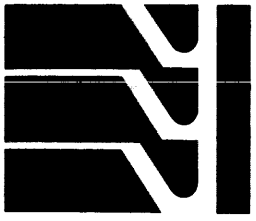
DIGI-DATA CORPORATION
8580 Dorsey Run Rd., Jessup, Md. 20794



SYNCHRONOUS TRANSPORT OPERATION AND MAINTENANCE MANUAL MODEL 1140, 1640, 1740 AND 1840

SYNCHRONOUS TRANSPORT
OPERATION AND MAINTENANCE MANUAL
MODEL 1140, 1640, 1740, and 1840

Second Printing

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1 - GENERAL INFORMATION

1.1 SCOPE OF MANUAL. This manual includes operation and maintenance information for the 40 Series Synchronous Magnetic Tape Transports manufactured by Digi-Data Corporation, 8580 Dorsey Run Road, Jessup, MD 20794. Sections 1 through 4 describe operation, installation, and interfacing; Sections 5 through 10 include circuit operation, trouble-shooting techniques, and adjustment and replacement procedures.

1.2 DESCRIPTION OF EQUIPMENT. The 40 Series tape transport write and read non-return-on-zero (NRZ) 7 or 9 track data or phase encoded (PE) 9 track ANSI/IBM compatible tapes at synchronous tape speeds from 12.5 to 75 inches per second (IPS). See ANSI Interchangeability Specifications X3.39-1973, X3.22-1973, and X3.14-1973.

1.2.1 TAPE MOVEMENT. A single capstan mounted on the shaft of a DC permanent magnet motor controls tape movement. The tape is in contact with approximately 180 degrees of the capstan surface. Feedback from the capstan motor's integral DC tachometer keeps tape velocity and acceleration ramps constant. Tape is buffered by two tension arms that control the take-up and supply reel motors via position servomechanisms. Beginning-of-tape and end-of-tape detection, high speed rewind, and low speed unload are incorporated in all four models. Available tape speeds are indicated in Figure 1-1.

Tape Speed	Model 1140 7" dia. reel max. (600')	Model 1640 8½" dia. reels max. (1200')	Model 1740 10½" dia. reels max. (2400')	Model 1840 10½" dia. reel max. (2400')
12.5 IPS	OPTIONAL	OPTIONAL	OPTIONAL	N/A
18.75 IPS	OPTIONAL	OPTIONAL	OPTIONAL	N/A
25 IPS	STANDARD	STANDARD	OPTIONAL	N/A
37.5 IPS	N/A	OPTIONAL	OPTIONAL	N/A
45 IPS	N/A	N/A	STANDARD	N/A
75 IPS	N/A	N/A	N/A	STANDARD

Figure 1-1. Available Tape Speeds

1.2.2 DATA TRANSFER. Recording data requires an external clock. NRZ data is encoded by the transport; PE data must be already encoded when presented to the transport.

NRZ data recovered from tape is amplified, decoded, deskewed, and sent to the controller with a clock developed from the data. PE data is squared up and threshold discriminated but is neither decoded nor deskewed; these last two functions are performed in the PE formatter.

Each unit has three read thresholds: high for read-after-write error checking, normal, and low for recovering severely degraded data. Each unit also includes file protection to prevent accidental erasure, and edit capability to allow rewriting of a single record/block in the midst of other records/blocks. All units are equipped with a dual gap read-after-write head.

1.2.3 TAPE PROTECTION. Since customer tapes often contain important data the transport incorporates several unique tape protection circuits. During power losses, the reel motors are brought to a controlled stop using energy stored in oversized filter capacitors and the tape buffering arms are gently relaxed to their mechanical stops. A mechanical relay protects the tape from motor amplifier circuit failure. Write circuitry is shut down during power failures to protect previously recorded data. Tape loading is inhibited if the AC line voltage is low, if the position servo sensor illuminators are not drawing current (burned out bulb or reversed connector), or if the speed control platforms on the motor control assembly are incorrectly installed or missing.

1.2.4 PHYSICAL DESCRIPTION. Each 40 Series transport is built on a single machined aluminum plate; all tape handling components are mounted directly on this precision surface to assure the flattest possible tape path. The tension arms are light to provide low inertia and are mounted in double ball-bearings to maintain perpendicularity and smooth operation.

The electronics is distributed on three printed circuit cards. The cards include over fifty labeled test stakes and each card is mounted with the component side readily accessible to the maintenance engineer. All major components are connected via plugs and sockets to speed replacement. The last card interfaces with the formatter through two fifty-pin ribbon cable plug connectors.

1.3 OPTIONS.

1.3.1 EMBEDDED FORMATTER WITH SUPPLEMENTARY POWER SUPPLY. A microprocessor-controlled formatter mounts on the rear of the transport card chassis and is available in NRZ, PE, or NRZ/PE configurations. Up to three additional transports may be daisy chained to a formatted transport.

1.3.2 UNATTENDED RESTART. This option allows a transport to load and come on line automatically following a power outage. This feature is valuable only in conjunction with a computer/controller incorporating the same feature.

1.3.3 UNIT SELECT SWITCH. These selector switches allow the operator to easily change a transport's address. Normally a transport's address is programmed on the write/control card as Ø, 1, 2, or 3. The unit with this option can respond to any or all of these addresses.

1.3.4 I/O ADAPTOR. An adaptor which mounts on the rear of the card cage provides an alternate industry standard I/O on three 36-pin card edges.

1.3.5 MISCELLANEOUS. Tape transports are also available without front doors.

1.4 MODEL NUMBERING SCHEME. The Digi-Data transport model number completely describes the series, number of tracks, data packing density, tape speed, line voltage, and options of the transport. Figure 1-2 outlines the model number scheme.

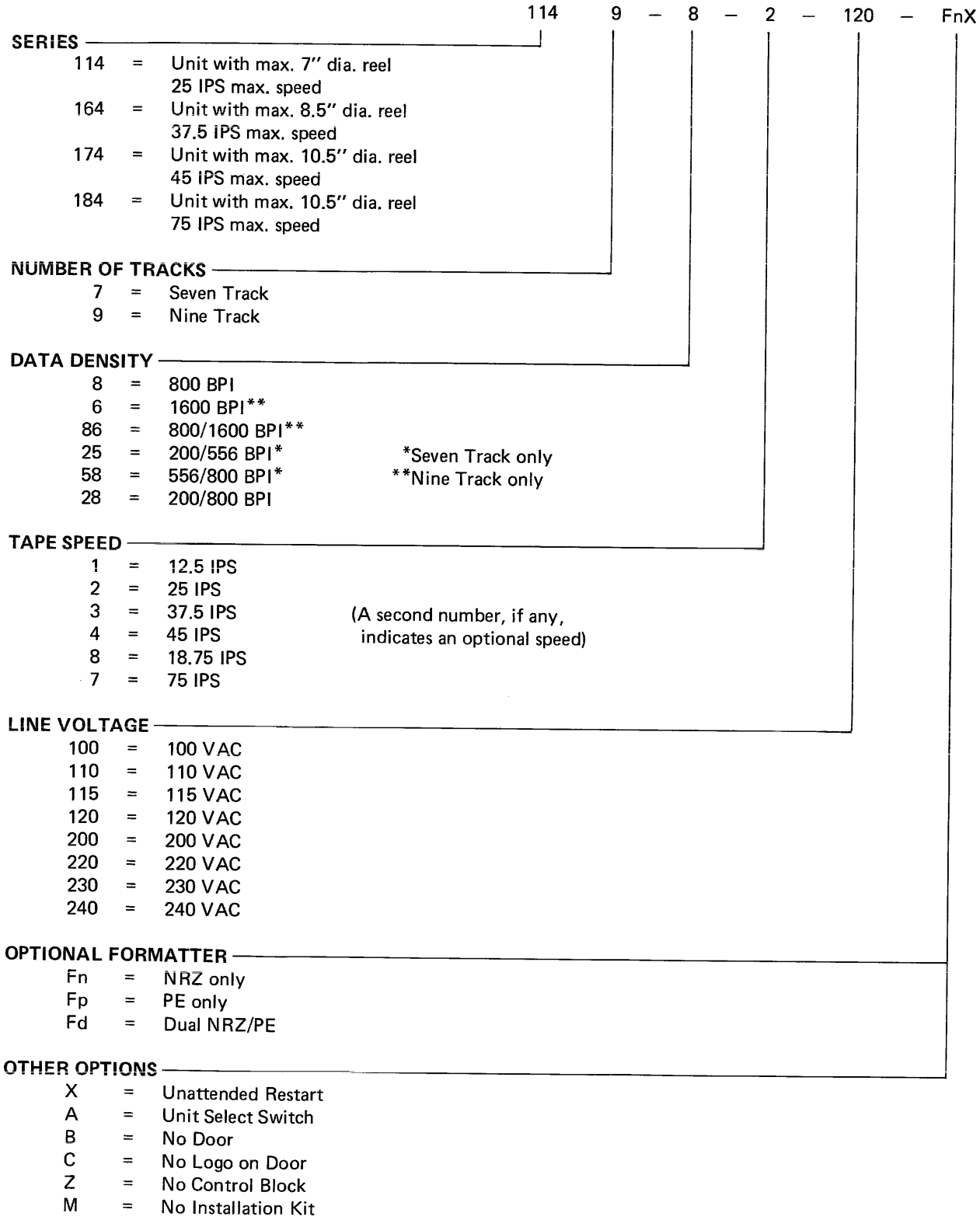


Figure 1-2. Model Numbering Scheme

1.5 SPECIFICATIONS

CHARACTERISTICS	VALUE
Recording Mode	NRZ, PE, or both
Number of Tracks	7 or 9 Track NRZ, IBM, ANSI Compatible 9 Track PE, IBM, ANSI Compatible
Data Packing Density	200, 556, 800 or 1600 BPI
Head	Dual gap (read-after-write)
Start/Stop Distance	0.19 inch ±0.02
Start/Stop Time	5.0 msec ±0.5 @ 75 IPS 8.4 msec ±0.9 @ 45 IPS 10.1 msec ±1.1 @ 37.5 IPS 15.2 msec ±1.6 @ 25 IPS 20.3 msec ±2.0 @ 18.75 IPS 30.4 msec ±3.2 @ 12.5 IPS
Instantaneous Speed Variation	±4% of the long term speed maximum
Long Term Speed Variation	±1% Maximum
Interchannel Displacement (Write)	150 microinches maximum
Tape Specifications	0.5 inch width, 1.9 mil, computer grade
Tape Tension	8 oz. Nominal
Tape Buffering	Tension arm, 30 to 60 degree arc
BOT/EOT Sensing	Photoelectric
Head and Tape Guide Spacing	IBM compatible
Power Fail Protection	Dynamic electrical braking, control maintained to rest.
Read Thresholds	NRZ: Normal 20%, High 34%, Low 10% PE: Normal 10%, High 30%, Low 5%

	1140	1640	1740	1840
Maximum Reel Size	7" dia. (600')	8.5" dia. (1200')	10.5" dia. (2400')	10.5" dia. (2400')
Synchronous Tape Speed	Up to 25 IPS	Up to 37.5 IPS	Up to 45 IPS	75 IPS only
Rewind Velocity	75 IPS	100 IPS	150 IPS	150 IPS

CHARACTERISTIC	VALUE
Electronics	Solid State Silicon TTL Low Power Schottky
Electrical Interface	Line Drivers: 7406/7407 buffers, open collector Line Receivers: 7414 or equivalent with 220 ohms to V_{CC}, 330 ohms to ground
Line Voltage	100 VAC ±10% 110 VAC ±10% 115 VAC ±10% 120 VAC ±10% 220 VAC ±10% 230 VAC ±10% 240 VAC ±10%
Line Frequency (AC)	49 to 62 Hz
Input Current	3.0 Amps Max 100-120 VAC 1.5 Amps Max 200-240 VAC 1140,1640, and 1740 5.0 Amps Max 100-120 VAC 2.5 Amps Max 200-240 VAC 1840
Operating Environment	0 to 20,000 feet (6,000m.) 35 to 122 degrees F (2 to 50 degrees C)* to 95% RH without condensation
Non-operating Environment	0 to 50,000 feet (15,000 m.) –40 to 160 degrees F(–40 to 70 degrees C)

	1140	1740	1640	1840
Weight	39 lbs. (17.7 kg.)	46 lbs. (20.9 kg.)	70 lbs. (31.18 kg.)	95 lbs. (43.18 kg)
Height	8.75 inches (22.22 cm)	12.25 inches (31.11 cm)	24.0 inches (60.96 cm)	24.0 inches (60.96 cm)
Depth, Overall	12.85 inches (32.64 cm)	12.85 inches (32.64 cm)	12.85 inches (32.64 cm)	12.85 inches (32.64 cm)
Depth, Overall with Formatter	13.65 inches (34.67 cm)	13.65 inches (34.67 cm)	13.65 inches (34.67 cm)	13.65 inches (34.67 cm)
Depth, Behind front plate	10.5 inches (26.67 cm)	10.5 inches (26.67 cm)	10.5 inches (26.67 cm)	10.5 inches (26.67 cm)
Depth, Behind with Formatter	11.38 inches (28.70 cm)	11.38 inches (28.70 cm)	11.38 inches (28.70 cm)	11.38 inches (28.70 cm)
Width	19.0 inches (48.26 cm)	19.0 inches (48.26 cm)	19.0 inches (48.26 cm)	19.0 inches (48.26 cm)
Mounting in EIA Cabinet	On Slides	On Slides	On Hinges	On Hinges

*Operating temperature *behind* the front plate. Due to the temperature characteristics of magnetic tape and tape heads the operating temperature in the tape area is restricted to 60 to 90°F (15 to 22°C), 20 to 80% RH.

2 · OPERATOR'S INFORMATION

2.1 INTRODUCTION. This section describes each operator control and indicator lamp and explains tape loading and unloading.

2.2 CONTROLS AND INDICATORS. The standard operator control panel on all four models is identical.

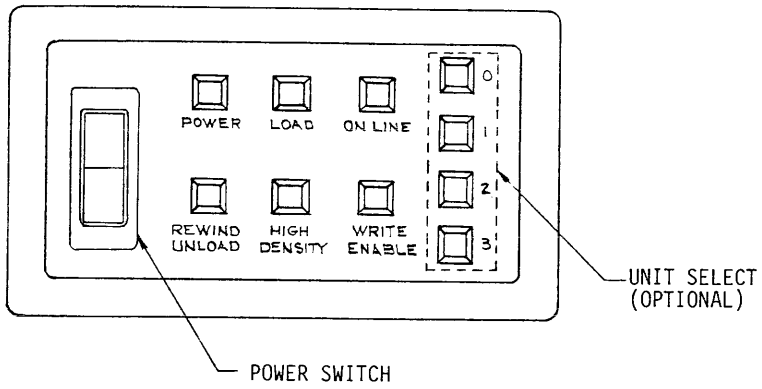


Figure 2-1. Operator Control Panel

2.2.1 POWER. This alternate action pushbutton switch applies power to the transport; the POWER indicator is illuminated when power is on.

2.2.2 LOAD. This momentary pushbutton switch activates the load sequence, positioning tape at the BOT marker. When the BOT marker is being sensed the LOAD indicator is illuminated.

2.2.3 REWIND/UNLOAD. This momentary pushbutton switch initiates either the rewind or the unload sequence. While rewinding or unloading the indicator is illuminated. Normally, pressing this switch starts a rewind sequence and takes the transport off line. If, however, either the LOAD or the REWIND indicator is illuminated when the REWIND pushbutton is pressed, an unload operation occurs.

2.2.4 ON LINE. This momentary pushbutton switch alternately places the transport "on line," enabling remote control, and "off line," disabiling remote control. The indicator is illuminated only when the transport is on line.

2.2.5 WRITE ENABLE. This indicator is illuminated when a reel of tape containing a write enable ring is loaded on the transport. It warns that the tape is not "file protected" and that writing/erasing functions are therefore permitted.

2.2.6 HIGH DENSITY. This alternate action pushbutton switch selects either low or high data density. The indicator is illuminated only when the high density is selected.

2.2.7 UNIT SELECT. These selector switches are optional. The transport may be set to any combination of addresses Ø, 1, 2, and 3.

2.3 LOADING TAPE. Loading tape on the 1140, 1640 and 1740/1840 transports is explained below in three separate paragraphs since the tape path of each is unique.

When mounting tape on a transport, only apply pressure in the center of the reel; pressing on the flanges will damage the tape edges and cause unreliable performance.

Before loading tape on any transport look at the back of the reel to see if the "write ring" is present. When a reel of tape with the ring removed is mounted on the transport writing and erasing are impossible; the transport is "file protected" and only reading is permitted. When a reel of tape with the write ring inserted is mounted on the transport writing and erasing are possible and the WRITE ENABLE indicator on the operator control panel will be illuminated.

2.3.1 LOADING TAPE ON THE 1140 TRANSPORT. To load tape on the 1140 transport follow these instructions while referring to figure 2-2. The maximum size reel which may be mounted on the 1140 is 7 inches in diameter.

1. Open the transport access door.
2. Press the POWER pushbutton switch to apply power to the transport. The POWER indicator should be illuminated.
3. Press the reel of tape onto the supply hub (located on the left). Check that the reel is firmly seated behind all three catches.
4. Thread the tape from the reel around the left of the supply tension arm. Continue under the left tape guide post, over the tape cleaner, between the two elements of the BOT/EOT sensor assembly, over the head (but under the flux gate), under the right tape guide post, under the capstan, and counter-clockwise up onto the take-up hub.
5. After winding four or five feet of tape onto the take-up hub, place your right index finger against the tape between the capstan and the take-up hub and pull the tape to the left, looping it over the take-up tension arm.
6. Remove any slackness in the tape by turning either hub. Check that the tape is threaded as shown on the decal affixed to the transport front plate (or in figure 2-2).
7. Close the transport access door.
8. Press the LOAD pushbutton switch. The reel motors will tension the tape and the tape will move forward. When the BOT (beginning of tape) reflective marker reaches the BOT/EOT sensor, the tape will stop and the LOAD indicator will be illuminated. This location is called "load point."
9. Press the ON-LINE pushbutton switch. The indicator illuminates only when the transport is ON LINE, i.e. under remote control. The unit may now be operated by the computer or other controller.

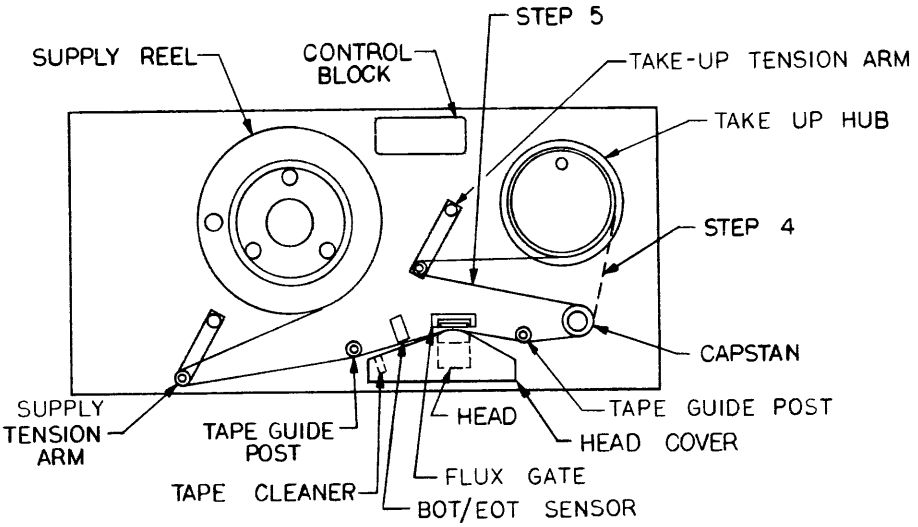


Figure 2-2. Tape Loading Diagram, 1140

2.3.2 LOADING TAPE ON THE 1640 TRANSPORT. To load tape on a 1640 transport, follow these instructions while referring to figure 2-3. The maximum size reel which may be mounted on the 1640 is 8.5 inches in diameter.

1. Open the transport access door.
2. Press the POWER pushbutton switch to apply power to the transport. The POWER indicator should be illuminated.
3. Pull outward on the reel-locking knob in the center of the supply hub (on the left). Place the reel of tape on the supply hub, then press inward on the reel-locking knob to lock the reel in place.
4. Thread the tape from the reel around the right of the stationary roller below the supply reel, then around the left of the supply tension arm. Return under the left tape guide post, above the tape cleaner, between the two elements of the BOT/EOT sensor assembly, over the tape head (but under the flux gate), under the right tape

guide post, under the capstan, to the right of the stationary roller, and counter-clockwise up onto the hub. A reel is not required on the take-up hub of the 1640 transport.

5. After winding four or five feet of tape onto the take-up hub place your right index finger against the tape between the capstan and the stationary roller and pull the tape to the left, looping it over the take-up tension arm.
6. Remove any slackness in the tape by turning either hub. Verify that the tape is threaded as shown on the decal affixed to the transport front plate (or in figure 2-3).
7. Close the transport access door and perform steps 8. and 9. of paragraph 2.3.1.

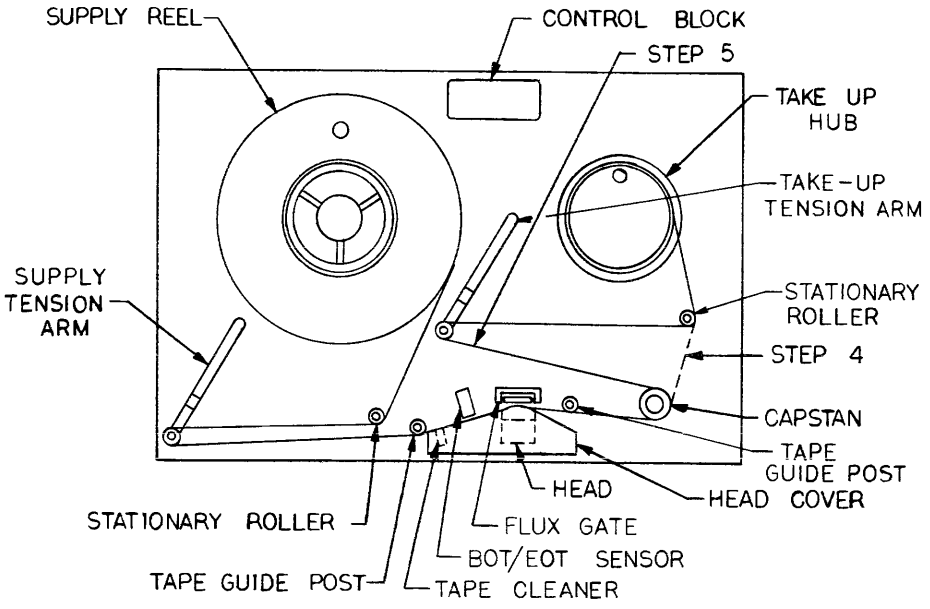


Figure 2-3. Tape Loading Diagram, 1640

2.3.3 LOADING TAPE ON THE 1740/1840 TRANSPORTS. To load tape on a 1740 or 1840 transport, follow these instructions while referring to figure 2-4. The maximum size reel which may be mounted on the 1740 or 1840 transport is 10.5 inches in diameter.

1. Open the transport access door.
2. Press the POWER pushbutton switch to apply power to the transport. The POWER indicator should be illuminated.
3. Pull outward on the reel-locking knob in the center of the supply hub (at the bottom). Place the reel of tape on the supply hub, then press inward on the reel-locking knob to lock the reel in place.
4. (1740) Thread the tape from the bottom (supply) reel over the stationary roller to the right of the reel, then down around the bottom tension arm roller. Return upward to the right of the bottom tape guide post, left of the tape cleaner, between the two elements of the BOT/EOT sensor assembly, between the tape head and its attached flux gate and to the right of the top guide post. Continue over the top of the capstan directly onto the top (take-up) reel. The tape should be wound onto the take-up reel in the clockwise direction.
   (1840) Thread the tape from the bottom (supply) reel over the stationary roller to the right of the reel, then down around the bottom tension arm roller. Return upward to the right of the tape damper, left of the tape cleaner, right of the bottom tape guide post, between the two elements of the BOT/EOT sensor assembly, between the tape head and its attached flux gate and to the right of the top guide post. Continue over the top of the Capstan directly onto the top (take-up) reel. The tape should be wound onto the take-up reel in the clockwise direction.
5. After winding five or six feet of tape onto the take-up reel, pull the tape down between the capstan and the top stationary roller onto the top tension arm roller.
6. Remove any slackness in the tape by turning either reel. Verify that the tape is now threaded as shown in the decal affixed to the transport front plate (or in figure 2-4).
7. Close the transport access door and perform steps 8. and 9. of paragraph 2.3.1.

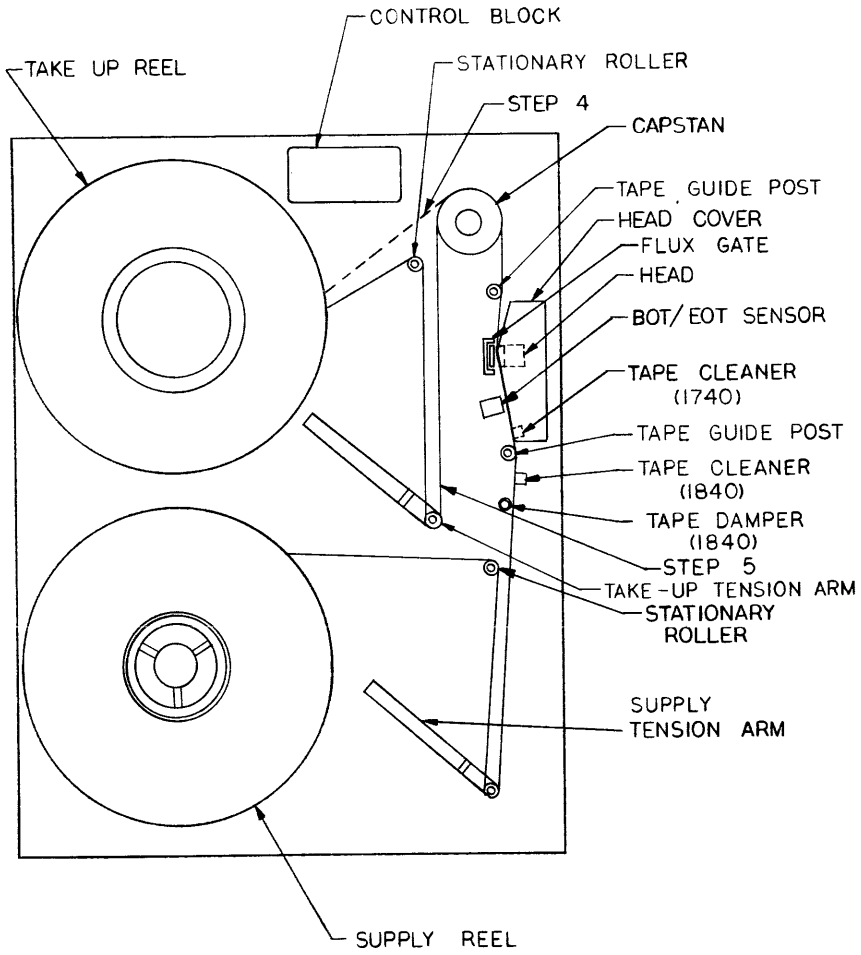


Figure 2-4. Tape Loading Diagram, 1740 and 1840

2.4 UNLOADING TAPE. To unload tape from any 40 Series transport follow this procedure. If power has been off see paragraph 2.5.1 first.

1. Press the rewind pushbutton *twice.* Tape will rewind to load point at high speed and then unload at low speed.
2. After tape tension is lost open the transport access door and by hand wind the tape completely onto the supply reel.
3. On the 1840, 1740 and 1640 pull up on the reel-locking knob at the center of the supply hub. Remove the reel. Press down on the reel-locking knob and close the front access door. On the 1140 tape unit, simply remove the file reel from the supply hub and close the front access door.

2.5 RECOVERING FROM PROBLEM CONDITIONS.

2.5.1 RECOVERING FROM A POWER OUTAGE. In the event of power failure the 40 Series transports will use energy stored in filter capacitors to stop the reel motors completely under servo control, even when rewinding, and then relax the tension arms to their stops. Tape will never be damaged in any way. To rewind the tape after restoration of power, follow the procedure below.

1. Remove any slackness in the tape by turning either hub. Press the Load pushbutton. Tape will tension and move forward.
2. Press the LOAD and ON LINE pushbuttons simultaneously. Tape motion will cease. NOTE: Steps 1 and 2 are not necessary if the unit is equipped with the unattended restart option.
3. Press the rewind pushbutton. Tape will rewind to the load point.

2.5.2 RECOVERING AFTER RUNNING TAPE ENTIRELY OFF THE SUPPLY REEL. Should the tape accidently be wound entirely from the supply reel the transport will halt when tape tension is lost. To reload the tape follow these instructions.

1. Open the front access door.
2. Thread the tape from the take-up hub to the supply reel as shown on the tape threading decal affixed to the front plate.
3. Turn the supply reel counter-clockwise until the EOT (end of tape) reflective marker is encountered (approximately ten feet). If no EOT marker is present, attach one along the edge of the tape nearest to the plate on the non-oxide surface.
4. Remove slackness from the tape and check that the tape is threaded properly. Close the front access door.
5. Press the LOAD and ON LINE pushbuttons simultaneously to load and stop forward tape motion before the tape runs entirely off the supply reel.
6. Press REWIND and the tape will rewind to the load point.

2.6 CLEANING. Perform the following procedure after *every eight hours* of system use, or after every reel of tape if system use is infrequent. Otherwise, small particles of dust and oxide from the tape will accumulate and cause data errors, possibly permanently damaging the magnetic tape.

1. Remove tape from the transport as described in paragraph 2.4.
2. Moisten a cotton swab (or any lint-free cloth) with isopropyl alcohol or commercial head cleaning solvent. Do not use carbon tetrachloride or an abrasive cloth.
3. Lifting the flux gate, clean the head and the two tape guides.
4. Clean the tape cleaner, the tension arm rollers, and the stationary rollers. Rotate the rollers as you clean them to insure the complete removal of all contaminants. Once cleaned, a surface should not be touched with the fingers. Excessive liquid is not required! Allow a few seconds for the alcohol to evaporate before loading tape on the transport.
5. Rotate the capstan with one hand on the center shaft (not the outer surface, as it may be accidently deformed), while holding the cleaning implement with the other hand against the outer surface. If the capstan outer surface shows signs of cracking or polish, advise the maintenance engineer.

3 - INSTALLATION AND INITIAL CHECKOUT

3.1 INTRODUCTION. This section describes the unpacking, inspection, initial checkout and rack-mounting of the 40 Series tape transports.

3.2 UNPACKING THE TRANSPORT. Digi-Data transports are shipped in fiberboard cartons with spacers for shock absorption. These cartons and spacers should be retained if the transport is to be re-shipped.

If at any time during the unpacking procedure it becomes clear that the transport is damaged, unpack no further. Advise Digi-Data Corporation of the loss, and file a claim with the carrier. Since the carrier's claim agent may wish to inspect the packing materials these should be retained.

Once you have removed the transport verify that you have received everything as ordered. A packing list is contained in the plastic envelope attached to the top of the outer carton. Check the *model number* and *serial number* of the transport against that indicated on the packing list. Check also that all accessories (cables, manual, mounting hardware, etc.) indicated on the packing list are included. Advise Digi-Data of any discrepancies.

If the transport is to be re-shipped, use of the original packing materials is recommended. Seal all flaps well with paper or vinyl tape.

3.3 INITIAL CHECKOUT. To check for proper operation of the transport before placing it in the system perform the following procedure. Additional operation information is contained in Section 2 of this manual.

1. Check that the input voltage noted on the transport's model number tag and the actual line voltage at the intended installation agree. If not, remove the two screws holding the card cage in place and swing it away. Remove the two screws holding the motor control card in place and unplug it from its connectors. Two slide switches will now be visible. Use the screwdriver's blade to slide the switches to the proper settings indicated in Figure 3-1. Note that only one voltage range is available in any machine; to change the voltage range only the power control unit must be changed. See paragraph 9.12.

Voltage Range 1	Voltage Range 2	Switch Settings		AC Fuse, Slo Blo 1140, 1640,1740	AC Fuse, Slo Blo 1840
110 VAC ±10%	100 VAC ±10%	115	LO	3A	5A
120 VAC ±10%	115 VAC ±10%	115	NOR	3A	5A
220 VAC ±10%	200 VAC ±10%	230	LO	1.5A	2.5A
240 VAC ±10%	230 VAC ±10%	230	NOR	1.5A	2.5A

Figure 3-1. Voltage Range Switch Settings

2. Check the AC fuse visually.
3. Load tape on the transport as described in Paragraph 2.3.
4. When the LOAD indicator is illuminated press the ON LINE pushbutton several times and verify that the ON LINE indicator alternately is illuminated and is extinguished.
5. Locate the three-position service switch on the write/control card. With the transport ON LINE verify that the service switch is inoperable.
6. With the transport OFF LINE, move the service switch to the FORWARD position. After several feet of tape have run onto the take-up reel return the service switch to NORMAL; tape motion should cease.
7. Move the service switch to REVERSE. After several feet of tape have run onto the supply reel, return the switch to NORMAL; tape motion will again cease. NOTE: The service switch ignores the BOT and EOT markers.
8. Use the service switch to run the tape forward again. Visually check all the tape path components for smooth operation.
9. After stopping the tape, place the transport ON LINE, then press the REWIND pushbutton switch. The transport will go OFF LINE and the tape will rewind until the BOT reflective marker is sensed. The tape will overshoot the load point by several inches, and then return forward to the exact load point location. While rewinding, the REWIND indicator will be illuminated. After the tape has returned to load point the LOAD indicator will be illuminated.
10. Use the service switch again to run fifty to a hundred feet of tape onto the take-up reel. Return the service switch to NORMAL. Press the REWIND SWITCH. After the tape has reached the full rewind speed, press the POWER switch off. The transport should stop smoothly without damaging tape.

11. Press the POWER switch on again. Remove any slackness from the tape. Press LOAD and the tape will begin to advance. Press LOAD and ON LINE simultaneously (this creates a false BOT indication) and the tape will halt.
12. Press REWIND *twice*. The tape will rewind at full speed and then automatically unload at low speed.
13. Remove the tape from the transport.
14. Important!! The service switch must be in the NORMAL position for "normal" on line operation. Make sure that you have left it in NORMAL.

Additional checks may be performed with the Digi-Data transport exerciser card if available. See the manual supplied with this card.

3.4 RACK-MOUNTING THE TRANSPORT. Digi-Data 40 Series tape transports may be mounted in any standard 19-inch EIA rack or cabinet. Models 1140 and 1640 mount on slides supplied with the transport to accomodate rack depths between 22 and 28 inches. Models 1740 and 1840 are mounted on hinges, also supplied with the transport.

3.4.1 RACK-MOUNTING THE 1140 and 1640. The 1140 transport requires 8.75 inches of panel height in a standard 19 inch EIA rack or cabinet; the 1640 transport requires 12.5 inches of panel height. The transport should be centered on the rack at the desired height and the slides mounted in the 0.5 inch spaced holes 3.5 inches above the transport bottom edge. See installation drawing and parts list 0051911-0000 and 0051911-0001 included in Section 11 of this manual during the following rack-mounting procedure.

1. Remove the inner rail of the left slide from the outer rail and mount it on the left side panel of the transport chassis with the bolts provided.
2. Attach a shorter slide holder behind the rack's left front mounting rail using two bolts and a bar nut.
3. Attach a longer slide holder in front of the rack's left rear mounting rail using two bolts and a bar nut.
4. Place the outer slide rail into the front and rear slide holders and attach it with three bolts and nuts.
5. Repeat steps 1 through 4, for the right side.
6. Place the transport into the rack, carefully guiding the inner slide rail into the outer slide rail on each side.
7. Turn the twist lock fasteners with a screwdriver to secure the transport to the rack.

3.4.2 RACK-MOUNTING THE 1740 AND 1840. The 1740 and 1840 transports require 24 inches of panel height in a standard 19-inch EIA rack or cabinet. See installation drawings and parts lists 0051552-0000, 0051552-0001, 0051896-0000, and 0051896-0001 included in Section 11 of this manual.

1. Fasten the two hinge blocks to the left mounting rail of the rack with the four bolts and the long bar-nut provided. The top bolt of the top hinge block should be 2.5 inches or more below the desired location of the top edge of the transport front plate. The long bar nut controls the vertical alignment of the top mounting block with respect to the bottom mounting block.
2. Lift the transport and, holding it *perpendicular* to the mounting suface, approach the mounting blocks with the left side of the dust cover. Maneuver the longer top pin into its hole first, then the shorter bottom pin. NOTE: Handling the transport in this step normally requires two persons.
3. Swing the transport inside the rack and turn the twist-lock fastener clockwise with a screwdriver to secure the right side of the transport.
4. Insert a keeper below each hinge and attach with hardware provided. The keepers prevent the transport from inadvertantly being lifted up and off the hinge pins.
5. Unlock the transport and swing it out of the rack. Close and lock the transport again.

4 - INTERFACING AND CONTROL

4.1 INTRODUCTION. This section describes the electrical interface, defines each I/0 signal, describes the tape format, and explains how to control the transport to perform the various write/read operations.

4.2 ELECTRICAL PHYSICAL INTERFACE REQUIREMENTS. All line drivers in the transport are 7406/7407 open-collector buffers or the equivalent. All inputs are terminated in a 220 Ohm resistor to V_{CC} and a 330 Ohm resistor to ground. The formatter/controller should drive all transport inputs with open collector circuits capable of sinking at least 25 milliamps while maintaining 0.5 volts maximum (noise inclusive) at the transport line receiver. The recommended interface circuit is depicted in Figure 4-1.

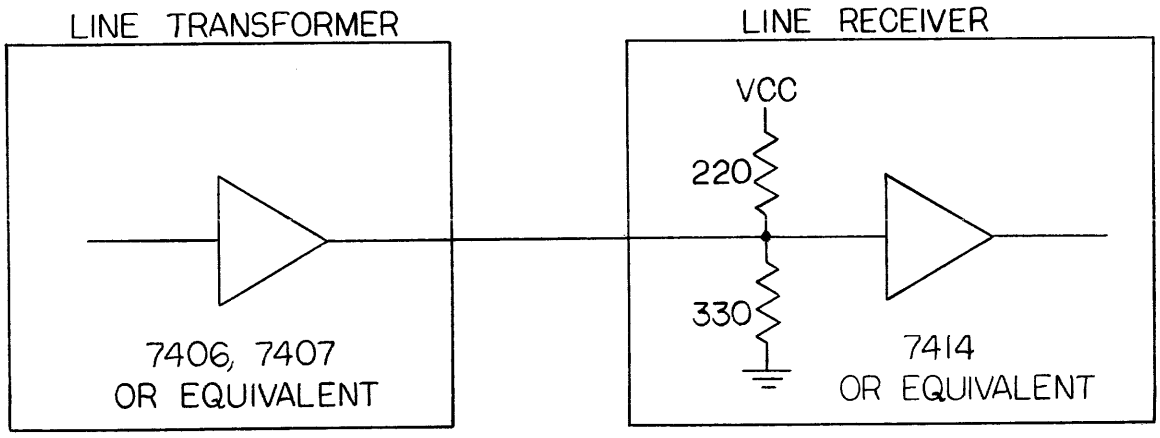


Figure 4-1. Recommended Interface Circuit

The minimum recommended pulse width on the interface lines is one microsecond. Inputs which elicit immediate confirming responses from the transport may be narrower if they go false upon detecting the transport's response. All signals to and from the transport are low true. All rise and fall times should be less than 50 nanoseconds.

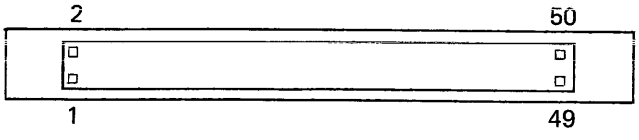
TRUE	=	LOW	=	0 to 0.5 VDC
FALSE	=	HIGH	=	Greater than 2.0 VDC

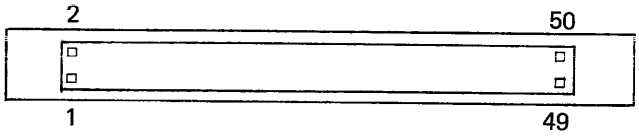
The transport I/0 connectors, located at the top edge of the write/control p.c. card are fifty-pin ribbon cable plug connectors (AMP part number 1-102154-0 or the equivalent). Figure 4-2 lists transport interface connector pin assignments and signal mnemonics. These signals are described in paragraph 4.3.

4.3 TRANSPORT INTERFACE SIGNALS.

4.3.1 TRANSPORT COMMAND INPUT SINGALS.

SELECT (SLT, SLTØ, SLT1, SLT2, SLT3). A true low level on the appropriate line selects a transport for operation. A false high level immediately terminates any tape motion except rewinding. Programming jumpers are provided to control response to each of these input lines. See paragraph 6.3.1 for details.





J2

1	RWC	GND	2
3	OFFC	GND	4
5	WD7.1	GND	6
7	WD6.2	GND	8
9	WD5.4	GND	10
11	WD4.8	GND	12
13	WD3.A	GND	14
15	WD2.B	GND	16
17	WD1	GND	18
19	WDØ	GND	20
21	WDP.C	GND	22
23	DDS	GND	24
25	RDS	GND	26
27	RD7.1	GND	28
29	RD6.2	GND	30
31	RD5.4	GND	32
33	RD4.8	GND	34
35	RD3.A	GND	36
37	RD2.B	GND	38
39	RD1	GND	40
41	RDØ	GND	42
43	ROL	GND	44
45	RDIS	GND	46
47	RDP.C	GND	48
49	FMT1	GND	50

J1

1	FMT2	SP1	2
3	SGL	GND	4
5	SPØ	SP2	6
7	RDY	GND	8
9	ONL	GND	10
11	RWD	GND	12
13	FPT	GND	14
15	LDP	GND	16
17	EOT	GND	18
19	FMT3	SPS	20
21	SLT	GND	22
23	SWS	GND	24
25	WARS	GND	26
27	WDS	GND	28
29	RTH2	GND	30
31	RTH1	GND	32
33	OVW	GND	34
35	SLT2	GND	36
37	SLT3	GND	38
39	SLTØ	GND	40
41	SLT1	GND	42
43	SFC	GND	44
45	SRC	GND	46
47	+5V	GND	48
49	+5V	GND	50

Figure 4-2. Transport I/O

SYNCHRONOUS FORWARD COMMAND (SFC). A true low level moves tape forward. This command is blocked if the transport is not READY.

SYNCHRONOUS REVERSE COMMAND (SRC). A true low level moves tape in reverse. This command is blocked if the transport is not READY. If the BOT marker is sensed while in reverse, the transport will stop with the marker .52" to .92" (depending on tape marker lengths) closer to the head than the normal load point.

REWIND COMMAND (RWC). A true low pulse causes the transport to rewind the tape onto the supply reel until the BOT marker is sensed. Write current is inhibited. RWC is ignored if the transport is already at BOT.

OFF-LINE COMMAND (OFFC). A true low pulse places the transport off line, disabling remote control and extinguishing the front panel ON LINE indicator. The transport remains off line until the operator presses the ON LINE pushbutton or until the ROL input is pulsed low. OFFC is gated only by SLT, permitting the transport to go off line while rewinding.

REMOTE ON LINE (ROL). A true low pulse causes the transport to apply tension to the tape and to go ON LINE. If the transport is already on line it will go off line. (The tape unit must be threaded properly by the operator before this command is executed.)

SET WRITE STATUS (SWS). A true low level or pulse concurrent with SFC or SRC and remaining true for at least 25 microseconds after the motion command is set energizes write and erase circuitry. After being set the write circuit-

ry will remain energized (except in the overwrite mode) until another SFC or SRC is initiated with SWS held false or until RWC or OFFC is received. A programming jumper is available for disabling write circuitry upon removal of SWS. See paragraph 6.3.3 for details.

NOTE: The tape transport will not write unless a write ring is installed on the tape reel.

OVERWRITE (OVW). A true low level or pulse places the transport in the overwrite mode if SWS and OVW are true for at least 25 microseconds after SFC or SRC is initiated. In overwrite, the write and erase heads are turned off immediately after the WARS pulse while the tape is still at speed to avoid erasing the following record.

DATA DENSITY SELECT (DDS). A true low level selects the lowest available density on a dual density transport. A false high level selects the highest available density. This input must be held at the desired level for the duration of the read or write operation. A programming jumper is available for inverting the sense of this signal for industry compatible applications. See paragraph 6.3.5 for details.

READ DISABLE (RDIS). A true low level disables the read circuits so that only recording is possible.

READ THRESHOLD 1 (RTH1). Not used since dual gap transports automatically switch to high read threshold when performing read-after-write operations. See paragraph 7.10.1 for details.

READ THRESHOLD 2 (RTH2). A true low level lowers the read amplifier threshold to increase sensitivity for recovering severely degraded data. Normal threshold is selected when RTH2 is false high. See paragraph 7.10.1 for details.

SPEED SELECT (SPS). A true low level on this line selects the optional tape speed on transports equipped with this feature. The optional speed may be either faster or slower than the standard speed.

4.3.2 TRANSPORT STATUS OUTPUT SIGNALS.

ON LINE (ONL). A true low level indicates that the operator has placed the transport under remote control. A programming jumper is available for disabling the front panel switch to provide permanent on line status. See paragraph 6.3.6 for details.

READY (RDY). A true low level indicates that the transport is on line, selected, loaded with tape, and not rewinding. Motion commands will be ignored if READY is false.

LOAD POINT (LDP). A true low level indicates that the tape is positioned at the BOT marker.

END OF TAPE (EOT). A true low level indicates that the EOT marker has been encountered by or has passed the BOT/EOT sensor in the forward direction. A programming jumper is available to provide EOT status only when directly over the reflective marker. See paragraph 6.3.4 for details.

FILE PROTECT (FPT). A true low level indicates that the write ring is removed from the supply reel. The transport will not write or erase when FPT is true even if SWS is asserted.

REWINDING (RWD). A true low level indicates that the transport is rewinding or advancing to load point after rewinding.

SINGLE GAP (SGL). This line will always be false high, indicating that the selected transport is equipped with a dual gap head.

FORMAT 1, 2, 3, (FMT1,2,3). These three signals together indicate the format of the selected transport (See figure 4-3.

SPEED STATUS Ø, 1, 2 (SPØ,1,2). These three signals taken together indicate the tape speed of the transport. See figure 4-4.

4.3.3 DATA INPUT SIGNALS.

WRITE DATA STROBE (WDS). A true pulse strobes information on the WRITE DATA lines into the transport write circuitry. In NRZ one WDS is needed for each data character and, in 9 track 800 BPI, another for the CRCC. In PE two WDS pulses are required per character, one for the "phase bit" and one for the "data bit". The frequency at

which the formatter/controller must supply WRITE DATA STROBES is determined by transport tape speed and the desired data packing density. Specific timing constraints are placed on this signal with respect to the write data inputs as described in WRITE DATA INPUTS.

WRITE AMPLIFIER RESET (WARS). A true low pulse resets the transport's write amplifiers to the direction of tape erasure, the normal state at the beginning and end of every write operation. During an overwrite (edit) operation in both NRZ and PE, WARS initiates a gradual turn-off of the write and erase head currents while the tape transport is still at speed. In NRZ, WARS writes the longitudinal redundancy check character (LRCC) the eighth character position (9 track 800 BPI) or fourth character position (7 track or 9 track 200 BPI) after the last data character of a record. No WDS should be supplied when writing the LRCC.

	40 SERIES COMPATIBILITY			30 SERIES COMPATIBILITY		
FORMAT	**FMT1**	**FMT2**	**FMT3**	**FMT1 (DDI)**	**FMT2 (7 TK)**	**FMT3 (NRZ)**
7 Tk, 200 BPI, NRZ	LO	LO	LO	LO	LO	LO
7 Tk, 556 BPI, NRZ	LO	LO	HI	HI	LO	LO
7 Tk, 800 BPI, NRZ	HI	LO	LO	HI	LO	LO
9 Tk, 200 BPI, NRZ	LO	HI	LO	LO	HI	LO
9 Tk, 800 BPI, NRZ	HI	HI	LO	LO	HI	LO
9 Tk, 1600 BPI, PE	LO	HI	HI	HI	HI	HI
9 Tk, 6250 BPI, GCR	HI	HI	HI	NA	NA	NA
Unassigned	HI	LO	HI	NA	NA	NA

Paragraph 6.3.8 provides complete details for configuring programming jumpers and switches for each of the compatibility schemes outlined above.

Figure 4-3. Format Signal Decoding

	40 SERIES COMPATIBILITY			30 SERIES COMPATIBILITY		
TAPE SPEED	**SP2**	**SP1**	**SP0 (LSPD)**	**SP2**	**SP1**	**SP0 (LSPD)**
Unassigned	HI	HI	HI	*	*	**
12.5 IPS	HI	HI	LO	*	*	**
18.75 IPS	HI	LO	HI	*	*	**
25 IPS	HI	LO	LO	*	*	**
37.5 IPS	LO	HI	HI	*	*	**
45 IPS	LO	HI	LO	*	*	**
75 IPS	LO	LO	HI	*	*	**
125 IPS	LO	LO	LO	*	*	**

* = Don't Care
** = Must be true for the lowest speed drive in multi-drive installation

For configuring a 40 Series drive for compatability with a 30 Series drive, SPØ is equivalent to LSPD, which must be true when the drive is in the lower of 2 available speeds selectable in old formatters. See paragraph 6.3.7 for complete details on programming switches.

Figure 4-4. Speed Status Decoding

WRITE DATA INPUTS (WDP, WDØ - WD7). These levels must be present 200 nanoseconds before the leading edge of WDS and remain stable until the trailing edge. In NRZ a low level reverses the direction of tape magnetization, resulting in a logical "one" on tape. A high level does not change the direction of tape magnetization, resulting in a logical "zero." In PE, a high level aligns the direction of tape magnetization with the direction of erasure; a low level aligns the magnetization opposite the direction of erasure. The formatter/controller generates these lines from the data to accomplish phase encoding.

4.3.4 DATA OUTPUT SIGNALS

READ DATA STROBE (RDS). A true low pulse of two microseconds nominal duration clocks NRZ data from the READ DATA OUTPUTS into the formatter. The READ DATA OUTPUTS completely envelop the RDS pulse. RDS remains false during PE operations.

READ DATA OUTPUTS (RDP, RDØ - RD7). In NRZ a true low level during the READ DATA STROBE indicates that a logical "one" was read in the associated track on tape. The READ DATA OUTPUTS appear prior to the leading edge of the RDS pulse and remain present until after its trailing edge. In PE, data is presented at these outputs; PE data is not deskewed, so transitions reflect each track in real time.

4.4 NRZ TAPE FORMAT. The formatter/controller must produce tapes on the transport formatted in accordance with IBM and ANSI specifications. These specifications for nine track and seven track NRZ tape are illustrated in figure 4-5 and 4-6. See also ANSI interchangeability Standards X3.14-1973 and X3.22-1973.

Two reflective markers attached to the non-oxide side of the tape effectively determine the useable bounds of the tape (see figure 4.5). The "beginning of tape" marker is located along the edge of the tape farthest away from the transport's front plate, 16' ±2' from the physical beginning of the tape. All tape before the BOT marker is considered leader. The "end of tape" marker is located between 25 and 30 feet before the physical end of the tape, along the edge of the tape nearest the front plate. The transport cannot record or read before the BOT marker; data may, however, be written and read beyond the EOT marker. The formatter/controller or computer is responsible for terminating forward tape motion before the physical limit of the tape is reached after receiving the EOT status indication.

Data is recorded on magnetic tape in blocks or records separated by inter-record gaps (IRG). These erased gaps in the data provide space for the transport to stop and start tape. The IRG is 0.75 inches (nominal) on seven track tape and 0.6 inches (nominal) on nine track tape.

Each data block or record may contain between 18 and 2048 data characters; the number is usually determined only by the customer's application. Data is recorded in seven or nine parallel tracks (also called channels) which run the length of the tape. A data character consists of one bit in each track perpendicular across the tape. Characters are written either 200, 556, or 800 to the inch on seven track tape and 200 or 800 characters per inch on nine track NRZ tapes. A data character on seven track tape contains six data bits and one vertical parity bit. Seven track tapes with odd parity are binary tapes; seven track tapes with even parity are BCD tapes. A nine track data character contains eight data bits, together commonly called a byte, and one parity bit. Nine track parity is usually odd.

In addition to vertically verifying data via the parity bit in each character data is verified horizontally. At the end of each block of data one check character (on 9 track 200 BPI and all 7 track tapes) or two check characters (on 9 track 800 BPI tape) are recorded. The longitudinal redundancy check character (LRCC) is formed by calculating the even parity of each track. It is written either four (7 track or 9 track 200 BPI) or eight (9 track 800 BPI) character positions beyond the last data character to distinguish it from the data. The LRCC is generated in the transport during write operations and is verified in the formatter/controller during read operations.

Nine track 800 BPI NRZ tapes also include the cyclic redundancy check character (CRCC), written four character periods after the last data character of a record. The CRCC is generated in the formatter/controller during write operations and checked during read operations. (See ANSI X3.22 for CRCC recording details.)

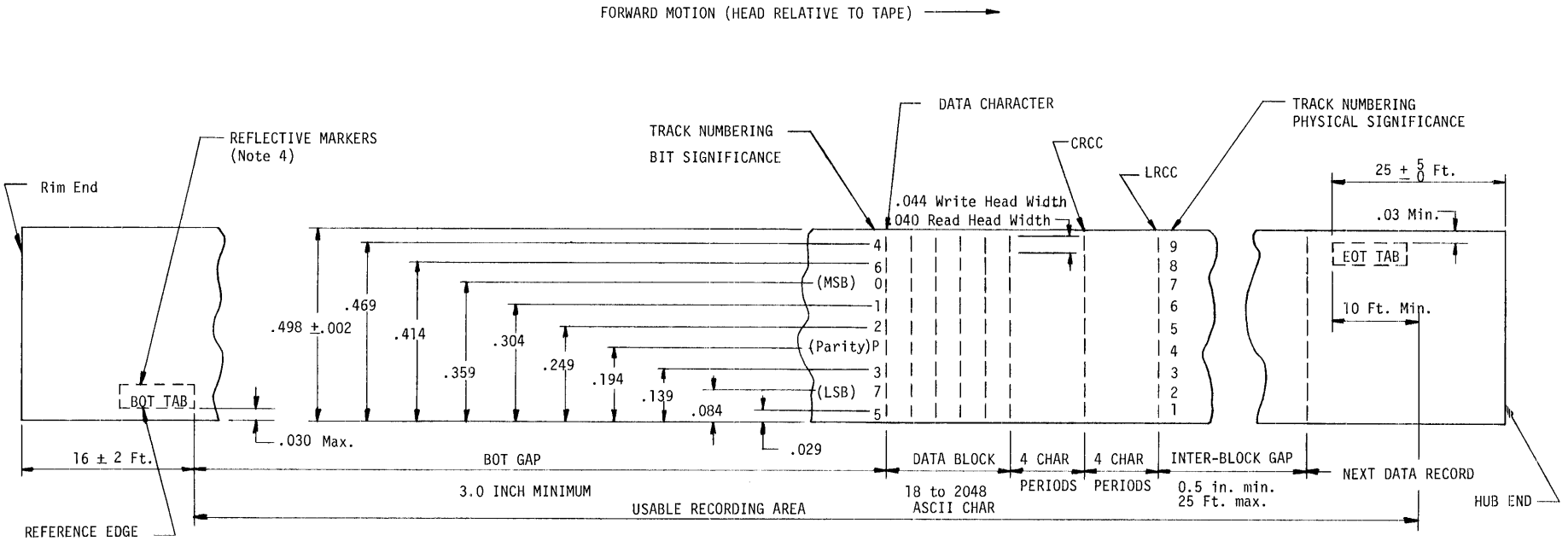
The abbreviation NRZ stands for non-return-on-zero. In NRZ, a "one" in a particular track is recorded as a magnetic flux change on tape; the direction of the change carries no significance, only the existence of the change itself. A "zero" is indicated by no magnetic flux change in that bit position.

Each character must contain at least one "one" for the character to be detected during read. Odd parity tapes automatically fulfill this requirement since an all "zero" data character results in a "one" parity bit. Even parity 7 track (BCD) tape conventions dictate that an all "zeros" data character be recorded as a binary ten (001010). This "zero to ten conversion" for BCD must be performed in the formatter/controller.

Several records or blocks of data on tape are usually grouped together as a "file" and are separated from other files by a "file mark." The file mark consists of a special file character and its associated LRCC. The special file character is 001111 for 7 track or 00010011 for 9 track, and is always written with a false parity bit. (9 track file marks do not have a binary CRCC).

4.5 PHASE ENCODED TAPE FORMAT. The format specifications for nine track phase encoded tape are illustrated in figure 4-7. The data packing density is always 1600 BPI. Characters consist of eight data bits and one odd parity bit and are recorded with each bit in a defined track perpendicular across the tape. The tracks are numbered Ø through 7 and P are arranged in the same sequence with the same physical locations and dimensions as nine track 800 BPI tape (see ANSI Interchangeability Standard X3.39-1973).

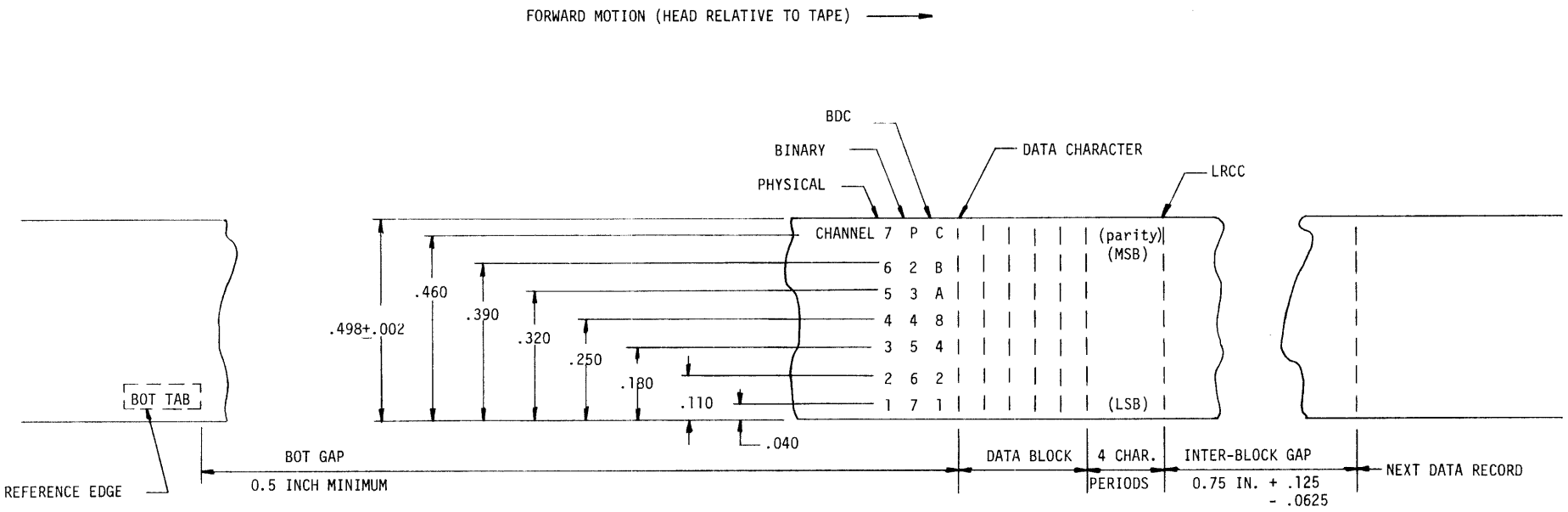
In PE, "ones" and "zeros" are specified by the direction of change of magnetic flux in the center of the bit cell. At the transport I/O a "one" is defined as a change from low to high, and a "zero" as a change from high to low. In between two data transitions in a track there may be a phase transition to establish the proper flux polarity for the upcoming data



NOTES:

1. TAPE SHOWN WITH OXIDE SIDE UP.
2. CHANNELS 0 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.
3. DATA PACKING DENSITY IS FIXED AT 800 CHARACTERS PER INCH.
4. PHOTO REFLECTIVE MARKER SHALL NOT PROTRUDE BEYOND THE EDGE OF TAPE AND SHALL BE FREE OF WRINKLES AND EXCESSIVE ADHESIVE. MARKER DIMENSIONS: 1.1 ± 0.2 inch; Width 0.19 ± .02 inch; Thickness 0.0008 inch max.

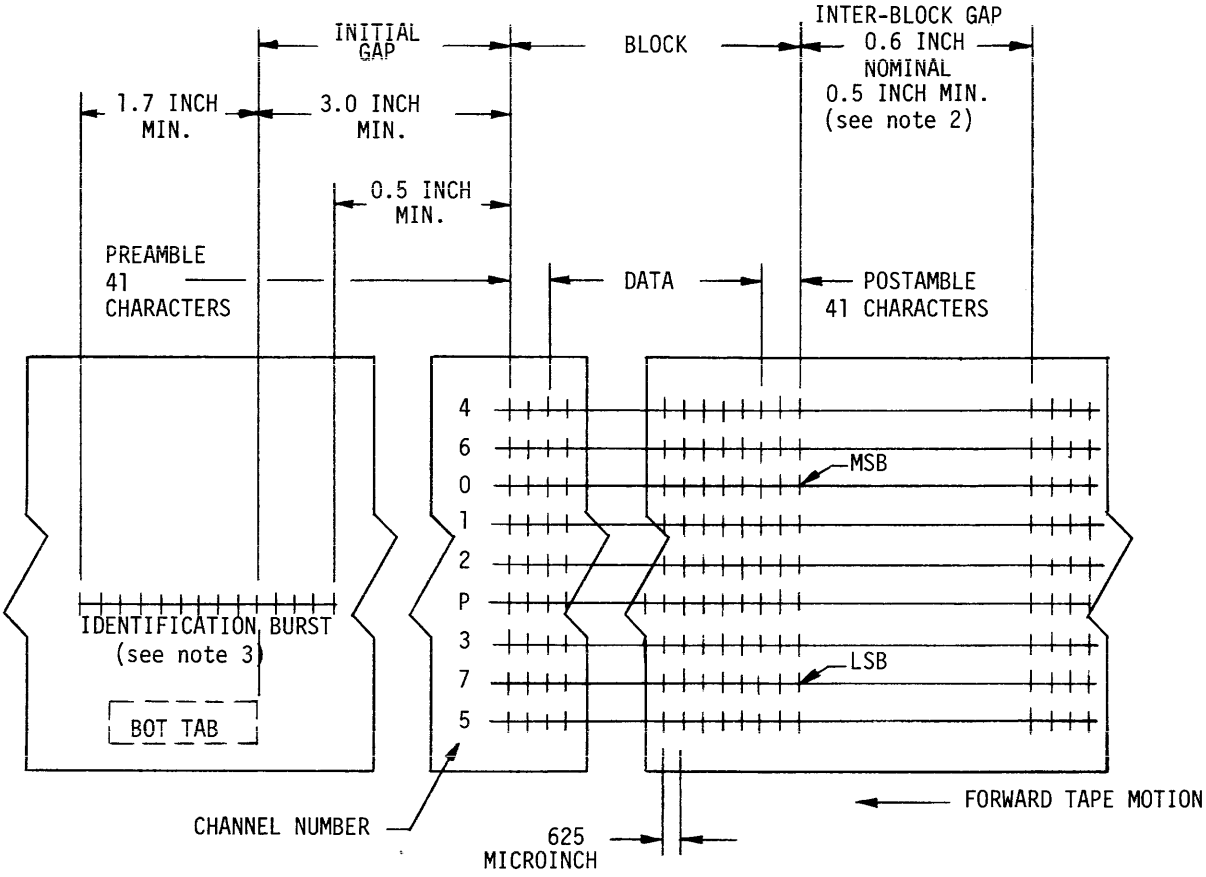
Figure 4-5. Nine Track NRZ Tape Format



NOTES:

1. TAPE SHOWN WITH OXIDE SIDE UP.
2. CHANNELS 2 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.
3. DATA PACKING DENSITY MAY BE 200, 556 or 800 CHARACTERS PER INCH.

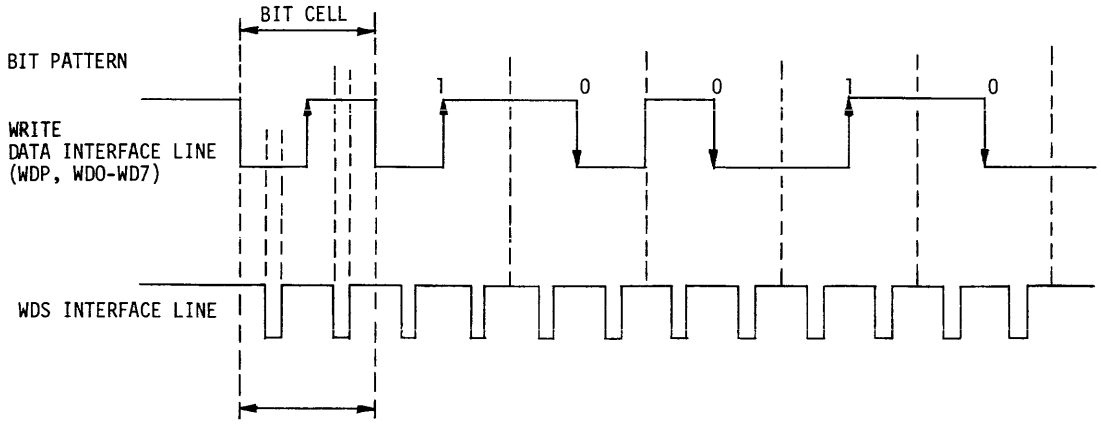
Figure 4-6. Seven Track NRZ Tape Format



NOTES:

1. TAPE IS SHOWN WITH OXIDE SIDE UP.
2. TAPE IS TO BE FULLY SATURATED IN THE ERASED DIRECTION IN THE INTER-BLOCK GAP AND THE INITIAL GAP.
3. THE IDENTIFICATION BURST MUST EXTEND PAST THE END OF THE BOT MARKER.

Figure 4-7. Track Phase Encoded Tape Format



12.5	IPS	50	USEC
18.75	IPS	33.3	USEC
25	IPS	25	USEC
37.5	IPS	16.6	USEC
45	IPS	13.9	USEC
75	IPS	8.3	USEC

Figure 4-8. Phase Encoded Interface Signals Write Data

transition. By refering to figure 4-8 it may be seen that a stream of all "ones" or all "zeros" in a track requires 3200 flux reversals per inch, i.e. 1600 data transitions each preceded by a phase transition; a stream of alternating "ones" and "zeros" characters requires no phase transitions.

Whenever a phase encoded tape is written it must be identified by an ID Burst. The ID Burst is a stream of alternating "ones" and "zeros" written alongside the BOT marker in track P with all other tracks DC erased. The ID Burst enables dual density transports with automatic mode selection to condition themselves to read PE data.

Each data block on tape contains three elements; a preamble, the data, and a postamble. The preamble, consisting of 40 all "zeros" characters followed by an all "ones" character, enables the formatter/controller to synchronize the data transitions when reading. The all "ones" character signals the end of the preamble and the beginning of the data. The postamble, consisting of one all "ones" character followed by 40 all "zeros" characters, signals the end of data and also enables synchronization when reading reverse.

The phase encoded file mark (EOF) consists of 40 "zeros" in tracks 2, 6 and 7 with tracks 1, 3 and 4 DC erased. Tracks P, Ø, and 5 may either be erased or contain "zeros". The file mark must be preceded by at least 3 inches of erased tape.

4.6 NRZ TRANSPORT CONTROL. The NRZ formatter/controller must:

1. Generate various delays to allow the transport time to accelerate and decelerate, and to dictate the IRG length and the head position during specific operations.
2. Generate WRITE DATA STROBES at the frequency required by tape speed and desired data packing density.
3. Generate vertical parity for each character and detect parity errors during read.
4. Generate a WRITE AMPLIFIER RESET (WARS) pulse to record the LRCC at the proper location; verify the LRCC during read.
5. Generate the CRCC and the appropriate timing to record it on tape; verify the CRCC during read (9 track 800 BPI only).
6. Detect the end of block and detect and segregate the check characters from the data.
7. Generate and detect file marks.

4.6.1 MOTION CONTROL AND TIMING. Four signals control tape motion.

SYNCHRONOUS FORWARD COMMAND (SFC)	J1-43
SYNCHRONOUS REVERSE COMMAND (SRC)	J1-45
REWIND COMMAND (RWC)	J2-1
SELECT (SLT, SLTØ, SLT1, SLT2, SLT3)	J1-21,39,41,35,37

The transport status output READY (RDY) must be true or motion commands will be ignored. READY indicates that the transport is selected, on line (pushbutton switch and associated indicator light), not rewinding (J1-11 false), and loaded with tape (determined within the transport by means of photo-electric sensors).

Should SELECT go false all tape motion except rewinding is terminated.

When either SFC or SRC is true the transport's capstan will accelerate the tape to synchronous speed. The tape distance crossed while accelerating from rest to full velocity is always .19 inch ±0.02 regardless of the transport's specified tape speed. Acceleration is constant, so the nominal time required to reach synchronous speed is always .19 inches divided by one-half the synchronous speed.

Whenever SFC or SRC is removed tape decelerates. Deceleration from full speed to rest requires the same distance and time as acceleration. Acceleration and deceleration ramp times for the more common speeds are:

SYNCHRONOUS TAPE SPEED	DISTANCE TRAVERSED	TIME TO ACCELERATE (NOMINAL)
12.5 inch/sec	0.19 inches ±0.02	30.4 msec.
18.75 inch/sec	0.19 inches ±0.02	20.3 msec.
25 inch/sec	0.19 inches ±0.02	15.2 msec.
37.5 inch/sec	0.19 inches ±0.02	10.1 msec.
45 inch/sec	0.19 inches ±0.02	8.4 msec.
75 inch/sec	0.19 inches ±0.02	5.1 msec.

The tape formatter must not attempt to write during acceleration or deceleration.

4.6.2 WRITE OPERATIONS. The SET WRITE STATUS (SWS) line determines whether an operation is a read or a write. For a write operation SWS must go true concurrent with the motion command (SFC or SRC) and remain true for at least 25 microseconds. This input combination energizes the write and erase circuitry in the transport; this circuitry will remain energized until the transport receives a subsequent motion command with SWS held false (see paragraph 6.3.3), REWIND or OFF LINE, or WARS (in OVERWRITE mode). An electromechanical interlock in the transport prevents the write and erase circuitry from being energized when a write ring is not installed in the supply tape reel.

The formatter must control five types of write operations:

WRITE DATA
WRITE DATA WITH EXTENDED GAP
WRITE FILE MARKS
EDIT
ERASE

4.6.2.1 WRITE DATA OPERATIONS. To write a data record on tape the formatter/controller must perform the following sequence:

1. Select a transport and set DDS as necessary.
2. Act upon the various status indications from the transport as necessary.
3. Issue SYNCHRONOUS FORWARD COMMAND (SFC) with SET WRITE STATUS (SWS) true for at least 25 microseconds.
4. Accelerate the tape to synchronous speed before attempting to write data.
5. Issue WRITE DATA STROBES (WDS) at the appropriate frequency (the product of synchronous speed and desired packing density). Place a data character on the WRITE DATA lines (WDØ - WD7) to envelop WDS. Also place the correct parity bit for each character on the WRITE DATA PARITY line (WDP) coincident with that data character. WDØ - WD7 and WDP must be stable 200 nanoseconds before the leading edge of WDS and remain stable until its trailing edge.
6. Calculate and write the CRCC (Cyclic Redundancy Check Character) in the fourth character position following the last data character of the record. The CRCC is written by setting the character on the WRITE DATA lines and pulsing WDS. (9 track 800 BPI only.)
7. Write the LRCC (Longitudinal Redundancy Check Character) in the fourth character position (eighth character position in 9 track 800 BPI) following the last recorded character. The formatter/controller need not calculate the LRCC; it is obtained simply by resetting the write flip-flops in the transport. A special input, WRITE AMPLIFIER RESET (WARS) does this. No WDS or write data should be supplied when writing the LRCC.
8. Allow the read head to pass all the data before decelerating the tape. The distance between the read and write gaps of a dual gap head is 0.15 inches for 9 track units, and 0.3 inches for 7 track units.
9. Remove the SYNCHRONOUS FOWARD COMMAND (SFC), decelerating the tape.
10. Motion in the same direction may be commanded at any time before, during or after deceleration; if commanded before or during, the same prerecord delay as normally required when accelerating from rest must be maintained to create a sufficiently long interrecord gap. Motion in the opposite direction should not be commanded until the formatter/controller has determined that tape motion has ceased.

4.6.2.2 WRITE WITH EXTENDED GAP OPERATIONS. To write a data record with an extended interrecord gap preceding it (i.e. a skip-write operation) the controller/formatter should perform the sequence indicated in paragraph 4.6.2.1, except that the delay between issuing the motion command and starting to record data must be extended to create the desired "gap" on tape. An extended interrecord gap is required preceding the first data record when starting from load point; this is sometimes referred to as the "BOT Jump". An extended gap can also be used to skip over defective portions of tape.

4.6.2.3 WRITE FILE MARK OPERATIONS. A file mark is a one character record with LRCC which separates the tape into logical divisions. The write file mark operation is identical to a write data operation except for the following points.

1. The prerecord delay, following the motion command, is extended to provide for a preceding gap of at least 3 inches.
2. Place the file mark character on the WRITE DATA lines and issue a single WRITE DATA STROBE (WDS). The nine track file mark character is "ones" in tracks 3, 6 and 7; the seven track file mark character is "ones" in tracks 1, 2, 4 and 8.
3. No CRCC is written.

4. The LRCC is written four character spaces (eight on 9 track 800 BPI tapes) after the file mark character, and is identical to it since longitudinal parity is even. The LRCC is generated and recorded by pulsing WARS, as previously described for data records.
5. After an appropriate delay, decelerate the tape, as for data records.

4.6.2.4 EDIT OPERATIONS. The edit operation replaces an existing record on tape with a new record of equal length in the same physical position without disturbing the surrounding data. The edit operation is identical to the normal write data operation described in paragraph 4.6.2.1 except in the following points:

1. When the SYNCHRONOUS FORWARD (SFC) command comes true, OVERWRITE (OVW) and SET WRITE STATUS (SWS) must be held true for at least 20 microseconds. When OVW is asserted at the start of a record, the write current turns off slowly following the WARS pulse at the end of the record to avoid erasing the next record.
2. The formatter/controller must position the write head in the same location on tape as it was when the record to be editted was originally written. This is normally accomplished by reading reverse over the record with a longer than normal postrecord delay.

4.6.2.5 ERASE OPERATIONS. To erase a variable length portion of tape perform the following sequence:

1. Issue the SYNCHRONOUS FORWARD COMMAND (SFC) with SET WRITE STATUS (SWS) true for at least 25 microseconds.
2. Suppress WRITE DATA STROBES (WDS).
3. After the delay for the desired amount of tape travel, remove the motion command. Tape motion will cease in 0.19±0.02 inches. *NOTE:* The formatter/controller may use the prerecord delays required for the "BOT Jump," "Skip-Write," or "Write EOF" operations (described in paragraph 4.6.2.2 and 4.6.2.3) to create fixed length erasures. The edit operation with no WDS supplied to the transport could edit erase a record in the midst of other records.

4.6.3 READ OPERATIONS. The formatter/controller must read data at a synchronous rate, detect parity errors, isolate check characters, and recognize file marks. Since the formatter/controller initiates and terminates tape motion it must also determine the absence of data (i.e. the interrecord gap).

4.6.3.1 READ DATA OPERATIONS. To recover a normal data record from tape the formatter/controller must perform the following steps:

1. Select a tape transport and set DDS as necessary.
2. Act upon the various status indications as necessary.
3. Issue the SYNCHRONOUS FORWARD (SFC) or SYNCHRONOUS REVERSE COMMAND (SRC) with SET WRITE STATUS (SWS) held false.
4. Wait until the transport is at synchronous speed and during this time suppress read data resulting from gap noise.
5. Receive and use each READ DATA STROBE (RDS) supplied by the transport to sample the READ DATA lines (RDØ-RD7, RDP).
6. Verify that the vertical parity of each character is correct.
7. Monitor the RDS for missing pulses to distinguish the CRCC and LRCC (each preceded by either three or seven empty character spaces) from the data.
8. Verify the CRCC and LRCC as necessary.
9. Recognize the interrecord gap by the continued absence of data.
10. After the postrecord delay, remove the motion command and decelerate tape. A new motion command in the same direction may be issued at any time before, during, or after deceleration. Motion in the opposite direction should not be commanded until the tape is at rest.

4.6.3.2 READ THRESHOLDS. Two inputs, READ THREHOLD 1 and READ THRESHOLD 2, select three different read threshold levels. These commands are not latched by the transport and should be held true for the entire operation.

RTH1 is terminated in the transport but is not used; the transport automatically selects high threshold (34%) whenever the write status flip flop is set (i.e. during read-after-write operations).

READ THRESHOLD 2 is used to recover severely degraded data from tape. The discrimination level is decreased to only about 10% nominal signal amplitude with RTH2 held true.

When RTH 2 is false a normal threshold level of 20% of nominal signal amplitude is employed.

4.6.3.3 FILE MARK RECOGNITION. Reading file marks is not different from reading data records. Since the file mark character and its LRCC are identical, the file mark record appears the same in both the forward and reverse directions. The formatter/controller should have a decoding circuit to recognize file marks.

4.7 PHASE ENCODED TRANSPORT CONTROL. The phase encoded controller must:

1. Generate various delays to allow the transport time to accelerate and decelerate and to dictate IRG length and head position during specific operations.
2. Encode data to be written and generate two WRITE DATA STROBES per character period.
3. Generate preamble, postamble, vertical odd parity, the ID burst, and EOF records in their proper places on tape.
4. During read operations, discriminate preamble and postamble from data.
5. Deskew and decode read data and develop a read strobe.
6. Detect format errors, dropouts, and data parity errors and correct single channel dropouts.
7. Identify the ID Burst and EOF records.

4.7.1 MOTION CONTROL AND TIMING. Motion control of phase encoded transports is identical to that of NRZ transports; see paragraph 4.6.1.

4.7.2 WRITE OPERATIONS. Asserting SWS (SET WRITE STATUS) concurrent with SFC or SRC energizes the write and erase circuitry in the transport. SWS is sampled within 24 microseconds of the leading edge of SFC or SRC; SWS may go false any time thereafter if so desired. The "file protect" circuitry in the transport disables the write current when the write ring is absent from the supply reel.

4.7.2.1 WRITE DATA OPERATIONS. To write a data record on tape the formatter/controller must perform the following sequence:

1. Select a transport and set DDS as necessary.
2. Act upon the status information (e.g. tape speed) from the selected transport as necessary.
3. Issue the SYNCHRONOUS FORWARD COMMAND (SFC) with SET WRITE STATUS (SWS) true for at least 25 microseconds.
4. Allow the transport to reach synchronous speed.
5. Issue WRITE DATA STROBES to record forty phase encoded "zeros." Two WDS pulses are required for each character. The WRITE DATA lines must be stable 200 nanoseconds before the leading edge of WDS and remain stable until its trailing edge.
6. Generate the preamble all "ones" character and the associated strobes.
7. Issue phase encoded data with the accompanying odd parity and WRITE DATA STROBES.
8. Generate the postamble all "ones" character followed by forty all "zeros" characters, with the associated strobes.
9. Allow the read head to pass all data before decelerating tape. The distance between read and write gaps is 0.15 inches.
10. Forward motion may be commanded at any time before, during or after deceleration. The formatter should determine when tape motion has ceased before commanding reverse motion.

4.7.2.2 WRITE FROM LOAD POINT. When writing from load point the ID Burst must be recorded alongside the BOT marker and an extended gap must appear before the first record. The following sequence is required.

1. Assert SFC and SWS.
2. Wait for the transport to reach synchronous speed.
3. Begin writing the ID Burst while the trailing edge of the BOT marker is still at least 1.7 inches to the supply reel side of the head. (At load point, there is 2.165±.2 inches from the trailing edge of BOT to the write head.) The ID Burst consists of alternating PE "one" and "zero" bits on WDP track only with all other tracks DC erased. The ID Burst must continue past the trailing edge of the BOT marker.
4. Before issuing the first data record wait until the following two conditions are met:
   A. The first record must be at least 0.5 inches beyond the ID burst;
   B. The first record must be at least 3 inches, and at most 25 feet, beyond the BOT marker.
5. Write the first record as described in paragraph 4.7.2.1.

4.7.2.3 WRITE FILE MARK OPERATION. The PE EOF (End-of-File) record consists of 40 "zeros" in tracks 2, 6, and 7 with tracks 1, 3, and 4 erased. (Tracks P, O, and 5 may be erased or may contain zeros.) The following sequence is required:

1. Assert SFC and SWS.
2. Move tape at least three inches before presenting the EOF record on the WRITE DATA lines.
3. The formatter/controller may use its preamble generating circuit to provide 40 "zeros" at WD2, WD6 and WD7 while holding WD1, WD3 and WD4 false.
4. After an appropriate delay remove SFC (as in a write data operation).

4.7.3 READ OPERATIONS. The formatter/controller must detect transitions at each READ DATA input independent of the other READ DATA inputs. It must decode and deskew the data, detect parity and format errors, and recognize the special EOF record. It must also accelerate and decelerate to and from synchronous speed in the interrecord gaps. When reading from load point the controller may wish to test for the ID Burst.

4.7.3.1 READ DATA OPERATIONS. To recover a normal data record from tape perform the following sequence.

1. Select a transport and set DDS as necessary.
2. Act upon status information (e.g. tape speed) from the selected transport as necessary.
3. Issue the SYNCHRONOUS FORWARD COMMAND (SFC) or SYNCHRONOUS REVERSE COMMAND (SRC) with SET WRITE STATUS (SWS) held false.
4. Wait until the transport is at synchronous speed.
5. Detect the preamble in each track and synchronize on the data transition. Detect any dropouts.
6. After receiving the all "ones" character, read, decode, and deskew the data and verify that vertical parity is correct.
7. Detect the beginning of the postamble as distinct from data.
8. Detect the end of the record.
9. Cross a portion of the interrecord gap at synchronous speed.
10. Remove the motion command and determine when the transport is at rest.
11. When reading, the controller may wish to maintain the transport at synchronous speed rather than stop in each gap.

4.7.3.2 READ THRESHOLDS. As in NRZ, there are three PE read clipping levels. High threshold 30%) is forced whenever the write current is energized. Low threshold of 5% nominal signal amplitude occurs when RTH2 is asserted. The normal PE read threshold is 10%.

4.8 FORMATTER TIMING. Figure 4-9 lists the recommended timing delays for formatter controlled operations.

9 TRACK	**12.5**	**18.75**	**25**	**37.5**	**45**	**75**
WRT/RD FROM BOT	87.5	58.3	43.8	29.2	24.3	14.6
WRITE NORMAL	33.2	22.1	16.6	11.1	9.24	5.54
READ NORMAL	30.1	20.0	15.0	10.0	8.35	5.01
FIRST WRITE CLOCK	6.82	4.54	3.41	2.27	1.89	1.14
POST RECORD DELAY						
WRITE	22-22.4	14.6-14.9	11.0-11.2	7.33-7.46	6.11-6.22	3.67-3.73
READ FWD	4.01	2.67	2.00	1.34	1.11	.668
READ REV	3.47	2.31	1.74	1.15	.964	.578
READ REV EDIT	25.1	16.7	12.5	8.36	6.96	4.18
STAY AT SPD WINDOW	33.1	22.1	16.5	11.0	9.19	5.51
TRANSPORT STOPPING	33.1	22.1	16.5	11.0	9.20	5.52

All times given in milliseconds.

Figure 4-9. Formatter Timing (continued on next page)

7 TRACK	12.5	18.75	25	37.5	45	75
WRT/RD FROM BOT	87.5	58.3	43.8	29.2	24.3	14.6
WRITE NORMAL	33.2	22.1	16.6	11.1	9.24	5.54
READ NORMAL	30.1	20.0	15.0	10.0	8.35	5.01
FIRST WRITE CLOCK	6.82	4.54	3.41	2.27	1.89	1.14
POST RECORD DELAY						
WRITE	21.7-22.0	14.5-14.7	10.9-11.0	7.25-7.33	6.04-6.11	3.62-3.67
READ FWD	3.73	2.48	1.86	1.24	1.04	.621
READ REV	15.5	10.3	7.74	5.16	4.30	2.58
READ REV EDIT	37.1	24.7	18.5	12.4	10.3	6.18
STAY AT SPD WINDOW	33.1	22.1	16.5	11.0	9.19	5.51
TRANSPORT STOPPING	33.1	22.1	16.5	11.0	9.20	5.52

All times are given in milliseconds.

Figure 4-9. Formatter Timing (continued)

5 - PREVENTIVE MAINTENANCE

5.1 INTRODUCTION. Digi-Data 40 Series transports are manufactured to well-conceived and proven designs in an environment of strict quality-control. With regular preventive maintenance, primarily cleaning, each transport should provide years of trouble-free service in your system.

Figure 5-1 outlines the recommended preventive maintenance schedule. The head and other surfaces in contact with the magnetic tape should be cleaned daily by the system operator as described in paragraph 2.6. Tasks scheduled quarterly may be performed by either the operator or a maintenance engineer. All tasks scheduled annually must be performed by a qualified maintenance engineer.

5.2 CLEANING. Periodic cleaning of the tape head, tape guides, tape cleaner, arm rollers, stationary rollers, and capstan outer surface is absolutely necessary. Dust and/or accumulated oxide particles will cause "drop-outs" and result in writing and reading errors. See paragraph 2.6.

Quarterly the entire transport front plate and dust cover should be cleaned with glass cleaner and a soft, lint-free cloth.

5.3 INSPECTING FOR WEAR.

5.3.1 CAPSTAN. Inspect the capstan outer surface for cracking or polish quarterly. Since the capstan is manufactured to precision tolerances, it should be inspected for possible deformity resulting from abuse. See paragraph 9.3 for replacement procedures.

5.3.2 HEAD. Inspect the magnetic tape head for wear quarterly. The head has a flat gutter on either side of the tape contact area. When the crown wears down to the depth of the gutters (approximately .010 inch or 2000-3000 hours of tape motion) the head should be replaced.

PREVENTIVE MAINTENANCE SCHEDULE

Refer to	Task	Daily	Quarterly	Yearly
2.6	Clean Head, other tape surfaces	X	X	X
5.2	Clean entire Transport		X	X
5.3	Inspect head wear and capstan		X	X
10.3.3	Check Start/Stop ramps			X
10.4.3	Check tension arm positions			X
10.5	Check BOT/EOT adjustment			X
10.8	Check read amplifier gain			X
10.10.1	Check read skew			X
10.7	Check write current waveform (PE only)			X
10.12	Check skew gate			X

Figure 5-1, Preventive Maintenance Schedule

6 · REMEDIAL MAINTENANCE OVERVIEW

6.1 INTRODUCTION. This section includes general service information for Digi-Data's 40 Series Tape Transports. It explains p.c. card variables, plug jumper and DIP switch options, and electrical sub-assembly and component designations; it also includes a recommended tool list.

To isolate a transport malfunction to a faulty component or improper adjustment use the troubleshooting procedure in Section 8. Detailed component removal and replacement instructions are found in Section 9. When a component has been replaced several adjustments are usually required; Section 10 explains how to perform these required adjustments.

6.2 REPLACEMENT GUIDELINES. All 40 Series transports use basically the same electronics. There are currently eighteen versions of the read card, twelve versions of the motor control card, and a single version of the write/control card. Remember, however, that the write/control card contains several plug jumpers and DIP switches which must be in the appropriate positions when exchanging cards. See paragraph 6.3, 9.2 and 10.7.

The variables which affect read card versions are shown in figure 6-1. When replacing a defective card be sure that the new card is the same version. See paragraphs 9.2, 10.8 and 10.12 for detailed replacement and adjustment procedures.

The motor control card is supplied with either a short heat sink (required in the 1140) or a tall heat sink (required in the 1640, 1740 and 1840). Other variables, as shown in figure 6-2, are the unattended restart option (designated in the transport model number with an "X") and the optional second tape speed. When a motor control card is replaced several potentiometer adjustments are also necessary. See paragraphs 9.2, 10.2, 10.3 and 10.4.3.

The location of each card in the transport is shown in figure 6-3. Figure 6-4, 6-5, and 6-6 explain the system of designations employed in the transport. See also transport schematic diagram 0252337-0000 contained in Section 11 of this manual.

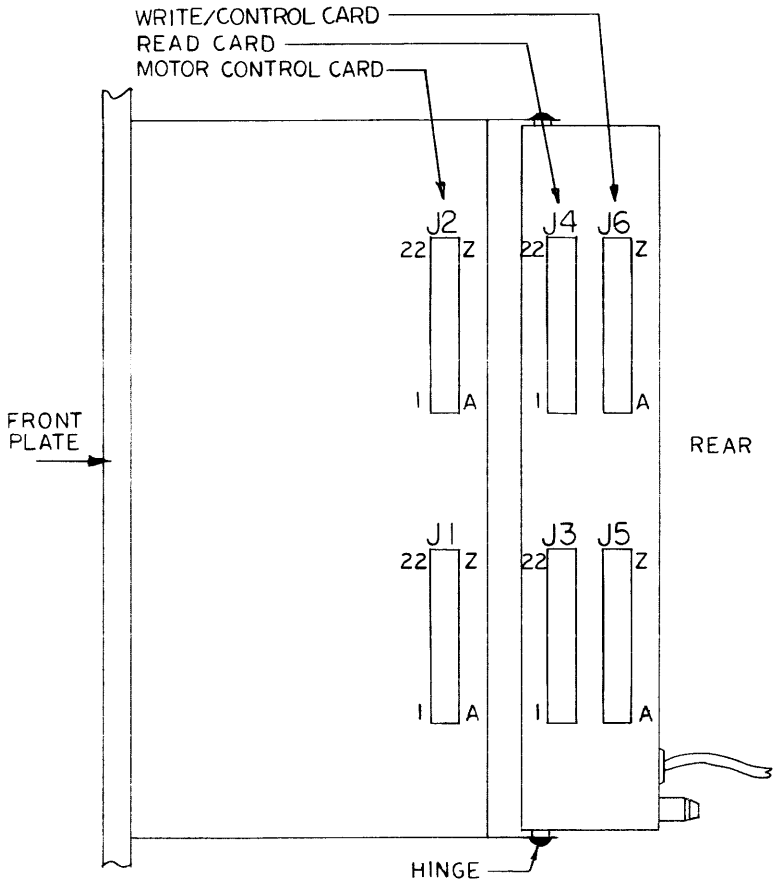
KIT ASSY PART NO. AND VERSION	RECORDING FORMAT(S)	STANDARD TAPE SPEED	INCORPORATES PCBA PART NO. AND VERSION
0051548-0001	NRZ	12.5 IPS	0051740-0002
-0002	NRZ	18.75 IPS	-0003
-0003	NRZ	25 IPS	-0004
-0004	NRZ	37.5 IPS	-0005
-0005	NRZ	45 IPS	-0006
-0006	PE	12.5 IPS	0051739-0002
-0007	PE	18.75 IPS	-0003
-0008	PE	25 IPS	-0004
-0009	PE	37.5 IPS	-0005
-0010	PE	45 IPS	-0006
-0011	PE/NRZ	12.5 IPS	0051726-0002
-0012	PE/NRZ	18.75 IPS	-0003
-0013	PE/NRZ	25 IPS	-0004
-0014	PE/NRZ	37.5 IPS	-0005
-0015	PE/NRZ	45 IPS	-0006
-0016	NRZ	75 IPS	0051778-0002
-0017	PE	75 IPS	0051777-0002
-0018	PE/NRZ	75 IPS	0051656-0002

Figure 6-1. Read Card Versions

KIT ASSY PART NO. AND VERSION	HEAT SINK	UNATTENDED RESTART	OPTIONAL SPEED	INCORPORATES PCBA PART NO. AND VERSION
0051550-0001	SHORT	NO	NO	0052022-0001
-0002	SHORT	YES	NO	-0002
-0003	SHORT	NO	YES	-0003
-0004	SHORT	YES	YES	-0004
-0005	TALL	NO	NO	-0005
-0006	TALL	YES	NO	-0006
-0007	TALL	NO	YES	-0007
-0008	TALL	YES	YES	-0008
-0009*	TALL	NO	NO	-0009
-0010*	TALL	YES	NO	-0010
-0011*	TALL	NO	YES	-0011
-0012*	TALL	YES	YES	-0012

*75 IPS only.

Figure 6-2. Motor Control Card Versions



Model 1740 and 1840, Right Side View
Models 1640 and 1140, Bottom View

Figure 6-3. Transport Card Connector Locations

A01	CONTROL PANEL ASSEMBLY		
	A01S1/DS1	Power Switch/Indicator	
	A01S3/DS3	Load Switch/LDPT Indicator	
	A01S2/DS2	Rewind Switch/Indicator	
	A01S5/DS5	On Line Switch/Indicator	
	A01DS6	Write Enable Indicator	
	A01S4/DS4	High Density Switch/ Indicator	
	A01S7-S10/ DS7-DS10	Unit Select Switch/Indicator	
	A01J1	Connector, Signal	
A02	TAKE-UP ARM SERVO ASSEMBLY		
	A02P1 - Connector		
A03	SUPPLY ARM SERVO ASSEMBLY		
	A03P1 - Connector		
A04	BOT/EOT SENSOR ASSEMBLY		
A05	POWER CORD ASSEMBLY		
	A05P1	Power, Input	
	A05P2	Power, Switched	
	A05F1	Fuse	
A06	POWER CONTROL UNIT		
	A.C. 100-240V		
	A06S1	115/230 Switch	
	A06S2	LO/NOR Switch	
	A06P1	Power, Switched	
	A06CR1	Bridge Rectifier, SPS	
	A06CR2	Bridge Rectifier, Logic Supply	
	A06CR3	Bridge Rectifier, SNS	
A07	MOTOR CONTROL CARD		
A08	READ CARD		
A09	WRITE/CONTROL CARD		
A10	FORMATTER POWER SUPPLY		
A11	EMBEDDED FORMATTER ASSEMBLY		

Figure 6-4. Electrical Sub-Assembly Designations

C1	Filter Capacitor, SPS	P8	Supply Motor Connection
C2	Filter Capacitor, Logic Supply	P9	Capstan Motor Connection
C3	Filter Capacitor, SNS	P10	Take-up Motor Connection
		P11	Control Panel Connector
CR4	Bridge Rectifier, Take-Up Motor Suppression		
		S5	File Protect (WRITE ENABLE) Switch
CR5	Bridge Rectifier, Supply Motor Suppression	S8	Arm Limit Switch
		R1	Bleeder Resistor SPS
CG1	Chassis Ground, Safety	R2	Bleeder Resistor, Logic Supply
CG2	Chassis Ground, Safety	R3	Bleeder Resistor, SNS
J1,J2	Motor Control Card Connectors	R4	Rewind Resistor - Supply
J3,J4	Read Card Connectors	R5	Rewind Resistor - Take-Up
J5,J6	Write/Control Card Connectors		
		G1	Capstan Tachometer
K1/XK1	Servo Relay and Socket	M1	Capstan Motor
K2/XK2	Rewind Relay and Socket	M2	Supply Reel Motor
		M3	Take-Up Reel Motor
L1	File Protect (WRITE ENABLE) Solenoid		

Figure 6-5. Electrical Component Designations on the Chassis

CONNECTOR MATING		
A07P1	Mates With	J1
A07P2	Mates With	J2
A08PA	Mates With	J3
A08PB	Mates With	J4
A09PA	Mates With	J5
A09PB	Mates With	J6
A05P2	Mates With	A06P1
A01J1	Mates With	P11
P8	Mates With	P8
P9	Mates With	P9
P10	Mates With	P10
A02P1	Mates With	P12
A03P1	Mates With	P13

Figure 6-6. Transport Connector Mating

ITEM	QUANTITY	ITEM	QUANTITY
Oscilloscope w/dual trace	1	Solder-wick	1
Probe, 1:1	1	Solder, Rosin core	1
Probe, 10:1	2	Cotton Swabs	1
Screwdriver set, blade	1	Isopropyl alcohol	1
Nutdriver set	1	Multimeter	1
Allen driver set	1	Chip-clip	3
Diagonal cutter	1	Scrub Mag Tape, 600'	1
Long-nose pliers	1	Master skew tape	1
Scale, 6-inch	1	Wire Stripper	1
Soldering iron and tips	1	Transport test card	1

Figure 6-7. List of Tools and Equipment

6.3 PLUG JUMPER AND SWITCH OPTIONS. The position of several plug jumpers and DIP switches on the write/control card define the features described below.

6.3.1 TAPE UNIT SELECTION. The plug jumpers which affect unit selection are W5, W6, W7, W8, W9, W10 and W26. The following eight combinations are valid.

A. To label the transport unit Ø so that it may be selected via SLTØ (J1-39) install W8 and W10.
B. To label the transport unit 1 so that it may be selected via SLT1 (J1-41) install W9 and W10.
C. To label the transport unit 2 so that it may be selected via SLT2 (J1-35) install W7 and W10.
D. To label the transport unit 3 so that it may be selected via SLT3 (J1-37) install W6 and W10.
E. To select a transport via the general SLT line (J1-21) install W5 and W10.
F. To select the transport all the time install *none* of the applicable plug jumpers.
G. To select the transport whenever it is ON LINE install W26 only.
H. If the transport has a Unit Select Switch on the control panel install only W10. (The Unit Select Switch takes the place of jumpers W6-W9.)

6.3.2 TRANSPORT STATUS GATING. Either W11 or W12, but not both, must be installed in the transport; usually W12 is installed. With W11 installed the status lines LDP, EOT and FPT are gated to the formatter whenever SLTD is true. With W12 installed LDP, EOT and FPT are gated by the ARM I/O (equivalent to RDY).

6.3.3 WRITE MODE CLEAR. Either W13 or W14, but not both, must be installed in the transport; usually W13 is installed. SWS is latched in the WRITE MODE flip-flop at the beginning of each operation. With W14 installed WRITE MODE is cleared when SWS goes false. With W13 installed WRITE MODE remains true until a subsequent operation with SWS false is begun.

6.3.4 EOT STATUS. Either W17 or W18, but not both, must be installed in the transport; usually W18 is installed. With W17 installed the EOT status line is true *only* when the EOT reflective marker is within the photoelectric sensor. With W18 installed EOT status is latched true when the marker is passed while moving forward. The EOT latch is not cleared until a rewind is commanded or until the EOT marker is passed while moving reverse. Latching EOT is required in certain controller installations. See controller manual for details.

6.3.5 DENSITY SELECTION. The density selection plug jumpers are W15, W16, W19, W20, W21 and W31. There are six valid combinations.

A. A single density NRZ only unit must have only W19 installed.
B. A single density PE unit must have only W21 installed.
C. A seven or nine track dual density NRZ unit with density selected by the DDS input must have W19 and W15 installed.
D. A seven or nine track dual density NRZ unit with density selected by the front panel HIGH DENSITY switch must have W19 and W16 installed.
E. A nine track PE/NRZ unit with density selected by the DDS input must have W20 and W15 installed.
F. A nine track PE/NRZ unit with density selected by the front panel HIGH DENSITY switch must have W20 and W16 installed.
G. A nine track industry compatible PE/NRZ unit with density selected by the DDS input must have W15 and W31 installed; format lines should be set for 30 Series compatibility (see paragraph 6.3.8.2).

6.3.6 ON LINE STATUS. Either W29 or W30, but not both, must be installed in the transport; usually W30 is installed. With W29 installed ON LINE is always true. With W30 installed ON LINE is true only when the ON LINE flip-flop is set.

6.3.7 SPEED STATUS. The speed status lines are controlled by the settings of DIP switch S3 and the level of the SPS input. These three outputs (SP2, SP1, SPØ) reveal the transport's tape speed to the formatter.

6.3.7.1 40 SERIES COMPATIBILITY

A. Standard speeds (SPS False)

12.5 IPS	ON - 2,6	OFF - 4
18.75 IPS	ON - 4,6	OFF - 2
25 IPS	ON - 6	OFF - 2,4
37.5 IPS	ON - 2,4	OFF - 6
45 IPS	ON - 2	OFF - 4,6
75 IPS	ON - 4	OFF - 2,6

B. Optional speeds (SPS True)

12.5 IPS	ON 1,5	OFF 3
18.75 IPS	ON 3,5	OFF 1
45 IPS	ON 5	OFF 1,3
37.5 IPS	ON 1,3	OFF 5
45 IPS	ON 1	OFF 3,5
75 IPS	ON 3	OFF 1,5
none	ON 1,3,5	

6.3.7.2 30 SERIES COMPATIBILITY

A. Standard Speed (SPS False)

Lo Speed	ON	OFF - 2,4,6
Hi Speed	ON - 4	OFF - 2,6

B. Optional Speed (SPS True)

Lo Speed	ON	OFF 1, 3, 5
Hi Speed	ON - 3	OFF 1, 5

Note that SPS is held true when cabling to 30 Series Formatters.

6.3.8 FORMAT STATUS. Plug jumpers W2, W3, W24 and W25 and DIP switch S1 generate the format status lines FMT1, FMT2, and FMT3. FMT1, FMT2, and FMT3 specify the transport's density and format.

FORMAT SIGNAL DECODING

	40 Series Compatibility			30 Series Compatibility		
FORMAT	**FMT1**	**FMT2**	**FMT3**	**FMT1 (DDI)**	**FMT2 (7TK)**	**FMT3 (NRZ)**
7 Tk, 200 BPI, NRZ	LO	LO	LO	LO	LO	LO
7 Tk, 556 BPI, NRZ	LO	LO	HI	HI	LO	LO
7 Tk, 800 BPI, NRZ	HI	LO	LO	HI	LO	LO
9 Tk, 200 BPI, NRZ	LO	HI	LO	LO	HI	LO
9 Tk, 800 BPI, NRZ	HI	HI	LO	LO	HI	LO
9 Tk, 1600 BPI, PE	LO	HI	HI	HI	HI	HI
Unassigned	HI	HI	HI	NA	NA	NA
Unassigned	HI	LO	HI	NA	NA	NA

6.3.8.1 40 SERIES COMPATIBILITY. Proper setting of the transport's switches and jumpers when used with 40 Series formatters are:

	S1				
CONFIGURATION	**–1 or –2**	**–3 or –4**	**–5,–6 or –7**	**W2 or W3**	**W24 or W25**
9 Tk 800/1600 BPI	–1	–4	–7	W3	W24
9 Tk 200/800	–2	–3	–7	W3	W24
9 Tk 800 only	–2	–3	–6	W3	W24
9 Tk 200 only	–2	–3	–5	W3	W24
9 Tk 1600 only	–1	–4	–5	W2	W24
7 Tk 800 only	–2	–4	–6	W2	W24
7 Tk 556 only	–2	–4	–6	W3	W24
7 Tk 200 only	–2	–4	–5	W2	W24
7 Tk 200/556	–2	–4	–7	W3	W24
7 Tk 556/800	–2	–3	–7	W2	W24
7 Tk 200/800	–2	–4	–7	W2	W24

6.3.8.2 30 SERIES COMPATIBILITY. Proper settings of the transport's switches and jumpers when used with 30 Series formatters are:

	S1				
	1 or 2	**3 or 4**	**5, 6 or 7**	**W2 or W3**	**W24 or W25**
9 Tk 800/1600 BPI	–1	–3	–7	W3	W24
9 Tk 800 only	–1	–3	–5	W3	W24
9 Tk 1600 only	–1	–3	–6	W3	W24
7 Tk 800 only	–2	–4	–6	W2	W25
7 Tk 556 only (high density)	–2	–4	–6	W2	W25
7 Tk 556 only (low density)	–2	–4	–5	W2	W25
7 Tk 200 only	–2	–4	–5	W2	W25
7 Tk 200/556	–2	–4	–7	W2	W25
7 Tk 556/800	–2	–4	–7	W2	W25
7 Tk 200/800	–2	–4	–7	W2	W25

6.3.9 INDICATOR LAMP CHANGES. With plug jumper W22 installed the HIGH DENSITY indicator indicates high density status. This lamp can be changed to an EOT status indicator by removing W22 and installing W23.

With plug jumper W27 installed the ON LINE indicator indicates ON LINE status. This lamp can be changed to a READY status indicator by removing W27 and installing W28 instead.

6.3.10 TEST CARD POWER. To supply +5 VDC to the test card, install plug jumper W4. This jumper *must not* be installed when the transport is connected in a system.

6.3.11 PE WRITE CURRENT MONOSTABLE. Plug jumper W1 is installed to decrease the length of the PE write current monostable in higher speed transports. See paragraph 10.7. This jumper is not required in NRZ only units.

7 - CIRCUIT DESCRIPTIONS

7.1 TRANSPORT BLOCK DIAGRAM. The maintenance engineer should be familiar with the operation of the transport's major circuits to help him isolate and correct transport malfunctions. This paragraph describes the function of each major circuit using the transport block diagram, figure 7-1. Subsequent paragraphs in this section describe the circuits in more detail. All signals between major blocks are shown in schematic 0252337-0000 and in the first sheets of schematics 0252195-0000, 0251741-0000, 0252023-0000 and 0251663-0000 included in Section 11 of this manual.

SELECT: All I/O signals are gated directly or indirectly by the select line; several transports may thus be daisy-chained to a single formatter.

CONTROL LOGIC: Formatter command signals, operator pushbuttons, and certain information from within the transport are inputs to the control logic, located primarily on the write/control card. The control logic directs the motor circuits, enables the write or read circuits as required, generates the read threshold signals, and indicates status to the formatter.

WRITE AMPLIFIERS: When a write command is latched by the control logic the write power is routed through the file protect switch to determine if a write enable ring is present in the supply reel. Write data is sent from the formatter on nine parallel inputs together with a write strobe. The write register and amplifiers control the current through the write head windings; the erase head is energized whenever write power is available.

READ AMPLIFIERS: Read data is amplified, digitized, and sent to the formatter on nine parallel outputs. In NRZ, read data is also decoded, deskewed, and provided with a read strobe. PE and various NRZ densities are selected via three signals from the control logic.

POWER SUPPLIES: The power supplies provide three unregulated voltages [SPS (Servo Positive Supply), Logic Supply, and SNS (Servo Negative Supply)] and four regulated voltages (+5, +5L, +12, −12). If the transport contains an embedded formatter a third +5 volt regulator is installed (described separately in the formatter manual).

RELAY CONTROL: All three motors are connected to their servo amplifiers through a relay. This relay is de-energized in certain failure modes to protect the magnetic tape. The relay control circuit also generates the power fail sequencing which stops all three motors under servo control and releases the tension arms to their physical stops.

CAPSTAN SERVO AMPLIFIER: The capstan servo circuit controls tape velocity. Constant acceleration and deceleration ramps are added to the motion command signal to enable the formatter to determine the exact tape position. The capstan motor is controlled by feedback from an integral DC tachometer.

REEL SERVO AMPLIFIERS: The motion control signals generated in the capstan circuit are fed to the reel servo circuits to optimally position the tape buffering arms during each operation. The movement of the reel motors is controlled by comparing the actual position of the arm with the arm's desired position. The actual arm position is supplied to the reel servo amplifier as a varying photocell output voltage.

7.2 RAW POWER SUPPLIES

7.2.1 UNREGULATED DC VOLTAGES. The 40-Series Transport includes several AC power control units. Each produces three raw D.C. voltages: a nominal +20V (+25, 1840) designated SPS; a nominal −20V (−25, 1840) designated SNS; and a nominal +8V designated Logic Supply. These voltages are filtered by C1, C2, and C3, located on the chassis.

7.2.2 AC POWER CONTROL UNIT. The line side of the AC line is fused by A05F1, then switched by A01S1 in the front panel. The primary windings of transformer A06A01T1 are arranged by switches A06A01S1 (115/230) and A06A01S2 (LO/NOR) to suit four different line voltages. See figure 3-1. The transformer secondaries are connected to bridge rectifiers A06CR1, A06CR2 and A06CR3, which provide SPS, Logic Supply and SNS respectively.

7.3 REGULATED POWER SUPPLIES. Four regulated D.C. voltages are produced in the power supply circuits on the motor control card. See schematic 0252023-0000 sheet 2.

Two of these voltages are derived from SPS. +5L, adjustable with 5LADJ potentiometer R62, comes from regulator chip U11. This voltage is designated +5L to distinguish it from another +5 volt supply derived from the logic supply. During line power failures the +5L supply regulates longer than +5 supply, so +5L is used throughout the capstan and reel servo circuits.

Series pass transistor Q6, controlled by U10, supplies the regulated +12 volts. This voltage is adjusted by +12ADJ potentiometer R52. Current is limited by Q26, which diverts base drive current away from Q6 when the drop across R59 provides sufficient bias.

Regulated −12 volts comes from SNS. Regulator U14 supplies base current to series pass transistor Q7; Q28 limits the current. −12V is not adjustable.

Another +5 volts is derived from the logic supply. This +5 regulator is referenced to the +5L output via differential amplifier U6. U6 controls Q24 which drives Q5. Q25 limits the current by diverting current away from Q24's base when the drop across R43 biases Q25 on. +5 volts is usually used on the read and write/control cards and +5L on the motor control card.

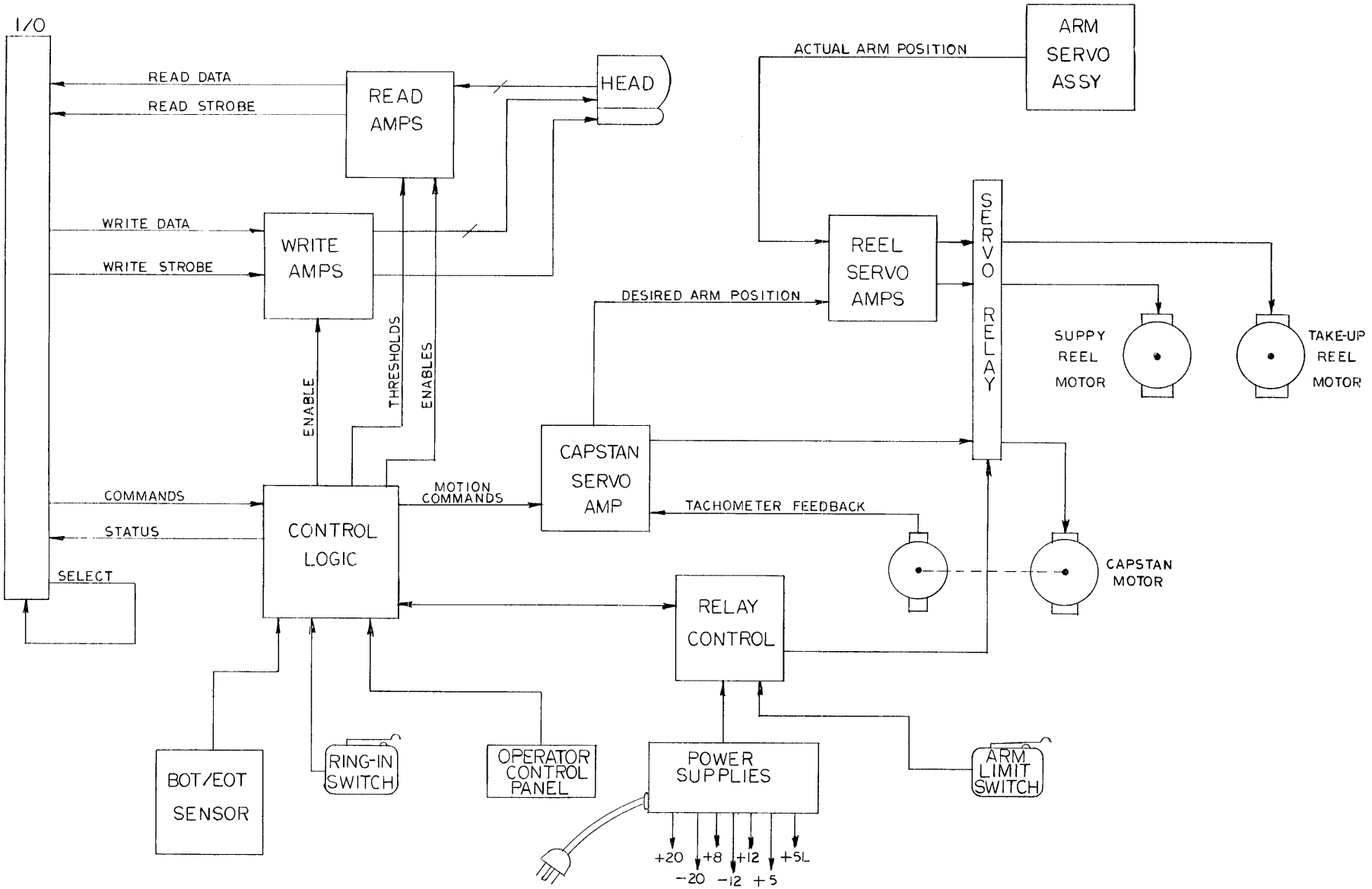


Figure 7-1. Transport Block Diagram

VOLTAGE	ADJUSTMENT	USE
SPS	none	Motors, +12 reg., +5L reg.
SNS	none	Motors, −12 reg.
Logic Supply	none	+5 reg.
+5L	R62	Logic on Motor Control Card
+5	follows +5L	Logic on read, write cards, Control Block Lamps
+12	R52	Op amps, arm sensor lamps
−12	none	Op amps

Figure 7-2. Usage of DC Voltages

7.4 CAPSTAN RAMP GENERATOR AND SERVO AMPLIFIER. These circuits on the motor control card control tape movement across the recording head. The capstan motor is accelerated and decelerated to move a specific amount of tape in a specific length of time. See schematic drawing 0252023-0000, sheets 4 and 5 during the following discussion.

The control logic produces FORWARD (TP13) whenever tape is to move forward and RVS RAMP (TP11) whenever tape is to move reverse (including rewind operations). Op amp U13-4 converts these TTL signals into a bi-polar signal, RSC. RSC is limited to ±6 volts by precision clamps U13-3/CR15 and U12-13/CR16. At TP12 RSC is −6 volts for a forward command, +6 volts for a reverse command, and 0 volts for neither command.

The circuit centered upon the U12 op amps and integrator U6-10 adds the linear velocity control ramps to RSC. The signal at U6-10 not only has ramps added, but has opposite polarity to RSC (TP12). U12-4 is a non-inverting amplifier whose output is precision clamped by CR12 and CR13. When ramping, the voltage at input U12-5 is non-zero; when not ramping (i.e. either at rest or at full speed) the input is 0 volts.

The +6 clamp reference voltage (nominal) is supplied by the RAMP potentiometer through voltage follower U12-3. Normally no current flows through R64 since U8-2/13 is open (i.e. not installed). The positive clamp operates at +6 volts and the negative clamp at −6 volts. U12 makes the junction of CR12/CR13 approximately −6 volts when accelerating forward or decelerating in reverse, +6 volts when decelerating forward or accelerating in reverse, and 0 volts when at rest or at synchronous speed.

The voltage at the CR12/13 junction produces a current through resistor U8-1/14 to the virtual ground at U6-8, the inverting input of U6-10. Current will be constant due to the precision clamps, so C19 will charge at a constant rate to produce a linearly increasing voltage. When U6-10 is equal and opposite to RSC, U12-5 will be at 0 volts and no more current will flow through U8-1/14.

When a SHORT RAMP is desired (dual speed units) input resistor U8-1/14 is paralleled with resistor U7-2/15; C19 charges at a faster rate, producing a steeper ramp.

The motion command is then split according to polarity so that the reverse and forward speeds may be adjusted separately. The motion command and ramps at U6-10 produces a small current through resistor U8-8/7 to the virtual ground at U6-6. The feedback current flows through either CR8 and R42 or CR7 and R40, depending on polarity.

Amplifier's U6-3's output is proportional to the sum of the currents through R38 (zero offset), R39 and R48 (forward command), R41 and R49 (reverse command), and U8-3/12 (rewind add-on). FWD potentiometer R48 adjusts the forward motion current, and hence the forward speed; REV potentiometer R49 adjusts the reverse and rewind speeds, since the current through U8-3/12 is always proportional to the current through R41. When REWIND is false the R54/R55 junction is low, holding Q27 off. When REWIND comes true C23 charges through R54 and R55, gradually increasing the conduction of Q27 to produce the rewind ramp. When the rewind operation is complete REWIND goes false and C23 discharges through R55, gradually decreasing the conduction of Q27 and thus the current to the summing point of the CSC amplifier. Note that RVS RAMP is also true when REWIND is true, so the output of the rewind ramp generator is added to that of the reverse ramp generator.

During an unload operation REWIND is false, REVERSE is true, and REELS ON is false. This combination of signals forward biases CR17 to allow current to flow through the voltage divider (R57, CR17 and R55), charging C23 and turning Q27 on to provide a current to the summing amplifier through U8-3/12.

When FAST SPEED is selected in a dual speed transport the input resistor to the polarity splitter is paralleled by resistor U7-7/10 and the FAST potentiometer R47. This proportionally increases the current through R39 or R41 to summing point U6-1. The FAST potentiometer permits fine adjustment of the alternate tape speed.

CAPSTAN SERVO COMMAND (CSC, TP4) is sent to the capstan servo amplifier (sheet 5). The output voltage of this power amplifier is proportional to the difference between the CSC and the tachometer feedback voltage (which represents actual tape speed). The first stage is therefore a differential amplifier, U1-10. The difference between the filtered tach voltage (TP1) and the CSC is amplified in subsequent gain stages. A positive signal at CPSN MOTOR (TP8) moves tape forward; a negative signal moves tape reverse.

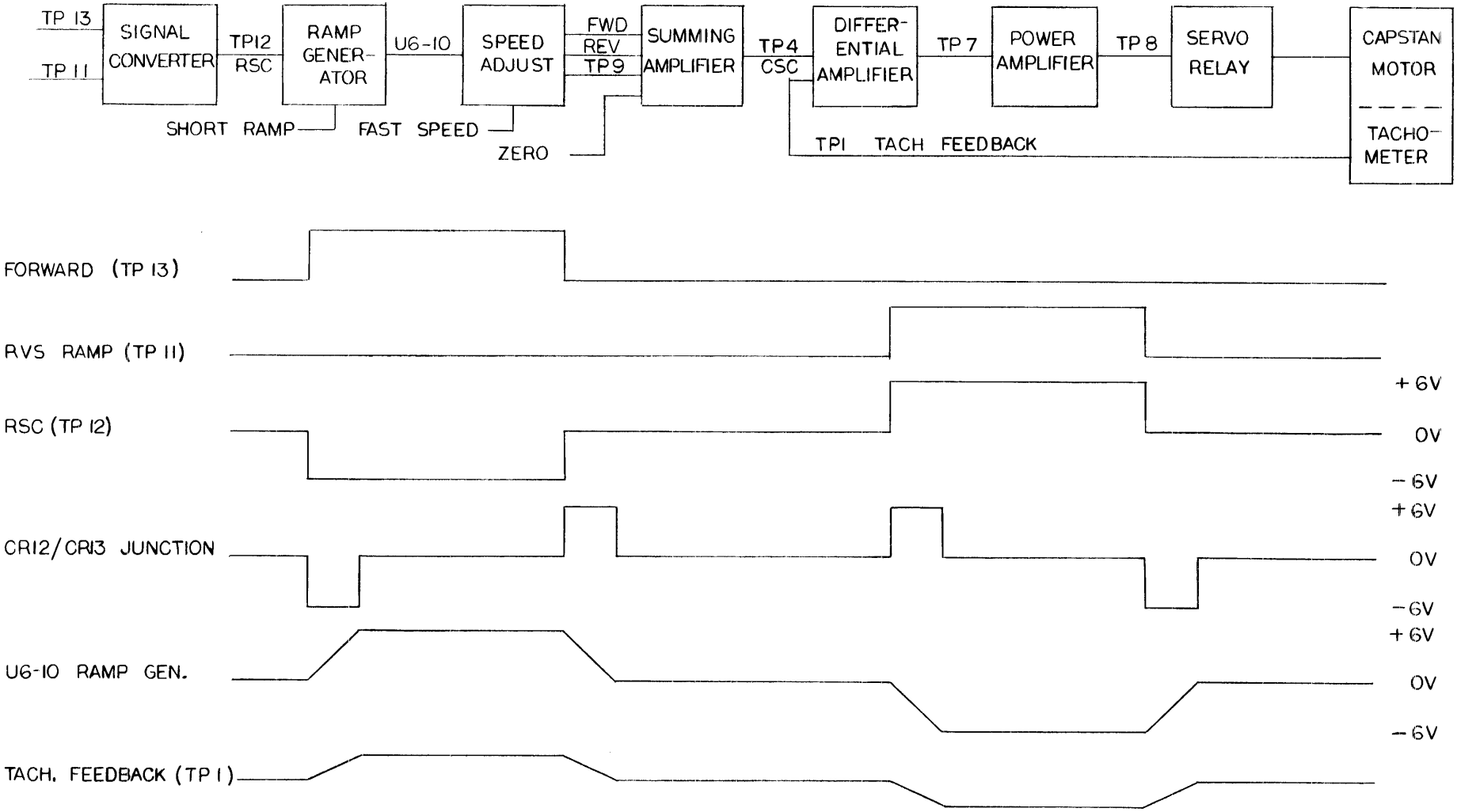


Figure 7-3. Capstan Block Diagram and Waveforms

Q23 and Q21 limit the current to the output stages by diverting their base drive when the output current through R29 or R10 produces an IR drop of .65 volts. CR2 and CR4 protect output transistors Q3 and Q1 against inductive voltage transients.

The CPSN MOTOR signal (TP8) is connected to the capstan motor winding through servo relay K1. See schematics 0252338-0000, 0252348-0000 and 0052349-0000 included in Section 11 of this manual.

7.5 REEL SERVO CIRCUITS. The reel servo circuits (schematic 0252023-000, sheet 6) control the motion of the supply and take-up reels in response to the movements of the tape-buffering arms. Tape is buffered because the capstan accelerates far more quickly than the reel motors. While moving tape in either direction the arms are positioned to allow the largest possible degree of buffering. For example, during forward motion the supply arm is positioned at the end of its arc (up on the 1740 and 1840, right on the 1640 and 1140). When the forward motion of the capstan ceases the supply arm absorbs the tape still being unwound from the supply reel. The take-up arm, on the other hand, is positioned just off the mechanical stop (bottom of arc on 1740 and 1840, left on 1640 and 1140). When the capstan stops moving forward the take-up arm provides tape to the still winding take-up reel. Arm positions for the various operations are shown in figure 7-4. Attached to the shaft of each buffering arm is a round disk containing an eccentric slit. Mounted on one side of this disk is a lamp and on the other a photocell. The movement of the arm through its operating arc rotates the photodisk, varying the amount of light on the photocell. This produces a voltage analogous to actual arm position which is input to the reel servo circuit on the motor control card as TAKE-UP P.C. (TP15) and SUPPLY P.C. (TP16).

When no tape motion is commanded each arm should be in the center of its operating arc. The center positions are adjusted by TUCEN and SUPCEN potentiometers R134 and R135. With the arm at the center of its operating arc the voltage at TP15 and TP16 is nominally 2.7 volts. The following paragraphs discuss the operation of the take-up reel servo circuits; the supply side is basically identical.

The take-up photocell signal and the TUCEN adjustment (from −8 to −12 volts) form a voltage divider. When U27-5 is non-zero current flows through resistor U24-6/9 and through the lead-lag network R133, C59, C60 to d.c. servo amplifier summing point U27-8. This current is amplified in subsequent gain stages and flows to the take-up reel motor through relay K1. Both the take-up and the supply power amplifiers are basically identical to the capstan power amplifier discussed previously; the only difference is that larger values of R89, R81, R147 and R120 limit the reel amplifier current to lower levels than the capstan amplifier.

With no capstan motion, the take-up reel motor turns, winding or unwinding tape, until TAKE-UP P.C. produces 0 volts at U27-5. A positive voltage at power amplifier output TP14 winds tape onto the take-up reel; a negative voltage unwinds tape. Winding (tensioning) tape moves the arm upward/rightward, increasing the photocell voltage; unwinding (slackening) tape moves the arm downward/leftward, decreasing the photocell voltage.

Forward or reverse commands add an offset to the "center arm" current. This steady-state offset current flows to summing point U27-8 through resistor U24-4/11. During forward commands RSC is clamped at −6 volts and APC (sheet 3) is false, so U27-3 (TP18) goes to +2 volts. This positive offset through the servo loop forces U27-4 to contribute a negative to summing point U27-8; when the motor unwinds tape and the take-up arm drops or moves left, TAKE-UP P.C. will become less positive, making U27-5 negative.

The proportion of the total current supplied by the offset determines how far the arm swings away from the center position. Increasing the center current (functionally equivalent to decreasing the offset current) lessens the operating arc of the arm by decreasing the width of the swing away from the center position. The center current may be increased by increasing the gain of U27-4 using TUARC potentiometer R124. To widen the operating arc the gain of U27-4 would, of course, be decreased.

To move the arm smoothly to its new desired position as soon as forward or reverse motion is commanded an exponential component is added to the TP18 signal by the RC network containing op amp U27-12, yielding roughly constant motor current over the full transit time of the arm.

Again, during forward operations TP18 is +2 volts. U28-3 (TP19) inverts this (U28-2 is 0 volts since REELS ON is true) to produce a current through resistor U26-4/11. Op amp U28-12 adds the transient components. These currents are summed with the current supplied through U26-6/9 and amplified to turn the supply motor and move the supply arm until the photocell output nulls out the arm offset voltage. This new supply arm position is opposite to that of the takeup arm.

A reverse command has the opposite effect. RSC is +6V, TP18 is −2 volts, and TP19 is +2 volts; the take-up arm shifts up/right and the supply arm shifts down/left.

During a rewind on the 1740 and 1840 the same control voltages are produced in the reel servos as in a normal reverse. During a rewind on the 1640 or 1140 APC (Arm Position Control) goes true, canceling out RSC; there is almost no offset current and both arms are positioned near the center of their operating arcs.

When SET BT is true (e.g. power failures or exceeding the arm limits), the motion commands are clamped low, making RSC 0 volts. APC is true, so U27-2 is +1.5 volts and TP18 is approximately +2 volts. REELS ON is also clamped false, so U28-2 and TP19 are both approximately +2 volts. Both arms are offset near their mechanical stops. This same set of conditions occurs during unload operations. When unloading, RSC is 0 volts even through REV is true because RVS RAMP is false (sheet 3).

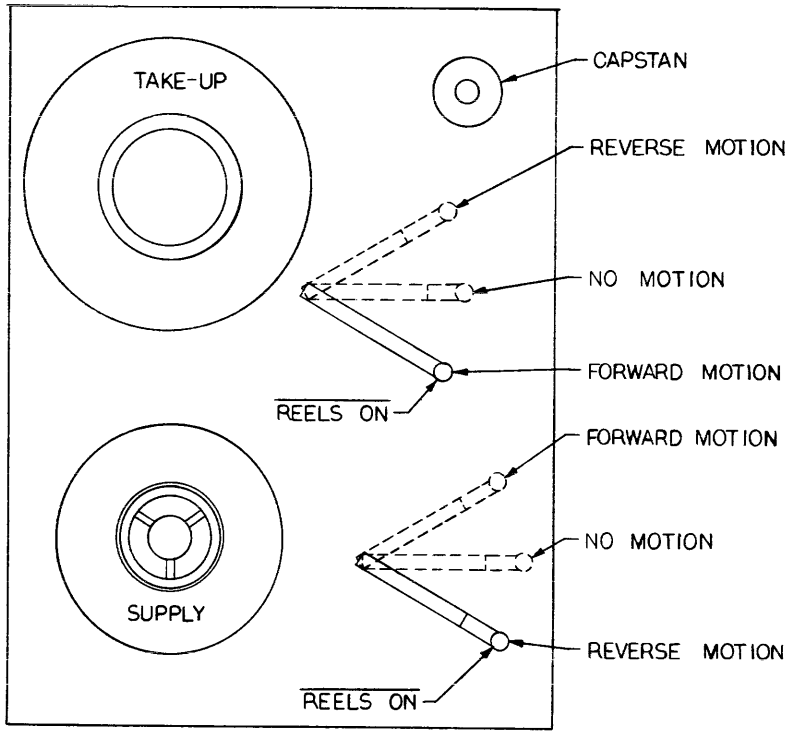


Figure 7-4. Desired Arm Positions, 1740

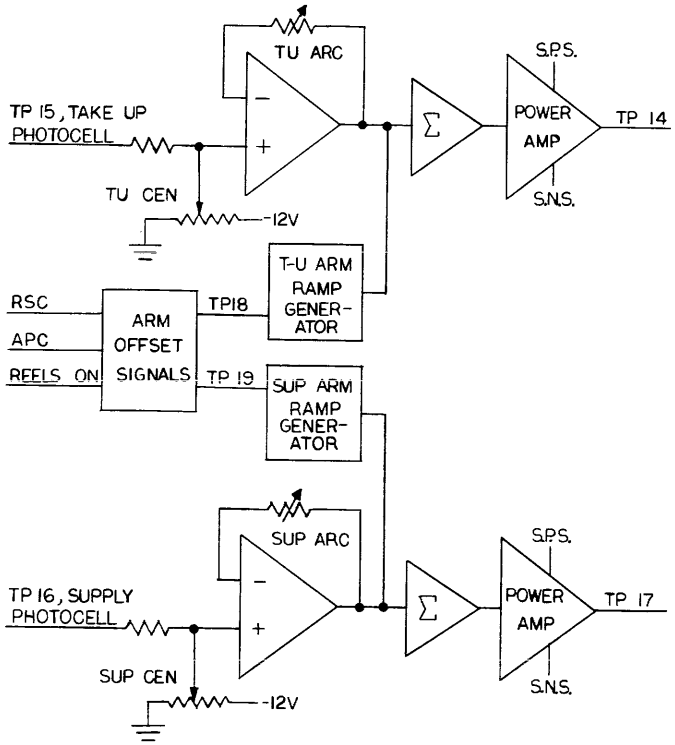


Figure 7-5. Reel Servo Block Diagram

MOTION	RSC	APC	REELS ON	TP18	TP19
Forward	−6	False	True	+2	−2
Reverse	+6	False	True	−2	+2
Rewind (1740,1840)	+6	False	True	−2	+2
Rewind (1640,1140)	+6	True	True	0	0
"SET BT"	0	True	False	+2	+2
Unload	0	True	False	+2	+2

Figure 7-6. Reel Servo Signal Levels

7.6 RELAY CONTROL CIRCUITS. All three motors are connected to their amplifiers by SERVO RELAY K1. This relay is activated by REELS ON true (normal operation), REVERSE true (unload), or CPF true (beginning of the power fail sequence). When the reel motors are not connected to their amplifiers they are connected to the arm relaxer circuit discussed below.

K2, the REWIND RELAY, is installed in 1740, 1840, and 37.5 IPS 1640 units. K2 connects the supply reel motor return to SNS and the take-up reel motor return to SPS instead of to ground to provide adequate voltage for a full-speed rewind. See schematics 0252338-0000 and 0252348-0000. When relay K2 is not installed (i.e. the 1140 and the 25 IPS or less 1640), jumper U8-9/6 must be installed to make APC true during rewinds. APC moves each arm to the center of its arc since RVS RAMP is also true. This jumper should not be installed when relay K2 is present.

SET BT (schematic 0252023-0000, sheet 3) sets the BROKEN TAPE flip-flop on the write/control card, which in turn resets every control flip-flop in the transport. SET BT clamps all motion commands on REELS ON low, making APC true so that the capstan stops the tape and the reel servos position the arms near their mechanical stops.

SET BT will go true if:

1. The servo assembly connectors are reversed or either bulb in the arm photocell servo assembly burns open. These two lamps are connected in series on the +12 volt supply. When they are not drawing current comparator U23-14 switches low.
2. The arm limit switch is closed (i.e. the supply arm swings beyond its normal operating limits due to excessive or inadequate tape tension). This protects the tape from electrical failure in the reel servo circuits.
3. Speed platforms U26, U24 and U8 are not installed (see Section 11).
4. Power fails (i.e. POWER UP is false). POWER UP is the output of voltage comparator U23-1 (schematic 0252023-0000, sheet 7). During power losses the logic supply decays rapidly but +5L stays within tolerance for at least one second longer. When the logic supply goes below the +5L, U23-1 switches high, making POWER UP false and SET BT true.

SET BT going high forces REVERSE+REELS ON (U17-6) low, triggering the CPF one-shot (U22-5). The trailing edge of CPF triggers a second one-shot, RELAX EN. Note that these two one-shots operate *only* when SET BT is due to a power loss; both are held clear by the other SET BT conditions.

CPF keeps servo relay K1 activated so that all three motors remain connected to their respective amplifiers; it also moves the capstan forward (sheet 4) by applying a small voltage to the capstan ramp generator. At the trailing edge of CPF the servo relay is released and the reel motors are connected to the arm relaxer circuit (sheet 7). With no motor current spring tension drops the arms toward their mechanical stops.

Meanwhile RELAX EN charges C36 (sheet 7) to the voltage permitted by zener diode CR29. Transistor Q34, acting as an emitter follower, biases two Darlington pairs (Q33/Q12 and Q35/Q13) on. The collectors of the Darlingtons are now connected to the reel motor windings since K1 is no longer energized. The current supplied to the motors through the Darlingtons opposes the action of the tension spring so that the arms move gently to their stops. Following the trailing edge of RELAX EN, C36 discharges through R101, providing enough motor current to smoothly decrease tension to zero.

7.7 RESTART OPTION. Many installations suffer frequent or infrequent power outages. The restart options brings the transport back on line without operator intervention when power returns. The restart sequence simulates a load operation with the tape already at BOT. The restart option is not recommended for installations where tape units are not mounted vertically.

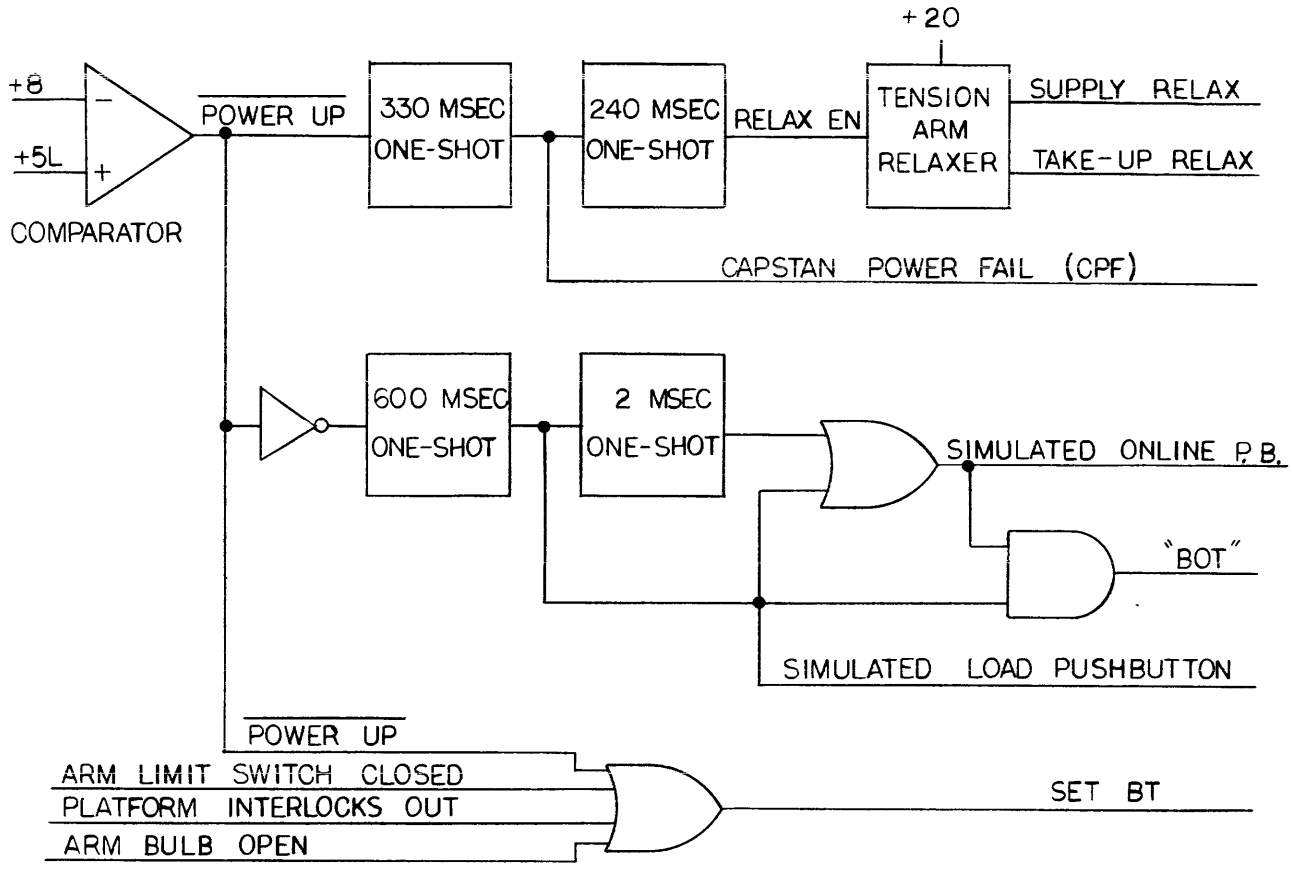


Figure 7-7. Block Diagram, Power Fail and Unattended Restart

This option may be configured in two ways (schematic 0252023-000, sheet 3). With jumpers U7-3/14 and U7-4/13 installed the restart sequence occurs when power is restored to the transport. With jumpers U7-1/16 and U7-8/9 installed the restart sequence is initiated by selecting the transport and then pulsing ROL low.

In either case the sequence begins by triggering the first one-shot, U4-13, which simulates the simultaneous pressing of the LOAD and ON LINE pushbutton switches. This creates a false BOT indication (schematic 0252195-0000 sheet 3A), tensioning the tape without beginning the forward searching motion. The trailing edge of this first one-shot triggers another one-shot, U4-5, which simulates the make-break switch action required to toggle the ON LINE flip-flop. At the end of this pulse the unit is ON LINE and READY.

NOTE: On transports equipped with the restart option configured to operate upon power restoration, tape should usually be loaded *after* the POWER switch is turned on to avoid false indications to the controller.

7.8 MOTION CONTROL LOGIC. See schematic 0252195-0000 sheets 2 and 3 during the following discussion.

7.8.1 BOT/EOT DETECTION. The BOT marker or the EOT marker reflects light from an infrared LED toward the appropriate photoelectric sensor. When BOT is sensed, $\overline{\text{BOT SENSE}}$ (TP15) goes low and comparator U75-13 (sheet 3A) indicates BOT true. (U80-10 allows the operator to simulate BOT by pressing the LOAD and ON LINE pushbuttons simultaneously.)

When no tape is loaded, light is reflected to both photocells by the reflective surface on the head cover; BOT and EOT are ANDed (U80-4, sheet 2) to set the broken tape (BT) flip-flop.

Note that EOT is latched (U73-9) to keep the I/O status line true after the marker has been passed. EOT is cleared only by rewinding or by moving reverse past the marker.

7.8.2 LOAD SEQUENCE. When the transport is powered up the BT flip-flop (U57-13) is set. BT in turn clears all the other control flip-flops (sheet 2) and makes REELS ON false. The BT flop can only be cleared by pressing the LOAD pushbutton, either physically or electrically (i.e. unattended restart). When BT goes false REELS ON comes true,

energizing the SERVO RELAY and thus connecting all three motors to their servo amplifiers. The arms move to their center positions as the tape tensions. The arm limit switch cannot create SET BT while the LOAD pushbutton is depressed (and shortly thereafter) to allow the supply arm time to travel into its normal operating arc.

When BT is cleared DLY1 is triggered (sheet 3A). The trailing edge of this pulse (TP13) triggers DLY2 (TP14), which resets the $\overline{\text{LOAD}}$ flip-flop (U55-13, sheet 2). $\overline{\text{LOAD}}$ reset makes FWD true, enabling the capstan to move tape forward. When the BOT marker is sensed the LOAD flip-flop is set and the tape halts. $\overline{\text{LOAD}}$ set triggers DLY1 again, triggering DLY2, which sets the READY flip-flop (U57-7) now that BOT is true.

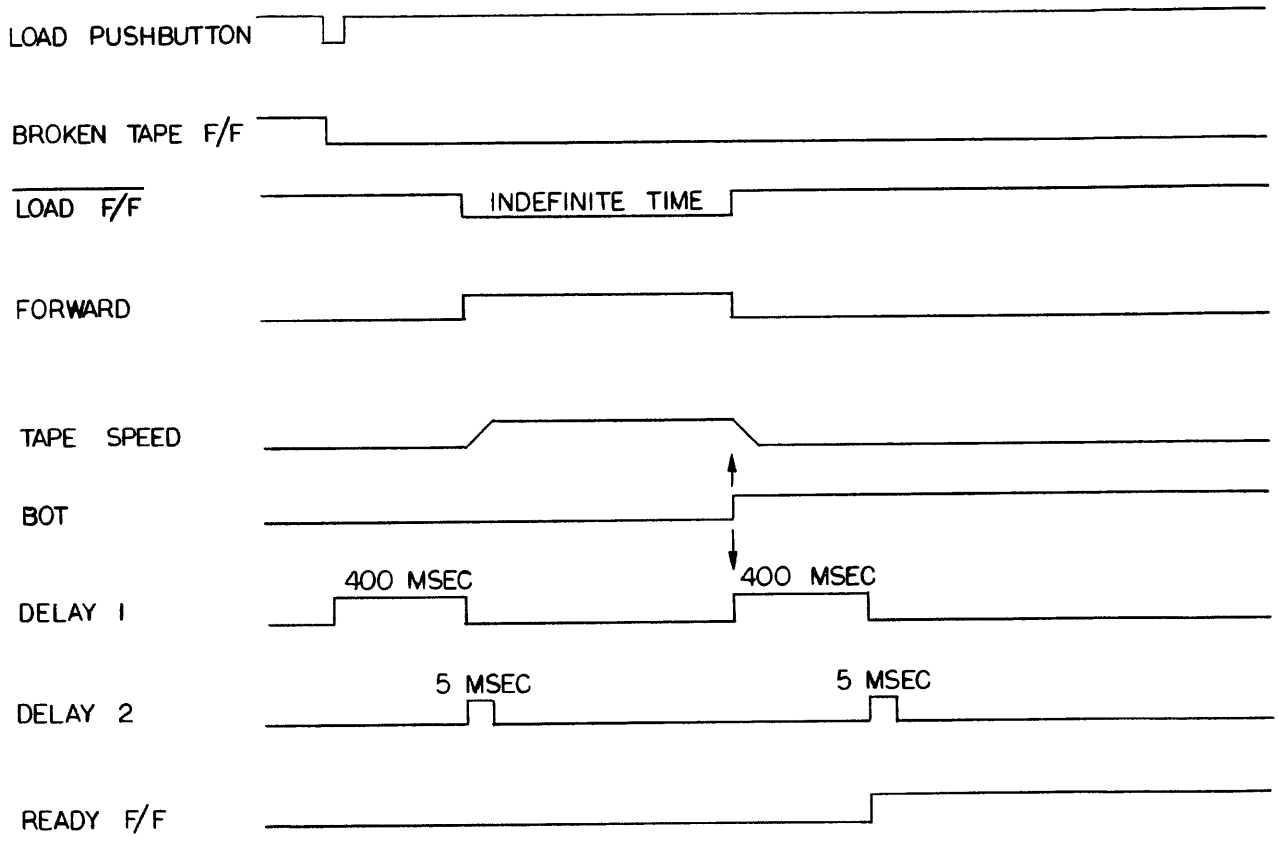


Figure 7-8. Load Sequence Timing Diagram

7.8.3 ON LINE OPERATION. To operate the transport under remote control RDY must be true; internally this signal is called ARM I/0 (U65-6). ARM I/0 gates all motion commands (SFC, SRC, and RWC) and tape status indicators (LDP, EOT, and FPT). It also gates the read data outputs (RDØ-7,P) and the write data strobe input (WDS). For ARM I/0 to be true the transport must be loaded with tape (i.e. READY; see paragraph 7.8.2), selected, ON LINE, and not rewinding (see paragraph 7.8.4).

The transport is selected (sheet 3B) by holding the SLT line determined by the unit select plug jumper (or by the optional UNIT SELECT switch) low. See paragraph 6.3.1.

Each time the ON LINE pushbutton is pressed the ON LINE flip-flop (sheet 3B) is clocked, alternately placing the transport on and off line. ON LINE may be clocked electrically by ROL. Pressing REWIND or pulsing OFFC (off line command) low direct clears the ON LINE flop. The ON LINE indicator lamp is illuminated only when the transport is on line.

When the transport is *off* line the three-position service switch, located on the write/control card, may command forward or reverse tape motion to the capstan servo circuit. The center NORM position is off.

7.8.4 REWIND SEQUENCE. Rewinds may be initiated either by pressing the REWIND pushbutton or by pulsing the I/O line RWC low. Either method sets the rewind flip-flop (U55-4, sheet 2), resets the rewind status flip-flop (U57-9), and makes ARM I/O and RDY false.

Eventually, the BOT marker is sensed. The trailing edge of BOT triggers DLY1 (TP13, sheet 3A), which resets the rewind flip-flop to decelerate tape. The trailing edge of DELAY 1 triggers DELAY 2 (TP14), which starts the load sequence by resetting the $\overline{\text{LOAD}}$ flip-flop. When the load sequence is completed the READY flip-flop is set and the rewind status (RWD ST) flip-flop is set.

Note that the I/O signal RWD (U47-8, based upon RWD ST) is true until the entire load-after-rewind sequence is complete. The REWIND indicator, however, is true only while the transport RWD (U55-4) is set. If the rewind operation was initiated by RWC rather than the pushbutton switch, the transport will still be ON LINE and RDY will come true again at the completion of the rewind.

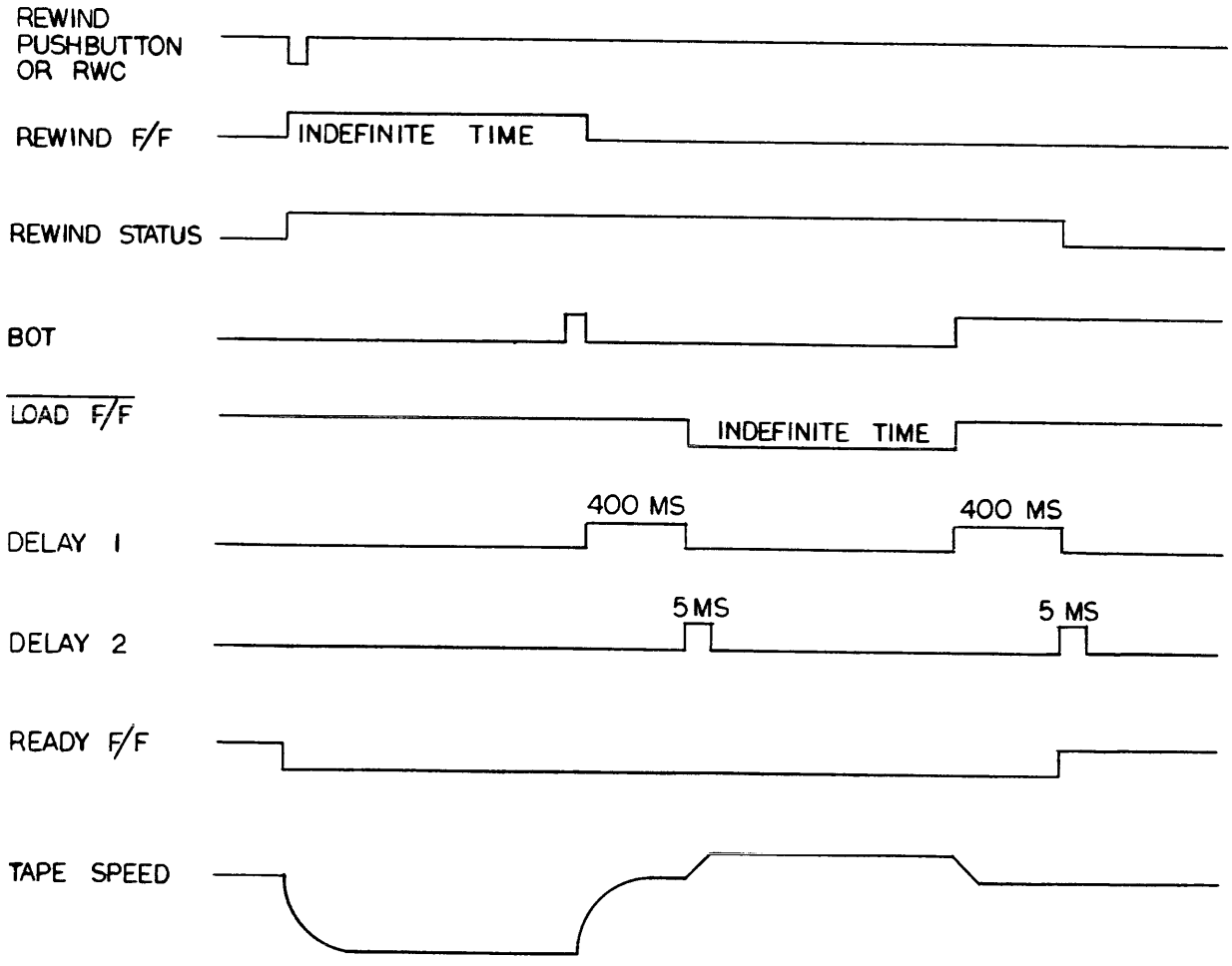


Figure 7-9. Rewind Sequence Timing Diagram

7.8.5 UNLOAD SEQUENCE. The operator may unload tape by pressing the REWIND pushbutton either while the tape is at BOT or while a rewind operation is in progress.

When REWIND is pressed at BOT, BOT and LOC RWD are ANDed (U64-11) to set the UNLOAD flip-flop (U57-4). Note that when UNLOAD is set the RWD flop is reset. When REWIND is pressed while rewinding the "automatic unload" flip-flop (U73-6) is set; when the rewind sequence is complete, UNLOAD is set via U49-12 to automatically initiate unloading. Typical operator practice is to press REWIND once to rewind or twice to rewind and unload.

UNLOAD makes REELS ON false and REV true. REV keeps the Servo Relay energized. REELS ON false makes APC true (schematic 0252023-000, sheet 33), moving the tape-buffering arms to a position near their stops. Although REV is true, RVS RAMP is not; the capstan servo produces only the low speed reverse motion described in paragraph 7.4. Tape motion terminates when tape tension is lost because the arm limit switch produces SET BT, deactivating K1.

7.9 WRITE CIRCUITS. For a write operation to take place the reel of tape mounted on the supply hub must contain a write enable ring. This ring is detected by a microswitch which rides on a plunger protruding through the transport front plate near the supply hub. The 12 volts required for the write head windings is routed through this microswitch. When the switch is closed (i.e. the plunger is pushed back by the ring) SWITCHED +12 biases Q1 on (schematic 0252195-0000, sheet 5A), creating RING IN and, when the load operation beings, SOL ON. The leading edge of SOL ON triggers one-shot U2-3 on the motor control card (schematic 0252023-0000, sheet 7). U2-3 turns "pull-in" transistor Q19 on to retract the file protect plunger so that it does not scrape against the ring when the tap begins to move. "Hold-in" transistor Q18, biased on by SOL ON, keeps the plunger retracted after Q19 turns off.

SWITCHED +12 (schematic 0252195-0000, sheet 5A) goes to the Write Head Commons through the Write Power Switch (Darlington Q3/Q4), controlled by WRITE MODE and SET BT. Note that any time that write power is available the erase head is active. The WRITE MODE flop latches SWS when the last tape motion begins. The formatter initiates a write operation by making SWS true for at least 25 microseconds after either SFC or SRC comes true. SFC and SRC are gated with ARM I/O and then ORed to trigger the U51-5 delay (schematic 0252195-0000, sheet 5A). The trailing edge of this one-shot triggers a second one-shot (U51-13) which clocks the WRITE MODE flip-flop. WRITE MODE will be true if SWS is true (unless one of the direct clears is present). The WRITE MODE flip-flop cannot be set if the transport is off line, rewinding, or loaded with a tape reel containing no write enable ring.

The nine write channels are diagrammed on schematic 0252195-0000 sheets 5B and 6. The following discussion describes only channel P; the remaining eight channels operate in the same way.

Again, in NRZ a "one" is encoded as a flux reversal in a bit position; a "zero" generates no flux reversal. The *direction* of any reversal carries no meaning, only its presence or absence is significant.

The direction of current through each write head winding is controlled by the complementary outputs of the write register. When a write operation begins, the entire write register (U16-5, etc.) is reset; each WH- winding is grounded opposite the write power. When writing NRZ tapes PE is false and U15-8 is high. This provides a parallel current path, increasing the current through the head winding. When writing PE tapes, U15-8 is low and less current is drawn through the winding. When a transition occurs, however, the parallel paths to ground are switched in for the duration of WDSD.

If the first bit to be written is a NRZ "one," WDP goes low and the J and K inputs of U16 both go high. When clocked by WCLK, a gated version of WDS, the flip-flop will toggle so that U41-3 and U32-3 go high and U41-5 and U32-5 go low. Write current will now be drawn through the WH4+ winding, and the direction of tape magnetization will be reversed. A second "one" toggles the flip-flop back to the reset state, a third "one" to set, and so forth.

When writing a NRZ "zero," WDP is high and the J and K inputs are both low so that the flip-flop will not change states at WCLK time.

When phase encoded tapes are written these circuits operate a little differently. In phase encoding the *direction* of each flux reversal carries significance: a change *into* the direction of gap erasure is a "one," a change *out of* the direction of gap erasure is a "zero." A non-data transition must therefore occur between any two consecutive one or zero bits; to write two "ones" in a row an intervening non-data "zero" transition is required. For this reason the formatter provides *two* WRITE DATA STROBEs for each data character to be written.

XOR U7-6 now maintains the J and K inputs of the write register at opposite levels; the register is operated as a set/reset rather than a toggle/no toggle.

Since PE is true the transition detectors now come into play. XOR U7-3 compares the new level of WDP with the level that was present before the last WDS (WCLK). When U14-15 is set the WDSD pulse is gated through U15-11 and U15-8 to add current through the head winding for the duration of WDSD.

WDSD (sheet 5A), the output of one-shot U9-6 triggered by the leading edge of each WCLK, adds extra current to the write head winding at each transition. At the trailing edge of WDSD the write current is reduced to its PE reference level. Writing PE tapes in this manner reduces peak shifting in the PE read circuits since each transition is clearly defined. When there is *no* phase transition (e.g. a data "one" following a data "zero") U14-15 reset prevents WDSD from adding current through the winding. Typical write waveforms are shown in figure 7-10.

At the end of each data block the formatter issues the "write amplifier reset" pulse (WARS). WARS via $\overline{\text{WR RES}}$ direct clears the entire write register. When operating in NRZ those channels which have recorded an *odd* number of "ones" in that block change status once more, creating another "one" on tape. Resetting the write register thus automatically generates an even longitudinal parity check by writing the LRCC on tape.

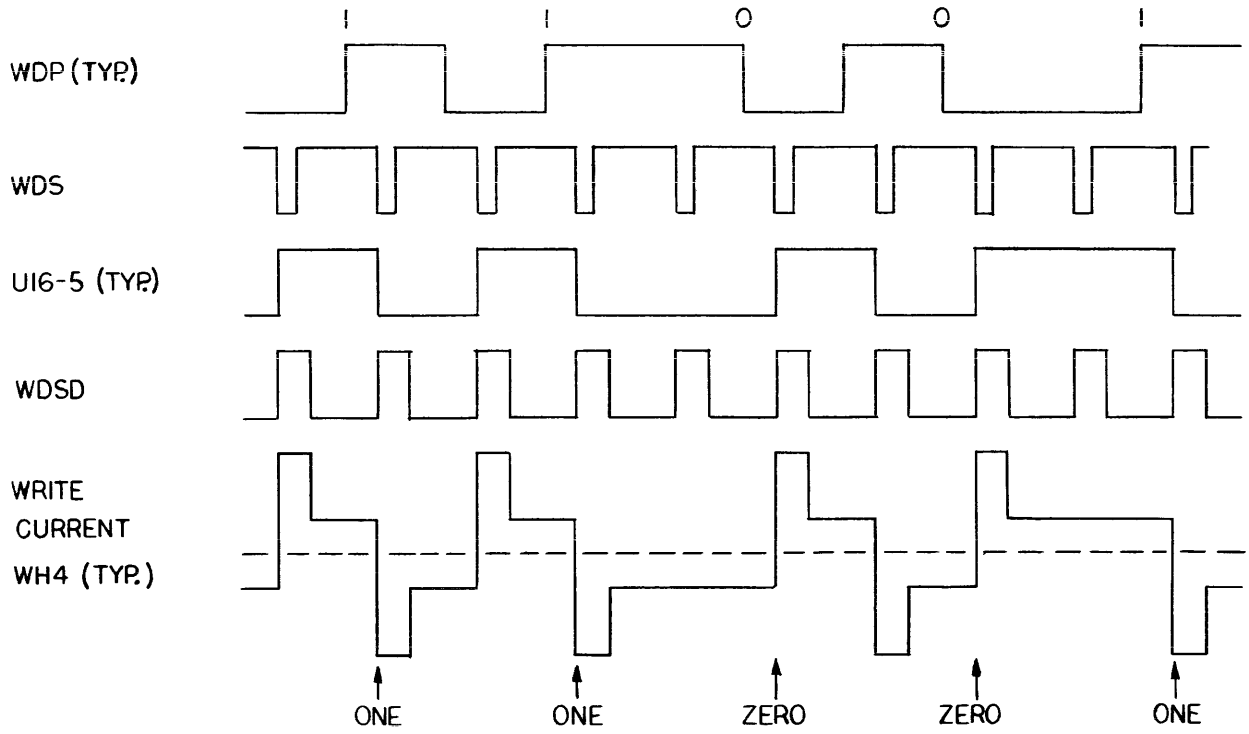


Figure 7-10. Phase Encoded Write Waveforms

7.10 READ CIRCUITS. The read circuits are located primarily on the second p.c. card in the transport; some of these circuits are also located on the write/control card, however.

7.10.1 READ THRESHOLDS. Since the 40 Series transport is equipped with a dual gap (read-after-write) head, the high read threshold command RTH1 is not required. Instead, high threshold ($\overline{HT}$) is selected whenever WRITE MODE is true. Normal threshold ($\overline{NT}$) is true if neither WRITE MODE nor the low threshold command RTH2 are true. See schematic 0252195-0000 sheet 4. $\overline{NT}$ and $\overline{HT}$ develop six separate threshold voltages (schematic 0251741-0000, sheet 2), three for NRZ and three for PE. See figure 7-11.

Two read enable signals, $\overline{\text{PE READ EN}}$ and NRZ READ EN, are derived from ARM I/O based on the selected density. When $\overline{\text{PE READ EN}}$ is true the NRZ TV is raised almost to +6V to prevent NRZ read circuit activity from feeding noise into the PE read circuits.

THRESHOLD	WRITE MODE	RTH2	NT	HT	PE TV (TP4)	NRZ TV (TP3)
High	HI	X	HI	LO	+4.9V	+1.5V
Normal	LO	HI	LO	HI	+1.5V	+0.76V
Low	LO	LO	HI	HI	+1.1V	+0.38V

Figure 7-11. Read Threshold Levels

7.10.2 READ PREAMPLIFIER. As the magnetic tape moves across the read stack, small currents are induced in each head winding. These currents correspond to the magnetic flux direction in each track on tape. The signal across each winding is sent to the inputs of a differential amplifier (U101, etc., schematic 0251741-0000, sheet 3). These amplifiers have individual gain adjustments (R108, etc.) to compensate for track-to-track variations in the head windings; associated passive filters control bandwidth to maximize noise immunity.

Since recovering NRZ data from this amplified head signal requires different techniques from recovering PE data the balance of the read circuits are discussed in two separate paragraphs which follow.

7.10.3 NRZ READ CIRCUITS. The amplified head signal is full-wave rectified (TP103, etc.) and clipped below the NRZ threshold voltage. Positive peaks, corresponding to changes in the direction of magnetic flux on tape, are detected. The peak detector output (Q102, etc.) is a pulse of fixed duration and is independent of input signal amplitude.

When a peak is detected in a channel the appropriate read deskewing flip-flop is set (sheet 4), indicating that a "one" has been read. As soon as the first "one" in a character is read the $\overline{\text{SKEW GATE ENABLE}}$ bus is pulled down through an isolating diode (CR109, etc.).

$\overline{\text{SKEW GATE ENABLE}}$ (sheet 3) triggers one of the two SKEW GATE one-shots, U4-5 (TP6) for high density, U3-6 (TP5) for low density. The width of each output pulse is adjustable with a 50K potentiometer; pulse width should be 50% of a character period. SKEW GATE allows time for all the channels to arrive. Its trailing edge triggers the READ DATA STROBE one-shot U3-13, whose output is gated with NRZ READ EN and buffered on the write/control card to form RDS. When the formatter receives this pulse, it samples the read data outputs (RDØ, P). The read data outputs are simply the values of the read deskewing register gated by NRZ READ EN and buffered on the write/control card (U67, U59). Those channels which have not detected ones are assumed to be zeros. All bits in a character generally arrive within 15% of the character period.

On the trailing edge of RDS the delay U2-5 is triggered, after which a $\overline{\text{CLEAR}}$ pulse (TP13) is generated to clear the read register in anticipation of the next character's arrival.

7.10.4 PHASE ENCODED READ CIRCUITS. In PE the read head signal is amplified by the same differential amplifier as in NRZ. Because the flux reversals on phase encoded tape vary between 312 and 625 microinches apart depending on the data pattern, the induced head signal varies in amplitude. The amplified head signal is equalized (i.e. differentiated; U102 and TP102, etc.) and shifted ninety degrees. Next a Schmitt trigger zero crossing detector (U105, etc.) squares up the read signal, making it identical in time to the actual bit pattern on tape.

The Schmitt trigger output is gated with an activity monitor (ACTIVE) to insure its validity; it is then buffered on the write/control card and transmitted to the formatter as RDØ-7, P. The Schmitt trigger outputs of all nine channels are tied together through 100K resistors to provide a PE SKEW test point (TP9, sheet 4). PE SKEW is also present when reading NRZ tapes with a PE/NRZ unit.

Each channel's ACTIVE signal comes from the PE threshold discrimination circuit. This circuit requires approximately 3½ character periods to turn on and two character periods to turn off to enable it to verify both signal amplitude and signal duration. The first stage is a Schmitt trigger (U104, etc.) whose threshold voltage is controlled by PE TV. Positive peaks from the differentiator which exceed the threshold pulse U104-6 negative, placing a −3.5 volt charge on C123 through CR107. This turns Q103 off, enabling C124 to charge toward +12 volts through R140. It takes approximately 3½ consecutive valid bits before Q104 biases on to make ACTIVE high.

When the differentiator output falls below the threshold, C123 charges toward +12 volts through R139. If this continues for two character periods, Q103 will forward bias and turn on, discharging C124 and turning Q104 off, making ACTIVE false. Note that Q103 and Q104 cannot operate unless PE RE (a +12 volt signal) is true. The ACTIVE signals in all nine channels are tied together through isolating diodes so that when ACTIVE is false in any channel the DROP DET bus (TP10) is low.

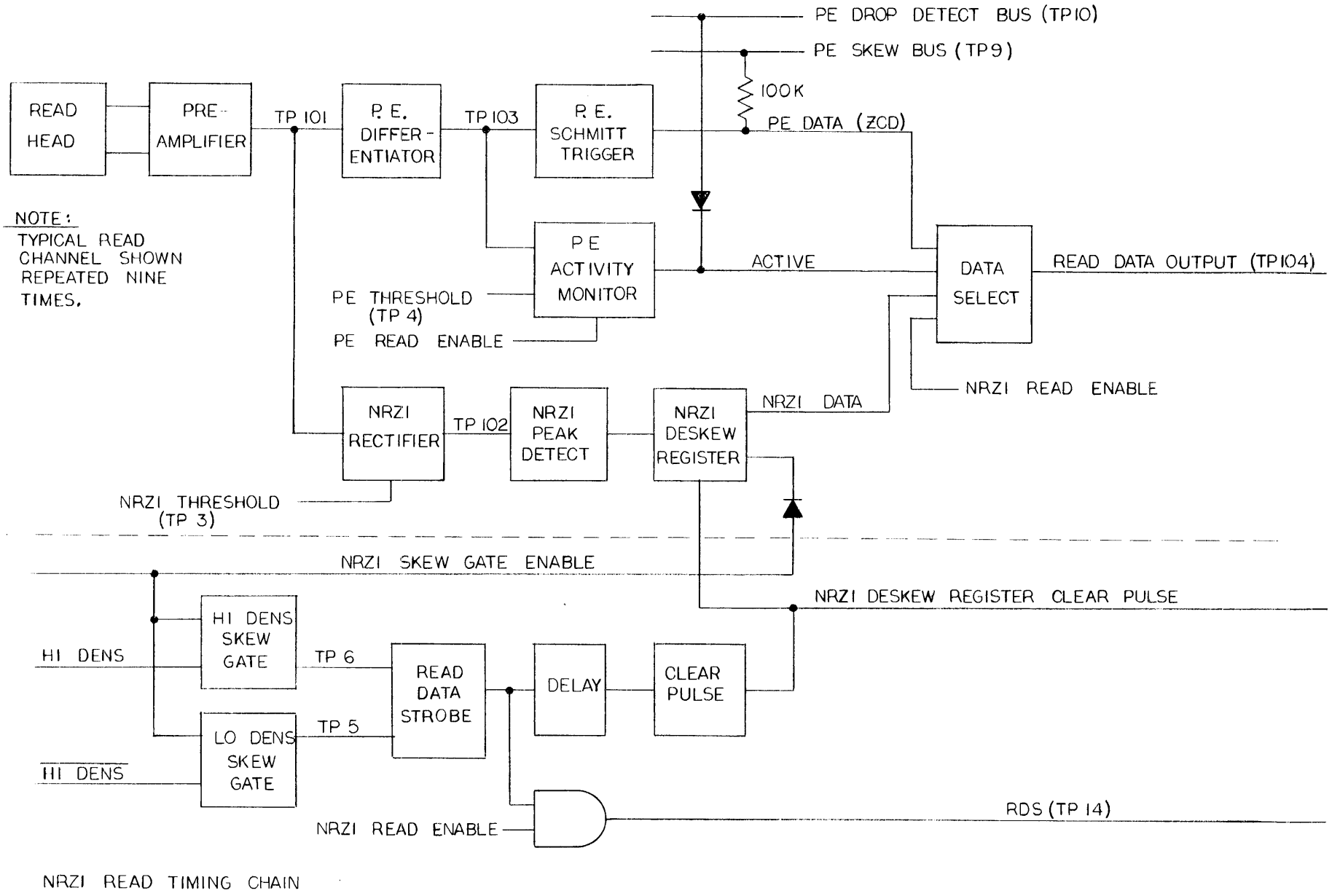


Figure 7-12. Read Block Diagram

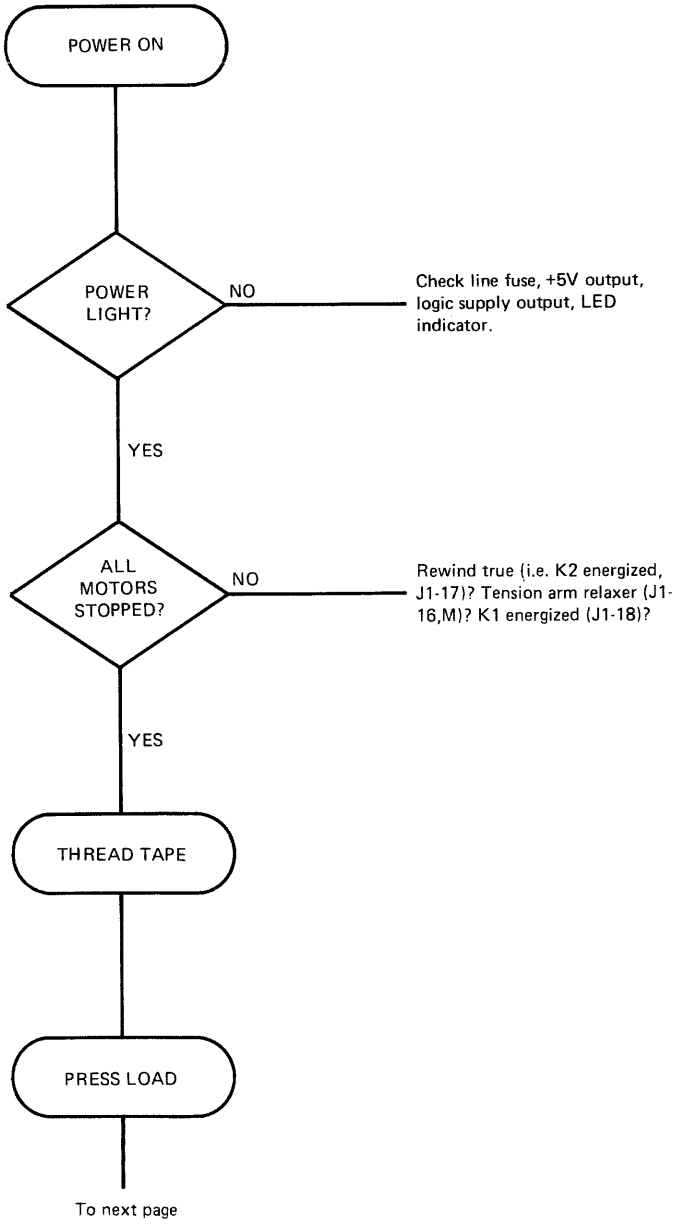
8 - TROUBLESHOOTING

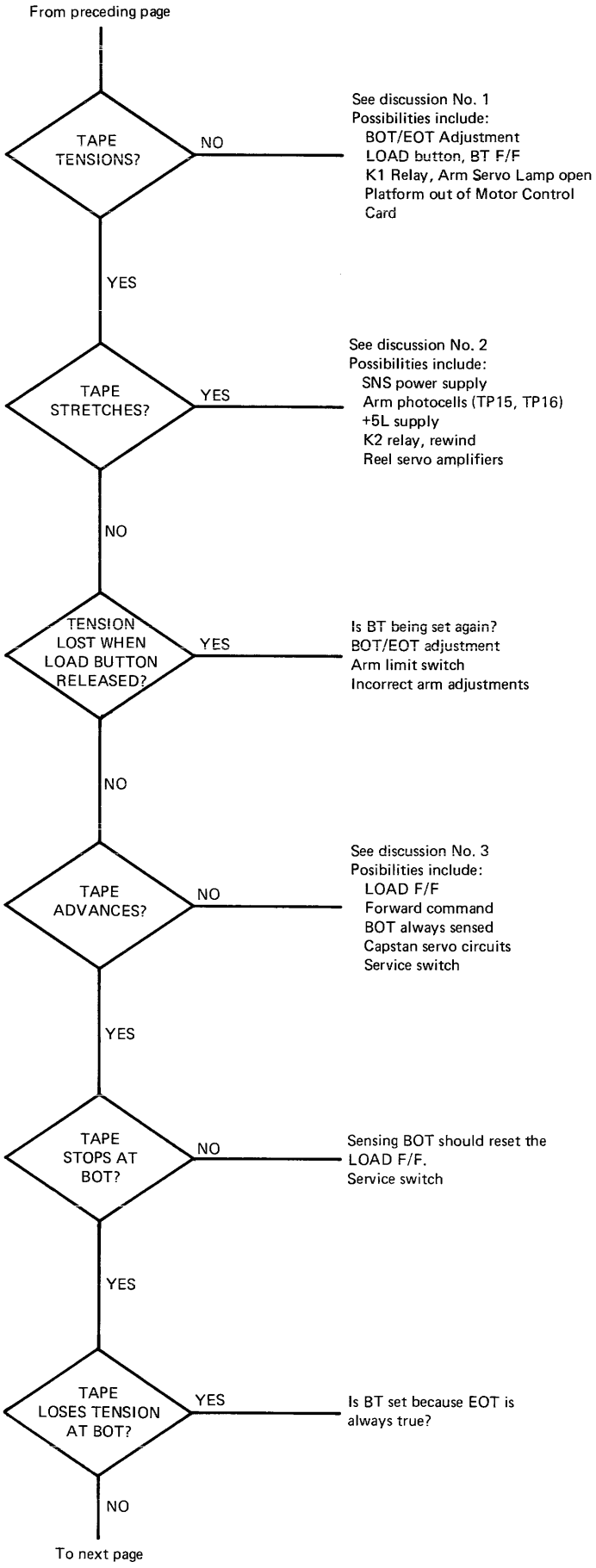
8.1 INTRODUCTION. This section includes a problem isolation flow chart to help the field maintenance engineer isolate transport malfunctions to a particular component or circuit. It also describes the service switch and explains one particularly useful technique for troubleshooting the motor control circuits.

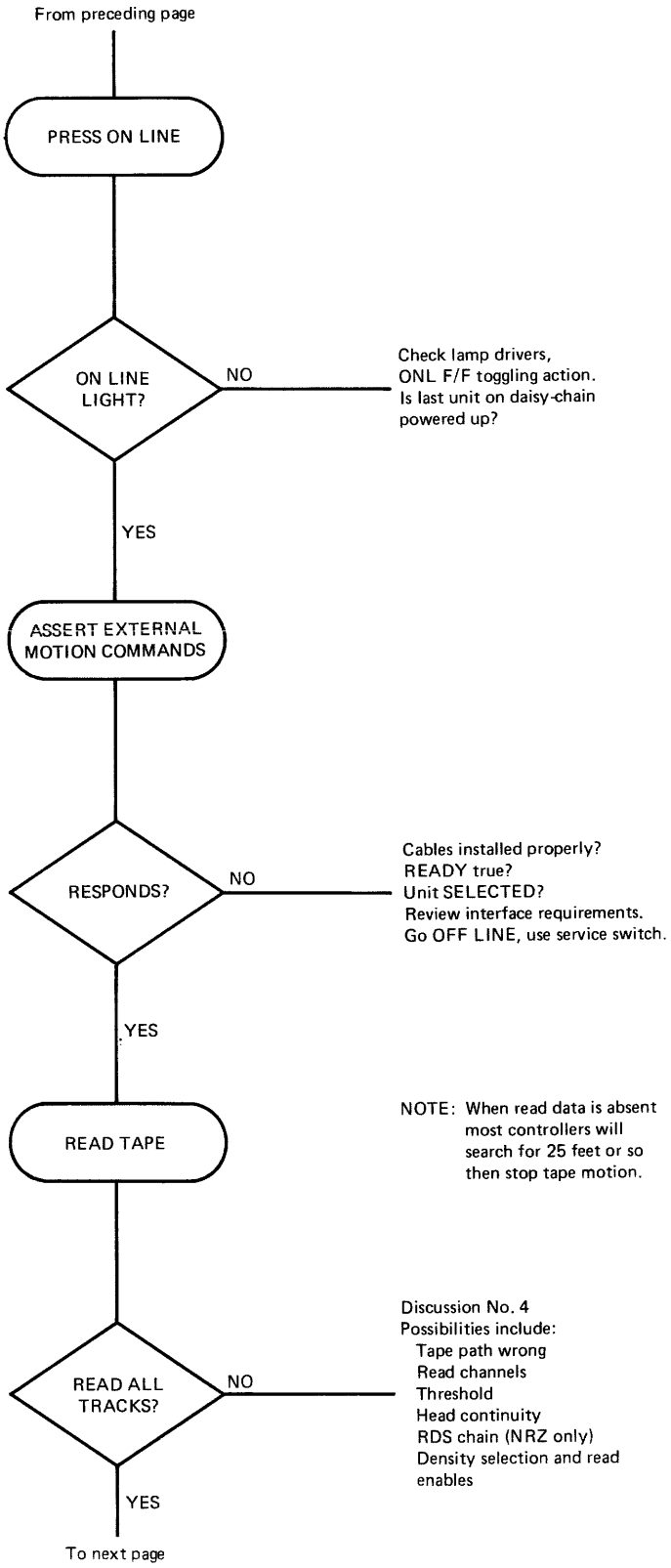
The problems identified in the flow chart are not in strict sequential order, but generally tape movement problems must be corrected before tackling write or read errors as is shown. Many seemingly sophisticated problems may be solved by performing the adjustments and alignments described in Section 10 of this manual.

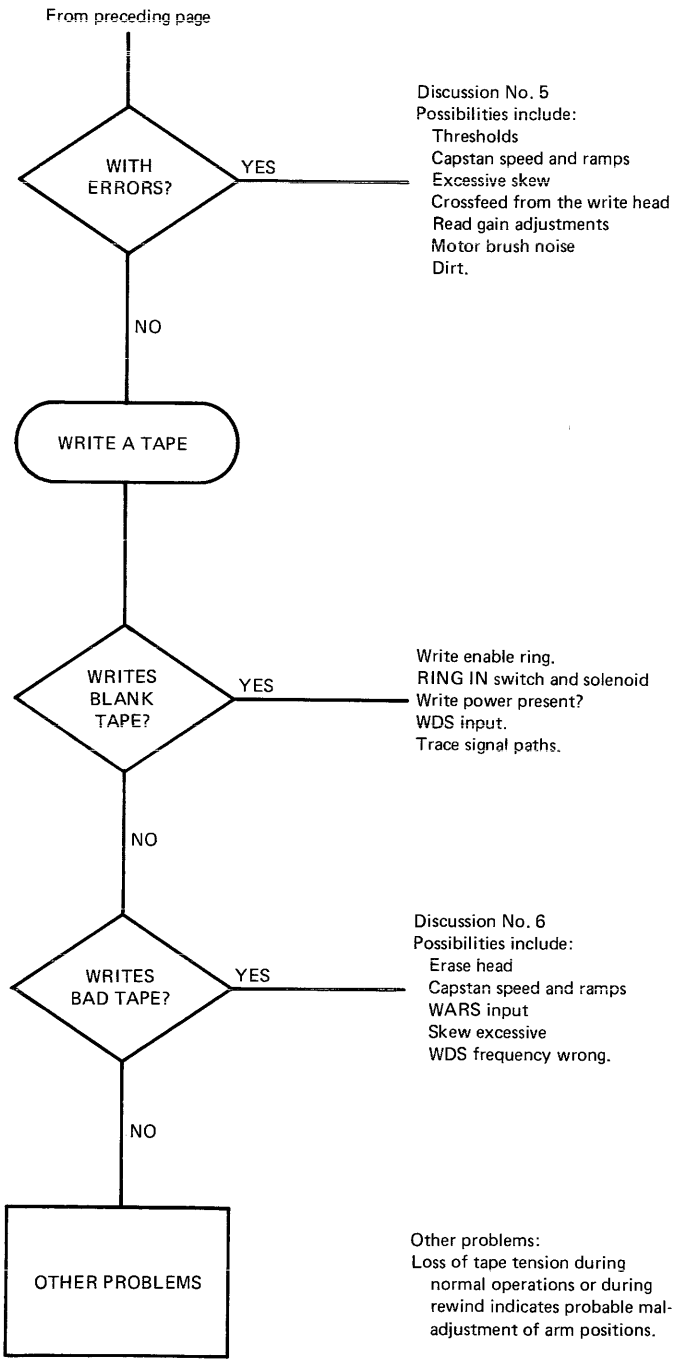
Upon isolating the problem, see Sections 9 and/or 10 to correct it. See Section 7, as required, for a description of any particular circuit's operation.

8.2 PROBLEM ISOLATION FLOW CHART.




From preceding page
TAPE TENSIONS?
NO
See discussion No. 1
Possibilities include:
BOT/EOT Adjustment
LOAD button, BT F/F
K1 Relay, Arm Servo Lamp open
Platform out of Motor Control Card
YES
TAPE STRETCHES?
YES
See discussion No. 2
Possibilities include:
SNS power supply
Arm photocells (TP15, TP16)
+5L supply
K2 relay, rewind
Reel servo amplifiers
NO
TENSION LOST WHEN LOAD BUTTON RELEASED?
YES
Is BT being set again?
BOT/EOT adjustment
Arm limit switch
Incorrect arm adjustments
NO
TAPE ADVANCES?
NO
See discussion No. 3
Posibilities include:
LOAD F/F
Forward command
BOT always sensed
Capstan servo circuits
Service switch
YES
TAPE STOPS AT BOT?
NO
Sensing BOT should reset the LOAD F/F.
Service switch
YES
TAPE LOSES TENSION AT BOT?
YES
Is BT set because EOT is always true?
NO
To next page


From preceding page
PRESS ON LINE
ON LINE LIGHT?
NO
Check lamp drivers, ONL F/F toggling action. Is last unit on daisy-chain powered up?
YES
ASSERT EXTERNAL MOTION COMMANDS
RESPONDS?
NO
Cables installed properly? READY true? Unit SELECTED? Review interface requirements. Go OFF LINE, use service switch.
YES
READ TAPE
NOTE: When read data is absent most controllers will search for 25 feet or so then stop tape motion.
READ ALL TRACKS?
NO
Discussion No. 4
Possibilities include:
Tape path wrong
Read channels
Threshold
Head continuity
RDS chain (NRZ only)
Density selection and read enables
YES
To next page


From preceding page
WITH ERRORS?
YES
Discussion No. 5
Possibilities include:
Thresholds
Capstan speed and ramps
Excessive skew
Crossfeed from the write head
Read gain adjustments
Motor brush noise
Dirt.
NO
WRITE A TAPE
WRITES BLANK TAPE?
YES
Write enable ring.
RING IN switch and solenoid
Write power present?
WDS input.
Trace signal paths.
NO
WRITES BAD TAPE?
YES
Discussion No. 6
Possibilities include:
Erase head
Capstan speed and ramps
WARS input
Skew excessive
WDS frequency wrong.
NO
OTHER PROBLEMS
Other problems:
Loss of tape tension during normal operations or during rewind indicates probable mal-adjustment of arm positions.

DISCUSSION # 1. The LOAD pushbutton should reset the BT F/F and force REELS ON (P1-W) high. REELS ON should activate relay K1 (P1-18 low) to connect all three motors to their servo amplifiers. Work through this sequence. Remember that BOT/EOT will prevent BT from resetting, so be sure they are adjusted. An open arm servo lamp or missing motor control card platform will also hold BT true. Hold the LOAD pushbutton down when troubleshooting or hold the take-up arm within its operating arc to prevent the arm limit switch from generating SET BT.

DISCUSSION # 2. The reel motors in all three models are connected to their servo amplifiers so that if the amplifier output is positive the motor winds tape onto its reel and if negative the motor unwinds tape. When an amplifier outputs an unrestrained positive voltage, tape will stretch until the supply arm trips the arm limit switch. If the field engineer holds the LOAD pushbutton down to override the arm limit switch, the tape will eventually separate. See paragraph 8.4 to operate the transport without tape loaded.

There are several possible causes of a continual positive voltage from the amplifier.

1. No photocell input to the reel servo at TP15 or TP16 because either the photocell of the +5L is defective.
2. No negative supply voltages.
3. One amplifier of the other is defective. Compare TP17 with U28-10, and TP14 with U27-10. Check the power transistors on the heat sink for emitter-collector shorts. After replacing a defective transistor check all associated transistors with an ohmmeter before applying power again.

Possibilities 1 and 2 affect both reel motors; the third possibility usually affects only one.

A problem in the rewind circuit may also stretch tape, particularly on transports that include relay K2 to switch a greater potential across the motor windings.

SERVO AMP OUTPUT	REEL/TAPE ACTION	1140, 1640 REEL TURNS	1740, 1840 REELS TURNS
Positive	Winding	CCW	CCW
Negative	Unwinding	CW	CW
Positive	Winding	CCW	CW
Negative	Unwinding	CW	CCW

Figure 8-1. Expected Reel Action

DISCUSSION # 3. Resetting BT starts a one-shot which triggers another one-shot on its trailing edge. This second one-shot sets the LOAD F/F, which makes FORWARD true at P1-2. Look for −6 volts at TP12, a positive signal at TP4, a positive signal at TP8, and a positive signal at K1-6 to quickly isolate the problem within the capstan servo circuit.

DISCUSSION # 4. If the transport fails to read in all tracks check to see that the tape was correctly threaded, particularly at the tape guide after the head. In dual density units check NRZ READ ENABLE, $\overline{\text{PE READ ENABLE}}$, and DENSITY. In NRZ units check the timing chain which generates RDS; check also the threshold against the voltages in figure 7-11.

In individual tracks, check the numerous test points for read data moving toward the head. With power off, check continuity from ground to each of the eighteen (fourteen) read amplifier inputs.

DISCUSSION # 5. Before attempting any other corrective measures check that the head and guides are clean and that the tape is good quality. Check tape speed and start/stop ramps per paragraph 10.3.3. Check skew per paragraph 10.10.1. Adjust the read amplifier gain potentiometers per paragraph 10.8. Verify that threshold level is correct. If the problem occurs only during read-after-write, perform the cross-feed minimization procedure in paragraph 10.9. To determine if the problem is a noisy motor brush read a bulk-erased tape while monitoring either RDS or one of the read channels.

DISCUSSION # 6. Check the write signal at the head in all tracks while writing all ones. If the unit writes tapes which it can read but other systems cannot, the problem is probably excessive skew (paragraph 10.10) or improper tape speed (paragraph 10.3). Other items to check are: frequency of WDS; data is stable for the duration of each WDS; WARS is being supplied; the erase head is energized.

8.3 SERVICE SWITCH. A three position slide switch located on the write/control card enables the maintenance engineer to move tape while Off Line. With this service switch in FORWARD the capstan servo circuity is commanded to move forward continually. In REVERSE reverse motion is commanded. This reverse command is not disabled by BOT detection, so be careful not to run tape entirely off either reel. When not in use the switch should always be returned to the normal position. This switch is inoperable with the transport ON LINE.

8.4 TROUBLESHOOTING WITHOUT TAPE LOADED. The following troubleshooting technique allows the field maintenance engineer to rapidly isolate a malfunction using only the operator's control panel and the service switch.

A. *Disable the "set BT" conditions.* Place a small piece of magnetic tape between the two elements of the BOT/EOT sensor assembly to prevent the BROKEN TAPE F/F from being held set. (The load indicator should go off when this step is performed.) Use a rubber band or write enable ring between the arm roller and stationary roller to hold the take-up arm off its stop so that the arm limit switch does not produce SET BT.

B. *Initiate the load sequence.* Press and release the LOAD pushbutton. Check that both reel motors begin to spin and that about half a second later the capstan starts to turn CCW. This indicates that the LOAD pushbutton has reset BT, generating REELS ON and activating relay K1 to connect all three motors to their amplifiers. The capstan motion indicates that the one-shot delays, the LOAD F/F, and the capstan servo are all functioning.

C. *Check the reel servos.* The LOAD F/F is producing a forward motion command. With your hand move the *take-up* arm off its stop. As you pass over the first dimple (on the front plate) the take-up reel motor should stop and reverse direction. The null point for the *supply* arm will be near the second dimple at the opposite end of the arc. These are the proper arm positions for forward motion. This check tests whether both reel servo circuits are functioning properly. If one motor spins continually or not at all and fails to change velocity or direction with arm position, its servo amplifier is suspect. If both motors spin, the problem is generally in the power supply.

D. *Fake a BOT marker.* Press the LOAD and ON LINE pushbuttons simultaneously and release. This generates a fake BOT and resets the LOAD F/F to halt the capstan halts. The proper arm position is now center. Verify this as in the previous stop.

E. *Move tape with the service switch.* Place the transport Off Line and move the service switch to REVERSE and then to FORWARD. Check capstan direction and proper arm positions. (Proper arm positions for reverse are take-up arm at second dimple, supply arm at first dimple.)

F. *Rewind.* Press the REWIND pushbutton. The capstan will turn CW at high speed. Proper arm positions cannot be checked in this mode with this technique. Press ON LINE and LOAD simultaneously. The capstan should halt after the buttons are released and then move forward as in the load sequence. Press ON LINE and LOAD simultaneously and the capstan will halt.

G. *Unload.* Press LOAD, ON LINE and REWIND simultaneously. The capstan will turn reverse at slow speed. The proper take-up and supply arm positions are both at the first dimple.

9 - COMPONENT REMOVAL AND REPLACEMENT

9.1 INTRODUCTION. This section provides removal and replacement procedures for all field replaceable components, including all items appearing on the recommended spare parts lists. When a part is replaced some adjustement or alignment is generally required. The last step of each replacement procedure below refers the maintenance engineer to the appropriate paragraphs in Section 10 , Adjustment and Alignment.

WARNING!

Remove power input cable from branch circuit before performing any service operations.

9.2 PRINTED CIRCUIT CARDS. To remove and replace the motor control card, read card, or write/control card perform the following steps.

1. Turn off power and wait a minute for the capacitors to discharge.
2. Remove the two screws holding the card in place and remove the card by pulling firmly out. (Access to the motor control card may be improved by removing the two screws holding the card cage in place and swinging it away).
3. Inspect the replacement card. See Section 6 for details.
   A. If a motor control card, are the proper versions of platforms U8, U24 and U26 installed? Is the card itself the proper version?
   B. If a read card, is it the proper version?
   C. If a write/control card, are *all* plug jumpers installed in the desired positions?
4. Insert the replacement card in the appropriate card slot; press firmly to insure a good seat in the connectors and replace the hold-down screws. The component side of the motor control card and the write/control card must be to the rear; the component side of the read card must be to the front.
5. See the appropriate adjustment procedures in Section 10 of this manual:
   Motor Control Card: paragraphs 10.2, 10.3 and 10.4.3
   Read Card: paragraphs 10.8 and 10.12.
   Write/Control Card: paragraph 10.5 and 10.7.

9.3 CAPSTAN MOTOR. To remove and replace the capstan motor follow the procedure below.

1. Turn off power and disconnect the motor electrically by separating motor to chassis connector P9/P9.
2. Measure and record for future use the distance between the capstan and the front plate. See figure 9-1.

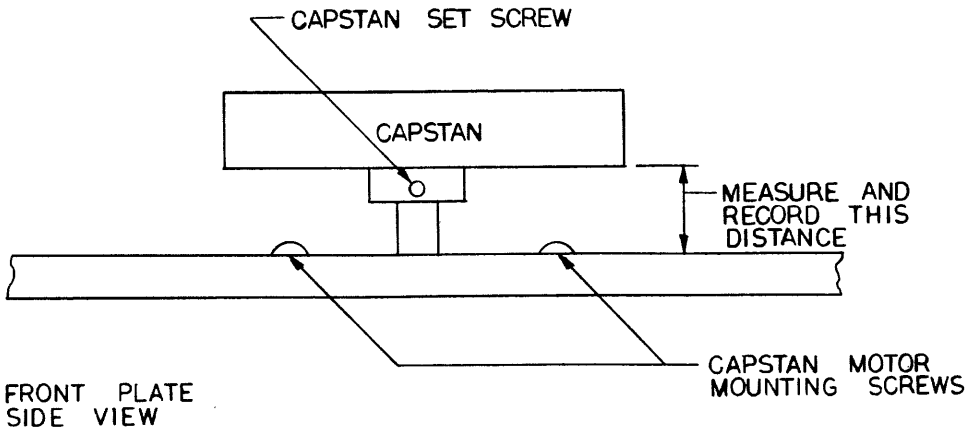


Figure 9-1. Capstan Height Measurement

3. Loosen the set screw in the capstan with the appropriate Allen wrench and remove the capstan from the motor shaft. The capstan is machined from a soft metal, so excessive force may deform it.

4. Remove the four screws holding the motor to the plate while supporting the motor with your hand. Remove motor. Save any shims and note where they were installed.
5. Insure that the mounting surface of plate and replacement motor are clean to avoid perpendicularity problems.
6. Install the new motor with the four screws. Reinstall the shims from step 4.
7. Mount capstan on the motor shaft at the previously recorded height. Tighten the set screw after lining it up with the flat of the motor shaft.
8. Plug together connector P9/P9.
9. Use the service switch to run tape forward and reverse, and visually verify that tape is tracking properly across the capstan.
10. Perform capstan servo adjustments per paragraph 10.3. Note that the shortcut method of duplicating voltage reading at TP1 cannot be used since these readings are for the old motor. Also check the read skew per paragraph 10.10.1.

9.4 REEL MOTORS. To remove and replace either reel motor follow the procedure below.

1. Turn off power and disconnect the motor electrically; supply motor connector is P8/P8, take-up motor connector is P10/P10.
2. To improve access to the reel motors swing the card cage away and remove the motor control card entirely.
3. Measure and record for future use the distance between the hub and the plate. See figure 9-2.

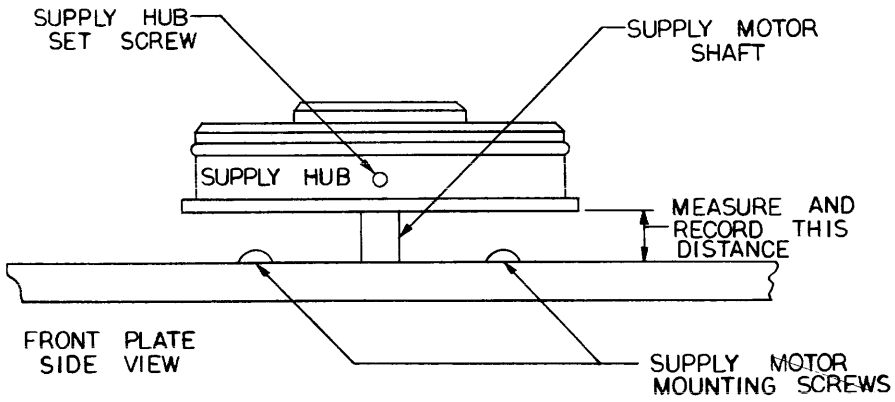


Figure 9-2. Reel Hub Height Measurement

4. If a supply motor is being removed skip to step 5. On the 1640 or 1140 remove the rubber ring from the take-up hub by pulling it up with your fingers. On the 1740 or 1840 remove the three screws from the reel retaining plate; remove the reel retaining plate and take-up reel.
5. Loosen the set screw in the hub with the appropriate allen wrench and remove the hub from the reel motor shaft.
6. Remove the four screws holding the motor to the plate and remove the motor. Support the motor with one hand during this step.
7. Check that the mounting surfaces of the plate and new motor are clean and mount the new motor with the screws.
8. Mount the hub on the motor shaft at the previously recorded height. Tighten the set screw after lining it up with the flat of the motor shaft.
9. If a supply motor is being installed skip to step 10. On the 1640 or 1140 reinstall the rubber ring on the take-up hub. On the 1740 or 1840 reinstall the plastic reel and metal reel retaining plate with the three screws.
10. Plug the new motor's electrical connector together.
11. Reinstall the motor control card. Apply power, load tape, and use the service switch (located center of write/control card) to run tape forward and reverse. Check that the tape edge does not ride against the edge of either reel. Readjust the hub height if necessary. Perform the adjustments in paragraph 10.4.3.

9.5 BOT/EOT SENSOR ASSEMBLY. To replace the BOT/EOT sensor (BES) perform the steps listed below.

1. Unsolder the following wires from J5.

J1-10	black	BES GND
J5-D	violet	BES LED POWER
J5-R	white	BOT SENSE
J5-S	yellow	EOT SENSE

2. Remove the screw holding the BOT/EOT sensor assembly in place, and remove the assembly by pulling the attached wires through the hole in the plate.
3. Thread the wires of the replacement sensor assembly back through the same hole and mount the sensor assembly on the plate with the screw and washers previously removed.
4. Align the sensor assembly parallel to the head cover surface opposite it.
5. Run the four wires into the center cable harness and back to J5. Attach cable ties as necessary. Solder the four wires onto the pins indicated in step 1 above.
6. Perform the BOT/EOT adjustment procedure per paragraph 10.5.

9.6 ARM SERVO ASSEMBLY. To remove and replace either arm servo assembly perform the following steps while referring to figure 9-3. Note that the supply arm lamp and take-up arm lamp are connected in series so that if either fails the other will also be extinguished. With power off, use an ohmmeter to determine which lamp has opened.

1. Remove the vane (photo disk) using the appropriate Allen wrench.
2. Remove the connector attached to the p.c. assembly.
3. Remove the two screws which hold the assembly to the arm block and remove the assembly.

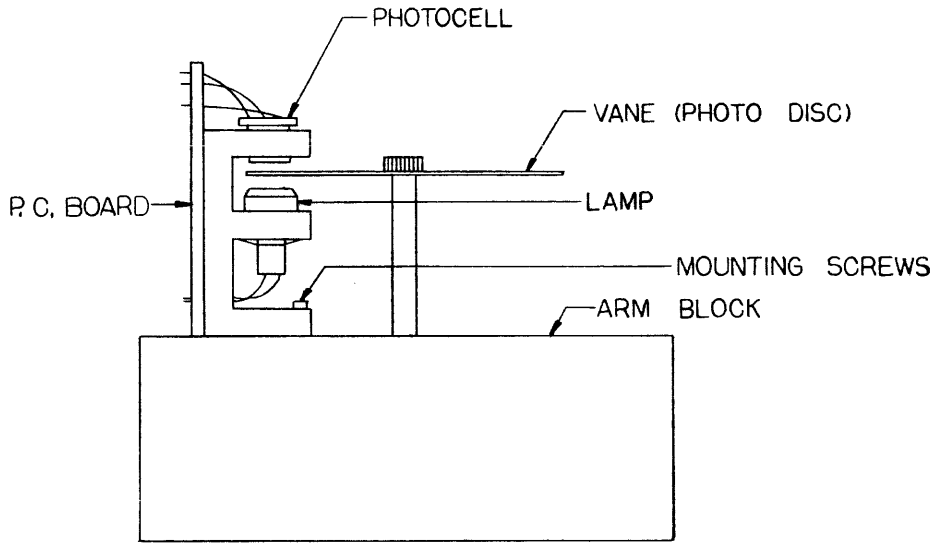


Figure 9-3. Arm Servo Assembly

4. Install the new arm servo assembly to the arm block with the two screws.
5. Reconnect the connector to the p.c. card, orienting it properly. If the connector is reversed the machine will not operate but will not be damaged.
6. Mount the vane using the socket head screw. Move the tension arm with your hand; the slot in the vane should move inward as the arm is moved off the stop. If not, the vane is mounted upside down.
7. Perform the arm servo alignment procedure in paragraph 10.4.1.
8. If the take-up arm servo assembly was replaced, perform the arm limit switch adjustment procedure in paragraph 10.4.2.
9. Adjust the arm positioning potentiometers per paragraph 10.4.3.

9.7 CONTROL PANEL ASSEMBLY. To replace a defective control panel perform the following sequence.

1. Remove the four screws which hold the assembly to the plate.
2. Unplug connect P11/A01J1.
3. Label and pull off the quick-disconnect power connections from the POWER switch of the defective assembly.
4. Push the power connections onto the POWER switch in the new control panel assembly.
5. Connect P11/A01J1 in the proper orientation. If the connector is reversed the machine will not operate but no damage will occur.
6. Mount the new assembly on the front plate with the four screws and washers.
7. No electrical adjustments are required.

9.8 **RELAYS.** All 40 Series transports contain at least one relay. The 1840, 1740 and the 1640 at 37.5 IPS tape speed contain two relays. To replace either, perform the following sequence.

1. Turn off power.
2. Snap off the relay retaining spring by prying it lightly up and pushing it off to the side.
3. Unplug the relay from its socket.
4. Line up the pins of the replacement with the socket and plug the relay in.
5. Push the retaining spring up into the catch on the top of the relay.
6. No adjustments are required.

9.9 FILE PROTECT ASSEMBLY. To replace the file protect assembly (which senses the present or absence of the write enable ring) perform the following sequence.

1. Label and remove the four wires connected to the RING IN switch and solenoid.

L1(+)	J2-K	yellow
L1(–)	TB-1	black
S5-COM	J1-V	white
S5-N.O.	J6-E	white

2. Remove the two screws which hold the file protect assembly to the front plate and remove.
3. Mount the replacement assembly with two screws and washers.
4. Reconnect the four wires disconnected in step 1.
5. Perform the solenoid plunger/microswitch adjustment per paragraph 10.6

9.10 POWER COMPONENTS

9.10.1 BRIDGE RECTIFIERS. To replace any of the three bridge rectifiers (CR1, CR2, or CR3) follow the procedure below.

1. Pull off the four connections from the rectifier to be replaced.
2. Remove the screw and the split-lock and flat washers from the center of the rectifier and remove the rectifier from the chassis.
3. Apply heat sink compound to the bottom of the replacement rectifier and to the mounting surface of the chassis. Mount the rectifier with the hardware previously removed.
4. Push onto the proper rectifier terminals the four wires previously removed.
   CR1: (+) to C1(+), (–) to TB1–1, (AC) to T1 red/white
   CR2: (+) to C2(+), (–) to TB1–1, (AC) to T1 violet/white
   CR3: (+) to TB1–1, (–) to C3(–), (AC) to T1 blue/white
5. Adjust the regulator outputs per paragraph 10.2.

9.10.2 FILTER CAPACITORS. To replace any of the three filter capacitors (C1, C2 or C3) located on the chassis perform the following sequence.

1. Swing open the card cage and remove the motor control card.
2. Label and remove the connecting wires and bleeder resistor from the terminals of the capacitor to be replaced.
3. Measure and record the height of the capacitor above the chassis and note the orientation of the vent plug. Loosen the capacitor clamp and slide the capacitor out of the chassis.
4. Insert the replacement capacitor into the clamp, and tighten the clamp with the capacitor located at the height previously noted and with the vent plug in the proper location.
5. Connect all wires and the bleeder resistor previously removed to the capacitor terminals.
6. Re-install the motor control card and verify the voltage regulator outputs per paragraph 10.2. Secure the card cage in its closed position with hardware.

9.10.3 MOTOR SUPPRESSION RECTIFIERS. To replace either motor suppression rectifier (CR4 or CR5) follow the procedure below.

1. Pull off the connections from the rectifier to be replaced.
2. Remove the screw and the split-lock washers from the center of the rectifier and remove the rectifier from the chassis.
3. Mount the replacement with the hardware previously removed.
4. Push the four wires previously removed onto the proper terminals:
   Blue wire to (–);
   Red wire to (+);
   White wires to AC.

9.11 RECOMMENDED SPARE PARTS INVENTORY. Each of the components and assemblies appearing on the parts list at the end of this section is field replaceable.

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
1		2060002-0002	FUSE, 1.5A SLO-BLO	
2		2060002-0001	FUSE, 3.0A SLO-BLO	
3		2060007-0001	RELAY, 12VDC	
4		2550001-0001	RECTIFIER, CR4, CR5	
5		2550000-0001	RECTIFIER, CR1, CR2, CR3	
6		2551088-6353	CAPACITOR, 35VDC 35K UF	
7		2551088-6114	CAPACITOR, 35VDC 110K UF	
8		2250101-6753	CAPACITOR, 15VDC, 75K UF	
9		0052802-0001 to 0002	CONTROL BLOCK KIT	
10		2050027-0001	MOTOR/TACHOMETER	
11		2051067-0002	REEL MOTOR	
12		2050035-0002	REEL MOTOR	
15		0051553-0001	BOT/EOT SENSOR ASSEMBLY	
16		0052312-0001	ASSEMBLY SERVO	
17		0051477-0001	EXTENSION SPRING ASSEMBLY	
18		0051550-0001 to 0012	ASSEMBLY, MOTOR CONTROL	
19		0051706-0003	WRITE/CONTROL CARD KIT	
20		0051548-0001 to 0018	READ CARD KIT	

	SH.	P.L. NO.	REV.
SPARE PARTS LIST, 40 SERIES TRANSPORT			

D.D.C. FORM 117

10 - ADJUSTMENT AND ALIGNMENT

10.1 INTRODUCTION. This section provides step-by-step procedures for the alignment of various mechnical assemblies and the adjustment of the transport's twenty-five potentiometers.

10.2 REGULATED VOLTAGES. The transport has four regulated voltages, two of which are adjustable. Maximum AC ripple is 50 mV p-p.

1. With an accurate voltmeter connected between TP10 (GND) and TP5 (+5L) adjust potentiometer R62 to obtain +5V ±0.05.
2. Adjust potentiometer R52 to obtain +12V ±0.05 between TP10 (GND) and TP2 (+12).
3. Verify that the voltage at TP3 is +5V ±0.1.
4. Verify that the voltage at TP6 is −12V ±0.6.

10.3 CAPSTAN SERVO ADJUSTMENT. These adjustments determine the transport's tape speed and acceleration. The procedures given below require a transport test card.

10.3.1 ZERO ADJUSTMENT. Load a reel of magnetic tape to BOT. With no motion commanded adjust the voltage at TP7 to 0.00V ±0.01 with ZERO potentiometer R46. This adjustment removes any d.c. offset caused by tolerance build-up from the servo amplifier.

10.3.2 SPEED ADJUSTMENTS. The transport's forward and reverse speeds are each adjustable with a potentiometer. The rewind speed, since it is directly proportional to reverse speed, requires no adjustment. The optional dual speed transport contains a FAST potentiometer for adjusting the faster speed after the forward and reverse speed adjustments have been made at the slower speed.

Two different procedures are given below for performing the speed adjustments. Either procedure may be used when the motor control card is replaced. Only the longer procedure B may be used when the capstan motor is replaced.

Procedure A.

1. Locate the round label on the capstan tachometer (see figure 10-1). This label indicates the voltage readings at TP1 (tachometer feedback) when the factory technician properly adjusted the forward and reverse speeds at the time of manufacture using a method similar to Procedure B.
2. Connect an accurate voltmeter between TP10 (GND) and TP1 (tachometer feedback).
3. Move tape forward using either the service switch or the test card. Adjust R48 to voltage "F" on the capstan label.
4. Move tape reverse and adjust R49 to voltage "R" on the capstan label.

   NOTE: The service switch ignores the BOT marker.

5. If the transport has an optional second tape speed the FAST potentiometer must be adjusted. The input line SPS selects either a faster or slower speed. The four steps above must be performed at the slower of the two available tape speeds (whether normal or optional). To adjust FAST potentiometer R47, stop tape, switch to the higher speed and then generate a forward motion command. Duplicate the voltage at TP1 which appears on the tachometer label preceded by "FF." Be sure to stop tape motion before switching back to the slower speed.

Procedure B. This procedure for adjusting tape speed requires an 800 BPI master alignment tape and a frequency counter.

1. Load an 800 BPI master alignment tape to BOT. This tape reel should *not* contain a write enable ring.
2. Monitor the output at TP101 on the read card with a frequency counter (or oscilloscope).
3. Generate continuous forward motion at the lowest available speed with the service switch or the test card and adjust potentiometer R48 (FWD) to the frequency indicated on the following chart.

TAPE SPEED	FREQUENCY	PERIOD
12.5 IPS	5 KHz	200 usec
18.75 IPS	7.5 KHz	133 usec
25 IPS	10 KHz	100 usec
37.5 IPS	15 KHz	66.7 usec
45 IPS	18 KHz	55.5 usec
75 IPS	30 KHz	33.3 usec

4. Generate continuous reverse motion using either the service switch or test card and adjust R49 (REV) to obtain the same frequence as in step 3 above.
5. On a dual speed transport stop the tape and switch to the higher speed. Then move tape forward and adjust FAST potentiometer R47 to the frequency appropriate to that speed. Be sure to stop tape motion before switching back to the lower speed.
6. Unload and remove the master alignment tape.

10.3.3 RAMP ADJUSTMENT. This procedure requires an oscilloscope with a calibrated time base and a transport test card.

1. Set the test card switches to PULSE and FWD.
2. Load a reel of scrub tape to BOT and place the transport on line.
3. Trigger the scope negative on TP12 of the motor control card and view TP1. Adjust the test card STOP and GO times to achieve an adequate scope presentation; twice the desired ramp time generally works well.
4. Uncalibrate the scope amplitude and position the trace so that the 90% amplitude point of the start ramp may be easily determined. See figure 10-2.
5. Adjust RAMP potentiometer R45 to achieve the correct ramp time as indicated below.

TAPE SPEED	TIME TO READ 90% AMPLITUDE
12.5 IPS	27 milliseconds
18.75 IPS	18 milliseconds
25 IPS	13.5 milliseconds
37.5 IPS	9 milliseconds
45 IPS	7.5 milliseconds
75 IPS	4.5 milliseconds

6. Trigger positive and check that the stop ramp is approximately equal in time to the start ramp.
7. Move the motion switch on the test card to REV and check that the reverse start and stop ramps are approximately equal to each other and to the forward ramps.

10.4 REEL SERVO ADJUSTMENTS. These adjustments are all related to the operation of the tape-buffering arms.

10.4.1 PHOTODISK ALIGNMENT. This alignment is required only when the photodisk has been moved (e.g. while replacing the arm servo assembly).

1. Power up, but do not load tape.
2. Connect a voltmeter between ground and TP16 (supply photocell) or TP15 (take-up photocell) on the motor control card.
3. Hold the appropriate arm in the approximate center of its operating arc, equidistant between the two dimples.
4. The voltmeter should read 2.7V ±0.1. If it does not, loosen the set screw holding the photodisk and rotate the photodisk until the voltmeter reads 2.7V.
5. Tighten the set screw and ensure that the voltmeter still reads 2.7V with the arm held center.

10.4.2 ARM LIMIT SWITCH ALIGNMENT. See figure 10-3 regarding this alignment.

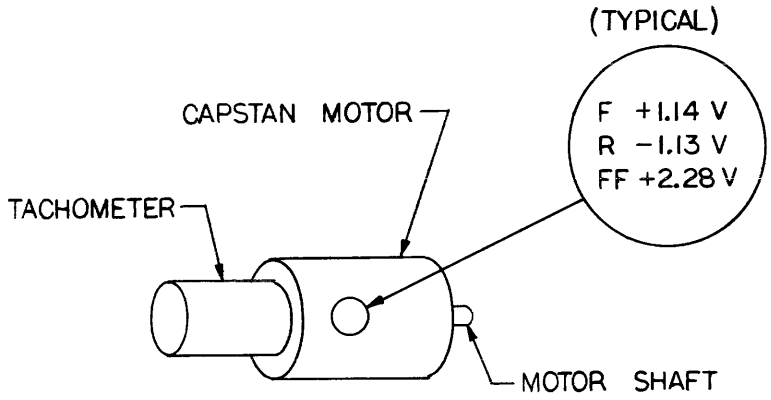


Figure 10-1. Location of Capstan Tachometer Feedback Voltage Readings

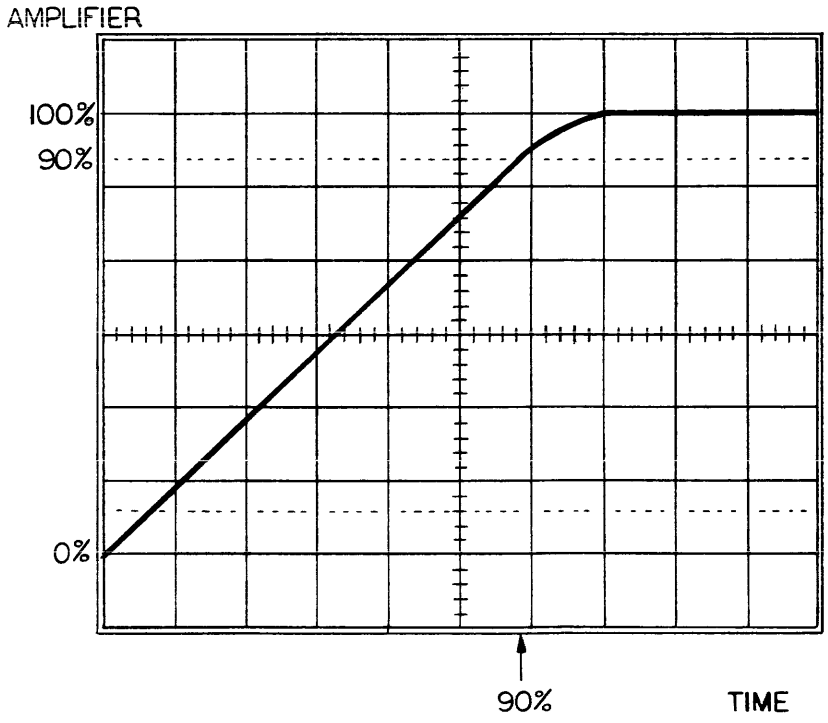


Figure 10-2. Ramp Adjust Scope Display

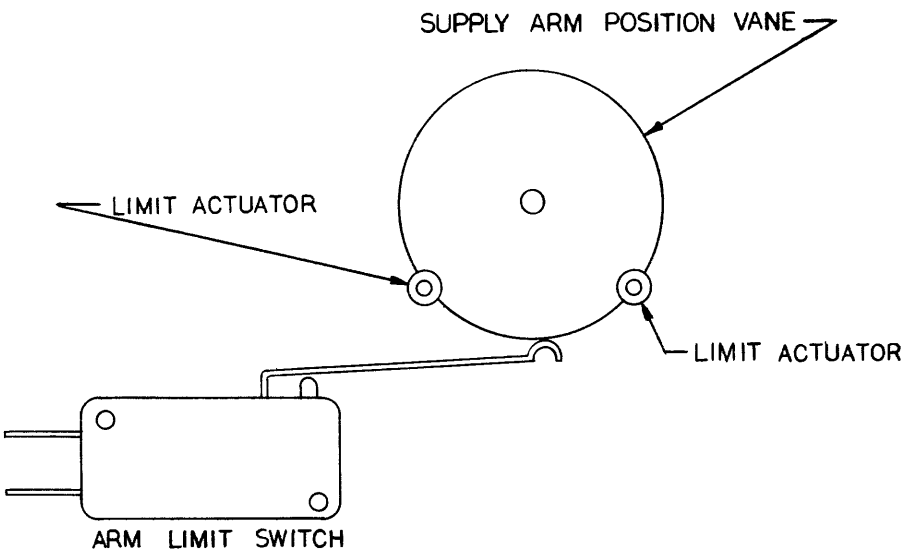


Figure 10-3. Arm Limit Switch Actuation

1. Check that the screws holding the microswitch in place are tight. Power *off*.
2. Connect an ohmmeter between the two connected lugs of the switch (COM and N.O.).
3. Lift the take-up arm off its top. The meter should go from "short" to "open" before the first dimple is reached. Release the arm to the stop; the meter should return to "short."
4. Move the take-up arm to the opposite end of its arc. The meter should go from "open" to "short" after the second dimple is passed. Bring the arm back again and the meter should indicate "open" before the dimple is reached.
5. Loosen and move the appropriate arm limit reactor(s) on the take-up photodisk as necessary to obtain the conditions described in steps 3 and 4.

10.4.3 ARM POSITION ADJUSTMENTS. The adjustments of the TUCEN, SUPCEN, TUARC and SUPARC potentiometers on the motor control card determine the position of the tape-buffering arms during various operations. Whenever the motor control card, a reel motor, or an arm servo assembly is replaced the following adjustment procedure must be performed.

1. Set the TUARC and/or SUPARC potentiometer(s) fully counter-clockwise. Set the TUCEN and/or SUPCEN potentiometer(s) to mid-range.
2. Load a reel of *scrub* tape to BOT. If tape will not load, adjust the TUCEN potentiometer *slightly* clockwise and try again.
3. Move tape forward several feet off BOT, then place the test card motion switch in SHUTTLE. Increase the GO time on the test card to one second to permit a full swing of the tape-buffering arms. If a test card is not available the maintenance engineer may simulate the shuttling mode by manually switching the service switch from FWD to REV repeatedly.
4. The arm reaches its widest swing when its associated reel is nearly empty. Turn TUARC potentiometer R124 clockwise, gradually increasing the take-up arm's arc until it reaches the dimples on the front plate. As this adjustment is made the arm will probably reach one dimple before the other. Adjust TUCEN potentiometer R134 to shift the entire arc. Continue to make repeated small adjustments to the TUARC and TUCEN potentiometers until the take-up arm is swinging exactly to each dimple. Figure 10-4 indicates the effect of the arm adjustments upon the arm's operating arc.
5. Switch the test card to forward motion and run most of the tape onto the take-up reel. Near EOT, switch to SHUTTLE mode again. Turn SUPARC potentiometer R125 gradually clockwise, widening the supply arm's arc. Adjust SUPCEN potentiometer R135 as required to achieve an arm swing from dimple to dimple.
6. Rewind and unload the tape.

Figure 10-4. Effect of Arm Adjustments

10.5 BOT/EOT SENSOR ADJUSTMENTS. Perform these adjustments whenever either the write/control card or the BOT/EOT sensor assembly is replaced. Only a voltmeter is needed.

1. Power up and wait at least one minute for warm-up before performing the voltage measurements in the following steps.
2. Thread tape and turn the reels to make the tape taut through the BOT/EOT sensor. Check that neither the BOT nor the EOT reflective tab is located within the sensor assembly.
3. Connect the voltmeter between ground and TP15 on the write/control card (J5-R) and adjust BOT potentiometer R81 until the meter reads at least +9 volts.
4. Connect the voltmeter between ground and TP16 on the write/control card (J5-S) and adjust EOT potentiometer R82 until the meter reads at least +9 volts.
5. Remove the tape from the sensor assembly. The voltages at TP15 and TP16 must drop below +1 volt.

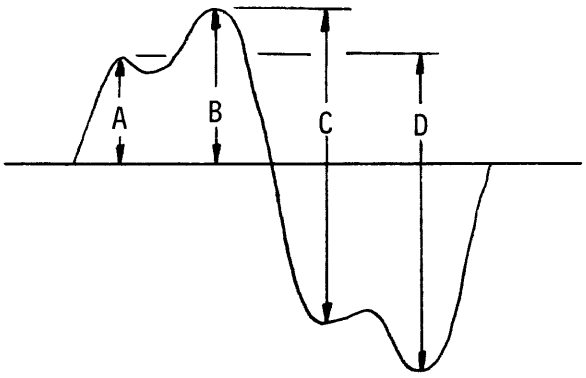
10.6 FILE PROTECT ALIGNMENT. The point of depression at which the ring-detecting plunger actuates the RING IN microswitch must be set when the file-protect assembly is replaced. See figure 10-5.

1. Power off and no tape loaded.
2. Connect an ohmmeter between the two connected lugs of the RING IN (WRT EN) microswitch. The meter should indicate an "open."
3. Depress the plunger which protudes through the front plate. The meter should indicate a "short" at the inner lip of the supply hub. See figure 10-5.
4. Loosen the set screw in the plunger cam and move the cam on the plunger as necessary to obtain the condition described in step 3.
5. Disconnect the meter. Power up, load a reel of tape with a write enable ring installed and verify that the solenoid retracts the plunger fully when the LOAD pushbutton is pressed. Check also that the WRITE ENABLE indicator is illuminated. The write power check described in paragraph 10.11 may be performed at this point but is not required.

10.7 PE WRITE CURRENT ADJUSTMENT. This adjustment is not necessary on NRZ only transports.

1. Load a master output tape (SRM 3200 or equivalent) on the transport.
2. Set up the test card to write phase encoded tape at 1600 flux reversals per inch (see the test card manual).
3. With oscilloscope, view TP102 on the read card.
4. Adjust potentiometer R1 on the write/control card to obtain the "cowboy hat" waveform shown in figure 10-6.
5. If unable to obtain the proper waveform, remove plug jumper W1 on the write/control card and adjust R1 again.
6. Check TP202 through TP902 to insure that all nine tracks exhibit similar waveforms. If necessary, readjust R1 for the best signal in the average track.
7. Uncalibrate the scope and check that the "dip" in the top of the "cowboy hat" is above 50% of the peak amplitude. See figure 10-7.

Figure 10-5. File Protect Assembly Alignment



1. **B shall be greater than or equal to A in both forward *and* reverse.**
2. **C shall be equal to D in both forward *and* reverse. (Note: C forward may not equal C reverse and D forward may not equal D reverse due to read head output differential in forward to reverse directions.)**

Figure 10-6. Differentiator Outputs at 1600 FRPI

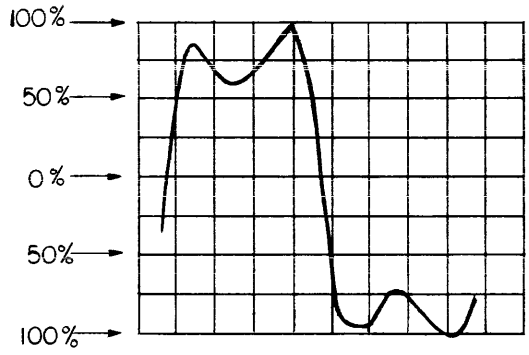


Figure 10-7. Proper Differentiator Output at 1600 FRPI

10.8 READ GAIN ADJUSTMENTS. The gain of the read preamplifiers must be adjusted when either the read card or the tape head is replaced. When making these adjustments a standard reference level tape (i.e. master output tape SRM 3200 or equivalent) recently recorded with "all one's" data should be used. Do *not* use a master alignment tape for these adjustments. Use only the first read pass after writing the tape for read normalization.

10.8.1 PE AND PE/NRZ READ GAIN. Any transport capable of reading phase encoded tapes should be adjusted using the following procedure.

1. Record entire length of master output tape at 3200 FRPI. Stop the tape at EOT and rewind. (To write a 3200 FRPI tape with the test card see the test card operation manual).
2. Read the phase encoded tape just recorded in step 1.
3. View TP102 with an oscilloscope and adjust potentiometer R108 to obtain a 6 volt peak-to-peak signal. See Figure 10-8. (Average out amplitude modulation).
4. Repeat step 2 for each of the remaining channels (TP202 and R208, etc.).
5. If the read forward pass ends (EOT reached) before all 9 tracks are adjusted repeat Step 1 above before continuing adjustments. Only the first read after write pass may be used for gain adjustments.

10.8.2 NRZ ONLY READ GAIN. To adjust the read amplifier gains on a NRZ only transport perform the following procedure.

1. Record entire length of master output tape at 800 FRPI. Stop the tape at EOT and rewind.
2. Read the NRZ tape recorded in step 1.
3. View TP101 with an oscilloscope and adjust potentiometer R108 to obtain a 10 volt peak-to-peak signal. (Average out amplitude modulation.)
4. Repeat step 2 for each of the remaining channels (TP201 and R208, etc.). Seven-track units do not use channels Ø and 1 (i.e. TP701 and TP801).
5. If the read forward pass ends (EOT reached) before all 9 tracks are adjusted repeat Step 1 above before continuing adjustments. Only the first read after write pass may be used for gain adjustments.

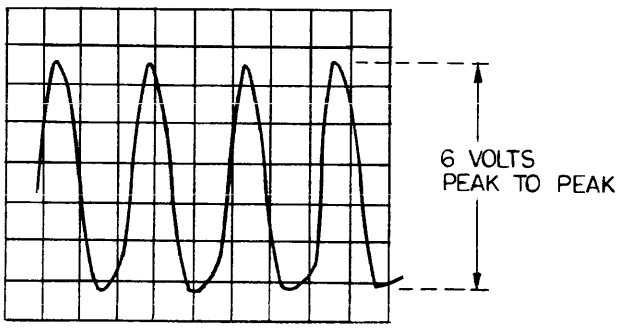


Figure 10-8, Read Gain Adjustment at 3200 FRPI

10.9 CROSS-FEED MINIMIZATION. If read-after-write errors are occurring or if a dual gap head is replaced the "flux gate" may have to be adjusted to minimize the cross-feed between the write and read stacks.

1. Verify that the gain of each read preamplifier is properly adjusted; see paragraph 10.8.
2. If the density select plug jumper located next to the service switch on the write/control card is not in W19, move it from W20 or W21 to W19 for the duration of this adjustment.
3. Turn power on and thread a scrub tape on the transport, omitting the capstan from the tape path (i.e. go directly from the tape guide (take-up side) to the tension arm roller).
4. Set up the transport test card to write all "ones" at 800 BPI with continuous forward tape motion. Press the LOAD pushbutton; the reel motors will tension tape and the capstan will rotate CCW. Press LOAD and ON LINE simultaneously to simulate BOT detection; the capstan will stop and then start forward again as the pushbuttons are released. The write circuits are now active. But since the tape is not moving the read circuits cannot really read-after-write; any activity in the read channels must be cross-feed from the write circuits.
5. With an oscilloscope view the pre-amplifier output TP101; the peak-to-peak signal must not exceed the maximum value listed below.

TAPE SPEED	MAXIMUM CROSSFEED SIGNAL
12.5 IPS	0.75 volts p-p
18.75 IPS	0.50 volts p-p
25 IPS	0.38 volts p-p
37.5 IPS	0.25 volts p-p
45 IPS	0.25 volts p-p
75 IPS	0.25 volts p-p

6. If signal amplitude exceeds the specification in step 5 loosen the two screws which hold the "flux gate" assembly to the plate. Move the assembly slowly from side to side and note the position which results in the smallest peak-to-peak cross-feed signal. The assembly should be parallel to the head and as close as possible to it without touching the tape.
7. Place the assembly in the optimum position for minimum cross-feed and tighten the two mounting screws. Verify that the assembly has not shifted while tightening the screws. Check also that TP201 through TP901 are within the maximum values indicated in step 5.
8. Turn off power, remove the tape, and return the density select plug jumper to W20 or W21 if moved in step 2.

10.10 TAPE SKEW. The difference in time, and therefore distance, between the first-to-arrive and the last-to-arrive channels is called interchannel displacement, or skew. There are two causes of skew. Static skew is unchanging from character to character and results from tolerance build-up. For example, the head windings may be neither perfectly in line with each other nor perfectly perpendicular to the tape because of head mounting, plate flatness and guide height variations. The tape guides should ensure that the tape moves across the head perpendicular to the winding, but relying on the tape guides to remove static skew will cause more dynamic skew.

Dynamic skew varies with tape direction, tape speed, and arm positions. Reel hub height, capstan height, and the variation of an arm's height throughout its arc all cause dynamic skew.

10.10.1 SKEW MEASUREMENT. To measure skew on the 40 Series transport a Digi-Data test card is generally required. See the skew measurement procedure in the test card operation manual. Maximum allowable skew (static plus dynamic) is 150% of the figure indicated below.

STATIC SKEW	TIME IN MICROSECONDS AT AVAILABLE SPEEDS					
	12.5 IPS	18.75 IPS	25 IPS	37.5 IPS	45 IPS	75 IPS
150 microinches	12.0	8.0	6.0	4.0	3.33	2.0

10.10.2 SKEW CORRECTION. Before concluding that one of the tape guides needs to be shimmed, check the following.

1. Verify that the tape has been properly threaded.
2. Clean all tape-handling components.
3. Check each tension arm roller for axial play. The roller should not move up and down. (Horizontal tilt is normal.) If either roller exhibits vertical play, it will have to be replaced.
4. Check the stationary rollers (1640 and 1740 only) for vertical play, and have either replaced if necessary.

5. Check the tape guide springs for freedom of movement. When depressed and released, the bottom flange should snap up to its original position. If the flange's movement feels spongy or sticks, remove, disassemble, and clean the tape guide. Recommended solvents are heptane or alcohol.
6. If none of the above is the cause of the skew problem, tape guide shims must be added or removed. A small label on the rear of the front plate near the head tells which guide (if either) was shimmed and how much. To determine which guide to shim, perform the skew measurement procedure per the test card operation manual. Press lightly on the outside edge of the tape near each tape guide in turn; the guide where the skew is worsened by pressing must be shimmed.

10.11 WRITE POWER CHECK. This procedure verifies that the transport can write only when specific conditions are met.

1. Load a scrub tape *without* a write enable ring. Place the transport on line.
2. Connect a voltmeter to J6-C.
3. Generate *pulsing* forward tape motion with the test card set up to WRITE. The meter must indicate 0 volts.
4. With your finger, press the file protect plunger rearward. The solenoid should take over and fully retract the plunger and hold it back. The meter should not indicate approximately +10 volts.
5. Switch the test card to READ; the meter should indicate 0 volts. Switch back to WRITE.
6. Place the transport off line; the write power should again go to 0 volts. Place the transport back on line.
7. Rewind; the write power should again go to 0 volts and return to +10 volts at the end of the rewind if the transport is still on line.
8. With your fingers, lift the actuator of the arm limit switch slightly (this is the microswitch which rides on the take-up arm's photodisk). "Broken tape" should be indicated; the meter will read 0 volts and will *not* return to +10 volts.
9. Press the LOAD pushbutton, then the LOAD and ON LINE buttons simultaneously. Rewind and unload the tape.

10.12 NRZ SKEW GATE ADJUSTMENT. This adjustment is necessary whenever the read card is replaced on any transport capable of reading NRZ tapes. All the data bits in a character must arrive during the SKEW GATE one-shot, which is triggered by the first bit to arrive. Nine-track ANSI standards require that all bits arrive within 34% of the character period.

1. Read any tape. View TP6 on the read card with an oscilloscope.
2. Adjust the width of the high (or single) density skew gate (TP6) with potentiometer R27 to the time indicated below.

SPEED	200 BPI	556 BPI	800 BPI
12.5	200 usec	72 usec	50 usec
18.75	133 usec	48 usec	33 usec
25	100 usec	36 usec	25 usec
37.5	67 usec	24 usec	17 usec
45	56 usec	20 usec	14 usec
75	33 usec	12 usec	8 usec

3. In seven-track dual density units, switch to the lesser density via the DDS input line or the optional front panel density select switch. Viewing TP5, the low density skew gate, adjust R24 to obtain the time indicated above.

11 - ENGINEERING DOCUMENTATION

SCHEMATICS

SCHEMATIC, MOTOR CONTROL ASSEMBLY	0252023-0000
SCHEMATIC, WRITE/CONTROL ASSEMBLY	0252195-0000
SCHEMATIC, READ CARD	0251741-0000
SCHEMATIC, H.S. READ CARD	0251663-0000
SCHEMATIC, TRANSPORT	0252337-0000
SCHEMATIC, MOTOR CONTR, 10½" TRANSPORT	0252338-0000
SCHEMATIC, MOTOR CONTR, 7, 8½" TRANSPORT, 25 IPS	0252348-0000
SCHEMATIC, MOTOR CONTR, 8½" TRANSPORT, 37.5 IPS	0252349-0000
SCHEMATIC, OPERATOR CONTROL PANEL	0252048-0000

INSTALLATION DRAWINGS

KIT INSTALLATION, 1140 and 1640 TRANSPORT	0051911-0000
KIT INSTALLATION, 1740 and 1840 TRANSPORT	0052710-0000
KIT INSTALLATION, 1740 and 1840 TRANSPORT w/o DOOR	0051896-0000
INSTALLATION DRAWING, I/O CABLE ADAPTER	0051614-0000

ASSEMBLY DRAWINGS

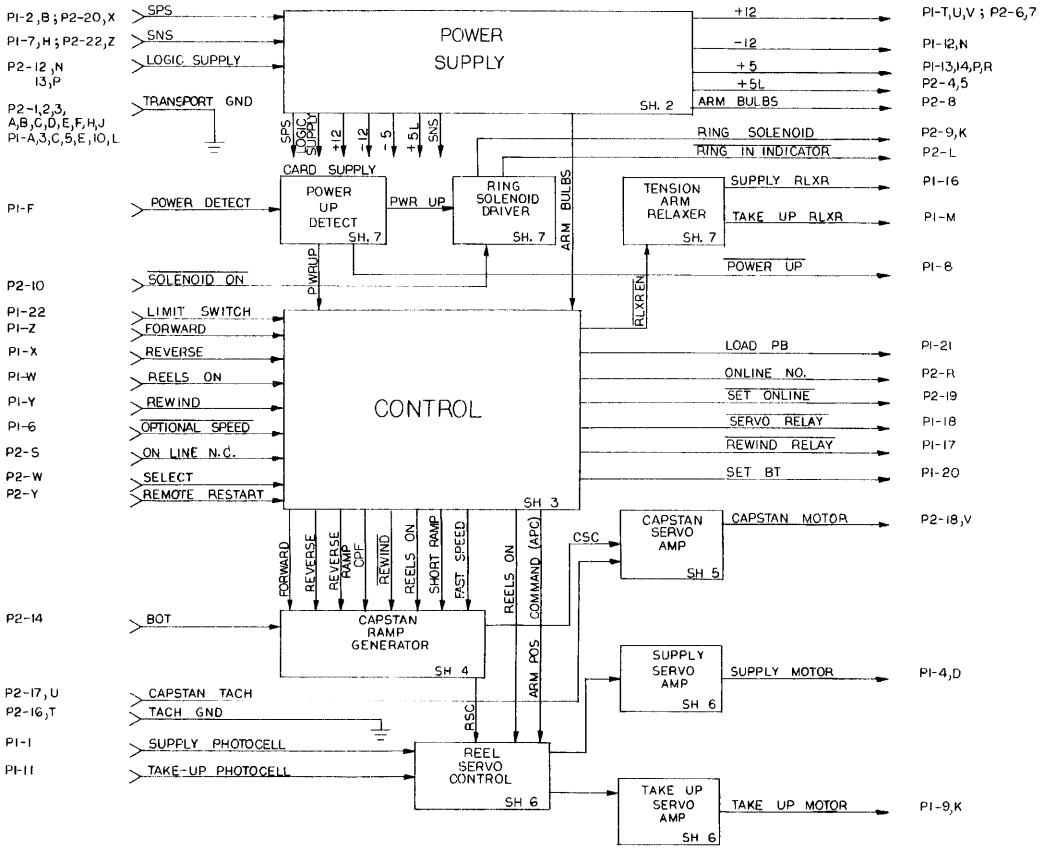
ASSEMBLY, MOTOR CONTROL	0052022-0000
ASSEMBLY, WRITE/CONTROL	0052198-0000
ASSEMBLY, PE/NRZ READ CARD	0051726-0000
ASSEMBLY, H.S. PE/NRZ READ CARD	0051656-0000

INSTALLATION PART LISTS

KIT INSTALLATION, 1140 and 1640 TRANSPORT, P/L	0051911-0001
KIT INSTALLATION, 1740 and 1840 TRANSPORT, P/L	0052710-0001
KIT INSTALLATION, 1740 and 1840 TRANSPORT w/o DOOR, P/L	0051896-0001

ASSEMBLY PARTS LISTS

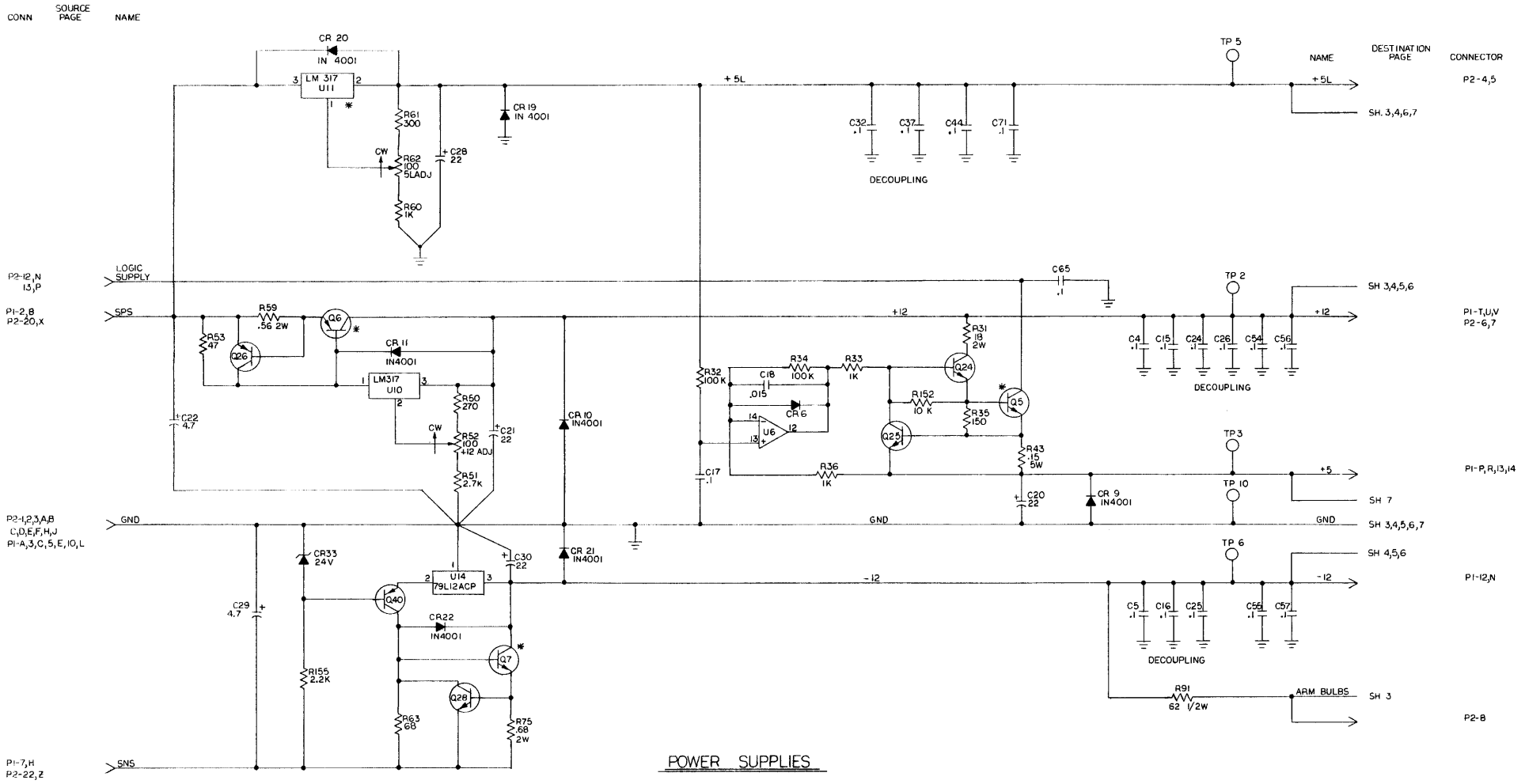
ASSEMBLY, MOTOR CONTROL, P/L	0052022-0001,-0002,-0009
ASSEMBLY, WRITE/CONTROL, P/L	0052198-0001 thru -0002
ASSEMBLY, PE/NRZ READ CARD, P/L	0051726-0001 thru -0006
ASSEMBLY, H.S. PE/NRZ READ CARD, P/L	0051656-0001 thru -0002



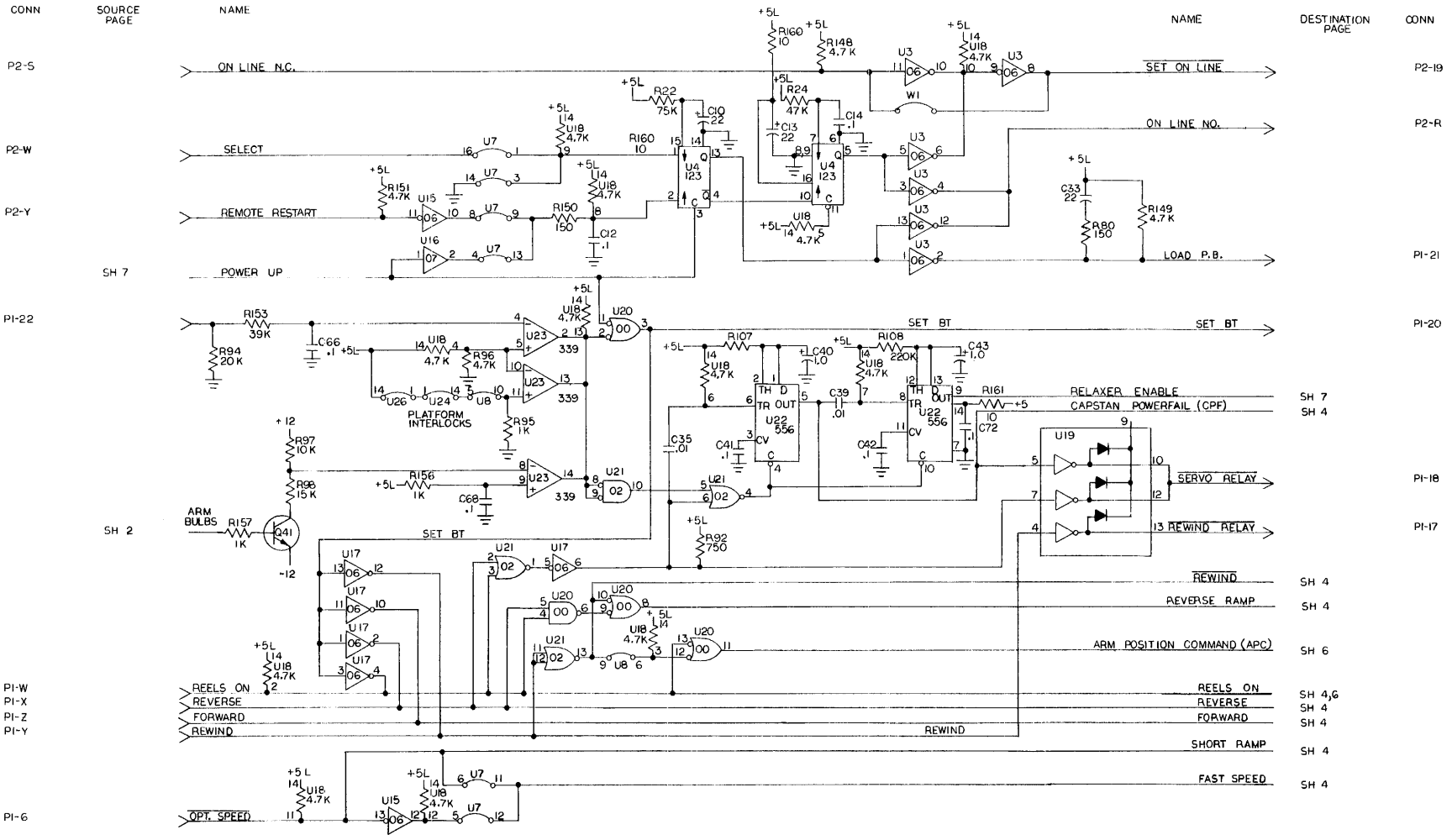
BLOCK DIAGRAM

NOTES :

1. UNLESS OTHERWISE SPECIFIED :
   A. ALL CAPACITORS CALLED OUT IN MICROFARADS.
   B. ALL RESISTANCES ARE IN OHMS.
2. * INDICATES THAT COMPONENT IS MOUNTED ON HEATSINK.
3. DEVICE TYPES INDICATED ON SCHEMATICS ARE PROVIDED FOR REFERENCE ONLY AND MAY BE SUBSTITUTED WITH EQUIVALENT PART TYPES WITHOUT NOTICE.

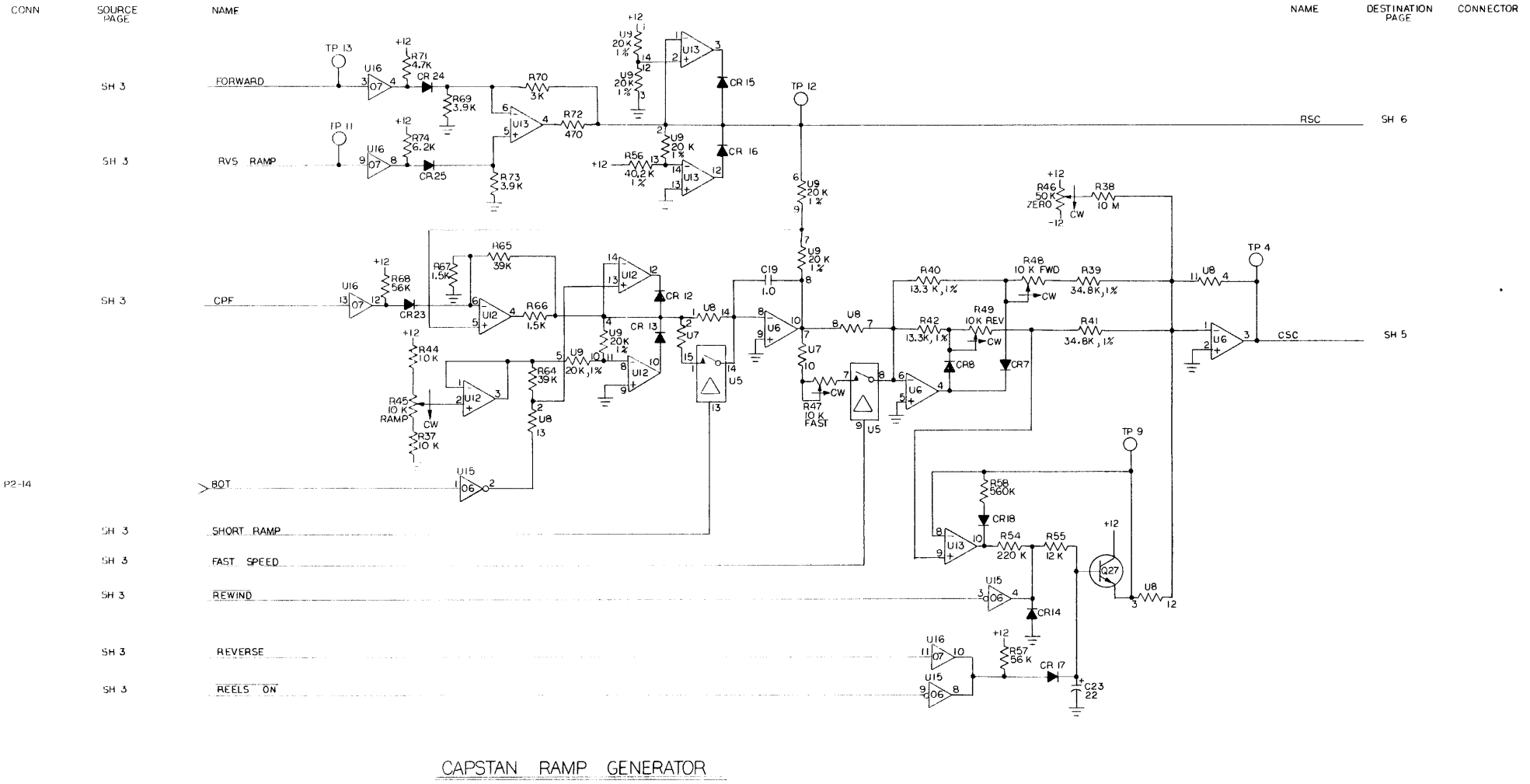


Schematic, Motor Control Assembly DWG 0252023-0000-02 (2 of 7)



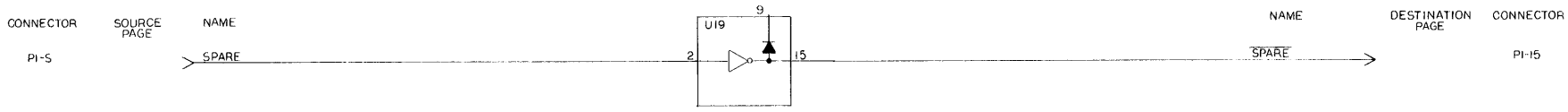
CONTROL

Schematic, Motor Control Assembly DWG 0252023-0000-02 (3 of 7)

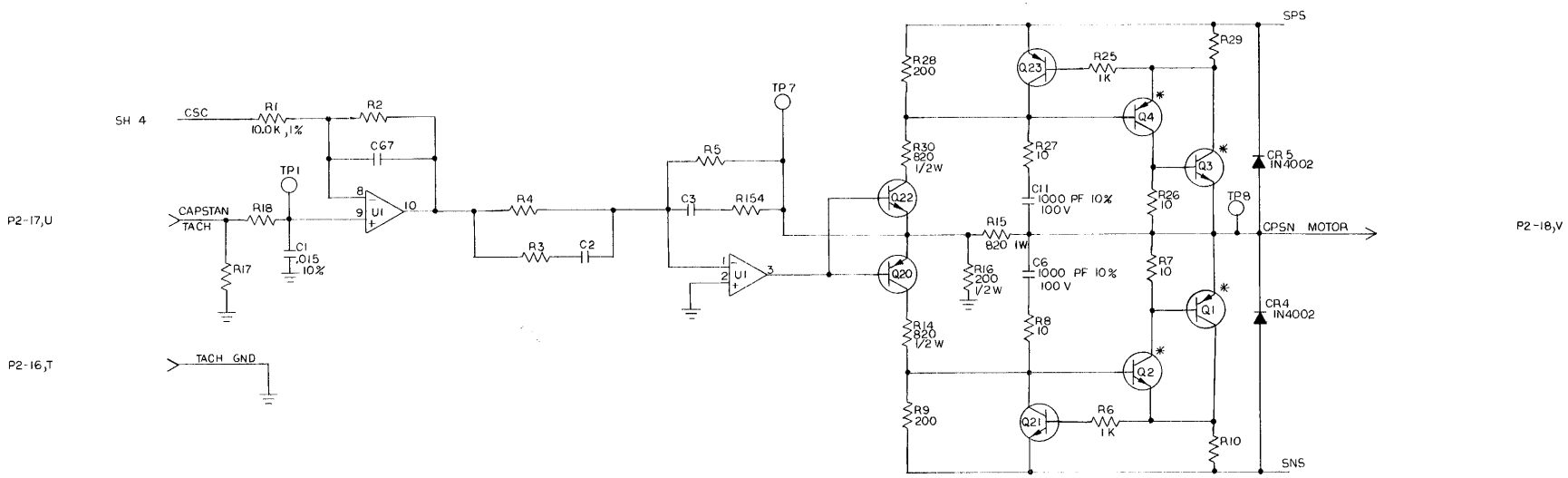


CAPSTAN RAMP GENERATOR

Schematic, Motor Control Assembly DWG 0252023-0000-02 (4 of 7)

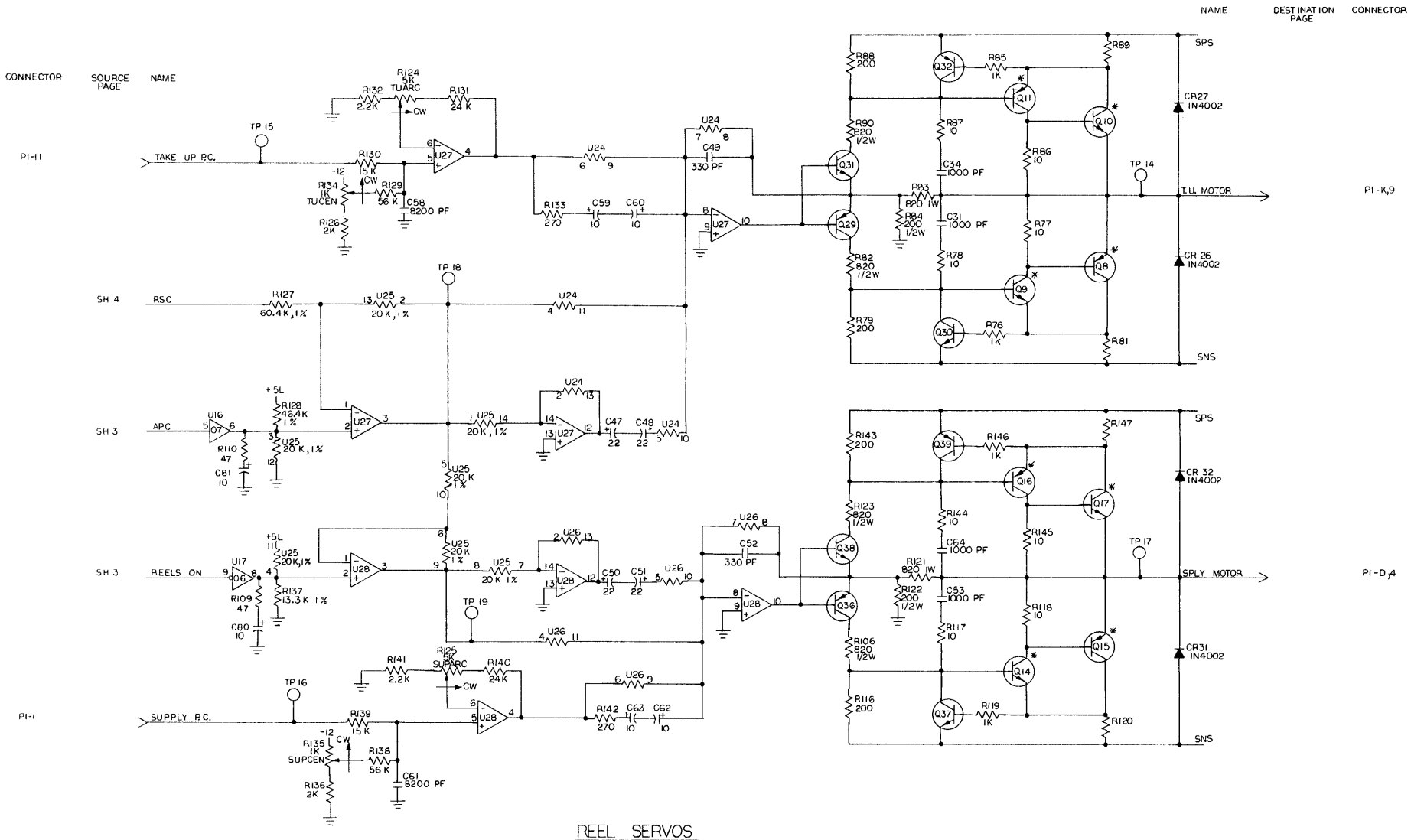


LAMP DRIVER (SPARE)

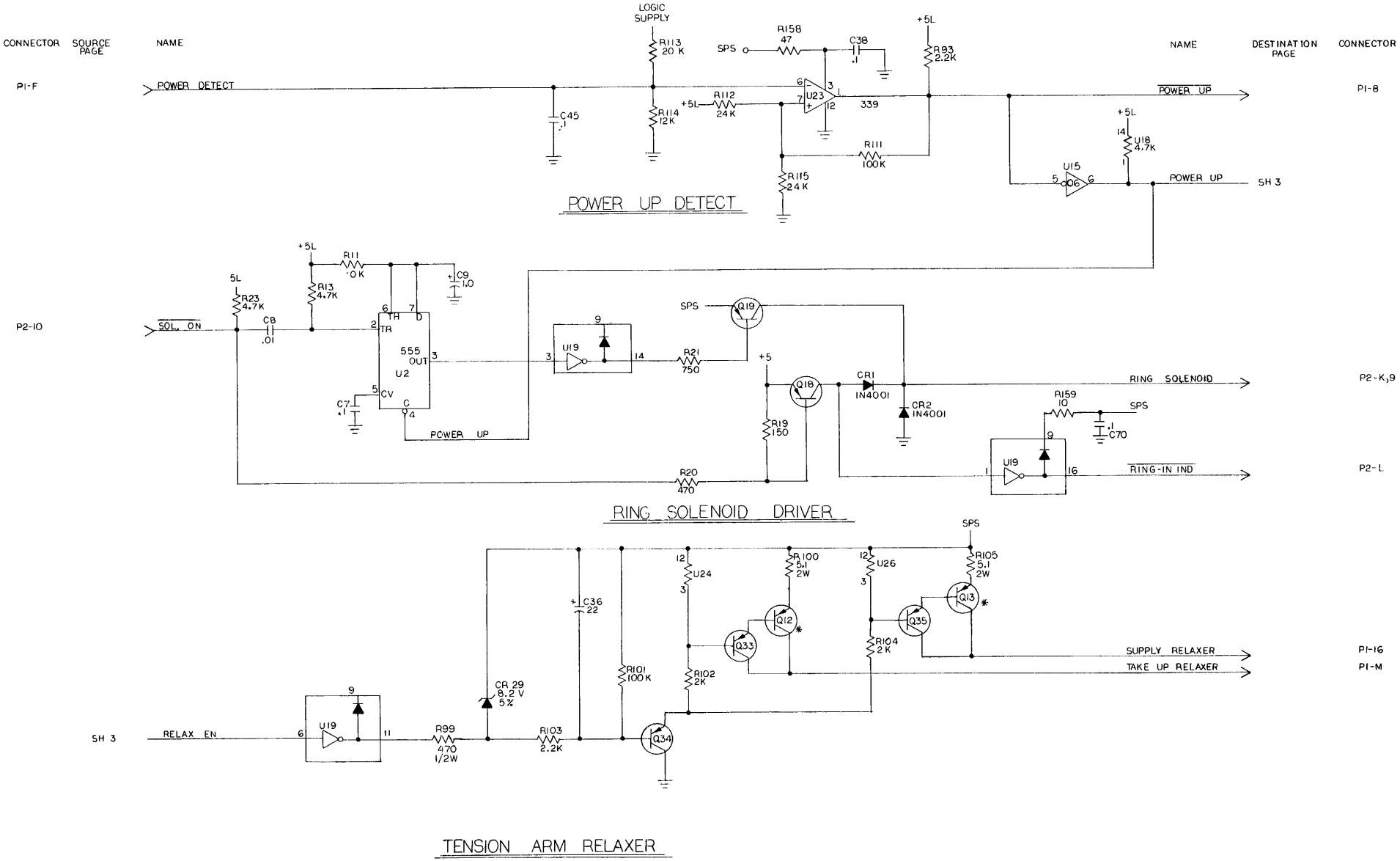


CAPSTAN SERVO AMP

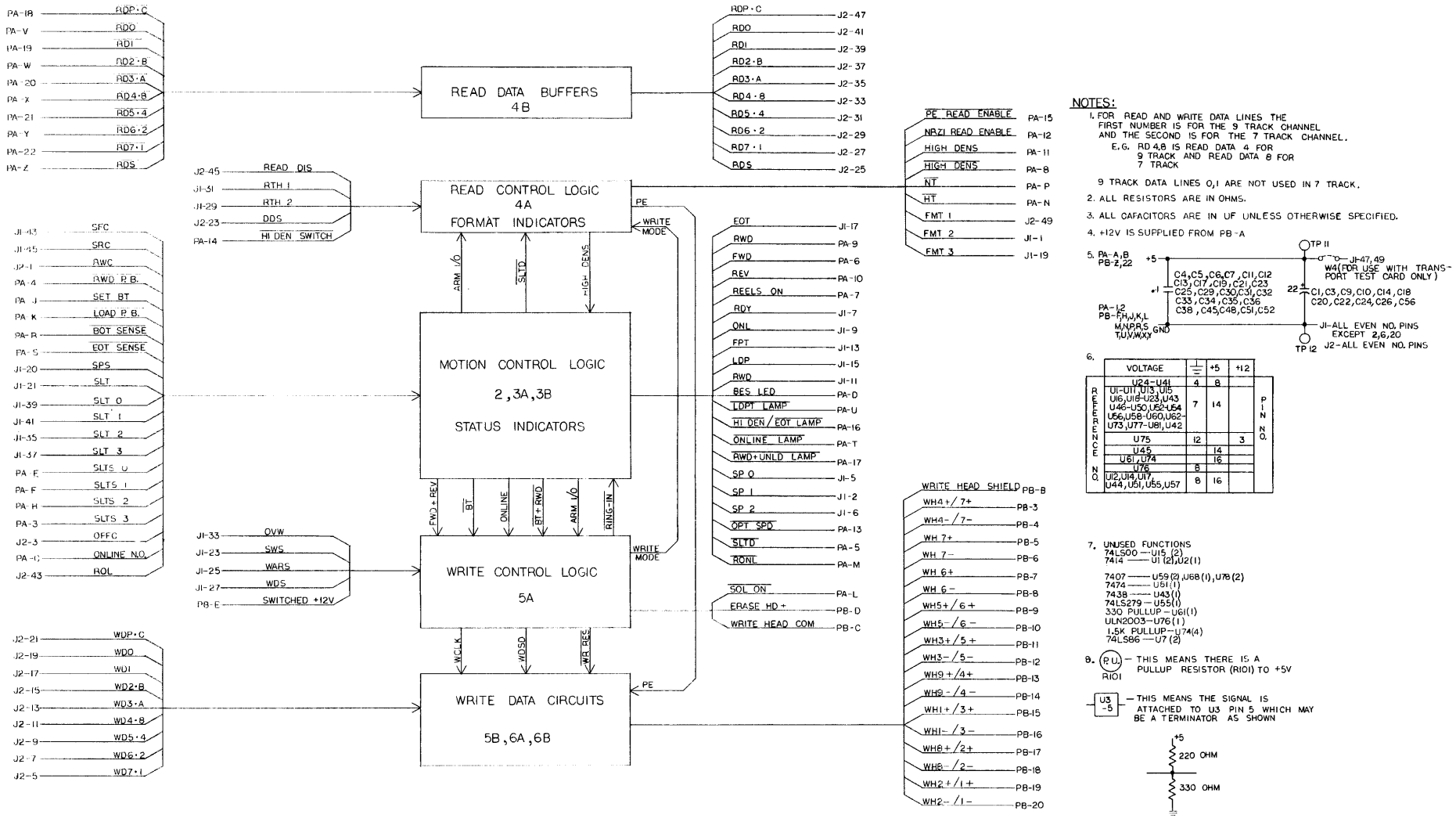
Schematic, Motor Control Assembly DWG 0252023-0000-02 (5 of 7)



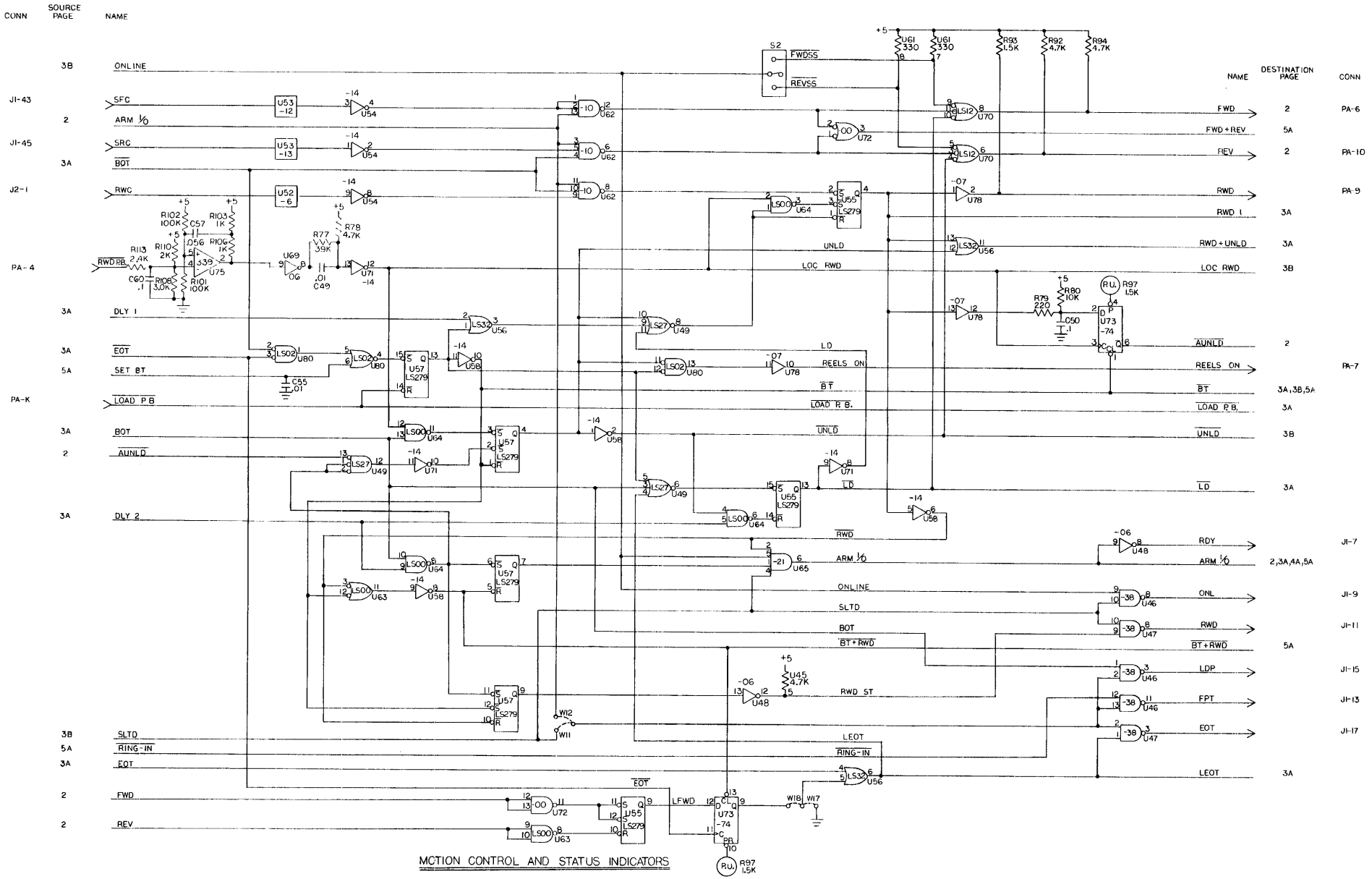
Schematic, Motor Control Assembly DWG 0252023-0000-02 (6 of 7)



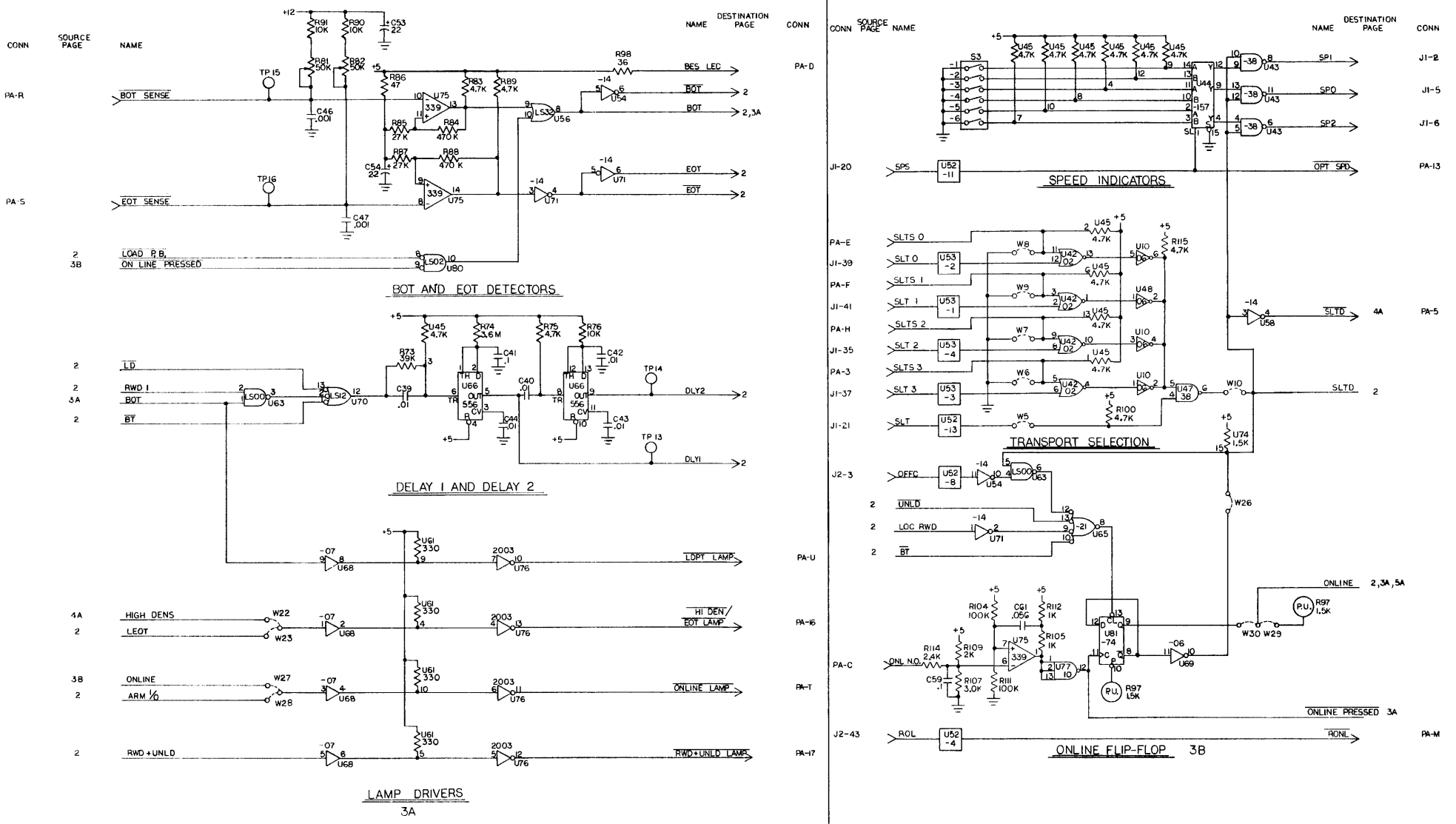
Schematic, Motor Control Assembly DWG 0252023-0000-02 (7 of 7)



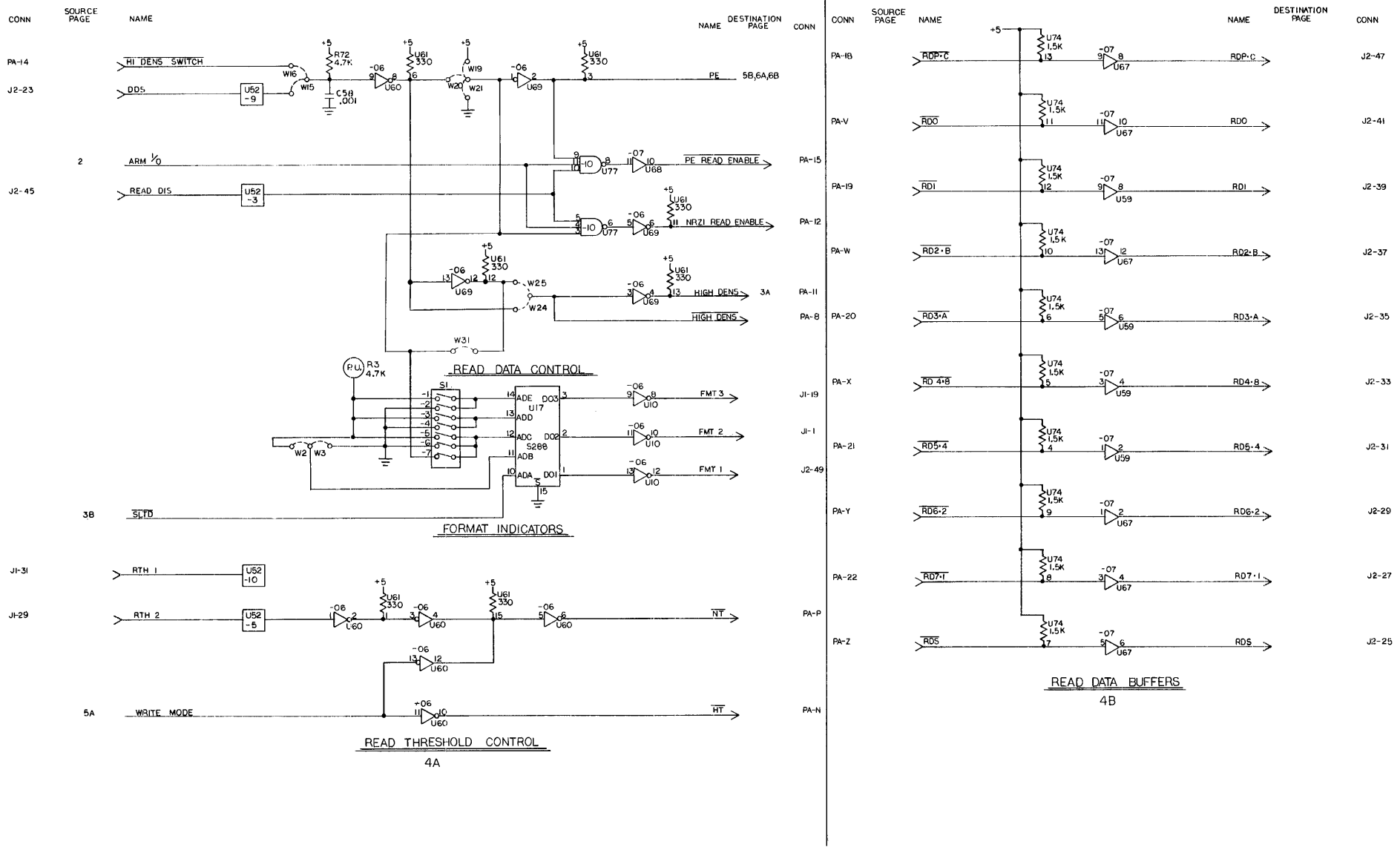
Schematic, Write/Control Assembly DWG 0252195-0000-02 (1 of 6)



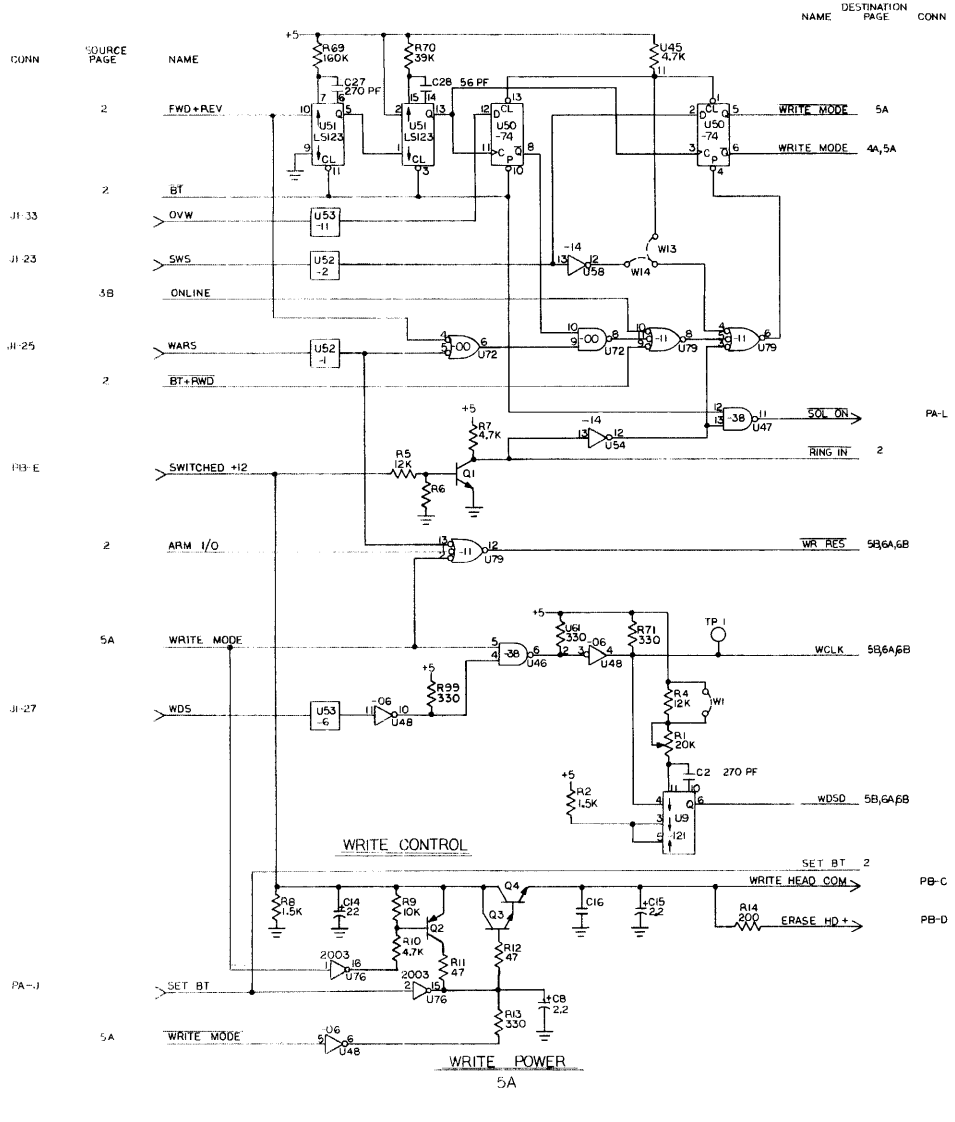
Schematic, Write/Control Assembly DWG 0252195-0000-02 (2 of 6)

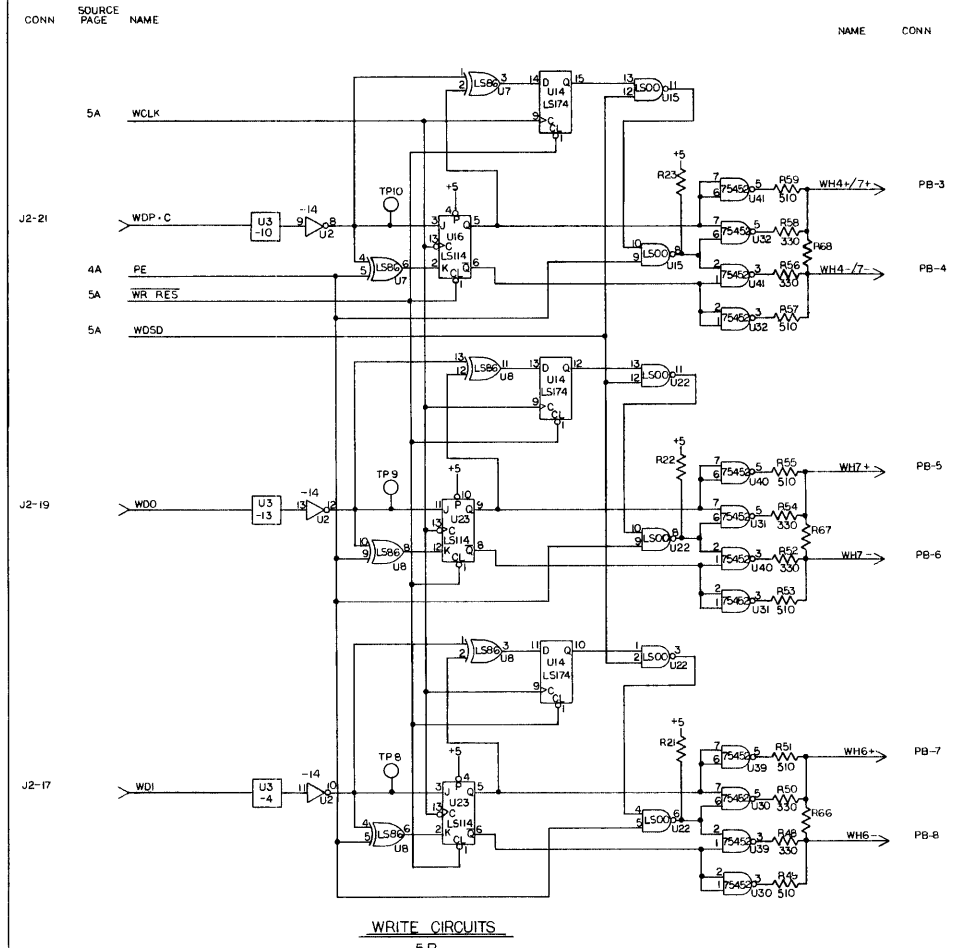


Schematic, Write/Control Assembly DWG 0252195-0000-02 (3 of 6)

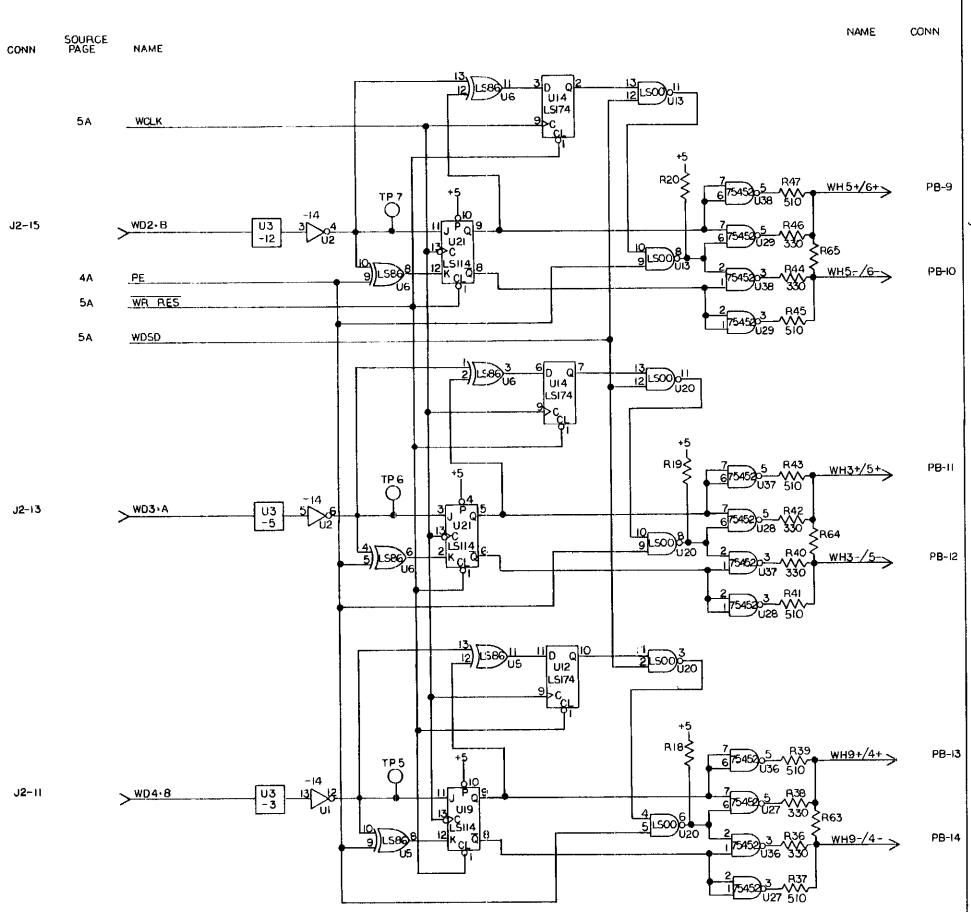


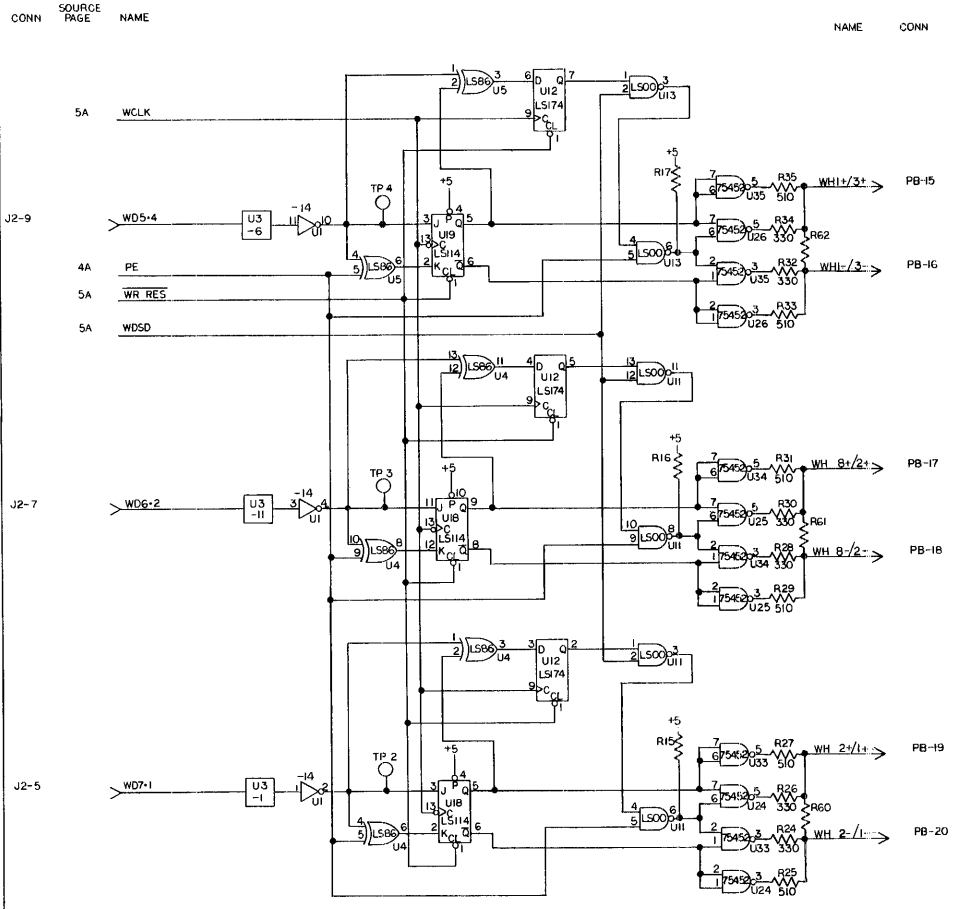
Schematic, Write/Control Assembly DWG 0252195-0000-02 (4 of 6)



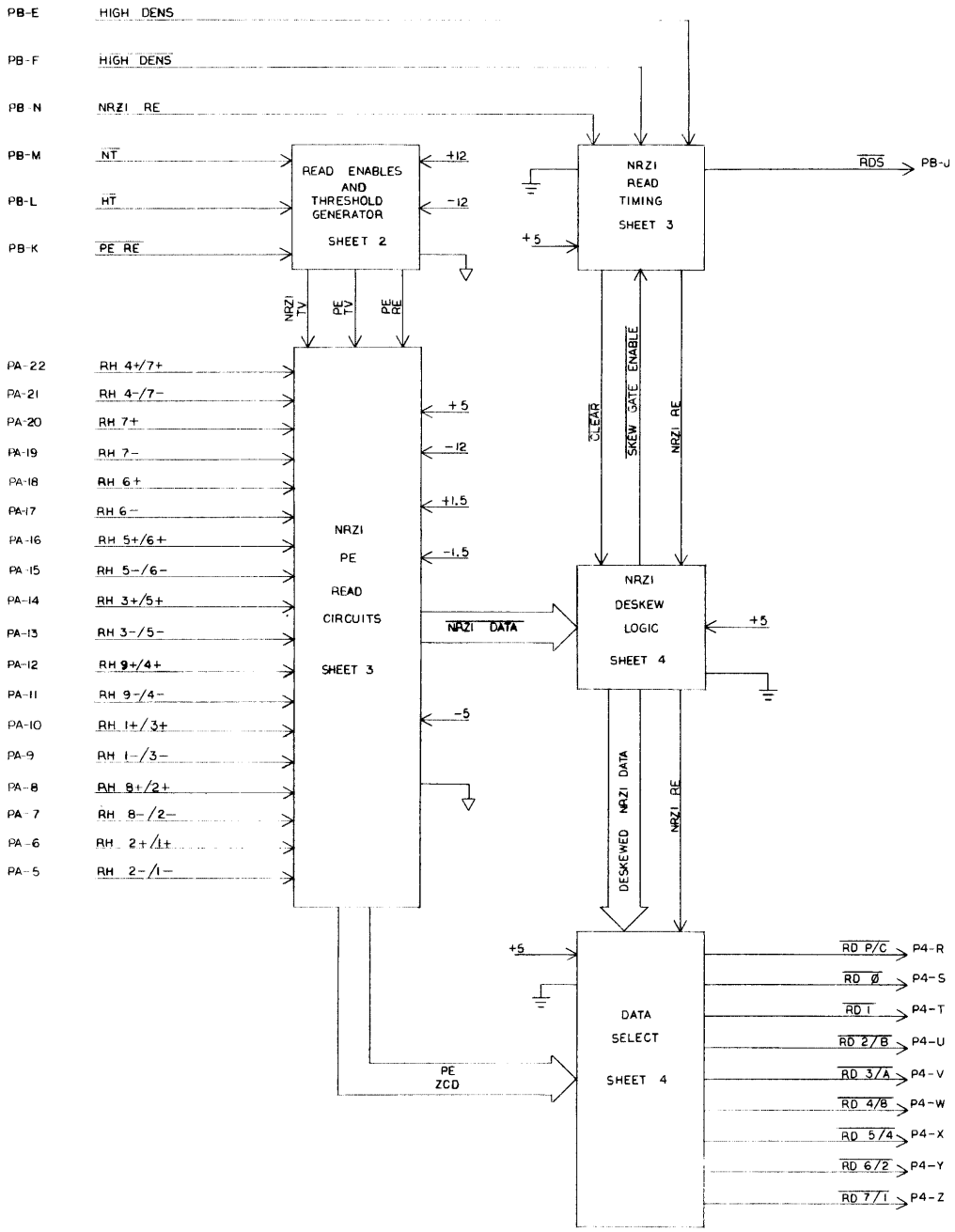


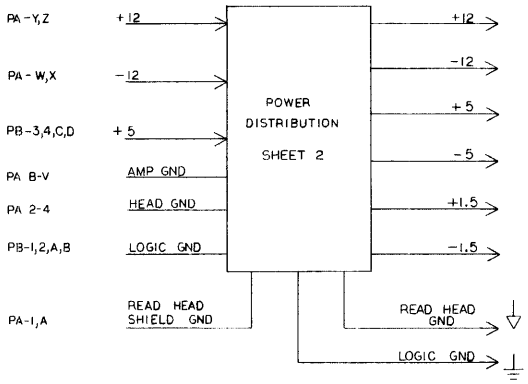
Schematic, Write/Control Assembly DWG 0252195-0000-02 (5 of 6)





Schematic, Write/Control Assembly DWG 0252195-0000-02 (6 of 6)





NOTES:

1. ALL CAPACITANCES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCES ARE IN OHMS.
3. ⏚ = LOGIC GROUND ⏚ = HEAD GROUND

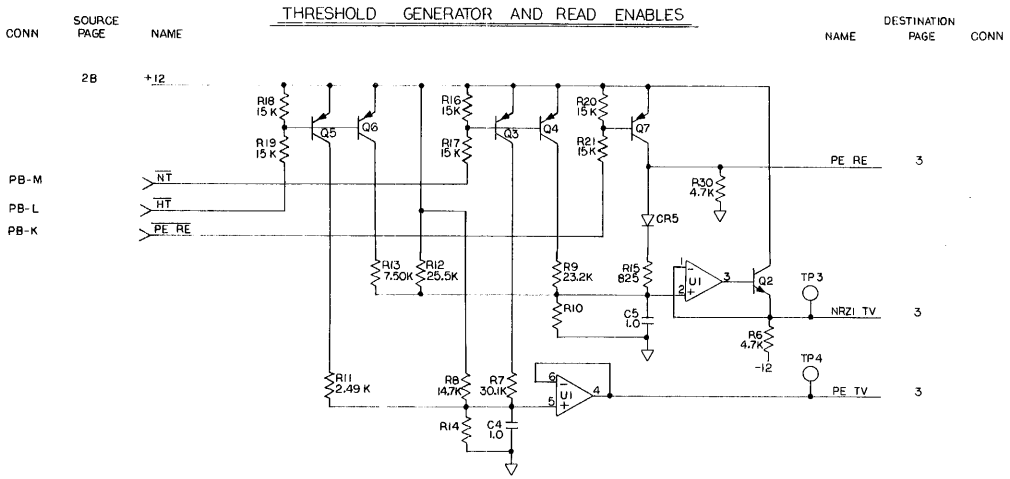
IC SUPPLY VOLTAGE AND PIN USED

VOLTAGE	⏚	⏚	+5	-5	+12	-12
U1					11	7
U2,U3,U4		8	16			
U5		7	14			
U101-U901					7	4
U102-U902					7	4
U103-U903					7	4
U104-U904			7	4		
U105-U905	1			4	8	

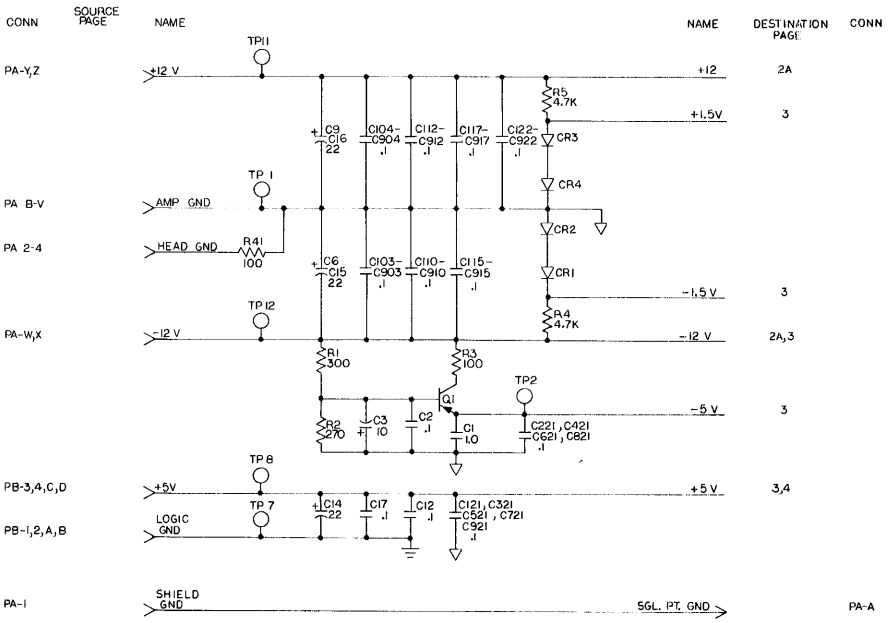
(PERFORMANCE) (PIN NO.)

Schematic, Read Card DWG 0251741-0000-06 (1 of 4)

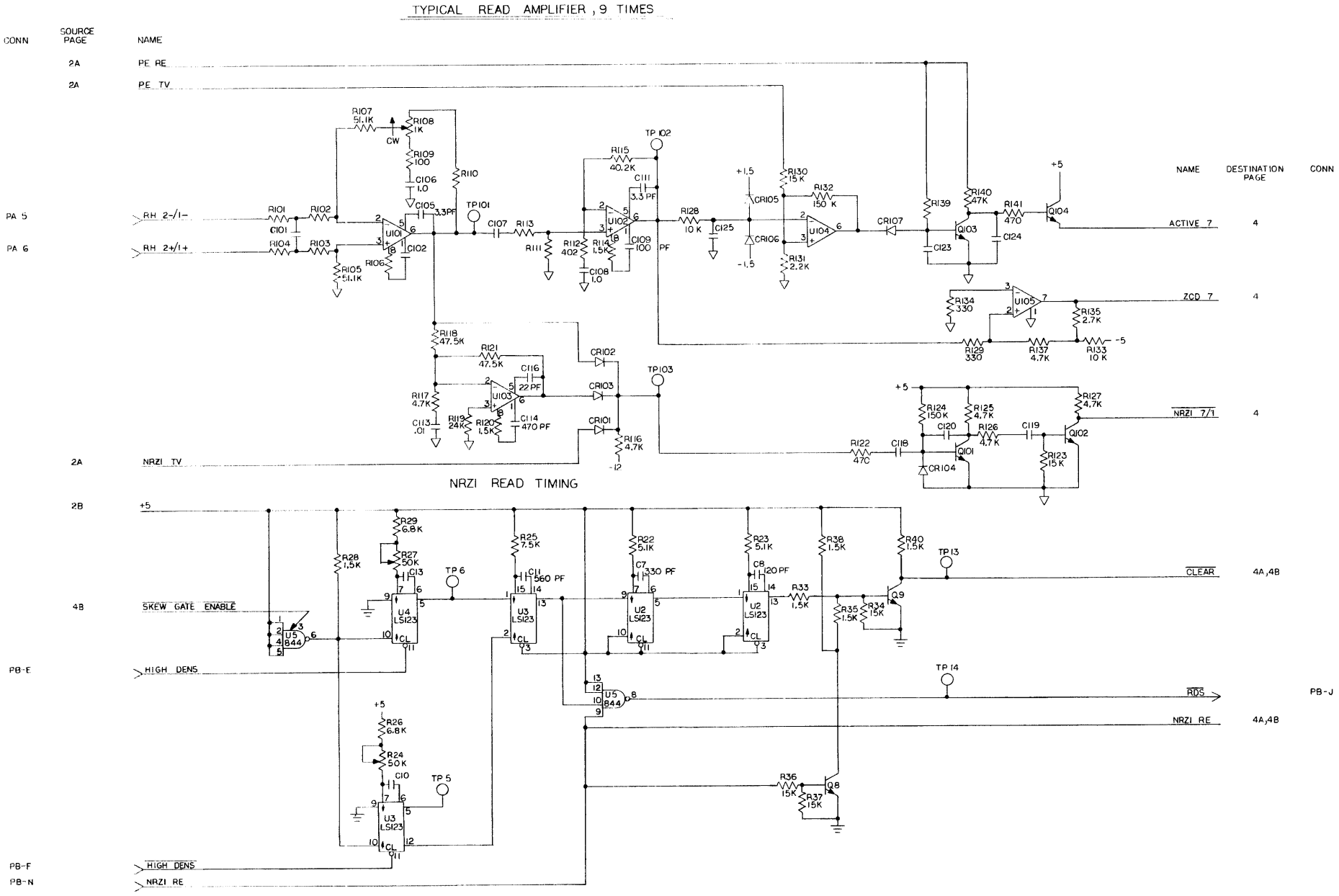
THRESHOLD GENERATOR AND READ ENABLES



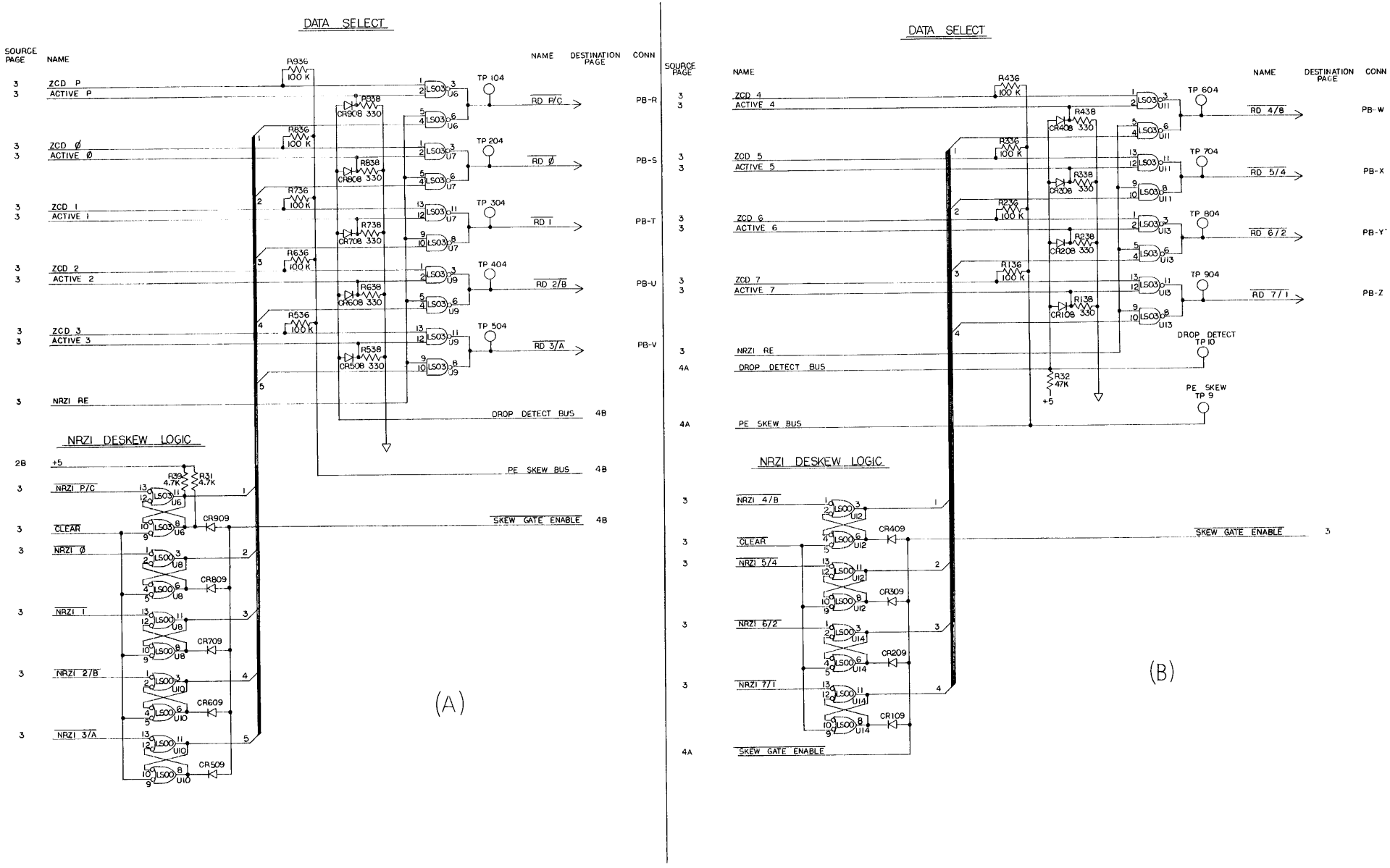
POWER DISTRIBUTION



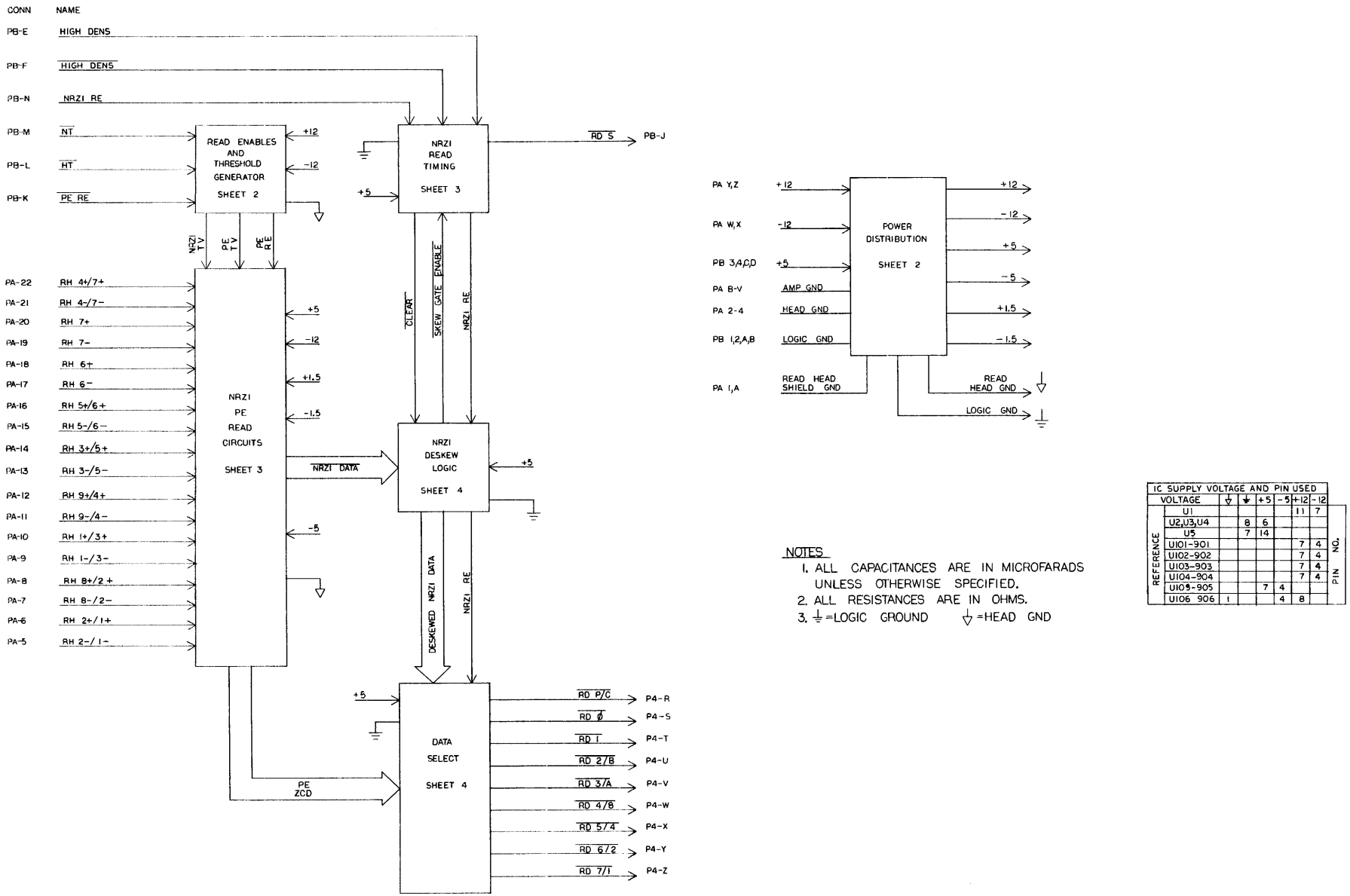
Schematic, Read Card DWG 0251741-0000-06 (2 of 4)



Schematic, Read Card DWG 0251741-0000-06 (3 of 4)



Schematic, Read Card DWG 0251741-0000-06 (4 of 4)



NOTES

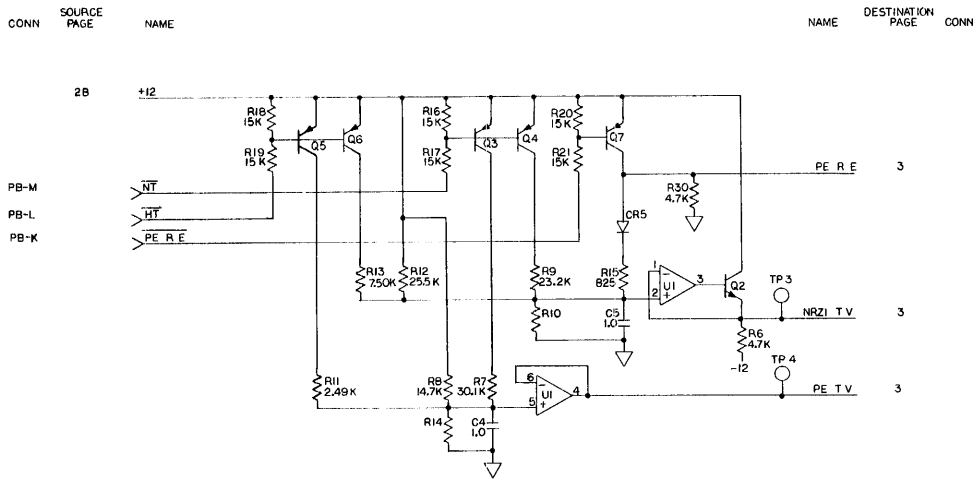
1. ALL CAPACITANCES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCES ARE IN OHMS.
3. ⏚ =LOGIC GROUND ▽ =HEAD GND

IC SUPPLY VOLTAGE AND PIN USED

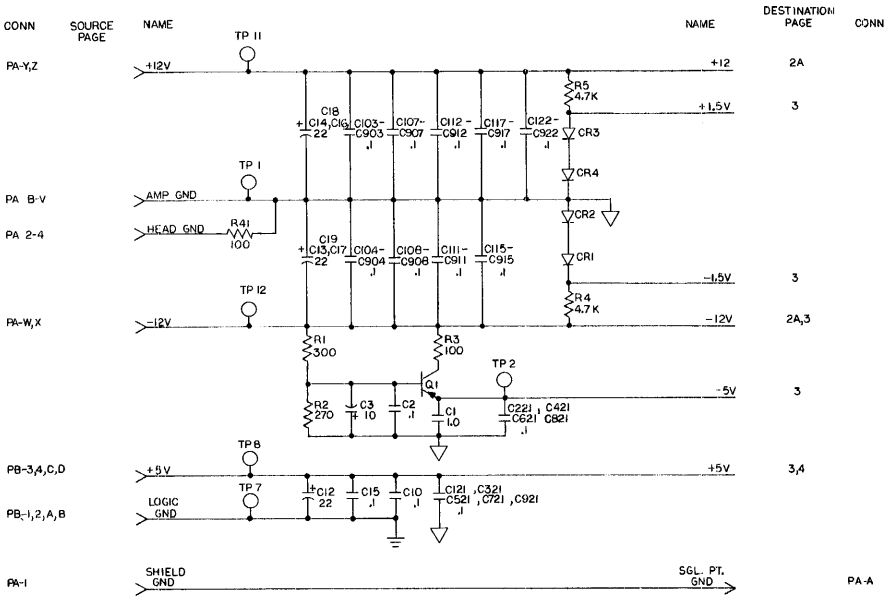
REFERENCE NO.	▽	⏚	+5	-5	+12	-12
U1					11	7
U2,U3,U4		8	6			
U5		7	14			
U101-901					7	4
U102-902					7	4
U103-903					7	4
U104-904					7	4
U105-905			7	4		
U106 906	1			4	8	

Schematic, High Speed Dual Mode Read DWG 0251663-0000-03 (1 of 4)

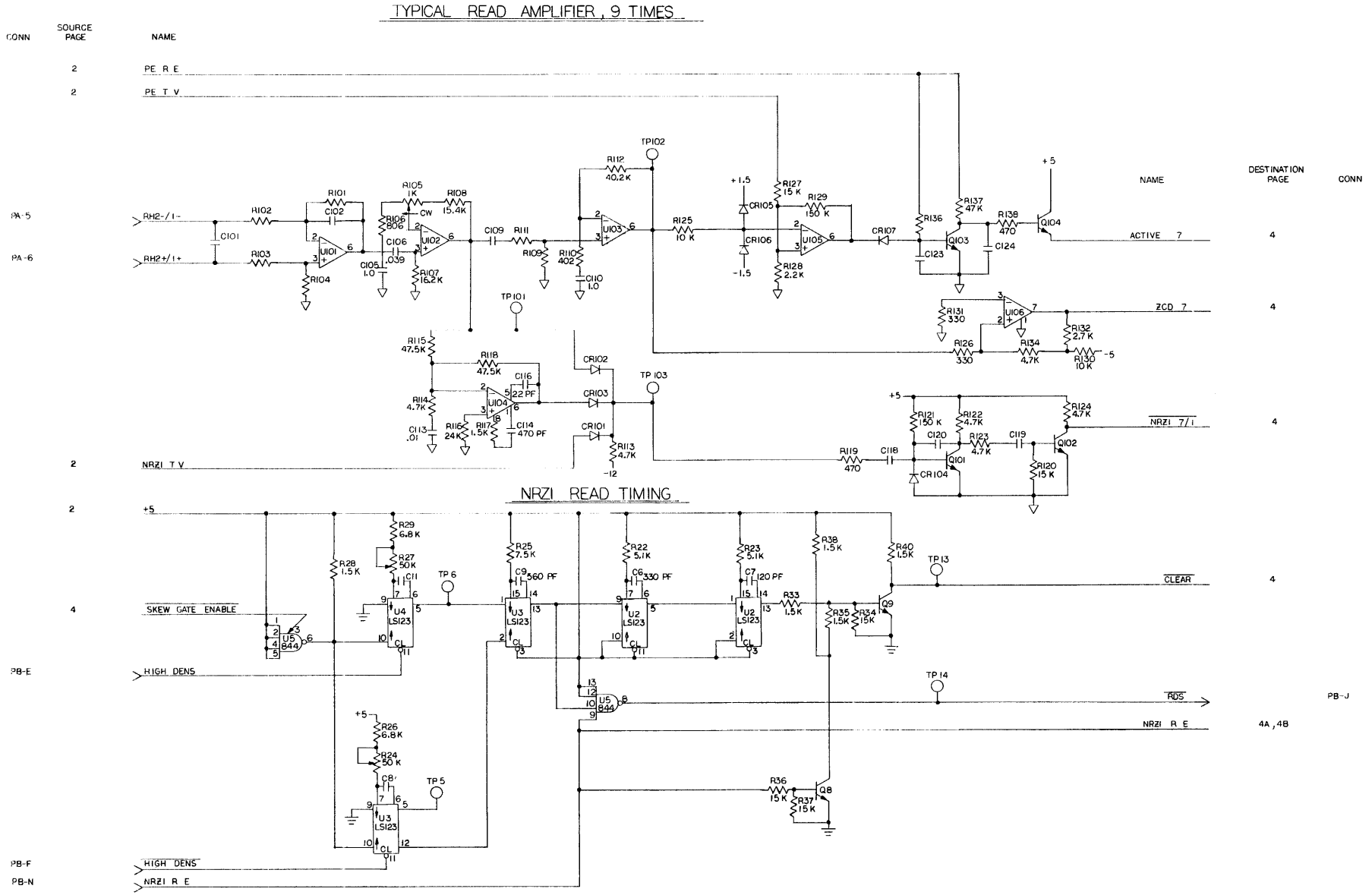
THRESHOLD GENERATOR AND READ ENABLES



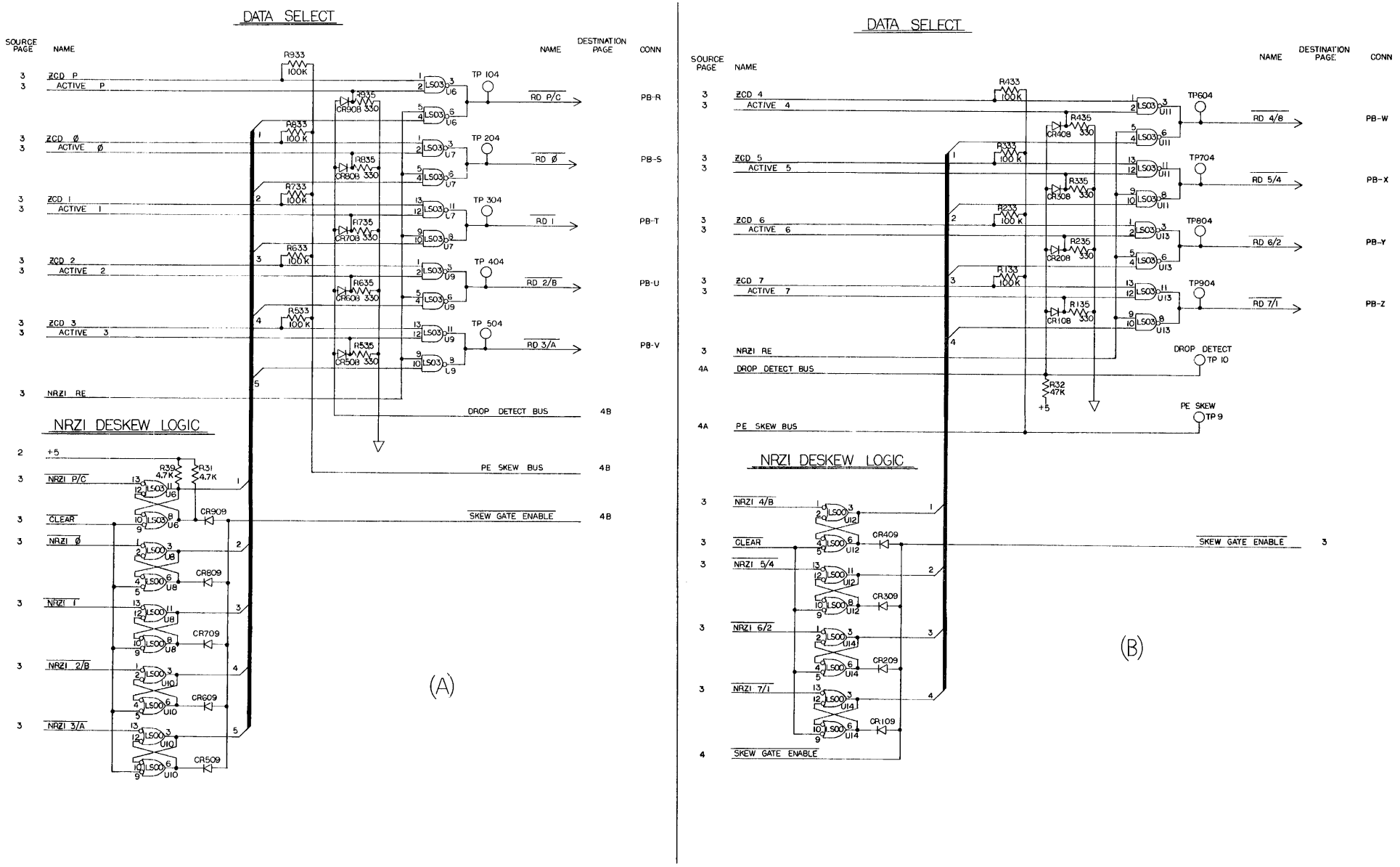
POWER DISTRIBUTION



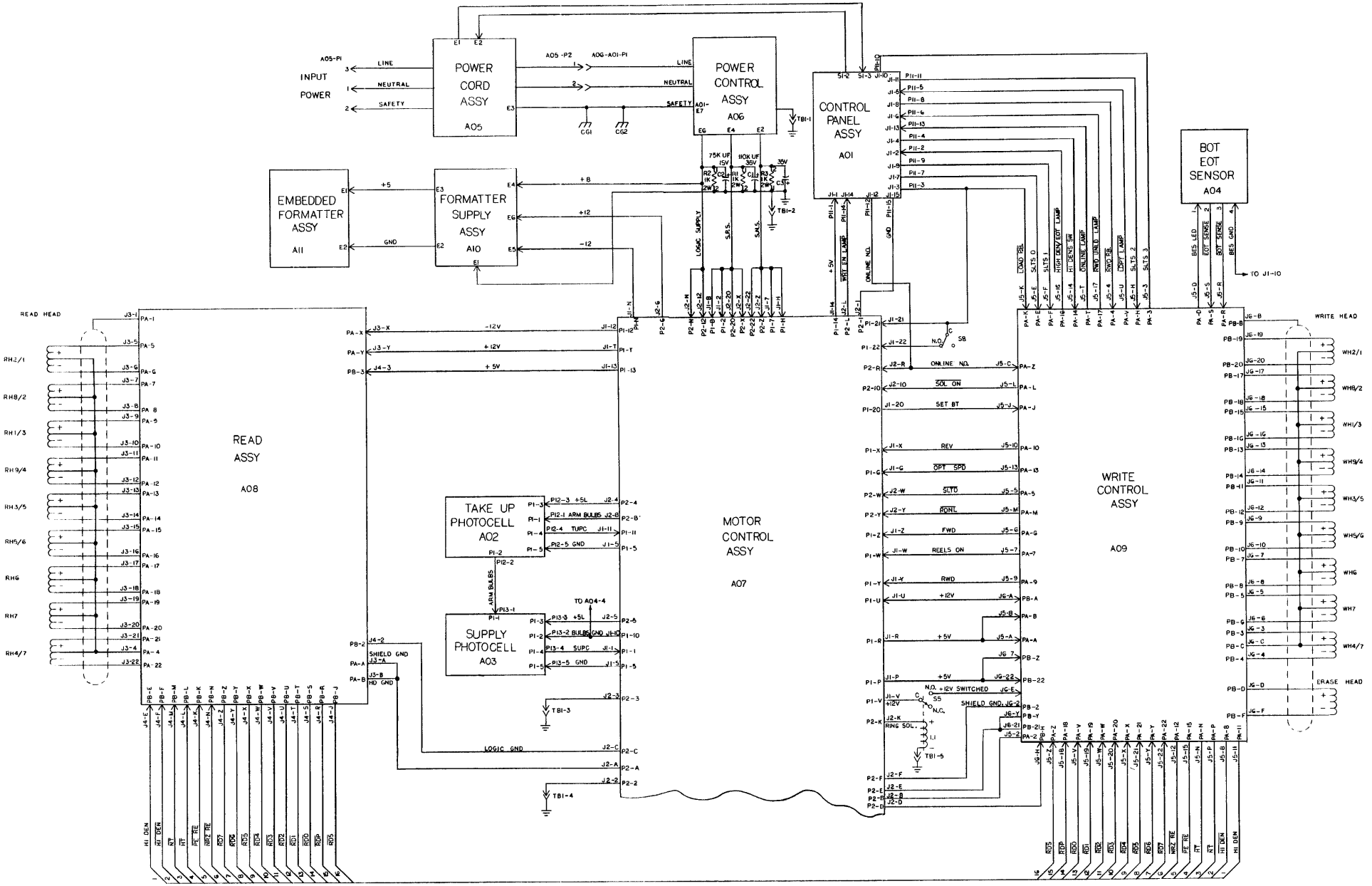
Schematic, High Speed Dual Mode Read DWG 0251663-0000-03 (2 of 4)



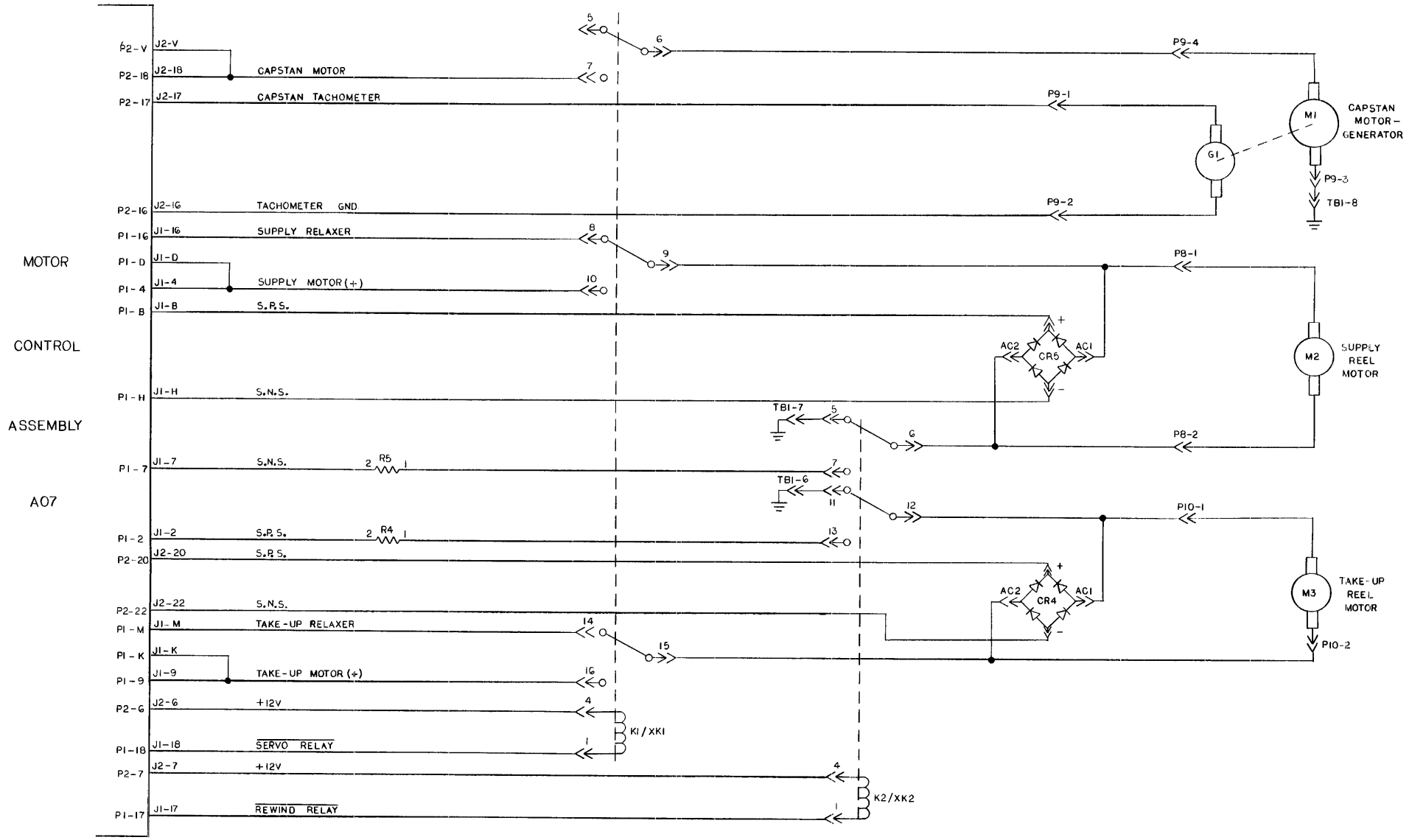
Schematic, High Speed Dual Mode Read DWG 0251663-0000-03 (3 of 4)



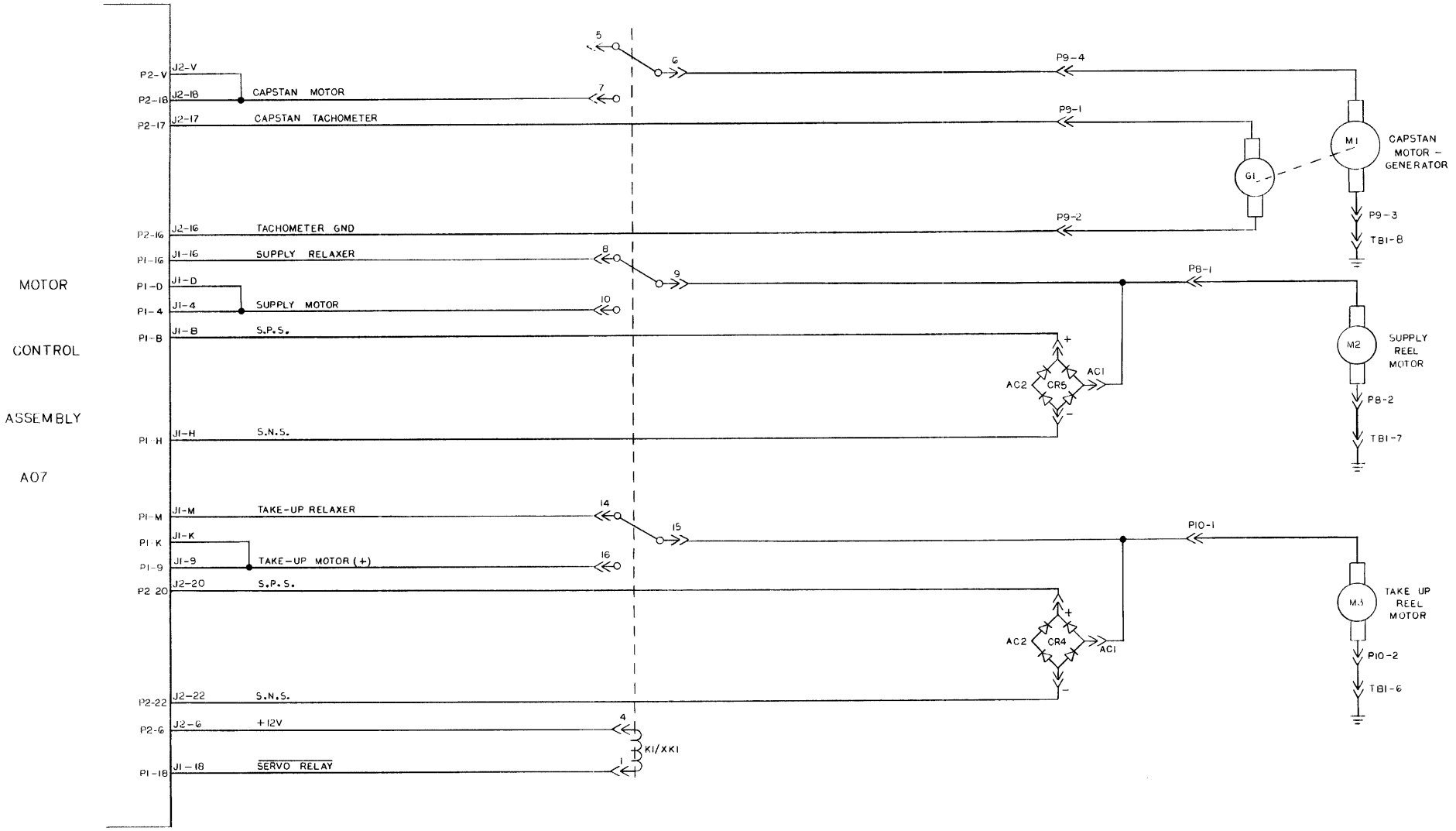
Schematic, High Speed Dual Mode Read DWG 0251663-0000-03 (4 of 4)



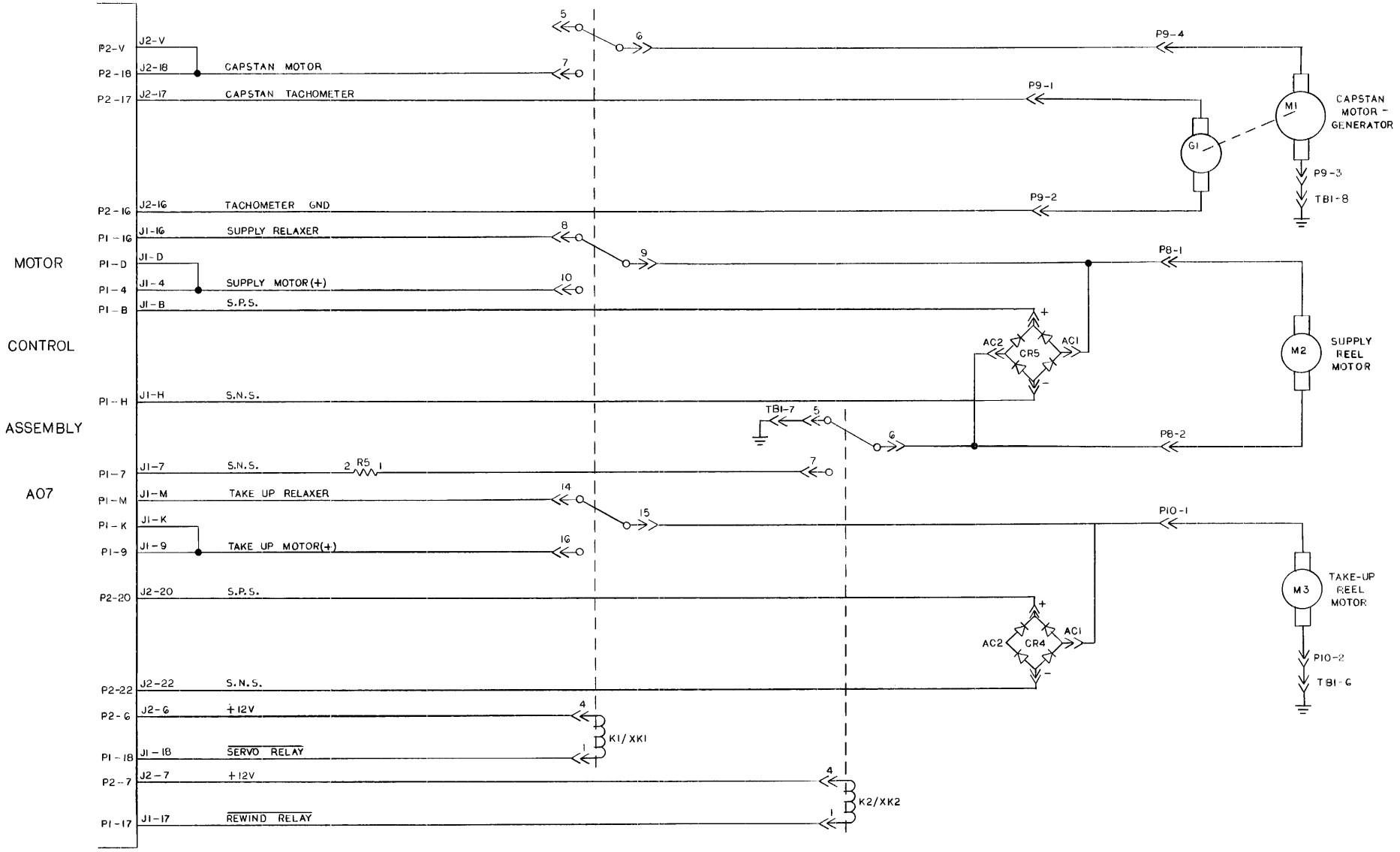
Schematic, Transport DWG 0252337-0000-02



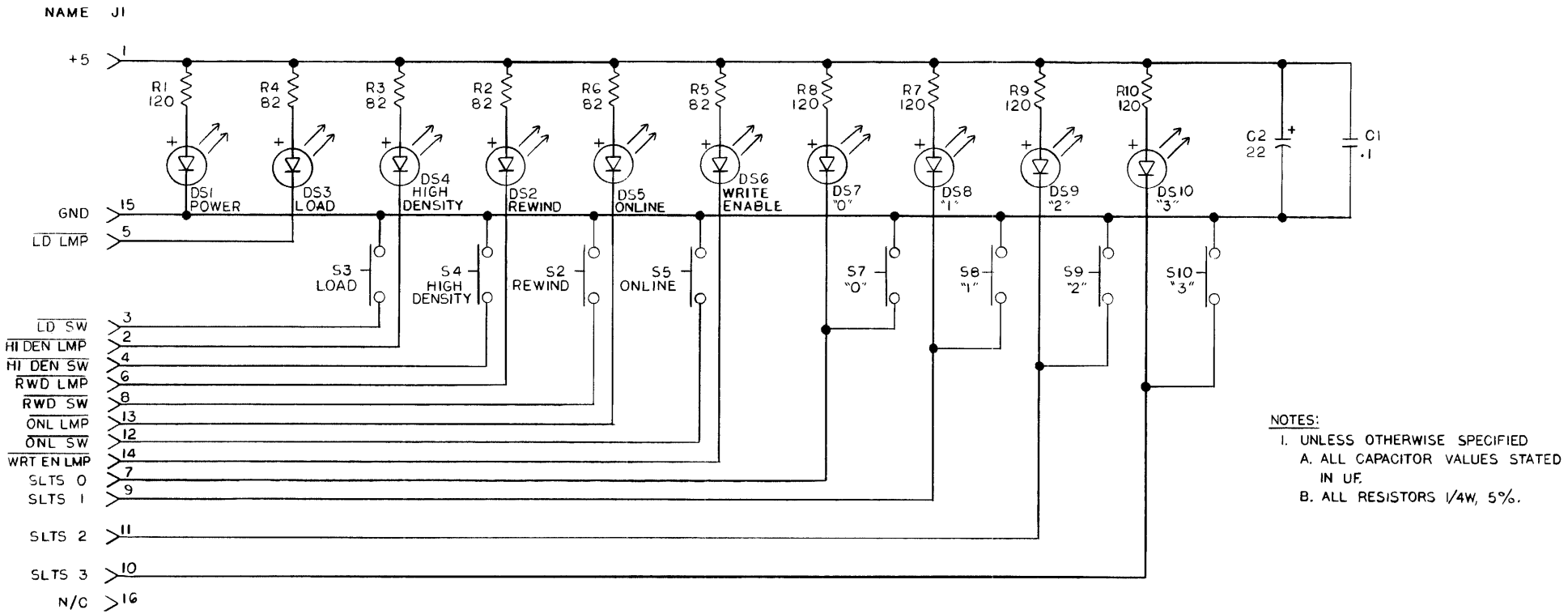
Schematic, Motor Control, 10.5" Transport DWG 0252338-0000-02



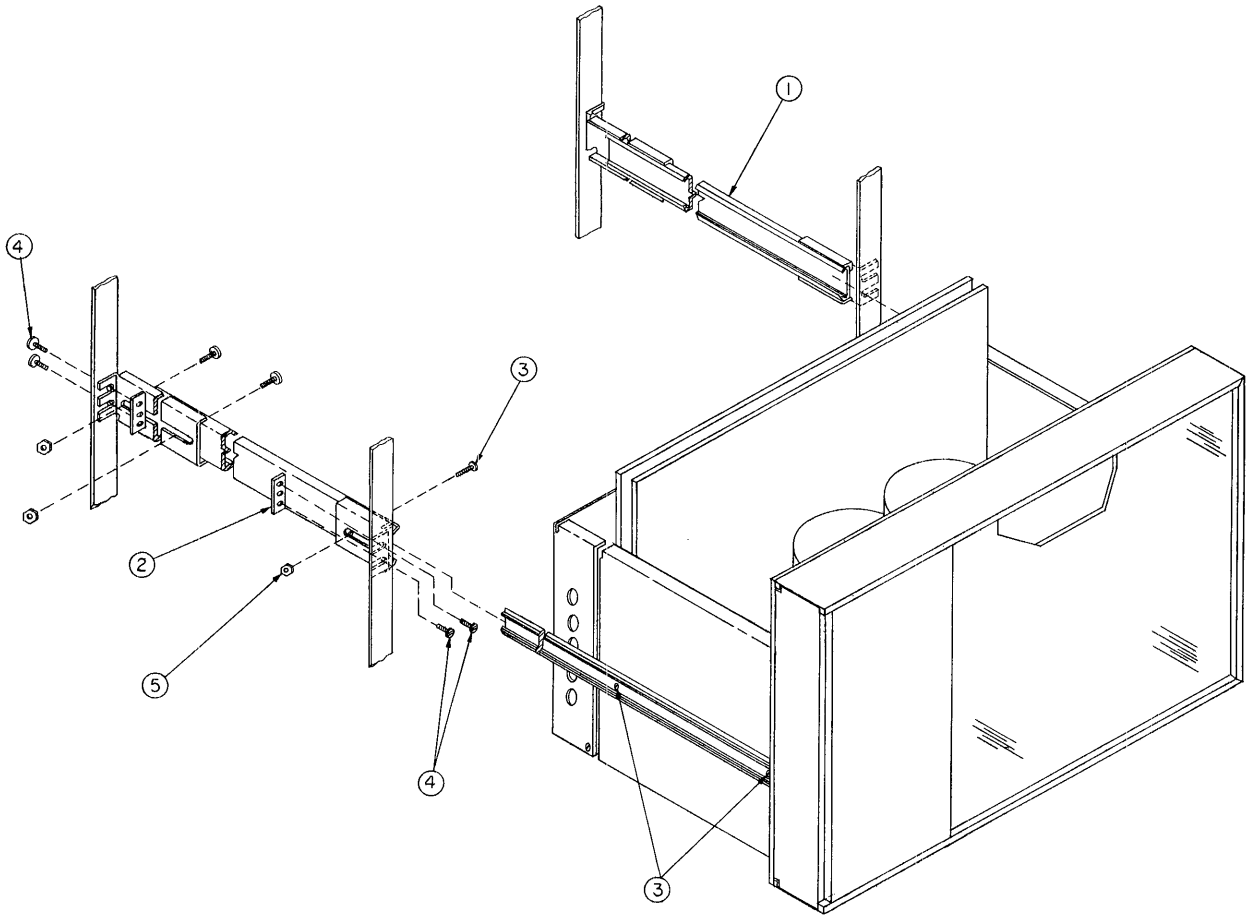
Schematic, Motor Control, 7, 8.5" Transport, 25 IPS DWG 0252348-0000-02

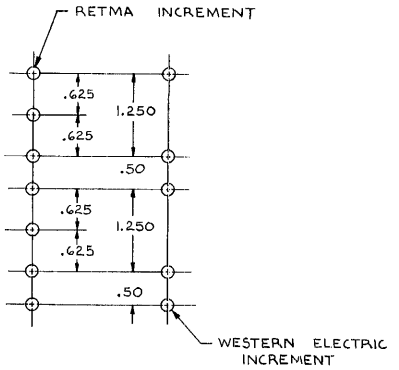


Schematic, Motor Control, 8.5" Transport, 37.5 IPS DWG 0252349-0000-02

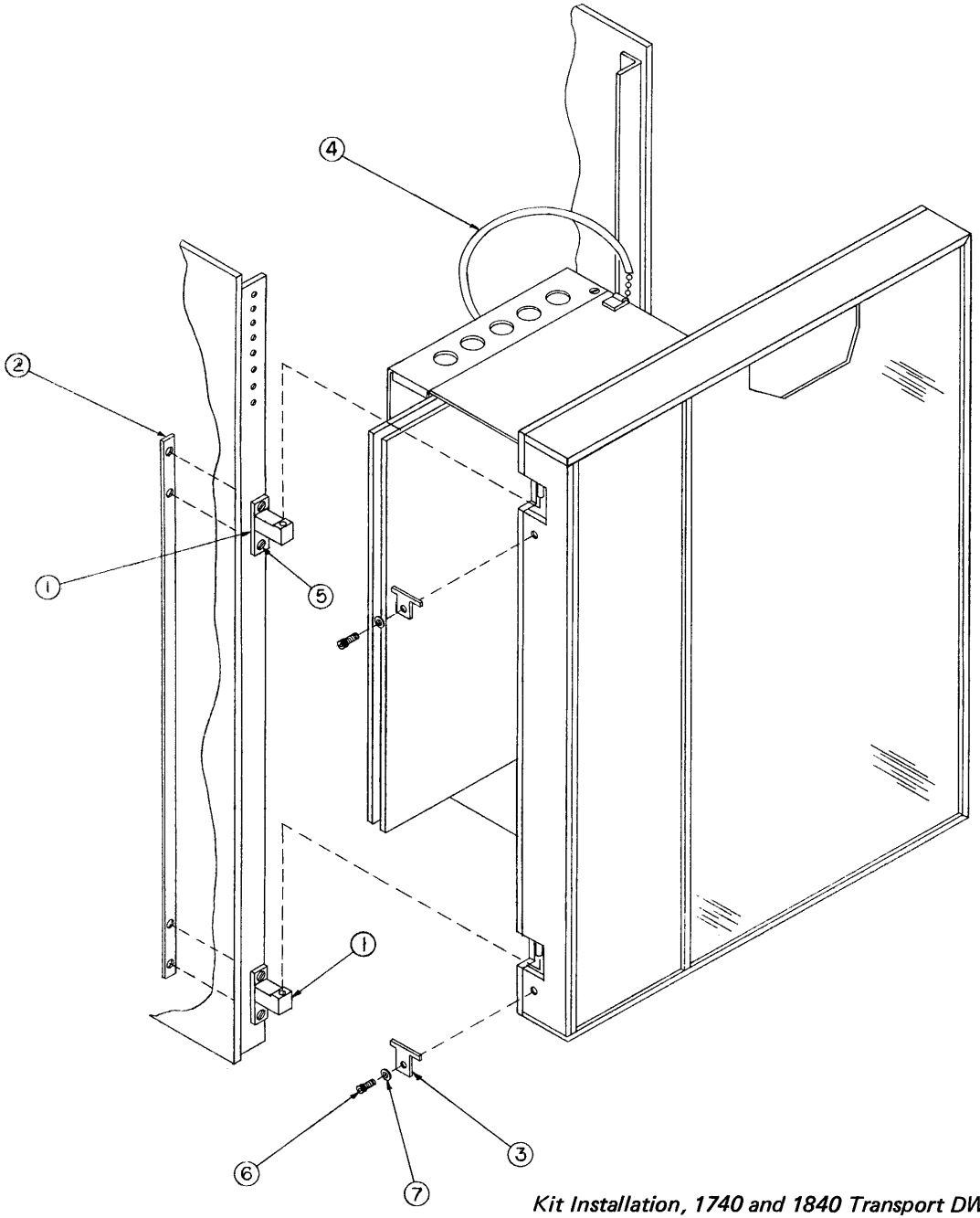


Schematic, Operator Control Panel DWG 0252048-0000-02

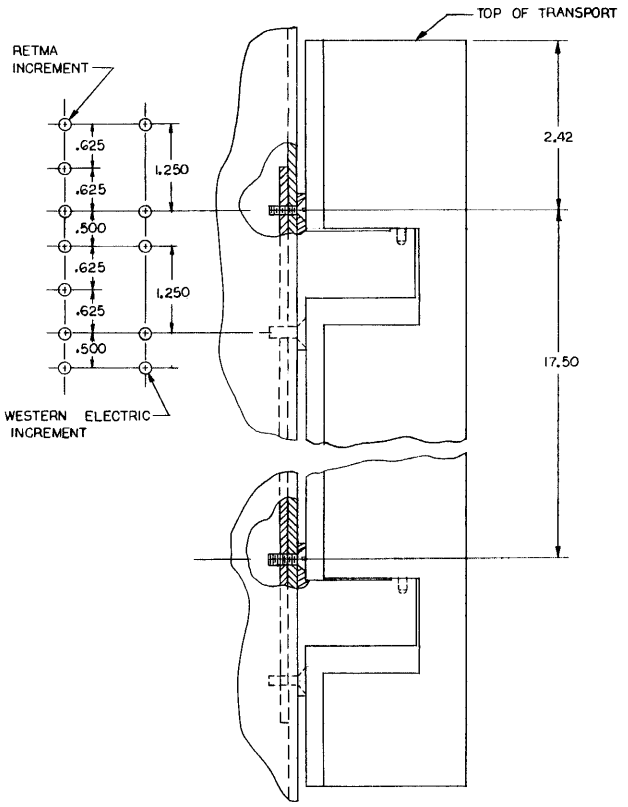




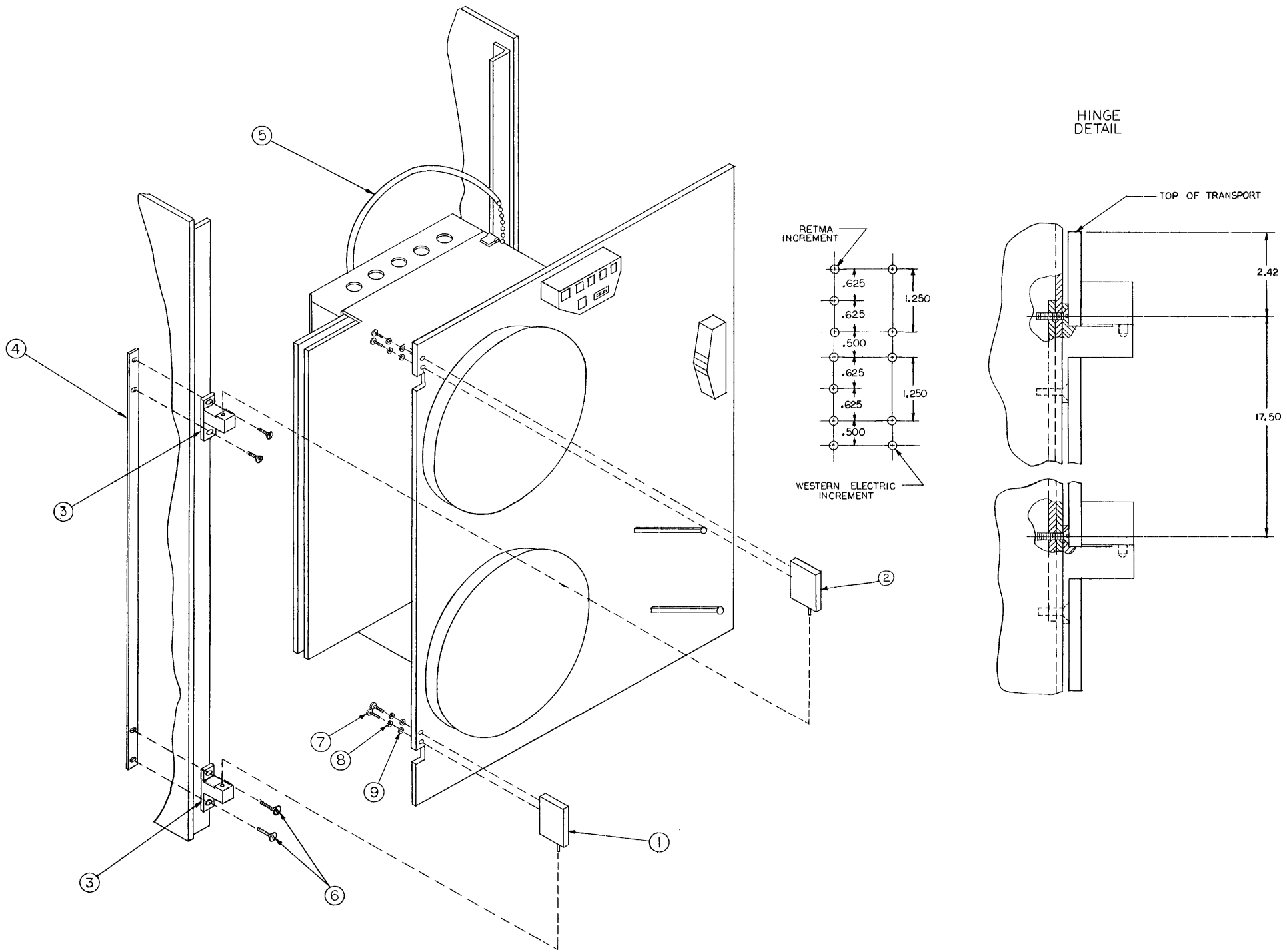
Kit Installation, 1140 and 1640 Transport DWG 0051911-0000-01



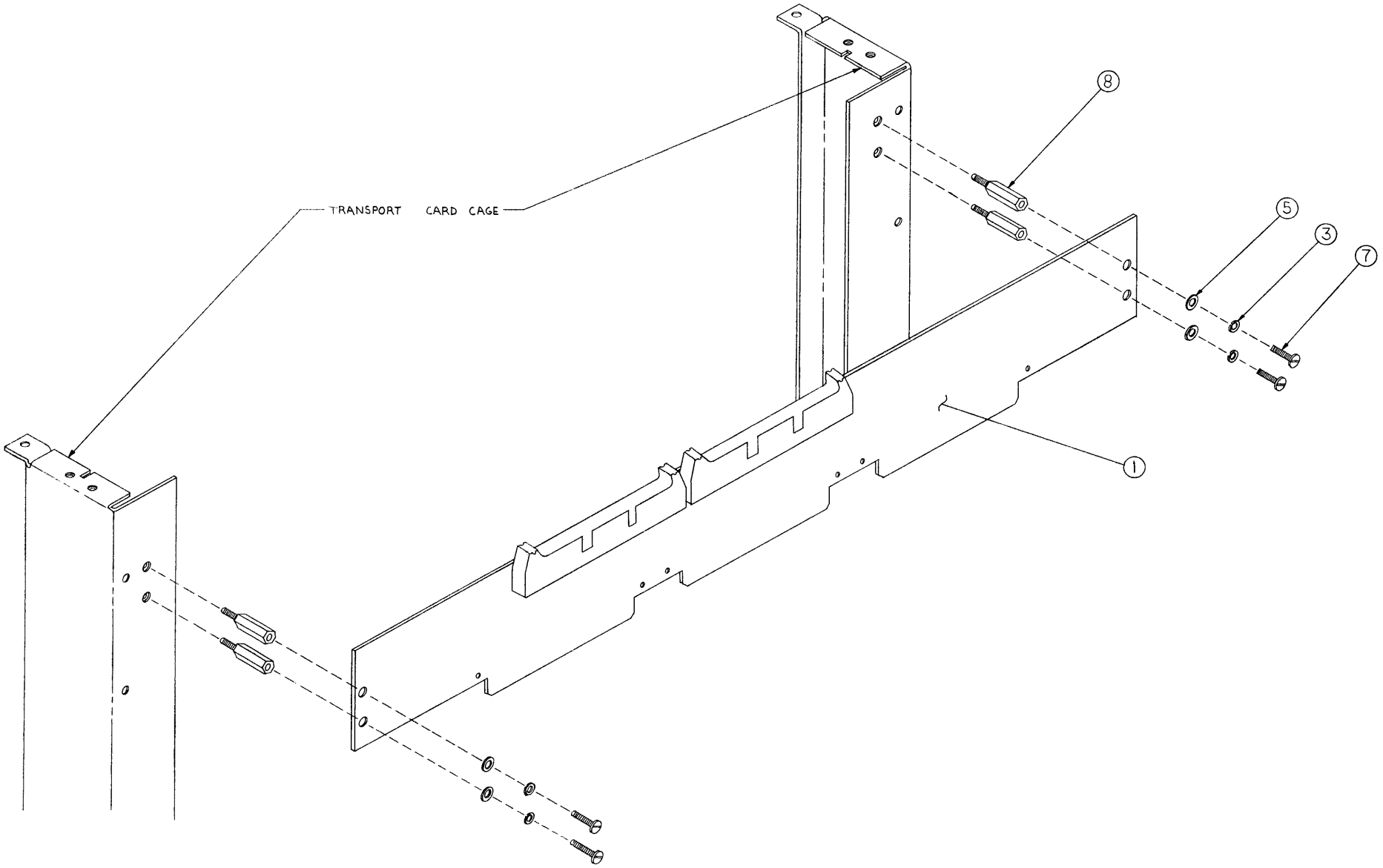
HINGE
DETAIL



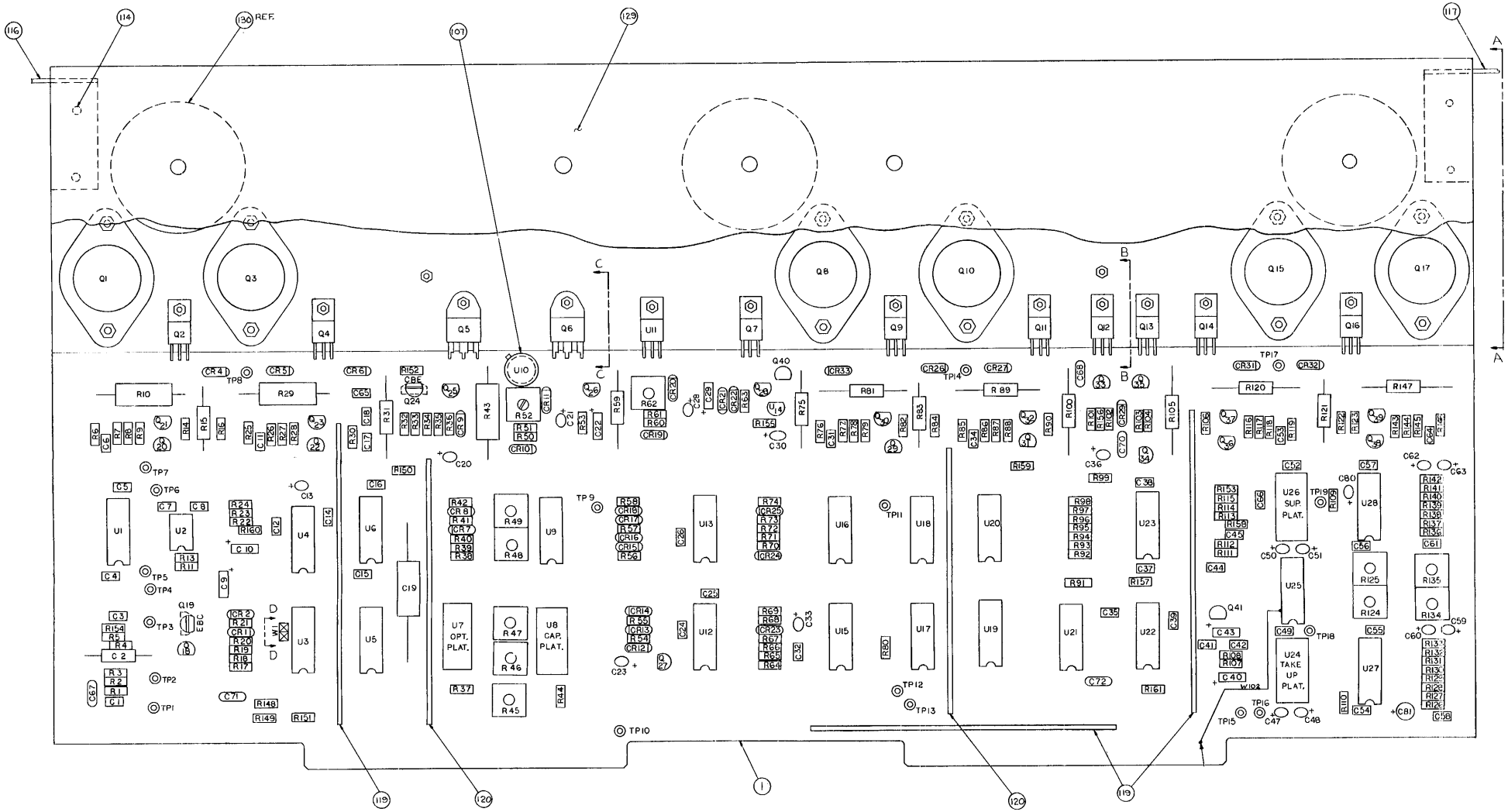
Kit Installation, 1740 and 1840 Transport DWG 0052710-0000-01



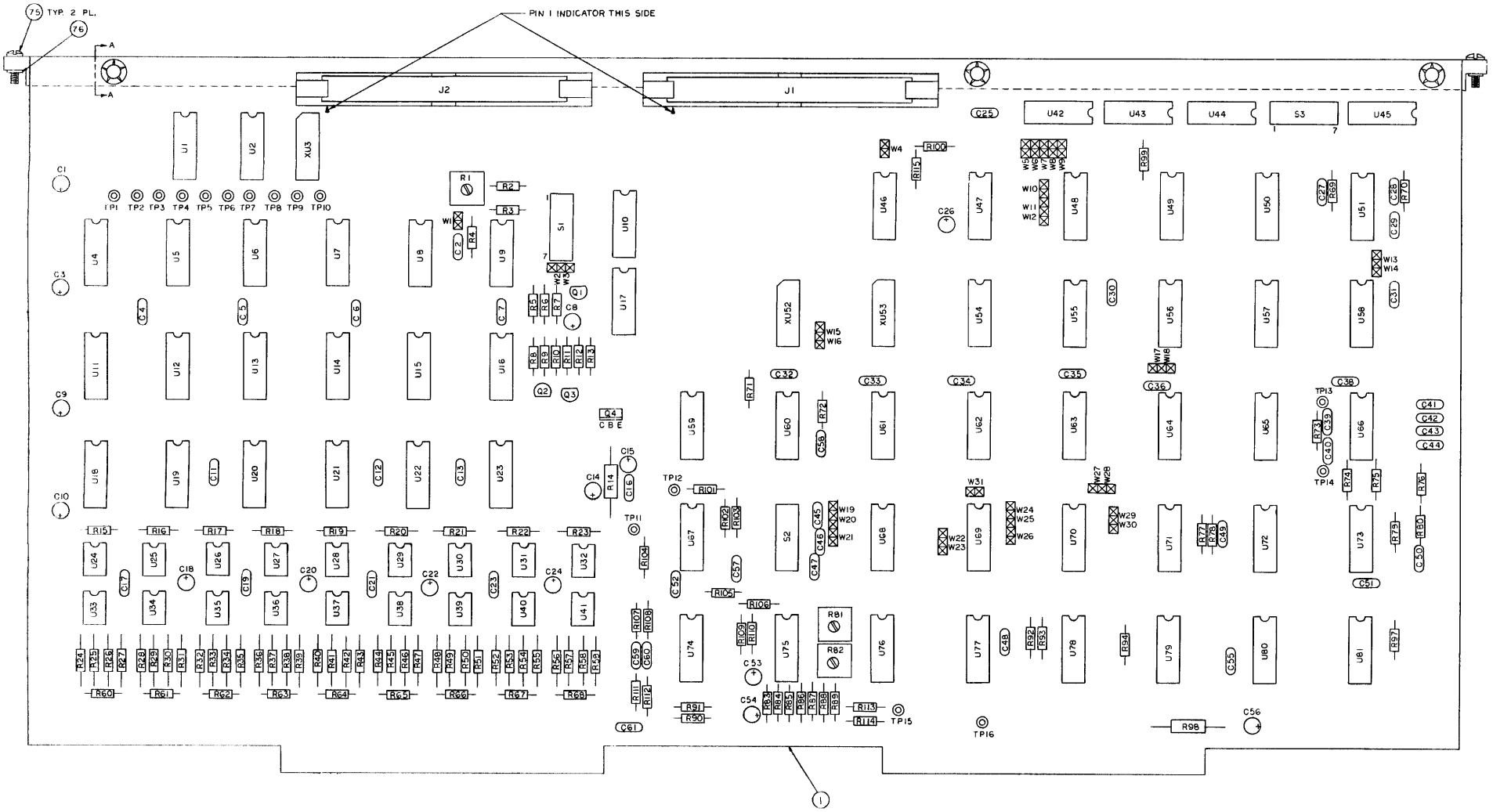
Kit Installation, 1740 and 1840 Transport w/o Door DWG 0051896-0000-02



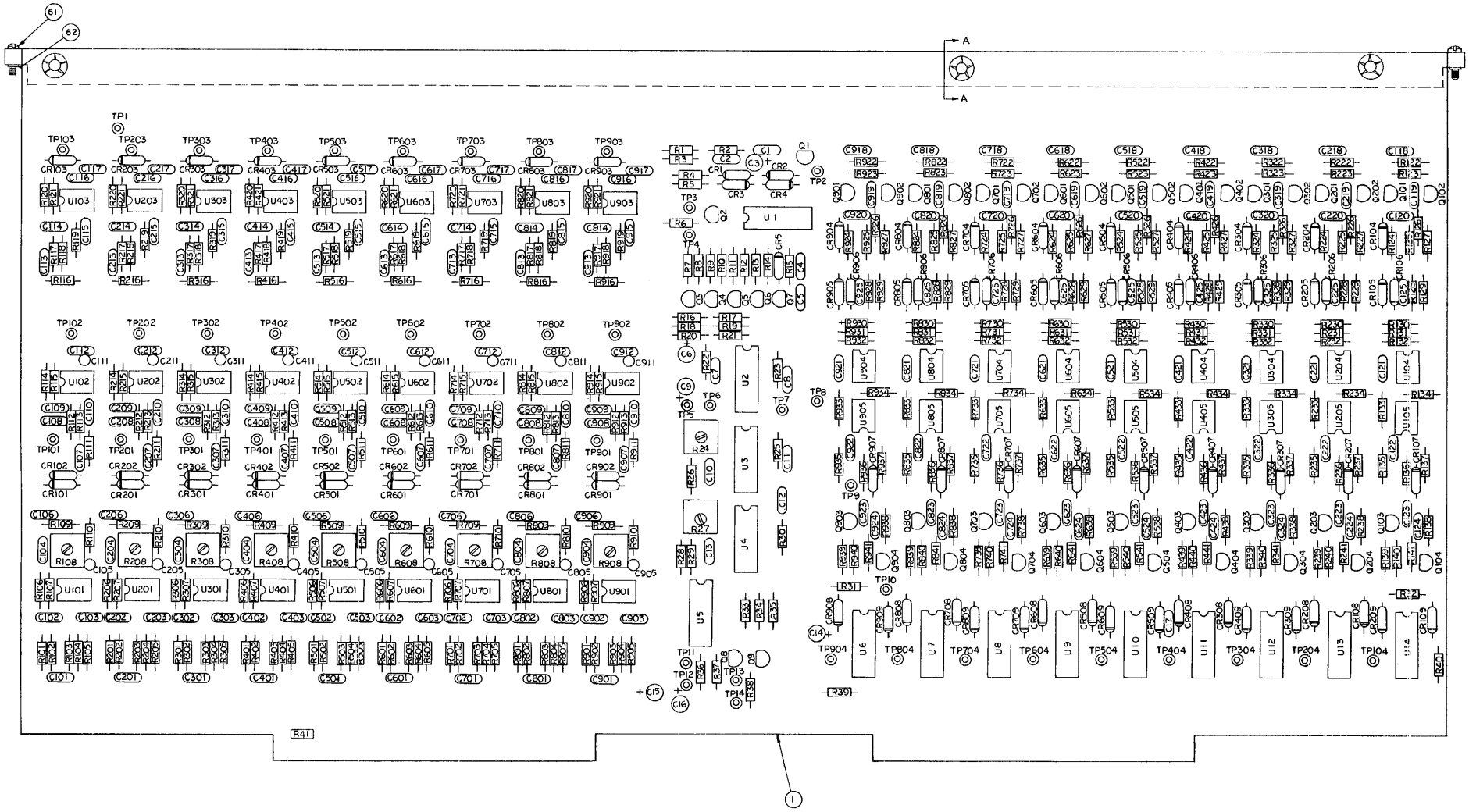
Installation Drawing, I/O Cable Adapter DWG 0051614-0000-01



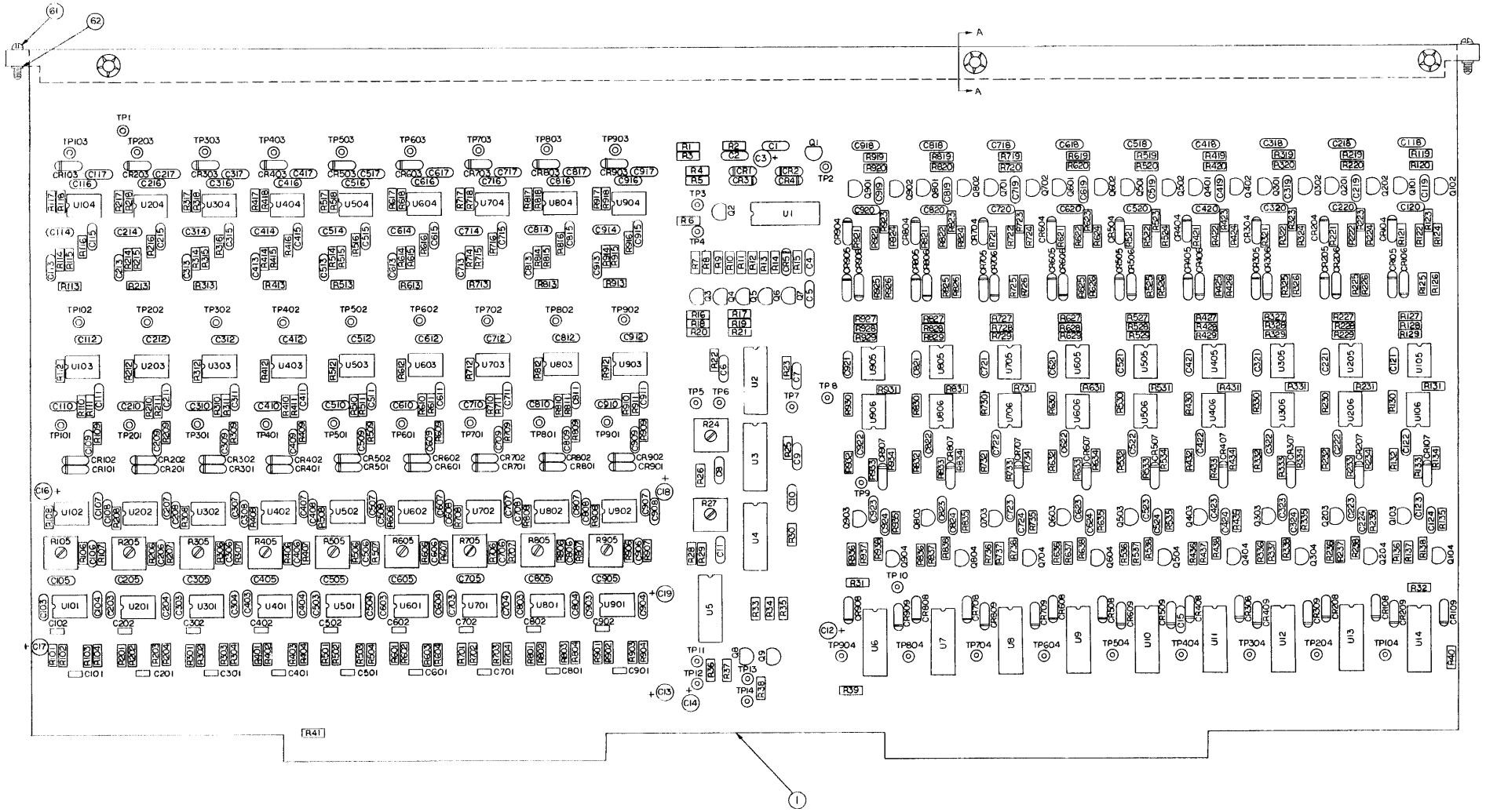
Assembly, Motor Control DWG 0052022-0000-02



Assembly, Write Control DWG 0052198-0000-05



Assembly, PE/NRZ Read Card DWG 0051726-0000-06



Assembly, H.S. PE/NRZ Read Card DWG 0051656-0000-03

ITEM	QTY/DASH 1				PART NUMBER	DESCRIPTION	REFERENCE
1	2				5950045-0001	CHASSIS SLIDE	
2	4				5950028-0001	BAR NUT	
3	10				5050005-0406	SCREW BD. HEAD #8-32 x 3/8 LG.	
4	8				5050005-0606	SCREW BD. HEAD #10-32 x 3/8 LG.	
5	6				5150004-1203	KEP NUT #8	
6	REF				0051911-0000	KIT INSTALLATION 1140 & 1640 TRANSPORT	

BASIC VERSION

NOTES:

DIGI-DATA CORPORATION

DR | ENG

CHK

TITLE: KIT INSTALLATION 1140 & 1640 TRANSPORT

P.L. NO. 0051911-0001 | SH. 1 OF 1 | REV.

REV.	CHG. NO.	DATE	APPR.	NEXT ASSY	USED ON

D.D. FORM 04-1-50001-0000

P.L. NO. 0051911-0001

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
1	2	1052714-0001	RACK MOUNTING BLOCK	
2	1	1051729-0001	MOUNTING BAR	
3	2	1152705-0001	RETAINER	
4	1	0050063-0001	ASSEMBLY, RETAINING CHAIN	
5	AR	5050009-0608	SCREW FLAT HD #10-32 x ½ LG	
6	AR	5050011-0204	SCREW SOCKET HD. #4-40 x ¼ LG	
7	AR	5250008-0312	WASHER FLAT #4	
8	REF	0052710-0000	KIT INSTAL. 1740 & 1840 TRAN.	

DIGI-DATA CORPORATION

DR. | ENG.

CHK.

TITLE: KIT, INSTALLATION 1740 & 1840 TRANSPORT

SH. 1 | P.L. NO. 0052710-0001 | REV.

REV.	ECO NO.	DATE	APPR.	REV.	ECO NO.	DATE	APPR.

D.D.C. FORM 105 REV. A

7PARTS/0

0052710-0001

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
1	1	0052711-0001	ASSEMBLY, HINGE BLOCK	
2	1	0052711-0002	ASSEMBLY, HINGE BLOCK	
3	2	1052714-0001	RACK MOUNTING BLOCK	
4	1	1051729-0001	MOUNTING BAR	
5	1	0050063-0001	ASSEMBLY RETAINING CHAIN	
6	AR	5050009-0608	SCREW FLAT HEAD #10-32 x ½ LG	
7	AR	5050005-0310	SCREW BD. HD. #6-32 x 5/8 LG	
8	AR	5250004-0512	WASHER LOCK #6	
9	AR	5250008-0612	WASHER FLAT #6	
10	REF	0051896-0000	KIT, WITHOUT DOOR INSTALLATION	

SH. 2 | P.L. NO. 0051896-0001 | REV. 02

D.D.C. FORM 117

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
1	1	1352648-0001	DRILL DETAIL, 80 MCA	
2	1	2450049-3173	REG. ADJ. 3 TERM.	U11
3	1	2450049-3172	REG. ADJ. 3 TERM	U10
4	1	2450048-1210	REG. 3 TERM. L.P. NEG.	U14
5	6	2450050-3611	QUAD OPERATIONAL AMP	U1,U6,U12,U13,U27,U28
6	1	2450045-3391	QUAD COMPARATOR	U23
7	1	2450052-9000	54/74 LS SERIES TTL GATE	U20
8	1	2450052-9002	54/74 LS SERIES TTL GATE	U21
9	2	2450053-9006	54/74 SERIES TTL GATE	U15,U17
10	1	2450053-9007	54/74 SERIES TTL GATE	U16
11	1	2450051-0031	DARLINGTON TRAN. ARRAY	U19
12	1	2450047-1001	I.C. TIMER	U2
13	1	2450047-9002	I.C. TIMER	U22
14	10	2350016-0001	TRANSISTOR, SILICON NPN	ADDENDUM
15	12	2350017-0001	TRANSISTOR, SILICON PNP	ADDENDUM
16	1	2350023-0011	TRANSISTOR, 1W, NPN	Q24
17	1	2350023-0511	TRANSISTOR, 1W PNP	Q19
18	4	2350026-6290	TRANS. SILICON MED PWR COMP	Q2,Q7,Q9,Q14
19	5	2350026-6109	TRANS. SILICON MED PWR COMP	Q4,Q11,Q12,Q13,Q16
20	1	2350025-3055	TRANS. SILICON 90W, COMP NPN	Q5
21	1	2350025-2955	TRANS. SILICON 90W, COMP PNP	Q6
22	3	2350024-5878	TRANSISTOR SILICON	Q3,Q10,Q17
23	3	2350024-5876	TRANSISTOR SILICON	Q1,Q8,Q15
24	13	2550002-9140	DIODE, SILICON FAST SWITCHING	ADDENDUM
25	9	2550010-4001	DIODE, SILICON, 1 AMP	ADDENDUM
26	6	2550010-4002	DIODE, SILICON, 1 AMP	ADDENDUM
27	1	2550009-2829	DIODE, ZENER, 1W, 8.2V, 5%	CR29
28				
29	1	2250163-4331	CAP,M/C,COG,200V,±10%,330pF	C3
30	6	2250160-4102	CAP,M/C,COG,X7F,100V,±10%,1000pF	C6,C11,C31,C34,C53,C64
31	2	2250161-4822	CAP,M/C,COG,X7R,100V,±10%,8200pF	C58,C61
32	5	2250162-7103	CAP,M/C,COG,Z5U,100V,+80%-20%,.01uF	C8,C35,C39,C49,C52
33	2	2250161-4153	CAP,M/C,COG,X7R,100V±10%,.015uF	C1,C18
34	26	2250162-7104	CAP,M/C,COG,Z5U,100V,+80%,-20%,.1uF	ADDENDUM
35	3	2250116-4105	CAP, TANT. 35V, ±10%,1.0uF	C9,C40,C43
36	1	2250116-7475	CAP, TANT 35V,-20 +80%,4.7uF	C22,C29,
37	6	2250166-4106	CAP,DIPPED TANT.,15V,±10%,10uF	C59,C60,C62,C63,C80,C81
38	6	2250166-4226	CAP,DIPPED TANT.,15V,±10%,22uF	C23,C36,C47,C48,C50,C51
39	1	2250121-3105	CAP,MYLAR W.F.,50V,±5%,1.0uF	C19
40	1	2250121-3153	CAP.,MYLAR,50V,5%,.015uF	C2
41	15	2150012-0100	RESISTOR 10 OHM, ¼W 5%	ADDENDUM
42	1	2150004-0680	RESISTOR, 68 OHM, ¼W 5%	R63
43	4	2150004-0470	RESISTOR 47 OHM, ¼W 5%	R53,R109,R110,R158
44	3	2150004-0151	RESISTOR, 150 OHM, ¼W 5%	R19,R35,R80
45	6	2150004-0201	RESISTOR, 200 OHM, ¼W 5%	R9,R28,R79,R88,R116,R143
46	3	2150004-0271	RESISTOR, 270 OHM, ¼W 5%	R50,R133,R142
47	1	2150004-0301	RESISTOR, 300 OHM, ¼W 5%	R61
48	2	2150004-0471	RESISTOR, 470 OHM, ¼W 5%	R20,R72
49	2	2150004-0751	RESISTOR, 750 OHM, ¼W 5%	R21,R92
50	12	2150004-0102	RESISTOR, 1K, ¼W 5%	ADDENDUM
51	2	2150004-0152	RESISTOR, 1.5K, ¼W 5%	R66,R67
52	4	2150004-0202	RESISTOR, 2K, ¼W 5%	R102,R104,R126,R136
53	5	2150004-0222	RESISTOR, 2.2K, ¼W 5%	R93,R103,R132,R141,R155
54	1	2150004-0272	RESISTOR, 2.7K, ¼W 5%	R51
55	1	2150004-0302	RESISTOR, 3K, ¼W 5%	R70
56	2	2150004-0392	RESISTOR, 3.9K, ¼W 5%	R69,R73

TITLE: ASSEMBLY, LO SP MOTOR CONTROL SHORT HEAT SINK	SCALE REF:	PART NO. 0052022-0001	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED: .XX ± .010, .XXX ± .005, ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 1

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
57	6	2150004-0472	RESISTOR, 4.7K, ¼W 5%	ADDENDUM
58	1	2150004-0622	RESISTOR, 6.2K, ¼W 5%	R74
59	6	2150004-0103	RESISTOR, 10K, ¼W 5%	R11,R18,R37,R44,R97,R152
60	3	2150004-0153	RESISTOR, 15K, ¼W 5%	R130,R139,R98
61	2	2150004-0203	RESISTOR, 20K, ¼W 5%	R94,R113
62	4	2150004-0243	RESISTOR, 24K, ¼W 5%	R112,R115,R131,R140
63	3	2150004-0393	RESISTOR, 39K, ¼W 5%	R64,R65,R153
64	4	2150004-0563	RESISTOR, 56K, ¼W 5%	R57,R68,R129,R138
65	4	2150004-0104	RESISTOR, 100K, ¼W 5%	R32,R34,R101,R111
66	1	2150004-0512	RESISTOR 5.1K, ¼W 5%	R17
67	2	2150004-0224	RESISTOR, 220K, ¼W 5%	R54,R108
68	1	2150004-0564	RESISTOR, 560K, ¼W 5%	R58
69	1	2140004-0106	RESISTOR, 10 MEG, ¼W 5%	R38
70	2	2150004-0123	RESISTOR, 12K, ¼W 5%	R55,R114
71	1	2150006-0620	RESISTOR, 62 OHM, ½W 5%	R91
72	3	2150006-0201	RESISTOR, 200 OHM, ½W 5%	R16,R84,R122
73	1	2150006-0471	RESISTOR, 470 OHM, ½W 5%	R99
74	6	2150006-0821	RESISTOR, 820 OHM, ½W 5%	ADDENDUM
75	3	2150008-0821	RESISTOR, 820 1W 5%	R15,R83,R121
76	1	2150038-0568	RESISTOR .56 2W WW 5%	R59
77	1	2150038-0688	RESISTOR .68 2W WW 5%	R75
78	2	2150038-0519	RESISTOR, 5.1 2W WW 5%	R100,R105
79	1	2150038-0180	RESISTOR, 18 2W WW 5%	R31
80	4	2150038-0228	RESISTOR, .22 2W WW 5%	R81,R89,R120,R147
81	1	2150039-0158	RESISTOR, .15 OHM 5W WW 5%	R43
82	2	2150039-0188	RESISTOR, .18 5W WW 5%	R10,R29
83	1	2150020-1002	RESISTOR, 10.0K 1/8W 1% M.F.	R1
84	3	2150020-1332	RESISTOR, 13.3K 1/8W 1% M.F.	R40,R42,R137
85	2	2150020-3482	RESISTOR, 34.8K 1/8W 1% M.F.	R39,R41
86	1	2150020-4022	RESISTOR, 40.2K 1/8W 1% M.F.	R56
87	1	2150020-2261	RESISTOR 2.26K 1/8W 1% M.F.	R3
88	1	2150020-4642	RESISTOR, 46.4K 1/8W 1% M.F.	R128
89	1	2150020-6042	RESISTOR, 60.4K 1/8W 1% M.F.	R127
90	1	2150020-4322	RESISTOR, 43.2K 1/8W 1% M.F.	R4
91	1	2150020-8662	RESISTOR, 86.6K 1/8W 1% M.F.	R5
92	1	2150020-2003	RESISTOR, 200K 1/8W 1% M.F.	R2
93	2	2150046-1101	POTENTIOMETER SINGLE TURN	R52,R62
94	2	2150046-1102	POTENTIOMETER SINGLE TURN	R134,R135
95	2	2150046-1502	POTENTIOMETER SINGLE TURN	R124,R125
96	3	2150046-1103	POTENTIOMETER SINGLE TURN	R45,R48,R49
97	1	2150046-1503	POTENTIOMETER SINGLE TURN	R46
98	2	2150049-2002	RESISTOR NETWORK DIP 14 PIN 1%	U9,U25
99	1	2150048-2472	RESISTOR NETWORK DIP 14 PIN PULLUP	U18
100	6	2950009-0001	MICA INSULATOR TO-3	
101	10	2950010-0001	MICA INSULATOR TO-220	
102	2	2950011-0001	MICA INSULATOR TIP	
103	AR	9050001-0001	SILICONE H.S. COMPOUND	
104	AR	3950000-0001	SOLDER	
105	3	2950006-0001	DIP SOCKET, SOLDER TAIL	XU8,XU24,XU26
106	6	5950034-0002	INSULATOR, SHOULDER	
107	1	2950022-0001	MOUNTING PAD INSULATOR	
108	AR	5050021-0207	SCREW BD. HD. 4-40 x 7/16 LG	
109	AR	5250008-1203	WASHER, FLAT #4	
110	AR	5250004-1203	WASHER, LOCK #4	
111	AR	5150001-1203	NUT, HEX #4-40	
112	AR	5250005-2102	WASHER, INT. TOOTH #4	

TITLE: ASSEMBLY, LO SP MOTOR CONTROL SHORT HEAT SINK	SCALE REF:	PART NO. 0052022-0001	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED: .XX ± .010, .XXX ± .005, ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 2

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
113	AR	5250005-1202	WASHER, INT. TOOTH #4	
114	AR	5951120-0411	RIVET SNAP HEAD	
115	AR	5950015-1220	INSERT SELF CLINCHING	
116	1	1152128-0001	HOLD DOWN BRACKET	
117	1	1152128-0002	HOLD DOWN BRACKET	
118	19	2070017-0001	TERMINAL, TURRET, THRU HOLE	ADDENDUM
119	3	2950029-0001	BUSS BAR	
120	2	2950029-0002	BUSS BAR	
121	2	2951271-0001	STRAIGHT HEADER	W1
122	REF	0052022-0000	ASSY MOTOR CONTROL	
123	REF	0252023-0000	SCHEMATIC MOTOR CONTROL	
124				
126	1	2150004-0334	RESISTOR, 330K ¼w 5%	R107
127	1	2051274-0001	JUMPER TERMINAL	W1
128	AR	5050005-0418	SCREW BD. HD. 8-32 x 1 1/8 LG	
129	2	1150011-0001	HEAT SINK	
130	3	1010488-0001	HEAT SINK SPACER	
151	5	2050166-7226	CAP, TANT 15V, -20 +80%, 22uF	C20,C21,C28,C30,C33
152	AR	2050025-0093	WIRE, 26 AWG, KYNAR INSULATED	W102

TITLE: ASSEMBLY, LO SP MOTOR CONTROL SHORT HEAT SINK	SCALE REF:	PART NO. 0052022-0001	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED: .XX ± .010, .XXX ± .005, ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 3

DDC FORM 80

ADDENDUM

ITEM	REFERENCE
14	Q21,Q22,Q25,Q27,Q28,Q30,Q31,Q37,Q38,Q41
15	Q18,Q20,Q23,Q26,Q29,Q32,Q33,Q34,Q35,Q36,Q39,Q40
24	CR6,CR7,CR8,CR12,CR13,CR14,CR15,CR16,CR17,CR18,CR23,CR24,CR25
25	CR1,CR2,CR9,CR10,CR11,CR19,CR20,CR21,CR22
26	CR4,CR5,CR26,CR27,CR31,CR32
34	C4,C5,C7,C15,C16,C17,C24,C25,C26,C32,C37,C38,C41,C42, C44,C45,C54,C55,C56,C57,C65,C66,C68,C70,C71,C72,
41	R7,R8,R26,R27,R77,R78,R86,R87,R117,R118,R144,R145,R154, R159,R161
50	R6,R25,R33,R36,R60,R76,R85,R95,R119,R146,R156,R157
57	R13,R23,R71,R96,R151,R148,R149
74	R14,R30,R82,R90,R106,R123
118	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13 TP14,TP15,TP16,TP17,TP18,TP19

TITLE: ASSEMBLY, LO SP MOTOR CONTROL SHORT HEAT SINK	SCALE REF:	PART NO. 0052022-0001	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED: .XX ± .010, .XXX ± .005, ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 4

DDC FORM 80

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
1	1	1352648-0001	DRILL DETAIL, 80 MCA	
2	1	2450049-3173	REG. ADJ. 3 TERM.	U11
3	1	2450049-3172	REG. ADJ. 3 TERM	U10
4	1	2450048-1210	REG. 3 TERM. L.P. NEG.	U14
5	6	2450050-3611	QUAD OPERATIONAL AMP	U1,U6,U12,U13,U27,U28
6	1	2450045-3391	QUAD COMPARATOR	U23
7	1	2450052-9000	54/74 LS SERIES TTL GATE	U20
8	1	2450052-9002	54/74 LS SERIES TTL GATE	U21
9	2	2450053-9006	54/74 SERIES TTL GATE	U15,U17
10	1	2450053-9007	54/74 SERIES TTL GATE	U16
11	1	2450051-0031	DARLINGTON TRAN. ARRAY	U19
12	1	2450047-1001	I.C. TIMER	U2
13	1	2450047-9002	I.C. TIMER	U22
14	10	2350016-0001	TRANSISTOR, SILICON NPN	ADDENDUM
15	12	2350017-0001	TRANSISTOR, SILICON NPN	ADDENDUM
16	1	2350023-0011	TRANSISTOR, 1W, NPN	Q24
17	1	2350023-0511	TRANSISTOR, 1W PNP	Q19
18	4	2350026-6290	TRANS. SILICON MED PWR COMP	Q2,Q7,Q9,Q14
19	5	2350026-6109	TRANS. SILICON MED PWR COMP	Q4,Q11,Q12,Q13,Q16
20	1	2350025-3055	TRANS. SILICON 90W, COMP NPN	Q5
21	1	2350025-2955	TRANS. SILICON 90W, COMP PNP	Q6
22	3	2350024-5878	TRANSISTOR SILICON	Q3,Q10,Q17
23	3	2350024-5876	TRANSISTOR SILICON	Q1,Q8,Q15
24	13	2550002-9140	DIODE, SILICON FAST SWITCHING	ADDENDUM
25	9	2550010-4001	DIODE, SILICON, 1 AMP	ADDENDUM
26	6	2550010-4002	DIODE, SILICON, 1 AMP	ADDENDUM
27	1	2550009-2829	DIODE, ZENER, 1W, 8.2V, 5%	CR29
29	1	2250163-4331	CAP,M/C,COG,200V,±10%,330pF	C3
30	6	2250160-4102	CAP,M/C,COG,X7F,100V,±10%,1000pF	C6,C11,C31,C34,C53,C64
31	4	2250161-4822	CAP,M/C,COG,X7R,100V,±10%,8200pF	C49,C52,C58,C61
32	3	2250162-7103	CAP,M/C,COG,Z5U,100V,+80%-20%,.01uF	C8,C35,C39
33	2	2250161-4153	CAP,M/C,COG,X7R,100V±10%,.015uF	C1,C18
34	25	2250162-7104	CAP,M/C,COG,Z5U,100V,+80%,-20%,.1uF	ADDENDUM
35	3	2250116-4105	CAP, TANT. 35V, ±10%,1.0uF	C9,C40,C43
36	2	2250116-7475	CAP, TANT 35V,-20 +80%,4.7uF	C22,C29
37	6	2250166-4106	CAP,DIPPED TANT.,15V,±10%,10uF	C59,C60,C62,C63,C80,C81
38	6	2250166-4226	CAP,DIPPED TANT.,15V,±10%,22uF	C23,C36,C47,C48,C50,C51
39	1	2250121-3105	CAP,MYLAR W.F.,50V,±5%,1.0uF	C19
40	1	2250121-3153	CAP.,MYLAR,50V,5%,.015uF	C2
41	15	2150012-0100	RESISTOR 10 OHM, ¼W 5%	ADDENDUM
42	1	2150004-0680	RESISTOR, 68 OHM, ¼W 5%	R63
43	4	2150004-0470	RESISTOR 47 OHM, ¼W 5%	R53,R109,R110,R158
44	3	2150004-0151	RESISTOR, 150 OHM, ¼W 5%	R19,R35,R80
45	6	2150004-0201	RESISTOR, 200 OHM, ¼W 5%	ADDENDUM
46	3	2150004-0271	RESISTOR, 270 OHM, ¼W 5%	R50,R133,R142
47	1	2150004-0301	RESISTOR, 300 OHM, ¼W 5%	R61
48	2	2150004-0471	RESISTOR, 470 OHM, ¼W 5%	R20,R72
49	2	2150004-0751	RESISTOR, 750 OHM, ¼W 5%	R21,R92
50	12	2150004-0102	RESISTOR, 1K, ¼W 5%	ADDENDUM
51	2	2150004-0152	RESISTOR, 1.5K, ¼W 5%	R66,R67
52	4	2150004-0202	RESISTOR, 2K, ¼W 5%	R102,R104,R126,R136
53	5	2150004-0222	RESISTOR, 2.2K, ¼W 5%	R93,R103,R132,R141,R155
54	1	2150004-0272	RESISTOR, 2.7K, ¼W 5%	R51
55	1	2150004-0302	RESISTOR, 3K, ¼W 5%	R70
56	2	2150004-0392	RESISTOR, 3.9K, ¼W 5%	R69,R73
57	6	2150004-0472	RESISTOR, 4.7K, ¼W 5%	ADDENDUM

TITLE: ASSEMBLY LOW SPEED MOTOR CONTROL TALL HEAT SINK	SCALE REF:	PART NO. 0052022-0002	REV: .
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 1

DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
58	1	2150004-0622	RESISTOR, 6.2K, ¼W 5%	R74
59	6	2150004-0103	RESISTOR, 10K, ¼W 5%	R11,R18,R37,R44,R97,R152
60	3	2150004-0153	RESISTOR, 15K, ¼W 5%	R130,R139,R98
61	2	2150004-0203	RESISTOR, 20K, ¼W 5%	R94,R113
62	4	2150004-0243	RESISTOR, 24K, ¼W 5%	R112,R115,R131,R140
63	3	2150004-0393	RESISTOR, 39K, ¼W 5%	R64,R65,R153
64	4	2150004-0563	RESISTOR, 56K, ¼W 5%	R57,R68,R129,R138
65	4	2150004-0104	RESISTOR, 100K, ¼W 5%	R32,R34,R101,R111
66	1	2150004-0512	RESISTOR 5.1K, ¼W 5%	R17
67	2	2150004-0224	RESISTOR, 220K, ¼W 5%	R54,R108
68	1	2150004-0564	RESISTOR, 560K, ¼W 5%	R58
69	1	2140004-0106	RESISTOR, 10 MEG, ¼W 5%	R38
70	2	2150004-0123	RESISTOR, 12K, ¼W 5%	R55,R114
71	1	2150006-0620	RESISTOR, 62 OHM, ½W 5%	R91
72	3	2150006-0201	RESISTOR, 200 OHM, ½W 5%	R16,R84,R122
73	1	2150006-0471	RESISTOR, 470 OHM, ½W 5%	R99
74	6	2150006-0821	RESISTOR, 820 OHM, ½W 5%	ADDENDUM
75	3	2150008-0821	RESISTOR, 820 1W 5%	R15,R83,R121
76	1	2150038-0568	RESISTOR .56 2W WW 5%	R59
77	1	2150038-0688	RESISTOR .68 2W WW 5%	R75
78	2	2150038-0519	RESISTOR, 5.1 2W WW 5%	R100,R105
79	1	2150038-0180	RESISTOR, 18 2W WW 5%	R31
80	4	2150038-0228	RESISTOR, .22 2W WW 5%	R81,R89,R120,R147
81	1	2150039-0158	RESISTOR, .15 OHM 5W WW 5%	R43
82	2	2150039-0188	RESISTOR, .18 5W WW 5%	R10,R29
83	1	2150020-1002	RESISTOR, 10.0K 1/8W 1% M.F.	R1
84	3	2150020-1332	RESISTOR, 13.3K 1/8W 1% M.F.	R40,R42,R137
85	2	2150020-3482	RESISTOR, 34.8K 1/8W 1% M.F.	R39,R41
86	1	2150020-4022	RESISTOR, 40.2K 1/8W 1% M.F.	R56
87	1	2150020-2261	RESISTOR 2.26K 1/8W 1% M.F.	R3
88	1	2150020-4642	RESISTOR, 46.4K 1/8W 1% M.F.	R128
89	1	2150020-6042	RESISTOR, 60.4K 1/8W 1% M.F.	R127
90	1	2150020-4322	RESISTOR, 43.2K 1/8W 1% M.F.	R4
91	1	2150020-8662	RESISTOR, 86.6K 1/8W 1% M.F.	R5
92	1	2150020-2003	RESISTOR, 200K 1/8W 1% M.F.	R2
93	2	2150046-1101	POTENTIOMETER SINGLE TURN	R52,R62
94	2	2150046-1102	POTENTIOMETER SINGLE TURN	R134,R135
95	2	2150046-1502	POTENTIOMETER SINGLE TURN	R124,R125
96	3	2150046-1103	POTENTIOMETER SINGLE TURN	R45,R48,R49
97	1	2150046-1503	POTENTIOMETER SINGLE TURN	R46
98	2	2150049-2002	RESISTOR NETWORK DIP 14 PIN 1%	U9,U25
99	1	2150048-2472	RESISTOR NETWORK DIP 14 PIN PULLUP	U18
100	6	2950009-0001	MICA INSULATOR TO-3	
101	10	2950010-0001	MICA INSULATOR TO-220	
102	2	2950011-0001	MICA INSULATOR TIP	
103	AR	9050001-0001	SILICONE H.S. COMPOUND	
104	AR	3950000-0001	SOLDER	
105	3	2950006-0001	DIP SOCKET, SOLDER TAIL	XU8,XU24,XU26
106	6	5950034-0002	INSULATOR, SHOULDER	
107	1	2950022-0001	MOUNTING PAD INSULATOR	
108	AR	5050021-0207	SCREW BD. HD. 4-40 x 7/16 LG	
109	AR	5250008-1203	WASHER, FLAT #4	
110	AR	5250004-1203	WASHER, LOCK #4	
111	AR	5150001-1203	NUT, HEX #4-40	
112	AR	5250005-2102	WASHER, INT. TOOTH #4	
113	AR	5250005-1202	WASHER, INT. TOOTH #4	

TITLE: ASSEMBLY LOW SPEED MOTOR CONTROL TALL HEAT SINK	SCALE REF:	PART NO. 0052022-0002	REV: /
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 2

DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
114	AR	5951120-0411	RIVET SNAP HEAD	
115	AR	5950015-1220	INSERT SELF CLINCHING	
116	1	1152128-0001	HOLD DOWN BRACKET	
117	1	1152128-0002	HOLD DOWN BRACKET	
118	19	2070017-0001	TERMINAL, TURRET, THRU HOLE	ADDENDUM
119	3	2950029-0001	BUSS BAR	
120	2	2950029-0002	BUSS BAR	
121	2	2951271-0001	STRAIGHT HEADER	W1
122	REF	0052022-0000	ASSY MOTOR CONTROL	
123	REF	0252023-0000	SCHEMATIC MOTOR CONTROL	
126	1	2150010-4123	RESISTOR,412K,1/8W,1%,MF	R107
127	1	2051274-0001	JUMPER TERMINAL	W1
128	AR	5050005-0412	SCREW BD. HD. 8-32 x 3/4 LG	
129	2	1150011-0002	HEAT SINK	
130	3	1010488-0001	HEAT SINK SPACER	
151	5	2050166-7226	CAP, TANT 15V, -20 +80%, 22uF	C20,C21,C28,C30,C33
152	AR	2050025-0093	WIRE, 26 AWG, KYNAR INSULATED	W102

TITLE: ASSEMBLY LOW SPEED MOTOR CONTROL TALL HEAT SINK	SCALE REF:	PART NO. 0052022-0002	REV: .
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 3

DDC FORM 120

ADDENDUM

ITEM	REFERENCE
14	Q21,Q22,Q25,Q27,Q28,Q30,Q31,Q37,Q38,Q41
15	Q18,Q20,Q23,Q26,Q29,Q32,Q33,Q34,Q35,Q36,Q39,Q40
24	CR6,CR7,CR8,CR12,CR13,CR14,CR15,CR16,CR17,CR18,CR23,CR24,CR25
25	CR1,CR2,CR9,CR10,CR11,CR19,CR20,CR21,CR22
26	CR4,CR5,CR26,CR27,CR31,CR32
34	C4,C5,C7,C15,C16,C17,C24,C25,C26,C32,C37,C38,C41,C42, C44,C45,C54,C55,C56,C57,C65,C66,C68,C70,C71,C72,
41	R7,R8,R26,R27,R77,R78,R86,R87,R117,R118,R144,R145,R154, R159,R161
45	R9,R28,R79,R88,R116,R143
50	R6,R25,R33,R36,R60,R76,R85,R95,R119,R146,R156,R157
57	R13,R23,R71,R96,R151,R149
74	R14,R30,R82,R90,R106,R123
118	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13 TP14,TP15,TP16,TP17,TP18,TP19

TITLE: ASSEMBLY LOW SPEED MOTOR CONTROL TALL HEAT SINK	SCALE REF:	PART NO. 0052022-0002	REV: .
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 4

DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
1	1	1352648-0001	DRILL DETAIL, 80 MCA	
2	1	2450049-3173	REG. ADJ. 3 TERM.	U11
3	1	2450049-3172	REG. ADJ. 3 TERM	U10
4	1	2450048-1210	REG. 3 TERM. L.P. NEG.	U14
5	6	2450050-3611	QUAD OPERATIONAL AMP	U1,U6,U12,U13,U27,U28
6	1	2450045-3391	QUAD COMPARATOR	U23
7	1	2450052-9000	54/74 LS SERIES TTL GATE	U20
8	1	2450052-9002	54/74 LS SERIES TTL GATE	U21
9	2	2450053-9006	54/74 SERIES TTL GATE	U15,U17
10	1	2450053-9007	54/74 SERIES TTL GATE	U16
11	1	2450051-0031	DARLINGTON TRAN. ARRAY	U19
12	1	2450047-1001	I.C. TIMER	U2
13	1	2450047-9002	I.C. TIMER	U22
14	7	2350016-0001	TRANSISTOR, SILICON NPN	ADDENDUM
15	9	2350017-0001	TRANSISTOR, SILICON PNP	ADDENDUM
16	1	2350023-0011	TRANSISTOR, 1W, NPN	Q24
17	1	2350023-0511	TRANSISTOR, 1W PNP	Q19
18	1	2350026-6290	TRANS. SILICON MED PWR COMP	Q7
19	2	2350026-6109	TRANS. SILICON MED PWR COMP	Q12,Q13
20	1	2350025-3055	TRANS. SILICON 90W, COMP NPN	Q5
21	1	2350025-2955	TRANS. SILICON 90W, COMP PNP	Q6
22	3	2351781-5886	TRANSISTOR SILICON	Q3,Q10,Q17
23	3	2351781-5884	TRANSISTOR SILICON	Q1,Q8,Q15
24	13	2550002-9140	DIODE, SILICON FAST SWITCHING	ADDENDUM
25	9	2550010-4001	DIODE, SILICON, 1 AMP	ADDENDUM
26	6	2550010-4002	DIODE, SILICON, 1 AMP	ADDENDUM
27	1	2550009-2829	DIODE, ZENER, 1W, 8.2V, 5%	CR29
28	1	2552002-1970	DIODE, ZENER, 24V 10%, 400 MW	CR33
29	2	2250163-4331	CAP,M/C,COG,200V,±10%,330pF	C49,C52
30	6	2250160-4102	CAP,M/C,COG,X7F,100V,±10%,1000pF	C6,C11,C31,C34,C53,C64
31	2	2250161-4822	CAP,M/C,COG,X7R,100V,±10%,8200pF	C58,C61
32	3	2250162-7103	CAP,M/C,COG,Z5U,100V,+80%-20%,.01uF	C8,C35,C39
33	2	2250161-4153	CAP,M/C,COG,X7R,100V±10%,.015uF	C1,C18
34	26	2250162-7104	CAP,M/C,COG,Z5U,100V,+80%,-20%,.1uF	ADDENDUM
35	3	2250116-4105	CAP, TANT. 35V, ±10%,1.0uF	C9,C40,C43
36	2	2250116-7475	CAP, TANT 35V,-20 +80%,4.7uF	C22,C29
37	4	2250166-4106	CAP,DIPPED TANT.,15V,±10%,10uF	C59,C60,C62,C63
38	6	2250166-4226	CAP,DIPPED TANT.,15V,±10%,22uF	C23,C36,C47,C48,C50,C51
39	1	2250121-3105	CAP,MYLAR W.F.,50V,±5%,1.0uF	C19
40	1	2250161-4104	CAP.,M/C, X7R,100V ±10%,.1uF	C3
41	15	2150012-0100	RESISTOR, 10 OHM, ¼W 5%	ADDENDUM
42	1	2150004-0680	RESISTOR, 68 OHM, ¼W 5%	R63
43	2	2150004-0470	RESISTOR 47 OHM, ¼W 5%	R53,R158
44	3	2150004-0151	RESISTOR, 150 OHM, ¼W 5%	R19,R35,R80
45	6	2150004-0201	RESISTOR, 200 OHM, ¼W 5%	R9,R28,R79,R88,R116,R143
46	3	2150004-0271	RESISTOR, 270 OHM, ¼W 5%	R50,R133,R142
47	1	2150004-0301	RESISTOR, 300 OHM, ¼W 5%	R61
48	2	2150004-0471	RESISTOR, 470 OHM, ¼W 5%	R20,R72
49	2	2150004-0751	RESISTOR, 750 OHM, ¼W 5%	R21,R92
50	12	2150004-0102	RESISTOR, 1K, ¼W 5%	ADDENDUM
51	2	2150004-0152	RESISTOR, 1.5K, ¼W 5%	R66,R67
52	4	2150004-0202	RESISTOR, 2K, ¼W 5%	R102,R104,R126,R136
53	5	2150004-0222	RESISTOR, 2.2K, ¼W 5%	R93,R103,R132,R141,R155
54	1	2150004-0272	RESISTOR, 2.7K, ¼W 5%	R51
55	1	2150004-0302	RESISTOR, 3K, ¼W 5%	R70
56	2	2150004-0392	RESISTOR, 3.9K, ¼W 5%	R69,R73

TITLE: ASSEMBLY, HIGH SPEED MOTOR CONTROL	SCALE REF:	PART NO. 0052022-0009	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 1

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
57	6	2150004-0472	RESISTOR, 4.7K, ¼W 5%	ADDENDUM
58	1	2150004-0622	RESISTOR, 6.2K, ¼W 5%	R74
59	6	2150004-0103	RESISTOR, 10K, ¼W 5%	R11,R17,R37,R44,R97,R152
60	3	2150004-0153	RESISTOR, 15K, ¼W 5%	R98,R130,R139
61	2	2150004-0203	RESISTOR, 20K, ¼W 5%	R94,R113
62	4	2150004-0243	RESISTOR, 24K, ¼W 5%	R112,R115,R131,R140
63	3	2150004-0393	RESISTOR, 39K, ¼W 5%	R64,R65,R153
64	4	2150004-0563	RESISTOR, 56K, ¼W 5%	R57,R68,R129,R138
65	4	2150004-0104	RESISTOR, 100K, ¼W 5%	R32,R34,R101,R111
66	1	2150004-0304	RESISTOR 300K, ¼W 5%	R107
67	2	2150004-0224	RESISTOR, 220K, ¼W 5%	R54,R108
68	1	2150004-0564	RESISTOR, 560K, ¼W 5%	R58
69	1	2140004-0106	RESISTOR, 10 MEG, ¼W 5%	R38
70	2	2150004-0123	RESISTOR, 12K, ¼W 5%	R55,R114
71	1	2150006-0620	RESISTOR, 62 OHM, ½W 5%	R91
72	3	2150006-0201	RESISTOR, 200 OHM, ½W 5%	R16,R84,R122
73	1	2150006-0471	RESISTOR, 470 OHM, ½W 5%	R99
74	6	2150006-0821	RESISTOR, 820 OHM, ½W 5%	R14,R30,R82,R90,R106,R123
75	3	2150008-0821	RESISTOR, 820 1W 5%	R15,R83,R121
76	1	2150038-0568	RESISTOR .56 2W WW 5%	R59
77	1	2150038-0688	RESISTOR .68 2W WW 5%	R75
78	2	2150038-0519	RESISTOR, 5.1 2W WW 5%	R100,R105
79	1	2150038-0180	RESISTOR, 18 2W WW 5%	R31
81	7	2150039-0158	RESISTOR, .15 OHM 5W WW 5%	ADDENDUM
82	1	2150020-6041	RESISTOR, 6.04K 1/8W 1%,M.F.	R18
83	1	2150020-1002	RESISTOR, 10.0K 1/8W 1% M.F.	R1
84	3	2150020-1332	RESISTOR, 13.3K 1/8W 1% M.F.	R40,R42,R137
85	2	2150020-3482	RESISTOR, 34.8K 1/8W 1% M.F.	R39,R41
86	1	2150020-4022	RESISTOR, 40.2K 1/8W 1% M.F.	R56
88	1	2150020-4642	RESISTOR, 46.4K 1/8W 1% M.F.	R128
89	1	2150020-6042	RESISTOR, 60.4K 1/8W 1% M.F.	R127
90	2	2150020-4122	RESISTOR, 41.2K, 1/8W 1% M.F.	R4,R154
91	1	2150020-6652	RESISTOR, 66.5K, 1/8W, 1% M.F.	R2
92	1	2150020-2743	RESISTOR, 274K, 1/8W 1% M.F.	R5
93	2	2150046-1101	POTENTIOMETER SINGLE TURN	R52,R62
94	2	2150046-1102	POTENTIOMETER SINGLE TURN	R134,R135
95	2	2150046-1502	POTENTIOMETER SINGLE TURN	R124,R125
96	3	2150046-1103	POTENTIOMETER SINGLE TURN	R45,R48,R49
97	1	2150046-1503	POTENTIOMETER SINGLE TURN	R46
98	2	2150049-2002	RESISTOR NETWORK DIP 14 PIN 1%	U9,U25
99	1	2150048-2472	RESISTOR NETWORK DIP 14 PIN PULLUP	U18
100	6	2950009-0001	MICA INSULATOR TO-3	
101	10	2950010-0001	MICA INSULATOR TO-220	
102	2	2950011-0001	MICA INSULATOR TIP	
103	AR	9050001-0001	SILICONE H.S. COMPOUND	
104	AR	3950000-0001	SOLDER	
105	3	2950006-0001	DIP SOCKET, SOLDER TAIL	XU8,XU24,XU26
106	6	5950034-0002	INSULATOR, SHOULDER	
107	1	2950022-0001	MOUNTING PAD INSULATOR	
108	AR	5050021-0207	SCREW BD. HD. 4-40 x 7/16 LG	
109	AR	5250008-1203	WASHER, FLAT #4	
110	AR	5250004-1203	WASHER, LOCK #4	
111	AR	5150001-1203	NUT, HEX #4-40	
112	AR	5250005-2102	WASHER, INT. TOOTH #4	
113	AR	5250005-1202	WASHER, INT. TOOTH #4	
114	AR	5951120-0411	RIVET SNAP HEAD	

TITLE: ASSEMBLY, HIGH SPEED MOTOR CONTROL	SCALE REF:	PART NO. 0052022-0009	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 2

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
115	AR	5950015-1220	INSERT SELF CLINCHING	
116	1	1152128-0001	HOLD DOWN BRACKET	
117	1	1152128-0002	HOLD DOWN BRACKET	
118	19	2070017-0001	TERMINAL, TURRET, THRU HOLE	ADDENDUM
119	3	2950029-0001	BUSS BAR	
120	2	2950029-0002	BUSS BAR	
121	2	2951271-0001	STRAIGHT HEADER	W1
122	REF	0052022-0000	ASSY MOTOR CONTROL	
123	REF	0252023-0000	SCHEMATIC MOTOR CONTROL	
124	3	2350026-6107	TRANSISTOR SILICON	Q4,Q11,Q16
125	1	2051274-0001	JUMPER TERMINAL	W1
128	AR	5050005-0412	SCREW BD. HD. 8-32 x 3/4 LG	
129	2	1150011-0002	HEAT SINK	
130	3	1010488-0001	HEAT SINK SPACER	
131	3	2351782-0005	TRANSISTOR, SILICON	Q22,Q31,Q38
132	3	2351782-0055	TRANSISTOR, SILICON	Q20,Q29,Q36
133	3	2350026-6292	TRANSISTOR, SILICON	Q2,Q9,Q14
151	5	2050166-7226	CAP, TANT 15V, -20 +80%, 22uF	C20,C21,C28,C30,C33
152	AR	2050025-0093	WIRE, 26 AWG, KYNAR INSULATED	W102

TITLE: ASSEMBLY, HIGH SPEED MOTOR CONTROL	SCALE REF:	PART NO. 0052022-0009	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 3

ADDENDUM

ITEM	REFERENCE
14	Q21,Q25,Q27,Q28,Q30,Q37,Q41
15	Q18,Q23,Q26,Q32,Q33,Q34,Q35,Q39,Q40
24	CR6,CR7,CR8,CR12,CR13,CR14,CR15,CR16,CR17,CR18,CR23,CR24,CR25
25	CR1,CR2,CR9,CR10,CR11,CR19,CR20,CR21,CR22
26	CR4,CR5,CR26,CR27,CR31,CR32
34	C4,C5,C7,C15,C16,C17,C24,C25,C26,C32,C38,C37,C41,C42,C44,C45,C54,C55,C56 C57,C65,C66,C68,C70,C71,C72
41	R7,R8,R26,R27,R77,R78,R86,R87,R117,R118,R144,R145,R159,R161
50	R6,R25,R33,R36,R60,R76,R85,R95,R119,R146,R156,R157
57	R13,R23,R71,R96,R149,R151
81	R10,R29,R43,R81,R89,R120,R147
118	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13 TP14,TP15,TP16,TP17,TP18,TP19

TITLE: ASSEMBLY, HIGH SPEED MOTOR CONTROL	SCALE REF:	PART NO. 0052022-0009	REV:
DIGI-DATA CORPORATION	UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½°	DO NOT SCALE THIS DRAWING	SHT: 4

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
1	1	1352595-0001	DRILL DETAIL, 80 WCA	
2	1	2450053-9000	54/74 SERIES TTL GATE	U72
3	7	2450052-9000	54/74 LS SERIES TTL GATE	SEE SHEET 4
4	2	2450052-9002	54/74 LS SERIES TTL GATE	U80,U42
5	5	2450053-9014	54/74 SERIES TTL GATE	SEE SHEET 4
6	4	2450053-9006	54/74 SERIES TTL GATE	U10,U48,U60,U69
7	4	2450053-9007	54/74 SERIES TTL GATE	U59,U67,U68,U78
8	2	2450053-9010	54/74 SERIES TTL GATE	U62,U77
9	1	2450053-9011	54/74 SERIES TTL GATE	U79
10	1	2450052-9012	54/74 LS SERIES TTL GATE	U70
11	1	2450053-9021	54/74 SERIES TTL GATE	U65
12	1	2450052-9027	54/74 LS SERIES TTL GATE	U49
13	1	2450052-9032	54/74 LS SERIES TTL GATE	U56
14	3	2450053-9038	54/74 SERIES TTL GATE	U43,U46,U47
15	3	2451171-1074	54/74 SERIES TTL D FLIP-FLOP	U50,U73,U81
16	5	2450052-9036	54/74 LS SERIES TTL GATE	U4,U5,U6,U7,U8
17	5	2451344-9114	54/74 LS SER TTL EDGE TRIG FLIP-FLOP	SEE SHEET 4
18	1	2450056-9121	54/74 SER TTL MONO. MULTIVIB	U9
19	1	2450054-0022	54/74 LS SER TTL MONO MULTIVIB	U51
20	1	2451288-9157	54/74 SER DATA SEL/MULTIPLEX	U44
21	2	2451306-9174	54/74 LS SER D-TYPE FLIP-FLOP w/CLEAR	U12,U14
22	2	2451508-9279	54/74 LS SERIES QUAD $\overline{S}$-$\overline{R}$ LATCHES	U55,U57
23				
24	18	2451194-9052	DUAL PERIPHERAL DRIVER	SEE SHEET 4
25	1	2450051-0031	DARLINGTON TRANSISTOR ARRAY	U76
26	1	2450047-2002	I.C. TIMER	U66
27	1	2450045-3391	QUAD COMPARATOR	U75
28	1	2151498-3152	RESISTOR NET, DIP, 16 PIN PULLUP	U74
29	1	2150048-3472	RESISTOR NET, DIP, 14 PIN PULLUP	U45
30	1	2151498-3331	RESISTOR NET, DIP, 16 PIN PULLUP	U61
31	3	2150004-0470	RESISTOR, ¼W 5%, 47 OHM	R12,R86,R11

REV.	ECO NO.	DATE	APPR.	REV.	ECO NO.	DATE	APPR.
		1-21-81	TPK				

DIGI-DATA CORPORATION

DR. | ENG.

CHK.

TITLE
ASSEMBLY; WRITE CONTROL - BASIC

SH. 1 | P.L. NO. 0052198-0001 | REV.

D.D.C. FORM 105 REV. A 6PARTS/D

0052198-0001

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
32	1	2150004-0221	RESISTOR, ¼W 5%, 220 OHM	R79
33	3	2150004-0331	RESISTOR, ¼W 5%, 330 OHM	R13,R71,R99
34	4	2150004-0102	RESISTOR, ¼W 5%, 1K OHM	SEE SHEET 4
35	4	2150004-0152	RESISTOR, ¼W 5%, 1.5K OHM	R2,R8,R93,R97
36	2	2150004-0202	RESISTOR, ¼W 5%, 2K OHM	R109,R110
37	12	2150004-0472	RESISTOR, ¼W 5%, 4.7K OHM	SEE SHEET 4
38	2	2150004-0302	RESISTOR, ¼W 5%, 3K OHM	R108,R107
39	5	2150004-0103	RESISTOR, ¼W 5%, 10K OHM	SEE SHEET 4
40	2	2150004-0123	RESISTOR, ¼W 5%, 12K OHM	R4,R5
41	2	2150004-0273	RESISTOR, ¼W 5%, 27K OHM	R85,R87
42	3	2150004-0393	RESISTOR, ¼W 5%, 39K OHM	R70,R73,R77
43	4	2150004-0101	RESISTOR, ¼W 5%, 100K OHM	SEE SHEET 4
44	1	2150004-0164	RESISTOR, ¼W 5%, 160K OHM	R69
45	2	2150004-0474	RESISTOR, ¼W 5%, 470K OHM	R84,R88
46	1	2150004-0365	RESISTOR, ¼W 5%, 3.6M OHM	R74
47				
48	2	2150004-0242	RESISTOR, ¼W, 5%, 2.4K OHM	R113,R114
49	4	2150006-0331	RESISTOR, ½W, 5%, 330 OHM	SEE SHEET 4
50	18	2150006-0511	RESISTOR, ½W, 5%, 510 OHM	SEE SHEET 4
51	1	2150016-0360	RESISTOR, 1W, 5%, 36 OHM	R98
52	1	2150037-0161	RESISTOR, 2W, 5%, 160 OHM	R14
53	1	2150046-1203	POT, SINGLE TURN, 20K OHM	R1
54	2	2150046-1503	POT, SINGLE TURN, 50K OHM	R81,R82
55	1	2250160-4560	CAP, MONO CER,10%,100V,56pF	C28
56	2	2250160-4271	CAP, MONO CER,10%,100V,270pF	C2,C27
57	3	2250161-4102	CAP, MONO CER,10%,100V,.001uF	C46,C47,C58
58	7	2250162-7103	CAP, MONO CER,-20 +80,100V,.01uF	SEE SHEET 4
59	23	2250162-7104	CAP, MONO CER,-20 +80%,100V,.1uF	SEE SHEET 4
60	4	2250161-4104	CAP, MONO CER,10%,100V,.1uF	C41,C50,C60,C59
61	2	2250161-5563	CAP, MONO CER,20%,100V,.056	C57,C61
62	3	2250166-4225	CAP, DIP SOLID TANT,10%,15V,2.2uF	C8,C15,C54
63	6	2250166-4226	CAP, DIP SOLID TANT,10%,15V,22uF	SEE SHEET 4
64	1	2350017-0001	TRANSISTOR, SILICON PNP	Q2
65	2	2350016-0001	TRANSISTOR, SILICON, NPN	Q1,Q3
66	1	2350023-0011	TRANSISTOR, 1W, NPN	Q4
67	52	2951271-0001	STRAIGHT HEADER	SEE SHEET 4
68	3	2590006-0001	DIP SOCKET, 14 PIN	XU3,XU52,XU53
69	2	2051449-0002	DIP SWITCH	S1,S3

SH. 2 | P.L. NO. 0052198-0001 | REV.

D.D.C. FORM 117 6PARTS/D

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
70	1	2060005-0009	SLIDE SWITCH	S2
71	16	2070017-0001	TERMINAL TURRET	SEE SHEET 4
72	2	2052256-0004	I/O CONNECTOR, 50 PIN	J1,J2
73	1	1251456-0001	CARD HOLD-DOWN RAIL	
74	3	5951539-0003	PRESS ON FASTENER	
75	2	5051537-0306	SCREW, CAPTIVE	
76	2	5051538-1102	WASHER, RETAINING	
77	AR	3950000-0001	SOLDER	
78	REF	0052198-0000	ASSEMBLY; WRITE CONTROL	
79	REF	0252195-0000	SCHEMATIC; WRITE CONTROL ASSY	

ASSEMBLY; WRITE CONTROL, BASIC | SH. 3 | P.L. NO. 0052198-0001 | REV. 08

D.D.C. FORM 117

ITEM	REFERENCE
3	U11,U13,U15,U20,U22,U63,U64
5	U1,U2,U54,U58,U71
17	U16,U18,U19,U21,U23
24	U24,U25,U26,U27,U28,U29,U30,U31,U32,U33,U34,U35,U36,U37 U38,U39,U40,U41
34	R105,R112,R103,R106
37	R3,R7,R10,R72,R75,R78,R83,R89,R92,R94,R100,R115
39	R9,R76,R80,R90,R91
43	R111,R102,R101,R104
49	R24,R26,R28,R30,R32,R34,R36,R38,R40,R42,R44,R46,R48,R50,R52, R54,R56,R58
50	R25,R27,R29,R31,R33,R35,R37,R39,R41,R43,R45,R47,R49,R51,R53, R55,R57,R59
58	C39,C49,C42,C43,C44,C49,C55
59	C4,C6,C7,C12,C17,C13,C11,C5,C19,C21,C23,C25,C29,C30,C31,C33, C34,C36,C38,C48,C52,C32,C45
63	C1,C24,C14,C18,C53,C56
67	W1,W2,W3,W4,W5,W6,W7,W8,W9,W10,W11,W12,W13,W14,W15,W16,W17, W18,W19,W20,W21,W22,W23,W24,W25,W26,W27,W28,W29,W30,W31
71	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13,TP14, TP15,TP16

size A | dwg no 0052198-0001 | rev

SHEET 4 OF 4

DDC Form 102 6PARTS/f1

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	REFERENCE
101	1	0052198-0001	ASSY WRITE CONTROL BASIC	
102	1	2451386-0002	32 x 8 TRI STATE PROM	U17

REV.	CHG. NO.	DATE	APPR.	NEXT ASSY.
B	[illegible]	9-24-80	JPR	
C	L60-531	4-10-82	[illegible]	
D1	CL'B' REL	5-5-82	JPR	

DIGI-DATA CORPORATION

DR. [illegible] 5-8-80 ENG. [illegible] 5-8-80

CHK [illegible] 5-8-80

TITLE ASSEMBLY, WRITE CONTROL STANDARD FORMAT LINES

P.L. NO. 0052198-0002 SH. 1 OF 1 REV. 05

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
1	1	1352203-0001	DRILL DETAIL, 80 DMR	
2	36	2451167-7011	OPERATIONAL AMPLIFIER	ADDENDUM
3	9	2451168-7112	VOLTAGE COMPARATOR	U105-U905
4	1	2450050-3611	QUAD OPERATIONAL AMPLIFIER	U1
5	1	2450063-1844	DTL GATES	U5
6	4	2540052-9000	54/74 LS SERIES GATE	U8,U10,U12,U14
7	5	2450052-9003	54/74 LS SERIES GATE	U6,U7,U9,U11,U13
8	3	2450054-0022	DUAL MONOSTABLE TTL LS	U2,U3,U4
9	39	2350016-0001	TRANSISTOR, NPN SILICON	ADDENDUM
10	6	2350017-0001	TRANSISTOR, PNP SILICON	Q1,Q3-Q7
11	86	2550002-9140	DIODE, SILICON, F.S.	ADDENDUM
12	18	2251566-2339	CAP, MONO CER COG, 100V, 3.3pF	C105-C905,C111-C911
13	9	2250163-4220	CAP, MONO CER,±10,COG,200V,22pF	C116-C916
14	9	2250163-4101	CAP, MONO CER,±10,COG,200V,100pF	C109-C909
15	1	2250163-4121	CAP, MONO CER,±10,COG,200V,120pF	C8
16	1	2250163-4331	CAP, MONO CER ±10,COG,200V,330pF	C7
17	9	2250163-4471	CAP, MONO CER,±10,COG,200V,470pF	C114-C914
18	1	2250161-4561	CAP, MONO CER,±10,X7R,100V,560pF	C11
19	75	2250162-7104	CAP, MONO CER,-20 +80,Z5U,100V,.1uF	ADDENDUM
20	21	2250158-7105	CAP, MONO CER,-20 +80,Z5U,50V,1uF	ADDENDUM
21	1	2250166-7106	CAP, DIP TANT,15V,10uF	C3
22	5	2250166-7226	CAP, DIP TANT,15V,22uF	C14-C16,C6,C9
23	11	2150004-0101	RES, D.C., ¼W, 5%, 100 OHM	C109-C909,R3,R41
24	1	2150004-0271	RES, D.C., ¼W, 5%, 270 OHM	R2
25	1	2150004-0301	RES, D.C., ¼W, 5%, 300 OHM	R1
26	36	2150004-0331	RES, D.C., ¼W, 5%, 330 OHM	ADDENDUM
27	18	2150004-0471	RES, D.C., ¼W, 5%, 470 OHM	R122-R922,R141-R941
28	23	2150004-0152	RES, D.C., ¼W, 5%, 1.5K OHM	ADDENDUM
29	9	2150004-0222	RES, D.C., ¼W, 5% 2.2K OHM	R131-R931
30	9	2150004-0272	RES, D.C., ¼W, 5%, 2.7K OHM	R135-R935
31	60	2150004-0472	RES, D.C., ¼W, 5%, 4.7K OHM	ADDENDUM
32	2	2150004-0512	RES, D.C., ¼W, 5%, 5.1K OHM	R22,R23
33	2	2150004-0682	RES, D.C., ¼W, 5%, 6.8K OHM	R26,R29
34	1	2150004-0752	RES, D.C., ¼W, 5%, 7.5K OHM	R25
35	18	2150004-0103	RES, D.C., ¼W, 5%, 10K OHM	R128-R928,R133-R933
36	27	2150004-0153	RES, D.C., ¼W, 5%, 15K OHM	ADDENDUM
37	9	2150004-0243	RES, D.C., ¼W, 5%, 24K OHM	R119-R919
38	10	2150004-0473	RES, D.C., ¼W, 5%, 47K OHM	R140-R940
39	9	2150004-0104	RES, D.C., ¼W, 5%, 100K OHM	R136-R936
40	18	2150004-0154	RES, D.C., ¼W, 5%, 150K OHM	R124-R924,R132-R932
41	9	2150020-4020	RES, M. F., 1/8W 1%, 402 OHM	R112-R912
42	2	2150020-8250	RES, M. F., 1/8W 1%, 825 OHM	R10,R15
43	1	2150020-1501	RES, M.F., 1/8W 1%, 1.50K OHM	R14
44	1	2150020-2491	RES, M.F., 1/8W 1%, 2.49K OHM	R11
45	1	2150020-7501	RES, M.F., 1/8W 1%, 7.50K OHM	R13
46	1	2150020-1472	RES, M.F., 1/8W 1%, 14.7K OHM	R8
47	1	2150020-2322	RES, M.F., 1/8W 1%, 23.2K OHM	R9
48	1	2150020-2552	RES, M.F., 1/8W 1%, 25.5K OHM	R12
49	1	2150020-3012	RES, M.F., 1/8W 1%, 30.1K OHM	R7
50	9	2150020-4022	RES, M.F., 1/8W 1%, 40.2K OHM	R115-R915
51	18	2150020-4752	RES, M.F., 1/8W 1%, 47.5K OHM	R118-R918,R121-R921
52	18	2150020-5112	RES, M.F., 1/8W 1%, 51.1K OHM	R105-R905,R107-R907
53	9	2150046-1102	POT, SINGLE TURN, 1K OHM	R108-R908
54	2	2150046-1503	POT, SINGLE TURN, 50K OHM	R24,R27
55	50	2070017-0001	TERMINAL TURRET, THRU HOLE	ADDENDUM
56	1	1251456-0001	CARD HOLD DOWN RAIL	

TITLE: ASSY; READ CARD-PE/NRZ BASIC | SCALE REF: | PART NO. 0051726-0001 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX± .010 .XXX± .005 ANGLES± ½° | DO NOT SCALE THIS DRAWING | SHT: 1

DDC FORM 20

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
57	3	5951539-0003	PRESS ON FASTENER	
58	9	2250163-4330	CAP, MONO CER,±10%, COG, 200V, 33pF	C102-C902
61	AR	5051537-0306	SCREW, CAPTIVE	
62	AR	5251538-1102	WASHER, RETAINING	
63	REF	0051726-0000	ASSY; READ CARD-PE/NRZ	
64	REF	0251741-0000	SCHEMATIC, READ CARD	
65	AR	3950000-0001	SOLDER	
66	9	2250162-7103	CAP, MONO CER,-20 +80,Z5U,100V,.01uF	C113-C913

ADDENDUM

ITEM	REFERENCE
2	U101-U901,U102-U902,U103-U903,U104-U904
9	Q101-Q901,Q102-Q902,Q103-Q903,Q104-Q904,Q2,Q8,Q9
11	CR101-CR901,CR102-CR902,CR103-CR903,CR104-CR904,CR105-CR905,CR106-CR906, CR107-CR907,CR108-CR908,CR109-CR909,CR1-CR5
19	C103-C903,C104-C904,C110-C910,C112-C912,C115-C915,C117-C917,C121-C921, C122-C922,C2,C12,C17
20	C106-C906,C108-C908,C1,C4,C5
26	R129-R929,R134-R934,R138-R938,R106-R906
28	R120-R920,R114-R914,R28,R33,R35,R38,R40
31	R116-R916,R117-R917,R125-R925,R126-R926,R127-R927,R137-R937,R4-R6,R30, R31,R39
36	R123-R923,R130-R930,R16-R21,R34,R36,R37
55	TP101-TP901,TP102-TP902,TP103-TP903,TP104-TP904,TP1-TP14

TITLE: ASSY; READ CARD-PE/NRZ BASIC | SCALE REF: | PART NO. 0051726-0001 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX± .010 .XXX± .005 ANGLES± ½° | DO NOT SCALE THIS DRAWING | SHT: 2

DDC FORM 20

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
67	1	0051726-0001	ASSEMBLY; READ CARD - PE/NRZ BASIC	
69	9	2250163-4680	CAP, MONO CER,±10%, COG,200V,68pF	C120-C920
70	18	2250163-4221	CAP, MONO CER,±10%,COG,200V,220pF	C119-C919,C125-C925
71	9	2250163-3471	CAP, MONO CER,±5%,COG,200V,470pF	C107-C907
72	9	2250161-4102	CAP, MONO CER,±10%,X7R,100V,1000pF	C101-C901
73	9	2250161-4122	CAP, MONO CER,±10%,X7R,100V,1200pF	C123-C923
74	2	2250161-4123	CAP, MONO CER,±10%,X7R,100V,.012uF	C10,C13
75	9	2250161-4103	CAP, MONO CER,±10%,X7R,100V,.01uF	C118-C918
76	9	2250161-4183	CAP, MONO CER,±10%,X7R,100V,.018uF	C124-C924
78	9	2150020-2100	RESISTOR, M.F., 1/8W, 1%, 210 OHM	R111-R911
79	36	2150020-9310	RESISTOR, M.F., 1/8W, 1%, 931 OHM	ADDENDUM
80	9	2150020-4021	RESISTOR, M.F., 1/8W, 1%, 4.02K OHM	R113-R913
81	9	2150020-3482	RESISTOR, M.F., 1/8W, 1%, 34.8K OHM	R110-R910
82	9	2150020-2673	RESISTOR, M.F., 1/8W, 1%, 267K OHM	R139-R939

ADDENDUM

ITEM	REFERENCE
79	R101-R901,R102-R902,R103-R903,R104-R904

TITLE: ASSEMBLY, READ CARD PE/NRZ 12.5 IPS | SCALE REF: | PART NO. 0051726-0002 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX± .010 .XXX± .005 ANGLES± ½° | DO NOT SCALE THIS DRAWING | SHT: 1

DDC FORM 20

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
67	1	0051726-0001	ASS'Y; READ CARD-PE/NRZ, BASIC	
69	9	2250163-4470	CAP, MONO CER,±10%,COG,200V,47pF	C120-C920
70	18	2250163-4151	CAP, MONO CER,±10%,COG,200V,150pF	C119-C919,C125-C925
71	9	2250163-3331	CAP, MONO CER,±5%,COG,200V,330pF	C107-C907
72	9	2250163-4471	CAP, MONO CER,±10%,COG,200V,470pF	C101-C901
73	9	2250161-4821	CAP, MONO CER,±10%,X7R,100V,820pF	C123-C923
75	11	2250161-4682	CAP, MONO CER,±10%,X7R,100V,6800pF	C10,C13,C118-C918
76	9	2250161-4123	CAP, MONO CER,±10%,X7R,100V,.012uF	C124-C924
78	9	2150020-2000	RESISTOR, M.F.,1/8W,1%,200 OHM	C111-C911
79	36	2150020-1371	RESISTOR, M.F.,1/8W,1%,1.37K OHM	ADDENDUM
80	9	2150020-3831	RESISTOR, M.F.1/8W,1%,3.83K OHM	R113-R913
81	9	2150020-3482	RESISTOR, M.F.,1/8W,1%,34.8K OHM	R110-R910
82	9	2150020-2553	RESISTOR, M.F.,1/8W,1%,255K OHM	R139-R939

ADDENDUM

ITEM	REFERENCE
79	R101-R901,R102-R902,R103-R903,R104-R904

TITLE: ASSY; READ CARD PE/NRZ 18.75 IPS | SCALE REF: | PART NO. 0051726-0003 | REV:
DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1
DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
67	1	0051726-0001	ASS'Y; READ CARD-PE/NRZ, BASIC	
69	9	2250163-4330	CAP, MONO CER,±10%,COG,200V,33pF	C120-C920
70	18	2250163-4101	CAP, MONO CER,±10%,COG,200V,100pF	C119-C919,C125-C925
71	9	2250163-4271	CAP, MONO CER,±10%,COG,200V,270pF	C101-C901
72	9	2250163-3271	CAP, MONO CER,±5%,COG,200V,270pF	C107-C907
73	9	2250161-4561	CAP, MONO CER,±10%,X7R,100V,560pF	C123-C923
75	11	2250161-4562	CAP, MONO CER,±10%,X7R,100V,5600pF	C10,C13,C118-C918
76	9	2250161-4822	CAP, MONO CER,±10%,X7R,100V,8200uF	C124-C924
78	9	2150020-1820	RESISTOR, M.F.,1/8W,1%,182 OHM	R111-R911
79	36	2150020-1781	RESISTOR, M.F.,1/8W,1%,1.78K OHM	ADDENDUM
80	9	2150020-3481	RESISTOR, M.F.,1/8W,1%,3.48K OHM	R113-R913
81	9	2150020-3322	RESISTOR, M.F.,1/8W,1%,33.2K OHM	R110-R910
82	9	2150020-2803	RESISTOR, M.F.,1/8W,1%,280K OHM	R139-R939

ADDENDUM

ITEM	REFERENCE
79	R101-R901,R102-R902,R103-R903,R104-R904

TITLE: ASSY; READ CARD PE/NRZ 25 IPS | SCALE REF: | PART NO. 0051726-0004 | REV:
DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1
DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
67	1	0051726-0001	ASS'Y; READ CARD-PE/NRZ, BASIC	
68	9	2250163-4220	CAP, MONO CER,±10%,COG,200V,22pF	C120-C920
70	18	2250163-4680	CAP, MONO CER,±10%,COG,200V,68pF	C119-C919,C125-C925
71	9	2250163-4121	CAP, MONO CER,±10%,COG,200V,120pF	C101-C901
72	9	2250163-3181	CAP, MONO CER,±5%,COG,200V,180pF	C107-C907
73	9	2250163-4391	CAP, MONO CER,±10%,COG,200V,390pF	C123-C923
74	2	2250161-4392	CAP, MONO CER,±10%,X7R,100V,3900pF	C10,C13
75	9	2250161-4332	CAP, MONO CER,±10%,X7R,100V,3300pF	C118-C918
76	9	2250161-4562	CAP, MONO CER,±10%,X7R,100V,5600uF	C124-C924
78	9	2150020-1820	RESISTOR, M.F.,1/8W,1%,182 OHM	C111-C911
79	36	2150020-2671	RESISTOR, M.F.,1/8W,1%,2.67K OHM	ADDENDUM
80	9	2150020-3481	RESISTOR, M.F.,1/8W,1%,3.48K OHM	R113-R913
81	9	2150020-3402	RESISTOR, M.F.,1/8W,1%,34.0K OHM	R110-R910
82	9	2150020-2673	RESISTOR, M.F.,1/8W,1%,267K OHM	R139-R939

ADDENDUM

ITEM	REFERENCE
79	R101-R901,R102-R902,R103-R903,R104-R904

TITLE: ASSY; READ CARD PE/NRZ 37.5 IPS | SCALE REF: | PART NO. 0051726-0005 | REV:
DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1
DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
67	1	0051726-0001	ASS'Y; READ CARD-PE/NRZ, BASIC	
68	9	2250163-4180	CAP, MONO CER,±10%,COG,200V,18pF	C120-C920
70	18	2250163-4560	CAP, MONO CER,±10%,COG,200V,56pF	C119-C919,C125-C925
71	9	2250163-4820	CAP, MONO CER,±10%,COG,200V,82pF	C101-C901
72	9	2250163-3151	CAP, MONO CER,±5%,COG,200V,150pF	C107-C907
73	9	2250163-4331	CAP, MONO CER,±10%,COG,200V,330pF	C123-C923
74	2	2250161-4332	CAP, MONO CER,±10%,X7R,100V,3300pF	C10,C13
75	9	2250161-4272	CAP, MONO CER,±10%,X7R,100V,2700pF	C118-C918
76	9	2250161-4472	CAP, MONO CER,±10%,X7R,100V,4700pF	C124-C924
78	9	2150020-1820	RESISTOR, M.F.,1/8W,1%,182 OHM	R111-R911
79	36	2150020-3241	RESISTOR, M.F.,1/8W,1%,3.24K OHM	ADDENDUM
80	9	2150020-3481	RESISTOR, M.F.,1/8W,1%,3.48K OHM	R113-R913
81	9	2150020-3402	RESISTOR, M.F.,1/8W,1%,34.0K OHM	R110-R910
82	9	2150020-2673	RESISTOR, M.F.,1/8W,1%,267K OHM	R139-R939

ADDENDUM

ITEM	REFERENCE
79	R101-R901,R102-R902,R103-R903,R104-R904

TITLE: ASSY; READ CARD-PE/NRZI 45 IPS | SCALE REF: | PART NO. 0051726-0006 | REV:
DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1
DDC FORM 120

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
1	1	1352206-0001	DRILL DETAIL, 80HSR	
2	27	2451770-1318	OPERATIONAL AMPLIFIER	ADDENDUM
3	18	2451167-7011	OPERATIONAL AMPLIFIER	U104-U904,U105-U905
4	9	2451168-7112	VOLTAGE COMPARATOR	U106-U906
5	1	2450050-3611	QUAD OPERATIONAL AMPLIFIER	U1
6	1	2450063-1844	DTL GATE	U5
7	4	2450052-9000	54/74 LS SERIES GATE	U8,U10,U12,U14
8	5	2450052-9003	54/74 LS SERIES GATE	U6,U7,U9,U11,U13
9	3	2450054-0022	DUAL MONOSTABLE TTL LS	U2,U3,U4
10	39	2350016-0001	TRANSISTOR, NPN SILICON	ADDENDUM
11	6	2350017-0001	TRANSISTOR, PNP SILICON	Q1,Q3,Q4,Q5,Q6,Q7
12	86	2550002-9140	DIODE, SILICON F.S.	ADDENDUM
13	9	2250163-4220	CAP, MONO CER,±10%,COG,200V,22pF	C116-C916
14	1	2250163-4121	CAP, MONO CER,±10%,COG,200V,120pF	C7
15	1	2250163-4331	CAP, MONO CER,±10%,COG,200V,330pF	C6
16	9	2250163-4471	CAP, MONO CER,±10%,COG,200V,470pF	C114-C914
17	1	2250163-4561	CAP, MONO CER,±10%,COG,200V,560pF	C9
18	93	2250162-7104	CAP, MONO CER,-20 +80%,Z5U,100V,.1uF	ADDENDUM
19	21	2250158-7105	CAP, MONO CER,-20 +80%,Z5U,50V,1uF	ADDENDUM
20	1	2250166-4106	DIP TANT, ±10%,15V,10uF	C3
21	7	2250166-4226	DIP TANT, ±10%,15V,22uF	C12-C14,C16-C19
22	2	2150004-0101	RES, D.C., ¼W, 5%, 100 Ohm	R3,R41
23	1	2150004-0271	RES, D.C., ¼W, 5%, 270 Ohm	R2
24	1	2150004-0301	RES, D.C., ¼W, 5%, 300 Ohm	R1
25	27	2150004-0331	RES, D.C., ¼W, 5%, 330 Ohm	ADDENDUM
26	18	2150004-0471	RES, D.C., ¼W, 5%, 470 Ohm	R119-R919,R138-R938
27	14	2150004-0152	RES, D.C., ¼W, 5%, 1.5K	ADDENDUM
28	9	2150004-0222	RES, D.C., ¼W, 5%, 2.2K	R128-R928
29	9	2150004-0272	RES, D.C., ¼W, 5%, 2.7K	R132-R932
30	60	2150004-0472	RES, D.C., ¼W, 5%, 4.7K	ADDENDUM
31	2	2150004-0512	RES, D.C., ¼W, 5%, 5.1K	R22,R23
32	2	2150004-0682	RES, D.C., ¼W, 5%, 6.8K	R26,R29
33	1	2150004-0752	RES, D.C., ¼W, 5%, 7.5K	R25
34	18	2150004-0103	RES, D.C., ¼W, 5%, 10K	R125-R925,R130-R930
35	27	2150004-0153	RES, D.C., ¼W, 5%, 15K	ADDENDUM
36	9	2150004-0243	RES, D.C., ¼W, 5%, 24K	R116-R916
37	10	2150004-0473	RES, D.C., ¼W, 5%, 47K	R137-R937,R32
38	9	2150004-0104	RES, D.C., ¼W, 5%, 100K	R133-R933
39	18	2150004-0154	RES, D.C., ¼W, 5%, 150K	R121-R921,R129-R929
40	9	2150020-4020	RES, M.F., 1/8W, 1%, 402 Ohm	R110-R910
41	9	2150020-8060	RES, M.F., 1/8W, 1%, 806 Ohm	R106-R906
42	2	2150020-8250	RES, M.F., 1/8W, 1%, 825 Ohm	R15,R10
43	1	2150020-2491	RES, M.F., 1/8W, 1%, 2.49K	R11
44	1	2150020-7501	RES, M.F., 1/8W, 1%, 7.50K	R13
45	1	2150020-1472	RES, M.F., 1/8W, 1%, 14.7K	R8
46	9	2150020-1622	RES, M.F., 1/8W, 1%, 16.2K	R107-R907
47	9	2150020-1542	RES, M.F., 1/8W, 1%, 15.4K	R108-R908
48	1	2150020-2322	RES, M.F., 1/8W, 1%, 23.2K	R9
49	1	2150020-2552	RES, M.F., 1/8W, 1%, 25.5K	R12
50	1	2150020-3012	RES, M.F., 1/8W, 1%, 30.1K	R7
51	9	2150020-4022	RES, M.F., 1/8W, 1%, 40.2K	R112-R912
52	18	2150020-4752	RES, M.F., 1/8W, 1%, 47.5K	R115-R915,R118-R918
53	9	2150046-1102	POT, SINGLE TURN, 1K	R105-R905
54	2	2150046-1503	POT, SINGLE TURN, 50K	R24,R27
55	50	2070017-0001	TERMINAL TURRET, THRU HOLE	ADDENDUM
56	1	1251456-0001	CARD HOLD DOWN RAIL	

TITLE: ASSEMBLY, PE/NRZ HIGH SPEED READ CARD - BASIC | SCALE REF: | PART NO. 0051656-0001 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED: XX ± .010, XXX ± .005, ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
57	3	5951539-0003	PRESS ON FASTENER	
61	2	5051537-0306	SCREW, CAPTIVE	
62	2	5251538-1102	WASHER, RETAINING	
63	AR	3950006-0001	SOLDER	
64	REF	0051656-0000	ASSY, PE/NRZ HIGH SPEED READ CARD	
65	REF	0251663-0000	SCHEMATIC, HI SP DUAL MODE READ	
66	9	2250161-4393	CAP, MONO CER,±10%, X7R, 100V, .039uF	C106-C906
67	1	2150020-1501	RES, 1/8W,MF,1%, 1.50K	R14
68	9	2250162-7103	CAP, MONO CER,-20 +80%,Z5U,100V,.01uF	C113-C913

ADDENDUM

ITEM	REFERENCE
2	U101-U901,U102-U902,U103-U903
10	Q101-Q901,Q102-Q902,Q103-Q903,Q104-Q904,Q2,Q8,Q9
12	CR101-CR901,CR102-CR902,CR103-CR903,CR104-CR904,CR105-CR905, CR106-CR906,CR107-CR907,CR108-CR908,CR109-CR909,CR1-CR5
18	C103-C903,C104-C904,C107-C907,C108-C908,C111-C911,C112-C912,C115-C915, C117-C917,C121-C921,C122-C922,C2,C10,C15
19	C105-C905,C110-C910,C1,C4,C5
25	R126-R926,R131-R931,R135-R935
27	R117-R917,R28,R33,R35,R38,R40
30	R113-R913,R114-R914,R122-R922,R123-R923,R124-R924,R134-R934,R4-R6,R30, R31,R39
35	R120-R920,R127-R927,R16-R21,R34,R36,R37
55	TP101-TP901,TP102-TP902,TP103-TP903,TP104-TP904,TP1-TP14

TITLE: ASSEMBLY, PE/NRZ HIGH SPEED READ CARD - BASIC | SCALE REF: | PART NO. 0051656-0001 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED: XX ± .010, XXX ± .005, ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 2

ITEM #	QTY	PART NO.	DESCRIPTION	REFERENCE
100	1	0051656-0001	ASSY, PE/NRZ HI SP READ CARD - BASIC	
101	9	2150020-2000	RES, M.F., 1/8W, 1%, 200 Ohm	R109-R909
102	9	2150020-3831	RES, M.F., 1/8W,1%,3.83K	R111-R911
103	18	2150020-1002	RES, M.F., 1/8W,1%,10.0K	R102-R902,R103-R903
104	18	2150020-2103	RES, M.F., 1/8W,1%,210K	R101-R901,R104-R904
105	9	2150020-2433	RES, M.F.,1/8W,1%,243K	R136-R936
107	11	2250161-4182	CAP, MONO CER,±10%,X7R,100V,1800pF	C118-C918,C8,C11
108	9	2250161-4272	CAP, MONO CER,±10%,X7R,100V,2700pF	C124-C924
109	9	2251566-4330	CAP, MONO CER,±10%,COG,100V,33pF	C101-C901
110	9	2250163-4221	CAP, MONO CER,±10%,COG,200V,220pF	C123-C923
111	9	2251566-1159	CAP, MONO CER,±.25pF,COG,100V,1.5pF	C102-C902
112	9	2250163-3820	CAP, MONO CER,±5%,COG,200V,82pF	C109-C909
113	9	2250130-4120	CAP, E.E. CER,±10%,CK05,100V,12pF	C120-C920
114	9	2250163-4330	CAP, MONO CER,±10%,COG,200V,33pF	C119-C919

TITLE: ASSY,PE/NRZ HIGH SPEED READ CARD, 75 IPS | SCALE REF: | PART NO. 0051656-0002 | REV:

DIGI-DATA CORPORATION | UNLESS OTHERWISE SPECIFIED: XX ± .010, XXX ± .005, ANGLES ± ½° | DO NOT SCALE THIS DRAWING | SHT: 1