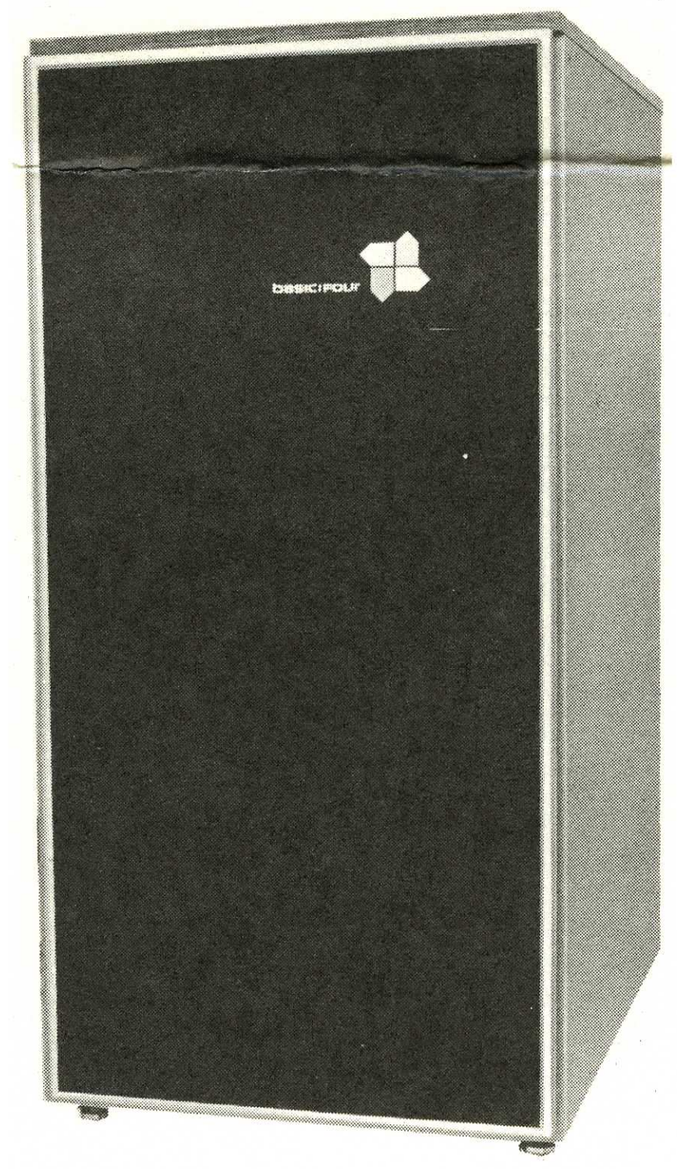
SERVICE MANUAL

for the

Disc Storage Unit

and

Controller



basic / four corporation ®

SM 2020

SERVICE MANUAL
for
DISC STORAGE UNIT

November 1, 1974

basic / four corporation
A Subsidiary of Management Assistance Inc. (MAI)
1335 South Claudina Street, Anaheim, California 92805

Printed in U.S.A.

PROPRIETARY INFORMATION

List of Effective Pages

Page	Revision Date
1-1 thru 1-15	Original
2-1 thru 2-2	Original
3-1 thru 3-73	Original
4-1 thru 4-45	Original

TABLE OF CONTENTS

SECTION 3. MAINTENANCE (continued)

SECTION 4. PARTS LISTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (continued)

Section 1

GENERAL DESCRIPTION

1.1 SCOPE

This manual contains the general description, operation, and maintenance data for the Models 2115-100, 2215-100, 2215-200, and 2315-200 Disc Storage Units, manufactured by Basic/Four Corporation, 18552 MacArthur Boulevard, Santa Ana, California 92707. The Disc Storage Unit is an integral part of the BASIC/FOUR® data processing systems. Control of the Disc Storage Unit by the Central Processing Unit (CPU) is effected through the DMA/Disc Controller, Part Number 900280, described in TM 2002 and LD 2002. Figure 1-1 shows the Disc Storage Unit before mounting in either a CPU cabinet or a Disc cabinet.

TO BE SUPPLIED

Figure 1-1. Disc Storage Unit

Section 1, the general description, includes both physical and functional descriptions of the disc storage units as well as a brief description of disc organization as a memory device. Section 2 contains descriptions of control functions and indicator significance. Section 3 contains a detailed functional description of the disc drive units; preventive maintenance, cleaning, removal, replacement, and alignment procedures followed by functional block and flow diagrams. The functional block and flow diagrams are designed to provide all the information normally needed to isolate a malfunction to a replaceable assembly. At the end of Section 3 is a troubleshooting flow diagram outlining logical steps a repairman may use to isolate the source of a trouble to a replaceable assembly. Section 4 is an illustrated parts list.

1.2 PURPOSE

Each Disc Storage Unit (also referred to as disc drive or drive) is used to record (write) encoded serial data from the DMA/Disc Controller (controller) within a discrete area on the disc specified by the controller. Then, on command by the controller, retrieve that stored data (read) and send it to the controller. Each disc drive contains a permanently mounted (fixed) disc and, when operating, a removable disc cartridge (removable disc). Both discs are rotated on the same shaft at 1500 rpm during operation. Each removable disc cartridge must be initialized for use before data is recorded (stored) on it. Thereafter the data may be retrieved by any other disc drive with the same model number.

The Disc Storage Unit model number indicates the density of storage available on a disc. Table 1-1 lists the different model numbers and contrasts their storage capacity. It is possible to have up to four disc drives in a Data Processing System. Data bytes are transferred directly between the CPU core memory and either disc in any drive within a system through the controller so it is possible that a Data Processing System may have nearly 34 million bytes of available memory.

Table 1-1. Storage Capacity of Disc Storage Units

Series Number	Number of	Per Sector	Per Track	Per Cylinder	Per Disc	Per Drive	Maximum System
2115	Data Bytes	110	5,280	10,560	1,056,000	2,112,000	8,448,000
2115	Total Bytes	150	7,200	14,440	1,440,000	2,880,000	11,520,000
2215	Data Bytes	110	5,280	10,560	2,112,000	4,224,000	16,896,000
2215	Total Bytes	150	7,200	14,440	2,880,000	5,760,000	23,040,000
2315	Data Bytes	110	5,280	10,560	4,224,000	8,448,000	33,792,000
2315	Total Bytes	150	7,200	14,440	5,760,000	11,520,000	46,080,000

1.3 PHYSICAL DESCRIPTION

The dimensions of the drive are listed in table 1-2. The front door of the drive is pulled forward and down to permit insertion and removal of disc pack cartridges. Disc storage Unit 0 is mounted in the CPU cabinet. When a system includes two, three, or four drives, the additional drives are mounted in a Disc Cabinet and designated as Disc Storage Units 1, 2, and 3. Two cables between the CPU Cabinet and the Disc Cabinet connect the drives in a daisy-chain fashion. The disc drive components are mounted on a preformed aluminum chassis. Mounted lengthwise in the center of the chassis is a solid anodized aluminum base bar which reinforces the chassis. Mounted on the solid base bar are the disc spindle, rotary actuator motor, and optical transducer. The power supply card and components of the air filtration system are mounted on the bottom of the chassis. All of the drive control and servo electronics are mounted at the top rear of the chassis. Covers completely enclose all of the drive components to protect them against contamination and physical damage.

The drive consists of an optically controlled closed-loop servo mechanism carrying four read/write heads (one per disc surface), a spin motor which rotates both discs at 1500 RPM, and the read/write electronics. Both discs are serviced by the same moving servo mechanism. When commanded by the controller, the servo mechanism moves the four read/write heads over the same area (cylinder) of both rotating discs.

The servo mechanism consists of a head carriage whose linear motion is provided by a rotary actuator and controlled by closed-loop servo system with an optical position sensing device in the feedback loop. During a write operation, the heads are positioned over the desired track, the write electronics receive serial data from the controller and generate write current transitions in the read/write head using the double-frequency recording method. Later, during a read operation after the heads are positioned over the desired track, the read electronics amplify, detect, and filter the flux transitions from the disc and generate serial read data and read data clocks which are sent back to the controller for processing.

Figure 1-2 shows the locations of drive subassemblies on top of the chassis. Figure 1-3 shows the drive components mounted on the bottom of the chassis. Table 1-3 lists and describes components of all three Models of the disc drive. Table 1-2 provides a source of quick reference data for the drive.

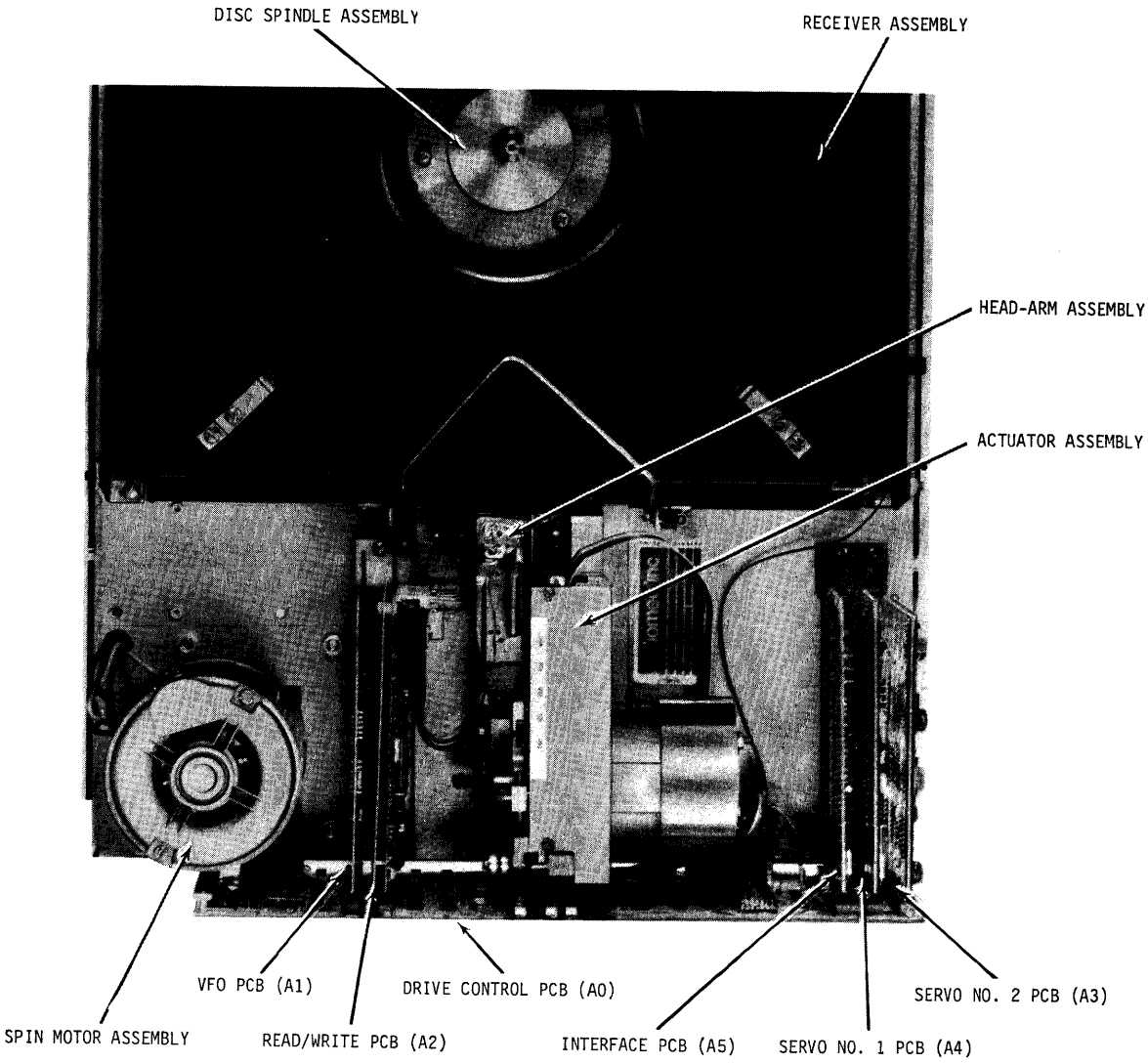


Figure 1-2. Cartridge Receiver Area with Component Cover Removed

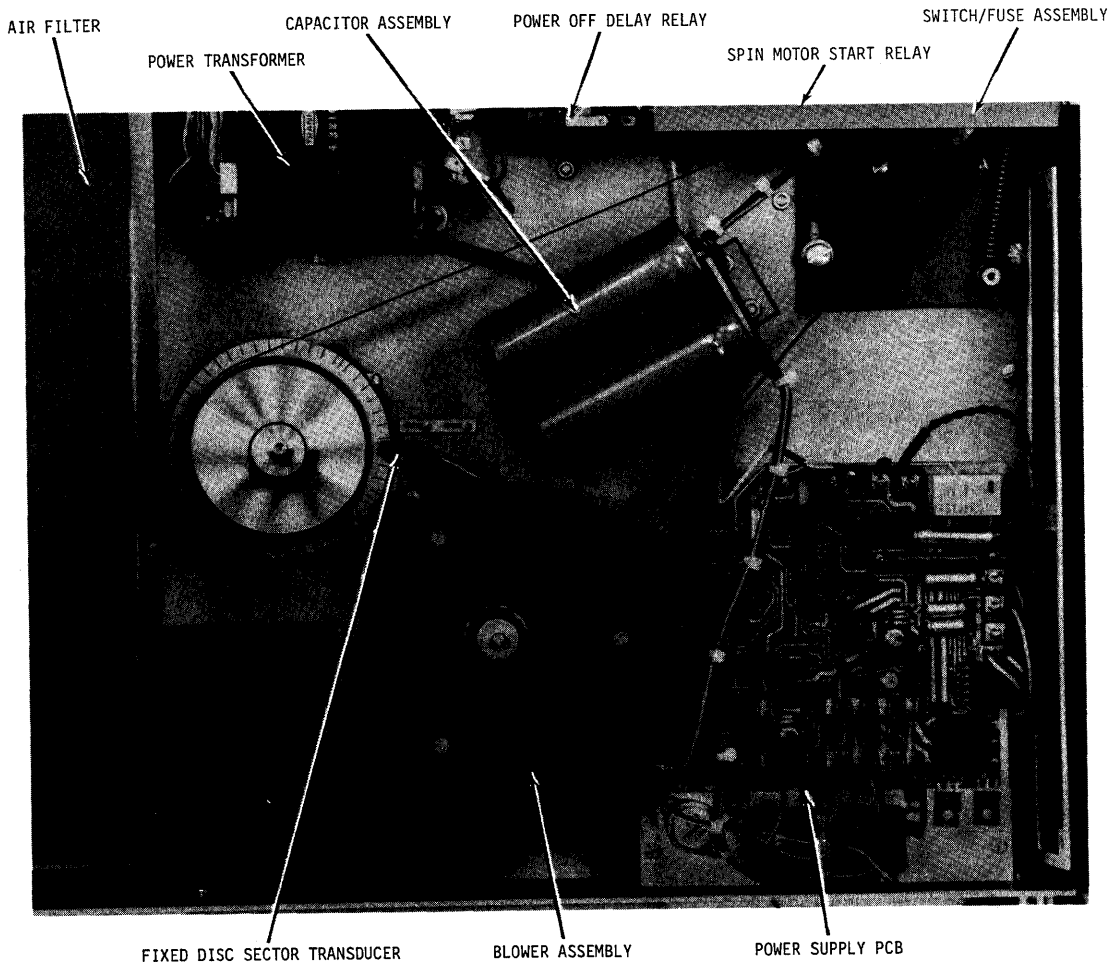


Figure 1-3. Disc Drive Bottom View

Table 1-2. Specifications

Parameter	Characteristics
ACCESS TIMES (Including Head Settling)	
track-to-track:	20 milliseconds
average random move:	35 milliseconds
average rotation delay:	12.5 milliseconds
RECORDING TECHNOLOGY	
bit density:	2200 bits/inch (innermost track)
recording format:	double frequency
data transfer rate:	1.56 M bits/seconds (nominal)
clock frequency:	3.12 M Hz/second (nominal)
bit cell time:	640 nanoseconds (nominal)
disc rotation speed:	1,500 rpm
disc diameter:	14 inch
number of heads:	4
DRIVE POWER REQUIREMENTS	
AC:	115 volts ±10%, 60 Hz ±1% 220 volts ±10%, 50 Hz ±1% 200 Watts Continuous
ACCESS MECHANISM	
Actuator:	electromagnetic rotary motor
Positioner:	optical
ENVIRONMENT	
Temperature	
operating:	+10°C to +30°C (50°F to 85°F)
non-operating/power off:	-15°C to +71°C (5°F to 160°F)
Humidity (without condensation)	
operating:	8% to 80%
non-operating/power off:	0% to 95%
cooling:	forced room air, ambient at installed location
air circulation:	40 CFM (ducted)
altitude:	10,000 feet (maximum)
GENERAL	
dimensions:	Height 8.72 inches Width 19.0 inches Depth 24.75 inches Weight 65 pounds

Table 1-3. Component Description

Name	Description	Part Number
Switch Panel	The switch panel, located on the front of the bezel, mounts two rocker switches and three indicators. The function of each is described in Section 2.	74210
Spin Motor Assembly	The spin motor drives the blower for the air filtration/ circulation system and the spindle supporting the discs by a single continuous belt. The spin motor assembly consists of a 50/60 Hz ac motor and an attached pulley and is attached to a self-adjusting, spring-loaded bracket mounted to the bottom of the drive chassis.	73401
Actuator Assembly	The actuator assembly moves the carriage assembly which supports the read/write heads and shutter assembly. The actuator is a rotary motor. The shutter is a glass mask that passes between a LED light source and photo electric cell of the optical transducer assembly.	73020
Optical Positioning Transducer Assembly	The optical positioning transducer assembly detects carriage position, velocity, direction, and carriage home position. This assembly consists of a LED and mask mounted on a block and separated from a PC board upon which is mounted three photo diodes and three operational amplifiers.	73010
Drive Control Logic (A0)	This circuit card contains the circuits that monitor drive status, compare carriage position to the controller-commanded track number, decode head selection signals from the controller, and control read/write operations according to controller commands and drive status. It is mounted at the rear of the drive chassis and contains the interface connectors for the controller and other drive units, the mounting connectors for five other printed circuit cards, and connectors for chassis-mounted assemblies.	73720
Interface (A5)	This circuit card interfaces the controller to the drive. It contains the logic to generate the sector and index pulses for both the removable disc and the fixed disc and the logic to determine if the disc rotation has stopped or if the disc is rotating at greater than 70% rated speed.	73540
Servo No. 1 (A4)	This circuit card contains the analog circuits that processes the optic transducer outputs to determine carriage position, motion and direction, track 0, and home position detection, and a linear tachometer signal. It also contains the mixer amplifier for the primary positioning signal.	73590

Table 1-3. Component Description (continued)

Name	Description	Part Number
Servo No. 2 (A3)	This circuit card contains circuits which convert digital positioning data into an analog voltage, an electronic tachometer, mixing circuits for the final positioning signal, and the preamp drivers that control both forward and reverse direction of the rotary actuator.	73480
Read/Write (A3)	This circuit card contains the write amplifier, write safety circuits, the head selection diode matrix; the read signal conditioning and zero crossing detector circuits that convert signals read from the disc to RAW DATA.	73460
VFO (Variable Frequency Oscillator) (A1)	This circuit card contains the circuits that convert the RAW DATA read from the disc into READ DATA and READ CLOCK signals.	73560
Removable Disc Sector Transducer Assembly	The removable disc sector transducer detects sector slots in the rotating skirt of the removable disc. It is attached to the front of the fixed disc cover assembly near the removable disc skirt.	73190
Fixed Disc Sector Transducer Assembly	The fixed disc sector transducer detects sector slots in the rotating sector ring. This assembly is attached to the bottom of the drive chassis near the sector ring of the fixed disc.	73606
Power Supply	This circuit card contains the fuses and circuits that provide the ±15-volt regulated, and the +5-volt regulated power used throughout the drive. It also contains the head unload relay which causes the heads to retract from the discs during abnormal power conditions or when the discs are rotating at less than 70% of normal speed. The power supply is mounted on the bottom of the chassis.	73700
Switch/Fuse	This assembly consists of two slow blow fuses, an ac power switch, and a line filter.	73418
Power Off Delay Relay	This relay delays removal of ac power to the primary of the power transformer to allow two seconds for the heads to unload before ac power is removed when the front panel power switch is set to POWER OFF position, before the cartridge switch is set to CARTRIDGE UNLOCK.	18970

Table 1-3. Component Description (continued)

Name	Description	Part Number
Blower Assembly	The blower circulates cooling air from the prefilter through the absolute filter and provides continuous air flow over the discs, electronic cards, and spin motor. The blower is attached to the chassis and is belt driven by the spin motor.	73120

1.4 FUNCTIONAL DESCRIPTION

The disc drive unit stores and retrieves data for use by the CPU. The combination of a fixed disc and a removable disc permits the user to establish a limitless library of memory, affords the user flexibility in applications, and enables the user to protect files by duplication of data from disc to disc. The functions of the disc drive unit are dictated by the physical characteristics of the disc as a memory device and the arbitrary system of organizing the storage surfaces of the discs so the user can recover specific segments at will. Figure 1-4 illustrates the utilization of a disc surface and track spacing for 1, 2, and 4 million data bytes per disc.

A bit cell is the area of the disc surface used to record one data bit. Since there are the same number of bits per track, bit cells become smaller for each successive higher track number. Bit cells are also smaller when the number of tracks per inch increases. Since, ultimately, the retrieval of the recording in a bit cell is the function of a drive, greater precision is required of drive operation as the number of available bit cells on a disc is increased.

Figure 1-5 shows typical construction details of a disc cartridge. The plastic cartridge consists of two pieces with a door in each. The lower half of the cartridge has an air door that is forced upward toward the disc by the drive air flow. The upper half of the cartridge has a disc access door which is raised by levers attached to the drive as the cartridge is inserted in the drive. When the disc access door is raised, the disc is exposed and the opening becomes the head access area. The disc assembly rests in a molded depression surrounding the sector ring. This arrangement keeps the disc edges from coming in contact with the edge of the cartridge. Forty-seven of the disc sectors are identified by notches

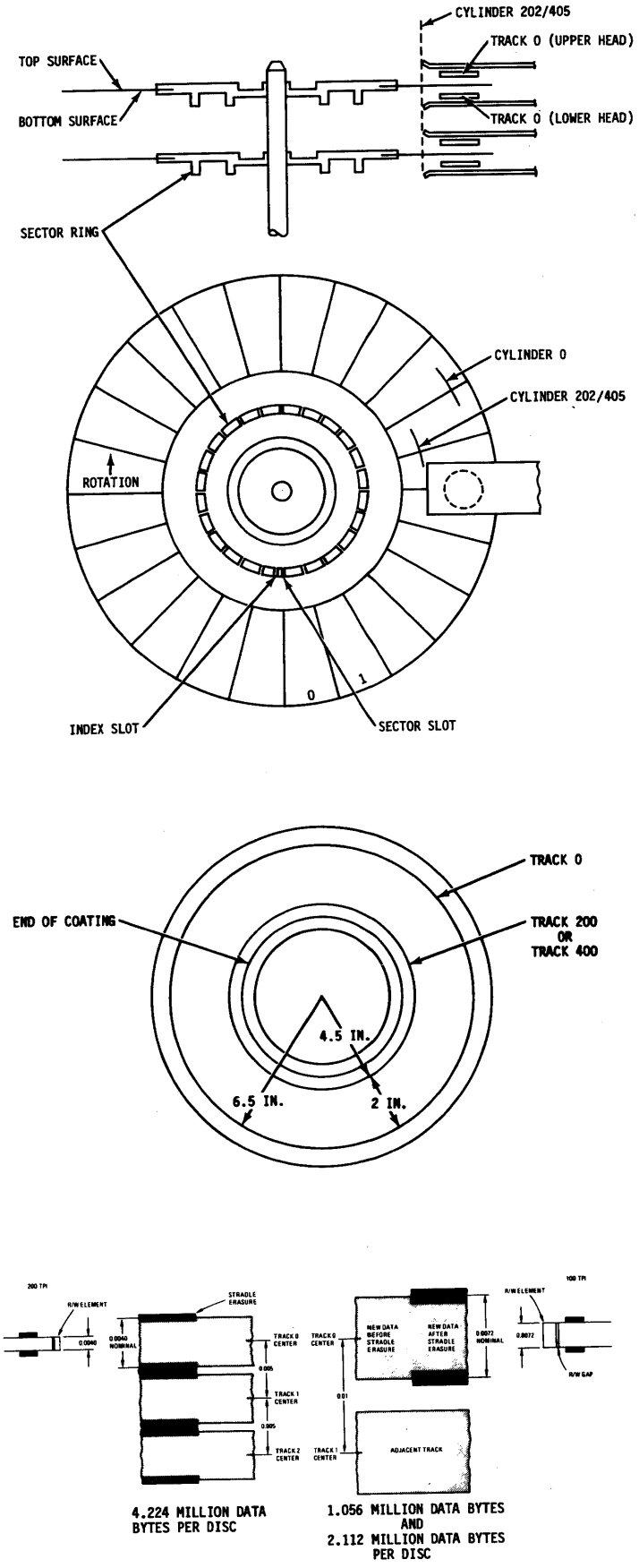


Figure 1-4. Disc Organization

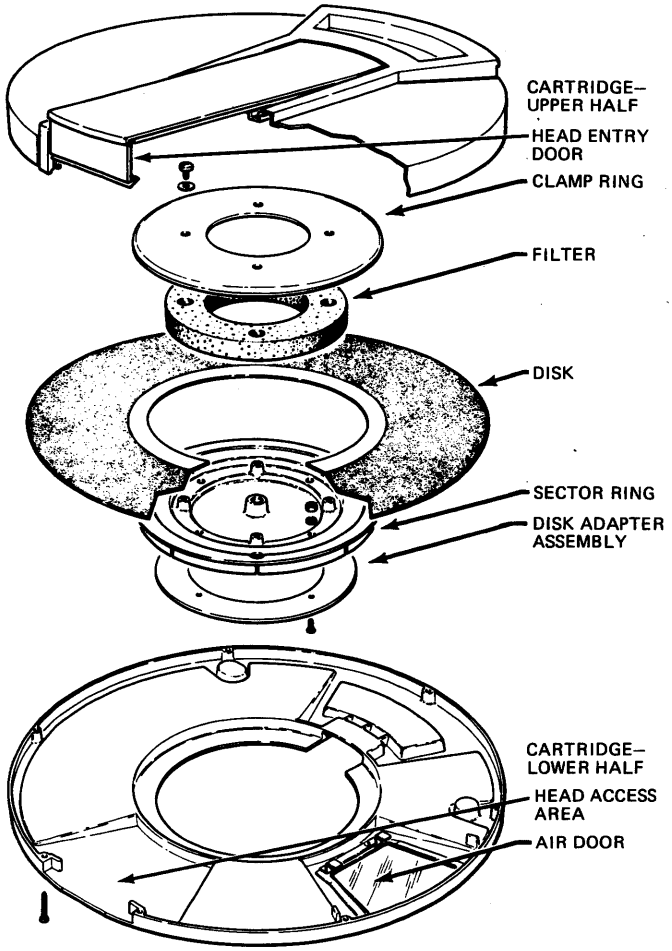


Figure 1-5. Disc Cartridge, Exploded View

in the sector ring; the forty-eighth sector is not identified by a notch but an early notch between the forty-seventh and the first sectors signifies that it is the last sector. The early notch is the index notch. The disc itself is a 14-inch diameter disc of aluminum with an oxide coating on each side. The oxide coating is tapered so the thickness varies from about 300 microns thick at the edge, to about 200 microns thick near the center clamp ring.

When a data processing system includes more than one disc drive unit the drives and discs are numbered sequentially from 0. The removable discs are always even numbered (0 in drive 0, 2 in drive 1, 4 in drive 2,...) and the fixed discs are odd numbered (1 in drive 0, 3 in drive 1, 5 in drive 2,...).

The functions of the drive may be divided into (1) positioning the read/write heads over a specific radial location over/under the discs (a track or cylinder), (2) identifying the specific part of a track (a sector) passing under the heads at a particular time, (3) magnetically recording (writing) data on one of the four disc surfaces, and (4) retrieving data previously recorded on the disc (reading). Because the four functions can only be performed after the discs are rotating at a fixed velocity, the drive sequences through a start-up procedure each time a disc cartridge is inserted. Then, because the disc cartridge and read/write heads would be damaged if the disc cartridge were removed while the drive was in operation, the door permitting access to the disc cartridge is locked while the discs are rotating and there is a sequential stop procedure performed each time the motor switch is turned off.

A final constraint on effective drive operation is the quality and direction of motion of the air circulated within the drive enclosure. During operation of the disc drive, the read/write heads "fly" over the recording surface of the disc supported only by a cushion of air 100 microns (0.0001 inch) thick. Therefore, airborne contaminants might easily cause a head crash. For this reason the drive has a special fan, filter, and ducting arrangement. Figure 1-6 illustrates the relative sizes of some common hazards which may cause head crashes.

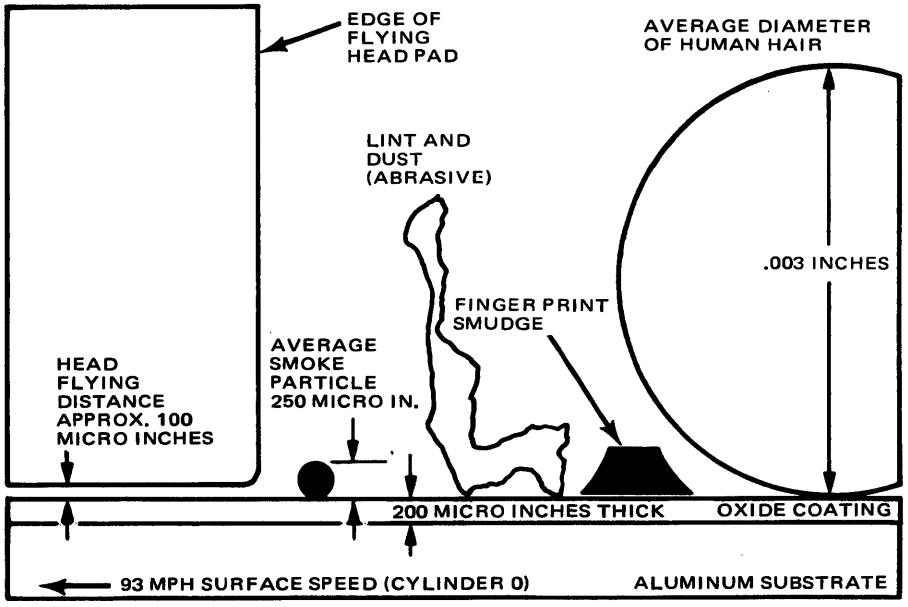


Figure 1-6. Comparison of Sizes: Disc-to-Head Separation and Contaminants

Figure 1-7 illustrates the relationship of the drive functions to the DMA/Disc Controller, to the discs, and to each other. When the disc drive unit is in a cabinet the back panel power switch is normally left on all the time. The normal startup sequence is to verify that the front panel cartridge switch is in the CARTRIDGE UNLOCK position then set the front panel power switch to POWER ON. As soon as the dc voltages are available the CARTRIDGE UNLOCK indicator lights and the front door is unlocked so it may be opened and a cartridge inserted.

With the door closed and a removable disc cartridge in place, the cartridge switch is set to the CARTRIDGE LOCK position. The spin motor starts the discs and blower rotating. The blower forces clean air across the disc surfaces to remove contaminants then out to cool the electronic circuits. After dc power becomes safe the Head Positioning Function supplies a reverse drive current to the actuator until the discs are spinning faster than 70% of their nominal speed. For about the first minute after the discs start spinning, the Start, Stop, and Status Function keeps the carriage at the home position. Then this function provides the control to load the heads to track 0. When the carriage is positioned at track 0 and there are no faults in the drive, READY is lighted. The status signals sent to the controller indicate that the disc drive is operational. The disc drive unit is then under program control.

Once the drive indicates an operational status to the controller, the CPU may command the drive to position the heads at an address (track number). The Start, Stop, and Status Function then causes the Track Number and Head Position comparison circuits to load the address in a register and initiate head repositioning. The present head position is compared to the contents of the address register and, when there is a difference, the resulting shaped error signal causes an actuator current to move the carriage until it is positioned to the commanded address. If the carriage is correctly repositioned in less than 200 milliseconds the status signals return drive control to the program. Index and sector pulses from the Sector and Speed Detection Function are then used by the controller to select the starting sector for either a read or write operation.

In order to write on one of the disc surfaces the controller has to command the Write Function to select a read/write head. Then as the correct sector begins to pass under the read/write head, the controller has to send control signals to the Write Function to generate the write signal.

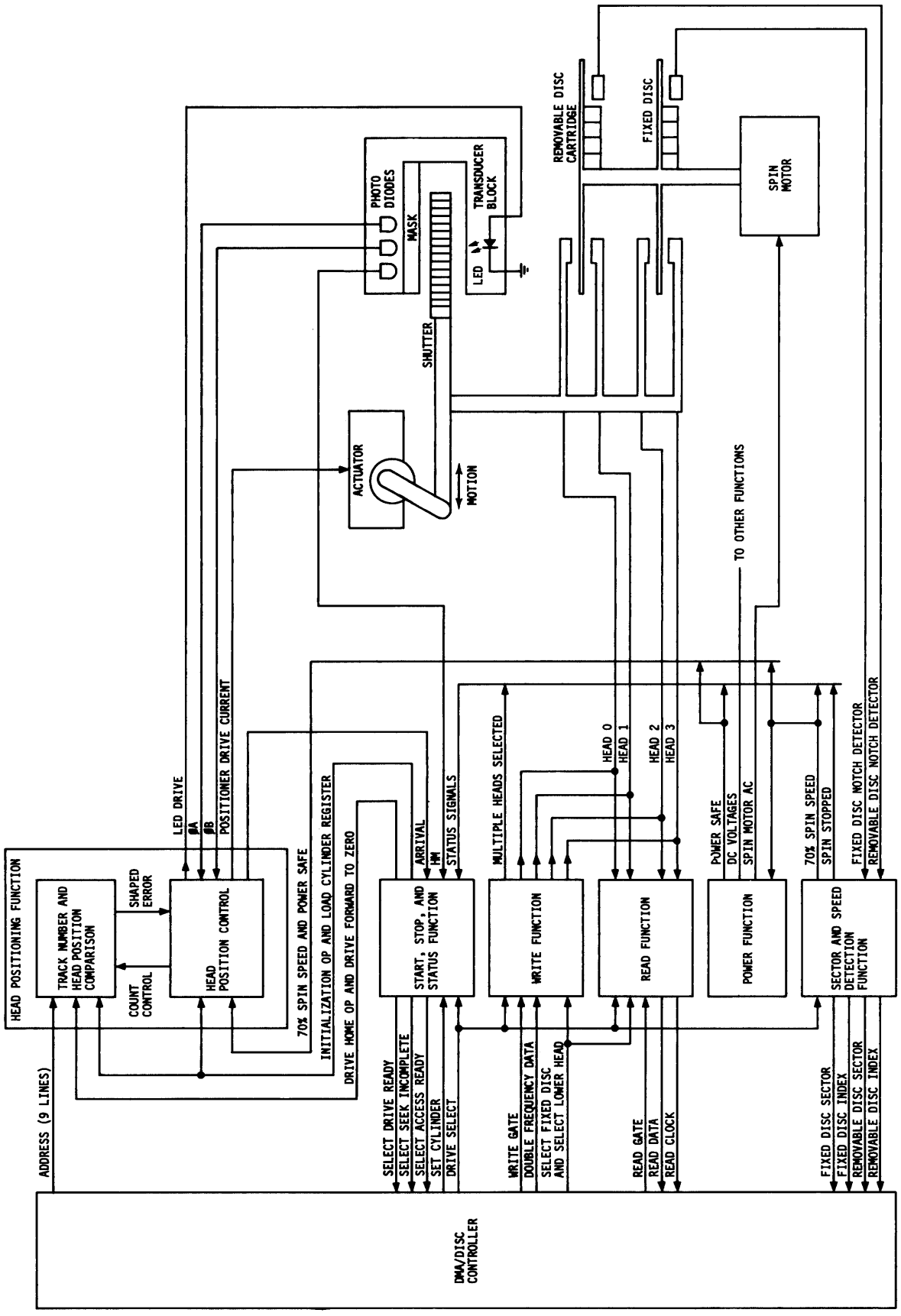


Figure 1-7. Functional Block Diagram

Data is read from a disc by having the carriage moved so the read/write head is positioned over the correct track then selecting the appropriate head to start reading at the beginning of the sector containing the required data. The read signal is converted read data.

Normal shut-down procedure is to set the cartridge switch to CARTRIDGE UNLOCK, wait for the door to be unlocked, remove the disc cartridge, close the door and set the front panel switch to POWER OFF. During this sequence the Start, Stop, and Status Function causes the Head Positioning Function to provide actuator current which drives the carriage to home position. When the Sector and Speed Detection function determines that the discs are spinning at less than 2% of normal speed the Start, Stop and Status Function unlocks the door so cartridge may be removed.

If the operator sets the power switch to POWER OFF and leaves the cartridge switch in the CARTRIDGE LOCK position the Power Function keeps power up for about two seconds to allow the carriage to be returned to home. Under these circumstances, there will be no power to unlock the door so the disc cartridge cannot be removed until after the front panel switches are set to CARTRIDGE UNLOCK and POWER ON.

If, during normal operation, the carriage is not positioned to the commanded track within 200 milliseconds, the Start, Stop and Status Function notifies the controller that the carriage is not at the commanded track. The controller must then issue a new command to home and re-seek.

Section 2

OPERATION

2.1 SWITCHES

2.1.1 BACK PANEL POWER SWITCH

The back panel power switch opens both input ac lines when off and connects both input ac lines to the Power Function when on.

2.1.2 FRONT PANEL POWER SWITCH

When the front panel power switch is in the POWER ON position the high ac line is connected to the power transformer and the cartridge (motor) switch. It also applies ground to the cartridge switch for the motor switch on signal in the POWER ON position.

2.1.3 CARTRIDGE (MOTOR) SWITCH

When the cartridge switch is in the CARTRIDGE UNLOCK position and both power switches are in the on position, the front door is unlocked and may be opened if the dc power is up and the discs are stopped. When it is in the CARTRIDGE LOCK position (and both power switches are on) the front door is locked and, if a cartridge is in place, ac is applied to the spin motor. In the CARTRIDGE LOCK position ground from the POWER ON position of the front panel power switch is routed to the power supply as the motor switch on signal. The motor switch on signal causes an amplifier to energize a relay which shunts the high ac line around the front panel power switch. This arrangement keeps ac power to the drive until the heads are retracted from the discs when the front panel power switch is set to POWER OFF before the cartridge switch is set to the CARTRIDGE UNLOCK position. This is to protect against head crashes caused by the heads being over the discs when the discs are moving too slowly to provide the air motion required to support the heads above/below the disc surfaces.

2.2 INDICATORS

2.2.1 POWER ON

This indicator lights when +15V is available from the power supply. This indicates that both the front panel and back panel power switches are on and that the line

fuses and F2 on the Power Supply are good. The POWER ON indicator will stay on for approximately one second after the front panel power switch is set to POWER OFF when the cartridge switch is in the CARTRIDGE LOCK position.

2.2.2 CARTRIDGE UNLOCK

The CARTRIDGE UNLOCK indicator is on when the front door is unlocked so a cartridge may be removed or inserted. It indicates that power is applied to the drive circuits and the discs are stopped.

2.2.3 READY

The READY indicator is on when the drive is operating, the initial time delays have expired, and the heads are loaded. READY will be extinguished anytime an unsafe condition is detected by the status circuits.

Section 3

MAINTENANCE

3.1 SCOPE

Section 3 contains information and instructions for procedures required to keep the drive in proper operating condition. Maintenance information includes a detailed functional description and preventive/corrective maintenance procedures.

The detailed functional description and its supporting illustrations (figures 3-34 through 3-40) near the end of this Section provide the information usually needed to determine appropriate corrective action.

Preventive maintenance is defined as the systematic care, inspection, and tests of the drive to keep it in operating condition and to correct minor failures before they develop into major failures. General preventive maintenance categories are adjust, align, check, clean, inspect, lubricate, replace, and test for operational readiness.

Corrective maintenance is defined as the systematic isolation of a fault in a failed drive. This includes tests necessary to isolate the faulty component, the procedures necessary to remove and replace it, and the tests necessary to ensure the drive is operating properly.

3.2 SPECIAL CAUTIONS

Most procedures of this section require that the drive be exposed by extending the drive from the cabinet and removing the top and back covers. Operating in this manner for prolonged periods of time can result in damage to the read/write heads, discs, carriage, and positioner motor if care is not exercised to keep all foreign matter out of these areas. Although the drive is equipped with a clean air filtration system when operating without covers the read/write heads should be checked for contamination at hourly intervals and cleaned, if necessary. The positioner motor has a strong magnetic field which will magnetize a wrist-watch if worn while working on the drive. Also, if you should drop any hardware in this area while servicing the drive, it is likely that they will be attracted to the magnet. During removal and replacement procedures, do not place small items such as screws

and washers on the drive base as they may accidentally fall through the air door into the fixed disc housing where they may cause catastrophic failure later. Do not touch the fixed disc exposed surface at any time.

3.3 DETAILED FUNCTIONAL DESCRIPTION

The circuits in the disc drive unit are divided into six functional groups:

1. The Power Function (figure 3-34) includes the distribution of ac input power to the spin motor and the power transformer, the generation and distribution of dc voltages, the generation of the motor switch on and power safe logic signals, and the safety circuit which maintains power to the drive long enough to ensure head retraction in cases where the front panel power switch is set to POWER OFF before the carriage switch is set to CARRIAGE UNLOCK.
2. The Start, Stop, and Status Function (figure 3-35) includes the circuits that control start-up and stop sequencing and the circuits that check drive status and generate appropriate status signals for the controller.
3. The Head Positioning Function consists of the track number and head comparison circuits (figure 3-36) and the head position control circuits (figure 3-37). The track number and head comparison circuits generate a shaped error signal for the head position control circuits. The shaped error signal usually is the result of the controller commanding the drive to move the read/write heads to a different track. This command results in there being a difference between the present cylinder address (present head position) and the address contained in the cylinder register (new address). During the drive start up sequence the shaped error is a result, first, of a drive home signal and, second, a drive to track 0 signal (load heads). During a stop sequence the shaped error is a result of a drive home signal. The head position control circuits detect the direction and velocity of head motion (the carriage, shutter, and read/write heads all move together). From this information and the shaped error signal, the head position control circuits develop a positioner drive current that causes the heads to be quickly and accurately positioned over the commanded cylinder of the discs, track 0, or home position.
4. The Sector and Speed Detection Function (figure 3-38) detects notches in the fixed disc pulley and the removable disc skirt. Forty-seven of the notches for each disc are sector notches and the forty-eighth notch is an index notch. From these notch-detected signals the Sector and Speed Detection Function generates signals that identify the beginning of each sector and each revolution (index) of the fixed and removable discs. This function also generates a 70% spin speed signal when the discs are rotating fast enough for it to be safe to load the heads and a spin stopped signal to indicate that the discs are rotating at less than 2% of normal spin speed so it is safe to open the door.
5. The Write Function (figure 3-39) decodes the select fixed disc and select lower head signals form the controller to select one of the four read/write heads and generates a bipolar write current form the double frequency write data signal when enabled by the write gate signal. The Write Function also generates an erase current during the time of, and 25 microseconds after,

the write gate signal. This erase current creates a quiet gutter between recorded tracks on the disc surface. The Write Function also varies the amount of write current so the low numbered tracks (the tracks farthest from the center of the disc) are recorded with more write current than the high numbered tracks.

6. The Read Function (figure 3-40) decodes the select fixed disc and select lower head signals from the controller to select one of the four read/write heads (this is done by the same circuits in both the Read Function and the Write Function). When the read gate signal from the controller is active, the signals from the selected head are amplified and converted to a logic signal called raw data. Raw data is used by the variable frequency oscillator (VFO) to synthesize a read clock and reformat the raw data to a read data signal synchronized to the read clock. These signals are used by the controller to reconstruct the data initially recorded on the disc.

The six functional groups are described in detail in the following paragraphs. The functional block diagrams, timing diagrams, and flow charts provide all the information normally needed to isolate troubles to a replaceable card or mechanical assembly.

3.4 POWER FUNCTION (figure 3-34)

The power cord for the disc drive unit is plugged into the ac receptable at the bottom of the CPU or Disc Cabinet. During normal day-to-day operation the back panel power switch is left set to ON so power to the drive is controlled by the front panel power switch. When the front panel power switch is set to the POWER ON position, ac is applied to the power transformer and the cartridge (motor) switch. The power transformer provides the return line for the spin motor and stepped-down ac voltages to the ±15 volt bridge rectifier and the +5 volt bridge rectifier. When the ac line is 115 volts, the spin motor return tap on the power transformer and the high side of the ac line are 115 volts. When the ac line is 220 volts, the voltage supplied to the spin motor is from the power transformer primary and is 115 volts so long as the line connections to the power transformer are correct for the line voltage. The +15 unregulated voltage is applied to the drive home amplifier on the power supply, through F4 to the reverse amplifier on the power supply and to the Drive Control Logic (mother board) as +15V raw, and through F2 to the +15 volt regulator. The +15V raw is applied to the cartridge unlock solenoid. The +15 volts (regulated) is supplied through the Drive Control Logic to the front panel lamps so the POWER lamp is on whenever there is +15 volts available in the drive. The -15 volts unregulated is routed through F5 to the forward amplifier on the power supply and through F3 to the -15 volt regulator.

After power has been switched on to the drive and the cartridge switch set to CARTRIDGE LOCK the high side of the ac line is connected through the receiver interlock switch to the motor start relay if there is a cartridge in the receiver. The motor start relay limits the starting current of the spin motor until its armature is rotating at a safe speed. The ground connection from the Drive Control Logic card is routed through the front panel power switch in the POWER ON position and the cartridge switch in the CARTRIDGE LOCK position and back to the Drive Control Logic card to become the motor switch on signal. The motor switch on signal and the read/write safe 2 signal are combined to disable the +5-volt regulator when the drive is in normal operation and the cartridge switch is set to the CARTRIDGE UNLOCK position. When the motor switch on signal is low (POWER ON and CARTRIDGE LOCK) it enables the +5 volt regulator and discharges the input capacitor on the delay relay driver which energizes the ac power delay relay. If the front panel power switch is set to POWER OFF before the cartridge switch is set to CARTRIDGE UNLOCK the delay relay driver keeps the ac power delay relay energized for about two seconds (until the input capacitor charges enough to turn off the delay relay driver). This allows the dc voltages to remain long enough to retract the read/write heads from the discs before power is removed from the spin motor.

After all the dc voltages are in the safe operating range the power safe signal is made active low. The power safe signal is routed to the Drive Control Logic where it is used by the Start, Stop, and Status Function.

3.5 START, STOP, AND STATUS FUNCTION (figure 3-35)

With the front panel power switch in the POWER ON position and the cartridge switch in the CARTRIDGE UNLOCK position both the spin stopped and motor switch on signals are high. This combination results in the 5V off signal being active (low), in the cartridge unlock lamp being on, and in the cartridge unlock (door) solenoid being energized so the door may be open to remove or insert a cartridge. With a cartridge in place and the door closed the motor switch on signal will go low when the cartridge switch is placed in CARTRIDGE LOCK. This deactivates the 5V off signal thus enabling +5 volts to the drive logic. The spin stopped signal will go low almost immediately since it is active (high) when the discs are rotating less than 2% of normal speed. When spin stopped goes low, a 64-second delay one-shot is triggered. This ensures that the load heads signal will remain low for a minute to allow the spin motor to come up to normal speed.

When the +5 volts is enabled and the load heads signal is low, drive home op is set active low. A low drive home op signal sets the initialize latch which sets the cylinder register to all zeroes and the present cylinder address register to all ones. This configuration of the registers is for track 0 and results in a shaped error signal of zero so the drive home op signal is substituted for bit 32 of the present cylinder address register. The drive home op signal then becomes a shaped error signal equivalent to a real situation where the carriage is positioned 32 tracks closer to the center of the disc than the commanded track address. This causes the head positioning actuator to drive back to the home position and into the rear crash stop. When the initialize latch was set it triggered the 200-millisecond home delay one-shot. After the one-shot times out, the drive home op signal is reset high removing the reverse drive signal to the head positioning actuator.

Under normal circumstances, the spin motor reaches 70% of its normal speed within a few seconds after the motor starts so the 70% spin speed becomes active (high). When the 64-second delay times out the load heads signal becomes active (high) activating the drive forward to zero signal which is substituted for bit 16 of the cylinder register. This becomes the shaped error signal which causes the head positioning actuator to drive the carriage forward. This loads the heads and when they reach track 0 the track 0 signal clocks the initialize latch resetting it. This makes the drive forward to zero signal inactive and the normal positioning signals control final positioning of the heads over track 0. The arrival flip-flop is set and both R/W safe 1 and R/W safe 2 are active making the drive ready signal active. Drive ready lights the DRIVE READY indicator and, when this drive is selected by the controller, the select drive ready and select access ready status signals to the controller are active.

Any time the drive ready and access ready status signals are active (low) the controller can place a track number (address) on the address lines and issue a set cylinder signal. The set cylinder signal causes a load cylinder register signal and resets the seek incomplete latch. The load cylinder register signal triggers the 200-millisecond home-position-delay one-shot which causes the access ready signal to become inactive. When the heads are positioned over the commanded track the seek incomplete latch is kept in the reset state unless the 200-millisecond one-shot has not timed out. If the arrival flip-flop is not set in less than 200-milliseconds the seek incomplete latch is set, select seek

incomplete and select access ready status signals are active to the controller. The controller must now issue a new track command sequence (track number then set cylinder). Even if the heads are positioned to the correct track before a new track command is issued, the seek incomplete status prohibits the CPU from using this address until a set cylinder signal causes the seek incomplete status to be reset.

During typical shut down, the cartridge switch to set to CARTRIDGE UNLOCK which sets the motor switch on high causing the load heads signal to go low. Drive ready becomes inactive and drive home op is set low. The DRIVE READY indicator is dark and select drive ready and select access ready are inactive. The initialize latch is set resetting the cylinder and present cylinder address registers for track 0. Drive home op (as bit 32 of the present cylinder address) drives the actuator to home position. When the discs slow to less than 2% of normal speed, the 5V off signal disables the +5V regulator and the cartridge unlock solenoid and lamp are energized. The front door may be opened and the cartridge removed. The front panel power switch is then set to POWER OFF and the normal shut-down sequence is complete. If the power switch is set to POWER OFF first, the ac power delay relay maintains ac to the drive for about two seconds so the same sequence has time to retract the heads (so they won't crash) but the front door will not be unlocked because the +15 volts used to energize the cartridge unlock solenoid will not be available when the spin stopped signal would have enabled the unlock circuits.

3.6 HEAD POSITIONING FUNCTION

The Head Positioning Function consists of the track number and head position comparison and the head position control circuits. The head position control circuits are used for start-up, normal, and shut down operations whereas the actual comparison of track number and head position occurs only during normal operation.

3.6.1 TRACK NUMBER AND HEAD POSITION COMPARISON CIRCUITS (figure 3-36)

When the program requires that data be written on or read from a disc, the controller puts the track number of the selected location on the address bus and issues a set cylinder command to the Start, Stop, and Status Function. Set cylinder causes an active load cylinder register which loads the new address into the cylinder register. When the new address is track 0 the cylinder register decode 0 signal is active (high). The new address is added to the present cylinder address counter contents and when the difference is other than 0, a shaped error signal is generated by the digital to analog converter on Servo Number Two card.

The address in the cylinder register is the binary number of the designated track. The contents of the present cylinder address counter is the ones complement of the track number of the present head location. When the commanded address is equal to the present head location, all of the adder outputs are high and the drive forward signal is high. The drive forward signal is exclusive-ored with each bit from the adder so the outputs from the exclusive-or gates are all low. When the carriage is positioned so the heads are over track 0 the present cylinder address counter is set to all ones. As the carriage moves forward, count down pulses are generated in the head position control circuits and the present cylinder address counter counts down.

Any time a carry (forward signal) results from adding the outputs of the cylinder register and the present cylinder address counter the forward signal becomes the drive forward signal unless the carry/borrow latch has been set by a carry from the present cylinder address counter. A carry is generated by the adders each time the new address from the cylinder register is for a track number higher than the present address.

The outputs from the exclusive-or function is the binary difference between the cylinder register contents and the present cylinder address counter contents when the new address is for a lower numbered track than the present head location. The output of the exclusive-or function is the complement of the difference when the new address is for a higher numbered track.

3.6.2 HEAD POSITION CONTROL CIRCUITS (figure 3-37)

The head position control circuits form a closed servo loop. When a new track number is entered from the controller the difference = 0 signal becomes inactive (high) and the forward switch is energized if drive forward is high or the reverse switch is energized if drive forward is low. The shaped error signal is passed by the forward switch or the inverted shaped error signal is passed by the reverse switch to become the positioner drive signal. The positioner drive signal is combined in a summing amplifier with feedback and tachometer signals to become the forward preamp drive or reverse preamp drive signal.

Whichever of these signals exist cause their drive amplifier to provide current to move the head positioning actuator. The forward drive amplifier passes current from the -15V supply through the actuator to ground. The reverse drive amplifier passes current from ground through the actuator to the +15V supply. This current causes a feedback signal to the summing amplifier that is proportional to the amount of

current flowing through the actuator and opposite to the polarity of the positioner drive signal (negative feedback). When the carriage is out of the linear zone only about one-eighth of the feedback is input to the summing amplifier.

As the head positioning actuator rotates, the carriage is moved. The read/write heads are mounted on the carriage and so is the mask for the shutter assembly.

The mask consists of a sheet of optical glass which is overlaid with several slot patterns. One of the slot patterns resembles a picket fence in that there are alternate transparent and opaque slots spaced at track intervals. Behind this group of slots are two photodiodes which receive varying amounts of infrared radiation from a light-emitting-diode (LED) radiation source as the mask moves. The outputs of the photodiodes are the ϕA and ϕB signals. The physical spacing of the photodiodes is such that, when considered ac signals, there is approximately a 90° phase shift (lead or lag) between ϕA and ϕB. The ϕA and ϕB signals are combined in amplifier to become $(\phi A + \phi B)$ (algebraic sum, not logical or) and $(\phi A - \phi B)$. The output of one $(\phi A + \phi B)$ amplifier is rectified, filtered, and compared to a reference voltage. The difference between the reference voltage and the $(\phi A + \phi B)$ signal controls the amount of current through the led so the total effective radiation at the ϕA and ϕB photodiodes is constant. The output of the second $(\phi A + \phi B)$ amplifier is converted to a logic signal, converted to a tachometer signal, and monitored to detect the arrival zone.

The (A - B) signal is delayed and logic then compares the (A + B), (A - B), and (A - B)-delayed signals to develop count-down pulses when the carriage is moving forward (the (A + B) signal is high before the (A - B) signal) or to develop count-up pulses when the carriage is moving back toward track 0 (the (A - B) signal is high before the (A + B) signal). The count up or count down pulses increment or decrement the present cylinder address counter until the difference = 0 signal is active (low). When the difference = 0 signal is active the next low state of the (A + B) signal generates the linear zone enable signal which increases the amount of effect the current feedback and tach signals have on the output of the summing amplifier. When the carriage is positioned near enough to the selected track for the linear zone enable signal to be active the servo loop is extremely sensitive to very small error signals thus making it possible to position the carriage so the read/write heads are positioned over the center of a track that is only 0.005 inch wide.

If, during normal drive operation, the disc rotational speed should drop below 70% nominal or ac power is lost (either because the back panel power switch is set to off or because ac to the drive fails), K1 on the power supply will be deenergized and the drive home amplifier will apply reverse drive to the actuator to retract the heads.

3.7 SECTOR AND SPEED DETECTION FUNCTION (figure 3-38)

When the spin motor is turned on the discs start to rotate. The fixed disc hub has 48 sector notches and one index notch and the removable disc skirt has 47 sector notches and one index notch. An optical detector for each disc generates a signal for each notch that passes the detector. These detected notch signals are used by the circuits on the interface board to generate the sector pulses and index pulses for the fixed and removable discs.

The fixed disc notch detected signal triggers a 620-microsecond delay one-shot. When the next notch is detected before the one-shot times out the pulse for that notch triggers a 5-microsecond one-shot whose output is the fixed disc index pulse. Each time the 620-microsecond delay one-shot is triggered, it triggers a 5-microsecond one-shot whose output is the fixed disc sector pulse. Each fixed disc sector pulse triggers a retriggerable 2.2-second one-shot. The $\overline{Q}$ output of the 2.2-second one-shot (spin stopped) is always low when the next sector pulse occurs oftener than every 2.2 seconds. When fixed disc sector pulses are less frequent than every 2.2 seconds the spin stopped signal becomes active (high).

The removable disc notch detected signal triggers a removable disc transducer delay one-shot. The delay caused by this one-shot is adjustable from 18 to 180 microseconds in order to account for differences in transducer alignment in different drives. This makes it possible to use removable discs in all drives of the same model. At the end of the variable delay a 730-microsecond delay one-shot is triggered. The index notch will be detected before the 730-microsecond one-shot times out and will trigger the 5-microsecond index one-shot which generates the removable disc index pulse. The 47 sector notches will all be detected after the 730-microsecond delay so a removable disc sector pulse is generated each time the 730-microsecond delay one-shot is triggered. The forty-eighth sector pulse is generated by a 210-microsecond delay one-shot that is triggered by the removable disc index pulse. The removable disc index pulse triggers a retriggerable 57-millisecond one shot. When removable disc index pulses occur oftener than

57-milliseconds, the one-shot remains set and the 70% spin speed signal is always high. The sector and index pulses are gated to the controller when the drive is selected.

3.8 WRITE FUNCTION

After the controller has caused the heads to be positioned over a specific track the index and sector pulses provide the information necessary for the controller to indentify a specific sector on that track. The controller then selects the disc surface for a write operation by the appropriate select fixed disc and select lower head signal combination.

Head zero is selected (top surface of the removable disc) when both signals are high.

Head one is selected (bottom surface of the removable disc) when select fixed disc is high and select lower head is low.

Head two is selected (top surface of the fixed disc) when select fixed disc is low and select lower head is high.

Head three is selected (bottom surface of removable disc) when both signals are low.

When the appropriate sector passes under the read/write heads the drive select and write gate signals from the controller are both active (low) enabling the write current generator. Then double frequency write data from the controller causes the write current to the selected read/write head to be alternated once for a zero and twice for a one.

When the designated track is greater than 256 (128 for Model 2215), the write current is decreased by about 15%. This maintains a recording level that compensates for the decrease in bit cell size as the heads are moved closer to the center of the disc. Otherwise the read signal would constantly increase with higher track numbers and cross-talk interference between tracks might become a problem.

When the write gate enables the write current generator, it also enables the erase gate so a gutter is erased on both sides of the track (figure 1-4). A 25-micro-second erase gate delay one-shot is triggered at the end of the write gate so the gutter is erased to the end of the recorded area. This is necessary because the erase head is physically placed behind (in the direction of disc rotation) the read/write head.

3.9 READ FUNCTION (figure 3-40)

As in the write function, the controller causes the read/write heads to be positioned over a specific track and, by use of the index and sector pulses, locates the start of the specific beginning sector where the required data is stored. The same circuits decode the head selection signals (select fixed disc and select lower head) for reading as for writing (paragraph 3.8). Drive select is active and the controller makes the read gate active at the beginning of the first sector to be read. The read signal from the selected read/write head is processed by the read signal conditioning circuits and converted to logic levels by the zero crossing detector. The raw data signal from the Read/Write card is essentially the same as the double frequency write data signal which caused the data to be recorded in the sector. However, small variations in the disc rotational speed are common and this causes variations in the timing of bit cells. In order to reconstruct the data originally used to generate the double frequency signal, the signal from each bit cell must be identified so the logic state of the original data bit may be determined. This is accompolished by synchronizing a variable frequency oscillator (VFO) to the raw data. The VFO output is a double frequency clock (2F read clock) synchronized to the raw data. The oscillator on the VFO card is started by the read gate and delayed read gate.

The double frequency read clock from the VFO is compared to the raw data. When the 2F read clock occurs too soon a lag correction signal is generated which changes the control current from a bidirectional current source. This lowers the frequency of the oscillator. Similarly a lead correction signal may be generated to increase the frequency of the oscillator. The raw data is examined at the double frequency clock rate to create the restored data. This read data is not synchronized to any timing in the controller or the CPU so a read clock (1F read clock) is sent with the read data to the controller.

3.10 TROUBLESHOOTING

Troubleshooting is performed whenever a malfunction occurs and requires a thorough knowledge of normal drive operation. In addition, specific diagnostic test programs can significantly reduce the time needed to isolate troubles to a removable assembly.

In addition to the functional block and data flow diagrams (figures 3-34 through 3-40), an interconnection diagram (figure 3-41) and a power supply schematic (figure 3-42) are provided as troubleshooting and repair aids.

In digital data processing equipment, a failure can often be isolated to a specific assembly by means of deductive reasoning about the symptoms of a malfunction. This kind of approach can be substituted successfully for extensive signal tracing of individual circuits, at a considerable saving of time. Therefore, the flow chart (figure 3-43) describing the sequential method of troubleshooting should be used to the maximum extent, with only minimal reliance on specific procedures for checking individual circuits.

The basic approach to troubleshooting should be to first determine if the Disc Drive is malfunctioning. Once the Disc Drive has been isolated as the cause of the malfunction, further isolate the malfunction to one of the functions. Refer to the appropriate repair procedure once the malfunctioning function is determined. Troubleshooting may be continued by observing waveforms and voltages of a circuit and/or circuit components to finally isolate the malfunction to a faulty integrated circuit package or discrete component, if desired.

Before troubleshooting the drive perform the following checks to eliminate apparent malfunctions.

1. Verify that the back panel power switch and the cabinet circuit breaker are both on and that the drive power cord is plugged into the receptacle in base of cabinet.
2. Verify that the DMA/Disc Controller is properly seated in its connector in the CPU, that the rear edge connector (connectors) is securely attached to the controller, and, when applicable, the appropriate cables are connected between the CPU and Disc Cabinets.
3. Verify that the cable from the controller is securely attached to P1 on the Drive Control Logic card and that the terminator or cable to the next drive is securely attached to P2 on the Drive Control Logic.

3.11 SPECIAL TOOLS, TEST EQUIPMENT AND MATERIALS

Most of the tools and test equipment required for maintenance of the drive are standard items. Special tools are required only for shop maintenance. Cleaning materials, however, are appropriate for field use.

3.11.1 SPECIAL TOOLS

The following special tools will be necessary:

Card Extender
Test Hub
Disc Diagnostic Cartridge
Head Clamping Wrench
Head Spacers

3.11.2 CLEANING MATERIALS

The following cleaning materials will be necessary:

Lint-free Tissue
3/4-inch X 6-inch hardwood tongue depressors
(91%) Isopropyl Alcohol
Masking Tape
Cotton Swab
Lens Paper
Dental Mirror

3.11.3 FIXED DISC REPLACEMENT KIT

A fixed disc replacement kit is available which consists of a recording disc, nylon glove, and instructions for installation.

3.11.4 TEST EQUIPMENT

The following test equipment will be necessary:

Alignment Cartridge
Drive Test Unit

3.12 PREVENTIVE MAINTENANCE

The following preventive maintenance operations and routine checks are intended to assure reliable operation of the Disc Storage Unit. Drives being operated more than 200 hours per month should have more frequent attention. For example, a drive being operated 350-400 hours per month should have six-month checks performed at three-month intervals.

Table 3-1. Six-Month Preventive Maintenance

Step	Procedure
1	Remove disc cartridge from drive and leave receiver door in opened position.
2	Remove drive power, loosen two captive screws securing drive to cabinet, and, extend drive to obtain access to back and bottom of drive.
3	Remove nine screws securing bottom cover to drive chassis and remove cover.
4	Remove six screws securing component cover to drive chassis and remove cover.

Table 3-1. Six-Month Preventive Maintenance (continued)

Step	Procedure
5	Remove two screws securing head cable bracket to drive chassis (figure 3-1).
6	Remove all circuit cards from connectors.
7	Remove head connectors from Read/Write circuit card.
8	Remove four screws securing drive control logic card to mounting bracket.
9	Position drive control logic card out of the way.
10	While holding carriage assembly against rear crash-stop, insert head spacers between removable-disc heads and the fixed-disc heads (figure 3-2).

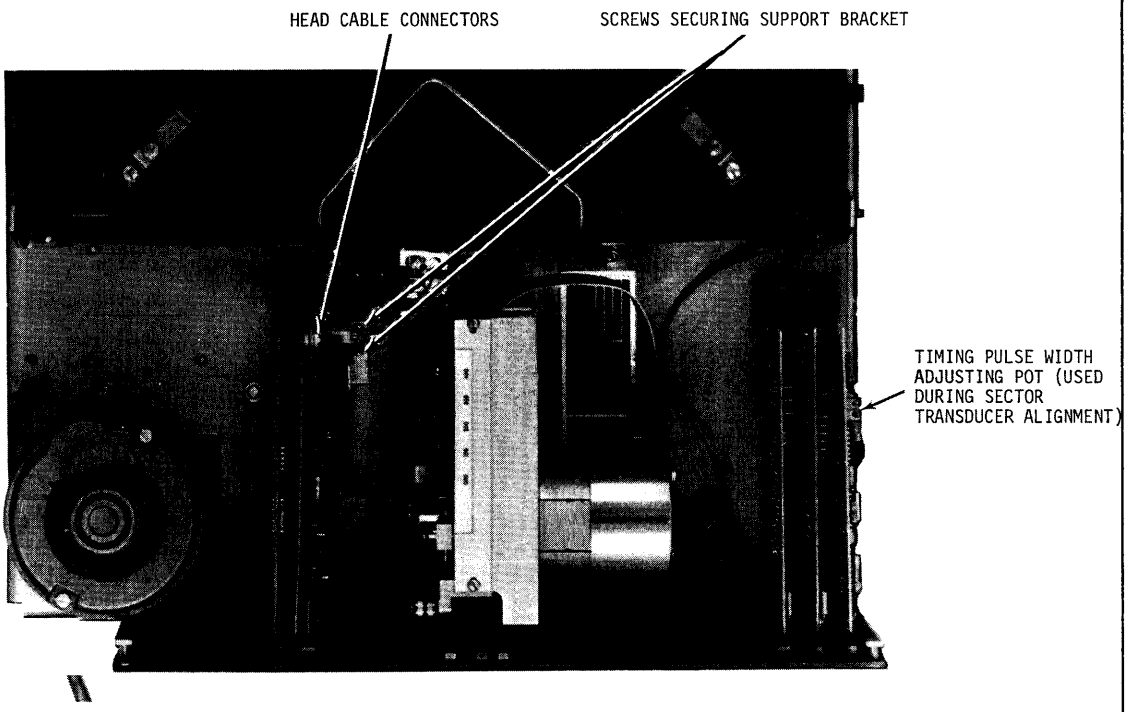


Figure 3-1. Drive Component Identifier

Table 3-1. Six-Month Preventive Maintenance (continued)

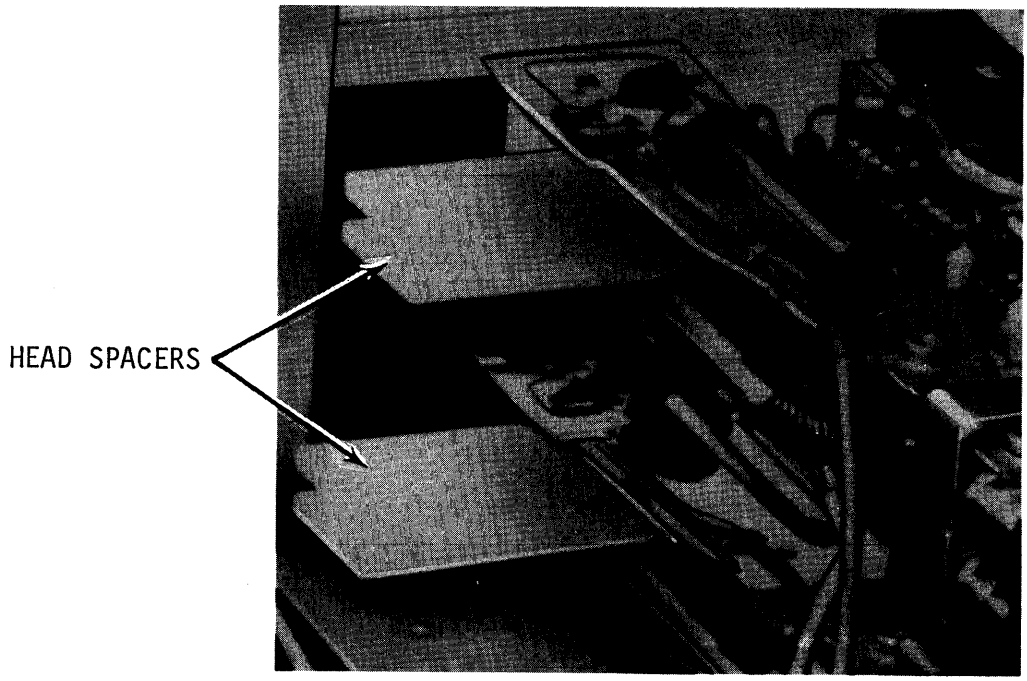
Step	Procedure
	
	Figure 3-2. Head Spacers Inserted Between Heads
11	Using dental mirror, check read/write heads for evidence of oxide build up. If oxide build up is present, check disc surfaces for evidence of contamination. If contamination exists, clean discs.
12	Clean read/write heads. a. Prepare a cleaning paddle by wrapping several layers of tissue around tongue blade. b. Lightly dampen paddle in alcohol, do not soak. CAUTION Never touch heads with fingers. c. Using a second unwrapped tongue blade to support the back of each head, swab head surfaces with lightly dampened paddle. d. Prepare a new paddle; repeat step (c) until cleaning tissue shows no signs of having removed head-surface residue. e. Using dental mirror, inspect head surface. If still dirty, repeat cleaning steps.

Table 3-1. Six-Month Preventive Maintenance (continued)

Step	Procedure
13	Move the carriage assembly back and forth and clean both the top and bottom carriage rails using a lint-free tissue dampened with 91% Isopropyl Alcohol. CAUTION Ensure that head spacers are installed between both removable-disc and fixed-disc heads.
14	Use a cotton swab dampened with molycoat G to lubricate the long and short actuator rails while moving the carriage assembly back and forth. See figure 3-3.
15	Holding the carriage assembly against the rear crash-stop and remove head spacers from between the removable-disc heads and the fixed-disc heads.

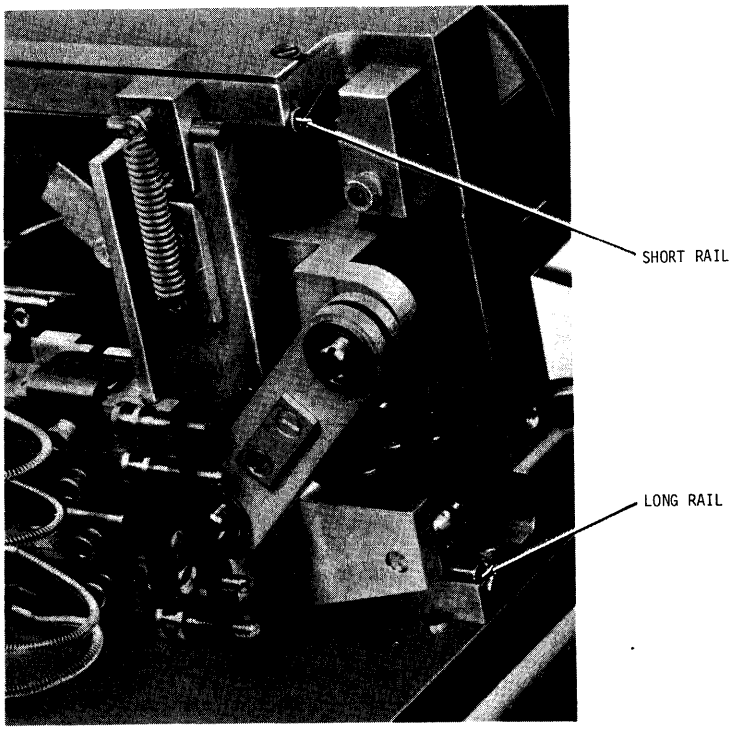


Figure 3-3. Lubrication Locations

Table 3-1. Six-Month Preventive Maintenance (continued)

Step	Procedure
16	Clean the removable-disc sector transducer. a. Wrap masking tape around one hand with sticky surface exposed. b. Press the tape against all surfaces of the transducer (figure 4-3) until all the metallic and dirt particles adhere to the tape.
17	Clean the fixed-disc sector transducer. a. Loosen two screws securing fixed-disc sector transducer (figure 1-3) and slide transducer towards back of drive. b. Using the sticky surface of masking tape, press tape against surfaces of transducer until all metallic and dust particles are removed. c. Replace sector transducer to original position and retighten mounting screws.
18	Clean the disc spindle area. a. Wrap masking tape around one hand with the sticky surface exposed. b. Press the tape against all areas of the spindle until all metallic and dirt particles adhere to the tape.
19	Replace the prefilter. a. Position drive control logic card so that access may be made to three prefilter plate mounting screws. b. Remove three screws securing prefilter plate to chassis. Remove screen prefilter (figure 3-4).

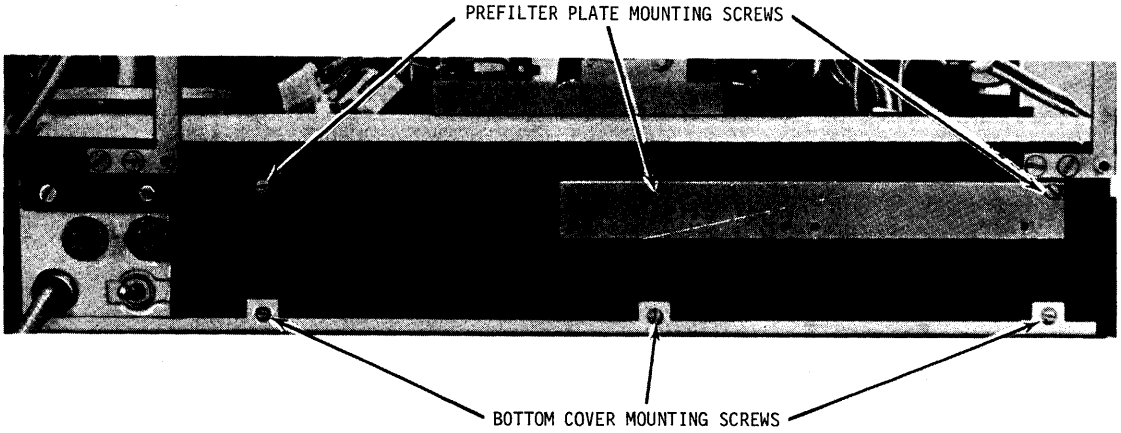


Figure 3-4. Prefilter Mounting Screw Location

Table 3-1. Six-Month Preventive Maintenance (continued)

Step	Procedure
	c. Replace screen prefilter with P/N 73325.
	d. Reassemble prefilter assembly in the reverse order of removal.
20	Inspect drive belt for evidence of wear or excessive stretch. Replace worn belt.
21	Attach drive control logic card to mounting bracket with four screws.
22	Attach head connectors to Read/Write circuit card.
23	Insert all circuit cards in appropriate connectors.
24	Replace head cable bracket and secure to drive chassis with two screws.
25	Inspect interior for loose wire connections, frayed wiring, dirt, or physical defects. Vacuum interior of drive. Tighten or repair loose connections and replace damaged components.
26	Verify that all circuit cards are firmly seated.
27	Verify that the head 0 through head 3 cable connectors are firmly seated in their respective J0 through J3 positions of the Read/Write circuit card.
28	Inspect bottom of drive chassis for dirt or other contaminants, loose wire connections, frayed wiring, and burnt or damaged components. Vacuum bottom of drive. Tighten or repair loose connections and replace damaged components.
29	Replace bottom cover and secure with nine screws.
30	Replace top cover and secure with six screws.
31	Push drive into cabinet and tighten two captive mounting screws.

Table 3-2. Twelve-Month Preventive Maintenance

Step	Procedure
1	Perform six-month preventive maintenance to step 20.
2	Adjust drive belt tension.
	a. Remove two screws securing switch/fuse assembly to drive chassis (figure 3-5). Position switch/fuse assembly such that spin motor mount is accessible (figure 3-6).

Table 3-2. Twelve-Month Preventive Maintenance (continued)

Step	Procedure

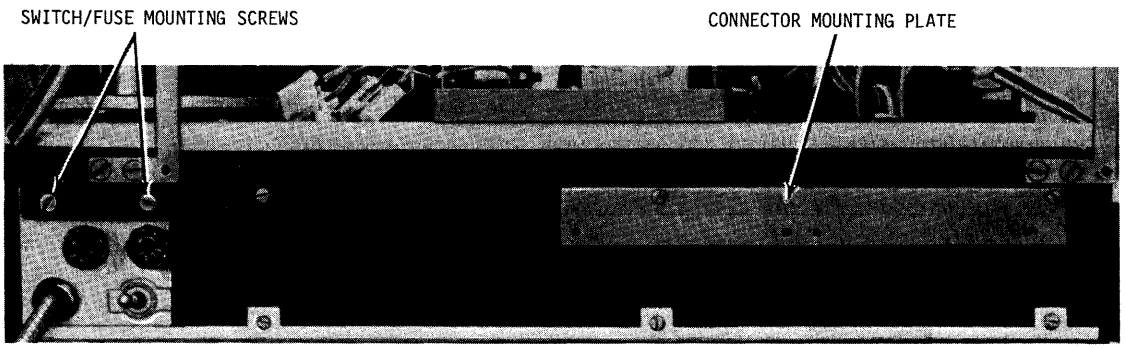


Figure 3-5. Switch/Fuse Assembly Mounting Screw Location

b. Loosen three screws holding the spin motor mounting plate to the drive chassis (figure 3-6).

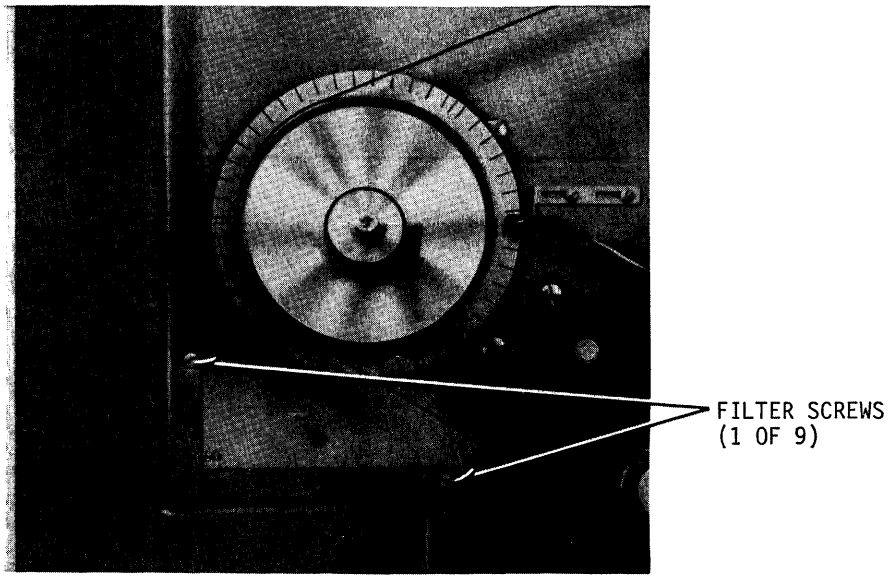


Figure 3-6. Spin Motor Mounting Plate Location

c. Temporarily install switch/fuse assembly. Ensure that the drive is in an upright position.

Table 3-2. Twelve-Month Preventive Maintenance (continued)

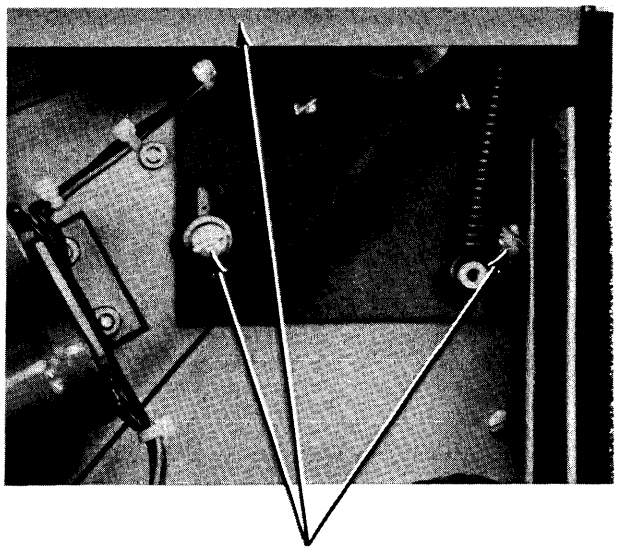
Step	Procedure
	d. Place the drive in normal operation by setting ac switch to ON position, the power switch to POWER ON, and the spin motor switch to CARTRIDGE LOCK position. e. Verify that the belt tension spring automatically shifts the motor to the correct belt tension. f. Remove power by setting the spin motor switch to CARTRIDGE UNLOCK position, power switch to POWER OFF and ac switch to OFF position. g. Remove two screws securing switch/fuse assembly to drive chassis. h. Retighten the three mounting screws holding the drive motor mounting plate to the drive chassis. i. Install switch/fuse assembly.
3	Replace the absolute filter. a. Remove nine screws securing air filter to bottom of drive chassis. Remove air filter (figure 3-7).  ADJUSTING SCREWS Figure 3-7. Filter Mounting Screw Location b. Replace absolute filter with P/N 73663.

Table 3-2. Twelve-Month Preventive Maintenance (continued)

Step	Procedure
	c. Reassemble absolute filter assembly in the reverse order of removal. NOTE Tighten the nine screws mounting the air filter such that the foam tape between the air filter and the chassis is evenly compressed.
4	Perform steps 21 through 31 of six-month preventive maintenance.

3.13 CLEANING SHUTTER AND REMOVABLE DISCS

Some malfunctions may be caused by a dirty shutter or by an accumulation of foreign particles on the surface of removable discs. The following paragraphs detail the accepted method for cleaning these items.

3.13.1 SHUTTER CLEANING PROCEDURE

1. Remove glass shutter from shutter assembly.

NOTE

The glass shutter should only be cleaned when removed from drive.

2. Prepare a few pieces of lens paper lightly dampened (do not soak) with 91% Isopropyl Alcohol.
3. Holding the shutter on the edge, gently wipe the shutter surface until all foreign material is removed.
4. Repeat steps (2) and (3) if necessary.

3.13.2 REMOVABLE DISC CLEANING PROCEDURE

1. Prepare a cleaning paddle by wrapping several layers of tissue around tongue blade.
2. Lift and rotate disc from the bottom of opened cartridge while wiping surface lightly with dampened paddle.

3.14 OPTICAL TRANSDUCER AND SHUTTER ALIGNMENT

The optical transducer and shutter alignment should be performed when either the optical positioning transducer or the shutter has been replaced or when positioning errors are detected. This alignment procedure is to set the correct distance

between the shutter assembly and the transducer block mask. The correct nominal spacing is 0.005 inch. The optimum shutter/mask spacing is obtained by moving the shutter while observing a Lissajous pattern indicating a 90° phase difference between ϕA and ϕB.

NOTE

It is not necessary to perform the steps to loosen the transducer block or shutter to check the transducer block/shutter alignment.

Table 3-3. Optical Transducer/Shutter Alignment

Procedure	Remarks
1. Remove cartridge, remove power and extend drive to obtain access to back and bottom of drive.	a. Set switch to CARTRIDGE UNLOCK. b. When CARTRIDGE UNLOCK lights, pull down on receiver door and remove the cartridge, then set switch to POWER OFF. c. Set ac switch on rear panel to the OFF position.
2. Remove nine screws securing bottom panel to chassis and remove bottom cover.	This permits access to disconnect actuator motor.
3. Disconnect red lead from servo motor to E13 and the black lead to E14 on power supply card (figure 3-8).	This disconnects drive current to the actuator motor.

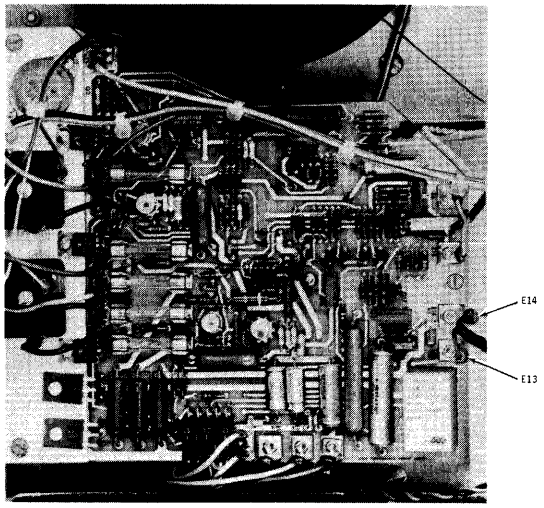


Figure 3-8. Actuator Motor Leads

Table 3-3. Optical Transducer/Shutter Alignment (continued)

Procedure	Remarks
4. Remove six screws securing the component cover to the chassis and remove cover.	This permits access to transducer block and shutter.
5. Remove four screws securing the drive control logic card to the mounting brackets and slide the card assembly out of the way.	Remove Read/Write circuit card from connector of the drive control logic card.
6. Manually position the carriage assembly against rear crash-stop.	
7. Using a dental mirror verify that shutter assembly is not broken and that a clearance exists between the mask and shutter by sighting down from rear of drive toward the disc spindle (figure 3-9).	Replace the shutter if it is broken or scratched. If clearance does not exist between shutter and mask, perform steps 8, 9, 16, 17 and 18 before performing step 10.
8. Set ac switch on rear panel to ON position.	
9. Set power switch to the POWER ON position.	
10. Connect scope probe between TP1 on the A4 circuit card and oscilloscope channel 1.	a. TP1 on the A4 circuit card is -HOME POSITION. b. Connect ground lead to SERVO GRD on component side of drive control logic card.

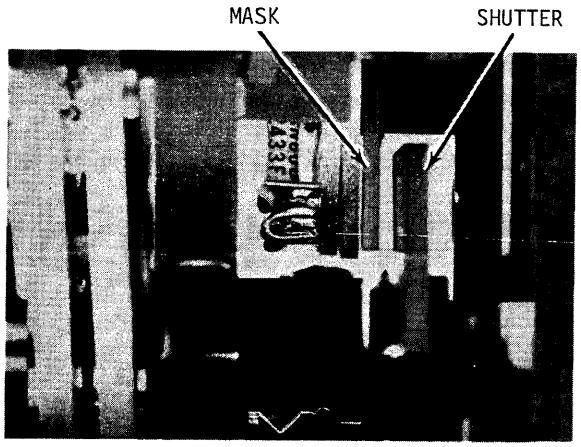


Figure 3-9. Shutter/Mask Spacing

Table 3-3. Optical Transducer/Shutter Alignment (continued)

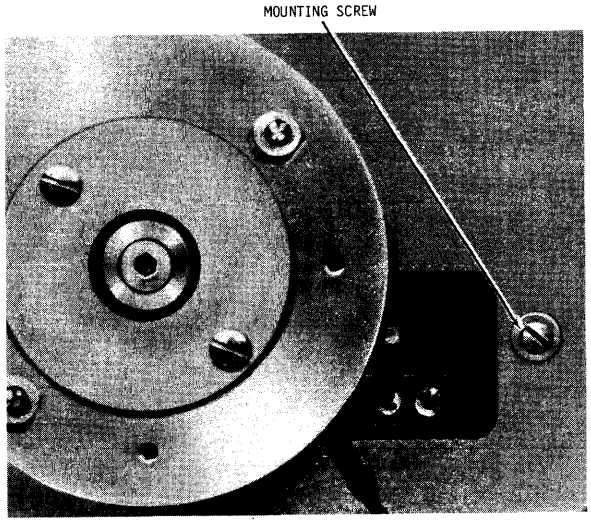
Procedure	Remarks
	c. Adjust oscilloscope to observe a 0 volt to +5 volt logic level.
11. Loosen screw holding transducer block (figure 3-10) and position block towards back of drive.	a. Keep transducer block firmly against actuator assembly frame. b. Keep carriage against crash-stop.
	
	Figure 3-10. Block Screw
12. Keeping transducer block firmly downward against the actuator frame, slowly move the block towards the disc spindle until the -HOME POSITION line goes low.	When -HOME POSITION line goes low (logical 0), the home position for the carriage has been detected.
13. Continue moving the block toward the disc spindle approximately 0.020- to 0.040-inch further from the position observed in Step 12.	Each division of the scale indicator is 0.025 inch.
14. Being careful not to shift the transducer block position, torque the screw mounting the block to the actuator frame to 8 inch-pounds.	This alignment insures that the home position is detected before the carriage assembly contacts the crash-stop.
15. Verify that the transducer block has been positioned to detect home position.	a. Move the carriage assembly approximately 1/2-inch from the rear crash-stop. b. Slowly move the carriage assembly toward the rear crash-stop

Table 3-3. Optical Transducer/Shutter Alignment (continued)

Procedure	Remarks
	c. Observing the scope display, verify that the -HOME POSITION signal goes low when the carriage is 0.020 to 0.040 inches from the crash-stop and remains low when the carriage is against the crash-stop.
	The following steps are to obtain the correct shutter to mask clearance.
CAUTION With the actuator disconnected, the operator must insure that the carriage is positioned against the rear crash-stop before loading and unloading the disc cartridge, and starting the spin motor.	
16. Insert an operational disc cartridge.	
17. Set cartridge switch to CARTRIDGE LOCK position.	Verify that the discs are spinning at rated speed.
18. Set maximum clearance between the shutter and the mask (figure 3-9).	a. Position carriage assembly to rear crash-stop and loosen forward mounting screw (figure 3-11). Position the front of the shutter assembly toward the actuator.

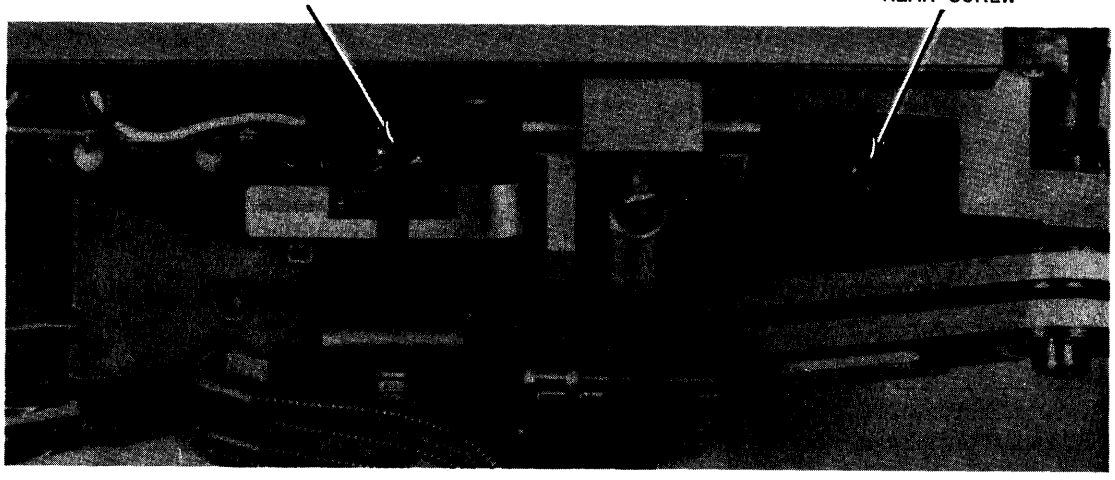


Figure 3-11. Shutter Mounting Screws

Table 3-3. Optical Transducer/Shutter Alignment (continued)

Procedure	Remarks
	b. Manually move carriage assembly toward Cylinder 100, loosen rear mounting screw (figure 3-11) and position the rear of the shutter assembly toward the actuator. c. Tighten both mounting screws snug.
19. Connect one scope probe between channel 1 on the oscilloscope and TP6 on A4 circuit card.	a. This connects ϕB to the oscilloscope vertical deflection plates. b. Set vertical sensitivity to 0.5 V/CM. c. Set ground tract at top graticule of scope. d. Input selector: DC.
20. Connect another scope probe between HORZ INPUT (EXT INPUT) on oscilloscope and TP7 on A4 circuit card.	a. Calibrate external horizontal input to .5 V/division. b. Connect TP7 (ϕA) to oscilloscope horizontal deflection plates. c. Time base: EXT. d. Coupling: DC. e. Slope: (+) f. Mode: AUTO
21. Loosen the forward shutter mounting screw and position shutter slightly away from the dc actuator motor.	This reduces the shutter to mask space at the front end of the shutter.
22. Verify that clearance between the shutter and mask still exists.	If no clearance exists, position the shutter slightly toward the actuator motor.
23. While monitoring the oscilloscope display, move the carriage back and forth between the rear crash-stop and just prior to the head load position (heads fly over disc).	The Lissajous pattern will at first reassemble the shape of the SAFE waveform shown (figure 3-12).

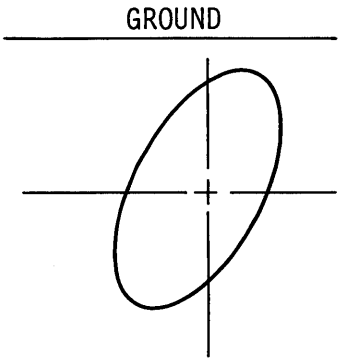


Figure 3-12. Safe Waveform (Too Much Space)

Table 3-3. Optical Transducer/Shutter Alignment (continued)

Procedure	Remarks
24. Repeat steps 21 through 23 until the Lissajous pattern takes the shape of the CORRECT waveform (figure 3-13).	It is possible to obtain a pattern which looks similar to the correct pattern but with incorrect amplitude. Ignore these positions and continue to adjust the shutter position until the correct amplitude is obtained; then, continue adjusting until the correct pattern is obtained.
25. Position the carriage assembly to Cylinder 100.	
26. Loosen the rear shutter mounting screw and position the shutter slightly away from dc actuator motor.	This reduces the shutter to mask space at the rear of the shutter.
27. Verify that clearance between the shutter and mask still exists.	If no clearance exists, position the shutter slightly toward the actuator motor.
28. While monitoring the oscilloscope display, move the carriage back and forth between Cylinder 50 and Cylinder 100.	The Lissajous pattern will at first resemble the shape of the SAFE waveform (figure 3-12).

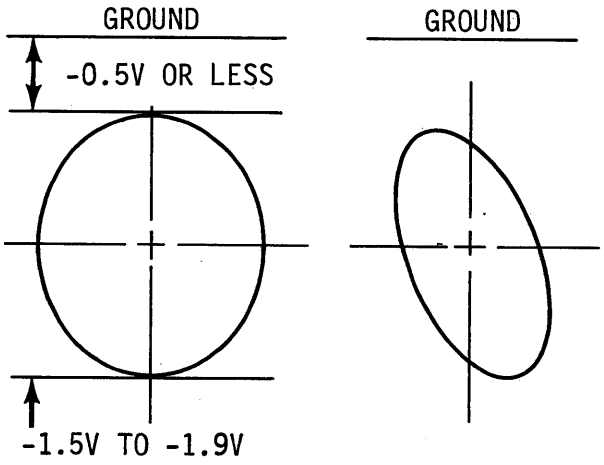


Figure 3-13. Correct and Unsafe Waveforms

Table 3-3. Optical Transducer/Shutter Alignment (continued)

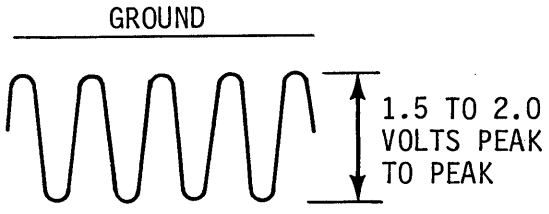
Procedure	Remarks
29. Repeat steps 26 through 28 until the CORRECT Lissajous pattern is obtained (figure 3-13).	It is possible to obtain a pattern which looks similar to the correct pattern but with incorrect amplitude. Ignore these positions and continue to adjust the shutter position until the correct amplitude is obtained; then, continue adjusting until the correct pattern is obtained (figure 3-13).
30. Repeat steps 26 through 29 while moving carriage back and forth between Cylinder 150 and 200.	
31. Verify that the CORRECT pattern is obtained as the carriage is moved through the range of travel from 000 to 200.	If the pattern deviates from the CORRECT waveform while moving the carriage, repeat steps 23 through 30. Tighten shutter mounting screws for the CORRECT pattern.
32. ϕA and ϕB check steps:	
a. Connect TP7 on the A4 circuit card to channel 2 of the oscilloscope.	a. Set channel 2 ground trace equal to that of ground trace of channel 1. b. Set channel 2 vertical sensitivity to 0.5 V/division. c. Input selector: DC. d. Time base: INT. e. Coupling: DC. f. Slope: (+). g. Mode: AUTO.
b. Verify that the TP6 waveform (figure 3-14) has a peak-to-peak amplitude of 1.5 volts minimum to 2.0 volts maximum, as the carriage is moved back and forth between cylinders 000 and 200.	 Figure 3-14. TP6 Waveform If waveform is less than 1.5 volts peak-to-peak, recheck Lissajous pattern, step 24 through 30.

Table 3-3. Optical Transducer/Shutter Alignment (continued)

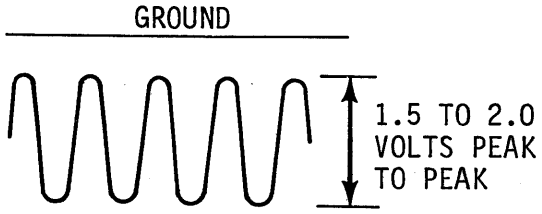
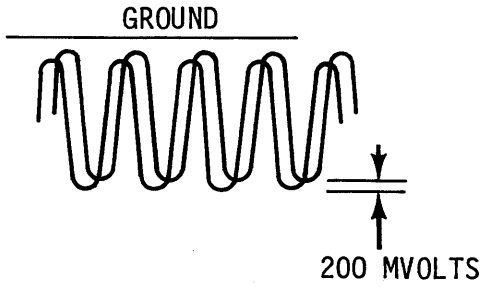
Procedure	Remarks
c. Verify that the TP7 (figure 3-25) waveform has a peak-to-peak amplitude of 1.5 volts to 2.0 volts as the carriage is moved back and forth between cylinders 000 and 200.	 Figure 3-15. TP7 Waveform If waveform is less than 1.5 volts peak-to-peak, recheck Lissajous pattern steps 24 through 30.
d. Setting both TP6 and TP7 waveforms on scope (figure 3-16) (MODE: CHOP), verify that the difference between the negative-peak amplitudes does not exceed 200 mv.	 Figure 3-16. Combined TP6 and TP7 Waveforms
33. HMPT Check Step.	
a. Set channel 1 scope probe to pin S of A4 circuit card.	Set oscilloscope to monitor channel 1 only.
b. Verify that the voltage at A4 pin S swings to -2.0 volts as the carriage is moved through Cylinder 000.	Move carriage slowly back and forth through Cylinder 000.
34. Power-down drive and reconnect actuator leads to power supply card.	a. Position carriage at crash-stop. b. Set cartridge switch to CARTRIDGE UNLOCK. c. Set power switch to POWER OFF position. d. Set rear ac switch to OFF position. e. Connect red lead to E13. f. Connect black lead to E14.

Table 3-3. Optical Transducer/Shutter Alignment (continued)

Procedure	Remarks
35. Power up drive, load heads, and reposition the cylinder indicator on top of actuator if necessary. 36. Verify proper head alignment by performing head alignment procedure.	Set front edge carriage indicator to scale indication 000, after heads load.

3.15 REMOVABLE DISC HEAD ASSEMBLY ALIGNMENT

The removable disc head assembly should be aligned after the replacement of the optical transducer block, the shutter assembly, a removable disc head, the disc spindle assembly, or the acturator assembly.

NOTE

It is not necessary to perform the steps to loosen the head/arm clamping screws in order to check head alignment. The head alignment tolerance is ±5%.

Table 3-4. Removable Disc Head Alignment

Procedure	Remarks
1. Remove user cartridge, remove power and extend drive to obtain access to back of drive.	a. Set cartridge switch to the CARTRIDGE UNLOCK. b. When CARTRIDGE UNLOCK lights, remove the cartridge. c. Set power switch to the POWER OFF position. d. Set ac switch to drive rear panel to OFF position.
2. Remove drive component cover.	
3. Insert test module interface cable into the J1 connector.	Set all test module switches to the OFF position.

CAUTION

With power OFF the operator must ensure that the heads are not forced off the head load cam while loosening the head clamping screws.

Table 3-4. Removable Disc Head Alignment (continued)

Procedure	Remarks
4. Loosen both removable disc head clamping screws using had clamping wrench (figure 3-17).	Leave head clamping screws snug but not tight.

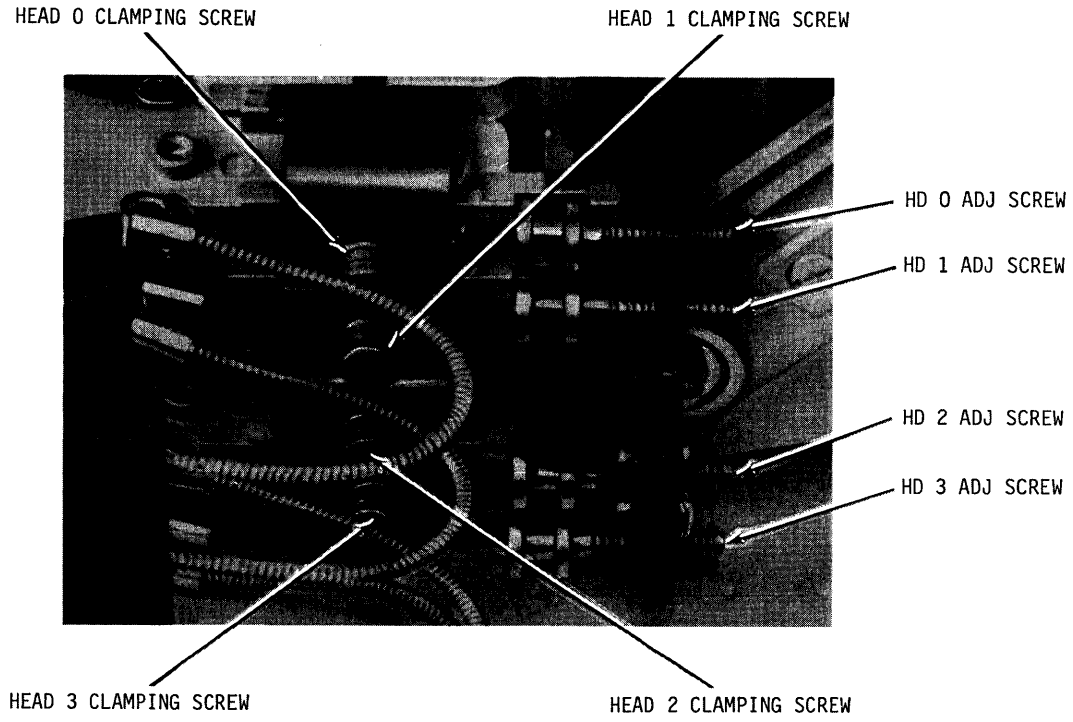


Figure 3-17. Head Adjusting Screw Location

5. Turn both head 0 and head 1 adjusting screws counterclockwise until the screws just begin to bind.	Insert screwdriver through cutout in the drive control logic circuit card (figure 3-17).
6. Power up drive, install alignment cartridge and load heads.	a. Set ac power switch to ON position. b. Set power switch to the POWER ON position. c. Install alignment cartridge. d. Set cartridge switch to LOCK position. e. Set test module MAINT switch ON (Heads will load approximately 5 seconds after placing MAINT switch to the ON position).

Table 3-4. Removable Disc Head Adjustment (continued)

Procedure	Remarks
NOTE 1 Do not perform step 7 through step 18 of this alignment procedure until the disc has been spinning for at least one hour.	This time allows for thermal expansion of the alignment cartridge.
NOTE 2 It is possible to enter statements at the VDT instead of using the test module.	When the VDT is used instead of the test module the Disc Drive Unit being aligned must be selected before step 7.
7. Set up oscilloscope to observe the read test points.	a. Channel 1: TP18 on Control Logic circuit card. b. Channel 2: TP19 on Control Logic circuit card. c. Sync: TP1 of A5 circuit card (+INDEX REM). d. Vertical: 0.2 V/division. e. Time Base: 5 mSec/division. f. Sync: EXT (+). g. Mode: ADD. h. Channel 2: INVERT.
8. When aligning a Model 2X15-100 Disc Drive Unit position heads to cylinder 105. When aligning a Model 2X15-200 Disc Drive Unit position heads to Cylinder 210.	a. Set test module CYLINDER ADDRESS switches to 64, 32, 8, and 1 to ON (128, 64, 16, and 2 to ON for Model 2X15-200. b. Set test module SELECT CYLINDER switch ON. c. Press test module RESET pushbutton. d. Press test module INITIATE pushbutton. e. The servo drives the heads to Cylinder 105 (210).
9. After positioning the heads at Cylinder 105, disable the cylinder accessing function.	Set the test module SELECT CYLINDER switch to the OFF position.
10. Select head 0.	a. Set the test module switches HEAD 1 and HEAD 2 to the OFF position. b. Set the SET HD/SCTR switch ON. c. The top head of the removable disc is now enabled to read.

Table 3-4. Removable Disc Head Adjustment (continued)

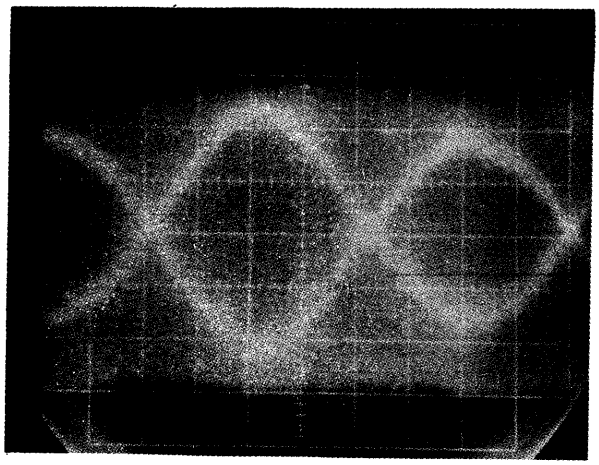
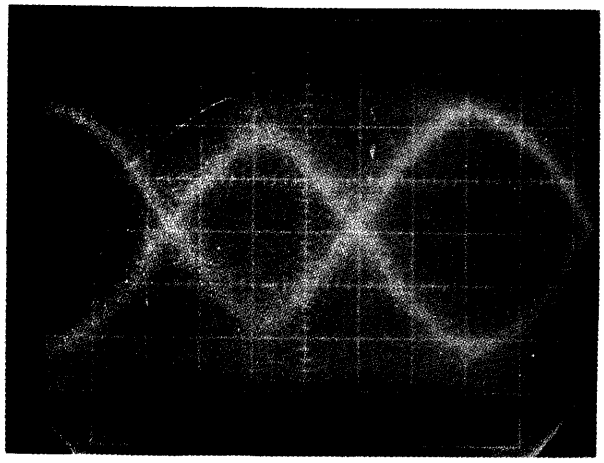
Procedure	Remarks
11. Turn head 0 adjusting screw clockwise until display begins to take shape of the waveform shown in figure 3-18.	 Figure 3-18. Waveform; Head 0.0003 Inch from Cylinder 105 (210)
12. Continue turning the screw clockwise until the oscilloscope display resembles the waveform shown in figure 3-19.	 Figure 3-19. Waveform; Head 0.0001 Inch from Cylinder 105 (210)

Table 3-4. Removable Disc Head Adjustment (continued)

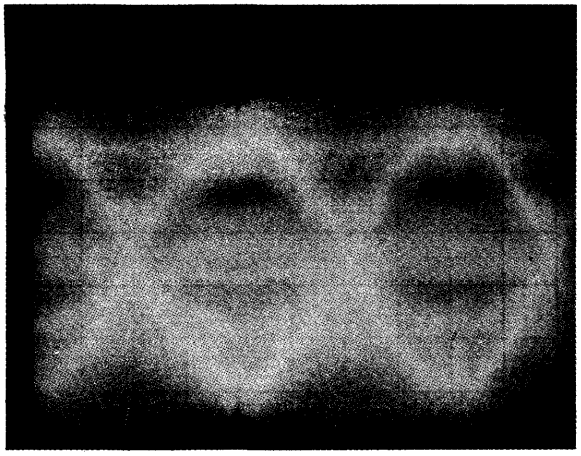
Procedure	Remarks
13. Make final adjustments on the screw by making the "A" value equal the "B" value (maximum allowable difference is 10%).	 Figure 3-20. Waveform for Correct Head Alignment
14. Back off head adjusting screw 1/2 turn.	The head assembly is held in position by the head clamp.
15. Using torque wrench, torque head clamping screw to 8 inch-pounds while observing the oscilloscope waveform.	a. Ensure tightening of the clamping screw does not effect head positioning (indicated by a change in the waveform shown in figure 3-20). b. Ensure that a space exists between adjacent head clamps (figure 3-17). c. If the waveform changes while tightening the clamping screw: 1. loosen clamping screw. 2. turn adjusting screw to obtain correct waveform. 3. repeat steps 14 and 15.
16. Select Head 1. Head 1 is aligned in the following steps.	a. Set test module switch Head 1 ON. b. Press RESET. c. Press INITIATE. d. The bottom head of the removable disc is now selected to read.
17. Using the head 1 adjusting screw, align head 1 using the procedures outlined in steps 11 through 15.	Head 1 is the head facing the bottom surface of the removable disc.
18. To ensure correct alignment, set the carriage to Cylinder 000, and then return the carriage to Cylinder 105 (210).	This will ensure that the carriage was not moved off track 105 (210) during the head adjustment.

Table 3-4. Removable Disc Head Adjustment (continued)

Procedure	Remarks
19. Verify that the CORRECT waveform is observed for both head 0 and head 1. 20. After successful head alignment, perform removable disc sector transducer alignment.	

3.16 REMOVABLE DISC SECTOR TRANSDUCER DELAY AND SECTOR PULSE 48 ALIGNMENT

The removable disc sector transducer delay alignment should be made whenever the removable disc sector transducer is moved or replaced. The sector pulse 48 position should be checked after the delay alignment is completed. Both alignments should be made whenever the interface circuit card is replaced.

Table 3-5. Removable Disc Transducer Alignments

Procedure	Remarks
1. Remove user cartridge, remove power and extend drive to access back of drive.	a. Set cartridge switch to the CARTRIDGE UNLOCK position. b. When CARTRIDGE UNLOCK lights, remove the cartridge. c. Set power switch to POWER OFF position. d. Set ac switch on drive back panel to the OFF position.
2. Remove drive component cover.	
3. Install test module to the J1 connector	Set all test module switches to the OFF position.
4. Power up drive, install alignment cartridge and load heads.	a. Set ac switch to ON position. b. Set power switch to POWER ON. c. Install alignment cartridge. d. Set cartridge switch to CARTRIDGE LOCK position. e. Set test module MAINT switch ON (heads will load approximately 5 seconds after placing MAINT switch to the ON position).

Table 3-5. Removable Disc Transducer Alignments (continued)

Procedure	Remarks
5. Set up oscilloscope to observe the read test points.	a. Channel 1: Pin 10 of A2 circuit card (LIM RD TP). b. Channel 2: Pin 11 of A2 circuit card (-LIM RD TP). c. Sync: TP1 of A5 circuit card (+INDEX REM). d. Vertical: 0.5 V/division. e. Time Base: 5 µSec/division. f. Mode: ADD. g. Sync: EXT (+). h. Channel 2: INVERT.
6. Position heads to Cylinder 100 (200).	a. Set test module SELECT CYLINDER switch ON. b. Set CYLINDER ADDRESS switches 64, 32, and 4 (128, 64, and 8) to ON. c. Press RESET, then INITIATE push-buttons.
7. Select head 0.	a. Set test module SELECT CYLINDER switch OFF. b. Set all CYLINDER ADDRESS switches OFF. c. Set SELECT HD/SECT switch ON. d. Press RESET, then INITIATE push-buttons.
8. Verify the time delay from the leading edge of the Index Pulse (Sync Point) to the synchronizing timing pulse peaks. The CORRECT timing pulse peaks. The nominal correct time delay is 30 ±5 micro-seconds from the start of sweep (figure 3-21), however, verify that time delay is within the range listed on the alignment cartridge being used. NOTE If head 0, or head 1 time delays are incorrect, perform adjust-ment procedure of step 11.	Ignore polarity of the timing pulse.

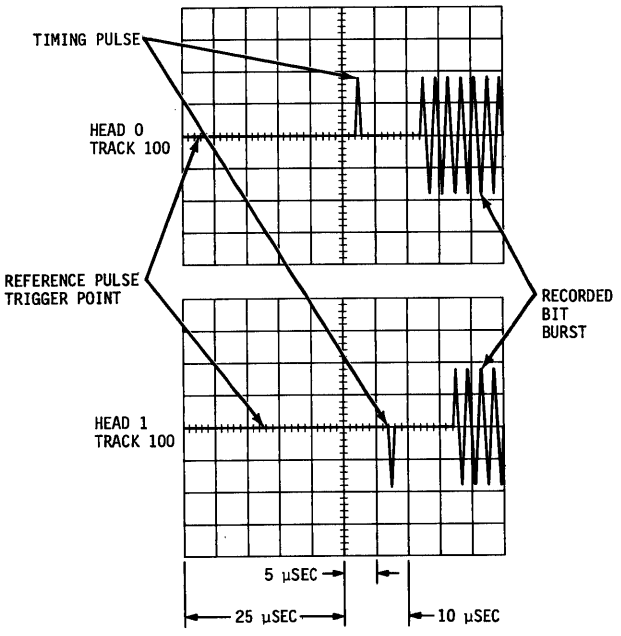


Figure 3-21. Timing Pulse Waveforms

Table 3-5. Removable Disc Transducer Alignment (continued)

Procedure	Remarks
9. Select head 1.	a. Set test module HEAD 1 switch ON. b. Press RESET, then INITIATE push-buttons.
10. Verify head 1 time delay by observing waveform of figure 3-21.	This verifies that head 1 timing pulse occurs 30 ±5 microseconds from the start of sweep.
11. Increase or decrease the delay of head 0 or head 1 TIMING PULSE by adjusting R3 on the A5 circuit card.	a. Turning adjusting screw clockwise increases the time between beginning of sweep and the TIMING PULSE. b. Observe oscilloscope pattern while performing the adjustment.
NOTE Since head 0 and head 1 TIMING PULSE delays are controlled by R3, it may be necessary to alternately switch from head 0 to head 1 to obtain the CORRECT waveform (figure 3-21).	
12. Set up oscilloscope to measure index delay one-shot output.	a. Channel 1: U14 pin 9 on A5 circuit card. b. Sync: TP1 of A5 circuit card. c. Vertical: 1 V/division d. Time Base: 50 µSec/division. e. Sync: EXT +.
13. Adjust R22 on A5 circuit card for 205 microsecond negative pulse.	Adjusts delay from index pulse to forty-eighth sector pulse.
14. Check equal spacing of sector pulses.	a. Channel 1: V3 pin 6 on A5 circuit card. b. Time Base: 1 mSec/division. c. Verify equal spacing between pulses. d. Time Base: 5 mSec/division. e. Check for equal spacing.
15. Readjust R22 if necessary to obtain equal spacing between sector pulses.	

3.17 ACCESS TIME ALIGNMENT

The access time alignment should be performed whenever the actuator, the A3 circuit card, or the A4 circuit card is replaced.

Table 3-6. Access Time Alignment

Procedure	Remarks
1. Remove power and extend drive to obtain access to back of drive.	a. Set cartridge switch to the CARTRIDGE UNLOCK. b. When CARTRIDGE UNLOCK lights, remove the disc cartridge. c. Set power switch to the POWER OFF position. d. Set ac switch on drive rear panel to OFF position.
2. Remove drive component cover.	
3. Insert test module interface cable into J1 connector.	Set all test module switches to the OFF position.
4. Connect one scope probe between TP4 (POS DR) of A4 circuit card and channel 1 of oscilloscope.	
5. Connect second scope probe between pin E (ACCESS READY) of A5 circuit card and channel 2 of oscilloscope.	
6. Connect third scope probe between pin P (SET CYLINDER) of A5 circuit card and EXT SYNC on oscilloscope.	
7. Set oscilloscope controls to the following:	a. Channel 1 Vertical Sensitivity to 2 V/division. b. Channel 2 Vertical Sensitivity to 2 V/division. c. Time base to 10 mS/division. d. Sync: EXT (-). e. Mode: Chop.
8. Power up drive.	a. Set power switch on rear panel of drive to ON position. b. Set switch to POWER ON position. c. Set switch to CARTRIDGE LOCK position. d. Set test module MAINT switch to ON (Heads will load approximately 5 seconds after placing MAINT switch to the ON position).
9. Set test module switch to perform an automatic seek operation from track 0 to track 67 (134) to verify.	a. Set test module CYLINDER ADDRESS switches 64, 2, and 1 (128, 4, and 2) to ON. b. Set test module SELECT CYLINDER switch ON.

Table 3-6. Access Time Alignment (continued)

Procedure	Remarks
	c. Press test module RESET pushbutton. d. Press test module INITIATE push-button. e. The servo drives the heads between tracks 0 and 67 for -100 Models, or tracks 0 and 134 for -200 Models.
10. Verify that average access time without overshoot is less than: 35 mSec maximum	
11. If overshoot or access time is greater than allowable, adjust potentiometer R77 on A3 circuit card to obtain a waveform similar to the one shown in figure 3-22.	a. Sync on pin 4 (LINEAR ZONE ENABLE) of A3 circuit card. b. Set Time Base to 5 mSec/division.

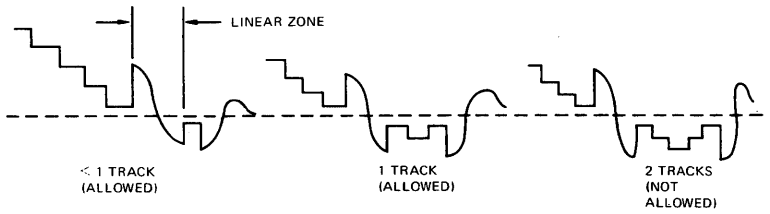


Figure 3-22. Access Time Waveforms

3.18 REMOVABLE DISC HEAD-ARM ASSEMBLY REMOVAL

1. Remove disc cartridge from drive.
2. Remove drive power and extend drive to obtain access to back of drive.
3. Remove six screws securing component cover to drive chassis. Remove component cover.
4. Remove two screws securing head lead support bracket (figure 3-1).
5. Remove four screws securing drive control logic circuit card to mounting bracket and slide all PC Cards toward rear of drive.
6. Remove the A1 and A2 circuit cards from connectors.
7. Disconnect J0 through J3 head cable connectors from the A2 circuit card (figure 3-1).

8. Loosen two screws securing the head adjusting bracket and remove the bracket out the appropriate head cable (hd 0 or hd 1).

CAUTION

When performing step 9, hold carriage assembly against rear crash-stop while removing two screws securing the head adjusting bracket.

9. Remove two screws securing the head adjusting bracket and remove the bracket (figure 3-23)

10. Remove the appropriate head clamping screw (hd 0 or hd 1) holding the head clamp. Remove clamp from head-arm assembly (figure 3-23).

CAUTION

Use extreme care while removing the head-arm assembly to prevent damage to the head not being replaced.

11. Hold the carriage assembly against rear crash-stop and slide the head-arm assembly slightly forward (toward disc spindle). After the locating tab of the head-arm stiffener clears the carriage, slide head-arm assembly out toward back of drive (figure 3-24).

3.19 REMOVABLE DISC HEAD-ARM REPLACEMENT

1. Insert adjusting tab end of the head-arm into the carriage slot (figure 3-24).
2. Position the slide spring of the head-arm against the head load cam.
3. Applying a slight amount of pressure at the center of the head-arm (in direction perpendicular to head motion) slide the head-arm assembly towards back of drive. Ensure that the head-arm locating tab is within the carriage slot (figure 3-24).
4. Reassemble drive by performing in reverse order steps 4 through 10 of paragraph 3.18.

NOTE

a. Position each adjusting screw in the center of the adjusting tab slot.

b. Adjust the twist in the head cable springs such that the cables do not make contact with the A2 circuit card, baseplate, or the carriage, when the carriage is in motion.

5. Perform removable disc head-arm alignment.

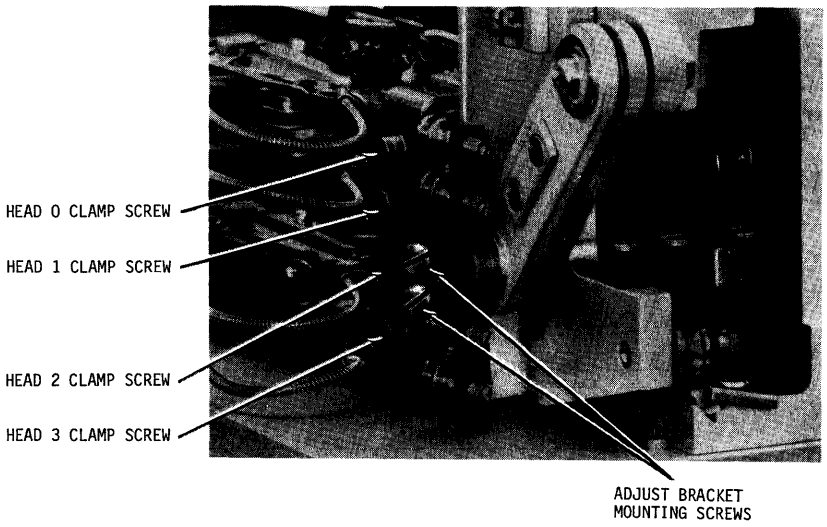


Figure 3-23. Mounting Screws for Head Clamps and Adjusting Bracket

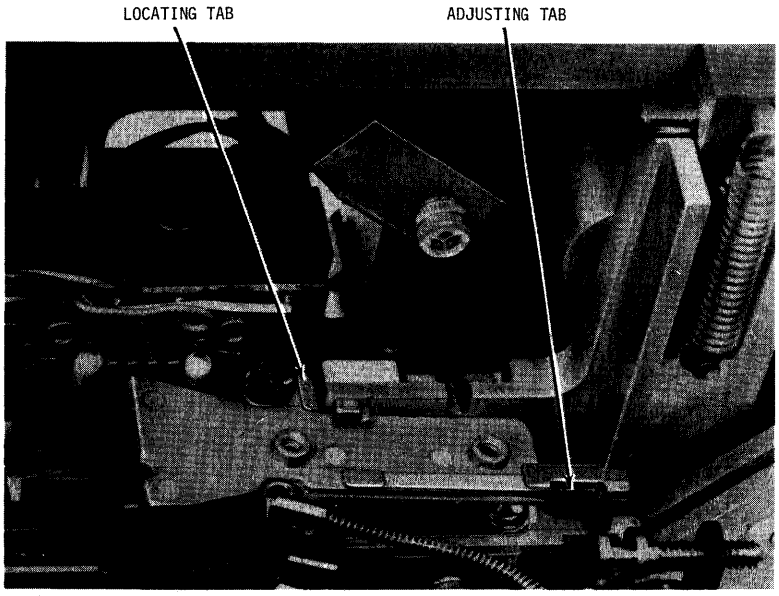


Figure 3-24. Head Removal and Replacement

3.20 FIXED DISC HEAD-ARM ASSEMBLY REMOVABLE

1. Remove disc cartridge from drive.
2. Remove drive power and extend drive to obtain access to back of drive.
3. Remove six screws securing component cover to drive chassis. Remove component cover.
4. Remove two screws securing head lead support bracket to drive chassis (figure 3-1).
5. Remove four screws securing drive control logic circuit card to mounting bracket and slide all PC cards toward rear of drive.
6. Remove the A1 and A2 circuit cards from connectors.
7. Disconnect J0 and J3 head cable connectors from the A2 circuit card (figure 3-1).
8. Loosen two screws mounting head wire cable to the support bracket and slide out the appropriate head cable (hd 2 or hd 3).

CAUTION

When performing step 9, hold carriage assembly against rear crash-stop while removing two screws securing the head adjusting bracket.

9. Remove two screws securing the head adjusting bracket and remove the bracket (figure 3-23).
10. Remove the appropriate head clamping screw (hd 2 of hd 3) holding the head clamp. Remove clamp from head-arm assembly (figure 3-23).

CAUTION

Use extreme care while removing the head-arm assembly to prevent damage to the head not being replaced.

11. Hold the carriage assembly against rear crash-stop and slide the head-arm assembly slightly forward (toward disc spindle). After the locating tab of the head-arm stiffener clears the carriage, slide head-arm assembly out toward back of drive (figure 3-24).

3.21 FIXED DISC HEAD-ARM ASSEMBLY REPLACEMENT

1. Insert adjusting tab end of the head-arm into the carriage slot (figure 3-24).
2. Position the slide spring of the head-arm on top of the head load cam (figure 3-24).
3. Applying a slight amount of pressure at the center of the head-arm (in the direction perpendicular to head motion) slide the head-arm assembly towards back of drive. Ensure that the head-arm locating tab is within the carriage slot (figure 3-24).

4. Replace head adjusting mounting bracket.
5. Position each adjusting screw in the center of the adjusting tab slot.
6. Replace head clamp and tighten head clamping screw snug but not tight.
7. Turn the head adjusting screw of the head replaced counterclockwise until screw just begins to bind.
8. Turn head adjusting screw clockwise four complete revolutions (this will set the adjusting tab in the center of the carriage bar).
9. Reassemble drive by performing in reverse order steps 1 through 8 of paragraph 3.20.

NOTE

Previously recorded data may be recovered from the fixed disc after head-arm replacement by performing the following steps prior to installing component cover.

a. Power up drive and install disc cartridge
b. Loosen the appropriate head clamp.
c. Turn the head adjusting screw counterclockwise until screw just begins to bind.
d. Load heads and enable appropriate head.
e. Set up oscilloscope as in step 7 of table 3-4 except sync negative on pin 14 of A5 circuit card.
f. Turn adjusting screw clockwise until maximum amplitude is obtained at track 0.
g. Tighten head clamping screw (ensure that the amplitude remains maximum).

10. Perform disc diagnostic.

3.22 ACTUATOR ASSEMBLY REMOVAL

1. Remove disc cartridge from drive.
2. Remove drive power and extend drive to obtain access to back and bottom of drive.
3. Remove nine screws securing bottom cover to drive chassis.
4. Remove the red lead from E13 and the black lead from E14 on the power supply card (figure 3-8).
5. Remove six screws securing component cover to drive chassis. Remove cover.
6. Remove screw securing head cable bracket to drive chassis (figure 3-1).
7. Remove four screws securing drive control logic circuit card to mounting bracket.
8. Remove A1 through A5 circuit cards from drive control logic circuit card.

9. Remove head connector cables (J0 through J3) from the A2 circuit card (figure 3-1).
10. While holding carriage assembly against rear crash-stop, insert head spacers between the removable disc heads and the fixed disc heads (figure 3-2).
11. Remove screw mounting front of actuator frame to drive chassis (figure 3-11).
12. Position carriage forward until rear mounting screw is accessible and remove mounting screw (figure 3-26).
13. Slide entire actuator assembly towards rear of drive.

NOTE

Actuator must be held in erect position to prevent it from tipping over.

14. Disconnect connector B4 from drive control logic card (figure 3-25).
15. Pull red and black leads from dc motor through access hole and remove actuator assembly from drive.

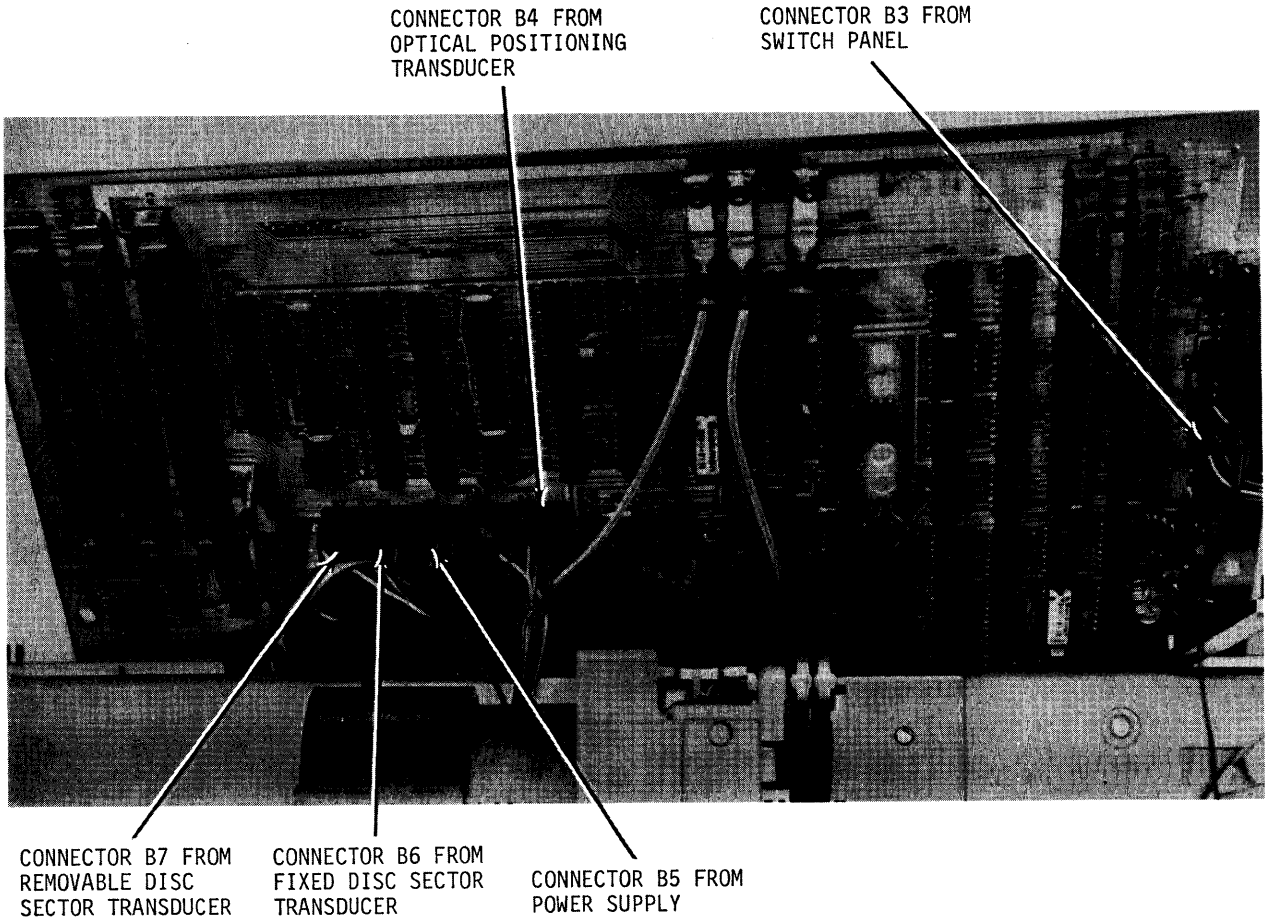


Figure 3-25. Drive Control Logic Circuit Card Connector Location

3.23 ACTUATOR ASSEMBLY REPLACEMENT

1. Perform in reverse order steps 6 through 15 of paragraph 3.22.

NOTE

The actuator assembly is properly aligned when the actuator frame is positioned against the two alignment pins.

2. Verify correct alignment of the optical positioning transducer block assembly, shutter assembly, and removable disc heads.

3.24 OPTICAL POSITIONING TRANSDUCER REMOVAL

1. Remove disc cartridge from drive.
2. Remove drive power and extend drive to obtain access to back of drive.
3. Perform steps 5 through 14 of the actuator assembly removal and replacement procedure, paragraph 3.22.
4. Remove screw securing optical positioning transducer block to actuator frame (figure 3-10).
5. Slide transducer block out towards front of drive (figure 3-27).
6. Temporarily remount actuator assembly to drive chassis by guiding the actuator forward along two guide pins and temporarily securing rear actuator frame mounting screw.
7. Loosen two screws securing shutter assembly to shutter adjusting bracket (figure 3-11).
8. Position shutter assembly towards the actuator and temporarily tighten the two mounting screws.

3.25 OPTICAL POSITIONING TRANSDUCER REPLACEMENT

1. Remount optical positioning transducer assembly by performing in reverse order steps 4, 5 and 6 of paragraph 3.24.
2. Reassemble remaining drive components by performing in reverse order steps 6 through 14 of paragraph 3.22.
3. Verify correct alignment of optical positioning transducer assembly, shutter assembly and removable disc heads by performing alignments of tables 3-3 and 3-4.

3.26 SHUTTER ASSEMBLY REMOVAL

1. Remove disc cartridge.
2. Remove power and extend drive to obtain access to back of drive.
3. Perform steps 5 through 13 of the actuator assembly removal and replacement procedure, paragraph 3.22.
4. Remove screw securing optical positioning transducer block to actuator frame (figure 3-10).

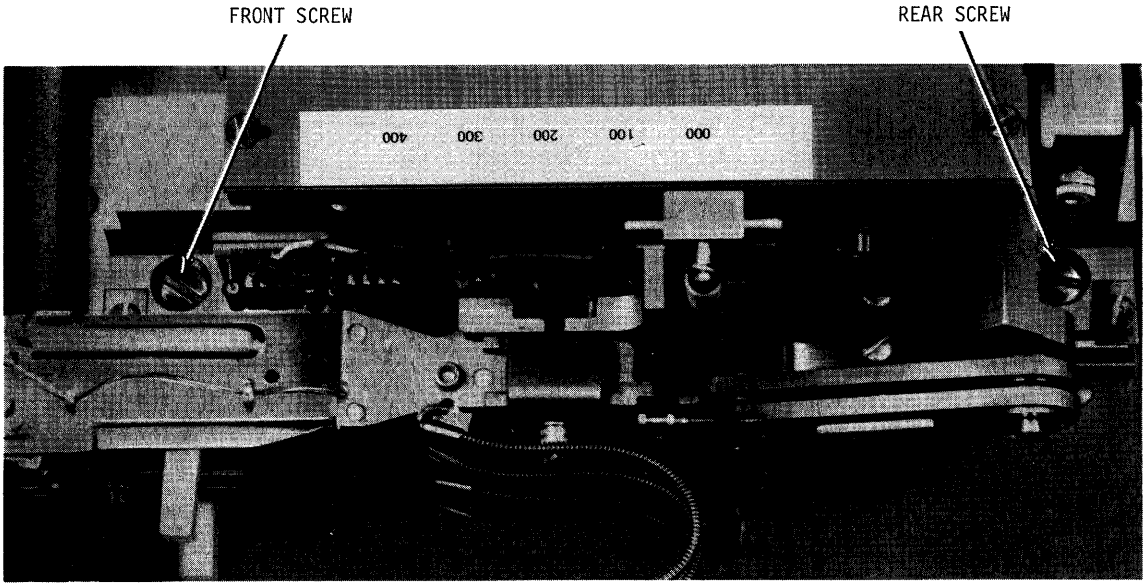


Figure 3-26. Actuator Mounting Screws

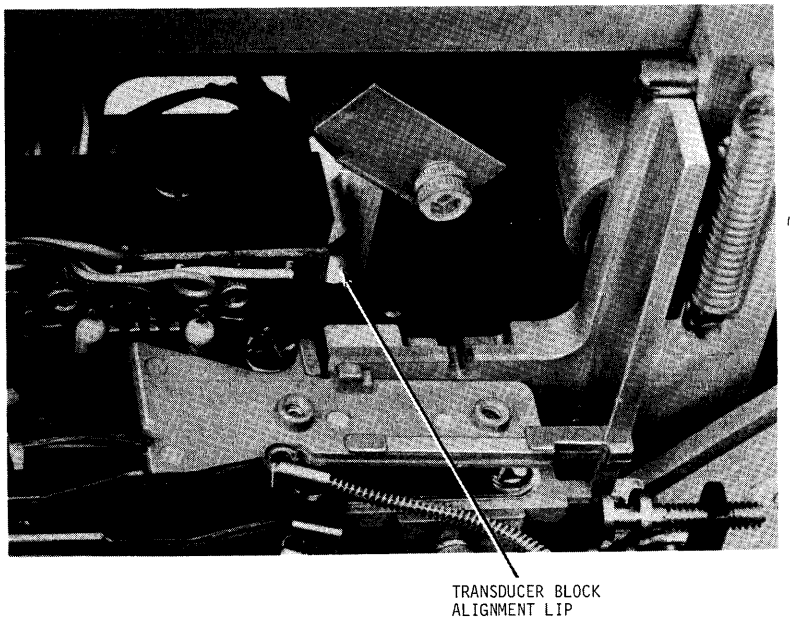


Figure 3-27. Optical Positioning Transducer Removal and Replacement

5. Remove transducer block by sliding it out towards front of drive (figure 3-26). Place transducer block out of the way.
6. Temporarily remount actuator assembly to chassis by guiding the actuator forward along two guide pins and temporarily securing rear actuator frame mounting screw.
7. Loosen rear shutter adjusting bracket mounting screw two turns (figure 3-28).
8. Position carriage towards rear of drive.
9. While holding shutter assembly at back of drive, loosen front shutter adjusting bracket mounting screw until shutter separates from carriage (figure 3-28).
10. Slide shutter assembly out from back of drive.
11. Remove two screws securing shutter to adjusting bracket and remove shutter.

3.27 SHUTTER ASSEMBLY REPLACEMENT

NOTE

Do not touch flat surfaces of the glass shutter.

1. Place shutter assembly on adjusting bracket such that the shutter is positioned away from the bracket and temporarily tighten the two screws.
2. Position carriage assembly toward back of drive.
3. Position the shutter assembly forward along the carriage assembly until the shutter adjusting bracket tab is positioned under the rear mounting screw.
4. Tighten rear shutter adjusting bracket mounting screw temporarily.
5. Tighten front shutter adjusting bracket mounting screw while holding adjusting bracket against the carriage.

NOTE

Do Not Touch Glass Shutter.

6. Tighten rear shutter adjusting bracket mounting screw.
7. Replace optical positioning transducer block assembly by performing in reverse orders steps 4 and 5 of paragraph 3.26.
8. Reassemble remaining drive components by performing in reverse order steps 6 through 12 of paragraph 3.22.
9. Verify correct alignment of the optical positioning transducer assembly, shutter assembly and removable disc heads by performing alignments of tables 3-3 and 3-4.

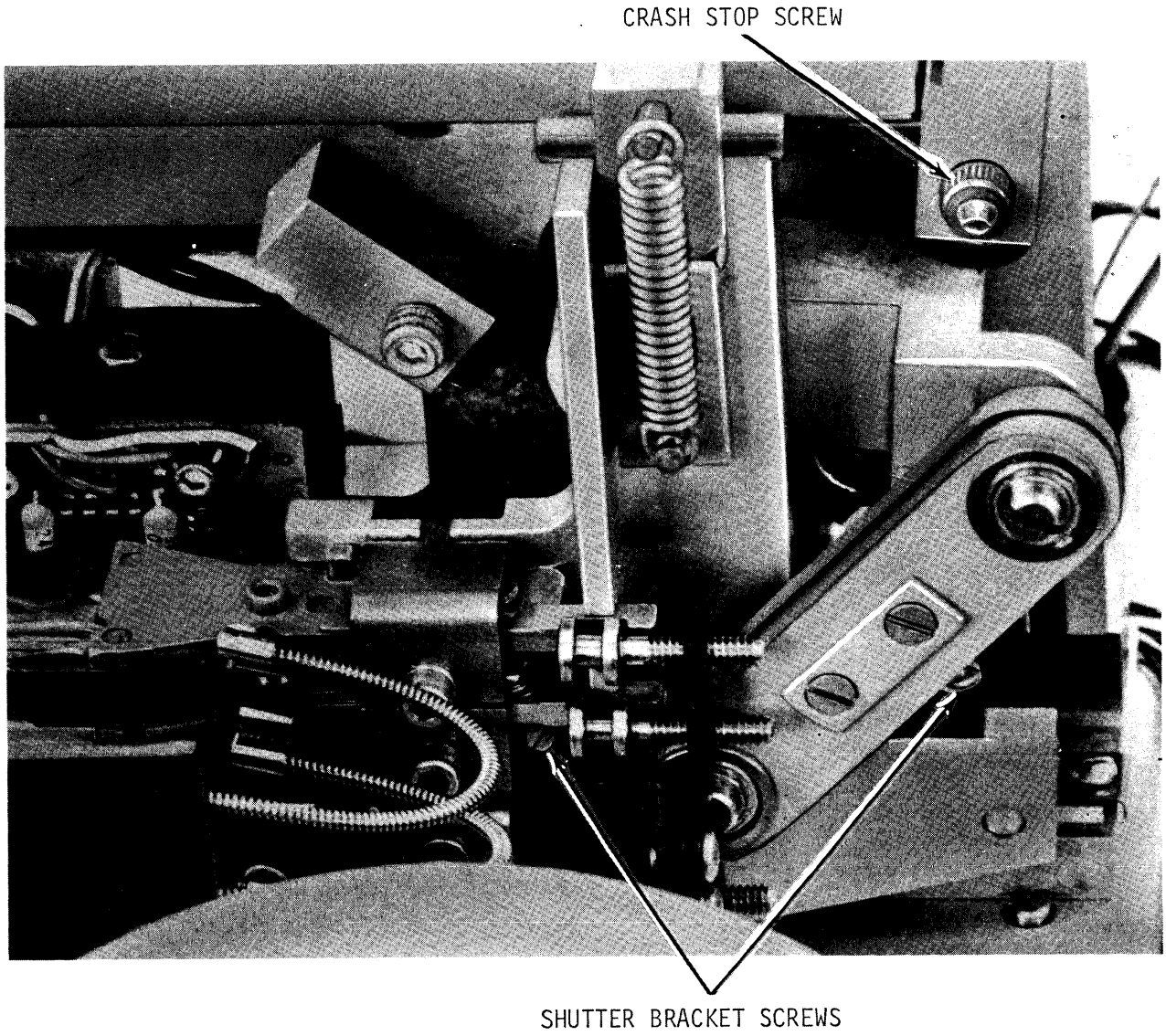


Figure 3-28. Shutter Removal, Crash-Stop and Shutter Adjusting Bracket Mounting Screws

3.28 SPIN MOTOR REMOVAL

1. Remove disc cartridge from drive.
2. Remove power and extend drive to obtain access to back and bottom of drive.
3. Remove nine screws securing bottom cover to drive chassis and remove bottom cover.
4. Remove six screws securing component cover to chassis. Remove cover.
5. Remove two screws securing switch/fuse assembly to chassis (figure 3-5). Position switch/fuse assembly such that access can be made to the motion plate mounting screws.
6. Loosen three screws securing the spin motor spring-loaded mounting bracket to chassis (figure 3-6).
7. While pushing spin motor toward actuator, remove drive belt from around pulley.
8. Remove four screws securing the spin motor to the mounting bracket (figure 3-29).
9. Remove four wires from spin motor as follows:
   a. blue wire - terminal 1 of spin motor start relay.
   b. red wire - terminal 2 of spin motor start relay.
   c. black/yellow wire - terminal 7 of the power transformer (60 Hz configuration).
   d. green wire from spin motor frame.
10. Remove spin motor assembly through top of drive chassis.

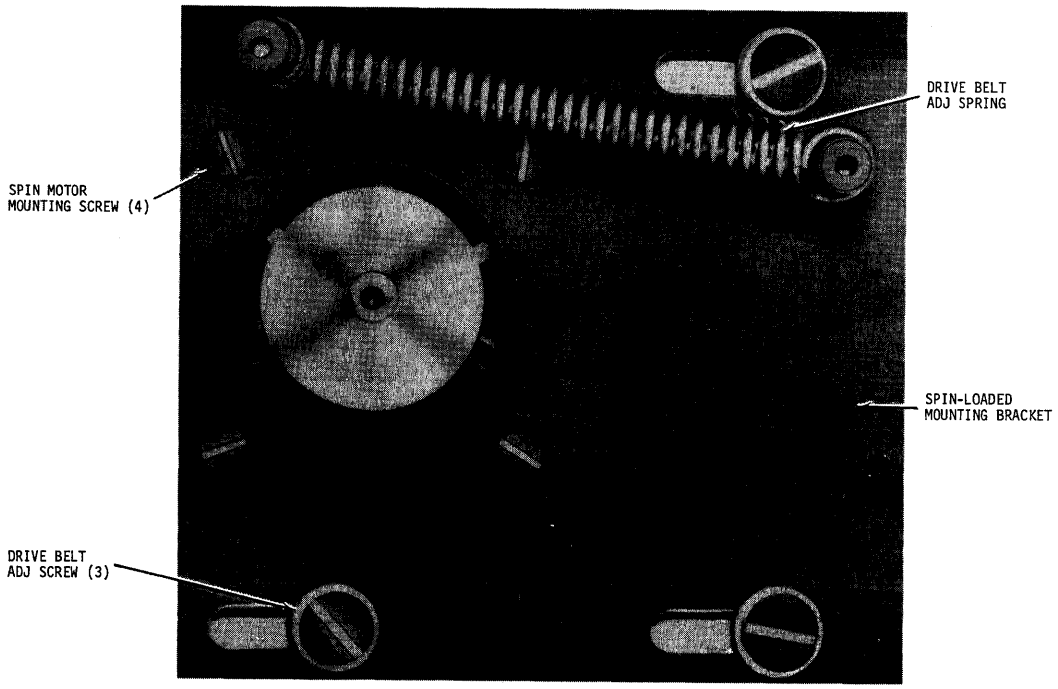


Figure 3-29. Spin Motor Mounting Screws

3.29 SPIN MOTOR REPLACEMENT

1. Perform in reverse order steps 7 through 10 of paragraph 3.28.
2. Leaving the three screws that secure the spin motor spring-loaded mounting bracket to chassis loose, temporarily install the switch/fuse assembly. Ensure that the drive is in an upright position.
3. Place the drive in normal operation by setting ac switch to ON position, the power switch to POWER ON, and the spin motor switch to CARTRIDGE LOCK position.
4. Verify that the belt tension spring automatically shifts the motor to the correct belt tension.
5. Remove ac power by setting the spin motor switch to CARTRIDGE UNLOCK position, power switch to POWER OFF and ac switch to OFF position.
6. Remove two screws securing switch/fuse assembly to drive chassis.
7. Perform in reverse order steps 1 through 6 of paragraph 3.28.

3.30 FIXED DISC REMOVAL

Replacement of the fixed disc requires that the fixed disc spindle assembly be replaced as a unit. Removing the disc spindle assembly involves removing several assemblies; therefore, this procedure provides the removal procedure for those assemblies.

1. Remove disc cartridge.
2. Remove power, extend drive and disconnect power cable. If rack-mounted, remove drive and place on work bench.
3. Using 1/8-inch allen wrench, remove six screws securing component cover to drive chassis and remove cover.
4. Remove nine screws securing bottom cover to drive chassis. Turn drive on its side and remove bottom cover.
5. Remove fixed disc sector pulley assembly (figure 3-30).
   a. Remove drive belt from around fixed disc sector pulley assembly.
   b. Loosen two set screws securing fixed disc sector transducer and slide sector transducer out of the way.
   c. Using 1/16-inch allen wrench, loosen two set screws located in sector pulley.
   d. Using 5/32-inch allen wrench, remove allen head screw securing fixed disc sector pulley assembly to the disc spindle assembly. Pull off the fixed disc sector pulley.
6. Place drive in upright position to remove fixed disc cover assembly and proceed as follows.

CAUTION

Ensure that the carriage assembly is against the rear crash-stop.

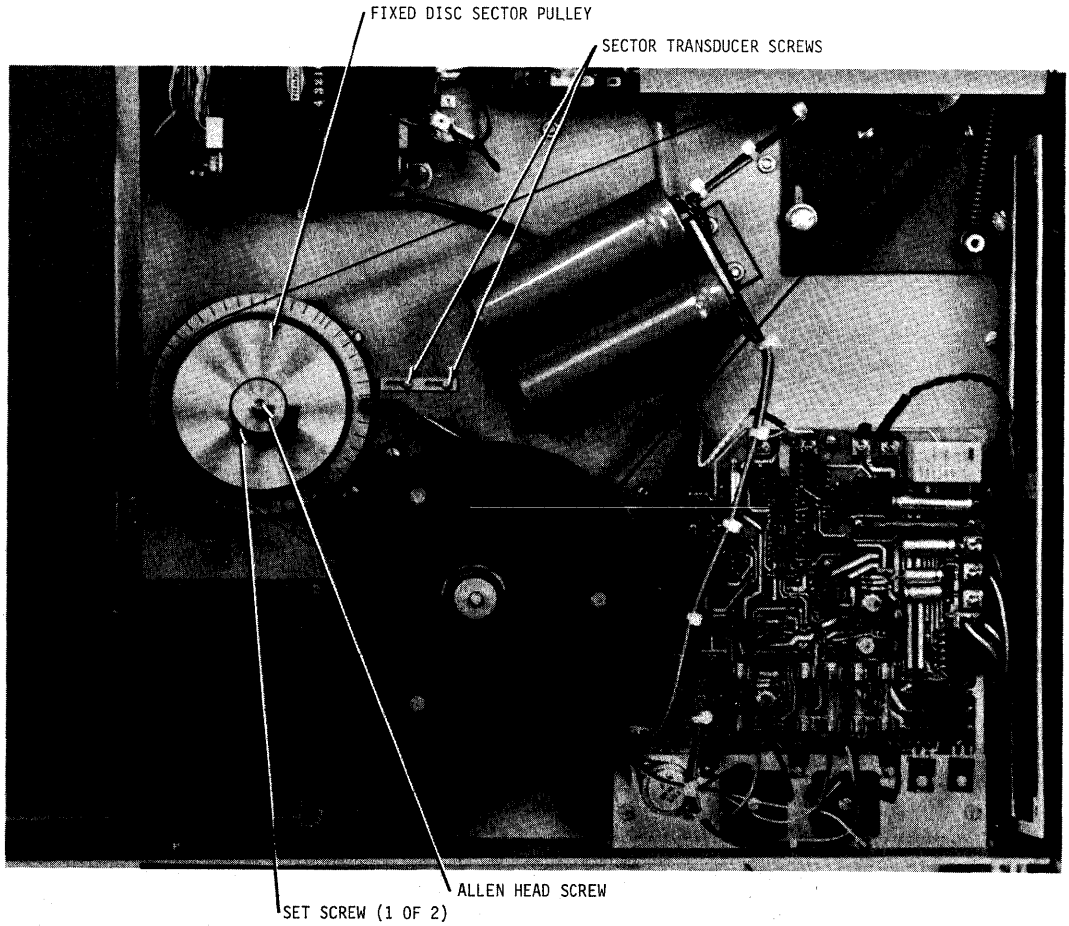


Figure 3-30. Fixed Disc Removal; Fixed Disc Sector Transducer and Sector Pulley

a. With receiver handle in the up position, remove two springs holding receiver assembly (figure 3-31).

TO BE SUPPLIED

Figure 3-31. Fixed Disc Removal; Receiver Cover

b. Lift up receiver assembly to gain access to four screws (figure 3-32).

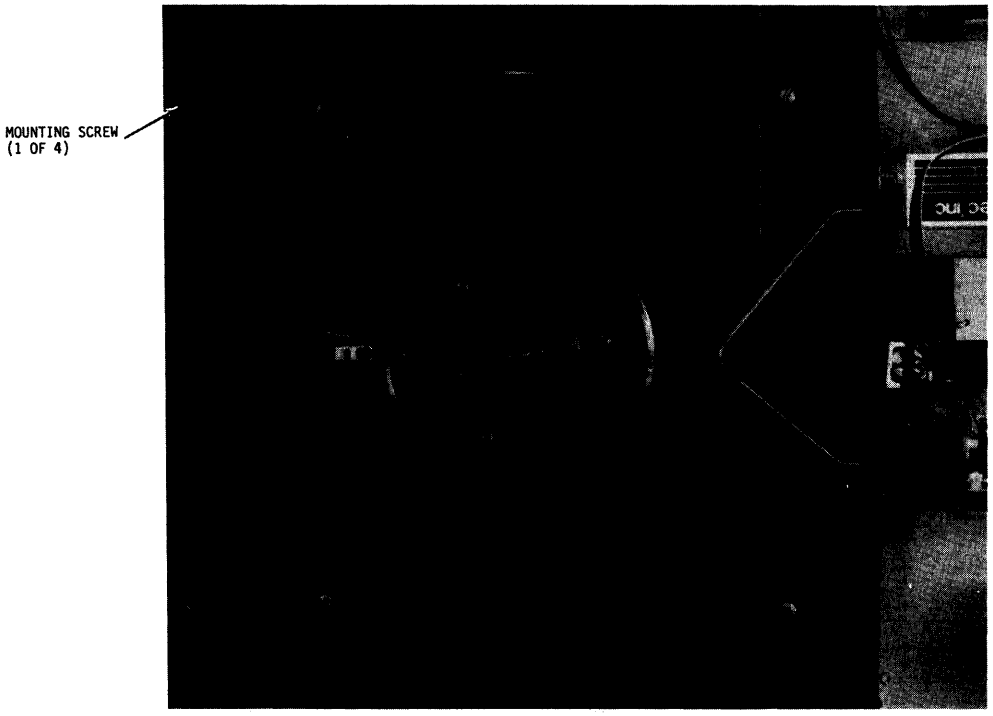


Figure 3-32. Fixed Disc Removal; Fixed Disc Cover

c. Loosen two screws holding one of the receiver brackets, slide bracket away from receiver until the flange bearing comes out. Then, remove receiver cover.

d. After identifying wire destination, remove the blue and violet leads from the solenoid.

e. After identifying wire destination, remove both red leads from the microswitch.

f. Remove latch linkage from fixed disc cover assembly (figure 3-31).

g. Disconnect B7 connector from the drive control logic circuit card (figure 3-25).

h. Remove four screws securing fixed disc cover to drive chassis and remove fixed disc cover (figure 3-32).

NOTE

Four spacers are located under the fixed disc cover assembly.

7. Extend drive over the work bench such that the disc spindle is accessible from the bottom.

8. Using 5/32-inch allen wrench, remove three screws securing the disc spindle assembly to the chassis (figure 3-33).

9. Push fixed disc and disc spindle (as a unit) out through the top of the chassis.

TO BE SUPPLIED

Figure 3-33. Fixed Disc Removal; Disc Spindle Mounting Screws

3.31 FIXED DISC ASSEMBLY REPLACEMENT

Before replacing the fixed disc assembly thoroughly clean interior of drive by vacuuming first then wiping interior with alcohol dampened lintless cloth.

CAUTION

Do not touch the surfaces of the disc. Grasp the disc spindle by the shaft.

1. Install the disc spindle through the top of the drive.
2. Install the fixed disc sector pulley.

CAUTION

Exercise care when installing the fixed disc cover to avoid contact between the spacers and disc surfaces.

3. Align the four fixed disc cover spacers with chassis mounting holes.

CAUTION

Ensure that the carriage assembly is positioned against the rear crash-stop.

4. Install fixed disc cover. Temporarily tighten the four screws.
5. Connect B7 connector to drive control logic circuit card.
6. Connect the red leads to the appropriate microswitch contacts.
7. Connect the blue and violet leads to the appropriate solenoid contacts.
8. Connect the latch link from the solenoid to the fixed disc cover assembly.
9. Install receiver assembly as follows:
   a. Align the two flange bearings with the receiver assembly mounting brackets and tighten the four screws.
   b. Align the microswitch on the fixed disc cover such that the microswitch contacts are made when the receiver assembly is in place.
   c. Install the two springs and four anchors.
10. Slide fixed disc sector transducer all the way forward and tighten the two screws.

CAUTION

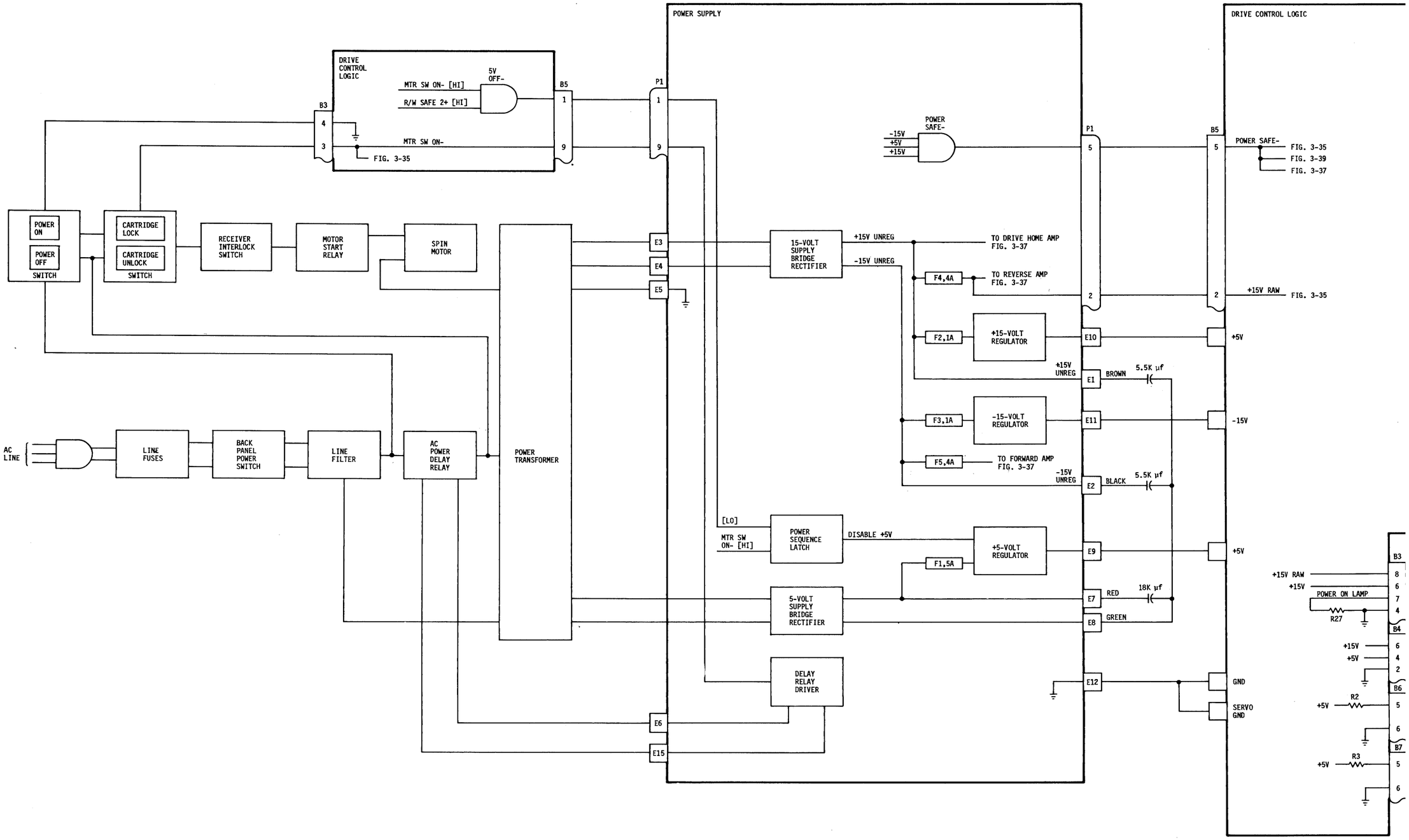
Ensure that clearance exists between the sector transducer and the sector pulley assembly.

11. Install drive belt.
12. Install component cover.
13. Install drive into cabinet.

14. Perform removable disc head-arm alignment procedure in accordance with table 3-4.
15. Install users cartridge and perform initialization of the fixed disc and the surface test diagnostic.

3.32 DRIVE BELT REPLACEMENT

1. Remove disc cartridge.
2. Remove drive power and extend drive to obtain access to back and bottom of drive.
3. Remove nine screws securing bottom cover. Remove cover.
4. Remove six screws securing component cover. Remove cover.
5. Remove two screws securing switch/fuse assembly to chassis (figure 3-5). Position switch/fuse assembly such that cables are not stretched and access can be made to the spin motor mounting bracket.
6. Loosen three screws securing the spin motor spring-loaded mounting bracket to chassis (figure 3-29).
7. While pushing spin motor toward actuator, remove drive belt from around pulley.
8. After marking, remove four wires from capacitor assembly.
9. Remove one screw (nearest disc spindle) securing one leg of the blower assembly.
10. Loosen the other screws securing two legs of the blower assembly.
11. Replace new drive belt by performing in reverse order step 7 through 10 above.
12. Leaving the three screws that secure the spin motor spring-loaded mounting bracket to chassis loose, temporarily install the switch/fuse assembly. Ensure that the drive is in an upright position.
13. Place the drive in normal operation by setting rear panel ac power switch to ON position, the power switch to POWER ON, and the spin motor switch to CARTRIDGE LOCK position.
14. Verify that the belt tension spring automatically shifts the motor to the correct belt tension.
15. Remove ac power by setting the spin motor switch to CARTRIDGE UNLOCK position, power switch to POWER OFF and ac switch to OFF position.
16. Remove two screws securing switch/fuse assembly to drive chassis.
17. Perform in reverse orders steps 1 through 6 above.


POWER SUPPLY
DRIVE CONTROL LOGIC
DRIVE CONTROL LOGIC
MTR SW ON- [HI]
R/W SAFE 2+ [HI]
5V OFF-
MTR SW ON-
FIG. 3-35
B3
B5
P1
POWER ON
POWER OFF
SWITCH
CARTRIDGE LOCK
CARTRIDGE UNLOCK
SWITCH
RECEIVER INTERLOCK SWITCH
MOTOR START RELAY
SPIN MOTOR
AC LINE
LINE FUSES
BACK PANEL POWER SWITCH
LINE FILTER
AC POWER DELAY RELAY
POWER TRANSFORMER
E3
E4
E5
E6
E15
15-VOLT SUPPLY BRIDGE RECTIFIER
+15V UNREG
-15V UNREG
POWER SAFE-
-15V
+5V
+15V
TO DRIVE HOME AMP FIG. 3-37
F4,4A
TO REVERSE AMP FIG. 3-37
F2,1A
+15-VOLT REGULATOR
E10
+15V UNREG
E1
BROWN
5.5K µf
F3,1A
-15-VOLT REGULATOR
E11
F5,4A
TO FORWARD AMP FIG. 3-37
-15V UNREG
E2
BLACK
5.5K µf
[LO]
MTR SW ON- [HI]
POWER SEQUENCE LATCH
DISABLE +5V
+5-VOLT REGULATOR
F1,5A
E9
5-VOLT SUPPLY BRIDGE RECTIFIER
E7
RED
18K µf
E8
GREEN
DELAY RELAY DRIVER
E12
P1
5
2
B5
5
2
POWER SAFE-
FIG. 3-35
FIG. 3-39
FIG. 3-37
+15V RAW
FIG. 3-35
+5V
-15V
+5V
GND
SERVO GND
B3
+15V RAW
8
+15V
6
POWER ON LAMP
7
R27
4
B4
+15V
6
+5V
4
2
B6
R2
+5V
5
6
B7
R3
+5V
5
6

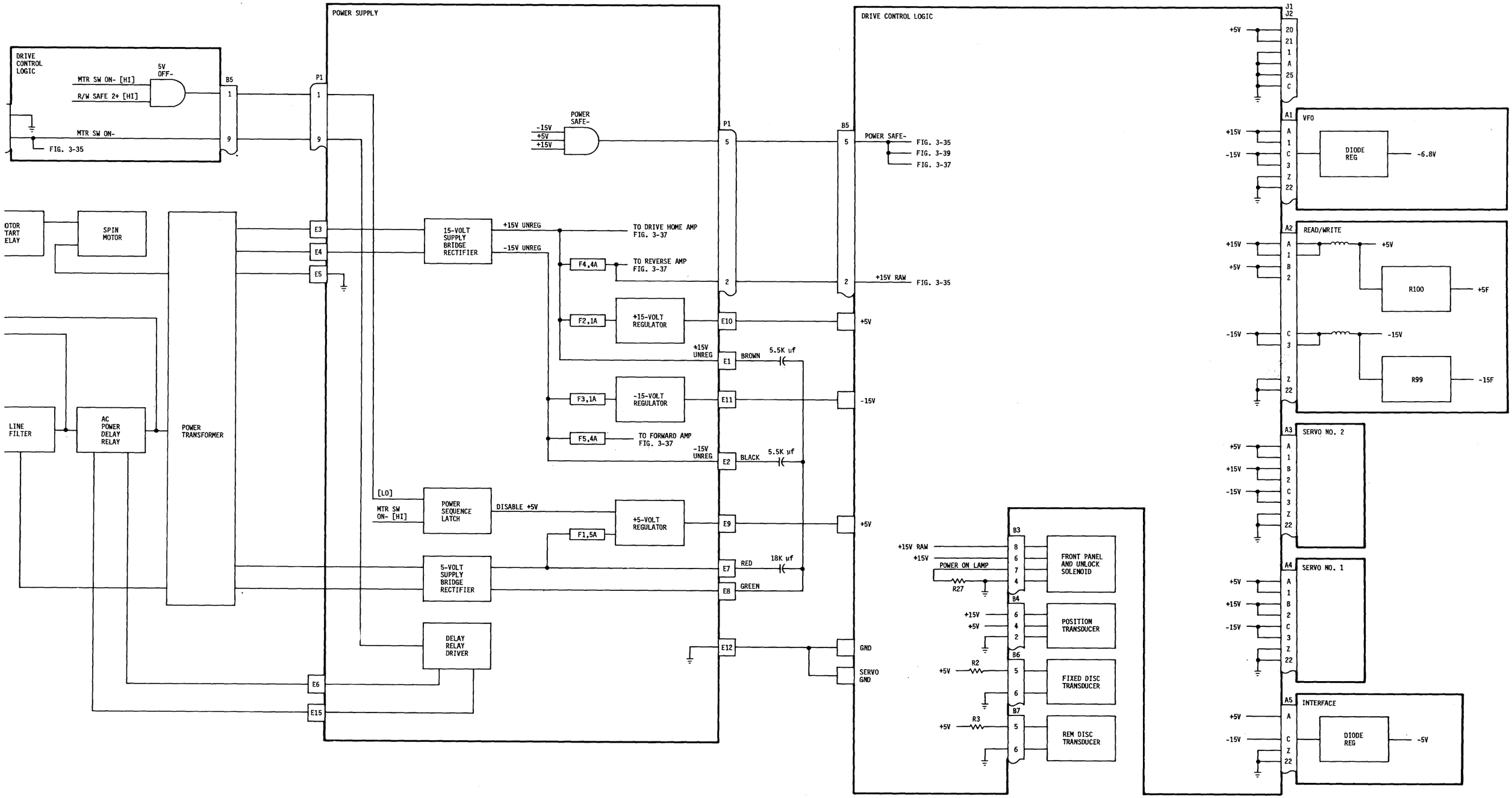
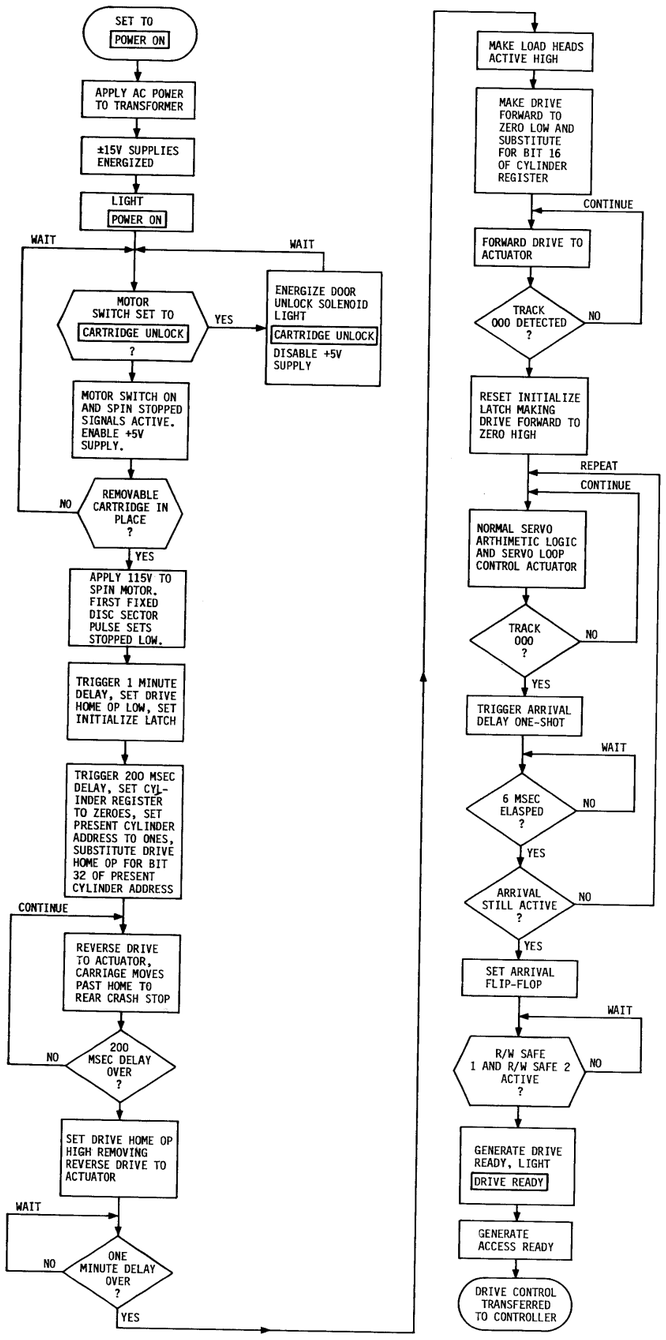
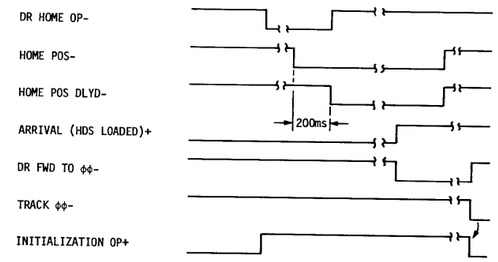


Figure 3-34. Power Function

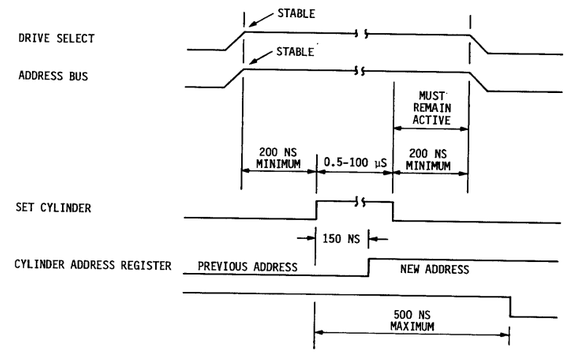
START-UP



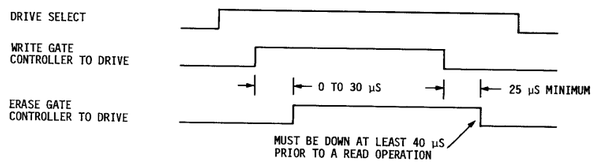
FLOW AND TIMING DIAGRAMS



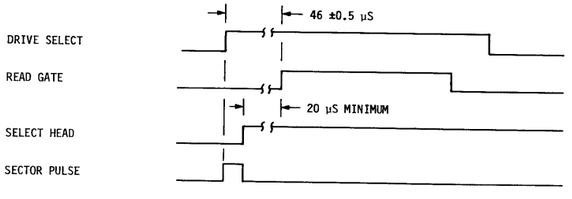
TYPICAL INITIALIZATION TIMING



NEW ADDRESS (TRACK)



WRITE DATA OPERATION



READ DATA OPERATION

NEW ADDRESS SEQUENCE

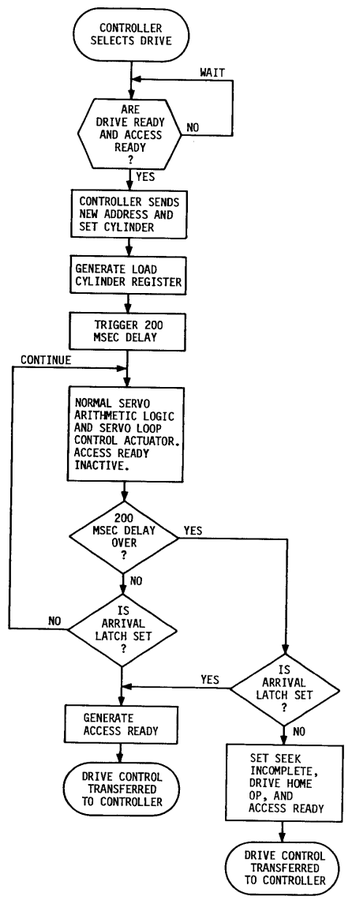
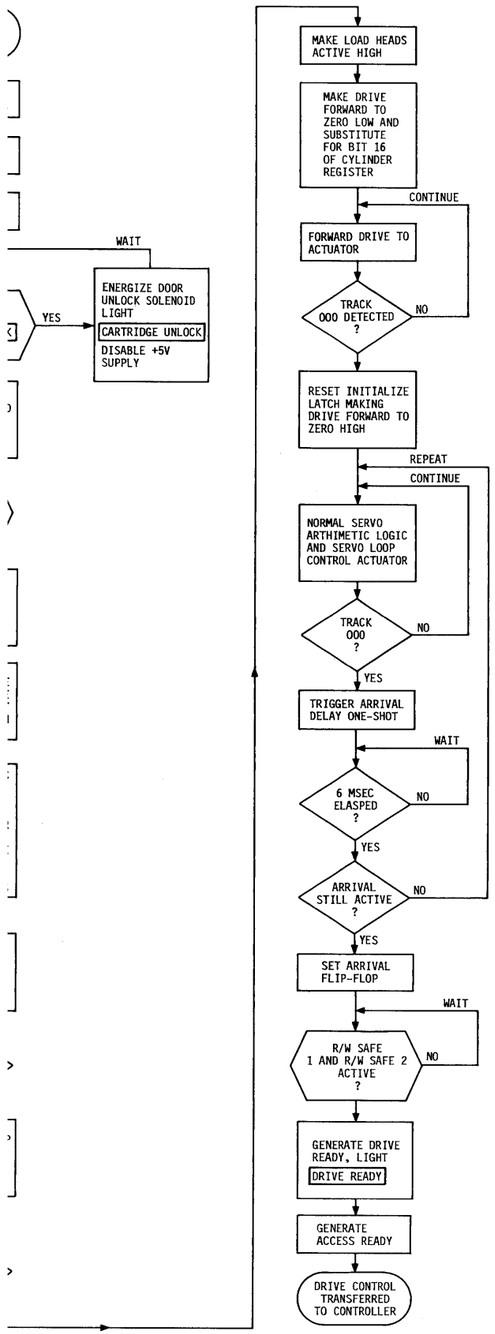
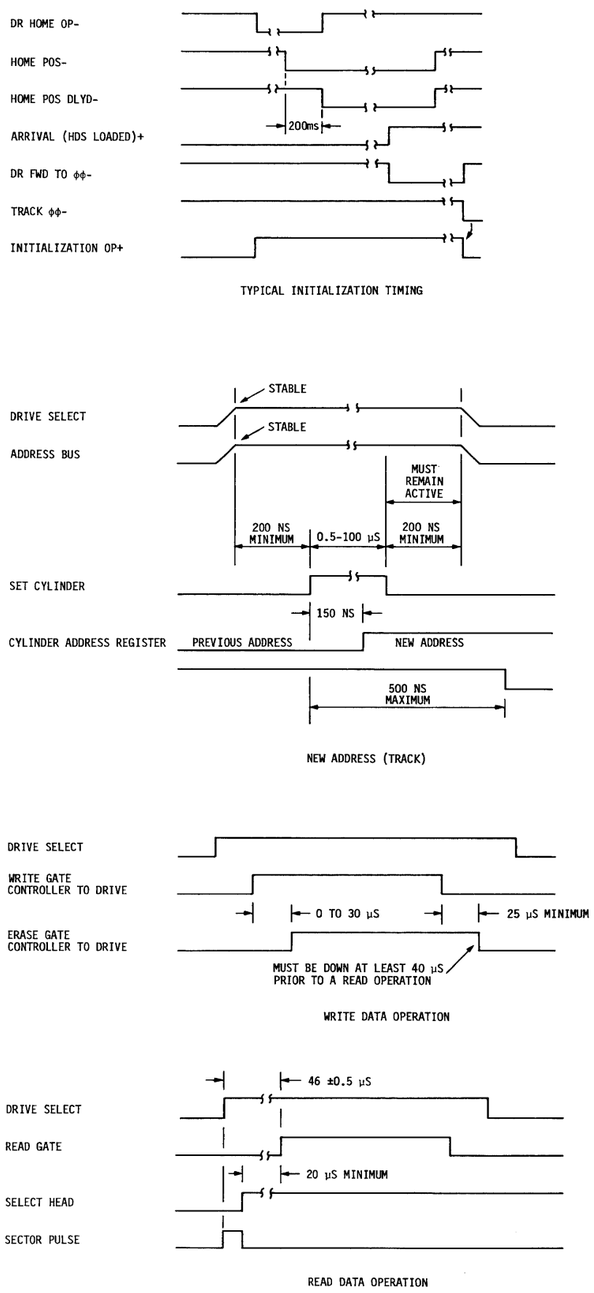


Figure 3-35. Start,

START-UP



FLOW AND TIMING DIAGRAMS



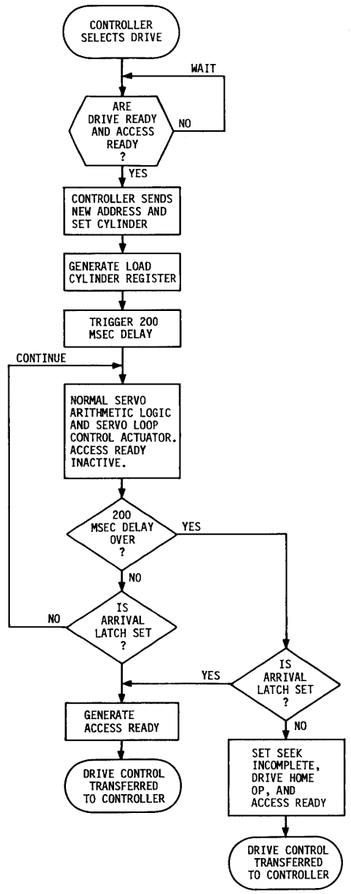
TYPICAL INITIALIZATION TIMING

NEW ADDRESS (TRACK)

WRITE DATA OPERATION

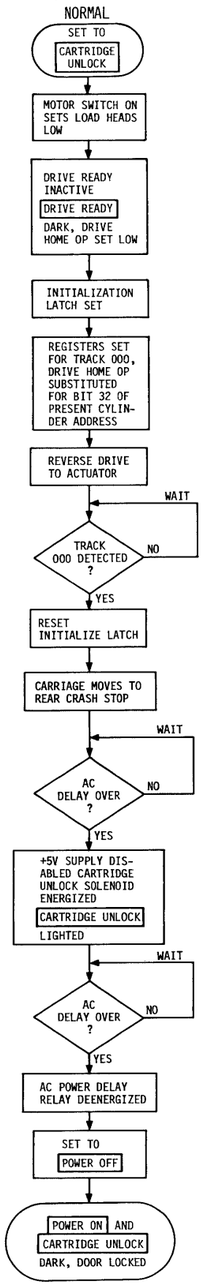
READ DATA OPERATION

NEW ADDRESS SEQUENCE



TURN-OFF

NORMAL



INCORRECT

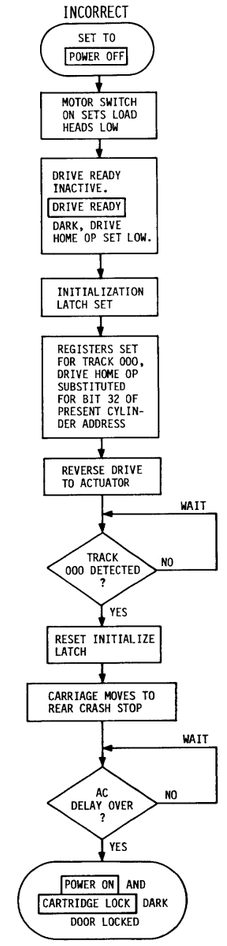
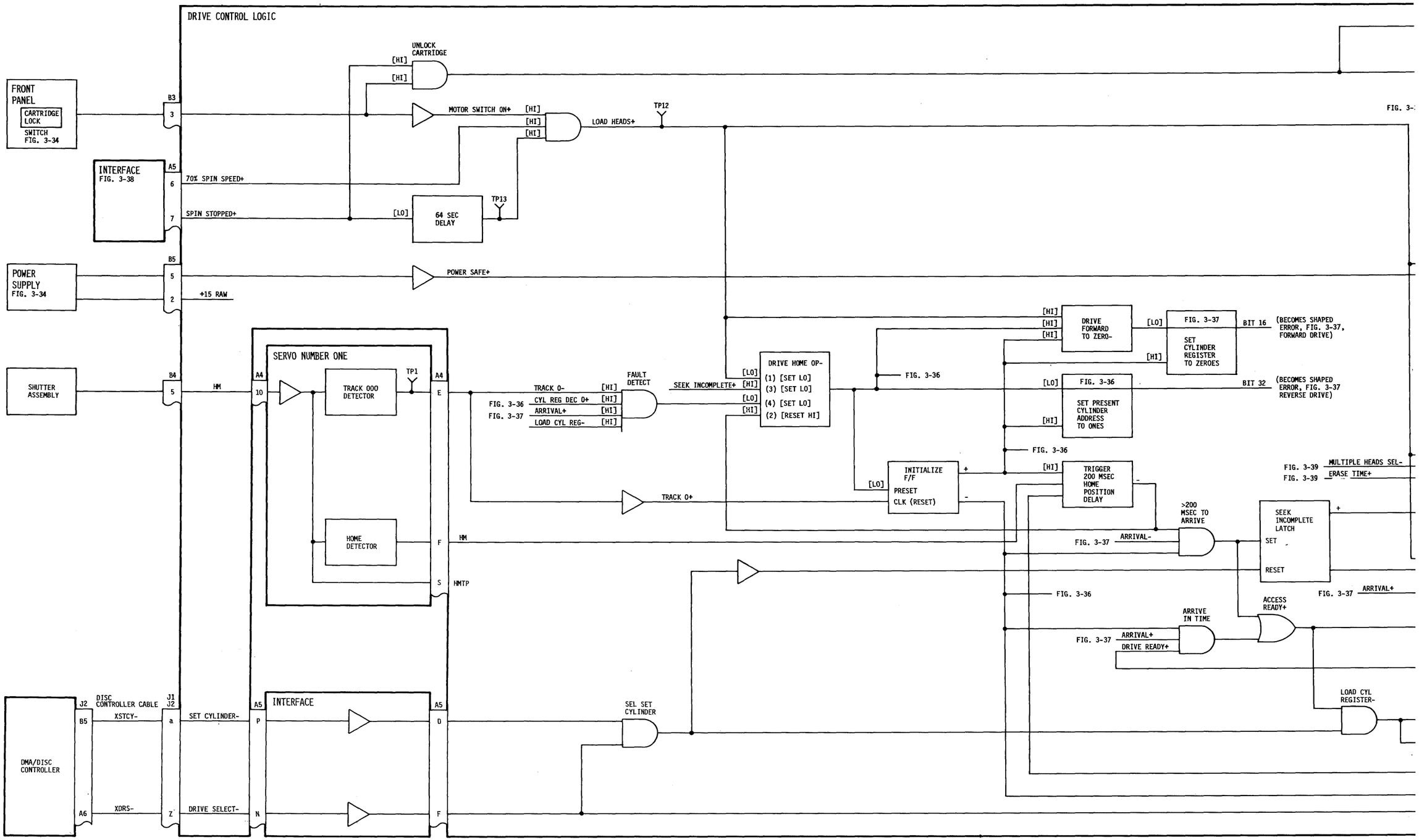


Figure 3-35. Start, Stop, and Status Function, Sheet 1


DRIVE CONTROL LOGIC
FRONT PANEL
CARTRIDGE LOCK SWITCH FIG. 3-34
B3
3
UNLOCK CARTRIDGE
[HI]
[HI]
MOTOR SWITCH ON+
[HI]
[HI]
[HI]
LOAD HEADS+
TP12
FIG. 3-
INTERFACE FIG. 3-38
A5
6
70% SPIN SPEED+
7
SPIN STOPPED+
[LO]
64 SEC DELAY
TP13
POWER SUPPLY FIG. 3-34
B5
5
POWER SAFE+
2
+15 RAW
SERVO NUMBER ONE
SHUTTER ASSEMBLY
B4
5
HM
A4
10
TRACK 000 DETECTOR
TP1
A4
E
HOME DETECTOR
F
HM
S
HMTP
TRACK 0-
CYL REG DEC 0+
ARRIVAL+
LOAD CYL REG-
[HI]
FIG. 3-36
FIG. 3-37
FAULT DETECT
SEEK INCOMPLETE+
[HI]
[LO]
[HI]
[LO]
[HI]
DRIVE HOME OP-
(1) [SET LO]
(3) [SET LO]
(4) [SET LO]
(2) [RESET HI]
TRACK 0+
DRIVE FORWARD TO ZERO-
[HI]
[HI]
[HI]
[LO]
FIG. 3-37
BIT 16
(BECOMES SHAPED ERROR, FIG. 3-37, FORWARD DRIVE)
SET CYLINDER REGISTER TO ZEROES
[HI]
FIG. 3-36
[LO]
FIG. 3-36
BIT 32
(BECOMES SHAPED ERROR, FIG. 3-37 REVERSE DRIVE)
SET PRESENT CYLINDER ADDRESS TO ONES
[HI]
FIG. 3-36
INITIALIZE F/F
PRESET
CLK (RESET)
[LO]
+
-
TRIGGER 200 MSEC HOME POSITION DELAY
[HI]
-
FIG. 3-39
MULTIPLE HEADS SEL-
FIG. 3-39
ERASE TIME+
>200 MSEC TO ARRIVE
FIG. 3-37
ARRIVAL-
SEEK INCOMPLETE LATCH
SET
RESET
+
FIG. 3-37
ARRIVAL+
FIG. 3-36
ACCESS READY+
ARRIVE IN TIME
FIG. 3-37
ARRIVAL+
DRIVE READY+
LOAD CYL REGISTER-
DMA/DISC CONTROLLER
J2
DISC CONTROLLER CABLE
J1 J2
B5
XSTCY-
a
SET CYLINDER-
A5
P
INTERFACE
A5
D
SEL SET CYLINDER
A6
XDRS-
Z
DRIVE SELECT-
N
F

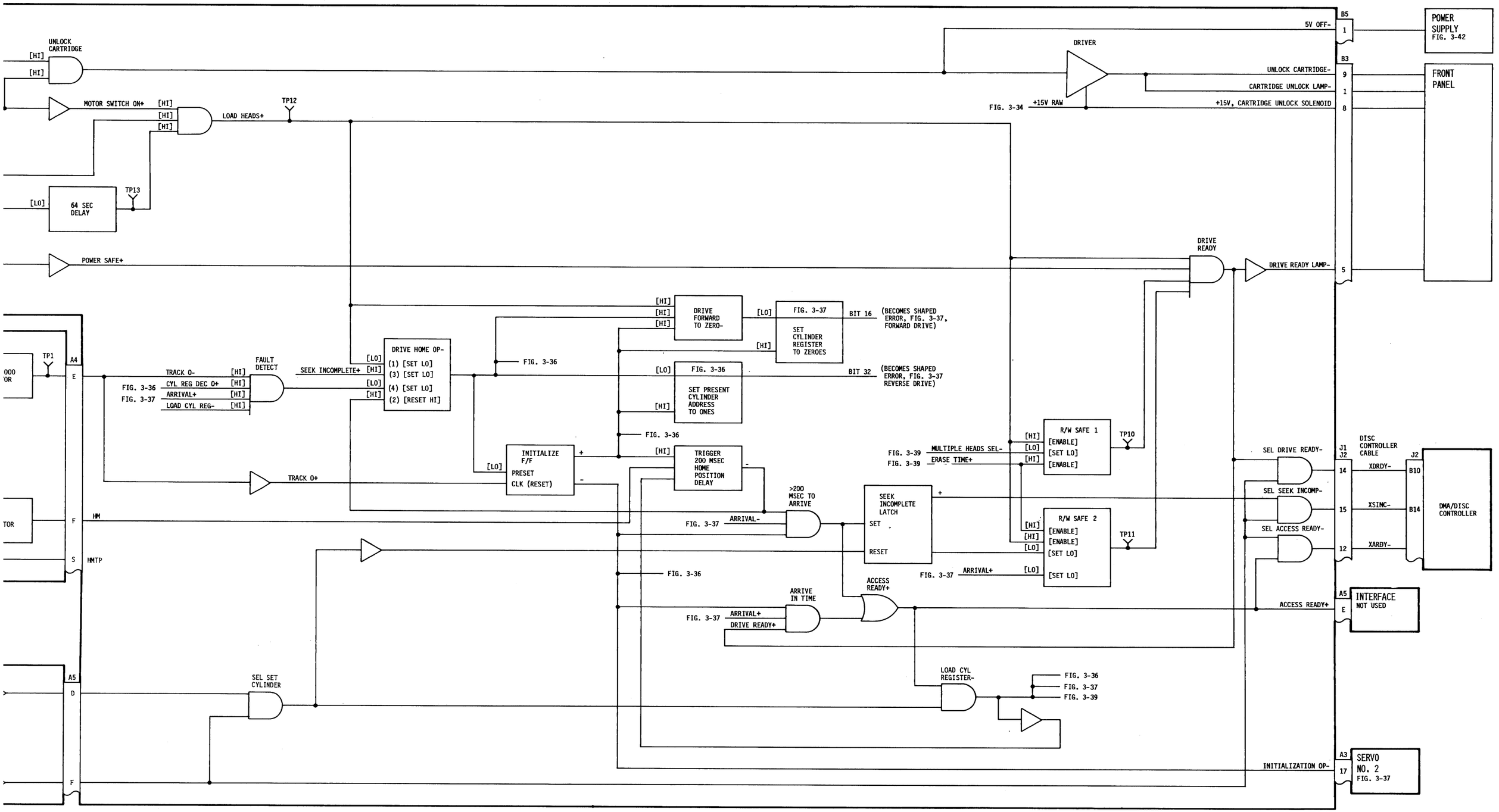
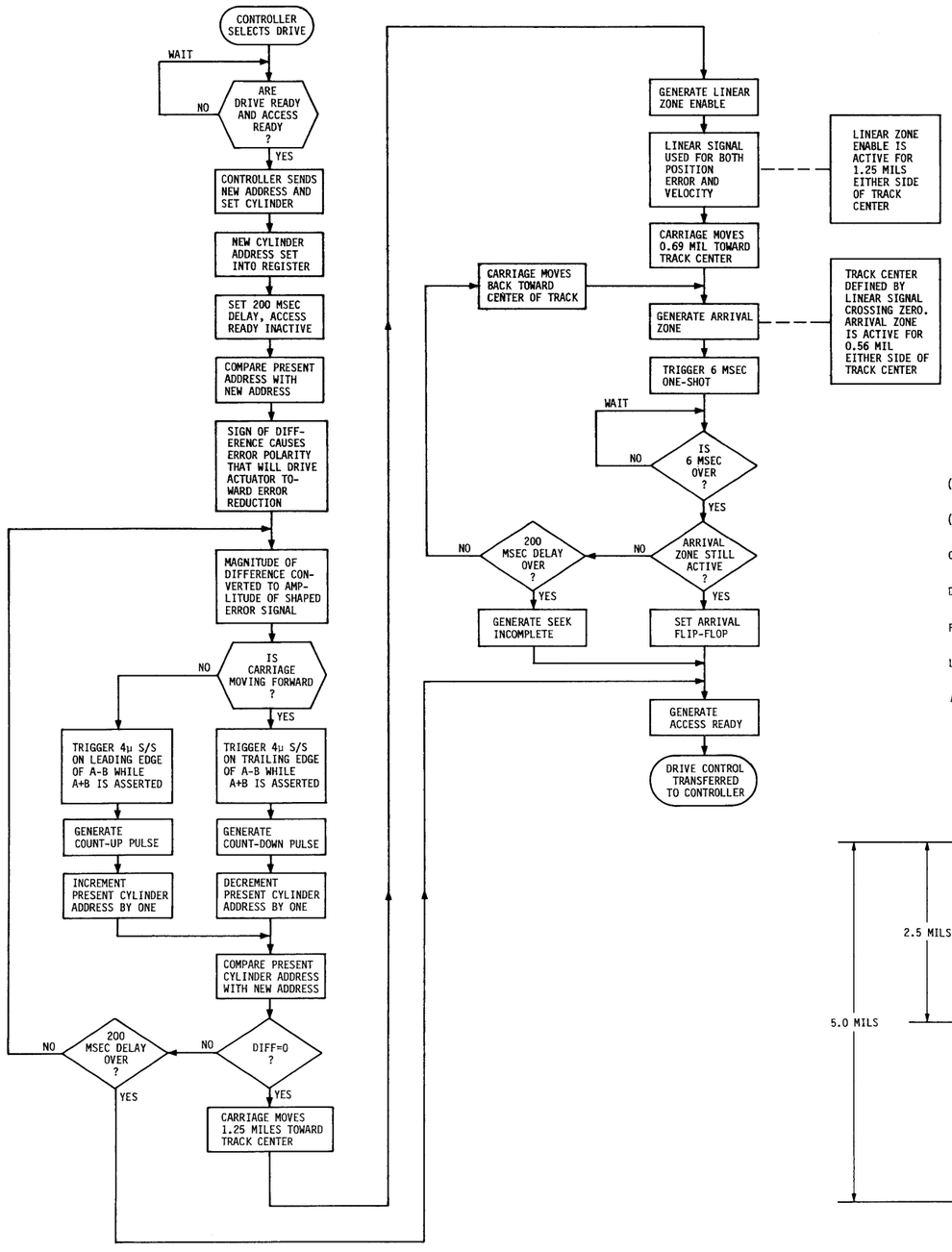
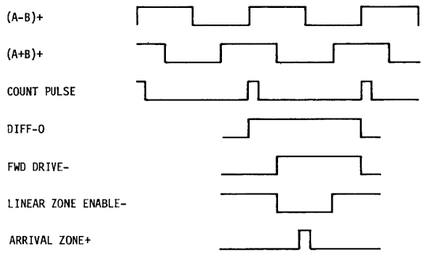


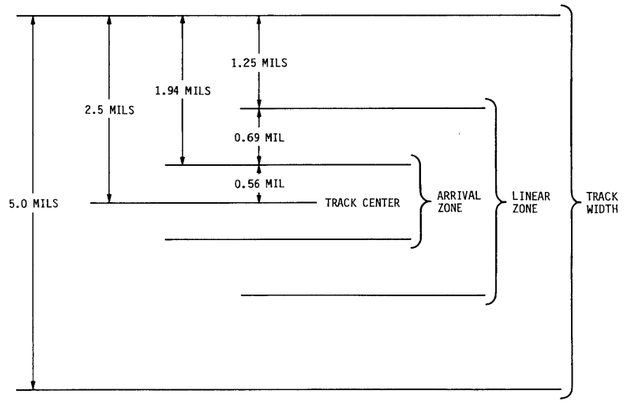
Figure 3-35. Start, Stop, and Status Function, Sheet 2

FLOW AND TIMING DIAGRAMS FOR HEAD POSITIONING FUNCTION

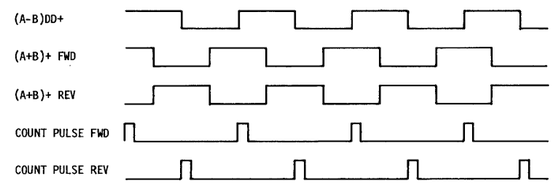


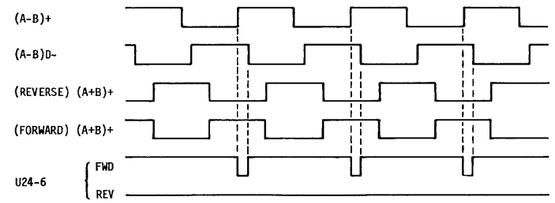
SERVO TIMING

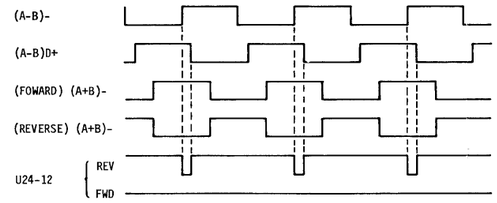


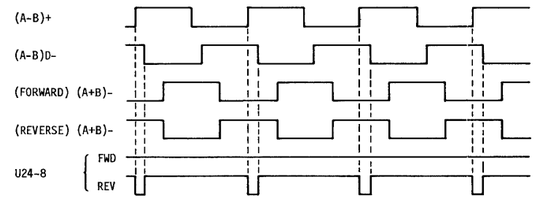


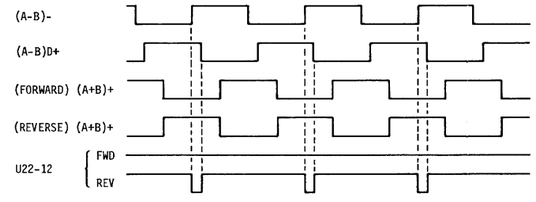
DIRECTION SENSE AND COUNT CONTROL











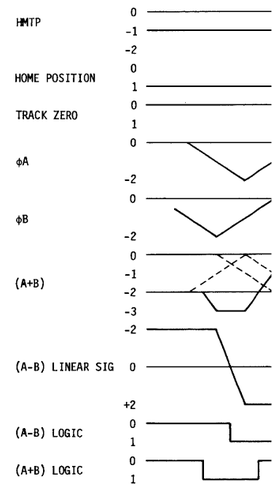


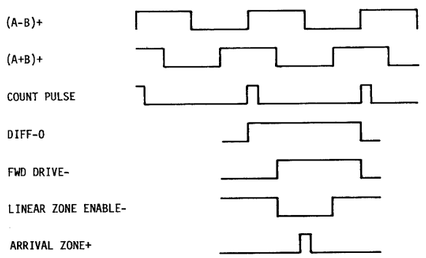
Figure 3-36. Tra
Co

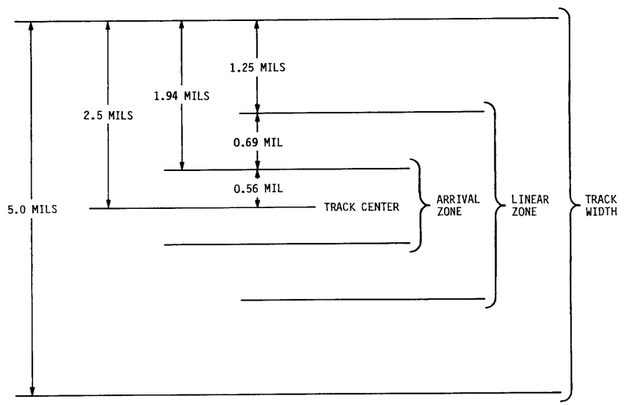
FLOW AND TIMING DIAGRAMS FOR HEAD POSITIONING FUNCTION

LINEAR ZONE ENABLE IS ACTIVE FOR 1.25 MILS EITHER SIDE OF TRACK CENTER

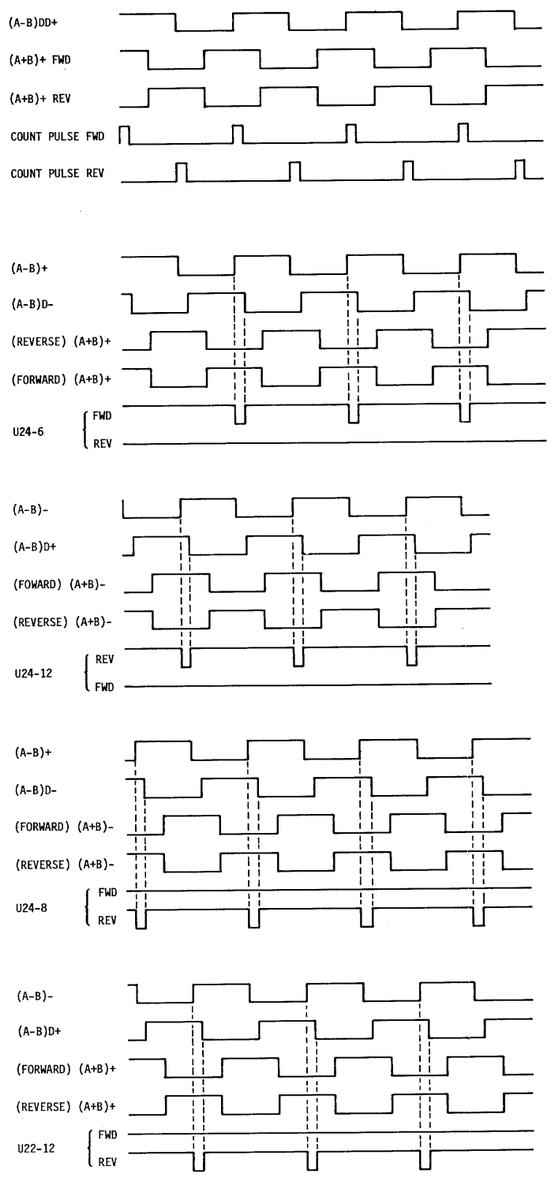
TRACK CENTER DEFINED BY LINEAR SIGNAL CROSSING ZERO. ARRIVAL ZONE IS ACTIVE FOR 0.56 MIL EITHER SIDE OF TRACK CENTER

SERVO TIMING

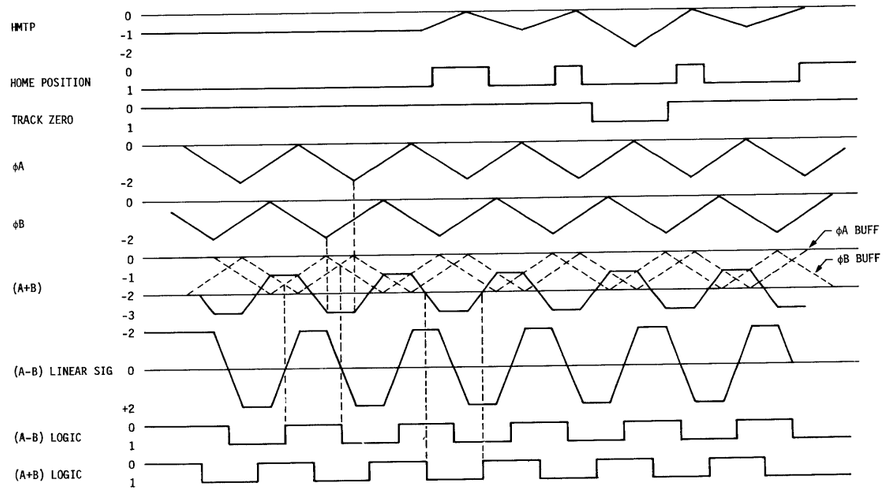




DIRECTION SENSE AND COUNT CONTROL



OPTICAL SIGNAL PROCESSING TIMING



LOGIC MECHANIZATION

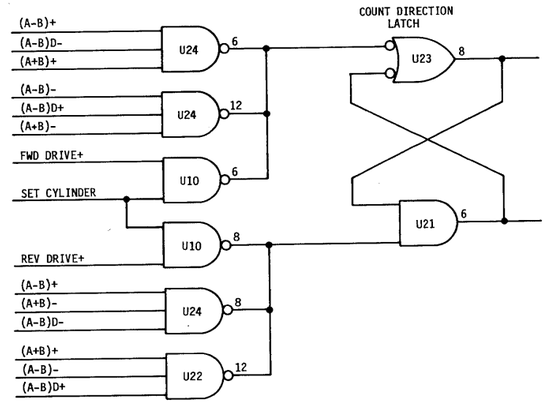
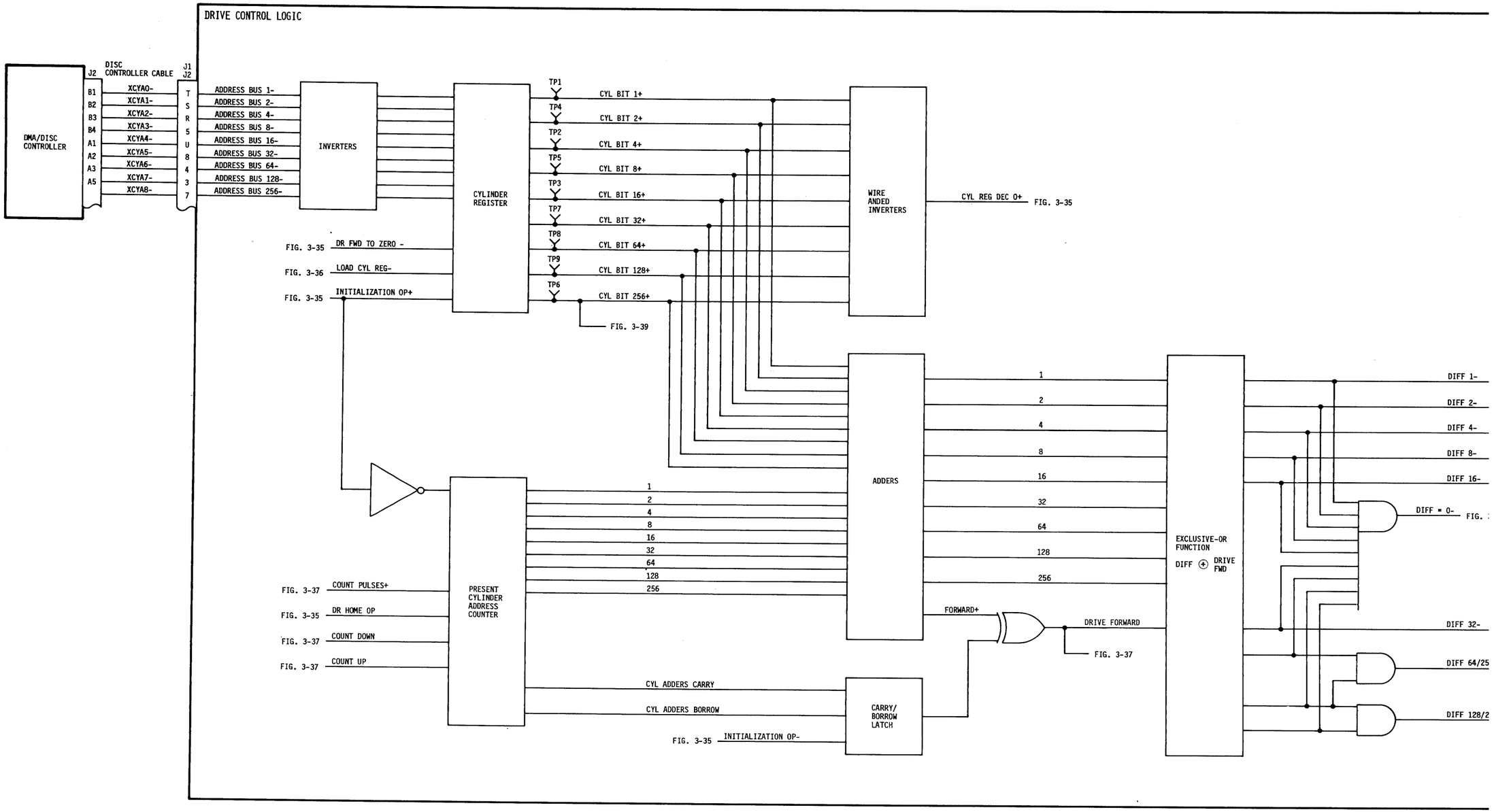


Figure 3-36. Track Number and Head Position Comparison Circuits, Sheet 1


DRIVE CONTROL LOGIC
DMA/DISC CONTROLLER
DISC CONTROLLER CABLE
J2
J1
J2
B1
B2
B3
B4
A1
A2
A3
A5
XCYA0-
XCYA1-
XCYA2-
XCYA3-
XCYA4-
XCYA5-
XCYA6-
XCYA7-
XCYA8-
T
S
R
5
U
8
4
3
7
ADDRESS BUS 1-
ADDRESS BUS 2-
ADDRESS BUS 4-
ADDRESS BUS 8-
ADDRESS BUS 16-
ADDRESS BUS 32-
ADDRESS BUS 64-
ADDRESS BUS 128-
ADDRESS BUS 256-
INVERTERS
CYLINDER REGISTER
TP1
TP4
TP2
TP5
TP3
TP7
TP8
TP9
TP6
CYL BIT 1+
CYL BIT 2+
CYL BIT 4+
CYL BIT 8+
CYL BIT 16+
CYL BIT 32+
CYL BIT 64+
CYL BIT 128+
CYL BIT 256+
FIG. 3-39
WIRE ANDED INVERTERS
CYL REG DEC 0+
FIG. 3-35
FIG. 3-35 DR FWD TO ZERO -
FIG. 3-36 LOAD CYL REG-
FIG. 3-35 INITIALIZATION OP+
ADDERS
1
2
4
8
16
32
64
128
256
PRESENT CYLINDER ADDRESS COUNTER
FIG. 3-37 COUNT PULSES+
FIG. 3-35 DR HOME OP
FIG. 3-37 COUNT DOWN
FIG. 3-37 COUNT UP
CYL ADDERS CARRY
CYL ADDERS BORROW
FIG. 3-35 INITIALIZATION OP-
CARRY/ BORROW LATCH
FORWARD+
DRIVE FORWARD
FIG. 3-37
EXCLUSIVE-OR FUNCTION
DIFF ⊕ DRIVE FWD
DIFF 1-
DIFF 2-
DIFF 4-
DIFF 8-
DIFF 16-
DIFF = 0-
FIG.
DIFF 32-
DIFF 64/25
DIFF 128/2

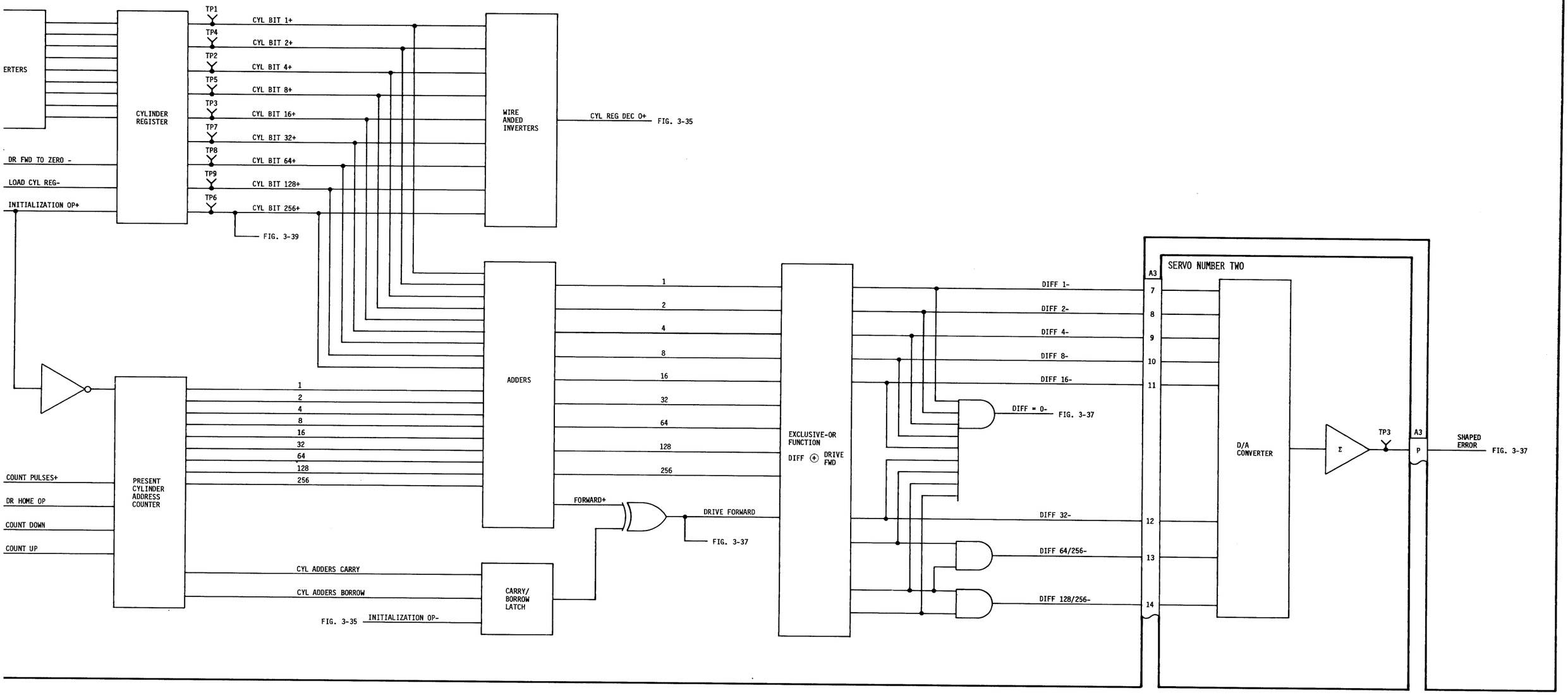


Figure 3-36. Track Number and Head Position Comparison Circuits, Sheet 2

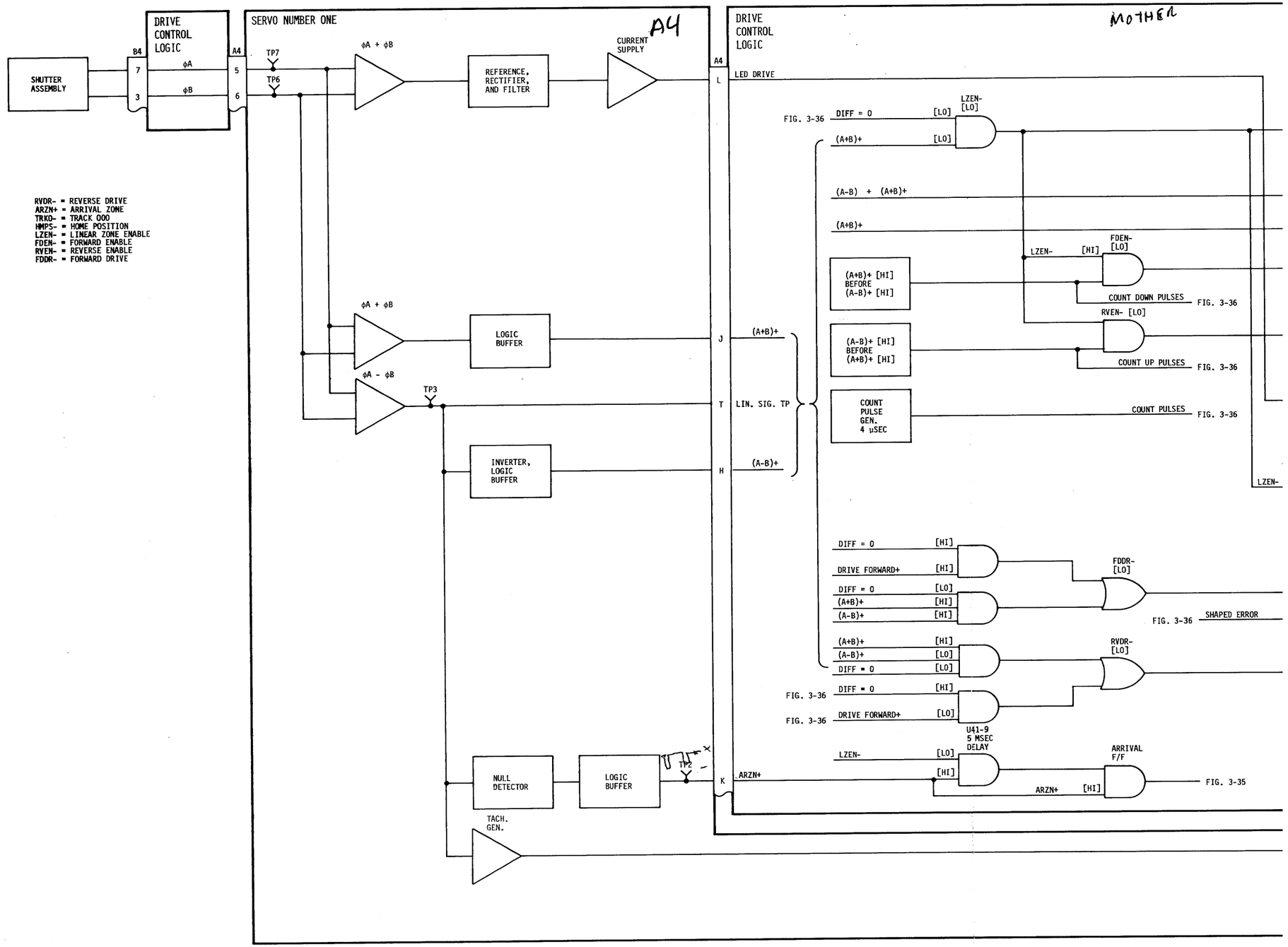

SERVO NUMBER ONE
A4
MOTHER
SHUTTER ASSEMBLY
DRIVE CONTROL LOGIC
B4
7
3
φA
φB
A4
5
6
TP7
TP6
φA + φB
REFERENCE, RECTIFIER, AND FILTER
CURRENT SUPPLY
RVDR- = REVERSE DRIVE
ARZN+ = ARRIVAL ZONE
TRKO- = TRACK OOO
HMPS- = HOME POSITION
LZEN- = LINEAR ZONE ENABLE
FDEN- = FORWARD ENABLE
RVEN- = REVERSE ENABLE
FDDR- = FORWARD DRIVE
φA + φB
LOGIC BUFFER
φA - φB
TP3
INVERTER, LOGIC BUFFER
NULL DETECTOR
LOGIC BUFFER
TP2
TACH. GEN.
DRIVE CONTROL LOGIC
A4
L
LED DRIVE
J
(A+B)+
T
LIN. SIG. TP
H
(A-B)+
K
ARZN+
FIG. 3-36
DIFF = 0
[LO]
(A+B)+
[LO]
LZEN-
[LO]
(A-B) + (A+B)+
(A+B)+
LZEN-
[HI]
FDEN-
[LO]
(A+B)+ [HI] BEFORE (A-B)+ [HI]
COUNT DOWN PULSES
FIG. 3-36
RVEN- [LO]
(A-B)+ [HI] BEFORE (A+B)+ [HI]
COUNT UP PULSES
FIG. 3-36
COUNT PULSE GEN. 4 μSEC
COUNT PULSES
FIG. 3-36
LZEN-
DIFF = 0
[HI]
DRIVE FORWARD+
[HI]
DIFF = 0
[LO]
(A+B)+
[HI]
(A-B)+
[HI]
FDDR-
[LO]
FIG. 3-36
SHAPED ERROR
(A+B)+
[HI]
(A-B)+
[LO]
DIFF = 0
[LO]
RVDR-
[LO]
FIG. 3-36
DIFF = 0
[HI]
FIG. 3-36
DRIVE FORWARD+
[LO]
U41-9
5 MSEC
DELAY
LZEN-
[LO]
[HI]
ARRIVAL F/F
ARZN+
[HI]
FIG. 3-35

Figure 3-37. F

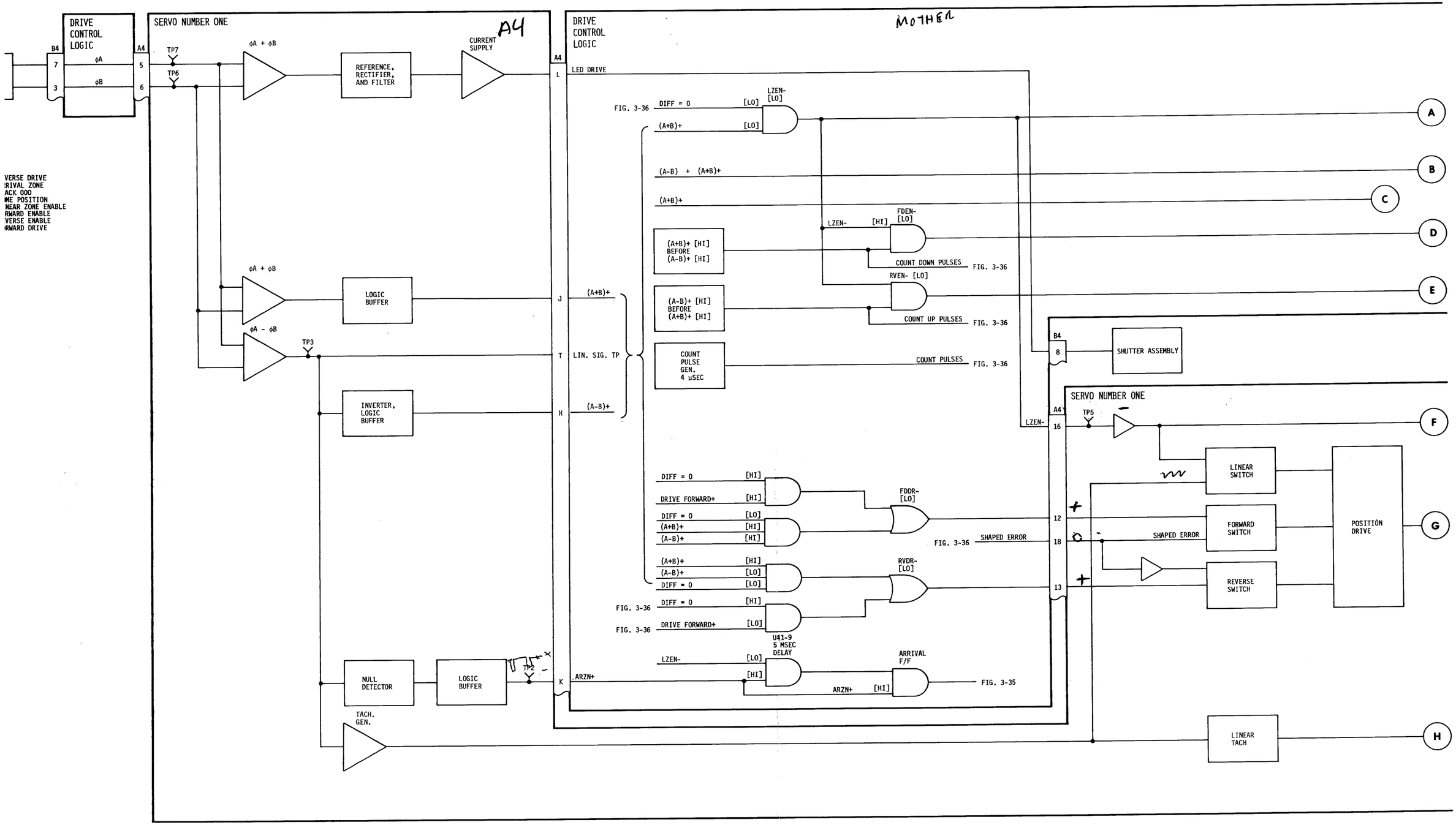
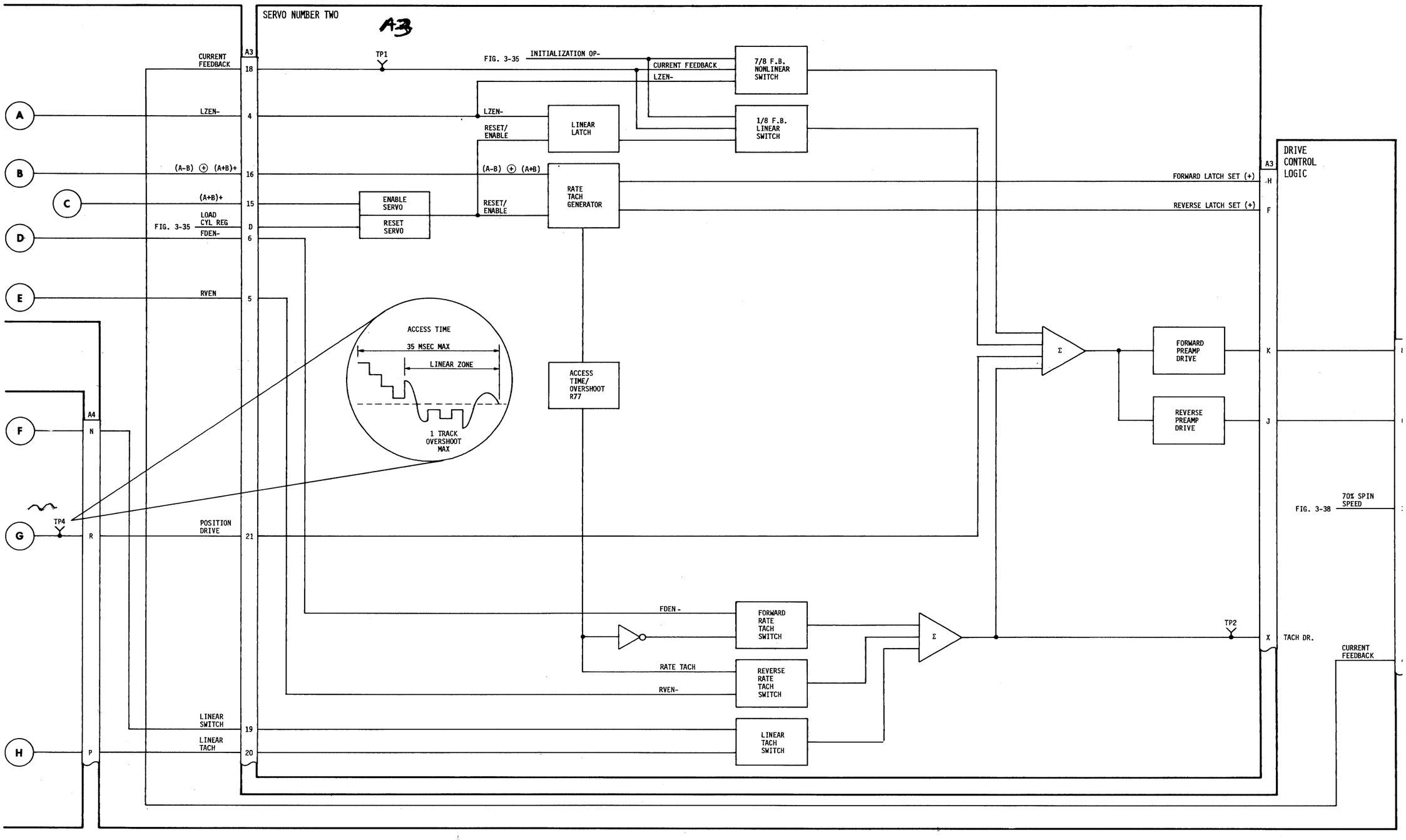


Figure 3-37. Position Control Circuits, Sheet 1


SERVO NUMBER TWO
A3
CURRENT FEEDBACK
A3
18
TP1
FIG. 3-35
INITIALIZATION OP-
CURRENT FEEDBACK
LZEN-
7/8 F.B. NONLINEAR SWITCH
1/8 F.B. LINEAR SWITCH
A
LZEN-
4
LZEN-
RESET/ ENABLE
LINEAR LATCH
B
(A-B) ⊕ (A+B)+
16
(A-B) ⊕ (A+B)
RATE TACH GENERATOR
C
(A+B)+
15
ENABLE SERVO
RESET SERVO
RESET/ ENABLE
FIG. 3-35
LOAD CYL REG
D
FDEN-
6
D
RVEN
5
E
ACCESS TIME
35 MSEC MAX
LINEAR ZONE
1 TRACK OVERSHOOT MAX
ACCESS TIME/ OVERSHOOT R77
A4
F
N
TP4
R
POSITION DRIVE
21
G
FDEN-
FORWARD RATE TACH SWITCH
RATE TACH
REVERSE RATE TACH SWITCH
RVEN-
LINEAR SWITCH
19
LINEAR TACH
20
LINEAR TACH SWITCH
H
P
Σ
FORWARD PREAMP DRIVE
REVERSE PREAMP DRIVE
A3
H
F
K
J
DRIVE CONTROL LOGIC
FORWARD LATCH SET (+)
REVERSE LATCH SET (+)
TP2
X
TACH DR.
70% SPIN SPEED
FIG. 3-38
CURRENT FEEDBACK

A3

TP1

FIG. 3-35 INITIALIZATION OP-

CURRENT FEEDBACK

LZEN-

7/8 F.B. NONLINEAR SWITCH

1/8 F.B. LINEAR SWITCH

LZEN-

RESET/ ENABLE

LINEAR LATCH

(A-B) ⊕ (A+B)

RESET/ ENABLE

RATE TACH GENERATOR

ENABLE SERVO

RESET SERVO

FORWARD LATCH SET (+)

REVERSE LATCH SET (+)

A3

-H

F

DRIVE CONTROL LOGIC

ACCESS TIME

35 MSEC MAX

LINEAR ZONE

1 TRACK OVERSHOOT MAX

ACCESS TIME/ OVERSHOOT R77

Σ

FORWARD PREAMP DRIVE

REVERSE PREAMP DRIVE

K

J

8

6

POWER SUPPLY

FIG. 3-34 -15V

F5

FORWARD DRIVE

REVERSE DRIVE

HEAD PROTECTION

E13

F4

+15V FIG. 3-34

70% SPIN SPEED

FIG. 3-38

3

POWER SAFE

FIG. 3-34

DRIVE HOME

HEAD POSITIONING ACTUATOR

+15V UNREG FIG. 3-34

FDEN-

FORWARD RATE TACH SWITCH

RATE TACH

REVERSE RATE TACH SWITCH

RVEN-

LINEAR TACH SWITCH

Σ

TP2

X

TACH DR.

CURRENT FEEDBACK

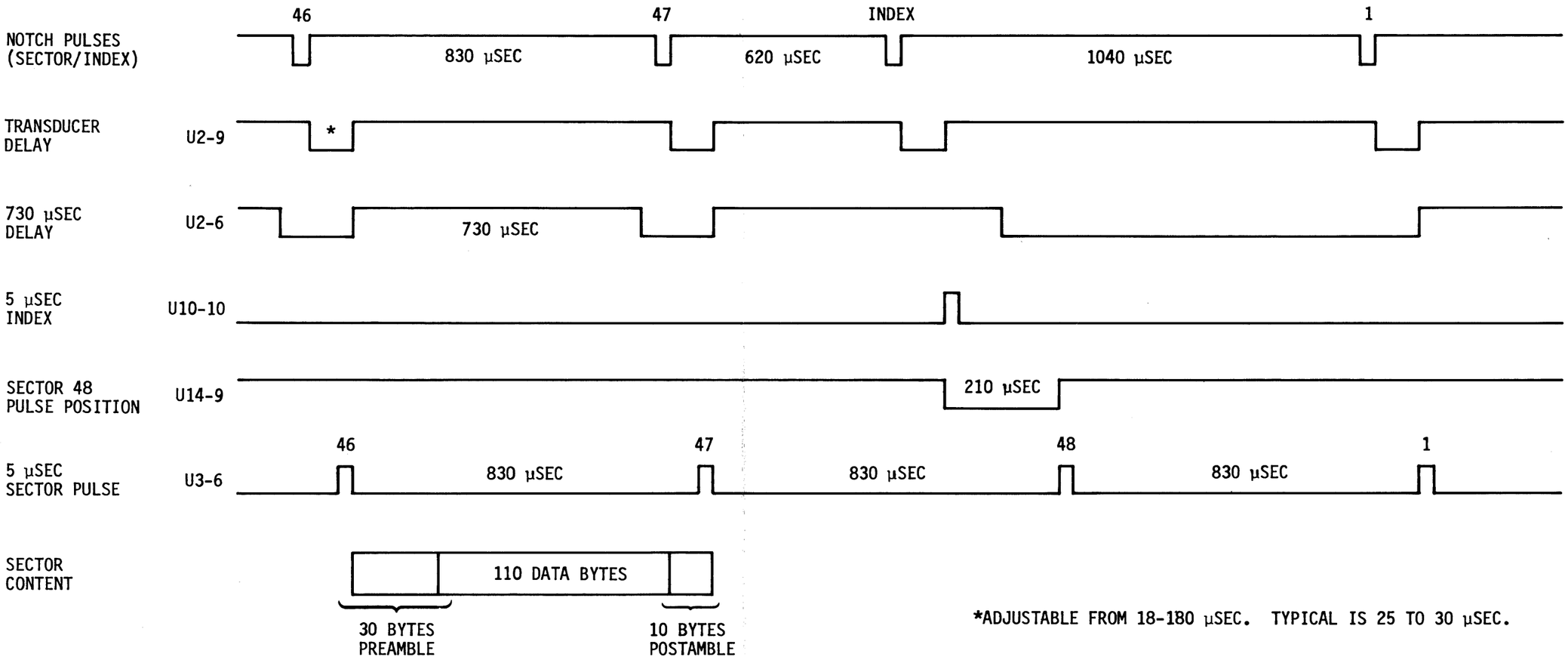
4

CURRENT FEEDBACK

E14

Figure 3-37. Position Control Circuits, Sheet 2

SECTOR AND INDEX PULSE TIMING



*ADJUSTABLE FROM 18-180 µSEC. TYPICAL IS 25 TO 30 µSEC.

POSTAMBLE CONTAINS SECTOR NUMBER, TRACK NUMBER, AND OTHER HOUSEKEEPING INFORMATION.

Figure 3-38. Sector and Speed Detection Function, Sheet 1

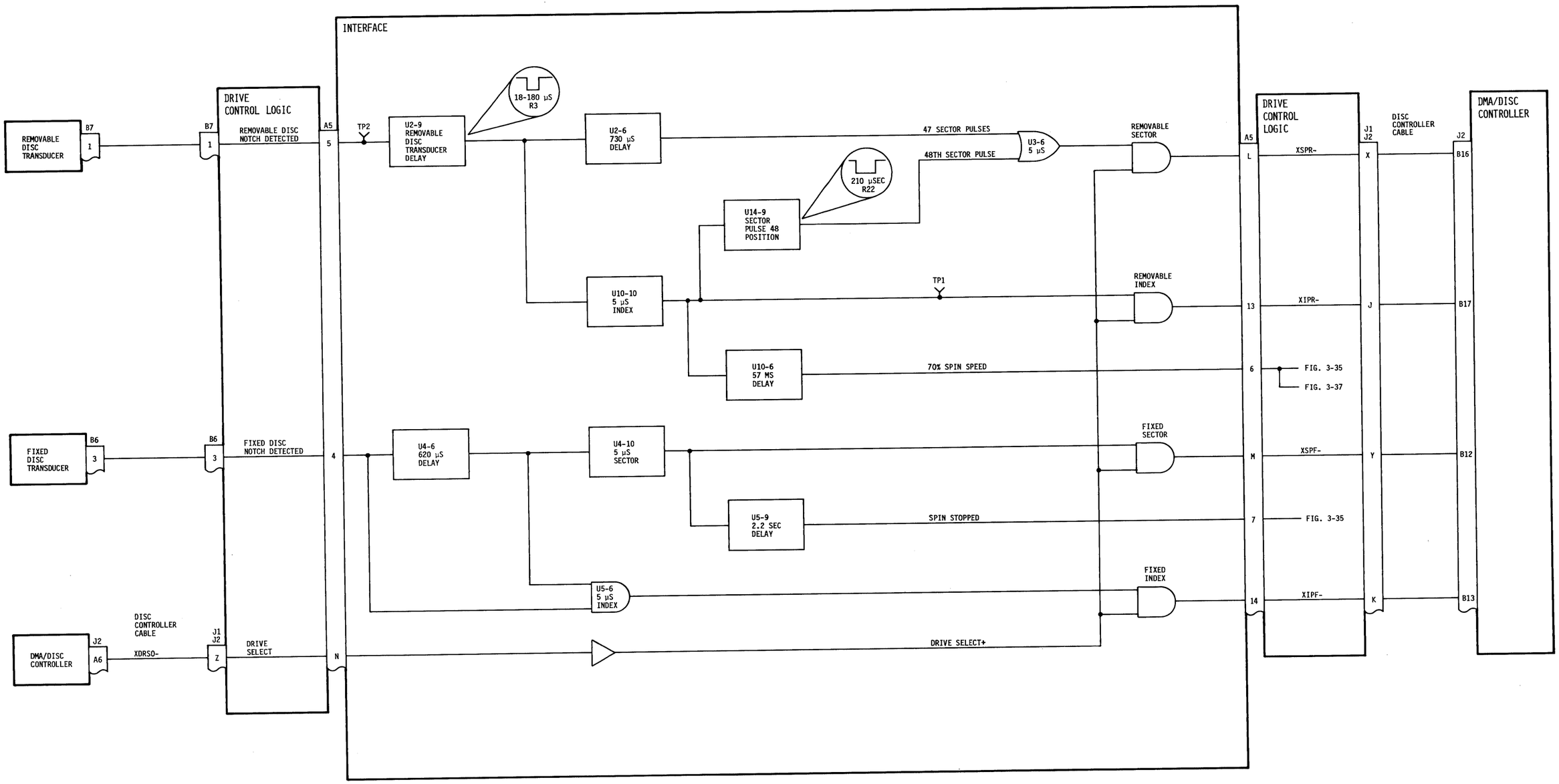
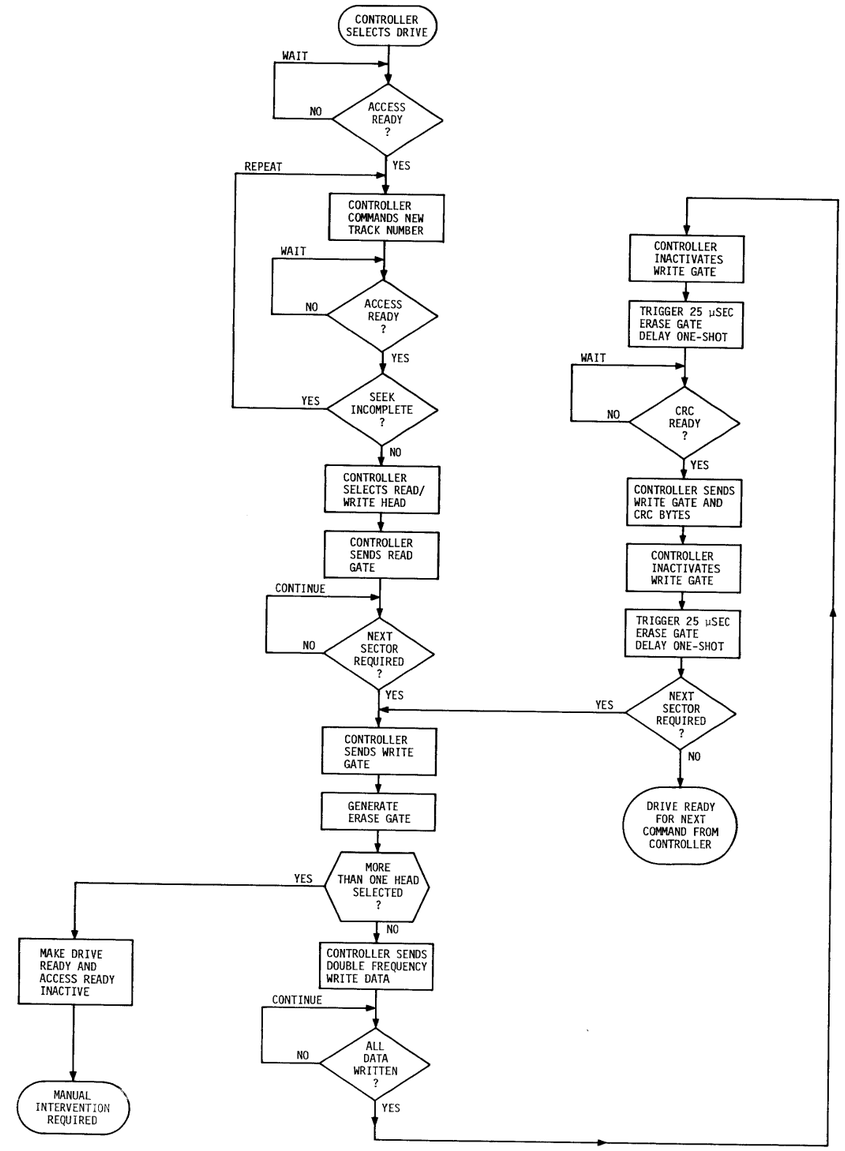


Figure 3-38. Sector and Speed Detection Function, Sheet 2

WRITE FLOW DIAGRAM



TRANSFORMATION FROM

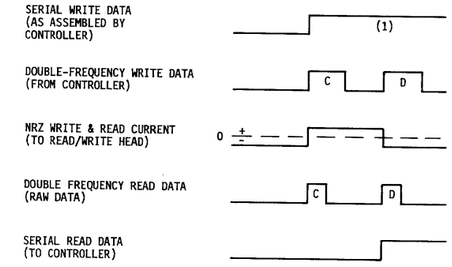
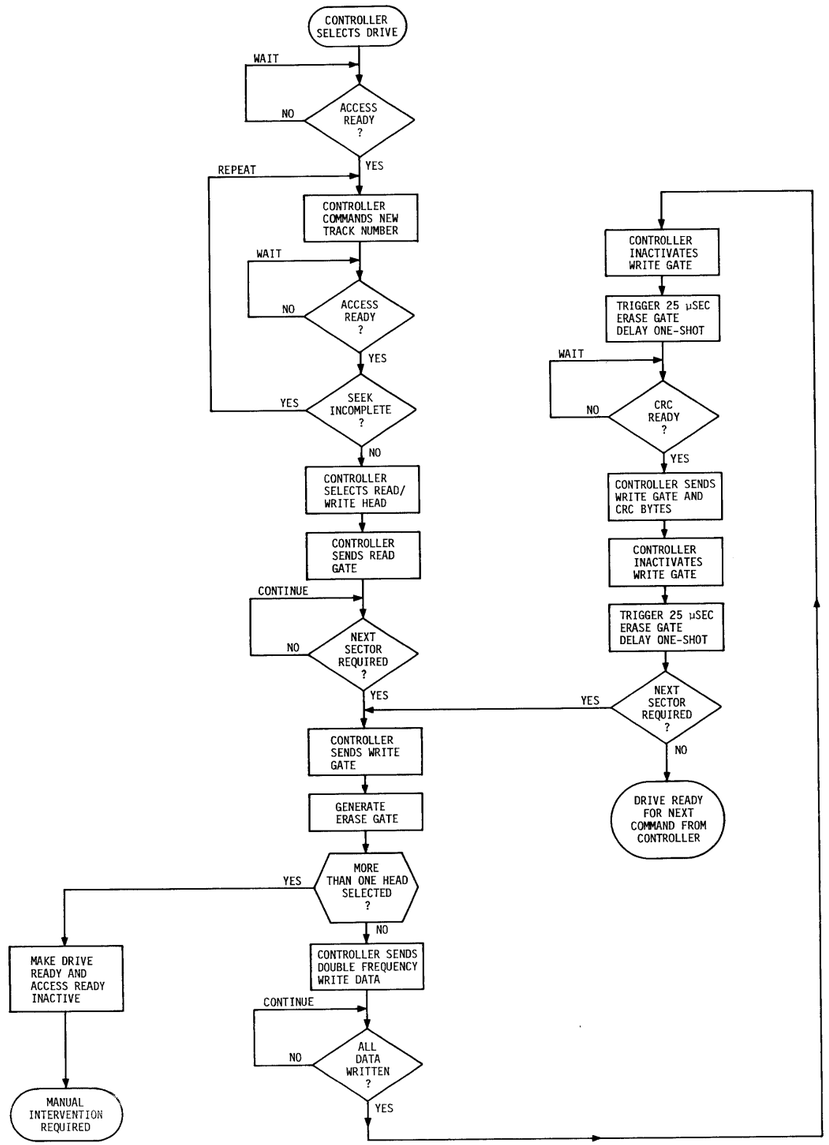


Figure 3-3

WRITE FLOW DIAGRAM



TRANSFORMATION FROM BINARY TO RECORDING SIGNAL TO READ SIGNAL TO BINARY

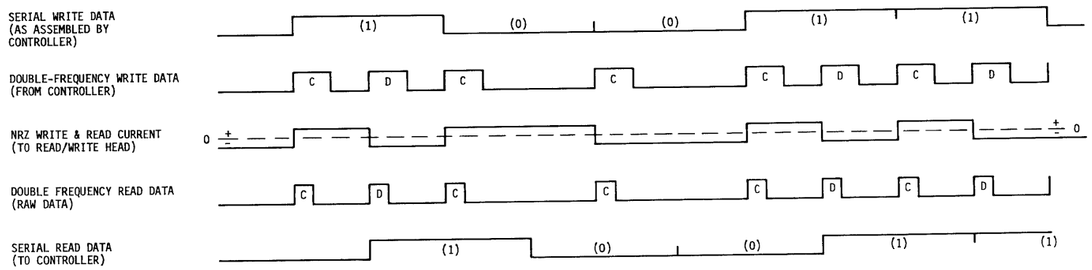
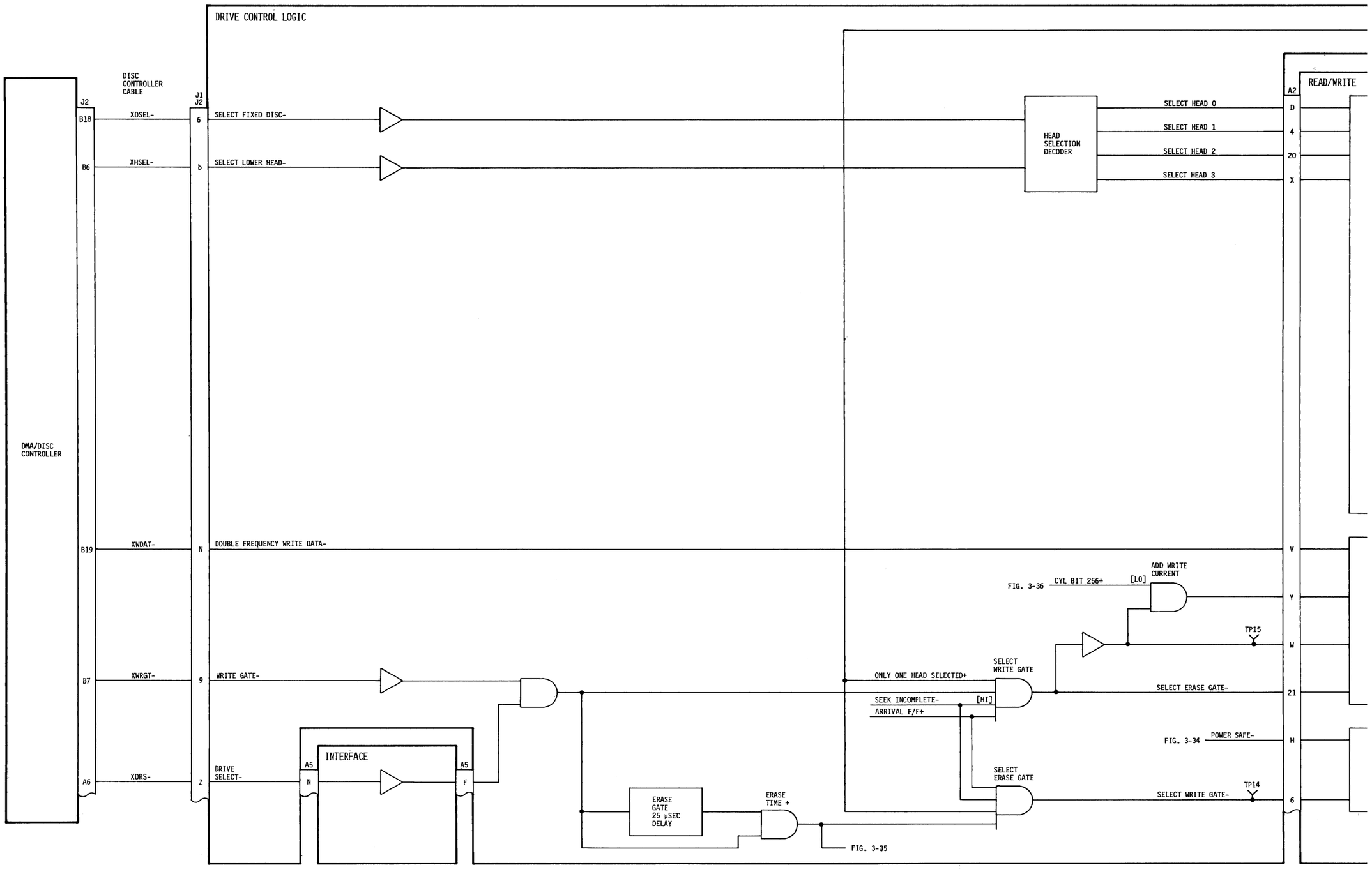


Figure 3-39. Write Function, Sheet 1


DRIVE CONTROL LOGIC
DMA/DISC CONTROLLER
DISC CONTROLLER CABLE
J2
J1
J2
B18
XDSEL-
6
SELECT FIXED DISC-
B6
XHSEL-
b
SELECT LOWER HEAD-
HEAD SELECTION DECODER
SELECT HEAD 0
SELECT HEAD 1
SELECT HEAD 2
SELECT HEAD 3
A2
READ/WRITE
D
4
20
X
B19
XWDAT-
N
DOUBLE FREQUENCY WRITE DATA-
V
ADD WRITE CURRENT
FIG. 3-36
CYL BIT 256+
[LO]
Y
TP15
W
B7
XWRGT-
9
WRITE GATE-
SELECT WRITE GATE
ONLY ONE HEAD SELECTED+
SELECT ERASE GATE-
21
SEEK INCOMPLETE-
[HI]
ARRIVAL F/F+
INTERFACE
A5
A5
FIG. 3-34
POWER SAFE-
H
SELECT ERASE GATE
A6
XDRS-
Z
DRIVE SELECT-
N
F
ERASE GATE 25 μSEC DELAY
ERASE TIME +
TP14
SELECT WRITE GATE-
6
FIG. 3-35

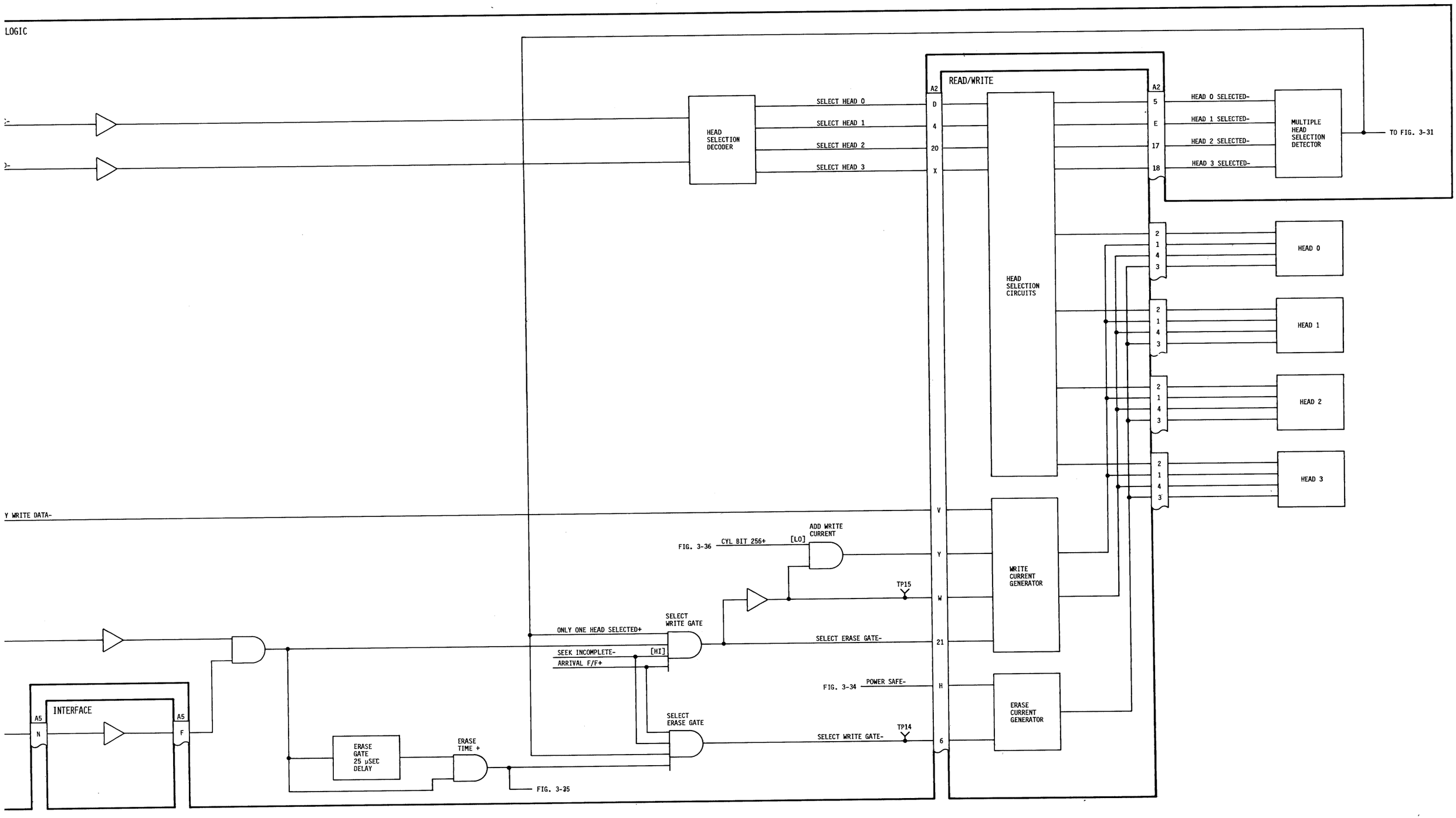
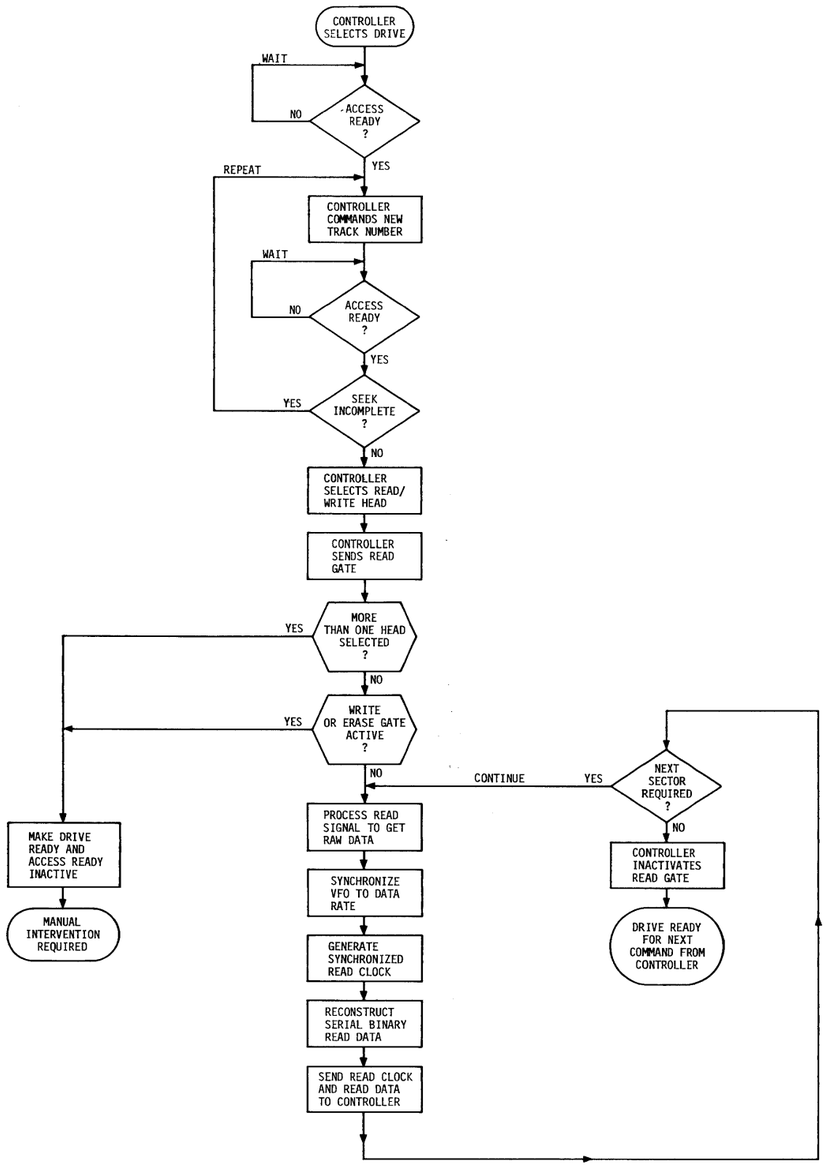


Figure 3-39. Write Function, Sheet 2

READ FLOW DIAGRAM



READ DEMODULATOR TIMING

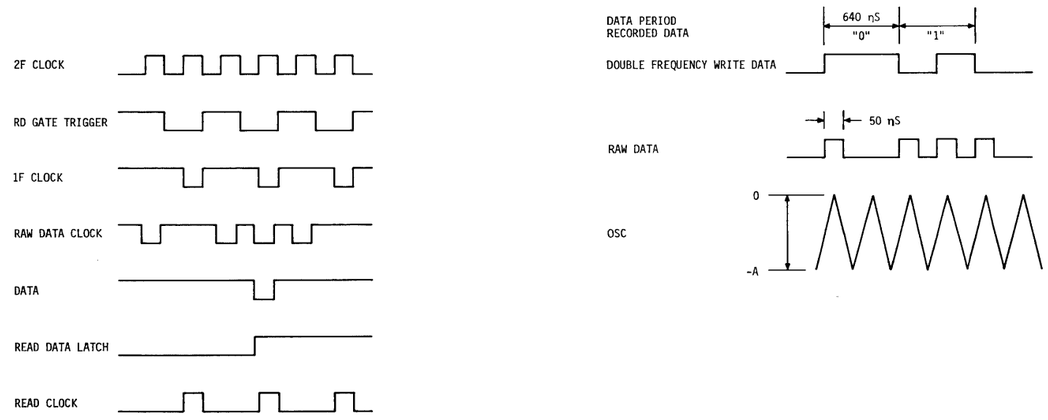
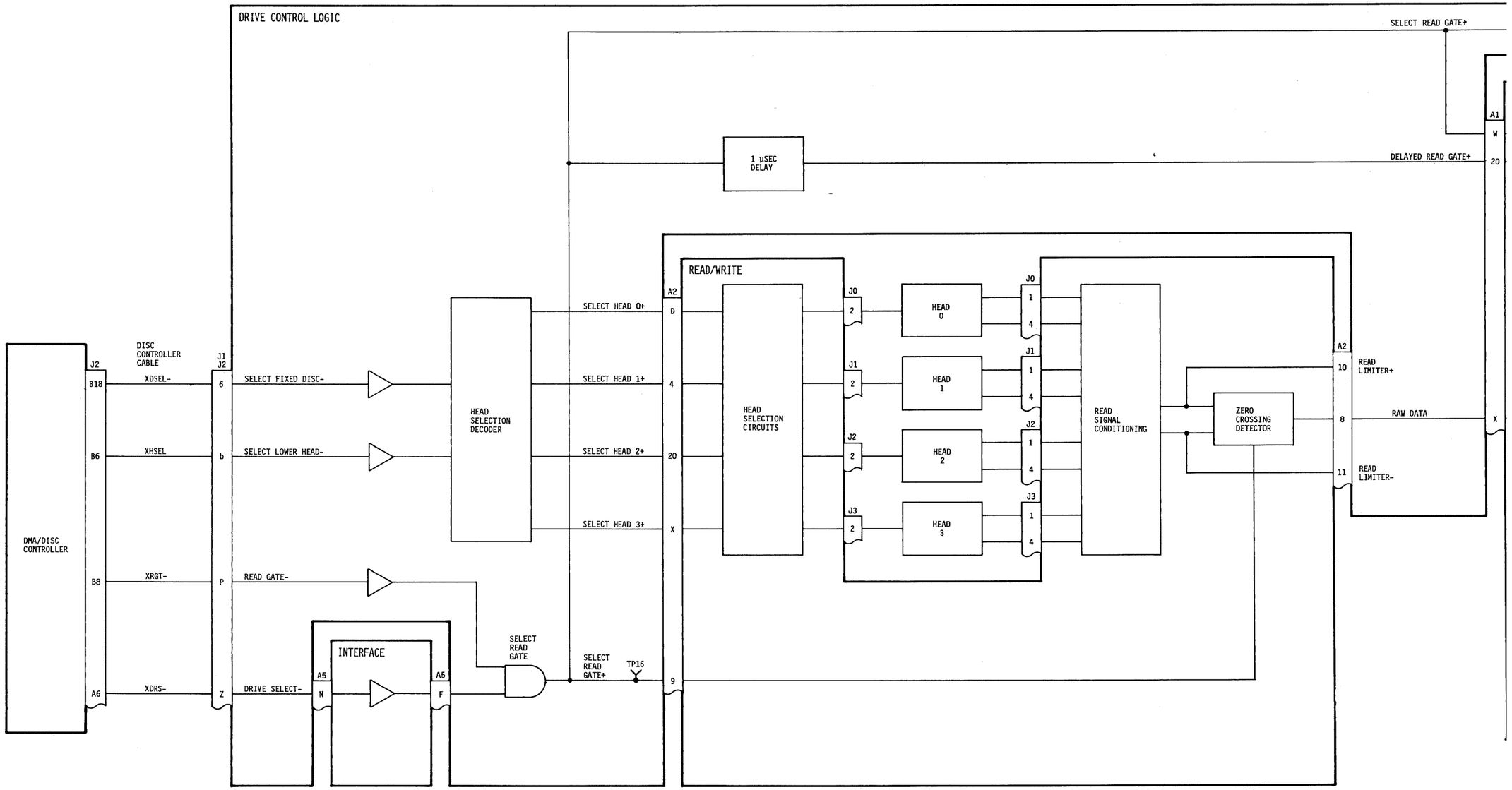


Figure 3-40. Read Function, Sheet 1


DRIVE CONTROL LOGIC
SELECT READ GATE+
1 µSEC DELAY
DELAYED READ GATE+
A1
W
20
READ/WRITE
A2
J0
SELECT HEAD 0+
D
2
HEAD 0
1
4
J1
J1
2
HEAD 1
1
4
J2
J2
2
HEAD 2
1
4
J3
J3
2
HEAD 3
1
4
HEAD SELECTION DECODER
SELECT HEAD 1+
SELECT HEAD 2+
SELECT HEAD 3+
4
20
X
HEAD SELECTION CIRCUITS
READ SIGNAL CONDITIONING
ZERO CROSSING DETECTOR
A2
10
READ LIMITER+
8
RAW DATA
X
11
READ LIMITER-
DISC CONTROLLER CABLE
J2
J1
J2
B18
XDSEL-
6
SELECT FIXED DISC-
B6
XHSEL
b
SELECT LOWER HEAD-
DMA/DISC CONTROLLER
B8
XRGT-
P
READ GATE-
A6
XDRS-
Z
DRIVE SELECT-
INTERFACE
A5
N
A5
F
SELECT READ GATE
SELECT READ GATE+
TP16
9

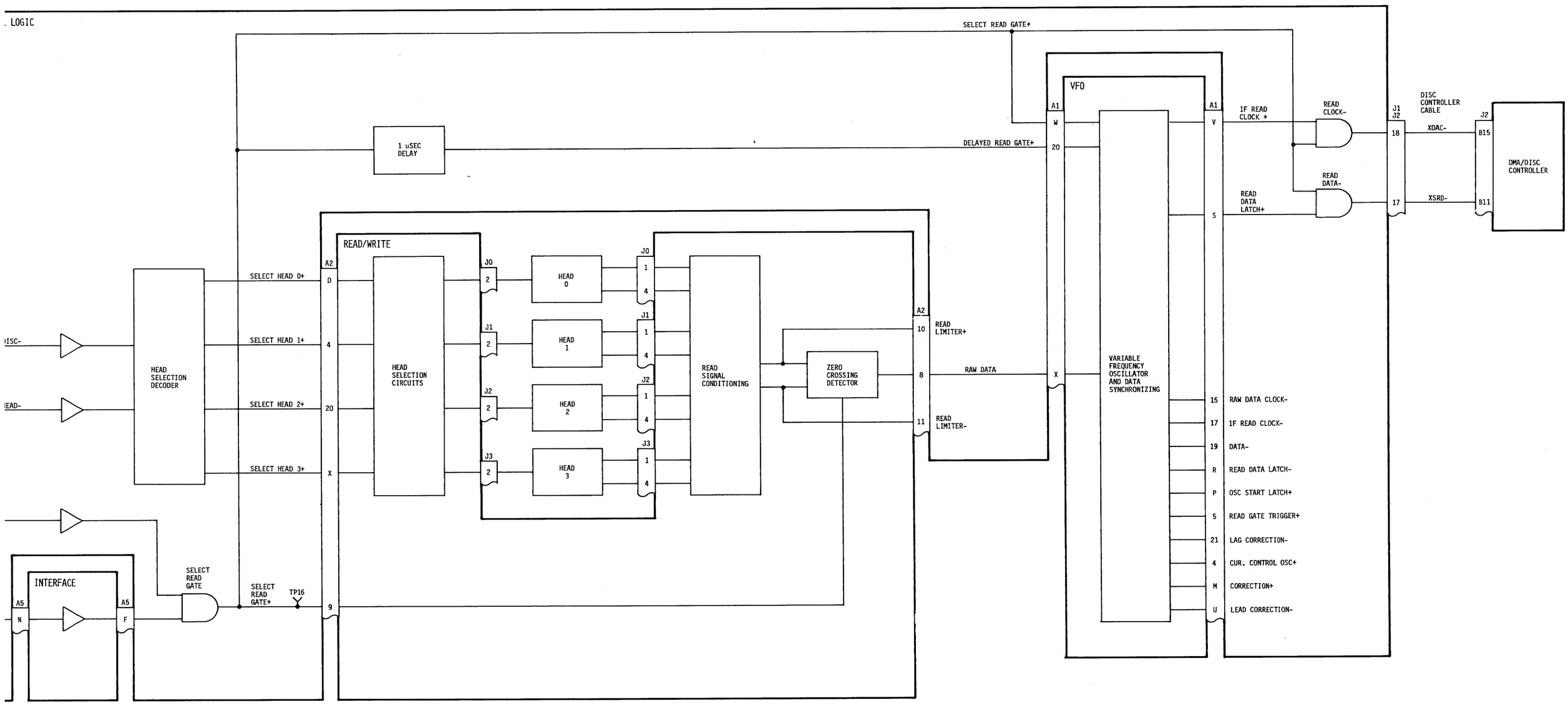


Figure 3-40. Read Function, Sheet 2

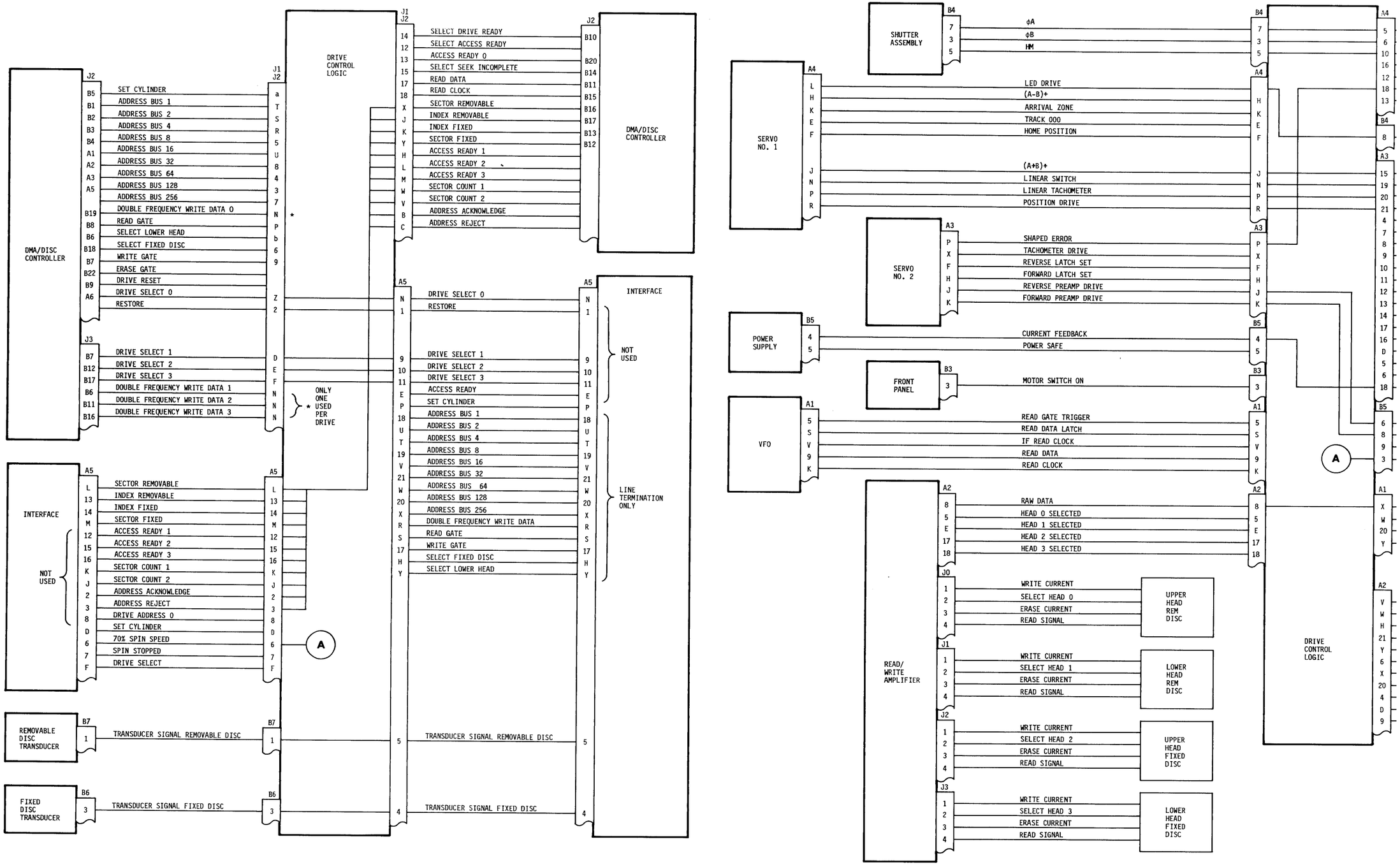

DMA/DISC CONTROLLER
J2
SET CYLINDER
ADDRESS BUS 1
ADDRESS BUS 2
ADDRESS BUS 4
ADDRESS BUS 8
ADDRESS BUS 16
ADDRESS BUS 32
ADDRESS BUS 64
ADDRESS BUS 128
ADDRESS BUS 256
DOUBLE FREQUENCY WRITE DATA 0
READ GATE
SELECT LOWER HEAD
SELECT FIXED DISC
WRITE GATE
ERASE GATE
DRIVE RESET
DRIVE SELECT 0
RESTORE
J3
DRIVE SELECT 1
DRIVE SELECT 2
DRIVE SELECT 3
DOUBLE FREQUENCY WRITE DATA 1
DOUBLE FREQUENCY WRITE DATA 2
DOUBLE FREQUENCY WRITE DATA 3
J1
J2
DRIVE CONTROL LOGIC
ONLY ONE USED PER DRIVE
J1
J2
SELECT DRIVE READY
SELECT ACCESS READY
ACCESS READY 0
SELECT SEEK INCOMPLETE
READ DATA
READ CLOCK
SECTOR REMOVABLE
INDEX REMOVABLE
INDEX FIXED
SECTOR FIXED
ACCESS READY 1
ACCESS READY 2
ACCESS READY 3
SECTOR COUNT 1
SECTOR COUNT 2
ADDRESS ACKNOWLEDGE
ADDRESS REJECT
J2
DMA/DISC CONTROLLER
A5
DRIVE SELECT 0
RESTORE
DRIVE SELECT 1
DRIVE SELECT 2
DRIVE SELECT 3
ACCESS READY
SET CYLINDER
ADDRESS BUS 1
ADDRESS BUS 2
ADDRESS BUS 4
ADDRESS BUS 8
ADDRESS BUS 16
ADDRESS BUS 32
ADDRESS BUS 64
ADDRESS BUS 128
ADDRESS BUS 256
DOUBLE FREQUENCY WRITE DATA
READ GATE
WRITE GATE
SELECT FIXED DISC
SELECT LOWER HEAD
A5
INTERFACE
NOT USED
LINE TERMINATION ONLY
INTERFACE
NOT USED
SECTOR REMOVABLE
INDEX REMOVABLE
INDEX FIXED
SECTOR FIXED
ACCESS READY 1
ACCESS READY 2
ACCESS READY 3
SECTOR COUNT 1
SECTOR COUNT 2
ADDRESS ACKNOWLEDGE
ADDRESS REJECT
DRIVE ADDRESS 0
SET CYLINDER
70% SPIN SPEED
SPIN STOPPED
DRIVE SELECT
A
REMOVABLE DISC TRANSDUCER
TRANSDUCER SIGNAL REMOVABLE DISC
FIXED DISC TRANSDUCER
TRANSDUCER SIGNAL FIXED DISC
SHUTTER ASSEMBLY
ϕA
ϕB
HM
SERVO NO. 1
LED DRIVE
(A-B)+
ARRIVAL ZONE
TRACK 000
HOME POSITION
(A+B)+
LINEAR SWITCH
LINEAR TACHOMETER
POSITION DRIVE
SERVO NO. 2
SHAPED ERROR
TACHOMETER DRIVE
REVERSE LATCH SET
FORWARD LATCH SET
REVERSE PREAMP DRIVE
FORWARD PREAMP DRIVE
POWER SUPPLY
CURRENT FEEDBACK
POWER SAFE
FRONT PANEL
MOTOR SWITCH ON
VFO
READ GATE TRIGGER
READ DATA LATCH
IF READ CLOCK
READ DATA
READ CLOCK
READ/ WRITE AMPLIFIER
RAW DATA
HEAD 0 SELECTED
HEAD 1 SELECTED
HEAD 2 SELECTED
HEAD 3 SELECTED
WRITE CURRENT
SELECT HEAD 0
ERASE CURRENT
READ SIGNAL
UPPER HEAD REM DISC
SELECT HEAD 1
LOWER HEAD REM DISC
SELECT HEAD 2
UPPER HEAD FIXED DISC
SELECT HEAD 3
LOWER HEAD FIXED DISC
DRIVE CONTROL LOGIC
A

Figure 3-41.

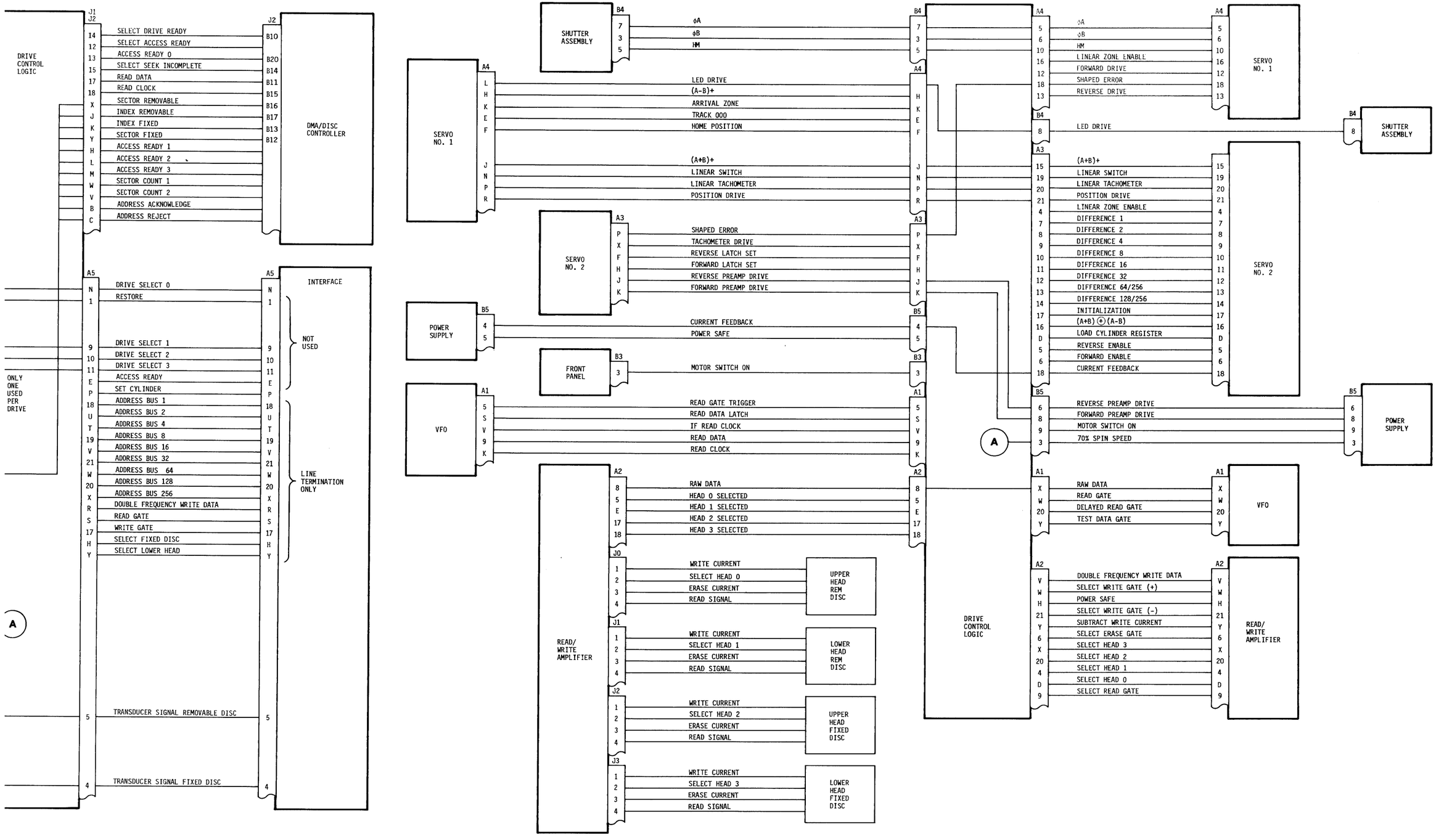
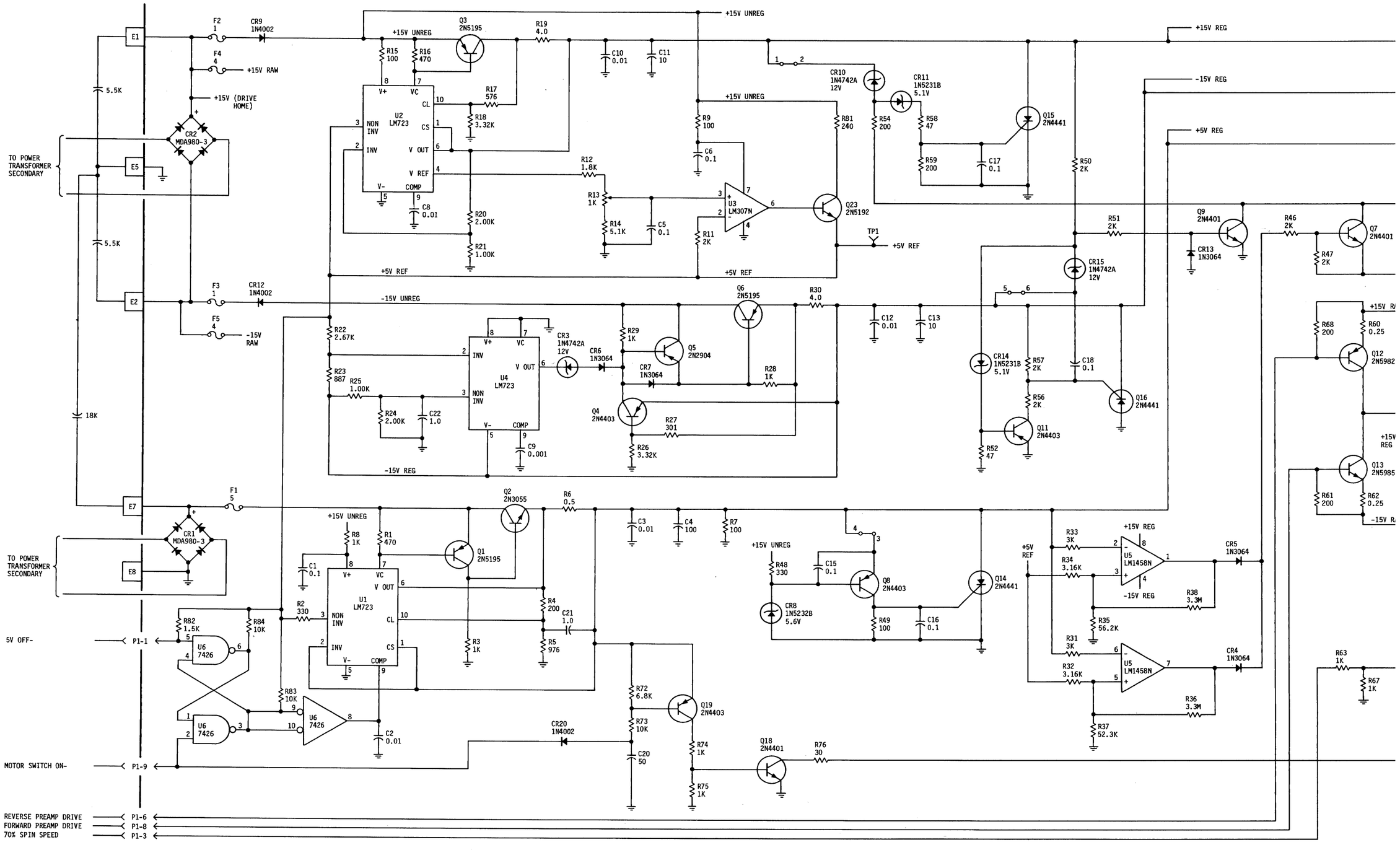


Figure 3-41. Interconnection Diagram


TO POWER TRANSFORMER SECONDARY
E1
E2
E5
E7
E8
F1 5
F2 1
F3 1
F4 4
F5 4
+15V RAW
+15V (DRIVE HOME)
-15V RAW
CR1 MDA980-3
CR2 MDA980-3
CR9 1N4002
CR12 1N4002
5.5K
5.5K
18K
+15V UNREG
-15V UNREG
+15V REG
-15V REG
+5V REG
+5V REF
Q3 2N5195
Q6 2N5195
Q2 2N3055
Q1 2N5195
U1 LM723
U2 LM723
U4 LM723
U3 LM307N
R15 100
R16 470
R17 576
R18 3.32K
R19 4.0
R20 2.00K
R21 1.00K
R12 1.8K
R13 1K
R14 5.1K
R11 2K
R9 100
R81 240
R54 200
R58 47
R59 200
R50 2K
C8 0.01
C5 0.1
C6 0.1
C10 0.01
C11 10
CR10 1N4742A 12V
CR11 1N5231B 5.1V
Q15 2N4441
Q23 2N5192
TP1
R22 2.67K
R23 887
R25 1.00K
R24 2.00K
C22 1.0
C9 0.001
CR3 1N4742A 12V
CR6 1N3064
CR7 1N3064
R29 1K
R28 1K
Q5 2N2904
Q4 2N4403
R27 301
R26 3.32K
R30 4.0
C12 0.01
C13 10
R51 2K
CR15 1N4742A 12V
Q9 2N4401
CR13 1N3064
R46 2K
R47 2K
Q7 2N4401
CR14 1N5231B 5.1V
R57 2K
C18 0.1
R56 2K
Q11 2N4403
R52 47
Q16 2N4441
R68 200
R60 0.25
Q12 2N5982
R61 200
R62 0.25
Q13 2N5985
R63 1K
R67 1K
R8 1K
R1 470
C1 0.1
R2 330
R4 200
C21 1.0
R5 976
R3 1K
C3 0.01
C4 100
R7 100
R6 0.5
R48 330
C15 0.1
CR8 1N5232B 5.6V
Q8 2N4403
R49 100
C16 0.1
Q14 2N4441
R33 3K
R34 3.16K
R35 56.2K
R31 3K
R32 3.16K
R37 52.3K
U5 LM1458N
R38 3.3M
R36 3.3M
CR5 1N3064
CR4 1N3064
R82 1.5K
R84 10K
R83 10K
U6 7426
C2 0.01
CR20 1N4002
R72 6.8K
R73 10K
C20 50
Q19 2N4403
R74 1K
R75 1K
Q18 2N4401
R76 30
5V OFF-
MOTOR SWITCH ON-
P1-1
P1-9
REVERSE PREAMP DRIVE
FORWARD PREAMP DRIVE
70% SPIN SPEED
P1-6
P1-8
P1-3

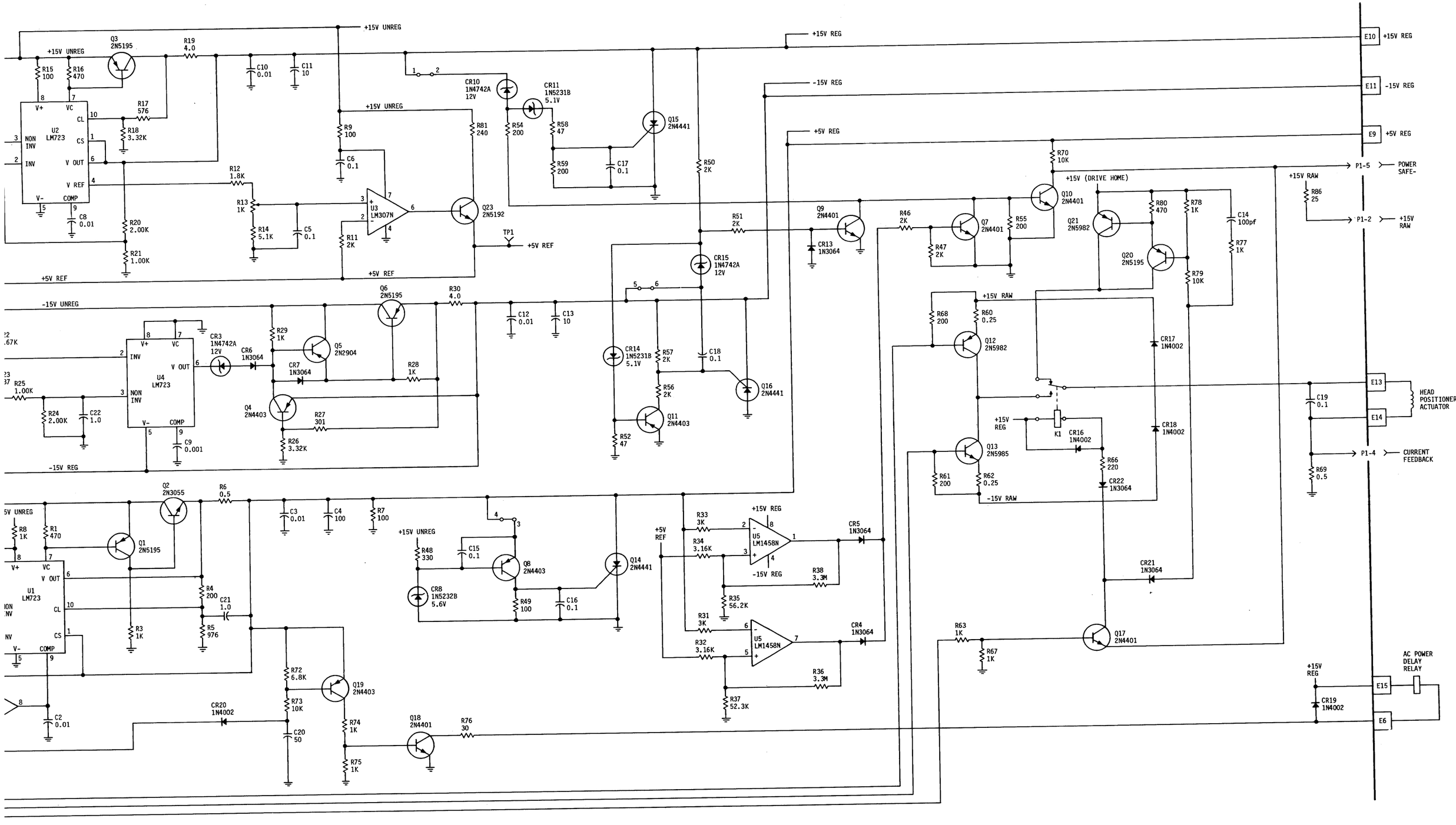


Figure 3-42. Power Supply Circuit Card Schematic Diagram

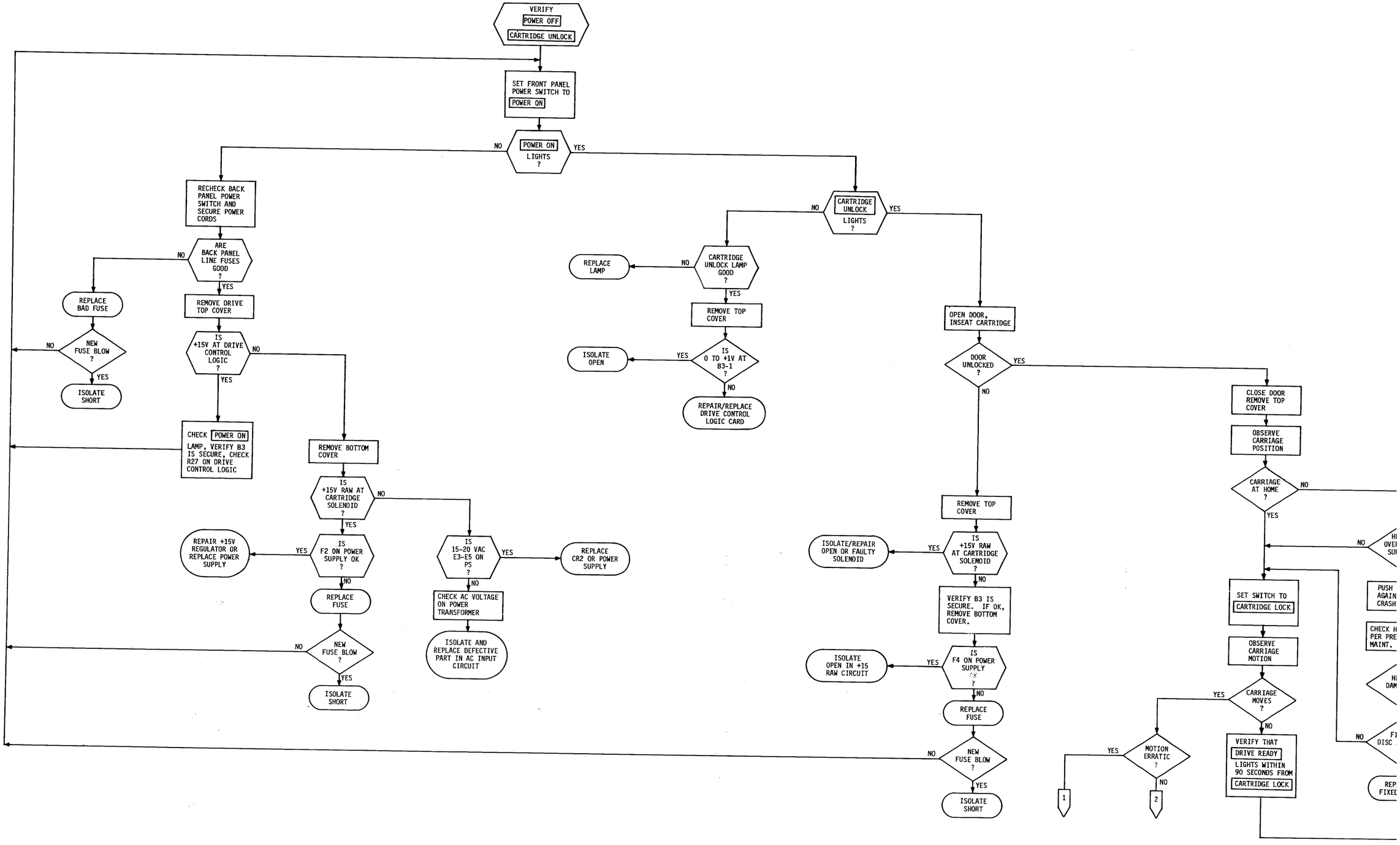


Figure 3-43. Tro

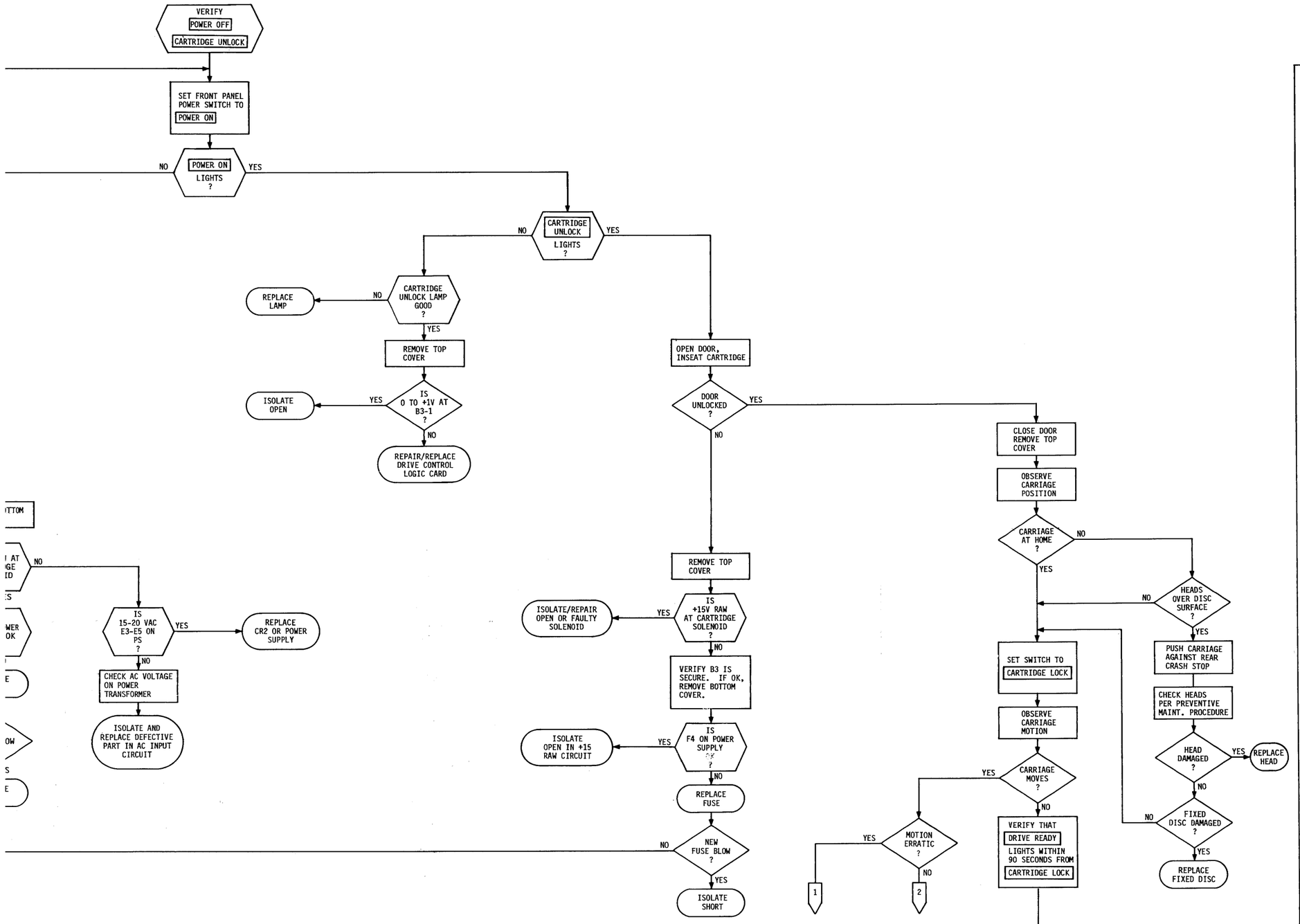


Figure 3-43. Troubleshooting Flow Diagram, Sheet 1

TWO-TRACK SEEK LOOP PROGRAM

ENTER FROM KEYBOARD:

```
NEW
10 DIM A$ (110)
20 GET 0,0,A$
30 FOR A = 0 TO 50
40 NEXT A
50 GET 0,300,A$
60 IF A = 50 GOTO 80
70 GOTO 20
80 END
RUN
```

NOTE: STEP 50, CHANGE 300 TO TX96 TO SEEK DIFFERENT TRACK

TRACK STEP PROGRAM

ENTER FROM KEYBOARD

```
NEW
10 DIM A$ (110)
20 FOR S = 0 TO 19200 STEP 96
30 IF S = 19200 GOTO 60
40 GET 0,S,A$
50 NEXT S
60 END
```

NOTE: CHECK DIFF1 AT A3-7 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 192
RUN
```

NOTE: CHECK DIFF2 AT A3-8 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 384
RUN
```

NOTE: CHECK DIFF4 AT A3-9 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 768
RUN
```

NOTE: CHECK DIFF8 AT A3-10 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 1536
RUN
```

NOTE: CHECK DIFF16 AT A3-11 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 3072
RUN
```

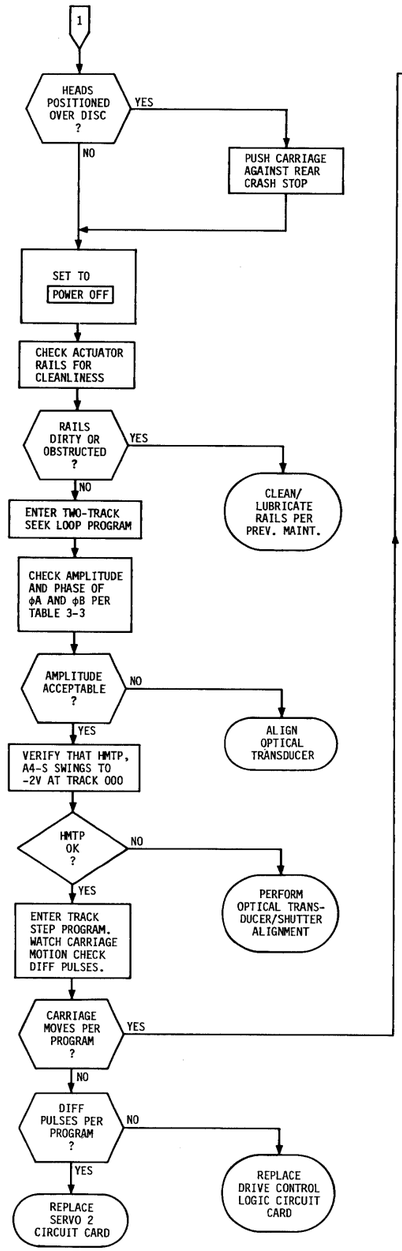
NOTE: CHECK DIFF32 AT A3-12 FOR LOW PULSES THEN ENTER:

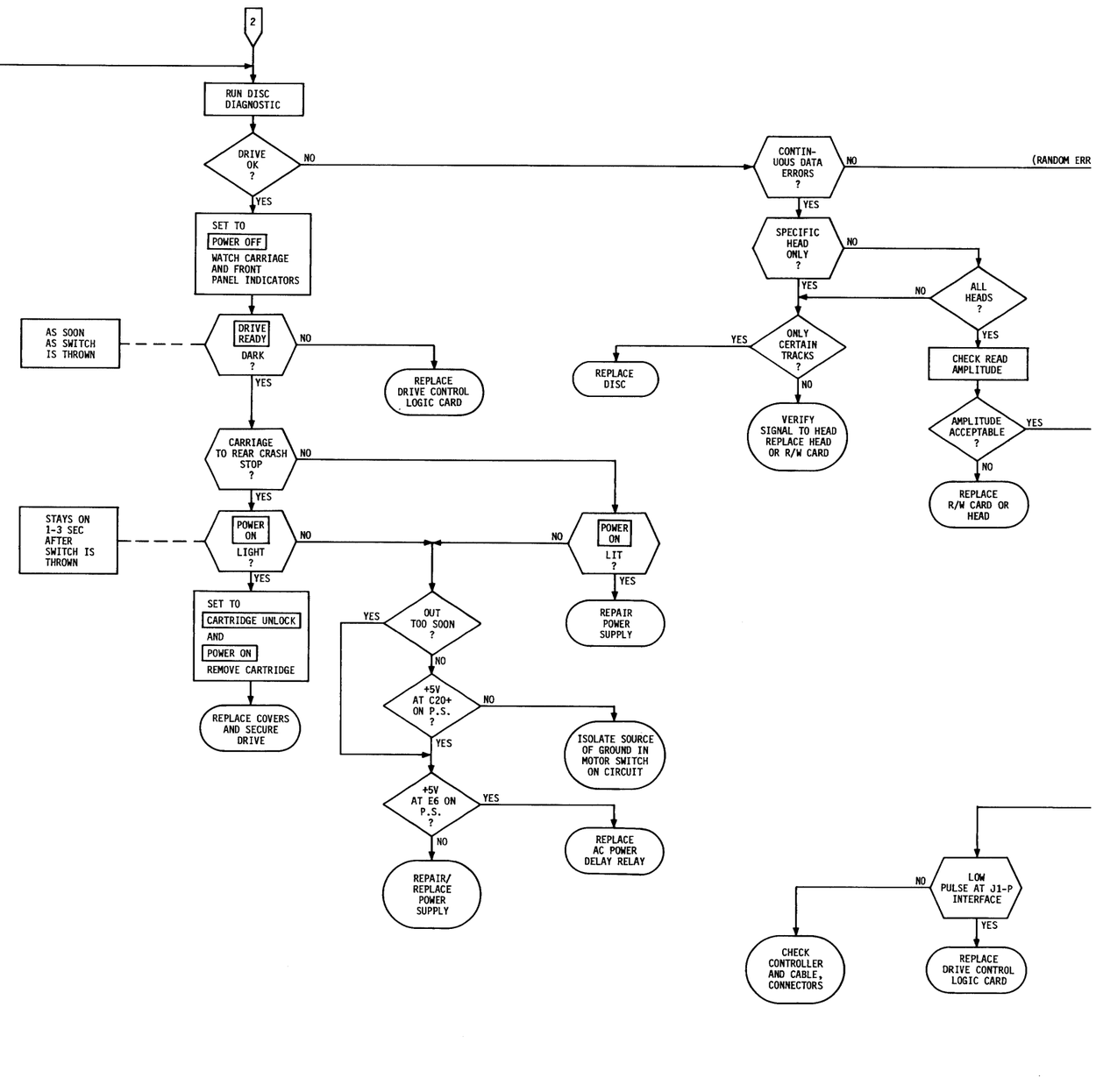
```
20 FOR S = 0 TO 19200 STEP 6144
RUN
```

NOTE: CHECK DIFF64/256 AT A3-13 FOR LOW PULSES THEN ENTER:

```
20 FOR S = 0 TO 19200 STEP 12288
RUN
```

NOTE: CHECK FOR LOW PULSE DIFF128/256 AT A3-13.





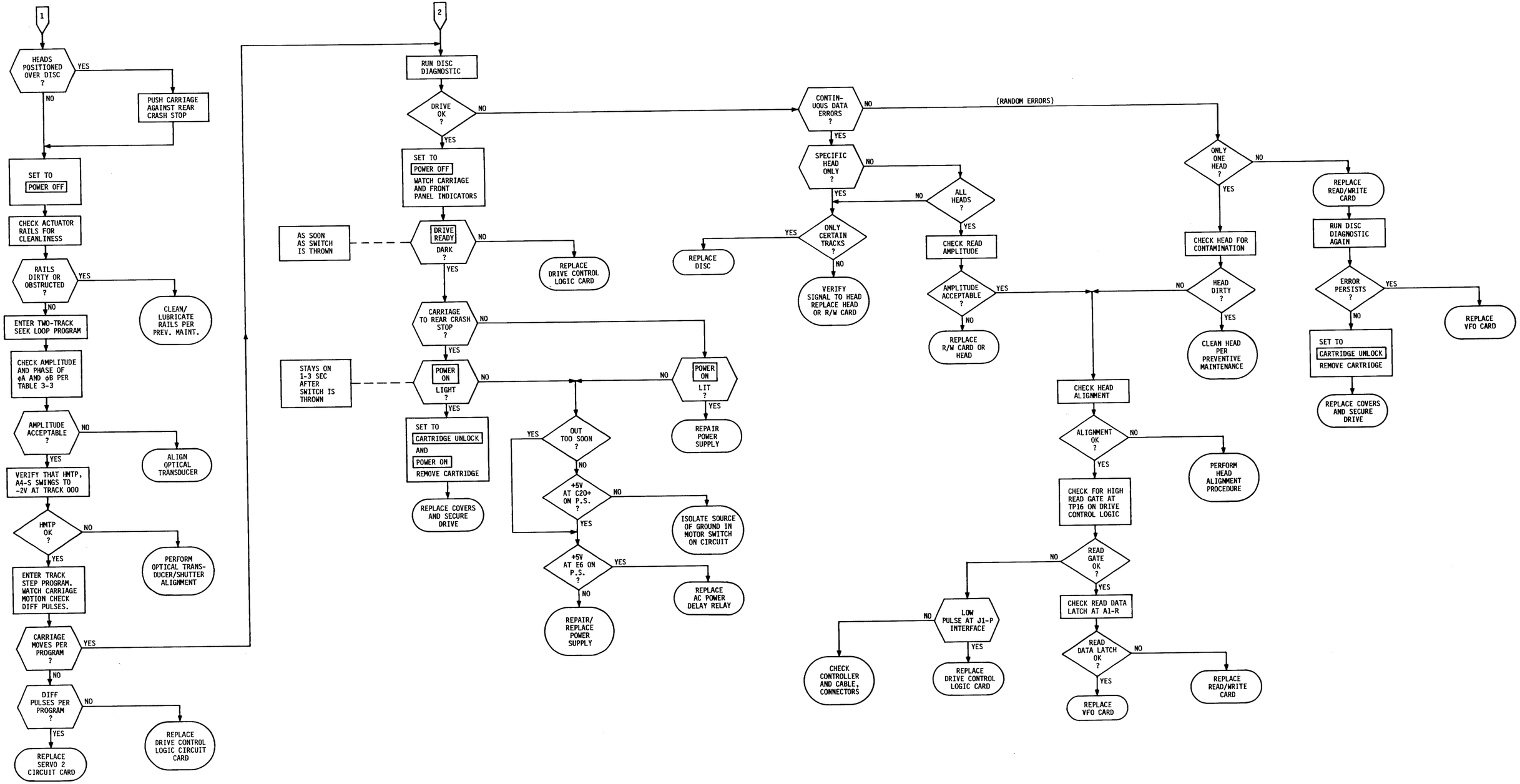


Figure 3-43. Troubleshooting Flow Diagram, Sheet 2

Section 4

PARTS LISTS

4.1 SCOPE

This section contains illustrated parts breakdowns and complete piece parts listings. The first part of this section includes exploded view illustrations of the drive mechanical components. The second part of this section contains assembly drawings of circuit cards and parts lists organized by reference designator (symbol) numbers.

4.2 PART NUMBERS OF DISC STORAGE UNITS

Model Number	Packing Density	Operating Power	Part Number
2115	2,100,000	115V, 60Hz	400180
2115	2,100,000	220V, 50Hz	400181
2215	4,200,000	115V, 60Hz	400170
2215	4,200,000	220V, 50Hz	400171
2315	8,400,000	115V, 60Hz	400173
2315	8,400,000	220V, 50Hz	400174

Parts List for Disc Drive Assembly, figure 4-1

Reference No.	Part Number	Part Name	Quantity
1	73170	Receiver assembly	1
2	73184	Anchor	4
3	19160	Spring	2
4	13372	Screw	4
5	73180	Cover assembly, fixed disc	1
6	73540	Interface circuit card	1
7	73590	Servo circuit card No. 1	1
8	73480	Servo circuit card No. 2	1
9	73460	Read/write circuit card	1
10	73560	VFO circuit card	1
11	73720	Drive control logic circuit card	1
12	73401	Spin motor assembly	1
13	19140	Flange bearing	4
14	73281	Standoff	4
15	25500	Tape	5
16	73160	Door assembly	1
17	73193	Bracket	2
18	13349	Screw	4

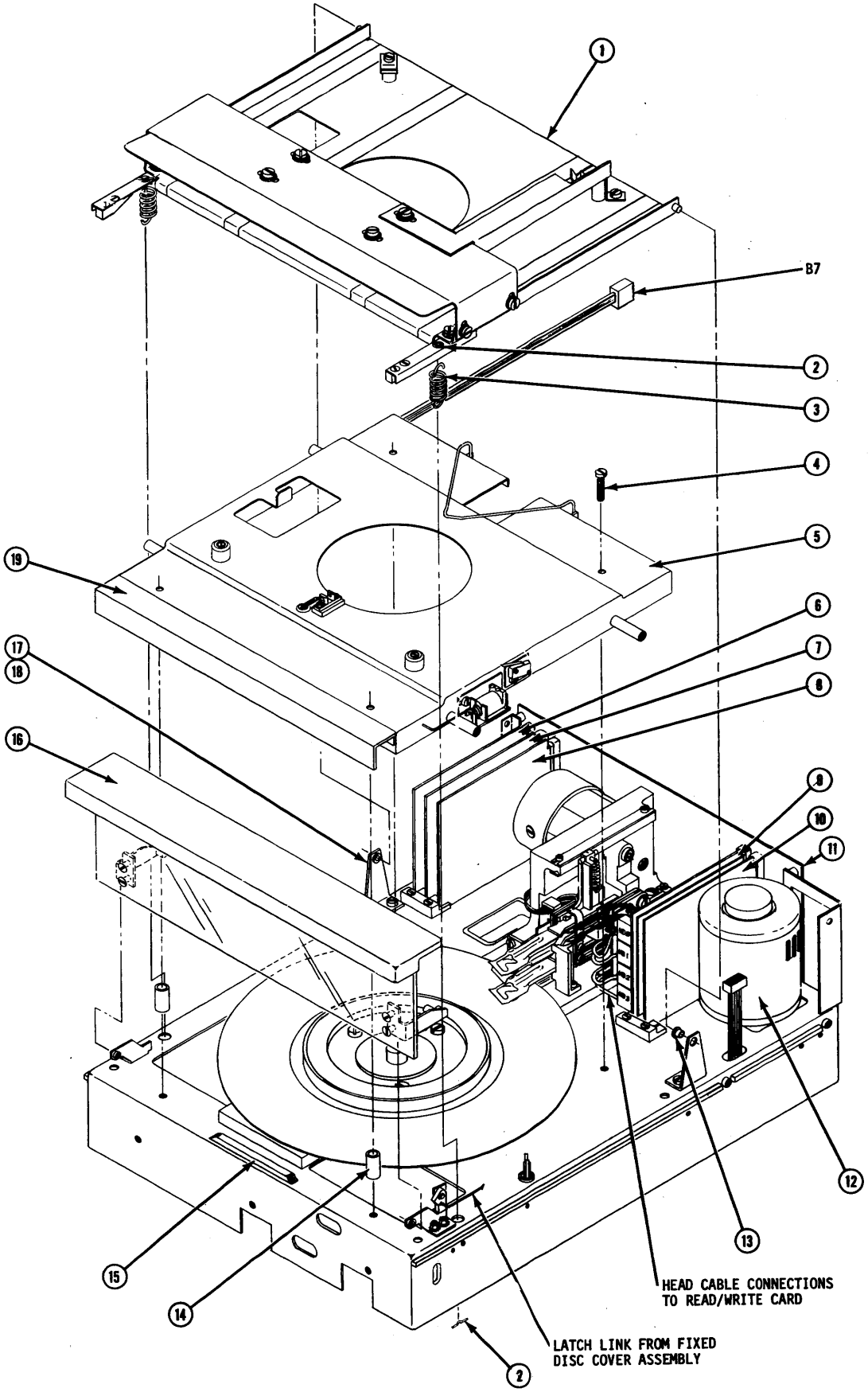


Figure 4-1. Disc Drive Assembly

Parts List for Receiver Assembly, figure 4-2

Reference No.	Part Number	Part Name	Quantity
1	74408	Guide strip assembly	1
2	73267	Strap	1
3	73271	Guide, right side	1
4	73271	Guide, left side	1
5	13330	Screw	6
6	14024	Washer, lock	6
7	14003	Washer, plain	6
8	73265	Receiver	1
9	13429	Screw	4
10	73276	Extension, right side	1
11	73275	Extension, left side	1
12	73372	Ramp, right side	1
13	73278	Ramp, left side	1
14	73347	Tape	4
15	73299	Stop	2
16	73298	Spring	2
17	74407	Tubing, heat shrink	A/R
18	13346	Screw	2
19	13358	Screw	2
20	13349	Screw	8
21	14004	Washer, plain	8
22	73375	Shield	1
23	14025	Washer, lock	4

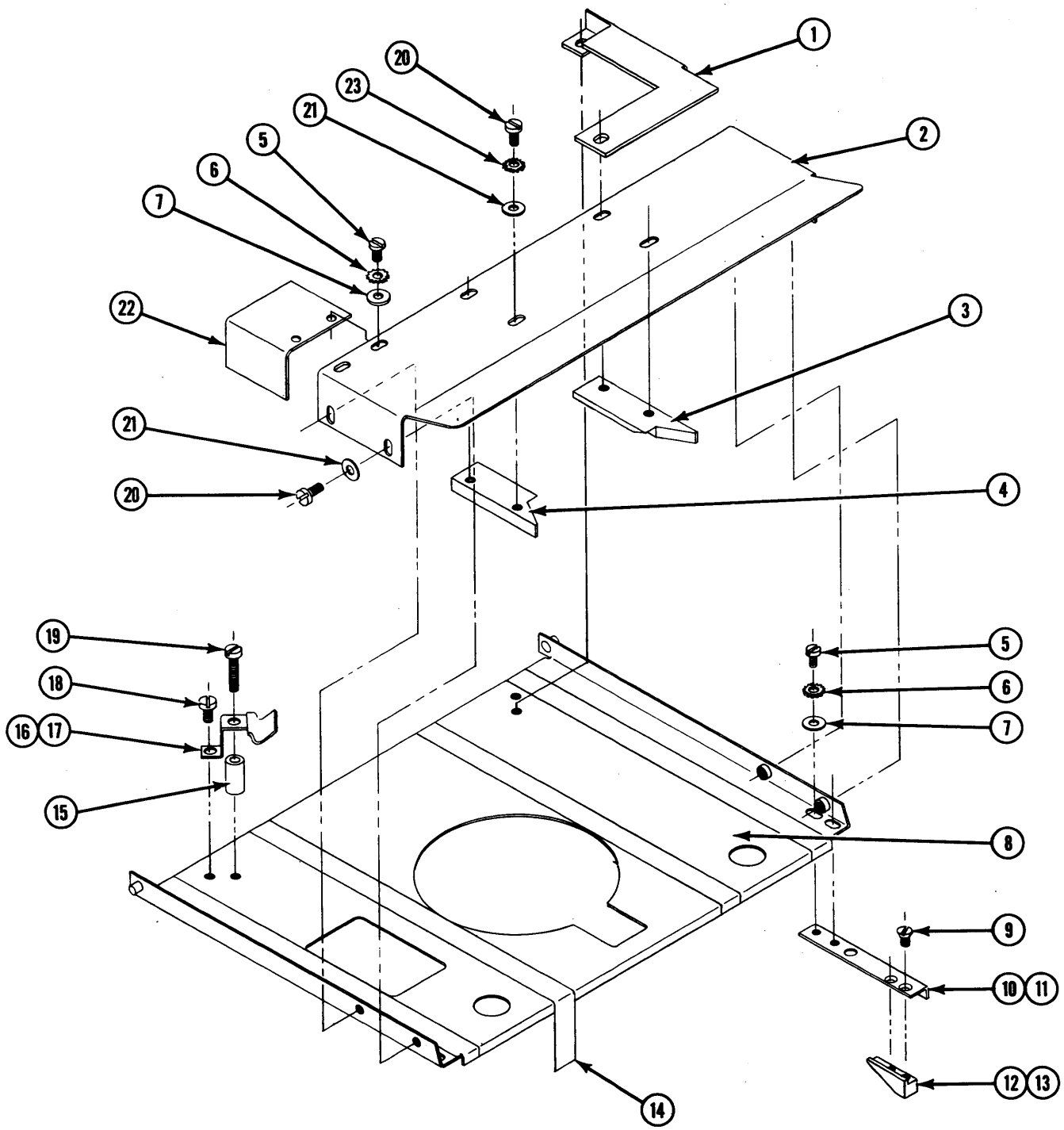


Figure 4-2. Receiver Assembly (73170)

Parts List for Fixed Disc Cover Assembly, Right Side, figure 4-3

Reference No.	Part Number	Part Name	Quantity
1	73255	Cam, cartridge door open	1
2	13364	Screw	4
3	14026	Washer, lock	4
4	73296	Standoff	4
5	18660	Micro switch	1
6	13318	Screw	2
7	73282	Plate, micro switch mounting	1
8	13313	Screw	4
9	73270	Handle latch assembly	1
10	74390	Seal strip assembly	1
11	B74373	Cartridge guide	2
12	13334	Screw	2
13	24680	Screw	4
14	19120	Grommet	1
15	73190	Transducer assembly	1
16	73606	Sector transducer	1
17	19280	Nut	2
18	73266	Cover, fixed disc	1

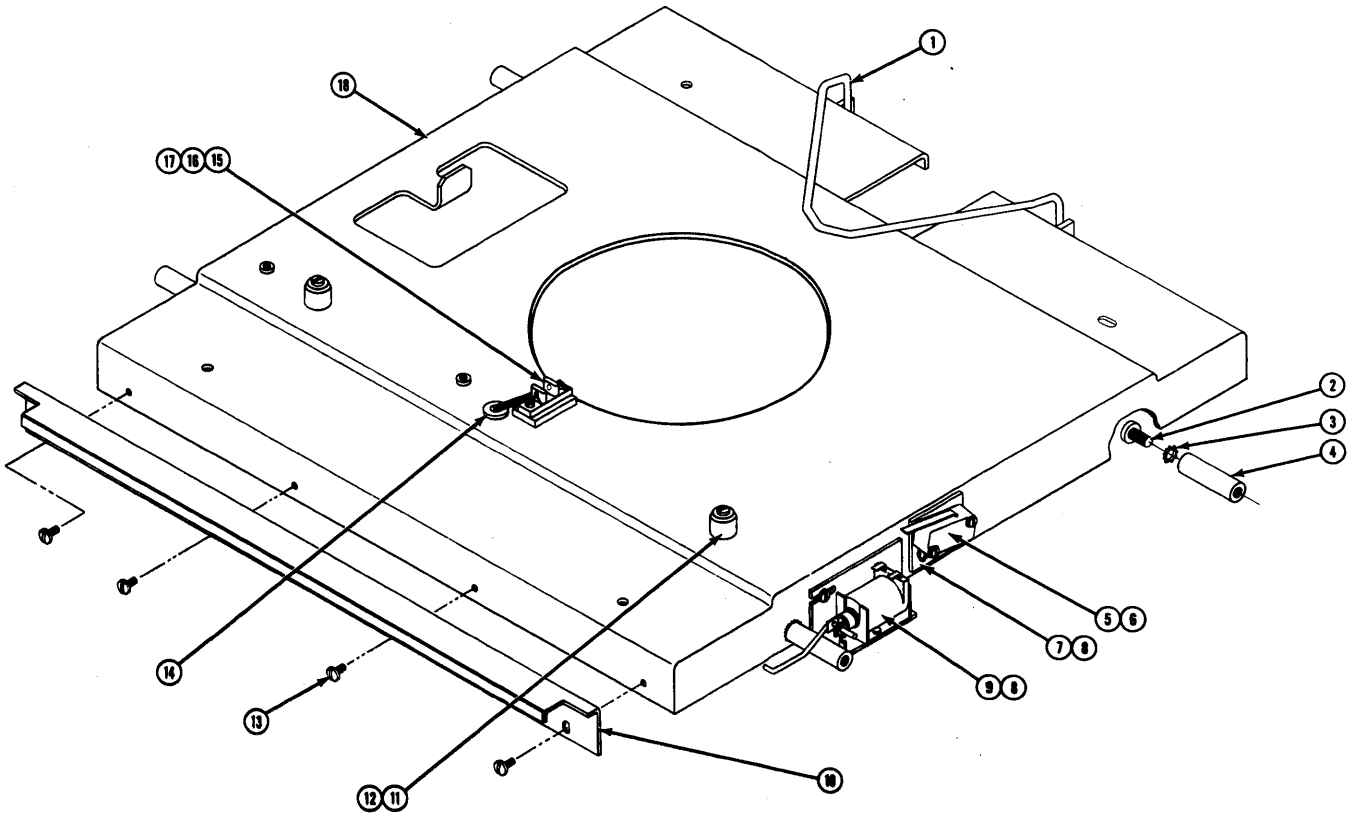


Figure 4-3. Fixed Disc Cover Assembly (73180), Right Side

Parts List for Fixed Disc Cover Assembly, Left Side, figure 4-4

Reference No.	Part Number	Part Name	Quantity
1	73297	Clamp, cable	4
2	73185	Guide, cartridge	2
3	19120	Grommet	1
4	13313	Screw	4
5	18390	Plug, keying	2
6	19150	Ring, truarc	1
7	73188	Spring, cam	4
8	73255	Cam, cartridge door open	1
9	73342	Pivot, cam	2
10	13330	Screw	4

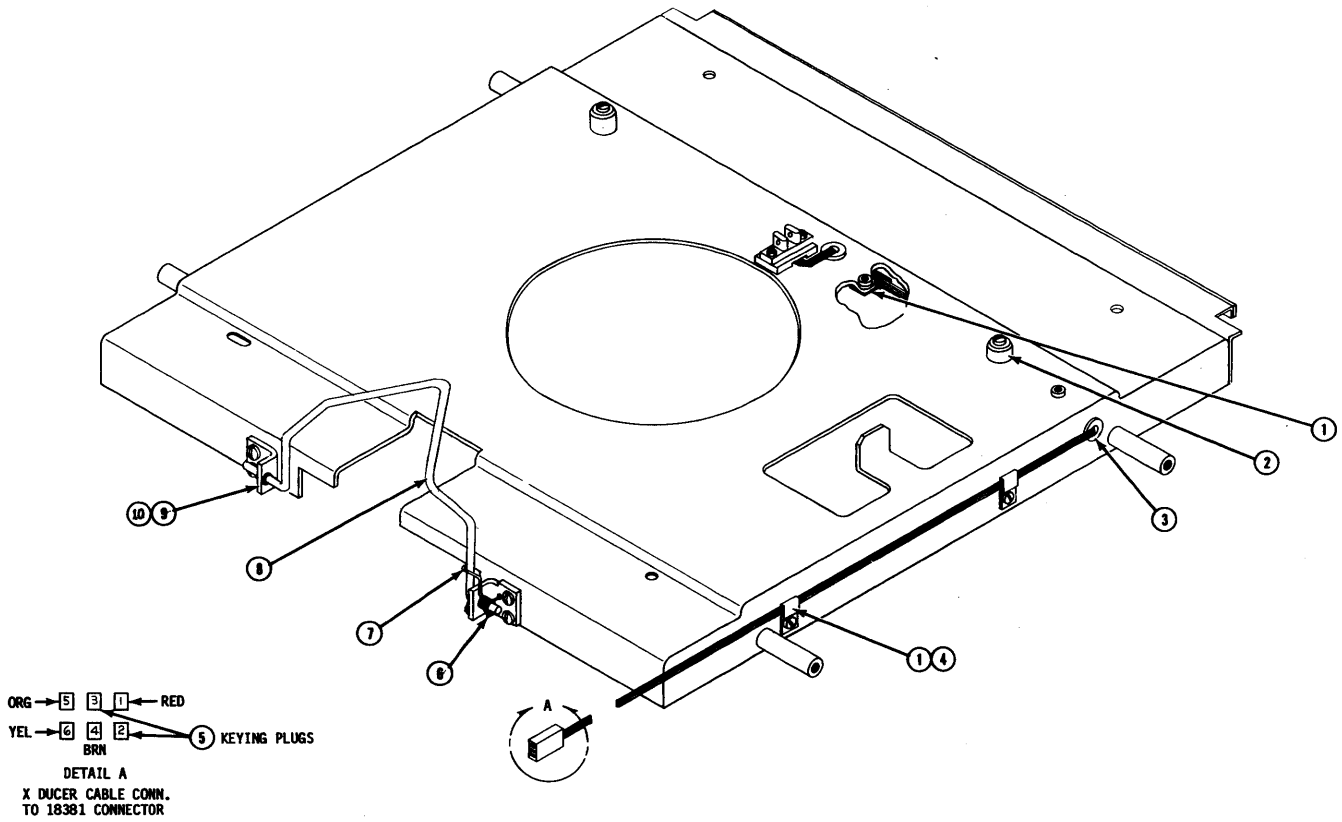


Figure 4-4. Fixed Disc Cover Assembly (73180), Left Side

Parts List for Door Assembly, figure 4-5

Reference No.	Part Number	Part Name	Quantity
1	73292	Strip, attaching	1
2	73286	Window	1
3	73285	Handle, door	1
4	14004	Washer, plain	4
5	14025	Washer, lock	4
6	14104	Nut	4
7	73268	Hinge, right side	1
8	14003	Washer, plain	4
9	14024	Washer, lock	4
10	14103	Nut	4
11	73269	Hinge, left side	1
12	73349	Shim (up to 8 may be used)	2
13	19248	Screw	4
14	73348	Shim	1

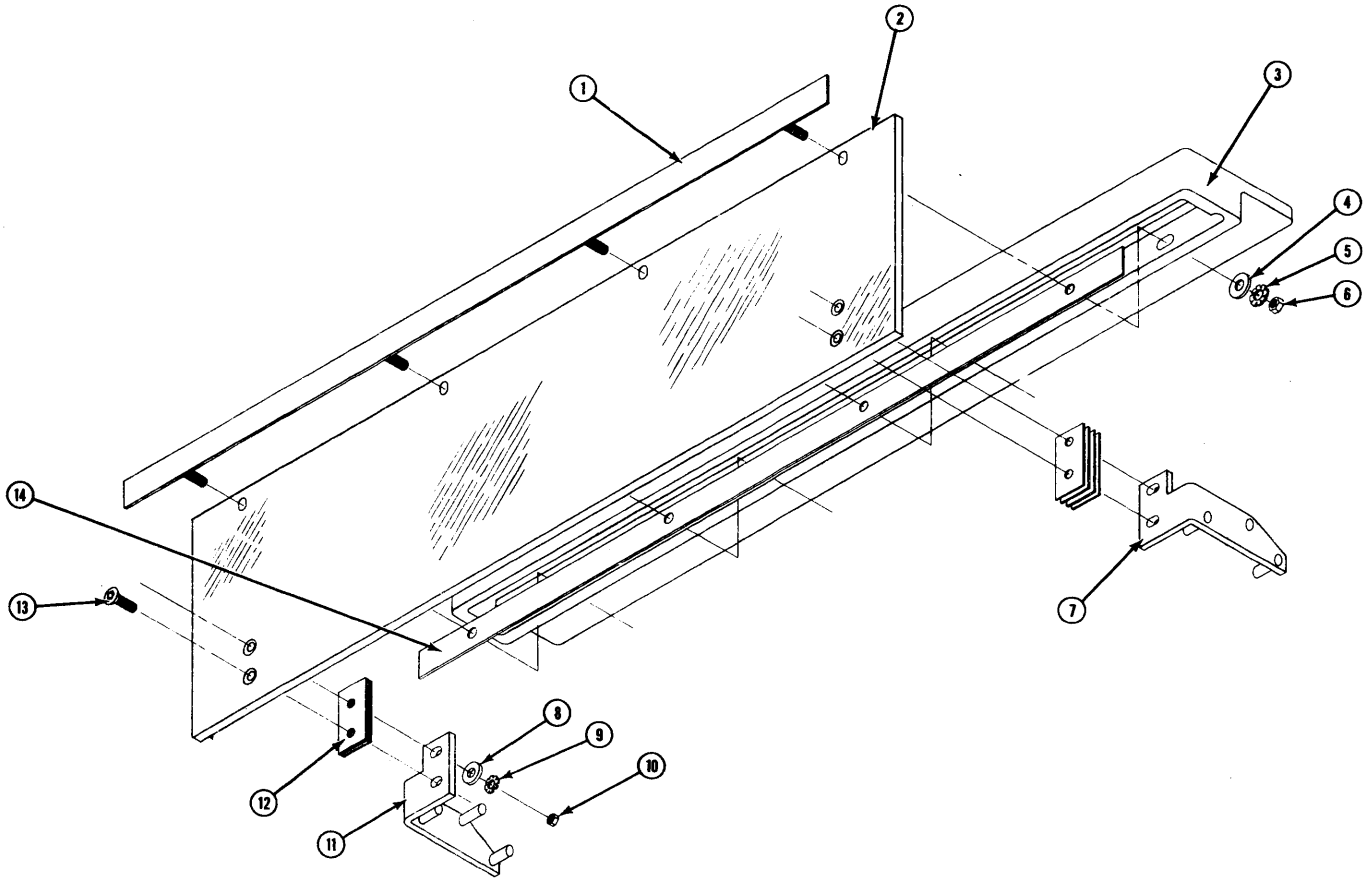


Figure 4-5. Door Assembly (73160)

Parts List for Chassis Assembly, figure 4-6

Reference No.	Part Number	Part Name	Quantity
1	13366	Screw	2
2	B73020	Actuator	1
3	73720	Drive control logic circuit card	1
4	13331	Screw	4
5	18763	Washer, nylon	4
6	13612	Screw	2
7	73401	Spin motor assembly	1
8	73367	Mounting block, head lead	1
9	73366	Bracket	1
10	13313	Screw	2
11	74354	Card separator (2 card)	1
12	26601	Bushing	1
13	25500	Foam tape	A/R
14	18510	Snap bushing	1
15	A73080	Chassis assembly, 115V, 60Hz	1
	E73080	Chassis assembly, 220V, 50Hz	1
16	14122	Nut	4
17	19262	Grommet	1
18	73280	Locking latch assembly	1
19	60049	Tape	A/R
20	73273	Bracket	1
21	73135	Cam	1
22	13316	Screw	2
23	74354	Card separator (3 card)	1
24	13335	Screw	4
25	K8140	Lower head, 100 TPI	1
	H8140	Lower head, 200 TPI	1
26	J8140	Upper head, 100 TPI	1
	G8140	Upper head, 200 TPI	1

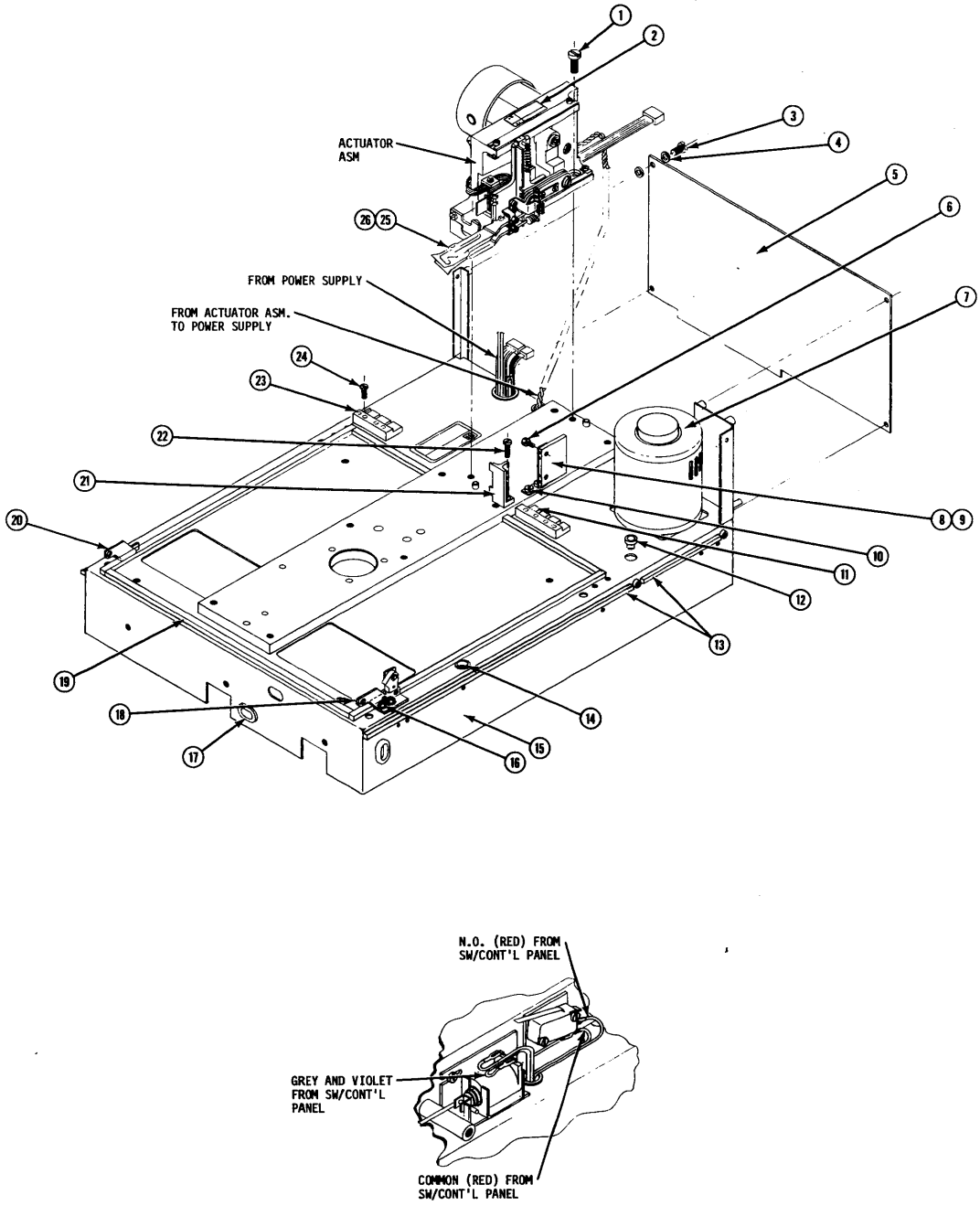


Figure 4-6. Chassis Assembly (73080), Top View

Parts List for Actuator Assembly Top View, figure 4-7

Reference No.	Part Number	Part Name	Quantity
1	74226	Actuator motor	1
2	13314	Screw	12
3	73301	Track indicator plate	1
4	73121	Rail, short	1
5	14015	Washer, lock	4
6	A/B 73664	Crash stop	2
7	18570	Stop	2
8	73115	Clamp	4
9	14104	Nut	9
10	14015	Washer, lock	6
11	73122	Rail, long	1
12	13644	Screw	2
13	73116	Crank	1
14	73118	Retainer, shaft	2
15	19010	Screw	2
16	13317	Screw	4
17	73205	Bracket, adjusting	1
18	73111	Bearing, carrier	1
19	19201	Dowel pin	1
20	18460	Groove pin	2
21	73105	Carriage	1
22	73665	Limiter	1
23	73008	Spring	1
24	73012	Washer	8
25	73117	Spring plate	2
26	73024	Bearing	4
27	73021	Link	2
28	73023	Spring	1
29	73113	Screw	2
30	13414	Screw	4
31	13316	Screw	2
32	73206	Bracket, plate mounting	1
33	73108	Screw, adjusting	4
34	73207	Plate, adjusting	1
35	73666	Screw	4
36	14014	Washer, lock	6
37	73208	Clamp	2
38	73229	Clamp	2
39	73030	Shutter assembly	1
40	73138	Pin, bearing	3
41	73231	Bearing, actuator	3
42	74227	Cap	3
43	74228	Spacer	3
44	18560	Washer, wave	3
45	0546	Bearing	3
46	14013	Washer, lock	3
47	14102	Nut	3
48	14103	Nut	3
49	73010	Transducer assembly	1
50	73446	Clamp, cable	1
51	73106	Frame	1
52	74403	Washer	1
53	13619	Screw	1

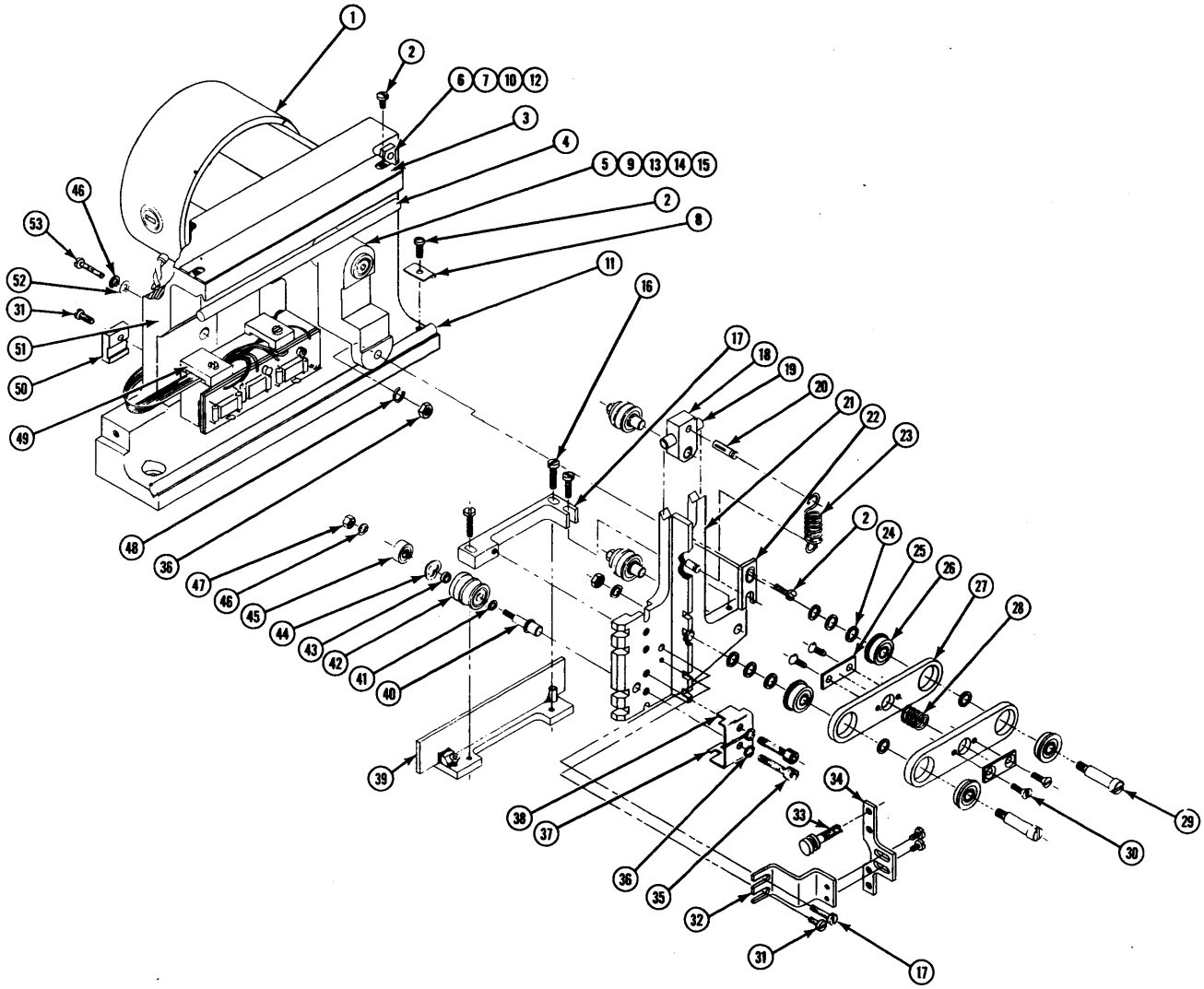


Figure 4-7. Actuator Assembly (73020)

Parts List for Actuator Motor Assembly, figure 4-8

Reference No.	Part Number	Part Name	Quantity
1	19010	Screw	2
2	73118	Retainer, shaft	2
3	13330	Screw	2
4	73051	Retainer, spring	1
5	73448	Back plate, double	1
6	73224	Clip	2
7	73045	Finger spring	1
8	73046	Bearing	1
9	73236	Actuator motor	1
10	73034	Shaft, actuator	1
11	73037	Bearing	1
12	73318	Screw, double, actuator	2
13	73225	Cap	4
14	73226	Brush	4
15	73223	Holder, brush	4
16	73631	Cable assembly	1
17	13824	Screw, set	4

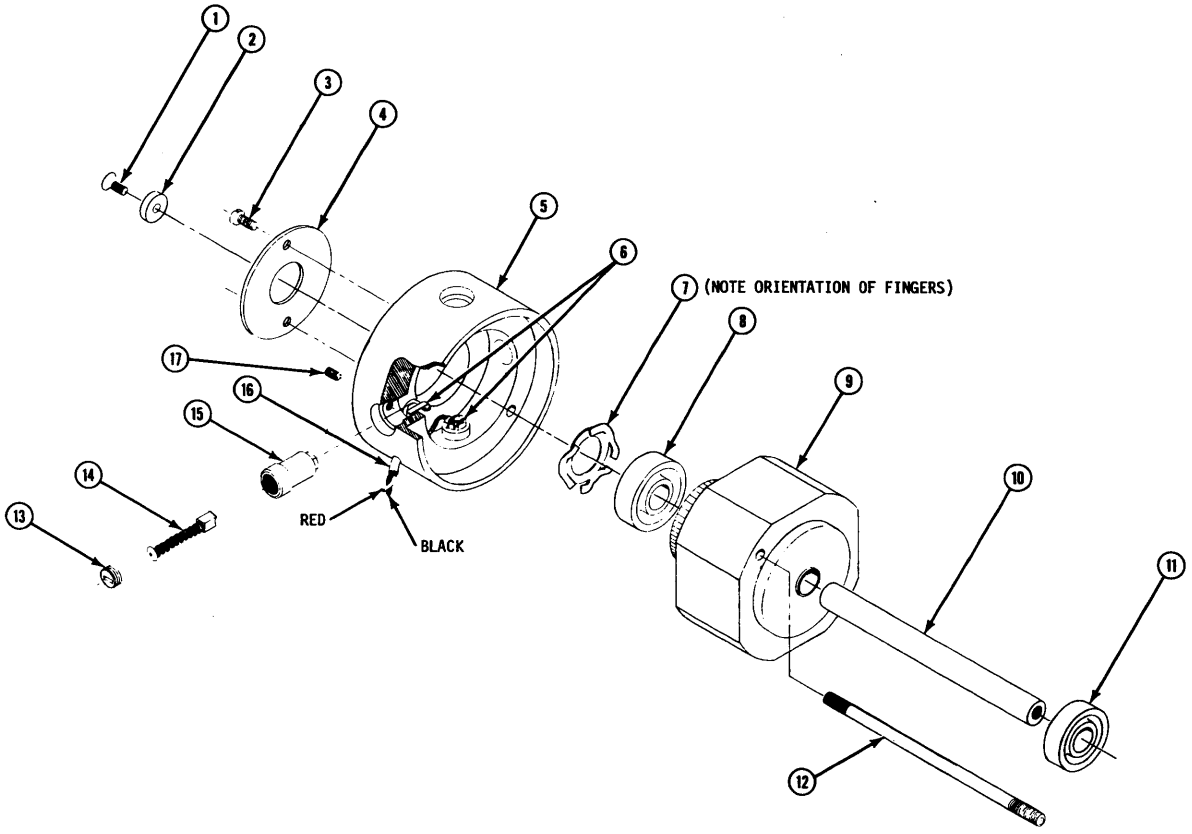


Figure 4-8. Actuator Motor Assembly (74226)

Parts List for Chassis Assembly, Bottom View, figure 4-9

Reference No.	Part Number	Part Name	Quantity
1	B73408	Disc spindle assembly	1
2	D73633	Wire assembly	1
3	73635	Cable assembly	1
4	73606	Sector transducer	1
5	13303	Screw	2
6	14016	Lockwasher	3
7	13656	Screw	3
8	74210	Panel assembly, switch	1
9	15802	Cable tie	3
10	13349	Screw	2
11	73663	Air filter	1
12	13316	Screw	9
13	13653	Screw	1
14	14016	Washer	1
15	13835	Screw, set	2
16	A73409	Sector pulley	1
17	60411	Belt, flat	1
18	13351	Screw	1
19	A73120	Blower assembly	1
20	73622	Cable assembly	1
21	74303	Bracket, circuit card mounting	1
22	A73633	Wire assembly	1
23	B73633	Wire assembly	1
24	C73633	Wire assembly	1
25	13449	Screw	4
26	74304	Bracket, circuit card mounting	2

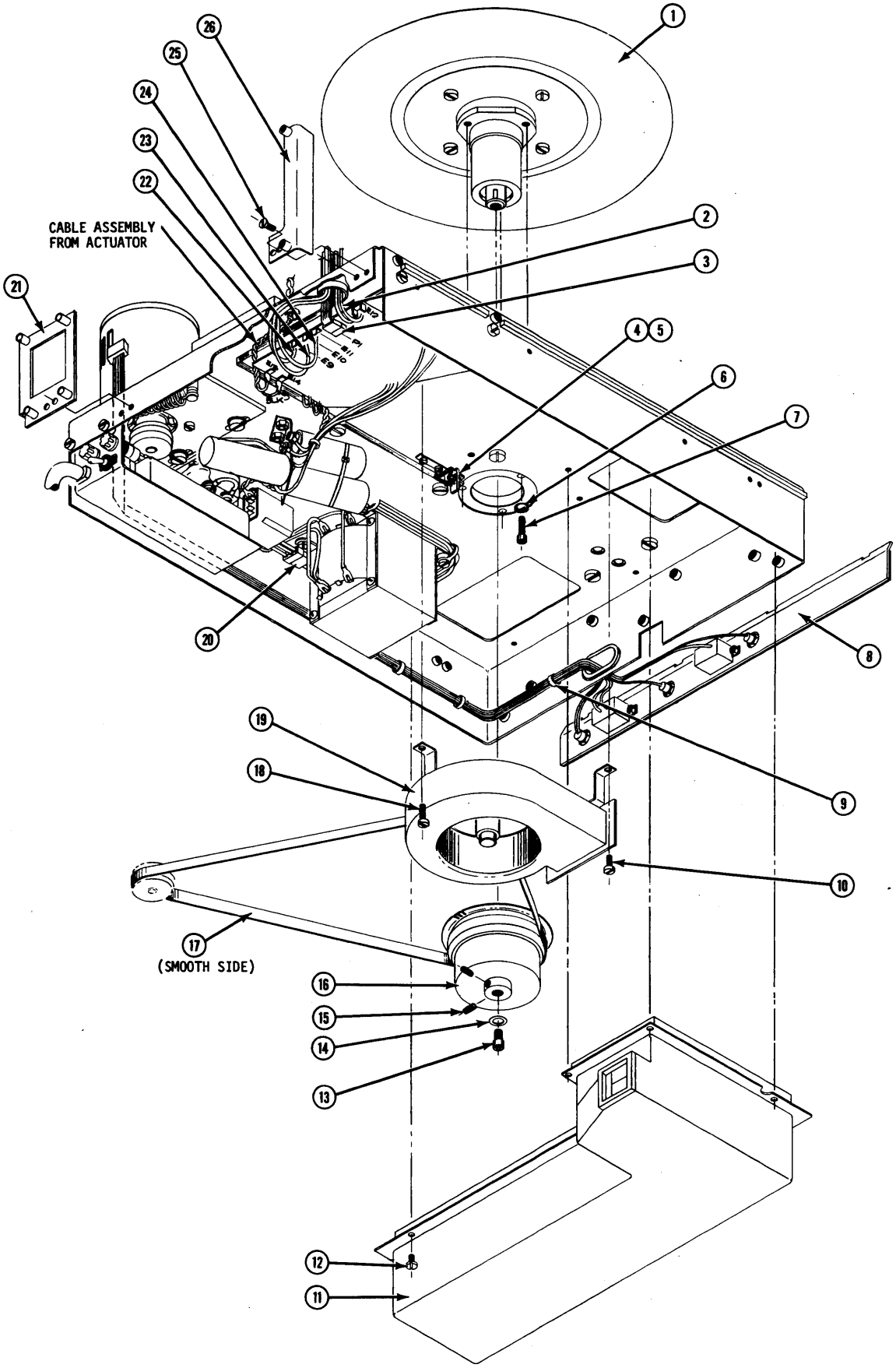


Figure 4-9. Chassis Assembly (73080), Bottom View

Parts List for Chassis Assembly, Partial, figure 4-10

Reference No.	Part Number	Part Name	Quantity
1	19200	Dowel Pin	2
2	73033	Drive base	1
3	13333	Screw	4
4	73700	Power supply circuit card	1
5	22580	Capacitor	1
6	15845	Clamp	1
7	18501	Standoff	1
8	13314	Screw	3
9	13366	Screw	1
10	73081	Base chassis	1
11	73420	Transformer	1
12	13351	Screw	8
13	13349	Screw	2
14	14025	Washer, lock	4
15	0576	Spring	1
16	13384	Screw	3
17	14006	Washer	3
18	73079	Spring post	1
19	73402	Bracket post assembly	1
20	18590	Relay, spin motor start	1
21	18510	Bushing	2
22	14026	Washer	1
23	13838	Screw, set	2
24	13453	Screw	1
25	73401	Spin motor assembly	1
26	73091	Pulley, spin motor, 1500, 60Hz	1
	73092	Pulley, spin motor, 1500, 50Hz	1
27	18511	Snap bushing	1
28	14122	Nut	2
29	14004	Washer	2
30	13353	Screw	2
31	24330	Circuit breaker	1
32	74413	Bracket	1
33	73333	Insulator	1
34	14105	Nut	2
35	19104	Washer, shoulder	2
36	73417	Capacitor assembly	1
37	18550	Capacitor, 15V	2
38	18543	Capacitor, 5V	1
39	73242	Spin motor	1
40	18970	Relay, power off delay	1
41	73418	Switch/fuse assembly, 115V, 60Hz	1
	73419	Switch/fuse assembly, 220V, 50Hz	1

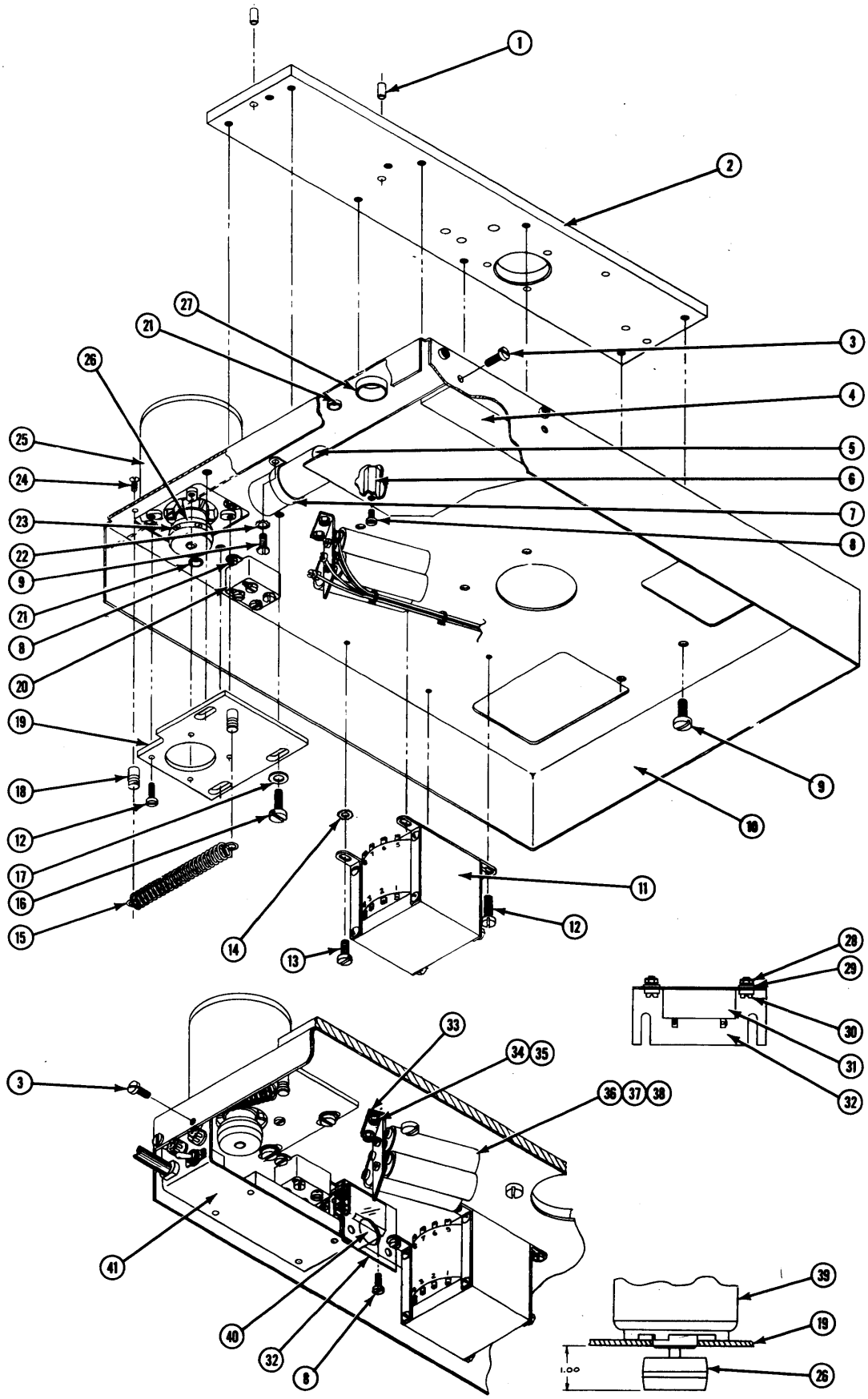


Figure 4-10. Chassis Assembly (73080), Partial

Parts List for Blower Assembly, figure 4-11

Reference No.	Part Number	Part Name	Quantity
1	13838	Screw, set	2
2	73261	Pulley	1
3	73405	Blower assembly	1

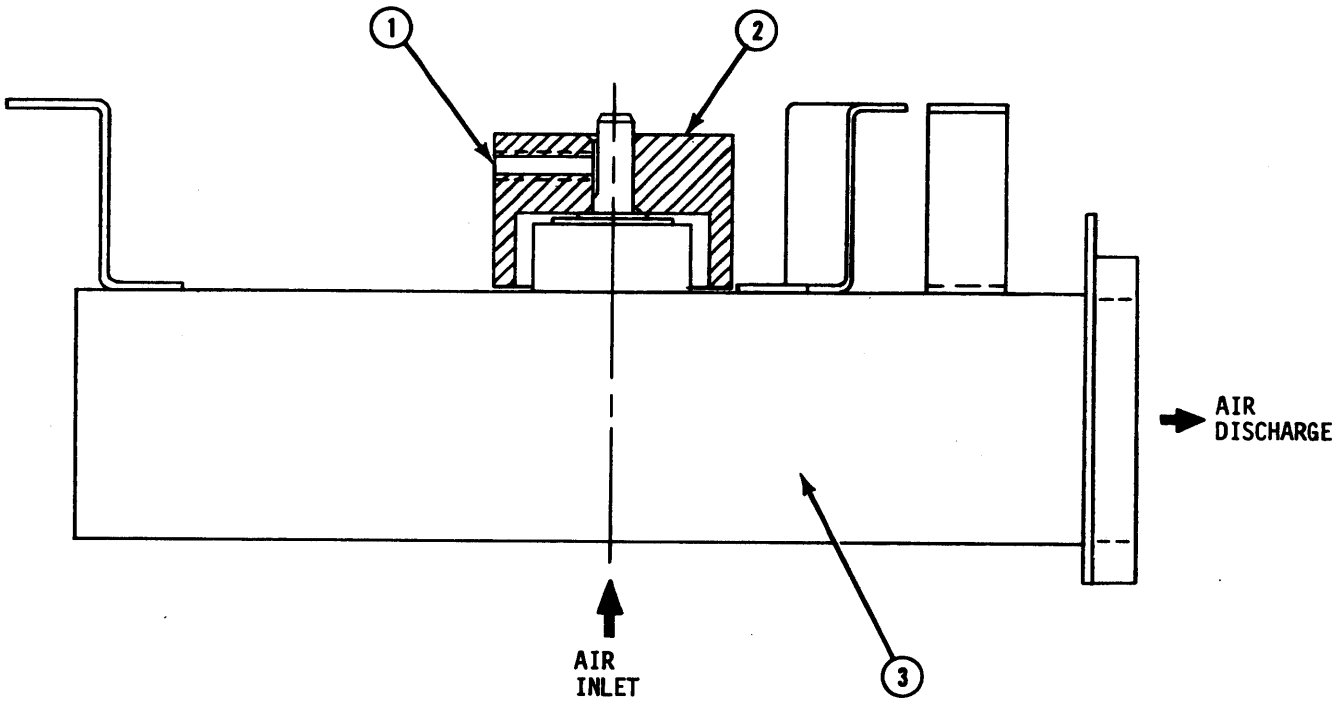


Figure 4-11. Blower Assembly (73120)

Parts List for Transformer Assembly, figure 4-12

Reference No.	Part Number	Part Name	Quantity
1	73211	Transformer	1
2	14961	Receptacle	5

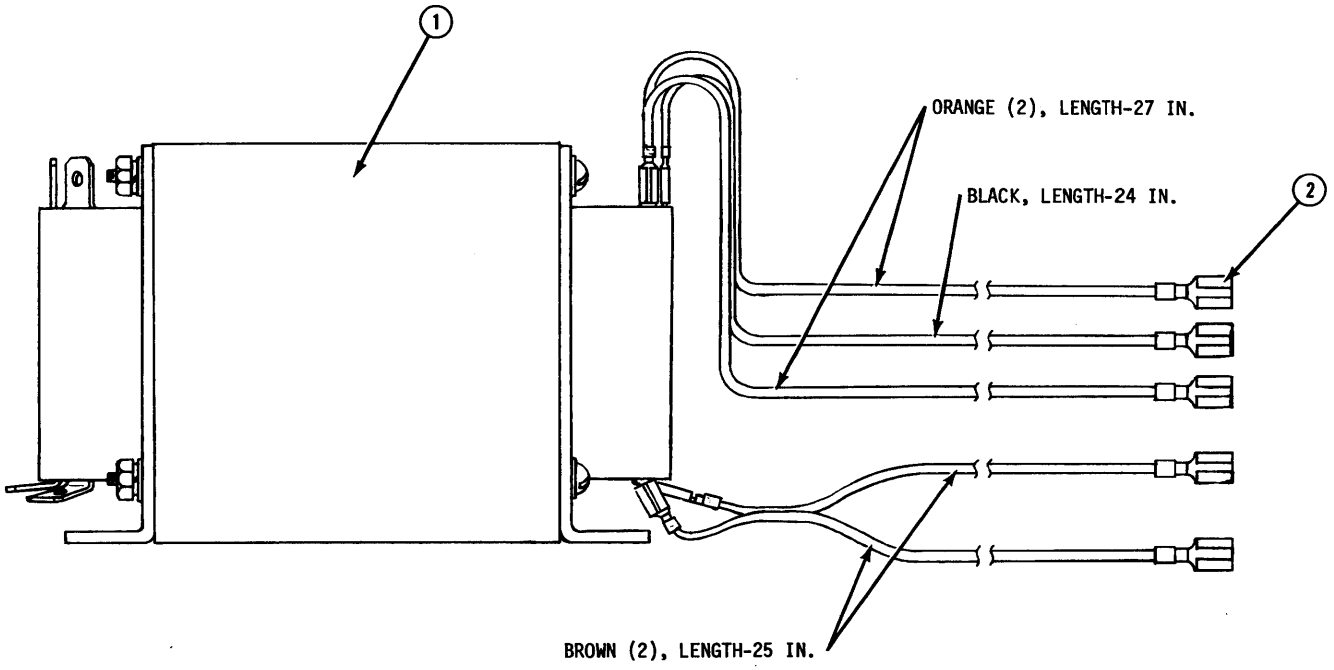


Figure 4-12. Transformer Assembly (73420)

Parts List for Prefilter Assembly, figure 4-13

Reference No.	Part Number	Part Name	Quantity
1	13320	Screw	3
2	73081	Base-chassis	1
3	73325	Screen	1
4	73324	Plate, prefilter	1

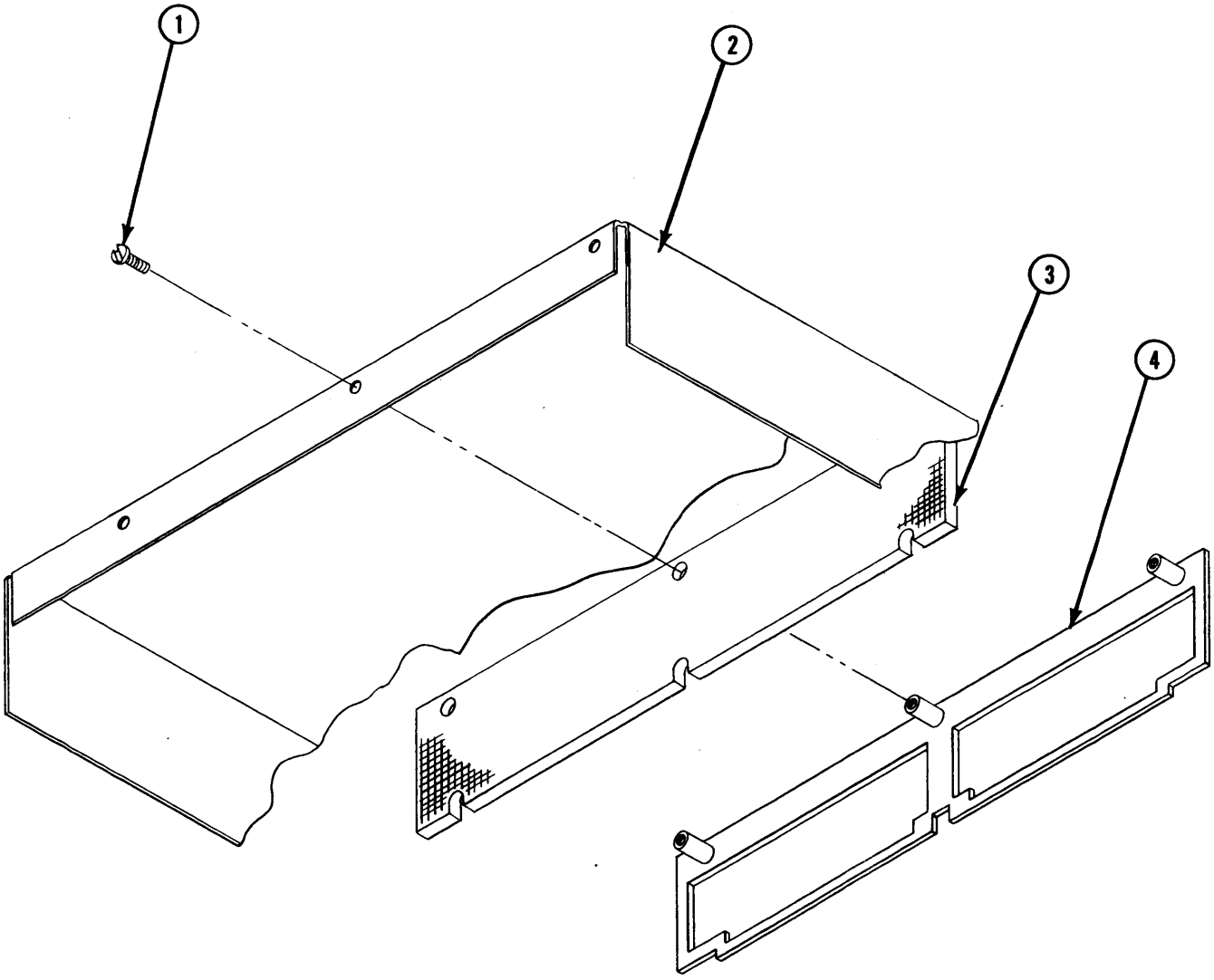


Figure 4-13. Prefilter Assembly (73130)

Parts List for Covers, figure 4-14

Reference No.	Part Number	Part Name	Quantity
1	73295	Equipment cover	1
2	19210	Bumper	2
3	73150	Bezel assembly	1
4	73000	Base plate	1
5	13316	Screw	6
6	18720	Screw	6
7	18723	Screw	4
8	73329	Rear cover	1
9	13320	Screw	3
10	73130	Prefilter assembly	1

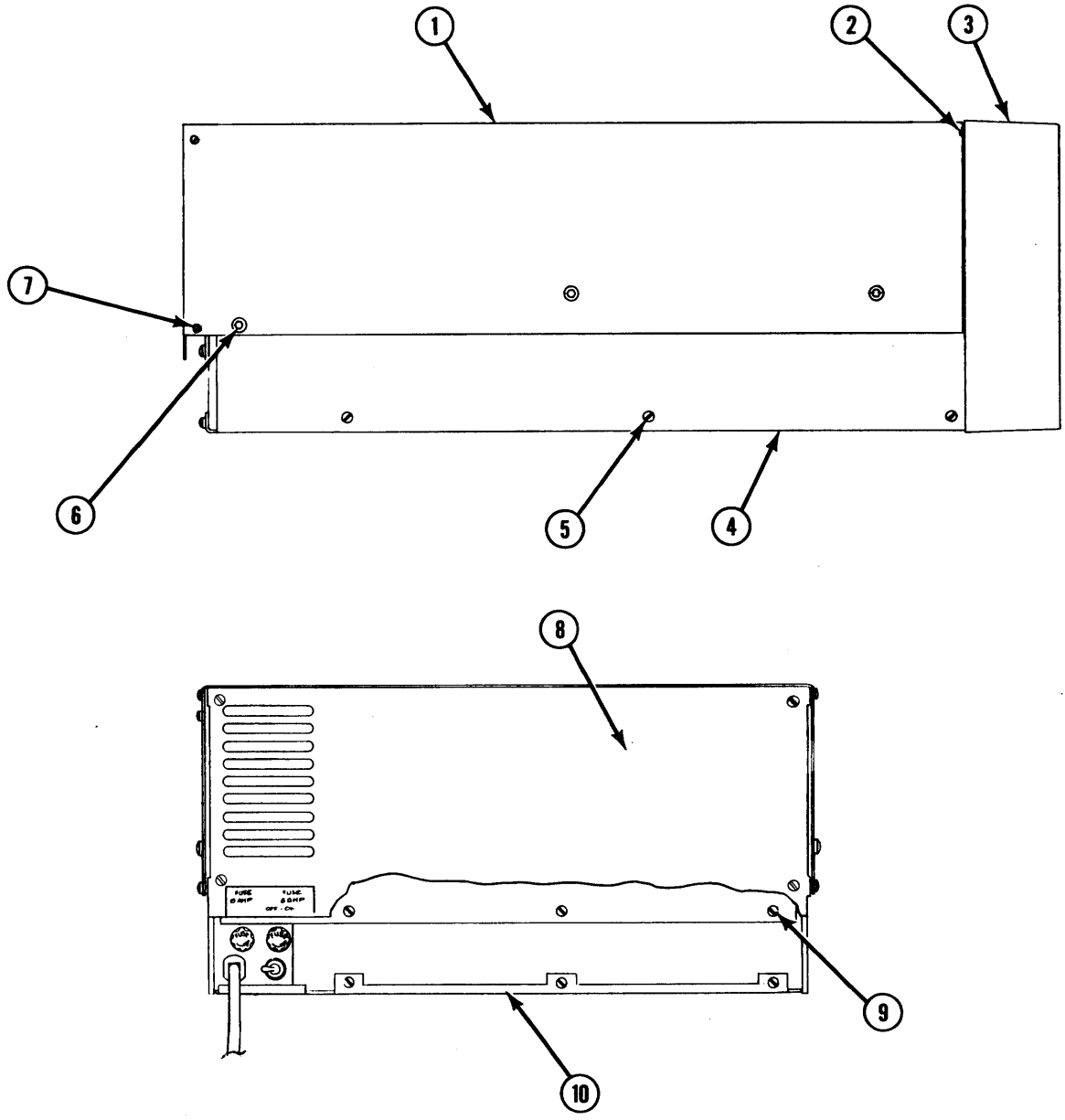


Figure 4-14. Covers Package (73240)

Parts List for Switch Panel Assembly, figure 4-15

Reference No.	Part Number	Part Name	Quantity
1	73210	Control panel	1
2	60241	Lamp assembly	1
3	60242	Lamp assembly	2
4	60750	Lamp	3
5	18600	Switch, rocker	2
6	15801	Cable tie	9
7	23390	Arc suppressor	1
8	14501	Tubing	A/R
9	73200	Switch panel	1

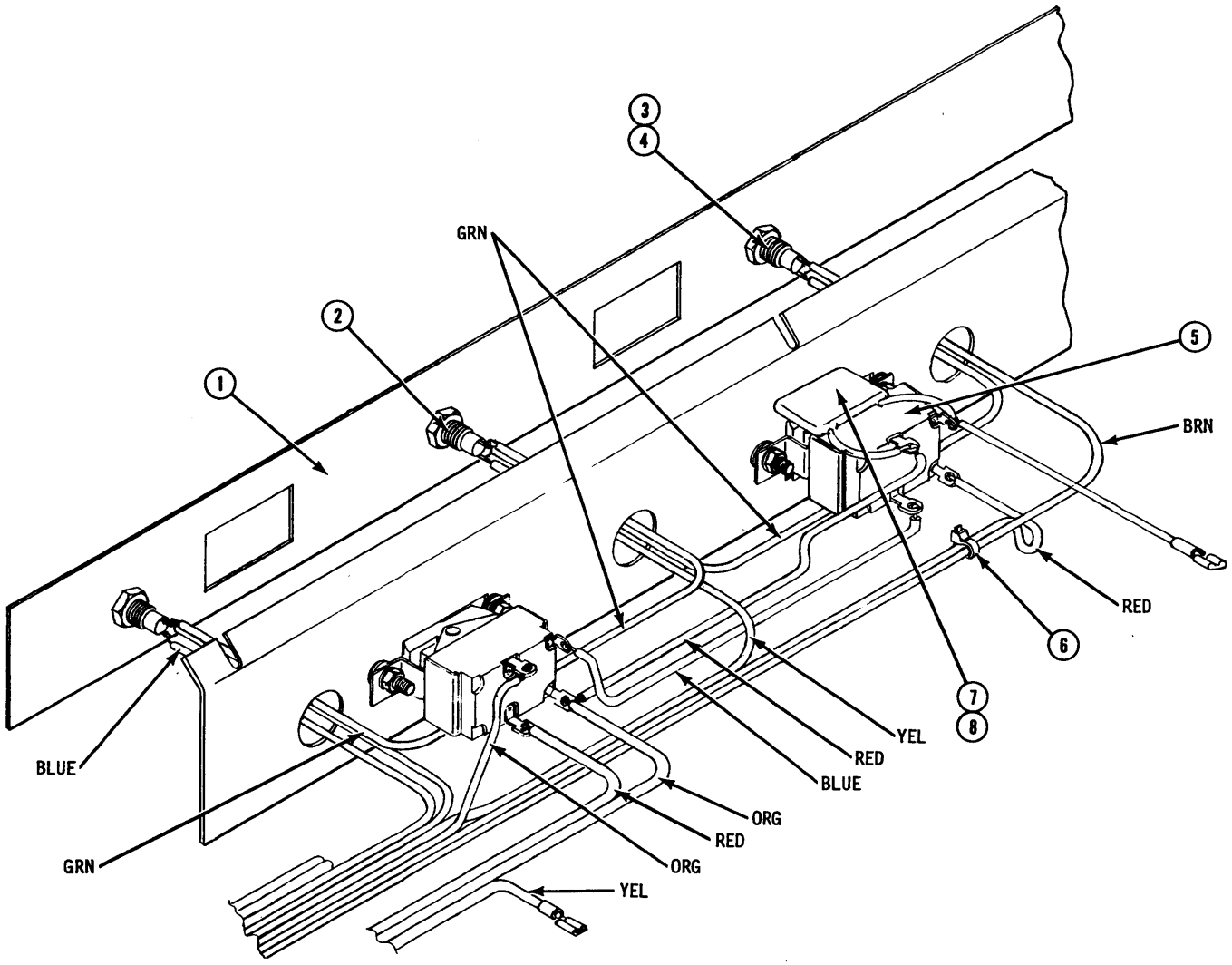


Figure 4-15. Switch Panel Assembly (73250)

Parts List for Sector Transducer Assembly, figure 4-16

Reference No.	Part Number	Part Name	Quantity
1	18381	Connector	1
2	60379	Contact	4
3	18390	Plug	2
4	60377	Cable	1
5	73165	Sector sensor	1

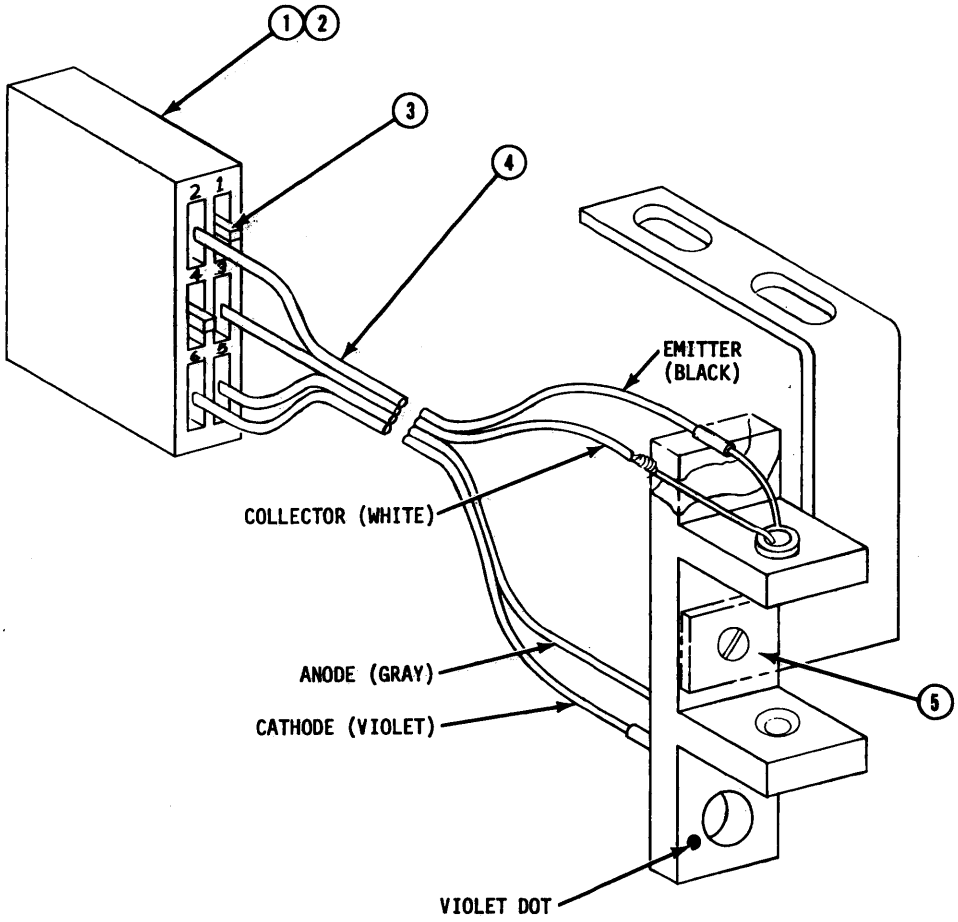


Figure 4-16. Sector Transducer Assembly (73606)

Parts List for Bottom Panel, figure 4-17

Reference No.	Part Number	Part Name	Quantity
1	15807	Cable tie	3
2	15802	Cable tie	9
3	73613	Cable	1
4	24330	Circuit breaker	1
5	22390	Arc suppressor	1
6	15830	Cable clamp	1
7	15845	Clamp	1
8	22580	Capacitor, motor start	1

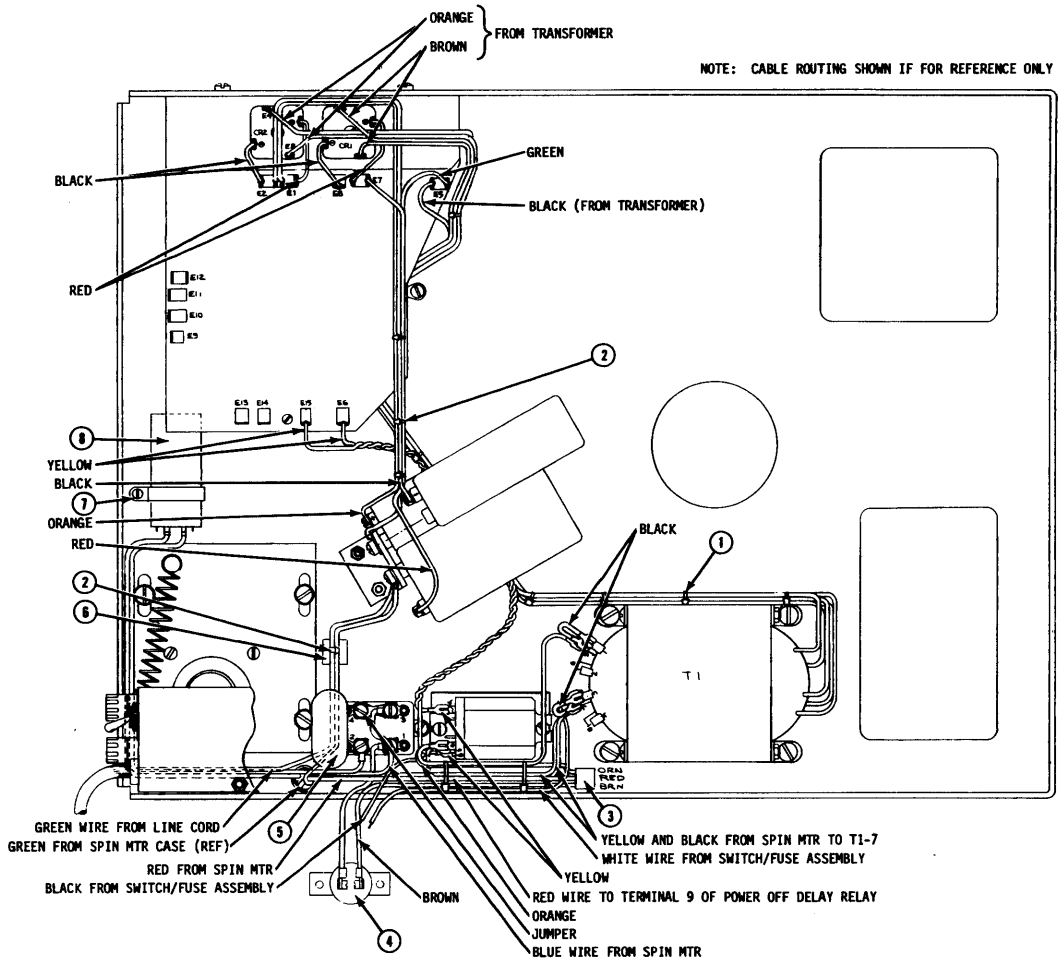


Figure 4-17. Bottom Panel (73080)

Parts List for Drive Control Logic Circuit Card, figure 4-18

Reference Designator	Part No.	Part Name	Quantity
	74450	Drive control logic assemble	Ref
	74291	Circuit card	
A0 thru A5	2885	Connector, P.C. board, 44 pin	6
B1 thru B7,TP1 thru TP10,TP12 thru TP17	18521	Contact pins	52
C1,C2,C3,C14,C15,C16 C39,C40	12720	Capacitor, 150D, 6.8µf, 20V	8
C4,C9,C11,C17,C23,C24, C27,C28,C29,C30,C33, C35,C36,C37,C38,C43,C45	12812	Capacitor, CER, 0.1µf, 50V	17
C5,C6,C12,C13,C20,C21, C22,C32,C44	12641	Capacitor, DM15, 500pf, 500V	9
C7,C8,C19,C25,C26	12534	Capacitor, 192P, 0.001µf, 200V	5
C10	12814	Capacitor, CER, 0.22µf, 50V	1
C18	1206	Capacitor, 150D, 220µf, 10V	1
C31,C41	12818	Capacitor, CER, 1.0µf, 50V	2
C34	12801	Capacitor, CER, 0.01µf, 50V	1
C42	12723	Capacitor, 150D, 22µf, 20V	1
C46	12661	Capacitor, DM15, 3300pf, 500V	1
CR1,CR2,CR3	13007	Diode, 1N4002	3
J1,P1	26071	Connector, socket, 50 pin	2
R1,R8,R11,R13,R14,R15, R21,R25,R26,R28 thru R35	10053	Resistor, RC07, 1.5K ±5%, 1/4w	17
R2,R3,R17,R18	10022	Resistor, RC07, 75 ohm ±5%, 1/4w	4
R4 thru R7,R17	10028	Resistor, RC07, 130 ohm ±5%, 1/4w	5
R9	10148	Resistor, RC07, 910K ±5%, 1/4w	1
R10,R20	10111	Resistor, RC07, 27K ±5%, 1/4w	2
R12	10246	Resistor, RC20, 750 ohm ±5%, 1/2w	1
R19	10896	Resistor, RN55D, 17.4K ±1%, 1/8w	1
R22,R23,R24	10432	Resistor, RC32, 200 ohm ±5%, 1w	3
R27	10987	Resistor, RN55D, 24.9K ±1%, 1/8w	1
Q1	12923	Transistor, 2N5088	1
Q2	12921	Transistor, 2N5192	1
U1,U2,U6,U7	17021	Integrated Circuit, SN7405	4
U3	17008	Integrated Circuit, SN7430	1
U4,U31,U35,U36,U43,U44, U45	17001	Integrated Circuit, SN7404	7
U5	18000	Integrated Circuit, Resistor, 1.5K	1
U8,U17,U30,U41,U48,U49, U53,U54	17002	Integrated Circuit, SN7400	8
U9,U38	17055	Integrated Circuit, 9602	2
U10,U21,U22,U33,U34, U40,U52	17003	Integrated Circuit, SN7410	7
U11	17033	Integrated Circuit, SN7406	1
U12,U24	17020	Integrated Circuit, SN74174	2
U13,U16,U25	17058	Integrated Circuit, SN7483	3
U14,U20,U26,U29	17032	Integrated Circuit, SN7486	4
U15,U27	17053	Integrated Circuit, SN74193	2
U18	17013	Integrated Circuit, SN7476	1
U19	17029	Integrated Circuit, SN7414	1
U23,U37	17004	Integrated Circuit, SN7420	2
U28,U32,U42,U50,U55	17042	Integrated Circuit, SN7408	5
U39	17011	Integrated Circuit, SN7474	1
U46,U47,U51	17024	Integrated Circuit, SN7438	3
	18650	Connector, fast-on, ±15, +5	3
	18631	Connector, fast-on, GND	2
	70315	Eyelet	5
	27250	Key, polarizing	6
	25390	Washer, fiber	2

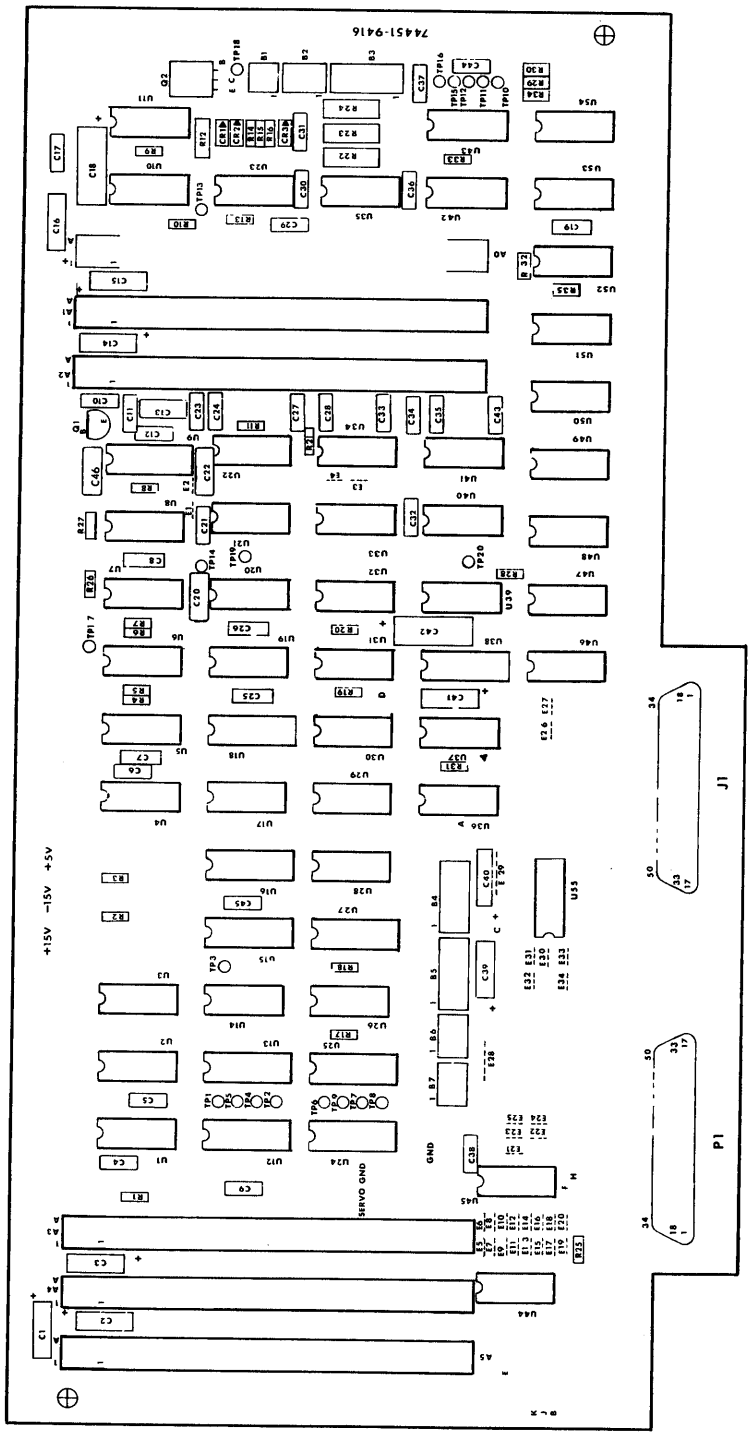


Figure 4-18. Drive Control Logic (73720)

Parts List for Interface Circuit Card, figure 4-19

Reference Designator	Part No.	Part Name	Quantity
	74510	Interface Assembly	Ref
C1	12509	Capacitor, 192P, 0.01µf ±10%, 80V	1
C2	22540	Capacitor, 0.1µf ±2%, 80V	1
C3,C4,C5,C9,C10,C11, C18,C22,C23	12641	Capacitor, DM15, 500pf ±5%, 500V	9
C6,C16	12723	Capacitor, 150D, 22µf ±20%, 20V	2
C7,C13,C14,C19,C20,C21	12812	Capacitor, CER, 0.1µf ±20%, 50V	6
C8	12521	Capacitor, 192P, 0.1µf ±10%, 80V	1
C12	1206	Capacitor, 150D, 220µf ±20%, 10V	1
C17	12515	Capacitor, 192P, 0.033µf ±10%, 80V	1
CR3,CR5	13005	Diode, 1N3064	2
CR4	13009	Diode, 1N5231B, 5.1V ±5%	1
R1,R11,R12,R19	10063	Resistor, RC07, 3.9K ±5%, 1/4w	4
R2,R13	10105	Resistor, RC07, 15K ±5%, 1/4w	2
R3,R22	13212	Potentiometer, 50K, 3/4w	2
R4,R23	11068	Resistor, RN55D, 4.99K ±1%, 1/8w	2
R5	10990	Resistor, RN55D, 26.7K ±1%, 1/8w	1
R6,R7,R15,R16,R17,R24	10112	Resistor, RC07, 30K ±5%, 1/4w	6
R8	11166	Resistor, RN55D, 8.45K ±1%, 1/4w	1
R9,R20	10069	Resistor, RC07, 6.8K ±5%, 1/4w	2
R10,R21	10101	Resistor, RC07, 10K ±5%, 1/4w	2
R14	10975	Resistor, RN55D, 18.7K ±1%, 1/8w	1
R18	10045	Resistor, RC07, 680 ohm ±5%, 1/4w	1
U1	60573	Integrated Circuit, 75107N	1
U2,U3,U4,U6,U7,U13	17055	Integrated Circuit, 9602	6
U5,U9	17001	Integrated Circuit, 7404	2
U8	17021	Integrated Circuit, 7405	1
U10	18000	Integrated Circuit, resistor pac, 1.5K	1
U11,U12	17024	Integrated Circuit, 7438	2
U14	17013	Integrated Circuit, 7476	1
U15	17002	Integrated Circuit, 7400	1
U16	17042	Integrated Circuit, 7408	1

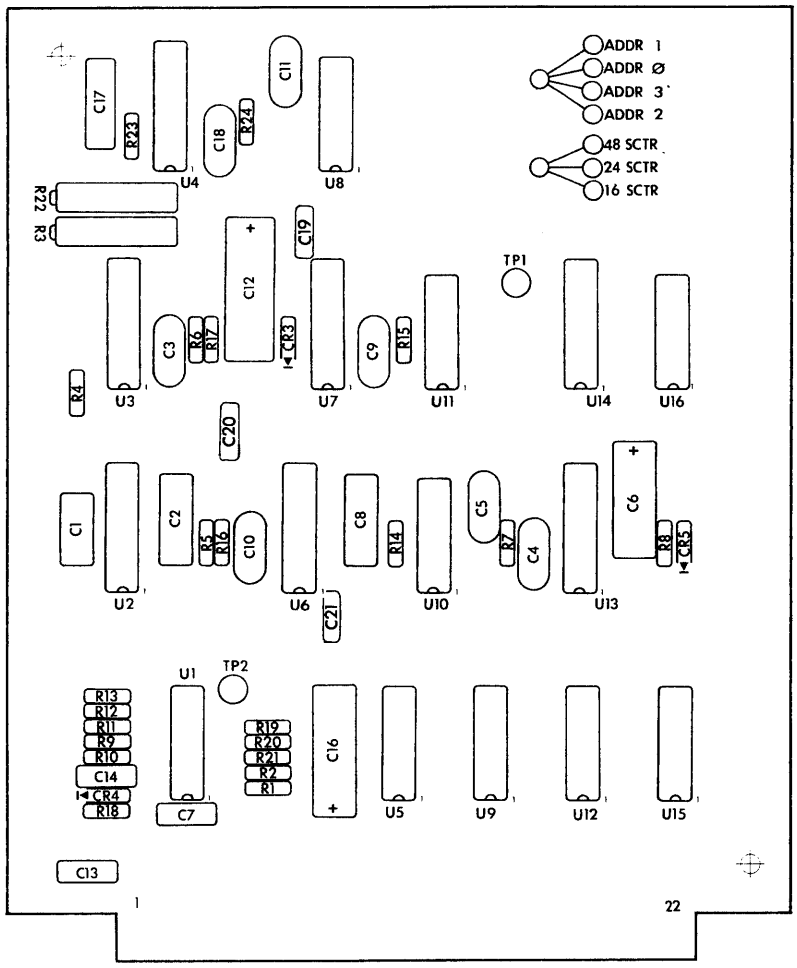


Figure 4-19. Interface (73540)

Parts List for Servo Circuit Card No. 1, figure 4-20

Reference Designator	Part No.	Part Name	Quantity
	73591	Servo circuit card No. 1	Ref
C1	12623	Capacitor, DM15, 100pf, ±5%, 500V	1
C2,C6,C7,C9	12812	Capacitor, CER, 0.1µf ±20%, 50V	4
C3	12818	Capacitor, CER, 1µf ±20%, 50V	1
C4	12513	Capacitor, 192P, 0.022µf ±10%, 80V	1
C5	12505	Capacitor, 192P, 0.0047µf ±10%, 80V	1
C8	12720	Capacitor, 150D, 6.8µf ±20%, 20V	1
C10 thru C13	12510	Capacitor, 192P, 0.012µf ±10%, 80V	4
CR1 thru CR7,CR9 thru CR18	13005	Diode, 1N3064	17
CR8	13009	Diode, 1N5231B, 5.1V ±5%	1
Q1,Q2,Q8,Q9	12909	Transistor, 2N4401	4
Q3	12910	Transistor, 2N4403	1
Q4	12920	Transistor, 2N5195	1
Q5,Q6,Q7	12927	Transistor, 2N5462	3
R1,R2,R3,R7,R12,R16, R17,R29,R31,R32,R36, R37,R45,R49,R57,R69, R71,R76,R79,R80	10873	Resistor, RN55D, 10.0K ±1%, 1/8w	20
R4,R10,R19,R51,R52, R67,R68,R88	10056	Resistor, RC07, 2K ±5%, 1/4w	8
R5,R11,R24,R65,R66	10029	Resistor, RC07, 150 ohm ±5%, 1/4w	5
R6	11066	Resistor, RN55D, 4.75 ±1%, 1/8w	1
R8,R60,R61,R64	10995	Resistor, RN55D, 30.1K ±1%, 1/8w	4
R9	11185	Resistor, RN55D, 75.0K ±1%, 1/8w	1
R13,R14,R38,R42,R55,R56	11230	Resistor, RN55D, 200K ±1%, 1/8w	1
R15	10988	Resistor, RN55D, 25.5K ±1%, 1/8w	1
R18	11230	Resistor, RN55D, 200K ±1%, 1/8w	1
R20	11052	Resistor, RN55D, 3.40K ±1%, 1/8w	1
R21,R22	11162	Resistor, RN55D, 7.68K ±1%, 1/8w	2
R23	10149	Resistor, RC07, 1 MEG 5%, 1/4w	1
R25	16729	Resistor, 10 ohm ±5%, 2w	1
R27,R35,R41	10142	Resistor, RC07, 510K ±5%, 1/4w	3
R28,R70,R74	10978	Resistor, RN55D, 20.0K ±1%, 1/8w	3
R30	11156	Resistor, RN55D, 6.65K ±1%, 1/8w	1
R33,R81	11068	Resistor, RN55D, 4.99K ±1%, 1/8w	2
R39	10969	Resistor, RN55D, 2.87K ±1%, 1/8w	1
R43,R48	11071	Resistor, RN55D, 3.01K ±1%, 1/8w	2
R44,R47	11201	Resistor, RN55D, 100K ±1%, 1/8w	2
R46,R50	10970	Resistor, RN55D, 2.94K ±1%, 1/8w	2
R53,R54	11079	Resistor, RN55D, 36.5K ±1%, 1/8w	2
R58,R59,R72	10849	Resistor, RN55D, 1.00K ±1%, 1/8w	3
R62,R63	10971	Resistor, RN55D, 3.01K ±1%, 1/8w	2
R73	11193	Resistor, RN55D, 90.9K ±1%, 1/8w	1
R75	11044	Resistor, RN55D, 499 ohm ±1%, 1/8w	1
R77	11169	Resistor, RN55D, 9.09K ±1%, 1/8w	1
R78	11064	Resistor, RN55D, 4.53K ±1%, 1/8w	1
R82	11083	Resistor, RN55D, 40.2K ±1%, 1/8w	1

Parts List for Servo Circuit Card No. 1, figure 4-20 (continued)

Reference Designator	Part No.	Part Name	Quantity
U1 thru U7,U9,U10	60358	Integrated circuit, LM1458M	9
U8	17023	Integrated circuit, SN7407	1
U11	17029	Integrated circuit, SN7414	1

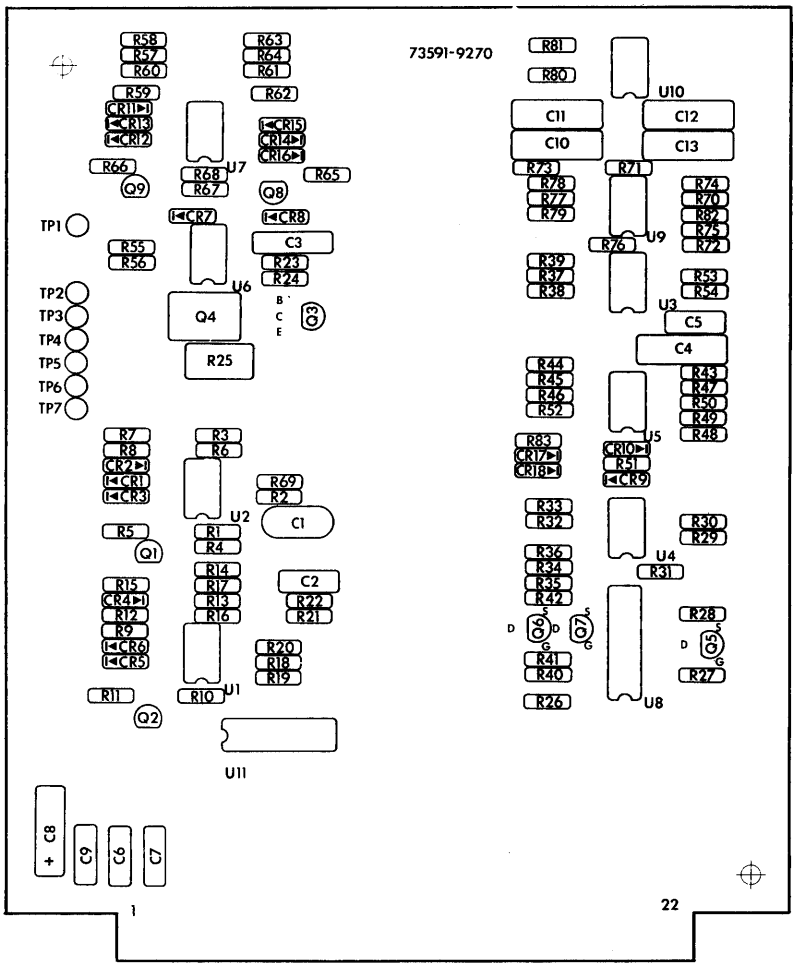


Figure 4-20. Servo Card No. 1 (73590)

Parts List for Servo Circuit Card No. 2, figure 4-21

Reference Designator	Part No.	Part Name	Quantity
	73480	Servo No. 2 assembly	Ref
	73481	Servo circuit card No. 2	Ref
C1,C2,C4,C10 thru C16	12812	Capacitor, CER, 0.1µf ±20%, 50V	10
C3	12720	Capacitor, 150D, 6.8µf ±20%, 30V	1
C5,C6	12501	Capacitor, 192P, 0.0022µf ±10%, 80V	2
C7	12515	Capacitor, 192P, 0.033µf ±10%, 80V	1
C8	12801	Capacitor, CER, 0.01µf ±20%, 50V	1
C9	12640	Capacitor, DM, 470pf, ±5%, 500V	1
CR1 thru CR6	13005	Diode 1N3064	6
Q1 thru Q12,Q19,Q20,Q21	12927	Transistor, 2N5462	15
Q13,Q15	12909	Transistor, 2N4401	2
Q14,Q16	12910	Transistor, 2N4403	2
Q17	12921	Transistor, 2N5192	1
Q18	12920	Transistor, 2N5195	1
R1 thru R16,R32 thru R36,R58,R59,R78,R79, R82,R83,R90	10125	Resistor, RC07, 100K ±5%, 1/4w	28
R17	11852	Resistor, RN60D, 604K ±1%, 1/4w	1
R18	11247	Resistor, RN55D, 301K ±1%, 1/8w	1
R19	11218	Resistor, RN55D, 150K ±1%, 1/8w	1
R20	11185	Resistor, RN55D, 75.0K ±1%, 1/8w	1
R21	11080	Resistor, RN55D, 37.4K ±1%, 1/8w	1
R22,R26,R27	10975	Resistor, RN55D, 18.7K ±1%, 1/8w	3
R23	11170	Resistor, RN55D, 9.31K ±1%, 1/8w	1
R24	11065	Resistor, RN55D, 4.64K ±1%, 1/8w	1
R25	11725	Resistor, RN60D, 1.0M ±1%, 1/4w	1
R28	10995	Resistor, RN55D, 30.1K ±1%, 1/8w	1
R29,R30	11152	Resistor, RN55D, 6.04K ±1%, 1/8w	2
R31	10874	Resistor, RN55D, 10.2K ±1%, 1/8w	1
R37,R38,R39,R50,R51, R52,R54,R81	10873	Resistor, RN55D, 10.0K ±1%, 1/8w	8
R40,R64,R65,R85 thru R89	10056	Resistor, RC07, 2K ±5%, 1/4w	8
R41,R42	10979	Resistor, RN55D, 20.5K ±1%, 1/8w	2
R43	10049	Resistor, RC07, 1K ±5%, 1/4w	1
R44,R45	10045	Resistor, RC07, 680 ohm ±5%, 1/4w	2
R46	10055	Resistor, RC07, 1.8K ±5%, 1/4w	1
R47	10881	Resistor, RN55D, 12.1K ±1%, 1/8w	1
R48	11164	Resistor, RN55D, 8.06K ±1%, 1/8w	1
R49,R61	10992	Resistor, RN55D, 28.0K ±1%, 1/8w	2
R53,R55,R62	11068	Resistor, RN55D, 4.99K ±1%, 1/8w	3
R56,R57	10978	Resistor, RN55D, 20.0K ±1%, 1/8w	2
R60	11166	Resistor, RN55D, 8.45K ±1%, 1/8w	1
R63,R66	10109	Resistor, RC07, 22K ±5%, 1/4w	2
R67 thru R70	10041	Resistor, RC07, 470 ohm ±5%, 1/4w	4
R71 thru R76	16636	Resistor, 50 ohm ±3%, 3.25w	6
R77	13209	Potentiometer, 5K ±10%, 3/4w	1
R80	10896	Resistor, RN55D, 17.4K ±1%, 1/8w	1

Parts List for Servo Circuit Card No. 2, figure 4-21 (continued)

Reference Designator	Part No.	Part Name	Quantity
U1,U2,U7,U8	17023	Integrated Circuit, SN7407	4
U3	17055	Integrated Circuit, 9602	1
U4	60335	Integrated Circuit, LM307N	1
U5,U6	60358	Integrated Circuit, LM1458N	2
U9,U11	17002	Integrated Circuit, SN7400	2
U10	17011	Integrated Circuit, SN7474	1

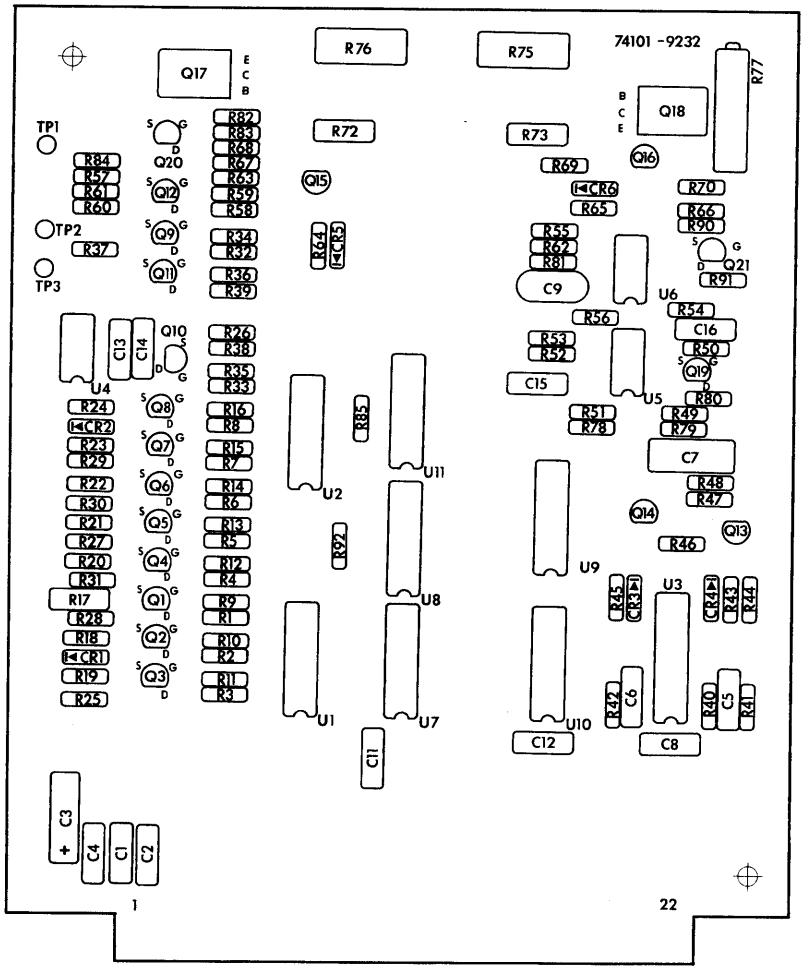


Figure 4-21. Servo Card No. 2 (73480)

Parts List for VFO Circuit Card, figure 4-22

Reference Designator	Part No.	Part Name	Quantity
	73920	VFO assembly	Ref
	73501	VFO circuit card	Ref
C1,C9	12631	Capacitor, DM15, 220pf, 500V	2
C2,C5,C12 thru C20	12812	Capacitor, CER, 0.1µf, 50V	11
C3	12742	Capacitor, 150D, 1µf, 50V	1
C4,C6	12720	Capacitor, 150D, 6.8µf, 20V	2
C8	12738	Capacitor, 150D, 0.22µf, 50V	1
C10	12628	Capacitor, DM15, 160pf, 500V	1
C11	12814	Capacitor, CER, 0.22µf, 50V	1
C21	12603	Capacitor, DM15, 15pf, 500V	1
C22	12641	Capacitor, DM15, 500pf, 500V	1
CR1,CR2,CR3	13005	Diode, 1N3064	3
CR4	13026	Diode, 1N4736, 6.8V ±10%	1
Q1 thru Q10	2191	Transistor, MPS3640	10
Q11	12909	Transistor, 2N4401	1
R1,R3,R8,R9,R16,R18	11132	Resistor, RN55D, 665 ohm ±1%, 1/8w	6
R2,R11	10054	Resistor, RC07, 1.6K ±5%, 1/4w	2
R4,R6,R10,R15,R26,R27, R34,R43,R14,R47,R48,R52	10018	Resistor, RC07, 51 ohm ±5%, 1/4w	12
R5	10845	Resistor, RN55D, 162 ohm ±1%, 1/8w	1
R7,R49,R54,R55	10841	Resistor, RN55D, 147 ohm ±1%, 1/8w	4
R12,R63,R64,R65	10049	Resistor, RC07, 1K ±5%, 1/4w	4
R13,R37,R41	10034	Resistor, RC07, 240 ohm ±5%, 1/4w	3
R14	10071	Resistor, RC07, 8.2K ±5%, 1/4w	1
R17	10052	Resistor, RC07, 1.3K ±5%, 1/4w	1
R19	11117	Resistor, RN55D, 82.5 ohm ±1%, 1/8w	1
R20	10937	Resistor, RN55D, 237 ohm ±1%, 1/8w	1
R21	11105	Resistor, RN55D, 61.9 ohm ±1%, 1/8w	1
R22	11363	Resistor, RN60D, 1.40K ±1%, 1/4w	1
R23	10427	Resistor, RC32, 120 ohm ±5%, 1w	1
R24	10032	Resistor, RC07, 200 ohm ±5%, 1/4w	1
R28,R29,R51	10039	Resistor, RC07, 390 ohm ±5%, 1/4w	3
R30,R32	13204	Potentiometer, 100 ohm, 3/4w	2
R31	10839	Resistor, RN55D, 140 ohm ±1%, 1/8w	1
R33	10925	Resistor, RN55D, 178 ohm ±1%, 1/8w	1
R35,R36	10861	Resistor, RN55D, 1.33K ±1%, 1/8w	2
R38	10035	Resistor, RC07, 270 ohm ±5%, 1/4w	1
R39,R40	10026	Resistor, RC07, 110 ohm ±5%, 1/4w	2
R42	10825	Resistor, RN55D, 100 ohm ±1%, 1/8w	1
R45	10045	Resistor, RC07, 680 ohm ±5%, 1/4w	1
R46	10864	Resistor, RN55D, 1.43K ±1%, 1/8w	1
R50	11025	Resistor, RN55D, 332 ohm ±1%, 1/8w	1
R53	10056	Resistor, RC07, 2K ±5%, 1/4w	1
R56,R61	10966	Resistor, RN55D, 2.67K ±1%, 1/8w	2
R57	10010	Resistor, RC07, 24 ohm ±5%, 1/4w	1
R58,R59	11027	Resistor, RN55D, 332 ohm ±1%, 1/8w	2
R60	11159	Resistor, RN55D, 7.15K ±1%, 1/8w	1
R62	10102	Resistor, RC07, 11K ±5%, 1/4w	1

Parts List for VFO Circuit Card, figure 4-22 (continued)

Reference Designator	Part No.	Part Name	Quantity
R66	10101	Resistor, RC07, 10K ±5%, 1/4w	1
R67	10066	Resistor, RC07, 5.1K ±5%, 1/4w	1
U2,U3,U5,U6,U7	2585	Integrated Circuit, CA3046	5
U13,U19,U20	17102	Integrated Circuit, 74H00	3
U14	17012	Integrated Circuit, 74107	1
U15	17013	Integrated Circuit, 7476	1
U17,U18	17103	Integrated Circuit, 74H10	2
U21,U25,U31,U32	17002	Integrated Circuit, 7400	4
U22	17055	Integrated Circuit, 9602	1
U23,U33,U34	17003	Integrated Circuit, 7410	3
U24	17001	Integrated Circuit, 7404	1
U26,U27	17053	Integrated Circuit, 74193	2
U28,U29	17010	Integrated Circuit, 7442	2
U30	17009	Integrated Circuit, 7402	1

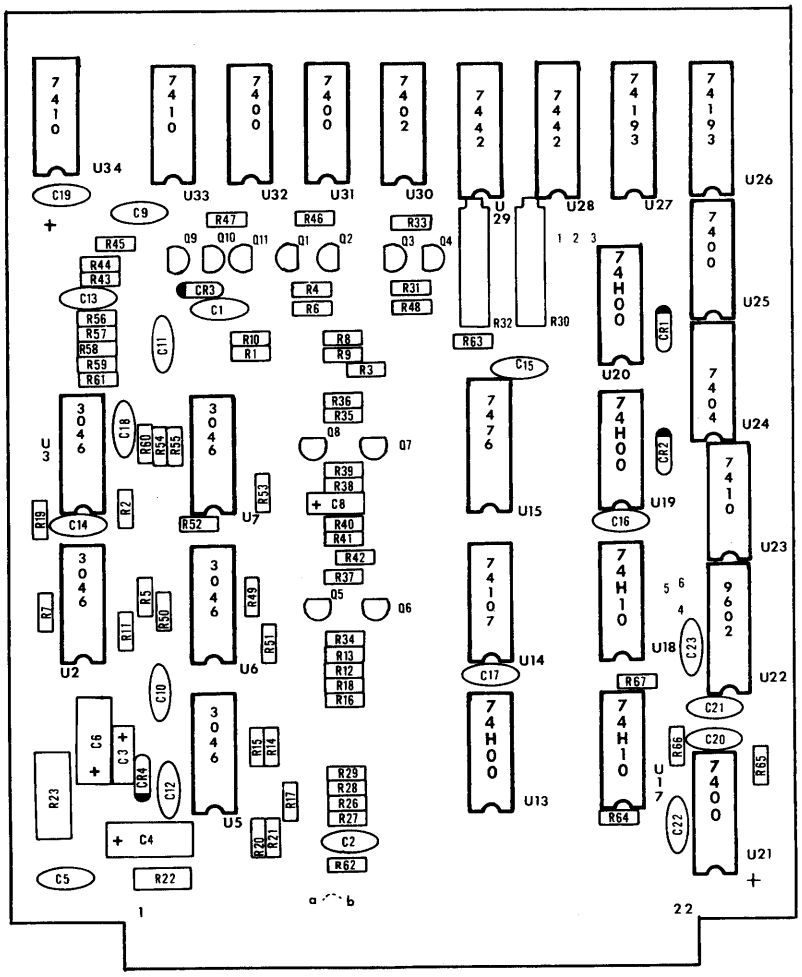


Figure 4-22. VFO (73560)

Parts List for Read/Write Circuit Card, figure 4-23

Reference Designator	Part No.	Part Name	Quantity
	73460	Read/Write circuit card	Ref
C1,C9,C10,C11,C12	12631	Capacitor, DM, 220pf, 500V	5
C2,C14,C15	12812	Capacitor, CER, 0.1µf, 50V	3
C3,C4	12505	Capacitor, 192P, 0.0047µf, 80V	2
C5	12627	Capacitor, DM, 150pf, 500V	1
C6,C7,C8,C13,C22,C23, C25,C26,C27,C28,C31,C32	12814	Capacitor, CER, 0.22µf, 50V	12
C16,C36	60008	Capacitor, DM, 560pf, 300V	2
C17,C19	12603	Capacitor, DM, 15pf, 500V	2
C18	12619	Capacitor, DM, 68pf, 500V	1
C20,C21,C29,C30	12801	Capacitor, CER, 0.01µf, 50V	4
C33,C34,C37,C38	17337	Capacitor, 150D, 10µf, 20V	4
C35	17329	Capacitor, 150D, 2.2µf, 20V	1
CR1 thru CR21	13005	Diode, 1N3064	21
CR22	13027	Diode 1N4735A, 6.2V ±5%	1
CR23	13025	Diode, 1N4742A, 12V ±5%	1
L1,L2,L3,L4,L5	14808	Inductor, 47µh	5
L6,L7	18320	Inductor, 100µh	2
Q1,Q2	12904	Transistor, 2N2904	2
Q3,Q4,Q7,Q8	12914	Transistor, 2N4924	4
Q5,Q6,Q9,Q10,Q11,Q19, Q20,Q21,Q22	12910	Transistor, 2N4403	9
Q12 thru Q16,Q28	12909	Transistor, 2N4401	6
Q17,Q18,Q29 thru Q34	2411	Transistor, MPS918	8
Q23 thru Q26	12943	Transistor, 2N5555	4
Q27	12921	Transistor, 2N5192	1
R2	10033	Resistor, RC07, 220 ohm ±5%, 1/4w	1
R3,R4,R36,R44	10032	Resistor, RC07, 200 ohm ±5%, 1/4w	4
R5	10106	Resistor, RC07, 16K ±5%, 1/4w	1
R6,R7	10044	Resistor, RC07, 620 ohm ±5%, 1/4w	2
R8,R10,R11,R15,R16, R18 thru R23,R101	10049	Resistor, RC07, 1K ±5%, 1/4w	12
R9,R24 thru R29,R102, R106,R107	10041	Resistor, RC07, 470 ohm ±5%, 1/4w	10
R12	12148	Resistor, RN650, 549 ohm ±1%, 1/2w	1
R13,R14,R49	10906	Resistor, RN55D, 20 ohm ±1%, 1/8w	3
R17	11054	Resistor, RN55D, 3.57K ±1%, 1/8w	1
R30,R31,R32,R33	10065	Resistor, RC07, 4.7K ±5%, 1/4w	4
R34,R35	10070	Resistor, RC07, 7.5K ±5%, 1/4w	2
R37,R39	10064	Resistor, RC07, 4.3K ±5%, 1/4w	2
R38	10068	Resistor, RC07, 6.2K ±5%, 1/4w	1
R40,R41	10072	Resistor, RC07, 9.1K ±5%, 1/4w	2
R42,R43	11137	Resistor, RN55D, 750 ohm ±1%, 1/8w	2
R45,R46	10930	Resistor, RN55D, 200 ohm ±1%, 1/8w	2
R47,R48,R100	10001	Resistor, RC07, 10 ohm ±5%, 1/4w	3
R50	10430	Resistor, RC32, 160 ohm ±5%, 1w	1
R51 thru R54	10051	Resistor, RC07, 1.2K ±5%, 1/4w	4

PINK +15
BLACK -15
RED +5

Parts List for Read/Write Circuit Card, figure 4-23 (continued)

Reference Designator	Part No.	Part Name	Quantity
R55 thru R58	10061	Resistor, RC07, 3.3K ±5%, 1/4w	4
R59 thru R62	10103	Resistor, RC07, 12K ±5%, 1/4w	4
R63 thru R66,R76	10056	Resistor, RC07, 2K ±5%, 1/4w	5
R67,R74,R75,R108,R109	10025	Resistor, RC07, 100 ohm ±5%, 1/4w	5
R68	10412	Resistor, RC32, 30 ohm ±5%, 1w	1
R69	11141	Resistor, RN55D, 825 ohm ±1%, 1/8w	1
R70	10858	Resistor, RN55D, 1.24K ±1%, 1/8w	1
R71	10060	Resistor, RC07, 3K ±5%, 1/4w	1
R72,R73	10046	Resistor, RC07, 750 ohm ±5%, 1/4w	2
R77,R78	11129	Resistor, RN55D, 619 ohm ±1%, 1/8w	2
R79,R80	11059	Resistor, RN55D, 4.02K ±1%, 1/8w	2
R81,R96,R104,R105	10018	Resistor, RC07, 51 ohm ±5%, 1/4w	4
R82	11058	Resistor, RN55D, 3.92K ±1%, 1/8w	1
R83,R84,R85	10849	Resistor, RN55D, 1K ±1%, 1/8w	3
R86,R87	10949	Resistor, RN55D, 1.78K ±1%, 1/8w	2
R88,R89	11035	Resistor, RN55D, 402 ohm ±1%, 1/8w	2
R90	10954	Resistor, RN55D, 2.02K ±1%, 1/8w	1
R91,R92	10263	Resistor, RC20, 3.9K ±5%, 1/2w	2
R93,R94	11034	Resistor, RN55D, 392 ohm ±1%, 1/8w	2
R95	10008	Resistor, RC07, 20 ohm ±5%, 1/4w	1
R97	10058	Resistor, RC07, 2.4K ±5%, 1/4w	1
R98	10066	Resistor, RC07, 5.1K ±5%, 1/4w	1
R99	10417	Resistor, RC32, 47 ohm ±5%, 1w	1
R103	10434	Resistor, RC32, 240 ohm ±5%, 1w	1
U1,U5	17012	Integrated Circuit, SN74107	2
U2	2339	Integrated Circuit, µA733	1
U3	2338	Integrated Circuit, µA711	1
U4	17050	Integrated Circuit, 9601	1
	73332	Shield, lower	1
	74359	Shield, upper	1
	60748	Screw, 4-40 X 0.38, nylon	3
	18792	Nut, 4-40, nylon	3
	19110	Spacer, #4, nylon	6
	18521	Connector pins	16
	18930	Test points	2

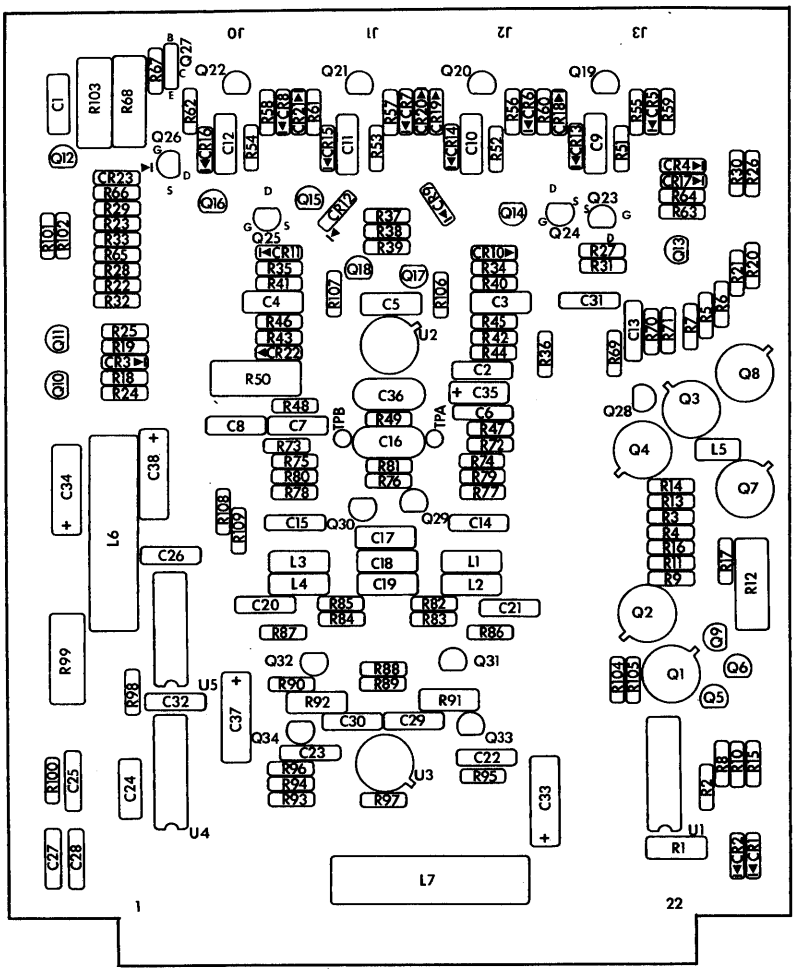


Figure 4-23. Read/Write (73460)

Parts List for Power Supply Circuit Board, figure 4-24

Reference Designator	Part No.	Part Name	Quantity
	73750	Power supply assembly	Ref
	73751	Power supply circuit board	Ref
C1,C5,C6,C7,C15 thru C18	12812	Capacitor, CER, 0.1µf, 50V	8
C2,C3,C8,C10,C12	12801	Capacitor, CER, 0.01µf, 50V	5
C4	16962	Capacitor, 30D, 100µf, 25V	1
C9	12534	Capacitor, 192P, 0.001µf, 200V	1
C11,C13	16924	Capacitor, 30D, 10µf, 50V	2
C14	16922	Capacitor, 30D, 100µf, 50V	1
C20	16966	Capacitor, 30D, 50µf, 25V	1
C21,C22	12818	Capacitor, CER, 1.0µf, 50V	2
CR1,CR2	2461	Bridge rectifier	2
CR3,CR10,CR15	13025	Diode, 1N4742A, 12V ±5%	3
CR4 thru CR7,CR13,CR16, CR21,CR22	13005	Diode, 1N3064	8
CR8	13031	Diode, 1N5232B, 5.6V ±5%	1
CR9, CR12,CR17 thru CR20	13007	Diode, 1N40002	6
CR11,CR14	13009	Diode, 1N5231B, 5.1V ±5%	2
F1	16102	Fuse, 5 amp	1
F2,F3	16106	Fuse, 1 amp	2
F4,F5	18703	Fuse, 4 amp	2
K1	18920	Relay, 603-12V	1
Q1	12907	Transistor, 2N3055	1
Q2,Q3,Q6,Q12,Q20	12920	Transistor, 2N5195	5
Q4,Q8,Q11,Q19	12910	Transistor, 2N4403	4
Q5	12904	Transistor, 2N2904	1
Q7,Q9,Q10,Q17,Q18	12909	Transistor, 2N4401	5
Q13,Q23	12921	Transistor, 2N5192	2
Q14,Q15,Q16	12937	Transistor, 2N4441 (SCR)	3
Q21	12947	Transistor, 2N5982	2
Q22,Q24	12929	Transistor, 2N5303	2
R1,R16	10041	Resistor, RC07, 470 ohm ±5%, 1/4w	2
R2,R48,R77	10037	Resistor, RC07, 330 ohm ±5%, 1/4w	3
R3,R8,R28,R29,R63,R67, R74,R75	10049	Resistor, RC07, 1K 5%, 1/4w	8
R4	10930	Resistor, RN55D, 200 ohm ±1%, 1/8w	1
R5	11148	Resistor, RN55D, 976 ohm ±1%, 1/8w	1
R6	16635	Resistor, RS-10, 0.5 ohm ±3%, 13w	1
R7	10029	Resistor, RC07, 150 ohm ±5%, 1/4w	1
R9,R15,R49	10025	Resistor, RC07, 100 ohm ±5%, 1/4w	3
R10	10045	Resistor, RC07, 680 ohm ±5%, 1/4w	1
R11,R46,R47,R50,R51, R56,R57	10056	Resistor, RC07, 2K ±5%, 1/4w	7
R12	10055	Resistor, RC07, 1.8K ±5%, 1/4w	1
R13	13207	Potentiometer, 1K	1
R14	10066	Resistor, RC07, 5.1K ±5%, 1/4w	1
R17	11126	Resistor, RN55D, 576 ohm ±1%, 1/8w	1

Parts List for Power Supply Circuit Board, figure 4-24 (continued)

Reference Designator	Part No.	Part Name	Quantity
R18	11551	Resistor, RN60D, 3.32K ±1%, 1/4w	1
R19,R30	16728	Resistor, 4 ohm ±5%, 7w	2
R20	11454	Resistor, RN60D, 2.00K ±1%, 1/4w	1
R21,R25	10849	Resistor, RN55D, 1.00K ±1%, 1/8w	2
R22	11466	Resistor, RN60D, 2.67K ±1%, 1/4w	1
R23	11144	Resistor, RN55D, 887 ohm %1%, 1/8w	1
R24	10954	Resistor, RN55D, 2.00K ±1%, 1/8w	1
R26	11051	Resistor, RN55D, 3.32K ±1%, 1/8w	1
R27	10947	Resistor, RN55D, 301 ohm ±1%, 1/8w	1
R31,R33	10060	Resistor, RC07, 3K ±5%, 1/4w	2
R32,R34	11049	Resistor, RN55D, 3.16K ±1%, 1/8w	2
R35	11173	Resistor, RN55D, 56.2K ±1%, 1/8w	1
R36,R38	10161	Resistor, RC07, 3.3M ±5%, 1/4w	2
R37	11094	Resistor, RN55D, 52.3K ±1%, 1/8w	1
R52,R58,R80,R87,R88	10017	Resistor, RC07, 47 ohm ±5%, 1/4w	5
R54,R55,R59,R61,R68	10032	Resistor, RC07, 200 ohm ±5%, 1/4w	5
R60,R62	16623	Resistor, RS-2C, 0.25 ohm ±3%, 6.5w	2
R66	10233	Resistor, RC20, 220 ohm ±5%, 1/2w	1
R69,R90	16625	Resistor, RS-5, 1.0 ohm ±3%, 6.5w	2
R70,R73,R83,R84	10101	Resistor, RC07, 10K ±5%, 1/4w	4
R71	10013	Resistor, RC07, 33 ohm ±5%, 1/4w	1
R72	10069	Resistor, RC07, 6.8K ±5%, 1/4w	1
R76	10212	Resistor, RC20, 30 ohm ±5%, 1/2w	1
R78	10039	Resistor, RC07, 390 ohm ±5%, 1/4w	1
R79	10063	Resistor, RC07, 3.9K ±5%, 1/4w	1
R81	10434	Resistor, RC32, 240 ohm ±5%, 1w	1
R82	10053	Resistor, RC07, 1.5K ±5%, 1/4w	1
R86	16731	Resistor, 25 ohm ±5%, 10w	1
R89	16624	Resistor, RS-2C, 0.5 ohm ±3%, 6.5w	1
U1,U2,U4	60303	Integrated circuit, LM723	3
U3	60335	Integrated circuit, LM307N	1
U5	60358	Integrated circuit, LM1458N	1
U6	17025	Integrated circuit, 7426	1

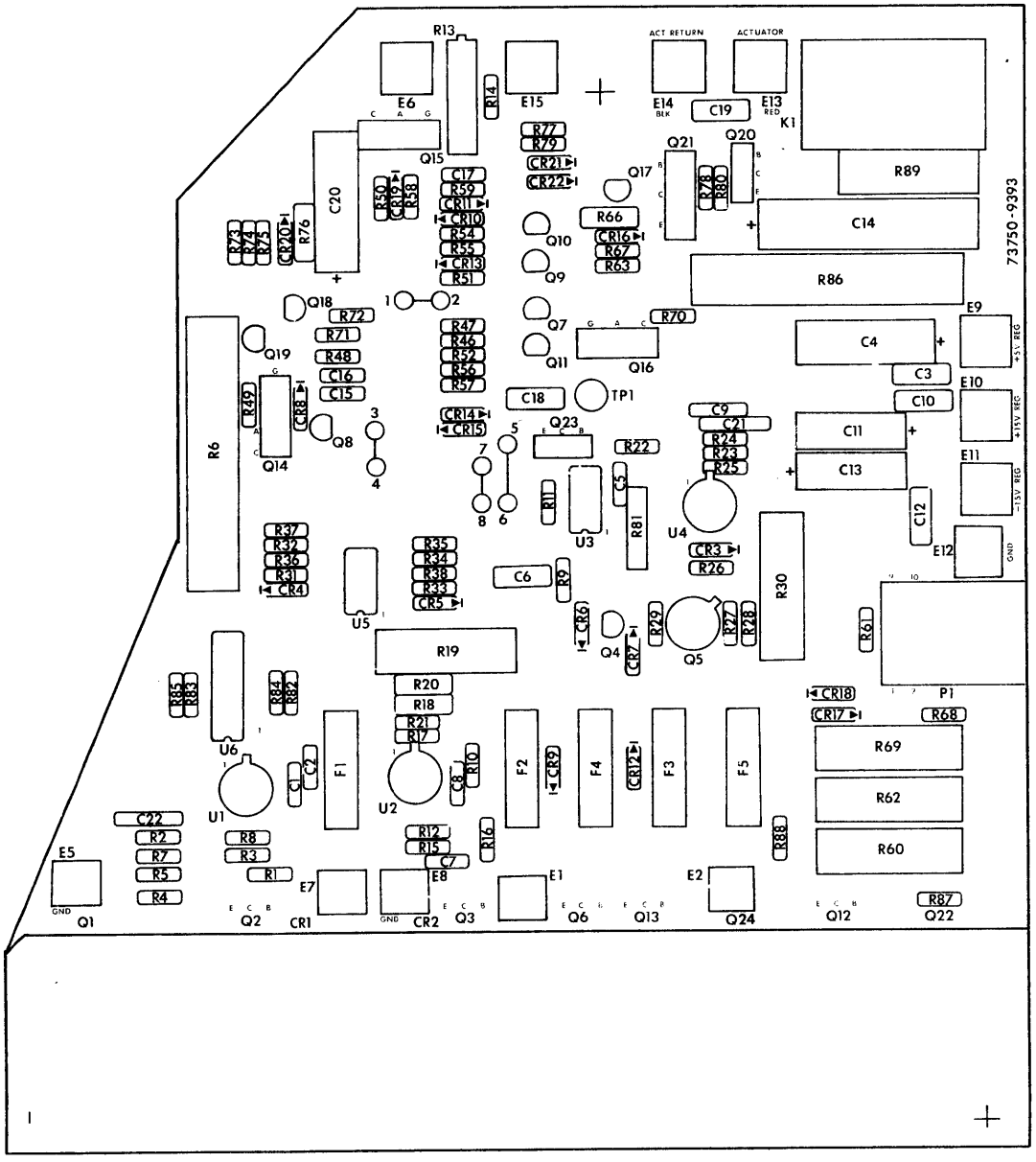


Figure 4-24. Power Supply (73700)

Parts List for Terminator Assembly, figure 4-25

Reference Designator	Part No.	Part Name	Quantity
C1		Capacitor, CER, 2200pf, 50V	1
C2		Capacitor, 150D, 2.2µf, 20V	1
J1		Connector, AMP 5839001	1
R1		Resistor, RC07, 200 ohm ±5%, 1/4w	1
R2		Resistor, RC07, 130 ohm ±5%, 1/4w	1
U1,U2		Integrated circuit, resistor pac 220/330 ohm	2

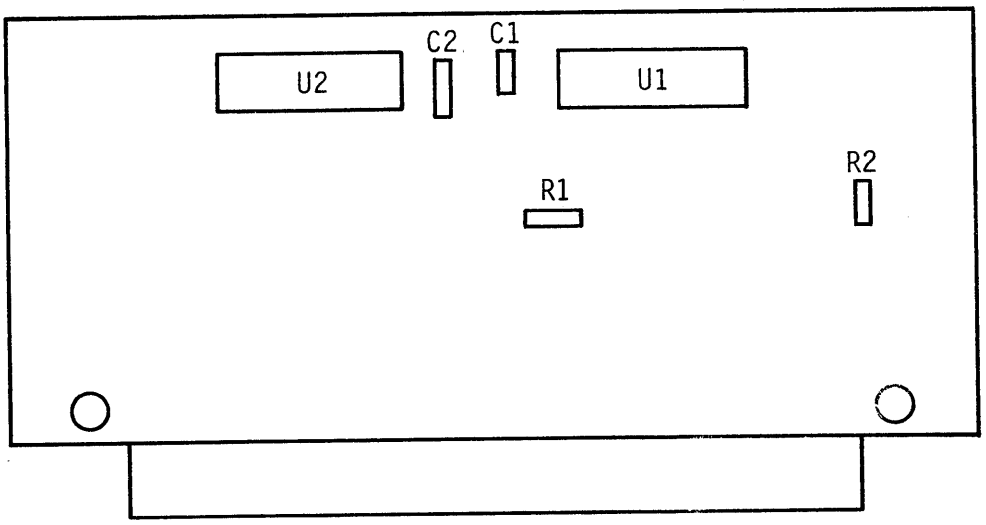


Figure 4-25. Terminator Assembly (73710)

basic / four®

November 1, 1974

To The User of SM 2020:

Concurrent with publication of SM 2020, dated November 1, 1974, two configurations of the Drive Control Logic board are being installed in Disc Drive Units. The boards are interchangeable by virtue of a connector adapter attached to Drive Control Logic boards having edge connectors for J1 and J2.

Add the following note to figures 3-35, 3-36, and 3-38 through 3-41.

NOTE: PRINTED PIN NUMBERS/LETTERS SHOWN FOR DRIVE CONTROL LOGIC BOARD APPLY TO BOARDS HAVING EDGE CONNECTORS FOR J1 AND J2. ADDED PIN NUMBERS APPLY TO BOARDS HAVING INTEGRAL MALE/FEMALE CONNECTORS FOR J1 AND J2.

Make the following pen-and-ink changes.

Figure 3-34.

Add "ORN" to wire from Power Supply E10 to Drive Control Logic and change +5V to +15V.

Add "BLK" to wire from Power Supply E11 to Drive Control Logic -15V.

Add "RED" to wire from Power Supply E9 to Drive Control Logic +5V.

Figure 3-35, sheet 2.

Near left margin, add "33" below a and "46" above Z on J1-J2.

Near right margin, add "37" below 14, "36" above 15 and "39" above 12 on J1-J2. Add B20 to J2 for XARDY-.

Figure 3-36, sheet 2.

Near left margin, add the following numbers on address lines to the left of J1-J2: "6" for 0, "10" for 1, "7" for 2, "11" for 3, "4" for 4, "8" for 5, "5" for 6, "9" for 7, and "26" for 8. Add "B9" to J2 for XCYA8-.

Figure 3-38, sheet 2.

Near left margin, add "46" to XDRSO- line near J1-J2.

Near right margin, add "14" below X, "13" above J, "12" above Y, and "15" above K in J1-J2.

Figure 3-40, sheet 2.

Near left margin, add "49" below 6, "32" above b, "30" above P, and "46" above Z in J1-J2.

Near right margin, add "38" below 18 and "35" above 17 in J1-J2.

Figure 3-40.

On lines to left of J1-J2 add the following.

"33" near a	"11" near 5	"9" near 3	"32" near b
"6" near T	"4" near U	"26" near 7	"49" near 6
"10" near S	"8" near 8	"50" near N	"31" near 9
"7" near R	"5" near 4	"30" near P	"46" near Z

On the lines to the right of J1-J2 add the following.

"37" near 14	"35" near 17	"13" near J
"39" near 12	"38" near 18	"15" near K
"36" near 15	"14" near X	"12" near Y