MAI Basic Four®
5-1/4 Inch Fixed Media Disk Drive
(Machine Types 4171/4120/4326)
Service Manual

MAI BasicFour®

PAGE STATUS

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Page Status	iii/iv	April 1986
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NOTICE

MAI Basic Four® equipment is designed to meet the safety requirements of Underwriters Laboratories (UL), the emission requirements of the Federal Communications Commission (FCC) and Verbandes Deutcher Elektrotechniker (VDE), as well as certain requirements of other safety or regulatory agencies. Compliance with the recommendations and standards of these agencies or organizations may require the use of specific interconnecting cables, which have been determined to meet the applicable criteria. Use of cables not meeting these requirements could result in violation of local Building Codes or other regulations, and result in damages. MAI Basic Four, Incorporated, shall have no reponsibility for any results whatsoever that arise from any use of any cables not supplied or installed by MAI Basic Four, Incorporated, or our authorized representative.

PREFACE

This manual contains service information for the 5-1/4 Inch Fixed Media Disk
Drive, Machine Types 4171 (71 MB), 4120 (120 MB), and 4326 (127 MB). The
information is presented as a field-service aid and supports the installation,
operation, and maintenance of the subject Disk Drive.

The Disk Drive is used on the MAI Basic Four® Series 2000 and Series 7000 com-
puter systems, and differs only in the formatted storage capacity provided by
each system. On Series 2000 systems, the Disk Drive is formatted for 71 MB
(Machine Type 4171) or 120 MB (Machine Type 4120); on Series 7000 systems, the
Disk Drive is formatted for 127 MB (Machine Type 4326).

The major topics covered in this manual are:

Section I   Introduction

Section II   Installation

Section III   Functional Description

Section IV   Maintenance

Section V   Removal/Replacement

Section VI   Illustrated Parts Lists

Section VII   Schematics

WARNING

This equipment generates, uses, and can radiate
radio frequency energy and, if not installed and
used in accordance with the instructions manual,
may cause interference to radio communications,
as temporarily permitted by regulation. It has
not been tested for compliance with the limits
for Class A Computing Devices pursuant to Subpart
J of Part 15 of FCC rules, which are designed to
provide reasonable protection against such inter-
ference. Operation of this equipment in a
residential area is likely to cause interference,
in which case the User at his own expense will be
required to take whatever measures that may be
required to correct the interference.
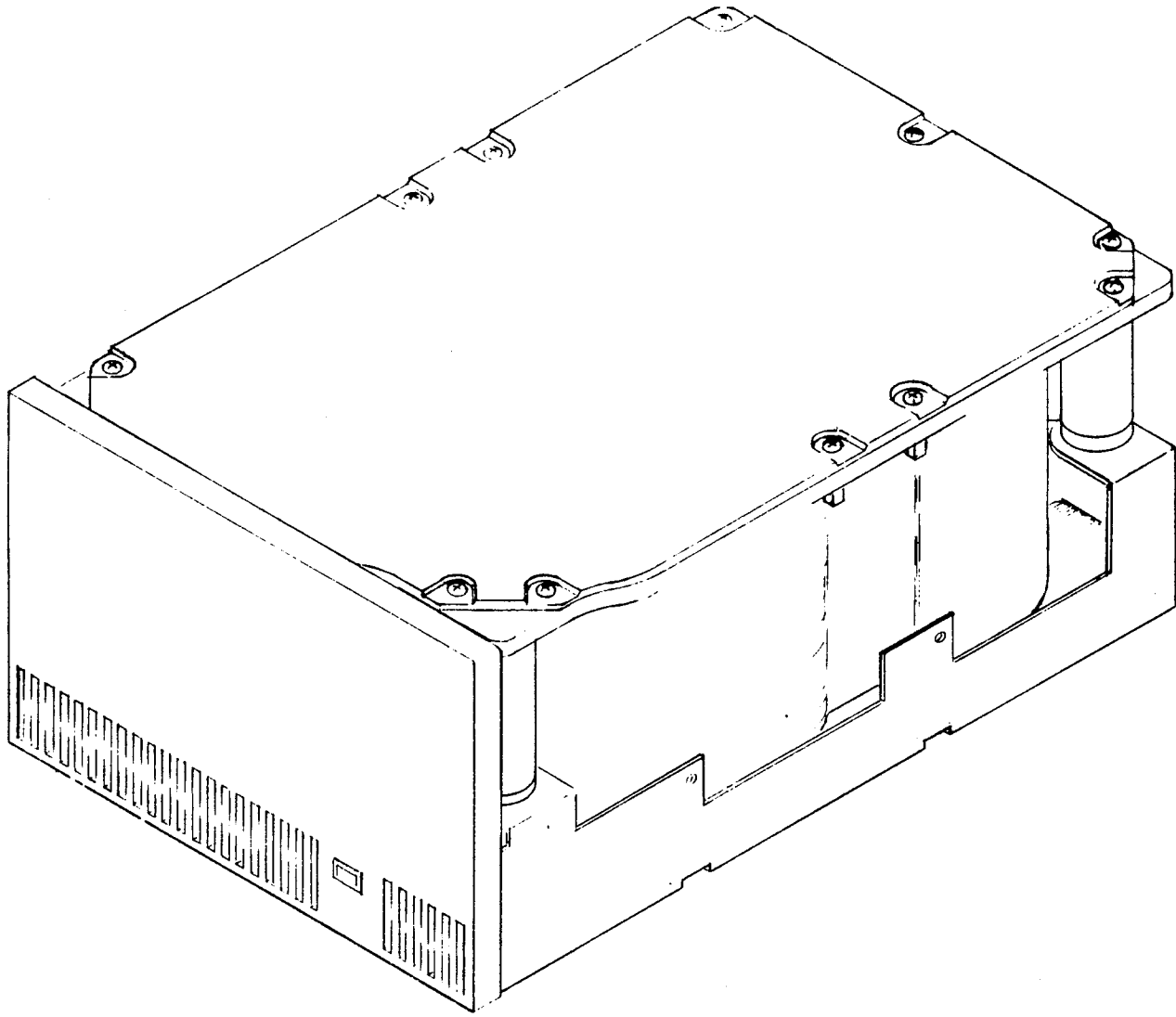
Figure 1-1.   5-1/4 Inch Fixed Media Disk Drive

SECTION I

INTRODUCTION

1.1 GENERAL DESCRIPTION

The 5-1/4 Inch Fixed Media Disk Drive, used on MAI Basic Four® Series 2000 (Machine Types 4171 and 4120) and Series 7000 computer systems (Machine Types 4326), is a microprocessor controlled servo disk drive system (see figure 1-1). The Machine Type 4171 Disk Drive uses eight data heads, one servo head, and five non-removable 5-1/4 inch disks as storage media. Machine Type 4171 Disk Drive data surfaces employ one moveable head to access 1,024 cylinders for a total of 8,192 tracks. The Machine Types 4120 and 4326 use 15 data heads, one servo head, and eight non-removable 5-1/4 inch disks as storage media. Each data surface employs one moveable head to access 918 cylinders for a total of 13,770 tracks.

The disk drive unit consists of the following major components:

o Mechanical Assembly

o Read/Write and Control Electronics

o Power Supply

1.1.1 Mechanical Assembly

The disk drive consists of a single printed circuit board, a frame for mounting the drive, and a head disk assembly (HDA). The components inside the HDA are: disks, spindle motor, head positioning assembly, heads, actuator arm assembly, and air filter. Shock mounts are provided to minimize the transmission of vibration from the frame to the HDA.

1.1.1.1 Printed Circuit Board Assembly (PCBA)

The PCBA, figure 1-2, is a multilayer board with the internal planes being primarily used for voltage and ground only. The circuitry contained on the PCBA is used to control the spindle motor, actuator positioning system, actuator latch, and read/write circuitry.

1.1.1.2 Head Arm Assembly

The read/write heads are mounted on a head arm assembly which is then mounted to a ball-bearing supported shaft. The voice coil, an integral part of the head arm assembly, lies inside the magnet housing when installed in the drive. See figure 1-3.
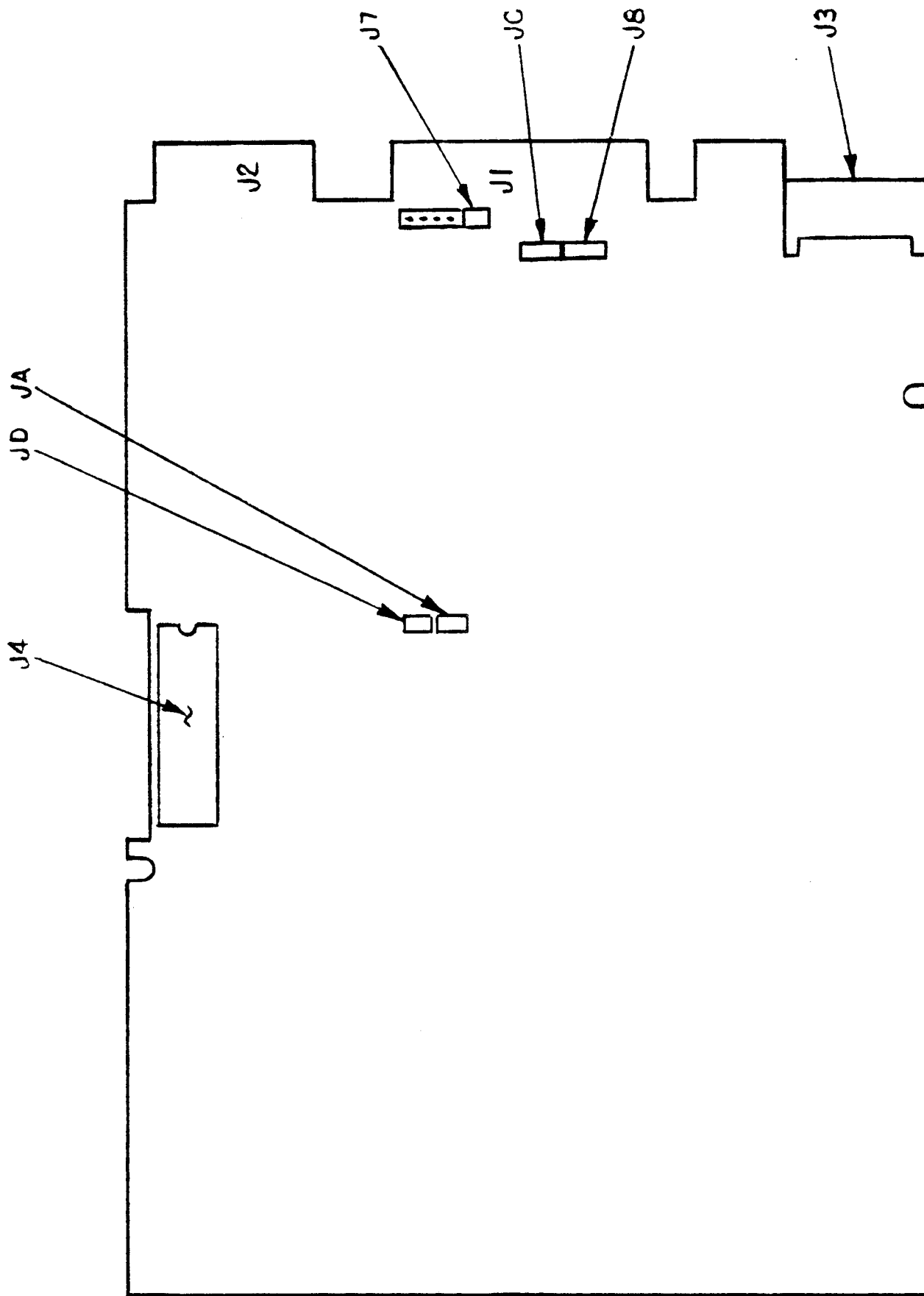
Figure 1-2. Disk Drive PCBA
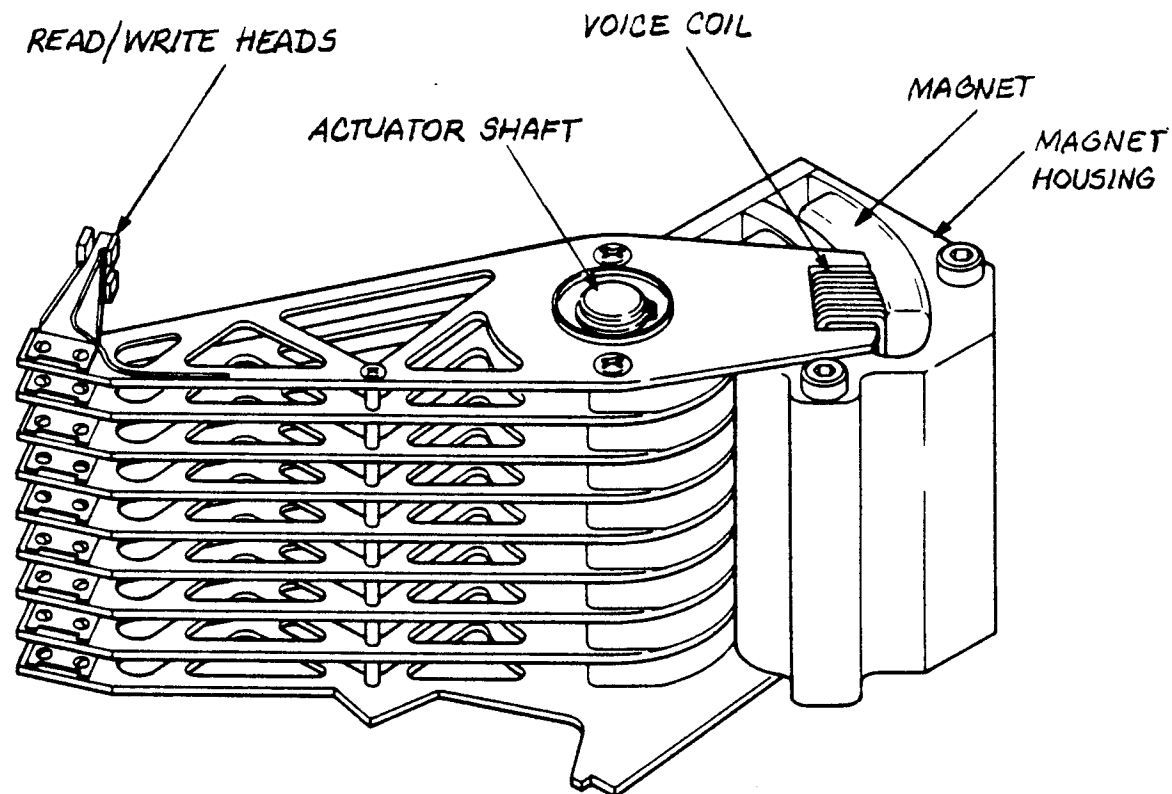
Figure 1-3. Head Positioning System

Current from the power amplifier, controlled by the servo system, causes a magnetic field in the voice coil which interacts with the field around the permanent magnets. This reaction causes the voice coil to move within the magnetic field. Since the head arms are mounted to the voice coil, the voice coil movement is translated through the pivot point directly to the heads and achieves positioning over the desired cylinder.

Actuator movement is controlled by the servo feedback signal from the servo head. The servo head is located on the lower surface of the bottom disk where servo information is prewritten at the factory. This servo information is used as a control signal for the actuator to provide track-crossing signals during on-cylinder seek operation, and timing information such as index and servo clock.

1.1.1.3 Spindle Motor Assembly

The spindle drive is a brushless dc drive motor contained within the spindle hub itself. The rotational speed of spindle is 3600 rpm. The motor and spindle are dynamically balanced to insure a low vibration level during operation. Dynamic braking is used to quickly stop the spindle motor when power is removed.

1.1.1.4 Heads and Disks

The heads utilized in the Disk Drive are composite manganese-zinc ferrite head sliders and flexures. These heads are used to record and read information on the thin film metal disks. The thin film metal disks provide a highly abrasion-resistant surface decreasing the potential for damage caused by shipping shock and vibration.

1.1.1.5 Air Filtration System

The disks and read/write heads are assembled in a clean-air environment and then sealed within the HDA. The HDA contains a 0.3 micron absolute filter mounted inside the casting to provide constant internal air filtration. A second 0.3 micron filter, located on the HDA top cover, permits pressure equalization between internal air and ambient air. See figure 1-4.

1.1.2 Read/Write and Control Electronics

The read/write and control electronics are packaged on the PCBA. This PCBA, which includes two microprocessors, performs the following functions:

- Read/write of data
- Index detection
- Head positioning
- Head selection
- Drive selection
- Fault detection
- Voice coil actuator drive circuitry
- Track 0 detection
- Recalibration to track 0 on power-up
- Track position counter
- Power and speed control for spindle drive motor
- Braking for the spindle drive motor
- Drive up-to-speed indication circuit
- Reduced write current on the inner tracks
- Monitor write fault conditions
- Control of all internal timing
- Generation of seek complete signals

RECIRCULATING FILTER

ROTARY VOICE COIL

AIR FLOW PATH
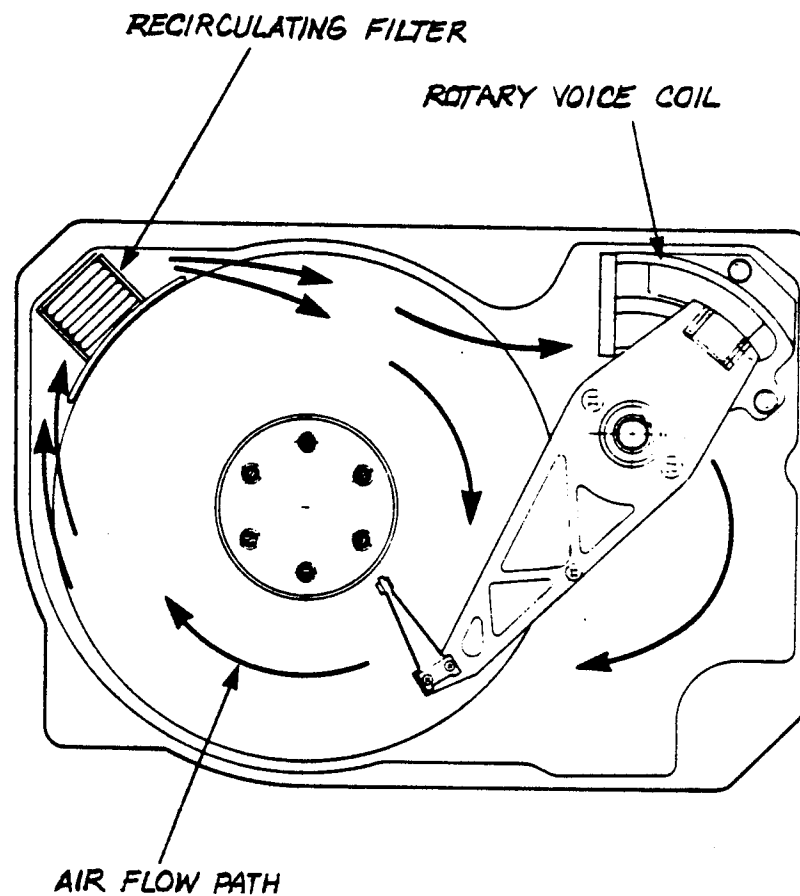
Figure 1-4. Air Filtration System

1.1.3 Power Supply

The Disk Drive requires only dc power for operation. DC power is supplied from an external power supply with outputs of +12 Vdc (+5%) at 4.5A maximum, and +5 Vdc (+5%) at 1.9A maximum. Typical current drawn from the +12 Vdc source during operation is 1.57A and from the +5 Vdc source is 1.7A. DC power is fed to the disk drive via a 4-pin connector on the component side of the PCBA.

1.2 DISK DRIVE SPECIFICATIONS

Table 1-1 lists the specifications for the 5-1/4 Inch Fixed Media Disk Drive.

Table 1-1. Specifications, 5-1/4 Inch Fixed Media Disk Drive

PHYSICAL

Height: 3.4 in (8.6 cm)
Width: 5.9 in (15.0 cm)
Depth: 8.2 in (20.8 cm)
Weight: 6.3 lbs (2.9 kg)

ENVIRONMENTAL

Ambient Temperature

Operating: 50 to 113 °F
   (10 to 45 °C)
Non-Operating: -40 to 140 °F
   (-40 to 60 °C)

Maximum Temperature Gradient

Operating: 18 °F/hr (10 °C/hr)
Non-Operating: Below Condensation

Relative Humidity (non-condensing)

Operating: 8 to 80%
Non-Operating: 8 to 95%

Maximum Elevation

Operating: 10,000 ft
Non-Operating:
   -1,000 ft to 40,000 ft

Vibration

Operating: 5-25 Hz, 0.006 in P-P
   25-500 Hz, 0.25G peak
   acceleration

Operating Shock

With retries: 2 G's (1/2 sine -11 ms)
Without retries: 10 G's (1/2 sine
   -11 ms)

ENVIRONMENTAL (continued)

Non-Operating Shock

20 G's (1/2 sine -11 ms)

POWER

DC Voltage

Control: +12V $\pm$5%, 1.57A Typical,
   4.5A Max (at power on)
Logic: +5V $\pm$5%, 1.7A Typical,
   1.9A Max

Maximum Ripple (Included in
   Tolerance): +5 = 50mV,
   +12 = 120mV

Power Dissipation: 57W, high;
   9W, low

Heat Dissipation: 25W, Typical,
   28W Max

GENERAL

Capacity (Unformatted)

Machine Type 4171:
   Per Drive: 85.32 MB
   Per Surface: 10.60 MB
   Per Track: 10.42 KB

Machine Types 4120:
   Per Drive: 143.55 MB
   Per Surface: 9.57 MB
   Per Track: 10.42 KB

Machine Types 4326:
   Per Drive: 143.55 MB
   Per Surface: 9.57 MB
   Per Track: 10.42 KB

Table 1-1. Specifications, 5-1/4 Inch Fixed Media Disk Drive (continued)

GENERAL (continued)

Capacity (Formatted)

Machine Type 4171:
(Series 2000 Systems)
Per Drive: 71.32 MB
Per Surface: 8.40 MB
Per Track: 8.20 KB
Per Sector: 512 Bytes

Machine Type 4120
(Series 2000 Systems)
Per Drive: 119.85 MB
Per Surface: 7.99 MB
Per Track: 8.20 KB
Per Sector: 512 Bytes

Machine Type 4326:
(Series 7000 Systems)
Per Drive: 126.90 MB
Per Surface: 8.46 MB
Per Track: 8.20 KB
Per Sector: 1,024 Bytes

Access Time (Includes Settling Time)

Machine Type 4171:
Average: 28 msec
Track-to-Track: 4 msec
Full Stroke: 49 msec

Machine Types 4120 and 4326:
Average: 27 msec
Track-to-Track: 4 msec
Full Stroke: 46 msec

Error Rates

Soft Read: 1 per 10^{11} bits read
Hard Read*: 1 per 10^{13} bits read
Seek: 1 per 10^{7} seeks

GENERAL (continued)

NOTE

The disk drive is provided with an error map showing the location of media defects. The defective areas are identified by cylinder number, head number, and bytes from index.

The disk drive is guaranteed to be error free on cylinder 000. Additionally there will be no more than an average of 10 defects per surface. The maximum number of defects is 128.

No surface shall have more than 20 defects. No track shall have more than 5 defects.

Mean Time Between Failures: 8,000 POH, Typical

Component Design Life: 5 years

Rotational Speed: 3,600 rpm

Recording Density: 9,875 bits per inch

Track Density: 1,000

Cylinders (Machine Type 4171): 1,024

Cylinders (Machine Types 4120 and 4326): 918

Tracks
Machine Type 4171: 8,192
Machine Types 4120 and 4326: 13,770

*Not Recoverable within 16 retries

Table 1-1. Specifications, 5-1/4 Inch Fixed Media Disk Drive (continued)

GENERAL (continued)

Sectors: 440,640

Data Heads (Machine Type 4171): 8

Data Heads (Machine Types 4120
  and 4326): 15

Servo Heads: 1

Disks (Machine Type 4171): 5

Disks (Machine Types 4120 and
  4326): 8

DC Power Connector (P3): 4-pin AMP
  P/N1-480424-0 (using AMP pins
  P/N 350078-4) (strip) or
  P/N 61173-4 (loose piece)

DC Power Connector (J3, on PCBA):
  4-pin AMP MATE-N-LOCK connector
  P/N 350543-1

Frame Ground Connector (J4):
  AMP P/N 61761-2 (Faston Type)

Frame Ground Connector (J4):
  AMP P/N 62187-1 (Recommended)

SECTION II

INSTALLATION

2.1 INTRODUCTION

This section contains general procedures/requirements for Disk Drive installation. Specific procedures for removal/replacement and installation of the Disk Drive on the Series 2000 and Series 7000 systems may·be found in section V.

NOTE

> Further information on disk drive installation and configuration may be found in the Series 2000 System Installation Manual, M8086, or in the Series 7000/8000 System Installation Manual, M8089.

2.2 UNPACKING INSTRUCTIONS

1. Open the shipping container.

2. Carefully remove the top half of the inner foam insert.

3. Remove the drive from the container and remove the conductive plastic covering. Inspect the drive for physical damage.

4. Remove the defect map from the top of the drive. Use the information on the map for defect management. Copy the map and file a copy for use in the event the original is lost or misplaced.

5. The Drive is now ready for operation. There are no external shipping locks.

6. After unpacking the drive, store the packing materials for possible future use.

2.3 SPACE REQUIREMENTS

The Disk Drive is shipped mounted in a frame assembly with a face plate installed. Figure 2-1 shows the external dimensions of the drive.

5.88
REF

8.00
REF

3.38
REF

.19
REF

1.87
REF

3.12
REF

.86
REF
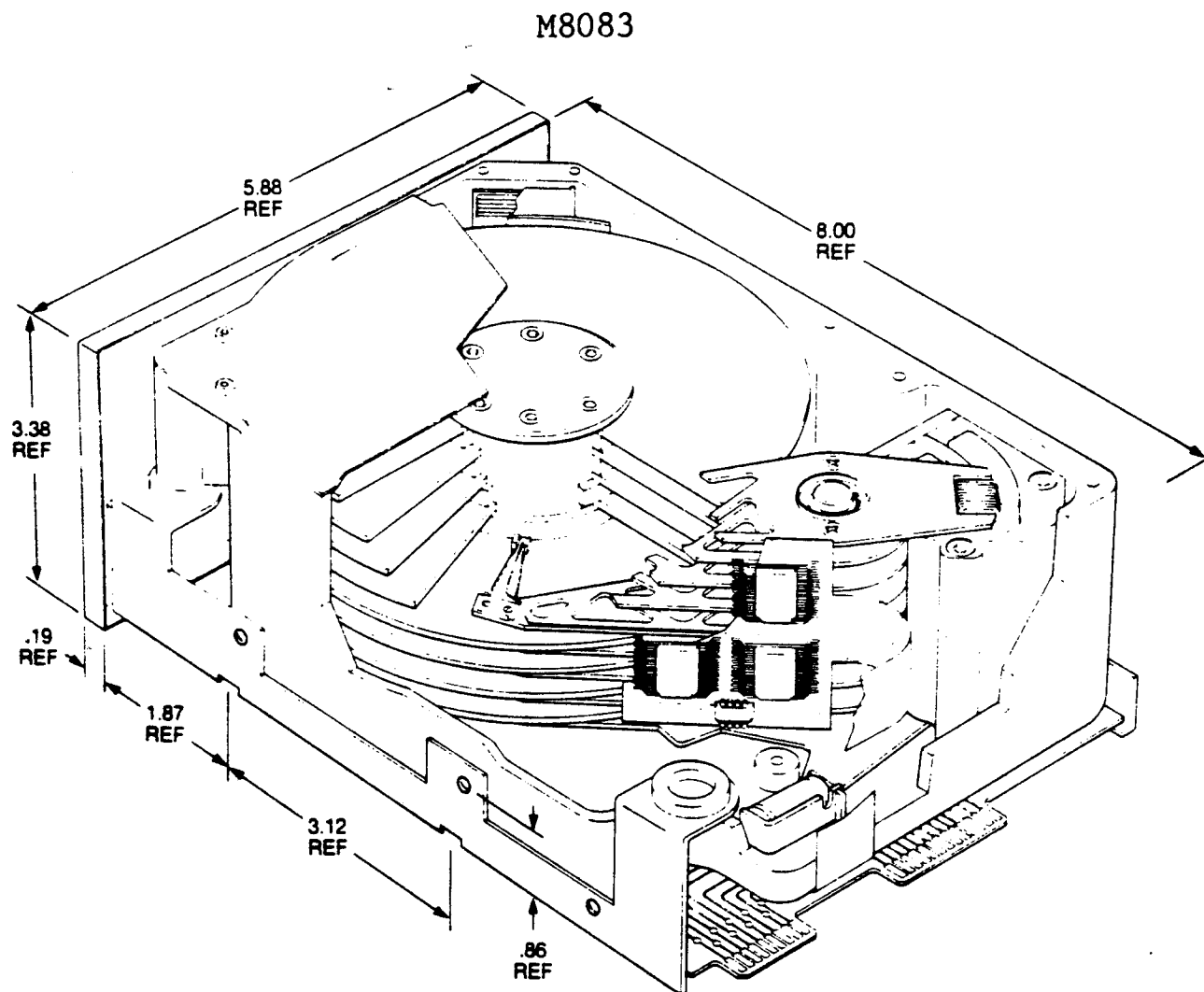
Figure 2-1. Disk Drive Mechanical Dimensions

2.4 MOUNTING

The Disk Drive may be mounted in any orientation. The Disk Drive has mounting
holes on three sides of the frame for ease of mounting. Figure 2-2 shows the
location of the mounting holes.

```
┌─────────────┐
│  CAUTION    │
└─────────────┘
```

The casting is very close to the frame mounting holes
in some locations. Mounting screw lengths must be
chosen such that no more than 0.125" of the screw is
available to enter the frame mounting hole. The torque
applied to the mounting screws should be at least 9 inch-
pounds but to avoid stripping the threads, the maximum
torque applied shall not exceed 12 inch-pounds.

.06 ± .01

3.25 ± .01

3.38 ± .01

.19 ± .01 |← 1.87 ± .02 →|← 3.12 ± .02 →|

.86 ± .02

8.00
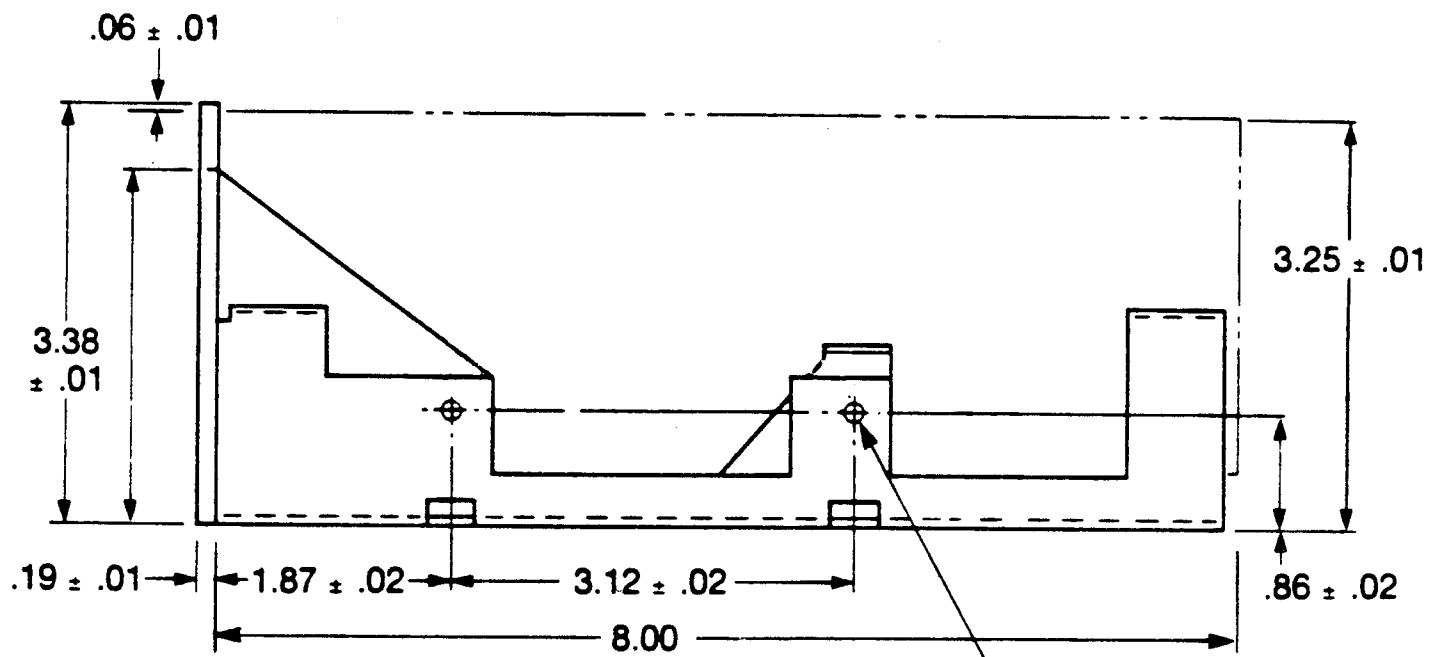
NOTE: MOUNTING SCREWS
SHALL NOT BE TORQUED
TO GREATER THAN 12 IN. lb.

MOUNTING HOLES —
4 ON BOTTOM, 2 ON EACH SIDE —
PROTRUSION OF SCREWS THROUGH
SIDE HOLES IS LIMITED TO .12 IN.

5.88 ± .01

$5.75 \begin{array}{l} +.00 \\ -.02 \end{array}$

5.50 ± .02

.06 ± .01

|← 3.12 ± .02 →|
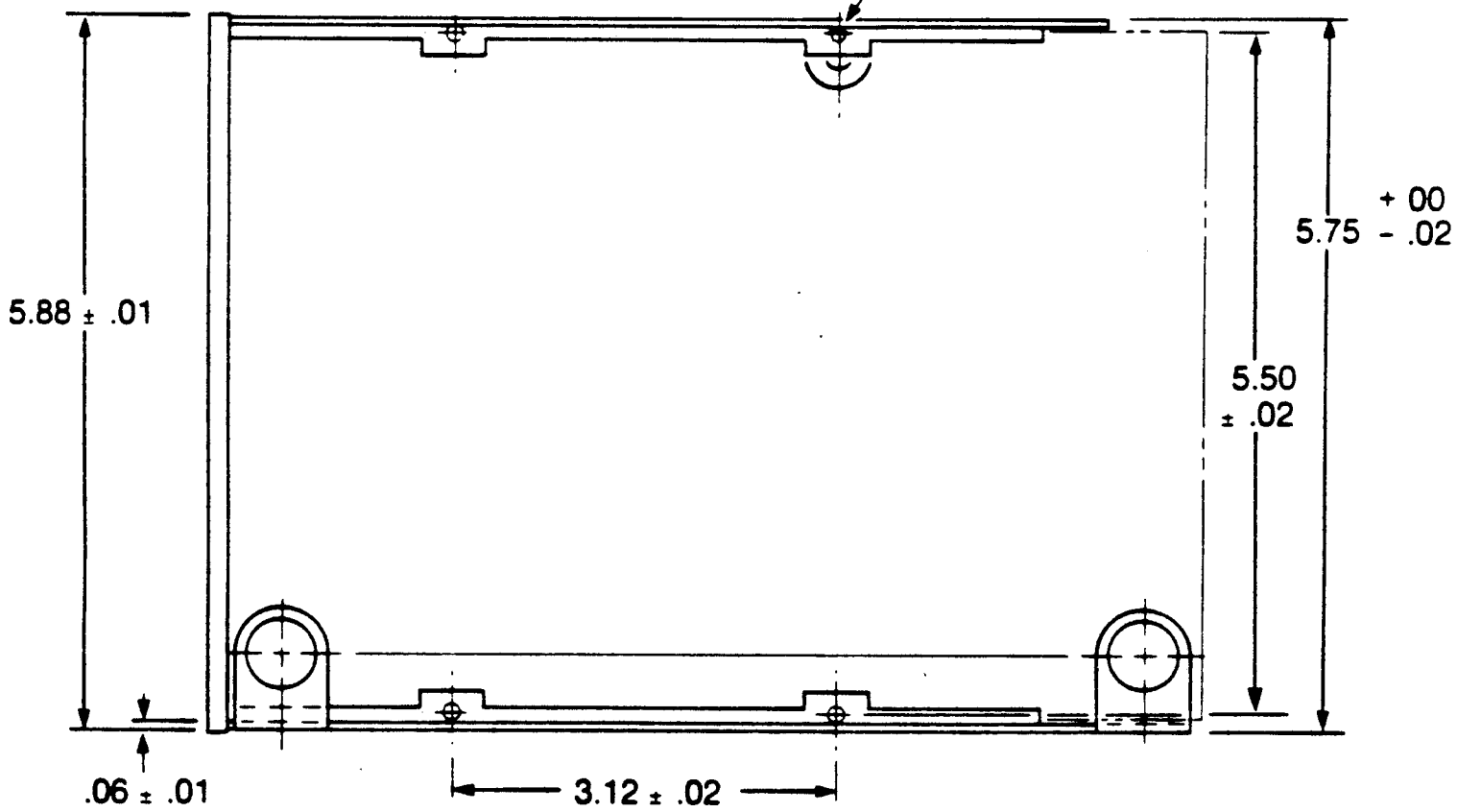
ALL DIMENSIONS IN INCHES

Figure 2-2.   Disk Drive Mounting Dimensions

2-3

M8083

2.6.1 DC Power Connector

The dc power connector (J3) is the equivalent of a 4-pin AMP MATE-N-LOCK con-
nector P/N 350543-1 mounted on the component side of the PCBA. The recommended
mating connector (P3) is AMP P/N 1-480424-0 utilizing AMP pins P/N 350078-4
(strip) or P/N 61173-4, (loose piece). DC power connector J3 pin locations and
voltage assignments are shown in figure 2-4.

2.6.2 Frame Ground Connector

The frame ground connector (J4) is a Faston type connector, AMP P/N 61761-2.
The recommended mating connector is AMP P/N 62187-1. If wire is used, the hole
in J4 will accommodate a wire size of 18AWG maximum.

Frame and logic ground are NOT connected together when the drive is shipped.

2.7 CONNECTORS

The following paragraphs describe the Interface Connectors, Control Cable Term-
ination, and Jumper Settings required to operate the disk drive.

2.7.1 Interface Connectors

Two interface connections are required by the disk drive: a control cable (J1)
and a data cable (J2). Details of the control and data signals required can be
found in section III.

Connection to J1 is via a 34-pin PCBA edge connector. Connector dimensions are
shown in figure 2-5. The pins are numbered 1 through 34 with the even pins
located on the component side of the PCBA and the odd pins located on the
solder side. Pin 2 is located on the end of the connector closest to the power
connector J3. A key slot is provided between pins 4 and 6. The recommended
mating connector for P1 is AMP ribbon connector P/N 88373-3.

Connection to J2 is via a 20-pin PCBA edge connector. Connector dimensions are
shown in figure 2-6. The pins are numbered 1 through 20 with the even pins
located on the component side of the PCBA. The recommended mating connector is
an AMP ribbon connector P/N 88373-6. A key slot is provided between pins 4 and
6.

```
          J3
   ┌──────────────────┐
   │ ④  ③  ②  ①      │
   └──────────────────┘

   (PCBA, COMPONENT SIDE)
```

```
PIN 4
  +5 VOLTS DC = 5%
PIN 3
  +5 VOLT RETURN

PIN 1
  +12 VOLTS DC = 5%
PIN 2
  +12 VOLT RETURN
```
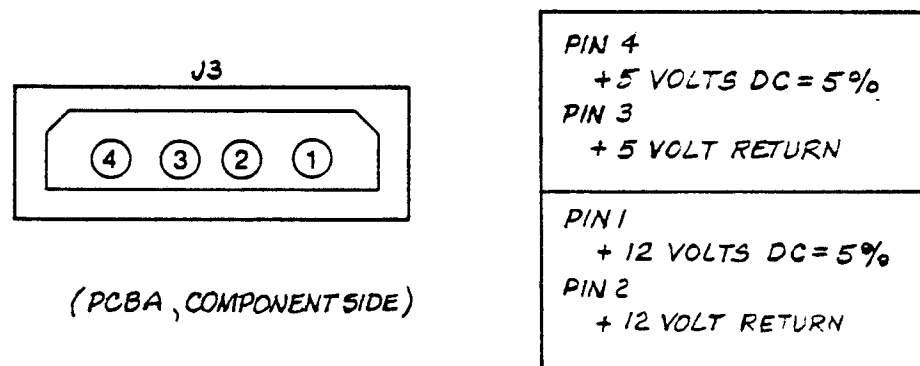
Figure 2-4. DC Power Connector (J3) Pin Locations and Pin Assignments

.036 =.004   .063 NOM

4 6

.400 =.010   .450   BOARD THICKNESS
.062 =.007

.060 =.010   .100 =.010

1.775 =.010   ALL DIMENSIONS
IN INCHES
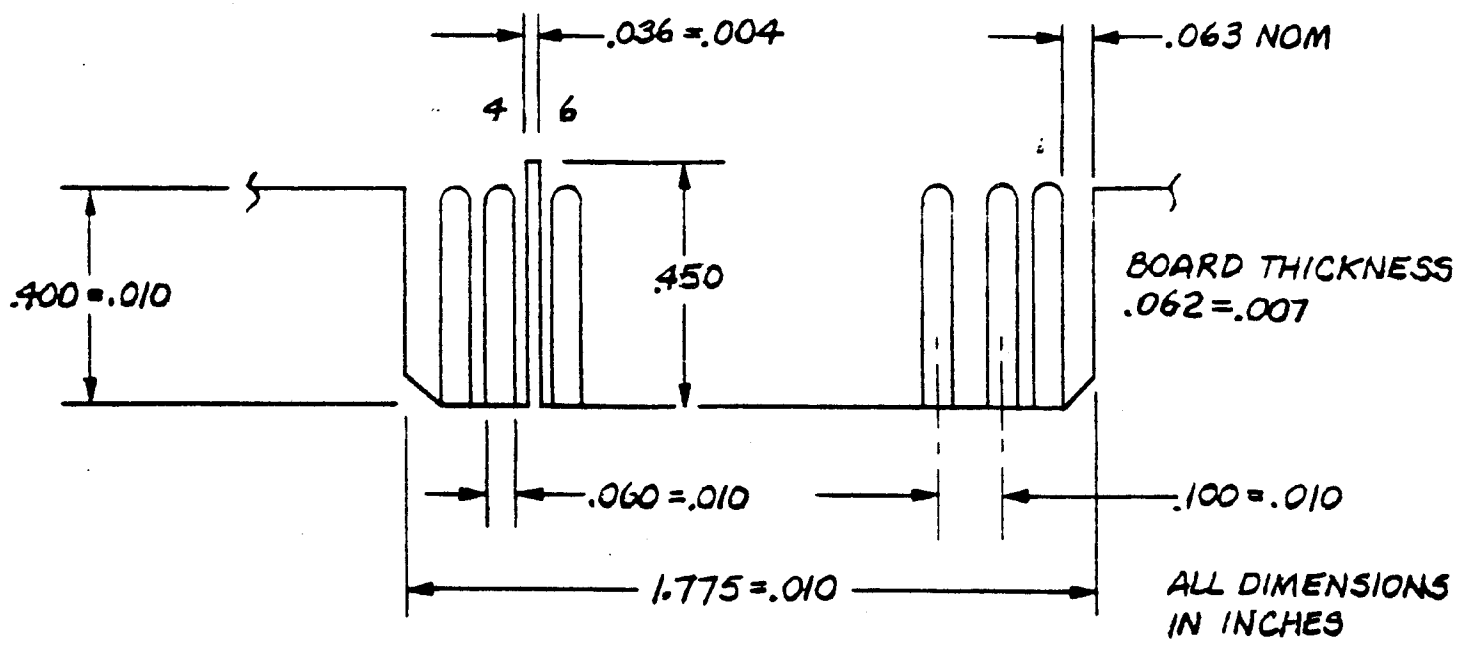
Figure 2-5.   Connector J1 Dimensions

.036 =.004   .063 NOM

4 6

.400 =.010   .450   BOARD THICKNESS
.062 =.007

.060 =.010   .100 =.010

1.075 =.010   ALL DIMENSIONS
IN INCHES
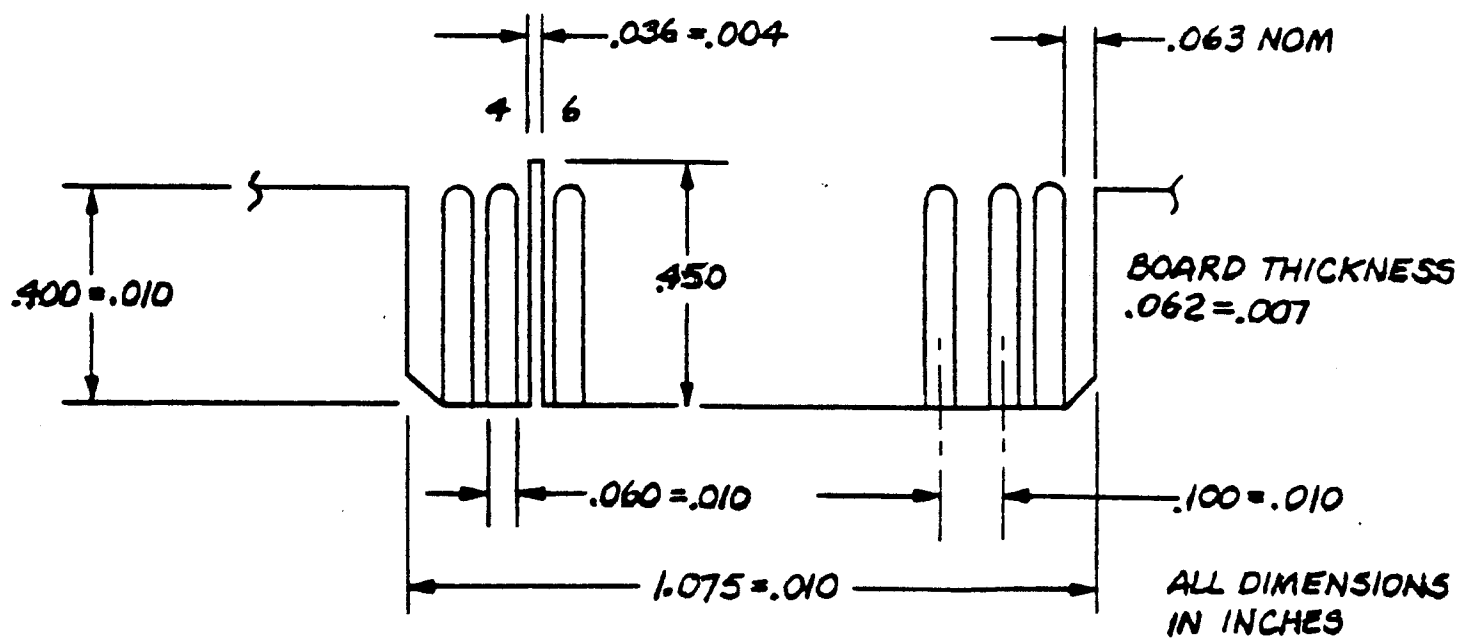
Figure 2-6.   Connector J2 Dimensions

2.7.2 Control Cable Termination

If the Disk Drive is the last drive at the end of the control signal cable, a 220/330 ohm termination resistor pack must be installed on the PCBA near connector J1. The terminator must be removed if the drive is not at the end of a string of drives. The part number for the terminator pack is 42101.

2.7.3 Factory Installed Jumper Settings

The following jumpers are located on the Disk Drive PCBA and are installed at the factory. The jumper locations are shown in figure 1-2. Jumper JA provides for different track per inch (tpi) settings. Jumper JC enables off-track detection to create a WRITE FAULT if off-track is detected during a write operation. Jumper JD is a factory aid used to disable the UNSAFE signal from the HDA.

2.8 OPTIONS

The Disk Drive has two options available to the operator or user by means of jumper settings, drive address selection (J7) and write protect switch connection (J8). Figure 1-2 shows the location of these jumpers. The installer must set the drive address jumper to the appropriate position to allow the system to address the drive. If Write Protect is to be used, a switch must be connected to terminals located on the drive PCBA.

2.8.1 Drive Address Selection Option

In multiple drive configurations it is necessary to configure each drive (maximum of four per host controller) with an unique address. This is accomplished by locating the jumper plug over the correct pins as shown in figure 2-7. The standard drive is shipped addressed as Drive 1/Drive 0 (actual address designation is dependent upon the numbering system used).

2.8.2 Write Protect Option

A write protect option is incorporated into the Disk Drive. The option can be invoked by attaching a shorting plug or attaching a switch across two test pins located near IC U63 on the PCBA. These pins are on 0.100" centers to allow ease of installing a switch connector.

2.9 VENTILATION

The Disk Drive operates with a minimum of air circulation. Air circulation of 3 cfm around the drive is adequate provided the temperature of the ambient air does not exceed 122 °F (50 °C). Enclosures should be designed or chosen such that this minimal air circulation is provided and that the maximum temperature is not exceeded.

4 C 3 2 C 1
1 2 3 4 5 6

TERMINATOR
RESISTOR
PACK
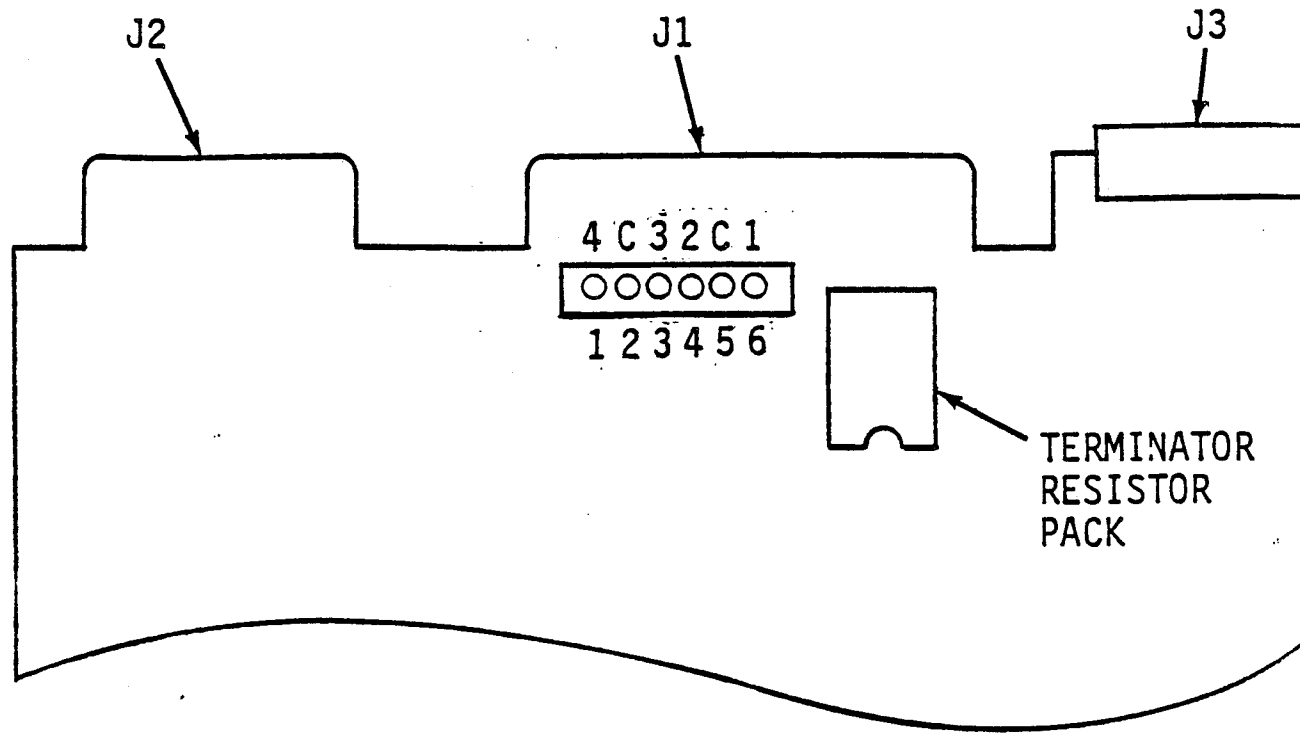
FUNCTION	PHASE 1 JUMPER BLOCK PIN NUMBERS	PHASE 2 JUMPER BLOCK PIN NUMBERS
Drive Select 0	C,1	5,6
Drive Select 1	2,C	4,5
Drive Select 2	C,3	2,3
Drive Select 3	4,C	1,2

Figure 2-7. Drive Select Jumper Options

SECTION III

FUNCTIONAL DESCRIPTION

3.1 INTRODUCTION

This section contains the functional description of the Disk Drive on the following levels:

- Operational description of the various tasks performed by the system

- Interface description

- Format description and examples of formats

3.2 OPERATIONAL DESCRIPTION

The Disk Drive consists of read/write and control electronics, read/write heads, head positioning actuator, disks, and air filtration system. These components interpret and generate control signals, position the heads over the desired track, read and write data, and provide a contamination-free environment.

3.2.1 Spindle Motor Operation

The Disk Drive uses a Z8 microprocessor for spindle motor control. The timers within the microprocessor are used to time a revolution within 3.6 microseconds. The timers are crystal controlled to ensure the accuracy of the measurement. With this measurement the microprocessor develops an error signal relative to the deviation from 3600 rpm and assures that the rotational speed is within $\pm$3.6 microseconds of 3600 rpm. This results in a $\pm$0.1% speed control.

An adaptive offset loop (figure 3-1) provides error correction to lock the spindle motor exactly on 3600 rpm.

The input to the microprocessor is a square wave developed by the switching of the hall sensors in the brushless dc motor. Physical position of the spindle relative to the hall sensors provides rotational information to the microprocessor, figure 3-2. As the motor rotates the microprocessor in effect rotates the commutation so that the motor speed is exactly in sync with the hall sensors.

Spindle rotation is controlled with two modes of operation: start mode and run mode. A description of each mode follows.
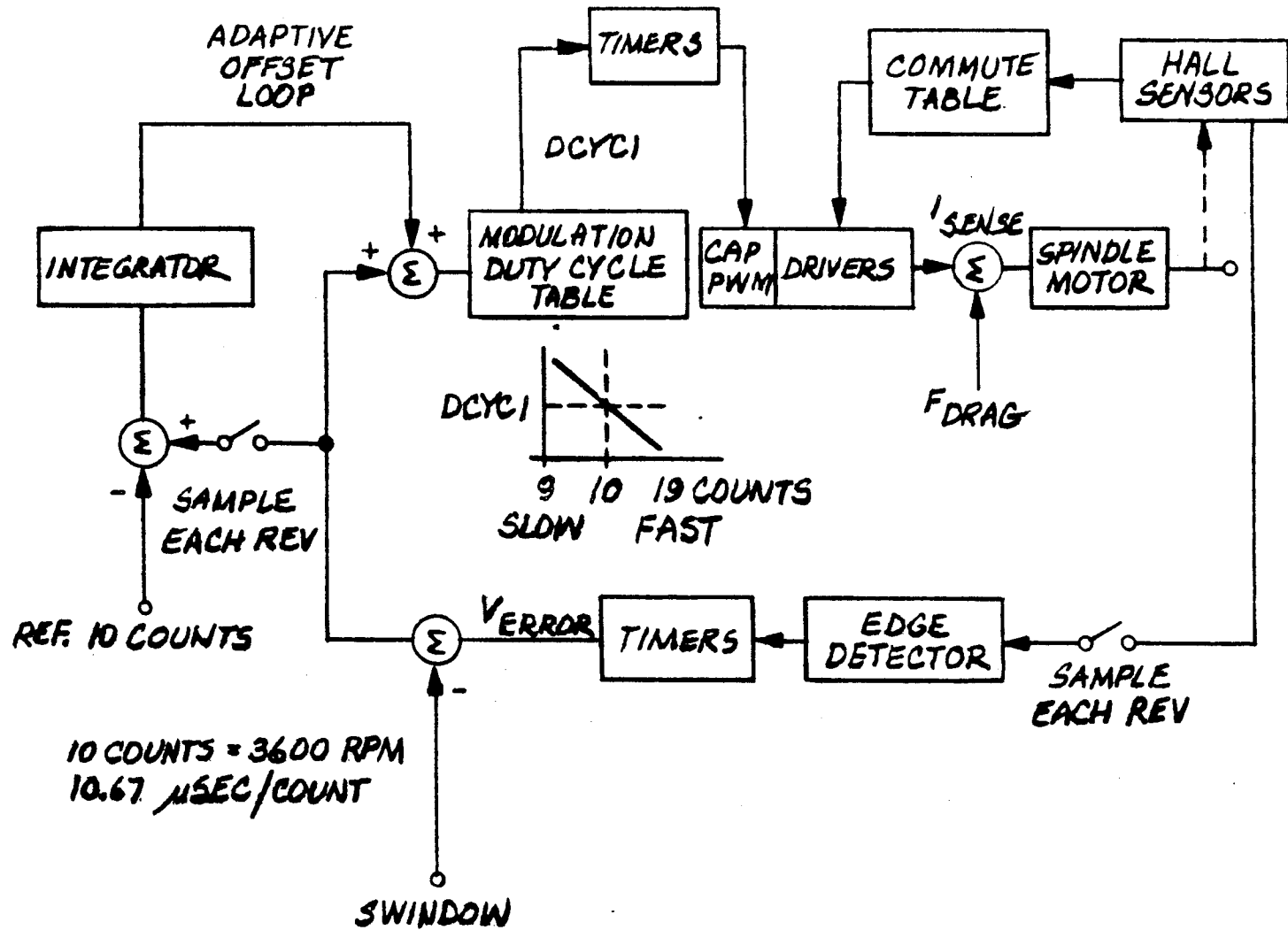
Figure 3-1. Spindle Motor Control Block Diagram
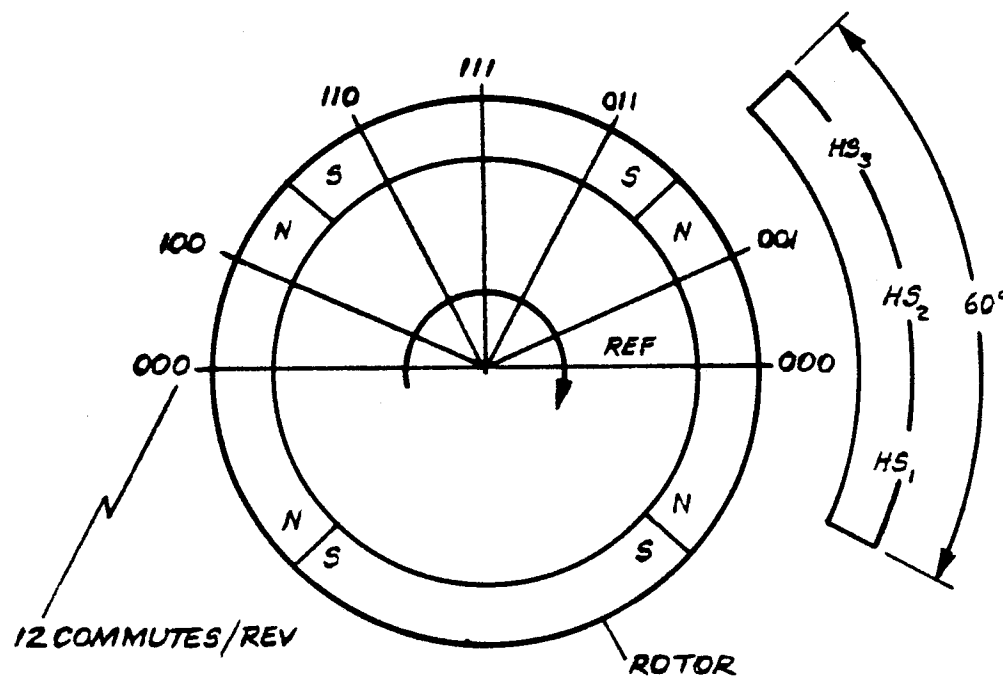
Figure 3-2. Spindle Motor Hall Sensors Relationships

3.2.1.1 Start Mode

The start mode starts the spindle motor rotating and causes the heads to fly as soon as possible to minimize the headwear. To achieve this, a high torque is required due to the mass of the disks and the drag caused by the non-flying heads. The heads nominally start to fly off of the disk at approximately 1000 rpm which takes about 3 seconds. Because of system and/or power supply constraints, this initial torque is limited by limiting the +12 volt current to 4 amps. This current limiting is accomplished via analog circuitry on the PCBA assembly.

The spindle is allowed to run at 4 amps for approximately 3 seconds which is the time it takes to get the disks rotating to at least 1000 rpm and the heads flying. After the 3 second current limit, the motor rotational speed increases, increasing the back electromagnetic force (emf) and decreasing the motor current, figure 3-3. As figure 3-3 shows, the current decreases exponentially as the spindle speed approaches 3600 rpm. This operation consumes approximately 18 seconds. At this point, the current is approximately 1 amp which is where the second mode of operation begins.

Another feature of the start mode is the time-out condition which occurs in the event that the spindle is not up to 1000 rpm in 10 seconds. This feature protects the heads from excessive wear if there is a problem, and also protects the spindle drivers if too much current is required to get the spindle up in the appropriate amount of time. If the time-out condition exists, the spindle motor is turned off and the only way to start the spindle up again is to remove power from the drive and then reapply power to the drive. It should be noted at this time that if the drive is power cycled at a rate faster than 30 seconds, and there is a problem in the HDA, that is physically restraining the spindle from turning, the spindle drivers could overheat and be damaged in the process.
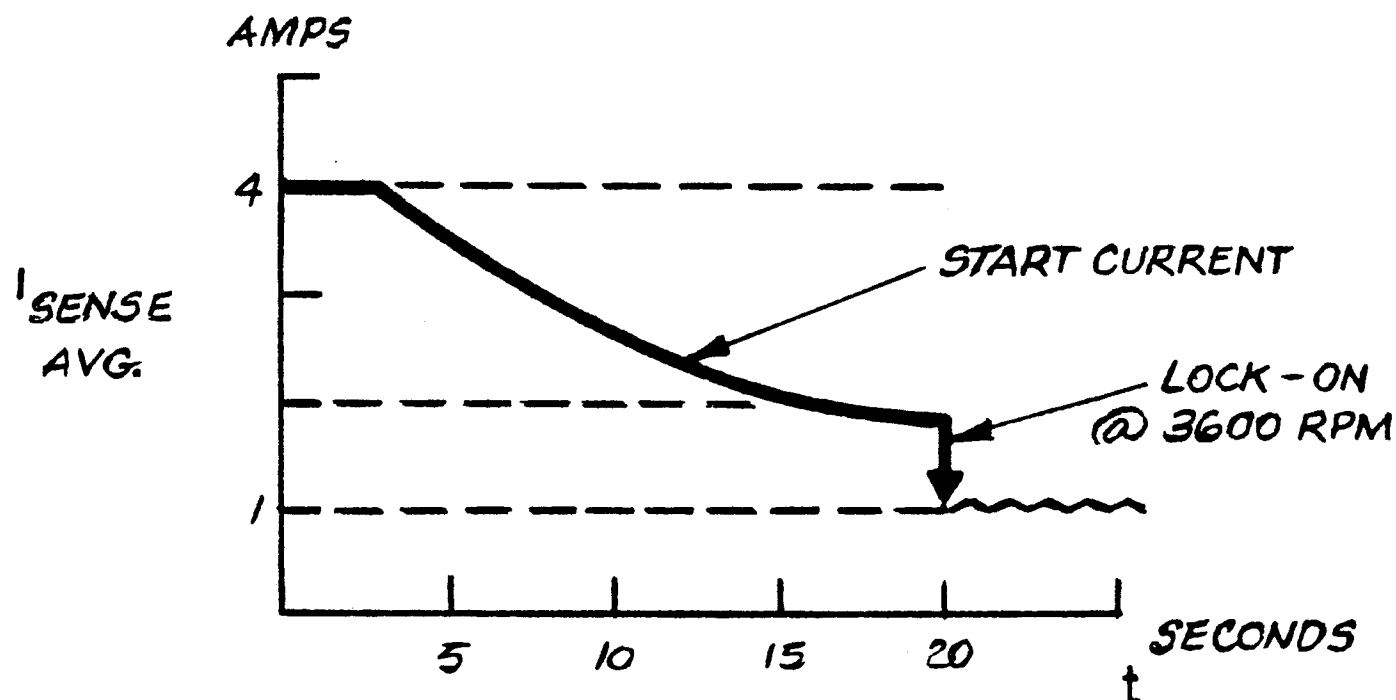
Figure 3-3. Spindle Motor Current Profile

3-3

.2.1.2 Run Mode

n the run mode the drive uses pulse width modulation to control the speed.
his method of analog control also reduces noise. Since the drive to the
pindle does not have to be a full ON and full OFF condition, no audible noise
s generated. Pulse width modulation causes the driving hexfets to operate in
heir linear region. This reduces the large surge of ON and OFF currents which
ould result in an audible 720 Hz noise. Figure 3-3 shows that at the 3600 rpm
ock, the current drops from 2 amps to approximately 1.2 amps. This is due to
he analog control taking effect in which the hexfets now are run in their
inear region requiring less current and resulting in less heat dissipation.

ue to the switching of the hexfets and the internal inductance of the motor,
arge induced current spikes are generated that need to be suppressed. These
arge currents are produced in part because of the delta configuration of the
pindle motor. The delta hookup has circulating currents when switching from
ne phase to another. Small capacitors are added to the spindle drive hexfets
o minimize these spikes that would otherwise be on the +12 volt power bus.

he head arm assembly is driven to the landing zone and latched when power is
emoved from the disk drive. This is accomplished by using energy stored in a
apacitor during normal operation. A capacitor is charged from the +12 volt
ower supply. When power is lost, the capacitor's charge is applied to the
ctuator to move the heads into the landing zone and become latched. After the
eads are latched and in the landing zone, the drive goes into the dynamic
raking mode. During dynamic braking, there is still voltage available due to
he back emf of the spindle motor. The spindle motor is now used as a gener-
tor to cause all the motor windings to be shorted via the hexfets which are
till enabled by the residual emf. The large short circuit current acts in
pposition to spindle motion, causing heavy breaking action.

.2.2 Servo System Operation

he servo system in the disk drive utilizes a di-bit pattern on the lower sur-
ace of the lower disk in the HDA assembly. The servo head, servo pattern,
ervo circuitry on the main PCBA, and the actuator mechanism are the main com-
onents that make up a closed loop servo system in the drive. This servo
ystem allows precision track following which compensates for variations in
rack location caused by thermal conditions. See figure 3-4.
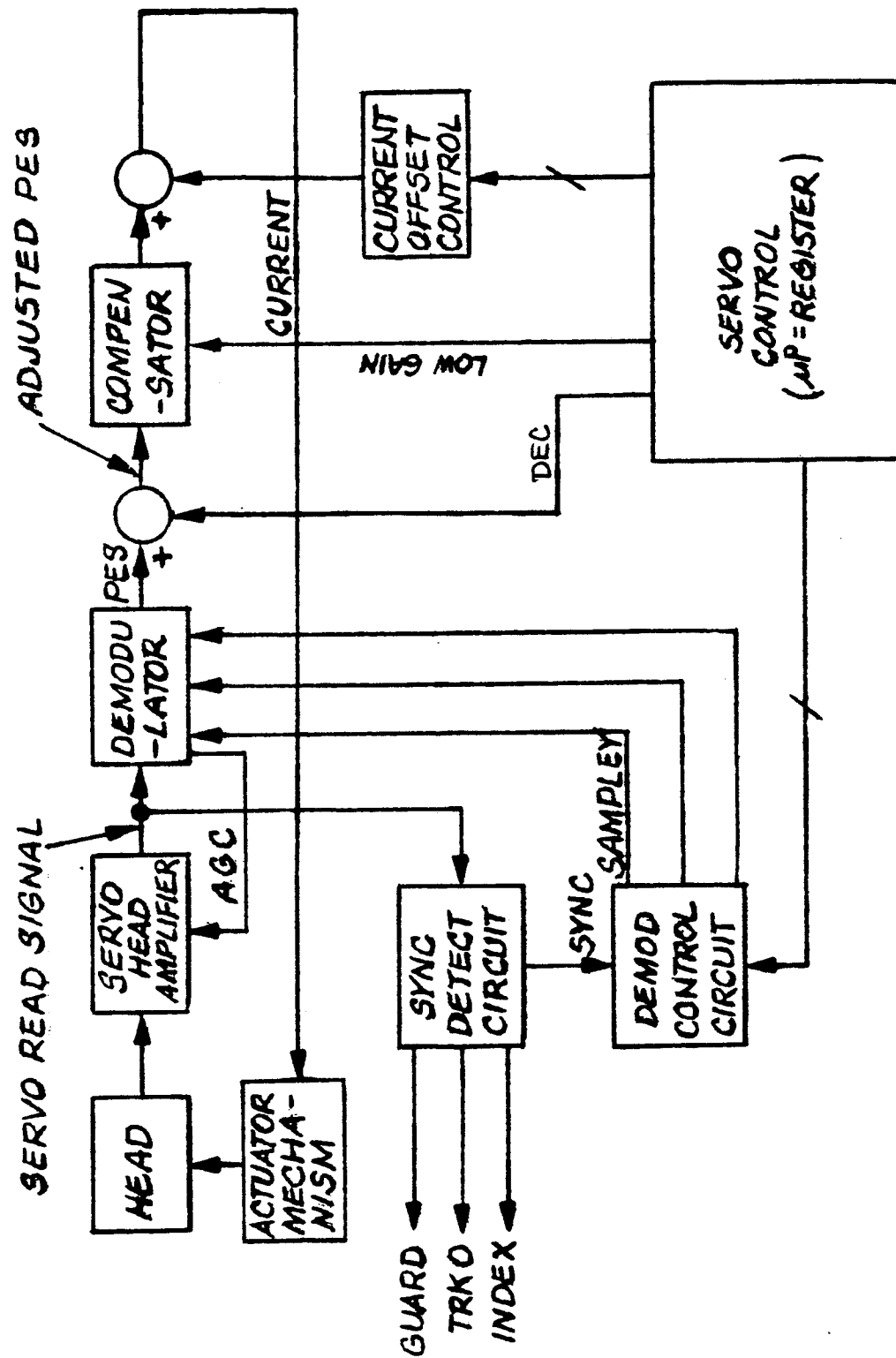
Figure 3-4.   Servo System Block Diagram

3.2.2.1 Servo Circuitry

The output of the servo head must be proportional to the distance off track for any given head position with respect to the servo track. Since each head has a slightly different width, and output is a function of width, the gain for each head must be compensated for in the electronics. This guarantees that the output in volts per inch of track offset is identical for any servo head so that the circuitry will perform smooth and accurate track following.

The head output signal is fed to the servo read amplifier. The output of this amplifier is of constant amplitude due to the Automatic Gain Control (AGC) signal. The amplitude of the sync pulses in the di-bit pattern is about 4.4 volts peak-to-peak at the Servo Read Signal (figure 3-4) which is between the servo read amplifier and the demodulator.

The demodulator, under control of the demod control circuits, samples A and B or C and D pulses and uses the difference in amplitude to generate a position error signal (PES). The discharge signal is used to discharge the peak detector circuit in the demodulator prior to the next sample period.

The demodulator output, PES, is applied to a summing mode along with the DAC output from the microprocessor to generate ADJUSTED PES. This DAC output signal is only used during seeks or to force offtrack conditions for analysis.

ADJUSTED PES feeds the compensator which takes a position signal and generates an acceleration command. This acceleration command must be smooth and orderly to obtain a well behaved servo loop. The compensator output is fed to the actuator mechanism through an actuator current control circuit. The output is 0.25 amp for each volt of input from the compensator. This current through the actuator coil causes the actuator mechanism to move the heads over the disk surface.

The actuator mechanism contains a coil with a dc resistance of approximately 4.5 ohms and a shorted turn to allow the fast rise times required to obtain fast access times. The coil and the shorted turn act as a transformer with a turns ratio of 136:1. The low impedance of the shorted turn (secondary) is reflected into the voice coil (primary), allowing the fast rise time.

The microprocessor is essentially not used during the track following mode except to monitor that the servo system is operating properly. The processor is required to get the servo system started when power is applied or after a malfunction and for performing seeks.

The sync detect circuit detects guard bands, track 0, and index pulses. Guard bands are written outside track 0 and inside the innermost data track. The purpose of the guard band is to allow the servo circuitry to sense that the heads are not over a known data area. The guard bands are written in such a manner as to cause the actuator to move in the proper direction to get back over the data area. The index pulse is used to signify the beginning of a track. The track 0 pulse indicates that the actuator is positioned at cylinder 0.

3.2.2.2   Servo Pattern

The servo pattern is basically a di-bit pattern. The servo circuitry along
with this pattern has been designed to be tolerant of small disk defects.
Since the patterns are timing related, fake sync pulses can be inserted if
sync is not detected in signals read from the servo track.

The pattern contains eleven bits of information and is repeated 625 times per
track. See figure 3-5. The information that can be contained in the pattern
is: sync, 4 bits of information; track 000; guard band; index; and 4 bits of
track center information A, B, C, and D.

The sync, track 0000, guard band, and index signals are written 10 time units
apart. The track information is written 20 time units from the sync bits and
20 time units from each other.

The track information is repeated every four tracks (figure 3-5). These pulses
are monitored for track following. In figure 3-5, the example shows the head
path such that the amplitudes of pulses A and B will be equal and half ampli-
tude when the head is following the track center. Pulse C will have no ampli-
tude and pulse D will have full amplitude.

Since pulses A and B are only known by their time relationship, one additional
piece of information is required. This information will allow the servo system
to know the proper direction to drive the actuator when an off-track condition
exists. For example, if the A pulse is larger than the B pulse, the error is
in a different direction on track 0 than it is on track 2. The drive does not
know which of the 918 tracks the heads are on, however, it does know which
track of any given set of four that it is looking at. In this way the circuit-
ry applies correction in the proper direction. The microprocessor keeps track
of which track the heads are on by monitoring the increments and decrements to
track count on the data bus, under the direction of the direction in signal.
If the least significant bit (LSB) is a 0, the A and B pulses are monitored for
track position. If the least significant bit is a 1, the C and D pulses are
monitored. The most significant bit of the counter (direction in) controls the
direction of correction applied for an offset between any pulse pair.

The sync pattern is written starting with a pair of pulses. Following this
pair are time slots for track 0, guard band, and index pulses, if required.
These are then followed by another pair of sync pulses. The A, B, C, and D
pulses for track location are as shown in figure 3-5. The guard band track
center pulses, however, are somewhat different. The outer guard bands, outside
of track 0, are written with only A and C pulses. This will cause correction
to always be applied to move the heads inward toward track 0. Likewise, the
inner guard bands, inside the innermost track, are written with only B and D
pulses, thus causing correction outward toward the data tracks.

The index pulse is repeated twice for redundancy. Therefore, if one index
pulse is not detected, the other should be and the drive will always generate
an index pulse once per revolution. If one of the index pulses is not detect-
ed, the width of the index pulse will be halved to 26.7 microseconds. Normal
index pulse width is 53.4 microseconds.
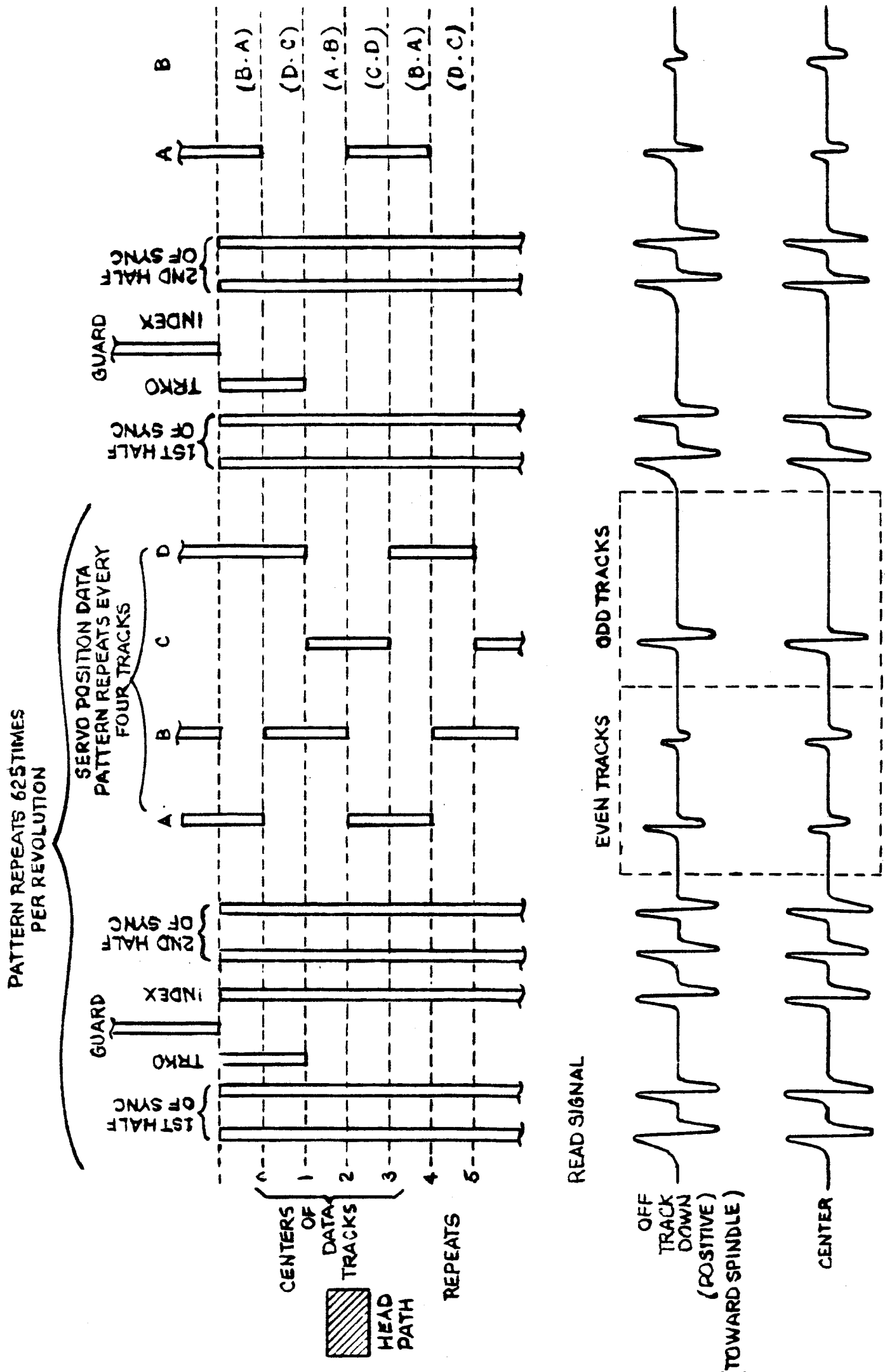
Figure 3-5. Servo Pattern

3.2.3 Read/Write Channel Operation

The read/write channel performs the recording and reading of data to the disk drive. Figure 3-6 shows typical read timing while figure 3-7 shows a block diagram of the read/write channel.

The read/write circuits are provided with +11 volts through the voltage regulator circuit consisting of U31 and Q15. This +11v is derived from the +12F input voltage. The read/write data is transmitted between the heads and the drive PCBA electronics via the read/write flex circuit and the associated preamps (SS1104).
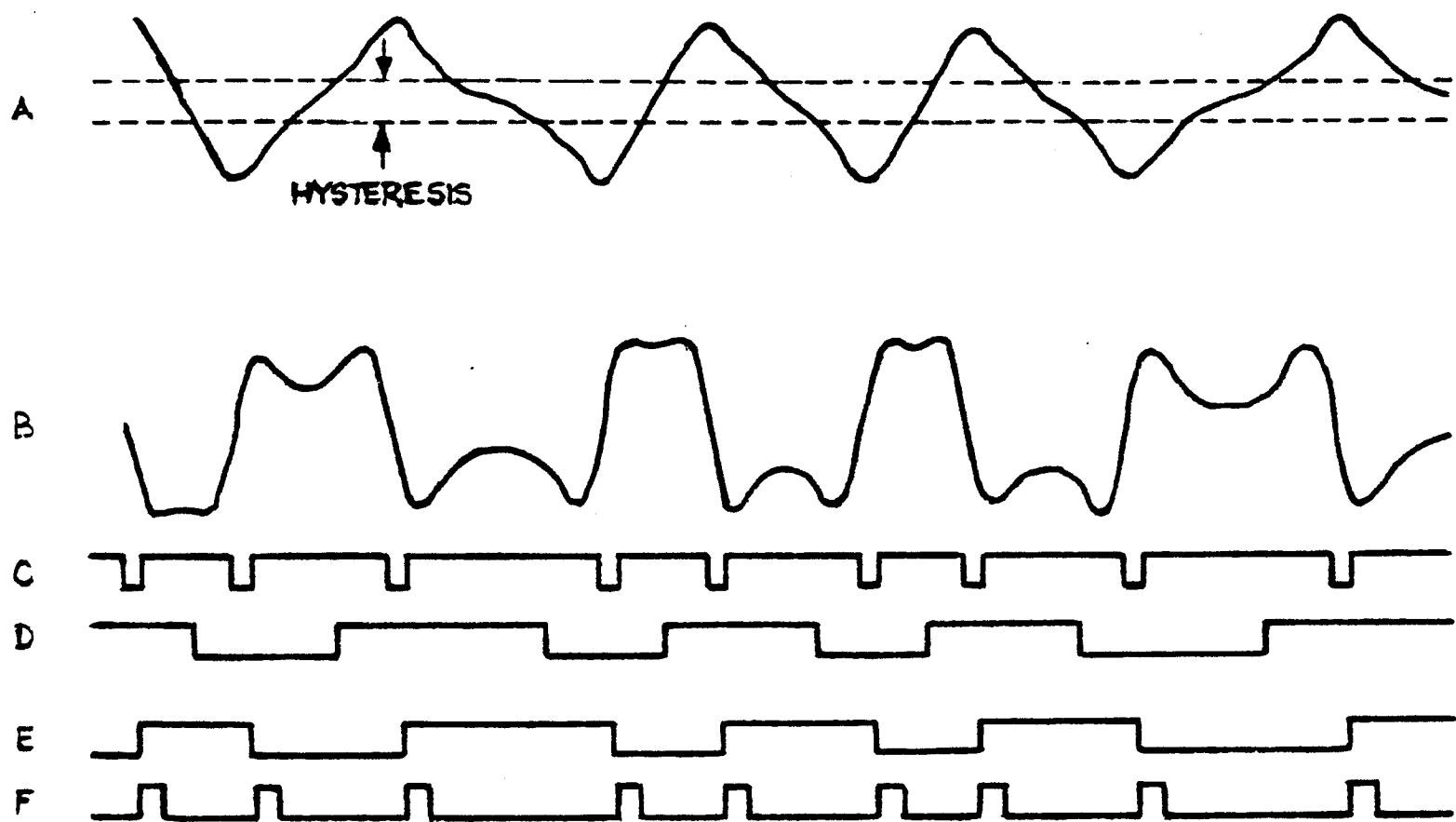
Figure 3-6. Read Function Timing Diagram
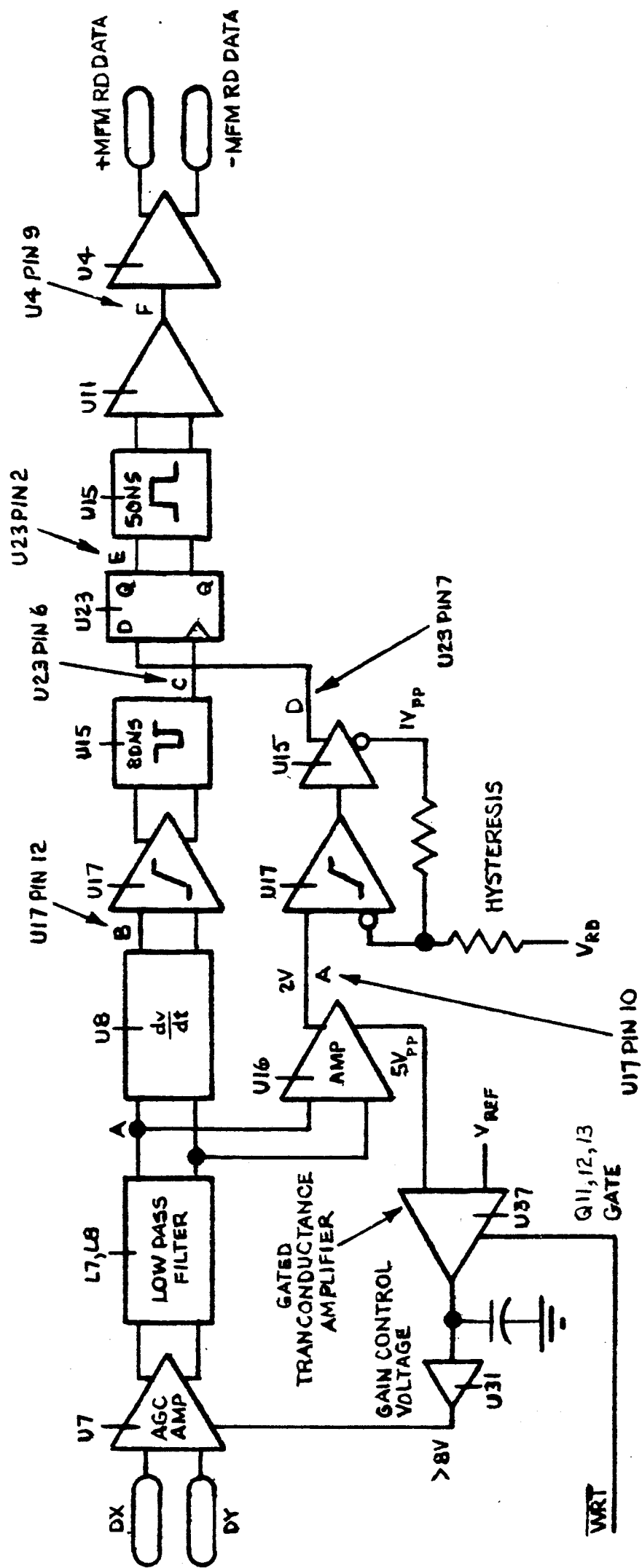
Figure 3-7. Read Function Block Diagram

3.2.3.1 Write Function

The write function is shown in block diagram form in figure 3-8. The two signals HDSEL22 and HDSEL23 are fed to the decoder U29 selecting one of the set of four preamps within the HDA. Actual writing of data happens if, and only if, the four signals to the decode chip are true, namely safe condition from the HDA preamp, drive selected, seek complete, and write gate true. The MFM WRITE DATA signal received by the differential receiver will then be written on the disk. As each transition is received by the write data receiver U11, it goes through a resistor level translator U21. As long as WRITE GATE is active, flip-flop U23 will toggle for each transition. If any of the conditions for the write function are not true, flip-flop U23 will be held reset forcing the Q output to be a logic 1 level. This forces the Q output to be a logic 1 thus disallowing any current to flow through the Read/Write preamps. The two diodes at the Dx Dy HDA outputs are back biased.

When the decode U29 is satisfied, the write select and write current control signals are at +8.5 and +1 volt levels respectively. This indicates that a write function is in process. When the decode U29 is not satisfied, the write select and write current controls are at +5 and +4.3 volts. This indicates that a read function is in process. During the write operation, U37B, a transistor package, is turned off. This causes the voltage controlled current sink to allow current to flow from the preamps. When U19B is on, it is a non-write function. The voltage controlled current sink is forced to sink current from the +5 volt supply.

A block diagram of the read/write preamps used on the Disk Drive is shown in figure 3-9. Each preamp supports four heads.

3.2.3.2 Read Function

The read function is shown in block diagram form in figure 3-7. The typical analog signal that can be seen at the differential inputs Dx and Dy is shown in figure 3-6, Read Function Timing Diagram. This analog signal is fed into the AGC amplifier and then to a low pass filter. At this point, the signal path has two directions.

The first direction is the AGC loop which is the direction going towards the bottom of the page. The analog signal is now processed through a buffer amplifier which branches again in two directions. The AGC loop is the direction that goes toward the GATED TRANSCONDUCTANCE AMPLIFIER. This amplifier is gated with WRITE GATE to inhibit the AGC loop during WRITE operations. This gating inhibits saturation of the read amplifiers due to the very high amplitude write signals.

The transconductance amplifier is referenced to a fixed reference voltage (Vref). If the average input voltage is above Vref, the output of the amplifier is increased, thereby reducing the gain of the AGC amplifier. Conversely, if the average input signal is below Vref, the amplifiers output is decreased, which causes the AGC amplifier gain to be increased.
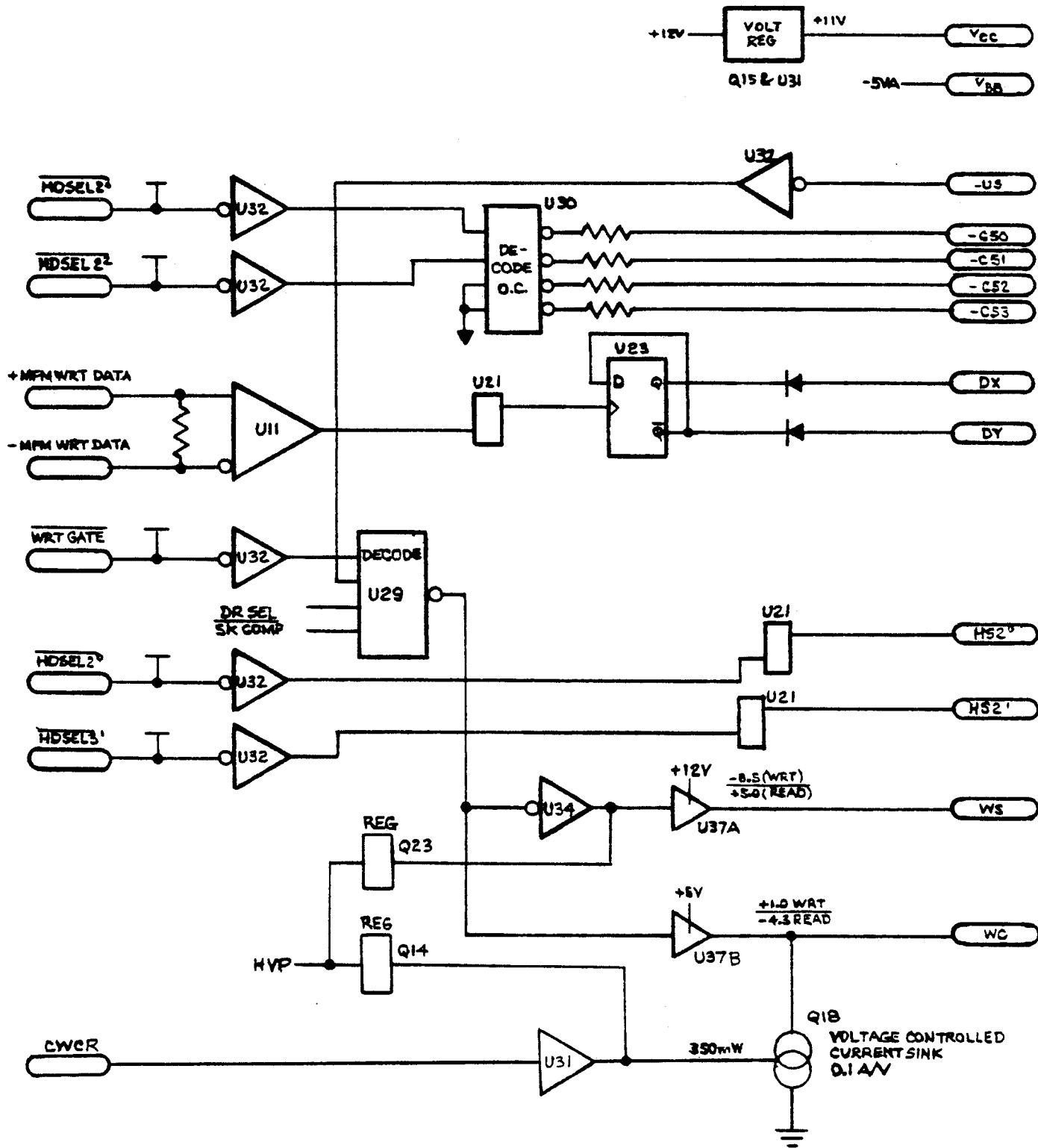
Figure 3-8. Write Function Block Diagram
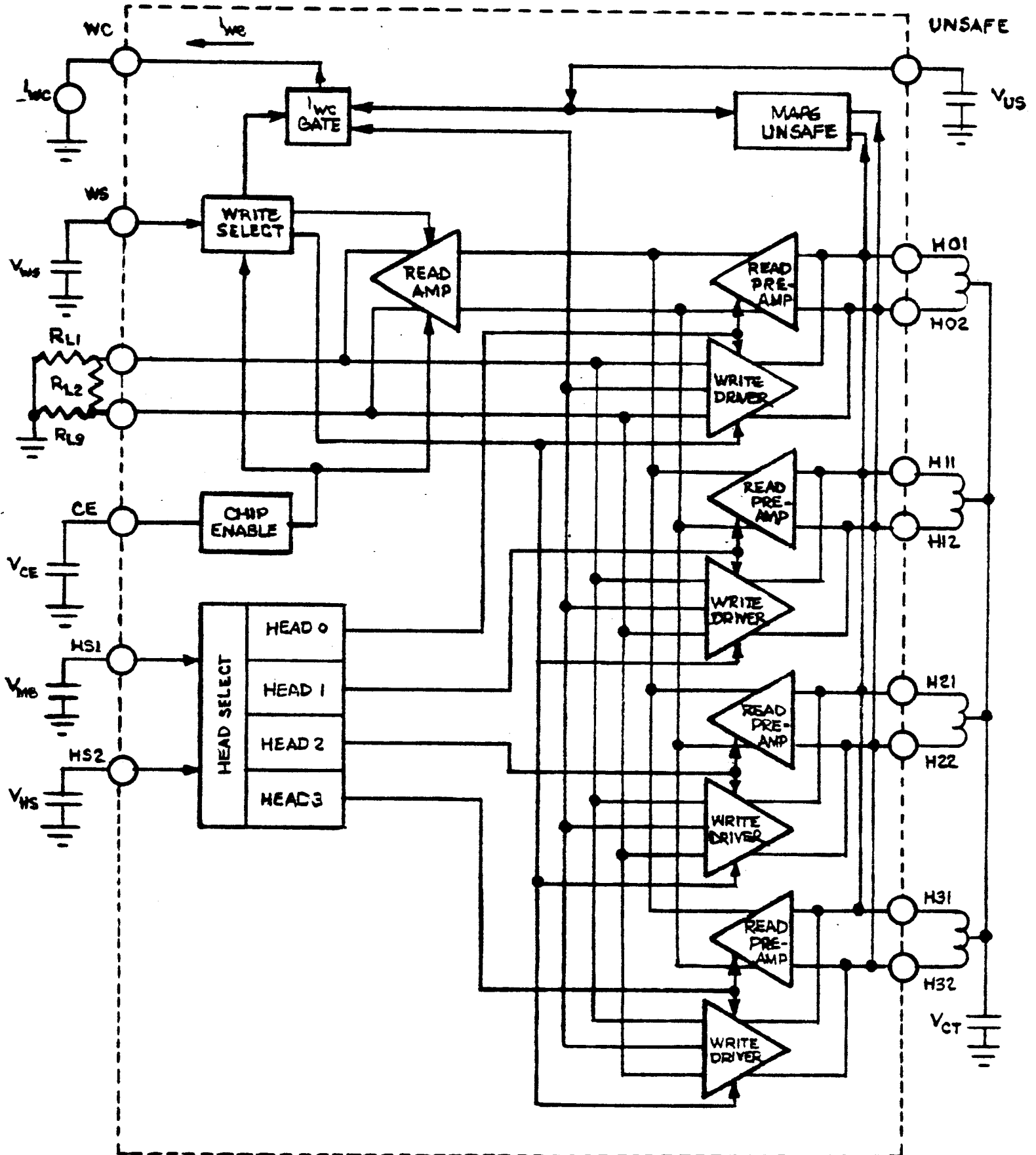
Figure 3-9. Read/Write Circuits (Pre-Amp)

The AGC amplifier is used to cause a constant average amplitude with varying head outputs. This compensates for output variations from head to head and for the signal reduction that occurs as the heads are moved from cylinder 000 to cylinder 917. This reduction of signal with cylinder position is due to increased bit density and decreased wavelength.

The other output of the buffered amplifier is a 2V p-p signal which is fed through a hysteresis loop. This loop compensates for bit patterns that on high resolution media will cause the signal to cross through the hysteresis levels again. High resolution can cause a phenomenon called shouldering. Shouldering is a portion of the signal waveform that has zero slope other than at the peaks. These areas of zero slope can be mistaken for peaks if not properly recognized and processed. The hysteresis loop causes these potential pulses to be ignored as the analog signal is converted to digital as shown on signal D of figure 3-6. This signal is fed into the D input of flip-flop U23.

The second path for the signal is through the low pass filter. The filter output is fed into a differential amplifier. The output of this amplifier is signal A. The other path of the low pass filter output is through the differentiator and pulse shaper. The output of the pulse shaping circuit is designated as signal C. This signal is fed into the clock of flip-flop U23 and along with the signal on the D input, generates the signal E. This signal E is then processed by a bi-directional circuit to generate a MFM read signal. This MFM signal is translated from ECL levels to TTL levels, buffered, and presented differentially to the interface as +MFM READ DATA and -MFM READ DATA.

3.2.4 Power-Up Sequencing

DC power (+5V and +12V) may be applied to the drive in any order, but +12 volt is required to start the spindle motor. When the spindle reaches full rotational speed, the actuator lock automatically disengages and the heads then recalibrate to track 000. Step pulses received during the recalibration, Track 000, READY, and SEEK COMPLETE status signals will be true. The drive will not perform any read, write, or seek operations until READY is true. If 1000 rpm spindle speed is not reached within 10 seconds of power application, an automatic shutdown procedure is initiated: power to the spindle motor is removed and the drive will not come ready. Figure 3-10 shows the timing for power up sequencing.

NOTE

During power-up and recalibration, the drive will emit a variety of audible sounds. This is caused by the actuator voice coil and is perfectly normal.
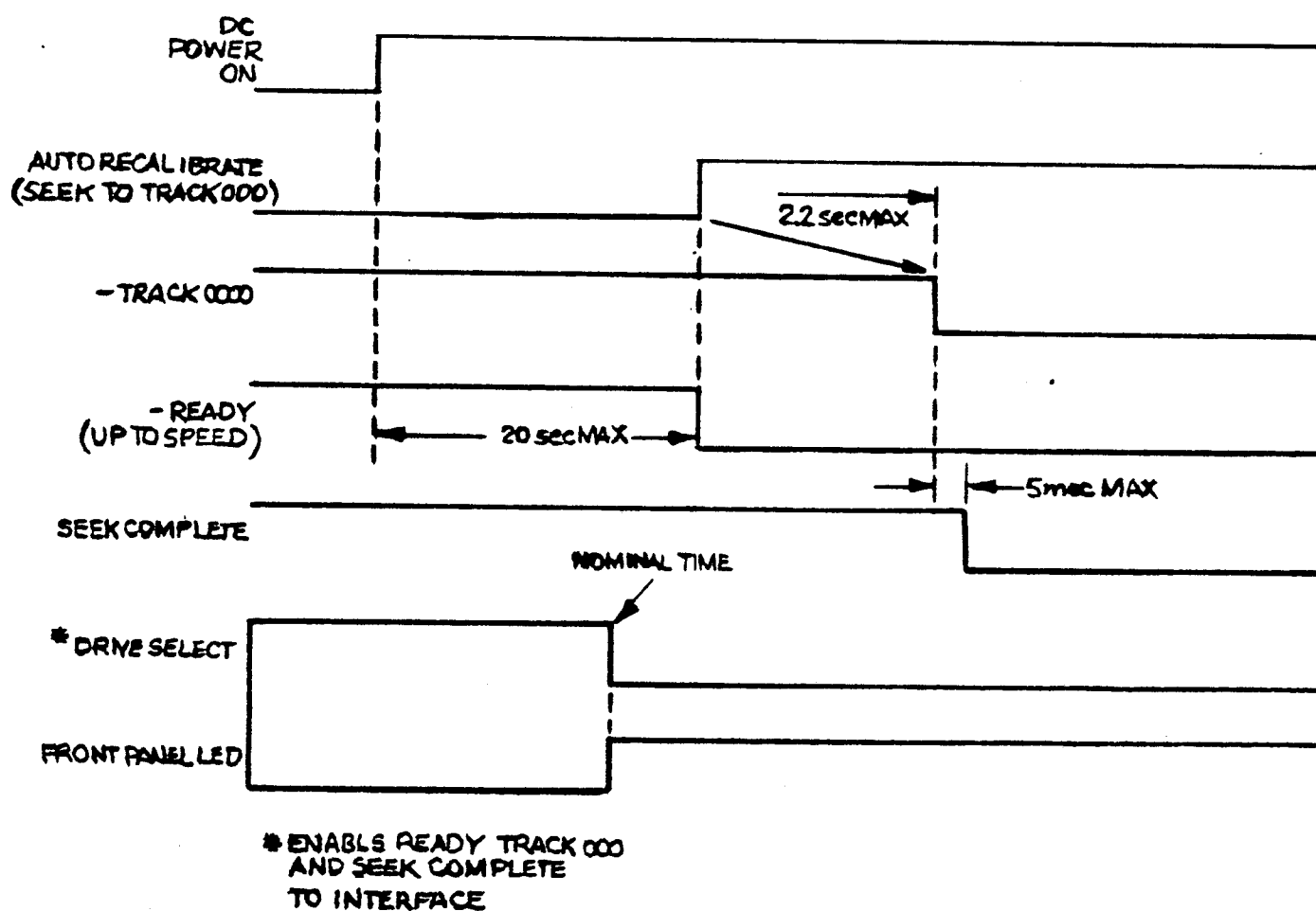
Figure 3-10. Power-Up Sequencing

3.2.5 Power-Down Operation

Upon removal of either or both of the dc voltages from the drive, the drive circuitry causes the actuator to be retracted to a shipping and landing zone located at the inner diameter of the disks. The actuator is latched in this position by the actuator latch until power is again applied and the spindle motor is up to speed. The spindle motor is also dynamically braked, by back emf, to decrease the stopping time when the heads are in contact with the disks. The disks will stop rotating in approximately 9 seconds.

3.3 INTERFACE DESCRIPTION

The Disk Drive has two interface connectors: one for control signals (J1) and one for data transfer signals (J2). The control signals are TTL while the data signals are differential. The following paragraphs describe the signals, timing requirements, and pin assignments associated with these two interface connectors. The driver/receiver pair used on the drive is also discussed. The location of these two connectors is shown in figure 3-11.
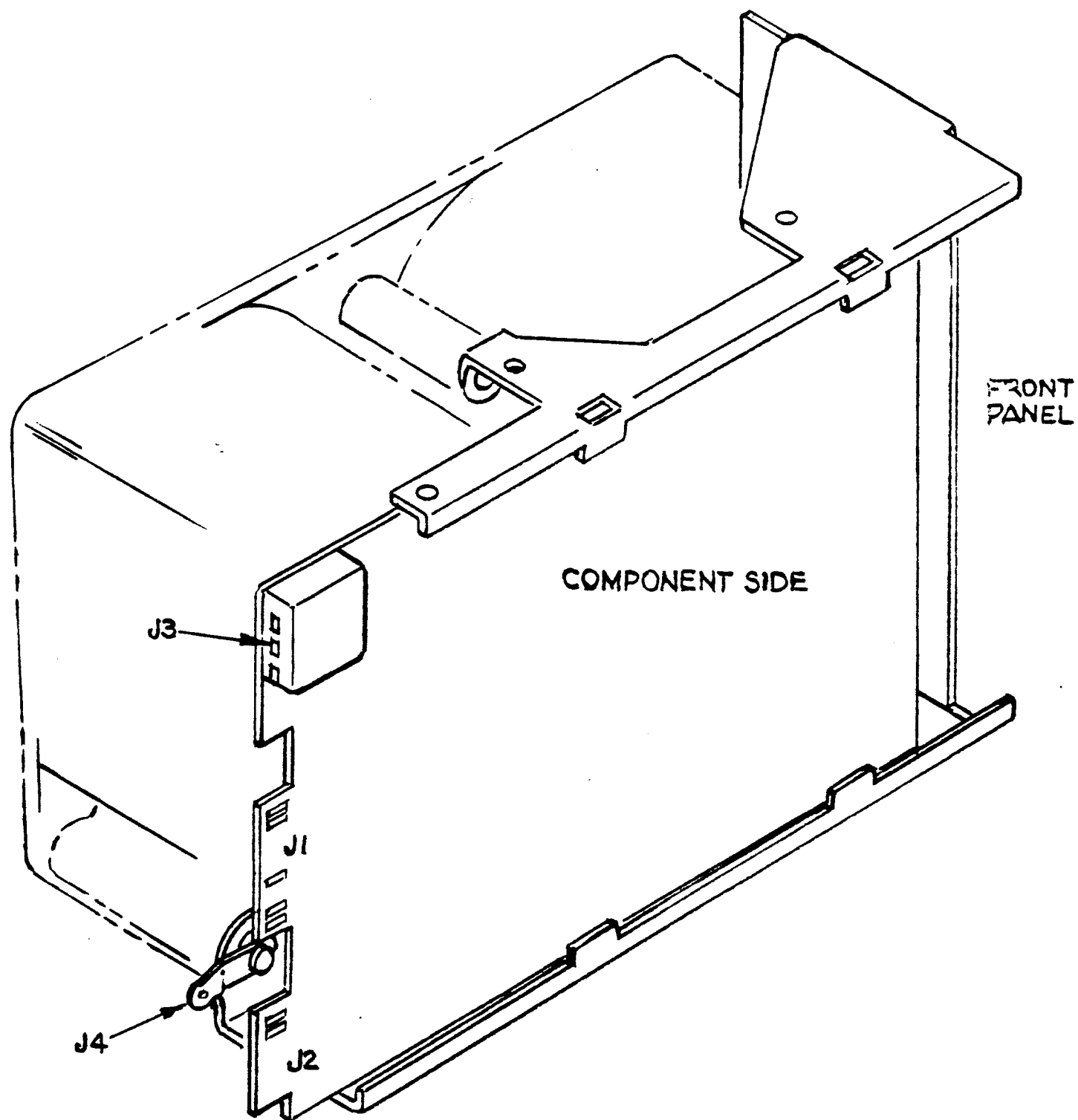
Figure 3-11. Interface Connector Locations

3.3.1 Control Signal Interface

The control signals are both input and output, originating external to the
drive and internal to the drive respectively. The control signals can also be
divided into two types: those intended to be multiplexed in a multi-drive
system and those intended to do the multiplexing. The controls signals that do
the multiplexing are:

- DRIVE SELECT 0
- DRIVE SELECT 1
- DRIVE SELECT 2
- DRIVE SELECT 3

The signals to be multiplexed are:

- HEAD SELECT 2^0
- HEAD SELECT 2^1
- HEAD SELECT 2^2
- HEAD SELECT 2^3
- TRACK 000

- WRITE GATE
- INDEX
- READY
- SEEK COMPLETE
- WRITE FAULT

Up to four drives may be installed in a daisy chain configuration using a single control cable. The last drive in the string must have a termination resistor pack installed while all others must have the terminator removed.

The input lines have the following electrical characteristics:

Logic "0" = TRUE = 0.0 Vdc to 0.4 Vdc @ 1 in = 40ma (max) = LO
Logic "1" = FALSE = 2.5 Vdc to 5.25 Vdc @ 1 in = 250ua (open) = HI

The output lines are driven with a TTL open collector output capable of sinking a maximum of 40 milliamperes at the Logic "0" or TRUE state with a maximum voltage of 0.4 volts dc measured at the driver. When the driver is in the Logic "1" or FALSE state, the driver transistor is OFF and the source current is 250 microamperes maximum.

Driver/Receiver - The recommended driver/receiver combination for control signals is shown in figure 3-12. The maximum cable length recommended is 20 feet (6 meters). Pin assignments for the control cable are shown in figure 3-13 and table 3-1.
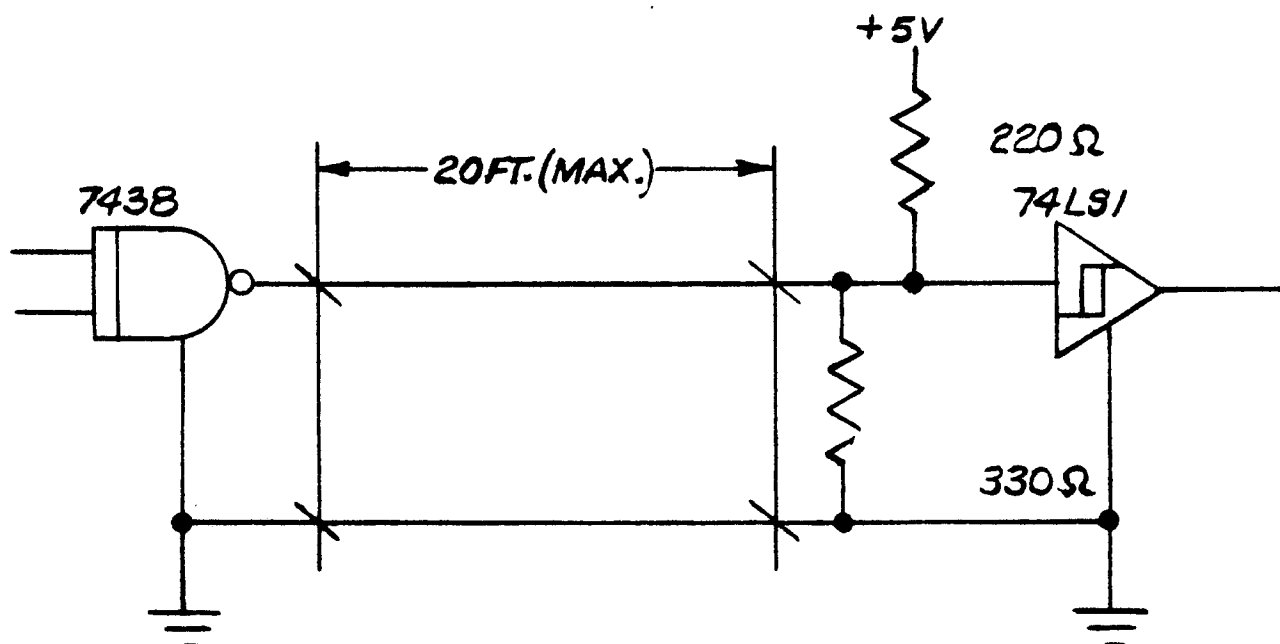
Figure 3-12. Control Signal Driver/Receiver Combination

FLAT RIBBON OR TWISTED
PAIR MAX 20 FEET

PI JI

GND	1	
HD SEL BIT 3	2	
GND	3	
HD SEL BIT 2 –	4	
GND	5	
WRITE GATE –	6	
GND	7	
SEEK COMPLETE –	8	
GND	9	
TRACK 000 –	10	
GND	11	
WRITE FAULT –	12	
GND	13	
HD SEL BIT 0 –	14	
GND	15	
N/C	16	
GND	17	
HD SEL BIT 1 –	18	
GND	19	
INDEX	20	
GND	21	
READY –	22	
GND	23	
STEP –	24	
GND	25	
DRIVE SEL 0 –	26	
GND	27	
DRIVE SEL 1 –	28	
GND	29	
DRIVE SEL 2 –	30	
GND	31	
DRIVE SEL 3 –	32	
GND	33	
DIRECTION IN –	34	

HOST SYSTEM

DISK DRIVE
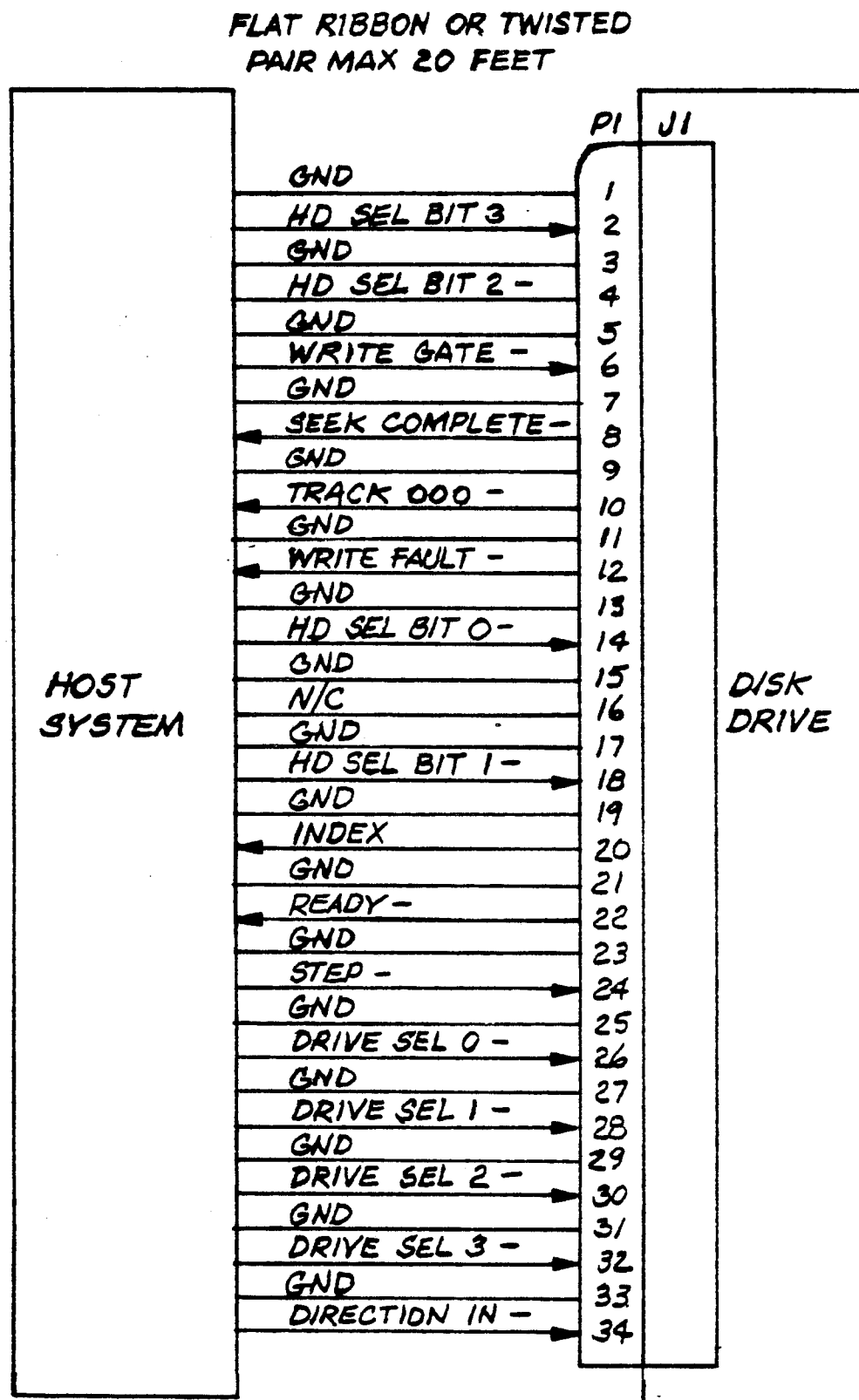
Figure 3-13. J1/P1 Connector Pin Assignments

Table 3-1. Control Signals (Daisy Chained)

GND RTN PIN	SIGNAL PIN AND NAME
1	2 Hd Sel Bit 3
3	4 Hd Sel Bit 2 −
5	6 Write Gate −
7	8 Seek Complete −
9	10 Track 000 −
11	12 Write Fault −
13	14 Hd Sel Bit 0 −
15	16 N/C
17	18 Hd Sel Bit 1
19	20 Index
21	22 Ready −
23	24 Step −
25	26 Drive Sel 0 −
27	28 Drive Sel 1 −
29	30 Drive Sel 2 −
31	32 Drive Sel 3 −
33	34 Direction In −

Note: "−" indicates low true signal

3.3.1.1 Control Input Signals

The following paragraphs describe the control input signals.

Head Select Lines − The following head select lines allow selection of each individual read/write head in a binary coded sequence:

$$2^0, 2^1, 2^2, \text{ and } 2^3$$

Head select 2^0 is the least significant select line. The heads are numbered 0 through 15. When all head select lines are high (inactive), head 0 will be selected. A 220/330 ohm resistor pack provides line termination.

Write Gate − The active state of this signal, or LO level, enables write data to be written on the disk. The inactive state of this signal, or HI level, enables data to be read from the drive. A 220/330 ohm resistor pack provides line termination.

Step − This interface line is a control signal which causes the read/write heads to move in the direction defined by the DIRECTION IN line. The access motion is initiated at the high to low level transition or leading edge of the signal pulse. Any change in the DIRECTION IN line must be made at least 100 nanoseconds before the leading edge of the STEP pulse. The DIRECTION IN line must not change for at least 100 nanoseconds after the trailing edge of the last STEP pulse. See figure 3-14 for General Step Timing. A 220/330 ohm resistor pack provides line termination.
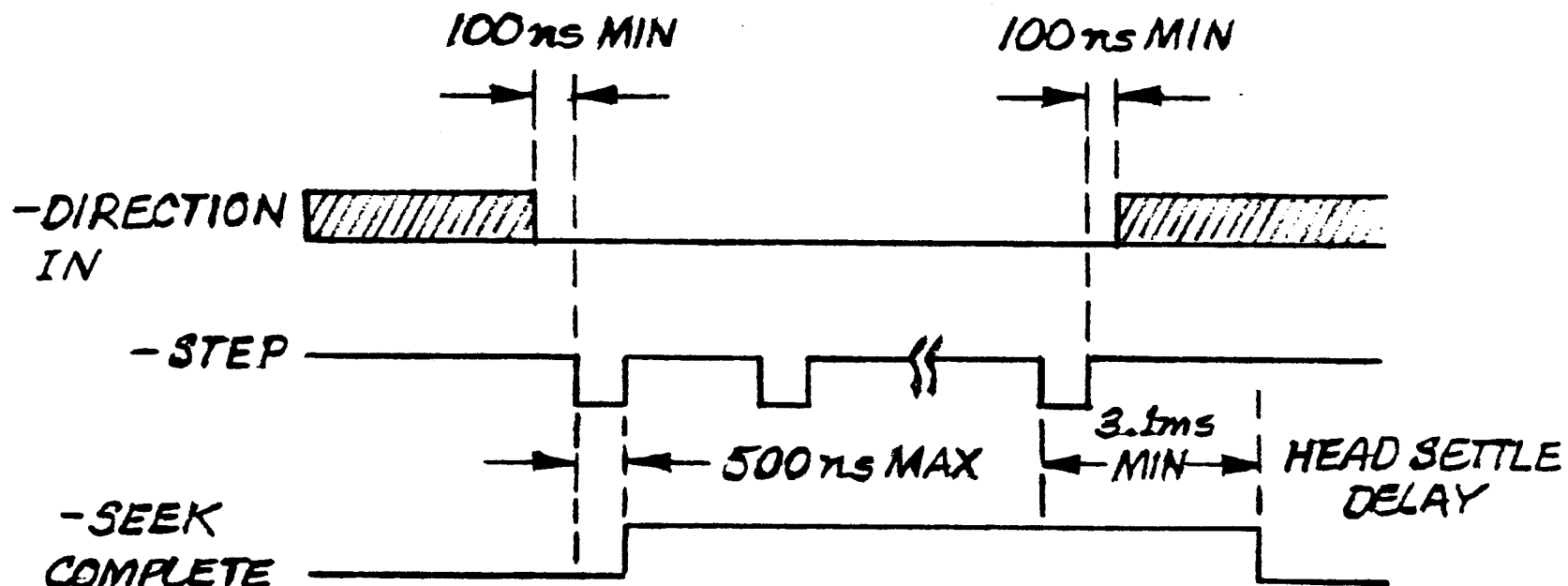
Figure 3-14. General Step Timing

All multiple cylinder seeks in the Disk Drives are buffered seeks. Optimum
performance from the drive will be achieved if the time between step pulses is
from 1 microsecond to 13 microseconds. Any time up to 3100 microseconds (3.1
milliseconds) will be accepted by the drive. See figure 3-15 and table 3-2.
Table 3-2 also shows performance expectations for different step rates.

The equations for the time of a seek of any given length L, are:

SEEK LENGTH (L)	SEEK TIME (including settling)
1	5ms
2 - 7	5ms + 0.43ms(L)
8 - 31	8ms + 0.22ms(L)
32 - 127	11ms + 0.11ms(L)
128 - 511	15ms + 0.053ms(L)
$\geq$ 512	23ms + 0.027ms(L)

The equation for calculating the average seek time is:

$$\text{AVERAGE SEEK TIME} = 2/M \sum_{L=1}^{M} (1 - L/M)\dagger L$$

WHERE: M is the number of cylinders
       L is the length of the seek in cylinders
       †L is the time for an L cylinder seek
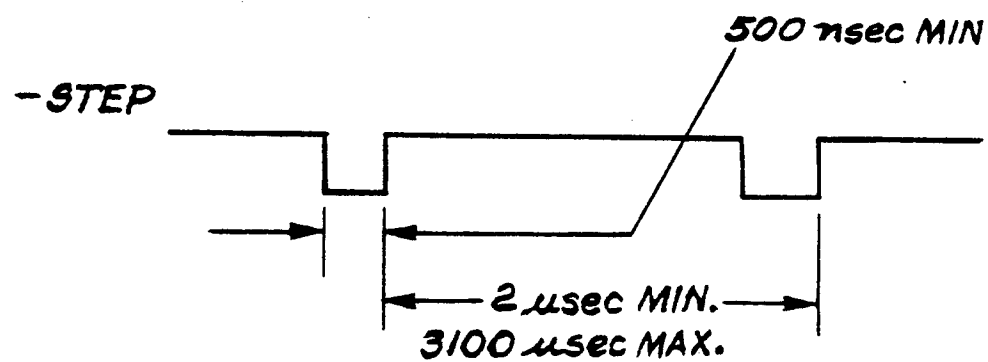
Figure 3-15. Step Pulse Timing

Table 3-2. Seek Performance Vs Step Time

STEP TIME (usec)	AVERAGE ACCESS TIME (msec)	MAXIMUM ACCESS TIME (msec)
1-13	30	48
14-26	34	78
30	42	85
35	43	92
40	44	92
45	45	92
50	46	92
60	47	105
70	52	112
80	55	115
90	57	122
100	59	126
150	71	164
200	83	210
300	110	296
400	140	383
500	170	474
600	200	564
700	230	653
800	260	744
900	290	835
1000	320	926

Time between step pulses cannot exceed 3.1 msec.

All seek times include settling and begin upon reception of the first step pulse.

Direction In - This signal defines the direction of motion of the read/write heads when the STEP line is pulsed. An open circuit or HI level defines the direction as "out" and when the STEP line is pulsed, the read/write heads will move away from the center of the disk and toward cylinder 000 (the outermost cylinder). If this line is at a LO level, the direction of motion will be defined as "in" and the read/write heads will move toward the center of the disk. Any changes in the level of the DIRECTION IN line must conform to the timing restrictions shown in figure 3-14. A 220/330 ohm resistor pack provides line termination.

Drive Select - DRIVE SELECT, when LO, connects the drive interface to the control lines. Positioning the DRIVE SELECT jumper between two appropriate pins on the PCB determines the address to which the drive will respond. The location of the DRIVE SELECT jumpers is shown in figure 2-7. The following table indicates which drive will be selected for each jumper position.

3.3.1.2 Control Output Signals

The following paragraphs describe the control output signals. See figure 3-13.

Seek Complete - This signal, when LO or true, indicates that the read/write heads have settled at the destination cylinder and that another seek, a read, or a write may be initiated.

Track 000 - This interface signal, when LO or true, indicates that the read/write heads are positioned at cylinder zero (the outermost data cylinder).

Write Fault - When LO or true, this signal indicates that a condition exists in the drive that may cause improper writing on the disk. Further writing is inhibited in the drive until the improper condition is cleared. WRITE FAULT can be cleared by deselecting the drive or by cycling power OFF and ON.

NOTE

This signal should be edge detected by the controller.

There are three conditions detected:

- Write current in a head without WRITE GATE active or no write current with WRITE GATE active and drive selected

- Multiple heads selected, no head selected, or improperly selected

- Head not properly positioned over track (OFF-TRACK detected)

Index - A pulse on this interface signal line is provided by the drive once each revolution (16.67 millseconds) to indicate the beginning of a track. This signal is normally HI and makes a transition to LO to indicate INDEX. The LO pulse is nominally 53.4 microseconds in length. Only the HI to LO transition is valid. Index timing is shown in figure 3-16.

Ready - This interface signal, when true together with SEEK COMPLETE, indicates that the spindle is up to speed and the drive is ready to read, write, or seek. When this line is false, writing and seeking are inhibited. Typical time for READY after power on is 15 seconds. Figure 3-17 shows some of the general timing requirements of the input and output signal lines of the drive.
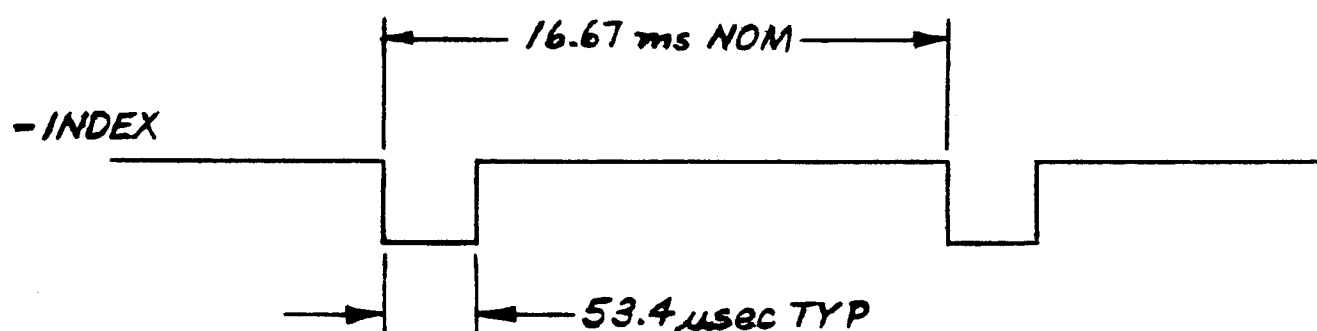
Figure 3-16. Index Timing
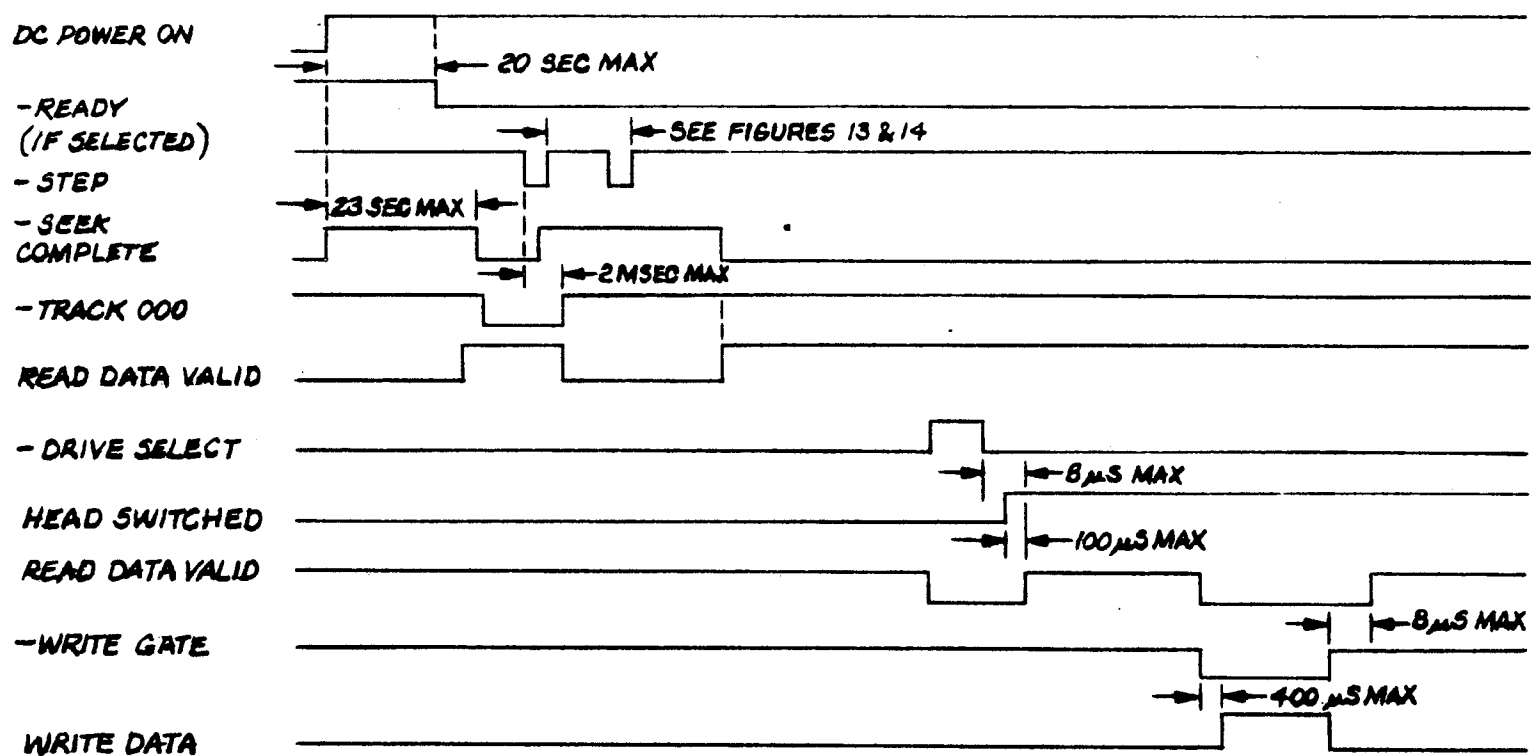
Figure 3-17. General Timing Requirements

3.3.2 Data Interface

The following paragraphs describe the data interface.

3.3.2.1 General Description

The lines associated with data transfer between the drive and the controller are differential in nature and may not be multiplexed. These lines, MFM READ DATA and MFM WRITE DATA, are provided at the J2/P2 connector on all drives. The driver/receiver combination used for these lines is shown in figure 3-18.

A third signal is available at J2/P2. That signal is DRIVE SELECTED which indicates the selection status of the drive. This line is an open collector TTL output.

NOMINAL "-" LINE

Z = 105 Ω

FLAT RIBBON OR TWISTED PAIR

MAXIMUM 20 FEET
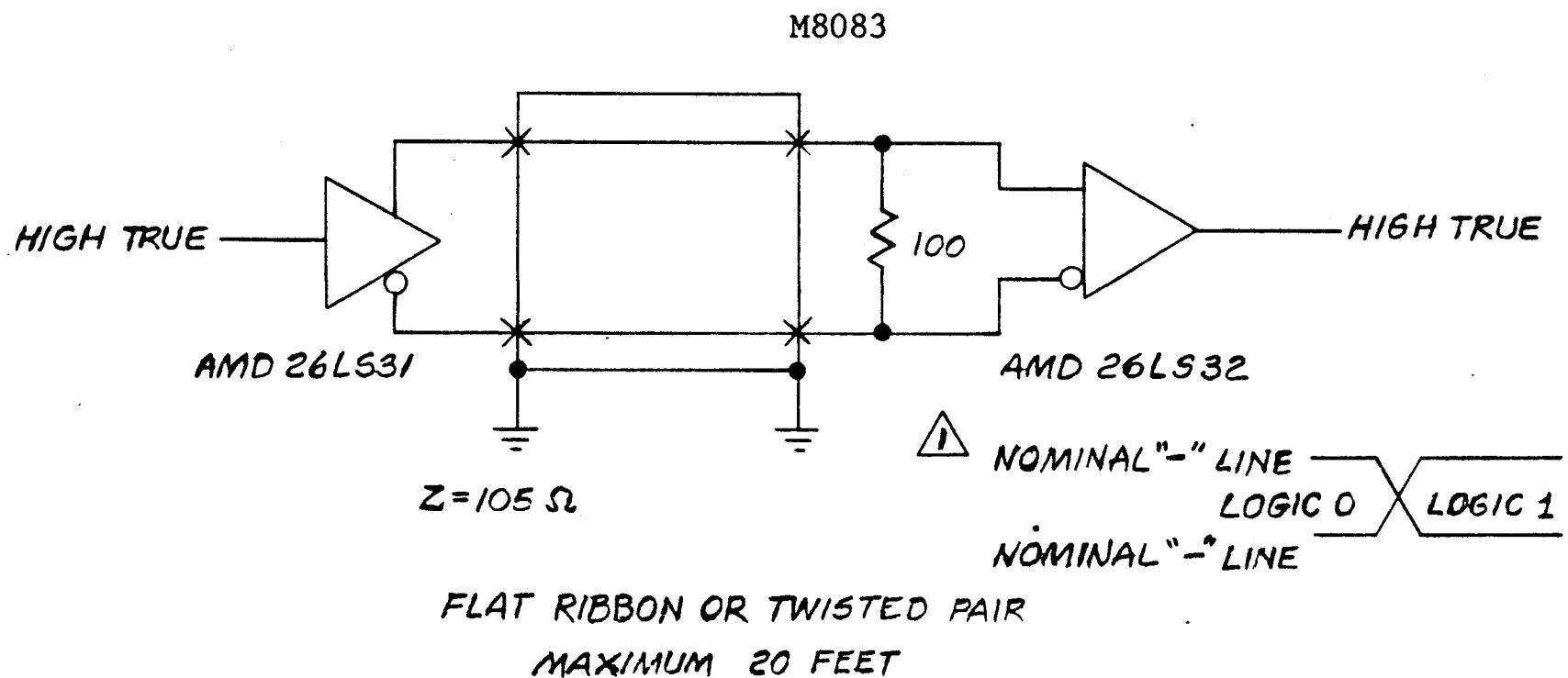
Figure 3-18. Data Line Driver/Receiver Combination

Pin assignments and line titles for J2/P2 are shown in figure 3-19 and table 3-3.

FLAT RIBBON OR TWISTED
PAIR MAX 20 FEET
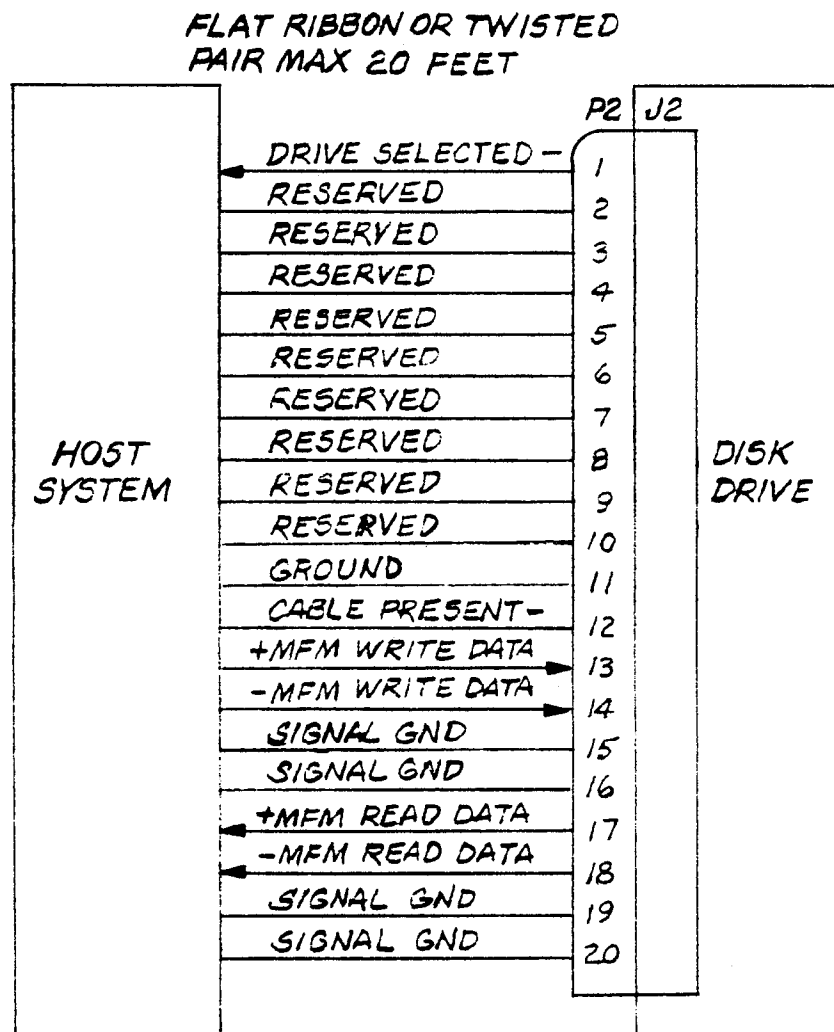
Figure 3-19. J2/P2 Connector Pin Assignments

Table 3-3. Data Signals (Radial)

SIGNAL PIN	SIGNAL NAME
1	Drive Selected -
2 - 10	Reserved
11	Ground
12	Cable Present -
13	+ MFM Write Data
14	- MFM Write Data
15	Signal Ground
16	Signal Ground
17	+ MFM Read Data
18	- MFM Read Data
19	Signal Ground
20	Signal Ground

Note: "-" indicates low true signal

3.3.2.2 MFM Write Data

This is a differential pair of data lines which define the transitions to be
written on the disk. The transition of + MFM WRITE DATA will cause a flux
reversal on the disk provided WRITE GATE is active. This signal must be driven
to an inactive state (+ MFM WRITE DATA more negative than - MFM WRITE DATA) by
the controller when in the read mode. See figure 3-20 for write data timing.

No write precompensation is required by the drive; if write precompensation is
used, some loss in read performance may result.
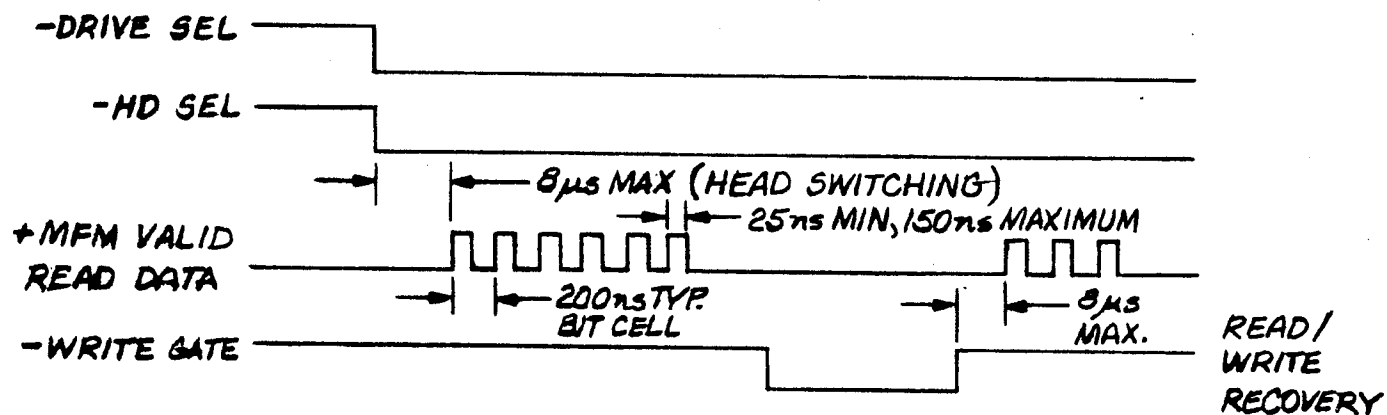
Figure 3-20. MFM Write Data Timing

3.3.2.3 MFM Read Data

Data recovered by reading prerecorded information from the disk is transmitted
to the controller by the differential pair of MFM READ DATA lines. The transi-
tion of the + MFM READ DATA going more positive than the − MFM READ DATA line
represents a flux reversal detection from the disk under the selected head.
See figure 3-21 for MFM READ DATA timing.

3.4 FORMAT DESCRIPTION AND EXAMPLES

The purpose of a format is to organize a data track into small blocks of data
called sectors. Each sector has a unique address in its header or ID field.

3.4.1 ST506/412 Format

The format shown below in figure 3-22, the ST506/412 format, is a format com-
monly used on lower performance disk drives. Its efficiency of 81% (unfor-
matted capacity/formatted capacity) is typical; however other efficiencies can
be obtained by varying the number of sectors per track. The ST506/412 format
is a soft sectored format which means that the beginning of each sector is de-
fined by an Address Mark and a prewritten identification (ID) field which con-
tains the physical sector address plus cylinder and head information. The ID
field is then followed by a user supplied data field.

The ST506/412 format is a slightly modified version of the IBM System 34 double
density format which is commonly used on floppy disk drives. The encoding is
Modified Frequency Modulation (MFM).
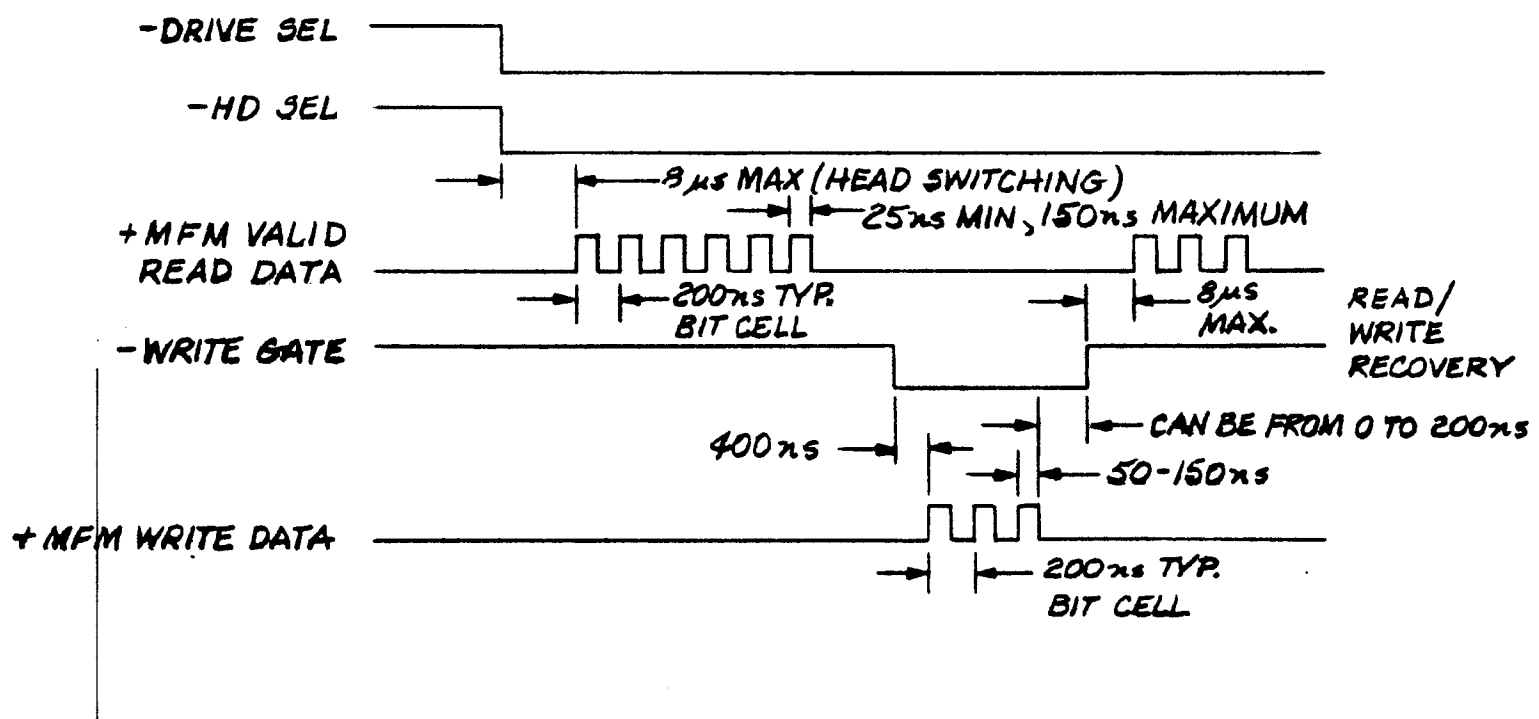
Figure 3-21. MFM Read Data Timing
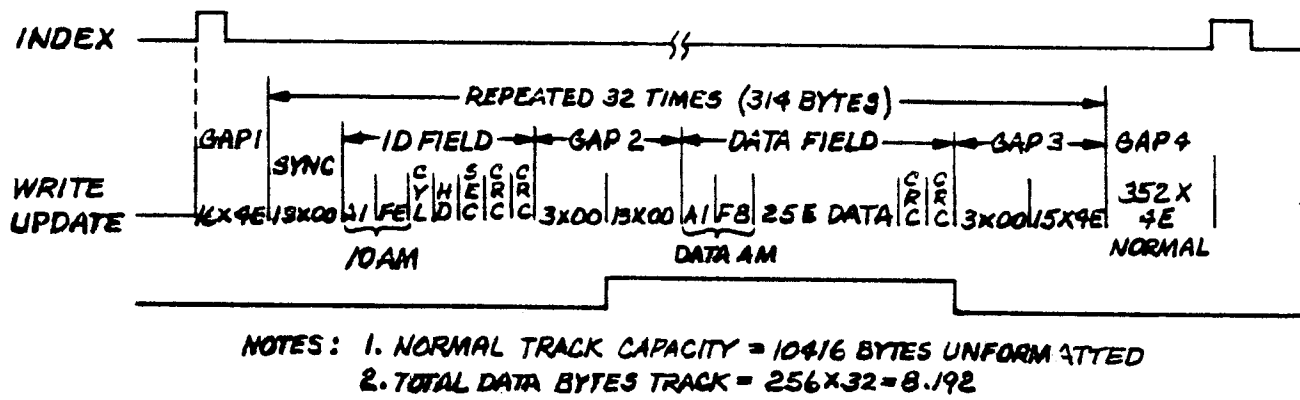
Figure 3-22. ST506/412 Format

3.4.2 Address Marks

The beginning of both the ID field and the data field are flagged by unique characters called Address Marks. An Address Mark is two bytes in length. The first byte is an "A1" data pattern. This is followed by either an "FE" pattern for an ID address mark, or an "F8" for the data address mark.

The "A1" pattern is made unique by violating the encoding rules of MFM by omitting one clock bit. See figure 3-23. This makes the Address Mark pattern unique to any other serial bit combination that could occur on the track.
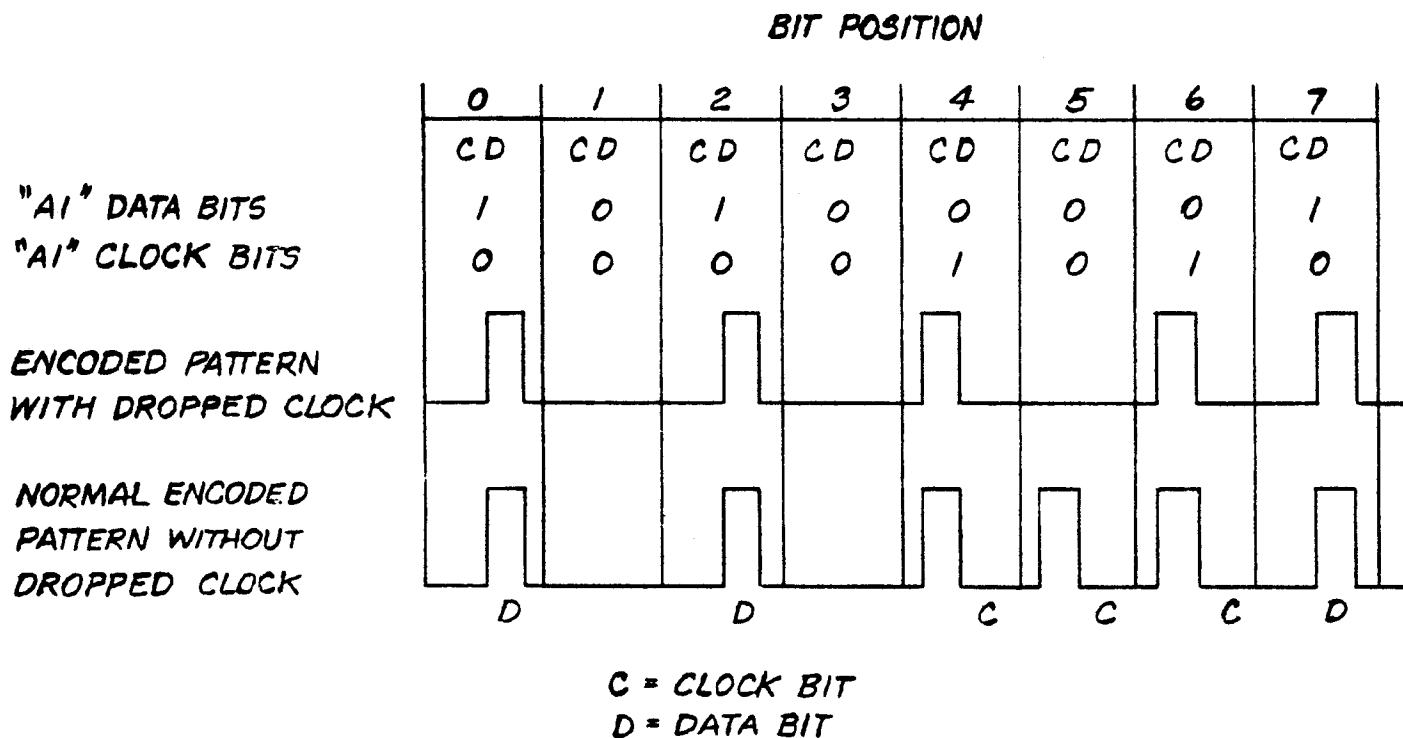
Figure 3-23. "A1" Address Mark Byte

3.4.3 Gap Length Calculation

Gaps surrounding the ID and data fields establish physical and timing relation-
ships between these fields.

Gap 1 - provides for variations in index detection. This gap must be at least
12 bytes long. Gap 1 is immediately followed by a sync field preceding the
first ID field.

Gap 2 - follows the CRC or ECC bytes of the ID field, and continues to the Data
Address Mark. It provides a known area for the data field write splice to
occur. The latter portion of this gap serves as the sync up area for the data
field Address Mark. Gap 2 is normally 16 bytes long, however, its minimum
length is determined by the "lock up" performance of the phase-lock-loop in the
data separator, which is part of the host control unit.

Gap 3 - follows each data field to allow for spindle speed variations. This
allows for the situation where a track has been formatted while the disk is
running slower than nominal, then write updated with the disk running faster
than normal. Without this gap, or if it is too small, the sync bytes or ID
field of the next field could be overwritten. The minimum gap is 8 bytes for a
sector size of 256 bytes.

Gap 4 - is a speed tolerance gap for the entire track, which is applicable in
full track formatting operations to avoid overflow into the index area. The
format operation which writes ID fields begins with the first encountered index
and continues to the next index. The actual bytes in Gap 4 depend on the exact
rotational speed during the format operation.

3.4.4 Sector Interleaving

The ST506/412 format normally uses an interleave factor of 4: That is, sequen-
tially sectored ID numbers are 0, 4, 8, 12, ..., 1, 5, 9, 13, etc. This
allows sufficient system turnaround time to process multiple sectors during a
single revolution, thus enhancing through-put of typical file read/write opera-
tions. Other interleave factors can be used.

SECTION IV

MAINTENANCE

4.1 INTRODUCTION

This section contains the information required by the technician for the maintenance of the Disk Drive.

4.2 PREVENTIVE MAINTENANCE

Other than a visual inspection to insure that dust accumulation has not restricted air flow, preventive maintenance is limited to general cleaning, which should be accomplished along with scheduled maintenance of the host system.

Cleaning of the Disk Drive is done in the following manner (see figure 4-1):

1. Use a soft bristle brush to clean dust from electrical surfaces.

```
CAUTION
```

Do not use abrasive cleaners and chemical cleaning agents that contain acetone, toluene, xylene, or benzene. These cleaners may cause equipment damage that requires major rpair.

2. Use a lint-free cloth dampened with a solution of 90 percent isopropyl alcohol to clean non-electrical surfaces.

3. Clean away any dust accumulation which could cause speed fluctuations.

TBD

Figure 4-1. Cleaning the Disk Drive

SECTION V

REMOVAL/REPLACEMENT PROCEDURES

5.1 INTRODUCTION

This section contains removal/replacement procedures for the Disk Drive and
the Disk Drive PCBA as installed on MAI Basic Four® Series 2000 and Series
7000 systems. Also included are procedures for installing additional disk
drives.

NOTE

Whenever a Disk Drive must be replaced, retain the
packing material from the replacement unit for use
in repacking and returning the defective unit.

5.2 DISK DRIVE REMOVAL/RELACEMENT - SERIES 2000 SYSTEMS

Remove/replace a disk drive in the Series 2000 Base Unit as follows:

1. Shut down the system and turn off the Base Unit power.

2. Unplug the Base Unit power cord from the ac outlet.

3. Unplug all connections to the Base Unit, including all attached peri-
    pherals.

4. Insert a screwdriver, or similar device, into the slot at the bottom
    right-hand side of the Base Unit cover, and push in to disengage the
    latch. Repeat with the left-hand side, and remove the cover.

5. If necessary, remove the required controller PCBAs to gain access to
    the cable connectors on the disk drive controller.

6. Unplug the bus and radial ribbon cables from connectors J1 and J2 on
    the disk drive/s (see figure 5-1).

7. Unplug the power cable from connector J3 on the disk drive/s (figure
    5-1).

8. Remove the front and rear facias by pulling up slightly on each plastic
    card holder until the corresponding facia is disengaged from the card
    holder.

9. Using a screwdriver, or similar tool, push back the two (2) plastic
    latches at the bottom rear of the disk drive chassis, while lifting the
    back of the drive to clear the latches (see figure 5-1).

LATCHES

LIGHTLY TWIST
SCREW DRIVER
TO SPRING
LATCH BACK

LIFT PLATE
(ONE SIDE
AT A TIME)

DRIVE
MOUNTING
PLATE

PLATE RESTS
AND HINGES
HERE

CMB

DRIVE MOUNTING
LATCHES (TYPICAL)

POWER
CABLE
PA2

POWER
CABLE
PA1

DRIVE 0 RADIAL CABLE
P/N 907604-001

DRIVE 1
J1 J2

DRIVE 0
J1 J2

J5

J4

J3

J3

J3

DRIVE 1 RADIAL CABLE
P/N 907604-002

SINGLE DRIVE BUS CABLE
P/N 907605-001
OR
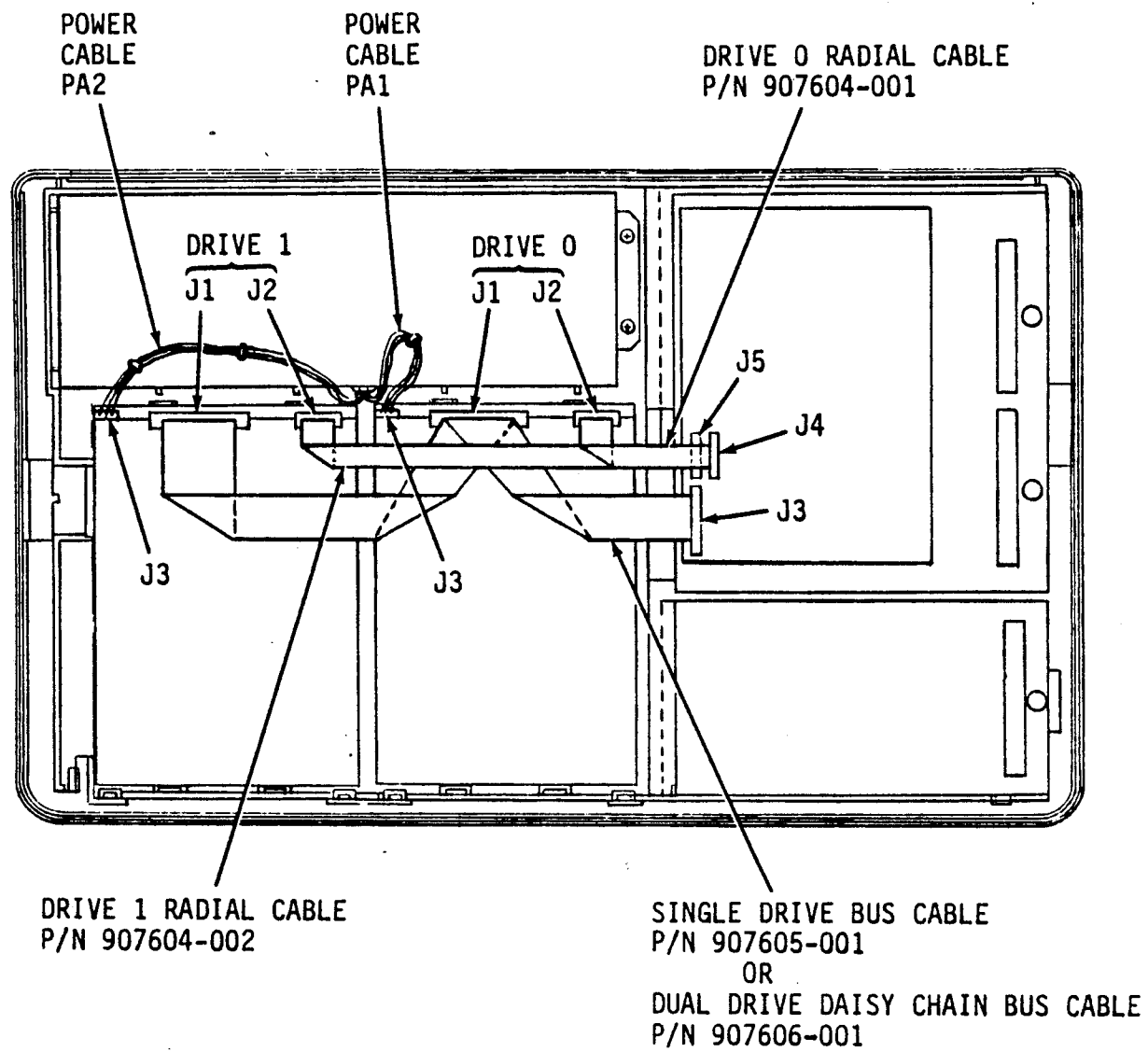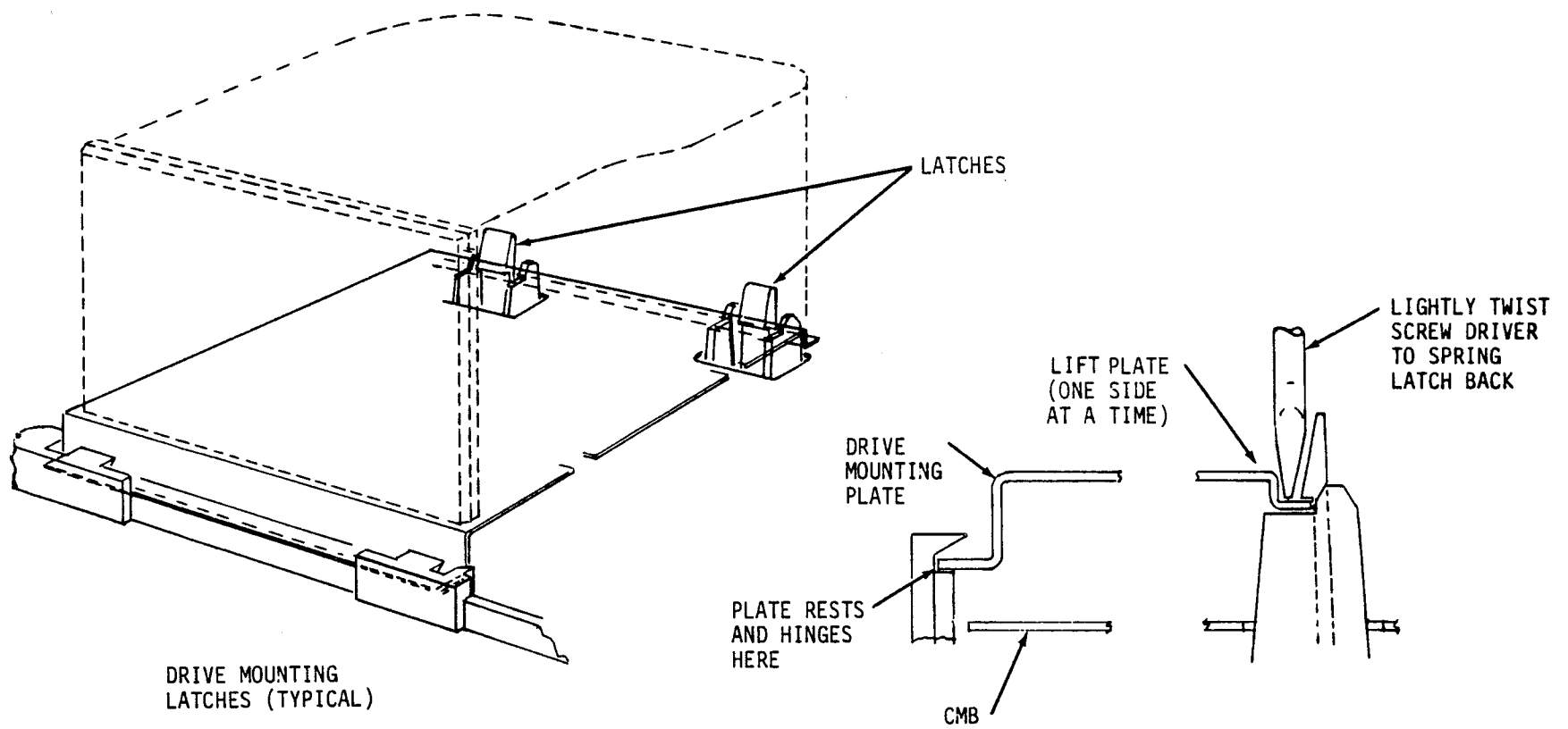DUAL DRIVE DAISY CHAIN BUS CABLE
P/N 907606-001

Figure 5-1. Disk Drive Removal/Replacement/Installation, Series 2000 Systems

10. Push the drive slightly toward the rear of the CMB so that the flange at the front of the drive clears the slot in the Base Unit bottom panel; lift the disk drive assembly from the Base Unit.

11. Before installing the replacement drive, observe the following:

    a. If replacing the drive on a single-drive system, be sure that the terminator resistor pack is installed and that the address select jumper plug is installed on the correct pins for Drive Select 0 (see figure 2-7).

    b. If replacing Drive 0 on a two-drive system, be sure that its terminator resistor pack is removed and that the address select jumper plug is installed on the correct pins for Drive Select 0 (figure 2-7).

    c. If replacing Drive 1 on a two-drive system, be sure that its terminator resistor pack is installed and that the address select jumper plug is installed on the correct pins for Drive Select 1 (figure 2-7).

CAUTION

Use care not to damage CMB components when replacing disk drives. Do not apply pressure to the top of the drives when installing same in the Base Unit. Using a screwdriver to press on the flange of the drive mounting plate will prevent damage to the CMB.

12. Install the replacement drive by following steps 1 thru 10 in reverse order

5.3 SECOND DISK DRIVE INSTALLATION - SERIES 2000 SYSTEMS

The Series 2000 Base Unit may have one or two disk drives installed; i.e., either Drive 0 or Drive 0 and Drive 1. The last drive in the system must have a terminator resistor pack installed. When a second drive (Drive 1) is added, the terminator must be removed from the Drive 0 PCBA and installed on Drive 1. The second drive must also be configured for the proper address (i.e., Drive Select 1). In addition, the "superblock" for the second drive must be modified and a filesystem must be installed.

Remove the floppy disk drive and install a second fixed disk drive in the Series 2000 Base Unit as follows:

1. Perform steps 1 thru 6, and step 8, of paragraph 5.2.

2. Unplug the power cable (PA2) from the rear of the floppy drive.

3. Using a screwdriver, or similar tool, push back the two (2) plastic latches at the bottom rear of the floppy drive chassis, while lifting the back of the drive to clear the latches (see figure 5-1).

4. Push the floppy drive slightly toward the rear of the CMB so that the flange at the front of the drive clears the slot in the Base Unit bottom panel.

5. Raise the floppy drive, unplug the ribbon cable from the CMB, and lift the floppy drive assembly from the Base Unit.

6. Repeat steps 3 and 4 to remove Drive 0.

7. Remove the terminator resistor pack from Drive 0 and verify that the terminator is installed on Drive 1 (the new drive).

8. Configure Drive 1 for the proper address (Drive Select 1) by installing the address select jumper plug over the correct pins (see figure 2-7).

```
CAUTION
```

Use care not to damage the CMB components when installing the second fixed disk drive. On some CMBs, R31, near the left-front shock mount, may require bending to clear the chassis of the second drive. Do not apply downward pressure on a drive when installing same in the Base Unit. Using a screwdriver to press on the flange of the drive mounting plate will prevent damage to the CMB.

9. Reverse steps 3 and 4 to reinstall Drive 0 and to install Drive 1.

10. Connect radial cable P/N 907604-001 to connector J4 on disk drive controller and to connector J2 on Drive 0 (see figure 5-1).

11. Connect radial cable P/N 907604-002 to connector J5 on disk drive controller and to connector J2 on Drive 1 (figure 5-1).

12. Connect daisychain bus cable P/N 907606-001 to connector J3 on disk drive controller, connector J1 on Drive 0, and connector J1 on Drive 1 (figure 5-1).

13. Connect power cable PA1 to connector J3 on Drive 0, and power cable PA2 to connector J3 on Drive 1 (figure 5-1).

14. Reassemble the Base Unit and connect power cord to ac outlet. Connect peripherals and power-up the system.

15. Change the Drive 1 superblock to reflect two partitions and install a filesystem on Drive 1 as follows:

    a. Log on to the system administrstor:

        ADMIN> usb /dev/rwd1 -get desc=<u>drive1</u>

        Note that "drive1" is an arbitrary name assigned to a file, used in this example to store the contents of the superblock in the second disk drive.

    b. Ved (edit) the file, /etc/diskdesc/<u>drive1</u>. Modify the file so that the last two lines read:

        **partition # : starting block : length in blocks

        1: 0: - 1

        You should only have to add the last line. Save the file with with the new edits.

    c. Update the superblock on Drive 1 with the parameters described in etc/diskdesc/<u>drive1</u>:

        ADMIN> usb /dev/rwd1 -save -set type=<u>drive1</u>

    d. Create the unbuffered raw device and the buffered device with the following commands:

        ADMIN>makedev /dev/<u>rdrive1</u> U 14 33

        ADMIN>makedev /dev/<u>drive1</u> B 14 33

        The device names used in this example are rdrive1 and drive1, but can be defined using other names. To follow convention, the unbuffered raw device should begin with the letter "r," which stands for raw device.

    e. Once the device is defined, create a filesystem using the makefs command:

        ADMIN>makefs /dev/<u>rdrive1</u>

    f. Verify that the second drive is correctly partitioned by using the "space" command:

        ADMIN> space /dev/<u>rdrive1</u>

        The number of blocks returned should reflect the size of the disk drive installed.

USE SLOT-HEAD
SCREWDRIVER TO
PRESS AND LIFT TOP

PANEL
FILLER

QUARTER TURN
EACH SIDE THEN
TILT FORWARD
AND LIFT OUT

Figure 5-2. Removal of Front, Top, and Side Panels, Series 7000 Systems

5.4.2 Removal/Replacement of Disk 0 or Disk 1

Remove/replace Disk 0 or Disk 1 on right-hand mounting plate as follows:

1. Disconnect power cables from connector J3 on Disk 0 and Disk 1 (see figure 5-3). Tag power cable for Disk 0.

2. Disconnect Disk 1 power supply (figure 5-3) from disk ACDU.

PLATE MOUNTING SCREWS (UPPER)

DISK 1 (DISK 2 ON LEFT-HAND MOUNTING PLATE)

TO REMOVE

POWER SUPPLY (DISK 1)

J3

J2

J1

PLATE MOUNTING SCREWS (LOWER)

DISK 0 (DISK 3 ON LEFT-HAND MOUNTING PLATE)

NOTE: ORIENTATION OF DRIVE CONNECTORS J1-J3 IS INVERTED ON DISKS 2 & 3
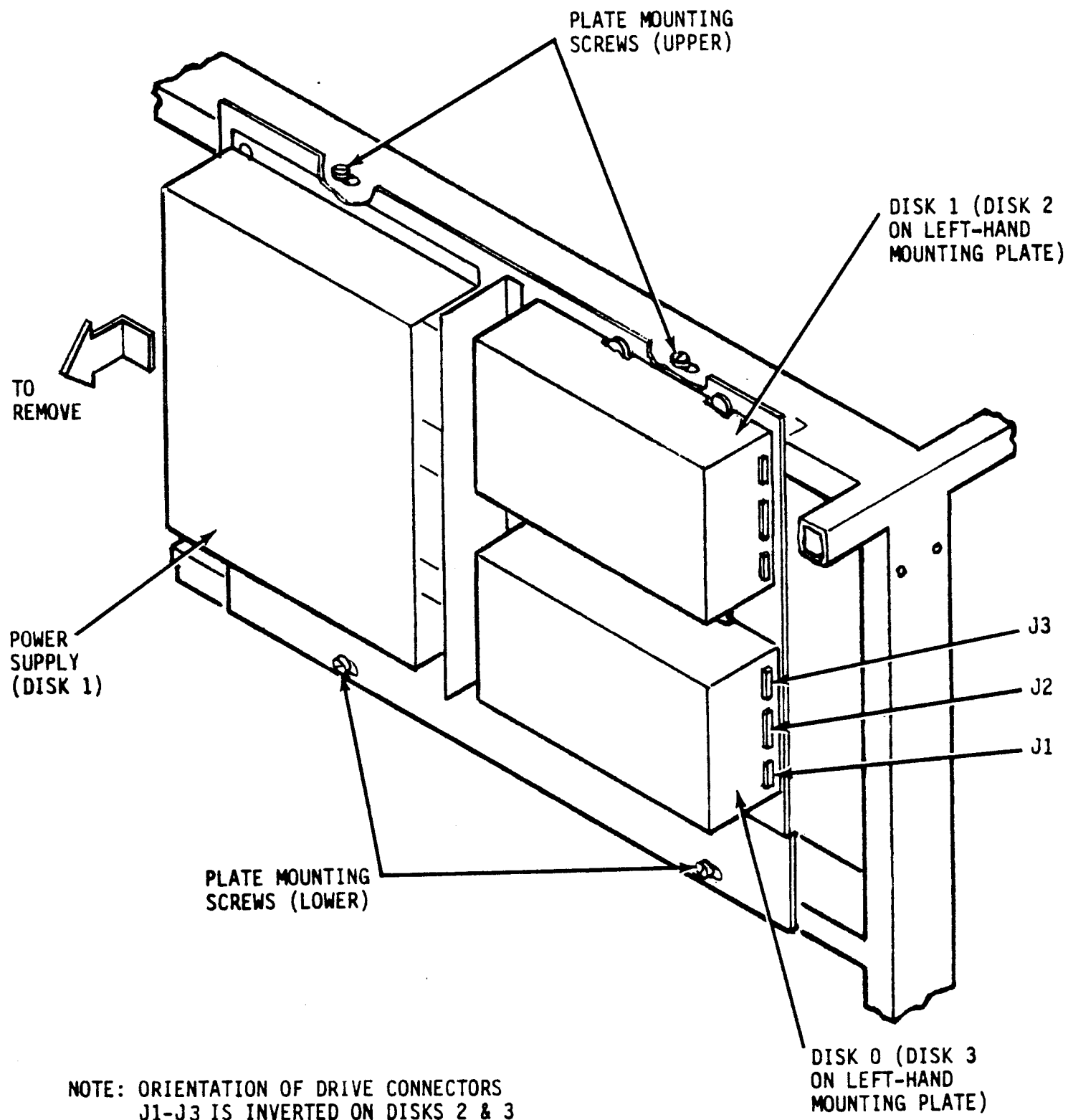
Figure 5-3. Disk Drive Removal/Replacement/Installation, Series 7000 Systems

3. Disconnect the daisychain bus cable from connector J1 and radial cables from connector J2 on Disk 0 and Disk 0. Identify cables for Disk 0.

4. Loosen the upper and lower plate-mounting screws with a 1/4-inch nut driver. Do NOT remove. The screw holes in the plate are slotted.

5. Grasp the plate firmly and slide it toward the rear of the unit.

6. Lift the plate out of the unit and lay it on a level, secure surface, drive side up. Be careful; the plate is heavy.

7. Carefully position the plate so that the disk drive to be removed extends over the edge of the level surface. This provides easy access for removal of the screws.

8. While holding the disk drive to be removed with your hand, remove the four screws and washers from the underside of the panel and the plastic spacers from the upper side of the panel at each of the four locations.

9 Lift the drive off the plate.

10. Before installing the replacement drive, observe the following:

   a. If replacing the only or last drive in a module, be sure that the terminator resistor pack is installed and that the address select jumper plug is installed on the correct pins for Drive Select 0, 1, 2, or 3 (see figure 2-7).

   b. If not replacing the last drive in a module, be sure that the terminator resistor pack is removed and that the address select jumper plug is installed on the correct pins for Drive Select 0, 1, or 2 (see figure 2-7).

11. Install the replacement drive by following steps 1 through 9 in reverse order. Insert the screw connected to the ground mount first.

5.4.3 Removal/Replacement of Disk 2 or Disk 3

Remove/replace Disk 2 or Disk 3 on left-hand mounting plate as follows:

1. To access the lower-left plate-mounting screw, remove the Magnetic Tape Cartridge Streamer (MTCS) drive as follows:

   a. Remove cartridge from the MTCS drive.

   b. Disconnect power cable from MTCS connector P2 and bus cable from MTCS connector P1 (see figure 5-4).

   c. Remove the four hex-head screws on the bottom of the MTCS using a 1/4-inch nut driver.

   d. Remove MTCS drive from Mainframe/Disk Module.

P2

P1

REMOVE 4 SCREWS TO REMOVE MTCS.
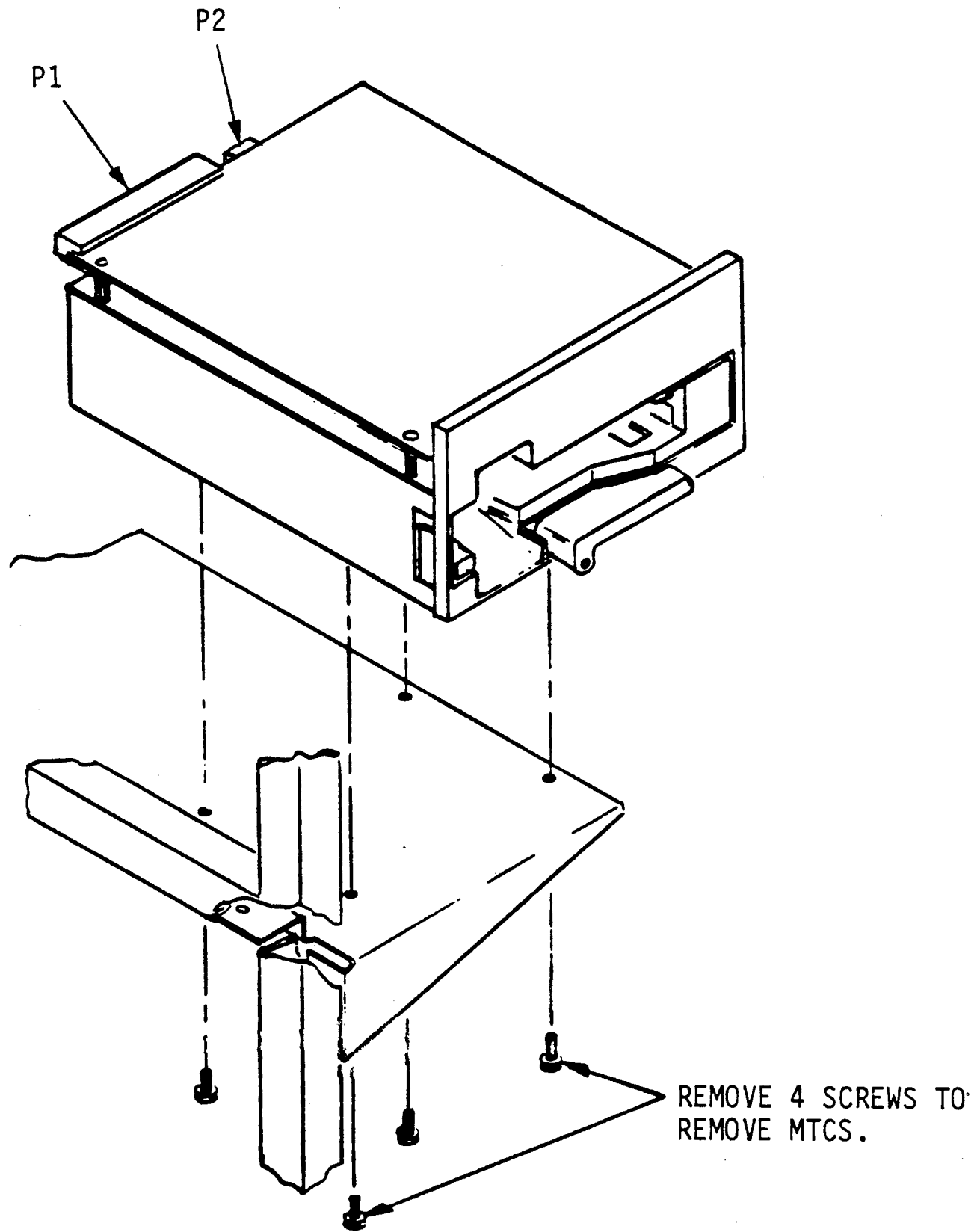
Figure 5-4. MTCS Removal/Replacement

2. Perform steps 1 through 11 of paragraph 5.4.2 to remove/replace Disk 2 or Disk 3.

3. Replace the MTCS as follows:

   a. Position MTCS drive and insert the four hex-head mpounting screws. Finger tighten the screws.

   b. Replace the front cover and bring the MTCS drive flush with the opening in the front cover. This can be accomplished by using one of three methods:

      ● When inserting the MTCS, slide it as far forward as the slotted screw holes allow. Replace the front cover and allow it to push the MTCS into the proper position. Tighten the screws under the MTCS by working through the open side panel; or by carefully removing the front panel, tightening the MTCS screws, and replacing the front panel.

      ● If the side panel(s) of the unit are removed, replace the front cover and carefully reach through the side opening and slide the drive forward until it is flush with the front cover. Tighten the screws under the MTCS by working through the open side panel. Replace the side panel(s).

      ● Replace the front cover and pull the MTCS forward by inserting your finger in the cartridge space and pulling the MTCS forward. Tighten the screws under the MTCS.

5.5 DISK DRIVE INSTALLATION - SERIES 7000 SYSTEMS

The Series 7000 Primary Mainframe and Add-on Disk Modules may receive from one to four disk drives. The disk drives in each Mainframe or Add-on Module are numbered in a logical sequence from (Disk) 0 to (Disk) 3. When installing an additional drive in the Mainframe or Add-on Module (i.e., the last drive in the sequence), be sure that the drive's terminator resistor pack is installed. The preceding drive must have its terminator removed. All drives added to a Mainframe or Add-on Module must have their address select jumper plug installed on the correct pins (i.e., for Drive Select 0, 1, 2, or 3).

Install a second, third, or fourth disk drive in the Series 7000 Primary Mainframe or Add-on Disk Module as follows:

1. Perform steps 1 thru 3 of paragraph 5.4.1.

2. If adding Disk 1, proceed as follows:

   a. Perform applicable procedures in steps 1 thru 7 of paragraph 5.4.2 to remove right-hand disk mounting plate.

   b. Remove screws that secure cover for Disk 1 Power Supply (see figure 5-3).

c. Install Power Supply P/N 400446-002 on mounting plate using hardware supplied.

d. Connect two-conductor ac power cable P/N 907747-001 to connector P3 on Power Supply.

e. Install address select jumper plug over correct pins on Disk Drive PCBA for Drive Select 1 (see figure 2-7).

f. If Disk 1 is to be last drive in sequence, be sure that terminator resistor pack is installed on Disk Drive PCBA.

g. Install drive on mounting plate (above Disk 0) using hardware supplied.

h. Connect hard-wired power cable from Disk 1 Power Supply to connector J3 on Disk 0 (see figure 5-3).

i. Install cover on Power Supply using screws removed in step 2b.

j. Remove Disk 0 from mounting plate as instructed in steps 8 and 9 of paragraph 5.4.2.

k. Remove terminator resistor pack from Disk 0 and reinstall drive on mounting plate.

l. Reinstall right-hand mounting plate within Mainframe or Add-on Module.

m. Connect two-conductor ac power cable (from Disk 1 Power Supply) to ACDU.

n. Attach connector PB on daisychain bus cable (existing cable) to connector J1 on Disk 0. Attach connector PC to connector J1 on Disk 1.

o. Attach radial cable from Micro-Peripheral Controller (MPC) PCBA, connector J1, to connector J2 on Disk 0. Attach radial cable from J2 on MPC PCBA to J2 on Disk 1.

3. Plug the Mainframe/Add-on Module power cable/s into the ac outlet.

4. Power-up the Series 7000 and load the operating system.

5. Refer to section 5 of the MAI BOSS/VS Utilities User Guide, M5102, for procedures on adding disks to the family of system drives.

6. If adding Disk 2 and/or Disk 3, proceed as follows:

a. Using supplied left-hand disk mounting plate, disk drive/s, power supply, cables, and attaching hardware, perform step 1 and steps 2c thru 2m for Disk 2 and/or Disk 3.

b. Attach connector PD on daisychain bus cable (existing cable) to
    connector J1 on Disk 2. Attach connector PE to connector J1 on
    Disk 3.

c. Attach radial cable from Micro-Peripheral Controller (MPC) PCBA,
    connector J3, to connector J2 on Disk 2. Attach radial cable from
    J4 on MPC PCBA to J2 on Disk 3.

d. Perform steps 3 thru 5.

5.6 REMOVAL/REPLACEMENT OF DISK DRIVE PCBA

Removal of the Disk Drive PCBA is accomplished with the Disk Drive removed from
the mounting plate. Refer to paragraph 5.4.2 or 5.4.3 for Disk Drive removal
procedures.

To remove the PCBA perform the following steps:

1. Remove the grounding lug J4 from the frame assembly.

2. Remove the three "E" clip retainers for the shock mounts.

3. Lift the frame off the drive. Use care not to damage the front panel
    LED cable and its connector.

2. Remove the PCBA.

To replace the Disk Drive PCBA, repeat the above steps in reverse order.

SECTION VI

ILLUSTRATED PARTS LISTS

6.1 INTRODUCTION

This section provides the parts list information for the Printed Circuit Board Assembly and the Disk Drive Mechanical Kit.

6.2 INDEX OF ASSEMBLIES

The following is an index of the assemblies covered in this section (the HDA is a sealed unit and not repairable):

ASSEMBLY	FIGURE	TABLE
Printed Circuit Board Assembly (P/N 59055)	6-1	6-1
Mechanical Kit (P/N 50461)	N/A	6-2
HDA (P/N 50454)	N/A	N/A
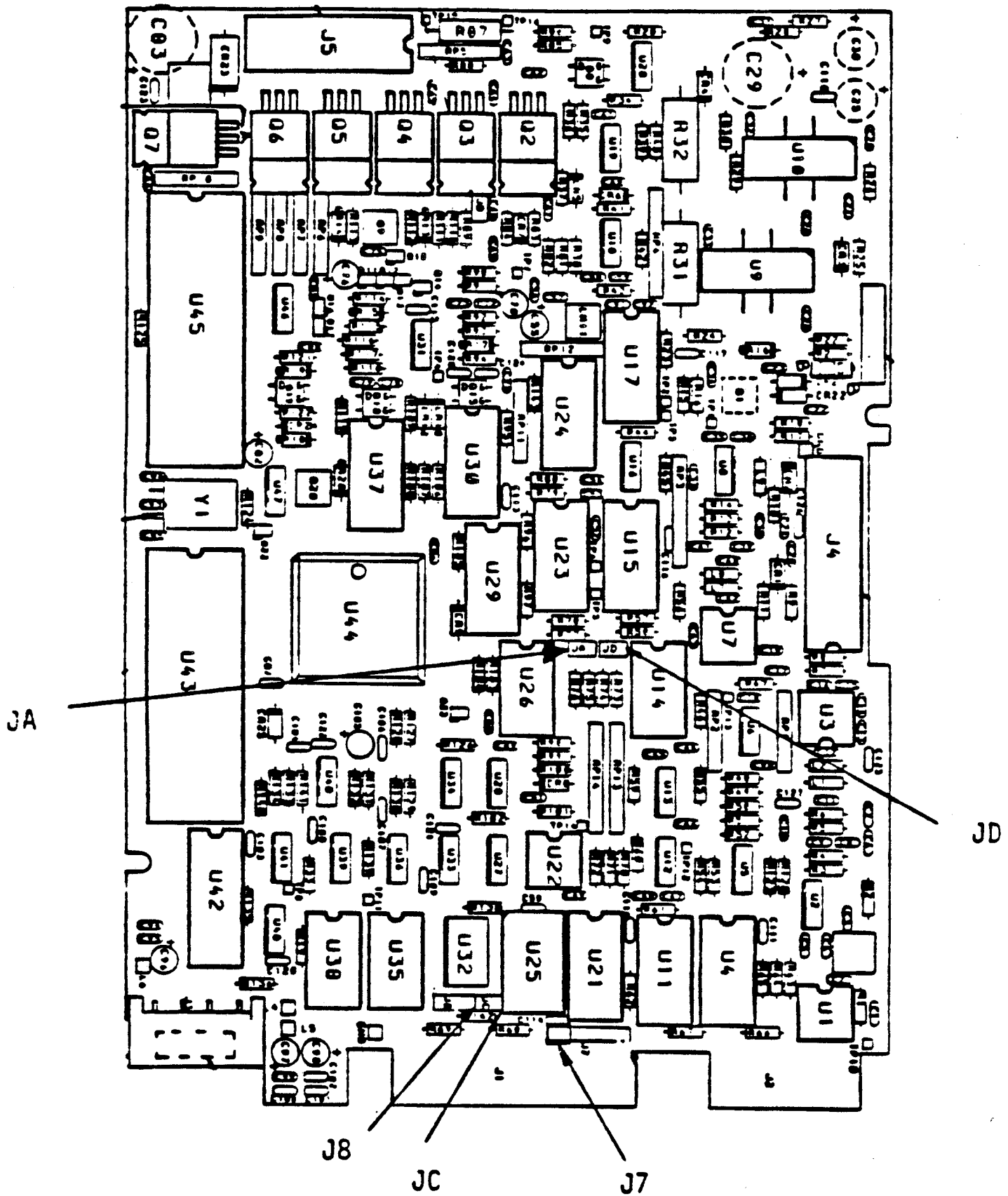
Figure 6-1. Printed Circuit Board Assembly (P/N 59055)

Table 6-1. Printed Circuit Board Assembly (P/N 59055)

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
30091	Adhesive, Tak Pack	
30104	Adhesive Accelerator	
30108	Shrink Tubing PVC 3/8 ID	
40109	Plug, Shorting	
40114	Pin, IC	
40119	Post, Feedthru	
47015	MCU, Z-8 4K, 12Mhz	U43
48010	Crystal, 12Mhz, HC-18	Y1
50487	Label, PCB Asm	
59056	Fabrication, PCB	
59058	Schematic, Control Module	

CAPACITORS

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
43000	Capac, 10.0PF, 5% (NPO), 50V	C1
43004	Capac, 22.0PF, 5% (NPO), 50V	C40, 84, 85
43006	Capac, 33.0PF, 5% (NPO), 50V	C11
43008	Capac, 47.0PF, 5% (NPO), 50V	C37
43010	Capac, 68.0PF, 5% (NPO), 50V	C128
43012	Capac, 100PF, 5% (NPO), 50V	C42, 88, 91
43014	Capac, 150PF, 5% (NPO), 50V	C12, 43
43018	Capac, 330PF, 5% (NPO), 50V	C44, 45, 46, 51, 52
43030	Capac, 3900pf, 5%, NPO 50V	C67, 68
43300	Capac, 0.01UF, +80/-20%, 50V	C6, 7, 13, 14, 17, 19, 22,
43301	Capac, 0.10UF, +80/-20%, 50V	C2, 3, 18, 23, 26, 34, 48, 49, 66, 71, 72, 73, 81, 86, 87, 89, 90, 93, 94, 100, 102, 103, 104, 107, 108, 109, 110, 111, 113, 116, 117, 118, 120, 121, 122, 123, 124, 125, 126, 127
43552	Capac, 10.0UF, 25V, Bulk	C55, 70, 76, 82, 96, 97, 98, 105
43560	Capac, 2200UF, 16V	C29, 83
43562	Capac, 220UF Elect, 16V Min	C25, 30
43600	Capac, 0.001UF, 10% X 7R, 50V	C20, 21, 24, 27, 50, 59, 62, 64, 65, 79, 99, 114
43608	Capac, 0.0047UF, 10% X 7R, 50V	C32, 33, 35, 36, 53, 54
43612	Capac, 0.01UF, 10% X 7R, 50V	C39, 41, 92, 106
43614	Capac, 0.015UF, 10% X 7R, 50V	C61, 69
43618	Capac, 0.033UF, 10% X 7R, 50V	C10
43624	Capac, 0.1UF, 10% (NPO), 50V	C4, 5, 8, 9, 15, 16, 28, 31, 47, 60, 63, 75, 78, 115

Table 6-1. Printed Circuit Board Assembly (P/N 59055) continued

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
	CONNECTORS	
40104	Conn, 28 Contact, Fem	J4
40120	Conn, 24 Contact, Fem	J5
40123	Conn 4 Contact, Fem	J3
	DIODES	
46001	Diodes Switching, 1N914	CR1, 2, 5, 6, 7, 8, 10, 12, 13, 15, 17, 18, 19, 20, 25
46002	Diodes Schottky, 1N6263	CR16
46004	Diodes, 1N4001, Pwr, 50V (DD-41)	CR3, 4, 14, 22
46005	Diodes, 80SQ030, Scottky Pwr	CR23
46007	Diodes, 1N5818	CR9, 21, 24
	INTEGRATED CIRCUITS	
44010	IC, 26LS31 QD, Hgh Spd Ln Drvr	U4
44011	IC, 26LS32 QD, Diff Ln Recv	U11
44051	SOIC14, 74LS00D QD, 2-In ND Gate	U33
44053	SOIC14, 74LS74AD, DL-D TP ET F-F	U41
44058	SOIC20, 74LS240D OCT INV BUF 3S	U32
44062	SOIC14, 74LS04D, Hex Inverter	U39
44067	SOIC14, 74LS02D, QD 2-in NOR GA	U36
44202	IC, QD 7438, 2-in NAND Buf (OC)	U35, 38
44203	IC, 7445 BCD, DECI/DECD DR (OC)	U29, 30
44251	SOIC14, 7406D, HX INV Buf/Dr (OC)	U27, 34, 46, 47
44300	IC, Quad, Ex-Dr ECL, 10107	U15
44301	IC, 10131 ECL Dual D F-F	U23
44302	IC, Triple Rec ECL, 10114	U17
45001	IC, LM318N, Hi Speed OP-AMP	U1
45003	IC, Ref 2.5V, LM336BZ-2.5	CR11
45005	IC, OP-AMP, LF356	U22
45007	IC, MC1350PIF AMP	U3, 7
45008	IC, DAC0832 88TuP, D-Buf D-A Con	U42
45009	IC, Volt Reg Low P. 8V, 78L08	Q1
45013	IC, LF347, WD BDWTH QD JFT OP-AM	U14
45014	IC, TBA810P, 7W Audio Amp	U9, 10
45052	SOIC14, LM324D, 6-P S-S OP-AMP	U6, 12, 18, 31
45054	SOIC14, LM339D, QD Volt Comparat	U5, 20, 40 48
45056	SOIC14, NE592D, Video Amplifier	U2, 8, 16
45060	SOIC14, HEF4066B, QDRUF Bilt Swt	U13, 19, 28
47011	IC, Z8-2K, MCU 8Mhz 40-Pin DIP	U45
47013	IC, Gate Array, Servo Control	U44

Table 6-1. Printed Circuit Board Assembly (P/N 59055) continued

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
	RESISTORS	
41001	Resis, 10.0 Ohms, 1%, 0.25W	R116
41009	Resis, 21.5 Ohms, 1%, 0.25W	R109
41025	Resis, 100.0 Ohms, 1%, 0.25W	R2, 43, 55, 59, 66, 76, 78
41027	Resis, 121.0 Ohms, 1%, 0.25W	R98
41028	Resis, 133.0 Ohms, 1%, 0.25W	R7, 8
41032	Resis, 196.0 Ohms, 1%, 0.25W	R9, 10, 103, 106
41033	Resis, 215.0 Ohms, 1%, 0.25W	R69
41035	Resis, 261.0 Ohms, 1%, 0.25W	R86
41037	Resis, 316.0 Ohms, 1%, 0.25W	R5, 6, 45, 68, 79, 80, 95,
41038	Resis, 348.0 Ohms, 1%, 0.25W	R99
41041	Resis, 464.0 Ohms, 1%, 0.25W	R23, 24, 96, 96, 124
41043	Resis, 562.0 Ohms, 1%, 0.25W	R11, 12, 13, 56
41044	Resis, 619.0 Ohms, 1%, 0.25W	R119
41046	Resis, 750.0 Ohms, 1%, 0.25W	R29
41047	Resis, 825.0 Ohms, 1%, 0.25W	R62
41049	Resis, 1K Ohm, 1%, 0.25W	R14, 15, 16, 19, 50, 51, 61, 64, 65, 83, 100, 105, 108, 117, 128, 135, 143
41052	Resis, 1.33K Ohms, 1%, 0.25W	R44
41056	Resis, 1.96K Ohms, 1%, 0.25W	R114
41061	Resis, 3.16K Ohms, 1%, 0.25W	R1, 3, 4, 49, 52, 63, 115
41062	Resis, 3.48K Ohms, 1%, 0.25W	R17, 18, 21, 22
41063	Resis, 3.83K Ohms, 1%, 0.25W	R118
41066	Resis, 5.11K Ohms, 1%, 0.25W	R92, 107
41067	Resis, 5.62K Ohms, 1%, 0.25W	R130
41068	Resis, 6.19K Ohms, 1%, 0.25W	R73, 93
41069	Resis, 6.81K Ohms, 1%, 0.25W	R48
41071	Resis, 8.25K Ohms, 1%, 0.25W	R38
41073	Resis, 10K Ohms, 1%, 0.25W	R20, 33, 42, 47, 58, 77, 85, 94, 101, 104, 111, 120, 123, 125, 138, 139, 142
41075	Resis, 12.1K Ohms, 1%, 0.25W	R60
41076	Resis, 16.2K Ohms, 1%, 0.25W	R131
41079	Resis, 17.8K Ohms, 1%, 0.25W	R54, 75
41080	Resis, 19.6K Ohms, 1%, 0.25W	R57
41084	Resis, 28.7 Ohms, 1%, 0.25W	R133, 134
41089	Resis, 46.4K Ohms, 1%, 0.25W	R81
41090	Resis, 51.1K Ohms, 1%, 0.25W	R88
41093	Resis, 68.1K Ohms, 1%, 0.25W	R129
41097	Resis, 100K Ohms, 1%, 0.25W	R132, 140
41100	Resis, 133K Ohms, 1%, 0.25W	R34, 90
41106	Resis, 237K Ohms, 1%, 0.25W	R110
41108	Resis, 287K Ohms, 1%, 0.25W	R122
41125	Resis, 76.8K Ohms, 1%, 0.25W	R76
41211	Resis, 27.4 Ohms, 1%, 0.25W	R25, 28

Table 6-1. Printed Circuit Board Assembly (P/N 59055) continued

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
	RESISTORS	
41260	Resis, 3.01K Ohms, 1%, 0.25W	R30
41284	Resis, 30.1K Ohms, 1%, 0.25W	R70, 71, 72, 136
41291	Resis, 59.0K Ohms, 1%, 0.25W	R36, 37
41292	Resis, 64.9K Ohms, 1%, 0.25W	R102, 126
41557	Resis, 18.2K Ohms, 1%, 0.25W	R74
41560	Resis, 4.99K Ohms, 1%, 0.25W	R35, 82
41563	Resis, 10.0M Ohms, 1%, 0.25W	R112
41564	Resis, 26.7K Ohms, 1%, 0.25W	R46
41566	Resis, 10.7K Ohms, 1%, 0.25W	R53
41572	Resis, 13.7K Ohms, 1%, 0.25W	R39, 40
41573	Resis, 57.6K Ohms, 1%, 0.25W	R89
41574	Resis, 143K Ohms, 1%, 0.25W	R91
41575	Resis, 19.1K Ohms, 1%, 0.25W	R84
42000	Resis, 0.1 Ohms, 3%, 2W	R87
42007	Resis, 1.00 Ohm, 5%, 0.25W	R26, 27
42010	Resis, 0.5 Ohm, 1%, 1W	R31, 32
42016	Resis, 1.00M Ohm, 5%, 0.25W	R113, 141
42045	Resis, 309K Ohms, 5%, 0.25W	R41
42046	Resis, 200 Ohms, 5%, 0.50W	R121
42100	Resis, DIP TTL-ECL Xlator Network	U21
42101	Resis, DIP 14-Pin, 220/330	U25
42102	Resis, Network, 470 Ohms, DIP	U24
42106	Resis, SIP, 1.0K, 6-Pin Ind.	RP5
42109	Resis, SIP, 10K, 6-Pin IND	RP1, 2, 7, 12
42111	Resis, SIP, 68K, 6-Pin IND	RP8
42117	Resis, SIP, 680, 6-Pin COM	RP11
42121	Resis, SIP, 10K, 6-Pin COM	RP6, 9, 10
42131	Resis, SIP, 2.2K, 8-Pin COM	RP14
42152	Resis Netw, 180 Ohms, SIP, 8-Pin-4R	RP3
42157	Resis, SIP, 10K, 2%, 8-Pin IND	RP4, 13
	TRANSISTORS	
46102	Tran, 2N3906	Q20
46103	Tran, Quad 2NPN/2PNP 6700	U26, 37
46107	Tran, IRFD123 N Ch Fet 4-Pin DIP	Q8, 18
46108	Tran, IRFD9123 P Ch Fet 4-Pin DIP	Q15, 19
46110	Tran, PN4393, N-CH JFET, TO-92	Q9
46111	Tran, IRF521, N-CH HEXFET TD220	Q5, 6, 7
46112	Tran, IRF9521, P-CH HEXFET, TO220	Q2, 3, 4
46151	Tran, 2N3904, NPN SOT-23	Q10, 22
46152	Tran, 2N3906, PNP SOT-23	Q14, 23
46153	Tran, SOT-23, NPN 2222A	Q11, 12, 13, 16, 17

Table 6-2. Mechanical Kit (P/N 50461)

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
	RESISTORS	
41266	Resis, 5.36K Ohms, 1%, 0.25W	R2
41267	Resis, 5.90K Ohms, 1%, 0.25W	R2
41268	Resis, 6.49K Ohms, 1%, 0.25W	R2
41269	Resis, 7.15K Ohms, 1%, 0.25W	R2
41279	Resis, 18.7K Ohms, 1%, 0.25W	R1
41280	Resis, 20.5K Ohms, 1%, 0.25W	R1
41281	Resis, 22.6K Ohms, 1%, 0.25W	R1
41282	Resis, 24.9K Ohms, 1%, 0.25W	R1
41283	Resis, 27.4K Ohms, 1%, 0.25W	R1
41284	Resis, 30.1K Ohms, 1%, 0.25W	R1
41285	Resis, 33.2K Ohms, 1%, 0.25W	R1
41555	Resis, 17.4K Ohms, 1%, 0.25W	R1
41556	Resis, 22.1K Ohms, 1%, 0.25W	R1
41557	Resis, 18.2K Ohms, 1%, 0.25W	R1
41558	Resis, 20.0K Ohms, 1%, 0.25W	R1
41560	Resis, 4.99K Ohms, 1%, 0.25W	R2
41575	Resis, 19.1K Ohms, 1%, 0.25W	R1
41576	Resis, 6.34K Ohms, 1%, 0.25W	R2
41577	Resis, 6.65K Ohms, 1%, 0.25W	R2
41578	Resis, 6.98K Ohms, 1%, 0.25W	R2
	MISCELLANEOUS	
30033	SCR 4-40 X 0.25 PAN PHIL	
30073	E-Ring	
30078	Washer, Lock Split #6 Set	
30088	Thread Locking Compound	
30110	Screw, Socket Head, 6-32 X 0.18	
30144	4-40 X 3/16 Flthd Rlvd Phillips	
30147	Washer, Flt Sm Pattern	
30148	Washer, Lock Ext Tooth	
40106	Ground Lug	
50091	ASM Face Plate	
50284	Label Warranty	
50288	Washer	
50458	ASM Chassis (SC2)	
50463	Label, Ser No.	
50468	PCB Insulator	
50475	Disk Drive ASM-Tab	

SECTION VII

SCHEMATICS

7.1 INTRODUCTION

The schematic diagrams for the 5-1/4 Inch Fixed Media Disk Drive are located in figure 7-1.

Figure 7-1. PCBA Schematic Diagram (sheet 1 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 2 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 3 of 10)
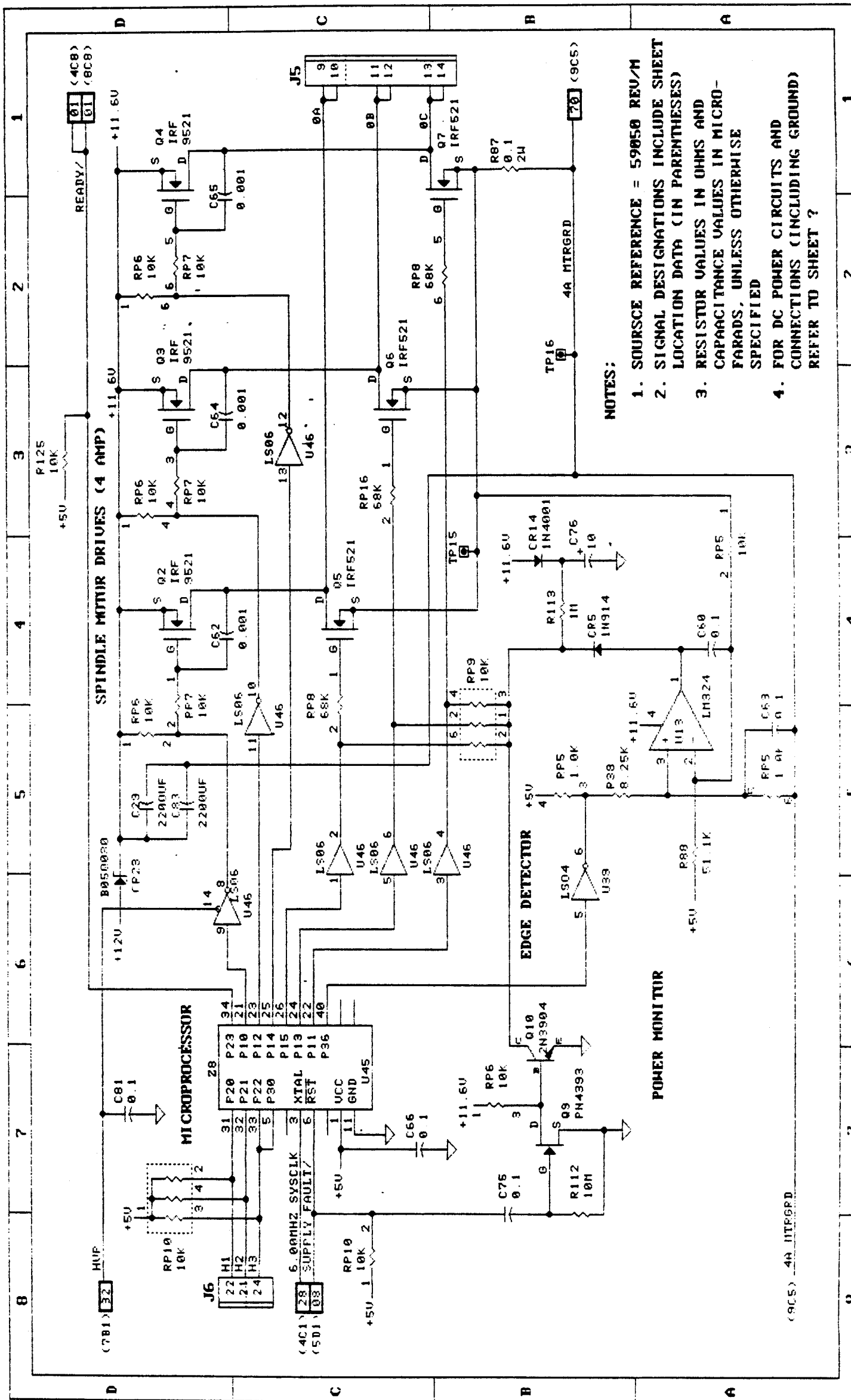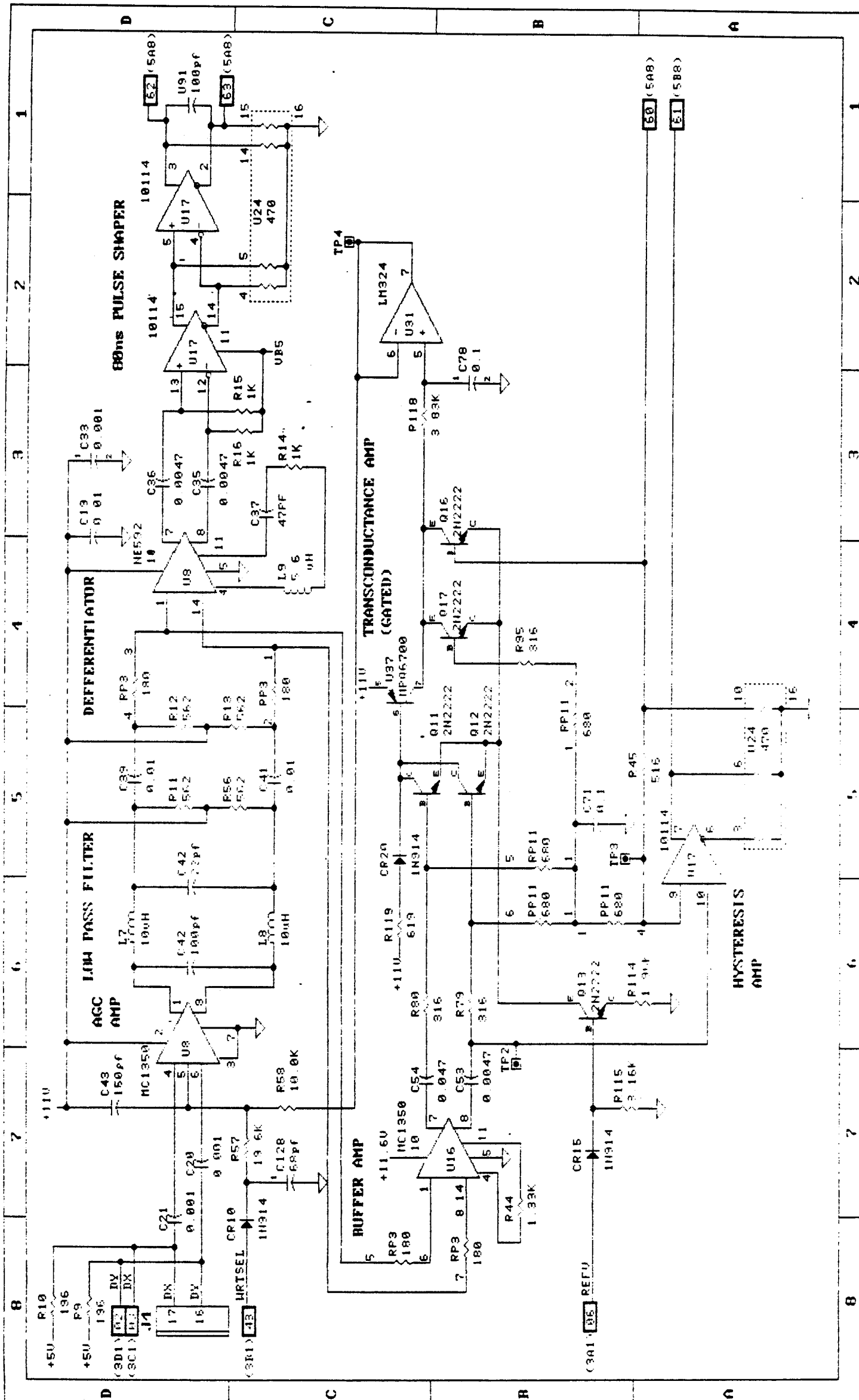Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 4 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 5 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 6 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 7 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 8 of 10)
Z8 Microprocessor Circuits

Figure 7-1. PCBA Schematic Diagram (sheet 9 of 10)
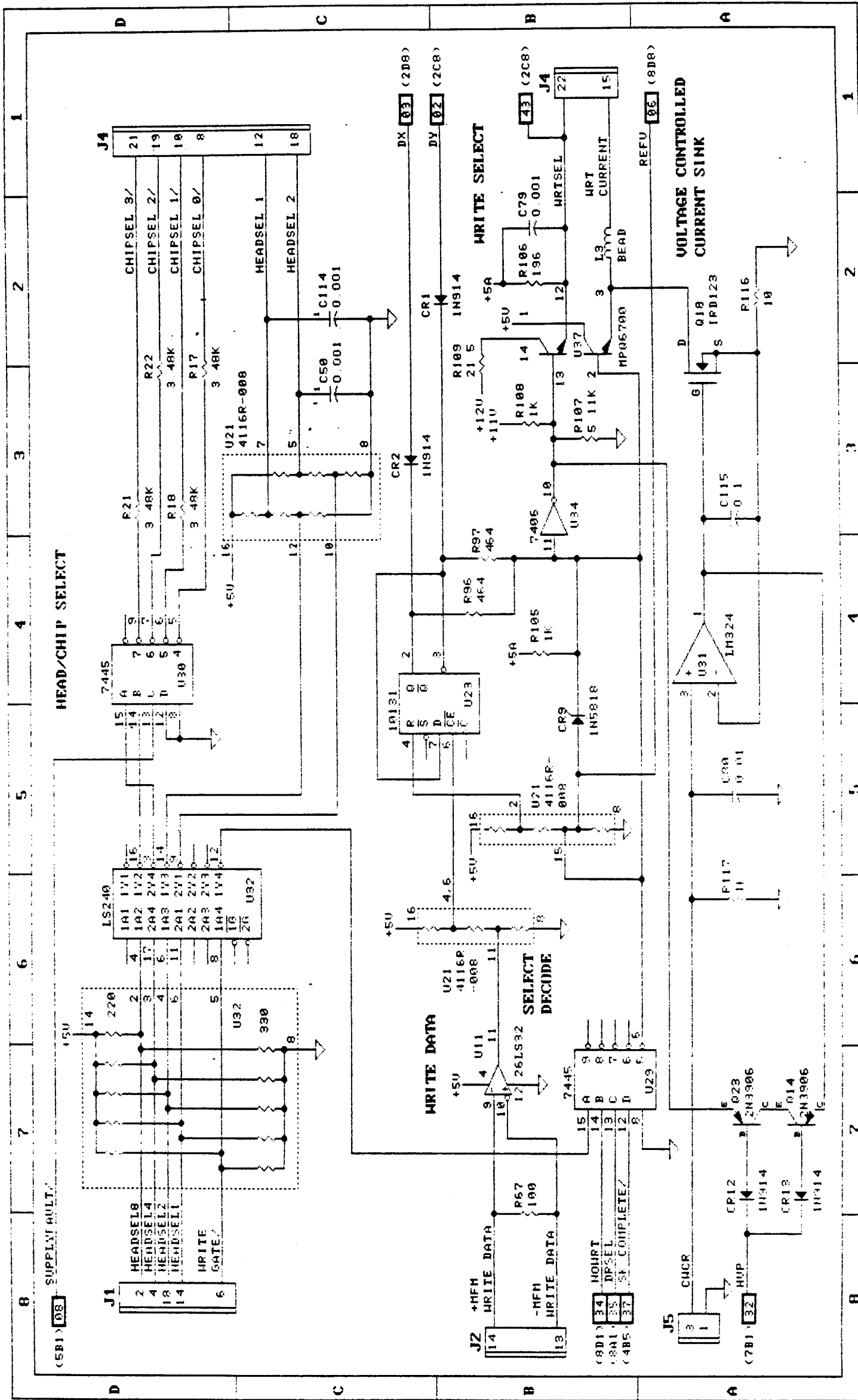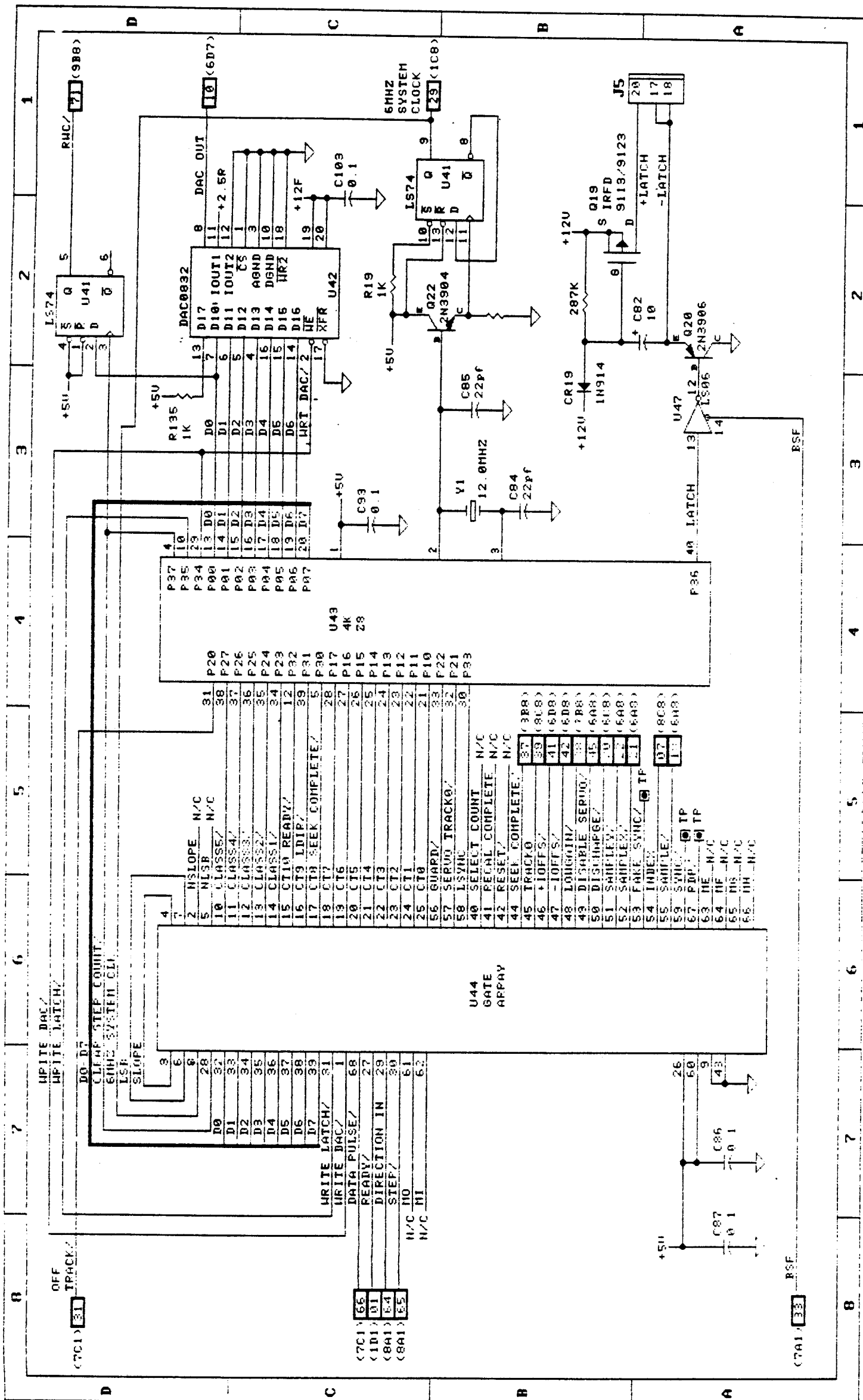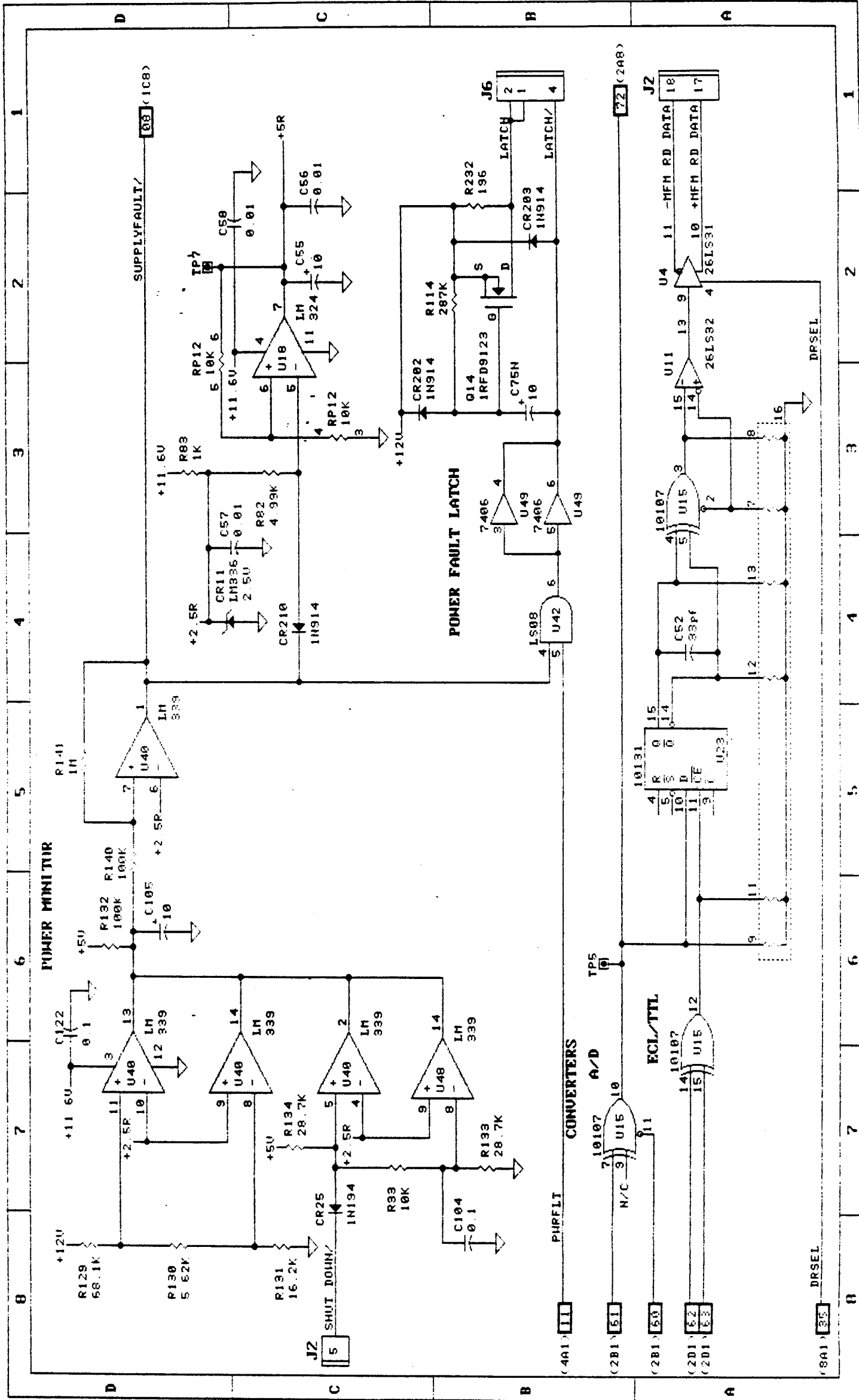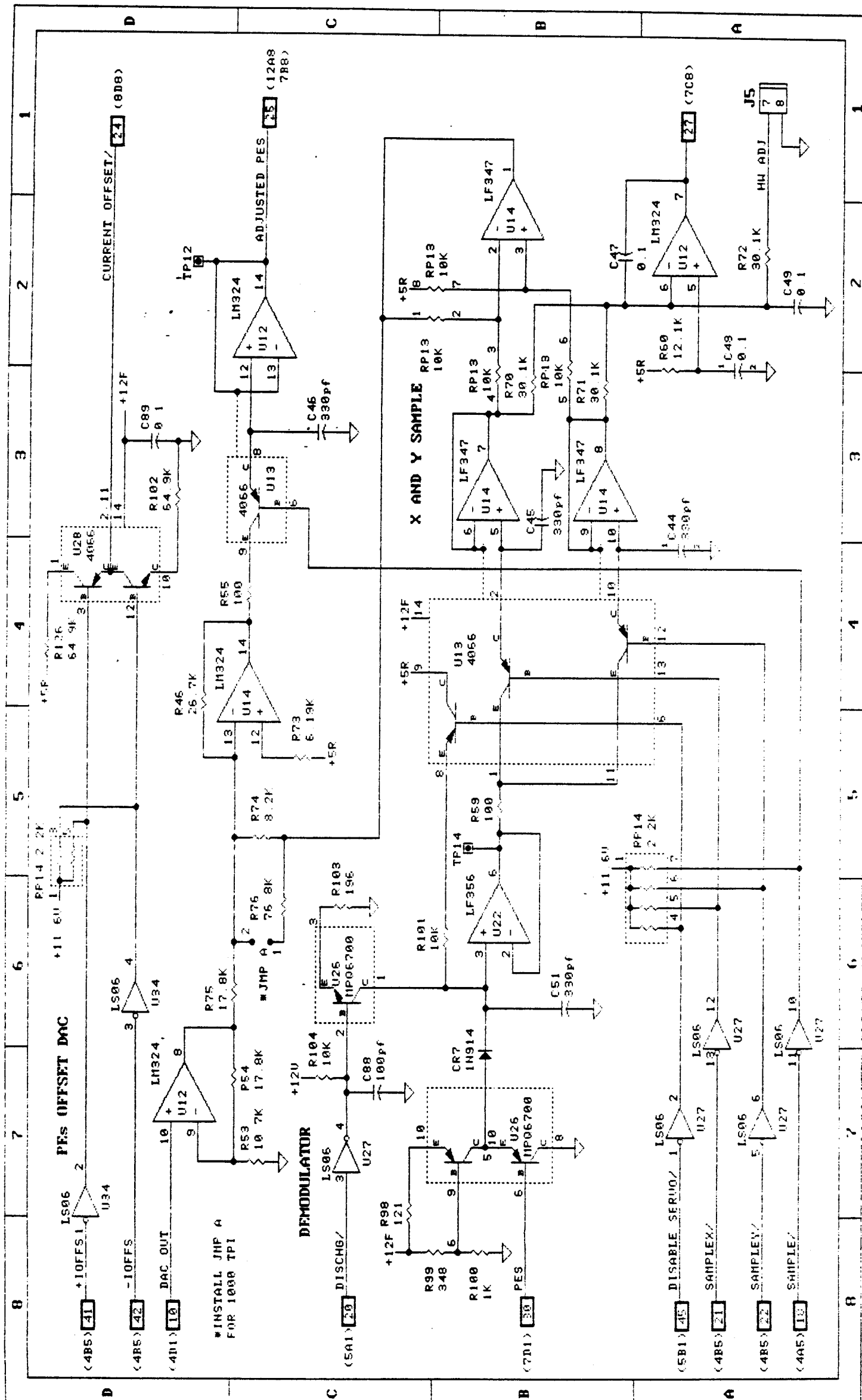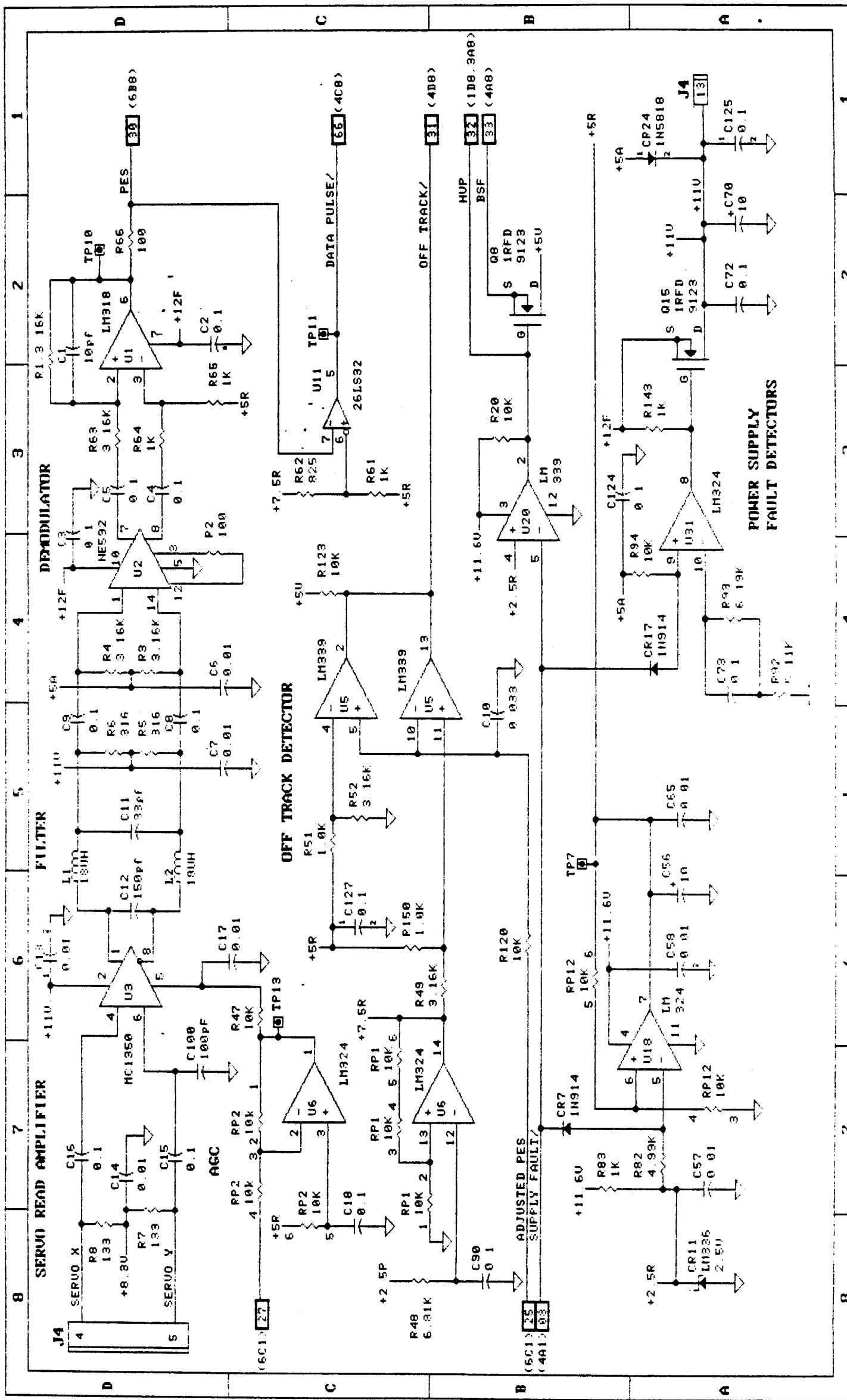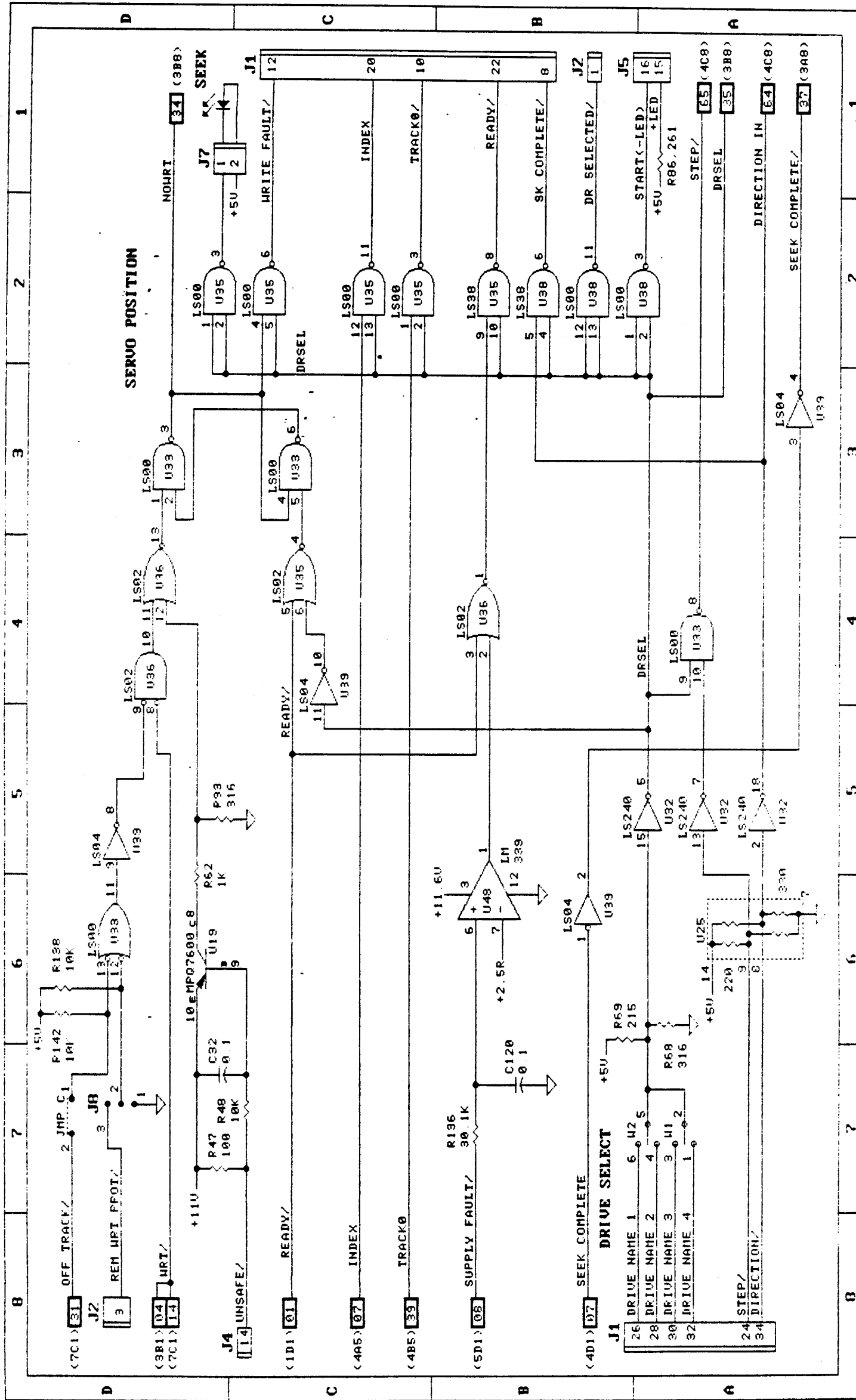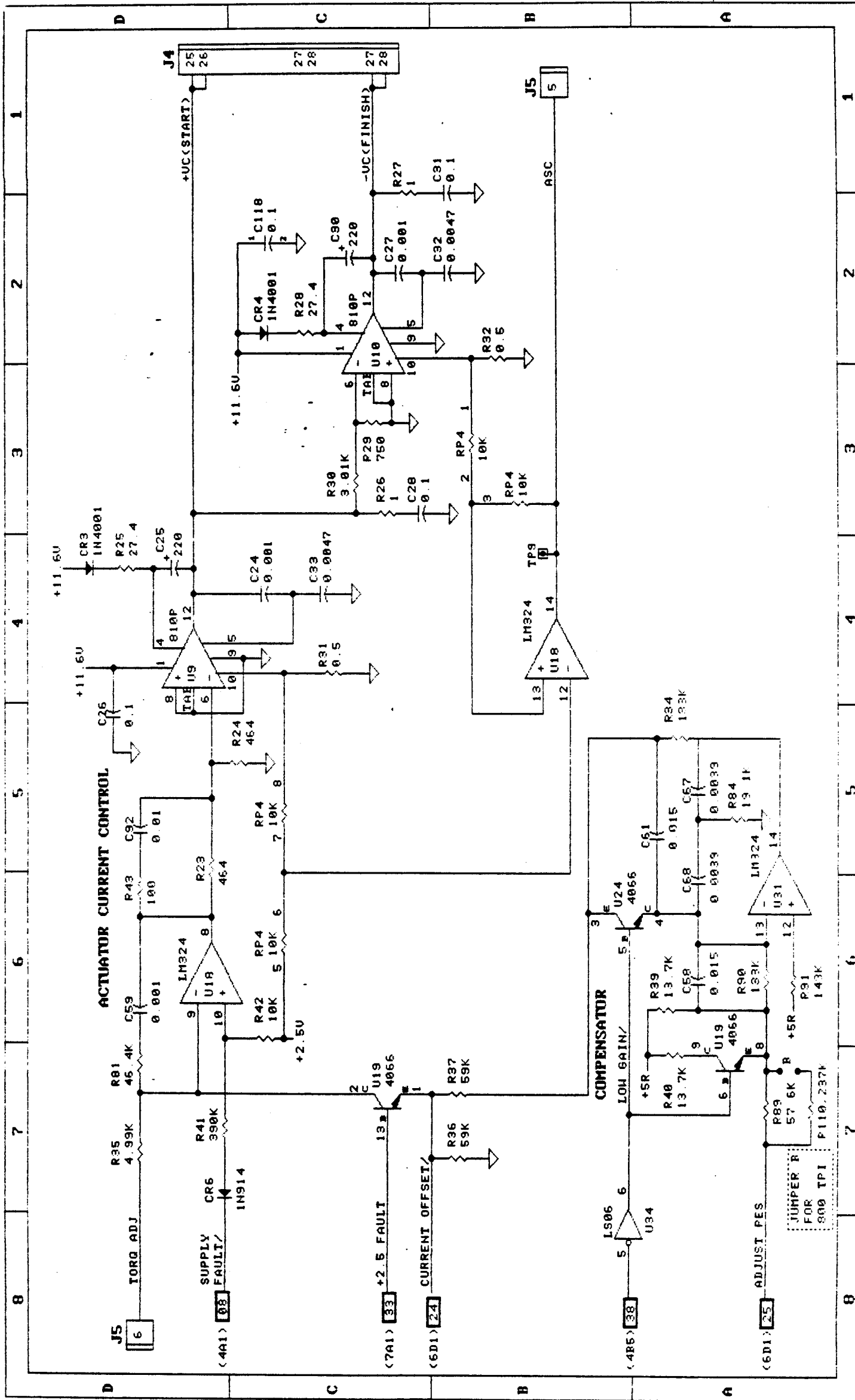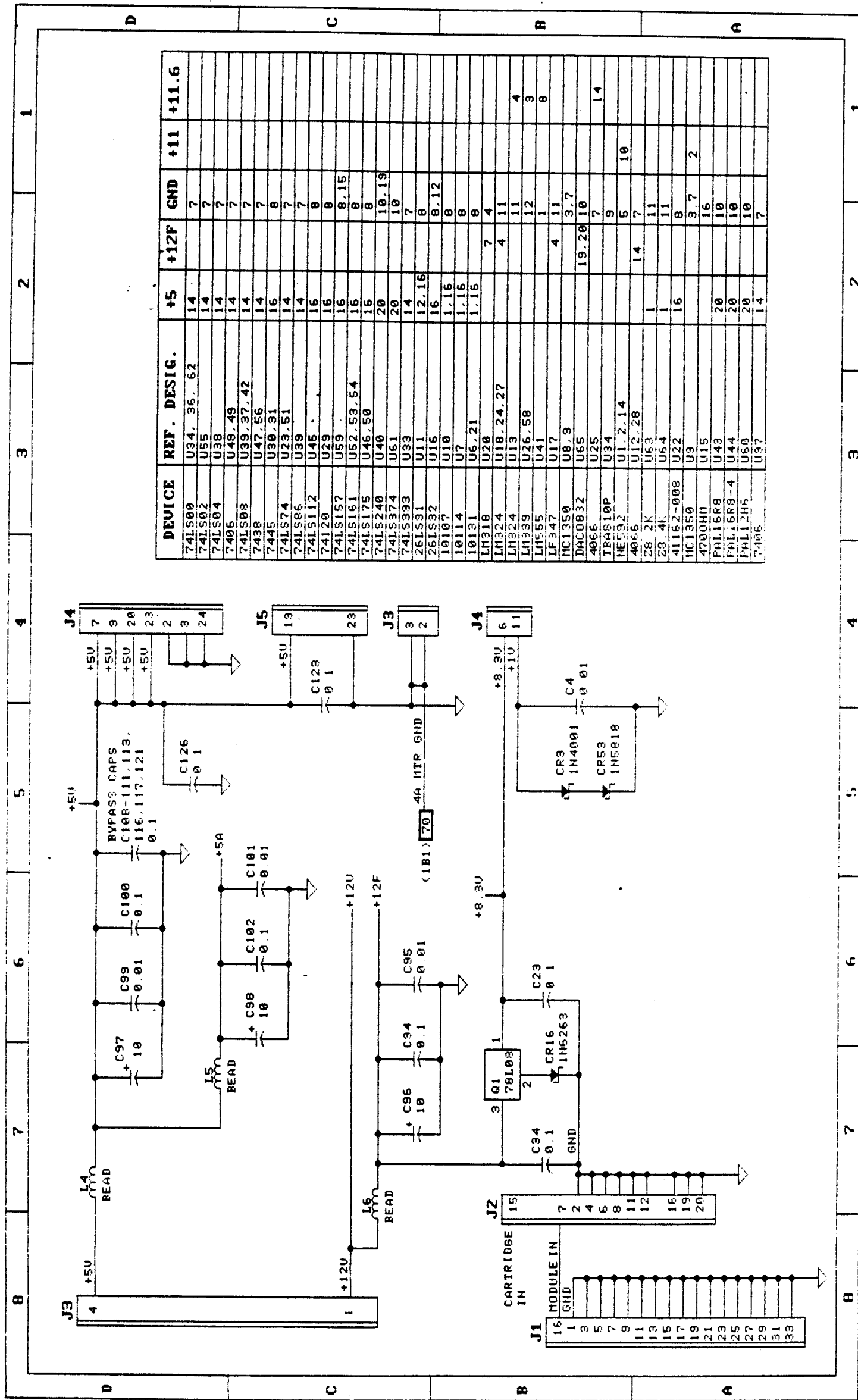Z8 Microprocessor Circuits

DEVICE	REF. DESIG.	+5	+12F	GND	+11	+11.6
74LS00	U34, 36, 62	14		7		
74LS02	U55	14		7		
74LS04	U38	14		7		
7406	U48, 49	14		7		
74LS08	U39, 37, 42	14		7		
7438	U47, 56	14		8		
7445	U30, 31	16		8		
74LS74	U23, 51	14		7		
74LS86	U39	14		7		
74LS112	U45	16		8		
74120	U29	16		8		
74LS157	U59	16		8, 15		
74LS161	U52, 53, 54	16		8		
74LS175	U46, 50	16		8		
74LS240	U40	20		10,19		
74LS374	U61	20		10		
74LS393	U33	14		7		
26LS31	U11	16		8		
26LS32	U16	12,16		8,12		
10107	U10	1,16		8		
10114	U7	1,16		8		
10131	U6, 21	1,16		8		
LM318	U20		7	4		4
LM324	U18, 24, 27		4	11		3
LM324	U13		4	11		8
LM339	U26, 58			12		
LM555	U41		1	1		14
LF347	U17		4	11		
MC1350	U8, 9			3, 7		
DAC0832	U65	16	19,20	10	10	
4066	U25			7		
TBA810P	U34			9		
NE592	U1, 2, 14		14	5	2	
4066	U3			7		
28.2K	U63	1		11		
23.4K	U64	1		11		
41162-008	U22	16		8		
MC1350	U3			3, 7		
4700HH1	U15	20		16		
74LS6R8	U43	20		10		
74LS6R8-4	U44	20		10		
74LS2H6	U50			10		
7406	U37	14		7		

Figure 7-1. PCBA Schematic Diagram (sheet 10 of 10)
Z8 Microprocessor Circuits