

KENNEDY CO.

Model 331
Digital Cartridge
Recorder



SECTION I

APPLICATION DATA

1.1 INTRODUCTION

The Kennedy Model 331 Cartridge Recorder is a rugged tape handler expressly designed for high reliability digital data recording.

The machine utilizes the 3M DC300A converter 1/4 inch data cartridge, which features a unique isoelastic drive system for maintaining constant tape tension and tape motion with a single drive motor. Drive power is provided by a high quality AC motor/tachometer velocity servo system which provides both tape and reel drive. The cartridge contains 300 feet of 0.25 inch computer grade tape, along with internal tape guides to ensure reliable recording.

The Model 331 is fully bidirectional at 25 ips normal speed, resulting in a data transfer rate of 40,000 bits per second at 1600 cpi recording density. Forward and reverse search modes as well as rewind speed are 90 ips.

The drive can be equipped with a variety of heads for maximum flexibility. One, two and four-track versions are available. Each track is treated independently, allowing cartridge interchange between transports of differing track configurations. Every track is equipped with a separate erase gap to ensure against inadvertent data erasure.

The Model 331 is designed to meet the requirements of the proposed ANSI standard for quarter-inch cartridges. The standard provides for a recording density of 1600 cpi written in a phase encoded format. A 16 character preamble precedes the data for read synchronization. Data is followed immediately by a 16 character CRC and then a 16 character postamble. Record gaps are 1.2 inches minimum.

The write electronics in the Model 331 consists only of head drivers. The proper phase encoded data including preamble, CRC and postamble must be presented to the unit in the correct serial order.

Read electronics consist of preamplifiers and cross-over detectors. Outputs are in digital form, TTL compatible.

The Model 331 provides an extremely reliable means of storing digital data. It is well suited to use as a programming device for minicomputers, a storage

device for terminal and point-of-sale systems, and any other data processing applications requiring maximum capability in minimum space.

1.2 ELECTRICAL/MECHANICAL SPECIFICATIONS

Table 1-1 lists the general specifications for the Model 331. Figure 1-1 is an outline and installation drawing for this unit.

Cartridge type	3M, DC300A Isoelastic Data Cartridge
Tape width	0.25 inch, 1.0 mil
Tape length	300 feet
Recording density	1600 bpi
Number of tracks	1, 2, or 4
Recording head	Dual gap read-after-write with separate erase bar for each track
Record format	Single track, phase encoded
Record mode	Single track serial
Normal tape speed	25 ips
Rewind/search tape speed	90 ips nominal
Start/stop time	at 25 ips, 30 ms \pm 1 ms; at 90 ips, 120 ms nominal
Start/stop displacement	at 25 ips, 0.375 inch; at 90 ips, 5.4 inches nominal
Transfer rate	40,000 bits per second
Instantaneous speed variation	\pm 5 percent
Long term speed variation	\pm 2 percent
Write	Bidirectional
Read	Bidirectional
Power requirements	+5 vdc at 0.5 amp \pm 24 vdc at 3 amps peak (unregulated)
Weight	3.75 pounds
Dimensions	6.5 inches wide, 4.75 inches high, 8.625 inches deep (16.51 cm x 12.06 cm x 21.9 cm)
Interface	DTL/TTL low true

Table 1-1. Specifications

1.3 INTERFACE CONNECTORS

The interface connectors on the Kennedy Model 331 cartridge transport are designed for twisted pair inputs and outputs. The mating interface connector consists of one 44 pin Cinch Jones. Refer to Figure 1-4 for interface assignments.

1.4 INTERFACE SIGNAL CHARACTERISTICS

The tape unit responds to zero-volt true inputs and provides zero-volt true outputs. Logic 1 = 0v to +0.4 vdc, while logic 0 = +2.8 vdc to +5 vdc. Each signal input is terminated in such a manner as to provide matching for twisted pair cables (see Figure 1-2). Each output line is driven with an open collector driver. For best results the typical interfacing circuit configurations shown on Figure 1-2 should be used. The recommended twisted pair cable will reduce the magnitude of intercable crosstalk. Unless otherwise specified, all wires should be 24 AWG minimum, with a minimum insulation thickness of 0.01 inch. Each pair should have not less than one twist per inch, and cable length between transport and control unit should be no more than 20 feet.

The input receiver circuits, due to zero true current sinking logic design, will interpret a disconnected wire or removal of power at the format control unit as a logic zero or false condition. The logic 1 or true state requires 25 mA current sink with less than 0.4 volt. The logic 0 or false state will be +3 volts due to the input matching resistors. Each output line is driven with an open collector current sinking logic driver which is capable of sinking up to 40 milliamperes in the true state. All outputs are disabled when the tape unit is not on line and selected.

1.5 TAPE MOTION COMMANDS

The Model 331 responds to four input tape motion commands: RUN FORWARD, RUN REVERSE, FAST FORWARD and FAST REVERSE. The transport includes a linear ramp generator which drives the capstan servo and provides linear accelerations from full stop to required speed, and linear deceleration from run to stop. Start and stop operations occur within the interrecord gaps. The ramp time is 30 milliseconds for the standard synchronous speed (25 ips). Ramp time for 25 ips is adjusted so that the amount of tape travel during the ramp-up or ramp-down is always 0.375 inch.

The ramp time and tape travel during the ramp must be taken into consideration when writing and gapping. A delay is required before writing to insure that the

tape is up to speed, and to allow read after write. An additional delay is required before terminating RUN FORWARD during a write mode to allow for the spacing between the read and write heads. The timing diagram, Figure 1-3, provides the necessary information to produce properly formatted tapes.

1.6 CONTROL SIGNALS

Pin U - RUN FORWARD COMMAND (RF). A level that when true and the transport is ready causes tape to move forward at the normal speed. When the level goes false, tape motion ramps down and ceases.

Pin T - RUN REVERSE COMMAND (RR). A level that when true and the transport is ready causes tape to move in the reverse direction at the normal speed.

Pin S - FAST REVERSE COMMAND (FR). A level that when true and the transport is ready causes tape to move in the reverse direction at the search speed. When the level goes false, tape motion ceases.

Pin R - FAST FORWARD COMMAND (FF). A level that when true and the transport is ready causes tape to move in the forward direction at the search speed. When the level goes false, tape motion ceases.

Pin J - CARTRIDGE RELEASE (CR). A pulse which will cause the cartridge to be ejected. The cartridge release solenoid is actuated on command from the interface, releasing the 3M cartridge whenever CARTRIDGE RELEASE goes true. To protect the cartridge release solenoid, the input command is internally timed out in the event that CARTRIDGE RELEASE is not turned off after the cartridge has been ejected.

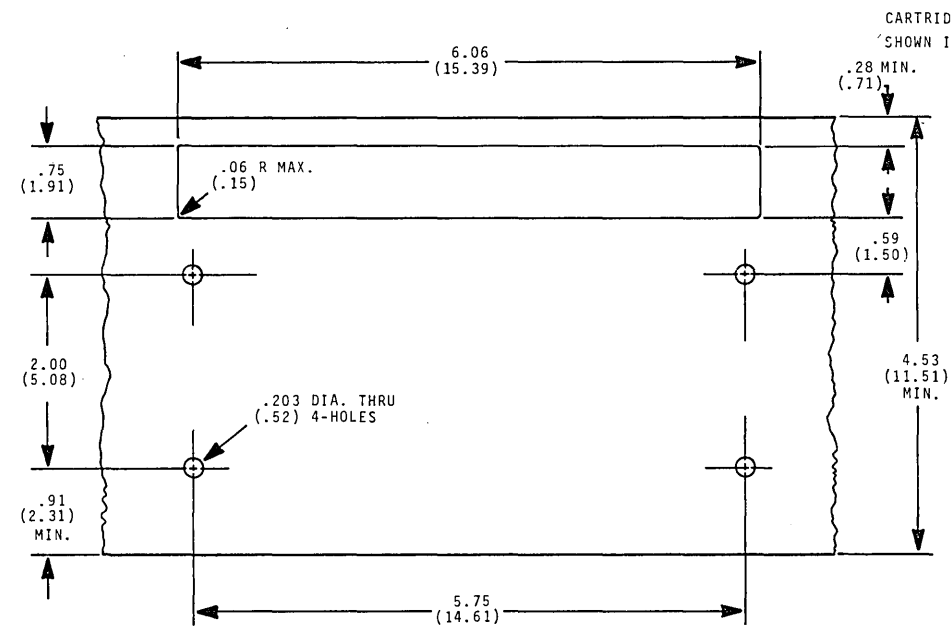
Pin N - WRITE ENABLE (WEN). A level that when true and when a cartridge with the write plug in the write position has been mounted on the transport allows writing of data.

1.7 STATUS OUTPUTS

Pin P - READY (RDY). A level that is true when the tape transport mechanical interlocks are made. When true, the transport is ready to receive a remote command.

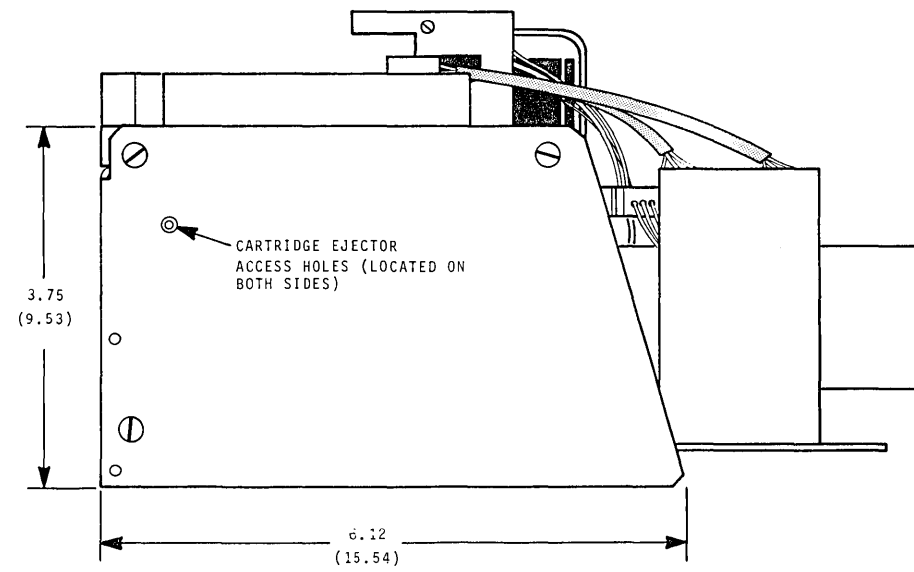
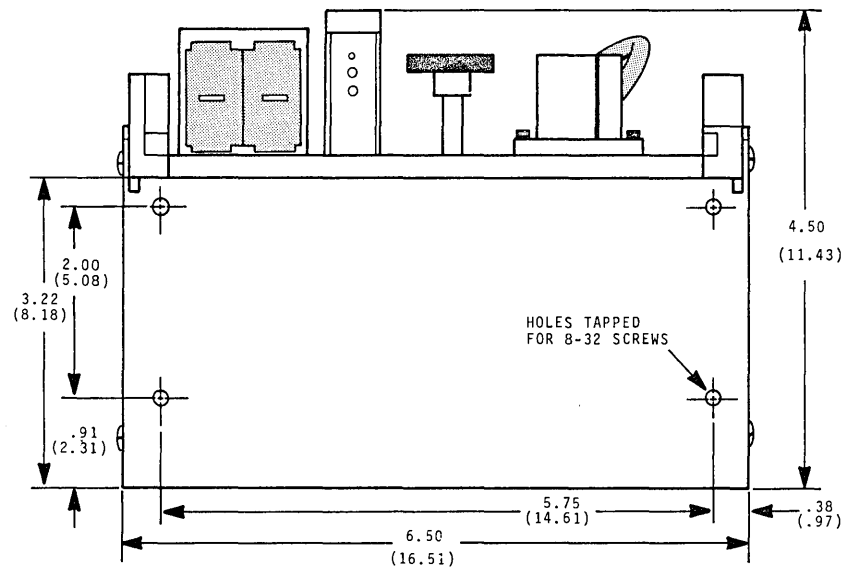
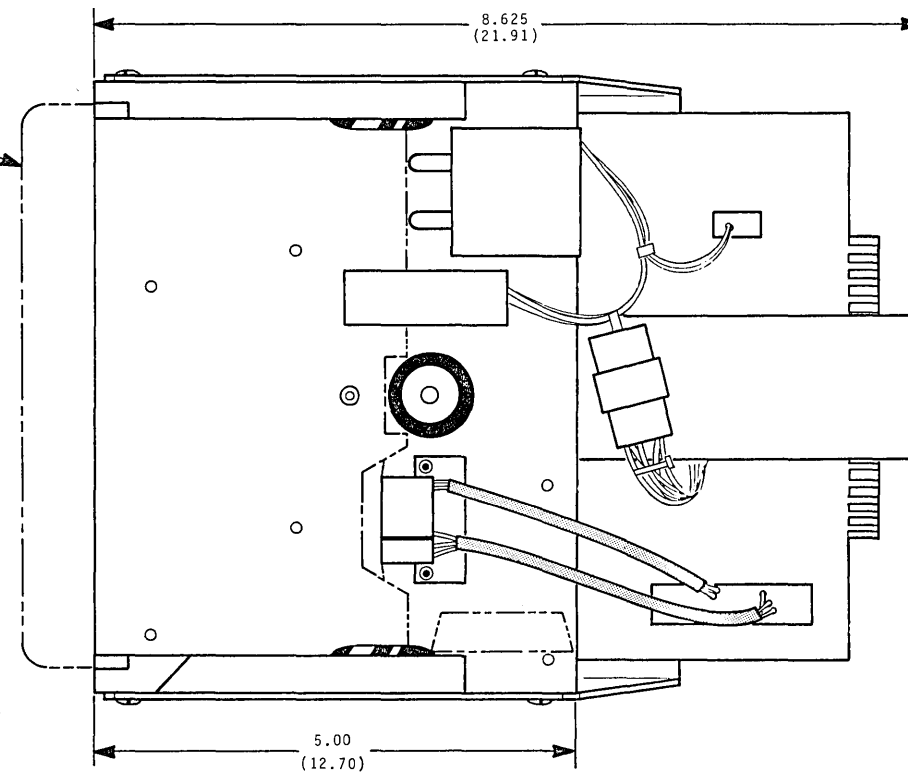
Pin H - PHOTOCCELL B. Output levels which provide position information for determining load point, EOT, BOT, end of tape warning, etc.

NOTE: It is required that the photocell outputs be decoded and stored in order to accurately determine position on tape.



SUGGESTED PANEL
MOUNTING DIMENSIONS

FIRST DIMENSIONS SHOWN ARE IN INCHES.
DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS.



410-4012

Figure 1-1.
Outline and Installation Drawing

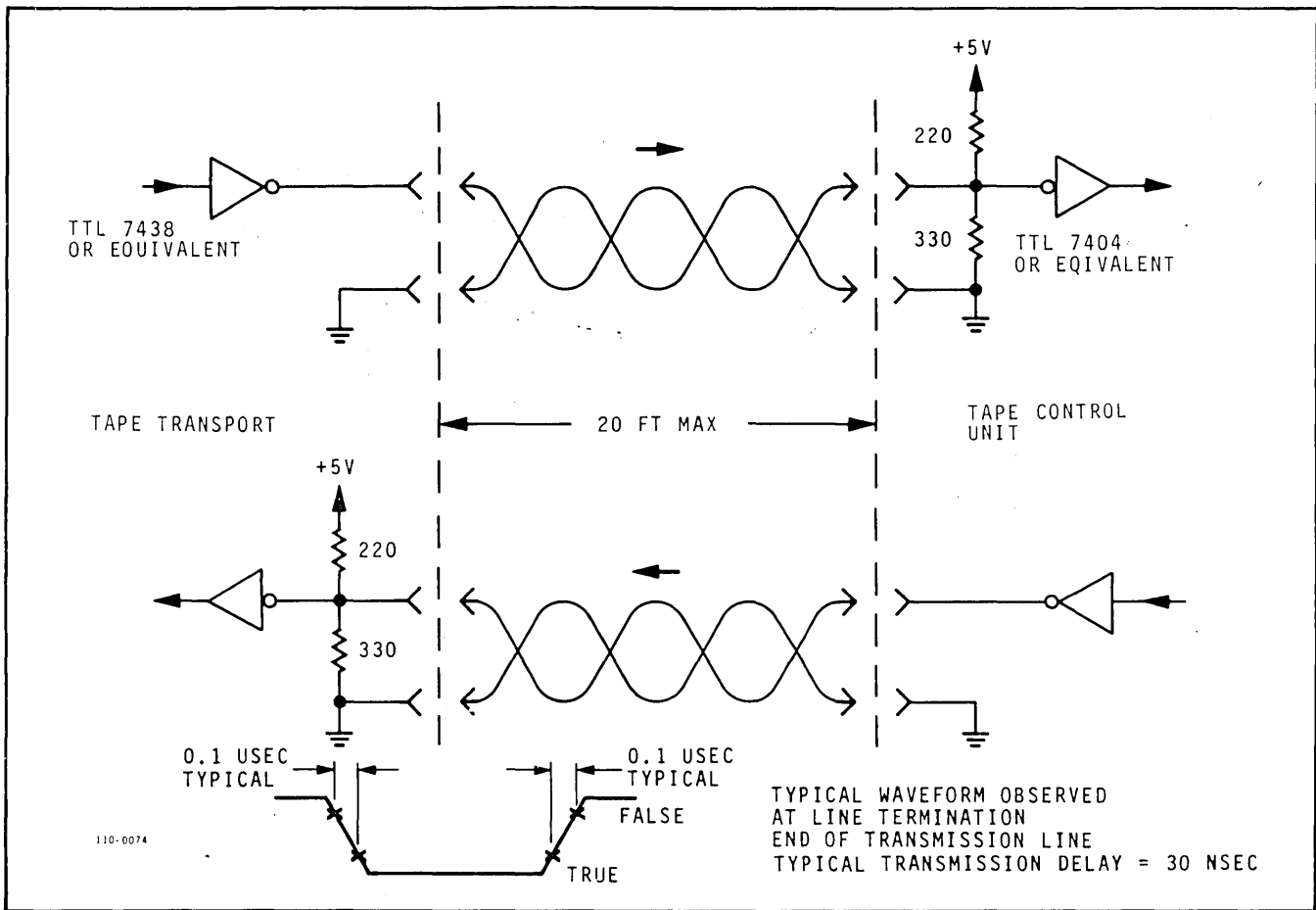


Figure 1-2. Typical Interface Circuit

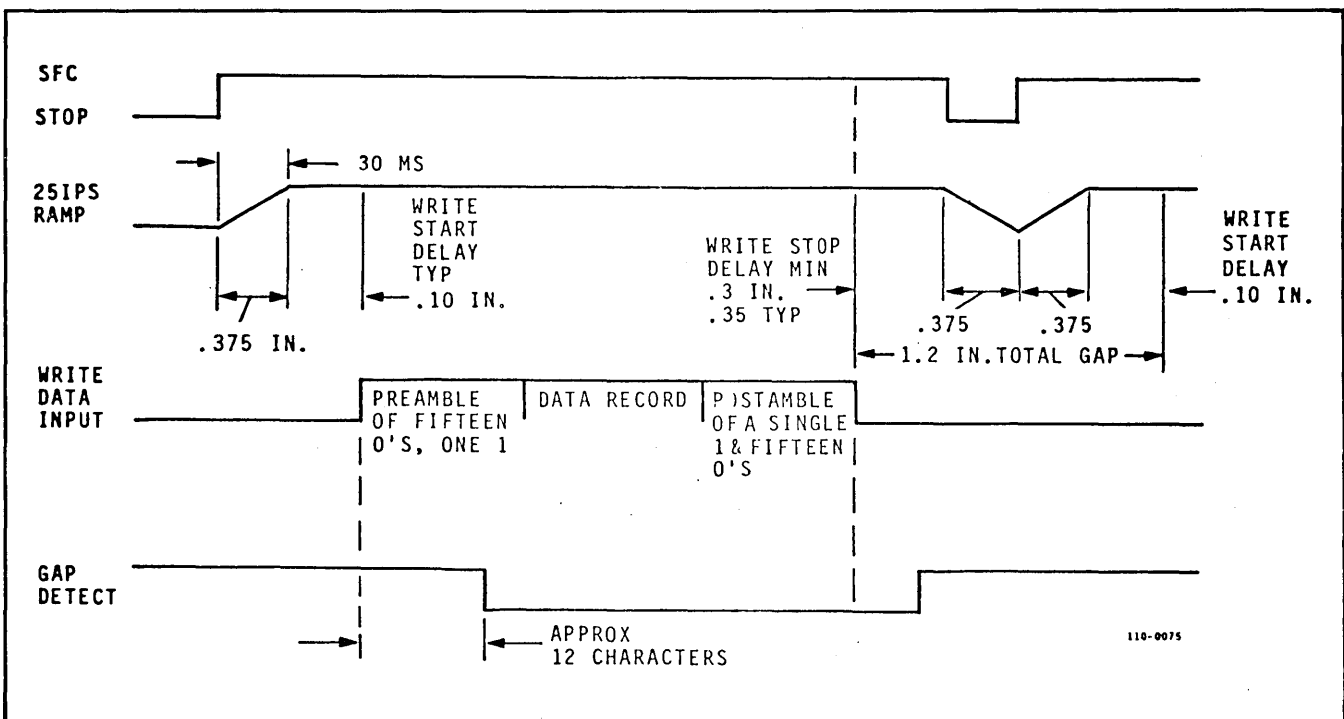
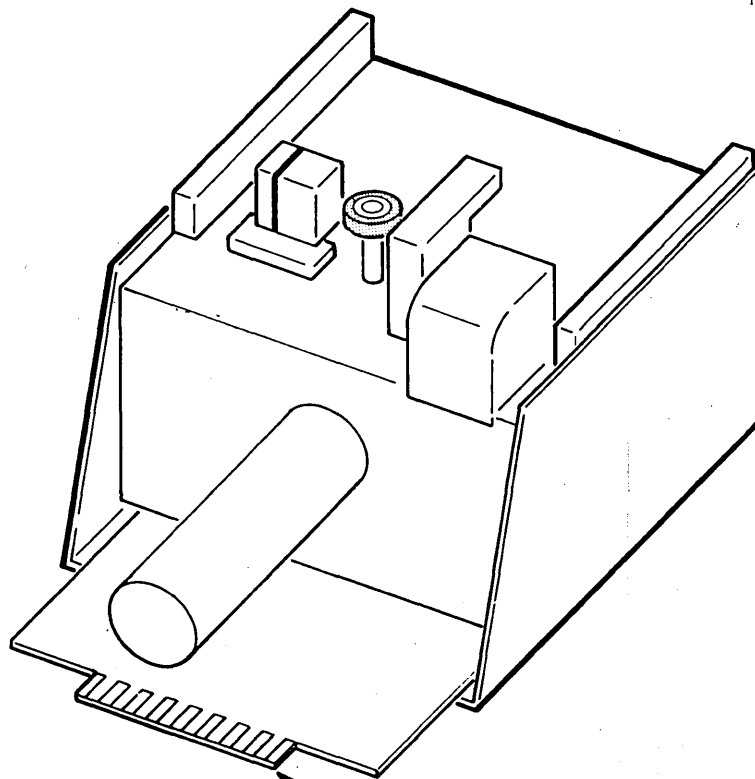


Figure 1-3. Write Motion Command Timing



SIGNAL LEVELS

LOGIC 0: +2.8 TO +5 VDC
 LOGIC 1: 0 TO +0.4 VDC

INTERFACE CONNECTOR,
 CINCH-JONES, 22 PIN

PIN INPUT SIGNALS

M	WRITE DATA
K	SELECT A
L	SELECT B
N	WRITE ENABLE
J	CARTRIDGE RELEASE
U	RUN FORWARD
T	RUN REVERSE
R	FAST FORWARD
S	FAST REVERSE

BINARY SELECT

<u>TRK</u>	<u>A</u>	<u>B</u>
1	0	0
2	0	1
3	1	0
4	1	1

PIN OUTPUT SIGNALS

V	READ DATA
F	PHOTOCELL A
H	PHOTOCELL B
P	READY
W	SAFE

PIN POWER CONNECTIONS

E	+5.0 VDC (0.5 AMP)
C	+24 VDC (3 AMP PEAK)
D	-24 VDC (3 AMP PEAK)
A	SIGNAL GROUND
B	MOTOR GROUND

Figure 1-4. Interface Pin Assignments

For example, when the cartridge is initially inserted a rewind operation should be performed. A fast reverse command is issued until both the A and B holes are detected simultaneously in reverse. When they are, beginning of tape has been reached and fast reverse should be dropped. If it is desired to advance to load point, run forward should be issued until the A hole is detected in the forward direction. This position on tape is LOAD POINT. The next time the A output is detected in the forward direction, the end of tape warning position has been reached. Continued forward tape motion should only be allowed until both the A and B outputs are simultaneously detected signifying end of tape.

1.8 READ/WRITE SECTION

Pin V - READ DATA (RD). Data is presented in serial format, TTL compatible, and consists of coded flux transitions. A 0 transition is defined as a voltage transition from low to high at the interface. A 1 transition is defined as a voltage transition from high to low at the interface. READ DATA OUTPUT is forced high (false) during the read gap. The particular track to be read is selected by means of a low true SD1, 2, 3, or 4 input, which is determined by the states of SELECT A and SELECT B interface signals. Read Data output is forced high (false) during the Read Gap.

Pin M - WRITE DATA (WD). Serial input data in the proper phase encoded format, including preamble, CRC, and postamble, are presented on this line. Write data consists of encoded flux transitions. The polarity of this signal is such that a high (false) input state generates the ANSI standard erase polarity for gap generation.

Transport electronics consist only of write head drivers on the Write Head Driver board. WRITE ENABLE must be true (high) before write data can be applied to the selected write head. Write head selection is accomplished by means of SELECT A and SELECT B interface signals.

Pin K - SELECT A. When combined with SELECT B, this level selects one of four tracks for read/write operation. A table of the logic states required to select each track is furnished on the Transport Electronics schematic.

Pin L - SELECT B. When combined with SELECT A, this level selects one of four tracks for read/write operation. A table of the logic states required to select each track is furnished on the Transport Electronics schematic.

Pin N - WRITE ENABLE. When true (low) this level enables the write head selected by SELECT A and SELECT B signal states. When false (high) this level disables the write heads.

1.9 POWER SUPPLY

The Model 331 requires ± 24 vdc unregulated and +5 vdc regulated supply voltage for operation. The 30 ips version of the Model 331 requires ± 27 vdc nominal $+20\%$ - 10% , in place of the +24 vdc.

The +24 vdc unregulated is reduced to ± 15 vdc regulated by a regulator circuit on the Transport Electronics board. Table 1-2 lists the current and voltage requirements of the Model 331.

Voltage	Current
+5v $\pm 3\%$	Maximum 0.95A
+24v $+20\%$ -10%	Maximum 3.0A (100 msec surge when ramping - average 1.0A)
-24v $+20\%$ -10%	Maximum 3.0A (60 msec surge when ramping - average 1.0A)

Table 1-2. Power Supply Requirements

SECTION II

INSTALLATION AND OPERATION

2.1 INSTALLATION

2.1.1 MOUNTING

Physical dimensions and outline of the transport are shown in Figure 1-1. The transport requires 4.56 inches of mounting space on a 7.5 inch rack. The transport should be located so that the cabling length between the transport and the format control unit is no longer than 20 feet.

2.1.2 SERVICE ACCESS

The two circuit boards are readily accessible without dismantling the chassis. To gain access to the mechanical parts inside the chassis, detach the connectors and Write Head Driver board from the Transport Electronics board. Then detach the Transport Electronics board from the bottom of the chassis (four nuts). The front and sides of the Model 331 are easily removable as one unit for making certain mechanical repairs.

2.1.3 INTERCABLING AND POWER CONNECTIONS

The connector pin assignments and cable requirements are specified in Section I of this manual. An external power supply is required for the tape transport. It may be purchased directly from the Kennedy Company or may be acquired elsewhere. The power supply connections and specifications are detailed in Section I.

2.2 OPERATION

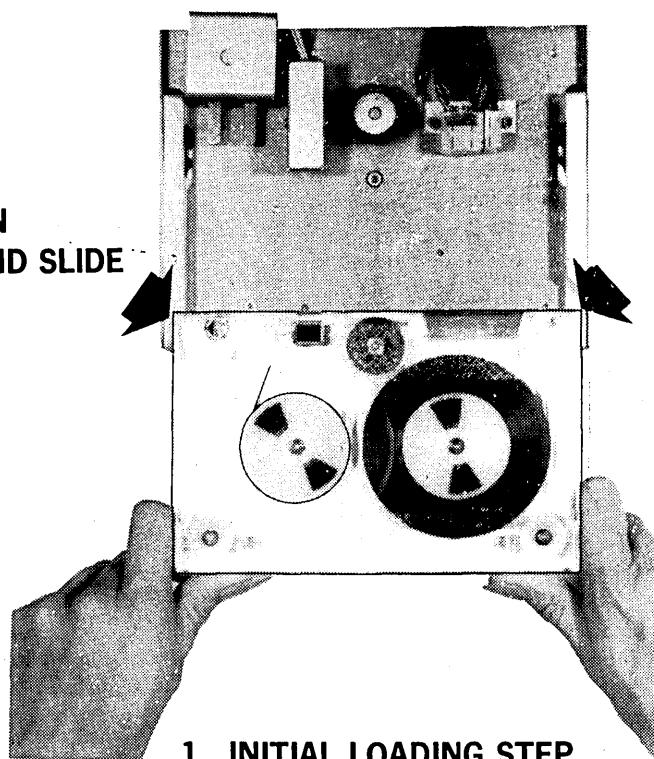
Before operating the unit, make certain that all power supply and formatter connections have been made.

2.2.1 OPERATING PROCEDURE

After the interface connections are made as required and the power supply is connected to the transport, proceed as follows:

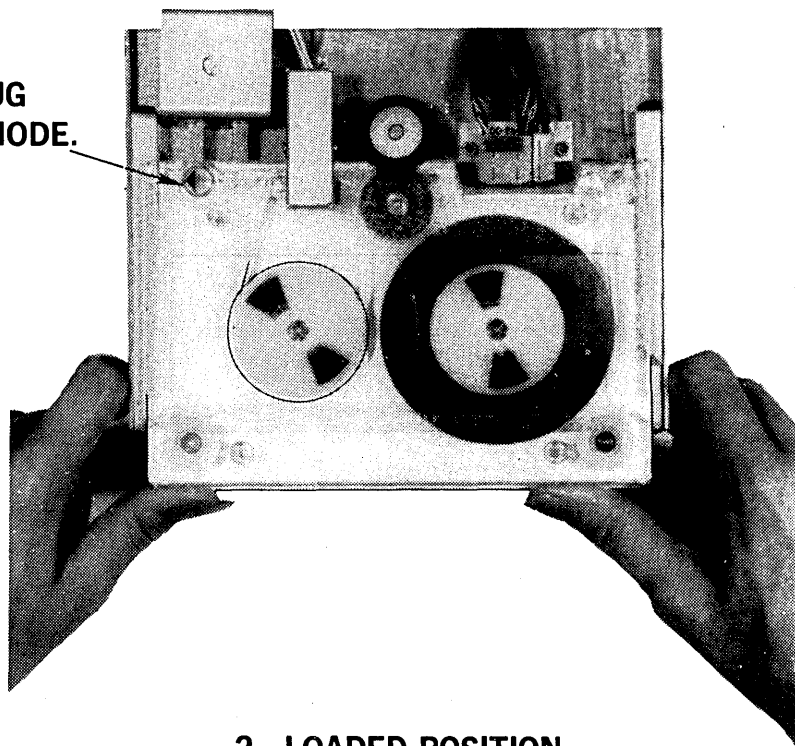
- a. Clean the transport read/write head to prevent degradation of magnetic tape.
- b. Using a screwdriver, rotate the write enable plug on the cartridge to the SAFE indication for the read mode, or away from the SAFE indication for the write mode. When in the write mode, the WRITE indicator on the front panel will be illuminated.
- c. To insert cartridge, place bottom plane of the cartridge on the lower ridge of the cartridge guides as shown in Figure 2-1. Slide cartridge all the way in and press until cartridge is engaged as shown in Figure 2-1.
- d. To eject a cartridge, issue a CARTRIDGE RELEASE command, which is automatically disabled after a predetermined delay. The tape can also be manually ejected by depressing the cartridge ejection mechanism within the machine with a small Allen wrench. Two access holes are provided on the side panels for this purpose. Alternately, insert the plastic ejector (Kennedy Part No. 191-4565-001) provided between the cartridge and the deck to trip the cassette latches.

TO LOAD
REST CARTRIDGE ON
LOWER NOTCHES AND SLIDE
INTO OPERATING
POSITION.



1. INITIAL LOADING STEP

WRITE ENABLE PLUG
SHOWN IN WRITE MODE.



2. LOADED POSITION



ROTATE PLUG TO
SAFE POSITION
FOR READ MODE.

Figure 2-1 Cartridge Loading

SECTION III

THEORY OF OPERATION

3.1 TRANSPORT COMMAND SIGNALS

The transport command lines include RUN FORWARD, FAST FORWARD, RUN REVERSE and FAST REVERSE. These control command inputs are supplied from the interface to the Transport Electronics Board. On that module, the motion controls are gated and applied to the ramp generator circuitry to develop the proper ramp ups and ramp downs for operating the drive motor. A capstan tachometer feeds back a regulating voltage and current for controlling motor speed.

3.2 A AND B HOLE PHOTOSENSORS

These vertically mounted photosensors detect the A and B holes on the tape, which indicate beginning of tape, end of tape and load point in accordance with the proposed ANSI standard. This information is directed back to the interface in the form of Hole A and Hole B status signals.

Note that the photocell outputs must be decoded and stored in order to accurately determine position on tape. For example, when the cartridge is initially inserted a rewind operation could be performed. A fast reverse command could be issued until both the A and B holes are detected simultaneously in reverse. When they are, beginning of tape has been reached and fast reverse should be dropped. If it is desired to advance to load point, run forward should be issued until the A hole is detected in the forward direction, the end of tape warning position has been reached. Continued forward tape motion should only be allowed until both the A and B outputs are simultaneously detected, signifying "End of Tape."

3.3 SELECT A AND SELECT B SIGNALS

The selected read or write track is determined by the state of these interface signals. For example, SELECT A high and SELECT B high choose track four for reading or writing. WRITE ENABLE false places the machine in the READ DATA mode; WRITE ENABLE true enables tape writing.

The SAFE SWITCH is activated when the WRITE ENABLE plug on the 3M tape cartridge is in the SAFE position. With the SAFE switch on, the write circuitry on the Transport Electronics Board is disabled to prevent accidental tape erasure.

3.4 WRITE DATA

The polarity of this signal is such that a high (false) input state generates the ANSI standard erase polarity for gap generation.

3.5 READ DATA

A "0" transition in lapse is defined as a voltage transition from low to high at the interface. A "1" transition is defined as a voltage transition from high to low at the interface. READ DATA OUTPUT is forced high (false) during the read gap.

3.6 CARTRIDGE RELEASE SOLENOID

This solenoid is actuated on command from the interface, releasing the 3M cartridge whenever CARTRIDGE RELEASE goes true. To protect the cartridge release solenoid, the input command is internally timed out in the event that CARTRIDGE RELEASE is not turned off after the cartridge has been ejected.

SECTION IV

MAINTENANCE INSTRUCTIONS

4.1 GENERAL

Kennedy Company tape transports are highly reliable precision instruments which will provide years of trouble-free performance when properly maintained. A planned program of routine inspection and maintenance is essential for optimum performance and reliability. The units require very few adjustments and these should not be performed unless there is strong reason to believe they are required. All electrical adjustments are preset at the factory and should not require readjustment except after long periods of use.

4.2 PREVENTIVE MAINTENANCE

To assure continuing trouble-free operation a preventive maintenance schedule should be kept. The items involved are few and simple but very important to proper tape transport operation. The frequency of performance will vary somewhat with the environment and degree of use of the transport so a rigid schedule applying to all machines is difficult to define. The periods recommended below apply to units in constant operation in ordinary environments. They should be modified if experience shows other periods are more suitable.

4.2.1 DAILY CHECK

Visually check the machine for cleanliness and obvious misadjustment. If items in the tape path show evidence of dirt or oxide accumulation, clean thoroughly.

4.2.2 CLEANING

All items in the tape path must be kept scrupulously clean. This is particularly true of the head. When cleaning heads, it is important to be thorough yet gentle and to avoid certain dangerous practices.

4.2.2.1 Head Cleaning

Oxide or dirt accumulations on the head surfaces are removed using a mild organic solvent and a swab. Q tips are convenient for this use but must be used with caution. Be sure the wooden portion does not contact head surfaces.

An ideal solvent is 1.1.1 trichloroethane contained in the Kennedy K21 maintenance kit. However, others such as isopropyl alcohol will do.

DO NOT USE - acetone or lacquer thinner
- aerosol spray cans
- rubbing alcohol

Do not use an excess of any solvent, and be extremely careful not to allow solvent to penetrate the ball bearings of the capstan motor, since it will destroy their lubrication.

4.2.2.2 Other Cleaning

Use a vacuum cleaner to remove accumulations of dust inside the dust cover or elsewhere in the unit. Compressed air may be used if caution is exercised to avoid blowing dirt into bearings.

4.3 ROUTINE ADJUSTMENT

There are no routine adjustments. Need for adjustment becomes manifest when malfunction occurs. Under normal circumstances adjustment will be more likely to cause trouble than to prevent it.

4.4 LUBRICATION

No bearing lubrication is required. All bearings are lubricated for life and introduction of oil may destroy their lubrication.

4.5 HEAD WEAR

Head wear is generally signaled by an increase in error rate. Confirmation is a sizable increase in output voltage from the read head as measured at the read preamplifier. When the head becomes worn it must be replaced. Head replacement is described in paragraph 4.9.5.

Worn heads usually can be resurfaced at least once if returned to the factory. This is more economical than replacement with a new head. Consult Section V for details of head return.

4.6 PERIODIC INSPECTION

Every two months, it is advisable to make a more

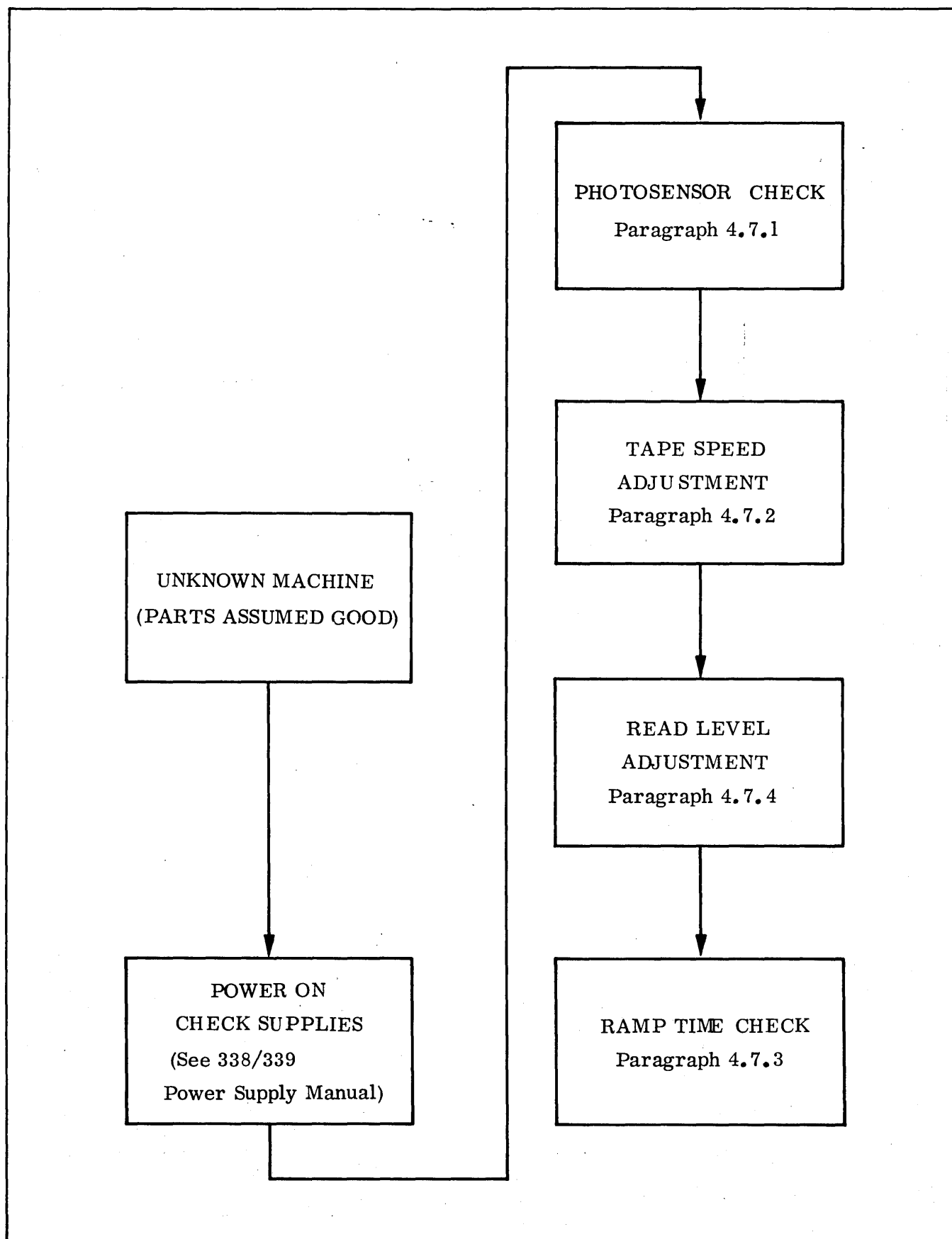


Table 4-1. Adjustment Sequence

thorough check of machine operating parameters to insure that no progressive degradation goes unnoticed. The recommended sequence for checks and adjustments is shown in Table 4-1.

4.7 CHECKS AND ADJUSTMENTS

4.7.1 PHOTOSENSOR CHECK

Characteristics of the A and B photosensors vary depending on age and usage. The photosensors are checked as follows:

Test Procedure

1. Disconnect capstan motor.
2. Connect voltmeter to test point X of the Transport Electronics board.
3. Insert a tape cartridge.
4. Turn capstan by hand until the small A hole is opposite the A photosensor. Voltage change at test point A should measure +3 volts minimum.
5. Reconnect voltmeter to test point Y on Transport Electronics board.
6. Turn capstan by hand to double set of large holes. Voltage change at test point B should measure +6 volts minimum.
7. Remove tape cartridge, disconnect voltmeter, and reconnect capstan motor.

4.7.2 TAPE SPEED ADJUSTMENT

Procedure No. 1 (Use with machines containing read after write heads)

1. Connect channel 1 probe of a dual trace oscilloscope to the input write data. A convenient location would be P9-1 of the Write Head Driver board. Trigger scope on channel 1 and select 2 ms/cm time constant.
2. Connect channel 2 probe to test point B and write on channel 1.
3. Write short blocks, one to ten characters long.
4. Adjust potentiometer R66 on the Transport Electronics board so that the delay between the leading edge of the read data block is 12 ms at 25 ips. For machines operating at other tape speeds the

formula for deriving the proper delay time is

$$\frac{0.3}{s} = \text{delay in ms}$$

where s = tape speed in inches per second.

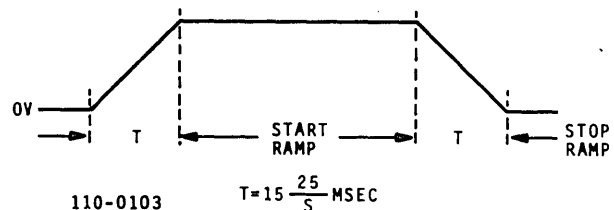
Procedure No. 2 (Use with machines containing combination read/write heads)

Special equipment required: Speed Adjustment Tape Cartridge, Kennedy Part No. 198-0045-001.

1. Connect oscilloscope probe to test point B. Select read operation.
2. Select a 2 ms/cm time constant on the oscilloscope.
3. Adjust R66 on the Transport Electronics board for a 10 ms read pattern which is 44 ANSI compatible characters long.

4.7.3 RAMP TIME CHECK

Tape is brought up to speed at constant acceleration. To control tape velocity, a ramp voltage is generated by the transport electronics which rises linearly to the required running speed and falls linearly to zero volts at stop. Ramp time is 30 ms (+0 -5 ms) at 25 ips and varies inversely with speed.



where

$$T = \text{ramp time in milliseconds}$$

$$S = \text{tape speed in inches per second}$$

To Check Ramp Time

1. Establish rapid start/stop motion.
2. Observe waveforms at test point A on the Transport Electronics board. Synchronize on RUN command. Be sure time is long enough to produce a flat area between ramps.

3. If ramp times vary significantly from specifications, the ramps should be adjusted by changing the value of R63. A higher value of R63 results in a faster ramp time.

4.7.4 READ DATA LEVEL ADJUSTMENT

1. Connect oscilloscope probe to test point B on the Transport Electronics board.
2. Write short 0-1 binary pattern data blocks on track 1.
3. While reading track 1, adjust potentiometer R25 on the Transport Electronics board for 15 volts p-p output as measured at test point B of the Read Amplifier board.

4.7.5 INTERLOCK SWITCH CHECK AND ADJUSTMENT

If READY signal does not go true when the cartridge is inserted:

1. Remove Transport Electronics board (four nuts).
2. Insert tape cartridge until it begins to engage with the latching mechanism. Contacts on both interlock switches should begin to open.
3. Press cartridge inward until it locks in place. Switch contacts should close completely. (This can be checked by gently pressing the switch contact toward the switch body. Any movement indicates contact is not completely closed.)

Adjustment

If contact will not close completely, loosen switch mounting screw and readjust switch position for complete contact closure.

4.8 TROUBLESHOOTING

Troubles that can arise in the Model 331 can usually be classified as either mechanical or electrical. However, the classification may often become confusing because a basically mechanical problem can cause what appears to be an electronic malfunction and vice versa. In any case the problem should be thoroughly analyzed before adjustments are changed.

Electronic troubleshooting is greatly facilitated by the modular construction - a new card may be substituted and the effect observed.

4.8.1 COMPATIBILITY

Model 331 accepts and produces tapes conforming to the ANSI standards. Occasionally compatibility problems can arise. For example:

- a. Cartridges written by and acceptable to the 331 are not acceptable to another transport.
- b. Foreign cartridges cannot be read by the 331 but its own tapes can.

Tape speed and ramp times are important factors in tape compatibility. These should be checked as described under paragraph 4.7, Checks and Adjustments.

4.8.2 OTHER MALFUNCTIONS

Normal troubleshooting procedures should be used to locate and isolate electronic malfunctions. The first items to check are the power supply voltages on the Transport Electronics board.

IMPORTANT

Power should be off before removing or inserting circuit boards.

Assuming the power supply voltages are correct, Table 4-3 or 4-4 should help to isolate the malfunction.

4.9 PARTS REPLACEMENT

Removal and replacement of most items in the Model 331 are obvious. Certain items, such as the photo-sensor assembly, require adjustment after installation. Adjustments and any precautions which should be exercised are described in the following removal and installation procedures.

4.9.1 PHOTOSENSOR ASSEMBLY REPLACEMENT

Removal

1. Remove sensor cover (two screws).
2. Detach sensor's molex connector. (Carefully pry it from its receptacle with a small screwdriver. Rocking connector back and forth can ruin the contacts.)
3. Remove two 3/32 inch Allen screws and detach photosensor assembly from chassis.

Installation

TABLE 4-2

High Error Rate—clean machine, good cartridge

Symptom	Possible Cause	Indication	Action	Ref.
Continuous errors, every block (read mode)	Broken connection to interface or internally	Continuity broken	Correct connection	
	Bad preamplifier channel	No output at test point on write test	Replace transport electronics board	
	Tape speed wrong	Tape speed check	Adjust tape speed	4.7.4
	Bad head channel	No data from preamplifier	Replace head	4.9.5
Continuous errors, write mode only	Broken connection on write data	Continuity broken	Correct connection	
	Bad write amplifier channel	Wrong or no signal at read amplifier test point in write test mode	Replace write head driver board	

TABLE 4-3

Control Malfunctions

Capstan rotates uncontrolled when power is on	Defective transport electronics	Same as symptom	Replace transport electronics board	
Cartridge won't release during ejection (solenoid clicks)	Defective cartridge casing sticks in loading tracks	Same as symptom	Replace cartridge	2.2.2d

TABLE 4-4

Loading Errors

Cartridge fails to eject during unloading	Bad solenoid driver and/or	Same as symptom	Substitute new Transport Electronics board Check eject solenoid	4.9.2
	Shorted eject solenoid	Same as symptom		
Tape will not move	Defective Transport Electronics board	Same as symptom	Substitute new Transport Electronics board	

Reverse removal sequence.

NOTE

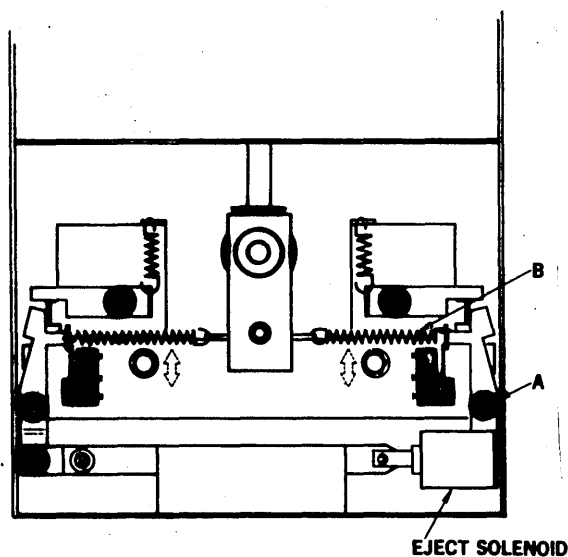
Check for 1/32 inch clearance between photosensor and a loaded tape cartridge. Carefully adjust replacement photosensor to achieve this clearance.

4.9.2 EJECT SOLENOID REPLACEMENT

If the Model 331 has been damaged by a current overload and the eject solenoid will not actuate, it probably requires replacement. It should be tested for shorts and replaced if it is defective.

Removal

1. Remove the Transport Electronics board (four nuts).
2. Remove press nut A shown in Figure 4-1.
3. Disconnect spring B shown in Figure 4-1.
4. Lift eject solenoid assembly off its mounting post, then slide solenoid armature off the solenoid shaft.
5. Detach solenoid case from the spring arm.



110-0115A

Figure 4-1. Eject Solenoid Replacement

CAUTION

Do not change the setting of the solenoid adjustment arm.

Replacement

Reverse removal procedure. After replacement, make certain interlock switches function properly. (See paragraph 4.7.5 for test procedure.)

4.9.3 BEVEL GEAR REPLACEMENT

1. Remove Transport Electronics board (four nuts.)
2. Using a 3/32 inch Allen wrench, detach capstan shaft mounting assembly from chassis. (This Allen screw is located on top of the transport deck.)
3. Loosen capstan bevel setscrew and slip bevel gear off the capstan shaft.
4. Motor shaft bevel gear can also be easily removed at this time. Simply loosen its setscrew and slip the bevel gear off the motor shaft.

4.9.4 FILE PROTECT/INTERLOCK ASSEMBLY REPLACEMENT

1. Unsolder connecting wires from the assembly. Note wire colors to facilitate reconnection.
2. Using a No. 1 Phillips screwdriver, remove the two mounting screws and detach entire assembly from chassis. It is replaceable as an assembly.

Installation

Reverse removal procedure.

NOTE

After installation, check for 1/32 inch clearance between file protect switch contacts and an inserted tape cartridge. Adjust file protect assembly to obtain this clearance as required.

4.9.5 MAGNETIC HEAD REPLACEMENT

1. Disconnect magnetic head's molex connectors.
2. Detach magnetic head assembly from chassis by removing 3/32 inch Allen mounting screws.

NOTE

Since the heads are factory aligned on their mounting plates, these components should be replaced as a unit.

Installation

Reverse removal procedure.

4.9.6 CAPSTAN MOTOR REPLACEMENT

1. Disconnect capstan motor's molex connector.
2. Detach Transport Electronics board (four nuts).
3. Detach front and side panel. (Note screw lengths to facilitate replacement.)
4. From top of transport, remove 3/32 inch Allen screw fastening capstan shaft mounting assembly to chassis. Capstan shaft can now be moved, permitting access to capstan motor screws.
5. Remove capstan motor mounting screws and lift motor out of chassis.

Installation

Reverse removal procedure.

NOTE

The motor shaft bevel gear must be perfectly centered with respect to the cap-

stan bevel gear before the capstan motor mounting screws are tightened. Figure 4-2 illustrates bevel gear centering.

Bevel Centering

1. Replace the capstan shaft mounting block. Mount the capstan motor in position but leave the mounting screws loose.
2. From the front of the machine, sight down both edges of the capstan shaft mounting block, lining them up with the edges of the capstan shaft. (See Figure 4-2.) Note the amount of motor shaft bevel gear visible from both sighting positions.
3. Adjust motor position until the same amount of motor shaft bevel is visible from both sighting positions. (See Figure 4-2.) Then tighten the capstan motor mounting screws.

4.10 MAINTENANCE TOOLS

In addition to normal electronic tools and test gear (oscilloscope, voltohmmeter, etc.) the following items should be available for service and repair:

Set of nut drivers or open end wrenches,
Phillips and standard slot-head screwdrivers,
Maintenance Kit, Kennedy PN 198-2324-001:
Head cleaner
Hex socket keys 7/64", 5/32", 1/8", 3/32"
Lint-free swabs

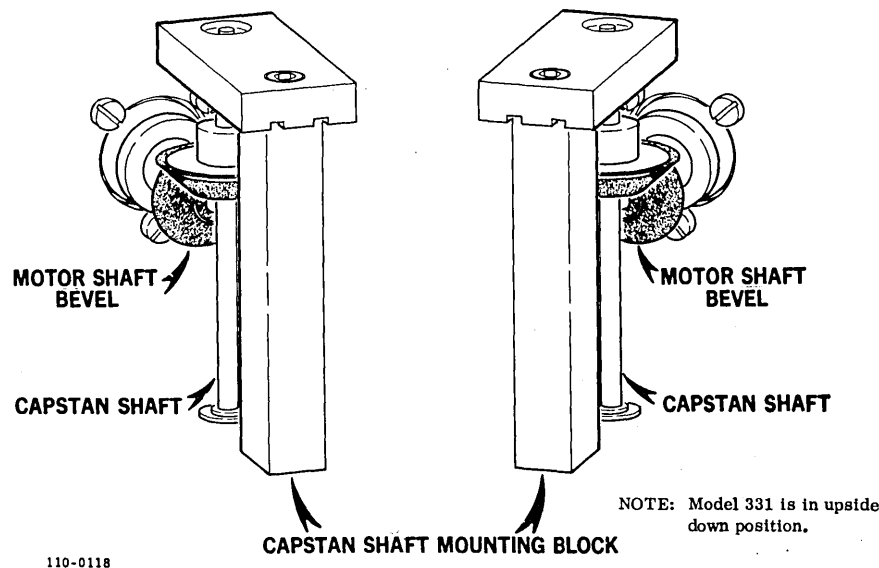


Figure 4-2. Motor Shaft Bevel Centering

SECTION V

PARTS IDENTIFICATION

5.1 SPARE PARTS ORDERING INFORMATION

This section describes the replaceable parts in your tape unit which are available only from Kennedy Company. Many parts of the unit are common commercial parts and can be obtained locally from the manufacturer. These parts are marked with the manufacturer's name and part number and are not listed herein.

The serial number and part number of the tape unit are the keys to numerous engineering details applying to your unit. These numbers are found on the serial number tag located on the right side panel or deck underside. When ordering spare parts, accessories, or tools always specify the serial number and part number of your unit.

Changes to Kennedy units are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements developed in our engineering department. If a part you have ordered has been replaced by a new part, a Kennedy representative will contact you concerning any change in part number.

All part orders should be addressed directly to Kennedy Company, Parts Order Department, 540 West Woodbury Road, Altadena, California 91001, telephone (213) 798-0953, TWX 910-588-3751.

5.2 IN-WARRANTY REPAIR PARTS ORDERING INFORMATION

Repair parts for in-warranty units are made available on an exchange basis through the Kennedy Company Customer Engineering Department.

The serial number and part number of the tape unit are necessary to insure shipment of the proper replacement parts.

All inquiries should be directed to Kennedy Company, Customer Engineering Department, 540 West Woodbury Road, Altadena, California 91001, telephone (213) 798-0953, TWX 910-588-3751.

5.3 EXPORT ORDERS

Customers outside the United States and Canada are served by Kennedy Company international sales agents. All correspondence regarding your tape unit should be directed to your sales agent. If you prefer, correspondence may be addressed directly to Kennedy Company, Parts Order Department, 540 West Woodbury Road, Altadena, California 91001, TWX 910-588-3751, cable KENNEDYCO.

5.4 ILLUSTRATED PARTS LIST

To assist in parts identification, an illustrated parts list is included in this section with references to photographs of the machine. All major parts are shown but those considered replaceable are indicated by the first three digits of the part number being 198. These items are listed again in the replaceable parts list.

5.5 FIELD KITS

Some replacement components may be supplied in the form of repair or field change kits. The repair kits contain parts that are matched or assembled and adjusted at the factory because of complexity or to aid the field technician. Components ordered as field kits either by correspondence with Kennedy service engineers or by direct order will be supplied with complete installation instructions. The change kits are intended for standard or special options not originally included in the unit.

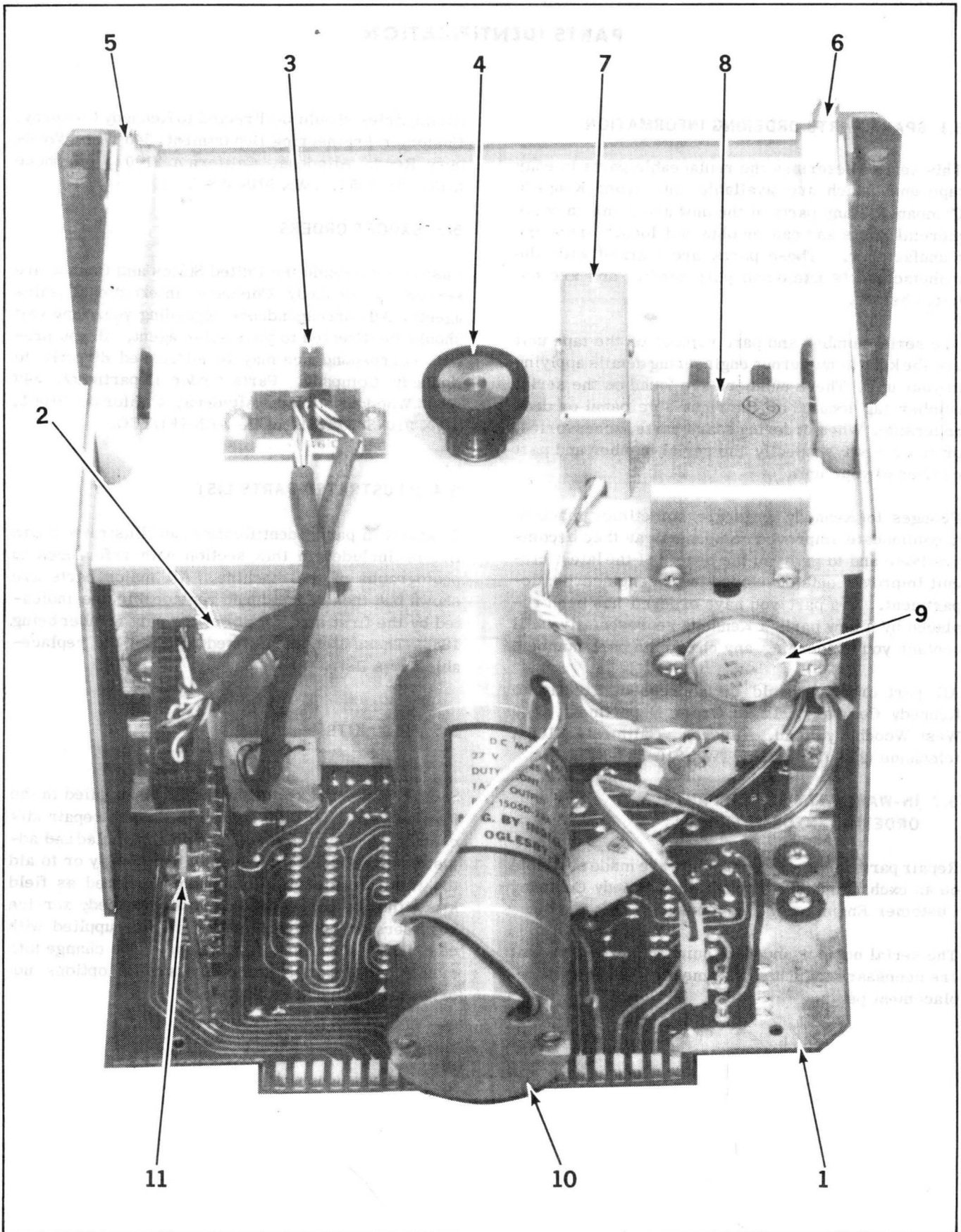


Figure 5-1. Model 331: Front View

ILLUSTRATED PARTS BREAKDOWN FOR FIGURE 5-1

<u>Item No.</u>	<u>Part No.</u>	<u>Description</u>	<u>Notes</u>
5-1-1	890-5305-xxx	Transport Electronics Board	1
5-1-1	890-6305-xxx	Transport Electronics Board	1
5-1-2	848-0099-001	Transistor, 2N3790	
5-1-3	890-3995-001	4 Track Magnetic Head Assy, RAW	2
5-1-3	890-3995-002	4 Track Magnetic Head Assy, R/W (less erase head)	2
5-1-4	891-3870-001	Capstan	
5-1-5	891-3878-001	Left Hand Tape Guide	
5-1-6	891-3877-001	Right Hand Tape Guide	
5-1-7	890-4133-001	Photosensor Assy, complete	
5-1-8	890-4136-002	File Protect Switch Assy	
5-1-9	848-0098-001	Transistor, 2N3714	
5-1-10	198-0041-001	Capstan Motor/Tachometer Assy	
5-1-10	198-0091-001	Capstan Motor/Tachometer Assy	
5-1-11	890-4308-xxx	Write Head Driver Board	

NOTES

1. When ordering, specify the complete part number. The last three digits are stamped on the circuit board.
2. Heads are supplied with connector.

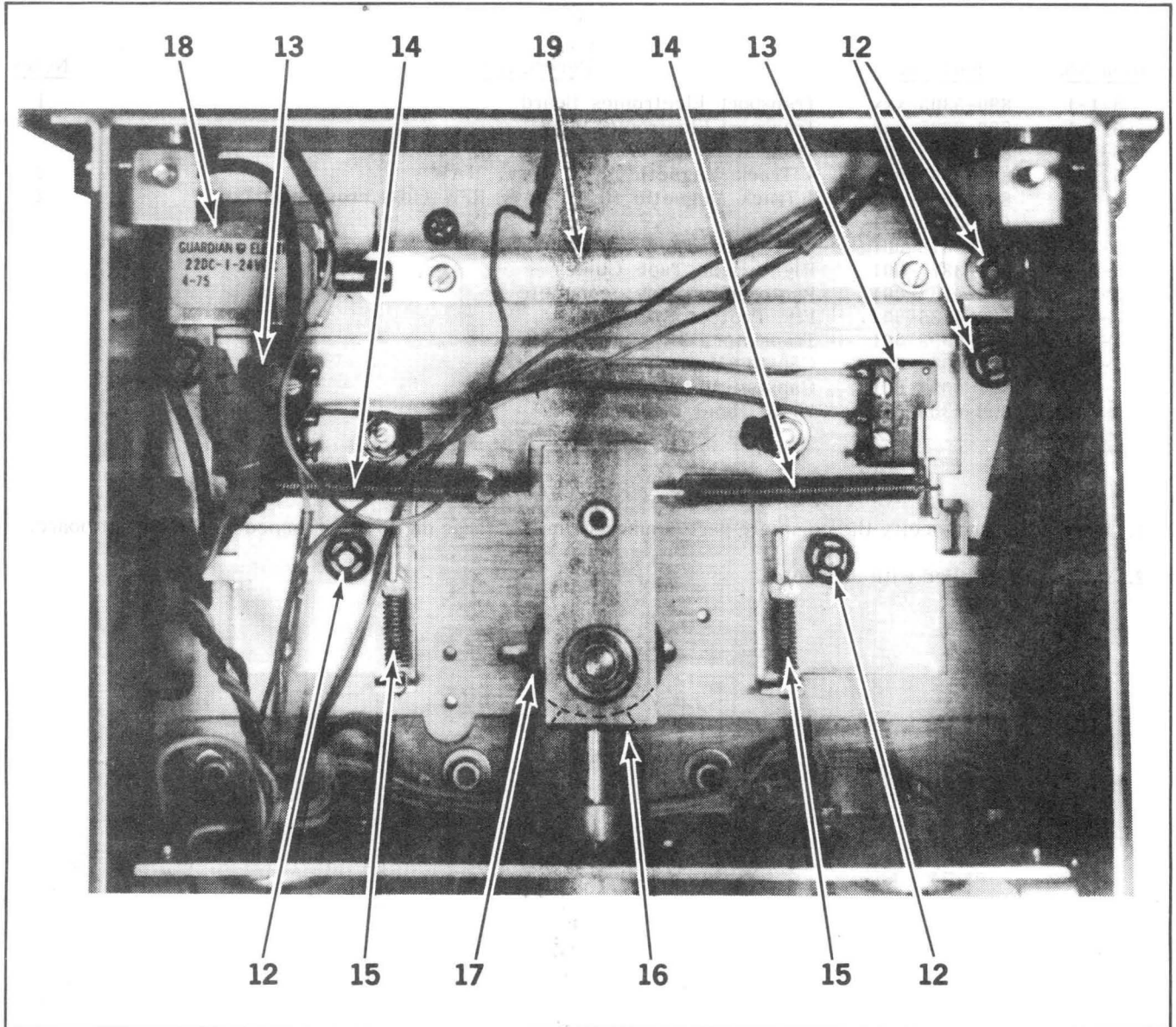


Figure 5-2. Model 331: Bottom View

ILLUSTRATED PARTS BREAKDOWN FOR FIGURE 5-2

<u>Item No.</u>	<u>Part No.</u>	<u>Description</u>
5-2-12	128-0123-001	Pushnut, 1/8" ID
5-2-13	851-0058-001	Eject Switch
5-2-14	125-0036-001	Spring, 1.5" L x 3/16" OD
5-2-15	125-0073-001	Spring, 5/8" L x 3/16" OD
5-2-16	891-4388-001	Motor Bevel
5-2-16	891-4388-003	Motor Bevel
5-2-17	891-3872-002	Capstan Bevel
5-2-18	822-2224-001	Eject Solenoid (shaft not included)
5-2-19	190-4000-001	Cartridge Interlock Assy, complete

RECOMMENDED SPARE PARTS LIST

<u>Item No.</u>	<u>Part No.</u>	<u>Description</u>	<u>Notes</u>
5-1-1	890-5305-xxx	Transport Electronics Board	1
5-1-1	890-6305-xxx	Transport Electronics Board	1
5-1-2	848-0099-001	Transistor, 2N3790	
5-1-3	890-3995-001	4 Track Magnetic Head Assy, RAW	2
5-1-3	890-3995-002	4 Track Magnetic Head Assy, R/W (less crase head)	2
5-1-4	891-3870-001	Capstan	
5-1-5	891-3878-001	Left Hand Tape Guide	
5-1-6	891-3877-001	Right Hand Tape Guide	
5-1-7	890-4133-001	Photosensor Assy, complete	
5-1-8	890-4136-002	File Protect Switch Assy	
5-1-9	848-0098-001	Transistor, 2N3714	
5-1-10	198-0041-001	Capstan Motor/Tachometer Assy	
5-1-10	198-0091-001	Capstan Motor/Tachometer Assy	
5-1-11	890-4308-xxx	Write Head Driver Board	
5-2-13	851-0058-001	Eject Switch	
5-2-16	891-4388-001	Motor Bevel	
5-2-16	891-4388-003	Motor Bevel	
5-2-17	891-3872-002	Capstan Bevel	
5-2-18	822-2224-001	Eject Solenoid (shaft not included)	

NOTES

1. When ordering, specify the complete part number. The last three digits are stamped on the circuit board.
2. Heads are supplied with connector.

SECTION VI
WIRING AND SCHEMATIC DIAGRAMS

This section contains the schematic diagram of the Model 331 Transport Electronics board and the Write Head Driver board.

Electronics symbols used in the drawing conform to MIL-STD-15. Abbreviations conform to MIL-STD-12 unless otherwise specified. The logic diagram conforms to MIL-STD-806C.

NOTES TO SCHEMATIC SECTION

Certain conventions have been observed in preparing schematics for this manual:

1. Resistor values are given in ohms. If wattage is unspecified the resistor may be either 1/4 or 1/2 watt.
2. Capacitor values may be given in picofarads or microfarads. Those values for which neither designation is provided are assumed to be obvious from circuit function. Filter capacitors on certain supply lines do not have logic significance. In general, they are not shown on schematics. On PC board silkscreens they are designated as CF.
3. Normally, IC power connections are on pins 14 (+5v) and 7 (ground) for 14 pin packages, and 16 (+5v) and 8 (ground) for 16 pin packages. Some ICs — 7476, 7492, 7493 for example — have power connections on pin 5 (+5v) and pin 10 (ground). Operational amplifiers in the 8 pin package have power connections on pin 4 (-Vcc) and pin 7 (+Vcc). Power connections are not shown unless they are nonstandard.
4. Where multiple inputs are tied together only one pin may be designated on the schematic.
5. Unused inputs that are tied high are not normally indicated unless the connection has logic significance.
6. From and to designations are intended to describe inputs and outputs only. The same signal may be connected to several other points not shown on a particular drawing.
7. Abbreviations used in from and to designations are as follows:

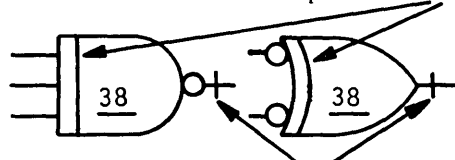
CI	Control Interface
PBC	Pushbutton Control
RG	Ramp Generator
SA	Sensor Amplifier/Driver
DT	Delay Timing
RA/CL	Read Amplifier/Clipping Level
RA	Quad Read Amplifier
WA1	Four Channel Write Amplifier
WA2	Five Channel Write Amplifier

8. Positive logic is shown for all internal connections. Interface connections are zero true but the bar is omitted.
9. Integrated circuit symbols contain a circuit designator that corresponds to the number silk-screened onto the circuit module above an underlined number representing the IC type.

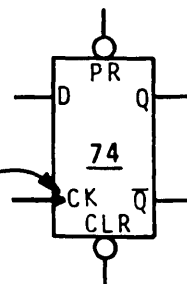
The IC type number is abbreviated and omits the portions of the manufacturer's type number pertaining to case and vendor identification. Further, since the TTL 7400 series makes up most of the circuitry, the 74 is omitted on these. Thus a 00 designation indicates a 7400 quad two input NAND gate. T.I.'s complete part number is SN7400N. In multifunctional units in close proximity to each other the type designation may be omitted. The type designation may appear outside the symbol if the symbol is too small.

Military Standard 806C is the base for logic symbols. Additional conventions are shown below.

Line indicates buffer or power driver



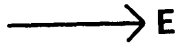
Line indicates open collector



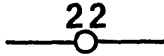
Triangle indicates response to edge (in this case positive)

10. Semiconductor types on schematics may be replaced by their functional equivalents. If not indicated, diodes are 1N914, NPN transistors are 2N2714, and PNP transistors are MPS6517.
11. Unless otherwise specified, light emitting diodes are FLV102 or equivalent.

12. Module connector pins are shown as



where no further connection is shown on the schematic, and as



when there is a connection shown.

13. Where an input is represented by an arrow instead of a complete line, the input source is designated. Where outputs are so shown their destinations may not be shown.
14. Some schematics of modules include certain external elements which aid in understanding the

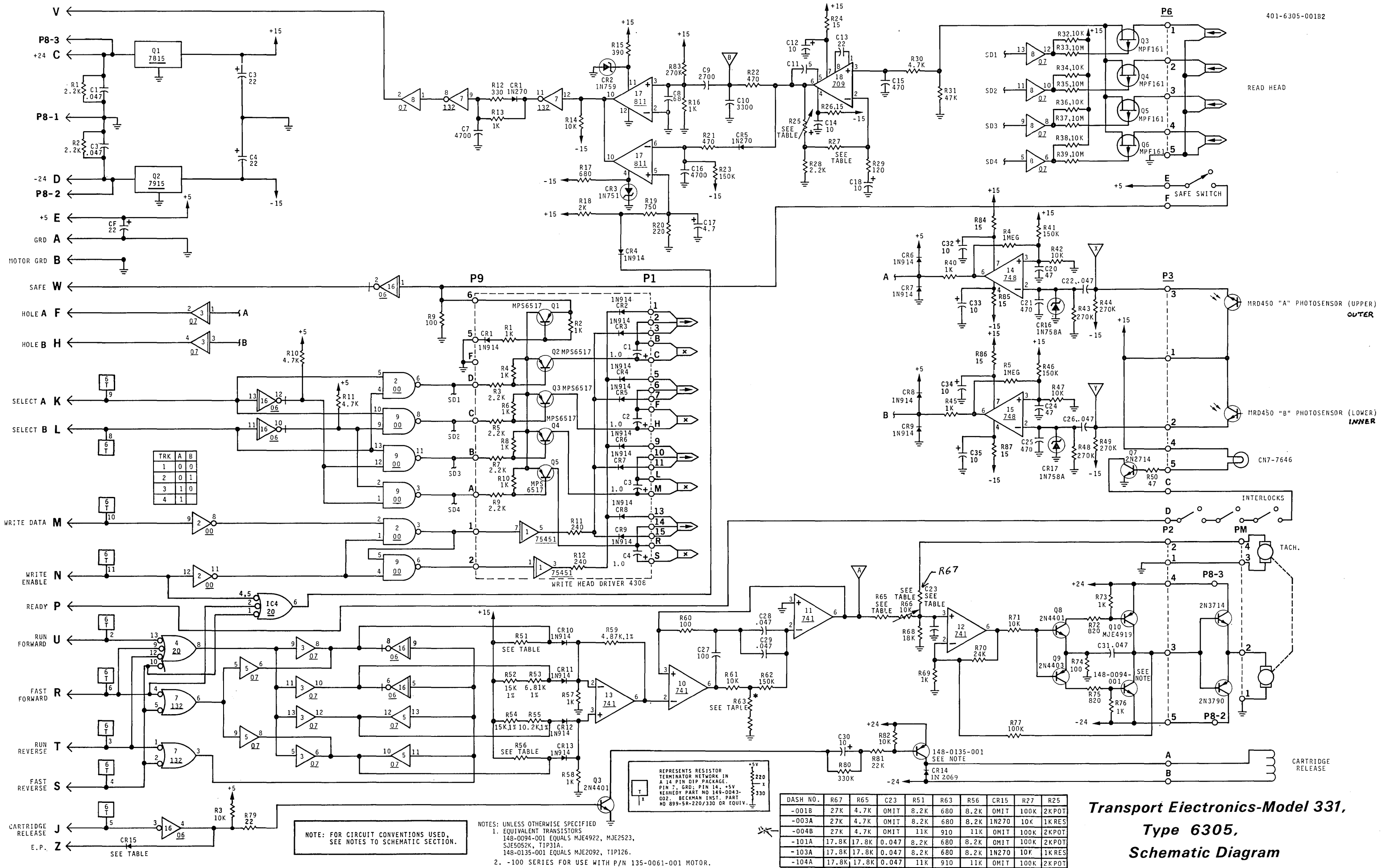
circuit function. In this case all the connections to the element may not be shown in the interest of clarity.

15.



designates a test point provided on the module. Letters proceed from top to bottom of card with the ground test point, if present, as the bottommost terminal.

16. Socket terminals are designated with numbers for component side connections and letters for circuit side connections when a double sided socket is used. These are the designations on the socket. When a single sided socket is provided, all connections are designated by letters regardless of which side of the board they lie on the etch. Letters follow the 22 pin alphabet, ABCDEFHJKLMNPRSTUVWXYZ; numbers are 1 through 22.



**Transport Electronics-Model 331,
Type 6305,
Schematic Diagram**

MODEL 331 TRANSPORT ELECTRONICS

CIRCUIT DESCRIPTION

This schematic includes the Transport Electronics board, Write Head Driver board, Read Heads, Write Heads, Capstan Motor and Tachometer, and the A and B hole photosensors.

The functions of the Transport Electronics board are as follows:

1. It generates the ramp output to the capstan motor.
2. It amplifies the \bar{A} and \bar{B} holes detected by the \bar{A} and \bar{B} photosensors.
3. It contains the write enable, read amplifier and track select circuitry.
4. It contains the cartridge interlock circuits.
5. It contains the solenoid release circuitry.
6. It contains a power supply regulator for converting ± 24 vdc unregulated voltage into ± 15 vdc regulated voltage.

The Write Head Driver board plugs into the Transport Electronics board.

RAMP GENERATION

The ramp generator requires four input voltages to produce four output ramps for RUN FORWARD, FAST FORWARD, RUN REVERSE and FAST REVERSE speeds. These input voltages are supplied by a ladder network consisting of IC13 and its related circuitry. Depending upon whether RUN FORWARD, FAST FORWARD, RUN REVERSE or FAST REVERSE is selected, a voltage of ± 3.5 v, ± 13 v or ground will be generated at IC13, pin 6. The output voltage of IC13, pin 6 is reflected at IC11, pin 6 after a ramp time. During the ramp time, IC10 is completely saturated, permitting C28 and C29 to charge to their respective steady states. The ramp time can be varied by changing the value of trim resistor R63. A higher value of this resistor generates a faster ramp because it increases the charging current in R62. Note that the output ramp voltages are negative for forward motion commands, positive for reverse motion commands.

The output of the ramp generator at Test Point A is supplied to IC12, pin 3, and to the velocity servo

summing junction through a speed adjustment potentiometer, R66.

The velocity servo consists of summing network IC12 and related components for tach voltage and input signal, preamplifier stage Q8, Q9, Q10, Q11 with its limited gain, and voltage follower type power amplifier 2N3714/2N3790 which is mounted on the motorplate. Tape speed is adjusted by R66 as described in paragraph 4.7.2 of the maintenance section.

A AND B HOLES

The output of the MRD 450 photosensors located on deck are supplied to a pair of operational amplifiers IC14 and IC15.

The output of these amplifiers is inverted by IC3 and supplied to the interface whenever an A or B hole is detected. The A and B indications are used to locate tape position. Detection of these holes is AC coupled.

WRITE ENABLE

The Transport Electronics board contains a SAFE switch which disables tape writing when it is opened. The switch is controlled by the position of the write enable plug on the cartridge. When the plug is in the WRITE position, it closes the SAFE switch in the file protect assembly, applying +5v write drive voltage to the write heads through transistor Q1. When the write enable plug is in the SAFE position, the 5v supply is disconnected and a SAFE true signal is transmitted to the interface through pin W.

CARTRIDGE INTERLOCK

When the cartridge is inserted properly, three interlock switches are closed. If the sensor lamp is not burned out, transistor Q7 turns on, supplying READY true to the interface at pin P. This enables the tape motion operation.

READ PREAMPLIFIER

The state of SELECT A, SELECT B and the WRITE ENABLE signals determines whether SD1, SD2, SD3 or SD4 will be generated to turn on one of the read heads. When SD1 goes true (low), for example, it triggers the gate of N type FET Q3, passing read

data to the read preamplifiers. These are IC17, IC18 and associated circuitry. The read data level is adjusted by R25 as described in paragraph 4.7.6 of the maintenance section.

CARTRIDGE RELEASE

The Cartridge Release Solenoid is controlled by CARTRIDGE RELEASE signal input at pin J. (Pin Z is a

cartridge release pretest line in case of power shutdown.) When CARTRIDGE RELEASE goes true (low) transistors Q3 and Q4 conduct, passing current through the solenoid to release the cartridge. The solenoid drive is disabled after a short delay for solenoid protection should it become jammed. This is the function of the RC network composed of capacitor C30 and resistor R80. Naturally, CARTRIDGE RELEASE false achieves the same effect.

INSTALLATION/ADJUSTMENT INSTRUCTIONS

Portescap Motor Kit

ITEMS INCLUDED:

Qty	Kennedy Part Number	Description
1	190-3999-003	Portescap Motor Assembly
2	147-0009-313	17.8K ohm, 1/4w, 1% resistor
1	147-0009-290	10.2K ohm, 1/8w, 1% resistor, metal film
1	147-0009-280	8.06K ohm, 1/8w, 1% resistor, metal film
1	115-5040-473	0.047 mF, 50v capacitor

ELECTRONICS MODIFICATION

Perform the following changes to the ramp generator circuit on the Transport Electronics PC board:

Model 330

1. Locate the type 4924 Transport Electronics PC board in the card cage. Remove it.
2. Unsolder resistors R44, R46 and R47.

Replace as follows: R44 - 17.8K ohm; R46 - 10.2K ohm; R47 - 8.06K ohm.
3. Add capacitor C24 (0.047 mF capacitor supplied).

Model 331

1. Detach type 6305 Transport Electronics PC board from 331 transport underside (four hex spacers).
2. Unsolder resistors R65 and R67.
3. Replace resistors R65/R67 with 17.8K ohm, 1/4 resistors supplied.
4. Add capacitor ^{C23} C24 (0.047 mF capacitor supplied).

PORTESCAP MOTOR ASSEMBLY REPLACEMENT

1. Turn unit upside down to expose motor and mounting bracket.
2. Detach old motor and mounting bracket as a unit (four Phillips screws, one molex connector).
3. Attach replacement Portescap motor and mounting bracket, using the same Phillips screws.

4. Check condition of capstan bevel. Replace as required. (Capstan bevel is Kennedy Part Number 191-3872-002.)
5. Check for a properly centered motor bevel and proper motor/capstan bevel tension. (Capstan should turn when motor bevel is rotated. However, pressure should not be so great as to deform the bevels where they make contact. Loosen motor bevel's Allen mounting screw and readjust motor bevel if required.)
6. If bevel centering is incorrect, perform the following procedure:

Bevel Centering

1. Replace the capstan shaft mounting block. Mount the capstan motor in position but leave the mounting screws loose.
2. From the front of the machine, sight down both edges of the capstan shaft mounting block, lining them up with the edges of the capstan shaft. (See Figure 1.) Note the amount of motor shaft bevel gear visible from both sighting positions.
3. Adjust motor position until the same amount of motor shaft bevel is visible from both sighting positions. (See Figure 1.) Then tighten the capstan motor mounting screws.

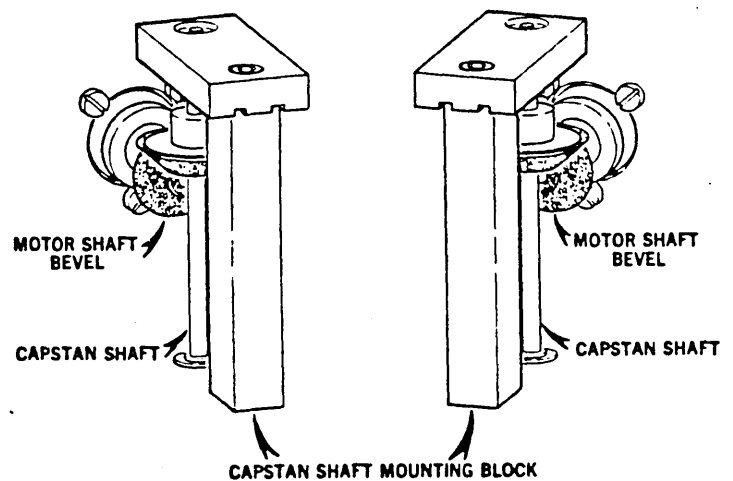


Figure 1

- Replace Transport Electronics PC board. Don't forget to reconnect mox receptacle attached to the new Portescap motor assembly.
- Check tape speed and ramp time as follows (readjust if required):

TAPE SPEED ADJUSTMENT

Procedure No. 1

(Use with machines containing read after write heads.)

- Connect channel 1 probe of a dual trace oscilloscope to the input write data. A convenient location would be P9-1 of the Write Head Driver board. Trigger scope on channel 1 and select 2 ms/cm time constant.
- Connect channel 2 probe to test point B and write on channel 1.
- Write short blocks, one to ten characters long.
- Adjust potentiometer R66 on the Transport Electronics board so that the delay between the first write strobe and the leading edge of the read data block is 12 ms at 25 ips. For machines operating at other tape speeds the formula for deriving the proper delay time is

$$\frac{0.3}{s} = \text{delay in ms}$$

where s = tape speed in inches per second.

Procedure No. 2

(Use with machines containing combination read/write heads.)

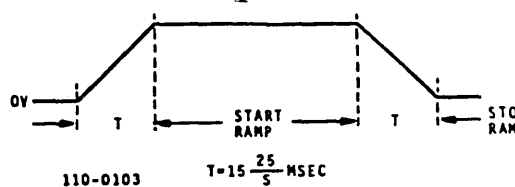
Special equipment required: Speed Tape Cartridge, Kennedy Part Number 198-0045-001.

- Connect oscilloscope probe to test point B. Select read operation.

- Select a 2 ms/cm time constant on the oscilloscope.
- Adjust R66 on the Transport Electronics board for a 10 ms read pattern length which is 44 ANSI compatible characters long.

RAMP TIME CHECK

Tape is brought up to speed at constant acceleration. To control tape velocity, a linear positive or negative ramp voltage is generated. Ramp time is 30 ms (+0 - 5 ms) at 25 ips and varies inversely with speed. Ramp voltage is positive going in reverse; negative going in forward mode.



where

T = ramp time in milliseconds

S = tape speed in inches per second

To Check Ramp Time

- Establish rapid start/stop motion.
- Observe waveforms at test point A on the Transport Electronics board. Synchronize on RUN command. Be sure time is long enough to produce a flat area between ramps.
- If ramp times vary significantly from specifications, the ramps should be adjusted by changing the value of R63. A higher value of R63 results in a faster ramp time.

Warranty

Kennedy Company products are warranted to be free from defects in materials and workmanship for a period of one year.

Kennedy Company reserves the right to inspect any defective parts or material to determine damage and cause of failure.

This warranty does not apply to any Kennedy equipment that has been subject to neglect, misuse, improper installation and maintenance, or accident.

Liability under warranty is limited to no charge repair of defective units when equipment is shipped prepaid to factory or authorized service center after authorization from Kennedy Company to make such return.

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

KENNEDY CO.

88-110

KENNEDY

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