 7400002-1
  - C. APPROXIMATE 0900003-1

09 000003-2



CONNECTOR PIN  
DETAIL 0623  
10/13/71

VOLTAGE LEVELS	
NOMINAL	RANGE
-48 VDC	-43.7 TO -51.3 VDC
-12 VDC	-11.5 TO -13.5 VDC
+12 VDC	+11.5 TO +13.5 VDC
+20 VDC	+19.5 TO +21.5 VDC
+5 VDC	+4.75 TO +5.25 VDC
+30 VDC SOCKET 27, PIN 4	+27.6 TO +32.4 VDC

Figure 9-21. Electronic Gate



## 9.7 LOGIC AND SCHEMATIC DIAGRAMS

Logic diagrams and schematic diagrams for printed wiring assemblies (PWA's) are arranged in socket number order. Each diagram is a logical representation of a particular circuit configuration that is identified by a basic part number and a dash number.

In addition, schematic diagrams only are presented for the following circuits located elsewhere in the disk drive:

- DC Power Supply (50 Hz and 60 Hz)
- Sequence Panel (50 Hz and 60 Hz)
- Power Driver

The following PWA schematic diagrams are not included in this section due to their proprietary nature:

- PWA 6, Defect Detector
- PWA 18, Temp Comp and Safety
- PWA 20, Cylinder Detector
- PWA 21, AGC
- PWA 23, Tachometer

### 9.7.1 Pin Connections

Only pins used for input and output signals are shown on the diagrams. These pins correspond with sockets in the electronic gate or terminal connection points located on other components. Voltages and ranges are listed in Figure 9-21.

### 9.7.2 Line Names

Names assigned to signal lines on diagrams are listed at source output and destination input points. Additional information provided below the line name shows the socket and pin numbers for connection with other circuits.

For example, the output signal "+Velocity Too Great" from socket 18, pin 16 goes to 1406.

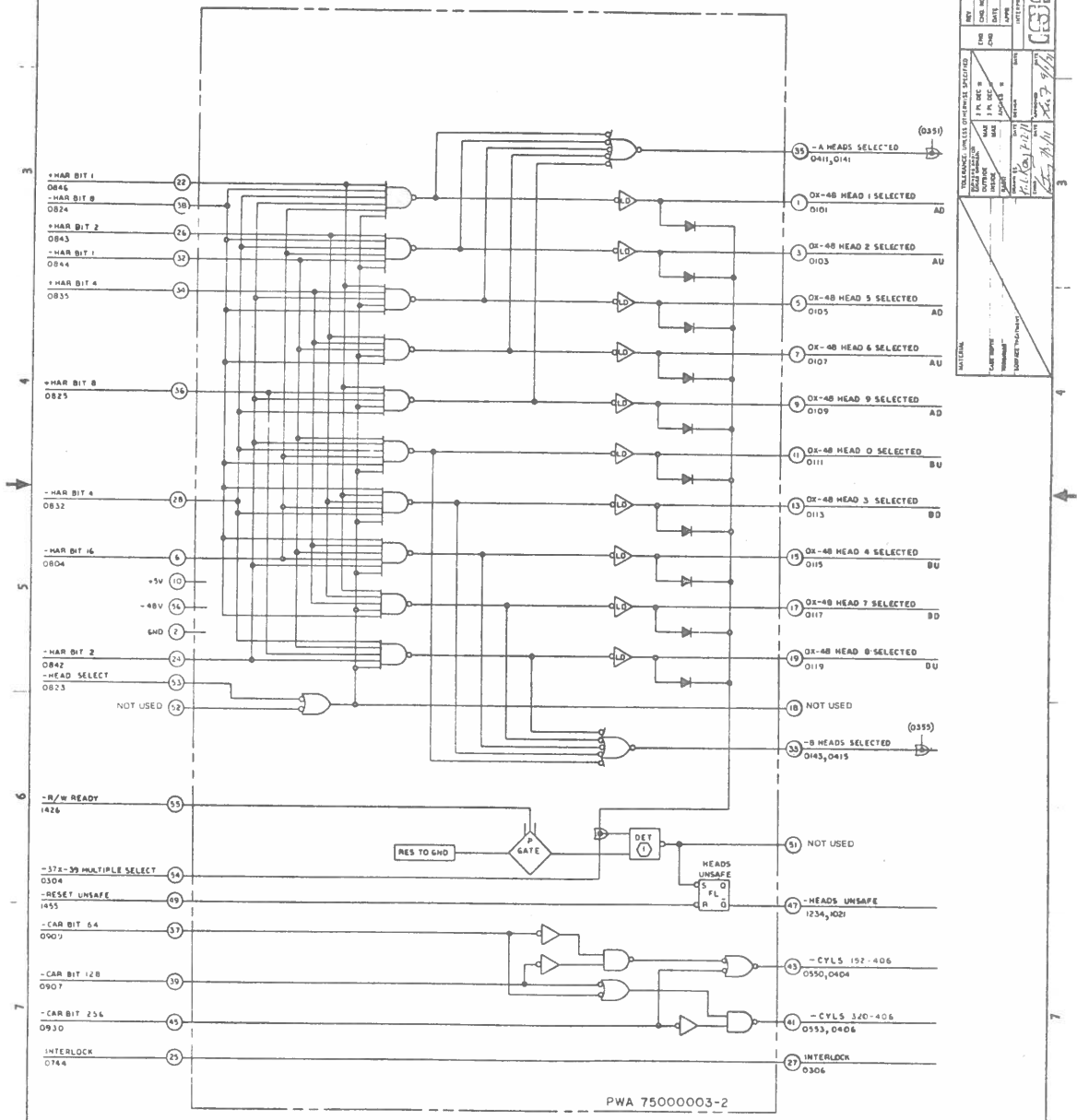
Where: 14 = Socket Number  
06 = Pin Number on Socket

07000003-2F

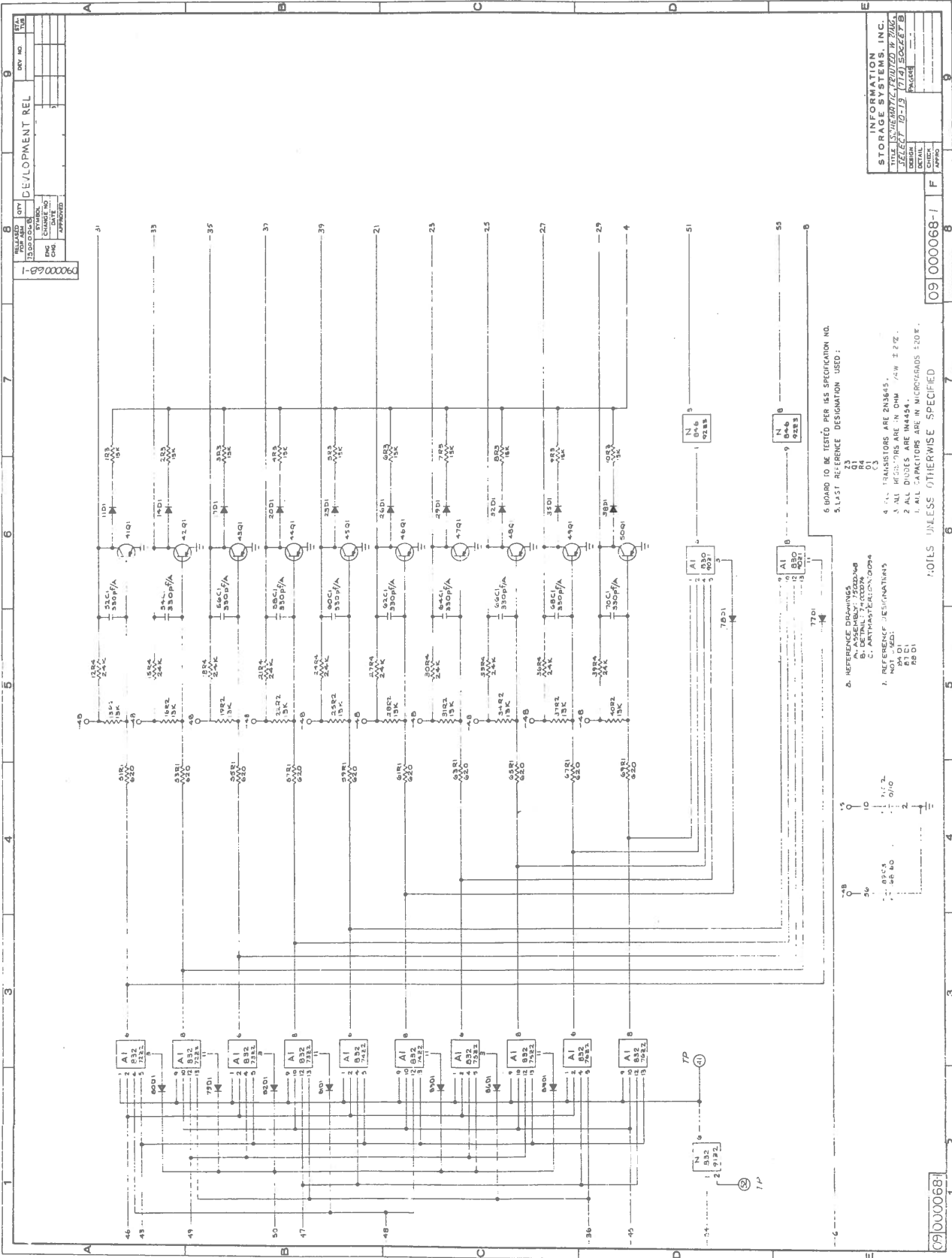
07000003-2F  
 SKT 2

07000003-2F  
 LOGIC DIAGRAM  
 SELECT 0-9

DATE: 10/21/64  
 BY: [Signature]  
 CHECKED BY: [Signature]  
 APPROVED BY: [Signature]  
 TITLE: LOGIC DIAGRAM  
 PART: 07000003-2F  
 DRAWING NO: 07000003-2F  
 REVISION: 1 OF 1



OUTPUT IS LOW IF 2 OR MORE HEADS SELECTED OR ANY HEAD SELECTED AND NO R/W READY  
 SELECT 0-9  
 SOCKET 2



REV. NO.	DATE	BY	CHK.
1	09/00/68		

DEVELOPMENT REEL

091000068-1

091000068-1

091000068-1

091000068-1

091000068-1

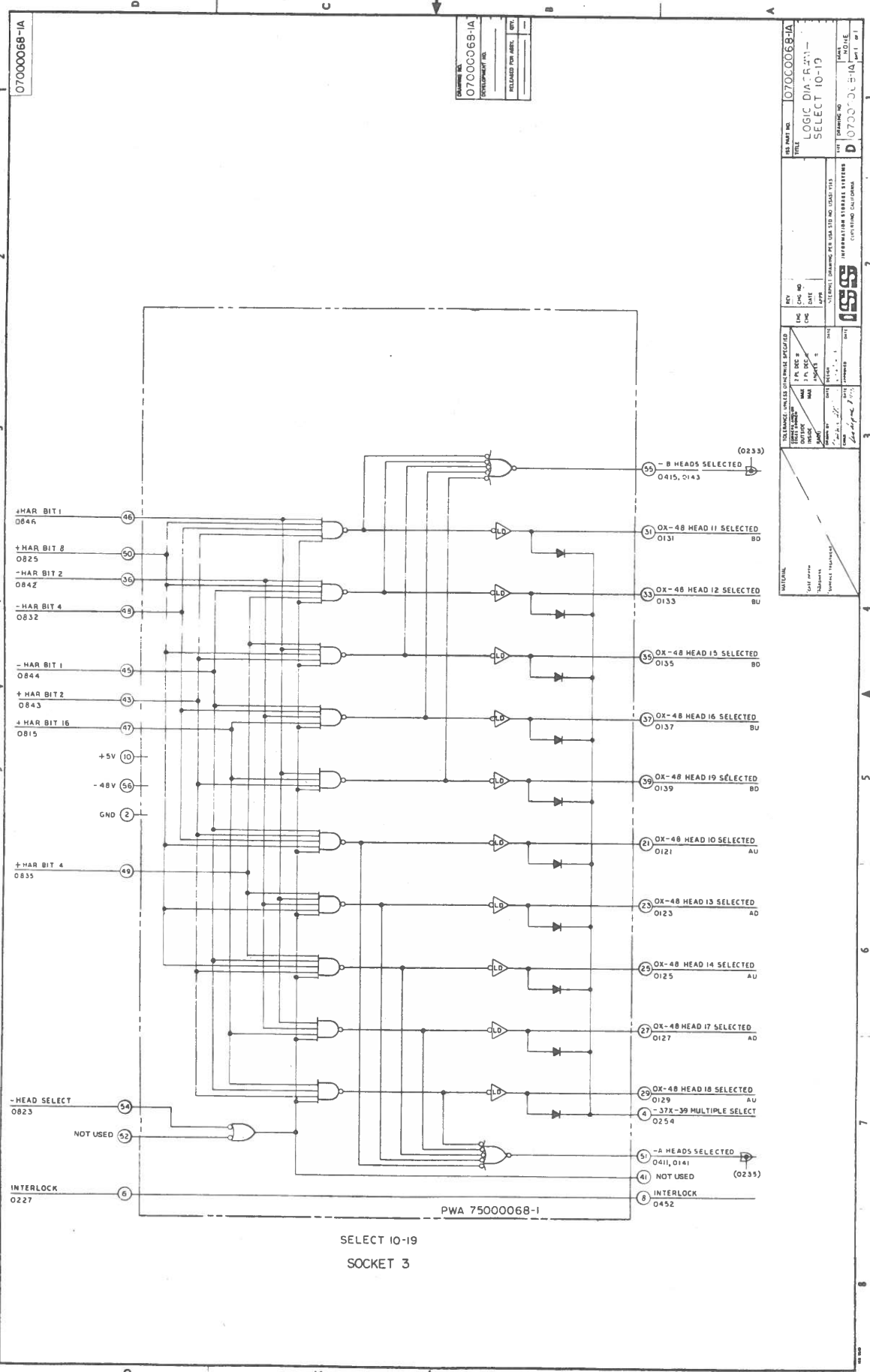
091000068-1

091000068-1

- 6 BOARD TO BE TESTED PER IS5 SPECIFICATION NO.
- 5. LAST REFERENCE DESIGNATION USED :
- 4. ALL TRANSISTORS ARE 2N3645.
- 3. ALL RESISTORS ARE IN OHM / 5W ± 2%.
- 2. ALL DIODES ARE 1N4454.
- 1. ALL CAPACITORS ARE IN MICROGRADS ± 20%.

- A. REFERENCE DRAWINGS
- B. DETAIL 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100
- C. PARTS LIST
- D. REFERENCE DESIGNATIONS
- E. PARTS LIST
- F. PARTS LIST
- G. PARTS LIST
- H. PARTS LIST
- I. PARTS LIST
- J. PARTS LIST
- K. PARTS LIST
- L. PARTS LIST
- M. PARTS LIST
- N. PARTS LIST
- O. PARTS LIST
- P. PARTS LIST
- Q. PARTS LIST
- R. PARTS LIST
- S. PARTS LIST
- T. PARTS LIST
- U. PARTS LIST
- V. PARTS LIST
- W. PARTS LIST
- X. PARTS LIST
- Y. PARTS LIST
- Z. PARTS LIST

091000068-1

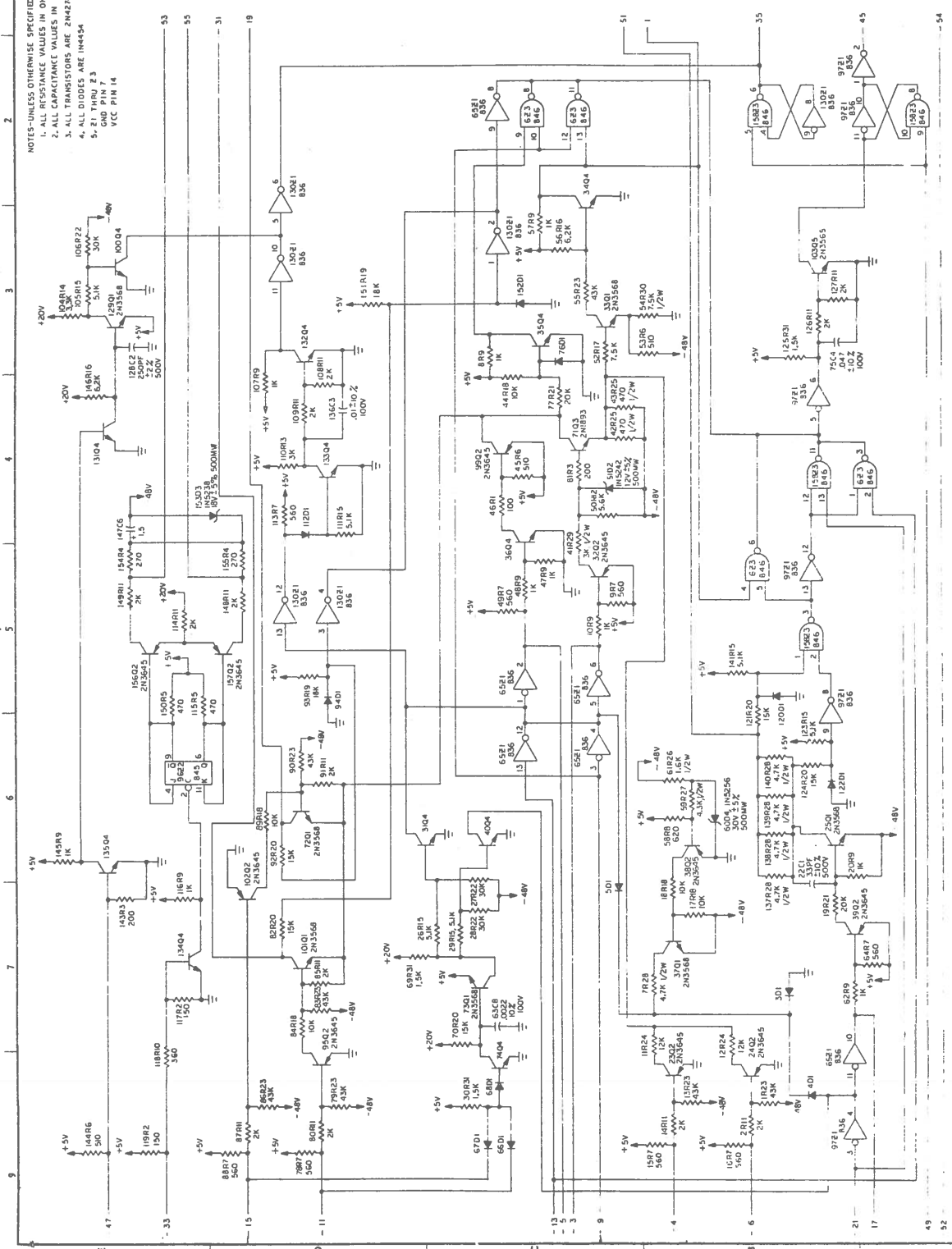


DRAWING NO. 07000068-1A  
 DEVELOPMENT NO.  
 RELEASED FOR AMT. USE

PWA PART NO. 07000068-1A TITLE LOGIC DIAGRAM SELECT 10-19 DATE 10-17-60 DRAWING NO. D 07000068-1A SHEET NO. 1 OF 1	
REV. NO. DATE BY CHECKED BY	THIS DRAWING IS UNCLASSIFIED DATE 11-19-01 BY 60322 UCBAW/BJS AUTHORITY 48 CFR 1.101-11.4
THE INFORMATION CONTAINED HEREIN IS UNCLASSIFIED DATE 11-19-01 BY 60322 UCBAW/BJS AUTHORITY 48 CFR 1.101-11.4	INFORMATION SYSTEMS DIVISION OPERATIONS DIVISION GAITHERSBURG, CALIFORNIA

09004343-1

- NOTES-UNLESS OTHERWISE SPECIFIED:
- 1. ALL RESISTANCE VALUES IN OHMS- $\frac{Z}{W}$
  - 2. ALL CAPACITANCE VALUES IN UF- $\frac{Z}{W}$
  - 3. ALL TRANSISTORS ARE 2N4274
  - 4. ALL DIODES ARE 1N4454
  - 5. 21 THRU 23
  - 6. 1N4148
  - 7. VCC PIN 14



09004343-1

09004343-1

SCHEMATIC DIAGRAM - WHITE

REVISIONS	
NO.	DESCRIPTION
1	ASSEMBLY DRAWING FOR THE 100 OHM FULL
2	REVISED TO 100 OHM FULL
3	REVISED TO 100 OHM FULL
4	REVISED TO 100 OHM FULL
5	REVISED TO 100 OHM FULL
6	REVISED TO 100 OHM FULL
7	REVISED TO 100 OHM FULL
8	REVISED TO 100 OHM FULL
9	REVISED TO 100 OHM FULL
10	REVISED TO 100 OHM FULL

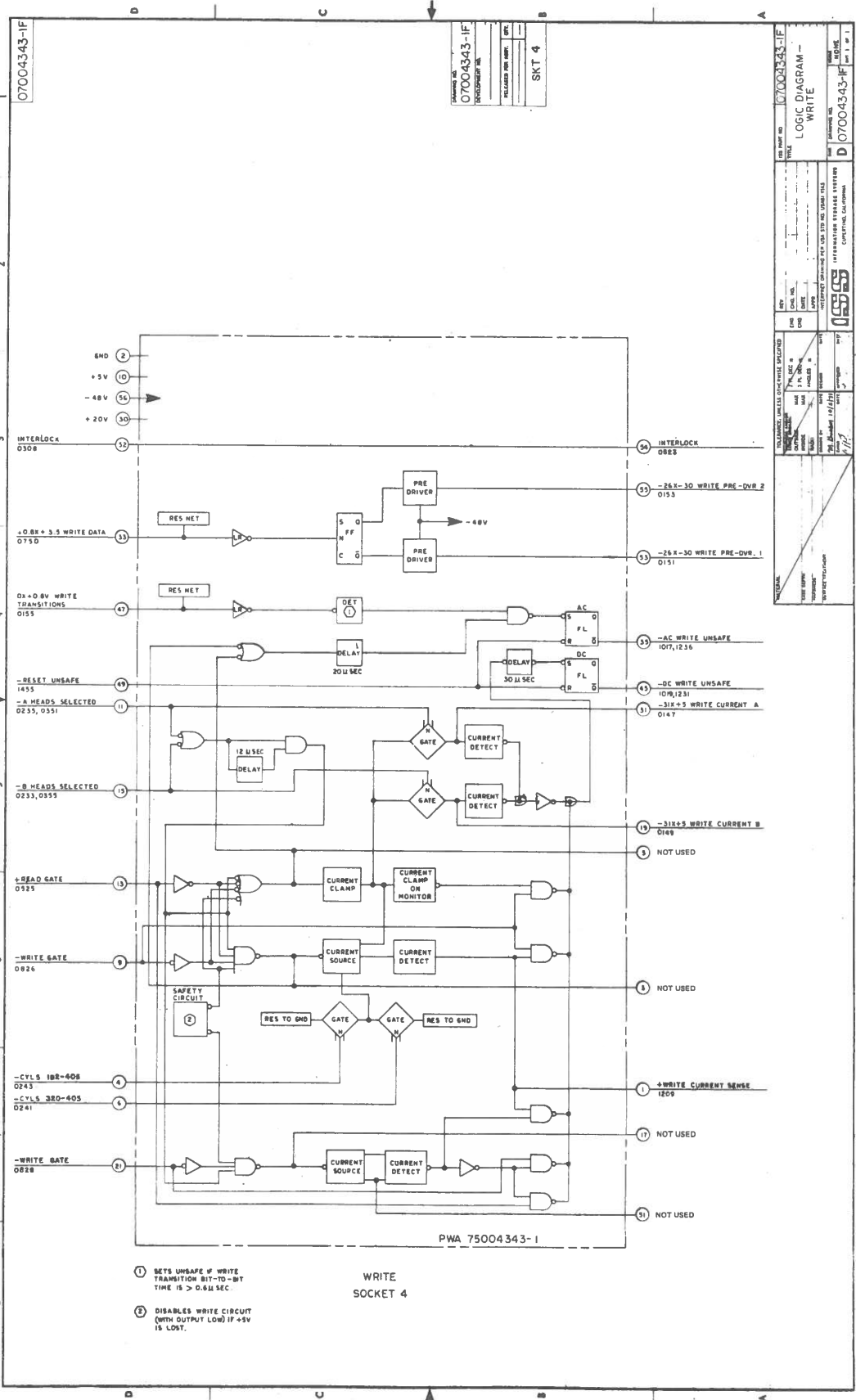
ISS

09004343-1

09004343-1

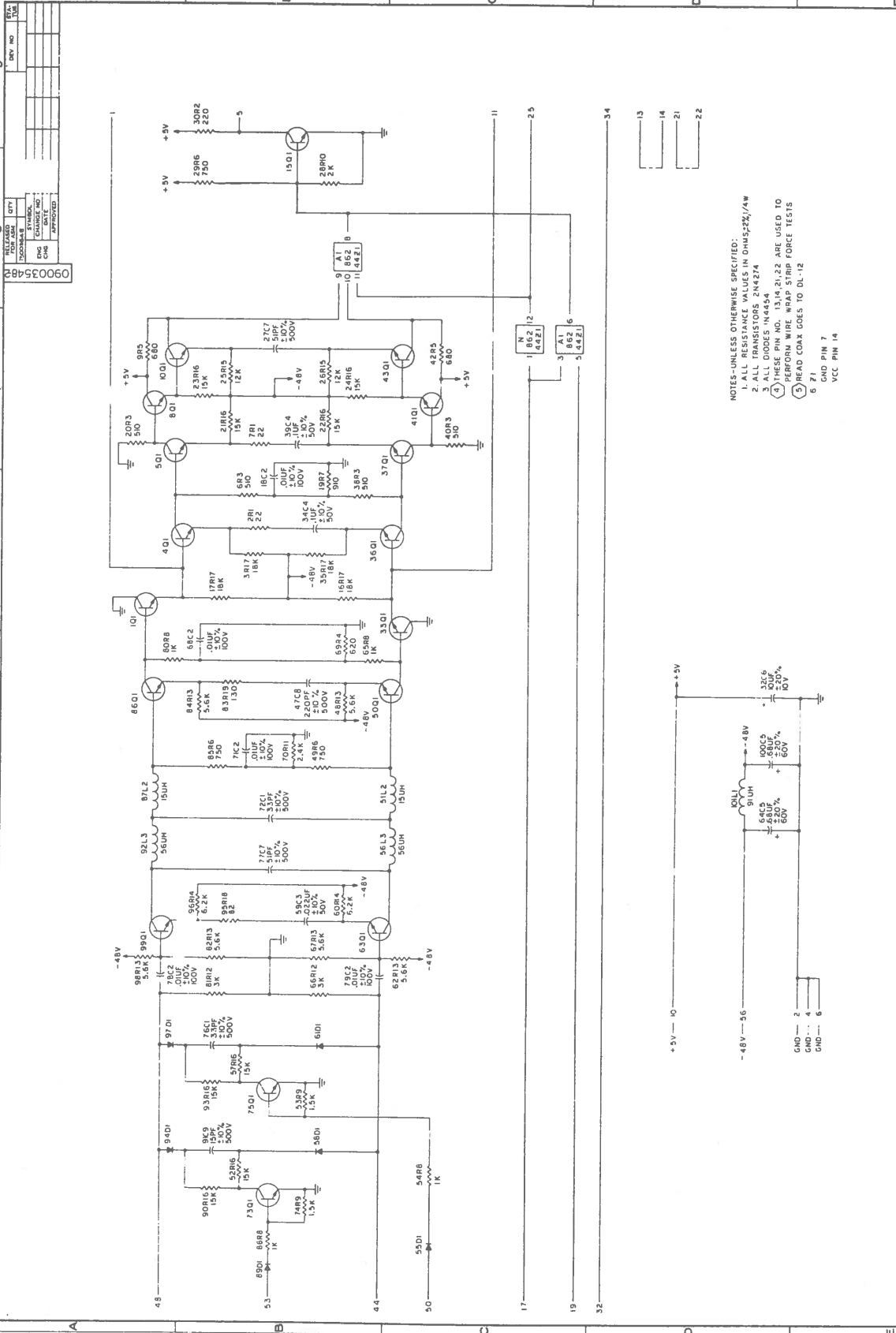
09004343-1

09004343-1



07004343-IF		07004343-IF	
REV	DATE	REV	DATE
1		1	
LOGIC DIAGRAM - WRITE			
INFORMATION SYSTEMS DIVISION OPERATING P.E. CO. 37500 VANDERBILT CUPERTINO, CALIFORNIA			
07004343-IF		07004343-IF	
D		D	
1		1	

09003548-4



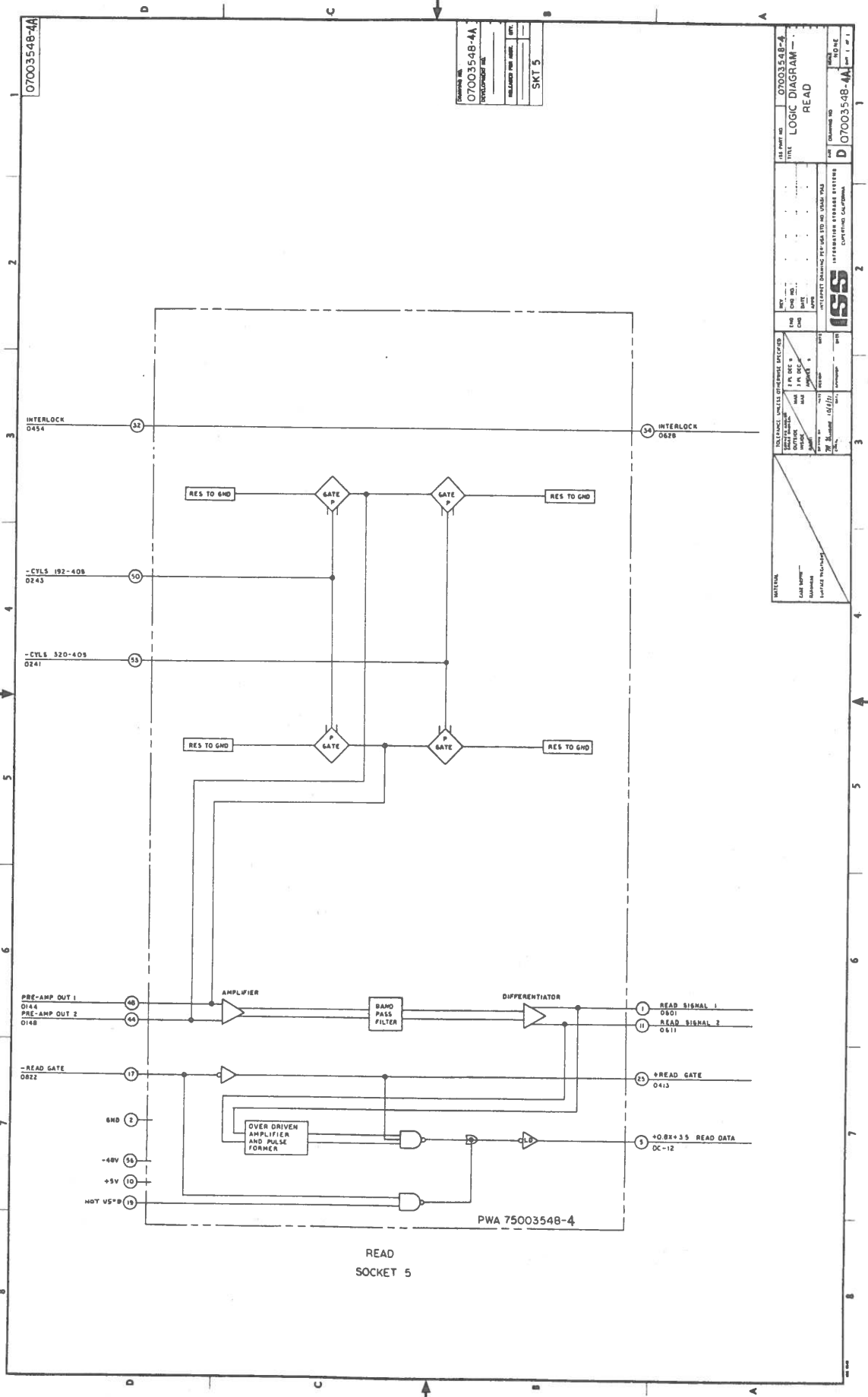
- NOTES—UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCE VALUES IN OHMS, 2% / 4W
  2. ALL TRANSISTORS 2N4274
  3. ALL DIODES 1N4454
  4. THESE PIN NO. 13, 14, 21, 22 ARE USED TO TERMINATE WIRE WRAP STRIP FORCE TESTS
  5. READ COLOR CODES TO 0L1/2
  6. GND PIN 7
  7. VCC PIN 14

REV. NO.	1
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	

DESIGN	
DATE	
BY	
CHKD	
APPD	

STORING INFORMATION  
 STORAGE INSTRUCTIONS  
 TITLE SCHEMATIC DRAWING  
 SCALE 1:1  
 READ SOCKET 5

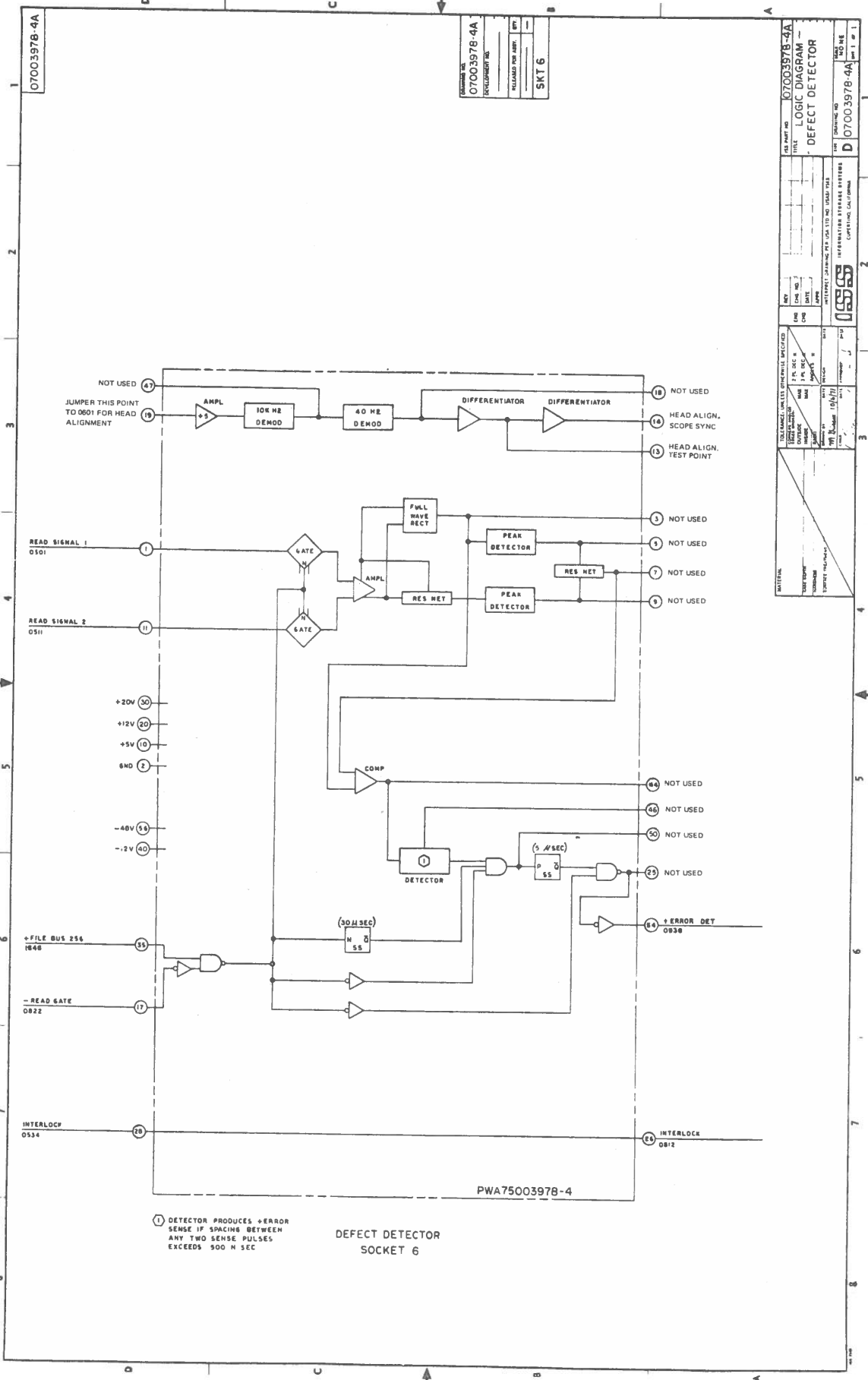
09003548-4
09003548-4



DRAWING NO. 07003548-4A  
 DEVELOPMENTAL NO.  
 RELEASED PER AUTHORITY OF: SKT 5

DRAWING NO. 07003548-4 TITLE LOGIC DIAGRAM - READ	
DATE DESIGNED BY CHECKED BY APPROVED BY	ISS INSTRUMENT DIVISION, P.O. BOX 150, CHAMBERS CONVENT ROAD, CALIFORNIA
MATERIAL PART NUMBER QUANTITY MANUFACTURE	CONTINUED ON DRAWING NO. 07003548-4A SHEET 1 OF 1





PART NO. 07003978-4A  
 DEVELOPMENT NO.  
 RELEASED FOR JSP. BY  
 SKT 6

07003978-4A	
DESIGN NO.	07003978-4A
TITLE	LOGIC DIAGRAM
DEFECT DETECTOR	
DATE	19(1/7)
BY	
CHECKED	
APPROVED	
INTERMEDIATE STAGES BETWEEN OPERATING CALIFORNIA	

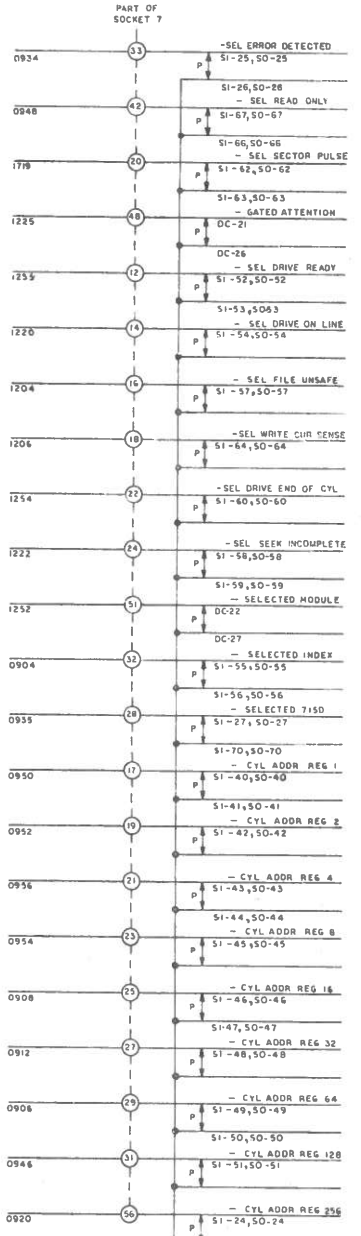
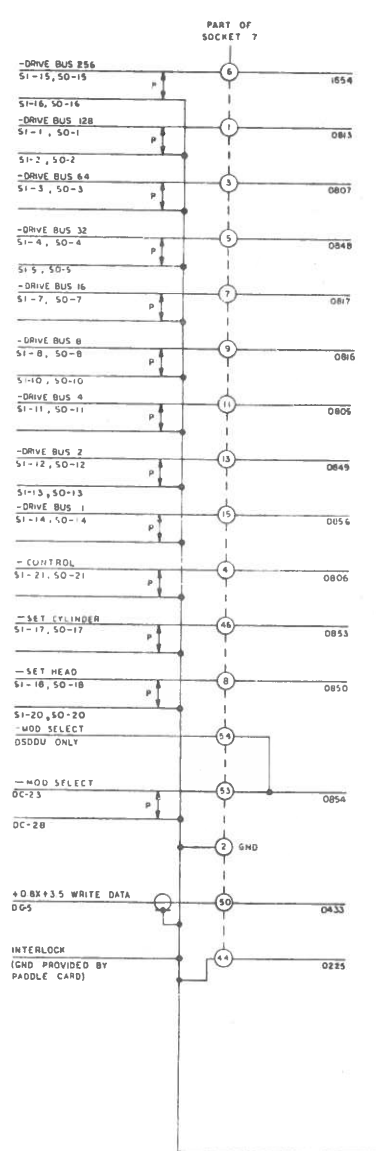
07004358-1A

07004358-1A  
SKT 7

07004358-1A  
INTERCONNECTION  
DIAGRAM-SIGNAL PADDLE

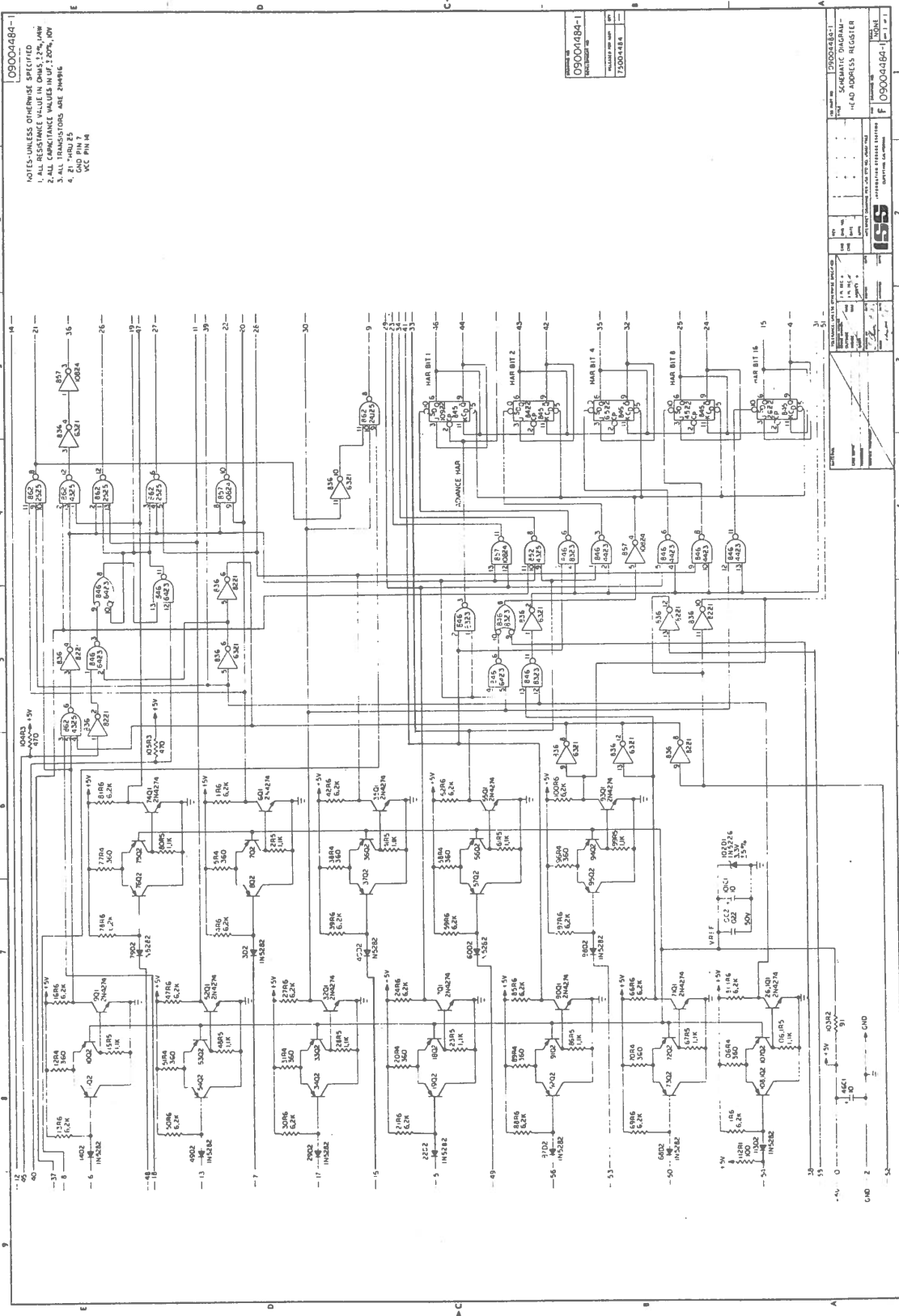
2  
3  
4  
5  
6  
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8

2  
3  
4  
5  
6  
7  
8



PART OF HARNESS ASSEMBLY 83004358-1

SIGNAL PADDLE  
SOCKET 7



09004484-1

NOTES-UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTANCE VALUES IN OHMS, 1% TOL, UNLESS NOTED OTHERWISE.  
 2. ALL CAPACITANCE VALUES IN UF, 20% TOL, UNLESS NOTED OTHERWISE.  
 3. ALL TRANSISTORS ARE 2N3904 UNLESS NOTED OTHERWISE.  
 4. GND PIN IS 14.  
 5. VCC PIN IS 16.

DESIGN NO.	09004484-1
REVISION NO.	1
DATE	7/20/64

DATE	7/20/64	DESIGNER	W. J. BROWN
APPROVED		CHECKED	
<b>ISS</b>			
INTEGRATED SYSTEMS SERVICES			
1100 N. 17TH ST., SUITE 100, DENVER, CO. 80202			
TELEPHONE: 333-4400			
FAX: 333-4400			
F 09004484-1			

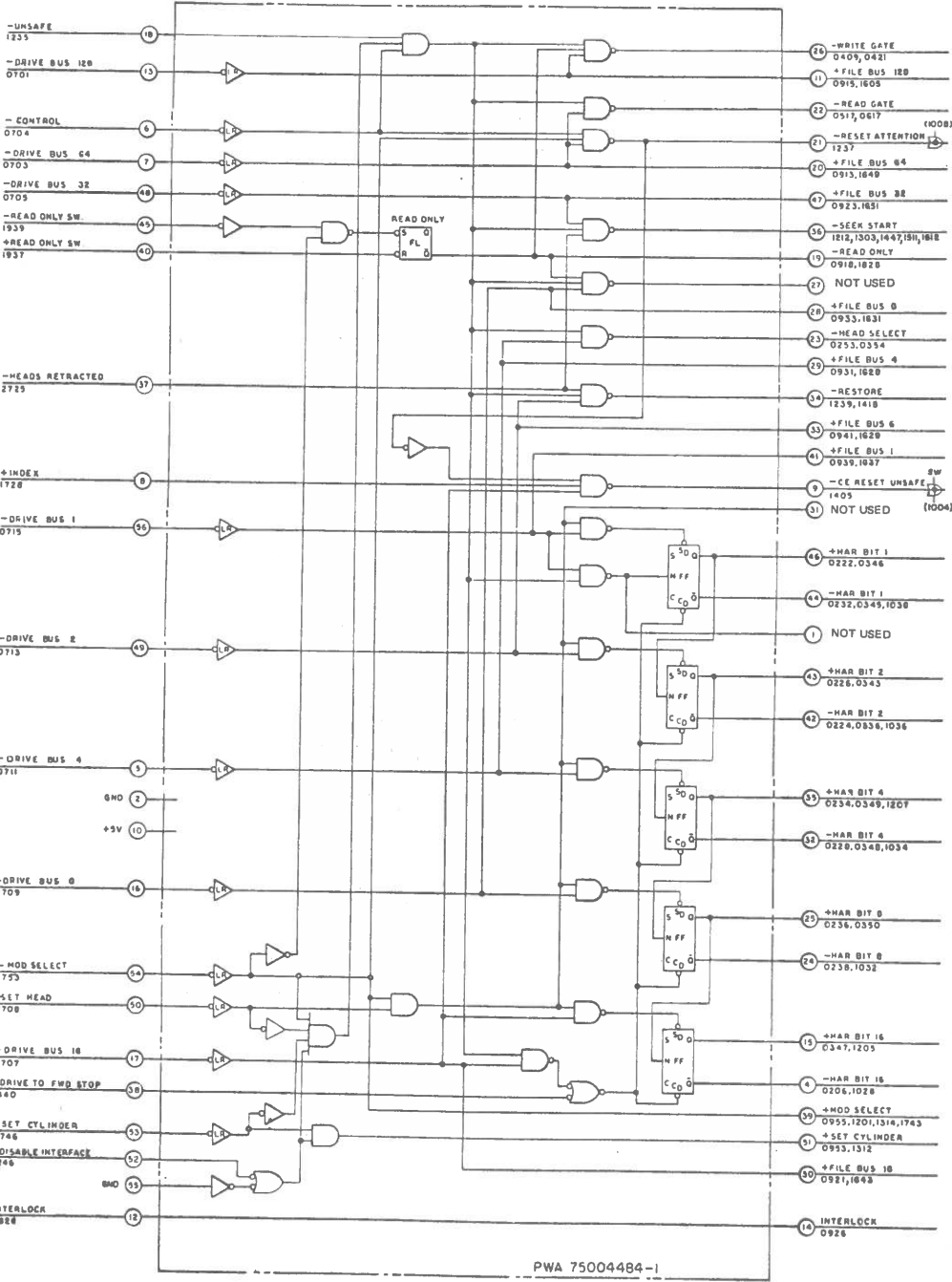
07004484-1A

07004484-1A  
PWA 75004484-1  
RELEASED FOR ASST  
BY  
DATE

SKT 8

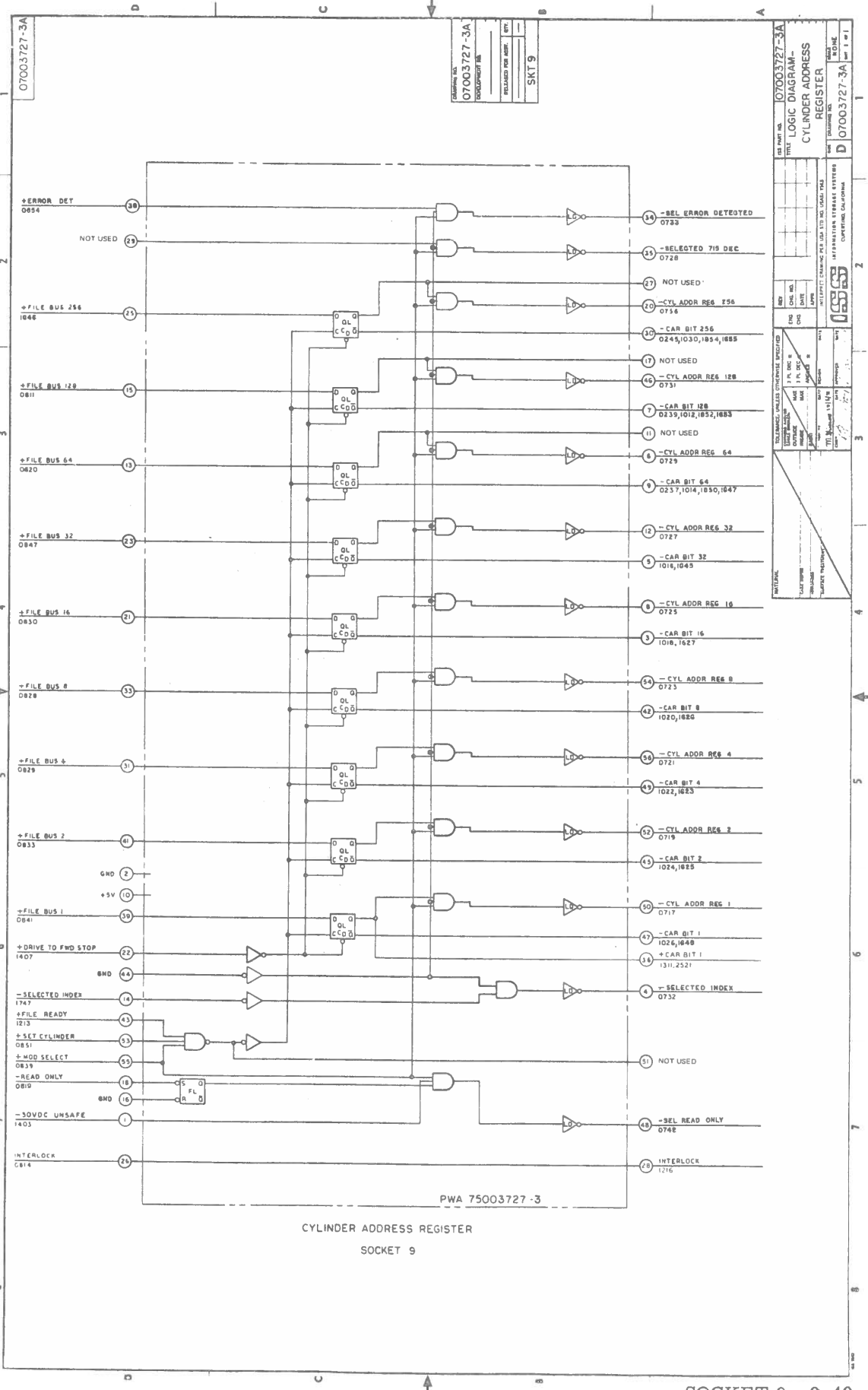
07004484-1A  
LOGIC DIAGRAM -  
HEAD ADDRESS  
REGISTER  
D 07004484-1A

INTERLOCK  
+CE RESET UNSAFE  
+FILE BUS I  
+FILE BUS 6  
+FILE BUS 1  
+FILE BUS 4  
+FILE BUS 8  
+FILE BUS 2  
+FILE BUS 0  
+FILE BUS 10  
+FILE BUS 18  
+FILE BUS 16  
+FILE BIT 8  
+FILE BIT 6  
+FILE BIT 4  
+FILE BIT 2  
+FILE BIT 1  
+FILE BIT 0  
+INDEX  
+READ ONLY SW  
+READ ONLY SW  
+DRIVE BUS 18  
+DRIVE TO FWD STOP  
+SET CYLINDER  
+DISABLE INTERFACE  
+MOD SELECT  
+SET HEAD  
+DRIVE BUS 16  
+DRIVE BUS 10  
+DRIVE BUS 8  
+DRIVE BUS 6  
+DRIVE BUS 4  
+DRIVE BUS 2  
+DRIVE BUS 1  
+HEADS RETRACTED



BUS & TAG CONTROL, HEAD ADDRESS REGISTER  
SOCKET 8





DRAWING NO. 07003727-3A  
 WORKING DRAWING  
 PREPARED FOR: SKT 9

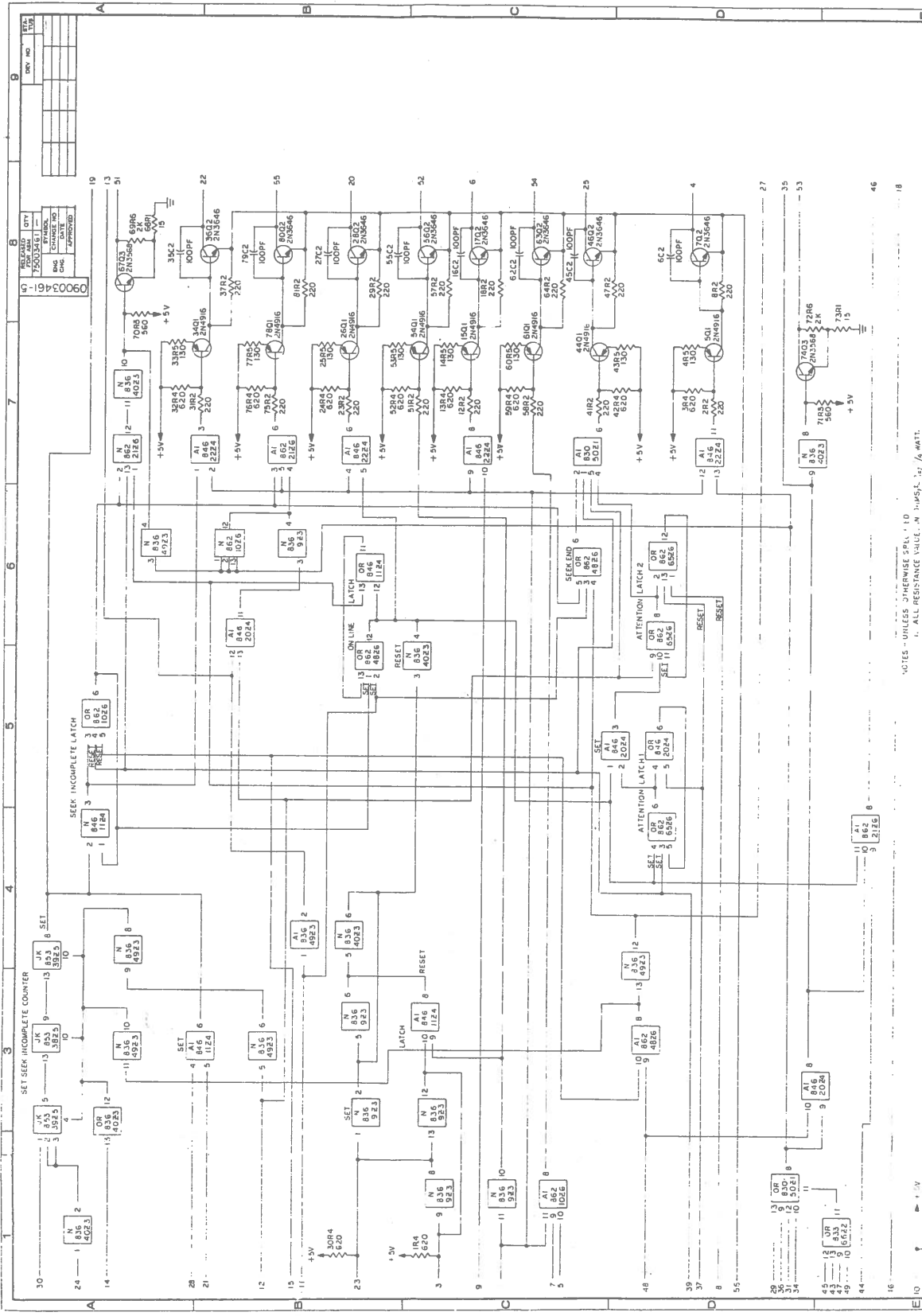
07003727-3A LOGIC DIAGRAM - CYLINDER ADDRESS REGISTER	
07003727-3A INFORMATION SYSTEMS DIVISION OPERATING DIVISION	07003727-3A SKT 9
07003727-3A INFORMATION SYSTEMS DIVISION OPERATING DIVISION	07003727-3A SKT 9

PWA 75003727-3  
 CYLINDER ADDRESS REGISTER  
 SOCKET 9



FROM	LINE NAME	PADDLE PIN
1339	-Diff Counter Bit 256	27
1341	-Diff Counter Bit 128	1
1335	-Diff Counter Bit 64	3
1346	-Diff Counter Bit 32	5
1349	-Diff Counter Bit 16	7
1351	-Diff Counter Bit 8	9
1353	-Diff Counter Bit 4	11
1355	-Diff Counter Bit 2	13
1322	-Diff Counter Bit 1	15
0930	-CAR Bit 256	30
0907	-CAR Bit 128	12
0909	-CAR Bit 64	14
0905	-CAR Bit 32	16
0903	-CAR Bit 16	18
0942	-CAR Bit 8	20
0949	-CAR Bit 4	22
0945	-CAR Bit 2	24
0947	-CAR Bit 1	26
0804	-HAR Bit 16	28
0824	-HAR Bit 8	32
0832	-HAR Bit 4	34
0842	-HAR Bit 2	36
0844	-HAR Bit 1	38
0435	-AC Write Unsafe	17
0445	-DC Write Unsafe	19
0247	-Heads Unsafe	21
1829	-Velocity Unsafe	23
2603	-AC Unsafe	25
1739	-Pack Speed Unsafe	29
1841	-Any Unsafe Except R/W	31
1442	-Forward	33
1451	-Seek in Process	35
1438	+Hold Reverse	37
1407	+Drive to Forward Stop	39
1429	-Head Load	41
1544	-Drive Forward 5"/Sec	43
1543	-Drive Forward 20"/Sec	45
1525	-Drive Reverse 5"/Sec	47
1427	-Linear Mode	49
	+Go Reverse	51
	-Go Forward	53
	-Diff Equals One	55
	-Diff Equals Zero	56
	-Even Cylinder	42
	-Odd Cylinder	44
	-Retracted Mode	46
	- First Cyl Detected	48
	-File Ready	50
	-Power On/Start Reset	54
	-Forward Stop	52
	GND	2
	+5 Volts	10
	+30 Volts	6
	-12 Volts	40





REV	DATE	BY	CHK
1	7/20/61	WJ	WJ
2	8/1/61	WJ	WJ
3	8/1/61	WJ	WJ
4	8/1/61	WJ	WJ
5	8/1/61	WJ	WJ
6	8/1/61	WJ	WJ
7	8/1/61	WJ	WJ
8	8/1/61	WJ	WJ
9	8/1/61	WJ	WJ
10	8/1/61	WJ	WJ

INFORMATION SYSTEMS, INC.  
 TITLE: SCHEMATIC DIAGRAM -  
 FILE: STATUS SOCKET 12  
 PROJECT: 100-10000-1000  
 DETAIL: 100-10000-1000-1000  
 DATE: 8/1/61  
 CHK: WJ  
 APPR: WJ

- NOTES - UNLESS OTHERWISE SPECIFIED:
- ALL RESISTANCE VALUES IN OHMS, UNLESS OTHERWISE SPECIFIED.
  - ALL CAPACITANCE VALUES IN P.F. UNLESS OTHERWISE SPECIFIED.
  - 21 THRU 25.
- GND: PIN 7  
 ACC: PIN 14

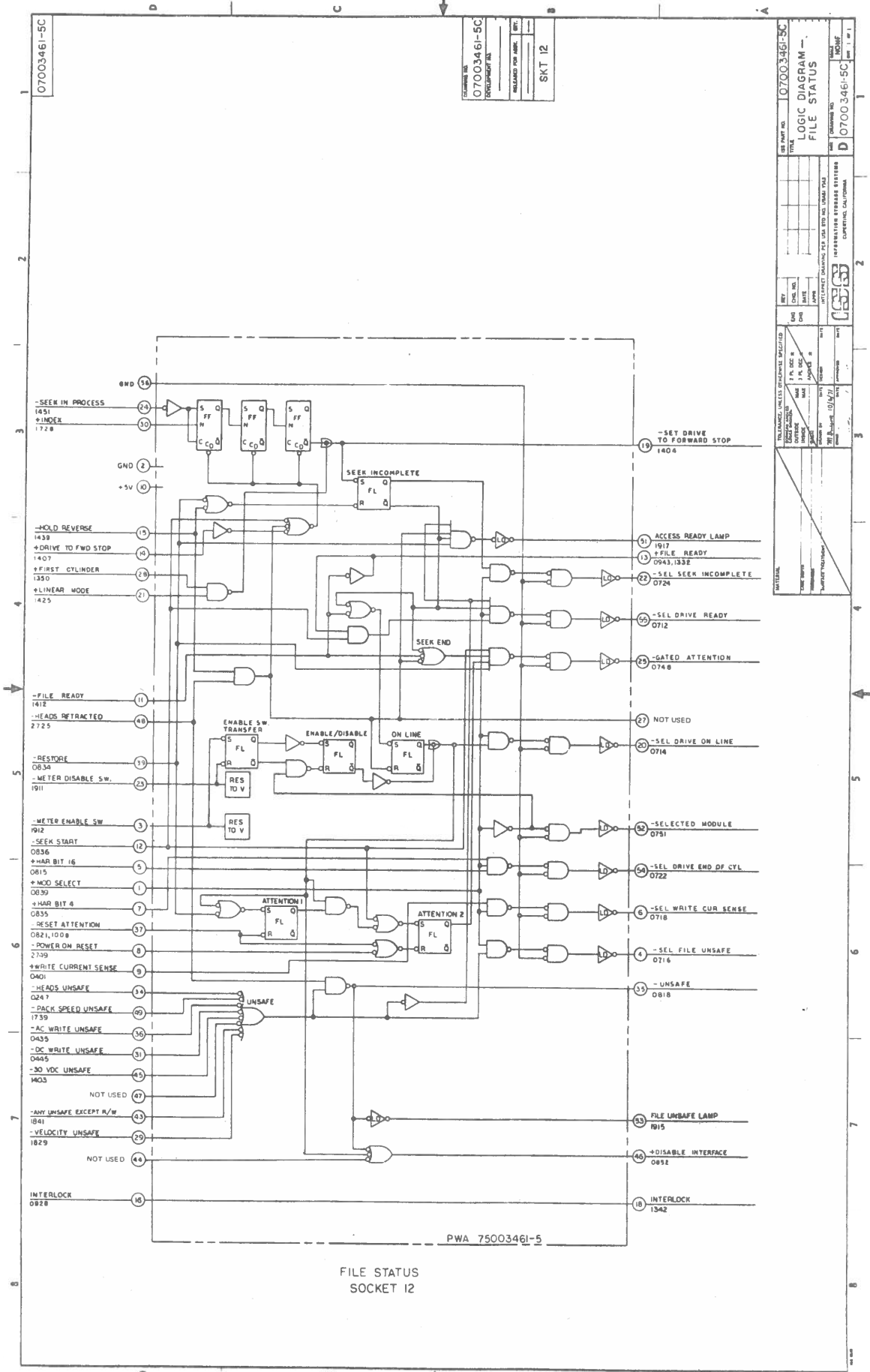
07003461-5C

FORMER NO. 07003461-5C  
REPLACEMENT PART  
REPLACES FOR PART: SKT 12

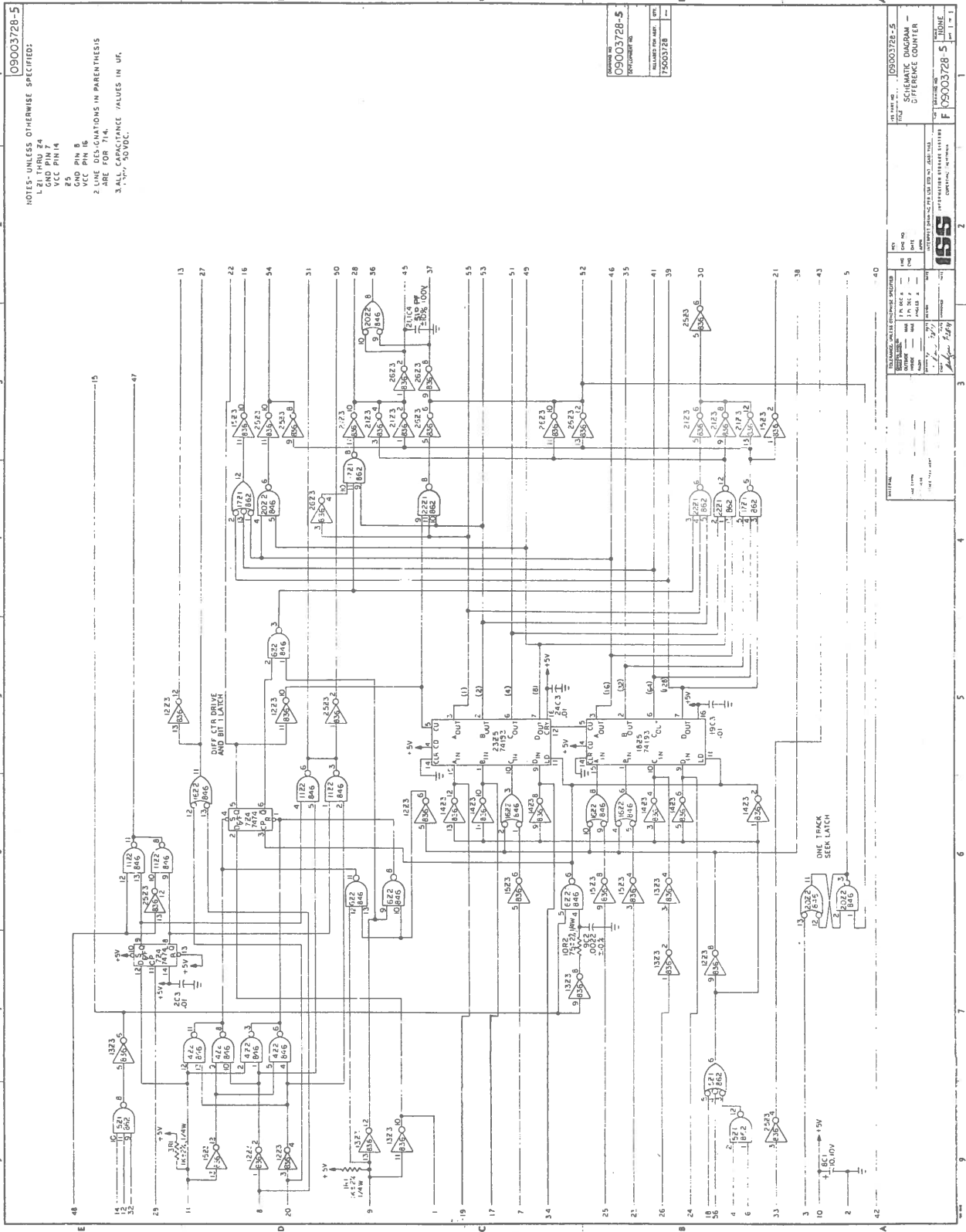
07003461-5C  
LOGIC DIAGRAM  
FILE STATUS

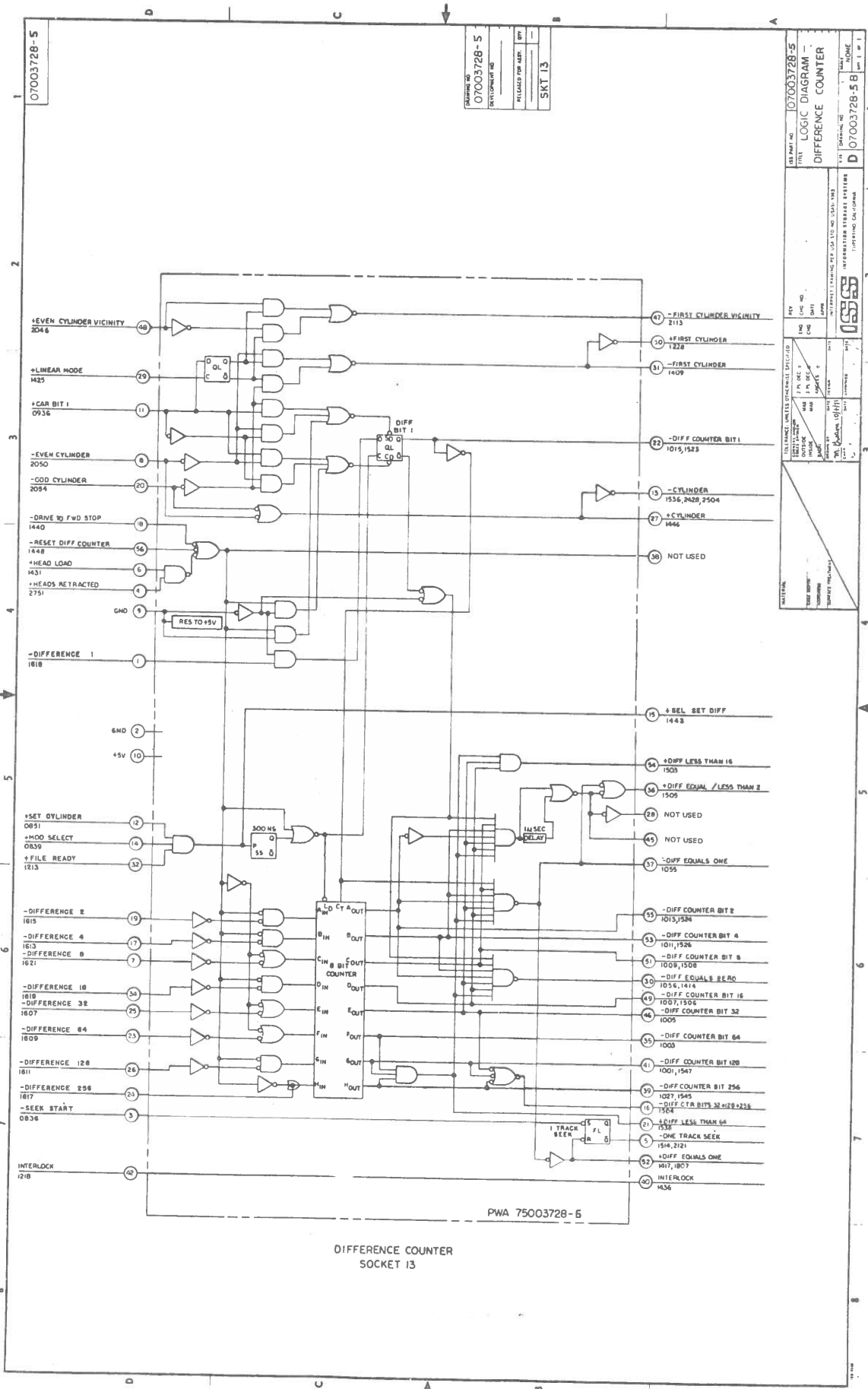
COMPONENTS LISTED OR IDENTIFIED BY THIS DIAGRAM  
PART NO. QTY. IN STOCK  
DATE  
REVISION  
BY  
DATE

07003461-5C  
COMPONENTS LISTED OR IDENTIFIED BY THIS DIAGRAM  
PART NO. QTY. IN STOCK  
DATE  
REVISION  
BY  
DATE



FILE STATUS SOCKET 12





07003728-5

Drawing No  
07003728-5  
Development No  
RELEASED FOR AER. BY  
SKT 13

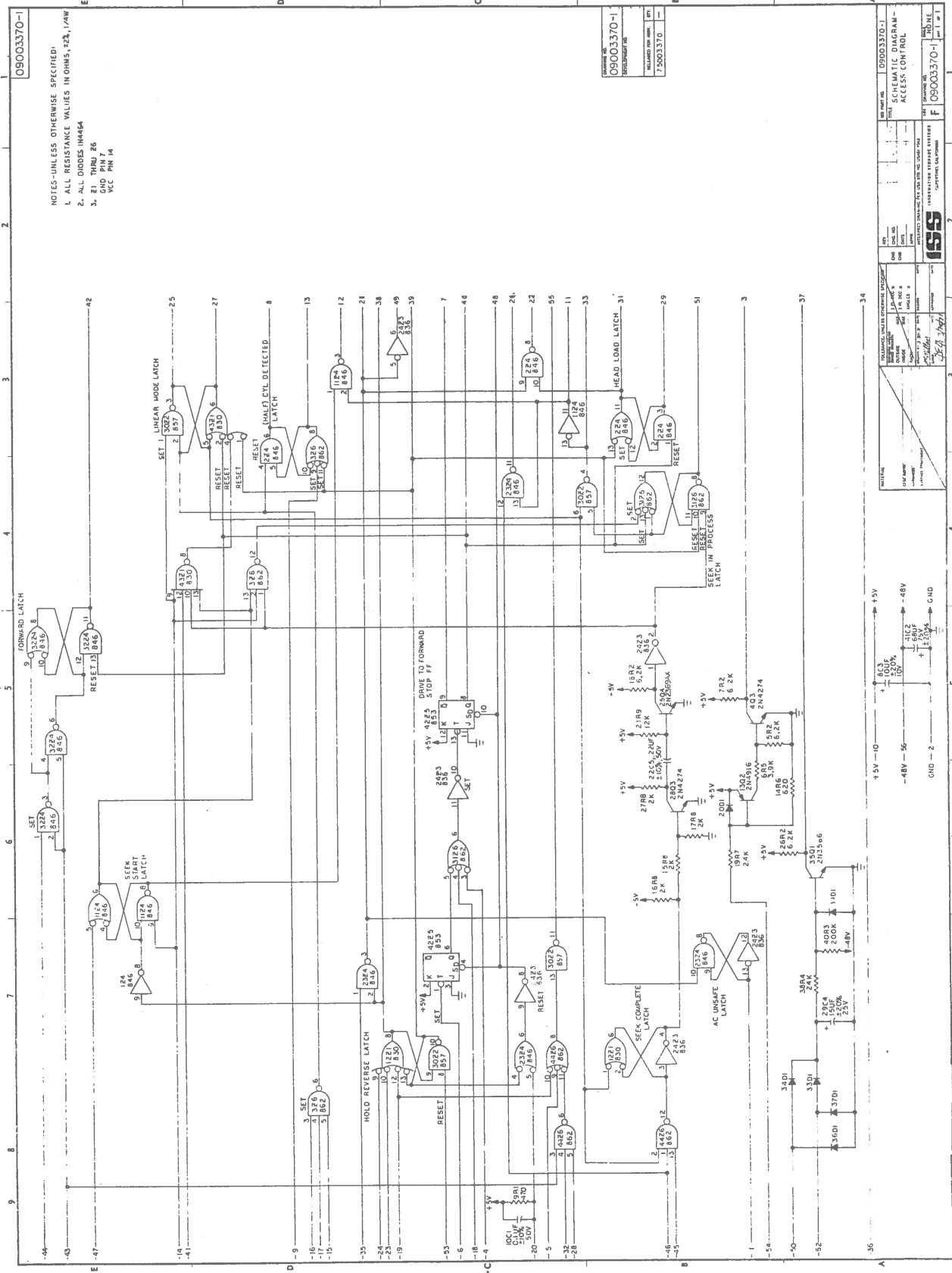
REV  
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07003728-5 B

LOGIC DIAGRAM  
DIFFERENCE COUNTER

15 - SET DIFF (1442)  
16 - DIFF LESS THAN 16 (1503)  
17 - DIFF EQUAL / LESS THAN 2 (1505)  
18 - NOT USED  
19 - NOT USED  
20 - DIFF EQUALS ONE (1055)  
21 - DIFF COUNTER BIT 2 (1015, 1524)  
22 - DIFF COUNTER BIT 4 (1011, 1526)  
23 - DIFF COUNTER BIT 8 (1009, 1508)  
24 - DIFF EQUALS ZERO (1054, 1414)  
25 - DIFF COUNTER BIT 16 (1007, 1506)  
26 - DIFF COUNTER BIT 32 (1005)  
27 - DIFF COUNTER BIT 64 (1003)  
28 - DIFF COUNTER BIT 128 (1001, 1547)  
29 - DIFF COUNTER BIT 256 (1027, 1545)  
30 - DIFF CTR BITS 32+128+256 (1504)  
31 - DIFF LESS THAN 64 (1538)  
32 - ONE TRACK SEEK (1514, 2121)  
33 - DIFF EQUALS ONE (1417, 1807)  
34 - INTERLOCK (1436)

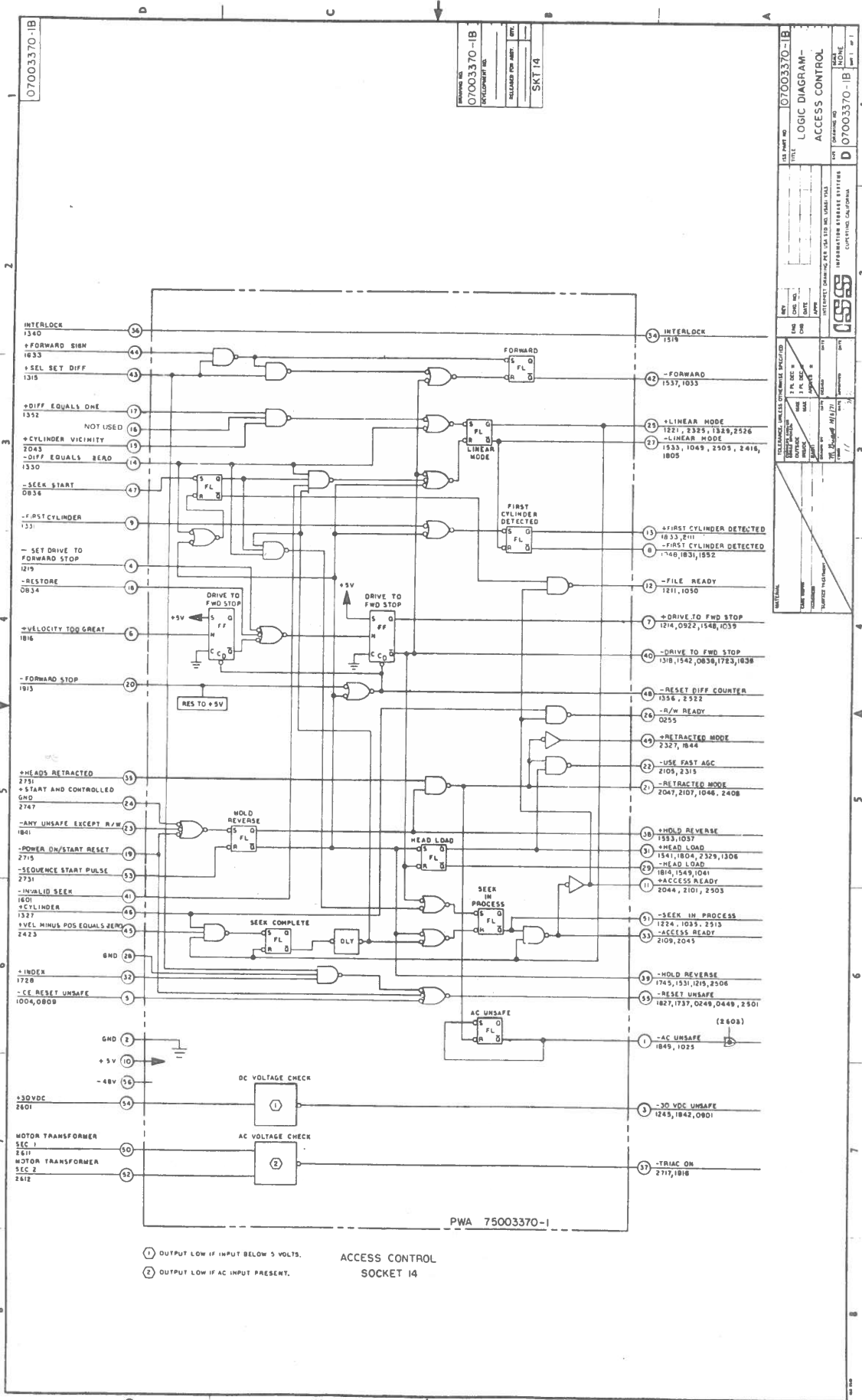
DIFFERENCE COUNTER SOCKET 13



NOTES—UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTANCE VALUES IN OHMS, 22Ω, 1/4W  
 2. ALL DIODES IN484  
 3. 21 THRU 26  
 GND PIN 7  
 VCC PIN 14

09003370-1  
 70003370

09003370-1  
 SCHEMATIC DIAGRAM—  
 ACCESS CONTROL  
 09003370-1  
 1 of 1



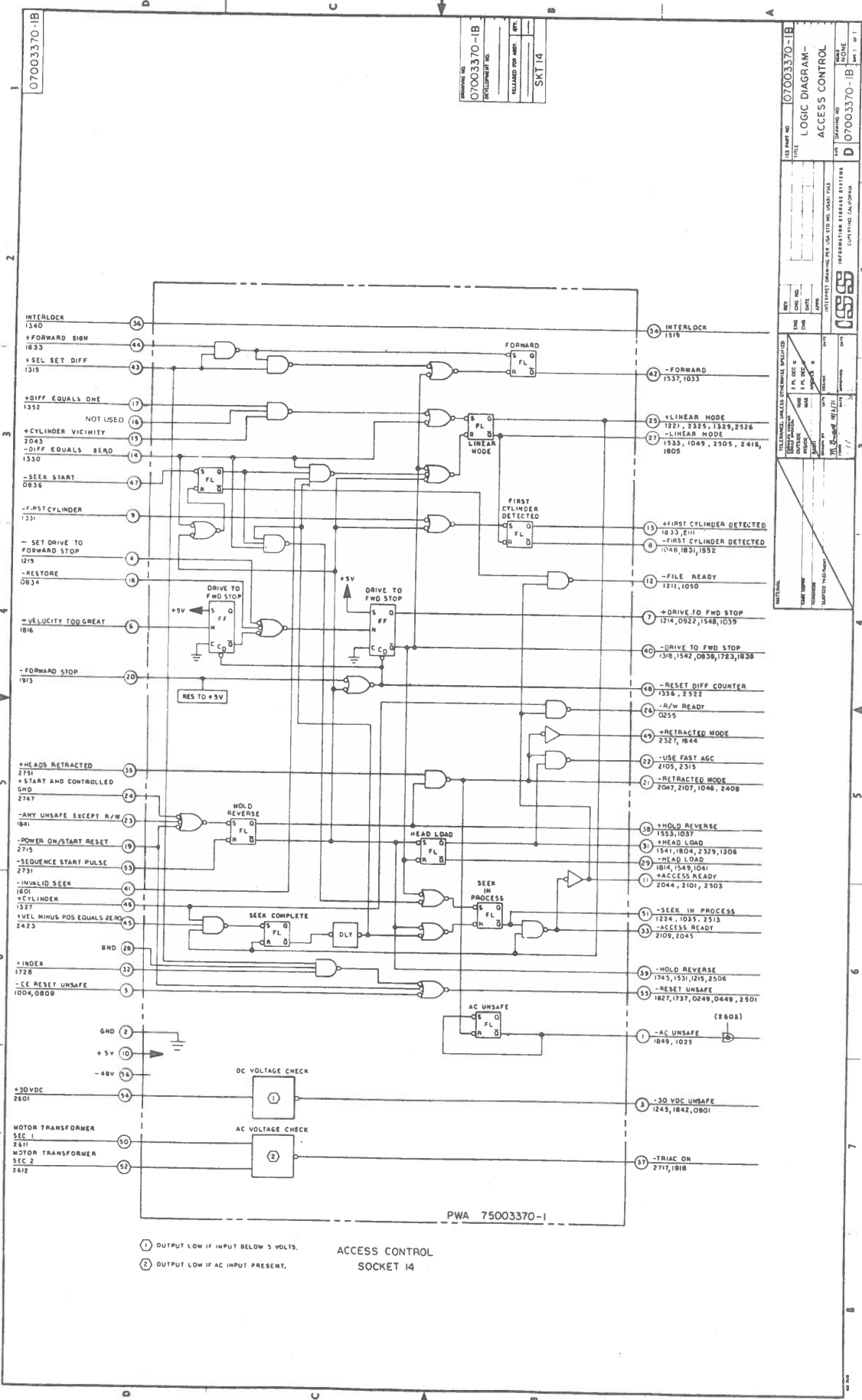
07003370-1B  
 DEVELOPMENT NO.  
 RELEASED FOR AMT  
 SKT 14

07003370-1B	
LOGIC DIAGRAM- ACCESS CONTROL	07003370-1B
DATE	NOV 68
BY	...
CHKD BY	...
DATE	...
APP'D BY	...
DATE	...
REVISIONS	...
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- ① OUTPUT LOW IF INPUT BELOW 5 VOLTS.
- ② OUTPUT LOW IF AC INPUT PRESENT.

ACCESS CONTROL  
 SOCKET 14





DRAWING NO. 07003370-1B  
 DEVELOPMENT NO.  
 RELEASED FOR AMBY: 8/7/71  
 SMT 14

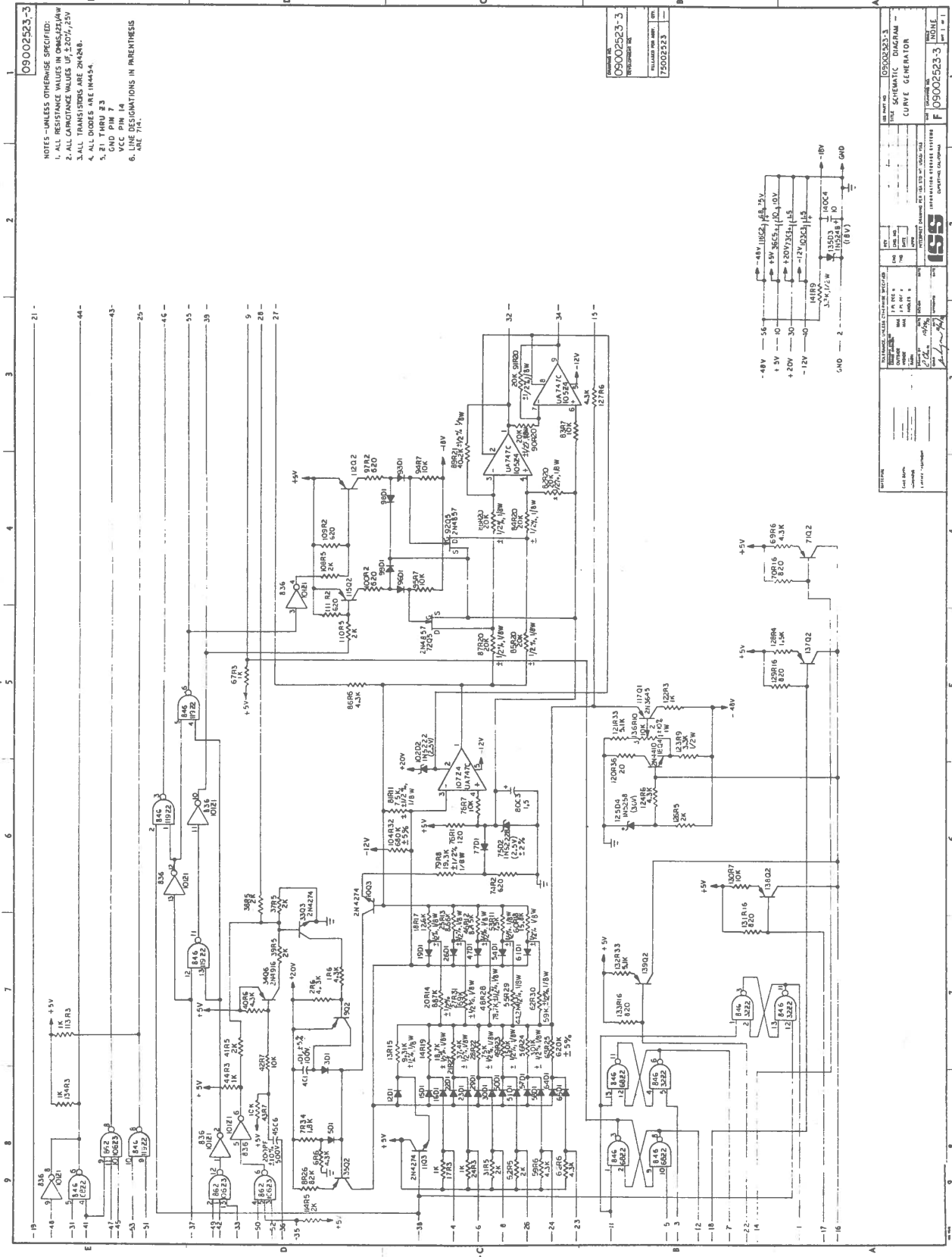
LOGIC DIAGRAM  
 ACCESS CONTROL  
 D 07003370-1B (Rev. 1)

REV.	DATE	BY	CHKD.	APPV.
1	11/27/70	J. P. COE	J. P. COE	J. P. COE
2	11/27/70	J. P. COE	J. P. COE	J. P. COE
3	11/27/70	J. P. COE	J. P. COE	J. P. COE
4	11/27/70	J. P. COE	J. P. COE	J. P. COE

TOLERANCES UNLESS OTHERWISE SPECIFIED:  
 DIMENSIONS IN PARENS ARE PREFERRED  
 DIMENSIONS IN SQUARES ARE PERMISSIBLE  
 DIMENSIONS IN TRIANGLES ARE PERMISSIBLE  
 DIMENSIONS IN CIRCLES ARE PERMISSIBLE  
 DIMENSIONS IN DASHES ARE PERMISSIBLE

INTERLOCK 1340  
 FORWARD SIGN 1833  
 SEL SET DIFF 1315  
 DIFF EQUALS ONE 1352  
 NOT USED 18  
 CYLINDER VICINITY 2043  
 DIFF EQUALS ZERO 1330  
 SEEK START 0836  
 FIRST CYLINDER 1331  
 SET DRIVE TO FORWARD STOP 1219  
 RESTORE 0834  
 VELOCITY TOO GREAT 1816  
 FORWARD STOP 1913  
 HEADS RETRACTED 2739  
 START AND CONTROLLED GND 2747  
 ANY UNSAFE EXCEPT R/W 1841  
 POWER ON/START RESET 2715  
 SEQUENCE START PULSE 2731  
 INVALID SEEK 1801  
 CYLINDER 1327  
 VEL MINUS POS EQUALS ZERO 2423  
 GND 28  
 INDEX 1728  
 CE RESET UNSAFE 1004, 0808  
 +30VDC 2801  
 MOTOR TRANSFORMER SEC 1 2811  
 MOTOR TRANSFORMER SEC 2 2812  
 INTERLOCK 1519  
 FORWARD 1537, 1033  
 LINEAR MODE 1221, 2325, 1329, 2526  
 LINEAR MODE 1333, 1049, 2505, 2418, 1805  
 FIRST CYLINDER DETECTED 1833, 2111  
 FIRST CYLINDER DETECTED 1046, 1831, 1552  
 FILE READY 1211, 1050  
 DRIVE TO FWD STOP 1214, 0922, 1548, 1039  
 DRIVE TO FWD STOP 1318, 1542, 0838, 1723, 1838  
 RESET DIFF COUNTER 1356, 2522  
 R/W READY 0255  
 RETRACTED MODE 2327, 1844  
 USE FAST AGC 2105, 2315  
 RETRACTED MODE 2047, 2107, 1046, 2408  
 HOLD REVERSE 1833, 1037  
 HEAD LOAD 1541, 1804, 2329, 1306  
 HEAD LOAD 1814, 1549, 1041  
 ACCESS READY 2044, 2101, 2505  
 SEEK IN PROCESS 1224, 1039, 2315  
 ACCESS READY 2109, 2045  
 HOLD REVERSE 1745, 1531, 1215, 2506  
 RESET UNSAFE 1827, 1737, 0249, 0449, 2501 (2408)  
 AC UNSAFE 1845, 1025  
 30 VDC UNSAFE 1245, 1842, 0801  
 TRIAC ON 2717, 1818





NOTES—UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTANCE VALUES IN OHMS,  $\Omega$ ,  $k\Omega$ ,  $M\Omega$   
 2. ALL CAPACITANCE VALUES UP TO  $100\mu F$ ,  $\mu F$   
 3. ALL TRANSISTORS ARE 2N4274.  
 4. ALL DIODES ARE 1N4148.  
 5.  $R1$  THRU  $R3$   
 6.  $C1$  THRU  $C3$   
 7. VCC PIN 14  
 8. DIMENSIONS IN PARENTHESES

PART NO. 95002523-3 PART NAME CURVE GENERATOR QUANTITY 1 NOTES SEE DRAWING FOR DIMENSIONS	
TESTED BY DATE APPROVED BY DATE	ISS 155

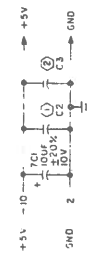
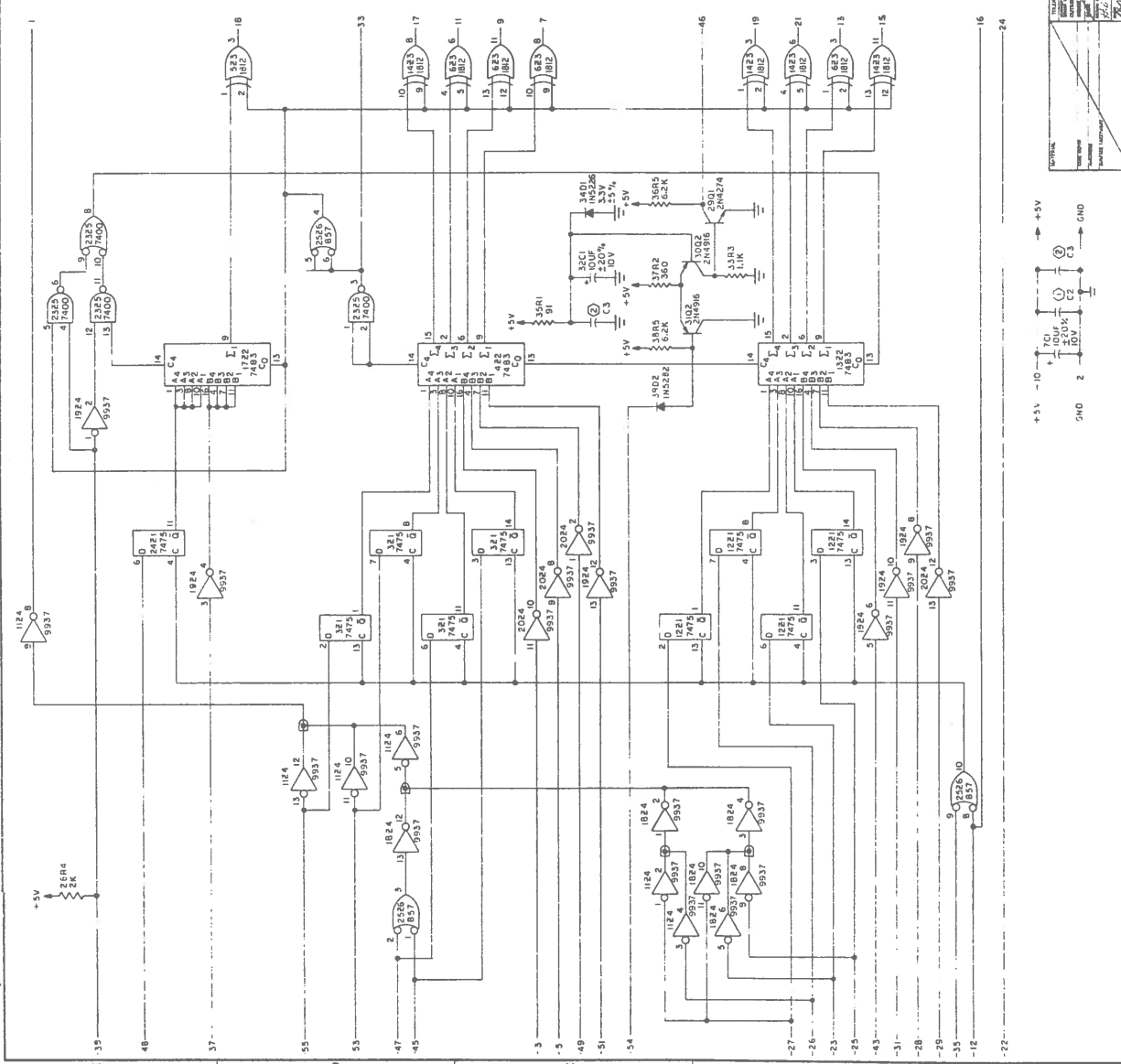


09004293-2

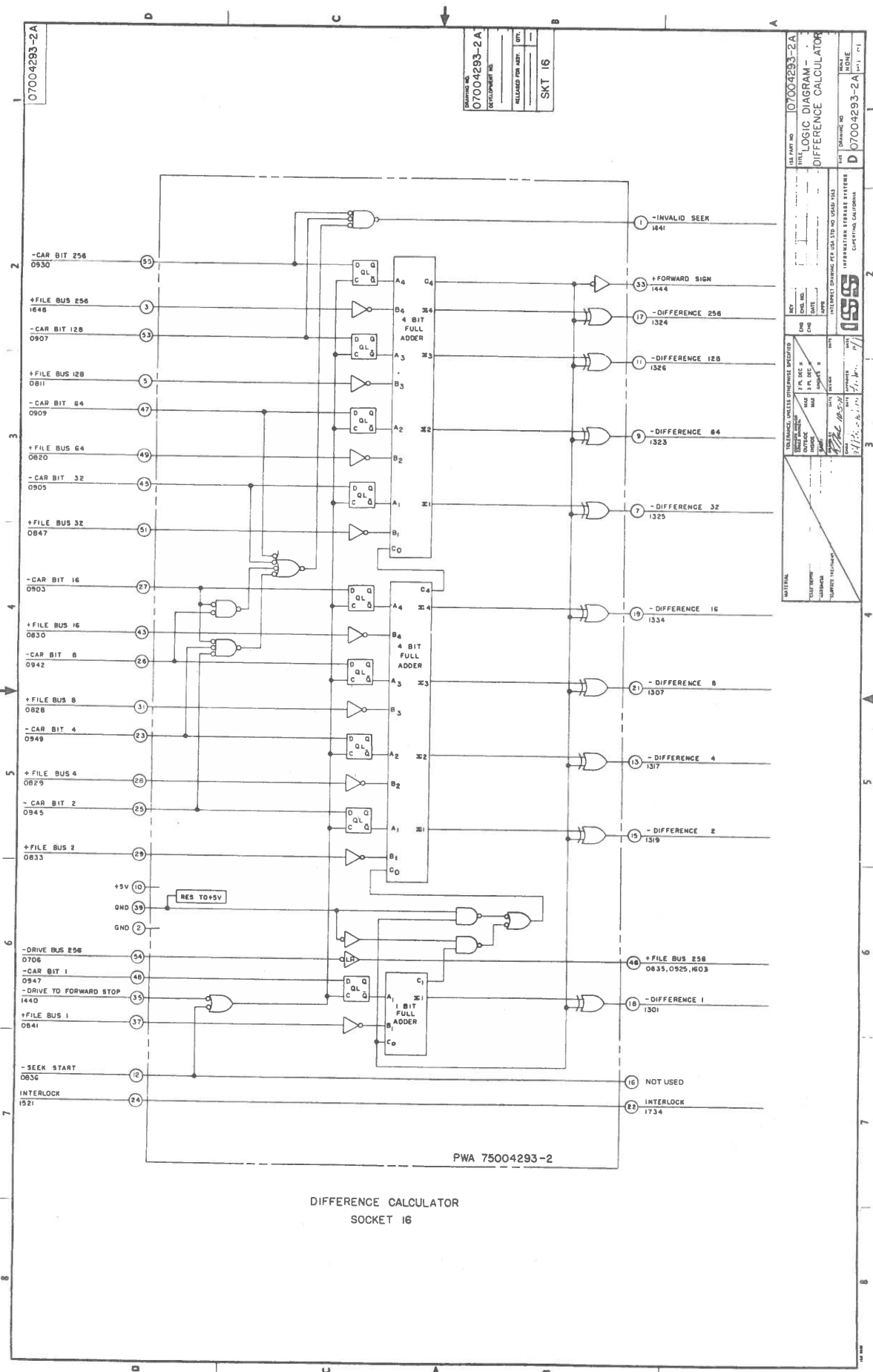
NOTES - UNLESS OTHERWISE SPECIFIED:  
① ALL CE CAPACITORS ARE .001UF ±20%, 50V, AND ARE USED IN THE FOLLOWING LOCATIONS 9, 14, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

- 21. PE PIN 12
- VCC PIN 5
- 23. THRU 36
- GND PIN 7
- VCC PIN 14
- 4. ALL RESISTORS ARE 2.2K/1/4W.

09004293-2  
75004293 -

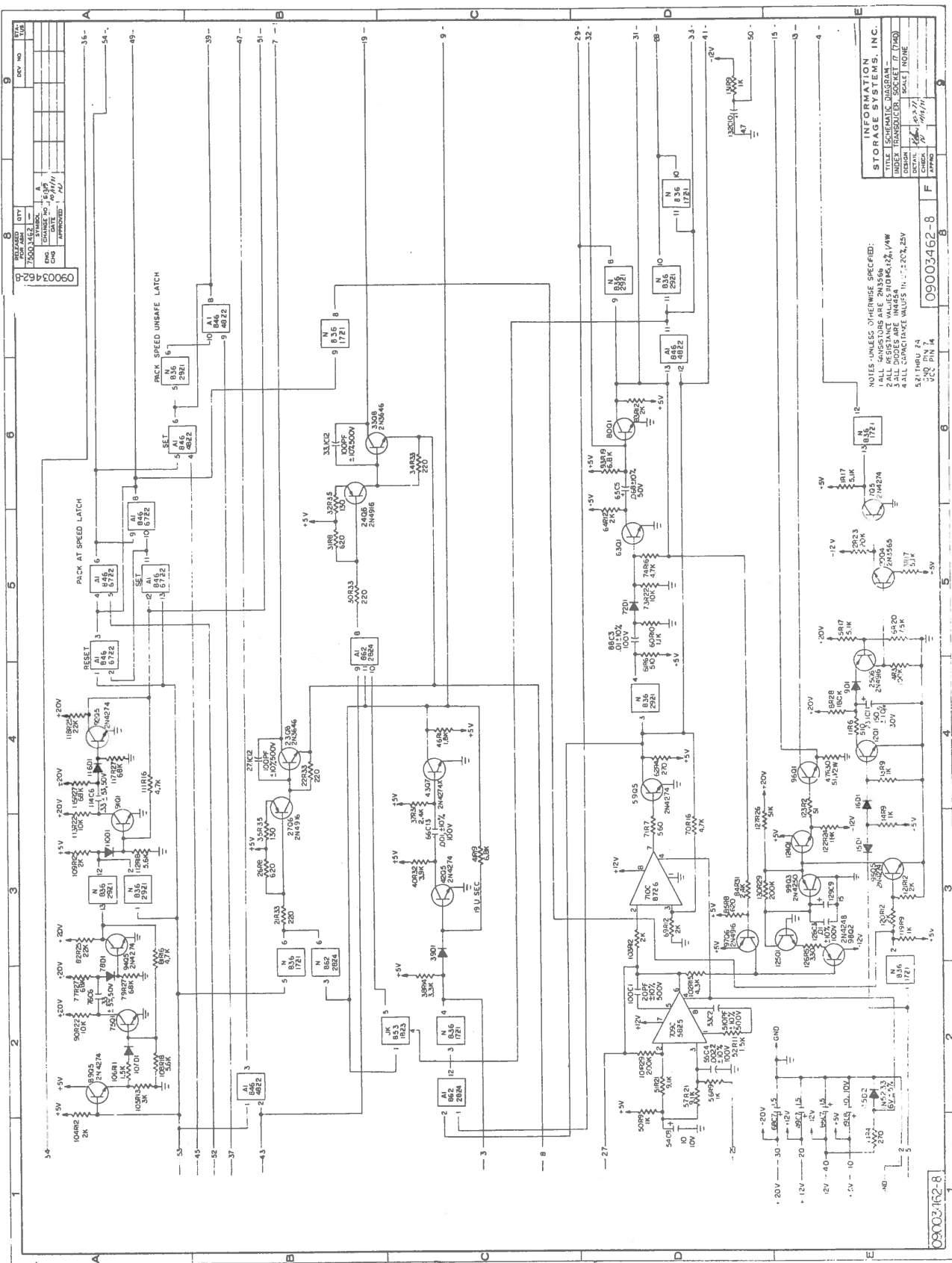


REV.	DATE	BY	CHK.	APP.	DESCRIPTION
1					DIFFERENCE CALCULATOR
2					DIFFERENCE CALCULATOR
3					DIFFERENCE CALCULATOR
4					DIFFERENCE CALCULATOR
5					DIFFERENCE CALCULATOR
6					DIFFERENCE CALCULATOR
7					DIFFERENCE CALCULATOR
8					DIFFERENCE CALCULATOR
9					DIFFERENCE CALCULATOR
10					DIFFERENCE CALCULATOR
11					DIFFERENCE CALCULATOR
12					DIFFERENCE CALCULATOR
13					DIFFERENCE CALCULATOR
14					DIFFERENCE CALCULATOR
15					DIFFERENCE CALCULATOR
16					DIFFERENCE CALCULATOR



PART NO. 07004293-2A  
 REVISION NO. \_\_\_\_\_  
 RELEASED FOR ASST. ENT. \_\_\_\_\_  
 SKT 16

PART NO. 07004293-2A  
 TITLE LOGIC DIAGRAM - DIFFERENCE CALCULATOR  
 DRAWING NO. D 07004293-2A  
 DATE \_\_\_\_\_  
 DESIGNED BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 APPROVED BY \_\_\_\_\_  
 INTERPRET DRAWING PER ISA 312 AND 313  
 1959  
 INFORMATION SERVICES SYSTEMS  
 GAITHERSBURG, CALIFORNIA



REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

09003462-8

REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

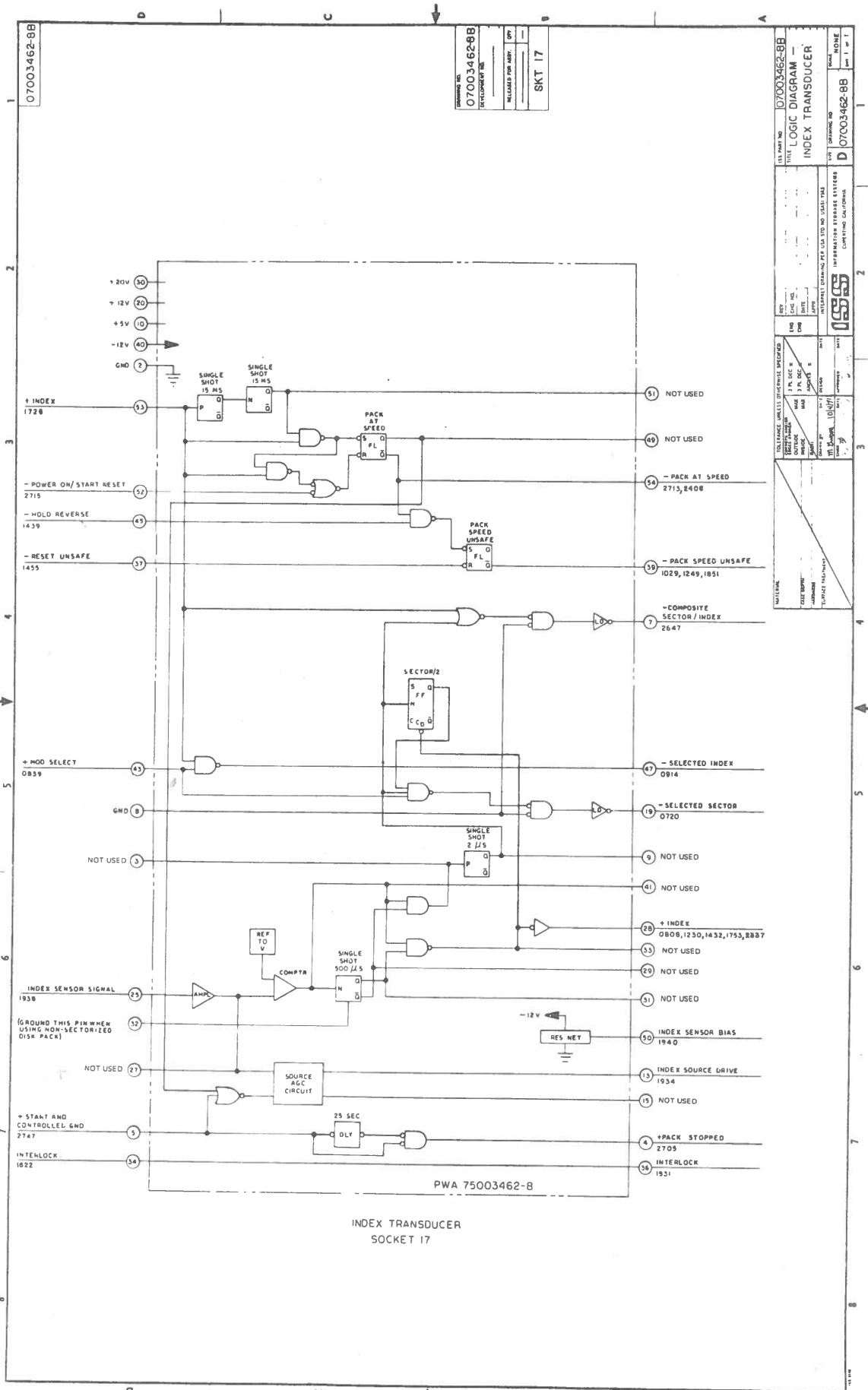
REV. NO.	9
REV. NO.	8
REV. NO.	7
REV. NO.	6
REV. NO.	5
REV. NO.	4
REV. NO.	3
REV. NO.	2
REV. NO.	1

09003462-8

INFORMATION  
 STORAGE SYSTEMS, INC.  
 TITLE SCHEMATIC DIAGRAM - (7500)  
 INDEX TRANSISTOR  
 SERIAL 10-17  
 CHECK 10-17  
 APPROV 10-17

NOTES - UNLESS OTHERWISE SPECIFIED:  
 1. ALL DIMENSIONS ARE IN INCHES.  
 2. ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.  
 3. ALL CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.  
 4. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.  
 5. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

09003462-8

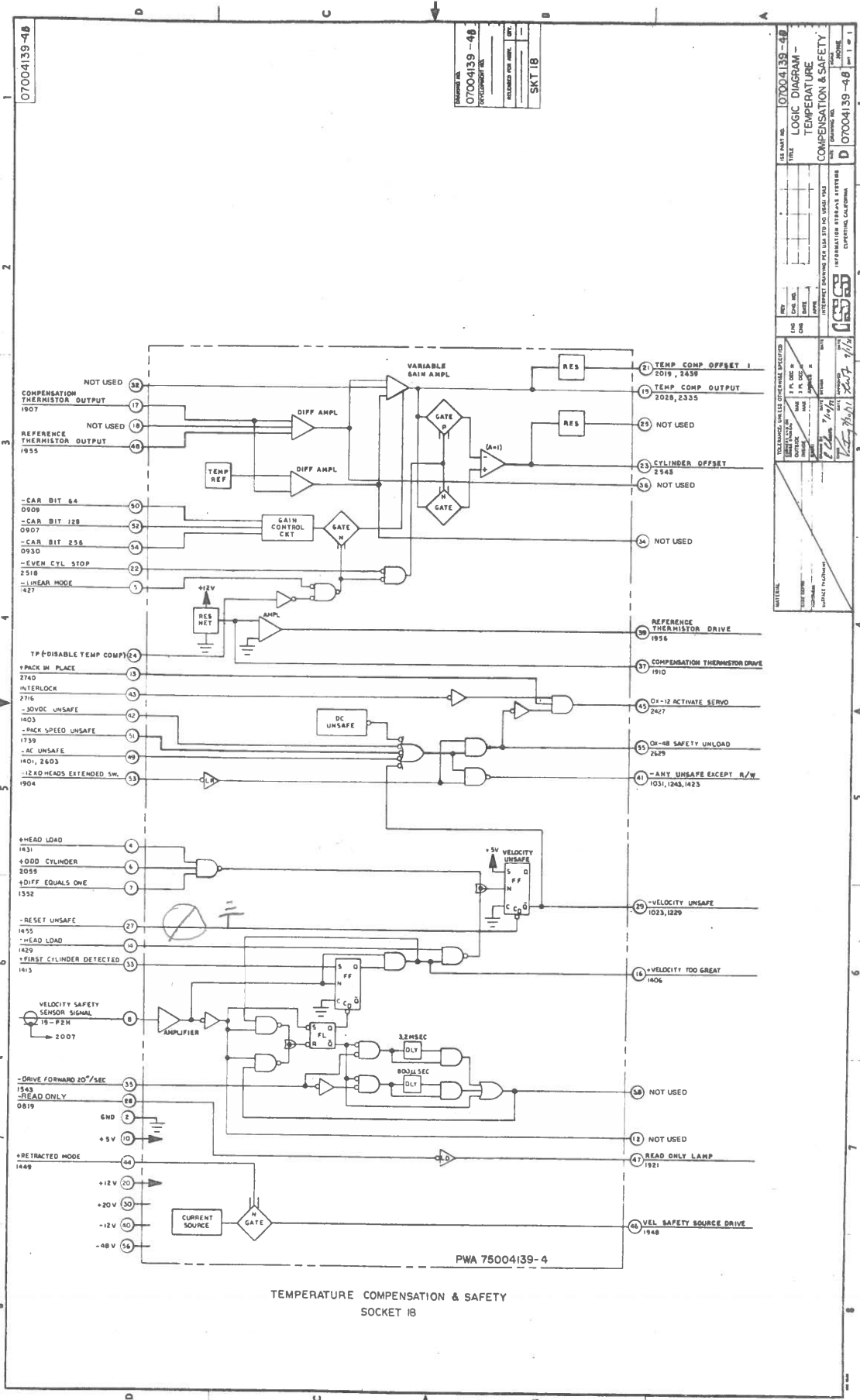


07003462-8B

07003462-8B  
REVISED FOR ASST. OPT.  
REPLACEMENT PART  
SKT 17

REV. NO.	07003462-8B
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
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REV. NO.	
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REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	
REV. NO.	
REV. DATE	
REV. BY	
REV. FOR	





Drawing No. 07004139-4B  
 Part No. SKT 18  
 RELEASED FOR INFO: [ ]  
 DATE: [ ]

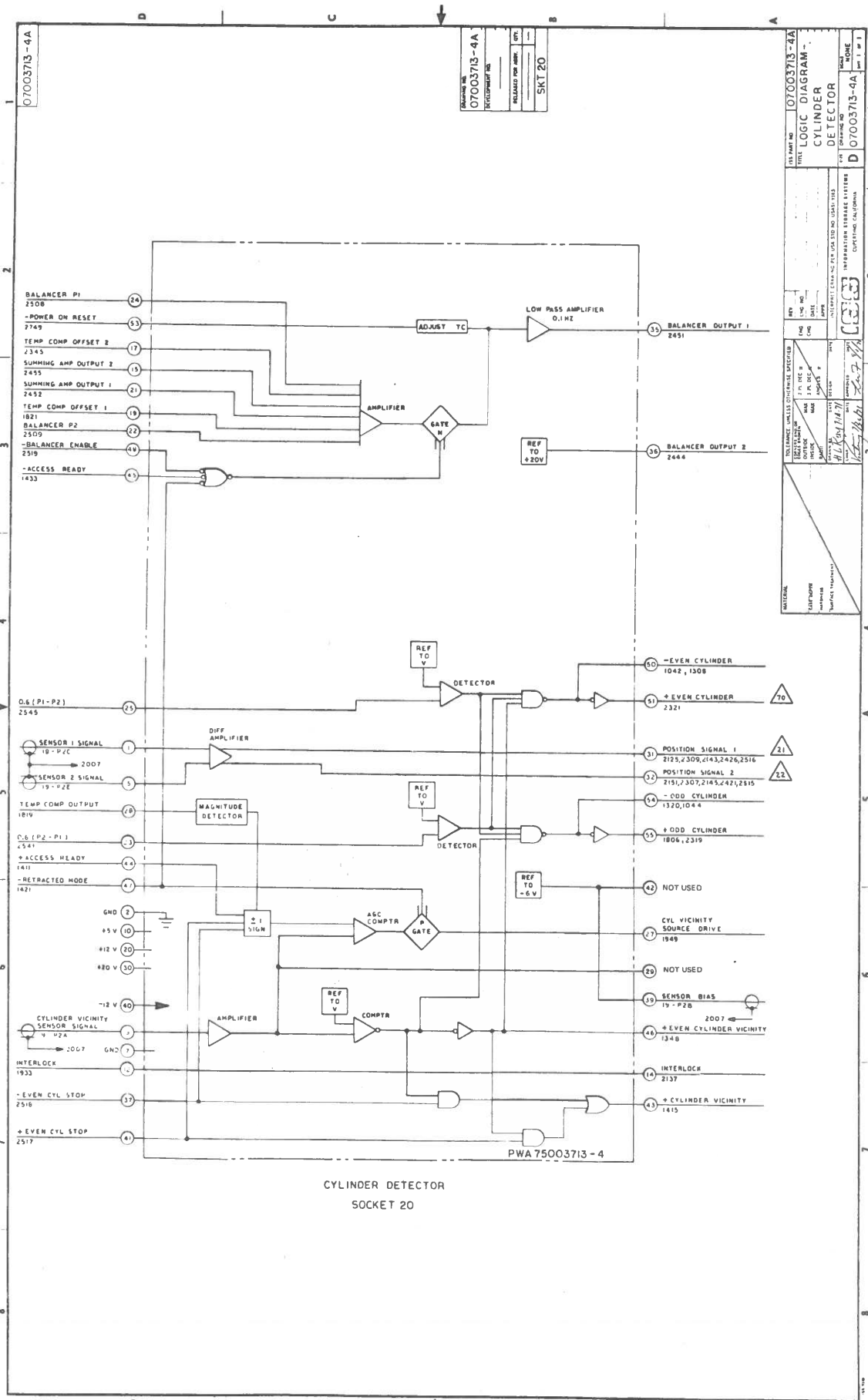
THIS DRAWING IS UNLESS OTHERWISE SPECIFIED:  
 UNLESS OTHERWISE SPECIFIED:  
 DIMENSIONS ARE IN INCHES  
 DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS  
 UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE:  
 FRACTIONS DECIMALS  
 .005 .005  
 .010 .010  
 .015 .015  
 .020 .020  
 .030 .030  
 .040 .040  
 .050 .050  
 .060 .060  
 .070 .070  
 .080 .080  
 .090 .090  
 .100 .100  
 .125 .125  
 .150 .150  
 .175 .175  
 .200 .200  
 .250 .250  
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07004139-4B  
 LOGIC DIAGRAM  
 TEMPERATURE  
 COMPENSATION & SAFETY  
 DRAWING NO. 07004139-4B  
 SHEET 1 OF 1  
 DATE: 9/1/65  
 DESIGNED BY: [ ]  
 CHECKED BY: [ ]  
 APPROVED BY: [ ]  
 TITLE: LOGIC DIAGRAM  
 PART NO.: SKT 18  
 DRAWING NO.: 07004139-4B  
 SHEET 1 OF 1









PWA 75003713-4A  
 SKT 20

07003713-4A LOGIC DIAGRAM CYLINDER DETECTOR	
DATE: 11/17/71 BY: [Signature]	CHECKED: [Signature] DATE: [ ]
INTER-OFFICE ROUTING SLIP INFORMATION SERVICES DIVISION D 07003713-4A	DRAWING NO. 07003713-4A SHEET NO. 1 OF 1











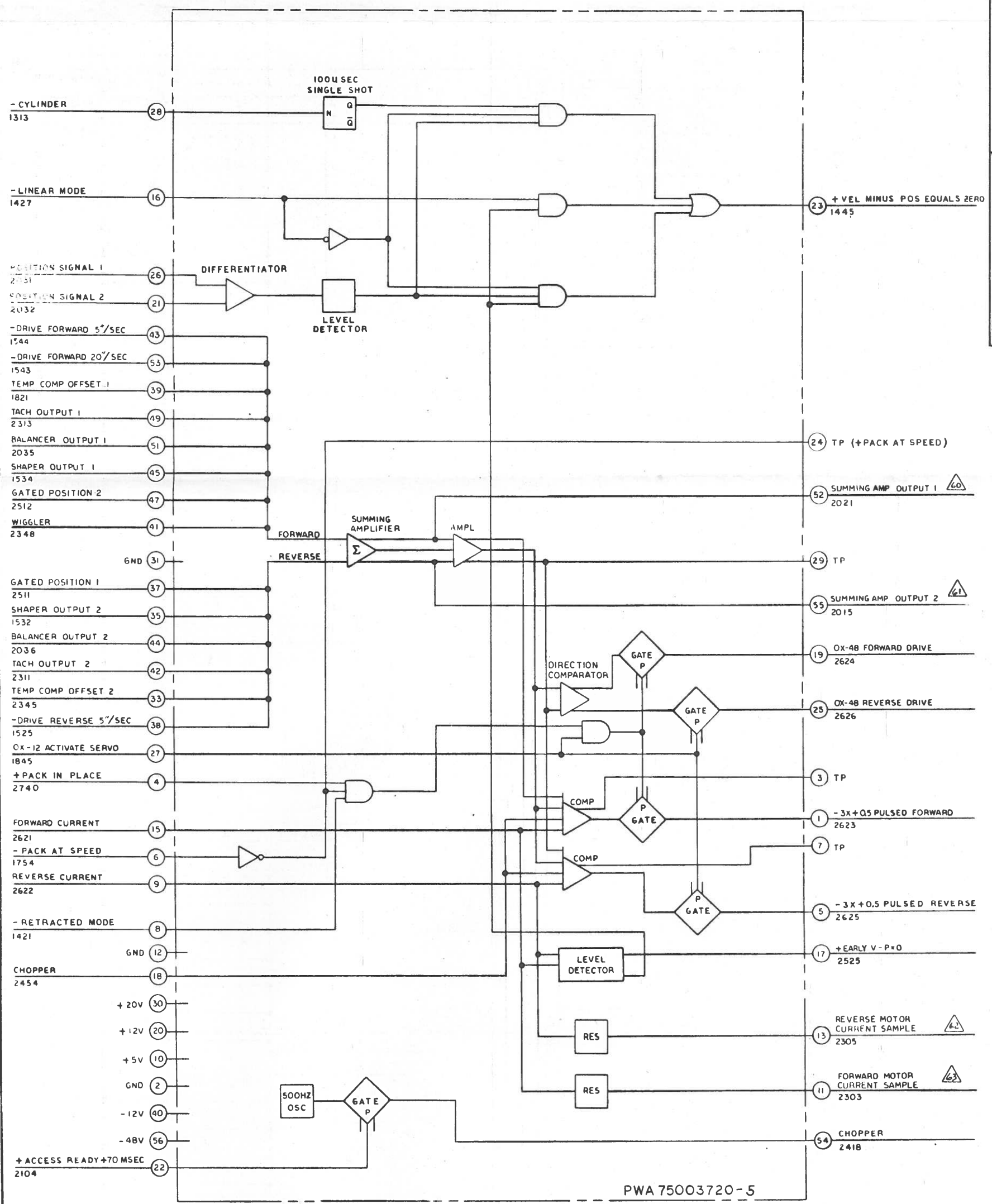


07003720-5A

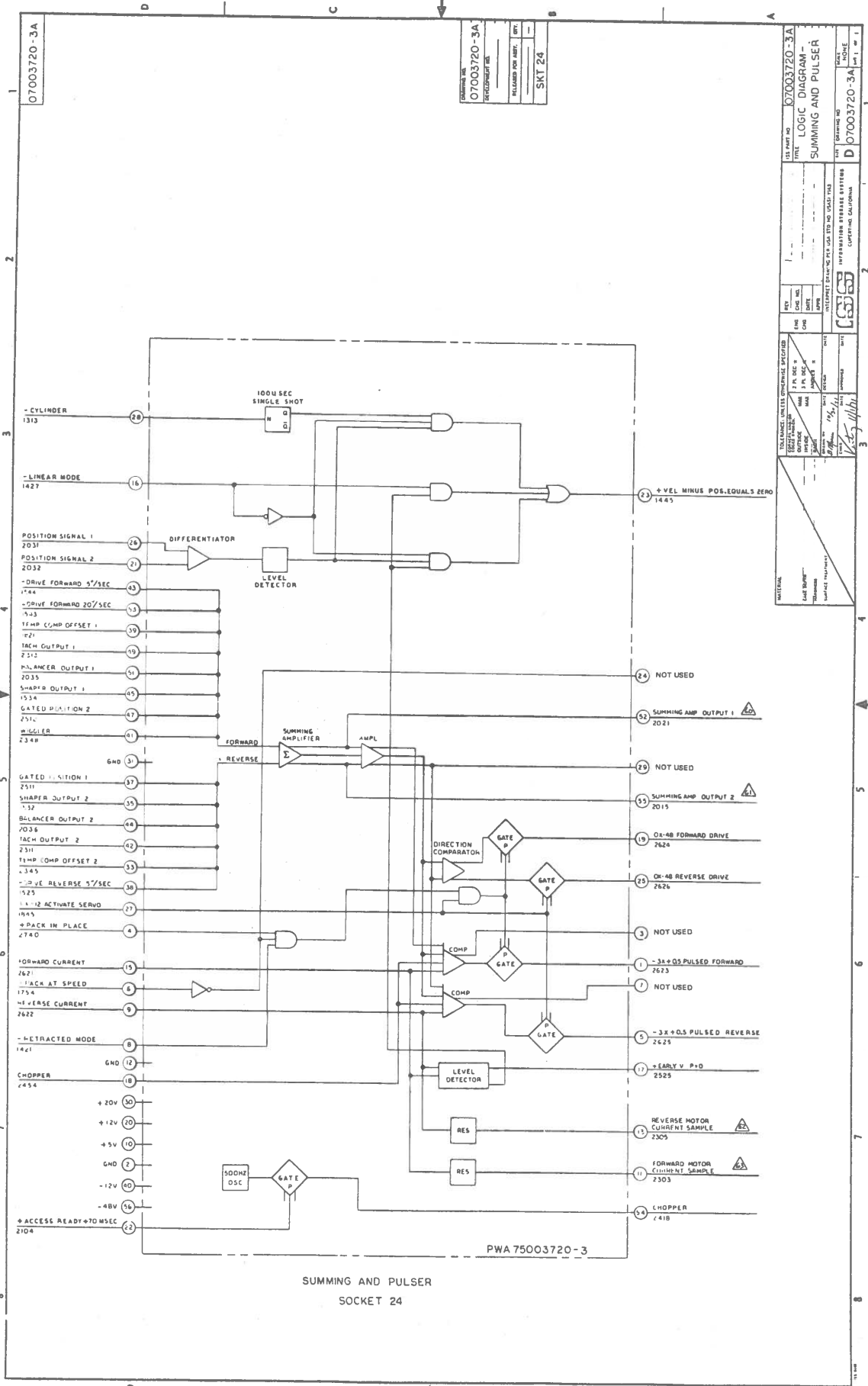
DRAWING NO. 07003720-5A  
DEVELOPMENT NO.  
RELEASED FOR ASSY. QTY  
SKT 24

REDUCED SIZE  
PRINT

ISS PART NO.	07003720-5A
TITLE	LOGIC DIAGRAM - SUMMING AND PULSER
REV	A
CHG NO.	11479
DATE	11/19/72
APPR	SPC
INTERPRET	DRAWING PER USA STD NO. USASI Y145
SCALE	NONE
DRAWING NO.	D 07003720-5A
SHEET	1 OF 1
 INFORMATION STORAGE SYSTEMS CUPERTINO, CALIFORNIA	



SUMMING AND PULSER  
SOCKET 24

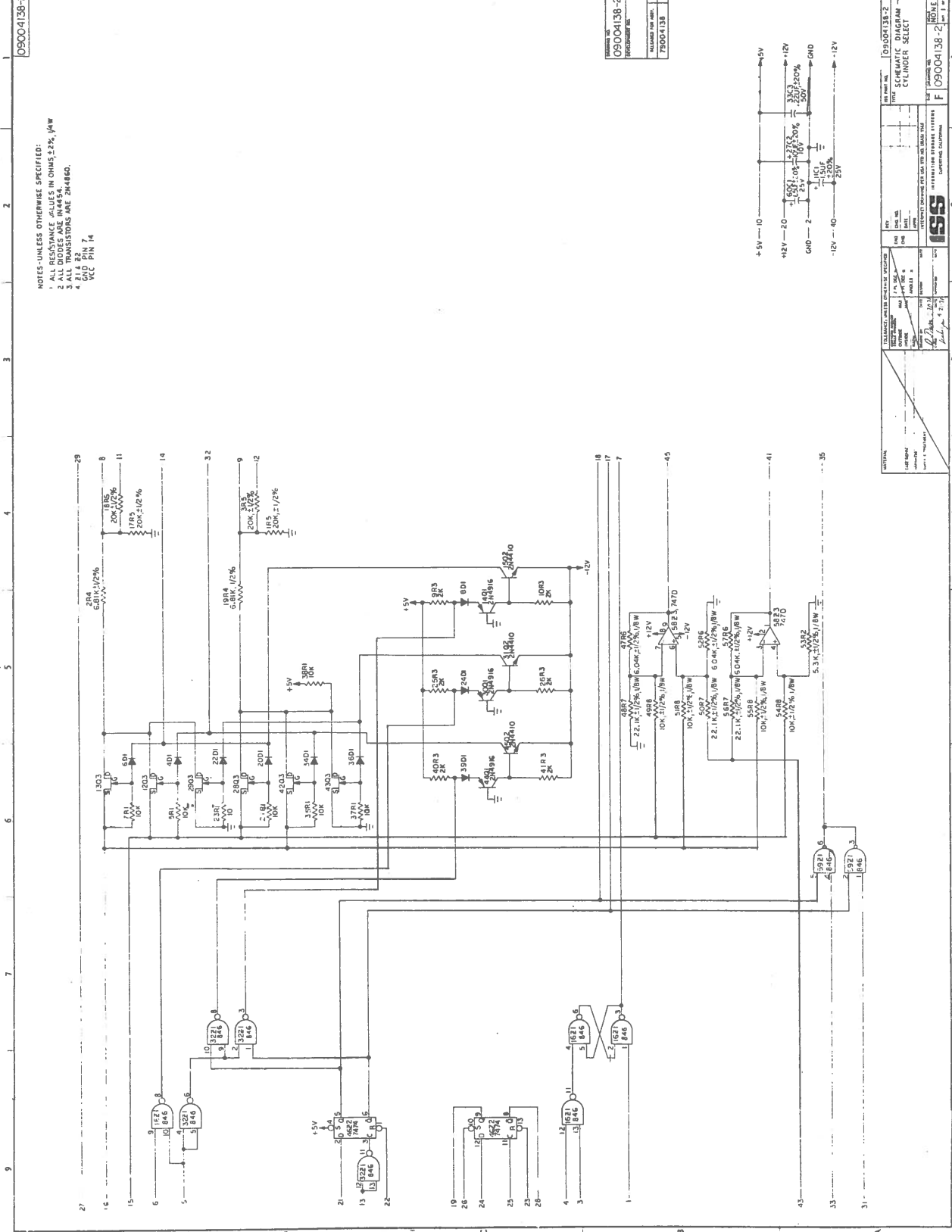


07003720-3A  
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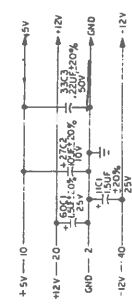
1313	07003720-3A
1427	LOGIC DIAGRAM -
2031	SUMMING AND PULSER
2032	
1744	
1743	
1721	
1722	
2512	
2035	
1734	
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1421	
2454	
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1445	
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2015	
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2529	
2305	
2303	
2418	

09004138-2

NOTES-UNLESS OTHERWISE SPECIFIED:  
1 ALL RESISTANCE VALUES IN OHMS, 2%, 1/4W  
2 ALL CAPACITANCE VALUES IN P.F.  
3 ALL TRANSISTORS ARE 2N4480.  
4 21, 4, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.



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REVISED BY	
DATE	
APPROVED BY	
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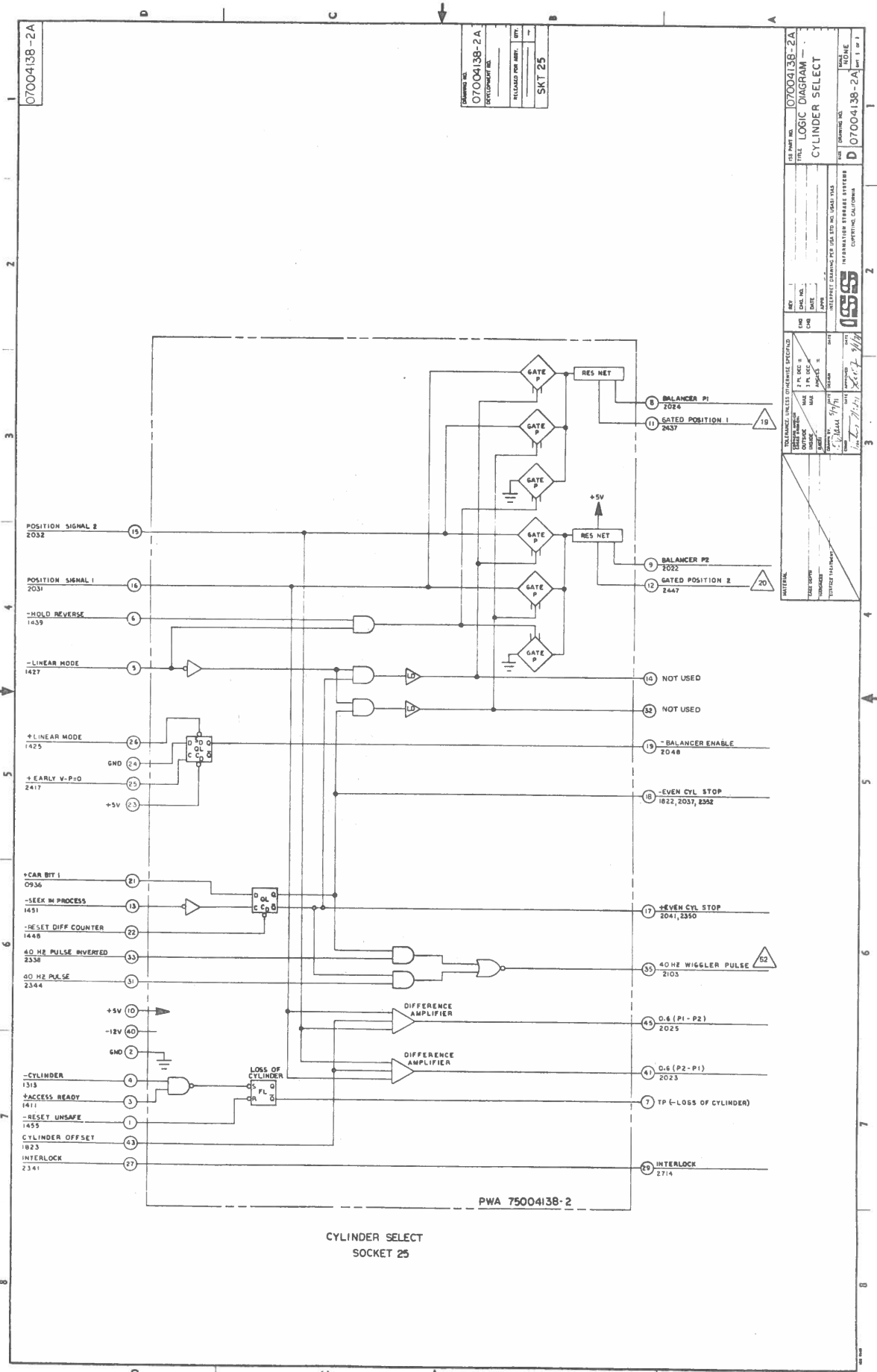
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REVISED FOR AMPL. BYT.  
SKT 25

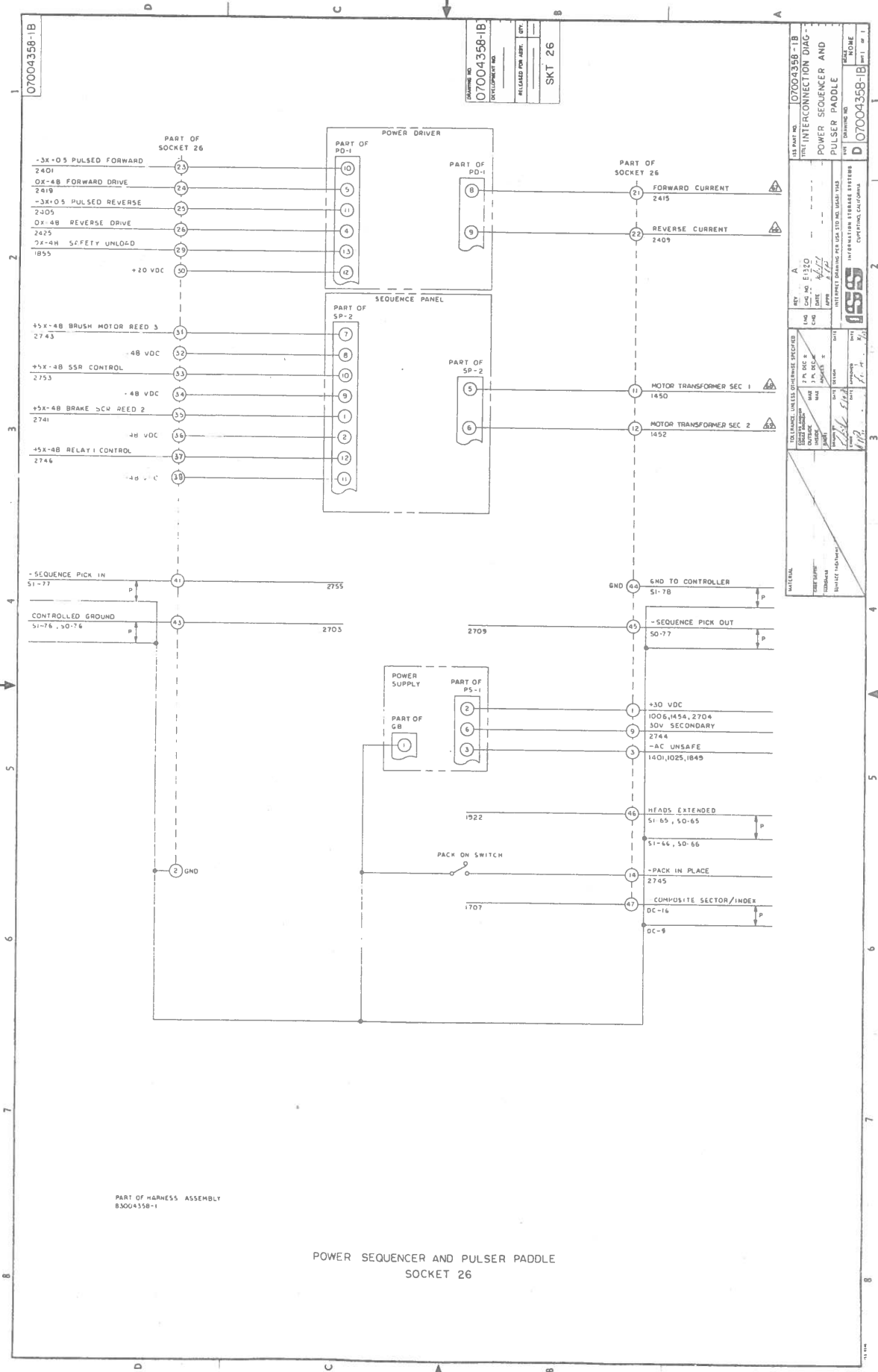
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07004138-2A  
DRAWING NO. D  
REV. 1 OF 1



CYLINDER SELECT  
SOCKET 25





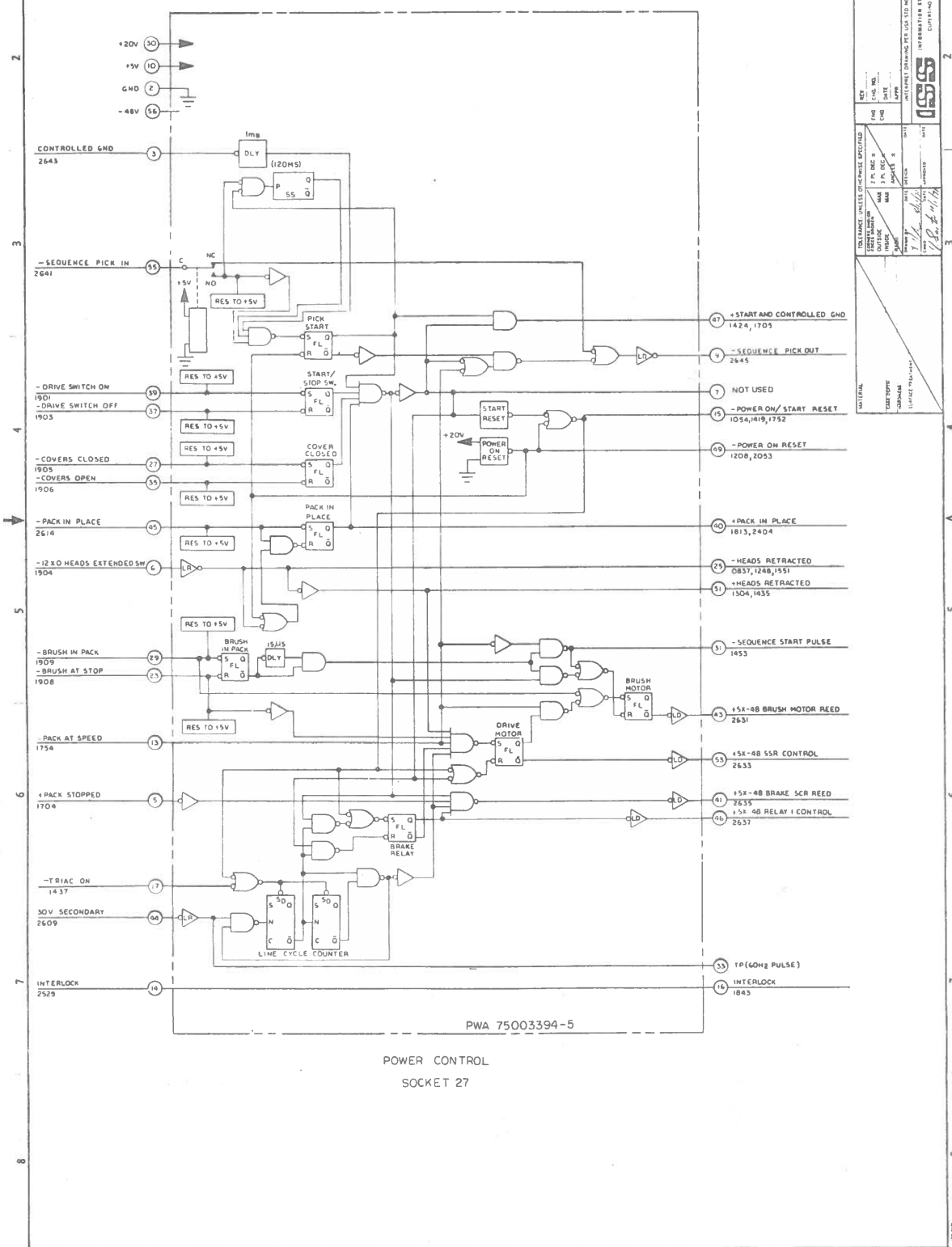
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07003394-5B

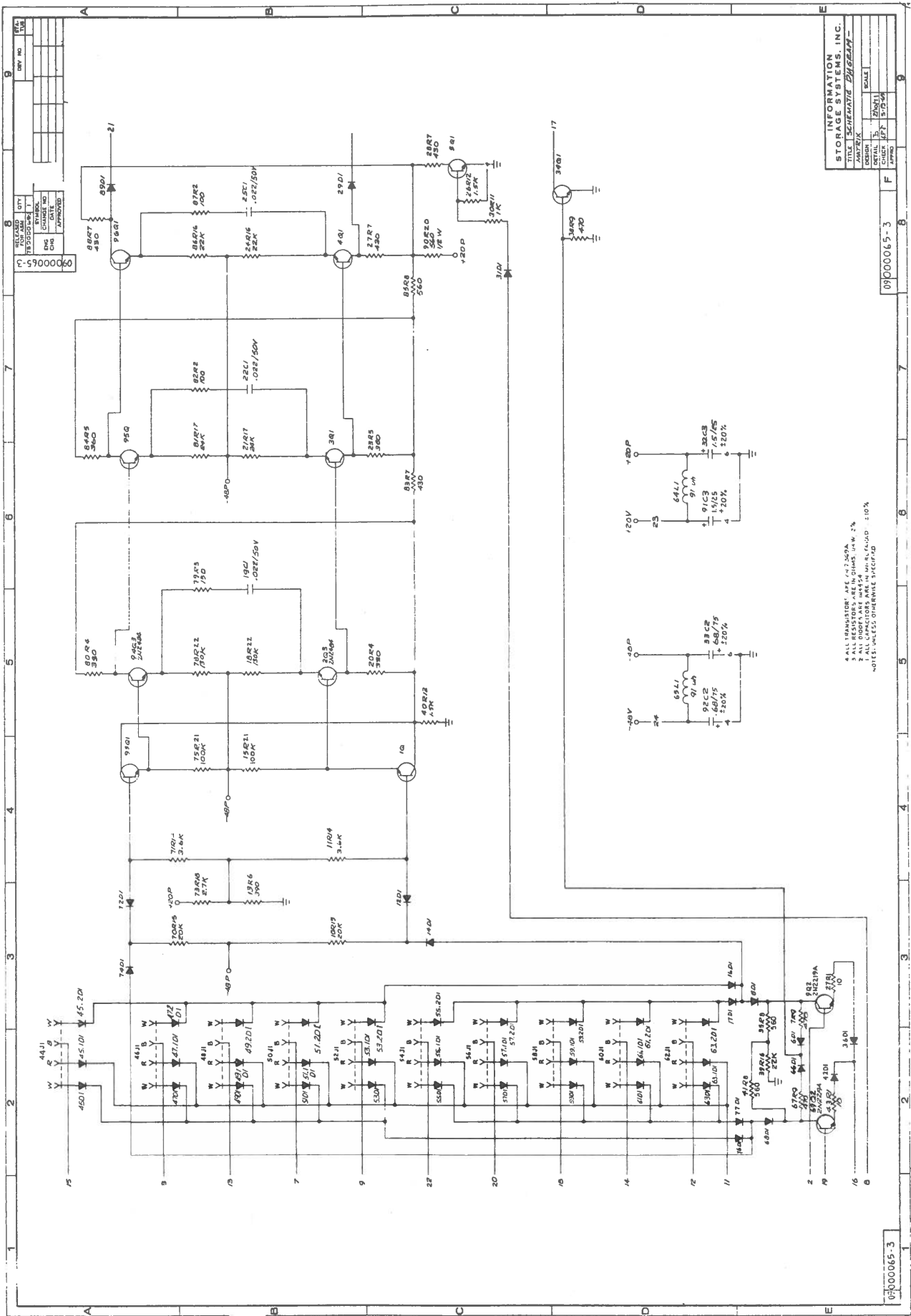
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SKT 27

07003394-5B  
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POWER CONTROL



DESIGNED BY	DATE	REV	BY	DATE
CHECKED BY				
APPROVED BY				
TESTED BY				
DATE TESTED				
TEST RESULTS				
TESTED BY				
DATE TESTED				
TEST RESULTS				
TESTED BY				
DATE TESTED				
TEST RESULTS				





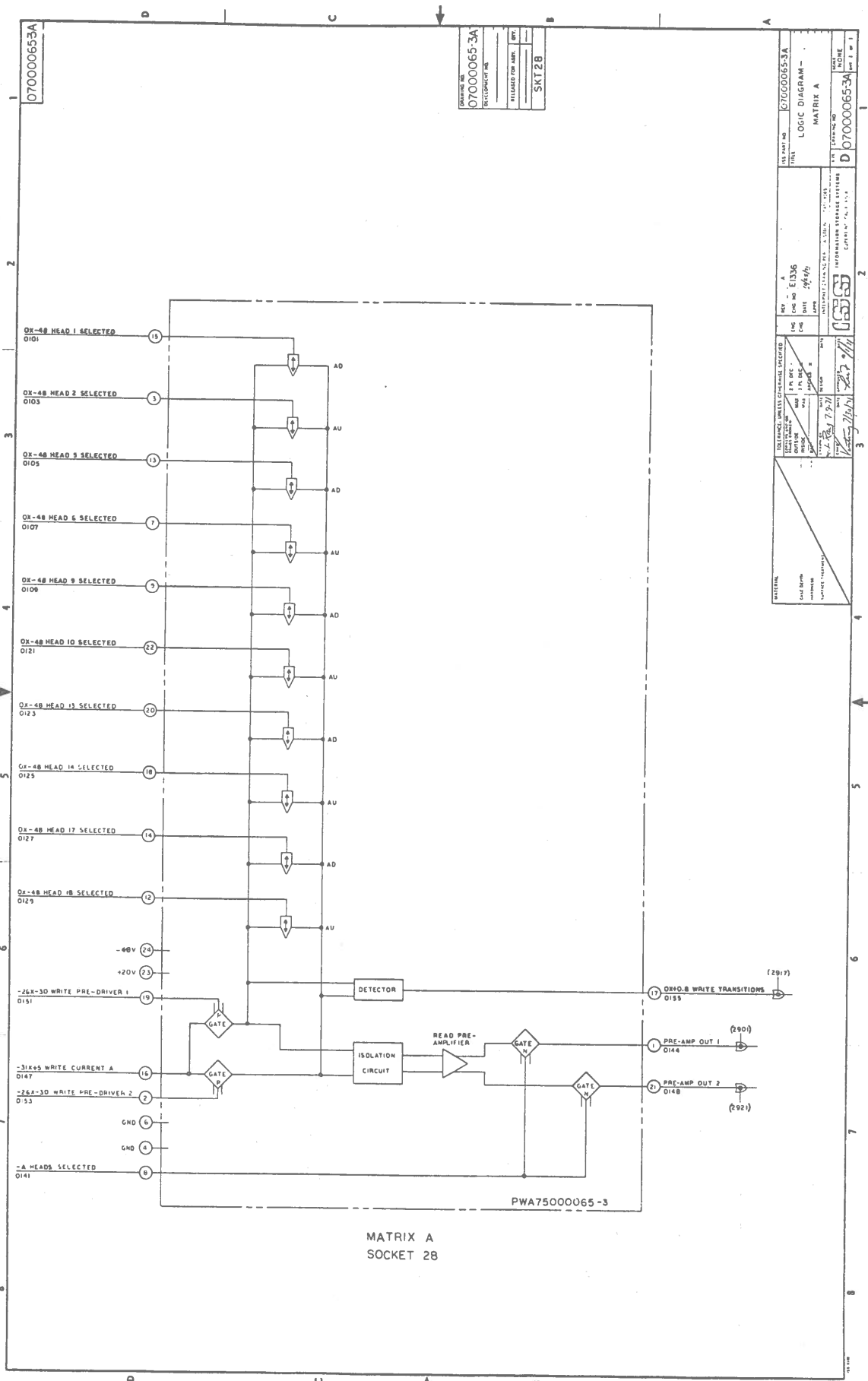
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DATE	
BY	
CHKD	
APPD	

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SCALE	1:1
DATE	5/21/54
APPD	

INFORMATION STORAGE SYSTEMS, INC.  
 TITLE SCHEMATIC DIAGRAM  
 PART NO. 99000065-3  
 SHEET 1 OF 1

99000065-3

4 ALL TRANSISTORS ARE 1/2 WATT  
 2 ALL DIODES ARE 1/4 WATT  
 2 ALL CAPACITORS ARE 50V UNLESS OTHERWISE SPECIFIED  
 10% TOLERANCE UNLESS OTHERWISE SPECIFIED

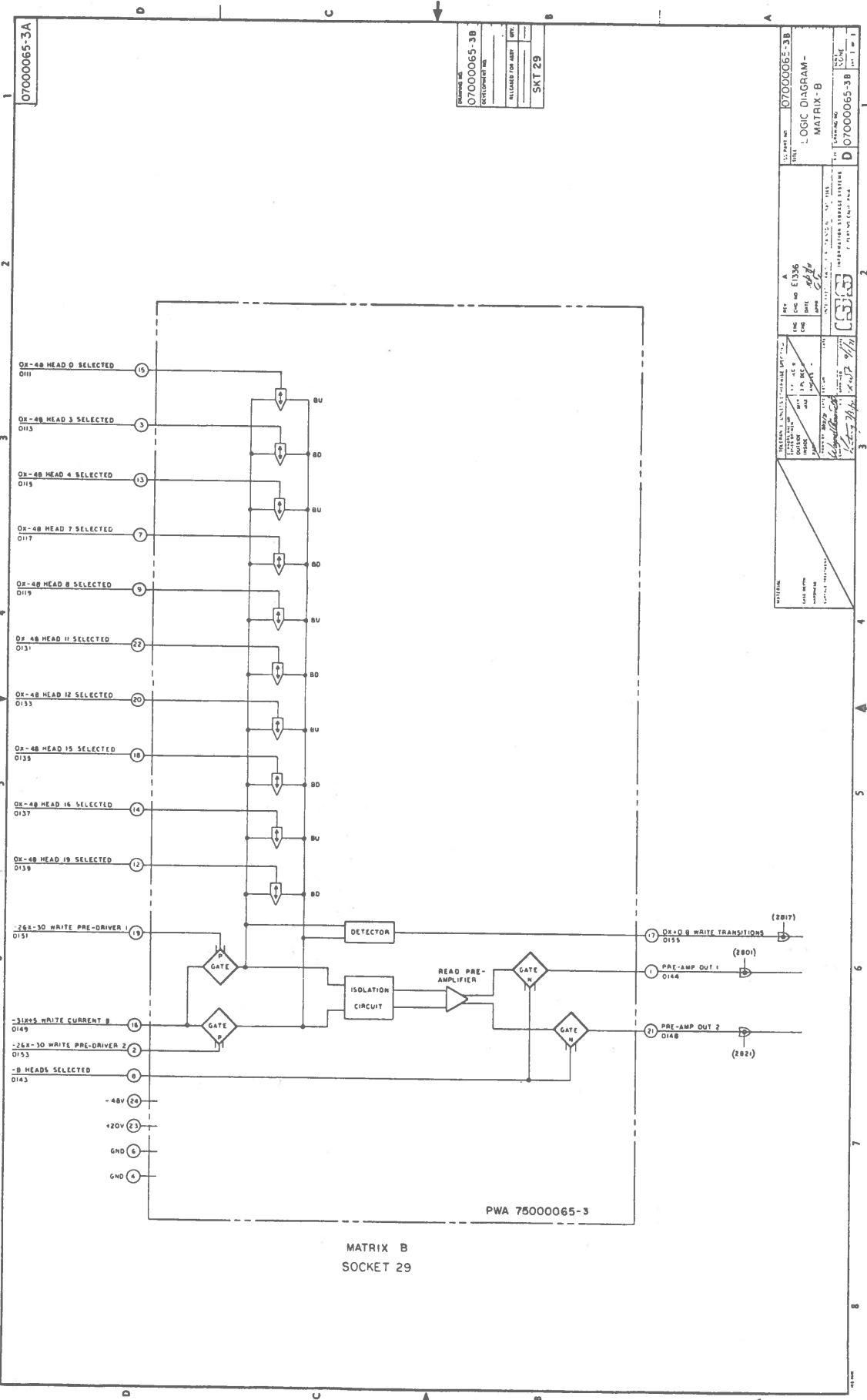


DRAWING NO. 07000065-3A  
 DEVELOPMENT NO.  
 RELEASED FOR AMP. USE  
 SKT 28

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MATRIX A  
SOCKET 28





07000065-3A

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 SKT 29

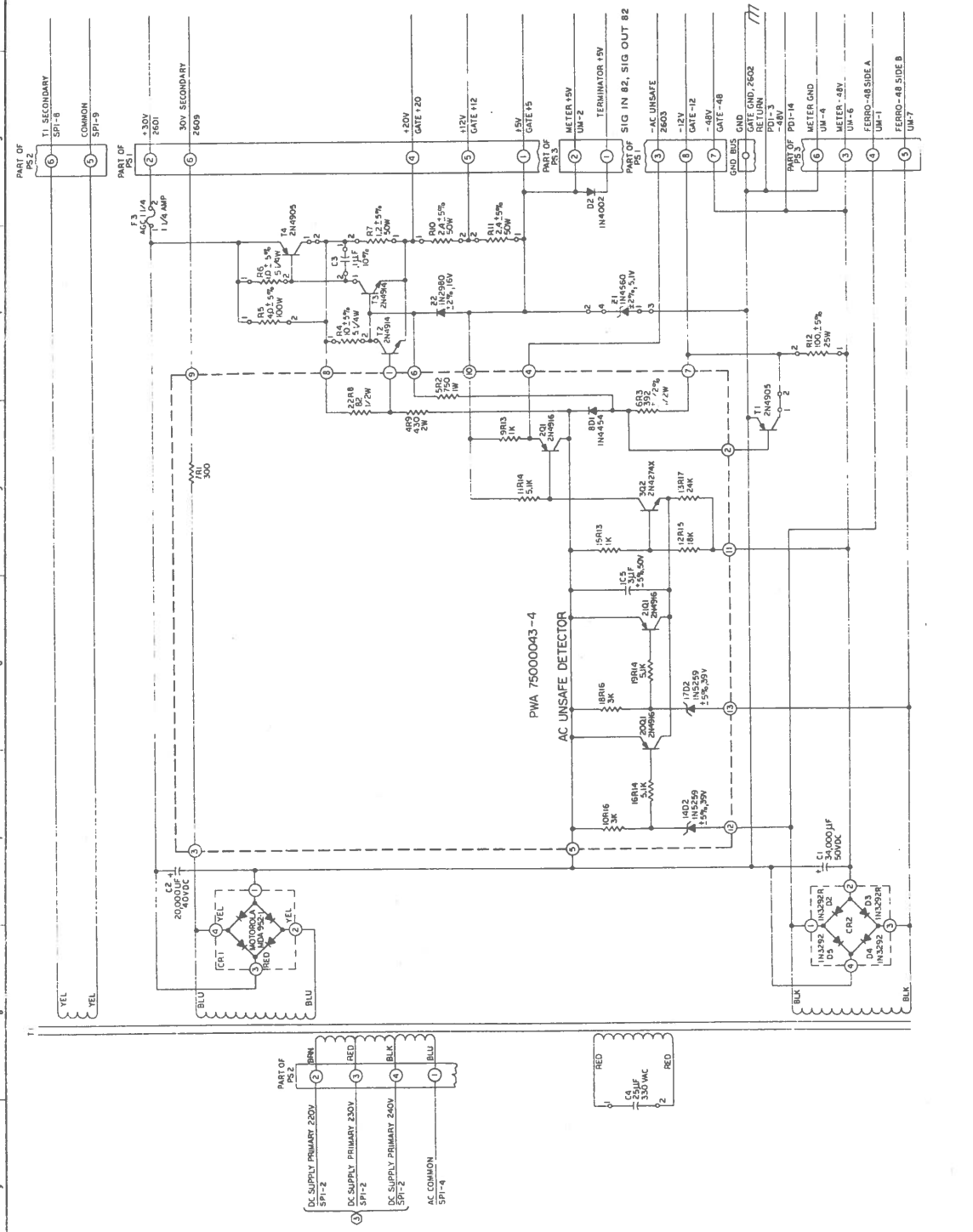
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 D 07000065-3B

REV	A
CHKD BY	EJ336
DATE	10/1/64
BY	WJL
APP'D	[Signature]
TESTED BY	[Signature]
TEST DATE	9/1/64
TESTED BY	[Signature]
TEST DATE	9/1/64

REVISIONS:

NO.	DESCRIPTION	DATE
1	INITIAL DESIGN	8/1/64
2	REVISED TO CORRECT ERROR	9/1/64

- NOTES - UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCE VALUES IN OHMS, 1/2%, 1/4W
  2. COMPONENT TERMINAL DESIGNATION
  3. ONLY ONE OF THE THREE INPUTS IS CONNECTED TO SPI-2 DEPENDENT ON INPUT VOLTAGE.
  4. TERMINATION ABBREVIATIONS:  
 PD - POWER DRIVER  
 SP - SEQUENCE PANEL  
 PS - POWER SUPPLY  
 UM - USAGE METER



SCHEMATIC DIAGRAM  
 DC POWER SUPPLY-50HZ

ISS  
 INTERNATIONAL SCIENTIFIC SUPPLY COMPANY  
 1400 W. 14TH AVENUE  
 LAUREL, CALIFORNIA 90045

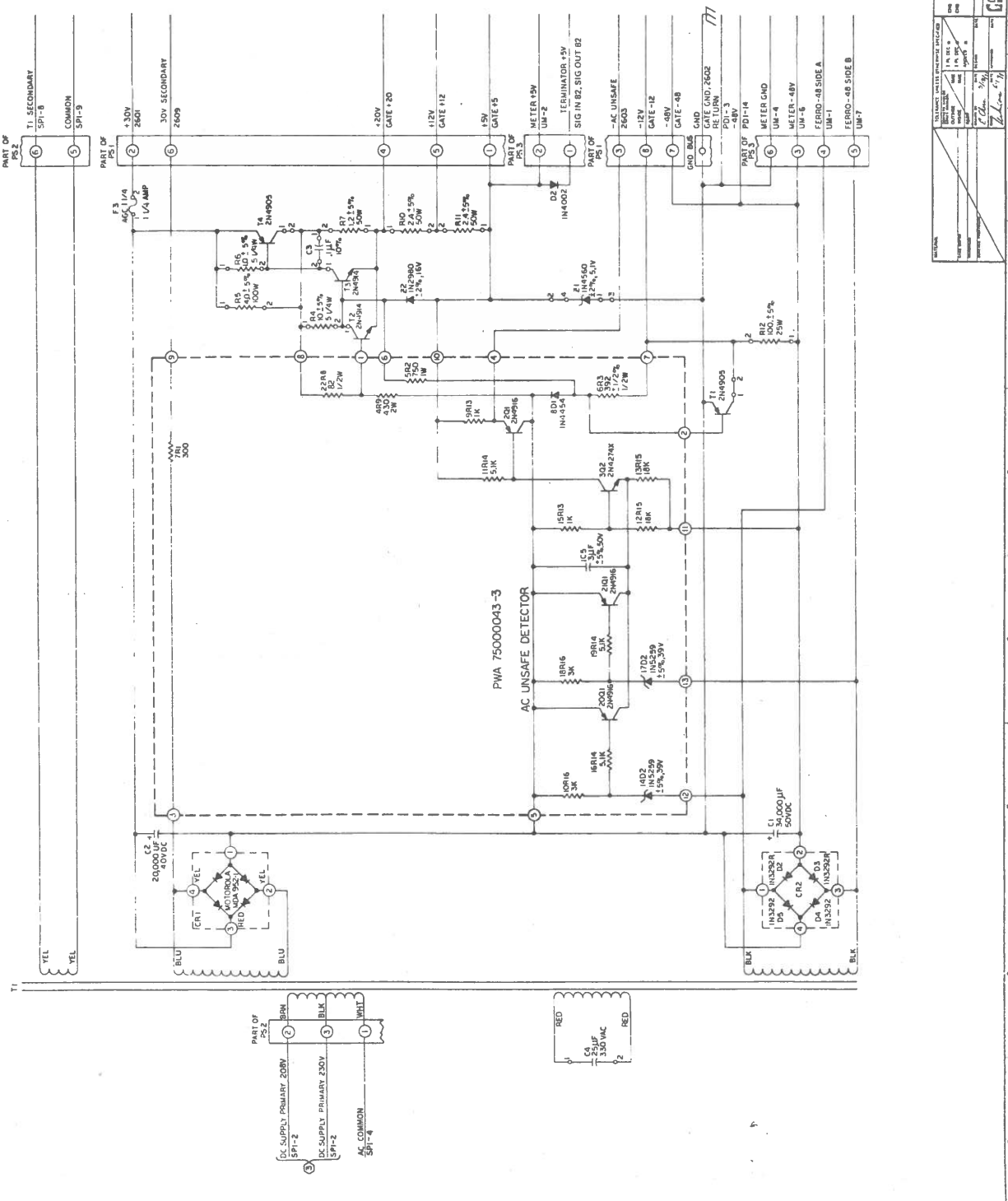
DATE: 10/10/77  
 DRAWN BY: J. J. JONES  
 CHECKED BY: J. J. JONES  
 PART NUMBER: F 07000003-3

07000605-2

NOTES - UNLESS OTHERWISE SPECIFIED:

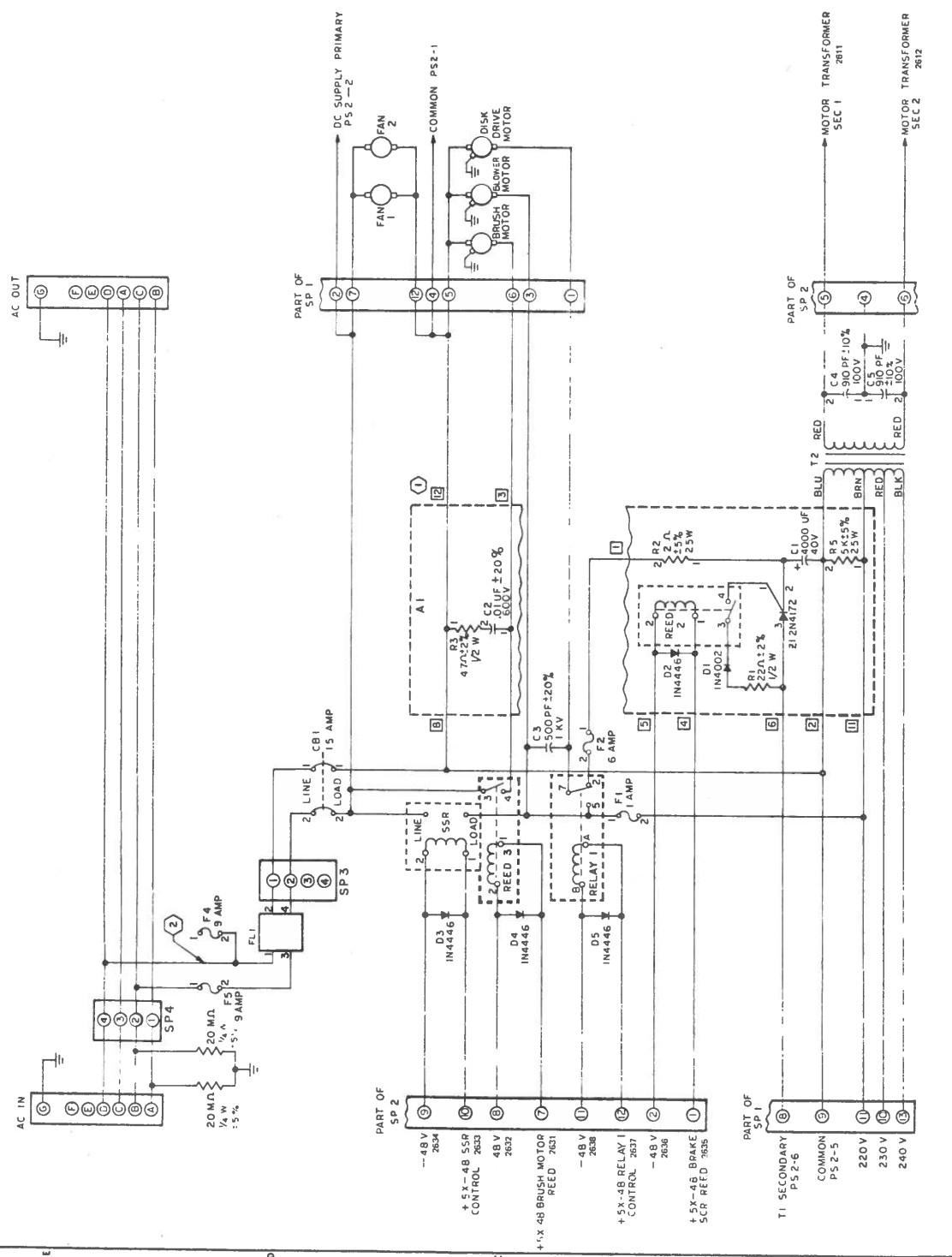
1. ALL RESISTANCE VALUES IN OHMS, 2%, 1/4W
2. 5 COMPONENT TERMINAL DESIGNATION
3. ONLY ONE OF THE TWO INPUTS IS CONNECTED TO SPI-2 DEPENDING ON INPUT VOLTAGE.
4. TERMINATION ABBREVIATIONS:  
PD POWER DRIVER SP-SEQUENCE PANEL  
PS POWER SUPPLY UM-USAGE METER

DESIGNED BY	07000605-2
REVISION NO.	
REVISION DATE	
REVISION BY	
REVISION REASON	
REVISION DATE	
REVISION BY	
REVISION REASON	
REVISION DATE	
REVISION BY	
REVISION REASON	



DESIGNED BY	07000605-2
REVISION NO.	
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REVISION DATE	
REVISION BY	
REVISION REASON	
REVISION DATE	
REVISION BY	
REVISION REASON	

NOTES: UNLESS OTHERWISE SPECIFIED -  
 ① NUMBERS IN SQUARES REPRESENT  
 WIRE RUN NUMBERS OF A1.  
 ② CONNECTION SHOWN IS FOR WYE INPUT.  
 FOR DELTA INPUT, REMOVE JUMPER  
 BETWEEN FILTER I-1 AND SP4-4, AND  
 RECONNECT IT BETWEEN F4-1 AND SP4-1.



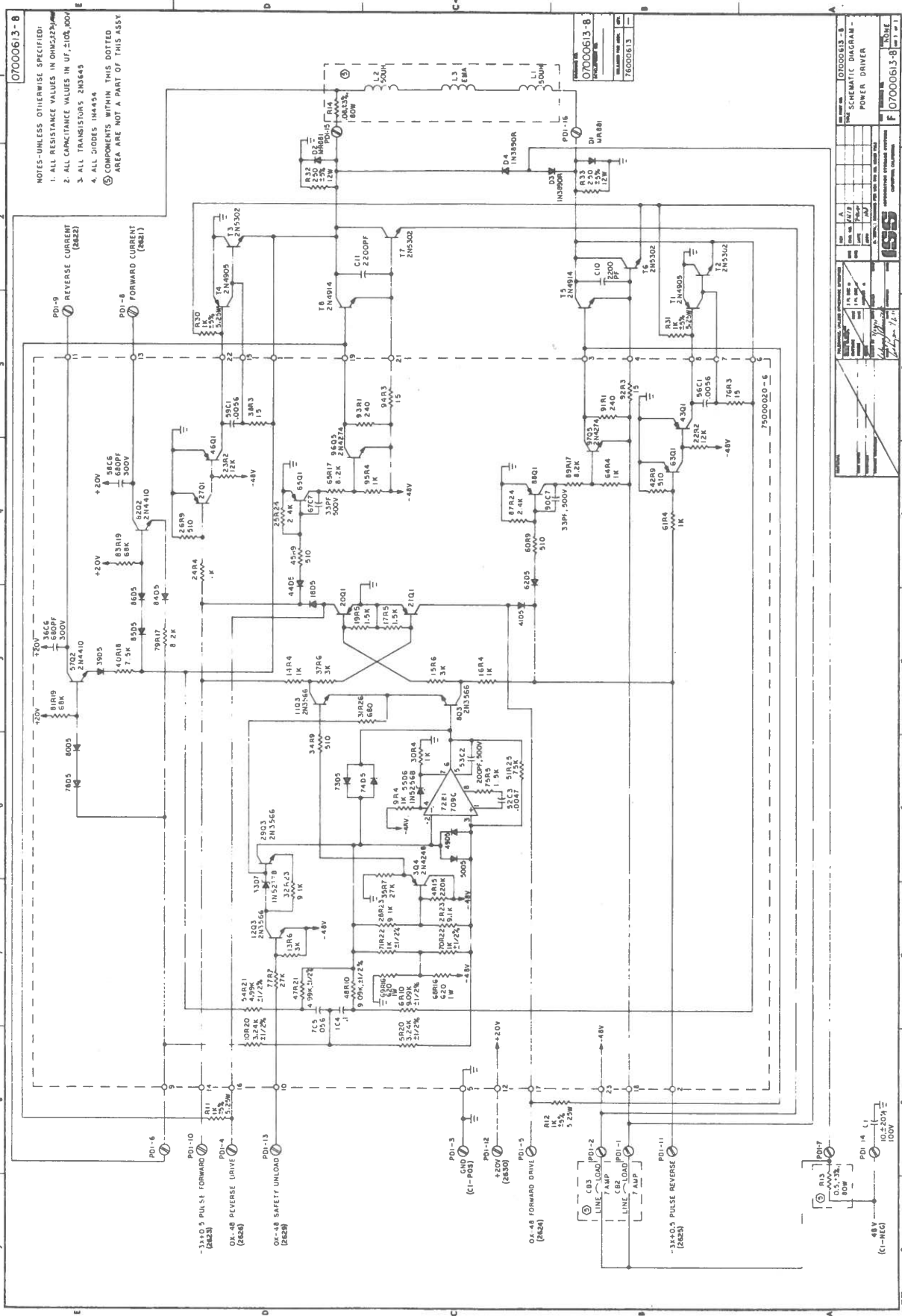
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 76003963-1

07003963-1 SCHEMATIC DIAG. POWER SEQUENCE 50 Hz	
PART NO. 07003963-1	REV. 1
DATE 11-1-61	DESIGNED BY J. J. ...
DRAWN BY ...	CHECKED BY ...
APPROVED BY ...	AUTHORITY ...
07003963-1 F 07003963-1	

9-90 SEQUENCE PANEL (50 Hz)







NOTES-UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTANCE VALUES IN OHMS, K $\Omega$ , OR M $\Omega$ .  
 2. ALL CAPACITANCE VALUES IN UF, 100N, 100P.  
 3. ALL TRANSISTORS 2N3645  
 4. ALL DIODES 1N4544  
 5. COMPONENTS WITHIN THIS DOTTED AREA ARE NOT A PART OF THIS ASSY

REV	DATE	BY	CHKD	DESCRIPTION
1				ISSUED FOR PRODUCTION
2				REVISION
3				REVISION
4				REVISION
5				REVISION
6				REVISION
7				REVISION
8				REVISION
9				REVISION
10				REVISION

07000613-B  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

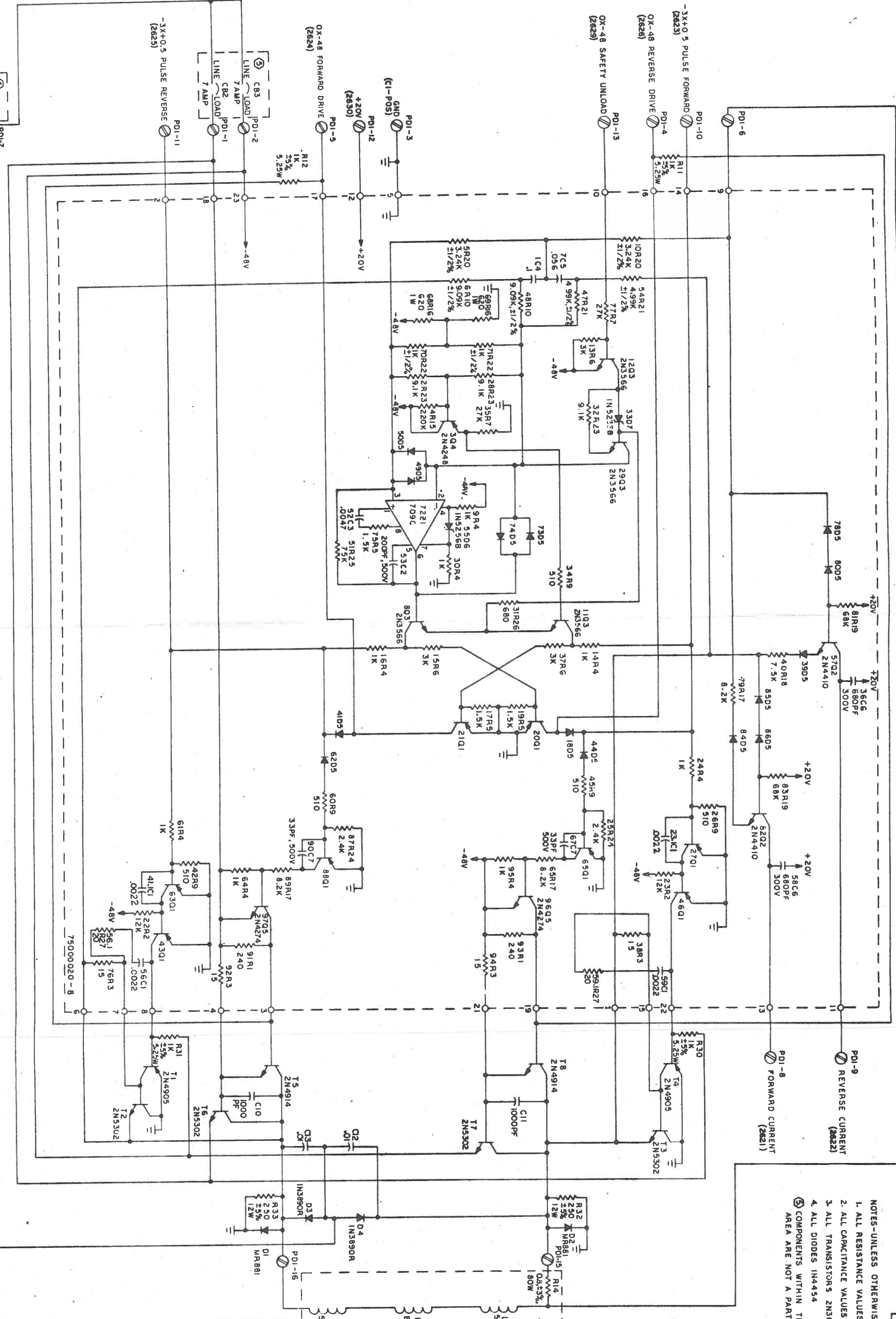
07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

07000613-B  
 SCHEMATIC DIAGRAM  
 POWER DRIVER

NOTES - UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTANCE VALUES IN OHMS, 2% TOL.  
 2. ALL CAPACITANCE VALUES IN UF, ±10%, 100V  
 3. ALL TRANSISTORS 2N3645  
 4. ALL DIODES 1N4454  
 5. COMPONENTS WITHIN THIS DOTTED AREA ARE NOT A PART OF THIS ASSY.



**REduced SIZE**  
**LINE**

07000613-10  
 DATE: 11/13/54  
 REV: 1  
 750000613

DATE	11/13/54	REV	1
BY	W. J. B.	CHKD	W. J. B.
APP'D		DATE	11/13/54
DESIGNED BY	W. J. B.	CHKD BY	W. J. B.
DRAWN BY		DATE	11/13/54
CHECKED BY		DATE	11/13/54
TESTED BY		DATE	11/13/54
INSPECTED BY		DATE	11/13/54
APPROVED BY		DATE	11/13/54
TESTED BY		DATE	11/13/54
INSPECTED BY		DATE	11/13/54
APPROVED BY		DATE	11/13/54
TESTED BY		DATE	11/13/54
INSPECTED BY		DATE	11/13/54
APPROVED BY		DATE	11/13/54

07000613-10  
 DATE: 11/13/54  
 REV: 1  
 750000613

# APPENDIX A INTERNATIONAL 715DEC

## A.1 POWER REQUIREMENTS

### A.1.1 General Description

The international version of the 715DEC Disk Storage Drive includes special power transformers, a brush motor, and associated components which are selected for use with 3-phase, 50-Hz +1/2 -1% wye (Y) or delta ( $\Delta$ ) connected facility power. See Table A-1 for associated voltages. The selection of internal transformer primary windings to match the wye or delta VAC facility supply is made at terminal board connections for the sequence panel and DC power supply transformers. Drives are usually wired at the factory for a 3-phase, 4-wire, wye (Y) input connection that provides 220 VAC between any phase and common. The phase-to-phase voltage for this type of primary power is 380 VAC.

Table A-1. International Power Requirements  
(Phase-to-Common and Phase-to-Phase Voltages)

NOMINAL FACILITY AC INPUT VOLTAGE (PHASE-TO-PHASE)	AC VOLTAGE AT INPUT OF DRIVE			
	Pin A-B	Pin B-C	Pin C-A	
220 delta ( $\Delta$ )	220	220	220	Phase
230 delta ( $\Delta$ )	230	230	230	to
240 delta ( $\Delta$ )	240	240	240	Phase
	Pin A-D	Pin B-D	Pin C-D	
*380 wye (Y)	*220	*220	*220	Phase
400 wye (Y)	230	230	230	to
415 wye (Y)	240	240	240	Phase
*As shipped from factory.				

### CAUTION

Before installation, the voltage level and the type of input connection must be checked to determine if it matches the type of primary power for which the drive is wired. Wiring on drives whose wiring does not match the primary power of the input facility must be changed before connecting the AC cable between the drive and its power source.

## A.2 INTERNATIONAL DRIVE CHARACTERISTICS

The drive characteristics listed in Chapter 2 apply to international units except as follows:

### Connecting Cables

AC . . . . . 1 cable for up to three drives. 2 cables for more than three drives, P/N 84003770-XX.

Signal Terminator . . . . Special Order Item, P/N 76000696-5.

### Power Requirements

Primary (See Table A-1) . . 220, 230, 240 BAC  $\pm 10\%$ , 3-phase, 50 Hz, +0.5% -1.0%

The international 715DEC also includes tool-operated, self-locking latches which are located on the front and two rear access covers. Insert a suitable tool (e.g., screwdriver) through the plastic grommet (3/16-inch diameter), positioned on the top edge of each cover, to depress and release the spring-loaded cover latch.

## A.3 FACILITY POWER CONNECTIONS

Primary power is supplied to the international 715DEC via an AC power cable (P/N 84003770) connected to the site facility receptacle. An appropriate plug or connector must be fitted to the cable which mates with the particular power outlet facility receptacle at installation. The power cable connections must conform to the following color code:

BLACK	for $\emptyset$ A
BLACK	for $\emptyset$ B
BROWN	for $\emptyset$ C
BLUE	for NEUTRAL
GREEN/YELLOW	for Gnd
Taped Shield	for Gnd

### CAUTION

The taped shield connection must be tied to ground in the facility outlet box.

## A.4 INPUT POWER CONNECTIONS

### A.4.1 Wye or Delta Power Configuration

The international 715DEC Disk Storage Drive is normally shipped with the DC power supply and power sequence transformer connections arranged for a wye-connected, 380-VAC, phase-to-phase input power source.

Input wiring connections are made at the sequence panel and power supply (Figures A-1 and A-2) according to the following procedures.

1. Inspect wiring connections on Terminal Board SP3 and SP1 of the sequence panel to ensure that primary input leads are connected as shown in Figure A-1.
2. Inspect wiring connections on Terminal Board PS2 of the DC power supply to ensure that primary input leads are connected as shown in Figure A-2.
3. Measure the facility voltage to determine the type (delta or wye) and voltage level of primary power that is supplied for the drive. If the phase-to-phase measured voltage is 380 to 415 VAC, the primary power is a 4-wire wye (Y) configuration. If the phase-to-phase measured voltage is 220 to 240 VAC, the primary power is a 3-wire delta ( $\Delta$ ) configuration. Refer to Table A-1 for phase-to-common voltage levels of a wye configuration.

**NOTE:** If the facility power is a 4-wire, wye configuration, the phase-to-common voltage is 220 VAC (380 VAC phase-to-phase), and the wiring connections conform to Figures A-1 and A-2, no wiring changes are necessary. Otherwise, proceed to step 4.

4. Make wiring changes by relocating transformer input leads on the sequence panel and DC power supply terminal boards as described in the following paragraphs and shown in Figures A-1 and A-2.

#### WARNING

Ensure that the AC power cable is disconnected from drive before making any wiring changes. Failure to do so may cause serious injury or loss of life by exposing personnel to 220- to 415-volt power.

- a. Paragraphs A.4.2 and A.4.3 describe connections required for 230 and 240 volts, respectively, for both wye and delta input power.

- b. Paragraph A.4.4 describes connections also required for delta input power.

#### **A.4.2 230-Volt Wiring Changes ('Y' or 'Δ' Input)**

If the supply voltage is nominal 230 volts, the following wiring changes must be made.

1. Sequence Panel - disconnect the input wire at SP1-11 and reconnect it to SP1-10.
2. DC Power Supply - disconnect the input wire at PS2-2 and reconnect it to PS2-3.

#### **A.4.3 240-Volt Wiring Changes ('Y' or 'Δ' Input)**

If the supply voltage is a nominal 240 volts, the following wiring changes must be made.

1. Sequence Panel - disconnect the input wire at SP1-11 and reconnect it to SP1-13.
2. DC Power Supply - disconnect the input wire at PS2-2 and reconnect it to PS2-4.

#### **A.4.4 Additional Delta Input Power Wiring Changes**

If the AC power supply is a " Δ " input, the wire connected between CB1 and SP3-4 of the sequence panel must also be disconnected at SP3-4 and reconnected to SP3-1.

**NOTE:** The effect of this change is that the AC supply voltage for the 3-wire, " Δ " input is taken across two phases of a 3-phase AC voltage supply. With the 4-wire, "Y" input, the AC supply voltage is taken across any phase and common (neutral).

### **A.5 ACCESS VELOCITY ADJUSTMENT**

The access velocity is checked to determine the timing interval from the beginning of seek start of occurrence of access ready. During this check, an unsafe condition may occur as a result of a velocity unsafe condition. When this happens, adjustment is to be performed as follows:

1. Install disk pack. (If maintenance disk pack is used, connect a jumper from 1732 to 1702).
2. Connect Off-Line Testor.
3. Turn drive on and obtain FILE READY status.

4. Set up oscilloscope as follows:
  - a. Connect scope channel 1 input probe to 273 (50-Hz Pulse Test Point).
  - b. Set time base at 2ms/cm.
  - c. Set vertical deflection at 2v/cm.
  - d. Set trigger to internal (INT) and slope to minus.
  - e. Adjust variable time base to obtain two complete AC cycles displayed over 10 divisions as shown in View A, Figure A-3.
5. Ground 1824 (this prevents the temperature compensation circuit from having an effect on the access velocity adjustment).
6. Set up Off-Line Testor to perform seek operations as follows:
  - a. Perform initial cylinder 000 recalibrateseek operation.
  - b. Perform 000-128 seek-seek operation.
7. Set up oscilloscope to read velocity signal by connecting channel 1 input probe to 2101 (+Access Ready).
8. Observe scope pattern. Look for pulse that is displaced 7.0 div. from start of sweep (View B, Figure A-3).

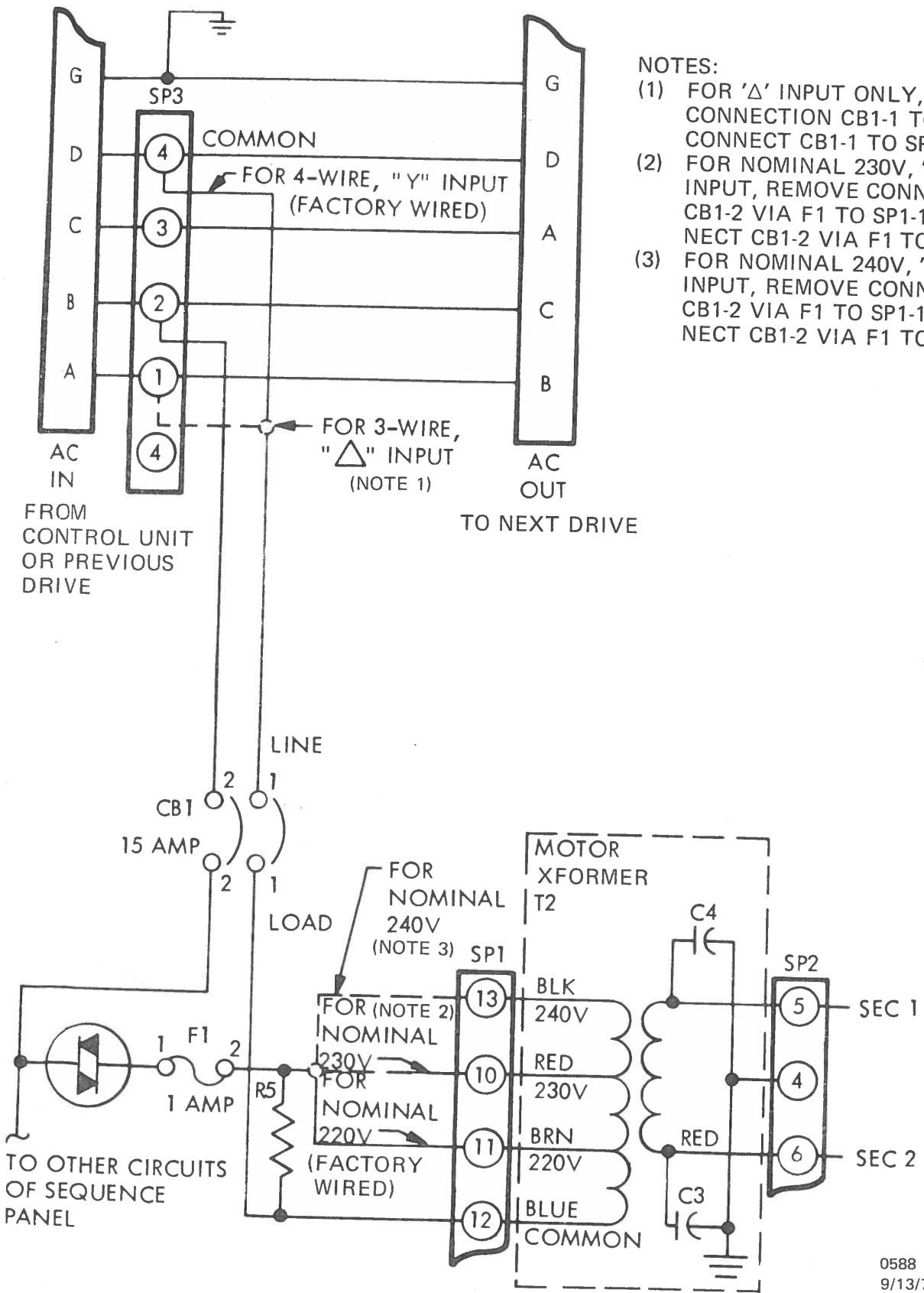
Actually, two pulses will appear close together; one each for forward and reverse motion as shown in View B.

9. Adjust access velocity as described below if 7.0 div pulse displacement is not present.
10. Check 406 cylinder seeks, recalibration, and head load operations for velocity unsafe condition.
11. Remove jumper from 1824 and ground.
12. Remove jumper from 1732 and ground.

#### Velocity Adjustment

Adjustment is made at potentiometer 136R10, located on the curve generator PWA 15. Adjustment is made to obtain scope pattern of View B, Figure A-3.

1. Speed up access velocity by rotating adjustment screw CCW. An increase in access speed causes pulse to appear early (which decreases number of divisions present from start of sweep).
2. Slow down access velocity by rotating adjustment screw CW. A decrease in access speed causes pulse to appear at a later time (which increases number of divisions present from start of sweep).

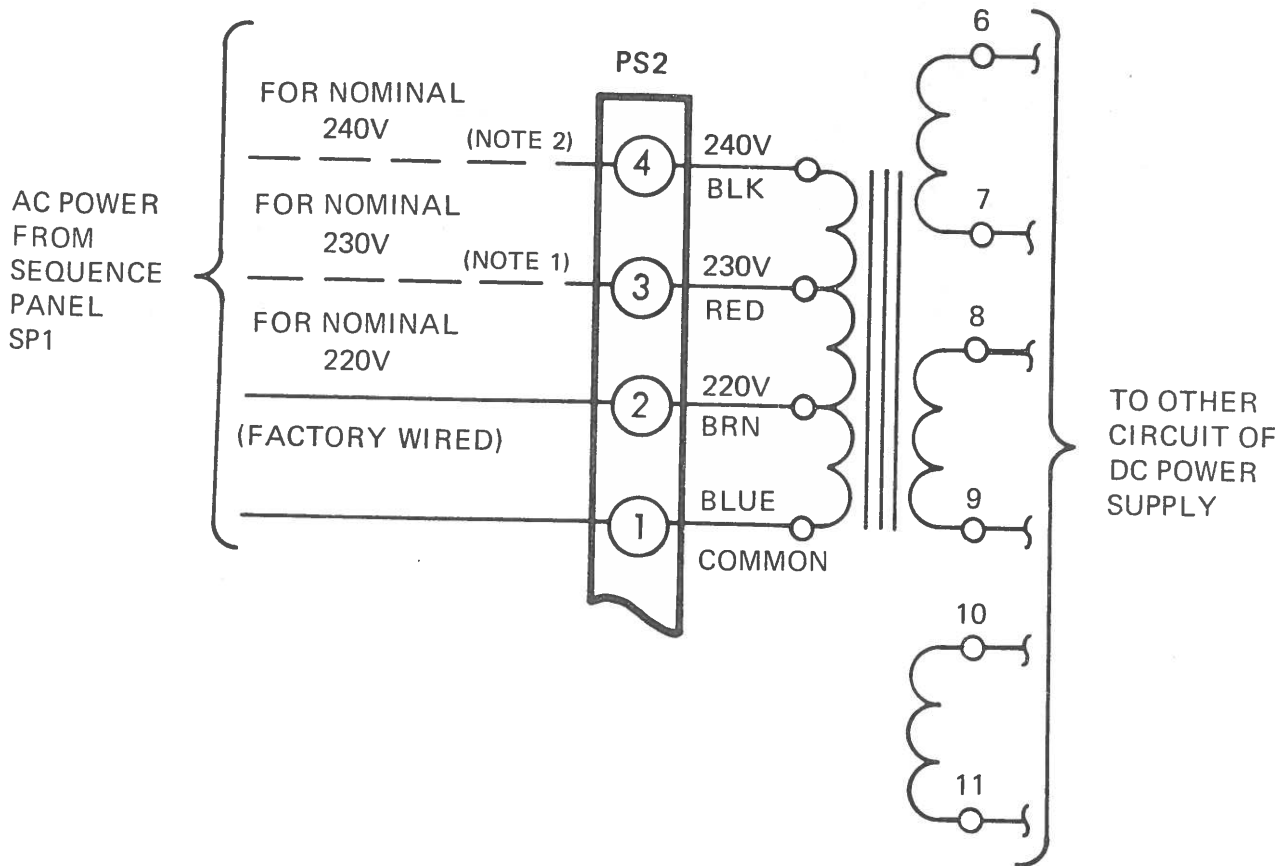


- NOTES:
- (1) FOR 'Δ' INPUT ONLY, REMOVE CONNECTION CB1-1 TO SP3-4. CONNECT CB1-1 TO SP3-1.
  - (2) FOR NOMINAL 230V, 'Y' OR 'Δ' INPUT, REMOVE CONNECTION CB1-2 VIA F1 TO SP1-11. CONNECT CB1-2 VIA F1 TO SP1-10.
  - (3) FOR NOMINAL 240V, 'Y' OR 'Δ' INPUT, REMOVE CONNECTION CB1-2 VIA F1 TO SP1-11. CONNECT CB1-2 VIA F1 TO SP1-13.

Figure A-1. Wire Connection Changes for Sequence Panel

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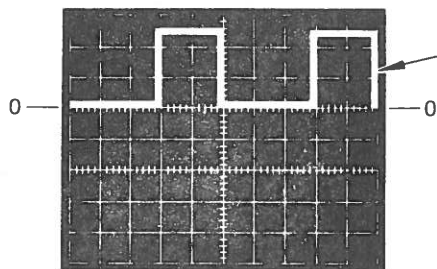


NOTES: (FOR BOTH 'Y' AND 'Δ' INPUT POWER)

- (1) FOR NOMINAL 230V, REMOVE INPUT CONNECTION TO PS2-2. CONNECT THIS INPUT WIRE TO PS2-3.
- (2) FOR NOMINAL 240V, REMOVE INPUT CONNECTION TO PS2-2. CONNECT THIS INPUT WIRE TO PS2-4.

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Figure A-2. Wire Connection Changes for DC Power Supply

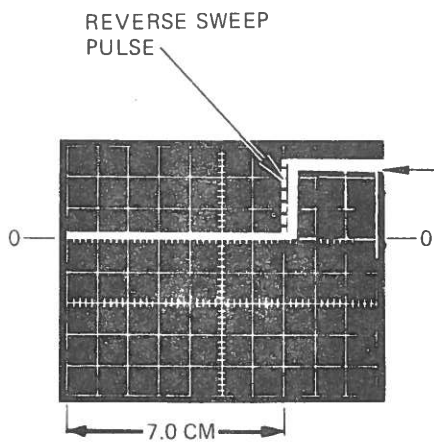


SWEEP IS TWO OVERDRIVEN  
50 CPS SINEWAVES

TIME BASE: 2ms/cm (UNCALIBRATED)  
VERTICAL: 2v/cm  
TRIGGER: INTERNAL (-)  
CHANNEL 1 INPUT: 2733 (50 HZ TEST POINT)

TIME BASE CALIBRATION ADJUSTMENT

VIEW A



FORWARD SWEEP PULSE (ADJUSTED)

CHANNEL 1 INPUT: 21-01 (+ACCESS READY)  
TRIGGER: INTERNAL (-)  
ACCESS: 128 CYL SEEK-SEEK  
VERTICAL: 2v/cm  
TIME BASE: AS SET UP FOR VIEW A.

VELOCITY SIGNAL TRACE

VIEW B

Figure A-3. Scope Patterns for Access Velocity Safety Check/Adjustment

