MODELS T9640 AND T9660
SYNCHRONOUS WRITE
SYNCHRONOUS READ
TAPE DRIVES

DDC Pertec

MODEL NO. _____

SERIAL NO. _____

MODELS T9640 AND T9660
SYNCHRONOUS WRITE
SYNCHRONOUS READ
TAPE DRIVES

PPC **PERTEC**
PERIPHERALS
CORPORATION

SUBSIDIARY OF TRIUMPH-ADLER

OPERATING AND SERVICE MANUAL NO. 103906

FOREWORD

This manual provides operating and service instructions for the Synchronous Write/ Synchronous Read Tape Drive, Models T9640 and T9660, manufactured by Pertec Peripherals Corporation (PPC™), Chatsworth, California.

The content includes a detailed description, specifications, installation instructions, and checkout of the drive. Also included are theory of operation and preventive maintenance instructions. Section VII contains photo parts lists and schematics.

All graphic symbols used in logic diagrams conform to the requirements of ANSI Y32.14 and all symbols used in schematic diagrams are as specified in ANSI Y32.2.

WARNING

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

PROPRIETARY NOTICE

COPYRIGHT NOTICE

SERVICE AND WARRANTY

This Pertec Peripherals Corporation (PPC™) product has been rigorously checked out by capable quality control personnel. The design has been engineered with a precise simplicity which should assure a new level of reliability. Ease of maintenance has been taken into consideration during the design phase with the result that all components (other than mechanical components) have been selected wherever possible from manufacturer's off-the-shelf stock. Should a component fail, it may be readily replaced from PPC or your local supplier. The unit has been designed for plug-in replacement of circuit boards or major components which will ensure a minimum of equipment down time.

PPC warrants products to be in accordance with its applicable specifications and to be free from defect in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment to Buyer or for such shorter period as may be set forth by contract.

PPC's sole and exclusive obligation under this warranty is limited to repair or replace, at PPC's option, at its authorized repair centers, all Products that are returned to said repair centers within the applicable warranty period and found by PPC to be defective, excluding those Product parts that are subject to normal wear. In the event PPC's inspection discloses that returned Product is not defective, the Buyer shall reimburse PPC for shipment costs to return Product to Buyer.

Buyer is responsible for properly packaging Product to be returned, at Buyer's expense, in accordance with applicable user manual instructions and shall ship Product prepaid at Buyer's expense. PPC shall return Product to Buyer prepaid at PPC's expense.

This warranty shall immediately be null and void if, in PPC's sole judgement, the Product has been altered or repaired other than with authorization from PPC and by its approved procedures, has been subjected to misuse, abuse, negligence or accident, damaged by excessive current, damaged in shipment, subjected to improper environmental conditions, or had its serial numbers and/or other Product markings altered, defaced or removed.

Adjustments of the Products, as set forth in PPC's Operating and Service Manuals, are the responsibility of the Buyer and excluded from this warranty.

This warranty will remain in effect notwithstanding Buyer's shipment to third parties, but warranty remedies defined herein are applicable only to Buyer and are not transferrable.

Buyer shall disclose to third parties, prior to sale, the precise terms of this warranty and all the disclaimers and limitations set forth herein and shall indemnify PPC from any failure to make such disclosure and from any warranties made by Buyer beyond those set forth herein.

THIS WARRANTY IS IN LIEU OF, AND BUYER WAIVES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, ARISING BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES STATED IN THIS WARRANTY CLAUSE ARE EXCLUSIVE.

Please read the instruction manual thoroughly as to installation, operation, maintenance, and component reference list.

Contact your local PPC Sales office for servicing and maintenance on all PPC equipment except D8000 disk drives. D8000 disk drives must be returned to the PPC factory repair center for servicing.

Please contact the following groups for assistance with your specific problem.

NORTH AMERICA

SERVICE SUPPORT
* For all servicing requirements on PPC equipment, please contact your local PPC Sales office.

NEW EQUIPMENT ORDERS
* For price quotation, order placement, and delivery schedules on new equipment orders contact your local PPC Sales office.

PPC MARKETING SUPPORT

9600 Irondale Avenue, Chatsworth, California 91311, (213) 882-0030
Mailing Address: P.O. Box 2198, Chatsworth, CA 91311

Our Chatsworth facilities are staffed to provide assistance in the following areas.

EMERGENCY SPARES
* For spare parts that are required immediately to repair a down unit at a customer (end-user) site, and warranty replacement.

ORDER ADMINISTRATION
* For spare parts price quotation, spare parts order placement and delivery schedules.

REPAIR ADMINISTRATION
* For all questions related to equipment sent back or being sent back to the factory repair center. This includes schedules, repair costs, or refurbishments and authorization to return equipment for repair.
* Paperwork sent with the equipment being returned for repair should include the Returned Goods Authorization (RGA) number.

SPARES SUPPORT
* For part number identification, recommended spare parts lists and other questions on spare parts.

TECHNICAL SUPPORT
* For equipment troubleshooting assistance.
* For applications information.
* For any other information or questions, or if you need assistance and you just don't know who to call.

TRAINING SUPPORT
* Contact the Training Coordinator for class schedules, for classes to be held at your facilities, or for having a customized training program developed.

EUROPE AND INDIA

10 Portman Road, Reading, Berkshire RG3 1DU, England
Phone Reading (734) 591441 / TWX 847-101

Users of PPC equipment in Europe and India should direct all inquiries on the subjects listed for North America to the Reading office.

Servicing of all PPC equipment is coordinated through the Reading office, including U.S. OEMs that ship systems to Europe.

PACIFIC

Users of PPC equipment in Australia, Japan, New Zealand, and South America should direct all inquiries on the subjects listed for North America to their local PPC representatives.

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SECTION I
GENERAL DESCRIPTION AND SPECIFICATIONS

1.1 INTRODUCTION

This section provides a physical description, functional description, and specifications for the Synchronous Write/Synchronous Read Tape Drive, Models T9640 and T9660, manufactured by Pertec Peripherals Corporation (PPC™), Chatsworth, California.

The manual includes installation instructions and parts list information applicable to Models FT9640A and FT9660A. (FT in a model number identifies a drive equipped with a Microformatter.)

1.1.1 MODEL IDENTIFICATION

The model code employed within the T9000 family of tape drives is given in Figure 1-1. For example, Model T9840-9-75 is a vacuum column tape product with 32 c/mm (800 cpi) packing density. The drive is equipped with a 9-track read-after-write magnetic head; tape speed is 1.905 m/s (75 ips).

1.2 PURPOSE OF EQUIPMENT

The tape drive has the capability of recording digital data on 9-track magnetic tape at speeds from 0.953 m/s to 1.905 m/s (37.5 to 75 ips), in 63 c/mm (1600 cpi) Phase Encoded IBM compatible format. The data can be recovered when the tape is played back on an IBM digital tape drive or its equivalent.

```
T 9 X X X — X — X X
                    └──────── Tape Speed

                         0.953 m/s (37.5 ips)
                         1.143 m/s (45 ips)
                         1.905 m/s (75 ips)

               └──────── Tracks and Additional Data Densities

                    72   7-track with 8 c/mm (200 cpi) capability
                    75   7-track with 22 c/mm (556 cpi) capability
                     9   9-track
                    98   9-track dual format (NRZI and PE), 63/32 c/mm (1600/800 cpi)
                   500   9-track, 32 c/mm (800 cpi) and 7-track 32/22 c/mm
                           (800/556 cpi) Read Only
                   850   9-track, 63/32 c/mm (1600/800 cpi) and 7-track
                           32/22 c/mm (800/556 cpi), Read Only
                   852   9-track, 63/32 c/mm (1600/800 cpi) and 7-track
                           22/8 c/mm (556/200 cpi), Read Only

          └──────── Head Type

                    60   Read/Write (Single Stack)
                    40   Read After Write (Dual Stack)
                    12   Read Only Multiple Format (Dual Stack)
                    11   Read Only Multiple Format (Single Stack)

        └──────── Highest Data Density Handled

                     5   22 c/mm (556 cpi)
                     6   63 c/mm (1600 cpi)
                     8   32 c/mm (800 cpi)

      └──────── 9000 Series (Vacuum Column)

    └──────── Tape Product
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Figure 1-1. Model Identification

The drive can also synchronously read 9-track Phase Encoded magnetic tape at a speed up to 1.905 m/s (75 ips), which has been recorded in Phase Encoded IBM compatible format.

1.3 PHYSICAL DESCRIPTION OF EQUIPMENT

The Model T9640 Drive is shown in Figure 1-2 (Model T9660 is identical in appearance). Tape reels up to 266.7 mm (10.5 inches) in diameter may be used. All electrical and mechanical components necessary to operate the drives are mounted on the baseplate which is designed to be hinge mounted in a standard 482.6 mm (19-inch) EIA rack.

The drive operates directly from 95v to 125v ac, or 200v to 250v ac, single phase, 50 ± 2 or 60 ± 2 Hz power, which is supplied through a standard cord and 3-pin plug at the rear of the drive. Three printed circuit interface connectors are also located at the rear of the unit.

The door protects the magnetic tape, heads, capstan, and other tape path components from dust and other contaminants. The door should be closed during normal operation to achieve maximum data reliability.

The T9640 drive is equipped with a dual-stack head which has the read and write heads separated by 3.8 mm (0.15 inch). The dual-stack head enables simultaneous write and read operations to be performed so data just recorded by the write head can be read by the read head after the tape has moved on approximately 3.8 mm (0.15 inch). This technique allows writing and checking of data in a single pass.

The T9660 drive utilizes a single head for both reading and writing data. Therefore, changing from the Read to the Write mode is accomplished through internal switching logic when one mode or the other is selected.

The operator controls are located in the upper left corner of the equipment and are accessible with the door closed. The controls are illuminated when the associated functions are being performed.

A 3-position Maintenance switch is provided at the rear of the drive for off-line forward and reverse operation.

Access to the printed circuit boards is from the rear of the unit, as shown in Figure 1-3.

1.4 FUNCTIONAL DESCRIPTION

Figures 1-4 and 1-5 are block diagrams of the T9640 and T9660 models, respectively. A single capstan drive is used for controlling tape motion. Tape tension is maintained at 2.224 newtons (8 ounces).

Capstan motion is controlled by a velocity servo. Velocity information is generated by a dc tachometer that is directly coupled to the capstan motor shaft. This velocity feedback voltage is proportional to the speed of the capstan; it is compared to a reference voltage and the difference is used to control the capstan motor. This technique provides precise control of tape accelerations and velocities.

Prior to writing data, tape is accelerated at a constant rate to the required velocity. This velocity is maintained constant and data characters are written on the tape at a constant rate such that: Bit Density = Character Rate ÷ Tape Velocity. When data recording is complete, tape is decelerated to zero velocity in a controlled manner.
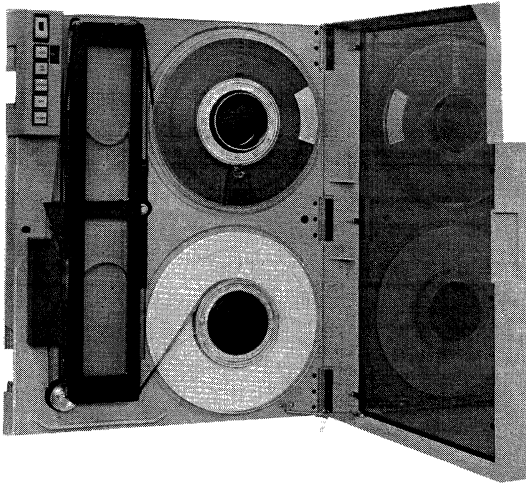
Figure 1-2. Model T9640 Tape Drive,
Front View
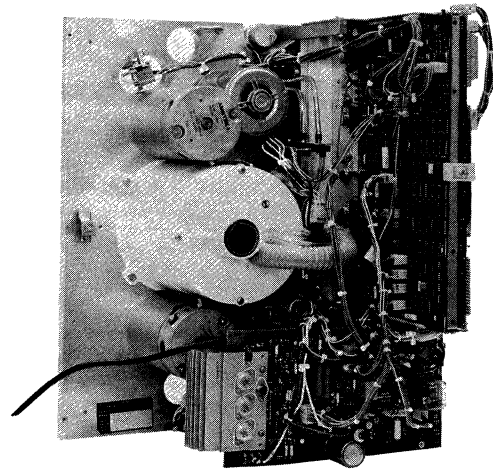
Figure 1-3. Model T9640 Tape Drive,
Rear View

Since the writing operation relies on a constant tape velocity, Inter-Block Gaps (IBGs) (containing no data) must be provided to allow for tape acceleration and deceleration distances. Control of tape motion to produce a defined IBG is provided externally by the customer controller.

When performing a Read operation, tape is accelerated at a constant rate to the synchronous velocity. When the end of a record is detected in the customer's controller, tape is decelerated to a stop. The drive can be operated in the Read mode in either the forward or reverse direction.

Nine data channels are presented to the interface.

The end of a record is detected in the customer's controller by using *Missing Pulse Detector* circuits and the tape is commanded to decelerate in a controlled manner.

The unit uses a vacuum column tape storage system to buffer the fast starts and stops of the capstan from the high inertia of the supply and takeup reels. Tape position information in the column is provided to the reel servo by pressure switches located behind each column. Tape velocity information in each reel servo is generated by a tachometer connected to a roller guide at each column inlet.

A photoelectric sensor is provided to detect the Beginning of Tape (BOT) tab and the End of Tape (EOT) tab.

A tape cleaner is provided to minimize tape contamination. Air is pulled by the rear of the tape cleaner blade to maximize the cleaning efficiency.

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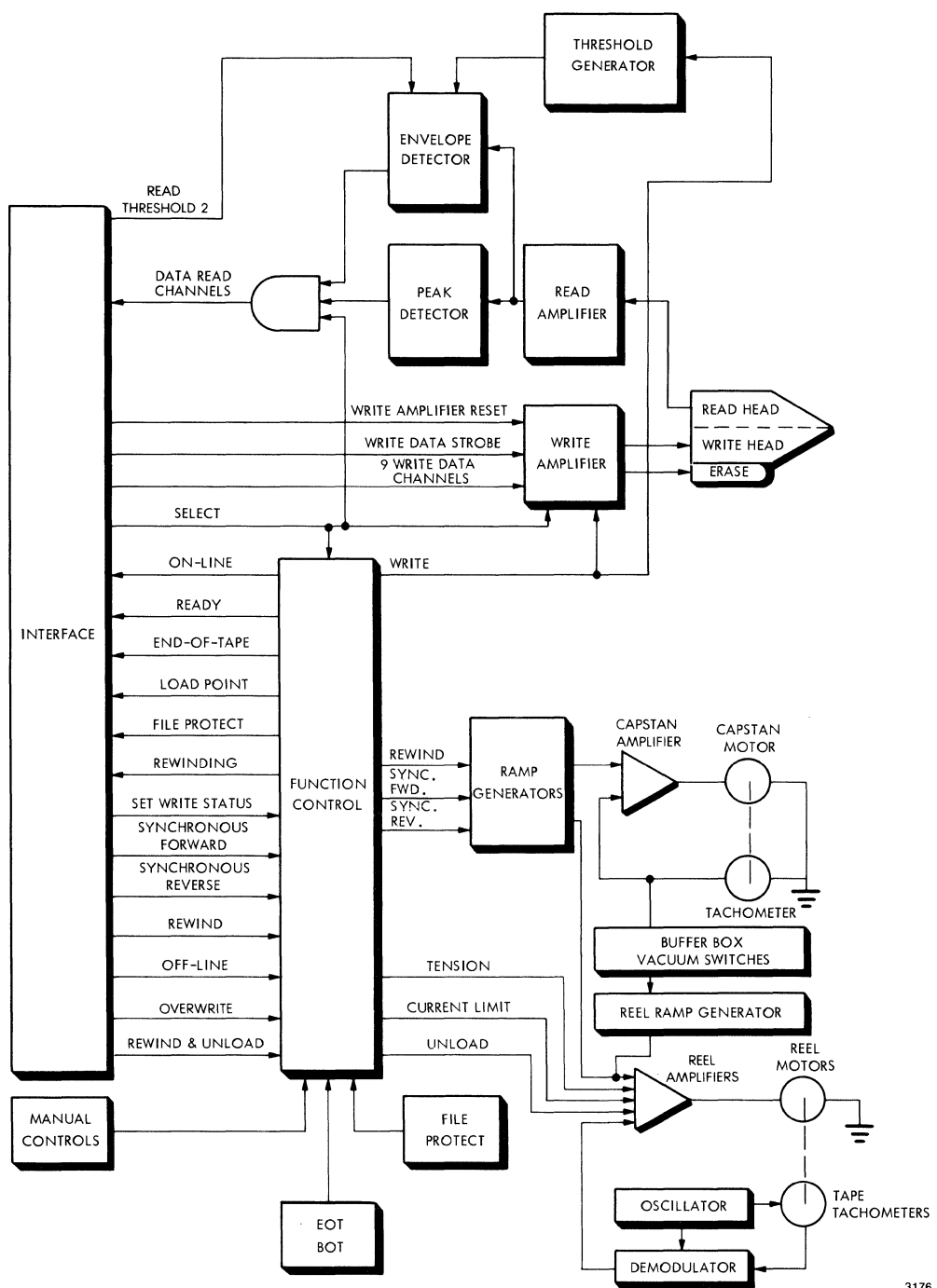
Figure 1-4. Model T9640 Tape Drive, Block Diagram
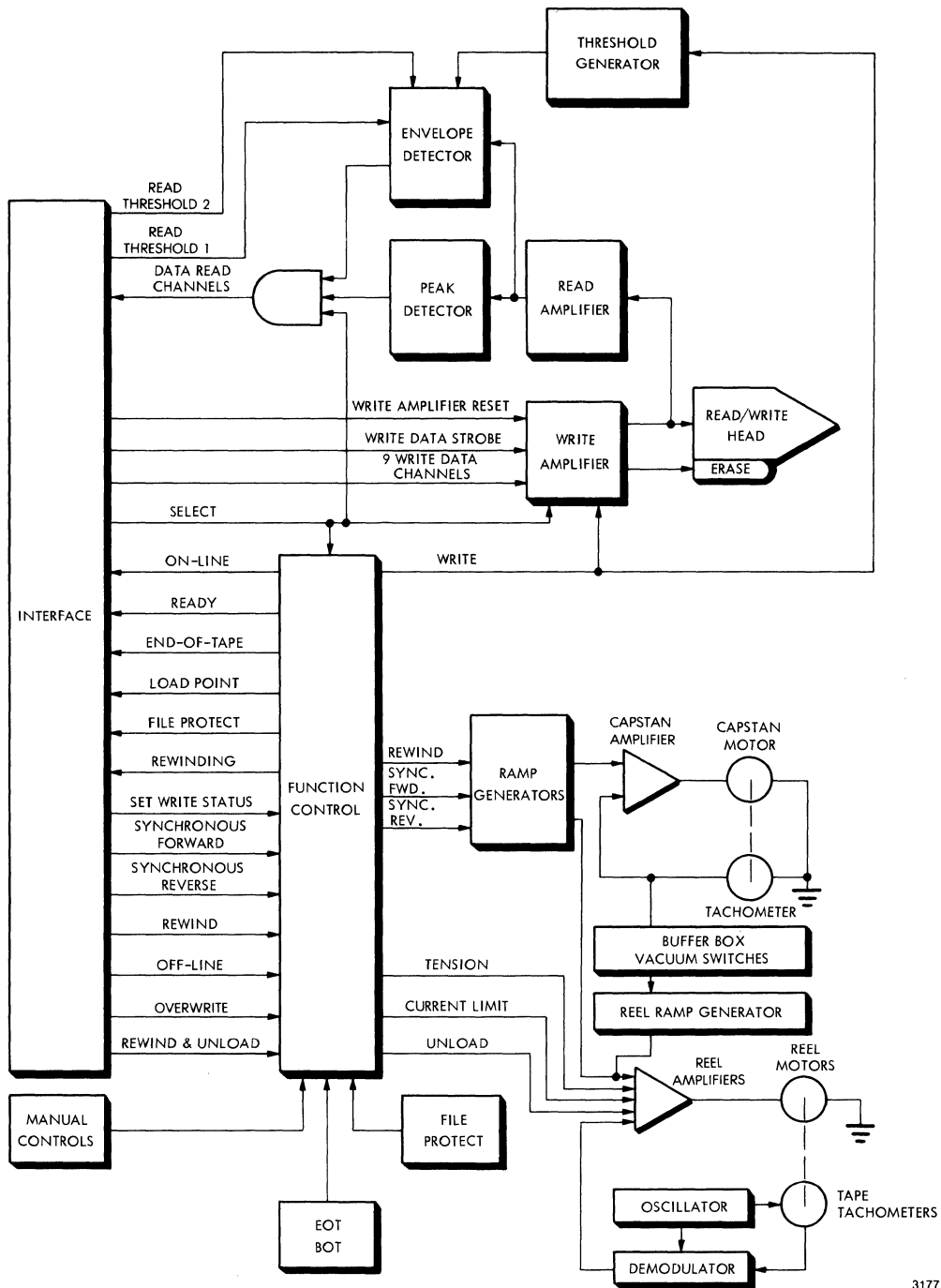
Figure 1-5. Model T9660 Tape Drive, Block Diagram

1.5 MECHANICAL AND ELECTRICAL SPECIFICATIONS

Table 1-1 details the mechanical and electrical specifications for the T9640 tape drive; Table 1-2 details the mechanical and electrical specifications for the T9660 drive.

1.5.1 INTERFACE SPECIFICATIONS

Levels: True = Low = 0 to +0.4v (approximately)
          False = High = +3v (approximately)

Pulses: Levels as above. Edge transmission delay over 6 metres (20 feet) of cable is not greater than 200 nsec.

The interface circuits are designed so any disconnected wire results in a false signal.

Figure 1-6 shows the configuration for which the drivers and receivers have been designed.
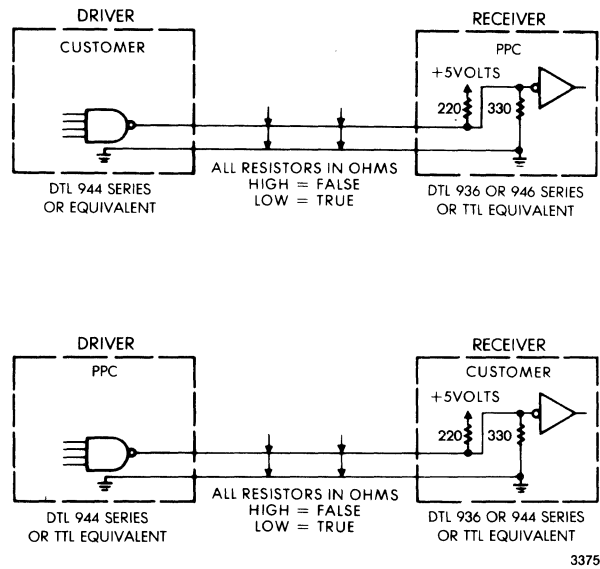
Figure 1-6. Interface Configuration

Table 1-1
Model T9640 Mechanical and Electrical Specifications

Tape (computer grade)
  Width
  Thickness
	Conforming to ANSI X3.40-1976
	12.6492 ± 0.0508 mm (0.498 ± 0.002 inch)
	0.0381 mm (1.5 mil)

Tape Tension	2.224 N ± 0.139 N (8 ± 0.5 ounces)
Reel Diameter	266.7 mm (10.5 inches) maximum
Recording Mode (IBM Compatible)	63 c/mm (1600 cpi) Phase Encoded
Magnetic Head	Dual Stack (with Erase Head)
Tape Speed, Standard	1.905, 1.143, 0.953 m/s (75, 45, 37.5 ips)
Instantaneous Speed Variation	±3%
Long-Term Speed Variation	±1%
Rewind Time 731.5 m (2400 feet)	115 seconds nominal
Tape Cleaner	Perf. Plate Type Connected to Vacuum Supply

Interchannel Displacement Error (Skew)
  Read
  Write
	
	400 microinches maximum (Note 1)
	200 microinches maximum (Note 2)

Stop/Start Time at 1.905 m/s (75 ips) (inversely proportional to tape speed)	5 ± 0.35 millisecond
Stop/Start Displacement	4.826 ± 0.5080 mm (0.19 ± 0.02 inch)
Beginning of Tape (BOT) and End of Tape (EOT) Detectors (Note 3)	Photoelectric IBM Compatible
Weight (maximum)	70.31 kg (155 pounds)

Dimensions (maximum)
  Height
  Width
  Depth (from mounting surface)
  Depth (Total)
	
	609.6 mm (24 inches)
	482.6 mm (19 inches)
	406.4 mm (16 inches)
	508.0 mm (20 inches)

Operating Temperature	4° to 43°C (40° to 110°F) (Note 4)
Non-operating Temperature	−45° to 71°C (−50° to 160°F)
Cooling Air Flow	150 cfm at sea level
Operating Altitude	0 to 1219.2 m (0 to 4,000 feet) 1219.2 to 2133.6 m (4000 to 7000 feet) (Note 5)
Non-operating Altitude	15,240 m (50,000 feet) maximum

Power
  Volts ac
  Frequency
	
	95, 105, 115, 125, 190, 200, 210, 220, 230, 240, 250
	50 ±2 or 60 ±2 Hz

Watts (average) (Note 6)
  Standby (Unloaded)
  Standby (Loaded)
  Tape In Motion, 1.9 m/s (75 ips)
  Maximum
	
	75
	325
	450
	805

Mounting	Standard 482.6 mm (19-inch) EIA Rack
Electronics	All Silicon

NOTES:

1. The maximum displacement between any two bits of a character when reading a PPC-approved master tape using the read section of the read-after-write head.
2. The maximum displacement between any two bits of a character on a tape written with all 1s using the write section of the read-after-write head.
3. Approximate distance from detection area to head gap equals 35.6 mm (1.4 inches).
4. Temperature specifications listed are equipment specifications. Actual operating temperature will be limited by specifications of media used, and may be lower.
5. Blower pulley, belt change, and vacuum pressure readjustment are required.
6. Tape Drive only. For power consumption of Microformatter, refer to Section I of the Microformatter Addendum.

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Table 1-2
Model T9660 Mechanical and Electrical Specifications

Tape (computer grade)
  Width
  Thickness
	Conforming to ANSI X3.40-1976
	12.6492 ± 0.0508 mm (0.498 ± 0.002 inch)
	0.0381 mm (1.5 mil)

Tape Tension	2.224 N ± 0.139 N (8 ± 0.5 ounces)
Reel Diameter	266.7 mm (10.5 inches) maximum
Recording Mode (IBM Compatible)	63 c/mm (1600 cpi) Phase Encoded
Magnetic Head	Single Stack (with Erase Head)
Tape Speed, Standard	1.905, 1.143, 0.953 m/s (75, 45, 37.5 ips)
Instantaneous Speed Variation	±3%
Long-Term Speed Variation	±1%
Rewind Time 731.5 m (2400 feet)	115 seconds nominal
Tape Cleaner	Perf. Plate Type Connected to Vacuum Supply
Interchannel Displacement Error	200 microinches maximum (Note 1)
Stop/Start Time at 1.905 m/s (75 ips) (inversely proportional to tape speed)	5 ± 0.35 milliseconds
Stop/Start Displacement	4.826 ± 0.508 mm (0.19 ± 0.02 inch)
Beginning of Tape (BOT) and End of Tape (EOT) Detectors (Note 2)	Photoelectric — IBM Compatible
Weight (maximum)	70.31 kg (155 pounds)

Dimensions
  Height
  Width
  Depth (from mounting surface)
  Depth (Total)
	
	609.6 mm (24 inches)
	482.6 mm (19 inches)
	406.4 mm (16 inches)
	508.0 mm (20 inches)

Operating Temperature	4° to 43°C (40° to 110°F) (Note 3)
Non-operating Temperature	−45° to 71°C (−50° to 160°F)
Cooling Air Flow	150 cfm at sea level
Operating Altitude	0 to 1219.2 m (0 to 4,000 feet) 1219.2 to 2133.6 m (4000 to 7000 feet) (Note 4)
Non-operating Altitude	15,240 m (50,000 feet) maximum

Power
  Volts ac
  Frequency
	
	95, 105, 115, 125, 190, 200, 210, 220, 230, 240, 250
	50 ± 2 or 60 ± 2 Hz

Watts (average)
  Standby (Unloaded)
  Standby (Loaded)
  Tape In Motion, 1.9 m/s (75 ips)
  Maximum
	
	75
	325
	450
	850

Mounting	Standard 482.6 mm (19-inch) EIA Rack
Electronics	All Silicon

NOTES:
1. The maximum displacement between any two bits of a character when reading a PPC-approved master tape on the drive.
2. Approximate distance from detection area to head gap is 35.56 mm (1.4 inches).
3. Temperature specifications listed are equipment specifications. Actual operating temperature will be limited by specifications of media used, and may be lower.
4. Blower pulley, belt change, and vacuum pressure readjustment are required.

SECTION II
INSTALLATION AND INITIAL CHECKOUT

2.1 INTRODUCTION

This section contains a summary of interface lines, information for uncrating the drive, and the procedure for electrically connecting and performing the initial checkout of the unit.

2.2 UNCRATING THE DRIVE

The drive is shipped in a protective container which meets the National Safe Transit Specification (Project 1A, Category 1). The container is designed to minimize the possibility of damage during shipment. The following procedure describes the recommended method for uncrating the unit.

(1) Place the shipping container on a low, flat surface. Ensure that the carton is positioned so that the model and serial number information are visible on the entrance surface of the carton.

(2) Remove or cut tape from around top of carton and open flaps. Refer to Figure 2-1(A).

(3) Fold outer carton flaps out and away from carton.

(4) Remove Operating and Service Manual from carton.

(5) Slit tape holding inner carton flaps together.

(6) Remove the four corner blocks and fold the inner flaps out and away from the carton. Rotate packing assembly 90 degrees to position shown in Figure 2-1(B); rotate another 90 degrees until the entire packing assembly is in the position shown in Figure 2-1(C).

(7) Lift outer and inner carton together up and away from the steel framework securing the equipment.

(A)   (B)   (C)
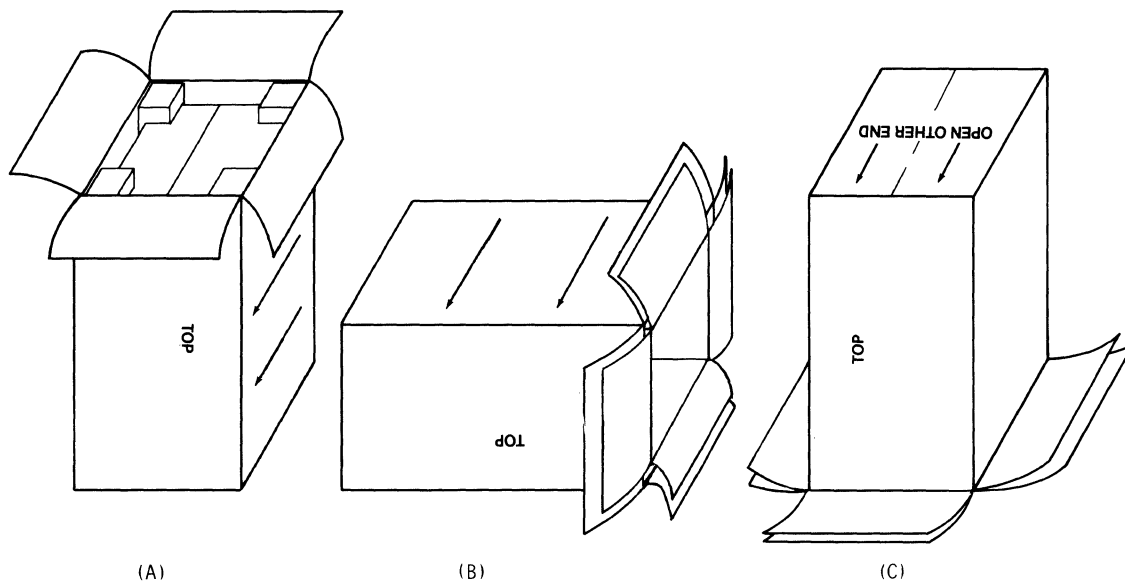
3004

Figure 2-1. Carton Placement for Removal of Drive

(8) Cut the tape holding the protective corrugated wrapper and remove the wrapper from the top of the mounting frames.

(9) Remove tape from the unit door and head cover.

(10) Check the contents of the shipping container against the packing slip; investigate the contents for possible damage — notify the carrier immediately if any damage is noted.

(11) Check the identification label for correct model number and line voltage requirement.

CAUTION

IF THE ACTUAL LINE VOLTAGE AT THE INSTALLATION DIFFERS FROM THAT ON THE IDENTIFICATION LABEL, REFER TO SECTION IV.

2.3 POWER CONNECTIONS

A fixed, strain-relieved power cord is supplied for plugging into a polarized 115v output. For other power sockets, the power plug supplied must be removed and the correct plug installed. Table 2-1 lists, in several languages, the color code for the supplied power cord.

2.4 INITIAL CHECKOUT PROCEDURE

Section III contains a detailed description of all controls. To check for proper operation of the drive before placing it in the system, perform the following.

(1) Ensure proper primary connection to the power transformer; refer to Paragraph 4.3.4.1.

(2) Connect the power cord (replace the power plug if necessary).

(3) Load tape as described in Paragraph 3.3.

(4) Turn the power on by depressing the POWER control. Note that the POWER indicator, as well as the lamp in the EOT/BOT sensor, are illuminated.

NOTE

If the drive is equipped with the Door Safety Switch Option, ensure that either the dust cover door is closed or the Door Safety Switch plunger is pulled to its outermost (detented) position. Refer to Paragraph 3.4.9.

Table 2-1

Power Cord Color Code

Black or Brown AC 'Hot' (Live)	Nero o Marrone (Vivo)	Noir ou Brun (haut Voltage)	Negro o Moreno (Vivo)	Schwarz oder Braun (Heiss)
White or Blue AC Return (Neutral) (Common)	Bianco o Blue AC Ritorno (Neutro) (Comune)	Blanc ou Blue AC Retour (Neutre) (Commun)	Blanco o Azul AC Neutro (Neutro) (Comun)	Weiss oder Blau AC Zurück (Neutral) (Gemeinsamer)
Green or Green with Yellow Stripes Chassis (Ground)	Verde o Verde con le Righe Gialle Telaio (Terra o massa)	Vert ou Vert avec Rayure Jaune Chassis (Terre)	Verde o Verde con Rayas Amarillas Chasis (Tierra)	Grün oder Grün mit Gelben Streifen Chassis (Grund)

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(5) Depress the LOAD/RESET control momentarily one time to initiate the load sequence. The tape will move forward until it reaches the BOT tab — at which point it stops. The LOAD/RESET indicator should illuminate when the BOT reaches the photosensor and remain illuminated until the tape moves off the Load Point. Additional pressing of the LOAD/RESET control will terminate any automatic sequence.

NOTE

If the BOT is not detected within 7 seconds, an automatic
rewind will be initiated.

(6) Check On-Line by depressing the control repeatedly and observe that the ON LINE indicator is alternately illuminated and extinguished.

(7) With the drive Off-Line (ON LINE indicator not illuminated), run from 1 to 2 metres (several feet) of tape onto the takeup reel; this is done by activating the Maintenance switch on the Tape Control PCBA. Return the Maintenance switch to the off position. Check that, when the unit is On-Line, the action of the Maintenance switch is inhibited in all positions.

(8) Perform tape tension check and adjustment procedures detailed in Paragraph 6.7.4.

(9) Place the Maintenance switch in the reverse position; tape will move in the reverse direction until the BOT tab reaches the photosensor.

(10) Visually check tape path components for correct tape tracking (tape rides smoothly in the head guides, etc.).

(11) Using the Maintenance switch, run 60 to 90 metres (several hundred feet) of tape onto the takeup reel. Place the Maintenance switch in the off position. Depress the REWIND control momentarily to initiate a rewind. Check for illumination of the REWIND indicator. Tape will rewind past the BOT tab and stop with the LOAD/RESET indicator illuminated. If the REWIND control is momentarily depressed when the tape is at BOT, the LOAD/RESET indicator will be extinguished and an unload sequence will be executed.

(12) Remove the write enable ring from a reel of tape and thread the tape. Initiate a load sequence. At the BOT, confirm that the FPT indicator is illuminated.

2.5 INTERFACE CONNECTIONS

It is assumed that interconnection of PPC and Customer equipment uses a harness of individual twisted pairs, or a PPC-approved flat ribbon cable; either with the following characteristics.

(1) Maximum length of 6 metres (20 feet).

(2) Characteristic impedance of 110 to 150 ohms.

(3) 22- to 28-gauge conductor with specified insulation thickness.

It is important that signal lines are capacitively shielded, i.e., by an arrangement of ground-signal-ground wire routing, either as twisted pairs or in the flat ribbon cable.

Three printed circuit edge connectors are required. ELCO Part No. 00-6007-036980-002, or PPC Part No. 503-0036 should be used and must be supplied and wired by the customer. A strain relief is provided at the rear of the card cage to support the interface cables.

Details relating to the interface signals are contained in Section III.

2.6 RACK MOUNTING THE DRIVE

The physical dimensions of the drive are such that it may be mounted in a standard 482.6 mm (19-inch) EIA rack; 609.6 mm (24 inches) of panel space is required. A depth of at least 406.4 mm (16 inches) behind the mounting surface is required; 457.2 mm (18 inches) when a Multiple Transport Adapter (MTA) is installed. Figure 2-2 illustrates the outline dimensions of T9000 Series Drives; Figure 2-3 illustrates the outline dimensions of FT9000 Series Drives.

CAUTION

COOLING AIRFLOW OF 0.07 CUBIC METRES/SECOND (150 CFM) AT SEA LEVEL IS REQUIRED FOR RELIABLE TAPE DRIVE OPERATION. THE TEMPERATURE OF THE HEATSINK BETWEEN THE CAPSTAN SERVO TRANSIS-TORS MUST BE LESS THAN 75°C (167°F) WHILE OPER-ATING IN THE WORST CASE SHUTTLE MODE (MINIMUM RECORD LENGTH).

All hardware required to rack mount the unit is included in the shipping kit supplied with each unit. Figure 2-4 illustrates the mounting procedure and should be referenced in conjunction with the following procedure.

(1) Install the hinge blocks on the EIA rail. Insert the ¼-20 screws through the stiffener bar and EIA rail as shown in Figure 2-4, then thread into the hinge block. Place the 1.02 mm (0.04 inch) thick brass washer over the pivot pin on the lower hinge block.

(2) With the unit in the vertical position, remove the left side of the shipping frame.

CAUTION

THE UNIT WEIGHS APPROXIMATELY 70 KILOGRAMS (155 POUNDS). A LIFTING RING HAS BEEN PROVIDED AT THE REAR OF THE BASEPLATE FOR HANDLING WHEN OVERHEAD EQUIPMENT IS AVAILABLE.

(3) Lift the drive to the hinge blocks. The lower hinge pin will always engage before the upper pin. When the equipment weight has settled, note that the lower hinge block provides the primary means of supporting the weight.

(4) Remove the right-hand shipping frame from the baseplate.

(5) Install a No. 12 panhead screw adjacent to the pawl latch.

(6) Open the tape deck to approximately 90 degrees and install the safety blocks using the 10-32 hardware provided.

(7) Ensure that the pawl engages behind the EIA rail.
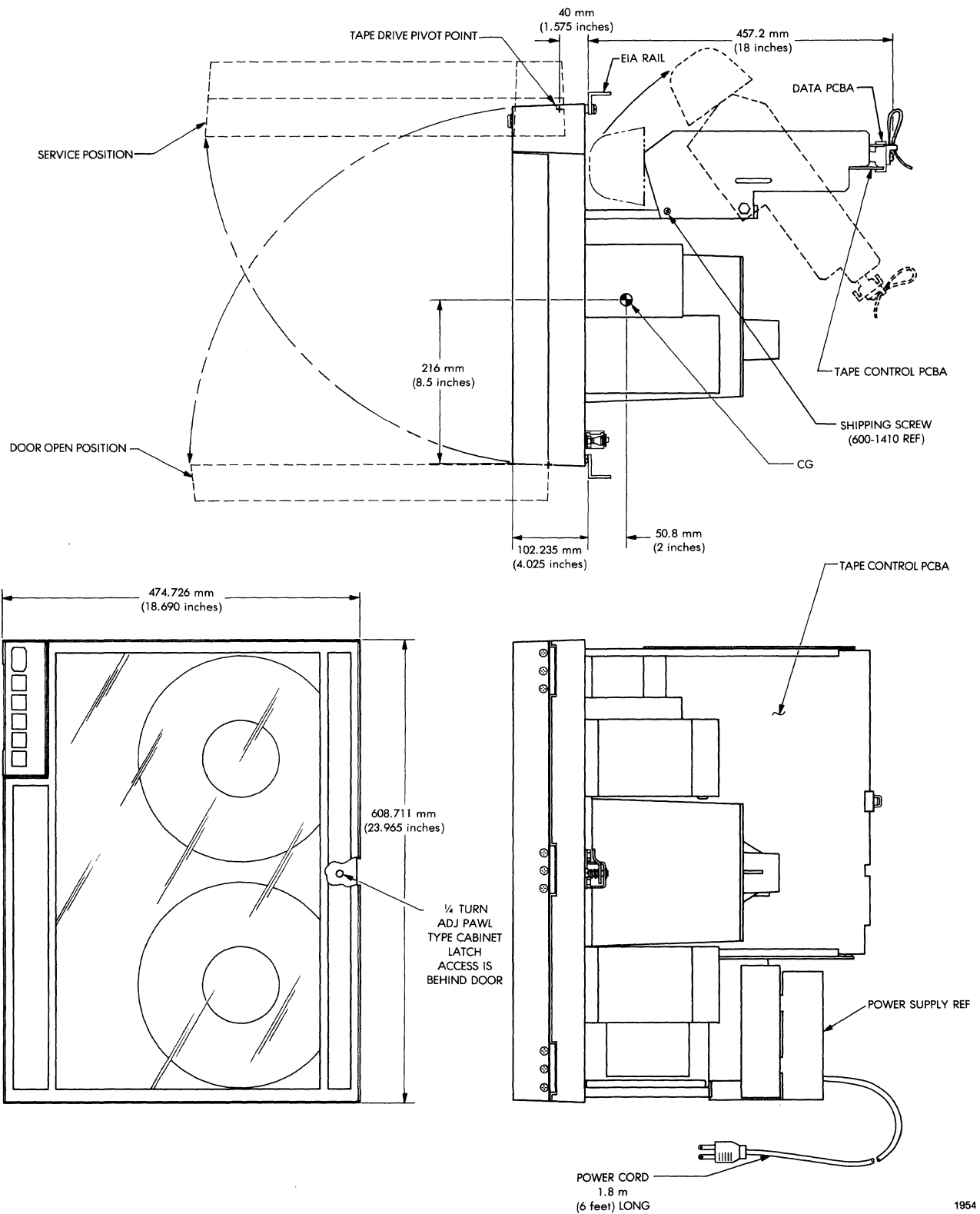
Figure 2-2. T9000 Installation Diagram

TAPE DRIVE PIVOT POINT

40 mm
(1.575 inches)

EIA RAIL

DATA PCBA

INTERCONNECT
E PCBA

SERVICE POSITION

216 mm
(8.5 inches)

SHIPPING SCREW
(600-1410 REF)

DOOR OPEN POSITION

CG

50.8 mm
(2 inches)

102.235 mm
(4.025 inches)

474.726 mm
(18.690 inches)

608.711 mm
(23.965 inches)

¼ TURN
ADJ PAWL
TYPE CABINET
LATCH
ACCESS IS
BEHIND DOOR

INTERCONNECT
E PCBA

POWER SUPPLY REF

POWER CORD
1.8 m
(6 feet) LONG
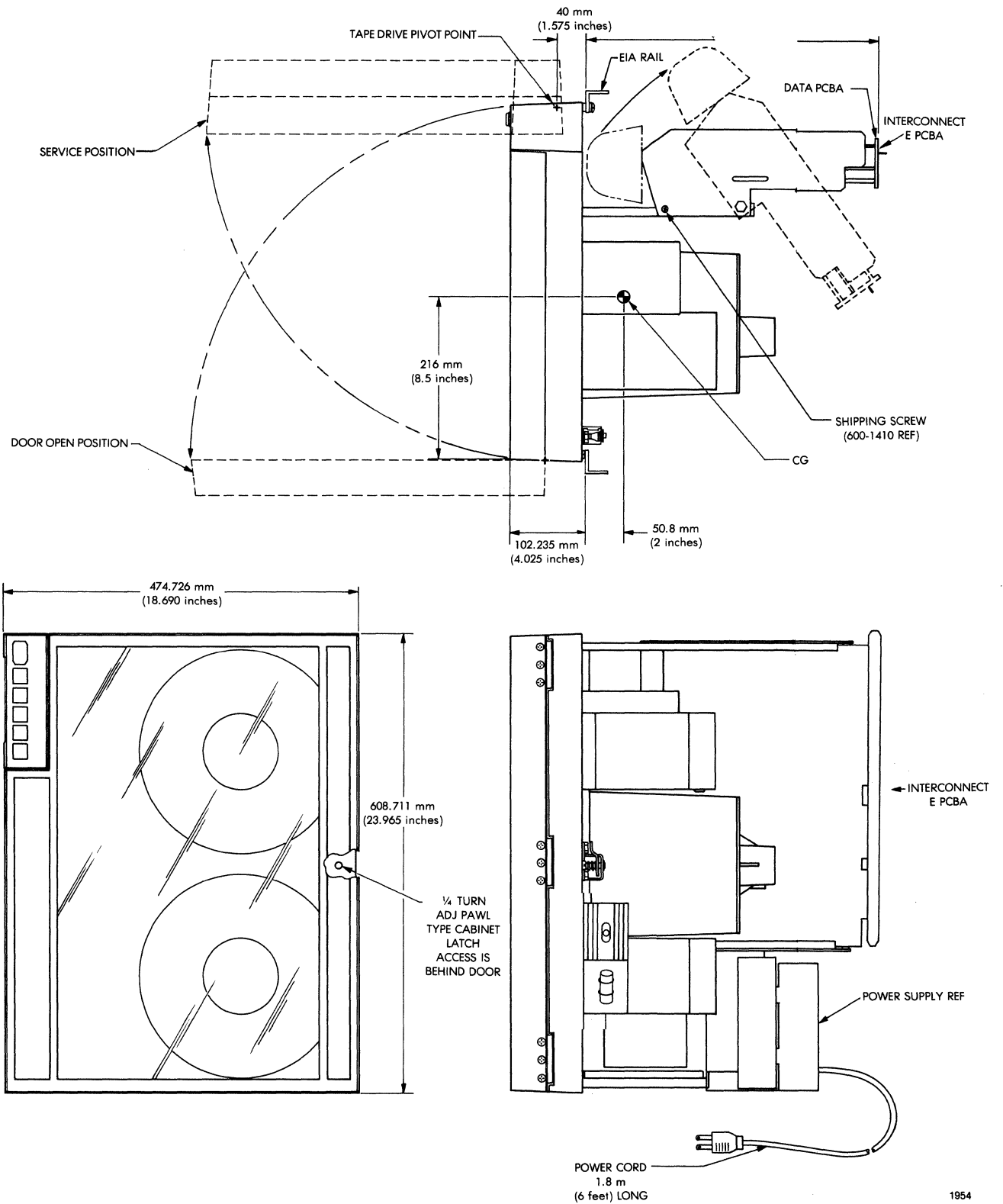
1954

Figure 2-3. FT9000 Installation Diagram

TRIM REF

BASE PLATE REF

DOOR REF

12 - 24 x 1/2 LG THD
ROLLING SCREW
P/N 608-1208

VIEW A - A
STRIKER SCREW
INSTALLATION

EIA RAIL

1/4 - 20 SOCKET
HD SCREW x 1.0 LG
P/N 602-1416 (4 REQ'D)

STIFFENER P/N 103985-01

0.257 DIA
(4 REQ'D)

28.57 mm
(1.125 inches)

371.475 mm
(14.625 inches)

28.57 mm
(1.125 inches)

BRASS WASHER .25 ID x .56 OD
P/N 612-1466

5.72 mm
(0.225 inches)

12.70 mm
(0.50 inches)

76.20 mm
(3.00 inches)

A

A

SAFETY BLOCK P/N 103810-05
(2 REQ'D)

10 LOCK WASHER P/N 605-0000
(2 REQ'D)

10-32-PAN HD SCREW x 1.00 LG
P/N 600-0016 (2 REQ'D)

HINGE BLOCK P/N 103802-01 (2 REQ'D)

1956

Figure 2-3. Rack Mounting the Drive

2-7

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SECTION III
OPERATION

3.1 INTRODUCTION

This section explains the manual operation of the drive and defines the interface functions with regard to timing, levels, and interrelationships.

3.2 CLEANING THE HEAD, GUIDES, AND BUFFER BOX

The brief operation described in Paragraph 6.4 should be performed daily to realize the data reliability capabilities of the drive.

3.3 LOADING TAPE ON THE DRIVE

The supply reel (reel to be recorded or reproduced) is located at the top of the unit. The tape must unwind from the supply reel when the reel is turned in a clockwise direction. Note that a write enable ring is required on the supply reel to close the interlocks which allow writing.

To load a tape reel, position the reel on the quick-release hub and depress the hub actuator. Thread the tape along the tape path shown in Figure 3-1. Wrap the tape leader onto the takeup reel so that the tape will be wound onto the reel when it is rotated clockwise. Wind at least 3 turns onto the takeup reel. Remove all slack in the tape path.

3.3.1 BRINGING TAPE TO LOAD POINT (BOT)

If the unit is equipped with the Door Safety switch option, the dust cover door must be closed during normal operation, thus permitting tape motion. For temporary, test, or maintenance purposes, tape can be moved with the dust cover door open by pulling the Door Safety switch plunger to its outermost (detented) position. Refer to Paragraph 3.4.9.

After tape has been manually tensioned and checked for correct seating in the guides, bring tape to Load Point as follows.

(1) Turn power on by depressing the POWER control.

(2) Depress and release the LOAD/RESET control. A load sequence will be initiated. Recheck the tape tracking in the guides and close the dust cover door.

CAUTION

THE DUST COVER DOOR SHOULD REMAIN CLOSED AT ALL TIMES WHEN TAPE IS ON THE TAKEUP REEL. DATA RELIABILITY MAY BE IMPAIRED BY CONTAMINANTS IF THE COVER IS LEFT OPEN.

When the load cycle is complete the tape will stop at load point. The unit is now ready to receive additional commands.

3.3.2 UNLOADING THE TAPE

To unload a recorded tape, complete the following procedure if power has been switched off; if power is on, start at Step (4).

(1) Turn power on by depressing the POWER control.

(2) Rotate the takeup reel to remove all slack tape.

(3) Depress and release the LOAD/RESET control; a load sequence will be initiated. If a BOT tab is not encountered, the unit will run for 7 seconds, then automatically rewind.

POWER

UNIT SELECT (OPTIONAL)

SUPPLY TAPE TACHOMETER

BUFFER BOX DOOR

LOAD/RESET

ON LINE

REWD

FPT

1600 CPI

SUPPLY BUFFER

SUPPLY REEL

QUICK-RELEASE HUB

HUB ACTUATOR

DOOR SAFETY SWITCH (OPTIONAL)

HEAD GUIDE

TAPE CLEANER

EOT/BOT PHOTO SENSOR AND REFLECTOR

HEAD

TAKE UP BUFFER

TRIM ASSEMBLY*

TAKEUP REEL

FLUX GATE

HEAD GUIDE

CAPSTAN

TAKEUP TAPE TACHOMETER
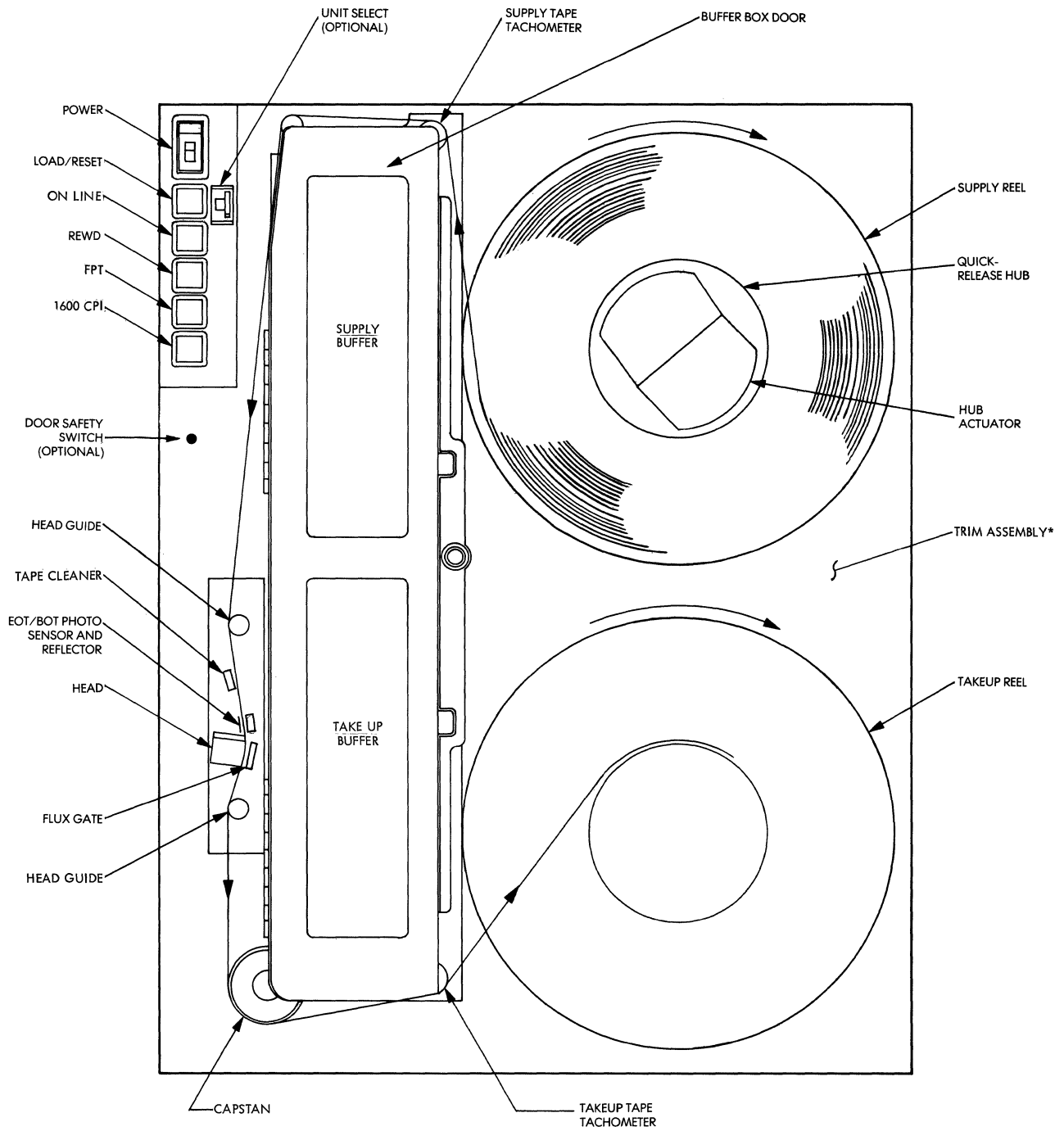
*NOTE: THE TRIM ASSEMBLY CONSISTS OF THE OVERLAY AND DOOR. THE DOOR IS NOT SHOWN IN THIS ILLUSTRATION.

1955

Figure 3-1. Tape Path

(4) With the drive in an Off-line mode, depress and release the REWIND control; the tape will rewind to the BOT tab then stop.

(5) Depress the REWIND control a second time and release it; this initiates an unload sequence.

NOTE

It is not necessary to wait for the tape to rewind to BOT if an unload is desired. An unload can be accomplished by depressing the REWIND control twice in succession.

(6) Open the tape access door and remove the reel. Close the door.

3.4 MANUAL CONTROLS

The operational controls with indicators are located on the control panel on the front of the drive, as shown in Figure 3-1. The following paragraphs describe the functions of these controls.

3.4.1 POWER ON/OFF

The ON/OFF power control is an alternate action switch/indicator which connects line voltage to the power transformer. When power is turned on, all power supplies are established and a reset signal is applied to the logic.

3.4.2 LOAD/RESET

The LOAD/RESET control is a momentary switch/indicator. Depressing and releasing the control energizes the servo system and initiates a load sequence. Vacuum is applied and tape enters the vacuum column (buffers). A forward command is initiated which causes tape to move to and stop at the Load Point. The drive is now ready to receive additional commands. While the BOT tab is located over the photosensor, the LOAD/RESET indicator is illuminated. Subsequent activation of the LOAD/RESET control terminates any automatic sequence (including Load).

3.4.3 REWIND

The REWIND control is a momentary switch/indicator which is enabled only in the Off-line mode. Depressing and releasing the control causes tape to rewind. On reaching the BOT tab, the tab will overshoot the photosensor, reverse direction, then stop at the Load Point.

If the REWIND control is depressed twice in succession or depressed when the tape is at Load Point (LOAD/RESET indicator illuminated), an unload sequence will be initiated. The REWIND indicator is illuminated throughout any rewind operation.

3.4.4 ON LINE

The ON LINE control is a momentary switch/indicator which is enabled after an initial Load or Rewind sequence has been completed. Depressing and releasing the switch changes the unit to an On-line mode and illuminates the indicator. In this condition, the drive can accept external commands provided it is also Ready and Selected.

The equipment will revert to the Off-line mode if the following occur.

(1) ON LINE is depressed a second time.

(2) An external REWIND UNLOAD command (IRWU) is received.

(3) Vacuum column interlock is broken.

(4) AC power is lost.

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3.4.5   FPT (FILE PROTECT)

This is an indicator which is illuminated whenever power is on, tape is in the vacuum column, and the supply reel has a write enable ring removed.

3.4.6   1600 CPI

This is an indicator which is illuminated whenever power is applied to the drive.

3.4.7   SELECT (OPTIONAL)

The Select switch is an option which must be specified when the equipment is ordered. It is an 8-position rotary switch which provides selective addressing of four drives. The address can be changed only when the drive is in the Off-line mode.

3.4.8   MAINTENANCE SWITCH

In addition to the manual controls and indicators located on the front panel, a 3-position toggle switch is provided on the Tape Control PCBA. This switch provides manual control of tape motion when the unit is in the Off-line mode.

When the switch is positioned toward the drive, tape will move in the forward direction at nominal speed; when the switch is in the center position, tape motion will cease; when the switch is positioned away from the drive, tape will move in the reverse direction at nominal speed.

3.4.9   DOOR SAFETY SWITCH (OPTIONAL)

The Door Safety switch, located beneath the control panel on units equipped with this option, is a spring-loaded interlock that stops tape motion when the dust cover door is open.

The switch has three positions. When the dust cover door is closed, the switch plunger is pushed in to permit tape motion. When the dust cover door is open, spring action moves the plunger to its center position. This stops the capstan and reel motors. To override the interlock, for test and adjustment purposes, use the PPC Switch Retractor Tool, Part No. 617-0010. Hook the end of the tool under the plunger lip and pull the plunger out. It will remain detented in its override (outermost) position. Tape can then be moved by either the Maintenance switch, front panel controls, or interface control.

3.5   INTERFACE INPUTS (CONTROLLER TO DRIVE)

All waveform names correspond to the logical true condition. Drivers and receivers belong to the TTL family where the true level is 0v and the false level is between +3v and +5v. Interface signals are described in the following paragraphs and are summarized in Table 3-1.

3.5.1   SELECT 0 (ISLT0)

This is a level which, when true, enables all the interface drivers and receivers in the drive, thus connecting the unit to the controller.

3.5.2   SELECT 1, 2, 3 (ISLT1, ISLT2, ISLT3)

SELECT lines 1, 2, and 3 are used in conjunction with ISLT0 in multiple drive configurations. This signal is a level which, when true and the Select switch setting corresponds, enables all the interface drivers and receivers in the unit, thus connecting the selected drive to the controller.

It is assumed that all of the interface inputs discussed in the following paragraphs are gated with SELECT.

Table 3-1

Interface Lines

	Drive Connector	36 Pin Etched PC Edge Connector	
	Mating Connector	36 Pin ELCO 00-6007-036-980-002	
Connector	Live Pin	Gnd Pin	Signal
J101 Tape Control PCBA	B J A 18 V C E H L K T M N U R P S 15	2 8 8 8 8 3 5 7 10 9 16 11 12 17 14 13 — —	OVERWRITE (IOVW) SELECT 0 (ISLT0) SELECT 1 (ISLT1) SELECT 2 (ISLT2) SELECT 3 (ISLT3) SYNCHRONOUS FORWARD COMMAND (ISFC) SYNCHRONOUS REVERSE COMMAND (ISRC) REWIND COMMAND (IRWC) REWIND & UNLOAD (IRWU) SET WRITE STATUS (ISWS) READY (IRDY) ON-LINE (IONLINE) REWINDING (IRWD) END OF TAPE (IEOT) LOAD POINT (ILDP) FILE PROTECT (IFPT) + 5V POWER (Optional) WRITE AMPLIFIER RESET (IWARS)*
J102 Data PCBA	A C E F L M N P R S T U V	1 3 5 6 10 11 12 13 14 15 16 17 18	WRITE DATA STROBE (IWDS) WRITE AMPLIFIER RESET (IWARS) READ THRESHOLD 1 (IRTH1) (Model T9660) READ THRESHOLD 2 (IRTH2) WRITE DATA PARITY (IWDP) WRITE DATA 0 (IWD0) WRITE DATA 1 (IWD1) WRITE DATA 2 (IWD2) WRITE DATA 3 (IWD3) WRITE DATA 4 (IWD4) WRITE DATA 5 (IWD5) WRITE DATA 6 (IWD6) WRITE DATA 7 (IWD7)
J103 Data PCBA	1 3 4 8 9 14 15 17 18	A C D J K R S U V	READ DATA PARITY (IRDP) READ DATA 0 (IRD0) READ DATA 1 (IRD1) READ DATA 2 (IRD2) READ DATA 3 (IRD3) READ DATA 4 (IRD4) READ DATA 5 (IRD5) READ DATA 6 (IRD6) READ DATA 7 (IRD7)
*This signal must be connected externally to J102 pin C on the Data PCBA.			

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3.5.3 SYNCHRONOUS FORWARD COMMAND (ISFC)

This is a level which, when true and the drive is Ready (Paragraph 3.6.1), causes tape to move forward at the specified velocity. When the level goes false, tape motion ceases. The velocity profile is trapezoidal with nominally equal rise and fall times.

3.5.4 SYNCHRONOUS REVERSE COMMAND (ISRC)

This is a level which, when true and the drive is Ready (Paragraph 3.6.1), causes tape to move in the reverse direction at the specified velocity. When the level goes false, tape motion ceases. The velocity profile is trapezoidal with nominally equal rise and fall times. An ISRC will be terminated upon encountering the BOT tab, or ignored if given when the tape is at Load Point.

3.5.5 REWIND COMMAND (IRWC)

This is a pulse (minimum width of 2 microseconds) which, if the drive is Ready, causes tape to move in the reverse direction at approximately 6.35 m/s (250 ips). Upon reaching BOT, the tape overshoots the tab, reverses direction, then comes to rest at BOT. An IRWC is ignored if tape is already at BOT.

The REWIND indicator is illuminated for the duration of the rewind.

3.5.6 SET WRITE STATUS (ISWS)

This is a level which must be true for a minimum of 20 microseconds after the front edge of an ISFC when the Write mode of operation is required. The front edge of the delayed ISFC is used to sample the ISWS signal and set the Write/Read flip-flop to the Write state.

If the Read mode of operation is required, the ISWS signal must be false for a minimum period of 20 microseconds after the front edge of an ISFC (or ISRC), in which case the Write/Read flip-flop will be set to the read state.

3.5.7 WRITE DATA LINES (IWDP, IWD0—IWD7, 9-CHANNEL; IWDP, IWD2—IWD7, 7-CHANNEL)

These are levels which, when true at WRITE DATA STROBE (IWDS) time (when the unit is in the Write mode), result in a flux reversal being recorded on the corresponding tape track. These lines must be held steady during the IWDS and for 0.5 microsecond before and after the IWDS pulse.

3.5.8 WRITE DATA STROBE (IWDS)

This is a pulse (2 microseconds minimum) for each character to be recorded. The frequency of the IWDS is equal to twice the character transfer rate. The IWDP, IWD0—IWD7 levels must be steady during and for 0.5 microsecond before and after the IWDS. The trailing edge of IWDS is used to copy the PE waveform into the drive.

3.5.9 WRITE AMPLIFIER RESET (IWARS)

This is a pulse (2 microseconds minimum) which, when true, turns off the write current in the drive. It is used in conjunction with the Overwrite mode of operation. The leading edge of IWARS must be coincident with the last flux transition of the postamble.

3.5.10 REWIND AND UNLOAD (IRWU)

This is a pulse (2 microseconds minimum) which resets the On-line flip-flop to the false state and initiates a rewind operation. Upon completion of the rewind, an unload sequence is automatically executed.

3.5.11 OVERWRITE (IOVW)

This is a level which, when true, conditions appropriate circuitry to allow updating (rewriting) of a selected record. The drive must be in the Write mode of operation to utilize the IOVW feature.

3.5.12 READ THRESHOLD (IRTH2) (T9640 DRIVE)

This is a level which, when true, selects a low level for the read circuits in the T9640 drive. This level is selected only when it is required to recover very low amplitude data. IRTH2 must be held steady for the duration of each record being read.

3.5.13 READ THRESHOLD (IRTH1) (T9660 DRIVE)

This is a level which, when true, conditions the read electronics of the T9660 drive to operate in the high read threshold mode. When false, the read electronics of the unit reverts to the normal read threshold. The true level will normally be used only when it is required to perform a read-after-write data check.

3.5.14 READ THRESHOLD (IRTH2) (T9660 DRIVE)

This is a level which, when true and the T9660 drive is in the Read mode and IRTH1 is false, selects an extra low threshold level for the read circuits in the unit. This level will normally be made true only when it is required to recover very low amplitude data. IRTH2 must be held steady for the duration of the record.

3.5.15 +5V POWER

This line is used to supply +5v to the interface for use with Multiple Transport Adapters (MTAs).

3.6 INTERFACE OUTPUTS (DRIVE TO CONTROLLER)

It is assumed that all interface outputs discussed in the following paragraphs are gated with SELECT (refer to Paragraphs 3.5.1 and 3.5.2).

3.6.1 READY (IRDY)

This is a level which is true when the unit is ready to accept any external command, i.e., when

(1) Tape is under tension in the vacuum column.

(2) A LOAD or REWIND command has been completed.

(3) There is no UNLOAD command in progress.

(4) The drive is On-line.

3.6.2 READ DATA (IRDP, IRD0—IRD7)

The signals on these 9 lines are the outputs of the 9 peak detectors individually gated with the outputs of an envelope detector associated with each channel. These signals are a replica of the PE waveforms used to drive the write amplifiers.

The characteristics of any threshold detector are such that the signal from approximately four successive bits must exceed the threshold level before the detector will enable the output gate for its channel. If the signal suddenly ceases (e.g., due to a dropout) the threshold detector disables the output gate to its channel approximately two bits after the dropout.

3.6.3 ON-LINE (IONLINE)

This is a level which is true when the On-line flip-flop is set. When true, the drive is under remote control; when false, it is under local control.

3.6.4 LOAD POINT (ILDP)

This is a level which is true when the unit is Ready and tape is at rest with the BOT tab under the photosensor. The signal goes false after the tab leaves the photosensor area.

3.6.5 END OF TAPE (IEOT)

This is a level which, when true, indicates that the EOT reflective tab is positioned under the photosensor.

3.6.6 REWINDING (IRWD)

This is a level which is true when any Rewind operation is in progress.

3.6.7 FILE PROTECT (IFPT)

This is a level which is true when power is on and tape is loaded and under tension in the vacuum column and the supply reel has the write enable ring removed.

3.7 INTERFACE TIMING

3.7.1 WRITE AND READ WAVEFORMS

Figure 3-2 shows typical Write and Read waveforms. The controller generates all command waveforms.
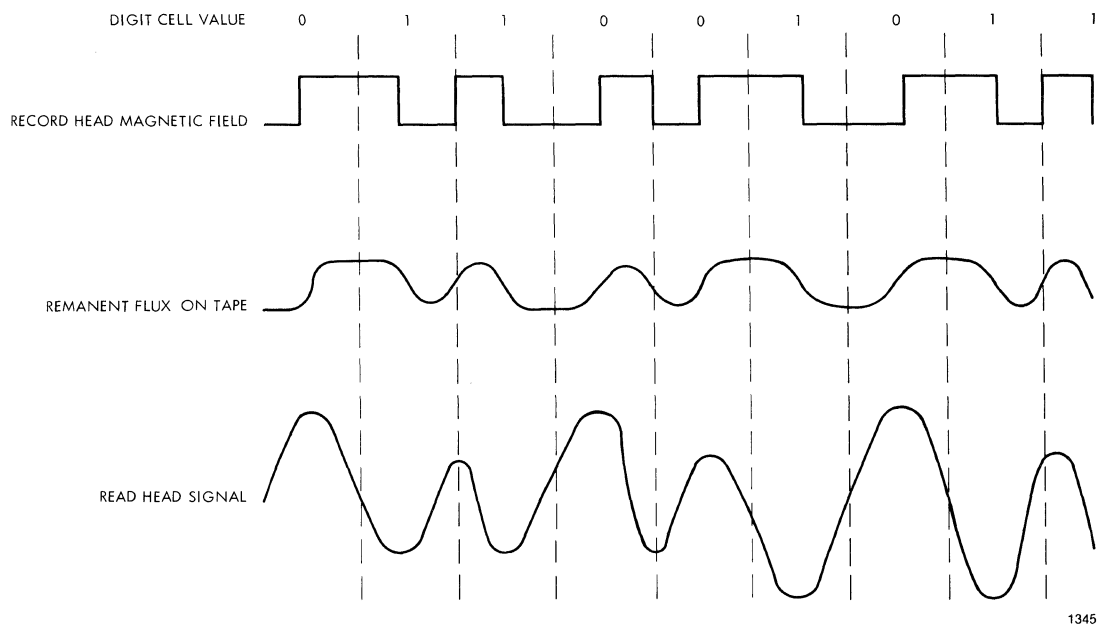
Figure 3-2. PE Write and Read Waveforms

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SECTION IV
THEORY OF OPERATION

4.1 INTRODUCTION

This section provides a description of the operation of the T9640 and T9660 Tape Drives.

These units have the mechanical and electronic components necessary to handle magnetic tape in such a manner that data can be reproduced from a tape recorded on an IBM digital tape drive or its equivalent; and, a tape can be generated from which data can be completely recovered when played back on an IBM drive or its equivalent.

4.2 FUNCTIONAL ORGANIZATION

The following paragraphs describe the organization of the drive. Figure 4-1 shows this organization and should be referred to in conjunction with the text.

For purposes of discussion, the unit can be considered as being made up of five functional electronic areas:

    (1) Capstan Servo

    (2) Reel Servos

    (3) Control Logic

    (4) Power Supply

    (5) Data Electronics

All Input/Output (I/O) and manual controls are processed by the Control Logic. The Control Logic activates the servos in an appropriate manner and enables the Data Electronics. The Capstan Servo acts as the prime tape mover and pulls the tape across the magnetic head assembly for data recording and reproduction. The Supply and Takeup Reel Servos respond to this motion in such a way as to ensure smooth tape supply and takeup operations. The Reel Servos sense the position of the tape in the chamber via vacuum switches as well as sensing the velocity of the tape across the supply and takeup tachometers.

The vacuum chambers act as a low-inertia storage device, similar in function to the arms on a tension arm drive. This vacuum action takes up tape slack and acts to buffer the initial speed differences between the capstan and reel motors. Thus, as the reel motor catches up to the capstan motor, the tape speed into and out of the chamber is equalized and the tape loop assumes a stationary position.

The Power Supply converts the ac line input voltage into the required secondary dc voltage used by the drive motors and electronics.

4.3 FUNCTIONAL SUBSYSTEM DESCRIPTION

4.3.1 CAPSTAN SERVO

The Capstan Servo is a dc velocity servo which acts as the prime tape mover and pulls tape across the magnetic head assembly for data recording and reproduction. The capstan servo consists of the functional blocks shown in Figure 4-2.

The heart of the servo is the summing amplifier. It receives current signals from five sources, sums them, and forces the power amplifier to the proper voltage. The power amplifier applies this voltage to the capstan motor, which responds with the appropriate speed. The capstan tachometer is shaft-coupled to the capstan motor and produces a dc
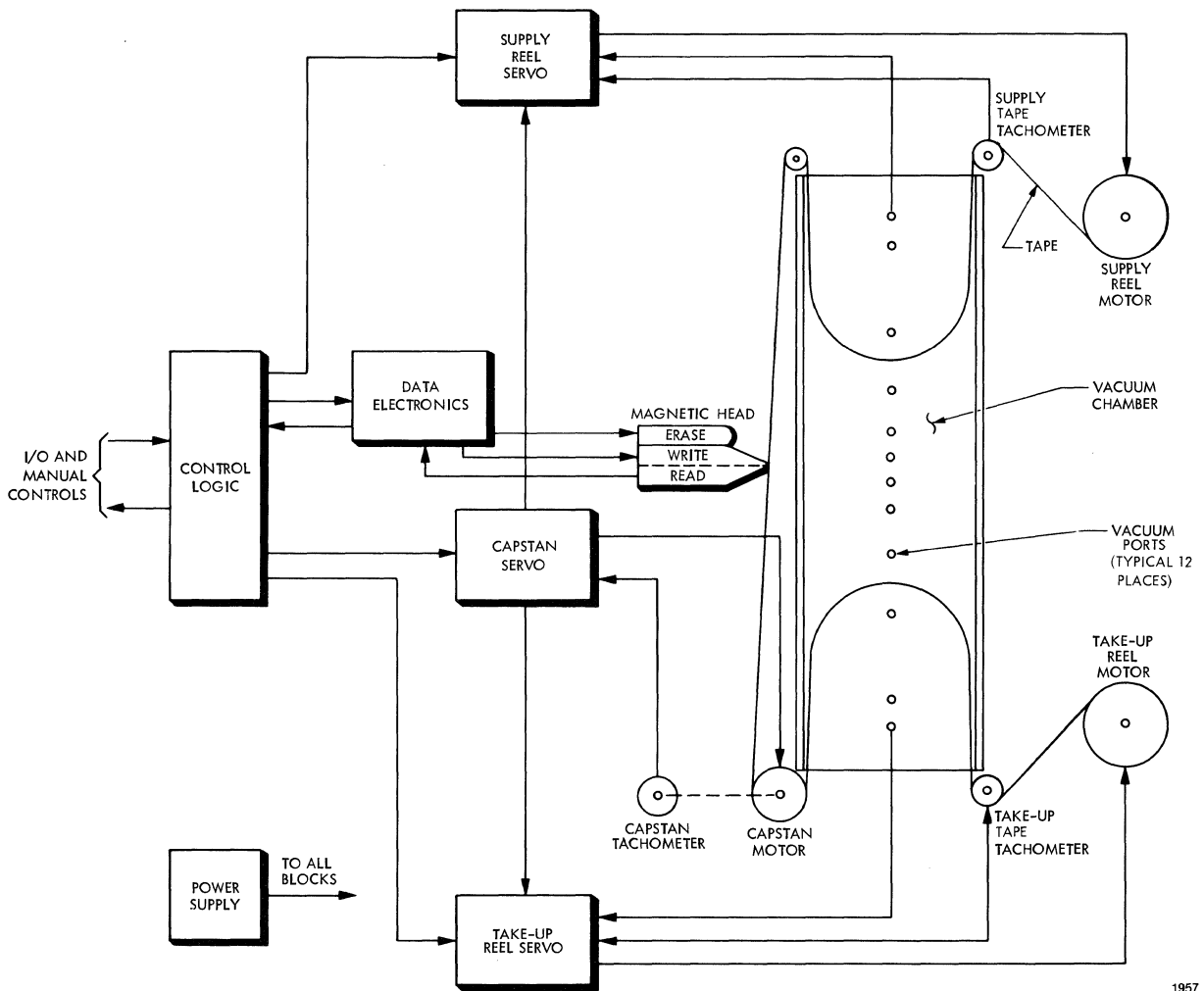
Figure 4-1. T9000 Series Tape Drives, Functional Block Diagram

1957
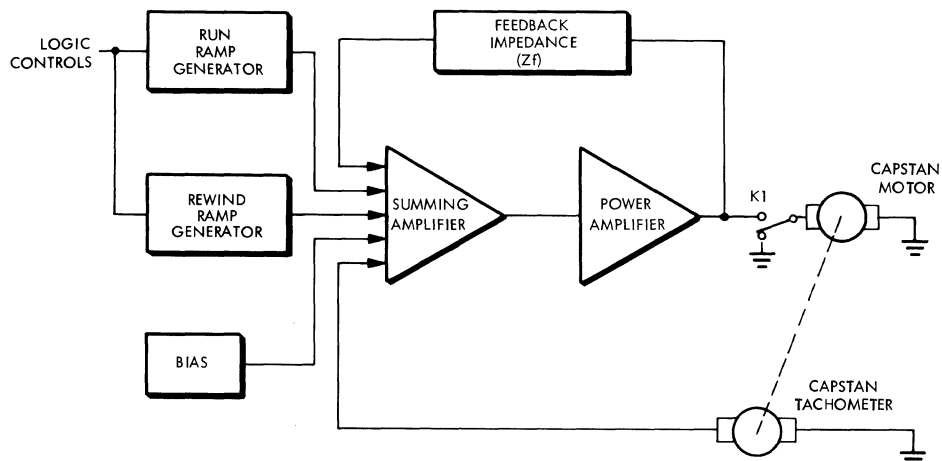
Figure 4-2. Capstan Servo Block Diagram

1949

output voltage proportional to the speed of the capstan motor. This voltage produces the tachometer feedback current required for constant velocity operation.

The primary inputs to the capstan servo are the logic control signals. These signals enter via the Run and Rewind Ramp Generators and initiate either a positive or negative ramp for forward and reverse operation, or a long rewind ramp used to accelerate the capstan motor to rewind speed. The ramp slopes and final velocities for forward and reverse are adjusted to achieve the desired start/stop characteristics. In rewind, only the speed is adjustable; the ramp profile cannot be adjusted.

Figure 4-3 illustrates typical capstan servo waveforms. The following sequence of events describe the normal operation of the capstan servo.

   (1) With power applied and tape loaded, relay K1 (Figure 4-2) is energized, connecting the Capstan Motor to the Power Amplifier.

   (2) Upon receipt of a SYNCHRONOUS FORWARD COMMAND (ISFC), the Run Ramp Generator produces a ramp input to the Summing Amplifier.

   (3) The Summing Amplifier controls the Power Amplifier which applies voltage to the Capstan Motor.

   (4) The Capstan Motor turns as a function of the applied voltage and accelerates at a constant rate (controlled by the ramp slope) to its nominal running speed.

   (5) The dc Capstan Tachometer generates a voltage proportional to the capstan speed. This voltage produces a current which is compared by the Summing Amplifier with the input control voltage to achieve constant velocity.

   (6) An electrical feedback, Zf, is also provided. This impedance represents the electrical feedback used to control servo bandwidth and amplifier gain.

   (7) When an ISFC is terminated, the servo is decelerated to a stop with the same type of ramp profile.

   (8) For Rewind operation, the rewind ramp is used in conjunction with a reverse ramp to provide the current necessary for high-speed rewind motion.
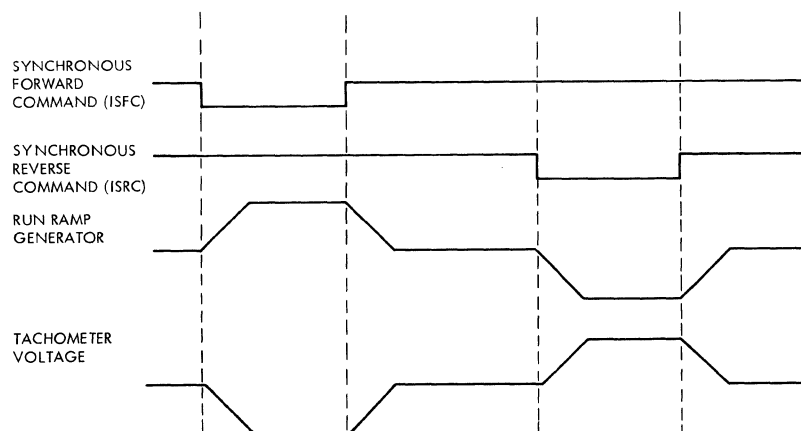
1966

Figure 4-3. Typical Capstan Servo Waveforms

906M

4.3.2   REEL SERVOS

The Reel Servos are basically velocity servomechanisms whose task is to always seek the long-term velocity of the capstan system. Although both reel servos receive velocity information from the Capstan Tachometer, each acts independently of the other.

Each servo uses an independent tachometer feedback for control of tape velocity. The tachometers are located at the entrance to each vacuum chamber as shown in Figure 4-4 and are driven by the tape as it enters each chamber.

The tachometer used to sense tape velocity is an ac drag-cup rate generator. Although the generator is an ac device, a dc voltage signal is derived from its output which is similar to that obtained from a conventional dc tachometer. The advantage of this technique is that it provides tape position information when in the standby mode and eliminates the need for dc brushes, hence increasing reliability. This information is used to eliminate loop drift in the vacuum chamber when the capstan is stationary.

The velocity that each reel servo seeks at any point in time is that of the capstan motor. This is done by comparing the output of the Capstan Tachometer and the reel tachometers. The difference obtained by this comparison is an error signal which is used to control the reel motors. This error signal is modified by the physical position of the tape loop in the chamber. The loop position is sensed at discrete points in the column by vacuum switches attached to small ports in the column floor. These ports organize the column into the working zones shown in Figure 4-4.

When the capstan velocity is zero, each tape loop comes to rest within its *parking zone*. As the capstan accelerates to the nominal forward speed, the tape loops begin to move upward. When the loop passes into the FORWARD 90% ZONE, the reel begins to accelerate linearly to a tape speed that is 90 percent of the capstan speed. Because of the 10 percent difference between capstan and reel speeds, the tape loop continues to move up in the chamber until it enters the FORWARD 110% ZONE. When the tape loop enters this zone, the reel is accelerated to 110 percent of the capstan speed, thus driving the tape loop back across the vacuum switch port between the FORWARD 110% ZONE and the FORWARD 90% ZONE.

Thus, it can be seen that a Synchronous Forward operation will cause the tape loop to continuously cycle up and down across the vacuum switch port between the 90 and 110 percent zones. Reverse operation is accomplished in the same manner except that the tape loops are positioned at the opposite end of each chamber.

The functional blocks of the supply reel servo and the takeup reel servo are shown in Figures 4-5 and 4-6, respectively. Both supply and takeup operation of the servos are basically the same except that auxiliary inputs such as Load Loop and Tension are injected at different points.

Referring to Figures 4-5 and 4-6, it can be seen that the Capstan Tachometer provides a reference input to each reel servo. The Vacuum Switches initiate an input signal to the Ramp Generator. The output of the Ramp Generator is supplied to the Summing Amplifier whose output controls the Power Amplifier and subsequently the Reel Motor.

When the capstan begins to rotate forward, tape is pulled out of the supply chamber until the first vacuum switch is activated. At this point, a 90-percent ramp is applied to the power amplifier and the reel motor begins to accelerate. As the reel turns, tape is pulled across the reel tachometer producing a voltage which is proportional to the tape speed.

SUPPLY TACHOMETER

VACUUM CHAMBER

TO SUPPLY REEL

FORWARD 110% ZONE

FORWARD 90% ZONE

SUPPLY BUFFER

SUPPLY INTERLOCK ZONE

PARKING ZONE

PORTS TYPICAL 12 PLACES

REVERSE 90% ZONE

REVERSE 110% ZONE

FORWARD 110% ZONE

FORWARD 90% ZONE

TAKE-UP BUFFER

TAKE-UP INTERLOCK ZONE

PARKING ZONE

REVERSE 90% ZONE

REVERSE 110% ZONE

TO TAKE-UP REEL

VACUUM CHAMBER

CAPSTAN

FORWARD

TAKE-UP TACHOMETER

1958

Figure 4-4. Vacuum Control Organization

906M
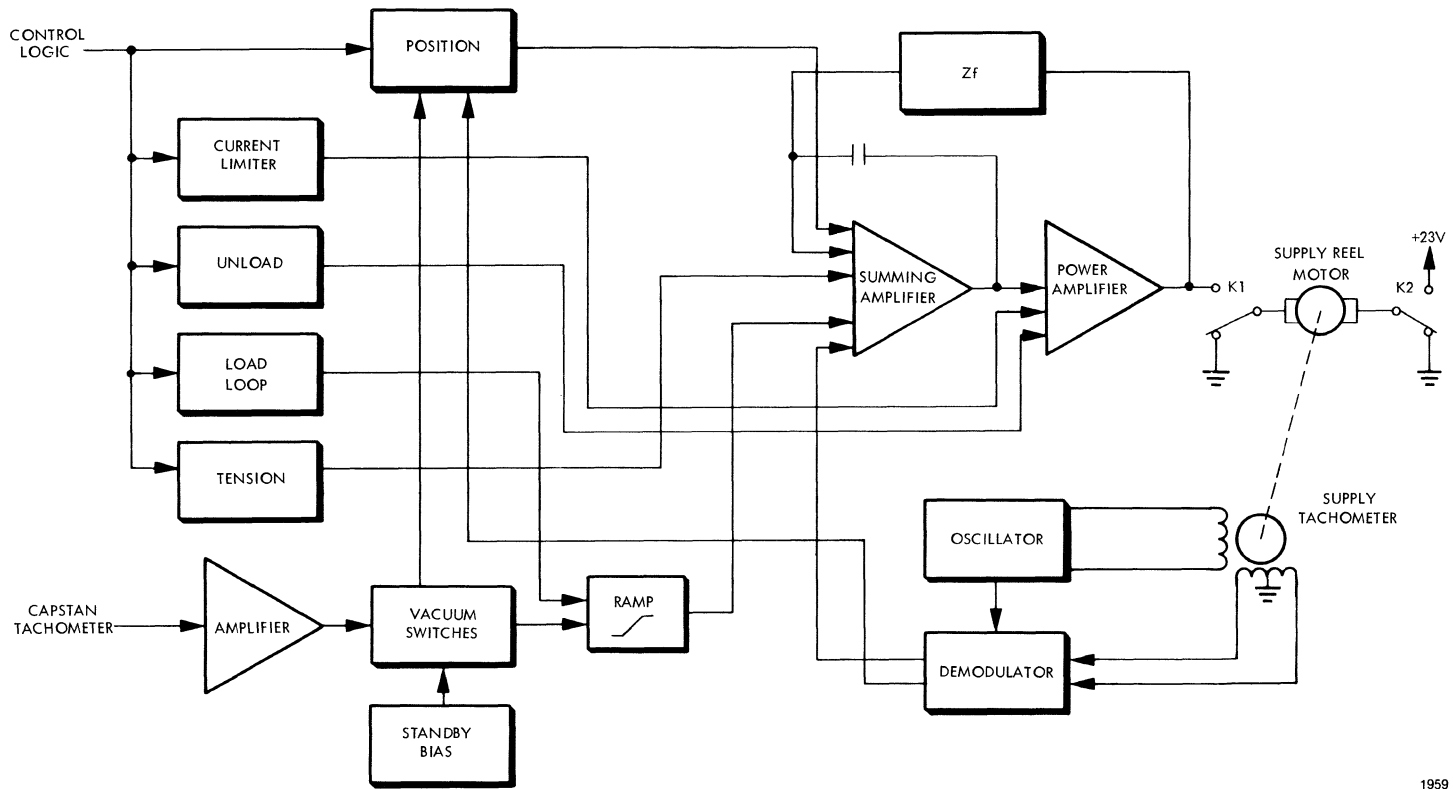
Figure 4-5. Supply Reel Servo Block Diagram
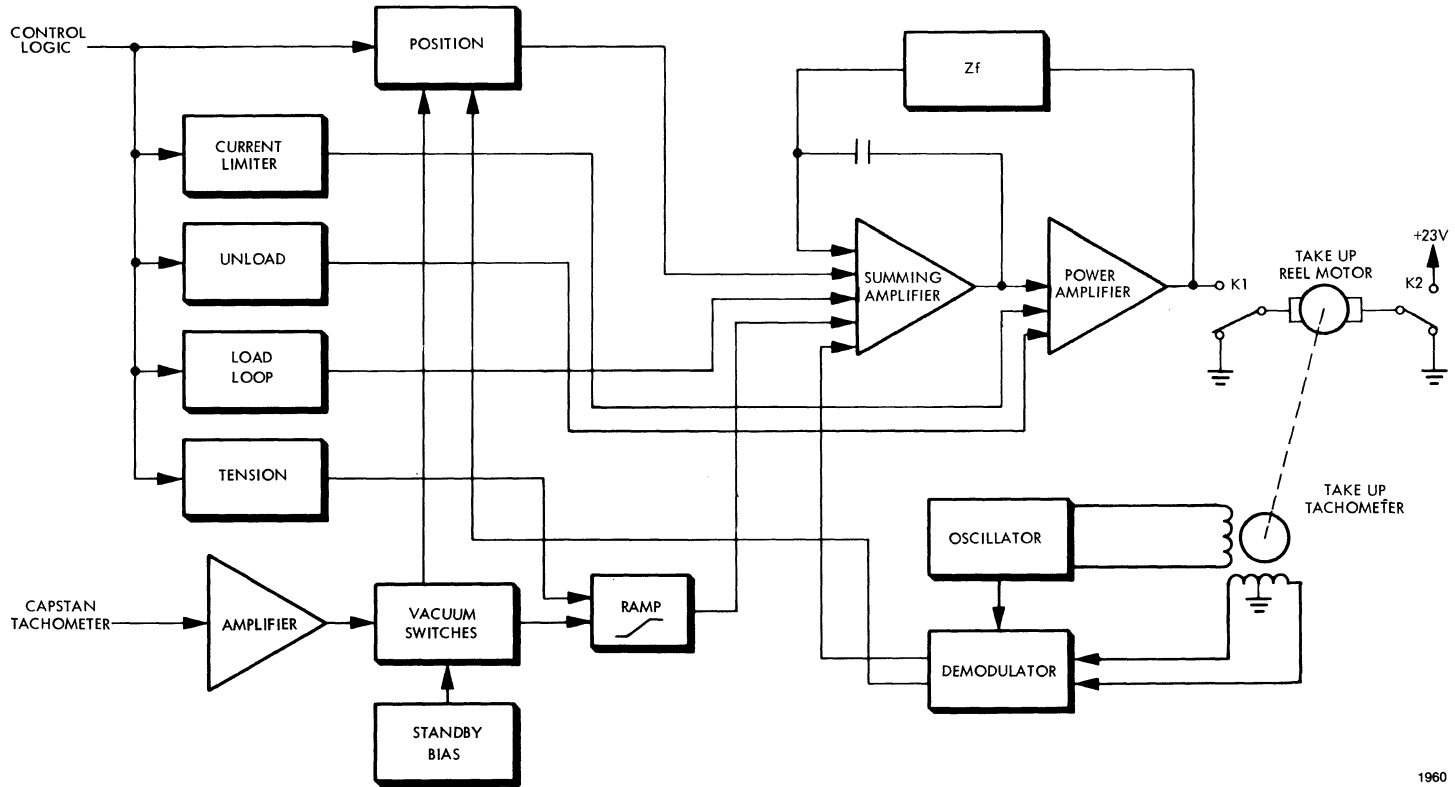
Figure 4-6. Takeup Reel Servo Block Diagram

Since the tachometer is an ac device, demodulation techniques are employed to recover a dc signal. The dc signal out of the Demodulator is summed at the Summing Amplifier and provides for constant velocity control.

Briefly, normal operation of the Reel Servos can be summarized as follows.

(1) The Capstan Tachometer input to Vacuum Switches is converted to a 90 or 110 percent ramp.

(2) The Ramp signal via the Summing Amplifier and the Power Amplifier provides power to the reel motor.

(3) The reel motor motion causes tape to pass over the tachometer.

(4) The tachometer motion produces an amplitude modulated signal which is applied to the Demodulator.

(5) The Demodulator takes the amplitude modulated signal and converts it to a dc voltage which is proportional to the reel tachometer speed.

(6) This voltage acts to add or subtract current from the Summing Amplifier until the reference velocity (90 or 110 percent of the capstan speed) is achieved.

4.3.2.1 Reel Servo Circuits, Load Operation

Auxiliary circuits are provided to load tape into the vacuum chamber. This circuitry receives its commands directly from the Control Logic. The functional blocks used for loading are the Current Limiter, Unload, Load Loop, and Tension, shown in Figures 4-5 and 4-6.

During a load operation, the following sequence of events occurs in the reel servo circuitry; refer to Figure 4-7.

(1) When the LOAD/RESET control is depressed, a Tension (NTNA) signal is received from the control logic and is converted to the appropriate signal level by the Tension circuitry.

(2) The Tension signal to the supply servo (Figure 4-5) provides a constant current input to the Summing Amplifier.

(3) The Tension signal to the takeup servo (Figure 4-6) provides a constant current to the Ramp circuitry which, in turn, provides a constant current to the Summing Amplifier.

(4) Concurrent with the Tension signal, the Current Limit (CURLIM) signal is applied to the Power Amplifier. This signal prevents saturation of the Power Amplifier from the application of the constant current into the Summing Amplifier.

(5) The current into the two summing amplifiers (supply reel and takeup reel) provides positive tape tension by driving the supply and takeup reels in opposite directions.

(6) A few seconds after the tape is tensioned, the Load Loop circuitry is activated.
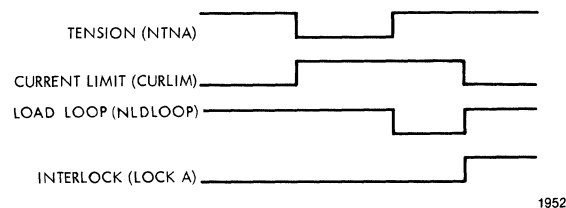
Figure 4-7. Load Timing

(7) The Load Loop (NLDLOOP) signal injects a constant current into the Ramp generator and hence the Summing Amplifier on the supply reel servo (Figure 4-5) and also directly into the Summing Amplifier of the takeup reel servo (Figure 4-6).

(8) The current supplied to the Summing Amplifiers causes a voltage inversion in the Power Amplifiers that forces the reel motors to reverse, and simultaneously load tape into the vacuum chambers. The Tension signal is removed when Load Loop is applied.

(9) The Load Loop and Current Limit signals are removed when vacuum interlock is accomplished.

4.3.2.2 Reel Servo Circuits, Unload Operation

The same auxiliary circuits employed to load tape into the vacuum chambers are used during an unload operation. Refer to Figures 4-5 and 4-6.

During an unload operation the following sequence of events occurs in the reel servo circuitry. Refer to Figure 4-8.

(1) The control logic removes power from the ac blower motor and sends a Tension (NTNA) signal to the reel servos. The application and use of this signal is identical to that described in Paragraph 4.3.2.1.

(2) The Current Limit circuitry is activated in a manner similar to that described for Load in Paragraph 4.3.2.1 except that the presence of the Unload (UNLOAD) signal inhibits the Current Limit on the takeup reel amplifier. Thus, the takeup reel is placed in a *free-wheeling* mode.

(3) With tension applied to the supply reel, and the takeup reel *free-wheeling,* tape is pulled from the vacuum chambers and wound onto the supply reel.

(4) The Unload signal is removed 0.5-second after the tape leader clears the EOT/BOT sensor. The reel motors then come to rest.

4.3.2.3 Reel Servo Circuits, Position Control

To stabilize the tape loop in the vacuum column during standby operation (i.e., capstan stationary), an auxiliary circuit is used in the reel servos. This circuitry is represented by the Position block in Figures 4-5 and 4-6. The position control circuitry senses tape position information from the tachometers and vacuum switches when there is no capstan motion. The Demodulators recognize the tachometer positional information and produce a current nulling effect at the Summing Amplifiers.

Operation of the position control circuitry can be summarized as follows.

(1) A capstan stop condition is indicated from the control logic circuitry, thus enabling tachometer position information (interpreted by the Demodulator) to be fed into the Summing Amplifier.
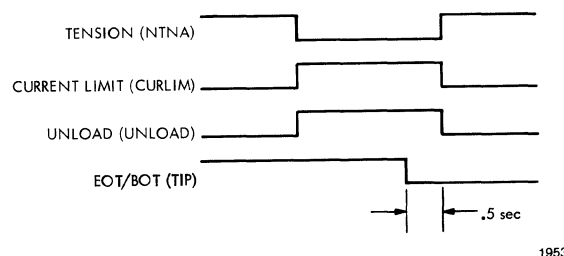
Figure 4-8. Unload Timing

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(2) If the nulling current causes tape to seek a position past a vacuum switch port, the switch closure provides a counteracting signal to reposition the tape to another nulling point further in the parking zone.

4.3.2.4 Reel Servo Circuits, Oscillator/Demodulator

An 800-Hz oscillator, shown in Figures 4-5 and 4-6, provides the ac reference signal to the reel tachometer field windings. When the tachometer is rotating, an 800-Hz secondary signal is produced by the tachometer. This signal is amplitude modulated according to the speed of the tachometer. A synchronous demodulator circuit is used to sense this amplitude variation. Use of this circuit alleviates the offset problem associated with bi-directional speed detection. Normal amplitude modulation detection would detect out-of-phase, as well as in phase, signal leading to zero crossover distortion. The velocity signal from the synchronous demodulator is not rectified but the low bandwidth of the reel servo limits the frequency response and reacts to the peak amplitude information.

When the tachometer is stopped, it acts as a transformer with a variable reluctance characteristic dependent on shaft position. An AM detector rectifies this signal and uses it in controlling the position circuitry.

4.3.3 CONTROL LOGIC

The Control Logic electronics processes all I/O and manual commands and activates the drive servos and data electronics in the appropriate manner. Figure 4-9 is a simplified block diagram of the control logic and should be referred to in conjunction with the following discussion.

The primary commands to the Control Logic circuitry originate at the manual operator controls. The first command recognized by this logic is the Power On signal. The logic senses power turn-on and generates a Master Reset signal which clears the logic. The logic is now capable of receiving the second required manual command, LOAD. Until the tape is loaded and the necessary interlocks are made, the logic will ignore all other commands except RESET, which will stop the Load operation.

Assuming that the tape has been properly threaded, a LOAD command causes the Load control logic to initiate the sequence required to load the tape into the vacuum chamber and bring it to Load Point (BOT). The logic sequence for a LOAD command is as follows.

(1) LOAD command initiated.

(2) Vacuum motor turned on.
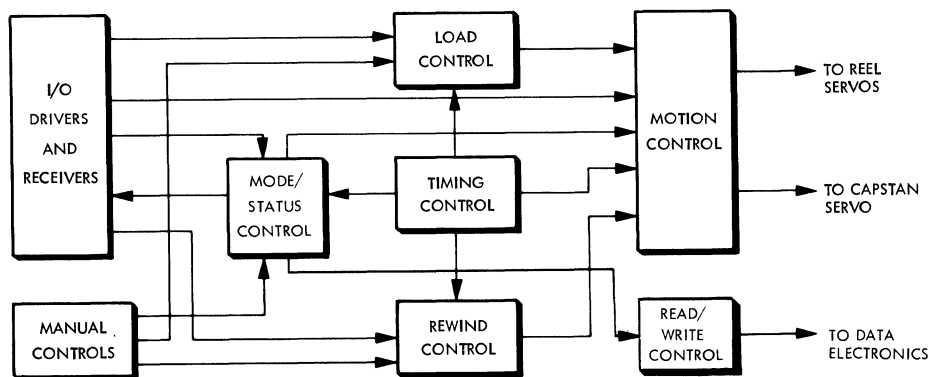
Figure 4-9. Control Logic Block Diagram

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(3) Signal reel servos to tension tape.

(4) After 7 seconds, signal reel servos to load tape into the vacuum chambers.

(5) Upon sensing interlock, stop the tape load.

(6) Run forward until BOT is reached, or until 7 seconds have elapsed.

(7) If the BOT was not detected within 7 seconds, initiate an automatic rewind.

Upon completion of a successful load operation, the control logic will now accept all other commands except LOAD. In order to execute another LOAD command, one of the vacuum interlocks must have been opened. Any subsequent activation of the LOAD/RESET control terminates any automatic sequences.

Assuming that the tape is loaded and positioned between the BOT and EOT, a REWIND command may be initiated via the interface or manual operator control. Receipt of the REWIND command by the Rewind control logic causes the following.

(1) REWIND command initiated.

(2) A high speed reverse signal is sent to the capstan servo.

(3) Tape is wound onto the supply reel at high speed until the BOT tab is sensed.

(4) The tape overshoots the BOT tab as the servos slow to a halt.

(5) A forward signal is generated to bring the tape back to the BOT tab.

If an unload operation is desired, the Rewind Control logic will accept a manual REWIND command while the tape is positioned at BOT, or will accept two successive REWIND commands if the tape is not at BOT. The Rewind Control logic will then initiate an unload sequence as follows.

(1) An unload operation is initiated.

(2) The vacuum motor is turned off.

(3) A slow reverse signal is sent to the supply reel servo and a free-wheel signal is sent to the takeup reel servo.

(4) The tape is slowly wound onto the supply reel until 0.5-second after the loss of tape in path is sensed at the BOT/EOT sensor.

Additionally, an UNLOAD command can be initiated from the interface. If the tape is not at the BOT, a rewind will be executed, then the unload operation. If the tape is at the BOT, only the unload operation will be executed.

4.3.3.1 Motion Control

The Motion Control logic processes the signals from the other functional blocks shown in Figure 4-9 and directs the commands to the proper servos. The basic operations performed by the servos under control of the Motion Control logic are: Forward, Reverse, Tension (no motion), Load Loop, Rewind (fast reverse), and Unload (slow reverse).

4.3.3.2 Status Control

The Status Control logic controls all of the various functions that direct internal logic action. The following is a list of these functions and their associated responsibilities.

(1) EOT/BOT. The EOT and BOT signals indicate the two reference positions on the tape. The BOT (Beginning of Tape) indication is used to stop the normal LOAD sequence, the reverse motion and the rewind operation. It also conditions the Rewind Control logic for an unload operation. The EOT indication marks the End of Tape and stops only a manual forward operation.

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(2) ON LINE. The ON LINE switch/indicator conditions the Control Logic to accept either interface (On-line) commands or manual (Off-line) commands.

(3) READY. The Control Logic will accept commands only when the logic is interlocked, the initial load sequence has been completed, the drive is On-line and is not rewinding or unloading. This condition is signaled by a true condition on the READY line.

(4) INTERLOCK. The drive is interlocked to ensure proper logic operation. The interlocks provided are:

- VACUUM INTERLOCK. Indicates that the tape is properly positioned in the vacuum chamber (see Figure 4-4).

- POWER INTERLOCK. Indicates that primary (ac) power has been applied and that servo power is applied.

- WRITE LOCKOUT. Indicates whether or not the loaded tape reel is write protected, i.e., Write Enable ring present, or not present.

(5) WRITE STATUS. Controls the write power to the Write Electronics.

4.3.3.3 Timing Control

The Control Logic employs two basic frequencies to control the internal logic timing. Two oscillators provide these frequencies. A high frequency oscillator operates at 1 MHz and provides timing pulses for edge detection and write status strobe. The critical timing which determines the range for the high frequency is the strobing by the Motion signal of the OVERWRITE and SET WRITE STATUS lines. The Motion signal is delayed nominally by the period of the 1 MHz clock pulse and the associated sampling error. The second oscillator operates at 2 Hz and provides half-second timing intervals for use in the time-outs associated with the Load, Unload, and Rewind operations. The critical timing which determines the range for the low frequency is the maximum time-out for BOT search during LOAD and minimum delay for relay K2 activation during REWIND.

4.3.3.4 Interface Drivers and Receivers

The I/O driver and receiver portion of the Control Logic is operable only when Selected, Ready, and On-line. Details of the electrical and signal characteristics required for proper operation are described in Paragraph 1.5.1.

4.3.4 POWER SUPPLY

The Power Supply consists of a power transformer mounted to the base plate, a chassis assembly, and an optional 5v microformatter regulator. The chassis assembly portion of the supply contains filter capacitors and the regulator PCBA. The power supply receives primary ac line voltage and converts it to the required secondary ac and dc voltages necessary for equipment operation. The power supply may contain either a Power Supply G1 PCBA or a Power Supply G2 PCBA. Functional differences between the two PCBAs are explained in the following paragraphs.

4.3.4.1 Power Transformer and AC Motor Primary Connections

WARNING

DANGEROUS VOLTAGES ARE PRESENT IN THE POWER SUPPLY. DISABLE THE PRIMARY AC LINE VOLTAGE BEFORE REMOVING THE POWER SUPPLY COVER.

Primary connections to the power transformer are shown in Figure 4-10. Line voltages of 95v to 125v ac and 190v to 250v ac at 50 or 60 Hz can be used as primary power input. All voltages listed are accommodated through use of two coded plugs, one of which (PPC Part

No. 104586) routes primary power to the appropriate taps on the power transformer, and the other (PPC Part No. 104587) which routes primary power to the appropriate windings on the ac vacuum motor and start capacitors. One set of coded plugs, corresponding to the source voltage used by the drive, is provided with the unit as specified by the user in the purchase order. Additional coded plugs for other voltages shown in Figure 4-10 can be obtained by ordering the relevant PPC part number.

CAUTION

ELECTRICAL DAMAGE CAN OCCUR IF THE DRIVE IS OPERATED AT A LINE VOLTAGE OTHER THAN THE ONE FOR WHICH THE CODED PLUGS ARE SPECIFIED.

NOTE

It is necessary to change the ac blower motor pulley and belt when changing the unit from 60 to 50 Hz, or from 50 to 60 Hz operation. Refer to Paragraph 6.7.9 for details.

Figure 4-11 is a block diagram of the power supply and should be referred to for the remainder of the power supply discussion.

4.3.4.2 Power Rectifier

Primary line voltage is received by the transformer in the Power Rectifier circuitry and is converted to 12.7 and 23.7v ac (fully loaded values). These voltages are then rectified by bridge rectifiers and converted to unregulated + 12 and − 12v dc and + 23 and − 23v dc.

NOTE

Unregulated voltages will be referred to in the text as 12 and 23v, respectively. These voltages may range from 12 to 18v and 23 to 32v, respectively.

4.3.4.3 + 5v Regulator and − 5v Regulator

The + 12v dc unregulated voltage is received by the + 5v regulator and converted to + 5v regulated dc. The − 12v dc unregulated voltage is received by the − 5v regulator and converted to − 5v regulated dc. Regulated + 5v dc is used primarily in the logic and lamp drive circuitry. Regulated − 5v dc is used in biasing circuitry and for lamp drivers. Both the + 5v and − 5v regulators contain current limiting circuitry to provide overcurrent protection.

On the Power Supply G1 PCBA, the + 5v regulator uses a Type 723 IC to control the series power transistor and has a full load capacity of 4 amperes. The − 5v regulator is referenced to the + 5v regulator and uses a Type 741 IC to control its series power transistor. The − 5v regulator has a full load capacity of 1 ampere.

On the Power Supply G2 PCBA, the + 5v regulator uses a Type LM317 IC to control the series power transistor and has a full load capacity of 4 amperes. The − 5v regulator consists of an LM337 IC and its associated circuitry and has a full load capacity of 1 ampere.

4.3.4.4 + 10v Regulator and − 10v Regulator

The + 23v dc unregulated voltage is received by the + 10v regulator and converted to regulated + 10v dc. The − 23v dc unregulated voltage is received by the − 10v regulator and converted to regulated − 10v dc. The regulated + 10v dc and − 10v dc are the reference voltages used in the capstan and reel servos. Special reference lines are provided for the capstan reference voltages to ensure noise immunity.
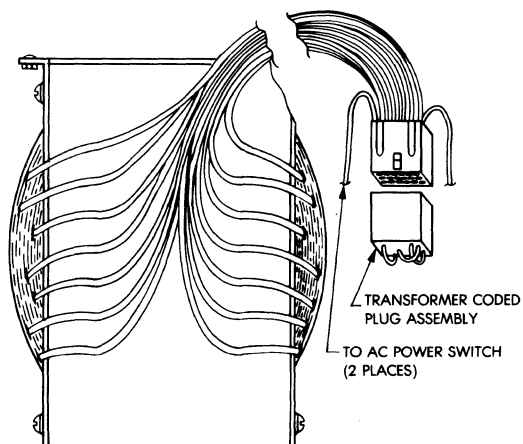
TRANSFORMER CODED-PLUG AND JUMPER IDENTIFICATION							AC-MOTOR CODED-PLUG AND JUMPER IDENTIFICATION
AC LINE VOLTAGE	PPC PART NO.	PIN 2 TO	PIN 8 TO	PIN 11 TO	PIN 24 TO	PIN 23 TO	
95	104586-01	3	1		16	19	USE PPC PART NO. 104587-01 (PLUG) WITH THE FOLLOWING JUMPERS: 2 TO 5 7 TO 18 4 TO 10 13 TO 15 20 TO 23
105	104586-02	3	1		9	14	
115	104586-03	6		1	17	22	
125	104586-04	6		1	14	9	
190	104586-05	3	16			19	USE PPC PART NO. 104587-02 (PLUG) WITH THE FOLLOWING JUMPERS: 2 TO 23 15 TO 18 4 TO 10
200	104586-06	3	16			9	
210	104586-07	3	14			9	
220	104586-08	3		16		9	
230	104586-09	6		17		22	
240	104586-10	6		14		22	
250	104586-11	6		14		9	

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Figure 4-10. Primary Power Input Connections
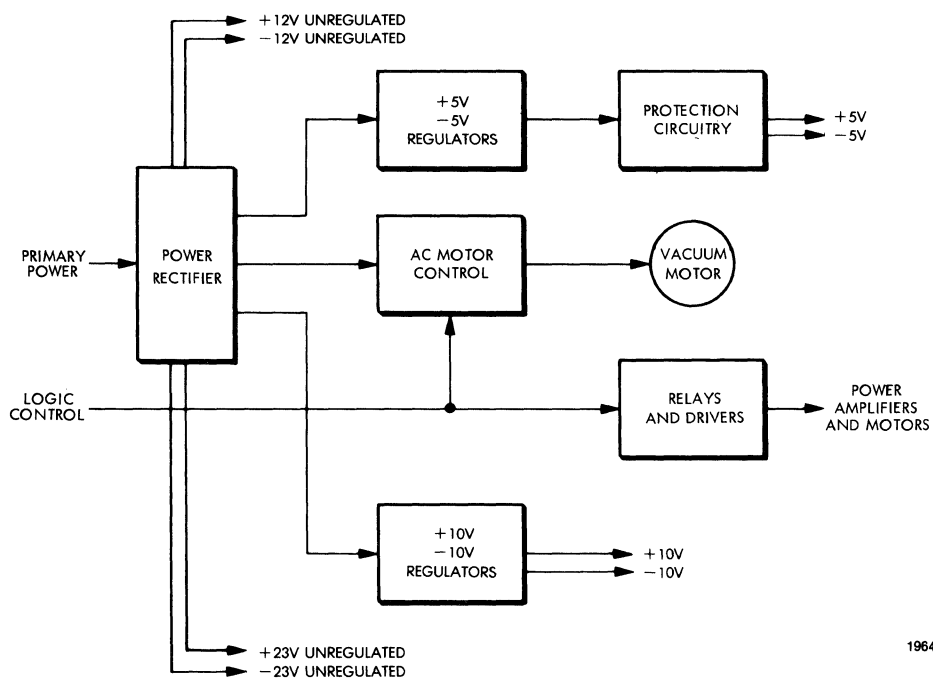
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Figure 4-11. Power Supply Block Diagram

On the Power Supply G1 PCBA, the + 10v regulator uses a Type 723 IC to control the series power transistor and has a full load capacity of 1.5 amperes. The − 10v regulator is referenced to the + 10v regulator and uses a Type 741 IC to control its series power transistor. It also has a full load capacity of 1.5 amperes. The regulated − 10v dc is adjustable to achieve proper symmetry with the regulated + 10v dc.

On the Power Supply G2 PCBA, the + 10v regulator uses a Type LM317 IC and has a full load capacity of 1.5 amperes. The − 10v regulator uses a Type LM337 IC and is referenced to the + 10v regulator by a Type 741 IC. It also has a full load capacity of 1.5 amperes. Symmetry is achieved by adjusting the reference between the two regulators.

4.3.4.5 AC Motor Control

The AC Motor Control circuitry controls a triac which provides line voltage to the ac vacuum motor. Logic signals are received and combined with a zero crossover detector to activate the vacuum motor at the proper time. The ac zero crossover detector is also used to sense loss of ac power and provide a logic Power Supply OK signal to the control logic.

An internal thermal protect switch will open power circuitry to the start-and-run windings of the ac vacuum motor in the event that the ambient temperature exceeds the specified value. When this occurs, the motor will stop, then, when the temperature drops to the specified operating ambient range, the thermal protect switch will close and the motor will resume normal operation.

4.3.4.6 Protection Circuitry

Overvoltage protection is provided on the + 5v and − 5v lines. A voltage over 6.2v *crowbars* an SCR and forces the output voltage to 1.2v, nominal. Prime power must be removed for a short period of time in order to reset the crowbar circuitry. In addition, on the Power Supply G2 PCBA, the regulator inputs are fuse protected and the regulators incorporate overcurrent protection.

<div align="center">

WARNING

***DANGEROUS VOLTAGES ARE PRESENT ON THIS PCBA.
DISABLE THE PRIMARY LINE VOLTAGE BEFORE RE-
MOVING THE COVER FROM THE AC MOTOR CONTROL.***

</div>

4.3.4.7 Relays and Drivers

Two relays (three on the Power Supply G2 PCBA) provide power to the reel motors. Relay K1 (K1 and K2 on the Power Supply G2 PCBA) ties the motors to ground in their inactive state and connects the reel and capstan motors to their associated power amplifiers in their active state. Relay K2 (K3 on the Power Supply G2 PCBA) is used only by the reel servos during a Rewind operation to apply + 23v to the reel motors. The relay drivers are Type 75452 ICs and receive their appropriate control signals from the Logic Control circuitry. A + 5v signal is also supplied through relay K1 and indicates the condition of the power interlock to Control Logic circuitry. The + 5v is also used via the Control Logic to supply the write power circuitry.

4.3.5 DATA ELECTRONICS

Information is recorded in the Phase Encoded (PE) mode. The PE system interprets a flux change toward the magnetization direction of the Inter-Block Gap (IBG) as a 1 bit. A flux change in the opposite direction represents a 0 bit. A flux reversal is written between successive 1 bits or successive 0 bits to establish proper polarity. Thus, up to two flux changes are required per bit for the PE method of data decoding.

The PE method of recording data differs from the NRZI method in that the NRZI employs only one flux change in either direction to represent a 1 bit, and the lack of a flux change to represent a 0 bit.

Figure 4-12 illustrates the basic recording waveform components of the NRZI and PE modes. Note that in the PE mode there is a flux shift within each cell period indicative of a 1 or 0 bit. The direction of magnetic flux change on the tape at the center of the bit cell determines its value (0 or 1).

Figure 4-13 illustrates the relevant 9-track allocation, spacing, and format of 1600 cpi PE tape. Consecutive data channels are not allocated to consecutive tracks. This organization increases tape system reliability because the most used data channels are located near the center of the tape. Consequently, they are least subject to errors caused by contamination of the tape.

The data block is preceded by a preamble consisting of 40 bytes of all 0s and one byte of all 1s. Note that the data block is followed by a postamble which is the mirror image of the preamble, i.e., one byte of all 1s followed by 40 bytes of all 0s.

NOTE

The preamble and postamble bursts are configured so that during a Read Reverse operation their functions are interchangeable.
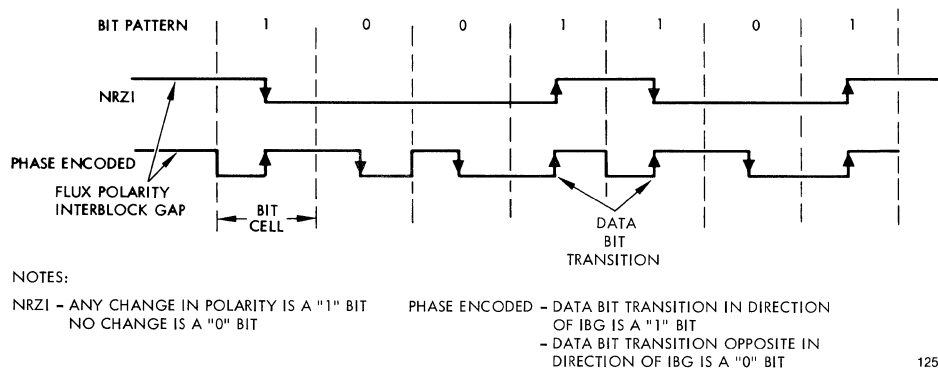

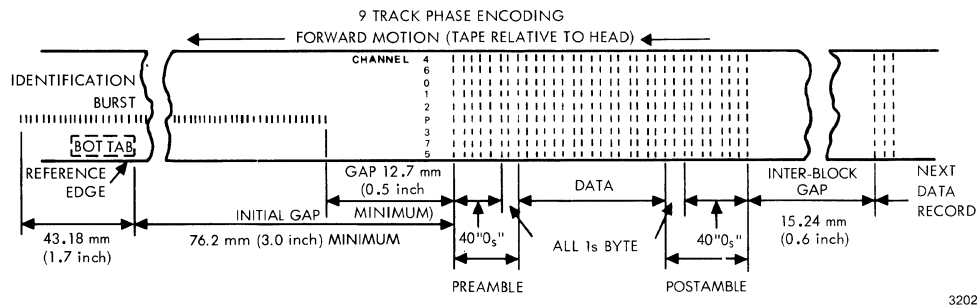Figure 4-12. Comparison of NRZI and PE Recording Modes

Figure 4-13. 9-Track PE Allocation, Spacing, and Format

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During a read operation, as the tape passes over the read/write head, any flux pattern recorded on the tape (1 or 0) generates a waveform in its appropriate data track. It is important to note that during a Read Reverse operation the read signal is inverted, i.e., a 1 bit is a negative transition and a 0 bit is a positive transition.

Illustrated in Figure 4-14* are waveforms that occur on a channel during a Write and Read-back operation. Magnetization transitions recorded on the tape are not perfectly sharp because of the limited resolution of the magnetic recording process.

During a read-back, the voltage induced in the head is amplified, differentiated, and then applied to a Schmitt trigger and an envelope detector. The differentiator and Schmitt trigger form a peak detector. The envelope detector performs a gating function. Thus, the output is present on the interface line only when a data block is present.

Figures 4-15* and 4-16* are functional logic diagrams of one channel of data electronics and the relevant common control logic for the T9640 and T9660, respectively. This diagram is to be used only for purposes of describing system operation.

4.3.5.1 Operation with Dual- and Single-Stack Heads

A dual-stack head, used on the T9640, enables simultaneous Read and Write operations to take place, thus allowing writing and checking of data in a single pass.

Gap scatter in both the write and read heads is held within tight limits so that correction is not necessary. Conversely, the azimuth angles of both heads are not held within such tight limits, and correction is therefore necessary.

The read head azimuth adjustment is provided by shimming the fixed head guides adjacent to the head so that the tape tracks at 90 degrees to the read azimuth. Since the write and read heads are constructed in the same block, an independent method of azimuth adjustment is required for the write head. This is achieved electronically by triggering the write waveform generators for different channels sequentially and at such times that the azimuth error in the write head is nullified.

The T9660 utilizes a single gap head for both read and write operations. Azimuth alignment for the single-stack head is accomplished by shimming the fixed head guides adjacent to the head so the tape will track at exactly 90 degrees to the head gap. Since the same gap is used for both reading and writing, no additional azimuth compensation is required.

4.3.5.2 Data Recording (Dual-Stack Model T9640)

Figure 4-17* shows a timing diagram for data recording. Assume that the drive is Selected, Ready, On-line and has a write enable ring installed. The WRT PWR control line will therefore be at +5v, providing power for the head driver circuits.

When a SYNCHRONOUS FORWARD COMMAND (ISFC) is received, the MOTION signal generated on the Tape Control PCBA goes high, removing one input of OR gate U8. See Figure 4-15.

In operation, the front edge of the ISFC is delayed and differentiated and the resulting pulse is used to sample the condition of the SET WRITE STATUS (ISWS) line. If this is true, the following action takes place.

    (1) The Write/Read mode flip-flop is set.

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*Foldout drawing, see end of section.

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(2) The NWRT waveform becomes low.

(3) Erase driver Q3 is energized.

(4) Both the S_D and C_D inputs of flip-flop U4 go high. The action of the *stretcher* circuit is to delay the rise of the C_D input relative to the S_D input, ensuring that the flip-flop is in the reset state before a recording starts.

The polarity of the field from the erase and write heads under these conditions is such that tape will be erased in an IBM-compatible direction.

(5) The C_D input of control flip-flop U9 goes high, unclamping the flip-flop.

The ISFC (Plot 1 on Figure 4-17) enables the ramp generator, which causes tape to accelerate to the prescribed velocity (Plot 2). After a time (T1) determined by the required IBG displacement, the WRITE DATA (IWD) inputs (Plot 4), together with the IWDS (Plot 3), are supplied to the interface connector. Preamble, data block, and postamble are recorded.

The IWD input is received by interface receiver U1 and is strobed into flip-flop U3 at the trailing edge of the WRITE DATA STROBE (IWDS). On the IWD lines (IWDP—IWD7), a one is a positive going edge at data flux reversal time and a zero is a negative going edge. The phase edge can be positive or negative going. Both outputs of flip-flop U3 are fed to head driver transistors Q1 and Q2, which cause current to flow in one half or the other of the center-tap head winding. Consequently, magnetization on the tape is maintained in the appropriate direction between change-overs and changes direction in accordance with the input signal IWD.

At the completion of the postamble, ISFC goes false after the post-record delay time (T2). The ramp generator is disabled and the tape velocity decelerates to zero.

The IBG displacement consists of the following.

(1) The stop distance: the distance traveled during the tape deceleration period to zero velocity.

(2) The start distance: the distance traveled while the tape is accelerating to the prescribed velocity.

(3) An additional distance determined by the pre-record time (T1), from the ISFC command going true to the time of the first IWDS and the post-record time (T2), from the end of the postamble to ISFC going false. (Time delays T1 and T2 are provided by the customer's controller.)

4.3.5.3 Data Recording (Single-Gap Model T9660)

Assume the drive is Selected, Ready, On-line, and has a write enable ring installed. The WRT PWR control line will therefore be at +5v, providing power for the head driver circuits.

When an ISFC is received, the MOTION signal generated on the Tape Control PCBA goes high removing one input of OR gate U7 via U6.

In operation, the front edge of the ISFC is delayed and differentiated and the resulting pulse is used to sample the condition of the ISWS line. If this is true, the following action takes place.

(1) The Write/Read mode flip-flop U41B on the Tape Control PCBA is set.

(2) The NWRT waveform becomes low.

(3) The −5v driver (Q3) is turned on.

(4) The erase head is energized through Q4.

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(5) The C_D input of U3 goes high. The polarity of the field from the erase and write heads under these conditions is such that tape will be erased in an IBM-compatible direction.

Figure 4-17 is a timing diagram illustrating relationships of signals during data recording and should be referred to in conjunction with Figure 4-16. The ISFC enables the ramp generator, which causes tape to accelerate to the prescribed velocity. After a time (T1) determined by the required IBG displacement, the IWD inputs together with the IWDS are supplied to the interface connector. Preamble, data block, and postamble are recorded.

The IWD input is received by interface receiver U1 and is strobed into flip-flop U3 at the trailing edge of the IWDS. On the IWD lines (IWDP—IWD7), a one is a positive going edge at data flux reversal time and a zero is a negative going edge. The phase edge can be positive or negative going. Both outputs of flip-flop U3 are fed to head driver transistors Q1 and Q2, which cause current to flow in one half or the other of the center-tap head winding. Consequently, magnetization on the tape is maintained in the appropriate direction between change-overs and changes direction in accordance with the input signal IWD.

At the completion of the postamble, ISFC goes false after the post-record delay time (T2). The ramp generator is disabled and the tape velocity decelerates to zero.

The IBG displacement consists of the following.

(1) The stop distance: the distance: the distance traveled during the tape deceleration period to zero velocity.

(2) The start distance: the distance traveled while the tape is accelerating to the prescribed velocity.

(3) An additional distance determined by the pre-record time (T1), from the ISFC command going true to the time of the first IWDS and post-record time (T2), from the end of the postamble to ISFC going false. (Time delays T1 and T2 are provided by the customer's controller.)

4.3.5.4 Overwrite (IOVW) (T9640, T9660)

The Overwrite function allows updating (rewriting) of a selected record. The new data block to be inserted must be exactly the same length as the data block being replaced. This restriction is necessary since replacing a block of data with a block longer than the original could result in an IBG distance which is less than the minimum allowed, or in writing over the next record. If the new data is shorter than the existing block, errors could result since some unerased portion of the old data would remain.

Additionally, when write and erase currents are switched off abruptly, there is a small area of tape which is influenced by the collapsing magnetic fields of the heads. This constitutes flux transients on the tape which appear as spurious signals when read back. The Overwrite feature of the drive has effectively eliminated this problem by turning the write current off slowly while tape is still in motion.

To update a previously recorded record, the drive must be Selected, Ready, On-line, and have a write enable ring installed. Additionally, the IOVW signal from the controller must be true and coincident with ISWS and ISFC.

Overwrite operation is terminated by the IWARS signal disabling the WRT PWR circuitry. This action causes the write current to ramp down to zero as the tape decelerates to rest. The transient pulse, generated when the write current is switched off, is spread over a longer distance on the tape and produces a negligible signal on replay.

4.3.5.5 Data Reproduction (T9640)

When an ISFC is received, the MOTION signal generated on the Tape Control PCBA goes true so that NAND gate U4 (Figure 4-15) is enabled. Also, the Forward ramp generator is enabled and tape accelerates to the prescribed velocity.

Figure 4-18* illustrates typical PE read timing and waveforms and should be referred to in conjunction with Figure 4-15. Data signals from the magnetic head are fed by a shielded cable to the read amplifier. The read amplifier gain is adjusted so that the output of the differentiator is 4v peak-to-peak.

The differentiated signal is fed to a Schmitt trigger which squares the signal and outputs it to Line Driver U4. The signal is also applied to the envelope detector which requires four successive characters greater than the threshold before its output goes high to enable the Line Driver U4. The output of the envelope detector goes false when the differentiated read signal envelope goes below the threshold for more than two successive characters.

When the drive is in the Read While Write mode, a threshold level of approximately 45 percent of the nominal peak output is generated regardless of the IRTH2 waveform levels. When the drive is in the Read mode and IRTH2 is high, the threshold level is approximately 15 percent of the nominal peak output.

The IRTH2 line, when low and the unit is in the Read mode, will generate a read threshold of approximately 7.5 percent of the nominal peak output to enable the user to recover very low amplitude data. Operation at this threshold is recommended only after an attempt has been made to read the data at the normal read threshold level.

4.3.5.6 Data Reproduction (Single-Stack Model T9660)

When an ISFC is received, the MOTION signal generated on the Tape Control PCBA goes true so that NAND gate U4 (Figure 4-16) is enabled. Also, the Forward ramp generator is enabled and tape accelerates to the prescribed velocity.

Figure 4-18 illustrates typical PE read timing and waveforms, and should be referred to in conjunction with Figure 4-16. Data signals from the magnetic head are fed by a shielded cable to the read amplifier. The read amplifier gain is adjusted so that the output of the differentiator is 4v peak-to-peak.

The differentiated signal is fed to a Schmitt trigger which squares the signal and outputs it to Line Driver U4. The signal is also applied to the envelope detector which requires four successive characters greater than the threshold before its output goes high to enable the Line Driver U4. The output of the envelope detector goes false when the differentiated read signal envelope goes below the threshold for more than two successive characters.

When the drive is in the Read mode, and both IRTH1 and IRTH2 waveforms are high, a threshold level of approximately 15 percent of nominal peak output is generated. During the Write mode, IRTH1 is low. When IRTH1 is low, the threshold level is 45 percent of the nominal peak output regardless of the IRTH2 level.

When the IRTH2 line is low, the IRTH1 line is high, and the drive is in the Read mode, a read threshold of approximately 7.5 percent of the nominal peak output is generated to enable the user to recover very low amplitude data. Operation at this threshold is recommended only after an attempt has been made to read the data at the normal read threshold level, i.e., when both IRTH1 and IRTH2 are high.

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*Foldout drawing, see end of section.
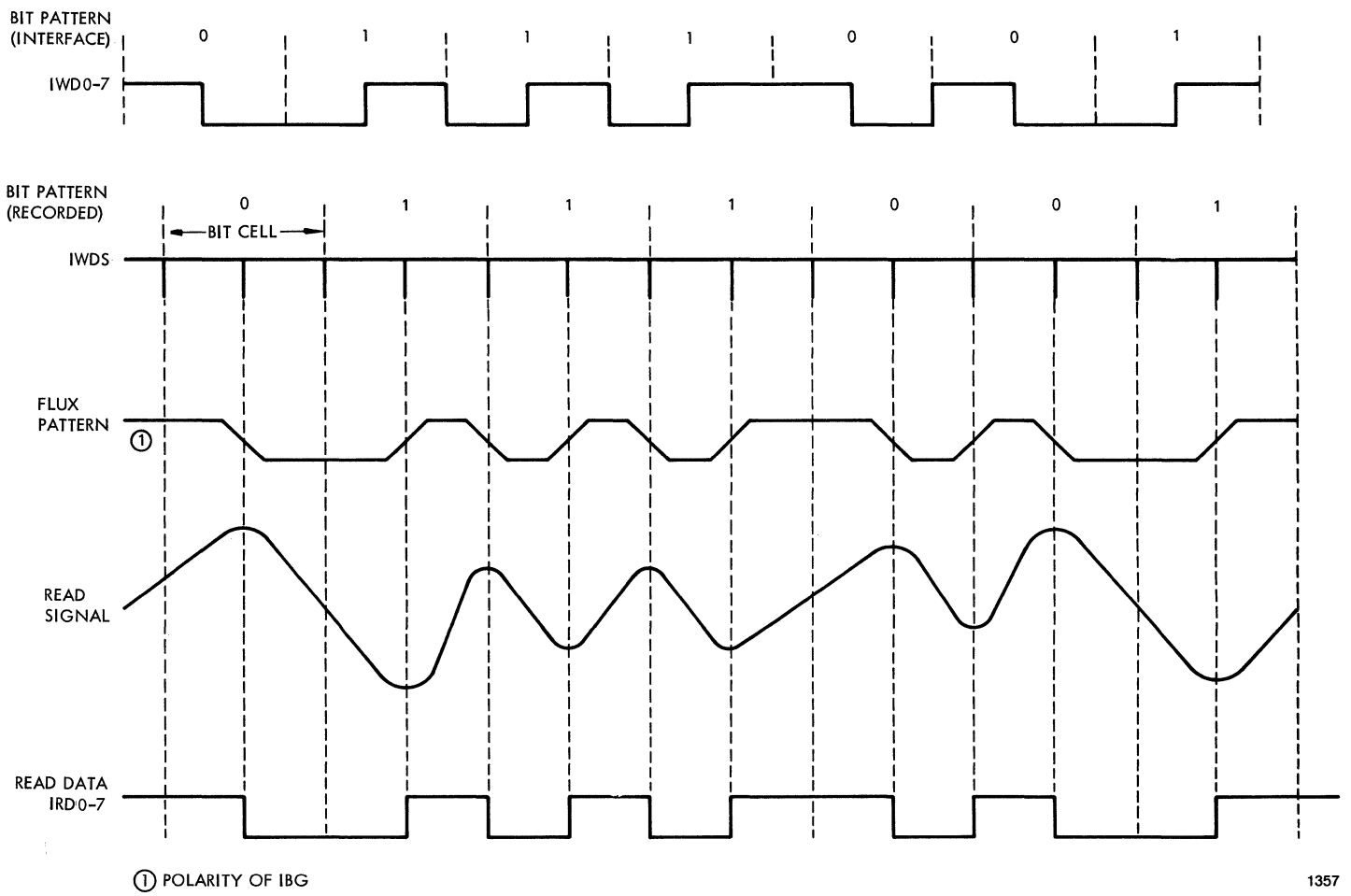
Figure 4-14. PE Write and Read Waveforms

4-21/4-22
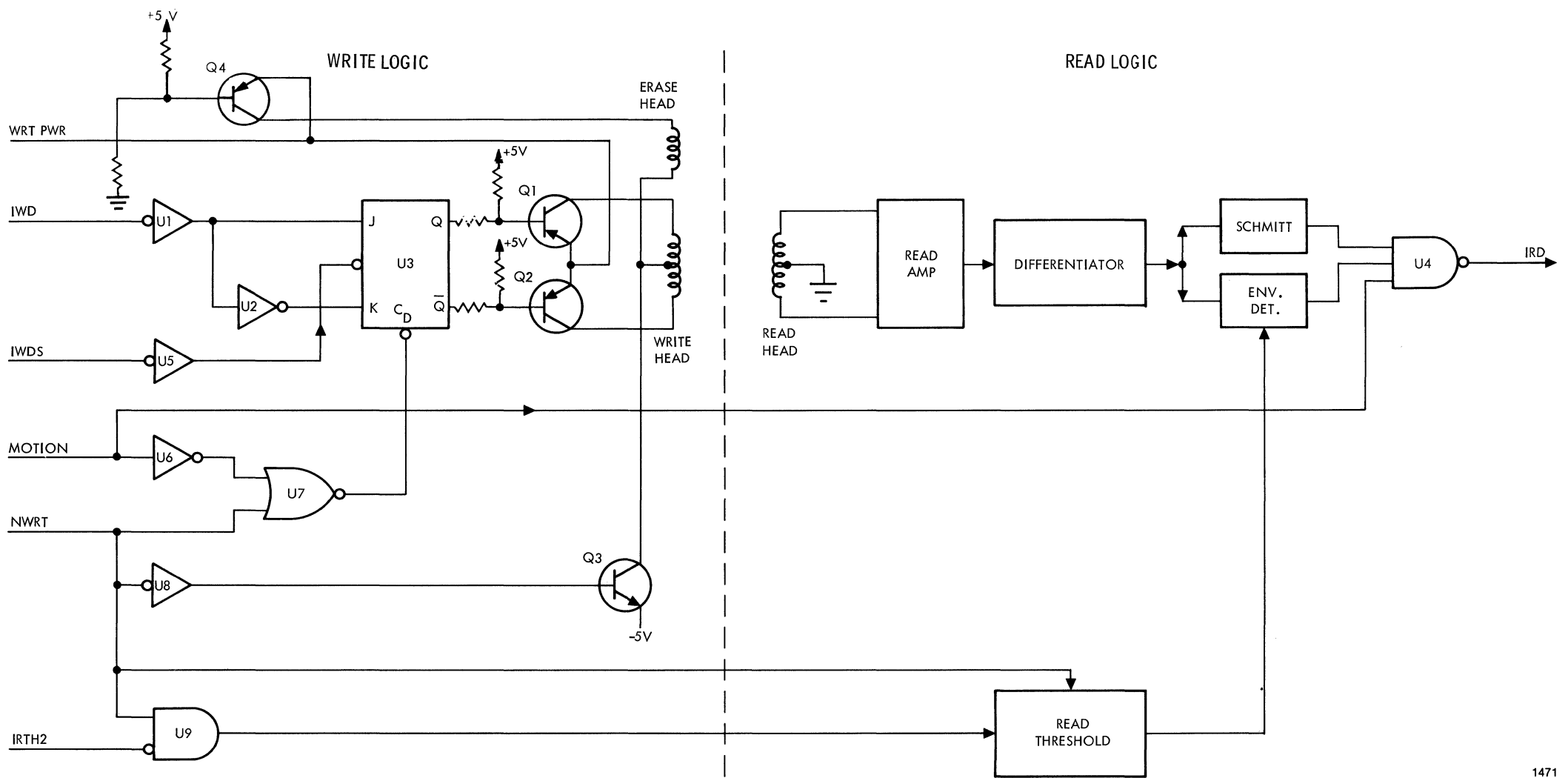
Figure 4-15. One Channel of Data
Electronics, Model T9640

4-23/4-24
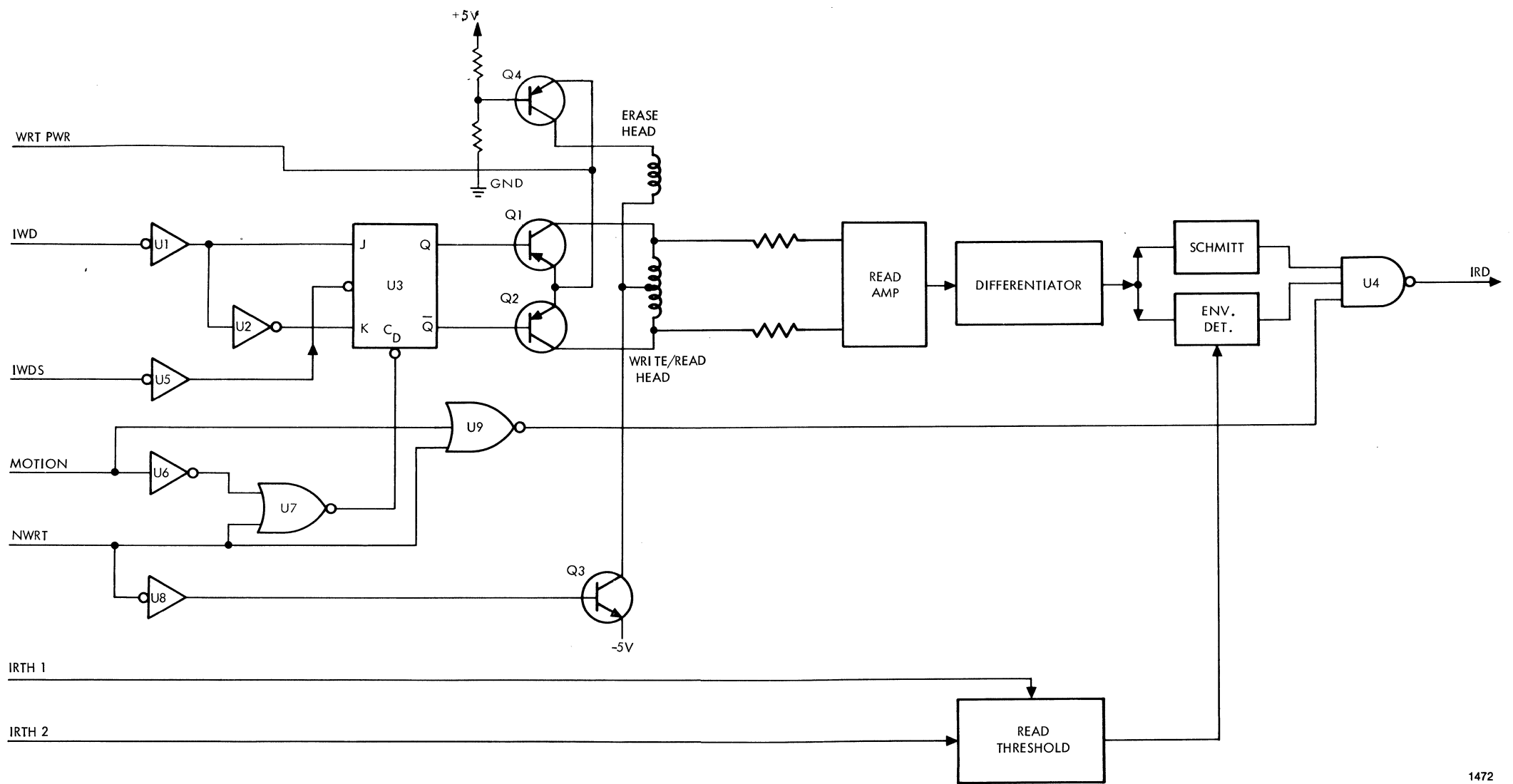
Figure 4-16. One Channel of Data
Electronics, Model T9660

4-25/-26

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PLOT

1   ISFC

2   VEL

3   BIT PATTERN
     (INTERFACE)
     IWDO-7
     (TYPICAL)

     BIT CELL

     0   0   0   1   0   1   1   0   0   0

4   IWDS

5   BIT PATTERN
     (RECORDED)
     WRITE CURRENT

     ①   0   0   0   1   0   1   1   0   0   0

     T1   T2
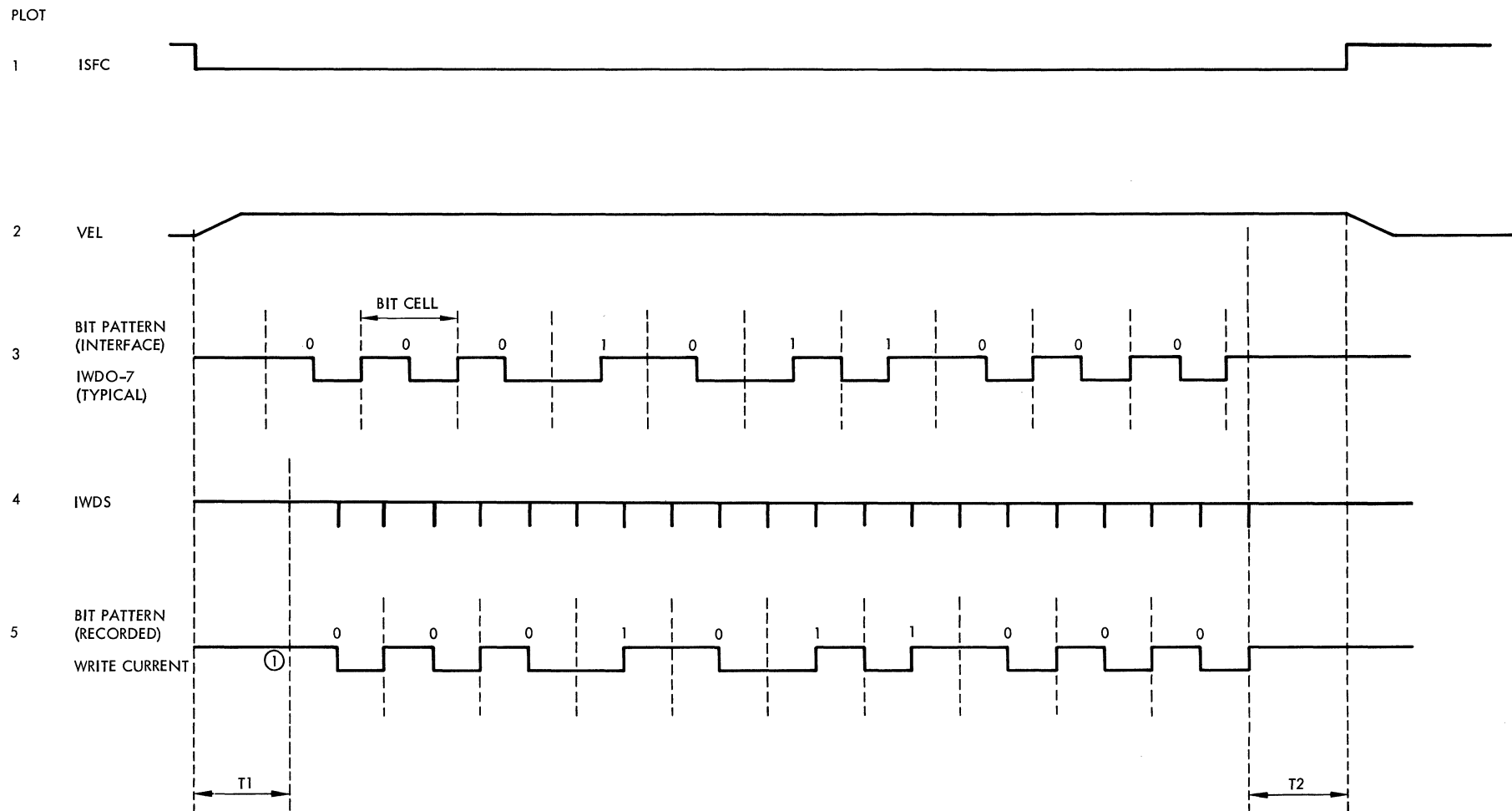
①   THIS DIRECTION OF CURRENT
    IS SUCH AS TO MAGNETIZE
    TAPE IN THE DIRECTION
    OF THE IBG.

1355

Figure 4-17. Timing Diagram,
Data Recording

4-27/4-28

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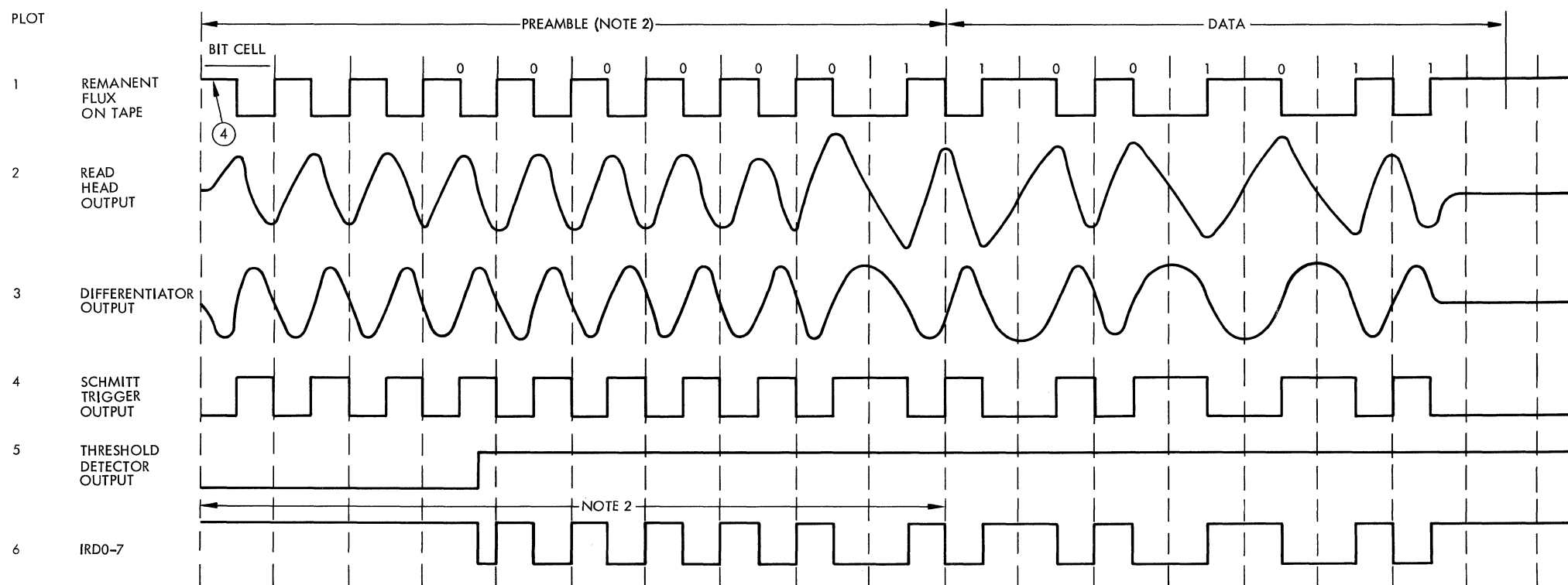
NOTES:
1. TRANSPORT MUST BE SELECTED, READY, AND ON-LINE AND GATED WITH SFC OR SRC.
2. PREAMBLE IS SHOWN SHORTENED TO SIMPLIFY DRAWING. PREAMBLE CONSISTS OF 40 ZEROS FOLLOWED BY ONE 1.
3. POSTAMBLE NOT SHOWN. POSTAMBLE CONSISTS OF ONE 1 FOLLOWED BY 40 ZEROES.
4. FLUX POLARITY OF INTERBLOCK GAP.

1364

Figure 4-18. Timing Diagram,
Data Reproduction

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SECTION V
PRINTED CIRCUIT BOARDS THEORY OF OPERATION

5.1 INTRODUCTION

This section contains the theory of operation of the printed circuit boards used in the Models T9640 and T9660 Tape Drives. The schematic and assembly drawings for each board are contained at the end of Section VII.

5.2 THEORY OF OPERATION

Refer to Drawing No. 103894 contained at the end of Section VII for the interconnections between the various PCBAs. Note that one of two Power Supply PCBAs is installed in the drive. The Power Supply G1 PCBA is described in Paragraph 5.2.2 and the Power Supply G2 PCBA is described in Paragraph 5.2.3.

5.2.1 TAPE CONTROL K PCBA

The following is a description of the Tape Control K PCBA (refer to Schematic No. 103882 and Assembly No. 103883).

The Tape Control K PCBA contains the logic necessary for primary operational control of the drive. Figure 5-1 shows the placement of each connector and test point on the PCBA. The PCBA is 406.4 mm (16 inches) long. Interface edge connector J101 is located at one end and is slotted to mate with a key in the mating plug. The functions of J501 through J514 are shown in Figure 5-1.

Prior to the execution of any command, the logic must be conditioned to accept the command. Additionally, the high and low frequency oscillators must be enabled. The Master Reset signal (NMR1 and NMR2, sheet 4, zone E2) is used to partially accomplish this conditioning.

The Master Reset circuitry has four basic modes of operation: initial power on, interlock fault, ac power fault, and sequence termination. Upon initial application of power, NMR1 and NMR2 are held low until the threshold of the Schmitt trigger U2 (sheet 4, zone E5) is reached via the charging action of R222 and C37. In this condition, relay K1 is normally de-energized and the PS signal (J501 pin 1) is high. The action of the Master Reset signal causes the logic to be put into a known stable state. In the case of an interlock fault condition, K1 de-energizes and the K1 relay contact at pin 4 of J510 is changed from +5v to ground. Thus, a negative pulse appears at the base of Q56 (sheet 4, zone E6) discharging C37 and forcing a Master Reset condition. The ac fault condition occurs when ac power is no longer sensed by the power supply, causing the PS signal to go low, inducing a Master Reset. Manual activation of the LOAD/RESET control, after the drive has entered the Load sequence, induces a Master Reset and terminates any automatic sequence in progress.

When power is applied to the unit, the two oscillators on the Tape Control K PCBA are enabled. The high frequency Schmitt trigger oscillator (sheet 5, zone D7) is designated Phase A (Φ_A) and produces a 1 MHz nominal clock signal. The Phase B (Φ_B) oscillator (sheet 5, zone C7) operates as a low frequency unijunction relaxation oscillator and produces a 2 Hz (nominal) clock signal.

The high frequency oscillator is primarily used for edge detection and microsecond delays. Its critical timing application is its use in delaying the SYNCHRONOUS FORWARD COMMAND (ISFC) or SYNCHRONOUS REVERSE COMMAND (ISRC) to strobe the SET WRITE STATUS (ISWS) or OVERWRITE (IOVW) signal. The maximum length of this delay is 20 microseconds (defined by the interface specification).
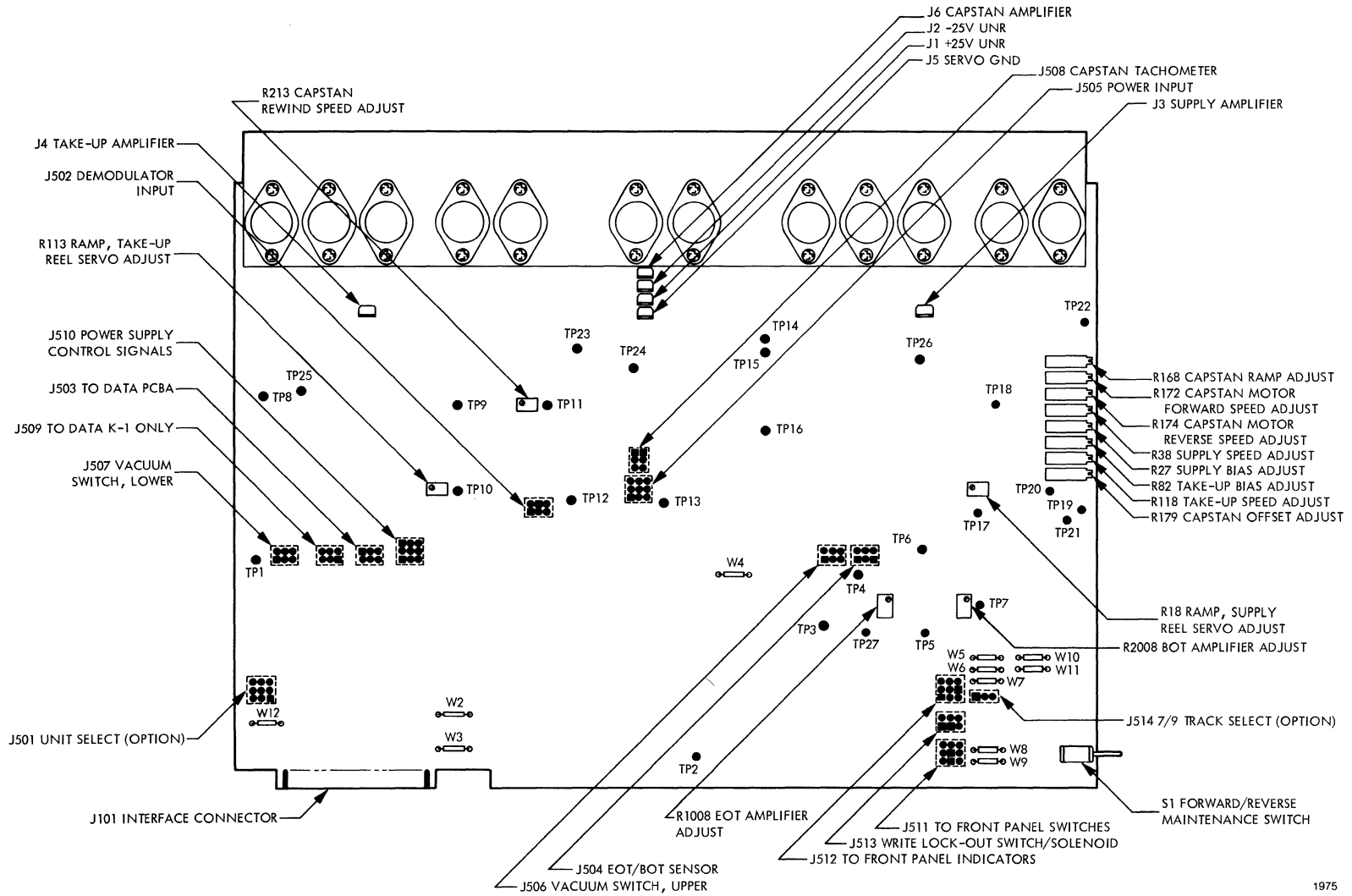
5-1

Figure 5-1. Tape Control K PCBA, Test Point and Connector Placement

The low frequency oscillator is primarily used for timing and timeouts. Its basic 0.5-second period is used to delay activation of the relay K2 (NK2ENERG) and Fast Reverse signal (NREWRI) to the capstan during a rewind. Φ_B is also counted to provide the 7-second timeout for vacuum motor acceleration during a load sequence and the maximum 7-second search for BOT timeout (also during a load sequence). A 0.5-second delay is also used to delay MOTION immediately after making interlock, and to delay Stop during the unload after tape is sensed to be out of the tape path.

Subsequent to conditioning the logic, but prior to the execution of any other command, tape must be properly loaded into the vacuum chamber. Assuming the tape is properly threaded, depressing the LOAD/RESET switch/indicator initiates this load sequence.

Flip-flop U44-5 (TENCNT) (sheet 6, Zone E6) goes high causing flip-flop U22-5 (sheet 5, zone B3) to set. U22-6 forces VPA high at pin 2 of J510. This high is sensed by the Power Supply PCBA and turns on the vacuum motor. The set of U44-5 forces U44-6 (NTENCNT) low. This, in turn, forces NPICK K1 low enabling the K1 relay connecting the servo amplifiers to the motors. Setting TENCNT forces CURLIM high via U13 and NTNA low via U13 and U11. CURLIM is used in the reel servos to current limit and NTNA causes the servo summing amplifier to saturate. The net effect of this action is to tension the tape. TENCNT also enables counter U26 (sheet 5, zone 7B) to timeout for 7 seconds. This timeout provides for proper vacuum power to be achieved. At the end of the U26 count, NLDLOOP (sheet 5, zone B1) goes low forcing the reel servos to load tape for 0.5 second, or until vacuum interlock is achieved. Making vacuum interlock sets LOCK A and LOCK B which creates a negative pulse on NLOCKTIME (sheet 4, zone 2F) which, in turn, resets TENCNT. Resetting TENCNT sets U44-9, U43-5, and U43-9. U44-9 and U43-9 going high causes NFWD (sheet 6, zone G1) to go low via U38-6, U39-8, and U24-6. NFWD going low signals the capstan to go forward and search for the BOT. U43-5 enables counter U41 (sheet 6, zone D4) to timeout for 7 seconds and stop the search for BOT if BOT is not reached in 7 seconds. This is done via U48-8 which resets U44-9, U43-5, and U43-9. If the BOT is detected before 7 seconds have elapsed, U44-9, U43-5, and U43-9 are reset and tape motion stops. If the BOT Is not detected in 7 seconds, an automatic rewind is initiated via U48-8 (NSKTO).

Resetting U43-5 sets U54-9, thus denoting that the unit is loaded. Completion of the Load sequence is signaled via the READY (IRDY) line via U19-8 and SRO. The true condition on this line indicates that the unit is loaded, interlocked, not rewinding and not unloading.

Two reflective tab sensors, BOT and EOT, are used to detect the beginning or end of tape. The signals are received from the sensors via J504 (sheet 4, zone H8) and are amplified by Q1002 and Q2002 and digitized via Schmitt triggers U18-8 and U18-6.

Another sensor set, the vacuum switches, indicates the relative position of the tape in the vacuum chamber. These switches are used differentially and are either open or closed (tied to ground) depending on the pressure differential applied to the switch. There are 6 holes in each chamber of the vacuum column which are connected to the vacuum switches. The two extreme (outermost) holes represent vacuum interlock and indicate a fault if the tape loop position ever exceeds these limits. The next two holes represent a 110 percent signal to the reel servos and the innermost two holes represent a 90 percent signal to the reel servos. In continuous forward operation the tape should just ride on the upper 110 percent hole in the top chamber and on the upper 110 percent hole in the lower chamber. When operated in reverse, the tape should just ride on the lower 110 percent hole in the upper chamber and on the lower 110 percent hole in the lower chamber.

The Vacuum Interlock switches are connected in series and connect the Tape Control K PCBA via J506 and J507 (sheet 4, zone F8). When tape is in the proper position in both the upper and lower chambers, the switches are closed and ground is felt at the base of Q55

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(sheet 4, zone F7). The circuitry associated with Q55 controls the rise and fall times of the interlock signal and hence its noise immunity and pulse duration. It can be seen that, except for NTENCNT and NUNLOAD1, the Interlock directly controls the K1 relay driver via U6-8 (IL2), U14-12, U14-6, and NPICK K1. Loss of interlock forces a master clear to all of the logic either directly via LOCK A (sheet 4, zone G2) or indirectly via the K1 relay contact initiating a Master Reset.

The File Protect/Write Enable microswitch is used to sense the presence of a write enable ring on the supply reel. If the ring is present, the microswitch (sheet 4, zone F8) is closed and transistor Q57 (sheet 4, zone B6) is turned on. Thus the driver circuit causes the sensing arm of the switch to be retracted, preventing it from rubbing on the ring. The switch closure also acts to present +5v to the Write Power circuitry via J503 pin 4 which, in turn, is enabled by the logic.

Another basic manual input is the ON LINE command. Activating the ON LINE switch/indicator changes the state of flip-flop U54-5 (sheet 6, zone C7). Assuming tape is properly loaded and U54-5 is set, gate U53-8 enables the ON LINE signal to appear at the output of OLD (sheet 6, zone D1). With OLD high, all manual controls (except ON LINE) are inhibited and the interface lines are enabled. Depressing the ON LINE switch again resets U54-5 and returns the unit to the Off-line state.

Tape motion is accomplished logically in three basic ways.
    (1) Automatic control initiated by an external command other than ISFC or ISRC.
    (2) Manual control using the Maintenance Switch.
    (3) Interface control using ISFC or ISRC.
All of these methods control the capstan motion control signals originating at NFWD (sheet 6, zone G1) or NREV (sheet 6, zone H1). NFWD represents a Forward command and NREV represents a Reverse command. They are mutually exclusive. The automatic control is initiated via a command such as LOAD or REWIND and the prescribed logical sequence of signals cause NFWD or NREV to provide the proper motion.

This motion is exclusive of the reel servo controlled motion described for the LOAD Operation. During LOAD, the motion is represented by U38-6 going low causing the search for BOT. In REWIND the motion is activated by NR1 going low causing the initial reverse direction motion and later NLDLOOP going low causing the search for BOT after rewind.

Manual control is achieved via the Maintenance switch located at the top of the Tape Control PCBA. It is active only in the Off-line, Ready condition. Positioning the switch toward the machine causes the tape to move forward; positioning the switch away from the machine causes the tape to move in reverse.

Interface control is accomplished via the ISFC and ISRC lines. These lines are active only in the On-line, Ready and Selected conditions.

A MOTION (sheet 6, zone G1) signal is generated whenever the capstan is signalled to move via the interface. GO (sheet 6, zone G1) is used to strobe the ISWS and the IOVW commands. Another motion signal, MOT (sheet 6, zone G1), is used to tell the reel servos when the capstan is stopped or is stopping.

A REWIND command may be initiated automatically, manually, or via the interface, or automatically as a result of loading. Tape Rewind is automatic if BOT is not sensed in 7 seconds, during the Tape Load mode. A manual command is accomplished by activating the REWIND switch/indicator when the unit is Off-line and not at BOT. An interface command to rewind is accomplished via IRWC when the unit is On-line, Ready, Selected,

and not at BOT. Either method activates the rewind control logic by setting U50-5, U50-9 (RW1), U51-9 (sheet 5, zone F6, F7). RW1 high and U51-9 low creates a negative pulse at U53-11 (sheet 5, zone F5) which activates the rewind status logic by setting U29-5 and U29-9 (sheet 5, zone D5). Setting U29-5 (NRS1) activates a reverse motion command to the capstan (NREV, sheet 6, zone H1) and tape begins to move in the reverse direction.

If the BOT is encountered, U29-9 is reset on the trailing edge of the BOT thus resetting U29-5 via U23-8, U11-6, U32-6 and U28-5, and U28-9 directly. If the BOT is not encountered within 1 second, U36-9 sets and enables NK2ENERG to go low. U11-6 going high activates U30-9 and U30-5 (sheet 5, zone B4) and enables NRWFWD to go low at U23-6. NRWFWD low causes a Forward command to the capstan to search for the BOT. When the BOT is encountered the second time, NRWFWD goes high and tape motion ceases. U50-5, U50-9 and U51-9 are reset and the rewind is complete.

If the BOT was not encountered within 1 second, U36-9 (sheet 5, zone D3) is set and enables NK2ENERG to go low. NK2ENERG low activates relay K2 and + 23v dc is applied to the reel motors. If the BOT is encountered before another 0.5 second elapses, the terminating sequence described in the preceding paragraph occurs. If not, U36-5 is set enabling NREWRI low. NREWRI low signals the capstan to go into fast reverse via the rewind ramp. The tape proceeds in fast reverse until the BOT is encountered which resets U29-9, U28-5, U28-9 and U36-5. U36-5 reset causes NREWRI to go high shutting off the fast rewind signal to the capstan.

An UNLOAD command may also be initiated either manually or via the interface. A manual command is accomplished by activating the REWIND switch/indicator when tape is at BOT. If the tape is not at BOT, depressing the REWIND switch/indicator once executes the Rewind operation; depressing it twice causes an Unload to occur after the Rewind.

An interface command is executed via IRWU (sheet 4, zone B8) when the unit is On-line, Ready, and Selected.

Either method activates the Rewind control logic in a similar manner. If the tape is not at BOT a rewind operation is executed as previously described in the discussion of a rewind operation. If the tape is at BOT, the unload is started with RW1 (sheet 5, zone G1) reset and U51-5 (sheet 5, zone F5) set. This forces NDUN (sheet 5, zone F1) low via U27-6. NDUN going low resets the vacuum signal via U37-6 (sheet 5, zone F4), U20-4, U22-6, and U20-6 (VPA). If the command is executed via the interface, the unit is immediately taken off-line via NOLUNL, U53-6 and U52-6 which resets U54-5 (sheet 6, zone C7).

When U46-9 (sheet 5, zone F4) sets (delayed via U51-5 and U46-5) approximately 0.5 second after Unload is started, UNLOAD (sheet 5, zone G1) goes high and signals the supply reel motor to run slowly in reverse. NUNLOAD going low turns on the current limit (CURLIM) on the reel motors and supplies tension through NTNA. The condition is similar to the Load condition except that the UNLOAD signal allows tension to be applied only to the supply reel while the takeup reel *free wheels*.

Tape is wound onto the supply reel and finally pulled through the tape path. With no tape in path, both EOT and BOT sensors go high because of a reflector opposite the sensor in the tape path. This causes TIP (sheet 5, zone H8) to go low, resetting U51-5 via U53-3 and U52-12. Approximately 0.5 second later, U46-5 resets and relay K1 is de-energized, thus stopping the supply motor.

WRITE/READ commands are accomplished only via the interface by use of ISWS, IOVW, IWARS, and the data lines. The control signals generated for writing data are based on the unit being On-line, Ready and Selected, a write enable ring installed to the supply reel, and the proper interface signals for writing are received.

It is important to note that the unit is always reading except when writing, and requires no special signals to enable the Read mode other than the ones required to take the unit out of the Write mode.

A Write operation is accomplished via IOVW or ISWS (sheet 4, zone C8) as defined by the interface specification. The IOVW/ISWS signal is strobed into the write enable logic U15-9 and U15-5 by the GO signal (sheet 4, zone G8). This enables the Write Enable signal to go low (U4-5) via U21-8 or U21-3 and U21-11. U4-5 going low activates the Write Power circuitry associated with Q59 (sheet 4, zone B5) and power is applied to the data electronics write circuitry. In the Overwrite mode, the turn-off of the Write Enable is controlled by the IWARS pulse which resets U22-9 and disables U21-8.

Capstan operation is initiated via the Motion Control portion of the logic. Forward motion is obtained when NFWD (sheet 6, zone G1) is low and reverse motion is obtained when NREV (sheet 6, zone H1) is low. Rewind occurs when NREWRI (sheet 5, zone D1) from the Rewind Status portion of the logic and NREV are low together.

Forward motion is activated by NFWD turning off Q43 (sheet 3, zone G7) which allows current to flow out of the non-inverting input of U68. This forces U68-6 negative but clamped to approximately 6.6v as determined by zener diode VR2 and the diode bridge. U67 goes positive according to the time constant established by R168, R169, and C25. R158 provides U69 with a sense of the ramp output voltage to fix it at a constant voltage determined by the divider R156, R157 and R165, approximately 5v. U66 also senses this voltage and turns on the appropriate FET to feed the proportional current to the summing junction of U64. For Forward motion this voltage is positive, causing U66 to go negative, turning Q47 on. Q47 in its on state applies + 10v to the gate of FET Q45, allowing positive current into the summing junction as determined by the adjustment of R172.

Potentiometer R172 is used to adjust the steady state forward speed and potentiometer R174 is used to adjust the reverse speed.

Capstan rotation produces a voltage which is proportional to the speed of the capstan tachometer. This voltage (pin 2 of J508) appears across the network associated with R152 and R153 (sheet 3, zone H5) and injects a current to produce constant velocity control. It should be noted that, for forward motion, the tachometer input to the board is negative and, for reverse motion, this input is positive.

In the execution of a Rewind operaton, a REVERSE command is first received by the capstan via NREV. Approximately one second later NREWRI is forced low, activating the rewind ramp. The rewind ramp output is added to the currents at the summing junction of U64. This occurs when NREWRI goes low turning off Q53 and subsequently turning on Q54. Q54 saturates to − 5v which draws current out of the non-inverting input of U65 according to the time constant established by R208, R209, and C32. This ramp time constant is several seconds in duration. The output of U65 going negative causes a negative current to flow from the summing junction of U64 as determined by R213. R213 is adjusted to achieve the desired rewind speed.

Zero bias is achieved by adjusting R179 (sheet 3, zone F5). This compensates for any constant offset found in the capstan servo when it is stopped.

For Forward motion the net current into the summing junction of U64 is positive and the output goes negative. U64 going negative turns on Q50 which turns on Q52 and causes the output of the power amplifier to go negative. This negative voltage at J6 causes forward tape motion by the capstan.

The reel servos respond to tape motion initiated by the capstan or they can initiate their own tape motion via auxiliary circuitry which is used for Load, Unload, and Stop stabilization. The normal velocity control mode for the reel servos utilizes the vacuum switches, reel tachometers, reel ramp generators, summing amplifiers, and power amplifiers.

For normal velocity control operation, tape motion is initiated by the capstan. As the tape moves on the vacuum chamber it crosses into the 90 percent region and opens the appropriate vacuum switch. The switch opening ungrounds J506-5 (sheet 2, zone G8) and the resistors in the network preceding U71.

NOTE

The operation principle is identical for both reel servos and directions of motion; therefore, only the supply servo in forward motion will be described.

Figure 5-2 shows the equivalent operating circuit of U71 (sheet 2, zone G6). The percentage regions are defined according to this equivalent circuit. The 100 percent current is defined as that current which flows into the summing junction of U71 with the 90 percent switch open, the 110 percent switch closed and TP16 shorted to TP17.

With 2v at TP17 this current is approximately 82 microamperes. The 90 percent current exists when the 90 percent switch is open, the 110 percent switch is closed, and TP16 and TP17 are not tied together. The 110 percent switch current exists when the 90 percent switch is open, the 110 percent switch is open and TP16 and TP17 are not tied together. In the parking zone both switches are closed. To prevent the reel servos from allowing tape to be moved out of the parking zone (when the capstan is stopped) a current source is provided via R13 and CR1. This current is enabled whenever the 90 percent switch opens and there is insufficient voltage from the capstan tachometer to reverse-bias CR1.

U71 responds to the vacuum switch and capstan tachometer input with a ramp output. This reel ramp is determined by R15, R18, R19, and C2 (sheet 2, zone G6). Potentiometer R18 is adjusted to achieve the proper ramp as observed at TP19. The current from the ramp is established by R20 and is fed to the summing junction of U69 (sheet 2, zone F4). For forward
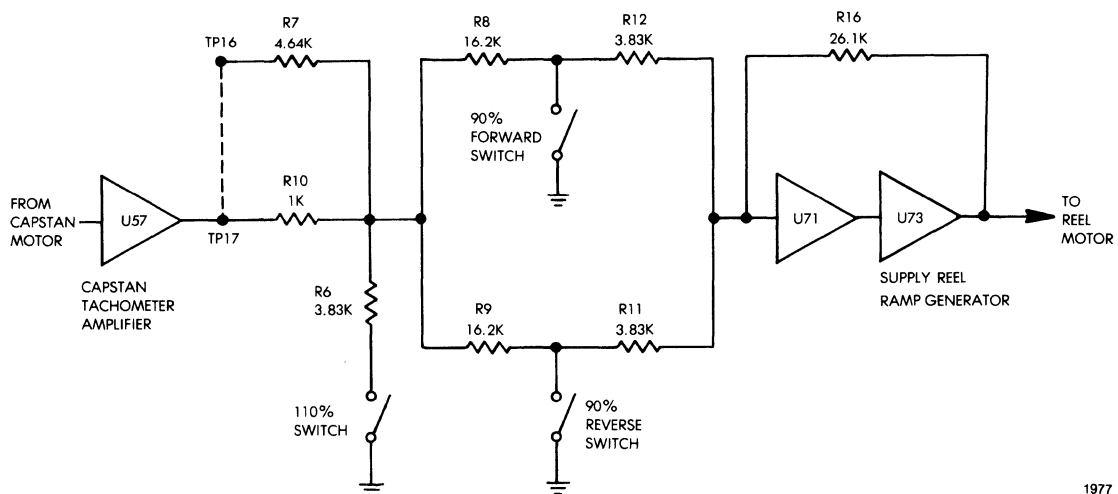
Figure 5-2. Equivalent Circuit Tape Velocity Control

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motion this ramp is negative which causes the output of U69 to go positive, turning on Q5, which turns Q2 on, which turns Q4 and Q3 on. With Q4 and Q3 conducting, a positive voltage is felt at the amplifier output J3 (sheet 2, zone F1). This positive voltage produces forward reel motion.

Reel tachometer feedback is used to control the reel motor speed. The supply tachometer output (ac) is received by the power supply, demodulated and sent to the Tape Control PCBA as a dc signal at J502 pin 2 (sheet 2, zone E8). U72 amplifies the speed proportional signal by a factor of two and potentiometer R38 (sheet 2, zone F5) is adjusted to achieve constant velocity operation at 100 percent ramp current.

The auxiliary circuitry used to control the reels during Load and Unload receive commands directly from logic control signals. Functionally, this circuitry consists of the current limiter, tension, throw loop, and unload circuitry.

For a Load operation, CURLIM (sheet 2, zone D8) goes high and NTNA (sheet 2, zone D8) goes low. The high CURLIM turns Q23 off which turns Q20 and Q39 off and allows the power amplifiers to be current limited. This current limiting is accomplished by sensing the output voltage with R53 (sheet 2, zone F3) and R151 (sheet 2, zone B1) and feeding it back to Q18 and Q38. With NTNA low, Q13 turns on, saturating the supply summing amplifier and produces a negative voltage at the Supply Power Amplifier Output J3 (sheet 2, zone F1). This negative voltage is sensed by Q18 which controls Q17 until an equilibrium point is established with approximately 0.7v across the supply motor. NTNA low also turns Q21 on, saturating the takeup reel ramp generator. This, in turn, saturates the takeup summing amplifier and produces a positive voltage at the Takeup Power Amplifier Output J4 (sheet 2, zone C1). This positive voltage is sensed by Q38 which controls Q24 until an equilibrium point is established via zener VR3 with nominally 3v across the takeup motor. At this point the tape is lightly tensioned and approximately 3 turns of leader are slowly wound onto the takeup reel.

Next, the signal to load loops is activated and the tension signal is removed. The Load Loop signal, NLDLOOP (sheet 2, zone H8), goes low which turns Q1 on. Q1 then drives the supply ramp to the appropriate load voltage which then drives the supply summing amplifier and power amplifier to the proper voltage and a positive voltage appears across the supply reel motor. Thus, the supply reel motor is forced to load tape into the vacuum chamber.

NLDLOOP low also turns on Q35 (sheet 2, zone B3) which drives the takeup ramp to the appropriate load voltage. This, in turn, drives the takeup summing amplifier and power amplifier to the proper voltage and a negative voltage appears across the takeup reel motor. Thus, the takeup reel motor is forced to load tape into the vacuum chamber.

As soon as both the upper and lower interlocks are made, the Load Loop and current limit signal is removed. At this point, tape should be properly loaded into the vacuum chamber.

For an unload operation, tape is tensioned and current limited as described in the preceding paragraphs. In addition, UNLOAD (sheet 2, zone D8) goes high. UNLOAD high modifies the current limit on the reel power amplifiers to allow the supply motor to rewind at approximately 60 rpm and the takeup motor to *free wheel* as tape is pulled off of it and onto the supply reel. This is done by UNLOAD high turning Q22 off which allows Q18 to be referenced to the zener voltage of VR1, which enables the sense voltage via R53 to go higher before current limiting is enabled. An equilibrium point is achieved with an output on the supply motor of nominally 5v. UNLOAD high also turns Q37 (sheet 2, zone A3) on which inhibits the action of Q38 and the current limiting action. Thus, the output voltage of the power amplifier is only the back-emf generated by the takeup motor being turned.

Position stabilization control uses the position output of the reel tachometers. The reel tachometer outputs are rectified in the power supply and sent to the Tape Control PCBA as Supply Position and Takeup Position (sheet 2, zone B,E8) at J502 pins 6 and 3, respectively.

When the tape is stopped in the vacuum chamber parking zone, the Position signal is position sensitive. The amplitude of the signal varies with the tachometer rotational position. This positional signal is received by R30 (sheet 2, zone E7) and gated through FET Q10 to the summing junction of U69.

Q10 (sheet 2, zone E6) is turned on whenever U70 senses that the capstan has stopped via MOT (sheet 2, zone F8) low and the tape in the parking zone. With capstan motion or tape out of the parking zone, U70 goes negative turning Q7 on which turns on Q9. Q9 conducting turns off Q10.

In order to ensure that the positional output does not try to correct the tape position outside of the parking zone and thus become trapped into alternately switching across the parking zone boundary, an additional FET is used to short the reel tachometer feedback briefly to ensure a positional *kick* far enough into the center of the parking zone away from the boundary. This is accomplished by differentiating the boundary sense generated by U70 with C9 (sheet 2, zone E6) and feeding this pulse to the gate of Q8. To prevent activation of this signal during a normal run operation, Q12 (sheet 2, zone E5) senses the negative Position signal, turning on Q12 which then turns on Q11 and prevents the pulsing of Q8.

To eliminate all constant offsets and bias associated with the reel servo stop, potentiometer R27 (sheet 2, zone E7) is adjusted to achieve zero drift in the parking zone and potentiometer R82 is used for this purpose in the takeup servo.

Three FETs, Q73, Q74, and Q75 (sheet 2, zones E1 and E2) are used to clamp the power amplifiers off while switching the relays in or out. This prevents high current surges through the relays from the amplifiers thus prolonging relay life. U76 is a one-shot which is used to turn on the reel amplifier FETs while the K2 relay switches in or out during the rewind operation.

5.2.2 POWER SUPPLY G1 PCBA

The following is a description of the T9000 Power Supply G1 PCBA which may be installed in the drive (refer to Schematic No. 104582 and Assembly No. 104579).

The power supply converts the primary ac line voltage into the proper dc voltage levels required for operation. Additionally, auxiliary circuits are provided for control of the ac motor used in the drive. Figure 5-3 shows the placement of each connector and test point on the PCBA.

Primary line voltage is received from the primary power plug through the power switch (S1) and line fuse F401 at J604 (zone G22) and is routed via the transformer coded plug to the chassis-mounted power transformer. The coded plug is wired to facilitate various line voltage implementations. The ac motor coded plug connects the ac blower circuitry either in parallel (95v—125v) or in series (190v—250v). Details of the primary power configurations are given in Paragraph 4.3.4.

The power transformer secondary is rectified to produce the four basic unregulated voltages, +23v, −23v, +12v, −12v. These unregulated voltages are processed by four regulators to produce +10v, −10v, +5v, and −5v regulated supplies.

Unregulated +12v is used to obtain the +5v regulated voltage used in the unit. This unregulated +12v is obtained by rectifying the 12v ac from the power transformer with the
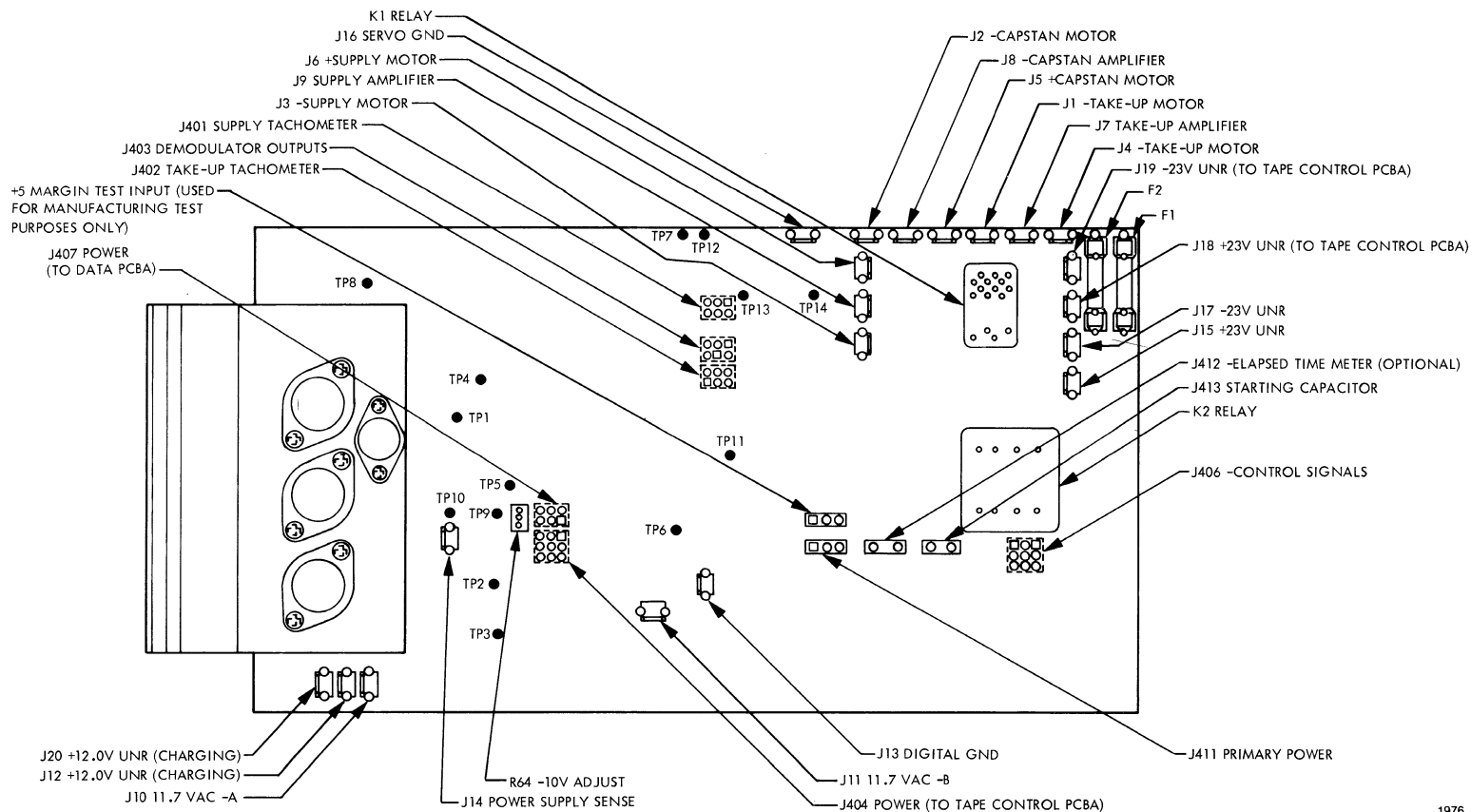
K1 RELAY
J16 SERVO GND
J6 +SUPPLY MOTOR
J9 SUPPLY AMPLIFIER
J3 -SUPPLY MOTOR
J401 SUPPLY TACHOMETER
J403 DEMODULATOR OUTPUTS
J402 TAKE-UP TACHOMETER
+5 MARGIN TEST INPUT (USED FOR MANUFACTURING TEST PURPOSES ONLY)
J407 POWER (TO DATA PCBA)

J2 -CAPSTAN MOTOR
J8 -CAPSTAN AMPLIFIER
J5 +CAPSTAN MOTOR
J1 -TAKE-UP MOTOR
J7 TAKE-UP AMPLIFIER
J4 -TAKE-UP MOTOR
J19 -23V UNR (TO TAPE CONTROL PCBA)
F2
F1
J18 +23V UNR (TO TAPE CONTROL PCBA)
J17 -23V UNR
J15 +23V UNR
J412 -ELAPSED TIME METER (OPTIONAL)
J413 STARTING CAPACITOR
K2 RELAY
J406 -CONTROL SIGNALS

TP7 TP12
TP8
TP13 TP14
TP4
TP1
TP11
TP5
TP10 TP9
TP6
TP2
TP3

J20 +12.0V UNR (CHARGING)
J12 +12.0V UNR (CHARGING)
J10 11.7 VAC -A

R64 -10V ADJUST
J14 POWER SUPPLY SENSE

J13 DIGITAL GND
J11 11.7 VAC -B
J404 POWER (TO TAPE CONTROL PCBA)

J411 PRIMARY POWER

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Figure 5-3. Power Supply G1 PCBA, Test Point and Connector Placement

bridge rectifier CR30 (zone G17) and filtering it with chassis mounted capacitor C403. R14 acts as a *bleeder* resistor to speed the turnoff discharge. Capacitors C4 and C5 reduce the crossover noise associated with the bridge rectification.

A Type 723 temperature compensated IC regulator U4 (zone F15) is used to control the series regulator transistor Q4 (zone G14) and to produce + 5v at its emitter. Regulated + 5v is supplied to J404 pin 8, J407 pin 4, and J408 pin 2. The voltage is established via the reference resistor divider network R31 and R32. Current foldback is employed to limit the maximum current passed by Q4 to 4 amps. This current is sensed by R29 and compared to the current limit established by the resistor reference network R34 and R35.

Overvoltage protection of the regulated + 5v supply is provided by an SCR crowbar circuit. When the voltage on the emitter of Q6 (zone F14) exceed the zener voltage on its base by more than 0.7v, SCR Q30 (zone F13) is fired, providing a short circuit path to ground for the + 5v supply. U4 senses this excess current drain and reduces the voltage at the emitter of Q4 until an equilibrium value is established, nominally approximately 1.2v. This crowbar condition will remain until power is removed which allows the SCR to reset.

Unregulated − 12v is used to obtain the − 5v regulated voltage used in the unit. This unregulated − 12v is obtained by rectifying the 12v ac from the power transformer with CR30 (zone G17) and filtering it with board-mounted capacitor C3. R11 acts as a *bleeder* resistor to speed the turnoff discharge.

A Type 741 operational amplifier U2 (zone E15) is referenced to the + 5v regulator reference and is used to control the series regulator transistor Q10 (zone E14). The voltage is established via the reference resistor divider network R39 and R40, R41. Current foldback is employed to limit the maximum current passed by Q10 to 1 amp. This current is sensed by R49 and compared to the current limit established by the resistor reference network R42 and R45.

Overvoltage protection is provided to the regulated − 5v supply by an SCR crowbar circuit. When the voltage on the base of Q7 (zone F13) exceeds − 0.7v, SCR Q31 (zone F13) is fired, providing a short circuit path to ground for the − 5v supply. U2 and its associated transistors Q8 and Q9 sense this excess current drain and reduce the voltage at the emitter of Q10 until an equilibrium value is established, nominally approximately 1.2v. This crowbar condition remains until power is removed which allows the SCR to reset.

Unregulated + 23v is used to obtain the + 10v regulated voltage used in the unit. This unregulated + 23v is obtained by rectifying the 23v ac from the power transformer with the chassis mounted bridge rectifier CR401 (zone F20) and filtering it with chassis mounted capacitor C402. R9 acts as a *bleeder* resistor to speed the turnoff discharge.

Fuse F1 (zone E16) is a 15 amp slowblow fuse which protects all circuitry using the + 23v unregulated voltage (in the power supply and on the Tape Control PCBA).

A Type 723 temperature compensated IC regulator U3 (zone D15) is used to control the series regulator transistor Q12 (zone D14) and to produce + 10.5v at its emitter. Regulated + 10v is supplied to J404 pins 6 and 7, and J407 pin 3. The + 10v can be measured at TP5. The voltage is established via the reference resistor divider network R55, R56, and R62. Current foldback is employed to limit the maximum current passed by Q12 to 1.5 amps. This current is sensed by R54 and compared to the current limit established by the resistor reference network R60 and R61.

Unregulated − 23v is used to obtain the − 10 regulated voltage used in the unit. This unregulated − 23v is obtained by rectifying the 23v ac from the power transformer with the

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chassis mounted bridge rectifier CR401 (zone F20) and filtering it with chassis mounted capacitor C401. R10 acts as a *bleeder* resistor to speed the turnoff discharge.

Fuse F2 (zone D16) is a 15 amp slowblow fuse which protects all circuitry using the − 23v unregulated voltage both in the power supply and on the Tape Control PCBA.

A Type 741 operational amplifier U1 (zone B15) is referenced to the + 10v regulator reference and is used to control the series regulator transistor Q16 (zone B14). Regulated − 10v is supplied to J404 pins 3 and 4, and J407 pin 1. The − 10v can be measured at TP6. The voltage is established via the reference resistor divider network R58, R64, R65, and R67. R64 is a potentiometer which allows the − 10v to be adjusted to achieve precise symmetry required between + 10v and − 10v.

Current foldback is employed to limit the maximum current passed by Q16 to 1.5 amps. This current is sensed by R77 and compared to the current limit established by the resistor reference network R71 and R73.

Three separate functional areas are provided within the Power Supply G-1 PCBA for control of the ac and dc motors; these are: ac motor control, oscillator-demodulator, and relay and relay driver circuitry.

The ac vacuum motor is controlled by the logic via a TRIAC and its associated firing circuitry. VPA is the enabling signal received from the logic via J406 pin 2 (zone H11). This signal allows the enable signal generated by the zero-crossover circuitry via U9 (zone F11) to fire the TRIAC firing circuit Q1, Q2 and related components. The zero crossover circuitry, CR3, CR4, R15, and R16 (zone C18) detects when the ac line voltage is approximately zero and, at this time, enables the TRIAC to turn on without having a large surge of current flow through it. The crossover pulses are sensed by a line voltage dropout detector U12 (zone C16), which signals the logic via the PS signal at J406 pin 1 that more than 3 cycles of the ac line are missing. U12 is a retriggerable one-shot whose output is high as long as it is retriggered within the time constant determined by R19, R20, and C7.

The vacuum motor control TRIAC Q29 (zone E19) is turned on by Q1. Q1 is controlled by Q2 and the opto-isolator U8. U8 is used to separate line voltages from the logic and servo ground systems. The motor also uses two chassis mounted starting capacitors C404 and C405 (zone B21). These capacitors, as well as the motor windings, are connected in parallel for low voltage (95—125v ac) operation and in series for high voltage (190—250v ac) operation.

The reel servos use ac tachometers to supply velocity and position information. The field exitation for these tachometers is provided by an 800-Hz squarewave oscillator located on the Power Supply PCBA. A Type 741 operational amplifier U7 (zone D12) is used as the preamplifier and oscillates at a rate determined by C27, R79, R80 and R78. U7 drives a push-pull power amplifier Q18, Q19 whose output power transistors Q17 and Q20 saturate to + 10v and − 10v, respectively. The power amplifier drives the two ac tachometer fields and the pulse transformer (T1) primary (zone D11).

Two forms of signal processing are used to recover the information from the tachometers. A quadrature detector, or synchronous demodulator, is used to recover the velocity information, and a rectifier is used to recover the position information.

The synchronous demodulator uses the secondary windings of the pulse transformer T1 to control the base currents of Q21, Q22, Q23, and Q24 (zone D10) in the supply tachometer and Q25, Q26, Q27, Q28 (zone C10) in the takeup tachometer. The outputs at J403-2 and

J403-1 represent the 800-Hz fullwave rectified signal depicted in Figure 5-4. The amplitude of the signal is proportional to the speed of the generator and the polarity indicates forward or reverse direction.

The rectifiers use Type 741 operational amplifiers U5 and U6 (zone D9, C9) to overcome the diode's dead zone and rectify the null output signal during standby. The signal, shown in Figure 5-5, is halfwave rectified and is provided at J403-6 for supply position, and J403-3 for takeup position. The amplitude of the signal is proportional to shaft position on the generator with 4 maximum and minimum points per 360 degrees of mechanical rotation.

Two relays are used to control the operation of the three dc motors used in the drive. K1 (zone F9) is used by the reel motors and the capstan motor and connects the motors either to their respective amplifiers or to ground. K1 is driven by a Type 75452 driver U10-5 (zone G10) which is activated by the logic signal NPICKK1 at pin 3 of J406. When NPICKK1 is low and PS signal is high, the relay is activated and the motors are tied to their respective amplifiers on the Tape Control PCBA.

K2 is used only by the reel motors to supply the additional voltage required for fast rewind operation. K2 is driven by a Type 75452 driver U10-3 (zone F10) which is activated by the logic signal NK2ENERG at pin 6 of J406. When NK2ENERG is low, the reel motors have their negative side tied to +23v instead of ground.

The diodes associated with the relays are used to protect the relay contacts from voltage spikes during connect and disconnect. The resistor-capacitor network reduces contact arcing. R88 provides for controlled current takeup motor stopping should the relays open while the motors are operating, e.g., loss of ac power during a rewind operation. This ensures that the supply motor will stop before the takeup motor thereby preventing the possibility of tape stretch.

5.2.3 POWER SUPPLY G2 PCBA

The following is a description of the T9000 Power Supply G2 PCBA which may be installed in the drive (refer to Schematic No. 110620 and Assembly No. 110621).

The power supply converts the primary ac line voltage into the proper dc voltage levels required for operation of the drive. Additionally, auxiliary circuits are provided for control of the ac and dc motors used in the drive. Figure 5-6 shows the placement of each connector and test point on the PCBA.
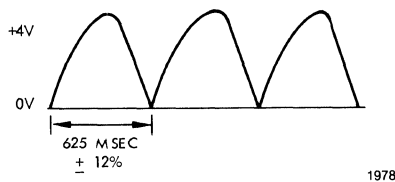
Figure 5-4. Sync Demodulator, Rectified Signal Output
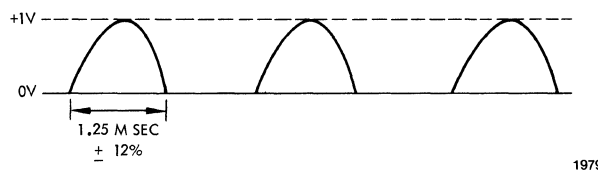
Figure 5-5. Tachometer Position Information, Rectified

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J18 +23V UNR (TO TAPE CONTROL PCBA)
J15 +23V UNR
J19 —23V UNR (TO TAPE CONTROL PCBA)
F2 —23V UNR
J16 SERVO GND
J401 SUPPLY TACHOMETER
F1 +23V UNR
J402 TAKEUP TACHOMETER
J17 —23V UNR
J403 DEMODULATOR OUTPUTS
F3 —10V

J407 POWER (TO DATA PCBA)
J404 POWER (TO TAPE CONTROL PCBA)
J14 POWER SUPPLY SENSE
J7 TAKEUP AMPLIFIER
J6 +SUPPLY MOTOR
J9 SUPPLY AMPLIFIER
J8 CAPSTAN AMPLIFIER
K1 RELAY
J2 —CAPSTAN MOTOR
J5 +CAPSTAN MOTOR

F4 +10V
J4 +TAKEUP MOTOR
J18A

TP1
TP2
TP3
TP13
TP7
TP5
TP6
TP8
TP9
TP10
TP11
TP12
TP4

J3 —SUPPLY MOTOR
J1 —TAKEUP MOTOR
J16A

F5 —5V
F6 +5V
J20 +12V UNR (CHARGING)
J11 11.2VAC—B
R36 ±10V ADJUST
R38 +5V ADJUST
R39 —5V ADJUST
J12 +12V UNR (CHARGING)
J10 11.2VAC—A
J13 DIGITAL GND

K3 RELAY
K2 RELAY
J406 CONTROL SIGNALS
J412 PRIMARY POWER
J413 ELAPSED TIME METER (OPTIONAL)
J411 STARTING CAPACITOR

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Figure 5-6. Power Supply G2 PCBA, Test Point and Connector Placement

Primary line voltage is received from the primary power plug through the power switch (S1) and line fuse F401 at J604 (sheet 2 zone D5) and is routed via the transformer coded plug to the chassis-mounted power transformer. The coded plug is wired to facilitate various line voltage implementations. The ac motor coded plug connects the ac blower circuitry either in parallel (95v—125v) or in series (190v—250v). Details of the primary power configurations are given in Paragraph 4.3.4.

The power transformer secondary is rectified to produce the four basic unregulated voltages, +23v, −23v, +12v, −12v. These unregulated voltages are processed by four regulators to produce +10v, −10v, +5v, and −5v regulated supplies.

Unregulated +12v is used to obtain the +5v regulated voltage used in the drive. This unregulated +12v is obtained by rectifying the 12v ac from the power transformer with the bridge rectifier CR29 (sheet 3 zone D5) and filtering it with chassis mounted capacitor C403. R56 acts as a *bleeder* resistor to speed the turnoff discharge. Capacitors C33 and C34 reduce the crossover noise associated with the bridge rectification.

A Type LM317 temperature compensated IC regulator VR4 (sheet 3 zone D4) is used to control the series regulator transistor Q19 (sheet 3 zone D4) and to produce +5v at its collector. Regulated +5v is supplied to J404 pin 8 and J407 pin 4. The voltage is established via the reference resistor divider network R49 and R38. A current limiting circuit internal to VR4 is employed to limit the current through the regulator to 2.2 amperes and the total output current to 4 amperes. Additional overcurrent protection is provided by 4 ampere, fast blow fuse F6.

Overvoltage protection of the regulated +5v supply is provided by an SCR crowbar circuit. When the voltage on the emitter of Q15 (sheet 3 zone D2) exceeds the base voltage by more than 0.7v, SCR Q14 (sheet 3 zone D2) is fired, providing a short circuit path to ground for the +5v supply. This crowbar condition will remain until power is removed which allows the SCR to reset.

Unregulated −12v is used to obtain the −5v regulated voltage used in the drive. This unregulated −12v is obtained by rectifying the 12v ac from the power transformer with CR29 and filtering it with board-mounted capacitor C35. R57 acts as a *bleeder* resistor to speed the turnoff discharge.

A Type LM337 IC, VR3, is used, in conjunction with reference resistor divider network R39 and R48, to produce −5v. A current limiting circuit internal to VR3 is employed to limit the maximum current to 2.2 amperes. Additional overcurrent protection is provided by 1 ampere, fast blow fuse F5. If the current level goes to a point where regulator limiting occurs, and remains at that level, the fuse will blow.

Overvoltage protection is provided to the regulated −5v supply by an SCR crowbar circuit. When the voltage on the base of Q16 (sheet 3 zone C3) exceeds −0.7v, SCR Q13 (sheet 3 zone C2) is fired, providing a short circuit path to ground for the −5v supply. This crowbar condition remains until power is removed which allows the SCR to reset.

Unregulated +23v is used to obtain the +10v regulated voltage used in the drive. This unregulated +23v is obtained by rectifying the 23v ac from the power transformer with the chassis mounted bridge rectifier CR401 (sheet 2 zone C3) and filtering it with chassis mounted capacitor C402. R10 acts as a *bleeder* resistor to speed the turnoff discharge. Fuse F1 (zone E16) is a 15 amp slowblow fuse which protects all circuitry using the +23v unregulated voltage (in the power supply and on the Tape Control PCBA).

A Type LM317 temperature compensated IC regulator VR2 (sheet 3 zone C4) is used to provide the + 10.5v output. Regulated + 10v is supplied to J404 pins 6 and 7, and J407 pin 3. The + 10v can be measured at TP6. The voltage is established via the reference resistor divider network R33 and R35. A current limiting circuit internal to VR2 is employed to limit the maximum current to 2.2 amperes. Additional overcurrent protection is provided by 1.6 ampere, fast blow fuse F4. If the current level goes to a point where regulator limiting occurs, and remains there, the fuse will blow.

Unregulated − 23v is used to obtain the − 10v regulated voltage used in the drive. This unregulated − 23v is obtained by rectifying the 23v ac from the power transformer with the chassis mounted bridge rectifier CR401 (sheet 2 zone C3) and filtering it with chassis mounted capacitor C401. R9 acts as a *bleeder* resistor to speed the turnoff discharge. Fuse F2 (sheet 3 zone B5) is a 15 amp slowblow fuse which protects all circuitry using the − 23v unregulated voltage both in the power supply and on the Tape Control K PCBA.

A Type LM337 IC regulator VR1 (sheet 3, zone B4) is used to provide the − 10v output. Regulated − 10v is supplied to J404 pins 3 and 4, and J407 pin 1. The − 10v can be measured at TP1. The voltage is established via the reference resistor divider network R37 and R22. A current limiting circuit internal to VR1 is employed to limit the maximum current to 2.2 amperes. Additional overcurrent protection is provided by 1.6 ampere, fast blow fuse F3. If the current level goes to a point where regulator limiting occurs, and remains there, the fuse will blow.

Tracking between the + 10v regulator and the − 10v regulator is accomplished using a comparator circuit that consists of a Type 741 operational amplifier U4 (sheet 3, zone B4), a pair of matched resistors R23 and R34, and ± 10v adjustment potentiometer R36. The regulator adjustment terminals are connected to the output of U4. U4 provides a potential on which the regulator adjustment terminals float. The summed regulator outputs are then compared to the power supply common. Thus, any change in the output of one regulator causes an opposite change at the adjustment terminal and a corresponding change in the output of the other regulator. The balance between the two regulator outputs is adjusted by means of R36.

Three separate functional areas are provided within the Power Supply G2 PCBA for control of the ac and dc motors; these are: ac motor control, oscillator-demodulator, and relay and relay driver circuitry.

The ac vacuum motor is controlled by the logic via a triac and its associated firing circuitry. VPA is the enabling signal received from the logic via J406 pin 2 (sheet 4 zone D6). This signal allows the enable signal generated by the zero-crossover circuitry via U9 (sheet 4 zone C6) to fire the triac firing circuit Q17, Q18 and related components. The zero-crossover circuitry, CR31, CR32, R66, and R67 (sheet 3 zone B7) detects when the ac line voltage is approximately zero and, at this time, enables the triac to turn on without having a large surge of current flow through it. The crossover pulses are sensed by a line voltage dropout detector U6 (sheet 3 zone A5), which signals the logic via the PS signal at J406 pin 1 that more than 3 cycles of the ac line are missing. U6 is a retriggerable one-shot whose output is high as long as it is retriggered within the time constant determined by R52, R53, and C30.

The vacuum motor control triac Q20 (sheet 3 zone B7) is turned on by Q18. Q18 is controlled by Q17 and the opto-isolator U5. U5 is used to separate line voltages from the logic and servo ground systems. The motor also uses two chassis mounted starting capacitors C404 and C405 (sheet 2 zone A6). These capacitors, as well as the motor windings, are connected in parallel for low voltage (95—125v ac) operation and in series for high voltage (190—250v ac) operation.

The reel servos use ac tachometers to supply velocity and position information. The field excitation for these tachometers is provided by an 800-Hz squarewave oscillator located on the Power Supply PCBA. A Type 741 operational amplifier U3 (sheet 4 zone B7) is used as the preamplifier and oscillates at a rate determined by C6, R16, R17 and R18. U3 drives a push-pull power amplifier Q5, Q10 whose output power transistors Q11 and Q12 saturate to + 10v and − 10v, respectively. The power amplifier drives the two ac tachometer fields and the pulse transformer (T1) primary (sheet 4 zone B6).

Two forms of signal processing are used to recover the information from the tachometers. A quadrature detector, or synchronous demodulator, is used to recover the velocity information, and a rectifier is used to recover the position information.

The synchronous demodulator uses the secondary windings of the pulse transformer T1 to control the base currents of Q1, Q2, Q6, and Q7 (sheet 4 zone B4) in the supply tachometer, and Q3, Q4, Q8, and Q9 (sheet 4 zone A4) in the takeup tachometer. The outputs at J403-2 and J403-1 represent the 800-Hz fullwave rectified signal depicted in Figure 5-4. The amplitude of the signal is proportional to the speed of the generator and the polarity indicates forward or reverse direction.

The rectifiers use Type 741 operational amplifiers U1 and U2 (sheet 4 zone B4,A4) to overcome the diode's dead zone and rectify the null output signal during standby. The signal, shown in Figure 5-5, is halfwave rectified and is provided at J403-6 for supply position, and J403-3 for takeup position. The amplitude of the signal is proportional to shaft position on the generator with 4 maximum and minimum points per 360 degrees of mechanical rotation.

Three relays are used to control the operation of the three dc motors used in the drive. K1 and K2 (sheet 4 zone C3,D3) are used by the reel motors and the capstan motor and connect the motors either to their respective amplifiers or to ground. K1 and K2 are driven by a Type 75452 driver U7-5 (sheet 4 zone D5) which is activated by the logic signal NPICKK1 at pin 3 of J406. When NPICKK1 is low and PS signal is high, the relays are activated and the motors are tied to their respective amplifiers on the Tape Control PCBA.

K3 is used only by the reel motors to supply the additional voltage required for fast rewind operation. K3 is driven by a Type 75452 driver U7-3 (sheet 4 zone D5) which is activated by the logic signal NK2ENERG at pin 6 of J406. When NK2ENERG is low, the reel motors have their negative side tied to + 23v instead of ground.

The diodes associated with the relays are used to protect the relay contacts from voltage spikes during connect and disconnect. The resistor-capacitor network reduces contact arcing. R19 provides for controlled current takeup motor stopping should the relays open while the motors are operating, e.g., loss of ac power during a rewind operation. This ensures that the supply motor will stop before the takeup motor thereby preventing the possibility of tape stretch.

5.2.4 DATA F PCBA

The following is a description of the Data F PCBA, used with the Model T9640 (dual stack) drive. (Refer to Schematic No. 101345 and Assembly No. 101346).

The Data F PCBA is 406.4 mm (16 inches) long and 220.7 mm (8.69 inches) wide with edge connectors at each end along one edge. Figure 5-7 illustrates the placement of each connector and test point. J102 and J103 are the interface connectors. There are three additional connectors on the Data F: J8 is used to connect power and control signals from the Tape Control PCBA, J1 and J2 are the connectors into which the write and read head cables plug.
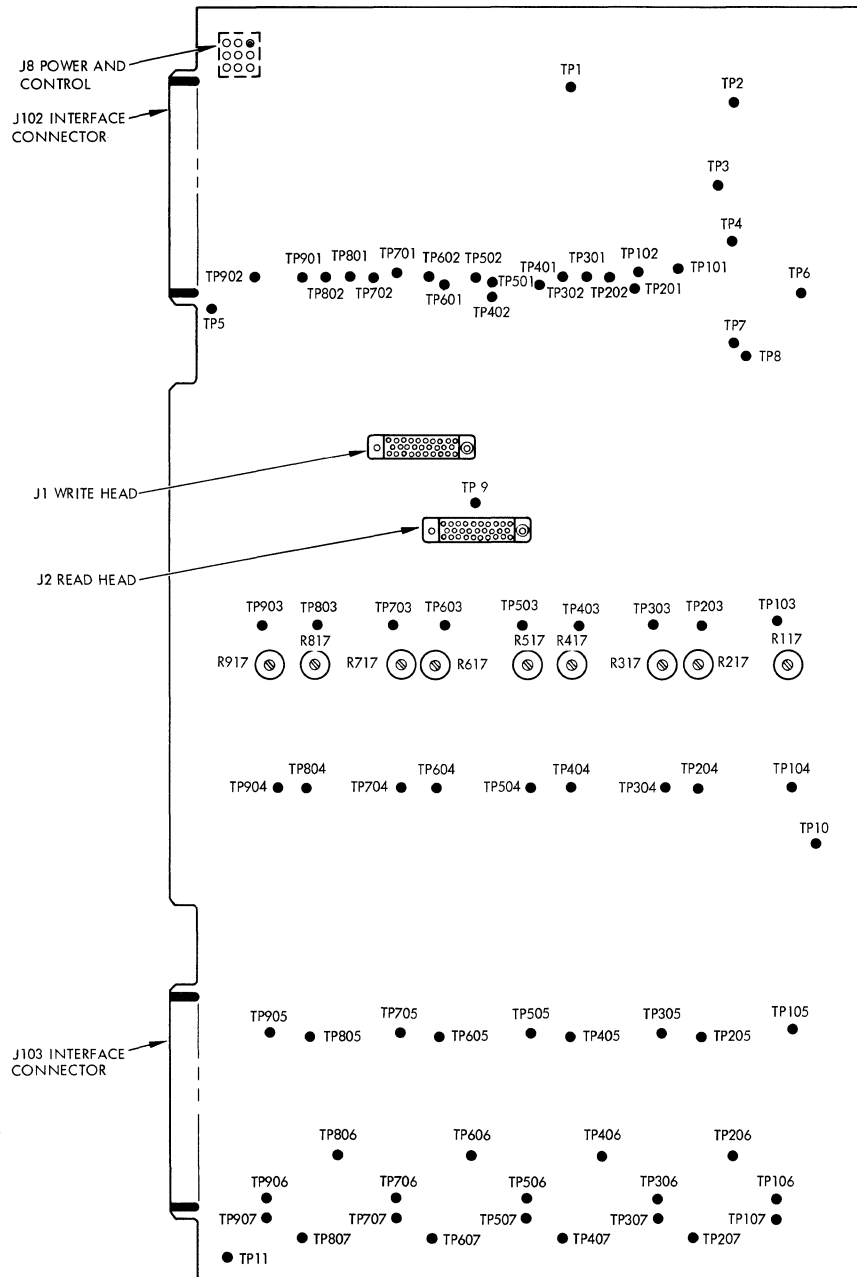
Figure 5-7. Data F PCBA, Test Point and Connector Placement

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The PCBA operation is described with reference to circuit 100, which is identical to circuits 200 through 900. All interface signals relevant to writing data (nine WRITE DATA signals, (IWD0, etc.), and WRITE DATA STROBE (IWDS)), enter via J102 and are terminated by a resistor combination and an IC inverter.

Referring to circuit 100, the WRITE DATA PARITY (IWDP) data line is terminated by resistors R101, R102, and inverter U6-E. IWDP (TP3) and its complement are applied to the J and K inputs of write buffer flip-flop U8-A. At the trailing edge of IWDS, which is applied to the toggle input of U8-A from power gate U10-A, flip-flop U8-A copies in the inverse of IWDP.

The outputs of the write buffer flip-flop drive write amplifier transistors Q101 and Q102, whose emitters are taken to + 5v when the WRT PWR line (J8-4) is high. The transistor connected to the low (approximately 0v) output of the flip-flop will conduct and a current will flow in the associated half of the head winding. The center taps of all the windings are connected to the collector of Q3 which goes to − 5v when the NWRT signal is false, i.e., the drive is in the Write mode. When the WRT PWR line is low (approximately 0v) or the NWRT signal is true, writing is inhibited because the write amplifier transistors cannot conduct. Similarly, the erase current supplied by transistor Q1 is inhibited when the WRT PWR line is low or the NWRT signal is true. In operation, the write current is defined by resistors R107 and R108. R109 is the associated damping resistor.

To improve the writing characteristics at 126 fr/mm (3200 frpi) the write compensation capacitors C101 and C102 are used to cause an overshoot of current on each leading edge.

The head windings are phased so that the output of the write buffer flip-flops, when reset, cause current to flow in the standard *erase* direction. The write buffer register is held reset unless the drive is in the Write mode (NWRT is low) and the tape is moving (MOTION, J8-6, is high).

The IWARS signal is received by resistors R22 and R23 but is not used on the Data F PCBA. A jumper from J102-C (Data PCBA) to J101-15 (Tape Control PCBA) routed IWARS to the Overwrite circuitry on the Tape Control PCBA. IWARS is issued at the end of writing the postamble and is used in conjunction with IOVW to reset the WRT flip-flop on the Tape Control PCBA. The purpose of this is to turn off the write and erase current so that the adjacent record will not be erased during an overwrite operation.

When reading data from tape, signals from the read head at a level of 5 to 15 millivolts are fed, via connector J2, to the read amplifier (U16-B) which is one-half of a dual operational amplifier IC. The amplifier output is maintained close to 0v in the absence of an input signal by the feedback path of resistors R114 and R116. The cutoff frequency of the amplifier is determined by C104 and R114. The operating gain of the amplifier is defined by resistor network R114, R116, and R117. R117 is a variable resistor used in the initial setup to set the differentiator output peak-to-peak amplitude.

Figure 5-8 illustrates typical read signal and timing relationships and should be referred to in the following discussion.

Amplifier U21-B is connected as a differentiator so that a peak in the output voltage of U16-B (TP103) is changed to a zero crossing at the output of amplifier U21-B (TP104). The gain of U21-B is determined by R118, R119, and C105. Since the capacitive reactance of C105 decreases as frequency increases, the gain of U21-B increases with frequency until cut off by C106 and R119. Therefore, the amplitude of the envelope at TP104 is essentially independent of the data pattern. R117 should be adjusted so that the amplitude at TP104 is 4v peak-to-peak.
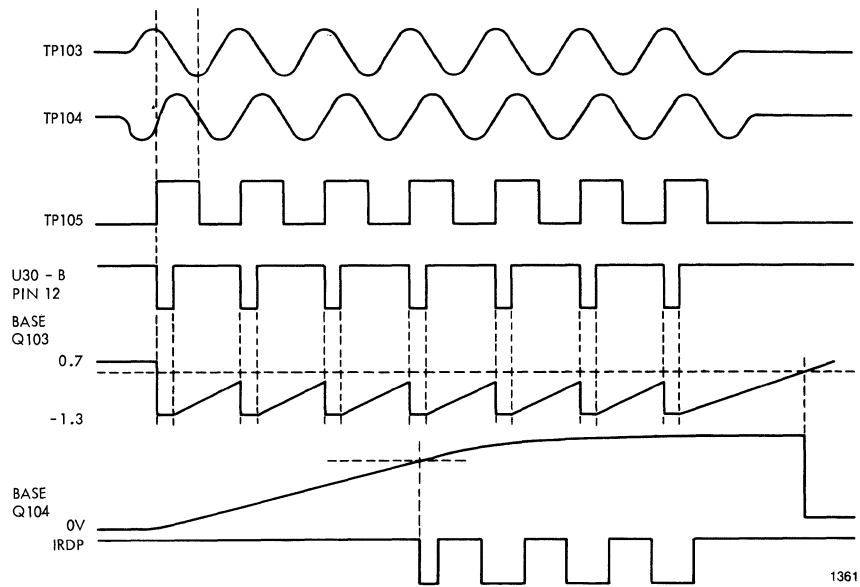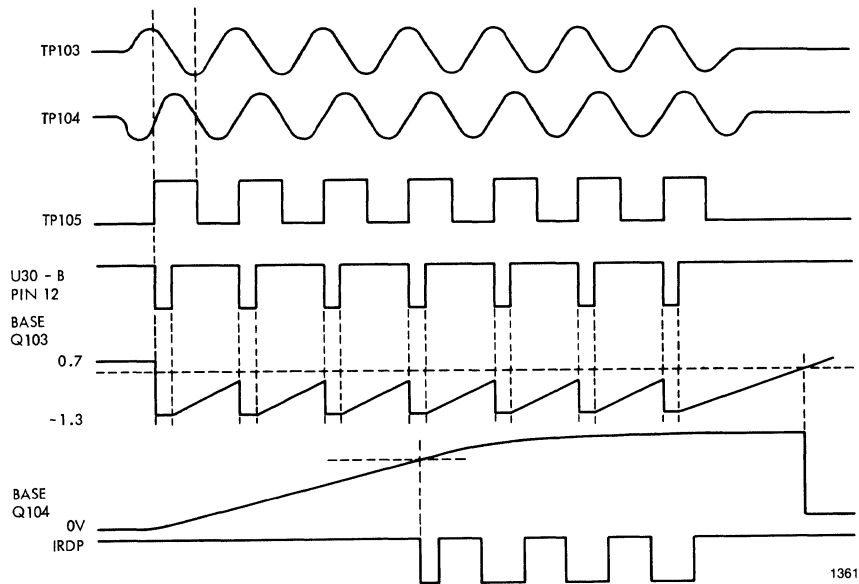
Figure 5-8. Timing and Signal Relationships, One Channel Read Electronics

The differentiated signal is fed to U30-A, a Schmitt trigger (an amplifier with a small amount of positive feedback) which squares and inverts the signal (TP105). The read data is then applied to the power NAND gate U35-A.

The output of the differentiator (U21-B) is also fed to the input of the Envelope Detector (U30-B). The envelope detector compares the positive halves of the differentiator signal (TP104) on pin 9 of U30-B against the divided threshold level on pin 8 of U30-B. The threshold level, when the drive is in the Write mode, is 45 percent of the nominal peak output and is determined by R18 and R19. Q4 and Q5 are cut off during a Write operation. During a normal Read operation Q4 is conducting and the threshold is approximately 15 percent of the nominal peak output. If IRTH2 is true during a Read operation, Q5 also conducts and the threshold drops to 7.5 percent of the nominal peak output.

During the portion of the positive peak of the differentiated signal, the output at pin 12 of U30-B goes to approximately − 2v; this also pulls C111 to approximately − 1.3v through CR104 and causes Q103 to cut off. When the peak falls below the threshold, the output of U30-B goes positive and C111 is charged by R131 until Q103 conducts. The charge time for C111 is one and one-half to two times the period for a single character. While Q103 is cut off, C109 is charging through R132. When the voltage on C109 reaches approximately + 2v, the conduction level of emitter follower Q104 enables power NAND gate U35-A. Read data from U30-A is presented to the interface line when U35-A is enabled by the outputs of U30-B, and the MOTION signal being high. The charge time for C109 is about four character times. If no positive peaks exceed the threshold for one and one-half to two consecutive character periods, C111 will charge to + 0.7v and cause Q103 to conduct. C109 will discharge, until Q104 conducts, and disables U35-A. Since C109 requires four character periods to enable U35-A, there must have been four continuous peaks of the differentiated signal before U35-A was enabled.

5.2.5 DATA G PCBA

The following is a description of the Data G PCBA, used with the Model T9660 (single stack) drive. (Refer to Schematic No. 101375 and Assembly No. 101376.)

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The Data G PCBA is 406.4 mm (16 inches) long and 220.7 mm (8.69 inches) wide with edge connectors at each end along one edge. Figure 5-9 illustrates the placement of each connector and test point. J102 and J103 are the interface connectors and are slotted to mate with keys in the mating plugs. There are two additional connectors on the Data G: J8 is used to connect power and control signals from the Tape Control PCBA, J1 is the connector into which the read/write head cable plugs.
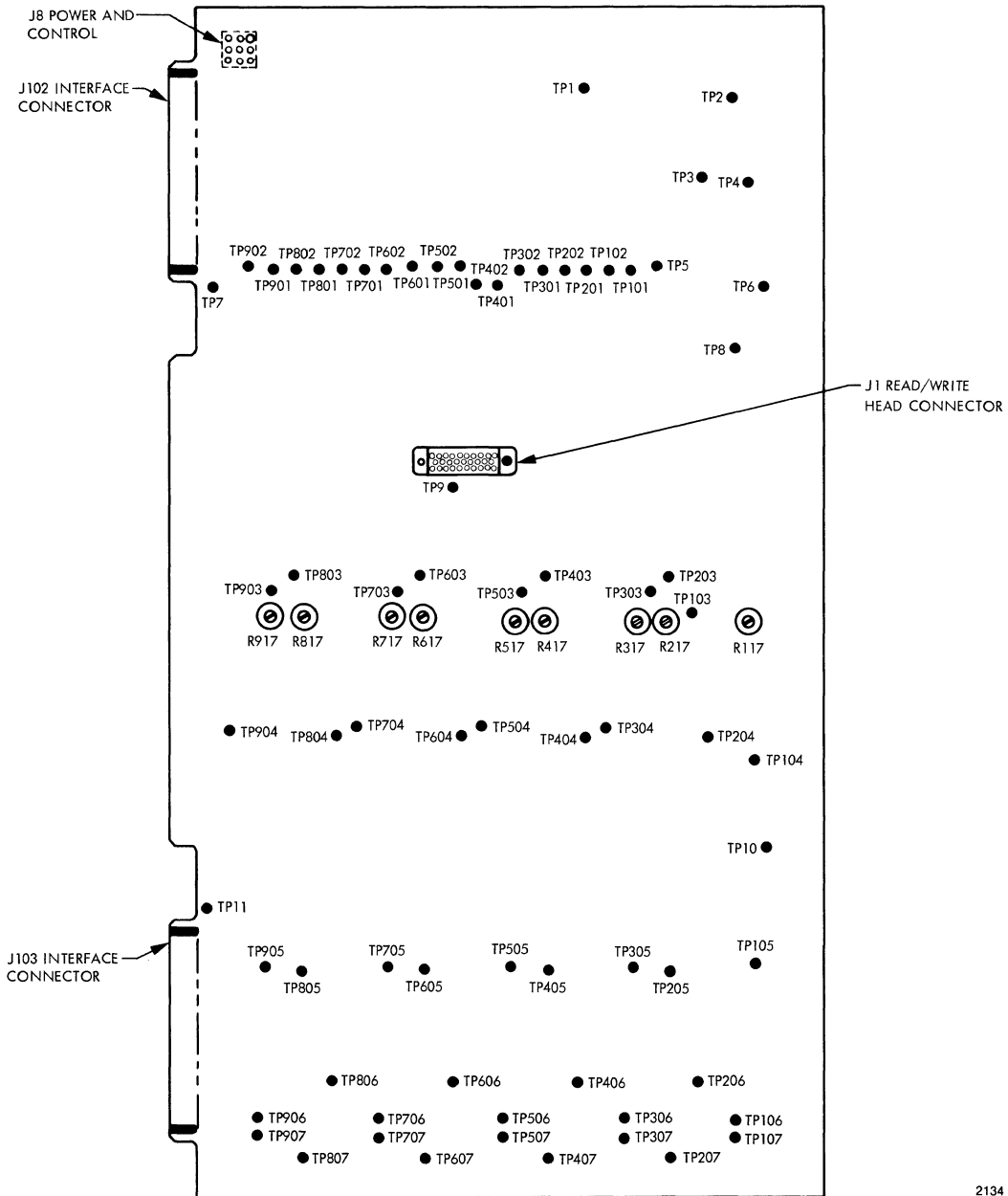
Figure 5-9. Data G PCBA, Test Point and Connector Placement

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The PCBA operation is described with reference to Circuit 100, which is identical to Circuits 200 through 900. All interface signals relevant to writing data (nine WRITE DATA signals (IWD0, etc.) and WRITE DATA STROBE (IWDS)), enter via J102 and are terminated by a resistor combination and an IC inverter.

Referring to Circuit 100, the WRITE DATA PARITY (IWDP) data line is terminated by resistors R101, R102, and inverter U6-E. IWDP and its complement are applied to the J and K inputs of write buffer flip-flop U8-A. At the trailing edge of IWDS (TP3), which is applied to the toggle input of U8-A from power gate U10-A, flip-flop U8-A copies in the inverse of IWDP.

The outputs of the write buffer flip-flop drive write amplifier transistors Q101 and Q102, whose emitters are taken to +5v when the WRT PWR line (J8-4) is high. The transistor connected to the low (approximately 0v) output of the flip-flop will conduct and a current will flow in the associated half of the head winding. The center taps of all the windings are connected to the collector of Q3 which goes to −5v when the NWRT signal is low (i.e., the drive is in the Write mode). When the WRT PWR line is low (approximately 0v) or the NWRT signal is high, writing is inhibited because the write amplifier transistors cannot conduct. Similarly, the erase current supplied by transistor Q1 is inhibited when the WRT PWR line is low or the NWRT signal is high. In operation, the write current is defined by resistors R107 and R108.

To improve the writing characteristics at 126 fr/mm (3200 frpi) the write compensation capacitors C101 and C102 are used to cause an overshoot of current on each leading edge.

The head windings are phased so that the output of the write buffer flip-flops, when reset, cause current to flow in the standard *erase* direction. The write buffer register is held reset unless the drive is in the Write mode (NWRT is low) and tape is moving (MOTION, J8-6, is high).

The IWARS signal is received by resistors R25 and R26 but is not used on the Data PCBA. A jumper from J102-C (Data PCBA) to J101-15 (Tape Control PCBA) routes IWARS to the Overwrite circuitry on the Tape Control PCBA. IWARS is issued at the end of writing the postamble and is used in conjunction with IOVW to reset the WRT flip-flop on the Tape Control PCBA. The purpose of this is to turn off the write and erase current so that the adjacent record will not be erased during an Overwrite operation.

When reading data from tape, signals from the read head are fed via connector J1 to the read amplifier (U16-B) which is one-half of a dual operational amplifier IC. The amplifier output is maintained close to 0v in the absence of an input signal by the feedback path of resistors R114 and R116. The cutoff frequency of the amplifier is determined by C104 and R114. The operating gain of the amplifier is defined by resistor network R114, R116, and R117. R117 is a variable resistor used in the initial setup to set the differentiator output peak-to-peak amplitude.

Figure 5-10 illustrates typical read signal and timing relationships and should be referred to in the following discussion.

Amplifier U21-B is connected as a differentiator so that a peak in the output voltage of U16-B (TP103) is changed to a zero crossing at the output of amplifier U21-B (TP104). The gain of U21B is determined by R118, R119, and C105. Since the capacitive reactance of C105 decreases as frequency increases, the gain of U21-B increases with frequency until cut off by C106 and R119. Therefore, the amplitude of the envelope at TP104 is essentially independent of the data pattern. R117 should be adjusted so that the amplitude at TP104 is 4v peak-to-peak.

Figure 5-10. Timing and Signal Relationships, One Channel Read Electronics

The differentiated signal is fed to U30-A, a Schmitt trigger (an amplifier with a small amount of positive feedback) which yields a square signal (TP105). The read data is then applied to the power NAND gate U35-A.

The output of the differentiator (U21-B) is also fed to the input of the Envelope Detector (U30-B). The envelope detector compares the positive peaks of the differentiator signal (TP104) on pin 9 of U30-B against the voltage-divided threshold level on pin 8 of U30-B. During a normal Read operation Q4 is conducting and the threshold is approximately 15 percent of the nominal peak output.

If IRTH2 is low during a Read operation, Q5 also conducts and the threshold drops to approximately 7.5 percent of the nominal peak output. If IRTH1 is low, the threshold is 45 percent of the nominal peak output regardless of the condition of IRTH2.

During the portion of the positive peak of the differentiated signal the output at pin 12 of U30-B goes to approximately −4v; this also pulls C111 to approximately −3v through CR104 and causes Q103 to cut off. When the peak falls below the threshold the output of U30-B goes positive and C111 is charged by R131 until Q103 conducts. The charge time for C111 is approximately one and one-half to two times the period for a single character. While Q103 is cut off, C109 is charging through R132. When the voltage on C109 reaches approximately −2v, emitter follower Q104 enables power NAND gate U35-A. Read data from U30-A is presented to the interface line when U35-A is enabled by the outputs of U30-B, and the MOTION signal being high. The charge time for C109 is about four character times. If no positive peaks exceed the threshold for one and one-half to two consecutive character periods, C111 will charge to +0.7v and cause Q103 to conduct. C109 will discharge, until Q104 turns off, and disables U35-A. Since C109 requires four character periods to enable U35-A, there must have been four continuous peaks of the differentiated signal before U35-A was enabled.

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SECTION VI
MAINTENANCE AND TROUBLESHOOTING

6.1 INTRODUCTION

This section provides information necessary to perform electrical and mechanical adjustments, parts replacement, and troubleshooting. Sections IV and V contain the theory of operation of components and circuits for reference.

6.2 FUSE IDENTIFICATION

Fuses are located at the rear of the tape drive and are identified in Table 6-1.

6.3 SCHEDULED MAINTENANCE

The drive is designed to operate with a minimum of maintenance and adjustments. Part replacement is planned to be as simple as possible. Repair equipment is kept to a minimum and only common tools are required in most cases. A list of the special equipment required to service the unit is given in Paragraph 6.5.2.

6.3.1 MAINTENANCE PHILOSOPHY

The objective of any maintenance program is to provide maximum machine readiness with a minimum of downtime. To provide this type of reliability it is necessary to perform preventive maintenance at specific intervals; a preventive maintenance schedule for the drive is given in Table 6-2.

In general, it is not necessary to alter any adjustment on equipment that is performing in a satisfactory manner.

6.3.2 GENERAL MAINTENANCE

Perform a visual inspection of the equipment for loose electrical connections, dirt, cracks, binding, excessive wear, and loose hardware while conducting any maintenance function.

Cleanness is essential for proper operation. Minute particles of dirt trapped between the head and the tape can cause data errors.

Table 6-1

Fuse Identification

	Location	Function	Type
F401	Power Supply Chassis	Line Fuse	15 Amp FB, 125v and below or 8 Amp FB, 190v and above
F1	Power Supply G1 or G2 PCBA	+ 23v (Unreg.)	15 Amp SB
F2	Power Supply G1 or G2 PCBA	− 23v (Unreg.)	15 Amp SB
F3	Power Supply G2 PCBA	− 10v	1.6 Amp FB, 250v
F4	Power Supply G2 PCBA	+ 10v	1.6 Amp FB, 250v
F5	Power Supply G2 PCBA	− 5v	1.0 Amp FB, 250v
F6	Power Supply G2 PCBA	+ 5v	4.0 Amp FB, 250v

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Table 6-2

Preventive Maintenance Schedule

Interval	Item	Paragraph Ref.
Daily	Clean Head Clean Fixed Guides (2) Clean Tape Cleaner Clean Capstan Clean Vacuum Chamber Clean Rotating Tape Guides (3)	6.4.1 6.4.2 6.4.2 6.4.2 6.4.2 6.4.3
2500 Hours or 6 Months	Check Head Wear Check Tape Tracking Check Capstan Speed Check Reel Servo Adjustments Check Skew (T9640) Check Skew (T9660) Replace Plug-in Relays K1 and K2 (Power Supply G1 PCBA) Replace Plug-in Relays K1, K2, and K3 (Power Supply G2 PCBA) Check EOT/BOT Adjustment*	6.7.7 6.7.11 6.6.3 6.6.6—6.6.9 6.7.2 6.7.3 Figure 5-3 Figure 5-6 6.6.12
5000 Hours or 12 Months	Replace Air Filter* Check Blower Belt for Wear and Proper Tracking Check Tape Tension	6.7.11 6.7.8 6.7.4
24,000 Hours	Replace Reel Motors Replace Capstan Motor Replace Blower Motor and Belt Replace Delrin Roller Guide Assy	6.7.12 6.7.14 6.7.8 6.7.10
*More frequent servicing may be required if operating in an abnormally dirty environment.		

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6.3.3 DOOR SAFETY SWITCH

The optional Door Safety switch is an interlock that prevents tape motion when the door is open. To override the interlock, a PPC Switch Retractor Tool, Part No. 617-0010, is used to pull the switch plunger to its outermost position. Tape can then be moved by either the Maintenance switch, front panel controls, or interface control. Refer to Paragraph 3.4.9.

6.4 CLEANING THE DRIVE

The head, fixed and rotating tape guides, tape cleaner, capstan, and vacuum chamber require special attention to realize the maximum data reliability of the unit. Details for cleaning are given in the following paragraphs; cleaning intervals are specified in Table 6-2.

6.4.1 CLEANING THE HEAD

To clean the head, use a lint-free cloth or cotton swab moistened in 91 percent isopropyl alcohol or Freon TF. Wipe the head carefully to remove all accumulated oxide and dirt.

CAUTION

DO NOT USE ROUGH OR ABRASIVE CLOTHS TO CLEAN THE MAGNETIC HEAD. USE ONLY 91 PERCENT ISOPROPYL ALCOHOL OR FREON TF. OTHER SOLVENTS, SUCH AS CARBON TETRACHLORIDE, MAY CAUSE SEVERE DAMAGE TO THE HEAD LAMINATION ADHESIVE.

6.4.2 CLEANING THE FIXED GUIDES, TAPE CLEANER, CAPSTAN, AND VACUUM CHAMBER

To clean the fixed guides, tape cleaner, capstan, and vacuum chamber, use only a cotton swab moistened with 91 percent isopropyl alcohol or Freon TF to remove accumulated oxide and dirt. The vacuum column door may be opened to gain access to the chamber surfaces.

6.4.3 CLEANING THE ROTATING TAPE GUIDES

To clean the rotating tape guides, use a lint-free cloth or cotton swab moistened in 91 percent isopropyl alcohol or Freon TF. Wipe the surfaces carefully to remove all oxide and dirt.

CAUTION

DO NOT SOAK GUIDES WITH EXCESSIVE SOLVENT. IT MAY SEEP INTO GUIDE BEARINGS, CAUSING CONTAM- INATION OR BREAKDOWN OF BEARING LUBRICANT.

6.5 PART REPLACEMENT ADJUSTMENTS

Table 6-3 indicates the adjustments that may be necessary after a part has been replaced. The details of the adjustments are given in Paragraphs 6.6—6.8.

6.5.1 ADJUSTMENT PHILOSOPHY

Acceptable limits are defined in each adjustment procedure, taking into consideration the assumed accuracy of the test equipment specified. When the measured value of any parameter is within the specified acceptable limits, NO ADJUSTMENTS should be made. If the measured value falls outside the specified acceptable limits, adjustment should be made in accordance with the relevant procedure; the value set should be the exact value specified (to the best of the operator's ability). Adjustment procedures detailed in this section should be performed at room temperature, 18° to 24°C (65° to 75°F).

6.5.2 SPECIAL EQUIPMENT

The following equipment (or equivalent) is required to service the drive.

    (1) Oscilloscope, Tektronix 465 (vertical and horizontal sensitivity specified to ± 2 percent accuracy).

    (2) Digital Multimeter, Fluke Model 8030A-01 (± 0.1 percent specified accuracy).

    (3) Tapes used for test and adjustment

        • Performance evaluation and checkout, PPC Part No. 516-0078 (177.8 mm [7-inch] reel), 516-0088 (216 mm [8.5-inch] reel), or 516-0108 (266.7 mm [10.5-inch] reel).

        • Master Skew Tape, PPC Part No. 516-0002 (177.8 mm [7-inch] reel), 516-0003 (216 mm [8.5-inch] reel), or 516-0004 (266.7 mm [10.5-inch] reel).

        • Master Output Tape, PPC 516-0007 (177.8 mm [7-inch] reel), or 516-0008 (216 mm [8.5-inch] reel).

    (4) Exerciser, Hand Held, Wilson Laboratories Inc. Model No. TX500 (PPC Part No. 110180).

    (5) Differential Pressure Gauge, 0 to 762 mm (0 to 30 inch) Water Range (Dwyer Instruments, Inc. Model No. 2030 with portable case).

    (6) Tension Spring Gauge, range 0 to 178 newton-metres (0 to 40 pounds).

Table 6-3
Part Replacement Adjustments/Checks

Part Replaced	Auxiliary Adjustments/Checks	Paragraph Ref.
Blower	Blower Belt Tension Tape Tension	6.7.8 6.7.4
Blower Belt	Blower Belt Tension	6.7.8
Blower Motor	Blower Belt Tension Tape Tension Blower Pulley Height	6.7.8 6.7.4 6.7.8
Capstan Motor	Capstan Servo Offset Capstan Forward Speed Capstan Reverse Speed Capstan Rewind Speed	6.6.2 6.6.3 6.6.3 6.6.4
Control Switch	None	—
Data PCBA	Read Amplifier Gain Write Skew Read Skew (T9640 only)	6.6.10 6.7.2, 6.7.3 6.7.2
Head	Read Amplifier Gain Read Skew (T9640 only) Write Skew Flux Gate (T9640 only)	6.6.10 6.7.2 6.7.2, 6.7.3 6.7.6
Photosensor	EOT/BOT Mechanical Alignment EOT/BOT Amplifier	6.7.7 6.6.12
Power Supply Assy	Power Supply Regulators	6.6.1
Power Supply PCBA	Power Supply Regulators	6.6.1
Reel Tachometer	Reel Tachometer Pulley Height Reel Servo Position Bias Reel Servo Speed	6.7.11 6.6.9 6.6.8
Reel Drive Motor	Reel Servo Position Bias Reel Servo Speed Reel Hub Height	6.6.9 6.6.8 6.7.12
Tape Control PCBA	Power Supply Regulators Tape Tension EOT/BOT Amplifier Capstan Servo Offset Capstan Forward Speed Capstan Reverse Speed Capstan Rewind Speed Capstan Ramp Timing Reel Servo Position Bias Reel Servo Speed Reel Servo Ramp (Check) Option Jumpers	6.6.1 6.7.4 6.6.12 6.6.2 6.6.3 6.6.3 6.6.4 6.6.5 6.6.9 6.6.8 6.6.7 6.8
Delrin Roller Guide Write Skew	Read Skew (T9640 only) 6.7.2, 6.7.3	6.7.2
Vacuum Switch	None	—

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6.5.3 TAPE LOOP FABRICATION

During certain test and adjustment procedures, particularly if a malfunction prevents tape loading, the use of a 6-foot tape loop is recommended as an alternative to loading a reel of tape on the drive. Fabricate and load a tape loop as follows.

(1) Join the ends of a 6-foot piece of tape that is undamaged and free of contaminants. Ensure there are no twists in the loop.

(2) Thread the 6-foot loop through the tape path. Do not place the tape over the capstan; thread the tape outside the flux gate to avoid contaminating the head surface.

NOTE

When the drive is able to load tape from a reel, it may be necessary to recheck certain adjustments that were performed using the tape loop. This will be specified in the individual procedures when required.

6.5.4 ADJUSTMENT SEQUENCE

Some adjustments interact and require performance of related adjustment procedures in a certain order. When related adjustments are required, they are listed in the subject procedure. When it is necessary to adjust a tape drive which is grossly out of adjustment, refer to the recommended adjustment sequences given in Table 6-4.

Table 6-4

Recommended Adjustment Sequence

Sequence No.	Adjustment Procedure	Paragraph Reference
1	Power Supply Regulators	6.6.1
2	Tape Tension	6.7.4
3	Photosensor	6.7.7
4	EOT/BOT Amplifier	6.6.12
5	Capstan Servo Offset	6.6.2
6	Capstan Forward and Reverse Speed	6.6.3
7	Capstan Rewind Speed	6.6.4
8	Capstan Ramp Timing	6.6.5
9	Reel Servo Ramps	6.6.7
10	Reel Servo Speed	6.6.8
11	Reel Servo Position Bias	6.6.9
12	Read Amplifier Gain	6.6.10
13	Threshold Generator	6.6.11
14	Skew Measurement and Adjustment (T9640)	6.7.2
15	Skew Measurement and Adjustment (T9660)	6.7.3
16	Flux Gate	6.7.6
17	Erase Efficiency Check	6.7.15

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6.6 ELECTRICAL ADJUSTMENTS

Paragraphs 6.6.1—6.6.12 describe the test configurations, test procedures, adjustment procedures, and related adjustments for all electrical adjustments. Refer to Figure 5-1 for location of Tape Control test points and adjustments.

NOTE

Before these adjustments are made, remove keeper screw from card cage end plate (Figure 2-2). This allows the card cage to be pivoted on its vertical axis to facilitate access to test points and components on the PCBAs.

NOTE

Some adjustments may require corresponding adjustments in other parameters; ensure that adjustments are made as specified in the individual procedures. The − 10v regulator must be checked prior to attempting any electrical adjustment.

If the drive cannot bring the tape to the Load Point after the operator has properly loaded a reel of tape, make the following initial adjustments.

NOTE

Attempt to bring the tape to Load Point after making each adjustment. If the attempt is unsuccessful, continue with the initial adjustment sequence until the Load sequence is successful; then perform the standard test and adjustment procedures as required.

(1) On the Tape Control PCBA, set R38 (SUS, supply speed adjust) and R118 (TUS, takeup speed adjust) fully clockwise.

(2) On the Tape Control PCBA, set R18 (ramp, supply reel servo adjust) and R113 (ramp, takeup reel servo adjust) fully counterclockwise.

(3) On the Tape Control PCBA, set R172 (FWD, capstan motor, forward speed adjust) and R174 (REV, capstan motor, reverse speed adjust) fully clockwise.

(4) On the Tape Control PCBA, set R179 (COS, capstan offset adjust) to the center of its range, i.e., 10 turns from either end of the potentiometer.

(5) On the Tape Control PCBA, verify and adjust (if necessary) the EOT/BOT sensor potentiometers R1008 and R2008 according to the procedure outlined in Paragraph 6.6.14.

(6) On the Power Supply G1 PCBA, verify and adjust (if necessary) R64 (Figure 5-3) so that the − 10v is within 0.05v of the + 10v value. On the Power Supply G2 PCBA, the adjustment control is R36 (Figure 5-6).

(7) On units equipped with the Power Supply G2 PCBA only, verify and adjust (if necessary) R38 (+ 5v) and R39 (− 5v) so that these voltages are within 0.25v of the nominal value (Figure 5-6).

NOTE

If operational difficulties are still encountered after completing the foregoing, refer to Paragraph 6.10 (Troubleshooting), for possible causes and corrective action.

6.6.1 POWER SUPPLY REGULATORS

The drive may be equipped with either the Power Supply G1 PCBA or the Power Supply G2 PCBA. On units with the G1 PCBA, the only regulator adjustment is for − 10v. Units with the G2 PCBA require three regulator adjustments; ± 10v, + 5v, and − 5v. Adjustment procedures for both power supply PCBAs are given in the following paragraphs.

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6.6.1.1 −10v Regulator

The −10v regulator on the Power Supply G1 PCBA is referenced to the +10v regulator. The −10v regulator is adjusted by means of potentiometer R64. The difference in magnitude between the +10v and −10v must be less than 0.05v.

6.6.1.1.1 Test Configuration

(1) Load a 6-foot tape loop or reel of tape.

(2) Apply power to the unit.

(3) Depress and release LOAD/RESET control to load tape into the vacuum column.

6.6.1.1.2 Test Procedure

(1) Using a digital voltmeter, measure and note the voltage between TP5 (+10v) and TP9 (0v) on the Power Supply G1 PCBA.

(2) Using a digital voltmeter, measure and note the voltage between TP6 (−10v) and TP9 (0v) on the Power Supply G1 PCBA.

(3) Acceptable Limits

- ☐ +10v Regulator
  - +10v minimum
  - +11v maximum
- ☐ −10v Regulator
  - Difference in magnitude between +10v and −10v must be less than 0.05v.

6.6.1.1.3 Adjustment Procedure

When the acceptable limits are exceeded, adjust potentiometer R64 on the Power Supply G1 PCBA and monitor the −10v at TP6 (using TP9 as ground) until the voltage equals that recorded for the +10v and the acceptable limits are achieved.

6.6.1.2 ±10v Regulator

The + and −10v regulators on the Power Supply G2 PCBA are referenced to each other. The difference in magnitude between the +10v and −10v must be less than 0.05v. The difference between the two outputs is adjusted by means of potentiometer R36.

6.6.1.2.1 Test Configuration

(1) Load a 6-foot tape loop or reel of tape.

(2) Apply power to the unit.

(3) Depress and release the LOAD/RESET control to load tape into the vacuum column.

6.6.1.2.2 Test Procedure

(1) Using a digital voltmeter, measure and note the voltage between TP6 (+10v) and TP9 (0v) on the Power Supply G2 PCBA.

(2) Using a digital voltmeter, measure and note the voltage between TP1 (−10v) and TP9 (0v) on the Power Supply G2 PCBA.

(3) Acceptable Limits

- ☐ −10v Regulator
  - −9.8v minimum
  - −11.2v maximum
- ☐ +10v Regulator
  - Difference in magnitude between +10v and −10v must be less than 0.05v.

6.6.1.2.3 *Adjustment Procedure*

When the acceptable limits are exceeded, adjust potentiometer R36 on the Power Supply G2 PCBA and monitor the + 10v at TP6 (using TP9 as ground) until the voltage equals that recorded for the − 10v and the acceptable limits are achieved.

6.6.1.3 5v Regulators

The 5v regulators are located on the Power Supply G2 PCBA. The + 5v regulator is adjusted by means of potentiometer R38. The − 5v regulator is adjusted by means of potentiometer R39.

6.6.1.3.1 *Test Configuration*

    (1) Load a 6-foot tape loop or reel of tape.

    (2) Apply power to the unit.

    (3) Depress and release the LOAD/RESET control to load tape into the vacuum column.

6.6.1.3.2 *Test Procedure*

    (1) Using a digital voltmeter, measure and note the voltage between TP4 (+ 5v) and TP9 (0v) on the Power Supply G2 PCBA.

    (2) Using a digital voltmeter, measure and note the voltage between TP11 (− 5v) and TP9 (0v) on the Power Supply G2 PCBA.

    (3) Acceptable Limits

        ☐ + 5v Regulator

            • + 4.68v minimum

            • + 5.38v maximum

        ☐ − 5v Regulator

            • − 4.68v minimum

            • − 5.38v maximum

6.6.1.3.3 *Adjustment Procedure*

When the acceptable limits are exceeded, adjust potentiometer R38 (+ 5v) or R39 (− 5v) on the Power Supply G2 PCBA and monitor the + 5v at TP4 and the − 5v at TP11 (using TP9 as ground) and adjust the voltage to its optimum level.

6.6.1.4 Related Adjustments

The following areas must be checked and adjusted subsequent to adjusting the − 10v, + 10v, + 5v or − 5v regulators.

    (1) Capstan Servo Offset (Paragraph 6.6.2).

    (2) Capstan Forward Speed (Paragraph 6.6.3).

    (3) Capstan Reverse Speed (Paragraph 6.6.3).

    (4) Capstan Rewind Speed (Paragraph 6.6.4).

    (5) Capstan Ramp Timing (Paragraph 6.6.5).

    (6) Reel Servo Position Bias (Paragraph 6.6.9).

6.6.2 CAPSTAN SERVO OFFSET

The drive is provided with an adjustable capstan offset. This adjustment serves to precisely null the capstan servo output when the capstan is stopped. A perfectly nulled output will assure that the capstan will remain stationary when the unit is stopped. The

capstan offset is adjusted by R179 on the Tape Control PCBA and is accessible from the top of the card cage through the hole designated COS.

NOTE

The −10V Regulator must be within acceptable limits prior to adjusting the Capstan Servo Offset.

6.6.2.1 Test Configuration
(1) Load a 6-foot tape loop or reel of tape.
(2) Apply power to the unit.
(3) Depress and release LOAD/RESET control to load tape into the vacuum column.

6.6.2.2 Test Procedure
(1) Connect a digital voltmeter probe to the capstan amplifier output (the output is located at TP23 on the Tape Control PCBA).
(2) Connect the digital voltmeter ground to TP9 on the Power Supply PCBA and note the voltage.
(3) Acceptable Limits
   - +0.05v
   - −0.05v

6.6.2.3 Adjustment Procedure
When the acceptable limits are exceeded, the following adjustment is made.
(1) Establish the test configuration described in Paragraph 6.6.2.1.
(2) Perform the test procedure described in Paragraph 6.6.2.2.
(3) Adjust potentiometer R179 on the Tape Control PCBA for 0.0v.

6.6.2.4 Related Adjustments
The following areas must be checked and adjusted subsequent to adjusting the Capstan Servo Offset.
(1) Capstan Forward Speed (Paragraph 6.6.3).
(2) Capstan Reverse Speed (Paragraph 6.6.3)
(3) Capstan Rewind Speed (Paragraph 6.6.4).

6.6.3 CAPSTAN FORWARD AND REVERSE SPEED
Both the synchronous forward and synchronous reverse speeds are adjustable in the drive. The following paragraphs provide the procedures for both coarse and fine speed adjustments on the Tape Control PCBA. R172 adjusts the forward speed; R174 adjusts the reverse speed. These potentiometers are accessible at the top of the card cage through the holes designated FWD and REV, respectively.

NOTE

The −10v Regulator and Capstan Servo Offset must be within acceptable limits prior to adjusting the Capstan Speed.

6.6.3.1 Test Configuration (Coarse Speed Adjustment)
(1) Load a 6-foot tape loop or reel of tape.
(2) Apply power to the unit.
(3) Depress and release LOAD/RESET control to load tape into the vacuum column.

6.6.3.2 Test Procedure (Coarse Speed Adjustment)

(1) Connect a digital voltmeter probe to TP11 on the Tape Control PCBA.

(2) Connect the digital voltmeter ground to TP25 or TP26 on the Tape Control PCBA.

(3) Place Maintenance switch in the forward position; tape will move forward.

(4) Monitor the voltage reading at TP11.

(5) Acceptable Limits
- ☐ 1.905 m/s (75 ips)
  - – 2.43v minimum
  - – 2.97v maximum
- ☐ 1.143 m/s (45 ips)
  - – 1.46v minimum
  - – 1.78v maximum
- ☐ 0.953 m/s (37.5 ips)
  - – 1.22v minimum
  - – 1.49v maximum

(6) Place Maintenance switch in the reverse position; tape will move in reverse.

(7) Monitor the voltage at TP11.

(8) Acceptable Limits
- ☐ 1.905 m/s (75 ips)
  - + 2.43v minimum
  - + 2.97v maximum
- ☐ 1.143 m/s (45 ips)
  - + 1.46v minimum
  - + 1.78v maximum
- ☐ 0.953 m/s (37.5 ips)
  - + 1.22v minimum
  - + 1.49v maximum

(9) When the voltages representative of forward and reverse speeds fall within the limits specified in Steps (5) and (8), respectively, the Fine Speed adjustments (Paragraph 6.6.3.5) may be made.

When the voltages representative of forward and reverse speeds fall outside the limits specified in Steps (5) and (8), proceed to the Coarse Speed adjustment in Paragraph 6.6.3.3.

6.6.3.3 Adjustment Procedure (Coarse Speed Adjustment)

When the forward or reverse tape speed exceeds the specified limits, the following adjustments are performed.

(1) Establish the test configuration described in Paragraph 6.6.3.1.

(2) Perform the test procedure described in Paragraph 6.6.3.2, Steps (1)—(4).

(3) Adjust potentiometer R172 on the Tape Control PCBA for the following voltage.
- ☐ 1.905 m/s (75 ips)
  - – 2.70v
- ☐ 1.143 m/s (45 ips)
  - – 1.62v
- ☐ 0.953 m/s (37.5 ips)
  - – 1.35v

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(4) Place Maintenance switch in the reverse position; tape will move in reverse.

(5) Monitor the voltage at TP11.

(6) Adjust potentiometer R174 on the Tape Control PCBA for the following voltage.

☐ 1.905 m/s (75 ips)

  • + 2.70v

☐ 1.143 m/s (45 ips)

  • + 1.62v

☐ 0.953 m/s (37.5 ips)

  • + 1.35v

6.6.3.4 Related Adjustments

Subsequent to making coarse speed adjustments, the fine speed adjustment must be made (Paragraph 6.6.3.5).

6.6.3.5 Capstan Forward and Reverse Speed Adjustments (Fine Speed Adjustment)

The capstan-mounted strobe disk may be used when making fine adjustments to the tape speed.

Tape speed adjustments made using the strobe disk are accomplished by illuminating the capstan hub from a fluorescent light source and adjusting the capstan servo until the disk image (created by the pulsating light source) becomes stationary. Table 6-5 lists the available disks, synchronous tape speeds, and light source frequencies.

Some strobe disks have two or three concentric sets of strobe markings on each disk. The following rules apply to disks marked with multiple sets of strobe markings.

(1) Part No. 101744-03 (0.953 m/s, 37.5 ips). There are three sets of strobe markings on this disk. The outer ring is used when checking and adjusting synchronous tape speeds of 0.953 m/s (37.5 ips) from a 60 Hz fluorescent light source. The middle ring is used at a tape speed of 0.953 m/s (37.5 ips) from a 50 Hz light source. The inner ring is not used on this equipment.

(2) Part No. 101744-05 (1.143 m/s, 45 ips). The outer ring of strobe markings is used when checking and adjusting synchronous tape speeds from a 60 Hz fluorescent light source. The inner rings are not used on this equipment.

(3) Part No. 101744-13 (1.905 m/s, 75 ips). The outer ring of strobe markings is used when checking and adjusting synchronous forward speeds from a 60 Hz fluorescent light source. The inner ring is used with a 50 Hz fluorescent light source.

The use of the capstan-mounted strobe disk should be limited to fine adjustments of the synchronous tape speed. When coarse speed adjustments are necessary (e.g., when replacing the Tape Control PCBA or capstan motor), refer to the procedures described in

Table 6-5

Strobe Disks

PPC Part No.	Tape Speed	Light Source Frequency (Hz)
101744-03	0.953 m/s (37.5 ips)	60/50
101744-05	1.143 m/s (45 ips)	60
101744-13	1.905 m/s (75 ips)	60/50

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Paragraphs 6.6.3.1—6.6.3.4. When a strobe disk is not available for a particular model (e.g., 1.143 m/s, 45 ips, 50 Hz), fine speed adjustments may be accomplished by observing the data frequency when reading a frequency certified all-1s tape.

6.6.3.6 Test Configuration (Fine Speed Adjustment)
(1) Load a reel of tape.
(2) Apply power to the unit.
(3) Depress and release LOAD/RESET control to load tape into the vacuum column.
(4) Illuminate the strobe disk with a fluorescent light source at the appropriate frequency.

6.6.3.7 Test Procedure (Fine Speed Adjustment)
(1) Establish the test configuration described in Paragraph 6.6.3.6.
(2) Place Maintenance switch in the forward position; tape will move forward.
(3) Observe the appropriate strobe disk image; the image should appear stationary.
(4) Place Maintenance switch in the reverse position; tape will move in reverse.
(5) Observe the appropriate strobe disk image; the image should appear stationary.

6.6.3.8 Adjustment Procedure (Fine Speed Adjustment)
(1) Establish the test configuration described in Paragraph 6.6.3.6.
(2) Adjust potentiometer R172 on the Tape Control PCBA until the strobe disk image appears stationary for the forward direction.
(3) Adjust potentiometer R174 on the Tape Control PCBA until the strobe disk image appears stationary for the reverse direction.

6.6.3.9 Related Adjustments (Fine Speed Adjustments)
• Reel Servo Speed (Paragraph 6.6.8).
• Read Amplifier Gain (Paragraph 6.6.10).
• Capstan Rewind Speed Adjustment (Paragraph 6.6.4).

6.6.4 CAPSTAN REWIND SPEED ADJUSTMENT
The rewind speed is controlled by R213 on the Tape Control PCBA. The test configuration is common to all models; use a 732-metre (2400-foot) reel of tape. Refer to the appropriate paragraph for the model under test.

6.6.4.1 Test Configuration
(1) Load a 732-metre (2400-foot) reel of tape.
(2) Apply power to the unit.
(3) Depress and release LOAD/RESET control to load tape into the vacuum column.
(4) Place the Maintenance switch in the forward position and run approximately 90 metres (300 feet) of tape onto the takeup reel.
(5) Connect a digital voltmeter between TP11 on the Tape Control PCBA and either TP25 or TP26 (both are servo grounds).

6.6.4.2 Test Procedure, 1.905 m/s (75 ips) Drives
(1) Place the Maintenance switch in the reverse position.
(2) Observe and record the voltage indicated on the digital voltmeter, while the tape is traveling in reverse, at 1.905 m/s (75 ips).

(3) Place the Maintenance switch in the forward position and run tape to the EOT tab.

(4) Depress and release the REWIND control. When the full rewind speed is reached, the voltage at TP11 should indicate 3.33 times the voltage noted in Step (2).

6.6.4.3 Test Procedure, 1.143 m/s (45 ips) Drives

(1) Place the Maintenance switch in the reverse position.

(2) Observe and record the voltage indicated on the digital voltmeter, while the tape is traveling in reverse, at 1.143 m/s (45 ips).

(3) Place the Maintenance switch in the forward position and run tape to the EOT tab.

(4) Depress and release the REWIND control. When the full rewind speed is reached, the voltage at TP11 should indicate 5.56 times the voltage noted in Step (2).

6.6.4.4 Test Procedure, 0.953 m/s (37.5 ips) Drives

(1) Place the Maintenance switch in the reverse position.

(2) Observe and record the voltage indicated on the digital voltmeter, while the tape is traveling in reverse, at 0.953 m/s (37.5 ips).

(3) Place the Maintenance switch in the forward position and run tape to the EOT tab.

(4) Depress and release the REWIND control. When the full rewind speed is reached, the voltage at TP11 should indicate 6.67 times the voltage noted in Step (2).

6.6.4.5 Adjustment Procedure

When the rewind time is incorrect, as indicated by the voltage measurement obtained in Step (4) of the appropriate paragraph for the model under test, proceed as follows.

(1) Adjust variable resistor R213 on the Tape Control PCBA to obtain the correct voltage during rewind.

(2) For all models, verify rewind time for a full 732-metre (2400-foot) reel of tape.

(3) Acceptable Limits
   • 110 seconds minimum
   • 125 seconds maximum

6.6.4.6 Adjustment Procedure, Alternate Method

When the rewind time exceeds the limits specified in the appropriate paragraph for the model under test, the following alternate adjustment may be performed.

(1) Establish the test configuration described in Paragraph 6.6.4.1.

(2) Perform the test procedure described in the appropriate paragraph for the model under test, as follows:
   • 1.905 m/s (75 ips) drives: Paragraph 6.6.4.2
   • 1.143 m/s (45 ips) drives: Paragraph 6.6.4.3
   • 0.953 m/s (37.5 ips) drives: Paragraph 6.6.4.4

(3) For all models, adjust variable resistor R213 on the Tape Control PCBA to obtain the nominal rewind time of 115 seconds.

6.6.4.7 Related Adjustments

• None.

6.6.5 CAPSTAN RAMP TIMING

The capstan ramp timing is adjusted by variable resistor R168 on the Tape Control PCBA. Access to the resistor is through the top of the card cage at the hole designated RMP.

Two test configurations are given for the Capstan Ramp Timing procedure; Paragraph 6.6.5.1 gives the test configuration for use with the Wilson Tape Drive Exerciser, Model TX500. Paragraph 6.6.5.2 gives an alternate test configuration. Note that the test and adjustment procedures (Paragraphs 6.6.5.3 and 6.6.5.4) are relevant to both test configurations.

NOTE

The − 10v Regulator must be within acceptable limits prior to adjusting the Capstan Ramp Timing (refer to Paragraph 6.6.1).

6.6.5.1 Test Configuration

(1) Connect the tape drive exerciser to the interface connectors.

(2) Connect an oscilloscope probe to TP11 on the Tape Control PCBA.

(3) Connect the oscilloscope probe ground to TP25 or TP26 on the Tape Control PCBA.

(4) Connect the oscilloscope external trigger to RAMP SYNC (+) on the exerciser.

(5) Set the exerciser to write 8192-length records in the forward direction (READ BKWD and READ FWD switches off).

(6) Load a reel of tape.

(7) Apply power to the unit.

(8) Depress and release LOAD/RESET control to load tape into the vacuum column.

(9) Depress and release the ON LINE control.

6.6.5.2 Test Configuration (Alternate)

(1) Load a reel of tape.

(2) Apply power to the unit.

(3) Depress and release LOAD/RESET control to load tape into the vacuum column.

(4) Depress and release the ON LINE control.

(5) Connect an oscilloscope probe to TP11 on the Tape Control PCBA.

(6) Connect the ground connection of the oscilloscope probe to either TP25 or TP26 (both are servo ground) on the Tape Control PCBA.

(7) Connect the oscilloscope external trigger to TP12 on the Tape Control PCBA.

(8) Place the Maintenance switch in the forward position.

NOTE

To generate a forward capstan ramp, depress and release the ON LINE control repeatedly.

6.6.5.3 Test Procedure

(1) Adjust the oscilloscope variable vertical (volt/div) control to display 0 to 100 percent of the ramp waveform height over the full height of the oscilloscope graticule.

(2) Adjust the trigger position to the extreme left line on the oscilloscope graticule.

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(3) With the time base set to 1.0 msec/div, observe that the ramp waveform crosses the 10 percent graticule of the oscilloscope, as shown in Figure 6-1A.

(4) Acceptable Limits

☐ 1.905 m/s (75 ips) drives
  • 4.1 milliseconds minimum
  • 4.7 milliseconds maximum

☐ 1.143 m/s (45 ips) drives
  • 6.9 milliseconds minimum
  • 7.9 milliseconds maximum

☐ 0.953 m/s (37.5 ips) drives
  • 8.2 milliseconds minimum
  • 9.4 milliseconds maximum

(5) Change the oscilloscope external trigger to RAMP SYNC (−) on the exerciser or adjust the oscilloscope trigger slope and level as required if the alternate test configuration was used.

(6) Repeat Steps (1)—(4) for the stop ramp with tape moving in the forward direction.

(7) Set the exerciser to write in the reverse direction or set the maintenance switch to the reverse position to provide tape motion in the reverse direction. If using the alternate test configuration, change the external trigger point for the oscilloscope to TP13 (NREV) on the Tape Control PCBA. Depress and release the ON LINE control repeatedly to generate the reverse capstan ramp.

(8) Repeat Steps (1)—(6) for the capstan start and stop ramps with tape moving in the reverse direction.

6.6.5.4   Adjustment Procedure

When the acceptable limits are exceeded, the following adjustments are performed.

(1) Establish the test configuration described in Paragraph 6.6.5.1.

(2) Perform the test procedure described in Paragraph 6.6.5.2, Steps (1)—(3).
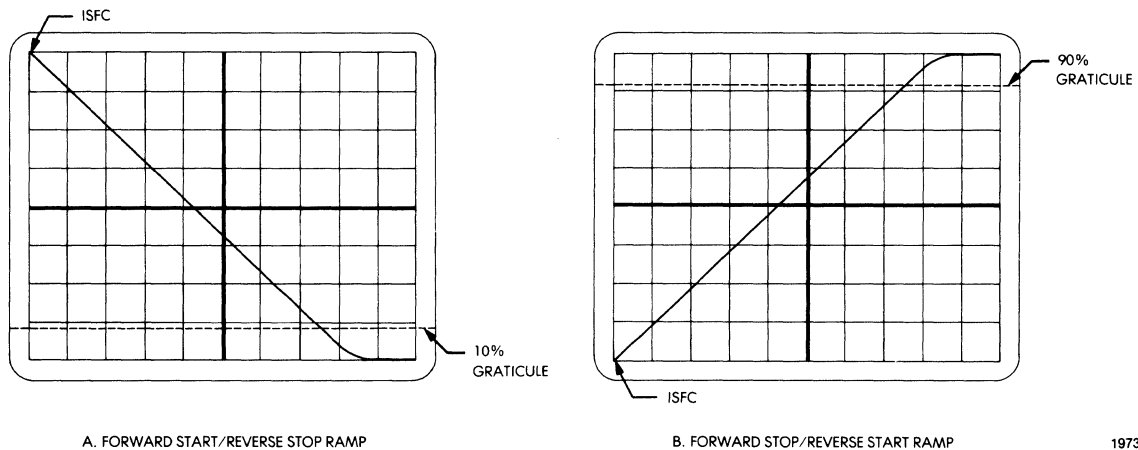
A. FORWARD START/REVERSE STOP RAMP   B. FORWARD STOP/REVERSE START RAMP   1973

Figure 6-1. Ramp Timing (Idealized Example)

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(3) Adjust variable resistor R168 on the Tape Control PCBA to obtain ramp adjustment time as follows.

☐ 1.905 m/s (75 ips) drives
- 4.4 milliseconds

☐ 1.143 m/s (45 ips) drives
- 7.4 milliseconds

☐ 0.953 m/s (37.5 ips) drives
- 8.8 milliseconds

6.6.5.5 Related Adjustments
- None.

6.6.6 REEL SERVO, GENERAL ADJUSTMENT PROCEDURE

The supply and takeup reel servo mechanisms are designed to operate at an optimum performance level at all capstan forward and reverse speeds. At slower tape speeds, the tape loop will stay in or near the parking zone of each column.

6.6.7 REEL SERVO RAMPS

The supply and takeup reel servos have adjustable ramps. These ramps control the servo response to capstan speed information as switched by the vacuum switches. The ramps are controlled by top adjust potentiometers R18 and R113 on the Tape Control PCBA.

NOTE

The − 10v Regulator must be within acceptable limits prior to adjusting the Reel Servo Ramps. The Capstan Forward and Capstan Reverse Speeds must be within acceptable limits (refer to Step (5) of Paragraph 6.6.3.2).

6.6.7.1 Test Configuration
(1) Fabricate two jumper assemblies as shown in Figure 6-2.
(2) Remove J506 from the Tape Control PCBA and install jumper J506 in its place.
(3) Remove J507 from the Tape Control PCBA and install jumper J507 in its place.
(4) Remove the supply reel and apply power to the unit.
(5) Connect a jumper from TP17 to TP16.
(6) Place the Maintenance switch in the reverse position.
(7) Insert tape segment between EOT/BOT sensor and the reflector plate.

6.6.7.2 Test Configuration (Alternate)
(1) Load a 6-foot tape loop.
(2) Apply power to the unit.

WARNING

PERSONAL INJURY CAN RESULT IF HANDS ARE NOT CLEAR OF THE REEL HUBS WHEN THE THROW LOOP IS INITIATED.

(3) Depress and release LOAD/RESET control; when vacuum motor is up to speed, allow tape to move into vacuum chambers.
(4) Depress and release LOAD/RESET control once more to reset the seek load point sequence.
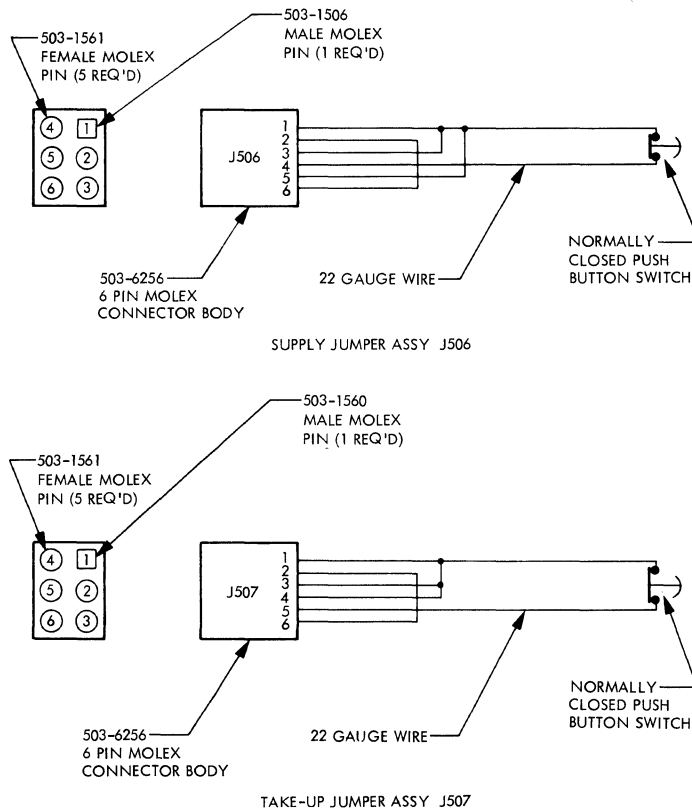
Figure 6-2. J506 and J507 Test Jumper Assemblies

(5) Connect a jumper from TP17 to TP16.

(6) Place the Maintenance switch in the reverse position.

6.6.7.3 Test Procedure

(1) Connect an oscilloscope probe to TP19 on the Tape Control PCBA.

(2) Connect the ground connection of the oscilloscope to TP25 or TP26 on the Tape Control PCBA.

(3) Connect an external trigger probe from the oscilloscope to the top (upper) side of R17 on the Tape Control PCBA.

(4) Set the external trigger to positive edge trigger and monitor TP19 on the Tape Control PCBA.

(5) Adjust the oscilloscope variable vertical (volt/div) control to display 0 to 100 percent of the ramp waveform over 100 percent of the vertical divisions of the oscilloscope graticule; amplitude should be approximately 2v.

(6) Depress the pushbutton switch on jumper J506, or manually move the tape loop across the supply reverse 90 percent port (Figure 4-4) if using the alternate test configuration, and observe the ramp timing.

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(7) Acceptable Limits
    ☐ 1.905 m/s (75 ips)
        • 50 milliseconds minimum
        • 65 milliseconds maximum
    ☐ 1.143 m/s (45 ips)
        • 29.7 milliseconds minimum
        • 38.7 milliseconds maximum
    ☐ 0.953 m/s (37.5 ips)
        • 24.8 milliseconds minimum
        • 32.3 milliseconds maximum

(8) Move the oscilloscope signal probe from TP19 to TP10.

(9) Move the oscilloscope trigger probe to the top (upper) side of R111 on the Tape Control PCBA.

(10) Remove jumper between TP17 and TP16.

(11) Connect jumper between TP17 and TP8.

(12) With the oscilloscope adjusted as specified in Step (5), observe that the takeup servo ramp timing is within the limits specified in Step (7). Limits should be as specified when the pushbutton switch on jumper J507 is depressed, or the tape loop is moved across the takeup reverse 90 percent port (Figure 4-4) if using the alternate test configuration.

(13) Terminate the test sequence by removing ac power.

6.6.7.4 Adjustment Procedure

When the acceptable limits are exceeded, the following adjustments are made.

(1) Establish the test configuration described in Paragraph 6.6.7.1 or 6.6.7.2

(2) Perform the test procedure described in Paragraph 6.6.7.3, Steps (1)—(7).

(3) Adjust the variable resistor R18 on the Tape Control PCBA to obtain a ramp time as follows.
    ☐ 1.905 m/s (75 ips)
        • 57 milliseconds
    ☐ 1.143 m/s (45 ips)
        • 34.2 milliseconds
    ☐ 0.953 m/s (37.5 ips)
        • 28.5 milliseconds

(4) Perform the test procedure described in Paragraph 6.6.7.2, Steps (8)—(11).

(5) Adjust variable resistor R113 on the Tape Control PCBA to obtain a ramp time as follows.
    ☐ 1.905 m/s (75 ips)
        • 57 milliseconds
    ☐ 1.143 m/s (45 ips)
        • 34.2 milliseconds
    ☐ 0.953 m/s (37.5 ips)
        • 28.5 milliseconds

(6) Remove power from the drive.

(7) Remove all jumpers and return the drive to normal configuration.

6.6.7.5 Related Adjustments
  • None.

6.6.8 REEL SERVO SPEED

The supply and takeup reel servos have an adjustable tachometer velocity control. The tachometer inputs to the reel servos are adjusted by R38 and R118 on the Tape Control PCBA. These adjustments are accessible at the top of the card cage through the holes designated SUS and TUS, respectively. See Figure 5-1 for location of test points and adjustments.

NOTE

The − 10v Regulator must be within acceptable limits prior to adjusting the Reel Servo Ramps. The Capstan Forward and Reverse Speeds must be within acceptable limits (refer to Step (5) of Paragraph 6.6.3.2).

6.6.8.1 Test Configuration
  (1) Load a reel of tape.
  (2) Apply power to the unit.
  (3) Depress and release LOAD/RESET control to load tape into the vacuum column.

6.6.8.2 Test Procedure
  (1) Place the Maintenance switch in the forward position; run the tape forward until the tape on the supply hub has a pack diameter of 172.72 mm (6.8 inches).
  (2) Connect a jumper from TP17 to TP16 on the Tape Control PCBA.
  (3) Place the Maintenance switch in the reverse position; tape will move in reverse.
  (4) Observe the position of the tape in the upper vacuum chamber.
  (5) Tape position should remain stationary between ports 4 and 5, or drift slowly taking at least 1 second to drift from port-to-port.
  (6) Return the Maintenance switch to center position.
  (7) Remove the jumper from TP16 and connect it to TP8.
  (8) Place the Maintenance switch in the reverse position and hold until the tape on the takeup reel has a pack diameter of 172.72 mm (6.8 inches).
  (9) Observe the position of the tape in the lower vacuum chamber.
  (10) Tape position should remain stationary between ports 8 and 9, or drift slowly taking at least 1 second to drift from port-to-port, while in the reverse mode.
  (11) Return the Maintenance switch to the center position.
  (12) Disconnect the jumper.

6.6.8.3 Adjustment Procedure
  (1) Establish the test configuration described in Paragraph 6.6.8.1.
  (2) Perform the test procedure described in Paragraph 6.6.8.2, Steps (1)—(3).
  (3) Adjust R38 on the Tape Control PCBA until the tape position remains stationary between ports 4 and 5 (in the reverse mode).
  (4) Return the Maintenance switch to the center position.
  (5) Remove the jumper from TP16 and connect it to TP8.
  (6) Place the Maintenance switch in the reverse position and hold in the reverse mode until a tape diameter of 172.72 mm (6.8 inches) is on the takeup reel.
  (7) Adjust R118 on the Tape Control PCBA until the tape position remains stationary between ports 8 and 9 (in the reverse mode).

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(8) Return the Maintenance switch to the center position.

(9) Disconnect the jumper and return the drive to normal configuration.

6.6.8.4 Related Adjustments

- None.

6.6.9 REEL SERVO POSITION BIAS

Two adjustments are provided on the Tape Control PCBA to stabilize the tape when it is in the standby or *parking* mode. R27 provides adjustable position bias for the supply reel servo; R82 provides adjustable position bias for the takeup reel servo. These potentiometers are accessible at the top of the card cage through the holes designated SUP and TUP, respectively. See Figure 5-1 for location of test points and adjustments.

6.6.9.1 Test Configuration

(1) Load a reel of tape.

(2) Apply power to the unit.

(3) Depress and release LOAD/RESET control to load tape into the vacuum column.

(4) Place the Maintenance switch in the forward position; run tape forward until equal amounts of tape are on the supply and takeup reels.

6.6.9.2 Test Procedure

(1) With the capstan stopped, observe the tape loop in both vacuum chambers. Tape should remain stationary in the *parking* zone between the two 90 percent holes in both the upper and lower vacuum chambers. Recheck this condition with supply reel full and then with the takeup reel full.

(2) If the tape does not remain in the position indicated in Step (1), perform the following adjustment procedure.

6.6.9.3 Adjustment Procedure

(1) Establish the test configuration described in Paragraph 6.6.9.1.

(2) Place the Maintenance switch in the forward position; run the tape forward until equal amounts of tape are on the supply and takeup reels.

(3) Connect a digital voltmeter probe to TP20 on the Tape Control PCBA.

(4) Connect the digital voltmeter ground to TP25 or TP26 on the Tape Control PCBA.

(5) Adjust R27 (SUP) cw until the tape in the upper chamber starts to move; note the voltage as V_1.

(6) Adjust R27 (SUP) ccw until the tape in the upper chamber starts to move in the opposite direction; note the voltage as V_2.

(7) Calculate the center voltage via the following formula.

$$\frac{V_1 + V_2}{2} = V_{Center}$$

(8) Adjust R27 (SUP) to achieve the value calculated for V_{Center} ±5%.

(9) Connect the digital voltmeter probe to TP21 on the Tape Control PCBA.

(10) Adjust R82 (TUP) cw until the tape loop in the lower chamber starts to move; note the voltage as V_1.

(11) Adjust R82 (TUP) ccw until the tape in the lower chamber starts to move in the opposite direction; note the voltage as V_2.

(12) Calculate the center voltage using the formula in Step (7).

(13) Adjust R82 (TUP) to achieve the value calculated for V_{Center} ±5%.

6.6.9.4 Related Adjustments

- None.

6.6.10 READ AMPLIFIER GAIN

The gain of each of the read amplifiers located on the Data PCBA is independently adjustable.

NOTE

The Tape Speed must be checked and adjusted prior to adjusting the Read Amplifier Gain.

In considering the overall gain of the read system, it is important to note that the output of the read head is particularly dependent upon the type of magnetic tape used and the condition of the tape, i.e., new or used. Use good quality tape.

A read amplifier gain adjusted too high will result in amplifier saturation; gain set too low will increase the susceptibility to data errors due to drop-outs.

Read amplifier gain may be determined by reading (in the Read Only mode) an all-1s tape which was recorded on the drive. An all-1s tape may be generated by using a Wilson Tape Drive Exerciser, Model TX500.

6.6.10.1 Test Configuration

(1) Clean the head assembly and tape path as described in Paragraph 6.4.

(2) Load a master output tape (Paragraph 6.5.2).

(3) Apply power to the unit.

(4) Depress and release LOAD/RESET control to load tape into the vacuum column.

6.6.10.2 Test Procedure

(1) Place the Maintenance switch in the forward position; tape will move forward at the specified velocity.

(2) Using the signal probe of an oscilloscope, measure and record the peak-to-peak amplitude of the read amplifier waveforms viewed at the output of each differentiator (TP104—TP904) on the Data PCBA.

(3) Acceptable limits (peak-to-peak when utilizing an all-1s tape generated on the drive).
   - 3.25v minimum
   - 4.75v maximum

6.6.10.3 Adjustment Procedure

When the acceptable limits are exceeded, the following adjustments are performed.

(1) Establish the test configuration described in Paragraph 6.6.10.1.

(2) Perform the test procedure described in Paragraph 6.6.10.2.

(3) Observe TP104—TP904 on the Data PCBA and adjust variable resistors R117—R917 associated with these test points to 4v peak-to-peak.

6.6.11 THRESHOLD GENERATOR

The output voltage of the threshold generator can be checked at TP6 on the Data PCBA in the different modes of operation. The following values are included as a check only; no adjustment procedure is applicable. If the listed limits are exceeded, this is indicative of a fault in the threshold circuitry.

(1) Write Mode
   - 3.8v minimum
   - 5.0v maximum

(2) Read Mode
- ☐ IRTH2 False
  - 1.8v minimum
  - 2.4v maximum
- ☐ IRTH2 True
  - 0.8v minimum
  - 1.4v maximum

6.6.12 EOT/BOT AMPLIFIER

The EOT/BOT Amplifier is located on the Tape Control PCBA. Before performing the following procedure, examine the PCBA and determine the value of resistors R1002 and R2002.

6.6.12.1 Test Procedure

(1) Apply power to the unit.

(2) With the head cover installed and no tape in path, measure and note the voltage across resistor R1002 (EOT).

(3) Measure and note the voltage across resistor R2002 (BOT).

(4) Acceptable Limits
- Resistor value 3300 ohms: ≥0.5v
- Resistor value 10k ohms: ≥1.5v

(5) Place tape in the tape path (between the sensor and reflector) and measure and note the voltage across resistor R1002 (EOT). Ensure that reflective tab is not under the sensor.

(6) Measure and note the voltage across R2002 (BOT).

(7) Acceptable Limits
- Resistor value 3300 ohms: <0.2v
- Resistor value 10k ohms: <0.6v

NOTE

If the voltage is 0.6v (nominal) with 3300 ohm resistor or 1.5v (nominal) with 10k ohm resistor with no tape in path, and greater than 0.2v with 3300 ohm resistor or 0.6v with 10k ohm resistor with no tape in path, the sensor is defective.

6.6.12.2 Adjustment Procedure

When the acceptable limits are exceeded, make the following adjustments.

(1) Apply power to the unit.

(2) If resistor value of R1002 and R2002 is 3300 ohms, perform Steps (3), (4), and (7). If resistor value of R1002 and R2002 is 10k ohms, perform Steps (5), (6), and (7).

(3) With no tape in path, adjust R1008 (EOT) until the voltage across R1002 is 0.6v.

(4) With no tape in path, adjust R2008 (BOT) until the voltage across R2002 is 0.6v.

(5) With tape in path (off tab), adjust R1008 (EOT) until the voltage across R1002 is 0.55v.

(6) With tape in path (off tab), adjust R2008 (BOT) until the voltage across R2002 is 0.55v.

(7) Verify Steps (2)—(7) of the test procedure in Paragraph 6.6.12.1.

6.6.12.3 Related Adjustments

- None

6.7 MECHANICAL ADJUSTMENTS AND PARTS REPLACEMENT

Paragraphs 6.7.1—6.7.14 describe the mechanical adjustment procedures and related adjustments.

6.7.1 TRIM ASSEMBLY REMOVAL AND REPLACEMENT

The trim assembly, shown in Figure 3-1, refers to the overlay and the hinged door. The door remains attached to the overlay when the assembly is removed. Six screws, accessible from the rear, hold the assembly in place. Some adjustments may require removal of the trim assembly for access to the front of the drive base plate. This is accomplished as follows.

(1) Remove ac power from the unit.

(2) Remove the head cover set.

(3) Remove the fixed takeup reel by loosening two screws on the reel hub face (approximately two turns), then pull the reel forward.

(4) Close the hinged door and remove six 6-32 screws which attach the trim to the drive (three screws along the left rear and three screws along the right rear side).

(5) Slide the entire trim assembly forward and away from the unit.

The trim assembly is installed as follows.

(1) Position the trim assembly on the drive so that the six screw holes are aligned.

(2) Install and tighten the six 6-32 attaching screws.

(3) Install the takeup reel and torque the two screws on the reel hub face to 0.28 newton-metres (2.5 inch-pounds).

6.7.2 SKEW MEASUREMENT AND ADJUSTMENT (T9640)

Drive skew is adjusted by first checking and, if necessary, adjusting write skew, then checking the read skew. The requirements on PE read skew are not severe since the system uses a multiple buffer register per channel for read data recovery.

6.7.2.1 Write Skew Measurement (T9640)

An indication of the write skew may be obtained by observing the algebraic sum of the peak detectors at TP10 on the Data PCBA with the write head connector (P1) plugged into the read head receptacle (J2).

Figure 6-3 illustrates an example of correctly adjusted skew. This method of determining the system write skew is accomplished as follows.
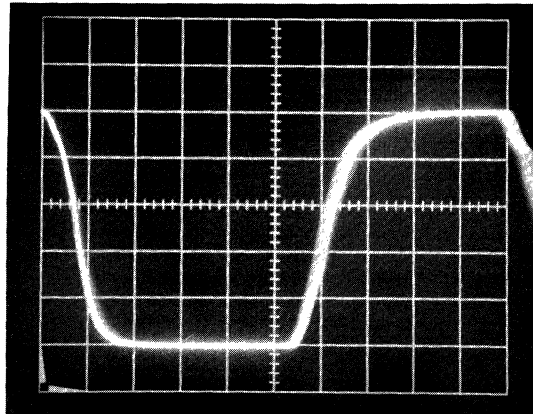
Figure 6-3. Skew Waveform (Typical)[2297]

(1) Disconnect the write head and read head connectors from J1 and J2, respectively, on the Data PCBA.

(2) Plug the write head connector into the read head connector (J2) on the Data PCBA.

(3) Set the vertical sensitivity on the oscilloscope to 1v/cm.

(4) Set the oscilloscope to trigger on Channel 1, negative slope, alternate mode.

(5) Load a 32 c/mm (800 cpi) Master Skew Tape (Paragraph 6.5.2), bring to BOT and position the Maintenance switch to the forward position.

(6) Observe the oscilloscope waveform and adjust the horizontal time/division fixed and variable controls to display one complete cycle.

NOTE

With an 800 cpi tape, each cycle represents 1250 micro-inches. The scope graticule is divided into 10 major divisions each of which is divided into 5 divisions; therefore, 1250 microinches ÷ 50 divisions = 25 microinches/division.

(7) Observe that the fall time of the waveform viewed at TP10 is less than eight small divisions of the oscilloscope graticule, i.e., 200 microinches. This measurement should be taken between the 95- and 5-percent points of the waveform.

(8) Disconnect the write head connector from the read head receptacle (J2). Connect the write and read head connectors to J1 and J2, respectively, on the Data PCBA.

6.7.2.2   Write Skew Adjustment (T9640)

Reduction of skew to within acceptable limits is accomplished as follows.

(1) Perform skew measurement procedure described in Paragraph 6.7.2.1, Steps (1)—(7).

(2) While observing the waveform at TP10 on the Data PCBA, and with tape moving in the forward direction, ease the edge of the tape off the head guide cap toward the spring-loaded ring guide. This should be done first on one guide, then the other.

NOTE

Moving the tape one- to two-thousandths of an inch from one of the guides will reduce the skew to within the specified range.

(3) Observe the waveform and determine which movement (upper or lower) improves the display. If moving the tape off the upper guide improves the display, the lower guide should be shimmed.

NOTE

The shims are one-half-thousandth-inch (0.0005) thick berylium copper (PPC Part No. 100298-01).

(4) Observe and note the fall time of the waveform observed at TP2 with an oscilloscope set up as described in Paragraph 6.7.2.1, Step (4).

(5) Since the character spacing at 800 cpi is 1250 microinches, the actual skew can be calculated. The skew correction provided by the addition of one shim (500 microinches thick) is 500 ÷ 12 = 42 microinches. The number of shims used must satisfy the following.

• Skew must be reduced to a minimum consistent with the maximum number of shims allowable.

• The maximum number of shims used must not exceed four.

Therefore, if, for example, the measured skew is 250 microinches, four shims will yield a skew correction of 168 microinches (i.e., 4 × [500 ÷ 12] = 168 microinches). This satisfies the requirements listed above.

(6) Move the Maintenance switch to the reverse position. When the BOT tab is encountered, tape motion will cease. Remove tape from the drive.

(7) Remove the head guide retaining screw (accessible from the rear of the deck) and remove the guide assembly that is to be shimmed.

(8) Insert the required number of shims and reinstall the head guide assembly.

NOTE

Shim only one head guide.

(9) Recheck skew measurement as described in Paragraph 6.7.2.1, Steps (1)—(6) in both the forward and reverse directions.

(10) Reinstall connectors J1 and J2 in their correct positions on the Data PCBA.

6.7.2.3   Read Skew Measurement (T9640)

Measurement of read skew is accomplished by reading an all-1s or all-0s tape with the read head connector plugged into the read head receptacle (J2) on the Data PCBA. This measurement is accomplished as follows.

(1) Set the oscilloscope vertical sensitivity to 1v/cm.

(2) Set the oscilloscope to trigger on Channel 1, negative slope, alternate mode.

(3) Load an 800-cpi Master Skew Tape (Paragraph 6.5.2) and bring to BOT.

(4) Position the Maintenance switch to the forward position.

(5) Observe oscilloscope waveform and adjust the horizontal time/division fixed and variable controls to display one complete cycle.

NOTE

With an 800 cpi tape, each cycle represents 1250 micro-inches. The scope graticule is divided into 10 major divisions each of which is divided into 5 divisions; therefore, 1250 microinches ÷ 50 divisions = 25 microinches/division.

(6) Observe that the fall time of the waveform viewed at TP2 is less than 16 small divisions of the oscilloscope graticule; i.e., 400 microinches. This measurement should be taken between the 95- and 5-percent points of the waveform.

6.7.3   SKEW MEASUREMENT AND ADJUSTMENT (T9660)

Drive skew is adjusted mechanically as outlined in the following paragraphs. The requirements on PE read skew are not severe since the system uses a multiple buffer register per channel for read data recovery.

6.7.3.1   Skew Measurement (T9660)

An indication of the skew may be obtained by observing the algebraic sum of the peak detectors at TP10 on the Data PCBA.

Figure 6-4 illustrates an example of correctly adjusted skew. This method of determining the system write head skew is accomplished as follows.

(1) Set the vertical sensitivity on the oscilloscope to 1v/cm.

(2) Set the oscilloscope to trigger on Channel 1, negative slope, alternate mode.

(3) Load a 32 c/mm (800 cpi) Master Skew Tape (Paragraph 6.5.2) and bring to BOT.

(4) Activate the Maintenance switch so that tape moves in the forward direction.

6-25
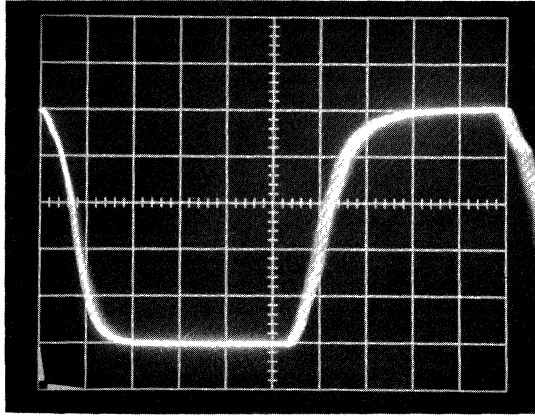
2297

Figure 6-4. Skew Waveform (Typical)

(5) Observe the oscilloscope waveform and adjust the horizontal time/division fixed and variable controls to display one complete cycle.

NOTE

With an 800 cpi tape, each cycle represents 1250 micro-inches. The scope graticule is divided into 10 major divisions each of which is divided into 5 divisions; therefore, 1250 microinches ÷ 50 divisions = 25 microinches/division.

(6) Observe that the fall time of the waveform viewed at TP10 is less than eight small divisions of the oscilloscope graticule, i.e., 200 microinches. This measurement should be taken between the 95- and 5-percent points of the waveform.

(7) Acceptable Skew Limits

• The maximum displacement between any two bits of a character when reading an IBM master tape using the write head is 200 microinches.

• The maximum displacement between any two bits of a character on an all-1s tape written with the write section of the read-after-write head, and read with the read section of the read-after-write head is 400 microinches.

6.7.3.2   Skew Adjustment (T9660)

Reduction of skew to within acceptable limits is accomplished as follows.

(1) Perform skew measurement procedure described in Paragraph 6.7.3.1.

(2) While observing the waveform at TP10 on the Data PCBA, and with tape moving in the forward direction, ease the edge of the tape off the head guide cap toward the spring-loaded washer. This should be done first on one guide, then the other.

NOTE

Moving the tape one- to two-thousandths of an inch from one of the guides will reduce the skew to within the specified range.

(3) Observe the waveform and determine which movement (upper guide or lower guide) improves the display. If moving the tape off the upper guide improves the display, the lower guide should be shimmed.

NOTE

The shims are one-half-thousandth-inch (0.0005) thick berrylium copper (PPC Part No. 100298-01).

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(4) Observe and note the fall time of the waveform observed at TP10 with an oscilloscope set up as described in Paragraph 6.7.3.1, Step (5).

(5) Since the character spacing at 800 cpi is 1250 microinches, the actual skew can be calculated. The skew correction provided by the addition of one shim (500 microinches thick) is 500 ÷ 12 = 42 microinches. The number of shims used must satisfy the following.

- Skew must be reduced to a minimum consistent with the maximum number of shims allowable.

- The maximum number of shims used must not exceed four.

Therefore, if, for example, the measured skew is 250 microinches, four shims will yield a skew correction of 168 microinches (i.e., 4 × (500 ÷ 12) = 168 microinches). This satisfies the requirements listed above.

(6) Move the Maintenance switch to the stop position.

(7) Remove the head guide retaining screw (accessible from the rear of the deck) and remove the guide assembly that is to be shimmed.

NOTE

When removing the guide, care should be taken not to drop the spring and washer.

(8) Insert the required number of shims and reinstall the head guides.

NOTE

Shim only one head guide.

(9) Recheck skew measurement as described in Paragraph 6.7.3.1.

6.7.4   TAPE TENSION

Tape tension is adjusted by adjusting the airflow through the variable orifice located on the rear of the blower housing cover.

Tape tension should always be checked upon initial installation of the unit and each time the unit is relocated to a different site. This is necessary since tape tension may change with changes in altitude above sea level.

6.7.4.1   Test Procedure

Tape tension is checked as follows.

(1) Connect the low pressure side of a differential pressure gauge to the tape cleaner hose port on the blower housing cover.

(2) Load tape on the unit and bring to Load Point.

(3) Observe that the water level indication of vacuum pressure is within the following limits.

- 457.2 mm (18 inches) minimum
- 482.6 mm (19 inches) maximum

6.7.4.2   Adjustment Procedure

When the acceptable limits of vacuum pressure are exceeded, perform the following.

(1) Remove the sound barrier material from the blower intake and loosen the screws (one or two turns) at the bottom of the intake.

(2) Connect the low pressure side of a differential pressure gauge to the tape cleaner hose port on the blower housing cover.

(3) Load tape on the unit and bring to Load Point.

(4) Rotate the orifice plate until a pressure gauge reading of 469.9 mm (18.5 inches) is indicated.

(5) Tighten the screws at the bottom of the intake and reinstall the sound barrier material.

(6) Remove the pressure gauge and reconnect the tape cleaner hose.

6.7.5 HEAD REPLACEMENT

The head may require replacement because of internal faults, faulty cabling, or from wear. Internal faults can be verified by reading a master tape; wear can be verified by measuring the depth of the wear pattern on the head crown. On heads having *guttering* (grooves cut on the crown on either side of the tape path), the heads should be replaced. Replacement should take place when the guttering is worn down to a depth in excess of 0.254 mm (0.01 inch). In those heads showing guttering, the head wear should be measured with a brass shim that is 0.254 mm (0.01 inch) thick. The shim width should be less than the minimum tape width 12.598 mm (0.496 inch). The shim is placed in the worn area of the head crown with one side butted against the worn step. When the upper surface of the shim is below the unworn surface of the head crown (i.e., the head has worn to a depth greater than 0.254 mm or 0.01 inch), the head should be replaced.

6.7.5.1 Head Replacement Procedure

Replacement of the head is accomplished as follows.

(1) Remove the head cover.

(2) Disconnect the head connectors from the Data PCBA.

(3) Remove the two screws that attach the head to the head plate.

(4) Ease the head cables through the hole in the baseplate.

(5) Check the replacement head for cleanliness of the mounting surface.

NOTE

The mounting surface must be free of all foreign substances or excessive skew may result.

(6) Route the head connectors and cables through the baseplate.

(7) Plug the write head connector into J1, and the read head connector into J2 on the Data PCBA.

(8) Attach the head with the two screws removed in Step (3).

NOTE

Two sets of screw holes are provided for mounting the head. The upper set (nearest the switch housing) is used for dual-stack heads.

(9) Load an all-1s tape and bring to Load Point.

(10) Operate the drive in a *shuttling* mode (i.e., forward, then reverse) and observe the oscilloscope signal amplitude at the output of the read amplifiers.

(11) While operating in the shuttling mode, mechanically rotate the head assembly until the observed amplitude difference between forward and reverse operation is minimum and the erase head is in contact with the tape.

6.7.5.2 Related Adjustments

• Read Amplifier Gain (Paragraph 6.6.10).

• Read Skew (Paragraph 6.7.2.3, T9640; Paragraph 6.7.3, T9660).

• Write Skew (Paragraph 6.7.2.1, T9640).

• Flux Gate (Paragraph 6.7.6, T9640).

6.7.6 FLUX GATE ADJUSTMENT (T9640 ONLY)

Crosstalk can be checked and, if necessary, reduced to within acceptable limits by mechanically adjusting the flux gate. Refer to Figure 5-1 to locate Tape Control test points and adjustments. The check and adjustment procedure is as follows.

6.7.6.1 Test Configuration

(1) Connect the Wilson Hand Held Exerciser, Model TX500 (PPC Part No. 110180), to the drive.

NOTE

If a Wilson Exerciser is not available, the customer can use an alternate method to generate an all-1s pattern, writing short record lengths in a Forward/Stop program mode.

(2) Load a reel of tape and bring to Load Point.

6.7.6.2 Test Procedure

(1) Depress the ON LINE switch/indicator.

(2) Configure the exerciser to write short record lengths in a Forward/Stop Program mode.

(3) Place the trigger probe of an oscilloscope on the Synchronous Forward Command (SFC) test point (TP12) on the Tape Control PCBA.

(4) Using the signal probe, observe the waveforms at TP103—TP903 on the Data PCBA.

(5) Note the large data waveform and the smaller crosstalk waveform side by side as shown in Figure 6-5.

(6) Observe and note the amplitude of the crosstalk waveform.

(7) Acceptable Limits

• 1v peak-to-peak maximum

6.7.6.3 Adjustment Procedure

If acceptable crosstalk limits are exceeded, perform the following adjustment procedure.

(1) Perform an unload operation and remove the reel of tape from the unit.

(2) Adjust the small setscrew in the flux gate base until the flux gate surface is parallel to the head surface.

(3) Partially loosen the screw which secures the flux gate assembly to the head plate. Take care to ensure that the flux gate spring does not move the assembly.

(4) Place a white card (e.g., business card) between the flux gate and the magnetic head and press the flux gate assembly lightly against the head.

(5) Figure 6-6 illustrates the correct relationship between the magnetic head and the flux gate.
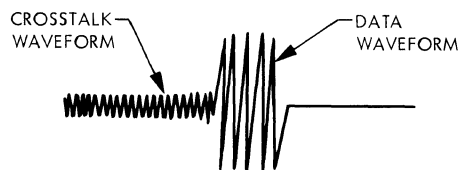
Figure 6-5. Crosstalk Waveform

906M
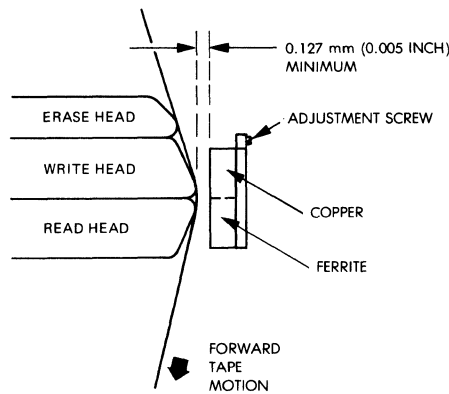
Figure 6-6. Flux Gate Adjustment

(6) Tighten the flux gate assembly screws.

(7) Load a reel of tape and bring to Load Point; repeat the Test Procedure described in Paragraph 6.7.6.2.

NOTE

*It may be necessary to move or rotate the assembly slightly
to achieve the best compromise between all tracks.*

6.7.7 PHOTOSENSOR REPLACEMENT

Replacement of the photosensor is accomplished as follows.

(1) Disconnect the cable that connects the photosensor to the Tape Control PCBA (P504).

(2) Remove the screw that attaches the sensor assembly to the head plate (the screw is accessible from the rear of the baseplate).

(3) Feed the connector forward through the hole in the baseplate, then through the hole in the trim.

(4) Insert the cable of the replacement sensor through the trim and the baseplate.

(5) Replace the connector in the Tape Control PCBA.

(6) Align the surface of the sensor parallel to the tape and tighten the retaining screw.

(7) Adjust the Tape-In-Path reflector so that its surface is parallel to the tape without touching it.

6.7.8 BLOWER DRIVE SYSTEM

The vacuum blower drive is composed of an ac induction motor, a motor pulley, and a drive belt. To obtain sufficient vacuum pressure under various conditions of line frequency and altitude, four different pulley/belt combinations are available; refer to Table 6-6 for these combinations. All new units are factory set for 50 or 60 Hz operation at low altitude (0 to 1219 metres or 0 to 4000 feet); for operation above 1219 metres (4000 feet), the pulley and belt must be changed and the tape tension rechecked. The belt should also be checked at regular intervals for wear and proper tracking.

NOTE

*The blower drive system must also be tested and adjusted
in accordance with the procedure in Paragraph 6.7.4.*

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Table 6-6
Pulley/Belt Combinations

Frequency/Altitude	Motor Pulley Part No.	Belt Part No.
60 Hz 0—1219 metres (0—4000 feet)	103899-01	102634-03
60 Hz 1219—2438 metres (4000—8000 feet)	103899-02	102634-04
50 Hz 0—1219 metres (0—4000 feet)	103899-03	102634-05
50 Hz 1219—2438 metres (4000—8000 feet)	103899-04	102634-06

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6.7.8.1 Blower Belt Tension Check and Replacement Procedure

(1) Remove the trim assembly for access to the blower drive components (refer to Paragraph 6.7.1).

(2) A circular notch is provided in the deck plate, below the supply reel hub assembly, for checking blower belt tension. Move the blower belt back and forth to check for looseness.

NOTE

Blower belt slippage causes excessive belt wear.

(3) If looseness of the belt was noted in Step (2), replace the blower belt.

(4) Remove the four 1/4-20 screws and nuts holding the blower housing to the base plate. The screws are removed from the front of the drive, the nuts from the rear. Do not remove the blower housing.

CAUTION

TWO OF THE FOUR BLOWER HOUSING RETAINING NUTS, LOCATED NEAR THE HEAT SINK OF THE TAPE CONTROL PCBA, MAY FALL INTO THE POWER SUPPLY ASSEMBLY UNLESS CARE IS TAKEN.

(5) Loosen the three screws retaining the blower motor assembly. The assembly is now free to slide vertically, thus relieving blower belt tension.

(6) Remove and replace the blower belt.

(7) Exert approximately 178 newton-metres (40 pounds) of downward pressure on the blower motor assembly while tightening the three mounting screws. This will tension the blower belt to approximately 89 newton-metres (20 pounds).

(8) Replace the four 1/4-20 blower housing screws and nuts removed in Step (4).

(9) Replace the trim assembly (refer to Paragraph 6.7.1).

6.7.8.2 Blower Motor Assembly Removal

Refer to Figure 7-3 for parts location in conjunction with this procedure.

(1) Remove four screws from the rear of the blower housing cover.

(2) Remove blower housing cover.

(3) Remove filter from inside the blower housing.

(4) Remove the four screws and nuts holding the blower housing to the baseplate. The screws are removed from the front of the drive, the nuts from the rear.

CAUTION

TWO OF THE FOUR BLOWER HOUSING RETAINING NUTS, LOCATED NEAR THE HEAT SINK OF THE TAPE CONTROL PCBA, MAY FALL INTO THE POWER SUPPLY ASSEMBLY UNLESS CARE IS TAKEN.

(5) Remove the blower housing.

(6) From the front of the unit, remove three screws holding the blower motor assembly.

(7) Remove the blower motor assembly.

6.7.8.3 Blower Motor Assembly Installation

(1) Reverse the procedure given in Paragraph 6.7.8.2.

(2) Exert approximately 178 newton-metres (40 pounds) of downward pressure on the blower motor assembly while tightening the three mounting screws. This will tension the blower belt to approximately 89 newton-metres (20 pounds).

(3) Replace the trim assembly (refer to Paragraph 6.7.1).

6.7.8.4 Related Adjustments

• Tape Tension (Paragraph 6.7.4).

6.7.9 AIR FILTER REMOVAL AND REPLACEMENT

(1) Remove the four screws retaining the blower housing cover.

(2) Pull the cover away; remove the filter.

(3) Install a new filter and replace the cover and screws.

6.7.9.1 Related Adjustments

• Tape Tension (Paragraph 6.7.4).

6.7.10 DELRIN ROLLER GUIDE ASSEMBLY REPLACEMENT AND TRACKING CHECK

The Delrin roller guide assembly is located at the upper left side of the vacuum chamber. This roller guide should be checked periodically for freedom of rotation and for tape tracking accuracy. The roller barrel should rotate freely when turned by hand; if any roughness is detected, replace the assembly. The assembly is removed by loosening the No. 10 screw at the rear of the baseplate.

NOTE

The replacement roller assembly is factory set to the proper height.

After installation of a replacement roller guide assembly, check for proper tape tracking as follows.

(1) Load a reel of tape.

(2) Move the Maintenance switch to the forward position.

(3) Sight down the inside column wall adjacent to the roller guide and note the position of the tape in relation to the floor of the column and the glass cover. Observe that the gaps between the tape edges and the column wall and glass are approximately equal, i.e., tape is not riding on column floor or on glass surface.

(4) If the conditions of Step (3) are not met, remove power from the drive and remove the trim (refer to Paragraph 6.7.1).

(5) Adjust the roller guide height by loosening the setscrew in the guide base and adjusting the guide height until the tape is centered between the glass and the column floor at the entry point of the column.

6.7.10.1 Related Adjustments

The following procedures must be performed subsequent to changing the Delrin roller guide assembly.

- Read Skew (Paragraph 6.7.2.3, T9640; Paragraph 6.7.3, T9660).
- Write Skew (Paragraph 6.7.2.1, T9640).

6.7.11 TAPE TACHOMETER REPLACEMENT AND TAPE GUIDE TRACKING CHECK

The tachometers are located on the right side of both the supply and takeup chambers and should be checked periodically for freedom of rotation and for tape tracking accuracy.

The tachometer pulley should rotate freely when turned by hand. If any roughness is detected, or should the tachometer require replacement due to an electrical problem, the following procedure is performed.

(1) Place a 13/64 open-end wrench on the flats behind the tachometer pulley and remove the pulley by loosening the socket head screw in the shaft.
(2) Remove all shims from the tachometer shaft.
(3) Remove the three tachometer mounting screws.
(4) Install the replacement tachometer.
(5) Install shims to achieve a thickness totaling 0.014-inch.

NOTE

Use two 0.005-inch thick shims (Part No. 612-1010) and two 0.002-inch thick shims (Part No. 612-1011).

(6) Reinstall the tachometer pulley, load tape, and place the Maintenance switch in the forward position.
(7) Check for proper tape tracking by sighting down the adjacent inside column wall and noting that the gaps between the tape edges and the column floor and glass are approximately equal, i.e., tape not riding on column floor or on glass surface at entry point. If this condition is not met, remove the pulley and add or subtract shims until the tape is centered between the glass and the column floor at the entrance point to the column.

6.7.11.1 Related Adjustments

The following procedures must be performed subsequent to changing a tachometer.

- Reel Servo Position Bias (Paragraph 6.6.9).
- Reel Servo Speed (Paragraph 6.6.8).

6.7.12 REEL MOTOR REPLACEMENT AND REEL HUB HEIGHT ADJUSTMENT

A reel motor may be replaced as follows.

(1) Remove the trim assembly (refer to Paragraph 6.7.1).
(2) Loosen the two screws securing the reel hub to the motor shaft and slide the hub forward and free of the shaft.
(3) Remove the motor lead connections at the Power Supply PCBA (connectors P3 and P6 for the Supply reel; connectors P1 and P4 for the Takeup reel).
(4) Remove four motor mounting screws on the front of the baseplate. Remove the motor from the rear.

(5) Install the replacement motor and reconnect the leads.

(6) Reinstall the reel hub and adjust the hub flange to 31.52 mm (1.241 inches) from the baseplate front surface.

(7) Torque both clamping screws evenly to 2.71 newton-metres (24 inch-pounds).

(8) Reinstall trim assembly and check tape clearance to each reel flange while running tape in both directions. There should be no tape contact with the reel flange.

(9) Readjust as required.

6.7.12.1   Related Adjustments

The following procedures must be performed subsequent to changing a reel motor.
- Reel Servo Position Bias (Paragraph 6.6.9).
- Reel Servo Speed (Paragraph 6.6.8).
- Tape Tension (Paragraph 6.7.4).

6.7.13   REEL HUB GRIP RING REPLACEMENT

The following procedure is used to replace the grip ring on the supply and takeup reel hubs.

6.7.13.1   Supply-Reel Hub Grip Ring

(1) Place the supply hub actuator in its locked position.

(2) Remove the Allen-head screw from the hole in the center of the actuator.

(3) Remove the plastic expansion ring around the actuator, along with the rubber grip ring; note the location of the two plastic notches on the expansion ring, with reference to the hub face assembly.

(4) Install friction ring and expansion ring kit (PPC Part No. 109502-01).

(5) Align the slots in the hub face assembly with the notches on the expansion ring noted in Step (3).

(6) Reinstall the hub face assembly and partially tighten the Allen-head screw removed in Step (2).

NOTE

The Allen-head screw adjusts the grip force exerted on the tape reel.

(7) Release (unlock) the supply hub actuator.

(8) Mount a reel of tape on the supply hub.

(9) Lock the supply hub actuator.

NOTE

If the tape reel binds as it is slipped on the hub, or the actuator is difficult to operate, loosen the Allen-head screw installed in Step (6) in small increments until the tape reel no longer binds.

(10) Manually turn the tape reel clockwise with one hand while holding the hub assembly with the other hand. If the reel slips on the hub, tighten the Allen-head screw in the center of the actuator, in small increments, periodically checking the grip force until the tape reel no longer slips.

(11) Thread the tape onto the takeup reel.

(12) Apply power to the unit.

(13) Bring tape to Load Point.

(14) Manually turn the supply reel clockwise until the tape loop in the vacuum column crosses one of the 90 percent holes. This will cause the jump circuit to oppose the hand movement of the tape reel.

(15) Loosen the Allen-head screw until the supply tape reel just starts to slip on the hub.

NOTE

As the supply tape reel slips on the hub while repeatedly performing Step (14), tighten the Allen-head screw in the center of the actuator until the tape reel just stops slipping, then tighten the Allen-head screw approximately 1/8 turn.

(16) Rewind the tape, de-energize the unit, and remove the tape reel.

6.7.13.2   Takeup Reel Hub Grip Ring

(1) Remove the two Phillips-head screws on the takeup reel hub assembly.

(2) Remove the plastic expansion ring from the hub, along with the rubber grip ring; note the location of the two plastic notches on the expansion ring, with reference to the hub face assembly.

(3) Install friction ring and expansion ring kit (PPC Part No. 109502-01).

(4) Align the slots in the hub face assembly with the notches on the expansion ring noted in Step (2).

(5) Reinstall the hub face assembly by partially tightening the two Phillips-head screws removed in Step (1).

NOTE

These two Phillips-head screws adjust the grip force exerted by the hub against the takeup reel.

(6) Install an empty reel on the takeup reel hub.

(7) Alternately tighten each Phillips-head screw on the takeup reel hub until the pressure is sufficient to keep the reel from slipping on the hub.

NOTE

Check for reel slippage by manually turning reel with one hand while holding the hub in place with the other.

(8) Mount a reel of tape on the supply reel hub.

(9) Thread the tape on the takeup reel.

(10) Apply power to the unit.

(11) Bring tape to Load Point.

(12) Manually turn the supply reel counterclockwise until the tape loop in the vacuum column crosses one of the 90 percent holes. This will cause the jump circuit to oppose the hand movement of the tape reel.

NOTE

If the takeup reel slips on the hub while being turned counterclockwise, tighten the two Phillips-head screws alternately until the reel just stops slipping, then tighten each screw approximately 1/8 turn. If the takeup reel does not slip, alternately loosen each screw until the reel just starts to slip and repeat Step (12) until each screw is set.

(13) Rewind the tape, de-energize the unit, and remove the tape reel.

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6.7.14 CAPSTAN AND CAPSTAN MOTOR REPLACEMENT

6.7.14.1 Capstan Replacement

(1) With the buffer box door closed, but not latched, remove the six Allen-head screws that secure the two door hinges. The door panel and its glass cover can then be removed by gently pulling it outward.

(2) Remove the Allen-head screw in the center of the capstan. This will free the capstan so that it can be removed from the capstan motor shaft.

(3) Install the replacement capstan.

(4) Replace the Phillips-head screw removed in Step (2).

(5) Replace the buffer box door removed in Step (1).

(6) Replace the six Allen-head screws removed in Step (1).

(7) Load a tape and check that it tracks evenly over the surface of the capstan.

NOTE

The capstan motor shaft must be perpendicular to the baseplate to establish a parallel capstan surface to the tape and to ensure proper tape tracking. Operate the Maintenance switch alternately between forward and reverse, moving tape back and forth across the capstan. Check that there is minimal repositioning of the tape (tape walk) on the capstan, and that the tape does not contact the buffer box walls entering and leaving the buffer box. If the tape does not track evenly over the surface of the capstan, install shims as required (Part No. 612-1011) and perform the Related Adjustments in Paragraph 6.7.14.3.

6.7.14.2 Capstan Motor Replacement

The capstan motor may be replaced as follows.

(1) Remove the trim assembly (refer to Paragraph 6.7.1).

(2) Remove the motor leads from the Power Supply PCBA (P2 and P5).

(3) Remove the tachometer connector (P508) from the Tape Control PCBA.

(4) Remove three motor mounting screws on the front of the baseplate. Remove the motor from the rear.

NOTE

Ensure that shims are not lost when removing capstan motor. Anticipate the possibility of a shim dropping and take precautionary measures to prevent its loss.

(5) Remove the capstan from the motor and install on the replacement motor.

(6) Install the replacement motor.

(7) Replace the three mounting screws removed in Step (4).

(8) Replace the tachometer connector (P508) on the Tape Control PCBA.

(9) Connect motor leads (P2 and P5) to the Power Supply PCBA.

(10) Replace trim assembly (refer to Paragraph 6.7.1).

(11) Load a tape and check that it tracks evenly over the surface of the capstan.

NOTE

If the tape does not track evenly over the surface of the capstan, install shims as required on the motor mounting screws (Part No. 612-1011) and perform the Related Adjustments in Paragraph 6.7.14.3.

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6.7.14.3 Related Adjustments

The following items must be checked and, if necessary, adjusted subsequent to capstan motor replacement.

- Capstan Servo Offset (Paragraph 6.6.2).
- Capstan Forward Speed (Paragraph 6.6.3).
- Capstan Reverse Speed (Paragraph 6.6.3).
- Capstan Rewind Speed (Paragraph 6.6.4).
- Tape Tension (Paragraph 6.7.4).

6.7.15 ERASE EFFICIENCY CHECK

The following procedure provides a check of the operating efficiency of the erase head. Failure of the unit to perform within the acceptable limits indicates an internal fault. Refer to Paragraph 6.7.5 for head replacement procedures.

(1) Load a master output tape (Paragraph 6.5.2).

(2) Apply power.

(3) Beginning at BOT, write a continuous all 1s PE pattern on the tape for 3 minutes.

(4) Rewind the tape to BOT.

(5) Connect the oscilloscope to monitor the output of the read differentiators as viewed at TP102—TP902 on the Data PCBA.

(6) Write 32-character all 1s records and adjust the oscilloscope until the complete interblock gap can be observed.

(7) Using the oscilloscope, measure the peak-to-peak baseline noise amplitude during the interblock gap.

(8) Acceptable limit:
- 100 mv maximum

(9) Write forward, read reverse, and read forward 32-character all 1s records and then rewind the tape to BOT.

(10) Read forward while observing the interblock gaps at TP102—TP902 on the Data PCBA. Ensure that there are no more than three spikes in any interblock gap with amplitudes greater than 275 mv.

(11) Rewind the tape.

6.8 TAPE CONTROL PCBA REPLACEMENT

The Tape Control K PCBA is designed to accommodate certain options by use of jumpers W2 through W12 and by use of removable components (terminating resistor pack). A summary of the options and associated jumpers is listed in Table 6-7. The jumpers are identified as follows.

(1) W2. Interface density select.

(2) W3. +5v to interface.

(3) W4. Automatic On-line-off.

(4) W5, W6, W7. 7/9-track select.

(5) W8, W9. Density select.

(6) W10. File protect indicator.

(7) W11. 7/9-track indicator.

(8) W12. Ready delay.

Table 6-7
Option Jumper Configurations

Configuration	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
Standard	0	1	1	X	1	0	0	1	1	0	0
Automatic On-line	0	1	0	X	1	0	0	1	1	0	X
No +5v to Interface	0	0	1	X	1	0	0	1	1	0	X
Remote MTA	0	1	1	X	1	0	0	1	1	0	X
7/9-track Select	0	1	1	1	0	1	0	1	0	1	X
Hi Density Only	X	1	1	X	1	0	1	X	1	0	X
7-track Only	0	1	1	0	0	0	0	1	1	0	X
Density Select by Switch Only	0	1	1	X	1	0	0	1	1	0	X
Density Select	1	1	1	X	1	0	0	1	1	0	X

1   Jumper (P/N 100-0005) must be installed.
0   Jumper must not be installed.
X   Jumper may or may not be installed (has no effect on configuration).

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To ensure that the configuration of the replacement PCBA is identical with respect to options on the replaced PCBA, jumper positions must be compared. Check jumpers W2 through W12 and the terminating resistor socket on the replacement PCBA to ensure compatibility.

NOTE

Further information on use of these jumper options may be obtained through your local PPC representative.

6.9   MAINTENANCE TOOLS
The following listed tools are required to maintain the tape drive.
  (1) Hex socket key set.
  (2) Open-end wrench set up to 9/16-inch.
  (3) 13/64 open-end wrench.
  (4) Phillips screwdriver set.
  (5) Standard blade screwdriver set.
  (6) Flashlight.
  (7) Inspection mirror.
  (8) Lint-free cloth.
  (9) Cotton swabs.
  (10) 91 percent isopropyl alcohol.
  (11) Torque wrench, 0—4 newton-metres (0—35 inch pounds).
  (12) Molex pin extractor.
  (13) Switch Retractor Tool, PPC Part No. 617-0010.

6.10   TROUBLESHOOTING
Table 6-8, Systems Troubleshooting chart, provides a means of isolating faults, possible causes, and remedies. The troubleshooting chart is used in conjunction with the schematics and assembly drawings in Section VII.

Table 6-8
System Troubleshooting

Symptom	Probable Cause	Remedy	Reference
Tape does not tension and the capstan shaft rotates freely when the LOAD/RESET control is depressed for the first time after threading tape.	Interlock relay K1 does not close.	Check operation of relay; replace if necessary.	5.2.2 Figure 5-3
	LOAD/RESET control is not operative.	Check LOAD operation; replace if necessary.	5.2.1
	Relay driver defective.	Check collector voltage of the relay drive transistor with the LOAD/RESET control depressed. It should be less than +1v. If greater, isolate defective relay driver component and replace.	
	Arc suppression FETs always on.	Check FET drives and FETs.	
Tape does not load when LOAD/RESET control is depressed (vacuum motor does not start).	No tape in path or tape improperly threaded.	Place tape in path of EOT/BOT sensor.	3.3
	Tape in path not sensed.	Adjust EOT/BOT sensor.	6.6.12
Tape does not enter vacuum chamber when LOAD/RESET control is depressed.	Tape not properly seated on capstan or roller guides.	Check tape path and ensure three turns of tape wound onto takeup reel.	3.3
Tape does not load properly when LOAD/RESET control is depressed.	Reel tachometer adjusted too slow.	Adjust SUS and TUS.	6.6.8
	Reel tachometers reversed.	Check connections to power supply.	5.2.2 or 5.2.3
Reels activate and throw tape when power switch is turned on.	Relay K1 shorted. Relay K2 stuck in energize position.	Check relay K1; replace if necessary.	5.2.2 or 5.2.3
		Check relay K2; replace if necessary.	
Unload does not stop upon removal of tape in path.	EOT/BOT reflective plate improperly adjusted.	Adjust for maximum reflection to sensor.	6.6.12
+23v or −23v not present on Tape Control PCBA.	Fuse F1 or F2 blown in power supply.	Check fuse; replace if necessary.	5.2.2 or 5.2.3
Tape faults at end of rewind.	Multiple BOT detected.	Check for additional BOT or clean existing BOT. Check BOT amplifier and adjust.	5.2.1, 6.6.12
	Relay K2 sticking.	Check relay K2; replace if necessary.	5.2.2 or 5.2.3
Drive remains in Rewind mode after rewind.	BOT not detected during search for BOT after rewind.	Check BOT sensor and amplifier. Adjust BOT amplifier.	6.6.12
Tape runs past the BOT marker.	BOT tab dirty or tarnished.	Replace tab.	Tape Manufacturer's instructions.

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Table 6-8
System Troubleshooting (Continued)

Symptom	Probable Cause	Remedy	Reference
Tape runs past the BOT marker (continued).	Photosensor or amplifier defective.	Check for appropriate voltage levels in sensor systems with tab not over photosensor. Check for appropriate voltage levels in sensor systems when tab is over photosensor. Adjust amplifiers.	6.6.12
	Logic Fault	Replace or repair Tape Control PCBA.	5.2.1
Drive does not move in response to SYNCHRONOUS FORWARD or REVERSE COMMANDS.	Interface cable fault or receiver fault.	Check levels at outputs and inputs of receivers on Tape Control PCBA. Replace or repair cable or Tape Control PCBA.	5.2.1
	Drive is not Ready.	Replace or repair Tape Control PCBA.	5.2.1
	Fault in ramp generator capstan servo amplifier.	Check TP22 on Tape Control PCBA. Replace or repair Tape Control PCBA.	5.2.1
Drive responds to SYNCHRONOUS FORWARD COMMAND, but tape is not written.	Write current is not enabled.	Check presence of write enable ring on supply reel, FPT indicator should be off. Check TP1 on Tape Control PCBA (should be +5v for writing). Replace Write Lockout Assy if faulty. Check that WRT PWR is +5v at Data PCBA interface connector and appropriate test point on Data PCBA when writing.	5.2.1, 5.2.4 or 5.2.5
	Write status or MOTION signal to Data PCBA is not correct.	Check receiver on Tape Control PCBA and on Data PCBA for Write status.	5.2.1, 5.2.4 or 5.2.5
		Check Data PCBA for MOTION signal. Replace or repair Data or Tape Control PCBA if faulty.	5.2.1, 5.2.4 or 5.2.5
	WRITE DATA or WRITE DATA STROBE is not received correctly on Data PCBA from interface.	Check presence of correct levels on Data PCBA. Replace or repair Data PCBA or interface cable if faulty.	5.2.4 or 5.2.5
	Head incorrectly plugged in.	Check read and write heads on Data PCBA.	Figure 5-7 or 5-9
Data incorrectly written.	Incorrect data format.	Use correct format.	IBM Form A22-6589-3 (729 or 727 Series) IBM Form A22-6866-3 (2400 Series)

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Table 6-8

System Troubleshooting (Continued)

Symptom	Probable Cause	Remedy	Reference
Data incorrectly written (continued).	Fault on one track due to failure in write circuits.	Check receiver and write amplifier on Data PCBA. Replace or repair Data PCBA if faulty.	5.2.4 or 5.2.5
	Intermittent WRT PWR, WRITE DATA, MOTION, or IWARS signal.	Examine signals; replace or repair Tape Control PCBA or Write Lockout Assy on Data PCBA, if faulty.	5.2.1, 5.2.4, or 5.2.5
Correct tape cannot be read.	Interface cable or transmitter fault.	Replace or repair interface cable or Data PCBA.	5.2.4 or 5.2.5
	Head is not plugged in.	Check read and write head connectors on Data PCBA.	Figure 5-7 or 5-9
	Tape tracking on skew is badly adjusted.	Readjust according to procedures in Section VI.	6.7.2 or 6.7.3
	Head and guides dirty.	Clean head and guides.	6.4
	Read amplifier gains are incorrectly adjusted.	Check and adjust amplifier gains.	6.6.10
	Faulty write amplifier causes current to be passed through head while reading.	Check write amplifier output test points and replace or repair Data PCBA if faulty.	5.2.4 or 5.2.5
	Component fault in read channel.	Check test points on Data PCBA. Replace or repair Data PCBA.	5.2.4 or 5.2.5
	Envelope detector delays not correct.	Check TP106—TP906 on Data PCBA for correct on and off times. Replace or repair Data PCBA.	5.2.4
	Threshold level incorrect.	Check level at TP6 on Data PCBA. Repair or replace PCBA.	6.6.11

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SECTION VII
PARTS LISTS, LOGIC LEVELS AND WAVEFORMS, AND SCHEMATICS

7.1 INTRODUCTION

This section includes illustrated parts lists, logic level and waveform definitions, recommended spare parts, and schematic and assembly drawings.

7.2 ILLUSTRATED PARTS BREAKDOWN (IPB)

Figures 7-1 through 7-4, used in conjunction with Tables 7-1 through 7-4, respectively, provide identification by PPC part number of the mechanical and electrical components of the T9000 and FT9000 Series Tape Drives.

7.3 RECOMMENDED SPARE PARTS

Table 7-5 provides a list of the recommended subassembly spare parts for the T9000 and FT9000 Series Tape Drives. The customer should always furnish the model number and the serial number of the drive when ordering parts.

An additional recommended spare parts list containing the part number, description, current price for component parts, subassembly parts, and special tools, is also available. This list can be obtained by providing the unit part number from the ID label on the drive to Spares Administration, PPC, P.O. Box 2198, Chatsworth, CA 91311.

7.4 PART NUMBER CROSS REFERENCE

Table 7-6 provides a cross reference to the manufacturer's part number from typical PPC part numbers.

7.5 LOGIC LEVELS AND WAVEFORMS

The drive control and interface logic uses the DTL800 series of logic elements. Logic levels are: +5.0v — logical true; +0.4v — logical false.

All basic waveform names are chosen to correspond to the logical true condition, e.g., SET WRITE STATUS (ISWS) enables the write circuits when it is logically true (+5.0v), or disables the write circuits when it is logically false (0v).

The inverse of a waveform is denoted by the prefix 'N'. Therefore, NBOT will be 0.4v when the BOT tab is under the photosensor head, or +5.0v otherwise.

All interface lines connecting the drive to the controller are prefixed by 'I'. Each line must be terminated at the receiver end of the cable by a 220/330-ohm divided chain between +5.0v and 0v.

All interface waveforms are low-true. Their logic levels are: +3.0v — logical false; +0.4v — logical true. For example, ISFC (SYNCHRONOUS FORWARD COMMAND) will be +0.4v when the drive is driven in the forward direction, or +3.0v otherwise.

The Glossary contains the waveforms mnemonics referred to in this manual.
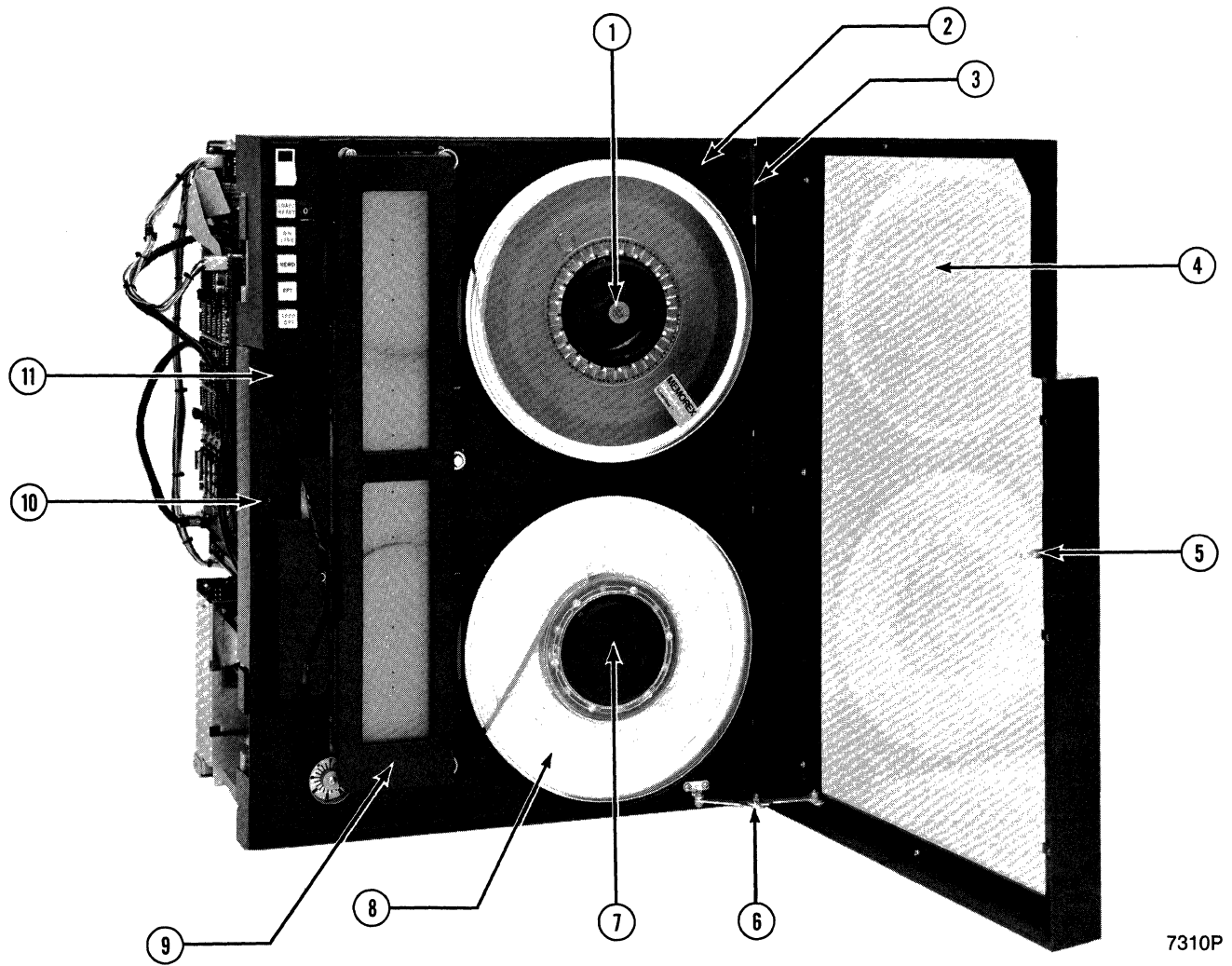
Figure 7-1. T9000 and FT9000 Series, Photo Parts Index (Front View)

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Table 7-1
T9000 and FT9000 Series Photo Parts List

Figure and Index No.	Part No.	Description
Figure 7-1		
1	108844-01	Supply Reel Hub Assembly
2	103833-04	Trim, Gray
	103833-05	Trim, Black
	103833-06	Trim, Dark Gray
	103833-07	Trim, Cream
3	103838-01	Door Hinge, Gray (3 places)
	103838-02	Door Hinge, Black (3 places)
4	103831-01	Transport Window
5	615-0078	Ball Stud
	615-9740	Standoff
6	101777-02	Door Stop Assembly
		or
	615-0116	Door Stop
	600-0604	Screw (2 required)
7	103343-03	Takeup Reel Hub Assembly
8	516-0100	Clear Takeup Reel
9	103901-01	Buffer Box Assembly, Black
	103901-03	Buffer Box Assembly, Cream
10	615-0007	Catch Spring
	600-0604	Screw (2 required)
	605-0600	Washer (2 required)
11	108383-01	Interlock Switch Kit, Gray*
	108383-02	Interlock Switch Kit, Black*
	108383-03	Interlock Switch Kit, Dark Gray*
Not Shown	103806-01	Insert, White with logo
	103806-05	Insert, White
*See PIB T9108.		

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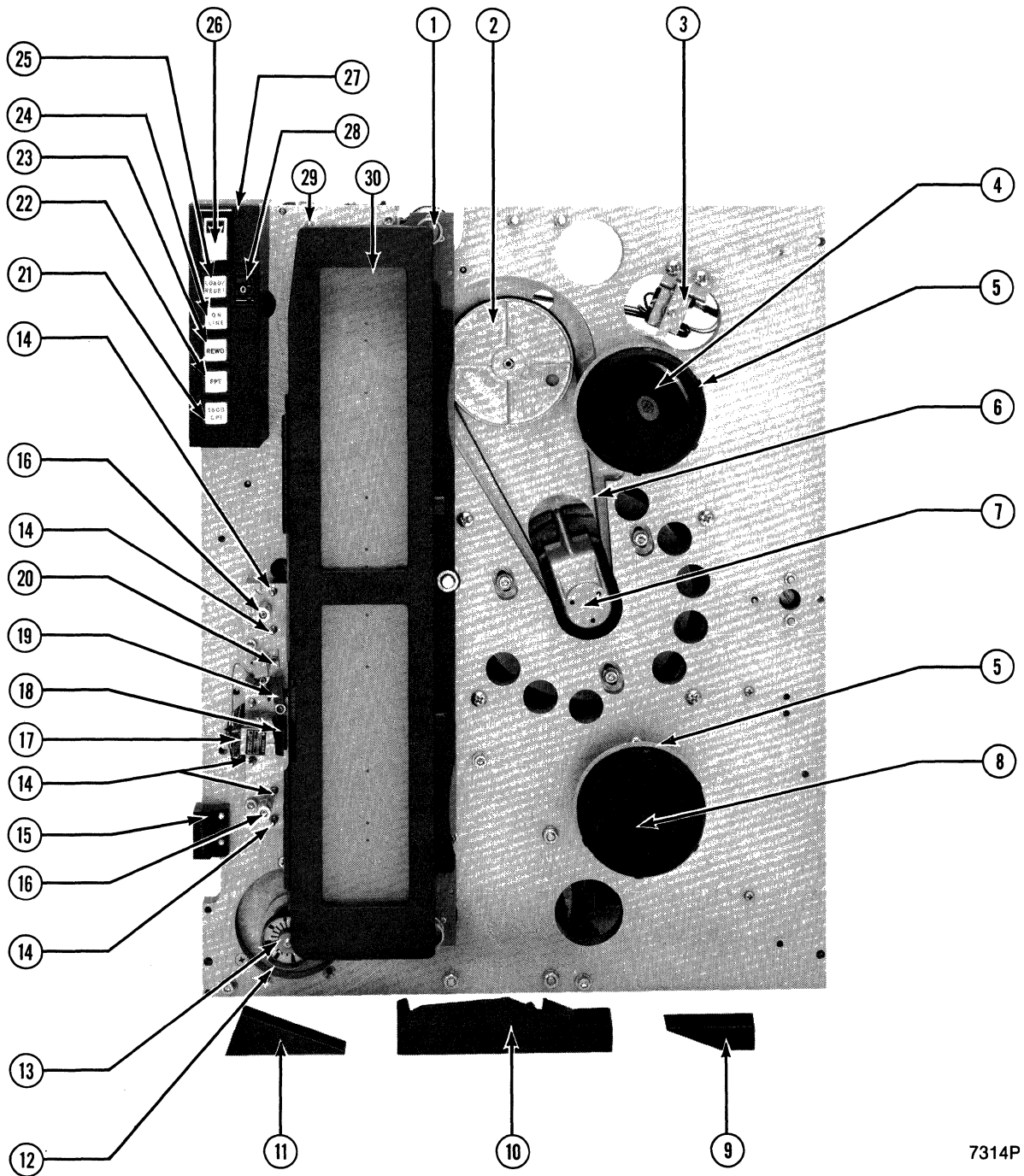
Figure 7-2. T9000 and FT9000 Series, Photo Parts Index (Front View)

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Table 7-2
T9000 and FT9000 Series Photo Parts List

Figure and Index No.	Part No.	Description	Figure and Index No.	Part No.	Description
Figure 7-2					
1	103850-01	Rate Generator (Tachometer) Pulley	15	103802-02	Hinge Block, Gray (2 places) (T9000)
	602-0604	Screw		103802-04	Hinge Block, Black (2 places) (FT9000)
	606-0600	Washer		602-0024	Screw (2 required)
	612-1010	Shim, 0.005 Thick		605-0000	Washer (2 required)
	612-1011	Shim, 0.002 Thick	16	100810-01	Head Guide Assembly (matched pairs)
2	103899-01	AC Drive Motor Pulley, 60 Hz, 0—1219 m (0—4000 ft)		602-0418	Screw
	103899-02	AC Drive Motor Pulley, 60 Hz, 1219—2438 m (4000—8000 ft)	17	510-6189	Head (T9X40, all speeds)
				510-6269	Head (T9640, all speeds)
	103899-03	AC Drive Motor Pulley, 50 Hz 0—1219 m (0—4000 ft)	18	102581-01	Flux Gate Assembly
	103899-04	AC Drive Motor Pulley, 50 Hz, 1219—2438 m (4000—8000 ft)	19	112691-02	EOT/BOT Assembly Kit (Reflector is part of the assembly)
	603-8006	Setscrew	20	103805-01	Tape Cleaner Housing
	667-0008	Loctite		602-0405	Screw (2 required)
3	103910-01	Write Protect Assembly		100761-01	Tape Cleaner Blade
	506-6361	Switch		600-0403	Screw (2 required)
4	108844-01	Supply Reel Hub Assembly	21	102357-25	Blank Switch Assembly
5	109502-01	Friction Ring and Expansion Ring Kit		102357-21	1600 CPI Switch Assembly
				659-0730	Lamp
6	102634-03	Blower Belt, 60 Hz, 0—1219 m (0—4000 ft)	22	102357-22	FPT Switch Assembly
				659-0730	Lamp
	102634-04	Blower Belt, 60 Hz, 1219—2438 m (4000—8000 ft)	23	102357-18	REWIND Switch Assembly
				659-0730	Lamp
	102634-05	Blower Belt, 50 Hz, 0—1219 m (0—4000 ft)	24	102357-17	ON LINE Switch Assembly
				659-0730	Lamp
	102634-06	Blower Belt, 50 Hz, 1219—2438 m (4000—8000 ft)	25	102357-15	LOAD/RESET Switch Assembly
7	518-0007	Blower, Belt Driven		659-0730	Lamp
	103810-01	Standoff (3 required)	26	506-1821	ON/OFF Switch
	602-1420	Screw (3 required)	27	103834-04	Switch Housing (without provision for Select Switch)
	605-0140	Washer (3 required)			
	606-0010	Washer (3 required)		103834-03	Switch Housing (with provision for Select Switch)
8	103343-03	Takeup Reel Hub Assembly			
9	103835-02	Lower Head Cover, Black	28	102363-03	Select Switch Assembly
	103835-05	Lower Head Cover, Dark Gray		506-0019	Switch, 4 Position
	103835-08	Lower Head Cover, Cream	29	103902-01	Tape Guide Assembly
10	103835-01	Center Head Cover, Black		600-0016	Screw
	103835-04	Center Head Cover, Dark Gray		605-0000	Washer
	103835-07	Center Head Cover, Cream	30	103901-01	Buffer Box Assembly
11	103835-03	Upper Head Cover, Black		103901-03	Buffer Box Assembly
	103835-06	Upper Head Cover, Dark Gray		103816-01	Buffer Box Window
	103835-09	Upper Head Cover, Cream		615-0121	Fastener, Press Lock/Unlock
12	102354-01	Capstan		605-0200	Washer
13	101744-03	Strobe Disk, 37.5 ips		601-0205	Screw
	101744-05	Strobe Disk, 45 ips		604-0200	Nut
	101744-13	Strobe Disk, 75 ips	Not Shown	110626-01	Head Strain Relief Kit
14	615-0460	Banana Plug			

*See PIB T9108

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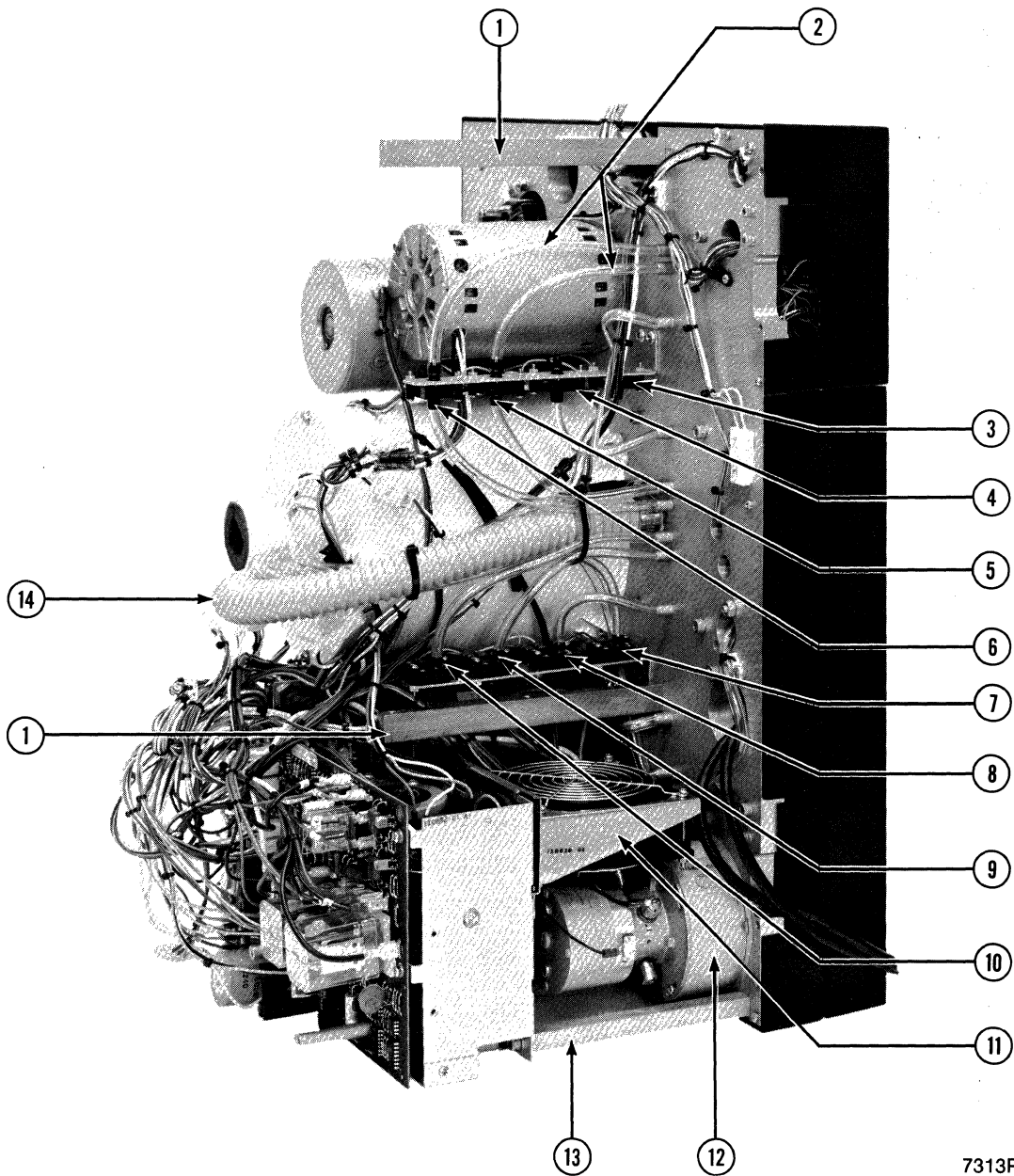
Figure 7-3. T9000 and FT9000 Series, Photo Parts Index
(Rear View, PCBAs Removed)

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Table 7-3
T9000 and FT9000 Series Photo Parts List

Figure and Index No.	Part No.	Description
Figure 7-3		
1	103851-01	Card Cage Support Bar (2 required)
	602-1420	Screw (4 required)
2	669-0011	Sensing Tubing 3/16″ ID (15 places)
3	506-0023	Pressure Sensing Switch, Supply 90% Forward/Reverse
4	506-0023	Pressure Sensing Switch, Supply 90% Reverse
5	506-0023	Pressure Sensing Switch, Supply 110% Forward/Reverse
6	506-0005	Pressure Sensing Switch, Supply Interlock Switch
7	506-0023	Pressure Sensing Switch, Takeup 90% Reverse
8	506-0023	Pressure Sensing Switch, Takeup 90% Forward
9	506-0023	Pressure Sensing Switch, Takeup 110% Forward/Reverse
10	506-0005	Pressure Sensing Switch, Takeup Interlock Switch
11	110610-01	Fan Assembly
12	103895-01	Capstan Motor Assembly
13	103810-03	Standoff (3 places)
	602-1420	Screw (3 required)
	605-0140	Washer (3 required)
14	669-0004	Vacuum Hose 1″ ID
	615-0149	Hose Clamp

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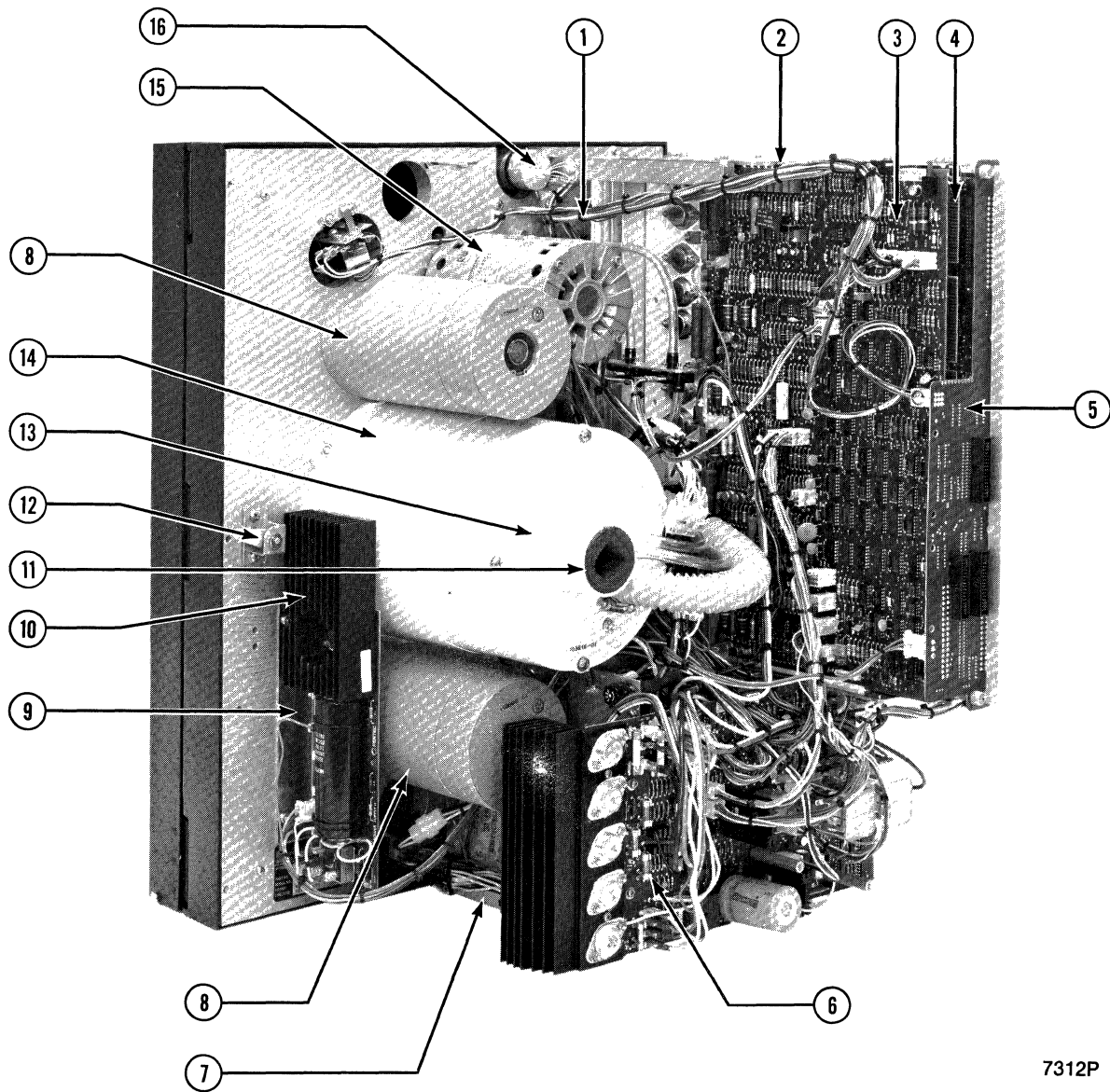
Figure 7-4. T9000 and FT9000 Series, Photo Parts Index
(Rear View, PCBAs Extended)

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Table 7-4
T9000 and FT9000 Series Photo Parts List

Figure and Index No.	Part No.	Description
Figure 7-4		
1	103824-01	Heatsink
2	104878-01	Card Cage End Plate (2 places)
3	103883-*	Tape Control K PCBA
4	107605-*	Microformatter PCBA (FT9000 only)
5	107611-01	Interconnect E PCBA (FT9000 only)
6	110621-01	Power Supply G2 PCBA
	502-0005	Relay, K1
	502-1215	Relay, K2 and K3
		or
	104575-01	Power Supply G1 PCBA (Not Shown)
	502-1244	Relay, K1
	502-1215	Relay, K2
	502-1211	Socket
7	104580-01	Transformer Assembly (T9000)
	104580-02	Transformer Assembly (FT9000)
8	103896-01	Reel Motor Assembly
	600-0020	Screw (4 required)
	605-0000	Washer (4 required)
9	104883-01	Bracket (FT9000 only)
	600-2816	Screw (2 required)
	606-0800	Washer (2 required)
10	107615-06	Power Supply II PCBA (FT9000 only)
		or
	107615-02	Power Supply II PCBA (not shown) (FT9000 only)
	107653-03	Interconnect Cable (Power Supply II to Microformatter)
	102709-05	Standoff (2 required)
	600-2808	Screw (2 required)
	606-0800	Washer (2 required)
11	103839-02	Sound Barrier
12	615-4410	Pawl Fastener
	600-0016	Screw (2 required)
	604-2000	Nut (2 required)
13	103820-01	Blower Housing Cover
	600-2007	Screw (4 required)
	606-0000	Washer (3 required)
14	103819-01	Blower Housing
	600-2120	Screw (4 required)
	604-0140	Nut (4 required)
15	104581-01	AC Motor Assembly
	601-0808	Screw (4 required)
16	103897-01	Rate Generator Assembly (Tachometer)
	601-0405	Screw (3 required)
Not Shown	103912-01	Running Time Kit (60 Hz)
	103912-02	Running Time Kit (50 Hz)
	614-0004	Air Filter
	104712-01	Guide Pin
	602-0018	Screw
	605-0000	Washer
	630-0032	FCC Warning Label
*Order as indicated on component side of PCBA.		

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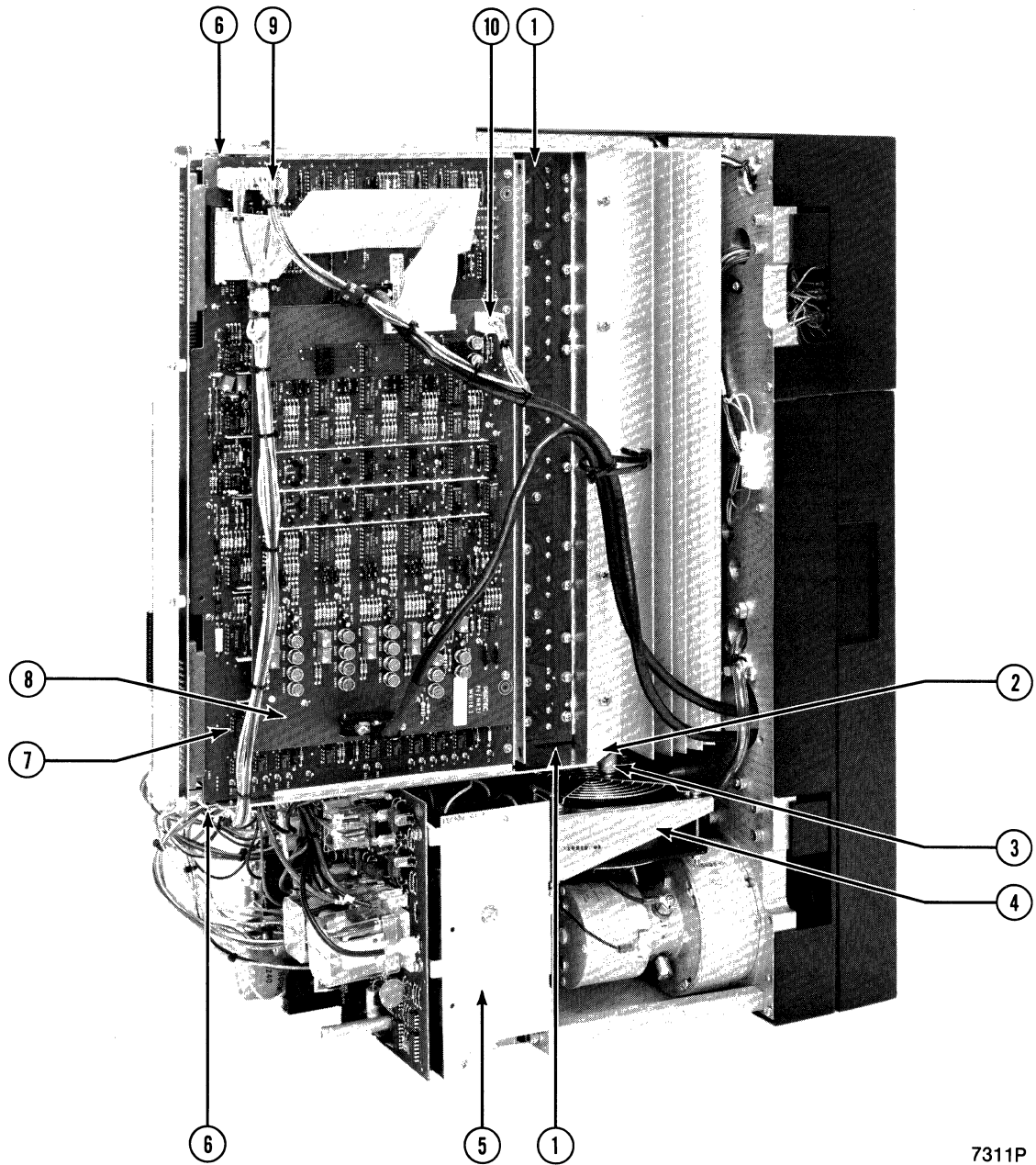
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Figure 7-5. T9000 and FT9000 Series, Photo Parts Index
(Rear View, PCBAs Extended)

Table 7-5

T9000 and FT9000 Series Photo Parts List

Figure and Index No.	Part No.	Description
Figure 7-5		
1	109647-01	Adjustable Card Stop (See PIB 9109A)
	600-2606	Screw
	604-3600	Nut
2	104878-01	Card Cage End Plate (2 places)
3	103810-01	Standoff
4	110610-01	Fan Assembly
5	110632-01	Power Supply Assembly
		or
	104579-01	Power Supply Assembly (not shown)
6	104880-01	Card Cage Adaptor Bracket (FT9000 only)
7	*	Data PCBA
8	*	PE/NRZI Write PCBA (T9640-98 and FT9640-98)
9	101915-04	Interconnect Cable Board, Data to TCK
10	102368-02	Interconnect Cable Board, Write 2 to Data K2
	102368-01	Interconnect Cable Board, Write to Data K1
Not Shown	615-7298	PCBA Spacer (Between Data K1, K2 and Write, Write 2)
	615-0357	Hinged Standoff on PE/NRZI Write PCBA
	615-0351	Hinged Standoff on PE/NRZI Write 2 PCBA
	652-1650	Card Guide (6 places)
	101070-02	Card Alignment Block (T9000 only)
*Order as indicated on component side of PCBA.		

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Table 7-6
T9000 and FT9000 Series Recommended Spare Parts List

Item	Part No.
1. Data F PCBA (9640)	101346-*
Data K1 PCBA (9640-98)	102326-*
Data K2 PCBA (9640-98)	104721-*
Data E19 PCBA (9X40) 9-Track	101711-*
2. PE/NRZI Write PCBA (9640-98)	102308-*
PE/NRZI Write 2 PCBA (9640-98)	104726-*
3. Tape Control K PCBA	103883-*
4. Power Supply G2 PCBA	110621-01
or	
Power Supply G1 PCBA	104575-01
5. Reel Motor Assembly	103896-01
6. Capstan Motor Assembly	103895-01
7. AC Motor Assembly	104581-01
8. Rate Generator Assembly	103897-01
9. POWER Switch	506-1821
10. LOAD/RESET Switch Assembly	102357-15
11. ON LINE Switch Assembly	102357-17
12. REWIND Switch Assembly	102357-18
13. 1600 CPI Switch Assembly	102357-21
14. FPT Switch Assembly	102357-22
15. Blank Switch Assembly	102357-25
16. EOT/BOT Sensor Assembly	110643-02
17. Tape Guide Assembly	103902-01
18. Pressure Switch	506-0023
19. Flux Gate Assembly	102581-01
20. 9-Track Head (9X40) All Speeds	510-6189
9-Track Head (9640 and 9640-98) All Speeds	510-6269
21. Air Filter	614-0004
22. Write Protect Switch	506-6360
23. Microformatter PCBA (FT9000 only)	107605-*
24. Interconnect E PCBA (FT9000 only)	107611-01
25. Power Supply II PCBA (FT9000 only)	107615-06
or	
Power Supply II PCBA (FT9000 only)	107615-02
26. Supply Reel Hub Assembly	108844-01
27. Friction/Expansion Ring Kit	109502-01
28. Relay, Power Supply G2 PCBA K1	502-0005
Relay, Power Supply G2 PCBA K2 and K3	502-1215
or	
Relay, Power Supply G1 PCBA K1	502-1244
Relay, Power Supply G1 PCBA K2	502-1215
29. Lamp for Switches	659-0730
*Order as indicated on component side of PCBA.	

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Table 7-7
T9000/FT9000 Series
Part Number Cross Reference

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Capacitors, Aluminum Electrolytic		
70 µfd + 100% − 10%, 20wvdc, TT710020CON6P	Mallory	133-7060
330 µfd + 100% − 10%, 25wvdc, VTL330S25	Mallory	134-3360
4,600 µfd + 100% − 10%, 20wvdc, CGS462V020R2C3PH	Mallory	134-0001
25,000 µfd + 75% − 20%, 15wvdc, CGS253V015R4C3PL	Mallory	134-2591
Capacitors, Ceramic		
0.001 µfd ± 10%, 1000wvdc, 5GA-D10	Sprague	135-1002
0.0022 µfd ± 20%, 1000wvdc, 5GA-D22	Sprague	135-2272
0.01 µfd ± 10%, 100wvdc, 192CX7R103X9100H1	Sprague	135-1031
0.02 µfd + 80% − 20%, 600wvdc, 811-600V-25U-2032	Tusonix •	135-2062
0.47 µfd ± 20%, 50wvdc, DB46D25U474M	West Cap	135-4742
0.5 µfd + 80% − 20%, 50wvdc, TCD-5032	Arco	135-5062
Capacitors, Dipped Mica	(Comply with MIL-C-5)	
10 pf ± 5%, 500wvdc, MWB-100	Sprague	130-1005
15 pf ± 5%, 500wvdc, MWB-150	Sprague	130-1505
22 pf ± 5%, 500wvdc, MWB-220	Sprague	130-2205
33 pf ± 5%, 500wvdc, MWB-330	Sprague	130-3305
47 pf ± 5%, 500wvdc, MWB-470	Sprague	130-4705
100 pf ± 5%, 500wvdc, MWB-101	Sprague	130-1015
150 pf ± 5%, 500wvdc, MWB-151	Sprague	130-1515
220 pf ± 5%, 500wvdc, MWB-221	Sprague	130-2215
330 pf ± 5%, 500wvdc, MWB-331	Sprague	130-3315
470 pf ± 5%, 500wvdc, MWB-471	Sprague	130-4715
750 pf ± 5%, 500wvdc, DM15-751J	Arco	130-7515
Capacitors, Film		
0.001 µfd ± 10%, 100wvdc, 192P10292	Sprague	131-1020
0.0015 µfd ± 10%, 100wvdc, 192P15292	Sprague	131-1520
0.0022 µfd ± 10%, 100wvdc, 192P22292	Sprague	131-2220
0.0033 µfd ± 10%, 100wvdc, 192P33292	Sprague	131-3320
0.0047 µfd ± 10%, 100wvdc, 192P47292	Sprague	131-4720
0.0068 µfd ± 10%, 100wvdc, 192P68292	Sprague	131-6820
0.01 µfd ± 10%, 100wvdc, 192P10392	Sprague	131-1030
0.015 µfd ± 10%, 100wvdc, 192P15392	Sprague	131-1530
0.033 µfd ± 5%, 50wvdc, K5R333J	Elpac	136-3331
0.033 µfd ± 10%, 100wvdc, 192P33392	Sprague	131-3330
0.047 µfd ± 10%, 100wvdc	Sprague	131-4730
0.068 µfd ± 10%, 100wvdc, 192P68392	Sprague	131-6830
0.15 µfd ± 10%, 100wvdc, 192P15492	Sprague	131-1540
0.22 µfd ± 10%, 100wvdc, 192P22492	Sprague	131-2240
0.33 µfd ± 10%, 100wvdc, PEIS-33-100-10	Southern Electric	131-3340
1.5 µfd ± 20%, 100wvdc, 453P155X0100MA3	Sprague	131-1550
Capacitors, Solid Tantalum		
0.47 µfd ± 10%, 35wvdc, TARR-47K40V	ITT	139-4755
2.2 µfd ± 20%, 20wvdc, TARR2-2M20V	ITT	139-2244
2.7 µfd ± 5%, 10wvdc, NAA275J10M	NEC	139-2710
2.7 µfd ± 20%, 35wvdc, TIM275M035POW	Mallory	132-2752
12 µfd ± 20%, 10wvdc, TIM126K010POW	Mallory	132-1262
22 µfd ± 10%, 15wvdc, TARS22K16V	ITT	139-2261
22 µfd ± 20%, 15wvdc, TAC226K015P04	Mallory	139-2262
22 µfd ± 20%, 6wvdc, TIM226M006POW	Mallory	132-2262
Diodes		
1N4002, Rectifier, 1A, 100vdc, DO-41	Fairchild	300-4002
1N4446, Switching, 75PIV, DO-35	Fairchild	300-4446
1N5402, Rectifier, 3A, 220PIV, DO-35	Motorola	300-4721
A15A, Rectifier, 3A, 100PIV	General Electric	300-4004
Diodes, Zener		
1N4730A, 3.9w ± 5%, 1w, DO-41	Siemens	330-0395
1N4732A, 4.7w ± 5%, 1w, DO-41	Siemens	330-0475
1N4734A, 5.6w ± 5%, 1w, DO-41	Siemens	330-0565
1N4736A, 6.8w ± 5%, 1w, DO-41	Texas Instruments	330-0685
1N4742A, 12w ± 5%, 1w DO-41	Fairchild	330-1205

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Table 7-7
T9000/FT9000 Series
Part Number Cross Reference (Continued)

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Diodes, Zener (Continued)		
1N5223B, 2.7w ±5%, 500mw, DO-7	Motorola	331-0275
1N5228B, 3.9w ±5%, 500mw, DO-7	Siemens	331-0395
1N5246B, 16w ±5%, 500mw DO-7	ITT	331-1605
Integrated Circuits		
LM305AH +4.5v to +40v, TO-99	Fairchild	400-0305
LM317K, Voltage Regulator	National	400-0007
LM318N, Op. Amp. Single	National	400-0318
LM337K, Voltage Regulator	National	400-0006
LM339N, Voltage Comparator Dual	National	400-0339
MC14376, Dual, TO-116	Motorola	400-1437
NE521N, Comparator, Dual	Signetics	700-0521
NE555P, Timer, Single, Monostable	Texas Instruments	400-0555
SN15836N, Inverter, TO-116	Texas Instruments	700-8360
SN15844N, Gate Power, M-75	Texas Instruments	700-8440
SN15846N, Gate NAND, M-75	Texas Instruments	700-8460
SN158093N, Flipflop, Dual	Texas Instruments	700-8530
SN74504N, Hex, 14 Pin DIP	Texas Instruments	700-4040
SN7400N, Positive NAND	Texas Instruments	700-7400
SN7402N, Digital, Positive-NOR	Texas Instruments	700-7402
SN7404N, Hex, Single Input Inverter	Texas Instruments	700-7404
SN7410N, Gate Positive NAND	Texas Instruments	700-7410
SN74107N, Flipflop	Texas Instruments	700-4107
SN74121N, Multivibrator	Texas Instruments	700-4121
SN74123N, Multivibrator	Texas Instruments	700-4123
SN7413N, Dual Schmitt	Texas Instruments	700-7413
SN7416N, Inverter Buffer	Texas Instruments	700-7416
SN7420N, Positive NAND, Dual	Texas Instruments	700-7420
SN74221, Multivibrator, Dual	Texas Instruments	700-4221
SN7430N, Positive NAND	Texas Instruments	700-7430
SN7433N, Gate Buffer	Texas Instruments	700-7433
SN7437N, Gate, Positive NAND	Texas Instruments	700-7437
SN7438N, Positive NAND, Digital	Texas Instruments	700-7438
SN7440N, Positive NAND	Texas Instruments	700-7440
SN7474N, Flipflop, D-Type	Texas Instruments	700-7474
SN7476, Flipflop, Dual	Texas Instruments	700-7476
SN7486N, Exclusive-OR, Quad	Texas Instruments	700-7486
SN7493N, Counter Binary	Texas Instruments	700-7493
SN7496N, Register	Texas Instruments	700-7496
SN75107AN, Receiver	Texas Instruments	700-5107
SN75451P, Dual	Texas Instruments	700-7545
SN75452P, Positive NAND	Texas Instruments	700-5452
VA741CP, Op. Amp. Single	Texas Instruments	400-2741
SN74LS00N, Positive NAND	Texas Instruments	710-7400
SN74LS02N, Positive	Texas Instruments	710-7402
SN74LS04N, Inverter Hex	Texas Instruments	710-7404
SN74LS08N, Gate Positive	Texas Instruments	710-7408
SN74LS10N, Gate Positive	Texas Instruments	710-7410
SN74LS11N, Gate Positive	Texas Instruments	710-7411
SN74LS14N, Inverter	Texas Instruments	710-7414
SN74LS27N, Gate Positive	Texas Instruments	710-7427
SN74LS30N, Gate Positive	Texas Instruments	710-7430
SN74LS32N, Gate Positive	Texas Instruments	710-7432
SN74LS38N, Gate Positive NAND	Texas Instruments	710-7438
SN74LS74N, Flipflop	Texas Instruments	710-7474
SN74LS76N, Flipflop	Texas Instruments	710-7476
SN74LS86N, Gate, Exclusive-OR	Texas Instruments	710-7486
SN74LS95N, Register, Right Shift	Texas Instruments	710-7495
SN74LS96N, Register, Shift	Texas Instruments	710-7496
SN74LS151, Digital Selector	Texas Instruments	710-4151
SN74LS153, Digital Selector	Texas Instruments	710-4153
SN74LS161N, Synchronous Counter	Motorola	710-4161
SN74LS163PC, Synchronous Counter	Fairchild	710-4163
SN74LS164N, Synchronous Register	Motorola	710-4164
SN74LS174N, Flipflop, D	Texas Instruments	710-4174

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Table 7-7

T9000/FT9000 Series
Part Number Cross Reference (Continued)

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Integrated Circuits (Continued)		
SN74LS175N, Flipflop, D	Texas Instruments	710-4175
SN74LS280N, Parity Generator	Texas Instruments	710-4280
Rectifier, Bridge		
10A, 100PIV, MB12A 10V10	Westinghouse	320-1010
25A, 100PIV, MB12A 25V10	Westinghouse	320-2510
Rectifier, Silicon Controlled		
2N6394, 12 Amp	Motorola	201-0126
C122F, 8A	General Electric	201-0122
S2600S, 7A	RCA	201-4654
Resistors, Carbon Film, Carbon Composition	(Comply with MIL-R-11)	
6.2 ohms ±5%, ¼w		100-0605
10 ohms ±5%, 1w		102-1005
12 ohms ±5%, ¼w		100-1205
15 ohms ±5%, ¼w		100-1505
22 ohms ±5%, ¼w		100-2205
22 ohms ±5%, 2w		103-2205
33 ohms ±5%, ¼w		100-3305
47 ohms ±5%, ¼w		100-4705
56 ohms ±5%, ½w		101-5605
68 ohms ±5%, ¼w		100-6805
82 ohms ±5%, ½w		101-8205
100 ohms ±5%, ¼w		100-1015
100 ohms ±5%, ½w		101-1015
100 ohms ±5%, 1w		102-1015
120 ohms ±5%, ¼w		102-1215
150 ohms ±5%, ¼w		100-1515
150 ohms ±5%, 1w		102-1515
180 ohms ±5%, ¼w		100-1815
180 ohms ±5%, 1w		102-1815
220 ohms ±5%, ¼w		100-2215
220 ohms ±5%, ½w		101-2215
220 ohms ±5%, 1w		102-2215
270 ohms ±5%, ¼w		100-2715
270 ohms ±5%, ½w		101-2715
330 ohms ±5%, ¼w		100-3315
330 ohms ±5%, ½w		101-3315
330 ohms ±5%, 1w		102-3315
390 ohms ±5%, ¼w		100-3915
390 ohms ±5%, ½w		101-3915
470 ohms ±5%, ¼w		100-4715
470 ohms ±5%, ½w		101-4715
470 ohms ±5%, 2w		103-4715
560 ohms ±5%, ½w		101-5615
680 ohms ±5%, ¼w		100-6815
680 ohms ±5%, ½w		101-6815
820 ohms ±5%, ¼w		100-8215
820 ohms ±5%, ½w		101-8215
1k ohms ±5%, ¼w		100-1025
1k ohms ±5%, ½w		101-1025
1.2k ohms ±5%, ¼w		100-1225
1.5k ohms ±5%, ¼w		100-1525
1.5k ohms ±5%, ½w		101-1525
1.5k ohms ±5%, 2w		103-1525
1.8k ohms ±5%, ¼w		100-1825
2.2k ohms ±5%, ¼w		100-2225
2.2k ohms ±5%, ½w		101-2225
2.7k ohms ±5%, ¼w		100-2725
2.7k ohms ±5%, ½w		101-2725
3.3k ohms ±5%, ¼w		100-3325
4.7k ohms ±5%, ¼w		100-4725
4.7k ohms ±5%, ½w		101-4725
5.6k ohms ±5%, ¼w		100-5625

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Table 7-7
T9000/FT9000 Series
Part Number Cross Reference (Continued)

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Resistors, Carbon Film, Carbon Composition (Cont.)	(Comply with MIL-R-11)	
5.6k ohms ±5%, ½w		101-5625
6.8k ohms ±5%, ¼w		100-6825
8.2k ohms ±5%, ¼w		100-8225
10k ohms ±5%, ½w		101-1035
12k ohms ±5%, ¼w		100-1235
15k ohms ±5%, ¼w		100-1535
18k ohms ±5%, ¼w		100-1835
22k ohms ±5%, ¼w		100-2235
22k ohms ±5%, ½w		101-2235
27k ohms ±5%, ¼w		100-2735
33k ohms ±5%, ¼w		100-3335
39k ohms ±5%, ¼w		100-3935
47k ohms ±5%, ½w		101-4735
56k ohms ±5%, ¼w		100-5635
68k ohms ±5%, ¼w		100-6835
82k ohms ±5%, ¼w		100-8235
82k ohms ±5%, ½w		101-8235
100k ohms ±5%, ¼w		100-1045
100k ohms ±5%, ½w		101-1045
120k ohms ±5%, ½w		101-1245
150k ohms ±5%, ¼w		100-1545
220k ohms ±5%, ½w		101-2245
270k ohms ±5%, ½w		101-2745
390k ohms ±5%, ¼w		100-3945
470k ohms ±5%, ¼w		100-4745
470k ohms ±5%, ½w		101-4745
1.0m ohms ±5%, ¼w		100-1055
1.5m ohms ±5%, ½w		101-1555
2.2m ohms ±5%, ¼w		100-2255
10m ohms ±5%, ¼w		100-1065
Resistors, Metal Film		
11 ohms ±1%, 1/8w		107-0110
110 ohms ±1%, 1/8w		107-1100
121 ohms ±1%, 1/8w		107-1210
178 ohms ±1%, 1/8w		107-1780
422 ohms ±1%, 1/8w		107-4220
422 ohms ±1%, ¼w		104-4220
562 ohms ±1%, ¼w		104-5620
619 ohms ±1%, 1/8w		107-6190
619 ohms ±1%, ¼w		104-6190
681 ohms ±1%, 1/8w		107-6810
825 ohms ±1%, 1/8w		107-8250
909 ohms ±1%, 1/8w		107-9090
909 ohms ±1%, ¼w		104-9090
1k ohms ±1%, 1/8w		107-1001
1k ohms ±1%, ¼w		104-1001
1.1k ohms ±1%, ¼w		104-1101
1.21k ohms ±1%, 1/8w		107-1211
1.47k ohms ±1%, 1/8w		107-1471
1.47k ohms ±1%, ¼w		104-1471
1.78k ohms ±1%, 1/8w		107-1781
1.96k ohms ±1%, 1/8w		107-1961
2.15k ohms ±1%, 1/8w		107-2151
2.37k ohms ±1%, 1/8w		107-2371
2.61k ohms ±1%, ¼w		104-2611
3.16k ohms ±1%, 1/8w		107-3161
3.48k ohms ±1%, ¼w		104-3481
3.83k ohms ±1%, ¼w		104-3831
4.22k ohms ±1%, ¼w		104-4221
4.64k ohms ±1%, 1/8w		107-4641
4.64k ohms ±1%, ¼w		104-4641
5.11k ohms ±1%, 1/8w		107-5111
5.11k ohms ±1%, ¼w		104-5111
5.62k ohms ±1%, 1/8w		107-5621

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Table 7-7

T9000/FT9000 Series
Part Number Cross Reference (Continued)

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Resistors, Metal Film (Cont.)		
6.19k ohms ±1%, 1/8w		104-6191
6.19k ohms ±1%, 1/4w		104-6191
7.5k ohms ±1%, 1/4w		104-7501
9.09k ohms ±1%, 1/8w		107-9091
9.09k ohms ±1%, 1/4w		104-9091
10k ohms ±1%, 1/8w		107-1002
10k ohms ±1%, 1/4w		104-1002
11k ohms ±1%, 1/4w		104-1102
13.3k ohms ±1%, 1/8w		107-1332
13.3k ohms ±1%, 1/4w		104-1332
14.7k ohms ±1%, 1/8w		107-1472
14.7k ohms ±1%, 1/4w		104-1472
16.2k ohms ±1%, 1/4w		104-1622
23.7k ohms ±1%, 1/8w		107-2372
24.9k ohms ±1%, 1/4w		104-2492
26.1k ohms ±1%, 1/4w		104-2612
34.8k ohms ±1%, 1/8w		107-3482
34.8k ohms ±1%, 1/4w		104-3482
56.2k ohms ±1%, 1/8w		107-5622
68.1k ohms ±1%, 1/8w		107-6812
75k ohms ±1%, 1/4w		104-7502
82.5k ohms ±1%, 1/8w		107-8252
100k ohms ±1%, 1/4w		104-1003
133k ohms ±1%, 1/4w		104-1333
147k ohms ±1%, 1/8w		107-1473
162k ohms ±1%, 1/8w		107-1623
162k ohms ±1%, 1/4w		104-1623
196k ohms ±1%, 1/4w		104-1963
422k ohms ±1%, 1/4w		104-4223
909k ohms ±1%, 1/4w		104-9093
Resistors, Wirewound		
0.015 ohms ±3%, 10w		118-0013
0.3 ohms ±3%, 10w		118-0033
0.20 ohms ±3%, 5w		109-0002
0.75 ohms ±5%, 25w		117-0715
2.2 ohms ±5%, 2w		114-0225
5 ohms ±3%, 5w		109-0009
5 ohms ±5%, 25w		117-0505
820 ohms ±5%, 15w		119-0820
Resistors, Variable		
100 ohms ±10%, 1/2w, 25 Turn, 66W-100	Beckman	124-1010
500 ohms ±10%, 3/4w, 20 Turn, 79PR500	Beckman	121-5010
1k ohms ±10%, 1/2w, 25 Turn, 66W-1K	Beckman	124-1021
1k ohms ±10%, 3/4w, 79PR1K	Beckman	121-1020
1k ohms ±20%, 3/4w, Single Turn, A2B102	Allen Bradley	123-1020
2k ohms ±10%, 1/2w, 25 Turn, 66W-2K	Beckman	124-2020
5k ohms ±10%, 1/2w, 25 Turn, 66W-5K	Beckman	124-5020
5k ohms ±10%, 3/4w, 79PR5K	Beckman	121-5020
5k ohms ±20%, 1/2w, 1 Turn, A2B502	Allen Bradley	123-5020
10k ohms ±10%, 1/2w, 25 Turn, 66W-10K	Beckman	124-1030
10k ohms ±10%, 3/4w, 20 Turn, 79PR10K	Beckman	121-1030
10k ohms ±20%, 1/2w, 1 Turn, A2B103	Allen Bradley	123-1030
20k ohms ±10%, 1/2w, 25 Turn, 66W-20K	Beckman	124-2030
50k ohms ±10%, 1/2w, 25 Turn, 66W-50K	Beckman	124-5030
50k ohms ±10%, 3/4w, 79PR50K	Beckman	121-5030
100k ohms ±10%, 3/4w, 79PR100K	Beckman	121-1040
Thermistors		
1J13, 10k ohms ±10%	CAL-R	127-1031
Thyristor (Triac)		
T6006D, 15A, TO-220	RCA	205-4015

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Table 7-7

T9000/FT9000 Series
Part Number Cross Reference (Continued)

Manufacturer Part No./Description	Manufacturer	Pertec Part No.
Transistors		
MJ2955, PN, 60v, 15A, 115w, T = −65 +200	Motorola	200-2955
2N3053, NPN, Medium Power, TO-5	Texas Instruments	200-3053
2N3055, NPN, Power, TO-3	Motorola	200-3055
2N3772, NPN, Selected, TO-3	TRW	200-3772
2N4037, PNP, Medium Power, TO-5	Motorola	200-4037
2N4123, NPN, Switching, TO-92	Motorola	200-4123
2N4124, NPN, Switching, TO-92	Motorola	200-4124
2N4125, PNP, Switching, TO-92	Motorola	200-4125
2N4402, PNP, Switching, TO-92	Motorola	200-4402
2N5321, NPN, TO-5	RCA	200-5321
2N5323, PNP, High Power, TO-5	Fairchild	200-5323
2N6051, PNP, TO-3	Motorola	200-6051
RCA31B, NPN, TO-218AA	RCA	200-3100
RCA32B, NPN, TO-218AA	RCA	200-3200
Transistors, Field Effect		
2N4860, N-Channel, Switching, TO-18	Motorola	204-0074
2N4393, N-Channel, Switching, TO-18	National	204-4393

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APPENDIX A
GLOSSARY FOR PPC T6000, T7000, T8000 AND T9000 TAPE DRIVES

Symbol	Description	Symbol	Description
AOS	Arm Offset (T8000 Drives)	EEC	Enable Echo Check
B1B	Buffer 1 Busy	EEP	Enable Encoder Pulse
BCD	Binary Coded Decimal	EF	Erase Winding Finish
BOT	Beginning of Tape	EFM	Enable File Mark
BOTD	Beginning of Tape Delay	ENV*	Envelope Detected
BOTDP	Beginning of Tape Delay Pulse	EOT*	End of Tape
BOTI	Beginning of Tape Input	EOTI	End of Tape Input
BOTO	Beginning of Tape Output	EOTO	End of Tape Output
BOV*	Buffer Overflow	EPNP	Encoder Pulse Narrow Powerful
BPI	Bits Per Inch	EPS	Erase Power Start
BUSY	Drive Busy	EPW	Encoder Pulse Wide
CBY	Command Busy	ERASE*	Erase
CCG*	Check Character Gate	ES	Erase Winding Start
CCS	Check Character Strobe	EWPC	Enable Write Power Control
CER*	Correctable Error	EWRS	Enable Write/Read Status
CHARDET*	Character Detect	FAD*	Formatter Address
CLRNZDATA*	Clear NRZI Data	FBY*	Formatter Busy
CMP1,2	Clamp Waveform 1,2	FEN*	Formatter Enable
COPY*	Copy	FER*	Formatter Error
COS	Capstan Offset Adjustment	FGC	File Gap Command
CPI	Characters Per Inch	FGL	File Gap Lamp
CRC0—CRC7	Cyclic Redundancy Check, Ch 0—7	FGR	File Gap Ramp
CRCC	Cyclic Redundancy Check Character	FLR	First Load or Rewind
CRCP	Cyclic Redundancy Check Parity	FM	File Mark
CT0—CT7	Center Tap 0—7	FMK*	File Mark
CTP	Center Tap Parity	FMKNZ*	File Mark NRZI
CT4	Count 4	FMKPE*	File Mark PE
CT8	Count 8	FPT	File Protect
CUR	Clean-up Ramp	FRPI	Flux Reversals Per Inch
CURLIM	Reel Servo Current Limit	fr/mm	Flux Reversals Per Millimetre
c/mm	Characters Per Millimetre	FWD	Forward
D8CT	Disables 8 Count	GIP	Gap In Process
DBOT	Delayed Beginning of Tape	GO	Pulse that occurs at the beginning of MOTION
DBY	Data Busy		
DCLM	Delay Current Limit Motors	GO1*	GO
DD1	Data Density Indicator	GRS	General Reset
DDS	Data Density Select	HER*	Hard Error
DDSX	Data Density Select External	HERNZ*	Hard Error NRZI
DEN*	Density	HID	High Density
DGATE*	Data Gate	HIS	High Speed Adjustment
DI*	Data In	HSR	High Speed Ramp Adjustment
DMC	Disable Manual Controls	IBG	Inter-Block Gap (same as IRG)
DROPDET*	Drop Detected	ID*	Identification
DUN	Done and Unload	IDGATE	Identification Gate
EAO	Encoder Amplifier Output	ILKS	Interlock Switch, Supply (Vacuum Column Models)
ECC	Error Check Character (Group Coded Recording)		
		ILKT	Interlock Switch, Takeup (Vacuum Column Models)
ECD	Echo Check Disable		
ECE	Echo Check Error	INTLK	Interlock Signal
ECLK	Envelope Clock	INTLK SW	Interlock Switch (Tension Arm Models)
ECO0—ECO7	Echo Check Output, Ch 0—7	IRG	Inter-Record Gap (same as IBG)
ECOP	Echo Check Output Parity		
ECR	Echo Check Reset	IRGC	Inter-Record Gap Command
ECRC	Enable CRC	K1-ON	Relay K1 On
EDIT*	Edit	K2 ENERG	Relay K2 Energize
		LD	Lamp Driver

NOTES:
1. *Microformatter Only
2. Symbols are often prefixed with I (Interface signal) or N (low active signal) when used in text and tables.
3. Tape drive and tape transport are synonymous.

APPENDIX A (Continued)

Symbol	Description	Symbol	Description
LDCRC*	Load Cyclic Redundancy Check	PE	Phase Encoded
LDFAIL	Load Fail	PICKK1	Pick K-1 Relay
LDLOOP	Load Loop	POSTJUMP*	Postamble Jump
LDP	Load Point	POSTEST*	Postamble Test
LDWRTDATA*	Load Write Data	PR*	Parity
LFC	Load Forward Command	PRESET*	Preset
LFR	Load Forward Ramp	PS SIGNAL	Power Supply Ready Signal
LKS	Interlock Switches, Supply	PSEN*	Power Supply Enable
LKT	Interlock Switches, Takeup	PSO0—PSO7	Peak Sensor Output, Ch 0—7
LOAD	Load Forward	PSOP	Peak Sensor Output Parity
LOAD SW	Load Switch Signal, Low True	PSP	Peak Sensor Parity
LOCK	Interlock Off pulse	RAC	Reset AC
LOCKA	Interlock A	RACT	Read Amplifier Center Tap
LOCKB	Interlock B	RAP1, RAP2	Read Amplifier Parity, Output 1, Output 2
LOCKTIME	Locktime pulse	RCLK*	Read Clock
LOL*	Load On Line	RD0—RD7	Read Data, Ch 0—7
LOS	Low Speed Adjustment	RDI	Relay Driver Input
LRCC	Longitudinal Redundancy Check Character	RDNZ*	Read NRZI Data
LSR	Low Speed Ramp Adjustment (T8000 Models)	RDP	Read Data Parity
LWD*	Last Word	RDS	Read Data Strobe
m	Metric system abbreviation for metre equal to 39.37 inches	RDY	Ready
		REN*	Read Enable
mm	Metric system abbreviation for millimetre equal to 0.001 metre or 0.03937 inch	RENDNZ*	Read End NRZI
		RENDPE*	Read End PE
MOT	Tape Motion. Goes true for internal tape motion of any kind, i.e. forward, reverse, manual, rewind (T9000 Models)	REV	Reverse
		REW*	Rewind
MOTION	Tape Motion in response to interface commands	REW RAMP A	Rewind Ramp Output A
		REW RAMP B	Rewind Ramp Output B
MRY	Master Reset	REWRI	Rewind Ramp Initiate
MTA	Multiple Transport Adapter	RF0—RF7	Read Finish 0—7
N	Metric system unit of force; abbreviation for newton; equal to the force that produces an acceleration of one metre per second on a mass of one kilogram	RFP	Read Finish Parity
		RGATENZ*	Read Gate NRZI
		RGATEPE*	Read Gate PE
	Conversion from the U.S. system is as follows: pounds × 4.448 = N ounces × 0.278 = N	RGC	Inter-Record Gap Command
		RGR	Inter-Record Gap Ramp
N·m	Metric system measurement of torque; abbreviation for newton-metre	RMP	Capstan Ramp Adjustment (Vacuum Column Models)
		RO	Ready and On Line
	Conversion from the U.S. system is as follows: foot-pounds × 1.3558 = N·m inch-pounds × 0.11298 = N·m	ROT	Read Only Transport
		RROS	Rewind Reel Offset
		RRS	Remote Reset
		RS1	Rewind Step 1
NRZ*	Non-Return to Zero	RSC*	Read Strobe Counter
NRZI	Non-Return to Zero Inverted	RSP	Read Start Parity
OFC*	Off Line Command	RST	Reset
OFFC	Off Line Input Command	RSTR*	Read Strobe
OFL*	Off Line	RSTRNZ*	Read Strobe NRZI
OLUNL	Off Line Unload	RSTRPE*	Read Strobe PE
ONEDET*	Ones Detected	RTH1	Read Threshold 1
ONLD	On Line Delay	RTH2	Read Threshold 2
ONLINE	On Line Status Signal	RTN1	Front Panel Switches Ground Return 1
OOLL	On Line/Off Line Lamp	RWC	Rewind Command
ORD	ORed Data	RWD	Rewinding
OVW	Overwrite	RWD REL DRVR	Rewind Relay Driver
PARC*	Parity Correcting	RWL	Rewind Lamp

NOTES:
1. *Microformatter Only
2. Symbols are often prefixed with I (Interface signal) or N (low active signal) when used in text and tables.
3. Tape drive and tape transport are synonymous.

APPENDIX A (Continued)

Symbol	Description	Symbol	Description
RWU	Rewind Unit	TRR	Transport Ready
RWR	Rewind Ramp	TU F 90% SW	Takeup Forward 90% Switch (T9000 Models)
RW1	Rewind Sequence 1. Active during entire rewind sequence	TU F/R 110% SW	Takeup Forward/Reverse 110% Switch (T9000 Models)
RW2	Rewind Sequence 2. Active upon first detecting BOT	TU R 90% SW	Takeup Reverse 90% Switch (T9000 Models)
RW3	Rewind Sequence 3. Active upon passing over BOT tab detected in RW2	TUC	Takeup Arm Centering Adjustment (T8000 Models)
RYC	Ready Command	TUP	Takeup Position Adjustment (Vacuum Column Models)
SBY	Start Busy Delay		Takeup Swing Adjustment (T6000 and T8000 Models)
SEEKLP	Seek Load Point	TUS	Takeup Speed Adjustment (Vacuum Column Models)
SFC	Synchronous Forward Command		
SFCD	Synchronous Forward Command Delayed	ULOS	Unload Offset
SFL1—SFL4	Step Forward Level 1—4	UNL	Unload
SGL*	Single	VPA	Vacuum Pump Actuator
SHLCLK*	Shift Left Clock	WARS	Write Amplifier Reset
SHRCLK*	Shift Right Clock	WCLK*	Write Clock
SKLP	Seek Load Point	WCN*	Write Control
SKTO	Seek Time Out	WCRC	Write CRC
SLT0—SLT3	Select Drive 0—3	WD*	Write Data
SPC*	Space Command	WDO	Write Data Output
SPD*	Speed	WD0—WD7	Write Data, Ch 0—7
SRC	Synchronous Reverse Command	WDP	Write Data Parity
SRO/SRO1	Selected, Ready and On-Line	WDS	Write Data Strobe
SRST	Switch Reset	WDSN	Write Data Strobe Narrow
STAC	Stop Tension Arm Cocking (T8000 Models)	WDSW	Write Data Strobe Wide
SUC	Supply Arm Centering Adjustment (T8000 Models)	WF0—WF7	Write Finish, Ch 0—7
SUP	Supply Position Adjustment (T9000 Models)	WFM	Write File Mark
SUP F 90% SW	Supply Forward 90% Switch (T9000 Models)	WFP	Write Finish Parity
SUP F/R 110% SW	Supply Forward/Reverse Switch (T9000 Models)	WLO	Write Lockout
	Supply Swing Adjustment (Tension Arm Models except T7000)	W/RF0—W/RF7	Write/Read Head Winding Finish, Ch 0—7
SUS	Supply Speed Adjustment (Vacuum Column Models)	W/RFP	Write/Read Head Winding Finish Parity
		WRS	Write/Read Status
		W/RS0—W/RS7	Write/Read Head Winding Start, Ch 0—7
SWS	Set Write Status	W/RSP	Write/Read Head Winding Start Parity
TAD	Turnaround Delay	WRT*	Write
TAD0,1*	Transport Address	WRT EN	Write Enable
TBY	Turnaround Busy	WRT PWR	Write Power
TENCNT	Tension Control	WS0—WS7	Write Start, Ch 0—7
THR*	Read Threshold	WSC	Write Step Command
TIP	Tape In Path	WSP	Write Start Parity
TNA	Tension Amplifier	WSTR*	Write Strobe
TNT	Tape Not Tensioned (Vacuum Column Models)	9 TRK	Nine Track Format

NOTES:

1. *Microformatter Only
2. Symbols are often prefixed with I (Interface signal) or N (low active signal) when used in text and tables.
3. Tape drive and tape transport are synonymous.

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MICROFORMATTER ADDENDUM

FOREWORD

This addendum is designed to be used in conjunction with Pertec Peripherals Corporation (PPC™) tape drive models T6000, T7000, T8000, T9000, and T1000 having microformatter capabilities.

The document describes the theory of operation, interface specifications, installation and interface connections. Also described is the Power Supply II PCBA.

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1.1 INTRODUCTION

This section provides the physical description, functional description and specifications for the NRZI, PE, and Dual (PE/NRZI) Microformatters manufactured by Pertec Peripherals Corporation (PPC™), Chatsworth, California.

1.2 PURPOSE OF EQUIPMENT

The microformatter, in conjunction with a companion PPC tape drive, enables the generation and decoding of ANSI and IBM compatible, 9-track, NRZI (800 cpi) and PE (1600 cpi) tapes. All timing and control necessary for the recording and reproduction of NRZI or PE data are provided by the microformatter.

Model numbers for microformatted systems are given in Table 1-1. The system is comprised of a PPC tape drive and an internally mounted microformatter.

1.3 PHYSICAL DESCRIPTION

The Microformatter PCBA is mounted within the tape drive as illustrated in Section II of the companion Operating and Service Manual. An additional 5-volt regulator is added to the drive to supply voltage to the Microformatter PCBA. The interface signals from the customer's controller are connected to the Microformatter PCBA via edge connectors.

Table 1-1

Microformatted Systems

PPC Model No.	Data Format Drive			Data Format Formatter			Drive Tape Speeds Available							
	PE	NRZI	PE/NRZI	PE	PE/NRZI	NRZI	12.5	18.75	25	37.5	45	75	112.5	125
FT6840-9F		X		X			X	X	X	X	X			
FT6640-9F	X			X			X	X	X	X	X			
FT6840-9DF		X				X	X	X	X	X	X			
FT6640-9DF	X					X	X	X	X	X	X			
FT6640-98DF			X			X	X	X	X	X	X			
FT7840-9F		X		X			X	X	X					
FT7640-9F	X			X			X	X	X					
FT7640-9DF	X					X	X	X	X					
FT8840A-9F		X		X			X	X	X	X	X			
FT8640A-9F	X			X			X	X	X	X	X			
FT8840A-9DF		X				X	X	X	X	X	X			
FT8640A-9DF	X					X	X	X	X	X	X			
FT8640A-98DF			X			X	X	X	X	X	X			
FT9840-9F		X		X						X	X	X		
FT9640-9F	X			X						X	X	X		
FT9840-9DF		X				X				X	X	X		
FT9640-9DF	X					X				X	X	X		
FT9640-98DF			X			X				X	X	X		
FT1640-98DF			X			X						X	X	X

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1.4 FUNCTIONAL DESCRIPTION

All logic and functions associated with the reading and writing of 9-channel NRZI or PE ANSI and IBM compatible tape are contained in the microformatter.

For NRZI operation, all logic for the generation of the initial gap, Inter-Block Gaps (IBGs), and file mark gaps is provided, in addition to the logic necessary to record data on tape. The logic for complete data recovery (including buffering, error and file mark detection) is also provided.

The NRZI functions of the microformatter include the following:

(1) Compatibility with drives having either single- or dual-stack heads.

(2) Provision for fixed and variable length erase commands.

(3) Facility for the generation of special commands for editing previously recorded tapes.

(4) Facility for internal or external parity.

For PE operation, all logic for the generation of the preamble, postamble, PE data, and file mark is provided, in addition to the logic necessary to record data on tape. The logic for complete data recovery (including data decoding, buffering, error and file mark detection, and error correction) is also provided.

The PE functions of the microformatter include the following:

(1) All timing necessary for the generation of IBM compatible IBGs and for correct head positioning between records.

(2) Compatibility with drives having either single- or dual-stack heads.

(3) Automatic recording of a PE identification burst prior to recording the first record on a tape.

(4) Automatic testing for the PE identification burst when reading the first record on a tape.

(5) Provision for fixed and variable length erase commands.

(6) Facility for the generation of special commands for editing previously recorded tapes.

Two microformatters may be daisy-chained to a controller and up to four drives may be daisy-chained to a microformatter. Figure 1-1 illustrates a system configuration of eight drives, two of which are microformatted drives.

```
┌──────────────┐
│   CUSTOMER   │          CONTROLLER
│  CONTROLLER  │          INTERFACE CABLE
└──────────────┘
                          CONTROLLER
                          DAISY-CHAIN (DC) CABLE

┌──────────────┬──────────────┐        ┌──────────────┬──────────────┐
│MICROFORMATTER│ INTERCONNECT │        │ INTERCONNECT │MICROFORMATTER│
│     PCBA     │      E       │        │      E       │     PCBA     │
│              │              │        │              │              │
│ DRIVE NO. 1  │  NOTE 1,3,5  │        │  NOTE 1,3,5  │ DRIVE NO. 5  │
└──────────────┴──────────────┘        └──────────────┴──────────────┘

┌──────────────┬──────────────┐        ┌──────────────┬──────────────┐
│              │ INTERCONNECT │        │ INTERCONNECT │              │
│ DRIVE NO. 2  │      E       │        │      E       │ DRIVE NO. 6  │
│              │              │        │              │              │
│              │ NOTE 1,2,3,5 │   DRIVE│ NOTE 1,2,3,5 │              │
└──────────────┴──────────────┘  DAISY CHAIN └──────────┴───────────┘
                                  CABLES
┌──────────────┬──────────────┐        ┌──────────────┬──────────────┐
│              │ INTERCONNECT │        │ INTERCONNECT │              │
│ DRIVE NO. 3  │      E       │        │      E       │ DRIVE NO. 7  │
│              │              │        │              │              │
│              │ NOTE 1,2,3,5 │        │ NOTE 1,2,3,5 │              │
└──────────────┴──────────────┘        └──────────────┴──────────────┘

┌──────────────┬──────────────┐        ┌──────────────┬──────────────┐
│              │ INTERCONNECT │        │ INTERCONNECT │              │
│ DRIVE NO. 4  │      E       │        │      E       │ DRIVE NO. 8  │
│              │              │        │              │              │
│              │NOTE 1,2,3,4,5│        │NOTE 1,2,3,4,5│              │
└──────────────┴──────────────┘        └──────────────┴──────────────┘
```

NOTES:

1. THESE INTERCONNECT E PCBAS ARE DC PCBAS WHEN USED WITH T7000 DRIVES ONLY.

2. THESE INTERCONNECT E PCBAS ARE MTA II WHEN USED WITH T6000, T8000 AND T9000 DRIVES THAT DO NOT HAVE MICROFORMATTER CAPABILITY.

3. THESE INTERCONNECT E PCBAS ARE NOT REQUIRED WHEN USED WITH T1000 DRIVES.

4. TERMINATORS ARE REQUIRED ON THE LAST DC PCBA ON A DAISY CHAIN.

5. THE UNIT SELECT SWITCH IS LOCATED ON THE DC II PCBA OR THE INTERCONNECT PCBA.

6. DISCONNECT P5 FROM J5 ON THE INTERCONNECT E PCBA ON ALL SLAVE FT6000, FT8000, AND FT9000 DRIVES ON A DAISY CHAIN.

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Figure 1-1. Typical System Configuration

SECTION II
INSTALLATION AND INTERFACE CONNECTION

2.1 INTRODUCTION

This section contains a summary of the physical interface connections for the micro-formatter. Also given are the configuration requirements of master and slave drives when used in a daisy-chain configuration.

2.2 INTERFACE ELECTRICAL SPECIFICATIONS

Levels: True = Low = 0v to + 0.4v dc
         False = High = + 3v dc

Pulses: Levels as above. Minimum pulsewidth is 1 microsecond.

The interface circuits are designed so that an open circuit results in a high signal. Figure 2-1 shows the configuration of the drivers and receivers between the controller and microformatter.

2.3 POWER SPECIFICATIONS

The power consumption of the Microformatter PCBA and the + 5 volt regulator is 60 watts (maximum). This consumption is in addition to the drive power requirements listed in Section I of the companion drive manual.

2.4 INTERFACE CONNECTIONS

Two 50-lead flat cables (3M 3365-50 or equivalent) are required for the microformatter to controller interface. This interface is given in Table 2-1. These two cables connect directly to P4 and P5 on the Microformatter PCBA. The two 50-lead flat cables are not supplied by PPC. Two edge connectors are required and will be supplied by PPC upon request at no charge. Edge connector part numbers are: PPC P/N 503-0147; 3M P/N 3415.
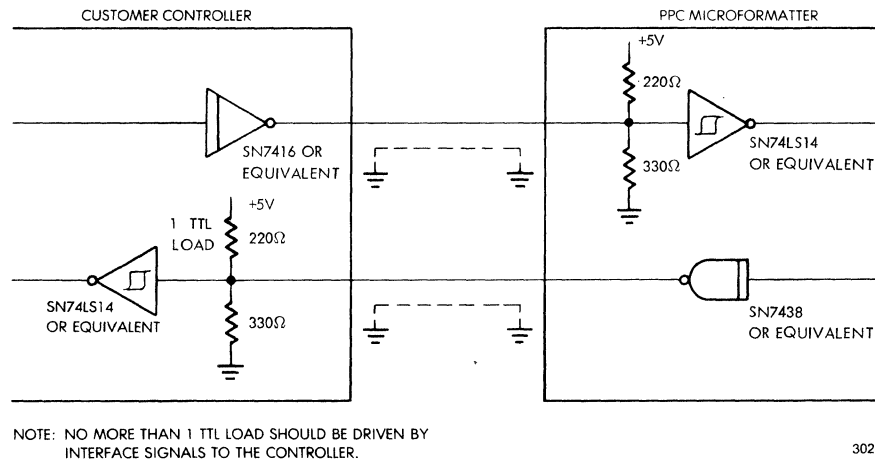
Figure 2-1. Driver/Receiver Interface Configuration

To connect the interface, the following must be considered.

(1) When connecting a controller to a single microformatter, the length of cable should be limited to 12.2 m (40 feet).

(2) When two microformatters are connected in a daisy-chain configuration to a controller, the *total* cable length should be limited to 12.2 m (40 feet). There should be no more than 1.5 m (5 feet) of cable between the two microformatters, although this distance may be increased to 6.1 m (20 feet) if a 220/330 ohm DIP terminator for each microformatter to controller interface signal is installed within 305 mm (12 inches) of the last microformatter in the daisy-chain.

Table 2-1

Controller/Microformatter Interface Lines

Microformatter P4/P5		Signal (Controller to Microformatter)	Microformatter P4/P5		Signal (Microformatter to Controller)
Live Pin	Return Pin		Live Pin	Return Pin	
P5-48	P5-47	FORMATTER ADDRESS (IFAD)	P4-2	P4-1	FORMATTER BUSY (IFBY)
P4-46	P4-45	TRANSPORT ADDRESS (ITAD0)	P5-38	P5-37	DATA BUSY (IDBY)
P5-46	P5-45	TRANSPORT ADDRESS (ITAD1)	P5-16	P5-15	CHECK CHARACTER GATE (ICCG)*
P4-8	P4-7	INITIATE COMMAND (IGO)	P5-16	P5-15	IDENTIFICATION (IDENT)*
P4-18	P4-17	REVERSE/FORWARD (IREV)	P5-12	P5-11	HARD ERROR (IHER)
P4-34	P4-33	WRITE/READ (IWRT)	P5-14	P5-13	FILE MARK (IFMK)
P4-42	P4-41	WRITE FILE MARK (IWFM)	P5-28	P5-27	READY (IRDY)
P4-38	P4-37	EDIT (IEDIT)**	P5-44	P5-43	ON-LINE (IONL)
P4-40	P4-39	ERASE (IERASE)	P5-30	P5-29	REWINDING (IRWD)
P4-44	P4-43	READ THRESHOLD 1 (IRTH1)	P5-32	P5-31	FILE PROTECT (IFPT)
P4-36	P4-35	READ THRESHOLD 2 (IRTH2)	P5-4	P5-5	LOAD POINT (ILDP)
P5-50	P5-49	DENSITY SELECT (IDEN)	P5-22	P5-21	END OF TAPE (IEOT)
P4-20	P4-19	REWIND (IREW)	P5-26	P5-25	NRZI (INRZ)
P5-24	P5-23	OFF-LINE (IOFL)	P4-14	P4-13	SINGLE (ISGL)
P4-4	P4-3	LAST WORD (ILWD)	P5-40	P5-39	SPEED (ISPEED)
P5-18	P5-17	FORMATTER ENABLE (IFEN)	P5-36	P5-35	WRITE STROBE (IWSTR)
P4-22	P4-21	WRITE DATA PARITY (IWP)	P5-34	P5-33	READ STROBE (IRSTR)
P4-10	P4-9	WRITE DATA 0 (IW0)	P5-1	P5-5	READ DATA PARITY (IRP)
P4-12	P4-11	WRITE DATA 1 (IW1)	P5-2	P5-5	READ DATA 0 (IR0)
P4-30	P4-21	WRITE DATA 2 (IW2)	P5-3	P5-5	READ DATA 1 (IR1)
P4-26	P4-25	WRITE DATA 3 (IW3)	P4-48	P4-47	READ DATA 2 (IR2)
P4-6	P4-5	WRITE DATA 4 (IW4)	P4-50	P4-49	READ DATA 3 (IR3)
P4-32	P4-31	WRITE DATA 5 (IW5)	P5-6	P5-5	READ DATA 4 (IR4)
P4-28	P4-27	WRITE DATA 6 (IW6)	P5-20	P5-19	READ DATA 5 (IR5)
P4-24	P4-23	WRITE DATA 7 (IW7)	P5-10	P5-9	READ DATA 6 (IR6)
P4-16	P4-15	LOAD ON LINE (ILOL)	P5-8	P5-7	READ DATA 7 (IR7)
			P5-42	P5-41	CORRECTED ERROR (ICER)

*ICCG and IDENT line shared by NRZI and PE.

**Not applicable to FT1000.

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2.5 DAISY-CHAIN CONNECTIONS

Three 34-lead flat cables (3M 3365-34 or equivalent) are required for the drive daisy-chain interface.

When one, two, or three slave drives are daisy-chained to a master drive, the interconnecting cables may be 12.2 m (40 feet) maximum length. These three cables connect to J11, J12, and J13 of the Cable Adapter (DC) PCBAs when used with the FT7000 series drives. These cables connect to the Interconnect E PCBA when used with FT6000, FT8000, and FT9000 series drives. When used with the FT1000 model, the cables connect to the Interconnect D or D1 PCBA.

To ensure proper operation, terminators are required on the last Cable Adapter PCBA (FT7000) or Interconnect E PCBA (FT6000, FT8000, and FT9000) in a daisy chain. In addition, connector P5 must be disconnected from J5 on the Interconnect E PCBA on all slave drives.

The Cable Adapter (DC) PCBAs are shown in Figure 2-2 and the Interconnect E PCBA is shown in Figure 2-3. When using the microformatter with an FT1000 model, refer to Figure 2-4 and the companion Operating and Service Manual for the description of the Interconnect D or D1 PCBA. The daisy-chain interface is described in Table 2-2.

2.5.1 T7000 DAISY-CHAIN

When connecting the Cable Adapter (DC) PCBAs to a T7000, Cable Adapter I (DC) connects to J101 of the Tape Control PCBA, Cable Adapter II (DC) connects to J102 of the Data PCBA, and Cable Adapter III (DC) connects to J103 of the Data PCBA. Refer to Paragraph 2.5.4 for configurations and to Table 2-3 for details of the cable assembly used for these connections.

The three flat cables referred to in Paragraph 2.5 connect to:

  (1) P1 of the Microformatter PCBA and J11 of Cable Adapter II (DC) PCBA.

  (2) P2 of the Microformatter PCBA and J12 of Cable Adapter II (DC) PCBA.

  (3) P3 of the Microformatter PCBA and J13 of Cable Adapter III (DC) PCBA.

2.5.2 T6000, T8000 OR T9000 DAISY-CHAIN

When connecting the Interconnect E PCBA to a T6000, T8000, or T9000, J101 of the Interconnect E PCBA connects to J101 of the Tape Control PCBA, J102 and J103 of the Interconnect E PCBA connects to J102 and J103 of the Data PCBA, and J1, J2, and J3 of the Interconnect E PCBA connect to P1, P2, and P3 of the Microformatter PCBA. Refer to Paragraph 2.5.4 for configurations.

One end of the three flat cables referred to in Paragraph 2.5 connect to J11, J12, and J13 of the Interconnect E PCBA, the other ends connect to the remaining drives in the daisy-chain. Refer to Table 2-4 for details of the cable assembly used for these connections.

2.5.3 T1000 DAISY-CHAIN

When daisy chaining T1000 Drives, connectors J201, J202, and J203 of the Interconnect D or D1 PCBA are used. Refer to Table 2-4 for details of the cable assembly used for these connections.

J101 TO TAPE CONTROL PCBA (J101)

J102 TO DATA PCBA (J102)

J5 DC #1 (XJ4)

UNIT SELECT SWITCH
S1, S2, S3, S4

107631-
CABLE ADAPTER I (DC)

107635-
CABLE ADAPTER II (DC)

ON

OFF

U1 TERMINATOR (NOTE)
J11 TO MICROFORMATTER (P1)

XJ4 DC #2 (J5)

U2 TERMINATOR (NOTE)

U1 TERMINATOR (NOTE)
U2 TERMINATOR (NOTE)
J12 TO MICROFORMATTER (P2)

J103 TO DATA PCBA (J103)

107639-
CABLE ADAPTER III (DC)

UNIT SELECT SWITCH

ADDRESS	S1	S2	S3	S4
0	ON	OFF	OFF	OFF
1	OFF	ON	OFF	OFF
2	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	ON

NOTE:
USED ON LAST DRIVE
IN DAISY CHAIN

J13 TO MICROFORMATTER (P3)

U1 TERMINATOR (NOTE)

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Figure 2-2. Cable Adapter (DC) PCBAs

J103 TO DATA PCBA (J103)

J13 TO DAISY CHAIN (READ) (NOTE 2)

J12 TO DAISY CHAIN (WRITE) (NOTE 2)

J102 TO DATA PCBA (J102)

TERMINATOR (NOTE 1)

TERMINATOR (NOTE 1)

TERMINATOR (NOTE 1)

INTERCONNECT E

XU4

XU3

XU6

TERMINATOR (NOTE 1)

XU7

XU5

J4 TO REMOTE DRIVE SELECT SWITCH

NC

NO

UNIT SELECT SWITCH
S1,S2,S3,S4,S5,S6,S7,S8

TERMINATOR (NOTE 1)

J5 POWER (P5) (NOTE 3)

J2 TO MICROFORMATTER (P2)

J101 TO TAPE CONTROL PCBA (J101)

J1 TO MICROFORMATTER (P1)

J3 TO MICROFORMATTER (P3)

J11 TO DAISY CHAIN (CONTROL) (NOTE 2)

NOTES:
1. USED ON LAST DRIVE IN DAISY CHAIN.
2. PHANTOM LINES INDICATE BACK OF BOARD.
3. DISCONNECT P5 FROM J5 ON ALL SLAVE DRIVES.

UNIT SELECT SWITCH

COMMAND	S1	S2	S3	S4	S5	S6	S7	S8
DRIVE 0	NC	NO	NO	NO	NO			
DRIVE 1	NO	NC	NO	NO	NO			
DRIVE 2	NO	NO	NC	NO	NO			
DRIVE 3	NO	NO	NO		NO			
REMOTE SELECT								
NRZI						NC		
PE						NO		
SINGLE HEAD							NC	
DUAL HEAD							NO	
LOW SPEED								NC
HIGH SPEED								NO

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Figure 2-3. Interconnect E PCBA

EDGE CONNECTOR J102
TO CONTROLLER, EXTERNAL
FORMATTER, OR OPTIONAL
SELF-TEST PCBA

EDGE CONNECTOR J101
TO CONTROLLER, EXTERNAL
FORMATTER, OR OPTIONAL
SELF-TEST PCBA

EDGE CONNECTOR J103
TO CONTROLLER, EXTERNAL
FORMATTER, OR OPTIONAL
SELF-TEST PCBA

J3 TO P3 ON MIA PCBA
(GCR UNITS ONLY)
OR J3 TO P3 ON
MICROFORMATTER
(PE/NRZI ONLY)

J1 TO P1 ON MIA PCBA
(GCR UNITS ONLY)
OR J1 TO P1 ON
MICROFORMATTER
(PE/NRZI ONLY)

J2 TO P2 ON MIA PCBA
(GCR UNITS ONLY)
OR J2 TO P2 ON
MICROFORMATTER
(PE/NRZI ONLY)

J5 TO P5 DATA L
PCBA

J7 TO P7 WRITE PCBA

W1   W2

J202 CONTROLLER AND/OR
DAISY CHAIN (3M HEADER)
ONLY.

J204 CONTROLLER AND/OR
DAISY CHAIN (3M HEADER)
ONLY. (GCR ONLY)

J201 CONTROLLER AND/OR
DAISY CHAIN (3M HEADER)
ONLY.

J203 CONTROLLER AND/OR
DAISY CHAIN (3M HEADER)
ONLY.

J8 TO P8 TAPE
CONTROL M2 PCBA

TB1 TO POWER CHASSIS

J11 TO P11 CAPSTAN/
REGULATOR PCBA

CAUTION

IN MULTIPLE-DRIVE DAISY-CHAINED SYSTEMS, W1 MUST
BE REMOVED FROM ALL DRIVES EXCEPT THE MASTER,
AND MUST BE REMOVED FROM THE MASTER ALSO IF THE
INTERFACE IS TO OPERATE ON HOST SYSTEM VOLTAGE.
REFER TO DAISY CHAIN INSTRUCTIONS.

J24 ON D1 ONLY (CAPTIVE ON D)

J12 TO P12 REEL
SERVO PCBA

CABLE LENGTH: 1219.2 +25.4, −0.0 mm
(48 +1.0, −0.0 inches)

J21 TO P21 (KEY 1)
INTERCONNECT
F/F1 PCBA
(BASE ASSEMBLY)

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Figure 2-4. Interconnect D1 PCBA

Table 2-2(A)
Control Signals, Drive/Cable Adapter I, Interconnect D or D1, or Interconnect E

Drive J101		Cable Adapter (DCI) J11 or Interconnect E, J11 or FT1000, J201		Signal
Live	Return	Live	Return	
1	2	17	—	LOAD ON LINE (ILOL)
A	8	16	—	WRITE AMPLIFIER RESET #2 (IWARS2)
B	2	15	33	OVERWRITE (IOVW)
C	3	14	32	SYNCHRONOUS FORWARD COMMAND (ISFC)
D	4	13	31	DATA DENSITY SELECT (IDDS)
E	5	12	30	SYNCHRONOUS REVERSE COMMAND (ISRC)
F	6	11	29	DATA DENSITY INDICATOR (IDDI)
H	7	10	28	REWIND COMMAND (IRWC)
K	9	8	26	SET WRITE STATUS (ISWS)
L	10	7	25	OFF-LINE COMMAND (IOFC)/REWIND UNLOAD (IRWU)*
M	11	6	24	ON-LINE (IONL)
N	12	5	23	REWIND (IRWD)
P	13	4	22	FILE PROTECT (IFPT)
R	14	3	21	LOAD POINT (ILDP)
T	16	19	20	READY (IRDY)
U	17	2	34	END OF TAPE (IEOT)
J	8	9	27	SELECT 0 (ISLT0)**
—	—	1	—	POWER SUPPLY ENABLE (IPSEN)

*REWIND UNLOAD applies to FT9000 and FT1000.
**Provided through Select Switch.

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2.5.4 OTHER CONFIGURATIONS

To daisy-chain a Model FT7000 to T7000 models, both the master and slave drives require the Cable Adapter (DC) PCBA, Figure 2-2. In order to daisy-chain a model FT7000 to T6000 and/or T8000 models, the master drive requires the Cable Adapter (DC) PCBAs and the slave drives require an MTA II. Refer to PPC Operating and Service Manual No. 103920 for details of the MTA II.

NOTE

When T7000 drives are daisy-chained, the Cable Adapter (DC) PCBAs must be used.

When daisy-chaining a model FT6000, FT8000, or FT9000 to either T6000, T8000, or T9000 models, the master drive requires an Interconnect E PCBA (see Figure 2-3) and the slave drives require an MTA II.

To daisy-chain the model FT1000 to T1000 models, no adapters are required. When daisy-chaining a model FT1000 to T6000, T8000, or T9000 models, the slave drives require an MTA II.

Units having different tape speeds may be daisy-chained only if the tape speeds are related by a factor of two. For example, a 25 ips machine can be daisy-chained only with another 25 ips unit or a 12.5 ips unit. In any case, the microformatter must be set for the higher of the two speeds.

Table 2-2(B)
Write Signals, Drive/Cable Adapter II, Interconnect D or D1,
or Interconnect E

Drive J102		Cable Adapter (DCII) J12 or Inter-connect E, J12 or FT1000, J202		Signal
Live	Return	Live	Return	
A	1	34	2	WRITE DATA STROBE (IWDS)
C	3	32	4	WRITE AMPLIFIER RESET (IWARS)
F	6	29	7	READ THRESHOLD 2 (IRTH2)*
L	10	25	11	WRITE DATA PARITY (IWDP)
M	11	24	12	WRITE DATA 0 (IWD0)
N	12	23	13	WRITE DATA 1 (IWD1)
P	13	22	14	WRITE DATA 2 (IWD2)
R	14	21	15	WRITE DATA 3 (IWD3)
S	15	20	16	WRITE DATA 4 (IWD4)
T	16	19	17	WRITE DATA 5 (IWD5)
U	17	18	—	WRITE DATA 6 (IWD6)
V	18	1	—	WRITE DATA 7 (IWD7)
—	—	33	2	SELECT 1 (ISLT1)**
—	—	31	5	SELECT 2 (ISLT2)**
—	—	28	8	SELECT 3 (ISLT3)**
—	—	26	10	TACHOMETER (ITACH)***

*Not applicable to FT7000.
**Provided through Select Switch.
***Applicable to FT9000 and FT1000 only.

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Table 2-2(C)
Read Signals, Drive/Cable Adapter III,
Interconnect D or D1, or Interconnect E

Drive J103		Cable Adapter (DCIII) J13 or Inter- connect E, J13 or FT1000, J203		Signal
Live	Return	Live	Return	
1	A	34	2	READ DATA PARITY (IRDP)
2	B	33	3	READ DATA STROBE (IRDS)[1]
3	C	32	4	READ DATA 0 (IRD0)
4	D	31	5	READ DATA 1 (IRD1)
8	J	27	7	READ DATA 2 (IRD2)
9	K	26	8	READ DATA 3 (IRD3)
10	L	25	9	NRZI (INRZ)[2]
12	N	23	6	SINGLE (ISGL)[2,3]
13	P	22	14	SPEED (ISPD)[2]
14	R	21	15	READ DATA 4 (IRD4)
15	S	20	16	READ DATA 5 (IRD5)
17	U	18	—	READ DATA 6 (IRD6)
18	V	1	—	READ DATA 7 (IRD7)

NOTES:

1. Relevant to NRZI operation only.
2. Not applicable to FT7000.
3. Not applicable to FT1000.
4. The following pins provide +5v from the microformatter to the dc assemblies.

J11*	J13*	J201/J204**	J203**
18	11, 28	18	11, 28
	12, 29		12, 29
	13, 30		13, 30
*FT6000, FT7000, FT8000, and FT9000 **FT1000 only.			

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Table 2-3
FT7000 Daisy Chain Cable Assemblies

Max. No. of Units	Cable Lengths mm (inches)				Part No.(s) Required
	A*	B**	C**	D**	
1	0.25 (10) 0.43 (17) 0.70 (27.5)				107647-01 107647-02 107647-03
2	0.25 (10) 0.43 (17) 0.70 (27.5)	1.52 (60) 1.52 (60) 1.52 (60)			107647-04***
4	0.25 (10) 0.43 (17) 0.70 (27.5)	1.52 (60) 1.52 (60) 1.52 (60)	3.04 (120) 3.04 (120) 3.04 (120)	1.52 (60) 1.52 (60) 1.52 (60)	107647-04***

*Microformatter to DC PCBAs in first unit.

**DC PCBAs to DC PCBAs.

***Includes the three required cables.

Table 2-4
FT6000/FT8000/FT9000/FT1000 Daisy Chain Cable Assemblies

Max. No. of Units	Cable Lengths m (feet)				Cable Part No.
	A*	B**	C**	D**	
2	1.52 (5)				103936-01
2	3.04 (10)				103936-02
4		1.52 (5)	3.04 (10)	1.52 (5)	103936-03
4		3.04 (10)	3.04 (10)	3.04 (10)	103936-04

SECTION III
OPERATION

3.1 INTRODUCTION

This section contains the basic microformatter operation and a detailed definition of the microformatter to controller interface lines.

3.2 BASIC OPERATION

The microformatter is capable of executing the commands necessary to enable the modes of operation described in the following paragraphs. All commands, with the exception of Rewind, Off Line and Load On Line, are executed by sampling the logic states of the interface lines as given in Table 3-1. Rewind, Off Line, and Load On Line commands are executed directly from the interface without combination.

Refer to Table 3-1 in conjunction with the following command descriptions.

3.2.1 READ FORWARD

The Read Forward command causes tape on the selected unit to be accelerated to the normal drive operating speed. The microformatter reads the first record of data encountered and then decelerates the tape to a stop. The microformatter generates the delays necessary for proper positioning of the drive read head in the Inter-Block Gap (IBG). It is possible to read the next record on tape by supplying a new Read Forward command to the microformatter prior to the completion of the tape deceleration, thereby improving the access time to the next record by as much as one ramp time. This is referred to as *on the fly* operation.

Table 3-1
Microformatter Commands

Command	IREV	IWRT	IWFM	IEDIT*	IERASE
Read Forward	F	F	F	F	F
Read Reverse (Normal)	T	F	F	F	F
Read Reverse (Edit)*	T	F	F	T	F
Write	F	T	F	F	F
Edit*	F	T	F	T	F
Write File Mark	F	T	T	F	F
Erase (Variable Length)	F	T	F	F	T
Erase (Fixed Length)	F	T	T	F	T
Space Forward	F	F	F	F	T
Space Reverse	T	F	F	F	T
File Mark Search Forward	F	F	T	F	F
File Mark Search Reverse	T	F	T	F	F
File Mark Search Forward (Ignore data)	F	F	T	F	T
File Mark Search Reverse (Ignore data)	T	F	T	F	T

NOTES:
1. T = True, F = False
2. *Not applicable to FT1000

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3.2.2 READ REVERSE

The Read Reverse command is similar to a Read Forward command except that tape motion is in the reverse direction. Records may also be read in reverse *on the fly*. During any reverse operation, the microformatter always resets to the quiescent state when the BOT signal is present. A Read Reverse command may be modified to position the head further back in the gap after reading a record. This change in position of the head is to facilitate the editing of a record, and is done by the microformatter in response to an Edit command. Details of the Edit command are contained in Paragraph 3.2.4.

3.2.3 WRITE

When executing a Write command, the microformatter accelerates tape and, after the appropriate pre-record delay time, begins to transfer data from the controller to the drive. The process continues until a LAST WORD (ILWD) is received from the controller. The tape will continue to move forward until the record has been read by the read head, then the tape will be decelerated to a stop with the write head properly located in the center of the IBG. Consecutive records may be written *on the fly*.

3.2.4 EDIT

Edit operations are similar to Write operations except that the write current is switched off slowly at the end of an edit sequence to minimize the possibility of recording a *glitch* on tape. For proper head positioning, Edit commands should be preceded by a Read Reverse (Edit) command.

3.2.5 WRITE FILE MARK

The Write File Mark command causes a file mark to be written on tape; Paragraphs 3.4.6 and 3.5.5 provide details of the Write File Mark command for PE Format and NRZI Format, respectively.

3.2.6 ERASE (VARIABLE LENGTH)

The Erase (Variable Length) command causes tape to be moved in the forward direction with erase current on. An ILWD signal from the controller terminates the erase operation. It should be noted that in the PE mode, the ID burst will not be erased when an Erase command is given from BOT.

3.2.7 ERASE (FIXED LENGTH)

The Erase (Fixed Length) command causes a 102 mm (4 inch) length of tape to be erased. This command is always executed while moving tape in the forward direction.

3.2.8 SPACE FORWARD

The Space Forward command is similar to a Read Forward command except that no READ STROBE (IRSTR) signals are supplied to the controller. Although error checking is not performed, a test is made to determine if the record spaced over was a File Mark.

3.2.9 SPACE REVERSE

The Space Reverse command is similar to a Read Reverse command except that no READ STROBE (IRSTR) signals are supplied to the controller. Although error checking is not performed, a test is made to determine if the record spaced over was a File Mark.

3.2.10 FILE MARK SEARCH FORWARD

A File Mark Search Forward command causes the drive to execute a series of Read Forward commands while in the *on the fly* mode of operation. This series is terminated by the recognition of either a File Mark character or the EOT tab. Tape is stopped following the reading of a File Mark in a manner similar to terminating a normal Read operation. If the EOT tab is encountered during a File Mark Search operation, the operation will terminate and tape will be stopped at the end of the record currently being processed. The File Mark Search Forward command may be combined with a Space Forward command, thereby preventing IRSTR, ICER and IHER signals from being presented at the Microformatter to Controller Interface.

3.2.11 FILE MARK SEARCH REVERSE

The File Mark Search Reverse command causes the drive to execute a series of Read Reverse commands while in the *on the fly* mode of operation. This series is terminated by the recognition of either a File Mark character or the EOT tab. The tape is stopped after reading a File Mark in a manner similar to terminating a normal Read operation. If the EOT tab is encountered during a File Mark Search operation, the operation is terminated and tape will be stopped at the end of the record currently being processed. The File Mark Search Reverse command may be combined with a Space Reverse command, thereby preventing IRSTR, ICER and IHER signals from being presented at the Microformatter to Controller Interface.

3.2.12 REWIND

The Rewind command causes the unit to rewind to BOT. In systems where more than one unit is daisy-chained, it is possible to rewind several drives while transferring data to or from another unit in the chain.

3.2.13 OFF-LINE

The Off-Line command places the drive under local control. Only the selected unit is placed off-line in daisy-chained systems. In some tape drives (e.g., T9000 series), this command causes the tape unit to perform a Rewind/Unload operation.

3.2.14 LOAD-ON-LINE

The Load-On-Line command enables a remote load sequence.

3.3 GAP GENERATION

3.3.1 INTER-BLOCK GAP GENERATION

The microformatter provides timing to generate the necessary 15.2 mm (0.6-inch) gap between data blocks. Longer gaps can be generated by using the Erase command.

3.3.2 INITIAL GAP

When writing in the NRZI format, the first data record is written approximately 89 mm (3.5 inches) down tape from the trailing edge of the BOT tab. In the PE format, the gap follows the ID burst.

3.3.3 FILE MARK GAP

A File Mark will be preceded by a gap of approximately 102 mm (4 inches) of tape and followed by a normal IBG.

3.4 PHASE ENCODED FORMAT

The following features apply only to PE and dual format drives. These models write tapes in accordance with ANSI Specification No. X3.39-1973 for 1600 cpi 9-track recording.

3.4.1 DATA

Phase Encoded (PE) data are characterized as follows.

    (1) A 0 bit corresponds to a transition in the middle of the bit cell away from the erase direction of magnetization. When writing, this corresponds to a high-to-low transition at the microformatter output to the drive.

    (2) A 1 bit corresponds to a transition in the middle of the bit cell toward the erase direction of magnetization. When writing, this corresponds to a low-to-high transition at the microformatter output to the drive.

    (3) In the case of successive 0 bits or successive 1 bits, an additional transition is required at the cell boundary. This transition is referred to as the *phase transition* and is in the opposite direction from that of the *data transition*.

3.4.2 PREAMBLE

The preamble is a burst of forty 0 bits and a 1 bit in all nine tracks at the beginning of each record. When reading, the microformatter tracking circuit uses this burst to synchronize the decoding circuits. The detection of the 1 bit indicates the beginning of the data field.

3.4.3 DATA FIELD

The data field is written with data and phase transitions as defined in Paragraph 3.4.1. The length of the data field may be a minimum of 18 characters and a maximum of 2,048 characters, in accordance with the ANSI specification. The microformatter is capable of writing and reading records of a minimum of three characters. There is no hardware limitation to the maximum number of data characters that may be included in a single data record.

3.4.4 POSTAMBLE

The postamble is comprised of a single 1 bit and a burst of forty 0 bits at the end of the record. The postamble provides a means of synchronization when reading tape in the reverse direction. The microformatter interprets a 1 bit and two consecutive 0 bits in all tracks as being a valid postamble.

3.4.5 PARITY

When writing, the data in the parity data track are generated by the microformatter in such a way as to provide odd parity for all characters in the data field. An external parity generator may also be used.

3.4.6 FILE MARK

When a Write File Mark command is executed, the microformatter generates the file mark gap and then generates a File Mark consisting of 256 flux reversals at 3200 frpi in Channels P, 0, 2, 5, 6, and 7. Channels 1, 3, and 4, are dc-erased.

When reading, the microformatter will recognize a File Mark if there are at least 64 flux reversals in Channels 2, 6, and 7 with Channels 1, 3, and 4 dc-erased. Channels P, 0, and 5 are ignored for this test.

3.4.7 IDENTIFICATION BURST

When performing a Write command from BOT, the microformatter writes an ANSI and IBM compatible identification (ID) burst consisting of a sequence of 1600 frpi flux reversals in Channel P, with all other tracks dc-erased. To write this ID Burst properly, a Write command from BOT should not be preceded by any Reverse command except Rewind.

In the Read mode, the microformatter samples the output of Channel P as the BOT tab traverses the read head. If an ID burst is detected, the IDENT interface line is pulsed.

3.4.8 DROPOUT AND ERROR CORRECTION

A dropout is detected by the microformatter for a particular track if no data are present on that track for more than one and one-fourth bit cell times. This test is made after approximately twenty 0 bits of the preamble have been read in each track. If only one of the nine tracks has a dropout detected in the microformatter, the microformatter will correct this track by using the odd parity nature of the data in conjunction with the single track dropout indication.

If a dropout of more than one track is indicated by the microformatter, data are invalid and the command is immediately terminated. Tape motion is not stopped until the end of the record is found.

3.4.9 DESKEW OF READ DATA

As data are read from tape, the data transitions corresponding to bits of a specific character may arrive at the microformatter at different times, due to the skewed relationship of the nine data tracks. Data may be skewed as much as 2.9 characters and still be deskewed properly to be presented at the controller interface.

3.4.10 ERROR DETECTION

If the data read back from the tape shows even parity for a particular data character with no track dropout indication, an error indication is provided during the transfer of that specific character to the controller. The command is not aborted. The microformatter continues execution of the current command, provided that none of the following errors occur. If one of these errors is detected, the command is aborted and the microformatter will search for the IBG.

   (1) A 1 bit is detected in either the preamble or postamble.

   (2) An overflow condition is detected in the deskew buffer, indicating excessive tape skew, i.e., greater than 2.9 characters.

   (3) One or more channels fails to detect the 1 bit at the end of the preamble.

   (4) A false postamble is detected in the middle of the record.

   (5) A dropout indication is generated for two or more channels.

3.4.11 TRACKING OSCILLATOR

When reading PE data, a tracking oscillator is used to decode data. This oscillator follows the long-term and short-term speed variation of the data being read. The characteristics of the oscillator are such that any PE tape that complies with the ANSI specification may be read by any PPC Microformatter/Drive PE tape system.

3.4.12 RECORD RECOGNITION

When a Read command is given to the microformatter, tape is ramped up to nominal speed and the microformatter searches for the preamble of a data record. Channels 2, 0, 4, and 5 inclusive are monitored. A valid preamble is declared if data are present on Channels 2, 0, 4, or 5 inclusive continuously for 10 character times.

If data are present on Channels 2, 0, 4, or 5 continuously for a time period less than 10 character times, the microformatter will assume that the few data pulses received were due to erroneous flux transitions occurring prior to the actual data record, and the microformatter will continue to search for the data record.

Once a valid record has been recognized at 10 character times into the preamble, any loss of data (as determined from Channels 2, 0, 4, and 5) results in the microformatter stopping tape motion. This is due to either the loss of data in these four channels or the valid end of the data record. The data loss must be continuous for greater than 22 character times for tape motion to stop.

3.5 NRZI FORMAT

The following NRZI Format description applies to all NRZI and dual format models. The data format described is consistent with ANSI Specification X3.22-1973 for 9-track, 800 cpi NRZI recording.

3.5.1 DATA

NRZI data are characterized as follows.

(1) A 1 bit corresponds to a flux transition in the center of the bit cell on tape. This corresponds to a logic true (1) on the WRITE DATA interface line to the drive during a Write operation.

(2) A 0 bit corresponds to a lack of any flux transition on tape or a logic false (0) on the WRITE DATA interface line to the drive during a Write operation.

3.5.2 DATA RECORD

A record of NRZI data may contain between 18 and 2048 ASCII characters. This is in accordance with the ANSI specification for 800 cpi 9-track recording. The microformatter is capable of writing and reading records of a minimum of three characters. There is no hardware limitation to the maximum number of data characters that may be included in a record. Channel P on tape is written to provide odd parity for all data characters. Nominal spacing between characters is 31.75 micrometers (1250 microinches).

3.5.3 CYCLIC REDUNDANCY CHECK CHARACTER

The Cyclic Redundancy Check Character (CRCC) is written on tape after a four character delay from the last data character. The CRCC is generated in accordance with the ANSI specification for 800 cpi NRZI magnetic tape recording.

3.5.4 LONGITUDINAL REDUNDANCY CHECK CHARACTER

The Longitudinal Redundancy Check Character (LRCC) is written on tape after a four character delay from the CRCC. The data in this character is such that the total number of 1 bits in a track (including the CRCC and LRCC) is even. The LRCC will never be an all-0s character. The LRCC is generated by the reset of the write register in the tape drive. The LRCC also serves to set the tape magnetization in the proper direction for IBG.

3.5.5 FILE MARK

When executing a Write File Mark command, the microformatter generates a one-character record. This single data character consists of a 1 bit in Channels 3, 6, and 7 and a 0 bit in all other channels. The CRCC contains all 0s. The LRCC is equivalent to the single data character.

The microformatter tests for the presence of the file mark pattern during every Read operation. When this is detected, the IFMK interface line to the controller is pulsed and the file mark characters are transmitted to the controller.

3.5.6 ERROR DETECTION

In the NRZI format, all deskewing functions during a Read operation are performed in the tape drive. The microformatter receives a nine-bit word from the drive and relays this word to the customer's controller. A HARD ERROR (IHER) is generated by the microformatter if any of the following read errors occur.

(1) A data character is read from tape containing even parity.

(2) A CRCC is read from tape containing even parity and the record contains an even number of data characters.

(3) A CRCC is read from tape containing odd parity and the record contains an odd number of data characters.

(4) Longitudinal parity on any track is odd.

(5) A track dropout occurs in such a way as to cause more than two check characters, i.e., CRCC and LRCC, to be detected when the microformatter interprets the dropout as an end-of-record condition.

It should be noted that all of the foregoing errors except (5) are checked during both Read Forward and Read Reverse operations. The error described in (5) is checked only during Read Forward operations.

3.6 CONTROLLER-TO-MICROFORMATTER INTERFACE

3.6.1 FORMATTER ADDRESS (IFAD)

This is a level which selects one of the two possible microformatters attached to the controller to microformatter interface.

False = Address 0

True = Address 1

The microformatter's address is predetermined by a switch on the Microformatter PCBA.

When selected, a microformatter is connected to the controller and all controller to microformatter interface lines are activated. Unless otherwise noted, the description of all other controller to microformatter lines will assume that the microformatter is selected.

3.6.2 TRANSPORT ADDRESS (ITAD0, ITAD1)

The levels on these two lines select one of the four units which may be daisy-chained to the microformatter. These lines are decoded by the microformatter and transmitted to the microformatter to drive interface as follows.

ITAD0	ITAD1	Address
False	False	ISLT0
False	True	ISLT1
True	False	ISLT2
True	True	ISLT3

3.6.3 INITIATE COMMAND (IGO)

This pulse initiates the commands given in Table 3-1. On the trailing edge of IGO, the command lines described in Paragraphs 3.5.4—3.6.8 are copied into the microformatter and the FORMATTER BUSY signal (IFBY) is set low. IFBY is described in Paragraph 3.7.1.

3.6.4 REVERSE/FORWARD (IREV)

This signal specifies forward or reverse tape motion.

True = Reverse

False = Forward

3.6.5 WRITE/READ (IWRT)

This signal specifies the operation mode of the system.

True = Write

False = Read

3.6.6 WRITE FILE MARK (IWFM)

This pulse causes a Write File Mark to be written on the tape, if IWRT is also low during this time.

3.6.7 EDIT (IEDIT)

The EDIT signal is employed in two ways:

(1) Read reverse. Modifies the read reverse stop delay to optimize head positioning when editing tapes.

(2) Write. The drive write current is turned off gradually at the end of the record, thus preventing an adjacent data record from being erased.

3.6.8 ERASE (IERASE)

When the IERASE and IWRT signals are low, the microformatter is conditioned to perform a dummy Write command. The microformatter goes through all the functions of a normal Write operation except that no data are recorded. A length of tape is erased equivalent to the length of the dummy record as defined by LAST WORD (ILWD) Paragraph 3.6.14.

Alternatively, if the IERASE, IWRT, and IWFM signals are low, the microformatter is conditioned to perform a dummy Write File Mark operation. A fixed length of tape of approximately 102 mm (4 inches) is erased.

The IERASE signal is also used to inhibit READ STROBE (IRST) during a space operation (Space Forward or Space Reverse) (NSPC) or File Mark Search operation.

3.6.9 READ THRESHOLD LEVEL 2 (ITHR2)

This signal is used on units having a low read threshold capability and is normally made true only when it is required to recover low amplitude data.

True = Low Threshold

False = Normal Threshold

3.6.10 DENSITY SELECT (IDEN)

The IDEN signal is used only when dual format microformatters are used in conjunction with drives equipped with PE or NRZI format selection capability. The state of this line is loaded into the microformatter with each INITIATE COMMAND (IGO).

True = 800 cpi (NRZI)

False = 1600 cpi (PE)

3.6.11 REWIND (IREW)

IREW is a pulse which causes the selected drive to rewind to Load Point, providing the unit is Ready and On-Line. The pulse is routed directly to the drive and does not cause the microformatter to become busy.

3.6.12 OFF-LINE (IOFL)

This pulse causes the selected drive to be placed in the Off-Line mode of operation. IOFL is routed directly to the drive and does not cause the microformatter to become busy.

3.6.13 LAST WORD (ILWD)

During the execution of a Write command or an Erase (Variable Length) command, this pulse is used to indicate that the next character to be strobed into the microformatter is the last character of the record. The line will be set low by the controller at the time the last data character is set on the interface lines.

3.6.14 FORMATTER ENABLE (IFEN)

This is a level which, when high, causes the microformatter to reset to the quiescent state. The signal is not gated by IFAD, hence, if two microformatters are connected to the interface, both will be simultaneously reset.

This line may be used to disable the microformatter if the controller power is lost, or, to clear the microformatter logic.

3.6.15 WRITE DATA LINES (IW0—7)

These eight lines transmit write data from the controller to the microformatter. The eight data bits appearing on WRITE DATA LINES (IW0—7) are written onto the corresponding channels on tape. IW7 corresponds to the least significant bit of the character.

The first character of the data record should be available on these lines within one character period after IDBY goes true and should remain true until the trailing edge of the first IWSTR pulse issued by the microformatter. The next character of information must then be set up in less than half a character period. Subsequent characters will be processed in this way until ILWD is set low, indicating that the last character is being transferred. Table 3-2 identifies these lines with regard to interface identification, ANSI Track Number and binary weight.

3.6.16 WRITE DATA PARITY (IWP)

This line is used only when the external parity generation option is used. This option requires the customer to generate odd parity on the eight data lines (IW0—7) and apply this parity bit to IWP. Setup timing requirements for this line are consistent with requirements for IW0—7. This line is ANSI track number 4.

Table 3-2
Write Data Line Identification

Interface Line	ANSI Track Number	Binary Weight
W0	7	2^7
W1	6	2^6
W2	5	2^5
W3	3	2^4
W4	9	2^3
W5	1	2^2
W6	8	2^1
W7	2	2^0

3.6.17 LOAD-ON-LINE COMMAND (ILOL) (Optional)

The ILOL pulse, when low (1 second minimum width), can be given at any time after ac power is applied to the drive. Tape is tensioned after the first ILOL pulse. When a second ILOL pulse (1 microsecond minimum duration) is given, the drive goes into an On-Line mode. The two pulses must be separated by at least 1 microsecond.

3.7 MICROFORMATTER-TO-CONTROLLER INTERFACE

3.7.1 FORMATTER BUSY (IFBY)

When a command is issued to the microformatter, FORMATTER BUSY (IFBY) goes low at the trailing edge of IGO and remains low until tape motion ceases after execution of the command. This signal may be used by the controller to inhibit further commands.

3.7.2 DATA BUSY (IDBY)

The IDBY signal goes low when the drive has reached operating speed, traversed the IBG, and the microformatter is about to write data on the tape or read data from the tape. IDBY remains low until the data transfer is finished and the appropriate post-record delay completed. IDBY goes high at the same time that the capstan starts to decelerate the tape. A new command may be given when IDBY goes high for an *on the fly* operation. *On the fly* commands must be of the same Read/Write mode and the same tape direction.

3.7.3 CHECK CHARACTER GATE (ICCG) — IDENTIFICATION (IDENT)

This interface line is shared by NRZI and PE Formats. In the NRZI format, the signal is ICCG and is set low by the microformatter when the read information currently being transmitted to the controller is either a CRCC or an LRCC. The signal is high when data characters are being transmitted. Data and check information can be distinguished by gating READ STROBE (IRSTR) with ICCG or its inverse.

In the PE format, the signal on this line is IDENT. The line is pulsed when an ID burst is read from the tape.

3.7.4 HARD ERROR (IHER)

The IHER signal is set low if a read error is detected by the microformatter. Read errors are defined in Paragraphs 3.4.10 and 3.5.6 for PE format and NRZI Format respectively.

All error information is reported to the controller before DATA BUSY (IDBY) goes high.

3.7.5 CORRECTED ERROR (ICER)

The CORRECTED ERROR signal (ICER) is used only in the PE mode. It is set low by a single track dropout during a Read or Read-After-Write operation. ICER in a Read-After-Write operation indicates that the record should be rewritten.

3.7.6 FILE MARK (IFMK)

This is a pulse which indicates that the microformatter read logic has detected a File Mark. This may be during execution of any Read Forward or Read Reverse operation, or during a Write File Mark operation for a read-after-write drive.

3.7.7 DRIVE STATUS AND CONFIGURATION LINES

Status: IRDY, IONL, IRWD, IFPT, ILDP, IEOT
Configuration: INRZ, ISPEED

These lines are used to indicate the status and configuration of the selected drive and are defined exactly the same as in the drive-to-microformatter interface description, except that they have also been gated with the FORMATTER ADDRESS LINE (IFAD). Refer to companion Operating and Service Manual (Section III) for these definitions.

3.7.8 WRITE STROBE (IWSTR)

The IWSTR line is pulsed for each data character to be written on tape. The pulsewidth of IWSTR is approximately 25 percent of a character time. IWSTR samples the WRITE DATA lines (IWP, IW0—7) from the controller and copies this information, character by character, into the microformatter write logic.

The first character must be available before the first IWSTR is issued, and succeeding characters must be set up within half a character period ofter the trailing edge of each IWSTR pulse.

This line is also active during Erase (Variable Length) commands; however, the data being copied into the microformatter will not be written on tape.

For a Write File Mark or Erase (Fixed Length) command, the required pattern is generated internally by the microformatter and IWSTR is not used.

3.7.9 READ STROBE (IRSTR)

The READ STROBE line (IRSTR) is pulsed for each character of read information (data, CRCC, and LRCC) to be transmitted to the controller. IRSTR is used to sample the READ DATA lines (IRP, IR0—7).

The transmission of check characters (CRCC and LRCC) is flagged by the CHECK CHARACTER GATE line (ICCG) as described in Paragraph 3.7.3 and in the event of an all 0s character, an IRSTR pulse is provided.

Note that although the average time between adjacent IRSTR pulses is $1/BV$ where

B = packing density

V = tape velocity

this time may vary considerably due to the combined effects of bit crowding and skew. The minimum time between adjacent pulses in one-half character period.

3.7.10 READ DATA LINES (IRP, IR0—7)

These nine lines transmit read data from the microformatter to the controller. Each character read from the tape is available by sampling IRP, IR0—7 in parallel by IRSTR.

Data remains set on IRP, IR0—7 for a full character period. The corresponding IRSTR pulse is placed centrally during the time that data are available.

SECTION IV
THEORY OF OPERATION

4.1 INTRODUCTION

A microformatted drive system (FT) consists of one or more tape drives, a Microformatter PCBA, and a Power Supply II PCBA. This section provides a block diagram description and the theory of operation of the microformatter. Also presented are methods of fault isolation and maintenance procedures.

NOTE

An FT1000 system does not require the Power Supply II PCBA.

Figure 4-1* is a block diagram of a Dual Microformatter and should be referred to in conjunction with the following paragraphs. It is important to note that the functional discussion of the block diagram is addressed to dual operation of the microformatter and individual NRZI and PE operations are discussed as subsets of the dual operation.

4.2 BASIC CONFIGURATION AND OPERATION

The microformatter may be configured as NRZI only, PE only, or Dual (both NRZI and PE).

Referring to Figure 4-1, it can be seen that the NRZI section contains the Clock Generator, Interface Logic, Master Control, NRZI Read Control, NRZI Read Logic, Error Gating Logic, Read Strobe Gating Logic, Input Read Logic, Output Read Logic and Write Data Generator.

Similarly, it can be seen that the PE section contains the Clock Generator, Interface Logic, Master Control, PE Read Control, Tracking Oscillator, PE Read Logic, Error Gating Logic, Read Strobe Gating Logic, Input Read Logic, Output Read Logic and Write Data Generator.

The microformatter must be selected to operate. Selection is according to the FORMATTER ADDRESS line (IFAD) and the settings of U112-S3 and S4 (refer to Table 4-1).

The microformatter logic must be conditioned according to the type of drive, i.e., PE, NRZI, or Dual. The drive must be selected by the switch settings on the Cable Adapter PCBA (DC) (FT7000 series), Interconnect E PCBA (FT6000, FT8000, and FT9000 series), or the Select Switch on the FT1000 series.

Additionally, if the drives are daisy-chained, U112-S5 and S6 must be set. Table 4-2 describes the method of format selection.

The drive status lines are received by the Interface Logic and coupled to the Master Control. The Interface Logic transmits these signals to the controller.

The SPEED signal is coupled through the Interface Logic and into the Clock Generator.

The Clock Generator controls all the timing within the microformatter for both NRZI and PE operation. The clock frequency is dependent on the tape speed and is programmed by the setting of U187 (Frequency Select). When SPEED is high, the output of the Clock Generator (WCLK and NWCLK) is divided by two. These clocks are applied to the Master Control, the Write Data Generator, and the NRZI Read Control.

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*Foldout drawing, see end of section.

Table 4-1

Formatter Address (U112)

Formatter Address	S3	S4
0	Down	Up
1	Up	Down

Table 4-2

Format Select (U112)

Switch	Format	Model FT7000	Models FT6000, FT8000, FT9000, FT1000
Format S5	PE	Up	Up
	NRZI	Down	Up
	Dual	Up	Up
Head S6	Dual	Up	Up

The Master Control receives signals from the Interface Logic via status and command lines and conditions the microprogram on Read Only Memory (ROM) chips. The Master Control provides the required control for both NRZI and PE Write and Read Logic. The Write signal (WRT) input to the Control logic determines whether the microprogram selects a Write operation or a Read operation.

When the Master Control receives a GO1 signal from the Interface Logic, the status and command lines set the Master Control. Formatter Busy (FBY) is set at this time. Data Busy (DBY) is set when the microformatter is processing data (write or read).

When WRT is high, the Master Control microprogram selects a Write operation. The coding of the Write Commands (WCN0, WCN1, WCN2) determines the type of data to be written. Also, Load Write Data (LDWRTDATA), Load Cyclic Redundancy Character (LDCRC) are provided to the Write Data Generator. Write Strobe (WSTR) is provided to the Interface Logic.

When WRT is low, the Master Control microprogram selects a Read operation. The state of the REVERSE command (IREV) determines if the Read operation is to be executed in a forward or reverse direction.

When in the PE mode, the LAST WORD (ILWD) sets a jump condition and a postamble is written.

4.3 WRITE OPERATION

The Write Data Generator receives and buffers Write signals (IWP, IW0—7) from the controller and transmits them to the drive (IWDP, IWD0—7). The WRITE PARITY signal (IWP) may be selected either internally or externally by setting U112-S1 and S2 (refer to Table 4-3).

Table 4-3
Parity Select (U112)

PARITY	S1	S2
Internal	Up	Down
External	Down	Up

4.3.1 NRZI WRITE OPERATION

Figure 4-2 is a timing diagram for a NRZI Write operation and should be referred to in conjunction with Figure 4-1. The Write Data Generator is enabled when DBY is high. The Write Data Generator transfers data when LDWRTDATA is high. WCN0, WCN1, WCN2 determine the type of data to be written.

After one character time, the first byte of data is coupled to the drive data lines. At the end of the character period, the WRITE DATA STROBE (IWDS) line is pulsed which transfers the byte of data to the selected tape unit. The drive encodes the data into NRZI form and writes it on the tape.

The data are also transferred into a CRC register and the register generates the CRCC, which is written on the tape after the end of the record.

At the end of the character period, a WRITE STROBE (IWSTR) pulse informs the controller that processing of this character is complete and that a new byte is required. The controller must set the new byte on IWP, IW0—7 within one-half character period after the trailing edge of IWSTR.

Subsequent characters are processed in this manner until the controller sets LAST WORD (ILWD) low, indicating that the last bit is being transmitted. Following the IWSTR pulse, the Write Data Generator starts a termination sequence and causes the CRCC and/or LRCC to be written on the tape.

The contents of the CRC register are coupled to the drive during the fourth character period after the last data bit is written. An additional IWDS pulse causes the information to be written on the tape. Four character periods later, the WRITE AMPLIFIER RESET (IWARS) line is pulsed, which resets the drive write register and causes the LRCC to be written on the tape.

After the LRCC is written, a post-record delay is entered. The post-record delay is initiated when the microformatter Read Logic completes a read-after-write check on the data. An internal signal, End NRZI (RENDNZ), indicates the end of the Read-After-Write operation.

The Erase (Variable Length) command is a dummy Write File Mark (WFM) command. A fixed length of tape is erased (approximately 102 mm [4 inches]).

The NRZI format requires that the first record appearing on tape be placed approximately 127 mm (5 inches) past the BOT marker. To accomplish this, the microformatter generates an extra long pre-record delay when a Write command is issued at BOT.

A File Mark consists of a single character record having 1 bits in Channels 3, 6, and 7 for both the data character and the LRCC. The CRCC contains all 0s. This record is separated from the previous record by approximately 102 mm (4 inches) and by a normal IBG of 15.2 mm (0.6 inch) from the following record.
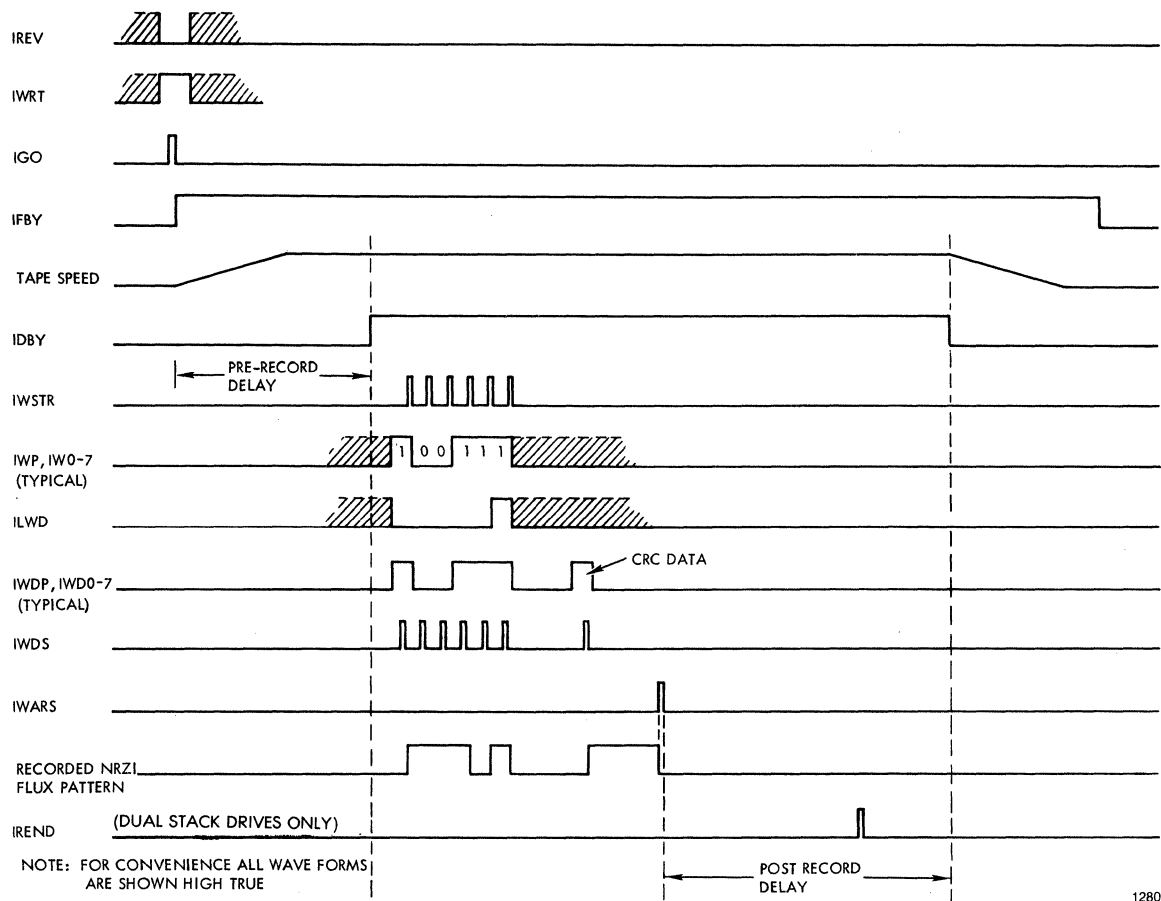
Figure 4-2. 9-Channel NRZI Write Operation

4.3.2 PE WRITE OPERATION

Figure 4-3 is a timing diagram of a PE Write operation. The Write Data Generator is enabled when DBY is high, and transfers data when LDWRTDATA is high. WCN0, WCN1, WCN2 determine the type of data to be written.

When DBY goes high, the microformatter generates a preamble data pattern consisting of forty 0 bits followed by a 1 bit. This pattern is phase encoded and written on the nine data channels on the tape.

During the time period in which the last preamble 1 bit is being recorded, an IWSTR pulse is sent to the controller. On the trailing edge of IWSTR, the data appearing on IWP, IW0—7 is transferred to the microformatter, encoded, and then written on the tape immediately following the preamble 1 bit.

The controller uses the trailing edge of the IWSTR pulse to set the next byte of data on IWP, IW0—7. The microformatter requires the first bit be set on the data lines before the first IWSTR is sent and the subsequent bits are set within one-half of a character period after the trailing edge of IWSTR.
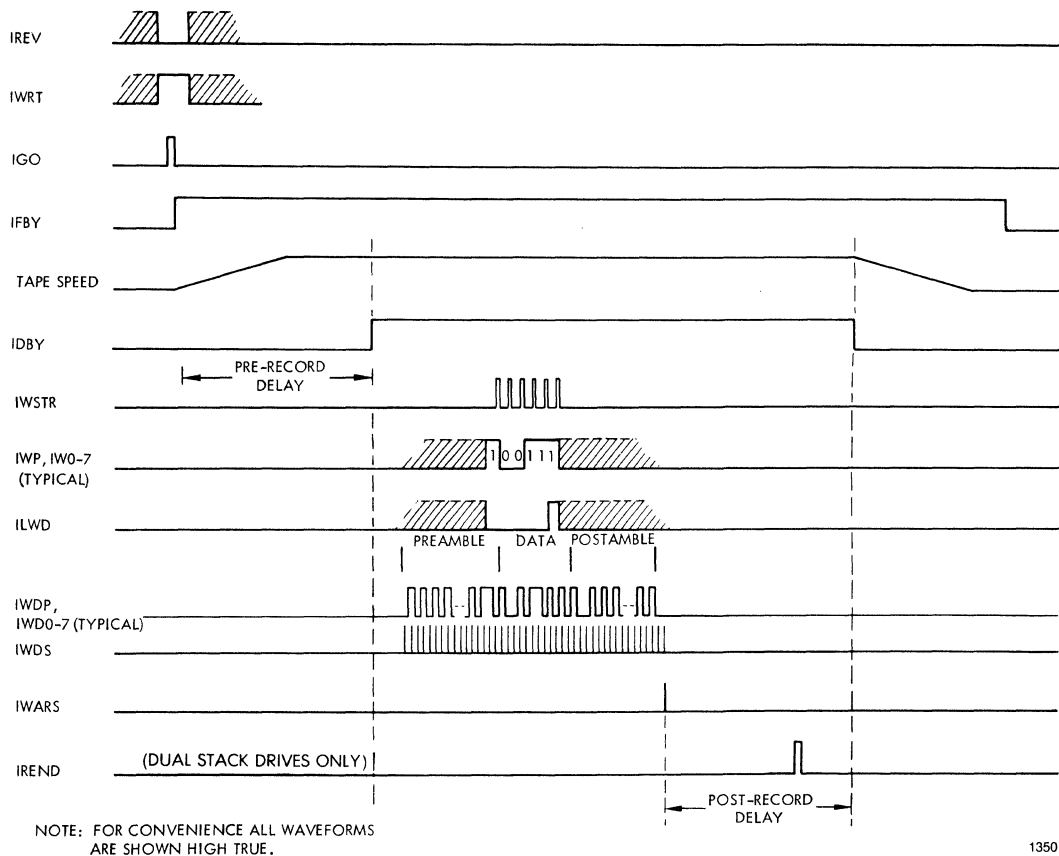
Figure 4-3. 9-Channel PE Write Operation

The controller sets ILWD low when the last data byte is set on IWP, IW0—7. When the following IWSTR pulse occurs, the microformatter samples ILWD and then enters a postamble sequence immediately following the writing of the last data byte.

The postamble pattern is a mirror image of the preamble and consists of a 1 bit followed by forty 0 bits. The postamble is phase encoded and written simultaneously on the nine tape tracks.

Shortly after the last postamble bit is recorded, a WRITE AMPLIFIER RESET (IWARS) pulse is issued by the microformatter. In some models, the IWARS pulse is used to control write current turn-off at the end of an Edit operation.

The post-record delay is initiated after the drive read electronics have completed a read-after-write check on the data just recorded. An internal signal, RENDPE, is used to indicate the end of the Read-After-Write operation.

The 1600 cpi PE format requires identification by a burst of alternate 1s and 0s at the BOT marker. It also requires the first record be written approximately 127 mm (5 inches) after the marker.

When writing from BOT, the microformatter generates an extra long pre-record delay. In a suitable time interval during the delay, the PE identification burst, consisting of a pattern of alternate 1s and 0s (1 0 1 0 1 0 1 0), is written in the Parity Channel. All other channels are erased.

After completion of the pre-record delay, the tape is positioned approximately 127 mm (5 inches) past the BOT marker and the first record is written.

A File Mark record consists of 256 flux reversals at 3200 frpi in Channels P, 0, 2, 5, 6, and 7. Channels 1, 3, and 4 are dc-erased. The File Mark is separated from the preceding record by approximately 102 mm (4 inches) and from the following record by a nominal IBG of 15.2 mm (0.6 inch).

The microformatter generates a long pre-record delay equivalent to a 95 mm (3.75-inch) IBG. The Write logic then generates and encodes 128 preamble 0 bits and records this on Channels P, 0, 2, 5, 6, and 7. This pattern is equivalent to 256 flux reversals at 3200 frpi.

At the completion of the Write File Mark operation, the command is terminated the same as other Write operations.

The Erase (Variable Length) is a dummy Write command used to erase any length of tape. This operation is useful in applications which require the ability to erase individual records on a previously recorded tape.

When executing the Erase (Variable Length) command, the microformatter performs all operations of a normal Write command except that the dummy data being transmitted from the controller to the microformatter is not recorded. Therefore, a length of tape equivalent to the dummy record is erased. The ILWD signal determines the record length, in the manner previously described.

The Erase (Fixed Length) command is a dummy Write File Mark command. When enabled, a fixed length of tape (approximately 102 mm [4 inches]) is erased.

4.4 READ OPERATION

Referring to Figure 4-1, it can be seen that there are two Read Logic sections of the microformatter, NRZI Read Logic and PE Read Logic. The NRZI section consists of the NRZI Read Control and the NRZI Read Logic. The PE section consists of the Tracking Oscillator, PE Read Control, and the PE Read Logic.

The Input Read Logic, Output Read Logic, Error Gating Logic and Read Strobe Gating Logic are common to both NRZI and PE Read operations. A Read operation is enabled by GO1.

Incoming Read data are routed through the Input Read Logic, buffered and supplied to either the NRZI Read Logic or the PE Read Logic.

Outgoing Read data are routed through the Output Read Logic from either the NRZI Read Logic or the PE Read Logic. The data are buffered and transmitted to the controller.

The Error Gating Logic and the Read Strobe Gating Logic are discussed within the NRZI and PE Read operations (Paragraphs 4.4.1 and 4.4.2).

4.4.1 NRZI READ OPERATION

The NRZI Read operation is enabled when the NRZ signal is high and WRT signal is low to the Master Control from the Interface Logic. The microprogram in the Master Control sets the NRZI Read Gate signal (RGATENZ1 and RGATENZ2) high. Refer to Figure 4-4.

The microformatter reads data either in the forward or reverse direction, depending on the state of REV1.

The Read data are received and buffered by the Input Read Logic and coupled to the NRZI Read Logic.

The RGATENZ inputs and the Read Strobe (RDS) input to the NRZI Read Control enables the NRZI Read Strobe (RSTRNZ) and forces Not Clear NRZI Data (NCLRNZDATA) high. The NCLRNZDATA signal enables the NRZI Read Logic. The Buffered Read signals and the Read Data Strobe (IRDS) from the drive provide RDS and the nine channels of Read Data (RDNZP—7), which are coupled to the Output Read Logic and the NRZI Read Control. The Output Read Logic buffers and transmits the data to the controller.

The RDNZP—7 signals fed back to the NRZI Read Control provide the following information.

(1) File Mark detection and the File Mark character (FNKNZ) are supplied to the Interface Logic and to the Master Control.

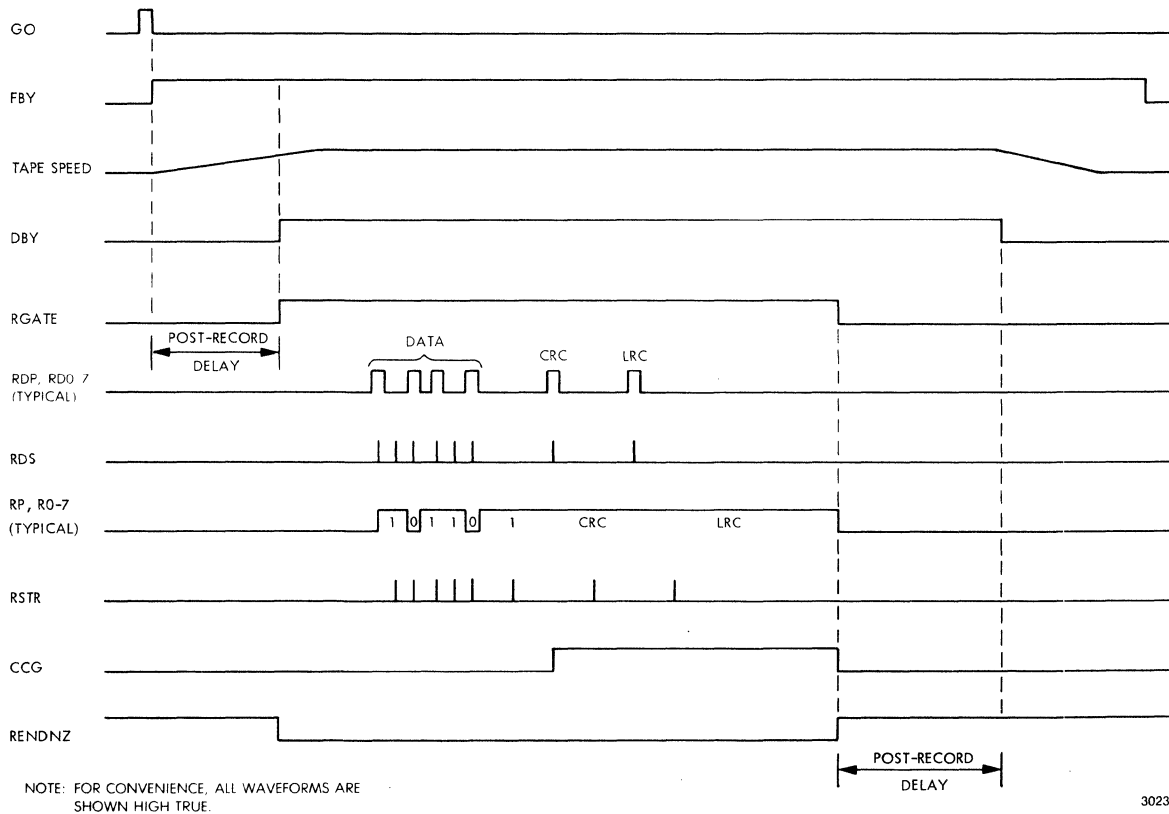(2) LRCC and CRCC detection (CCG) is supplied to the Interface Logic.

Figure 4-4. NRZI Read Operation

(3) Error information (HERNZ) is supplied to the Error Gating Logic.

(4) End of data (RENDNZ) is supplied to the Master Control.

The HERNZ signal is supplied to the Error Gating Logic, buffered, and transmitted to the controller as HARD ERROR (IHER).

RENDNZ is fed back to the Master Control and disables the RGATENZ signals. The low RGATENZ signals disable RSTR and sets NCLRNZDATA low. NCLRNZDATA clears the NRZI Read Logic and the Read operation is complete.

If a Space Forward or Reverse (NSPC) is commanded, the Error Gating Logic and the Read Strobe Gating Logic are disabled.

4.4.2 PE READ OPERATION

The Tracking Oscillator, the PE Read Control, and the PE Read Logic form a phase-lock-loop (PLL) oscillator.

The PE Read operation is enabled when the NRZ and WRT signals are low to the Master Control. The microprogram in the Master Control sets the PE Read Gate signals (RGATEPE1 and RGATEPE2) and the Identification Gate (IDGATE) high. Refer to Figure 4-5.

The microformatter reads data either in the forward or reverse direction, depending on the state of REV2.

The READ DATA (IRDP, IRD0—7) are received and buffered by the Input Read Logic and coupled to the PE Read Logic.

The free running Tracking Oscillator provides all the clocks immediately except the Shift Right clocks (SHRCLK and NSHRCLK).
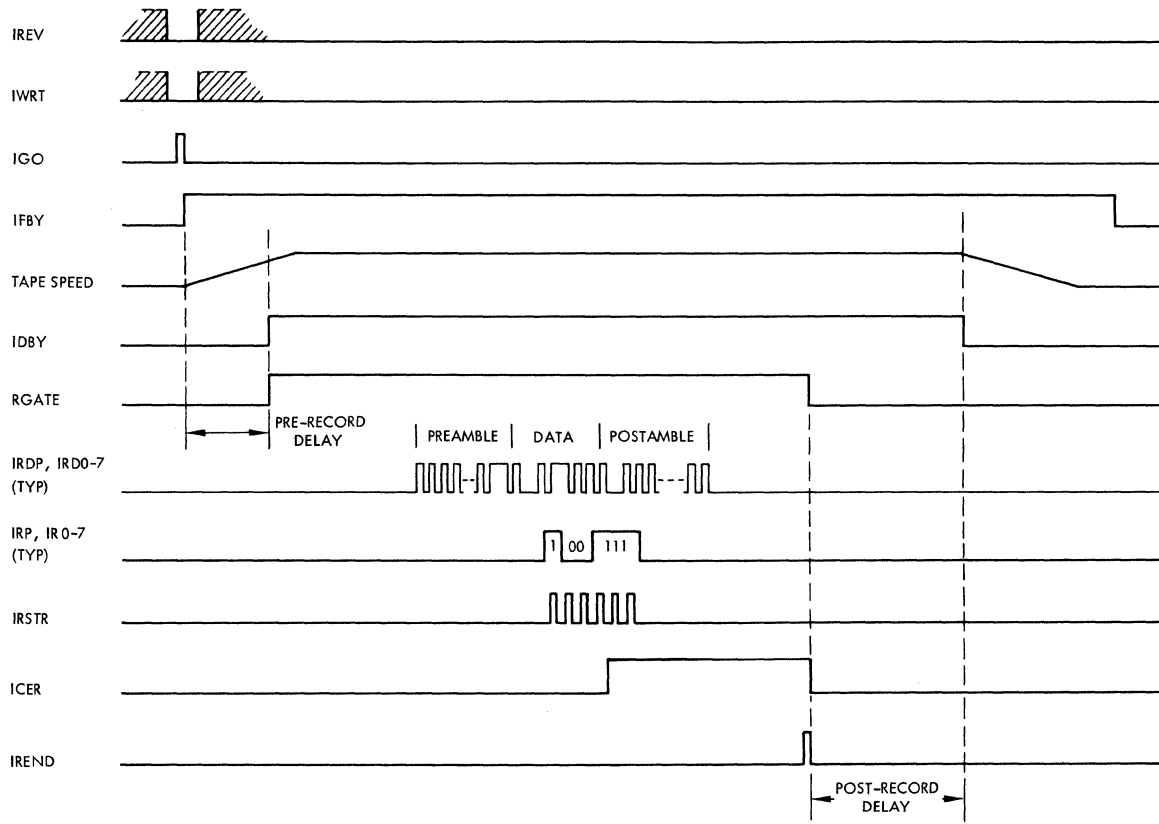
Plug-in R-C networks are used to determine the basic frequency of the oscillator. This basic frequency is dependent on the drive speed. Potentiometer R3 is provided for fine frequency adjust.

The clocks, SHRCLK and NSHRCLK, and signals, RGATE and IDGATE, are provided to the PE Read Logic. PE information is recognized and the feedback signals are generated. The feedback signals are:

(1) Delay Gate signals (DGATE/0 and DGATE/2) are supplied to the Tracking Oscillator to phase lock the oscillator.

(2) Envelope signals (ENV/P—7, ENV/0 and ENV/2) are supplied to the Tracking Oscillator to phase lock the oscillator. The ENV/P—7 signals are also supplied to the PE Read Control to generate the Drop signal (DROPDET), File Mark PE (FMKPE), and ID pulse (ID).

(3) Data In (D1/P—7) and Ones Detector (NONEDET/P—7) are supplied to the PE Read Control and provide control signals Postamble Test (POSTEST), Parity Correcting (PARC), Read Enable (REN1), Preset (PRESET), and Read Strobe (RSTRPE). The error status signals, Parity (PR), Formatter Error (NFER), and the Read Counter signals (RSC1 and NRSC2) are also provided to the Error Gating Logic.

(4) Character Detector signals (CHARDET/P—7) are supplied to the PE Read Control to trigger End of Data (RENDPE).

RSTRPE is supplied to the Read Strobe Gating Logic and is buffered and transmitted to the controller as READ STROBE (IRSTR).

IREV	
IWRT	
IGO	
IFBY	
TAPE SPEED	
IDBY	
RGATE	
	PRE-RECORD DELAY
IRDP, IRD0-7 (TYP)	PREAMBLE DATA POSTAMBLE
IRP, IR0-7 (TYP)	1 00 111
IRSTR	
ICER	
IREND	
	POST-RECORD DELAY

NOTE: FOR CONVENIENCE ALL
WAVEFORMS ARE SHOWN
HIGH TRUE.

1285

Figure 4-5. PE Read Operation Illustrating Error Correction for Last Two Data Bytes

The clocks and error signals are supplied to the Error Gating Logic. All error signals provide a HARD ERROR (IHER) indication except a single channel dropout (DROPDET1). DROPDET1 is a CORRECTED ERROR (ICER). RENDPE is fed back to the Master Control and disables the RGATEPE signals (low). The Read operation is complete.

If a Space Forward or Reverse (NSPC) is commanded, the Error Gating Logic and the Read Strobe Gating Logic are disabled.

4.5 FUNCTIONAL DESCRIPTION

The following paragraphs describe the major functional blocks of the microformatter. These blocks are shown in Figure 4-1 and should be referred to in conjunction with the following discussion.

4.5.1 INTERFACE LOGIC

The Interface Logic receives, buffers, and transmits status signals between the drive and controller. It also provides status signals to the microformatter circuits. U112-S3 and U112-S4 select either Microformatter Address 1 or 0. U112-5 (NRZI) is used for Format definition and U112-6 (SGL) is used for Head Type definition. Refer to Table 4-2.

4.5.2 CLOCK GENERATOR

The Clock Generator provides two programmed clock pulses, WCLK and NWCLK. U187 is set to provide the proper clock frequency, dependent on the drive speed. Refer to Table 4-4 for drive and switch settings.

The frequency of the clock pulses is eight times the PE data rate and sixteen times the NRZI data rate.

The SPEED signal causes the output frequency to be divided by two. This signal is used on dual speed systems only.

4.5.3 MASTER CONTROL

The Master Control stores the microprogram, contains the address counter, and provides the output buffer logic and the jump and output instructions. The Master Control also provides the Write Control logic signals (WCN0, WCN1 and WCN2) and the Write Load signal (LDWRTDATA).

Also provided by the Master Control logic are the PE Read Enable logic signals (RGATEP1, RGATEP2) or the NRZI Read Enable logic signals (RGATENZ1, RGATENZ2).

4.5.4 NRZI READ CONTROL

The NRZI Read Control provides control for decoding 9-track NRZI read data. This function is enabled by Reverse Command 1 (REV1) and allows the microformatter to decode read signals in both the forward and reverse directions.

Table 4-4
Master Oscillator Frequency Select (U187)

Drive (ips)	Frequency (kHz)	Switch Setting							
		1	2	3	4	5	6	7	8
12.5	160	U	U	U	D	D	U	D	U
18.75	240	U	U	U	D	D	D	U	U
22.5	288	Low Speed Only*							
25	320	D	D	U	D	U	D	U	U
37.5	480	U	U	D	D	D	U	U	U
45	576	D	D	D	U	D	U	U	U
75	960	D	U	D	D	U	U	U	U
112.5	1440	U	U	U	D	U	U	U	U
125	1600	D	D	D	U	U	U	U	U
U = Up									
D = Down									
*This frequency is selected by setting the switch to the 45 ips positions and SPEED is high.									

4.5.5 TRACKING OSCILLATOR

The Tracking Oscillator provides selected clock frequencies determined by the drive speed. The frequency is nominal until locked to the data rate by the Data Gate (DGATE) and the Envelope (ENV) signals. Deskew is controlled by the feedback signals, NCOPY and COPY. Refer to Table 4-5 for drive speed and frequency of the Tracking Oscillator. The frequency is selected by plug-in R-C networks and is adjusted by potentiometer R3 (Frequency Adjust).

4.5.6 PE READ CONTROL

The PE Read Control provides control for decoding PE read data. It also provides feedback signals to deskew the PE read data.

4.5.7 INPUT READ LOGIC

The Input Read Logic receives and buffers read signals from the drive.

4.5.8 PE READ LOGIC

The PE Read Logic buffers and decodes PE read data from the drive. This function is enabled by Reverse Command 2 (REV2) and allows the microformatter to decode read signals in both the forward and reverse directions. It also provides feedback signals to lock the Tracking Oscillator to the incoming data.

4.5.9 NRZI READ LOGIC

The NRZI Read Logic buffers and decodes 9-track NRZI read data from the drive. The circuits are enabled via the interface signal, READ DATA STROBE (IRDS) and an internal signal, Not Clear NRZI Data (NCLRNZDATA).

4.5.10 OUTPUT READ LOGIC

The Output Read Logic buffers and transmits read signals to the controller.

Table 4-5

Tracking Oscillator Frequency

Tape Speed (ips)	Config. Plug 107609 Version No.	Maximum Frequency Limit (kHz)	Minimum Frequency Limit (kHz)	Exact Frequency Value (kHz)
12.5	-01	465	455	460
18.75	-02	697	683	690
22.5	-03	836	820	828
25	-04	929	911	920
37.5	-05	1394	1366	1380
45	-06	1672	1639	1656
75	-07	2788	2732	2760
112.5	-08	4181	4100	4140
125	-09	4700	4500	4600

4.5.11 WRITE DATA GENERATOR

The Write Data Generator receives and buffers write signals from the controller, processes the signals, and transmits the write signals to the drive. Depending on the states of the write control signals, PE or NRZI data are written. These signals also determine when the CRCC is written.

U112-S1 selects external parity and U112-S2 selects internal parity.

4.5.12 ERROR GATING

Error Gating provides error signals to the controller. The error signals are HARD ERROR (IHER) or CORRECTED ERROR (ICER). NSPC disables Error Gating during a space command.

4.5.13 READ STROBE GATING

The Read Strobe Gating provides either a NRZI or PE read strobe to the controller. NSPC disables Read Strobe Gating during a space command.

4.6 MICROFORMATTER MAINTENANCE AND ADJUSTMENT

The following paragraphs provide a method of fault isolation between the microformatter and the drive. Electrical adjustment procedures for the microformatter are also given.

4.6.1 MICROFORMATTER—DRIVE(S) FAULT ISOLATION

The recommended level of fault isolation is to the Microformatter PCBA and to the drive components. Two methods of fault isolation, in order of preference, are:

(1) Use Wilson Laboratories Inc. Hand Exerciser, TFX500, and the operating instructions for the exerciser; refer to Section VI of the applicable operating and service manual for the drive.
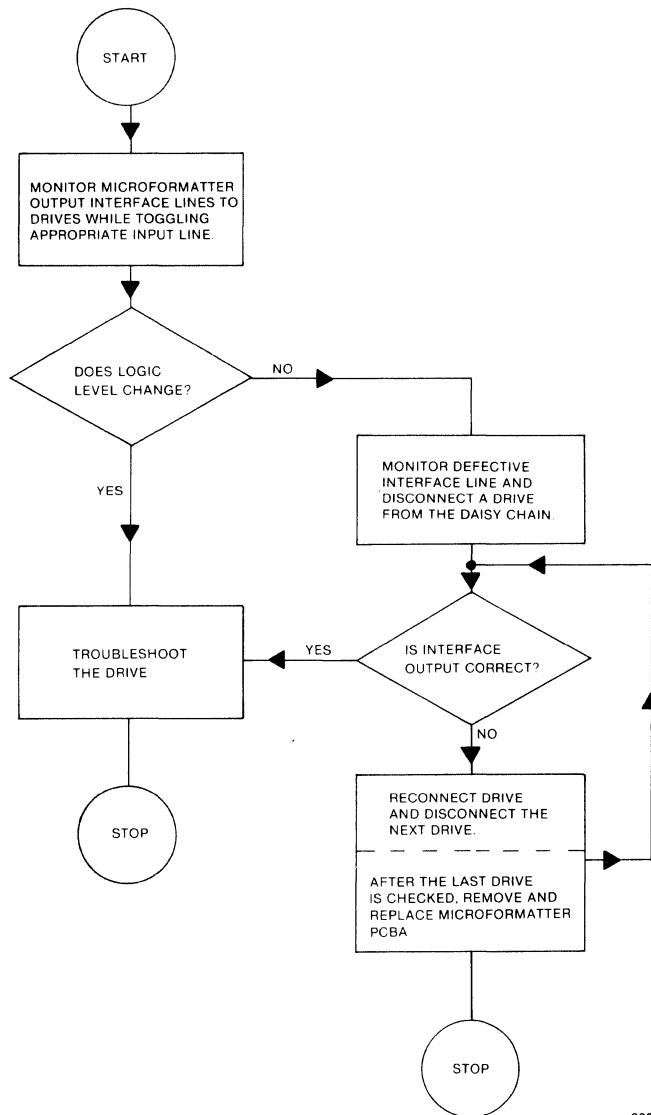
— OR —

(2) Use the procedure defined in Paragraph 4.6.1.1.

4.6.1.1 Fault Isolation

It is recommended that an all 1s tape for NRZI drive configurations, or an all 0s tape for PE drive configurations be generated. Also, a test tape to check errors and file marks should be available.

(1) Check the interface commands between the microformatter and the drive(s) using an oscilloscope. Refer to the fault isolation flow chart given in Figure 4-6.

(2) Using the previously generated test tapes, monitor (with an oscilloscope) the read interface lines between the microformatter and drive(s).

(3) Remove the all 1s or all 0s tape from the drive.

(4) Load a work tape, which is known to be good, onto the drive. Write an all 1s or an all 0s tape. Monitor the write interface lines between the microformatter and the drive(s).

When the fault is isolated to the microformatter or the drive, either replace the Microformatter PCBA or refer to Section VI of the applicable operating and service manual to fault isolate within the drive.

START

MONITOR MICROFORMATTER
OUTPUT INTERFACE LINES TO
DRIVES WHILE TOGGLING
APPROPRIATE INPUT LINE.

DOES LOGIC
LEVEL CHANGE?

NO

YES

MONITOR DEFECTIVE
INTERFACE LINE AND
DISCONNECT A DRIVE
FROM THE DAISY CHAIN.

TROUBLESHOOT
THE DRIVE

YES

IS INTERFACE
OUTPUT CORRECT?

STOP

NO

RECONNECT DRIVE
AND DISCONNECT THE
NEXT DRIVE.

AFTER THE LAST DRIVE
IS CHECKED, REMOVE AND
REPLACE MICROFORMATTER
PCBA

STOP

3025

Figure 4-6. Fault Isolation Flow Chart

4.6.2   MICROFORMATTER ADJUSTMENTS

Electrical adjustments to the Microformatter PCBA are made as follows.

    (1) Connect a DVM between TP1 and TP2 on the Microformatter PCBA.

    (2) Acceptable Limits:

        • +5.0v (maximum)

        • +4.9v (minimum)

(3) If the reading observed in step (2) is outside the acceptable limits, adjust R6 on Power Supply II PCBA for +4.95v.

NOTE

FT1000 systems only. This procedure may be performed by adjusting R179 on the Capstan/Regulator PCBA. However, some versions of the Capstan/Regulator PCBA have no provision for adjustment of the +5v.

(4) Set switch U112 as defined in Table 4-1, 4-2, or 4-3.

(5) Set switch U187 as defined in Table 4-4.

(6) Connect a frequency counter between TP3 and TP4 on the Microformatter PCBA.

(7) Monitor the output of the frequency counter. The frequency of the Tracking Oscillator should fall within the maximum and minimum frequency limits given in Table 4-5 for the drive tape speed.

(8) If the observed frequency falls outside the maximum and minimum frequency range, adjust R3 on the Microformatter PCBA for the exact Tracking Oscillator frequency given in Table 4-5.

4.7 POWER SUPPLY II PCBA

The Power Supply II PCBA is used in conjunction with the Microformatter PCBA on PPC Drive Models FT6000, FT7000, FT8000, and FT9000. 48v dc versions of the drive use a different version of the PCBA. The primary difference is that a dc input voltage is provided on the 48v units, eliminating the need for the rectifier. Refer to Schematic No. 107614 and Assembly No. 107615 for discussion of the power supply functions.

(1) Rectifier.

(2) +5v Regulator.

(3) Overcurrent Protection.

(4) Overvoltage Protection.

(5) Power Supply Enable

4.7.1   RECTIFIER (NOT USED ON 48V DC VERSIONS)

Rectifier CR1 is a full wave rectifier. The output of the rectifier is filtered, fused, and supplied to the regulator.

4.7.2   +5V REGULATOR

The +5v Regulator consists of U1, R5, R6, R7 and Q1. The regulator provides base drive to the series pass transistor, Q1. The voltage divider (R5, R6 and R7) determines the voltage output. R6 is adjusted to provide +4.95v at TP1 on the Microformatter PCBA. The regulator also has a current foldback circuit.

4.7.3   OVERCURRENT PROTECTION

The overcurrent protection is provided by a voltage divider (R2, R3 and R4). R3 is the current sense resistor. If the current increases across R3, the signal is fed back to U1 causing U1 to decrease its output. A short at the output causes U1 to shut off and remain shut off until the short is removed.

4.7.4   OVERVOLTAGE PROTECTION

The overvoltage protection is provided by Q2, VR1 and SCR1. If the output voltage exceeds +5.7 volts, VR1 conducts. This causes Q2 to conduct and fire SCR1. When SCR1 fires, a direct short (crowbar) occurs causing fuse F1 to open.

4.7.5 POWER SUPPLY ENABLE (PSEN)

The POWER SUPPLY ENABLE signal (IPSEN) is used to reset all microformatter logic to the quiescent state. This is done while the +5v supply is being established after power is applied and while the supply is decaying after power is turned off. This ensures that the logic is in a defined state after power on and that no spurious signals are sent to the drive logic.

When power is applied, the regulated output builds up to +5v causing C6 to charge through R14 and R15. When the voltage on C6 reaches 2.5v, the voltage on the base of Q5 will be greater than the voltage on the base of Q3. Q4 and Q5 will then turn on causing the output PSEN to go to +4v approximately 50 milliseconds after power is applied. A loss of dc power is detected by Q3 when the voltage on C7 drops below +3v.

4.8 POWER SUPPLY II ELECTRICAL ADJUSTMENTS

The following paragraphs provide a method of fault isolation to a stage in the power supply.

4.8.1 POWER SUPPLY II

Figure 4-7 is a functional block diagram of the power supply. Table 4-6 lists measurement points and voltage readings for a normally operating power supply. All readings assume that the output voltage of the power supply as measured between pins 3 and 1 of Power Supply J2 is:

- +5.36v (maximum)
- +5.14v (minimum)

In the event that the voltage read between J2 pins 3 and 1 falls outside the acceptable limits, perform the adjustment given in Paragraph 4.8.2.

4.8.2 POWER SUPPLY II ALIGNMENT

Electrical adjustments to the power supply are made as follows.

(1) Connect a DVM between TP1 and TP2 on the Microformatter PCBA.
(2) Acceptable Limits:
- +5.0v (maximum)
- +4.9v (minimum)
(3) If the reading observed in step (2) is out of tolerance, adjust R6 on Power Supply II PCBA until a voltage reading of +4.95v is obtained between TP1 and TP2 on the Microformatter PCBA.
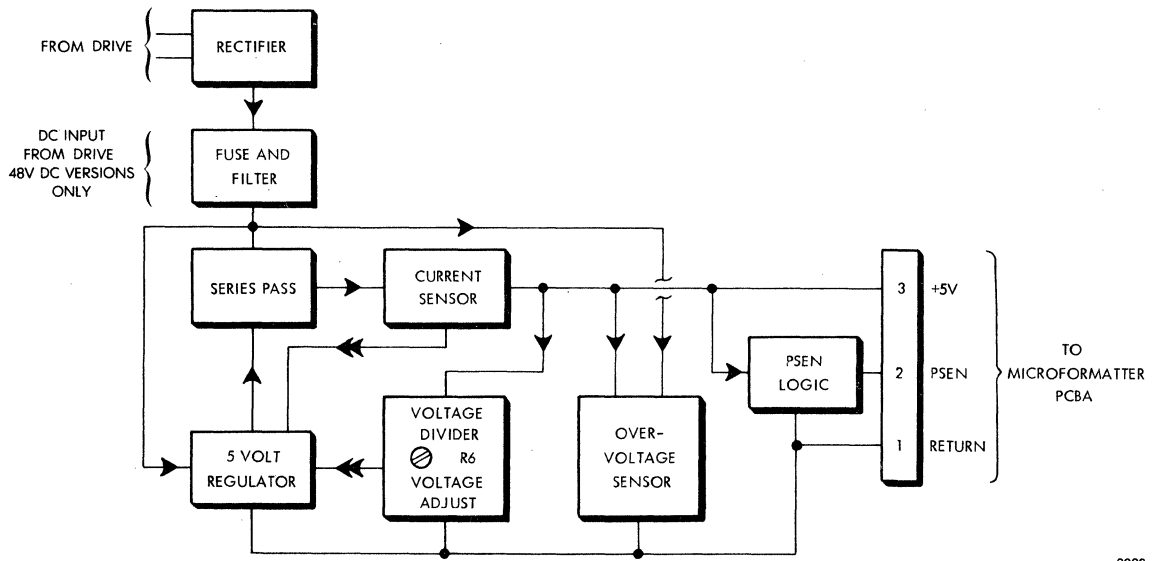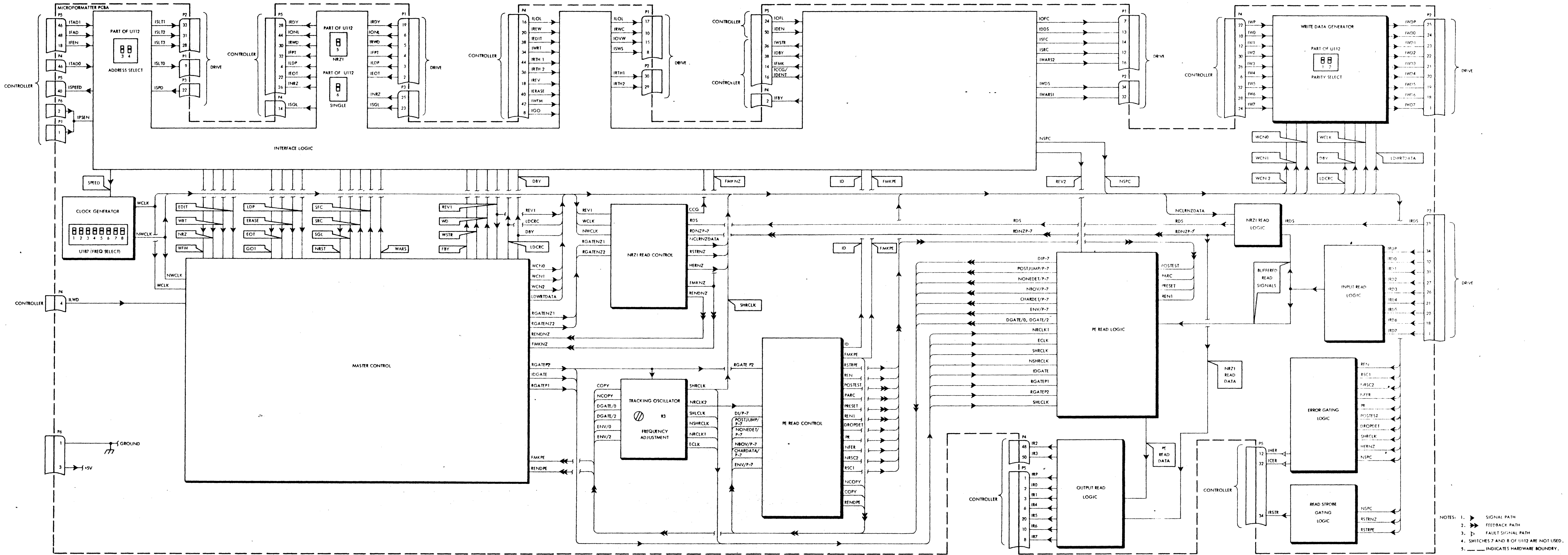
Figure 4-7. Power Supply Functional Block Diagram

Table 4-6

Nominal Power Supply Voltage Readings

Measurement Point	Voltage Reading
Across rectifier input	10.4v ac
Q1E/GND	+ 10.5
Q1B/GND	+ 9.0
Q1C/GND	+ 6.0
JCT R3-R5/GND	+ 5.25
JCT R6-R7/GND	+ 1.8
VR1 Cathode/GND	+ 5.2
Q2B/GND	+ 5.2
Q2C/GND	0v

Figure 4-1. Dual Microformatter Block Diagram

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