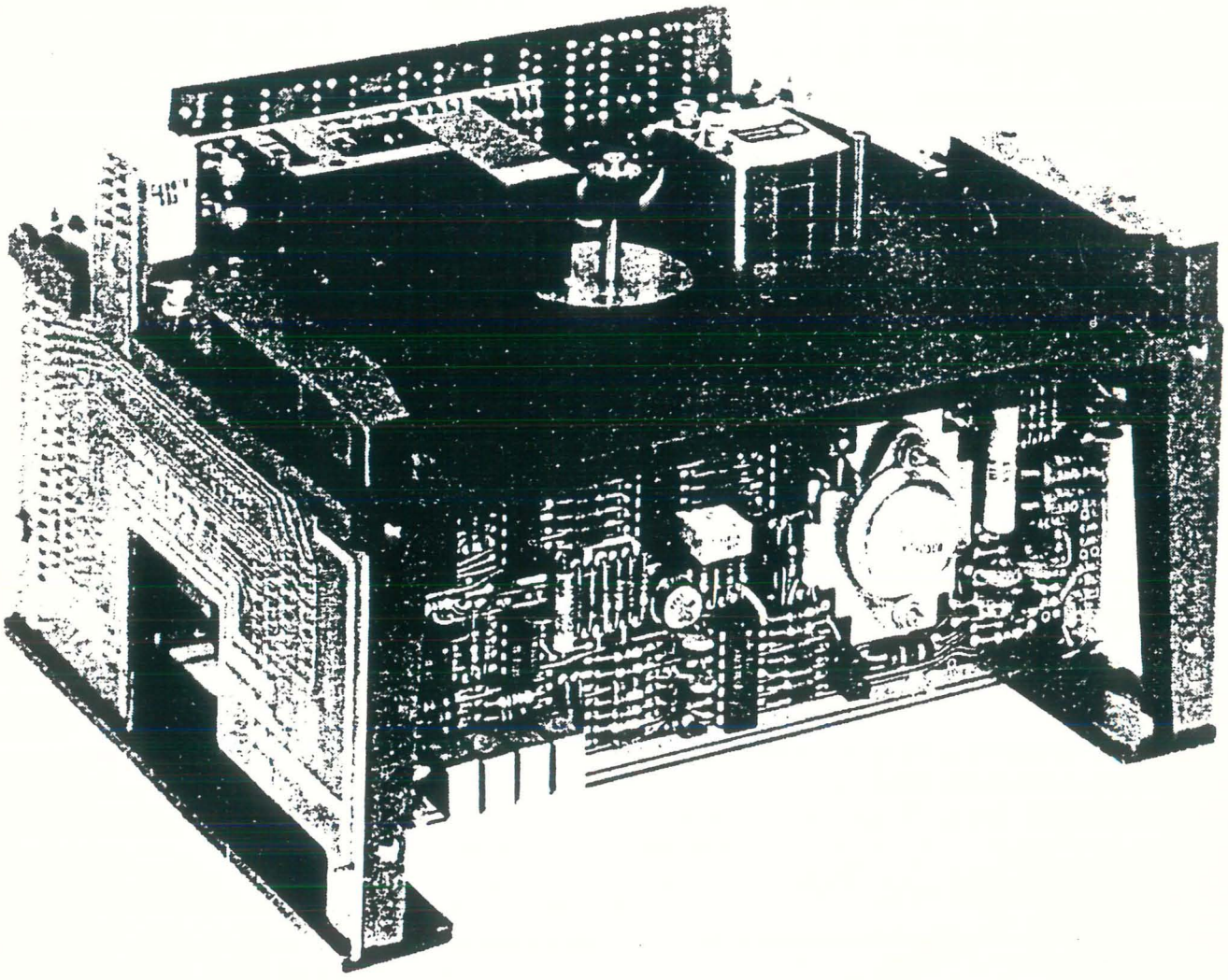
DATA ELECTRONICS INC.

CARTRIDGE MAGNETIC TAPE DRIVE

SERIES CMTD-3000S2

OPERATION AND MAINTENANCE MANUAL



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SECTION 1

DESCRIPTION

1.1 INTRODUCTION

This manual covers the CMTD-3000S2 Cartridge Magnetic Tape Drive (Figure 1-1) manufactured by Data Electronics, Inc., San Diego, California. The manual consists of eight sections including unit description, installation procedures, operation (including signal description), general theory of operation, maintenance procedures, adjustment procedures, an illustrated parts list, and a section on test equipment.

The S2 drive is designed for use with a tape cartridge as a read-and-write memory device in a digital system. The tape cartridge employed must conform to ANSI X3.55-1977. The drive records and reads 1600 bpi, phase encoded data per ANSI X3.56-1977. The phase encoded data format is applied to a dual gap, read-while-write recording head with a separate erase section. The data tracks are written in four track serial format.

1.2 GENERAL DESCRIPTION

Locations of major drive components are illustrated in Figure 1-1 and 1-2. All electronic assemblies are designed as plug-in modules. These modules include a magnetic head assembly, switch/sensor assembly, interconnect board, data board, servo board, and a heat sink assembly.

All module-to-module wiring is performed by means of the interconnect board. All modules are plug-in type and can be removed or installed without the need for soldering or unsoldering.

Precision side rails position the tape cartridge with respect to the tape head and capstan. Spring loaded pawl assemblies engage the upper surface of the cartridge baseplate against a fixed, vertical reference surface, and provide a secure, fixed horizontal stop.

The heat sink assembly contains the drive motor/tachometer, power transistors and a three-piece heat sink. This plug-in module is pivoted at its center-of-gravity, and spring-loaded so that the capstan maintains proper pressure on the cartridge drive roller regardless of drive position or attitude.

The data board connects to the magnetic head assembly. It contains the read, write, and erase track selection circuitry, read amplifier and the write head driver.

The servo board contains the power distribution and motor control circuits.

The switch/sensor assembly circuitry senses the Beginning-of-Tape,

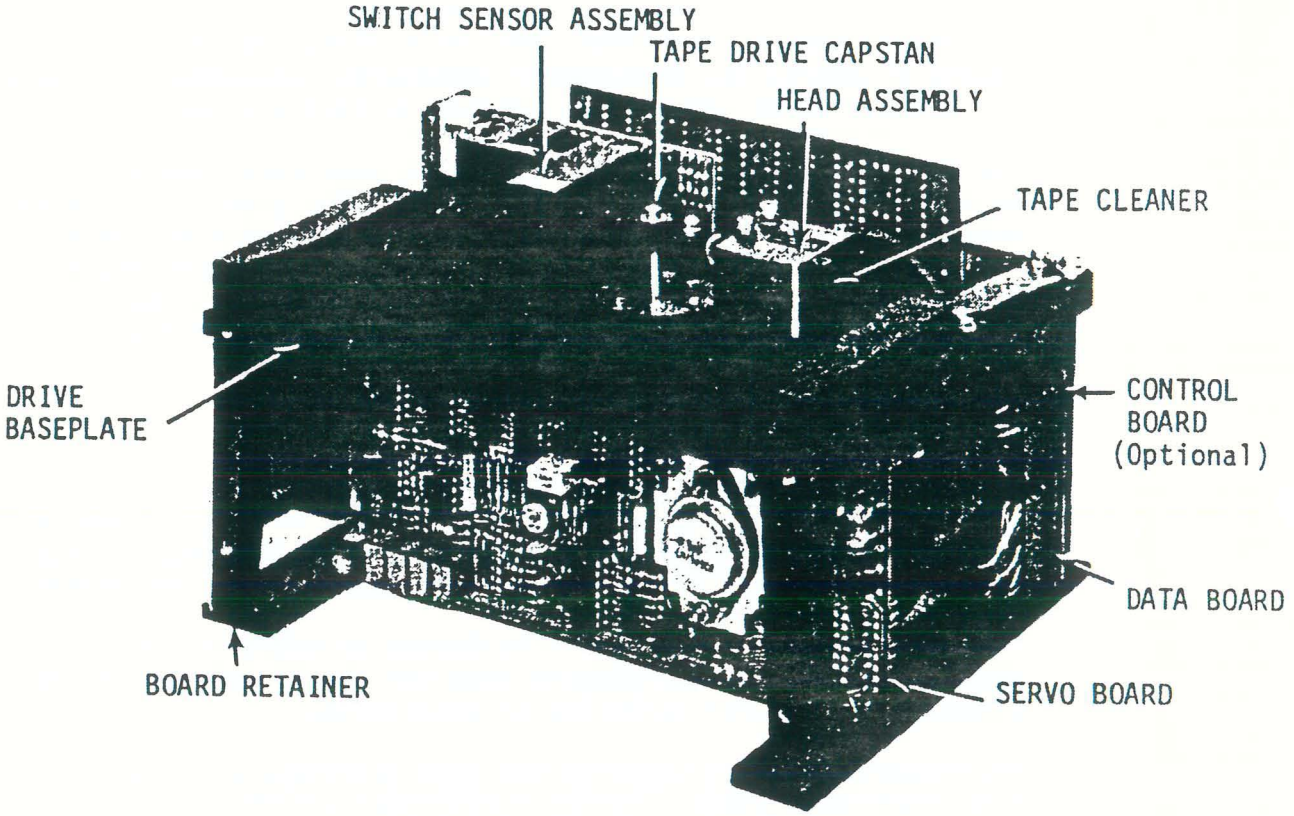
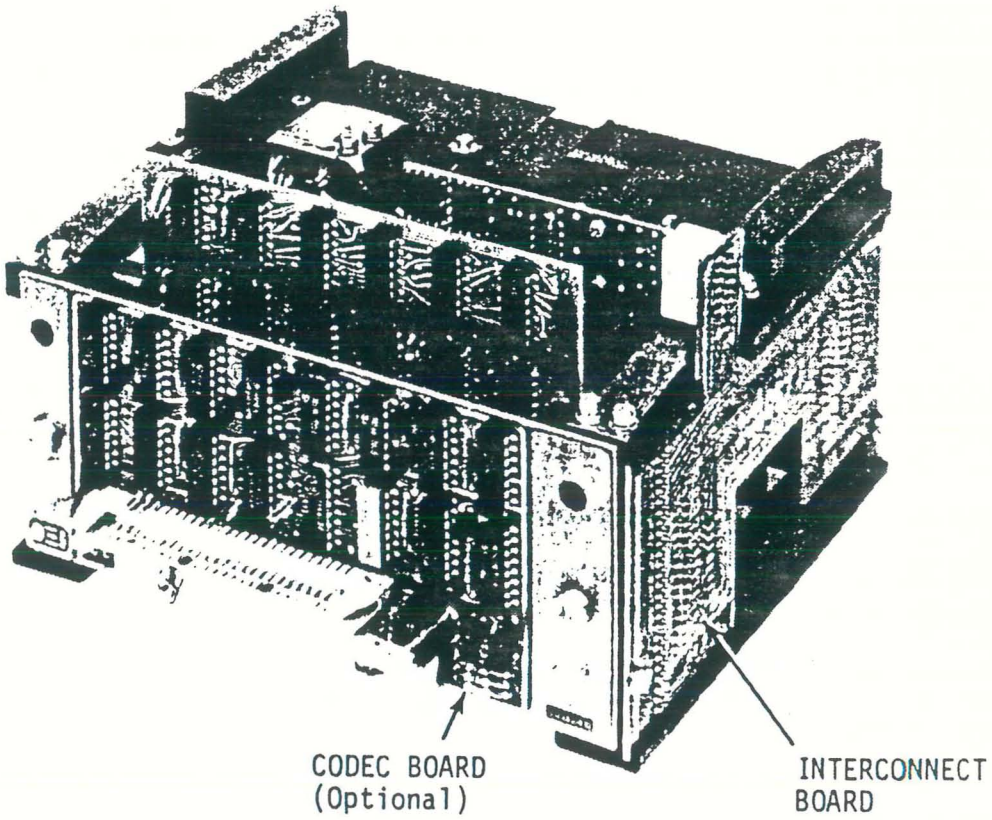


Figure 1-1. CMTD-3000S2 Drive



REAR VIEW

Figure 1-2. CMTD-3000S2 Drive

Load-Point, Early-Warning, and End-of-Tape holes which indicate tape location. This assembly also contains the File-Protect and Cartridge-in-Place switches. The File-Protect switch indicates whether or not a cartridge is write protected, while the Cartridge-in-Place switch signals whether or not the cartridge has been inserted. These functions are described in greater detail in Section 4, Theory of Operation.

1.3 OPTIONAL CONFIGURATIONS

The Series CMTD 3000S2 is available in three versions:

* Basic Model
* Basic Model with Control Board
* Basic Model with Control Board and Codec Board

1.3.1 Control Assembly

The optional control board provides several functions which, therefore, need not be provided by the controller. These are:

* Selectable unit address
* Forward tape motion prevented at End-of-Tape (EOT).
* Reverse tape motion prevented at Beginning-of-Tape (BOT).
* High speed only permitted between Load Point (LP) and Early Warning (EW).
* Automatic tape positioning to Beginning-of-Tape (BOT) after cartridge insertion, power on, or a rewind operation.
* Generation of high level status.

1.3.2 Codec Board

The optional Codec Board converts NRZ formatted data to the PE format prior to sending the write data to the drive and decodes phase encoded data returning NRZ data and strobe to the interface.

1.3.3 Read-While-Write Without Erase

An optional read-while-write magnetic head assembly without the separate erase head is also available.

1.4 MODEL CODES FOR DRIVE OPTIONS

A typical model number for the standard S2 drive is 3647-44ABEF-S2. Figure 1-3 indicates how this number is decoded. Table 1-1 provides a general breakdown for all S2 drive model codes.

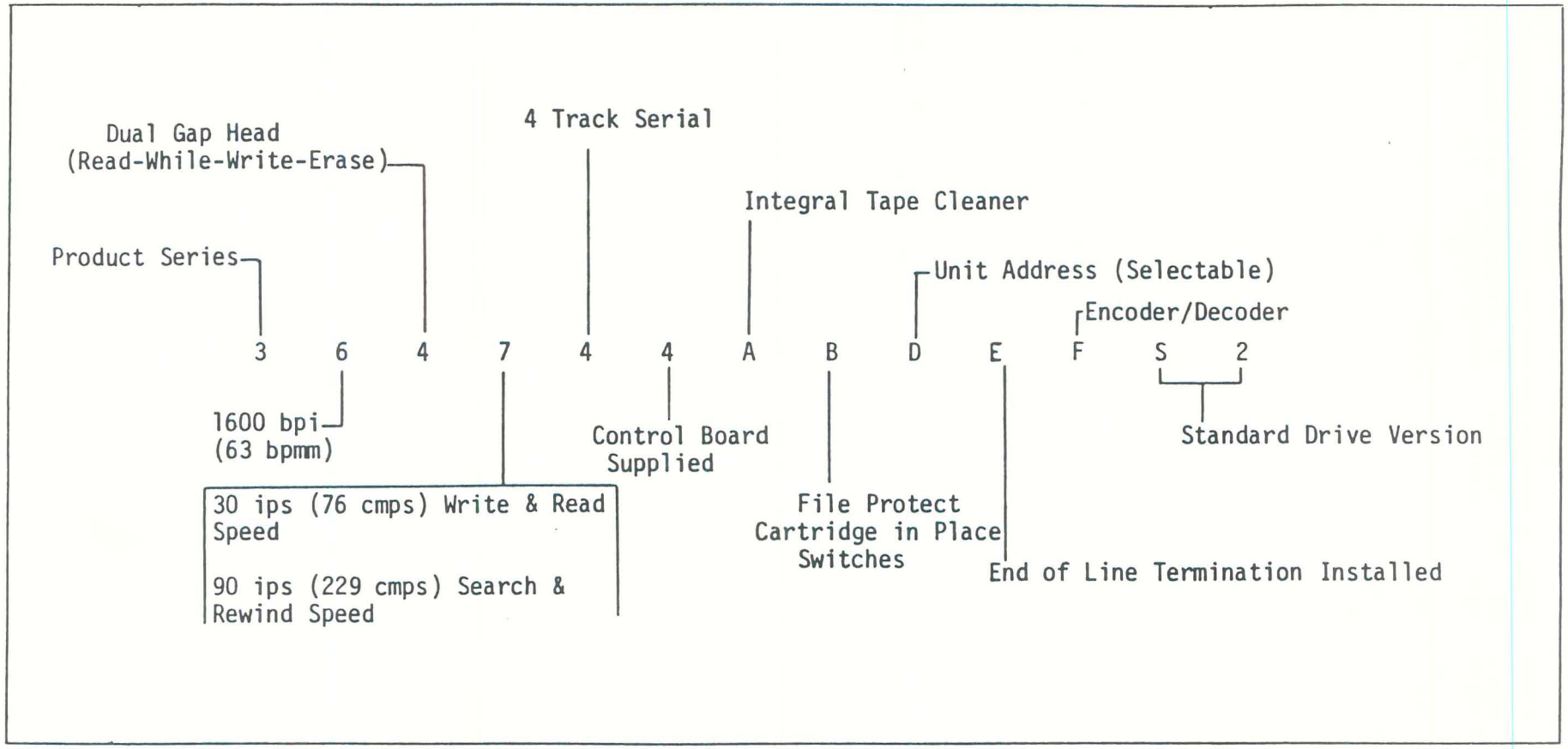


FIGURE 1-3 Model Code for Typical 1600 S2 Drive

PRODUCT SERIES	RECORDING DENSITY	HEAD TYPE	TAPE SPEED	NUMBER OF TRACKS	CONFIGU-RATION	OPTIONS/ SELECTIONS
3	6 1600 bpi (630 bpcm)	3 Dual Gap (Read-While Write) 4 Dual Gap with Erase (Read-While Write-While Erase)	7 30/90 ips (76/229 cmps)	4 Four Track Serial	4 With Control Board 5 No Control Board	A Integral Tape Cleaner B File Protect and Cartridge-In-Place Switches C* Unit Addressing Set at Factory (C1 or C2) OR D* Unit Addressing (Selectable) E End of Line Termination Installed F Data Encoder/Decoder Included (Available on drives with control boards only)
* NOTE: C1 or C2 for Drives without Control Boards D is for Drives with Control Boards						

TABLE 1-1 Model Description and Corresponding Model Number

1.5 SPECIFICATIONS

1.5.1 General

General specifications for the 1600 bpi S2 drive are provided in Table 1-2.

Since these specifications are subject to change, refer to DEI Specification 301,183 for the maintained engineering document.

Cartridge:	ANSI X3.55-1977 1/4 in. (6.3mm) X 450 ft.
Recording Density:	1600 bpi (63 bpmm) Phase Encoded, 3200 frpi (126 frpmm)
Number of Tracks:	4
Read/Write Head Type:	Dual Gap, Read-While-Write with Separate Erase
Read/Write Mode:	4-Track Serial
Operating Speeds:	30 ips (76 cmps) Write, Bidirectional Read
	90 ips (229 cmps) Bidirectional Search and Rewind
Transfer Rate:	6 kBytes/sec at 30 ips (76 cmps)
Short Term Speed Variation:	$\pm$ 7%
Long Term Speed Variation:	$\pm$ 3% Forward, $\pm$ 4% Reverse @ 30 ips (76 cmps)
	$\pm$ 4% Forward, $\pm$ 5% Reverse @ 90 ips (229 cmps)
Start/Stop Time:	At 30 ips (76 cmps), 25/26 msec
	At 90 ips (229 cmps), 71/74 msec
Start/Stop Distance: (Nominal)	At 30 ips (76 cmps), 0.30/.41 in. (7.6/10.2 mm)
	At 90 ips (229 cmps), 2.97/3.42 in. (75.4/86.9 mm)
Interface Logic:	TTL Low True, 3.2 milliamp maximum loads. 125 ohms line impedance.
Power:	See Table 1-3.
Warm-Up Time:	Less than three seconds, assuming ambient operating conditions.
Relative Humidity:	20% to 80%*, operating (non-condensing)
	0% to 99% maximum storage (non-condensing)
Temperature:	41°F to 113°F (5°C to 45°C) operating
	-17°F to 150°F (-30°C to 60°C) non-operating

TABLE 1-2 General Specifications

Table 1-2 General Specifications Continued...

Physical Dimensions:	Height = 4.25 inches (10.8 cm) Width = 6.96 inches (17.68 cm) Depth = 5.72 inches (14.53 cm)** 6.67 inches (16.94 cm) with Codec Board** Heat Dissipation = 15W power on, 35W typical, 69W maximum Weight = 4 lbs. (1.9 kg) * Limited by magnetic tape performance **Allow 1.2 inches (3.05 cm) for extension of the cartridge in the front of the drive.

1.5.2 Power Requirements

Table 1-3 describes the power requirements for the S2 drive.

DRIVE TYPE	Drive Power Dissipation Watts*		Operating Conditions	Current Requirements in Amperes (Tolerances Include Ripple)					
				V24+		V24-		V5+	
				+24Vdc±15%		-24Vdc±15%		+5Vdc+5%-3%	
	Typ.	Max.		Typ.	Max.	Typ.	Max.	Typ.	Max.
Basic Drive Without a Control Board	14.6	63.4	1	0.03	0.06	0.05	0.10	0.38	0.75
			2	0.03	0.06	0.65	1.5	0.52	1.0
			3	0.62	1.5	0.05	0.10	0.42	0.80
			4	1.6	3.1	1.7	3.5	0.42	0.80
Basic Drive With a Control Board	17.0	67.2	1	0.03	0.06	0.05	0.10	0.86	1.7
			2	0.03	0.06	0.65	1.5	1.0	2.0
			3	0.62	1.5	0.05	0.10	0.90	1.8
			4	1.6	3.1	1.7	3.5	0.90	1.8
Basic Drive With Control & Codec Boards	18.5	68.9	1	0.03	0.06	0.05	0.10	1.2	2.4
			2	0.03	0.06	0.65	1.5	1.3	2.6
			3	0.62	1.5	0.05	0.10	1.2	2.4
			4	1.6	3.1	1.7	3.5	1.2	2.4

*See 1.5.2.1 for operating conditions and assumptions

TABLE 1-3. Power Requirements

1.5.2.1 Power Requirements Operating Conditions

* Operating Conditions:

1. No tape motion, no write current.
2. Forward tape motion at 30 or 90 ips (76 or 229 cmps). Includes reading or writing conditions at 30 ips. (76 cmps).
3. Reverse tape motion at 30 or 90 ips (76 or 229 cmps) no writing.
4. Start/Stop Periods: As noted in Table 1-5.

General:

- All voltages measured at drive power connector.
- The ramp period current peaks do not occur simultaneously. A defective cartridge can extend ramp current periods.

Assumptions for power dissipation calculations:

Typical: Nominal voltages and typical currents, 2 starts and 2 stops per second, and running 50% of the remaining time.

Maximum: Nominal voltages and maximum currents, 17 starts and 17 stops per second.

1.6 PERFORMANCE SPECIFICATION

When the drive is operated under the previously described conditions, (paragraph 1.5) the performance shall be achieved as described:

1.6.1 Tape Motion - Steady State

Bit Period

The nominal apparent bit period for 30 ips (76.2 cmps) is 20.833 micro seconds. The corresponding nominal transfer rate is 6 kbytes per second serial (8 bits/byte).

Long Term

The long term average of the nominal bit period at 3200 flux reversals per inch (frpi) or 126 flux reversals per millimeter (frpmm), as shown in Table 1-4, will be within ± 3% (± 2% for drive, ± 1% for cartridge) for low speeds forward. Long term average is defined as being measured over 240 X 10^3 bits on tape (150 in. or 3.81m) or more, in the read-while-write mode with no error contribution assumed for the recorded tape.

SPEED RANGE	LONG TERM AVERAGE	
	FORWARD	REVERSE
30 ips	± 3.0%	± 4.0%
90 ips	± 4.0%	± 5.0%

TABLE 1-4. Long-Term Average of the Nominal Bit Period

Short Term

The short term average bit period at 3200 frpi (126 frpmm), will be within ± 7% of the long term average bit period, in a read-while-write mode. The short term average period is defined as a single bit period averaged over the four successive bit periods. This tolerance is inclusive of cartridge and drive variations. The rate of change of the short term average bit period shall be ≤2% per bit period, and tolerances apply to the forward or reverse at the speeds listed. These tolerances are exclusive of peak shift tolerances. In a read only mode, the short term average bit period can vary an additional ± 7%.

1.6.2 Tape Motions, Starting and Stopping

The start distance is defined as the period from application of the start (either forward or reverse) command to when ≥95% of final long term speed is reached, exclusive of short term speed changes. For start and stop distances, refer to Table 1-5.

The minimum stopping distance shall always be greater than the maximum starting distance. The ANSI interblock gap is 1.2 inches (3.048 cm) minimum, preambles and postambles not included. A delay of 33 X 10^{-3} seconds is required to assure the ANSI interblock gap (IBG). The delay is calculated from the beginning of the Forward command until the first bit of data is sent to the drive. The stop distance is the actual tape distance traveled during the stop period.

No program limitations exist for the applications of a start/stop command.

NOMINAL TAPE SPEED IN/SEC (CM/SEC)	CONDITION	PERIOD X 10^{-3} SEC.	DISTANCE* MIN IN (CM)	NOM IN (CM)	MAX. IN (CM)
30 (76.2)	STARTING	25	0.300 (0.762)	0.330 (0.838)	0.360 (0.914)
	STOPPING	25	0.390 (0.991)	0.420 (1.076)	0.450 (1.143)
90 (228.6)	STARTING	71	2.701 (6.861)	2.970 (7.544)	3.201 (8.130)
	STOPPING	74	2.792 (7.092)	3.420 (8.687)	4.088 (10.38)

*Allows for 3 ms inertial delay for nom. start and 3 ms @ 30 ips nom. stop with a 5 ms delay on max. and 1 ms delay on min. The balance of the 25 ms period @ 15 ips average.

TABLE 1-5 Start/Stop Parameters

1.6.3 Bit Period Tolerances

A data transition bit is defined as a flux transition which contains significant data information. A phase transition is defined as a flux transition which does not contain significant data information. The nominal time spacing between successive data bits is 20.833 microseconds. The following is the instantaneous spacing tolerances between data and phase transitions as seen on the output of the read data line.

> Timing between two successive data bits without an intervening phase transition is between 88% and 105% of the short term average bit period. The timing between successive data bits with an intervening phase transition is between 95% and 112% of the short term averabe bit period.
>
> The timing between a data bit and any adjacent phase transition is between 44% and 56% of the short term average bit period.

The above assumes input time base displacements of the input write data waveform of $\leq \pm$ 0.2% of nominal write periods. Figure 1-4 shows both successive data bits without intervening phase transitions, and with phase transitions (higher frequency). The rise and fall times will be $\leq$ 30 msec (time from +0.8 Vdc to 2.0 Vdc).

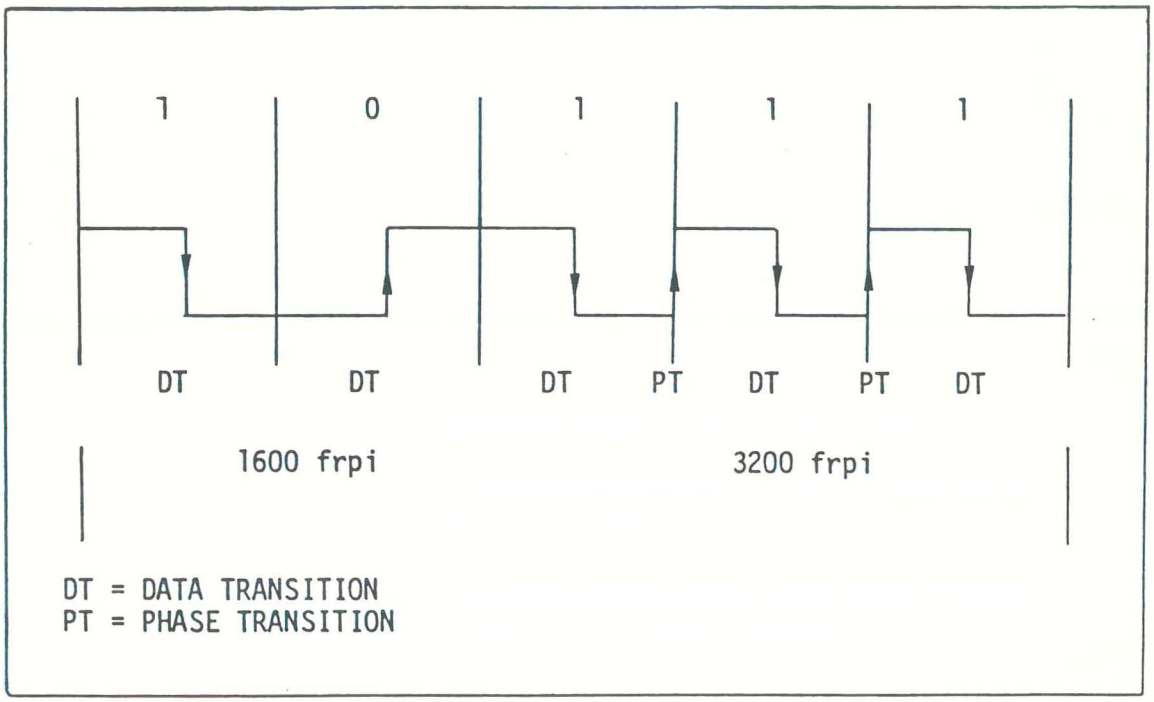


FIGURE 1-4. One & Two Frequency Waveforms

SECTION 2

INSTALLATION

2.1 MOUNTING

Because of its patented center of gravity motor mounting system, the drive may be mounted in any orientation without affecting performance. However, the drive must not be mounted in the position where the tape cartridge is inserted upward because in this position, residue from the tape cleaner will fall onto the tape and could cause data errors.

Mounting and overall dimensions for the drive are shown in Figure 2-1.

2.2 COOLING REQUIREMENTS

The drive is designed for use without forced cooling within the specified temperature range. If this range can only be maintained by forced cooling, then the cooling air should enter the side of the unit, Figure 2-2. The ambient inlet air must be below 45°C.

2.3 ELECTRICAL CONNECTIONS

2.3.1 Fuse Requirements

The following fuses shall be connected in series with the external power supply's +24V, -24V, and +5V lines to the drive:

Recommended Fuses:

+24 Vdc:	Buss AGC 3A, 250V) Slow Blow		
-24 Vdc:	Buss AGC 3A, 250V) Slow Blow		
+5 Vdc:	Basic Model	Basic Model w/Control Board	Basic Model w/Codec Board
	Buss AGC-1A, 250V	Buss AGC-2A 250V	Buss AGC-3A, 250V

TABLE 2-1

2.3.2 Power Supply Connections

All models come with a servo board for motion control. This is the power supply connection point as well and is to be wired as listed in Figure 2-3. All connections should be made and the minimum wire size is 20 AWG.

2.3.3 Signal Connections

All interface signals are TTL compatible, low true signals, (0 to .8Vdc).

Signal connections vary, depending on drive model. Table 2-2 indicates the interface signal connection points.

DRIVE VERSION	CONNECTOR	FIGURE
Basic Model:	P1,(Interconnect Board)	2-4
Basic Model with Control Board:	P600,(Control Board)	2-5
Basic Model with Control & Codec Boards:	P3,(Codec Board)	2-6

TABLE 2-2 Signal Connection Points

Figures 2-4, 2-5, and 2-6 provide signal pin lists for the three basic drive configurations including connector part numbers.

2.3.4 Signal Line Termination

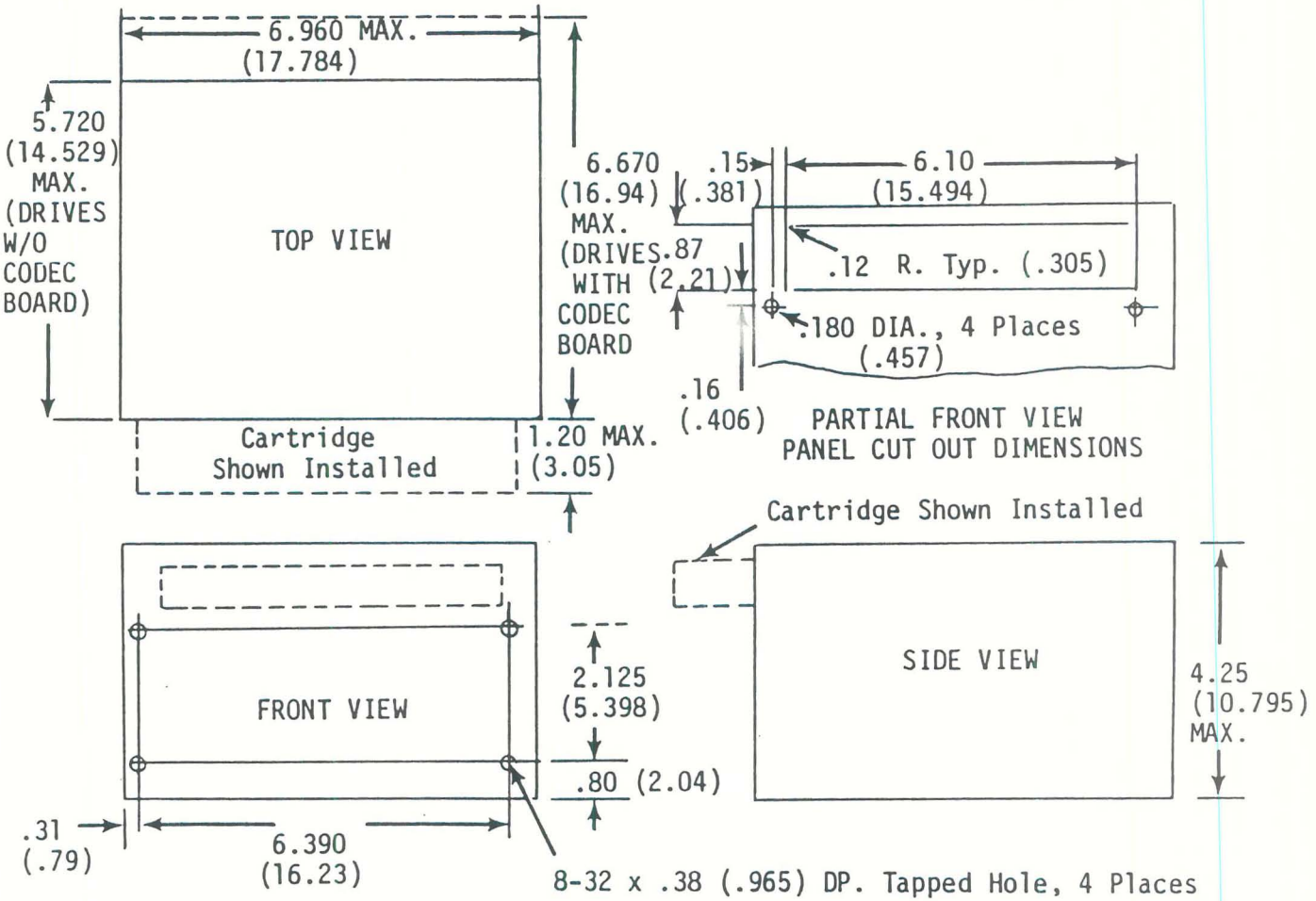
All signal lines should be terminated as shown in Figure 2-7. These are the recommended signal terminations for 100 to 132 ohm cables.

2.3.5 Multiple Drive Applications

As many as eight drives may be connected on a common bus. A flat ribbon cable connects to the input/output connector. Proper line termination is made only at the last drive in the daisy chain. Drives, as noted in Table 2-3 come with line termination. These should be removed except for the last drive on the bus.

TERMINATIONS	DATA, CONTROL, & STATUS SIGNALS
Basic Drive:	Data Board
Location:	Interconnect Board
Value:	220/330 ohm Pack
Basic Drive with Control Board:	U621
Location:	Control Board
Value:	220/330 Pack
Basic Drive with Control & Codec Boards:	R37, R38, R39, R40 U621
Location:	Codec Board, Control Board
Value:	220/330 ohm Discrete Resistors 220/330 ohm Pack

TABLE 2-3 Location of Line Terminations



NOTES:

1. Hole Diameter in Mounting Panel for 8-32 Screws; 0.40 Inches (1.016 cm) Maximum Penetration Required for Mounting.

2. All Dimensions Without Parenthesis in Inches; Dimensions Within Parenthesis in Centimeters.

3. XXX Dimensions ± .010 Inches; XX Dimensions ± .020 Inches.

Figure 2-1. Panel Mounting Dimensions

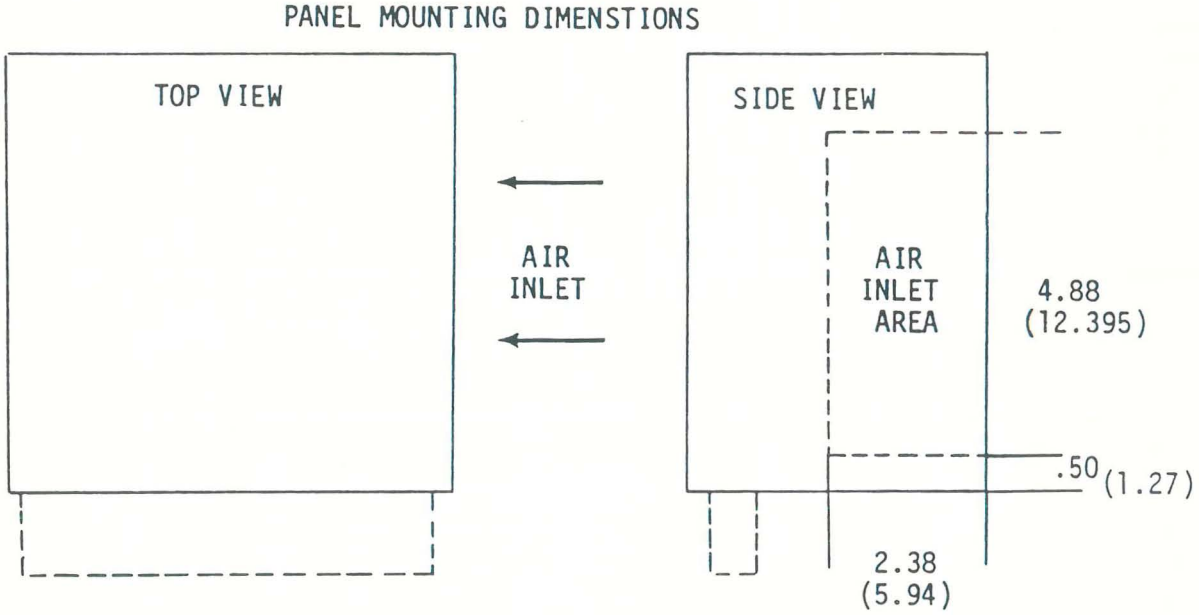
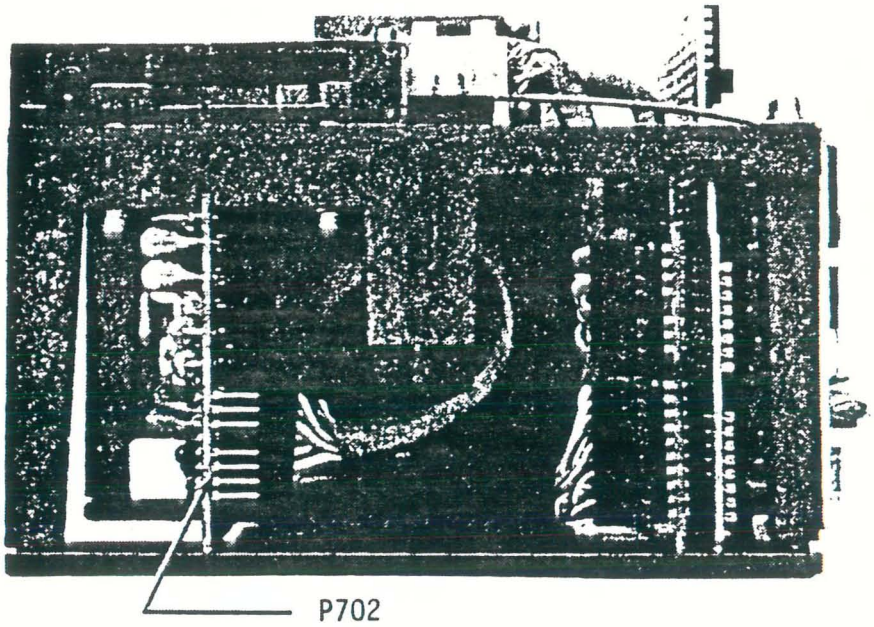
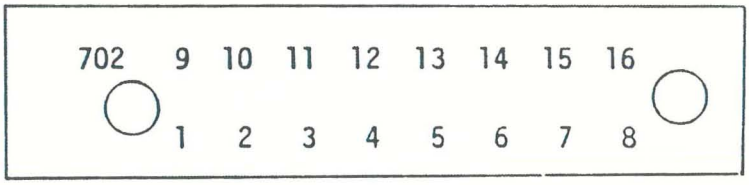


Figure 2-2. Ventilation Requirements

SERVO CIRCUIT BOARD ASSEMBLY





As viewed from solder side of servo board

Figure 2-3. Servo Board Power Connections (P-702)

PIN #	SIGNAL	FROM	COMMENTS
1	N.C.	----	Keying plug
2	V24+	Power Supply	+24 Vdc
3	V24-	Power Supply	-24 Vdc
4	N.C.	----	Keying Plug
5	SCom	Power Supply	Servo Common
6	V5+	Power Supply	+5 Vdc
7	LCom	Power Supply	Logic Common
8	CCom	Drive	Chassis Common
9	V5-	Drive	-5 Vdc
10	V24+	Power Supply	+24 Vdc
11	V24-	Power Supply	-24 Vdc
12	N.C.	----	Keying Plug
13	SCom	Power Supply	Servo Common
14	V5+	Power Supply	+5 Vdc
15	LCom	Power Supply	Logic Common
16	CCom	Drive	Chassis Common

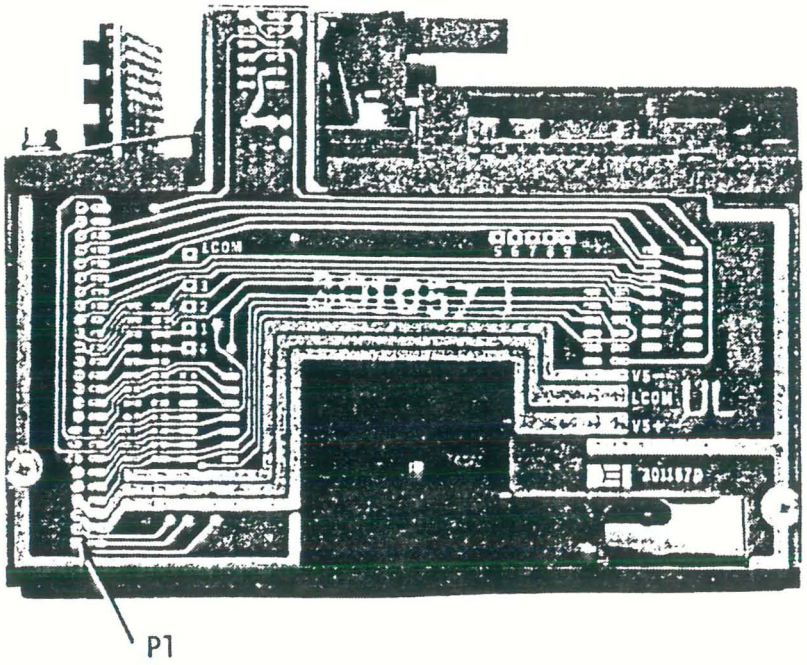
NOTES:
1) -5 Vdc is generated in Drive and available for monitoring.
2) Servo, Logic and Chassis Common are to be tied together and to ground at one point in power supply.
3) Chassis Common is the physical case of the Drive, Servo Common returns the $\pm$ 24 Vdc currents, and Logic Common returns + 5 Vdc currents.
4) Mating Connectors:

AMP Power Connector Part Numbers:
#2-86256-2, connector DEI #500116 (1 req'd.)
#86016-4, contacts DEI #500118 (16 req'd.)
#86286-1, key plugs DEI #500119 (3 req'd.)

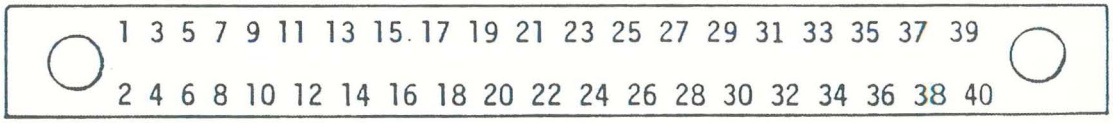
Cannon Power Connector Part Numbers:
#121-7326-10843, connector DEI #500621 (1 req'd.)
#11-0238-0091, contacts #500622 (13 req'd.)
#225-7301-001, key plugs DEI #500623 (3 req'd.)

Figure 2-3. Continued. Servo Board Power Connections (P-702)

Interconnect Circuit Board Assembly



Connections are made to P1 on interconnect circuit board (opposite side)



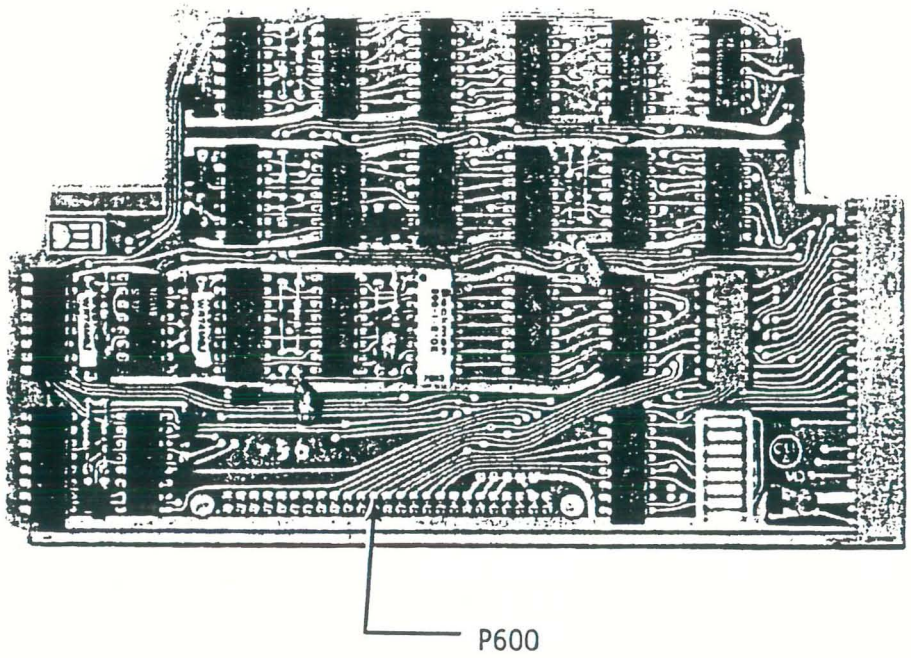
As viewed from solder side of circuit board

Figure 2-4. Input/Output Signal Connections to P1 for Drives without Control Board.

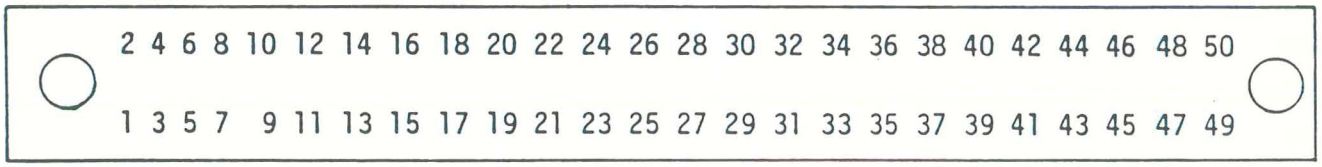
PIN #	SIGNAL	NAME	PIN #	SIGNAL	NAME
	OUTPUT FROM DRIVE			INPUT TO DRIVE	
5	FLP-	File Protected-	1	SL2-	Select Unit 2^1
6		File Protected Return	2		Select Unit Return 2^1
7	BLB-	Bulb-	3	SL1-	Select Unit 2^0
		Bulb Return	4		Select Unit Return 2^0
9	LTH-	Lower Tape Hole-			
10		Lower Tape Hole Return	25	TR2-	Track Select 2^1
			26		Track Select Return 2^1
11	CIP-	Cartridge in Place-	27	WDA+/-	Write Data-
12		Cartridge in Place Return	28		Write Data Return
13	UTH-	Upper Tape Hole-	29	TR1-	Track Select 2^0
14		Upper Tape Hole Return	30		Track Select Return 2^0
19	RDA+/-	Read Data-	31	WEN-	Write Enable-
20		Read Data Return	32		Write Enable Return
			33	ERA-	Erase Enable-
			34		Erase Enable Return
			35	FWD-	Forward-
			36		Forward Return
			37	REV-	Reverse-
			38		Reverse Return
			39	HSP-	High Speed
			40		High Speed Return

Figure 2-4 Continued. Input/Output Signal Connections to P1 for Drives without Control Board.

CONTROL BOARD



P 600 PIN IDENTIFICATION



As viewed from solder side

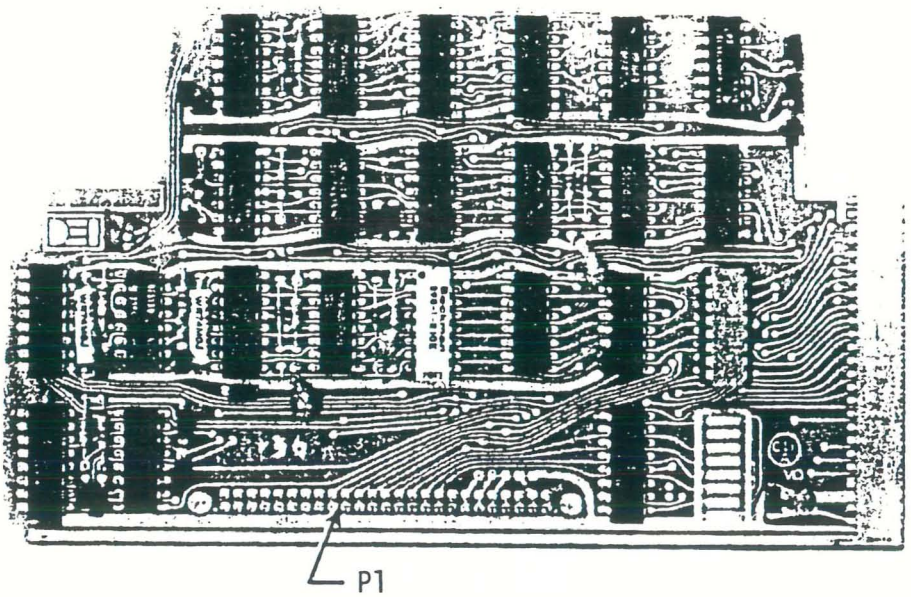
Figure 2-5. Input/Output Signal Connections P600 for Drives with Control Board

PIN #	SIGNAL	NAME	PIN#	SIGNAL	NAME
	OUTPUT FROM DRIVE			INPUT TO DRIVE	
2	SLD-	Selected-	18	RWD-	Rewind-
1		Selected Return	17		Rewind Return
4	RDY-	Ready-	20	REV-	Reverse-
3		Ready Return	19		Reverse Return
6	WND-	Write Enabled-	22	FWD-	Forward-
5		Write Enabled Return	21		Forward Return
			24	HSP-	High Speed-
8	FLG-	Flag-	23		High Speed Return
7		Flag Return	26	WEN-	Write Enable-
10	LPS-	Load Point Sensed	25		Write Enable Return
9		Load Point Sensed Return	28	SL1-	Unit Select 2^0
12	FUP-	File Unprotected	27		Unit Select Return 2^0
11		File Unprotected Return	30	SL2-	Unit Select 2^1
14	BSY-	Drive Busy	29		Unit Select Return 2^1
13		Drive Busy Return	32	SL4-	Unit Select 2^2
16	EWS-	Early Warning Sensed	31		Unit Select Return 2^2
15		Early Warning Sensed Return	34	SLG-	Select Gate-
			33		Select Gate Return
36	RDA+/-	Read Data-	44	WDA$^{\pm}$	Write Data-
35		Read Data Return	43		Write Data Return
			46	TR2-	Track Select 2^1
			45		Track Select Return Code 2^1
			50	TR1-	Track Select 2^0
			49		Track Select Return 2^0

NOTE: See Figures 6-4 and 6-5 for the board layouts and unit addressing.

Figure 2-5 Continued. Input/Output Signal Connections P600 for Drives with Control Board

CODEC BOARD



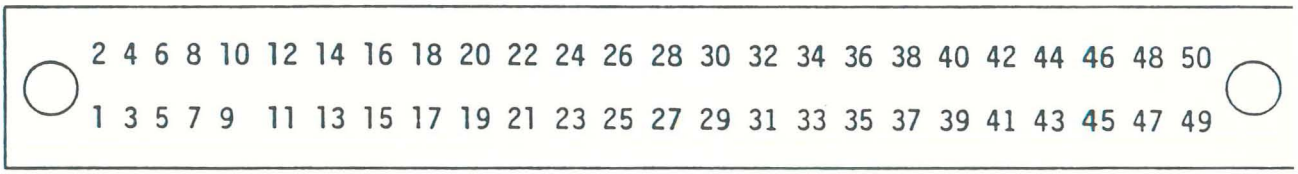


Figure 2-6. Input/Output Signal Connector P1 for Drive with Codec Board.

PIN #	SIGNAL	NAME
	OUTPUT FROM DRIVE	
2	SLD-	Selected-
1		Selected Return
4	RDY-	Ready-
3		Ready Return
6	WND-	Write Enabled-
5		Write Enabled Return
8	FLG-	Flag-
7		Flag Return
10	LPS-	Load Point Sensed-
9		Load Point Sensed Return
12	FUP-	File Unprotec-ed-
11		File Unprotec-ed Return
14	BSY-	Busy-
13		Busy Return
16	EWS-	Early Warning Sensed-
15		Early Warning Sensed Return
36	RNZ-	Read NRZ Data-
35		Read NRZ Data Return
38	RDS-	Read Data Strobe-
37		Read Data Strobe Return
40	DAD-	Data Detected-
39		Data Detected Return
48	WDS-	Write Data Strobe-
47		Write Data Strobe Return

PIN #	SIGNAL	NAME
	INPUT TO DRIVE	
18	RWD-	Rewind-
17		Rewind Return
20	REV-	Reverse-
19		Reverse Return
22	FWE-	Forward-
21		Forward Return
24	HSP-	High Speed-
23		High Speed Return
26	WEN-	Write Enable-
25		Write Enable Return
28	SL1-	Unit Select 2^0
27		Unit Select Return 2^0
30	SL2-	Unit Select 2^1
29		Unit Select Return 2^1
32	SL4-	Unit Select 2^2
31		Unit Select Return 2^2
34	SLG-	Select Gate
33		Select Gate Return
42	WDE-	Write Data Enable
41		Write Data Enable Return
44	WNZ-	Write NRZ Data-
43		Write NRZ Data Return
46	TR2	Track Select 2^1
45		Track Select Return 2^1
50	TR1	Track Select 2^0
49		Track Select Return 2^0

Figure 2-6 . Cont. Input/Output Signal Connector P1 for Drives with Codec Board

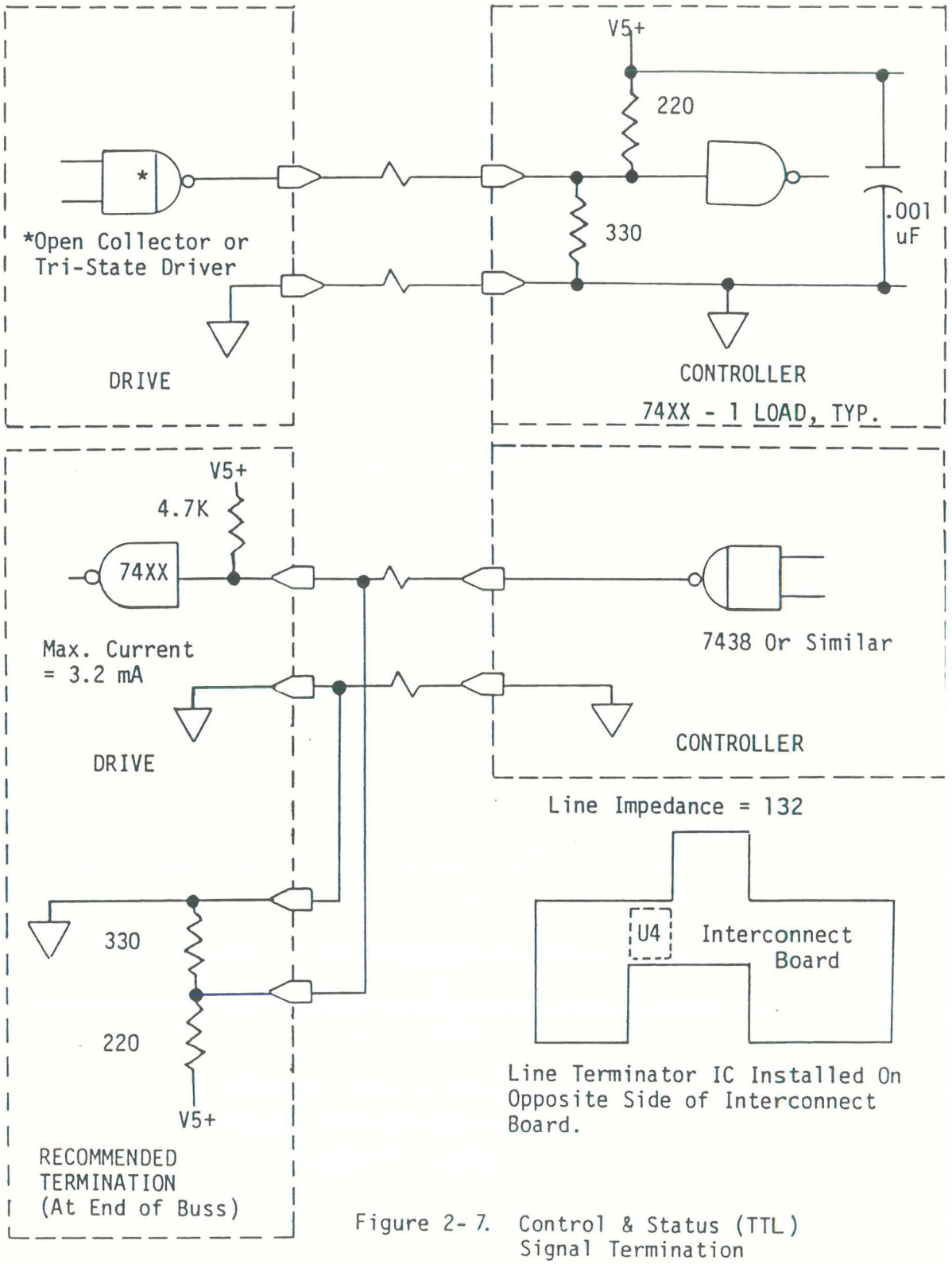


Figure 2-7. Control & Status (TTL) Signal Termination

SECTION 3

OPERATION

3.1 GENERAL

This section contains information on file protection, cartridge loading and unloading, tape position holes, data integrity, input and output signals, unit address, and start and stop times for interrecord gaps (IRG) and interblock gaps.

The drive operates in three modes: Read-While-Write; Read Only; and High Speed Search. In the Read-While-Write mode, data written on the tape is simultaneously recovered by the read channel. This allows the controller to verify the written data. In the Read Only mode, data is read from the tape and should be protected with the File Protect function. In the High Speed Search mode, the presence of the data envelope is detected and sent to the controller for processing.

3.2 FILE PROTECTION

File Protection is built into each cartridge. In order to prevent write operations, rotate the write protect plug on top of the cartridge to SAFE position. To enable write operations, return arrow to the position opposite SAFE.

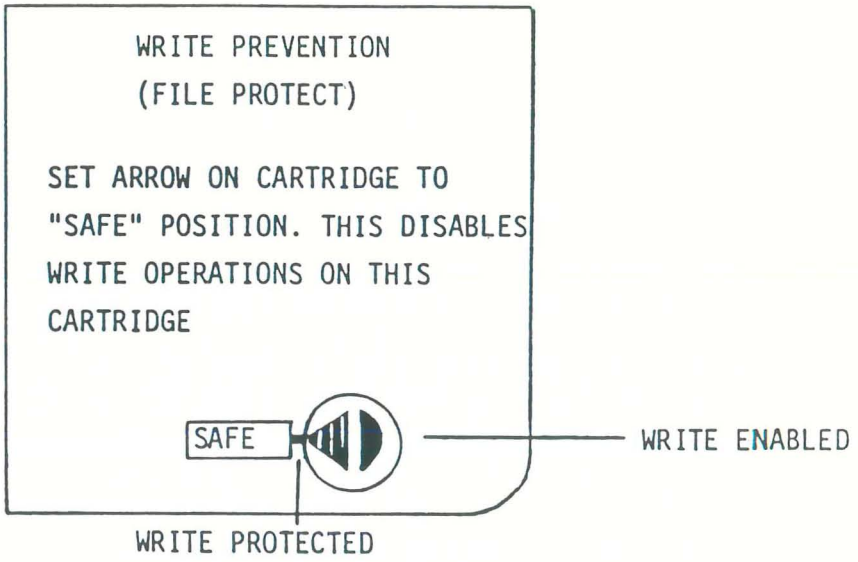


Figure 3-1. File Protection

3.3 LOADING AND UNLOADING

See Figure 3-2 for installation and removal of cartridge. Position the cartridge at the entry opening and slide forward until the first detent is felt. Continue sliding cartridge forward until it is fully engaged. To remove the cartridge, simply pull it out of the drive.

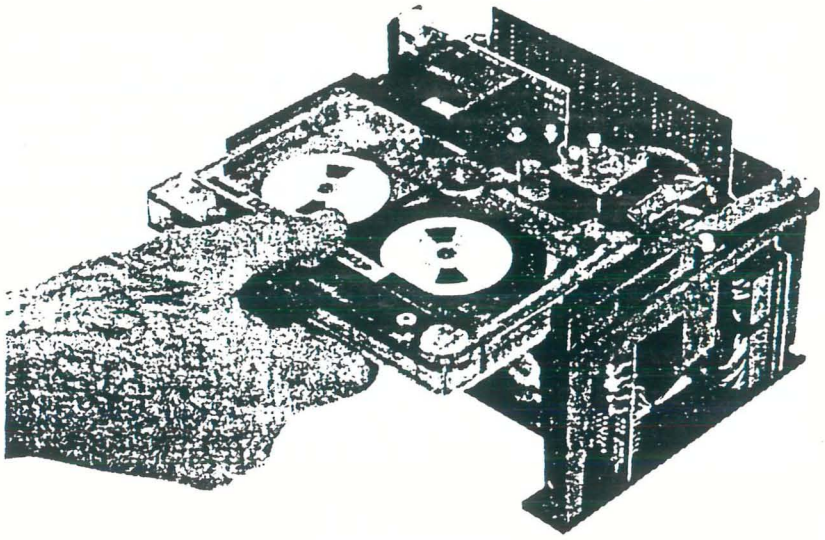


Figure 3-2. Cartridge Installation and Removal

3.4 TAPE POSITION HOLES

Figure 3-3 shows location of the ANSI specified tape position holes which are sensed to indicate tape position to the controller. Note that data should not be written prior to 6 inches (15.2 cm) beyond the load point hole (LP) nor more than 36 inches (91.4 cm) beyond the early warning (EW) hole at the end of the tape. In drives with control boards the tape will rewind past load point and the first set of beginning of tape (BOT) holes, and then stop, ready for a forward command. Load Point Sensed (LPS-) goes true after the load point hole is sensed in reverse direction. Since LPS- will later go false when the load point hole is detected in the forward direction, the controller can detect this status and with a delay cause the initial gap to be generated.

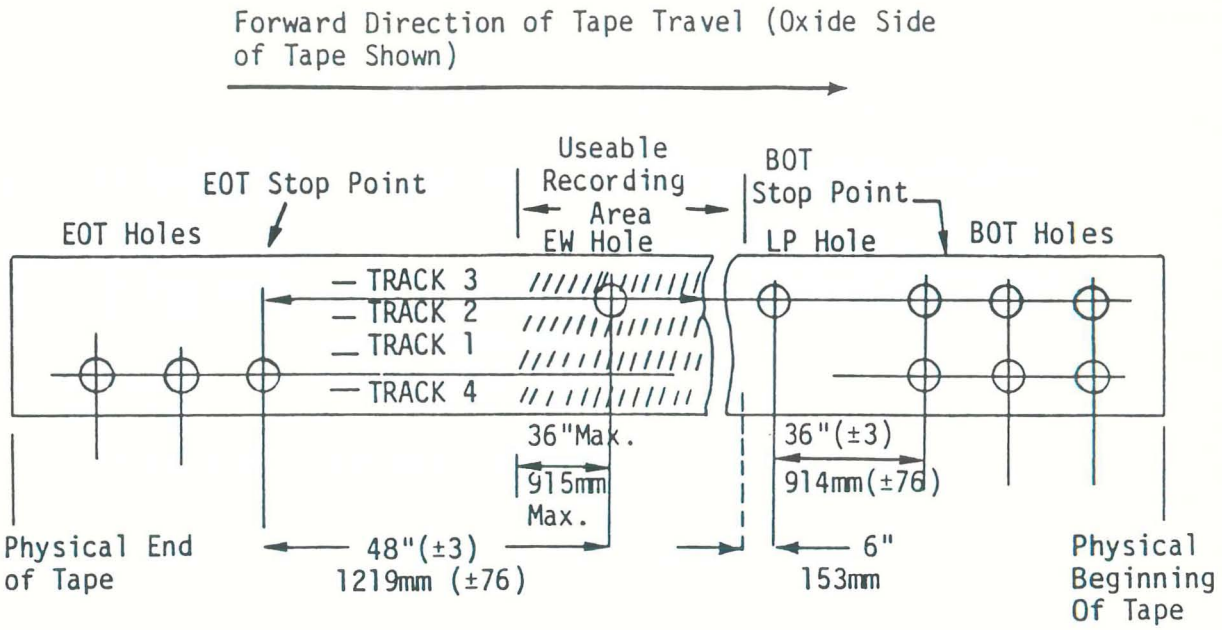


Figure 3-3. Tape Position Holes

3.5 START AND STOP TIMES FOR INTERBLOCK GAPS (IBG)

Timing for the interblock gaps and a suggested method for handling data are described in the following paragraphs.

The IBG delays, utilized when recording with this drive (at 30 ips and 1600 bpi), are externally generated delays used to insure, in the worst circumstances, writing and maintaining the ANSI minimum IBG of 1.2 inches (3.05 cm), Figure 3-4. They also insure that the stop position of the read head within the IBG is in a consistent place when stopping either from a write or read forward or read reverse condition.

3.5.1 IBG Stop Position (Figure 3-4)

The beginning and end of a data block (BOB) and EOB) can be sensed by monitoring the data envelope as the block passes the read head. When the tape is stopped, the read head should rest at the same place in the gap relative to EOB of block N and BOB of block N+1, Figure 3-4.

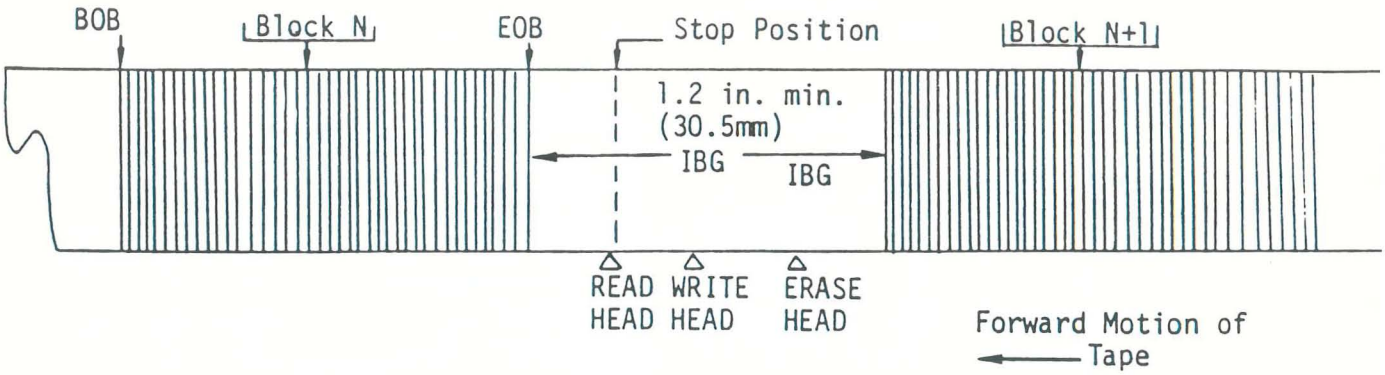


Figure 3-4. Interblock Gaps and Stop Position

3.5.2 Forward Stop Mode (Figure 3-5)

Stop is initiated when the read head detects the end of a data block. In a read-after-write mode this is 10 msec; 0.3 inches (1.6mm) after write data enable (WDE) goes false; the delay being caused by the physical distance between the write and read heads. (NOTE: The WDE line is provided only by the drive with CODEC. Its function must be provided in external encoding circuits.) The stop period is set for 26 msec, including approximately 5 msec for cartridge and servo response.

3.5.3 Forward Start Mode (See Figure 3-5)

The forward start ramp is initiated when FWD is true. The duration of the start period is 25 msec which includes a 5 msec response time for servo and cartridge. To establish the minimum IBG specified by ANSI,, a write start data delay of 33 ± 0.5 msec is required between the time FWD command is given and the time the drive begins to write data.

3.5.4 Reverse Stop Modes (See Figure 3-6)

An 8 msec stop delay should be built into the reverse stop operation to assure stopping the tape at the nominal IBG stop position referenced to the read head.

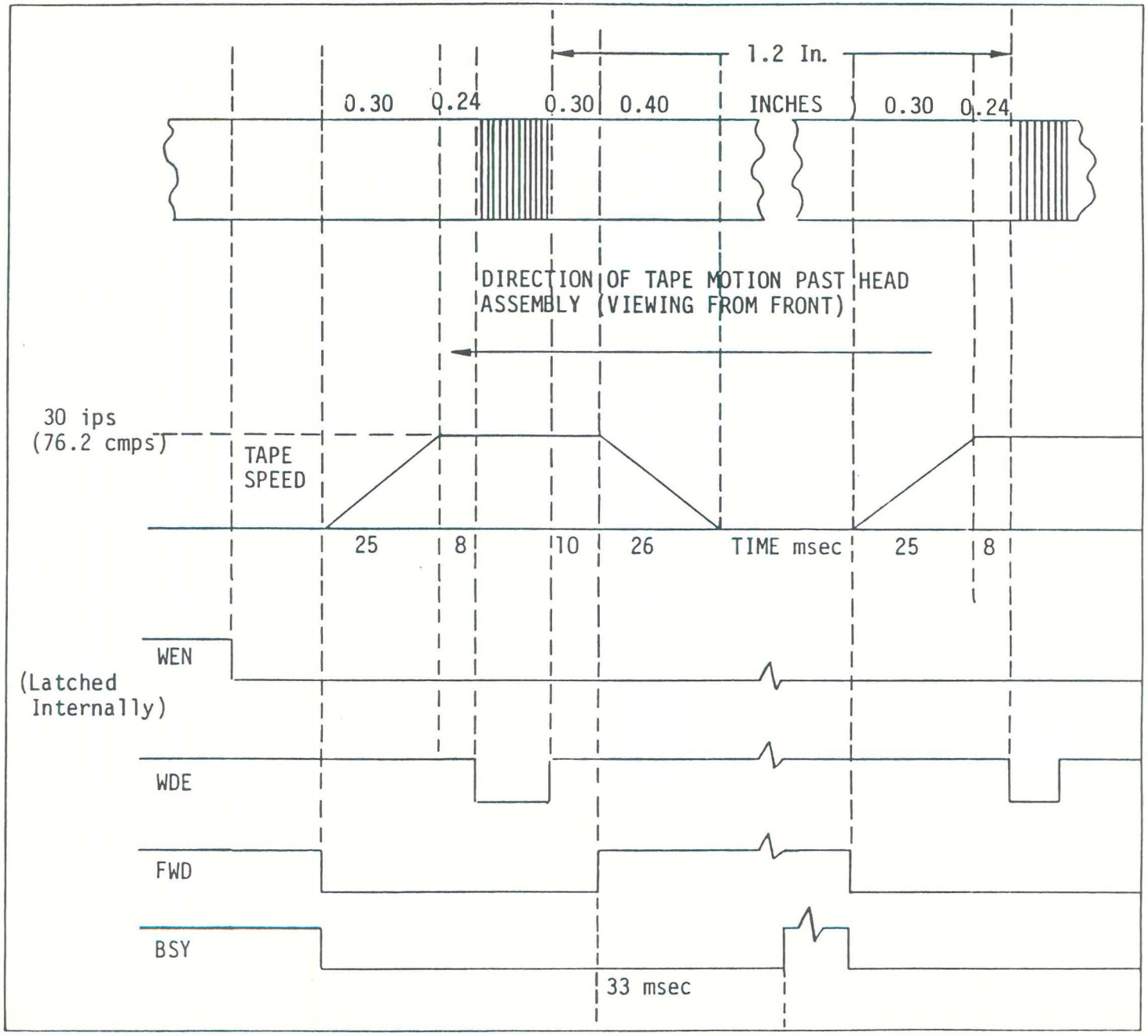
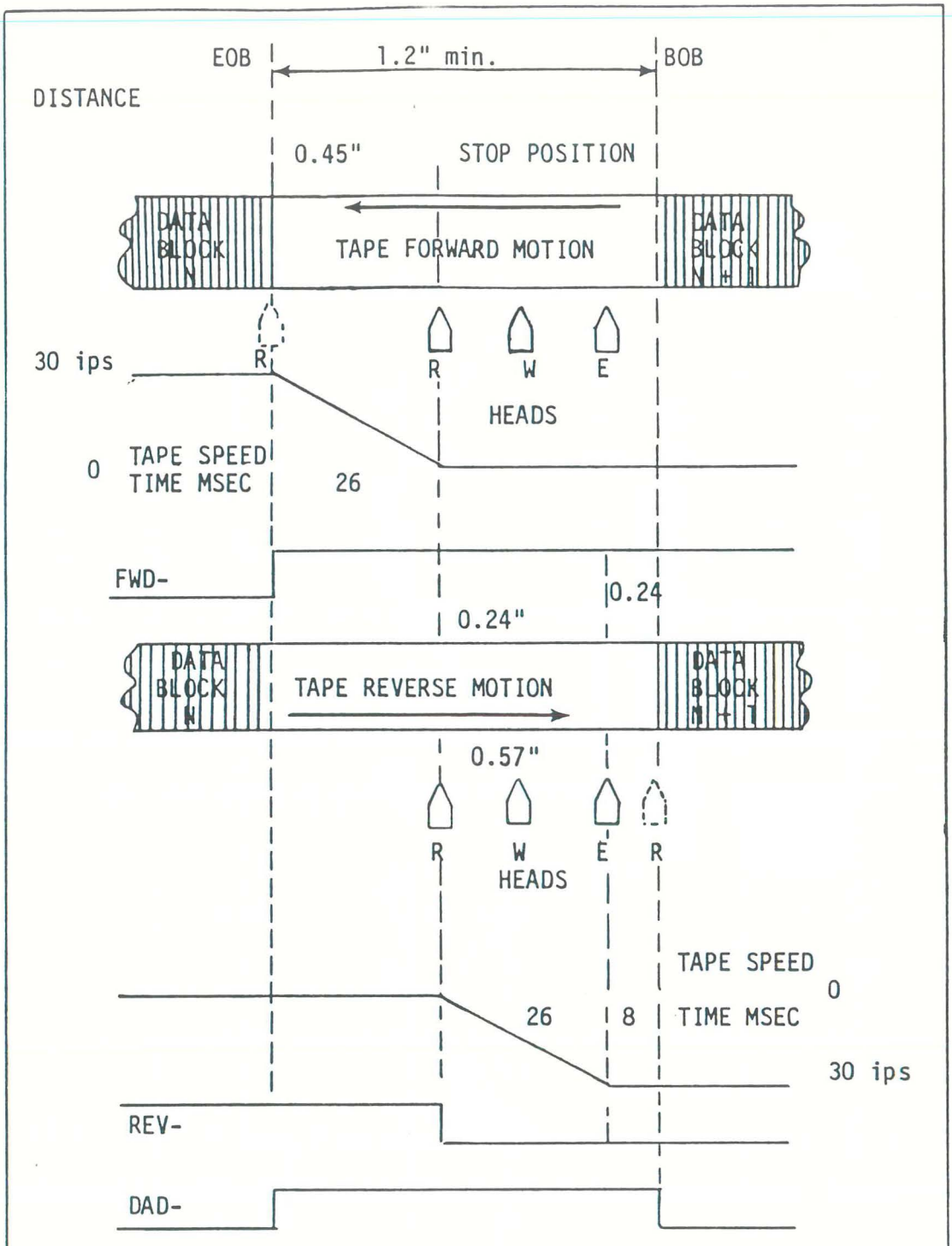


Figure 3-5. Time and Tape Budget for Forward Stop and Start Modes



TIME SCALE REFERENCED TO DISTANCE ON TAPE. TIME IN MSEC. (FIGURE IS NOT TO BE SCALED)

CONDITION	TIME	TAPE DISTANCE IN INCHES
TIME OUT REVERSE STOP DELAY	8 msec	0.24
STOP RAMP	26 msec	0.46

Figure 3-6. Time and Tape Budget for Reverse Start and Stop Modes

3.6 INPUT/OUTPUT SIGNALS FOR BASIC DRIVES

See Table 3-1 for input signals and Table 3-2 for output signals.

SIGNAL	NAME	DESCRIPTION
SL2- SL1	Unit Select 2 Unit Select 1	Up to two drives can share the buss; each can be selected by the signal which corresponds to its internal address which must be specified. The drive will not return status nor accept commands unless selected.
WDA+/-	Write Data	Write data input signal: A phase encoded signal of 48 Kbits/sec. Data rates should not cause more than 3200 frpi to be nominally recorded.
WEN-	Write Enable	To enable writing, the write enable signal must be true (low). Writing will continue until signal goes false; in the case of the Write Data lines being false (high) WEN causes tape to be erased in the standard polarity (i.e., per ANSI specification) Writing is internally disabled by the FIP signal.
ERA-	Erase Enable	To enable erasing, the erase enable signal must be true. This command is applicable to tape drives with erase heads.
FWD-	Forward	Causes forward tape motion. The speed is set by the high speed signal.
REV-	Reverse	Causes reverse tape motion. The speed is set by the high speed signal.
HSP-	High Speed	Causes the tape to move at high speed in the direction set by FWD or REV.
TR2- TR1-	Track 2^1 Track 2^0	Track select two-bit address.

ANSI Track No.	TR2	TR1
1	H	L
2	L	H
3	L	L
4	H	H

TABLE 3-1. Input Signals for Basic Drives

SIGNAL	NAME	DESCRIPTION
FIP-	File Protected	Cartridge installed is protected (i.e., cannot be written on).
BLB-	Bulb	Power is applied to tape drive (+5 VDC present) and sensor bulb is drawing current (is on).
UTH- LTH-	Upper Tape Hole Lower Tape Hole	Either upper (UTH) or lower (LTH) has been sensed. These signals are true for period of sensor activity $\geq 200 \times 10^{-6}$ sec. only. The hole period for simultaneous upper and lower holes (BOT) shall overlap by $\geq 50 \times 10^{-6}$ sec.
CIP-	Cartridge in Place	There is a cartridge installed in the drive.
RDA+/-	Read Data	These signals are replicas of the write waveforms. The read signals are always available for dual gap drives and are available for single gap drives except when WEN is true (-). The threshold levels are internally set depending on the mode of operation. These signals are internally latched and are not preset. A 'zero' bit transition (by ANSI definition) is a low going edge for both read and write signals.

TABLE 3-2. Output Signals for Basic Drives

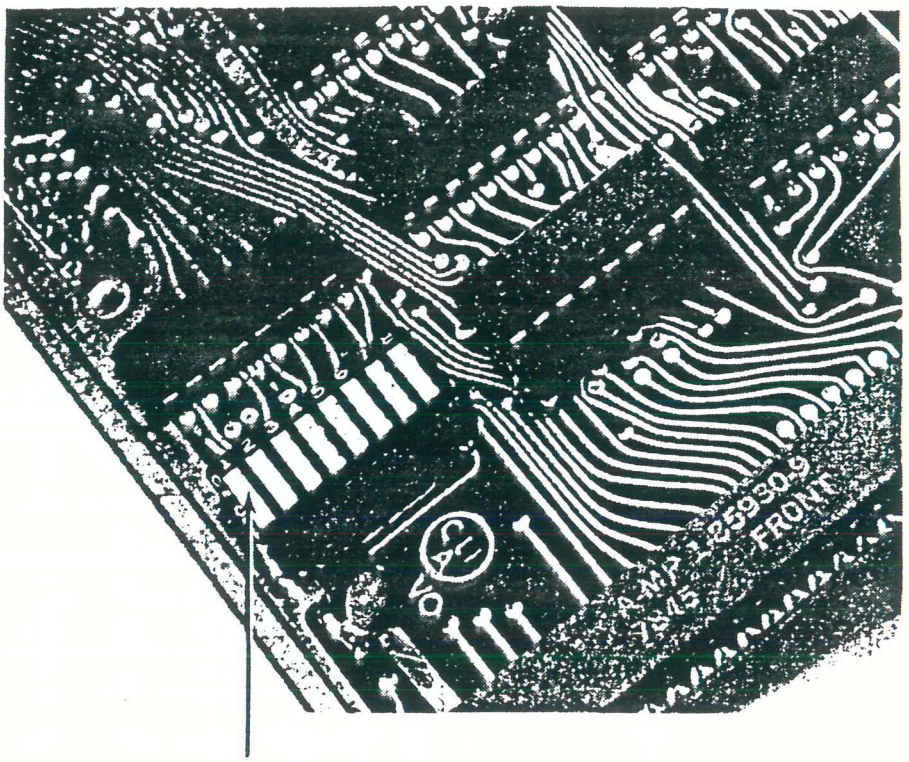
3.7 INPUT/OUTPUT SIGNALS FOR DRIVES WITH A CONTROL BOARD

3.7.1 Input Drive Addressing Signals for Drives with a Control Board

Up to 8 drives can exist on a single buss. Each drive is individually addressed by the signals shown in Table 3-3.

<table>
<tr><th>SIGNAL</th><th>NAME</th><th>DESCRIPTION</th></tr>
<tr><td>SLG-</td><td>Select Gate</td><td>Select Gate. When true, enables selection per the select or address code. It is used to prevent unwanted transient selection during changes in the select address.</td></tr>
<tr><td>SL4-
SL2-
SL1-</td><td>Unit Select</td><td>Unit Select address in the form of a binary number (true low):
$2^2\ 2^1\ 2^0$
wherein 2^2 is SL4-, 2^1 is SL2- and 2^0 is SL1-
The address is decoded by the drive as follows:
<table>
<tr><th>Logical Address</th><th>SL4-</th><th>SL2-</th><th>SL1-</th></tr>
<tr><td>1</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>2</td><td>H</td><td>L</td><td>H</td></tr>
<tr><td>3</td><td>H</td><td>L</td><td>L</td></tr>
<tr><td>4</td><td>L</td><td>H</td><td>H</td></tr>
<tr><td>5</td><td>L</td><td>H</td><td>L</td></tr>
<tr><td>6</td><td>L</td><td>L</td><td>H</td></tr>
<tr><td>7</td><td>L</td><td>L</td><td>L</td></tr>
<tr><td>8</td><td>H</td><td>H</td><td>H</td></tr>
</table>
The drive is equipped with an address switch to provide selection of drive addresses, see Figure 3-7. The switch nomenclature numerically corresponds to the logical address as shown in the table above.
The addressing function proceeds and remains during any other drive input and output function except where noted.</td></tr>
</table>

TABLE 3-3 Input Drive Addressing Signals



UNIT ADDRESS SWITCH U625

Figure 3-7. Address Switch on Control Board

3.7.2 Input Tape Motion Signals for Drives With a Control Board

SIGNAL	NAME	DESCRIPTION
FWD-	Forward	When true, causes the tape to move in a forward direction.
REV-	Reverse	When true, causes the tape to move in a reverse direction.
HSP-	High Speed	When true, causes the tape to move at high speed in the direction selected by either FWD- or REV-. Tape motion will proceed until the command signals go false or: a. In forward,where an EOT hole is encountered, whereupon motion will stop. b. In reverse, where a set of BOT holes is encountered, whereupon motion will stop. c. Both directions are commanded simultaneously, whereupon the tape will stop. d. Rewind command is received which will overrule other motion commands. e. Internal ready signal is not true, whereupon motion will stop. f. In high speed, motion will drop to low speed when an upper hole is sensed.
RWD-	Rewind	When true, causes the tape to be positioned to beginning of tape at high speed. The tape drive must be selected to start a rewind sequence, and may be deselected after the sequence is started. Beginning of tape is defined as between the two innermost (toward the middle of the tape) set of upper and lower holes located at the "head end" of the tape. This location is recommended for unloading the cartridge as the data recording area is completely protected. Rewind will "overrule"all other motion signals. Successive rewind commands will not cause the tape to be "run off". Rewind will stop if the internal Ready signal is false. An automatic rewind sequence is executed when a cartridge is installed in the tape drive or when power is applied after cartridge is installed.

TABLE 3-4 Input Tape Motion Signals

3.7.3 Input Data Signals for Drives With Control Board

<table>
<tr><th>SIGNAL</th><th>NAME</th><th>DESCRIPTION</th></tr>
<tr><td>TR2-
TR1-</td><td>Track 2^1
Track 2^0</td><td>Track select address: a binary number (true low) in the following form:
2^1, 2^0 wherein 2^1 is TR2 and 2^0 is TR1. The track selection is decoded as follows:
<table>
<tr><th>TRACK NUMBER (ANSI)</th><th>TR2</th><th>TR1</th></tr>
<tr><td>1</td><td>H</td><td>L</td></tr>
<tr><td>2</td><td>L</td><td>H</td></tr>
<tr><td>3</td><td>L</td><td>L</td></tr>
<tr><td>4</td><td>H</td><td>H</td></tr>
</table>
The track selection will select all heads for a given track (i.e., erase, write, and read) as appropriate.</td></tr>
<tr><td>WEN-</td><td>Write Enable</td><td>When true, enables the writing and erasing functions for the selected track. The writing and erasing processes occur only if the cartridge is in the unprotected state (not safe). This signal is internally latched and will remain set unless reset by:
-Reverse or High Speed commands.
-Internal Ready signal, not true.</td></tr>
<tr><td>WDA+/-</td><td>Write Data</td><td>Will modulate the write head to produce a recorded wave form on tape when WEN- is true and the cartridge is in the unprotected state (not safe).
In WDA+ (unactuated) state, the tape will be erased in the ANSI fashion. The WDA- state will cause the opposite polarity to be recorded. Therefore, if no erase head is used, erasing can be done by using the write head.
The minimum nominal clock period for data input should not allow the nominal resultant number of flux reversal from exceeding 3200 per inch (1,260 flux reversal per cm) and the rise and fall times should not be greater than .5 microseconds.
An ANSI defined "zero" data transition corresponds to a low going edge of the WDA signal.</td></tr>
</table>

TABLE 3-5 Track Select and Input Data for Drives With Control Card

3.7.4 Output Status Signals for Drives With Control Board

SIGNAL	NAME	DESCRIPTION
SLD-	Drive Selected	Will be true when the tape drive has receive its proper unit address.
RDY-	Drive Ready	Will be true when a cartridge is installed, the sensor lamp is drawing current, and the +5 Vdc is applied to the tape drive.
BSY-	Drive Busy	Will be true when the tape drive is in an automatic rewind sequence (i.e., when a cartridge is first installed in the tape drive), or when the tape drive is executing a rewind, forward, or reverse command. This signal will go true when the command is received and will remain true until the motion has stopped (i.e. ≈ 30 milliseconds after low speed motion has been commanded to stop and ≈80 milliseconds after ≈90 ips operation has been commanded to stop). In the case of receipt of a non-executed or illegal command, (FWD at EOT or REV at BOT), this signal will not be true, indicating the command is rejected.
FLG-	Flag	Will be set and latched when an automatic sequence to position the cartridge to BOT has been executed, or a rewind has been completed. This signal is reset by subsequent receipt of a FWD command.
WND-	Write Enabled	Will be true when a write enable condition is latched within the tape drive.
FUP-	File Unprotected	Will be true when a cartridge is installed and it is in the unprotected state (i.e., when the SAFE plug on the cartridge is NOT in the SAFE position.
LPS-	Load Point Sensed	Will be set and latched when the upper load point hole (the warning of beginning of tape) is passed in the reverse direction. This signal will be internally reset when the load point hole is subsequently passed in the forward direction. When this signal is true, high speed will be disabled. Reverse tape motion is allowed to proceed until the BOT holes are encountered where the tape drive will stop and accept only forward commands.

TABLE 3-6 Output Status Signals for Drives With Control Board

SIGNAL	NAME	DESCRIPTION
EWS-	Early Warning Sensed	Will be set and latched when the upper warning hole (the warning at end of tape) is passed in the forward direction. This signal will be internally reset when the early warning hole is subsequently passed in the reverse direction. When this signal is true, high speed is disabled. Forward tape motion is allowed to proceed until the EOT hole is encountered where the Tape Drive will stop and accept only reverse commands.

TABLE 3-6 (Cont'd) Output Status Signals for Drives With Control

3.7.5 Output Data for Drives with Control Board

SIGNAL	NAME	DESCRIPTION
RDA+/-	Read Data	This signal is a replica of the WDA data written onto the tape. The RDA line is latched and its initial state is not preset; hence, initially the RDA line may be high or low. Conditions can occur during erased portions of the tape that can set the RDA line in the opposite state. A filter is recommended to prevent passage of transitions unless, or until, at least four properly timed sequential transitions have occurred. The read signal is always available in dual gap drives, except when WEN has been set for single gap drives. The threshold levels are internally set as a function of the mode of operation. An ANSI defined 'zero' data transition shall correspond to a low going edge of the RDA signal. The threshold levels are internally set to three different levels depending on the write and motion commands. Read threshold occurs when running at low speed when writing. Search threshold occurs when running at high speed.

TABLE 3-7 Output Data for Drives With Control Board

3.8 INPUT/OUTPUT SIGNALS FOR DRIVES WITH CODEC BOARDS

Paragraph 3.7.1 describes input signals and Paragraph 7.4 describes output signals. All drives equipped with Codec Boards are also supplied with control boards which cover the above signals except WDA and RDA signals which are replaced by signals given in Table 3-9.

3.8.1 Input Signals for Drives With Codec Boards

SIGNAL	NAME	DESCRIPTION
WDE-	Write Data Enable	A control level input which enables write data encoding (the sending of write data strobes and the writing of data on tape). The WEN-function is still required and will enable both writing and erasing. After cartridge is up to speed and other conditions are met, WDE-true will cause the drive to send the first data strobe and commence to record flux transitions on tape. The first strobe is sent ≤ 21 µsec after WDE- goes true. All data to be written must include preambles, check characters and postambles.
WNZ-	Write Non-Return Zero Data	During the write data strobe period, the state of the input write data line is sensed as follows: WNZ = Low = 1, True WNZ = High = 0, False The state of WNZ- is examined only during the write data strobe period. The WNZ- signal must be steady 0.5 usec prior to the write data strobe true period (WDS = Low) and remains during the strobe true period: 5.2 µsec.
DAD-	Data Detected	Will be false except when data has been detected. Data detected requires at least 12 'zeros' and a 'one' without an intervening period of more than 50 microsec (without a data transition). This signal can be used to sense the presence of a block of data. This signal internally strips the preamble from the read data signal and is used to enable the data output signals.
RNZ-	Read Non-Return to Zero Data	During the read data strobe period, if RNZ- is low (true), then the data is a 'one'; if high, then the data is 'zero'. The RNZ signal will remain steady during the RDS true period.

TABLE 3-8 Output Signals for Drives With Codec Boards

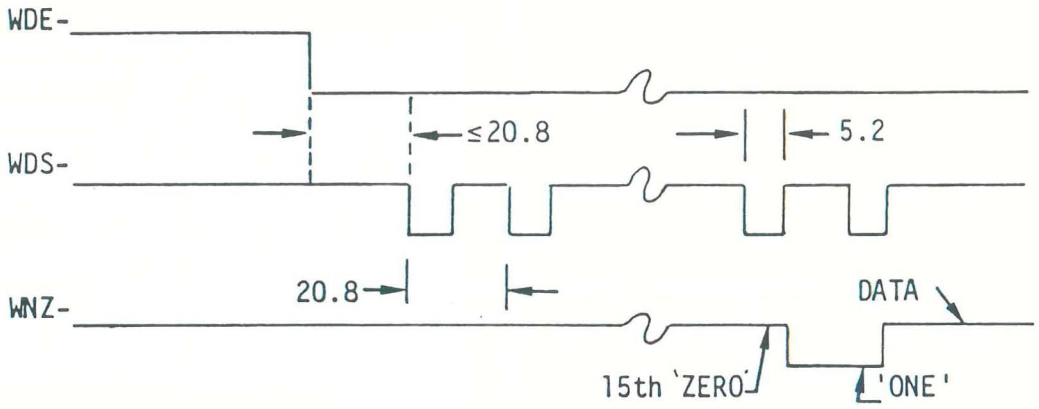
SIGNAL	NAME	DESCRIPTION
WDS-	Write Data Strobe	The write data strobe is generated within the Codec Board and is output to indicate when the drive is examining the state of the WNZ- signal (taking data). The low or true strobe period is 5.2 usec ± 5%.
RDS-	Read Data Strobe	Read Data Strobe. Will be low for 0.3(-50% + 150%) µsec. Read data in the forward direction will have the preamble removed but will stay true for all of the postamble and for approximately 50 µsec after the postamble has passed. (Therefore, CRCC - Cycle Redundancy Check Character - and postamble must be stripped in forward direction and the CRCC and preamble must be removed in the reverse direction.) To first set read data, 12 'zeros' must be sensed. A drop-out will disable RDS if it exists for more than 50 X 10^{-6} sec. and no read data will be available for at least 210 µsec. The read data threshold levels are internally set to three different levels depending on the write and motion commands. Read only threshold occurs when running at low speed without writing. Write threshold occurs when writing.. Search Search threshold occurs when running at high speed. The use of these threshold levels allows for the verification and establishment of the required data reliability margins during the read-while-write check.

TABLE 3-8 (Cont'd) Output Signals for Drives With Codec Board

3.9 SIGNAL TIMING FOR DRIVES WITH CODEC BOARD

Figure 3-8 defines the timing relationships necessary for input/output signals necessary for drives with Codec boards.

1. Write Timing:



2. Read Timing:

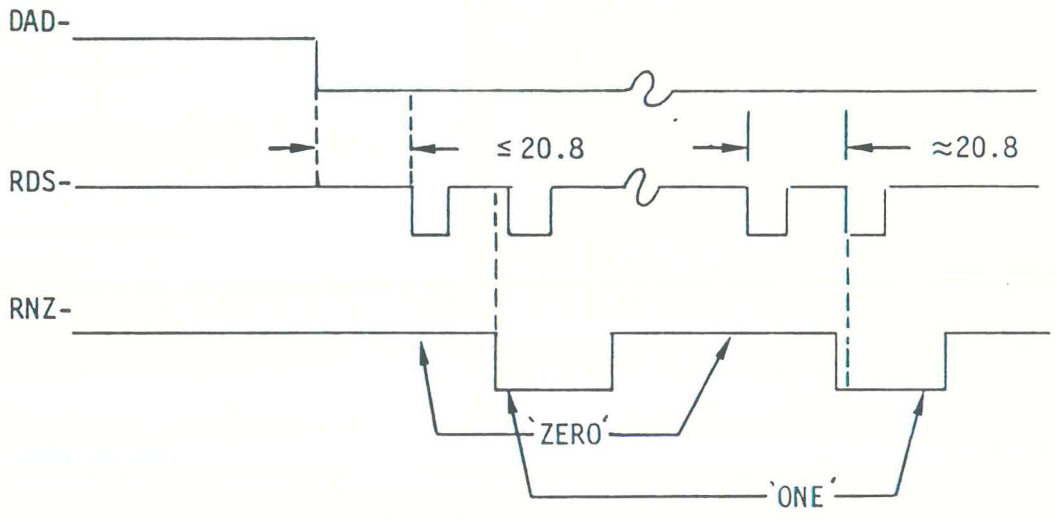


Figure 3-8. Input/Output Timing Signals for Drives with Codec Boards

3.9.1 Recording Format (ANSI X3.56-1977) (Figure 3-9)

The recommended ANSI recording format is shown in Figure 3-9. The format includes preamble check characters, and postambles.

1. Pre and Postambles: An appended non-data bearing pattern of fifteen (15) 'zeros' followed by one (1) 'ones' shall be added to the beginning of each data block. This pattern is called preamble. The reverse pattern (i.e., one (1) 'one' followed by fifteen (15) 'zeros') shall be added to the end of each data block. This pattern is called a postamble.

2. Check Characters: Any check characters shall be agreed to by the interchanging parties. The ANSI check character is a 16 bit number represented by the polynomial

$$X^{16} + X^{15} + X^2 + 1$$

Hence a data block is:

15 'zeros'; 1 'one', Data, Check Character, 1 'one', and 15 'zeros'.

3.10 THE INTERBLOCK GAP

The minimum interblock gap (IBG) shall be 1.2 inches. The interblock gaps shall be erased using a dc erase technique, and shall conform to the ANSI Std. polarity. An interblock gap is created by commanding WEN true, or for drives without a control board by commanding WEN and ERA true.

3.11 TAPE MARK

The ANSI tape mark consists of a preamble, two bytes of eight 'zero' bits each.

3.12 NUMBER OF TRACKS

There are four recordable tracks.

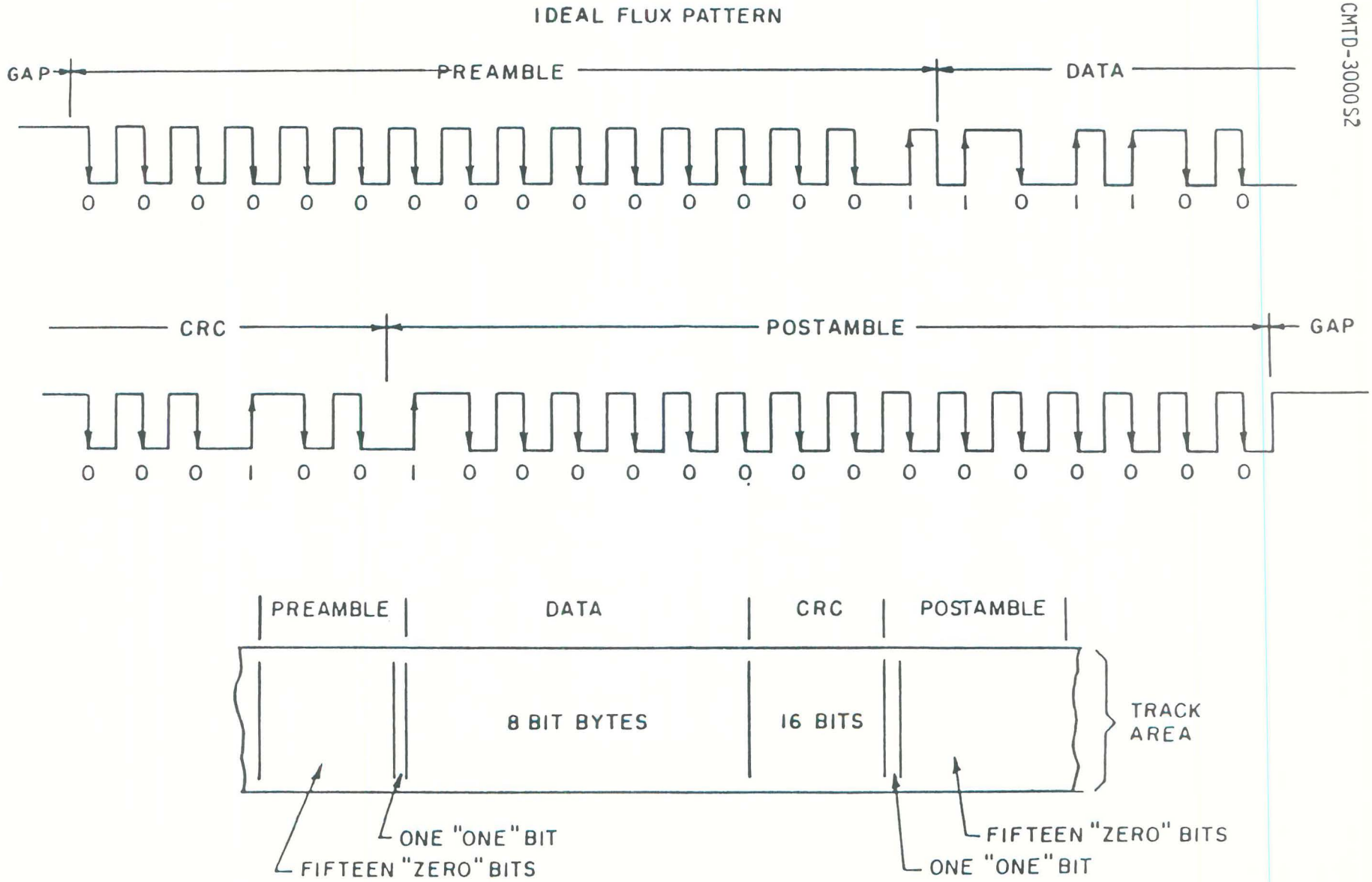


Figure 3-9. Record Block

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section describes the functions of various boards and major components, as well as the functions of status, data, and control circuitry Refer to Figure 4-1.

4.2 MAJOR COMPONENT FUNCTIONS

4.2.1 Head Assembly

The head assembly consists of a closed magnetic circuit constructed of laminated high permeability metal with wound coils for inducing and detecting flux reversals on magnetic tape. The head assembly has separate read and write functions, and , if supplied with erase, this shall be a separate function.

4.2.2 Data Board

This board, containing the analog read and threshold detection circuitry, write data circuitry, erase circuit, and the track selection circuitry, connects directly to the magnetic head assembly. Refer to Figure 4-2 for a block diagram of the data board.

4.2.3 Sensor Assembly

The switch/sensor assembly contains circuitry for sensing the Beginning-of-Tape holes, End-of-Tape holes, Load-Point hole, and Early-Warning hole. This assembly also contains the File Protect and Cartridge-in-Place switches.

4.2.4 Heat Sink Assembly

The heat sink assembly contains the capstan motor assembly, power transistor circuits, and a heat sink. This plug-in module is center-of-gravity mounted so that the capstan maintains proper pressure on the cartridge drive roller regardless of drive position or attitude.

4.2.5 Servo Board

The servo board drives the dc capstan motor; it provides all necessary servo control logic for translating digital tape motion control commands into analog capstan motor signals and processes the capstan tachometer signal to provide accurate motor speed regulation. Its voltage regulators develop the $\pm$ 15 volts and the -5 volts required by the various drive subassemblies. In addition, it provides the power shut-down circuit that automatically stops the drive motor in the event of power failure.

4.2.6 Control Board (Optional)

This board performs some of the tape motion control functions normally performed by the controller and thus simplifies interface design. Specific functions include:

a. Eight position unit address switch allowing up to eight drives to share a common I/O buss.

b. Forward motion prevention at end of tape.

c. Reverse motion prevention at Beginning-of-Tape.

d. High Speed operation permitted between load point and early warning holes only.

e. Simultaneous forward and reverse commands will stop the tape.

f. Drive internally completes automatic and externally commanded rewind sequences.

g. Automatic positioning to BOT holes on cartridge installation and power up.

h. Write Enable (WEN) is internally latched and reset by High Speed (HSP-), REV-), or Not Ready (RDY- false).

i. Bulb (BLB-), Cartridge-in-Place (CIP) and +5V Supply gated to produce a Ready (RDY-) status signal.

j. Busy (BSY-) status signal is true during tape motion; remains true during periods of tape motion.

k. A Flag (FLG-) status signal is provided to indicate completion of a rewind operation.

l. A Write Enabled (WND-) status signal is provided, indicating Write Enable has been latched.

m. Multiple rewind commands will not cause tape run-off.

n. Indicator drivers are provided for the operator control panel.

o. Unit address signals are provided for the operator control panel.

4.2.7 Interconnect Board

Besides functioning as a motherboard for the other circuit boards, the interconnect board can contain provisions for line termination in the case of drives without control boards and has a manual control and indicator socket for drives with control boards. Figure 4-3 illustrates the function of the interconnect board.

4.2.8 Codec Board (Optional)

This board performs two major functions:

a. Encoding. (NRZ to PE conversion of write data).

An internal oscillator generates a strobe signal which is encoded with NRZ write data to produce self-clocking phase encoded signal.

b. Decoding. (PE to NRZ conversion of read data).

Differential PE encoded read data is separated into a single-ended NRZ read data strobe and NRZ data. The preamble is automatically removed from the read data prior to transmission.

4.3 TAPE DRIVE STATUS SIGNALS

Table 4-1 illustrates the status signals available for each drive configuration.

STATUS	DESCRIPTION	BASIC	WITH CONTROL	WITH CODEC
FIP-	File Protected	X		
BLB-	Bulb	X		
LTH-	Lower Tape Hole	X		
CIP-	Cartridge In Place	X		
UTH-	Upper Tape Hole	X		
SLD-	Selected		X	X
RDY-	Ready		X	X
WND-	Write Enabled		X	X
FLG-	Flag		X	X
LPS-	Load Point Sensed		X	X
FUP-	File Unprotected		X	X
BSY-	Busy		X	X
EWS-	Early Warning Sensed		X	X
DAD-	Data Detected			X

TABLE 4-1. Status Signals

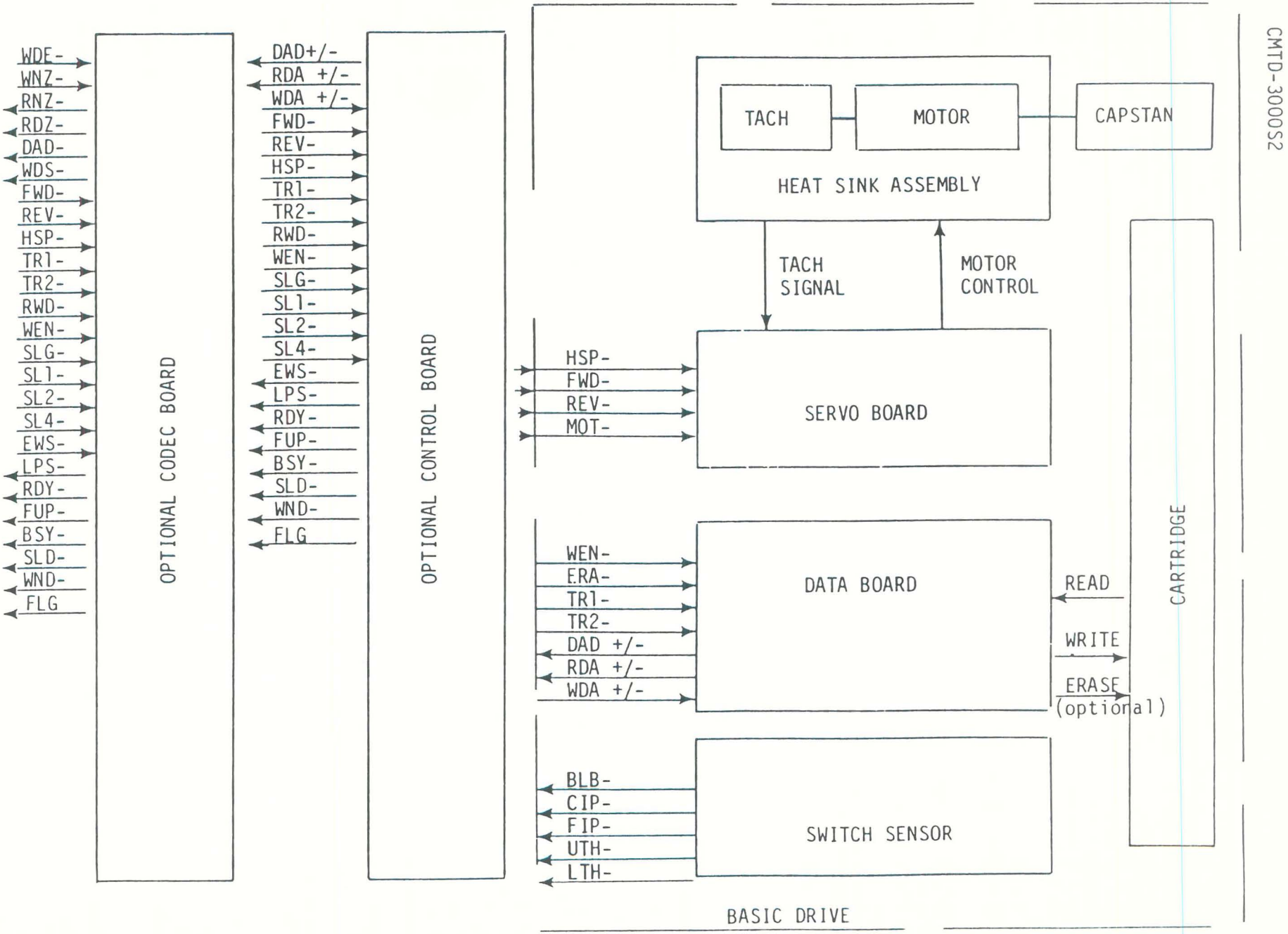


Figure 4-1. Drive Block Diagram

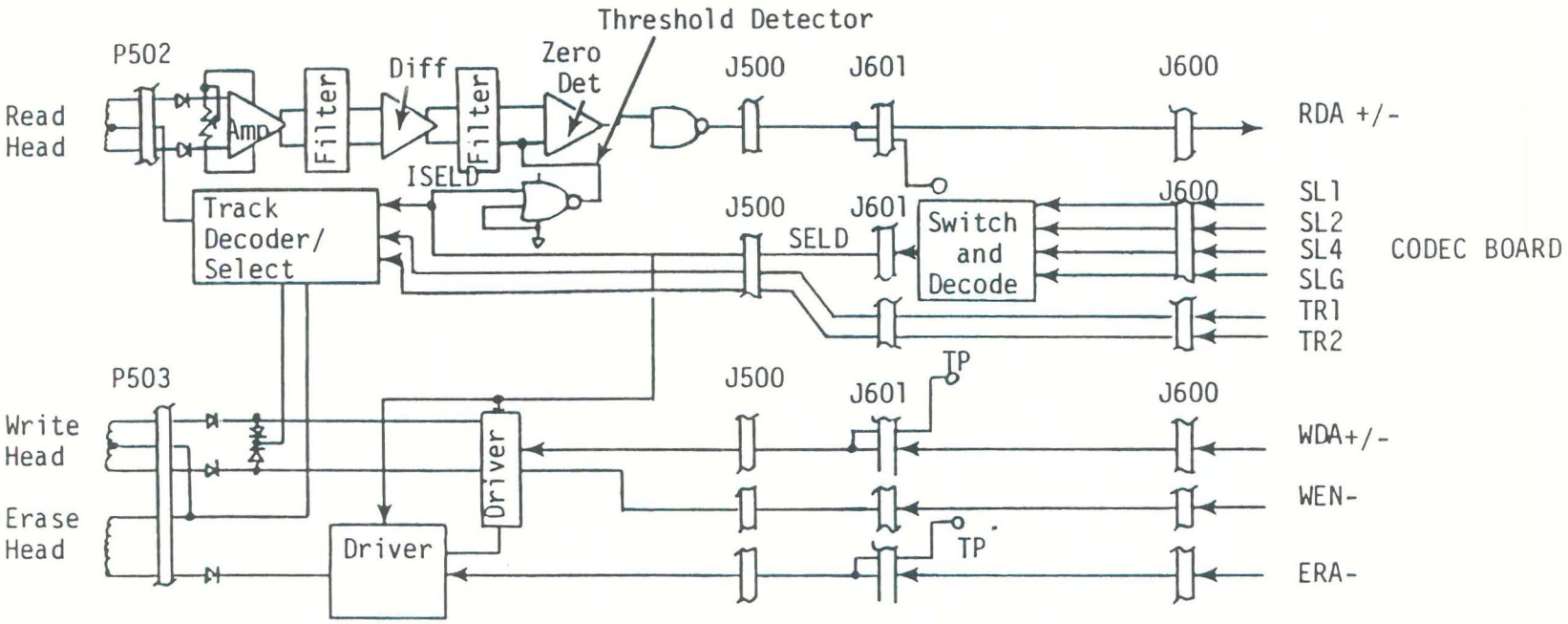


Figure 4-2. Read/Write/Erase Circuits Block Diagram (Data Board)

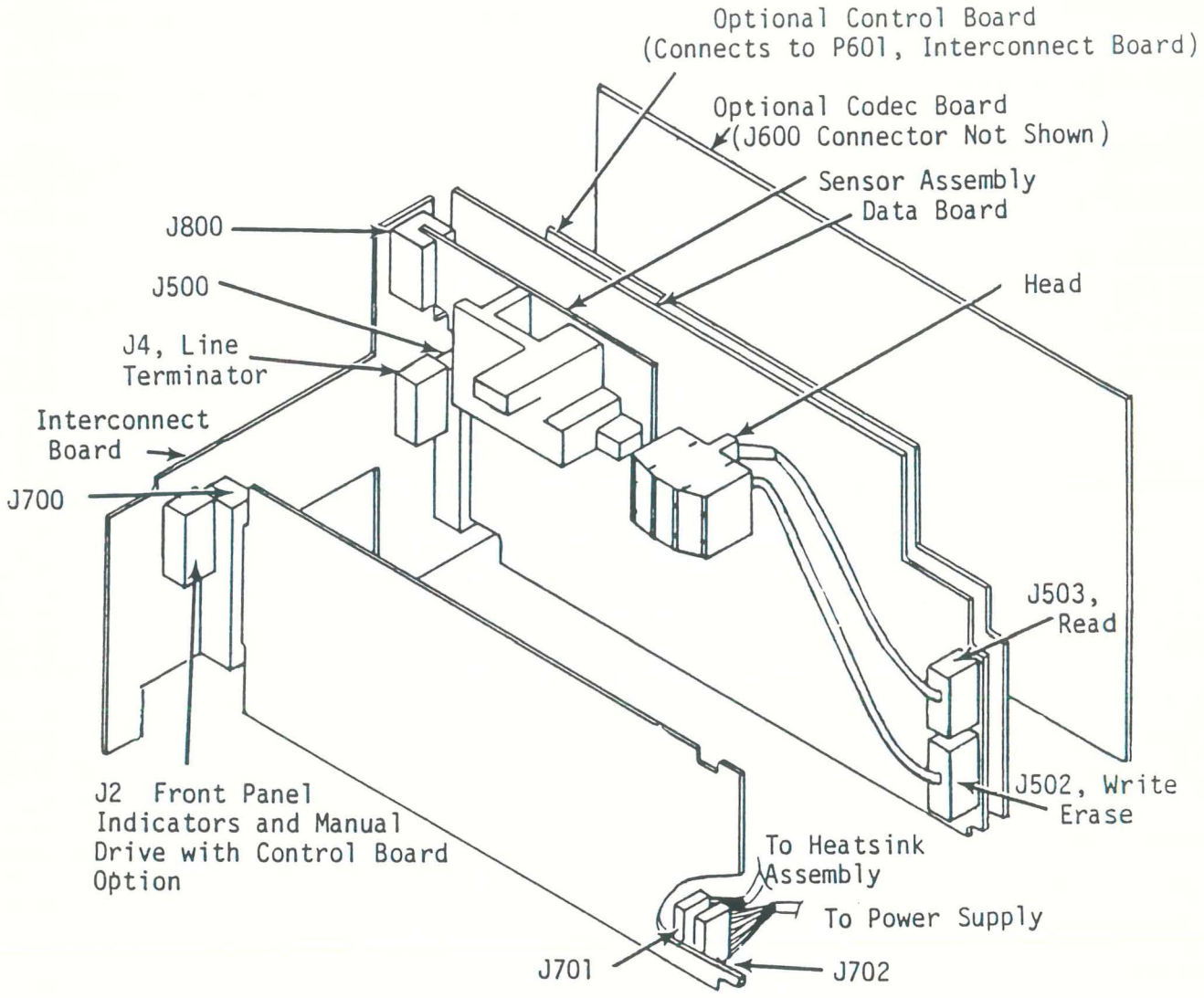


Figure 4-3. Major Subassembly Interconnections

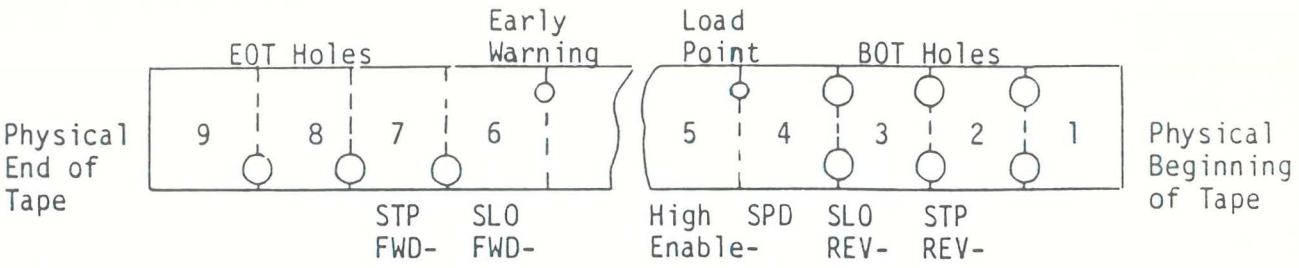


Figure 4-4. Tape Control Zones

Drive Selected (SLD-) true:	SL1, SL2, SL4 are decoded and equal to drive address as programmed on switch and SLG true.
Ready (RDY-) true:	Bulb (BLB-) true Cartridge in Place (CIP-) true V5+ true
File Unprotected (FUP-) true:	File Protect false Drive Ready true
Load Point Sensed (LPS-) true:	Slow Reverse true or Stop Reverse true
Flag (FLG-) true:	Flag. Will be set and latched when an automatic sequence to position the cartridge to BOT has been executed, or a rewind has been completed. This signal is reset by subsequent receipt of a FWD command.
Write Enabled (WND-) true:	Reverse false Auto Rewind Sequence false Rewind false High Speed false Write Enable was set true
Early Warning Hole Sensed (EWS-) true:	Slow Forward true or Stop Forward true
Drive Busy (BSY-) true:	Auto Rewind Sequence true or Forward true or Reverse true or Timer true (30/80 msec after motion command is false)

TABLE 4-2 Status Signal Truth Table

4.3.1 Status Signals Basic Drive

Status signals to the controller/formatter vary, depending upon whether or not a control board is employed. In the basic drives (without control board), the status signals from the sensor and data boards are output directly to the controller through the interconnect board. These signals are: Bulb (BLB-), Cartridge-in-Place (CIP-), File Protected (FIP-), Upper Tape Hole (UTH-), and Lower Tape Hole (LTH-). Two microswitches in the sensor assembly determine the state of the Cartridge-in-Place (CIP-) and File Protect (FIP-) signals. CIP- goes low true whenever a cartridge is installed, closing the right-hand switch as seen from the front of the drive. With the cartridge engaged, the left-hand File Protect switch will be closed only when the File Protect indicator arrow on the cartridge points away from the SAFE position. Under this condition, FIP- false will be issued to enable write operations. BLB- true indicates the photosensor's bulb is operating. If this bulb's filament opens, BLB- goes false, and the controller should disable tape motion commands. Upper Tape Hole (UTH-) and Lower Tape Hole (LTH-) status signals go true whenever an upper or lower tape hole passes the sensors. The hole patterns shown in Figure 4-4 must be decoded to indicate tape position to the controller. Due to tape skew and other factors, Upper and Lower Hole combinations may not be detected simultaneously though the signals will overlap.

4.3.2 Status Signals (Drives With Control Boards)

Status Signals from Control Board. In drives having control boards, the status signals are: Selected (SLD-), Ready (RDY-), Write Enabled (WND-), Flag (FLG-), Load Point Sensed (LPS-), File Unprotected (FUP-) Busy (BSY-) and Early Warning Sensed (EWS-). The control board performs tape control and status signal generating functions which would otherwise be performed by the controller. When the drive is first selected by the controller, the state of select line SL1-, SL2-, SL4, and Select Gate (SLG-) true are decoded and matched against the unit select switch setting. If the cartridge is inserted, the tape sensor bulb is illuminated, and +5V is present, then the Ready (RDY-) will be true indicating the drive is ready for its first command. FUP-, File Unprotected, is produced by gating the status of the RDY- and FIP- signals. Thus, FUP- true is used to tell the controller to not attempt write operations whenever an installed cartridge's File Protect switch is in the SAFE position.

LPS-, Load Point Sensed, goes true to indicate the Load Point hole has been detected in reverse. Slow Reverse and Stop Reverse, two internally generated commands, are OR'ed together to develop the LPS- true status. Slow Reverse is issued after the tape passes the Load Point hole. Stop Reverse replaces Slow Reverse when the Beginning-of-Tape holes are sensed. LPS- goes false after the Load Point hole is sensed in the forward mode.

Flag (FLG-) signal is set true to indicate a rewind operation or an automatic rewind sequence has been completed.

FLG- is reset false after a Forward command is received.

WND-, Write Enabled, is latched true when the drive is selected, File Protect is false and WEN- has been issued by the Controller. WND- will go false when WEN is reset by the receipt of a Reverse or High Speed command.

EWS-, Early Warning Sensed, goes true to indicate the Early Warning hole has been detected during forward tape motion. EWS monitors the state of two internal tape motion commands, Slow Forward and Stop Forward. As with the Slow and Stop Reverse signals, these commands are OR'ed. Slow Forward goes true when the Early Warning hole is detected in the Forward tape mode. Stop Forward goes true when the first End-of-Tape hole has been sensed. EWS- goes false when the Early Warning hole is sensed in reverse.

Busy, BSY, true status signal is issued to the controller when the drive is executing a rewind, forward, or reverse command or is engaged in an automatic rewind sequence following cartridge loading. BSY- will go false approximately 30 msec after low speed tape motion has been commanded to stop and approximately 80 msec after stopping a high speed tape motion. BSY- remains false following receipt of an illegal or unexecuted command. Table 4-2 illustrates the status signals from drives with control boards.

4.4 TAPE MOTION CONTROL

With the cartridge inserted, a lamp within the Sensor Assembly will illuminate either or both the top and bottom hole photosensors on the sensor board whenever a tape position hole is present. The sensor board outputs Upper and Lower Tape Hole true signals which are passed directly to the controller in drives without control boards after gating with drive select.

The control board utilizes the tape holes to control tape position so that the tape cannot run forward beyond the second End-of-Tape holes. The tape is divided into nine zones as shown in Figure 4-4.

Zones 3 through 7 are the only permissible zones for tape motion; Zones 1, 2, 8, and 9 are close to the physical tape ends and are, therefore, not allowed operationally. In fact, should one of these prohibited zones be detected in a drive with a control board, an internally generated ALARM signal is activated, causing the drive to automatically reposition the tape to Zone 3, the starting position. The zones are counted by using the upper and lower tape hole pulses to increment (in forward mode) or decrement (in reverse) an up/down counter; the counter states are then decoded into the zone positions. When Zone 6 is detected with tape moving forward, A SLO FWD command is issued. After Zone 7 is reached, a STP FWD command is issued to stop tape motion. SLO REV- and STP REV- are similarly output when Zones 4 and 3 are detected in reverse. High speed operation is permitted only in Zone 5.

4.4.1 Automatic Load Sequence (Drives with Control Boards)

When the cartridge is first inserted with the drive under power and BLB- is true, CIP true initiates the following automatic sequence to locate the beginning-of-tape:

1. All tape motion is delayed approximately one second to: (1) Allow for voltage stabilization during power-up, (2) human factors, allowing the operator to release the cartridge prior to motion, (3) to prevent erroneous tape hole sensing during cartridge insertion.

2. Tape runs forward for approximately 1 second to clear the third set of BOT holes. If a lower tape hole is sensed, the tape will stop and wait for the time to elapse. Tape then runs in reverse until the third set of BOT holes is again detected (Zone 3). The ARS (Auto Rewind Sequence) signal goes low true, force load- the counter with the binary equivalent of decimal 3.

3. This count state indicates the tape is in Zone 3. The decimal 3 line on the decoder goes low, issuing a STP REV- command to stop reverse tape motion and issue appropriate status.

4.4.2 Servo Operation

The servo board develops the proper analog motor control current from the digital motion control commands. The servo stages include a reference voltage generator, ramp generator, servo amplifier, power amplifier, and voltage regulators. High Speed, Forward, Reverse and Motion (selected commands) are applied to a reference generator. These signals are external commands to drives without a control board, and internal commands if the control board option is used.

When MOT is true with a forward or reverse tape motion command present, the reference generator develops the appropriate positive or negative voltage level to initiate the operating speed set by HSP.

Immediately after tape speed and direction are determined, the ramp generator initiates a linear ramp to the final servo reference voltage level. Ramp times are determined by an adjustable R-C network.

Ramps to and from the normal 30 ips tape speed are 23 msec, high speed 90 ips ramps are 69 msec. The ramp generator outputs a stable servo reference voltage after the ramp period is complete. The servo loop uses this reference voltage and sums it with the voltage from the tachometer. Various other feedback voltages are added into the summing network at the input of the servo amplifier. The tachometer is attached directly to the motor shaft and its output is approximately 2.4 Vdc/ 1000 rpm. Both motor and tachometer are in the same housing.

Two Darlington transistor pairs control forward or reverse motor current in proportion to the positive (forward) or negative (reverse) servo amplifier output. The -24 Vdc is used for forward tape motion; reverse tape motion uses the +24 Vdc supply. Ramp time, tape speed, speed balance (reverse mode speed adjustment) and dc offset adjustments are provided and described in the maintenance section. The servo board also contains the voltage regulation network, which produces +14 Vdc, ±15 Vdc, and -5 Vdc regulated voltages from the ±24 Vdc primary inputs. Two voltage regulators (adjusted for equivalency) develop ±15 Vdc. There is also one regulator used to supply -5 Vdc for the data board.

4.5 READ/WRITE OPERATIONS

All data operations are performed on the data board. This board contains: read data amplifier, low pass filters, zero crossing detector, read threshold circuits, the write head driver, erase head driver, and track select circuitry.

The 1600 bpi input data must be converted from NRZ to Phase Encoded form, then reconverted into NRZ data from the Phase Encoded Read signals. This function is performed by either an encoder/decoder external to the drive or by the optional Codec Board.

4.5.1 Write Data Recording

Without the Codec Board, encoded data (WDA+/-) is applied to the write head driver. The resulting flux reversal pattern is recorded on a particular tape track. Control board or user-produced Write Enable (WEN-) true must be present to enable write operations. To write data with drives not employing Codec Boards, the 1600 bpi Phase Encoded data must be inputted and applied to the selected write head by the data board. (Figure 1-4).

In units employing Codec Boards, NRZ formatted data enters the drive as WNZ-, (WNZ low = 1 and WNZ high = 0). The Write Data Strobe (WDS-) is generated by the Codec Board and the phase encoding uses a 1.92 MHz crystal controller oscillator. This basic oscillator frequency is divided by two series-connected counters. The crystal clock is divided by 40 to produce the 48 KHz data transmission rate required for 1600 bpi data packing density. The write clock is used to encode the data and phase transitions required by the Phase Encoded format.

The circuit is organized so that Write Data Enable (WDE-) and Unit Select from the interface must be true before write data strobes are issued and data is sent to the data board. Improper conditions, such as cartridge protected, disable the write function.

4.5.2 Read Data Generation

Read data is routed to the interface or to the optional Codec Board as RDA+/-. Read data is obtained by sensing the flux transitions on the tape. If the read signal level exceeds a predetermined threshold level, the data is outputted. During Read-Only operation, the threshold of the zero crossing detection comparitor is set to 90 mV. Signals which exceed this level are passed to the interface or routed to the Codec Board. During Read-While-Write, High-Speed Search, or Rewind operations, the threshold of the detection comparitor is set to 220 mV. Any signals which exceed this level are passed to the interface and outputted from the drive, or routed to the Codec Board.

The data board contains a read head selection switch, one stage of linear read data amplification, a low pass filter, a zero crossing detector, and a TTL line drive.

In drives without Codec Boards, the read data (RDA+/-) signal is outputted to the interface when the positive and negative read signal levels equal, or exceed approximately 90 mV during a normal read operation, 220 mV during a read-while-write check, 500 mV during a high speed search. The outputting of data is not a sufficient criteria for good data integrity. All data must be verified for accuracy.

When a Codec Board is employed, the phase encoded read data is processed by a data separator on the Codec Board. This board: (1) strips the preamble from the read data prior to transmitting it to the interface, (2) converts phase encoded read data to the NRZ format, (3) develops the Data Detected (DAD-) signal and the Read Data Strobe (RDS-) clock pulses. Preamble stripping is performed by a counter which counts to 12 preamble zeros prior to recognizing data. The data separator adjusts the recovery window based on actual period information extracted from the read data signal. The duration of the data separator period is adjustable and set as shown in Section 6.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section contains periodic maintenance, trouble-shooting, removal and installation of parts, testing, and maintenance considerations.

5.2 PERIODIC MAINTENANCE

Refer to Figure 1-1 for location of parts requiring periodic maintenance.

5.2.1 Cleaning Magnetic Head

CAUTION

Spray type head cleaners are not recommended because overspray may contaminate the motor bearings. Also, never clean the head with hard objects. This will result in permanent head damage.

The magnetic head should be cleaned daily if the tape drive is in regular use. Dirty heads may cause data dropouts during read operations. Use a non-residue, non-corrosive cleaning agent, such as duPont Freon TF, isopropyl alcohol, or similar solvents, and a cotton swab to clean the head assembly. Be sure to wipe up any excess and allow the heads to dry prior to operating the drive.

5.2.2 Cleaning Tape Cleaner

CAUTION

Do not use hard objects to clean the tape cleaner. If the tape cleaner should become chipped, it could scratch the tape surface, resulting in lost data and/or permanent tape damage.

The tape cleaner removes loose tape oxide and other foreign material from the tape before it contacts the head. This foreign material accumulates in and around the tape cleaner and must be removed to ensure that the tape cleaner will continue to work effectively. The tape cleaner should be cleaned on the same schedule as the head.

To clean, insert a folded sheet of paper in the bottom of the cleaning slot of the cleaner. Slide the paper up, lifting the foreign material from the cleaner. A soft brush may be used to remove the foreign material from the area around the tape cleaner and head assembly. The tape cleaner can be cleaned using the same materials used to clean the magnetic head.

5.2.3 Cleaning Motor Capstan

CAUTION

Be very careful not to permit cleaning solvent to contaminate the drive motor bearings.

The drive capstan should be cleaned on the same schedule as the head. It is composed of hard polyurethane and must be cleaned after foreign material has built up. Use isopropyl alcohol and a cotton swab to clean the drive capstan.

5.2.4 Cleaning Heat Sink, Circuit Boards, and Sensor Holes

To prevent possible overheating, dust and dirt should be removed from the heat sink and drive assembly components (removable). The time period between cleanings will vary widely, depending upon the operating environment. Use a soft brush and/or compressed air for cleaning.

5.3 TROUBLESHOOTING

The information provided in these paragraphs is intended to assist the operator in analyzing and locating system faults. This analysis consists of determining the particular malfunction and, with the aid of troubleshooting flow charts, locating the probable source.

To locate a particular fault, the user first determines the general category of malfunction by noting the various symptoms listed under the paragraph entitled "Troubleshooting Symptoms". Specific malfunctions are also listed to further define the general category.

Once the general category of a malfunction has been determined, the operator locates this category on page 1 of the Troubleshooting Flow Chart (Figure 5-2). This chart directs the operator to perform particular tests, depending upon the nature of the fault, thereby isolating the malfunction to a repairable level.

5.3.1 Troubleshooting Symptoms

A. Power Malfunction

1. Drive blows +24 Vdc fuse in power supply or draws excessive current.
2. Drive blows -24 Vdc fuse in power supply or draws excessive current.
3. Drive blows +5 Vdc fuse in power supply or draws excessive current.

B. Tape Motion Malfunction

1. Drive will not run in any mode.
2. Drive runs at 30 ips only.
3. Drive runs at 90 ips only.
4. Drive runs only forward (low and high speed).
5. Drive runs only reverse (low and high speed).
6. Motor creeps in either direction but responds to commands.
7. Motor creeps in either direction and does not respond to commands.
8. Motor turns but does not drive cartridge.
9. Motor "runs away" (into very high speeds).
10. Heat sink gets excessively hot without motion commands.
11. Inserting cartridge will not cause loading to BOT. (Drives with control boards only)
12. Motion causes excessive noise.
13. Motor runs too slow.
14. Ramp times are out of tolerance.
15. Motor runs at different speeds forward (versus reverse).

C. Status Malfunction:

(Drives with Control Boards)

1. No LPS or EWS signals.
2. No LPS signal - EWS present.
3. No EWS signal - LPS present.
4. LPS and EWS will not latch.
5. LPS and EWS will not unlatch.
6. Bulb not lit.
7. Ready status will not go true.
8. Busy status will not go true.
9. File unprotected status will not go true.
10. Selected status will not go true.
11. Write enabled status will not go true.
12. Flag status will not go true.
13. Indicators will not light (if operator panel used).
14. Indicators light when not supposed to (if operator panel used).

(Drives without Control Boards)

1. No UTH or LTH signals.
2. No UTH signal. LTH present.
3. UTH and/or LTH present at all times.
4. No LTH signal. UTH present.
5. No BLB signal.
6. FIP signal not functioning.
7. CIP signal not functioning.

D. Data Malfunction

1. Drive will not read, one track.
2. Drive will not read, all tracks.
3. Drive will not read or write.
4. Drive will not write but will read previously written tape.
5. Drive will not erase previous information written.
6. Excessive errors in reading-while-writing, but no errors while in read only.
7. Excessive errors in read only but not in read-while-write mode.
8. Excessive data errors in all modes.

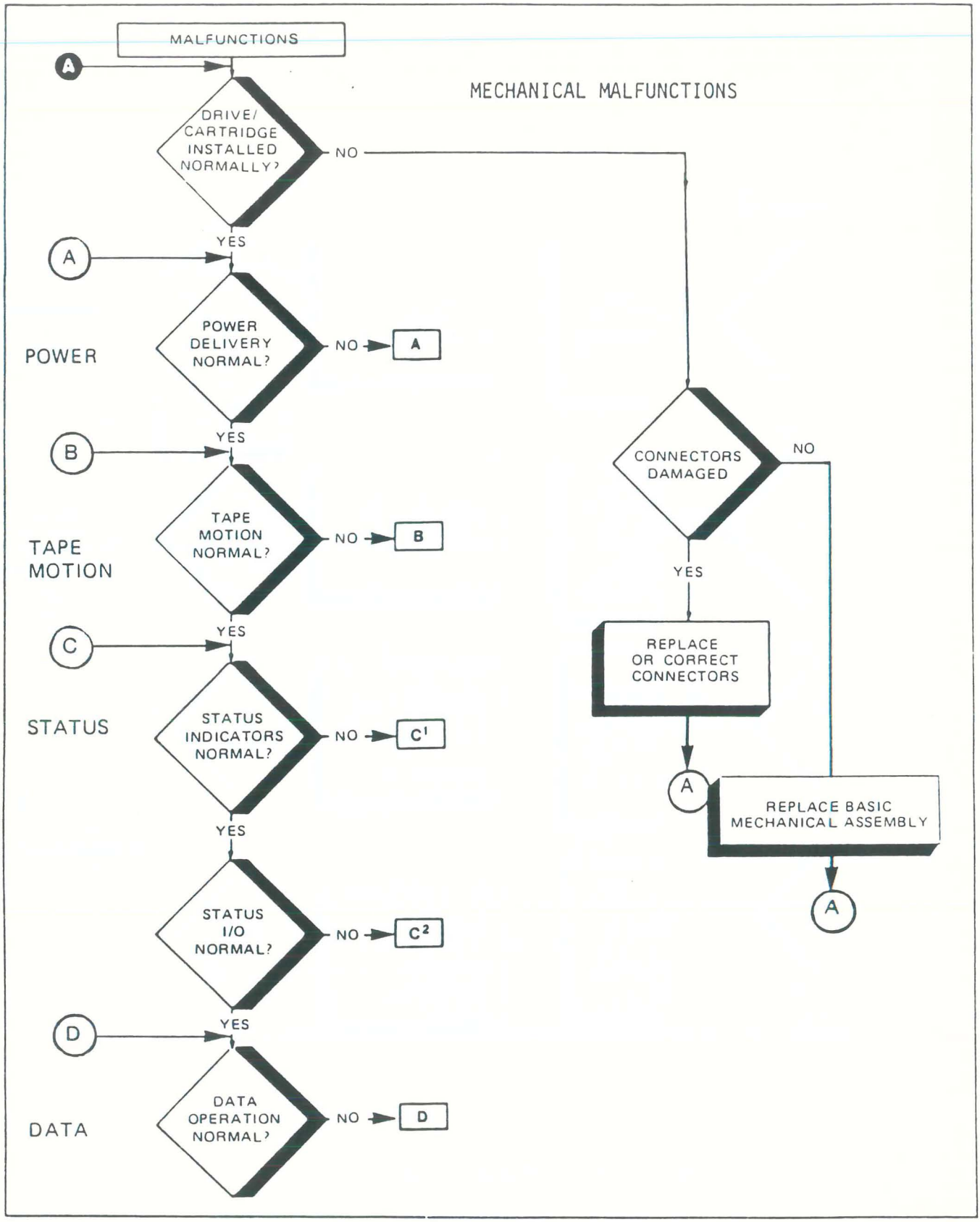


Figure 5-1. Drive Troubleshooting Strategy (Sheet 1 of 8)

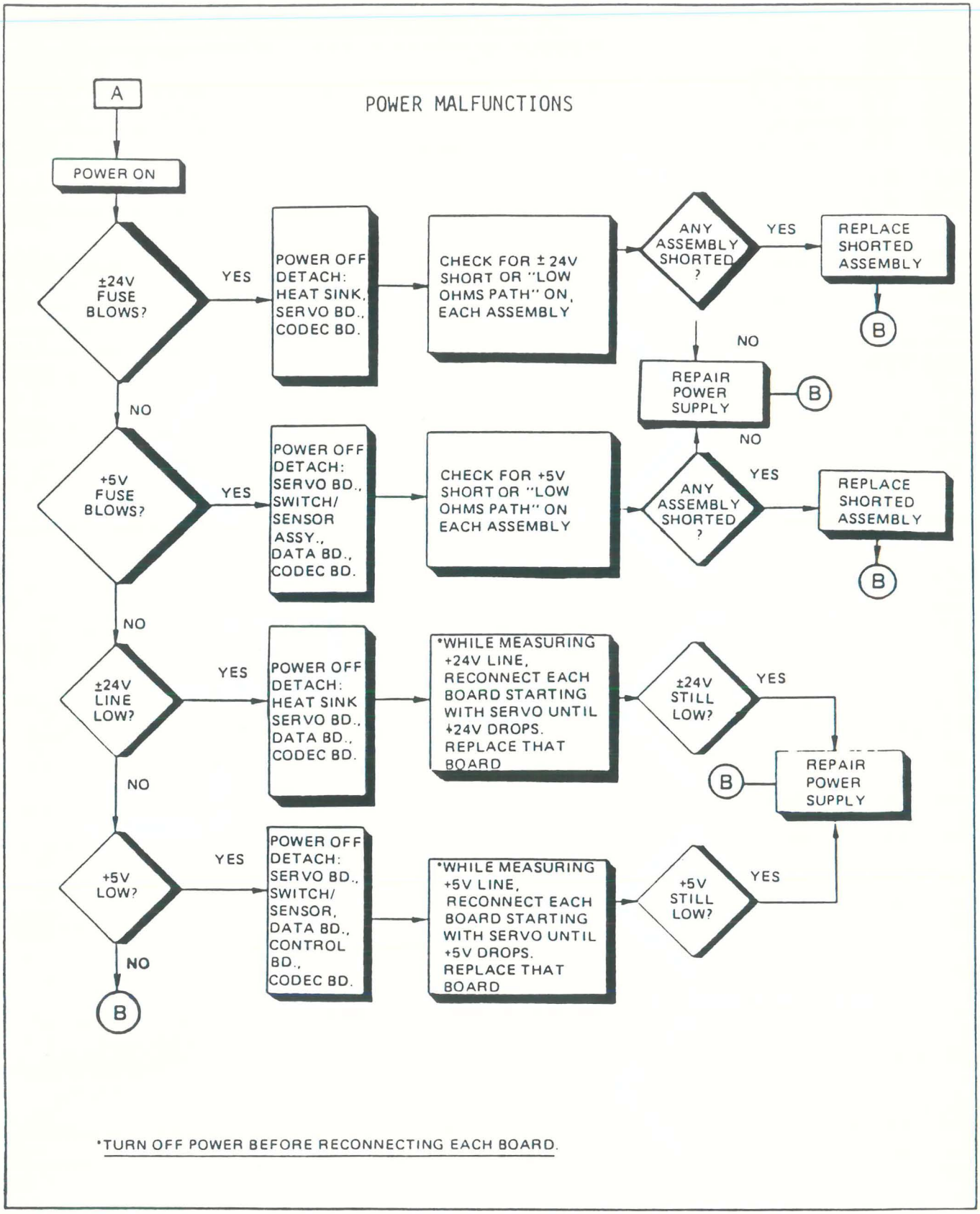


Figure 5-1. Drive Troubleshooting Strategy (Sheet 2 of 8)

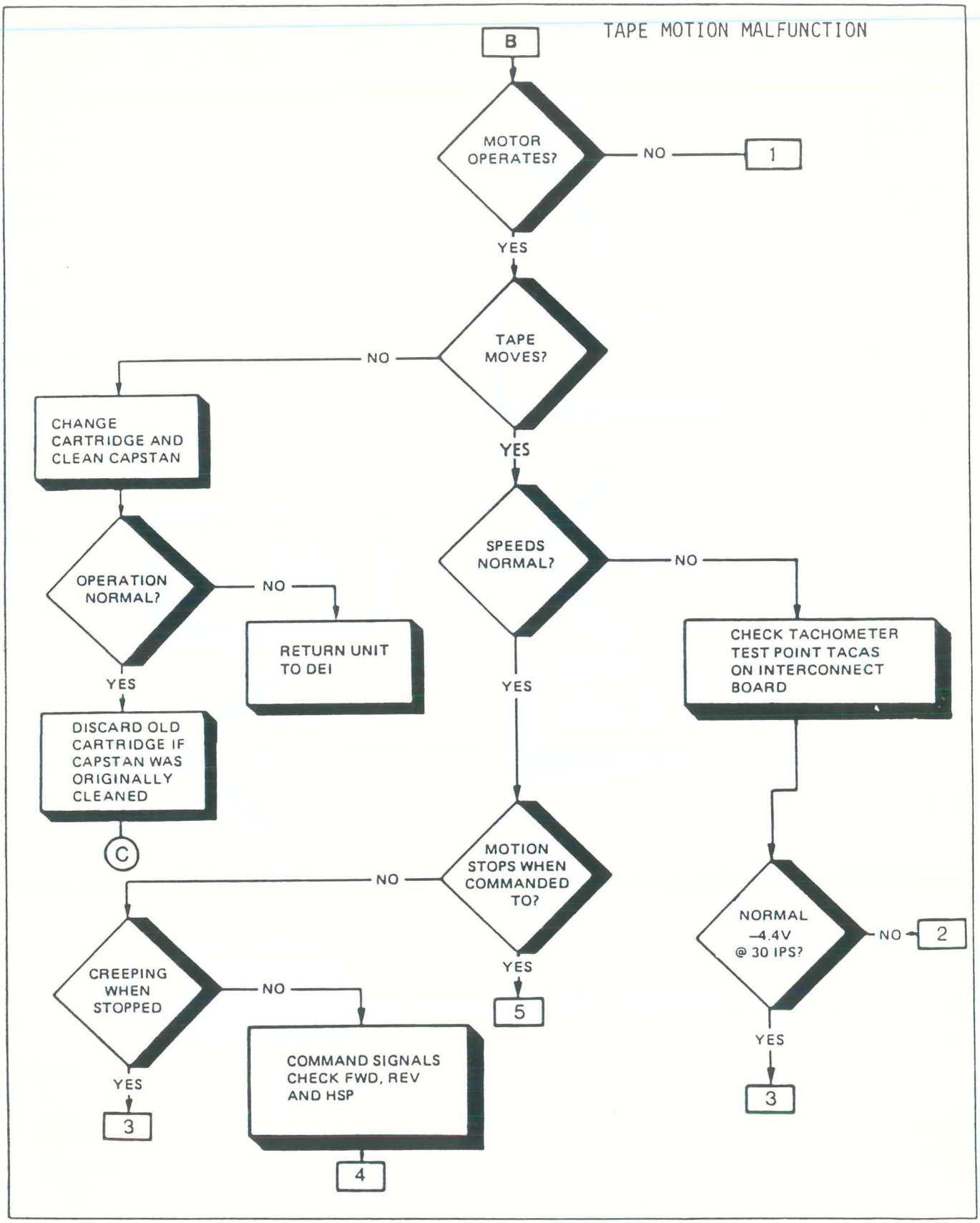


Figure 5-1. Drive Troubleshooting Strategy (Sheet 3 of 8)

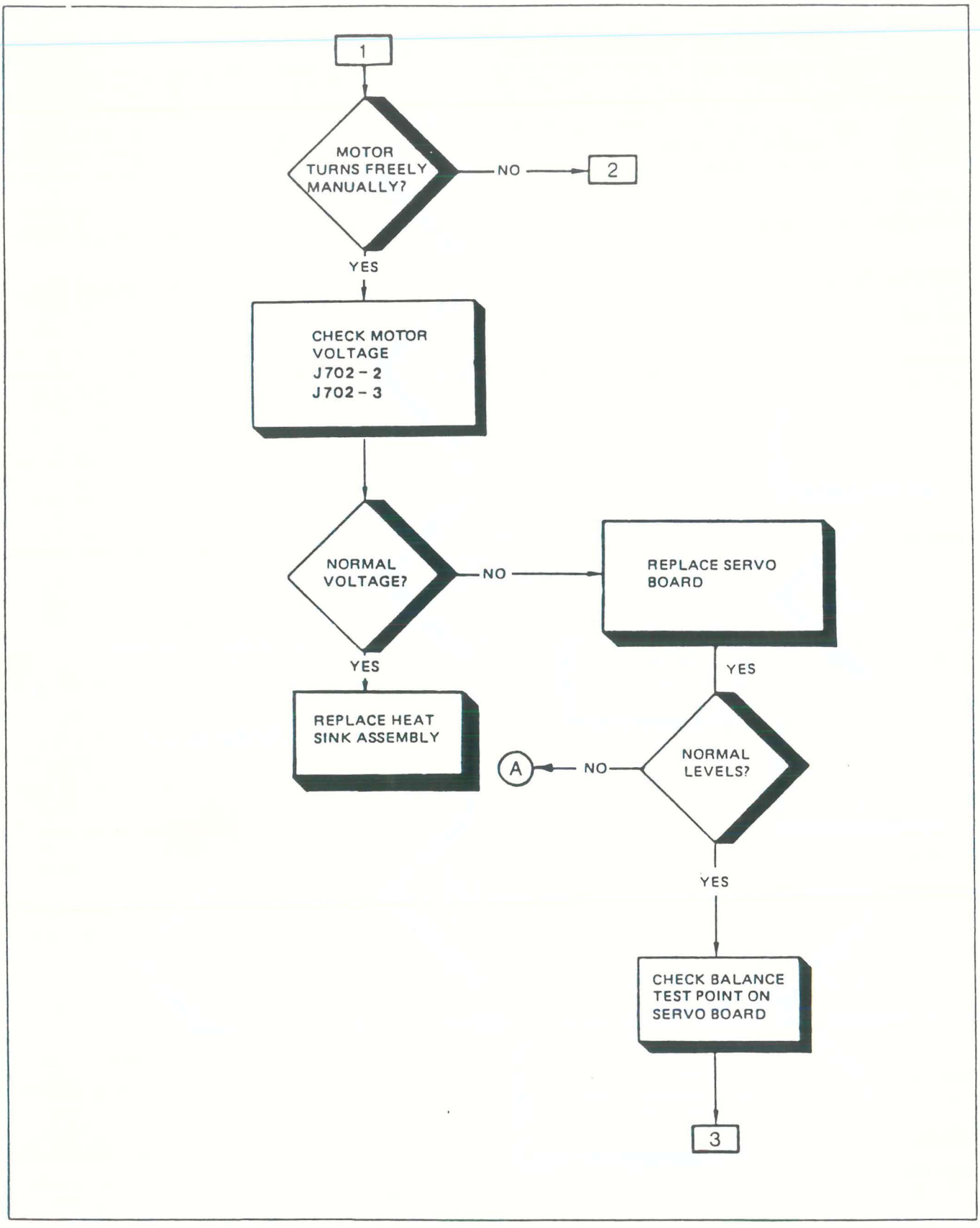


Figure 5-1. Drive Troubleshooting Strategy (Sheet 4 of 8)

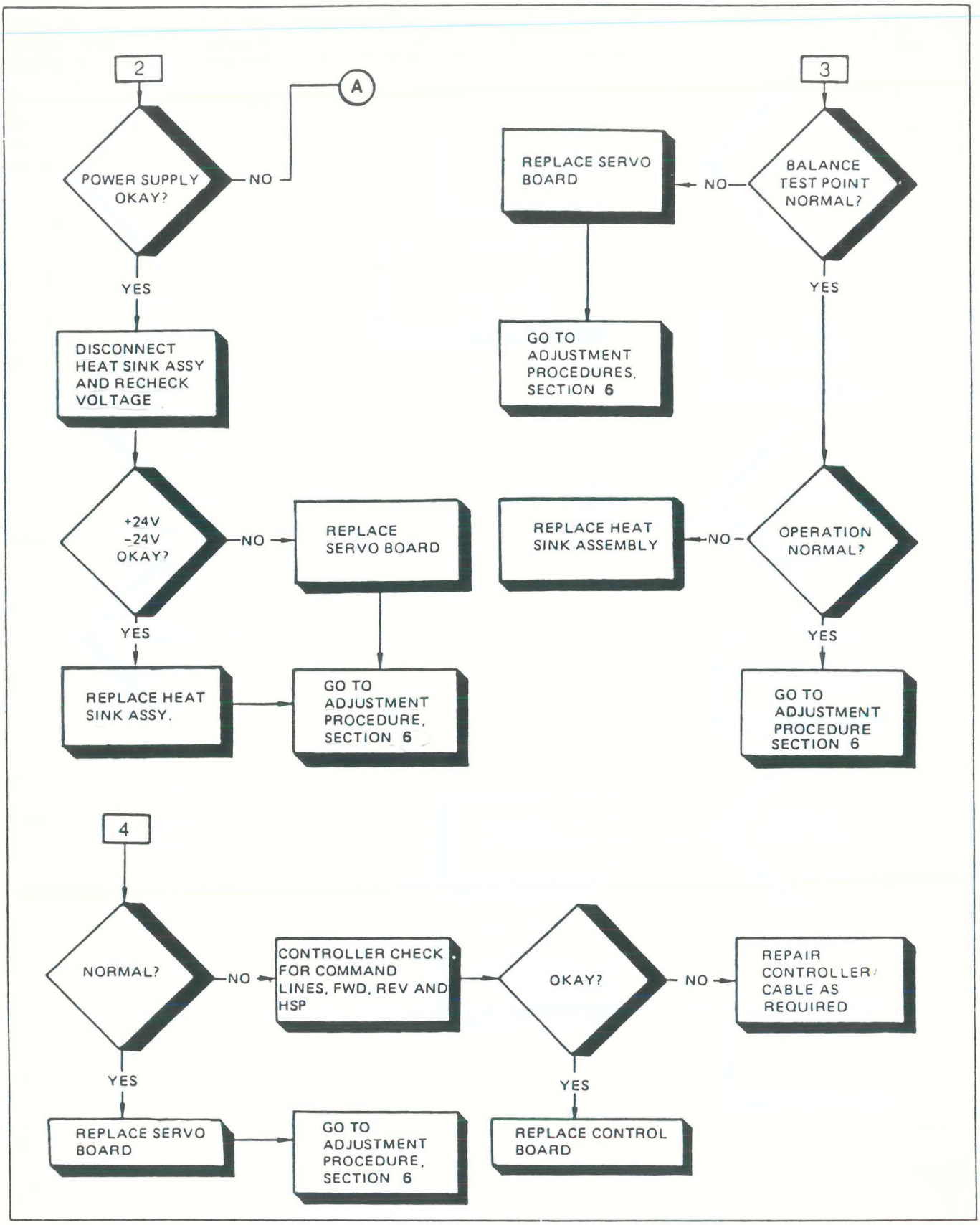


Figure 5-1. Drive Troubleshooting Strategy (Sheet 5 of 8)

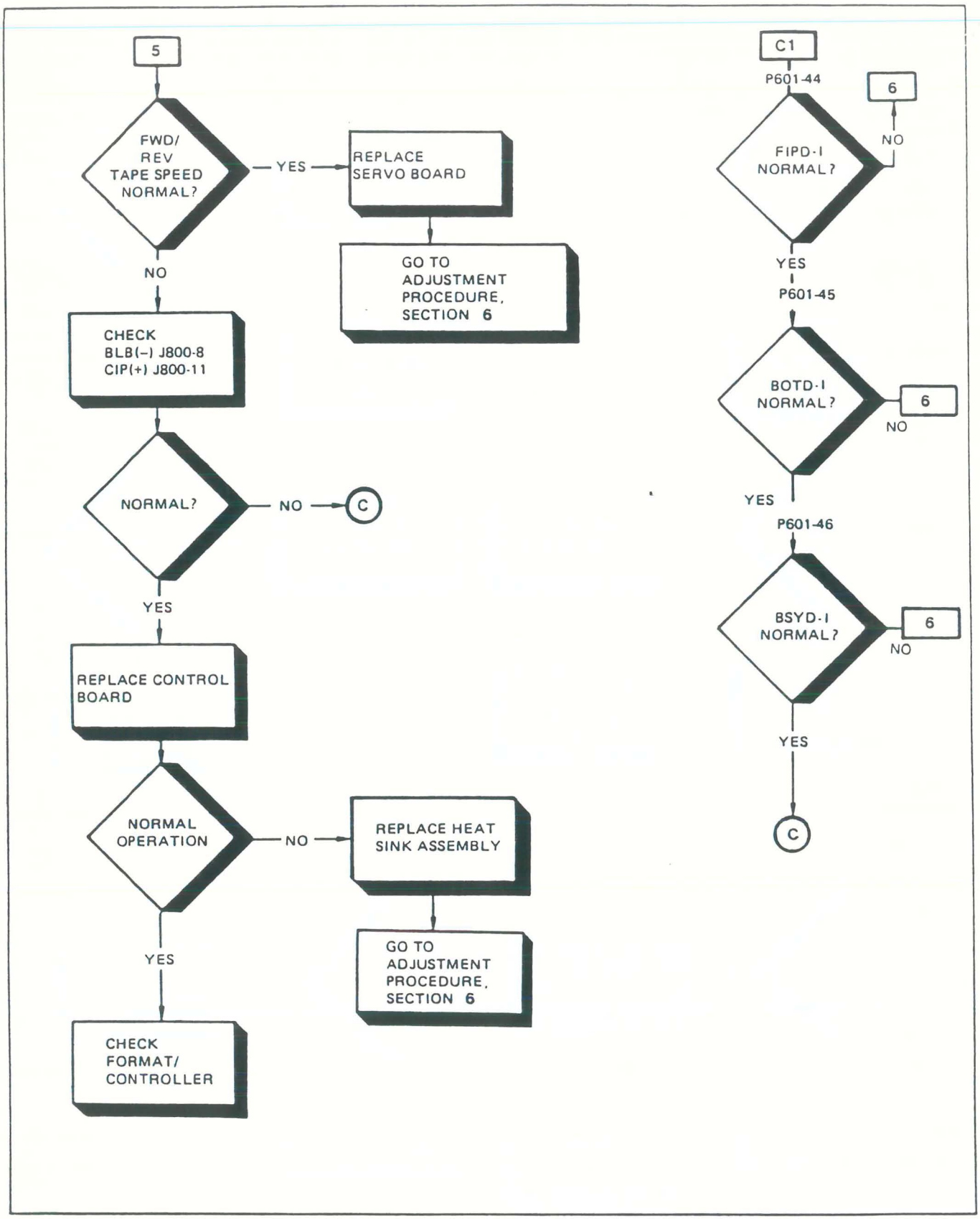


Figure 5-1. Drive Troubleshooting Strategy (Sheet 6 of 8)

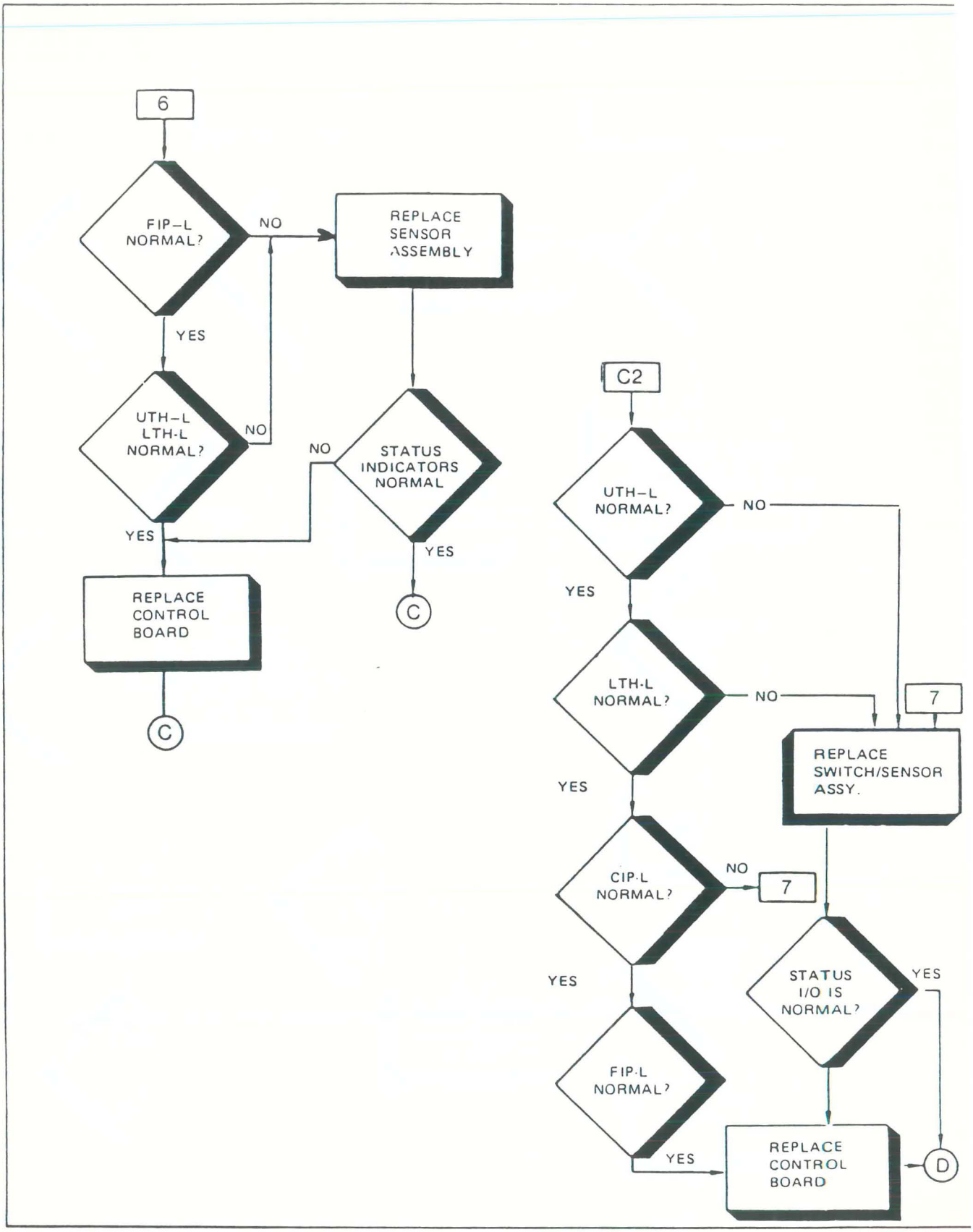


Figure 5-1. Drive Troubleshooting Strategy (Sheet 7 of 8)

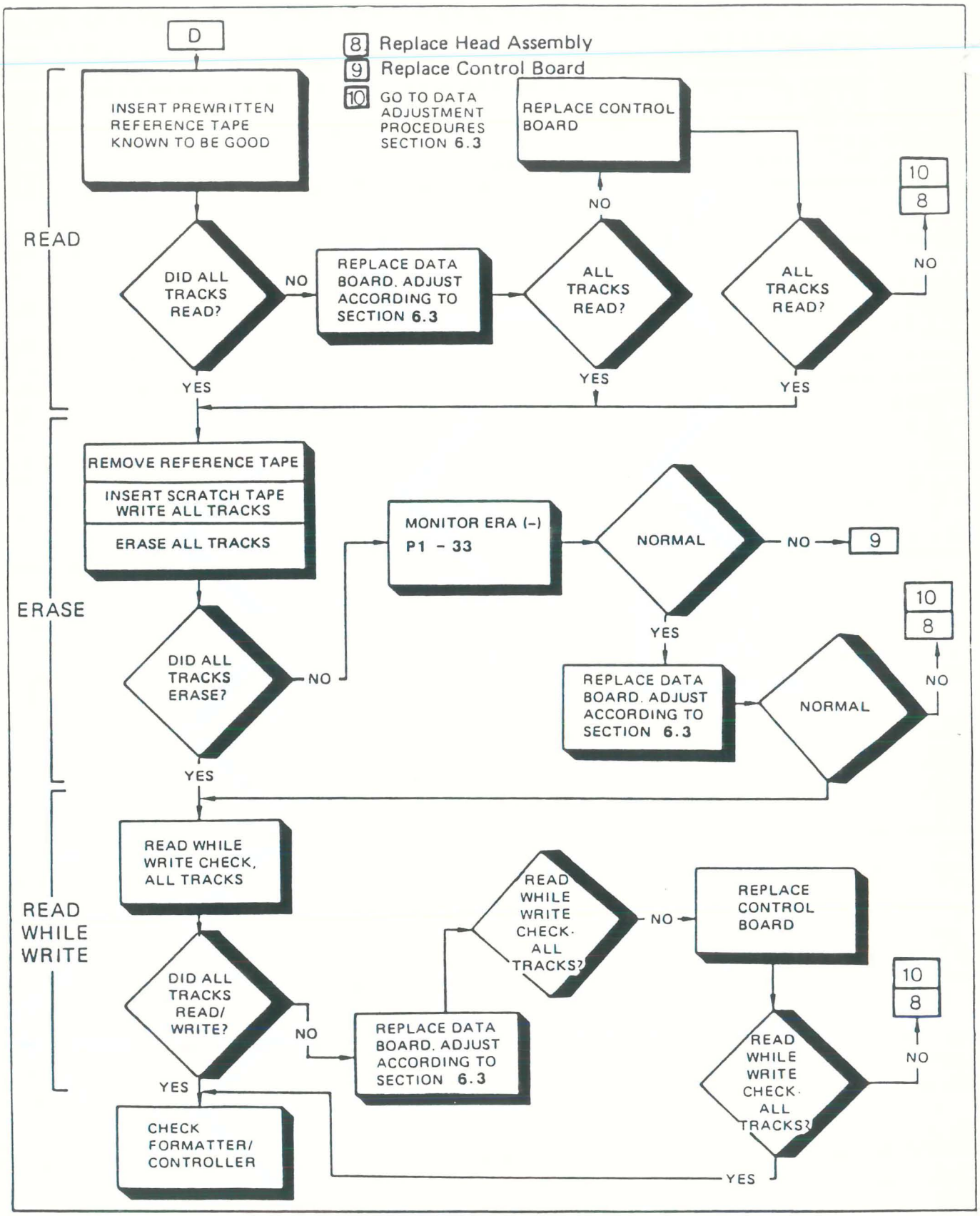


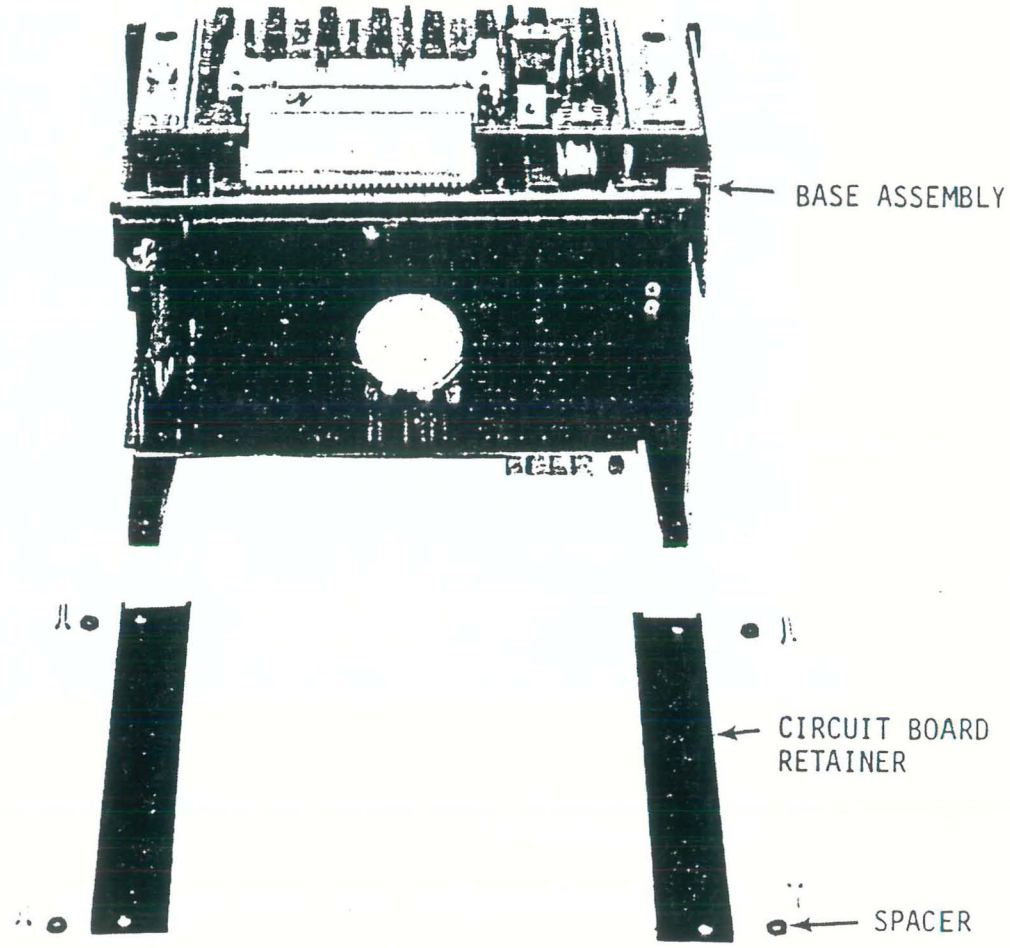
Figure 5-1. Drive Troubleshooting Strategy (Sheet 8 of 8)

5.4 DISASSEMBLY OF DRIVE

Refer to paragraphs 5.4.1 through 5.4.9 for disassembly of drive.

5.4.1 Removal of Circuit Board Retainers

Refer to figure 5-3 for removal of circuit board retainers.



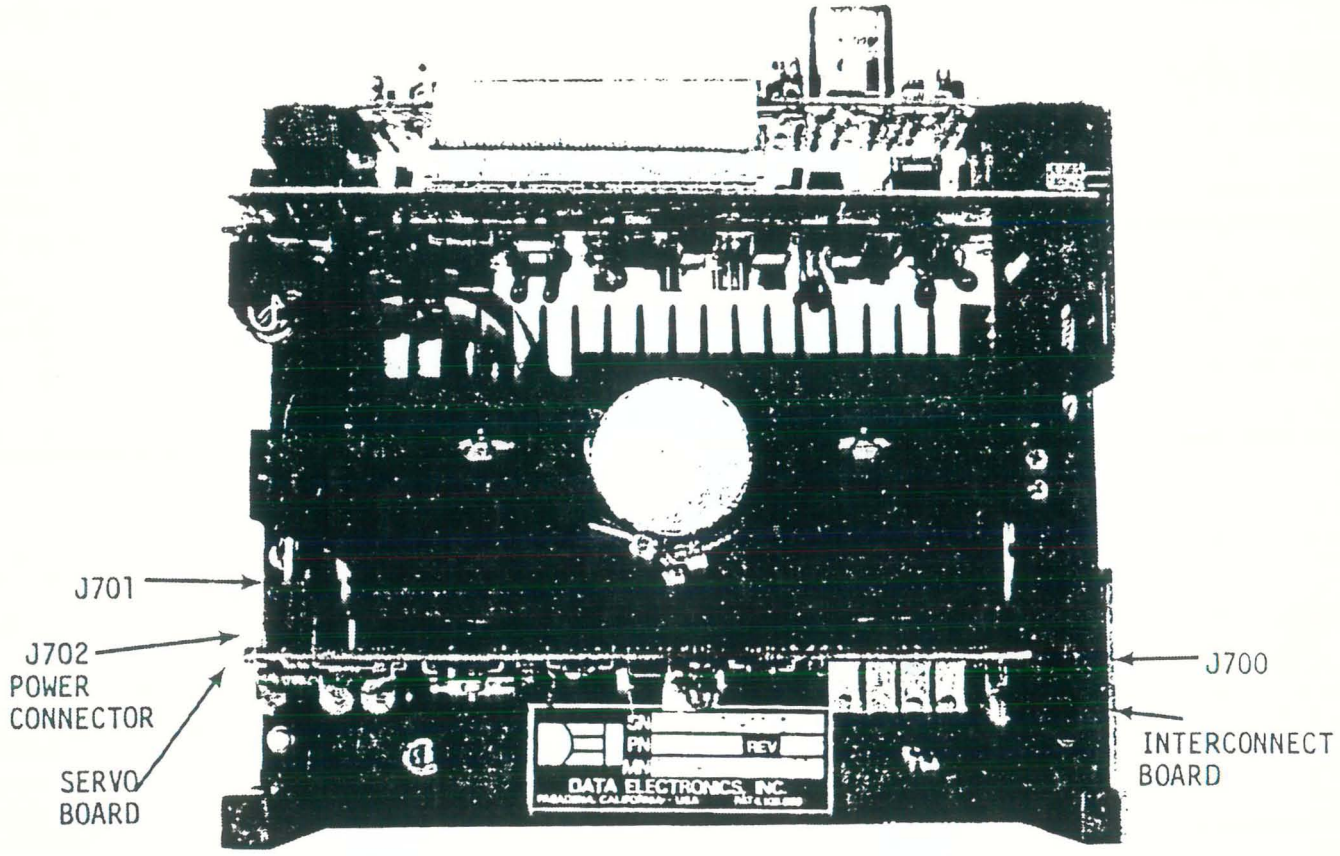
1. Remove circuit board retainers by removing four screws, two from each retainer.

   Note: When reassembling the retainers, be certain that spacers are placed between retainer and the base assembly of the drive.

Figure 5-2. Removal of Circuit Board Retainers

5.4.2 Removal of Servo Board

Refer to Figure 5-4 for removal of servo board.

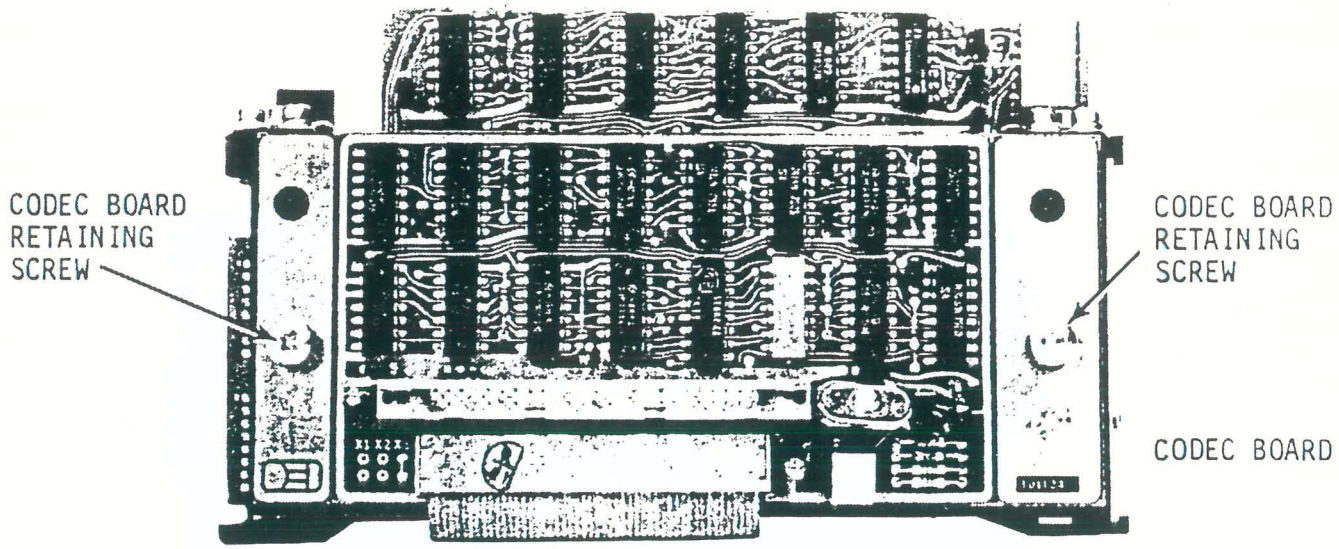


1. Remove circuit board retainer as described in paragraph 5.4.1.
2. Pull servo board free from interconnect board at J700.
3. Disconnect J701 and J702 if it is installed from servo board.

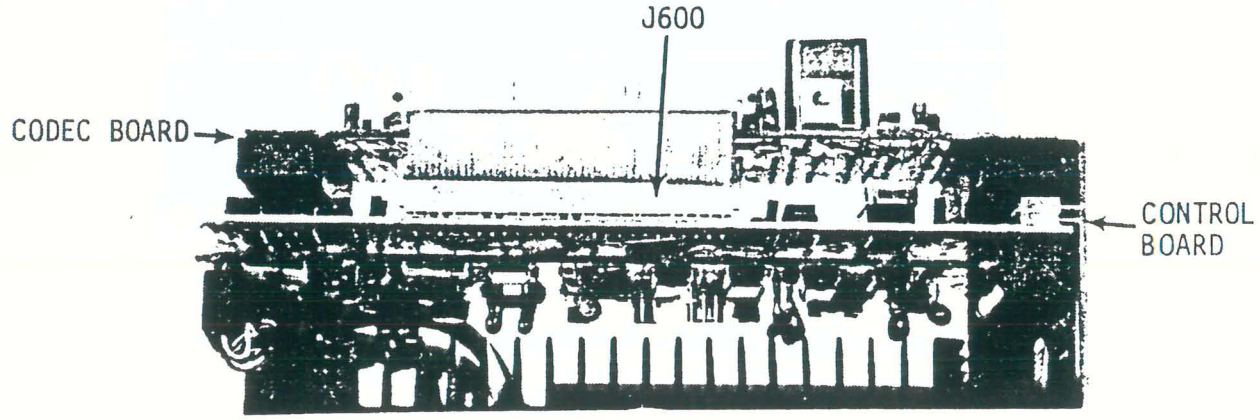
Figure 5-3. Removal of Servo Board

5.4.3 Removal of Codec Board

Refer to figure 5-5 for removal of Codec Board.



1. Remove two screws and washers that secure Codec Board to base assembly.

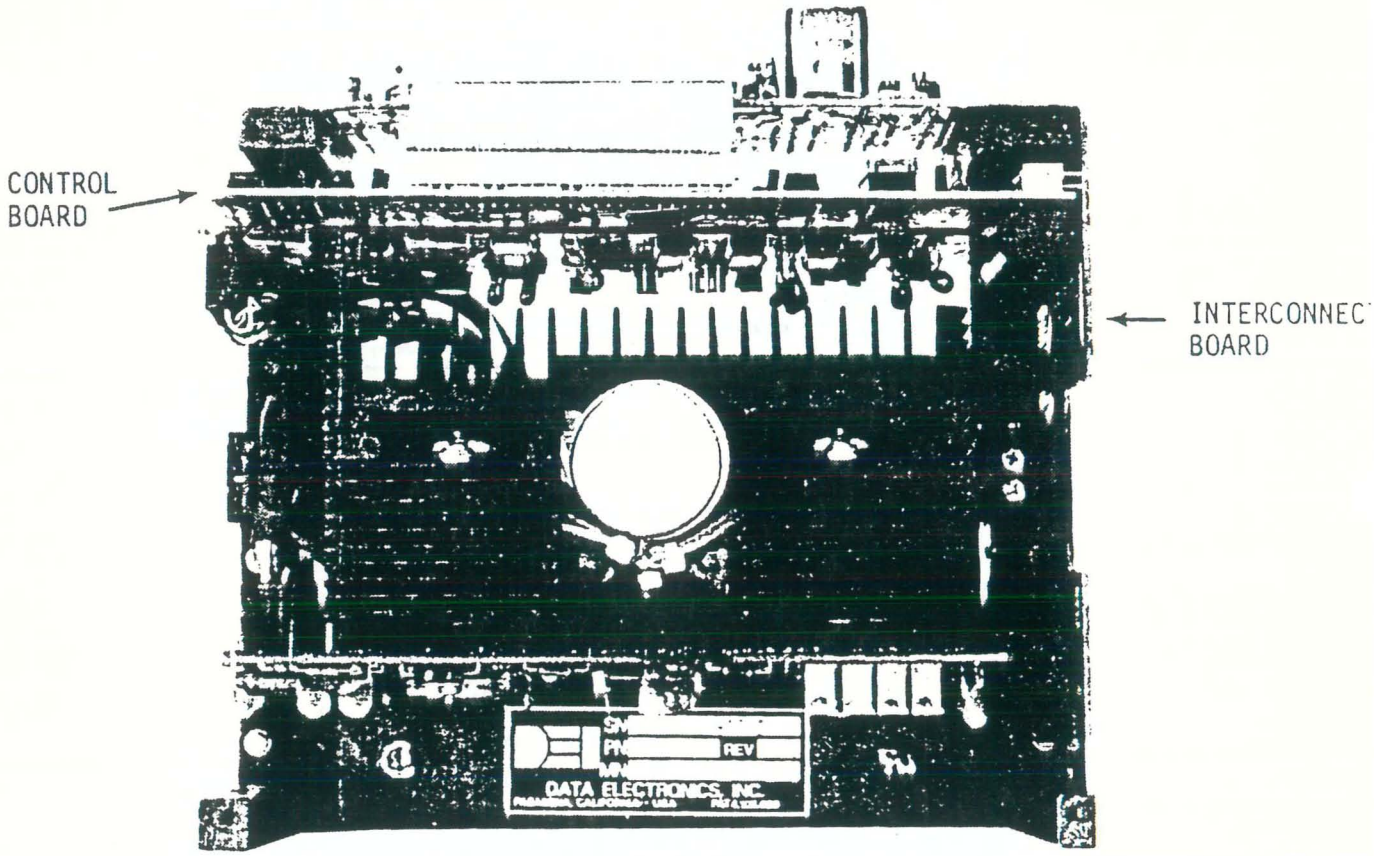


2. Disconnect J600, coming from Codec Board, from P600 on Control Board.

Figure 5-4. Removal of Codec Board

5.4.4 Removal of Control Board

Refer to figure 5-6 for removal of Control Board.

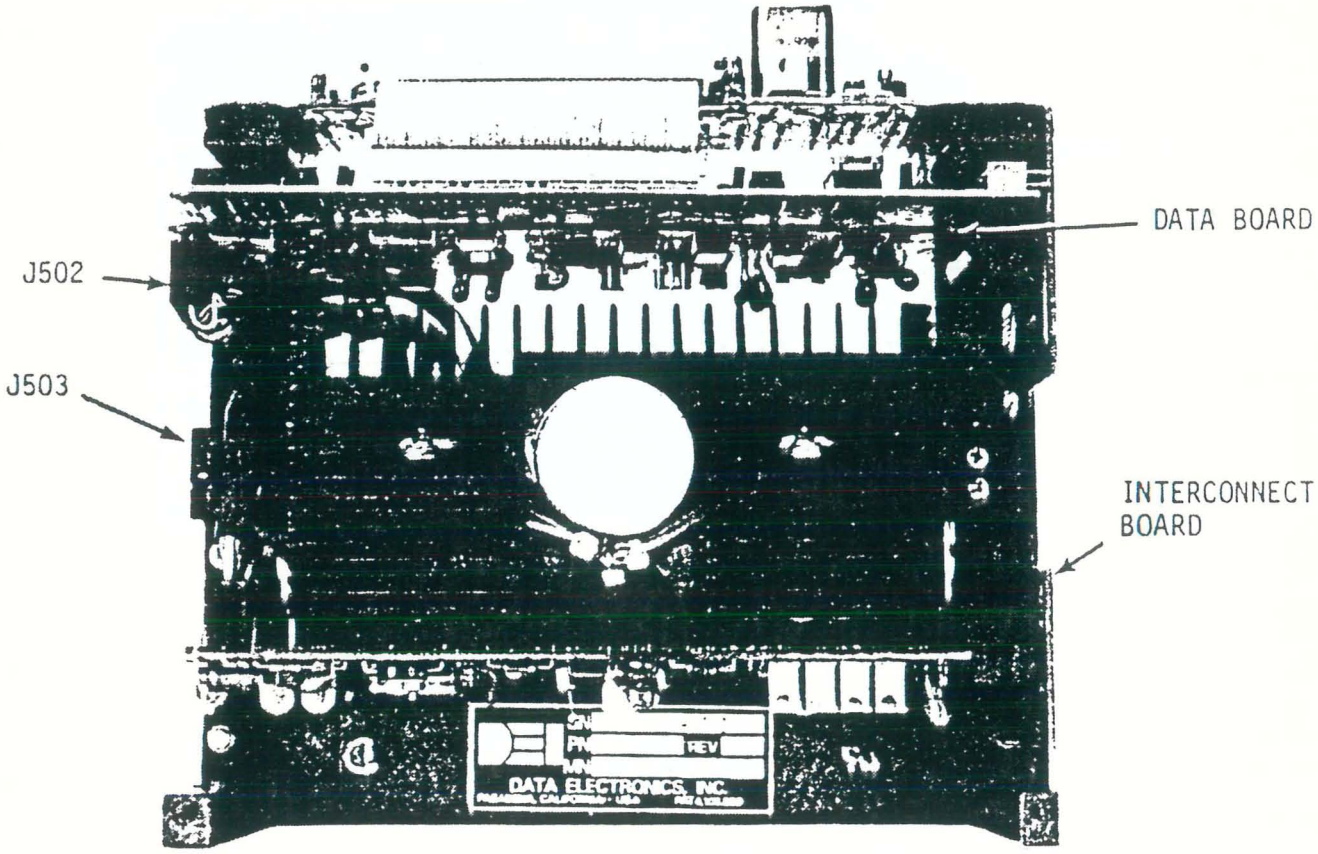


1. Remove circuit board retainers as described in paragraph 5.4.1.
2. Disconnect J600 from Control Board.
3. Pull Control Board free from interconnect board.

Figure 5-5. Removal of Control Board

5.4.5 Removal of Data Board

Refer to figure 5-7 for removal of Data Board.

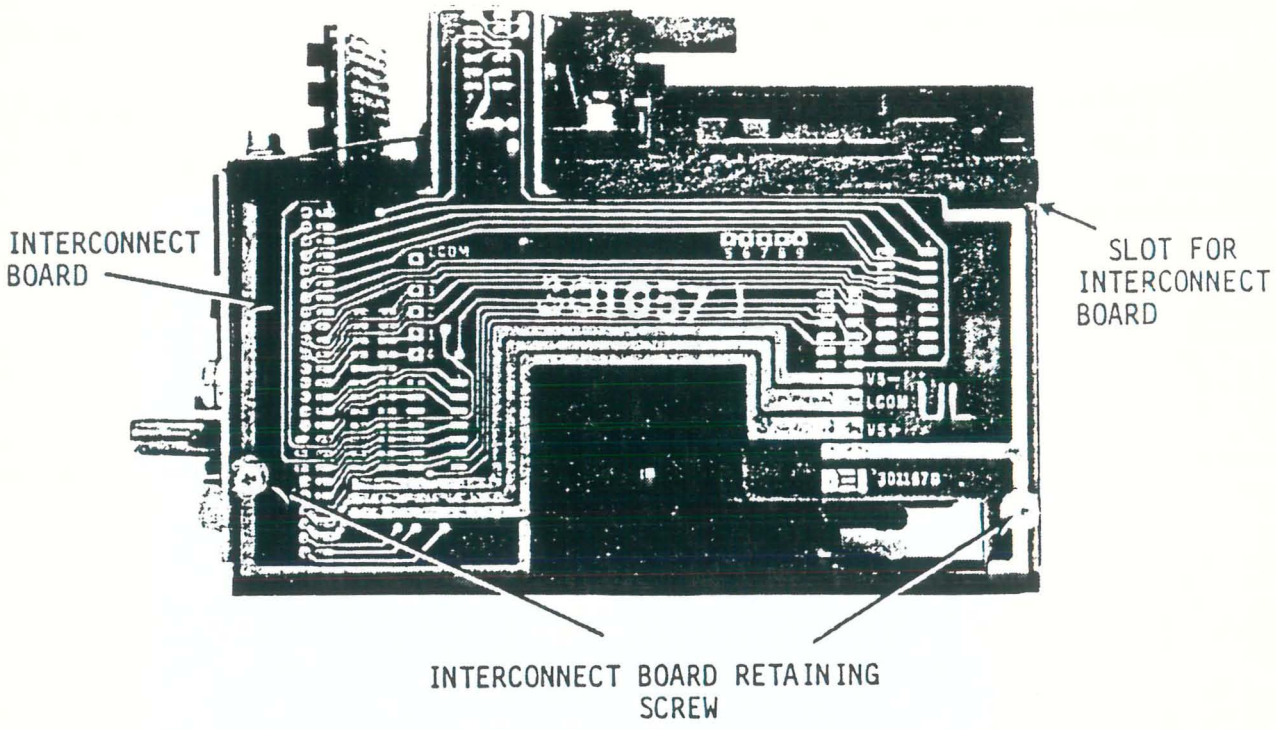


1. Remove circuit board retainers as described in paragraph 5.4.1.
2. Disconnect J502 and J503 from Data Board.
3. Pull board free from Interconnect Board.

Figure 5-6. Removal of Data Board

5.4.6 Removal of Interconnect Board

Refer to figure 5-8 for removal of Interconnect Board.



1. Remove two screws, split lock washers, and flat washers that secure interconnect board to base assembly.

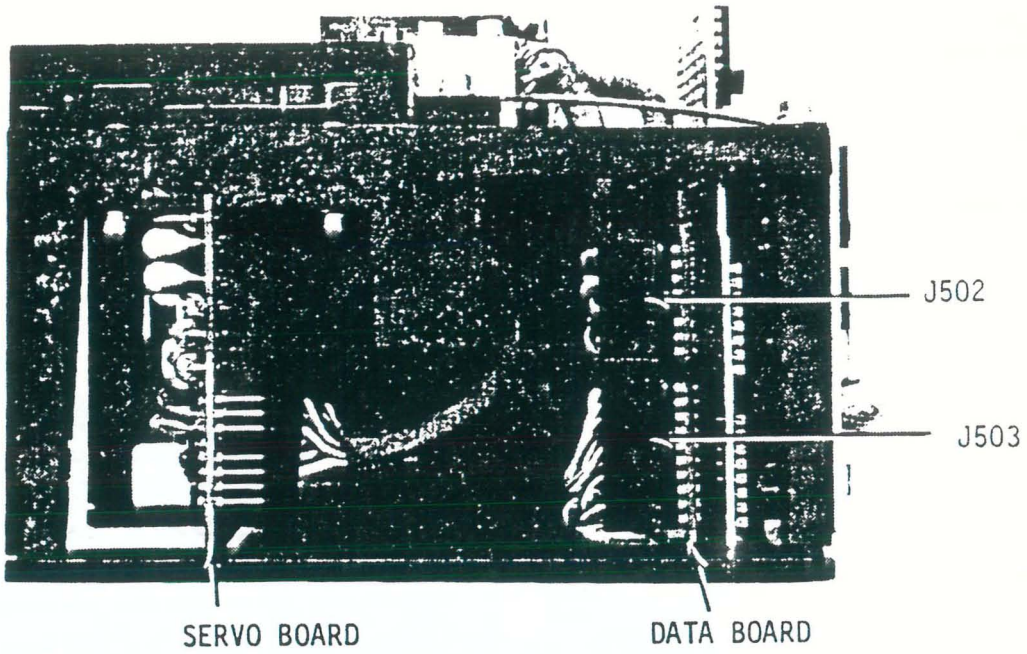
2. Remove switch/sensor assembly as described in paragraph 5.4.8.

3. Interconnect board may now be slid down and removed from drive.

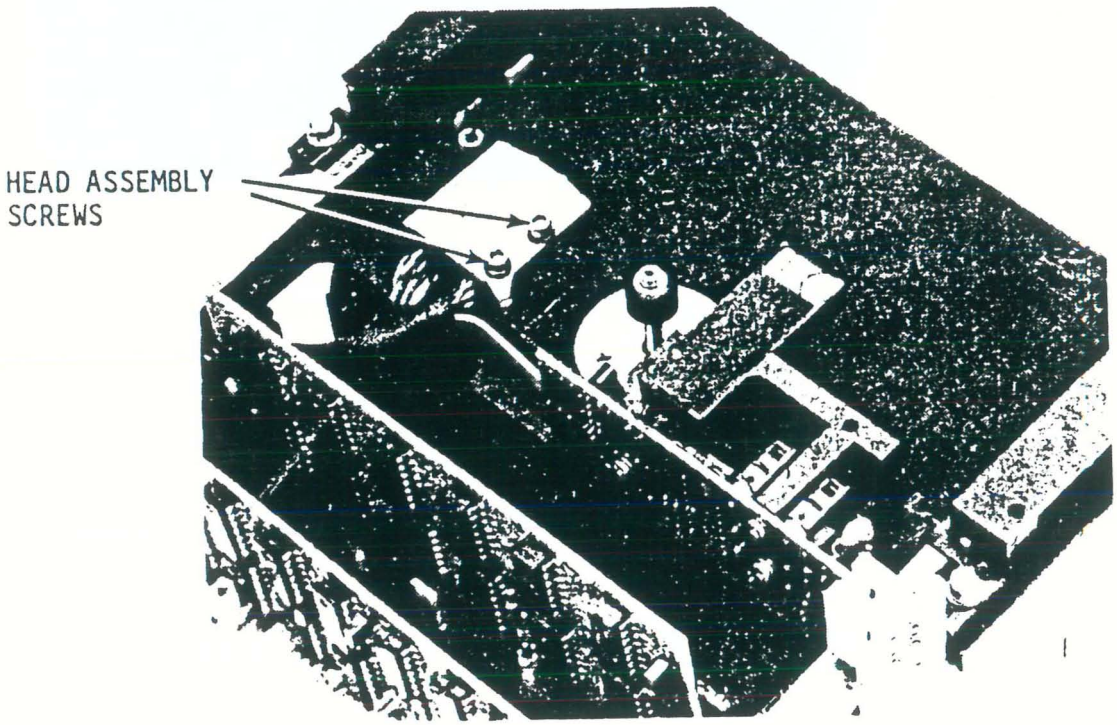
Figure 5-7. Removal of Interconnect Board

5.4.7 Removal of Head Assembly

Refer to figure 5-9 for removal of head assembly.

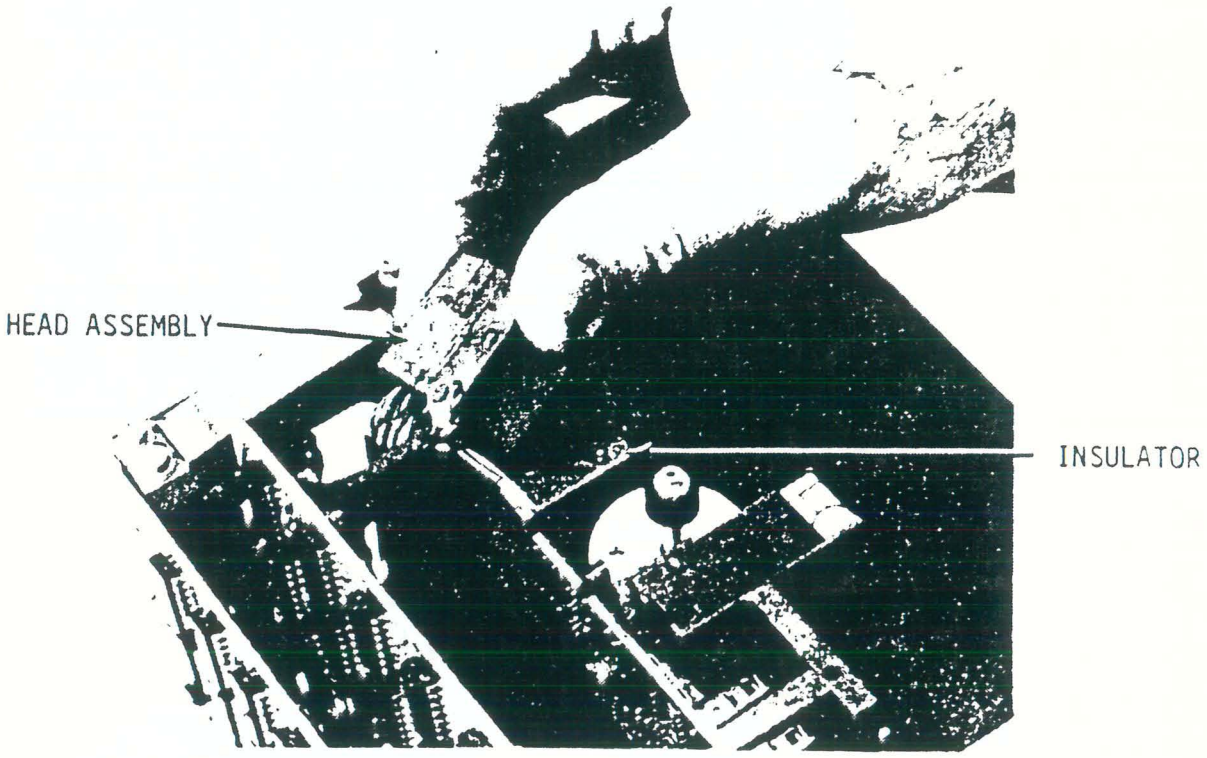


1. Remove J502 and J503 from data board.



2. Remove two screws, flat washer, and bushings from head assembly.

Figure 5-8. Removal of Head Assembly



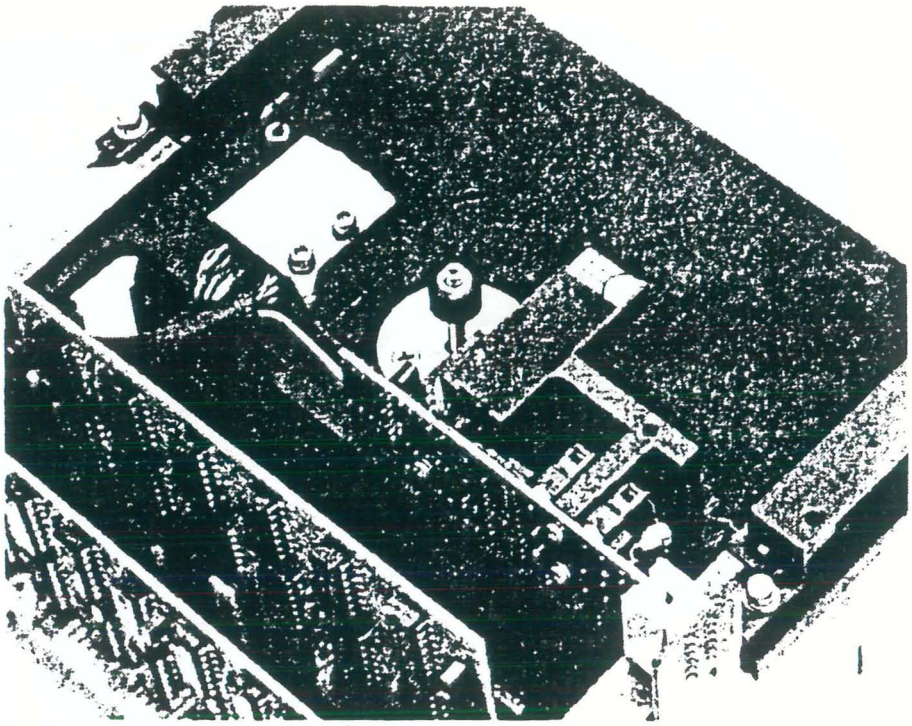
3. Lift head assembly free from drive.

NOTE: When reassemblying the head assembly, be certain that insulator is in place.

Figure 5-8. Continued. Removal of Head Assembly

5.4.8 Removal of Switch/Sensor Assembly

Refer to figure 5-10 for removal of switch sensor assembly.



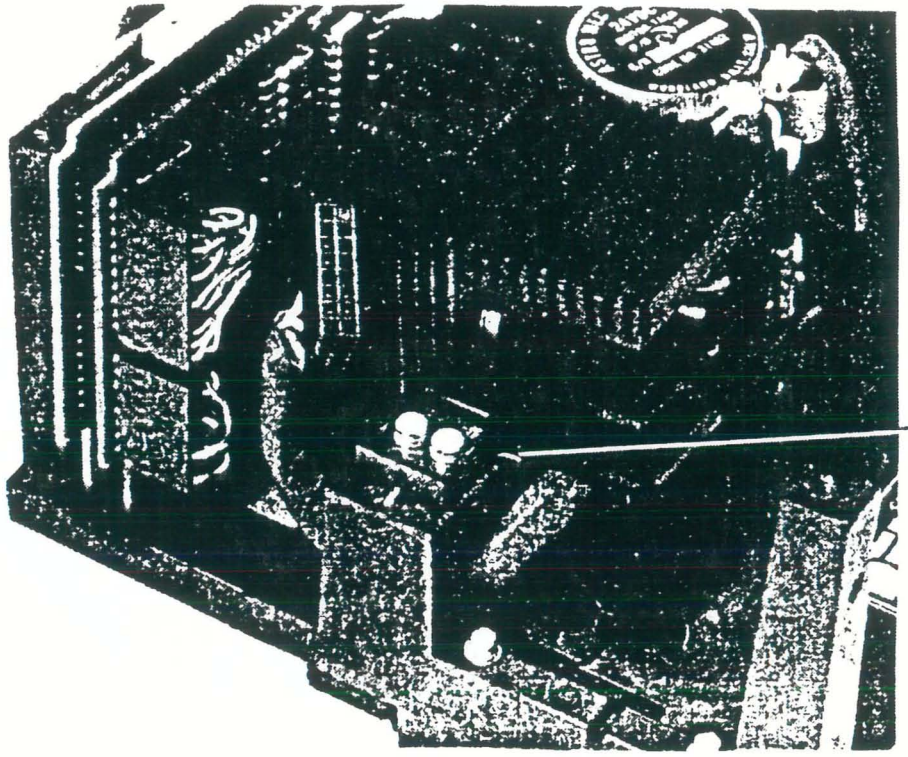
1. Remove two screws, two lock washers, two flat washers from switch/sensor assembly.

2. Slide switch/sensor assembly sideward to free from Interconnect Board.

Figure 5-9. Removal of Switch/Sensor Assembly

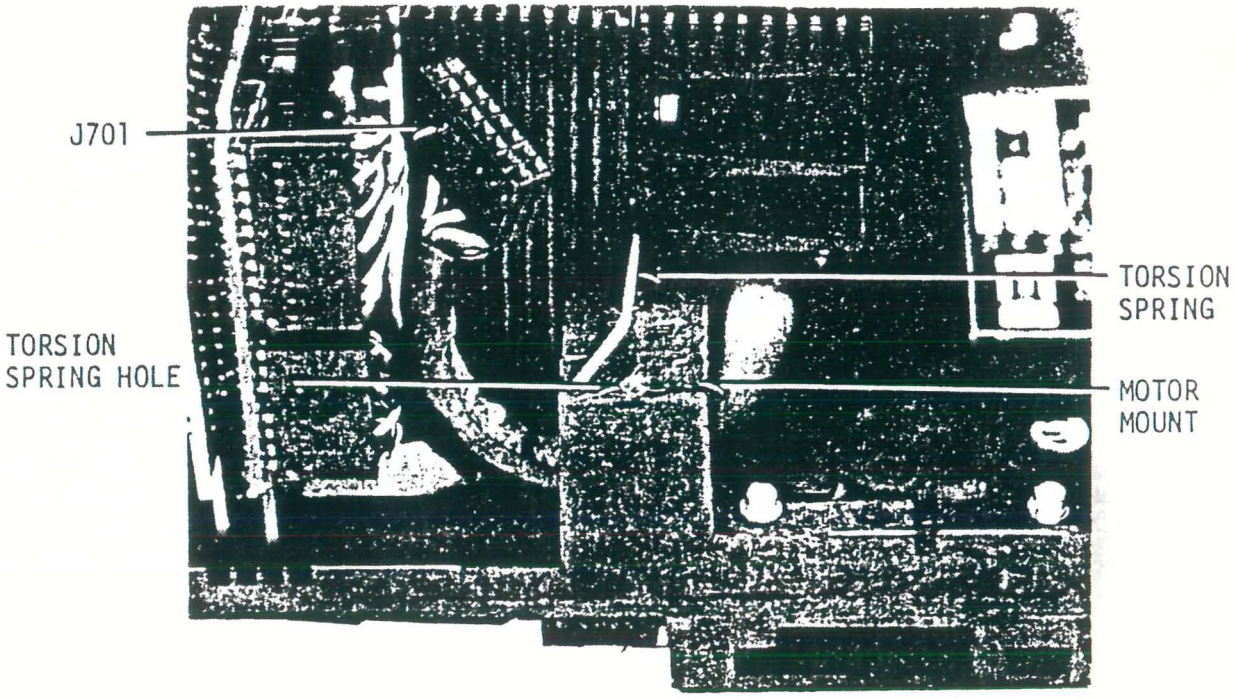
5.4.9 Removal of Heat Sink Assembly

Refer to figure 5-11 for removal of heat sink assembly.



1. Perform procedure of paragraph 5.4.1.
2. Remove servo board as described in paragraph 5.4.2.
3. Remove two screws, two lock washers, and two flat washers that secure each motor mount.

Figure 5-10. Removal of Heat Sink Assembly - Part I



4. Lift heat sink assembly out of drive. To do this, pull heat sink assembly cable through hole in motor mount. The torsion spring must be carefully lifted from hole in base. Damage to the torsion spring can occur if it is bent during disassembly.

Figure 5-10. Removal of Heat Sink Assembly Part II.

5.5 REASSEMBLY OF DRIVE

As described in the installation drawing, Figure 5-12, it is necessary that the heat sink be the first sub-assembly to be installed onto the Mechanical Assembly. Capstan pressure and travel must be verified at this stage before any additional sub-assemblies are installed.

5.5.1 Capstan Travel Adjustment

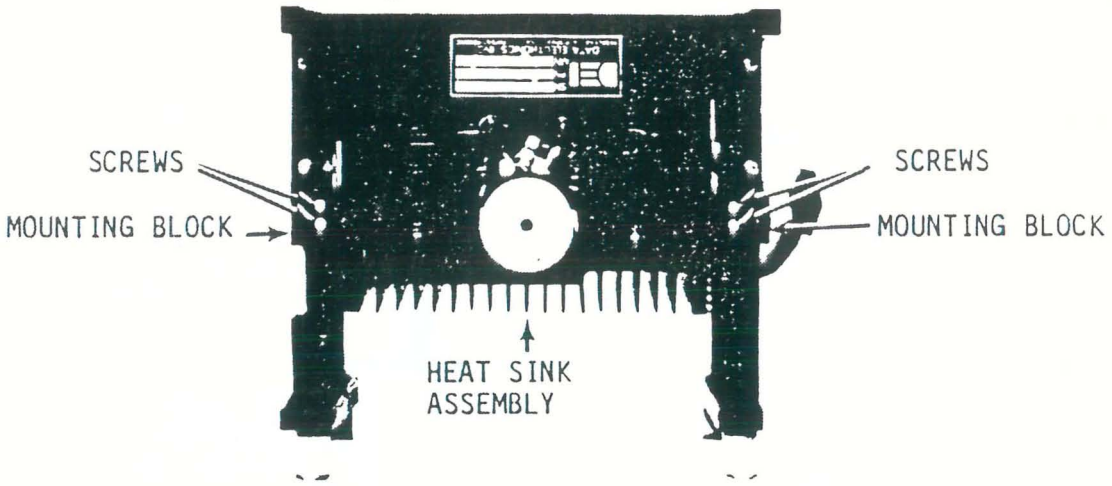
This adjustment is made to limit the travel of the heat sink assembly. The travel is limited by the set screw shown in Figure 5-13.

To adjust the capstan travel, install the heat sink assembly and insert fixture 301,201 between the cartridge retaining rails. Adjust socket head screw until there is 0.010 $\pm$ .010 inches clearance between the shoulder and stop of fixture 301,201. (See Detail 'A' of Figure 5-4)

5.5.2 Capstan Pressure Check

For correct drive operation, the torsion spring provides 24 to 32 ozs. force on the cartridge pulley. The force is measured with a cartridge in place and a spring scale. The spring scale is coupled to the drive capstan via a string loop as shown in Figure 5-14. Pressure is measured in line with cartridge insertion. The measurement is taken at the moment the drive capstan is lifted from the cartridge pulley. If, after reassembly, incorrect force is obtained, reassemble the heat sink assembly and replace the torsion spring as shown in Section 5.5.3

REASSEMBLY



Install the Heat Sink Assembly. Pass the J701 connector through its access slot in the deck frame. Be sure to press the end of the heat sink spring into its mounting hole completely (figure 5-13). Insert the heat sink assembly into the bottom of the unit. Screw in the mounting blocks as noted above. Attach J701. Refer to 5.5.1, 2 and 3. Adjust the capstan and torsion spring. Refer to figure 5-8 and mount the Interconnect Board (or the board can be left for step 4).

Figure 5-11. Reassembly

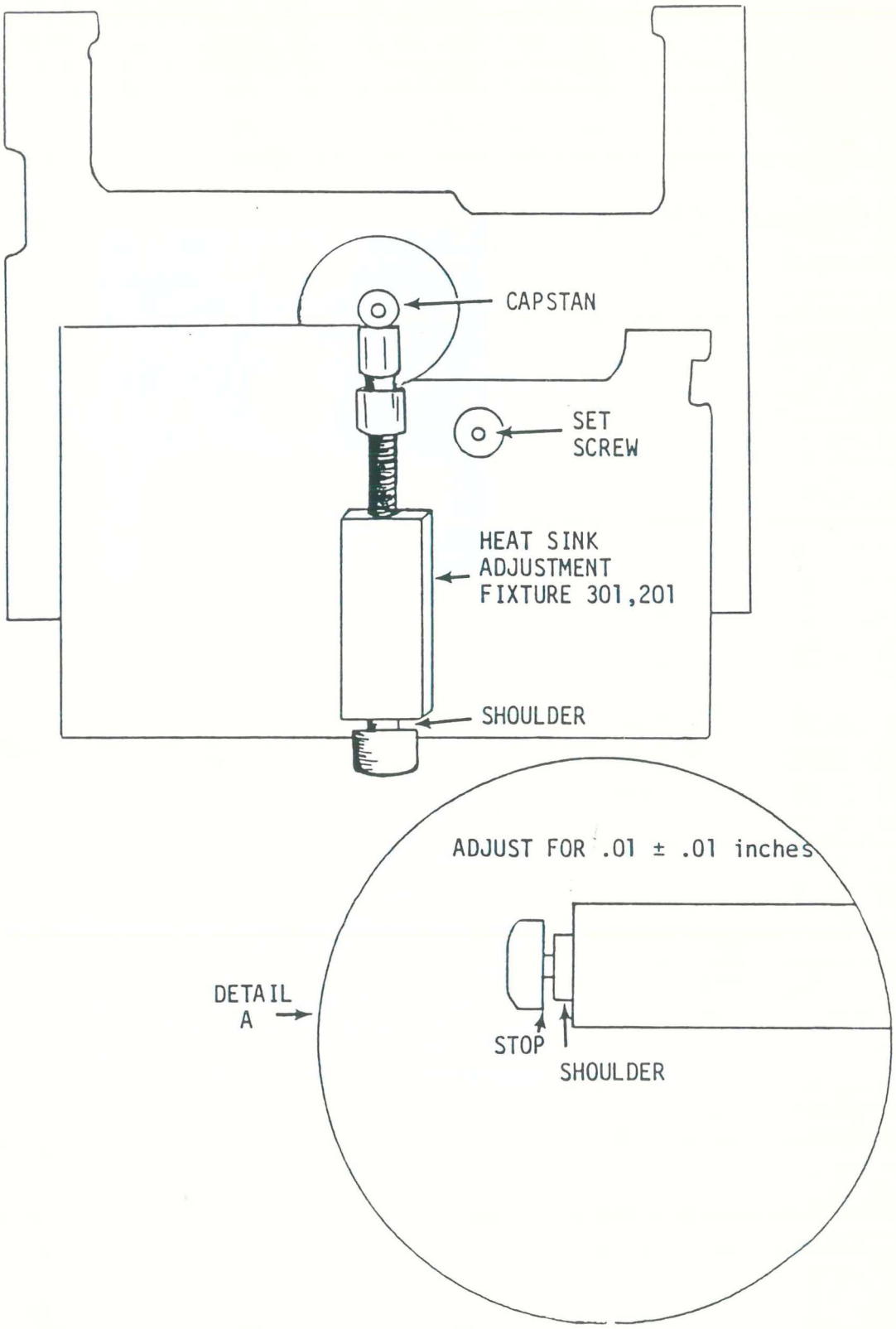


Figure 5-12. Capstan Travel Adjustment

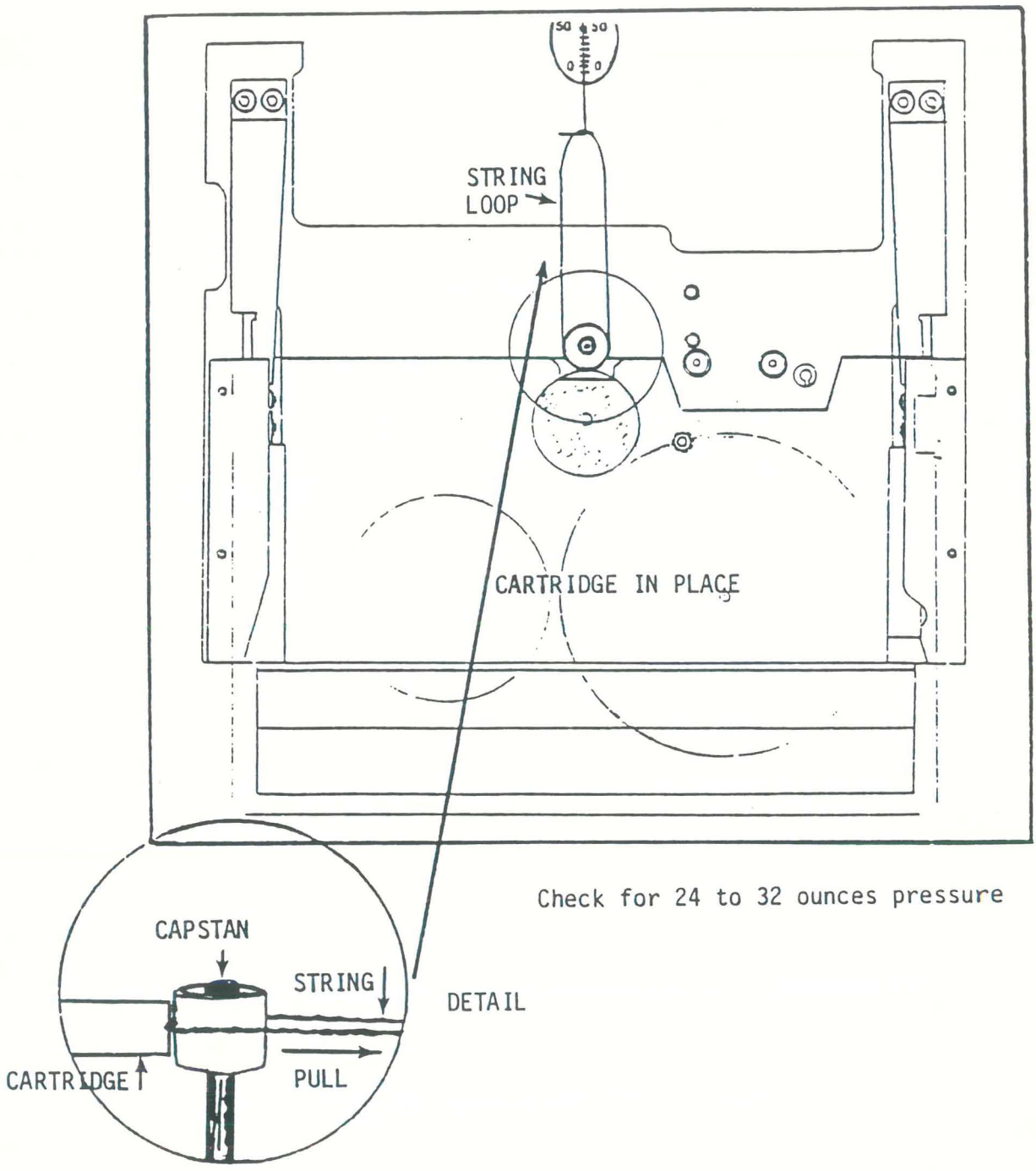


Figure 5-13. Capstan Pressure Check

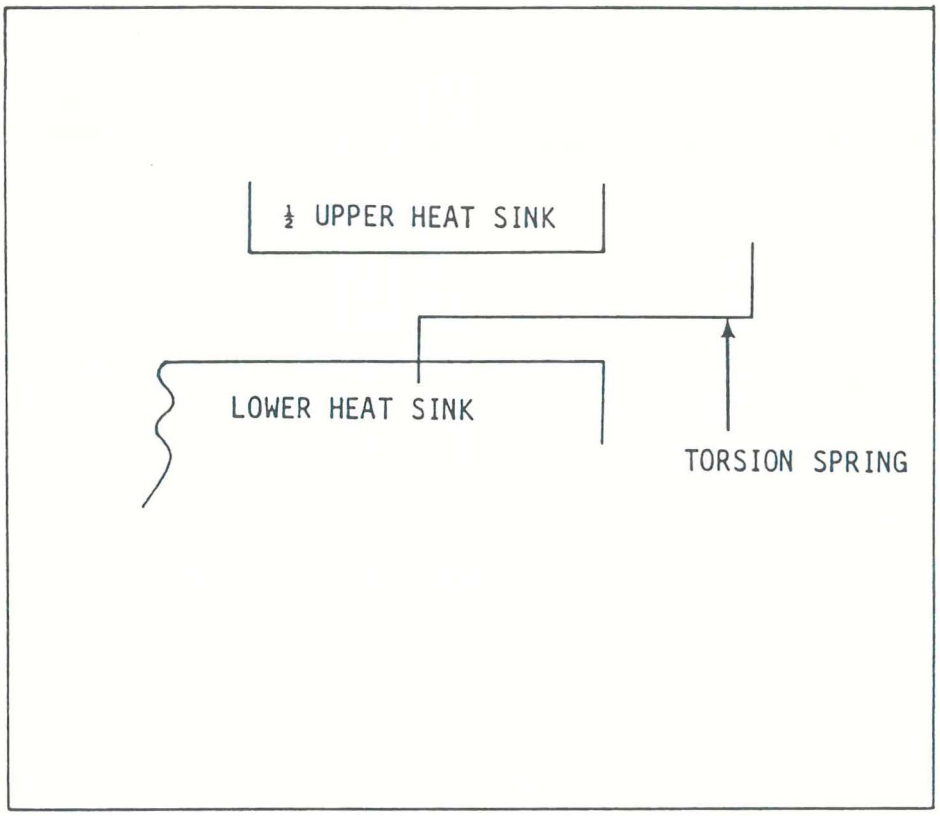


Figure 5-14. Replacement of Torsion Spring

5.5.3 Changing Torsion Spring

If it is necessary to change the torsion spring, proceed with care as damage to the torsion spring can cause later malfunction. The heat sink is assembled from three parts. Remove ONLY the assembly screws on the side next to the torsion spring. DO NOT disturb the relative position of the capstan motor. When the assembly screws next to the torsion spring are removed, the torsion spring may be extracted and the replacement spring installed. See Figure 5-15.

5.5.4 Sensor and Head Assembly.

The sensor assembly is installed as shown in Figure 5-16. The sensor assembly is adjusted on reassembly to provide 0.050 $\pm$ .010 inches clearance between the front face of the sensor and a fully inserted cartridge, see Figure 5-17.

The head uses dowel pins to assure proper alignment. Refer to Figure 5-16. To ensure that the head is electrically isolated from the base plate, the shoulder washers and insulator between the head and base must be used. The head case is taken back to ground by the ground lug only.

5.5.5 Printed Circuit Assembly

The printed circuit assemblies are assembled starting with the interconnect board, refer to Figure 5-18.

5.6 MAINTENANCE CONSIDERATIONS

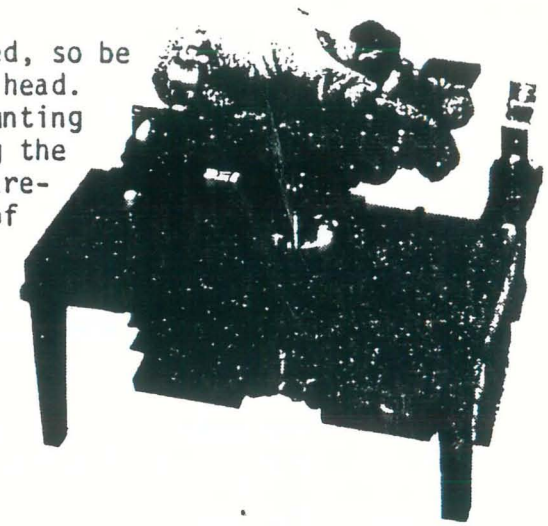
5.6.1 Normal Wear

Normal wear of magnetic tape occurs because the tape must make sliding contact with the head in order to be recorded and replayed. Degradation of performance is caused by the deposition of wear products onto the tape surface. These wear products consist of small pieces of the coating and the base film which are removed from the tape. These particles may collect on any fixed surface, such as the heads, and will slowly build up to form a protruding lump. It is the lumps which produce the performance deterioration by causing separation between tape and heads heads. Separation between tape and heads interferes with both the recording and the reproducing process.

5.6.2 Signal Dropouts

A dropout is defined as a 50 percent or more signal reduction, frequently caused by loss of intimate head-to-tape contact. This poor contact may be due to unclean heads on the drive, dust particles, fingerprints, and smoke particles on the surface of the tape, nodules on the tape, holes in the oxide coating, or distortion of the base material, or by a combination of these factors.

Install Head Assembly. The surface can be easily damaged, so be careful when installing the head. Slide it downward on the mounting dawels after first inserting the insulator and position it carefully before the insertion of the two screws and washers. This will insure proper alignment.



Install the Sensor Assembly. Attach the assembly to the top of the chassis with the two mounting screws after carefully inserting it into the Interconnect Board.

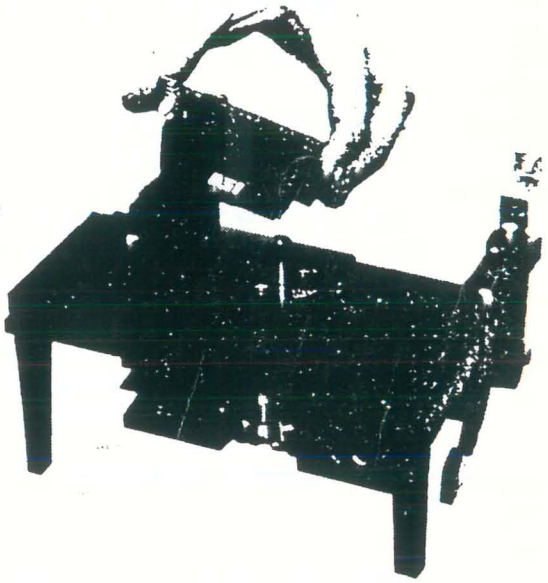


Figure 5-15. Reassembly

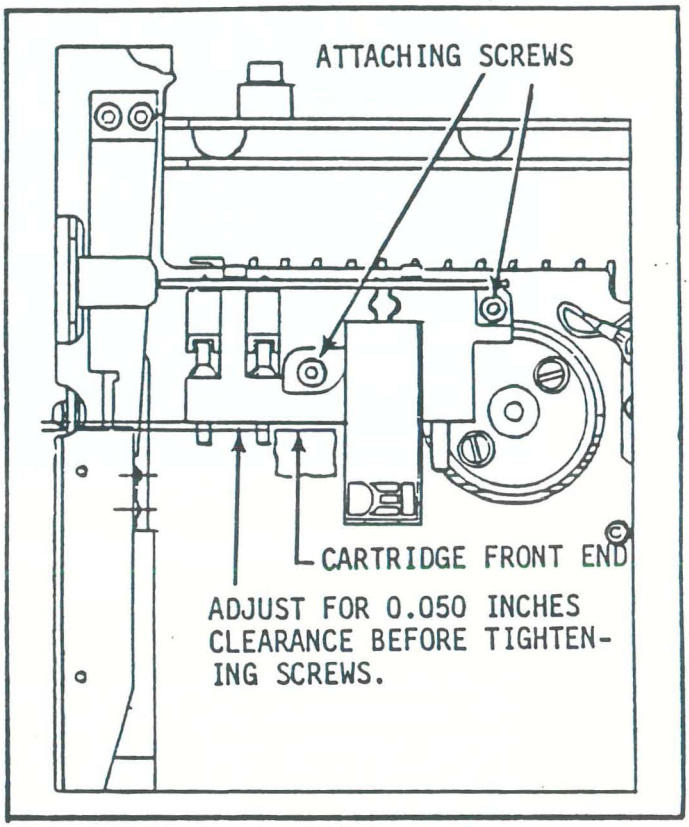
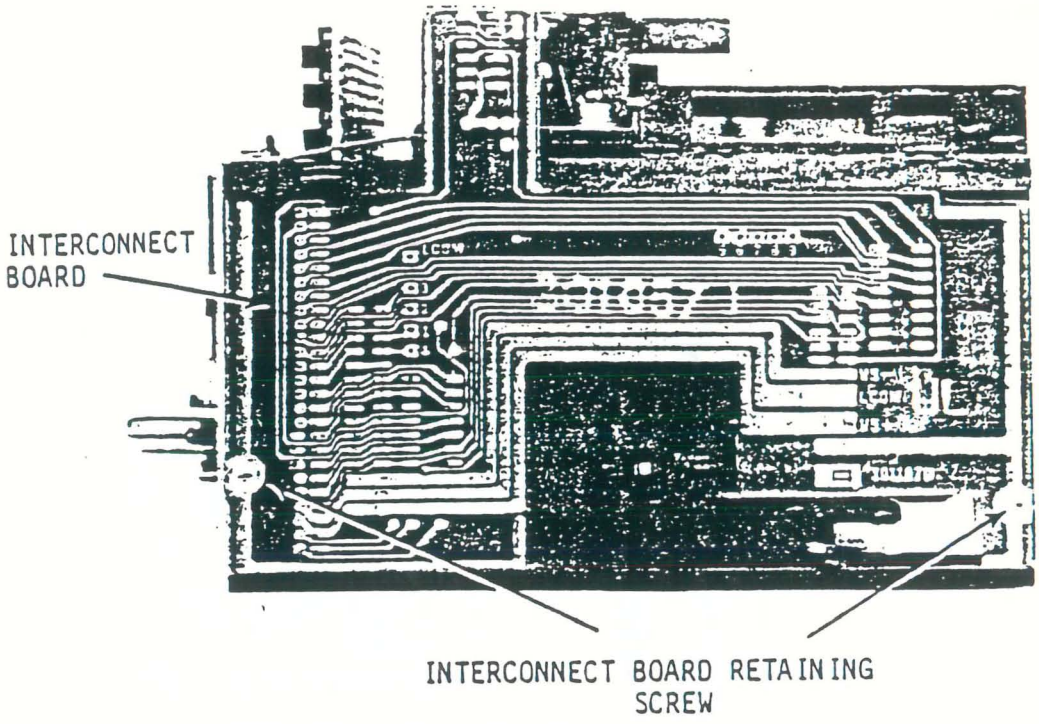


Figure 5-16. Sensor Adjustment



Complete the Board Assembly Mounting. For the Interconnect Board to be installed, the sensor assembly must not be installed. The Interconnect Board is inserted into the slot in the base. It can then be screwed into position. Attach the remaining boards into their proper positions by referring to figures 5-8 through 5-3, the reverse of assembly.

Figure 5-17. Reassembly

The 1/4 inch (6.30 mm) ANSI tape cartridge is designed to protect the tape from normal handling. Whenever the cartridge is removed from the drive, the tape should be at beginning-of-tape (BOT) and thus expose only to the few inches of tape near the beginning-of-tape holes. Operators and service personnel should be instructed to rewind the tape cartridge before removing it from the drive. This operation is facilitated by local control or automatic rewind sequences.

Parts of the recorder may become magnetized and this can cause tape erasure and signal degradation. As a preventative measure, periodic demagnetization of the magnet head and tape cleaner is recommended.

Use of tape cleaner: The tape cleaner on this drive should be cleaned as directed in Paragraph 5.2.2.

A well-designed cartridge tape drive will allow tape cartridges recorded on one drive to be interchanged on similar drives. The cartridge recording must be of high quality with respect to amplitude variation, phase distortion, pulse crowding, etc. for the interchange margin to occur. The cartridge drive does not have direct or precise control of tape speed, tape tension, or track registration, which are functions of the cartridge itself, and must therefore compensate for this loss of control by increasing the margin of those parameters which are controlled. The magnetic head is designed so that the reproduced data is well within the bandpass of the record transfer characteristics. The data separator must have a tracking bandwidth which will accommodate the speed variations of the cartridge and its natural resonance frequencies. The magnitude of these cartridge inclusive speed variations is $\pm$ 3% long term and $\pm$ 7% short term (within a frequency bandwidth of 0.2 Hz to approximately 20 kHz).

Cleaning the head, tape cleaner, and driving capstan every 8 hours of operation for any unusual dirt accumulations will assure intimate head-to-tape contact.

Proper storage of the cartridge is important. Serious damage may occur during improper storage. Elevated temperatures and high relative humidity can lead to "blocking" and mechanical deformation of the tape, such as "cinching," "spoking," "cupping," and "skew." Severe blocking may cause complete delamination between coating and base film, making the tape unusable. The possibility of damage during storage may be minimized by using the following procedures:

a. Tape should be stored under controlled environmental conditions. It is desirable to maintain the temperature between 5 and 34 degrees Celsius and to maintain the relative humidity between 20 and 80 percent. Large or rapid changes in environment should be avoided.

b. Tape stored under less than ideal environmental conditions should be conditioned by allowing it to remain in a suitable environment for at least 24 hours prior to use.

c. Tape cartridges should be stored on edge rather than lying flat to eliminate the possible horizontal shifting of the pack.

5.6.5 Effects of Temperature and Humidity on Magnetic Tape

Magnetic tape will operate properly over a relatively wide environmental range. Ideally, every use would be executed at room temperature and relative humidity in a range near 50 percent. Unfortunately, this is not always feasible. Therefore, the limitations of the tape must be considered and either compensated for or adhered to. As a rule of thumb, the cartridge will operate at temperatures within a range of +5 to +45 degrees Celsuis and humidity between 20 and 80 percent relative to ambient temperature. These limitations are based on conservative limits for the tape itself and the cartridge mechanical elements. Low humidity causes undesirable build-up of static electricity attracting dirt and dust, and in some cases, causes static discharge. This will degrade data performance. High humidity tends to accentuate both head and tape erosion.

5.6.6 Accidental Erasure or Saturation

The magnetic properties of tape are permanent for an indefinite period. Magnetic retentivity is permanent unless changed by magnetic means or at extreme temperatures. It may be altered, for example, by magnetic fields from permanent or electromagnets. These will cause erasure if the cartridge is placed close to medium strength magnetic fields. The magnetic fields necessary to produce complete erasure, however, are so strong that it is not likely to occur accidentally. However, slight erasure can occur without any noticeable attraction or vibration.

A partial erasure is noticeable at a field intensity of 100 oersteds, and a 6 dB loss occurs at a field strength of approximately 150 oersteds. A 6 dB loss is generally considered crucial because it represents a 50 percent reduction in signal strength. Recorded tapes should be kept away from electromagnetic bulk erasers.

Parts of the recorder may become magnetized and this can cause tape erasure or signal degradation. As a preventative measure, periodic demagnetization of the magnet head and tape cleaner is recommended.

5.6.7 Shipping Magnetic Tape

Fiberboard containers are considered as nonprotective or unshielding. However, these containers actually supply a small amount of protection from erasure, in addition to physical protection, simply because of spacing created by the material's thickness and the air space between the cartridge and the container's outer surface. In many instances, this is all that is required for erasure protection. But, if strong

fields of 100 or more oersteds are anticipated, further protection should be used.

Metal shipping containers offer increased protection against physical damage to the tape cartridge. Steel containers (as opposed to aluminum containers) can also provide additional erasure protection. While the steel does not actually prevent incidence of an external field, it shunts the flux lines safely away from the tape, thus reducing the field's erasing effectiveness by changing the geometry of its flux pattern. How well this is accomplished depends primarily on the metal's thickness, its permeability, and the strength of the affecting field.

5.6.8 Bulk Spacing

A three inch (7.62 cm) spacing provided by a low permeability material can provide sufficient separation from any anticipated magnetic sources to virtually eliminate accidental erasure. This packaging qualification is practical when cartridges are shipped as the incorporation of an additional three inches spacing perimeter of cartridges can easily be accomplished.

SECTION 6

ADJUSTMENT PROCEDURES

6.1 GENERAL

The servo and data boards in the cartridge drive contain adjustable circuits. When either of these boards is replaced, the new board must be adjusted. When the Control board is changed, the unit selection switch must be set. (Figure 3-7).

6.2 SERVO ADJUSTMENTS

NOTE: Warm up unit at least three minutes before making adjustments.

The following paragraphs describe how the Servo board is adjusted with the board installed. Low tape speed is 30 ips; high tape speed is 90 ips. The start/stop period is 25 msec for low speed, 71 msec for high speed (including mechanical delay in the cartridge). Refer to Figure 6-1.

6.2.1 Servo Power Adjustment

OBJECT: To ensure that the servo has balance supply voltages. Generally, this is not required unless a ±15 volt regulator has failed.

Procedure:

a. Connect the VOM or DVM reference lead to diode VR700, cathode, left.

b. Attach VOM or DVM test lead to pin four of operational amplifier U705. Record -15 Vdc voltage to three figure accuracy (XX.XXX).

c. Adjust R765 until +15 Vdc is within ±15 mV of the absolute value obtained at pin four of U705.

6.2.2 DC Offset Adjustment

OBJECT: To balance dc offset in the servo unit.

Procedure:

a. Attach VOM or DVM (voltage scale)to BALAS test point #8 on the Interconnect board. The reference lead should be attached to the cathode of diode VR700, Servo board.

b. With power on (no motion command selected), adjust to "0" Vdc (±5mV) by adjusting potentiometer R761, Servo board.

6.2.3 Tape Speed Adjustment

OBJECT: To achieve accurate 30 ips forward and reverse operation. This is essential to proper read data recovery. A special cartridge speed

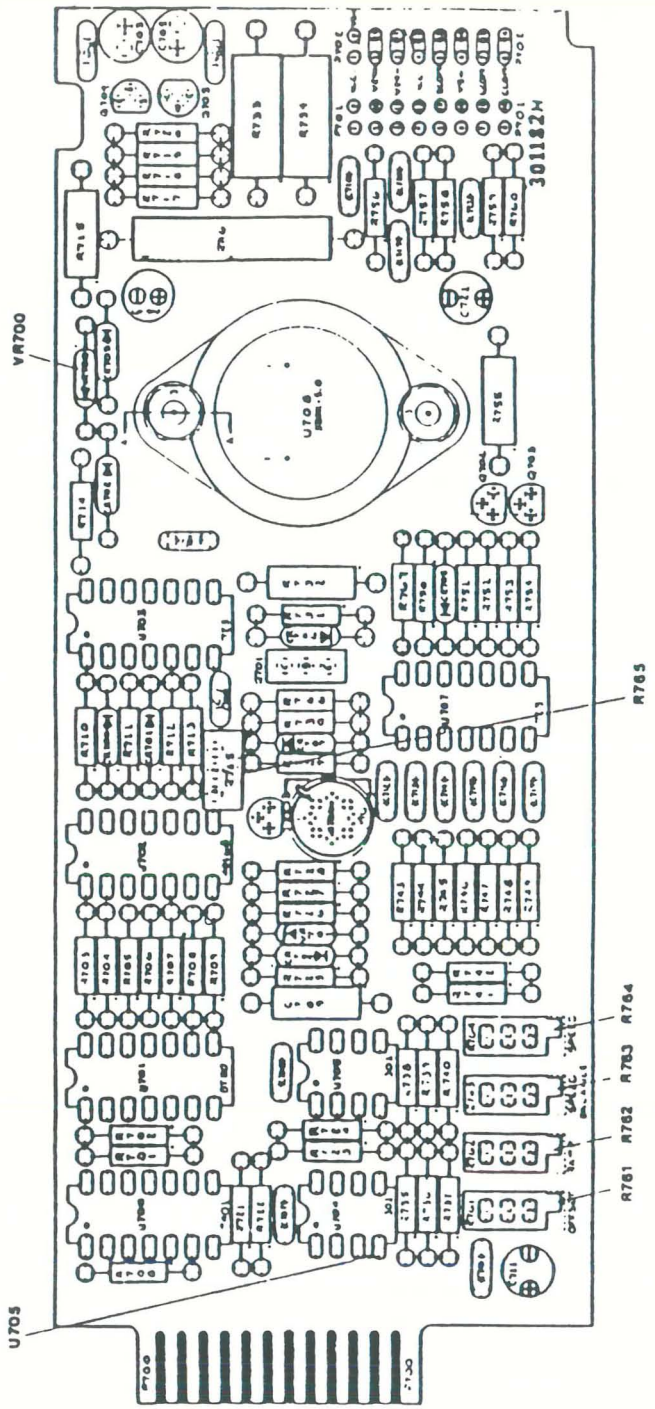


Figure 6-1 SERVO BOARD POTENTIOMETERS
TEST POINTS

indicator (DEI No. 302,028) and drive tester (DEI No. 302,022), Figure 8-1, are available which greatly simplifies tape speed adjustments. The indicator provides a direct digital readout of capstan speed, eliminating deficiencies inherent in other adjustment methods. The tester is available as a substitute controller, providing drive power, control, and status for all modes of operation.

Procedure:

a. Connect the drive to a DEI 302,022 drive tester to obtain FWD-, REV-, and HSP- commands (or use local controller to run drive.)

b. Insert the cartridge speed indicator.

c. Issue a FWD- command. Adjust pot R764 on the Servo board for 30 ips digital readout on the Indicator.

d. Issue a REV- command. Adjust pot R763 for a 30 ips digital readout on the indicator.

e. Repeat steps c and d to achieve forward and reverse tape speeds within 0.05 ips of each other. (Forward and reverse speed adjustments are somewhat interactive.)

6.2.4 Start/Stop Ramp Adjustment (Figure 6-2)

OBJECT: To obtain equal, 25/26 msec start/stop periods at 30 ips tape speed.

Procedure:

a. Toggle FWD- command line a 1 to 10 Hz (automatically available in drive tester).

b. Connect oscilloscope to RAMAS test point #6 on the Interconnect board.

c. Adjust pot R762 on servo board for 23 msec start ramp. Trigger on negative going leading edge of FWD- signal.

d. Retrigger oscilloscope on positive going trailing edge. Start/stop ramps should be approximately equal.

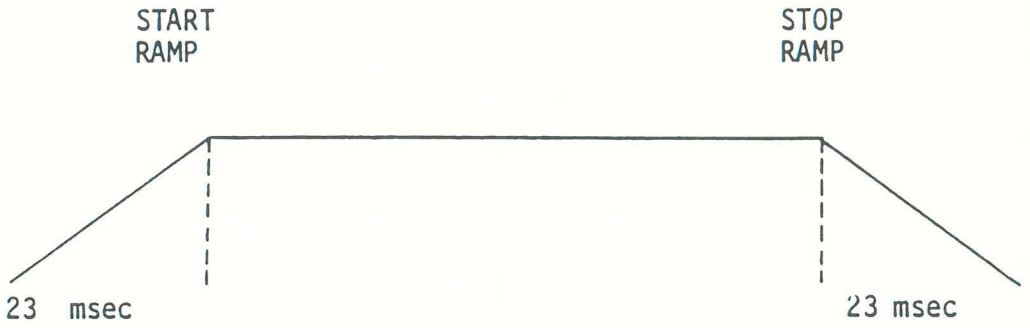


Figure 6-2. Start/Stop Ramps

e. Repeat steps a through d using a toggled 1 to 10 Hz REV- command to check reverse start/stop ramp times. Reverse mode start/stop ramps should be approximately 23 msec.

6.3 DATA ADJUSTMENT PROCEDURE FOR GAIN IN READ CHANNEL

The potentiometer location is shown in Figures 6-3 and 6-4 and the test point (TP) is shown in Figures 6-5 and 6-6.

Object: To match the head and electronics to insure a certain signal level in the data channels.

1. a. If Codec Board is used, set WDE- to true.

   b. If Codec is not used, an external DEI 302,030 Data Pattern Generator, or its user equivalent, should write an all "ones" test pattern (48 kHz at 30 ips). Pattern generator should be set to Mode 1, Frequency 1, Code 3. Unit select, select track 1, forward, and write enable are required.

2. A scope should be attached to J500-20 on interconnect board (Figures 6-5 and 6-6) which can be located by referencing test point point squares on the solder side of the board.

3. After determining which track exhibits the lowest amplitude read envelop while in the read-while-write mode, adjust R524, Figures 6-3 and 6-4 until signal (approximately a sine wave in appearance) is 1.9 Vdc $\pm$ 2 dB while in the read reverse pass after writing this track with the lowest amplitude.

4. Recheck all data tracks. The read signals should be within 0.3 Vdc.

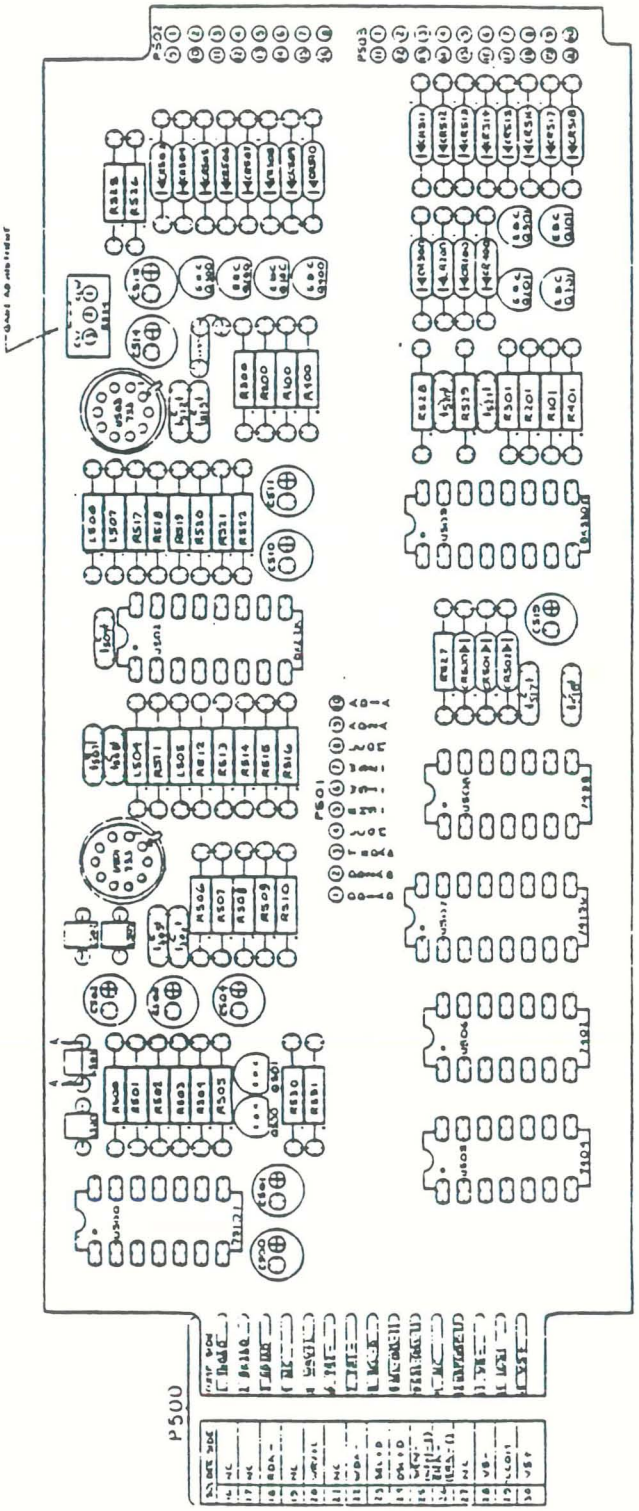


Figure 6-3. Data C Board

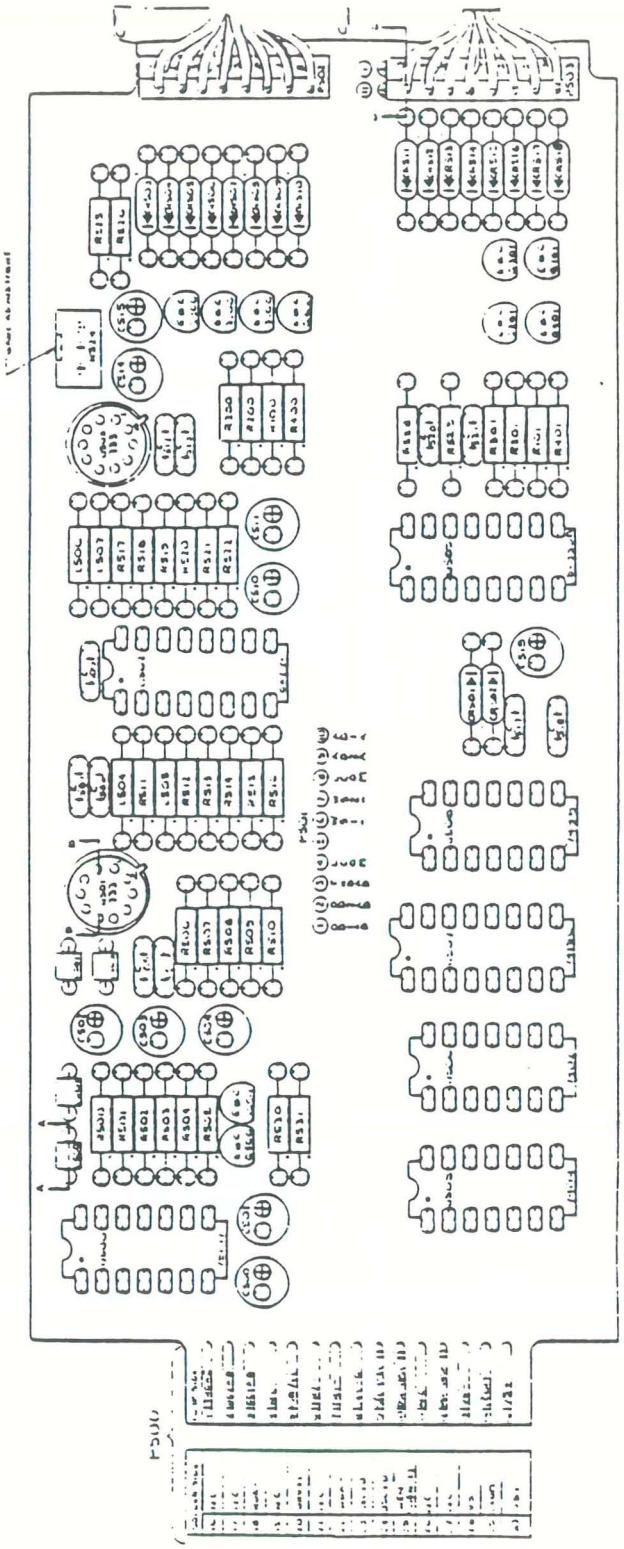


Figure 6-4. Data K Board
(When Control Not Used)

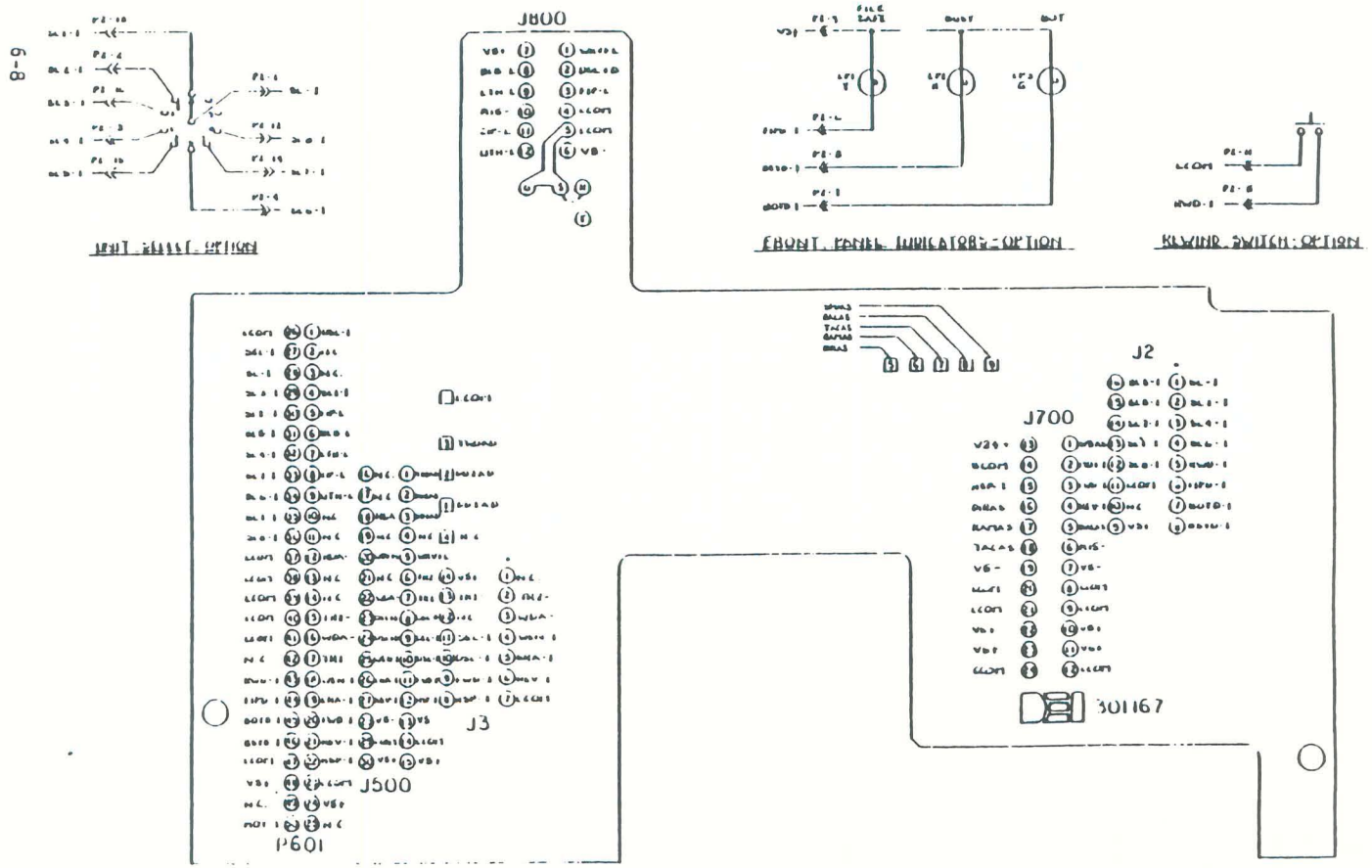


Figure 6-5. Interconnect # Board (Drive With Control Board) 301,176

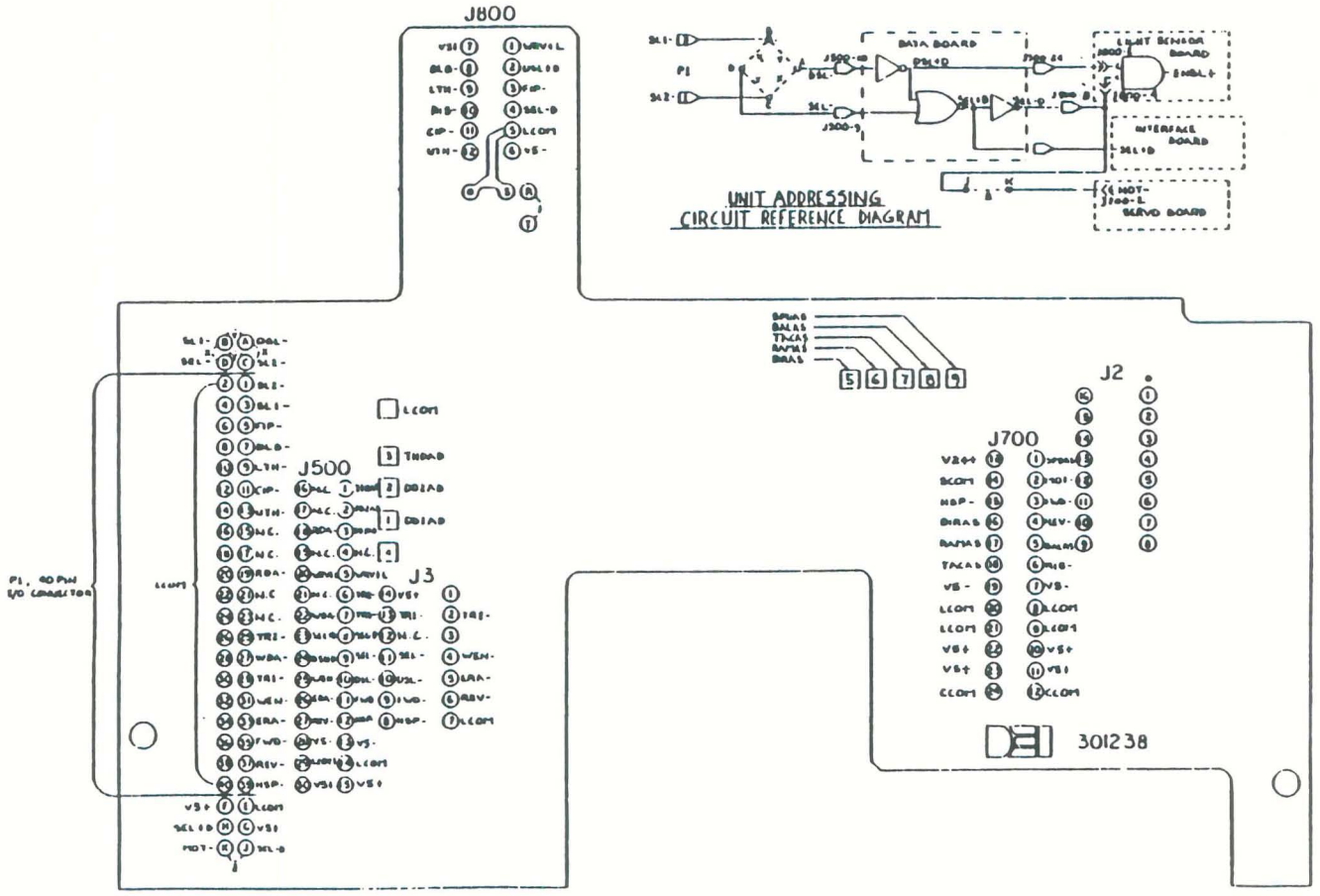


Figure 6-6. Interconnect Board, (Drive Without Control Board) 301,174

SECTION 7

PARTS LIST

Figure 7-1 shows the exploded view of the Tape Drive with item numbers referenced on the Parts List 7.1.

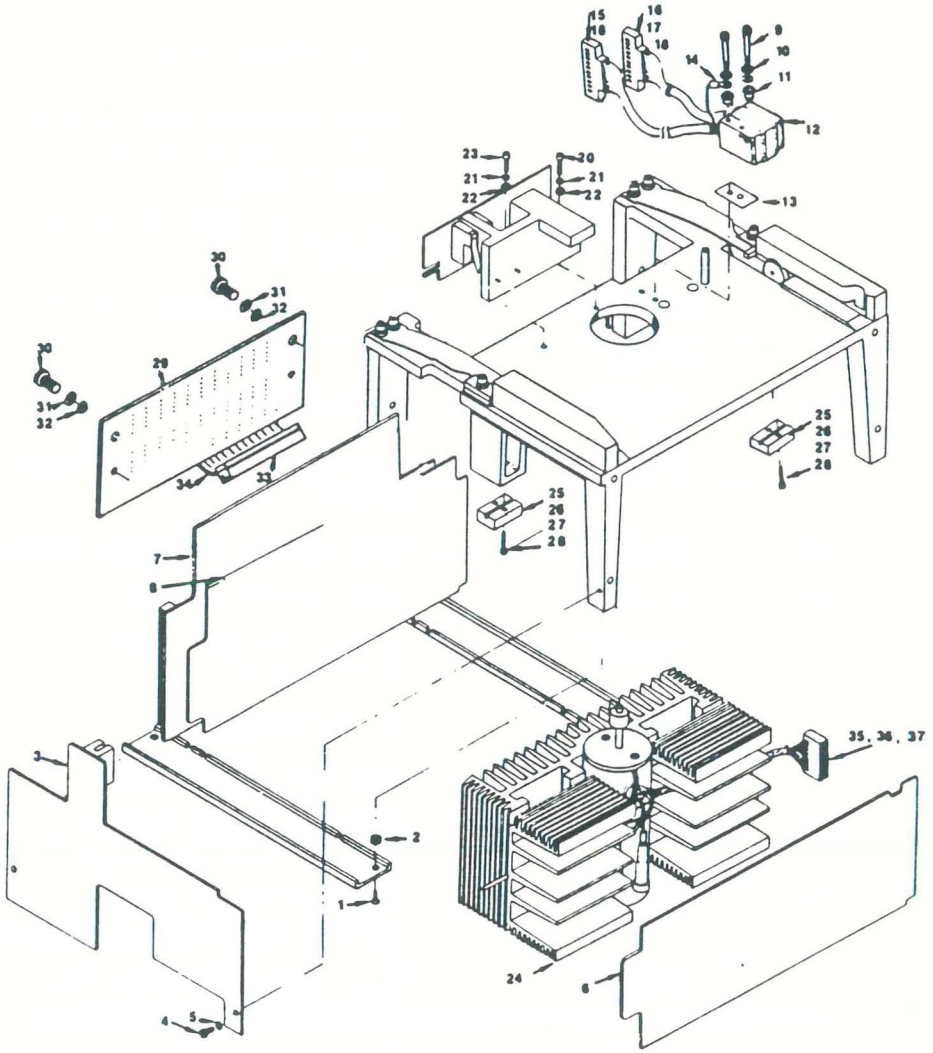


Figure 7-1. Exploded View of Drive

7.1 DRIVE PARTS LIST

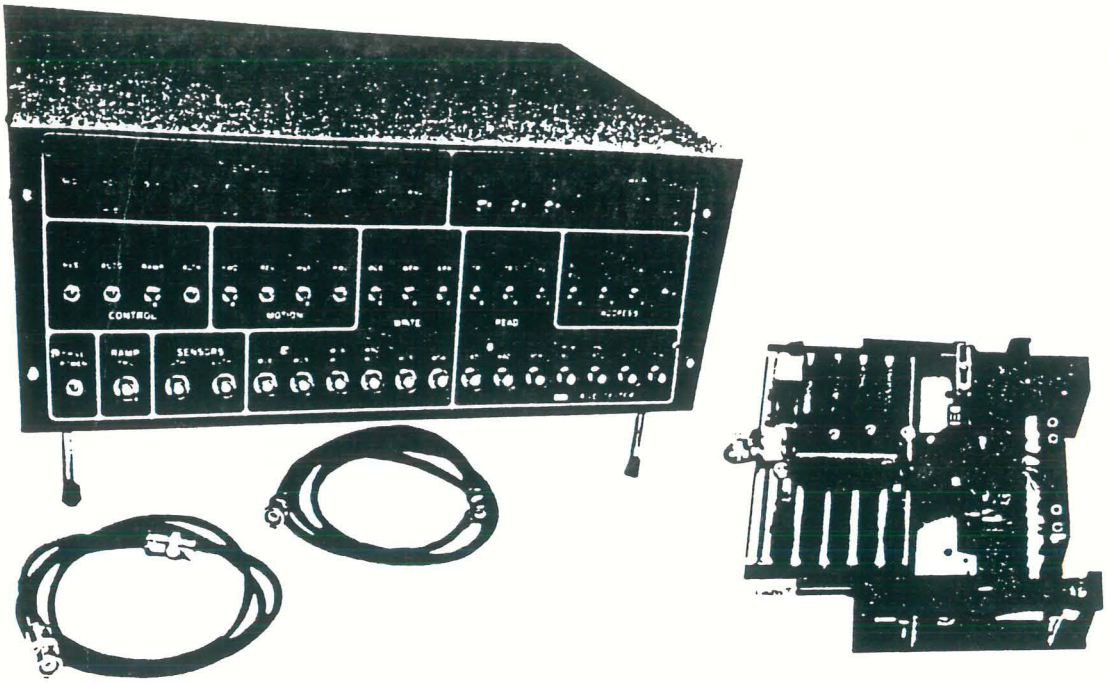
The drive parts are shown in Figure 7-1 and described in Table 7-1.

Item No.	Part No.	Description	Quantity
7-1-1	Commercial	Screw, Flat Head Phillips 4-40 X 0.38" L	4
-2	A300477	Spacer	4
-3a	301,054 or	Interconnect Board	1
-3b	301,057	Interconnect Board, With Control & w/ or w/o Codec Boards	
-4	Commercial	Screw Pan Head Phillips 4-40 X 0.25 "L	2
-5	Commercial	No. 4 Lockwasher, Split	2
-6	301,064	Servo Board	1
-7a	301,016 or	Control Board	Optional
-7b	301,033	Control Board, with Codec Board	1
-8a	301,043	Data Board, without Erase	Optional
-8b	301,002	Data Board, with Erase	1
-9	Commercial	Screw, Socket Head Cap, 4-40 X 1" L	2
-10	Commercial	No. 4 Flatwasher	2
-11	500665	Shoulder, Bushing	2
-12a	301,044	Magnetic Head Assembly, 4 Track Serial, Dual Gap with Erase	1
-12b	301,047	Magnetic Head Assembly, 4 Track Serial, Dual Gap without Erase	Optional
-13	A300225	Magnetic Head Shim (part of magnetic head assembly)	1
-14	500843	Terminal Lug (part of magnetic head assembly)	1
-15	500621	Connector (part of magnetic head assembly) (ITT Cannon 121-7326-108)	1
-16	500669	Connector (part of magnetic head assembly) (ITT Cannon 121-7326-110)	1

Item No.	Part No.	Description	Quantity
-17	500623	Keying Plug (part of magnetic head assembly)	1
-18	500622	Connector Contacts (part of magnetic head assembly) (ITT Cannon 11-0238-0091)	1
-19	301,096	Sensor Assembly	1
-20	Commercial	Screw, Pan Head Phillips 4-40 X 0.5" L	1
-21	Commercial	No. 4 Lockwasher, Split	2
-22	Commercial	No. 4 Flatwasher	2
-23	Commercial	Screw, Phillips .40 X 0.44 L	1
-24	301,066	Heat Sink Assembly	1
-25	B301126	Motor Mount Block	2
-26	Commercial	No. 4 Flatwasher	4
-27	Commercial	No. 4 Lockwasher	4
-28	Commercial	Screw, Pan Head Phillips 4-40 X .38 L	4
-29	301,029	Codec Board	Optional
-30	Commercial	Screw, Phillips 10-24 X 0.38 L	2
-31	Commercial	No. 10 Washer, Split Lock	2
-32	Commercial	No. 10 Washer, Flat	2
-33	500051	Connector, 50 position (part of Codec Board)(3M 3425-0000)	1
-34	500508	Cable, Ribbon 3" L (part of Codec Board)(Ansley No. 171--50)	1
-35	500621	Connector, 16 position (part of heat sink assembly)(ITT Cannon No. 121-7326-10843)	
-36	500622	Contact (part of heat sink assembly)(ITT Cannon No. 11-0238--0091)	9
-37	500623	Keying Plug (part of heat sink assembly)(ITT Cannon No. 225-7301-001)	1

SECTION 8

TEST EQUIPMENT



In addition to standard electronic test equipment, the tape drive requires certain specialized tools available from DEI. These items are:

DEI PART NO.	DESCRIPTION	QUANTITY
302022	Drive Tester - permits off line drive testing.	1 per depot
302030	Data Generator - produces all ones pattern and other patterns required for drive testing.	1 per depot
302028	Cartridge Speed Indicator - Provides a direct digital readout of tape speed, eliminating deficiencies inherent in other tape speed adjustment methods.	1 per depot
	Codec Test Board Converts TTL frequency generator output to differential read data and data detect signals for Codec Board adjustment.	1 per depot

Table 8-1. Optional Maintenance and Test Equipment

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GenRad

For more information or the location of your local GenRad sales office, contact:

U.S.A.
1-800-4-GENRAD

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TLX. 06-986766 GENRADCO
MSGA

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European Headquarters
TEL. 062839181
TLX. 848321 GENRADG

France
TEL. (1) 47970739
TLX: GENRA 220991 F

Germany
TEL. 089/431990
TLX. 529917 GEND

Italy
TEL. (02) 502951
TLX. 320 373 GENRAD I

Switzerland
TEL. 01/552420
TLX. 816828 GENRA CH

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TLX. 50535 GRBEN NL

Asia Pacific
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