Century Data Systems
A Xerox Company

Marksman

Technical Manual

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MARKSMAN DISK DRIVE
TECHNICAL MANUAL

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Century Data Systems
A Xerox Company

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ILLUSTRATIONS

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SECTION 1

GENERAL INFORMATION

SCOPE AND ORGANIZATION OF MANUAL

This manual contains information pertaining to the installation, operation, and maintenance of the Marksman Disk Drive. This manual is divided into six sections:

- Section 1 — General Information
- Section 2 — Installation and Operation
- Section 3 — Theory of Operation
- Section 4 — Options
- Section 5 — Maintenance
- Section 6 — Illustrated Parts Breakdown

GENERAL DESCRIPTION

The Marksman Disk Drive is a fixed media mass memory device used for data storage in a data processing system. The Marksman uses fourth generation technology for high performance and floppy disk techniques for maximum economy. Data integrity comparable to that found in large disk systems is assured by the use of Winchester heads and media.

System reliability is maximized by a sealed, contamination controlled disk area and the reduction in the parts count achievable by the use of a microprocessor. The Marksman stores data on both sides of a single disk using two moving heads per surface providing a maximum memory capacity of 20.16 megabytes.

The Marksman uses a fixed mechanical timing wheel attached to the rotating disk and a Phase Lock Oscillator (PLO) to establish the basic synchronization between disk position and all drive control and recording functions. The Marksman provides programmable sector recording format and uses Double Density (TFM) data encoding techniques.

Head positioning is provided by a split band-stepper motor mechanism whose performance is improved by the microprocessor allowing higher speed slew capabilities.

The basic Marksman Disk Drive includes sealed disk assembly with drive motor and stepper assembly and one circuit board for minimal drive control functions.

The complete linear read/write circuitry including a data separator function are part of the basic control circuit board.

SPECIFICATIONS

Table 1-1 lists the operating specifications for the Marksman Disk Drive.

OPTIONS

Century Data Systems provides five options for the basic Marksman Disk Drive:

- Receiver/Drive Interface Board
- DC Power Supply
- Enclosure and AC Distribution
- Rack Mount Slides
- VDE Safety Requirements

TABLE 1-1. MARKSMAN SPECIFICATIONS

Tracks per Cylinder	4
Number of Cylinders	213
Bytes per Track	24,000
Bytes per Cylinder	96,000
Bytes per Drive	20.16 million
Track Density	182 tracks per inch
Recording Density	7,545 bits per inch, nominal
Minimum Positioning Time	3 milliseconds
Maximum Positioning Time	113 milliseconds
Average Positioning Time	43 milliseconds
Head Settling Time	17 milliseconds
Rotational Speed	2,400 rpm ±4 percent
Maximum Latency Time	26 milliseconds
Average Latency Time	12.5 milliseconds
Recording Method	Bit serial Triple Frequency Modulation (TFM)
Data Transfer Rate	960,000 bytes per second
Bit Cell Time	130 nanoseconds
Drive Sequence Up Time	3 minutes (Start to Drive Ready)
Sequence Up Read Time	3 minutes
Sequence Up Write Time	3 minutes
AC Input Power	115 Volts rms (+10%, −15%) 50/60 Hertz (±1 Hz) Single Phase
Starting Current	11 amperes
Running Current	1.5 amperes
DC Power	+24 Volts ±5% at 2.7 amperes −12 Volts ±5% at 0.3 amperes +5 Volts ±5% at 2.5 amperes

Physical Dimensions	
Basic Drive (dimensions exclude all options)	
Width	16.5 inches (41.9 centimeters)
Depth	21.5 inches (54.6 centimeters)
Height	8.5 inches (21.6 centimeters)
Operating Weight	45 pounds (20.4 kilograms)
Shipping Weight	60 pounds (27.2 kilograms)
With Options (dimensions include optional enclosure, and power supply)	
Width	19 inches (48.3 centimters)
Depth	27.25 inches (69.2 centimeters)
Height	8.75 inches (22.2 centimeters)
Operating Weight	110 pounds (49.9 kilograms)
Shipping Weight	130 pounds (59 kilograms)
Ambient Limits	
Temperature	50°F to 104°F (6.1°C to (40°C) with maximum gradient of 18°F (10°C) per hour
Humidity	10 to 90 percent, relative, without condensation
Altitude	1,000 feet (0.3 kilometers) below sea level to 6,000 feet (1.8 kilometers) above sea level With optional kit: extend range to 10,000 feet (3 kilometers) above sea level
Heat Dissipation	650 BTU/Hour/Drive (Basic Drive with no interface board)
Air Cooling (without enclosure)	Air velocity of 200 feet/minute (over complete assembly)

SECTION 2

INSTALLATION AND OPERATION

UNPACKING AND INSPECTION

Marksman Disk Drives are normally packed in a preformed styrofoam container which is placed in a corrugated container for both domestic and overseas shipment and handling. These containers can be stacked. If the exterior condition of the container indicates the likelihood of interior damage to the unit, unpacking should be carried out in the presence of the carrier or his agent where possible. In any case, units should be unpacked and checked for shipping damage as soon as received.

UNPACKING AND HANDLING

The following procedure is based upon current packing methods and is subject to possible minor changes. After inspecting the exterior of the container for obvious shipping damage, proceed as follows:

Note

The shipping weight of the unit is approximately 60 pounds (27.2 kilograms). Care should be used in handling and moving.

1. Move the container to a suitable workbench.

Note

It may prove expedient to save all of the packing material for possible reshipment.

2. Open the box enclosure, remove and retain any loose items and/or documentation from the top of the inner container.

3. Remove styrofoam inner container from box enclosure and place on workbench.

4. Cut shipping tape and lift top up and off styrofoam container.

5. Lift disk drive out of styrofoam container and place on the workbench on its side with drive motor down (Figure 2-1).

6. Install four shipping legs to bottom of drive (Figure 2-2).

7. Set unit on all four shipping legs.

EQUIPMENT INSPECTION

Inspect the unit visually for evidence of rough handling during shipment, such as:

- Deformed frame members
- Cracks or breaks in casting
- Cracks or breaks in top of sealed unit
- Cracked printed circuit board, particularly around mounting holes
- Loose or broken cable connectors
- Loose or damaged drive motor pulley
- Bent or broken timing wheel and sensor assembly
- Damaged spindle pulley
- Loose or damaged relay assembly
- Drive belt loose or off pulleys

INSTALLATION CHECK LIST

An Installation Check List is provded, Table 2-1, followed by the recommended procedures for preinstallation unit checkout, unit installation, and installation checkout prior to online use.

Note

The Installation Check List is for the use of experienced installation technicians. Other service personnel should follow the recommended procedures.

Problems found during the preceding unit inspection must be corrected before proceeding further. If any adjustments or parts replacement are required to put the disk drive online, be sure to note all corrective action taken on the Installation Completion Form.

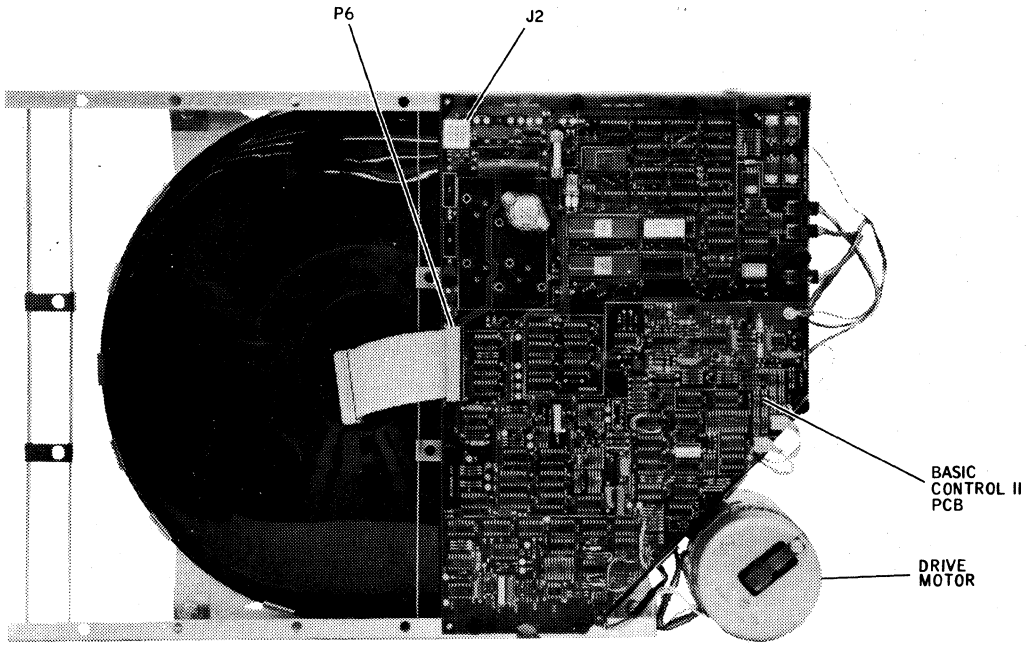

Figure 2-1. Marksman Disk Drive (Top View)

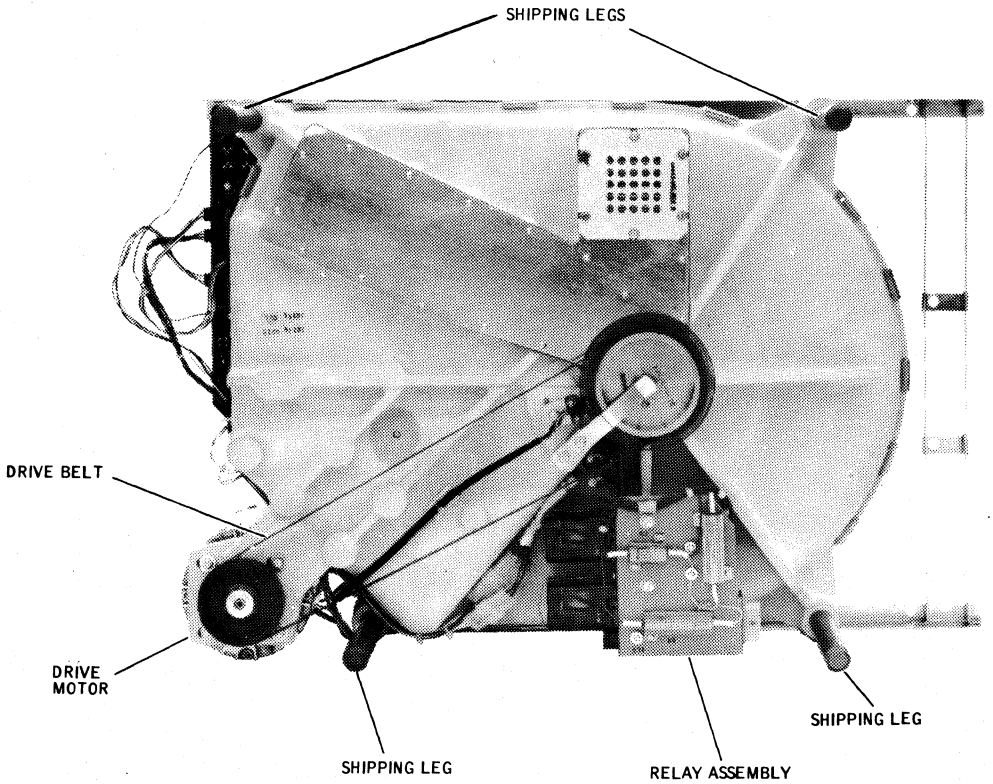

Figure 2-2. Marksman Disk Drive (Bottom View)

Table 2-1. INSTALLATION CHECK LIST

VISUAL INSPECTION

☐ Remove all packing material
☐ Check for shipping damage
☐ Check all wiring and connectors

ELECTROMECHANICAL CHECKS (OPTIONAL)

☐ Check spindle grounding brush pressure and electrical resistance

AC POWER CONNECTION

☐ Check for correct voltage and phase
☐ Connect ac power cord to J1 on relay assembly

DC VOLTAGE CONNECTION

☐ Connect dc power supply outputs to J2 on Basic Drive Control II pcb
☐ Check +24 volts ±5 percent
☐ Check +5 volts ±5 percent
☐ Check −12 volts ±5 percent

GROUNDING

☐ Controller to power supply grounding
☐ Logic ground from power supply to pcb grounding lug
☐ Ground strapping at power supply

OFFLINE OPERATIONAL CHECKOUT (OPTIONAL)

☐ Check spindle up/down operation
☐ Check positioning
☐ Check for index pulses
☐ Check for sector pulses

INTERFACE

☐ Install interface pcb
☐ Connect signal ribbon cable to interface pcb

INSTALLATION

☐ Remove shipping legs
☐ Mount unit

SYSTEM CABLING

☐ Install customer supplied signal and ground cables

ONLINE OPERATION

☐ Check write clock phasing
☐ Check unit sequencing and seek positioning
☐ Check unit for worst-casting data recovery

ELECTROMECHANICAL CHECKS (OPTIONAL)

The following electromechanical checks are optional and need to be performed only if the unit was obviously dropped or subject to gross mishandling during shipment. Detailed procedures for making these checks and any necessary adjustments can be found in the maintenance section.

1. Set unit on its side (drive motor down) and check spindle grounding brush pressure and electrical resistance.

2. Check spindle drive belt for proper centering and tension.

3. Check for any physical damage to pcb or sealed unit.

4. Set unit on all four shipping legs.

AC POWER CONNECTION

CAUTION

The basic Marksman Disk Drive is not protected by any ac line fuse or breaker; the user shall be responsible for all ac safety requirements.

WARNING

Compare voltage and frequency requirements from unit identification tag with available power. Connecting wrong voltage and/or frequency could damage the unit.

1. The unit end of the power cable should connect to a 4 pin, female MOLEX connector as shown in Figure 2-3.

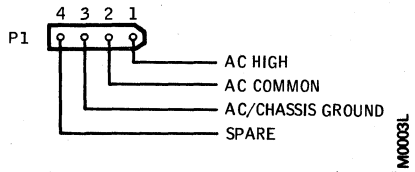

Figure 2-3. AC Power Connection

Note

Load balancing should be considered when uits are connected to a three-phase power source.

2. Connect plug P1, to jack, J1, on relay assembly (Figure 2-2).

DC VOLTAGE CONNECTIONS

The basic unit requires regulated +24 volts (±5%), −12 volts (±5%), +5 volts (±5%). The outputs of the dc power supplies should be connected to a 9 pin, female MOLEX connector as shown in Figure 2-4.

Note

When optional Model 2004 Exerciser and/or interface pcb is to be used, plug, P6, must be wired to plug, P2, as shown in Figure 2-3.

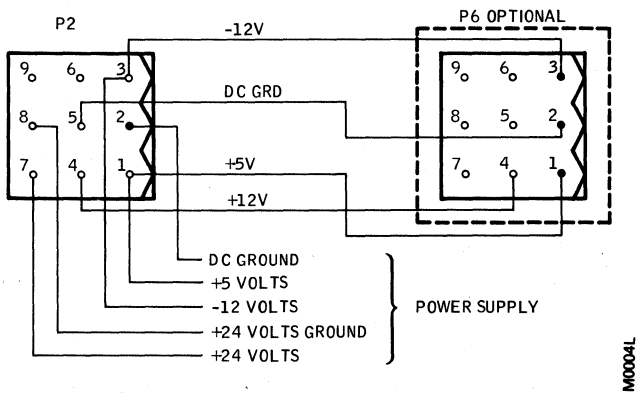

Figure 2-4. DC Voltage Connections

1. Connect plug, P2, to jack, J2, on Basic Drive Control II pcb (Figure 2-1).

2. If optional interface pcb is on basic unit, connect plug, P6, to jack, J6, on interface pcb.

GROUNDING

To provide the proper grounding of the basic unit to the system, proceed as follows (see Figure 2-5).

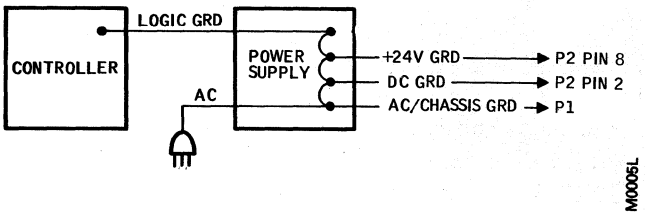

Figure 2-5. Grounding

1. Controller logic ground should be 3/8 inch braided wire.

2. All grounds must be strapped together at the power supply.

OFFLINE OPERATIONAL CHECKOUT (OPTIONAL)

The Model 2004 Exerciser must be used, if offline operational checks are required.

Note

Refer to Model 2004 Disk Drive Exerciser Technical Manual for exerciser operation.

1. Insure all power is off to the unit.

2. Disconnect plug, P6, from interface pcb (if present) and connect to exerciser.

3. Disconnect signal ribbon cable from interface and connect to exerciser.

4. Turn on ac power to unit.

5. Turn on dc power to unit and verify the unit is ready to accept commands from the exerciser.

6. Initiate a sequence-up operation.

7. Initiate continuous full-stroke, alternate seeks between cylinders 000 and 212 for at least one minute.

8. Stop the alternate seek operation and rezero the unit.

WARNING

Any write operation will destroy any data that was perviously written on the disk.

9. Initiate set sector command (12 sectors).

10. Initiate operation to format the disk.

11. Initiate continuous random seeks and read operation for at least 5 minutes. Unit should run error free.

12. Stop random seek and read operation and rezero unit.

13. Using an oscilloscope, verify Index pulses occur approximately every 25 milliseconds at chip A14, pin 9 on the Basic Control II board.

14. Using an oscilloscope, verify Sector pulses occur approximately every 2.08 milliseconds at chip A4, pin 4.

15. Initiate a sequence-down operation, when disk has stopped, turn off ac and dc power to the unit.

16. Disconnect exerciser.

SIGNAL CABLES AND CABLE FABRICATION

The basic unit supplies all interfacing signals via a 4-inch pin flat cable assembly from the Basic Control II board. All signals require cable drivers/receivers before they can be connected to the system.

Pin assignments for the 40 pin flat cable assembly are shown in Table 2-2.

Note

Refer to the operation portion of this section for signal definitions.

INSTALLATION

The Marksman Disk Drive may be mounted in either a horizontal or vertical position.

Note

Refer to specifications in Section I for drive dimensions, weight, and air circulation requirements.

1. Remove the four shipping legs.

2. Install unit as desired.

3. Connect all power and system cables.

TABLE 2-2. 40 PIN FLAT CABLE ASSEMBLY PIN ASSIGNMENTS

Pin No.	Signal Name
1	CACK
2	RST/
3	CBUS Ø
4	CBUS 1
5	SPARE
6	CREQ
7	GRD
8	CBUS 2
9	CBUS 6
10	CBUS 7
11	CBUS 5
12	CBUS 3
13	SPARE
14	IDX
15	GRD
16	DRDY
17	CRDY
18	GRD
19	1 MHZ
20	GRD
21	SEC
22	GRD
23	CSTAT
24	GRD
25	WRTCLK
26	GRD
27	NRZIN
28	GRD
29	RDCLK
30	GRD
31	NRZOUT
32	GRD
33	WRTGATE/
34	GRD
35	RDGATE
36	SPARE
37	NRZ/MILLER CONTROL
38	SPARE
39	WRTUSF
40	CBUS 4

WRITE CLOCK PHASE SELECTION

This selection of write clock phase is done to compensate for delays in write data timing due to differences in cable lengths between the controller and the various drives. This must be done on each new disk drive when it is first installed in the system or when a disk drive is physically relocated within the system.

1. Apply ac power to disk drive.

2. Apply dc power to disk drive.

3. When drive is ready, initiate a continuous write operation via the operating system using a data pattern of alternate zeros and ones.

4. Connect and adjust an oscilloscope to observe the relationship between NRZIN at A46 pin 12 and the write clock at A46 pin 11.

   SYNC: INT. POS.

   CHAN: 1 dc 2V/CM A46 pin 12 NRZIN

   CHAN: 2 dc 2V/CM A46 pin 11 WRITE CLOCK

   MODE: Alternate; Sync on CHAN 1 only

5. Rising edge of clock pulse must be withn 32.5 nanoseconds of the center of the NRZ data pulse as shown in Figure 2-6.

6. If clock transitions noted in step 5 are incorrect, move jumper (or plug) between test points E20 and E22 to E20 and E21.

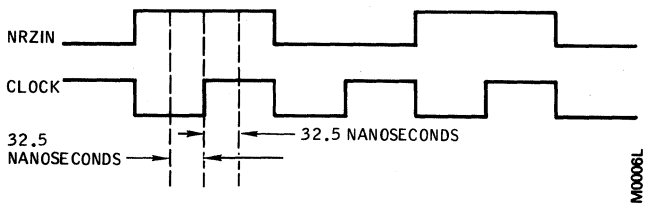

Figure 2-6. Write Clock Phasing

FIXED LENGTH SECTORING

If the system is to use fixed length sectoring, switch S1 on the pcb must be set for the desired number of sectors. The switch settings are as follows:

SWITCH S-1		NUMBER OF SECTORS	SECTOR LENGTH (USING FORMAT IV)
– 1	– 2		
CLOSED	CLOSED	111	128 BYTES
CLOSED	OPEN	69	256 BYTES
OPEN	CLOSED	40	512 BYTES
OPEN	OPEN	21	1024 BYTES

Figure 2-1. shows the location of switch S-1.

ONLINE OPERATION

Before placing the disk drive online, the operating system should be used to perform the following:

- Sequence Up and Down
- Random Seeks
- Write and Read

OPERATION

The Marksman Disk Drive is designed to operate online under control of the operating system without the necessity of an operator.

To ensure error-free operation disk formats, operation commands, and interface protocol have been defined for the Marksman Disk Drives.

FORMAT DEFINITIONS

Four different formats have been defined for the Marksman Disk Drive. They are illustrated in Figure 2-7.

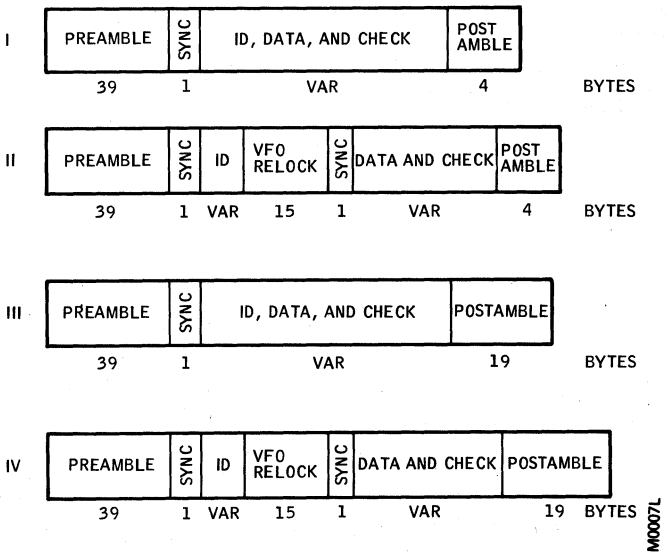

Figure 2-7. Sector Formats

SECTOR CALCULATIONS

The following formula is used to calculate the number of sectors for any given sector size.

$$N = \frac{2400}{Data + HDR - OH}$$

Where:

N = number of sectors (round to next lower integer)

Data = length of data field plus check characters

HRD = length of header

OH = 44 for Format 1
= 60 for Format II
= 59 for Format III
= 75 for Format IV

Whenever it is necessary to change heads at the end of a track and continue operation without losing a revolution, a 100 byte end of track pad must be assigned. In this case, the sector formula must be changed to:

$$N = \frac{23900}{Data \& HDR + OH}$$

SECTOR SIZE	FORMAT			
	I	II	III	IV
128 BYTES	129	119	119	111
256 BYTES	76	72	72	69
512 BYTES	42	41	41	40
1024 BYTES	22	21	21	21

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Figure 2-8. Number of Sectors per Track*

*Assuming a 8 byte ID field and a 5 byte check character.

SECTOR SIZE	FORMAT			
	I	II	III	IV
128 BYTES	13.87	12.79	12.79	11.93
256 BYTES	16.34	15.48	15.48	14.84
512 BYTES	18.06	17.63	17.63	17.20
1024 BYTES	18.92	18.06	18.06	18.06

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Figure 2-9. Net Capacity M-20**

**M-10 capacity is one half of that shown.

INTERFACE SIGNALS

Signals appearing at the Marksman Disk Drive interface and their use are shown in Tables 2-3 and 2-4.

INTERFACE DESCRIPTION

General

The controller interface functions may be divided into four areas:

- Single Word Commands (Sequence, Rezero, Status, Advance Head)
- Two Word Commands (Seek, Set Sector, Diagnose)
- Data Transfer Commands (Read, Write)
- Error Handling

Figures 2-10 thru 2-13 are the flow charts and timing diagrams for one byte commands.

Figures 2-14 and 2-15 are the same for the two word commands.

One Byte Commands

Sequence 7 6 5 4 3 2 1 0
0 0 0 1 0 0 0 X

Bit 0 = 0 Sequence Up

Bit 0 = 1 Sequence Down

The sequence command causes the disk drive motor to power up (Bit 0 = 0) or power-down (Bit 0 = 1). During a power up, the speed of the disk is checked and when the rotational speed is within tolerance, the heads are positioned to cylinder zero, head zero. During a power down, the heads are positioned to the landing zone before power is removed from the drive motor.

Head Advance 7 6 5 4 3 2 1 0
0 1 1 0 0 0 X X

X X	Meaning
0 0	No Operation
0 1	Head Advance one time
1 0	Head Advance two times
1 1	Head Advance three times

The head advance command provides a means for rapidly advancing the head thereby allowing sequential sector access across head boundaries.

TABLE 2-3. CONTROL SIGNALS

Signal Name	Mnemonic	I/O	Description
Control Bus	CBS0-7	Both	A high active 8 bit wide bus used to transfer commands from the Interface and status to the Interface.
Control Request	CREQ	I	A high active line from the Interface, used in conjunction with the CACK line to form a handshake between the Interface and the Drive, CREQ, indicates to the Drive: 1. The Interface has placed a byte of command or a byte of data on the Interface Data Bus. 2. The Interface has accepted the ending status from the Drive.
Control Acknowledge	CACK	O	A high active line from the Drive to the Interface to: 1. Acknowledge receipt of a byte of command or data from the Interface. 2. Notify the Interface the Drive has placed a byte of status information on the Data Bus.
Control Ready	CRDY	O	A high active line from the Drive to the Interface indicating the Drive is in the input mode and is waiting for a command.
Control Status	CSTAS	O	A high active line from the Drive to the Interface indicating that the Drive has placed a byte of status information on the Data Bus.
Drive Ready	DRDY	O	A positive true line from the Drive to the Interface indicates that the Drive is up to speed and DC power is safe.
Drive Reset	RST/	I	A low active signal from the Interface which provides the Drive with an unconditional reset and causes the heads to be relocated to the Landing Zone.
Index	IDX	O	A high active line from the Drive used to indicate the physical beginning of a track of data.
Sector	SEC	O	A high active line from the Drive used to indicate the physical beginning to a data record within a track.
Write Unsafe	WRTUSF	O	A positive true line from the Drive to the Interface shall indicate an unsafe write process was attempted. (i.e., multi-head DC unsafe, write on protected head.) Shall be cleared when status is presented.

TABLE 2-4. READ/WRITE SIGNALS

Signal Name	Mnemonic	I/O	Description
Write Data	NRZIN	I	A positive true line from the Interface to the Drive used to transmit serial write data to the Drive.
Write Clock	WRTCLK	O	A positive true line from the Drive to the Interface used to clock write data from the Interface. This clock shall be phase locked to the spindle rotation at all times.
Write Gate	WRTGATE/	I	A negative true line from the Interface to the Drive used to write data on the selected head.
Read Data	NRZOUT	O	A positive true line from the Drive to the Interface used to transmit serial read data to the Interface. This output shall be connected to the Read Data only, after RDGATE to True. All other conditions shall provide a clamped logic Zero output state.
Read Clock	RDCLK	O	A positive true line from the Drive to the Interface used to clock read data from the Drive.
Read Gate	RDGATE	I	A positive true line from the Interface to the Drive shall start lock-up of the phase lock loop (PLL) in the Data Separator (which controls the RDCLK output Read Gate true must not be raised over write splice (read gap) areas and must occur after seek complete. Read Gate False must occur prior to any write splice and must be maintained no less than 8 bytes before allowing Read Gate True.
MPU Clock	1MHZ	O	One MHZ clock not locked to the disk speed. To be used for control functions only.

Rezero 7 6 5 4 3 2 1 0
0 0 1 0 0 0 0 0

The rezero command causes the heads to be repositioned to cylinder zero, head zero.

Request Status 7 6 5 4 3 2 1 0
0 0 0 0 0 X X X

X X X	Meaning
0 0 0	Normal Status
0 0 1	Expanded Status
0 1 0	Last Command (MSB)
0 1 1	Last Command (LSB)
1 0 0	CAR (current cylinder)
1 0 1	Sectors per Track
1 1 0	Diagnostic Bits
1 1 1	Diagnostic Bits

A. **Normal Status**
- Bit 0 — Track zero: heads are located over track zero.
- Bit 1 — Landing zone: heads are located over landing zone.
- Bit 2 — Illegal command.
- Bit 3 — Ready: disk is up to rotational speed.
- Bit 4 — Spin acceleration/deceleration out of limit.
- Bit 5 — End of cylinder (Head 3 selected).
- Bit 6 — Diagnostic error.
- Bit 7 — Track zero error.

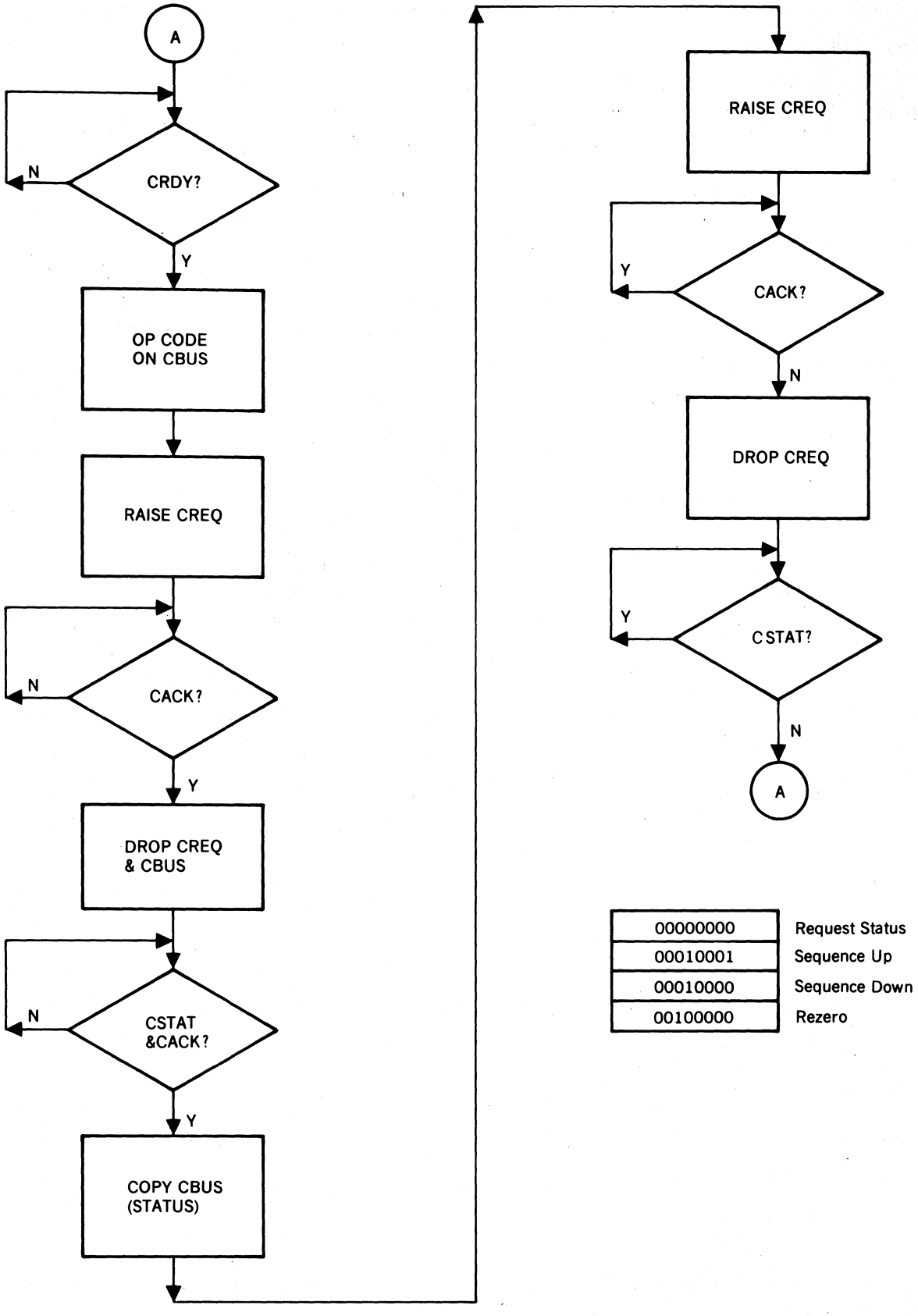


Figure 2-10. One Byte Commands (Except head advance) Flow Chart

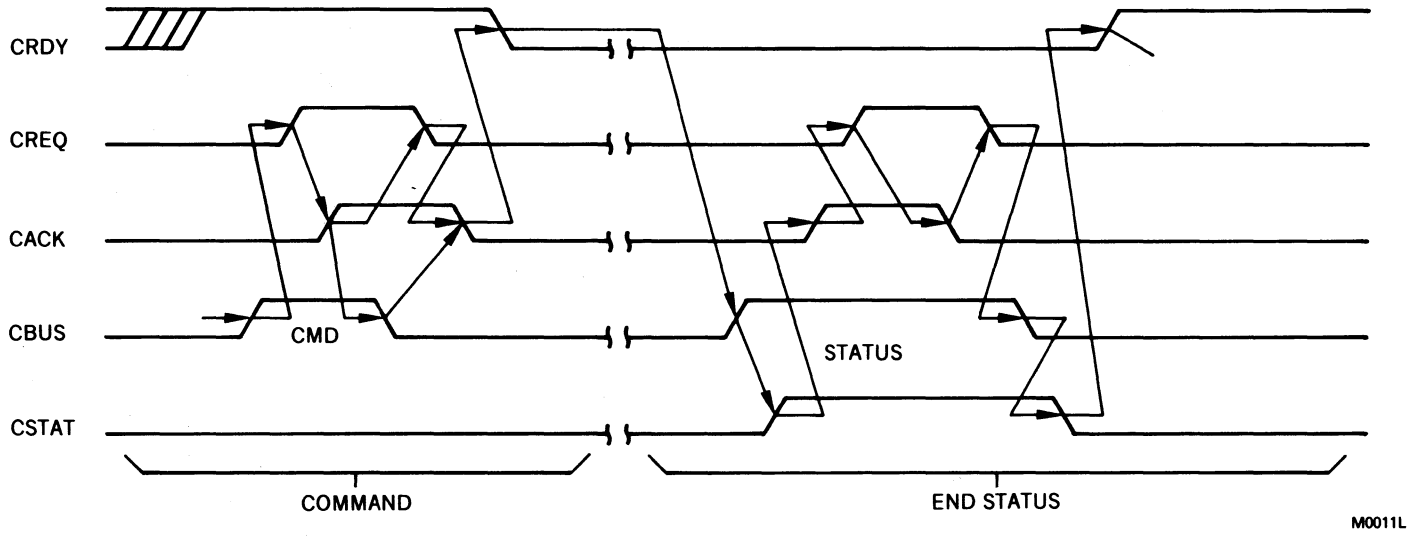


Figure 2-11. One Byte Commands (Except head advance) Timing Diagram

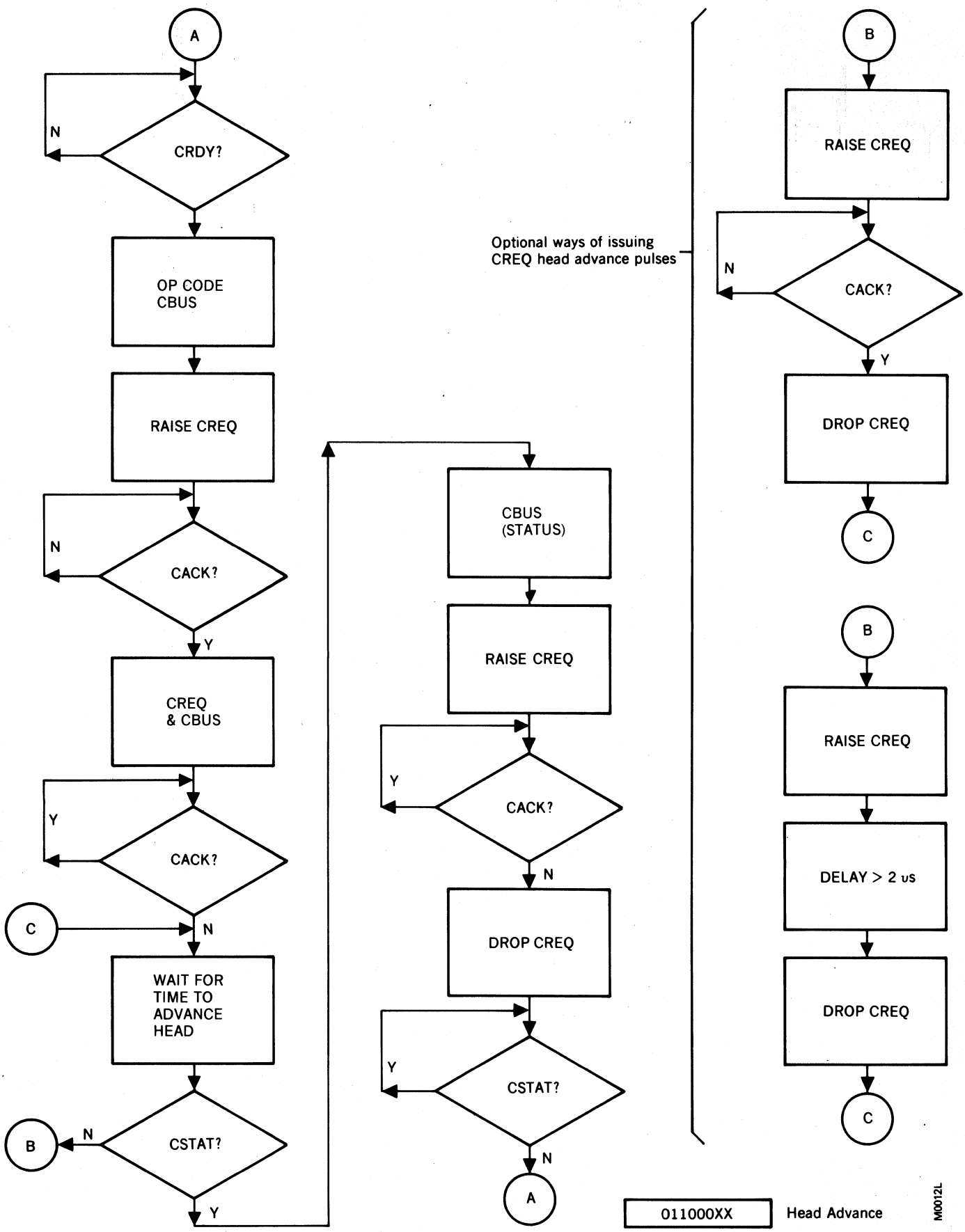
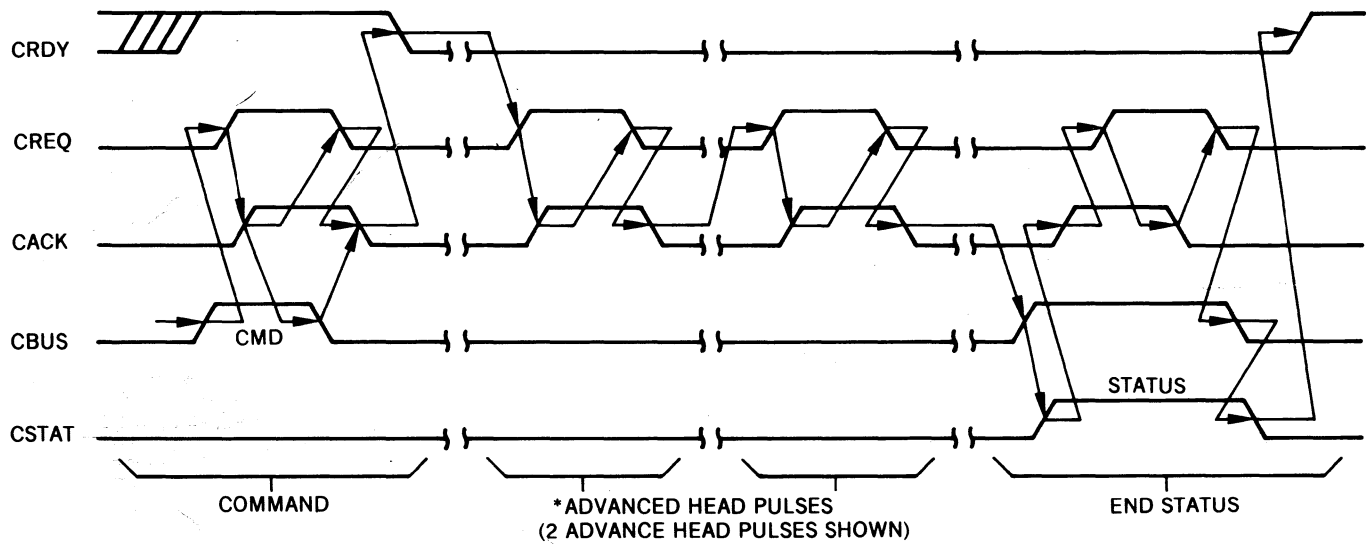


Figure 2-12. One Byte Head Advance Command Flow Diagram



*NOTE: CACK will echo the CREQ head advance pulses, but can rise after CREQ has dropped if CREQ is very narrow. (The head advance operation is still performed prior to the rise of CACK). CREQ for head advance, should be at least 2 μs wide.

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Figure 2-13. One Byte Head Advance Command Timing

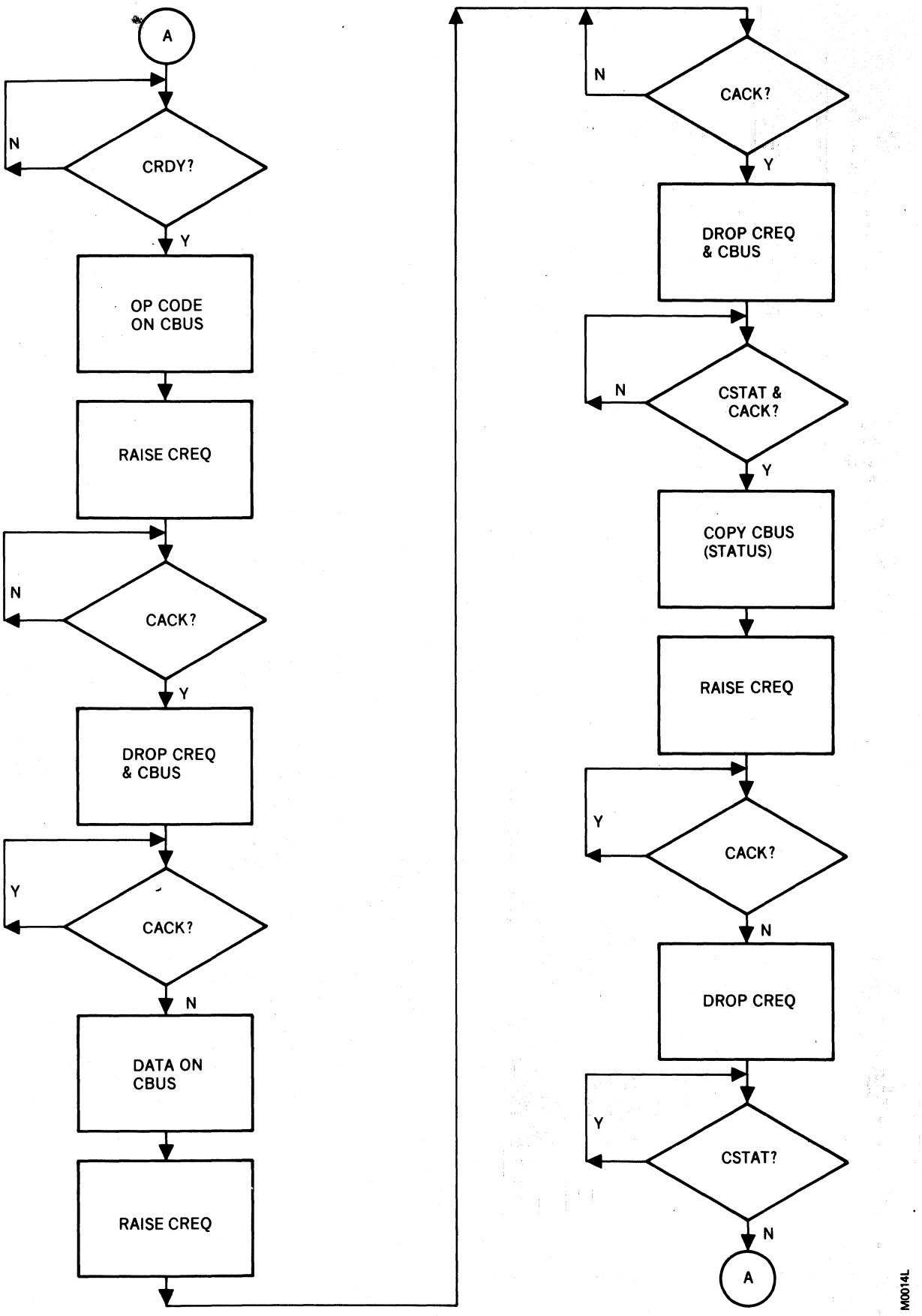


Figure 2-14. Two Byte Commands Flow Chart

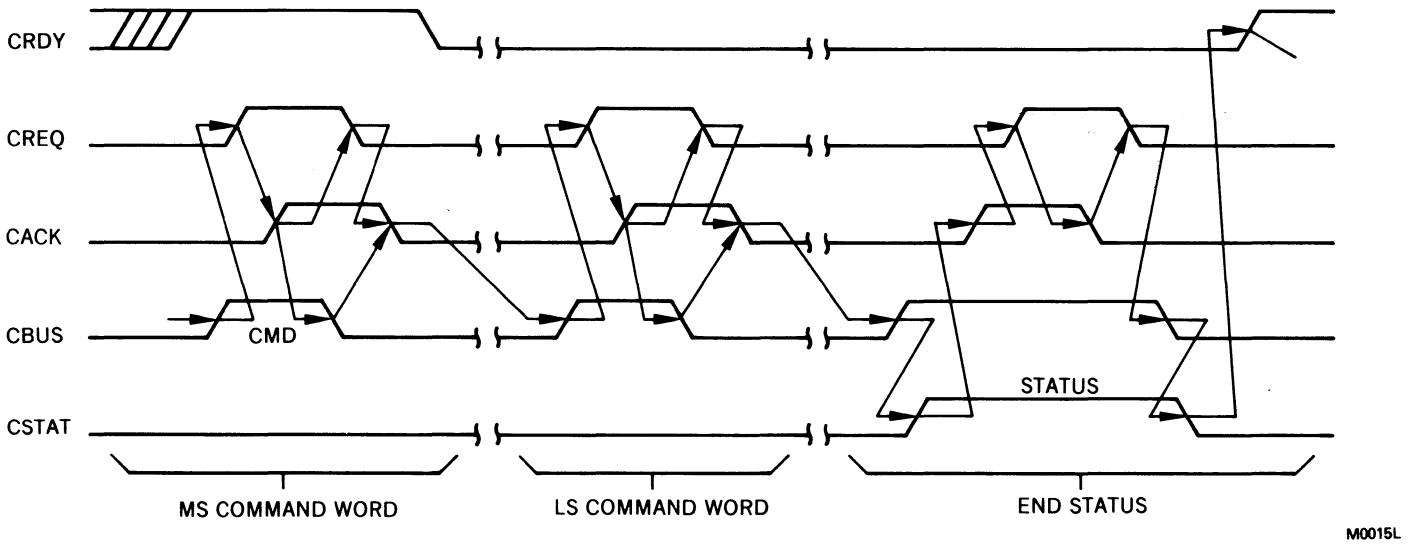


Figure 2-15. Two Byte Commands Timing Diagram

B. **Expanded Status**

Bit 0 — } Selector length switches.
Bit 1 — }
Bit 2 — Illegal set sector.
Bit 3 — Sector per track by:
0 = Sector length switches.
1 = Set sector command.
Bit 4 — Illegal rezero or seek
Bit 5 — Illegal cylinder
Bit 6 — Illegal command
Bit 7 — Attempted to write on a write-protected head

The request status command causes the current status of the drive to be returned to the interface. Normal status bits are cleared after being presented to user, except bits 0, 1, 3, and 5. Expanded status bits are cleared after a specific request for expanded status, except for bits 0, 1, 3, and 5.

Two Byte Commands

Seek

7 6 5 4 3 2 1 0
0 1 0 0 0 0 H H
Cylinder Address

The seek command is used to position the heads over the specified cylinder and select the head addressed by the low order bits of the command byte. The seek command requires one byte transferred with the command to specify the cylinder.

Set Sector

7 6 5 4 3 2 1 0
0 1 0 1 0 0 0 0
Sector Count

The set sector command is used to override the sector switch settings and set the number of sectors from 4 to 256. This selection will remain until another set sector command is issued or upon re-power-up, at which time, the switch settings will be used.

Diagnose (Optional)

7 6 5 4 3 2 1 0
1 0 0 0 0 0 0 0
0 Test Number

This command and op-code are reserved for future use.

Data Transfer

Media Initialization (Figure 2-16)

New media or media which has had a format change must first be formatted before data can be written onto the disk. Refer to Format Definition in this section.

The cylinder and track are selected in accordance with the previously mentioned procedure. At index time, Write Gate is activated and the appropriate data is written.

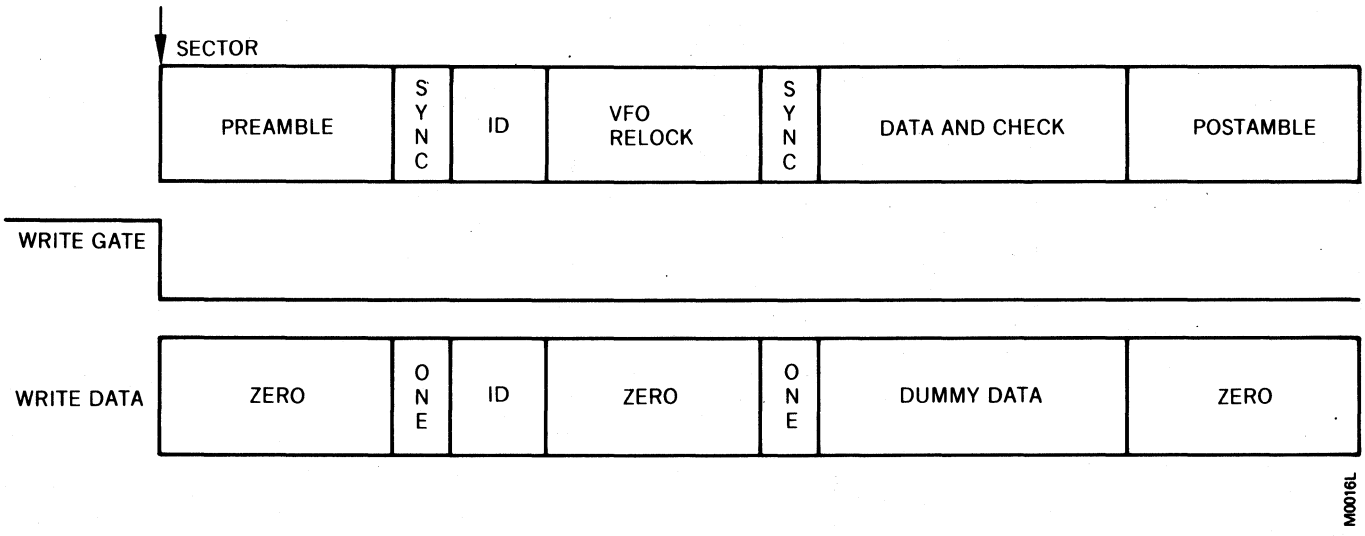


Figure 2-16. Media Initialization

Reading

Non-Imbedded ID Field (Figure 2-17)

Sixteen bytes after the sector pulse, Read Gate is activated. Zeros appear on NRZ data out signal until PPL is in sync or locked. Immediately following the sync byte is the ID or header field. At the end of the ID field, Read Gate must be deactivated for a four byte time period and reactivated. This action enables the read circuitry to reacquire lock before the sync byte.

Imbedded ID Field (Figure 2-18)

The Read Gate is activated sixteen bytes after Index pulse and deactivated after the data field. Read Gate must not be activated until at least 16 microseconds after Write Gate has been deactivated or the head has been selected.

Writing

Non-Imbeded ID FIeld (Figure 2-19)

Read Gate must be activated sixteen bytes after the sector pulse. At the end of ID field, Read Gate is deactivated, Write Gate is activated, and the appropriate data is written. Write Gate is deactivated one byte into the postamble.

Imbedded ID Field (Figure 2-20)

The Write Gate is activated at sector pulse time and deactivated one byte into the postamble.

Error Handling

The Marksman internal logic monitors a number of conditions which, if they occur, will compromise data integrity. They are as follows:

Multiple Heads Selected During Write

Write Unsafe (WRTUSF) signal is set. Resets when status is read.

Write Command to Protected Head

Write Unsafe (WRTUSF) signal is set. Resets when status is read.

Power Fault

Write Unsafe (WRTUSF) signal is set. Resets when status is read.

Illegal Command Received

Bit 2 of status word is set. Resets when status is read.

Spin Acceleration/Deceleration Out of Limit

Bit 4 of status word is set. Resets when status is read. Repeated operation when this condition exists could lead to excessive wear of the head and disk and result in data loss over a period of time.

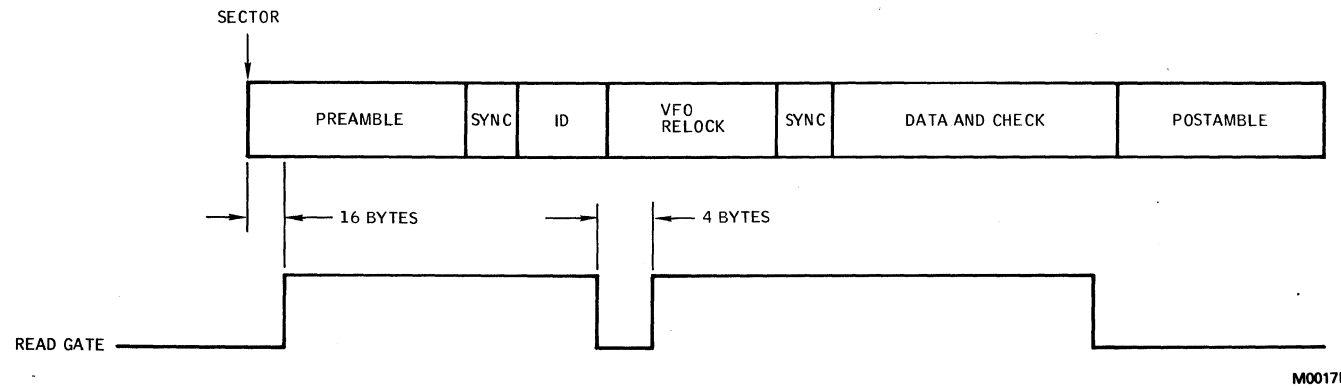


Figure 2-17. Non-Imbedded ID Field Read Timing

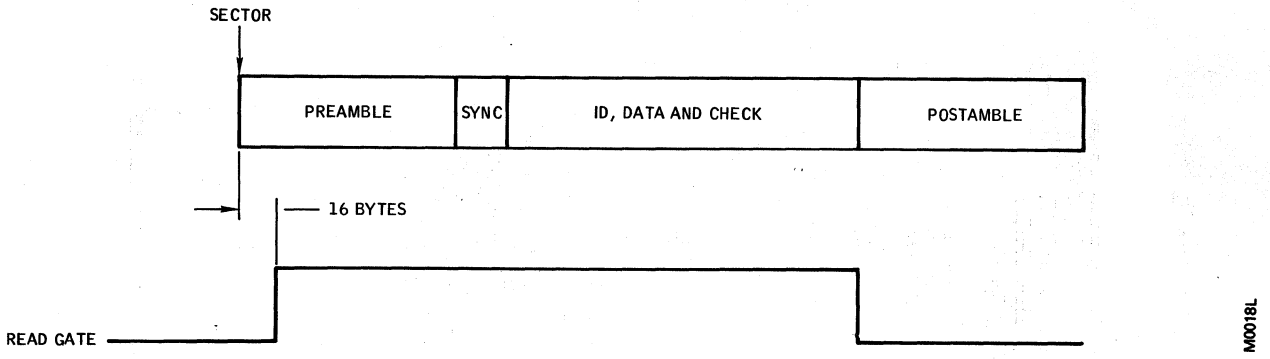


Figure 2-18. Imbedded ID Field Read Timing

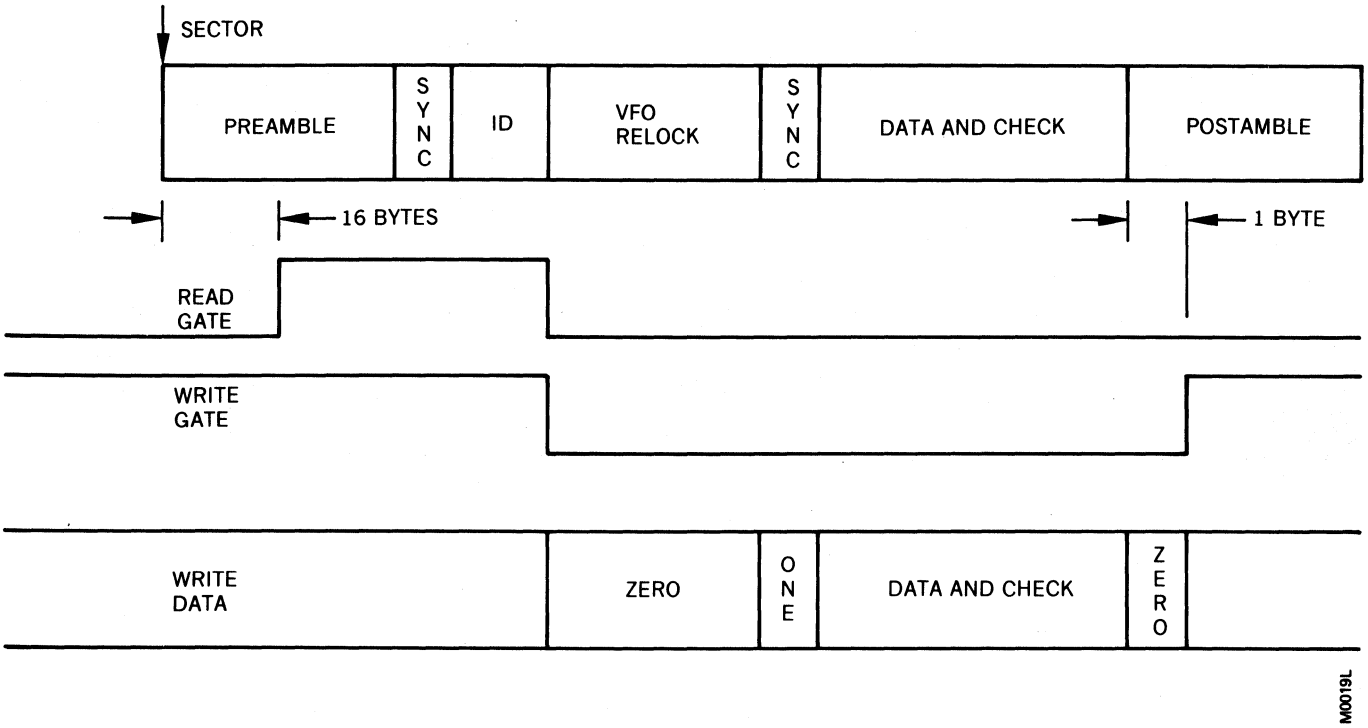


Figure 2-19. Non-Imbedded ID FIeld Write Timing

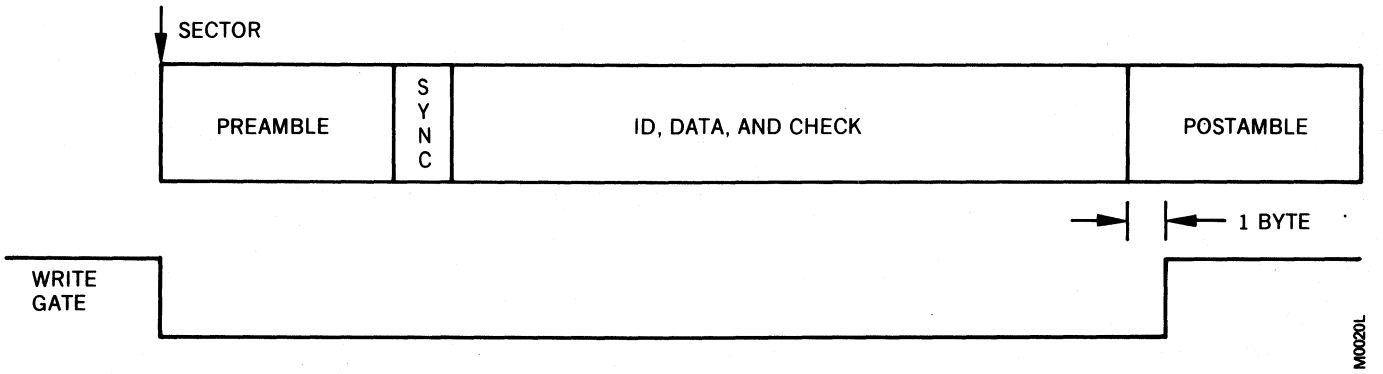


Figure 2-20. Imbedded ID Field Write Timing

SECTION 3

THEORY OF OPERATION

GENERAL

The Marksman Disk Drive can be divided into four major physical assemblies:

- Sealed Contamination-Controlled Unit
- Drive Motor and Brake Assembly
- Control Relay Assembly
- Printed Circuit Board

The Sealed Contamination-Controlled Unit contains a single disk, four read/write heads, head positioning stepper mechanism, and a recirculating air-filtration system.

The Drive Motor and Brake Assembly contains a capacitor start/induction run, single-phase motor that rotates at 3545 rpm at 60 Hz or 2957 rpm at 50 Hz. Through a belt-pulley assembly the motor causes the disk to rotate at 2400 rpm. An electrically released spring applied friction brake is mounted on the motor shaft.

The Control Relay Assembly contains two 24 vdc relays under control of the drive control logic on the printed circuit board. One relay transfers 110 vac to the drive motor winding and +24 vdc to the brake when energized. The other relay transfers 110 vac to the drive motor start winding when energized.

The Printed Circuit Board contains all the logic necessary to control all functions of the drive as well as all the read/write circuitry. The printed circuit board is divided into eight functional areas (see Figure 3-1):

- Power Regulator
- Stepper Motor Drive
- Drive Control Logic
- Write Driver
- Matrix
- Read Amplifier/Desnake
- Data Separator
- Phase Lock Oscillator

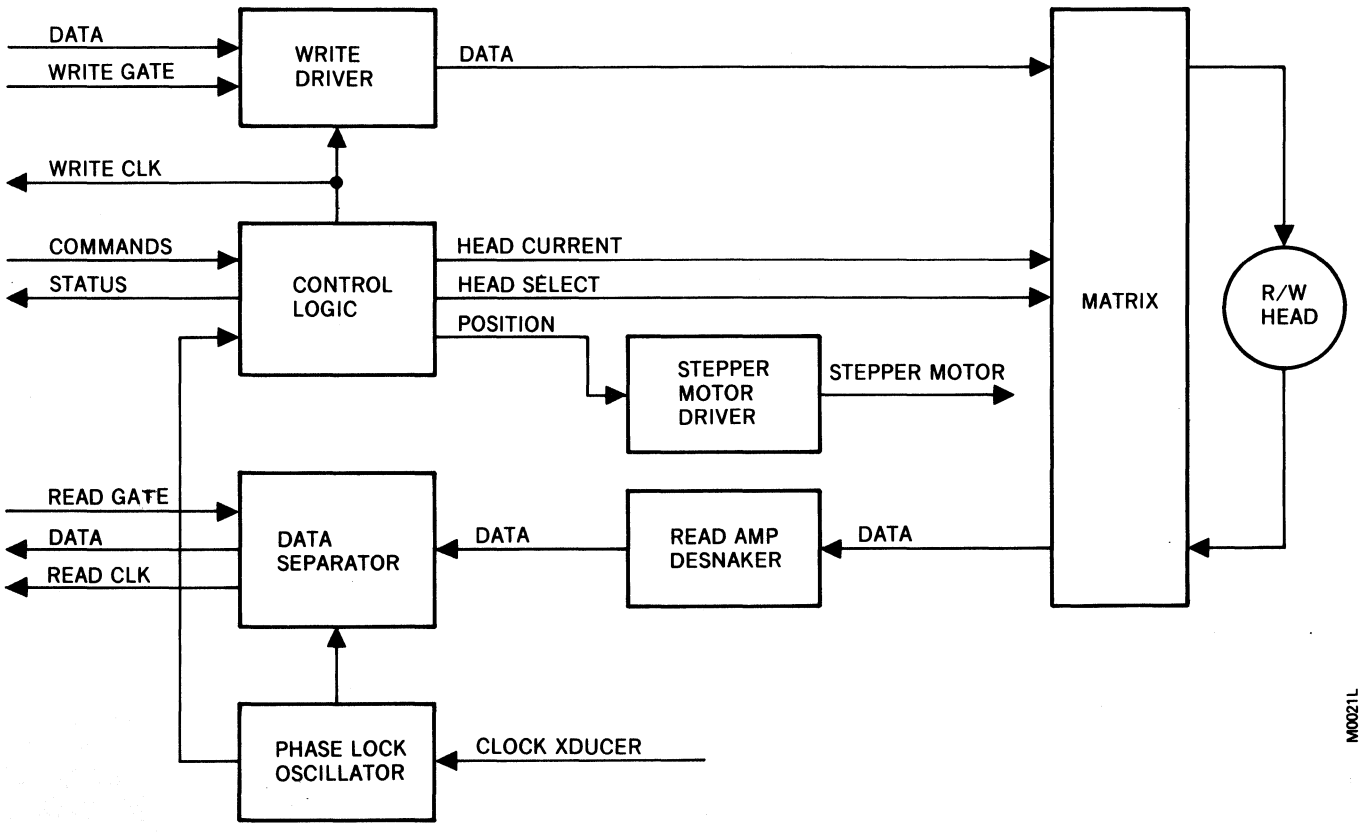


Figure 3-1. Marksman Disk Drive Functional Block Diagram

The Power Regulator contains a voltage regulator and filter networks to output +24 vdc, +12 vdc, −12 vdc, and +5 vdc. A fused +24 vdc input is routed directly to the stepper motor driver as well as the voltage regulator to produce the +12 vdc output. The −12 vdc and +5 vdc outputs are input directly from dc power supplies.

The Stepper Motor Driver contains transistor switches under control of a four-bit position code and current control bit from the drive control logic. Each different position code closes different switches causing current to flow through different windings of the four phase, permanent magnet stepper motor. This causes the shaft of the motor to rotate (step) to a specific location for each code. When stepping, the current control bit causes more current to flow through the selected windings to provide more torque. By providing a specific sequence of position codes, the drive control logic causes the motor to step clockwise or counterclockwise.

The Drive Control Logic contains a 6802 microprocessor (MPU), peripheral interface adapter (PIA), memory (ROM), programmable interval timer (PIT), and miscellaneous control and gate logic.

The MPU executes the program stored in the memory under control of commands received through the PIA from the interface. The MPU programs one of the PIA's registers to receive commands or output status to the interface. The other PIA register is used to output the position code and current control bit to the stepper motor driver. The three counters of the PIT are controlled by the MPU and used for various function delays.

The Write Driver is enabled by a write (WRT/) signal from the interface and contains the logic to convert NRZ coded data from the interface to double density (MFM) coded data. It also contains error detection logic for a write unsafe condition.

The Matrix contains the logic to select a read/write head for a read or write operation.

The Read Amplifier/Desnaker contains the logic necessary to amplify, shape, and digitize the small read signals from the read/write head. The output is double density coded data.

The Data Separator contains a reference one-shot and voltage-controlled oscillator that are used to separate clock and data from the double density data. The data pulses are then converted to NRZ coded data. The data red to the interface. A read clock is also generated and sent to the interface.

The Phase Lock Oscillator has a free-running frequency of 16.89 MHz that is phase-locked to the speed of the disk through timing pulses received from a clock transducer. The phase-locked frequency is 15.36 MHz. A 19.2 KHz clock is generated from a clock divider circuit that is used for speed detection. A gated write clock is generated at the PLO frequency for write operation synchronization. This section also has the index transducer logic that generates a pulse for each revolution of the disk.

DISK AND R/W HEAD CONFIGURATION

The Marksman Disk Drive uses a single 14-inch diameter lubricated ferrous-oxide coated disk. The four read/write heads are rigidly mounted to a head-positioning carriage as inner and outer facing pairs. See Figure 3-2. All heads are mounted on spring arms that are loaded to apply a pressure of approximately 9.5 grams toward their associated disk surface. When the disk is not rotating, the heads will be resting on the disk surface, however, the head pads and gimbaling are designed aerodynamically to "fly" the head on the air boundary layer created when the disk is rotating. This aerodynamic lift equalizes the spring load pressure causing the heads to fly between 19 and 22 microinches above the disk surface.

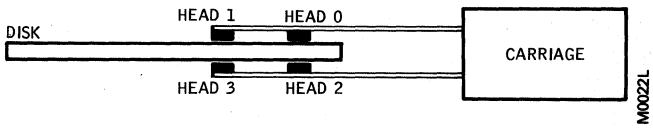


Figure 3-2. R/W Head Configuration

DISK ZONES AND R/W HEAD POSITIONING

Each surface of the disk is divided into two recording zones and two landing zones. See Figure 3-3. Each recording zone consists of 213 tracks (000-212) that may be used for recording. Although all tracks are available for recording, standard practice is to hold several in reserve as spares for bad tracks. A cylinder is defined as all four recording tracks that are accessible to the read/write heads for a given track position of the head positioning mechanism. The landing zones (cylinder 229) are the designated areas, for normal power down, where the read/write heads come to rest on the disk surface. Cylinder spacing on the disk surface is 0.0055 inch.

The head positioning carriage is physically attached to the shaft of the head positioning stepper motor. A one cyclinder step command causes the stepper motor shaft to rotate 0.9 degrees which is translated to 0.0055 inch of lateral movement of the head positioning carriage.

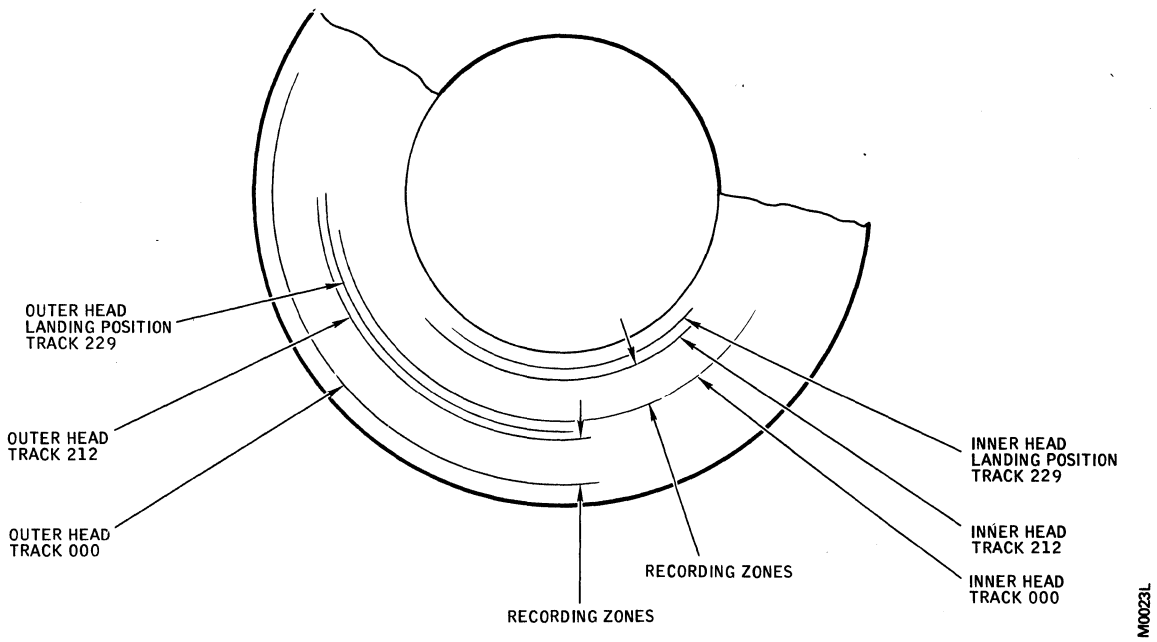


Figure 3-3. Disk Zones

DRIVE CONTROL

All functions performed by the disk drive except the actual read/write operation are under direct control of the 6802 microprocessor. Control is maintained by execution of a PROM stored program by the microprocessor. See Figure 3-4. After initialization the microprocessor is executing the wait loop portion of the program until a command is received from the interface. Upon receipt of the command, the program jumps to the command decode subroutine. When the command is decoded, the program jumps to the subroutine that will cause the correct action to execute the command. After the command has been executed, the program jumps to the status subroutine and outputs a new status word to the interface. When the receipt of the status word has been acknowledged, the program returns to the wait loop. Following are the legal commands that will be accepted and executed by the drive control logic:

- Sequence (Up/Down)
- Seek
- Rezero
- Head Advance
- Set Sector
- Diagnostic
- Status

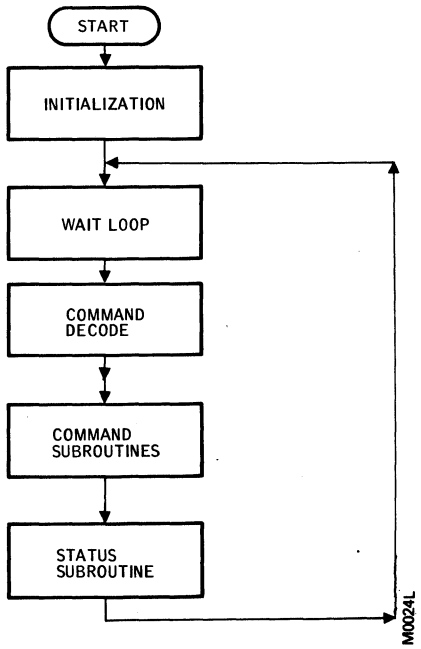


Figure 3-4. Program Flow Diagram

POWER ON AND INITIALIZATION SEQUENCE

Initially the drive motor is stopped and the read/write heads are resting on the disk surface at cylinder 229 (landing zone). When power is turned on, a reset signal is sent to the MPU causing it to access the upper two locations of memory (see Figure 3-5). The contents of those locations is the starting address of the initialization subroutine and is loaded into the program counter of the MPU. When the program counter is loaded, the MPU starts execution. First the MPU causes the Unsafe flip-flop to be reset and then all operating constants and tables are initialized. The PIA is then programmed to output position signals to the head positioning stepper motor and to accept commands from the interface. The sector switch settings are read and the program computes the number sectors per track and stores the information. Head zero is then selected and Control Ready (CRDY) is sent to the interface. The program then goes to the wait loop subroutine and waits for a command to be input. The first command to be input after power-on should be a Sequence-Up command.

SEQUENCE-UP OPERATION

When a command is received by the PIA, the MPU is interrupted. The MPU goes to the command decode subroutine. When the command is decoded as a sequence-up, the program jumps to the sequence-up subroutine. The program causes the motor and start relays to energize and then delays two seconds after which the start relay is de-energized. Two clocks are then enabled for speed detection. After a delay of six seconds the bytes per sector and sectors per track counters are initialized. After a delay of 26.5 milliseconds the program jumps to a subroutine to check disk speed. If no index pulse is detected within 2.65 seconds or if two index pulses are detected within 23.5 milliseconds the spin acceleration/deceleration bit is set in the status byte and the program jumps to the sequence-down subroutine. If the disk comes up to speed with no errors the program delays three minutes and then jumps to the subroutine to position the heads over track zero. When the heads are at track zero, the status subroutine is entered. After status has been sent and acknowledged the program returns to the wait loop.

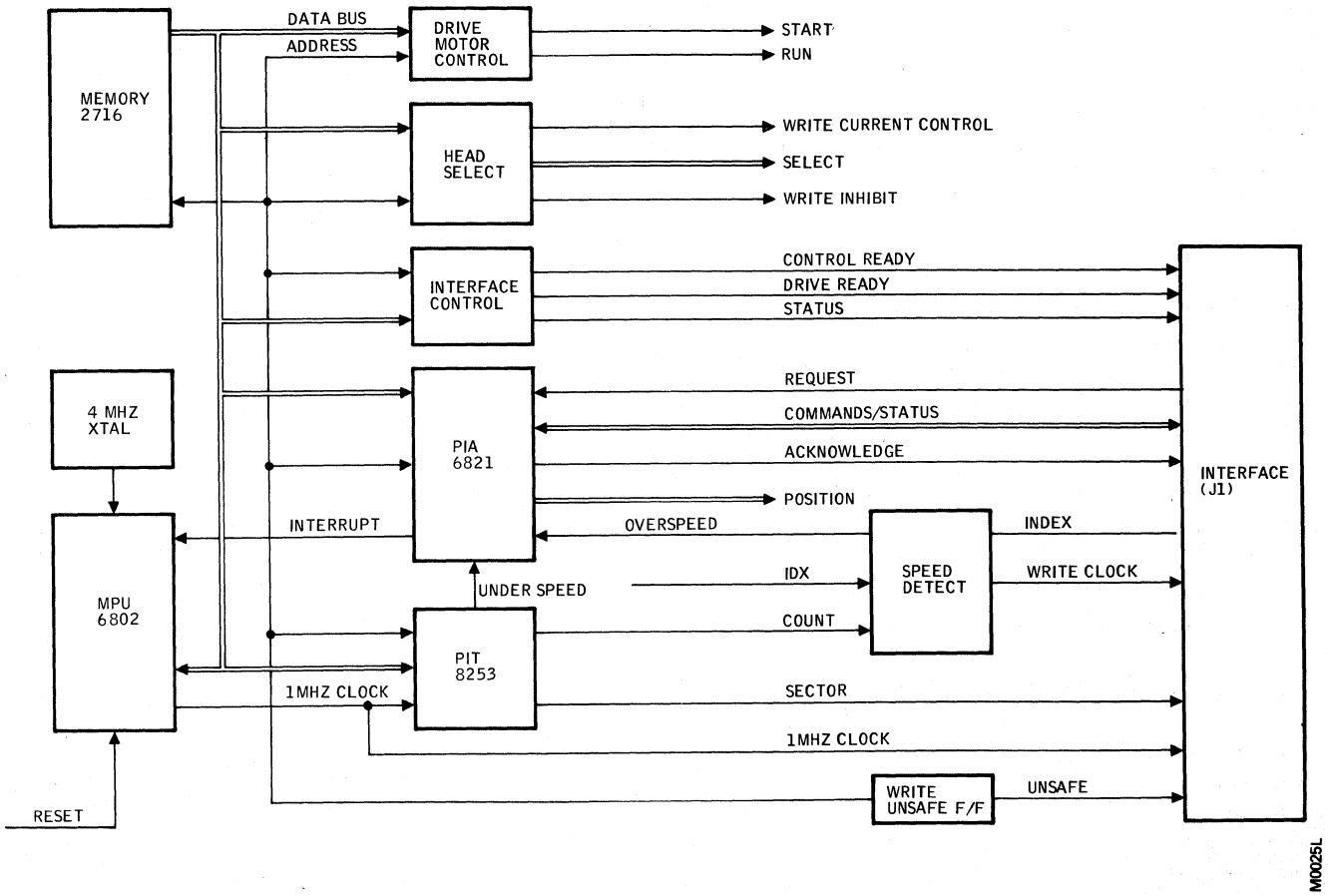


Figure 3-5. Drive Control Block Diagram

SEEK OPERATION

A seek operation requires the read/write heads be positioned to the cylinder indicated in the seek command and that the specified head be selected.

When a command is received by the PIA, the MPU is interrupted. The MPU goes to the command decode subroutine. When the command is decoded as a seek, the MPU waits for the second word containing the cylinder address to be input from the interface. The received cylinder address is checked to see if it is legal (less than 213). If the address is illegal, the status word is updated and output and the MPU returns to the wait loop. With a legal address, the read/write head indicated in the command word is selected. If the new cylinder is less than 125 the head current is increased. After verifying that the disk is up to speed, the MPU computes the difference between the new and present cylinder address to determine the direction of movement. The MPU then outputs position signals to the stepper motor, via the PIA, in the sequence necessary to move the head positioning carriage toward the new cylinder. After each position signal (step) the difference count is decremented and the present cylinder address is changed to indicate the new position. When the difference count reaches zero a 17 millisecond delay is started to allow the read/write heads to settle at the new cylinder. After the delay, the MPU sets the seek complete bit in the status word and then outputs it to the PIA. When the PIA receives an acknowledge for the status word from the interface, the MPU sets drive ready and goes to the wait loop.

REZERO OPERATION

A rezero operation requires the read/write heads to be positioned at cylinder zero and read/write head zero to be selected.

When the rezero command has been decoded, disk up to speed is verified and then the subroutine to position the heads at cylinder zero is entered. The cylinder zero indicator is checked. If on, a position signal is sent to the stepper motor to move the heads to cylinder one and then re-positioned at cylinder zero. If the cylinder zero indicator is off, an inward movement (to cylinder zero) flag is set. A sequence of position signals are sent to the stepper motor, via the PIA, to move the head carriage toward cylinder zero. Between each position signal the cylinder zero indicator is checked. This procedure continues until the indicator is on. Then the cylinder address is set to zero, read/write head zero is selected, and the status word is updated. The status word is output and after acknowledge control and drive ready are set. The MPU returns to the wait loop. If 235 steps are performed without detecting track zero, the MPU goes to the sequence-down subroutine.

HEAD ADVANCE OPERATION

The head advance command requires that the selected read/write head be advanced by the number indicated in the command word.

SET SECTOR OPERATION

The set sector command requires that the number of sector pulses, output to the interface for each revolution of the disk, be as indicated in the second word of the command.

When the MPU decodes a set sector command it enters the set sector subroutine and waits for sector count (second command word) to be input. When the sector count is received, it is checked for a count of less than three. If less than three, the illegal sector bit is set in the status word, the status word is output and the MPU returns to the wait loop. If the sector count is legal (3-255), the MPU enters a divide subroutine where the bytes per sector are computed. The PIT is then addressed and counter 2 is loaded with the bytes-per-sector count. PIT counter 3 is then loaded with the sector-per-track count. The MPU then delays 51 milliseconds to allow the counters to be synchronized with the index pulse. Both counters are enabled by index and counter 2 is clocked every 1.04 microseconds (1 byte time). When counter 2 has decremented to zero the output pulse is sent to the interface as a sector pulse and is also used to decrement counter 3. When counter 3 has decremented to zero both counters are disabled until the next index pulse. At the end of a 51 millisecond delay the MPU outputs the status word and returns to the wait loop.

DIAGNOSTIC OPERATION

(To be supplied)

REQUEST STATUS OPERATION

The request status command requires that the requested status byte (one of eight bytes) be transferred to the interface. Refer to section two for the contents of the eight status bytes.

When the command decode subroutine decodes a request status command, the three least significant command bits are used to lead the requested status byte into a working register and then jumps to the status subroutine. The PIA is programmed to output status and the status byte is transferred to the interface and the CACK line is activated. When the status has been received, the system activates the CREQ line. The MPU then deactivates CACK and when CREQ goes inactive the

PIA is programmed to receive commands. The status byte is cleared except for bits 0, 1, 3, and 5 and the program returns to the wait loop.

DATA RECORDING METHOD

The method or code used by the Marksman Disk Drive for recording data is called Triple Frequency Modulation (TFM). Data is received from and transmitted to the interface in bit-serial NRZ (non-return-to-zero) format in real time at the writing and reading rate of the disk drive. Figure 3-6 provides a comparison between NRZ, Miller Code, and TFM-coded data.

TFM data is called triple frequency because magnetic flux reversals on the recording media occur at three frequencies: at one bit, one and one-half bit, and two-bit cell intervals. Data bit cell time is 130.2 nanoseconds at speed, making the maximum recording frequency 7.68 megahertz (all-zeros or all-ones pattern). Minimum recording frequency would be half that, or 3.84 megahertz (for an alternate zero and one bit pattern).

TFM coding, as shown in Figure 3-6, can be reduced to the following three rules:

- A flux change occurring at the midpoint of a data cell is one data bit, regardless of polarity.
- A flux change occurring at a data cell boundary is a zero bit regardless of polarity.
- No flux reversal will occur for the first zero data bit following a one data bit.

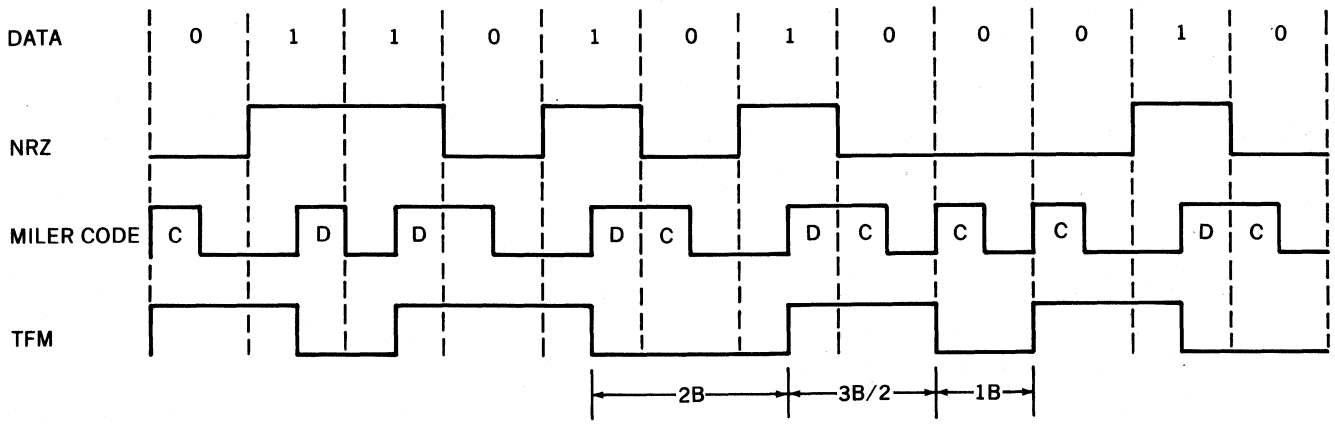
WRITE DATA RECORDING

Data to be written on the disk is sent by the interface in the form of serial NRZ code synchronized to a bit-rate write clock provided by the control logic of the disk drive. This clock is derived from a phase-locked oscillator that is locked onto the speed of the disk. See Figure 3-7.

The head to be used must be selected prior to the actual write operation. This is done with a seek command.

A write command from the interface enables the write data system. NRZ data on the NRZIN line is clocked into a NRZ-to Miller Code converter by the same bit-rate clock supplied to the interface for strobe gating of the write data. Synchronized Miller Code data from the converter is passed to the write flip-flop. The write flip-flop toggles when clocked by the rising, leading edge of each pulse from the Miller Code converter. The output of this flip-flop directly controls polarity reversals of the write current drivers to effect the flux transitions in the selected head.

The write current supplied to the selected head is not the same for outer and inner heads or for all cylinder locations. More current is supplied when outer heads (0 and 2) are selected than when inner heads (1 and 3) are selected. More current is supplied to the selected head to write on outer cylinders (000-125) than is supplied to write on inner cylinders. This is necessary because the tangential velocity of the disk decreases closer to the disk hub, which reduces the air pressure of the boundary



NOTES:
1. C = CLOCK PULSE
2. D = DATA PULSE
3. B = BIT CELL IN INTERVAL
4. 1B (BIT CELL TIME) = 130.2 NANOSECONDS

Figure 3-6. Code Format Comparisons and TFM Characteristics

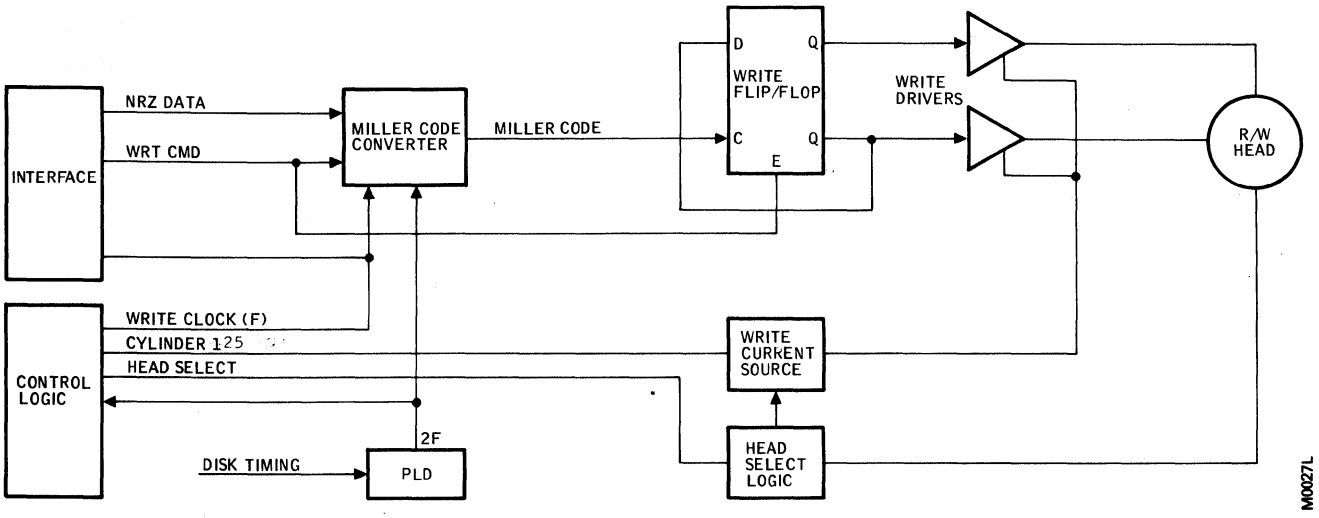


Figure 3-7. Write Data System Block Diagram

layer and causes the heads to fly closer to the disk surface as they move toward the hub. If the write current were not reduced for the inner heads and when writing on the inner cylinders, flux saturation would occur; this would reduce frequency response and increase crosstalk between tracks.

READ DATA RECOVERY

Data read from the disk is transferred to the interface in the form of serial NRZ code accompanied by a bit-rate clock provided by the disk drive for data strobing. This clock is derived from a voltage controlled oscillator that is locked onto the data stream from the read/write head. See Figure 3-8.

The head used for reading must be selected prior to the actual read operation in the same manner as for writing. Read is initiated when the readgate signal at the interface goes high. Good read data will be present on the interface NRZ output line approximately 6.77 microseconds later.

Error-free data recovery depends upon setting up accurate strobe windows relative to the raw data being read. This is accomplished by synchronizing a phase-locked, voltage-controlled oscillator (VCO) to the clock transitions of the read signal. This oscillator operates at the bit-rate frequency for window timing.

The series of all-zero sync bytes in the preamble of each record produces a TFM high frequency pattern at the bit rate. This read pattern is used for initial synchronization

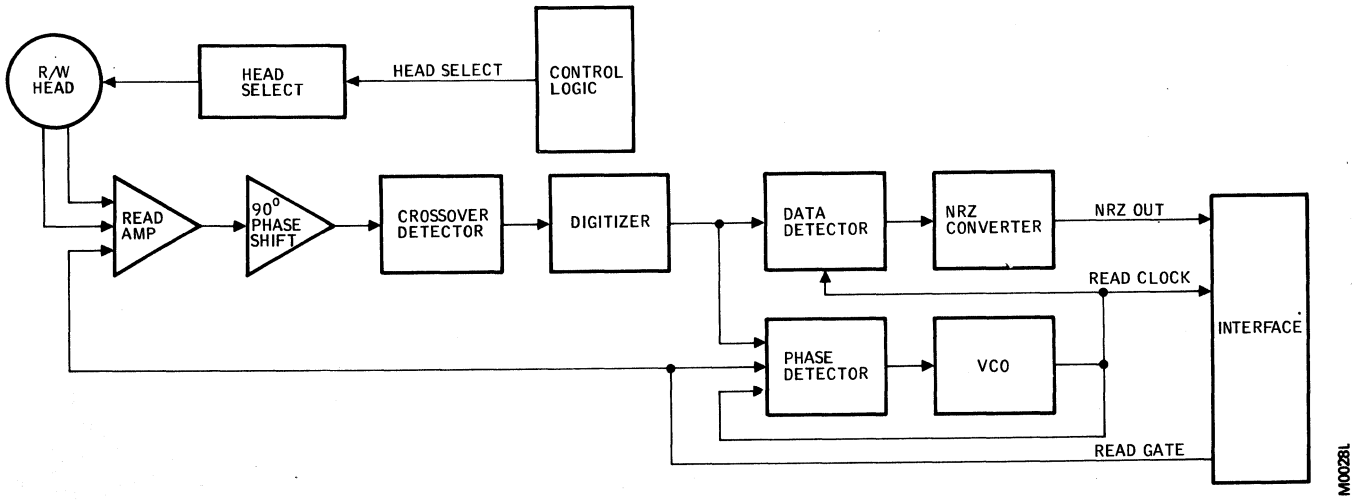


Figure 3-8. Read Data System Block Diagram

of the VCO by making a phase comparison between it and the VCO output. Phase differences produce a correction voltage that speed up or slows down the VCO until it is captured and locked in phase with the all-zeros bit rate clocks.

The raw read signal from the selected head is an analog signal, the maximum amplitude of which occurs when a flux transition domain is crossed. The polarity of maximum amplitude is indicative of the direction of the flux transitions, which, of course, alternates. This signal is amplified and phase-shifted 90 degrees so that the read signal polarity crossover points now occupy the position of maximum amplitude within the bit-cell interval. This is done because it is easier and more reliable to detect signal crossover points than to detect points of maximum signal amplitude, which can vary. See Figure 3-9.

After amplification and phase shifting, the raw read signal is processed back to digital TFM by a TFM crossover detector and then into a stream of Miller Code data pulses. Detection windows are set up by VCO clocks that are phase-shifted 90 degrees relative to the bit time interval by introducing a fixed delay into the incoming stream of Miller Code pulses. Read pulses with rising leading edges within the first or last quarters of the bit time interval are detected as clock pulses. Read pulses with leading edges occuring within the middle half of the bit time interval are detected as binary 1 data pulses. Detected data is converted to bit-interval, synchronous, serial NRZ code and sent to the interface.

FIXED LENGTH SECTORING

A hardware, switch selected, fixed length sector function is automatically implemented during a power-up or an interface initiated reset sequence. Both sequences cause the MPU to enter the initialization subroutine. During initialization, the MPU reads the sector switches, computes a bytes-per-sector count which is loaded into counter 2 of the PIT. PIT counter 3 is then loaded with the sector-per-track count. Sector switch configuration is as follows:

NUMBER OF SECTORS SWITCHES

SWITCH S-1		NUMBER OF SECTORS	SECTOR LENGTH (USING FORMAT IV)
– 1	– 2		
CLOSED	CLOSED	111	128 BYTES
CLOSED	OPEN	69	256 BYTES
OPEN	CLOSED	40	512 BYTES
OPEN	OPEN	21	1024 BYTES

WRITE PROTECT

Data previously recorded on the disk by a particular read/write head can be protected by a hardware, switch selected, function. There is a write protect switch with each of the four read/write heads. When a switch is closed and the associated head is selected the current source for the write drivers is inhibited. Write Protect switch configuration is as follows:

WRITE PROTECT SWITCHES

SWITCH S1				PROTECTED HEAD NUMBER
–3	–4	–5	–6	
CLOSED	—	—	—	1
—	CLOSED	—	—	2
—	—	CLOSED	—	3
—	—	—	CLOSED	0

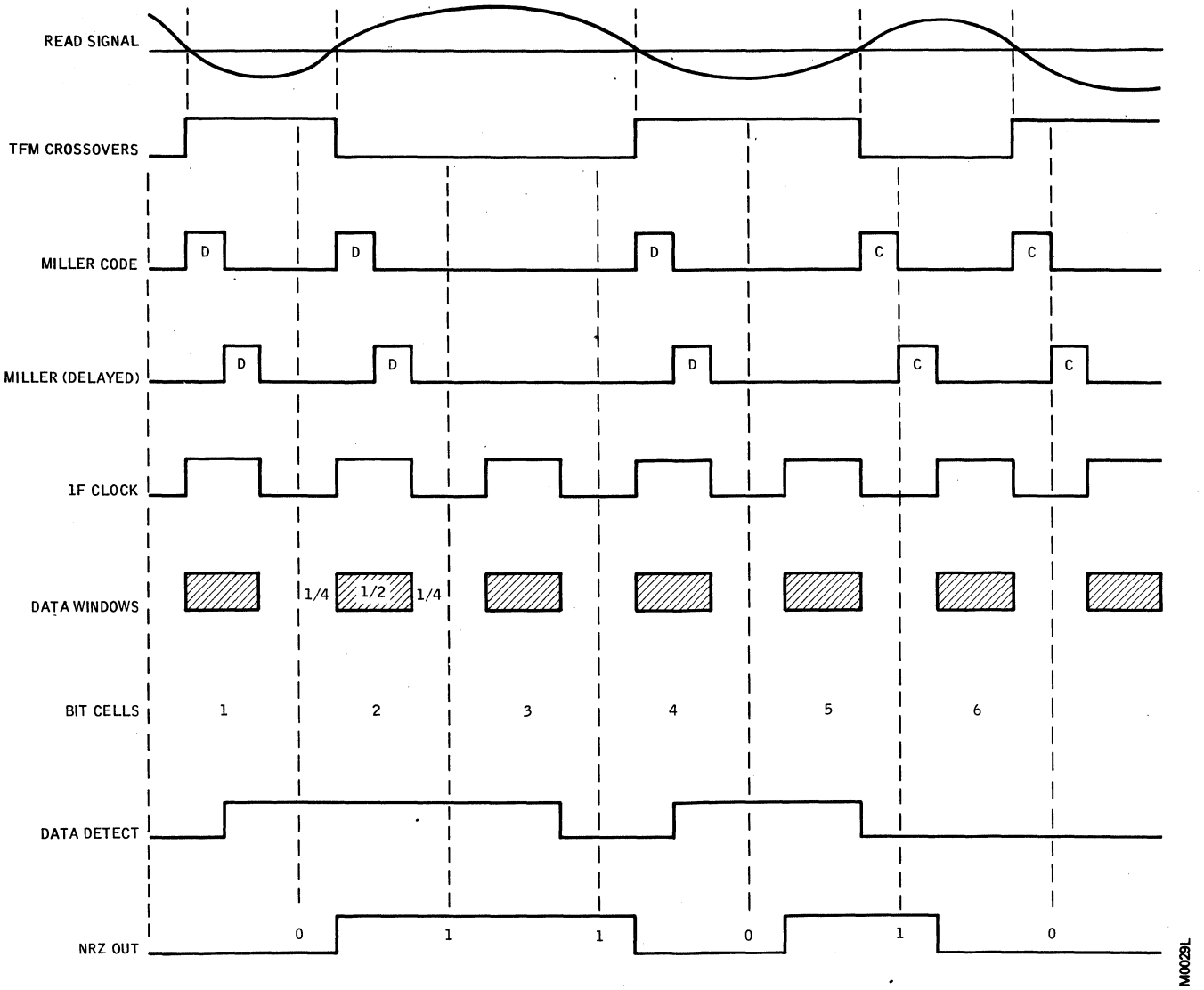


Figure 3-9. Read Data Detection

SECTION 4

OPTIONS

Several optional features are offered for the basic Marksman Disk Drives. A description of each option follows:

'DRIVER/RECEIVER II' INTERFACE PCB

Provides receivers and line drivers for all signals at the Basic Drive Control II pcb interface which shall connect directly to flat cable for off-drive control applications. This option is the minimal drive interface requirement to be used only when no other interface/control circuitry resides within the drive enclosure, including user defined circuitry. These receivers/drivers shall be located on a 4 by 16 inch circuit board adjacent to the basic control board. Included on this board shall be standard IC socket printed circuit patterns for user breadboarding. See Figure 4-1.

DC POWER SUPPLY

An optional DC Power Supply shall be provided. High-power units will be available with varying configurations for 100-240 volts, 50/60 cycle operation. Exact combinations not defined at this time.

ENCLOSURE AND AC DISTRIBUTION

An optional enclosure shall provide mounting for the sealed mechanical assembly, drive control board, interface board and power supply. Also included is the AC distribution located on the backpanel which receives AC power through a recessed connector, fuse, and line switch and supplies primary power to the power supply and spin motor assemblies. Moreover, this enclosure shall provide all necessary cooling required by the Marksman drive with options, reduce acoustic noise level below NC-55, increase immunity to undesired electromagnetic radiation and personnel static discharge susceptibility, and mounting for rack mount slides option.

These optional enclosures shall provide two mounting attitudes: 1) horizontal (spindle pulley down-circuit boards up, only), 2) vertical (side nearest spin motor rotated up, only).

An additional cosmetic cover option shall be provided for desk top configurations.

RACK MOUNT SLIDES

An optional set of slides shall mount between the optional enclosure and standard RETMA equipment racks and shall provide forward travel of the drive to extend clear of rack for ease of maintenance and installation. This option shall be available only for horizontal drive mounting.

V.D.E. SAFETY REQUIREMENTS

An optional feature for the Marksman disk drive shall provide power and equipment safety requirements of V.D.E. Specifically, the only affected areas shall be where U.L. approved hardware is in conflict with V.D.E. specifications.

COLOR OPTIONS

The front panel (part of the optional enclosure) and cosmetic cover shall be provided with standard industry colors. All such parts may be supplied with special color configurations as specified by the customer.

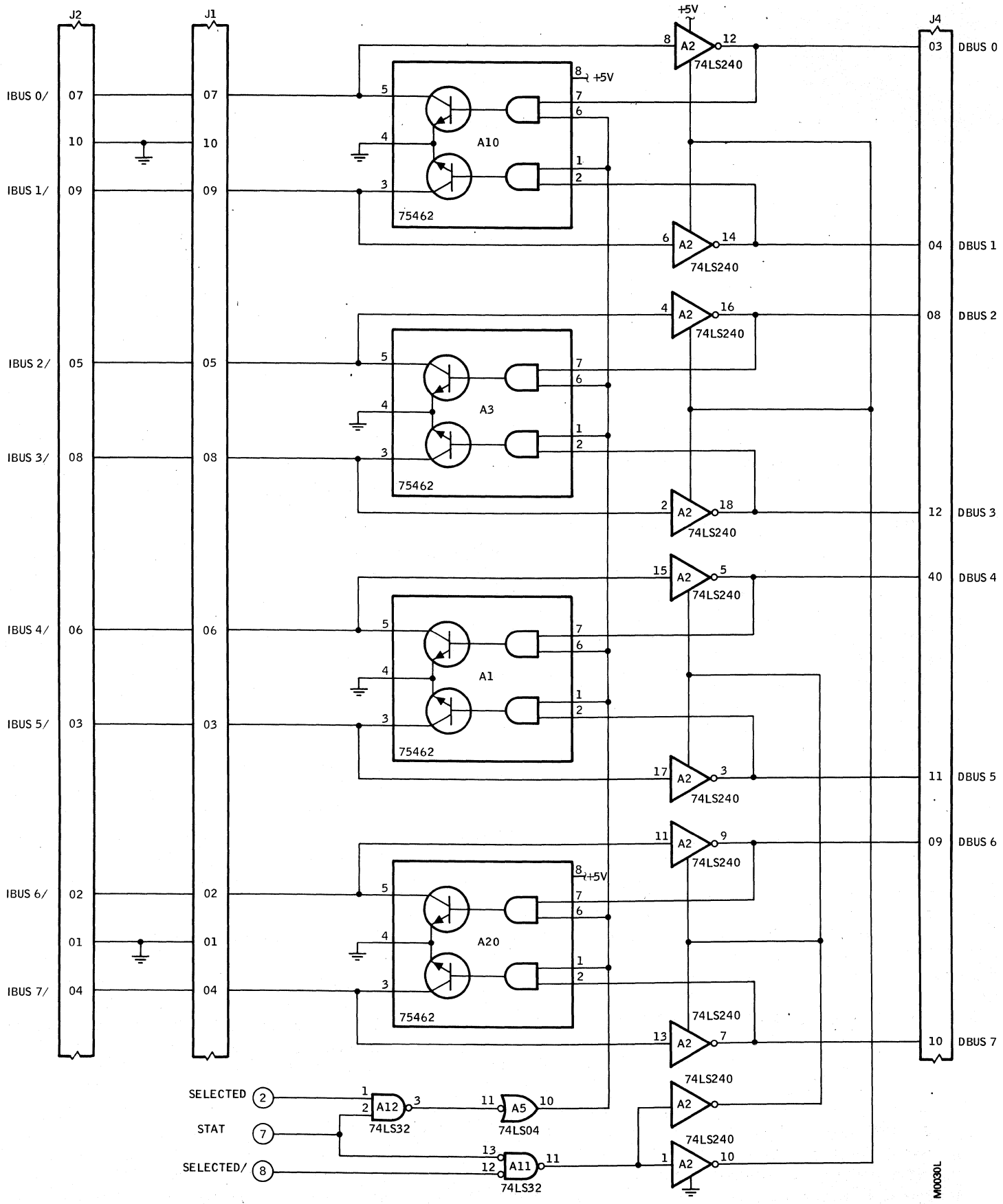


Figure 4-1. Driver/Receiver II Logic Diagram (Sheet 1)

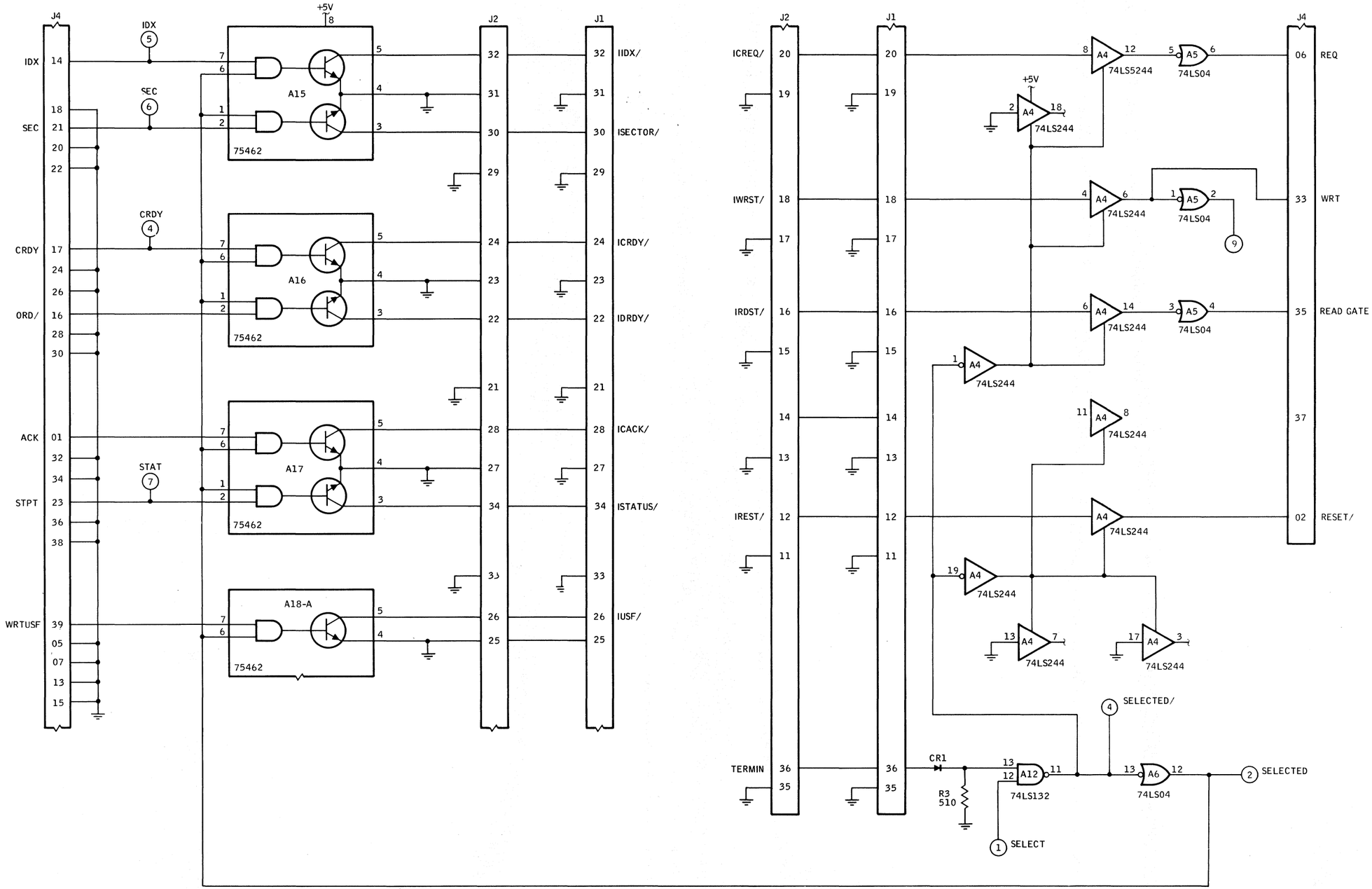


Figure 4-1. Driver/Receiver II Logic Diagram (Sheet 2)

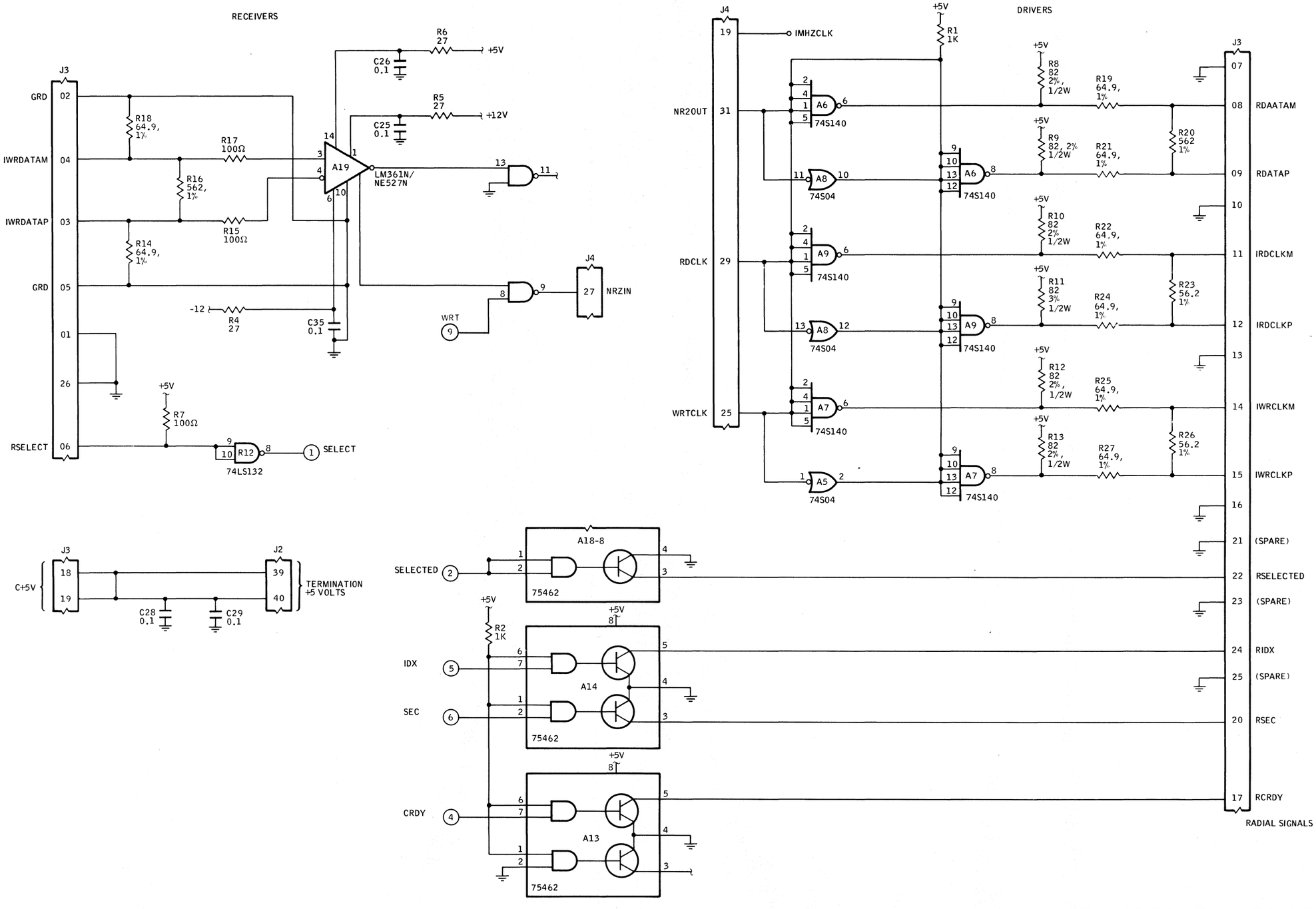


Figure 4-1. Driver/Receiver II Logic Diagram (Sheet 3)

POWER CONVERSION

A field conversion kit shall provide for modifying the operating line frequency only for the basic drive. This modification shall consist only of changing the spin motor pulley and belt.

CAUTION

The spin motor shall be available only for 115 Volt operation.

Should alternate line voltage operation be required, the Marksman drive must be configured with the optional high-power supply; this supply provides an auto transformer primary so that the input voltage range is tap selectable, whereas, the spin motor is connected to the 115V tap only. Future drives will be 100-240 Volt operation at 50/60 hertz.

INTERFACE CONVERSION

Field conversion kits shall provide for modifying the interface to any of the others available by exchanging the Interface Board(s) only if proper power supply is present.

ALTITUDE CONVERSION

A field conversion kit shall provide for modifying the optional enclosure assembly for drive operation at altitudes greater than 6,000 feet and less than 10,000 feet above sea level. Although the specified operating temperature range shall still apply at these higher altitudes, the noise level may increase to NC-60.

V.D.E. CONVERSION

A field conversion kit shall provide for modification of the Marksman drive to meet the power and equipment safety requirements of V.D.C. Specifically, the only affected areas shall be where U.L. approved hardware is in conflict with V.D.E. specifications.

SECTION 5

MAINTENANCE

The basic Marksman Disk Drives require no preventive maintenance. Corrective maintenance is limited to failure isolation and parts replacements.

BASIC DRIVE CONTROL II PCB REPLACEMENT

To remove and replace the Basic Drive Control II pcb, proceed as follows (see Figure 5-1).

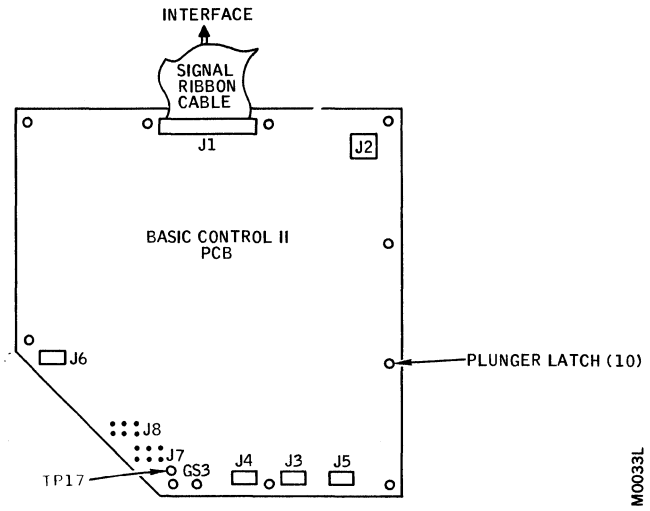


Figure 5-1. Basic Drive Control II Printed Circuit Board

1. Remove all power from the drive.
2. Make drive accessible (remove enclosure, etc.).
3. Disconnect signal ribbon cable (located at J1) from interface.
4. Disconnect wire from GS3.
5. Disconnect wire from TP17.
6. Disconnect plugs from jacks J2 through J8.
7. Pull up on the 10 plunger latches to release.
8. Lift pcb from drive.
9. To install new pcb, reverse procedures.

DRIVE MOTOR ASSEMBLY REPLACEMENT

To remove and replace the Drive Motor Assembly proceed as follows (see Figure 5-2).

1. Remove all power to the drive.
2. Make drive accessible (remove enclosure, etc.).
3. Disconnect system and power cables.
4. Remove complete drive, install accessory legs, and place on workbench.
5. Place drive on its side with drive motor up.
6. Remove belt cover.
7. Loosen the four drive motor mounting bolts.
8. Move drive motor to remove drive belt tension.
9. Remove drive belt and set aside.
10. Disconnect the drive motor and brake cables.
11. Loosen set screw holding drive motor pulley.
12. Remove pulley and set aside.

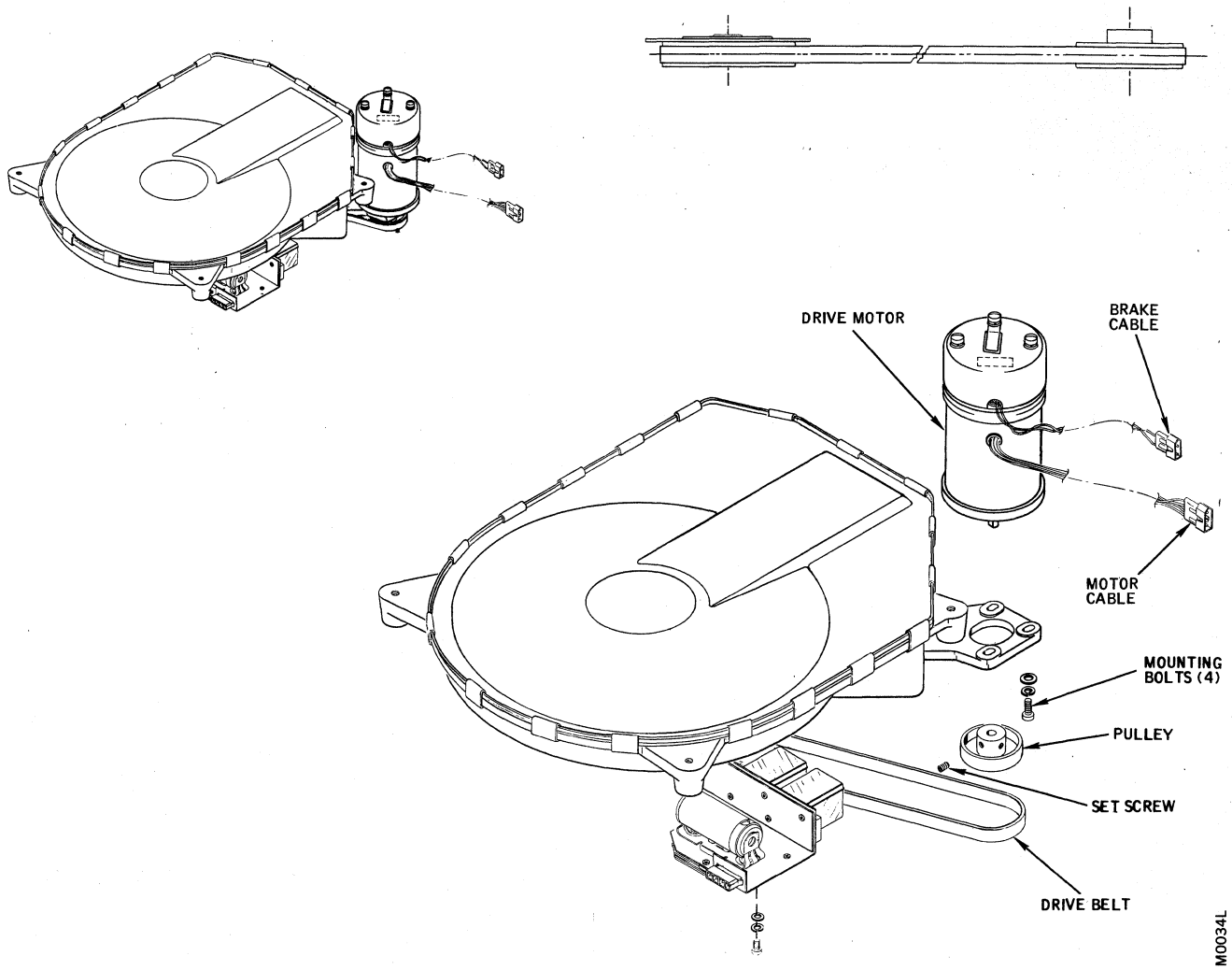


Figure 5-2. Drive Motor Assembly

13. Holding drive motor with one hand, remove the four mounting bolts.

14. Lift drive motor clear of drive.

Note

When installing the Drive Motor Assembly, the drive motor pulley must be aligned with the spindle pulley using a straight edge. The Drive Belt Tension procedure must be performed.

15. To install new drive motor, reverse procedure.

DRIVE MOTOR PULLEY REPLACEMENT

To remove and replace the Drive Motor Pulley, proceed as follows (see Figure 5-2):

1. Remove all power to the drive.
2. Make drive accessible (remove enclosure, etc.).
3. Disconnect all system and power cables.
4. Remove complete drive, install accessory legs, and place on workbench on its side with drive motor up.
5. Remove belt cover.
6. Loosen the four drive motor mounting bolts.
7. Move drive motor to remove drive belt tension.
8. Remove drive belt and set aside.
9. Loosen set screw holding drive motor pulley.
10. Remove drive motor pulley.

Note

Insure replacement drive motor pulley has the correct part number. New set screws should be used every time pulley is removed or replaced.

11. To install, reverse procedure and then perform Drive Belt Tension procedure.

BRAKE ASSEMBLY REPLACEMENT

To remove and replace the Brake Assembly, proceed as follows (see Figure 5-3):

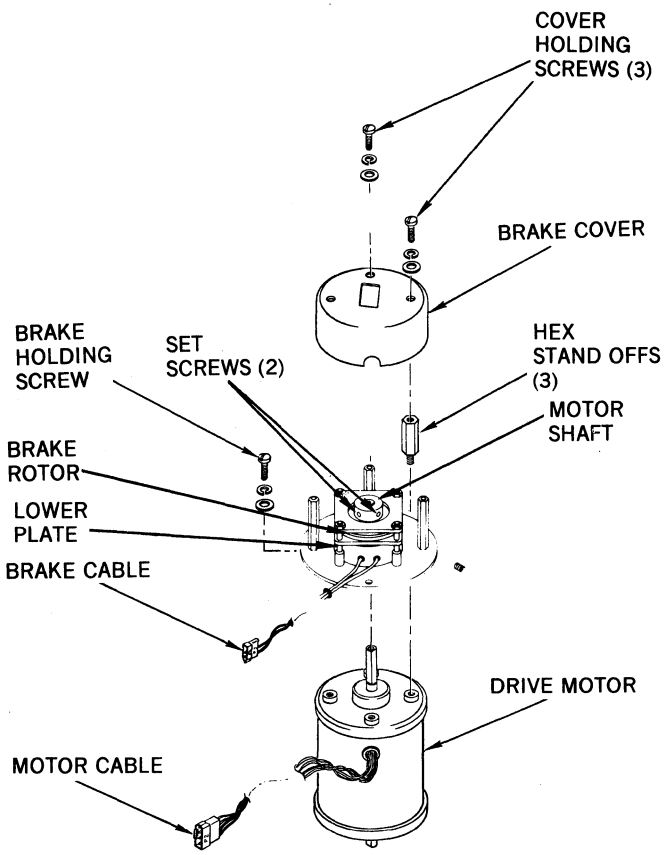


Figure 5-3. Brake Assembly

1. Remove all power to the drive.
2. Make drive accessible (remove enclosure, etc.).
3. Disconnect brake cable.
4. Remove the brake cover holding screws and lift off cover.

Note

Older drives have a grounding strap held by the center holding screw. The grounding strap and screw need not be installed on replacement brake.

5. Remove three hex standoffs holding brake to motor.
6. Remove brake holding screw (under cable).
7. Remove two set screws.
8. Lift off brake assembly.
9. To install new brake assembly, proceed as follows:
   a. Disconnect ac power plug, P1, from the relay assembly.
   b. Apply dc power to the drive.
   c. Position brake assembly onto drive motor.
   d. Install the three hex standoffs and torque to 19 inch-pounds.
   e. Install and tighten the brake holding screw with lock and flat washer.
   f. Jumper R38 to ground lug GS3 on pcb. (This releases the brake by energizing the run relay). See Figure 5-4.
   g. Insert two 0.0006 inch shims between lower plate and brake rotor (one shim on each side).

Note

The set screws must be turned alternately to prevent distorting or misalignment.

   h. Apply 90470-006 Loctite to the two set screws and install. Alternately turning set screws until snug.
   i. Torque set screws to 10 inch-pounds.
   j. Looking from brake assembly end, rotate lower spindle of motor counter-clockwise, verifying the brake is free-wheeling (no interference).
   k. Remove shims from brake assembly.
   l. Remove jumper from chip A1 on pcb.

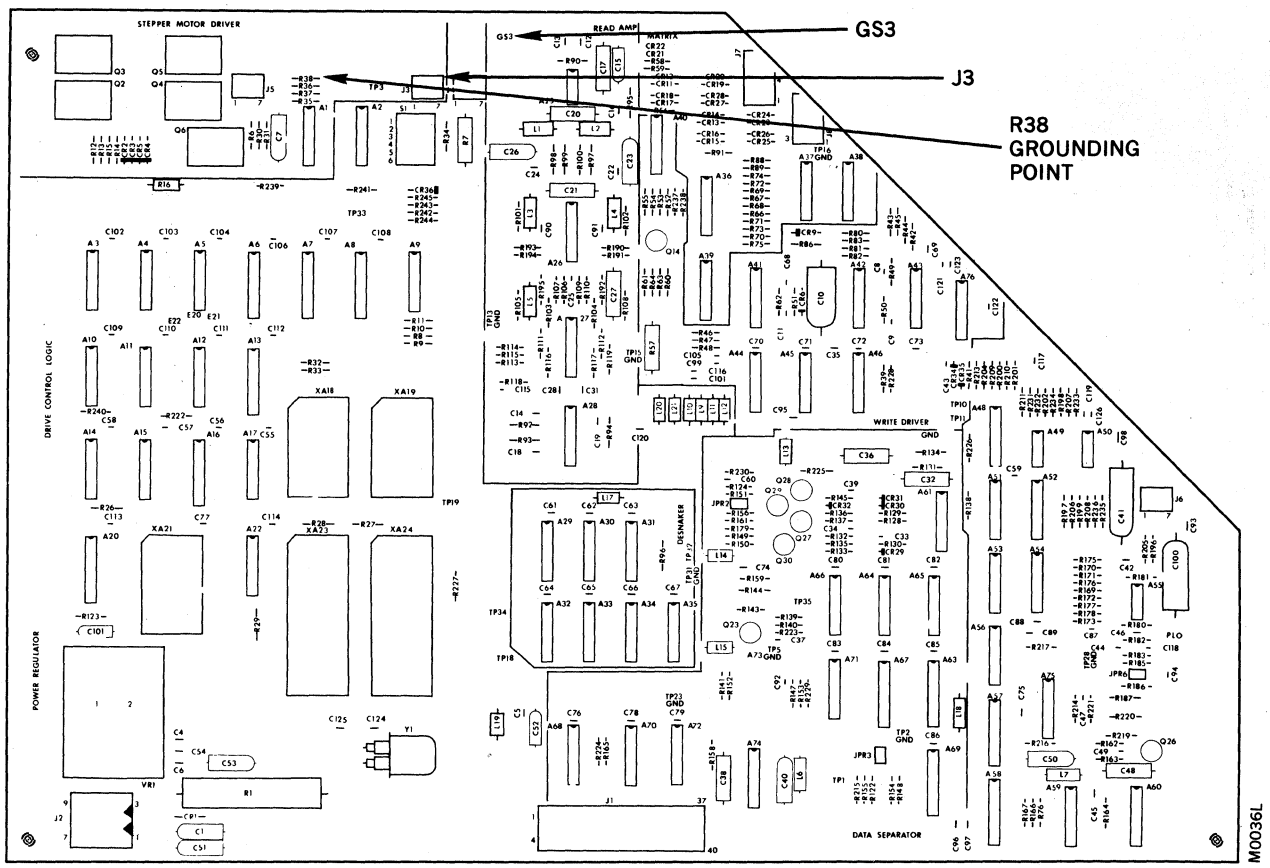


Figure 5-4. Brake Adjustment Jumper Location

m. Replace brake cover and secure with the three cover holding screws.

n. Remove dc power from drive.

o. Replace brake cable.

p. Replace ac power plug, P1, on relay assembly.

INDEX AND CLOCK TRANSDUCER REPLACEMENT

WARNING

It may be necessary to reformat the disk when the Index and Clock Transducer is replaced if the recommended disk format has not been followed.

To remove and replace the Index and Clock Transducer, proceed as follows (see Figure 5-5):

1. Remove all power to the drive.
2. Make drive accessible (remove enclosure, etc.).
3. Disconnect system and power cables.
4. Remove complete drive, install accessory legs, and place drive on workbench on its side with drive motor down.
5. Cut tywraps holding transducer cable.
6. Disconnect jack, J6, from Basic Drive Control II pcb.
7. Remove belt cover.
8. Remove holding screw and slide transducer off timing wheel.

WARNING

When installing new transducer take care not to hit and damage timing wheel.

9. To install new transducer, proceed as follows:

   a. Slide transducer toward center of spindle until pivot dowel pin touches back of pivot slot.

Note

Ensure timing wheel is in sensing slot.

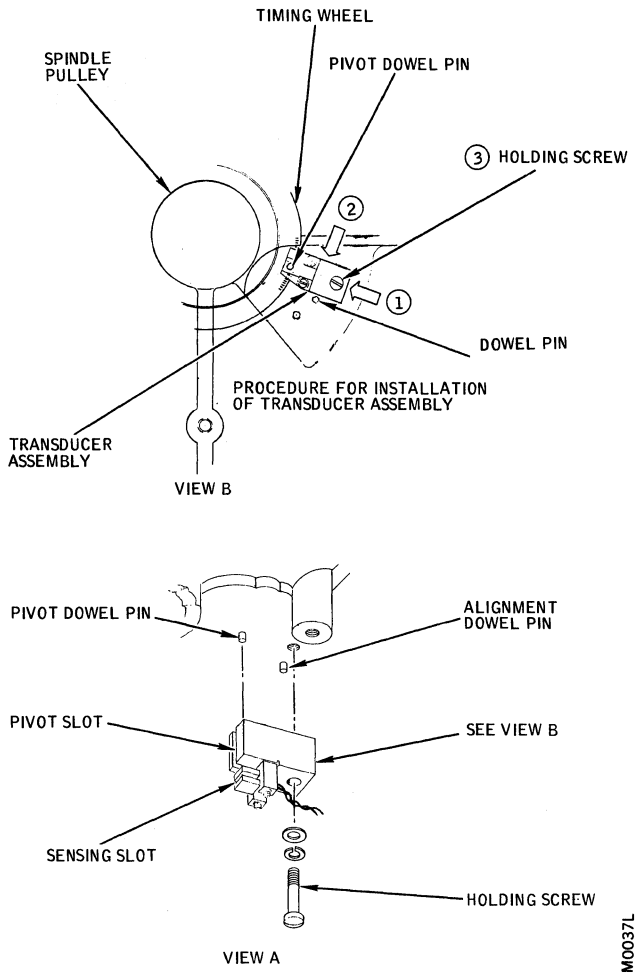


Figure 5-5. Index/Clock Transducer Assembly

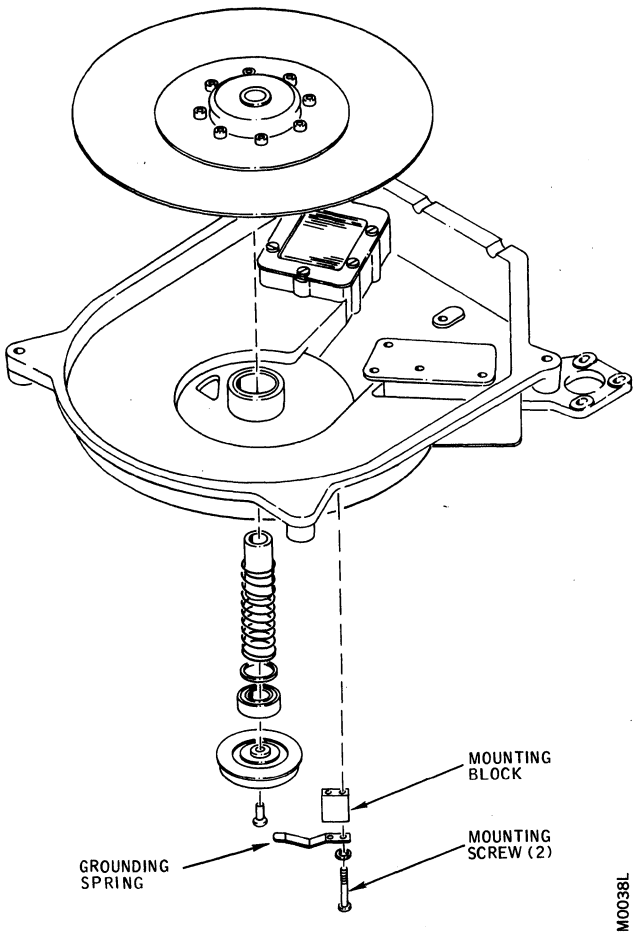


Figure 5-6. Grounding Spring Assembly

b. Holding transducer against pivot dowel pin, rotate clockwise against alighment dowel pin.

c. Tighten holding screw.

d. Connect jack J6, on Basic Drive Control II pcb.

e. Dress cable away from spindle drive belt and install new tywraps.

f. Remove accessory legs and install drive in system.

g. Connect all system and power cables.

h. Apply ac and dc power to drive and verify drive performs a sequence-up, the start relay drops out, and drive remains in the ready condition.

SPINDLE GROUNDING SPRING

To remove and replace the spindle grounding spring, proceed as follows (see Figure 5-6):

1. Remove all power to the drive.
2. Make drive accessible (remove enclosures, etc.).
3. Disconnect system and power cables.
4. Remove complete drive, install accessory legs, and place on workbench on its side with drive motor down.
5. Remove belt cover.
6. Remove two screws holding the spindle grounding spring and mounting block to casting.

CAUTION

Grounding brush JS spring loaded. Do not remove.

7. Place new grounding brush on mounting block and screw both to casting using the two holding screws.

8. Insure static resistance between spindle grounding brush and spring is less than 0.5 ohms.

9. Reinstall drive.

10. Connect all system and power cables.

11. Replace enclosure, etc.

12. Apply power to drive.

DRIVE BELT REPLACEMENT

Note

Before replacing Drive Belt, insure replacement belt is the correct part number.

To remove and replace Drive Belt, proceed as follows (see Figure 5-2):

1. Remove all power to the drive.

2. Make drive accessible (remove enclosure, etc.).

3. Disconnect system and power cables.

4. Remove complete drive, install accessory legs, and place on its side with drive motor up.

5. Remove belt cover.

6. Loosen (do not remove) the four drive motor holding bolts.

7. Move motor toward spindle to loosen drive belt.

8. Remove drive belt.

9. Place replacement belt on the spindle and drive motor pulleys.

10. Move drive motor away from spindle until correct belt tension is achieved as follows (see Figure 5-7):

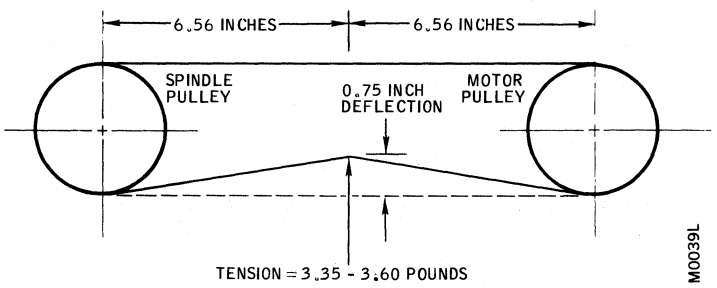


Figure 5-7. Drive Belt Tension

a. Using the Belt Tensionmeter (special tool), apply pressure at mid-point of drive belt.

b. Move drive motor until a belt deflection of 0.75 inch causes the tensionmeter to register between 3.35 and 3.60 pound.

c. Tighten drive motor holding bolts.

RELAY CONTROL ASSEMBLY AND COMPONENT REPLACEMENT

To remove and replace the Relay Control Assembly, proceed as followed (see Figure 5-8).

1. Remove all power to the drive.

2. Make drive accessible (remove enclosure, etc.).

3. Disconnect all system and power cables.

4. Remove complete drive, install accessory legs, and place on workbench on its side with drive motor up.

5. Disconnect plugs P1, P2, and P9 and jack J3.

6. Cut tywraps securing cable harness.

7. Remove two assembly holding screws and place relay assembly on workbench.

8. Replace components as required.

CAUTION

When placing relay assembly on base plate, do not pinch wire between assembly and plate.

9. Reinstall relay assembly by reversing this procedure.

SEALED DRIVE ASSEMBLY REPLACEMENT

To remove and replace the Sealed Drive Assembly, proceed as follows (see Figure 5-2).

1. Remove all power to the drive.

2. Make drive accessible (remove enclosure, etc.).

3. Disconnect all system and power cables.

4. Remove complete drive, install accessory legs and set on workbench.

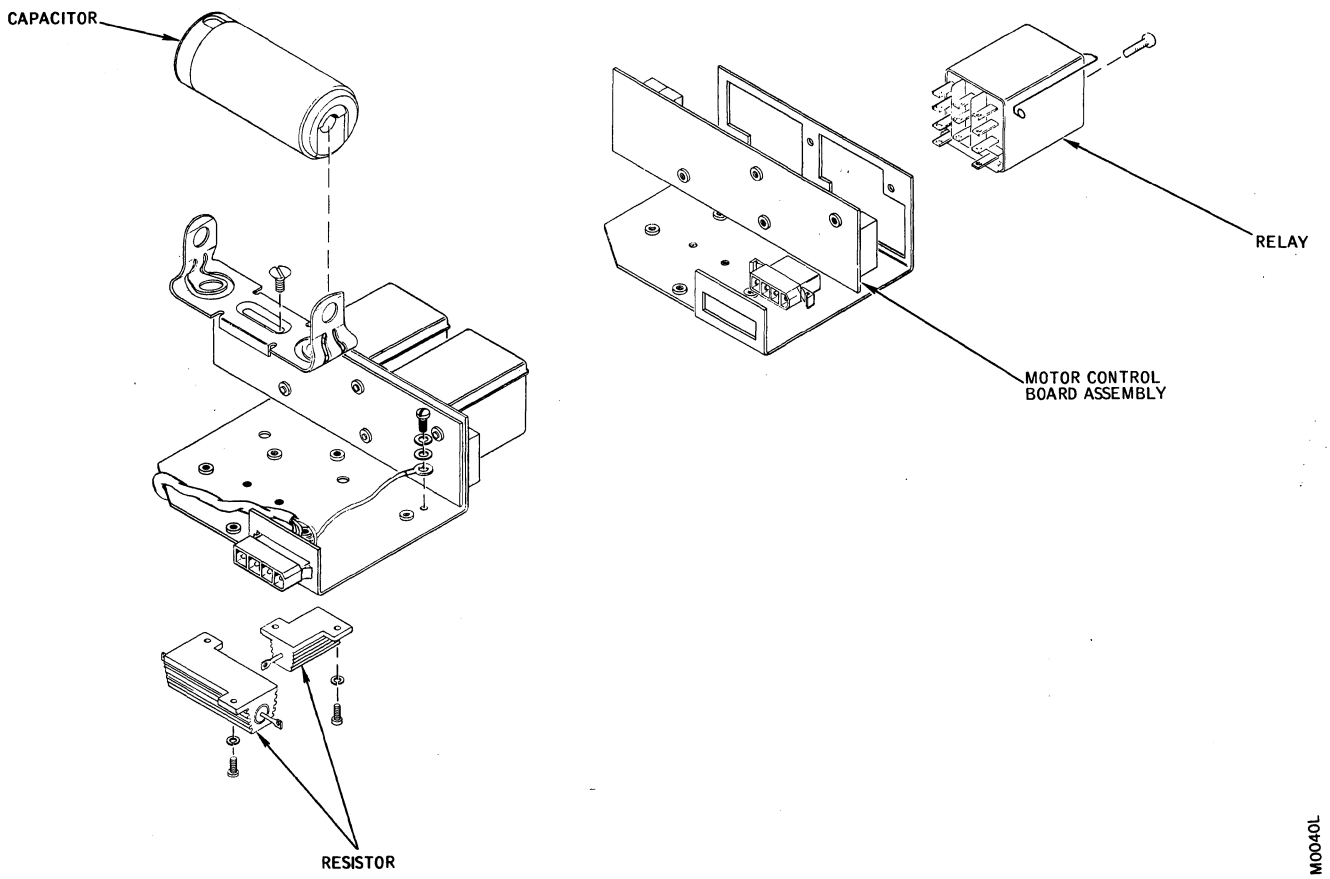


Figure 5-8. Control Relay Assembly

5. Perform steps 3 through 7 of Basic Drive Control II pcb, Replacement procedure.

6. Remove four pcb support holding screws.

7. Lift off support and set aside.

8. Remove drive motor by performing steps 5 through 14 of Drive Motor Replacement procedure.

9. Remove relay control assembly by performing steps 5 through 7 of Relay Control Assembly and Component Replacement procedure.

10. Remove accessory legs from sealed unit and install on replacement.

11. Install relay control assembly using the Relay Control Assembly and Component Replacement procedure observing caution.

12. Dress cables along casting and tywrap.

13. Install drive motor using the Drive Motor Replacement procedure, observing notes.

14. Place sealed unit on accessory legs and install pcb support and Basic Drive Control II pcb.

15. Remove accessory legs and install drive in system.

16. Test drive with exerciser.

17. Test drive on system.

MAINTENANCE AIDS

Table 5-1 contains information intended as a trouble-shooting guide for maintenance personnel involved in maintaining the basic disk drives.

Disk drive malfunctions are divided into five basic subsections that describe the majority of disk drive malfunctions.

- Power-Sequencing Malfunctions
- Read/Write Malfunctions
- Spindle Malfunctions
- Interface Malfunctions
- Positioning Malfunctions

Table 5-1. Troubleshooting Guide

POWER-SEQUENCING MALFUNCTIONS

When the power and sequencing subsystems fail to function properly, the malfunction can be identified quickly by systematic symptom analysis. Listed below are typical symptoms and probable causes for each:

Symptom	Probable Cause
Unable to initiate	• No ac input power
Motor off, no status	• Bad crystal oscillator • Defective dc power supply • Defective 6802 (A23)
Power-up, drive	• Line fuses open • Connector P2
Unable to initiate power-up, drive motor off, spin bit in status	• Connector J3 • Defective relay K1 or K2 • No +24 volts to pcb • Defective drive motor • Defective brake coil • No stepper ground to J2
Unable to initiate power-up, drive motor starts-stops, spin bit in status	• Drive belt broken or slipping • Connector J6 • Defective Index Transducer • Defective 8253 (A21) • Defective pcb • Defective drive motor
Over heating Drive Motor	• Start relay (K2) not dropping out • Defective motor • Defective brake • Wrong ac line voltage • Defective 6802 (A23) • Defective PROM (A18)

READ/WRITE MALFUNCTIONS

Symptom	Probable Cause
Read errors, all head	• Incorrect write clock phasing • Spindle grounding strap not making contact • Dc voltage at incorrect levels • Defective line receiver • Head positioned at wrong cylinder • Head cables swapped • Loose head connectors J7, J8 • Defective Basic Drive Control II pcb • Carriage not grounded • Defective 6802 (A23) • Defective 6821 (A24)
Intermittent read errors on a particular head or heads	• Loose connector J7 or J8 • Incorrect dc voltage level • Defective Head • Defective pcb • Incorrect write clock phasing
Cannot write on a particular head	• Write Protect switch in write protect position • Defective head • Loose connector J7 or J8
Cannot write, all heads	• Bad dc voltage (+12V, −12V) • Dc Unsafe Logic detected defective dc voltage • More than one head selected (Write Unsafe) • Sector switches set wrong

Table 5-1. Troubleshooting Guide (continued)

SPINDLE MALFUNCTIONS	
Symptom	**Probable Cause**
Disk does not turn, no speed	• Drive belt off or slipping • Defective drive motor • Defective pcb • Defective brake
Audible Noise	• Defective drive motor • Drive belt damaged • Drive motor start winding not dropping out (K2) • Head crash • Defective brake • Vibrating spindle ground strap • Defective spindle bearing

INTERFACE MALFUNCTIONS

Careful inspection of the interconnecting cables, receiver and driver modules, and logic modules necessary to perform specific interface functions will usually result in finding the cause of the problem.

If the Model T2004 Disk Drive Exerciser is available, it can be used to determine whether interface malfunctions are internal or external to the Basic Disk Drive.

Symptom	Probable Cause
Unable to respond to command (external)	• Loose cable connectors • Defective cabling • Defective interface logic
Unable to respond to command (internal)	• Defective microprocessor system (6802 (A23, 6821 (A24), 2716 (A18, A19)) • Defective Basic Drive Control II pcb • No ac to drive • Defective Dc voltage
POSITIONING MALFUNCTIONS	
Symptom	**Probable Cause**
No first seek on power-up	• No stepper (+24) ground • Loose connectors J3, J5 • Spindle speed to slow • Defective microporcessor system (6802, 6821, 2716, 8253)
Seek to cylinder inoperative	• Loose connector J1 • External interface malfunction • Defective microprocessor system (6802, 6821, 2716)

SECTION 6

ILLUSTRATED PARTS BREAKDOWN

This section contains an illustrated parts breakdown that lists, describes, and illustrates all replaceable parts for the Marksman Disk Drive Unit.

PURPOSE

The purpose of this section is to provide a listing of all items necessary to support the maintenance and overhaul effort for the Marksman Disk Drive. This section is intended for use in requisitioning, storing, issuing and identifying replacement parts. The section also serves to illustrate assembly and disassembly relationships.

SECTION USAGE

When the section or major assembly of the equipment in which a part is used is known, the part number may be located in the following manner:

- Turn to the ILLUSTRATIONS and find the page number for the major assembly or system in which the part is used.
- Locate the part and its item number on the illustration.
- Find the item in the Group Assembly Parts List to determine its part number and description.

GROUP ASSEMBLY PARTS LIST

The Group Assembly Parts List consists of a complete breakdown of the Marksman Disk Drive into subassemblies and detailed parts. Each assembly is listed in its order of disassembly and is followed immediately by its component parts indented to show their relationship to the assembly. Figures 6-1 through 6-4 illustrate the component parts of the disk drive and their physical relationships. Each illustration has been assigned a figure number that relates to its associated Group Assembly Parts List. The item number is shown on the illustration to portray its physical location within the assembly. The Group Assembly Parts List is divided into five columns of information as follows:

- Figure and Item Number
- Part Number
- Description
- Quantity Per Assembly
- Usage Code

Figure and Item Number

The figure number relates the parts list to its associated illustration. The item number assigned to each part is shown on the illustration to depict physical location.

Part Number

The Part Number column lists part numbers of all parts that are replaceable in the unit. Items without part numbers are listed as No Number. The notation XXX, when used with a part number indicates hardware length determined at installation.

Description

Description includes designated and descriptive information necessary to define the items adequately. Entries are indented to indicate their relationship to the next higher assembly. The subheading Attaching Parts within this column lists those parts used for attaching the immediately preceding item unless otherwise indicated.

The symbol ———*——— signifies the end of the attaching parts for the preceding item(s). The letters NHA refer to the Next Higher Assembly. U/O indicates Used On, NFS indicates Not Furnished Separately, and N/I indicates that the item is Not Illustrated.

Quantity Per Assembly

The Quantity Per Assembly column contains the number of parts required for each assembly or subassembly. The letters A/R denote that the selection or parts should be made As Required. REF refers to an assembly or item

that is shown completely assembled in a preceding illustration or the item is listed for reference only.

Usage Code

The Usage Code column lists part variations within different models, assemblies, or subassemblies of the same equipment. In cases where the column is blank, the part listed will apply to all models, assemblies, or subassemblies listed in this publication.

Items designated for more than one configuration are coded for usability. Codes used in this publication are shown in Table 6-1.

PURCHASED PARTS

Many parts used in the Marksman Disk Drive may be obtained directly from a vendor.

Purchased parts will also be supplied on receipt of an order specifying the part number and description as shown in this section. The inclusion of the model designation (such as Model Marksman) and the figure and item number for each part ordered will ensure positive identification of parts.

ACCESSORIES

The following accessories are available for use with the Marksman Disk Drive:

Board Assy, Driver/Receiver	21081-001
Kit, Rack Mount	20478-001
Kit, Desk Top	20480-001
Board Assy, Terminator	20910-001
Power Supply	20312-001
Exerciser Assembly T-2004	20424-001
Cable Assy, Exerciser, Power	21929-001
Kit, System Integration	21490-001
Kit, Tool, Site	13306-001
Kit, Tool, Regional	13307-001
Cord, Power, 125V	19224-001
Cord, Power, 250V	19229-001
Transformer Harness	22306-001

TABLE 6-1. USAGE CODES

Model	Serial No.	Usage Code
20MB, 115V, 60 Hz	All	A
20MB, 115V, 50 Hz	All	B
10MB, 115V, 60 Hz	All	C
10MB, 115V, 50 Hz	All	D
20MB, 220V, 50 Hz	All	E
10MB, 220V, 50 Hz	All	F

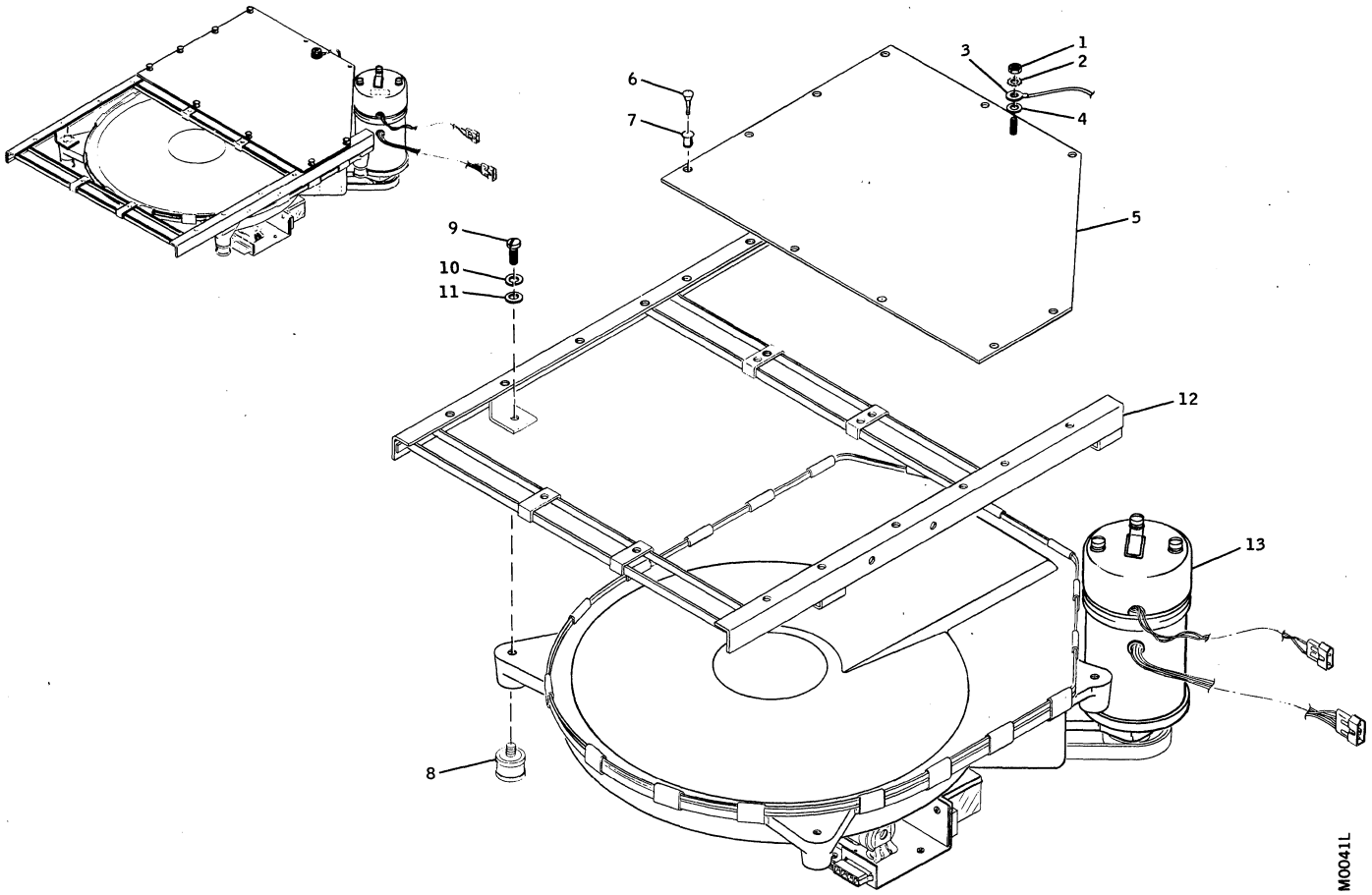


Figure 6-1. Marksman Disk Drive Unit

FIGURE ITEM NO.	PART NUMBER	DESCRIPTION	QTY PER ASSY	USAGE CODE
1-	20350-001	Disk Drive Unit, Marksman, 20MB, 115V, 60 Hz	REF	A
	20350-002	Disk Drive Unit, Marksman, 20MB, 115V, 50 Hz	REF	B
	20350-003	Disk Drive Unit, Marksman, 10MB, 115V, 60 Hz	REF	C
	20350-004	Disk Drive Unit, Marksman, 10MB, 115V, 50 Hz	REF	D
	20350-005	Disk Drive Unit, Marksman, 20MB, 220V, 50 Hz	REF	E
	20350-006	Disk Drive Unit, Marksman, 10MB, 220V, 50 Hz	REF	F
-1	90487-004	. Nut, Plain Hex	1	
-2	14907-006	. Lockwasher, Ext. Tooth	1	
-3	22051-001	. Ground Strap Assembly	1	
-4	90488-004	. Washer, Flat	1	
-5	21044-001	. Board Assy, Basic Control II, VR106 (Refer to Figure 6-2 for Components)	1	
		Attaching Parts		
-6	95495-002	. Latch, Plunger	8	
-7	95496-003	. Latch, Grommet	8	
		---*---		
-8	21348-001	. Mount, Shock	4	
		Attaching Parts		
-9	90448-055	. Screw, Cap, Hex Hd, 1/4-20 x 1/2 Lg	4	
-10	90489-006	. Lockwasher, Split	3	
-11	90488-008	. Washer, Flat	4	
	14907-014	. Lockwasher, Ext. Tooth, N/I	1	
		---*---		
-12	21151-001	. Support, Board, Basic Control	1	
-13	20351-001	. Drive Assy, Wired (Refer to Figure 6-3 for Components)	1	A
	20351-002	. Drive Assy, Wired (Refer to Figure 6-3 for Components)	1	B
	20351-003	. Drive Assy, Wired (Refer to Figure 6-3 for Components)	1	C
	20351-004	. Drive Assy, Wired (Refer to Figure 6-3 for Components)	1	D

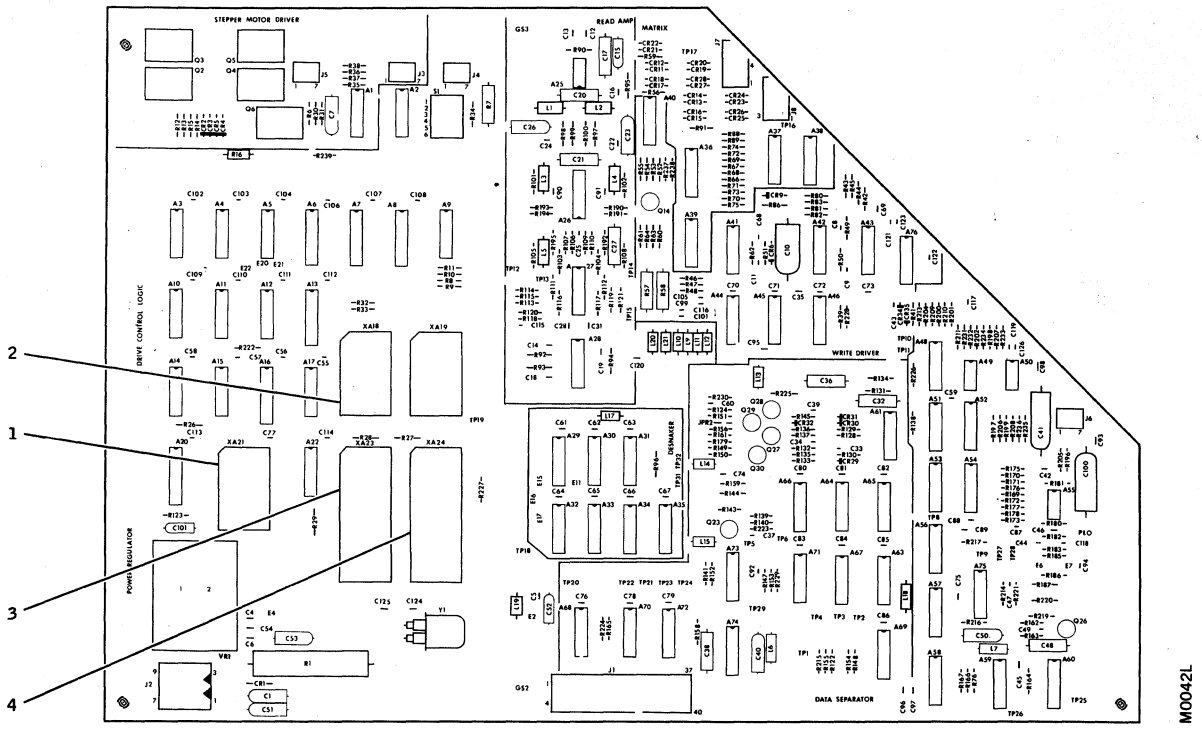


Figure 6-2. Basic Control II Board Assembly VR106

FIGURE ITEM NO.	PART NUMBER	DESCRIPTION	QTY PER ASSY	USAGE CODE
2-	21044-001	Board Assy, Basic Control II VR106 (See Figure 6-1 for NHA)	REF	
-1	19493-001	. IC, Programmable Interval Timer, XA21	1	
-2	21836-002	. IC, Memory, E Promimos, 16K, XA18	1	
-3	20963-001	. IC, Microprocessor, Control Unit w/Clock, XA23	1	
-4	20964-001	. IC, Mos, Peripheral Interface Adapter, XA24	1	

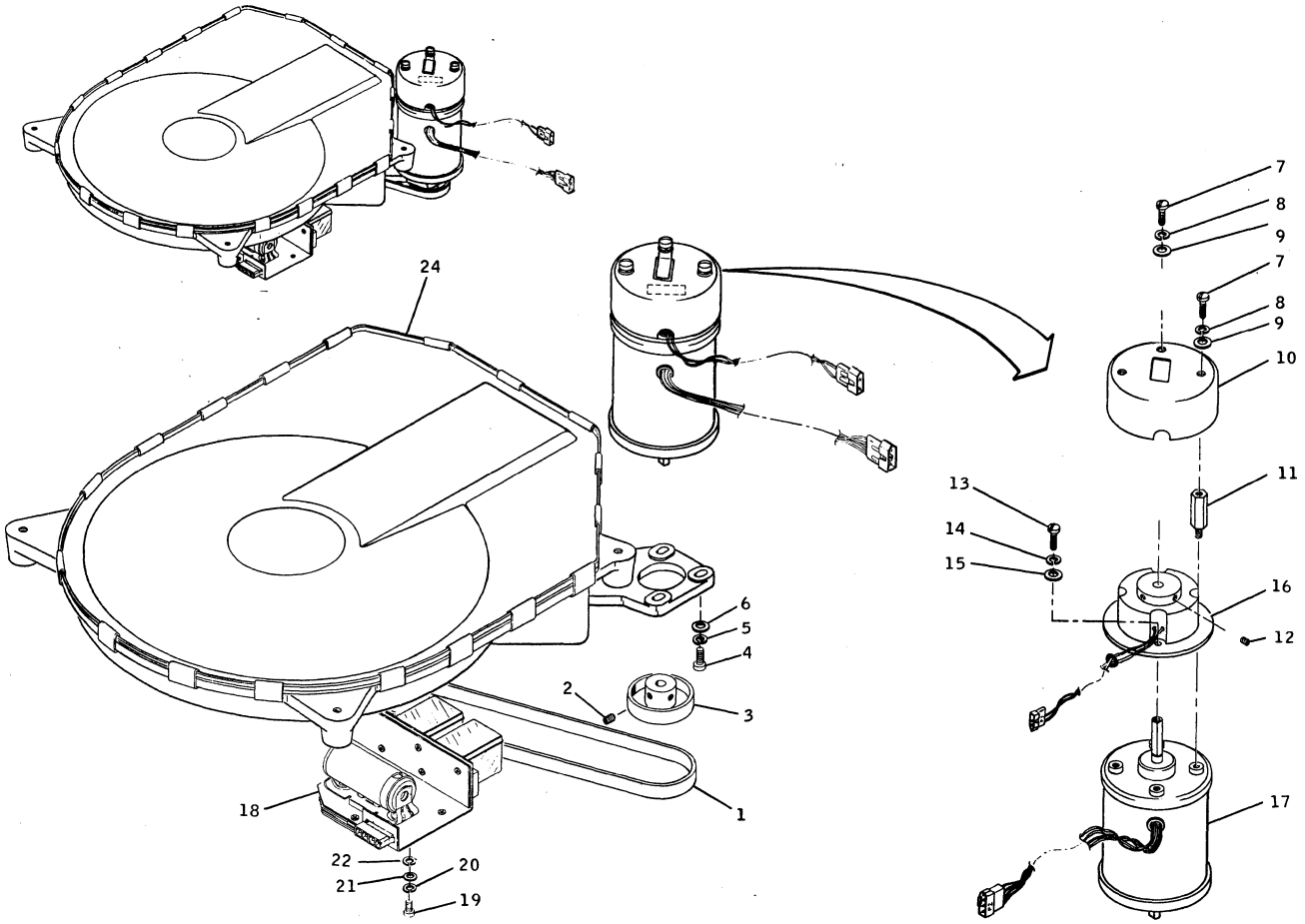


Figure 6-3. Wired Drive Assembly

FIGURE ITEM NO.	PART NUMBER	DESCRIPTION	QTY PER ASSY	USAGE CODE
3-	20351-001	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	A
	20351-002	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	B
	20351-003	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	C
	20351-004	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	D
	20351-005	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	E
	20351-006	Drive Assy, Wired (See Figure 6-1 for NHA)	REF	F
-1	95304-018	. Belt, Drive, Flat, 60 Hz	1	A,C
	95304-019	. Belt, Drive, Flat, 50 Hz	1	B,D-F
-2	90482-035	. Setscrew, Cup Point, 10-32	2	
-3	17748-006	. Pulley, Motor, 60 Hz	1	A,C
	17748-005	. Pulley, Motor, 50 Hz	1	B,D-F
	21608-001	. Motor/Brake Assy, Disk Drive	1	A-D
	21608-002	. Motor/Brake Assy, Disk Drive	1	E,F
		Attaching Parts		
-4	90448-036	. Screw, Pan Hd, 8-32 x 7/8 Lg	4	
-5	90489-004	. Lockwasher, Split	4	
-6	90048-070	. Washer, Flat	4	
		---*---		
-7	90448-031	. . Screw, Pan Hd, 8-32 x 1/2 Lg	3	
-8	90489-004	. . Lockwasher, Split	3	
-9	90488-005	. . Washer, Flat	3	
-10	21319-001	. . Guard, Motor Brake	1	
-11	21478-002	. . Standoff, Hex	3	
-12	90482-017	. . Setscrew, Cup Point	2	
-13	90448-031	. . Screw, Pan Hd, 8-32 x 1/2 Lg	1	
-14	90489-004	. . Lockwasher, Split	1	

FIGURE ITEM NO.	PART NUMBER	DESCRIPTION	QTY PER ASSY	USAGE CODE
3-15	90488-005	. . Washer, Flat	1	
-16	21533-001	. . Brake, Disk Drive	1	
-17	21532-001	. . Motor, Disk Drive	1	A-D
-18	21532-002	. . Motor, Disk Drive	1	E,F
-19	20420-001	. Relay Assy, Control (Refer to Figure 6-4 for Components)	1	
		Attaching Parts		
-20	90448-044	. Screw, Pan Gd, 10-32 x 1/2 Lg	2	
-21	90489-005	. Lockwasher, Split	2	
-22	90488-006	. Washer, Flat	2	
		---*---		
-23	90774-002	. Clamp, Cable, Nylon	1	
-24	20352-020	. Drive Assy, Sealed, 20MB	1	A,B,E
	20352-010	. Drive Assy, Sealed, 10MB	1	C,D,F
	21097-001	. . Spring, Grounding, Spindle, N/I	1	
	21084-001	. . Transducer Assy, Dual Optical, N/I	1	

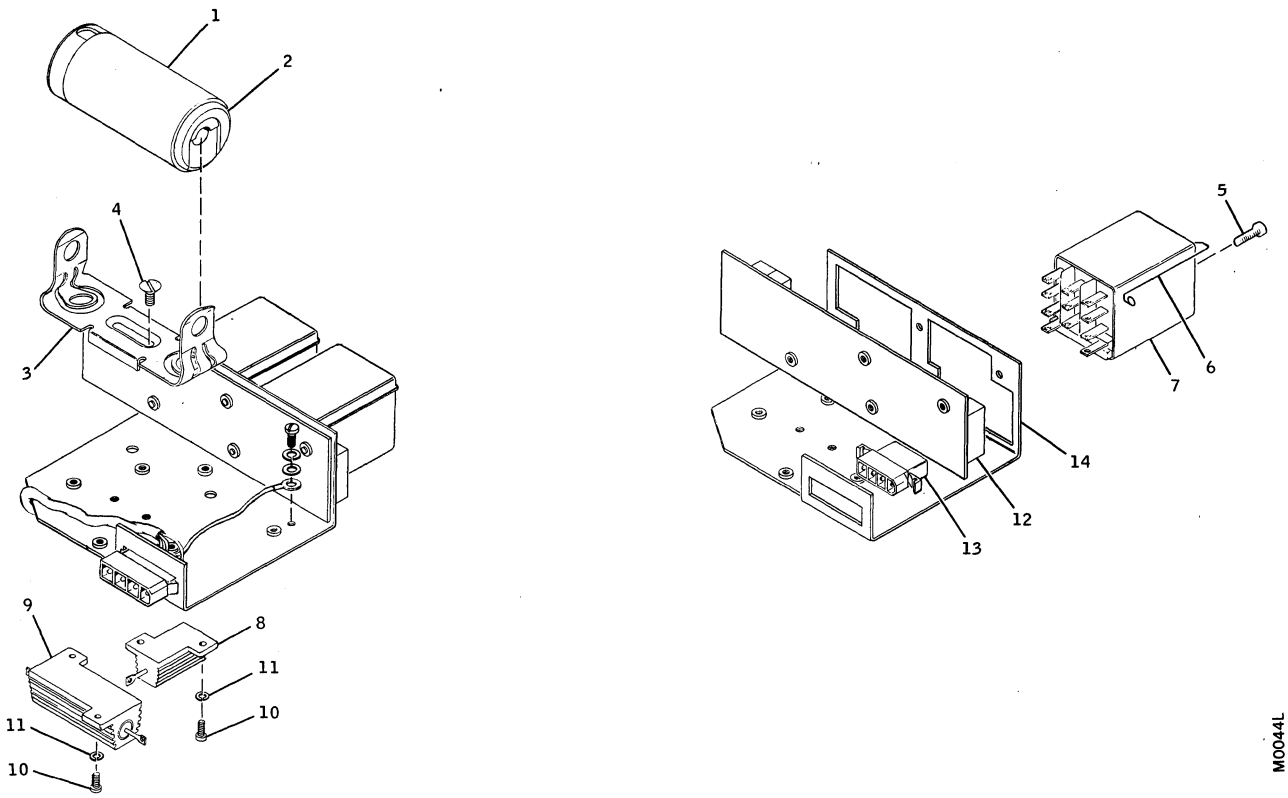


Figure 6-4. Control Relay Assembly

FIGURE ITEM NO.	PART NUMBER	DESCRIPTION	QTY PER ASSY	USAGE CODE
4-	20420-001	Relay Assy, Control (See Figure 6-3 for NHA)	REF	
-1	13744-008	. Capacitor, Motor Start, 108-130 Mf, C1	1	
-2	13745-003	. Cap, Terminal, Capacitor	1	
-3	17465-001	. Clamp, Capacitor	1	
		Attaching Parts		
-4	90484-051	. Screw, Flat Hd, 10-32 x 1/2 Lg	2	
		---*---		
-5	90448-020	. Screw, Pan Hd. 6-32 x 1/2 Lg	4	
-6	90411-001	. Retainer, Relay	2	
-7	90381-001	. Relay, General Purpose, 3PDT, K1, 2	2	
-8	94041-022	. Resistor, Wirewound, 30 ohm, 25W, R3	1	
-9	17883-002	. Resistor, Wirewound, 20 ohm, 50W, R1, 2	2	
		Attaching Parts (above two items)		
-10	90448-008	. Screw, Pan Hd, 4-40 x 5/16 Lg	6	
-11	90489-002	. Lockwasher, Split	6	
		---*---		
-12	21366-001	. Board Assy, Motor Control	1	
-13	13953-004	. Connector, 4 pin, J1	1	
	13954-004	. Connector, Receptacle, P2, N/I	1	
	90606-003	. Connector, Receptacle, P3, N/I	1	
-14	21333-001	. Bracket, Relay Control	1	

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