Installation and Operation Manual

KENNEDY

A Division of Shugart Corporation

Auto-Load Digital Tape System

Model
9600B / 9650B

FCC CERTIFIED COMPUTER EQUIPMENT

This equipment, freestanding with shielded Data and Control Cables, complies with Part 15, Subpart J of FCC Rules Governing Class A Computing Devices Operated In A Commercial Environment. However, the equipment generates radio frequency energy and, when operated in a residential area, the user must take adequate precautions against interference to radio communications.

Manual Revision B
93-09600-501

MODEL 9600B/9650B TAPE DRIVE
INSTALLATION AND OPERATION MANUAL
TABLE OF CONTENTS

Pages 93-09600-994
April, 1990

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I
GENERAL DESCRIPTION AND APPLICATION DATA

1.1   GENERAL DESCRIPTION

The Kennedy Model 9600B/9650B Tape Drive (Figure 1-1) is rack mountable (9600B) and desk-top (9650B) automatic load, tape drive that includes an embedded Formatter capable of communicating between an industry standard interface bus and ANSI-compatible PE 1600 and 3200 CPI, NRZI 800 CPI tapes. The drive can operate in Streaming Mode at 100 ips or Start/Stop Mode at 50 ips, and can read in either forward or reverse direction in all densities.

1.1.1   HOST INTERFACE

The 9600B/9650B Drive has Industry Standard Interface for Formatted 1/2-inch Tape Drives.

1.1.2   MICROCOMPUTER BASED DESIGN

The 9600B/9650B uses two microprocessors: one in the Formatter, and one in the Drive Control Electronics.

1.1.3   DIAGNOSTICS AND FAULT ISOLATION

The 9600B/9650B includes built-in diagnostics with front-panel eight-character LED readout.
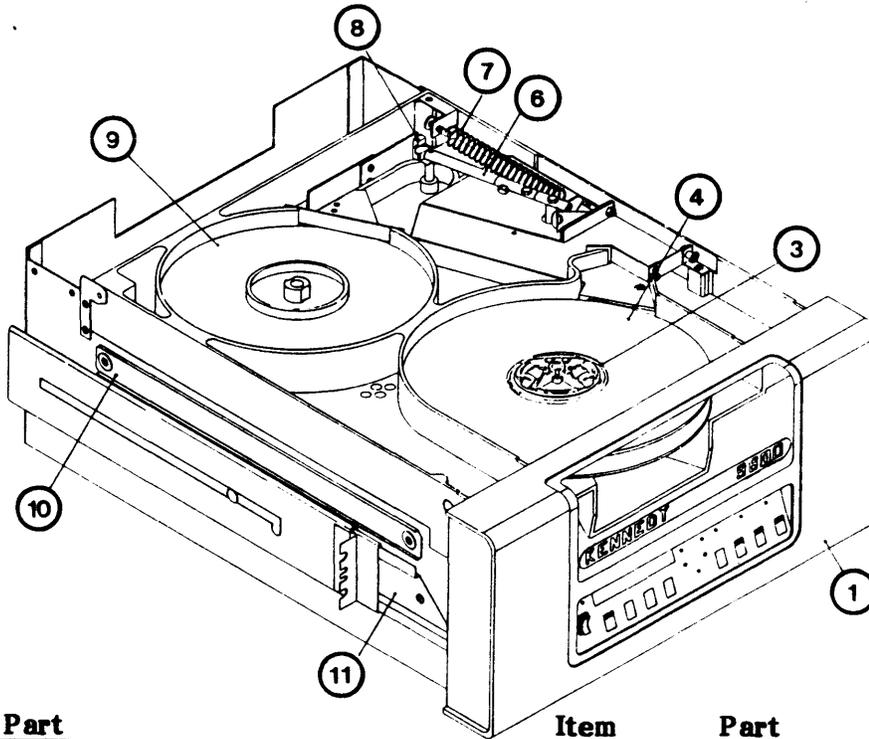
Item	Part	Item	Part
1	Panel Assembly	7	Spring, Extension
2	Supply Arm Assembly (bottom, hidden)	8	Take-up Arm Limit Sensor PCBA
3	Supply Hub Assembly	9	Vacuum Hub Assembly
4	Supply Reel Tape	10	Support Bar
5	Magnetic Head Assembly (hidden)	11	Slide Set
6	Take-up Arm Assembly (top)		

Figure 1-1.   Model 9600B/9650B Auto-load Tape Drive

1.2 SPECIFICATIONS

1.2.1 OPERATIONAL SPECIFICATIONS

NOTE: See Appendix A for parameter definitions.

Table 1-1. Operational Specifications

TAPE					
Width	0.498 (+/-0.002) inch				
Thickness	1.9 or 1.3 mil (0.038 or 0.0226mm)				
Tension	8.75 +/-0.5 ounces				
Reel Size (Open Reels - inches)	**6.0**	**7.0**	**8.5**	**10.5**	**Thickness**
Tape Length (feet):	200	600	1200	2400	1.9 mil
				3600	1.3 mil
Reel Capacity	(See Table 1-2)				

PERFORMANCE

Recording Densities:		Tape Speed:	
NRZI	800 CPI	Start/Stop	50 ips
PE	1600 CPI	Streaming	100 ips
DDPE	3200 CPI	Rewind, nominal	200 ips
Gap Length		NRZI/PE 0.6 inch (nominal - Read/Write)	

Data Access Time (nominal):

		Time	
Operation	**Density**	**50 IPS**	**100 IPS**
Read	800/1600/3200	12.4 ms	20.6 ms
Write	800/1600/3200	8.6 ms	19.1 ms

Command Reinstruct Time (with Autospeed Disabled):

		Time	
Operation	**Density**	**50 IPS**	**100 IPS**
Read	800/1600/3200	0.7 ms	4.2 ms
Write	800/1600/3200	0.7 ms	3.8 ms

Maximum Latency for Reinstruction on Ramp:

Operation	**Density**	**Speed**	**Time**
Read	800/1600/3200	50 IPS	3.2 ms
Write	800/1600/3200	50 IPS	3.2 ms

Table 1-1. Operational Specifications (Continued)

Reinstruct Time Limits for Auto Speed Transition to 100 IPS:

Operation	Density	Time
Read	800/1600/3200	2.8 ms
Write	800/1600/3200	2.4 ms

Reposition Time, Streaming Mode (100 IPS):

Operation	Density	Time
Read	800/1600/3200	42.5 ms
Write	800/1600/3200	42.5 ms

Data Transfer Rate:

		Rate (KB/SEC)	
Speed	Density (CPI)	Normal	Maximum
50 ips	NRZI 800	40	48
	PE 1600	80	96
	DDPE 3200	160	192
100 ips	NRZI 800	80	96
	PE 1600	160	192
	DDPE 3200	320	384

POWER REQUIREMENTS

AC Units:

| Input Voltage | 100, 120, 220, 240 VAC +15% -10% | |
	50 or 60 Hz +/-2 Hz	
Input Current	**120 VAC**	**220 VAC**
	3.0 amps	1.5 amps
Power: Nominal	300 watts	300 watts
Peak	400 watts	400 watts
Fuse	6 amp at 110/120	3 amp at 220/240 VAC (Slo-Blo)
Heat Dissipation	1025 BTU/hr	

DC Units:

Input Voltage	48, 60VDC +20% -10%	
Input Current	**48 VDC**	**60 VDC**
	7.5 amps	5.5 amps
Power: Nominal	350 watts	350 watts
Peak	450 watts	450 watts
Fuse	12 amp	10 amp
Heat Dissipation	1194 BTU/hr	

Table 1-2. Tape Reel Capacities

Reel Size (inches)	Tape Thickness		1.9 mil		1.3 mil	Blocks (Bytes)
	6	7	8.5	10.5	10.5	
NRZI (MBytes)	1 1.5 1.8 2	3 5 5.5 6	6 9 11 12	10 17 21 23	15 25 32 34	512 2K 8K 64K
PE (MBytes)	1.3 2.5 3.5 4	4 8 11 12	8 15 21 23	15 30 41 45	22 45 62 68	512 2K 8K 64K
DDPE (MBytes)	2.5 5 7 8	8 15 21 23	15 30 41 45	30 60 82 90	44 90 120 134	512 2K 8K 64K

1.2.2 PHYSICAL/ENVIRONMENTAL SPECIFICATIONS (Table 1-3)

Table 1-3. Physical/Environmental Specifications

PHYSICAL SPECIFICATIONS		

Dimensions:
  Height
  Width
  Depth: From Mounting Surface
  Depth: Overall
Mounting
	8.75 inches (22.23 cm)
	17.00 inches (43.18 cm)
	22.00 inches (55.88 cm)
	24.50 inches (62.23 cm)
	Slide Mount in standard 19-inch RETMA Rack	

Weight:	**9600B (with Slides)**	**9650B**
No Packing Material With Packing Material	110 lbs (49.5 Kgm) 135 lbs (60.75 Kgm)	122 lbs. (54.9 Kgm) 152 lbs (68.4 Kgm)
ENVIRONMENTAL SPECIFICATIONS		
Temperature operating Temperature, non-operating	60 to 90°F (15.6 to 32.2°C) -40 to +122°F (-40 to +50°C)	
Humidity, (with wet bulb)	Operating (+78° max) Storage (+83° max) 20 to 80% 5 to 90%	
Altitude, operating Altitude, shipping	-1300 to 10,000 ft. (-400 to 3000 meters) -1300 to 50,000 ft. (-400 to 15000 meters)	

1.3 INTERFACE SPECIFICATIONS

1.3.1 GENERAL

This section describes the signal requirements and characteristics of the interface between the tape drive and the controller. The connectors and cable requirements are described, as well as the actual lines and the commands derived from the lines. The interface lines are summarized in Tables 1-4A and 1-4B while the command structure is summarized in Table 1-5.

1.3.2 INTERFACE CONNECTORS

The interface connectors on the Model 9600B/9650B are designed for standard fifty line shielded cables. For each active connector pin there is an associated ground pin. The mating interface connectors are two 50-pin card cage connectors.

1.3.3 INTERFACE SIGNAL CHARACTERISTICS

Signals from the controller to the Model 9600B/9650B must conform to the following specifications:

Levels:	1 = Low = True = 0V (+0.7 Vdc)	NOTE:
	0 = High = False = +3V (+/−0.5 Vdc)	Total edge transmission
Pulses:	1 = Low = True = 0V (+0.7 Vdc)	Delay =<200 nanosec over
	0 = High = False = +3V (+/−0.5 Vdc)	a 20-foot cable.

All output signals from the Model 9600B/9650B are driven by open collector type line drivers capable of sinking up to 36 mA (25 standard unit loads) in the low true state. Open lines will result in false signal levels.

1.3.4 INTERFACE CABLES

Per FCC and ESD specs, interface cables should be braided and shielded with maximum allowable length of 20 feet.

1.3.5 RECEIVER/DRIVER CONFIGURATION AND TERMINATION

The input lines to the transport are terminated with a 220 ohm resistor to plus five volts, and a 330 ohm resistor to ground (Figure 1-2). All input circuits have low level input voltage of 0.7 V maximum and a high level input voltage of 2.0 V minimum. The input receivers are all 74LS type circuits.

All output lines must be terminated at the far end of the daisy chained cable with a 220 ohm resistor to plus five volts and a 330 ohm resistor to ground. Output circuits are 7438 open collector drivers as shown in Figure 1-2.
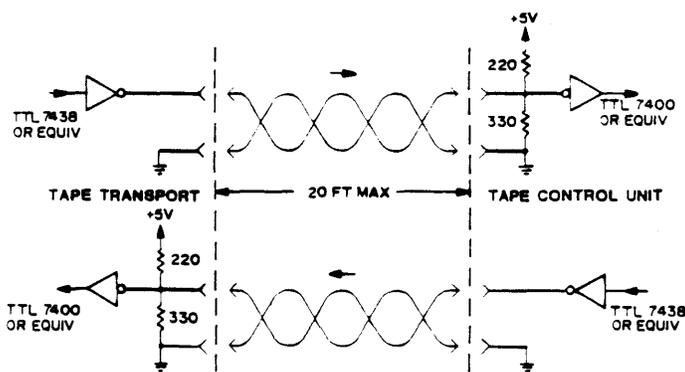
Figure 1-2. Receiver/Driver Interface Configuration

1.3.6   DAISY CHAINING

The 9600B/9650B transport may be configured to allow operation of up to eight transports with a single controller as shown in Figure 1-3.
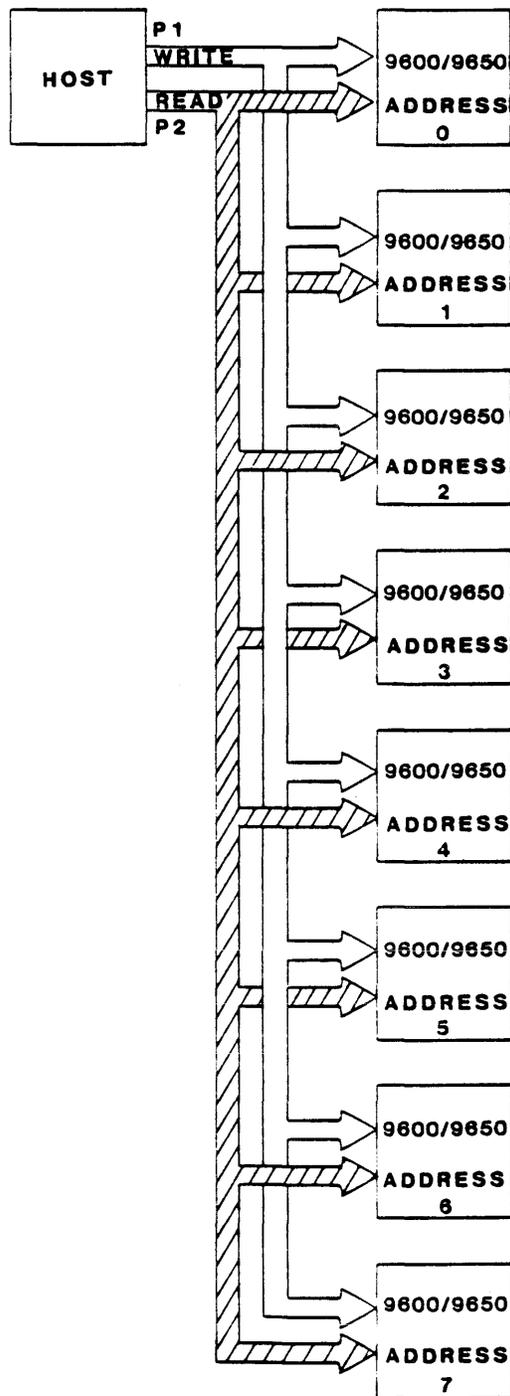
Figure 1-3.   Daisy Chaining

1.4   INTERFACE INPUT AND OUTPUT SIGNALS

The following sections tabulate and describe Host/Drive interface signals. Input Signals (IN) are Signals from the Host; Output Signals (OUT) are Signals to the Host. Tables 1-4A and 1-4B list Host-to-Drive I/O Signals. Connector Signal/Pin assignments include Signal and Ground Pins and related Signal Mnemonic.

Table 1-4A.   Drive Interface Summary, Connector P2

Pin Sig/Grd	Mnemonic	Signal Name	In/Out
P2-1/5	RP	Read Data P	Out
P2-2/5	R0	Read Data 0	Out
P2-3/5	R1	Read Data 1	Out
P2-4/5	LDP	Load Point	Out
P2-6/5	R4	Read Data 4	Out
P2-8/7	R7	Read Data 7	Out
P2-10/9	R6	Read Data 6	Out
P2-12/11	HER	Hard Error	Out
P2-14/13	FMK	File Mark	Out
P2-16/15	ID/CCG	ID Burst/Check Char Gate	Out
P2-18/17	FEN	Formatter Enable	In
P2-20/19	R5	Read Data 5	Out
P2-22/21	EOT	End of Tape	Out
P2-24/23	OFL	Off Line	In
P2-26/25	DEN1	Density 1	Out
P2-28/27	RDY	Ready	Out
P2-30/29	RWG	Rewinding	Out
P2-32/31	FPT	File Protect	Out
P2-34/33	RSTR	Read Strobe	Out
P2-36/35	WSTR	Write Strobe	Out
P2-38/37	DBY	Data Busy	Out
P2-40/39	SPD	Speed	Out
P2-42/41	CER	Corrected Error	Out
P2-44/43	ONL	On Line	Out
P2-46/45	TAD1	Transport Address 1	In
P2-48/47	FAD	Formatter Address	In
P2-50/49	HSP	High Speed	In

Table 1-4B.   Drive Interface Summary, Connector P1

Pin Sig/Grd	Mnemonic	Signal Name	In/Out
P1-2/1	FBY	Formatter Busy	Out
P1-4/3	LWD	Last Word	In
P1-6/5	W4	Write Data 4	In
P1-8/7	GO	Initiate Command	In
P1-10/9	W0	Write Data 0	In
P1-12/11	W1	Write Data 1	In
P1-14/13	DEN0	Density 0	Out
P1-16/15	LOL	Load On Line	In
P1-18/17	REV	Reverse/Forward	In
P1-20/19	REW	Rewind	In
P1-22/21	WP	Write Data P	In
P1-24/23	W7	Write Data 7	In
P1-26/25	W3	Write Data 3	In
P1-28/27	W6	Write Data 6	In
P1-30/29	W2	Write Data 2	In
P1-32/31	W5	Write Data 5	In
P1-34/33	WRT	Write/Read	In
P1-36/35	LGP	Long Gap	In
P1-38/37	EDT	Edit	In
P1-40/39	ERS	Erase	In
P1-42/41	WFM	Write File Mark	In
P1-44/43	Reserved		
P1-46/45	TAD0	Transport Address 0	In
P1-48/47	R2	Read Data 2	Out
P1-50/49	R3	Read Data 3	Out

1.4.1   INTERFACE INPUT SIGNALS (from Host to Drive)

1.4.1.1   TRANSPORT ADDRESS, FORMATTER ADDRESS

TAD0, TAD1, FAD   Level   P2-48, P1-46, P2-46

The states of these lines determine which of up to eight tape drives are selected by the controller. The following list defines the tape drives addresses produced as a result of the various TAD0, TAD1, FAD.

FAD	TAD0	TAD1	ADDRESS
0	0	0	SLT0
0	0	1	SLT1
0	1	0	SLT2
0	1	1	SLT3
1	0	0	SLT4
1	0	1	SLT5
1	1	0	SLT6
1	1	1	SLT7

1.4.1.2   INITIATE COMMAND - GO

GO   Pulse   P 1-3

A pulse which initiates any command specified by the command lines described in the following paragraphs. Information on the command lines is copied into the unit on the trailing edge of the GO pulse. At the end of the reinstruct window in streaming write commands only, it is possible for the Host to extend the reinstruct window by asserting and holding the GO pulse in a true state. The unit will continue to stream for up to one inch waiting for the trailing edge of the GO pulse as the Host returns GO to the false state. If one inch is exceeded and the GO pulse has yet to be denied, the unit shall enter a reposition cycle. This feature in effect creates extended gaps.

1.4.1.3   REVERSE

REV   Level   P 1-18

Command line refer to Table 1-5.

1.4.1.4   WRITE

WRT   Level   P 1-34

Command line refer to Table 1-5.

1.4.1.5   WRITE FILE MARK

WFM   Level   P 1-42

Command line refer to Table 1-5.

1.4.1.6   EDIT

EDT   Level   P 1-38

Command line refer to Table 1-5.

1.4.1.7   ERASE

ERS   Level   P 1-40

Command line refer to Table 1-5.

1.4.1.8   HIGH SPEED

HSP   Level   P 2-50

When true, this signal causes the selected on-line unit to operate in the high speed mode (100 ips).

1.4.1.9 LONG GAP

LGP   Level   P1-36

When true during a Write Mode, this level causes the generation of a longer Interrecord Gap (erased area on tape) to allow ample reinstruct periods as required for Host system latencies. Long Gap Time is limited by its setting in Setup Options, but terminates automatically if a Write Command is received before the selected limit.

1.4.1.10 REWIND

REW   Pulse   P1-20

A pulse which causes the selected transport to rewind to load point. This pulse does not cause the formatter to go busy. The Ready status will remain false during rewind. In daisy chained systems, the rewind pulse can be issued to one or more of the units in the chain while allowing data transfer operations to occur on any other unit in the chain.

1.4.1.11 OFF LINE/UNLOAD

OFL   Pulse   P2-24

This pulse causes the transport to go off line immediately, then rewind to load point and unload the tape.

1.4.1.12 LAST WORD

LWD   Level   P1-4

When this level is true during a write or variable erase command, it indicates that the next character to be strobed into the formatter is the last character of the record. LWD should go true when the last data character is placed on the interface lines.

1.4.1.13 FORMATTER ENABLE

FEN   Level   P2-18

When false this level causes all units in a daisy chain configuration to revert to the quiescent state. This line may be used to disable the units if controller power is lost or to clear unit logic when illegal commands or unusual conditions occur. When denied during command execution, the unit will abort the command in an orderly fashion and stop motion. The unit Set Up options (described in Operation and Maintenance Manual) allows the polarity of this level to be selected.

1.4.1.14 WRITE DATA LINES

WP, W0-W7   Level

These 9 lines transmit write data from the controller to the formatter. The 8 data bits appearing on W0-W7 are written onto the corresponding channels on tape; W7 corresponds to the least significant bit of the character. Line WP is optional and is utilized only if it is required to check the parity bit generated by the customer. The formatter generates odd parity internally on the basis of data contained on W0-W7.

The first character of a record should be available on these lines within one character period after DBY goes true and remain until the trailing edge of the first WSTR is issued by the unit. The next character of information must then be placed on these lines within one half of a character period. Subsequent characters of a record are processed in this manner until LWD is set true by the controller when the last character is transmitted.

INPUT LINE	ANSI CHANNEL	ANSI TRACK
W 0	0	7
W 1	1	6
W 2	2	5
W 3	3	3
W 4	4	9
W 5	5	1
W 6	6	8
W 7	7	2
WP	P	4

1.4.1.15   LOAD ON LINE

LOL   Pulse   P1-16

If tape is not loaded, the selected unit will execute a load sequence. Upon completion of the load sequence, the unit will go online. If tape is loaded and the selected unit is not online, it will go online.

1.4.2   INTERFACE OUTPUTS (9600B/9650B to host)

1.4.2.1   FORMATTER BUSY

FBY   Level   P1-2

This level goes true on the trailing edge of GO when a command is issued by the controller. FBY will remain true until tape motion ceases or optionally until DBY goes false on 100 ips commands. The unit Setup options (described in Operation and Maintenance Manual) allow selection of the cancellation point for FBY.

1.4.2.2   DATA BUSY

DBY   Level   P2-38

This level goes true during the active execution of all commands initiated by GO. A new command may be issued after DBY goes false.

1.4.2.3   HARD ERROR (All DENSITIES)

HER   Pulse   P2-12

When true, this pulse indicates one or more of the following error conditions has occurred. The following list summarizes the errors for all three densities.

NOTE: The HER may be reported as a real time pulse for each error condition as it occurs; or the occurrence of at least one HER or CER within the block can be captured by the Host before the falling edge of DBY at the end of the data block.

a. Longitudinal parity error.
b. Improper record format.
c. CRCC parity error.
d. Vertical parity error on a data character.
e. Host write parity error (optional).
f. No file mark detected in Read After Write mode when executing a Write File Mark command.
g. If a gap of 25 feet is detected while executing a Read Block, Space Block or Search File Mark command (optional).
h. Read after Write compare error.
i. Excessive skew.
j. Postamble error.
k. Multiple channel error.
l. CRC error.

1.4.2.4   CORRECTED ERROR (PE, DDPE MODE)

CER   Pulse   P2-42

This pulse indicates that a single track dropout has been detected during read or write and the unit will perform a vertical parity correction.

1.4.2.5   CHECK CHARACTER GATE (NRZI MODE ONLY)

ID/CCG   Level   P2-16

This level is set true by the unit when the read information being transmitted to the controller is the cyclic redundancy check character (CRCC) or the longitudinal redundancy check character (LRCC) of the data block. When data characters are transmitted, CCG goes false. Data and Check information can be distinguished by gating Read Strobe with CCG or its inverse. After leaving load point this line should only be used during NRZI mode.

NOTE: CCG and the Read Strobes (RSTR) for the check characters can be disabled as one of the Setup options (described in Operation and Maintenance Manual).

1.4.2.6   IDENTIFICATION BURST (PE, DDPE MODE)

ID/CCG   Level   P2-16

The level identifies that an ID burst is being detected for PE or DDPE.

1.4.2.7   FILE MARK

FMK   Pulse   P2-14

File mark is pulsed when a file mark is detected on the tape during a read operation or during a write file mark operation. The FMK line will be pulsed after a complete file mark has been read. When reading NRZI file marks, read strobes are issued to the interface.

1.4.2.8 WRITE STROBE

WSTR   Pulse   P2-36

This line pulses each time a data character is written onto tape. WSTR samples the write data lines WP, W0-W7 from the Host and copies this information character by character into the unit's write logic. The first character should be available prior to the first write strobe pulse and succeeding characters should be set up within half a character period after the trailing edge of each write strobe pulse. The write strobe is also active during variable length erase command; however, no data will be written to tape.

1.4.2.9 READ STROBE

RSTR   Pulse   P2-34

This line consists of a pulse for each character of read information allowing the transmission of data to the host. This signal should be used to sample the read data lines RP, R0-R7.

In a NRZI Read operation the transmission of CRC and LRC data characters will be flagged by the check character gate (CCG) signal as described previously under Check Character Gate.

1.4.2.10 READ DATA LINES

RP, R0-R7   Levels

These lines transmit the read data for all three densities. Each character read from tape is made available by parallel sampling the read lines using the Read Strobe. The data remains on the read lines for a full character period.

1.4.2.11 READY

RDY   Level   P2-28

RDY is true (low) only when the transport is ready to receive external commands; the following conditions must exist:

    a. All interlocks are made.
    b. Initial load or rewind sequence is complete.
    c. Transport is on-line.
    d. Transport is not rewinding.

1.4.2.12 ON LINE

ONL   Level   P2-44

When ONL is true (low), the transport is under host or remote control. ONL false (high) indicates the transport is under local control.

1.4.2.13 REWINDING

RWG   Level   P2-30

RWG is true (low) when the transport is engaged in a rewind operation or returning to the load point at the end of the rewind operation.

1.4.2.14 FILE PROTECT

FPT   Level   P2-32

FPT is true (low) when a reel of tape without a write-enable ring is mounted on the transport supply hub.

1.4.2.15 LOAD POINT

LDP   Level   P2-4

LDP is true (low) when the load point marker is under the BOT sensor and the transport is not rewinding. After receipt of a motion command the signal will remain true until the load point marker leaves the BOT sensor area.

1.4.2.16 END OF TAPE

EOT   Level   P2-22

EOT is true (low) when the EOT marker is detected in the forward direction. EOT goes false (high) when the EOT marker is detected in reverse (REWIND).

1.4.2.17 DENSITY

DEN0, DEN1   .   Level   P1-14, P2-26

Binary-coded signals that indicate the current density of the Drive. Two coding schemes are available. These schemes are:

DENSITY	DENS OUT NRZ ONLY		DENS OUT CODED	
	DEN 1	DEN 0	DEN 1	DEN 0
800	1	0	1	1
1600	0	0	0	1
3200	0	0	1	0

The coding scheme used can be selected as one of the Set-up options (described in the Operations and Maintenance Manual.)

1.4.2.18 SPEED

SPD   .   Level   P2-40

SPD true (low) indicates the selected transport is in the high speed streaming mode. A false level indicates low speed (50 ips).

1.4.3 COMMAND EXECUTION

The following section describes the appropriate combinations of signal lines required to achieve Command Execution followed by a description of the responses of the Model 9600B/9650B. Command configuration for the Model 9600B/9650B is shown in Table 1-5.

Table 1-5. Command Configuration

COMMAND	REV	WRT	WFM	EDT	ERS
READ FORWARD	0	0	0	0	0
READ REVERSE	1	0	0	0	0
READ REVERSE EDIT	1	0	0	1	0
WRITE	0	1	0	0	0
WRITE EDIT	0	1	0	1	0
WRITE FILE MARK	0	1	1	0	0
ERASE VARIABLE LENGTH	0	1	0	0	1
ERASE FIXED LENGTH	0	1	1	0	1
DATA SECURITY ERASE	0	1	1	1	1
SPACE FORWARD	0	0	0	0	1
SPACE REVERSE	1	0	0	0	1
FILE SEARCH FORWARD	0	0	1	0	0
FILE SEARCH REVERSE	1	0	1	0	0
FILE SEARCH FORWARD (IGNORE DATA)	0	0	1	0	1
FILE SEARCH REVERSE (IGNORE DATA)	1	0	1	0	1
SELECT 800 CPI	0	1	1	1	0
SELECT 1600 CPI	0	0	1	1	1
SELECT 3200 CPI	1	0	1	1	1
SCRUB	0	1	0	1	1

1.4.3.1 READ FORWARD

On receipt of the Read Forward command loaded into the unit with the GO pulse, the FBY signal goes true and the unit begins to accelerate the tape up to nominal velocity. When the tape is up to speed and the data block to be read is detected, DBY shall go true. Read Strobes (RSTR) accompany the decoded data. DBY will go false after the complete block has been read indicating readiness of the unit to accept a new command. If no command is received, the unit will either stop in the gap in 50 ips operation or enter a reposition operation in 100 ips operation and FBY will go false.

1.4.3.2   READ REVERSE

This command is similar to a read forward command except that the tape motion is in the reverse direction.

1.4.3.3   WRITE

On receipt of the Write command loaded into the unit with the GO pulse, the FBY signal goes true and the unit begins to accelerate the tape up to nominal velocity. When the tape is up to speed and the data block is ready to be written, DBY shall go true. Write Strobes (WSTR) are transmitted to the Host by the unit and the Host presents each data byte to be written. When LWD is received by the unit from the Host, the unit will finish reading the block, error status shall be made available to the Host and then the unit shall force DBY false indicating the end of the block just written. FBY will remain true if a new command in the same direction is received within the command reinstruct period. If no command is received, the unit will either stop in the gap in 50 ips operation or .enter a reposition operation in all 100 ips write operation and FBY will go false.

1.4.3.4   READ REVERSE EDIT

The Read Reverse Edit command besides providing data establishes the correct position of the tape relative to the magnetic head prior to the Host executing a Write Edit command.

1.4.3.5   WRITE EDIT

The Write Edit command must be preceded by a Read Reverse Edit command. The Write Edit command allows a block of the same length to be written over an already existing data block on the tape.

1.4.3.6   WRITE FILE MARK

This command invokes the writing of a file mark in the density selected.

1.4.3.7   FIXED LENGTH ERASE

This command invokes a 3.5 inch length of tape to be erased. This command is always executed in the forward direction of tape motion.

1.4.3.8   DATA SECURITY ERASE

This command invokes tape to be erased from the present tape position to a point 3 feet past End of Tape.

1.4.3.9   SPACE FORWARD AND SPACE REVERSE

These commands are similar to a Read Forward or Read Reverse command, except that no read strobes are returned to the Host and no error checking is performed. However, the unit will check and report if the record is a file mark.

1.4.3.10 FILE MARK SEARCH FORWARD/REVERSE

A file mark search forward command causes the unit to execute a series of read forward commands, and the reverse command, a series of read reverse commands searching for a file mark. Forward or reverse search is terminated by the presence of a file mark, 25 feet of blank tape, or BOT in reverse search. In the EOT region a gap of 5 feet results for a search termination. If the first block encountered is not a file mark and the command was issued at 50 ips, the unit will jump to 100 ips if autospeed is a selected option.

1.4.3.11 ERASE VARIABLE

This command causes the unit to execute a dummy write, erasing tape until Last Word (LWD) is issued by the Host. WSTR's are transmitted to the Host during the execution of this command.

1.4.3.12 DENSITY SELECT

The Density Select Command forces the unit to **write** tapes in the density specified. This Command is effective only when the unit is on line, selected, the tape is at BOT, and the unit has been placed in a remote density mode (the remote density LED is ON). However, if the unit performs a **read** from BOT of the tape, the unit will automatically read tape at the density of the tape.

1.4.3.13 SCRUB

A scrub command would be issued instead of a Write Filemark to logically end a tape. The scrub command will cause a 25 foot gap to be written, beginning at it's current location. The scrub command may be ENABLED or DISABLED depending upon the selection in the SET-UP menu.

SECTION II

INSTALLATION AND OPERATION

2.0   INTRODUCTION

Section II describes unpacking, inspecting, installing, cabling, adjusting and operating the Model 9600B/9650B Tape Drive.

2.1   UNPACKING

WARNING

The Model 9600B Tape Drive weighs **110 pounds. Use safe lifting practices** to remove the drive from the container.

The Model 9600B and 9650B Tape Drives are shipped cushioned by polyethylene foam supports in a heavy-weight cardboard container. Place the shipping container on a flat, horizontal, dry, non-slip surface. Carefully cut the binding straps, and remove the top lid. Remove the cardboard sides of the shipping container. The Drive can now be conveniently lifted from the shipping container. Set the Drive on a flat, horizontal surface. Save the following items: Slide Rails, AC Power Cord, Alternate Voltage Fuse Kit, Hardware (two Shipping Retainer Brackets, Rack-Latch Angle Bracket, screws, etc.) and 9600B/9650B Manual. Retain the shipping container, polyethylene wrap, and foam supports for possible future shipment.

Tape Drives shipped in racks may be held in place by the two Shipping Retainer Brackets mentioned above (Figure 2-1). These Brackets should be removed after the Rack is put in its final location at the installation site, and the Rack-Latch Angle Bracket (also mentioned above) must be installed in place of the left Retainer Bracket. This Bracket comprises the Catch (Figure 2-1) for the Retainer Latch located just inside the Front Panel.

2.2   INSPECTION

Inspect the drive for shipping damage such as scratches, dents, or cracks in the frame. On the Dust Cover (top of Drive), turn the two holding fasteners 1/4 turn counterclockwise and open the dust cover. With the Cover Support Bar (Figure 2-2), latch the Dust Cover in Maintenance Position. Check for loose or missing parts, and foreign material. Open the Tape Path Cover and verify that all parts/areas of the tape path are clean. Remove the PCBA Cover and verify that all PC Boards (Figure 2-4) are seated properly. Reinstall PCBA Cover.

2.3   CABLING AND DAISY CHAINING REQUIREMENTS

The user must provide Host-to-Drive interconnect cables. Up to eight Drives can be daisy chained, but combined cable length must not exceed 20 feet. Terminators U3, U4, and U11 must be removed from all Drive Formatter Boards except from the last Formatter Board on the daisy chain. To remove the Terminators:

1. Remove Top Cover at rear top of the Drive.
2. As applicable, disconnect two cables from the Formatter Board (Figure 2-4).
3. Grasp the PCB Ejectors firmly, and pull Ejectors toward the side of the unit. Board should pop partially out of the slot.
4. Locate Terminators U3, U4, and U11 (Figure 2-4), and remove them.
5. Replace the Formatter Board and Top Cover.

Recommended connectors and cables are as follows: - Daisy chains may optionally require a Cable Connector Adapter (See Figures 2-3 and 2-5).

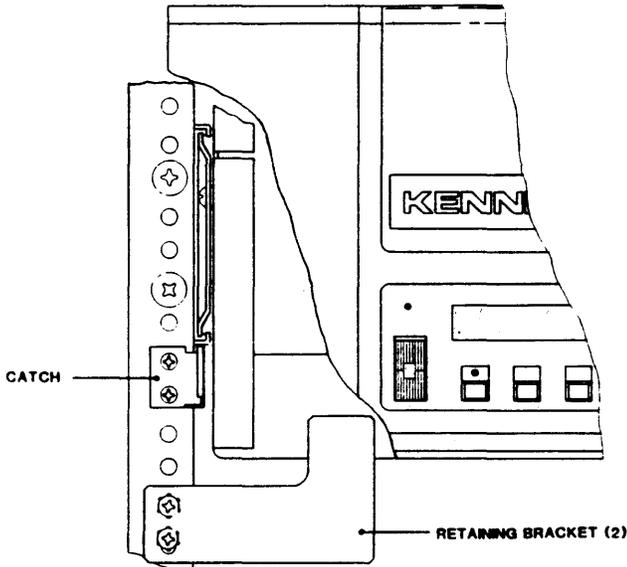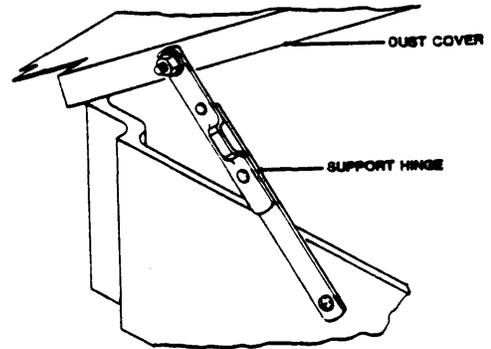| Item	Vendor	Part Number	Specifications
Connectors:			50-pin, card edge
Adapter:	Kennedy	90-08018-001	50-pin, 3-port
Cables:			50-wire, 28-AWG, shielded/flat/stranded/jacketed

Figure 2-1.   Shipping Retainer
Bracket and Catch

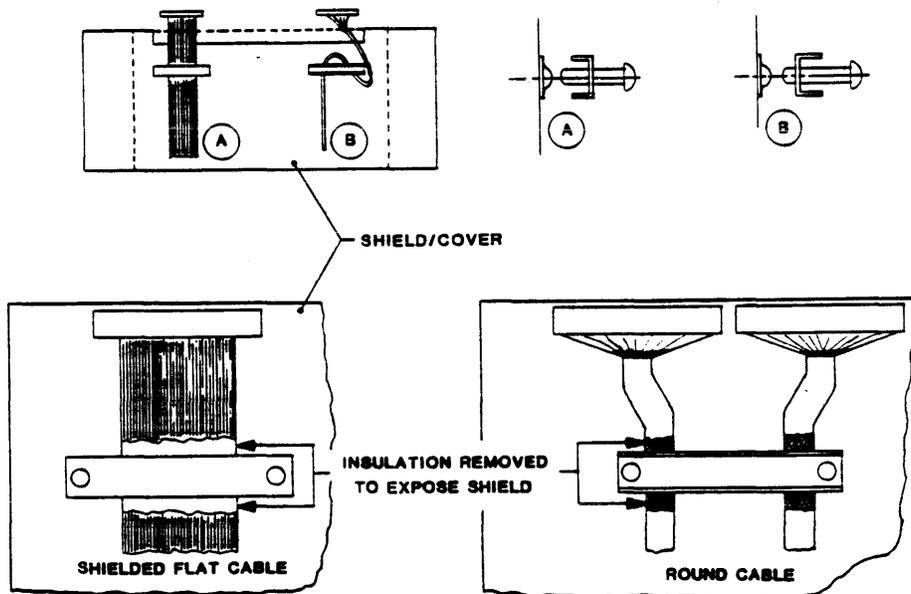Figure 2-2.
Dust Cover Support Bar

Figure 2-3.   Grounding Cable Clamp Details

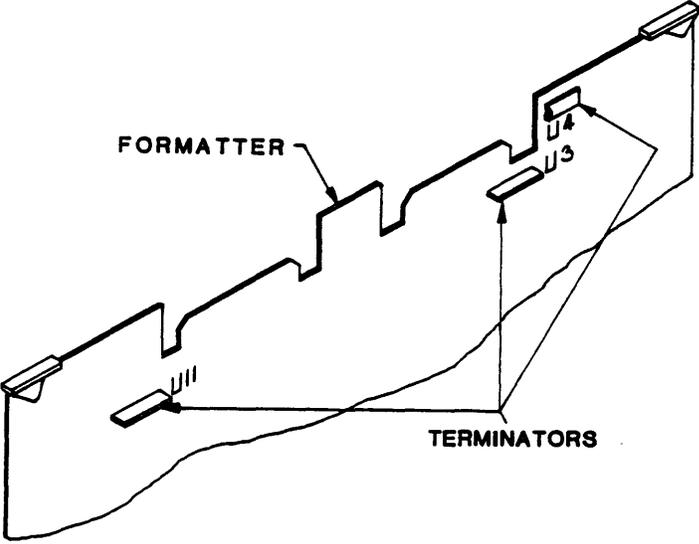Figure 2-4.   Card Cage, Cables, And Terminators

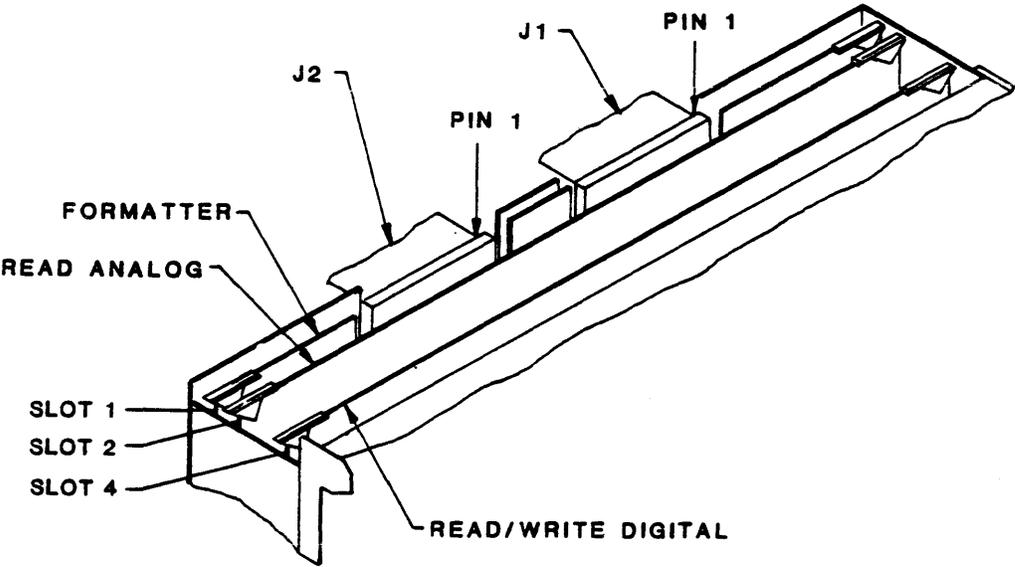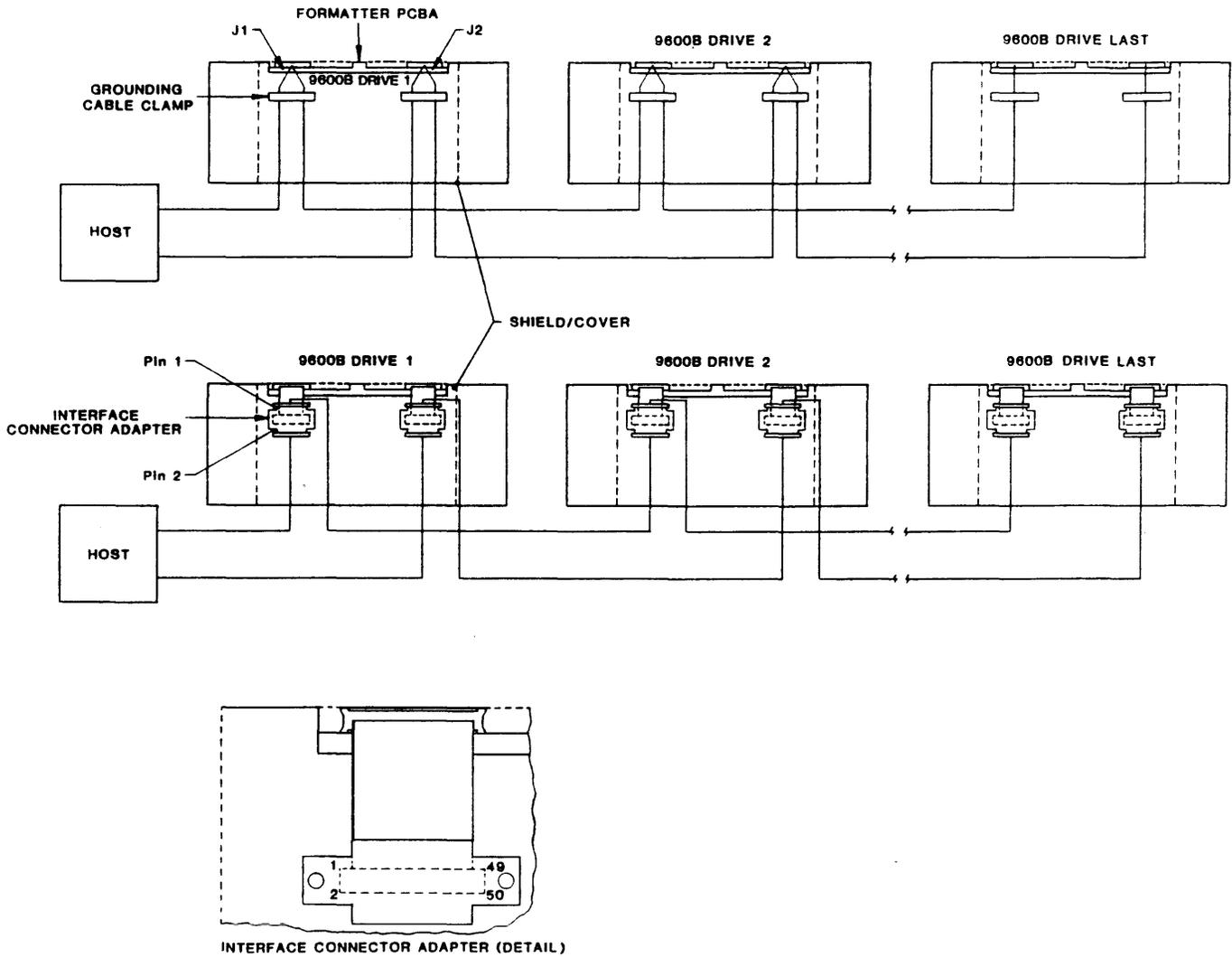**Figure 2-5.   Daisy Chaining**

NOTE:

1. Terminators removed from all but last Drive.

2. Shielded Cables are required to meet FCC Regulations. Ground the shields as illustrated. For Interface Connector Adapter, remove some insulation from the cable and connect cable shield under an Adapter Mounting Screw.

2.4 INSTALLATION

2.4.1 TABLE-TOP INSTALLATION

Place the Drive on a flat table top with dimensions to accommodate the Drive (Figure 2-6), of sufficient strength to support the weight of the Drive, and allow sufficient clearance for maintenance access. Do Steps E and F in paragraph 2.4.2.2.

2.4.2 RACK-MOUNT INSTALLATION

Mount the Tape Drive (Figure 2-7) in a standard EIA/RETMA 19-inch Rack allowing at least 8-3/4 inches vertical space. Install The Rack-Mount Rail Assembly supplied with the Drive as described in the following subparagraph 2.4.2.1.

2.4.2.1 RAIL ASSEMBLY COMPONENT CHECKOUT

The Rack-Mount Rail Assembly consists of two left/right interchangeable Track Subassemblies. Each consists of the following items:

ITEM	Outer/Center Track Assembly	ITEM	Outer/Center Track Assembly
1	Center Track	5	One Adjustable Mounting Bracket
2	Outer Track	6	Three Nut Plates
3	Fixed Mounting Bracket	7	Six 10-32 by 1/2-inch PH Screws
4	One Chassis Rail	8	Retention Latch Bracket

> **Note:** The standard Rack-Mount Rail Assembly has rails that fit cabinets up to 24 inches deep. For deeper cabinets, use Slide Extender P/N 28-00352-101. Order from:
>
> Kennedy Co. Spare Parts Order Department, 9292 Jeronimo Rd., Irvine, CA 92718. Tel: (714) 770-1100.

2.4.2.2 MOUNTING PROCEDURE

A. Install one of the Track Assemblies (Figure 2-8) on either side of the 19-inch Rack as follows:

   1. Using the 10-32 Slotted Screws (7) and Nut Plates (6)* provided, loosely assemble an Adjustable Mounting Bracket (5) to the rear of the Right Track Assembly.

      * Nut Plates not required for Racks with threaded mounting holes.

   2. Measure upward 2 inches from the bottom of the Rack opening allotted for the Drive, and mark the Rack at that point.

   3. Aligning the bottom of the Fixed Mounting Bracket (3) at the 2-inch mark on the front of the 19-inch Rack, and using the 10-32 Screws (7) provided, mount the Fixed Mounting Bracket (3) to the front of the 19-inch Rack, and mount the Adjustable Mounting Bracket (5) (loosely attached to the rear of the Center Track) to corresponding holes in the rear of the 19-inch Rack. Level the Track and tighten all Screws.

   4. Repeat Steps 1 through 3 for mounting the other Track Assembly.

B. Inspect all work and check that all screws are tight.

C. Remove power cable from the Drive Chassis.

D. With a minimum of two persons, one on each side of the Drive, lift and guide the Chassis Rails onto the Left and Right Center Tracks. Verifying that the rails are correctly aligned, push the Drive into the Rack.

E. Remove about an inch of insulation from each Interface Cable at a point where the Cable will pass under the Grounding Cable Clamp(s). This will expose the cable shield. Run the Interface Cables under the Cable Clamp(s) as illustrated in Figure 2-3. Tighten the Clamp(s).

F. Locate mounting holes on the front of the rack that align with Retention Latch on the Drive, located just within the front plastic access door to the left. Mount the Retention Latch Bracket (Item 8) so that it meshes with the Retention Latch Armature when the Drive is slid all the way into the rack.
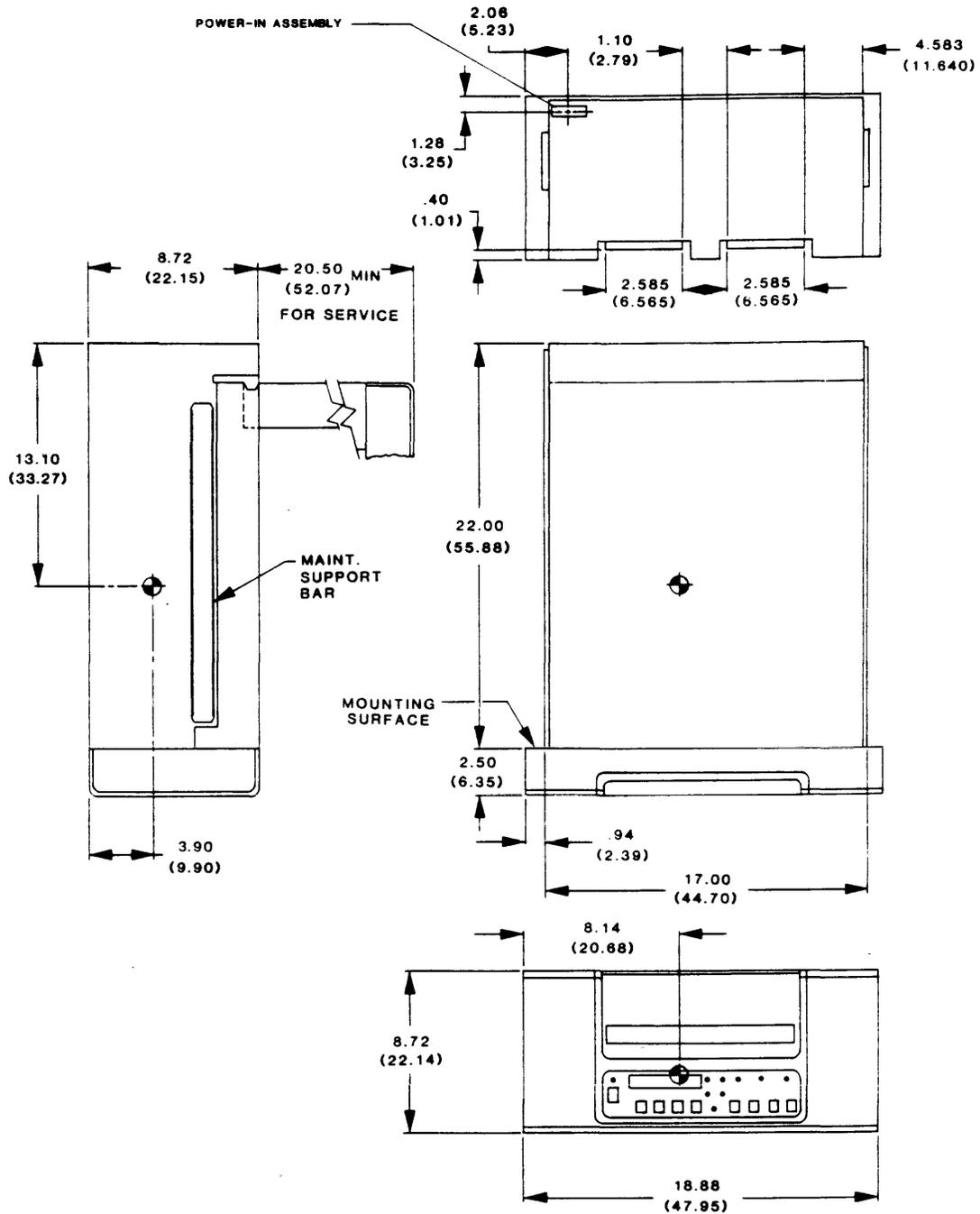
Figure 2-6. Outline And Installation Drawing, Model 9600B

25.25 in.
(64.14 cm)

DECK ASSY

SIDE VIEW – COVER OPEN

9.5 in.
(24.13 cm)

34.00 in.
(86.36 cm)

20.5 in.
(52.07 cm)

18.88 in.
(47.95 cm)

10.00 in.
(25.40 cm)

TOP VIEW

SIDE VIEW

24.5 in.
(62.23 cm)

26.5 in.
(67.31 cm)
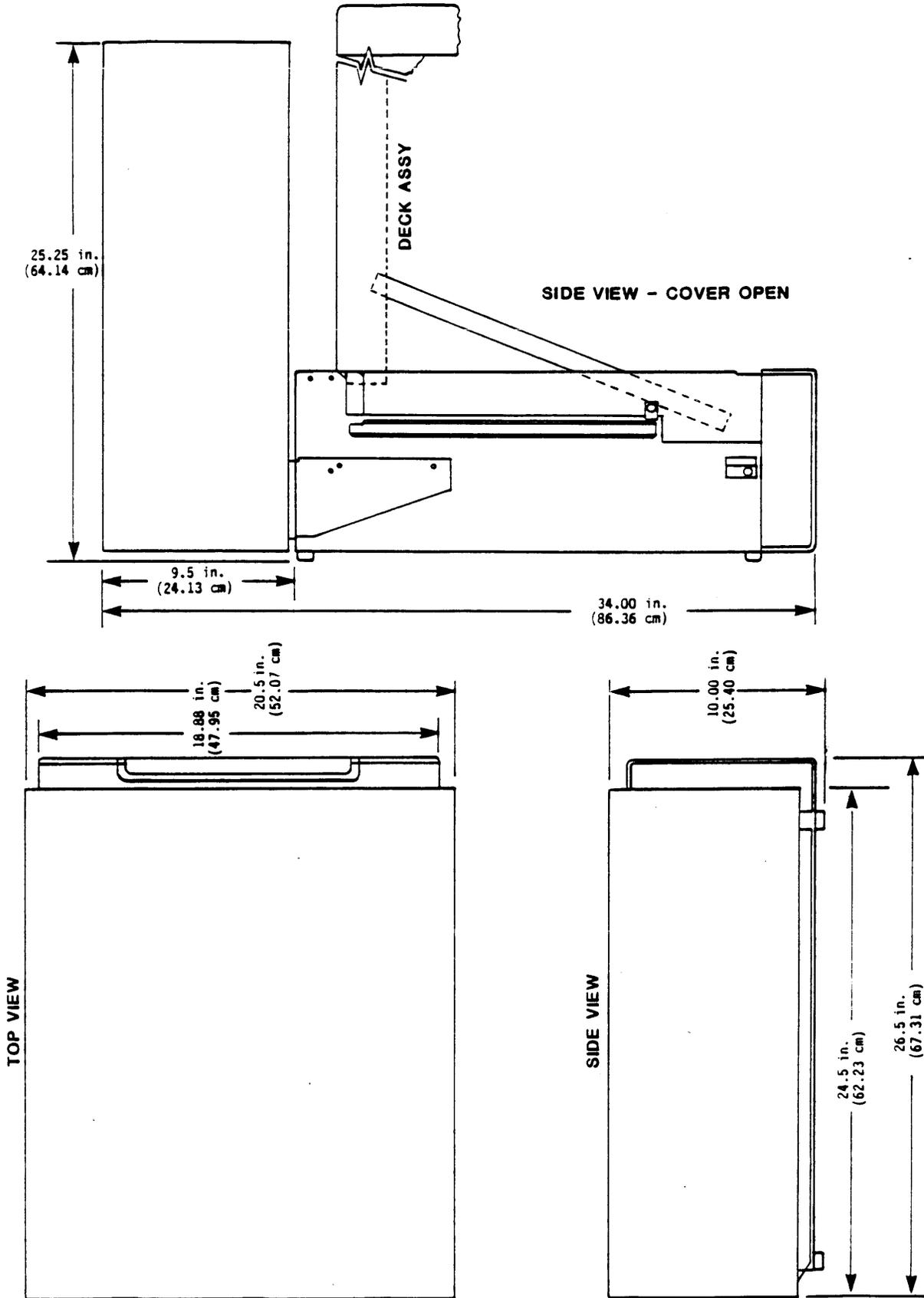
Figure 2-7. Installation and Outline Drawing, Model 9650B

SUPPORT BAR

OPERATE POSITION

LOCK BRACKET

LOCK BOLT
(4)

SUPPORT BAR

MAINT. POSITION

LOCK BRACKET
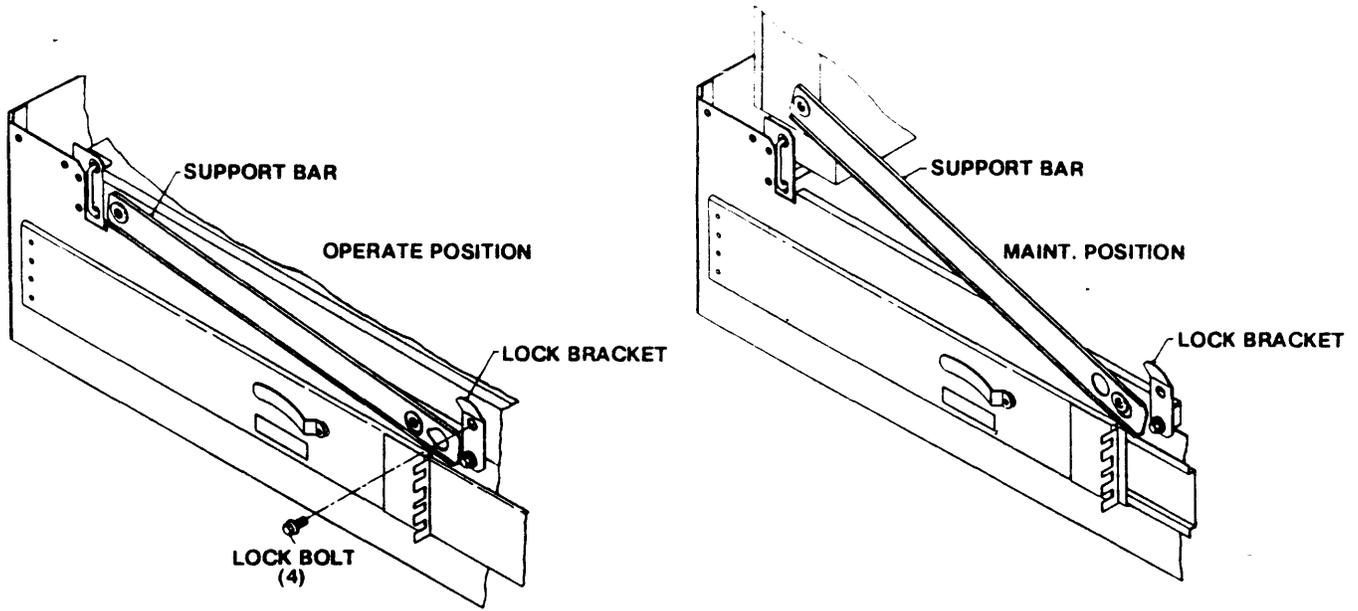
Deck Assembly Support Bar

COVER PLATE
(REF)

9600B DRIVE

②

⑥

RACK
(REF)

①

④

⑥

⑤

②

LABEL

③

①

④

⑦

Figure 2-8. Track Subassembly

2.5 POWER-UP AND INITIAL CHECKOUT

2.5.1 LINE VOLTAGE

2.5.1.1 AC LINE VOLTAGE (100-, 120-, 220-, or 240-Volt Operation)

The Drive is normally factory-set for 120-volt operation. Other voltage choices can be 100, 220, or 240. Locate the Power-In Assembly (Figure 2-9) at the rear of the unit (Figure 2-6). The Voltage Selector Card behind the plastic slide cover is 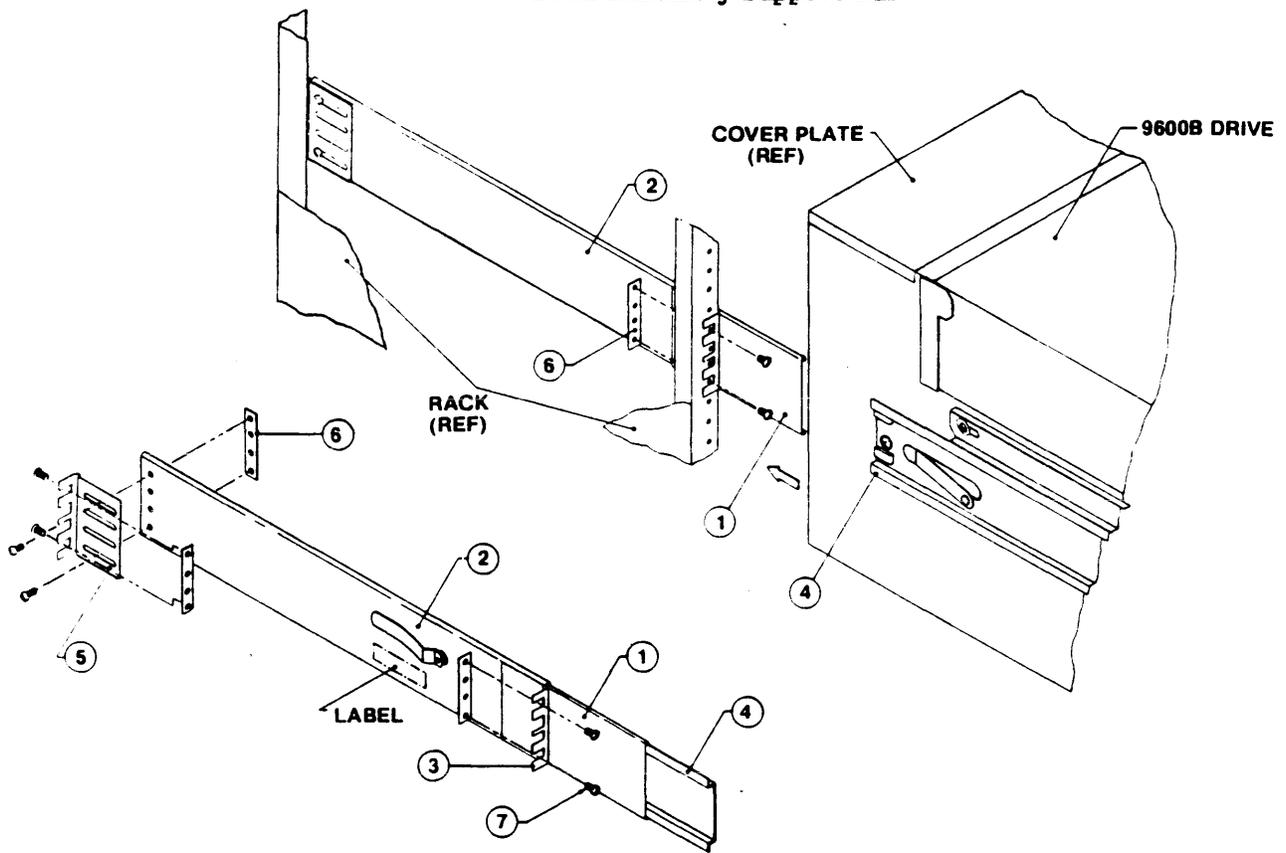installed with "120" legible. This indicates that the Drive is set for 120-volt operation. The following subparagraph describes changing this setting as necessary.
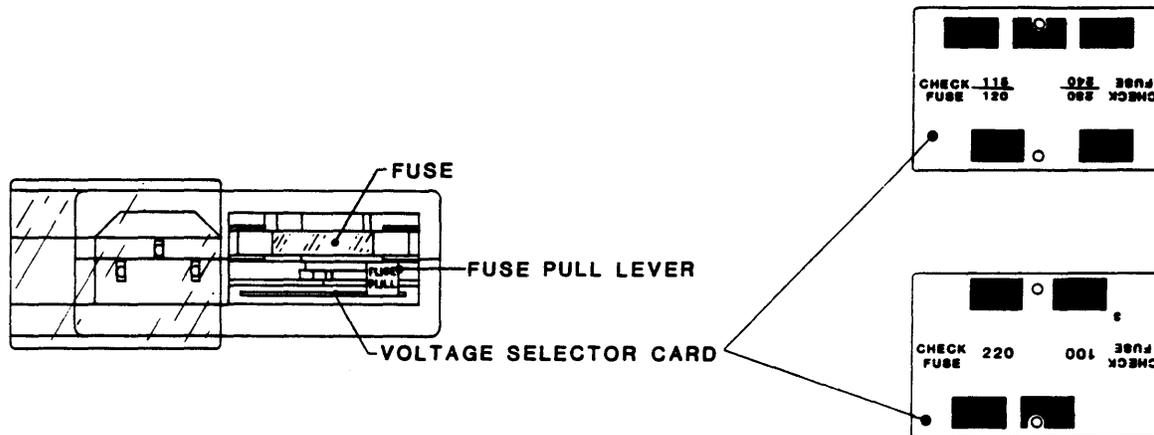

Figure 2-9. Power-In Assembly

Changing Operating Voltage:

Assuming that the Voltage Selector Card setting is other than the site voltage, proceed as follows:

A. Remove the AC power cord (if installed) from the Power-In Assembly (Figure 2-9).

B Slide the plastic Fuse Cover to the left.

C. Rotate the "FUSE PULL" lever to the left, and remove the fuse (if fuse is incorrect size).

D. Using long nose pliers, remove the Voltage Selector Card.

E. Position the Voltage Selector Card at the entrance to the card slot so that the correct voltage (100, 120, 220, or 240) is legible (facing upward), and install the Voltage Selector Card into the Power-In Assembly.

F. Install the proper-size fuse (supplied: 3-amp slo-blo for 220/240-Volt; 6-amp for 100/120-Volt).

G. Slide the plastic Fuse Cover to the right.

H. Install (as applicable) an appropriate power plug on the source end of the power cord.

I. Reconnect the power-cord to the Power-In Assembly and plug the other end of the power cord into an appropriate AC outlet.

2.5.1.2   DC LINE VOLTAGE (48, 60VDC Operation)

The drive is factory wired for either 48 or 60VDC as specified on the voltage label on the rear of the unit.

2.5.2   POWER-UP

A1.   On AC units, check that the Voltage Selector Card is set for the line voltage of the installation site per paragraph 2.5.1.1.

A2.   On DC units, check that the voltage label specifies the correct line voltage.

B.   Turn Power ON-OFF switch ON (Figure 2-10).

C.   Check that the Power-On LED (unmarked, located above the Power switch), and that the Character Display Readout indicates "TESTING" for a short time followed by "UNIT X" (X represents the Drive Unit Number. The initial (default) readout is "UNIT 0").

2.5.3   CHECKOUT

2.5.3.1   LOADING TAPE

A.   Swing open the Tape Access Door as shown in Figure 2-11, and mount a reel of tape onto the Hub. The reel must be properly seated with Write-Enable Ring facing downward toward the Deck Plate, and the tape leader should be loose.

B.   Close the Tape Access Door.

C.   Depress LOAD. The Readout displays "LOADING". The supply reel spins slowly three turns in reverse to ensure that tape is properly wound on the Reel. The Drive vacuum system automatically threads and loads tape onto the Take-up Reel. The loading process continues until the tape reaches the Beginning of Tape (BOT). At BOT, the LOAD and LOAD PT (Load Point) LEDs light and the Readout displays "UNIT X". If the Supply Reel has the Write Enable Ring installed, the WRITE ENABLE LED should be lit.

   NOTE: Some tapes fail to load because they develop an electrostatic charge. This can be recognized by observing the tendency for the tape to cling to itself around the Supply Reel. This can be remedied by trimming the end of the tape with a trimming/crimping tool.

2.5.3.2   LOAD DETAILS

A.   If the Load Sequence does not complete satisfactorily, an Error Message displays. See Section III, Table 3-3 for error information and remedial action.

B.   After the tape is wound on the Take-up Reel, the Buffer Arms move inward, their Rollers engaging and tensioning tape across the Magnetic Head.

C.   At the end of the Load Sequence, tape is tensioned, and at BOT, the Front Panel displays UNIT X, and the LOAD and LOAD PT LEDs are lit. If the tape is Write Enabled, the WRITE EN LED is lit.

2.5.3.3 CHECKOUT CONTINUED

Having loaded tape per 2.5.3.1 above:

A. Depress ON-LINE. ON-LINE LED lights; the Readout continues to display "UNIT X". When the Drive is selected, the SELECT LED lights.

B. Depress ON-LINE. ON-LINE LED goes out.

C. Depress DIAG. DIAG LED lights and the Readout displays "DIAG".

D. Depress ENTER. Readout displays "SELFTEST".

E. Repeatedly press SCAN and verify that the Readout displays, in turn, the following: "SELFTEST, MOTION, DRV ADJ, SET UP, CAL, DATADIAG, SELFTEST, MOTION."

F. With "MOTION" displayed, press ENTER. Readout displays "50 FWD" (50 ips Forward).

G. Repeatedly press SCAN and verify that each time SCAN is pressed the Readout displays as indicated in Table 2-1 beginning with Step 2, then to Step 1 and repeating the sequence.

H. Repeatedly press SCAN until Readout displays "100 FWD".

I. Press ENTER. Tape moves forward at 100 ips, the LOAD PT LED goes out, and the DIAG LED blinks. Let Drive run to the End of Tape (EOT). Readout displays "EOT".

Table 2-1. Motion Control Sequence

STEP	DISPLAY			MOTION
	NORMAL *	AT EOT	AT BOT	
1	50 FWD	EOT		50 ips Forward
2	50 REV		BOT	50 ips Reverse
3	50 FSS	EOT		50 ips Forward Start/Stop
4	50 RSS		BOT	50 ips Reverse Start/Stop
5	50 FRF	EOT	BOT	50 ips Forward/Reverse/Forward
6	100 FWD	EOT		100 ips Forward
7	100 REV		BOT	100 ips Reverse
8	100 FSS	EOT		100 ips Forward/Start/Stop
9	100 RSS		BOT	100 ips Reverse/Start/Stop
10	100 FRF	EOT	BOT	100 ips Forward/Reverse/Forward
11	50/100 F	EOT		50 ips/100 ips Forward
12	50/100 R		BOT	50 ips/100 ips Reverse
13	BURN IN			50 ips/100 ips/50 ips (Forward) Auto Rewind/... (Repeat) etc.

NOTE: Normal display is defined as any display when the tape
is neither at BOT or EOT

J. Scan through the entire menu. In the step for any Forward Motion Command, such as Step 1 (50 FWD), Step 3 (50 FSS), Step 5 (50 FRF), etc., the Display reads "EOT".

K. Depress SCAN. Readout displays "100 REV".

L. Depress ENTER. Tape runs at 100 ips in reverse. Let Drive run to the Beginning of Tape (BOT). Readout displays "BOT".

M. Scan through the entire menu. In the step for any Reverse Motion Command, such as Step 2 (50 REV), Step 4 (50 RSS), etc., the Display reads "BOT" and the Command cannot be entered.

N. Repeatedly depress DIAG until DIAG LED goes out and Readout displays "UNIT X".

O. Depress RWND/UNL. Tape rewinds to the supply reel, and Readout displays "UNLDNG" until tape is unloaded (stops motion), then the readout displays "UNIT X".

P. Open the Tape Access Door, remove the tape, and turn off power.

Q. Run DATATEST in Checkout procedure to verify Write/Read performance.

2.5.3.4 MOTION TEST SUMMARY

All Motion Tests, with the exception of Burn In, automatically stop at either BOT (Reverse Tests) or EOT (Forward Tests). Burn In consists of a 100/50/100 ips forward sequence until EOT is reached. At EOT, the Drive automatically rewinds tape to BOT at 200 ips. At BOT, the Drive repeats the 100/50/100 ips sequence and continues to repeat until the operator intervenes. All Motion Tests, including Burn In, may be stopped by depressing START/STOP, except when rewinding.

2.5.4 UNIT SELECTION

The Drive is factory-set for Unit Address 0. In daisy-chained systems, set the Unit Address for each Drive (other than Drive 0) as follows:

A. Turn AC power ON.

B. In turn, depress DIAG, ENTER, SCAN, SCAN, SCAN. Readout displays in sequence: "DIAG", "SELFTEST", "MOTION", "DRV ADJ", SET UP".

C. Depress ENTER. Drive enters SET UP Mode; Readout displays "UNIT NUM".

D. Depress ENTER. Readout displays "UNIT X".

E. Repeatedly depress SCAN until the Readout displays the desired Unit Number.

F. Depress ENTER. Readout displays "LOAD?".

G. Depress LOAD to save new Unit Number. Drive displays "DENS SEL" (the next parameter).

H. The Drive will now respond to the new Unit Number (address) sent from the Host.

I. Depress DIAG twice to return the Drive to Off Line status. The Readout displays the new Unit Number.
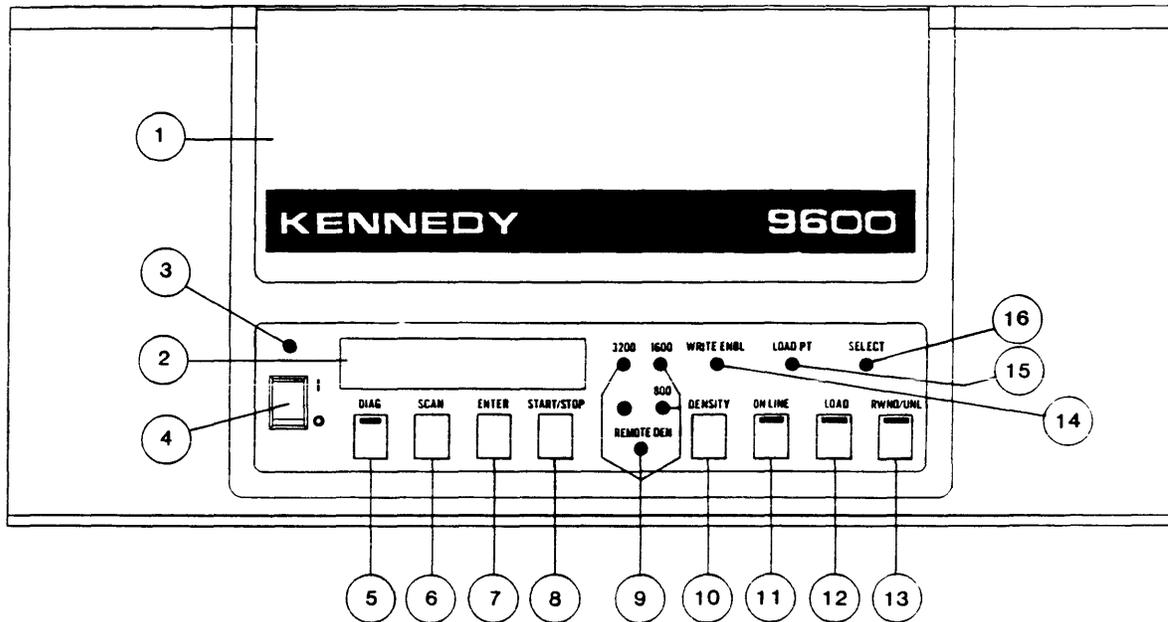
(1)   **Tape Access** Door - Supply Hub Access (Ref).

(2)   **Character Display** Readout - Displays operating mode, status, parameters, and diagnostic messages.

(3)   **Unmarked** LED - Lights when AC power is applied to Drive.

(4)   **ON/OFF** Switch - Controls AC power to Drive.

(5)   **DIAG** Pushbutton - Turns diagnostics ON and OFF when Drive is off-line. Internal LED lights when in the diagnostics mode.

(6)   **SCAN** Pushbutton - Scans diagnostics and calibrate menus.

(7)   **ENTER** Pushbutton - Enters selected commands when in diagnostics or calibrate mode.

(8)   **START/STOP** Pushbutton - Starts or stops selected commands in the diagnostics or calibrate mode.

(9)   **REMOTE DEN** LED - Lights when density is selectable by Host.
       800/1600/3200 LEDs - Indicates selected density.

(10)   **DENSITY** Pushbutton - Selects data density (800, 1600 or 3200) and REMOTE.

(11)   **ON-LINE** Pushbutton - Puts unit online or takes unit offline. Lights when Drive is On-line.

(12)   **LOAD** Pushbutton - Initiates Load sequence. Lights when drive is loaded.

(13)   **RWND/UNL** Pushbutton - Initiates Rewind or Unload when Drive is Off-line.

(14)   **WRITE ENBL** LED - Lights when supply reel is not write protected.

(15)   **LOAD PT** LED - Lights when tape is at Load Point.

(16)   **SELECT** LED - Lights when Drive is selected by the Host.

Figure 2-10. Panel Controls and Indicators
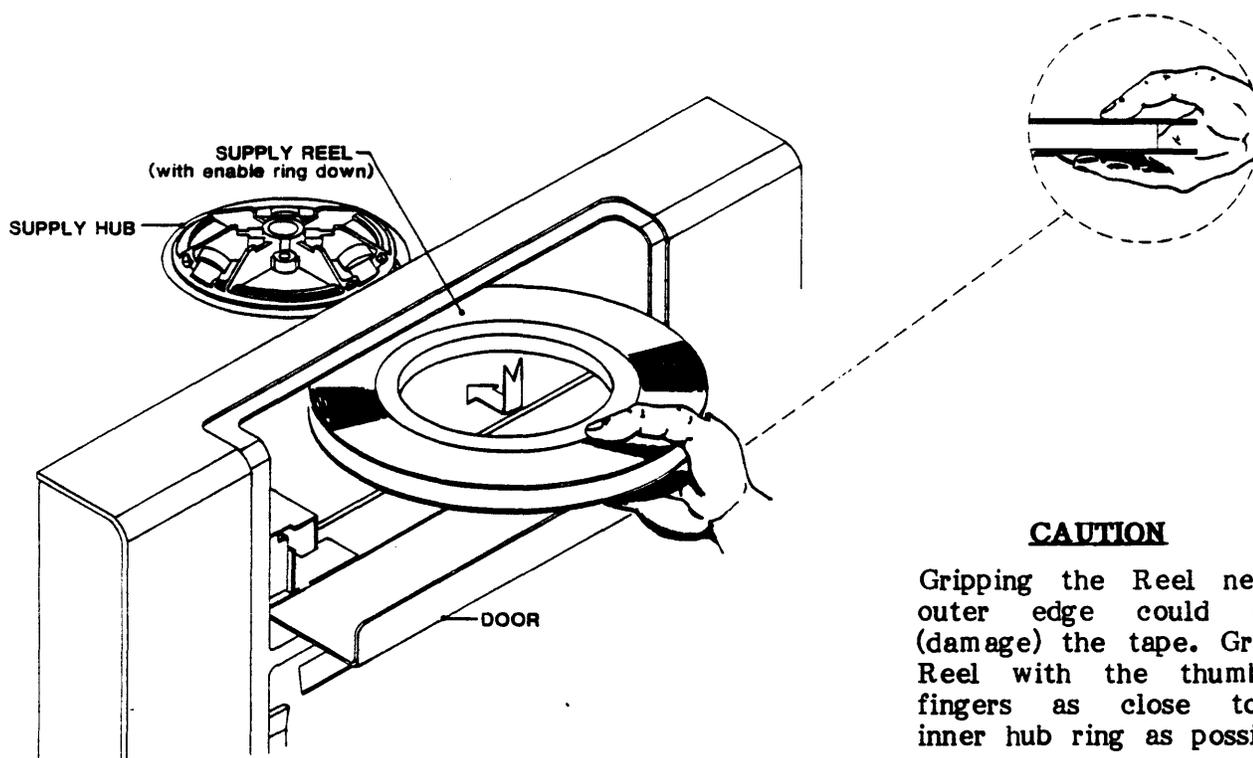
CAUTION

Gripping the Reel near its outer edge could distort (damage) the tape. Grip the Reel with the thumb and fingers as close to the inner hub ring as possible.

Figure 2-11. Installing Supply Reel

2.5.5 DATA DENSITY - INTRODUCTION

The Model 9600B/9650B can operate at 800 CPI density in Nonreturn-to-Zero (NRZI) format, at 1600 CPI density in Phase-Encoded (PE) format, and at 3200 CPI Density in Double Density PE (DDPE) format. When powered up, the Drive automatically defaults* to 1600 REMOTE, in which the Host controls density selection for Write Operations.** The operator can override the defaulted operating density by operating the Front Panel DENSITY Switch as described under A below:

* Default Density is factory-set, but can be changed as described below under C. **Changing Default Density.**

** In Remote Density Mode, the Host controls Density by Command issued at BOT only; but when reading tape, the Drive automatically selects the density of the tape currently loaded.

A. **Changing Operating Density:**

1. If tape is loaded, rewind tape to BOT and set the Drive to off-line. The Readout displays UNIT X and the current operating density and mode on the density LEDs and the Remote LED. The Drive is in Remote PE Mode.

2. Repeatedly, as necessary, press DENSITY. The Indicators will light in the following sequence, putting the Drive in the corresponding Density Mode. Leave the Drive in the desired Mode.

		LEDs Lit				LEDs Lit	
	Mode	Dens	Control		Mode	Dens	Control
a.	Local NRZI	800		e.	Local DDPE	3200	
b.	Remote NRZI	800	REMOTE DEN	f.	Remote DDPE	3200	REMOTE DEN
c.	Local PE	1600					
d.	Remote PE	1600	REMOTE DEN				

NOTE: If the drive is configured to operate in REMOTE density only the local selections will be skipped.

B. **Operation:**

1. In Read operation, if the Drive is in Remote Mode, the Drive reads automatically in the density in which the tape was written.

2. In Write operations, the Drive writes in the density indicated by the Density LEDs.

C. **Changing Default Density:**

1. Enter diagnostics mode by pressing the DIAG button. The readout will display DIAG and the LED in the DIAG button will illuminate. Press the ENTER key to enter diagnostics mode.

2. Press the SCAN button 3 times. The readout will display, in sequence: "SELFTEST, MOTION, DRV ADJ, SET UP".

3. Press the ENTER button to enter set up mode. The readout will display "UNIT NUM".

4. Press the SCAN key once. The readout will display "DENS SEL".

5. Press the ENTER button. The readout will display "NORMAL" indicating the drive will allow execution in local density mode. If operation in remote mode only is desired, press the SCAN button and the readout will show "REM ONLY". When the desired option is shown, press the ENTER button to select it.

6. The readout will display "LOAD?". Press the LOAD button to save the selected option.

7. The readout will then display "DFLT DEN". Press the ENTER button to select the default density. The readout will display "1600 REM" (the factory set default density).

8. Repeatedly press SCAN until the desired default density is displayed. The sequence of displays is:

    a. 800   c. 1600   e. 3200
    b. 800 REM   d. 1600 REM   f. 3200 REM

    NOTE: Only the remote density selection will be shown if the REM ONLY option was selected in step 5.

9. When the desired default density is selected press ENTER. The readout will display "LOAD?". Press the LOAD button to save the selection.

10. Press the DIAG button repeatedly until the LED in the DIAG button turns off to exit diagnostics mode.

2.6 OPERATING INSTRUCTIONS

2.6.1 OPERATING PROCEDURE

A. Turn Power On. Readout displays "TESTING" and if the Drive passes all tests, the Readout displays "UNIT X". Fault Conditions that could occur during Power-Up, and possible related failures, are listed and described in Section III.

B. Place Tape Reel on Reel Hub with Write Enable Ring facing downward.

C. Depress LOAD*. The Readout displays "LOADING" and the Drive automatically loads tape. When loading is successful, the Readout displays "UNIT X" and the WRITE ENBL, LOAD POINT, and LOAD LEDs light. If loading is unsuccessful, the Readout displays a diagnostic message such as: CHK HUB, ABORTED, REV REEL, etc., or a Failure Code, and the RWND/UNL LED flashes.

* Or Host can send a Load On-Line Command (ILOL) to start Load.

If loading is unsuccessful, correct the condition indicated by the Failure Code Readout per Section III, and depress LOAD to reattempt the load operation.

D. Depress ON-LINE. ON-LINE LED lights and the Readout continues to display the Unit Number.

E. The Tape Drive is now ready to accept commands from the Host. The Drive can be taken Off-line manually by the operator pressing ON-LINE or by the Host issuing an Off-Line Command.

2.6.2 OPERATION NOTES

A. **On-line Operations:**

When the Drive is on line, the Readout displays the Unit Number whether or not the Drive is selected.

B. **Load Operations:**

1. If the Drive is unable to Load, the Readout will display a diagnostic message such as: "CHK HUB", "ABORTED", "REV REEL" etc., and the RWND/UNL LED will flash.

   a. Pressing LOAD will start another Load attempt.

   b. Pressing RWND/UNL will clear flashing LED and Error Message.

   c. If nothing is done, after one minute, the Drive displays "UNIT X".

   d. See NOTE under paragraph 2.5.3.1, Step C.

2. Pressing RWND/UNL while the Drive is Loading, aborts the Load Sequence.

C. **Rewind Operations:**

1. If the Drive is off line, pressing RWND/UNLD once causes the Drive to rewind tape to BOT.

2. If the Drive is off line, pressing RWND/UNL while the Drive is rewinding, or while positioned at BOT, will initiate an Unload Operation after the Drive has completed Rewind.

D. Recovering From Tape Running Off Reel:

The Drive has a built-in feature to prevent tape runaway: If a block of data is not encountered within 25 feet of tape motion before EOT, or 5 feet of tape motion after EOT, the Drive will normally stop tape motion. However, the 25-foot/5-foot limit feature can be defeated in the Set Up Mode, or by continued Read Commands being received from the Host after EOT has been passed. Either of these conditions could result in tape being run completely off the Supply Reel. The following procedure is recommended to recover from this predicament.

1. The display will read TAPE END and the RWND/UNL LED will be flashing. Press the RWND/UNL switch and wait for the arms to retract.

2. Manually thread tape backwards through the tape path from the Take-up Reel to the Supply Reel. Refer to Figure 2-12.

3. Wrap tape around the Supply Reel in a **counterclockwise** direction.

4. Manually rotate the Supply Reel **counterclockwise** until the EOT Tab is on the Supply Reel.

5. Press LOAD. Tension Arms will tension tape and tape will rewind back to Load Point.
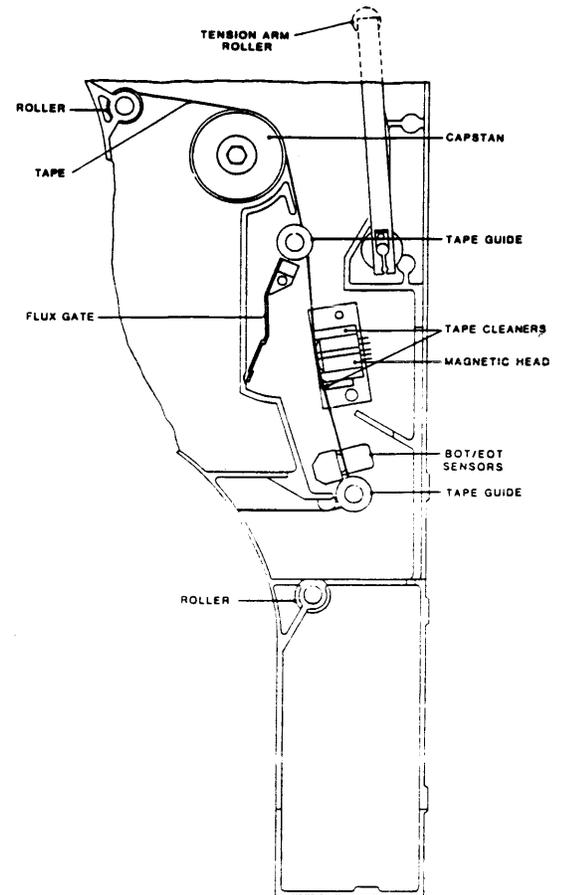

Figure 2-12. Tape Threading

E. Manually Locking/Unlocking Supply Reel on Supply Reel Hub:

The Supply Reel Hub normally automatically locks the Supply Reel in place during the loading sequence. However, the Supply Reel can be manually locked in place using the Manual Reel Locking Lever located just inside the Tape Access Door (illustrated in, Figure 2-11).

To manually install (lock) a Supply Reel onto the Hub:

1. Open the Tape Access Door and the Top Cover of the Drive.

2. Place a Supply Reel onto the Supply Reel Hub.

3. Press the Manual Reel Locking Lever inward (toward the rear of the Drive) while slowing turning the Supply Reel and Hub clockwise until the Reel Locking Fingers of the Hub extend outward and lock the Reel in place.

To manually release the Supply Reel from the Hub:

1. Press the Manual Reel Locking Lever inward while slowly turning the Supply Reel and Hub counterclockwise until the Reel Locking Fingers of the Hub retract and release the Supply Reel.

F. Default Parameters:

The Tape Drive is factory set to the following parameters. These parameters can be changed as desired as described in the Operation and Maintenance Manual.

Parameter	Default Setting	Description	Other Options
UNIT NUM	UNIT 0	Drive Unit Number (Address)	1 thru 7
DENS SEL	NORMAL	Enables manual density selection	REMOTE ONLY
DFLT DEN	1600 REM	Default Density, 1600 cpi Remote, Host selectable	1600 800, 800 REM 3200, 3200 REM
SPEED	HOST SEL	Tape Speed, Host selects	AUTO SPEED 50 ips, 100 ips
TIME OUT	25 FT ON	Drive times out if data not detected within 25 feet of tape run.	25 FT OFF
SECURITY	ENABLED	Host can command tape erasure from the tape's present position to a point 3 feet past End Of Tape.	DISABLED
EOD GAP	ENABLED	A 25 foot erased gap is written following any write that isn't terminated with a filemark and the next command is a reverse motion i.e. Read Reverse, Rewind, etc.	DISABLED
PARITY	IGNORE	Drive does not check write Data Parity	CHECK
LONG GAP	1.2 INCH	Long Gap Command from Host causes Interblock Gap of 1.2 inches when streaming at 100 ips.	2.5
NRZI CCG	ENABLED	The Drive sends NRZI CRC and LRC Characters to Host following each data block.	DISABLED
CLR FBSY	POSTREPO	The Drive clears FBSY after repositioning, following a 100 ips Command	WITH DBY
IFEN	NORMAL	Formatter Enable Signal is normal (not inverted)	INVERT
DENS OUT *	NRZ	Industry standard density status	CODED
FMK GAPS	EXTENDED	4 inch gap between data block and file mark, in all densities.	NOMINAL

NOTE: For full definition of parameters, see Operation and Maintenance Manual.
    *Refer to 1.4.2.18 for definition of CODED and NRZ.

SECTION III
DIAGNOSTICS

3.0 GENERAL

The Model 9600B/9650B Tape Drive incorporates extensive built-in Self-Test and Front-Panel Diagnostics providing tests for maintenance and troubleshooting aids. Self-Test Diagnostics occur automatically during Power Up, displaying appropriate failure codes if failure occurs. Front Panel Diagnostics are manually-controlled operations that exercise the Tape Drive, displaying appropriate readouts to indicate Drive condition.

3.1 CONTROLS AND INDICATORS

Controls and Indicators used in Diagnostics and Calibration Modes are listed and described in Section II, Figure 2-10.

3.2 POWER UP

Upon Power Up, and without a reel of tape inserted, the Readout normally displays: TESTING, for approximately 7 seconds. If TESTING continues to be displayed, this indicates that communication between Formatter and Drive is disrupted and no further testing can be accomplished. There is a problem in the Formatter or the interface between Formatter and Drive. Assuming that communication between Formatter and Drive is obtained, the Drive performs the Self-Tests described below. In addition to the Failure Codes, The Drive can display Failures in the form of words or abbreviations. Tables 3-1 and 3-2 list and describe the Failures represented by this type of display, and also indicate the possible causes of failure. If a failure should occur during Power Up, call service personnel, or refer to Operation and Maintenance Manual for diagnostics procedures.

Each Power Up Self-Test exercises the following areas of the Drive:

A. Drive Electronics:
   1. Power Supply
   2. Drive Electronics PCBA
   3. Front Panel
   4. Servo System including Reel and Capstan Motors.

B. Formatter and Read/Write Electronics:
   1. Formatter Board
   2. Write/Read Board
   3. Read Analog Board

3.2.1 DRIVE ELECTRONICS FAILURE DISPLAYS

Table 3-1 lists failure displays

Table 3-1.   Drive Electronics Failure Displays

DISPLAY	FAULT CONDITION/POSSIBLE FAILURE
TESTING	**Formatter not communicating with the Drive:** Diagnostics hangup: Formatter Board 8951, Drive Electronics Board 8952.
FMT ERR? and flash REW	**Formatter Error (Formatter Timeout):** Formatter Section has failed to interrogate Drive Electronics; or the Formatter has failed to send its Identification (ID) after request from the Drive Electronics. Check Formatter Board 8951.
TAK ARM?	Take-up Arm fails to calibrate.
SUP ARM?	Supply Arm fails to calibrate.
CAPSTAN?	No Tachometer Voltage. Check Capstan Motor, Capstan Power Amplifier, and Tachometer.
T MOTOR?	**Take-up Reel Motor not running:** Servo Preamplifier 7147, Servo Amplifier 7111, Drive Electronics Board 8952, Take-up Reel Motor.
S MOTOR?	**Supply Reel Motor not running:** Servo Preamplifier 7147, Servo Amplifier 7111, Drive Electronics Board 8952, Supply Reel Motor.
ROM ?	**Drive Electronics Program PROM Checksum Error:** Non-zero checksum detected.
EEPROM ? and Flash REW	**Checksum Error:** Non-zero checksum detected. Press RWND/UNL. The Drive will compute a new checksum and attempt to write it into the EEPROM. Check Drive Electronics Board 8952.
+12V ? +40V ? -12V ? -40V ?	Voltage below +10V Check applicable Voltage below +30V Power Supply Voltage above -7V and Regulator Voltage above -29V
FAIL XXX	(XXX refers to Failure Code - See Table 3-2)
ARM CAL?	The arm calibration values are uninitialized, i.e. a new EEPROM has been installed on the Drive Electronics Board or the EEPROM data has been corrupted.
ARM JPR?	Jumper W1 on the Position Sensor PCBA 9069 is missing.
BAD SCSI	SCSI Interface Board has failed the power-up test.
RETRACT?	One of the Retract Assemblies failed during the power-on testing.
DRV FAIL	Reset Circuit or Watch Dog Timer Circuit failed on the Drive Electronics Board.

3.2.2 FORMATTER FAILURE CODES

Table 3-2 lists the Failure Codes that could display during Power Up, indicating probable causes of failure. Note that Failure Codes 150 thru 159 include the option of obtaining a second Failure Code which indicates specific problems. If a Failure Code between 150 and 159 occurs, to obtain the second Failure Code, press DENSITY. **NOTE:** The Failure Code is preceded by the word: FAIL.

Table 3-2. Power Up Failure Codes

CODE	DESCRIPTION	PROBABLE FAILURE
128	External RAM Data Error	Compare RAM Formatter 8951
129	External RAM Addressing Error	
131	No RBSY for Read Amp Gain Values	Read Analog Board 9017
132	Wrong Formatter Board for 9600B/9650B	Formatter Board 8951
133	Wrong Analog Board for 9600B/9650B	Read Analog Board 9017
134	Wrong Digital Board for 9600B/9650B	Read Digital Board 9060
136	Address Counter Failure	Formatter Board 8951
140	Auto Adjust Ranging Error	Read Analog Board 9017
141	Dead Track found in Auto Adjust	
142	Over Range Signal in Auto Adjust	
150	No RBSY in Loop RAW Test	Press DENSITY Pushbutton for Second Code listed below:
151	No WBSY in Loop RAW Test	
152	Time-out on WBSY in Loop RAW Test	
153	Time-out on RBSY in Loop RAW Test	
154	WBSY ended too soon in Loop RAW Test	
155	Hard Error in Loop RAW Test	
156	Corrected Error in Loop RAW Test	
157	Compare Error in Loop RAW Test	
158	File mark during Loop RAW Test	
159	Block Size Error in Loop RAW Test	

ITEM	SECOND CODE	DESCRIPTION	
1	D-50 NRZ	Loop Write to Read Digital, 50 ips NRZ1	Read Digital Board 9060
2	D-100NRZ	Loop Write to Read Digital, 100 ips NRZ1	
3	D-50 PE	Loop Write to Read Digital, 50 ips PE	
4	D-100 PE	Loop Write to Read Digital, 100 ips PE	
5	D-50 DPE	Loop Write to Read Digital, 50 ips DDPE	
6	D-100DPE	Loop Write to Read Digital, 100 ips DDPE	Read Analog 9017
7	A-100 PE	Loop Write to Read Analog, 100 ips PE	
8	A-50 DPE	Loop Write to Read Analog, 50 ips DPE	
9	A-100DPE	Loop Write to Read Analog, 100 ips DPE	

Legend:
RBSY = Read Busy Signal   RAW = Read After Write
WBSY = Write Busy Signal

3.2.3   FORMATTER POWER UP SELF-TEST DESCRIPTIONS

The Drive displays TESTING during the Power Up Tests, and UNIT X when the testing is complete. If the Drive fails to power up, it displays either the failed module or a failure code. Power Up Self-Tests are described as follows:

a. **Micro-processor Sanity Check:**
   Verify operation of the Microprocessor.

b. **Microprocessor RAM Check:**
   Verify operation of 8031 internal RAM

c. **External RAM Check, Data Pattern 55H:**   Failure Code 128.
   Verify operation of External RAM with Data Pattern 55H.

d. **External RAM Check, Data Pattern AAH:**   Failure Code 128
   Verify operation of External RAM with Data Pattern AAH.

e. **External RAM Check, Addressing:**   Failure Code 129
   Verify addressing capability of External RAM.

f. **ID The Formatter:**   Failure Codes 132, 133, 134
   Verify that the Formatter, Read Analog, and Write/Read Boards are the proper type for 9600B/9650B operation.

g. **Address Counter Check:**   Failure Code 136
   Verify the operation of the data compare RAM address counter.

h. **Send Test Amp Gain Values to Analog Board:**   Failure Code 131
   Verify operation of Read Analog Board.

i. **Loop Write to Read Digital:**   Failure Codes 150-159
   Run data through the Write/Read Digital Board, looping it from the output of the Write Section back into the Read Section, and verify proper operation at all speeds and densities.

j. **Loop Write to Read Analog:**   Failure Code 150-159
   Loop data from the output of the Write Section of the Write/Read Board to the input of the Read Analog Board, and verify proper operation.

3.3 LOADING AND CALIBRATION FAILURE DISPLAY

The 9600B/9650B also includes automatic diagnostics that can detect loading failures, giving appropriate displays to indicate failures and their possible causes. Table 3-3 lists and describes the displays and related Fault Condition, and Possible Failures that could occur during Loading. After successfully completing Power Up, load a reel of tape into the Drive. If there is a loading failure, one of the displays listed in Table 3-3 will appear.

Table 3-3. Loading and Calibration Failures

DISPLAY	FAULT CONDITION/POSSIBLE FAILURE
1. CLOSE/DOOR COVER?	**Door Interlock Circuit:** (Drive cannot load) Tape Access Door open, Door Switch, Drive Electronics Board 8952, Interconnect Board 7228.
2. NO BOT?	**No BOT Marker detected:** Tape Marker missing from tape, Tape Leader too short, Faulty BOT Sensor, Drive Electronics Board 8952, Interconnect Board 7228.
3. ABORTED	**Automatic Load aborted:** No vacuum, Air leak in tape path, Drive Electronics Board 8952, Servo Boards 7111, 7147, Position Sensors, tape sticking (ref 2.5.3.2, Step C).
4. REV REEL	**Reverse Reel – Reel upside down.**
5. PLC REEL	**Place Reel.** Tape Reel not installed.
6. CHK SLND	**Check Hub Lock Solenoid – not locking:** Hub Lock Solenoid defective or needs adjustment, Drive Electronics Board 8952, Interconnect Board 7228.
7. CHK HUB	**Check Hub – Supply Reel not detected:** Reel-In-Place Tab Adjustment, Reel-In-Place Sensor, Drive Electronics Board 8952, Interconnect Board 7228.
8. BKN TAPE	**Broken Tape – Tape not detected:** Broken Tape, No EOT Marker, EOT Sensor, Interconnect Board 7228, Drive Electronics Board 8952.
9. TAK ARM?	**Take-up Arm not operating correctly:** Take-up Arm Position Sensors (Check with Arm relaxed), Position Sensor Board 9069, Interconnect Board 7228.
10. SUP ARM?	**Supply Arm not operating correctly:** Supply Arm Position Sensors (Check with Arm relaxed), Position Sensor Board 9069, Interconnect Board 7228.
11. ARM OFF?	**A Tension Arm traveled beyond the preset limits:** Recalibrate Tension Arms.

Table 3-3.   Loading and Calibration Failures (Continued)

DISPLAY	FAULT CONDITION/POSSIBLE FAILURE
12. A-T CAL?	**The Auto-Tune calibration values are invalid:** The calibration must be performed.
13. CHK ARMS	**The Drive Electronics PCBA 8952 has detected a gross error in the arm output voltage:** Position Sensor PCBA 9069 failure; Tension Arm out of adjustment.
14. CHK CAPS	**Tape motion fault, i.e. speed error, ramp timeout, loss of tach pulses:** Capstan Motor/Tach; Drive Electronics PCBA 8952; Servo Boards 7111, 7147.
15. CHK DRV	**The capstan gain is out of range during the auto-tune calibration:** Drive Electronics PCBA 8952.
16. CHK TAPE	This message appears after a tape loading operation has aborted and the operator has pressed the flashing RWD/ONL switch. The operator should open the tape access door to reset the "CHK TAPE" message and examine the tape path for any unusual conditions.
17. JUMPER?	**The Calibration Jumper (ST3 on the Drive Electronics PCBA 8952) is in the disabled position while the operator is attempting to perform certain calibration operations:** ST3 must be in the enabled position.
18. RET MOT?	One of the Tension Arm Retract Assemblies failed during the loading process.
19. TIC-SENS	Tape in channel sensor or emitter failed.
20. CANT WR	The Write Enable Ring is not being detected during Calibration Data Test and Data Diag.
21. TAPE END	**Failed to detect EOT and tape runs off the Supply Reel:** Tape marker missing from tape; tape trailer too short; faulty EOT Sensor; Interconnect PCBA or Drive Electronics failed.

SECTION IV
MAINTENANCE

4.0   GENERAL

Procedures described herein are limited to Preventive and Corrective Maintenance that can be accomplished in the field, and includes adjustment and replacement of PCBAs and other major components of the Drive. PCBAs are not considered field repairable and, if found defective, should be returned to the manufacturer for repair.

4.1   PREVENTIVE MAINTENANCE

To ensure continued trouble-free operation, complete the following preventive maintenance tasks regularly as recommended.

4.1.1   DAILY INSPECTION

All components in the tape path must be kept scrupulously clean. Daily, or after four hours of tape motion, inspect Deck Assembly, Read/Write/Erase Head, Rollers, and Sensors, for cleanliness. Look for dirt and oxide accumulation. Clean as required.

4.1.2   CLEANING

CAUTION

Using **non-recommended** cleaning fluids can damage components of the Tape Drive. Using excessive amounts of the recommended cleaning fluid can damage the Tape Drive by penetrating roller bearings, idler rollers, tape guides, capstan, or drive motor, and destroying lubrication.

4.1.2.1   TAPE REELS

Before installing any tape reel onto the Supply Hub, it is recommended that the inner surface of the Tape Reel Hub be cleaned with a lint free cloth dampened with clean water to remove any dirt, grease or other contamination.

4.1.2.2   ERASE/WRITE/READ HEAD CLEANING

Remove accumulation of oxide and/or dirt from the Erase/Write/Read Head surface (Fig. 4-1) using a clean lint-free cloth or cotton swab dampened with 1.1.1 trichloroethane or isopropyl alcohol (See **CAUTION** above). Wipe the Head with firm but gentle vertical strokes.
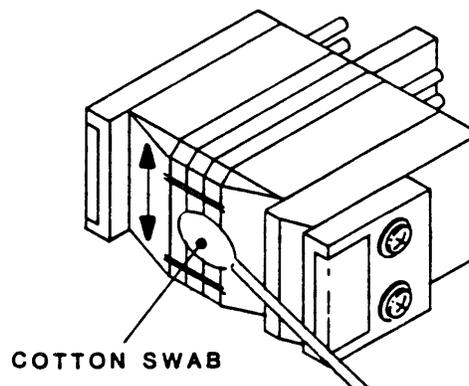

COTTON SWAB

Figure 4-1.   Erase/Write/Read Head Cleaning

4.1.2.3   TAPE PATH CLEANING

Miscellany (Figure 4-2)

Clean tape guides, rollers (except Capstan Roller), and the sapphire tape cleaners with a cotton swab dampened with isopropyl alcohol or 1.1.1 trichloroethane. Clean the Capstan rubber Roller with a cotton swab dampened with water or, if excessively dirty, dampened with mild soapy water. Dry thoroughly with a clean lint-free cloth.

Reel Locking Fingers

With no tape reel on the Supply Hub, press the Manual Reel Locking Lever while manually turning the Reel Hub clockwise until the Reel Locking Fingers extend fully outward. Then clean the Rubber Pads on the Fingers with a clean cotton swab or cloth dampened with water or if excessively dirty, with mild soapy water.

After cleaning the Rubber Pads, again press the Manual Reel Locking Lever and manually turn the Reel Hub counterclockwise until the Fingers retract to original position.

4.1.3   ROUTINE ADJUSTMENTS

There are no routine adjustments necessary to the Tape Drive. **DO NOT** make any adjustments except for corrective maintenance.

4.1.4   LUBRICATION

The Tape Drive uses only sealed, life-time lubricated bearings. No lubrication is required. **CAUTION: Do not lubricate.**
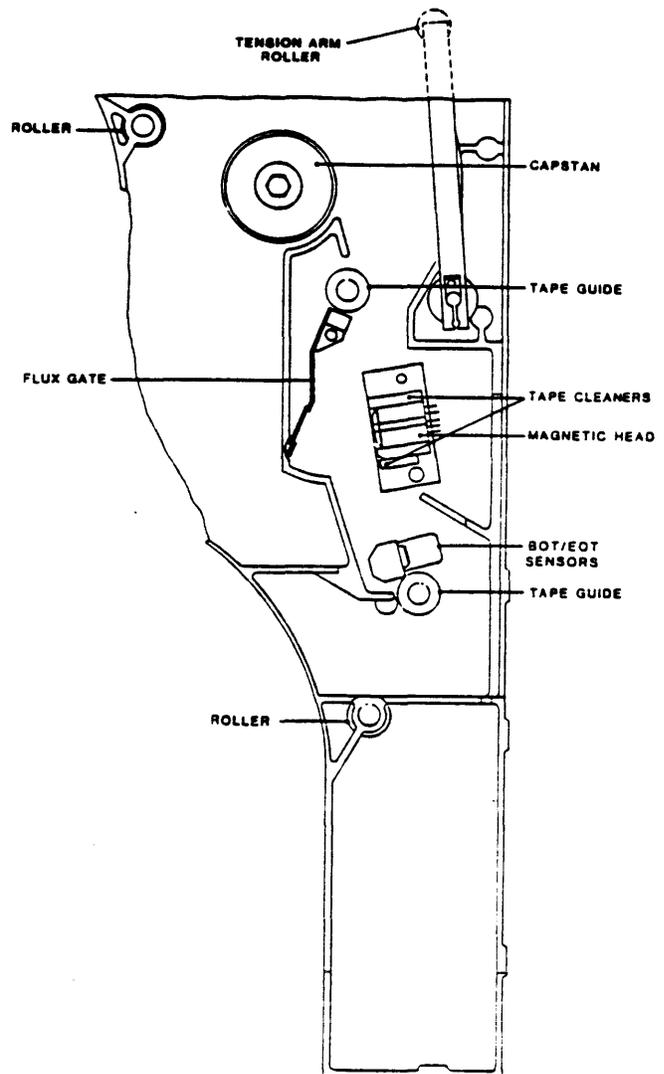

Figure 4-2.   Tape Path Cleaning

APPENDIX A - GLOSSARY

A.0 GENERAL

This appendix defines terms, acronyms, and abbreviations used in the manual.

Auto Speed. Operation of the Tape Drive whereby it shifts to an operating speed (50 or 100 ips) to accommodate the data throughput to/from the Host Computer.

BOT. Beginning of Tape: The section of tape near the physical beginning of tape that constitutes the approach to the beginning of the recording area. This section is marked by a photo-reflective Marker.

Block. A group of contiguous bytes considered and transmitted as a unit.

Byte. A group of eight contiguous bits that are acted on as a unit.

Character. A unit of information consisting of one byte plus a parity bit recorded as a unit.

CRC Character. Cyclic Redundancy Check Character:

In NRZI Mode, the next-to-last character placed in 9-track, 800-cpi, data blocks where a modified cyclic code is used. The CRC Character can be used for error detection.

Data Density. The number of single-byte characters stored per unit length of tape - usually expressed as Characters per Inch (CPI) or Bytes per Inch (BPI).

Data Access Time. Time required for tape to accelerate from a stopped state to nominal velocity and the Drive to start reading or writing data.

DDPE. Double-Density Phase-Encoded Data Format: Density is 3200 cpi which is double that of PE (Phase-Encoded Format).

EOT. End-of-Tape: A section of tape near the physical end of tape that constitutes the approch to the end of the recording area. This section is marked by a photo-reflective marker.

FM. File Mark or Tape Mark: A control block recorded on tape to separate data files from one another. A data file can consist of one or more data blocks.

Flux Transition. The change of magnetic flux from saturation in one direction to saturation in the opposite direction.

ID Burst. Density Identification Burst: A burst of data recorded near the beginning of tape, before BOT, that identifies the tape recording density as PE or DDPE.

IPS. Inches Per Second: Parameter for expressing tape speed.

IBG. Interblock Gap: A dc-erased section of tape used to separate data blocks.

Latency. For On-The-Fly Operations, Latency refers to the time between the end of a data block and the point after which the Drive will not immediately implement the next Command before tape comes to a complete stop.

Local Operation. Operation set up or controlled from the Front Panel of the Drive with no influence from the Host Computer.

LRC Character. Longititudinal Redundancy Check Character: Used in NRZI Mode. This character is the last character in each data block. It constitutes a set of longititudinal parity bits for checking data and restoring all tracks to the dc-erase polarity.

NRZI. Non-Return-to-Zero, Change-on-ONE Data Format: Recording technique characterized by having any transition from ONE to Zero or ZERO to ONE represent a Logic ONE; all steady states (no change) represents Logic ZERO. Recording density is 800 cpi.

On-The-Fly Operation. Refers to Start/Stop Mode – Operation whereby each successive Command is issued in rapid enough sequence to keep the tape moving continuously – not stopping in IBGs.

PE. Phase-Encoded Data Format: Recording technique whereby a specific change in magnetic flux polarity represents one logic level. The opposite change in polarity represents the other logic level. Recording density is 1600 cpi.

Physical Recording Density. The number of recorded flux transitions per unit length of tape. This parameter is usually given in ftpi (Flux Transitions per Inch).

Remote Operation. Operation of the Tape Drive by the Host Computer.

Reinstruction Time. Time allowed after the Drive has written or read a data block, and before the tape comes to a complete stop, for the Host Computer to issue the next Command and continue tape motions. (Ref Figure A-1)

Reinstruction Time On Ramp. For Start/Stop Mode only – Time allowed after tape has begun to ramp down in the IBG for the Host to issue a new Command and reaccelerate tape before it comes to a complete stop in the IBG. (Ref Figure A-1)

Reposition Time. Time required for Drive to reposition tape for the next Command if the next Command was issued too late to maintain tape motion. (Ref Figure A-1)

Start/Stop Operation. Operation of the Tape Drive whereby the tape stops and starts within each Interblock Gap. Start/Stop Operation can be done at any density, but is limited to 50 ips tape speed. See On-The-Fly Operation.

Streaming Operation. Operation whereby the tape moves continuously (with some exceptions) without stopping in the Interblock Gaps. The Host Computer is allowed a full IBG period (dependent on density and tape speed) to send a valid Command (that does not change tape motion direction). If the Command is not received, within the Interblock, the Drive enters a Reposition Routine that stops the tape in an area just before the related IBG. The next Command resumes tape motion. (Ref Figure A-1)
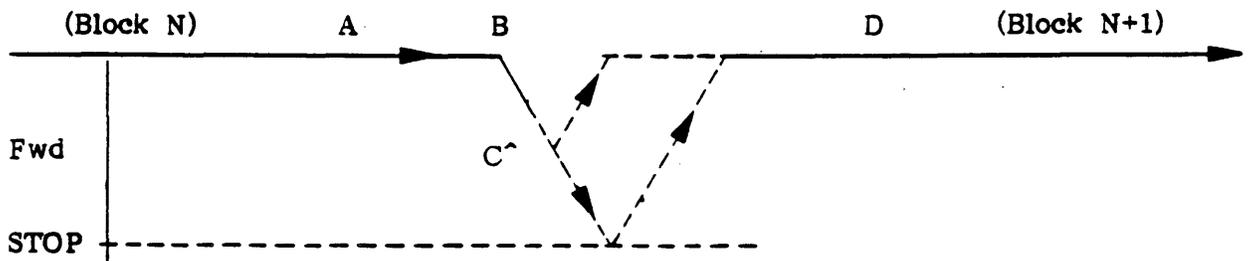
VPE. Vertical Parity Error: Each character transmitted occupies 8 tracks for data and one track for a Parity Bit. Vertical Parity Error is one based on the parity of each character on tape.

Tape/Head Orientation
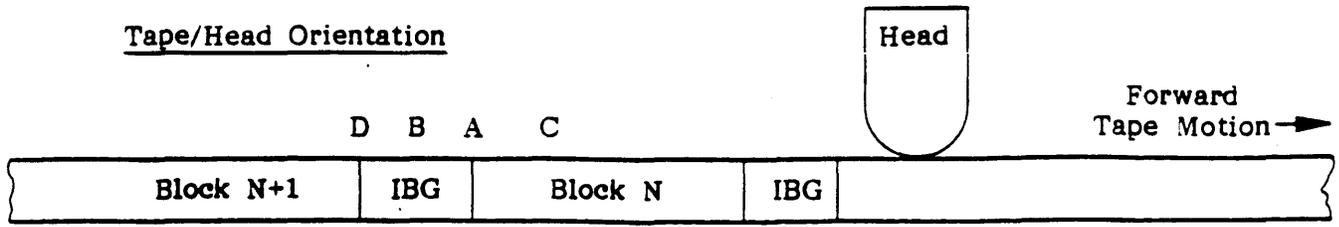
Streaming Operation
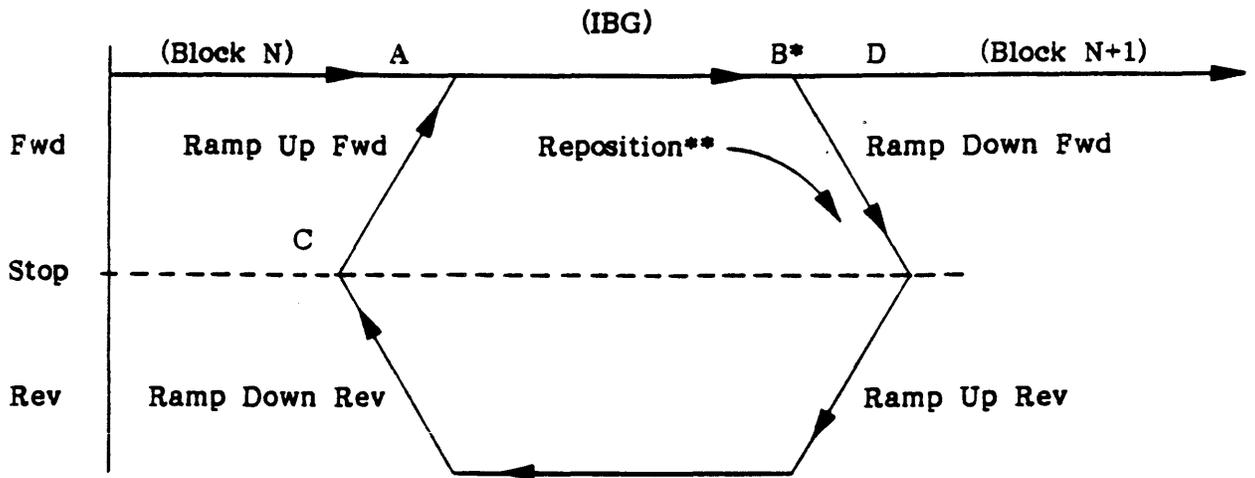
Stop/Start Operation

NOTE:

* Point B is the End of Reinstruct Window, the last point where the next Command can be executed without repositioning.

** Repositioning occurs from B to C.

^ Point C is last point where new Command can be executed without ramping to a complete stop

Figure A-1.   Velocity Profiles

Warranty

The Company warrants its devices against faulty workmanship or the use of defective materials (except in those cases where the materials are supplied by OEM) for a period of one year from the date of shipment to OEM, with the exception of ¼" cartridge products which are warranted for a period of ninety (90) days.

The liability of the Company under this warranty is limited to replacing, repairing, or issuing credit (at the Company's discretion) for any devices which are returned by OEM during such period provided that (a) the Company is promptly notified in writing upon discovery of such defects by OEM; (b) the defective unit is returned to the Company, transportation charges prepaid by OEM; and (c) the Company's examination of such unit shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, improper installation, repair alteration or accident.

Kennedy Company is continually striving to provide improved performance, value and reliability in its products and reserves the right to make these changes without being obligated to retrofit delivered equipment.

KENNEDY
A Division of Shugart Corporation

KENNEDY

A Division of Shugart Corporation