Technical Manual No.
799816-006
Revision E

MODELS M890 AND M891 CACHETAPE™ UNIT

VOLUME I

OPERATION AND MAINTENANCE

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10225 Willow Creek Road
San Diego, California 92131

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NOTICE

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions included in this manual, may cause interference to radio communications. Verification of compliance with Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference, is the responsibility of the installer.

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SECTION I

DESCRIPTION, UNPACKING, INSPECTION AND INSTALLATION

GENERAL

1-1. The Models M890 and M891 CacheTape™ Units (CTU) are a one-half inch, nine-track magnetic tape transport manufactured by Cipher Data Products, Inc., San Diego, California. The CTU simulates the performance characteristics of traditional start/stop tape drives while using the reliable Microstreamer® tape drive mechanical components. It incorporates the industry standard interface, a dual-gap head and all control, formatting and read/write electronics on a single printed-wiring board (PWB). The CTU will operate on 100, 120, 208, 220, 230 or 240 VAC, single-phase, 50-60 Hz line power. Reels to 10.5 inches can be accommodated. Tape speed and density capabilities are:

a. Models M890-I and M891-I CTU (1600 characters per inch CPI)
   (1) 100 ips at 1600 CPI Phase-Encode (PE)

b. Models M890-II and M891-II CTU (3200 CPI)
   (1) 100 ips at 1600 CPI (PE)
   (2) 50 ips at 3200 CPI

The simulated tape speed capability is switch selected and includes (a) M890: 12.5, 25, 37.5, 45, 75 ips, and (b) M891: 45, 75, 100, 120, 140, 170, 200, and 300 (approximate) ips. (Refer to Table 1-5 for the switch settings.) Autoload capabilities for the CTU will accomodate 7, 8-1/2 and 10-1/2-inch reel sizes.

UNPACKING AND INSPECTION

1-2. The CTU is shipped in a single carton reinforced to minimize the possibility of damage during shipment. Unpack as follows:

a. With shipping container on floor or workbench, cut side and center tapes securing top of box.

b. Pull top flaps down along sides of box. Remove the upper foam blocks and place the CTU on a workbench or table. Remove the manual and installation hardware from shipping carton.

c. Check contents of shipping container against the packing slip and inspect for possible damage. **If damage exists, notify carrier.**

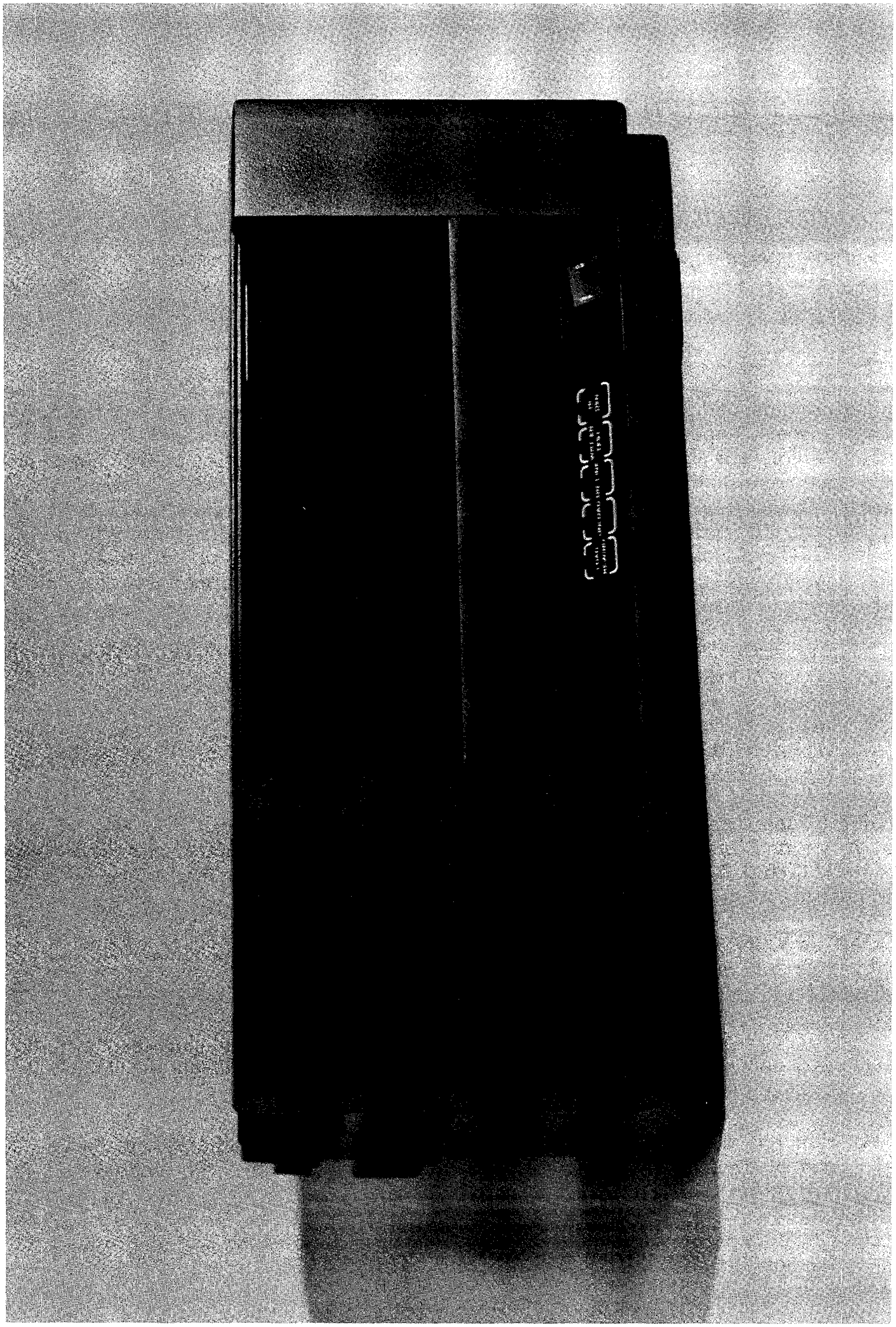


Figure 1-1. CacheTape™ Unit

d. Refer to the illustration taped to the front door. Remove tape holding top cover and front door in place. Open top cover by lifting sides directly behind front panel. Place cover stay (left-rear of top cover) in the slot provided. This is the maintenance access position. Pull tachometer (spring-loaded arm at left-rear of unit) away from hub and discard the foam cushion. Carefully replace tachometer assembly against hub.

e. Examine the hubs, tachometer, and other components in tape path area for foreign matter.

f. Using a screwdriver, loosen two captive screws at front sides of top plate casting. Close the top cover. Lift front panel (and top plate casting) by grasping the two lower corners of the front panel. Lift unit to its maximum upright position. Latch mechanism will automatically engage when unit is lowered approximately one inch. Insert the safety pin provided through both holes in the top plate support from outside inward (Figure 4-2). This is the service access position.

g. Remove 3 pieces of foam packing material from PWB. Check PWB and all connectors for correct installation.

h. To release latch mechanism, remove the safety pin and lift front panel before lowering it. Open top cover and tighten captive screws. Close top cover.

i. Do not replace packing tape or foam cushion materials.

j. Verify that the operating voltage indicated on the manufacturers label (rear of chassis) matches the power outlet voltage for the unit. If not, refer to paragraph 1-4 for instructions to change the operating voltage.

POWER CONNECTION

CAUTION

To prevent damage to the CTU and ensure proper operation, be sure the outlet voltage is correct before applying power to the CTU.

1-3. A power cord is supplied only for the voltage range indicated on the manufacturer's label.

1-4. **Operating Voltage Selection.** The CTU can be operated over a wide range of line voltages by selection of the appropriate power supply voltage option. To change the power supply option, proceed as follows:

CAUTION

When CTU is to be extended on slides from equipment rack, ensure that rack is mounted securely. Weight of CTU in extended position could upset an inadequately mounted equipment rack.

a. Switch transport power OFF and remove power cord from outlet.

b. Open unit to service access position. Refer to paragraph 1-2 (f).

c. Place a shop cloth or similiar item over the PWB in the area of the power supply assembly.

WARNING

Dangerous voltages can be encountered in the next two steps if the power cord is connected to an AC source or if the unit has had power applied in the last two minutes.

d. Refer to Figure 4-23. Remove two phillips head screws securing power supply cover, noting position of chassis ground cable. Pivot cover to the right and slide forward to remove.

e. Remove voltage selection card (4, Figure 4-25) from J9 on power supply PWB. Noting position of key slot on voltage selection card, reinstall the card in J9 to correspond to the desired voltage. Refer to Table 1-1.

f. Reverse steps c and d.

g. Replace the fuse, if required, with one of the correct current rating for the voltage selected. Refer to Table 1-1. Use a slo-blo, 250V type. The fuse holder is located on the right-front of the power supply assembly. Replace the power cord if required.

h. Note in a prominent location on the unit that the "operating voltage (has been) changed to ______."

NOMINAL LINE VOLTAGE (TOLERANCE)	SELECTION CARD	FUSE (AMPS)	FREQUENCY (Hz)
100 - (85 - 110)	100	3.0	49-61
120 - (102 - 132)	120	3.0	49-61
208 - (187 - 228)	220	1.5	49-61
220 - (187 - 242)	220	1.5	49-61
230 - (204 - 253)	240	1.5	49-61
240 - (204 - 264)	240	1.5	49-61

Table 1-1. Operating Voltage Selection

INITIAL CHECKOUT

1-5. Section II contains a detailed description of all controls. To check for proper operation before installation, proceed as follows:

a. Connect power cord.

b. Clean tape path as directed in paragraphs 4-4 through 4-10.

c. Apply power to unit and verify that UNLOAD indicator is illuminated. (Allow for normal delay of 5 seconds.) For other indications refer to paragraphs 2-6 and 2-7.

d. Ensure that tape is wound completely onto reel.

CAUTION

Both top cover and front panel door are locked during tape-loaded functions. Any attempt to open either top cover or front panel door before tape is unloaded will result in mechanical damage to the locking mechanism.

e. Open front panel door by pressing down gently on top (center) of door.

f. Insert tape into front panel of unit with write-enable ring side down.

g. Close front panel door.

h. Actuate LOAD switch. Access doors are now locked. When load sequence is completed, LOAD indicator will remain illuminated.

i. Initiate Service Aid 22 as described in paragraphs 3-11 and 3-32. Allow transport to cycle tape for a sufficient length of time to ensure proper servo operation. (It requires about 30 minutes to make a full pass on a 10.5 inch reel and complete a rewind sequence.)

j. Exit Service Aid 22. Refer to paragraph 3-11.

k. Check that LOAD indicator remains illuminated following rewind sequence.

l. Check ON-LINE switch and indicator by depressing repeatedly and observing that ON-LINE indicator is alternately illuminated and extinguished. Leave in off-line state (indicator extinguished).

m. Press UNLOAD switch. When the tape is unloaded (UNLOAD indicator illuminated) open front panel door and remove tape reel. Close front panel door.

n. Switch power off and remove power cord from outlet.

RACK MOUNTING

1-6. The CTU is designed to be mounted in a standard, 19-inch-wide, EIA equipment rack using the slides and mounting hardware provided with each unit. Refer to Figure 1-2 and drawing in Installation Hardware Package to mount the unit as follows:

a. Locate the front and rear rail holes to be used on the equipment rack (1, Figure 1-2). If they are threaded, drill them out to 0.281 inches.

b. Place the transport in service access position. Refer to paragraph 4-3.

c. Starting with either side, remove stationary section of slide (2) from transport by pulling stationary section to the front of transport.

d. Remove intermediate section of slide (3) from transport by pulling intermediate section to the rear of transport. When spring lock engages, depress to release.

e. Reassemble these sections by sliding front of intermediate section into rear of stationary section. Depress spring lock to slide completely together. Leave these sections assembled.

f. Determine, for the depth of rack, the appropriate holes to use in the mounting bracket and secure loosely to stationary section using two 10-32 X 3/8 binder head screws (4) and a nut plate (5).

g. Mount front flange of stationary section (2) to front rail by placing flange behind rack rail holes.

h. Install two 10-32 X 3/8 binder head screws (6), first through front of rail, then through stationary section flange and secure loosely with a nut plate (7).

i. Mount mounting bracket to rear of rack by placing flange in front of rack rail holes.

j. Install two 10-32 X 3/8 binder head screws (8), first through back of rack, then through mounting bracket flange and secure loosely with a nut plate (9).

k. Check alignment and correct as necessary. Tighten front, rear, and mounting bracket attachment screws.

l. Repeat steps b through j for other side.

m. Install the bottom edge of the rack latch bracket (10) on the left rail 2.13 inches below the center-line of slide using two 6-32 X 7/16 flat head screws (11), flat washers (12), split-lock washers (13) and No. 6 hex nuts (14).

n. Slide intermediate sections forward until locks engage.

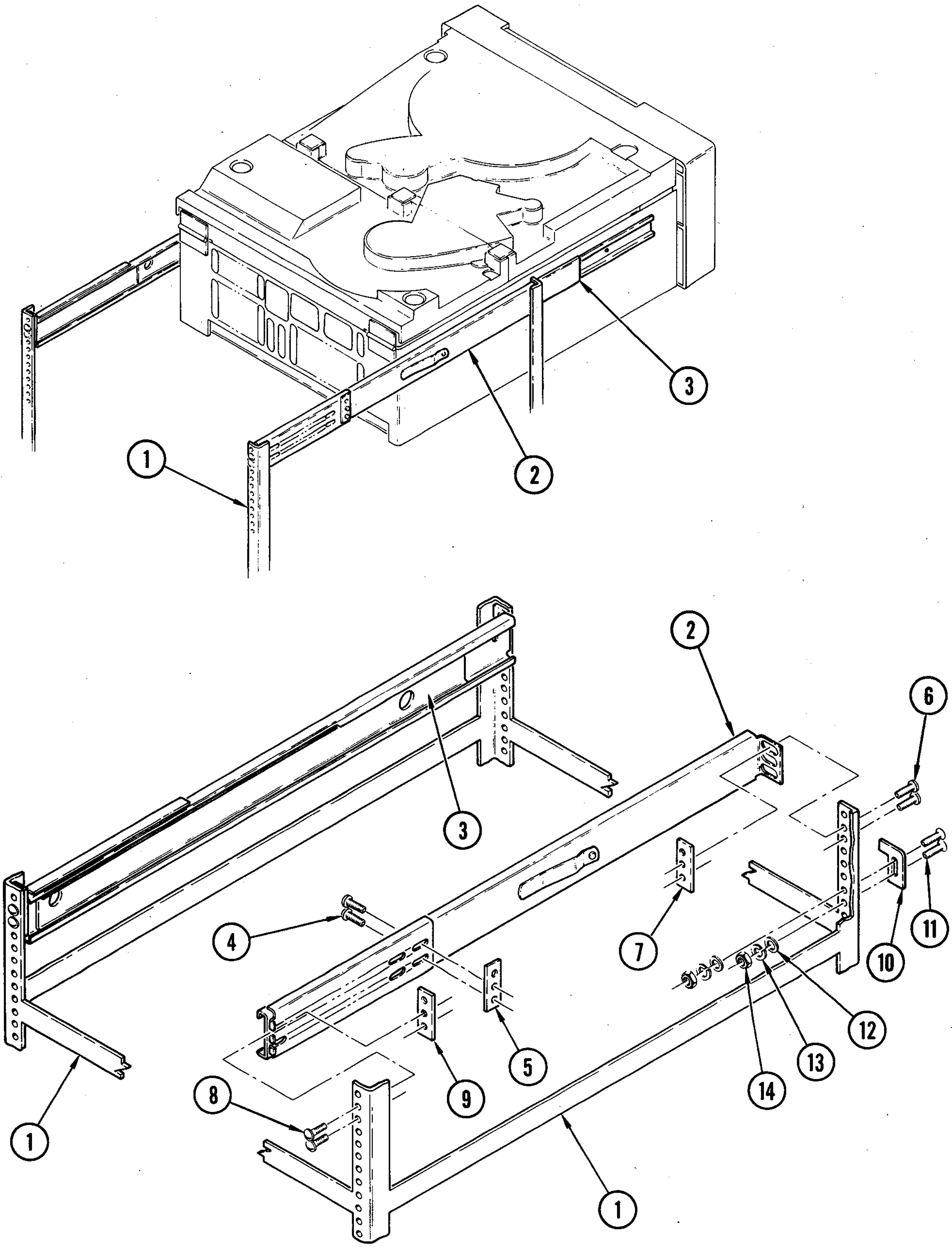


Figure 1-2. Rack Mounting

o. Carefully slide the CTU's transport-attached chassis mount sections (15) into intermediate sections while checking for binding or interference. Release locks and, before closing fully, check that the rack latch will engage securely.

p. Adjust rack latch bracket (10) or slides as required. To release, squeeze rack latch plate inside air duct opening at lower left of front panel.

q. Connect the power cord. A service loop must be provided. Ensure the cord will not chafe or interfere with other equipment.

INTERFACE CONNECTIONS

1-7. **Single-Transport Systems.** Interconnection of the CTU and system equipment should be made with a flat-ribbon cable or harness of individual twisted-pairs. To ensure reliable performance, the cables should have:

a. A maximum length of 25 feet to include service loop.

b. 28 AWG conductors for ribbon cable.

c. 22 or 24 AWG conductors with a 0.01 inch minimum insulation thickness and not less than one twist-per-inch for twisted-pair cables.

1-8. It is important that the alternate conductor in ribbon cable and the ground wires of twisted-pair be grounded at each end of the cable. The CTU will ground its end when connected. Tables 1-3 and 1-4 identify the connector pin assignments for each signal line. The signals indicated "Not Used" are properly terminated by the CTU for bus compatibility. The recommended connectors are:

a. Ribbon cable - 3M Co. Part No. 3415-0001 (or equivalent).

b. Twisted-pair cable - Viking Co. Part No. 3VT25/og JNH12 (or equivalent).

Assemble ribbon cable to connector so that it will enter the bottom of the connector when installed on the CTU.

1-9. For flat-ribbon cable, an I/O connector retainer is included with the unit. To install the connectors and retainer:

a. Open unit to service access position. Refer to paragraph 4-3.

b. Feed the interconnect cables through the opening at rear of chassis and connect to PWB. Any combination of P1/P2 may be used. See Figure 1-4 (last transport).

c. Refer to drawing in Installation Hardware Package and install connector retainer inside the chassis using two 10-32 X 1/2 pan head screws and No. 10 flat washers.

d. Select unit configuration. Refer to paragraph 1-10.

1-10. **Integration of the CTU to the System.** Refer to Tables 1-2 and 1-5 and local system installation instructions for the U3T and U5W configuration/option switch settings that establish the CTU operating parameters for block size, ramp delay, simulated speed, parity and various options.

1-11. U3T is set to match the performance capability of the CacheTape with the host system. If the configuration switch settings have not been previously established, the optimum operating configuration can be determined as follows:

CAUTION

When changing any U3T configuration switch setting, and prior to loading tape, a "Power-On Reset" must be performed by cycling the front panel power switch to its OFF position, then back to ON. This procedure will allow the CTU processor to update the new U3T switch settings into memory.

a. Select the 9K block size (U3T-3 and 4 OFF). Refer to paragraphs 1-13, 1-14, and 1-15.

b. **M891 only:** Enable the ramp delay (U3T-5 OFF).

c. Select the lowest speed (U3T-6, 7 and 8 OFF).

d. Run an actual tape program or functional tape diagnostic to establish basic compatibility; e.g., measure time to back-up 10 megabytes, as reference.

NOTE

Parametric diagnostics are designed for troubleshooting a particular tape transport and are not indicative of system performance. The best tests of CTU compatibility are the live programs that use the tape sub-system. Functional diagnostics that measure tape system performance are another legitimate tool.

e. Refer to Table 1-5 and set the next lower or higher block size (U3T-3 and 4), as appropriate, and repeat step d.

f. Select the next highest speed for increased throughput (U3T-6, 7 and 8).

g. Repeat steps (d) through (f) until the data rate of the CTU exceeds the data rate capability of the system, as evidenced by data late flags in the host system or a substantial increase in repositioning activity in the CTU (caused by write retries due to incomplete data transfers).

h. Select the next lowest speed (U3T-6, 7 and 8). Refer to paragraph 1-16.

i. Disable the ramp delays by closing switch U3T-5. If the data rate of the CTU again exceeds the system throughput rate (ref: step g), return switch U3T-5 to the OFF position (ramps enabled).

j. U3T-2 is used to select internal parity generation (U3T-2 OFF) or external parity generation (U3T-2 ON). In the external mode, the external parity is compared to the actual internal parity of the data character. If external and internal parity do not agree, a hard error is issued. The CTU does not drop tape tension for this IHER condition.

1-12. The maximum throughput can be determined by running a tape diagnostic and looking for data lates (buffer was empty when request for more data occurred) as the throughput is stepped up (increase in simulated speed). If backups only are run to intelligently integrate the unit, the top cover should be opened by accessing Diagnostic Service Aid 33 (depress TEST/HI-DEN/ON-LINE/ON-LINE/HI-DEN, in sequence). Note that each successive switch depression must be initiated within 3 seconds, or an entry reset will occur. Observe the tape motion as the throughput is stepped up to help assess if there is a cache flow problem evidenced by increased repositioning (ref: step g). If the performance configuration is not matched to the system capability during a backup, the CTU may go into write retries. Then, it drops tape after 16 repositions with Error Codes 11010 or 11001 (excessive write retries). CacheTape may also drop tape with Error Code 00011, because only partial data transmission occurred, causing a RAM parity error.

1-13. The lowest possible maximum blocksize should be set, also, so as to not unnecessarily limit throughput by limiting the cache buffer size. During read, if the maximum block size is set to 32K for a 9K actual block size, the throughput can be degraded by up to 50% compared to reading the same data at the 9K setting. Performance, although good, can be maximized by setting the configuration switches to the lowest maximum block size setting which will contain the actual recorded block size.

1-14. A performance enhancement feature is incorporated to prevent a dropped tape condition in the drive when an attempt is made to write a larger block of data than the maximum block size settings of unit configuration switches U3T-3 and U3T-4. When writing a block of data that exceeds the maximum block size setting, a hard error (IHER) flag is issued to the host and the drive automatically increments to the next higher maximum block size (from 9K to 16K or 16K to 24K, etc.).

CAUTION

IHER will be issued prior to termination of the data transfer. It is the responsibility of the host to issue a normal write retry sequence after recognizing the hard write error condition.

If, during the consequent write retry operation, the data block is still greater than the expanded block size, the drive will continue to increment to the next higher block size with each write retry generated by the host until one of the following events occur:

a. The data block is successfully written within the limits of the newly expanded maximum block size.

b. Block size expansion exceeds the 32K limit. In this event, the drive will flag IHER to the host, drop tape, and report hard error code 15 to the front panel.

1-15. The newly expanded final incrementation of maximum block size will remain fixed for the entire remainder of tape, and will reset to the selected block size only upon receiving an unload command. Therefore, to maintain optimum throughput performance it is important that the operating system maintain reasonable block sizes based on the initial switch settings of U3T-3 and U3T-4. Refer to Table 1-5 for configuration switch settings and to Figure 1-3 for switch locations.

1-16. In many cases the maximum throughput capability of the CTU is attained at one or more speed settings below the maximum attainable throughput setting. For example, the time for backing up 10.4 megabytes, in one instance, was 3 minutes at the 100, 120, 140, 170 and 200 ips setting. Consequently, the ideal setting would be 100 or 120 ips to eliminate the risk of data transfer problems at the higher speeds. This example is generally an indication of the limits of system throughput (bus activity-speed) and not controller/coupler limitations.

SPECIAL SOFTWARE OPTIONS

1-17. **Special Software Option No. 1** (EOT LOCATION). This switch selectable feature has been incorporated to allow special EOT Location software users the ability to perform read operations in conformance with the requirements of this software. By placing unit configuration switch U3T-1 in the ON position, the last record placed to tape is written over the EOT mark. This action properly terminates subsequent read operations of a volume by sensing the EOT at the last record to be read. The drive physically locates the EOT mark from a predicted point approximately 25 feet from the physical EOT (impending EOT pointer), locates the last block written, runs forward to EOT, repositions, reverses direction, and relocates its tape position back to the correct block location, and then proceeds with normal write operations. Cache memory capacity is reduced at this time to assure that the last record accepted from the host is written at EOT. The entire operation requires that the controller time-out be slightly greater than 20 seconds. This routine only occurs once for a full reel of tape (at impending EOT), therefore, degradation of throughput is insignificant. It is suggested that unit configuration switch U3T-1 remain OFF for users not operating under control of software that requires the physical EOT marker for orderly termination of read operations. Refer to Table 1-5 for configuration switch settings and Figure 1-3 for U3T location.

1-18. **Special Software Option No. 2** (Streaming EOT and DOUBLE FILEMARK). This switch selectable option allows the CTU to operate on a wider range of software systems. The range includes systems that support older conventional start/stop drives that require an EOT-actuated time-out to prevent these drives from writing off the end of the tape. For these systems, Option No. 2 can disable CacheTape's start/stop mode at EOT. This option also handles software systems that write double file marks at the end of each file or consecutive file marks during a backup operation. For these systems, the option switch can disable the normal mode of write sync on double file marks. Option No. 2 may be switch selected by placing switch U5W-4 in the ON position (refer to Figure 1-3). Otherwise, this option switch should remain in the OFF position.

1-19. **Special Software Option No. 3** (3200 BPI IDENT Status). Some software and couplers require the presence of IDENT status when operating from load point, regardless of the existence of the ID burst (as in the case of 3200 BPI operation due to a past convention). To implement this option, place switch U5W-5 in the ON position. When operating from load point, this option will cause the IDENT interface status line to be asserted when 3200 BPI density is selected (refer to Table 2-1, HI-DEN switch). As with all other switch selectable options, this switch setting should remain in the OFF position unless otherwise necessary for proper operation of the CTU. IDENT status will be asserted for 1600 BPI operation at all times (per ANSI standards).

1-20. **Parity Selection.** The user may select either internal parity generation or external parity (host provided) by the appropriate selection of unit configuration switch U3T-2. With U3T-2 in the OFF or OPEN position, parity of the IW0 through IW7 data lines is determined internally by the CTU. When U3T-2 is in the ON or CLOSED position, the CTU accepts the proper parity (always odd) from the host on the parity line, IWP. If the host parity is in disagreement with the CTU's internally derived parity, a non-catastrophic hard error will be reported to the host for the specific character being written, and the correct parity will be toggled on the IRP line.

MULTIPLE-TRANSPORT OPERATION

1-21. **Daisy Chaining.** Up to eight transports may be operated from the host system (if capable) and can include combinations of CTUs, Microstreamers and embedded formatter tape transports. Transport to transport interconnect cables must meet the same criteria as for single transport operation. The total cable length from the host system to the last physical transport (or embedded formattter) must not exceed 25 feet unless active repeaters are used. See Figures 1-5 and 1-6 for daisy chain combinations.

To configure the CTU to operate on a multiple-transport system, proceed as follows:

a. Open CTU to service access position. Refer to paragraph 4-3.

b. Remove terminator resistor packs U3W and U10W (Figure 1-3) from each transport except last unit.

c. Install interconnect cables. Refer to paragraph 1-9.

d. Select unit address. Refer to paragraph 1-22.

e. Select unit configuration. Refer to paragraph 1-10.

1-22. **Unit Address Select.** The CTU is selected by a combination of the levels on the IFAD, ITAD0, and ITAD1 signal lines and the position of U5W switches 1, 2 and 3. Note that U5W is set for address 0 from the factory. Refer to Table 1-2 for unit address select switch settings.

SWITCH	POSITION			FUNCTION	
U5W	1 TAD0*	2 TAD1*	3 FAD*		Unit Address Select
	ON	ON	ON	FAD0*	0
	ON	OFF	ON		1
	OFF	ON	ON		2
	OFF	OFF	ON		3
	ON	ON	OFF	FAD1*	4
	ON	OFF	OFF		5
	OFF	ON	OFF		6
	OFF	OFF	OFF		7
	4	ON		Streaming EOT and DOUBLE FILEMARK enabled	
	4	OFF		Streaming EOT and DOUBLE FILEMARK disabled	
	5	ON		3200 BPI IDENT enabled	
	5	OFF		3200 BPI IDENT disabled	
		6-8		NOT USED	

Table 1-2. Unit Address Select/Option Switch

NOTE

CacheTape and Microstreamer drives should not be connected to conventional embedded formatter drives on the same FAD line logic level; e.g., if a CTU is set for any address between 0 and 3, the conventional drive must be set for an address between 4 and 7.

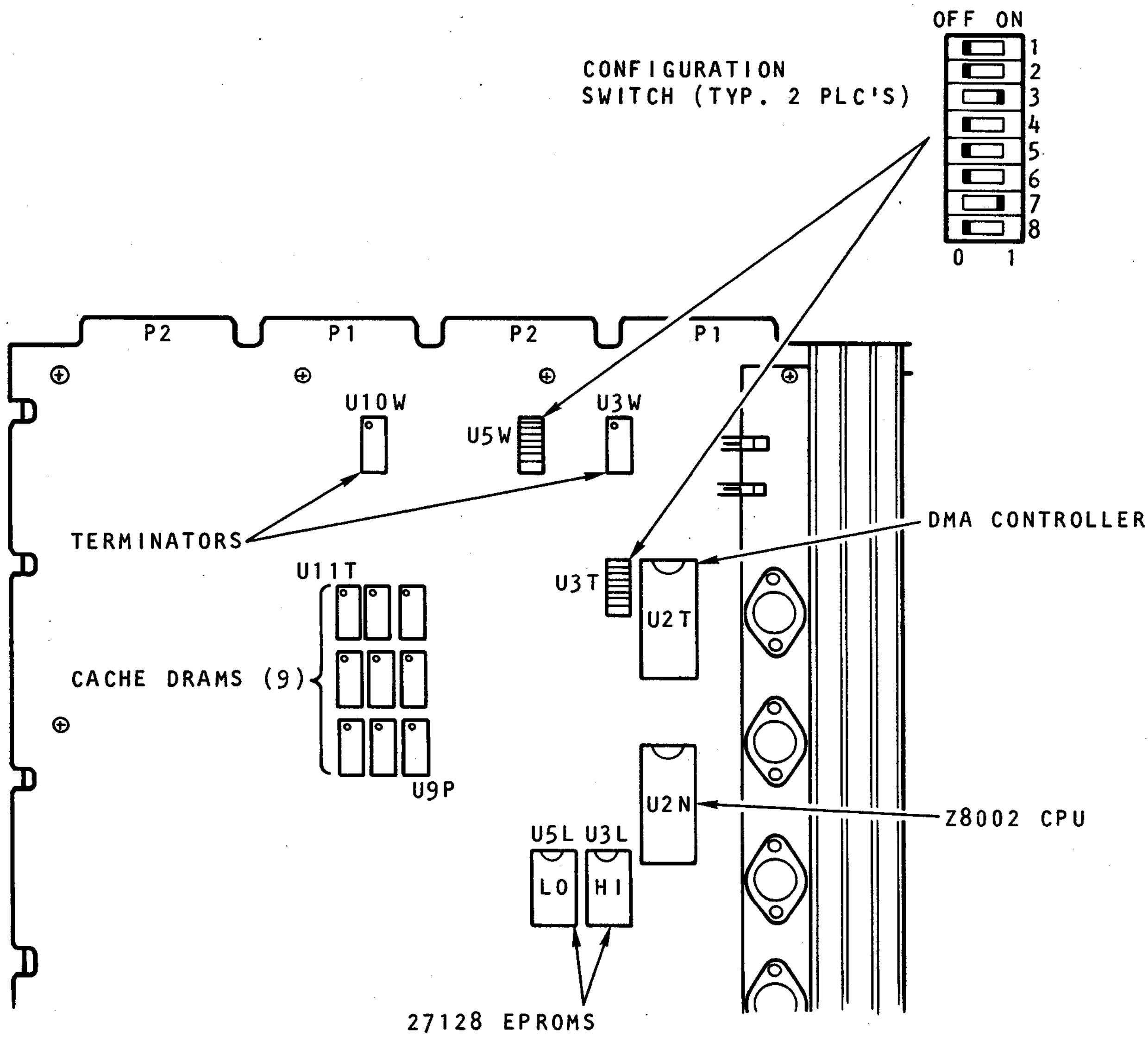


Figure I-3. Partial PWB Layout

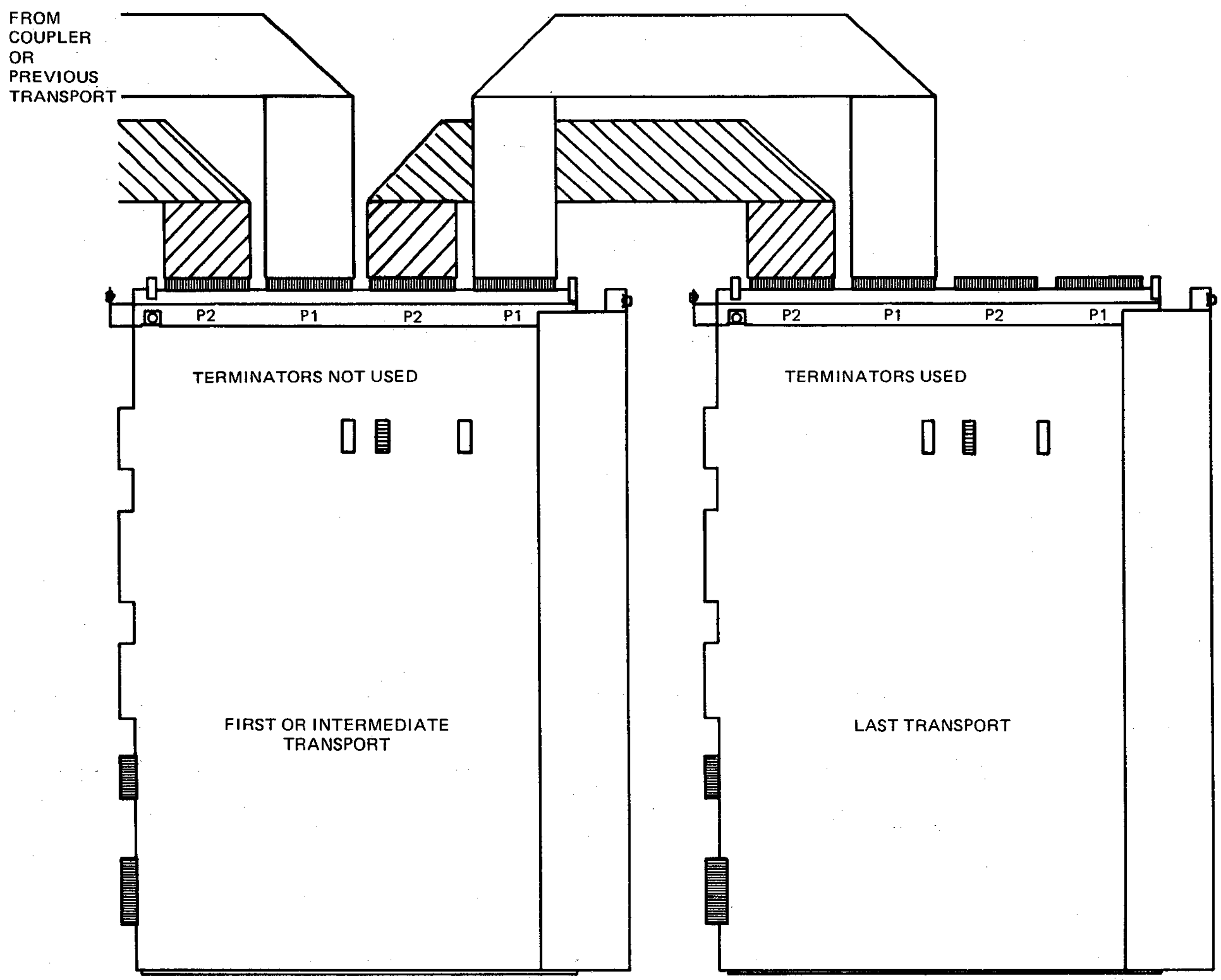


Figure 1-4. Daisy Chain Cable Configuration

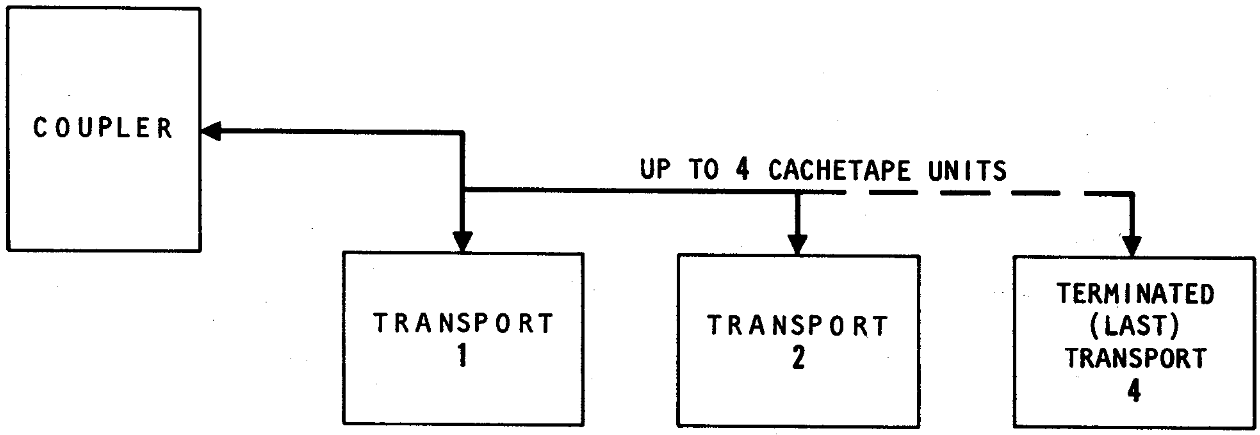


Figure 1-5. Daisy Chain Configuration

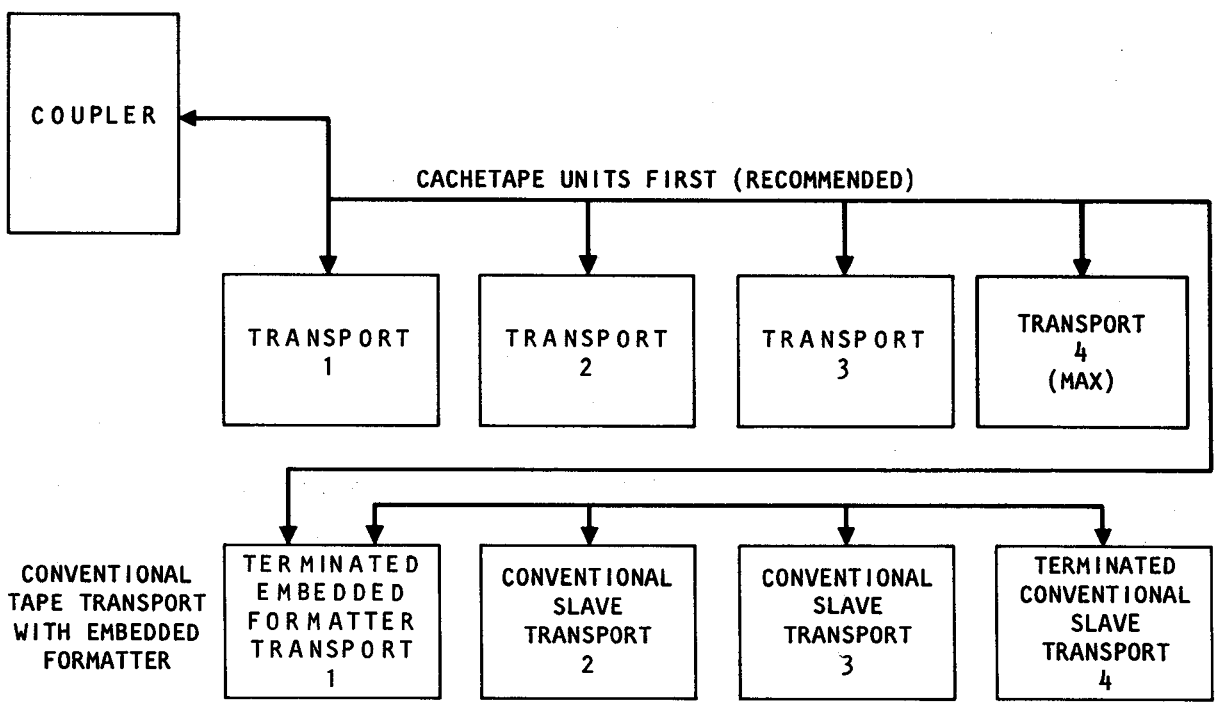


Figure 1-6. Hybrid Daisy Chain with CacheTape and Embedded Formatter Drives

PLUG NO.	LIVE PIN	GROUND PIN	SIGNAL DESCRIPTION	SIGNAL NAME
P1	4	3	Last Word	ILWD
P1	6	5	Write Data 4	IW4
P1	8	7	Initiate Command	IGO
P1	10	9	Write Data 0	IW0
P1	12	11	Write Data 1	IW1
P1	14	13	(Not Used)	(ISGL)
P1	16	15	(Not Used)	(ILOL)
P1	18	17	Reverse	IREV
P1	20	19	Rewind	IREW
P1	22	21	Write Data Parity	IWP
P1	24	23	Write Data 7	IW7
P1	26	25	Write Data 3	IW3
P1	28	27	Write Data 6	IW6
P1	30	29	Write Data 2	IW2
P1	32	31	Write Data 5	IW5
P1	34	33	Write	IWRT
P1	36	35	(Not Used)	(IRTH2)
P1	38	37	Edit	IEDIT
P1	40	39	Erase	IERASE
P1	42	41	Write File Mark	IWFM
P1	46	45	Transport Address 0	ITAD0
P2	18	17	Formatter Enable	IFEN
P2	24	23	Rewind/Unload	IRWU
P2	46	45	Transport Address 1	ITAD1
P2	48	47	Formatter Address	IFAD
P2	50	49	(Not Used)	(IHISP)

Table 1-3. Interface Signals, Controller to Transport

PLUG NO.	LIVE PIN	GROUND PIN	SIGNAL DESCRIPTION	SIGNAL NAME
P1	2	1	Formatter Busy	IFBY
P1	44	43	(Not Used)	(IRTHI)
P1	48	47	Read Data 2	IR2
P1	50	49	Read Data 3	IR3
P2	1	-	Read Data Parity	IRP
P2	2	-	Read Data 0	IR0
P2	3	-	Read Data 1	IR1
P2	4	-	Load Point	ILDP
P2	6	5	Read Data 4	IR4
P2	8	7	Read Data 7	IR7
P2	10	9	Read Data 6	IR6
P2	12	11	Hard Error	IHER
P2	14	13	File Mark	IFMK
P2	16	15	Identification	IIDENT
P2	20	19	Read Data 5	IR5
P2	22	21	End of Tape	IEOT
P2	26	25	(Not Used)	(INRZ)
P2	28	27	Ready	IRDY
P2	30	29	Rewinding	IRWD
P2	32	31	File Protect	IFPT
P2	34	33	Read Strobe	IRSTR
P2	36	35	Write Strobe	IWSTR
P2	38	37	Data Busy	IDBY
P2	40	39	(Not Used)	(ISPEED)
P2	42	41	Corrected Error	ICER
P2	44	43	On Line	IONL

Table 1-4. Interface Signals, Transport to Controller

SWITCH	POSITION			FUNCTION		
U3T		1 ON		EOT LOCATION enabled		
		1 OFF		EOT LOCATION disabled		
		2 ON		External Parity		
		2 OFF		Internal Parity		
	3		4	Select max. block size		
	OFF		OFF	9K Bytes		
	ON		OFF	16K Bytes		
	OFF		ON	24K Bytes		
	ON		ON	32K Bytes		
		5 OFF		Not Used		
	6	7	8	Selected Simulated Speed (ips)	Data Rate (KBS)	Ramp Delay (ms)
	OFF	OFF	OFF	12.5	20	30
	ON	OFF	OFF	25	40	15
	OFF	ON	OFF	37.5	60	10
	ON	ON	OFF	45	72	8.3
	OFF	OFF	ON	75	120	5.0
	ON	OFF	ON	75	120	5.0
	OFF	ON	ON	75	120	5.0
	ON	ON	ON	75	120	5.0

Table 1-5A. M890 Configuration Switches

SWITCH	POSITION			FUNCTION		
U3T	1 ON			EOT LOCATION enabled		
	1 OFF			EOT LOCATION disabled		
	2 ON			External Parity		
	2 OFF			Internal Parity		
	3		4	Select max. block size		
	OFF		OFF	9K bytes		
	ON		OFF	16K bytes		
	OFF		ON	24K bytes		
	ON		ON	32K bytes		
	5 OFF			Enable ramp delay		
	5 ON			Disable ramp delay		
	6	7	8	Selected Simu-lated Speed -IPS- (Avg & Min/Max)	Data Burst Transfer Rate -KBS- (Avg & Min/Max)	Ramp Delay -msec- (Enabled)
	OFF	OFF	OFF	45	72	8.3
	ON	OFF	OFF	75	120	5.0
	OFF	ON	OFF	100	160	3.7
	ON	ON	OFF	112 (103/120)	180 (165/192)	3.0
	OFF	OFF	ON	125 (108/140)	200 (172/225)	2.6
	ON	OFF	ON	155 (138/170)	250 (220/272)	2.2
	OFF	ON	ON	185 (160/206)	295 (256/330)	1.5
	ON	ON	ON	250 (200/300)	400 (320/480)	1.0

Table 1-5B. M891 Configuration Switches

COMMANDS

1-23. The basic transport commands are derived by decoding the REVERSE, WRITE, WRITE FILE MARK, EDIT, and ERASE interface lines. When a command is issued to the transport from the controller, the transport asserts the IFBY line (true state) and performs all timing and control functions necessary for the execution of the command.

1-24. The command lines are transferred to the command registers on the trailing edge of the IGO pulse. Any errors occurring during the execution of the command are reported to the controller via the IHER or ICER interface lines. Upon completion of the command, the IDBY interface line goes false, notifying the controller that it may issue another command. All acceptable combinations of the interface lines are listed in Table 1-6. The interface lines used for command decoding are defined as follows:

a. Reverse (IREV). This is a level which, when true, specifies reverse tape motion and, when false, specifies forward tape motion.

b. Write (IWRT). This is a level which, when true, specifies the write mode of operation, and when false, specifies the read mode of operation.

c. Write File Mark (IWFM). This is a level which, when true and IWRT is also true, causes a file mark to be written on the tape.

d. Edit (IEDIT). When this level is true and IWRT is true, the transport operates in the edit mode.

e. Erase (IERASE). This is a level which, when true in conjunction with a true level on the IWRT line, causes the transport to execute an erase variable length command. The transport will be conditioned to execute a normal write command but no data will be recorded. A length of tape, as defined by ILWD, will be erased. Alternately, if IERASE, IWRT, and IWFM command lines are true, the transport is conditioned to execute a fixed length erase command. A fixed length of tape of approximately 4 inches will be erased. When command lines IWRT, IWFM, IEDIT, and IERASE are true, the transport is conditioned to execute a security erase operation. A length of tape, from the point where the command was issued to five feet beyond EOT, will be erased. The following are the commands that can be executed by the CTU. These commands are strobed by IGO.

1-25. **Read.** The CTU reads data records or file marks in either a forward or reverse direction, generating output data (eight lines plus parity) and data strobes to the controller. A read reverse to load point resets the formatter. A read forward operation will be terminated, if it occurs more than 8 feet beyond EOT. The recovery threshold is automatically lowered during a read operation in order to provide additional reliability. The write threshold is approximately 25 percent, while the read threshold drops to 10 percent. During read retry attempts, the threshold level will be lowered to 2-3 percent to optimize low amplitude signal recover.

1-26. **Space** (Forward and Reverse). This operation is identical to a standard Read, except that Read Strobe and error flags are not generated. This command will space one record either forward or reverse.

1-27. **File Search.** This signal initiates a space operation in either the forward or the reverse direction. The read data lines may be deactivated during file search operation, thereby ignoring any data that is written on the tape. The File Search command is terminated when:

a. A file mark is encountered.

b. Load point is encountered in a reverse direction.

c. The formatter is externally cleared.

d. The tape is past EOT by 15 feet or more.

1-28. **Write** (Forward only). The CTU starts tape and generates the proper delay before transferring the data character, ensuring the generation of ANSI/IBM compatible inter-record gaps and ID burst for PE. When writing in 1600 bpi mode from load point, the tape drive always generates the required PE identification burst. When IDBY goes true, it indicates that the first IWSTR (write strobe) will occur no sooner than 40 character intervals later. The write operation continues until ILWD (Last Word) is received by the transport, which indicates the last character in the data block.

1-29. True write operations (not erase) generate an automatic read verification with the signals activated as in read commands, except that signal thresholds are higher (25%). If the read-after-write verification operation detects a write error on the tape, an automatic write retry sequence is initiated. The block in error plus an additional 0.2 inches of tape are erased and the record is re-written. This procedure will be repeated up to 16 times, or until the record is successfully written without error. This process is transparent to the host. If there are 16 unsuccessful tries, a hard error (IHER) will be latched, tape motion will stop, and Error Code 11 or 19 will be displayed on the front panel. Refer to Table 3-6.

NOTE

IHER is latched for any Write command operation that cannot be completed due to a catastrophic error.

1-30. The following are two variations of the basic write operation:

a. Edit. This signal is identical to the basic write operation, except that erase and write head currents are sequenced to overlap the record being rewritten. This operation should be preceded by a read reverse or read reverse edit command, to position the head in front of the block being edited. When editing, the new block must be exactly the same number of bytes as the old one, otherwise a hard error (IHER) will be flagged.

b. Write File Mark. This signal generates the compatible file mark and produces a (4.0 inch) IRG gap. The read file mark circuitry is activated. If a file mark status is not returned, the file mark should be backspaced and rewritten. File mark identification is reliable, since it is recovered by means of majority gating. All required and optional tracks are written with 80 transitions (40 characters) of 0's. Channels 1, 3, and 4 are DC erased.

1-31. **Erase.** This signal produces an erase field at the head with no data flux transitions. There are three variations to this command, as follows:

a. Erase Fixed Length: Erases fixed length of tape (4 inches).
b. Erase Variable Length: Continuous erasure until terminated by the controller. Length is determined by the last character flag used in a normal write operation.
c. Security Erase: Erases forward to five feet beyond EOT. No status lines are activated; other transports may be selected after a Security Erase has started. The transport may also be commanded to rewind after completion of Security Erase by issuing a Rewind. The transport will indicate an immediate rewinding status, but will complete Security Erase and Rewind automatically.

1-32. **Write Synchronize.** This command is used to ensure that all pending writes are complete. Following issuance of this command, IDBY remains set until the entire contents of the cache are written on tape. On receipt of back-to-back Write File Mark commands, CacheTape will automatically insert a Write Sync command prior to executing the second File Mark command, unless the streaming EOT/Double Filemark option is enabled.

1-33. **3200 BPI.** This is a command (3200 CPI model only) which, when initiated while at the BOT marker, specifies the 3200 bpi mode of operation.

1-34. **1600 BPI.** This is a command which, when initiated while at the BOT marker, specifies the 1600 bpi mode of operation.

1-35. **Read Extended Drive Status.** Extended drive status is available to the host in the form of four (4) independently accessible records containing up to sixteen (16) bytes each. Extended status can only be read when the drive is ON-LINE. To access one of the 16 byte records the host must first issue the Read Extended Status command, which is "00010" = EDIT (refer to Table 1-6). The command is accompanied by the usual IGO pulse. This command places the drive in the Extended Status Mode whereby the drive will wait for a second "ACCESS" command, accompanied by IGO. This second command, or Block Access Code, selects the appropriate 16 byte block to be transferred to the host as a normal read operation on the IRO-IR7 data lines, complete with read strobes. Should more than one record be desired, the Read Extended Status command/IGO pulse may be re-issued and the appropriate block access code asserted on the five command lines, accompanied by the IGO pulse. The new status block will then be strobed to the interface.

1-36. The Error History Block may be reset to zero if the block access code is "10011." A 16 byte block will still be transferred, but the bytes currently have no meaning. A description of the information provided by the Read Extended Status command is given in Table 1-7.

1-37. **Write Edit.** This command can be used to re-write an existing data block on tape. The command is 01010 = EDIT, WRITE. The use of this command has certain restrictions. First, the user must be positioned at the start of a valid data block via a space reverse or read reverse operation. If these conditions are not met, then an illegal command 7 code will result. Next, the block size transferred to replace the old block must not exceed the original block byte count. The block size may be less if the user can assure that the post-block gap will erase any old data. If the newly written block is greater than the old block, fault code 10 will result (refer to Table 3-6).

COMMAND	(LSB) REVERSE	WRITE	WRITE FILEMARK	EDIT	(MSB) ERASE
Read Forward	0	0	0	0	0
Read Reverse	1	0	0	0	0
Read Reverse Edit	1	0	0	1	0
Write	0	1	0	0	0
Write Edit	0	1	0	1	0
Write File Mark	0	1	1	0	0
Erase Variable Length	0	1	0	0	1
Erase Fixed Length	0	1	1	0	1
Security Erase	0	1	1	1	1
Space Forward	0	0	0	0	1
Space Reverse	1	0	0	0	1
File Search Forward	0	0	1	0	0
File Search Forward (Ignore Data)	0	0	1	0	1
File Search Reverse	1	0	1	0	0
File Search Reverse (Ignore Data)	1	0	1	0	1
Write Sync	0	0	0	1	1
3200 bpi*	1	0	1	1	1
1600 bpi (PE)	0	0	1	1	1
Read Extended Status	0	0	0	1	0
Current Status	0	0	0	0	0
Configuration Status	1	0	0	0	0
Error History Status	0	0	0	1	0
Machine Status	1	0	0	1	0
Error History Reset	1	0	0	1	1

*Product Option

Table 1-6. Command Decoding

Byte No.	Bit*	Contents		
		Current Status Block (Access Code = 00000)		
0		**Tape Status Byte #1**		
	0	IIDENT		
	1	IHER		
	2	ICER		
	3	IFMK		
	4	IRDY		
	5	IONL		
	6	IRWD		
	7	IFPT		
1		**Tape Status Byte #2**		
	0	ILDP		
	1	IEOT		
	2	Read Retries Exceeded		
	3	Write Parity Error At Interface		
	4	Write Hard Error		
	5	Illegal Command		
	6			
	7			
2		**Error Classification**		
	0	Cache Auto-Expanded	000 - 9K	011 = 32K
	1	Block Size	001 = 16K	100 = Reserved
	2		010 = 24K	
	3	Read From Tape To Cache Overrun		
	4	Write From Host To Cache Overrun		
	5			
	6			
	7			
3		**Track In Error**		
	0	Track 7 In Error		
	1	Track 6 In Error		
	2	Track 5 In Error		
	3	Track 4 In Error		
	4	Track 3 In Error		
	5	Track 2 In Error		
	6	Track 1 In Error		
	7	Track 0 In Error		

* Bit 0 = LSB; Bit 7 = MSB, unless otherwise specified. (1 = True/Yes, 2 = False/No)

Table 1-7. Read Extended Status

Byte No.	Bit*	Contents
		Current Status Block (Access Code = 00000)
4	0	**Track P In Error**
	1 Thru 7	LSB Read/Write Retry Count On Current Host Record MSB
5	0 Thru 4	LSB Front Panel Error Code MSB
6		**Density Code**
	0	Density Found/Operating Density (bpi):
	1	000 = Reserved 001 = 1600
	2	010 = 3200 011 = Reserved
	3	Density Requested:
	4	000 = Reserved 001 = 1600
	5	010 = 3200 011 = Reserved
	6	Read Density Conflict
	7	Write Density Conflict
7		**Unfixed Block Count** (includes file marks)
	0 Thru 7	Block Detectable Structures Remaining In Cache
		Fixed Block Count From BOT (includes file marks)
8		**Low Order Byte**
9		**Mid Order Byte**
10		**High Order Byte**
		Sequence Number Of Record In Hard Error
11		**Low Order Byte**
12		**Mid Order Byte**
13		**High Order Byte**

Table 1-7. Read Extended Status (Continued)

Byte No.	Bit*	Contents			
		Configuration Status Block (Access Code = 10000)			
0		**Capability**			
	0	Reserved			
	1	1600 bpi	0 = Does not have capability		
	2	3200 bpi	1 = Does have capability		
	3	Reserved			
	4	Other			
1		**Vendor Code**			
2		**Model Code**			
	0	000 = Other	011 = M891-I	110 = Reserved	
	1	001 = M890-I	100 = M891-II	111 = Reserved	
	2	010 = M890-II	101 = Reserved		
	Thru 7				
3		**Configuration State**			
	0	EOT Location--	1 = EOT Search,	0 = STD.	(U3T-1)
	1	Parity--	1 = External,	0 = Internal	(U3T-2)
	2	Max. Block	00 = 9K	10 = 24K	(U3T-3)
	3	Size	01 = 16K	11 = 32K	(U3T-4)
	4	Ramp--	1 = Disabled,	0 = Enabled	(U3T-5)
	5	Simulated Speed Setting (LSB)			(U3T-6)
	6	Simulated Speed Setting			(U3T-7)
	7	Simulated Speed Setting (MSB)			(U3T-8)
4		**Software Configuration**			
	0				
	1				
	2				
	3	EOT and Double Filemark Streaming Option			(U5W-4)
	4	3200 BPI IIDENT Status Option			(U5W-5)
	5				
	6				
	7				

Table 1-7. Read Extended Status (Continued)

Byte No.	Bit*	Contents		
		Error History Block (Access Code = 00010)		
0		**Read Retry Count - Since Unload (255 max)**		
1		**Write Retry Count - Since Unload (255 max)**		
		Track History - Error Counts Per Track (255 max)		
2		**Track 0**		
3		**Track 1**		
4		**Track 2**		
5		**Track 3**		
6		**Track 4**		
7		**Track 5**		
8		**Track 6**		
9		**Track 7**		
10		**Track P**		
		Machine Status Block (Access Code = 10010)		
		Head Pos'n/Tach Count In Multiples Of 1.28 Inches		
0		**Low Order Byte Of Tach Count**		
1		**High Order Byte Of Tach Count**		
		Logical Command History		
2		**Previous Host Command**		
3		**2nd Previous Host Command**		
4		**3rd Previous Host Command**		
5		**4th Previous Host Command**		
6		**5th Previous Host Command**		
7		**Operating Status**		
	0	Reel Size (LSB)	00 = Unknown	01 = 7-Inch
	1	Reel Size (MSB)	10 = 8-1/2--Inch	11 = 10-1/2--Inch
	2	Door Lock Status:	0 = Unlocked	1 = Locked

Table 1-7. Read Extended Status (Continued)

SECTION II

OPERATION

GENERAL

2-1. This section describes the controls and indicators of the CTU and provides operating instructions.

CONTROLS AND INDICATORS

2-2. Control/indicator types, functions, and the conditions required for enabling the corresponding functions are given in Table 2-1. Figure 2-1 shows the controls and indicators.

LOADING TAPE

2-3. To load tape, proceed as follows:

CAUTION

> Do not attempt to open either top cover or front panel door during load operation or while tape is loaded in transport. Both front panel door and top cover are locked during tape-loaded functions.

a. Apply power to unit and verify that UNLOAD indicator is illuminated. (Allow for normal delay of 5 seconds.)

b. Prepare tape-leader, if required, using Cipher tool Part No. 209990-500.

c. Verify that write-enable ring, if used, is fully seated.

d. Ensure that tape is wound completely onto reel.

e. Open front-panel door by pressing down gently on top (center) of door.

f. Insert tape into front of unit with write-enable ring side down. Tip edge of reel inside unit upward slightly to clear supply hub and place tape well inside unit. The door, when closed, should not touch the reel.

g. Close front-panel door.

h. Actuate LOAD switch. Access doors are now locked. When load sequence is completed, LOAD indicator will remain illuminated.

NOTE

During load sequence, actuation of ON LINE switch will place transport on line when BOT marker is sensed.

CONTROL/ INDICATOR	TYPE	FUNCTION	CONDITIONS
POWER	ON/OFF Rocker Switch and Indicator	Switches line power on and off.	Fuse installed. Line cord connected.
LOAD REWIND	Tactile Switch and Indicator	Loads tape to BOT marker.	Tape inserted in front panel door. Top cover and front panel door closed.
		Rewinds tape to BOT marker. Illuminates to indicate BOT tab is logically positioned at photosensor. When flashing, transport is executing a load or a rewind sequence.	Transport in off-line mode (ON-LINE indicator extinguished).
UNLOAD	Tactile Switch and Indicator	Unloads tape from any point. UNLOAD indicator flashes during unload sequence, then remains illuminated.	Transport in off-line mode. (ON-LINE indicator extinguished).

Table 2-1. Controls and Indicators

CONTROL/ INDICATOR	TYPE	FUNCTION	CONDITIONS
ON-LINE	Tactile Switch and Indicator	Switches transport to on-line mode. Illuminates to indicate transport is on line.	Tape loaded and transport in off-line mode (ON-LINE indicator extinguished).
		Second actuation switches transport off-line (must be off-line to unload). Indicator extinguished to indicate transport is off line.	Transport is in on-line mode. (ON-LINE indicator illuminated.)
TEST	Tactile Switch	Selects alternate operational mode for other switches.	Refer to paragraphs 3-6 and 3-9.
WRT EN (Write Enable)	Indicator	Illuminates to indicate write function may be performed.	Tape reel write-enable ring installed mounted on supply hub and tape loaded. Ring is removed for Write protect.
HI DEN	Tactile Switch and Indicator	First actuation (indicator illuminated): high density mode, 3200 CPI.	3200 CPI transport must be in off-line mode (ON-LINE indicator extinguished).
		Second actuation (indicator extinguished): lower density mode, 1600 CPI.	
		Indicator also reflects the density selected via the I/O command	

Table 2-1. Controls and Indicators (Continued)

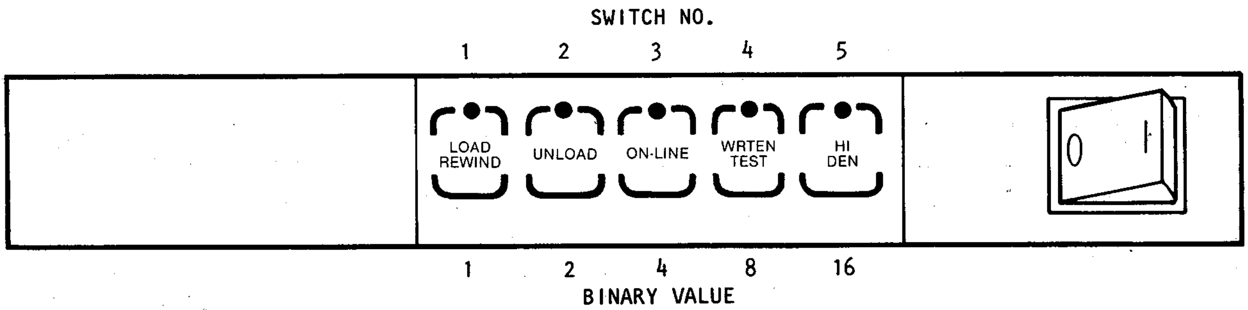


Figure 2-1. Control Panel

UNLOADING TAPE

2-4. To unload tape, proceed as follows:

a. Actuate UNLOAD switch. Transport must be in off-line mode (ON-LINE indicator extinguished).

NOTE

> During the unload sequence, UNLOAD indicator will flash and access doors will remain locked. When the unload sequence is completed, UNLOAD indicator will remain illuminated and access doors will unlock.

b. Open front-panel door when UNLOAD indicator remains illuminated.

c. Carefully lift up the reel to clear the supply hub and remove.

d. Close front-panel door.

ERROR CONDITIONS

2-5. Operating failures or fault conditions are indicated by various front panel display patterns. There are two groups of fault indications: those which are normally caused by the tape or operator and can be avoided by following the proper operating procedure, and those which are machine malfunctions and require correction by an experienced service technician.

2-6. **Operator Error Codes.** These fault indications occur during normal tape loading operation. They produce error codes which will be displayed as an even, ON/OFF pattern of the indicators on the front panel. Refer to Table 2-2. The operator error codes are repeated in Table 3-7 of the manual where all of the CTU's error types, definitions, and the methods for error recovery are divided under Soft, Medium I and 2 and Hard errors. **Note that error code 23 is a multi-error type.** When the problem is corrected (i.e., closing the front panel door) actuate the LOAD switch to clear the error condition and re-enter the load sequence. If these error codes occur when proper operating procedures have been followed, a machine malfunction is indicated.

2-7. **Transport Error Codes.** These faults indicate a serious deviation from the normal operating routine of the CTU. Each fault code is represented as a unique binary pattern of the front panel indicators, which flash a quick double-pulse to alert the operator. These faults inhibit the CTU and require correction by a service technician. They can be cleared only by turning the power off. Refer to Section III, Table 3-7 for these fault codes and troubleshooting instructions.

ERROR CODE*	INDICATION	CONDITIONS
22	All indicators except LOAD and TEST flashing	Early EOT marker encountered. EOT marker located greater than 25 feet prior to actual EOT. Used with switch U3T-1 "ON" only. Relocate EOT marker.
23	All indicators except TEST flashing	A load operation was attempted without inserting a tape reel into the transport, the reel of tape is not properly seated, or the supply reel was not locked when attempting a manual load. Check if file protect and hub seat sensor are working properly. Attempt another LOAD operation.
25	All indicators except UNLOAD and ON-LINE flashing	An insufficient amount of tape was wrapped around the takeup hub when attempting a manual load. A minimum of five wraps is required.
26	All indicators except LOAD and ON-LINE flashing	Tape end did not peel off of reel. Remove antistatic tape/foam block if used. If caused by static charge buildup, refer to paragraph 2-8 for manual load instructions.
27	All indicators except ON-LINE flashing	A load or unload operation was attempted with the front-panel door or top cover in the open position.
28	All indicators except LOAD and UNLOAD flashing	Tape reel prevented movement of the supply reel hub. Remove and re-insert tape reel to clear. Possible belt crank solenoid failure.
29	All indicators except UNLOAD flashing	Tape reel was inserted upside-down. The bottom of the tape reel is identified by the write-enable ring groove or the write enable ring (when installed) near the inside mounting circumference.
30	All indicators except LOAD flashing	The BOT marker was not detected within the first 35 feet of tape. The leader must be a minimum of 6 feet in length.
31	All indicators flashing	After four attempts, the CTU did not successfully complete the load sequence. The tape leader should be checked for excessive damage or static charge buildup. If a second attempt at autoloading fails, refer to paragraph 2-8 for manual load instructions.

Table 2-2. Operator Error Front Panel Indications

MANUAL LOAD

2-8. To load tape after a failure of the autoloading routine, proceed as follows:

a. Extend unit on its slides to clear equipment rack.

b. Place transport in operator maintenance access position by lifting top cover sides behind front panel. Place cover stay in slot provided.

c. Place reel of tape on supply hub. Ensure that reel is evenly seated on hub.

d. Depress and hold the manual unlock button, located behind front-panel door on bottom left hand side of tape reel opening, and simultaneously rotate the supply hub clockwise until supply reel is locked in place.

e. Thread tape along path shown in Figure 2-2. Carefully move tachometer assembly away from takeup hub, and, making one wrap of tape clockwise around takeup hub, gently replace tachometer assembly. Continue to wrap tape for FIVE (5) more revolutions of the takeup hub. Check that tape is seated correctly on guides and threaded properly over head assembly.

f. Close top cover, and place transport in normal operating position.

g. Depress and hold the HI DEN switch, then actuate the LOAD switch and release both. Tape should tension and advance forward until BOT tab is positioned at photosensor. LOAD indicator will illuminate, indicating that CTU is ready for use.

MANUAL UNLOAD

2-9. If for any reason the CTU cannot complete the rewind/unload sequence, the tape reel may be rewound manually as follows:

a. Place transport in operator maintenance access position. Refer to paragraph 4-2.

b. Rotate supply reel in counterclockwise direction to rewind tape onto supply reel.

c. Depress and hold the manual unlock button, located behind front-panel door on bottom left hand side of tape reel opening, and simultaneously rotate the supply reel counterclockwise until it rotates freely and can be removed from the transport.

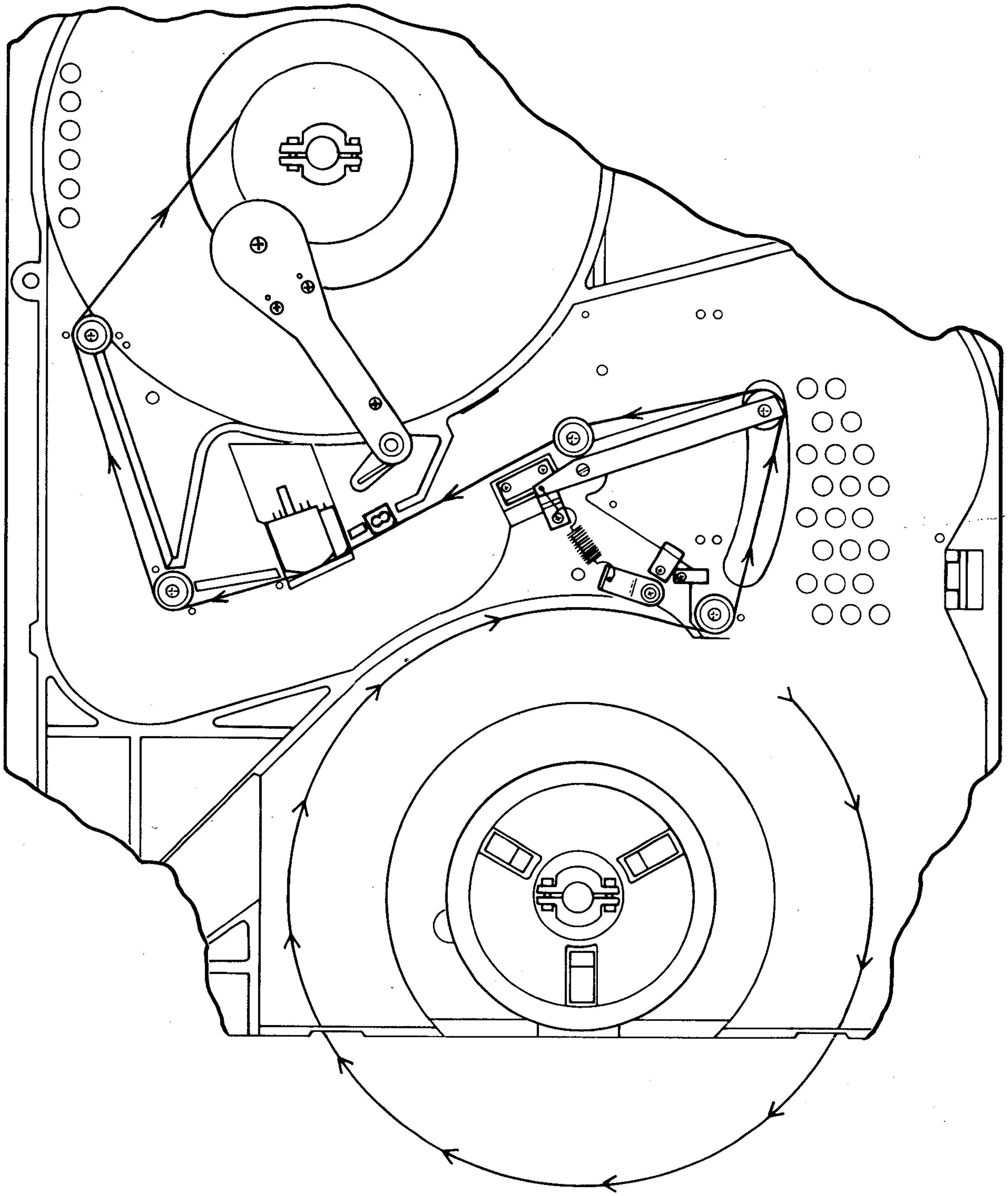


Figure 2-2. Tape Threading Path

SECTION III

TESTING AND TROUBLESHOOTING

TESTING

3-1. This section describes the two types of test capabilities available on the CTU: a series of tests that run automatically when the power is turned on, called power up self tests (PUST), and service aids, accessed by pressing the front panel switches in certain sequences that enable individual sections of the unit for testing and troubleshooting. Also, error conditions that can cause a CTU failure are listed and procedures to diagnose the failure are provided.

3-2. **Power Up Self Tests.** The PUST (Power Up Self Test) consists of a series of tests that are executed each time power is applied to the unit. These tests are designed to verify the proper operation of the unit prior to permitting tape to be loaded or, in the case of a failure, assist the technician in isolating the fault and repairing the unit. If the PUST is successful, the UNLOAD indicator is lighted continuously, and the transport is ready to be loaded. If the PUST is unsuccessful, a unique pattern will be displayed on the front panel LED's to indicate the areas of the failure. This is referred to as level 1 failure information. For certain tests, levels 2, 3, 4, and 5 failure information will be available to provide a more specific cause of the failure.

3-3. The failure display is a binary number which results from the "ON" (1) and "OFF" (0) states of the LED's with the least significant bit being the LOAD indicator on the left and the most significant bit being the HI DEN indicator on the right. See Figure 3-1. For the first six tests, the display will be the number of the test that failed and the drive will be inhibited, preventing any further interaction. Refer to Table 3-1 for PUST failure codes 1 through 6. If after power is applied to the unit, all LED's remain lighted continuously for longer than 1 second, and the LED display does not match the level 1 displays in Table 3-1, a failure of the Z8002 is indicated and no further failure information is available.

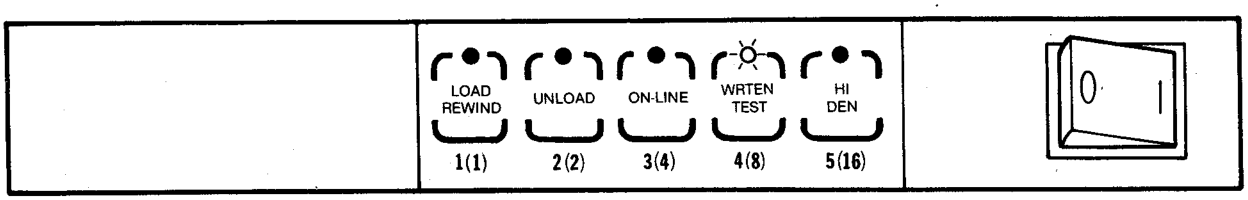


Figure 3-1. Front Panel Controls and Indicators (Diagnostic Mode)

3-4. A failure in test 7 will be indicated by LOAD, UNLOAD, and ON-LINE LED's flashing. Pressing the LOAD switch once will display the level two failure information. Levels 2 through 5 information is presented in two alternating 4-bit nybbles. The high order nybble is displayed when the HI-DEN LED is illuminated. When the HI-DEN indicator is extinguished, the low order nybble is displayed. Table 3-2 includes the levels 2 through 5 information available when the LOAD switch is pressed one through four times respectively.

3-5. A failure in tests 8-13 will be indicated initially by the front panel LED's flashing the failed test number. Referring to Table 3-3 and pressing LOAD a second time will display level two information about the failure, as described in paragraph 3-4.

3-6. When all the failure information is read, pressing the TEST switch will put the unit in the diagnostic mode. The TEST indicator will flash and the service aid access codes can then be entered. The TEST switch can be pressed (to put the unit in the diagnostic mode) any time after all front panel LED's flash. However, all failure information is then lost.

3-7. Use the procedure in Figure 3-2 and the information in Tables 3-1 through 3-3 to recognize and analyze a PUST failure.

3-8. **Service Aids.** The service aids are tests that are enabled by the technician. They are divided into two groups: those that run with no tape in the unit, and those that run after tape has been loaded.

3-9. In the case of a PUST failure of tests 8-13, pressing the TEST switch will put the unit in the diagnositc mode and the service aid codes can then be entered. Note that any failure information not read will be lost. Refer to paragraph 3-6.

3-10. For a normal power-up sequence, once the UNLOAD indicator is lighted continuously, the no-tape service aids can be accessed, or following a load sequence when the LOAD indicator is lighted continuously, the tape-loaded service aid codes can be entered.

3-11. Referring to Figure 3-1, which illustrates the controls of the CTU, the switch sequence for activating each service aid is as follows:

a. Press switches 4 and 5 in sequence to access the diagnostic mode.

b. Press switches corresponding to service aid number in sequence.

c. Execute service aid by pressing switch 5.

NOTE

Each successive switch depression must be entered within 3 seconds, or the diagnostic mode will be aborted and the switch sequence will have to be re-entered.

d. Press switch 4 to exit the service aid.

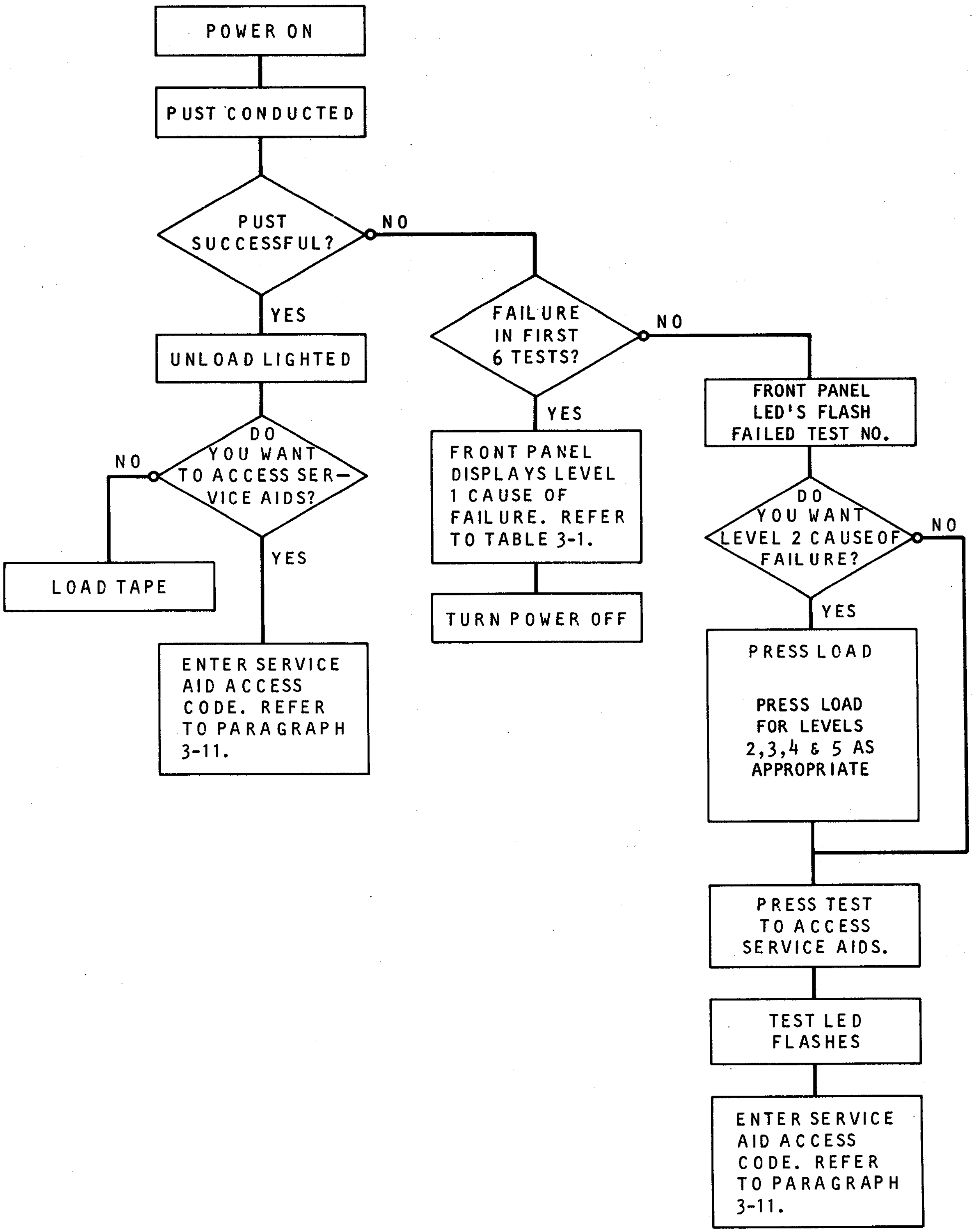


Figure 3-2. Power Up Self Test Process

PUST TEST	FAILURE	LEVEL 1 DISPLAY	LEVEL 2 DISPLAY	REMARKS
1	Low ROM (U5L)	1 0 0 0 0	---	Checksum error
2	High ROM (U3L)	0 1 0 0 0	---	Checksum error
3	Low RAM (U5N)	1 1 0 0 0	---	Data test error
4	High RAM (U3N)	0 0 1 0 0	---	Data test error
5	CIO TEST	1 0 1 0 0	---	Press LOAD
	CIO - Z1		0 0 0 1 0	IC-U9L fails
	CIO - Z2		0 0 0 0 1	IC-U11L fails
	CIO - Z3		0 0 0 1 1	IC-U13L fails
6	Early Test Exit	0 1 1 0 0		Generally indicates a failure in tests 1 thru 5, above. Tests for early PUST exit when TEST pressed and held during power up.

Table 3-1. Tests 1 through 6 PUST Failure Codes

LEVEL 1 DISPLAY	LEVEL 2 LOW	LEVEL 2 HIGH	LEVEL 3 LOW	LEVEL 3 HIGH	LEVEL 4 LOW	LEVEL 4 HIGH	LEVEL 5 LOW	LEVEL 5 HIGH	REASON
11100									DMA/Cache circuits
	10000	00001							DMA failure
			10000	00001					Base address error
			01000	00001					Word count error
			11000	00001					No count rollover
			00100	00001					Addition not 0
			10100	00001					No terminal count
	01000	00001							Cache RAM circuits
			10000	00001					Address error (low to high)
			01000	00001					Address error (high to low)
					10000	00001			RD7 - U10T
					01000	00001			RD6 - U11R
					00100	00001			RD5 - U11T
					00010	00001			RD4 - U9P
					00000	10001			RD3 - U9R
					00000	01001			RD2 - U10P
					00000	00101			RD1 - U11P
					00000	00011			RD0 - U10R
							10000	00001	Read parity error (U9T)
							01000	00001	Write parity error (U9T)

Table 3-2. Test 7 PUST Failure Codes

PUST TEST	LEVEL 1 DISPLAY	LEVEL 2 BYTE LOW	LEVEL 2 BYTE HIGH	REASON
8	00010			CIO initialization failure
9	10010			DAC/ADC test failed
		10000	00001	DAC failed auto-zero
		01000	00001	Reference voltage (VIN5) error
10	01010			Servo motor test failed
		10000	00001	Unexpected drive voltage
		01000	00001	Unexpected EMF on supply motor
		11000	00001	Unexpected EMF on takeup motor
		00100	00001	Takeup motor EMF out of tolerance
		10100	00001	Takeup motor rotation out of tolerance
11	11010			Tachometer test failed
		10000 or 01000	00001 00001	Either of the two phases missing
		11000	00001	Both phases missing
		00100	00001	Phase separation out of tolerance
13	10110			Compliance arm voltage not in tolerance
		10000	00001	Reset voltage too low
		01000	00001	Reference voltage (VIN6) error

Table 3-3. Tests 8 through 13 PUST Failure Codes

3-12. As an example, to cycle the supply and takeup servos in the forward and reverse direction, Service Aid 11 should be used with no tape in the unit. To access Service Aid 11 proceed as follows:

a. Press switches 4 and 5 in sequence.

b. Press switch 1 two times.

c. Execute Service Aid 11 by pressing switch 5.

3-13. Each service aid will run continuously, that is repeat its basic sequence, until switch 4 is pressed to exit the service aid. Each service aid description includes any modification of the basic routine that can be enabled while the service aid is running.

3-14. During some service aids, the front panel indicators provide output data relative to the service aid being performed. This data is displayed as a binary number with the LOAD indicator as the least significant bit (LSB) and the HI DEN indicator as the most significant bit (MSB). See Figure 3-1. Each Service Aid description includes information about output data, as appropriate.

3-15. **Service Aids (No tape in unit).** Service aids with no tape in the transport are described in the following subparagraphs. Refer to paragraph 3-14 for a description of the front panel indicators.

CAUTION

If tape is in the unit for the following service aids, it may be damaged.

3-16. **Service Aid 11.** This service aid enables both supply and takeup servo circuits, sequencing both reel hubs clockwise and counterclockwise. Press the LOAD switch to activate the high voltage rail switches Q5 and Q6 and current limit the servos to 1 ampere. Press the UNLOAD switch to deactivate Q5 and Q6 and enable maximum current limit.

3-17. **Service Aid 12.** This service aid activates and deactivates the write formatter circuitry to allow troubleshooting with no tape in the transport. When enabled, the write head/erase bar are turned on and a formatted, 40-character record is generated. The write head/erase bar is turned on for the length of the record (including pre/postamble) plus approximately 15 msec, then the head is turned off for approximately 15 msec and the sequence repeats. The "data" portion of the record simulates an all zeros (3200 fci) record. Press LOAD to select a 1-character record and ONLINE to select a 256-character record. Press UNLOAD for the 40-character record.

3-18. **Service Aid 13.** This service aid operates the same as Service Aid 12 except that the file-mark circuits are exercised.

3-19. **Service Aid 15.** This service aid is used to test the U3T configuration switches. The open/closed state of each switch is displayed on a front panel indicator. When the HI DEN indicator is off, U3T switches 1-4 are displayed on the LOAD, UNLOAD, ONLINE and TEST indicators, respectively. When the HI DEN indicator is on, switches 5-8 are displayed. When a switch is closed, the associated indicator should be on. The front panel indicators are updated continuously so that switches can be changed while the service aid is running. The HI DEN indicator will alternately flash on and off for high order and low order switches, respectively. Refer to Table 1-5.

3-20. **Service Aid 21.** This service aid activates the interface output status signals for troubleshooting. Refer to Figure 3-3 for the relative sequence/timing and test points to observe the signals.

3-21. **Service Aid 22.** This service aid is used to display the output of the BOT sensor. The display is updated continuously so that a piece of half-inch tape with a BOT marker can be inserted in the sensor area (as a loaded tape would be) to determine the output voltage levels for blank tape and a BOT marker. Use Table 3-4 to convert the binary count of the front panel indicators to a decimal equivalent in volts. Ambient light can affect the output levels. With no tape in the sensor area, the binary count should be 14 (about 0.9 volt) or greater. With blank tape the count should be 5 (about 0.3 volt) or less. Some blank tapes may cause the output level to be a negative value which is an acceptable condition (all indicators flashing). For tape with a BOT marker, the count should be 28 (about 1.8 volts) or greater.

3-22. **Service Aid 23.** This service aid is identical to Service Aid 22 except the EOT circuit is activated. Use the same criteria for output voltage levels. There is no requirement that both sensors exhibit the same output characteristics as long as each meets the criteria described for the BOT sensor.

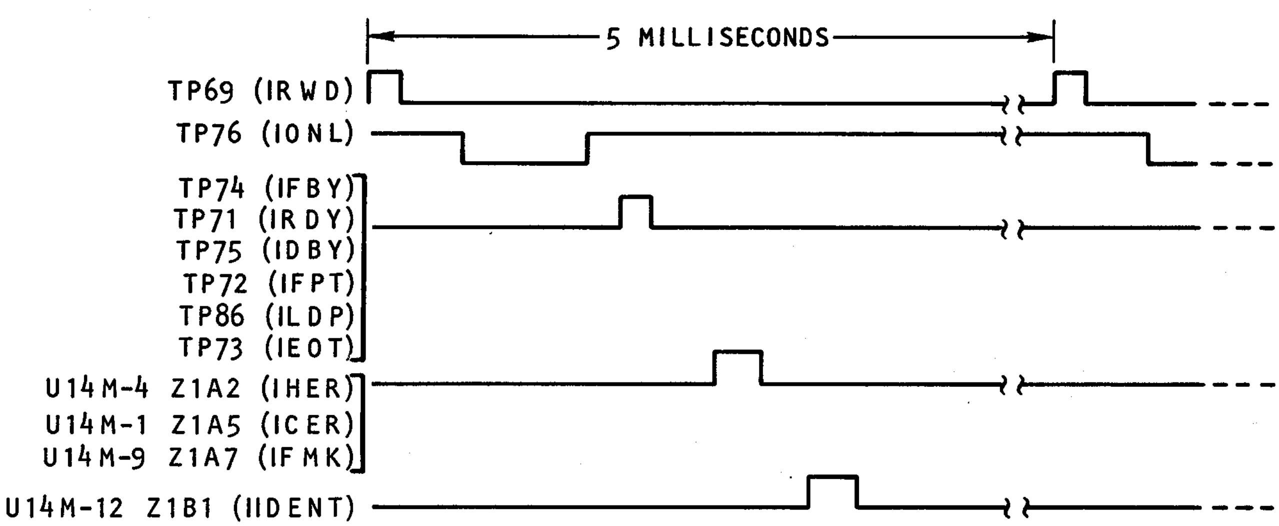


Figure 3-3. Service Aid 21 Sequence/Timing

BINARY DISPLAY	DECIMAL EQUIVALENT	OUTPUT VOLTS	BINARY DISPLAY	DECIMAL EQUIVALENT	OUTPUT VOLTS
0 0 0 0 0	0	0 or less	0 0 0 0 1	16	1.024
1 0 0 0 0	1	0.064	1 0 0 0 1	17	1.088
0 1 0 0 0	2	0.128	0 1 0 0 1	18	1.152
1 1 0 0 0	3	0.192	1 1 0 0 1	19	1.216
0 0 1 0 0	4	0.256	0 0 1 0 1	20	1.280
1 0 1 0 0	5	0.320	1 0 1 0 1	21	1.344
0 1 1 0 0	6	0.384	0 1 1 0 1	22	1.408
1 1 1 0 0	7	0.448	1 1 1 0 1	23	1.472
0 0 0 1 0	8	0.512	0 0 0 1 1	24	1.536
1 0 0 1 0	9	0.576	1 0 0 1 1	25	1.600
0 1 0 1 0	10	0.640	0 1 0 1 1	26	1.664
1 1 0 1 0	11	0.704	1 1 0 1 1	27	1.728
0 0 1 1 0	12	0.768	0 0 1 1 1	28	1.792
1 0 1 1 0	13	0.832	1 0 1 1 1	29	1.856
0 1 1 1 0	14	0.896	0 1 1 1 1	30	1.920
1 1 1 1 0	15	0.960	1 1 1 1 1	31	1.984 or greater

Table 3-4. Service Aids 22/23 Display Conversion (BOT/EOT)

BINARY DISPLAY	DECIMAL EQUIVALENT	VOLTS	BINARY DISPLAY	DECIMAL EQUIVALENT	VOLTS
0 0 0 0 0	0	0 to +0.312	0 0 0 0 1	16	0 to -0.312
1 0 0 0 0	1	+0.313	1 0 0 0 1	17	-0.313
0 1 0 0 0	2	+0.626	0 1 0 0 1	18	-0.626
1 1 0 0 0	3	+0.939	1 1 0 0 1	19	-0.939
0 0 1 0 0	4	+1.252	0 0 1 0 1	20	-1.252
1 0 1 0 0	5	+1.565	1 0 1 0 1	21	-1.565
0 1 1 0 0	6	+1.878	0 1 1 0 1	22	-1.878
1 1 1 0 0	7	+2.191	1 1 1 0 1	23	-2.191
0 0 0 1 0	8	+2.504	0 0 0 1 1	24	-2.505
1 0 0 1 0	9	+2.817	1 0 0 1 1	25	-2.817
0 1 0 1 0	10	+3.130	0 1 0 1 1	26	-3.130
1 1 0 1 0	11	+3.443	1 1 0 1 1	27	-3.443
0 0 1 1 0	12	+3.756	0 0 1 1 1	28	-3.756
1 0 1 1 0	13	+4.069	1 0 1 1 1	29	-4.069
1 1 1 1 0	15	+4.069 or greater	1 1 1 1 1	31	-4.069 or less

Table 3-5. Service Aid 24 Display Conversion (Compliance Arm)

3-23. **Service Aid 24.** This service aid is used to display the compliance arm transducer voltages on the front panel. When this service aid is initially activated, the front panel will display the actual maximum and minimum transducer voltages when the arm is at its rest position (against rear bumper) and its fully forward position, respectively. This initial voltage is displayed as a binary value on the front panel indicators. This is the mode 1 or actual arm voltage. Refer to Table 3-5 to convert the binary count to a decimal equivalent in volts. The display is continuously updated so that as the arm is moved, the binary value will change relative to the new position; e.g., when the service aid is activated and the compliance arm is in the rest position, the front panel may display a binary count of 5 (+1.565 volts). If the arm is moved slowly toward the front bumper, the count will be observed to decrement to 0, switch to 16 (this is the sign bit, indicating a negative voltage value), and then increment to perhaps 21 (-1.565 volts). These maximum/minimum readings are the absolute limits of the arm. To determine the total voltage change (V-Delta) of the arm, place the arm in its rest position and press UNLOAD (mode 2). The front panel display will indicate a zero volt reference value at this time. Flickering of the HI DEN indicator is an acceptable condition in this position. As the arm is moved to its fully forward position, the binary count will increment to perhaps a value of 10 (+3.13 volts, from Table 3-5). The minimum value of voltage change for proper operation within the compliance arm travel limits is 2.191 volts (binary 7). To return to the mode 1 voltage condition, press the LOAD switch. Unlike this example, the voltage readings could be entirely in the positive or negative voltage region. Press TEST to exit this service aid.

3-24. **Service Aid 31.** This service aid is used to check the file-protect/reel-seat sensor and tape-in-path sensor. Only the supply servo is enabled. To check the file-protect/reel-seat sensor, remove the write-enable ring from a tape reel and place the reel on the supply hub. As the hub rotates counterclockwise, a double pulse of the UNLOAD indicator should occur when the reel-seat tab passes the sensor. With a write-enable ring installed, an additional single pulse of the UNLOAD indicator should occur when the the file-protect tab rotates past the sensor. For tape-in-path testing, the LOAD indicator should be illuminated initially, indicating no tape-in-path. Insert a piece of half-inch tape so that it blocks the tape-in-path sensor and extinguishes the LOAD indicator. During this service aid, the LOAD switch controls the supply motor. Each time the LOAD switch is pressed the motor will decrease its speed. Repeated actuation of the LOAD switch will cause the motor to stop and then increase speed in the opposite direction. Without a tape reel mounted on the supply hub, no flashing indication of the UNLOAD indicator should occur.

3-25. **Service Aid 32.** This service aid activates the hub-lock and door-lock assemblies. The supply motor alternates direction to operate the supply reel locking pawls. In the counterclockwise direction, the pawls should retract (unlocked position) when the hub tab engages the bellcrank. In the clockwise direction, the pawls should extend (locked position) when the hub tab engages the bellcrank. If either the top cover or front panel door is open, the ONLINE indicator illuminates.

CAUTION

This service aid is intended for use only by a service technician during troubleshooting.

3-26. **Service Aid 33.** This service aid disables both top cover and front panel door interlocks to allow observation of the tape path during operation of tape-loaded service aids. It may be accessed either before or after an auto- or manual load sequence. This service aid is not terminated with the TEST switch and will remain enabled until the tape is unloaded or the power is turned off.

3-27. **Service Aid 34.** During this service aid, the LOAD switch controls the blower motor. When the LOAD indicator is illuminated, the blower motor should be on.

3-28. **Service Aid 41.** Identification of the EPROM firmware at PWB locations U3L and U5L is possible by executing this service aid and observing the front panel LED's. If LOAD is pressed and the TEST indicator is ON, high performance 125 ips firmware is installed; if the TEST indicator is OFF, 75 ips firmware is installed. If UNLOAD is pressed, HI DEN ON indicates 1600/3200 BPI density. HI DEN OFF indicates 1600 BPI density. Pressing ON-LINE will generate a sequenced front panel display with a binary value flashed to the indicators at a 1.2 second interval. Each binary value represents a digit in the Cipher part number of the low order EPROM in location U5L. A "0" in the part number is represented by the HI DEN LED being lit. A dash is indicated by all LED's being lit. There are 10 steps in the process, including the dash number. The sequence may be recycled by pressing ON-LINE again if the observer has difficulty reading the Cipher part number the first time through the sequence. Press TEST to exit this service aid.

3-29. **Service Aid 42.** This service aid activates the cache memory DMA controller (channel 2), address and data lines for troubleshooting. See Figure 3-4 for the relative timing/sequence of a cache memory write operation. The data lines have a high state (1) value rotated through the byte from LSB to MSB, therefore, only one bit is high at a time. The address lines have a low state (0) value rotated through the 16 bit address word, thus, only one address line is low at a time. Power must be cycled to exit this service aid.

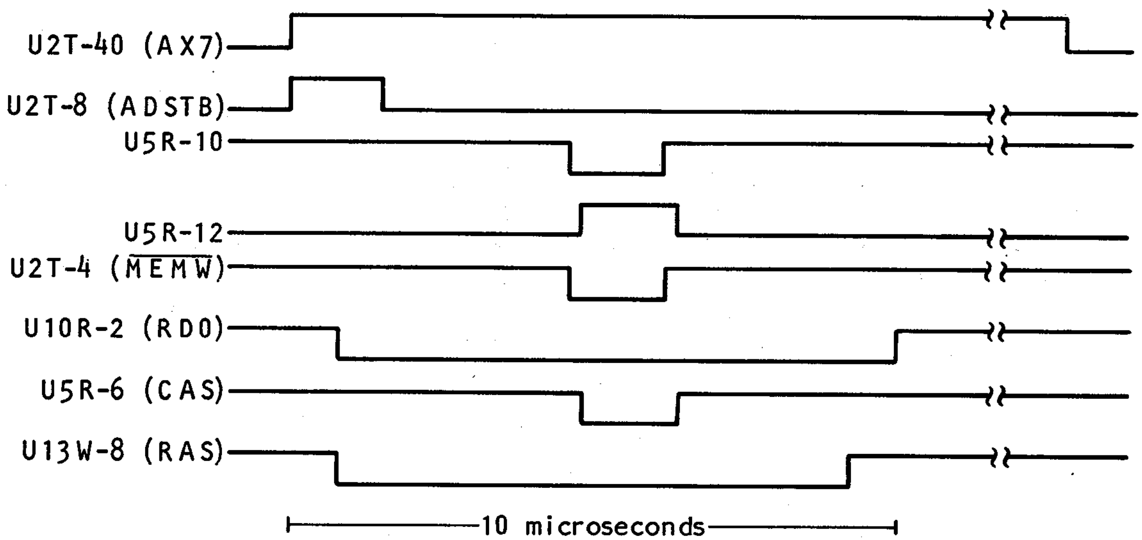


Figure 3-4. Service Aid 42 Sequence Timing

3-30. **Service Aids (Tape Loaded).** Service aids with tape in the unit are described in the following subparagraphs.

NOTE

> The tape loaded service aids cannot be initiated if the tape-in-path sensor is faulty. Refer to paragraph 3-24 for detection of a faulty tape-in-path sensor.

3-31. **Service Aid 21.** This service aid is intended for adjustment of the read threshold and is usually required only when changing the head assembly or the main PWB. A good quality tape, with the write enable ring installed, should be loaded prior to entering this service aid. While observing the front panel indicators, adjust R109 until three (3) or more LED's are flashing and no LED's are ON constantly. Refer to paragraph 4-17 for detailed adjustment procedure and cautionary notes.

3-32. **Service Aid 22.** This service aid cycles the tape in both forward and reverse directions simulating the tape motion requirements of interface commands. The formatting and data circuits are not active during this service aid. Tape travel in the forward direction is always greater, and, when the tape reaches the EOT marker, the unit will rewind and repeat the sequence. When the service aid is exited, the tape will rewind if not at BOT.

3-33. **Service Aid 23.** This service aid activates the read circuits and the write circuits using the sequence described for Service Aid 12. Press LOAD, UNLOAD, or ONLINE to select 1-byte, 40-byte, or 32K-byte records respectively. Selecting the block size initiates forward tape motion. An approximate 8 second dealy will occur before forward tape motion is observed. This delay is required to sequentially load and verify all 0's into each of the nine 64K-byte cache RAMs prior to tape motion. Press HI DEN to stop tape motion. Press HI DEN a second time for reverse tape motion. The HI DEN indicator illuminates to indicate reverse tape motion. Reverse motion inhibits the write function and read only is active. If the tape used is file protected, previously recorded data can be read in both forward and reverse directions. The EOT marker inhibits forward tape motion and BOT inhibits reverse. The 3200 CPI CTU will operate in the high density mode during this service aid (50 ips) when high density is selected (HI DEN indicator illuminated) before the service aid is entered. When the service aid is exited, the tape can be rewound to BOT by pressing LOAD/REWIND.

TRANSPORT ERROR CONDITIONS

3-34. Error conditions, other than those that would be indicated during PUST, may occur while operating the CTU. Those normally caused by the tape or operator (Operator Error Codes) are discussed in Section II, paragraph 2-6. The Transport Error Codes are machine malfunctions which indicate a serious deviation from the normal operating routine of the CTU. Each error code is represented by a unique binary pattern on the front panel indicators which flash a quick double-pulse to alert the operator. These faults inhibit the CTU and require correction by a service technician. They can be cleared only by turning the power off.

3-35. Table 3-6 is a quick descriptive list of the operator and transport errors which are explained in detail on Table 3-7. Refer to Table 3-7 for an explanation of the error conditions and some actions to take to correct the problem (1 designates a double-flashing indicator; 0 designates off). Some errors indicated during operation may, in turn, cause a PUST failure. In that case, the troubleshooting steps must begin with the PUST failure.

3-36. Data recovery example is given immediately after Table 3-7. **Data recovery must occur prior to Rewinding (IREW) or Rewinding/Unloading (IRWU).**

3-37. Table 3-8 contains a listing of mnemonics used in the Operation and Maintenance manual, together with their respective definitions.

Error		Error Type
3	Tape length greater than 3700 feet for 1-mil tape	Med 2
4	Arm out of limits during autoload	Hard
5	Sequence error, Read forward, internal status self-check fault	Med 1
6	Write/Erase to file-protected tape	Soft
7	Illegal command on interface	Soft
8	Unexpected done status in structure; internal status self-check fault	Med 1
10	Write Edit error, edited length greater than original length	Med 2
11	Excessive retries - Write fault	Med 2
13	Illegal status found in structure; internal status self-check fault	Med 1
14	18 feet past EOT	Med 2
15	Excessive block length, greater than 32 KB	Med 2
16	Sequence error, Read reverse, internal status self-check fault	Med 1
17	Operational arm fault or during load the absence of BOT marker	Hard
18	Tape speed variation greater than $\pm 10\%$	Med 1
19	Vertical parity error on retries	Med 2
20	DMA failure or no start of block	Med 1
21	Write fault, excessive retries on write filemarks	Med 2
22	EOT mark location out of tolerance (switch U3T - 1 option)	Med 2
*23	Load - no tape or hub seat failure Unload - hub not locked, too much slack tape Manual load - reel seat/file-protect sensor failure	Soft Soft Med 1
24	Cache RAM parity error or transfer rate mismatch at the interface	Med 1
25	Not enough tape on takeup reel for manual load	Soft
26	Tape stuck on the supply reel during autoload	Soft
27	Door interlock check	Soft
28	Servo failure or hub is jammed during manual load	Soft
29	Reel upside down during load or failure to get tape into tape path during autoload	Soft
31	Autoload failure after 4 retries, check tape end	Soft

Table 3-6. Error Type Description

*Error code 23 is a **multi-error** type and error codes 9, 12, and 30 are not used.

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
6	01100	The CTU received a write or erase command for a file-protected tape.	1. Possible host system failure. 2. Check that write-enable ring is removed from tape reel. 3. Check file-protect circuit with Service Aid 31. 4. Check interface logic with Service Aid 21.
7	11100	An illegal or undefined command was received by the CTU.	1. Possible host system failure. 2. Check interface logic for floating or grounded inputs.
23	11101	No tape or hub seat failure during autoload.	1. Insert a tape reel into the transport. 2. Make sure tape is properly seated.
23	11101	Hub not locked, too much slack tape during autoload.	1. Insert a tape reel into the transport. 2. Make sure tape is properly seated.
25	10011	Not enough tape on take-up reel for manual load.	1. A minumum of five wraps is required.
26	01011	Tape stuck on the supply reel during autoload	1. Tape end did not peel off of reel. Remove antistatic tape/foam block if used. 2. If caused by static charge buildup, refer to MANUAL load instructions.
27	11011	Door interlock check.	1. Close front panel door or top cover.

Table 3-7A. Soft Error Definitions

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
28	00111	Servo failure or hub is jammed during manual load.	1. Remove and re-insert tape reel to clear. 2. Possible belt crank failure.
29	10111	Tape reel was inserted upside down or failure to get tape into tape path during autoload.	1. The bottom of the tape reel is identified by the write-enable ring groove or the write-enable ring (when installed) near the inside mounting circumference.
31	11111	After four attempts, the CTU did not successfully complete the load sequence. Check tape end.	1. The tape leader should be checked for excessive damage or static charge buildup. 2. If a second attempt at autoloading fails, refer to Manual load instructions.

Method for Soft Error Recovery/Action			
Interface	Result When Unit is OFF-LINE	Result When Unit is ON-LINE	Operator Action
The CTU will go off-line.	Any front panel action--LOAD, UNLOAD, ON-LINE or power off--is allowed by the CTU.	The CTU goes off-line; the interface is inactive. Any front panel action is allowed by the CTU.	Allowed to go on-line.

Table 3-7A. Soft Error Definitions (Cont'd)

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
5	10100	Sequence error: read forward internal status self-check fault.	
8	00010	Unexpected done status in structure; internal status self-check fault.	1. Note host command sequence: operating system program, version, release, etc. 2. Contact factory.
13	10110	Illegal status found in structure. Internal status self-check fault.	
16	00001	Sequence error: read reverse internal status self-check fault.	
18	01001	Tape speed variation in excess of the ANSI maximum of ±10%.	1. Check servo operation with Service Aid 11. 2. Check tachometer operation using Service Aid 11.
20	00101	DMA failure. Word count not at 0 after timeout.	1. Verify that PUST test 7 is successfully completed. 2. Check DMA and cache address/data lines using Service Aid 42.
23	11101	Reel seat/file-protect sensor failure during **manual** load.	1. Check if file-protect or hub seat sensor are working properly.
24	00011	Parity error during Cache RAM refresh cycle. Generally, host cannot sustain throughput at present speed setting.	1. Check for "soft" RAM fault: cycle power to force power-up check. 2. Check cache RAM with PUST test 7. 3. Rerun host program.

Table 3-7B. Medium I Error Definitions

Method for Medium I Error Recovery/Action			
Interface	Result When Unit is OFF-LINE	Result When Unit is ON-LINE	Operator Action
IHER is latched and the tape remains tensioned.	Front panel LED's are flashing; all switches are inoperative.	The flashing front panel LED's allows: rewind from host, or rewind/unload from host, read data recovery from cache prior to rewind, read extended status.	Cycle power to reset.

Table 3-7B. Medium I Error Code Definitions (Cont'd)

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
3	11000	The CTU detected more than 3700 feet of tape.	1. Try a different reel.
10	01010	Write Edit failure.	1. New block size greater than original. 2. Re-check block size.
11	10010	The number of write retries exceeded 16.	1. Try a different tape. 2. Check write circuits using Service Aids 12 (no tape in unit) or 23 (tape loaded). 3. Check read circuits using Service Aid 23 (tape loaded).
14	01110	Tape travel beyond the EOT marker exceeded 18 feet.	1. Possible host system failure. 2. Check interface logic with Service Aid 21. 3. Check EOT/BOT circuit using Service Aid 32. 4. Ensure that EOT marker on tape is properly placed.
15	11110	Data block exceeded maximum block size allowed (32 KB).	1. Possible host system failure (write operation). 2. Check ILWD interface input logic for a floating condition.
19	11001	Vertical parity error on retries.	1. Check write and read circuits using Service Aid 23 (tape loaded).

Table 3-7C. Medium 2 Error Definitions

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
21	10101	Excessive retries on write filemarks.	1. Readjust read threshold using Service Aid 21 (tape loaded). 2. Check write formatter circuits with Service Aid 13 tape unloaded, not file protected and writing 40-character blocks (press UNLOAD after test entry).
22	01101	Early EOT marker encountered (switch U3T-1 option).	1. EOT marker located greater than 25 feet prior to actual EOT. 2. Relocate EOT marker.

Method for Medium 2 Error Recovery/Action			
Interface	Result When Unit is OFF-LINE	Result When Unit is ON-LINE	Operator Action
IHER is latched and the tape remains tensioned.	Front panel LED's are flashing and all switches are inoperative.	The flashing front panel LED's allows: rewind from host, rewind/unload from host, read data recovery from cache prior to rewind, read extended status.	Cycle the power, rewind or unload.

Table 3-7C. Medium 2 Error Definitions (Cont'd)

ERROR CODE NO.	BINARY DISPLAY	CONDITIONS	ACTION
4	00100	Compliance arm circuit voltage level is out of tolerance during the autoload sequence.	1. Ensure that tape is properly wrapped around take-up hub. 2. Check compliance arm operation with Service Aid 24.
17	10001	The compliance arm exceeded its travel limits during normal operation.	1. If unit missed EOT or BOT and tape ran off reel, check EOT/BOT circuit with Service Aid 32. 2. Check compliance arm operation with Service Aid 24. 3. Check servo operation with Service Aid 11.

Method for Hard Error Recovery/Action			
Interface	Result When Unit is OFF-LINE	Result When Unit is ON-LINE	Operator Action
IHER is latched and the tape remains tensioned.	Front panel LED's are flashing and all switches are inoperative.	The flashing front panel LED's allows: read data recovery, read extended status before the power is cycled.	Cycle power to reset.

Table 3-7D. Hard Error Definitions

DATA RECOVERY EXAMPLE

NOTE

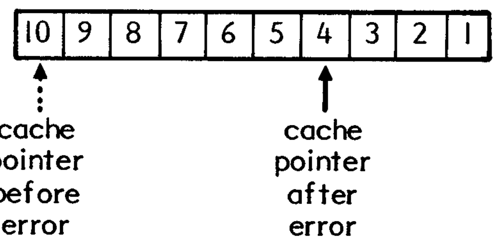
Data recovery must occur prior to Rewinding (IREW) or Rewinding/Unloading (IRWU).

a. The host is writing records to CTU thru interface: ten (10) records are sent.

b. Error code #11 occurs while attempting to fix record #4 to tape.

c. The results are following:

From the host into cache



BOT to physical tape.

d. The cache pointer is returned to the first unfixed record in cache . Any read or search command is legal. The normal recovery is by forward read, IHER resets sometime prior to IDBY going through. IHER will latch again if the unfixed record's boundary is crossed on either end.

TERM	IN/OUT	NAME	DEFINITION
Z1 - A0	I	IFEN	Formatter enable (not used)
A1	I	IGOT	Formatter command pulse detected
A2	0	IHER	Hard error
A3	0	ICER	Correctable error
A4	I	MERR	Memory parity error
A5	0	FWD/$\overline{\text{REV}}$	Formatter control
A6	I	PERR	Parity error
A7	0	IFMK	EOF detected
Z1 - B0	N/C		
B1	0	IDENT	ID burst at BOT
B2	0	IOENAB	Enable I/O at interface
B3	0	$\overline{\text{FMTRD}}$	Enable read transfer from formatter
B4	0	FIOCLK	Formatter interface clock
B5	I	$\overline{\text{POSTERR}}$	Postamble error
B6	I	$\overline{\text{VRCERR}}$	Vertical parity error
B7	I	$\overline{\text{POSTDET}}$	Postamble detect
Z1 - C0	O	$\overline{\text{W2XCLK}}$	Write logic 2X clock
C1	0	FRC2	Write state control 2
C2	0	FRC3	Write state control 3
C3	0	ENB 40 CNT	Enable 40 state counts (for FMK, Pre/Postamble)

Table 3-8. I/O Definitions (CIO)

TERM	IN/OUT	NAME	DEFINITION
Z2 - A0	I	$\overline{\text{RDROP 7}}$	Read after write channel drop detected
A1	I	$\overline{\text{RDROP 6}}$	"
A2	I	$\overline{\text{RDROP 5}}$	"
A3	I	$\overline{\text{RDROP 4}}$	"
A4	I	$\overline{\text{RDROP 3}}$	"
A5	I	$\overline{\text{RDROP 2}}$	"
A6	I	$\overline{\text{RDROP 1}}$	"
A7	I	$\overline{\text{RDROP 0}}$	"
Z2 - B0		$\overline{\text{RDROP P}}$	Read after write channel drop detected
B1	I	DOPEN	Door open (lid or front)
B2	I	HLOCK	Hub lock
B3	0	DLOCK	Door lock
B4	0	BLK	Block detect (read data)
B5	I	PHASE 2	Tach (pos'n interrupt)
B6	I	TIP	Tape in path
B7	0	MENAB	Motor enable (relay drive)
Z2 - C0	0	$\overline{\text{REFRESH}}$	Refresh DMA request
C1	0	$\overline{\text{PEN}}$	PE enable (read formatter)
C2	0	$\overline{\text{BLOWER}}$	Blower on
C3	N/C		

Table 3-8. I/O Definitions (CIO) (Cont'd)

TERM	IN/OUT	NAME	DEFINITION
Z3 - A0	I/O	LOAD	
A1	I/O	UNLOAD	
A2	I/O	ON-LINE	Front panel
A3	I/O	TEST	
A4	I/O	$\overline{\text{HIDEN}}$	
A5	0	M30	Minus 30 volt servo rail
A6	0	P30	Plus 30 volt servo rail
A7	0	$\overline{\text{MTREN}}$	Motor enable, supply & take-up
Z3 - B0	0	$\overline{\text{WHD}}$	Write head current
B1	I	TACH PULSE 0	
B2	I	$\overline{\text{EHD}}$	Erase head current
B3	I	01	Tach count enable
B4	0	HDEN	High density write select
B5	I	TACH PULSE 1	
B6	I	FPTTAB	File protect, hub seated sense
B7	I	PHASE 1	Tach count enable
Z3 - C0	0	DADR0	ADDRESS 0, D/A - A/D Converter
C1	0	DADR1	ADDRESS 1, D/A - A/D Converter
C2	0	DADR2	ADDRESS 2, D/A - A/D Converter
C3	0	$\overline{\text{DADREN}}$	D/A sample hold enable

Table 3-8. I/O Definitions (CIO) (Cont'd)

U6W PULSE No.	U6V INPUT		
0 -	AD0	IFBY	FORMATTER BUSY
	AD1	IRDY	TAPE DRIVE READY
	AD2	IDBY	DATA BUSY
	AD3	IFPT	FILE PROTECT
	AD4	ILDP	LOAD POINT (@ BOT)
	AD5	IEOT	END OF TAPE
1 -	.... SET ON-LINE		
2 -	.... CLEAR REWINDING		
3 -	.... SET REWINDING		
4 -	.... CLEAR OFF-LINE		
5 -			
6 -	.... IGO TRANSITION LATCH CLEAR		
7 -	.... CLEAR DMA REQ. FOR FORMATTER READ, SET FOR WRITE		

Table 3-8. I/O Definitions (CIO) (Cont'd)

SECTION IV

MAINTENANCE

GENERAL

4-1. This section contains periodic maintenance information and adjustment procedures. Table 4-1 presents the preventive maintenance schedule.

CTU POSITIONS FOR SERVICING

CAUTION

When CTU is to be extended on slides from equipment rack, ensure that rack is mounted securely. Weight of CTU in extended position could upset an inadequately anchored equipment rack.

4-2. **Operator Maintenance Access (See Figure 4-1).** To gain access to the tape path area for routine cleaning, proceed as follows:

a. Switch CTU power off.

b. Withdraw drive on its slides until locks engage.

c. Open top cover by lifting sides directly behind front panel. Place cover stay in slot provided.

d. Perform required maintenance.

e. To return drive to operating position, close top cover.

f. Release slide locks and push unit back into equipment rack.

g. Switch MSTU power on.

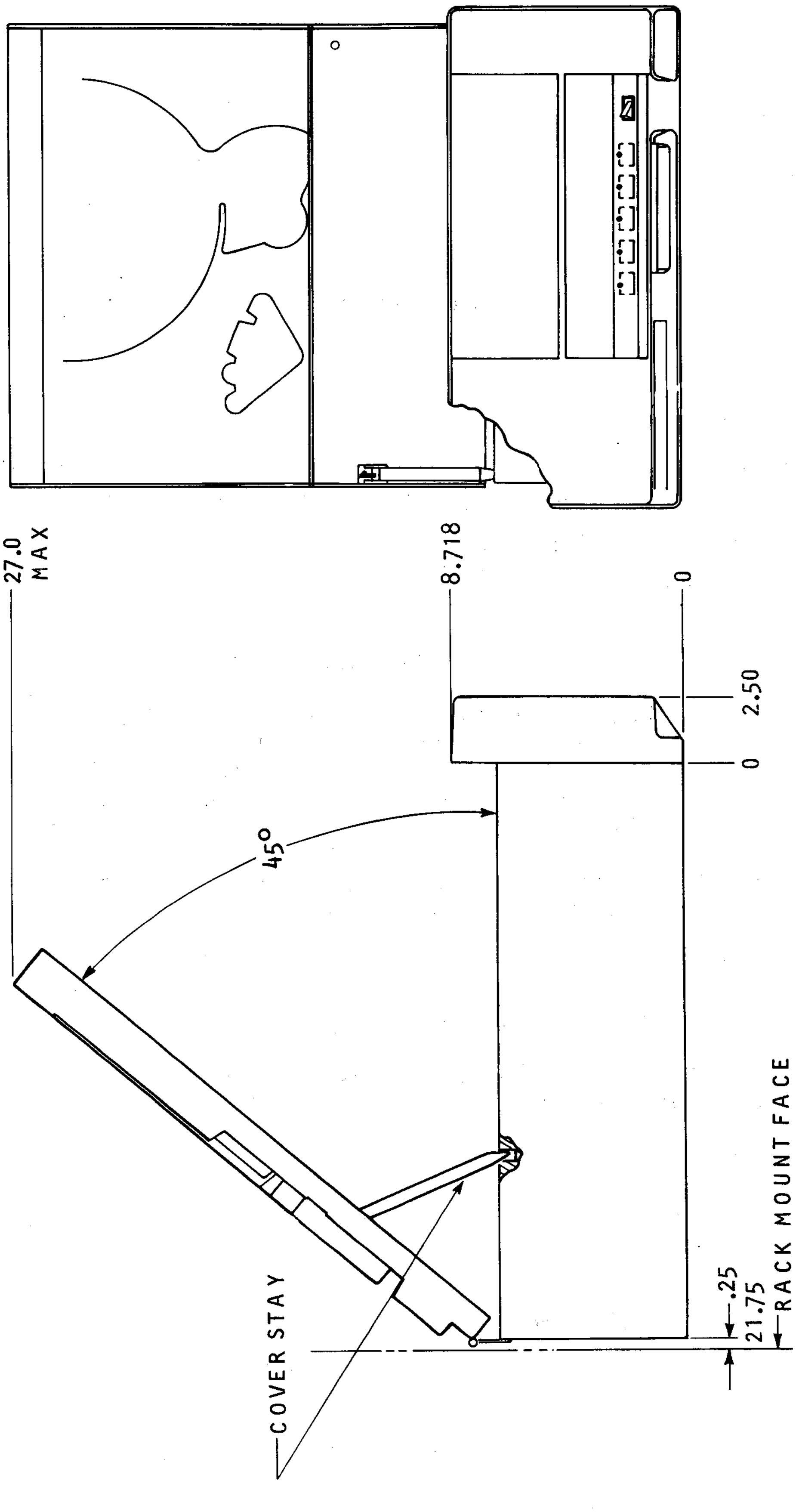


Figure 4-1. Operator Maintenance Access Position

4-3. **Service Access (See Figure 4-2).** To gain access to the main PWB and other internal components, proceed as follows:

a. Switch CTU power off.

b. Place drive in operator maintenance access position. (Refer to paragraph 4-2.)

c. Using a screwdriver, loosen two captive screws located at front sides of top plate casting.

d. Close top cover.

e. Grasping two lower corners of front panel, lift front panel to its maximum upright position. Lower slowly (about one inch) until the top plate support latch engages.

f. Insert the safety pin provided through both holes in the top plate support.

g. Perform required maintenance.

h. To return drive to operating position, remove the safety pin.

i. Lift front panel to its maximum upright position and lower smoothly to horizontal position.

j. Reverse steps a through d.

OPERATOR PREVENTIVE MAINTENANCE

4-4. For routine cleaning, place the CTU in the operator maintenance access position. Figure 4-3 identifies by number the locations of items that require routine cleaning. The recommended cleaning materials are:

a. Lint-free cloths

b. Solvent resistant swabs

c. Tape drive cleaner (liquid)

NOTE

Items a through c are available as Cipher Part No. 960855-001, Tape Drive Cleaning Kit.

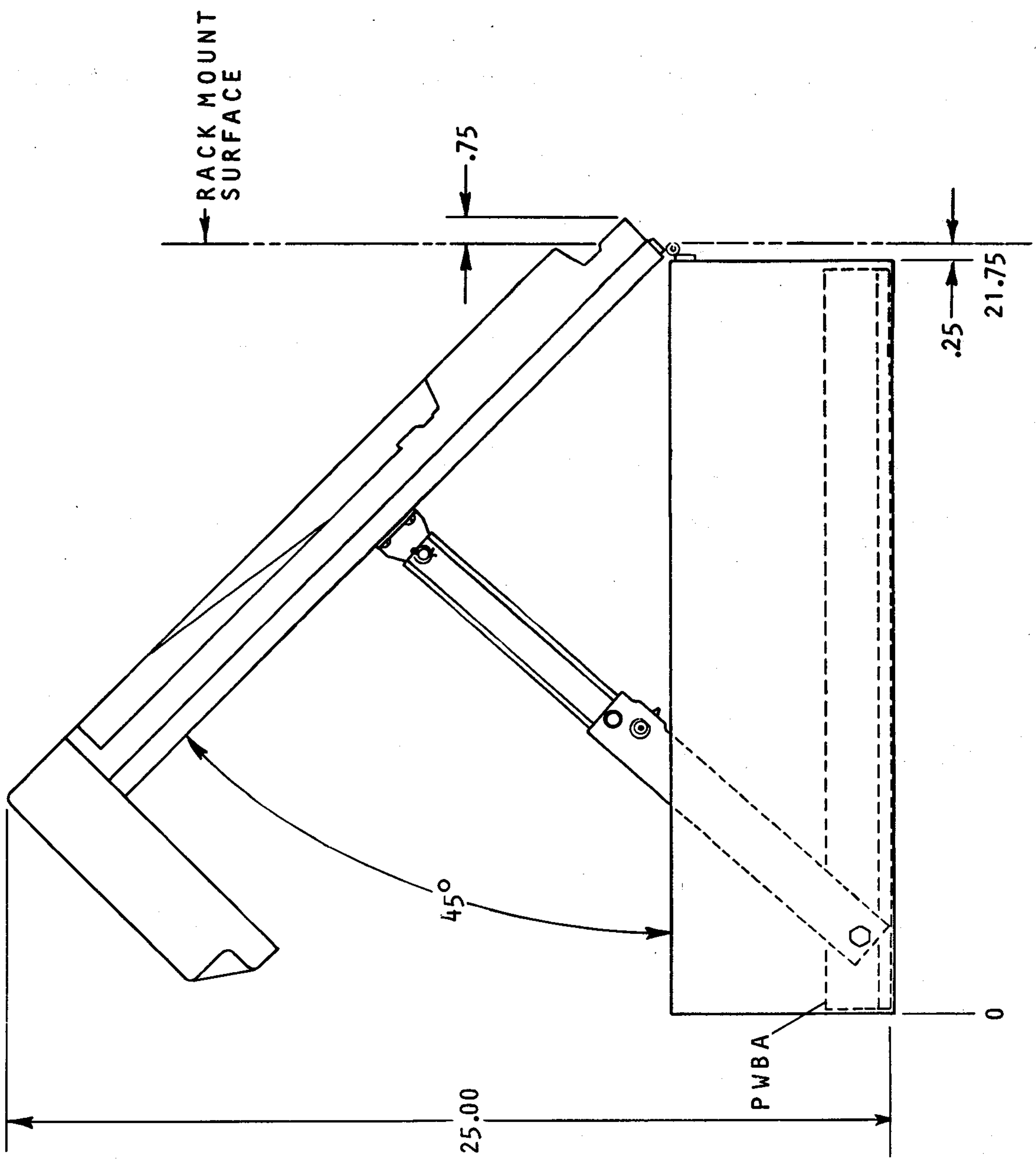


Figure 4-2. Service Access Position

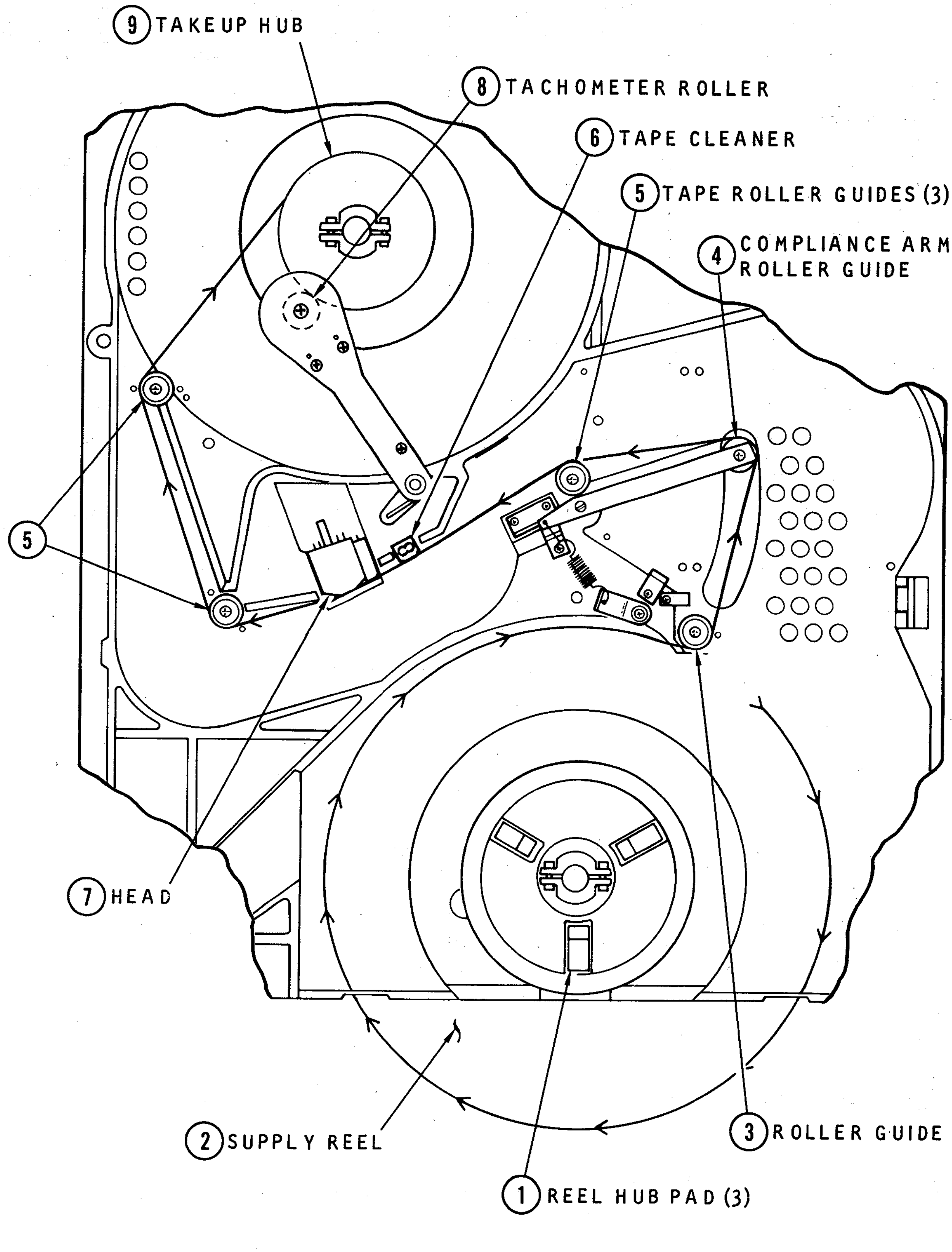


Figure 4-3. Tape Path and Related Parts

MAINTENANCE OPERATION	FREQUENCY (HOURS)	QUANTITY TO MAINTAIN	PROCEDURE PARAGRAPH
Operator			
Tachometer Roller	8	1	4-5
Take Up Hub	8	1	4-6
Roller Guides	8	5	4-7
Reel Hub Pads	8	3	4-8
Head	8	1	4-9
Tape Cleaner	8	1	4-10
Front Panel and Door	As Required	1	4-11
Top Plate Casting	As Required	1	4-12
Filter	1000	1	4-13
Service Technician			
Replace Reel Motors	5000	2	4-40 4-44

Table 4-1. Preventive Maintenance Schedule

CAUTION

Do not apply a cleaner directly from the container to the surface to be cleaned, even though instructions on the container may indicate to do so. Always apply the cleaner to a swab or wipe first, carefully removing any excess. The tachometer roller and roller guides contain precision bearings. Solvents allowed to run into the bearings will break down the lubricant.

4-5. **Tachometer Roller (8, Figure 4-3).** Use a swab moistened with tape path cleaner. Gently wipe the entire roller surface. The roller can be rotated by manually turning the take-up hub slowly.

4-6. **Take-Up Hub (9, Figure 4-3).** Use a swab or wipe moistened with tape path cleaner. Rotate the hub manually while gently wiping the tape wrapping surface.

4-7. **Roller Guides (3, 4 and 5, Figure 4-3).** Use a swab moistened with tape path cleaner. Rotate each roller and gently wipe the tape contact surface and flanges or washers.

4-8. **Reel Hub Pads (1, Figure 4-3).** Use a swab or wipe moistened with tape path cleaner. Wipe the contact surface of each pad and remove any debris around the pad.

4-9. **Head (7, Figure 4-3).** Use a swab or wipe moistened with head cleaner. Wipe the entire face of the head and attached erase bar, paying particular attention to the recessed areas.

CAUTION

Rough or abrasive materials can scratch sensitive surfaces of the head resulting in permanent damage. Other cleaners, such as alcohol based types, can cause read/write errors.

4-10. **Tape Cleaner (6, Figure 4-3).** Use a swab moistened with head cleaner. Wipe each blade along its length. Remove accumulated oxides from the recessed area between the blades.

CAUTION

Exercise care to avoid damage to sharp edges of tape cleaner blades.

4-11. **Front Panel and Door.** Use a wipe moistened with plastic cleaner.

4-12. **Top Plate Casting.** Use a wipe moistened with plastic cleaner. Referring to Figure 4-3, wipe away the oxide dust in the tape path area. Be careful not to get dirt on the head, rollers, etc. Avoid disturbing the sensors.

4-13. **Filter.** Locate and remove the filter from inside the air duct opening at the lower left of the front panel. See Figure 4-4. Clean the filter with low pressure compressed air, or vacuum, in the opposite direction of airflow and reinstall.

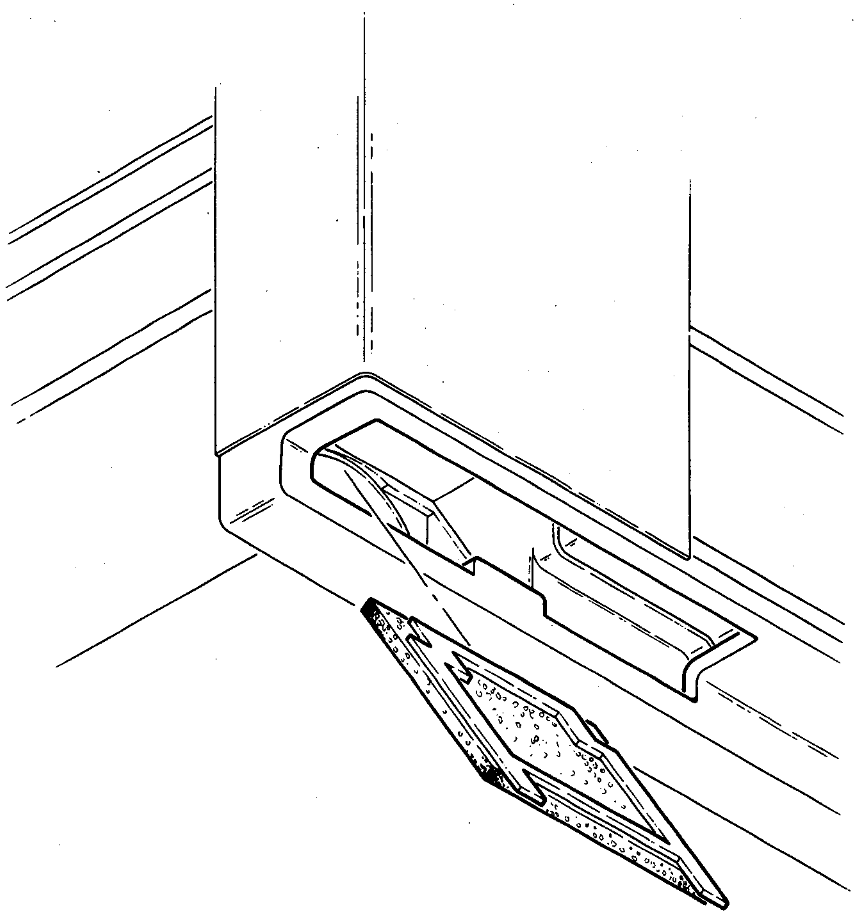


Figure 4-4. Air Filter Removal

SERVICE TECHNICIAN PREVENTIVE MAINTENANCE

4-14. **Reel Motors.** Replace both reel motors after 5000 hours of unit operation. Refer to paragraphs 4-40 and 4-44 for removal/replacement instructions.

CORRECTIVE MAINTENANCE

4-15. **Fuse Removal and Replacement.** To replace the fuse, proceed as follows:

WARNING

To prevent severe electrical shock, remove power plug from power source before performing any servicing operation on transport.

a. Remove power cord from outlet.

b. Place the drive in service access position. Refer to paragrpah 4-3.

c. Locate fuse cap on power supply housing. Push and twist cap to remove.

d. For 100-120 volt operation, use a 3-ampere, slo-blo, 250V type fuse.

e. For 208-240 volt operation, use a 1-1/2 ampere, slo-blo, 250V type fuse.

f. Reverse steps a through c.

4-16. **Voltage Regulator Adjustment.** A minor adjustment of the +5V voltage regulator circuit may be required following repair of the power supply or main PWB's or replacement of a major assembly on the unit. To adjust the +5V regulator circuit, proceed as follows:

a. Place the drive in service access position. Refer to paragraph 4-3.

b. Switch power on and allow unit to warm-up.

c. Connect a voltmeter to TP81 and ground.

d. Adjust R312 for +5.25, $\pm$0.05V.

e. Reverse steps a through c.

4-17. **Read Threshold Adjustment.** Adjustment of the read threshold level is required only when the head or main PWB is changed. Adjust read threshold as follows:

a. Place drive in service access position. Refer to paragraph 4-3.

b. Apply power to unit.

c. Load tape (write-enable ring must be installed).

NOTE

Use a National Bureau of Standards Reference Level Tape, or a certified tape that produces comparable read levels when compared with a National Bureau of Standards tape for this adjustment.

CAUTION

Do not use a library or removed tape for this adjustment because the tape used will be written on by the CTU.

d. Activate Service Aid 21. Refer to paragraphs 3-8 and 3-20.

e. Shield the LED indicators on the front panel from ambient light so that an accurate indication of ON, OFF or FLASHING can be observed.

f. Note the indication of the front panel LED's before attempting any adjustment.

g. If any three or more indicators are FLASHING with no indicator(s) ON steadily, NO ADJUSTMENT IS REQUIRED. Refer to step i.

h. If less than three indicators are FLASHING or any indicator(s) are ON steadily, adjust R109 for the indication in step g. R109 may require several turns (in either direction) to find the correct adjustment point. If the correct adjustment point cannot be found, a fault in (a) making the adjustment, (b) the head assembly, or (c) main PWB is indicated.

i. Exit Service Aid 21 by pressing TEST.

NOTE

This adjustment is based on the amplitude characteristics of the tape used for the adjustment. Other tapes whose amplitude characteristics are different may not provide the same indication after the adjustment. This fact simply reflects the difference in tapes and is not a fault condition. The tolerance range of the adjustment takes into account the inherent differences between tapes that otherwise meet the ANSI X 3.40-1976 criteria.

j. Reverse steps a through c.

REPAIR AND REPLACEMENT OF PARTS AND COMPONENTS

4-18. The CTU is designed to operate over long periods of time without requiring corrective maintenance of any kind. Spare parts are available for replacement of parts and subassemblies which may have become damaged or worn through extremely long and/or hard usage. This section presents instructions for removal of defective parts and subassemblies from the transport and replacement with the parts available, as well as disassembly, assembly, and adjustment instructions where applicable.

Except as noted, subassemblies and parts which can be removed from above the top plate are indexed in Figure 4-5, while those which can be removed from beneath the top plate are indexed in Figure 4-6. Refer to the respective key lists of these figures for the names of the subassemblies and parts indexed on each. These lists also contain the figure numbers of the detail drawings, presented in this section, in which removal and/or disassembly of these subassemblies and parts are illustrated.

WARNING

To prevent severe electrical shock, remove power plug from power source before performing any servicing operation on transport.

ITEM	DESCRIPTION	CIPHER P/N
1	Hub height adjustment tool	760105-545
2	Skew monitor (IC clip assy.)	960067-001
3	Spring scale (for tension arm) 0-36 oz spring scale John Chatillon & Sons 83-30 Kew Gardens Rd. Kew Gardens, NY 11415	Chatillon P/N LP36
4	Tape end cutter/crimper	209990-500
5	Vibratight (for adjustment screws)	209990-075
6	Torque seal (for screw heads)	209994-025
7	Loctite -222- adhesive	209990-072
8	Loctite 242	209990-074
9	Loctite -601- fast retaining compound	209990-076
10	Permabond - sealer (air duct)	209990-107
11	Lubriplate - bearing lubricant	210444
12	Master Skew tape (IBM)	799019-401
13	Tracking tape Pericomp Corp. 14 Huron Dr. Natick, MA 01760 (617) 237-4052	970039-001

Table 4-2. Repair and Maintenance Tool/Parts List

FRONT PANEL ASSEMBLY (1, Figure 4-5).

4-19. **Power Switch Replacement.** To replace the power switch (1, Figure 4-7), proceed as follows:

a. Remove power cord from outlet.

b. Position transport in service access position in accordance with instructions in paragraph 4-3.

c. Remove wire connectors from terminals of power switch in back of front panel, identifying each terminal as to the switch terminal from which it was removed.

d. Bend in tabs holding switch to panel, and push out of panel from back.

e. Place replacement switch in front panel, bend tabs in back of switch as necessary to fit tightly in panel, and reconnect wires as identified in step c.

f. Restore transport to operating position.

FIGURE & INDEX NO.	DESCRIPTION	DETAIL FIGURE NO.	PROCEDURE PARAGRAPH NO.
4-5	MODEL CTU TAPE TRANSPORT (Top View).....	REF	
-1	FRONT PANEL ASSEMBLY	4-7	4-21
-2	SUPPLY HUB ASSEMBLY	4-8	4-23
-3	HEAD ASSEMBLY............................	4-10	4-24
-4	ROLLER GUIDE ASSEMBLY...................	4-11	4-25
-5	EOT/BOT SENSOR ASSEMBLY.................	4-12	4-26
-6	TACHOMETER ASSEMBLY....................	4-13	4-27
-7	COVER ASSEMBLY	4-14	4-28
-8	TAKEUP HUB ASSEMBLY.....................	4-15	4-29
-9	COMPLIANCE ARM ASSEMBLY	4-17	4-30
-10	TAPE-IN-PATH SENSOR, TRANSMITTER	4-18	4-32
-11	TAPE-IN-PATH SENSOR, RECEIVER	4-19	4-33
-12	COMPLIANCE ARM BUMPER ASSEMBLY.......	4-20	4-34
-13	ROLLER TAPE GUIDE ASSEMBLY (Solid)	4-21	4-35
-14	FILE-PROTECT SENSOR......................	4-22	4-36

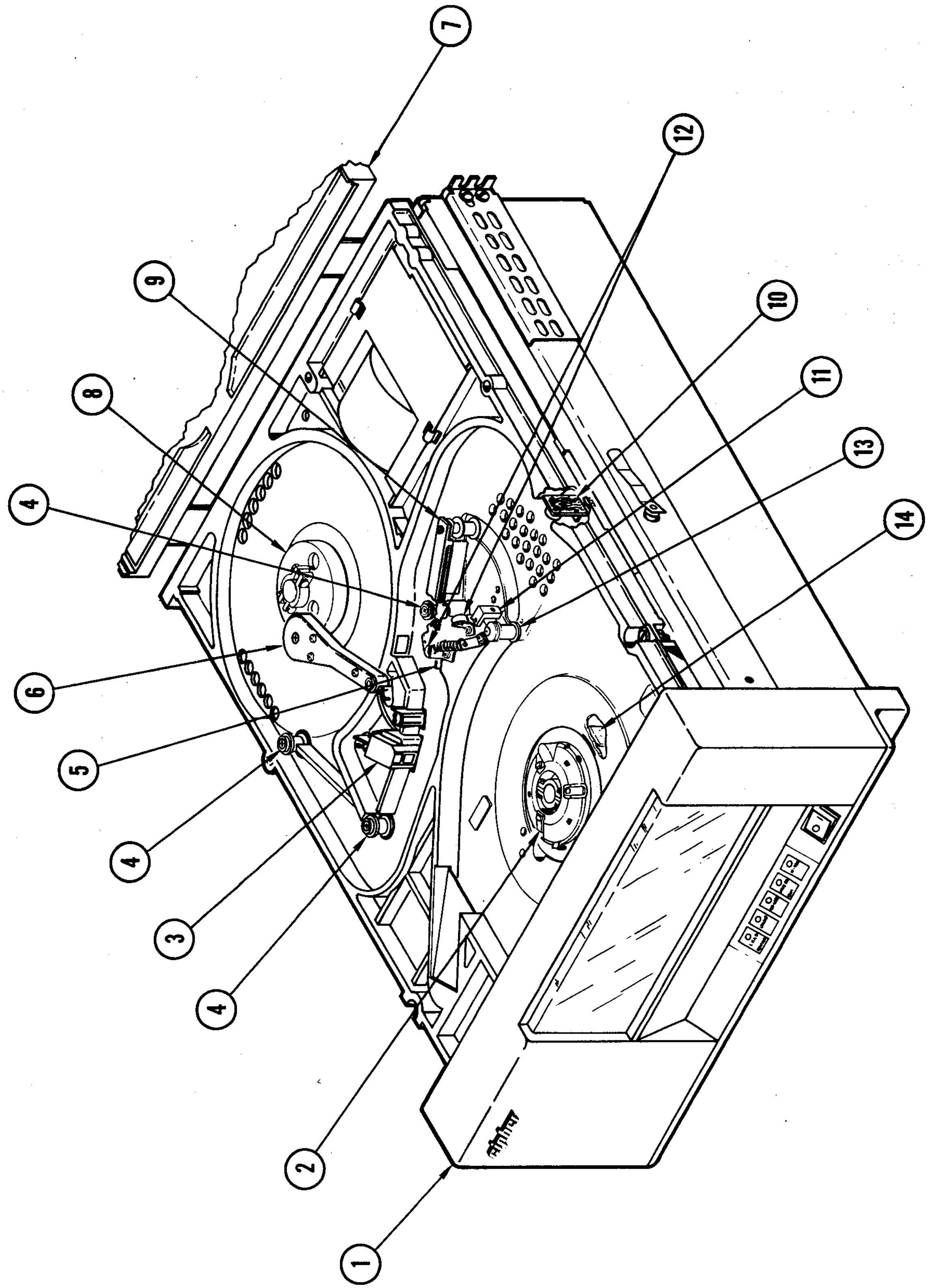


Figure 4-5. Model CTU Tape Transport (Top View)

FIGURE & INDEX NO.	DESCRIPTION	DETAIL FIGURE NO.	PROCEDURE PARAGRAPH NO.
4-6	MODEL CTU TAPE TRANSPORT (Bottom View) .	REF	
-1	DRIVE MAIN PWB ASSEMBLY	4-23	4-37
-2	POWER SUPPLY ASSEMBLY	4-24	4-38
-3	POWER SUPPLY PWB	4-25	4-39
-4	TAKEUP MOTOR ASSEMBLY..................	4-26	4-40
-5	AIR DUCT, top-plate	4-27	4-41
-6	AIR DUCT, front panel	4-27	4-42
-7	TUBE, air intake	4-27	4-41
-8	SUPPLY MOTOR ASSEMBLY	4-28	4-44
-9	AIR CAPACITOR ASSEMBLY..................	4-17	4-30
-10	HUB LOCK ASSEMBLY	4-29	4-45
-11	DOOR LOCK ASSEMBLY	4-30	4-48
-12	TRANSFORMER ASSEMBLY	4-31	4-49

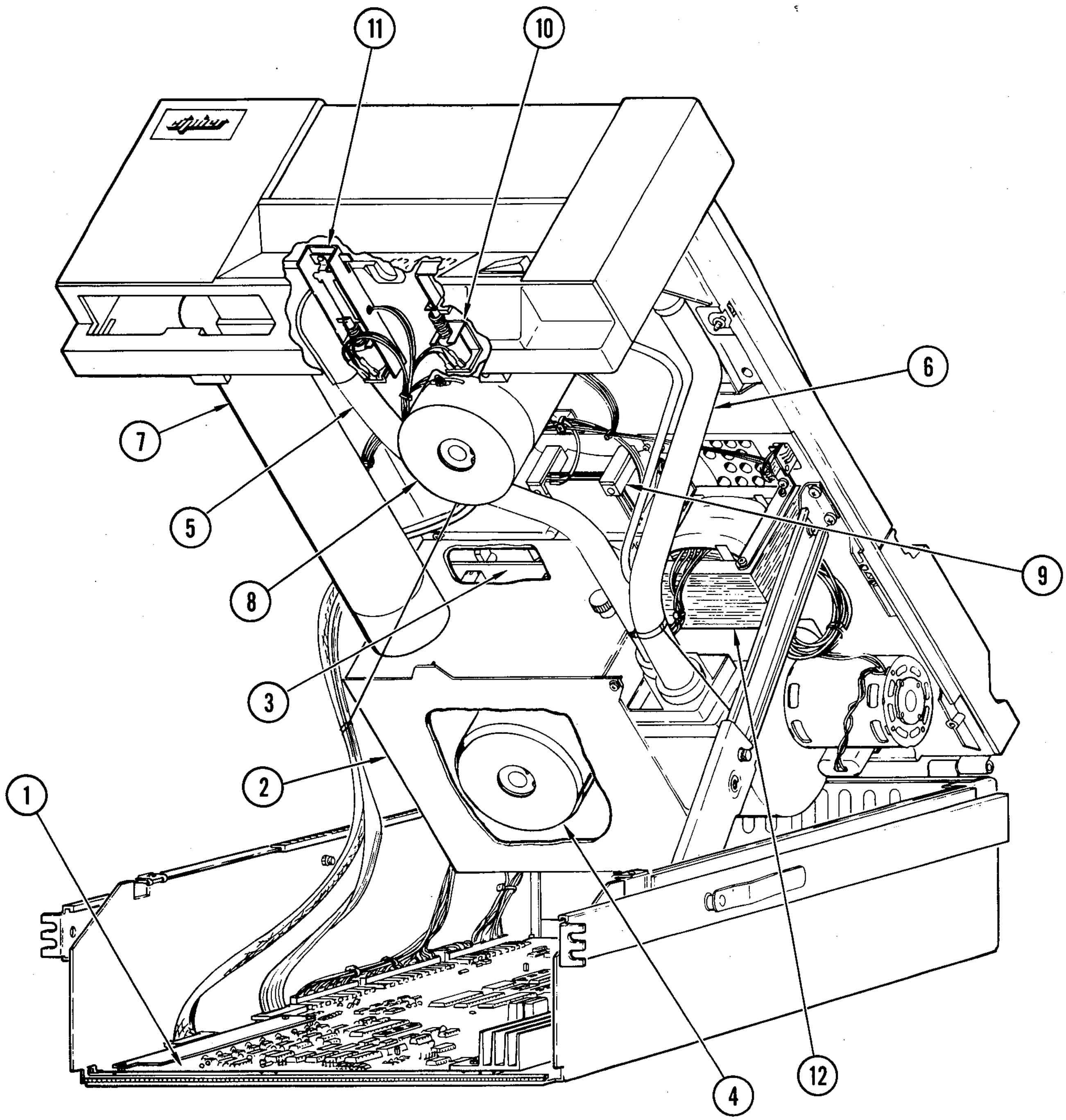


Figure 4-6. Model CTU Tape Transport (Bottom View)

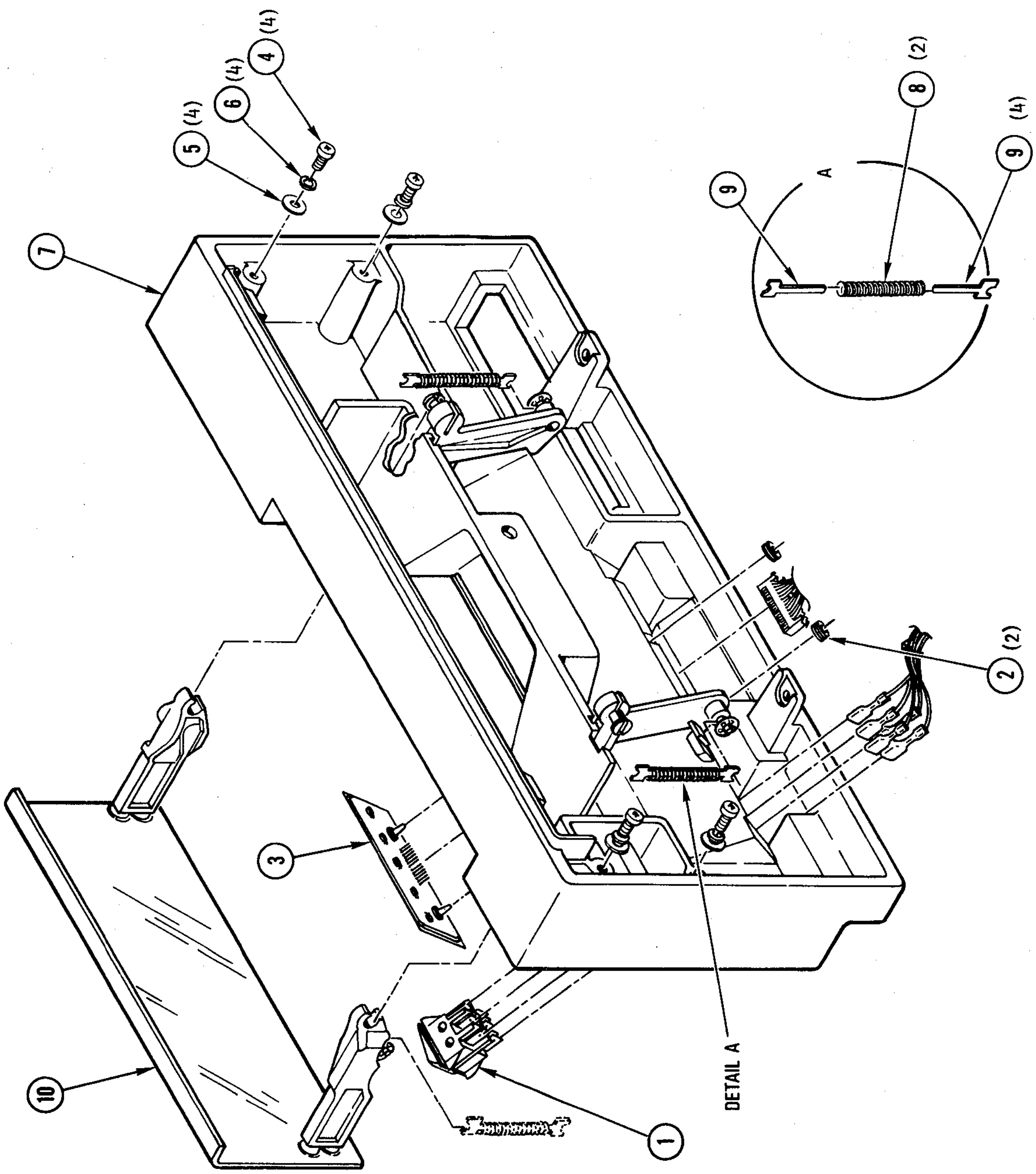


Figure 4-7. Front Panel Assembly

4-20. **Touch Switch Replacement.** To replace the touch switch (3, Figure 4-7), proceed as follows:

a. Position transport in service access position (paragraph 4-3).

b. Remove connector from switch in back of front panel, noting position of connector.

c. Remove grommets (2) from attachment posts of switch (3) and lift switch out of front panel.

d. Insert replacement switch in front panel, place grommets (2) on attachment posts, pressing down tightly against panel, and secure using Permabond.

e. Attach switch connector at back in same position as removed in step b (brown wire nearest power switch).

f. Restore transport to operating position.

4-21. **Front Panel Subassembly Replacement.** To replace the front-panel subassembly (7, Figure 4-7), proceed as follows:

NOTE

For purposes of this procedure, it is assumed that power switch (1), touch switch (3), and door assembly (10) are to be removed from discarded front panel subassembly and reused in replacement. If one or more of these items is also to be replaced, disregard instructions for removal of such items in this paragraph.

a. Position transport in service access position (paragraph 4-3).

b. Open front-panel door (10).

c. Remove four screws (4), lockwashers (5), and flat washers (6). Remove switch wire terminals and connectors attached to switches (1 and 3), noting position of each. Lift off entire front panel assembly.

NOTE

If air intake tube comes off with front panel, remove from front panel and set aside for reassembly.

d. Remove following parts and subassemblies from discarded front-panel subassembly (7) and replace in replacement front panel subassembly as follows:

(1)	Power switch:	refer to paragraph 4-19.
(2)	Touch switch:	refer to paragraph 4-20.
(3)	Door assembly:	refer to paragraph 4-22.

e. If air intake tube came off with front panel replace in front panel.

f. Attach complete front panel assembly to top plate with screws, washers, and lockwashers removed in step c. Ensure that gooseneck of front panel air duct is properly positioned (paragraph 4-42, step f).

g. Reconnect wires and connectors as identified in step c.

h. Restore transport to operating position.

i. Use Service Aid 32 to test door lock adjustment. Refer to paragraph 4-48, step j for adjustment procedure.

4-22. **Removal And Replacement of Door Assembly.** To replace the door assembly (10, Figure 4-7), proceed as follows:

a. Remove front panel assembly from top plate in accordance with paragraph 4-21, steps a, b, and c.

b. Remove two springs (8) and four guides (9), and push door out of front panel, using finger pressure on back of door from under side of panel.

c. Install door assembly in front panel subassembly by snapping arms onto plastic studs of front panel assembly, as indicated in Figure 4-7.

d. Assemble guides (9) with springs (8), with flat surfaces of guides in contact with each other.

e. Reinstall assembled front panel assembly on top plate in accordance with paragraph 4-21, steps e-i.

f. Use Service Aid 32 to test door lock adjustment. Refer to paragraph 4-48, step j for adjustment procedure.

SUPPLY HUB ASSEMBLY (2, Figure 4-5).

4-23. **Removal, Replacement and Adjustment (Figure 4-8).** Place transport in operator maintenance access position (paragraph 4-2) and proceed as follows:

a. Rotate hub assembly (1, Figure 4-8) so that socket-head screws face front panel door.

b. Open front-panel door and loosen socket-head screws (2).

c. Remove supply hub from reel motor shaft.

d. Install replacement hub on shaft, and position hub height gauge, Cipher Part No. 760105-545, as shown in Figure 4-9 so that it contacts the raised machined surface of the top plate. Raise the supply hub until the reference surface contacts the hub-height tool.

e. Ensuring that hub-height tool is in contact with both the top plate and reel hub, tighten socket-head screws (2).

f. Remove tool, restore transport to operating position, and load tape.

g. Run tape forward and reverse using Service Aid 23, noting tape position on reel for which replacement hub was installed. If tape is centered between sides of reel, adjustment is correct. If not, loosen socket-head screws and repeat steps d through g until positioning is correct.

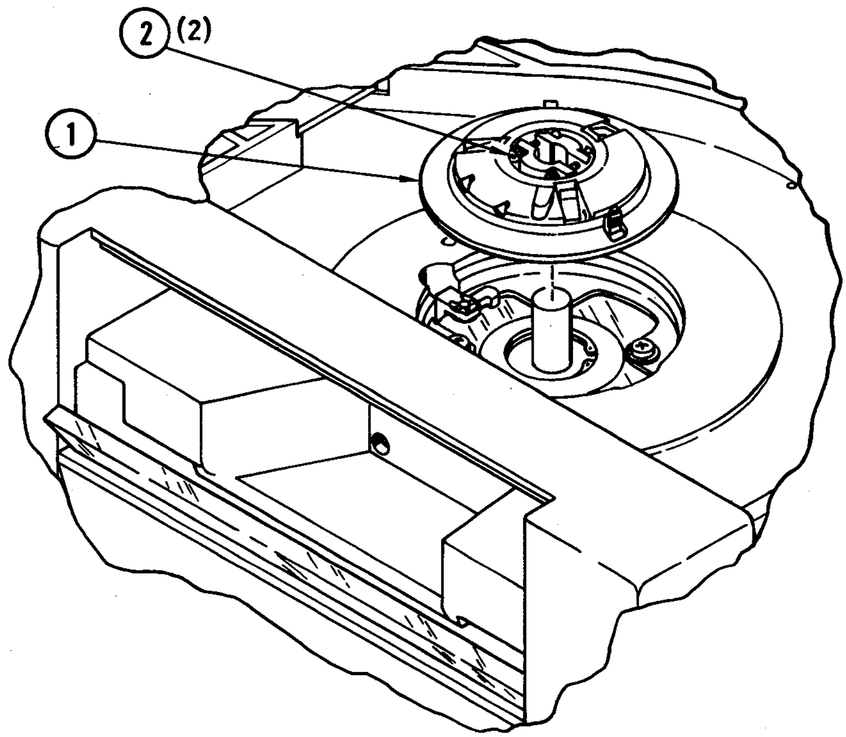


Figure 4-8. Supply Hub Assembly

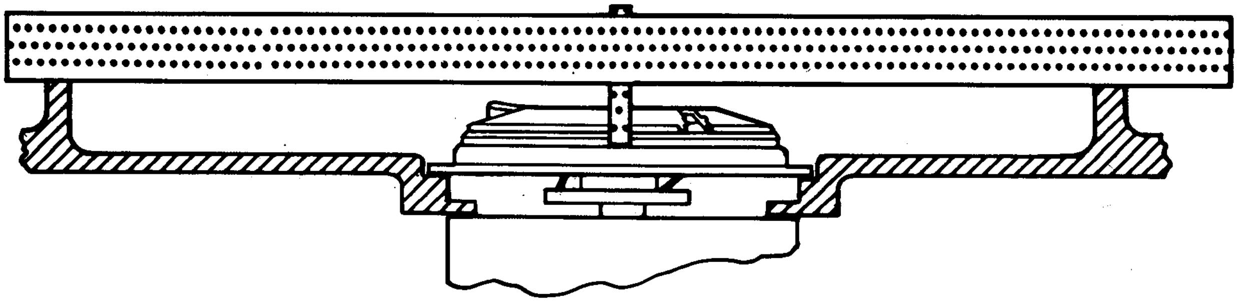


Figure 4-9. Supply Hub Adjustment

HEAD ASSEMBLY (3, Figure 4-5).

4-24. **Removal and Replacement of Assembly and Parts (Figure 4-10).** Place the transport in service access position (paragraph 4-3) and proceed as follows:

NOTE

It is not necessary to remove complete assembly from top plate in order to remove tape scraper (13, Figure 4-10). Refer to this paragraph, step f. If head is defective and in need of replacement, entire head assembly (8), including tape scraper (13) must be replaced.

a. Remove head connectors from P6/P7 on main PWB and remove from cable retractor.

b. Working from under side of top plate, remove center adjustment screw (1), flat washer (2), four screws (3), and lockwashers (4), three flat washers (5), one flat washer (6), and cable clamp (7) supporting assembly (8) with one hand as last screw is removed. Identify wire terminal and cable clamp as to position from which removed, and save attaching parts for reinstallation.

c. Pull assembly (8) and wire harness carefully down through hole in top plate and cables over air intake tube.

d. Install replacement assembly in reverse order of sequence in steps b and c, carefully pushing head and connectors through hole in top plate and attaching wire terminal and cable clamp in positions from which removed. Do not tighten center adjustment screw (1) at this time.

e. Feed head connectors and cables through cable retractor and over air intake tube and install on J6/J7 on main PWB.

f. If tape scraper (13) only is to be replaced. remove two socket-head screws (12), nuts (9), lockwashers (10), and flat washers (11). Save attaching parts for reassembly, and install replacement scraper in reverse order of removal.

g. Adjust tape scraper (13) as follows:

   (1) Insert and load a tape.

   (2) Loosen socket-head screws (12) and move tape scraper away from tape.

   (3) Slowly move tape scraper toward tape until it contacts tape.

   (4) Rotate tape scraper until both scraper blades are touching the tape. producing two vertical creases in the tape at the points of contact.

   (5) Verify that tape is touching erase bar. Check for vertical crease in tape at the point of contact.

   (6) Tighten socket-head screws (12) and reverify that tape is in contact with both blades of tape scraper and the erase bar.

h. Perform tape alignment procedure, paragraph 4-50.

i. Place transport in operating position.

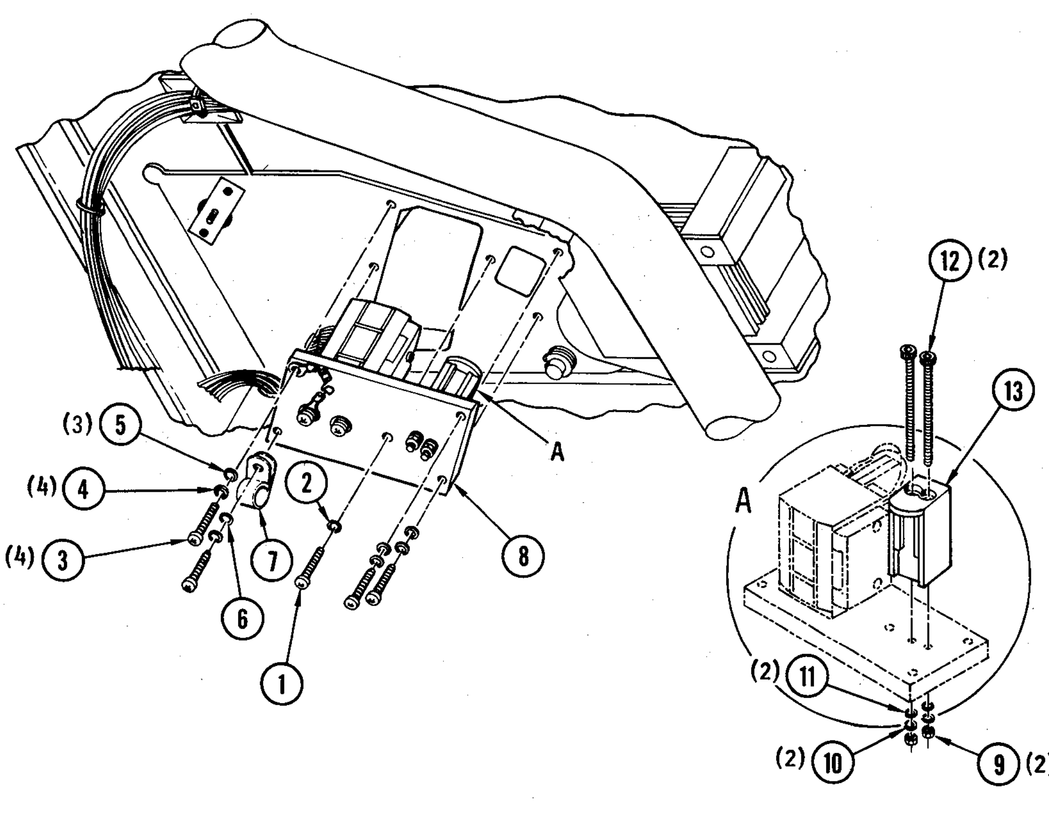


Figure 4-10. Head Assembly

ROLLER GUIDE ASSEMBLY (4, Figure 4-5).

4-25. **Removal and Replacement of Assembly (Figure 4-11).** Place the transport in operator maintenance access position (paragraph 4-2) and proceed as follows:

a. Remove attaching screw (1, Figure 4-11), leaving shims (4) and spring (3) in place, remove roller guide assembly through top of top plate, saving attaching parts for reassembly.

b. Install replacement roller guide (2), using original attaching parts.

c. Perform tape alignment procedure, paragraph 4-50.

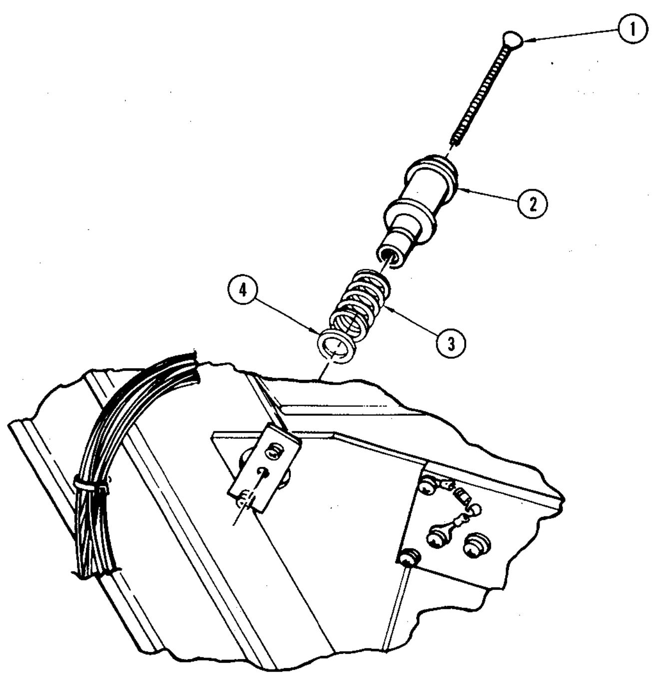


Figure 4-11. Roller Guide Assembly

EOT/BOT SENSOR ASSEMBLY (5, Figure 4-5).

4-26. **Removal and Replacement (Figure 4-12).** Place transport in operator maintenance access position (paragraph 4-2) and proceed as follows:

a. Holding compliance arm aside to provide access to mounting screws, remove two screws (1, Figure 4-12) and lock washers (2) and retain for reassembly.

b. Remove EOT/BOT assembly (3), carefully pulling wires and connector (4) through hole in top plate assembly.

c. Unplug EOT/BOT assembly.

CAUTION

To prevent misalignment, avoid contact with sensors mounted on replacement EOT/BOT PWB. Sensors are factory-aligned for optimum output.

d. Attach plug removed in step c.

e. Feed wires and connector (4) carefully through hole in top plate assembly (refer to step b).

f. Attach EOT/BOT assembly loosely with screws (1) and lockwashers (2), position assembly as close to tape as mounting bracket will allow, with PWB parallel to casting wall directly behind it, and tighten screws.

g. Place transport in operating position.

h. Use Service Aids 22 and 23 to test EOT/BOT assembly.

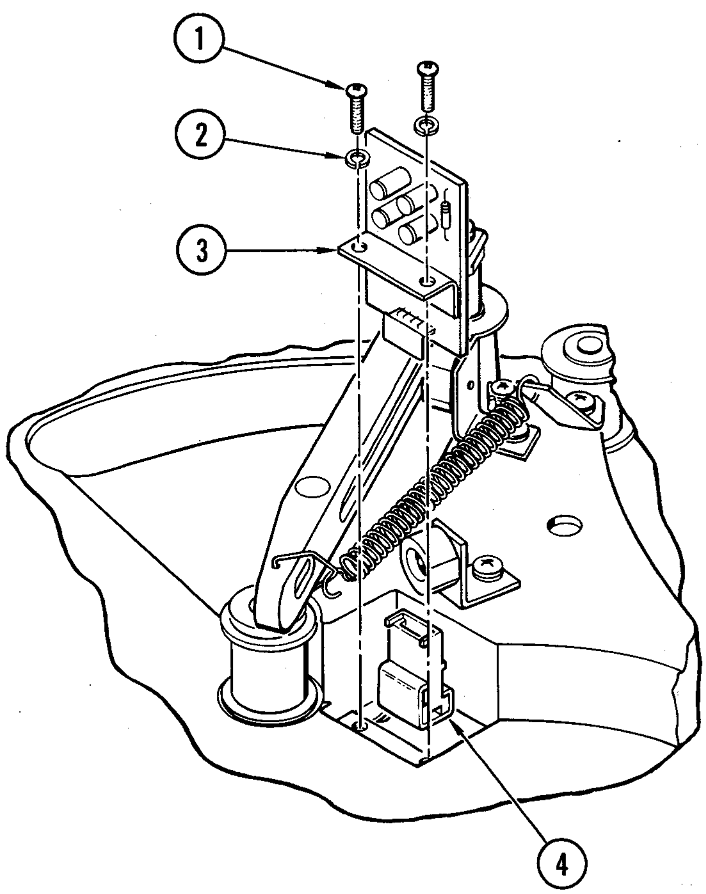


Figure 4-12. EOT/BOT Assembly

TACHOMETER ASSEMBLY (6, Figure 4-5).

4-27. **Removal and Replacement (Figure 4-13).** Place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Disconnect tachometer wiring harness connector from mating connector beneath top plate.

b. Remove grip ring (1, Figure 4-13), wavespring washer (2), and shim(s) (3) from tachometer post beneath top plate and save for reassembly.

c. Remove tachometer assembly (6) from top plate, pulling wire harness and connector carefully through hole.

d. If lower bearing (4) or upper bearing (5) was removed, apply Loctite 601 sparingly to outside surface of replacement bearing before installing.

e. Install replacement tachometer assembly through upper bearing (5) and lower bearing (4), seating end of spring in adjacent small hole in top plate.

f. Install shim(s) (3), wavespring washer (2), and grip ring (1). If necessary, install additional shims (3) to compress wavespring half of its height when grip ring is installed.

g. Push connector and wire harness through top plate hole, and connect beneath top plate.

h. Place transport in operating position.

i. Use Service Aid 11 to test tachometer operation.

COVER ASSEMBLY (7, Figure 4-5).

4-28. **Removal and Replacement of Assembly and/or Parts (Figure 4-14).** Place the transport in operator maintenance access position (paragraph 4-2). Remove damaged cover assembly, subassemblies, and/or parts as necessary in the sequence of index numbers (Figure 4-14) assigned to the item and its attaching parts, saving attaching parts for use during reassembly if necessary, and install the replacement item in reverse sequence of removal. Observe the following special instructions:

a. When replacing catch (10) tighten screws just enough to hold and then try closing cover. If catch is too far forward and prevents cover from closing or is too far back to engage latch on front panel assembly, loosen attaching screws (7) and move catch forward or backward so that the cover closes and catch latches securely on front panel.

b. Restore transport to operating position.

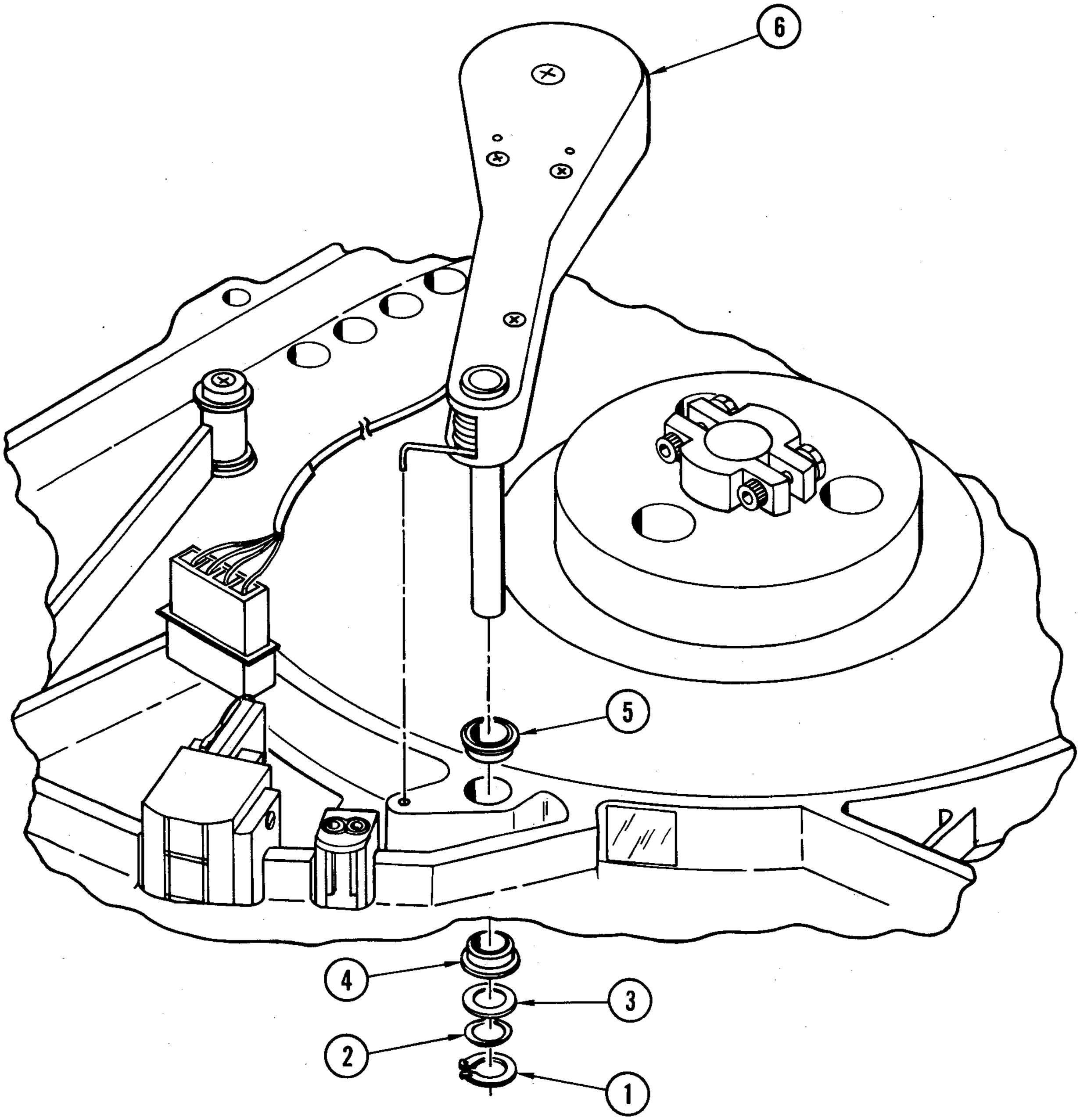


Figure 4-13. Tachometer Assembly

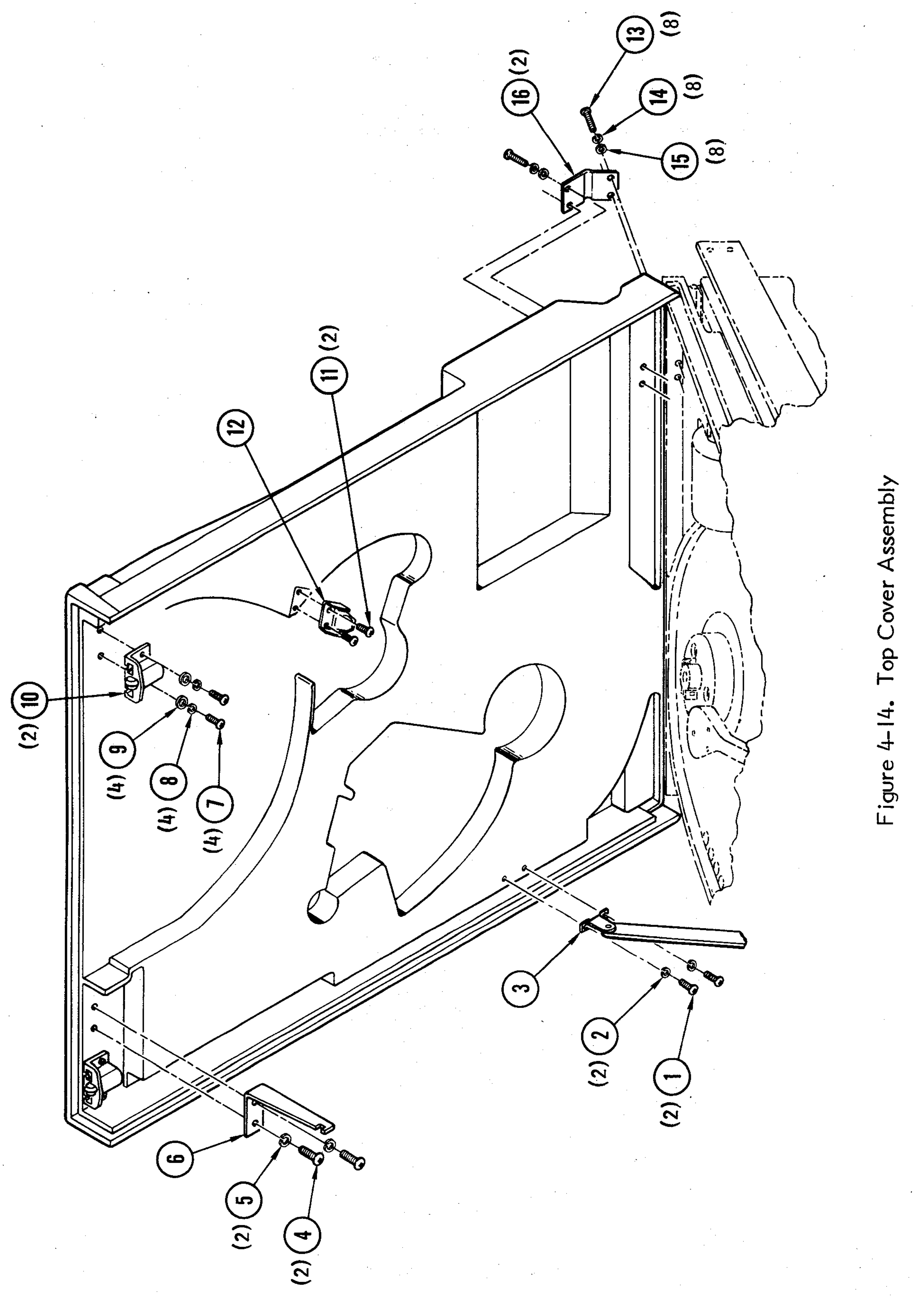


Figure 4-14. Top Cover Assembly

TAKEUP HUB ASSEMBLY (8, Figure 4-5).

4-29. **Removal, Replacement, and Adjustment (Figure 4-15).** Place the transport in operator maintenance access position (paragraph 4-2) and proceed as follows:

a. Secure tachometer assembly (1) away from the takeup hub.

b. Loosen socket-head screws (2, Figure 4-15) and remove hub (3).

c. Install replacement hub on shaft and position hub height gauge, Cipher part No. 760105-545, as shown in Figure 4-16.

d. Position hub on shaft so that hub height gauge is in contact with both the raised machined area of the top plate and takeup hub, and tighten socket-head screws (2).

e. Remove tool, carefully replace tachometer assembly against hub, restore transport to operating position, and load tape.

f. Run tape forward and reverse using Service Aid 23, noting tape position on replacement hub. If tape is centered on hub, adjustment is correct. If not, loosen socket-head screws (2) and repeat steps b through e.

g. Place transport in operating position.

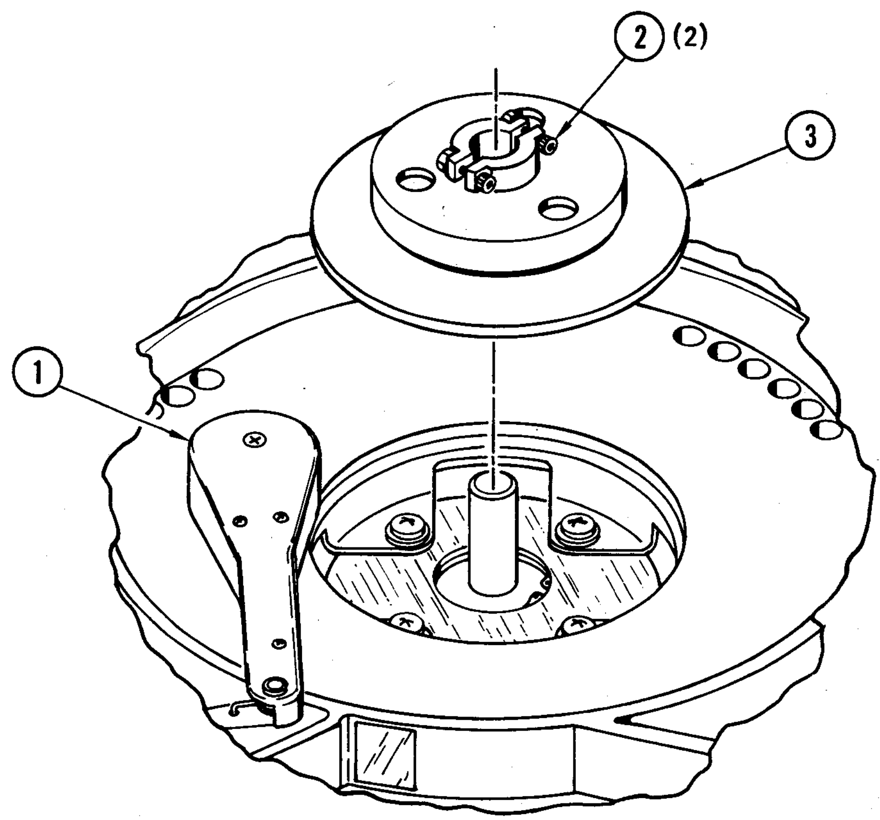


Figure 4-15. Takeup Hub

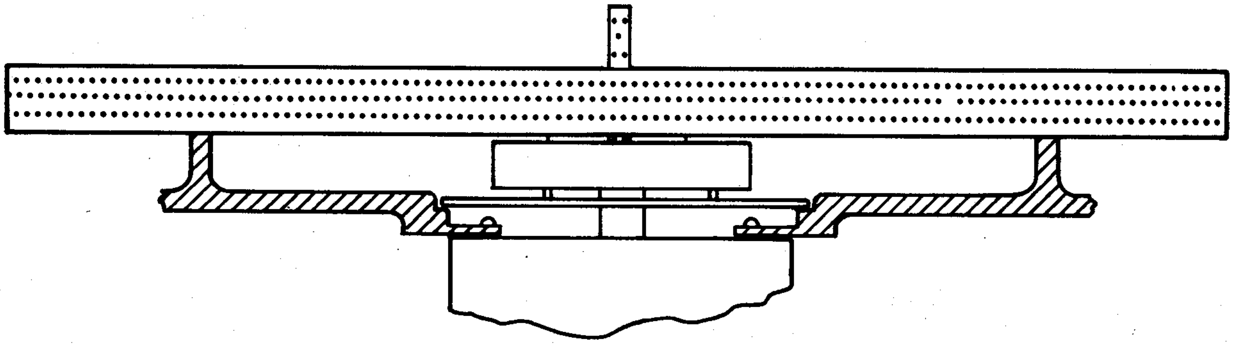


Figure 4-16. Takeup Hub Adjustment

COMPLIANCE ARM ASSEMBLY (9 Figure 4-5), AIR CAPACITOR ASSEMBLY (9, Figure 4-6).

NOTE

To facilitate removal of the compliance arm assembly, this procedure combines the removal, disassembly, assembly and installation of the compliance arm assembly with that of the air capacitor.

4-30. **Removal and Disassembly (Figure 4-17).** Place the transport in service access position (paragraph 4-3). Proceed as follows:

NOTE

Save all attaching parts for use in reassembly.

a. Remove the top plate air duct (paragraph 4-41). Do not remove Ty-rap.

b. Remove two screws (1), and flat washers (2) attaching air capacitor shutter blade (3) to hub (4), and remove blade (3) from air capacitor stator (7).

c. Remove wire terminals clipped to air capacitor stator (7) plates and identify for reassembly.

d. Remove two allen-head screws (5) and one allen-head screw (6), and remove air capacitor stator (7) from top plate.

e. Loosen socket head screw (8) and remove shutter hub (4) from end of compliance arm shaft.

f. From top side of plate, remove spring (9) from bracket (10).

g. From bottom side of top plate, remove retaining ring (11), wavespring washer (12), and shim (13). Lift compliance arm assembly from top plate. Remove lower bearing (14) or upper bearing (15) only if it requires inspection and/or replacement. These bearings are attached to top plate with Loctite 601.

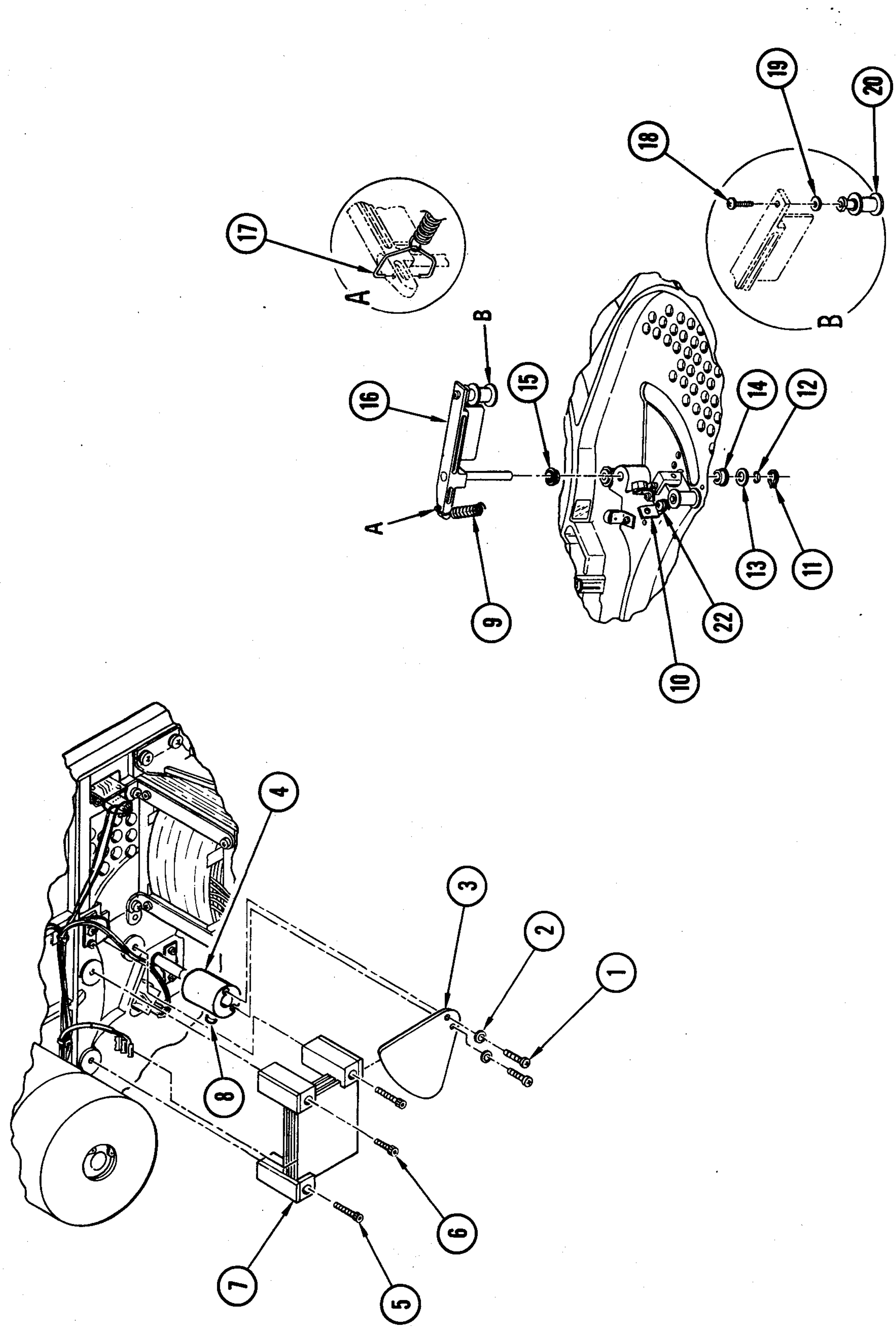


Figure 4-17. Compliance Arm and Air Capacitor Assemblies

h. Remove clip (17) from arm (16) by spreading ends out of hole in arm.

i. To remove tape guide (20), remove screw (18), and shim (19), saving shim for reassembly.

4-31. **Reassembly, Installation, and Adjustment.** Reassemble and install the compliance arm and air capacitor assemblies as follows:

a. Replace defective parts and reassemble compliance arm assembly as shown in Figure 4-17, in reverse order of steps g through i, paragraph 4-30, observing the following special instructions.

(1) Use attaching parts and shims saved from removal and disassembly as necessary.

(2) Apply Lubriplate to bearing surfaces between clip (17) and arm (16).

b. If bearing (14) or (15) was removed, apply small amount of Loctite 601 around outside of bearing and replace.

c. Install shaft carefully through bearings in top plate.

d. Install shim (13), wavespring washer (12), and retaining ring (11) on bottom of shaft. Check wavespring washer (12) to see that it is compressed half of its height. If not, add shims (13) as necessary, checking compliance arm for freedom of movement.

e. Slip hub (4) of capacitor shutter over end of compliance arm shaft, tightening socket head screw (8) just enough to hold hub on shaft.

f. Mount air capacitor stator (7) to under side of top plate with one screw (1/2 - inch) (6), and two screws (5/8-inch) (5), applying Loctite 242 to screws before insertion.

g. Slip blade (3) of capacitor shutter between two upper plates of capacitor stator (7), and attach to hub (loosen hub if required) with two screws (1), and flatwashers (2).

h. Rotate compliance arm assembly to front bumper and secure with Ty-rap.

i. Loosen hub socket head screw (8) slightly, rotate capacitor shutter blade (3) to within 0.1 inch of power supply housing, and adjust height of hub so that rotor blade does not bind on either plate of capacitor stator (7).

j. Tighten hub socket head screw (8).

k. Remove Ty-rap securing compliance arm assembly to front bumper and allow compliance arm to rotate to rear bumper (under its own weight). If compliance arm does not swing freely, readjust height of capacitor shutter, steps i and j, until compliance arm swings freely.

l. Attach compliance arm spring (9) to bracket (10).

m. Clip wire terminals to air capacitor stator (7) plates at points from which removed in step b, paragraph 4-30.

n. Place transport in operator maintenance access position (paragraph 4-2).

CAUTION

To prevent data reliability problems due to improper tape tensioning, the position of the compliance arm spring bracket (10) is factory aligned and should not be changed unless necessary.

o. If spring bracket position was changed, adjust for proper spring tension as follows:

(1) Attach 0 to 36 oz. spring scale, available from John Chatillon & Sons, 83-30 Kew Gardens Rd., Kew Gardens, New York 11415, Part No. LP36, to compliance arm by inserting hook end of scale into notch provided on top of compliance arm near the pivot point.

(2) Loosen screw (22) attaching bracket (10) and position bracket so that screw (22) is in the center of its slotted adjustment range.

(3) Pull spring scale toward front panel of transport until compliance arm roller is positioned between 4th and 5th row (from front panel) of holes in top plate. Scale must be held perpendicular to compliance arm.

(4) With compliance arm positioned between 4th and 5th holes in top plate, spring scale should indicate 19 (±2) ounces. Adjust spring bracket to obtain this reading by moving bracket to stretch or shorten spring. Any deviation from zero reading should be added or subtracted from spring scale reading.

(5) Verify that minimum spring tension required to move arm from rest position is 10 ounces.

(6) If readjustment is required in either substep (4) or (5), reverify both readings.

p. Use Service Aid 24 to test compliance arm and air capacitor assemblies.

TAPE-IN-PATH SENSOR, TRANSMITTER (10, Figure 4-5).

4-32. **Removal and Replacement (Figure 4-18).** Place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Remove connector at back of top plate from tape-in-path sensor transmitter.

b. Remove two screws (1, Figure 4-18) and lockwashers (2) and pull transmitter (3) carefully through hole from back of top plate.

c. Position replacement sensor transmitter carefully in place through hole from back of top plate and secure with screws (1) and lockwashers (2).

d. Attach connector removed in step a.

e. Place transport in operating position.

f. Use Service Aid 31 to test tape-in-path sensor, transmitter.

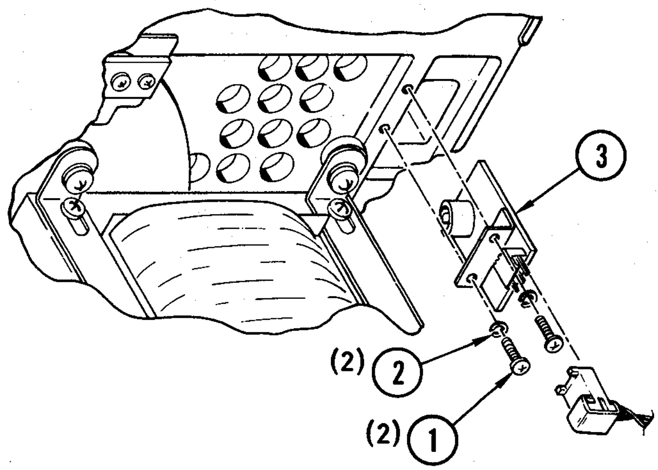


Figure 4-18. Tape-in-Path Sensor, Transmitter

TAPE-IN-PATH SENSOR, RECEIVER (11, Figure 4-5).

4-33. **Removal and Replacement (Figure 4-19).** Place the transport in service access position (paragraph 4-2) and proceed as follows:

a. Remove connector at back of top plate.

b. Remove attaching screw (1, Figure 4-18), lockwasher (2), and flatwasher (3) and remove tape-in-path sensor receiver (4). Save attaching parts for reassembly.

c. Install replacement receiver using screw (1), lockwashers (2) and flatwasher (3).

d. Reinstall connector.

e. Place transport in operating position.

f. Use Service Aid 31 to test tape-in-path sensor, receiver.

COMPLIANCE ARM BUMPER ASSEMBLY (12, Figure 4-5).

4-34. **Removal and Replacement (Figure 4-20).** With the transport in operator maintenance position (paragraph 4-2), proceed as follows:

a. Remove screw (1, Figure 4-20), lockwasher (2), and bumper assembly (3).

b. Reinstall in reverse order of removal, and adjust to contact compliance arm squarely. Ensure spring (4) does not touch bumper in the compliance arm's full arc of travel. Reposition bumper to clear spring if required.

c. Place transport in operating position.

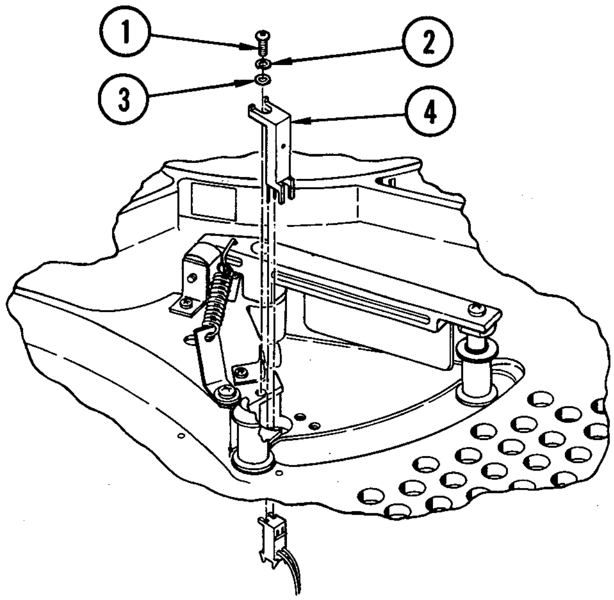


Figure 4-19. Tape-in-Path Sensor, Receiver

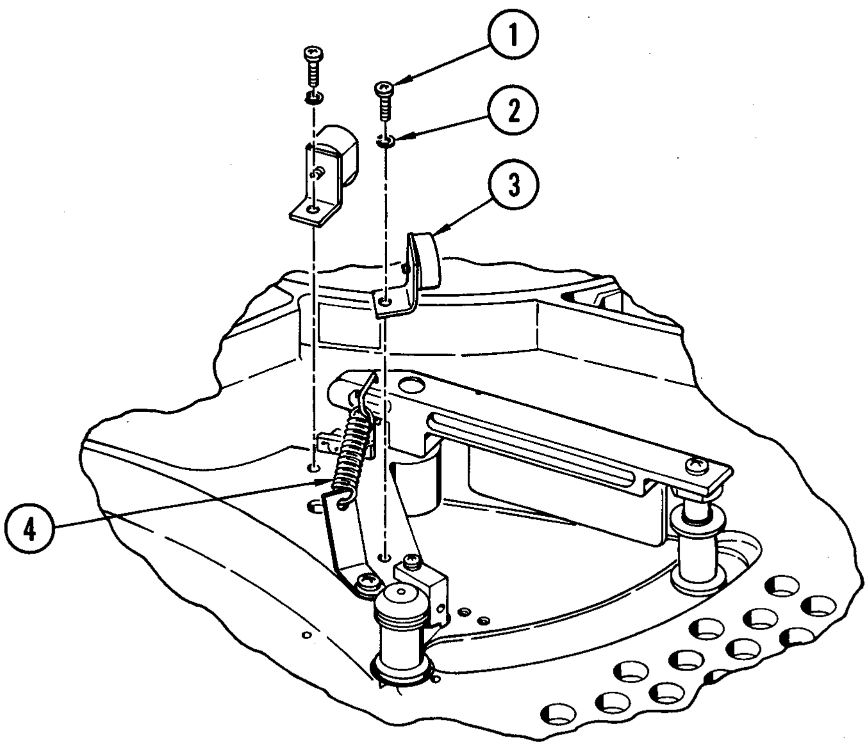


Figure 4-20. Compliance Arm Bumper Assembly

ROLLER TAPE GUIDE ASSEMBLY (SOLID) (13, Figure 4-5).

4-35. **Removal and Replacement (Figure 4-21).** Place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Remove attaching screw (1, Figure 4-21) and lockwasher (2), and leaving shims in place remove tape guide assembly (solid) from top of top plate. Save attaching parts for reinstallation.

b. Reinstall tape guide assembly (solid) (3) in reverse order of step a.

c. Perform tape alignment procedure in accordance with instructions in paragraph 4-50.

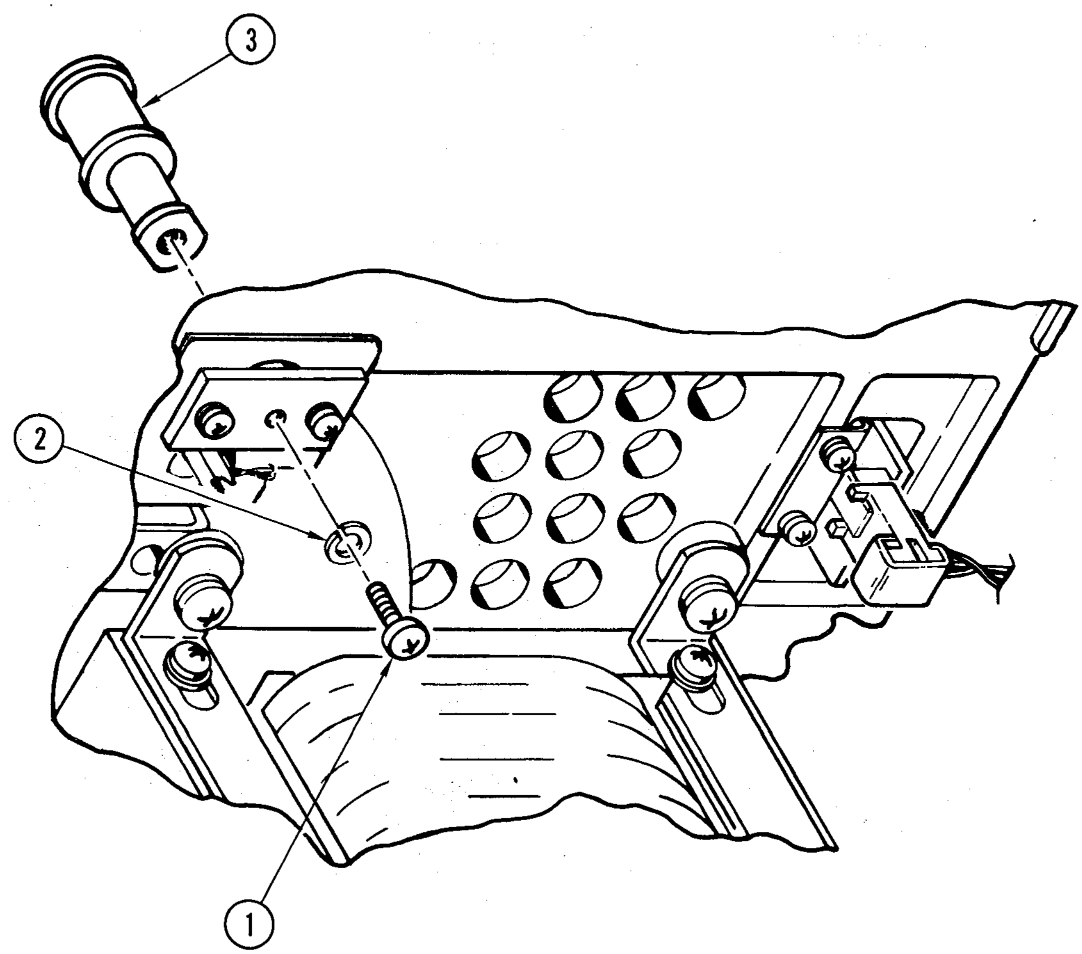


Figure 4-21. Tape Guide Assembly (Solid)

FILE-PROTECT SENSOR (14, Figure 4-5).

4-36. **Removal and Replacement (Figure 4-22).** Place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Remove connector (back of top plate) from file-protect sensor (3, Figure 4-22).

b. Remove two screws (1) and lockwashers (2) and pull sensor (3) carefully through hole of top plate. Save attaching parts for reassembly.

c. Position replacement sensor carefully through hole and secure with screws (1) and lockwashers (2).

d. Attach connector removed in step a.

e. Place transport in operating position.

f. Use Service Aid 31 to test file-protect sensor.

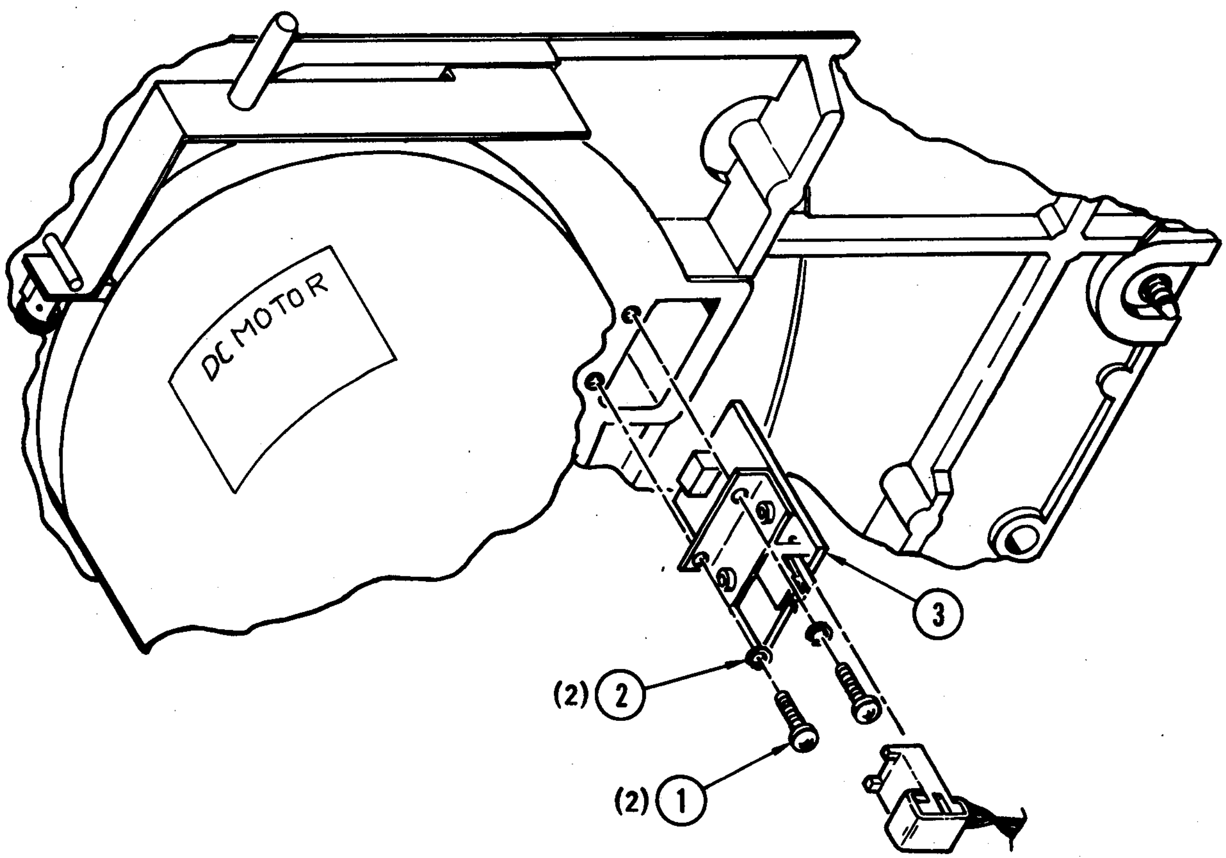


Figure 4-22. File-Protect Sensor

DRIVE MAIN PRINTED WIRING BOARD (PWB) ASSEMBLY (1, Figure 4-6).

4-37. **Removal and Replacement (Figure 4-23).** Place the drive in service access position (paragraph 4-3) and proceed as follows:

a. Remove power cord from outlet.

b. Remove screw (1), lockwasher (2), and flat washer (3) from front center of board.

c. Remove all connectors.

d. Lift front of board over lip on chassis, slide forward and remove I/O connectors.

e. Remove board from chassis.

f. Position replacement board and install I/O connectors.

g. Reconnect all connectors.

h. Secure board with screw (1), lockwasher (2), and flat washer (3).

i. Place transport in operating position.

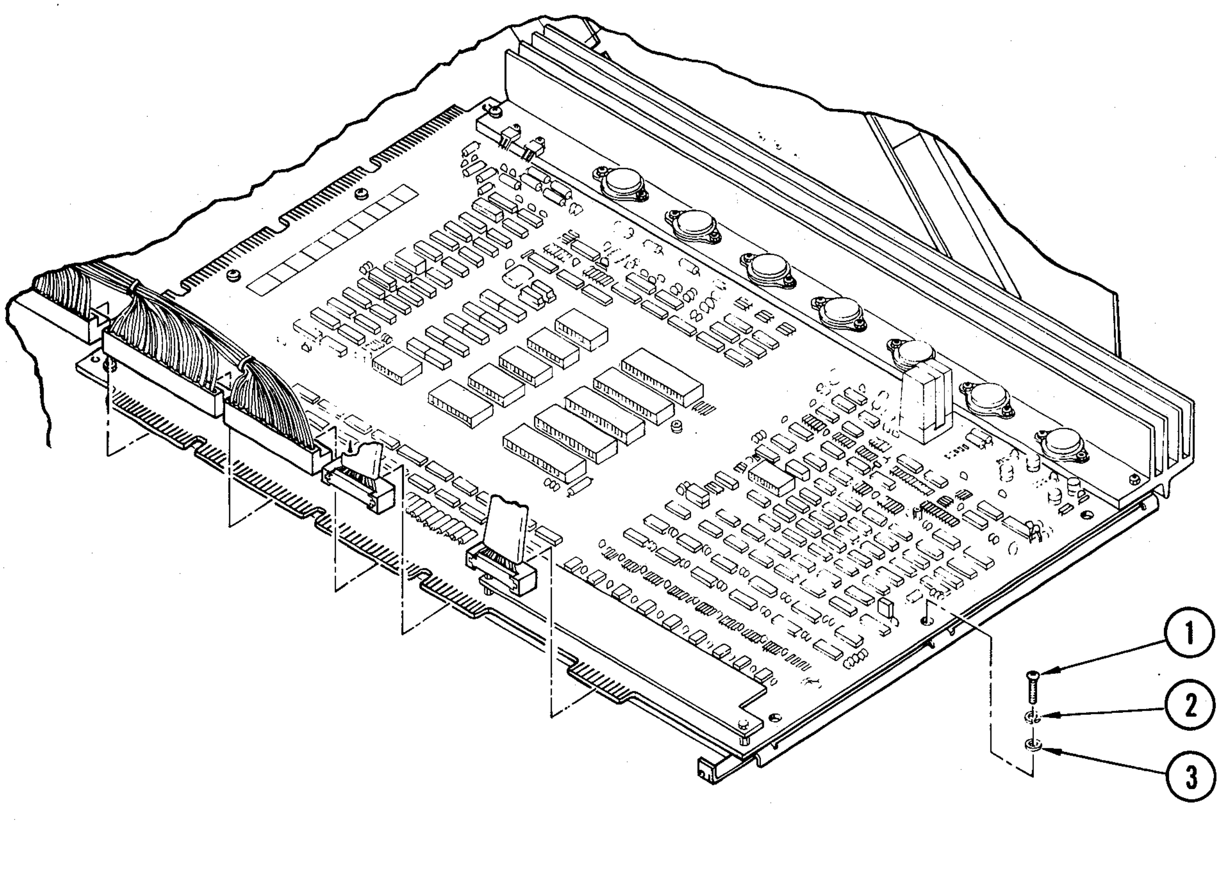


Figure 4-23. Drive Main Printed-Wiring Board

POWER SUPPLY ASSEMBLY (2, Figure 4-6).

4-38. **Removal and Replacement (Figure 4-24).** Place the drive in service access position (paragraph 4-3) and proceed as follows:

a. Turn power off and remove power cord from rear of power supply chassis.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

NOTE

Although not required, the following steps are simplified by removal of the top plate air duct (paragraph 4-41), front panel air duct (paragraph 4-42) and air intake tube (paragraph 4-43).

c. Remove screws (1, Figure 4-24), lockwashers (2), and flatwashers (3) securing power supply cover (4).

d. Remove wiring harness from clip cord (5) securing wiring harness to outside of power supply chassis, and disconnect wiring harness connector from power supply PWB.

e. Remove screws (6), lockwashers (7), and flatwashers (8) securing power supply chassis to top plate.

f. Remove screws (9), lockwashers (10), and flatwashers (11) securing chassis to rear bracket.

g. Disconnect air pump wires (13) and terminals from EMI filter (12) noting position from which removed.

h. If air pump assembly (15) is to be replaced, remove nuts (14), securing air pump to chassis.

i. Install replacement assembly in reverse order of removal ensuring transformer and power switch wire bundles are routed through the housing opening near the top plate.

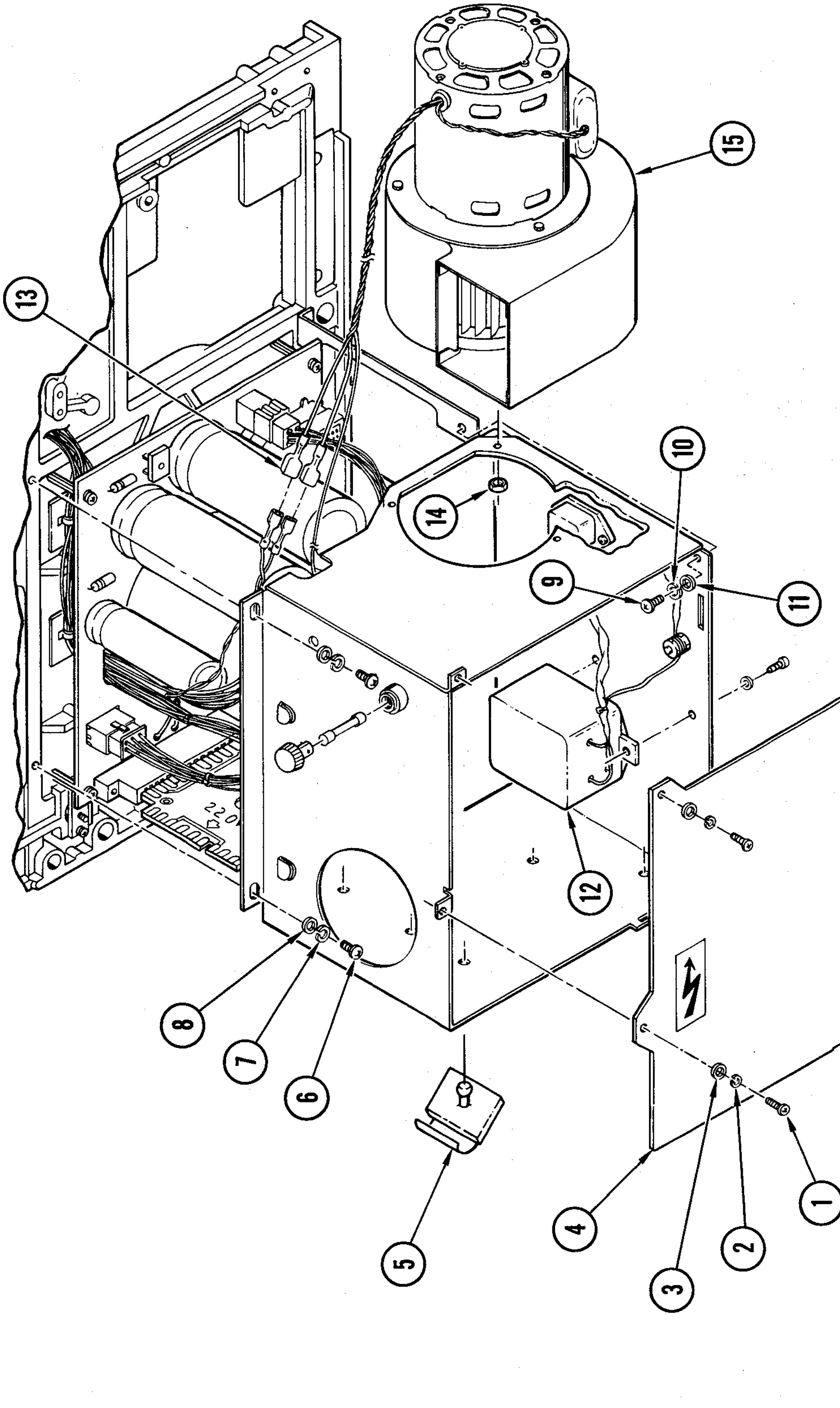


Figure 4-24. Power Supply Assembly

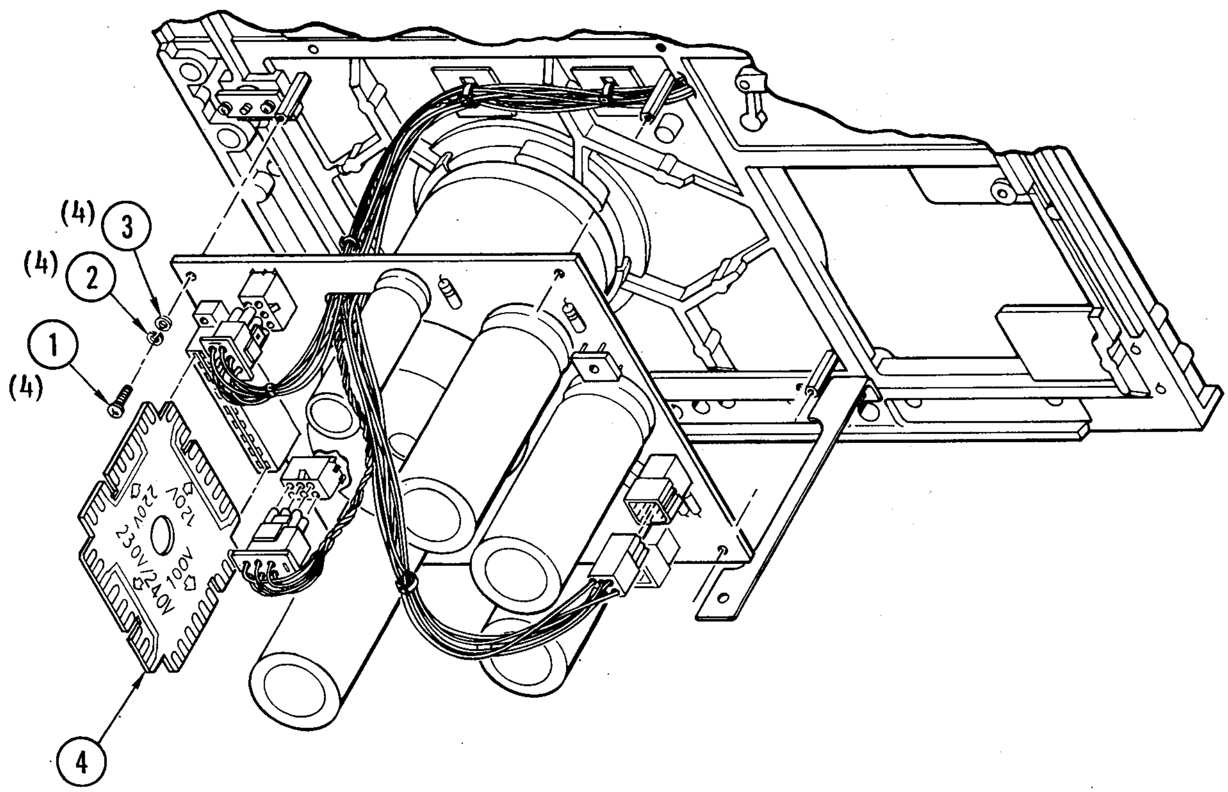


Figure 4-25. Power Supply PWB

POWER SUPPLY PWB (3, Figure 4-6).

4-39. **Removal and Replacement (Figure 4-25).** Place the drive in service access position (paragraph 4-3) and proceed as follows:

a. Remove power cord from outlet.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

c. Remove power supply assembly in accordance with instructions in paragraph 4-38.

d. Disconnect all wiring harness connectors from power supply PWB.

e. Remove screws (1), lockwashers (2), and flatwashers (3), and carefully lower power supply PWB while feeding cables through board opening. Remove voltage selection card (4).

f. Reconnect all connectors to replacement PWB and replace voltage selection card (4).

g. Hold PWB in place and secure with screws (1), lockwashers (2), and flatwasher (3).

h. Replace power supply chassis in reverse order of instructions in paragraph 4-38.

i. Place drive in operating position.

TAKEUP MOTOR ASSEMBLY (4, Figure 4-6).

4-40. **Removal, Replacement and Adjustment (Figure 4-26).** Place the transport in service access position (paragraph 4-3) and remove and replace the takeup motor assembly in accordance with the following procedure:

a. Remove power cord from outlet.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

c. Remove takeup hub in accordance with paragraph 4-29.

d. Remove power supply assembly cover in accordance with instructions in paragraph 4-38.

e. Disconnect motor wire terminals identifying as necessary for reinstallation.

f. Remove four screws (1, Figure 4-26), lockwashers (2), flatwashers (3), shoulder washers (4), and takeup motor (6) out of drive, noting orientation of motor. Save attaching parts, including insulator (5), for use in assembly.

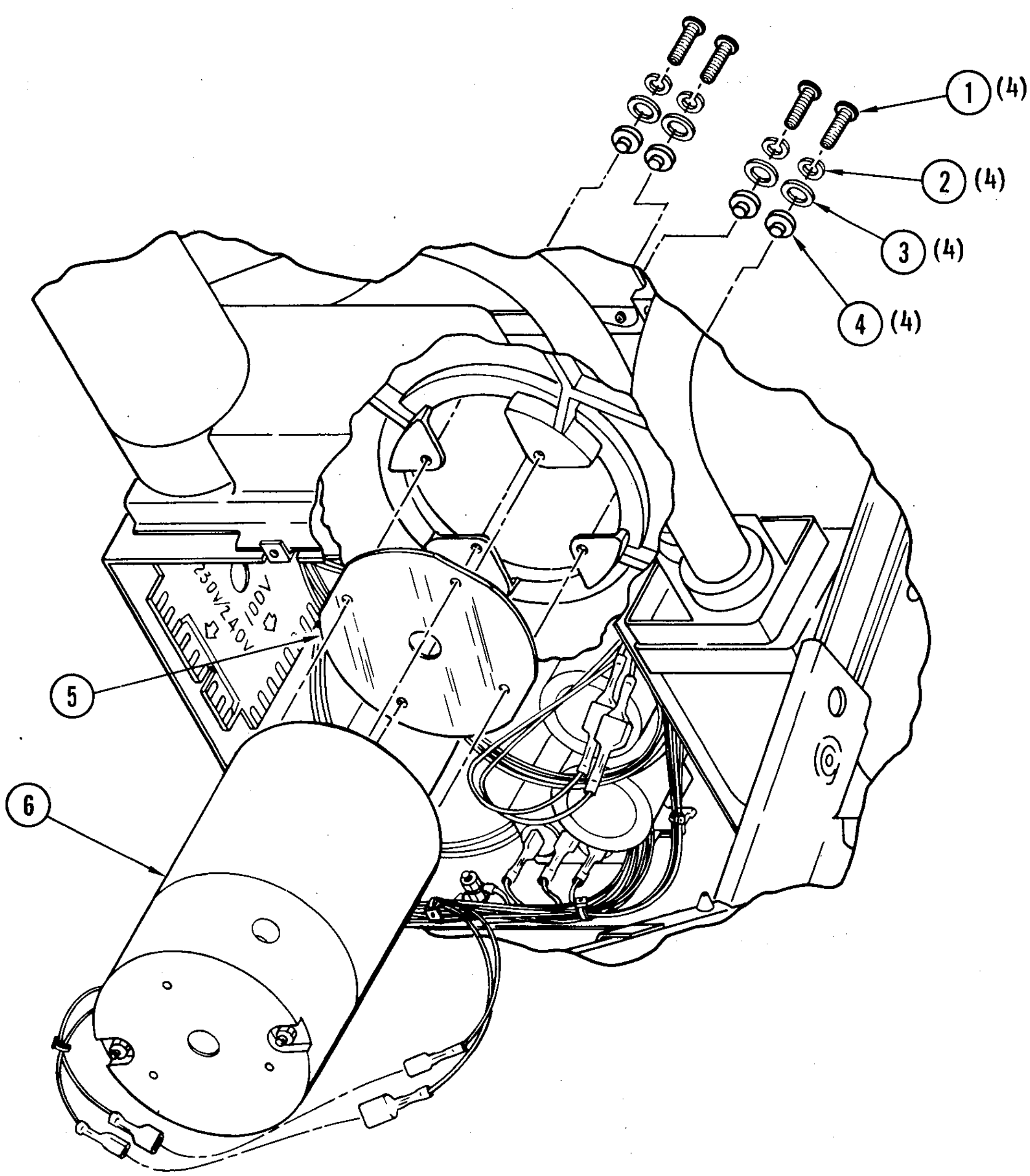


Figure 4-26. Takeup Motor Assembly

g. Install replacement motor in same orientation as motor removed in step f, in reverse order of steps e and f.

h. Reinstall power supply cover in accordance with instructions in paragraph 4-38.

i. Reinstall and adjust takeup hub in accordance with paragraph 4-29.

j. Reinstall main PWB in accordance with instructions in paragraph 4-37.

k. Use Service Aid 11 to test motor operation.

AIR DUCT, TOP PLATE (5, Figure 4-6), AIR DUCT, FRONT PANEL (6), TUBE, AIR INTAKE (7).

4-41. **Removal and Replacement (Figure 4-27).** Place the transport in service access position (paragraph 4-3). To replace the top-plate air duct, proceed as follows:

a. Remove head connectors J6/J7 from main PWB and cable retractor (5). At top-plate end of top-plate air duct (4), remove screw (1), lockwasher (2), and flatwasher (3).

b. Pull other end from blower adapter (6), and remove air duct.

c. Remove cable retractor (5) from old duct and secure with Ty-rap on replacement duct.

d. Install replacement duct by slipping flared end over blower adapter (6) and reinstalling screw, lockwasher and flat washer.

e. Place transport into operating position.

4-42. **Front Panel Air Duct (Figure 4-27).** Replace the front panel air duct as follows:

a. Note positions of power switch harness and safety pin retractor Ty-raps on duct and remove.

b. Remove front panel in accordance with instructions in paragraph 4-21, steps a, b, and c, but do not remove switch wire terminals and connectors.

c. Pull front panel just far enough away from transport to remove gooseneck end of front-panel air duct (7), noting position from which removed with reference to air deflector on front, right-hand edge of top plate.

d. Pull other end of duct off blower adapter (6).

e. To install replacement front-panel air duct (7), place flared end of duct on blower adapter.

f. Position gooseneck end of duct so that it opens into air deflector and holding end of duct in place, replace front-panel assembly, squeezing positioning block of front-panel over gooseneck, ensuring that air intake tube (8) is in place in front-panel adapter (9) and power supply.

g. Reinstall front panel assembly in accordance with paragraph 4-21, step f.

h. Fasten power switch wiring harness and safety pin retractor to duct with Ty-raps according to step a.

i. Place transport in operating position.

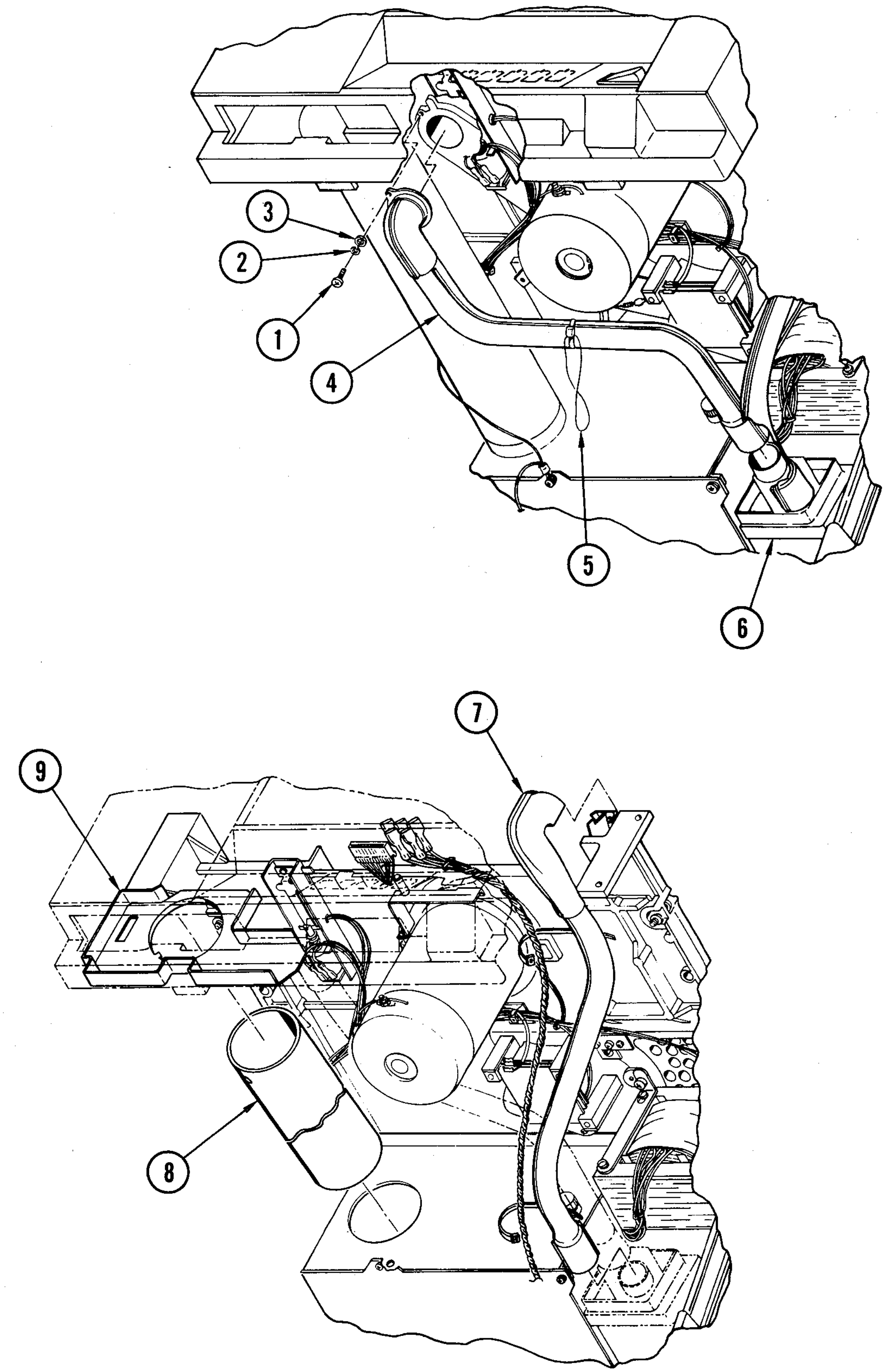


Figure 4-27. Top Plate Air Duct,
Front Panel Air Duct, Air Intake Tube

4-43. **Air Intake Tube. (Figure 4-27).** Replace the air intake tube as follows:

a. Remove the filter. Refer to paragraph 4-13.

b. Place unit in service access position.

c. Remove air intake tube (8) from power supply case by depressing tube slightly at hole (bottom of tube) to disengage tooth and slide forward into front panel adapter (9).

d. Remove front panel as in paragraph 4-42, but do not remove Ty-raps, etc.

e. Slide air intake tube out of front panel adapter.

f. Install replacement tube in reverse order of removal.

g. Place transport in operating position.

SUPPLY MOTOR ASSEMBLY (8, Figure 4-6).

4-44. **Removal and Replacement (Figure 4-28).** Place transport in service access position (paragraph 4-3) and remove and replace the supply motor assembly as follows:

a. Remove power cord from outlet.

b. Remove supply hub in accordance with paragraph 4-23.

c. Disconnect motor wire terminals from wire leads, identifying each as necessary for reinstallation.

d. Remove bell crank retaining ring (5, Figure 4-28).

e. Remove screw (1) lockwasher (2), flatwasher (3), shoulderwasher (4), and insulator (6), holding motor (7) as last screw is being removed.

f. Lower motor (7) from top plate, simultaneously slipping bellcrank off post on top of motor.

g. Install replacement motor with bellcrank post nearest bellcrank, slipping bellcrank onto post, in reverse order of removal.

h. Install retaining ring on bellcrank post (paragraph 4-45).

i. Connect motor wire terminals as identified in step c.

j. Reinstall and adjust supply hub in accordance with instructions in paragraph 4-23.

k. Use Service Aid 11 to test motor operation.

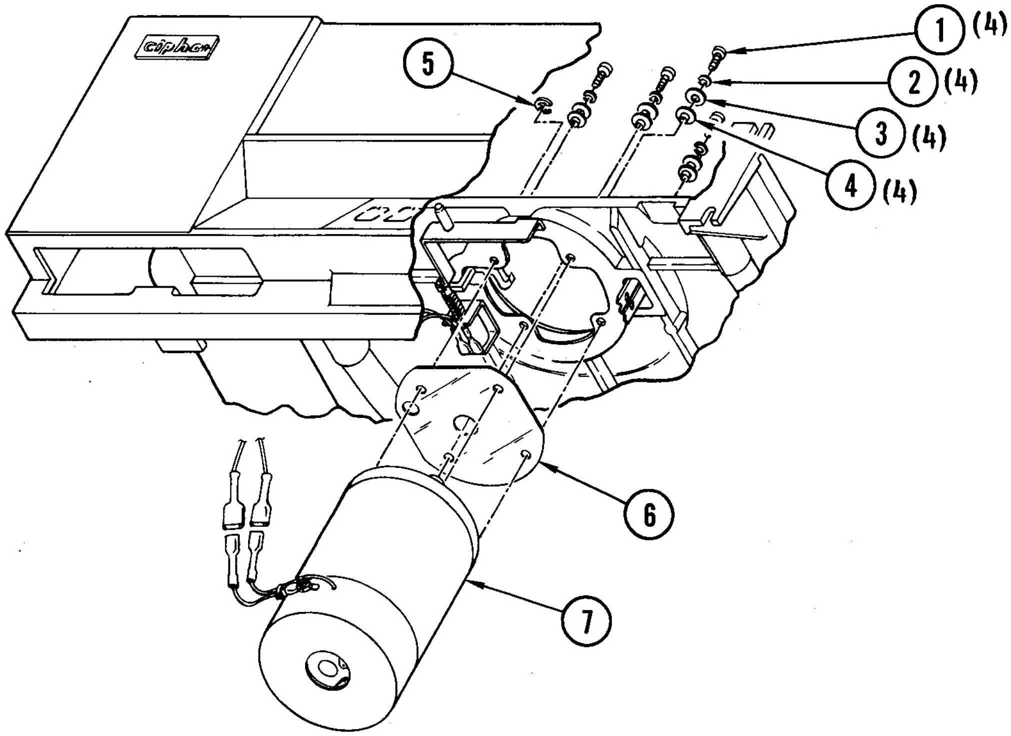


Figure 4-28. Supply Motor Assembly

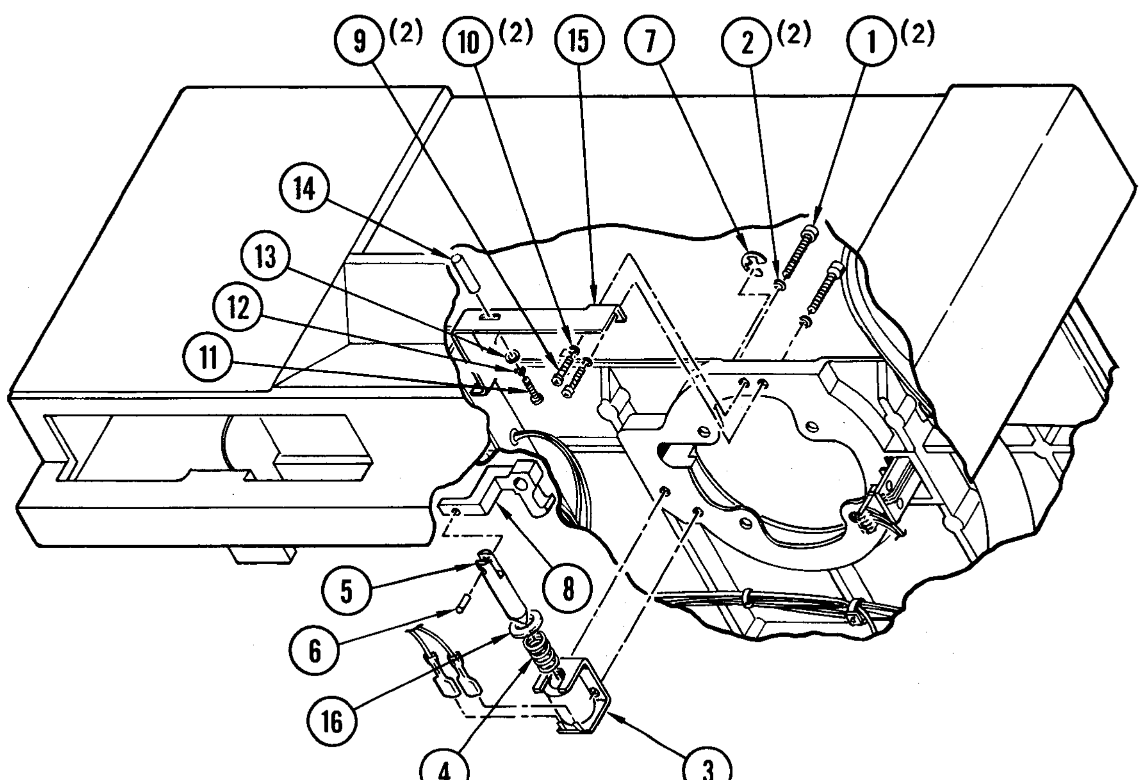


Figure 4-29. Hub Lock Assembly

HUB LOCK ASSEMBLY (10, Figure 4-6).

4-45. **Disassembly, Removal and Replacement (Figure 4-29).** To disassemble hub lock assembly and remove parts from top plate and supply motor, proceed as follows:

a. Remove power cord from outlet.

b. Place transport in service access position (paragraph 4-3).

c. Remove wire terminals from solenoid (3, Figure 4-29) and identify for reassembly.

d. Remove two screws (1), and lockwashers (2), and remove solenoid (3) from top plate and spring (4) and washer (16) from solenoid plunger (5).

e. If plunger (5) or bellcrank (8) must be replaced, remove supply motor in accordance with instructions in paragraph 4-44. Remove retaining ring (7) and bellcrank (8) from motor, and press out pin (6), releasing plunger (5).

4-46. **Reassembly and Installation.** Replace defective parts, and reassemble and install the hub lock assembly as follows:

a. Install bellcrank (8) on supply motor with retaining ring (7). Reinstall motor on top plate in accordance with instructions in paragraph 4-44.

b. Complete reassembly and reinstall solenoid (3) on top plate in reverse sequence of steps c and d, paragraph 4-45.

c. Place transport in operating position.

d. Use Service Aid 32 to test hub lock assembly operation.

4-47. **Manual Unlock Assembly (Hub Lock) (Figure 4-29).** To replace the manual unlock assembly or one of its parts, proceed as follows:

a. Place transport in service access position (paragraph 4-3).

b. Remove manual unlock assembly from top plate by removing two screws (9, Figure 4-29) and lockwashers (10).

c. Remove pin (14) from bracket (15) by removing screw (11), lockwasher (12), and flatwasher (13).

d. Reassemble and reinstall in reverse order of steps b and c.

e. Ensure that the hub lock solenoid spring will return the manual unlock assembly fully against the stop pin. Reposition the manual unlock assembly if required.

f. Place transport in operating position.

DOOR LOCK ASSEMBLY (11, Figure 4-6).

4-48. **Removal and Disassembly (Figure 4-30).** Place the transport in service access position (paragraph 4-3). Remove the door lock assembly from the top plate and disassemble as necessary to replace defective parts as follows:

a. Remove power cord from outlet.

b. Remove wire terminals from solenoid noting positions for reassembly.

c. Remove door lock assembly from top plate by removing two screws (1, Figure 4-30) and lockwashers (2).

d. Remove slip-on connectors from microswitch noting positions for reassembly and feed through grommet.

e. Remove two screws (3), and lockwashers (4), and remove solenoid (5) from assembly. Remove spring (6) and spacer (7).

f. Remove switch (13), by removing two nuts (8), lockwashers (9), flat washers (10), screws (11) and flat washers (12). Switch may then be removed by sliding out solenoid end of bracket.

g. No further disassembly is recommended.

h. Replace defective parts, and reassemble door lock assembly in reverse sequence of disassembly, steps c and d.

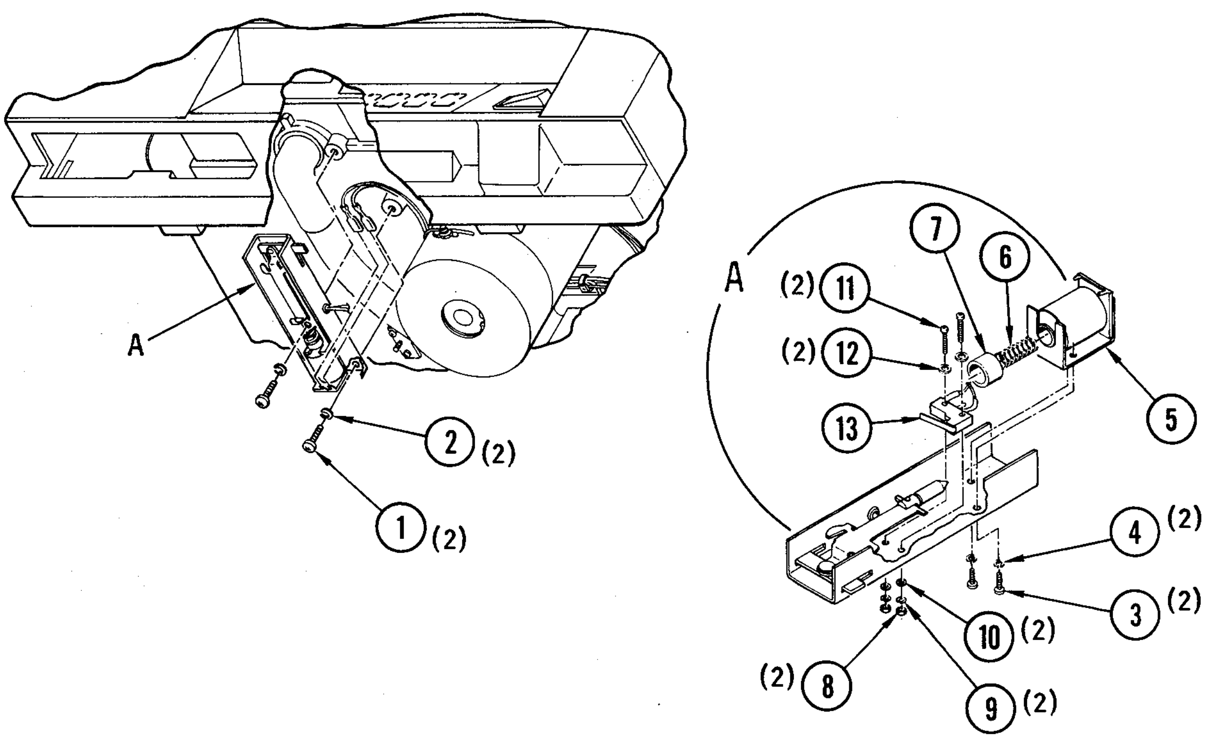


Figure 4-30. Door Lock Assembly

i. Install door lock assembly on top plate with attaching parts removed in step b. Do not tighten screws.

j. Adjust position of door lock assembly as follows:

(1) Close top cover of transport. Position door lock assembly so that the plate is approximately 1/8-inch in front of latching arm of cover lock tab (6, Figure 4-14), and tighten screws.

(2) Applying very light pressure, attempt to close transport door. If door will not close completely, loosen screws (1), push door lock assembly forward until door will close, and retighten screws (1).

(3) Place drive in operating position and connect to power source.

(4) Actuate POWER switch and LOAD touch switch. If only LOAD and POWER indicators illuminate, door lock assembly is properly positioned and adjustment is complete.

(5) If all indicators except ON-LINE are flashing upon excecution of step (4), place drive in service access position, loosen screws (1), and pull door lock assembly slightly toward rear of unit.

(6) Repeat steps (3), (4), and (5) until both top cover and door open with POWER switch off and only LOAD and POWER indicators illuminate when these switches are actuated.

k. Place transport in operating position.

TRANSFORMER ASSEMBLY (12, Figure 4-6).

4-49. **Removal and Replacement (Figure 4-31).** To replace the transformer assembly, place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Remove power cord from outlet.

b. Remove drive main PWB from transport (paragraph 4-37).

c. Remove power supply assembly and power supply PWB in accordance with paragraphs 4-38 and 4-39.

d. Unplug primary and secondary transfomer connectors from power supply PWB, and cut all Ty-raps securing transformer wire bundles to power supply components and other parts of drive, noting position of Ty-raps before removing.

e. Support transformer (4, Figure 4-31) and remove four screws four (1), four lockwashers (2), and four flatwashers (3), and remove from drive.

f. Install replacement transformer in reverse sequence of step e.

g. Replace Ty-raps removed in step c.

h. Reinstall power supply PWB in accordance with paragraph 4-39, ensuring that transformer wire bundles are properly secured with Ty-raps.

i. Plug in transformer primary and secondary connectors to power supply.

j. Reinstall power supply assembly in accordance with paragraph 4-38, and reinstall drive main PWB in accordance with paragraph 4-37.

k. Place drive in operating position.

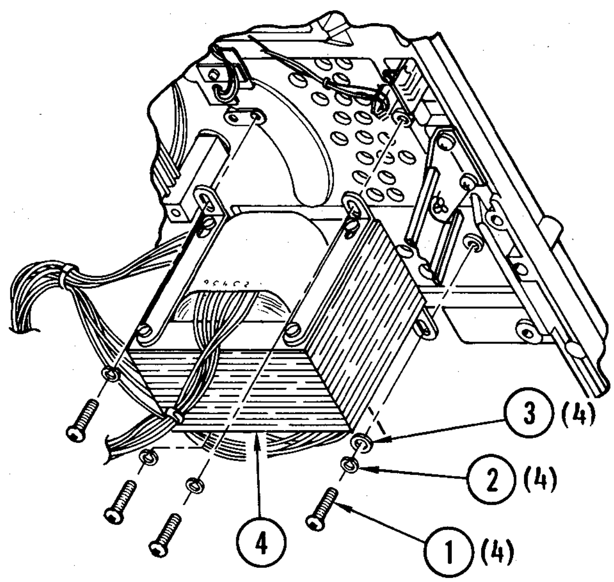


Figure 4-31. Transformer Assembly

TAPE ALIGNMENT

4-50. All tape guides must be checked for proper tape path alignment following replacement of any part in the tape path. Proceed as follows:

a. Actuate power switch to ON.

b. Insert and load a new tape.

NOTE

A used tape may have damaged or weak edges which would adversely affect its tape-path tracking characteristics.

c. Use Service Aid 33 to disable door and top cover lock. Place drive in operator maintenance access position.

d. Ensure that supply reel is properly seated on supply hub.

e. Referring to paragraph 3-33, operate drive in Service Aid 23.

f. If tape is not centered between sides of reel, unload tape and adjust hub height as necessary.

g. Observe position of tape on roller guide (2, Figure 4-32).

h. If tape is not centered on guide, turn power switch to OFF, and remove guide (2) from compliance arm in accordance with paragraph 4-30 step i and Figure 4-17.

i. Add or reduce thickness of shims (19) as required to compensate for off-center position of tape and reinstall guide on compliance arm. Repeat as necessary to obtain correct centering of tape on guide (2).

j. Run tape forward and check for edge curl on guide (3). If curl is present on lower washer, turn power switch to OFF and increase shims under roller guide (1). If curl is present on upper washer of guides (3), decrease shim thickness under roller guide (1). Resume forward tape motion and recheck tape position. Repeat this step until tape tracks smoothly around guide (3).

k. Depress lower washer on guide (3) and check for optimum movement of tape away from top washer of 0.005 inch. If necessary, reshim guide (2) to maintain proper tape centering.

l. Run tape in forward direction and check for edge curl on guide (4). If curl is present, turn transport power to OFF and add or remove shims on guide (5). Do not alter guide (5) more than ±0.005 inch from factory setting.

NOTE

> Curl on guide (4) can be caused by improper alignment on any other guide in the tape path. If tracking has been verified on guide (3), tape curl on guide (4) is probably caused by misalignment of guide (5). Normally, improper alignment of guides (1) and (2) will show up as tracking problems on guide (3).

m. Run tape in reverse direction (Service Aid 23) and check for tape curl on all edges.

n. Depress lower washer on guides (3), (4), and (5) and check for optimum tape movement, away from top washer, of 0.005 inch.

o. Add or delete shims on guides (1), (2) and (5) as required to eliminate edge curl on all rollers and reverify forward tape path alignment by checking for maximum tape shift on guide (2) of ±0.015 inch.

p. Check head azimuth and read skew. Refer to paragraph 4-51.

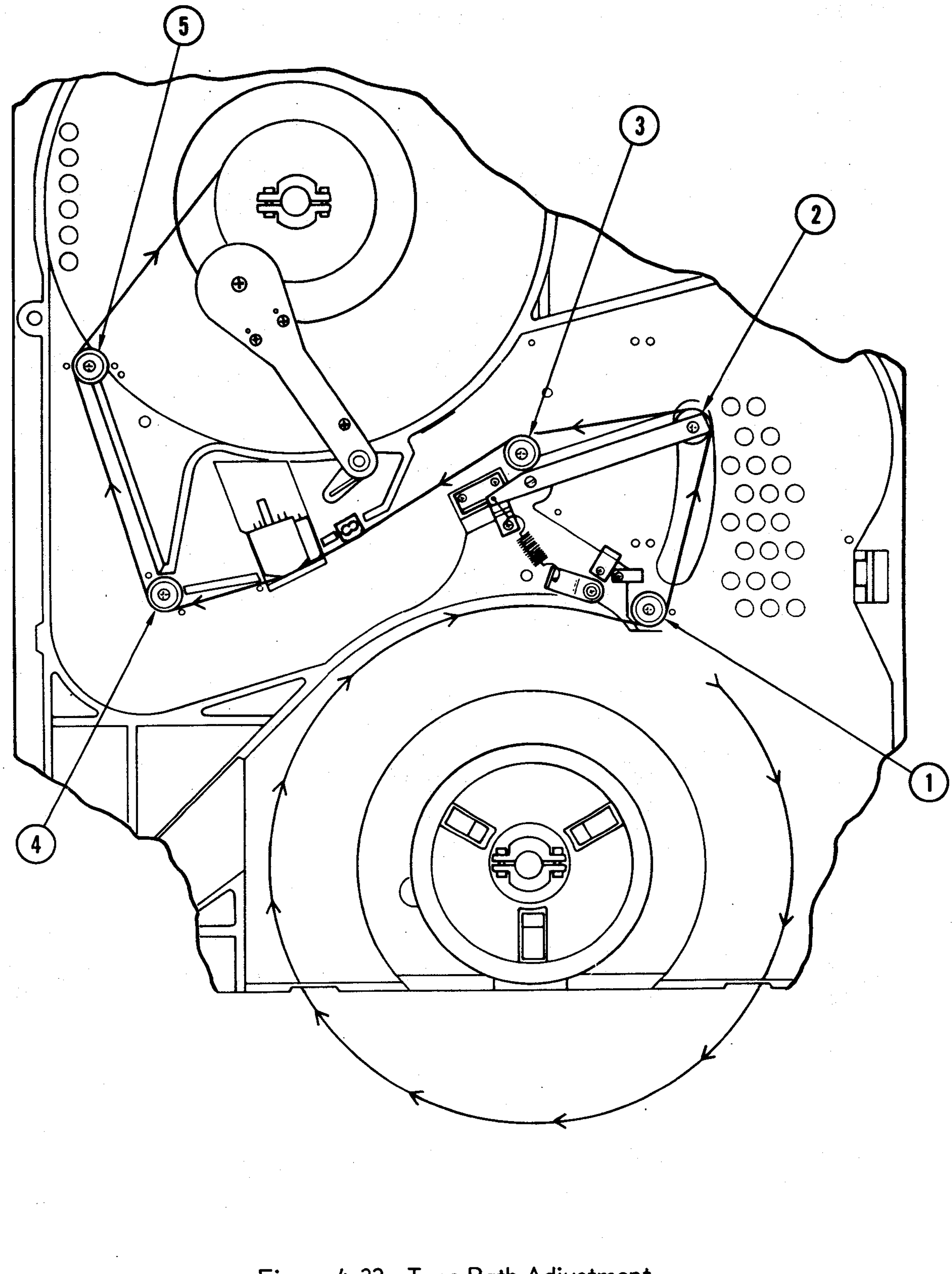


Figure 4-32. Tape Path Adjustment

4-51. **Head Azimuth Adjustment.** Adjust head azimuth as follows:

a. Place drive in service access position.

b. Turn transport power off and attach skew monitor, Cipher Part No. 960067-001 to U14A, U14D, and U14G.

(1) A skew monitor may be constructed using three 14-pin IC clips and nine 47K ohm resistors.

(2) Attach one end of a resistor to pins 9, 11, and 13 on each IC clip.

(3) Connect the other end of all nine resistors together to form a summing junction.

c. Actuate transport power switch to ON and load master skew tape, Cipher Part No. 799019-401.

d. Connect oscilloscope to test point on skew monitor and ground test point.

e. Loosen center adjustment screw (1, Figure 4-10).

f. Referring to paragraph 3-33, operate drive in Service Aid 23.

g. Adjust azimuth screw (1, Figure 4-10) so that outputs of all tracks, as monitored at test point on skew monitor, fall within 24% or less of the byte-to-byte period. (See Figure 4-33)

h. Run tape in reverse direction, using Service Aid 23, and verify reverse skew is within 24% or less of the byte-to-byte period.

i. Alternate tape direction between forward and reverse and optimize skew adjustment by minimizing width of skew pulse.

j. Apply torque seal, Cipher Part No. 209994-025, to head of adjustment screw.

k. Remove skew tape from transport and load a Pericomp tracking tape, available from Pericomp Corporation, Natick, Massachusetts 01760.

l. Connect oscilloscope to TP10 and ground.

m. Run tape in forward direction (Service Aid 23) and compare P1 and P2 on oscilloscope trace. See Figure 4-34.

n. Calculate difference in amplitude (positive peak) between P1 and P2 and refer to Table 4-3 for conversion of volts to inches. If P1 is greater than P2, subtract calculated figure from 0.007 inch. If P2 is greater than P1, add figure to 0.007 inch. Reference edge must be 0.007 ± 0.003 inch.

o. Remove skew monitor and place drive in normal operating position.

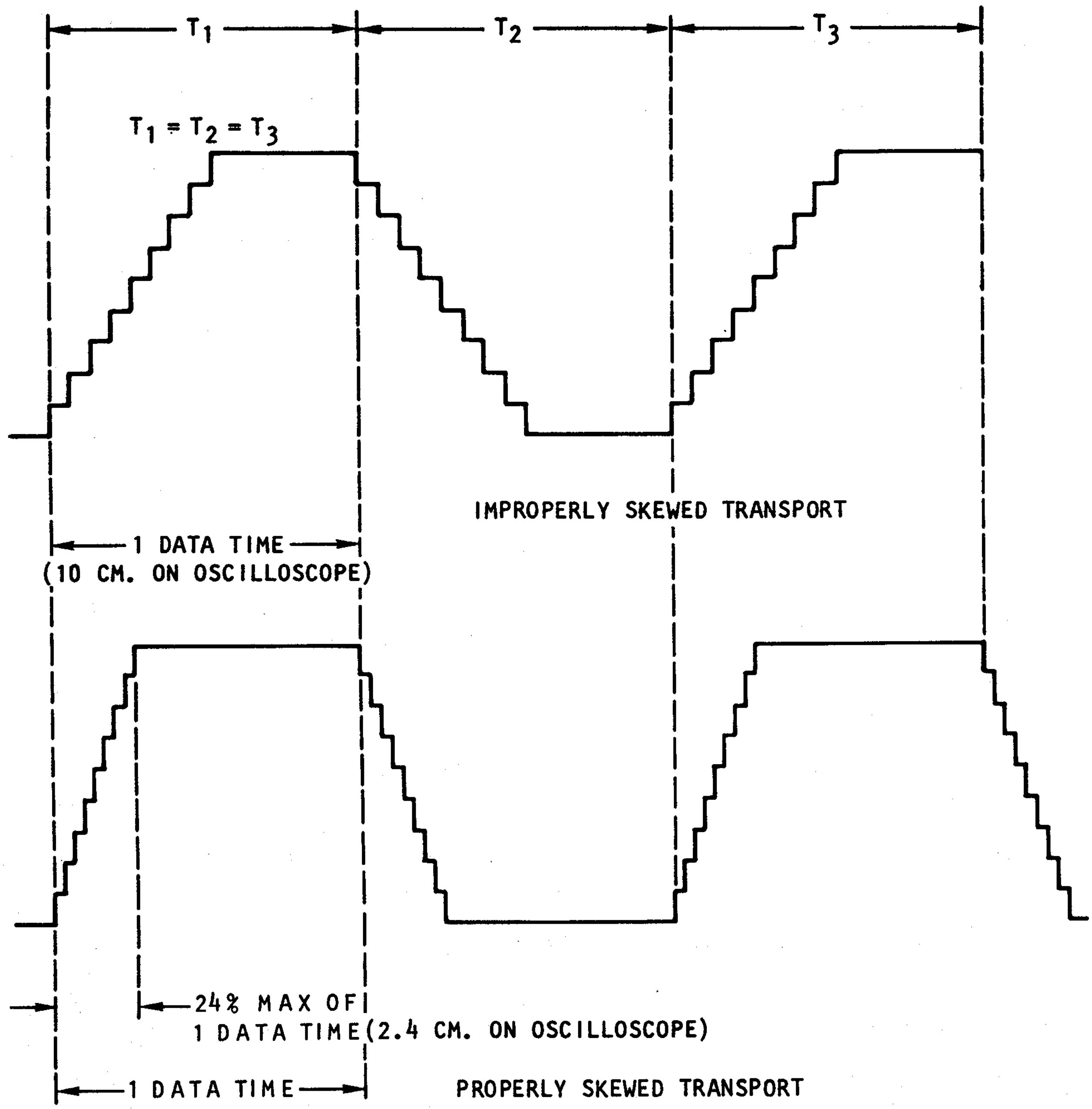


Figure 4-33. Skew Adjustment Waveform

VOLTS	INCHES
0.000 TO 0.024	0.000
0.025 TO 0.049	0.001
0.050 TO 0.074	0.002
0.075 TO 0.100	0.003

Table 4-3. Reference Edge Distance

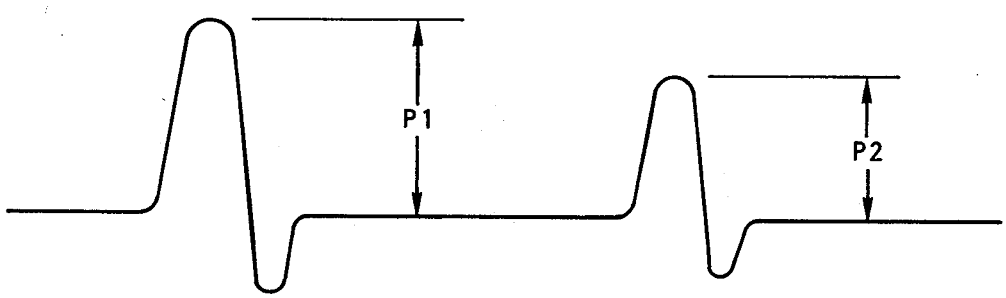


Figure 4-34. Reference Edge Measurement Waveform (TP10)
Using Pericomp Tracking Tape

ABBREVIATION	DEFINITION
ID	inner diameter
in.	inch (or inches)
kV	kilovolt
lg	long
meg	megohm
No. or Nos.	number or numbers
NPN	negative-positive-negative (transistors)
OD	outer diameter
	ohm
PNP	positive-negative-positive (transistors)
pF	picofarad
R	resistor
subs	subsequent
thk	thick
uF	microfarad
v	volt (or voltage)
VDC	volts direct current
VAC	volts alternating current
W	Watt
w/	with
x	by (or names)

EXPLANATION OF THE PARTS LIST

5-5. **FIG. & INDEX NO. Column.** Illustrations are numbered sequentially. The item numbers on each illustration are keyed to the same number appearing in the parts list. If a part number is shown for an item, but no index number is shown, the assembly is immediately broken out below the part number and each item in the assembly is given its own index number. If parts are interchangeable, only one index number will be assigned to the item.

5-6. **PART NUMBER Column.** The number that appears in this column will be the Cipher Data part number. In the case of an electronic component (capacitor, resistor, transistor, etc.), its location in an illustration is determined by the grid system, e.g., transistor U11F will be found by reading down the sides of the illustration to row number 11, then across the top of the illustration from right to left until the letter F row is reached. Each electronic component assigned a circuit symbol (i.e., reference designation) will have that designation listed in the Figure & Index No. in alphanumeric sequence. Where the sequence is broken due to the removal, revision, or change of a component, the notation "NOT USED" will appear in the DESCRIPTION column opposite the designation that has been removed.

5-7. **DESCRIPTION Column.** Descriptive data as to type, size, color, etc. is provided to fully identify the part when ordering or replacing. Blueprint titles are normally given first, with the basic noun name in capital letters, followed by additional descriptive terms. Acceptable abbreviations are contained in the abbreviation table above.

5-8. **QTY Column.** This column indicates the quantity of each part required for the assembly or subassembly. This quantity is not necessarily the total quantity used for the complete assembly.

NOTE

The same parts may be used in various subassemblies; or in the case of multiple components with attaching hardware, only the quantity of hardware used to attach one item is given.

5-9. **USABLE ON CODE Column.** This column lists the code letter assigned to the current models of the CacheTape Unit for identification purposes.

CODE	MODEL
A	Model M890 (1600 bpi)
B	Model M890 (3200 bpi)
C	Model M891 (1600 bpi)
D	Model M891 (3200 bpi)

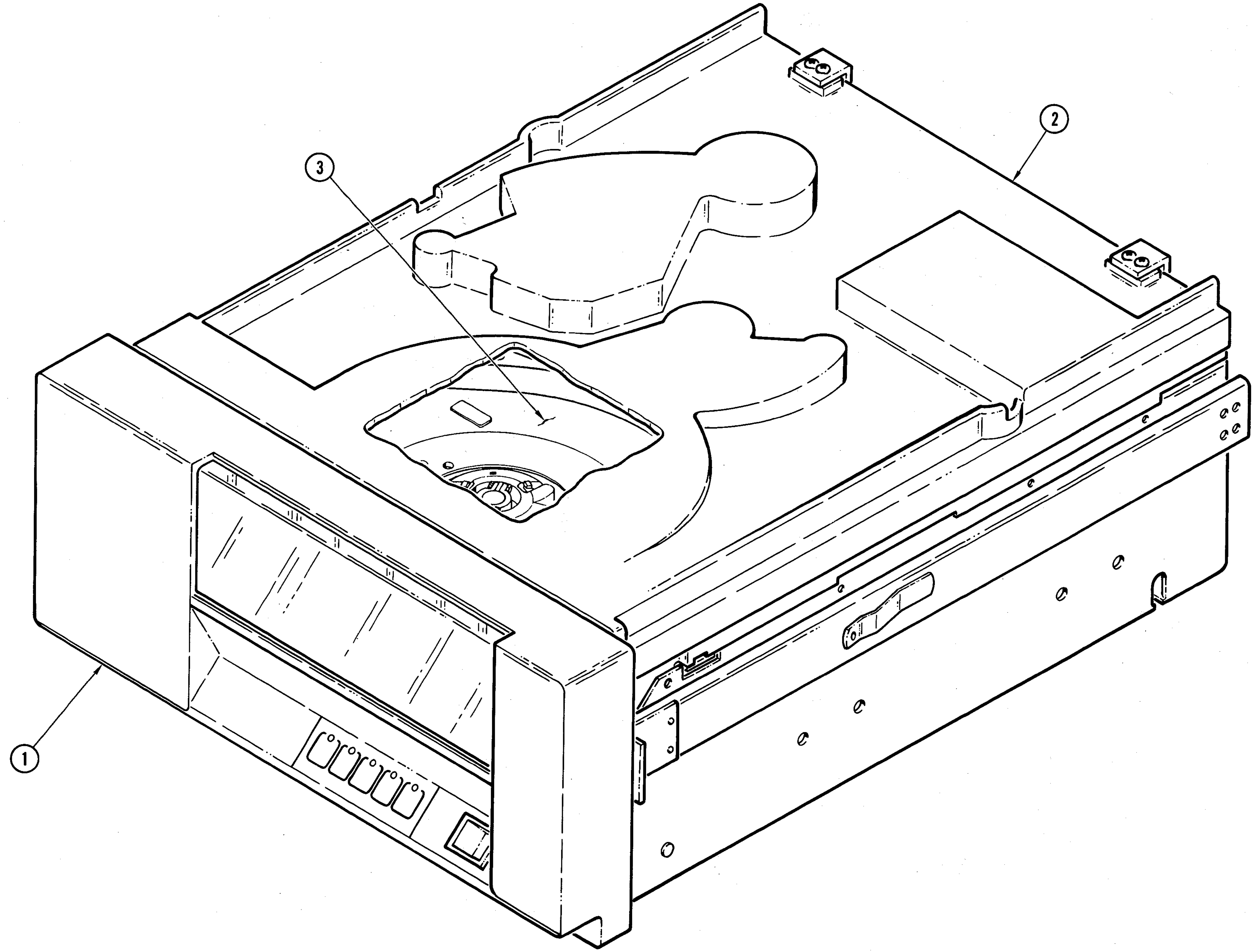


Figure 5-1. CacheTape Unit (Assembled View)

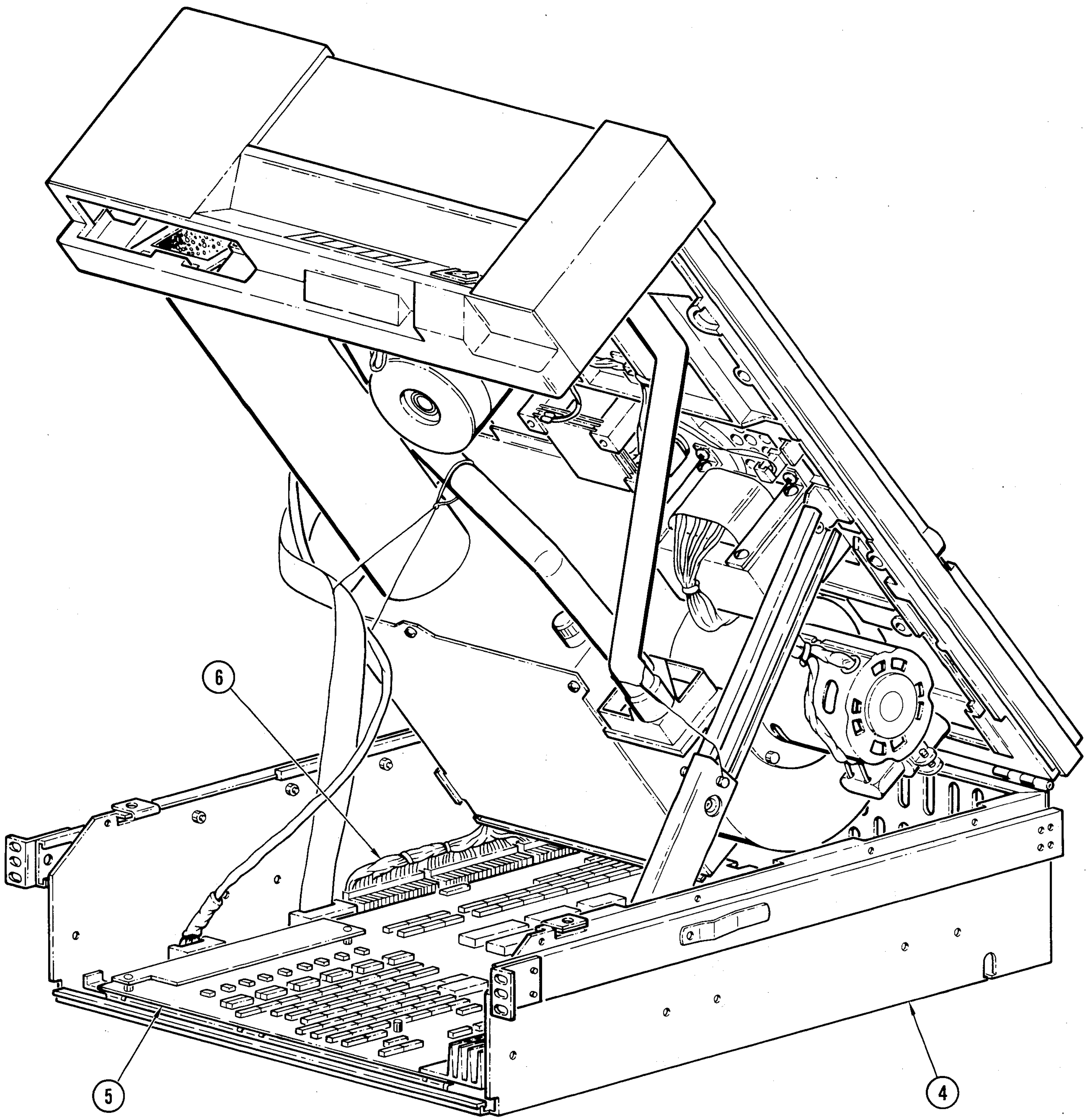


Figure 5-1. CacheTape Unit (Assembled View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-1	960652-003 960654-003 960666-003 960668-003	MAGNETIC TAPE TRANSPORT, ... (Assembled View) (See Figure 5-2)	REF	A B C D
-1	960359-001	. FRONT PANEL ASSEMBLY (Exploded View) ..... (See Figure 5-3)	1	
-2	960057-001	. TOP COVER ASSEMBLY (Exploded View)........ (See Figure 5-4)	1	
-3	960567-001	. BASIC DRIVE ASSEMBLY (Exploded View)....... (See Figure 5-5)	1	
-4	960566-001	. CHASSIS ASSEMBLY (Exploded View)........... (See Figure 5-6)	1	
-5	961019-002 961018-002 961020-002 961017-002	. PRINTED WIRING BOARD ASSEMBLY, ... (Exploded View) (See Figure 5-7)	1 1 1 1	A B C D
-6	960629-001	. HARNESS ASSEMBLY (Exploded View).......... (See Figure 5-8)	1	

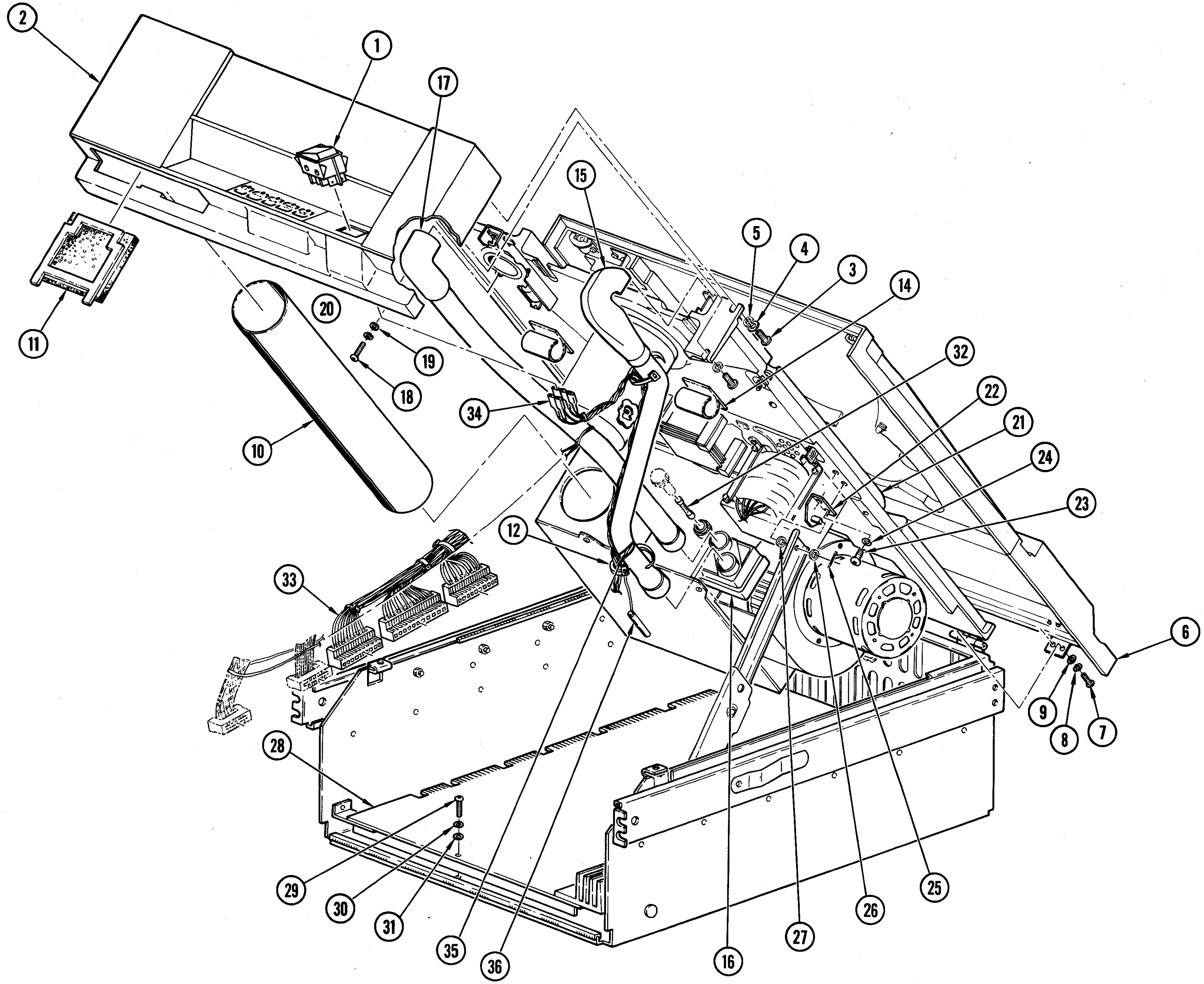


Figure 5-2. CacheTape Unit (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-2				
-11	960027-001	. FILTER, Air	1	
-12	210229-516	. TY-RAP, 8 in	2	
-13		. NOT USED		
-14	970457-001	. CABLE CLAMP, adhesive backed	3	
-15	760107-508	. DUCT, Air, front panel	1	
-16	760101-609	. NOZZLE, Blower	1	
-17	160109-478	. DUCT, Air, top plate	1	
		(ATTACHING PARTS)		
-18	213271-805	. SCREW, Pan head, phillips, 8-32 x 5/16 in. lg, cadmium black, zinc	1	
-19	207801-021	. WASHER, Flat, No. 8	1	
-20	207802-011	. WASHER, Split lock, No. 8	1	
-21	960567-001	. BASIC DRIVE ASSEMBLY (See Figure 5-5 for breakdown)	1	
-22	760101-660	. BRACKET, Support, top plate assembly	1	
		(ATTACHING PARTS)		
-23	213271-106	. SCREW	2	
-24	207102-011	. WASHER, Split lock, No. 10	2	
-25	205042-509	. PIN, Cotter, 1/16 x 1/2 in. lg	1	
-26	207104-021	. WASHER, Flat, No. 10	1	
-27	961084-001	. SPACER	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-2				
-28	961019-002 961018-002 961020-002 961017-002	. PRINTED WIRING BOARD ASSEMBLY, Drive/Formatter (See Figure 5-6 for breakdown)	1 1 1 1	A B C D
		(ATTACHING PARTS)		
-29	213274-606	. SCREW, Pan head, phillips, 6-32 x 3/8 in. lg	1	
-30	207602-011	. WASHER, Split lock, No. 6	1	
-31	207605-021	. WASHER, Flat, No. 6	1	
		--- * ---		
-32	211151-330	. FUSE, 3AG. slo-blo, 3 amp	1	A
-33	960629-001	. HARNESS ASSEMBLY (See Figure 5-7 for breakdown)	1	
-34	160105-453	. HARNESS ASSEMBLY, Power switch	1	
-35	970134-001	. LANYARD, Elastic	1	
-36	760105-519	. PIN, Safety	1	

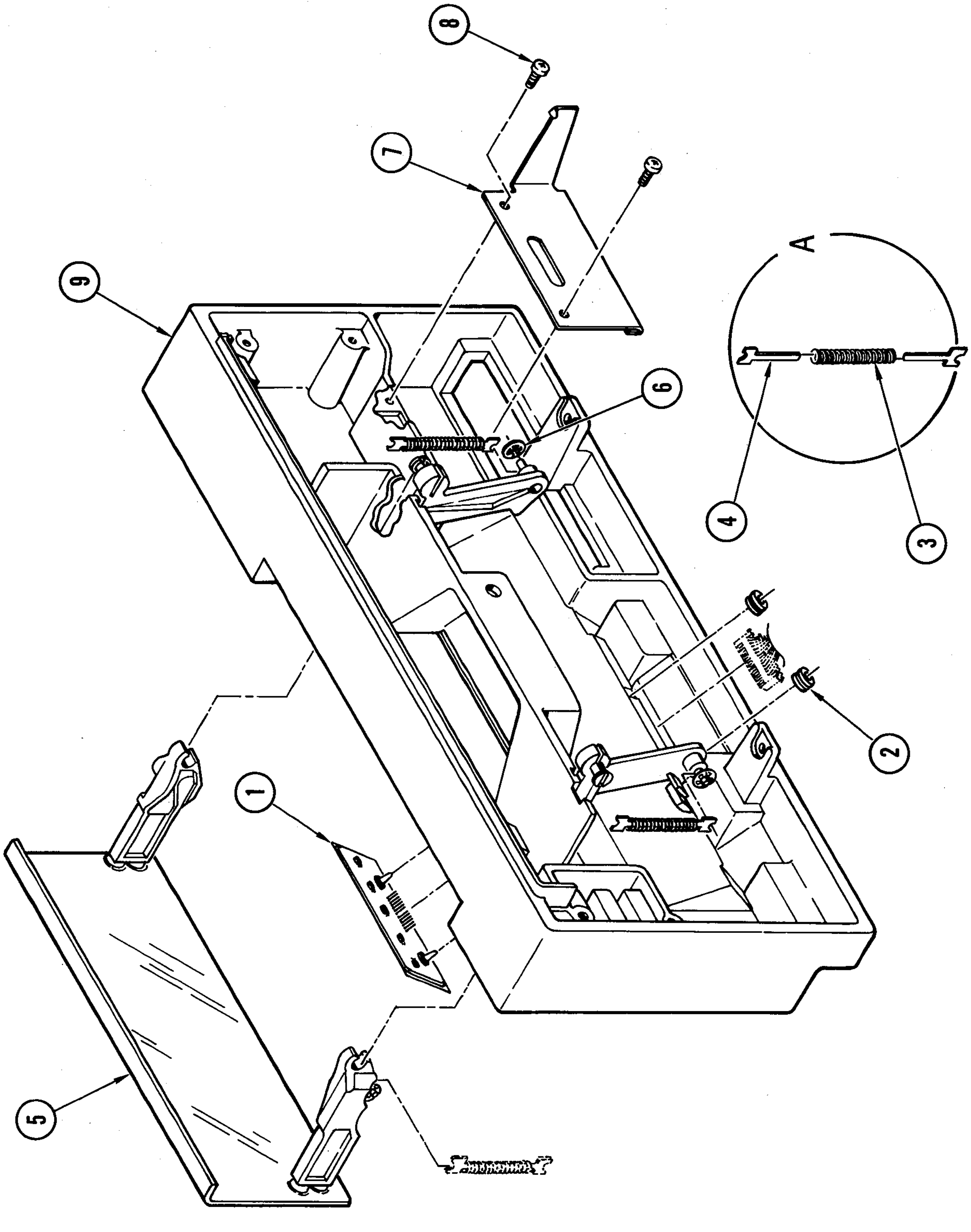


Figure 5-3. Front Panel Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-3	960359-001	FRONT PANEL ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	760102-595	. TOUCH SWITCH, Tactile response..............	1	
-2	210200-016	. RING, Retaining, push-on	2	
-3	210001-013	. SPRING, Compression, 5-lb	2	
-4	760101-591	. GUIDE, Spring	4	
-5	160101-451	. DOOR ASSEMBLY	1	
-6	210200-016	. RING, Retaining, push-on	2	
-7	760101-531	. LATCH, Rack	1	
		(ATTACHING PARTS)		
-8	970263-606	. SCREW, Pan head, phillips, ... 6-32 x 3/8 in. lg., cadmium plated, black, zinc	2	
		-- -- -- * -- -- --		
-9	760102-662	. FRONT PANEL, Painted	1	

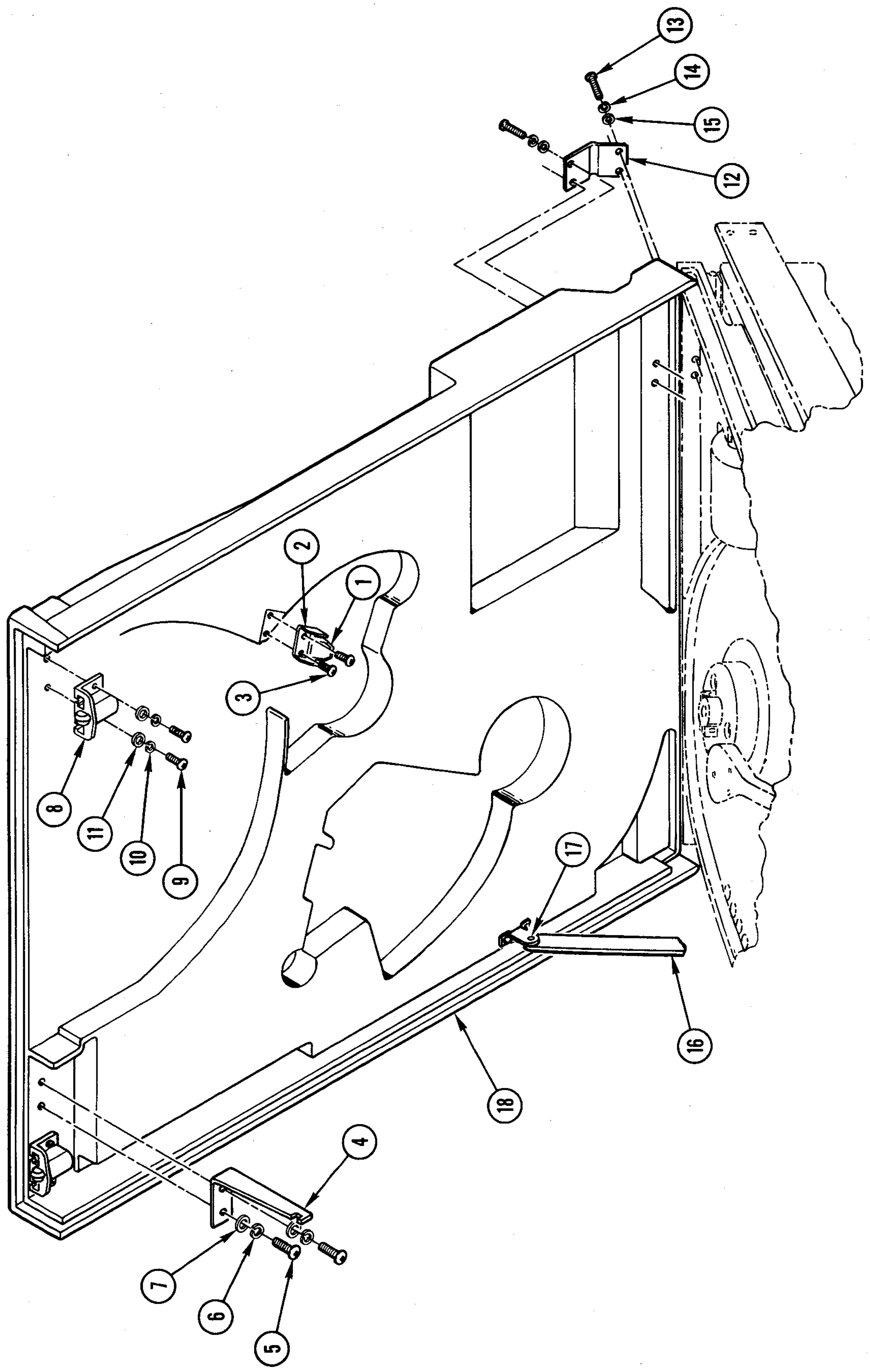


Figure 5-4. Top Cover Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-4	960057-001	TOP COVER ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	760101-825	. DEFLECTOR TAPE, diecast	1	
-2	760102-585	. BRACKET, Tape deflector	1	
		(ATTACHING PARTS)		
-3	213271-404	. SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg	2	
		-- -- -- * -- -- --		
-4	760101-580	. . TAB, Cover lock	1	
		(ATTACHING PARTS)		
-5	213271-604	. . SCREW, Pan head, phillips................... 6-32 x 1/4 in. lg, cadmium, black, zinc	2	
-6	207602-011	. . WASHER, Split lock, No. 6	2	
-7	207608-021	. . WASHER, Flat, No. 6	1	
		-- -- -- * -- -- --		
-8	210104-911	. . CATCH, Roller	2	
		(ATTACHING PARTS)		
-9	213271-406	. . SCREW, Pan head, phillips................... 4-40 x 3/8 in. lg, cadmium, black, zinc	4	
-10	207403-011	. . WASHER, Split lock, No. 4	4	
-11	207402-021	. . WASHER, Flat, No. 4	4	
		-- -- -- * -- -- --		
-12	760103-507	. HINGE, Rear, molded	2	
		(ATTACHING PARTS)		
-13	213274-605	. SCREW, Pan head, phillips..................... 6-32 x 5/16 in. lg	4	
-14	207602-011	. WASHER, Split lock, No. 6	4	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-4				
-15	207608-021	. WASHER, Flat, small OD, No. 6	4	
		--- --- --- * --- --- ---		
-16	960052-001	. . LID STAY, Relieved	1	
		(ATTACHING PARTS)		
-17	205003-005	. . PIN, Groove, 0.1875 x 0.625 in. lg	1	
		--- --- --- * --- --- ---		
-18	760104-502	. . TOP COVER..............................	1	

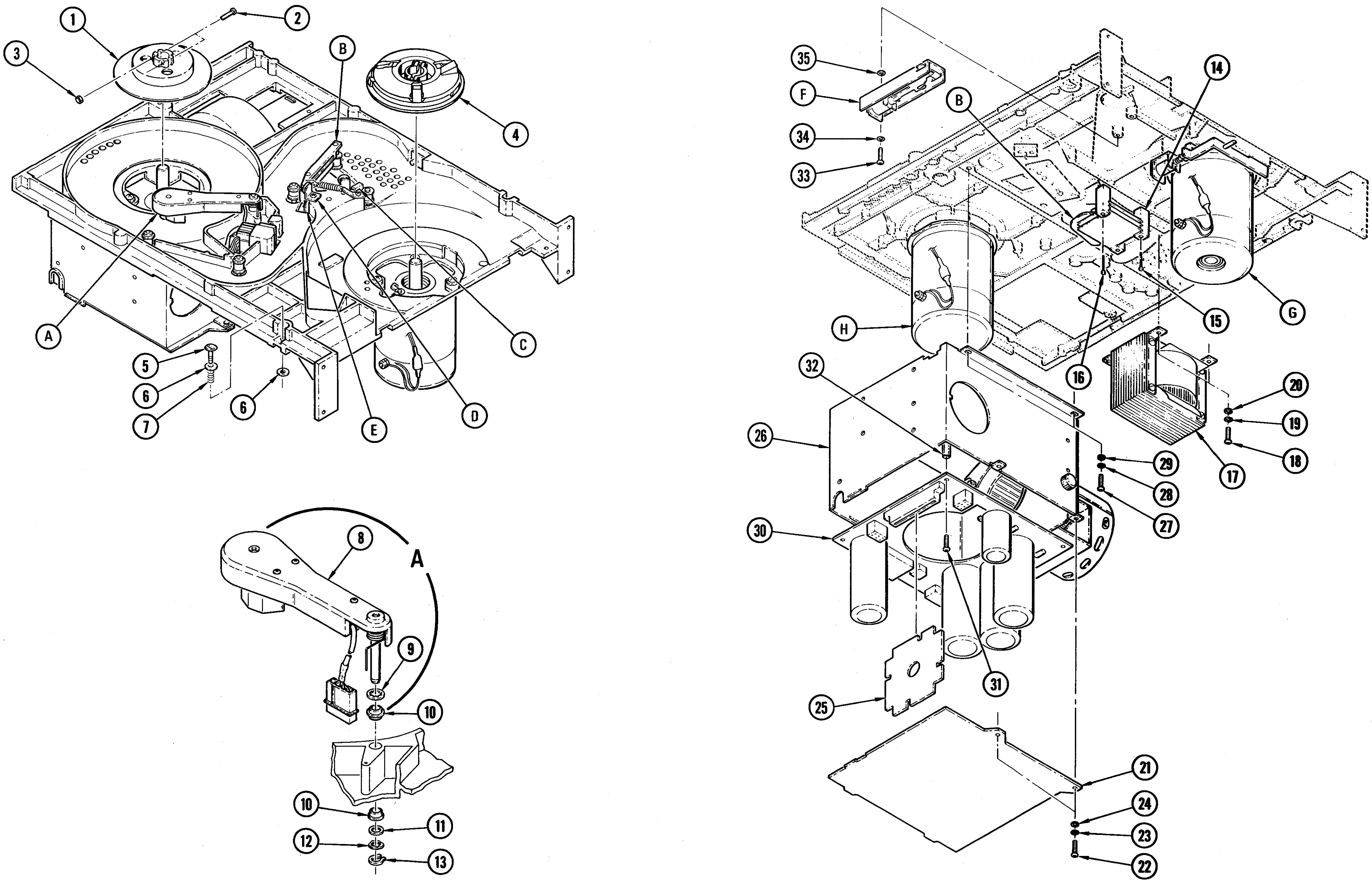


Figure 5-5. Basic Drive Assembly
(Exploded View)

Figure 5-5
Sheet 1 of 4

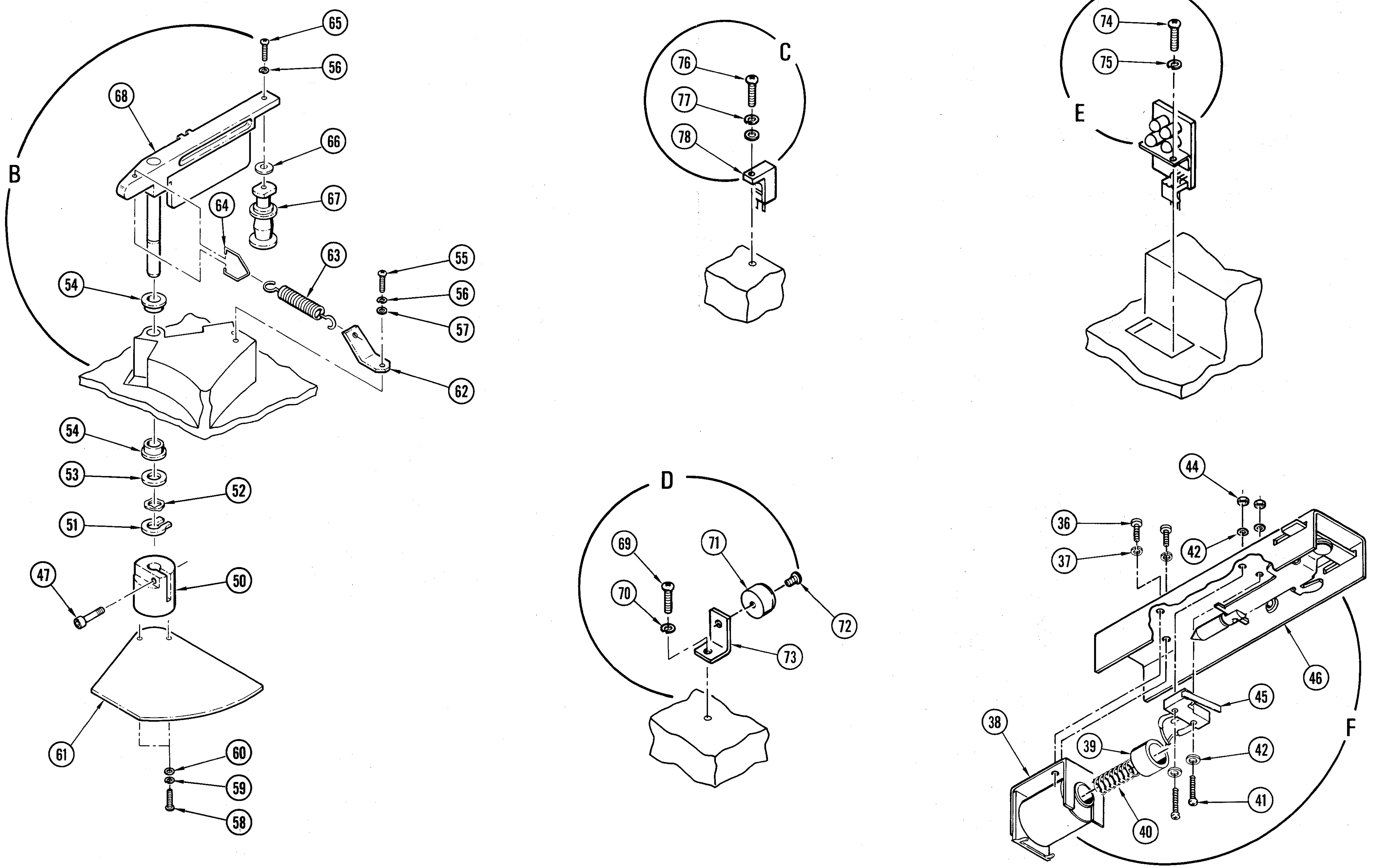


Figure 5-5. Basic Drive Assembly
(Exploded View)

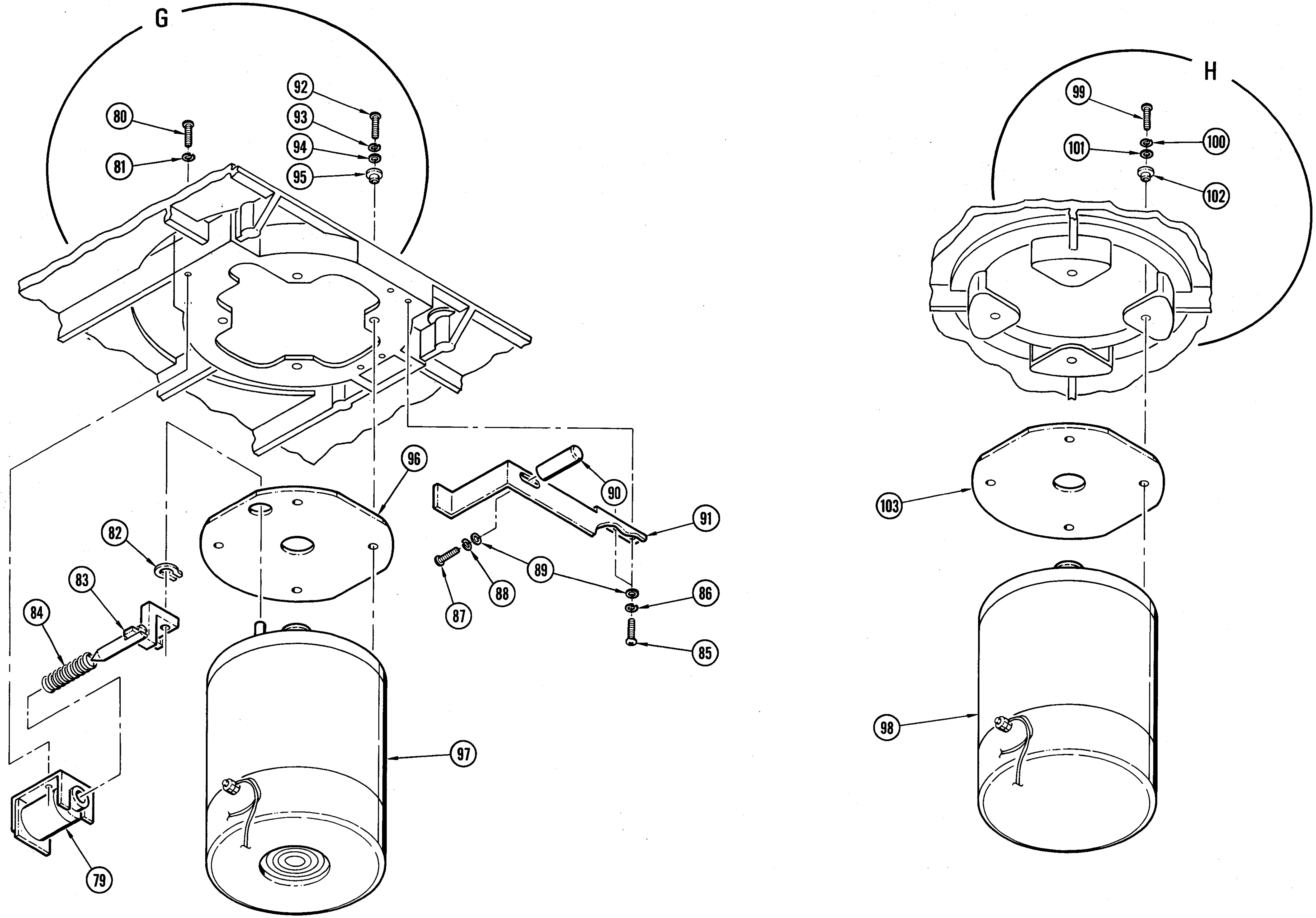


Figure 5-5. Basic Drive Assembly
(Exploded View)

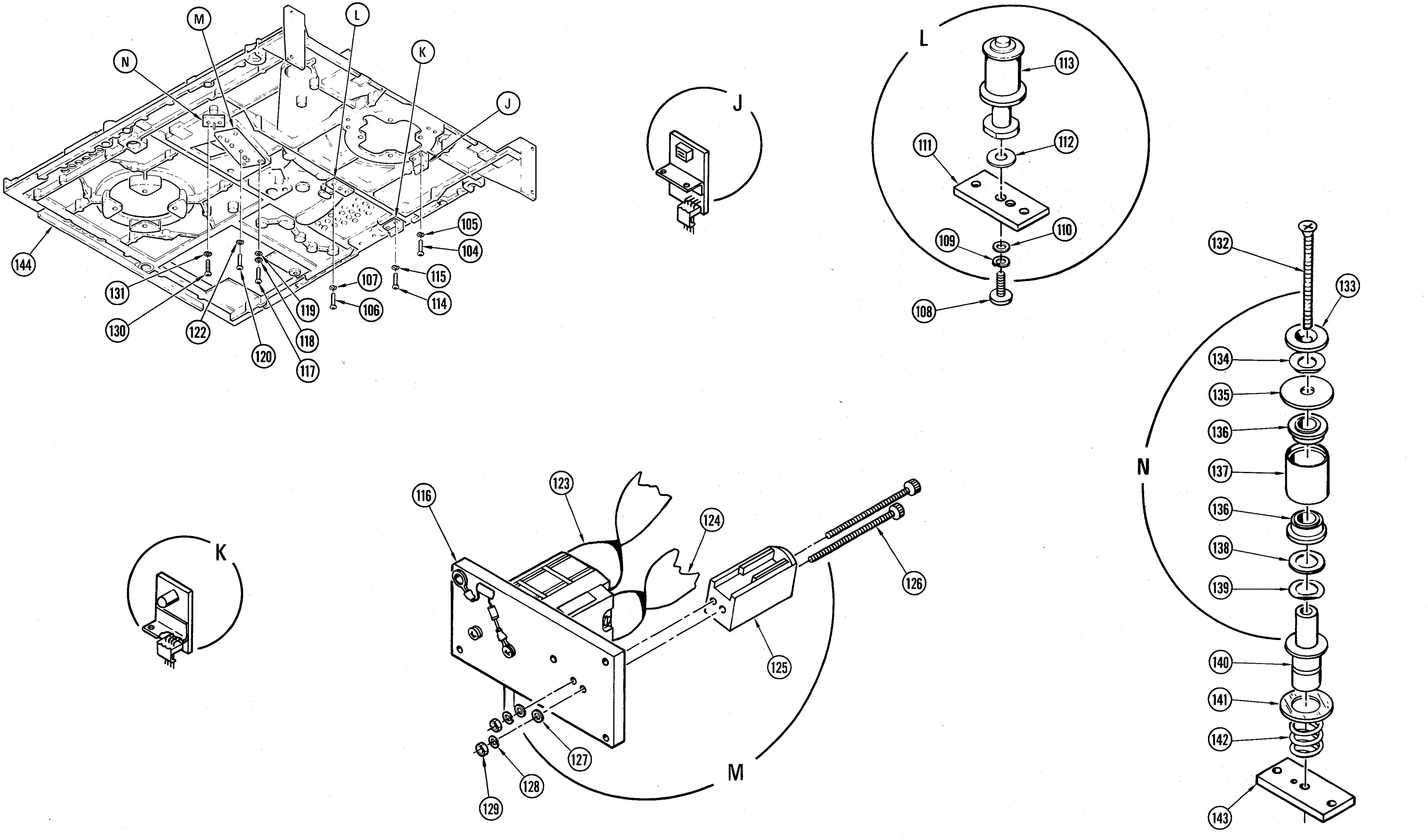


Figure 5-5. Basic Drive Assembly
(Exploded View)

Figure 5-5
Sheet 4 of 4

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5	960567-001	BASIC DRIVE ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	760106-567	. HUB, Takeup	1	
		(ATTACHING PARTS)		
-2	213091-614	. SCREW, Socket head cap, ... 6-32 x 7/8 in. lg	2	
-3	207607-051	. NUT, Hex, 6-32, No. 6	2	
		--- --- --- * --- --- ---		
-4	160101-406	. SUPPLY HUB ASSEMBLY .... (See Figure 5-10 for breakdown)	1	
-5	213599-000	. SCREW, Captive, quick opening	2	
-6	210116-026	. FASTENER RETAINER	2	
-7	210004-006	. SPRING, Compression, fastener	2	
-8	160105-433	. TACHOMETER ASSEMBLY....................	1	
		(ATTACHING PARTS)		
-9	210200-037	. RING, Retaining, Push-On	1	
-10	210067-001	. BEARING, 1/4 x 3/8 in.	2	
-11	731911-102	. SHIM, .005 in. thick, 1/4 in. ID	AR	
-12	210008	. WASHER, Wave spring	1	
-13	210200-032	. RING, Grip, 1/4 in. ID	1	
		--- --- --- * --- --- ---		

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-14	160101-471	. CAPACITOR PLATE ASSEMBLY	1	
		(ATTACHING PARTS)		
-15	213091-408	. SCREW, Socket head, cap 4-40 x 1/2 in. lg, cadmium, black zinc	1	
-16	213091-410	. SCREW, Socket head, cap 4-40 x 5/8 in. lg, cadmium, black zinc	2	
		--- --- --- * --- --- ---		
-17	160106-402	. TRANSFORMER ASSEMBLY	1	
		(ATTACHING PARTS)		
-18	213271-106	. SCREW, Pan head, phillips, 10-32 x 3/8 in. lg, cadmium plated, black, zinc	4	
-19	207102-011	. WASHER, Split lock, No. 10	4	
-20	207104-021	. WASHER, Flat, No. 10	4	
		--- --- --- * --- --- ---		
-21	960015-001	. COVER ASSEMBLY, Power supply housing	1	
		--- --- --- * --- --- ---		
		(ATTACHING PARTS)		
-22	213271-605	. SCREW, Pan head, phillips 6-32 x 5/16 in. lg, cadmium, black zinc	2	
-23	207602-011	. WASHER, Split lock, No. 6	2	
-24	207605-021	. WASHER, Flat, No. 6	2	
		--- --- --- * --- --- ---		
-25	760102-102	. PWB VOLTAGE SELECT	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-26	960292-001	. POWER SUPPLY HOUSING ASSEMBLY .... (See Figure 5-9 for breakdown)	1	
		(ATTACHING PARTS)		
-27	213091-106	. SCREW, Socket head, cap,..................... 10-32 x 3/8 in. lg, cadmium plated, black, zinc	4	
-28	207102-011	. WASHER, Split lock, No. 10	4	
-29	207104-021	. WASHER, Flat, No. 10	4	
		-- -- — * -- -- —		
-30	960298-001	. PWB ASSEMBLY, Power Supply	1	
		(ATTACHING PARTS)		
-31	213621-606	. SCREW, Socket set, knurled cup pt,............. 6-32 x 3/8, cadmium, black,zinc	4	
-32	210030-250	. STANDOFF, 1/4 Hex, 1, 6-32	4	
		-- -- — * -- -- —		
	160101-418	. DOOR LOCK ASSEMBLY	2	
		(ATTACHING PARTS)		
-33	213271-607	. SCREW, Pan head, phillips..................... 6-32 x 7/16 in. lg, cadmium plated, black, zinc	2	
-34	207602-011	. WASHER, Split lock, No. 6	2	
-35	207605-021	. WASHER, Flat. No. 6	2	
		-- -- — * -- -- —		

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-36	213271-602	. . SCREW, Pan head, phillips.................. 6-32 x 3/16 in. lg, cadmium plated, black, zinc	2	
-37	207602-011	. . WASHER, Split lock, No. 6	2	
-38	760101-840	. . SOLENOID, Coil	1	
-39	760106-512	. . SOLENOID, Spacer	1	
-40	760101-704	. . SPRING, Compression	1	
-41	213271-206	. . SCREW, Pan head, phillips.................. 2/56 x 1/2, in. lg, cadmium plated black, zinc	2	
-42	207202-021	. . WASHER, Flat, No. 2	4	
-43		Not Used		
-44	213884-300	. . NUT, Tinnerman	2	
-45	211015-011	. . SWITCH, Lever, quick disconnect............	1	
-46	760101-579	. . BRACKET, Door lock	1	
	160103-499	. COMPLIANCE ARM ASSEMBLY	1	
		(ATTACHING PARTS)		
-47	213092-608	. SCREW, Socket head set,...................... 6-32 x 1/2 in. lg, black	1	
-48		Not Used		
-49		Not Used		
-50	760101-711	. HUB, Capacitor shutter	1	
-51	210200-032	. RING, Retaining, external, 1/4 in...............	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-52	210008	. WASHER, Wave spring	1	
-53	731911-102	. SHIM, 0.005 in. thick x 1/4 in. ID	1	
-54	210067-001	. BEARING, 1/4 x 3/8 in.	2	
-55	213271-606	. SCREW, Pan head, phillips...................... 6-32 x 3/8 in. lg, cadmium, black, zinc	1	
-56	207602-011	. WASHER, Split lock, No. 6	2	
-57	207605-021	. WASHER, Flat, No. 6	1	
		--- --- --- * --- --- ---		
	160101-444	. CAPACITOR SHUTTER ASSEMBLY	1	
		(ATTACHING PARTS)		
-58	213271-407	. SCREW, Pan head, phillips, ... 4-40 x 7/16 in. lg, zinc	2	
-59	207403-011	. WASHER, Split Lock, No. 4....................	2	
-60	207408-021	. WASHER, Flat, small OD, No. 4................	2	
		--- --- --- * --- --- ---		
-61	760102-575	. SHUTTER, Molded	1	
-62	760101-565	. . BRACKET, Spring, compliance arm...........	1	
-63	210006-010	. . SPRING, Extension	1	
-64	760101-554	. . CLIP, Spring.................................	1	
-65	213271-607	. . SCREW, Pan head, phillips, ... 6-32 x 7/16 in. lg, cadmium, black, zinc	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-66	760104-524	. . SHIM, stainless steel........................	1	
-67	760104-500	. . TAPE GUIDE, Crowned roller, short	1	
-68	160104-492	. . ARM AND SHAFT ASSEMBLY	1	
	160106-479	. BUMPER ASSEMBLY	1	
	160106-478	. BUMPER ASSEMBLY	1	
		(ATTACHING PARTS)		
-69	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-70	207403-011	. WASHER, Split lock, No. 4	2	
		--- --- --- * --- --- ---		
-71	210119	. . BUMPER..................................	2	
-72	213271-403	. . SCREW, Pan head, phillips, ... 4-40 x 3/16 in. lg, cadmium, black, zinc	2	
-73	760101-662	. . BRACKET, Compliance arm, stop	2	
	160101-009	. PRINTED WIRING BOARD ASSEMBLY, ... Reflective sensor, EOT/BOT	1	
		(ATTACHING PARTS)		
-74	213271-405	. SCREW, Pan head, phillips, ... 4-40 x 5/16 in. lg, cadmium, black, zinc	2	
-75	207403-011	. WASHER, Split lock, No. 4	2	
		--- --- --- * --- --- ---		
	160103-433	. . SENSOR RECEIVER ASSEMBLY, Molded	1	
		(ATTACHING PARTS)		
-76	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-77	207403-011	. WASHER, Split lock, No. 4	1	
-78	207402-021	. WASHER, Flat, No. 4	1	
		-- -- -- * -- -- --		
-79	760101-840	. SOLENOID, 24VDC continuous	1	
		(ATTACHING PARTS)		
-80	213092-612	. SCREW, Socket head, cap .... 6-32 x 3/4 in. lg, black	2	
-81	207602-011	. WASHER, Split lock, No. 6	2	
-82	210200-001	. RING, Retaining	1	
		-- -- -- * -- -- --		
-83	760106-510	. BELLCRANK, Reel hub lock	1	
-84	760101-704	. SPRING, Compression	1	
	960930-001	. BRACKET, HUB UNLOCK	1	
		(ATTACHING PARTS)		
-85	213274-404	. SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg, cadmium plated, black, zinc	2	
-86	207403-011	. WASHER, Split lock, No. 4	2	
		-- -- -- * -- -- --		
-87	213274-404	. . SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg, cadmium plated, black, zinc	1	
-88	207403-011	. . WASHER, Split lock, No. 4	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-89	207402-021	. . WASHER, Flat, No. 4	3	
-90	760101-629	. . PIN, Reel hub unlock	1	
-91	760101-622	. . BRACKET, Spring, reel hub unlock	1	
	160101-497	. SUPPY MOTOR ASSEMBLY	1	
		(ATTACHING PARTS)		
-92	213271-107	. SCREW, Pan head, phillips, ... 10-32 x 7/16 in. lg, cadmium plated, black, zinc	4	
-93	207102-011	. WASHER, Split lock, No. 10	4	
-94	213704-100	. WASHER, Flat, No. 10	4	
-95	760101-768	. WASHER, Shoulder, insulating	4	
		--- --- --- * --- --- ---		
-96	760101-756	. INSULATOR, Motor	1	
-97	760101-527	. MOTOR, Permanent magnet, 4 in. .... diameter, supply	1	
-98	799031-201	. MOTOR, Permanent magnet, ... 4 in. dia, takeup	1	
		(ATTACHING PARTS)		
-99	213271-107	. SCREW, Pan head, phillips, ... 10-32 x 7/16 in. lg, cadmium plated, black, zinc	4	
-100	207102-011	. WASHER, Split lock, No. 10	4	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-101	213704-100	. WASHER, Flat, No. 10	4	
		-- -- — * -- -- —		
-102	760101-768	. WASHER, Shoulder, insulating	4	
-103	760101-756	. INSULATOR, Motor	1	
	160101-005	. PRINTED WIRING BOARD ASSEMBLY, ... File protect	1	
		(ATTACHING PARTS)		
-104	213217-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-105	207403-011	. WASHER, Split lock, No. 4	2	
		-- -- — * -- -- —		
	160104-401	. ROLLER GUIDE ASSEMBLY....................	1	
		(ATTACHING PARTS)		
-106	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-107	207403-011	. WASHER, Split lock, No. 4	2	
-108	213274-605	. . SCREW, Pan head, phillips, ... 6-32 x 5/16 in. lg	1	
-109	207602-011	. . WASHER, Split lock, No. 6	1	
-110	207605-021	. . WASHER, Flat, No. 6	1	
-111	760101-566	. . PLATE, Tape guide	1	
		-- -- — * -- -- —		

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-112	760104-524	. . SHIM, Stainless steel	1	
-113	799043-201	. . ROLLER, Tape guide	1	
	160101-010	. PRINTED WIRING BOARD ASSEMBLY, ... Reflective sensor, Tape-In-Path	1	
		(ATTACHING PARTS)		
-114	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-115	207403-011	. WASHER, Split lock, No. 4	2	
		--- --- --- * --- --- ---		
-116	961139-001	. HEAD ASSEMBLY............................	1	
		(ATTACHING PARTS)		
-117	213271-408	. SCREW, Pan head, phillips.................... 4-40 x 1/2 in. lg, cadmium plated black, zinc	4	
-118	207403-011	. WASHER, Split lock, No. 4	4	
-119	207402-021	. WASHER, Flat, No. 4	4	
-120	213092-408	. SCREW, Socket head, cap,..................... 4-40 x 1/2, black	1	
-121		. Not Used..................................		
-122	207402-021	. WASHER, Flat, No.4..........................	1	
		--- --- --- * --- --- ---		
-123	961003-001	. HEAD CABLE ASSEMBLY, Read	1	
-124	960413-001	. HEAD CABLE ASSEMBLY, Write...............	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-125	131047-001	. . TAPE SCRAPER ASSEMBLY	1	
		(ATTACHING PARTS)		
-126	213091-407	. . SCREW, Socket head, cap,..................	2	
-127	207408-021	. . WASHER, Flat, small OD, No. 4..............	2	
-128	207403-011	. . WASHER, Split lock, No 4	2	
-129	207406-081	. . NUT, Hex, radio pattern, No. 4, 4-40..........	2	
		-- -- — * -- -- —		
	160104-400	. ROLLER GUIDE ASSEMBLY..................	3	
		(ATTACHING PARTS)		
-130	213271-407	. SCREW. Pan head, phillips,.................... 4-40 x 7/16 in. lg, cadmium plated, black, zinc	3	
-131	207403-011	. WASHER, Split lock, No. 6	3	
		-- -- — * -- -- —		
-132	213151-424	. . SCREW, Fillister head, phillips 100 .... 4 x 40 x 1-1/2 in. lg.	1	
-133	754004-901	. . CAP, Roller guide	1	
-134	210260-000	. . WASHER, Spring, crescent	1	
-135	754007-901	. . WASHER, Guide	1	
-136	210067-001	. . BEARING, 1/4 x 3/8 in.	2	
-137	760101-540	. . ROLLER, Spring guide	1	
-138	731911-101	. . SHIM, .004 thick, 1/4 in. ID..................	1	
	731911-102	. . SHIM. .005 thick, 1/4 in. ID..................	1	
	731911-105	. . SHIM, .010 thick, 1/4 in. ID..................	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-139	210008	. . WASHER, Wave spring	1	
-140	760101-833	. . BASE, Roller guide	1	
-141	754007-801	. . WASHER, Guide	1	
-142	210003-038	. . SPRING, Compression	1	
-143	760101-567	. . PLATE, Tape guide	1	
-144	760106-547	. TOP PLATE	1	

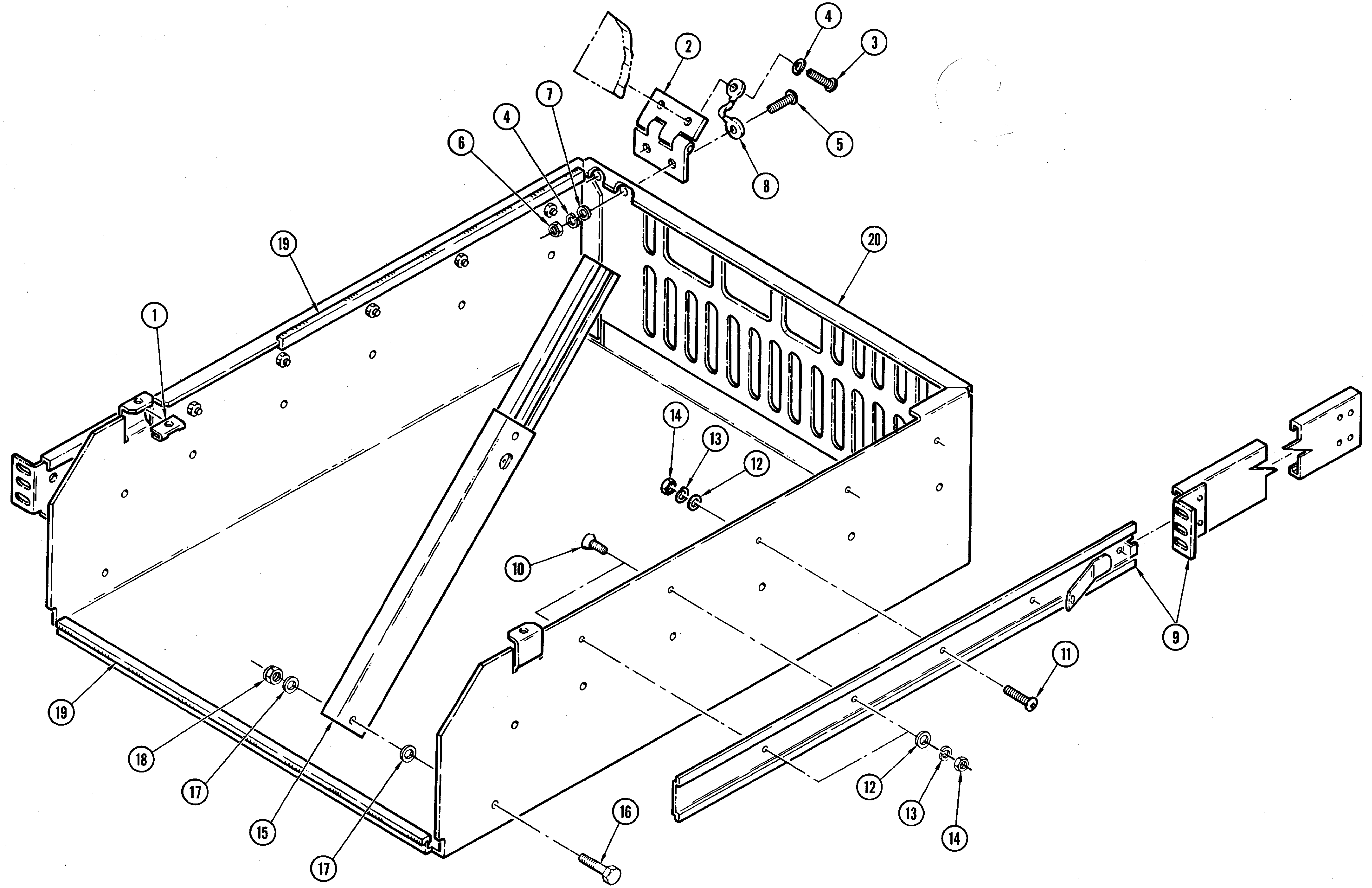


Figure 5-6. Chassis Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-6				
	960566-001	CHASSIS ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	210116-027	. FASTENER, Clip-on	2	
-2	760103-535	. HINGE..	2	
-3	213271-107	. SCREW, Pan head, phillips.................... 10-32 x 7/16 in. lg, cadmium black, zinc	4	
-4	207102-011	. WASHER, Split lock, No. 10	12	
-5	213271-106	. SCREW, Pan head, phillips, ... 10-32 x 3/8 in. lg, cadmium, black, zinc	4	
-6	207101-081	. NUT, Hex, radio pattern, No. 10................	4	
-7	207104-021	. WASHER, Flat, No. 10	4	
		--- --- --- * --- --- ---		
-8	960032-001	. GROUND STRAP, Chassis	1	
-9	960274-001	. SLIDE ASSEMBLY, Modified	2	
		(ATTACHING PARTS)		
-10	213151-107	. SCREW, Flat head, phillips,.................... 10-32 x 7/16 in. lg, cadmium, black or zinc	2	
-11	213271-106	. SCREW, Pan head, phillips.................... 10-32 x 3/8 in. lg, cadmium black or zinc	6	
-12	207104-021	. WASHER, Flat, No. 10	8	
-13	207102-011	. WASHER, Split lock, No. 10	8	
-14	207101-081	. NUT, Hex, Radio pattern, No. 10, 10-32	8	
		--- --- --- * --- --- ---		
-15	160106-408	. SUPPORT ASSEMBLY, Top plate	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-6				
		(ATTACHING PARTS)		
-16	213634-108	. SCREW, Hex head, .170 grip, 10-32 x 1/2 in. lg	1	
-17	207104-021	. WASHER, Flat, No. 10	2	
-18	205255-002	. NUT, Lock, hex, 10-32	1	
		--- * ---		
-19	205288-200	. GROMMET, Strip	2.5	
-20	960073-001	. CHASSIS, Narrow, modified	1	

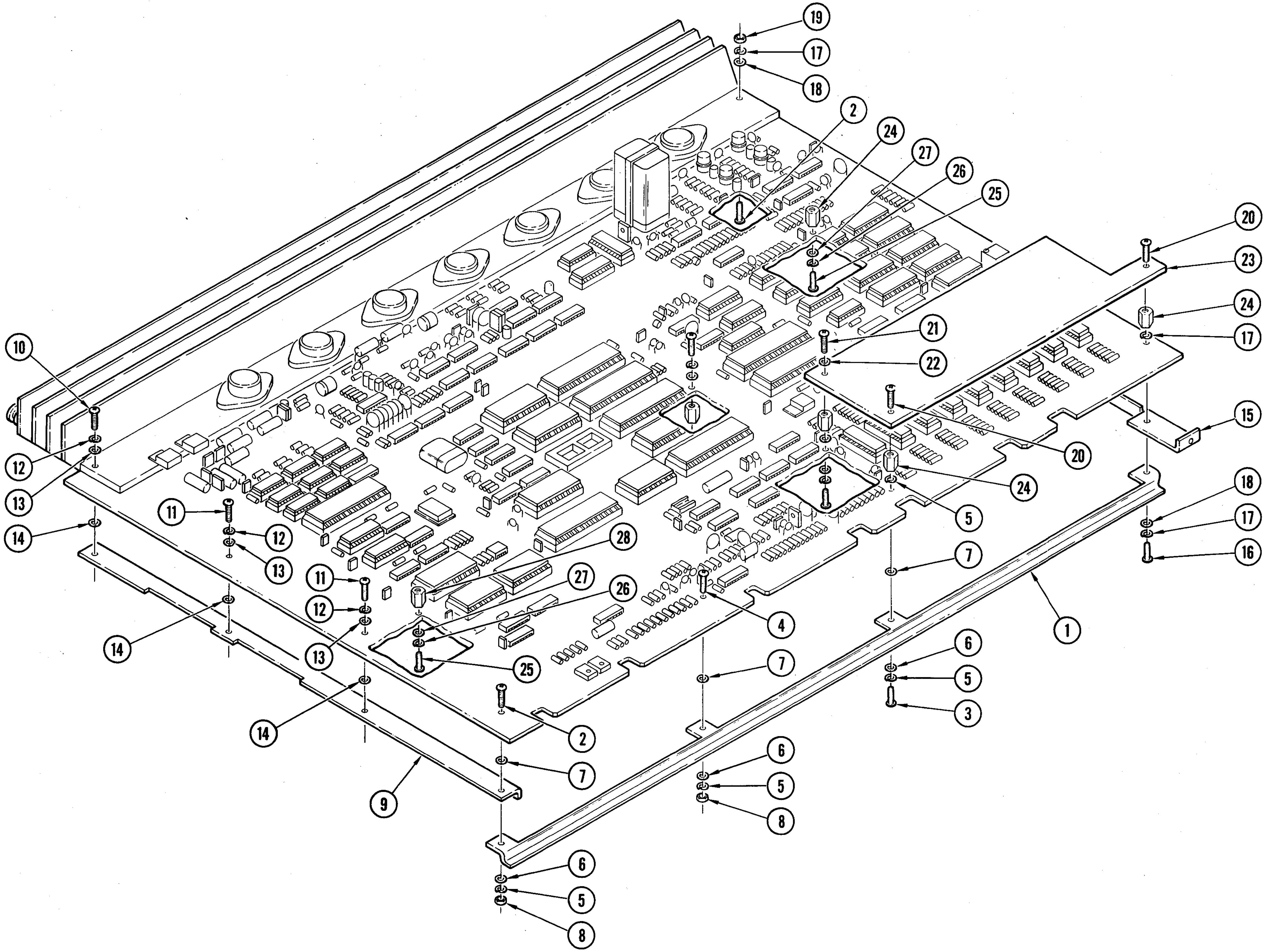


Figure 5-7. Drive Formatter Printed Wiring Board Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-7				
	961019-002 961018-002 961020-002 961017-002	PRINTED WIRING BOARD ASSEMBLY, Drive formatter (See Figure 5-2 for next higher assembly and Figure 5-11 for breakdown)	REF	A B C D
-1	760101-695	. STIFFENER, Left side	1	
		(ATTACHING PARTS)		
-2	213271-609	. SCREW, Pan head, phillips 6-32 x 9/16 in. lg, cadmium, black, zinc	1	
-3	213271-607	. SCREW, Pan head, phillips 6-32 x 7/16, cadmium, black zinc	1	
-4	213271-607	. SCREW, Pan head, phillips 6-32 x 7/16 in. lg, cadmium, black zinc	1	
-5	207602-011	. WASHER, Split lock, No. 6	4	
-6	207608-021	. WASHER, Flat, small OD, No. 6	3	
-7	213700-609	. WASHER, Flat, nylon, small OD, No. 6	3	
-8	207604-081	. NUT, Hex, radio pattern, 6-32	2	
		--- * ---		
-9	760101-693	. STIFFENER, Rear	1	
		(ATTACHING PARTS)		
-10	213271-609	. SCREW, Pan head, phillips 6-32 x 9/16 in. lg, cadmium black, zinc	1	
-11	213274-606	. SCREW, Pan head, phillips 6-32 x 3/8 in. lg, cadmium, black, zinc	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-7				
-12	207602-011	. WASHER, Split lock, No. 6	3	
-13	207608-021	. WASHER, Flat, small OD, No. 6................	3	
-14	213700-609	. WASHER, Flat, Nylon, small OD, No. 6..........	3	
		--- --- --- * --- --- ---		
-15	760102-543	. STIFFENER, Front	1	
		(ATTACHING PARTS)		
-16	213271-607	. SCREW, Pan head, phillips, ... 6-32 x 7/16 in. lg, cadmium, black, zinc	1	
-17	207602-011	. WASHER, Split lock, No. 6	3	
-18	207608-021	. WASHER, Flat, small OD, No. 6................	2	
-19	207604-081	. NUT, Hex, radio pattern, 6-32	1	
-20	20016-006	. SCREW, Nylon, 6-23 x 1/4....................	2	
-21	213271-604	. SCREW, Pan head, phillips.................... 6-32 x 1/4	1	
-22	207602-011	. WASHER, Split lock, No. 6	1	
-23	760101-803	. SHIELD....................................	1	
-24	210030-632	. STANDOFF, 1/4 in. hex, A/F,.................. 3/8 in., 6-32	5	
		--- --- --- * --- --- ---		
-25	213274-606	. SCREW, Pan head, phillips..................... 6-32 x 3/8 in. lg	5	
-26	207602-011	. WASHER, Split lock, No. 6	5	
-27	207608-021	. WASHER, Flat, small OD, No. 6................	5	
-28	210030-141	. STANDOFF, 1/4 hex, 7/16 in., 6-32	1	
		--- --- --- * --- --- ---		

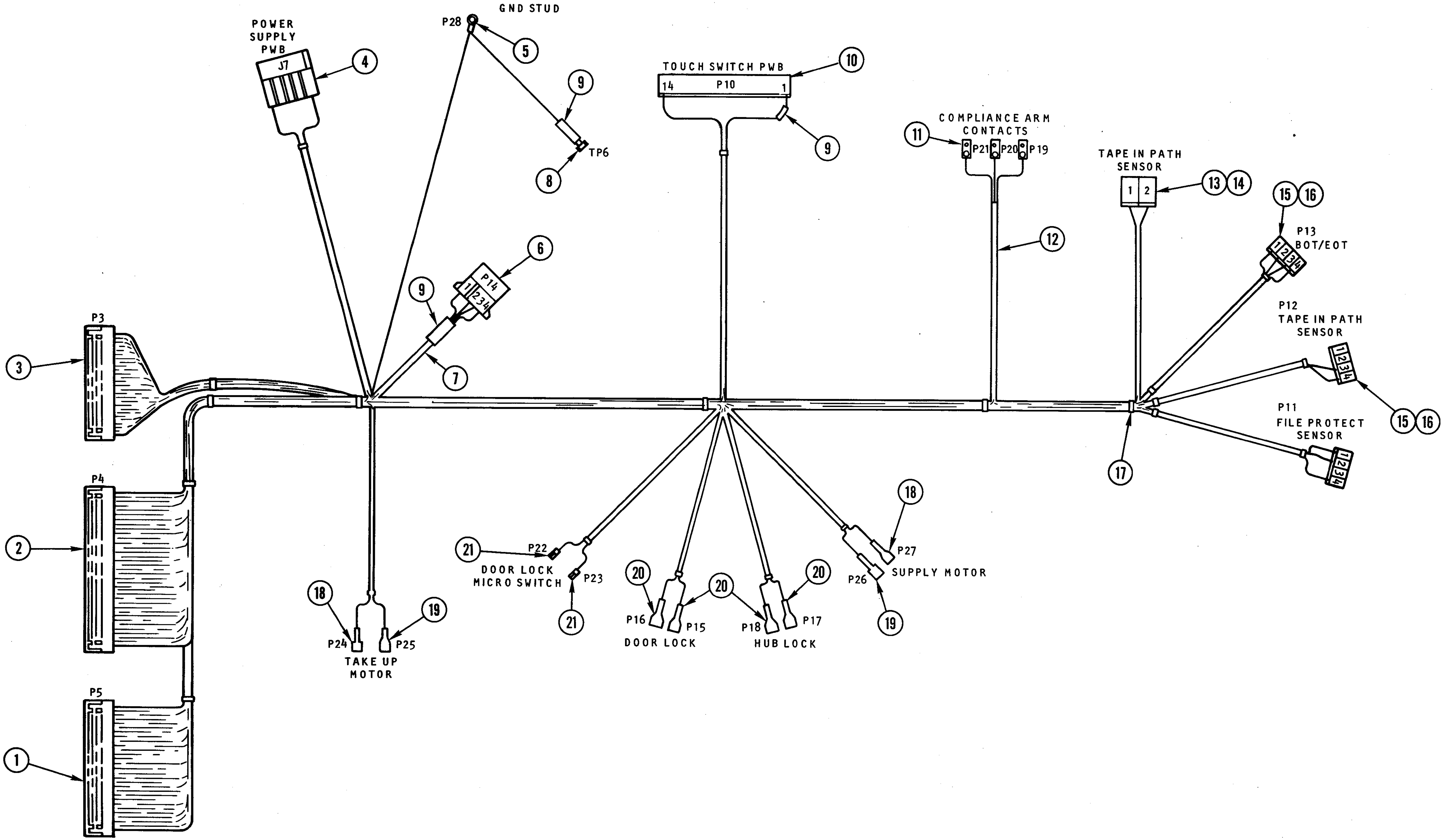


Figure 5-8. Harness Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-8	960629-001	HARNESS ASSEMBLY (See Figure 5-2 for next higher assembly)	REF	
-1	970302-018	. CONNECTOR, Printed circuit, right angle, 18-pin, without flanges	1	
-2	970302-022	. CONNECTOR, Printed circuit, right angle, 22-pin, without flanges	1	
-3	970302-015	. CONNECTOR, Printed circuit, right angle, 15-pin, without flanges	1	
-4	205071-500	. CONNECTOR, 15-position	1	
-5	210905	. LUG, Ring, No. 6	1	
-6	205107	. CONNECTOR, 4-position	1	
-7	208500-032	. CABLE, Shielded, 4-conductor, 24 AWG	AR	
-8	210575-611	. PIN, Receptacle, reel	1	
-9	210408-006	. TUBING, Heat shrink, black	AR	
-10	205124-108	. CONNECTOR, 14-position, ID	1	
-11	760101-729	. CONTACT, Capacitive plate	3	
-12	208500-041	. CABLE, Shielded, 2-conductor	2	
-13	970123-001	. CONNECTOR, 2-position, lock insulate	1	
-14	205089-002	. COVER, Connector, 2-position	1	
-15	205122-044	. CONNECTOR, 4-position, lock insulated, disp/plzd ramp	3	
-16	205089-001	. COVER, Connector, 4-position	3	
-17	210229-527	. TY-RAP, 1/32 in., 4 in. lg	52	
-18	210555-077	. TERMINAL, Nylon coupler, 22-18AWG	2	
-19	210555-078	. TERMINAL, 250x032 male, 22-18 gauge, fully insulated	2	
-20	210555-036	. TERMINAL, Slip-on, 0.187 tab, reel	4	
-21	210578-100	. TERMINAL, 0.093 tab, non-insulated	2	

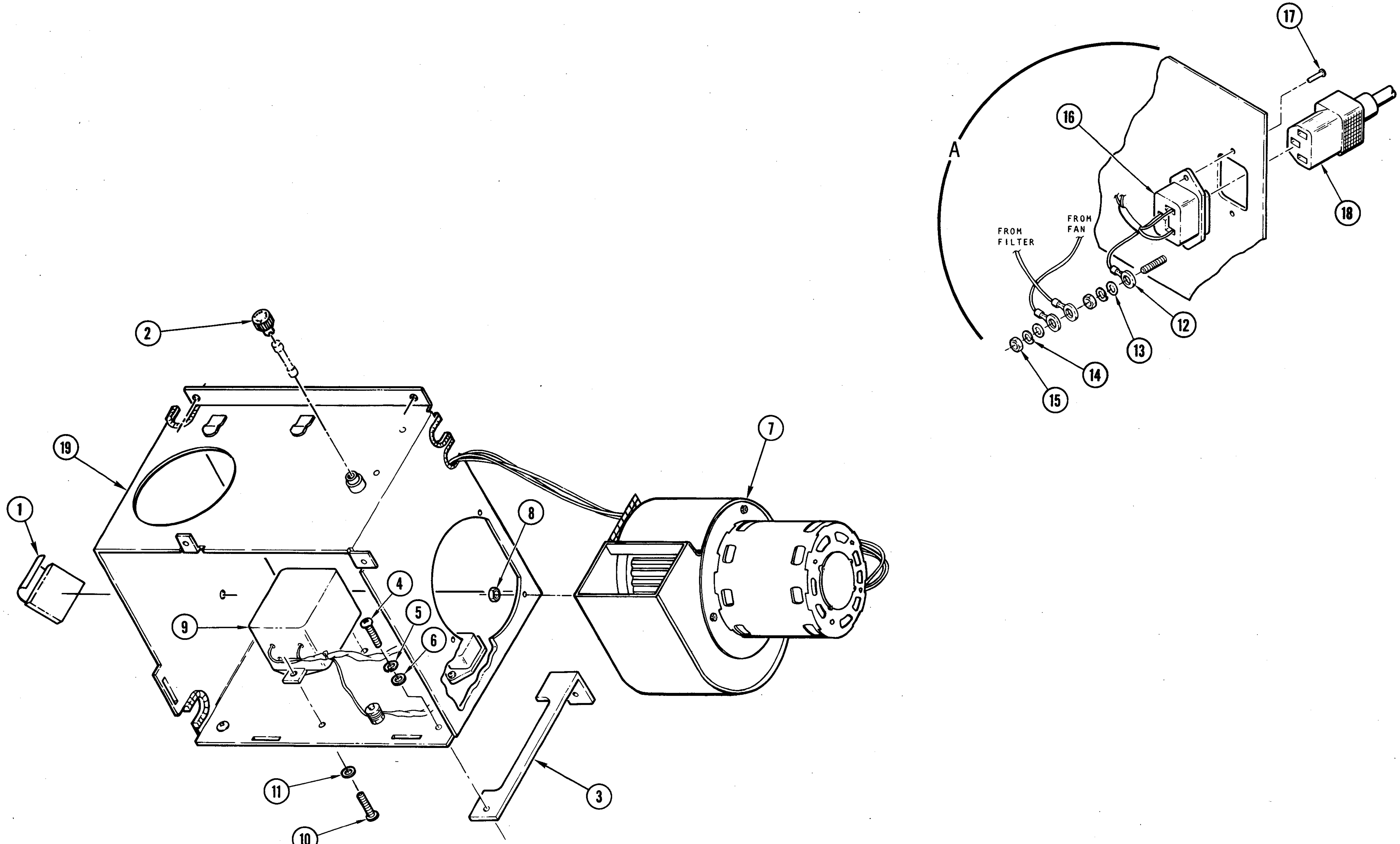


Figure 5-9. Power Supply Housing Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-9	960292-001	HOUSING ASSEMBLY, Power Supply Assembly..... (See Figure 5-5 for next higher assembly)	REF	
-1	970457-001	. CABLE CLAMP, Adhesive backed	1	
-2	799016-401	. FUSEHOLDER, Panel	1	
-3	760106-540	. BRACKET	2	
		(ATTACHING PARTS)		
-4	213092-106	. SCREW, Socket head cap .... 10-32 x 3/8 in lg, black only	2	
-5	207102-011	. WASHER, Split lock, No. 10	2	
-6	207104-021	. WASHER, Flat, No. 10	2	
-7	160105-439	. AIR PUMP ASSEMBLY.........................	1	
		(ATTACHING PARTS)		
-8	970219-012	. NUT, Hex, No. 8-32, Locking	3	
		-- -- -- * -- -- --		
-9	960294-001	. FILTER, ASSEMBLY, IEC	1	
		(ATTACHING PARTS)		
-10	213271-606	. SCREW, Pan head, phillips, ... 6-32 x 3/8 in lg, cadmium, black or zinc	2	
-11	207605-021	. WASHER, Flat, No. 6	2	
		-- -- -- * -- -- --		
-12	210555-027	. TERMINAL, Ring .... 22-16 AWG, No. 8	3	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-9				
-13	207801-021	. WASHER, Flat, No. 8	2	
-14	207802-011	. WASHER, Split lock, No. 8	2	
-15	207803-051	. NUT, Hex, No. 8, 8-32	2	
		-- -- -- * -- -- --		
-16	960412-001	. RECEPTACLE ASSEMBLY	1	
		(ATTACHING PARTS)		
-17	970099-001	. RIVET, Pop, 1/8 inch dia	2	
-18	970035-005	. POWER CORD, AC Line	1	
-19	960293-001	. HOUSING, Power Supply	1	

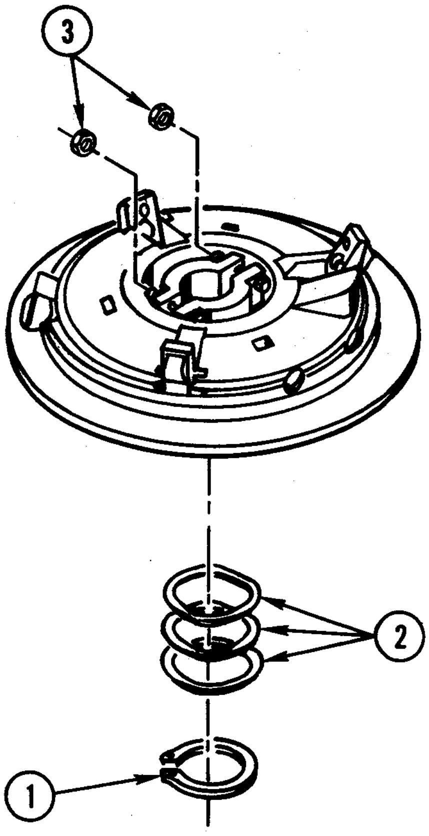
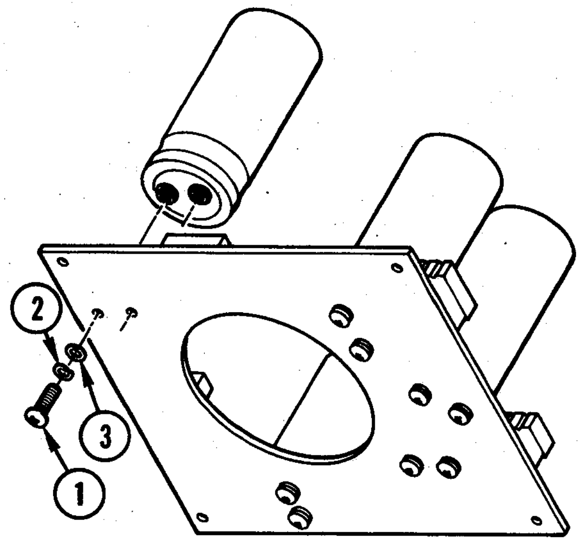


Figure 5-10. Supply Hub Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-10	160101-406	SUPPLY HUB ASSEMBLY .... (See Figure 5-5 for next higher assembly)	REF	
-1	210200-087	. RING, Retaining, external .... 7/8 in. ID	1	
-2	210009	. SPRING, Wave, No. 30	3	
		(ATTACHING PARTS)		
-3	207607-051	. NUT, Hex, No. 6	2	
		--- --- --- * --- --- ---		



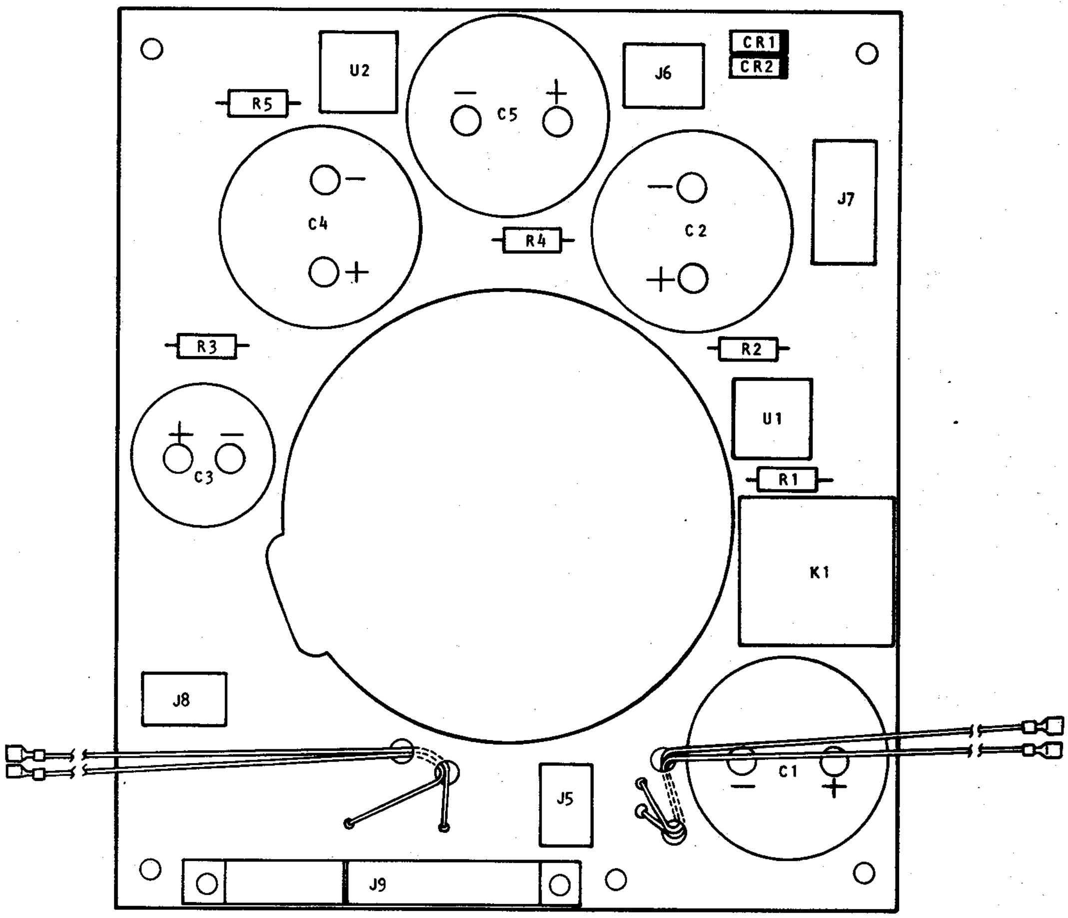


Figure 5-11. Power Supply Printed Wiring Board Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11	960298-001	PRINTED WIRING BOARD ASSEMBLY............ Power supply, (See Figure 5-8 for next higher assembly)	REF	
C1, C2	201174-250	. CAPACITOR, Electrolytic, 25000uF,............ 30V	2	
C3	201174-160	. CAPACITOR, Electrolytic, 16000uF,............ 15v	1	
C4, C5	201174-181	. CAPACITOR, Electrolytic, 19000-............... 21000uF, 40 Vdc	2	
		(ATTACHING PARTS)		
-1	213271-106	. SCREW, Pan head, phillips..................... 10-32 x 3/8 in. lg, cadmium black, zinc	10	
-2	207105-031	. WASHER, Internal lock, No. 10.................	10	
-3	207108-021	. WASHER, Flat, small OD, No. 4................	10	
		--- --- --- * --- --- ---		
CR1, CR2	202009-751	. DIODE, Rectifier, 6A, 12V	2	
J5	205195-200	. CONNECTOR, Socket assembly, ... 6-position	1	
J6	205064	. CONNECTOR, 9-position.....................	1	
J7	205070	. CONNECTOR HOUSING, 15-position	1	
J8	205195-300	. CONNECTOR, Socket assembly 6-position	1	
J9	205108-023	. CONNECTOR, Printed circuit .... edge, 9-position	1	
K1	970098-001	. RELAY, Opto isolated, printed circuit	1	
R1-5	200093-150	. RESISTOR, FC, 1.5K, 1W, ±5%.................	5	
U1, U2	202003-100	. RECTIFIER BRIDGE, 10 AMP..................	2	

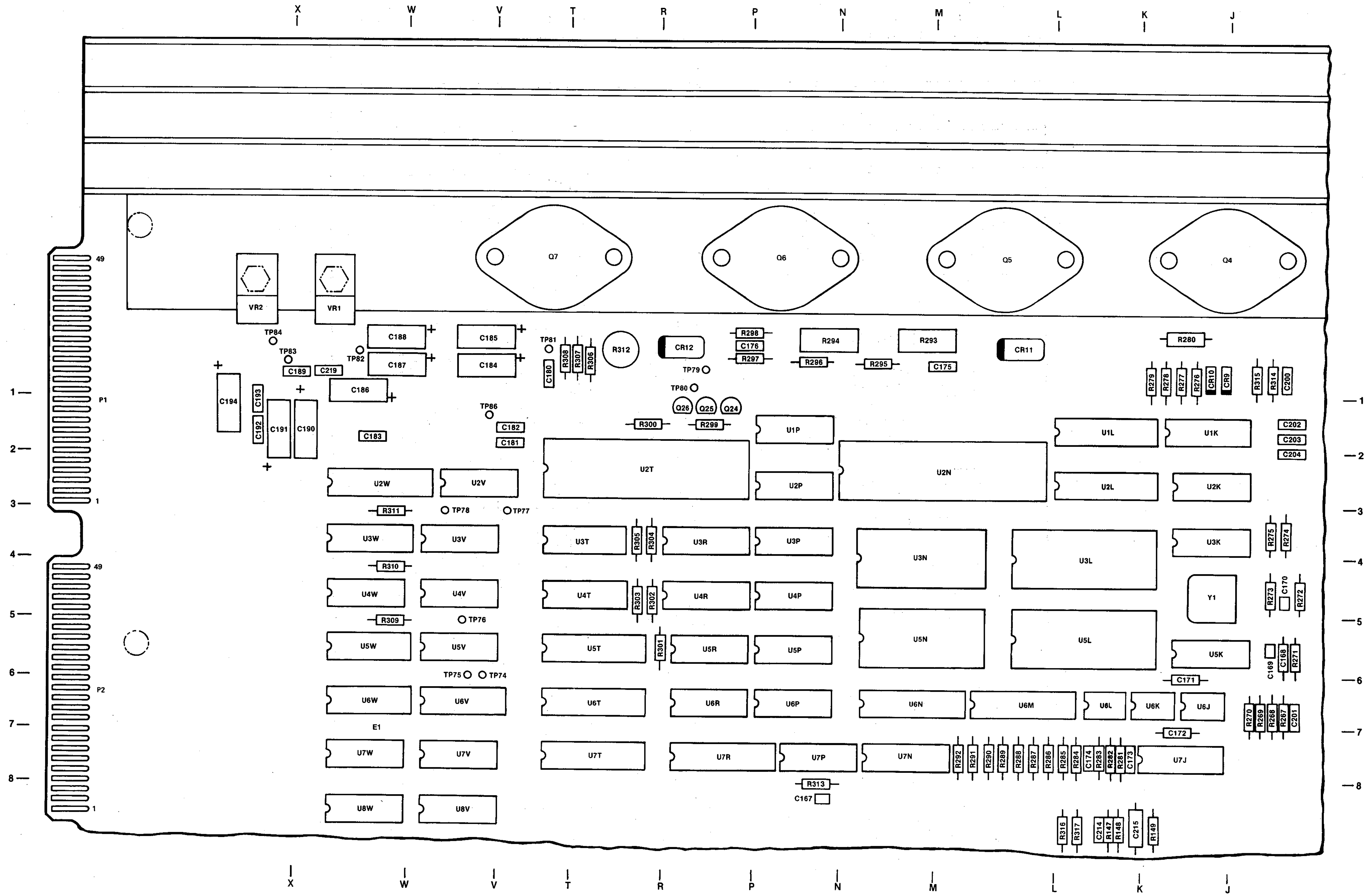


Figure 5-12. Drive Formatter PWB
(Orthographic View)

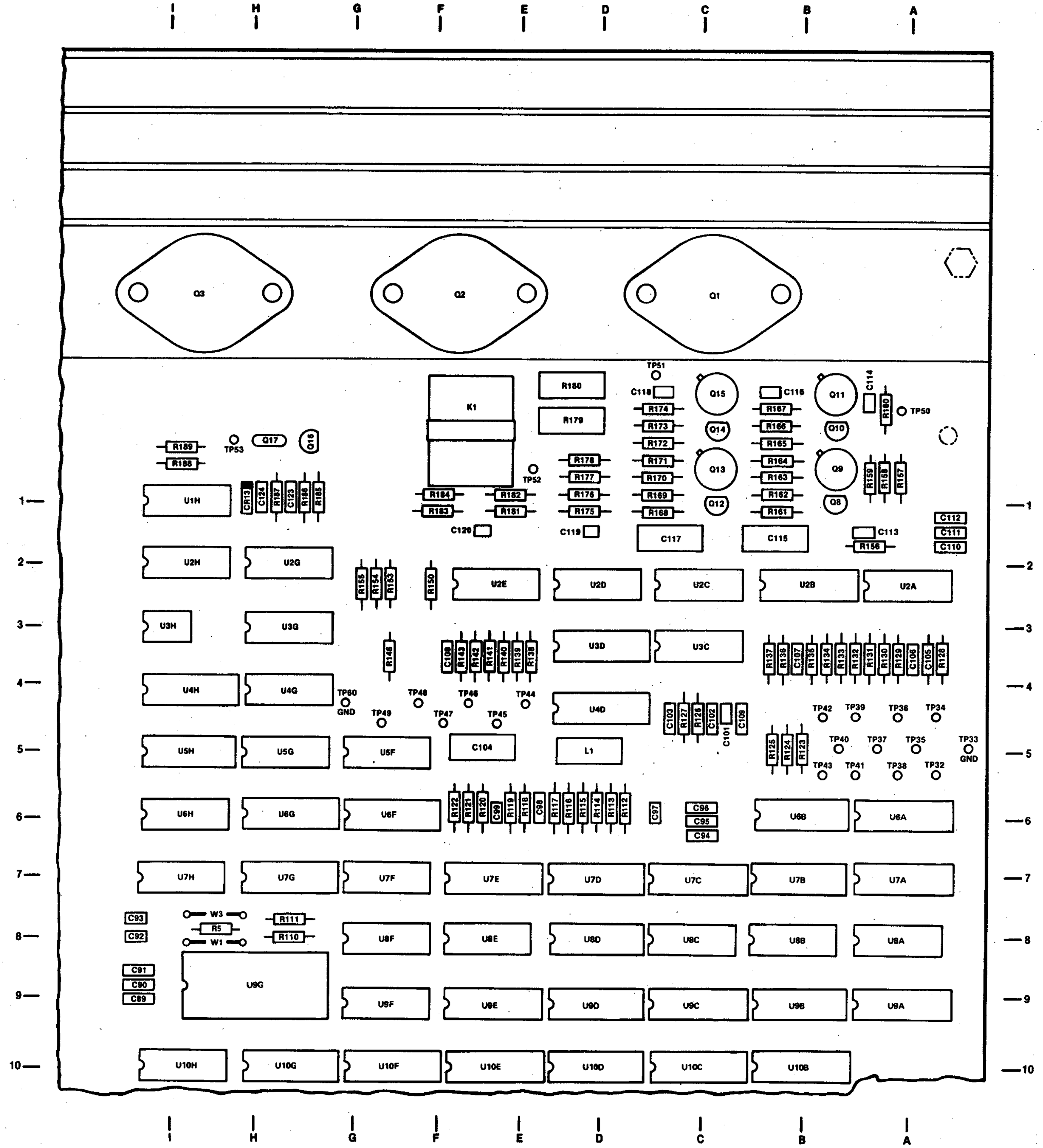


Figure 5-12. Drive Formatter PWB
(Orthographic View)

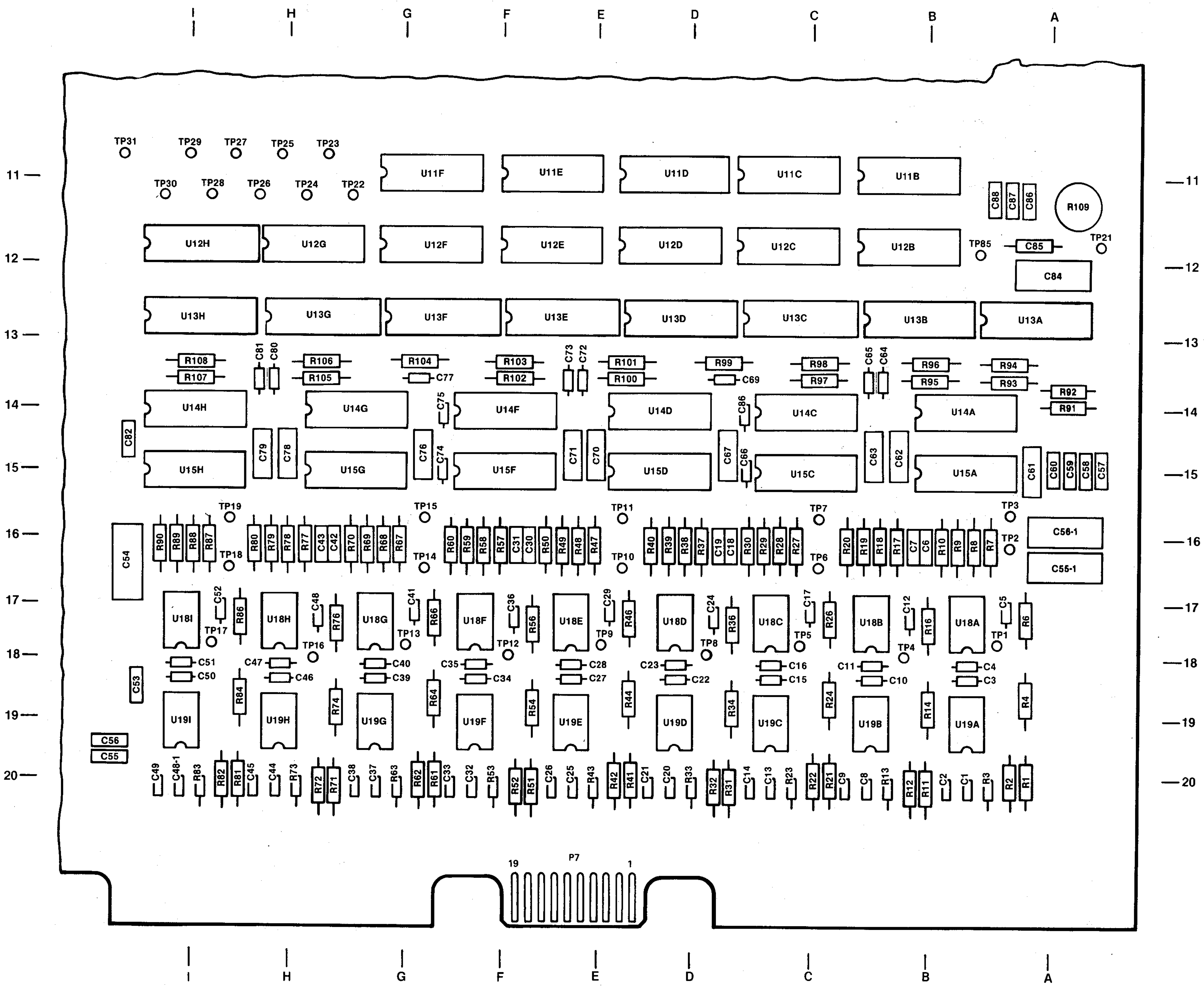


Figure 5-12. Drive Formatter PWB
(Orthographic View)

Figure 5-12
Sheet 3 of 4

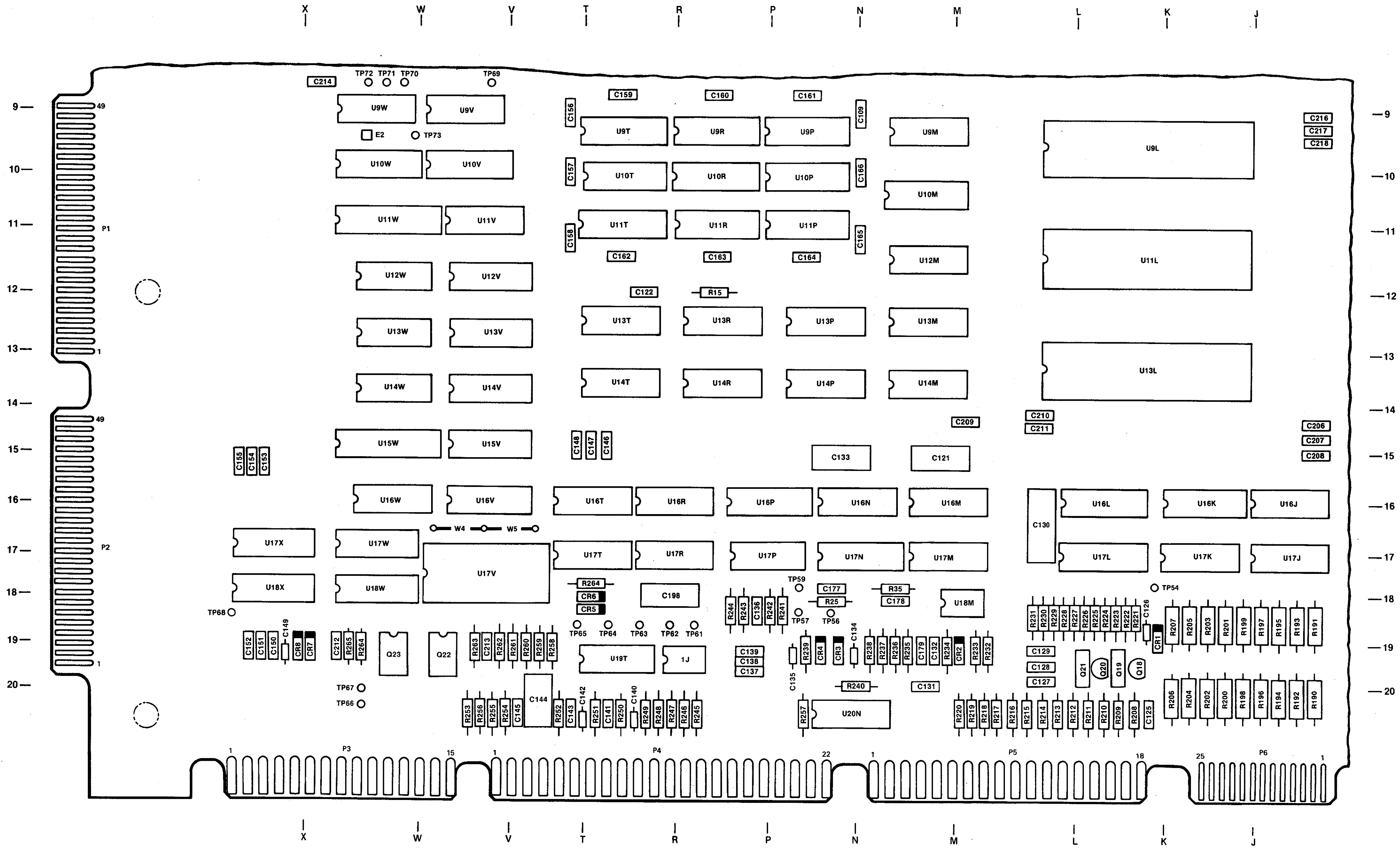


Figure 5-12. Drive Formatter PWB
(Orthographic View)

Figure 5-12
Sheet 4 of 4

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12	961019-002 961018-002 961020-002 961017-002	PRINTED WIRING BOARD ASSEMBLY............ Subassembly, drive-formatter (See Figure 5-6 for next higher assembly)	REF	A B C D
		(The following components are listed in alpha-numeric sequence according to their reference designation. Consult the schematic for location in the circuit.)		
C1	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C2	201204272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	
C3	201204-331	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 50V	1	
C4	201204-472	. CAPACITOR, Ceramic, 47.0 pF .... ±5%, 50V	1	
C5- C7	201114-105	. CAPACITOR, Ceramic, 0.010 uF .... ±10%, 50V	3	
C8	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C9	201204-272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	
C10	201204-331	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 50V	1	
C11	201204-472	. CAPACITOR, Ceramic, 47.0 pF .... ±5%, 50V	1	
C12	201114-105	. CAPACITOR, Ceramic, 0.010 uF .... ±10%, 50V	1	
C13	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C14	201204-272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
C15	201204-331	. CAPACITOR, Ceramic, 3.3 pF ±5%, 50V	1	
C16	201204-472	. CAPACITOR, Ceramic, 47.0 pF ±5%, 50V	1	
C17-C19	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	3	
C20	201103-820	. CAPACITOR, Ceramic, 0.0082 uF ±10%, 50V	1	
C21	201204-272	. CAPACITOR, Ceramic, 27.0 pF ±5%, 50V	1	
C22	201204-331	. CAPACITOR, Ceramic, 3.3 pF ±5%, 50V	1	
C23	201204-472	. CAPACITOR, Ceramic, 47.0 pF ±5%, 50V	1	
C24	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C25	201103-820	. CAPACITOR, Ceramic, 0.0082 uF ±10%, 50V	1	
C26	201204-272	. CAPACITOR, Ceramic, 27.0 pF ±5%, 50V	1	
C27	201204-331	. CAPACITOR, Ceramic, 3.3 pF ±5%, 50V	1	
C28	201204-472	. CAPACITOR, Ceramic, 47.0 pF ±5%, 50V	1	
C29, C31	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	3	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
C32	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C33	201204-272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	
C34	201204-331	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 50V	1	
C35	201204-472	. CAPACITOR, Ceramic, 47.0 pF .... ±5%, 50V	1	
C36	201114-105	. CAPACITOR, Ceramic, 0.010 uF .... ±10%, 50V	1	
C37	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C38	201204-272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	
C39	201204-331	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 50V	1	
C40	201204-472	. CAPACITOR, Ceramic, 47.0 pF .... ±5%, 50V	1	
C41-C43	20114-105	. CAPACITOR, Ceramic, 0.010 uF .... ±10%, 50V	3	
C44	201103-820	. CAPACITOR, Ceramic, 0.0082 uF .... ±10%, 50V	1	
C45	201204-272	. CAPACITOR, Ceramic, 27.0 pF .... ±5%, 50V	1	
C46	201204-331	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 50V	1	
C47	201204-472	. CAPACITOR, Ceramic, 47.0 pF .... ±5%, 50V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
C48	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C48-1	201103-820	. CAPACITOR, Ceramic, 0.0082 uF ±10%, 50V	1	
C49	201204-272	. CAPACITOR, Ceramic, 27.0 pF ±5%, 50V	1	
C50	201204-331	. CAPACITOR, Ceramic, 3.3 pF ±5%, 50V	1	
C51	201204-472	. CAPACITOR, Ceramic, 47.0 pF ±5%, 50V	1	
C52, C53	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	2	
C55-1	201160-680	. CAPACITOR, Tantalum, 6.8 uF ±10%, 35V	1	
C55-C62	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	8	
C56-1	201160-680	. CAPACITOR, Tantalum, 6.8 uF ±10%, 35V	1	
C63	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C64	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	1	
C65	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C66	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	1	
C67	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
C68, C69	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	2	
C70-C73	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	4	
C74, C75	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	2	
C76	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C77	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	1	
C78, C79	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	2	
C80, C81	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	2	
C82	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	
C84	201114-470	. CAPACITOR, Ceramic, 0.047 uF ±10%, 50V	1	
C85-C91	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	7	
C92, C93	201204-473	. CAPACITOR, Ceramic, 470 pF ±5%, 50V	2	
C94-C96	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	3	
C97	201204-183	. CAPACITOR, Ceramic, 180 pF ±5%, 50V	1	
C98	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
C99	201204-333	. CAPACITOR, Ceramic, 330 pF ±5%, 50V	1	
C100	201114-106	. CAPACITOR, Ceramic, 0.10 uF ±10%, 50V	1	
C101	201204-472	. CAPACITOR, Ceramic, 47.0 pF ±5%, 50V	1	
C102, C103	201114-105	. CAPACITOR, Ceramic, 0.10 uF ±10%, 50V	2	
C104	201224-224	. CAPACITOR, Mylar, 0.22 uF	1	
C105, C106	201114-154	. CAPACITOR, Ceramic, .0015 uF ±10%, 50V	2	
C107	201114-106	. CAPACITOR, Ceramic, 0.10 uF ±10%, 50V	1	
C109-C112	201114-105	. CAPACITOR, Ceramic, 0.010 uF ±10%, 50V	4	
C113, C114	201114-104	. CAPACITOR, Ceramic, 0.0010 uF ±10%, 50V	2	
C115	201224-684	. CAPACITOR, Mylar, 0.68 uF	1	
C116	201204-203	. CAPACITOR, Ceramic, 200 pF ±5%, 50V	1	
C117	201224-684	. CAPACITOR, Mylar, 0.68 uF	1	
C118	201204-203	. CAPACITOR, Ceramic, 200 pF ±5%, 50V	1	
C119-C121	201114-470	. CAPACITOR, Ceramic, 0.047 uF ±10%, 50V	3	
C122	201204-103	. CAPACITOR, Ceramic, 100 pF ±5%, 50V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
Q6	204026-050	. TRANSISTOR, Darlington, PNP	1	
Q7	203007-500	. INTEGRATED CIRCUIT, 3 amp .... 5 Volt positive	1	
Q8	204010-535	. TRANSISTOR, PNP, Silicon....................	1	
Q9	204007-700	. TRANSISTOR, Power, NPN....................	1	
Q10	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q11	204010-700	. TRANSISTOR, Power, PNP	1	
Q12	204010-535	. TRANSISTOR, PNP Silicon	1	
Q13	204007-700	. TRANSISTOR, Power, NPN....................	1	
Q14	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q15	204010-700	. TRANSISTOR, Power, PNP	1	
Q16	203013-317	. INTEGRATED CIRCUIT, Regulator .... + 5V, ±5%	1	
Q17	204027-037	. TRANSISTOR, NPN, Silicon	1	
Q18	204012	. TRANSISTOR, PNP, Silicon....................	1	
Q19	204027-034	. TRANSISTOR, PNP, Silicon....................	1	
Q20	204012	. TRANSISTOR, PNP, Silicon....................	1	
Q21	204027-034	. TRANSISTOR, PNP, Silicon....................	1	
Q22	204027-037	. TRANSISTOR, NPN, Silicon	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
Q23	204027-037	. TRANSISTOR, NPN, Silicon	1	
Q24	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q25	204010-535	. TRANSISTOR, PNP, Silicon	1	
Q26	204010-533	. TRANSISTOR, NPN, Silicon	1	
R1	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R2	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4W ±5%	1	
R3	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R3P	203085-001	. INTEGRATED CIRCUIT, Schmitt triggered input, Hex IV	1	
R4, R5	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R5R	203085-001	. INTEGRATED CIRCUIT, Schmitt triggered input, Hex IV	1	
R6	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R7	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R8, R9	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R10	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R11	200071-680	. RESISTOR, FC, 68 K Ohm, 1/4 W ±5%	1	
R12	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R13	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R14	200074-100	.RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R14A, D, G	203085-001	. INTEGRATED CIRCUIT, Schmitt Triggered input, Hex IV	3	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R15	200073-820	. RESISTOR, FC, 8.20 K Ohm, 1/4 W ±5%	1	
R16	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R17	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R18, R19	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R20	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R21	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R22	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R23	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R24	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R25	200076-100	. RESISTOR, FC. 1.00 meg ohm, 1/4 W ±5%	1	
R26	200074-150	. RESISTOR, FC, 15.00 K Ohm. 1/4 W ±5%	1	
R27	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R28, R29	200074-100	. RESISTOR, FC. 10.00 K Ohm, 1/4 W ±5%	2	
R30	200073-470	. RESISTOR, FC, 4.70 K Ohm. 1/4 W ±5%	1	
R31	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R32	200073-330	. RESISTOR, FC, 3.30 K Ohm. 1/4 W ±5%	1	
R33	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R34	200074-100	. RESISTOR, FC. 10.00 K Ohm. 1/4 W ±5%	1	
R35	200075-200	. RESISTOR, FC, 200.00 K Ohm, 1/4 W ±5%	1	
R36	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R37	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R38, R39	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R40	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R41	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R42	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R43	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R44	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R46	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R47	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R48, R49	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R50	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R51	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R52	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R53	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R54	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R56	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R57	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R58, R59	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R60	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R61	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R62	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R63	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R64	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R66	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R67	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R68, R69	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R70	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R71	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R72	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R73	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R74	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R76	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R77	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R78, R79	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R80	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R81	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R82	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R83	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W ±5%	1	
R84	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R86	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R87	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%	1	
R88, R89	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R90-R108	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	19	
R109	200209-202	. POTIOMETER, Ceramic, 2 K Ohm	1	
R110, R111	200075-220	. RESISTOR, FC, 220.00 K Ohm, 1/4 W ±5%	2	
R112, R113	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	2	
R114	200074-620	. RESISTOR, FC, 62.00 K Ohm, 1/4 W ±5%	1	
R115	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%	1	
R116	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R117	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%	1	
R118	200073-150	. RESISTOR, FC, 1.50 K Ohm. 1/4 W± 5%.	1	
R119	200072-100	. RESISTOR, FC, 100 Ohm, 1/4 W ±5%	1	
R120	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W ±5%	1	
R121	200023-301	. RESISTOR, FF, 3.01 K Ohm, 1/4 W ±1%	1	
R122	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W ±1%	1	
R123, R124	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W ±1%	2	
R125	200074-100	. RESISTOR, FC. 10.00 K Ohm, 1/4 W ±5%	1	
R126, R127	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W ±1%	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R128	200074-510	. RESISTOR, FC, 51.00 K Ohm, 1/4 W ±5%	1	
R129	200075-180	. RESISTOR, FC, 180.00 K Ohm, 1/4 W ±5%	1	
R130	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W ±1%	1	
R131	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W ±5%	1	
R132	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W ±1%	1	
R133	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W ±5%	1	
R134	200074-150	. RESISTOR, FC. 15.00 K Ohm, 1/4 W ±5%	1	
R135	200075-180	. RESISTOR, FC, 180.00 K Ohm, 1/4 W ±5%	1	
R136	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W ±5%	1	
R137	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W ±1%	1	
R138	200071-820	. RESISTOR, FC, 82 Ohm, 1/4 W ±5%	1	
R139	200072-150	. RESISTOR, FC. 150 Ohm, 1/4 W ±5%	1	
R140	200014-301	. RESISTOR, FF, 30.1 K Ohm, 1/8 W ±1%	1	
R141	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W ±1%..........	1	
R142	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W ±1%	1	
R143	200074-200	. RESISTOR, FC. 20.00 K Ohm, 1/4 W ±5%	1	
R146	200076-510	. RESISTOR, FC, 5.1 meg Ohm, 1/4 W ±5%........	1	
R147	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W ±5%.........	1	
R148	200075-330	. RESISTOR, FC. 330.00 K Ohm, 1/4 W ±5%.......	1	
R149	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%	1	
R150	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R153	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%	1	
R154	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%	1	
R155	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R156	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W ±5%	1	
R157	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%	1	
R158	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R159	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W ±5%	1	
R160	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W ±5%	1	
R161	200074-180	. RESISTOR, FC, 18.00 K Ohm, 1/4 W ±5%	1	
R162	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R163	200072-390	. RESISTOR, FC. 390 Ohm, 1/4 W ±5%	1	
R164	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R165	200074-180	. RESISTOR, FC, 18.00 K Ohm, 1/4 W ±5%	1	
R166	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R167	200072-390	. RESISTOR, FC, 390 Ohm, 1/4 W ±5%	1	
R168	200074-180	. RESISTOR, FC. 18.00 K Ohm, 1/4 W ±5%	1	
R169	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R170	200072-390	. RESISTOR, FC, 390 Ohm, 1/4 W ±5%	1	
R171	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R172	200074-180	. RESISTOR, FC, 18.00 K Ohm, 1/4 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R173	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W ±5%	1	
R174	200072-390	. RESISTOR, FC, 390 Ohm, 1/4 W ±5%	1	
R175, R176	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%	2	
R177, R178	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W ±1%	2	
R179, R180	200509-100	. RESISTOR, WW, 1 Ohm, 3 W ±1%	2	
R181	200014-301	. RESISTOR, FF, 30.1 K Ohm, 1/8 W ±1%	1	
R182	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W ±1%	1	
R183, R184	200013-100	. RESISTOR, FF, 1.00 K Ohm, 1/8 W ±1%	2	
R185	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W ±5%	1	
R186	200072-200	. RESISTOR, FC, 200 Ohm, 1/4 W ±5%	1	
R187	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W ±5%	1	
R188	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W ±1%	1	
R189	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W ±1%	1	
R190	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	1	
R191, R192	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	2	
R193, R195	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	3	
R196	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R197	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	1	
R198	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	1	
R199, R200	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	2	
R201	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	1	
R202	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	1	
R203, R204	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	2	
R205	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	1	
R206	200082-470	. RESISTOR, FC, 470 Ohm, 1/2 W ±5%	1	
R207	200082-560	. RESISTOR, FC, 560 Ohm, 1/2 W ±5%	1	
R208	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W ±5%	1	
R209	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%	1	
R210	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R211	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%	1	
R212	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R213	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%	1	
R214	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R215	200072-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%	1	
R216	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R217	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R218	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R219	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W ±5%.......	1	
R220	200071-150	. RESISTOR, FC, 15 Ohm, 1/4 W ±5%	1	
R221	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W ±5%.............	1	
R222	200072-240	. RESISTOR, FC, 240 Ohm, 1/4 W ±5%............	1	
R223	200073-100	. RESISTOR, FC. 1.00 K Ohm, 1/4 W ±5%.........	1	
R224	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%.........	1	
R225	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%.........	1	
R226	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W ±5%.........	1	
R227	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W ±5%.........	1	
R228	200074-100	. RESISTOR, FC, 10.0 K Ohm, 1/4 W ±5%.........	1	
R229-R231	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W ±5%.......	3	
R232	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	1	
R233	200071-150	. RESISTOR, FC, 15 Ohm, 1/4 ±5%...............	1	
R234	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W ±1%	1	
R235, R236	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%.........	2	
R237	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W ±5%.......	1	
R238	200076-470	. RESISTOR, FC, 4.70 meg Ohm. 1/4 W±5%........	1	
R239	200016-100	. RESISTOR, FF, 1.00 meg Ohm, 1/8 W ±1%.	1	
R240	200076-470	. RESISTOR, FC, 4.70 meg Ohm,1/4 W ±5%........	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R241	200073-130	. RESISTOR, FC, 1.30 K Ohm, 1/4 W ±5%.........	1	
R242	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W ±5%........	1	
R243	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	1	
R245	200073-130	. RESISTOR, FC, 1.30 K Ohm, 1/4 W ±5%.........	1	
R246	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W ±5%............	1	
R247	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%........	1	
R248	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W ±5%............	1	
R249	200072-100	. RESISTOR, FC, 100 Ohm, 1/4 W. ±5%.	1	
R250	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W ±5%............	1	
R251	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%........	1	
R252	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%.........	1	
R253	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W ±5%............	1	
R254	200070-560	. RESISTOR, FC, 5.60 Ohm, 1/4 W ±5%.	1	
R255	200072-150	. RESISTOR, FC, 150 Ohm 1/4 W 5%.	1	
R256	200074-430	. RESISTOR, FC, 43.00 K Ohm, 1/4 W ±5%........	1	
R257	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	1	
R258	200074-430	. RESISTOR, FC, 43.00 K Ohm, 1/4 W ±5%........	1	
R259	200074-100	. RESISTOR, FC, 10.0 K Ohm, 1/4 W ±5%.........	1	
R260	200074-120	. RESISTOR, FC, 12.00 K Ohm, 1/4 W ±5%........	1	
R261-R263	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%........	3	
R264	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W ±5%............	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R264-1	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W ±5%........	1	
R265	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W ±5%............	1	
R267	200013-249	. RESISTOR, FF, 2.49 K Ohm, 1/8 W ±5%	1	
R268-R170	200013-499	. RESISTOR, FF, 4.99 K Ohm, 1/8 W ±5%	3	
R271	2000520-100	. RESISTOR, FC, 1 Ohm.	1	
R272-R274	200072-330	. RESISTOR, FC, 330 Ohm 1/4 W ±5%.	3	
R275	200013-499	. RESISTOR, FF, 4.99 K Ohm, 1/8 W ±5%	1	
R276, R277	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%.........	2	
R278	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	1	
R279	200072-680	. RESISTOR, FC, 680 Ohm, 1/4 W ±5%............	1	
R280	200082-510	. RESISTOR, FC, 510 Ohm 1/2 W ±5%.	2	
R281	200072-750	. RESISTOR, FC, 750 Ohm 1/4 W ±5%.	1	
R282, R283	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W ±5%.........	2	
R284-R292	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	9	
R293, R294	200093-150	. RESISTOR, FC, 1.5 K Ohm, 1 W ±5%............	2	
R295	200073-100	. RESISTOR, FC, 1.00 K Ohm , 1/4 W ±5%........	1	
R296	200072-270	. RESISTOR, FC, 270 Ohm, 1/4 W ±5%............	1	
R297	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
R298	200072-270	. RESISTOR, FC, 270 Ohm, 1/4 W ±5%............	1	
R299	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R300	200073-470	. RESISTOR, FC. 4.70 K Ohm, 1/4 W ±5%.........	1	
R301	200072-330	. RESISTOR, FC, 330 Ohm, 1/4 W ±5%............	1	
R302-R305	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W ±5%.........	4	
R306	200071-220	. RESISTOR, FC, 22 Ohm, 1/4 W ±5%.............	1	
R307	200072-750	. RESISTOR, FC, 750 Ohm, 1/4 W 5%.............	1	
R308	200073-120	. RESISTOR, FC, 1.20 K, 1/4 W ±5%..............	1	
R309-R311	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%.	3	
R312	2000214-102	. POTIOMETER,PC. 1 K Ohm....................	1	
R313	200072-750	. RESISTOR, FC. 750 Ohm, 1/4 W ±5%............	1	
R314	200073-110	. RESISTOR, FC, 1.10 K Ohm, 1/4 W ±5%.	1	
R315, R316	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W ±5%.........	2	
R317	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W ±5%.	1	
R318	200073-240	. RESISTOR, FC, 2.40 K Ohm, 1/4 W ±5%.	1	
R319	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W ±5%.	1	
R320	200076-100	. RESISTOR, FC. 1.00 meg Ohm, 1/4 W ±5%.......	1	
R321	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W ±5%............	1	
R322, R323	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4W ±5%	2	
TP1-TP86	205026-999	. TEST POINT 0.058 in dia pin....................	86	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
TP21-TP54	205026	. TEST POINT 0.058 in dia pin	34	
TP56, TP57	205026	. TEST POINT 0.058 in dia pin	2	
TP59-TP86	205026	. TEST POINT 0.058 in dia pin	28	
U1H	203035-032	. INTEGRATED CIRCUIT, Quad 2 input .... positive OR gate	1	
U1K	203046-150	. INTEGRATED CIRCUIT, BCD-to-Decimal....... decoder	1	
U1L	203102-373	. INTEGRATED CIRCUIT, Octal................. D-type latch	1	
U1P	203027-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive and gate	1	
U2A	203012-136	. INTEGRATED CIRCUIT, Quad operational....... amplifiers	1	
U2B	203052-053	. INTEGRATED CIRCUIT, Multiplxr, triple .... 2 channel	1	
U2C	203012-136	. INTEGRATED CIRCUIT, Quad operational....... amplifiers	1	
U2E	203031-050	. INTEGRATED CIRCUIT, Dual 4-input........... positive NAND gate	1	
U2G	970221-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U2K	203026-999	. INTEGRATED CIRCUIT, Hex inverter	1	
U2L	203102-373	. INTEGRATED CIRCUIT, Octal D-type latch	1	
U2N	203575-120	. INTEGRATED CIRCUIT, CPU, 16 bit, 4 MHz	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U2P	203035-032	. INTEGRATED CIRCUIT, Quad 2-input .... positive OR gate	1	
U2T	203554-001	. INTEGRATED CIRCUIT, DMA, 8 bit, 4 MHz	1	
U2V	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U2W	203102-375	. INTEGRATED CIRCUIT, D Flop, octal	1	
U3C	203071-999	. INTEGRATED CIRCUIT, Dual V cont, MLTV.....	1	
U3D	203094-501	. INTEGRATED CIRCUIT, Dual J-K, positive...... edge trigger	1	
U3G	203029-003	. INTEGRATED CIRCUIT, Trip, 3-input .... AND gate	1	
U3H	203007-393	. INTEGRATED CIRCUIT, Comparator, low....... offset	1	
U3K	203042-510	. INTEGRATED CIRCUIT, Counter/Latch......... binary	1	
U3L	961385-001	. SOFTWARE ASSY, High ROM.................	1	A
U3L	961641-001	. SOFTWARE ASSY, High ROM.................	1	B
U3L	961391-001	. SOFTWARE ASSY, High ROM.................	1	C
U3L	961643-001	. SOFTWARE ASSY, High ROM.................	1	D
U3N	203075-002	. INTEGRATED CIRCUIT, 2 K X 8 RAM..........	1	
U3R	203030-367	. INTEGRATED CIRCUIT, Hex bus driver.........	1	
U3T	211015-003	. SWITCH Dip, 8 position, sealed................	1	
U3V	970221-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U3W	205255-500	. RESISTOR, Network, 220/330 Ohm	1	
U4D	203048-150	. INTEGRATED CIRCUIT, synchronous 4 .... bit counter	1	
U4G, U4H	203026-001	. INTEGRATED CIRCUIT, Hex inverter	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U4P	970010-001	. INTEGRATED CIRCUIT, Quad 2-input positive AND gate	1	
U4R	203030-367	. INTEGRATED CIRCUIT, Hex bus driver	1	
U4T	205257-101	. RESISTOR Network, 10 K Ohm.	1	
U4V	203029-003	. INTEGRATED CIRCUIT, Trip, 3-input AND gate	1	
U4W	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	1	
U5F	203029-010	. INTEGRATED CIRCUIT, Triple 3-input	1	
U5G	203012-999	. INTEGRATED CIRCUIT, Phase freq detectior	1	
U5H	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	1	
U5K	203035-032	. INTEGRATED CIRCUIT, Quad 2-input positive OR gate	1	
U5L	961385-002	. SOFTWARE ASSY, Low ROM	1	A
U5L	961641-002	. SOFTWARE ASSY, Low ROM	1	B
U5L	961391-002	. SOFTWARE ASSY, Low ROM	1	C
U5L	961643-002	. SOFTWARE ASSY, Low ROM	1	D
U5N	203075-002	. INTEGRATED CIRCUIT, 2K X 8 RAM	1	
U5P	203039-001	. INTEGRATED CIRCUIT, Dual D flip-flop	1	
U5T	203052-244	. INTEGRATED CIRCUIT, Octal buffer, tri-state	1	
U5V	970221-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	1	
U5W	211015-003	. SWITCH Dip, 8 position sealed	1	
U6A, U6B	203094-501	. INTEGRATED CIRCUIT, Dual J-K, positive edge trigger	2	
U6F, U6G	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip-flop	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U6H	203007-700	. INTEGRATED CIRCUIT, Voltage comparator	1	
U6J-U6K U6L	203130-999	. INTEGRATED CIRCUIT, JFET input, op amp	3	
U6M	203550-001	. INTEGRATED CIRCUIT, D to A, 10 bit..........	1	
U6N	203550-501	. INTEGRATED CIRCUIT, A to D, 10 bit..........	1	
U6P	203082-500	. INTEGRATED CIRCUIT, Hex buffer/drivers	1	
U6R	203035-032	. INTEGRATED CIRCUIT, Quad 2-input .... positive OR gate	1	
U6T	203102-373	. INTEGRATED CIRCUIT, Octal D-type latch	1	
U6V	203051-174	. INTEGRATED CIRCUIT, Hex D-type .... flip-flop	1	
U6W	203046-148	. INTEGRATED CIRCUIT, 3-8 Line decoder	1	
U7A, U7B	203094-501	. INTEGRATED CIRCUIT, Dual J-K, positive...... edge trigger	2	
U7C	203046-151	. INTEGRATED CIRCUIT, 1 to 8 data. .... select multiplexer	1	
U7D	203048-150	. INTEGRATED CIRCUIT, Synchronous 4 .... bit counter	1	
U7E	203046-153	. INTEGRATED CIRCUIT, 4-1 Line .... select multiplexer	1	
U7F	203049-164	. INTEGRATED CIRCUIT 8 Bit parallel........... output	1	
U7G	160102-445	. SOFTWARE ASSY, PE controller	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U7H	203027-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive AND gate	1	
U7J, U7N	203052-051	. INTEGRATED CIRCUIT, MULTIPLXER, 8 channel	2	
U7P	203046-132	. INTEGRATED CIRCUIT, Quad, 2-input..........	1	
U7R, U7T	203102-245	. INTEGRATED CIRCUIT, Octal bus .... tranceivers	2	
U7V	203027-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive AND gate	1	
U7W	203036	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
U8A-U8L	203026-001	. INTEGRATED CIRCUIT, Hex inverter	3	
U8D	203046-148	. INTEGRATED CIRCUIT, 3-8 Line decoder	1	
U8E, U8F	203049-164	. INTEGRATED CIRCUIT, 8 Bit parallel .... output	2	
U8V	970221-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND	1	
U8W	203036	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
U9A-U9D	203048-150	. INTEGRATED CIRCUIT, Synchronous 4 .... bit counter	4	
U9E	203047-157	. INTEGRATED CIRCUIT, Quad 2 to 1 .... line, data	1	
U9F	203049-164	. INTEGRATED CIRCUIT 8-Bit parallel .... output	1	
U9G	160101-447	. SOFTWARE Assembly, Read deskew	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U9L	203555-120	. INTEGRATED CIRCUIT, CIO, 16 bit, 4 MHz	1	
U9M	203035-032	. INTEGRATED CIRCUIT, Quad 2 input .... positive OR gate	1	
U9P, U9R, U9T	203564-123	. INTEGRATED CIRCUIT, Memory MOS.......... RAM 64 K x 1	3	
U9W	203036	. INTEGRATED CIRCUIT, Quad 2 input .... positive NAND buffer	1	
U10B-U10E	203048-150	. INTEGRATED CIRCUIT, Synchronous 4 bit ...... counter	4	
U10F, U10G	203046-151	. INTEGRATED CIRCUIT, 1 of 8 Data............ select multiplexer	2	
U10H	203082-500	. INTEGRATED CIRCUIT, Hex buff/drivers	1	
U10M	203051-100	. INTEGRATED CIRCUIT, Quad, D-type .... flip flop	1	
U10P, U10R, U10T	203564-123	. INTEGRATED CIRCUIT, Memory MOS.......... RAM 64 K x 1	3	
U10W	205255-500	. RESISTOR Network, 220/330 Ohm..............	1	
U11B, U11C	970221-001	. INTEGRATED CIRCUIT, Quad 2 input .... positive NAND gate	2	
U11D	203048-150	. INTEGRATED CIRCUIT, Synchronous........... 4 bit counter	1	
U11E, U11F	970221-001	. INTEGRATED CIRCUIT, Quad 2 input .... positive NAND gate	2	
U11L	203555-120	. INTEGRATED CIRCUIT, CIO, 16 bit, 4 MHz	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U11P, U11R, U11T	203564-123	. INTEGRATED CIRCUIT, Memory MOS RAM 64 K x 1	3	
U11V	203061-280	. INTEGRATED CIRCUIT, Parity tree, 9 input	1	
U11W	203030-202	. INTEGRATED CIRCUIT, Octal, bus driver	1	
U12B, U12C, U12D	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	3	
U12E	970221-001	. INTEGRATED CIRCUIT, Quad 2 input positive NAND gate	1	
U12F, U12G	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	2	
U12H	160101-461	. SOFTWARE Assembly data drop	1	
U12M	203035-032	. INTEGRATED CIRCUIT, Quad 2 input positive OR gate	1	
U12V	203051-100	. INTEGRATED CIRCUIT, Quad D-type flip flop	1	
U13A	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13B, U13C	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	2	
U13D	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13E, U13F	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	2	
U13G	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13H	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U13L	203555-120	. INTEGRATED CIRCUIT, CIO, 16 bit, 4 MHz	1	
U13M	203035-032	. INTEGRATED CIRCUIT, Quad 2 input,........... positive OR gate	1	
U13P	203036-039	. INTEGRATED CIRCUIT, Quad bus buffer........	1	
U13R	203039-001	. INTEGRATED CIRCUIT, Dual-D flip flop........	1	
U13T	203044	. INTEGRATED CIRCUIT, MNST MLTV	1	
U13V	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop....	1	
U13W	203039-001	. INTEGRATED CIRCUIT, Dual-D flip flop........	1	
U14D, U14F, U14H	203007-350	. INTEGRATED CIRCUIT, Volt comp buffer.......	3	
U14M	203036	. INTEGRATED CIRCUIT, Quad 2 input .... positive NAND buffer	1	
U14P	203039-001	. INTEGRATED CIRCUIT, Dual-D flip flop........	1	
U14R	970010-001	. INTEGRATED CIRCUIT, Quad 2 input .... postive AND gate	1	
U14T	203039-001	. INTEGRATED CIRCUIT, Dual D-Flip flop	1	
U14V	203051-100	. INTEGRATED CIRCUIT, Quad D-type .... flip flop	1	
U14W	203049-164	. INTEGRATED CIRCUIT, 8-bit parallel.......... output	1	
U15A, U15C, U15D, U15F-U15H	203007-350	. INTEGRATED CIRCUIT, Voltage............... comp/buffer	6	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U15V	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop....	1	
U15W	203102-375	. INTEGRATED CIRCUIT, D-flop, octal	1	
U16J	203026-500	. INTEGRATED CIRCUIT, Hex inverter .... buffer/driver	1	
U16K	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop....	1	
U16L	203122-368	. INTEGRATED CIRCUIT, Hex bus driver.........	1	
U16M, U16N	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate........	2	
U16P	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop....	1	
U16R	203029-002	. INTEGRATED CIRCUIT, Triple 3-input .... positive NAND gate	1	
U16T	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U16V	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop....	1	
U16W	203027-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U17J, U17K	203082-500	. INTEGRATED CIRCUIT, Hex buffer/drivers	2	
U17L	203051-100	. INTEGRATED CIRCUIT, Quad D-type flip flop...	1	
U17M	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate........	1	
U17N	203051-100	. INTEGRATED CIRCUIT, Quad D-type flip flop...	1	
U17P	203029-500	. INTEGRATED CIRCUIT, Hex ST inverter........	1	
U17R	203039-001	. INTEGRATED CIRCUIT, D-flip flop	1	
U17T	970221-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
U17V	960422-001	. SOFTWARE ASSY, Write	1	
U17W	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U17X	203026-500	. INTEGRATED CIRCUIT, Hex inverter buffer/driver	1	
U18A-U18I, U18M	203130	. INTEGRATED CIRCUIT, Jfet input operational amplifier	10	
U18W	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U18X	203026-500	. INTEGRATED CIRCUIT, Hex inverter buffer/driver	1	
U19A-U19I	203043-500	. INTEGRATED CIRCUIT, Operational amplifier, high performance	9	
U19T	203007-700	. INTEGRATED CIRCUIT, Voltage comparator	1	
U20N	203012-136	. INTEGRATED CIRCUIT, Quad operational amplifier	1	
VR1	203013-300	. INTEGRATED CIRCUIT, Voltage regulator	1	
VR2	203013-320	. INTEGRATED CIRCUIT, Voltage regulator	1	
XJ1	211011-008	. SOCKET, 8 pin, low profile	1	
XQ9, XQ11, XQ13 XQ15	211116	. TRANSIPAD TO-5	4	
XU2N, XU2T	211011-040	. SOCKET, 40 pin, low profile	2	
XU3L	211011-028	. SOCKET, 28 pin, low profile	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-12				
XU9G	211011-024	. SOCKET, 24 pin, low profile	1	
XU9L	211011-040	. SOCKET, 40 pin, low profile	1	
XU9T, XU9P, XU9T, XU9W	211011-016	. SOCKET, 16 pin, low profile	4	
XU11L	211011-040	. SOCKET, 40 pin, low profile	1	
XU11P, XU11R, XU11T XU12H	211011-016	. SOCKET, 16 pin, low profile	4	
XU13L	211011-040	. SOCKET, 40 pin, low profile	1	
XUK1	211078-999	. SOCKET, relay	1	
XUX7G, XUXU3W	211011-016	. SOCKET, 16 pin, low profile	2	
XUXU5L	211011-028	. SOCKET, 28 pin, low profile	1	
XUXU9P, XUXU9R	211011-016	. SOCKET, 16 pin, low profile	2	
XU16K	205025-516	. SOCKET, 16 pin, low profile	1	
XU17V	211011-024	. SOCKET, 24 pin, low profile	1	
Y1	210111-768	. CRYSTAL, 7.680 MHz	1	

SECTION VI

GLOSSARY OF TERMS

AD0-AD15	Multiplexed address/data lines used to provide addresses and route data between the microprocessor and certain memory devices.
A/D	Analog-to-digital converter.
ADSTB	DMA address strobe output used to strobe the upper address byte into the cache address latch.
AL0-AL15	Latched address lines used by the microprocessor to address and enable control circuit memory devices and I/O devices.
$\overline{AS}$	Microprocessor address strobe. When active, indicates that the signals on the address lines are valid addresses.
AX0-AX7	DMA address lines. The four least significant bits (AX0-AX3) are bidirectional; the four most significant bits are outputs and are enabled only during DMA service.
BITCLK	Bit Clock. Used to generate PECLK when both channel two and channel one are dropped.
Block	Term identifying a data record. Block sizes of 9K, 16K, 24K, or 32K bytes are selectable via configuration switch U3T.
BOT	Beginning of Tape. Indicated by a reflective marker placed on the tape that is detected by an optical sensor.
BPI	Bits per inch. Specifies the packing density of data on the tape (1600 bpi standard, 3200 bpi optional).
B/$\overline{W}$	Byte/Word. A microprocessor output that defines the type of memory reference on the address/data bus.
CAS	Column Address Strobe. Used in cache memory addressing to enable columns of data in the cache RAM's.
CDATAX	Corrected Data Multiplexed. Data byte that is sent to the cache bus register in serial form.

CHANP, 0-7	Write data transmitted to the write head via drivers U17J and U17K.
CHDROP P, 0-7	Channel Drop Multiplexed. This signal represents the multiplexed channel drop signals.
CIO	Counter/timer and parallel I/O unit. Devices used to generate timing signals and provide I/O parts for the microprocessor.
CLK4	A 3.84-MHz clock signal used as a peripheral clock (PCLK) by the CIO's, and by the DMA logic and cache memory addressing circuit.
CLK5	A 3.84-MHz clock signal used to clock the analog-to-digital converter.
Command Reinstruct Time	During streaming operation, a period of time after reading or writing the last character of a data block in which the system must instruct the tape drive either to continue or enter a repositioning cycle.
CTU	Short form for the Models M890 and M891 CacheTape Unit.
DAC	Digital-to-analog converter device.
$\overline{\mathrm{DACK0}}$-$\overline{\mathrm{DACK3}}$	Data acknowledge signals from the DMA. Used to acknowledge the receipt of Data Request signals (DREQ0-DREQ3) from the microprocessor.
DATA0X	Data Zeroes Multiplexed. This signal represents the serialized data bits input into the skew buffer.
DATA P, 0-7	Data. Refers to the data lines from the read logic to the formatter.
DAVL P, 0-7	Data Available. Term identifying data that is positioned at the read head and is ready to be clocked into the formatter.
DAVLX	Data Available Multiplexed. This signal is used to input the serialized data into the skew buffer.
$\overline{\mathrm{DCLK}}$	Data Clock. Generated in read skew buffer circuit; used in the cache bus interface logic to latch data bits to the read data lines.
DCLK1	Data Clock 1. Alternate input to the formatter read clock circuitry. Used in the event of data dropout in Read Channel 2.
DCLK2	Data Clock 2. Primary input to the formatter read clock circuitry. Synchronizes PE clock to the data rate.
$\overline{\mathrm{DINLOW}}$	Data in Low. Enables write data to be clocked into the write formatter circuit from the write formatting control circuit.
DMA	Direct Memory Access controller. Provides control of cache memory operations independent of direct microprocessor control.

DMAIO	DMA Input/Output. Generated in the DMA control logic by signals from the microprocessor; used as a chip select signal to enable the DMA controller.
DOUT	Data Out. This signal is used to enable the output from the skew buffer.
DREQ0	DMA Request 0. Request for DMA service to transfer data between cache memory and physical tape. (Highest priority DMA request.)
DREQ1	DMA Request 1. Request for DMA service to transfer data between cache memory and host interface.
DREQ2	DMA Request 2. Request for DMA service to perform microprocessor/cache memory communications via DMA.
DREQ3	DMA Request 3. Request for DMA service to refresh cache memory. (Lowest priorty DMA request.)
$\overline{\text{DS}}$	Data Strobe. This signal is initiated by the microprocessor and is used to strobe data in and out of the CPU.
DX0-DX7	DMA data bus lines. Bidirectional three-state signals used to transfer data between the cache memory and the DMA.
EEVEN	Generated by the parity generator and used during a memory read function to notify the microprocessor that a parity error (even parity) has been detected.
$\overline{\text{EOP}}$	End of Process. Generated by the DMA to indicate the completion of the current DMA service operation.
EOT	End of Tape. Indicated by a reflective marker placed on the tape that is detected by an optical sensor.
FBY	Formatter Busy. Generated by the transport status registers to signal the host interface on the IFBY line that tape motion is occurring.
File Mark	A special control block consisting of 80 flux reversals (40 characters) at 3200 frpi in channels P, 0, 2, 5, 6, and 7 with channels 1, 3, and 4 dc erased.
FRC1,2,3	Flux Reversal Control Lines. These lines determine the write formatter mode of operation. They are used as follows:

	FRC1	FRC2	FRC3
Write ID Burst	1	0	0
Write File Mark	1	0	1
Write Data	1	1	1

frpi	Flux reversals per inch. The number of changes of polarity, or flux changes, that occur during each one-inch segment of tape.
FSEL	Formatter Select. This signal indicates drive is selected by comparing the unit number of the drive to the IFAD and ITAD lines. FSEL enables drive status information (IONL, IRDY, etc.) to be sent to the controller.
FWD	Forward. This signal indicates forward tape motion to the read discriminator circuit.
$\overline{\text{GAP}}$	Gap Detected. Generated by the block/gap detection logic when no channel activity is occurring to notify the microprocessor that a gap has been detected.
GO	Initiated by IGO from the interface. Indicates that the CTU is on-line and selected, and that a tape motion command has been initiated.
HLDA	Hold Acknowledge. Signals the DMA that the microprocessor has relinquished control of the cache bus.
HLDR	Hold Request. Sent from the DMA to the microprocessor to request control of the cache bus.
IBG	Interblock Gap. A 0.6-inch gap between blocks of data recorded on the tape.
ICER	Correctable Error. Interface output signal. During a read/write opration, indicates the occurrence of a correctable error.
ID Burst	Identification Burst. A burst at the beginning of the tape of 1600 frpi in the P channel and erasure in all other channels to indicate a PE tape.
IDBY	Data Busy. Interface output signal. Goes true after simulated ramp delay and remains true during execution of all channels initiated by IGO.
IDENT	Identification. Interface output signal. Pulsed when read head passes BOT marker to identify a 1600 bpi (PE) tape.
IEDIT	Edit. Interface input signal. With IWRT true, causes CTU to operate in the edit mode.
IEOT	End of Tape. Interface output signal indicating that the EOT marker has been detected.
IERASE	Erase. Interface input signal specifying the erase mode of operation.
IFAD	Formatter Address. Interface input signal used in combination with ITAD0 and ITAD1 and switches S1, S2, and S3 to select the CTU.

IFBY	Formatter Busy. Interface output signal indicating that tape motion is occurring.
IFEN	Formatter Enable. Interface input signal. Enables the CTU.
IFMK	File Mark. Interface output signal. Indicates that the CTU has detected a file mark.
IFPT	File Protect. Interface output signal indicating that a reel of tape without a file protect ring is mounted on a selected CTU.
IGO	Initiate Command. Interface input signal used to latch the command specified on the command lines into the selected CTU.
IHER	Hard Error. Interface output signal used to indicate that an uncorrectable error has been detected by the CTU.
ILDP	Load Point. Interface output signal used to indicate that the BOT marker is positioned in front of the photosensor.
ILWD	Last Word. Interface input signal used during a write operation to indicate that the character to be strobed into the formatter is the last character of the record.
$\overline{\text{INTA}}$	Interrupt Acknowledge. Generated in the microprocessor logic and sent to the CIO's to indicate that an interrupt acknowledge cycle is in progress.
Interblock Gap	See IBG.
INTERDEN	Interface Device Enabled. Generated by PULSE2, FSEL, and ONL; when true, indicates that the device is not rewinding, is selected, and is on-line.
I/$\overline{\text{O}}$	Input/Output. Generated in microprocessor section to specify that an input/output operation is taking place.
IONL	On-Line. Interface output signal. Indicates that selected CTU is accessible to the host controller.
$\overline{\text{IOR}}$	I/O Read. Control signal used to access data from host controller when writing data in cache memory.
$\overline{\text{IOW}}$	Input/Output Write. Used in conjunction with $\overline{\text{DACK0}}$ to generate WLATCH when transferring data under DMA control from cache memory to the write formatter.
ips	Inches per second. The speed at which tape is moved through the physical transport.
IRDY	Ready. Interface output signal. Indicates that CTU is on-line, not rewinding, and ready to accept a remote command.

IREV	Reverse. Interface input signal. With CTU ready and on-line, causes tape to move in the reverse direction when true and in the forward direction when false.
IREW	Rewind. Interface input signal. With CTU ready, on-line, and not at BOT, causes tape to rewind in reverse direction.
IRP, IR0-IR7	Read Data. Interface output signals that carry read data from the CTU to the host controller.
IRSTR	Read Strobe. Interface output signal. Pulses to indicate that a character is present on the controller interface.
IRWD	Rewinding. Interface output signal that indicates the tape is rewinding to beginning of tape.
IRWU	Rewind/Unload. Interface input signal. With CTU on-line, causes selected unit to go off-line, rewind to BOT marker, and then unload the tape.
ISU	Supply reel servo current. The drive signal from the DAC to the supply servo circuit.
ITAD0, ITAD1	Transport Address 0 and 1. Interface input signal used with IFAD and switches S1, S2, and S3 to select the CTU.
ITHR	Read Threshold. Generated by the DAC and used in the read circuits to set the level at which a read signal is detected.
ITU	Takeup reel servo current. The drive signal from the DAC to the takeup servo circuit.
IWFM	Write File Mark. Interface input signal. With IWRT true, causes a file mark to be written on the tape.
IWP, IW0-IW7	Write Data. Interface input signals that carry write data from the host controller to the CTU.
IWRT	Write. Interface input signal. When true, specifies the write mode, and when false, specifies the read mode.
IWSTR	Write Strobe. Interface output signal. Indicates that the character on the data lines has been recorded and the next character is needed.
KBS	Kilobytes per Second. Density of the data recorded on tape with respect to tape speed.
$\overline{\text{LASTW}}$	Last Word. This signal indicates the last data character to be written is present on the interface.
$\overline{\text{MEMR}}$	Memory Read. Three-state DMA signal used to access data from cache memory during a DMA read operation.

$\overline{\text{MEMW}}$ — Memory Write. Three-state DMA signal used to enable the cache memory write function during a DMA write operation.

$\overline{\text{MREQ}}$ — Memory Request. Tri-state output active low signal which indicates that the address bus holds a valid address for a memory read or write operation.

$\overline{\text{NVI}}$ — Non-Vectored Interrupt. Generated by the analog-to-digital converter and sent to the microprocessor to request a non-vectored interrupt.

ONL — On-Line. Set by the microprocessor via the PULSE1 signal to indicate that the CTU is ready to accept commands from the host controller.

OUTLATCH0 — Generated by the output status register to initiate the Formatter Busy (FBY) status signal.

PCLK — Peripheral Clock. The CPU clock signal used to clock the CIO's.

PE — Phase-Encode. The data recording format used by the CTU.

PECLK — Phase Encode Clock. Clock (22 times the data rate) that is used to synchronize the data in the formatter.

$\overline{\text{PENAB}}$ — Phase Encode Enable. This signal enables formatter to send read strobes and data information.

Postamble — One all-ones byte and 40 all-zero bytes following a data block.

$\overline{\text{POSTERR}}$ — Postamble Error. This signal is true when an error has been detected in the postamble.

Preamble — 40 all-zero bytes followed by an all-ones byte preceding a data block.

PSEL — Parity Select. This signal gates parity channel from the read logic to the formatter.

PULSE 0 — Pulse 0. This signal clocks the I/O Control register.

PULSE 1 — Pulse 1. This signal sets the on-line flip-flop.

PULSE 2 — Pulse 2. This signal resets the rewind flip-flop.

PULSE 3 — Pulse 3. This signal sets the rewind flip-flop.

PULSE 4 — Pulse 4. This signal resets the on-line flip-flop.

PULSE 6 — Pulse 6. This signal resets the IGO flip-flop and the parity error flip-flop in the write data circuit after an error has been detected.

PULSE 7 — Pulse 7. This signal is the dynamic RAM enable signal and is used to clock the DREQ0 flip-flop in the DMA control logic.

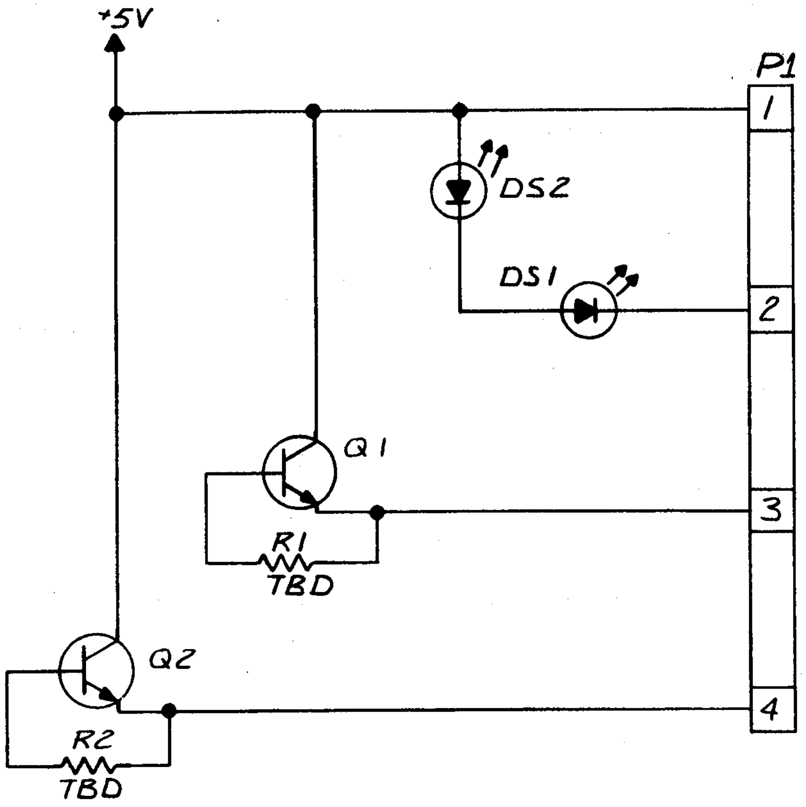
RAS	Row Address Strobe. Used in cache memory addressing to enable rows of data in the cache RAM's.
RDATA P, 0-7	Read Data. These signals are the nine data lines being read off tape.
$\overline{\text{RDCMD}}$	Read Command. Enables the outputs of the input motion commands latch, routing the motion commands to the microprocessor on the AD0-AD5 lines.
$\overline{\text{RDIN}}$	Read In. Generated in the microprocessor section during a CPU I/O read cycle; indicates that the CPU requests read data from the input motion commands logic, the DMA, or the analog-to-digital converter.
RDLD	Read Load. Enables the output of the read data latch in the cache read circuit.
$\overline{\text{RDROP P, 0-7}}$	Read Drop. This signal indicates the loss of data for a minimum of four character times. Used for block, file mark, and ID Burst detection.
Repositioning	In certain command sequences during streaming tape operation, places the tape in the correct position with respect to the record head when record velocity is attained during a subsequent command.
$\overline{\text{RES}}$	Reset. Input to the microprocessor. Active low signal that forces program counter to zero and initializes the CPU.
RESET	Generated in the $\overline{\text{RES}}$ logic and sent to the DMA to clear the command, status, request, and temporary registers. DMA is in the idle state following RESET.
RLATCH	Read Latch. Generated in the DMA control logic; clocks read data into the data latches in the cache read circuit.
RDP, RD0-RD7	Read data from the cache memory RAM's.
R/W, R/$\overline{\text{W}}$	Read/Write. Specifies the read/write status of the CPU.
RWD	Rewind. Set by the rewind latch in the motion commands circuit to specify a rewind operation.
SCAN P, 0-7	This signal selects which data channel will be multiplexed into the formatter.
SMDH	Supply Motor Drive High. This signal is used for the supply motor drive voltage.
SMDL	Supply Motor Drive Low. This signal is used for the supply motor return and current sense.

SODD	Summation Odd. This signal indicates the parity (odd or even) of the read data.
STRBX	This signal enables read strobes and read data from the formatter. Used to disable read strobes when the postamble has been detected.
SUMH	Supply Motor High. This signal is the supply motor drive signal that directly drives the motor.
SUML	Supply Motor Low. This is the return signal from the supply motor.
TMDH	Takeup Motor Drive High. This signal is used for the takeup motor drive voltage.
TMDL	Takeup Motor Drive Low. This signal is used for the takeup motor return and current sense.
TUMH	Takeup Motor High. This signal is the takeup motor drive signal that directly drives the motor.
TUML	Takeup Motor Low. This is the return signal from the takeup motor.
V9P	Voltage 9 Positive. This signal is the positive 9-vdc signal from the power supply that is used to generate the +5-vdc signal.
V20M	Voltage 20 Minus. Negative 20-vdc drive voltage for the reel servo circuits (clockwise rotation).
V30M	Voltage 30 Minus. Negative 30-vdc drive voltage for the reel servo circuits (counterclockwise rotation).
V30P	Voltage 30 Positive. Positive 30-vdc drive voltage for the reel servo circuits (clockwise rotation).
$\overline{\text{VHMON}}$	Voltage High Minus On. This signal enables -30 volts to the takeup and supply motors.
$\overline{\text{VI}}$	Vectored Interrupt. Used by the CIO when requesting a CPU interrupt.
VIN0	Voltage Input Zero. This signal is input voltage from the EOT sensor.
VIN1	Voltage Input One. This signal is input voltage from the BOT sensor.
VIN2	Voltage Input Two. This signal is input voltage from the compliance arm transducer logic.
VIN3	Voltage Input Three. This signal is used to determine supply servo EMF and voltage.

VIN4	Voltage Input Four. This signal is used to determine takeup servo EMF and voltage.
VIN6	Voltage Input Six. This signal is used to indicate the speed at which the compliance arm changes position.
VIN7	Voltage Input Seven. This signal is used to indicate the DAC servo offset voltage.
$\overline{\text{VRCERR}}$	Parity Error. This signal is true when a read parity error has been detected.
W2XCLK	Write 2 Times Clock. This signal clocks the data to the write head.
$\overline{\text{WAIT}}$	When active (low), this signal causes the CPU to go into the wait state.
WDCLK	Word Clock. This signal is used during a cache memory write operation to clock data from the host controller onto the cache bus.
WLATCH	Write Latch. This signal is used during a physical tape write operation to clock write data from the cache bus into the write formatter.
W/$\overline{\text{R}}$	Generated by R/$\overline{\text{W}}$ from the CPU; specifies the read/write status of the CPU.
$\overline{\text{WROUT}}$	Write Out. Generated in the microprocessor section during a CPU I/O write cycle; indicates that the CPU wants to input commands to the motion commands logic, the DMA, and the DAC.
WSTROBE	This signal is a clock that latches the write data into the formatter.
Z1A0-Z1A7, Z1B0-Z1B7, Z1C0-Z1C3, Z2A0-Z2A7, Z2B0-Z2B7, Z2C1, Z2C2, Z3A5-Z3A7, Z3B0-Z3B7, Z3C0-Z3C3	Input/output signals to/from the CIO's; used to interface with the CPU on the AD0-AD7 lines. (See Table 3-8 for additional information.)

360102-319 REV B

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	ENGR. RELEASE	SS	3/13/81	MT	3/19/81
B	INCORP ECO 13040	UA	9/28/82	KJ	9-28-82



NOTES:

1. 160101-010 CONTAINS DS1 ONLY.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS .XX = ± ~ .XXX = ± ~ ANGLES ± ~

DO NOT SCALE DRAWING

APPROVALS		DATE
DWN	SCHNEIDER	3-13-81
CHK	[signature]	3/17/81
MECH ENG	[signature]	3-18-81
ELEC ENG	[signature]	3-18-81
MFG ENG	[signature]	3-17-81
QC	[signature]	3/19/81
DOC CHK	[signature]	3/19/81

Cipher Data Products SAN DIEGO CALIF.

TITLE SCHEM- REFLECTIVE SENSOR

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	32274	360102-319	B

SCALE ~ | ~ | SHEET 1 OF 1

360101-309 REV B

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
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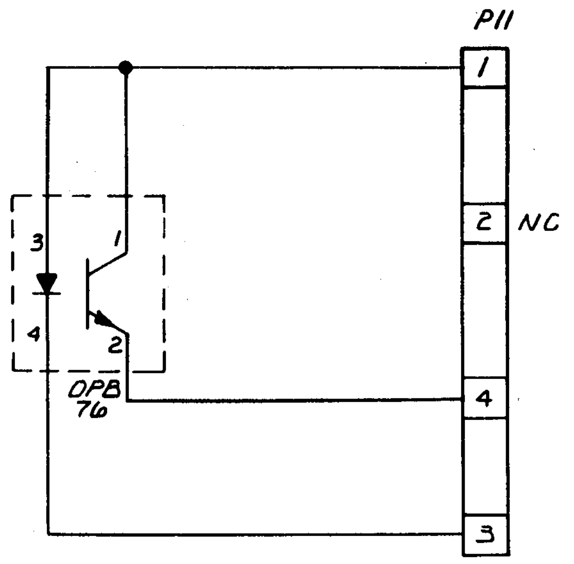
B	INCORP ECO 9223	RL	5/2/80		5-13-80



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS .XX = ± ~ .XXX = ± ~ ANGLES ± ~	APPROVALS	DATE
	DWN R. Abad	1-30-80
	CHK R. Doe	19-80
	MECH ENG	2-20-80
	ELEC ENG	
	MFG ENG	2-11-80
	QC	2-11-80
DO NOT SCALE DRAWING	DOC CHK	2/20/80

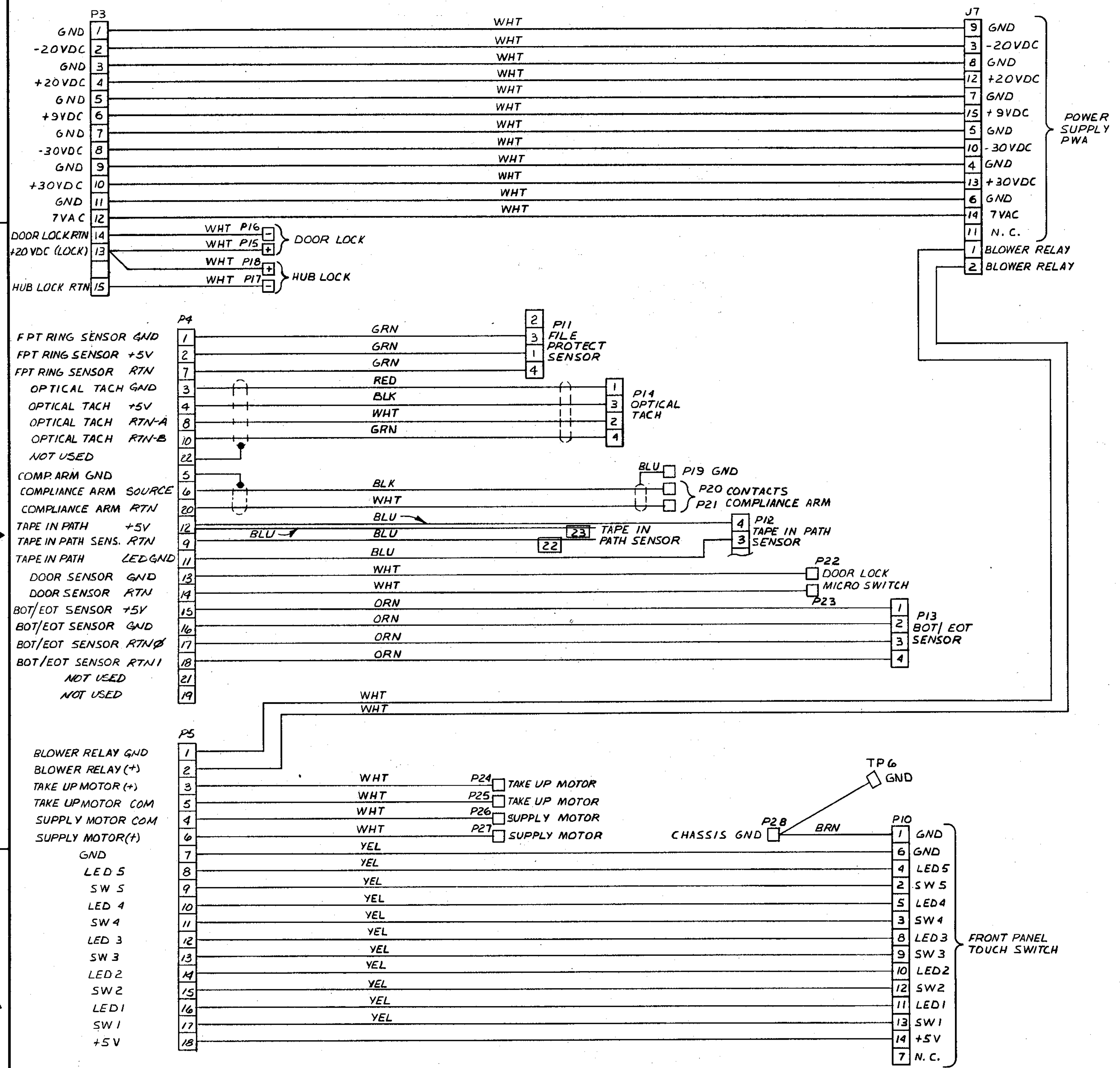
Cipher Data Products SAN DIEGO CALIF

TITLE SCHEM - FILE PROT. SENSOR

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	32274	360101 - 309	B

SCALE NONE SHEET 1 OF 1

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	ENGR. RELEASE	LL	4/23/80	MT	6/25/80
B	INCORP ECO 7851	RL	7/22/80		7-21-80
C	INCORP ECO 8028	LJ	8-13-80		8-14-80



360101-320 REV C

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS XX = ± ~ XXX = ± ~ ANGLES ± ~

DO NOT SCALE DRAWING

APPROVALS		DATE
DWN	L. LIPTAK	4-23-80
CHK		4/24/80
MECH ENG		
ELEC ENG		
MFG ENG		6-25-80
QC		
DOC CHK		6/25/80

Cipher Data Products, SAN DIEGO CALIF

TITLE: SCHEM - HARNESS

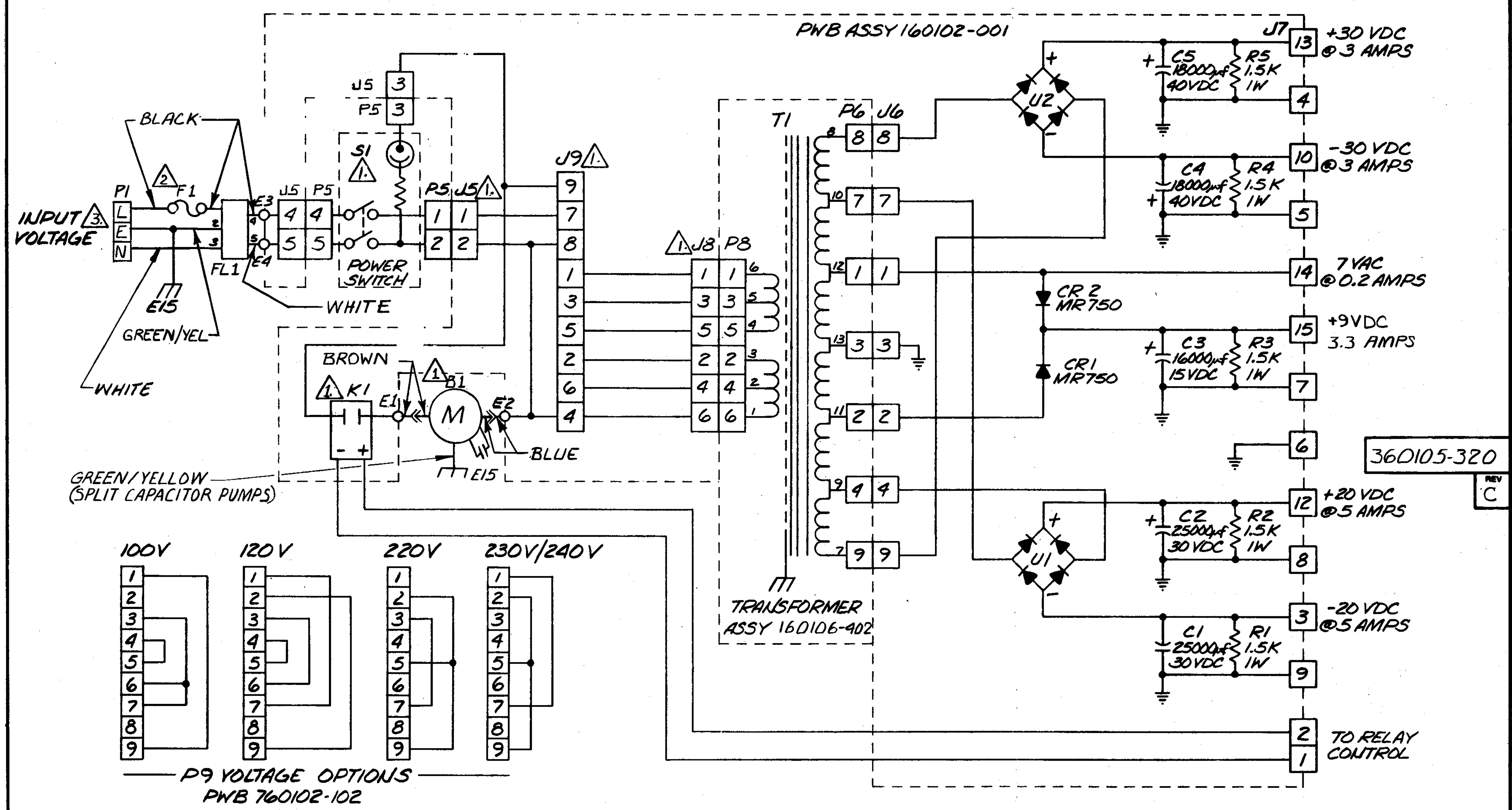
SIZE: D | CODE IDENT NO. 32274 | DRAWING NO. 360101-320 | REV C

SCALE NONE | SHEET 1 OF 1

INPUT VAC	FUSE REQ
100 V	3AG 3 AMP
120 V	
220 V	3AG 1½ AMP
230 V	
240 V	

TABLE 1

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	ENG REL	FS	[illegible]	CK	[illegible]
B	INCORP ECO 15526	EC	3/21/83	[illegible]	[illegible]
C	INCORP ECO 17310	EC	3/21/84	[illegible]	4/10/84



360105-320 REV C

NOTES:

3 FOR INPUT VOLTAGE SEE TABLE 1.

2 FOR FUSE SELECTION SEE TABLE 1.

1 PARTS NOTED AFFECT UL RECOGNITION.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: DECIMALS .XX = ± .XXX = ± ANGLES ±

DO NOT SCALE DRAWING

APPROVALS		DATE
DWN	F. Dahne	6/21/82
CHK	[illegible]	6-28-82
MECH ENG	[illegible]	7-8-82
ELEC ENG	[illegible]	7/13/82
MFG ENG		
QC		
DOC CHK	C. [illegible]	7/14/82

Cipher Data Products SAN DIEGO CALIF.

TITLE SCHEM-POWER SUPPLY

SIZE	CODE IDENT NO.	DRAWING NO.	REV
C	32274	360105-320	C

SCALE NONE SHEET 1 OF 1

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	ENG RELEASE	GP	6-82	[illegible]	12-28-82
B	INCORP ECO 15029	EC	[illegible]	[illegible]	[illegible]
C	INCORP ECO 15480	EC	[illegible]	[illegible]	[illegible]
D	INCORP ECO 15448	EC	[illegible]	[illegible]	[illegible]
E	INCORP ECO 15733	EC	[illegible]	[illegible]	[illegible]
F	INCORP ECO 15574	EC	4/4/83	[illegible]	4/6/83
G	INCORP ECO 15785	EPC	4/5/83		4/6/83
H	INCORP ECO 15658	EPC	4/5/83		4/6/83
J	INCORP ECO 16267	EPC	6/16/83	[illegible]	[illegible]
K	INCORP ECO 16728	EPC	8/25/83	[illegible]	[illegible]
L	INCORP ECO 16746	EPC	8/25/83	[illegible]	[illegible]
M	INCORP ECO 17073	EPC	[illegible]	[illegible]	[illegible]
N	INCORP ECO 17265	EPC	3/5/84	[illegible]	3-6-84
P	INCORP ECO 17640	CW	7/18/84	[illegible]	7/19/84
R	INCORP ECO 17723	CW	7/18/84	[illegible]	7/19/84
S	INCORP ECO 17663	CW	7/18/84	[illegible]	7/19/84
T	INCORP ECO 17787	CW	7/18/84	[illegible]	7/19/84

NOTES:

1. RESISTOR VALUES ARE IN OHMS, 1/4 W, 5%.
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. IC Vcc & GND PINS UNUSED PORTIONS:

a. +5 R & +5V DEVICES:

IC TYPE	REFERENCE DESIGNATOR	+5R	+5V	GND	UNUSED
74LS00	U2G, U3V, U5V, U8V, U11B, U11C, U11E, U11F, U12E, U17T		14	7	U2G-A U17T-B,D
74LS04	U2V, U3P, U4G, U4H, U8A, U8B, U8C, U16T		14	7	U2V-B,F, U5R-D U4H-B,C,D,E U16E
74LS08	U1P, U4P, U7H, U7V, U14R, U16W		14	7	U1P-C,D U7H-C U14R-A,B
74LS10	U16R	14		7	U16R-B,C
74LS11	U3G, U4V		14	7	U3G-C U4V-B
74LS14	U3P, U14A, U14D, U14G, U5R		14	7	–
74LS32	U1H, U2P, U5K, U6R, U9M, U12M, U13M		14	7	U13M-B
74LS42	U1K		16	8	–
74LS74	U5P, U13R, U13W, U14P, U14T, U17R		14	7	–
74LS86	U4W, U12B, U12C, U12D, U12F, U12G, U16M, U16N, U17M		14	7	U4W-B U12F-B,C U17M-A
74LS109	U3D, U5H, U6A, U6B, U7A, U7B, U13B, U13C, U13E, U13F, U13H		16	8	U3D-A U5H-A
74LS125	U13P		14	7	–
74LS132	U7P		14	7	U7P-B,C
74LS138	U6W, U8D		16	8	–
74LS151	U7C, U10F, U10G		16	8	–
74LS153	U7E		16	8	–
74LS157	U9E		16	8	–
74LS163	U4D, U7D, U9A, U9B, U9C, U9D, U10B, U10C, U10D, U10E, U11D, U17W, U18W		16	8	–
74LS164	U7F, U8E, U8F, U9F, U14W		14	7	–
74LS174	U6F, U6G, U6V, U13A, U13D, U13G, U13V, U15V, U16K, U16P, U16V		16	8	–
74LS175	U10M, U12V, U14V, U17L, U17N		16	8	–
74LS195	U3K		14	7	–
74LS240	U11W		20	10	–
74LS244	U5T		20	10	–
74LS245	U7R, U7T		20	10	–
74LS280	U11V		14	7	–
74LS367	U3R, U4R		16	8	–
74LS368	U16L		16	8	–
74LS373	U1L, U2L, U6T		20	10	–
74LS374	U2W, U15W		20	10	–
74S10	U5F		14	7	U5F-B
74S140	U2E		14	7	U2E-B
82S129	U7G		16	8	
339	U6H, U19T		3	12	
2128	U3N, U5N		24	12	
2764	U3L, U5L		28	14	
4864	U9P, U9R, U9T, U10P, U10R, U10T, U11P, U11R, U11T * CORRECT PINOUT		* 8	* 16	
6305	U12H		16	8	
6336-1	U9G, U17V		24	12	

IC TYPE	REFERENCE DESIGNATOR	+5R	+5V	GND	UNUSED
7404	U2K		14	7	
7406	U16J, U17X, U18X		14	7	U17X-B,C,D
7407	U6P, U10H, U17J, U17K		14	7	U10H-C,D U6P-A,B,C,F
7414	U17P	14		7	U17P-D,E,F
7438	U7W, U8W, U9W, U14M		14	7	–
74121	U13T		14	7	–
8237A-4	U2T		31	20	–
ADC1001	U6N		20	10	
MC4024	U3C		14	7	
MC4044	U5G		14	7	
Z8002	U2N		10	31	–
Z8036	U9L, U11L, U13L		23	7	–
RES PACK	U3W, U10W		16	8	
RES PACK	U4T		1-8		–

b. -6V +5V DEVICES

IC TYPE	REFERENCE DESIGNATOR	-6V	+5V	GND	UNUSED
4051	U7J, U7N	7	16	8	–
4053	U2B	7	16	8	–

C. -12V +15V DEVICES

IC TYPE	REFERENCE DESIGNATOR	-12V	+15V	GND	UNUSED
319	U14C, U14F, U14H, U15A, U15C, U15D, U15F, U15G, U15H	6	11		–
709P	U19A, U19B, U19C, U19D, U19E, U19F, U19G, U19H, U19I	4	7		–
4136	U2A, U2C, U20N	7	11		–
DAC1006	U6M		20	10	—
TL082	U6J, U6K, U6L, U18A, U18B, U18C, U18D, U18E, U18F, U18G, U18H, U18I, U18M	4	8		–

d. MISC DEVICES

IC TYPE	REFERENCE DESIGNATOR		UN REG 20V	GND	UNUSED
393	U3H		8	4	—

4. LAST USED REFERENCE DESIGNATOR

C	221	R	323	W	3
CR	13	S		E	2
DS		TP	86		
J	1	U			
K	1	VR	2		
P	7	Y	1		
Q	26	L	1		

5. SWITCHES – U3T: OPERATIONS OPTION SWITCH.
U5W: FMTR ADDRESS SELECT.

6. JUMPERS W1, W3, W4, W5 FOR FUTURE USE.

7. ⏚ DENOTES +5R GROUND

360105-322 REV T

REV STATUS	REV	T	J	N	J	R	S	N	A	N	N	F	A
	SH	1	2	3	4	5	6	7	8	9	10	11	12

P.E. MGR [signature] 12/2/82
UL/CSA [signature] 12/1/82

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE DECIMALS
.X ±
.XX ±
.XXX ±
ANGLES ±
DO NOT SCALE DRAWING

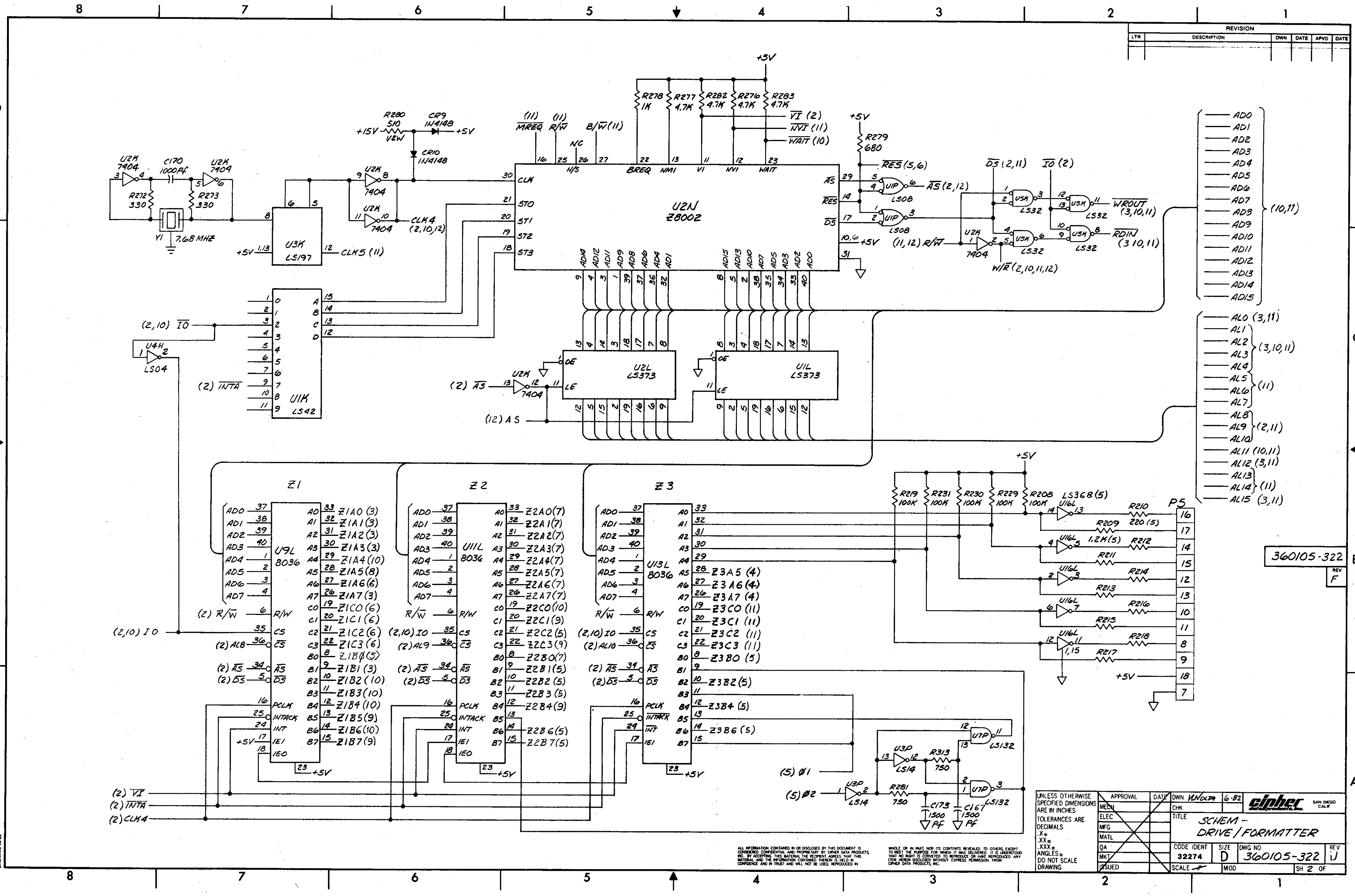
APPROVAL | DATE
MECH
ELEC [signature]
MFG
MATL
QA
MKT
ISSUED

DWN [signature] 6 82
CHK [signature] 11-1-82

cipher data products, inc. SAN DIEGO CALIF

TITLE SCHEM- DRIVE/FORMATTER

CODE IDENT 32274 | SIZE D | DWG NO 360105-322 | REV T
SCALE | MOD | SH 1 OF 12



REVISION
LTR
DESCRIPTION
DWN
DATE
APVD
DATE
U2N
Z8002
U3K
LS197
U1K
LS42
U2L
LS373
U1L
LS373
Y1 7.68 MHZ
Z1
U9L
8036
Z2
U11L
8036
Z3
U13L
8036
P5
360105-322
REV F
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
DECIMALS
ANGLES ±
DO NOT SCALE DRAWING
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SH 2 OF
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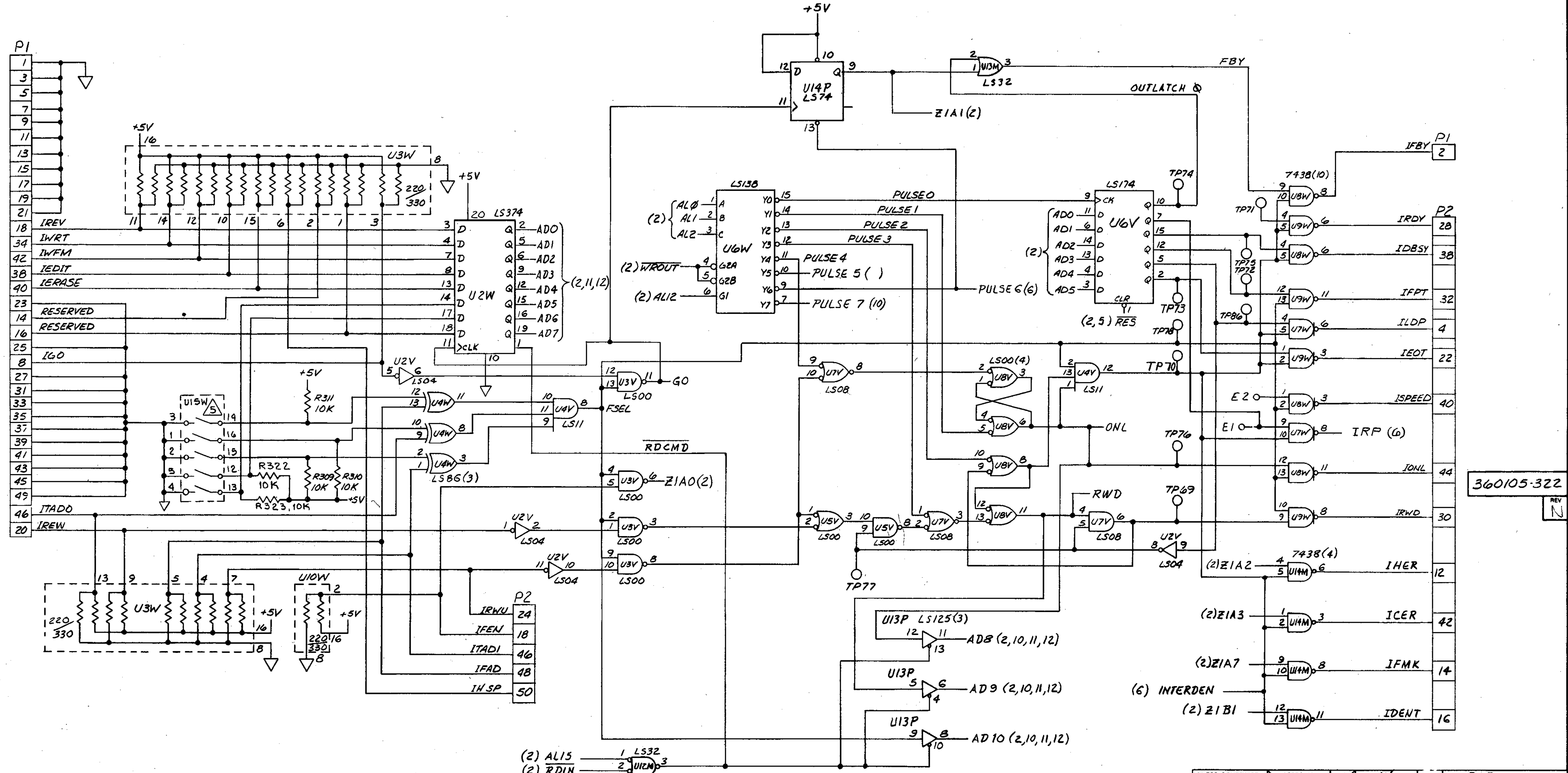

360105-322

REV N

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
DECIMALS
.X±
.XX±
.XXX±
ANGLES±
DO NOT SCALE DRAWING

APPROVAL	DATE
MECH	
ELEC	
MFG	
MATL	
QA	
MKT	
ISSUED	

DWN 11Nov74
CHK

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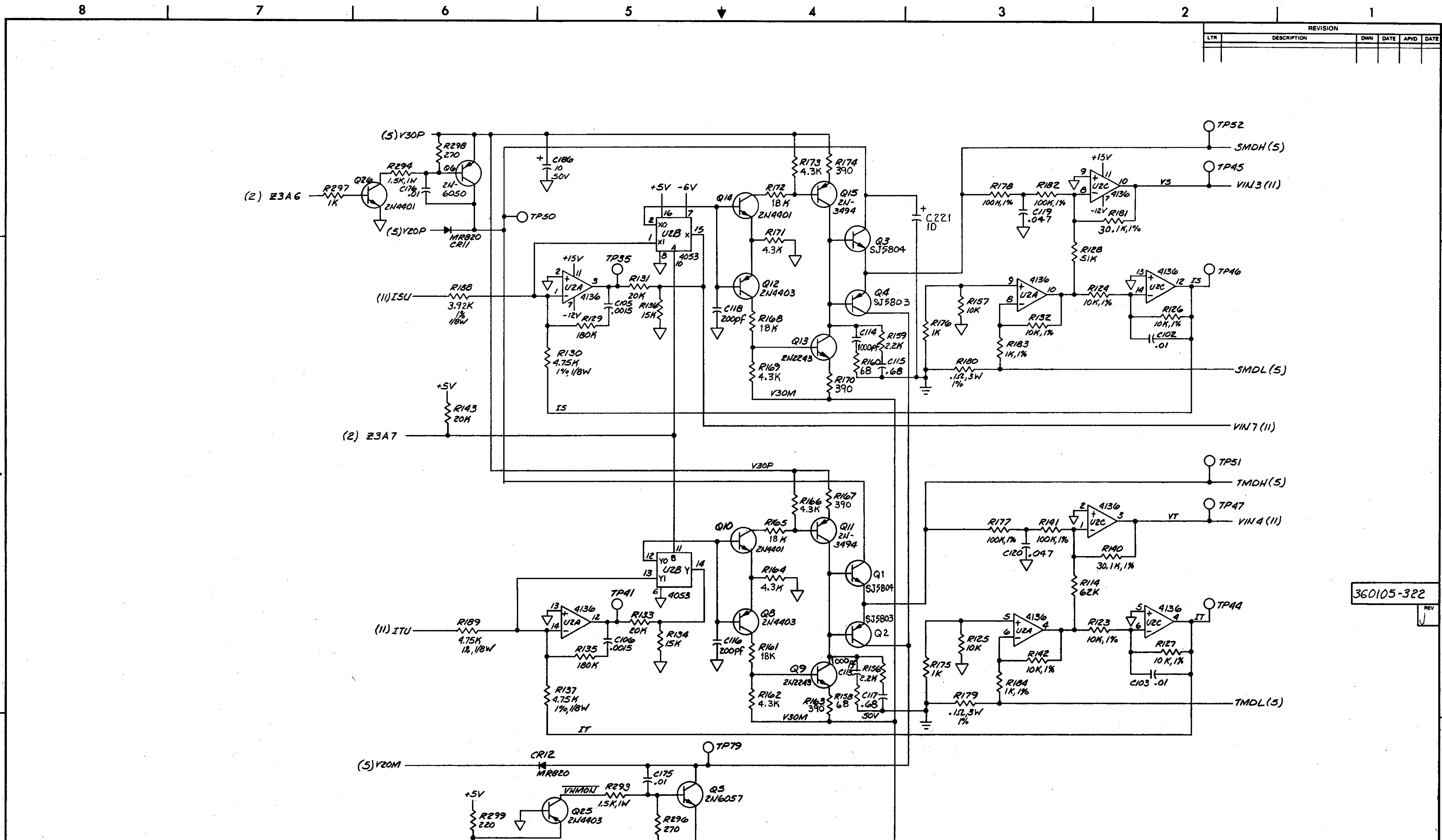
TITLE SCHEM - DRIVE/FORMATTER

CODE IDENT	SIZE	DWG NO	REV
32274	D	360105-322	N

SCALE — MOD SH 3 OF



REVISION

LTR	DESCRIPTION	DWN	DATE	APVD	DATE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE DECIMALS .X± .XX± .XXX± ANGLES±
DO NOT SCALE DRAWING

APPROVAL — DATE: MECH, ELEC, MFG, MATL, QA, MKT, ISSUED

DWN KN — CHK

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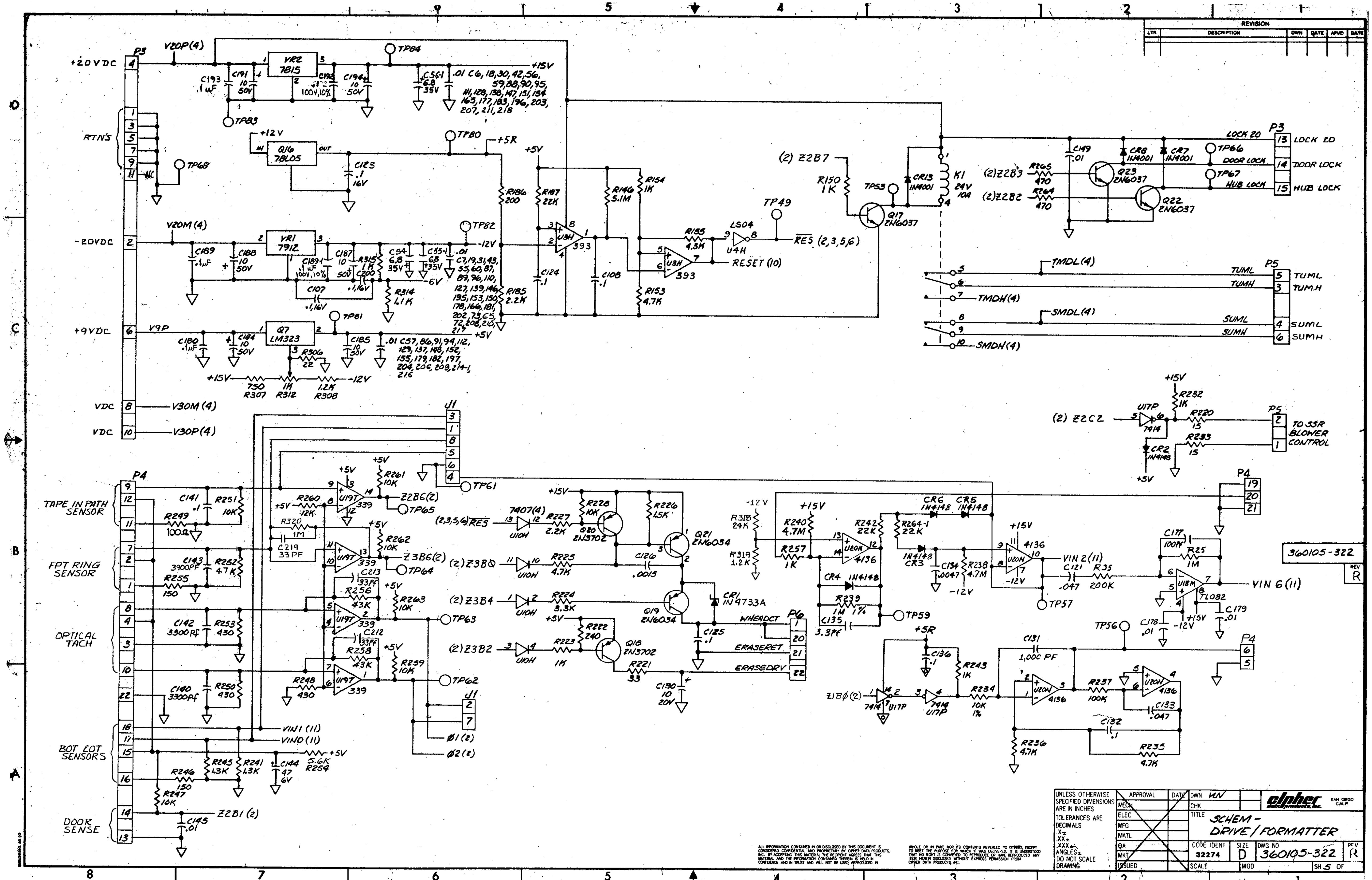
TITLE SCHEM - DRIVE / FORMATTER

CODE IDENT	SIZE	DWG NO	REV
32274	D	360105-322	J

SCALE — MOD — SH 4 OF



REVISION
LTR
DESCRIPTION
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DATE
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DATE
+20VDC
-20VDC
+9VDC
VDC
VDC
P3
V20P(4)
V20M(4)
V9P
V30M(4)
V30P(4)
RTN'S
VR2
7815
VR1
7912
Q16
78L05
Q7
LM323
+15V
+12V
+5R
+5V
-12V
-6V
TP84
TP83
TP80
TP68
TP82
TP81
TP49
TP53
U3H
393
U4H
LS04
RES (2,3,5,6)
RESET (10)
(2) Z2B7
R150
1K
Q17
2N6037
K1
24V
10A
CR13
1N4001
(2)Z2B3
(2)Z2B2
Q23
2N6037
Q22
2N6037
CR8
1N4001
CR7
1N4001
TP66
TP67
LOCK 20
DOOR LOCK
HUB LOCK
LOCK 20
DOOR LOCK
HUB LOCK
TMDL(4)
TMDH(4)
SMDL(4)
SMDH(4)
P5
TUML
TUMH
SUML
SUMH
(2) Z2C2
U17P
7414
TO SSR
BLOWER
CONTROL
P4
TAPE IN PATH
SENSOR
FPT RING
SENSOR
OPTICAL
TACH
BOT EOT
SENSORS
DOOR
SENSE
J1
TP61
TP65
TP64
TP63
TP62
U197
339
Z2B6(2)
Z3B6(2)
(2,3,5,6) RES
(2) Z3B8
(2) Z3B4
(2) Z3B2
U10H
7407(4)
Q20
2N3702
Q21
2N6034
Q19
2N6034
Q18
2N3702
CR1
1N4733A
P6
WHEADCT
ERASERET
ERASEDRV
VIN1 (11)
VIN0 (11)
Ø1 (2)
Ø2 (2)
Z2B1 (2)
U20N
4136
CR6
1N4148
CR5
1N4148
CR3
1N4148
CR4
1N4148
TP59
TP57
TP56
VIN 2 (11)
VIN 6 (11)
U18M
TL082
Z1BØ (2)
360105-322
REV
R
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
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SCHEM -
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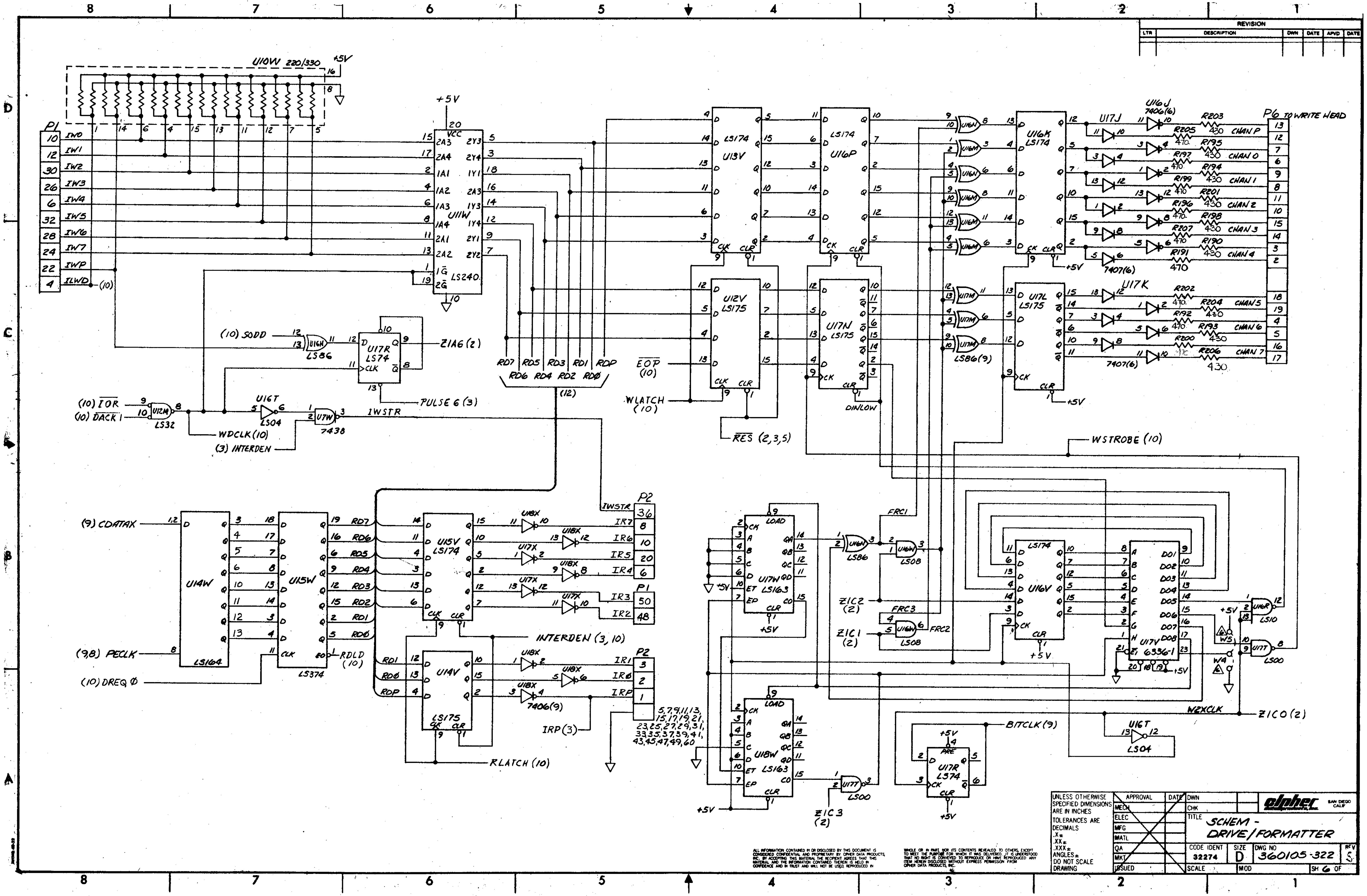
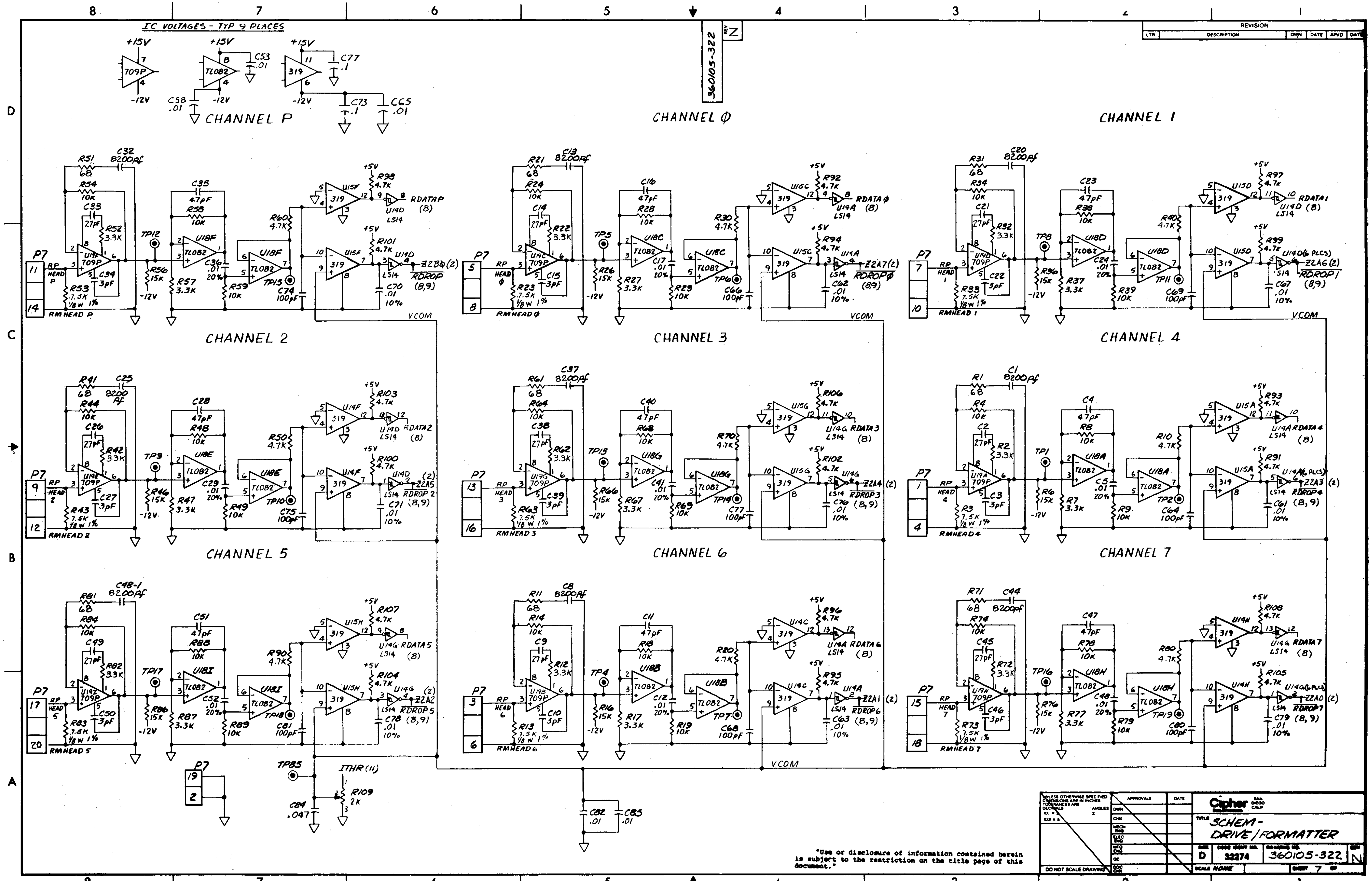


REVISION
LTR DESCRIPTION DWN DATE APVD DATE
U10W 220/330
+5V
P1
IW0 IW1 IW2 IW3 IW4 IW5 IW6 IW7 IWP ILWD
U11W LS240
U13V LS174
U16P LS174
U16K LS174
U12V LS175
U17N LS175
U17L LS175
U17R LS74
LS86
LS32
LS04
7438
IWSTR
WDCLK (10)
(3) INTERDEN
(10) SODD
ZIAG (2)
PULSE 6 (3)
(10) IOR
(10) DACK 1
RD7 RD6 RD5 RD4 RD3 RD2 RD1 RD0 RDP
EOP (10)
WLATCH (10)
RES (2,3,5)
DINLOW
P6 TO WRITE HEAD
CHAN P
CHAN 0
CHAN 1
CHAN 2
CHAN 3
CHAN 4
CHAN 5
CHAN 6
CHAN 7
7406(6)
7407(6)
LS86(9)
WSTROBE (10)
(9) CDATAX
(9,8) PECLK
(10) DREQ 0
U14W LS164
U15W LS374
RDLD (10)
U15V LS174
U14V LS175
U18X
U17X
7406(9)
INTERDEN (3,10)
IRP (3)
RLATCH (10)
P2
IR7 IR6 IR5 IR4 IR3 IR2 IR1 IR0 IRP
5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,60
U17W LS163
U18W LS163
FRC1
FRC2
FRC3
ZIC2 (2)
ZIC1 (2)
ZIC3 (2)
LS86
LS08
LS00
BITCLK (9)
U17R LS74
U16V LS174
U17V 6336-1
N2XCLK
ZIC0 (2)
U16T LS04
LS10
W5
W4
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE DECIMALS .X± .XX± .XXX± ANGLES±
DO NOT SCALE DRAWING
APPROVAL DATE
MECH ELEC MFG MATL QA MKT ISSUED
DWN CHK
TITLE SCHEM - DRIVE/FORMATTER
alpher SAN DIEGO CALIF
CODE IDENT 32274
SIZE D
DWG NO 360105-322
REV S
SCALE MOD SH 6 OF


IC VOLTAGES - TYP 9 PLACES
CHANNEL P
CHANNEL Φ
CHANNEL 1
CHANNEL 2
CHANNEL 3
CHANNEL 4
CHANNEL 5
CHANNEL 6
CHANNEL 7
VCOM
ITHR (11)
360105-322
REV N
REVISION
LTR
DESCRIPTION
DWN
DATE
APVD
"Use or disclosure of information contained herein is subject to the restriction on the title page of this document."
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APPROVALS
DATE
Cipher
SAN DIEGO CALIF
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SCALE NONE
SHEET 7

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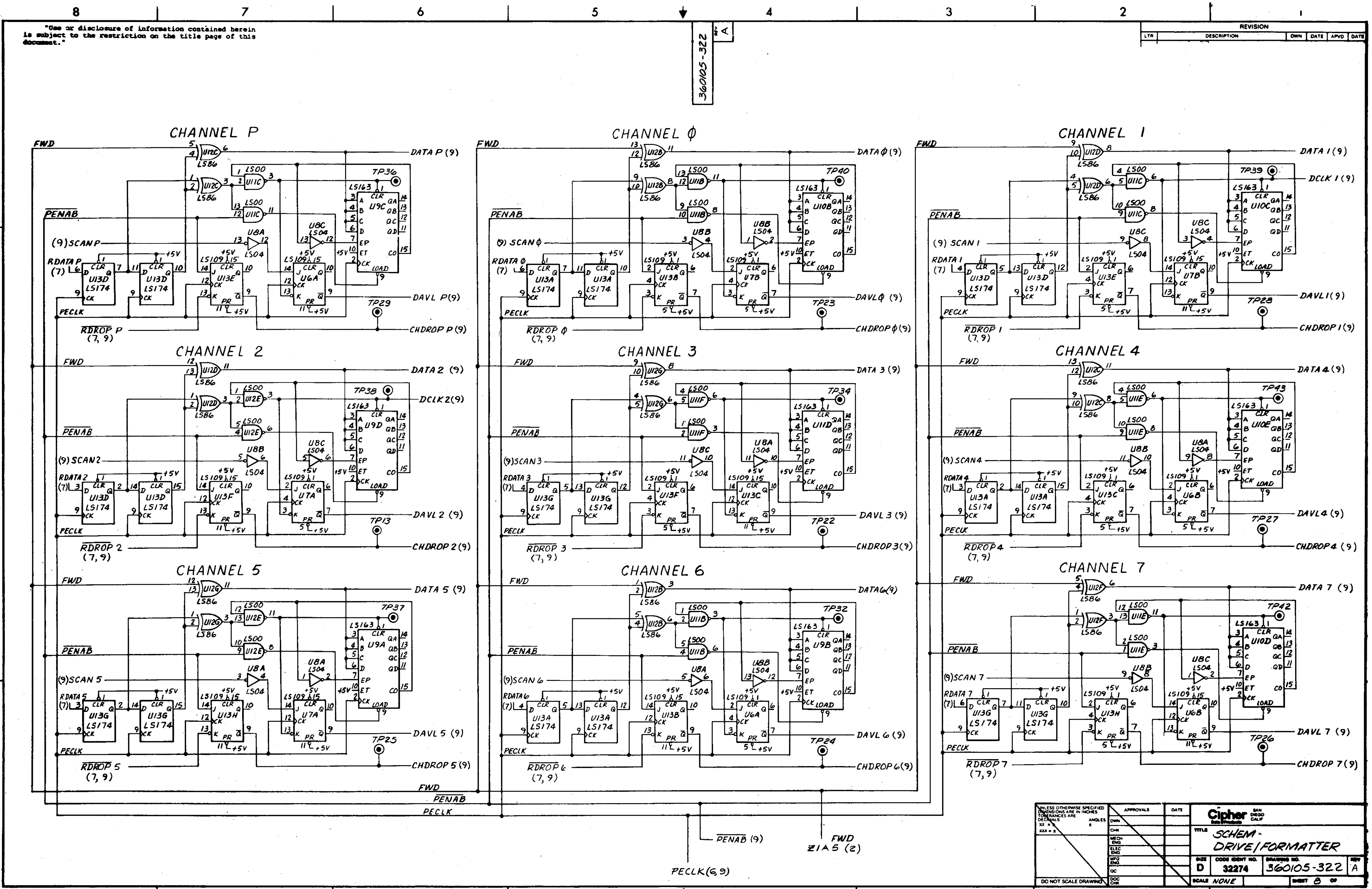
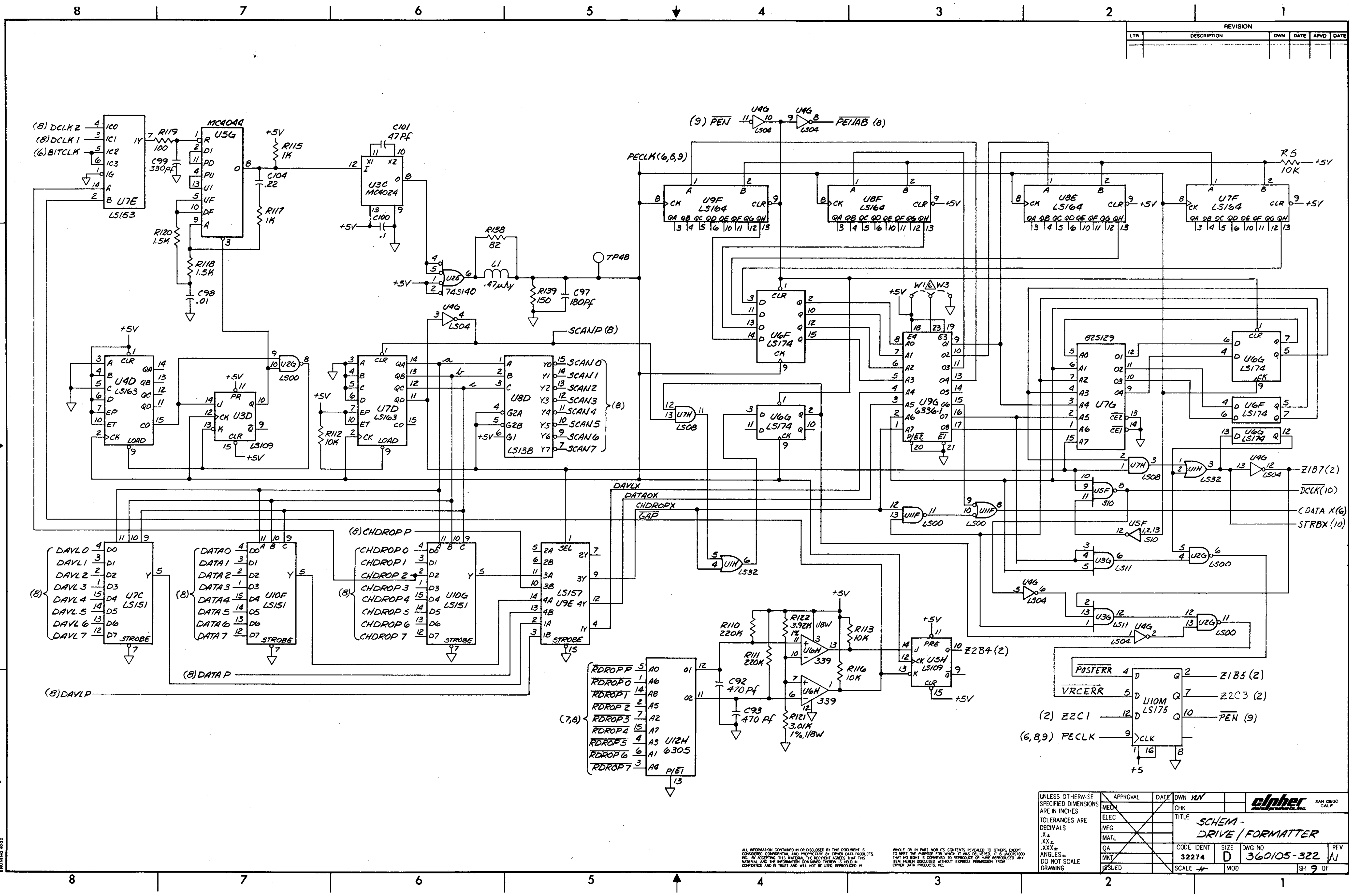
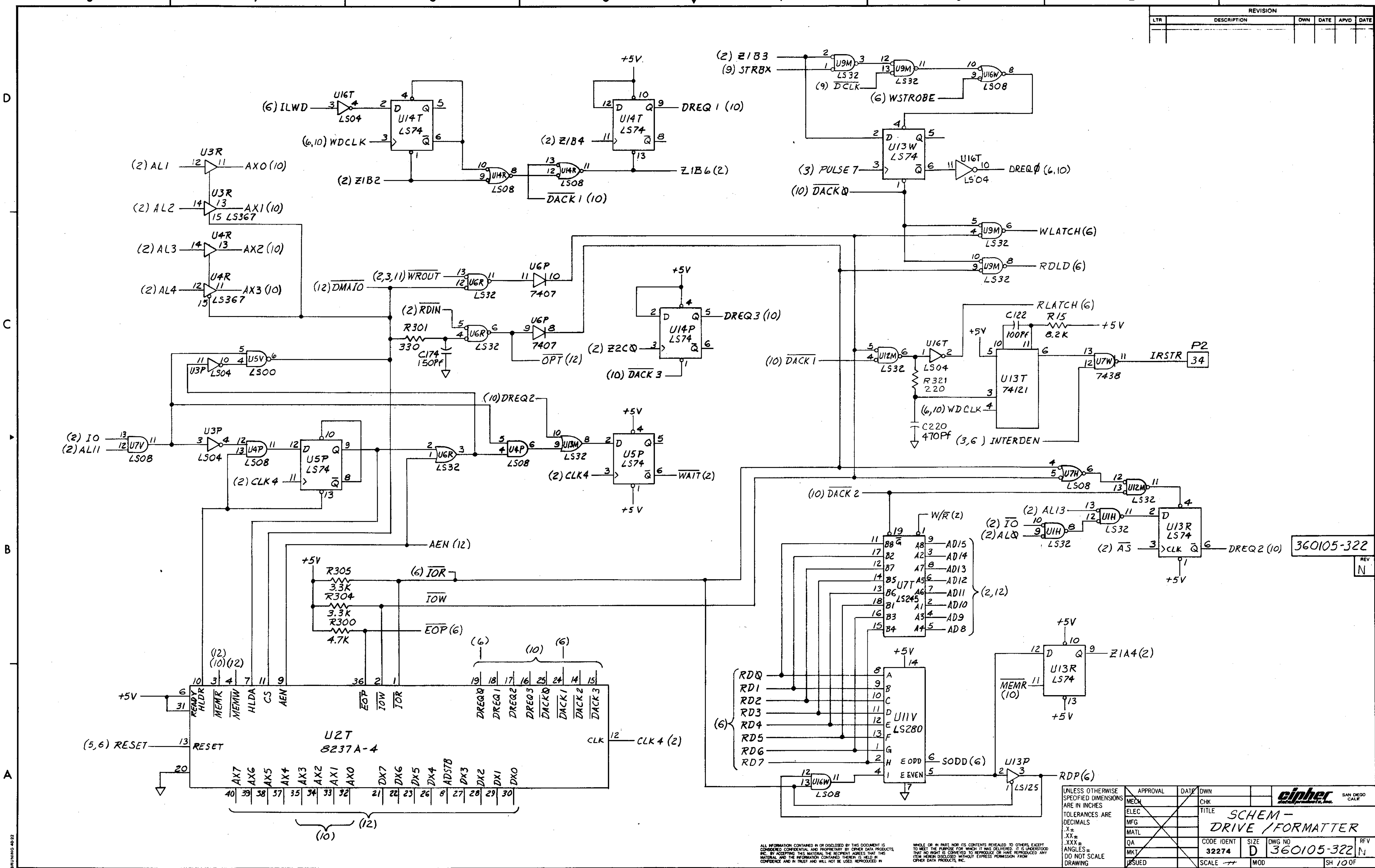
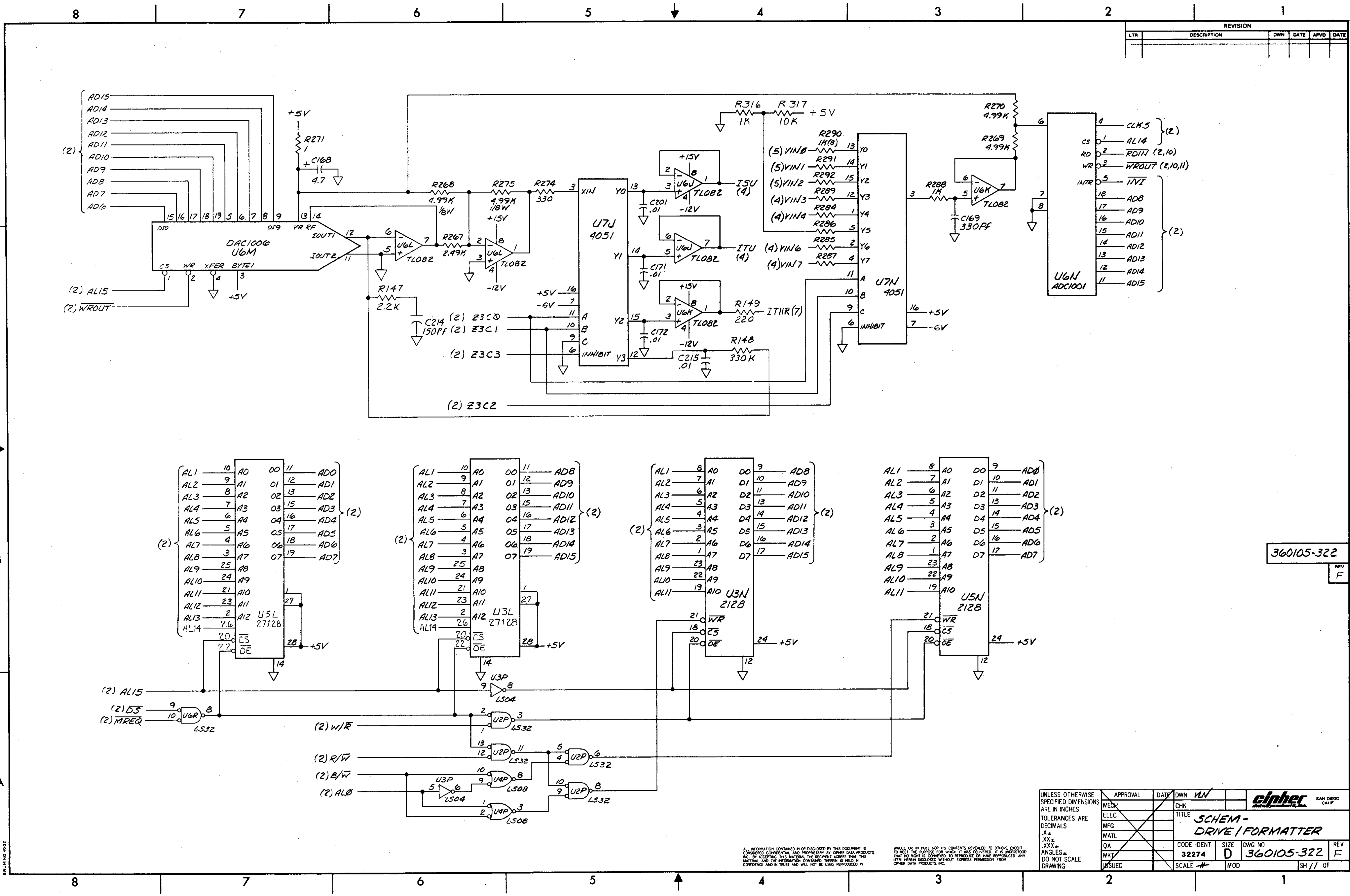



REVISION
LTR DESCRIPTION DWN DATE APVD DATE
U7E LS153
U5G MC4044
U3C MC4024
U2E 74S140
U4D LS163
U3D LS109
U7D LS163
U8D LS138
U9F LS164
U8F LS164
U8E LS164
U7F LS164
U6F LS174
U9G 6336-1
U7G 82S129
U6G LS174
U7C LS151
U10F LS151
U10G LS151
U9E LS157
U12H 6305
U6H 339
U5H LS109
U10M LS175
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE DECIMALS .X± .XX± .XXX± ANGLES±
DO NOT SCALE DRAWING
APPROVAL DATE
cipher SAN DIEGO CALIF
TITLE SCHEM - DRIVE / FORMATTER
CODE IDENT 32274
SIZE D
DWG NO 360105-322
REV N
SH 9 OF



U2T 8237A-4
U7T LS245
U11V LS280
U13T 74121
U14T LS74
U14P LS74
U5P LS74
U13W LS74
U13R LS74
(2) Z1B3
(9) STRBX
(9) DCLK
(6) WSTROBE
(6) ILWD
(6,10) WDCLK
(2) Z1B2
(2) Z1B4
DREQ 1 (10)
Z1B6 (2)
DACK 1 (10)
(3) PULSE 7
(10) DACK0
DREQ0 (6,10)
WLATCH (6)
RDLD (6)
RLATCH (6)
(2) AL1
AX0 (10)
(2) AL2
AX1 (10)
(2) AL3
AX2 (10)
(2) AL4
AX3 (10)
(12) DMAIO
(2,3,11) WROUT
(2) RDIN
DREQ3 (10)
(2) Z2C0
(10) DACK 3
OPT (12)
(10) DACK 1
IRSTR
P2
34
(6,10) WDCLK
(3,6) INTERDEN
(10) DREQ2
(2) IO
(2) AL11
(2) CLK4
WAIT (2)
(10) DACK 2
W/R (2)
(2) AL13
(2) IO
(2) AL0
(2) AS
DREQ2 (10)
AEN (12)
(6) IOR
IOW
EOP (6)
(2,12)
Z1A4 (2)
MEMR (10)
(5,6) RESET
CLK 4 (2)
SODD (6)
RDP (6)
RD0 RD1 RD2 RD3 RD4 RD5 RD6 RD7
AD15 AD14 AD13 AD12 AD11 AD10 AD9 AD8
360105-322
cipher data products, inc. SAN DIEGO CALIF
SCHEM — DRIVE / FORMATTER
CODE IDENT 32274
SIZE D
DWG NO 360105-322
REV N
SH 10 OF



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U6M
U7J
4051
U7N
4051
U6N
ADC1001
U5L
27128
U3L
27128
U3N
2128
U5N
2128
TL082
LS32
LS04
LS08
360105-322
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
DO NOT SCALE DRAWING
APPROVAL
MECH
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MATL
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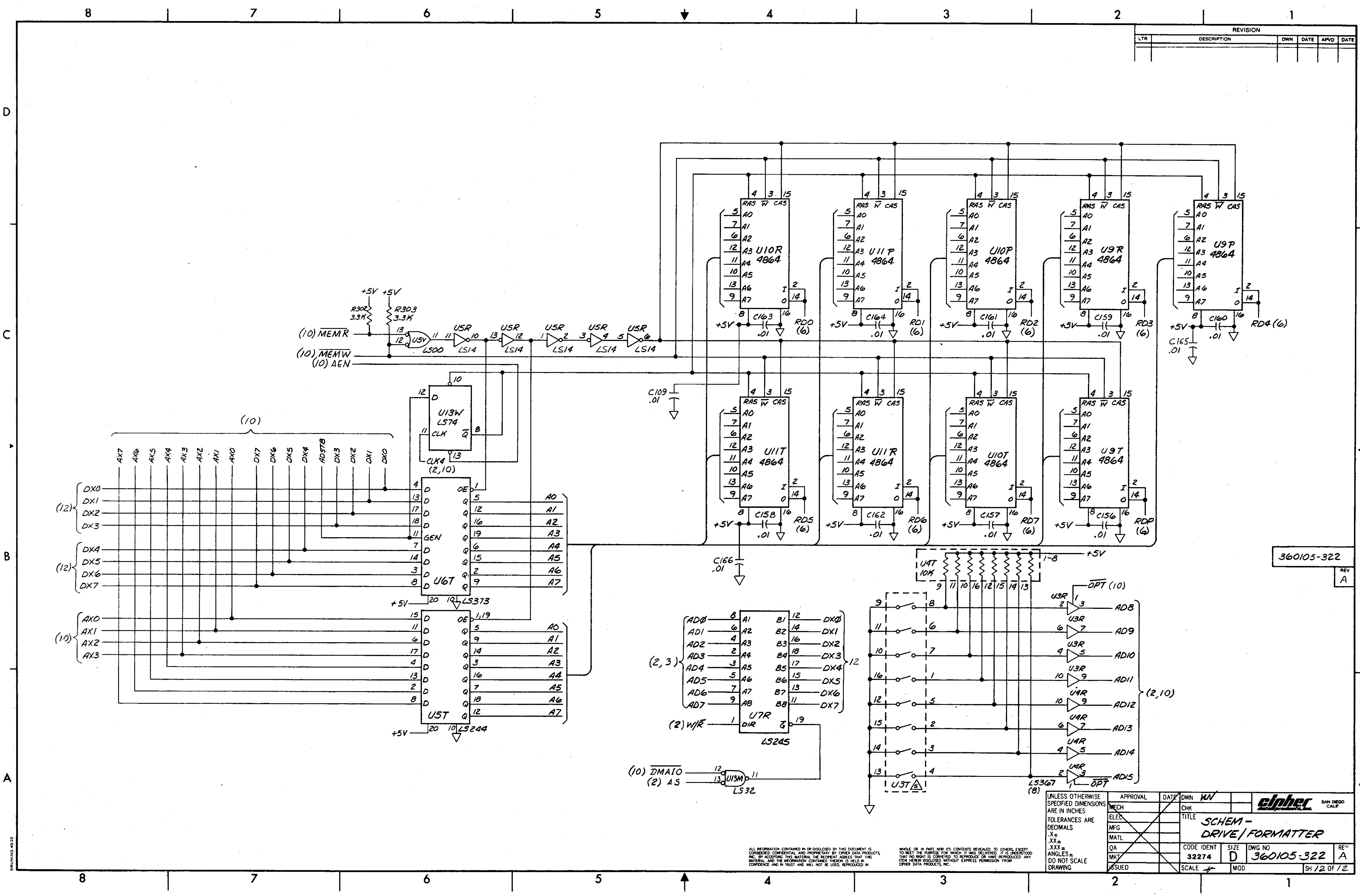
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U11P 4864
U10P 4864
U9R 4864
U9P 4864
U11T 4864
U11R 4864
U10T 4864
U9T 4864
RAS W CAS
A0 A1 A2 A3 A4 A5 A6 A7
RD0 (6) RD1 (6) RD2 (6) RD3 (6) RD4 (6)
RD5 (6) RD6 (6) RD7 (6) RDP (6)
C163 .01 C164 .01 C161 .01 C159 .01 C160 .01 C165 .01
C158 .01 C162 .01 C157 .01 C156 .01 C109 .01 C166 .01
+5V
R302 3.3K R303 3.3K
(10) MEMR
(10) MEMW
(10) AEN
U5V LS00
USR LS14
U13W LS74
CLK4 (2,10)
(10)
AX7 AX6 AX5 AX4 AX3 AX2 AX1 AX0 DX7 DX6 DX5 DX4 ADSTB DX3 DX2 DX1 DX0
(12) DX0 DX1 DX2 DX3
(12) DX4 DX5 DX6 DX7
(10) AX0 AX1 AX2 AX3
U6T LS373
U5T LS244
GEN OE
A0 A1 A2 A3 A4 A5 A6 A7
360105-322
REV A
U4T 10K
OPT (10)
U3R U4R
AD8 AD9 AD10 AD11 AD12 AD13 AD14 AD15
(2,10)
LS367 (8)
U3T
AD0 AD1 AD2 AD3 AD4 AD5 AD6 AD7
(2,3)
DX0 DX1 DX2 DX3 DX4 DX5 DX6 DX7
U7R LS245
DIR
(2) W/R
(10) DMAIO
(2) AS
U13M LS32
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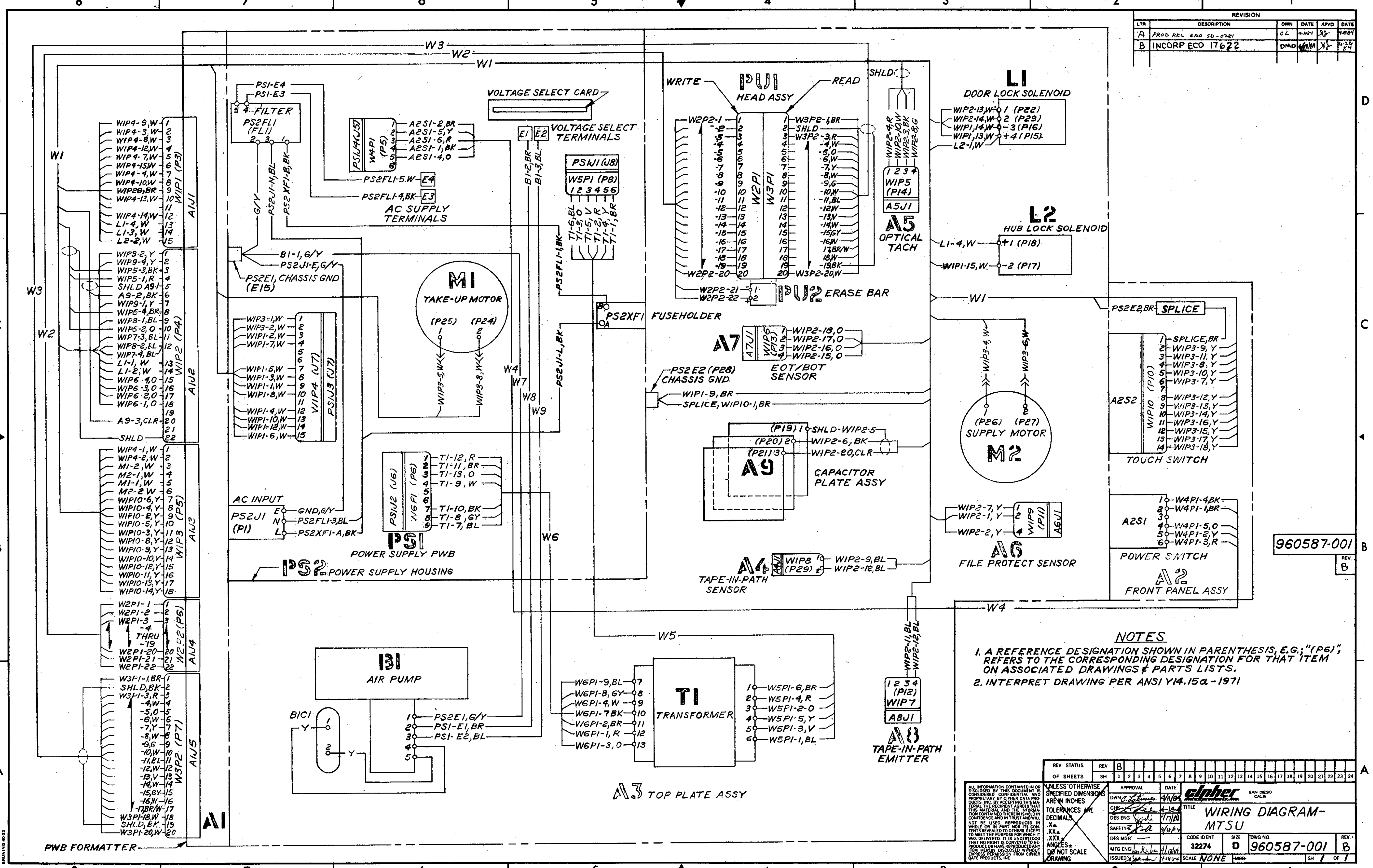
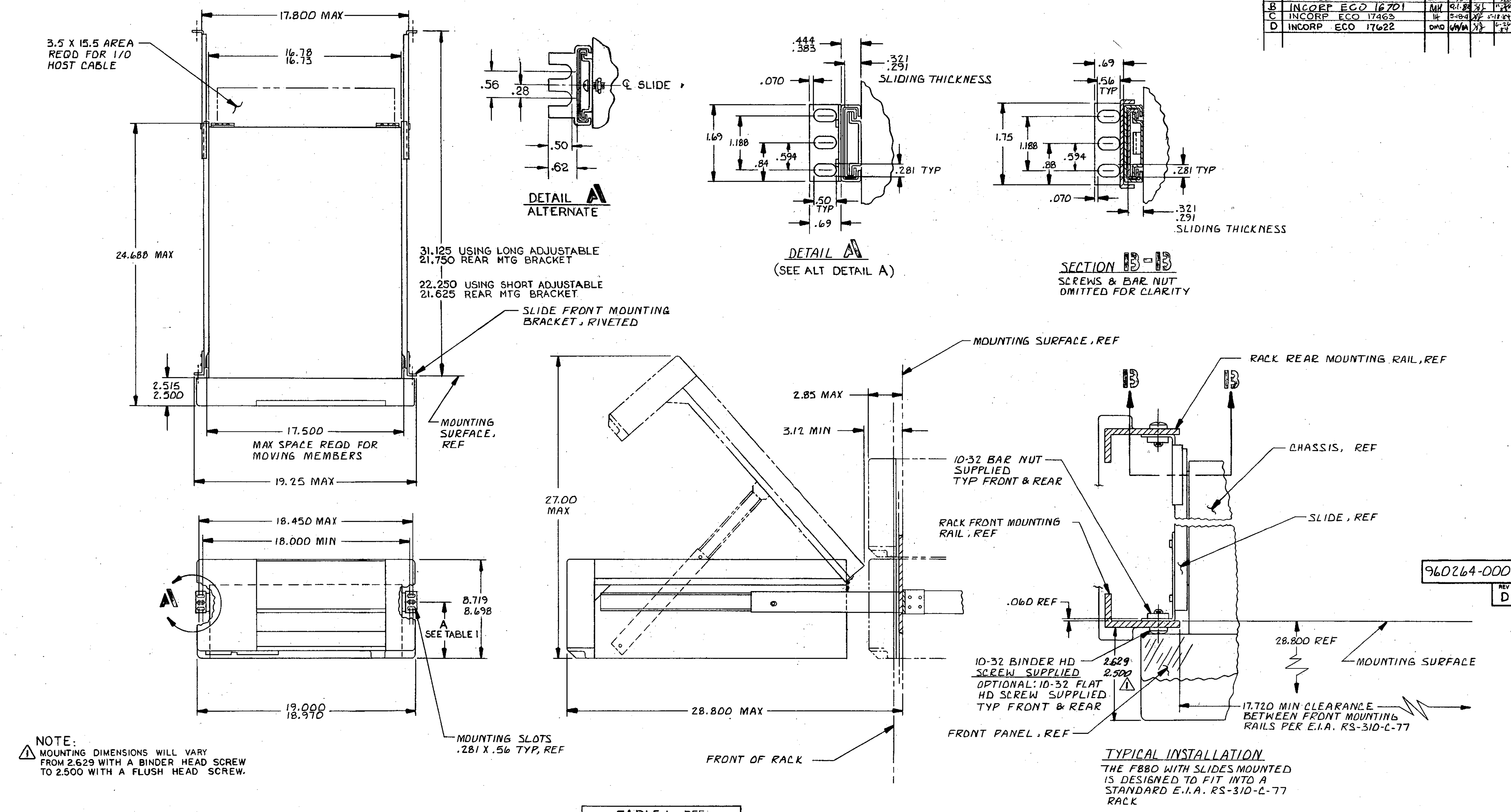
TITLE SCHEM - DRIVE/FORMATTER
CODE IDENT 32274 SIZE D DWG NO 360105-322 REV A
SCALE MOD SH 12 OF 12



REVISION
A PROD REL ERO SD-0281
B INCORP ECO 17622
PU1 HEAD ASSY
WRITE
READ
PU2 ERASE BAR
L1 DOOR LOCK SOLENOID
L2 HUB LOCK SOLENOID
A5 OPTICAL TACH
VOLTAGE SELECT CARD
VOLTAGE SELECT TERMINALS
AC SUPPLY TERMINALS
FILTER
PS2FL1 (FL1)
M1 TAKE-UP MOTOR
M2 SUPPLY MOTOR
PS2XF1 FUSEHOLDER
PS2E1, CHASSIS GND (E15)
PS2E2 (P28) CHASSIS GND
A7 EOT/BOT SENSOR
A9 CAPACITOR PLATE ASSY
A6 FILE PROTECT SENSOR
A4 TAPE-IN-PATH SENSOR
A8 TAPE-IN-PATH EMITTER
A2S2 TOUCH SWITCH
A2S1 POWER SWITCH
A2 FRONT PANEL ASSY
AC INPUT
PS2J1 (P1)
PS1 POWER SUPPLY PWB
PS2 POWER SUPPLY HOUSING
B1 AIR PUMP
T1 TRANSFORMER
A3 TOP PLATE ASSY
A1 PWB FORMATTER
960587-001
NOTES
1. A REFERENCE DESIGNATION SHOWN IN PARENTHESIS, E.G.; "(P6)", REFERS TO THE CORRESPONDING DESIGNATION FOR THAT ITEM ON ASSOCIATED DRAWINGS & PARTS LISTS.
2. INTERPRET DRAWING PER ANSI Y14.15a-1971
cipher SAN DIEGO CALIF
TITLE WIRING DIAGRAM-MTSU
CODE IDENT 32274
SIZE D
DWG NO. 960587-001
REV. B
SCALE NONE
SH 1 OF 1
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DO NOT SCALE DRAWING

LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	ENG REL	LS	3/4/83	CK	3/11/83
B	INCORP ECO 16701	MH	9-1-83		
C	INCORP ECO 17463	H	5-18-84		5-18-84
D	INCORP ECO 17622	DMD	6/19/84		6-26-84



NOTE:
⚠ MOUNTING DIMENSIONS WILL VARY FROM 2.629 WITH A BINDER HEAD SCREW TO 2.500 WITH A FLUSH HEAD SCREW.

960264-000 REV D

TABLE I - REF	
CHASSIS ASSY	DIM A
960566-001, -009 & -010	5.000 4.900
960566-002	3.972 3.872
960566-004	4.320 4.220

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE DECIMALS
.X ± .1
.XX ± .03
.XXX ± .010
ANGLES ±
DO NOT SCALE DRAWING

MECH 3/11/83
3/11/83

APPROVAL | DATE
MECH 3/11/83
ELEC 3/11/83
MFG 3/11/83
QA
MKT
ISSUED

DWN 3/4/83
CHK 3-11-83

cipher data products, inc. SAN DIEGO CALIF

TITLE MTSU-RACK MOUNT, INTERFACE

CODE IDENT 32274 | SIZE D | DWG NO 960264-000 | REV D
SCALE NONE | MOD | SH 1 OF 1

Model F880 Magnetic Tape Transport

Volume I: Operation Maintenance

Technical Manual No. 779816-003 Revision J

December 1983

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USA

NOTICE

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions included in this manual, may cause interference to radio communications. Verification of compliance with Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference, is the responsibility of the user.

Printed in U.S.A.

VOLUME I

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LIST OF ILLUSTRATIONS (Continued)

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SECTION I

DESCRIPTION, UNPACKING, INSPECTION, AND INSTALLATION

GENERAL

1-1. The Model F880 Magnetic Tape Streamer Unit (MTSU) is a dual-speed, dual-density, tape transport manufactured by Cipher Data Products Inc., San Diego, California. It incorporates a dual-gap head, providing read-after-write capability. Read/write, control, and formatting electronics are all incorporated in a single printed-wiring board (PWB). The transport is designed to operate on 85- to 132-Vac or 195- to 263-Vac, single-phase, 48- to 61-Hz line power. Reels to 10.5 inches in diameter can be accommodated. Tape speed and density capabilities are as follows:

a. Model F880 MTSU (1600 bpi)

(1) 25 ips at 1600 bpi

(2) 100 ips at 1600 bpi

b. Model F880 MTSU (3200 bpi)

(1) 25 ips at 1600 bpi

(2) 50 ips at 3200 bpi

(3) 100 ips at 1600 bpi

This section presents instructions for unpacking, inspecting, and installing the MTSU.

UNPACKING AND INSPECTION

1-2. The MTSU is shipped in a single carton reinforced by eight corner blocks to minimize the possibility of damage during shipping. Unpack as follows:

a. With shipping container on floor or workbench, cut side and center tapes securing top of outer box.

b. Pull box-top flaps down along sides of box. Lift upper foam corner blocks off MTSU, remove MTSU and place on table. Remove manual, I/O connector retainer, and rack latch bracket from shipping carton.

c. Check contents of shipping container against packing slip, and inspect for possible damage. **If damage exists, notify carrier.**

d. Refer to the illustration taped to the front door. Remove tape holding top cover and front door in place. Open top cover by lifting sides directly behind front panel. Place cover stay (left rear of top cover) in the slot provided. This is the maintenance access position. Pull tachometer (spring loaded arm at left-rear of unit) away from hub and discard the foam cushion. Carefully replace tachometer assembly against hub.

e. Examine the hubs, tachometer, and other components in tape path area for foreign matter.

f. Using a screwdriver, loosen two captive screws at front sides of top plate casting. Close the top cover. Lift front panel (and top plate casting) by grasping the two lower corners. Lift unit to its maximum upright position. Latch mechanism will automatically engage when unit is lowered approximately one inch. Insert the safety pin provided through both holes in the top plate support from outside inward (Figure 4-2). This is the service access position.

g. Remove 3 pieces of foam packing material from PWB. Check PWB and all connectors for correct installation.

h. To release latch mechanism, remove the safety pin and lift front panel before lowering it. Open top cover and tighten captive screws. Close top cover.

i. Do not replace packing tape or foam cushion materials.

j. Verify that the operating voltage indicated on the manufacturers label (rear of chassis) matches the power outlet voltage for the unit. If not, refer to paragraph 1-4 for instructions to change the operating voltage.

POWER CONNECTION

CAUTION

To prevent damage to the MTSU and ensure proper operation, be sure the outlet voltage is correct before applying power to the MTSU.

1-3. A power cord is supplied only for the voltage range indicated on the manufacturers label.

1-4. **Operating Voltage Selection.** The MTSU can be operated over a wide range of line voltages by selection of the appropriate power supply voltage option. To change the power supply option, proceed as follows:

CAUTION

When MTSU is to be extended on slides from equipment rack, ensure that rack is mounted securely. Weight of MTSU in extended position could upset an inadequately mounted equipment rack.

a. Switch transport power OFF and remove power cord from outlet.

b. Open unit to service access position. Refer to paragraph 1-2 (f).

c. Place a shop cloth or similiar item over the PWB in the area of the power supply assembly.

WARNING

Dangerous voltages can be encountered in the next two steps if the power cord is connected to an AC source or if the unit has had power applied in the last two minutes.

d. Refer to Figure 4-23. Remove two phillips head screws securing power supply cover, noting position of chassis ground cable. Pivot cover to the right and slide forward to remove.

e. Remove voltage selection card (4, Figure 4-24) from J9 on power supply PWB. Noting position of key slot on voltage selection card, reinstall the card in J9 to correspond to the desired voltage. Refer to Table 1-1.

f. Reverse steps c and d.

g. Replace the fuse, if required, with one of the correct current rating for the voltage selected. Refer to Table 1-1. Use a slo-blo, 250V type. The fuse holder is located on the right-front of the power supply assembly. Replace the power cord if required.

h. Adjust the +5V regulator circuit on the main PWB. Refer to paragraph 4-16.

i. Note in a prominent location on the unit that the "operating voltage (has been) changed to ______."

NOMINAL LINE VOLTAGE (TOLERANCE)	SELECTION CARD	FUSE (AMPS)	FREQUENCY (Hz)
100 - (85 - 110)	100	3.0	49-63
120 - (102 - 132)	120	3.0	49-63
208 - (187 - 228)	220	1.5	49-63
220 - (187 - 242)	220	1.5	49-63
230 - (207 - 253)	240	1.5	49-63
240 - (204 - 264)	240	1.5	49-63

Table 1-1. Operating Voltage Selection

INITIAL CHECKOUT

1-5. Section II contains a detailed description of all controls. To check for proper operation before installation, proceed as follows:

a. Connect power cord.

b. Clean tape path as directed in paragraphs 4-4 through 4-10.

c. Apply power to unit and verify that UNLOAD indicator is illuminated. (Allow for normal delay of 2 seconds). For other indications refer to paragraphs 2-6 and 2-7.

d. Ensure that tape is wound completely onto reel.

CAUTION

Both top cover and front panel door are locked during tape-loaded functions. Any attempt to open either top cover or front panel door before tape is unloaded will result in mechanical damage to the locking mechanism.

e. Open front panel door by pressing down gently on top (center) of door.

f. Insert tape into front panel of unit with write-enable ring side down.

g. Close front panel door.

h. Actuate LOAD switch. Access doors are now locked. When load sequence is completed, LOAD indicator will remain illuminated.

i. Initiate Service Aid 22 as described in paragraphs 3-3 and 3-27. Allow transport to cycle tape for a sufficient length of time to ensure proper servo operation. (It requires about 30 minutes to make a full pass on a 10.5 inch reel and complete a rewind sequence).

j. Exit Service Aid 22. Refer to paragraph 3-4.

k. Check that LOAD indicator remains illuminated following rewind sequence.

l. Check ON-LINE switch and indicator by depressing repeatedly and observing that ON-LINE indicator is alternately illuminated and extinguished. Leave in OFF-LINE state (indicator extinguished).

m. Press UNLOAD switch. When the tape is unloaded (UNLOAD indicator illuminated) open front panel door and remove tape reel. Close front panel door.

n. Switch power off and remove power cord from outlet.

RACK MOUNTING

1-6. The MTSU is designed to be mounted in a standard, 19 inch wide, EIA equipment rack using the slides and mounting hardware provided with each unit. Refer to Figure 1-1 and drawing in Installation Hardware Package to mount the unit as follows:

a. Locate the front and rear rail holes to be used on the equipment rack (1, Figure 1-1). If they are threaded, drill them out to 0.281 inches.

b. Place the transport in service access position. Refer to paragraph 4-3.

c. Starting with either side, remove stationary section of slide (2) from transport by pulling stationary section to the front of transport.

d. Remove intermediate section of slide (3) from transport by pulling intermediate section to the rear of transport. When spring lock engages, depress to release.

e. Reassemble these sections by sliding front of intermediate section into rear of stationary section. Depress spring lock to slide completely together. Leave these sections assembled.

f. Determine, for the depth of rack, the appropriate holes to use in the mounting bracket and secure loosely to stationary section using two 10-32 X 3/8 binder head screws (4) and a nut plate (5).

g. Mount front flange of stationary section (2) to front rail by placing flange behind rack rail holes.

h. Install two 10-32 X 3/8 binder head screws (6), first through front of rail, then through stationary section flange and secure loosely with a nut plate (7).

i. Mount mounting bracket to rear of rack by placing flange in front of rack rail holes.

j. Install two 10-32 X 3/8 binder head screws (8), first through back of rack, then through mounting bracket flange and secure loosely with a nut plate (9).

k. Check alignment and correct as necessary. Tighten front, rear, and mounting bracket attachment screws.

l. Repeat steps b through j for other side.

m. Install the bottom edge of the rack latch bracket (10) on the left rail 2.13 inches below the center-line of slide using two 6-32 X 7/16 flat head screws (11), flat washers (12), split-lock washers (13) and No. 6 hex nuts (14).

n. Slide intermediate sections forward until locks engage.

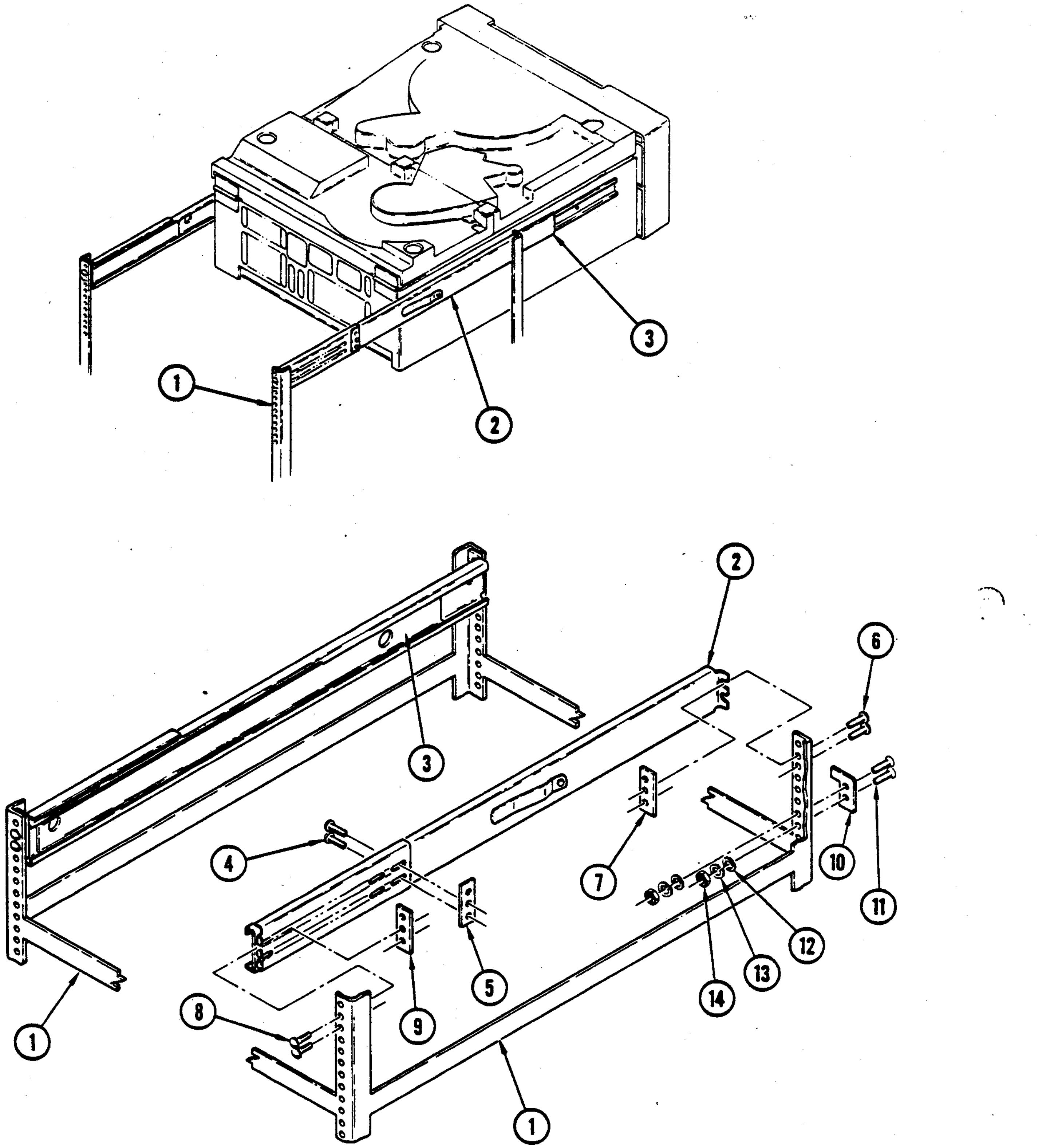

Figure 1-1. Rack Mounting

o. Carefully slide the MTSU's transport-attached chassis mount sections (15) into intermediate sections while checking for binding or interference. Release locks and, before closing fully, check that the rack latch will engage securely.

p. Adjust rack latch bracket (10) or slides as required. To release, squeeze rack latch plate inside air duct opening at lower left of front panel.

q. Connect the power cord. A service loop must be provided. Ensure the cord will not chafe or interfere with other equipment.

INTERFACE CONNECTIONS

1-7. It is recommended that interconnection of the MTSU and customer equipment be made with a flat ribbon cable or a harness of individual twisted pairs, each with the following characteristics:

a. Maximum length of 25 feet.

b. Not less than one twist per inch when using twisted pair.

c. 22- or 24-gauge conductor with minimum insulation thickness of 0.01 inch on twisted pair cables.

d. 28-gauge conductor is used with flat ribbon cable.

1-8. It is important that the ground side of each twisted pair, or the alternate conductor in a ribbon connector, be grounded. The mating connector (3M Company Part No. 3415-0001 or equivalent) must be wired by the customer. For twisted-pair cables, connector (Viking Part No. 3VT25/og JNH12 or equivalent) should be used.

1-9. Strain relief for flat-ribbon interface cables is provided for by the retainer included in the mounting hardware package. Install the connector retainer as follows:

a. Insert spring-loaded pins into holes located at each corner of PWB.

b. Lift retainer to allow access to edge connectors.

c. Install ribbon cables so that cables are on bottom sides of mating connectors.

d. Lower retainer and position over back sides of I/O connectors.

MULTIPLE-TRANSPORT OPERATION

1-10. The MTSU may be configured to allow operation of up to eight transports with a single controller. Use cables similar to those described in paragraph 1-7 for interconnection of transports. Refer to Figures 1-3 and 1-4.

1-11. To configure the MTSU to operate on a multiple transport system, proceed as follows:

a. Place MTSU in service access position. (See paragraph 4-4.)

b. Remove terminator resistor pack U3W and U10W (Figure 1-5) from each transport except last unit.

c. Install interconnection cables as shown in Figure 1-5.

1-12. The transport is selected by a combination of the levels on the IFAD, ITAD0, and ITAD 1 lines and the position of switches S1, S2, and S4. Refer to Table 1-2 for address decoding.

ADDRESS	IFAD	ITAD 0	ITAD 1	S1	S2	S4
0	0	0	0	1	1	1
1	0	0	1	1	1	0
2	0	1	0	1	0	1
3	0	1	1	1	0	0
4	1	0	0	0	1	1
5	1	0	1	0	1	0
6	1	1	0	0	0	1
7	1	1	1	0	0	0
0 = False Interface Level 1 = True Interface Level				0 = Open 1 = Closed		

Table 1-2. Address Line Decoding

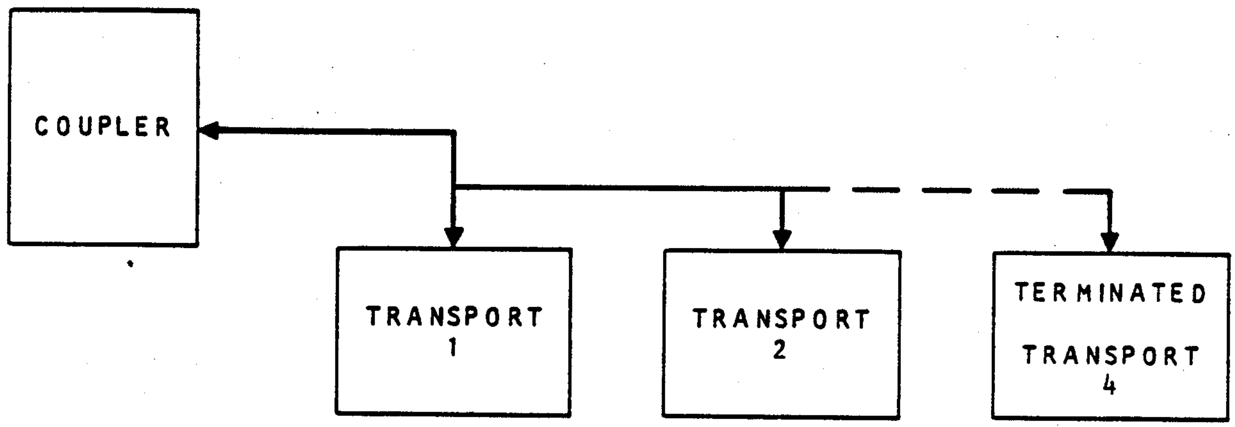

Figure 1-2. Daisy Chain Configuration

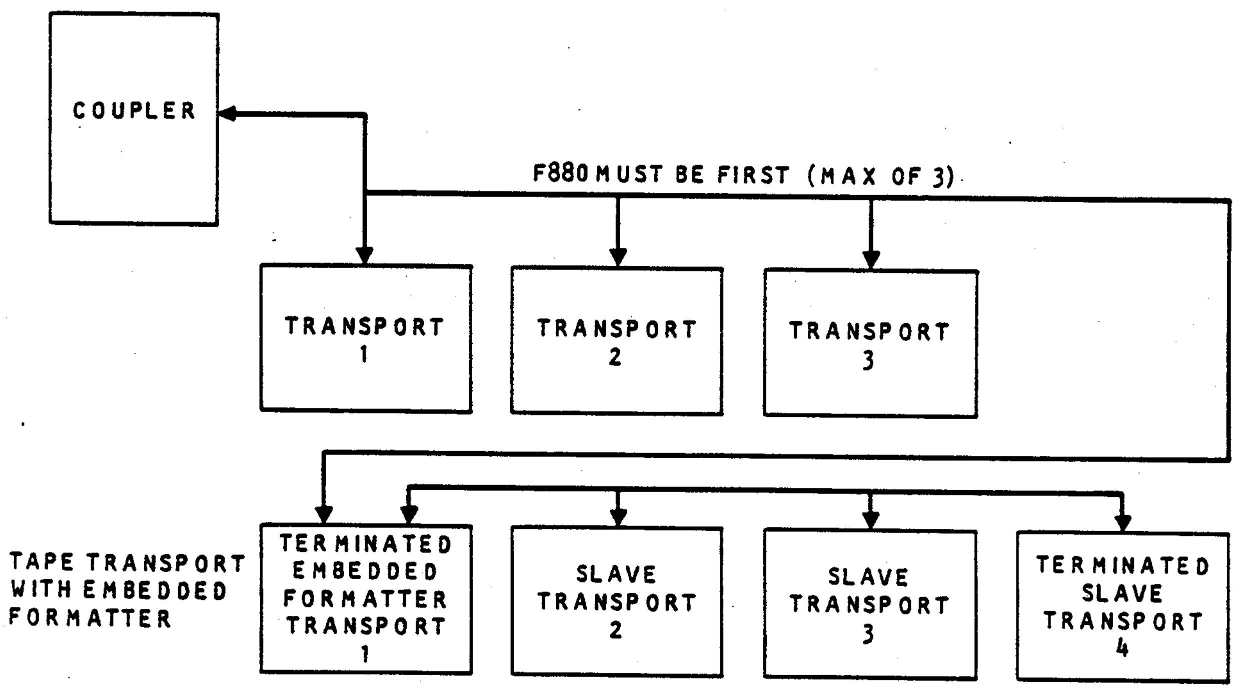

Figure 1-3. Daisy Chain with Embedded Formatted Drive

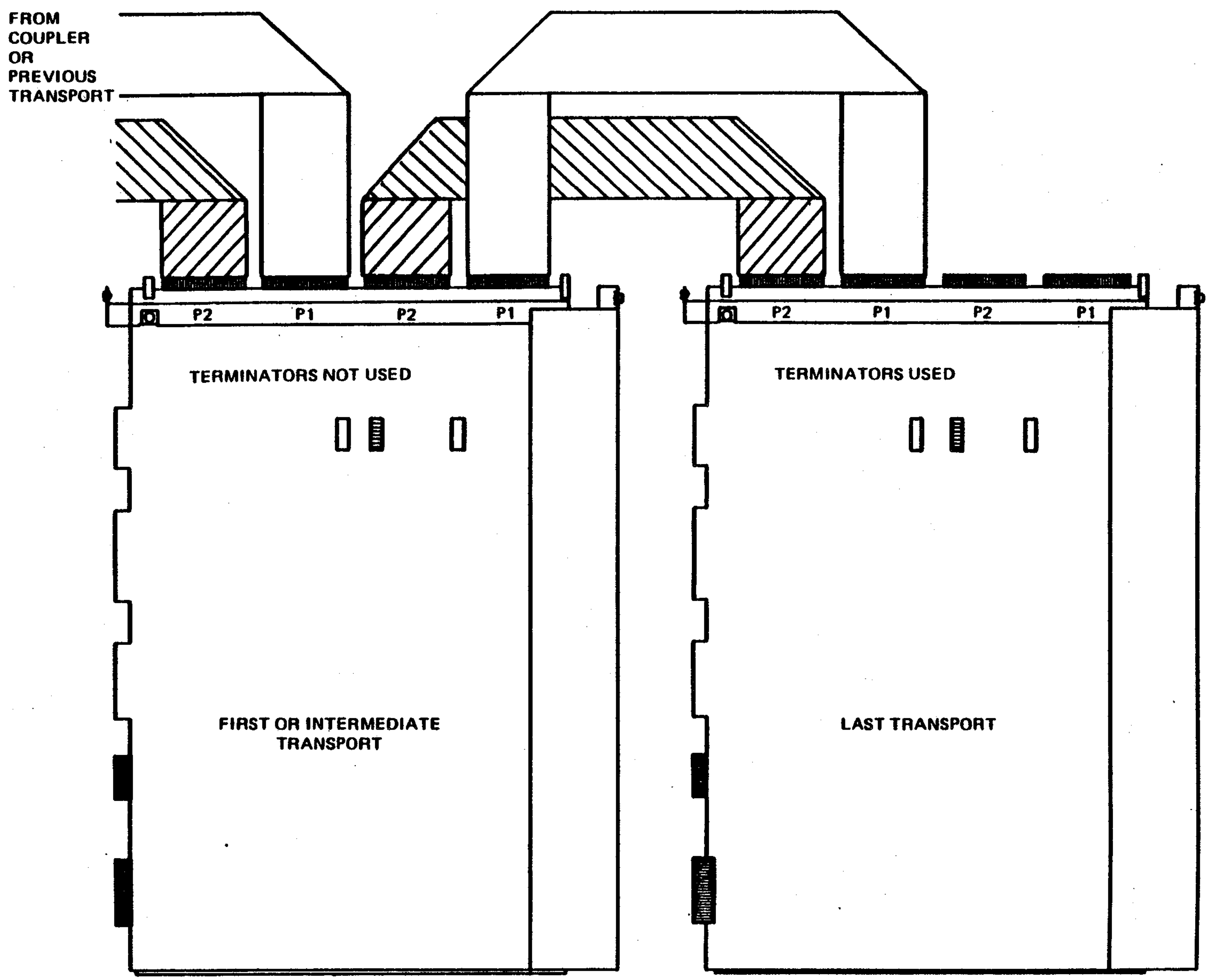

Figure 1-4. Daisy Chain Cable Configuration

SECTION II

OPERATION

GENERAL

2-1. This section describes the controls and indicators of the MTSU and provides operating instructions.

CONTROLS AND INDICATORS

2-2. Control/indicator types, functions, and the conditions required for enabling the corresponding functions are given in Table 2-1. Figure 2-1 shows the controls and indicators.

LOADING TAPE

2-3. To load tape, proceed as follows:

CAUTION

Do not attempt to open either top cover or front-panel door during load operation or while tape is loaded in transport. Both front-panel door and top cover are locked during tape-loaded functions.

a. Apply power to unit and verify that UNLOAD indicator is illuminated. (Allow for normal delay of 2 seconds.)

b. Insure that tape is wound completely onto reel.

c. Open front-panel door by pressing down gently on top (center) of door.

d. Insert tape into front of unit with write-enable ring side down.

e. Close front-panel door.

f. Actuate LOAD switch. Access doors are now locked. When load sequence is completed, LOAD indicator will remain illuminated.

CONTROL/ INDICATOR	TYPE	FUNCTION	CONDITIONS
POWER	ON/OFF Rocker Switch and Indicator	Switches line power on and off.	Fuse installed. Line cord connected.
LOAD REWIND	Tactile Switch and indicator	Loads tape to BOT marker. Rewinds tape to BOT marker. Illuminates to indicate BOT tab is positioned at photo-sensor. When pulsing, transport is executing a load or a rewind sequence.	Tape inserted in front panel door. Top cover and front panel door closed. Transport in off-line mode (ON-LINE indicator not illuminated).
UNLOAD	Tactile Switch and Indicator	Unloads tape from any point. UNLOAD indicator flashes during unload se-quence, then remains illuminated.	Transport in off-line mode. (ON-LINE indicator not illuminated.)
ON-LINE	Tactile Switch and Indicator	Switches transport to on-line mode. Illuminates to indicate transport is on line. Second actuation switches transport off line. Indicator extinguished to indicate transport is off line.	During load sequence actuation of ON-LINE switch will place transport on line when BOT marker is sensed. Transport is in on-line mode. (ON-LINE indicator illuminated.)
TEST	Tactile Switch	Selects alternate operational mode for other switches.	Refer to paragraph 3-3.
WRT EN (Write Enable)	Indicator	Illuminates to indicate write function may be performed.	Tape reel write enable ring installed mounted on supply hub and tape loaded.
HI DEN (High Density)	Tactile Switch and Indicator	First actuation (indicator illuminated): high-density mode, 3200 bpi; second actuation (indicator extinguished): lower density , 1600 bpi.	3200 bpi transport must be in off-line mode (ON-LINE indicator extinguished.)

Table 2-1. Controls and Indicators

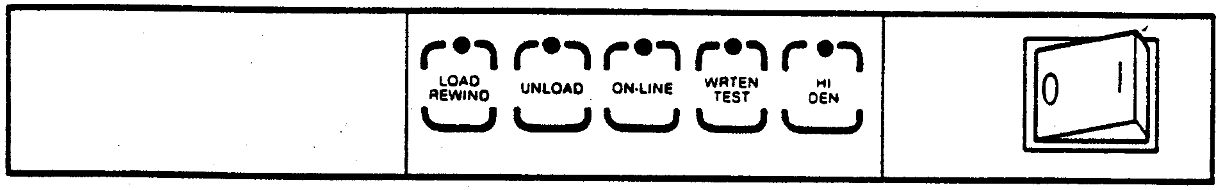

Figure 2-1. Control Panel

UNLOADING TAPE

NOTE

Transport must be in off-line mode (ON-LINE indicator extinguished).

2-4. To unload tape, proceed as follows:

a. Actuate UNLOAD switch.

NOTE

During the unload sequence, UNLOAD indicator will pulse and access doors will remain locked. When the unload sequence is completed, UNLOAD indicator will remain illuminated and access doors will unlock.

b. Open front-panel door when UNLOAD indicator remains illuminated.

c. Carefully remove tape reel.

d. Close front-panel door.

ERROR CONDITIONS

2-5. Operating failures or fault conditions are indicated by various front panel display patterns. There are two groups of error indications: those which are normally caused by the operator and can be avoided by following the proper operating procedure, and those which are machine malfunctions and require correction by an experienced service technician.

2-6. **Operator Error Codes.** These error indications are those which occur during normal tape loading operation and are usually caused by operator error. They produce error codes which will be displayed as an even, ON/OFF pattern of the indicators on the front panel. Refer to Table 2-2.

2-7. **Transport Error Codes.** These codes indicate a serious deviation from the normal operating routine of the MTSU. Each error code is represented as a unique binary pattern of the front panel indicators, which flash a quick double-pulse to alert the operator. Refer to Section III for troubleshooting instructions.

INDICATION	CONDITIONS
All indicators flashing	After four attempts, the MTSU did not successfully complete the load sequence. The tape leader should be checked for excessive damage. If a second attempt at autoloading fails, refer to paragraph 3-14 for manual load instructions.
All indicators except LOAD flashing	The BOT marker was not detected within the first 35 feet of tape. The leader must be a minimum of 6 feet in length.
All indicators except UNLOAD flashing	Tape reel was inserted upside-down. The bottom of the tape reel is indicated by the presence of an insertable write-enable ring near the inside mounting radius.
All indicators except ON-LINE flashing	A load or unload operation was attempted with the front-panel door or top cover in the open position.
All indicators except TEST flashing	A load operation was attempted without inserting a tape reel into the transport.

Table 2-2. Operator Error Front Panel Indications

MANUAL LOAD

2-8. To load tape after a failure of the autoloading routine proceed as follows:

a. Extend unit on its slides to clear equipment rack.

b. Place transport in operator maintenance access position by lifting top cover sides behind front panel. Place cover stay in slot provided.

c. Place reel of tape on supply hub. Ensure that reel is evenly seated on hub.

d. Depress and hold the manual unlock button, located behind front-panel door on bottom left hand side of tape reel opening, and simulataeously rotate the supply hub clockwise until supply reel is locked in place.

e. Thread tape along path shown in Figure 2-2. Carefully move tachometer assembly carefully away from takeup hub, and, making one wrap of tape clockwise around takeup hub, gently replace tachometer assembly. Check that tape is seated correctly on guides and threaded properly over head assembly.

f. Close top cover, and place transport in normal operating position.

g. Depress and hold the HI DEN switch, then actuate the LOAD switch and release both. Tape should tension and advance forward until BOT tab is positioned at photosensor. LOAD indicator will illuminate, indicating that MTSU is ready for use.

MANUAL UNLOAD

2-9. If for any reason the MTSU cannot complete the rewind/unload sequence, the tape reel may be rewound manually as follows:

a. Place transport in operator maintenance access position. Refer to paragraph 4-2.

b. Rotate supply reel in counterclockwise direction to rewind tape onto supply reel.

c. Depress manual unlock button, located behind front-panel door on bottom left hand side of tape reel opening, and simultaneously rotate the supply reel counterclockwise until it rotates freely and can be removed from the transport.

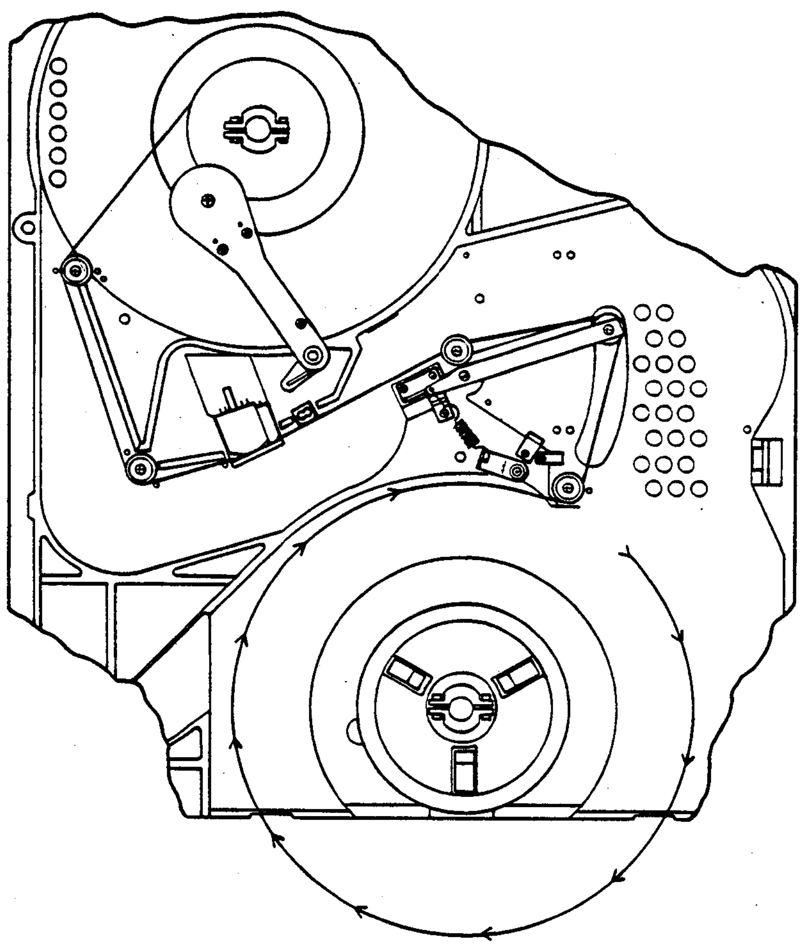

Figure 2-2. Tape Threading Path

SECTION III

TESTING AND TROUBLESHOOTING

TESTING

3-1. The MTSU incorporates three separate types of internal testing facilities. These self-test and diagnostic systems detect certain fault conditions and provide alignment and service aids for preventive maintenance.

3-2. **Self Test.** During power-up operation all indicator lights on the front panel are illuminated for approximately 1 second. If all indicators remain extinguished except UNLOAD following this period of time, no defect is indicated. If all indicators remain illuminated, then a failure of the ROM or RAM test is indicated. The auto-zero D to A, tachometer, and takeup servo circuits are also checked during the power-up diagnostic. Refer to paragraph 3-29 for a description of error indications.

3-3. **Diagnostic Mode Operation.** Diagnostic Service Aids are separated into two groups: those performed without tape loaded, and those performed with tape loaded on the transport. These service aids are designed to aid the technician in the isolation of electrical/electronic system failures and their remedies. Refer to paragraph 3-32 for troubleshooting instructions.

3-4. Referring to Figure 3-1, which illustrates the controls of the MTSU, the switch sequence for activating each service aid is as follows:

a. Actuate transport power switch to ON.

b. Press switches 4 and 5 in sequence.

c. Press switches corresponding to test number

d. Execute diagnostic by pressing switch 5.

e. Press switch 4 to exit diagnostic mode.

3-5. **Front Panel Indicators.** During operation in the diagnostic mode, the front panel indicators provide output data relative to the service aid being performed. This data is displayed as a binary pattern with the LOAD/REWIND indicator as the least significant bit (LSB) and the HI DEN indicator as the most significant bit (MSB). For example, during diagnostic Service Aid 14 with no tape loaded on the unit, the front panel indicators could display a binary count of 8 (TEST indicator flashing), which represents a nominal tachometer quadrature phase shift of 90 degrees. See Figure 3-1.

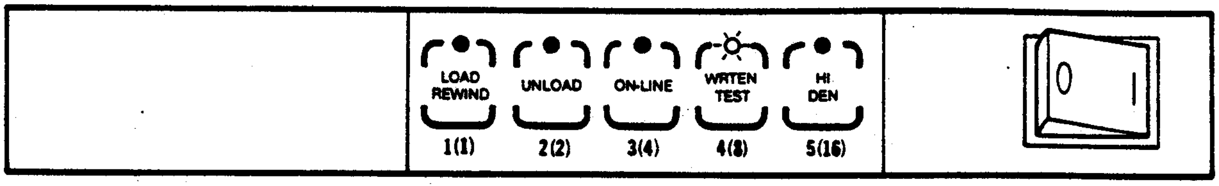

Figure 3-1. Front Panel Controls and Indicators (Diagnostic Mode)

NOTE

The complete switch sequence must be entered within 3 seconds, or the diagnostic routine will be aborted and the switch sequence will have to be reentered.

3-6. As an example, to cycle supply and takeup servos in the forward and reverse direction, Service Aid 11 would be used with no tape loaded on the unit. To access Service Aid 11 proceed as follows:

a. Actuate transport power switch to ON.

b. Press switches 4 and 5 in sequence.

c. Press switch 1 twice.

d. Execute Service Aid 11 by pressing switch 5.

3-7. **Diagnostic Mode (Tape Unloaded).** Diagnostic mode Service Aids with no tape in the transport are described in the following subparagraphs. Refer to paragraph 3-5 for description of front panel indicators.

3-8. Service Aid 11. This service aid enables both supply and takeup servo circuits, sequencing both reel hubs clockwise and counterclockwise. Press the LOAD switch to activate the high voltage rail drivers Q5 and Q6 (Sheet 4 of Dwg. No. 360103-309), and current limit the servos to 1 ampere. Press the UNLOAD switch to deactivate Q5 and Q6 and enable maximum current limit.

3-9. Service Aid 12. This service aid activates and deactivates the write circuitry to allow troubleshooting of the circuit with no tape loaded on the transport. To simulate a 100-ips data rate, press the LOAD switch. Actuation of the UNLOAD switch will select the 25-ips data rate. If the ILWD interface line is asserted, a 1-character pattern is written, including preamble and postamble.

3-10. Service Aid 13. This service aid performs the same functions as Service Aid 12, except the file-mark circuits are exercised.

3-11. Service Aid 14. Only the takeup servo is activated in this service aid. The purpose of this service aid is to sample the phase relationship for each quadrature of the tachometer assembly. During the first 5 seconds of the service aid, all indicators remain illuminated. Following this delay the percentage of phase shift between both tachometer inputs for quadrature 00 is displayed on the front panel indicators. Actuation of the LOAD switch will sequence to the next quadrature until all four of the phase quadratures have been displayed. On the next LOAD switch actuation, the servo direction is reversed and the previous sequence repeated. See Figure 3-2. A display count of 8 represents the nominal phase shift of about 90 degrees. The minimum phase shift allowable is 30 degrees, or a binary count of 3.

3-12. Service Aid 21. In this service aid hardware ports ONL and RWD are toggled with interrupts disabled for repeatable triggering. The on-line status latch and rewind status latch are pulsed in sequence. Next, the read formatter enables and the six output status ports are toggled in binary sequence. After a 10-millisecond delay, the entire sequence is repeated. The lines are toggled in binary sequence to allow quick, shorted-line detection, and to provide easily recognizable patterns for troubleshooting.

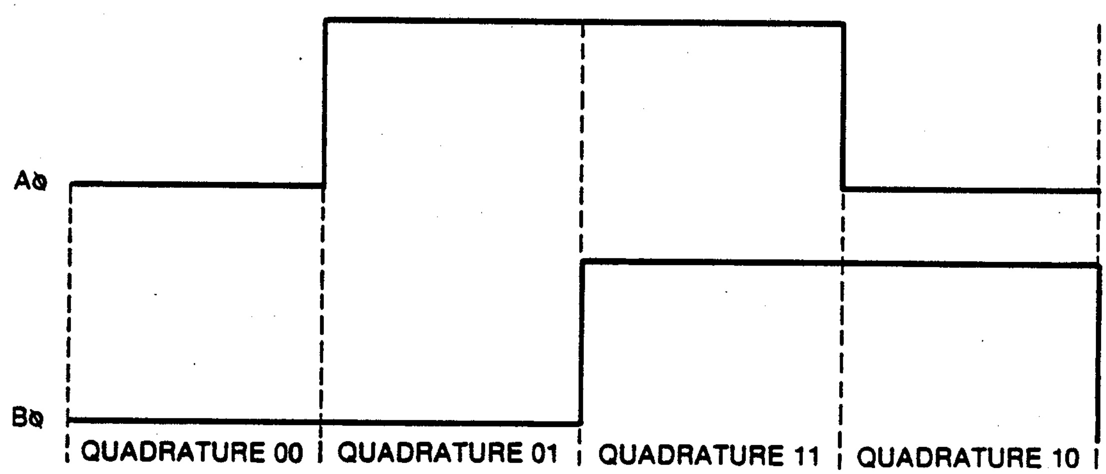

Figure 3-2. Tachometer Phase Quadrature

3-13. Service Aid 22. This service aid is used to display the output voltage of the BOT sensor via the front panel indicators. The value is periodically updated to allow insertion of a small piece of half-inch tape with a BOT reflective marker so that voltage levels produced from blank tape and BOT marker can be checked. To avoid erroneous indications, it may be necessary to shield the EOT/BOT sensor from ambient light. The binary output can be converted to an analog value by the following equation:

(Binary Count) X (0.16) = Output Voltage

3-14. Service Aid 23. This service aid is identical to Service Aid 22, except that the EOT circuit is activated.

3-15. Service Aid 24. This service aid measures the tension arm transducer voltage and displays the value as two 4-bit nybbles. The low-order bits (0 - 3) are displayed when the HI DEN indicator is not illuminated, and the high-order bits (4 - 7) are displayed when the HI DEN indicator is illuminated. The normal indicated range should be between negative 0.46 volt and positive 4.10 volts. Actuation of the LOAD switch will sequence the display from the low-order bits to the high-order bits. Refer to Table 3-1. The binary output can be converted to an analog value by the following equation:

(Binary Count) X (0.04) = Transducer Voltage

BITS				BITS				VOLTAGE
7	6	5	4	3	2	1	0	
0	1	1	1	1	1	1	1	+4.96
0	1	1	1	1	1	1	0	+4.92
0	1	1	1	1	1	0	1	+4.88
.	.	.	.	.	.	.	.	....
.	.	.	.	.	.	.	.	....
0	0	0	0	0	0	0	1	+0.04
0	0	0	0	0	0	0	0	0.00
1	1	1	1	1	1	1	1	-0.04
.	.	.	.	.	.	.	.	....
.	.	.	.	.	.	.	.	....
1	0	0	0	0	0	1	0	-4.92
1	0	0	0	0	0	0	1	-4.96
1	0	0	0	0	0	0	0	-5.00

Table 3-1. Compliance Arm Voltage Display

3-16. Service Aid 24 can also be used to display the absolute output of the compliance arm. To measure the voltage delta, actuate the UNLOAD switch while positioning the compliance arm against the forward stop. The binary output can be converted to an analog value by the following equation:

(Binary Count) X (0.04) = Voltage Delta

3-17. Service Aid 31. Only the supply servo is enabled in this service aid. Its purpose is to check the file-protect/reel-seat sensor and the tape-in-path sensor. To check the file-protect sensor, remove the write-enable ring from a reel of tape and place the tape on the supply hub. As the supply hub slowly rotates in a counterclockwise direction, a quick double pulse of the UNLOAD indicator should occur, which can only be observed by grasping and slowly rotating the supply hub until the reel-seat reflector moves past the sensor. With the write-enable ring installed, a single pulse of the UNLOAD indicator should also be observed as the file-protect tab rotates past the sensor. The LOAD indicator should initially be illuminated, indicating no tape in path. To check the sensor, insert a piece of half-inch tape so that it blocks the tape-in-path sensor and extinguishes the LOAD indicator.

3-18. Service Aid 32. This service aid rotates the supply servo counterclockwise while activating the hub lock solenoid. The hub should come to a stop when the hub tab engages the bellcrank. The reel servo is momentarily reversed and the hub lock solenoid disengaged. The hub is then positioned past the solenoid latch before it is reactivated and the cycle repeated. During this service aid, the door interlocks are also cycled. If both top cover and front panel doors are not closed, the ON-LINE indicator will illuminate.

CAUTION

This service aid is intended for use by skilled technicians only. Repeated activation of this service aid could damage door interlocks.

3-19. Service Aid 33. This service aid disables both top-cover and front panel door interlocks to allow observation of the tape path during operation. Door interlocks are reactivated when tape is unloaded following completion a load sequence or when transport power is turned off.

3-20. Service Aid 34. During this service aid, the LOAD switch controls the blower motor. When the LOAD indicator is illuminated, the blower motor should be activated.

3-21. **Diagnostic Mode (Tape Loaded).** Diagnostic mode service aids with tape in the transport are described in the following subparagraphs.

3-22. Service Aid 11. This service aid injects a 0.2-volt (peak-to-peak) 500 kHz, triangle wave (RNOISE) into the read amplifier circuits. This service aid may also be activated by the controller. Select this service aid only during 1600 bpi operation. If this service aid is selected during 3200 bpi operation, Hard Errors will result.

3-23. Service Aid 12. This service aid disables Service Aid 11.

3-24. Service Aid 13. Approximately + 0.25-volt of ripple is injected into the +5 VCC circuits. This service aid provides additional margin checking when combined with Service Aid 11 and activated during systems diagnostic operation.

3-25. Service Aid 14. This service aid disables Service Aid 13.

NOTE

Both Service Aids 11 and 13 are deactivated during tape unload and whenever the power-up sequence is initiated. This prevents inadvertent use of either service aid during normal operation.

3-26. Service Aid 21. This service aid allows adjustment of the read threshold circuit by utilizing the LOAD and UNLOAD indicators. Refer to paragraph 4-16.

3-27. Service Aid 22. During this service aid, the drive cycles tape in both forward and reverse directions while alternating speed between 25 and 100 ips. The front panel displays the maximum tension arm motion sensed before an arm fault would occur.

3-28. Service Aid 23. This service aid can be used to write data blocks at either 25 ips (LOAD switch activated) or 100 ips (UNLOAD switch activated). Last word (ILWD) must be grounded to generate a one-character data block complete with postamble. If ILWD is not grounded, a HER and a CER status will occur. If the reel of tape loaded on the transport does not have a write enable ring installed, only the data previously written on the tape will be read. The 3200 bpi MTSU has the additional capability of writing and reading at 3200 bpi (50 ips) by pressing the LOAD or UNLOAD switch following selection of Service Aid 23 with the transport operating in the HI DEN mode. Both models will perform a read reverse operation during Service Aid 23 if the HI DEN switch is depressed while selecting the desired operating speed.

NOTE

> When operating the MTSU in a multiple transport (daisy chain) configuration it is recommended that the system software be halted during execution of the following Service Aids: Service Aid 12, 13, and 21 with no tape loaded; Service Aid 21 and 23 with tape loaded.

TRANSPORT ERROR CONDITIONS

3-29. Abnormal conditions are indicated by various front panel display patterns. These error codes are also displayed as binary-coded patterns.

3-30. **Transport Error Codes.** These codes indicate a serious deviation from the normal operating routine of the MTSU. Each error code is represented as a unique binary pattern of the front panel indicators which flash a quick double-pulse to alert the operator.

3-31. Table 3-2 identifies each error code and describes briefly the conditions which may have caused the failure. Before normal operation is attempted, transport power must be turned off to reset the error. If the error code is repeated, refer to paragraph 3-32 for troubleshooting instructions.

BINARY CODE	INDICATION	CONDITIONS
3	LOAD and UNLOAD indicators flashing	The MTSU detected more than 3700 feet of tape beyond the BOT marker.
4	ON-LINE indicator flashing	The tension arm swing exceeded the range of normal operation during the auto load sequence.
5	LOAD and ON-LINE indicators flashing	The MTSU received an interface command prior to completion of the previous command.
6	UNLOAD and ON-LINE indicators flashing	The MTSU received a write command with a write-protected reel of tape loaded on the transport.
7	LOAD, UNLOAD, and ON-LINE indicators flashing	An illegal or undefined command was received by the MTSU.
8	TEST indicator flashing	A failure of the supply hub locking mechanism occurred.
9	NOT USED	-
10	UNLOAD and TEST indicators flashing	The auto-zero function of the digital-to-analog converter failed during the power-up sequence.
12	ON-LINE and TEST indicators flashing	Supply reel was not seated on hub, or a failure of the file protect circuit occurred.
13	LOAD, ON-LINE, and TEST indicators flashing	Supply reel did not remain locked during tape unload operation.
14	TEST, UNLOAD, and ON-LINE indicators flashing	Because of a controller error, tape travel beyond the EOT marker exceeded 18 feet.
17	LOAD and HI DEN indicator flashing	The tape buffer tension arm exceeded its free travel limits during any operation except those functions of the load and unload sequence where tape tension is not under arm control.
18	UNLOAD and HI DEN indicator flashing	Tape speed variations in excess of the ANSI maximum of $\pm 10\%$ deviation from normal operation speed occurred.

Table 3-2. System Fault Codes

3-32. Before performing any troubleshooting operation, the technician must have a good understanding of the theory of operation of the transport and any associated equipment. He should check carefully to ensure that all equipment is connected properly and that all associated equipment is in good operating condition. He should be thoroughly familiar with operating instructions and follow them carefully in performing the troubleshooting procedure.

3-33. To enable the maintenance technician to isolate malfunctions within the Magnetic Tape Streamer Unit (MTSU), the Troubleshooting Test Procedures (TTP) contain a recommended sequence to troubleshoot each malfunction. Erroneous failure symptoms may be caused by failures in the microprocessor circuitry. If a definite failure is not established upon completion of a specific TTP, use the TTP power-up failure (PF1000) to troubleshoot the microprocessor circuitry. Tables 3-3, 3-4, 3-5, and 3-6 list common symptoms associated with operation of a MTSU together with the probable cause and remedial action required to correct each failure.

3-34. Table 3-3 contains malfunction symptoms the MTSU may exhibit following a power-up failure.

3-35. Table 3-4 contains the malfunction symptoms the MTSU may exhibit if a failure occurs in the auto load sequence. Each malfunction will produce a fault code which displays itself as a steady flashing pattern ("on" then "off") on the respective front-panel indicators.

3-36. Table 3-5 contains the malfunction symptoms the MTSU may exhibit if a serious deviation takes place from the normal operating routine within the MTSU. Each symptom will be shown as a unique binary pattern on the front-panel indicators.

3-37. Table 3-6 contains the malfunction symptoms the MTSU may exhibit if a failure occurs outside the internal diagnostic circuits of the MTSU and cannot be detected.

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
Failure to complete power-up sequence. Transport unable to initiate any local or remote commands.	During power-up operation, all indicator lights on front panel illuminate for approximately one second. If all indicators extinguish except UNLOAD, no defect is indicated.	Refer to power-up failure TTP PF1000.
	Any invalid fault code also indicates failure. If the fan begins operating at power-up, a failure is also indicated.	Refer to TTP PF1000.

Table 3-3. Power-Up Malfunction Symptoms

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
All indicators flashing	1. After four automatic retries, transport cannot successfully complete load sequence. 2. Tape leader may be excessively damaged.	Refer to TTP LD1000. Remove damaged tape leader and replace BOT.
All indicators except LOAD flashing	BOT marker was not detected within first 35 feet of tape.	Check tape for BOT marker. Use Service Aid 22 to check BOT sensor. Refer to TTP BE1000.
All indicators except UNLOAD flashing	1. Tape reel inserted upside-down. 2. Tape-in-path sensor failed.	Insert reel correctly. Use Service Aid 31 to check tape path sensor. Refer to TTP HS1000.
All indicators except ON-LINE flashing	Load operation attempted with front panel door or top cover in open position.	Use Service Aid 32 to check door lock. Refer to TTP HD1000.
All indicators except TEST flashing	Load operation attempted without reel of tape inserted in unit.	1. Open top cover; verify reel is seated on supply hub. If not, retry load operation. During load operation, verify supply servo rotates in counterclockwise direction. Use Service Aid 11 to check supply servo. Refer to TTP SE1000. 2. If reel is seated and supply hub is rotating counterclockwise, use Service Aid 31 to check reel seat sensor. Refer to TTP HS1000.

Table 3-4. Operator Error Symptoms

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
LOAD and UNLOAD indicators flashing	MTSU detected more than 3700 feet of tape beyond BOT marker.	1. Usually caused by long reel of tape. Try different reel of tape. 2. Use Service Aid 14 to check tachometer position logic. Refer to TTP TA1000.
ON-LINE indicator flashing	Tension arm swing exceeded range of normal operation during load sequence.	1. Only occurs during load operation. Open top cover; verify tape is properly wrapped around takeup hub. If so, check compliance arm using Service Aid 24. Refer to TTP CA1000. 2. If tape is not wrapped around takeup hub, refer to TTP LD1000.
LOAD and ON-LINE indicators flashing	MTSU received interface command prior to completion of previous command. IGO should not go true until IDBSY goes false.	1. Usually caused by system failure. 2. Use Service Aid 21 to check interface signal IDBSY. Refer to TTP TI1000.
UNLOAD and ON-LINE indicators flashing	MTSU received write command with write-protected reel of tape loaded on MTSU.	1. Reset error code and reload tape. If WRT/EN indicator is extinguished, use Service Aid 31 to check file protect sensor. Refer to TTP HS1000. 2. If WRT/EN indicator is illuminated, use Service Aid 21 to check interface line to controller. Refer to TTP TI1000.

Table 3-5. Transport Failure Symptoms

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
LOAD, UNLOAD, and ON-LINE indicators flashing.	Illegal or undefined command was received by MTSU.	1. Check cables and interface command lines to MTSU. 2. Refer to TTP CL1000.
TEST indicator flashing	Failure of supply hub lock mechanism occurred.	1. Failure only occurs during load sequence. If reel appeared to lock correctly, use Service Aid 11 to check D to A converter. Refer to TTP SE1000. 2. Use Service Aid 32 to check hub lock solenoid. Refer to TTP HD1000.
UNLOAD and TEST indicators flashing	Auto-zero function of D to A converter failure during power-up sequence.	To bypass this error, switch MTSU power ON while pressing the TEST switch. Select Service Aid 11 to check D to A converter. Refer to TTP SE1000.

Table 3-5. Transport Failure Symptoms (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
UNLOAD, ON-LINE, and TEST indicators flashing.	Because of controller error, tape travel beyond EOT marker exceeded 18 feet.	Use Service Aid 21 to check IEOT interface line. Refer to TTP TI1000.
LOAD and HI DEN indicators flashing	The servo tension arm has exceeded its free travel limits during any operation except those functions of the load and unload sequence where tape tension is not under arm control.	1. If the MTSU missed the BOT or EOT marker and caused tape to run off reel, refer to TTP BE1000. 2. Use Service Aid 24 to check compliance arm. 3. Use Service Aid 11 to check servos and D to A converter. Refer to TTP SE1000.
UNLOAD and HI DEN indicators flashing	Tape speed variations occurred in excess of ANSI maximum of ±10% deviation from normal operating speed. Problem usually caused by bad tachometer assembly when drive is under system operation. A tachometer test is performed as part of the power-up diagnostic routine and may be bypassed to allow access to other diagnostic tests by depressing the TEST switch for 5 seconds during powerup.	1. If failure occurs during powerup, check that takeup hub moves momentarily counterclockwise then clockwise during powerup. If not, use Service Aid 11 to check the takeup servo. Refer to TTP SE1000. 2. Use Service Aid 14 to check tachometer. Refer to TTP TA1000.

Table 3-5. Transport Failure Symptoms (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
Read or write errors during system operation	System is unable to complete data transfer.	1. To determine if errors are caused by read or write logic, try to read a known good tape. If errors still occur, troubleshoot read formatter. Refer to TTP RF1000. 2. If the tape is read successfully, problem is in write formatter circuitry. Use Service Aid 12 to check formatter. Refer to TTP WR1000.
Tape reel cannot be removed from transport	Tape not wound completely on supply reel or tape reel.	1. Following an unload operation, ensure that tape is wound completely on supply reel. Use Service Aid 22 to check EOT/BOT sensors. Refer to TTP BE1000. 2. If tape is completely wound on supply reel, the tape reel should be unlocked. Use Service Aid 32 to check hub lock. Refer to TTP HD1000. 3. Use Service Aid 11 to check takeup servo circuit. Refer to TTP SE1000.
MTSU "runs away" with Data Busy false	Transport formatter no longer controlling tape motion.	Use Service Aid 14 to check tachometer. Refer to TTP TA1000.

Table 3-6. System Failure Symptoms

SYMPTOM	PROBABLE CAUSE	REMEDIAL ACTION
Transport "runs away" with Data Busy true	Transport formatter no longer controlling tape motion.	1. First, check read threshold and verify that it is in proper operating range. If transport was executing read operation when runaway occurred, check read formatter. Use Service Aid 23 to check read formatter. Refer to TTP RF1000. 2. If transport was executing write operation, use Service Aid 12 to check write formatter. Refer to TTP WR1000.
Doors will not lock or unlock. Operator unable to insert tape into transport.	Door lock malfunctioning.	Use Service Aid 32 to check door lock. Refer to TTP HD1000.
When drive is placed ON-LINE, tape unloads.	Transport will not operate in on-line mode.	Disconnect cables between transport and computer. If a problem still exists, transport is at fault. Refer to TTP LD1000.
System detects one or more of the following interface signals are not valid: IFBY, IRDY, IDBSY, IFPT, ILDP, IEOT, IONL, IRWD, or ISPEED	System unable to verify correct transport status.	Refer to TTP TI1000 to check interface signals.
Transport ignores all commands sent by the controller, or transport executes a command other than the command issued by the controller.	System unable to initiate any remote command.	Check interface cable connection between drive and controller. Check command lines. Refer to TTP CL1000.
System is unable to select transport.	Invalid status indications from transport to controller.	Check interface cable connection to transport. Refer to drive selection TTP DS1000.

Table 3-6. System Failure Symptoms (Continued)

3-38. **Power Control and System Failure Detect TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the power control and system failure detect logic circuits.

STATEMENT NUMBER	
PF1000	During power-up operation all indicator lights on the front panel are illuminated for approximately one second. If all indicators remain extinguished except UNLOAD following this period of time, no defect is indicated. A failure to properly complete the power-up sequence will be indicated by one of the following error indications: a. If all front panel indicators remain illuminated following actuation of the POWER switch, refer to TTP PF1010. b. Following actuation of the POWER switch, if all indicators are illuminated for approximately one second, then briefly extinguished, then illuminated continuously, refer to TTP PF1130. c. If any invalid fault code is displayed by the front panel indicators during power-up operation, refer to TTP PF1010.
PF1010	Is the signal at TP 89 a +5.0 ±0.25Vdc level? YES = PF1020 NO = PF1030
PF1020	Is the signal at TP 63 at a +5.0 ±0.25Vdc level? YES = PF1080 NO = PF1060
PF1030	Is P3-6 at a +10.0 ±2.0Vdc level? YES = PF1040 NO = PF1050
PF1040	Problem is Q7. When replaced and the signal at TP 89 is at +5.0Vdc level, refer to TTP PF1000.
PF1050	Problem is on the power supply board or a bad cable connection. When repaired, refer to TTP PF1000.
PF1060	Is P3 pin 4 at a +24.0 ±5Vdc level? YES = PF1070 NO = PF1050
PF1070	Problem is Q20. When replaced and the signal at TP 63 is at +5.0 ±0.25Vdc level, refer to TTP PF1000.
PF1080	Is U3L-9 high? YES = PF1090 NO = PF1100

STATEMENT NUMBER	
PF1090	Problem is U1K or supporting components. When repaired, refer to TTP PF1000.
PF1100	Switch MTSU power off. Using a jumper, ground U3L-8. Also remove U10L from its socket. Switch MTSU power on. Does the system fail indicator (DS1) remain illuminated?
	YES = PF1110 NO = PF1120
PF1110	Problem is U1K, U3L, Q17, or K1. Remove ground wire and reinstall U10L. If MTSU still does not power up successfully, refer to TTP PF1100.
PF1120	Problem is U2K, U1H, or U10L. Remove ground wire and reinstall U10L. When repaired, refer to TTP PF1130.
PF1130	The following steps are used to troubleshoot the system clock. Is U6L-6 a 2.0 ±0.01MHz clock?
	YES = PF1170 NO = PF1140
PF1140	Is the signal at TP 62 an 8.0 ±0.01 MHz clock?
	YES = PF1160 NO = PF1150
PF1150	Problem is Y1, U8R, U8P, or supporting components. When repaired and the signal at TP 62 is an 8MHz clock, refer to TTP PF1000.
PF1160	Problem is U8P or U8R. When repaired, refer to TTP PF1000.
PF1170	The following steps will verify all necessary voltages are applied to the board. Is the signal at TP 92 at a +12 ±0.6Vdc level?
	YES = PF1190 NO = PF1180
PF1180	Problem is VR2. When repaired and the signal at TP 92 is at a +12.0Vdc level, refer to TTP PF1000.
PF1190	Is the signal at TP 63 at a +5.0 ±0.25Vdc level?
	YES = PF1210 NO = PF1200
PF1200	Problem is Q20. When repaired and the signal at TP 63 is correct, refer to TTP PF1000.
PF1210	Is the signal at TP 90 at a -12 ±0.6Vdc level?
	YES = PF1230 NO = PF1220

STATEMENT NUMBER	
PF1220	Problem is VR1, cable connection or power supply. When repaired, refer to TTP PF1000.
PF1230	Is U3B-7 at a -5.0 ±0.25Vdc level? YES = PF1250 NO = PF1240
PF1240	Problem is C162, C4, or R352. When repaired. refer to TTP PF1000.
PF1250	Is the signal at TP 89 at a +5.0 ±0.25Vdc level? YES = PF1265 NO = PF1260
PF1260	Problem is Q7, the cable connection, or with the power supply board. When repaired, refer to TTP PF1000.
PF1265	Switch MTSU power off. Using a jumper wire, ground pins 1 and 4 of U17N. Does the drive now power up correctly? YES = PF1266 NO = Remove ground wire. Refer to TTP PF1270
PF1266	The microprocessor is failing due to excessive interrupts from the tachometer circuitry. Go to TA1000 and troubleshoot the tachometer, keeping in mind that U17N pins 1 and 4 are grounded.
PF1270	The power-up failure has now been narrowed down to the microprocesor logic. Due to the complexity in troubleshooting this area, first replace the following socketed IC's one at a time. Switch MTSU power off when replacing an IC. U6P, U7P, U6N, U8N, U10N, U12N, U6L, U14N, U8L, U10L, U12L, and U14L. If failure still exists, go to PF1280.
PF1280	Replace the following: U8R, U9P, U10P, U7H, U5F, U3N, U3L, or U4R. If failure is still present, we are unable to determine the cause.

3-39. **Auto-Load Sequence TTP.** This TTP describes the diagnostic steps required to isolate a failure during the auto-load sequence (Service Aid 33).

STATEMENT NUMBER		
LD1000	Activate Service Aid 33 to allow observation of the tape path area and initiate the load sequence by pressing the LOAD switch. Does the supply hub slowly rotate counterclockwise?	
	YES = LD1010	NO = SE1000
LD1010	Is the supply reel seated properly on the supply hub? If it is not, all indicators will flash except the TEST indicator.	
	YES = LD1020	NO = HS1000
LD1020	Does the blower motor begin operation?	
	YES = LD1030	NO = BL1000
LD1030	Does the MTSU lock the reel onto the supply hub?	
	YES = LD1040	NO = HD1000
LD1040	Does the supply servo perform a high speed spin for a short time to determine reel size?	
	YES = LD1050	NO = SE1000
LD1050	The supply servo should slowly turn counterclockwise until the end of tape is stripped off the reel and breaks the path of the tape-in-path sensor. The supply servo continues to turn counterclockwise until the tape is withdrawn and reenters a second time from the tape path, then the supply servo starts rotating in the clockwise direction, feeding tape in the column. Does this happen?	
	YES = LD1060	NO = SE1000 or HS1000.
LD1060	Does the tape continue past the EOT/BOT sensors and toward the takeup hub? If the EOT/BOT sensors fail to detect the tape go by within three seconds from the time TIP sensor was tripped, the MTSU will rewind the tape back on the supply hub and automatically retry the load sequence.	
	YES = BE1000	NO = LD1065
LD1065	Is the takeup servo rotating in the clockwise direction?	
	YES = LD1070	NO = SE1000

STATEMENT NUMBER	
LD1070	The tachometer should sense a decrease in speed as the tape wraps around the takeup hub. Once the tape is wrapped securely around the takeup hub both the takeup and supply servos should come to a stop. Do they?
	YES = LD1090 NO = LD1080
LD1080	Observing the takeup servo, which of the following best describes the failure symptom? a. Tape wraps around the takeup reel but the servo doesn't try to come to a stop and after four or five seconds the tape is rewound on the supply reel. If so, first clean the takeup hub and verify the tape isn't slipping on the hub. If the problem still occurs refer to TTP TA1000. b. The takeup servo is very unstable; possibly even changing directions and a fault code 4 or 18 occurs. Refer to TTP TA1000. c. The takeup hub starts turning in the counterclockwise direction and the MTSU displays fault code 4. Refer to TTP SE1000.
LD1090	Next the MTSU will calibrate the compliance arm. If an error is found the MTSU will display fault code 4. Does the MTSU calibrate the arm successfully?
	YES = LD1100 NO = CA1000
LD1100	The MTSU should move tape forward at 25 ips while looking for the BOT marker and determine if the tape reel has a write-eanable ring. If the write-enable ring is present the WRTEN/TEST indicator should illuminate. Does it?
	YES = LD1110 NO = HS1000
LD1110	Does the tape stop with the LOAD indicator illuminated at the BOT marker?
	YES = LD1120 NO = BE1000
LD1120	Press the ON-LINE switch. Does the ON-LINE indicator illuminate?
	YES = LD1130 NO = LD1140
LD1130	The LOAD sequence is now complete and the MTSU is ready for system operation.
LD1140	Is the MTSU still at BOT?
	YES = LD1150 NO = LD1160

STATEMENT NUMBER	
LD1150	Problem is U17L, U10L, the switch panel or a bad cable connection between the switch and the formatter PWB. When repaired, refer to TTP LD1000.
LD1160	Is U3V-1 low? YES = LD1180 NO = LD1170
LD1170	Troubleshoot the IONL and IRWD interface lines using Service Aid 21. Refer to TTP TI1000.
LD1180	Is the interface signal IRWU at U4W-9 low? YES = LD1190 NO = LD1200
LD1190	Problem is U4W, U10W, or the controller is holding the interface line low. When repaired, refer to TTP LD1000.
LD1200	Problem is U4W, U4V, U5V, or U3V. When repaired, refer to TTP LD1000.

3-40. **Takeup and Supply Servo TTP**. This TTP describes the diagnostic steps required to isolate a malfunction within the takeup and supply servo circuits (Service Aid 11).

STATEMENT NUMBER	
SE1000	Select Service Aid 11 and visually inspect the drive. Which of the following best describes the observed malfunction, if any? a. Neither one of the servos is working correctly. Refer to TTP SE1010. b. Takeup servo is working; however, the supply servo is not. Refer to TTP SE1290. c. Supply servo is working; however, the takeup servo is not. Refer to TTP SE1130. d. Both servos appear to be working properly. Refer to TTP SE1460. e. If directed to check out the D to A from another section, refer to TTP SE1010.
SE1010	The following will check out the D to A circuitry. Is the signal VOUTØ (U3M-8) at a +0.75 ±0.2Vdc level? YES = SE1020 NO = SE1080

STATEMENT NUMBER	
SE1020	Is the signal VOUT1 (U3M-1) at a -0.7 ±0.1Vdc level? YES = SE1030 NO = SE1080
SE1030	Is the signal VOUT2 (U3M-14) switching between +2.0Vdc and -2.0Vdc ±0.2Vdc? YES = SE1040 NO = SE1080
SE1040	Is the signal VOUT3 (U3M-7) at a +0.5 ±0.1Vdc level? YES = SE1050 NO = SE1080
SE1050	Is the signal VOUT4 (U2M-7) switching between +2.0Vdc and -2.0Vdc ±0.2Vdc? YES = SE1060 NO = SE1080
SE1060	Is the signal VOUT5 (U2M-1) at a +0.5 ±0.1Vdc level? YES = SE1062 NO = SE1080
SE1062	Switch MTSU power off. Check U5E-4 during the power-up sequence while all front-panel indicators are illuminated. Does U5E-4 go to a +5.3 ±0.3Vdc level? YES = SE1066 NO = SE1064
SE1064	Problem is U5E or U2N. When repaired, refer to TTP SE1000.
SE1066	During the power-up sequence and while all front panel indicators are off, U5E-4 should go to ground, leveling off somewhere between +5.0Vdc and -5.0Vdc, then the UNLOAD indicator should illuminate. Which of the following best describes the signal on U5E-4: a. The signal stays at +5.3 ±0.3Vdc and the MTSU fails with fault code 10. Refer to TTP SE1064. b. The signal goes to zero volts ±0.5Vdc and the MTSU fails with fault code 10. Refer to TTP SE1068. c. The signal goes to zero volts, slowly moves to either +5.0Vdc or -5.0Vdc, then goes to +5.0 ±0.3Vdc and the drive fails with fault code 10. Refer to TTP SE1068. d. The drive powers up correctly as described. Refer to TTP SE1070.

STATEMENT NUMBER

SE1068 Perform the test starting at SE1460. If, after replacing the IC's called out in statement number SE1780, the drive still fails with fault code 10, replace U5E and U2N. If a problem is found before reaching TTP SE1780, follow the instructions described in the statement.

SE1070 Reselect Service Aid 11. Do both servos appear to be operating correctly?

YES = SE1460 NO = SE1130

SE1080 Is the signal at TP 60 toggling?

YES = SE1090 NO = SE1100

SE1090 Replace U2N, U2M, U3N, and U3M. If the signal is still bad, problem is the destination IC.

If troubleshooting VOUT1, replace U5E.
If troubleshooting VOUT2, replace U4B.
If troubleshooting VOUT3, replace U3D.
If troubleshooting VOUT4, replace U3B.
If troubleshooting VOUT5, replace U3A.
When repaired, refer to TTP SE1000.

SE1100 Are the signals IOREQ* (U3L-3) and WR*(U4P-10) toggling?

YES = SE1110 NO = SE1120

SE1110 Problem is U3L, U4N, U4P, or U4R. When repaired and the signal at TP 60 is toggling, refer to TTP SE1000.

SE1120 Problem is the Z80 microprocessor, U6L, or the test wasn't selected correctly. When resolved, refer to TTP SE1000.

SE1130 The following will check out the takeup servo circuitry. Is the signal at TP 14 switching between +10Vdc and -10 ±2Vdc?

YES = SE1140 NO = SE1145

SE1140 Problem is a bad cable connection or a bad takeup motor. When problem is repaired and takeup servo is working correctly, refer to TTP SE1000.

SE1145 Check signals VOUT4 and VOUT5 by performing TTP SE1050 and SE1060. If the answer to both steps is YES, refer to TTP SE1150. If the answer to either one of the steps is NO, refer to the TTP it describes.

STATEMENT NUMBER	
SE1150	Is the signal P2A3 (U3B-11) low?
	YES = SE1170 NO = SE1160
SE1160	Problem is U12L. When repaired, refer to TTP SE1000.
SE1170	Is the signal at TP 61 at a -35.0 ±6.0Vdc level?
	YES = SE1220 NO = SE1180
SE1180	Is P3 pin 8 at a -35.0 ±6.0Vdc level?
	YES = SE1200 NO = SE1190
SE1190	Problem is the cable connection to the power supply or a failure in the power supply. When repaired and P3 pin 8 is at -35.0 ±6.0Vdc, refer to TTP SE1000.
SE1200	Is the signal P2B3 (U12L-30) low?
	YES = SE1210 NO = SE1160
SE1210	Problem is Q21, Q22, or Q5. When repaired and TP 61 is correct, refer to TTP SE1000.
SE1220	Is the signal at TP 6 switching between +9.0Vdc and -9.0 ±2.0Vdc?
	YES = SE1230 NO = SE1240
SE1230	Problem is U3B or one of the following transistors Q1, Q2, Q8, Q9, Q10, or Q11. When repaired, refer to TTP SE1000.
SE1240	Is the signal at TP 22 at a -0.5Vdc level?
	YES = SE1260 NO = SE1250
SE1250	Problem is U3A, R21, R20, CR1, or CR2. When repaired and the signal at TP 22 is at a -0.5Vdc level, refer to TTP SE1000.
SE1260	Does TP 16 go to a +10.0 ±2Vdc level for 80 ±40 milliseconds when the takeup hub starts to rotate clockwise and a -10.0 ±2Vdc level for 80 ±40 milliseconds when the servo starts to rotate counterclockwise?
	YES = SE1270 NO = SE1280
SE1270	Problem is U3A, R18, or R19. When repaired and TP 6 is correct, refer to TTP SE1000.

STATEMENT NUMBER	
SE1280	Problem is U3A, U3B, or supporting components. When repaired, refer to TTP SE1000.
SE1290	The following will check out the supply servo circuitry. Is the signal at TP 13 switching between +10.0Vdc and -10.0 ±2.0Vdc? YES = SE1300 NO = SE1310
SE1300	Problem is a bad cable connection to the servo circuit or a bad supply servo. When problem is repaired and supply servo is working correctly, refer to TTP SE1000.
SE1310	Check signals VOUT2 and VOUT3 by performing TTP SE1030 and SE1040. If the answer to both steps is YES, refer to TTP SE1320. If the answer to either one of the steps is NO refer to the TTP it describes.
SE1320	Is the signal P2A3 (U3B-10) low? YES = SE1330 NO = SE1160
SE1330	Is TP Ø at a +35.0 ±6Vdc level? YES = SE1380 NO = SE1340
SE1340	Is P3 pin 10 at a +35.0 ±6Vdc level? YES = SE1360 NO = SE1350
SE1350	Problem is the cable connection to the power supply or the power supply circuit. When repaired and P3 pin 10 is at +35.0 ±6Vdc, refer to TTP SE1000.
SE1360	Is the signal P2B2 (U12L-29) high? YES = SE1370 NO = SE1160
SE1370	Problem is Q23 or Q6. When repaired and TP Ø is correct, refer to TTP SE1000.
SE1380	Is the signal at TP 12 switching between +9.0Vdc and -9.0 ±2.0Vdc? YES = SE1390 NO = SE1400
SE1390	Problem is U3B or one of the following transistors: Q3, Q4, Q12, Q13, Q14, or Q15. When repaired, refer to TTP SE1000.
SE1400	Is the signal at TP 24 at a -0.5 ±0.2Vdc level? YES = SE1420 NO = SE1410

STATEMENT NUMBER	
SE1410	Problem is U3D, R71, R72, CR5, or CR6. When repaired and TP 24 is at a -0.5Vdc level, refer to TTP SE1000.
SE1420	Does TP 25 go to a +10.0 ±2.0Vdc level for 80 ±40 milliseconds when the takeup starts to rotate in the clockwise direction and a -10.0 ±2.0Vdc level for 80 ±40 milliseconds when the servo starts to rotate in the counterclockwise direction? YES = SE1430 NO = SE1440
SE1430	Problem is with U3A, R47, or R48. When repaired and TP 12 is correct, refer to TTP SE1000.
SE1440	Are signals P2A4 (U4B-11) and P2A5 (U4B-10) both high? YES = SE1450 NO = SE1460
SE1450	Problem is U4B or U3D. When repaired and TP 25 is correct, refer to TTP SE1000.
SE1460	The following will check out the inputs to the A to D converter. Is U2R-12 at a -3.0 ±0.5Vdc when the servos are rotating clockwise and at a +3.0 ±1.0 Vdc level when rotating counterclockwise? YES = SE1480 NO = SE1470
SE1470	Problem is U3E or U3D. When repaired and U2R-12 is correct, refer to TTP SE1480.
SE1480	Is U2R-1 at a -2.0 ±0.2Vdc level when the servos are rotating clockwise and at a +2.0 ±0.2Vdc level when rotating counterclockwise? YES = SE1500 NO = SE1490
SE1490	Problem is U3E or U3D. When repaired and U2R-1 is correct, refer to TTP SE1500.
SE1500	Is U2R-5 going to a -1.0 ±0.1Vdc level for 100 ±40 milliseconds when the servos start to rotate in the clockwise direction and at a +1.0 ±0.1Vdc level for 100 ±40 milliseconds when the servo starts to rotate counterclockwise? YES = SE1520 NO = SE1510
SE1510	Problem is R337, or C171; When repaired, refer to TTP SE1520.

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SE1520	Is U2R-2 going to a +1.0 ±0.1Vdc level for 100 ±40 milliseconds when the servos start to rotate in the clockwise direction and at a -1.0 ±0.1Vdc level for 100 ±40 milliseconds when the servo starts to rotate counterclockwise?
	YES = SE1540 NO = SE1530
SE1530	Problem is U3E or U3D. When repaired and U2R-2 is correct, refer to TTP SE1540.
SE1540	Is U2R-4 at a +2.5 ±0.5Vdc level when the servos are rotating clockwise and at a -2.0 ±0.5Vdc level when rotating counterclockwise?
	YES = SE1560 NO = SE1550
SE1550	Problem is U3B, R341, or C165. When repaired and U2R-4 is correct, refer to TTP SE1560.
SE1560	Is the signal at TP 61 a -35 ±6.0Vdc level?
	YES = SE1620 NO = SE1570
SE1570	Is P3 pin 8 at a -35 ±6.0Vdc level?
	YES = SE1590 NO = SE1580
SE1580	Problem is the cable connection to the power supply or the power supply circuit. When repaired and P3 pin 8 is at a -35.0 ±6.0Vdc level, refer to TTP SE1000.
SE1590	Is the signal P2B3 (U12L-30) low?
	YES = SE1610 NO = SE1600
SE1600	Problem is U12L. When repaired, refer to TTP SE1000.
SE1610	Problem is Q21, Q22, or Q5. When repaired and TP 61 is correct, refer to TTP SE1000.
SE1620	Is the signal at TP Ø a +35.0 ±6.0Vdc level?
	YES = SE1670 NO = SE1630
SE1630	Is P3 pin 10 at a -35.0 ±6.0Vdc level?
	YES = SE1650 NO = SE1640
SE1640	Problem is the cable connection to the power supply or the power supply circuit. When repaired and P3 pin 10 is at a +35.0 ±6.0Vdc level, refer to TTP SE1000.

STATEMENT NUMBER	
SE1650	Is the signal P2B2 (U12L-29) high?
	YES = SE1660 NO = SE1600
SE1660	Problem is Q23 or Q6. When repaired and TP Ø is correct, refer to TTP SE1000.
SE1670	Press the UNLOAD switch once. Is the signal at TP 61 -24.0 ±5.0Vdc?
	YES = SE1700 NO = SE1680
SE1680	Is the signal P2B3 (U12L-30) high?
	YES = SE1690 NO = SE1600
SE1690	Problem is Q21, Q22, or Q5. When repaired and the signal at TP 61 is -24.0 ±5.0Vdc, refer to TTP SE1700.
SE1700	Is the signal at TP Ø 24.0Vdc ±5.0Vdc?
	YES = SE1720 NO = SE1710
SE1710	Problem is Q23 or Q6. When repaired and TP Ø is correct, refer to TTP SE1720.
SE1720	Does the signal on TP 60 go low for 4.0 ±0.2 microseconds?
	YES = SE1770 NO = SE1730
SE1730	Does the signal on U4N-5 go high for 5.8 ±0.3 microseconds?
	YES = SE1740 NO = SE1760
SE1740	Does the signal on U4N-4 go low for 2.0 ±1.0 microseconds?
	YES = SE1750 NO = SE1760
SE1750	Problem is U4P or U4R. When repaired and TP 60 is correct, refer to TTP SE1000.
SE1760	Problem is U4N, U4P, or U3L. When repaired, refer to TTP SE1720.
SE1770	Does the signal at U4P-11 toggle?
	YES = SE1780 NO = SE1790
SE1780	Replace U2M and U2R. If problem still exists, we are unable to determine the cause of the failure.
SE1790	Problem is U4P, U3J, or U3L. When repaired, refer to TTP SE1000.

3-41. **Write Formatter TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the write formatter circuitry.

STATEMENT NUMBER	
WR1000	Activate Service Aid 12 with tape unloaded. This Service Aid activates the write formatter for approximately 3 milliseconds then resets the write circuitry for approximately 1 millisecond, then repeats the sequence. When the write circuit is active, check all nine data channels to the read/write head. Verify the following locations have a 3-microsecond square-wave clock: U17J-10, U18J-10, U17J-4, U18J-4, U17J-2, U18J-12, U17J-12, U18J-2, U17J-8, U18J-8, U17J-6, U18J-6, U18K-12, U18K-2, U18K-4, U18K-6, U18K-8, and U18K-10. Which of the following best describes the failures, if any? 1. All channels are working correctly. Refer to WR1010. 2. One or more channels are dead. Refer to TTP WR1120. 3. The channels are working but are the wrong frequency. Refer to TTP WR1240.
WR1010	Press the UNLOAD switch once. Is the signal W2XCLK* (U9R-8) an 80 ±0.08kHz clock? YES = WR1020 NO = WR1060
WR1020	Is the signal WHEADCT, P6 pin 1 at +11.0 ±0.5Vdc level for +3.0 ±0.5 milliseconds? YES = WR1030 NO = WR1090
WR1030	Is the signal at U4R-1 toggling? YES = WR1040 NO = WR1310
WR1040	Does the signal at U12P-7 go high for 950.0 ±50.0 microseconds? YES = WR1050 NO = WR1280
WR1050	All signals are correct leaving the board. Check cable connections and clean read/write head. If necessary, change head assembly. If problem still exists, we are unable to identify cause of the failure.
WR1060	Is the signal POB5 (U10R-3) high? YES = WR1070 NO = WR1080
WR1070	Problem is U10R, U11R, or U14W. When repaired and U9R-8 is an 80 kHz clock, refer to TTP WR1000.

STATEMENT NUMBER	
WR1080	Problem is U8L or the UNLOAD switch wasn't pressed. When repaired and U9R-8 is an 80kHz clock, refer to TTP WR1000.
WR1090	Is the signal P0B4 (U10H-1) a clock that is low for 3.0 ±0.5 milliseconds then goes high for 2.0 ±0.5 milliseconds? YES = WR1100 NO = WR1110
WR1100	The problem is U10H, Q36, Q37, Q38, head assembly, or a bad cable connection between the PWB and the head assembly. When repaired, refer to TTP WR1000.
WR1110	Problem is U8L. When repaired, refer to TTP WR1000.
WR1120	Are the signals P2B6 (U4P-1) and P2B7 (U4V-5) both clocks that are low for 2.0 ±0.5 milliseconds then high for 3.0 ±0.5 milliseconds? YES = WR1140 NO = WR1130
WR1130	Problem is U12L or the service aid wasn't selected correctly. When repaired, refer to TTP WR1000.
WR1140	Is the signal W2XCLK* (U18L-9) a 320 ±2.0 kHz clock? YES = WR1160 NO = WR1150
WR1150	Problem is U9R, U10R, U11R, or U10P. When repaired and U18L-9 is a 320 kHz clock, refer to TTP WR1000.
WR1160	During the 3 milliseconds that the write circuitry is active, are the signals FRC1 (U15W-10), FRC2 (U15W-2), and FRC3 (U15W-12) a 3.0 ±0.5 microsecond square-wave clock? YES = WR1170 NO = WR1180
WR1170	Depending on which channel is failing (determined in TTP WR1000) check the input of the failing channel's output inverter for a 3.0 ±0.5 microsecond square-wave clock. If the signal is correct, the problem is the output inverter, cable connection, or head assembly. If signal is incorrect, problem is U17K, U18L, U14W, U15W, or U13W. When repaired, refer to TTP WR1000.
WR1180	Is the signal LASTW* (U14R-2) low? YES = WR1185 NO = WR1200
WR1185	Is the signal W2XCLK* (U12W-9) toggling? YES = WR1190 NO = WR1250

STATEMENT NUMBER	
WR1190	Problem is U12W, U14R, or the interface line P1 pin 4 is shorted to ground. When repaired, refer to TTP WR1000.
WR1200	Is the signal at U14W-2 a 3.0 ±0.5 microsecond square-wave clock? YES = WR1210 NO = WR1230
WR1210	Is the signal at U14W-1 a 3.0 ±0.5 microsecond square-wave clock for 250 ±50 microseconds while remaining high the rest of the time? YES = WR1220 NO = WR1280
WR1220	Problem is U14W, U4P, U4V, or one of the destination IC's U13W, U14W, or U15W affecting the signal. When repaired, refer to TTP WR1000.
WR1230	Problem is U12R, U14R, U14W, or U8L. When repaired, refer to TTP WR1000.
WR1240	Is the signal W2XCLK* (U9R-8) a 320.0 ±2.0kHz clock? YES = WR1160 NO = WR1250
WR1250	Is the signal at U10R-2 an 8.0 ±0.008MHz clock? YES = WR1270 NO = WR1260
WR1260	Problem is with the clock generation circuit U8R or Y1. When repaired, refer to TTP WR1000.
WR1270	Problem is U10R, U11R, U9R, or U10P. When W2XCLK* is correct, refer to TTP WR1000.
WR1280	Is the signal P0B7 (U10P-4) always high? YES = WR1290 NO = WR1300
WR1290	Problem is U14R, U10P, U11P, U12P, or U14W. When repaired, refer to TTP WR1000.
WR1300	Problem is U10P or U8L. When repaired, refer to TTP WR1000.
WR1310	Problem is U14R, U4V, U4R, or U3J. When repaired, refer to TTP WR1000.

3-42. **Tachometer TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the tachometer circuitry.

STATEMENT NUMBER		
TA1000	Activate Service Aid 14 with tape unloaded. Check the signals at TP 70 and TP 72. Are they both a TTL clock that is high for 40.0 ±10 microseconds then low for 30.0 ±10 microseconds?	
	YES = TA1020	NO = TA1010
TA1010	Problem is tachometer assembly, a bad cable connection, or U19T. When repaired, refer to TA1000.	
TA1020	Is the signal at U18T-3 a clock that is high for 70.0 ±15 microseconds then low for 1.0 ±0.4 microseconds?	
	YES = TA1060	NO = TA1030
TA1030	Is U18R-2 a 1.0 ±0.001MHz clock?	
	YES = TA1050	NO = TA1040
TA1040	Problem is U8P. When repaired and U18R-2 is correct, refer to TA1000.	
TA1050	The problem is U17R, U12F, U18T, or one of the destination IC's U18N, U17N, or U17T affecting the signal. When repaired, refer to TA1000.	
TA1060	Is the signal at U18R-15 a clock that goes high for 1.0 ±0.4 microseconds then goes low for 70.0 ±15 microseconds?	
	YES = TA1100	NO = TA1070
TA1070	Is the signal at TP 67 always low?	
	YES = TA1080	NO = TA1090
TA1080	Problem is U18R, U18T, U17P, or U18P. When repaired, refer to TA1000.	
TA1090	Problem is U18R, U17T, U18T, U17M, or U14L. When repaired, refer to TA1000.	
TA1100	Is the signal PIASTR* (U17M-8) a clock that is low for 0.5 ±0.3 microsecond?	
	YES = TA1120	NO = TA1110
TA1110	Problem is U17M, U17T, U18T, or U14L. When repaired, refer to TA1000.	

STATEMENT NUMBER	
TA1120	Is the signal P1AØ (U17P-14) a 1.0 ±0.3 microsecond square-wave clock? YES = TA1130 NO = TA1200
TA1130	Is the signal P1A1 (U17P-13) a 2.0 ±0.5 microsecond square-wave clock? YES = TA1140 NO = TA1200
TA1140	Is the signal P1A2 (U17P-12) a 4.0 ±1.0 microsecond square-wave clock? YES = TA1150 NO = TA1200
TA1150	Is the signal P1A3 (U17P-11) an 8.0 ±2.0 microsecond square-wave clock? YES = TA1160 NO = TA1200
TA1160	Is the signal P1A4 (U18P-14) a 20.0 ±4.0 microsecond square-wave clock? YES = TA1170 NO = TA1200
TA1170	Is the signal P1A5 (U18P-13) a 35.0 ±8.0 microsecond square-wave clock? YES = TA1180 NO = TA1200
TA1180	Is the signal P1A6 (U18P-12) a clock that is high for greater than 1 microsecond and less than 6 microseconds? YES = TA1190 NO = TA1200
TA1190	Is the signal P1A7 (U18P-11) always low? YES = TA1210 NO = TA1200
TA1200	Problem is U17P, U18P, U17T, U14L, U18R, or U18T. When repaired, refer to TA1000.
TA1210	Is the signal P1B4 (U18N-14) a 70.0 ±12.0 microsecond square-wave clock? YES = TA1220 NO = TA1250
TA1220	Is the signal P1B5 (U18N-13) a 140.0 ±20.0 microsecond square-wave clock? YES = TA1230 NO = TA1250

STATEMENT NUMBER	
TA1230	Is the signal P1B6 (U18N-12) a 280.0 ±40.0 microsecond square-wave clock? YES = TA1240 NO = TA1250
TA1240	Is the signal P1B7 (U18N-11) always low? YES = TA1260 NO = TA1250
TA1250	Problem is U18N, U14L, or U17T. When repaired, refer to TA1000.
TA1260	Either CTCCLK0 (U17N-4), or CTCCLK1 (U17N-1) should be a 30.0 ±10.0 microsecond square-wave clock while the other clock should be low. Is it? YES = TA1270 NO = TA1280
TA1270	Step the test program by pressing the LOAD switch until the takeup motor changes direction. Check CTCCLK0 (U17N-4) and CTCCLK1 (U17N-1). Are the results the opposite of those observed in step TA1260? YES = TA1290 NO = TA1280
TA1280	Problem is U17N, U18N, U14L, or U14T. When repaired, refer to TA1000.
TA1290	Replace U14L and U14N. If the MTSU is still failing, we are unable to determine the fault.

3-43. **Interface Lines TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the interface lines (Service Aid 21).

STATEMENT NUMBER	
TI1000	**NOTE:** Pullups are required to check signals at the interface. If the MTSU is connected in a daisy-chain configuration and the computer system is using one of the other MTSU's, it will be necessary to change the failing MTSU's unit number to a value that will not be selected or polled by the computer. Example - If there are four MTSU's in the daisy-chain, change the unit number of the failing MTSU to unit 6. Activate Service Aid 21 to allow the following interface signals to toggle. This provides a loop to look at signals that may only occur once during normal operation. Which of the following interface signals are failing? IONL - refer to TTP TI1010 IRWD - refer to TTP TI1110 IFBY - refer to TTP TI1190 IRDY - refer to TTP TI1210 IDBSY - refer to TTP TI1230 IFPT - refer to TTP TI1250 ILDP - refer to TTP TI1270 IEOT - refer to TTP TI1290
TI1010	Is the signal P3A4 (TP 81) high for 5.0 ±1.0 microseconds? YES = TI1310 NO = TI1020
TI1020	Is the signal PULSE 1 (U2V-5) toggling? YES = TI1030 NO = TI1050
TI1030	Is the signal at U2V-2 toggling? YES = TI1040 NO = TI1060
TI1040	Problem is U2V, U6V, U8V, or U10L. When repaired, refer to TTP TI1000.
TI1050	Problem is U2W or U2V. When repaired and PULSE 1 is toggling, refer to TTP TI1000.
TI1060	Is the signal at U3V-1 always low? YES = TI1080 NO = TI1070

STATEMENT NUMBER	
TI1070	Problem is U2W, U4V, or U2V. When repaired, refer to TTP TI1000.
TI1080	Is the interface signal IRWU (U4W-9) low? YES = TI1090 NO = TI1100
TI1090	Problem is U4W, U10W, or the controller. When repaired, refer to TTP TI1000.
TI1100	Problem is U4W, U4V, U5V, or U3V. When repaired, refer to TTP TI1000.
TI1110	Is the signal at TP 87 high for 5.0 ±1.0 microseconds? YES = TI1310 NO = TI1120
TI1120	Is the signal PULSE 2 (U3V-10) toggling? YES = TI1140 NO = TI1130
TI1130	Problem is U2W or U3V. When repaired and U3V-10 is toggling, refer to TTP TI1000.
TI1140	Is the signal PULSE 3 (U4V-1) toggling? YES = TI1160 NO = TI1150
TI1150	Problem is U2W or U4V. When repaired, refer to TTP TI1000.
TI1160	Is the signal at U5W-10 toggling? YES = TI1170 NO = TI1180
TI1170	Problem is U2V, U3V, U4V, or U10V. When repaired and the signal at TP 87 is toggling, refer to TTP TI1000.
TI1180	Problem is U5W, U7V, or U2W. When repaired and U5W-10 is toggling, refer to TTP TI1000.
TI1190	Is the signal at TP 84 toggling? YES = TI1310 NO = TI1200
TI1200	Problem is U7V, U3V, U2W, or U7W. When repaired, refer to TTP TI1000.
TI1210	Is the signal at TP 82 toggling? YES = TI1310 NO = TI1220

STATEMENT NUMBER	
TI1220	Problem is U7V, U2W, or U7W. When repaired and the signal at TP 82 is toggling, refer to TTP TI1000.
TI1230	Is the signal at TP 86 toggling?
	YES = TI1310 NO = TI1240
TI1240	Problem is U7V, U7W, or U2W. When repaired and the signal at TP 86 is toggling, refer to TTP TI1000.
TI1250	Is the signal at TP 83 toggling?
	YES = TI1310 NO = TI1260
TI1260	Problem is U7W, U7V, or U2W. When repaired and TP 83 is toggling, refer to TTP TI1000.
TI1270	Is the signal at TP 78 toggling?
	YES = TI1310 NO = TI1280
TI1280	Problem is U7V, U2W, U8V, or U5W. When repaired and TP 78 is toggling, refer to TTP TI1000.
TI1290	Is the signal at TP 85 toggling?
	YES = TI1310 NO = TI1300
TI1300	Problem is U7V, U2W, or U8V. When repaired and the signal at TP 85 is toggling, refer to TTP TI1000.
TI1310	In order to check out the output interface gate it will be necessary to have the interface unit select lines equal to the MTSU unit number. Is the signal FSEL (U8V-13) always high?
	YES = TI1340 NO = TI1330
TI1330	Problem is U6V, U6W, or the unit select switch U8W. When repaired, refer to TTP TI1000.
TI1340	Is the signal ONLSEL (TP 80) toggling?
	YES = TI1380 NO = TI1350
TI1350	Is the signal at TP 81 toggling?
	YES = TI1360 NO = TI1010
TI1360	Is the signal at U6V-13 toggling?
	YES = TI1370 NO = TI1110

STATEMENT NUMBER	
TI1370	Problem is U6V or one of the destination IC's U8V, U7W, U4R, U17V, U17X, U18X, or U20X affecting the signal. When repaired, refer to TTP TI1000.
TI1380	Problem is U7W, U8V, U9V, cable connection between drive and controller, or the controller. When repaired, refer to TTP TI1000.

3-44. **EOT and BOT TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the BOT and EOT circuitry (Service Aids 22 and 23).

STATEMENT NUMBER		
BE1000	Switch MTSU power on to drive unit without a reel of tape installed. To check BOT, measure the voltage drop across R287. Is the voltage greater than 0.9 volt?	
	YES = BE1010	NO = BE1070
BE1010	To check EOT, measure the voltage drop across R292. Is the voltage greater than 0.9 volt?	
	YES = BE1020	NO = BE1070
BE1020	Insert a reel of tape and hand thread the tape through the tape path and around the takeup hub. Position the reflector strip away from the sensor. Is the voltage across R287 less than 0.3 volt?	
	YES = BE1030	NO = BE1070
BE1030	Is the voltage across R292 less than 0.3 volt?	
	YES = BE1040	NO = BE1070
BE1040	Position the BOT reflector marker in front of the sensor. Verify the tape is pulled tight and doesn't have any slack. Is the voltage drop across R287 greater than 1.3 volts?	
	YES = BE1050	NO = BE1070
BE1050	Position the EOT reflector marker in front of the sensor. Is the voltage drop across R292 greater than 1.3 volts?	
	YES = BE1060	NO = BE1070
BE1060	If the MTSU doesn't detect the EOT or BOT marker during operation, problem is U2R, R343, or R342. Once repaired, refer to TTP BE1000.	

STATEMENT
NUMBER

BE1070	Is P4 pin 15 a 4.4 ±0.5Vdc level?
	YES = BE1090 NO = BE1080
BE1080	Problem is R298 or C204. When P4 pin 15 is correct, refer to TTP BE1000.
BE1090	Problem is the cables or the EOT/BOT assembly. When repaired, refer to TTP BE1000.

3-45. **Compliance Arm TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the compliance arm circuitry (Service Aid 24).

STATEMENT
NUMBER

CA1000	Switch MTSU power on and activate Service Aid 24. The compliance arm should be at its full rest position. Measure the voltage at TP 64. Is it less than 4.1Vdc and greater than 2.6Vdc?
	YES = CA1010 NO = CA1030
CA1010	Pull the compliance arm fully against the front stop. Is the voltage at TP 64 greater than 0.0Vdc?
	YES = CA1020 NO = CA1160
CA1020	Is the voltage difference, from the readings taken in steps CA1000 and CA1010, between 2.6Vdc and 3.6Vdc?
	YES = CA1200 NO = CA1190
CA1030	Is TP 68 a 12.0 ±1.0Vdc peak-to-peak 10.5 ±0.5kHz sawtooth signal?
	YES = CA1110 NO = CA1040
CA1040	Is the signal CTCZC2 (U18M-11) a clock less than 42.0kHz and greater than 40.0kHz?
	YES = CA1060 NO = CA1050
CA1050	Problem is U14N or U18M. When repaired and the signal CTCZC2 is correct, refer to TTP CA1000.
CA1060	Disconnect the cable connector from P4. Is TP 68 a 12.0 ±1.0Vdc peak-to-peak 10.5kHz sawtooth signal?
	YES = CA1070 NO = CA1080

STATEMENT NUMBER	
CA1070	Problem is a short in the cable assembly or air capacitor assembly. When repaired, refer to TTP CA1000.
CA1080	Is U17M-6 a 20.8 ±1.0kHz clock?
	YES = CA1100 NO = CA1090
CA1090	Problem is U17M or U18M. When repaired, refer to TTP CA1000.
CA1100	Problem is U20N or supporting components. When repaired, refer to TTP CA1000.
CA1110	Measure the signal at TP 65. Is it a 4.0Vdc minimum, 10.5 ±0.5kHz clock?
	YES = CA1120 NO = CA1130
CA1120	Problem is U20N or supporting components. When repaired, refer to TTP CA1000.
CA1130	Is P4 pin 20 a 0.2Vdc minimum, 10.5 ±0.5kHz clock?
	YES = CA1140 NO = CA1150
CA1140	Problem is U20N or supporting components. When repaired, refer to TTP CA1000.
CA1150	Problem is a bad cable connection or air capacitor. When repaired, refer to TTP CA1000.
CA1160	Is the signal at TP 68 a 12.0 ±1.0Vdc peak-to-peak 10.5 ±0.5kHz sawtooth signal?
	YES = CA1170 NO = CA1140
CA1170	Is the signal at TP 65 a 2.0Vdc maximum, 10.5 ±0.5kHz clock?
	YES = CA1180 NO = CA1190
CA1180	Problem is U10N or supporting components. When repaired, refer to TTP CA1000.
CA1190	Problem is U20N, supporting components, or the air capacitor assembly. When repaired, refer to TTP CA1000.
CA1200	With the compliance arm at its full rest position measure the voltage at TP 20. Is it greater than -8.0Vdc and less than 0.0Vdc?
	YES = CA1210 NO = CA1220

STATEMENT NUMBER	
CA1210	With the compliance arm fully against the front stop, is voltage at TP 20 less than 11.0Vdc and greater than 2.0Vdc? YES = CA1240 NO = CA1220
CA1220	Is the signal VOUT 1 (U3M-1) at a -0.2 ±0.4Vdc level? YES = CA1230 NO = Test D to A using Service Aid 11
CA1230	Problem is U5E or U4B. When repaired, refer to TTP CA1000.
CA1240	Switch MTSU power off. Using a jumper wire, ground pins 10 and 11 of U4B. Switch MTSU power on while pressing the TEST switch until the UNLOAD indicator illuminates. Does the voltage at TP 25 swing greater than +3.0Vdc and less than -3.0Vdc when the compliance arm is moved back and forth between its limits? YES = CA1260 NO = CA1250
CA1250	Problem is U4B or U3D. When repaired, refer to TTP CA1000.
CA1260	Problem is U12L. If the MTSU still fails, refer to the next section recommended in the troubleshooting table. Otherwise we are unable to determine the cause of the failure.

3-46. **Reel Seat Sensor and Tape-In-Path Sensor TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the reel seat sensor and tape-in-path sensor (Service Aid 31).

STATEMENT NUMBER	
HS1000	If testing the reel seat or file protect sensor, refer to TTP HS1010. If testing the tape-in-path sensor, refer to TTP HS1130.
HS1010	Install a tape reel with a write ring and activate Service Aid 31. Is the supply hub slowly rotating in the counterclock wise direction? YES = HS1020 NO = SE1000
HS1020	Does the UNLOAD indicator flash "on" when the file protect tab passes the sensor? YES = HS1030 NO = HS1060

STATEMENT NUMBER	
HS1030	Does the UNLOAD indicator flash "on" when the reel seat tab passes the sensor? YES = HS1040 NO = HS1060
HS1040	When slowing the supply reel down by hand, does the UNLOAD indicator flash twice when the reel seat tab passes by the sensor? YES = HS1045 NO = HS1050
HS1045	Stop Service Aid 31 and remove the reel of tape from the MTSU. Press the LOAD switch and verify the MTSU doesn't engage the hub lock. If not, the hub sensors are working correctly. If the MTSU does engage the hub lock, refer to TTP HS1080.
HS1050	Problem is incorrect supply hub height or the reel seat tab is bent out of place. When repaired, refer to TTP HS1000.
HS1060	Does P2A1 (TP 21) toggle as the tab passes by the sensor? YES = HS1070 NO = HS1080
HS1070	Problem is U12L. When repaired and the UNLOAD indicator is working, refer to TTP HS1000.
HS1080	The signal at P4 pin 7 should be less than 0.15Vdc when a tab is not located in front of the sensor and greater than 0.3Vdc when a tab is located in front of the sensor. Is it? YES = HS1090 NO = HS1100
HS1090	Problem is U19T or U12L. When repaired, refer to TTP HS1000.
HS1100	Is P4 pin 2 at a 4.4 ±0.5Vdc level? YES = HS1120 NO = HS1110
HS1110	Problem is R298, C204, or broken PWB etch going to P4 pin 2. When P4 pin 2 is correct, refer to TTP HS1000.
HS1120	Problem is U19T, the tab sensors, cable connection, or incorrect hub height. When repaired, refer to TTP HS1000.
HS1130	The following checks the tape-in-path sensor. Activate Service Aid 31. Is the LOAD/REWIND indicator illuminated on the fron panel? YES = HS1140 NO = HS1150

STATEMENT NUMBER	
HS1140	Place your hand between the tape-in-path transmitter and receiver sensors. Does the LOAD/REWIND indicator extinguish? YES = HS1140 NO = HS1200
HS1145	The tape-in-path sensor is working correctly. If a problem still exists, refer to TTP HS1170 and TTP HS1210.
HS1150	Is P2A0 (TP 69) high? YES = HS1160 NO = HS1170
HS1160	Problem is U12L. When repaired, refer to TTP HS1000.
HS1170	Is P4 pin 9 greater than 0.3Vdc? YES = HS1180 NO = HS1190
HS1180	Problem is U19T or U12L. When repaired and TP 69 is high, refer to TTP HS1000.
HS1190	Problem is with tape-in-path sensors, sensor alignment, or a cable connection problem. When repaired, refer to TTP HS1000.
HS1200	Is the signal P2A0 (TP 69) low? YES = HS1160 NO = HS1210
HS1210	Is P4 pin 9 less than 0.15Vdc? YES = HS1220 NO = HS1230
HS1220	Problem is U19T or U12L. When repaired and TP 69 is low, refer to TTP HS1000.
HS1230	Problem is U19T or the light beam between the tape-in-path source and transmitter receiver has not been broken. When repaired, refer to TTP HS1000.

3-47. **Hub Lock and Door Lock TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the hub lock door and lock circuitry (Service Aid 32).

STATEMENT NUMBER	
HD1000	During this test the supply hub should rotate counter-clockwise while activating the hub lock and door lock solenoids. Also, if both the top cover and front door are not closed, the ON-LINE indicator should illuminate. Which of the following best describes the observed failure, if any? a. The hub lock solenoid is not working - refer to TTP HD1010. b. The hub lock solenoid is not working - refer to TTP HD1080. c. The top cover and front door are closed but the ON-LINE indicator is illuminated - refer to TTP HD1110.
HD1010	Is P3 pin 13 at a 24.0 ±5.0Vdc level? YES = HD1020 NO = HD1050
HD1020	Is the signal at TP 74 switching between 24.0Vdc ±5.0Vdc and 0.5Vdc? YES = HD1030 NO = HD1040
HD1030	Problem is cable connection or hub lock solenoid. When repaired, refer to TTP HD1000.
HD1040	Problem is U12L, R307, Q39, or a bad cable connection. When repaired, refer to TTP HD1000.
HD1050	Is P3 pin 4 at a 24.0 ±5.0Vdc level? YES = HD1060 NO = HD1070
HD1060	Problem is cable connection from power supply or power supply board. When repaired and P3 pin 4 is correct, refer to TTP HD1000.
HD1070	Problem is P3 pin 13 and P3 pin 4 should be connected. When repaired, refer to TTP HD1000.
HD1080	Is the signal at TP 75 switching between 24 ±5Vdc and 0.5Vdc? YES = HD1090 NO = HD1100
HD1090	Problem is front-panel door lock solenoid. When repaired and TP 75 is correct, refer to TTP HD1000.

STATEMENT NUMBER	
HD1100	Problem is U12L, R308, Q40, or a bad cable connection. When repaired and TP 75 is going to ground, refer to TTP HD1000.
HD1110	With both front panel door and top cover closed, is the signal P2A2, U12L-13 low?
	YES = HD1120 NO = HD1040
HD1120	Open one door at a time. Is P2A2 (U12L-13) high?
	YES = HD1030 NO = HD1040
HD1130	Problem is U12L. When repaired and ON-LINE indicator is working correctly, refer to TTP HD1000.
HD1140	The problem is the cable connection, U12L or the microswitch. When repaired, refer to TTP HD1000.

3-48. **Blower Motor TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the blower motor circuit (Service Aid 34).

STATEMENT NUMBER	
BL1000	Activate Service Aid 34 with tape unloaded. Does the blower motor start running?
	YES = BL1010 NO = BL1020
BL1010	Press the LOAD switch once. The LOAD indicator should extinguish and the blower motor should come to a stop. Does it?
	YES = DONE NO = BL1070
BL1020	Is P5 pin 2 between +5.0Vdc and +6.0Vdc?
	YES = BL1030 NO = BL1040
BL1030	Problem is the blower motor, power supply, or a cable connection. When repaired, refer to TTP BL1000.
BL1040	Is the signal P2B4 (U3K-12) low?
	YES = BL1050 NO = BL1060
BL1050	Problem is U3K or supporting components. When problem is repaired, refer to TTP BL1000.

STATEMENT NUMBER		
BL1060	Problem is U12L or Service Aid 34 wasn't selected. When repaired, refer to TTP BL1000.	
BL1070	Is P5 pin 2 less than +0.5Vdc?	
	YES = BL1080	NO = BL1090
BL1080	Problem is the power supply or motor. When repaired, refer to TTP BL1000.	
BL1090	Is the signal P2B4 (U3K-12) high?	
	YES = BL1110	NO = BL1100
BL1100	Problem is U12L. When repaired, refer to TTP BL1000.	
BL1110	Problem is U3K or supporting components. When repaired, refer to TTP BL1000.	

3-49. **Drive Selection TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the drive selection circuits.

STATEMENT NUMBER		
DS1000	The following should be used when the system diagnostic program is unable to select the MTSU.	
	Are the unit address swithces set to equal the MTSU number being tested?	
	YES = DS1020	NO = DS1010
DS1010	Change unit select switch to equal the address of MTSU being tested. When correct, refer to TTP DS1000.	
DS1020	Is the signal FSEL (U6V-8) high?	
	YES = DS1060	NO = DS1030
DS1030	Are the interface unit select lines IFAD, ITAD1, ITAD0 set correctly with the unit number being tested?	
	YES = DS1050	NO = DS1040
DS1040	Problem is interface cables or controller. When problem is corrected and interface lines equal unit number, refer to TTP DS1000.	

STATEMENT NUMBER	
DS1050	FSEL (U6V-8) should be high. If not, the problem is U6V, U6W, or unit select switch U8W. When problem is corrected, refer to TTP DS1000.
DS1060	Is the MTSU front panel ON-LINE indicator illuminated? YES = DS1080 NO = DS1070
DS1070	Press the ON-LINE switch on the front panel to place the drive on-line. Did the ON-LINE indicator illuminate? YES = DS1080 NO = DS1075
DS1075	Problem is switch panel, bad cable connection, U17L, or U10L. When repaired, refer to TTP DS1000.
DS1080	Is the signal IONL (U8V-3) low? YES = DS1100 NO = DS1090
DS1090	The problem is U8V, U2V, U2W, or U6V. When the problem is corrected and IONL (U8V-3) is low, refer to TTP DS1000.
DS1100	Is the signal IRDY (U7W-6) low? YES = DS1160 NO = DS1110
DS1110	Is the signal at TP 80 high? YES = DS1120 NO = DS1130
DS1120	Problem is U7W, U7V, or U2W. When repaired and IRDY (U7W-6) is low, refer to TTP DS1000.
DS1130	Is the signal at U3V-8 always high? YES = DS1140 NO = DS1150
DS1140	Problem is U6V or one of the destination IC's U8V, U7W, U4R, U17X, U17V, U18X, or U20X affecting the signal. When repaired and TP 80 is high, refer to TTP DS1000.
DS1150	Troubleshoot the IRWD interface line using Service Aid 21. Refer to TTP TI1000.
DS1160	If the MTSU is on-line and ready, the problem must be with the interface cables or the controller. When the problem is corrected, the system program should be able to select the MTSU.

3-50. **Command Lines TTP.** This TTP describes the diagnostic steps required to isolate a malfunction within the command lines.

STATEMENT NUMBER	
CL1000	It is the responsibility of the system program to detect a failure in this area. Which of the following best describes the failure if any? a. A command was sent; however, no tape motion occurred and IFBY did not go true. If so, refer to TTP CL1010. b. The tape drive fails with an illegal command fault code. If so, refer to TTP CL1070. c. The tape drive executes a different command than was sent. If so, refer to TTP CL1070.
CL1010	Put the system program in a loop to continually send a no-operation command. Is the signal IGO, P1, pin 8 going low for a minimum of 1 microsecond and no longer than 1 second? YES = CL1030 NO = CL1020
CL1020	Problem is the controller not sending an IGO pulse, bad cable connection, or failure of U3W, U5V, or U5W. When repaired, refer to TTP CL1000.
CL1030	Is the signal FSEL (U6V-8) high during the time IGO is low? YES = CL1040 NO = DS1000
CL1040	Is the signal POASTR* (U5V-11) at a low level only while IGO, U5W-13 is low? YES = CL1050 NO = CL1060
CL1050	Problem is U8L. When repaired, refer to TTP 1000.
CL1060	Problem is U5W, U5V, or U8L. When repaired, refer to TTP CL1000.
CL1070	Problem is U4W, U5W, U3W, or U8L. When repaired, refer to TTP CL1000.

3-51. **Read Formatter TTP.** This TTP describes the diagnostic steps required to check the read formatter logic. The circuitry is located on pages 7 - 10 of schematic drawing 360103-309.

STATEMENT NUMBER	
RF1000	Determine if the errors are being caused by the Write or Read circuits by reading a tape that is known to be good. If the errors persist while reading the good tape, the problem is in the read circuits and this TTP should be used. If errors are not detected while reading the good tape, it can be assumed that the write circuitry is the cause of the original errors and the procedure starting at WR1000 should be used.

NOTE

A good tape is defined as a tape containing record blocks that are greater than 18 and less than 2046 bytes, that the data in each block guarantees all data lines are changing, and there are no hard errors or corrected errors.

Before beginning, verify the following:

a. All cables are mated with the appropriate connectors, are properly seated, and are not inverted.

b. The AC line voltage is within operating limits and has the correct frequency.

c. The head, tape cleaner, and tape guides are clean and in good condition.

To use this troubleshooting procedure remove the write enable ring from tape and load tape on the transport. Unless otherwise specified, select Service Aid 23 for 25 ips operation.

This document covers two approaches to locating the failure. The first approach discussed is when the computer system can provide failure symptom information. The second approach is when the computer system is incapable of supplying information other than that the drive doesn't work.

Failure Information (supplied by system)

With failure information the circuitry most likely to be at fault can be determined. Which of the following best describes the failure?

a. Transport doesn't send any read strobes or read data information to controller. Refer to TTP RF1010.

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RF1000 (cont.)

b. Transport does send read data but is also sending hard error or corrected error information to controller. Refer to TTP RF1020.

c. Transport doesn't send or is always sending file mark status to controller. Refer to TTP RF3100.

d. Transport doesn't send or is always sending ID burst status to controller. Refer to TTP RF3000.

e. Transport sends incorrect data without indicating a hard error to controller. Refer to TTP RF3300.

f. The transport goes into a runaway condition when sent a read command to controller. Refer to TTP RF1010.

If the symptom isn't described above or if after following the statements called out the problem wasn't resolved, it will be necessary to step through each troubleshooting routine to locate the failure. Follow the instruction under "System Incapable of Supplying Failure Information."

System Incapable of Supplying Failure Information

Read Amplifiers - Starting at RF4000.
Read Control - Starting at RF2300.
Read Multiplexer - Starting at RF7100.
Read Clock - Starting at RF2000.
Read Data Lines - Starting at RF3300.
Read Strobe - Starting at RF3200.
Scan Generator - Starting at RF5000.
File Mark - Starting at RF3100.
Error Detect and Postamble - Starting at RF7500.
ID Burst - Starting at RF3000.
Read Control - Starting at RF2100.
Data Extractors - Starting at RF6100.
Skew Buffer - Starting at RF7300.

If after checking all the above circuits the failure still exists, we are unable to determine the cause of the problem or the failure is not located in the read formatter logic.

RF1010

Since the failure could be located in several different areas, it will be necessary to isolate the problem by checking the following circuits:

a. Read Control - Refer to TTP RF2300.
b. Read Multiplexer - Refer to TTP RF7100.
c. Read Control Register - Refer to TTP RF2100.
d. Read Strobe - Refer to TTP RF3200.
e. Read Data - Refer to TTP RF3300.
f. Return to TTP RF1000.

STATEMENT NUMBER	
RF1020	Isolate the problem by checking the read formatter circuits in the following order: a. Read Amplifiers - Refer to TTP RF4000. b. Read Multiplexers - Refer to TTP RF7100. c. Error Detect and Postamble - Refer to TTP RF7500. d. Return to TTP RF1000.
RF2000	In this section the read clock circuitry will be checked. The read clock logic is located in page 9 of the schematic drawing 360103-309. Load the good tape and select Service Aid 23 for 25 ips. Press the LOAD switch once and tape motion should stop. Measure the frequency at TP 93. Is it between 870kHz and 890kHz? YES = RF2010 NO = RF2030
RF2010	Initiate high speed, then stop tape motion. Is the clock at TP 93 between 3.48MHz and 3.56MHz? YES = RF2020 NO = RF2015
RF2015	Is the signal P0B5 zero (U12F-8) low if 25 ips is selected or high if 100 ips is selected? YES = RF2035 NO = RF2085
RF2020	Initiate low speed tape motion. Are the signals DCLK1 (TP 3) and DCLK2 (TP10) both toggling? YES = RF2025 NO = RF6100
RF2025	The read clock circuitry appears to be working correctly; return to the main troubleshooting routine that sent you here.
RF2030	Is the signal at U3G-8 always high? YES = RF2040 NO = RF2015
RF2035	Problem is U3G, U5G, U7H, U2G, or supporting components. When repaired, refer to TTP RF1000.
RF2040	Is the signal at U5G-1 a 40.0 ±1.0kHz clock? YES = RF2045 NO = RF2070
RF2045	Is the signal at U3G-6 toggling? YES = RF2050 NO = RF2035

STATEMENT NUMBER	
RF2050	Is the signal at U5G-3 toggling?
	YES = RF2035 NO = RF2055
RF2055	Is the signal at TP 93 toggling?
	YES = RF2060 NO = RF2065
RF2060	Problem is U3H, U2H, or U1J. When repaired and the signal at U5G-3 is toggling, refer to TTP RF1000.
RF2065	Problem is U2G or one of the destination chips U1H, U2H, U3H, U5H, U5F, U6A, U6B, U6F, U6G, U7A, U7B, U7D, U7F, U8F, U8E, U9A, U9B, U9C, U9D, U9F, U10B, U10C, U10D, U10E, U11D, U12V, U13A, U13B, U13C, U13D, U13E, U13F, U13G, U13V, U14V, U15V, or U19V. When repaired, refer to TTP RF1000.
RF2070	Is the signal at U9R-3 an 80.0 ±2.0kHz clock?
	YES = RF2075 NO = WR1000
RF2075	Is U7E-2 always low?
	YES = RF2080 NO = RF2300
RF2080	Problem is U7E, U9R, or U5G. When repaired, refer to TTP RF1000.
RF2085	Problem is with U8L, U12F, or one of the destination IC's U7H or U10H. When repaired, refer to TTP RF1000.
RF2100	In this section the read control register will be checked. The read control logic is located on page 10 of the schematic drawing 360103-309.
	Are the signals ENFMG (U18V-2), ENRD (U18V-7), and FWD (U18V-10) all toggling?
	YES = RF2110 NO = RF2130
RF2110	Is the signal at U18V-15 always low?
	YES = RF2120 NO = RF2150
RF2120	The read control register is working correctly. Return to the main troubleshooting flow.

STATEMENT NUMBER	
RF2130	Is the signal PULSE 5 (U18V-9) toggling? YES = RF2150 NO = RF2140
RF2140	Problem is U2W, U18V, or U18W. When repaired, refer to TTP RF1000.
RF2150	If the failing signal was ENFMG the problem is caused by U18V, U2H, U5H, or U3K. If the failing signal was ENRD, the problem is caused by U18V, U19W, U19X, or U2J. If the failing signal was FWD, the problem is U18V or one of the destination IC's U12D, U12C, U12F, U12B, or U12G. If the failing signal was U18V-15, the problem is U18V or U17V. When the failure is repaired, refer to TTP RF1000.
RF2300	In this section the read control circuitry will be checked. The read control logic is located on page 9 of the schematic drawing 360103-309. Select Service Aid 23 for 25 ips operation. Check the following RDROP signals. Are they all toggling? RDROPP* U12H-5 RDROP0* U12H-1 RDROP1* U12H-14 RDROP2* U12H-2 RDROP3* U12H-7 RDROP4* U12H-15 RDROP5* U12H-4 RDROP6* U12H-6 RDROP7* U12H-3 YES = RF2310 NO = RF4020
RF2310	Are both the signals at U5H-14 and U5H-13 toggling? YES = RF2330 NO = RF2320
RF2320	Problem is U12H, U6H, U5H, U7E, or U3K. When repaired, refer to TTP RF1000.
RF2330	Is the signal PECLK (U5H-12) a clock between 870 and 890 kHz? YES = RF2340 NO = RF2000
RF2340	Is the signal BLOCK (U5H-10) toggling? YES = RF2350 NO = RF2380

STATEMENT NUMBER	
RF2350	Is the signal P3A2 (U2H-6) toggling? YES = RF2360 NO = RF2400
RF2360	Is the signal PENAB* (U3J-8) toggling? YES = RF2370 NO = RF2410
RF2370	The read control circuitry is working correctly. Return to the troubleshooting routine that sent you here.
RF2380	Is the signal ENFMG (U5H-15) toggling? YES = RF2390 NO = RF2100
RF2390	Problem is U5H, U2J, or U1H. When repaired, refer to TTP RF1000.
RF2400	Problem is U5H, U1H, U2H, or U10L. When repaired, refer to TTP RF1000.
RF2410	Is the signal at U2J-8 toggling? YES = RF2420 NO = RF2430
RF2420	Problem is U3J or one of the destination IC's U11C, U12E, U13E, U13F, U13H, U11B, U13B, U11F, U11E, or U13C. When repaired, refer to TTP RF1000.
RF2430	Is the signal ENRD (U2J-9) toggling? YES = RF2440 NO = RF2100
RF2440	Is U5H-2 always low? YES = RF2450 NO = RF3100
RF2450	Problem is with U5H, U2J, or one of the destination IC's U3J, U12V, U6F, U9F, U6G. When repaired, refer to TTP RF1000.
RF3000	In this section the ID burst logic will be checked. The circuitry is located on page 9 of schematic drawing 360103-309. Remove the write enable ring from a good tape that is written in 1600 bpi phase encode and install in the drive. Select Service Aid 23 and press the LOAD switch for 25 ips operation. As the drive performs the read from load point, the drive should first send the ID burst status. It is necessary to terminate Service Aid 23 and reselect it for every ID burst pulse. A better troubleshooting loop can be accomplished if the command string of read, rewind, and loop can be executed by the computer system.

STATEMENT NUMBER	
RF3000 (con't.)	Does U6H-2 go high for a minimum of 4 milliseconds? YES = RF3010 NO = RF3060
RF3010	Does the signal ENFMG (U3K-5) go high when the BOT marker moves past the read/write head? YES = RF3020 NO = RF2300
RF3020	The signal IDENT P2 pin 16 should remain high when reading from load point. Does it? YES = RF3040 NO = RF3030
RF3030	The problem is U6V, U3K, cable connection between drive and controller, or the controller. When repaired, refer to TTP RF1000.
RF3040	In order to check out the output interface gate, the drive must be on-line and executing a read command. Does P2 pin 16 go low when reading from BOT? YES = RF3050 NO = RF3030
RF3050	The ID burst circuitry is working correctly. Return to the troubleshooting routine that sent you here.
RF3060	The problem is U12H, U6H, or U6V. When repaired, refer to TTP RF1000.
RF3100	In this section the file mark logic will be checked. This circuitry is located on page 9 of schematic drawing 360103-309. Load a scratch tape that is write-enabled. Select Service Aid 21 and adjust R115 so the UNLOAD indicator is always illuminated. Is the signal P3A3 (U5H-6) toggling? YES = RF3110 NO = RF3150
RF3110	U17X-8 should always be high. Is it? YES = RF3130 NO = RF3120
RF3120	The problem is U17X cable connection between drive and controller, or the controller. When repaired, refer to TTP RF1000.

STATEMENT NUMBER

RF3130 In order to check out the interface gate, the drive must be on-line and in a loop writing file marks. Does U17X-8 toggle?

YES = RF3140 NO = RF3120

RF3140 The file mark circuitry is working correctly. Return to the troubleshooting routine that sent you here. Refer to paragraph 6-17 for instructions on final read threshold adjustment.

RF3150 Is the signal ENFMG (U5H-1) toggling?

YES = RF3160 NO = RF2300

RF3160 Is the signal PECLK (U5H-4) toggling?

YES = RF3170 NO = RF2000

RF3170 Check the following signals. Are the signals RDROP1*, RDROP3*, RDROP4* always low and the rest toggling?

YES = RF3180 NO = RF4020

RDROPP*	U12H-5	RDROP0*	U12H-1
RDROP1*	U12H-14	RDROP2*	U12H-2
RDROP3*	U12H-7	RDROP4*	U12H-15
RDROP5*	U12H-4	RDROP6*	U12H-6
RDROP7*	U12H-3		

RF3180 The problem is U12H, U6H, U5H, or U17X. When repaired, refer to TTP RF1000.

RF3200 In this section the read strobe circuitry will be checked. The read strobe logic is located on page 10 of schematic drawing 360103-309.

Load the good tape without the write enable ring. Select Service Aid 23 for 25 ips operation.

Is there an active signal at U17W-5 with a positive going pulse width of 1.3 to 1.7 microseconds and with the same frequency (±5 kHz) as U17W-1?

YES = RF3210 NO = RF3250

RF3210 The signal IRSTR (U17V-11) should always be high. Is it?

YES = RF3230 NO = RF3220

STATEMENT
NUMBER

RF3220 Problem is with U17V, cable connection between drive and controller, or controller. When repaired, refer to TTP RF1000.

RF3230 In order to check out the output interface gate, the drive must be on-line and executing a read command. Is there an active signal at U17V-11?

YES = RF3240 NO = RF3220

RF3240 The read strobe circuitry is working correctly. Return to the troubleshooting routine that sent you here.

RF3250 Is U7W-1 high and U7W-2 toggling?

YES = RF3260 NO = RF7500

RF3260 Problem is U17W, U17V, or supporting components. When repaired, refer to TTP RF1000.

RF3300 In this section the data output logic will be checked. The data output circuitry is located on page 10 of schematic drawing 360103-309.

Load the good tape without a write enable ring. Select Service Aid 23 for 25 ips operation.

Check for a signal on U18W pins 2, 7, 10, and 15. Are they always low?

YES = RF3330 NO = RF3310

RF3310 Is the signal PULSE5 (U18W-9) toggling?

YES = RF3320 NO = RF2100

RF3320 Problem is U18W or U18X. When repaired, refer to TTP RF3300.

RF3330 Check the following locations. Do they all have a signal that is toggling?

U19W-10	U19X-2U19X-5
U19W-12	U19X-15U19X-7
U19W-15	U19X-12U19X-10

YES = RF3370 NO = RF3340

RF3340 Are the signals at U19V-1, U19X-9, and U19X-1 all toggling?

YES = RF3350 NO = RF7500

STATEMENT NUMBER

RF3350 Is the signal PECLK (U19V-8) a clock between 870 and 890 kHz?

YES = RF3360 NO = RF2000

RF3360 The problem is U19V, U19X, U19W, or one of the destination IC's U17V, U17X, U18X or U20X. When repaired, refer to TTP RF3300.

RF3370 Check the following locations. Are they all high?

U17V-6	U17X-6	U20X-8
U17V-3	U20X-3	U20X-11
U17X-11	U20X-6	U18X-6

YES = RF3390 NO = RF3380

RF3380 Problem is with U17V, U17X, U18X, U20X, cable connection between drive and controller, or controller. When repaired, refer to TTP RF3300.

RF3390 In order to check out the interface gates the drive must be online and executing a read command. Are the following locations all toggling?

U17V-6	U17X-6	U20X-8
U17V-3	U20X-3	U20X-11
U17X-11	U20X-6	U18X-6

YES = RF3399 NO = RF3380

RF3399 The read data circuitry is working correctly. Return to the troubleshooting routine that sent you here.

RF4000 In this section the read amplifiers will be checked. The read amplifier logic is on page 7 of schematic drawing 360103-309.

Power up the transport and before loading a tape reel, check TP 94. Is it a level between 0.10 and 0.70 volt?

YES = RF4010 NO = RF4220

STATEMENT NUMBER	
RF4010	Initialize the drive to Service Aid 23 and initiate low speed. Does the signal on all the following test points swing between +1.0 and +8.0 and -1.0 and -8.0 volts?

YES = RF4015 NO = RF4110

Channel P = TP 50
Channel 0 = TP 44
Channel 1 = TP 46
Channel 2 = TP 48
Channel 3 = TP 52
Channel 4 = TP 40
Channel 5 = TP 56
Channel 6 = TP 42
Channel 7 = TP 54

RF4015 The input read amplifiers are presumed to be working correctly. Return to the TTP that sent you here.

RF4020 Initialize the drive to Service Aid 23 and select 25 ips. Do all the following locations have a signal that swings more positive than 1.0 volt and more negative than -1.0 volt?

YES = RF4040 NO = RF4030

Channel P = U15F-4
Channel 0 = U15C-4
Channel 1 = U15D-4
Channel 2 = U14F-4
Channel 3 = U15G-4
Channel 4 = U15A-4
Channel 5 = U15H-4
Channel 6 = U14C-4
Channel 7 = U14H-4

RF4030 Depending on which channel or channels are failing, replace the following components. When repaired, refer to TTP RF1000.

Channel P = U15F, C106, or R191
Channel 0 = U15C, C83, or R158
Channel 1 = U15D, C85, or R176
Channel 2 = U14F, C89, or R180
Channel 3 = U15G, C108, or R202
Channel 4 = U15A, C52 or R136
Channel 5 = U15H, C126 or R224
Channel 6 = U14C, C53 or R154
Channel 7 = U14H, C123 or R213

RF4040 Are all the following signals toggling?

YES = RF4060 NO = RF4050

RDATAP = U14D-8
RDATA0 = U14B-8
RDATA1 = U14D-10
RDATA2 = U14D-12
RDATA3 = U14G-10
RDATA4 = U14B-10
RDATA5 = U14G-8
RDATA6 = U14B-12
RDATA7 = U14G-12

STATEMENT NUMBER	
RF4050	Depending on which channel or channels are failing, replace the following components. When repaired, refer to TTP RF1000.

RDATAP = U15F, U14D, OR U13D
RDATA0 = U15C, U14B, OR U13A
RDATA1 = U15D, U14D, OR U13D
RDATA2 = U14F, U14D, OR U13D
RDATA3 = U15G, U14G, OR U13G
RDATA4 = U15A, U14B, OR U13A
RDATA5 = U15H, U14G, OR U13G
RDATA6 = U14C, U14B, OR U13A
RDATA7 = U14H, U14G, OR U13G

RF4060 Are all the following signals toggling?

YES = RF4080 NO = RF4070

RDROPP* = U14D-4
RDROP0* = U14B-4
RDROP1* = U14D-6
RDROP2* = U14D-2
RDROP3* = U14G-6
RDROP4* = U14B-6
RDROP5* = U14G-4
RDROP6* = U14B-2
RDROP7* = U14G-2

RF4070 Depending on which signal or signals are failing, replace the following components. When repaired, refer to TTP RF1000.

RDROPP* = U15F, U14D, U13E, OR U12H
RDROP0* = U15C, U14B, U13B, OR U12H
RDROP1* = U15D, U14D, U13E, OR U12H
RDROP2* = U14F, U14D, U13F, OR U12H
RDROP3* = U15G, U14G, U13F, OR U12H
RDROP4* = U15A, U14B, U13C, OR U12H
RDROP5* = U15H, U14G, U13H, OR U12H
RDROP6* = U14C, U14B, U13B, OR U12H
RDROP7* = U14H, U14G, U13H, OR U12H

RF4080 Initiate 100 ips operation. Measure the signal at the following test points. Do they all swing between +0.3 to +0.7 volt and -0.3 to -0.7 volt?

YES = RF4130 NO = RF4090

Channel P = TP 49
Channel 0 = TP 43
Channel 1 = TP 45
Channel 2 = TP 47
Channel 3 = TP 51
Channel 4 = TP 39
Channel 5 = TP 55
Channel 6 = TP 41
Channel 7 = TP 53

STATEMENT NUMBER	
RF4090	Measure the voltage across R114. Is it less than 0.2 volt? YES = RF4100 NO = RF4160
RF4100	Depending on which channel is failing, replace the following components. If after replacing the listed components the failure still exists, replace the head assembly. When repaired, refer to TTP RF1000. Channel P = Q31, U19F, C99, R197, C100, C102, or R198 Channel 0 = Q28, U19C, C73, R164, C74, C70, or R165 Channel 1 = Q29, U19D, C76, R167, C77, C79, or R169 Channel 2 = Q30, U19E, C95, R186, C96, C93, or C187 Channel 3 = Q32, U19G, C112, R208, C113, C115, or R209 Channel 4 = Q26, U19A, C60, R142, C61, C58, or R144 Channel 5 = Q34, U19I, C133, R230, C134, C129, or R231 Channel 6 = Q27, U19B, C64, R145, C65, C67, or R146 Channel 7 = Q33, U19H, C119, R219, C120, C117, or R220
RF4110	Depending on which channel or channels are failing, check the appropriate test point. Does the signal swing between +0.3 to +0.7 volt and -0.3 to -0.7 volt? YES = RF4120 NO = RF4100 Channel P = TP 49 Channel 4 = TP 39 Channel 0 = TP 43 Channel 5 = TP 55 Channel 1 = TP 45 Channel 6 = TP 41 Channel 2 = TP 47 Channel 7 = TP 53 Channel 3 = TP 51
RF4120	Depending on which channel is failing, replace the following components. When repaired, refer to TTP RF1000. Channel P = U17F Channel 0 = U17C Channel 1 = U17D Channel 2 = U17E Channel 3 = U17G Channel 4 = U17A Channel 5 = U17I Channel 6 = U17B Channel 7 = U17H
RF4130	Measure the peak voltage at TP 57. Is it greater than 0.1 volt? Use TP 1 for ground reference. YES = RF4140 NO = RF4150
RF4140	Select Service Aid 12 and measure the peak voltage at TP 57. Is it greater than 0.1 volt? Use ground TP 1 for reference. YES = RF4190 NO = RF4150

STATEMENT NUMBER	
RF4150	The read amplifiers appear to be working correctly. If the problem has not been found and corrected, return to the troubleshooting routine which brought you to the read amplifiers.
RF4160	Make the following measurements while alternating between 100 ips and 25 ips. Does the signal at U12F-10 toggle with each speed change? YES = RF4180 NO = RF4170
RF4170	Problem is U8L or U12F. When repaired, refer to TTP RF1000.
RF4180	Problem is U10H, Q25, or the supporting components. When repaired, refer to TTP RF1000.
RF4190	Is the signal P3B6 (U10L-33) high? YES = RF4200 NO = RF4210
RF4200	Problem is U10L or U12V. When repaired and U10L-33 is low, refer to TTP RF1000.
RF4210	Problem is U12V or the supporting components. When repaired and TP 57 is correct, refer to TTP RF1000.
RF4220	Measure the voltage at TP 94 while adjusting R115. Can the voltage be adjusted between 0.1 and 0.7 volt? YES = RF4230 NO = RF4240
RF4230	Adjust R115 per read threshold adjustment procedure, then refer to TTP RF1000.
RF4240	Problem is with U2N, U3M, or R115. When repaired, adjust R115 per read threshold adjustment procedure, then refer to TTP RF1000.
RF5000	The following guide should be used when troubleshooting the scan generator. The scan generator circuitry is located on page 9 of schematic diagram 360103-309. Are the following signals toggling: a (U8D-1) b (U8D-2) c (U8D-3)? YES = RF5010 NO = RF5040
RF5010	Is the signal SCANP (U7H-6) toggling? YES = RF5020 NO = RF5110

STATEMENT NUMBER	
RF5020	Are all eight SCAN signals toggling? To determine this, check the following locations:

SCAN0, U8D-15	SCAN1, U8D-14
SCAN2, U8D-13	SCAN3, U8D-12
SCAN4, U8D-11	SCAN5, U8D-10
SCAN6, U8D-9	SCAN7, U8D-7

YES = RF5030 NO = RF5120

RF5030 The scan generator is working correctly. Return to the troubleshooting flow that sent you here.

RF5040 Is the signal PECLK (U7D-2) toggling?

YES = RF5060 NO = RF5050

RF5050 Troubleshoot the PE clock generator starting at RF2000.

RF5060 Is the signal SCANP (U7H-6) always low?

YES = RF5080 NO = RF5070

RF5070 Problem is U7D or one of the destination IC's U8D, U7C, U10F, U10G. When repaired, refer to TTP RF1000.

RF5080 Is the signal PSEL (U7H-5) high?

YES = RF5100 NO = RF5090

RF5090 Problem is U7H or one of the destination IC's U10V, U7D, U8A. When repaired, refer to TTP RF1000.

RF5100 Problem is U7D or one of the destination IC's U5F, U7G, U7H, U8D, U9E, U14V. When repaired, refer to TTP RF1000.

RF5110 Is the signal PSEL (U7H-5) toggling?

YES = RF5090 NO = RF5100

RF5120 If the failing signal is SCAN5 or SCAN6, problem is U8D or U8A.

If the failing signal is SCAN0, SCAN2, SCAN4, or SCAN7, problem is U8D or U8B.

If the failing signal is SCAN1 or SCAN3, problem is U8D or U8C.

When failing IC is replaced, refer to TTP RF1000.

STATEMENT NUMBER

RF6100

The following guide should be used when troubleshooting the Data Extractors. The guide has been written for the parity channel. If troubleshooting a different channel, use the cross-reference chart located below or reference page 8 of schematic drawing 360103-309. Select Service Aid 23 for 25 ips operation.

CROSS REFERENCE CHART

				CHANNELS				
P	1	2	3	4	5	6	7	0
U12C-5	U12D-9	U12D-12	U12G-9	U12C-13	U12G-12	U12B-1	U12F-5	U12B-13
U11C-12	U11C-9	U12E-4	U11F-2	U11E-9	U12E-9	U11B-4	U11E-1	U11B-10
U13D-9	U13D-9	U13D-9	U13G-9	U13A-9	U13G-9	U13A-9	U13G-9	U13A-9
U8A-13	U8C-9	U8B-5	U8C-11	U8B-11	U8A-3	U8A-5	U8B-9	U8B-3
U13D-6	U13D-4	U13D-3	U13G-4	U13A-3	U13G-3	U13A-4	U13G-6	U13A-6
U13E-13	U13E-3	U13F-13	U13F-3	U13C-3	U13H-13	U13B-13	U13H-3	U13B-3
TP 30	TP 32	TP 28	TP 29	TP 34	TP 33	TP 31	TP 35	TP 27
U9E	U10G	U10G	U10G	U10G	U10G	U10G	U10G	U10G
U13E-9	U13E-7	U13F-9	U13F-7	U13C-7	U13H-9	U13B-9	U13H-7	U13B-7
U13D-10	U13D-12	U13D-15	U13G-12	U13A-15	U13G-15	U13A-12	U13G-10	U13A-10
U6A-9	U7B-9	U7A-7	U13C-9	U6B-7	U7A-9	U6A-7	U6B-9	U7B-7
U12C-6	U12D-8	U12D-11	U12G-8	U12C-11	U12G-11	U12B-3	U12F-6	U12B-11
U11C-11	U11C-8	U12C-6	U11F-3	U11E-8	U12E-8	U11B-6	U11E-3	U11B-8
U9C	U10C	U9D	U11D	U10E	U9A	U9B	U10D	U10B
U9C-15	U10C-15	U9D-15	U11D-15	U10E-15	U9A-15	U9B-15	U10D-15	U10B-15
U11C-3	U11C-6	U12E-3	U11F-6	U11E-6	U12E-11	U11B-3	U11E-11	U11B-11
U8C-12	U8C-4	U8C-6	U8A-10	U8A-8	U8A-2	U8B-12	U8C-2	U8B-2
U6A-13	U7B-13	U7A-3	U13C-13	U6B-3	U7A-13	U6A-3	U6B-13	U7B-3
U6A-9	U7B-9	U7A-7	U13C-9	U6B-7	U7A-9	U6A-7	U6B-9	U7B-7
U8A	U8C	U8B	U8C	U8B	U8A	U8A	U8B	U8B

STATEMENT NUMBER	
RF6110	Is the signal FWD (U12C-5) toggling?
	YES = RF6120 NO = RF2100
RF6120	Is the signal PENAB* (U11C-12) toggling?
	YES = RF6130 NO = RF2300
RF6130	Is the signal PECLK (U13D-9) toggling?
	YES = RF6140 NO = RF2000
RF6140	Is the signal SCANP (U8A-13) toggling?
	YES = RF6150 NO = RF5000
RF6150	Are the signals RDATAP (U13D-6) and RDROPP* (U13E-13) both toggling?
	YES = RF6160 NO = RF4020
RF6160	Is the signal CHDROPP (TP 30) toggling?
	YES = RF6180 NO = RF6170
RF6170	Problem is U13E or U9E. When repaired, refer to TTP RF1000.
RF6180	Is the signal at U13D-10 toggling?
	YES = RF6200 NO = RF6190
RF6190	Problem is U13D or U12C. When repaired, refer to TTP RF1000.
RF6200	Is the signal DATAP (U12C-6) toggling?
	YES = RF6220 NO = RF6210
RF6210	Problem is U12C, U9C, or U9E. When repaired, refer to TTP RF1000.
RF6220	Is the signal at U11C-11 toggling?
	YES = RF6240 NO = RF6230
RF6230	Problem is U12C, U11C, or U9C. When repaired, refer to TTP RF1000.
RF6240	Is the signal at U9C-15 toggling?
	YES = RF6260 NO = RF6250

STATEMENT NUMBER	
RF6250	Problem is U9C, U8C, U11C, or U6A. When repaired, refer to TTP RF1000.
RF6260	Is the signal at U6A-13 toggling? YES = RF6280 NO = RF6270
RF6270	Problem is U11C, U6A, or U9C. When repaired, refer to TTP RF1000.
RF6280	Is the signal DAVLP (U6A-9) toggling? YES = RF6300 NO = RF6290
RF6290	Problem is U6A or U8A. When repaired, refer to TTP RF1000.
RF6300	The data extractors are working correctly. Return to the TTP that sent you here.
RF7100	In this section the read multiplexer circuitry will be checked. The read multiplexer logic is located on page 9 of schematic drawing 360103-309. Load the good tape and select Service Aid 23 for 25 ips operation. Are all eight DAVL signals a 45.0 ±7.5 kHz clock? DAVL0, U7C-4 DAVL1, U7C-3 DAVL2, U7C-2 DAVL3, U7C-1 DAVL4, U7C-15 DAVL5, U7C-14 DAVL6, U7C-13 DAVL7, U7C-12 YES = RF7110 NO = RF7105
RF7105	Troubleshoot the failing channel starting at RF6100.
RF7110	Is the signal at U7C-5 toggling? YES = RF7140 NO = RF7120
RF7120	Are the signals at U7C-9, -10, and -11 all toggling? YES = RF7130 NO = RF5000
RF7130	Problem is U7C or U9E. When repaired and U7C-5 is toggling, refer to TTP RF1000.

STATEMENT NUMBER	
RF7140	Are all eight DATA signals toggling? To determine this, check the following locations:

DATA0, U10F-4 — DATA1, U10F-3
DATA2, U10F-2 — DATA3, U10F-1
DATA4, U10F-15 — DATA5, U10F-14
DATA6, U10F-13 — DATA7, U10F-12

YES = RF7150 NO = RF7105

RF7150 Is the signal at U10F-5 toggling?

YES = RF7170 NO = RF7160

RF7160 Problem is U10F or U9E. When repaired and U10F-5 is toggling, refer to TTP RF1000.

RF7170 Are all eight CHDROP signals toggling? To determine this, check the following locations:

CHDROP0, U10G-4 — CHDROP1, U10G-3
CHDROP2, U10G-2 — CHDROP3, U10G-1
CHDROP4, U10G-15 — CHDROP5, U10G-14
CHDROP6, U10G-13 — CHDROP7, U10G-12

YES = RF7180 NO = RF7105

RF7180 Is U10G-5 toggling?

YES = RF7200 NO = RF7190

RF7190 Problem is U10G or U9E. When repaired and U10G-5 is toggling, refer to TTP RF1000.

RF7200 Are the signals DAVLP (U9E-3) and DATAP (U9E-13) both a 45.0 ±7.5 kHz clock?

YES = RF7201 NO = RF7105

RF7201 Is the signal at U9E-10 toggling?

YES = RF7210 NO = RF7105

RF7210 Is the signal PSEL (U9E-1) toggling?

YES = RF7220 NO = RF5000

RF7220 Is the signal CHDROPX (U9E-9) toggling?

YES = RF7240 NO = RF7230

STATEMENT NUMBER	
RF7230	Problem is U9E or one of the destination IC's U9G, U10V, U11F, or U11V. When repaired, refer to TTP RF1000.
RF7240	Is the signal DATAOX (U9E-12) toggling?
	YES = RF7260 NO = RF7250
RF7250	Problem is U9E or U9G. When repaired and U9E-12 is toggling, refer to TTP RF1000.
RF7260	Is the signal DAVLX (U9E-4) toggling?
	YES = RF7280 NO = RF7270
RF7270	Problem is U9E or U9G. When repaired and U9E-4 is toggling, refer to TTP RF1000.
RF7280	The read multiplexers are working correctly; return to the troubleshooting routine that sent you here.
RF7300	In this TTP the skew buffer circuitry will be checked. The skew buffer logic is located on page 9 of schematic drawing 360103-309.
	Because of the complexities to effectively troubleshoot the skew buffer, a logic analyzer must be used. However, due to the unavailability of a logic analyzer, the following procedure provides a recommended sequence to replace the IC's used in the skew buffer without troubleshooting the circuit.
	Replace U9G and U7G. Using the system program that detected the failure, have the symptoms changed?
	YES = RF1000 NO = RF7310
RF7310	Replace U9F, U8F, U8E, and U7F. Using the system program that detected the failure, have the symptoms changed?
	YES = RF1000 NO = RF7320
RF7320	Replace U6F and U6G. Using the system program that detected the failure, have the symptoms changed?
	YES = RF1000 NO = RF7330
RF7330	If the failure still occurs, we are unable to determine the cause. Return to the troubleshooting routine that sent you here.

STATEMENT NUMBER		
RF7500	In this section the error detect and postamble checking circuitry will be checked. This logic is located on page 9 of schematic drawing 360103-309. Load a scratch tape that is write-enabled. Using a jumper wire, ground U12W-5, then select Service Aid 23 for 25 ips operation. Is the signal STRBX (U17T -12) toggling?	
	YES = RF7510	NO = RF7600
RF7510	Is the signal DCLK (U5F-8) toggling?	
	YES = RF7520	NO = RF7620
RF7520	Is the signal CDATX (U11F-8) toggling?	
	YES = RF7530	NO = RF7640
RF7530	Is the signal DROP1 (U9V-13) toggling?	
	YES = RF7540	NO = RF7660
RF7540	Is the signal at U9V-10 toggling?	
	YES = RF7550	NO = RF7670
RF7550	Is the signal FERR (U1J-3) toggling?	
	YES = RF7560	NO = RF7680
RF7560	Are the signals at U18T-12 and U18T-13 toggling?	
	YES = RF7570	NO = RF7690
RF7570	Is the signal at U18T-11 always high?	
	YES = RF7580	NO = RF7700
RF7580	Is the signal at U10V-11 toggling?	
	YES = RF7590	NO = RF7720
RF7590	The error detect and postamble checking circuitry are working correctly. Return to troubleshooting routine that sent you here.	
RF7600	Is the signal POSTCHR (U10V-2) and PSEL (U10V-1) toggling?	
	YES = RF7610	NO = RF7300

STATEMENT NUMBER	
RF7610	Problem is U10V, U11V, U17T, or one of the destination IC's U12V, U1J, U14V, U15V, U2J, or U17W. When repaired, refer to TTP RF1000.
RF7620	Is the signal DOUT (U5F-10) toggling?
	YES = RF7630 NO = RF7300
RF7630	Problem is U5F, U3J, or one of the destination IC's U19X, U19W, or U17W. When repaired and U5F-8 is toggling, refer to TTP RF1000.
RF7640	Is the signal at U11F-9 toggling?
	YES = RF7650 NO = RF7300
RF7650	Problem is U11F, U19V, or U19X. When repaired and U11F-8 is toggling, refer to TTP RF1000.
RF7660	Is CHDROPX (U10V-13) toggling?
	YES = RF7670 NO = RF7100
RF7670	Problem is U11V, U12V, U10V, U9V, or U3J. When repaired, refer to TTP RF1000.
RF7680	Problem is U1J, U2J, or U3J. When repaired, refer to TTP RF1000.
RF7690	Is the signal U15V-1 toggling?
	YES = RF7700 NO = RF7710
RF7700	Problem is U14V, U15V, U13V, U18T, or U17T. When repaired, refer to TTP RF1000.
RF7710	Problem is U12V, U14V, U15V, or U1J. When repaired, refer to TTP RF1000.
RF7720	Problem is U10V, U11V, U12V. When repaired, refer to TTP RF1000.

SECTION IV

MAINTENANCE

GENERAL

4-1. This section contains periodic maintenance information and adjustment procedures. Table 4-1 presents the preventive maintenance schedule.

MTSU POSITIONS FOR SERVICING

CAUTION

When MTSU is to be extended on slides from equipment rack, ensure that rack is mounted securely. Weight of MTSU in extended position could upset an inadequately anchored equipment rack.

4-2. **Operator Maintenance Access (See Figure 4-1).** To gain access to the tape path area for routine cleaning, proceed as follows:

a. Switch MTSU power off.

b. Withdraw drive on its slides until locks engage.

c. Open top cover by lifting sides directly behind front panel. Place cover stay in slot provided.

d. Perform required maintenance.

e. To return drive to operating position, close top cover.

f. Release slide locks and push unit back into equipment rack.

g. Switch MSTU power on.

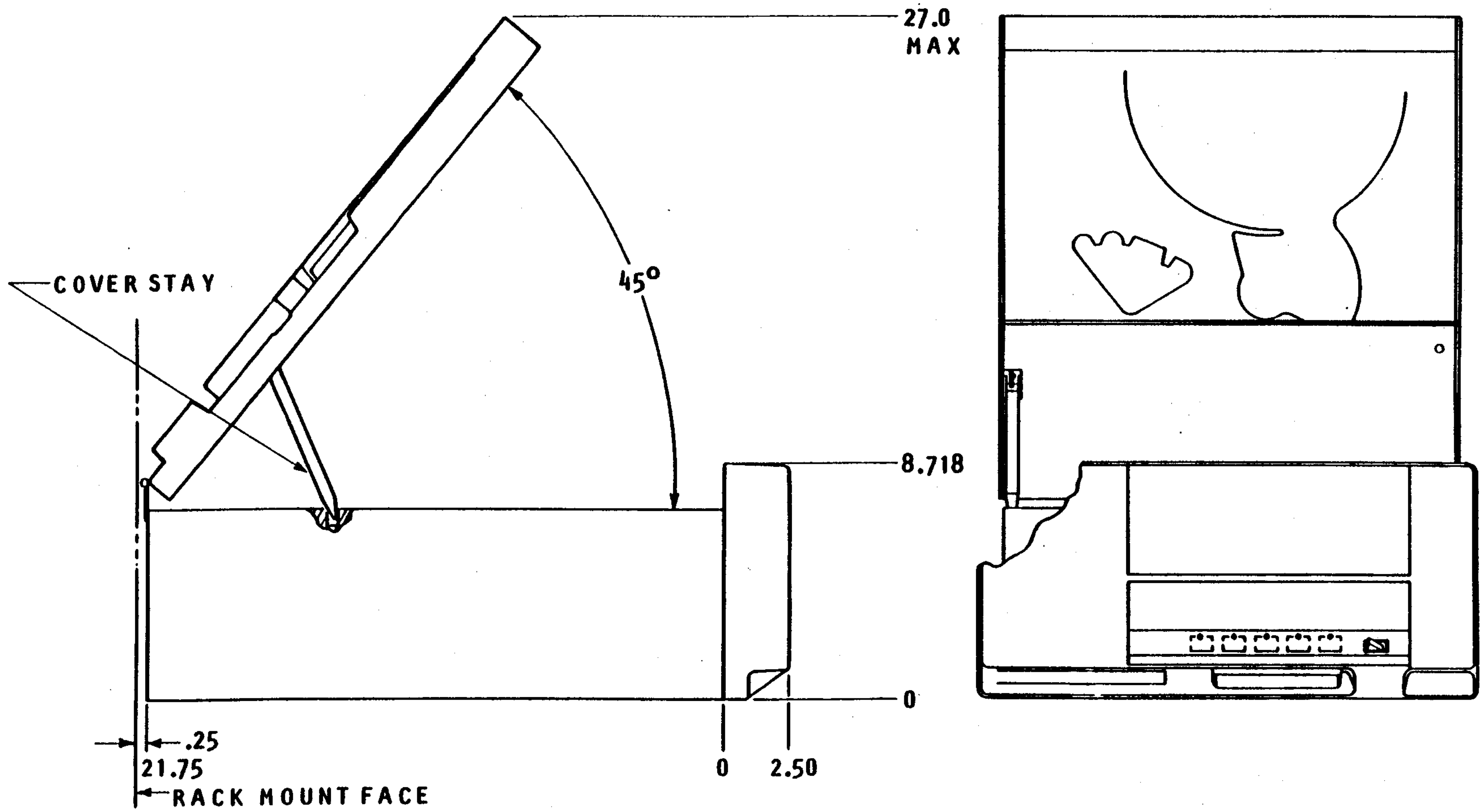

Figure 4-1. Operator Maintenance Access Position

4-3. **Service Access (See Figure 4-2).** To gain access to the main PWB and other internal components, proceed as follows:

a. Switch MTSU power off.

b. Place drive in operator maintenance access position. (Refer to paragraph 4-2).

c. Using a screwdriver, loosen two captive screws located at front sides of top plate casting.

d. Close top cover.

e. Grasping two lower corners of front panel, lift front panel to its maximum upright position. Lower slowly (about one inch) until the top plate support latch engages.

f. Insert the safety pin provided through both holes in the top plate support.

g. Perform required maintenance.

h. To return drive to operating position, remove the safety pin.

i. Lift front panel to its maximum upright position and lower smoothly to horizontal position.

j. Reverse steps a through d.

OPERATOR PREVENTIVE MAINTENANCE

4-4. For routine cleaning, place the MTSU in the operator maintenance access position. Figure 4-3 identifies by number the locations of items that require routine cleaning. The recommended cleaning materials are:

a. Tape Path Cleaner (Trichlorotrifluoroethane)

b. Head Cleaner (1,1,1-Trichloroethane)

c. Cotton Swabs

d. Plastic Cleaner - (Miller Stephenson Chemical Co., MS260, Windex, or equivalent commercial grade plastic cleaner).

e. Lint-Free, Non-Abrasive Wipes

NOTE

Items a through c are available as Cipher Part No. 131044-001, Tape Drive Cleaning Kit.

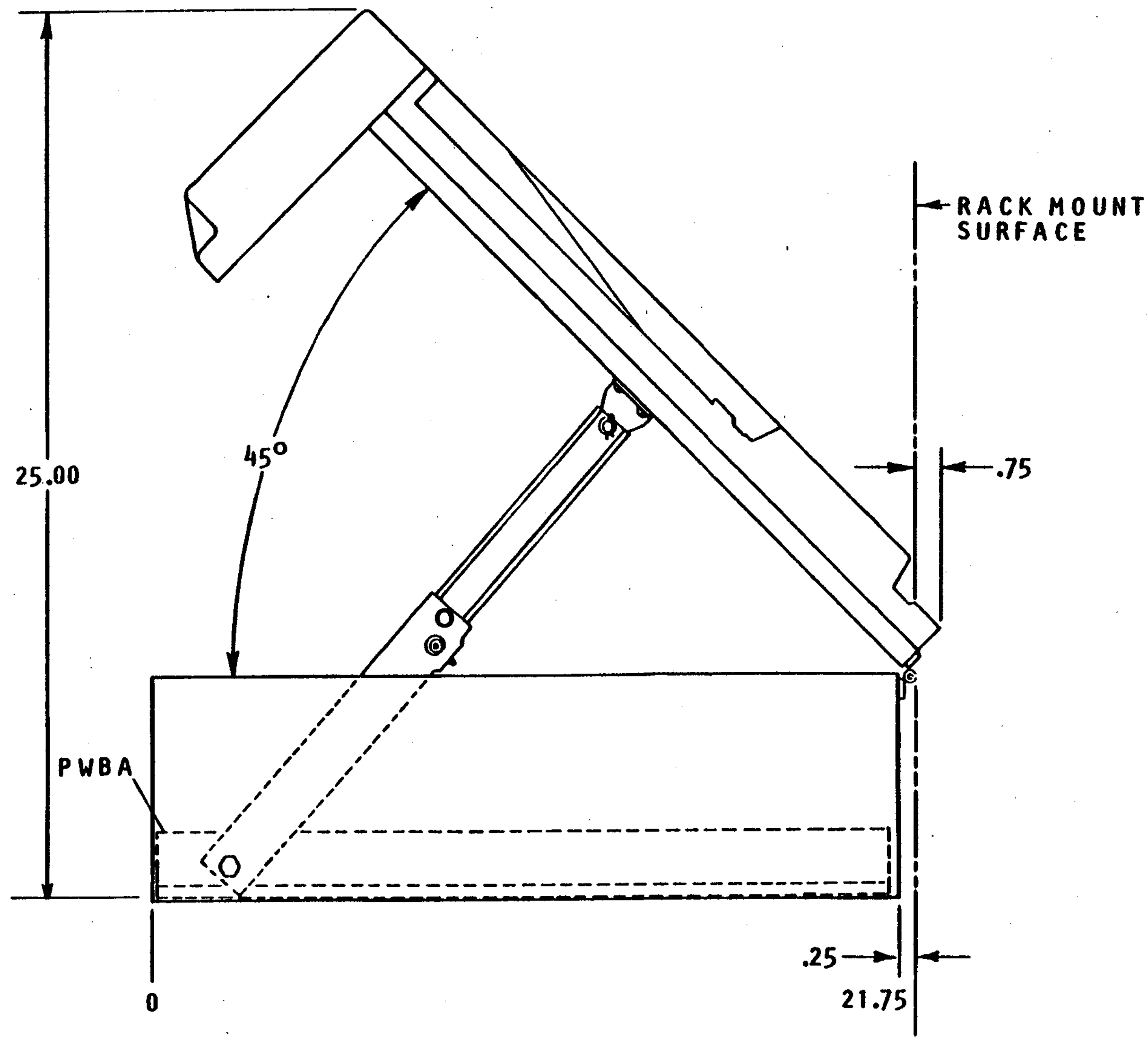

Figure 4-2. Service Access Position

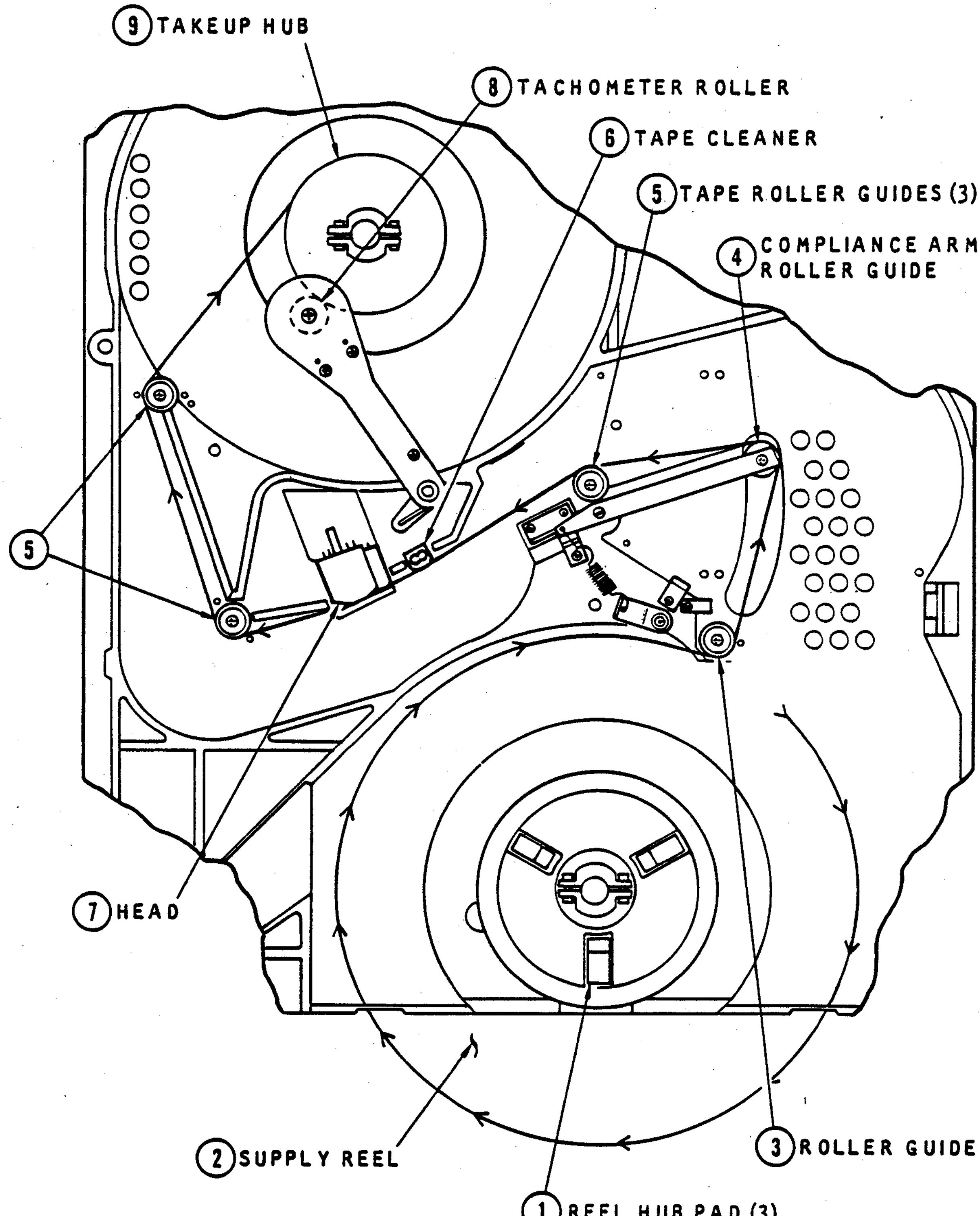

Figure 4-3. Tape Path and Related Parts

MAINTENANCE OPERATION	FREQUENCY (HOURS)	QUANTITY TO MAINTAIN	PROCEDURE PARAGRAPH
Operator			
Tachometer Roller	8	1	4-5
Take Up Hub	8	1	4-6
Roller Guides	8	5	4-7
Reel Hub Pads	8	3	4-8
Head	8	1	4-9
Tape Cleaner	8	1	4-10
Front Panel and Door	As Required	1	4-11
Top Plate Casting	As Required	1	4-12
Filter	1000	1	4-13
Service Technician			
Replace Reel Motors	5000	2	4-40 4-44

Table 4-1. Preventive Maintenance Schedule

CAUTION

Do not apply a cleaner directly from the container to the surface to be cleaned, even though instructions on the container may indicate to do so. Always apply the cleaner to a swab or wipe first, carefully removing any excess. The tachometer roller and roller guides contain precision bearings. Solvents allowed to run into the bearings will break down the lubricant.

4-5. **Tachometer Roller (8, Figure 4-3).** Use a swab moistened with tape path cleaner. Gently wipe the entire roller surface. The roller can be rotated by manually turning the take-up hub slowly.

4-6. **Take-Up Hub (9, Figure 4-3).** Use a swab or wipe moistened with tape path cleaner. Rotate the hub manually while gently wiping the tape wrapping surface.

4-7. **Roller Guides (3, 4 and 5, Figure 4-3).** Use a swab moistened with tape path cleaner. Rotate each roller and gently wipe the tape contact surface and flanges or washers.

4-8. **Reel Hub Pads (1, Figure 4-3).** Use a swab or wipe moistened with tape path cleaner. Wipe the contact surface of each pad and remove any debris around the pad.

4-9. **Head (7, Figure 4-3).** Use a swab or wipe moistened with head cleaner. Wipe the entire face of the head and attached erase bar, paying particular attention to the recessed areas.

CAUTION

Rough or abrasive materials can scratch sensitive surfaces of the head resulting in permanent damage. Other cleaners, such as alcohol based types, can cause read/write errors.

4-10. **Tape Cleaner (6, Figure 4-3).** Use a swab moistened with head cleaner. Wipe each blade along its length. Remove accumulated oxides from the recessed area between the blades.

CAUTION

Exercise care to avoid damage to sharp edges of tape cleaner blades.

4-11. **Front Panel and Door.** Use a wipe moistened with plastic cleaner.

4-12. **Top Plate Casting.** Use a wipe moistened with plastic cleaner. Referring to Figure 4-3, wipe away the oxide dust in the tape path area. Be careful not to get dirt on the head, rollers, etc. Avoid disturbing the sensors.

4-13. **Filter.** Locate and remove the filter from inside the air duct opening at the lower left of the front panel. See Figure 4-4. Clean the filter with low pressure compressed air, or vacuum, in the opposite direction of airflow and reinstall.

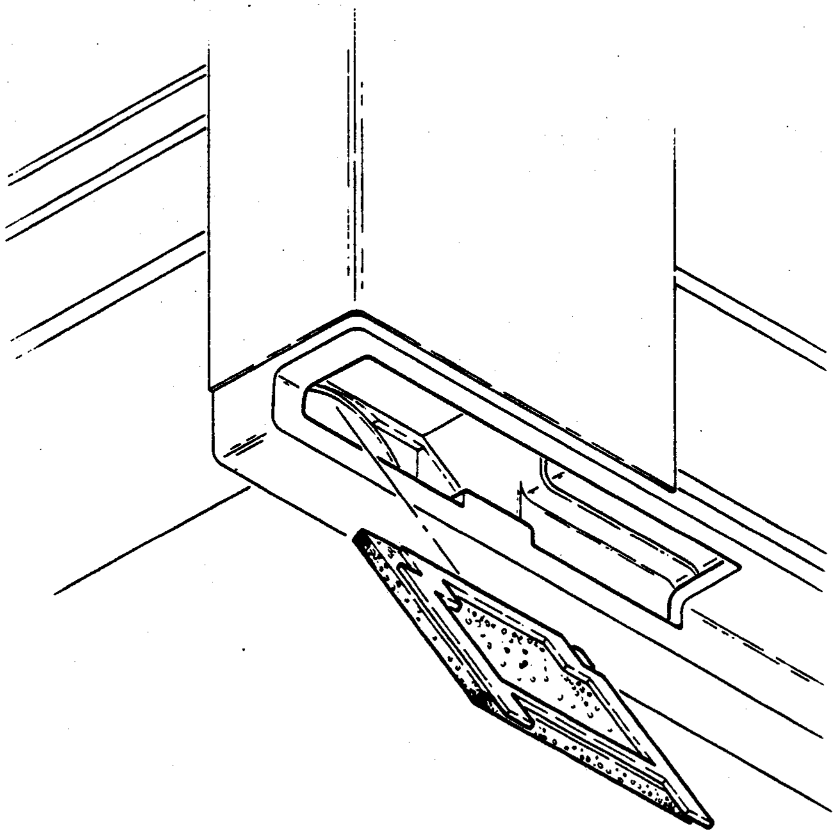

Figure 4-4. Air Filter Removal

SERVICE TECHNICIAN PREVENTIVE MAINTENANCE

4-14. **Reel Motors.** Replace both reel motors after 5000 hours of unit operation. Refer to paragraphs 4-40 and 4-44 for removal/replacement instructions.

CORRECTIVE MAINTENANCE

4-15. **Fuse Removal and Replacement.** To replace the fuse, proceed as follows:

WARNING

To prevent severe electrical shock, remove power plug from power source before performing any servicing operation on transport.

a. Remove power cord from outlet.

b. Place the drive in service access position. Refer to paragrpah 4-3.

c. Locate fuse cap on power supply housing. Push and twist cap to remove.

d. For 100-120 volt operation, use a 3-ampere, slo-blo, 250V type fuse.

e. For 208-240 volt operation, use a 1-1/2 ampere, slo-blo, 250V type fuse.

f. Reverse steps a through c.

4-16. **Read Threshold Adjustment.** Adjustment of the read threshold level is required only when the head or main PWB is changed. Adjust read threshold as follows:

a. Place drive in service access position. Refer to paragraph 4-3.

b. Apply power to unit.

c. Load tape (write-enable ring must be installed).

NOTE

Use a National Bureau of Standards Reference Level Tape, or a certified tape that produces comparable read levels when compared with a National Bureau of Standards tape for this adjustment.

d. Activate Service Aid 21. Refer to paragraphs 3-3 and 3-26.

e. Shield the LED indicators on the front panel from ambient light so that an accurate indication of ON, OFF or FLASHING can be observed.

f. Note the indication of the front panel LED's before attempting any adjustment.

g. If LOAD and UNLOAD indicators flash intermittently, NO ADJUSTMENT IS REQUIRED. Refer to step i.

h. If the LOAD and UNLOAD indicators are not flashing intermittently, adjust R115 for the indication in step g. R115 may require several turns (in either direction) to find the correct adjustment point. If the correct adjustment point cannot be found, a fault in (a) effecting the adjustment, (b) the head assembly, or (c) main PWB is indicated.

i. Exit Service Aid 21.

NOTE

This adjustment is based on the amplitude characteristics of the tape used for the adjustment. Other tapes whose amplitude characteristics are different may not provide the same indication after the adjustment. This fact simply reflects the difference in tapes and is not a fault condition. The tolerance range of the adjustment takes into account the inherent differences between tapes that otherwise meet the ANSI X 3.40-1976 criteria.

j. Reverse steps a through c.

REPAIR AND REPLACEMENT OF PARTS AND COMPONENTS

4-17. The MTSU is designed to operate over long periods of time without requiring corrective maintenance of any kind. Spare parts are available for replacement of parts and subassemblies which may have become damaged or worn through extremely long and/or hard usage. This section presents instructions for removal of defective parts and subassemblies from the transport and replacment with the parts available, as well as disassembly, assembly, and adjustment instructions where applicable.

4-18. Except as noted, subassemblies and parts which can be removed from above the top plate are indexed in Figure 4-5, while those which can be removed from beneath the top plate are indexed in Figure 4-6. Refer to the respective key lists of these figures for the names of the subassemblies and parts indexed on each. These lists also contain the figure numbers of the detail drawings, presented in this section, in which removal and/or disassembly of these subassemblies and parts are illustrated.

WARNING

To prevent severe electrical shock, remove power plug from power source before performing any servicing operation on transport.

FRONT PANEL ASSEMBLY (1, Figure 4-5).

4-19. **Power Switch Replacement.** To replace the power switch (1, Figure 4-7) proceed as follows:

a. Remove power cord from outlet.

b. Position transport in service access position in accordance with instructions in paragraph 4-3.

c. Remove wire connectors from terminals of power switch in back of front panel, identifying each terminal as to the switch terminal from which it was removed.

d. Bend in tabs holding switch to panel, and push out of panel from back.

e. Place replacement switch in front panel, bend tabs in back of switch as necessary to fit tightly in panel, and reconnect wires as identified in step c.

f. Restore transport to operating position.

FIGURE & INDEX NO.	DESCRIPTION	DETAIL FIGURE NO.	PROCEDURE PARAGRAPH NO.
4-5	MODEL F880 TAPE TRANSPORT (Top View)	REF	
-1	FRONT PANEL ASSEMBLY	4-7	4-21
-2	SUPPLY HUB ASSEMBLY	4-8	4-23
-3	HEAD ASSEMBLY............................	4-10	4-24
-4	ROLLER GUIDE ASSEMBLY....................	4-11	4-25
-5	EOT/BOT SENSOR ASSEMBLY..................	4-12	4-26
-6	TACHOMETER ASSEMBLY......................	4-13	4-27
-7	COVER ASSEMBLY	4-14	4-28
-8	TAKEUP HUB ASSEMBLY......................	4-15	4-29
-9	COMPLIANCE ARM ASSEMBLY	4-17	4-30
-10	TAPE-IN-PATH SENSOR, TRANSMITTER	4-18	4-32
-11	TAPE-IN-PATH SENSOR, RECEIVER	4-19	4-33
-12	COMPLIANCE ARM BUMPER ASSEMBLY........	4-20	4-34
-13	ROLLER TAPE GUIDE ASSEMBLY (Solid)	4-21	4-35
-14	FILE-PROTECT SENSOR......................	4-22	4-36

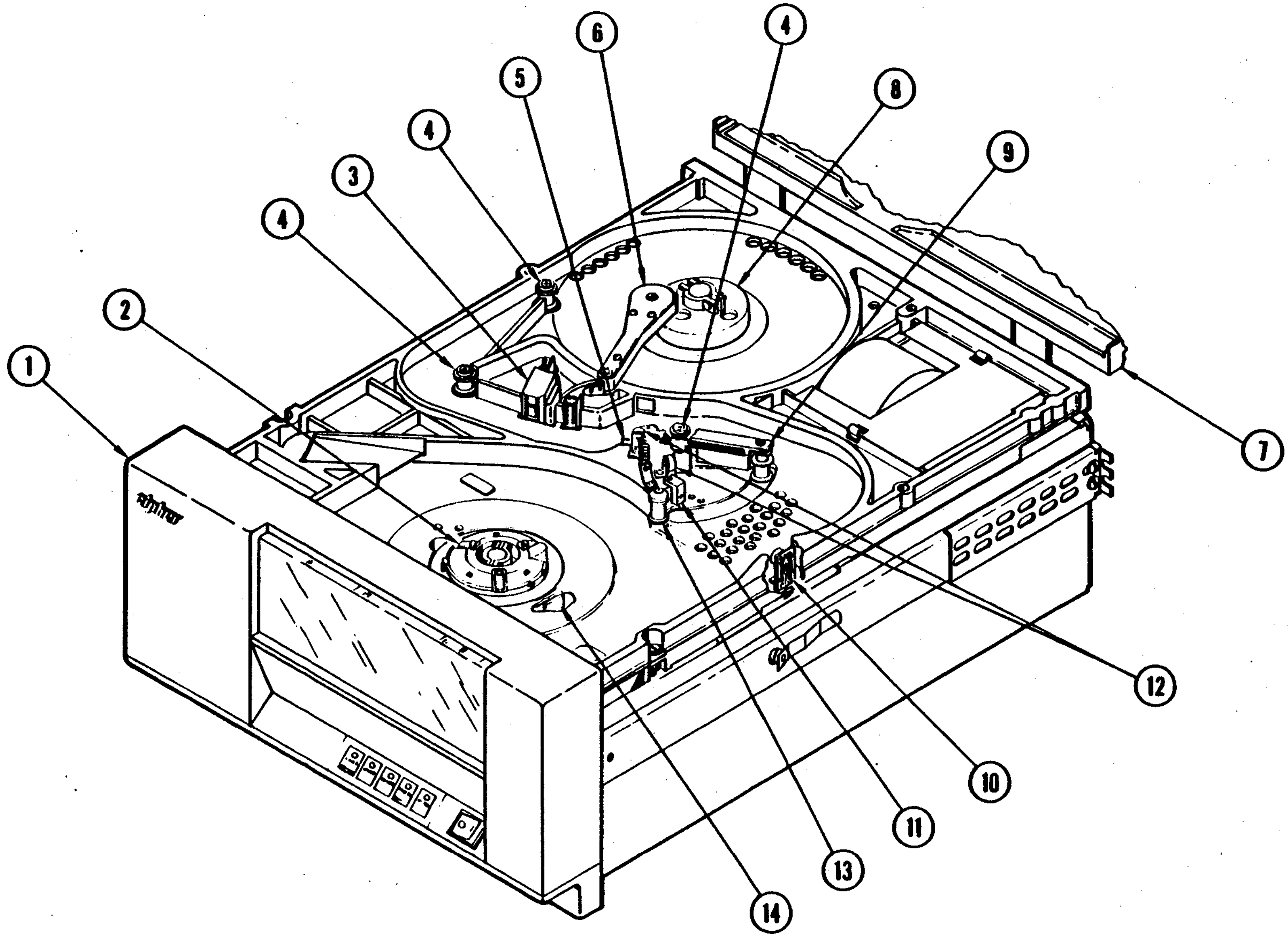

Figure 4-5. Model F880 Tape Transport (Top View)

FIGURE & INDEX NO.	DESCRIPTION	DETAIL FIGURE NO.	PROCEDURE PARAGRAPH NO.
4-6	MODEL F880 TAPE TRANSPORT (Bottom View) ..	REF	
-1	DRIVE MAIN PWB ASSEMBLY	4-23	4-37
-2	POWER SUPPLY ASSEMBLY	4-24	4-38
-3	POWER SUPPLY PWB	4-25	4-39
-4	TAKEUP MOTOR ASSEMBLY..................	4-26	4-40
-5	AIR DUCT, top-plate	4-27	4-41
-6	AIR DUCT, front panel	4-27	4-42
-7	TUBE, air intake	4-27	4-41
-8	SUPPLY MOTOR ASSEMBLY	4-28	4-44
-9	AIR CAPACITOR ASSEMBLY..................	4-17	4-30
-10	HUB LOCK ASSEMBLY	4-29	4-45
-11	DOOR LOCK ASSEMBLY	4-30	4-48
-12	TRANSFORMER ASSEMBLY	4-31	4-49

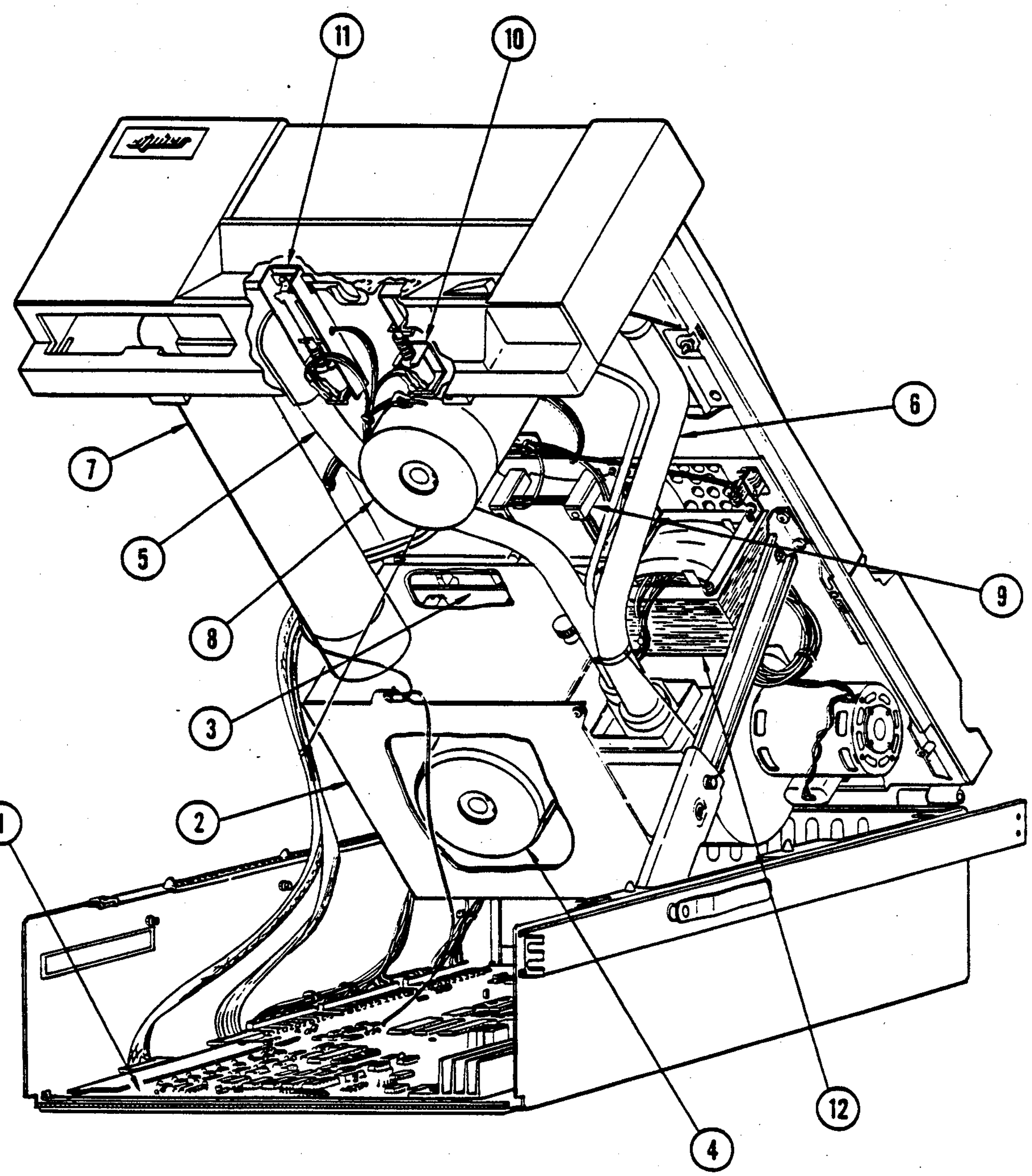

Figure 4-6. Model F880 Tape Transport (Bottom View)

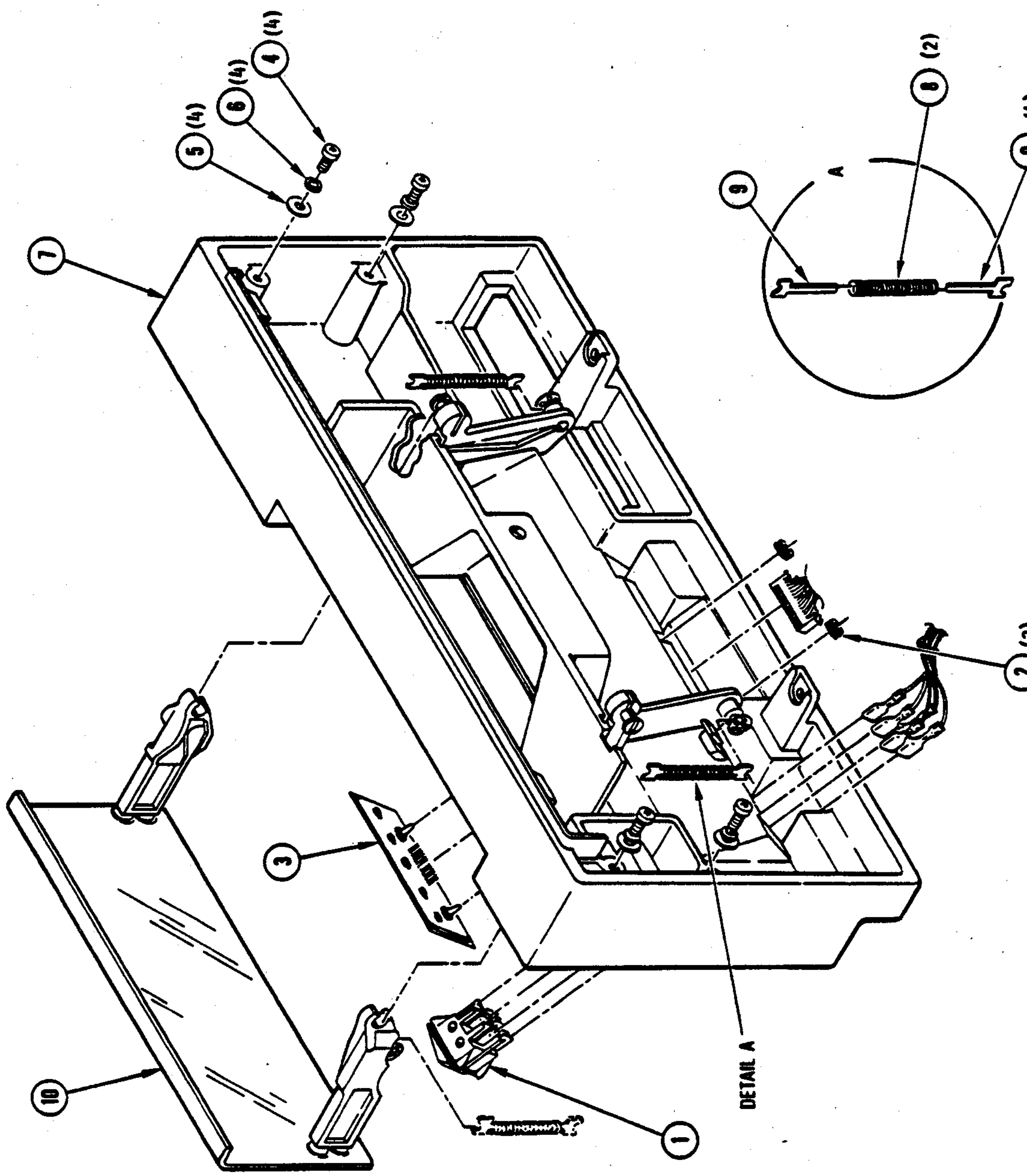

Figure 4-7. Front Panel Assembly

4-20. **Touch Switch Replacement.** To replace the touch switch (3, Figure 4-7), proceed as follows:

a. Position transport in service access position, in accordance with instructions in paragraph 4-3.

b. Remove connector from switch in back of front panel, noting position of connector.

c. Remove grommets (2) from attachment posts of switch (3) and lift switch out of front panel.

d. Insert replacement switch in front panel, place grommets (2) on attachment posts, pressing down tightly against panel, and secure using Permabond.

e. Attach switch connector at back in same position as removed in step b (brown wire nearest power switch).

f. Restore transport to operating position.

4-21. **Front Panel Subassembly Replacement.** To replace the front-panel subassembly (7, Figure 4-7), proceed as follows:

NOTE

For purposes of this procedure, it is assumed that power switch (1), touch switch (3), and door assembly (10) are to be removed from discarded front panel subassembly and reused in replacement. If one or more of these items is also to be replaced, disregard instructions for removal of such items in this paragraph.

a. Position transport in service access position, in accordance with instructions in paragraph 4-3.

b. Open front-panel door (10).

c. Remove four screws (4), lockwashers (5), and flat washers (6). Remove switch wire terminals and connectors attached to switches (1 and 3), noting position of each. Lift off entire front panel assembly.

NOTE

If air intake tube comes off with front panel, remove from front panel and set aside for reassembly.

d. Remove following parts and subassemblies from discarded front-panel subassembly (7) and replace in replacement front panel subassembly as follows:

   (1) Power switch: refer to paragraph 4-19.

   (2) Touch switch: refer to paragraph 4-20.

   (3) Door assembly: refer to paragraph 4-22.

e. If air intake tube came off with front panel replace in front panel.

f. Attach complete front panel assembly to top plate with screws, washers, and lockwashers removed in step c. Ensure that gooseneck of front panel air duct is properly positioned (paragraph 4-42, step f).

g. Reconnect wires and connectors as identified in step c.

h. Restore transport to operating position.

i. Use Service Aid 32 to test door lock adjustment. Refer to paragrpah 4-48, step j for adjustment procedure.

4-22. **Removal And Replacement of Door Assembly.** To replace the door assembly (10, Figure 4-7), proceed as follows:

a. Remove front panel assembly from top plate in accordance with paragraph 4-21, steps a, b, and c.

b. Remove two springs (8) and four guides (9), and push door out of front panel, using finger pressure on back of door from under side of panel.

c. Install door assembly in front panel subassembly by snapping arms onto plastic studs of front panel assembly, as indicated in Figure 4-7.

d. Assemble guides (9) with springs (8), with flat surfaces of guides in contact with each other.

e. Reinstall assembled front panel assembly on top plate in accordance with paragraph 4-21, steps e-i.

f. Use Service Aid 32 to test door lock adjustment. Refer to paragraph 4-48, step j for adjustment procedure.

SUPPLY HUB ASSEMBLY (2, Figure 4-5).

4-23. **Removal, Replacement and Adjustment (Figure 4-8).** Place transport in operator maintenance access position in accordance with paragraph 4-2 and proceed as follows:

a. Rotate hub assembly (1, Figure 4-8) so that socket-head screws face front panel door.

b. Open front-panel door and loosen socket-head screws (2).

c. Remove supply hub from reel motor shaft.

d. Install replacement hub on shaft, and position hub height gauge, Cipher Part No. 760105-545, as shown in Figure 4-9 so that it contacts the raised machined surface of the top plate. Raise the supply hub until the reference surface contacts the hub-height tool.

e. Ensuring that hub-height tool is in contact with both the top plate and reel hub, tighten socket-head screws (2).

f. Remove tool, restore transport to operating position, and load tape.

g. Run tape forward and reverse using Service Aid 23, noting tape position on reel for which replacement hub was installed. If tape is centered between sides of reel, adjustment is correct. If not, loosen socket-head screws and repeat steps d through g until positioning is correct.

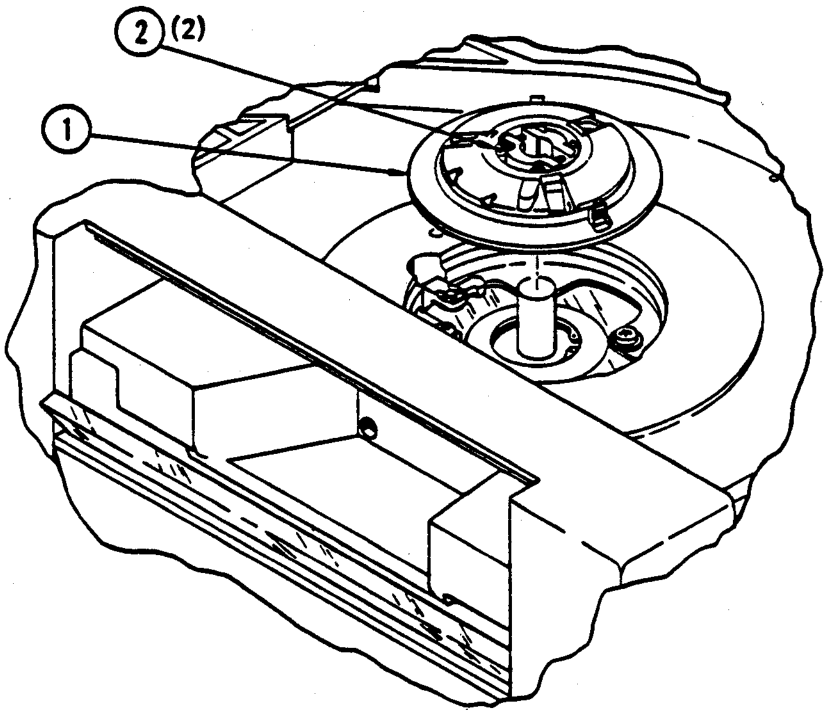

Figure 4-8. Supply Hub Assembly

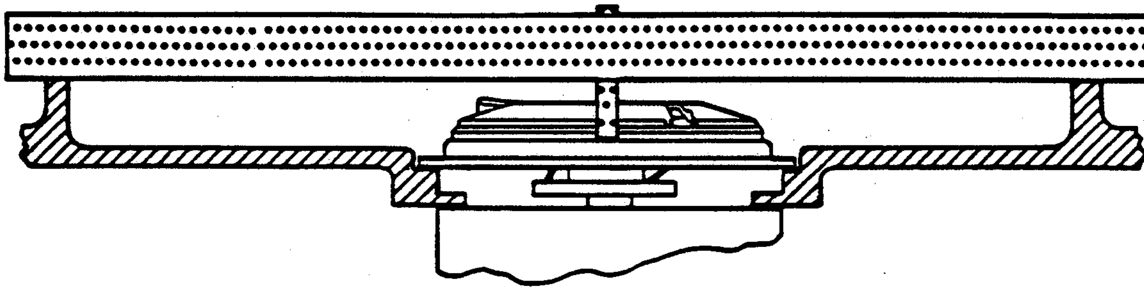

Figure 4-9. Supply Hub Adjustment

HEAD ASSEMBLY (3, Figure 4-5).

4-24. **Removal and Replacement of Assembly and Parts (Figure 4-10).** Place the transport in service access position in accordance with instructions in paragraph 4-3 and proceed as follows:

NOTE

It is not necessary to remove complete assembly from top plate in order to remove tape scraper (14, Figure 4-10). Refer to paragaph 4-24, f. If head is defective and in need of replacement, entire head assembly (9), including tape scraper (14) must be replaced.

a. Remove head connectors from P6/P7 on main PWB and remove from cable retractor.

b. Working from under side of top plate, remove center adjustment screw (1), lockwasher (2), flat washer (3), four screws (4), and lockwashers (5), three flat washers (6), one flat washer (7), and cable clamp (8) supporting assembly (9) with one hand as last screw is removed. Identify wire terminal and cable clamp as to position from which removed, and save attaching parts for reinstallation.

c. Pull assembly (9) and wire harness carefully down through hole in top plate and cables over air intake tube.

d. Install replacement assembly in reverse order of sequence in steps b and c, carefully pushing head and connectors through hole in top plate and attaching wire terminal and cable clamp in positions from which removed. Do not tighten center adjustment screw (1) at this time.

e. Feed head connectors and cables through cable retractor and over air intake tube and install on J6/J7 on main PWB.

f. If tape scraper (14) only is to be replaced, remove two socket-head screws (13), nuts (10), lockwashers (11), and flat washers (12). Save attaching parts for reassembly, and install replacement scraper in reverse order of removal.

g. Adjust tape scraper (14) as follows:

(1) Insert and load a tape.

(2) Loosen socket-head screws (13) and move tape scraper away from tape.

(3) Slowly move tape scraper toward tape until it contacts tape.

(4) Rotate tape scraper until both scraper blades are touching the tape, producing two vertical creases in the tape at the points of contact.

(5) Verify that tape is touching erase bar. Check for vertical crease in tape at the point of contact.

(6) Tighten socket-head screws (13) and reverify that tape is in contact with both blades of tape scraper and the erase bar.

h. Perform tape alignment procedure, paragraph 4-50.

i. Place transport in operating position.

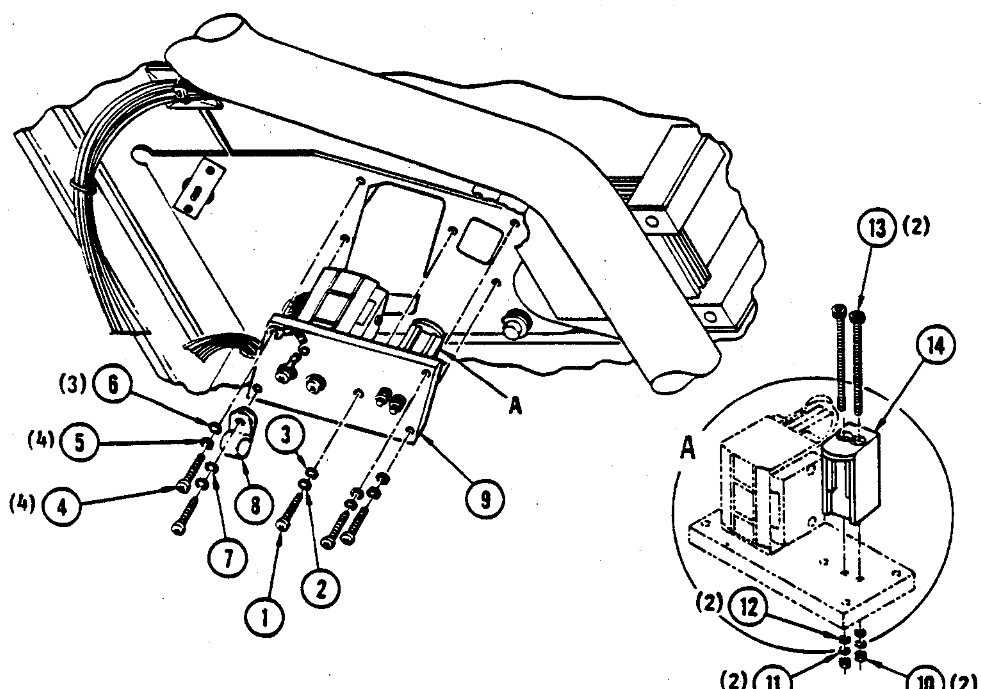

Figure 4-10. Head Assembly

ROLLER GUIDE ASSEMBLY (4, Figure 4-5).

4-25. **Removal and Replacement of Assembly (Figure 4-11).** Place the transport in operator maintenance access position in accordance with instructions in paragraph 4-2 and proceed as follows:

a. Remove attaching screw (1, Figure 4-11), leaving shims (4) and spring (3) in place, remove roller guide assembly through top of top plate, saving attaching parts for reassembly.

b. Install replacement roller guide (2), using original attaching parts.

c. Perform tape alignment procdure, paragraph 4-50.

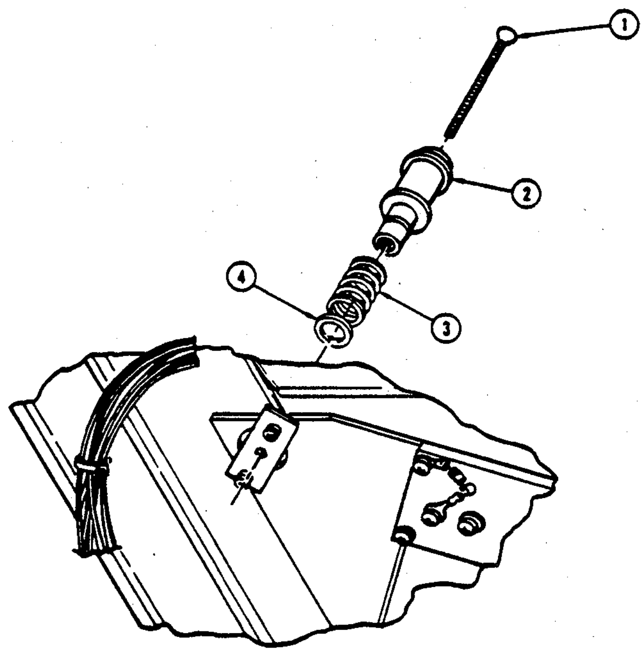

Figure 4-11. Roller Guide Assembly

EOT/BOT SENSOR ASSEMBLY (5, Figure 4-5).

4-26. **Removal and Replacement (Figure 4-12).** Place transport in operator maintenance access position, in accordance with paragraph 4-2, and proceed as follows:

a. Holding compliance arm aside to provide access to mounting screws, remove two screws (1, Figure 4-12) and lock washers (2) and retain for reassembly.

b. Remove EOT/BOT assembly (3), carefully pulling wires and connector (4) through hole in top plate assembly.

c. Unplug EOT/BOT assembly.

CAUTION

To prevent misalignment, avoid contact with sensors mounted on replacement EOT/BOT PWB. Sensors are factory-aligned for optimum output.

d. Attach plug removed in step c.

e. Feed wires and connector (4) carefully through hole in top plate assembly (refer to step b).

f. Attach EOT/BOT assembly loosely with screws (1) and lockwashers (2), position assembly as close to tape as mounting bracket will allow, with PWB parallel to casting wall directly behind it, and tighten screws.

g. Place transport in operating position.

h. Use Service Aids 22 and 23 to test EOT/BOT assembly.

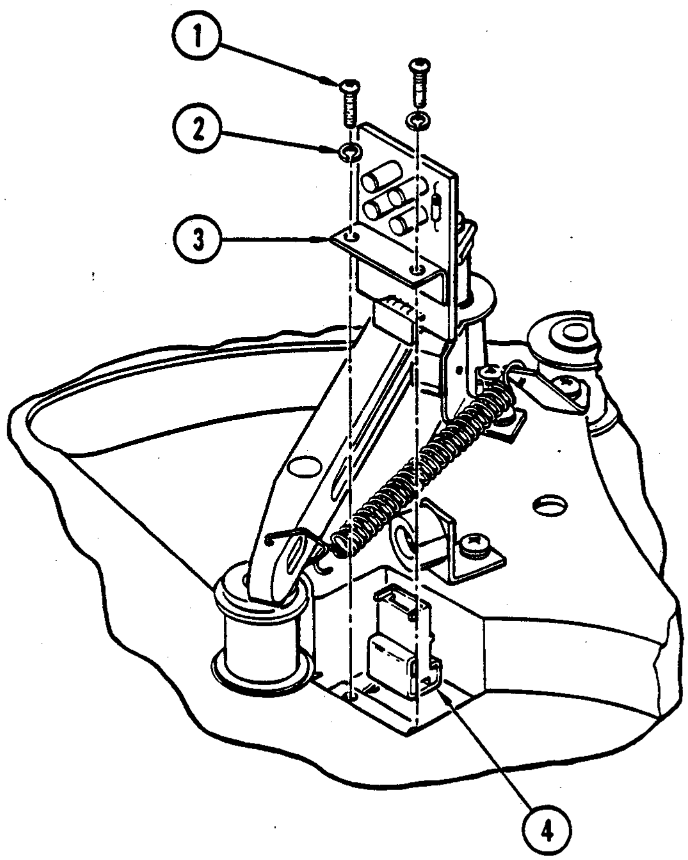

Figure 4-12. EOT/BOT Assembly

TACHOMETER ASSEMBLY (6, Figure 4-5).

4-27. **Removal and Replacement (Figure 4-13).** Place the transport in service access position in accordance with paragraph 4-3 and proceed as follows:

a. Disconnect tachometer wiring harness connector from mating connector beneath top plate.

b. Remove grip ring (1, Figure 4-13), wavespring washer (2), and shim(s) (3) from tachometer post beneath top plate and save for reassembly.

c. Remove tachometer assembly (6) from top plate, pulling wire harness and connector carefully through hole.

d. If lower bearing (4) or upper bearing (5) was removed, apply Loctite 601 sparingly to outside surface of replacement bearing before installing.

e. Install replacement tachometer assembly through upper bearing (5) and lower bearing (4), seating end of spring in adjacent small hole in top plate.

f. Install shim(s) (3), wavespring washer (2), and grip ring (1). If necessary, install additional shims (3) to compress wavespring half of its height when grip ring is installed.

g. Push connector and wire harness through top plate hole, and connect beneath top plate.

h. Place transport in operating position.

i. Use Service Aid 11 to test tachometer operation.

COVER ASSEMBLY (7, Figure 4-5).

4-28. **Removal and Replacement of Assembly and/or Parts (Figure 4-14).** Place the transport in operator maintenance access position (paragraph 4-2). Remove damaged cover assembly, subassemblies, and/or parts as necessary in the sequence of index numbers (Figure 4-14) assigned to the item and its attaching parts, saving attaching parts for use during reassembly if necessary, and install the replacement item in reverse sequence of removal. Observe the following special instructions:

a. When replacing catch (10) tighten screws just enough to hold and then try closing cover. If catch is too far forward and prevents cover from closing or is too far back to engage latch on front panel assembly, loosen attaching screws (7) and move catch forward or backward so that the cover closes and catch latches securely on front panel.

b. Restore transport to operating position.

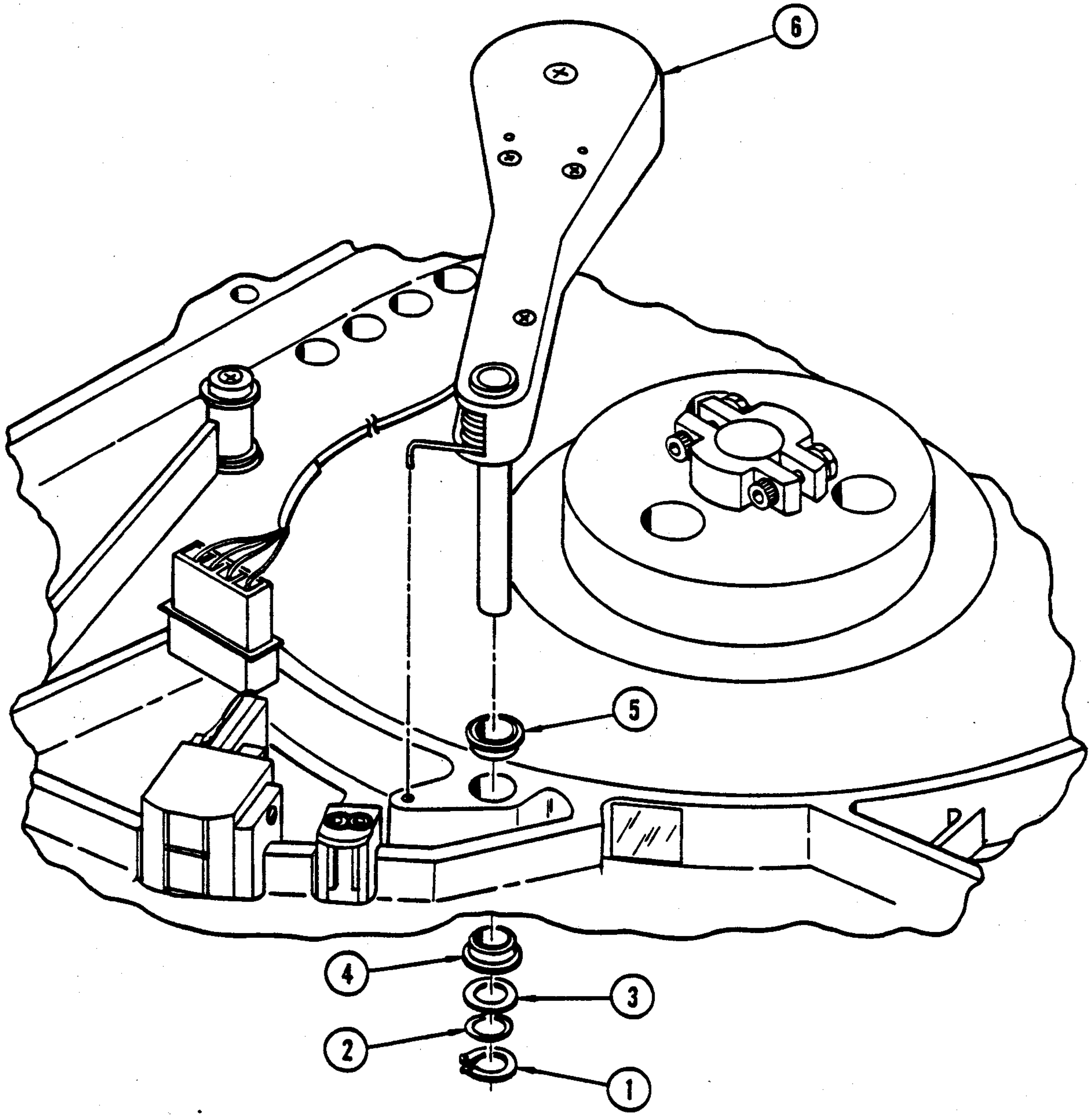

Figure 4-13. Tachometer Assembly

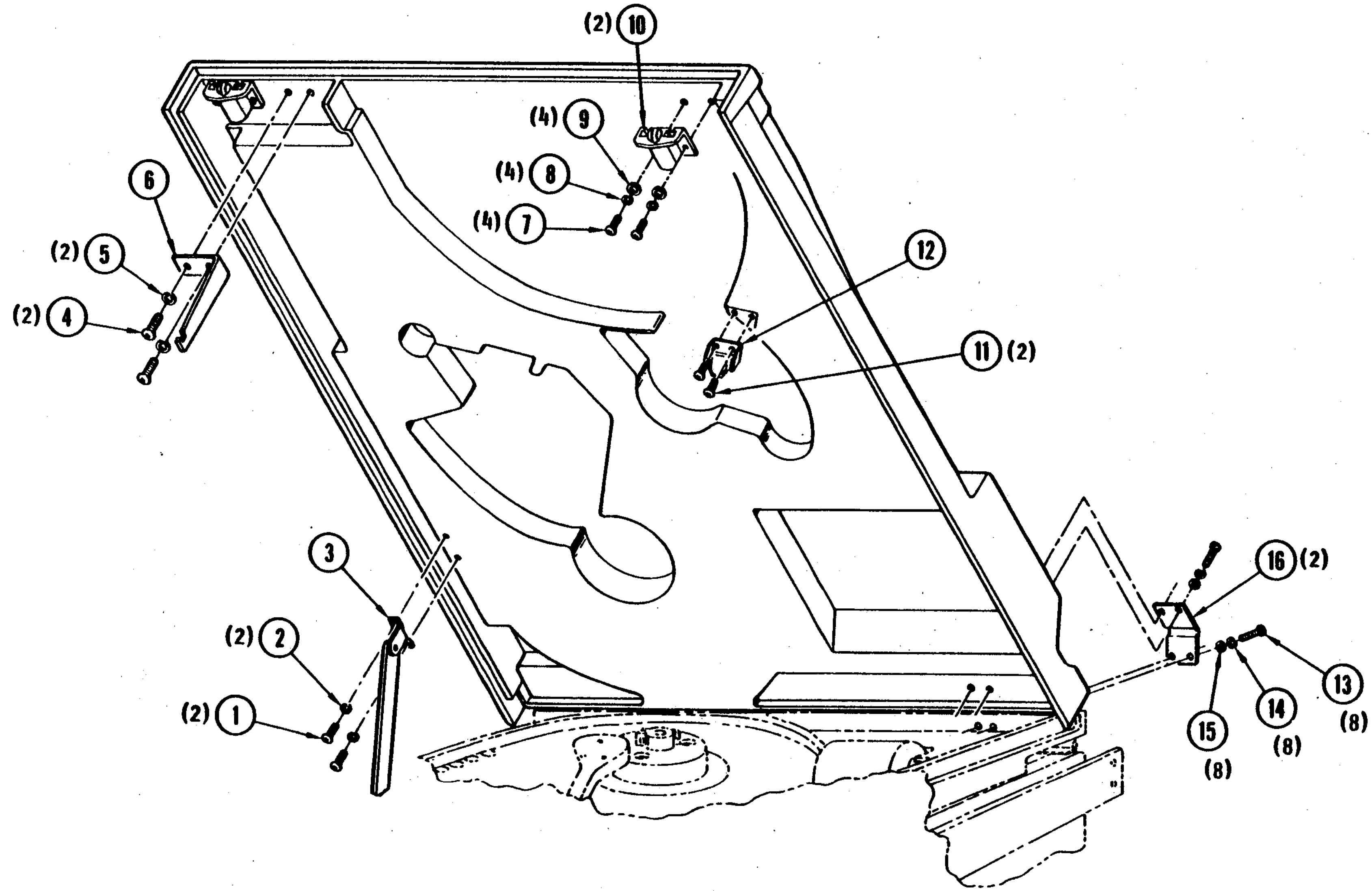

Figure 4-14. Top Cover Assembly

TAKEUP HUB ASSEMBLY (8, Figure 4-5).

4-29. **Removal, Replacement, and Adjustment (Figure 4-15).** Place the transport in operator maintenance access position in accordance with paragraph 4-2, and proceed as follows:

a. Secure tachometer assembly (1) away from the takeup hub.

b. Loosen socket-head screws (2, Figure 4-15) and remove hub (3).

c. Install replacement hub on shaft and position hub height gauge, Cipher part No. 760105-545, as shown in Figure 4-16.

d. Position hub on shaft so that hub height gauge is in contact with both the raised machined area of the top plate and takeup hub, and tighten socket-head screws (2).

e. Remove tool, carefully replace tachometer assembly against hub, restore transport to operating position, and load tape.

f. Run tape forward and reverse using Service Aid 23, noting tape position on replacement hub. If tape is centered on hub, adjustment is correct. If not, loosen socket-head screws (2) and repeat steps b through e.

g. Place transport in operating position.

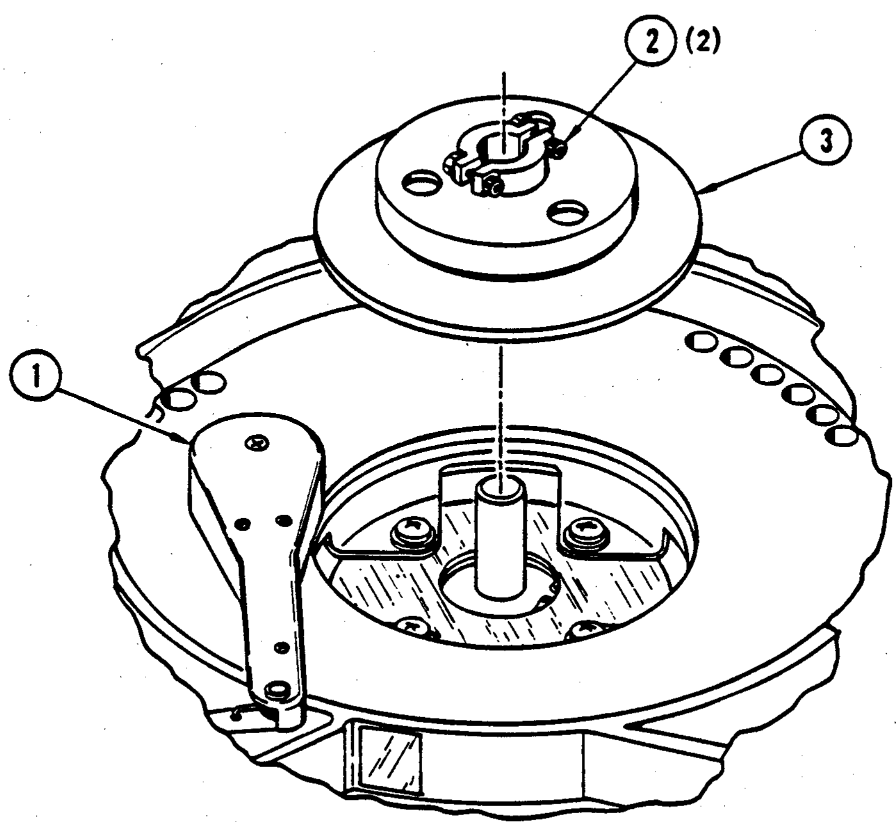

Figure 4-15. Takeup Hub

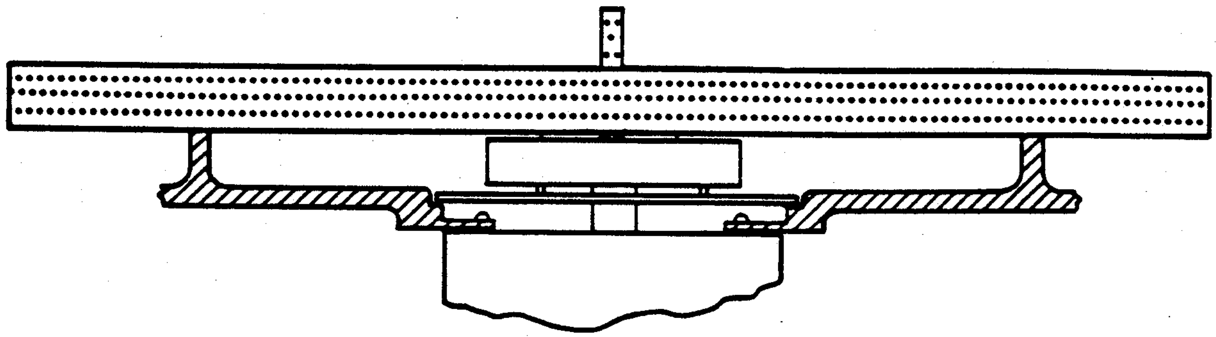

Figure 4-16. Takeup Hub Adjustment

COMPLIANCE ARM ASSEMBLY (9 Figure 4-5), AIR CAPACITOR ASSEMBLY (9, Figure 4-6).

NOTE

To facilitate removal of the compliance arm assembly, this procedure combines the removal, disassembly, assembly and installation of the compliance arm assembly with that of the air capacitor.

4-30. **Removal and Disassembly (Figure 4-17).** Place the transport in service access position in accordance wih instructions in paragraph 4-3. Proceed as follows:

NOTE

Save all attaching parts for use in reassembly.

a. Remove the top plate air duct. Refer to paragraph 4-41. Do not remove Ty-rap.

b. Remove two screws (1), lockwashers (2) and flat washers (3) attaching air capacitor shutter blade (4) to hub (5), and remove blade (4) from air capacitor stator (8).

c. Remove wire terminals clipped to air capacitor stator (6) plates and identify for reassembly.

d. Remove two allen-head screws (6) and one allen-head screw (7), and remove air capacitor stator (8) from top plate.

e. Loosen socket head screw (9) and remove shutter hub (5) from end of compliance arm shaft.

f. From top side of plate, remove spring (10) from bracket (11).

g. From bottom side of top plate, remove retaining ring (12), wavespring washer (13), and shim (14). Lift compliance arm assembly from top plate. Remove lower bearing (15) or upper bearing (16) only if it requires inspection and/or replacement. These bearings are attached to top plate with Loctite 601.

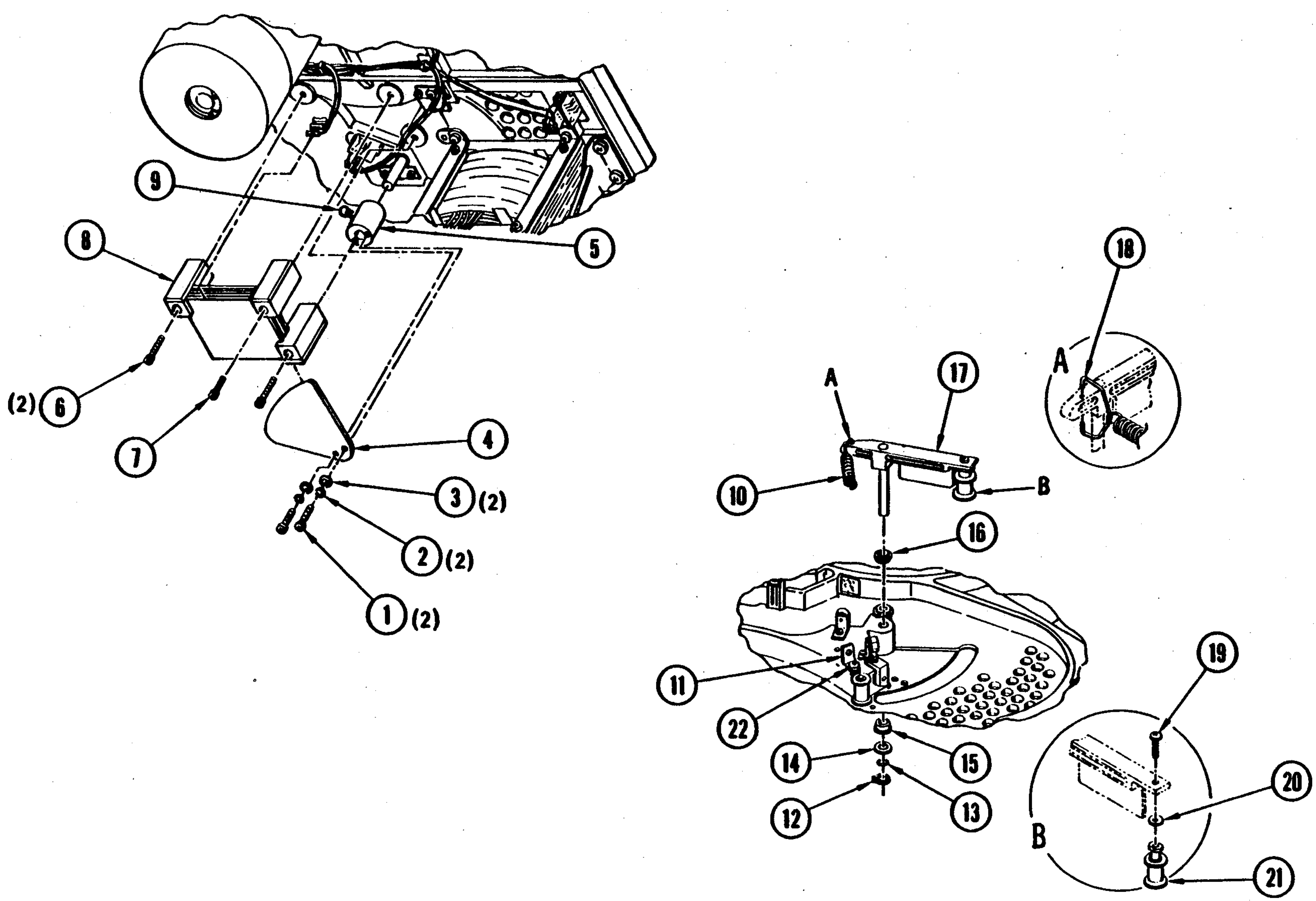

Figure 4-17. Compliance Arm and Air Capacitor Assemblies

h. Remove clip (18) from arm (17) by spreading ends out of hole in arm.

i. To remove tape guide (21), remove screw (19), and shim (20), saving shim for reassembly.

4-31. **Reassembly, Installation, and Adjustment.** Reassemble and install the compliance arm and air capacitor assemblies as follows:

a. Replace defective parts and reassemble compliance arm assembly as shown in Figure 4-17, in reverse order of steps g through i, paragraph 4-30, observing the following special instructions.

   (1) Use attaching parts and shims saved from removal and disassembly as necessary.

   (2) Apply Lubriplate to bearing surfaces between clip (17) and arm (18).

b. If bearing (15) or (16) was removed, apply small amount of Loctite 601 around outside of bearing and replace.

c. Install shaft carefully through bearings in top plate.

d. Install shim (14), wavespring washer (13), and retaining ring (12) on bottom of shaft. Check wavespring washer (13) to see that it is compressed half of its height. If not, add shims (14) as necessary, checking compliance arm for freedom of movement.

e. Slip hub (5) of capacitor shutter over end of compliance arm shaft, tightening socket head screw (9) just enough to hold hub on shaft.

f. Mount air capacitor stator (8) to under side of top plate with one screw (1/2 - inch) (7), and two screws (5/8-inch) (6), applying Loctite 242 to screws before insertion.

g. Slip blade (4) of capacitor shutter between two upper plates of capacitor stator (8), and attach to hub (loosen hub if required) with two screws (1), lockwashers (2), and flatwashers (3).

h. Rotate compliance arm assembly to front bumper and secure with Ty-rap.

i. Loosen hub socket head screw (9) slightly, rotate capacitor shutter blade (4) to within 0.1 inch of power supply housing, and adjust height of hub so that rotor blade does not bind on either plate of capacitor stator (8).

j. Tighten hub socket head screw (9).

k. Remove Ty-rap securing compliance arm assembly to front bumper and allow compliance arm to rotate to rear bumper (under its own weight). If compliance arm does not swing freely, readjust height of capacitor shutter, steps i and j, until compliance arm swings freely.

l. Tighten hub socket head screw (9).

m. Attach compliance arm spring (10) to bracket (11).

n. Clip wire terminals to air capacitor stator (8) plates at points from which removed in step b, paragraph 4-30.

o. Place transport in operator maintenance access position (paragraph 4-2).

CAUTION

To prevent data reliability problems due to improper tape tension the position of the compliance arm spring bracket (11) is factory aligned and should not be changed unless necessary.

p. If spring bracket position was changed, adjust for proper spring tension as follows:

(1) Attach 0 to 36 oz. spring scale, available from John Chatillon & Sons, 83-30 Kew Gardens Rd., Kew Gardens, New York 11415, Part No. LP36, to compliance arm by inserting hook end of scale into notch provided on top of compliance arm near the pivot point.

(2) Loosen screw (22) attaching bracket (11) and position bracket so that screw (22) is in the center of its slotted adjustment range.

(3) Pull spring scale toward front panel of transport until compliance arm roller is positioned between 4th and 5th row (from front panel) of holes in top plate. Scale must be held perpendicular to compliance arm.

(4) With compliance arm positioned between 4th and 5th holes in top plate, spring scale should indicate 19 ±2 ounces. Adjust spring bracket to obtain this reading by moving bracket to stretch or shorten spring. Any deviation from zero reading should be added or subtracted from spring scale reading.

(5) Verify that minimum spring tension required to move arm from rest position is 10 ounces.

(6) If readjustment is required in either substep (4) or (5), reverify both readings.

q. Use Service Aid 24 to test compliance arm and air capacitor assemblies.

TAPE-IN-PATH SENSOR, TRANSMITTER (10, Figure 4-5).

4-32. **Removal and Replacement (Figure 4-18).** Place the transport in service access position in accordance with paragraph 4-3 and proceed as follows:

a. Remove connector at back of top plate from tape-in-path sensor transmitter.

b. Remove two screws (1, Figure 4-18) and lockwashers (2) and pull transmitter (3) carefully through hole from back of top plate.

c. Position replacement sensor transmitter carefully in place through hole from back of top plate and secure with screws (1) and lockwashers (2).

d. Attach connector removed in step a.

e. Place transport in operating position.

f. Use Service Aid 31 to test tape-in-path sensor, transmitter.

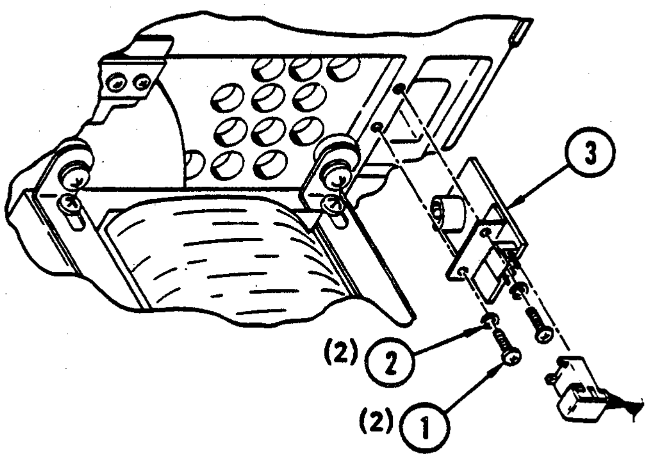

Figure 4-18. Tape-in-Path Sensor, Transmitter

TAPE-IN-PATH SENSOR, RECEIVER (11, Figure 4-5).

4-33. **Removal and Replacement (Figure 4-19).** Place the transport in service access position in accordance with paragraph 4-2 and proceed as follows:

a. Remove connector at back of top plate.

b. Remove attaching screw (1, Figure 4-18), lockwasher (2), and flatwasher (3) and remove tape-in-path sensor receiver (4). Save attaching parts for reassembly.

c. Install replacement receiver using screw (1), lockwashers (2) and flatwasher (3).

d. Reinstall connector.

e. Place transport in operating position.

f. Use Service Aid 31 to test tape-in-path sensor, receiver.

COMPLIANCE ARM BUMPER ASSEMBLY (12, Figure 4-5).

4-34. **Removal and Replacement (Figure 4-20).** With the transport in operator maintenance position (paragraph 4-2), proceed as follows:

a. Remove screw (1, Figure 4-20), lockwasher (2), and bumper assembly (3).

b. Reinstall in reverse order of removal, and adjust to contact compliance arm squarely. Ensure spring (4) does not touch bumper in the compliance arms full arc of travel. Reposition bumper to clear spring if required.

c. Place transport in operating position.

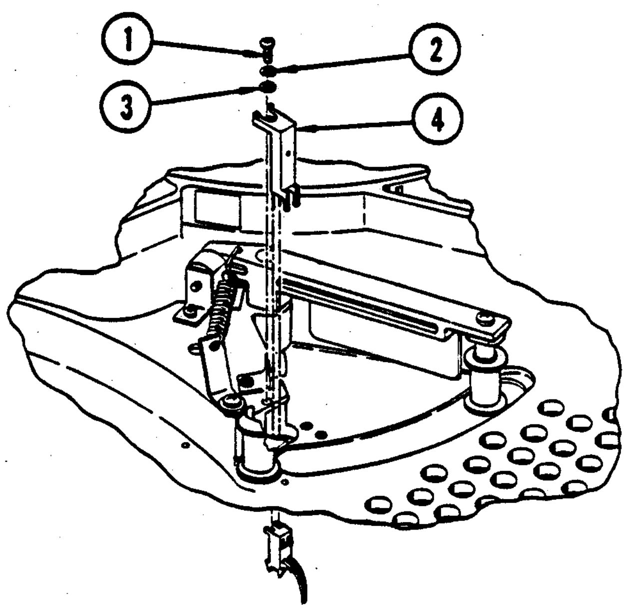

Figure 4-19. Tape-in-Path Sensor, Receiver

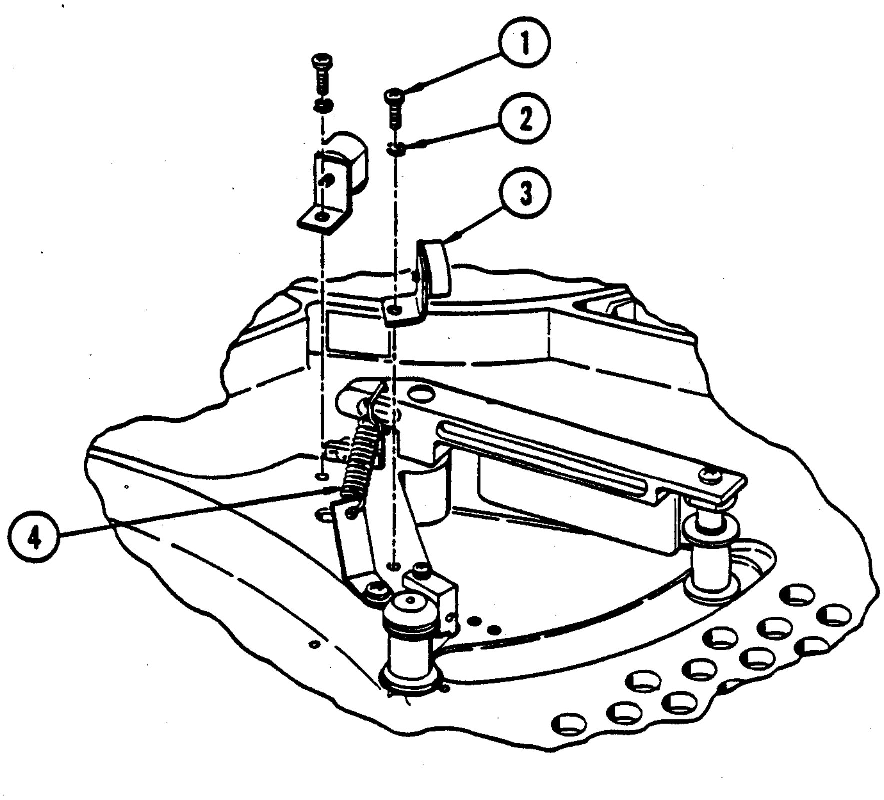

Figure 4-20. Compliance Arm Bumper Assembly

ROLLER TAPE GUIDE ASSEMBLY (SOLID) (13, Figure 4-5).

4-35. **Removal and Replacement (Figure 4-21).** Place the transport in service access position in accordance with instructions in paragraph 4-3 and proceed as follows:

a. Remove attaching screw (1, Figure 4-21) and lockwasher (2), and leaving shims in place remove tape guide assembly (solid) from top of top plate. Save attaching parts for reinstallation.

b. Reinstall tape guide assembly (solid) (3) in reverse order of step a.

c. Perform tape alignment procedure in accordance with instructions in paragraph 4-50.

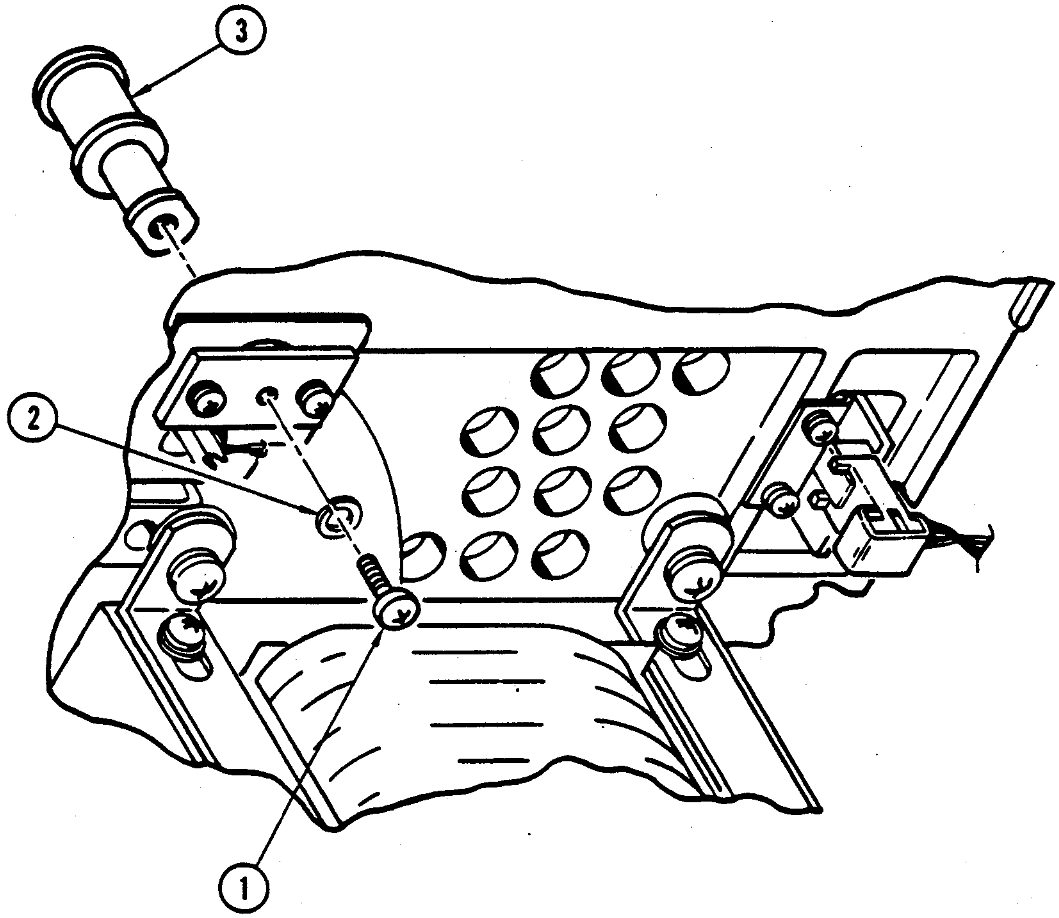

Figure 4-21. Tape Guide Assembly (Solid)

FILE-PROTECT SENSOR (14, Figure 4-5).

4-36. **Removal and Replacement (Figure 4-22).** Place the transport in service access position in accordance with paragraph 4-3 and proceed as follows:

a. Remove connector (back of top plate) from file-protect sensor (3, Figure 4-22).

b. Remove two screws (1) and lockwashers (2) and pull sensor (1) carefully through hole of top plate. Save attaching parts for reassembly.

c. Position replacement sensor carefully through hole and secure with screws (1) and lockwashers (2).

d. Attach connector removed in step a.

e. Place transport in operating position.

f. Use Service Aid 31 to test file-protect sensor.

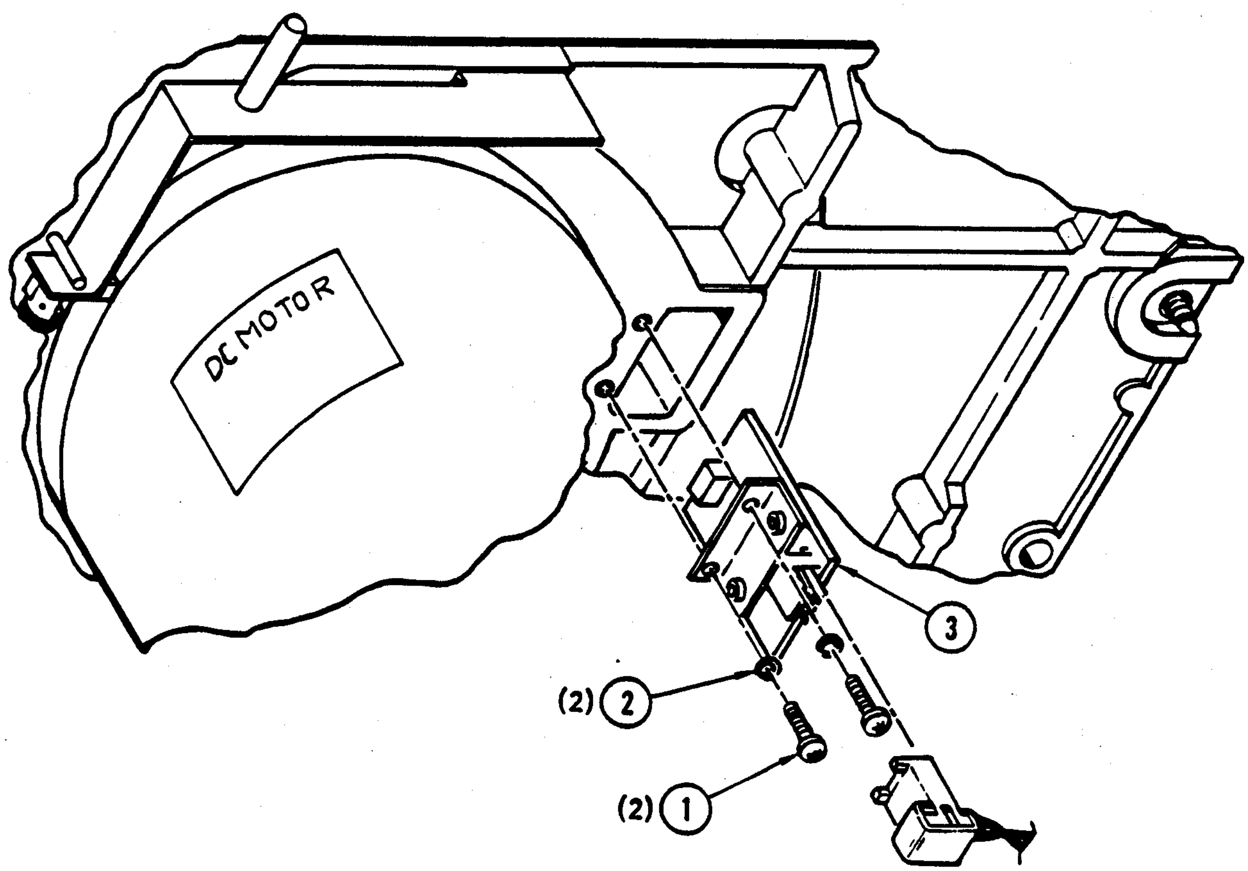

Figure 4-22. File-Protect Sensor

DRIVE MAIN PRINTED WIRING BOARD (PWB) ASSEMBLY (1, Figure 4-6).

4-37. **Removal and Replacement (Figure 4-23).** Place the drive in service access position in accordance with instructions in paragraph 4-3 and proceed as follows:

a. Remove power cord from outlet.

b. Remove screw (1), lockwasher (2), and flat washer (3) from front center of board.

c. Remove all side connectors and ground wire.

d. Lift front of board over lip on chassis, slide forward and remove I/O connectors.

e. Remove board from chassis.

f. Position replacement board and install I/O connectors.

g. Reconnect all side connectors and ground wire.

h. Secure board with screw (1), lockwasher (2), and flat washer (3).

i. Place transport in operating position.

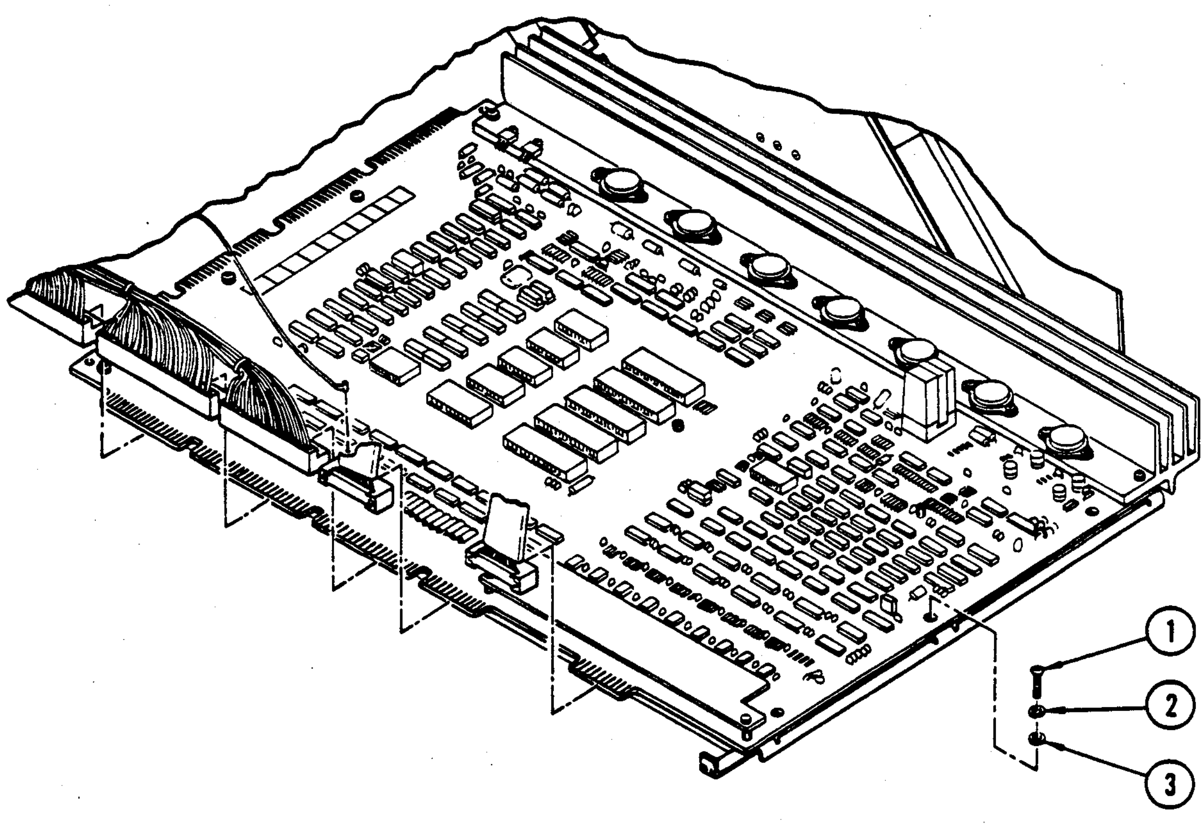

Figure 4-23. Drive Main Printed-Wiring Board

POWER SUPPLY ASSEMBLY (2, Figure 4-6).

4-38. **Removal and Replacement (Figure 4-24).** Place the drive in service access position in accordance with instructions in paragraph 4-3 and proceed as follows:

a. Turn power off and remove power cord from rear of power supply chassis.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

NOTE

Although not required, the following steps are simplified by removal of the top plate air duct (paragraph 4-41), front panel air duct (paragraph 4-42) and air intake tube (paragraph 4-43).

c. Remove screw (1, Figure 4-24), lockwasher (2), and flatwashers (3) securing ground wire terminal (4), and power supply cover (5).

d. Cut Ty-raps (5 places) securing wiring harness to outside of power supply chassis, and disconnect wiring harness connector from power supply PWB.

e. Remove screws (6), lockwashers (7), and flatwashers (8) securing power supply chassis to top plate.

f. Remove screws (9), lockwashers (10), and flatwashers (11) securing chassis to rear bracket.

g. Disconnect air pump wires (16) and terminals from EMI filter (15) noting position from which removed.

h. If air pump assembly (20) is to be replaced, remove nuts (17), lockwashers (18), and flatwashers (19) securing air pump to chassis.

i. Install replacement assembly in reverse order of removal ensuring transformer and power switch wire bundles are routed through the housing opening near the top plate.

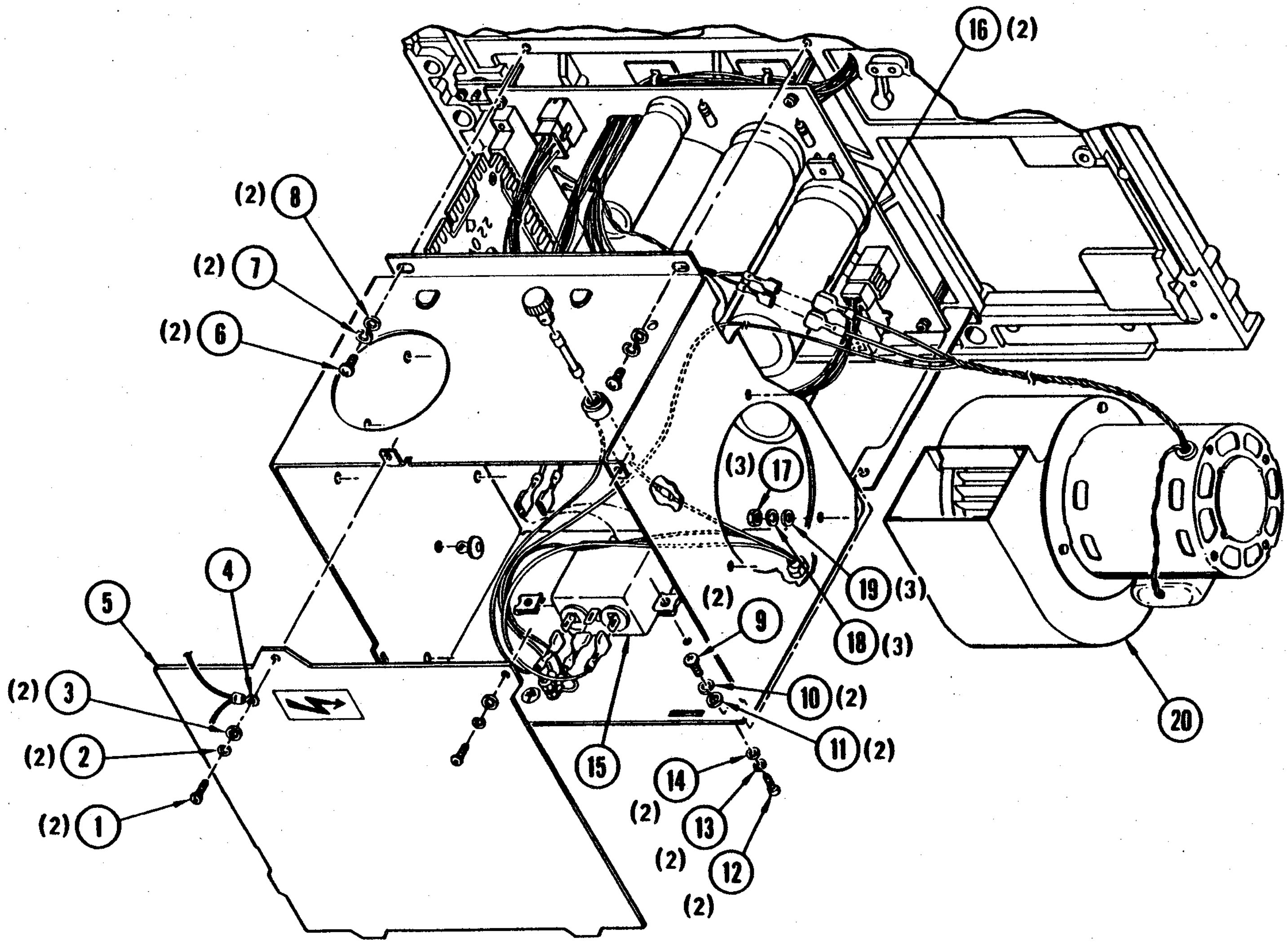

Figure 4-24. Power Supply Assembly

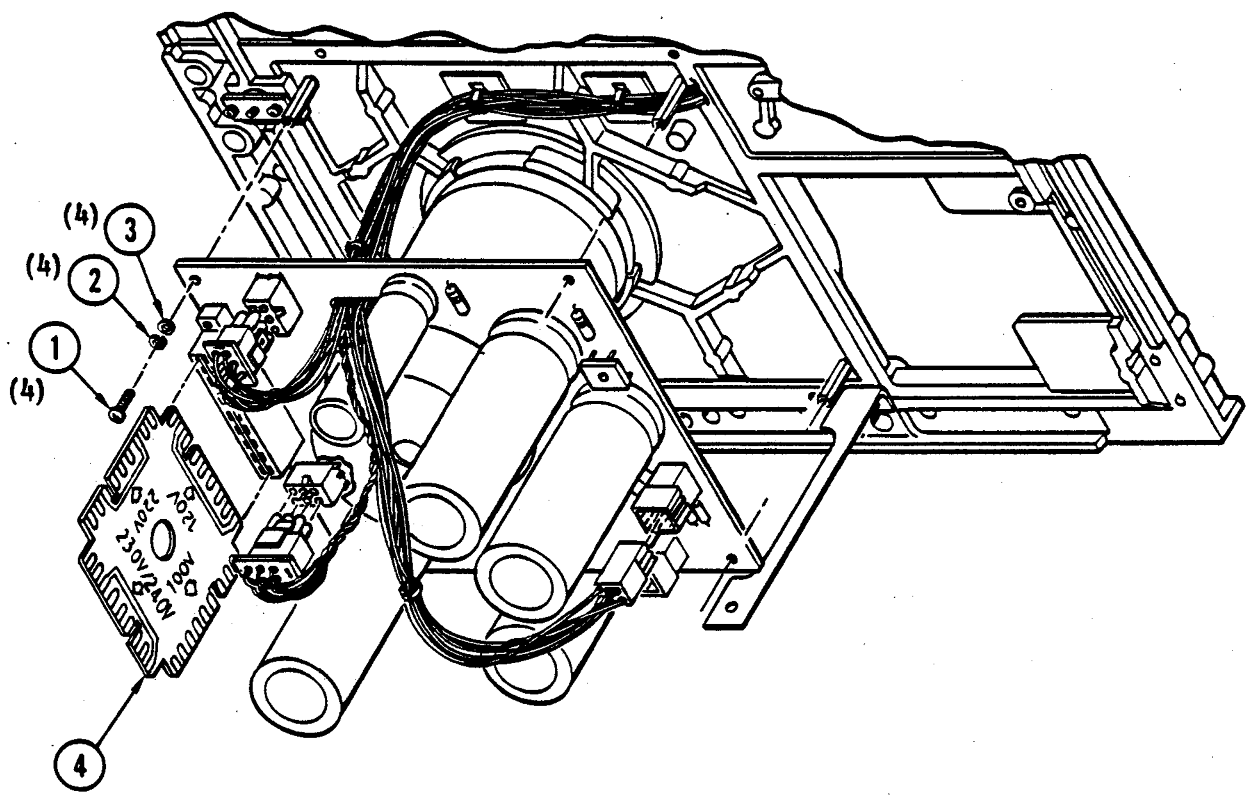

Figure 4-25. Power Supply PWB

POWER SUPPLY PWB (3, Figure 4-6).

4-39. **Removal and Replacement (Figure 4-25).** Place the drive in service access position in accordance with instructions in paragraph 4-3 and proceed as follows:

a. Remove power cord from outlet.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

c. Remove power supply assembly in accordance with instructions in paragraph 4-38.

d. Disconnect all wiring harness connectors from power supply PWB.

e. Remove screws (1), lockwashers (2), and flatwashers (3), and carefully lower power supply PWB while feeding cables through board opening. Remove voltage selection card (4).

f. Reconnect all connectors to replacement PWB and replace voltage selection card (4).

g. Hold PWB in place and secure with screws (1), lockwashers (2), and flatwasher (3).

h. Replace power supply chassis in reverse order of instructions in paragraph 4-38.

i. Place drive in operating position.

TAKEUP MOTOR ASSEMBLY (4, Figure 4-6).

4-40. **Removal, Replacement and Adjustment (Figure 4-26).** Place the transport in service access position, in accordance with paragraph 4-3, and remove and replace the takeup motor assembly in accordance with the following procedure:

a. Remove power cord from outlet.

b. Remove drive main PWB in accordance with instructions in paragraph 4-37.

c. Remove takeup hub in accordance with paragraph 4-29.

d. Remove power supply assembly cover in accordance with instructions in paragraph 4-38.

e. Disconnect motor wire terminals identifying as necessary for reinstallation.

f. Remove four screws (1, Figure 4-26), lockwashers (2), flatwashers (3), shoulder washers (4), and takeup motor (6) out of drive, noting orientation of motor. Save attaching parts, including insulator (5), for use in assembly.

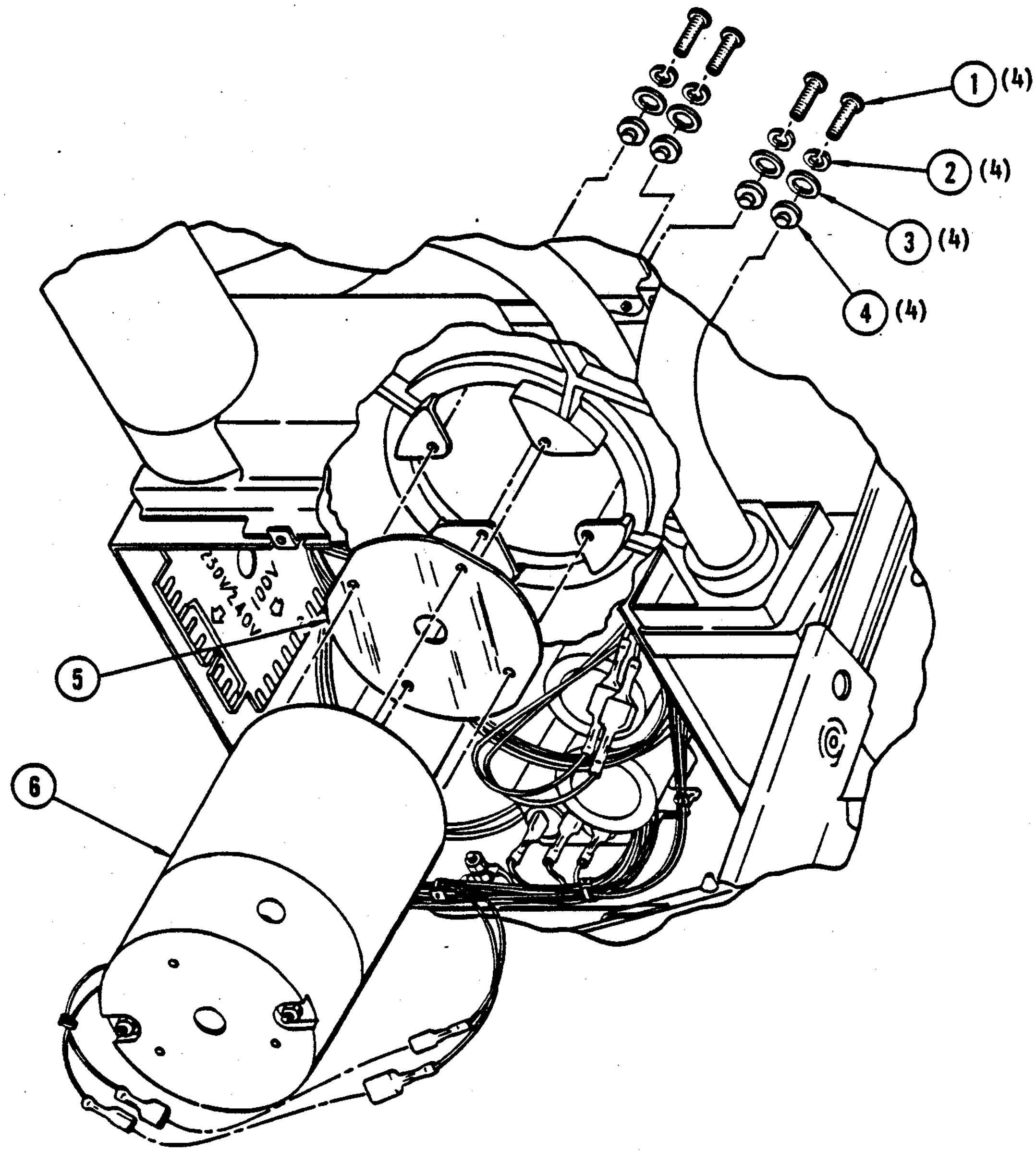

Figure 4-26. Takeup Motor Assembly

g. Install replacement motor in same orientation as motor removed in step f, in reverse order of steps e and f.

h. Reinstall power supply cover in accordance with instructions in paragraph 4-38.

i. Reinstall and adjust takeup hub in accordance with paragraph 4-29.

j. Reinstall main PWB in accordance with instructions in paragraph 4-37.

k. Use Service Aid 11 to test motor operation.

AIR DUCT, TOP PLATE (5, Figure 4-5), AIR DUCT, FRONT PANEL (6), TUBE, AIR INTAKE (7).

4-41. **Removal and Replacment (Figure 4-27).** Place the transport in service access position (paragraph 4-3). To replace the top-plate air duct, proceed as follows:

a. Remove head connectors J6/J7 from main PWB and cable retractor (5). At top-plate end of top-plate air duct (4), remove screw (1), lockwasher (2), and flatwasher (3).

b. Pull other end from blower adapter (6), and remove air duct.

c. Remove cable retractor (5) from old duct and secure with Ty-rap on replacement duct.

d. Install replacement duct by slipping flared end over blower adapter (6) and reinstalling screw, lockwasher and flat washer.

e. Place transport into operating position.

4-42. **Front Panel Air Duct (Figure 4-27).** Replace the front panel air duct as follows:

a. Note positions of power switch harness and safety pin retractor Ty-raps on duct and remove.

b. Remove front panel in accordance with instructions in paragraph 4-21, steps a, b, and c, but do not remove switch wire terminals and connectors.

c. Pull front panel just far enough away from transport to remove gooseneck end of front-panel air duct (7), noting position from which removed with reference to air deflector on front, right-hand edge of top plate.

d. Pull other end of duct off blower adapter (6).

e. To install replacement front-panel air duct (7), place flared end of duct on blower adapter.

f. Position gooseneck end of duct so that it opens into air deflector and holding end of duct in place, replace front-panel assembly, squeezing positioning block of front-panel over gooseneck, ensuring that air intake tube (8) is in place in front-panel adapter (9) and power supply.

g. Reinstall front panel assembly in accordance with paragraph 4-21, step f.

h. Fasten power switch wiring harness and safety pin retractor to duct with Ty-raps per step a notation.

i. Place transport in operating position.

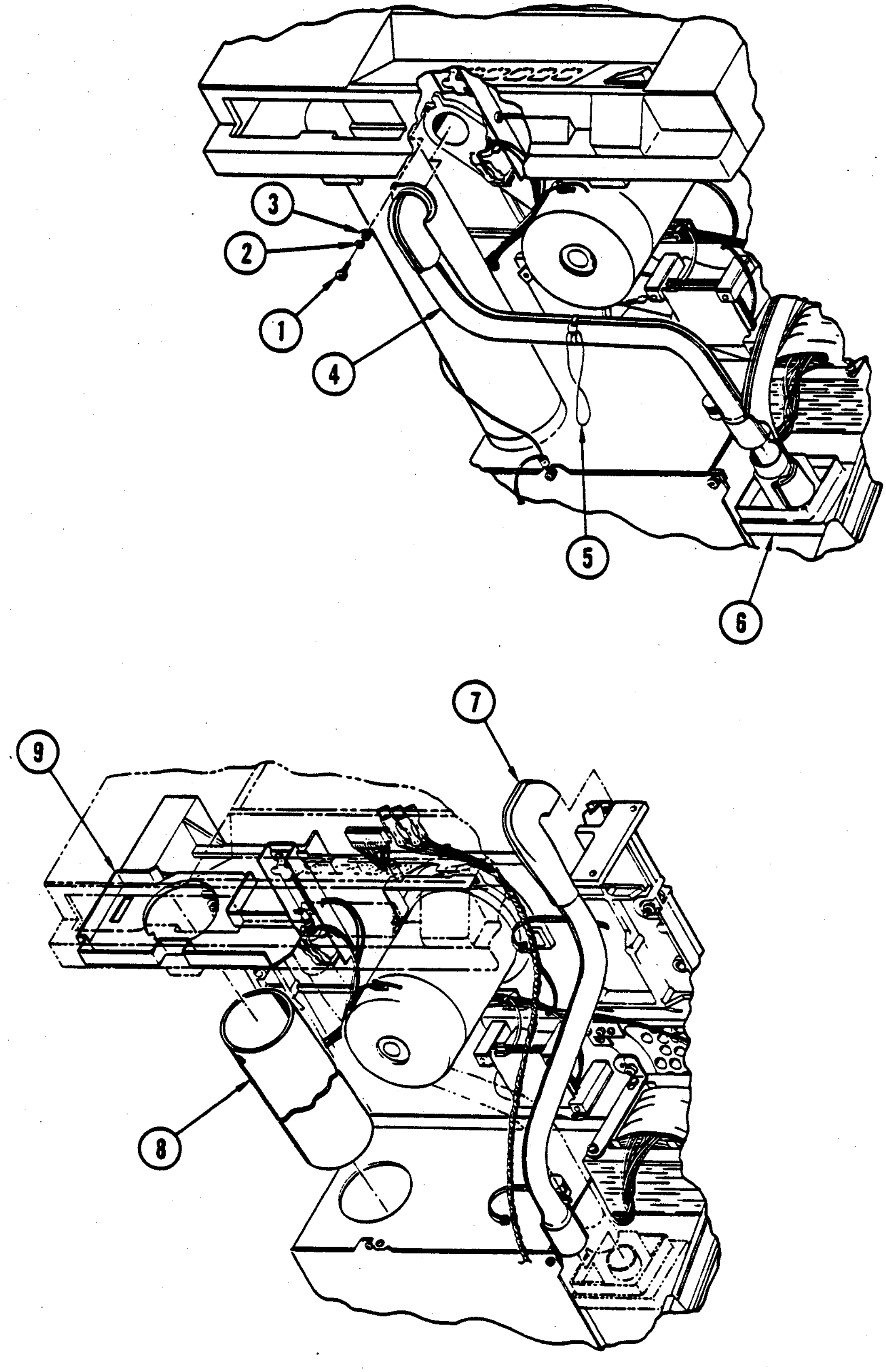

Figure 4-27. Top Plate Air Duct,
Front Panel Air Duct, Air Intake Tube

4-43. **Air Intake Tube. (Figure 4-27).** Replace the air intake tube as follows:

a. Remove the filter. Refer to paragraph 4-13.

b. Place unit in service access position.

c. Remove air intake tube (8) from power supply case by depressing tube slightly at hole (bottom of tube) to disengage tooth and slide forward into front panel adapter (9).

d. Remove front panel as in paragraph 4-42, but do not remove Ty-raps, etc.

e. Slide air intake tube out of front panel adapter.

f. Install replacement tube in reverse order of removal.

g. Place transport in operating position.

SUPPLY MOTOR ASSEMBLY (8, Figure 4-6).

4-44. **Removal and Replacement (Figure 4-28).** Place transport in service access position, in accordance with instructions in paragraph 4-3, and remove and replace the supply motor assembly as follows:

a. Remove power cord from outlet.

b. Remove supply hub in accordance with paragraph 4-23.

c. Disconnect motor wire terminals from wire leads, identifying each as necessary for reinstallation.

d. Remove bell crank retaining ring (5, Figure 4-28).

e. Remove screw (1) lockwasher (2), flatwasher (3), shoulderwasher (4), and insulator (6), holding motor (7) as last screw is being removed.

f. Lower motor (7) from top plate, simultaneously slipping bellcrank off post on top of motor.

g. Install replacement motor with bellcrank post nearest bellcrank, slipping bellcrank onto post, in reverse order of removal.

h. Install retaining ring on bellcrank post (paragraph 4-45).

i. Connect motor wire terminals as identified in step c.

j. Reinstall and adjust supply hub in accordance with instructions in paragraph 4-23.

k. Use Service Aid 11 to test motor operation.

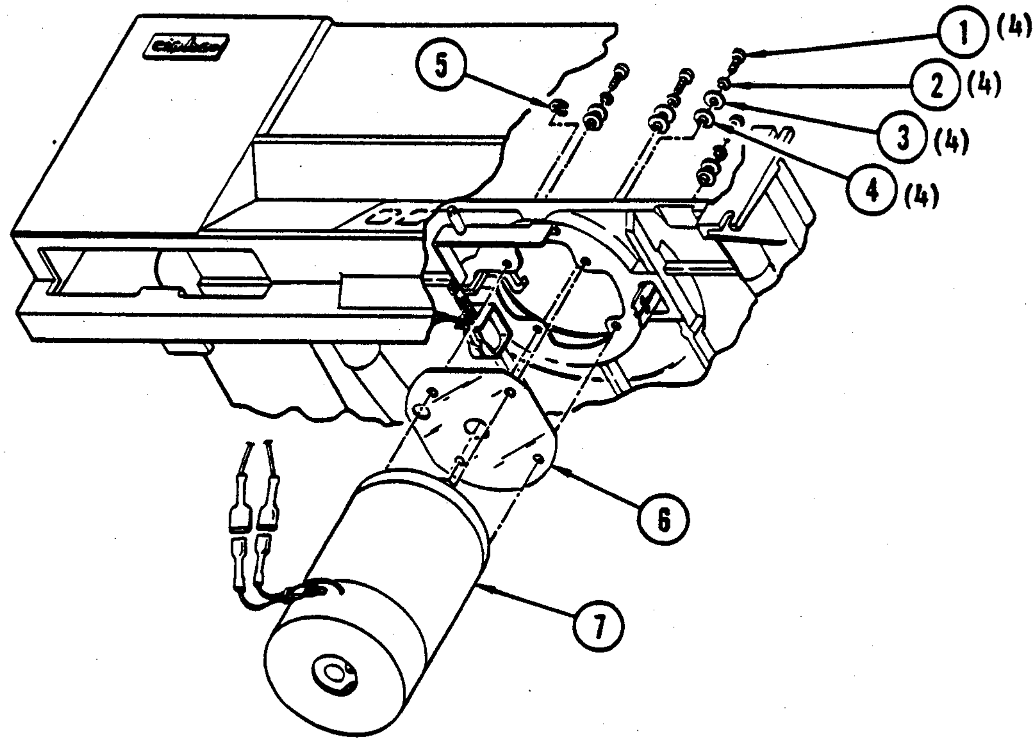

Figure 4-28. Supply Motor Assembly

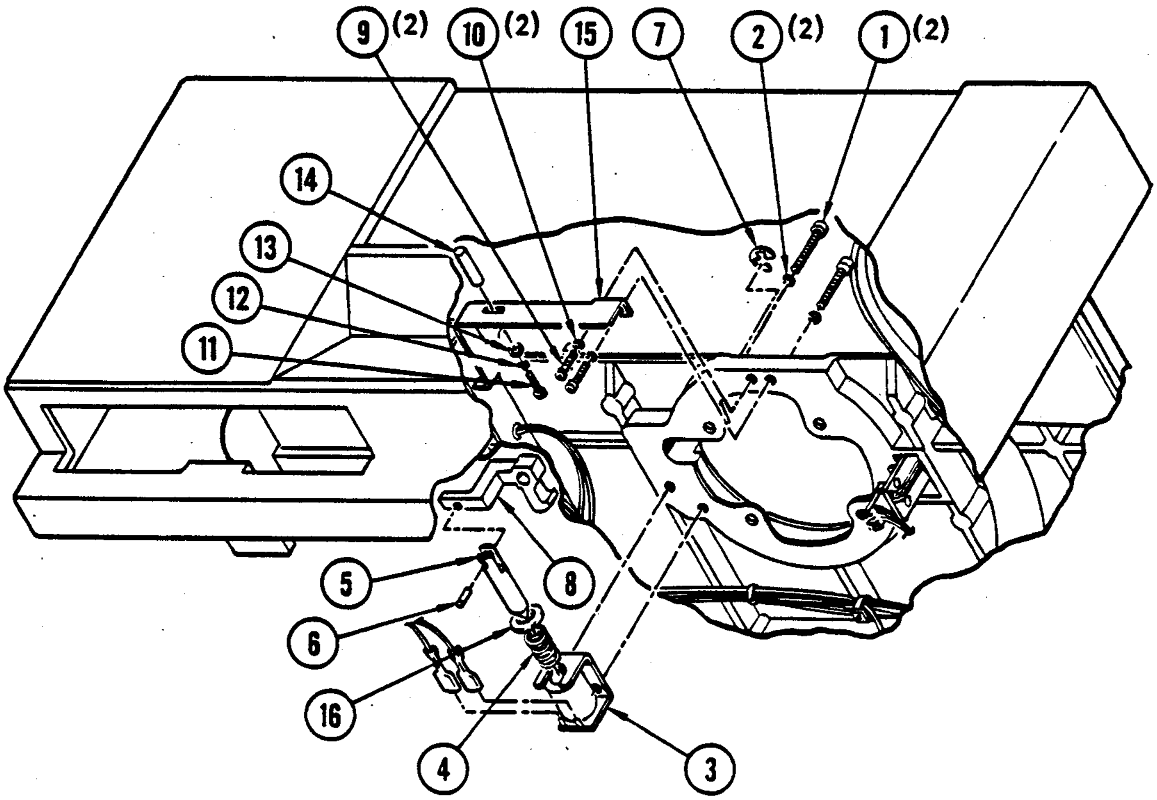

Figure 4-29. Hub Lock Assembly

HUB LOCK ASSEMBLY (10, Figure 4-6).

4-45. **Disassembly, Removal and Replacement (Figure 4-27).** To disassemble hub lock assembly and remove parts from top plate and supply motor, proceed as follows:

a. Remove power cord from outlet.

b. Place transport in service access position in accordance with instructions in paragraph 4-3.

c. Remove wire terminals from solenoid (3, Figure 4-27) and identify for reassembly.

d. Remove two screws (1), and lockwashers (2), and remove solenoid (3) from top plate and spring (4) and washer (16) from solenoid plunger (5).

e. If plunger (5) or bellcrank (8) must be replaced, remove supply motor in accordance with instructions in paragraph 4-44. Remove retaining ring (7) and bellcrank (8) from motor, and press out pin (6), releasing plunger (5).

4-46. **Reassembly and Installation.** Replace defective parts, and reassemble and install the hub lock assembly as follows:

a. Install bellcrank (8) on supply motor with retaining ring (7). Reinstall motor on top plate in accordance with instructions in paragraph 4-44.

b. Complete reassembly and reinstall solenoid (3) on top plate in reverse sequence of steps c and d, paragraph 4-45.

c. Place transport in operating position.

d. Use Service Aid 32 to test hub lock assembly operation.

4-47. **Manual Unlock Assembly (Hub Lock) (Figure 4-27).** To replace the manual unlock assembly or one of its parts, proceed as follows:

a. Place transport in service access position (Paragraph 4-3).

b. Remove manual unlock assembly from top plate by removing two screws (9, Figure 4-27) and lockwashers (10).

c. Remove pin (14) from bracket (15) by removing screw (11), lockwasher (12), and flatwasher (13).

d. Reassemble and reinstall in reverse order of steps b and c.

e. Ensure that the hub lock solenoid spring will return the manual unlock assembly fully against the stop pin. Reposition the manual unlock assembly if required.

f. Place transport in operating position.

DOOR LOCK ASSEMBLY (11, Figure 4-6).

4-48. **Removal and Disassembly (Figure 4-30).** Place the transport in service access position in accordance with instructions in paragraph 4-3. Remove the door lock assembly from the top plate and disassemble as necessary to replace defective parts as follows:

a. Remove power cord from outlet.

b. Remove wire terminals from solenoid noting positions for reassembly.

c. Remove door lock assembly from top plate by removing two screws (1, Figure 4-30) and lockwashers (2).

d. Remove slip-on connectors from microswitch noting positions for reassembly and feed through grommet.

e. Remove two screws (3), and lockwashers (4), and remove solenoid (5) from assembly. Remove spring (6) and spacer (7).

f. Remove switch (13), by removing two nuts (8), lockwashers (9), flat washers (10), screws (11) and flat washers (12). Switch may then be removed by sliding out solenoid end of bracket.

g. No further disassembly is recommended.

h. Replace defective parts, and reassemble door lock assembly in reverse sequence of disassembly, steps c and d.

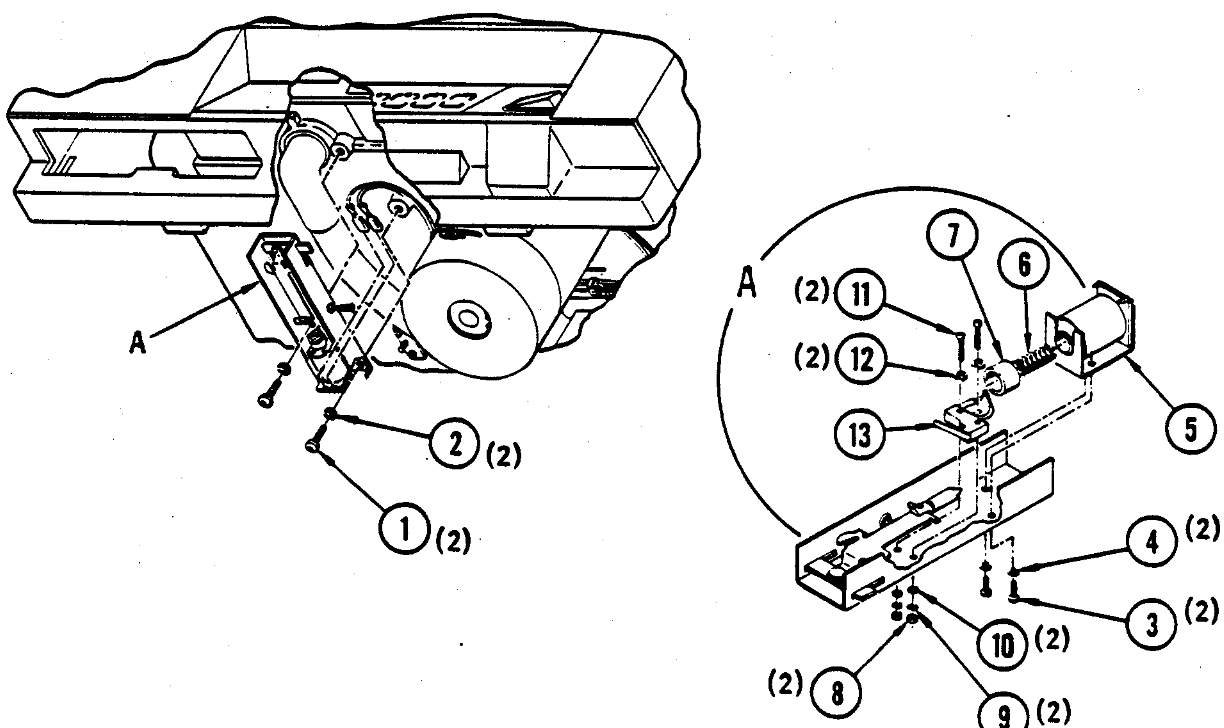

Figure 4-30. Door Lock Assembly

i. Install door lock assembly on top plate with attaching parts removed in step b. Do not tighten screws.

j. Adjust position of door lock assembly as follows:

(1) Close top cover of transport. Position door lock assembly so that the plate is approximately 1/8 inch in front of latching arm of cover lock tab (6, Figure 4-14), and tighten screws.

(2) Applying very light pressure, attempt to close transport door. If door will not close completely, loosen screws (1), push door lock assembly forward until door will close, and retighten screws (1).

(3) Place drive in operating position and connect to power source.

(4) Actuate POWER switch and LOAD touch switch. If only LOAD and POWER indicators illuminate, door lock assembly is properly positioned and adjustment is complete.

(5) If all indicators except ON-LINE are flashing upon excecution of step (4), place drive in service access position, loosen screws (1), and pull door lock assembly slightly toward rear of unit.

(6) Repeat steps (3), (4), and (5) until both top cover and door open with POWER switch off and only LOAD and POWER indicators illuminate when these switches are actuated.

k. Place transport in operating position.

TRANSFORMER ASSEMBLY (12, Figure 4-6).

4-49. **Removal and Replacement (Figure 4-31).** To replace the transformer assembly, place the transport in service access position (paragraph 4-3) and proceed as follows:

a. Remove power cord from outlet.

b. Remove drive main PWB from transport (paragraph 4-37).

c. Remove power supply assembly and power supply PWB in accordance with paragraphs 4-38 and 4-39.

d. Unplug primary and secondary transfomer connectors from power supply PWB, and cut all Ty-raps securing transformer wire bundles to power supply components and other parts of drive, noting position of Ty-raps before removing.

e. Support transformer (4, Figure 4-31) and remove four screws four (1), four lockwashers (2), and four flatwashers (3), and remove from drive.

f. Install replacement transformer in reverse sequence of step e.

g. Replace Ty-raps removed in step c.

h. Reinstall power supply PWB in accordance with paragraph 4-39, ensuring that transformer wire bundles are properly secured with Ty-raps.

i. Plug in transformer primary and secondary connectors to power supply.

j. Reinstall power supply assembly in accordance with paragraph 4-38, and reinstall drive main PWB in accordance with paragraph 4-37.

k. Place drive in operating position.

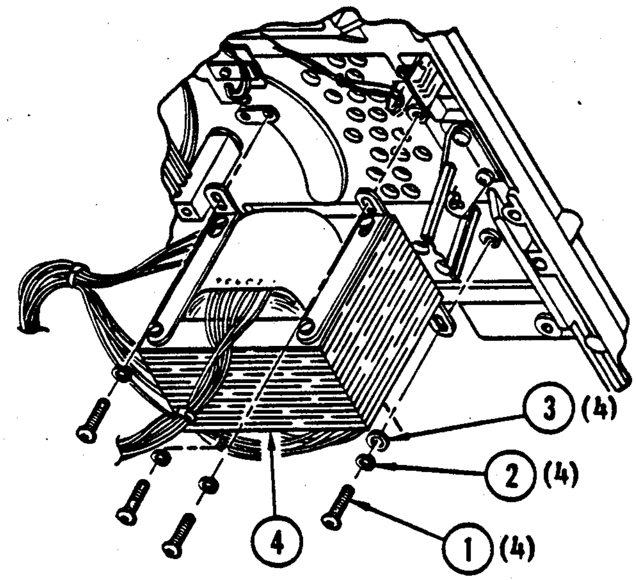

Figure 4-31. Transformer Assembly

TAPE ALIGNMENT

4-50. All tape guides must be checked for proper tape path alignment following replacement of any part in the tape path. Proceed as follows:

a. Actuate power switch to ON.

b. Insert and load a new tape.

NOTE

A used tape may have damaged or weak edges which would adversely affect its tape-path tracking characteristics.

c. Use Service Aid 33 to disable door and top cover lock. Place drive in operator maintenance access position.

d. Ensure that supply reel is properly seated on supply hub.

e. Referring to paragraph 3-32, operate drive in Service Aid 23.

f. If tape is not centered between sides of reel, unload tape and adjust hub height as necessary.

g. Observe position of tape on roller guide (2, Figure 4-32).

h. If tape is not centered on guide, turn power switch to OFF, and remove guide (2) from compliance arm in accordance with paragraph 4-30 step i and Figure 4-17.

i. Add or reduce thickness of shims (20) as required to compensate for off-center position of tape and reinstall guide on compliance arm. Repeat as necessary to obtain correct centering of tape on guide (2).

j. Run tape forward and check for edge curl on guide (3). If curl is present on lower washer, turn power switch to OFF and increase shims under roller guide (1). If curl is present on upper washer of guides (3), decrease shim thickness under roller guide (1). Resume forward tape motion and recheck tape position. Repeat this step until tape tracks smoothly around guide (3).

k. Depress lower washer on guide (3) and check for optimum movement of tape away from top washer of 0.005 inch. If necessary, reshim guide (2) to maintain proper tape centering.

l. Run tape in forward direction and check for edge curl on guide (4). If curl is present, turn transport power to OFF and add or remove shims on guide (5). Do not alter guide (5) more than ±0.005 inch from factory setting.

NOTE

Curl on guide (4) can be caused by improper alignment on any other guide in the tape path. If tracking has been verified on guide (3), tape curl on guide (4) is probably caused by misalignment of guide (5). Normally, improper alignment of guides (1) and (2) will show up as tracking problems on guide (3).

m. Run tape in reverse direction (Service Aid 23) and check for tape curl on all edges.

n. Depress lower washer on guides (3), (4), and (5) and check for optimum tape movement, away from top washer, of 0.005 inch.

o. Add or delete shims on guides (1), (2) and (5) as required to eliminate edge curl on all rollers and reverify forward tape path alignment by checking for maximum tape shift on guide (2) of ±0.015 inch.

p. Check head azimuth and read skew. Refer to paragraph 4-51.

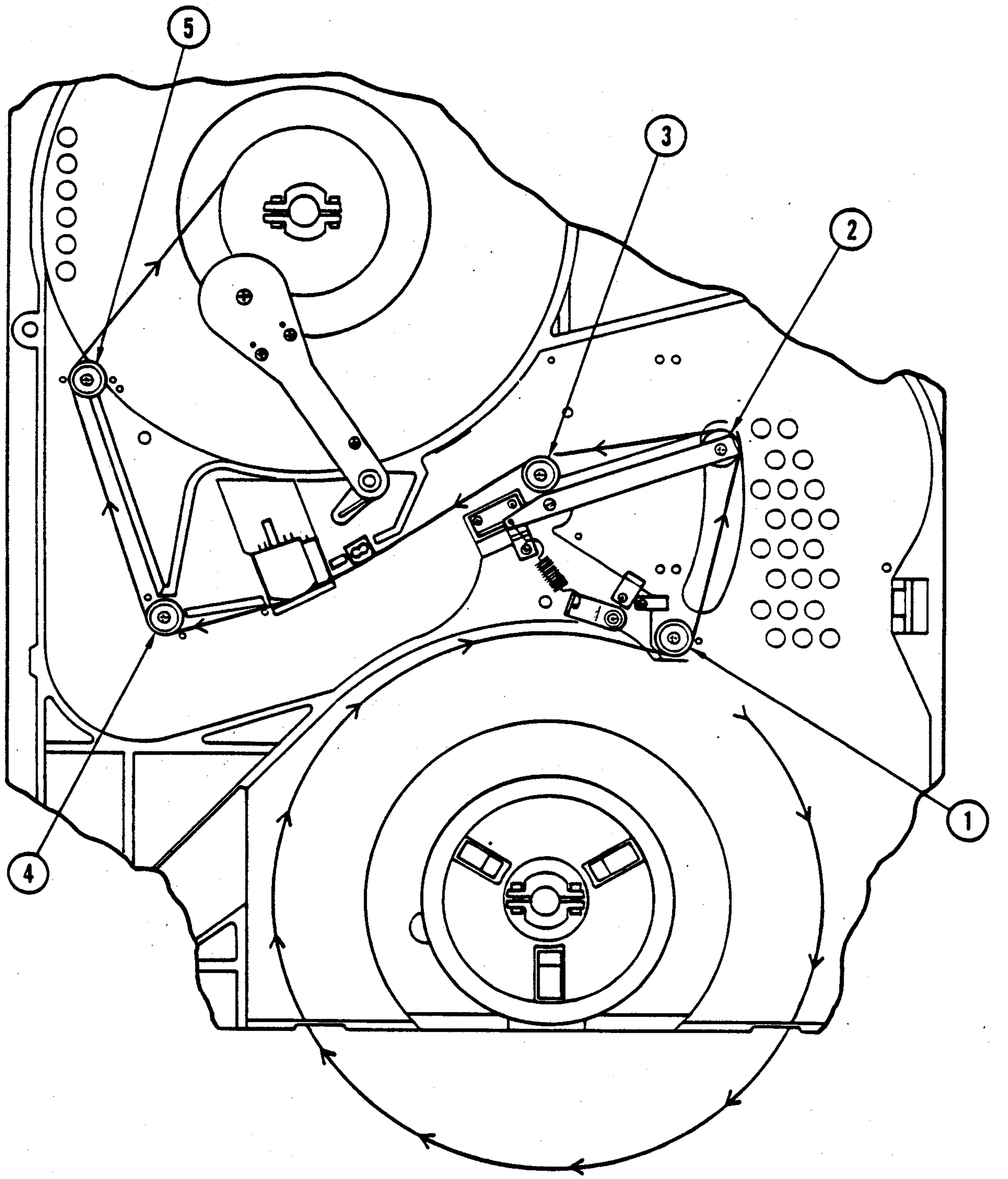

Figure 4-32. Tape Path Adjustment

4-51. **Head Azimuth Adjustment.** Adjust head azimuth as follows:

a. Place drive in service access position.

b. Turn transport power off and attach skew monitor, Cipher Part No. 600047-701 to U14B, U14D, and U14G.

(1) A skew monitor may be constructed using three 14-pin IC clips and nine 47k ohm resistors.

(2) Attach one end of a resistor to pins 9, 11, and 13 on each IC clip.

(3) Connect the other end of all nine resistors together to form a summing junction.

c. Actuate transport power switch to ON and load master skew tape, Cipher Part No. 799019-401.

d. Connect oscilloscope to test point on skew monitor and ground test point.

e. Loosen center adjustment screw (1, Figure 4-11).

f. Referring to paragraph 3-32, operate drive in Service Aid 23.

g. Adjust azimuth screw (1, Figure 4-11) so that outputs of all tracks, as monitored at test point on skew monitor, fall within 24% or less of the byte-to-byte period. (See Figure 4-33)

h. Run tape in reverse direction, using Service Aid 23, and verify reverse skew is within 24% or less of the byte-to-byte period.

i. Alternate tape direction between forward and reverse and optimize skew adjustment by minimizing width of skew pulse.

j. Appply torque seal, Cipher Part No. 209994-025 to head of adjustment screw.

k. Remove skew tape from transport and load a Pericomp tracking tape, available from Pericomp Corporation, Natick, Massachusetts 01760.

l. Connect oscilloscope to TP 10 and ground.

m. Run tape in forward direction (Service Aid 23) and compare P1 to P2 on oscilloscope trace. See Figure 4-34.

n. Calculate difference in amplitude (positive peak) between P1 and P2 and refer to Table 4-2 for conversion of volts to inches. If P1 is greater than P2, subtract calculated figure from 0.007 inch. If P2 is greater than P1, add figure to 0.007 inch. Reference edge must be 0.007 ±0.003 inch.

o. Remove skew monitor and place drive in normal operating position.

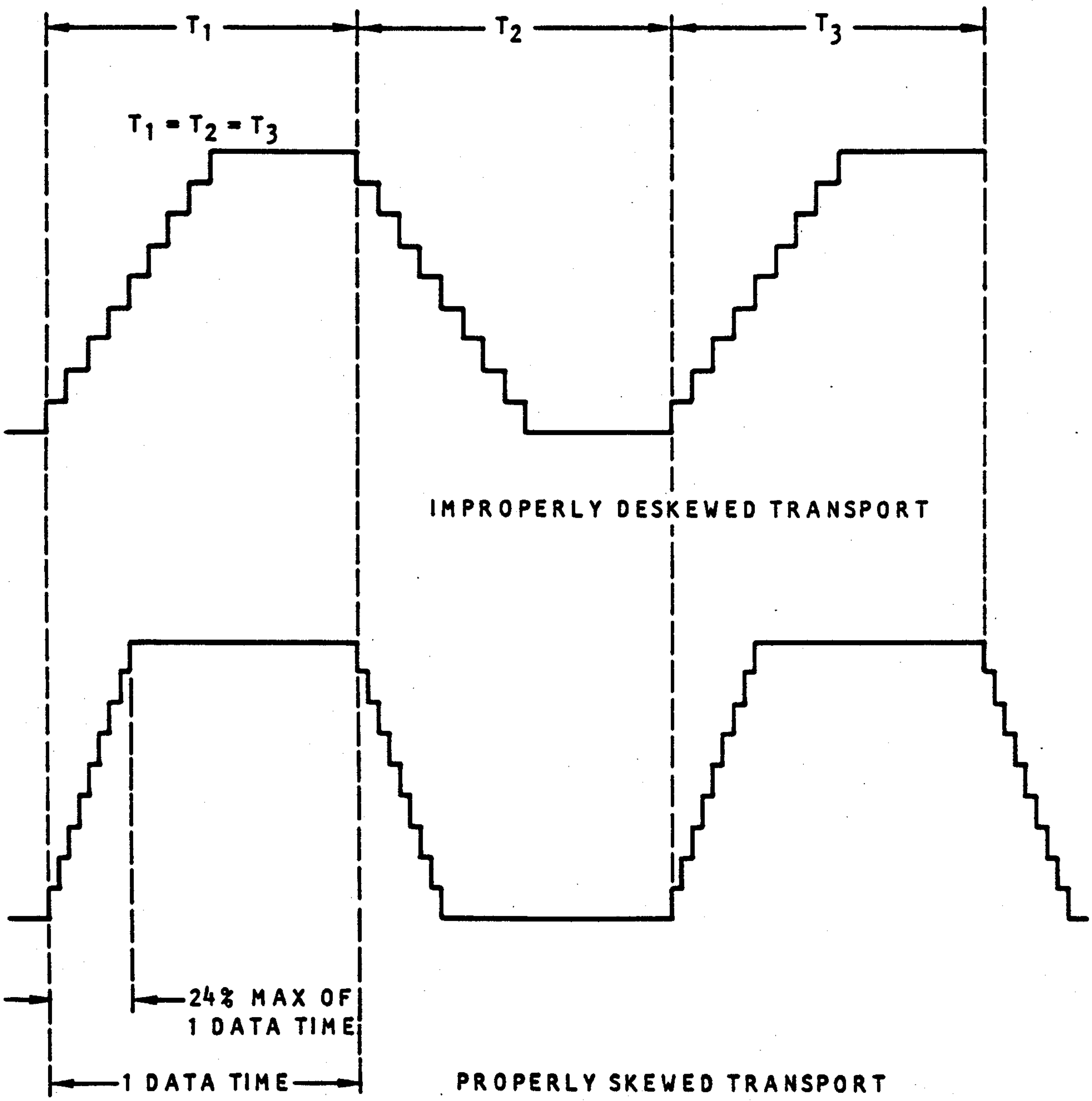

Figure 4-33. Skew Adjustment Waveform

VOLTS	INCHES
0.000 TO 0.024	0.000
0.025 TO 0.049	0.001
0.050 TO 0.074	0.002
0.075 TO 0.100	0.003

Table 4-2. Reference Edge Distance

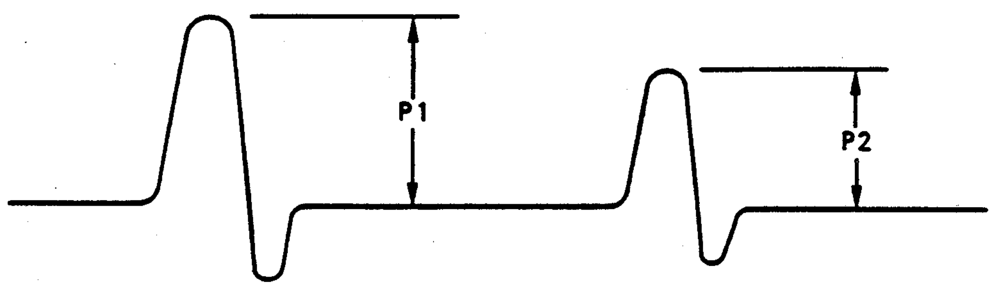

Figure 4-34. Reference Edge Measurement Waveform (TP10)
Using Pericomp Tracking Tape

SECTION V

ILLUSTRATED PARTS BREAKDOWN

INTRODUCTION

5-1. The illustrated parts breakdown divides the Model F880 Magnetic Tape Streamer Unit into assemblies, subassemblies, and component parts. Component parts are properly indented to show their relationship to the next higher assembly. Attaching parts are listed immediately following the item they attach, and preceding the components of that item.

5-2. Exploded view illustrations serve as a visual aid for identification of component parts of each assembly. Index numbers are used to identify the exploded parts shown. In the case of electronic components (capacitors, resistors, diodes, etc.) on a printed wiring board, a reference designation number is assigned to each, consisting of a capital letter (C for capacitor, R for resistor, etc.) and a sequential number, beginning with the numeral I for each capital letter. (Printed wiring boards are not exploded.) When used in conjunction with the schematic diagram and the DESCRIPTION column of the parts list, the reference designation numbers provide data required to troubleshoot, repair, or replace any components.

5-3. Figure 5-I is an overall view of the magnetic tape transport for use in identifying major assemblies. Figures 5-2 through 5-11 represent both an exploded view of these major assemblies and their relationships to the overall assembly.

5-4. Abbreviations used in this section are defined below.

ABBREVIATION	DEFINITION
A or amp	ampere
al	aluminum
cap	capacitor
dia	diameter
ft	feet (or foot)
hex	hexagon
Hz	Hertz

ABBREVIATION	DEFINITION
ID	inner diameter
in.	inch (or inches)
kV	kilovolt
lg	long
meg	megohm
No. or Nos.	number or numbers
NPN	negative-positive-negative (transistors)
OD	outer diameter
	ohm
PNP	positive-negative-positive (transistors)
pF	picofarad
R	resistor
subs	subsequent
thk	thick
uF	microfarad
v	volt (or voltage)
VDC	volts direct current
VAC	volts alternating current
W	Watt
w/	with
x	by (or names)

EXPLANATION OF THE PARTS LIST

5-5. **FIG. & INDEX NO. Column.** Illustrations are numbered sequentially. The item numbers on each illustration are keyed to the same number appearing in the parts list. If a part number is shown for an item, but no index number is shown, the assembly is immediately broken out below the part number and each item in the assembly is given its own index number. If parts are interchangeable, only one index number will be assigned to the item.

5-6. **PART NUMBER Column.** The number that appears in this column will be a Cipher Data part number in one of two categories: (a) Those parts designed and built by Cipher Data; (b) Those parts procured from outside vendors. Cipher part numbers consist of six digits or six digits with a three-digit dash number. Part numbers beginning with the numerals 1, 3, 4, 5, 6, 7, 8, or 9 are Cipher Engineering or Manufacturing numbers. Part numbers beginning with the numeral 2 are purchased parts from outside vendors. In the case of an electronic component (capacitor, resistor, transistor, etc.), its location in an illustration is determined by the grid system, e.g., transistor U11F will be found by reading down the sides of the illustration to row number 11, then across the top of the illustration from right to left until the letter F row is reached. Each electronic component assigned a circuit symbol (i.e., reference designation) will have that designation listed in the Figure & Index No. in alphanumeric sequence. Where the sequence is broken due to the removal, revision, or change of a component, the notation "NOT USED" will appear in the DESCRIPTION column opposite the designation that has been removed.

5-7. **DESCRIPTION Column.** Descriptive data as to type, size, color, etc. is provided to fully identify the part when ordering or replacing. Blueprint titles are normally given first, with the basic noun name in capital letters, followed by additional descriptive terms. Acceptable abbreviations are contained in the abbreviation table above.

5-8. **QTY Column.** This column indicates the quantity of each part required for the assembly or subassembly. This quantity is not necessarily the total quantity used for the complete assembly.

NOTE

The same parts may be used in various subassemblies; or in the case of multiple components with attaching hardware, only the quantity of hardware used to attach one item is given.

5-9. **USABLE ON CODE Column.** This column lists the code letter assigned to each of the two current models of the F880 for identification purposes.

CODE	MODEL
A	Model F880 (125V)
B	Model F880 (125V) (25/50/100 ips)

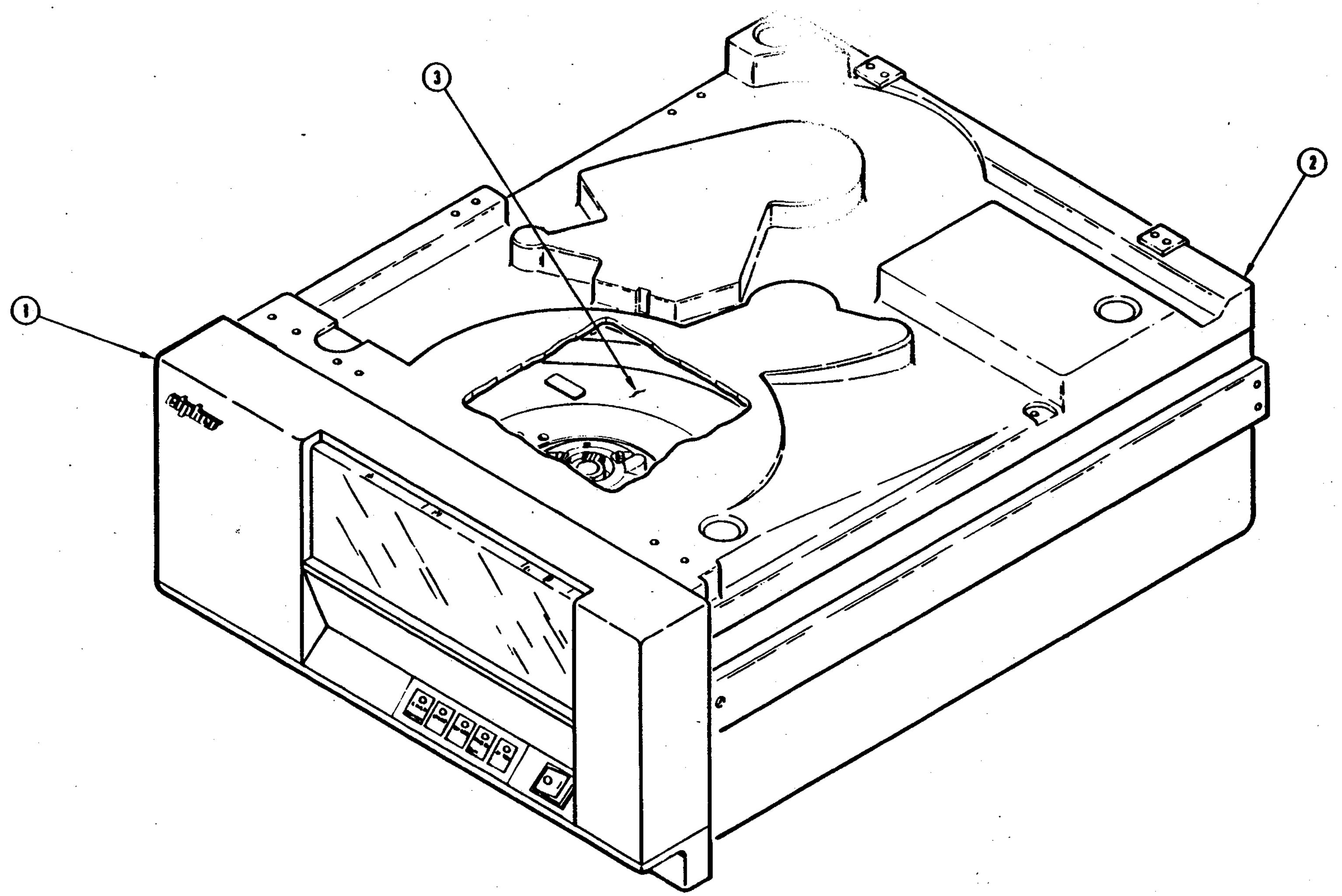

Figure 5-1. Model F880 Magnetic Tape Streamer Unit (Assembled View)

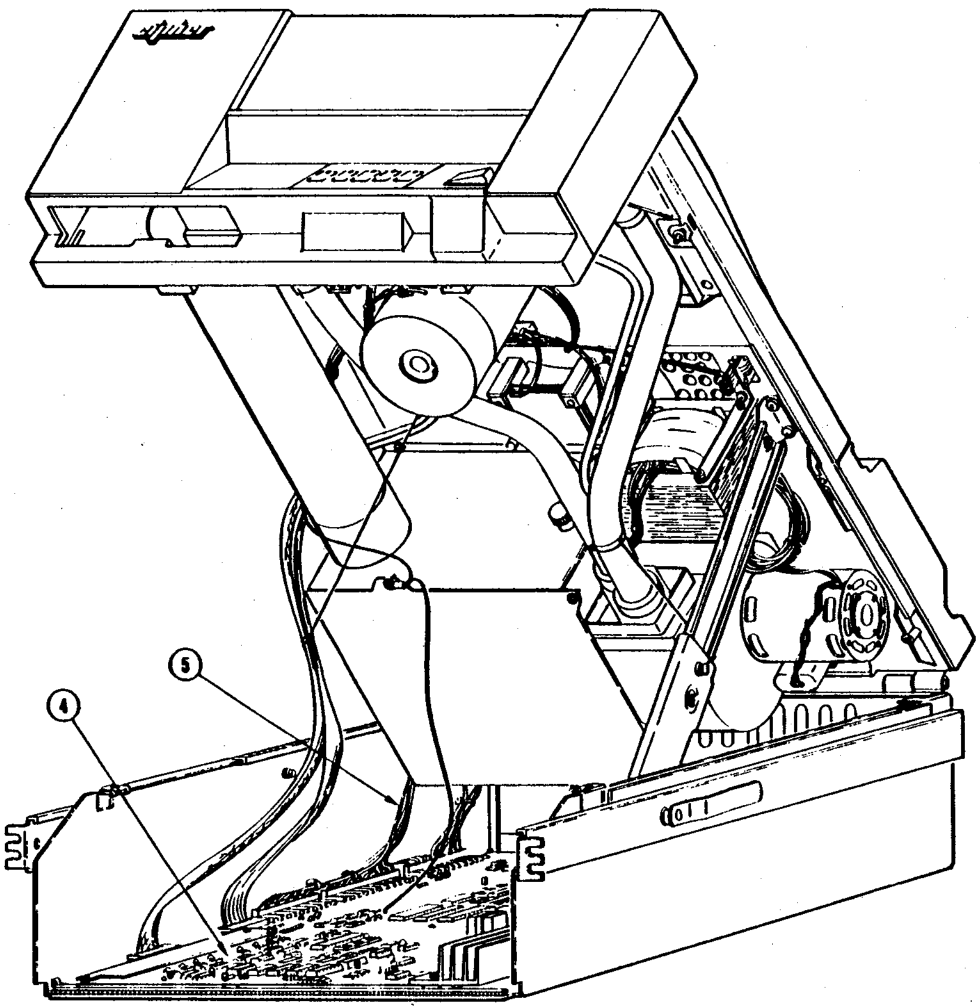

Figure 5-1. Model F880 Magnetic Tape Streamer Unit (Assembled View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-1	160100-503 160100-505	MAGNETIC TAPE TRANSPORT, ... Model F880 (Assembled View) (See Figure 5-2)	REF	
-1	960359-001	. FRONT PANEL ASSEMBLY (Exploded View) ..... (See Figure 5-3)	1	
-2	960057-001	. TOP COVER ASSEMBLY (Exploded View)........ (See Figure 5-4)	1	
-3	960279-001	. TOP PLATE/CHASSIS ASSEMBLY (Exploded View) (See Figure 5-5)	1	
-4	160106-001	. PRINTED WIRING BOARD ASSEMBLY.......... (Exploded View) (See Figure 5-6)	1	
-5	160106-409	. HARNESS ASSEMBLY (Exploded View).......... (See Figure 5-7)	1	

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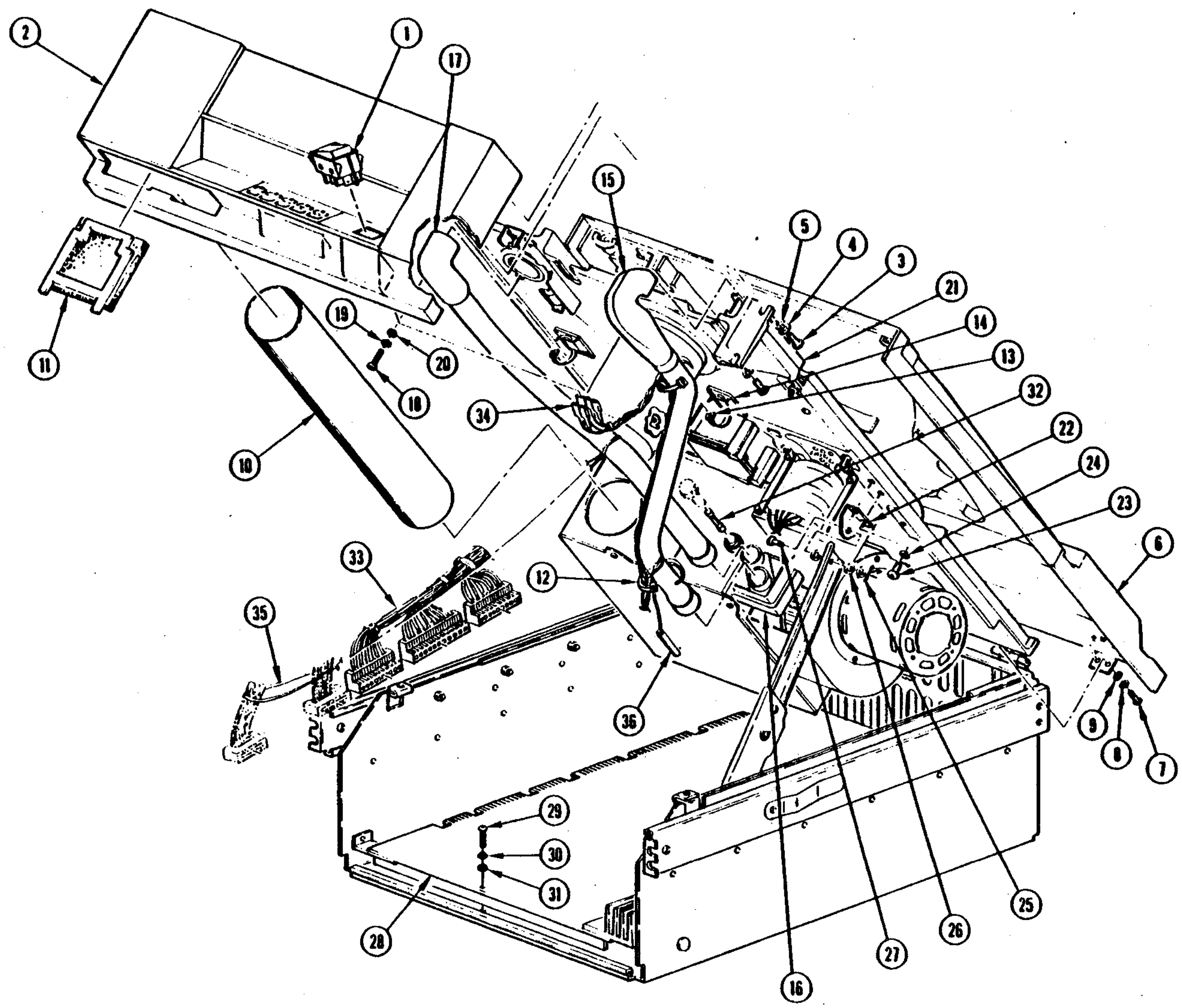

Figure 5-2. Model F880 Magnetic Tape Streamer Unit (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-2	160100-503	MAGNETIC TAPE TRANSPORT, Model F880, 25/100 ips, phase encode, 100/125V	REF	A
	160100-505	MAGNETIC TAPE TRANSPORT, Model F880, 25/50/100 ips, phase encode, 100//125V	REF	B
-1	760103-678	. SWITCH, Power, DPST, lighted 16A, 250V, UL, CSA, VDE	1	
-2	960359-001	. FRONT PANEL ASSEMBLY (See Figure 5-3 for breakdown)	1	
		(ATTACHING PARTS)		
-3	213271-108	. SCREW, Pan head, phillips 10-32 x 1/2 in. lg, cadmium plated, black, zinc	4	
-4	207104-021	. WASHER, Flat, No. 10	4	
-5	207102-011	. WASHER, Split lock, No. 10	4	
		--- * ---		
-6	960057-001	. TOP COVER ASSEMBLY (See Figure 5-4 for breakdown)	1	
		(ATTACHING PARTS)		
-7	213271-605	. SCREW, Pan head, phillips 6-32 x 5/16 in. lg, cadmium plated, black zinc	4	
-8	207602-011	. WASHER, Split lock, No. 6	4	
-9	207608-021	. WASHER, Flat, small OD, No. 6	4	
		--- * ---		
-10	760101-795	. . AIR DUCT (Tube)	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
-11	960027-001	. . FILTER, Air	1	
-12	210229-516	. . TY-RAP, 8 in	2	
-13	210229-524	. . TY-RAP, 1/16 x 1 1/4 in.	4	
-14	210229-529	. . MOUNT, Cable tie, adhesive back	2	
-15	760107-508	. . DUCT, Air, front panel	1	
-16	760101-609	. . NOZZLE, Blower	1	
-17	760106-554	. . DUCT, Air, top plate	1	
		(ATTACHING PARTS)		
-18	213271-805	. . SCREW, Pan head, phillips, 8-32 x 5/16 in. lg, cadmium black, zinc	1	
-19	207801-021	. .WASHER, Flat, No. 8	1	
-20	207802-011	. .WASHER, Split lock, No. 8	1	
-21	960189-001	. TOP PLATE/CHASSIS ASSEMBLY (See Figure 5-5 for breakdown)	1	
-22	760101-660	. BRACKET, Support, top plate assembly	1	
		(ATTACHING PARTS)		
-23	213271-106	. SCREW	2	
-24	207102-011	. WASHER, Split lock, No. 10	2	
-25	205042-509	. PIN, Cotter, 1/16 x 1/2 in. lg	1	
-26	207104-021	. WASHER, Flat, No. 10	3	
-27	205042-600	. PIN, Clevis, 3/16 x 1/2 in. lg	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-2				
-28	160106-001	. PRINTED WIRING BOARD ASSEMBLY, Drive formatter (See Figure 5-6 for breakdown)	1	
		(ATTACHING PARTS)		
-29	213274-606	. SCREW, Pan head, phillips, 6-32 x 3/8 in. lg	1	
-30	207602-011	. WASHER, Split lock, No. 6	1	
-31	207605-021	. WASHER, Flat, No. 6	1	
		--- * ---		
-32	211151-330	. FUSE, 3AG, slo-blo, 3 amp	1	A
-33	160106-409	. HARNESS ASSEMBLY (See Figure 5-7 for breakdown)	1	
-34	160105-453	. HARNESS ASSEMBLY, Power switch	1	
-35	760105-518	. LANYARD, Elastic	1	
-36	760105-519	. PIN, Safety	1	

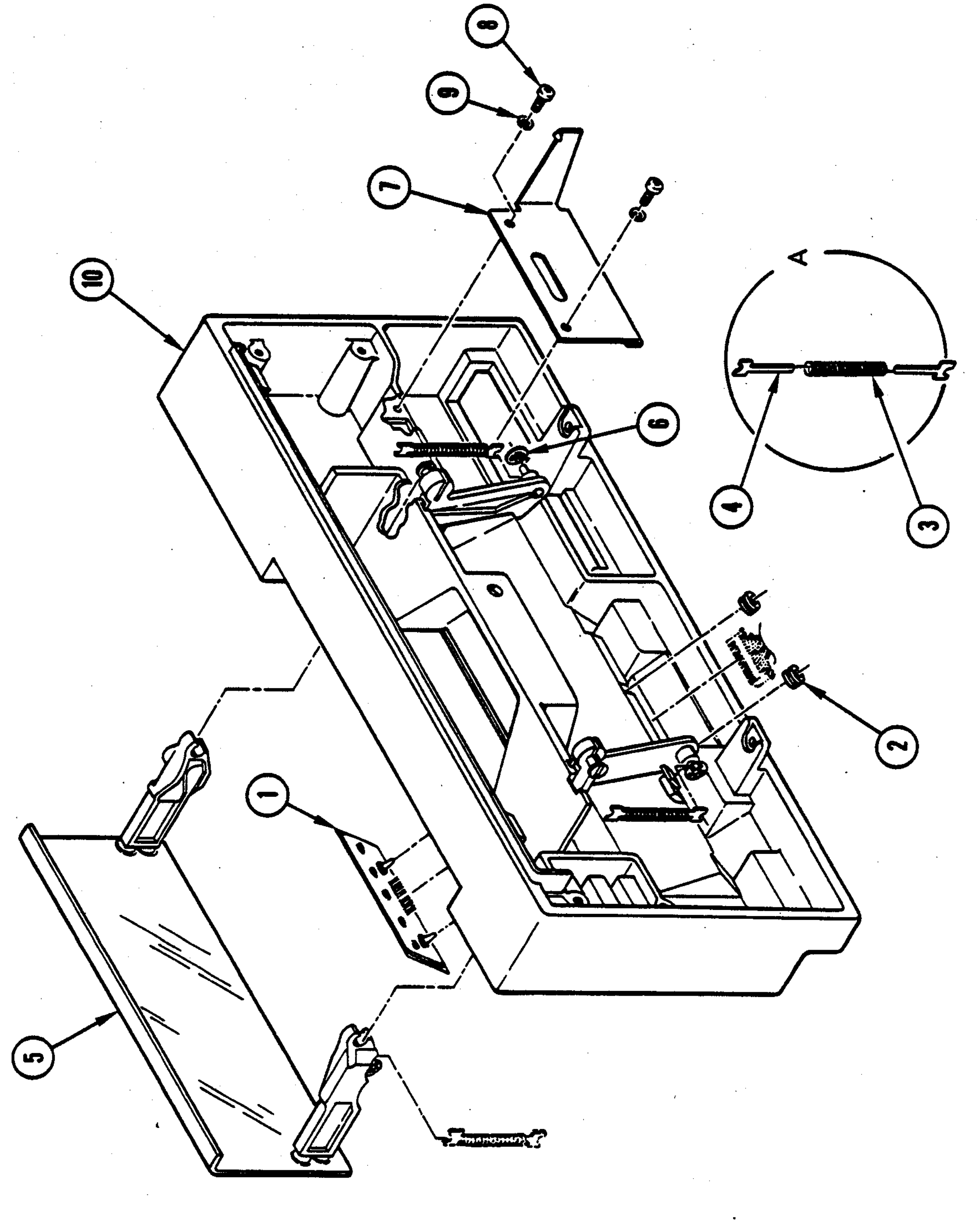

Figure 5-3. Front Panel Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-3	960359-001	FRONT PANEL ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	760102-595	. TOUCH SWITCH, Tactile response..............	1	
-2	210200-016	. RING, Retaining, push-on	2	
-3	210001-013	. SPRING, Compression, 5-lb....................	2	
-4	760101-591	. GUIDE, Spring	4	
-5	160101-451	. DOOR ASSEMBLY	1	
-6	210200-016	. RING, Retaining, push-on	2	
-7	760101-531	. LATCH, Rack	1	
		(ATTACHING PARTS)		
-8	213271-606	. SCREW, Pan head, phillips, ... 6-32 x 3/8 in. lg., cadmium plated, black, zinc	2	
-9	207602-011	. WASHER, Split lock, No. 6	2	
		— — — * — — —		
-10	760102-614	. FRONT PANEL, Painted	1	

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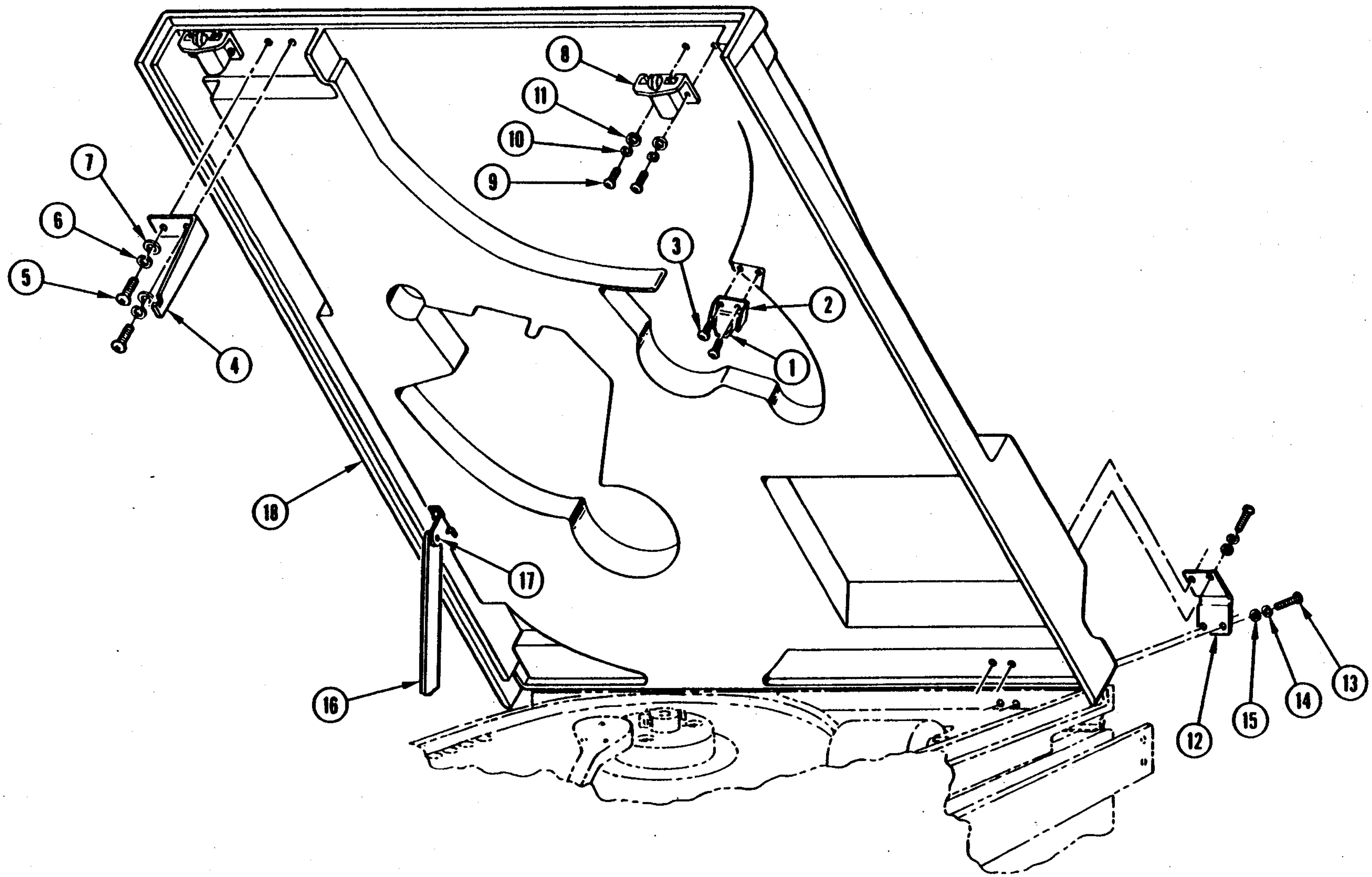

Figure 5-4. Top Cover Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-4	960057-001	TOP COVER ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	760101-825	. DEFLECTOR TAPE, diecast	1	
-2	760102-585	. BRACKET, Tape deflector	1	
		(ATTACHING PARTS)		
-3	213271-404	. SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg	2	
		--- * ---		
-4	760101-580	. . TAB, Cover lock	1	
		(ATTACHING PARTS)		
-5	213271-604	. . SCREW, Pan head, phillips.................... 6-32 x 1/4 in. lg, cadmium, black, zinc	2	
-6	207602-011	. . WASHER, Split lock, No. 6	2	
-7	207608-021	. . WASHER, Flat, No. 6	1	
		--- * ---		
-8	210104-911	. . CATCH, Roller	2	
		(ATTACHING PARTS)		
-9	213271-406	. . SCREW, Pan head, phillips.................... 4-40 x 3/8 in. lg, cadmium, black, zinc	4	
-10	207403-011	. . WASHER, Split lock, No. 4	4	
-11	207402-021	. . WASHER, Flat, No. 4	4	
		--- * ---		
-12	760103-507	. HINGE, Rear, molded.........................	2	
		(ATTACHING PARTS)		
-13	213274-605	. SCREW, Pan head, phillips..................... 6-32 x 5/16 in. lg	4	
-14	207602-011	. WASHER, Split lock, No. 6	4	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-4				
-15	207608-021	. WASHER, Flat, small OD, No. 6	4	
		---*---		
-16	960052-001	. . LID STAY, Relieved	1	
		(ATTACHING PARTS)		
-17	205003-005	. . PIN, Groove, 0.1875 x 0.625 in. lg	1	
		---*---		
-18	760104-502	. . TOP COVER................................	1	

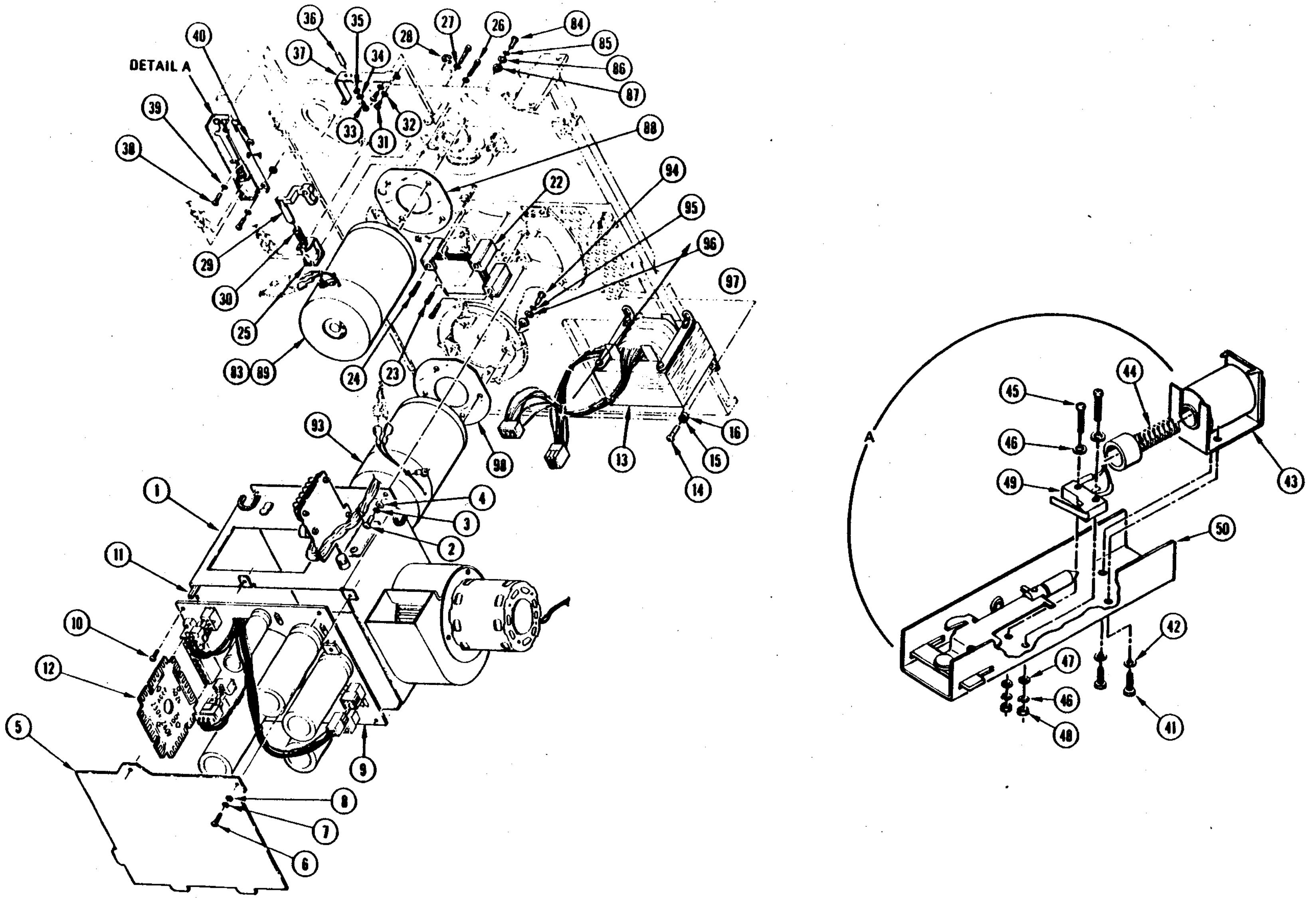

Figure 5-5. Top Plate/Chassis Assembly (Exploded View)

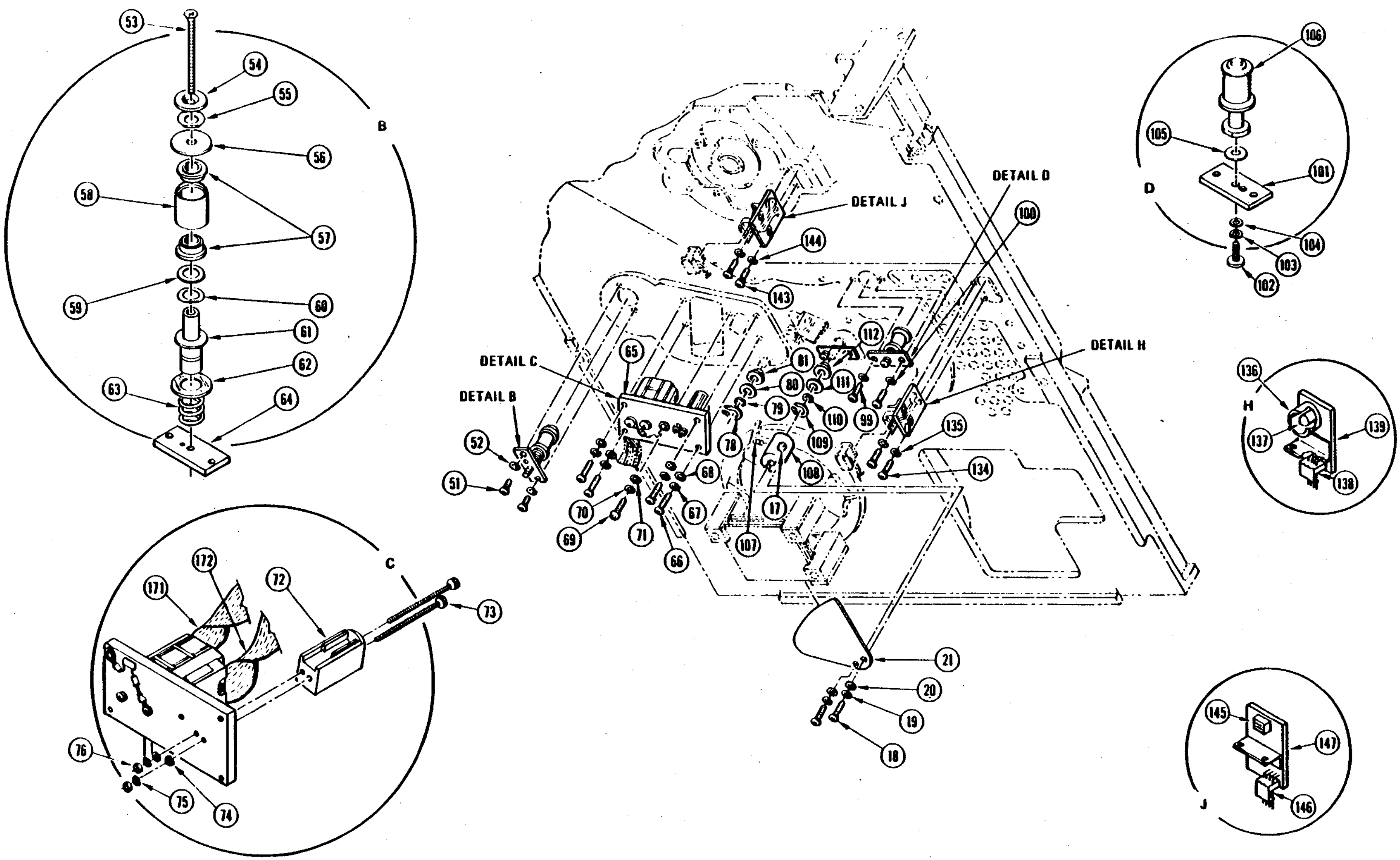

Figure 5-5. Top Plate/Chassis Assembly
(Exploded View)

Figure 5-5
Sheet 2 of 4

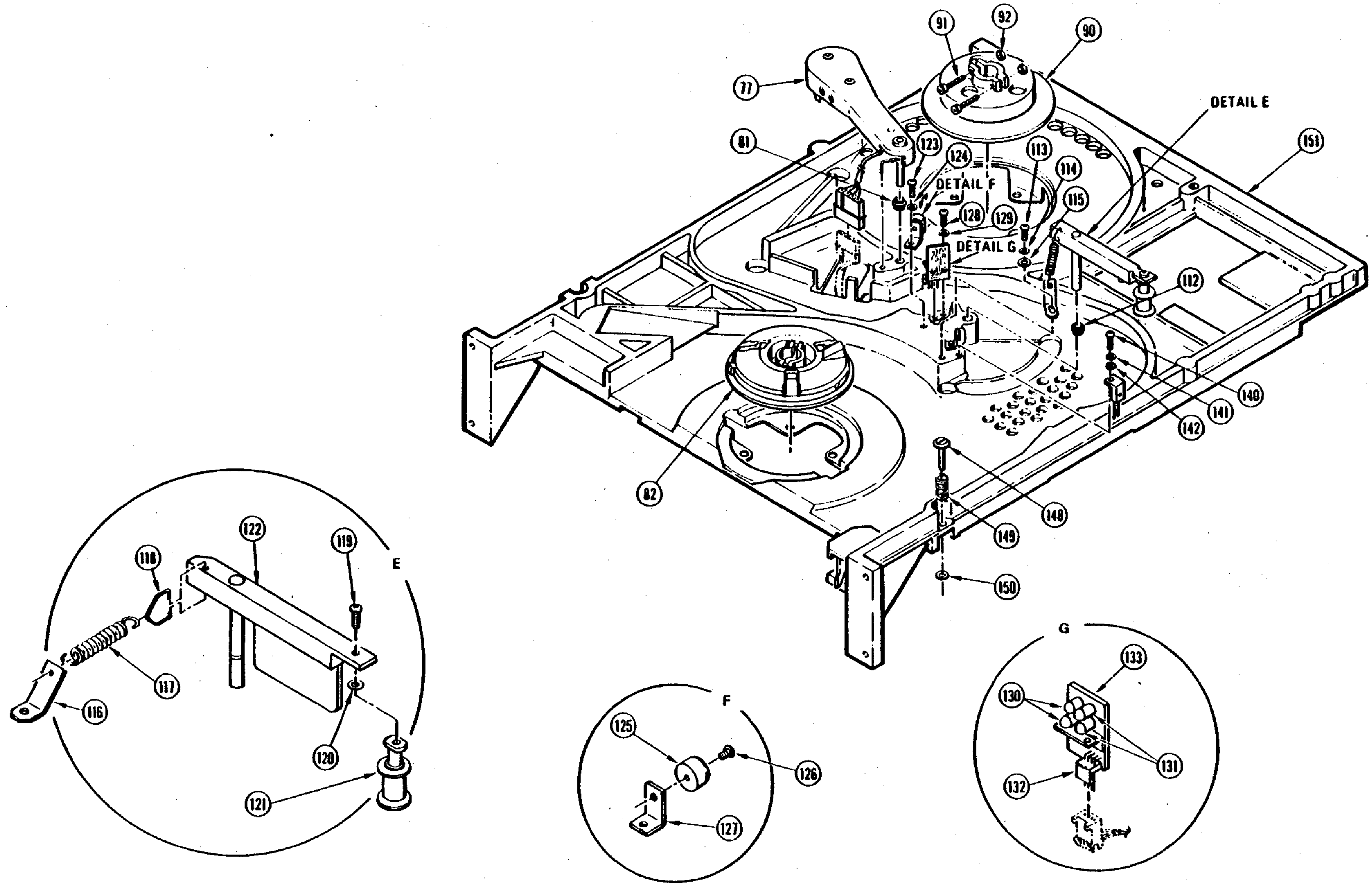

Figure 5-5. Top Plate/Chassis Assembly
(Exploded View)

Figure 5-5
Sheet 3 of 4

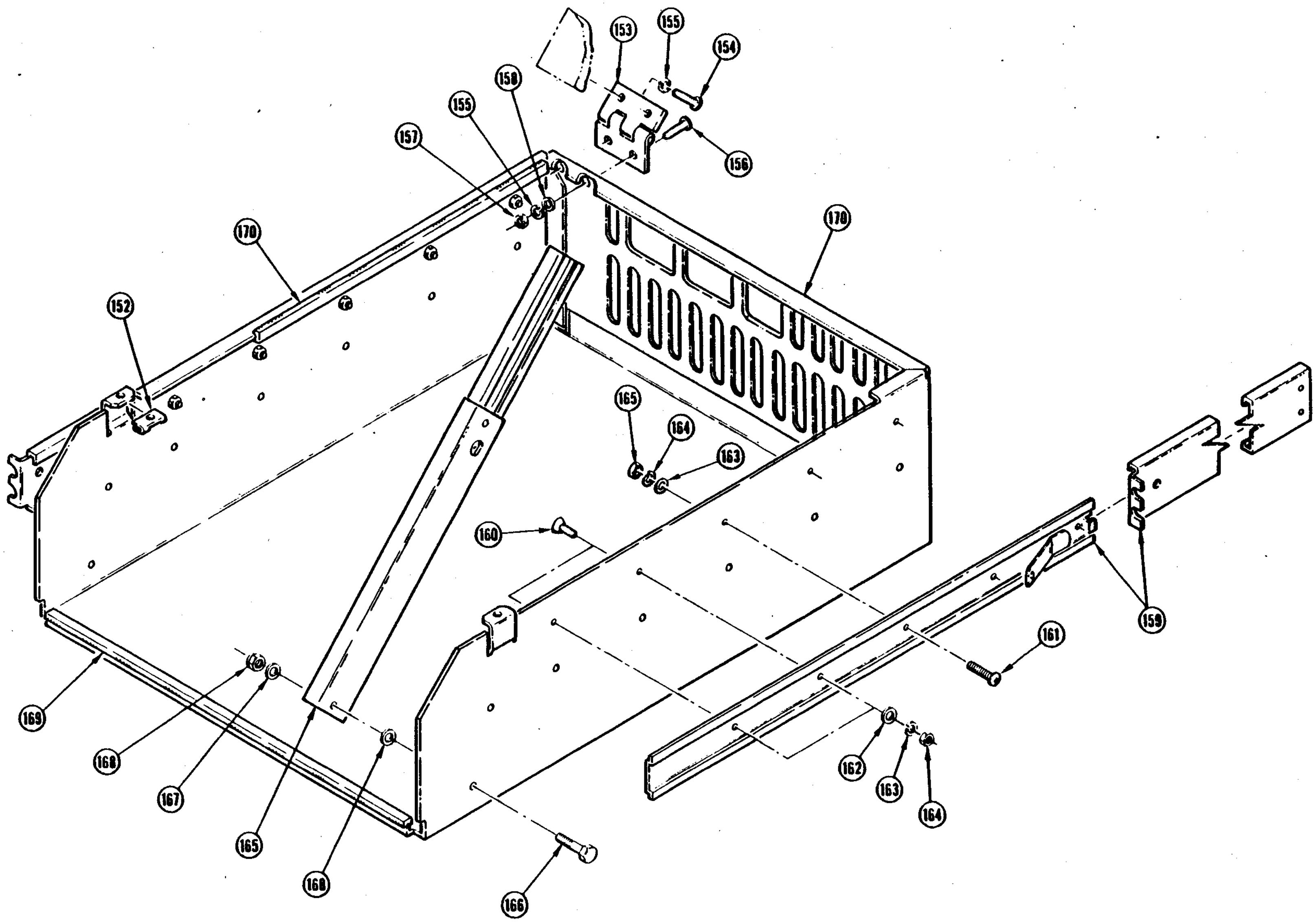

Figure 5-5. Top Plate/Chassis Assembly
(Exploded View)

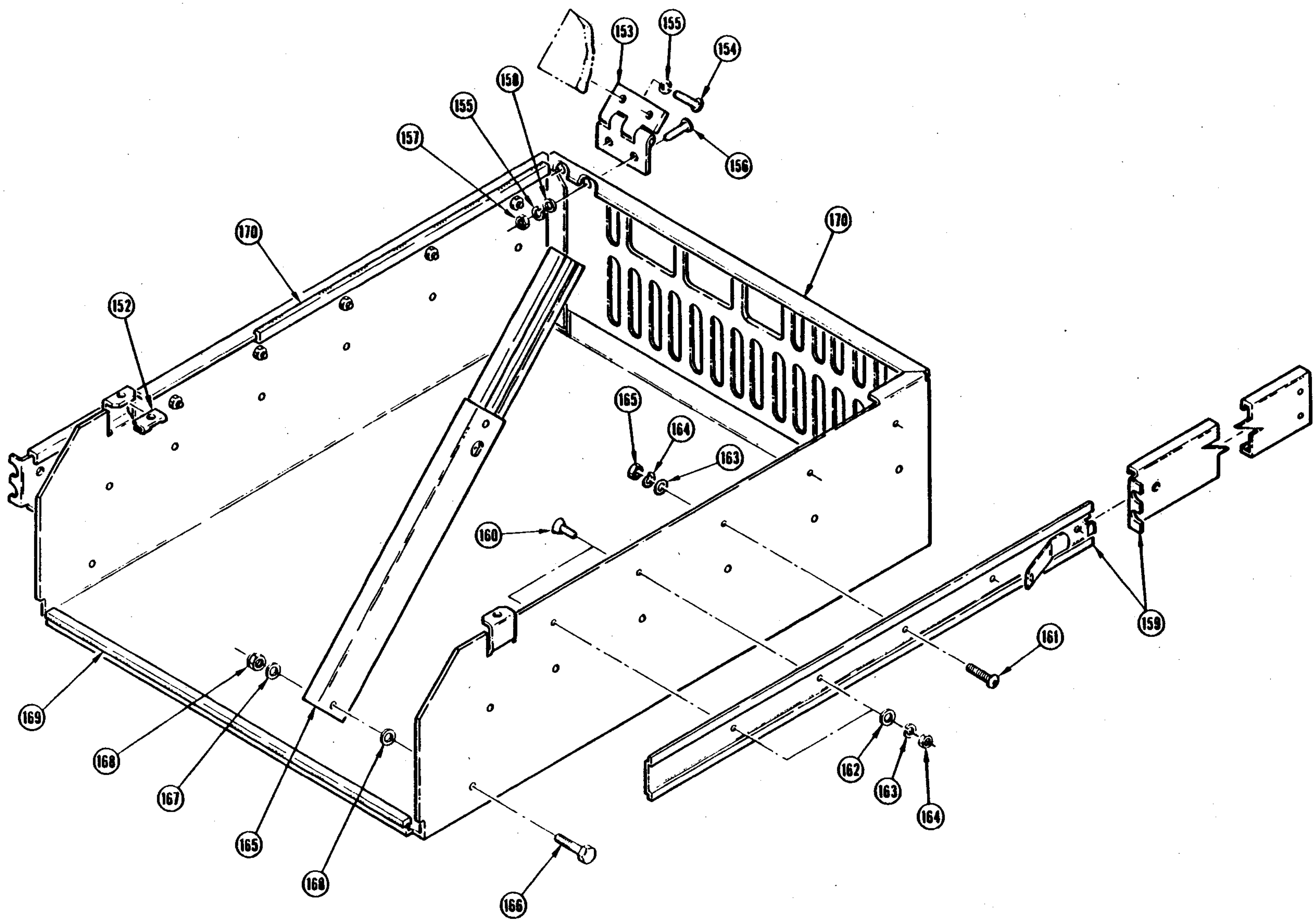

Figure 5-5. Top Plate/Chassis Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5	960279-001	TOP PLATE/CHASSIS ASSEMBLY................ (See Figure 5-2 for next higher assembly)	REF	
-1	960226-001	. POWER SUPPLY HOUSING ASSEMBLY......... (See Figure 5-8 for breakdown)	1	
		(ATTACHING PARTS)		
-2	213091-106	. SCREW, Socket head, cap,..................... 10-32 x 3/8 in. lg, cadmium plated, black, zinc	4	
-3	207102-011	. WASHER, Split lock, No. 10	4	
-4	207104-021	. WASHER, Flat, No. 10	4	
		---*---		
-5	960015-001	. COVER ASSEMBLY, Power supply housing.......	1	
		---*---		
		(ATTACHING PARTS)		
-6	213271-605	. SCREW, Pan head, phillips..................... 6-32 x 5/16 in. lg, cadmium, black zinc	2	
-7	207602-011	. WASHER, Split lock, No. 6	2	
-8	207605-021	. WASHER, Flat, No. 6	2	
		---*---		
-9	160107-002	. PWB ASSEMBLY, Power Supply	1	
		(ATTACHING PARTS)		
-10	213621-606	. SCREW, Socket set, knurled cup pt,............. 6-32 x 3/8, cadmium, black,zinc	4	
-11	210030-250	. STANDOFF, 1/4 Hex, 1, 6-32	4	
		---*---		
-12	760105-105	. PWB VOLTAGE SELECT	1	
-13	160106-402	. TRANSFORMER ASSEMBLY	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
		(ATTACHING PARTS)		
-14	213271-106	. SCREW, Pan head, phillips, 10-32 x 3/8 in. lg, cadmium plated, black, zinc	4	
-15	207102-011	. WASHER, Split lock, No. 10	4	
-16	207104-021	. WASHER, Flat, No. 10	4	
		---*---		
	160101-444	. CAPACITOR SHUTTER ASSEMBLY	1	
		(ATTACHING PARTS)		
-17	213092-608	. SOCKET HEAD, cap, 6-32 x 1/2 in. lg. black	1	
-18	213271-407	. SCREW, Pan head, phillips, 4-40 x 7/16 in. lg, cadmium, black, zinc	2	
-19	207403-011	. WASHER, Split lock, No. 4	2	
-20	207408-021	. WASHER, Flat, small OD, No. 4	2	
		---*---		
-21	760102-575	. SHUTTER, Molded	1	
-22	160101-471	. CAPACITOR PLATE ASSEMBLY	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
		(ATTACHING PARTS)		
-23	213091-408	. SCREW, Socket head, cap .... 4-40 x 1/2 in. lg, cadmium, black zinc	1	
-24	213091-410	. SCREW, Socket head, cap .... 4-40 x 5/8 in. lg, cadmium, black zinc	2	
		--- * ---		
-25	760101-840	. SOLENOID, 24VDC continuous	1	
		(ATTACHING PARTS)		
-26	213092-612	. SCREW, Socket head, cap .... 6-32 x 3/4 in. lg, black	2	
-27	207602-011	. WASHER, Split lock, No. 6	2	
-28	210200-001	. RING, Retaining	1	
		--- * ---		
-29	760106-510	. BELLCRANK, Reel hub lock	1	
-30	760101-704	. SPRING, Compression	1	
	160101-417	. MANUAL UNLOCK ASSEMBLY	1	
		(ATTACHING PARTS)		
-31	213274-404	. SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg, cadmium plated, black, zinc	2	
-32	207403-011	. WASHER, Split lock, No. 4	2	
		--- * ---		
-33	213274-404	. . SCREW, Pan head, phillips, ... 4-40 x 1/4 in. lg, cadmium plated, black, zinc	1	
-34	207403-011	. . WASHER, Split lock, No. 4	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-35	207402-021	. . WASHER, Flat, No. 4	1	
-36	760101-629	. . PIN, Reel hub unlock	1	
-37	760101-622	. . BRACKET, Spring, reel hub unlock	1	
	160101-418	. DOOR LOCK ASSEMBLY	1	
		(ATTACHING PARTS)		
-38	213271-607	. SCREW, Pan head, phillips..................... 6-32 x 7/16 in. lg, cadmium plated, black, zinc	2	
-39	207602-011	. WASHER, Split lock, No. 6	2	
-40	207605-021	. WASHER, Flat, No. 6 .... ---*---	2	
-41	213271-603	. . SCREW, Pan head, phillips.................... 6-32 x 3/16 in. lg, cadmium plated, black, zinc	2	
-42	207602-011	. . WASHER, Split lock, No. 6	2	
-43	760101-840	. . SOLENOID, Coil	1	
-44	760101-704	. . SPRING, Compression	1	
-45	213271-208	. . SCREW, Pan head, phillips.................... 2/56 x 1/2, in. lg, cadmium plated black, zinc	2	
-46	207202-021	. . WASHER, Flat, No. 2	4	
-47	207206-011	. . WASHER, Split lock, No. 2	2	
-48	207205-051	. . NUT, Hex, 2-56, No. 2	2	
-49	211015-011	. . SWITCH, Lever, quick disconnect.............	1	
-50	760101-579	. . BRACKET, Door lock........................	1	
	160104-400	. ROLLER GUIDE ASSEMBLY..................	3	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
		(ATTACHING PARTS)		
-51	213271-407	. SCREW, Pan head, phillips, 4-40 x 7/16 in. lg, cadmium plated, black, zinc	3	
-52	207403-011	. WASHER, Split lock, No. 6	3	
		--- * ---		
-53	213151-424	. . SCREW, Fillister head, phillips 100 4 x 40 x 1-1/2 in. lg.	1	
-54	754004-901	. . CAP, Roller guide	1	
-55	210260-000	. . WASHER, Spring, crescent	1	
-56	754007-901	. . WASHER, Guide	1	
-57	210067-001	. . BEARING, 1/4 x 3/8 in.	2	
-58	760101-540	. . ROLLER, Spring guide	1	
-59	731911-101	. . SHIM, .004 thick, 1/4 in. ID	1	
	731911-102	. . SHIM, .005 thick, 1/4 in. ID	1	
	731911-105	. . SHIM, .010 thick, 1/4 in. ID	1	
-60	210008	. . WASHER, Wave spring	1	
-61	760101-833	. . BASE, Roller guide	1	
-62	754007-801	. . WASHER, Guide	1	
-63	210003-038	. . SPRING, Compression	1	
-64	760101-567	. . PLATE, Tape guide	1	
-65	160106-419	. HEAD ASSEMBLY	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
		(ATTACHING PARTS)		
-66	213271-408	. SCREW, Pan head, phillips...................... 4-40 x 1/2 in. lg, cadmium plated black, zinc	4	
-67	207403-011	. WASHER, Split lock, No. 4	4	
-68	207402-021	. WASHER, Flat, No. 4	4	
-69	213092-408	. SCREW, Socket head, cap,..................... 4-40 x 1/2, black	1	
-70	207403-011	. WASHER, Split lock, No. 4	1	
-71	207402-021	. WASHER, Flat, No.4...........................	1	
		---*---		
-72	131047-003	. . TAPE SCRAPER ASSEMBLY	1	
		(ATTACHING PARTS)		
-73	213091-407	. . SCREW, Socket head, cap,....................	2	
-74	207408-021	. . WASHER, Flat, small OD, No. 4..............	2	
-75	207403-011	. . WASHER, Split lock, No 4	2	
-76	207406-081	. . NUT, Hex, radio pattern, No. 4, 4-40..........	2	
		---*---		
-77	160105-433	. TACHOMETER ASSEMBLY....................	1	
		(ATTACHING PARTS)		
-78	210200-032	. RING, Grip, 1/4 in. ID	1	
-79	210008	. WASHER, Wave spring	1	
-80	731911-102	. SHIM, .005 in. thick, 1/4 in. ID	AR	
-81	210067-001	. BEARING, 1/4 x 3/8 in.	2	
		---*---		

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-82	160101-406	. SUPPLY HUB ASSEMBLY .... (See Figure 5-9 for breakdown)	1	
-83	160101-497	. SUPPY MOTOR ASSEMBLY	1	
		(ATTACHING PARTS)		
-84	213271-107	. SCREW, Pan head, phillips, ... 10-32 x 7/16 in. lg, cadmium plated, black, zinc	4	
-85	207102-011	. WASHER, Split lock, No. 10	4	
-86	213704-100	. WASHER, Flat, No. 10	4	
-87	760101-768	. WASHER, Shoulder, insulating	4	
		--- * ---		
-88	760101-756	. INSULATOR, Motor	1	
-89	760101-527	. MOTOR, Permanent magnet, 4 in. .... diameter, supply	1	
-90	760106-567	. HUB, Takeup	1	
		(ATTACHING PARTS)		
-91	213091-614	. SCREW, Socket head cap, ... 6-32 x 7/8 in. lg	2	
-92	207607-051	. NUT, Hex, 6-32, No. 6	2	
		--- * ---		
-93	799031-201	. MOTOR, Permanent magnet, ... 4 in. dia, takeup	1	
		(ATTACHING PARTS)		
-94	213271-107	. SCREW, Pan head, phillips, ... 10-32 x 7/16 in. lg, cadmium plated, black, zinc	4	
-95	207102-011	. WASHER, Split lock, No. 10	4	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-96	213704-100	. WASHER, Flat, No. 10	4	
		---*---		
-97	760101-768	. WASHER, Shoulder, insulating	4	
-98	760101-756	. INSULATOR, Motor	1	
	160104-401	. ROLLER GUIDE ASSEMBLY....................	1	
		(ATTACHING PARTS)		
-99	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-100	207403-011	. WASHER, Split lock, No. 4	2	
-101	760101-566	. . PLATE, Tape guide	1	
-102	213274-605	. . SCREW, Pan head, phillips, ... 6-32 x 5/16 in. lg	1	
-103	207602-011	. . WASHER, Split lock, No. 6	1	
-104	207605-021	. . WASHER, Flat, No. 6	1	
		---*---		
-105	760104-524	. . SHIM, Stainless steel	1	
-106	799043-201	. . ROLLER, Tape guide	1	
	160103-499	. COMPLIANCE ARM ASSEMBLY	1	
		(ATTACHING PARTS)		
-107	213092-608	. SCREW, Socket head set, ... 6-32 x 1/2 in. lg, black	1	
-108	760101-711	. HUB, Capacitor shutter	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-109	210200-032	. RING, Retaining, external, 1/4 in.	1	
-110	210008	. WASHER, Wave spring	1	
-111	731911-102	. SHIM, 0.005 in. thick x 1/4 in. ID	1	
-112	210067-001	. BEARING, 1/4 x 3/8 in.	2	
-113	213271-606	. SCREW, Pan head, phillips..................... 6-32 x 3/8 in. lg, cadmium, black, zinc	1	
-114	207602-011	. WASHER, Split lock, No. 6	1	
-115	207605-021	. WASHER, Flat, No. 6	1	
		---*---		
-116	760101-565	. . BRACKET, Spring, compliance arm	1	
-117	210006-010	. . SPRING, Extension	1	
-118	760101-554	. . CLIP, Spring..............................	1	
-119	213271-607	. . SCREW, Pan head, phillips, ... 6-32 x 7/16 in. lg, cadmium, black, zinc	1	
-120	760104-524	. . SHIM, stainless steel........................	1	
-121	760104-500	. . TAPE GUIDE, Crowned roller, short	1	
-122	160104-492	. . ARM AND SHAFT ASSEMBLY	1	
	160106-479	. BUMPER ASSEMBLY	1	
	160106-478	. BUMPER ASSEMBLY	1	
		(ATTACHING PARTS)		
-123	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-124	207403-011	. WASHER, Split lock, No. 4	2	
		---*---		

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-125	210119	. . BUMPER..................................	2	
-126	213271-403	. . SCREW, Pan head, phillips, ... 4-40 x 3/16 in. lg, cadmium, black, zinc	2	
-127	760101-662	. . BRACKET, Compliance arm, stop	2	
	160101-009	. PRINTED WIRING BOARD ASSEMBLY, ... Reflective sensor, EOT/BOT	1	
		(ATTACHING PARTS)		
-128	213271-405	. SCREW, Pan head, phillips, ... 4-40 x 5/16 in. lg, cadmium, black, zinc	2	
-129	207403-011	. WASHER, Split lock, No. 4	2	
		--- * ---		
-130	202006-400	. . DIODE, Light emitting, IR....................	2	
-131	212000-012	. . PHOTOTRANSISTOR	2	
-132	211000-111	. . HEADER, 4-position, right angle	1	
-133	760101-111	. . PRINTED WIRING BOARD,.................. Reflective sensor	1	
	160101-010	. PRINTED WIRING BOARD ASSEMBLY, ... Reflective sensor, Tape-In-Path	1	
		(ATTACHING PARTS)		
-134	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-135	207403-011	. WASHER, Split lock, No. 4	2	
		--- * ---		
-136	760101-812	. . SHIELD, Reflective sensor	1	
-137	202006-400	. . DIODE, Light emitting, IR....................	1	
-138	211000-111	. . HEADER, 4-position, right angle	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-139	760101-111	. . PRINTED WIRING BOARD, ... Reflective sensor	1	
	160103-433	. . SENSOR RECEIVER ASSEMBLY, Molded	1	
		(ATTACHING PARTS)		
-140	213271-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	1	
-141	207403-011	. WASHER, Split lock, No. 4	1	
-142	207402-021	. WASHER, Flat, No. 4	1	
		--- * ---		
	160101-005	. PRINTED WIRING BOARD ASSEMBLY, ... File protect	1	
		(ATTACHING PARTS)		
-143	213217-406	. SCREW, Pan head, phillips, ... 4-40 x 3/8 in. lg, cadmium, black, zinc	2	
-144	207403-011	. WASHER, Split lock, No. 4	2	
		--- * ---		
-145	211131-101	. . SENSOR, Reflective object	1	
-146	211000-111	. . HEADER, 4-position, right angle	1	
-147	760101-105	. . PRINTED WIRING BOARD, File protect.......	1	
-148	213599-000	. SCREW, Captive, quick opening	2	
-149	210004-006	. SPRING, Compression, fastener	2	
-150	210116-026	. FASTENER RETAINER	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
-151	760106-547	. TOP PLATE	1	
-152	210116-027	. FASTENER, Clip-on	2	
-153	760103-535	. HINGE.......................................	2	
		(ATTACHING PARTS)		
-154	213271-107	. SCREW, Pan head, phillips.................... 10-32 x 7/16 in. lg, cadmium black, zinc	4	
-155	207102-011	. WASHER, Split lock, No. 10	8	
-156	213271-106	. SCREW, Pan head, phillips, ... 10-32 x 3/8 in. lg, cadmium, black, zinc	4	
-157	207101-081	. NUT, Hex, radio pattern, No. 10................	4	
-158	207104-021	. WASHER, Flat, No. 10	4	
		---*---		
-159	960274-001	. SLIDE ASSEMBLY, Modified	2	
		(ATTACHING PARTS)		
-160	213151-107	. SCREW, Flat head, phillips,.................... 10-32 x 7/16 in. lg, cadmium, black or zinc	2	
-161	213271-106	. SCREW, Pan head, phillips..................... 10-32 x 3/8 in. lg, cadmium black or zinc	6	
-162	207104-021	. WASHER, Flat, No. 10	8	
-163	207102-011	. WASHER, Split lock, No. 10	8	
-164	207101-081	. NUT, Hex, Radio pattern, No. 10, 10-32	8	
		---*---		
-165	160106-408	. SUPPORT ASSEMBLY, Top plate	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-5				
		(ATTACHING PARTS)		
-166	213634-108	. SCREW, Hex head, .170 grip, 10-32 x 1/2 in. lg	1	
-167	207104-021	. WASHER, Flat, No. 10	2	
-168	205255-002	. NUT, Lock, hex, 10-32	1	
		---*---		
-169	205288-200	. GROMMET, Strip	2.5	
-170	960073-001	. CHASSIS, Narrow, modified	1	
-171	160104-418	. HEAD CABLE ASSEMBLY, Read	1	
-172	160101-459	. HEAD CABLE ASSEMBLY, Write................	1	

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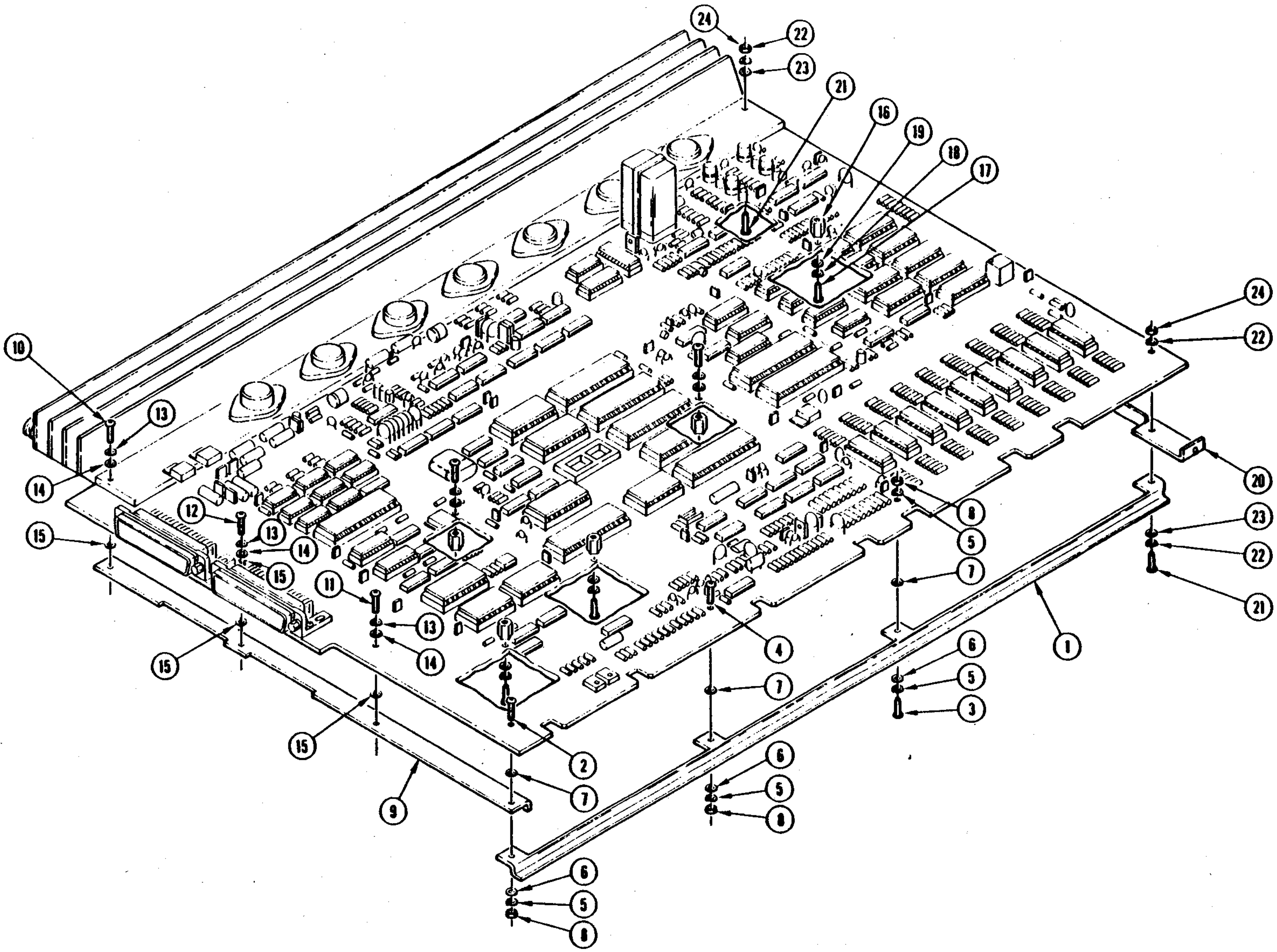

Figure 5-6. Drive Formatter Printed Wiring Board Assembly (Exploded View)

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-6				
	160106-001	PRINTED WIRING BOARD ASSEMBLY, Drive...... formatter (See Figure 5-2 for next higher assembly)	REF	
-1	760101-695	. STIFFENER, Left side	1	
		(ATTACHING PARTS)		
-2	213271-607	. SCREW, Pan head, phillips.................... 6-32 x 7/16 in. lg, cadmium, black, zinc	1	
-3	213020-608	. SCREW, BDR. hd. slot,........................ 6-32 x 1/4 nylon	1	
-4	213271-607	. SCREW, Pan head, phillips.................... 6-32 x 7/16 in. lg, cadmium, black, zinc	1	
-5	207602-011	. WASHER, Split lock, No. 6	4	
-6	207608-021	. WASHER, Flat, small OD, No. 6................	3	
-7	213700-609	. WASHER, Flat, nylon, small OD, No. 6	3	
-8	207604-502	. NUT, Hex, radio pattern, 6-32	3	
		---*---		
-9	760101-693	. STIFFENER, Rear	1	
		(ATTACHING PARTS)		
-10	213271-609	. SCREW, Pan head, phillips,.................... 6-32 x 9/16 in. lg, cadmium black, zinc	1	
-11	213271-606	. SCREW, Pan head, phillips,.................... 6-32 x 3/8 in. lg, cadmium, black, zinc	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-6				
-12	213271-607	. SCREW, Pan head, phillips, 6-32 x 7/16 in. lg, cadmium, black, zinc	1	
-13	207602-011	. WASHER, Split lock, No. 6	3	
-14	207608-021	. WASHER, Flat, small OD, No. 6	3	
-15	213700-609	. WASHER, Flat, Nylon, small OD, No. 6	4	
		--- * ---		
-16	210030-632	. STANDOFF, 1/4 in. hex, A/F, 3/8 in., 6-32	5	
		(ATTACHING PARTS)		
-17	213274-606	. SCREW, Pan head, phillips 6-32 x 3/8 in. lg	5	
-18	207602-011	. WASHER, Split lock, No. 6	5	
-19	207608-021	. WASHER, Flat, small OD, No. 6	5	
		--- * ---		
-20	760102-543	. STIFFENER, Front	1	
		(ATTACHING PARTS)		
-21	213271-608	. SCREW, Pan head, phillips, 6-32 x 1/2 in. lg, cadmium, black, zinc	2	
-22	207602-011	. WASHER, Split lock, No. 6	3	
-23	207608-021	. WASHER, Flat, small OD, No. 6	2	
-24	207604-081	. NUT, Hex, radio pattern, 6-32	2	
		--- * ---		

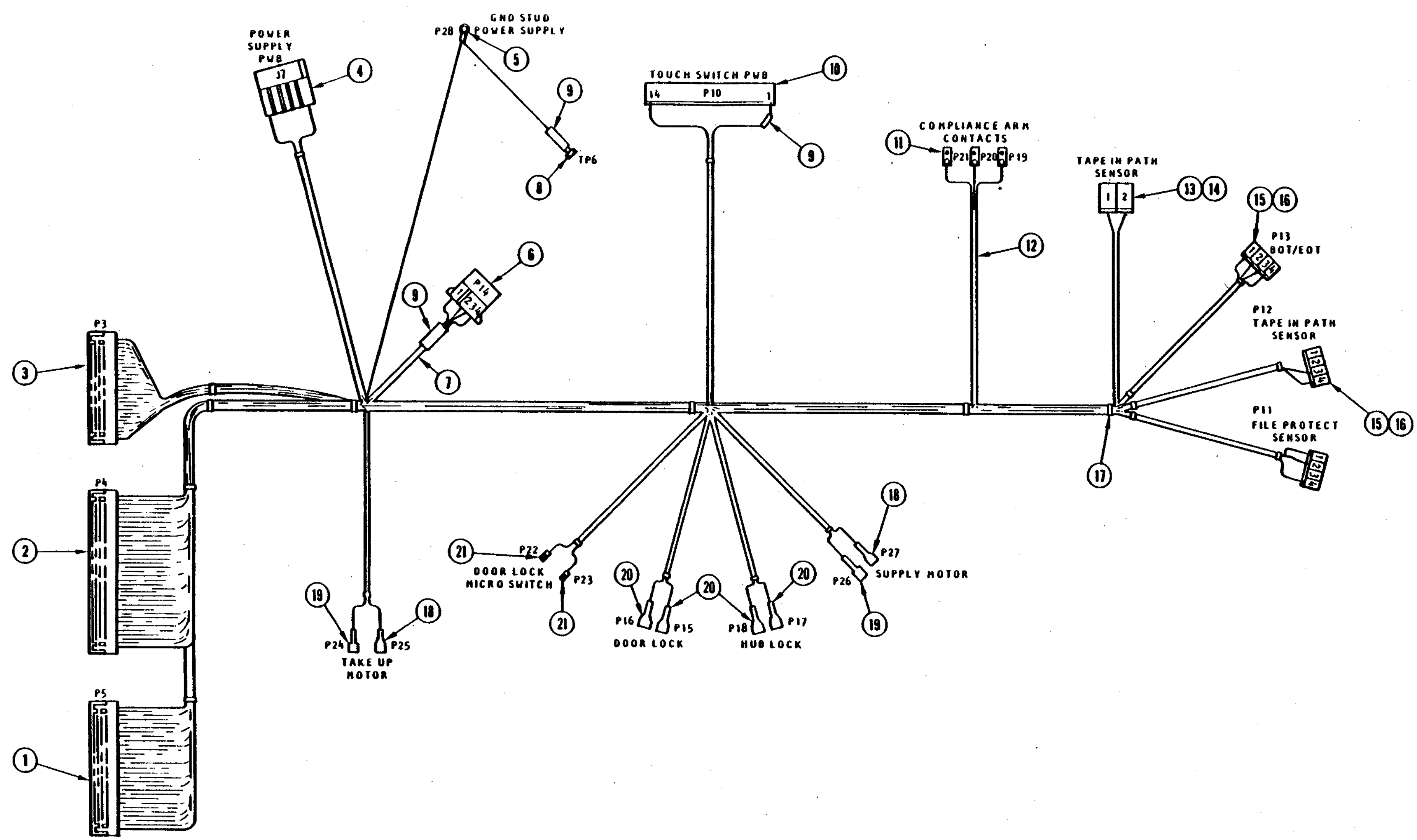

Figure 5-7. Harness Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-7	160101-409	HARNESS ASSEMBLY .... (See Figure 5-2 for next higher assembly)	REF	
-1	205108-118	. CONNECTOR, Printed circuit, right .... angle, 18-pin, without flanges	1	
-2	205108-122	. CONNECTOR, Printed circuit, right .... angle, 22-pin, without flanges	1	
-3	205108-115	. CONNECTOR, Printed circuit, right .... angle, 15-pin, without flanges	1	
-4	205071-500	. CONNECTOR, 15-position....................	1	
-5	210905	. LUG, Ring, No. 6............................	1	
-6	205107	. CONNECTOR, 4-position......................	1	
-7	208500-032	. CABLE, Shielded, 4-conductor, 24 AWG	AR	
-8	210575-611	. PIN, Receptacle, reel	1	
-9	210408-006	. TUBING, Heat shrink, black	AR	
-10	205124-108	. CONNECTOR, 14-position, ID	1	
-11	760101-729	. CONTACT, Capacitive plate....................	3	
-12	208500-041	. CABLE, Shielded, 2-conductor	2	
-13	205070-100	. CONNECTOR, 2-position, lock insulate	1	
-14	205089-002	. COVER, Connector, 2-position	1	
-15	205122-044	. CONNECTOR, 4-position, lock .... insulated, disp/plzd ramp	3	
-16	205089-001	. COVER, Connector, 4-position	3	
-17	210229-527	. TY-RAP, 1/32 in., 4 in. lg	32	
-18	210555-077	. TERMINAL, Nylon coupler, 22-18AWG	2	
-19	210555-078	. TERMINAL, 250x032 male, 22-18 gauge, ... fully insulated	2	
-20	210555-036	. TERMINAL, Slip-on, 0.187 tab, reel.............	4	
-21	210578-100	. TERMINAL, 0.093 tab, non-insulated...........	2	

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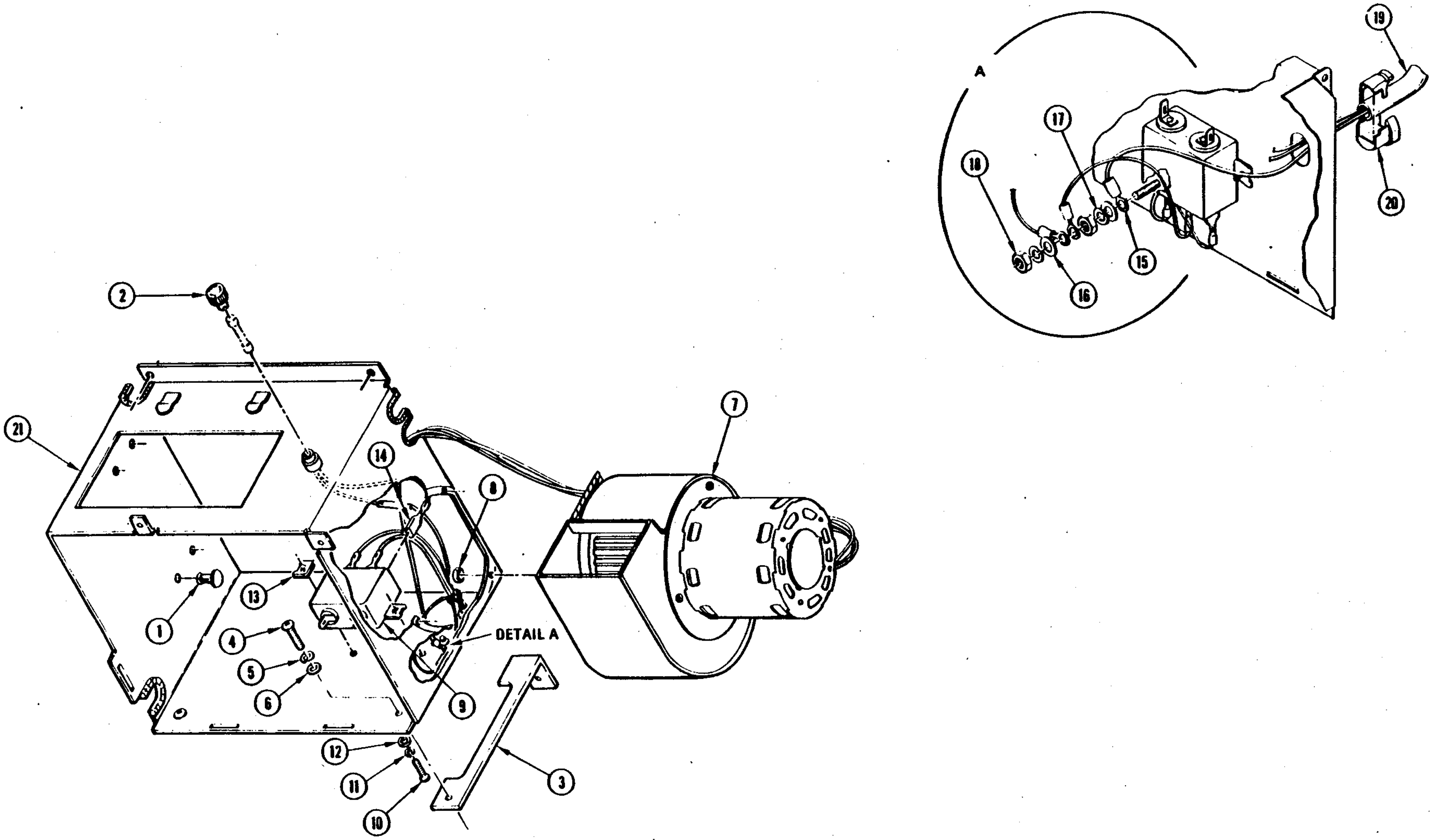

Figure 5-8. Power Supply Housing Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-8	960203-001	HOUSING ASSEMBLY, Power Supply Assembly ..... (See Figure 5-5 for next higher assembly)	REF	
-1	210229-005	. CABLE TIE, Pushbutton mount	6	
-2	799016-401	. FUSEHOLDER, Panel	1	
-3	760106-540	. BRACKET	2	
		(ATTACHING PARTS)		
-4	213092-106	. SCREW, Socket head cap .... 10-32 x 3/8 in lg, black only	2	
-5	207102-011	. WASHER, Split lock, No. 10	2	
-6	207104-021	. WASHER, Flat, No. 10	2	
-7	160105-439	. AIR PUMP ASSEMBLY	1	
		(ATTACHING PARTS)		
-8	207803-051	. NUT, Hex, No. 8-32	3	
		--- * ---		
-9	799016-701	. FILTER, EMI, 3-5 amp	1	
		(ATTACHING PARTS)		
-10	213271-606	. SCREW, Pan head, phillips, ... 6-32 x 3/8 in lg, cadmium, black or zinc	2	
-11	207602-011	. WASHER, Split lock, No. 6	2	
-12	207605-021	. WASHER, Flat, No. 6	2	
-13	213898-609	. NUT, 6-32, EH	2	
		--- * ---		
-14	210555-032	. TERMINAL, Slip-on, 250 tab	3	
-15	210555-027	. TERMINAL, Ring .... 22-16 AWG, No. 8	3	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-8				
-16	207801-021	. WASHER, Flat, No. 8	2	
-17	207802-011	. WASHER, Split lock, No. 8	2	
-18	207803-051	. NUT, Hex, No. 8, 8-32	2	
-19	160106-470	. POWER CORD ASSEMBLY, 6 ft lg.............	1	
-20	211026-100	. STRAIN RELIEF, 1/16 in. thick panel	1	
-21	960015-001	. HOUSING, Power Supply	1	

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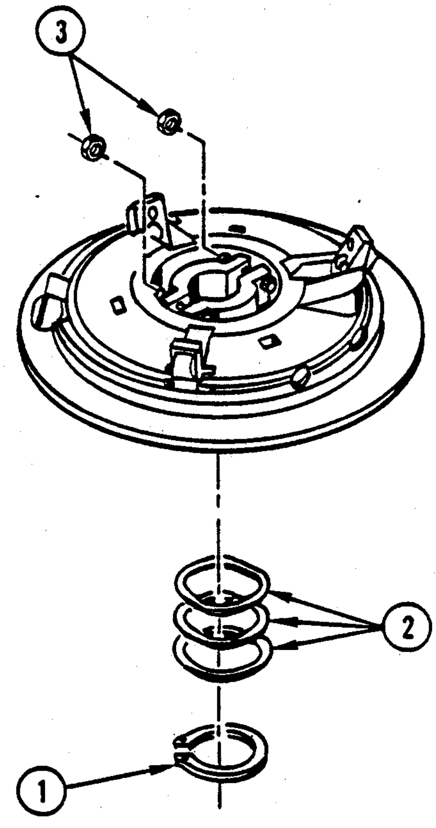

Figure 5-9. Supply Hub Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-9	160101-406	SUPPLY HUB ASSEMBLY .... (See Figure 5-5 for next higher assembly)	REF	
-1	210200-087	. RING, Retaining, external .... 7/8 in. ID	1	
-2	210009	. SPRING, Wave, No. 30	3	
		(ATTACHING PARTS)		
-3	207607-051	. NUT, Hex, No. 6	2	
		---*---		

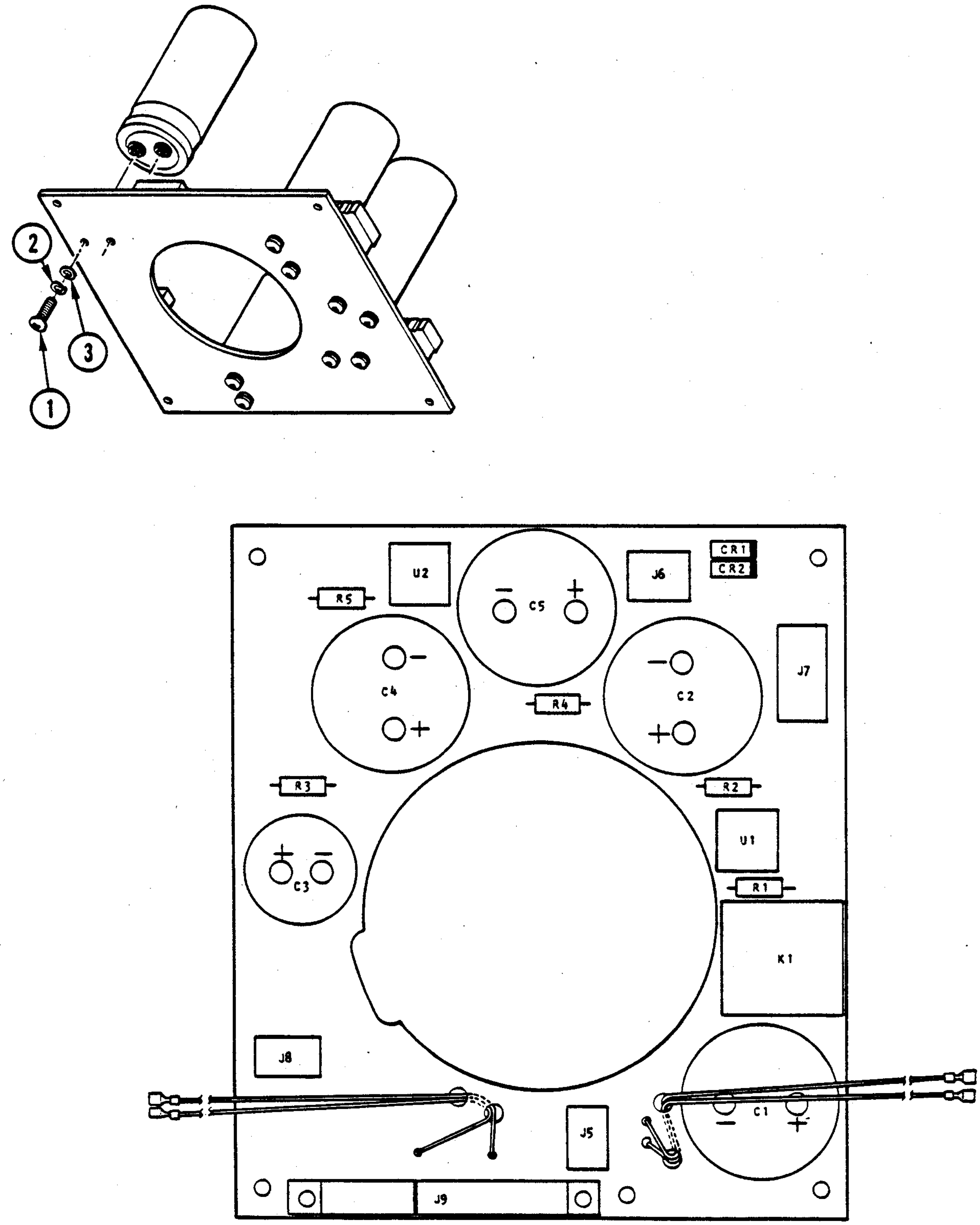

Figure 5-10. Power Supply Printed Wiring Board Assembly

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-10	160107-002	PRINTED WIRING BOARD ASSEMBLY............ Power supply, (See Figure 5-8 for next higher assembly)	REF	
C1, C2	201174-250	. CAPACITOR, Electrolytic, 25000uF,............ 30V	2	
C3	201174-160	. CAPACITOR, Electrolytic, 16000uF,............ 15v	1	
C4, C5	201174-181	. CAPACITOR, Electrolytic, 19000-............... 21000uF, 40 Vdc	2	
		(ATTACHING PARTS)		
-1	213271-106	. SCREW, Pan head, phillips..................... 10-32 x 3/8 in. lg, cadmium black, zinc	10	
-2	207105-031	. WASHER, Internal lock, No. 10................	10	
-3	207108-021	. WASHER, Flat, small OD, No. 4................	10	
		--- * ---		
CR1, CR2	202009-751	. DIODE, Rectifier, 6A, 12V	2	
J5	205195-200	. CONNECTOR, Socket assembly, ... 6-position	1	
J6	205064	. CONNECTOR, 9-position......................	1	
J7	205070	. CONNECTOR HOUSING, 15-position	1	
J8	205195-300	. CONNECTOR, Socket assembly 6-position	1	
J9	205108-023	. CONNECTOR, Printed circuit .... edge, 9-position	1	
K1	210195-100	. RELAY, Opto isolated, printed circuit	1	
R1-5	200093-150	. RESISTOR, FC, 1.5K, 1W, ±5%................	5	
U1, U2	799025-701	. RECTIFIER BRIDGE, Printed circuit............ mount	2	

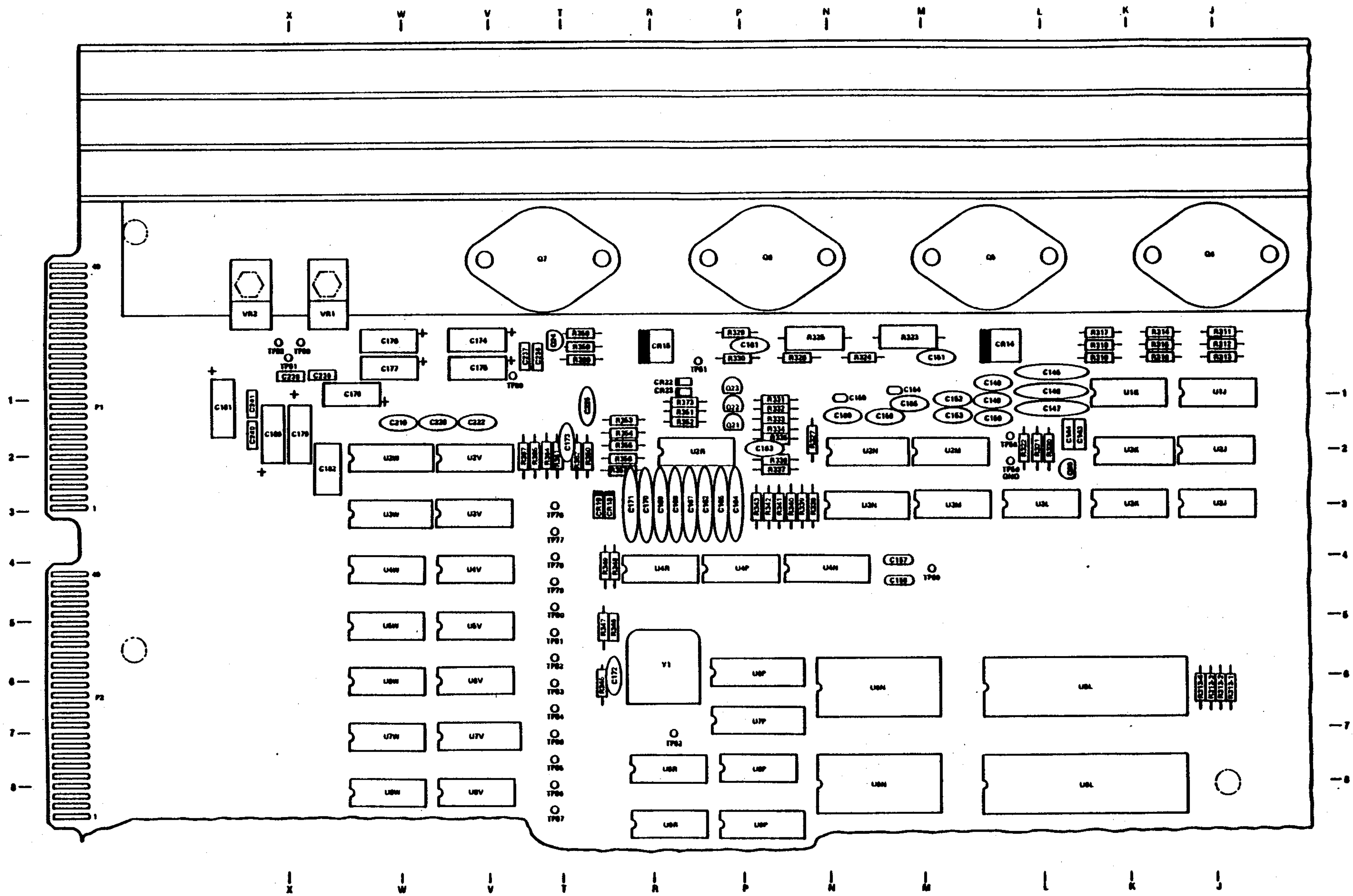

Figure 5-11. Drive Formatter PWB (Orthographic View)

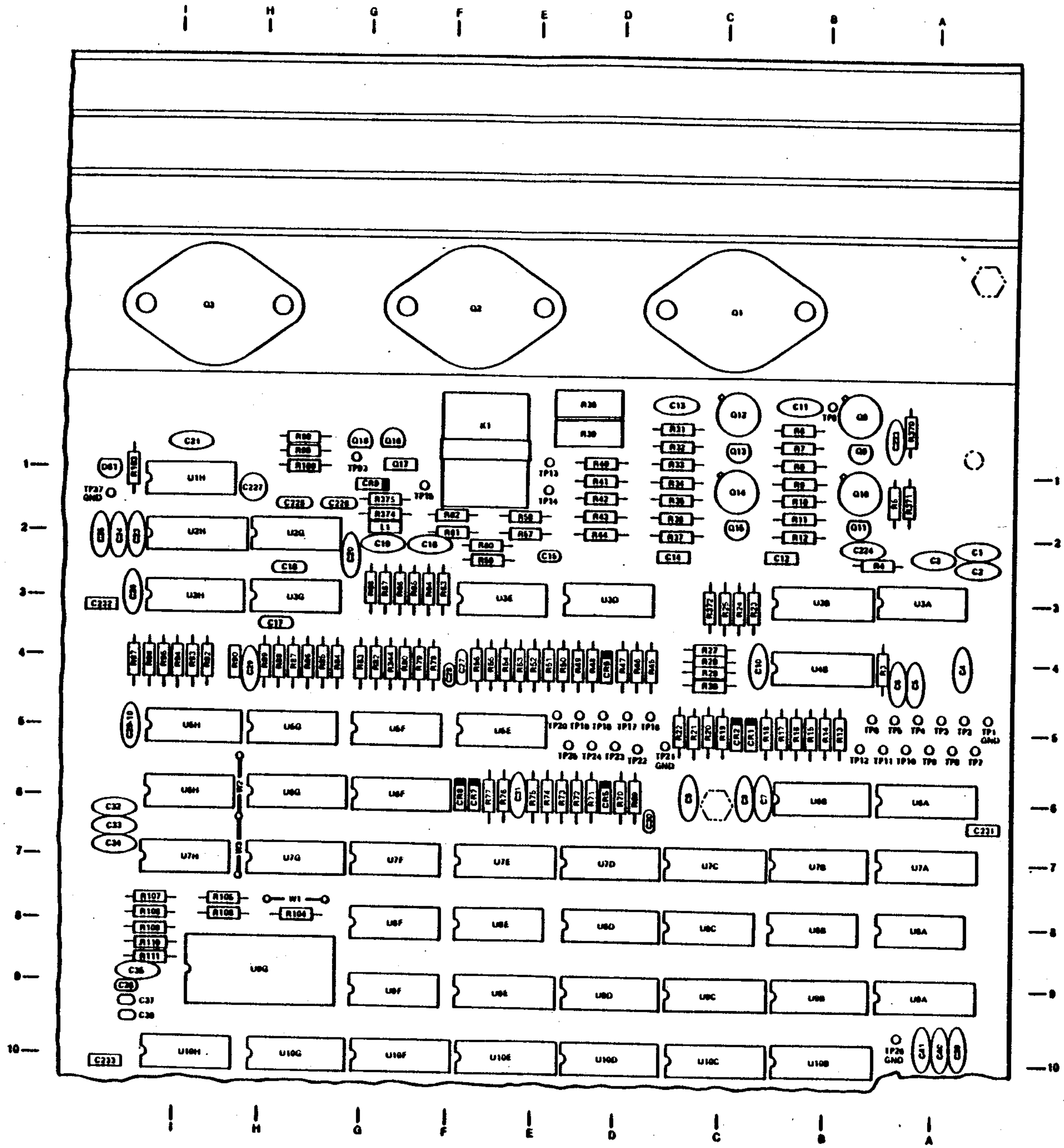

Figure 5-11. Drive Formatter PWB (Orthographic View)

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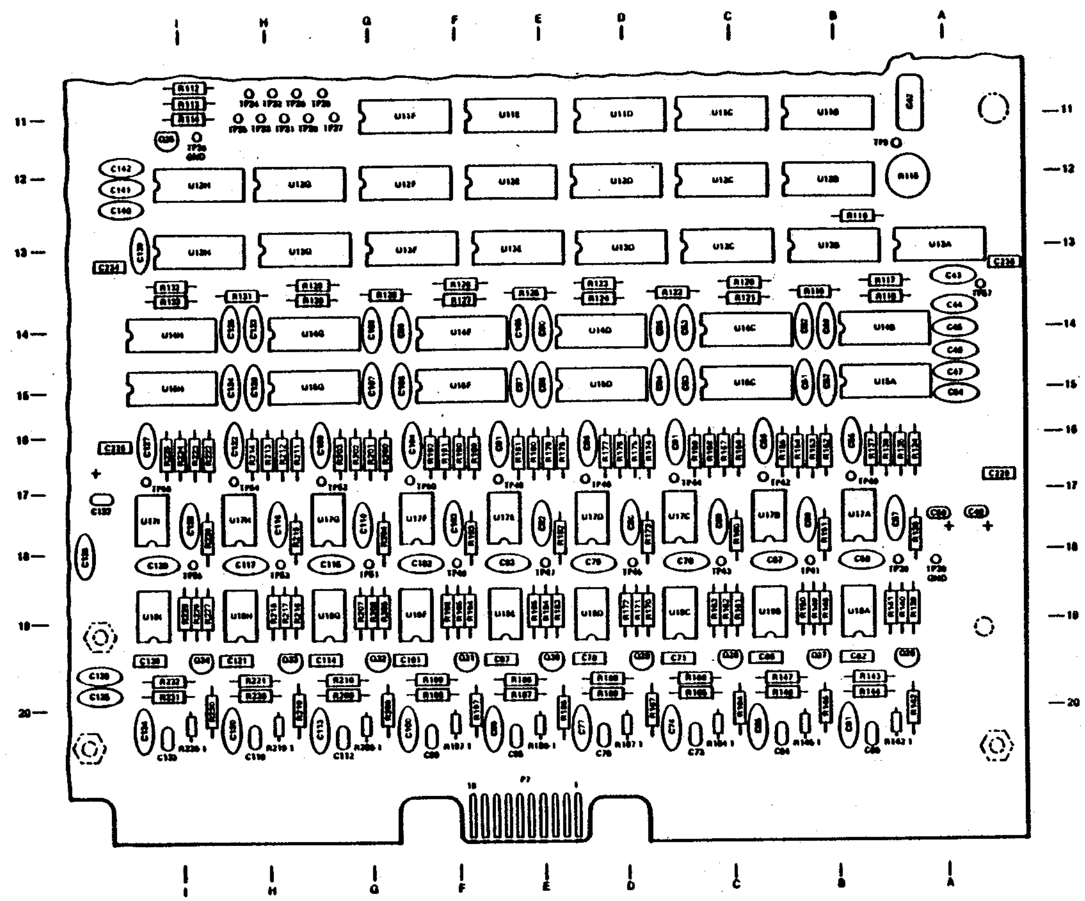

Figure 5-11. Drive Formatter PWB (Orthographic View)

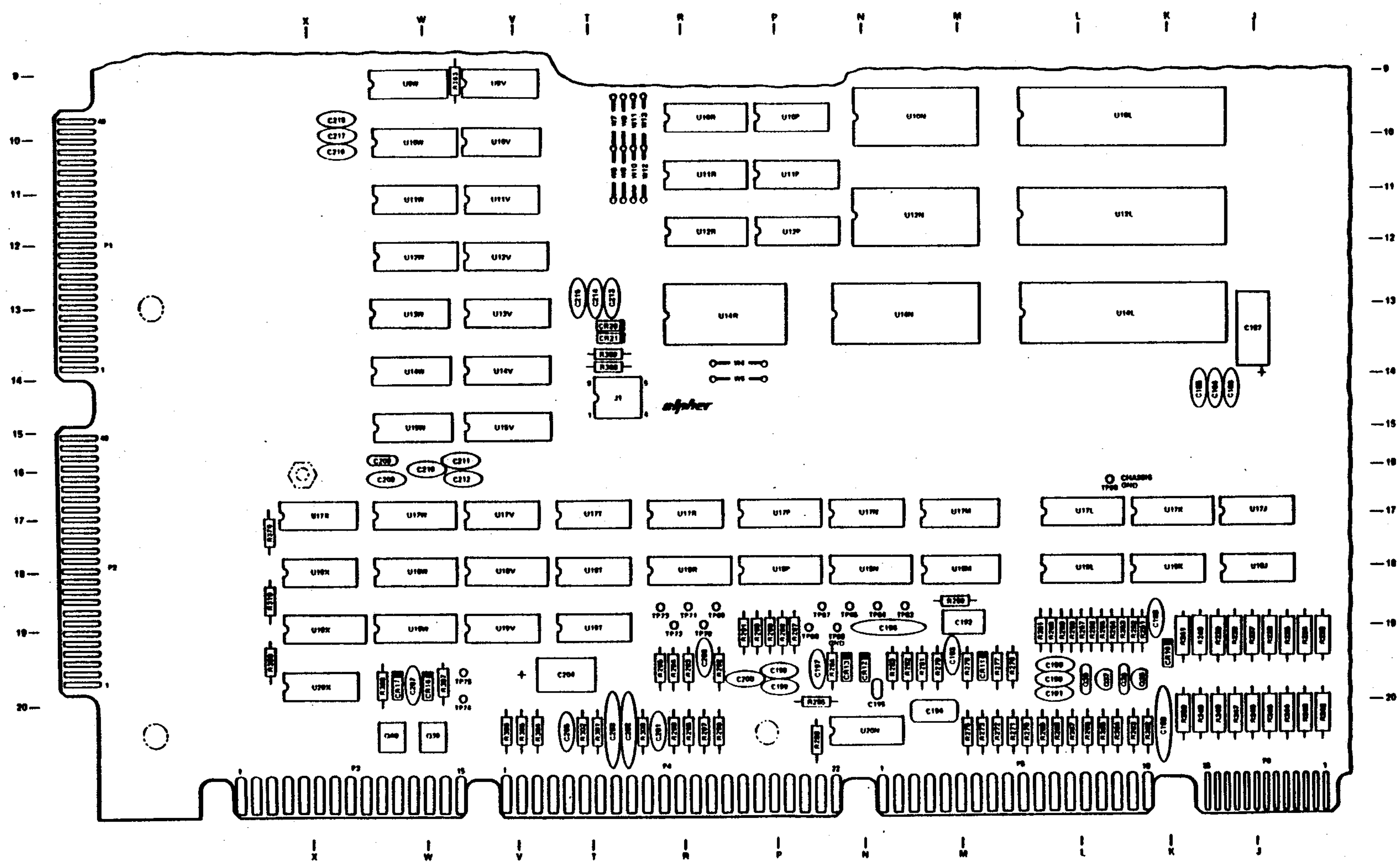

Figure 5-11. Drive Formatter PWB (Orthographic View)

Figure 5-11
Sheet 4 of 4

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11	160103-007	PRINTED WIRING BOARD ASSEMBLY, Subassembly, drive-formatter (See Figure 5-6 for next higher assembly)	REF	
		(The following components are listed in alpha-numeric sequence according to their reference designation. Consult the schematic for location in the circuit.)		
C1	201215-100	. CAPACITOR, Ceramic, 100 000 pF ±10%, 50 V	1	
C2, C3	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	2	
C4	201105-111	. CAPACITOR, Ceramic, 0.1 uF ±20%, 16 V	2	
C5, C6	201108-015	. CAPACITOR, Ceramic, 0.0015 uF ±10%, 600 V	2	
C7-C9	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	3	
C10	201104-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C11	201109-200	. CAPACITOR, Ceramic, 200 pF ±10%, 10 000 V	1	
C12	201105-330	. CAPACITOR, Ceramic, 0.33 uF ±10%, 50 V	1	
C13	201109-200	. CAPACITOR, Ceramic, 200 pF ±10%, 1000 V	1	
C14	201105-330	. CAPACITOR, Ceramic, 0.33 uF ±10%, 50 V	1	
C15	201114-680	. CAPACITOR, Ceramic, 0.068 uF ±10%, 50 V	1	
C16	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	1	
C17, C18	201215-100	. CAPACITOR, Ceramic, 100 000 pF ±10%, 50 V	2	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C19	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C20	201105-224	. CAPACITOR, Ceramic, 0.22 uF .... ±10%, 50 V	1	
C21, C23-C25	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	4	
C26	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C27	201148-120	. CAPACITOR, Ceramic, 0.12 uF .... ±5%, 50 V	1	
C28	201114-680	. CAPACITOR, Ceramic, 0.068 uF .... ±10%, 50 V	1	
C29	201109-200	. CAPACITOR, Ceramic, 200 pF .... ±10%, 1000 V	1	
C30	201114-680	. CAPACITOR, Ceramic, 0.068 uF .... ±10%, 50 V	1	
C31	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C32	201215-100	. CAPACITOR, Ceramic, 100 000 pF .... ±10%, 50 V	1	
C33, C34	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C35	201104-011	. CAPACITOR, Disk, 1000 pF .... ±10%, 500 V	1	
C36	201114-100	. CAPACITOR, Ceramic, 0.01 uF .... ±10%, 50 V	1	
C37, C38	201113-180	. CAPACITOR, Ceramic, 1800 pF .... ±10%, 50 V	2	
C39	201215-100	. CAPACITOR, Ceramic, 100 000 uF .... ±10%, 50 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C40, C41	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C42	201149-470	. CAPACITOR, Ceramic, 0.047 uF .... ±5%, 50 V	1	
C43	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C44	201104-011	. CAPACITOR, Disk, 1 000 pF .... ±10%, 500 V	1	
C45-C48	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	4	
C49, C50	201160-681	. CAPACITOR, Tantalum, 6.8 uF .... ±10%, 35 V	2	
C51	201214-393	. CAPACITOR, Ceramic, 0.39 uF .... ±10%, 50 V	1	
C52, C53	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	2	
C54	201214-393	. CAPACITOR, Ceramic, 0.093 uF .... ±10%, 50 V	1	
C55, C56	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C57	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C58	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	
C60	201103-820	. CAPACITOR, Ceramic, 8 200 pF .... ±10%, 50 V	1	
C61	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	
C62	201104-820	. CAPACITOR, Ceramic, 82 000pF .... ±10%, 50 V	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C64	201103-820	. CAPACITOR, Ceramic, 8 200 pF ±10%, 50 V	1	
C65	201121-270	. CAPACITOR, DM, 270 pF ±5%, 300 V	1	
C66	201104-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C67	201108-033	. CAPACITOR, Ceramic, 3.3 pF ±5%, 600 V	1	
C68, C69	201108-470	. CAPACITOR, Ceramic, 47 pF ±5%, 600 V	2	
C70	201108-033	. CAPACITOR, Ceramic, 3.3 pF ±5%, 600 V	1	
C71	201104-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C73	201103-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C74	201121-270	. CAPACITOR, DM, 27 pF ±5%, 300 V	1	
C76	201103-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C77	201121-270	. CAPACITOR, DM, 27 pF ±5%, 300 V	1	
C78	201104-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C79	201108-033	. CAPACITOR, Ceramic, 3.3 pF ±5%, 600 V	1	
C80	201108-470	. CAPACITOR, Ceramic, 47 pF ±5%, 600 V	1	
C81	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C82	201214-393	. CAPACITOR, Ceramic, 0.039 uF .... ±10%, 50 V	1	
C83	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C84	201214-393	. CAPACITOR, Ceramic, 0.068 uF .... ±10%, 50 V	1	
C85	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C86	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C87	201214-393	. CAPACITOR, Ceramic, 0.039 uF .... ±10%, 50 V	1	
C88	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C89	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C90, C91	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C92	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C93	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	
C95	201103-820	. CAPACITOR, Ceramic, 8 200 pF .... ±10%, 50 V	1	
C96	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	
C97	201104-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C99	201103-820	. CAPACITOR, Ceramic, 8 200 pF .... ±10%, 50 V	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C100	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	
C101	201104-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C102	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	
C103	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C104	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C105	201214-393	. CAPACITOR, Ceramic, 0.039 uF .... ±10%, 50 V	1	
C106	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C107	201214-393	. CAPACITOR, Ceramic, 0.039 uF .... ±10%, 50 V	1	
C108	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C109	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C110	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C112	201103-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C113	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	
C114	201104-820	. CAPACITOR, Ceramic, 82 000 uF .... ±10%, 50 V	1	
C115	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C116	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C117	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	
C119	201103-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C120	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	
C121	201104-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C122	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C123	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C124, C125	201214-393	. CAPACITOR, Ceramic, 0.039 uF .... ±10%, 50 V	2	
C126	201108-100	. CAPACITOR, Ceramic, 100 pF .... ±5%, 600 V	1	
C127	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C128	201108-470	. CAPACITOR, Ceramic, 47 pF .... ±5%, 600 V	1	
C129	201108-033	. CAPACITOR, Ceramic, 3.3 pF .... ±5%, 600 V	1	
C130	201104-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C133	201103-820	. CAPACITOR, Ceramic, 82 000 pF .... ±10%, 50 V	1	
C134	201121-270	. CAPACITOR, DM, 27 pF .... ±5%, 300 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C135, C136	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C137	201160-681	. CAPACITOR, Tantalum, 0.68 uF .... ±10%, 35 V	1	
C138-C142	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	5	
C143, C144	201106-107	. CAPACITOR, Ceramic, 0.01 uF .... ±10%, 50 V	2	
C145, C146	201105-111	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C147	201105-111	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C148-C151	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	4	
C152, C153	201104-011	. CAPACITOR, Disk, 1 000 pF .... ±10%, 500 V	2	
C154	201113-220	. CAPACITOR, Ceramic, 2 200 pF .... ±10%, 50 V	1	
C155, C156	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C157, C158	201102-020	. CAPACITOR, Ceramic, 220 pF .... ±10%, 50 V	2	
C159	201113-220	. CAPACITOR, Ceramic, 2 200 pF .... ±10%, 50 V	1	
C160	201104-011	. CAPACITOR, Disk, 1 000 pF .... ±10%, 50 V	1	
C161	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C162	201244-104	. CAPACITOR, Ceramic, 0.1 uF .... ±20%, 50 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C163	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C164	201244-104	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 50 V	1	
C165	201101-010	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C167-C171	201244-104	. CAPACITOR, Ceramic, 1.1 uF .... ±20%, 50 V	5	
C172	201108-015	. CAPACITOR, Ceramic, 0.0015 uF .... ±10%, 600 V	1	
C173	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C174-C181	201171-100	. CAPACITOR, Electrolytic, 10 uF .... 50 V	8	
C182	201149-100	. CAPACITOR, PC, 0.01 uF .... ±5%, 50 V	1	
C183-C185	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	3	
C186	201105-111	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	1	
C187	201171-100	. CAPACITOR, electrolytic, 10 uF .... 50 V	1	
C188	201108-015	. CAPACITOR, Ceramic, 0.0015 uF .... ±10%, 600 V	1	
C189-C191	201101-001	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 16 V	2	
C192	201149-470	. CAPACITOR, PC, 0.047 uF .... ±5%, 50 V	1	
C193	201244-104	. CAPACITOR, Ceramic, 0.01 uF .... ±20%, 50 V	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C194	970085-001	. CAPACITOR, DM, 680 pF ±1%, 300 V	1	
C195	201103-470	. CAPACITOR, Ceramic, 4 700 pF ±10%, 50 V	1	
C196	201244-104	. CAPACITOR, Ceramic, 0.1 uF ±20%, 50 V	1	
C197	201100-500	. CAPACITOR, Ceramic, 5 pF ±5%, 600 V	1	
C198-C200	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	3	
C201	201116-330	. CAPACITOR, Ceramic, 3 300 pF ±20%, 100 V	1	
C202, C203	201244-104	. CAPACITOR, Ceramic, 0.1 uF ±20%, 50 V	2	
C204	201191-006	. CAPACITOR, Aluminum, epoxy end seal	1	
C205	201116-330	. CAPACITOR, Ceramic, 3 300 pF ±20%, 100 V	1	
C206	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	1	
C207	201114-100	. CAPACITOR, Ceramic, 0.01 uF ±10%, 50 V	1	
C208	201108-100	. CAPACITOR, Ceramic, 100 pF ±5%, 600 V	1	
C209	201112-150	. CAPACITOR, Ceramic, 150 pF ±10%, 100 V	1	
C210-C220	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	1	
C222	201101-001	. CAPACITOR, Ceramic, 0.01 uF ±20%, 16 V	1	
C223	201102-330	. CAPACITOR, Ceramic, 330 pF ±10%, 500 V	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
C224	201102-330	. CAPACITOR, Ceramic, 330 pF ±10%, 500 V	1	
C225	201104-011	. CAPACITOR, Disk, 1 000 pF ±10%, 500 V	1	
C226	201112-180	. CAPACITOR, Ceramic, 180 pF ±10%, 50 V	1	
C227	201191-006	. CAPACITOR, Aluminum, epoxy end seal	1	
C228	201104-820	. CAPACITOR, Ceramic, 82 000 pF ±10%, 50 V	1	
C229-C235	201215-100	. CAPACITOR, Ceramic, 100 000 pF ±10%, 50 V	7	
C236-C241	201105-474	. CAPACITOR, Ceramic, 0.047 uF ±10%, 50 V	6	
CR1-CR8	202018-999	. DIODE, Switching	6	
CR9	202009-999	. DIODE, Rectifier, 1 amp	1	
CR10	202013-226	. DIODE, Zener, ±5%, 3.6 V	1	
CR11-CR13	202018-999	. DIODE, Switching	3	
CR14, CR15	202034-999	. DIODE, Rectifier	2	
CR16, CR17	202009-999	. DIODE, Rectifier, 1 amp	2	
CR18-CR23	202018-999	. DIODE, Switching	6	
DS1	202006-100	. DIODE, Light Emitting	1	
J1	211011-008	. SOCKET, 8 pin, Low Profile	1	
K1	210197-200	. RELAY, 2 PDT, 10 amp, 24 V	1	
L1	209991-004	. INDUCTOR, 0.47 mHy	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
Q1	204016-056	. TRANSISTOR, NPN, Silicon	1	
Q2	204016-054	. TRANSISTOR, PNP, Silicon	1	
Q3	204016-056	. TRANSISTOR, NPN, Silicon	1	
Q4	204016-054	. TRANSISTOR, PNP, Silicon	1	
Q5	204026-057	. TRANSISTOR, NPN, Darlington	1	
Q8	204010-700	. TRANSISTOR, PNP, Power	1	
Q9	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q10	204007-700	. TRANSISTOR, NPN, Silicon	1	
Q11	204010-535	. TRANSISTOR, NPN, Silicon	1	
Q12	204010-700	. TRANSISTOR, PNP, Power	1	
Q13	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q14	204007-700	. TRANSISTOR, NPN, Power	1	
Q15	204010-535	. TRANSISTOR, PNP, Silicon	1	
Q16	204012-999	. TRANSISTOR, PNP, Silicon	1	
Q17	204027-037	. TRANSISTOR, NPN, Silicon	1	
Q18	204012-999	. TRANSISTOR, PNP, Silicon	1	
Q20	203013-317	. INTEGRATED CIRCUIT, Regulator, +5 V ±5%	1	
Q21	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q22	204010-535	. TRANSISTOR, PNP, Silicon	1	
Q23	204010-533	. TRANSISTOR, NPN, Silicon	1	
Q24	204013-999	. TRANSISTOR, NPN, Silicon	1	
Q25	204012-999	. TRANSISTOR, PNP, Silicon	1	
Q26-Q34	204013-999	. TRANSISTOR, NPN, Silicon	9	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
Q35	204012-999	. TRANSISTOR, PNP, Silicon	1	
Q36	204027-034	. TRANSISTOR, PNP, Silicon	1	
Q37	204012-999	. TRANSISTOR, PNP, Silicon	1	
Q38	204027-034	. TRANSISTOR, PNP, Silicon	1	
Q39	204027-037	. TRANSISTOR, NPN, Silicon	1	
Q40	204027-037	. TRANSISTOR, NPN, Silicon	1	
R3	200075-180	. RESISTOR, FC, 180.00 Ohm, 1/4 W, ±5%	1	
R4, R5	200073-470	. RESISTOR, FC, 4.70 Ohm, 1/4 W, ±5%	1	
R6	200071-470	. RESISTOR, FC, 47 Ohm, 1/4 W, ±5%.............	1	
R7	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	1	
R8	200073-750	. RESISTOR, FC, 7.50 K Ohm, 1/4 W, ±5%	1	
R9	200073-200	. RESISTOR, FC, 2 K Ohm, 1/4 W, ±5%............	1	
R10	200071-470	. RESISTOR, FC, 47 Ohm, 1/4 W, ±5%.............	1	
R11	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	1	
R12	200073-750	. RESISTOR, FC, 7.50 K Ohm, 1/4 W, ±5%	1	
R13, R14	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	2	
R15, R16	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	2	
R17	200075-180	. RESISTOR, FC, 180.00 K Ohm, 1/4 W, ±5%	1	
R18	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W, ±1%	1	
R19	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W, ±1%	1	
R20, R21	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R22	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R23, R24	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W, ±1%	2	
R25	200014-121	. RESISTOR, FF, 12.1 K Ohm, 1/8 W, ±1%	1	
R26	200076-470	. RESISTOR, FC, 4.70 meg Ohm, 1/4 W, ±5%	1	
R27-R30	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	4	
R31	200071-470	. RESISTOR, FC, 47 Ohm, 1/4 W, ±5%.............	1	
R32	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	1	
R33	200073-750	. RESISTOR, FC, 7.50 K Ohm, 1/4 W, ±5%	1	
R34	200073-200	. RESISTOR, FC, 2 K Ohm, 1/4 W, ±5%............	1	
R35	200071-470	. RESISTOR, FC, 47 Ohm, 1/4 W, ±5%.............	1	
R36	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	1	
R37	200073-750	. RESISTOR, FC, 7.50 K Ohm, 1/4 W, ±5%	1	
R38	200509-100	. RESISTOR, WW, 0.1 Ohm, 3 W, ±1%	1	
R39	200509-100	. RESISTOR, WW, 0.1 Ohm, 3 W, ±1%	1	
R40, R41	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W, ±1%..........	2	
R42, R43	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	2	
R44	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R45	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W, ±1%	1	
R46	200072-330	. RESISTOR, FC, 330 Ohm, 1/4 W, ±5%............	1	
R47	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W, ±1%	1	
R48	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W, ±1%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R49	200013-866	. RESISTOR, FF, 8.66 K Ohm, 1/8 W, ±1%	1	
R50	200014-221	. RESISTOR, FF, 22.1 K Ohm, 1/8 W, ±1%	1	
R51	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R52	200074-510	. RESISTOR, FC, 51.00 K Ohm, 1/4 W, ±5%	1	
R53	200015-499	. RESISTOR, FF, 499 K Ohm, 1/8 W, ±1%	1	
R54	200015-332	. RESISTOR, FF, 332 K Ohm, 1/8 W, ±1%	1	
R55	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W, ±1%	1	
R56	200075-750	. RESISTOR, FC, 750.00 K Ohm, 1/4 W, ±5%	1	
R57	200014-806	. RESISTOR, FF, 80.6 K Ohm, 1/8 W, ±1%	1	
R58	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W, ±1%	1	
R59-R61	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W, ±1%	3	
R62, R63	200013-100	. RESISTOR, FF, 1.00 K Ohm, 1/8 W, ±1%	2	
R64	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W, ±1%	1	
R65	200074-620	. RESISTOR, FC, 62.00 K Ohm, 1/4 W, ±5%	1	
R66, R67	200014-100	. RESISTOR, FF, 10.00 K Ohm, 1/8 W, ±1%	2	
R68	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R69	200014-221	. RESISTOR, FF, 22.1 K Ohm, 1/8 W, ±1%	1	
R70	200013-475	. RESISTOR, FF, 4.75 K Ohm, 1/8 W, ±1%	1	
R71, R72	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	2	
R73	200013-432	. RESISTOR, FF, 4.32 K Ohm, 1/8 W, ±1%	1	
R74	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R75	200014-221	. RESISTOR, FF, 22.1 K Ohm, 1/8 W, ±1%	1	
R76	200076-470	. RESISTOR, FC, 4.70 meg, Ohm, 1/4 W, ±5%	1	
R77	200075-750	. RESISTOR, FC, 750.00 K Ohm, 1/4 W, ±5%	1	
R78	200014-402	. RESISTOR, FF, 40.2 K Ohm, 1/8 W, ±1%	1	
R79	200015-100	. RESISTOR, FF, 100 K Ohm, 1/8 W, ±1%	1	
R80	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R82	200013-301	. RESISTOR, FF, 3.01 K Ohm, 1/8 W, ±1%	1	
R83	200013-392	. RESISTOR, FF, 3.92 K Ohm, 1/8 W, ±1%	1	
R84, R85	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	2	
R86	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W, ±5%	1	
R88, R89	200071-100	. RESISTOR, FC, 10 Ohm, 1/4 W, ±5%.............	2	
R90	200072-100	. RESISTOR, FC, 100 Ohm, 1/4 W, ±5%............	1	
R92-R95	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	4	
R96	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R97	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R98, R99	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	2	
R100	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W, ±5%	1	
R103	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	1	
R104-R111	200075-220	. RESISTOR, FC, 220.00 K Ohm, 1/4 W, ±5%	8	
R112	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R113	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R114	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R115	200209-202	. POTENTIOMETER, Ceramic, 2 K Ohm, ... 1/4 W, ±5%	1	
R116-R123	200073-470	. RESISTOR, FC, 4.70 Ohm, 1/4 W, ±5%	8	
R124	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R125-R131	200073-470	. RESISTOR, FC, 4.70 Ohm, 1/4 W, ±5%	7	
R131	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	2	
R132, R133	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	2	
R134	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R135	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R136	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R137	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R138	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R139	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R140	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R141	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R142	200071-680	. RESISTOR, FC, 68 K Ohm, 1/4 W, ±5%...........	1	
R142-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R143	200071-330	. RESISTOR, FC, 33 K Ohm, 1/4 W, ±5%...........	1	
R144	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R145	200071-680	. RESISTOR, FC, 68 K Ohm, 1/4 W, ±5%...........	1	
R145-1	200063-750	. RESISTOR, FC, 7.50 K Ohm, 1/8 W, ±5%	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R146	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R147	200071-330	. RESISTOR, FC, 33 K Ohm, 1/4 W, ±5%...........	1	
R148	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R149	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R150	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R151	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R152	200073-330	. RESISTOR, FC, 3.30 Ohm, 1/4 W, ±5%	1	
R153	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R154	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R155	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R156	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R157	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R158	200073-470	. RESISTOR, FC, 4.7 K Ohm, 1/4 W, ±5%	1	
R159	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R160	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R161	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R162	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R163	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R164	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%.............	1	
R164-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R165	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R166	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%.............	1	
R167	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%.............	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 .	UNITS PER ASSY	USABLE ON CODE
5-11				
R167-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R168	200071-330	. RESISTOR, 33 Ohm, 1/4 W, ±5%	1	
R168	200073-330	. RESISTOR, FC, 30 K Ohm, 1/4 W, ±5%...........	1	
R170	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R171	200073-330	. RESISTOR, FC, 30 K Ohm, 1/4 W, ±5%...........	1	
R172	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R173	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R174	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R175	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R176	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R177	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R178	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R179	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 , ±5%..........	1	
R180	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R181	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R182	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R183	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R184	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R185	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R186	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%.............	1	
R186-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R187	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R188	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%.............	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R189	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R190	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R191	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R192	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R193	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R194	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R195	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R196	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R197	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%.............	1	
R197-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R198	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R199	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%.............	1	
R200	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R201	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R202	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R203	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R204	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R205	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R206	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R207	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R208	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%.............	1	
R208-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R209	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R210	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%	1	
R211	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R212	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R213	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R215	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R216	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R217	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R218	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R219	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%	1	
R219-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R220	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R221	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%	1	
R222	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R223	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R224	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R225	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R226	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R227	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R228	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R229	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R230	200071-680	. RESISTOR, FC, 68 Ohm, 1/4 W, ±5%	1	
R230-1	200063-750	. RESISTOR, FC, 7.5 K Ohm, 1/8 W, ±5%	1	
R231	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R232	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%.............	1	
R233	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	1	
R234, R235	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	1	
R236, R237	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	2	
R238	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	2	
R240, R241	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	2	
R242	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	1	
R243	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	1	
R244	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	1	
R245	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	1	
R246	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	1	
R247, R248	200082-390	. RESISTOR, FC, 390 Ohm, 1/2 W, ±5%............	2	
R249	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W, ±5%............	1	
R250	200082-360	. RESISTOR, FC, 360 Ohm, 1/2 W,.................	1	
R251	200071-330	. RESISTOR, FC, 33 Ohm, 1/4 W, ±5%.............	1	
R252	200072-240	. RESISTOR, FC, 240 Ohm, 1/4 W, ±5%............	1	
R253	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R254	200073-330	. RESISTOR, FC, 3.30 K Ohm, 1/4 W, ±5%	1	
R255	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R256	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W, ±5%	1	
R257	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R259-R262	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	4	
R263	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W, ±5%	1	
R264	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R265	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W, ±5%	1	
R266	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R267	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W, ±5%	1	
R268	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R269	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W, ±5%	1	
R270	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R271	200073-120	. RESISTOR, FC, 1.20 K Ohm, 1/4 W, ±5%	1	
R272	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R273	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	1	
R275	200071-150	. RESISTOR, FC, 15 Ohm, 1/4 W, ±5%.............	1	
R276	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R277	200071-150	. RESISTOR, FC, 15 Ohm, 1/4 W, ±5%.............	1	
R278	200013-976	. RESISTOR, FC, 9.76 K Ohm, 1/8 W, ±1%	1	
R279	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R280	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R281	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R282	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	1	
R283	200076-470	. RESISTOR, FC, 4.70 meg Ohm, 1/4 W, ±5%	1	
R284	200016-100	. RESISTOR, FC, 1.00 meg Ohm, 1/8 W, ±1%	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R285	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R285	200076-270	. RESISTOR, FC, 2.70 meg Ohm, 1/4 W, ±5%	1	
R286	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R287	200073-130	. RESISTOR, FC, 1.30 K Ohm, 1/4 W, ±5%	1	
R288-R291	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	4	
R292	200073-130	. RESISTOR, FC, 1.30 K Ohm, 1/4 W, ±5%	1	
R293	200074-120	. RESISTOR, FC, 12.00 K Ohm, 1/4 W, ±5%	1	
R294	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W, ±5%............	1	
R295	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	1	
R296	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W, ±5%............	1	
R297	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R298	200070-560	. RESISTOR, FC, 5.60 Ohm, 1/4 W, ±5%	1	
R299	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W, ±5%............	1	
R300	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W, ±5%............	1	
R301	200072-430	. RESISTOR, FC, 430 Ohm, 1/4 W, ±5%............	1	
R302	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R304	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R305	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	1	
R306	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W, ±5%............	1	
R307, R308	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	2	
R309	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R310	200074-130	. RESISTOR, FC, 13.00 K Ohm, 1/4 W, ±5%	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R311	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W, ±5%	1	
R312	200074-330	. RESISTOR, FC, 33.00 K Ohm, 1/4 W, ±5%	1	
R313	200073-180	. RESISTOR, FC, 1.80 K Ohm, 1/4 W, ±5%	1	
R313-3,4	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	2	
R314	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W, ±5%	1	
R315	200074-470	. RESISTOR, FC, 47.00 K Ohm, 1/4 W, ±5%	1	
R316	200076-510	. RESISTOR, FC, 5.1 meg Ohm, 1/4 W, ±5%	1	
R317	200073-430	. RESISTOR, FC, 4.30 K Ohm, 1/4 W, ±5%	1	
R318	200072-200	. RESISTOR, FC, 200 Ohm, 1/4 W, ±5%............	1	
R319, R320	200075-220	. RESISTOR, FC, 220.00 K Ohm, 1/4 W, ±5%	2	
R321	200073-200	. RESISTOR, FC, 2 K Ohm, 1/4 W, ±5%............	1	
R322	200013-249	. RESISTOR, FF, 2.49 K Ohm, 1/8 W, ±1%	1	
R323	200093-150	. RESISTOR, FC, 1.5 K Ohm, 1 W, ±5%............	1	
R324	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R325	200093-150	. RESISTOR, FC, 1.5 K Ohm, 1 W, ±5%............	1	
R326	200072-270	. RESISTOR, FC, 270 Ohm, 1/4 W, ±5%............	1	
R327	200072-330	. RESISTOR, FC, 330 Ohm, 1/4 W, ±5%............	1	
R329	200072-270	. RESISTOR, FC, 270 Ohm, 1/4 W, ±5%............	1	
R330	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	1	
R330-R332	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	3	
R333	200013-261	. RESISTOR, FF, 2.61 K Ohm, 1/8 W, ±1%	1	
R334	200073-620	. RESISTOR, FC, 6.20 K Ohm, 1/4 W, ±5%	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R335	200013-604	. RESISTOR, FF, 6.04 K Ohm, 1/8 W, ±1%	1	
R336	200074-510	. RESISTOR, FC, 51.00 K Ohm, 1/4 W, ±5%	1	
R337-R340	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	4	
R341	200075-100	. RESISTOR, FC, 100.00 K Ohm, 1/4 W, ±5%	1	
R342	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R343	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R344	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W, ±1%	1	
R345	200072-330	. RESISTOR, FC, 330 Ohm, 1/4 W, ±5%............	1	
R346, R347	200072-680	. RESISTOR, FC, 680 Ohm, 1/4 W, ±5%............	2	
R348	200074-150	. RESISTOR, FC, 15.00 K Ohm, 1/4 W, ±5%	1	
R349	200074-510	. RESISTOR, FC, 51.00 K Ohm, 1/4 W, ±5%	1	
R350	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W, ±5%	1	
R351	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
R352	200073-110	. RESISTOR, FC, 1.10 K Ohm, 1/4 W, ±5%	1	
R353-R355	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	3	
R356	200073-150	. RESISTOR, FC, 1.50 K Ohm, 1/4 W, ±5%	1	
R357	200074-200	. RESISTOR, FC, 20.00 K Ohm, 1/4 W, ±5%	1	
R358	200071-220	. RESISTOR, FC, 22 Ohm, 1/4 W, ±5%.............	1	
R359	200073-100	. RESISTOR, FC, 1.00 K Ohm, 1/4 W, ±5%	1	
R360	200073-240	. RESISTOR, FC, 2.40 K Ohm, 1/4 W, ±5%	1	
R361, R362	200072-470	. RESISTOR, FC, 470 Ohm, 1/4 W, ±5%............	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
R363-R367	200074-100	. RESISTOR, FC, 10.00 K Ohm, 1/4 W, ±5%	4	
R368	200073-220	. RESISTOR, FC, 2.20 K Ohm, 1/4 W, ±5%	1	
R369	200074-220	. RESISTOR, FC, 22.00 K Ohm, 1/4 W, ±5%	1	
R370, R371	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W, ±5%............	2	
R372	200073-470	. RESISTOR, FC, 4.70 K Ohm, 1/4 W, ±5%	1	
R373	200014-100	. RESISTOR, FF, 10.0 K Ohm, 1/8 W, ±1%	1	
R374	200071-820	. RESISTOR, FC, 82 Ohm, 1/4 W, ±5%.............	1	
R375	200072-150	. RESISTOR, FC, 150 Ohm, 1/4 W, ±5%............	1	
R376	200072-220	. RESISTOR, FC, 220 Ohm, 1/4 W, ±5%............	1	
TP0-95	205026-299	. TEST POINT, .058 diameter pin	96	
U1H	203039-001	. INTEGRATED CIRCUIT, Dual-D, flip-flop........	1	
U1J	203023-001	. INTEGRATED CIRCUIT, Quad 2-input, ... positive NAND gate	1	
U1K	203007-700	. INTEGRATED CIRCUIT, Voltage comparator	1	
U2G	203031-050	. INTEGRATED CIRCUIT, Dual, 4-input........... positive NAND gate	1	
U2H	203094-501	. INTEGRATED CIRCUIT, Dual J-K,............... positive edge trigger	1	
U2J	203029-003	. INTEGRATED CIRCUIT, Tripple, 3-input,........ NAND gate	1	
U2K	203046-001	. INTEGRATED CIRCUIT, Rtriggerable,........... MNST, MLTV	1	
U2M	203009-005	. INTEGRATED CIRCUIT, Operational .... amplifier, bifet	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U2N, U2R	203052-051	. INTEGRATED CIRCUIT, Multiplexer, 8 channel	2	
U2V	203023-001	. INTEGRATED CIRCUIT, Quad, 2-input, NAND gate	1	
U2W	203046-148	. INTEGRATED CIRCUIT, 3-8 Line decoder	1	
U3A	203012-136	. INTEGRATED CIRCUIT, Quad operational amplifier	1	
U3B	203052-053	. INTEGRATED CIRCUIT, Multiplexer, 2-channel	1	
U3D, U3E	203012-136	. INTEGRATED CIRCUIT, Quad operational amplifier	2	
U3G	203071-999	. INTEGRATED CIRCUIT, Dual V cont, MLTV	1	
U3H	203048-150	. INTEGRATED CIRCUIT, Synchronous, 4-bit counter	1	
U3J	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U3K	203036-038	. INTEGRATED CIRCUIT, Quad, 2-input, positive NAND buffer	1	
U3L	203081-001	. INTEGRATED CIRCUIT, Quad, 2-input positive NOR gate	1	
U3M	203009-005	. INTEGRATED CIRCUIT, Operational amplifier, bifet	1	
U3N	203049-008	. INTEGRATED CIRCUIT, Dia conv, 8 bit, high speed	1	
U3V	203023-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	1	
U3W	205255-500	. RESISTOR NETWORK 220/330 Ohm	1	
U4B	203052-053	. INTEGRATED CIRCUIT, Multiplexer 2-channel	1	
U4N	203046-001	. INTEGRATED CIRCUIT, Rtrig MNST MLTV	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U4P	203027-001	. INTEGRATED CIRCUIT, Quad, 2-input .... positive NAND gate	1	
U4R	203036-038	. INTEGRATED CIRCUIT, Quad, 2-input .... positive NAND buffer	1	
U4V	203027-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U4W	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U5E	203012-136	. INTEGRATED CIRCUIT, Quad.................. Operational Amplifier	1	
U5F	203029-010	. INTEGRATED CIRCUIT, 3-input	1	
U5G	203012-999	. INTEGRATED CIRCUIT, Phase .... frequency detector	1	
U5H	203094-501	. INTEGRATED CIRCUIT, Dual, J-K.............. positive edge trigger	1	
U5V	203023-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U5W	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U6A, U6B	203094-501	. INTEGRATED CIRCUIT, Dual J-K,.............. positive edge trigger	2	
U6F, U6G	203051-174	. INTEGRATED CIRCUIT, Hex D-type .... flip flop	2	
U6H	203007-700	. INTEGRATED CIRCUIT, Voltage comparator	1	
U6L	203575-101	. INTEGRATED CIRCUIT, Microprocessor, MOS....	1	
U6N	160105-422	. SOFTWARE ASSY, F880, dual	1	
U6P	203565-102	. INTEGRATED CIRCUIT, Memory,............... MOS RAM 256 X 2	1	
U6V	203029-003	. INTEGRATED CIRCUIT, 3-input AND gate	1	
U6W	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate.........	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U7A, U7B	203094-501	. INTEGRATED CIRCUIT, Dual J-K, positive edge trigger	2	
U7C	203046-151	. INTEGRATED CIRCUIT, 1-8 data select MUXR	1	
U7D	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U7E	203046-153	. INTEGRATED CIRCUIT, 4-1 line select MLTP	1	
U7F	203049-164	. INTEGRATED CIRCUIT, 8-bit parallel output	1	
U7G	160102-445	. SOFTWARE ASSY, PE Controller	1	
U7H	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U7P	203565-102	. INTEGRATED CIRCUIT, Memory, MOS RAM 256 X 2	1	
U7V	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U7W	203036-038	. INTEGRATED CIRCUIT, Quad, 2-input, positive NAND buffer	1	
U8A-U8C	203026-001	. INTEGRATED CIRCUIT, Hex inverter	3	
U8D	203046-148	. INTEGRATED CIRCUIT, 3-8 line decoder	1	
U8E, U8F	203049-164	. INTEGRATED CIRCUIT, 8-bit parallel output	2	
U8L	203001-881	. INTEGRATED CIRCUIT, Parallel I/O	1	
U8N	160105-423	. SOFTWARE ASSY, F880 dual	1	
U8P	203042-510	. INTEGRATED CIRCUIT, Counter/Latch, binary	1	
U8R	203026-999	. INTEGRATED CIRCUIT, Hex inverter	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U8V	203036-038	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
U8W	211015-003	. SWITCH DIP, 8 position sealed	1	
U9A-U9D	203048-150	. INTEGRATED CIRCUIT, Synchronous .... 4-bit counter	4	
U9E	203047-157	. INTEGRATED CIRCUIT, Quad 2-to-1 .... line data	1	
U9F	203049-164	. INTEGRATED CIRCUIT, 8-bit parallel .... output	1	
U9G	160101-447	. SOFTWARE ASSY, Read deskew	1	
U9P	203046-156	. INTEGRATED CIRCUIT, Dual 2-to-4 .... line decoder	1	
U9R	203039-001	. INTEGRATED CIRCUIT, Dual D flip flop	1	
U9V	203036-038	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
U9W	203061-280	. INTEGRATED CIRCUIT, Parity tree, ... 9 input	1	
U10B, U10C	203048-150	. INTEGRATED CIRCUIT, Synchronous .... 4-bit counter	2	
U10D,	203048-150	. INTEGRATED CIRCUIT, Synchronous .... 4-bit counter	2	
U10F	203046-151	. INTEGRATED CIRCUIT, 1-to-8 Data .... select MUXR	2	
U10H	203082-500	. INTEGRATED CIRCUIT, Hex buffer/drivers	1	
U10L	203001-881	. INTEGRATED CIRCUIT, Parallel I/O	1	
U10N	160105-424	. SOFTWARE ASSY, F880, dual	1	
U10P	203023-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U10R	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U10V	203027-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	1	
U10W	205255-500	. RESISTOR NETWORK, 220/330 Ohm	1	
U11B, U11C	203023-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	2	
U11D	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U11E, U11F	203023-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	2	
U11P,	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	2	
U11V	203035-032	. INTEGRATED CIRCUIT, QUAD 2 input positive OR gate	1	
U11W	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U12B-U12D	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	3	
U12E	203023-001	. INTEGRATED CIRCUIT, Quad 2-input positive NAND gate	1	
U12F	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	1	
U12G	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	1	
U12H	160101-461	. SOFTWARE ASSY, Data drop	1	
U12L	203001-881	. INTEGRATED CIRCUIT, Parallel I/O	1	
U12P	203048-150	. INTEGRATED CIRCUIT, Synchronous 4-bit counter	1	
U12R, U12V	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	2	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U12W	203051-100	. INTEGRATED CIRCUIT, Quad D-type flip flop	1	
U13A	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13B, U13C	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	2	
U13D	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13E,	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	2	
U13G	203051-174	. INTEGRATED CIRCUIT, Hex D-type flip flop	1	
U13H, U13V	203094-501	. INTEGRATED CIRCUIT, Dual J-K positive edge trigger	2	
U13W	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate	1	
U14B	203085-001	. INTEGRATED CIRCUIT, SCHM trig input, hex IV	1	
U14C	203007-350	. INTEGRATED CIRCUIT, Voltage comparator buffer	1	
U14D	203085-001	. INTEGRATED CIRCUIT, SCHM, trig input, hex IV	1	
U14F	203007-350	. INTEGRATED CIRCUIT, Voltage comparator buffer	1	
U14G	203085-001	. INTEGRATED CIRCUIT, SCHM, trig input, hex IV	1	
U14H	203007-350	. INTEGRATED CIRCUIT, Voltage comparator buffer	1	
U14L	203001-881	. INTEGRATED CIRCUIT, Parallel I/O	1	
U14N	203555-101	. INTEGRATED CIRCUIT, Control, MOS	1	
U14N	211011-028	. SOCKET, 28 Pin, low profile	1	

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FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U14R	160101-448	. SOFTWARE ASSY, data write	1	
U14V	203048-150	. INTEGRATED CIRCUIT, Synchronous............ 4-bit counter	1	
U14W	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate.........	1	
U15A-U15H	203007-350	. INTEGRATED CIRCUIT, Voltage................ comparator buffer	6	
U15V	203048-150	. INTEGRATED CIRCUIT, Synchronous............ 4-bit counter	1	
U15W	203042-001	. INTEGRATED CIRCUIT, Quad XOR gate.........	1	
U17A-U17I	203130-999	. INTEGRATED CIRCUIT, JFET, input OP amp.....	9	
U17J	203026-500	. INTEGRATED CIRCUIT, Hex inverter,........... bfr/drvr	1	
U17K	203051-174	. INTEGRATED CIRCUIT, Hex D-type .... flip flop	1	
U17L	203122-368	. INTEGRATED CIRCUIT, Hex bus driver..........	1	
U17M	203029-002	. INTEGRATED CIRCUIT, 3-input .... positive NAND gate	1	
U17N	203081-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NOR gate	1	
U17P	203048-150	. INTEGRATED CIRCUIT, Sync 4-bit counter	1	
U17R	203039-001	. INTEGRATED CIRCUIT, Dual-D flip-flop	1	
U17T	203026-001	. INTEGRATED CIRCUIT, Hex inverter	1	
U17V	203036-038	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
U17W	203102-002	. INTEGRATED CIRCUIT, Dual,.................. multivibrator	1	
U17X	203036-038	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
U18J, U18K	203082-500	. INTEGRATED CIRCUIT, Hex buffer/driver	2	
U18L	203051-100	. INTEGRATED CIRCUIT, Quad D-type .... flip flop	1	
U18M	203039-001	. INTEGRATED CIRCUIT, Dual-D flip flop	1	
U18N	203048-205	. INTEGRATED CIRCUIT, UP/DN .... Synchronous counter	1	
U18P, U18R	203048-150	. INTEGRATED CIRCUIT, Synchronous............ 4-bit counter	2	
U18T	203023-001	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND gate	1	
U18V, U18W	203051-100	. INTEGRATED CIRCUIT, Quad D-type .... flip flop	2	
U18X	203036-038	. INTEGRATED CIRCUIT, Quad, 2-input .... positive NAND buffer	1	
U19A-U19I	203043-500	. INTEGRATED CIRCUIT, Operational amp, ... high performance	9	
U19T	203007-700	. INTEGRATED CIRCUIT, Voltage comparator	1	
U19V	203049-164	. INTEGRATED CIRCUIT, 8-bit parallel.......... output	1	
U19W U19X	203051-174	. INTEGRATED CIRCUIT, Hex D-type .... flip flop	2	
U20N	203012-136	. INTEGRATED CIRCUIT, Quad .... operational amplifier	1	
U20X	203036-038	. INTEGRATED CIRCUIT, Quad 2-input .... positive NAND buffer	1	
VR1	203013-300	. INTEGRATED CIRCUIT, Voltage regulator	1	
VR2	203013-210	. INTEGRATED CIRCUIT, Voltage regulator	1	

FIGURE & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	UNITS PER ASSY	USABLE ON CODE
5-11				
W1 W15, W16, W19	208500-605	. WIRE, Jumper, insulated	4	
XK1	211078-999	. SOCKET, Relay	1	
XU3W	211011-016	. SOCKET, 16 Pin, low profile	1	
X76L	211011-040	. SOCKET, 40 Pin, low profile	1	
XU6N	211011-024	. SOCKET, 24 Pin, low profile	1	
XU6P	211011-018	. SOCKET, 18 Pin, low profile	1	
XU7G	211011-016	. SOCKET, 16 Pin, low profile	1	
XU7P	211011-018	. SOCKET, 18 Pin, low profile	1	
XU8L	211011-040	. SOCKET, 40 Pin, low profile	1	
XU8N, XU9G	211011-024	. SOCKET, 24 Pin, low profile	2	
XU10L	211011-040	. SOCKET, 40 Pin, low profile	1	
XU10N	211011-024	. SOCKET, 24 Pin, low profile	1	
XU10W	211011-016	. SOCKET, 16 Pin, low profile	1	
XU12H	211011-016	. SOCKET, 16 Pin, low profile	1	
XU12L	211011-040	. SOCKET, 40 Pin, low profile	1	
XU12N	211011-024	. SOCKET, 24 Pin, low profile	1	
XU14L	211011-040	. SOCKET, 40 Pin, low profile	1	
XU14R	211011-024	. SOCKET, 24 Pin, low profile	1	
Y1	210111-800	. CRYSTAL, Quartz, 8.000 megHz	1	

SECTION VI

GLOSSARY OF TERMS

A∅ -A15 — Address Bus - Tri-State output, active high. Provides the address for memory data exchanges and I/O device data exchanges.

A0 — A Phase - One of two clocks generated by the tachometer. These clocks are used to determine tape speed, direction, and position.

B/A SEL — PIO Port B or A Select (input, active high) - This pin defines which port will be accessed during a data transfer between the Z80-PIO. A low level on this pin selects Port A while a high level selects Port B.

BITCLK — Bit Clock - Used to generate PECLK when both channel two and channel one are dropped. (This condition will cause the Hard Error line to go active during data recovery.)

BLOCK — Block - Term identifying a data record. Block goes active aproximately 15 character times into the preamble.

B0 — B Phase - One of two clocks generated by the tachometer. These clocks are used to determine tape speed, direction, and position.

CS1-CS0 — Channel Select for CTC (input, Active high) - These pins form a 2-bit binary address code for selecting one of the four independent CTC channels for an I/O Write or Read (See truth table below.)

	CS1	CS0
Ch0	0	0
Ch1	0	1
Ch2	1	0
Ch3	1	1

CE* — Chip Enable of CTC (input, Active low) - A low level on this pin enables the CTC to accept control words, Interrupt Vectors, or time constant data words from the Z80 Data Bus during an I/O Read cycle.

C/D Sel	Control or Data Select for PIO (input, active high) - This pin defines the type of data transfer to be performed between the CPU and the PIO. A high level on this pin during a CPU write to the PIO causes the Z80 data bus to be interpreted as a command for the port selected by the B/A Select line. A low level on this pin means that the Z80 data bus is being used to transfer data between the CPU and the PIO. Often Address bit A1 from the CPU will be used for this function.
CDATX	Corrected Data Multiplexed - Data byte that is sent to the output register in serial form.
CHDROP P, Ø-7	Channel Drop - This signal indicates the loss of a data channel for a minimum of 4 character times.
CLK8M	Eight MegaHertz Clock - This clock is used to generate Phase Clock (Θ), One MegaHertz Clock (Θ1M), RNOISE, and Write Clock (W2XCLK).
CTCCLKØ	CTC Clock Zero - This clock indicates that tape is in motion. Also indicates forward or reverse direction depending on the tachometer quadrature.
CTCCLK1	CTC Clock 1 - This clock indicates that tape is in motion. Also indicates forward or reverse direction depending on the tachometer quadrature.
CTCZC2	CTC Clock Two - This Clock output from the CTC of approximately 40Hz is used to generate a sawtooth waveform for the compliance arm transducer.
D0-D7	CTC Data Bus of CTC - Tri-state input/output, active high. D0-D7 constitutes an 8-bit bidirectional data bus. The data bus is used for data exchanges with memory and I/O devices.
DATA	Recovered Data - Refers to the nine data lines clocked into the formatter.
DATA P,Ø-7	Data - Refers to the data lines from the read logic to the formatter.
DAVL P, Ø-7	Data Available - Term identifying data is positioned at the read head and is ready to be clocked into the formatter.
CDATX	Corrected Data Multiplexed - Data byte that is sent to the output register in serial form.
DCLK1	Data Clock 1 - Alternate input to the formatter read clock circuitry. Used in the event of data dropout in Read Channel 2.
DCLK2	Data Clock 2 - Primary input to the formatter read clock circuitry. Synchronizes PE clock to the data rate.

DINLOW — Data In Low - Enables write data to be clocked into the formatter from the controller.

ENFMG — Enable File Mark and Gap - Enables File Mark and Id Burst outputs from the formatter, as well as Block Detect to the Z80.

ENRD — Enable Read - Enables read strobes and data output from the formatter.

FRC 1, 2, 3 — Flux Reversal Control Lines - These lines determine the write formatter mode of operation. The following chart describes how they are used:

Command	FRC1	FRC2	FRC3
Write ID Burst	1	Ø	Ø
Write File Mark	1	Ø	1
Write Data	1	1	1

FSEL — Formatter Select - This signal indicates drive is selected by comparing the unit number of the drive to the IFAD and ITAD lines. FSEL enables drive status information (IONL, IRDY, etc.) to be sent to the controller.

FWD — Forward - This signal indicates forward tape motion to the read formatter logic. When tape is moving in the reverse direction, the read data will be inverted.

HIGH RATE — High Rate - This signal is a phase clock used by the formatter when the drive is selected for 100-ips operation.

INT* — Interrupt Request - Input, active low generated by CTC and PIO. INT* will be serviced by Z80 at the end of the current instruction.

IOREQ* — PIO Input/Output Request from Z80-CPU (input, active low) - The IOREQ* signal is used in conjunction with the B/A Select, C/D Select, CE*, and RD* signals to transfer commands and data between the Z80-CPU and the Z80-PIO. When CE* , RD* and IORQ* are active, the port addressed by B/A will transfer data to the CPU (a read operation). Conversely, when CE* and IORQ* are active but RD* is not active, then the port addressed by B/A will accept from the CPU, either data or control information as specified by the C/D Select signal. Also, if IORQ* and M1* are active simultaneously, the CPU is acknowledging an interrupt and the interrupting port will automatically place its interrupt vector on the CPU data bus if it is the highest device requesting an interrupt.

IS — Supply Servo Current - This signal represents the supply servo current.

IT	Takeup Servo Current - This signal represents the takeup servo current.
LASTW*	Last Word - This signal indicates the last data character to be written is present on the interface. It is also used to terminate the variable length erase operation.
MREQ*	Memory Request - Tri-state output active low signal which indicates that the address bus holds a valid address for a memory read or write operation.
MI*	PIO Machine Cycle One Signal from CPU (input, active low) - This signal from the CPU is used as a sync pulse to control several internal PIO operations. When MI is active and the RD signal is active, the Z80-CPU is fetching an instruction from memory. Conversely, when MI is active and IORQ is active, the CPU is acknowledging an interrupt. In addition, the MI signal has two other functions within the Z80-PIO. 1. MI synchronizes the PIO interrupt logic. 2. When MI occurs without an active RD or IORQ signal the PIO logic enters a reset state.
PECLK	Phase Encode Clock - Clock (22 times the data rate) that is used to synchronize the data in the formatter.
PENAB*	Phase Encode Enable - This signal enables formatter to send read strobes and data information.
POSTCHR	Post Character - This signal identifies detection of the Postamble.
PSEL	Parity Select - This signal gates parity channel from the read logic to the formatter.
PULSE Ø	Pulse Ø - This signal enables the I/O Control register.
PULSE 1	Pulse 1 - This signal sets the on-line flip-flop.
PULSE 2	Pulse 2 - This signal resets the rewind flip-flop.
PULSE 3	Pulse 3 - This signal sets the rewind flip-flop.
PULSE 4	Pulse 4 - This signal resets the on-line flip-flop.
PULSE 5	Pulse 5 - This signal is used to enable the formatter.
PULSE 6	Pulse 6 - This signal trigger is used in the error routine for troubleshooting the drive.
PULSE 7	Pulse 7 - This signal trigger is used in the error routine when outputting RAM to the data bus.

P0A0	PIO input which represents the IREV interface line.
P0A1	PIO input which represents the IWRT interface line.
P0A2	PIO input which represents the IWFM interface line.
P0A3	PIO input which represents the IEDIT interface line.
P0A4	PIO input which represents the IERASE interface line.
P0A5	PIO input which represents the IHISP interface line.
P0A6	Reserved for future use.
P0A7	Reserved for future use.
P0B0	PIO input which represents the IFEN interface line.
P0B1	PIO input which represents the IGO interface line. POASTR* strobes the command into the PIO.
P0B2	PIO output which, when high, selects the 3200 bpi mode of operation.
P0B3	PIO output which, when low, enables the erase head.
P0B4	PIO output which, when low, enables the write head.
P0B5	PIO output which, when high, selects the high speed (100 ips) mode of operation, and when low selects the low speed (25 ips) mode of operation.
P0B6	PIO output which indicates EOF (end of file) or the completion of a write bock.
P0B7	PIO output which, when high, selects the normal mode of write operation.
P1A0-P1A7	PIO inputs which represent counter values; P1A0 (LSB), P1A7 (MSB) used by the Z80 to determine tape speed (nominal binary count of 200).
P1B0-P1B1	PIO inputs which are used by the Z80 to determine the tachometer phase.
P1B2-P1B3	PIO outputs which, when active, enable the Z80 to prescale the tachometer for the following speeds:

00:	100 ips
10:	50 ips
11:	25 ips

P1B4-P1B7	PIO inputs which, when active, are used by the Z80 to calculate tape position.
P2A0	PIO input which, when high, indicates no tape in path.
P2A1	PIO input which pulses low to indicate the presence of a write enable ring.
P2A2	PIO input which, when high, indicates that the front panel door or top cover is open.
P2A3	PIO output which, when low, enables the servos.
P2A4	PIO output which, when low, enables the supply servo loop sense.
P2A5	PIO output which, when high, selects the supply servo voltage source.
P2A6	PIO output which, when high, selects the supply servo voltage or current drive.
P2A7	PIO output which, when high, selects the takeup servo voltage or current drive.
P2B0	PIO output which, when high, activates the door lock circuitry.
P2B1	PIO output which, when high, activates the hub lock circuitry.
P2B2	PIO output which, when high, enables +30Vdc to the servo circuits.
P2B3	PIO output which, when low, enables -30Vdc to the servo circuits.
P2B4	PIO output which, when low, activates the blower motor circuitry.
P2B5	PIO output which, when high, deactivates the system failure mechanism.
P2B6-P2B7	PIO outputs which, when high, select one of the following PE write modes of operation: 00: Clear 01: End of File 10: Identification Burst 11: Data Block
P3A0	PIO output which, when high, asserts the ISPEED interface line.
P3A1	Reserved for future use.

P3A2	PIO input which, when high, indicates Gap Detect.
P3A3	PIO input which, when high, represents the IFMK interface line.
P3A4	PIO input which, when high, represents the IONL interface latch.
P3A5	PIO input which, when high, represents the IRWD interface latch.
P3A6	Reserved for future use.
P3A7	PIO input/output which, when low, enables the servo motor shorting relay.
P3B0-P3B4	PIO outputs which enable the switch panel indicators and the PIO inputs which represent the front panel switches
P3B5	Reserved for future use.
P3B6	PIO output which, when high, enables the RNOISE circuitry.
P3B7	PIO output which, when low, enables the +5Vdc noise injection circuitry.
P_ARDY	This signal indicates the PIO is ready to accept information.
P_ASTR*	This signal clocks PIO causing input information to be latched. When the PIO is enabled an interrupt will occur.
RD*	Memory Read - (Tri-state active low) - RD* indicates that the CPU wants to read data from memory or an I/O device.
RDATA P, 0-7	Read Data - These signals are the nine data lines being read off tape.
RDROP P, 0-7*	Read Drop - This signal indicates the loss of data for a minimum of four character times. Used for block, file mark, and ID Burst detection.
RES*	Reset - Input to the Z80, active low signal that forces program counter to zero and initializes the CPU.
RNOISE	Read Noise - This signal injects a 500-kHz low amplitude signal into the read amplifiers, used for diagnostic firmware.
SCAN P, 0-7	This signal selects which data channel will be multiplexed into the formatter.
SIDR	Supply Input Drive - The drive could be operating on either the current or voltage mode depending upon the feedback enable.
SMDH	Supply Motor Drive High - This signal is used for the supply motor drive voltage.

SMDL	Supply Motor Drive Low - This signal is used for current sense.
STRBX*	This signal enables read strobes and read data from the formatter. Used to disable read strobes when the postamble has been detected.
TIDR	Takeup Input Drive - The drive could be operating in either the current or voltage mode depending upon the feedback mode.
TMDH	Takeup Motor Drive High - This signal is used for the takeup motor drive voltage.
TMDL	Takeup Motor Drive Low - This signal is used for current sense.
VCOM	Read Threshold Voltage - VOUT 0 will change the read threshold during a read or write operation.
VHMON*	Voltage High Minus ON - This signal enables -30 volts to the takeup and supply motors.
VHPON	Voltage High Positive ON - This signal enables +30 volts to the takeup and supply motors.
VIN0	Voltage Input Zero - This signal is input voltage from the EOT sensor.
VIN1	Voltage Input One - This signal is input voltage from the BOT sensor.
VIN2	Voltage Input Two - This signal is input voltage from the compliance arm transducer logic.
VIN3	Voltage Input Three - This signal is used to determine supply servo EMF and voltage.
VIN4	Voltage Input Four - This signal is used to determine takeup servo EMF and voltage.
VIN5	Voltage Input Five - This signal is used to determine supply servo current.
VIN6	Voltage Input Six - This signal is used to determine takeup servo current.
VOUT0	Voltage Output Zero - This signal controls the read threshold voltage.
VOUT1	Voltage Output One - This signal controls the compliance arm offset voltage into the supply servo logic.
VOUT2	Voltage Output Two - This signal is the supply servo voltage control.

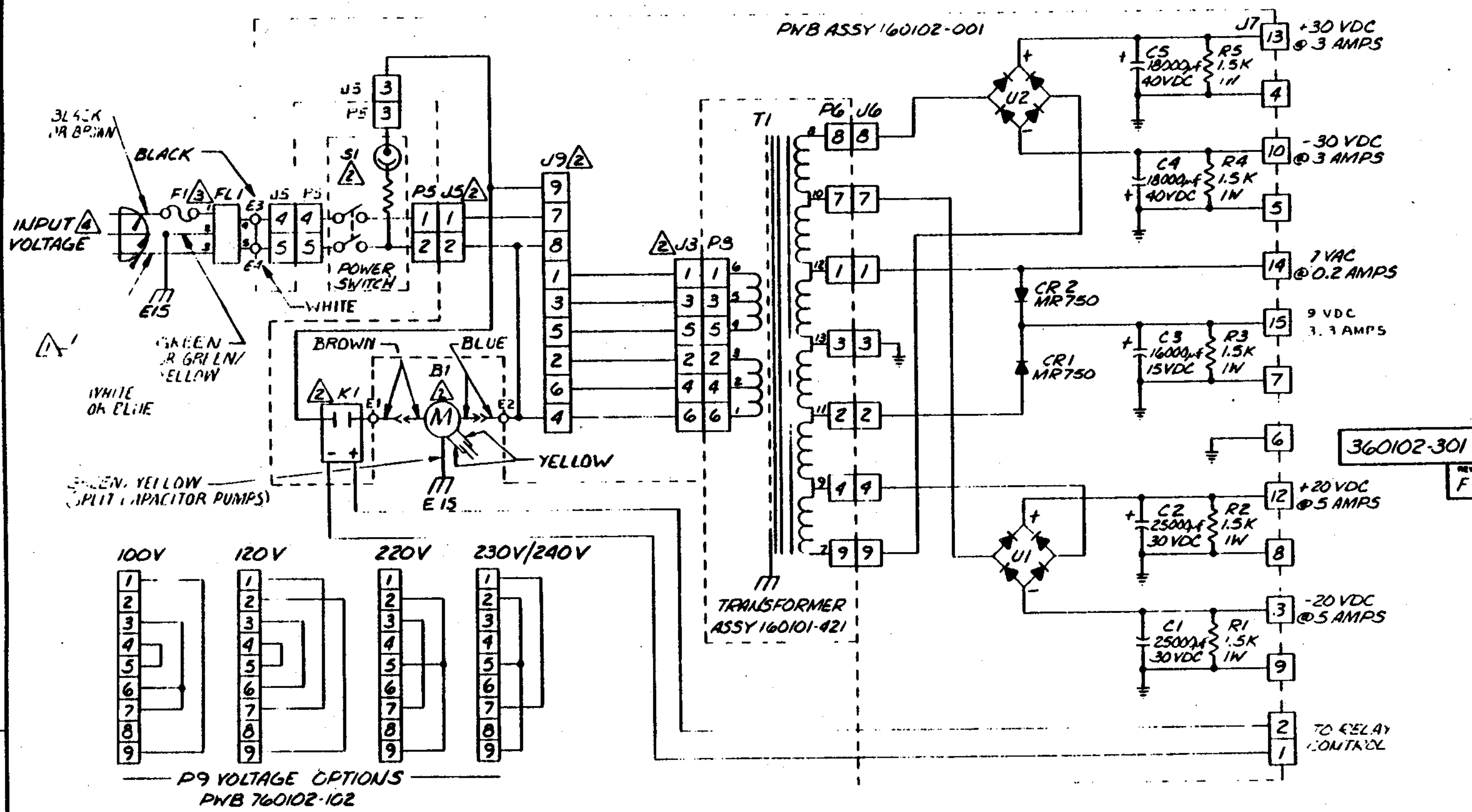
VOUT3	Voltage Output Three - This signal is the supply servo current limit control.
VOUT4	Voltage Output Four - This is a takeup servo voltage control.
VOUT5	Voltage Output Five - This is a takeup servo current limit control.
WAIT*	When active (low) this signal causes the Z80 to go into the wait state. The wait state is only used to send or receive data from the DAC.
WR*	Memory Write-Tri-state (active low). This signal indicates that the CPU data Bus (D0 - D7) holds valid data which is to be stored in memory or an I/O device.
WSTROBE	This signal is a clock that latches the write data into the formatter.
W2XCLK	Write 2 Times Clock - This signal clocks the data to the write head.
Ø	System Phase Clock - This signal is a two megahertz clock used for the microprocessor circuitry.
Ø1M	One Megahertz Clock - This signal is a one megahertz clock used for the microprocessor circuitry.
VIN7	Voltage Input Seven - This signal is used to determine the supply motor offset voltage.
V30P	Voltage 30 Positive - Positive 30Vdc drive voltage for the reel servo circuits (clockwise rotation).
V30M	Voltage 30 Minus - Negative 30Vdc drive voltage for the reel servo circuits (counter-clockwise rotation).
V20P	Voltage 20 Positive - Positive 20Vdc drive voltage for the reel servo circuits (clockwise rotation).
V20M	Voltage 20 Minus - Negative 20Vdc drive voltage for the reel servo circuits (counter-clockwise rotation).
VT	Voltage Takeup - This signal represents the takeup motor voltage feedback.
VS	Voltage Supply - This signal represents the supply motor voltage feedback.
V10P	Voltage 10 Positive - This signal is the positive 10Vdc from the power supply that is used to generate the +5Vdc signal.
V7AC	Voltage 7 Alternating Current - This signal is the AC input for the +5VCC noise injection circuitry.

DAVLX	Data Available Multiplexed - This signal is used to input the serialized data into the skew buffer.
DATA0X	Data Zeroes Multiplexed - This signal represents the serialized data bits input into the skew buffer.
CHDROPX	Channel Dropped Multiplexed - This signal represents the multiplexed channel drop signals.
DROP1	Drop One - This signal indicates that a single channel drop out has occurred.
FERR	Format Error - This signal asserts the IHER line following a parity error or a non-zero character in the postamble.
CHDT	Channel Detect - This signal is true if two or more channels are active and will assert IHER if a gap is not detected following the postamble.
HER*	Hard Error - This signal indicates excessive postamble length.
VRCCHR	Parity - This signal indicates the calculated parity of the byte being transferred to the interface.
DCLK	Data Clock - This signal is synchronized with CDATX data to generate IRSTR.
DOUT	Data Out - This signal is used to enable the output from the skew buffer.

INPUT VAC	FUSE REQ
100 V	3AG 3 AMP
120 V	
220 V	3AG [illegible] AMP
230 V	
240 V	

TABLE 1

REVISION					
LTR	DESCRIPTION	DWN	DATE	APVD	DATE
A	[illegible]	VV	[illegible]	[illegible]	[illegible]
B	INCORP ECO [illegible]	EC	[illegible]	[illegible]	[illegible]
C	INCORP ECO 13068	UA	[illegible]	[illegible]	[illegible]
D	INCORP ECO 13198	UA	[illegible]	[illegible]	[illegible]
E	INCORP ECO 13727	EC	[illegible]	[illegible]	[illegible]
F	INCORP ECO 14344	EC	[illegible]	[illegible]	[illegible]



360102-301

REV F

NOTES:

4. FOR INPUT VOLTAGE SEE TABLE 1.
3. FOR FUSE SELECTION SEE TABLE 1.
2. PARTS NOTED AFFECT UL RECOGNITION.
1. COLORS: BLACK, WHITE, GREEN FOR POWER CORD 210208
BLUE, BROWN, GREEN/YELLOW FOR POWER CORD 210208-020.

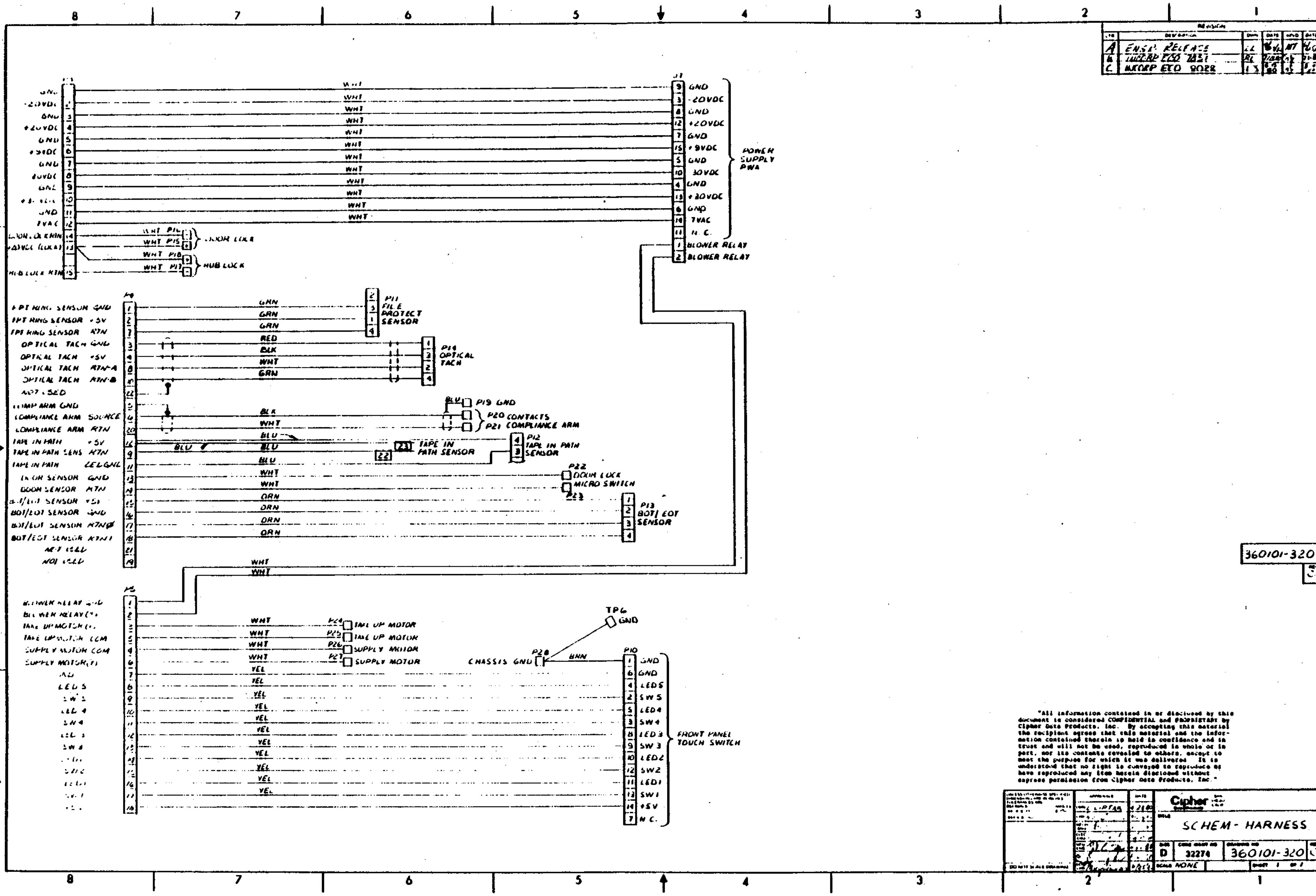
DO NOT SCALE DRAWING

Cipher Data Products

TITLE: SCHEM - POWER SUPPLY

SIZE	CODE IDENT NO	DRAWING NO	REV
C	32274	360102-301	F

SCALE | SHEET 1 OF 1



SCHEM - HARNESS
360101-320
D
32274
SCALE NONE
SHEET 1 OF 1
Cipher
A ENGR RELEASE
B INCORP ECO 7431
C INCORP ECO 9028
J1
GND
-20VDC
+20VDC
+9VDC
30VDC
+30VDC
7VAC
N.C.
BLOWER RELAY
POWER SUPPLY PWA
WHT
DOOR LOCK
HUB LOCK
P11 FILE PROTECT SENSOR
P14 OPTICAL TACH
P19 GND
P20 CONTACTS
P21 COMPLIANCE ARM
P12 TAPE IN PATH SENSOR
TAPE IN PATH SENSOR
P22 DOOR LOCK MICRO SWITCH
P13 BOT/EOT SENSOR
GRN
RED
BLK
BLU
ORN
YEL
BRN
TAKE UP MOTOR
SUPPLY MOTOR
TP6 GND
CHASSIS GND
P28
P10
FRONT PANEL TOUCH SWITCH
LED5
SW5
LED4
SW4
LED3
SW3
LED2
SW2
LED1
SW1
+5V
N.C.

NOTES: UNLESS OTHERWISE SPECIFIED

1. RESISTOR VALUES ARE IN OHMS, 1/4W, 5%
2. CAPACITOR VALUES ARE IN MICROFARAD
3. IC Vcc & GND PINS, UNUSED PORTION

a. +5L, +5V DEVICES

IC TYPE	REFERENCE DESIGNATOR	+5R	+5V	GND	UNUSED
SN74LS00N	U1J, U2V, U3V, U5V, U10P, U11B, U11C, U11E, U11F, U12E, U18T		14	7	[illegible]
SN74LS02N	U3L, U17N		14	7	U3L-C
SN7404N	U8R		14	7	U8R-D
SN74LS04N	U3J, U4W, U5W, U7H, U8A, U8B, U8C, U17T		14	7	U17T-E
SN7406N	U17J		14	7	
SN7407N	U10H, U18J, U18V		14	7	U13H-F
SN74LS08N	U4P, U4V, U10V		14	7	
SN74 S10N	U5F		14	7	
SN74LS10N	U17M	14		7	
SN74LS11N	U2J, U4V		14	7	U2J-A, U2K B,C
SN74LS14N	U14B, U19D, U14G		14	7	
SN74LS32N	U11V		14	7	
SN74S140	U2G		14	7	U2G-B
SN74LS38N	U3K, U4R, U7N, U8V, U9V, U17V, U18A, U20R, U17A		14	7	
SN74LS74N	U1H, U9K, U17R, U18M		14	7	
SN74LS86N	U6W, U12B, U12C, U12D, U12F, U26, U13W, U14W, U15W		14	7	U6W-D U14VI-D
SN74LS109N	U2H, U5N, U6A, U6B, U7A, U7B, U13B-C-E-F-H-V		16	8	U13V-B
SN74LS123N	U2K, U4N		16	8	
SN74LS138N	U2W, U8D		16	8	
SN74LS139N	U9P		16	8	
SN74LS151N	U7C, U10F, U10G,		16	8	
SN74LS153N	U7E		16	8	
SN74LS157N	U9E		16	8	
SN74LS163AN	U3H, U7D, U9A, U9B, U9C, U9D, U10B, U10C, U10D, U10E, U10R, U11P, U11R, U12P, U14V, U15V, U17R, U18P, U18R U1D		16	8	
SN74LS164N	U7F, U8E, U8F, U9F, U19V		14	7	
SN74LS169N	U18N		16	8	
SN74LS174N	U6F, U6G, U11W, U12R, U12V, U13A, U13D, U13G, U17K, U19W, U19X, U7V		16	8	
SN74LS175N	U12W, U18L, U18V, U18W		16	8	
SN74LS197N	U8P		14	7	
SN74LS280N	U19W		14	7	
SN74LS368A	U17L		16	8	U7L-D
SN74LS221	U17W		16	8	
Z80CPU	U6L		11	29	
Z80CTC	U14N		24	5	
Z80PIO	U8L, U10L, U12L, U14L		26	11	
339	U6H, U19T		3	12	

IC TYPE	REFERENCE DESIGNATOR	+5R	+5V	GND	UNUSED
82S129	U7G		16	8	
2111A	U6P, U7P		18	8	
2716	U6N, U8N, U10N, U12N		24	12	
MC4024	U3G		14	7	
MC4044	U5G		14	7	
6305	U12H		16	8	
6336-1	U9G, U14R		24	12	
RESISTOR PACK	U3W, U10W		16	8	

b. -5V, +5V DEVICES

IC TYPE	REFERENCE DESIGNATOR	-5V	+5V	GND	UNUSED
4051	U2N U7F	7	8	16	
4053	U3B, U4B	7	8	16	

c. -12V, +12V & MISC

IC TYPE	REFERENCE DESIGNATOR	-12	+12	GND	V 20P	UNUSED
339	U1K			12	3	
DAC08	U3N	3	13	1		
319	U14C, U14F, U14H, U5A, U15C, U15D, U15F, U15G, U15H	6	11			
709P	U19A, U19B, U19C, U19D, U19E, U19F, U19G, U19H, U19I	4	7			
4136	U3A, U3D, U3E, U5E, U20H	7	11			U5E-A,C, U20H-C,D, U22H-A,B
TL082	U17A, U17B, U17C, U17D, U17E, U17F, U17G, U17H, U17I	4	8			
TL084	U2M, U3A1	11	4			

4. LAST USED REFERENCE DESIGNATOR

C	241	K	1	S	—	VR	1
CR	23	P	7	TP	15	Y	1
DS	1	Q	40	U	—	L	1
J	1	R	376			W	19

TABLE 2 △

SPEED																					
	[illegible]	C57	C68	C69	C80	C92	C103	C110	C116	C128	C52	C53	C83	C85	C89	C106	C108	C123	C126	C32	C38
25/50	100	100	100	100	100	[illegible]	100	100	100	100	200	200	200	200	200	200	200	200	200	R200	R200
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	C95	C99	[illegible]	C119	C133	[illegible]	[illegible]	R145	R164	R167	R196	[illegible]	R208	R219	R210
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 3 △

SPEED																					
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	C52	C53	[illegible]	C85	C89	C106	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25/75	68	68	68	68	68	68	68	68	68	68	150	150	150	150	150	150	150	[illegible]	75	[illegible]	[illegible]
	C37	C56	[illegible]	[illegible]	[illegible]	C76	C95	C99	[illegible]	C119	C133	[illegible]	R145	[illegible]	R167	R196	[illegible]	[illegible]	R22	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82	82	82	82	82	82	82	[illegible]	82

△ JUMPER TABLE

ASSY NO.	SPEED	-IN-	-OUT-
160103-002	25/50	W1,6,8,10,12,14,17,18,21	W7,9,11,13,15,16,19,20
160103-003	25/50/100	W1,6,8,10,12,14,17,18,21	W7,9,11,13,15,16,19,20
160103-001	25/100	W1,6,8,10,12,14,17,18,21	W7,9,11,13,15,16,19,20
160104-002	25/50	W1,7,9,11,13,19,17,18,21	W6,9,10,12,15,16,11,22
160104-003	25/75	W1,7,9,11,12,19,17,18,21	W6,8,10,13,15,16,17,22
160104-004	25/100	W1,6,8,10,12,14,17,18,20	[illegible]
160105-003	25/50/100	[illegible]	W7,9,11,13,19,17,18,21
160106-001	25/50	W1,6,8,10,12,14,17,18,21	W7,9,11,13,15,16,17,21
W2,3,4,5 ARE FOR FUTURE USE			
W6,8,10,12,14,17,18 AND 21 ARE INTRINSIC TO... MUST BE OUT WHEN CUT			

6. DIP SWITCH U18W

POSITION	FUNCTION
S1	FORMATTER ADDRESS (SEE TABLE)
S2	TRANSPORT ADDRESS SEE TABLE
S3	RESERVED
S4	TRANSPORT ADDRESS SEE TABLE
S5	C=EXTERNAL PARITY SELECT (S6 OPEN)
S6	C=INTERNAL PARITY GENERATION (S5 OPEN)
S7	RESERVED
S8	RESERVED

C = CLOSED

ADDRESS LINE DECODING TABLE

IFAD	ITAD 0	ITAD 1	S1	S2	S4	ADDRESS
0	0	0	1	1	1	0
0	0	1	1	1	0	1
0	1	0	1	0	1	2
0	1	1	1	0	0	3
1	0	0	0	1	1	4
1	0	1	0	1	0	5
1	1	0	0	0	1	6
1	1	1	0	0	0	7

0 = FALSE INTERFACE LEVEL 0 = OPEN
1 = TRUE INTERFACE LEVEL 1 = CLOSED

7

TABLE 1 △

SPEED	C60	C64	C73	C76	C95	C99	C112	C119	C133	R230	R167	R192	R219	R164	R215	R145	R197	R196
25/100	5600	5600	5600	5600	5600	6600	5600	5600	5600	100	100	100	100	100	100	100	100	[illegible]
25/50/100	8200	8200	8200	8200	8200	8200	8200	8200	8200	68	68	68	68	68	68	68	68	68

△ FOR SPECIFIC VALUES SEE TABLE 1

△ CAPACITOR VALUES SHOWN IN TABLES 1, 2 & 3 ARE IN PICOFARADS

10 FOR SINGLE DENSITY ONLY, COMPONENTS CR10, R254 & Q36 HAVE BEEN REMOVED. CR10 HAS BEEN REPLACED BY A JUMPER (ITEM 281)

REVISION

LTR	DESCRIPTION			
A	ENG. RELEASE	[illegible]	[illegible]	[illegible]
B	INCORP ECO 10807	FN	[illegible]	
C	INCORP ECO 10841	FN	[illegible]	
D	INCORP ECO [illegible]	[illegible]	[illegible]	
E	INCORP ECO [illegible]	[illegible]	[illegible]	
F	INCORP ECO 11996	EF	[illegible]	
G	INCORP ECO [illegible]	UA	[illegible]	
H	INCORP ECO [illegible]	UA	[illegible]	
J	INCORP ECO 13006	UA	[illegible]	
K	INCORP ECO 13086	UA	[illegible]	
L	INCORP ECO [illegible]	[illegible]	[illegible]	
M	INCORP ECO 15642	[illegible]	[illegible]	
N	INCORP ECO [illegible]	[illegible]	[illegible]	
P	INCORP ECO [illegible]	[illegible]	[illegible]	
R	INCORP ECO [illegible]	[illegible]	[illegible]	
S	INCORP ECO [illegible]	[illegible]	[illegible]	
T	INCORP ECO [illegible]	[illegible]	[illegible]	
U	[illegible]			
V	[illegible]			
Y	[illegible]			

REV STATUS	REV	Y	P	N	U	Y	F	A	A	F	F
OF SHTS	SH	1	2	3	4	5	6	7	8	9	10

Cipher Data Products

SCHEM. DRIVE/FMTR. DAISY CHAIN

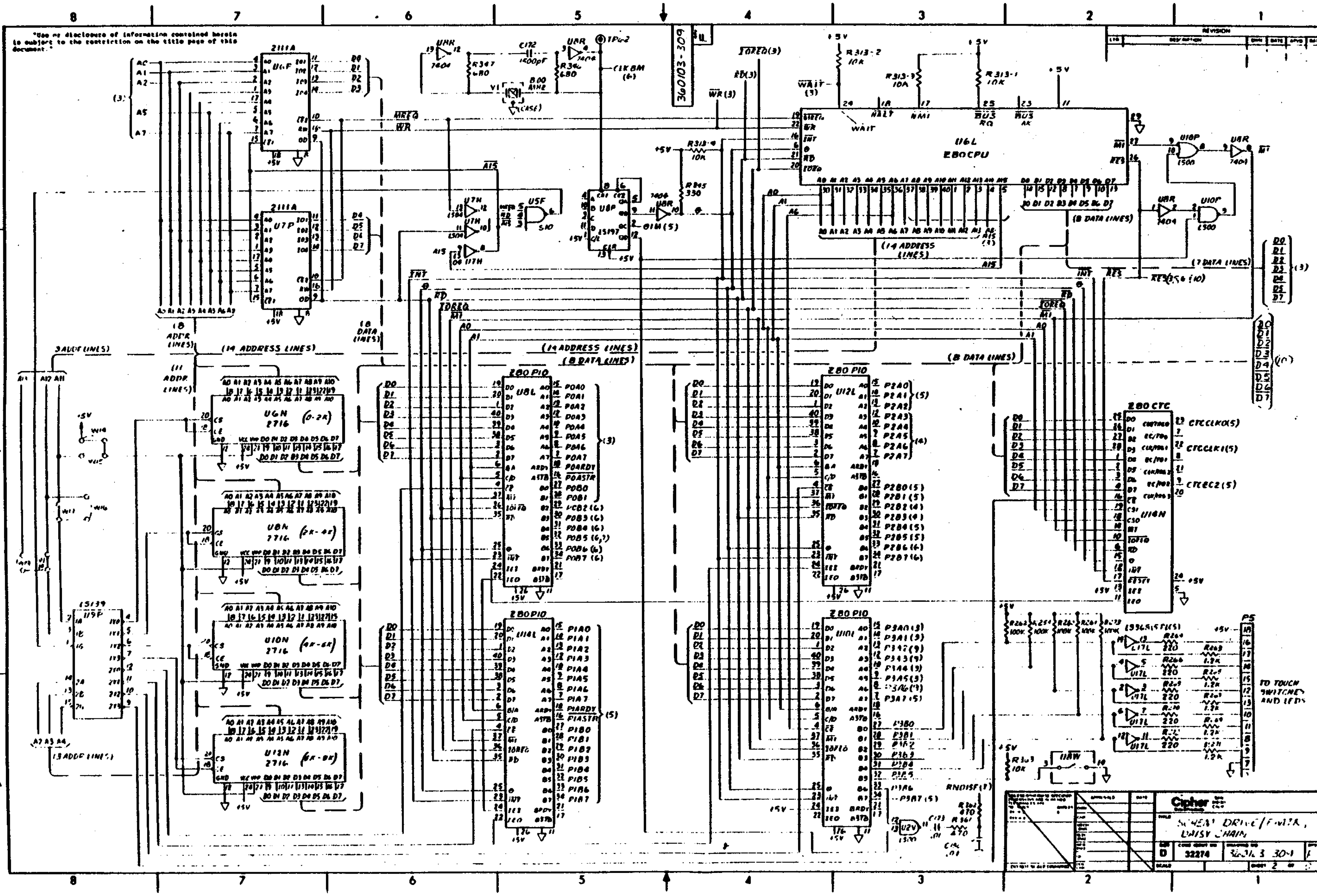
SIZE D | CODE IDENT NO 32274 | DRAWING NO 360103-309 | REV Y

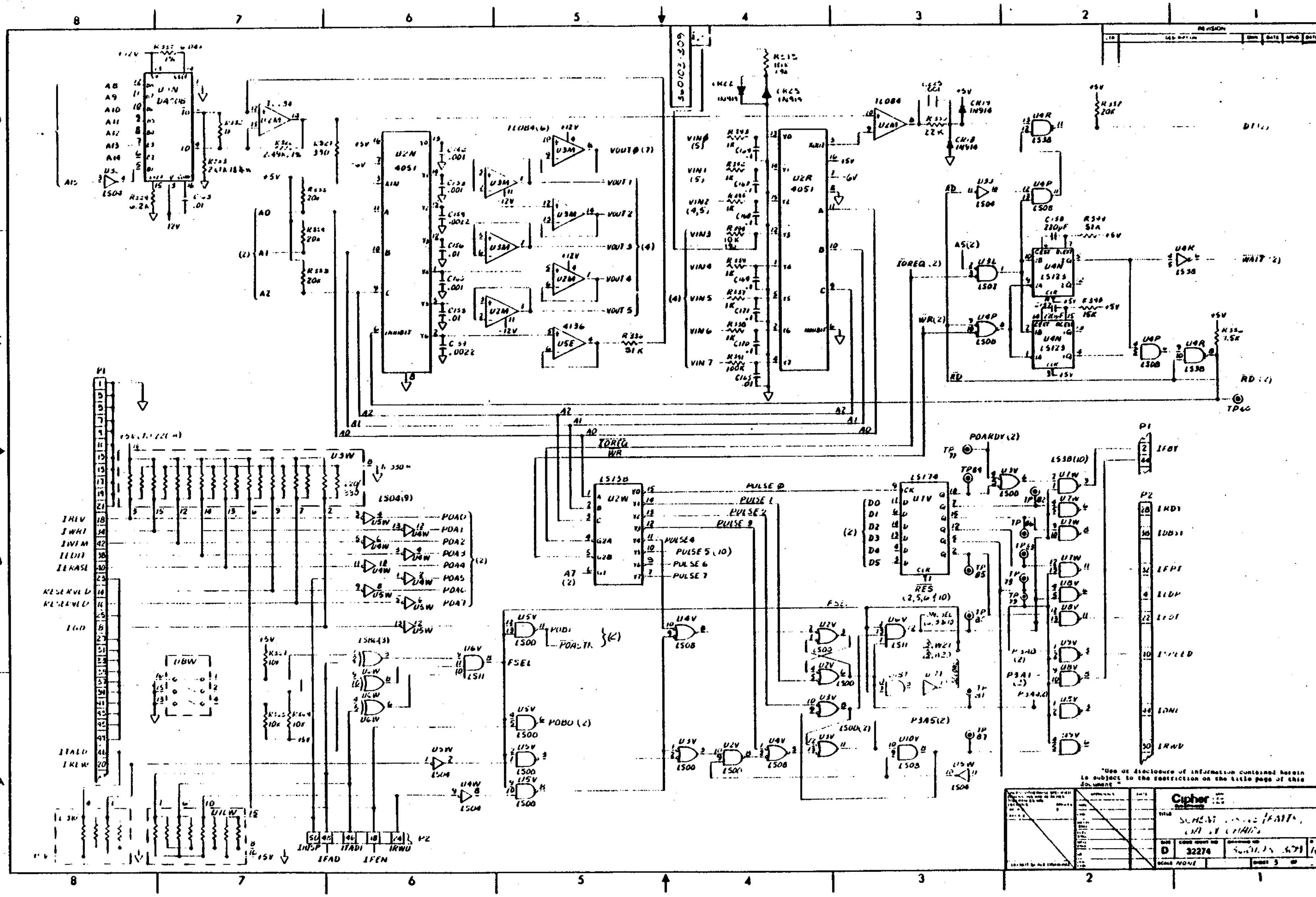
SCALE NONE | SHEET 1 OF 10

DO NOT SCALE DRAWING

360103-309

1


"Use or disclosure of information contained herein is subject to the restriction on the title page of this document."
360103-309
2111A
U6F
U7P
U16L
Z80CPU
Z80 PIO
U8L
U11L
U12L
U10L
Z80 CTC
U19N
UGN
2716
(0-2K)
U8N
(2K-4K)
U10N
(4K-6K)
U12N
(6K-8K)
(14 ADDRESS LINES)
(8 DATA LINES)
(7 DATA LINES)
(3 ADDR LINES)
CTCCLK0(5)
CTCCLK1(5)
CTCEC2(5)
CLK8M
TO TOUCH SWITCHES AND LEDS
Cipher
SCREEN DRIVE/FILTER, DAISY CHAIN
D
32274
360103 309-1
SHEET 2



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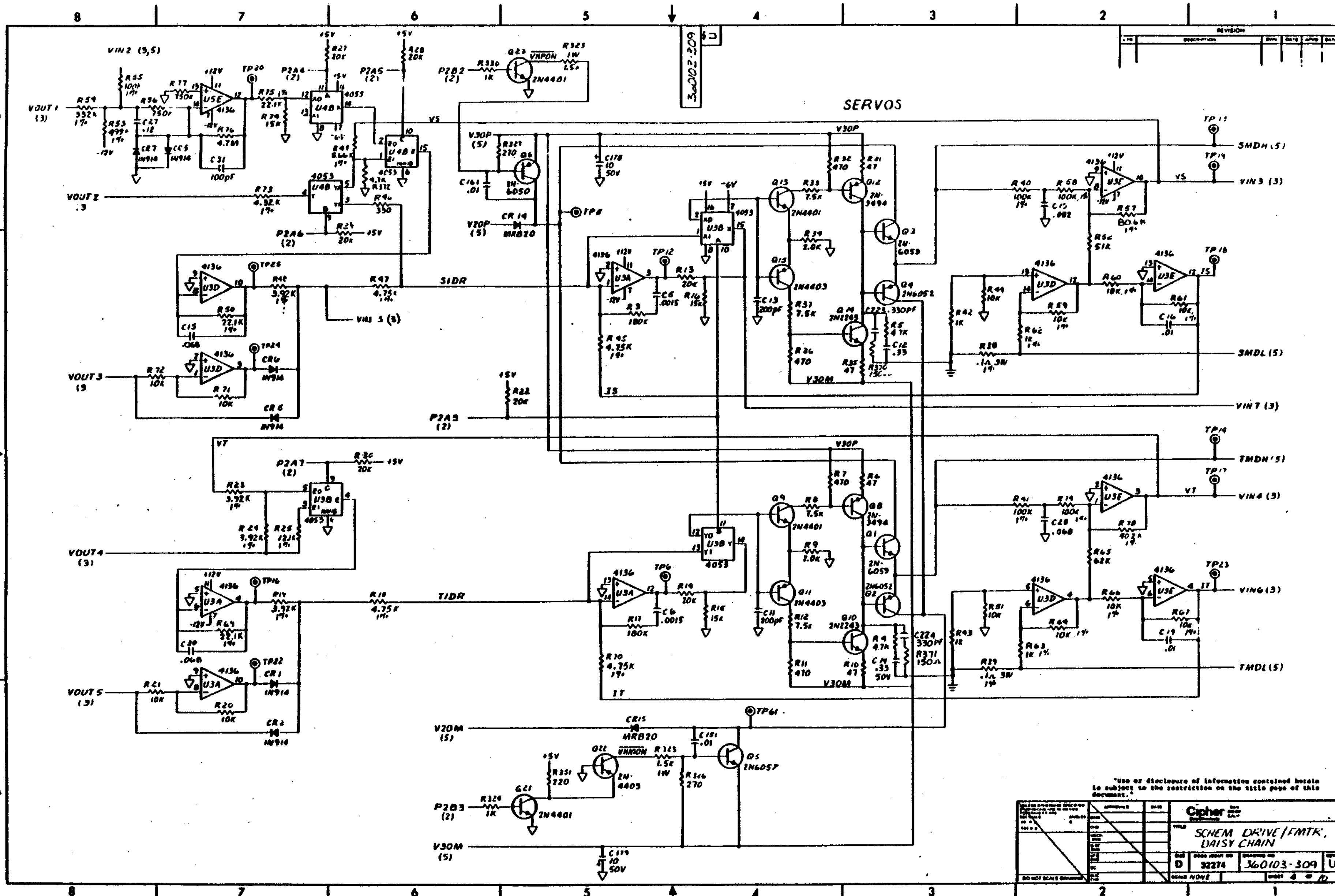
Cipher
D
32274
SCALE NONE



SERVOS
360102-309
VOUT 1
VOUT 2
VOUT 3
VOUT 4
VOUT 5
VIN 2 (3,5)
SIDR
TIDR
SMDH (5)
VIN 3 (3)
SMDL (5)
VIN 7 (3)
TMDH (5)
VIN 4 (3)
VIN 6 (3)
TMDL (5)
V30P
V20P
V20M
V30M
P2A4
P2A5
P2A6
P2A7
P2A9
P2B2
P2B3
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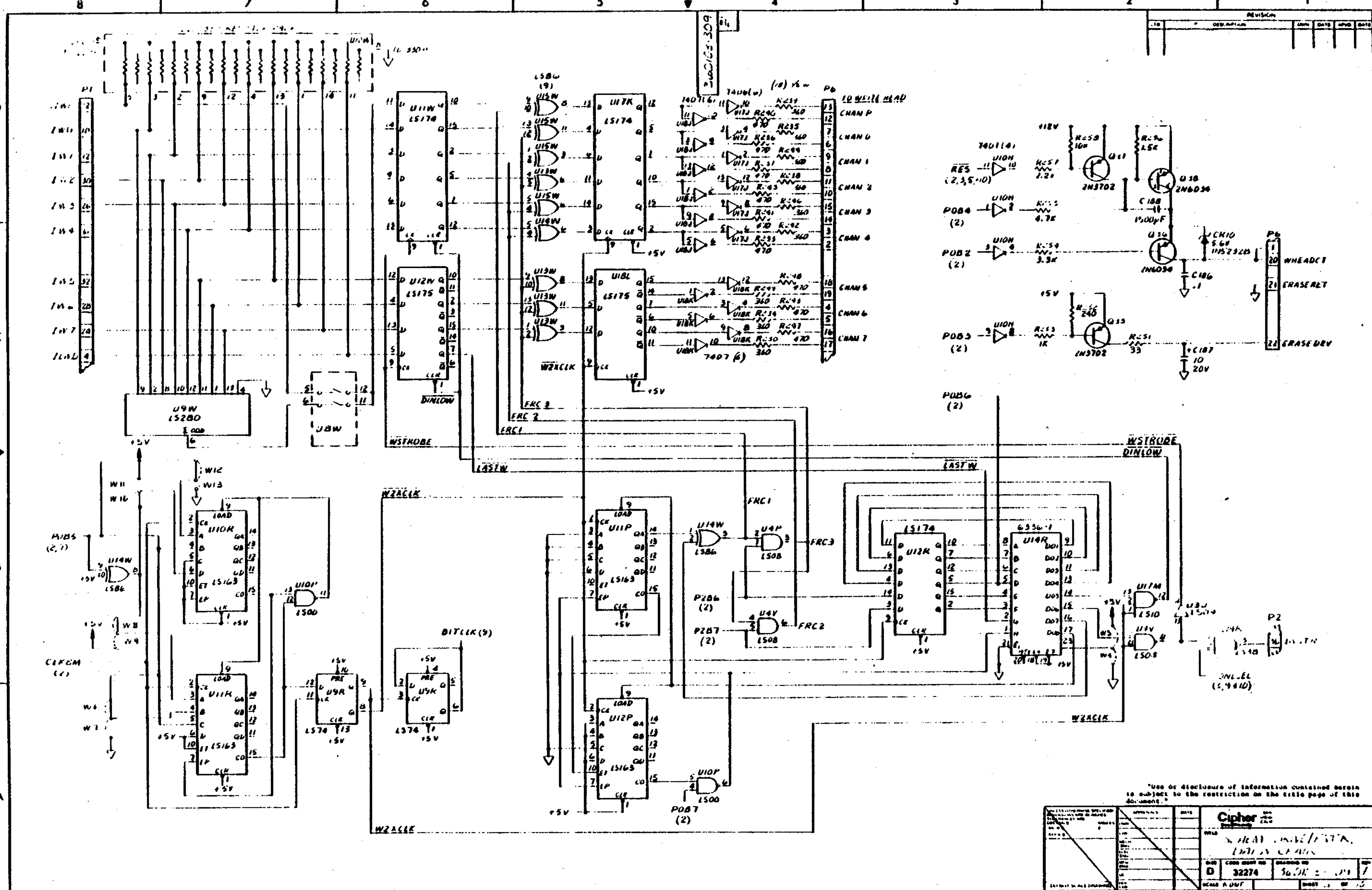
Cipher
SCHEM DRIVE/FMTR, DAISY CHAIN
D 32274 360103-309 U
SCALE NONE
SHEET 4 OF 10



TO WRITE HEAD
CHAN P
CHAN 0
CHAN 1
CHAN 2
CHAN 3
CHAN 4
CHAN 5
CHAN 6
CHAN 7
WHEADCT
ERASERET
ERASEDRV
WSTROBE
DINLOW
LASTW
W2XCLK
FRC1
FRC2
FRC3
BITCLK (9)
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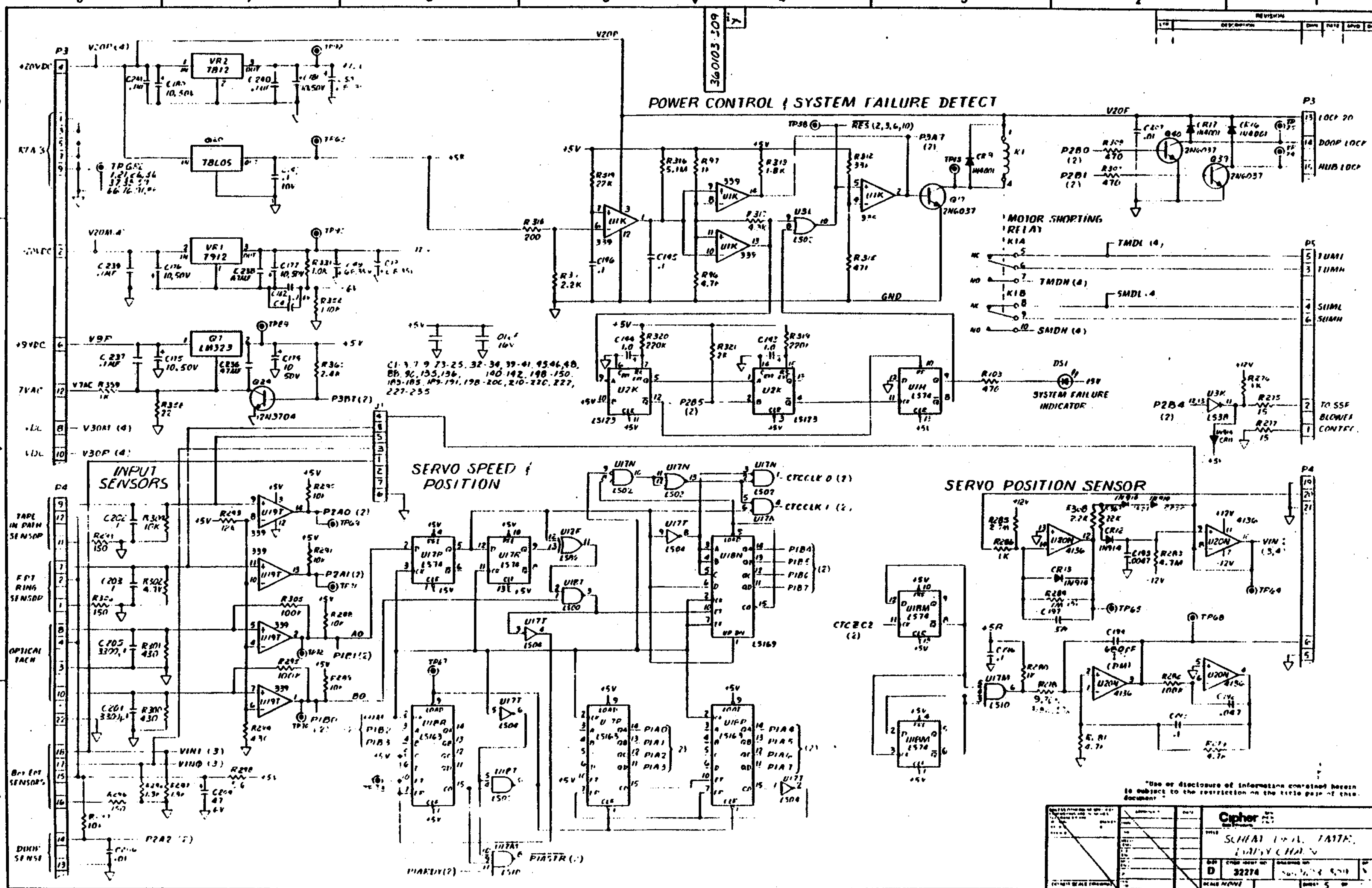
Cipher
32274


360103-209
POWER CONTROL & SYSTEM FAILURE DETECT
MOTOR SHORTING RELAY
SYSTEM FAILURE INDICATOR
SERVO SPEED & POSITION
SERVO POSITION SENSOR
INPUT SENSORS
TAPE IN PATH SENSOR
EOT RING SENSOR
OPTICAL TACH
DOOR SENSE
TO SSF BLOWER CONTROL
LOCK 20
DOOP LOCK
HUB LOCK
+20VDC
+9VDC
7VAC
VR2 7812
VR1 7912
78L05
Q1 LM323
2N3704
2N6037
RES (2,3,6,10)
GND
TMDL (4)
TMDH (4)
SMDL (4)
SMDH (4)
CTCCLK 0 (2)
CTCCLK 1 (2)
CTCEC2 (2)
PIASTR (2)
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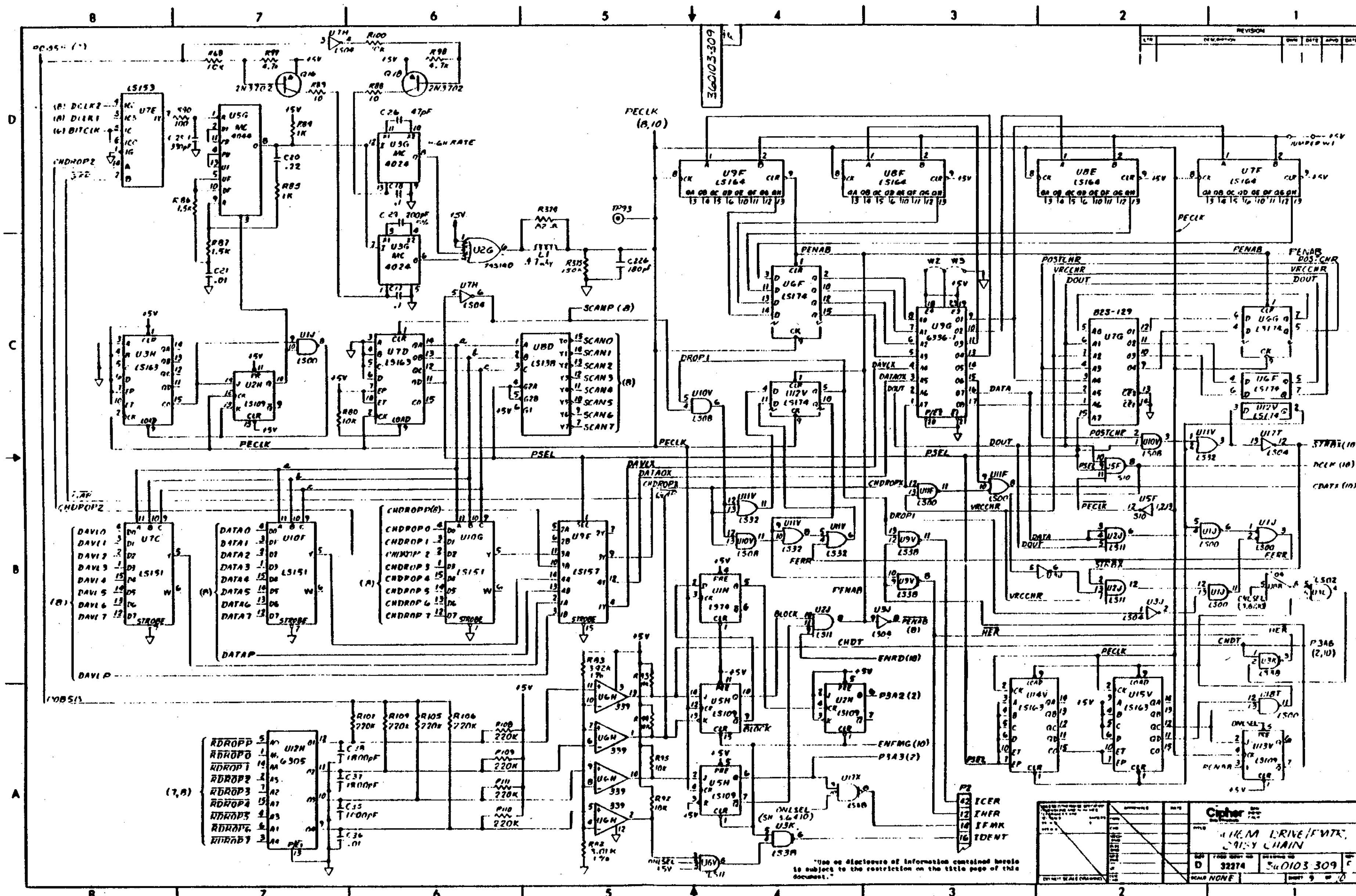
Cipher
D
32274


360103-309
Cipher
DRIVE/FMTR, DAISY CHAIN
D
32274
360103 309
NONE
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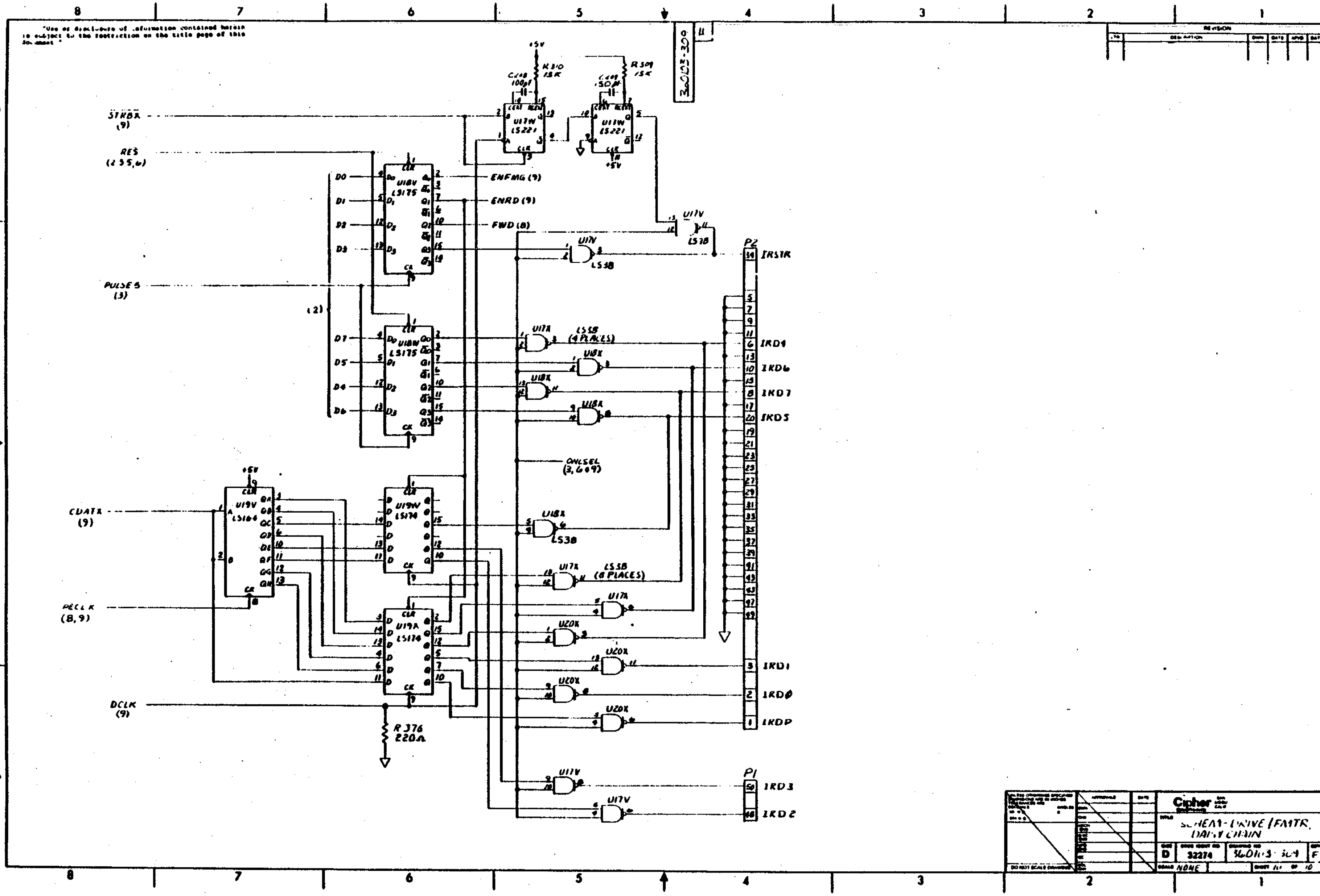

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36003-300
STRBX (9)
RES (2,3,5,6)
PULSE 5 (3)
CDATX (9)
PECLK (8,9)
DCLK (9)
D0 D1 D2 D3
D7 D5 D4 D6
(2)
U18V LS175
U18W LS175
U19V LS164
U19W LS174
U19X LS174
U17W LS221
C418 100pf
R310 15K
C419 150pf
R309 15K
+5V
ENFMG (9)
ENRD (9)
FWD (8)
ONLSEL (3,6,9)
U17V LS38
U17X LS38 (4 PLACES)
U18X LS38
U17X LS38 (8 PLACES)
U20X
R376 220Ω
P2
IRSTR
IRD4
IRD6
IRD7
IRD5
IRD1
IRDØ
IRDP
P1
IRD3
IRD2
DO NOT SCALE DRAWING
Cipher
SCHEM-DRIVE/FMTR, DAISY CHAIN
D
32274
36003-304
F
NONE

REVISION RECORD

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TAPEMASTER Product Specification

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USA

REVISION INFORMATION

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Revision	Date	Comments
01	7-1-81	Initial Release
A	8-1-81	Production Release
B	10-1-81	General Update
C	12-1-81	General Update
D	7-1-83	General Update

REFERENCE DOCUMENTS

The following documents are applicable to the CPC TAPEMASTER and will be of interest to the user:

1. User's Manual for applicable Tape Drive
2. The 8086 Family User's Manual--Intel
3. TAPEMASTER Application Note,

   CPC Publication 21020011
4. Multibus Specification,

   Intel Publication 9800683

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

This document describes the operation of the CPC TAPE-MASTER 1/2" Magnetic Tape Drive Adaptor. It provides the information necessary for the user to incorporate the TAPEMASTER into a Multibus-based system. Sections 2 through 5 contain detailed information on the operation of the adaptor.

1.1 GENERAL DESCRIPTION

This section contains a generalized overview of the operation of the TAPEMASTER. Detailed information is contained in later sections.

The TAPEMASTER is an intelligent, fully Multibus compatible 1/2" magnetic tape drive adaptor, capable of handling up to eight 1/2" formatted, start/stop or streaming tape drives. The adaptor functions in 8 or 16 bit systems, single or multiprocessor, with 16, 20 or 24 bit addressing.

Tape operations are controlled through Parameter Blocks placed in system memory by processors requiring use of the adaptor. The location of the Parameter Block is programmable for each operation, i.e., the location is passed to the adaptor at the start of each command or chain of commands. Once an operation has begun, no further system intervention is necessary. The TAPEMASTER will complete the task or tasks assigned, and then become available for the next command.

In addition to tape operations, the TAPEMASTER can perform several powerful data move and diagnostic functions and may be used as a general purpose DMA controller. It may also be used to execute user-written 8089 programs. Refer to later sections for details.

1.2 FEATURES

* Controls up to 8 start/stop or streaming, PE or NRZI formatted drives.
* Programmable for 8 or 16 bit systems.
* Full 24-bit addresing.
* DMA operation.
* Single or multi-master environments.
* Buffered, Direct or Streaming data transfer modes.
* Bus Lock option during DMA transfers.
* Programmable Interrupt option.
* Optional on-board buffer up to 16K bytes.
* Automatic retry for all recoverable errors.
* 64-byte buffer to ease demands on the system bus.
* Powerful Block Move and Exchange commands for generalized data handling.
* Extensive self-diagnostic commands.
* May be used to execute user-written 8089 programs.
* Single 5-volt operation.

2.0 DEFINITION OF TERMS

This section defines the terms used during the detailed description of TAPEMASTER operation.

2.1 CHANNEL ATTENTION

A Channel Attention is an I/O Write to the Multibus address of the TAPEMASTER which is in the system I/O space. It is issued by the system CPU to initiate each TAPEMASTER activity. The I/O address may be set by the user via DIP switches on the board. A Channel Attention must never be issued while the TAPEMASTER is busy (i.e., Gate closed).

Since the least significant bit of the I/O address is not selectable, the TAPEMASTER occupies two addresses. The Channel Attention is defined as the even address. The odd I/O address is defined as the Software Reset. A write to this address resets the TAPEMASTER CPU (see section 3.1.1).

2.2 GATE

The Gate is a byte of data in system memory which controls all access to the TAPEMASTER. It is located in the Channel Control Block in system memory (see section 3.1.4). The Gate may have two values - closed (FFH) or open (00H). A system CPU may only give the TAPEMASTER a command when the Gate is open. Before a system CPU issues a Channel Attention, it should close the Gate using a Test-and-Set type instruction. When the command completes, the TAPEMASTER will open the Gate and will be ready to accept another command.

2.3 POINTER

When system memory addresses are passed to the TAPEMASTER, they must be in the form of a Pointer. Following the Intel 8086 convention, a Pointer consists of two 16-bit words which are combined by the TAPEMASTER to form a 20-bit system memory address. The word at the higher address, or Base, is left-shifted by four bits and added to the lower addressed word, or Offset, to obtain the 20-bit result. Refer to Fig. 2-1 and to the Intel 8086 Family User's Manual for a more detailed discussion of Pointers.

Base left-shifted 4 bits and added to Offset - Bits 20-23 set to 0

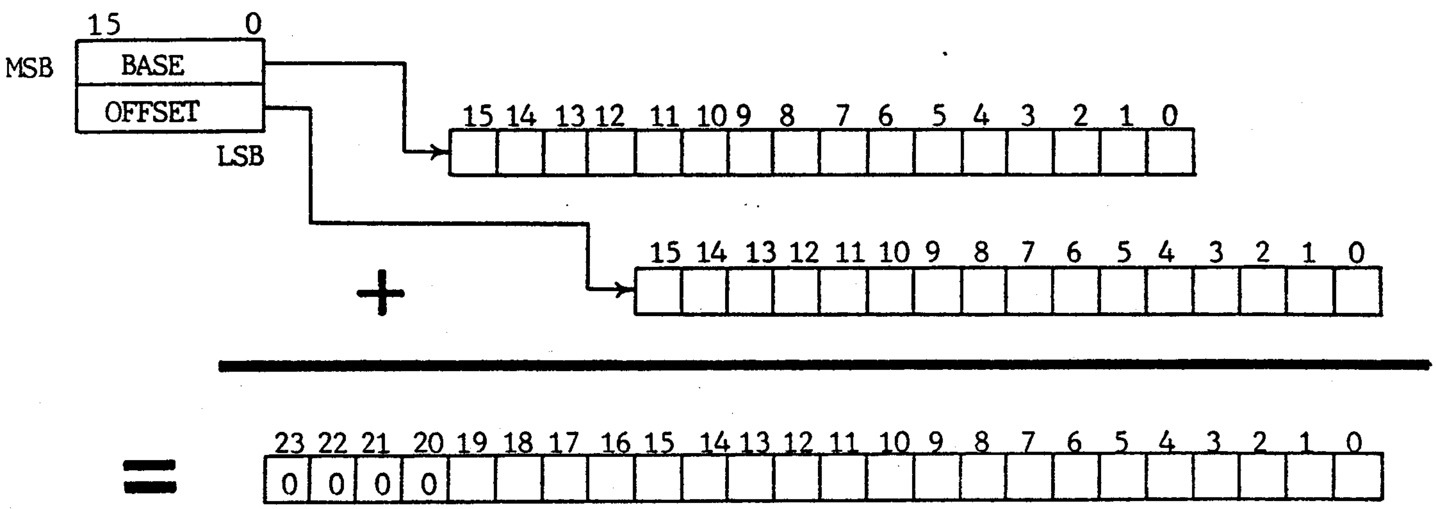

Figure 2-1. Pointer Value

To accomodate 24-bit addressing, the TAPEMASTER uses a 4-bit Page Register, which may be loaded by the user. The Page Register contains system address bits 20-23 (see section 5.1.2).

2.4 PARAMETER BLOCK

A Parameter Block is a short block of consecutively addressed data placed in system memory by a processor in preparation for command execution. The Parameter Block contains information the TAPEMASTER requires to perform the desired operation. The TAPEMASTER command always occupies the first byte of the Parameter Block, which is at the lowest-addressed location.

When execution of a TAPEMASTER command begins, the Parameter Block is read by the TAPEMASTER into Local memory and, just prior to opening the Gate, it is rewritten to system memory with appropriate updates.

3.0 FUNCTIONAL DESCRIPTION

This section contains a detailed description of the operation of the TAPEMASTER.

Operation may be separated into 2 parts: Initialization and Command Execution. All operations are initiated with the issuance of a Channel Attention to the TAPEMASTER.

3.1 INITIALIZATION

Initialization is the procedure through which the TAPEMASTER receives the definition of the system environment from the host. The TAPEMASTER always executes the Intialization procedure when it receives the first Channel Attention after a board reset (sec. 3.1.1).

After the Channel Attention, the TAPEMASTER initializes itself by reading information from three control blocks located in system memory. It is the responsibility of the system to correctly set up these control blocks prior to issuing the first Channel Attention.

The three control blocks are the System Configuration Pointer, the System Configuration Block, and the Channel Control Block. The Initialization process is outlined in Fig. 3-1.

3.1.1 BOARD RESET

The TAPEMASTER board-level Reset may be executed through a system reset or software reset. A system reset occurs when the INIT/ line on the Multibus is activated (low) according to bus convention. A software reset occurs when a write to the higher (odd) I/O address of the TAPEMASTER is executed by a system processor. The two signals are logically "OR'd" together on the board.

3.1.2 SYSTEM CONFIGURATION POINTER

The 6-byte System Configuration Pointer may begin at any system memory address in the lower 1 Mbyte. The only restriction is that the least significant nibble of the address must be 6H (SCP address = XXXX6H). The remaining address bits are set via jumpers on the board.

After the first Channel Attention, the TAPEMASTER reads the first byte of the System Configuration Pointer (SYSBUS) to determine the width of the system bus (initially assumed to be 8 bits). A 00H indicates an 8-bit system bus, 01H a 16-bit bus. Byte 2 is not used. Bytes 3-6 comprise a Pointer to the next block, the System Configuration Block.

After adjusting for physical bus size, the TAPEMASTER continues to the System Configuration Block and reads that information.

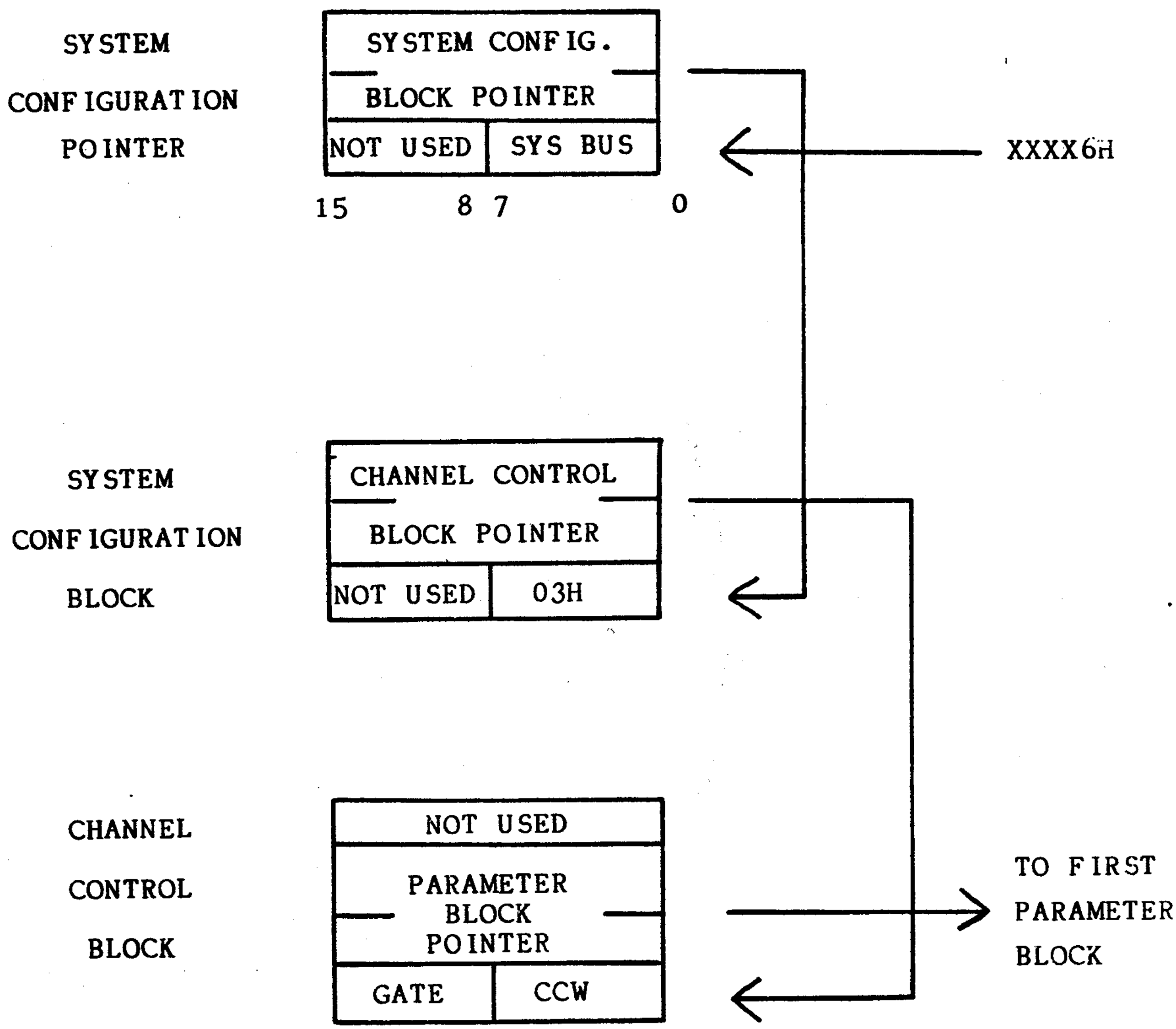

Figure 3-1. Initialization Process

3.1.3 SYSTEM CONFIGURATION BLOCK

The 6-byte System Configuration Block contains one byte whose value is fixed (03H), an unused byte and a 4-byte Pointer to the last Initialization block, the Channel Control Block. After picking up the Pointer in this block, the TAPEMASTER continues to the last block.

3.1.4 CHANNEL CONTROL BLOCK

The 8-byte Channel Control Block contains six bytes around which all TAPEMASTER operations revolve. Byte 1 is the Channel Control Word (CCW), which is used for the interrupt options. It must contain either of two values - 11H for normal operations, or 09H to clear an active non-vectored Multibus interrupt. The CCW may contain other values when executing user-written 8089 programs (See section 3.3 and 3.6 for further details).

Byte 2 is the Gate, which the TAPEMASTER uses to signal its readiness to execute a command. Bytes 3-6 (Parameter Block Pointer) form a Pointer to the location of the LSB of the first Parameter Block.

During the Initialization process, the only byte used in the Channel Control Block is the Gate. It must be set closed (set to FFH) prior to the Initialization process. When the Initialization process has been completed, the TAPEMASTER will open the Gate (set to 00H), indicating that it is now ready to execute commands. The locations used for the System Configuration Pointer and System Configuration Block, if they are RAM-based, may now be reused as required.

3.2 COMMAND EXECUTION

After the completion of the Initialization process, the TAPEMASTER is ready to accept commands, as it now "knows" the programmable locations of the Gate, and of the Parameter Block Pointer. A system processor wishing to execute a command may now do so through the following procedure:

A. Set up the Parameter Block or Blocks in memory.

B. Read the Gate location to determine when the TAPEMASTER is not busy. When the Gate is open (00H), the system processor may take control by setting it closed (FFH).
(Note: In a Multi-procesor system, a Test-and-Set type instruction must be used to close the Gate. This is necessary to prevent one processor from reading the Gate between the read and write of the Gate from a second processor).

C. After closing the Gate, the user sets the Parameter Block Pointer in the Channel Control Block to point at its first Parameter Block. It must also set the Channel Control Word as required.

D. Issue a Channel Attention to the TAPEMASTER.

The TAPEMASTER will then execute the selected command with no additional system intervention. Upon completion of each command, the TAPEMASTER may go on to another Parameter Block, or halt with or without interrupt, depending upon options selected. When it halts, it will open the Gate to signal its readiness to accept another command.

NOTE: The Configure command must be the first command executed after the Initialization process.

3.3 INTERRUPTS

The TAPEMASTER may be programmed, through the CONTROL field in the Parameter Block, to generate an interrupt at the completion of a command, (last command only in a linked chain) or if an unrecoverable error occurs. (If such an error occurs during the execution of an intermediate command in a linked chain, the TAPEMASTER will search through the chain and act on the interrupt options of the last command).

Interrupts may be of two types - Non-vectored Multibus or Mailbox interrupts.

3.3.1 NON-VECTORED INTERRUPTS

Non-vectored interrupts occur when the TAPEMASTER activates one of the eight Multibus interrupt lines. The interrupt will be asserted at the completion of the command or chain of commands for which an interrupt was enabled in the Control field. The interrupt line will remain active until it is cleared by setting the CCW to 09H and executing another TAPEMASTER command. The TAPEMASTER will clear the interrupt before it reads the Parameter Block. The Clear Interrupt command may be used here to avoid the time required for a normal Parameter Block sequence, since this command requires only a 2-byte command code and halts immediately after clearing the interrupt (see section 5.1.8).

3.3.2 MAILBOX INTERRUPTS

A Mailbox interrupt occurs when the TAPEMASTER writes data to the contents of a reserved memory location (Mailbox) at the completion of a command or chain of commands. The location of the Mailbox is stored in the Interrupt/Link Pointer field of the Parameter Block. When the TAPEMASTER has completed a command for which the Interrupt and Mailbox options were enabled in the Control field, it writes FFH to this Mailbox address. The Mailbox interrupt is most useful in Multiprocessor, position-independent systems.

3.4 DATA TRANSFER

Data can be transferred between system memory and the tape drive in three modes: Buffered, Direct or Streaming.

3.4.1 BUFFERED

During buffered data transfers, the TAPEMASTER completely buffers each block of data in on-board static RAM before transferring the data to the tape (write) or to system memory (read). Maximum block size in this mode is 16K bytes. This mode has the advantage of allowing the system memory to respond completely asynchronously, i.e., data need not be transferred at the speed required by the drive.

3.4.2 DIRECT

Direct data transfers move data directly from system memory, through the TAPEMASTER FIFO to the tape (write), or from the tape, through FIFO to memory (read). Maximum block size in this mode is 65K bytes. System memory must be able to supply or receive data at an average rate equal to or greater than that required by the tape drive.

3.4.3 STREAMING

Streaming data transfers are similar to Direct transfers, in that data is transferred directly between system memory and the tape, through the FIFO. However, unlike the Direct mode, the Streaming mode links multiple data blocks together through a 6-byte header which preceeds each block. This provides the fastest possible data transfer by eliminating the overhead of a full Parameter Block command for each block of data. In addition, the Streaming mode removes all burden of data block synchronization from the system software and accomplishes it in a single command.

3.5 TIME-OUT

The TAPEMASTER contains hardware time-out logic which injects an Acknowledge (ACK/) signal if an expected ACK/

is not received within 4ms after the start of a memory cycle. The time-out may be enabled or disabled by jumper (see Appendix D). It is recommended that TAPEMASTER software drivers be developed with the time-out disabled to more easily identify invalid addresses passed to the TAPEMASTER through the Parameter Blocks.

3.6 USER 8089 PROGRAMS

The TAPEMASTER can execute user-written 8089 programs either from system memory or Local memory. The TAPEMASTER can be directed to execute a user program by placing the starting address of the program (as a 4-byte Pointer) in the location normally occupied by the Command field of a Parameter Block. A Channel Attention begins execution.

For programs residing in system memory, the Channel Control Word in the Channel Control Block (sec. 3.1.4) should be changed from 11H to 13H. This causes the TAPEMASTER to begin execution in system memory rather than Local memory.

For programs residing in Local memory, the code must first be loaded into Local RAM using a Block Move or Exchange command. For such purposes, the TAPEMASTER Local RAM is logically located from Local address C000H. However, user programs should not start below C100H since the TAPEMASTER uses lower RAM locations for variables.

For further information, consult the 8086 Family User's Manual, or contact CIPRICO Inc.

4.0 TAPEMASTER PARAMETER BLOCKS

The TAPEMASTER uses three types of Parameter Blocks: Tape, Block Move, and Exchange. Each Parameter Block is divided into fields which may contain information needed by the TAPEMASTER (Input) and/or status information returned by the TAPEMASTER (Output). The various Parameter Blocks and their fields are described in the following section. Not all fields are used by all commands. Unused fields should be set to zero.

4.1 TAPE COMMAND EXECUTION

Tape commands allow the user to position the tape, write filemarks and to transfer data between the drive and system memory.

4.2 TAPE PARAMETER BLOCK

The normal form of the Tape Parameter Block (Fig. 4-1) contains 22 bytes which form 8 fields.

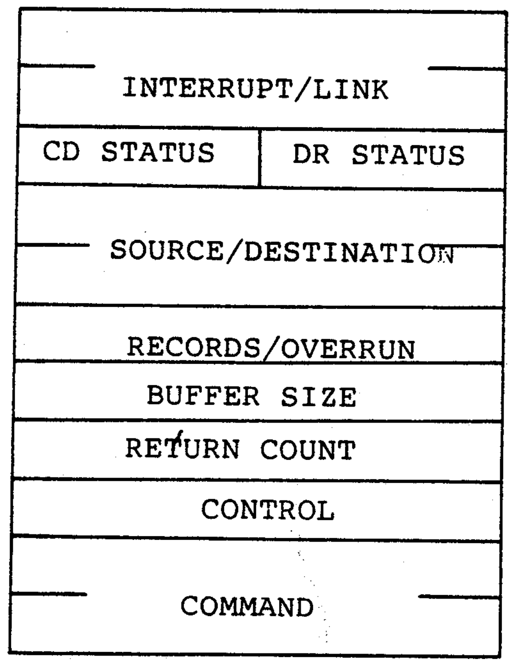

Figure 4-1 Tape Parameter Block

4.2.1 COMMAND (Input)

The lower two bytes of this field contains the hex code of the command to be executed. The upper two bytes must contain 00H for proper operation. (Command hex codes are listed in Appendix F).

4.2.2 CONTROL

This field (Fig. 4-2) contains various options used by the TAPEMASTER during operation. A bit is set if it = 1.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W		BRE	C	SD	R	SE	BS	BL	L	I	M	T	S		

Figure 4-2 Tape Control Field

TS - Tape Select: Selects one of the four tape drives on one bank. (The TAPEMASTER controls two banks composed of four drives each).

00 - Tape Drive 0	10 - Tape Drive 2
01 - Tape Drive 1	11 - Tape Drive 3

M - Mailbox Interrupts: If the I bit is set, the M bit selects Mailbox interrupts. If the M bit is not set, it selects non-vectored Multibus interrupts.

I - Interrupt: Causes the TAPEMASTER to interrupt on the completion of a command.

L - Link: Informs the TAPEMASTER that another Parameter Block follows. (The Link and Interrupt options are mutually exclusive, since each use the Source/Destination Pointer field. If both bits are set, then the Link will take priority).

BL - Bus Lock: Locks the system bus during DMA transfers.

BS - Bank Select: Selects one of the two banks. Physically, this bit is transmitted on the tape interface as the signal FAD/ (Formatter Address), pin J2-48.

0 - Bank 0
1 - Bank 1

SE - Skip EOT: Causes the TAPEMASTER to ignore the EOT signal and allow data transfers past the end of tape marker.

R - Reverse: The operation should proceed in the reverse direction where applicable.

SD - Speed/Density: Selects high speed on dual speed drives such as the Cipher Microstreamer, or low density on remote-selectable dual density drives. If this bit is not set, low speed on dual speed drives or high density on remote-selectable dual density drives is selected.

C - Continuous: Causes the tape to be left moving after a write operation (if the drive supports this feature), effectively extending the acceptable reinstruct window.

BRE - Buffered Read Enable: Allows data to be transferred from TAPEMASTER buffer to system memory when a tape time-out occurs during a Buffered Read command.

W - Width: Selects a 16-bit logical bus width. This bit may be used to force byte transfers on a 16-bit bus. If this bit is not set, the logical system bus width is 8 bits. The logical width must not exceed the physical width selected during Initialization.

4.2.3 RETURN COUNT (Output)

This field contains the block size (in bytes) actually transferred during a data transfer operation. It will also contain the size of the on-board static buffer available for buffered operations, after the execution of a Configure command.

4.2.4 BUFFER SIZE (Input/Output)

This field contains the block size of the tape block to be transferred during a data transfer operation. Maximum block size is 65K bytes (FFFFH). At the completion of a Read Foreign Tape command, this field contains bits 16-31 of the 32 bit block size read from the tape (see section 5.2.2).

4.2.5 RECORDS/OVERRUN (Input/Output)

This field contains a record count, which is required at the start of certain commands, such as the Space Command. At the completion of a Read or Buffered Read command, this field contains the number of bytes actually contained in the tape block just read. This information may be used to indicate that the record just read from the tape contained a fewer or greater number of bytes than requested in the Parameter Block. If the record just read contains more bytes than requested, the Records/Overrun field will contain a larger number than the Return Count and Buffer Size fields. If the record just read contains fewer bytes than requested, the Records/Overrun field will contain the same number as the Return Count field, but a smaller number than the Buffer Size field.

4.2.6 SOURCE/DESTINATION POINTER (Input)

This field contains the starting system memory address for those commands which access system memory.

4.2.7 DRIVE STATUS (Output)

The bits in this field (Fig. 4-3) reflect the status of the drive at the completion of a command.

7	6	5	4	3	2	1	0
FM	OL	LP	EOT	R	FB	P	

Fig. 4-3 Drive Status Field

- P - Write Protect: The tape does not have a write enable ring.
- FB - Formatter Busy: The Formatter is busy.
- R - Ready: The selected drive is ready.
- EOT - End of Tape: The EOT marker was detected.
- LP - Load Point: The tape is at Load Point.
- OL - On Line: The drive is On Line.
- FM - Filemark: A filemark was detected on this operation.

4.2.8 COMMAND STATUS (Output)

The bits in this field (Fig. 4-4) reflect the status of the command.

15	14	13	12	11	10	9	8
E	C	R	ERROR				

Fig. 4-4 Command Status Field

ERROR - This 5-bit field specifies an error code when a non-recoverable error is encountered. (Error codes are listed in Appendix C).

R - Retry: At least one retry was executed by the TAPEMASTER during this command.

C - Complete: The TAPEMASTER has successfully completed the command outlined in the Parameter Block.

E - Entered: The Parameter Block has been entered by the TAPEMASTER and has begun execution.

4.2.9 INTERRUPT/LINK POINTER (Input)

This field contains the system memory address of the next Parameter Block, if the Link bit is set, or of the Mailbox location, if the Mailbox and Interrupt bits are set.

4.3 BLOCK MOVE COMMAND EXECUTION

The TAPEMASTER can execute a Block Move, or memory-to-memory DMA operation, with many powerful options. The Parameter Block supplies the source address and destination address, either or both of which may be Local (on the TAPEMASTER board) or system memory. The byte count and options are also selected in the Parameter Block.

4.4 BLOCK MOVE PARAMETER BLOCK

The Block Move Parameter Block (Fig. 4-5) contains 28 bytes which form 10 fields.

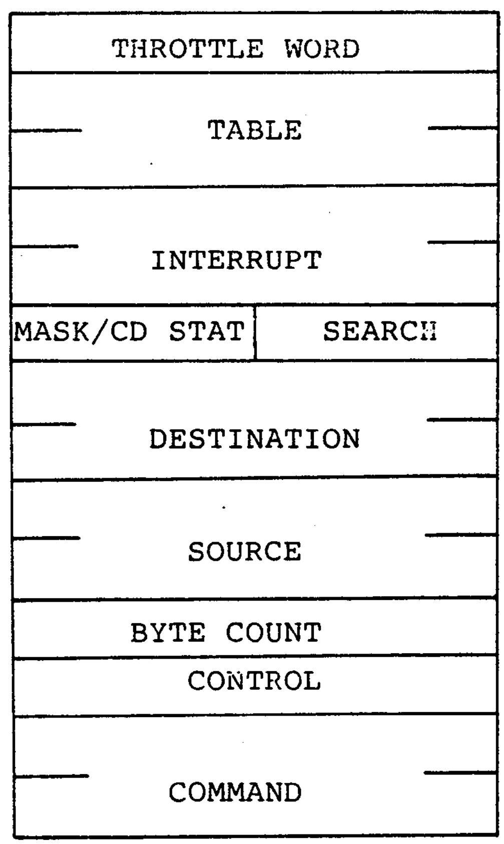

Figure 4-5 Block Move Parameter Block

4.4.1 COMMAND (Input)

The lower two bytes of this field contain the Block Move command hex code, 80H. The upper two bytes must contain 00H for proper operation.

4.4.2 CONTROL (Input)

This field (Fig. 4-6) contains various options used by the TAPEMASTER during the Block Move command. A bit is set if it = 1.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		DL	SL	TH	NC	S	T	BL	L	I	M	DW	DI	SW	SI

Figure 4-6 Block Move Control Field

SI - Source I/O: Causes the source address of the Block Move to remain constant after each transaction. If this bit is not set, the source address will increment.

SW - Source Width: Selects the logical width of the source as 16 bits. If this bit is not set, the logical width of the source is 8 bits.

DI - Destination I/O: Causes the destination address of the Block Move to remain constant after each transaction. If this bit is not set, the destination address will increment.

DW - Destination Width: Selects the logical width of the destination as 16 bits. If this bit is not set, the logical width of the destination is 8 bits.

M, I, L and BL are the same as for the Tape Control field in section 4.2.3.

T - Translate: Causes each byte from the source to be translated from a look-up table before being moved to the destination.

S - Search: Causes the TAPEMASTER to check each source byte against the Search field during the transfer, and stop on a compare or noncompare (see NC bit). Before the compare is made, each source byte is first masked with the Mask field, so that only desired bits are checked.

NC - Non-compare: If the S bit is set, the NC bit causes a search operation to stop when a source byte and the Search field are different (non-compare). If the NC bit is not set, a search operation will stop when a Source byte and the Search field are identical (compare).

TH - Throttle: Causes the TAPEMASTER to inject a delay between each byte or word transferred. The length of the delay is specified in the Throttle Word field of the Parameter Block. This option is used to prevent the TAPEMASTER from monopolizing the bus during a non-critical Block Move operation.

SL - Source Local: Specifies the source address as a 16-bit Local address (i.e., on the TAPEMASTER board). If this bit is not set, the source address is a 20 bit system memory address specified by a 4-byte Pointer.

DL - Destination Local: Specifies the destination address as a 16-bit Local address (i.e., on the TAPEMASTER board). If this bit is not set, the destination address is a 20-bit system memory address specified by a 4-byte Pointer.

4.4.3 BYTE COUNT (Input/Output)

At the start of the command, this field contains the number of bytes to be transferred. At the completion of the command, this field contains the number of bytes remaining to be transferred. Normally, this field would contain zeros at the termination of the command, indicating all bytes were transferred. However, if the Search bit is set, the Block Move may terminate on a Compare, and the Byte Count field will contain the number of remaining bytes.

4.4.4 SOURCE POINTER (Input)

This field contains the starting Local or system memory address from which data is to be moved. (If the source is Local, only the lower two bytes of this field are used).

4.4.5 DESTINATION POINTER (Input)

This field contains the starting Local or system memory address to which data is to be moved. (If the destination is Local, only the lower two bytes of this field are used).

4.4.6 SEARCH (Input)

This field contains an 8-bit value which is compared to each source byte, when the Search bit is set in the Control field.

4.4.7 MASK/COMMAND STATUS (Input/Output)

At the start of the command, this field contains an 8-bit value to which each source byte is masked before being compared to the Search field, if the Search bit it set. After the completion of the command, this field reflects the status of the command. (Fig. 4-7).

7	6	5	4	3	2	1	0
E	C	F	ERROR				

Fig. 4-7 Command Status Field

The E, C, and ERROR fields are the same as for the Tape Command Status field in section 4.2.8.

F - Found: indicates a match was found during a search operation.

4.4.8 INTERRUPT POINTER (Input)

This field contains the location of the Mailbox if the Mailbox and Interrupt bits are set.

4.4.9 TABLE POINTER (Input)

This field contains the starting system memory address of a 256-byte look-up table. If the Translate bit is set, each source byte is used as an index into this table. The entry at that table location is then moved to the destination.

4.4.10 THROTTLE WORD (Input)

This field contains the length of delay between each transferred byte or word, if the Throttle bit in the Control field is set. This 16-bit number is counted down to 0000 before each transfer at a rate of approximately 100 micro-seconds per count.

4.5 EXCHANGE COMMAND EXECUTION

The TAPEMASTER executes an Exchange command which will exchange part or all of the available TAPEMASTER RAM, on a byte basis, with system memory. The Parameter Block supplies the system memory address, the relative current Local address and the byte count to be exchanged.

4.6 EXCHANGE PARAMETER BLOCK

The Exchange Parameter Block (Fig. 4-8) contains 22 bytes which form 9 fields.

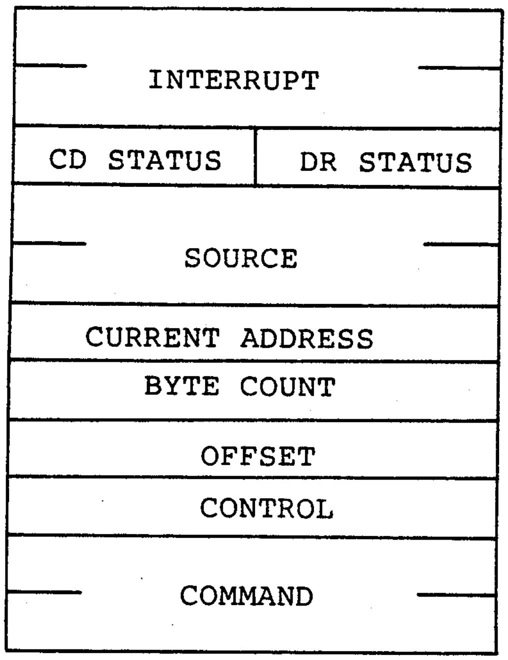

Figure 4-8 Exchange Parameter Block

4.6.1 COMMAND (Input)

The lower two bytes of this field contain the Exchange command hex code, OCH. The upper two bytes must contain 00H for proper operation.

4.6.2 CONTROL (Input)

This field (Fig. 4-9) contains only two options used by the TAPEMASTER during an Exchange command.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
										I	M				

Figure 4-9 Exchange Control Field

M and I are the same as for the Tape Control field in section 4.2.2.

4.6.3 OFFSET (Input)

This field contains the relative address in Local memory where the exchange will start. An offset of zero will result in a physical Local address of C100H.

4.6.4 BYTE COUNT (Input/Output)

At the start of the command, this field contains the number of bytes to be exchanged. At the completion of the command, this field contains the number of bytes remaining to be transferred. If a successful exchange has occurred, this field will contain zeros.

4.6.5 CURRENT ADDRESS (Output)

This field contains the current Local address. It is updated after command completion.

4.6.6 SOURCE POINTER (Input)

This field contains the starting system memory address.

4.6.7 DRIVE STATUS

This field is not used.

4.6.8 COMMAND STATUS (Output)

The bits in this field (Fig. 4-4) reflect the status of the command.

4.6.9 INTERRUPT POINTER (Input)

This field contains the Mailbox location, if the Mailbox and Interrupt bits in the Control field are set.

5.0 TAPEMASTER COMMANDS

The TAPEMASTER executes 31 commands in five catagories. Refer to the TAPEMASTER Parameter Block descriptions for the contents and significance of the Parameter Block fields. The Command Code (in hex) follows each command.

5.1 CONTROL STATUS COMMANDS

These commands transfer control and status information to and from the TAPEMASTER and/or the drives.

5.1.1 CONFIGURE (00)

This command initializes the on-board registers and memory of the TAPEMASTER, and calculates the buffer space which is available for buffered operations. The buffer size (in hex bytes) is returned in the Return Count field. This command must be the first command to be executed after the Initialization sequence.

5.1.2 SET PAGE REGISTER (08)

This command sets the 4-bit Page Register on the TAPE-MASTER. This register, which is cleared on Reset, contains the system memory address bits A20-A23. When this register is set, all TAPEMASTER memory references will use this register as the upper four bits of a 24-bit address. The Page Register contents are specified in bits 0-3 of the Records field.

5.1.3 NOP (20)

No operation. This command executes the mechanics of normal Parameter Block operation.

5.1.4 DRIVE STATUS (28)

This command returns the status of the selected drive in the Drive Status field.

5.1.5 TAPE ASSIGN (74)

This command is reserved to account for differences between formatters from various manufacturers, and to maintain compatibility between the TAPEMASTER and RIMFIRE 38T. For the software revision level referenced by this document, this command is equivalent to a NOP, and requires only the Command Code in the Command field.

5.1.6 SET RETRY (8C)

This command selects the number of times a recoverable error is retried. The number of retries, up to FFH, is specified in the LSB of the Records field. The default value is 6.

5.1.7 DRIVE RESET (90)

This command resets the selected Formatter Enable. It may be used to abort a run-away tape condition.

5.1.8 CLEAR INTERRUPT (9C)

This command clears an active Multibus interrupt and halts if the CCW in the Channel Control Block is set to 09H. The command requires only the Command Code in the Command field. The TAPEMASTER does not update the Parameter Block after the operation is complete.

5.2 TAPE POSITION COMMANDS

These commands move the tape to a known position relative to the read/write head, or perform various other functions which require the tape to be moved. No data is transferred between system memory and the tape.

5.2.1 OVERLAPPED REWIND (04)

This command initiates a Rewind command. Periodic Tape Status commands may then be executed to check for Load Point.

5.2.2 READ FOREIGN TAPE (1C)

This command searches for the next record and counts the bytes in that record. Data is ignored. The byte count is returned as a 32-bit hex number in the Return Count field (bits 0-15) and Buffer Size field (bits 16-31).

5.2.3 REWIND (34)

This command rewinds the tape to Load Point.

5.2.4 OFFLINE/UNLOAD (38)

This command causes the drive to go offline. For the Cipher Data Microstreamer, it also causes the tape to rewind and unload.

5.2.5 WRITE FILEMARK (40)

This command writes a filemark on the tape.

5.2.6 SEARCH FILEMARK (44)

This command searches, forward or reverse, until a filemark is found. If an EOT (forward) or Load Point (reverse) is encountered, this command will terminate early.

5.2.7 SPACE (48)

This command spaces, forward or reverse, a specified number of records. A filemark is counted as a record. The desired number of records is specified in the Records field.

5.2.8 ERASE FIXED LENGTH (4C)

This command erases a fixed length (approximately 3.5 inches) for each record specified in the Records field.

5.2.9 ERASE TAPE (50)

This command erases the entire tape from current position to several feet beyond the EOT.

5.2.10 SPACE FILEMARK (70)

This command is similar to Space except that it terminates early if a filemark is encountered before all the records are spaced over.

5.2.11 SEARCH MULTIPLE FILEMARKS (94)

This command is similar to a Search Filemark except that it proceeds until a specified number of consecutively written filemarks are located. This command is very useful when using double or triple filemarks as file separators. The number of filemarks, up to 255, is specified in the LSB of the Records field.

5.3 DATA TRANSFER COMMANDS

Data Transfer commands transfer data from the tape to system memory (read) or from system memory to the tape (write, edit). The desired data block size, in bytes, is contained in the Buffer Size field. The starting system memory address is contained in the Source/Destination Pointer field.

When the TAPEMASTER has completed the operation, the number of bytes actually transferred is returned in the Return Count field. For successful operations, this field will match the Buffer Size field. For all read commands, the TAPEMASTER will also return the actual number of bytes in the record in the Records/Overrun field.

5.3.1 BUFFERED READ (10)

This command transfers a data block from the tape to system memory in a two-part operation. Data is first moved from the tape to TAPEMASTER buffer, and then from buffer to system memory. This command eliminates any restrictions on system memory response time. Maximum block size is 16K bytes.

5.3.2 BUFFERED WRITE (14)

This command transfers a data block from system memory to the tape in a two-part operation. Data is first moved from system memory to TAPEMASTER buffer, and then to the tape from buffer memory. This command eliminates any restrictions on system memory response time. Maximum block size is 16K bytes.

5.3.3 BUFFERED EDIT (18)

This command edits, in Buffered mode, the record immediately preceeding the current position of the read/write head. Maximum block size is 16K bytes.

5.3.4 DIRECT READ (2C)

This command transfers a data block from the tape to system memory. The system must accept data at an average rate equal to or greater than that of the drive. Maximum block size is 65K bytes.

5.3.5 DIRECT WRITE (30)

This command transfers a data block from system memory to the tape. The system must supply data at an average rate equal to or greater than that of the drive. Maximum block size is 65K bytes.

5.3.6 DIRECT EDIT (3C)

This command edits, in Direct Mode, the record immediately preceeding the current position of the read/write head. Maximum block size is 65K bytes.

5.3.7 STREAMING READ (60)

The Streaming Read command transfers multiple blocks of data from the tape to system memory in the Direct mode. Multiple blocks are used to allow the user to provide a continuous source of data to the tape, which may be necessary to maintain streaming operation.

The Streaming Read requires one or more data blocks in system memory. Each block contains an 8-byte Block Header (Fig. 5-2) and a data area of variable length. The header contains several handshake bits, a byte count and a pointer to the next block, if one follows. Figure 5-1 indicates how multiple blocks, in this case three blocks, can be linked together.

When the TAPEMASTER begins a Streaming Read command, it proceeds to the first block and waits at the Block Gate until the Ready bit is set by the system. When this occurs and no faults are present, it clears "Ready", sets "Busy", reads the next record from the tape and fills the data area in the system memory block. The TAPEMASTER then clears "Busy", sets the "Complete" bit in the Block Gate, proceeds to the next block and repeats the same process, continuing until it enters a block the the "Last Block" bit set. Figure 5-3 diagrams the manner in which the TAPEMASTER handles the Block Gate and enters the block.

The Streaming Read command is useful for high-speed, streaming restore operations and provides for simple synchronization with the destination device (usually a disk).

5.3.8 STREAMING WRITE (64)

The Streaming Write command transfers multiple blocks of data from system memory to the tape in a manner similar to the Streaming Read (see Fig. 5-1, 5-2 and 5-3).

This command is useful for high speed, streaming dump operations and provides for simple synchronization with the source device (usually a disk).

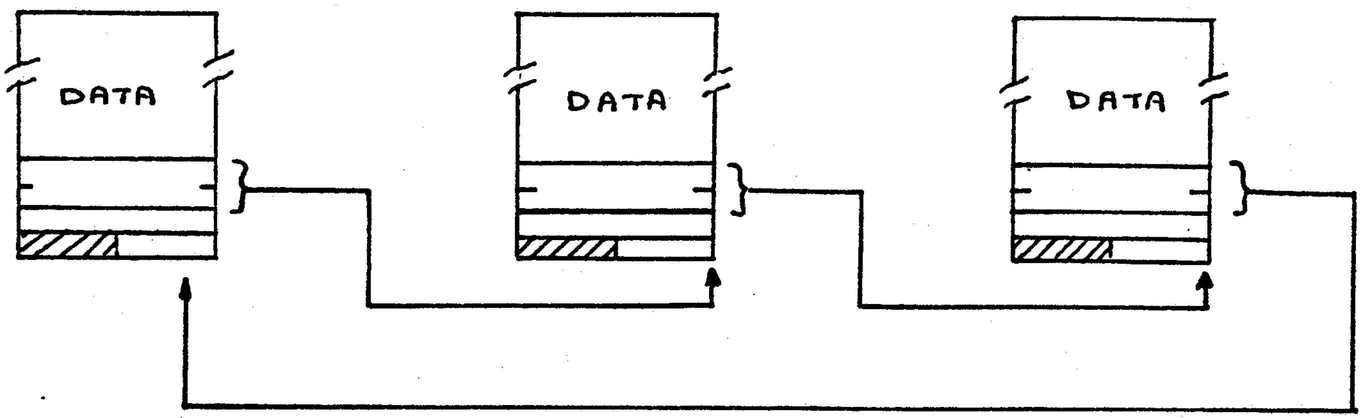

Figure 5-1 Streaming Read or Write

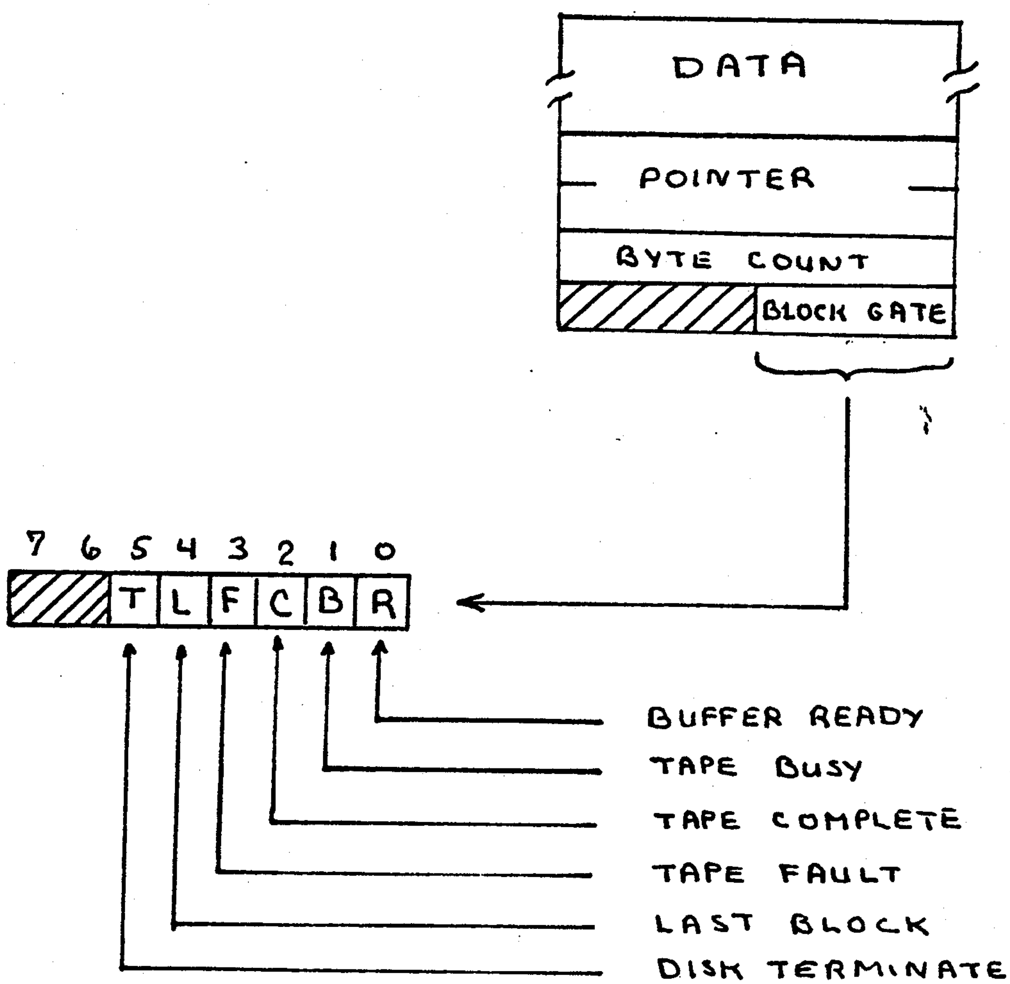

Figure 5-2 Streaming Block Header

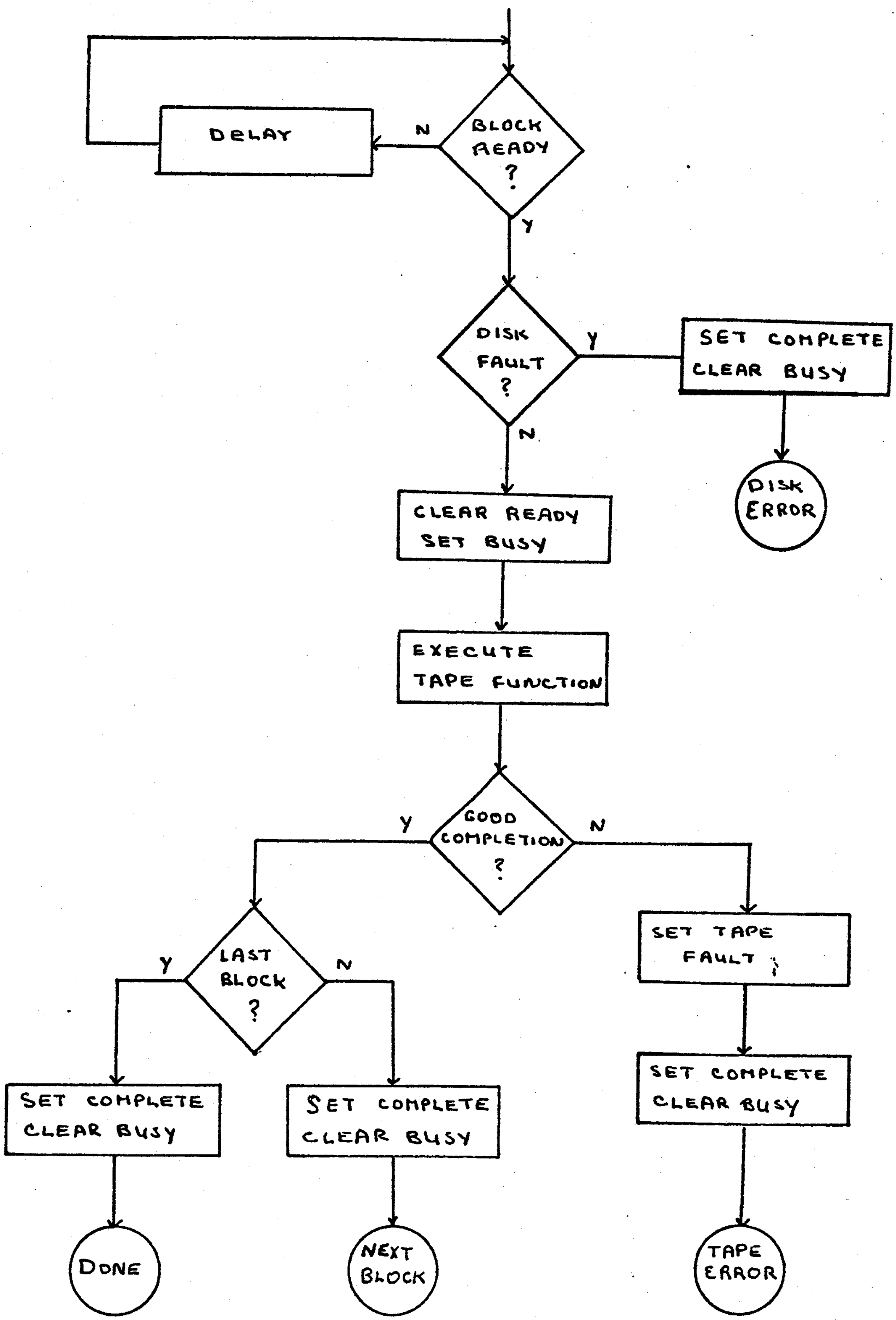

Figure 5-3 Streaming Block Gate Sequence

5.4 SPECIAL COMMANDS

The TAPEMASTER executes two Special commands which are not related to tape functions, and can be executed without the drive connected. These commands are provided to fully utilize the power of the 8089 CPU.

5.4.1 BLOCK MOVE (80)

This command moves up to 65K bytes of data between two memory locations. Either location may be local (on the TAPEMASTER board) or system memory, and may be constant or incrementing.

Several operations may be performed on the data during the Block Move command as outlined in section 4.3.

The Block Move provides a powerful tool for any Multibus system. Some example usages are:

* Extended Memory - Since the TAPEMASTER can address 16 Mbytes (24 address bits), it can be used in conjunction with a compatible memory board to provide access to memory not normally accessible to system processors.

* Memory-mapped I/O - If I/O devices are mapped in memory space, the Block Move can be used to transfer data to or from a peripheral such as a line printer or CRT. By using several of the options, the Block Move could be further extended to perform more complex I/O functions. For example, it could transfer data to a line printer, performing a conversion en route, then monitor the printer status byte and proceed when ready to the next line.

* User 8089 programs - The Block Move may be used to download a user-written 8089 program from system memory to TAPEMASTER RAM for execution (see section 3.6).

5.4.2 EXCHANGE (OC)

The Exchange command exchanges part or all of the available TAPEMASTER RAM with system memory on a byte basis. This command is useful for debugging purposes.

5.5 DIAGNOSTIC COMMANDS

The TAPEMASTER executes two diagnostic commands which are used to test TAPEMASTER RAM. These commands will operate only if jumpers 59-60 are connected on the TAPEMASTER board (see Appendix D). A Configure command must follow the execution of any diagnostic command or commands.

5.5.1 SHORT MEMORY TEST (54)

Consult factory.

5.5.2 LONG MEMORY TEST (58)

Consult factory.

APPENDICES

APPENDIX A - SPECIFICATIONS

Physical:	Height	6.75 in.	
	Length	12.00 in.	
Electrical:	Voltage +5v ±5%		
	Current	Typical	Maximum
	2K	2.55	2.60
	16K	3.00	3.10
Capacity:	8 drives		
Drives Controlled:	All drives complying with industry standard formatted interface.		
Transfer Rate:	Tape speed to 500 KBps (16 bit system) to 330 KBps (8 bit system) (400 ns ACK)		
MTBF:	71,000 hours		
Environmental:	0-55 degrees ambient (degrees C)		
Bus Interface:	Fully Intel Multibus compatible		
Mating Connectors:	J1, J2 -3M No. 3425 or equivalent		
	P1 -Viking No. 2VH43/1AV5 or equivalent		

APPENDIX B - CABLES

The TAPEMASTER requires two (2) 50-pin flat cables to the tape drive. Cables come in standard 10 and 20 foot lengths. Other lengths are available as special order items. Daisy-chain cables are also available. Part numbers are given in table B-1.

CPC P/N	Length	Function
81011021	10 ft.	TAPEMASTER J1 to Tape P1
81011022	20 ft.	TAPEMASTER J1 to Tape P1
81011011	10 ft.	TAPEMASTER J2 to Tape P2
81011012	20 ft.	TAPEMASTER J2 to Tape P2
81011041	10 ft.	Daisy-chain cable for Tape P1
81011042	20 ft.	Daisy-chain cable for Tape P1
81011051	10 ft.	Daisy-chain cable for Tape P2
81011052	20 ft.	Daisy-chain cable for Tape P2

TABLE B-1 TAPEMASTER Cable Part Numbers

All cables should be installed such that pin 1 on the drive and the TAPEMASTER are connected.

Some formatters utilize a single 100 pin board-edge connector instead of two 50-pin connectors. In such cases, an adaptor board may be obtained from the manufacturer.

APPENDIX C - ERROR CODES

This section lists the codes for unrecoverable errors detected by the TAPEMASTER during the execution of a command. The code is returned in bits 0-4 of the Command Status field.

Code	Description
00	No unrecoverable error.
01	Timed out waiting for expected Data Busy false.
02	Timed out waiting for expected Data Busy false, Formatter Busy false and Ready true.
03	Timed out waiting for expected Ready false.
04	Timed out waiting for expected Ready true.
05	Timed out waiting for expected Data Busy true.
06	A memory time-out occurred during a system memory reference.
07	A blank tape was encountered where data was expected.
08	An error occurred in the micro-diagnostic.
09	An unexpected EOT was encountered during a forward operation, or Load Point during a reverse operation.
0A	A hard or soft error occurred which could not be eliminated by retry.
0B	A read overflow or write underflow occurred. This error indicates that the FIFO was empty when data was requested by the tape during a write, or full when the tape presented a byte during a read.
0C	Not used.
0D	A read parity error occurred on the byte interface between the drive and the TAPEMASTER.
0E	An error was detected while calculating a checksum on the PROM.
0F	A tape time-out occurred, because the tape drive did not supply an expected read or write strobe. This normally occurs when attempting to read a larger record than was written.
10	Tape not ready.
11	A write was attempted on a tape without a write-enable ring.
12	Not used.
13	The diagnostic mode jumper was not installed while attempting to execute a Diagnostic command.
14	An attempt was made to link from a command which does not allow linking.
15	An unexpected filemark was encountered during a tape read.
16	An error in specifying a parameter was detected by the TAPEMASTER. The usual cause is an entry in the Byte Count field which is zero or too large.
17	Not used.
18	An unidentifiable hardware error occurred. Consult factory.
19	A streaming read or write operation was terminated by the operating system or disk.

APPENDIX D - JUMPER SETTINGS

This section describes the setting of jumpers and DIP switches on the TAPEMASTER board. Factory settings are indicated with an asterisk (*).

1. Jumpers 1-2 (BPRO/)

   These jumpers are set according to the type of bus priority used on the Multibus.

   * Serial Priority - Jumper 1-2
   Parallel Priority - No jumper

2. Jumpers 3-5, 51-53 (Bus Arbitration)

   These jumpers control the conditions under which the TAPEMASTER surrenders control of the Multibus during a transfer sequence. Jumpers 3,4,5 allow CBRQ/ to be jumpered low (3-5) or to the Multibus (3-4). Jumpers 51,52,53 allow the ANYQRST input on the 8289 Bus Arbiter to be jumpered high (51-52) or low (52-53). Four configurations are possible.

	Mode	Jumper	Description
	1	3-4 52-53	The TAPEMASTER will surrender the bus to a higher priority master, when that master activates CBRQ/.
	2	3-4 51-52	The TAPEMASTER will surrender the bus to a higher or lower priority master, when that master activates CBRQ/.
*	3	3-5 51-52	The TAPEMASTER will surrender the bus after each transfer cycle.
	4	3-5 52-53	The TAPEMASTER will surrender the bus to a higher priority master after every cycle.

3. Jumpers 18-22 (Maintenance)

   These jumpers are used at the factory to allow the insertion of the CPC 8089 Emulator into the CPU socket.

   Maintenance Mode - Jumper 19-21, 20-22
   * Normal Mode - Jumper 18-19, 20-21

4. Jumpers 15-16 (I/O Address Bus Width)

These jumpers select the width of the I/O Address Bus.

* 8-bit address - No jumper
16-bit address - Jumper 15-16

5. Jumpers 23-24

* Not used - must not be jumpered

6. Jumpers 25-30 (Cable parity)

These jumpers control generation and checking of parity on the byte bus between the TAPEMASTER and the drive.

* Check odd parity	-	Jumper 25-26
Check even parity	-	Jumper 26-27
* Generate odd parity	-	Jumper 28-29
Generate even parity	-	Jumper 29-30

7. Jumpers 31-50 (Initialization Address)

These jumpers allow the user to select the upper 16 bits of the 20-bit System Configuration Pointer address (see sec. 3.1.2). This address is normally set once to the optimum location for a particular system and is not changed thereafter.

The address is set in two groups of eight bits. Each group is set in a similar fashion. Each group contains 10 pins - 8 pins corresponding to address bits, one pin to a pull-up, and one to a ground. Those address bits which are to be active are daisy-chained to the pull-up, and those which are to be inactive are daisy-chained to the ground.

The pins have the following signficance.

31 - Ground	41 - Ground
32 - A4	42 - A12
33 - A5	43 - A13
34 - A6	44 - A14
35 - A7	45 - A15
36 - A8	46 - A16
37 - A9	47 - A17
38 - A10	48 - A18
39 - A11	49 - A19
40 - Pull-up	50 - Pull-up

As an example, Fig. D-1 indicates the connections necessary to set the address to 0FFF6H. (The lowest nibble is not selectable and must be 6H).

* Factory setting is 0FFF6H, unless requested otherwise.

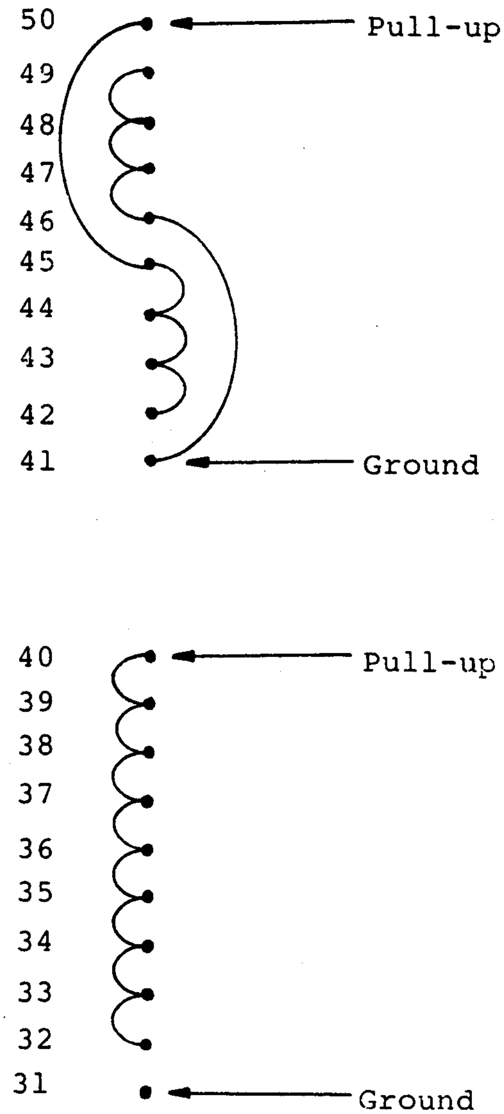

Fig. D-1 Initialization Address 0FFF6H

8. Jumper 51-53 (ANYRQST)

   See paragraph 2 of this Appendix.

9. Jumper 54-56 (PROM type)

   These jumpers select the PROM type, which is 2732(A) for the standard TAPEMASTER.

*   2732(A) PROM type - Jumper 54-55

10. Jumper 57-58 (Bus Time-Out)

   These jumpers enable or disable the system bus time-out.

   Time-out enabled - Jumper 57-58
*   Time-out disabled - No Jumper

11. Jumper 59-60 (Diagnostics)

These jumpers allow the execution of the diagnostic commands in section 5.5.

Diagnostic Mode - Jumper 59-60
* Normal Mode - No Jumper

12. Jumper INT, I0-I7 (Interrupts)

These jumpers select the non-vectored interrupt priority level by connecting the INT pin to the appropriate level (I0 = Interrupt 0, I7 = Interrupt 7).

* Factory setting is Interrupt level 7.

13. DIP Switch (Channel Attention, Software Reset, Bus Width)

The two DIP switches are used to select the Channel Attention address, the Software Reset address and the width of the system bus. Bit signficance is marked on the silkscreen on the board. Bit switches "A1" through "A15" select the upper 15 bits of the two I/O addresses and bit switch "8/16" selects the width of the system bus. Since the least significant bit of the I/O address is not selectable, the Channel Attention is defined as the lower or even address and the Software Reset is defined as the higher or odd address. A bit will be decoded as a "1" (active) if the corresponding switch is set towards the "1" on the silkscreen (open).

As an example, Fig. D-2 shows the switch settings for a Channel Attention address of 0FFAAH and a Software Reset address of 0FFABH, using a 16-bit data bus.

* Factory setting is XXAAH, using a 16-bit data bus, unless requested otherwise.

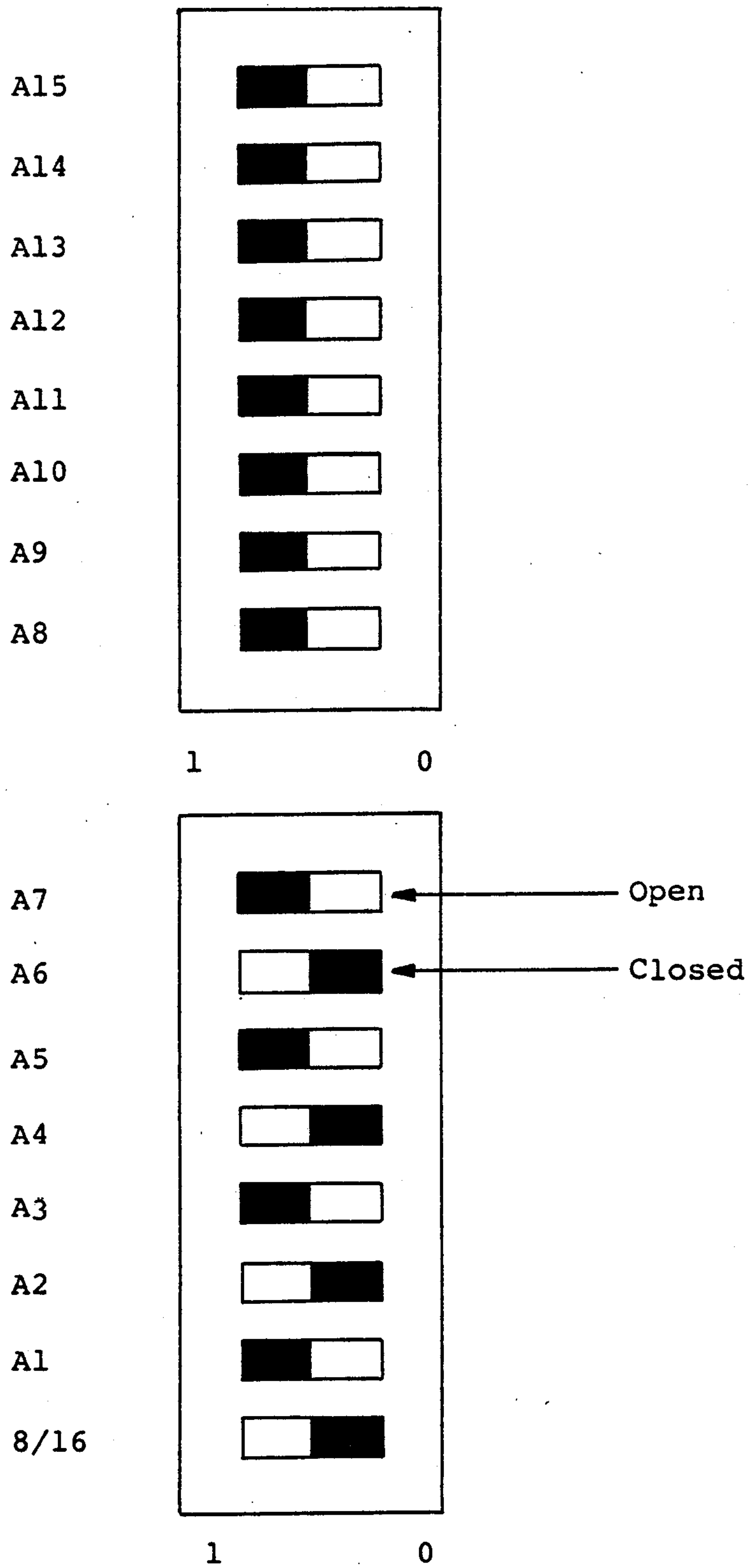

Figure D-2 Channel Attention Address OFFAAH

APPENDIX E - CONNECTOR PIN-OUTS

J1 Pin	Signal Description	J2 Pin	Signal Description
1	Ground	1	Read Parity
2	Formatter Busy	2	Read Data 0
3	Ground	3	Read Data 1
4	Last Word	4	Load Point
5	Ground	5	Ground
6	Write Data 4	6	Read Data 4
7	Ground	7	Ground
8	Initiate Command	8	Read Data 7
9	Ground	9	Ground
10	Write Data 0	10	Read Data 6
11	Ground	11	Ground
12	Write Data 1	12	Hard Error
13	Ground	13	Ground
14	Not Used	14	Filemark
15	Ground	15	Ground
16	Not Used	16	CCG/IDENT
17	Ground	17	Ground
18	Reverse	18	Formatter Enable
19	Ground	19	Ground
20	Rewind	20	Read Data 5
21	Ground	21	Ground
22	Write Parity	22	End of Tape
23	Ground	23	Ground
24	Write Data 7	24	Offline/Unload
25	Ground	25	Ground
26	Write Data 3	26	Not Used
27	Ground	27	Ground
28	Write Data 6	28	Ready
29	Ground	29	Ground
30	Write Data 2	30	Not Used
31	Ground	31	Ground
32	Write Data 5	32	File Protect
33	Ground	33	Ground
34	Write	34	Read Strobe
35	Ground	35	Ground
36	Read Threshold 2	36	Write Strobe
37	Ground	37	Ground
38	Edit	38	Data Busy
39	Ground	39	Ground
40	Erase	40	Not Used
41	Ground	41	Ground
42	Write Filemark	42	Corrected Error
43	Ground	43	Ground
44	Not Used	44	On Line
45	Ground	45	Ground
46	Transport Address 0	46	Transport Address 0
47	Ground	47	Ground
48	Read Data 2	48	Formatter Address
49	Ground	49	Ground
50	Read Data 3	50	Speed/Density

APPENDIX F - COMMAND CODES

This section lists the hex codes for all TAPEMASTER Commands.

Group I. Control Status Commands

- 00 - Configure
- 08 - Set Page Register
- 20 - No Operation (NOP)
- 28 - Drive Status
- 74 - Tape Assign
- 8C - Set Retry
- 90 - Drive Reset
- 9C - Clear Interrupt

Group II. Tape Position Commands

- 04 - Overlapped Rewind
- 1C - Read Foreign Tape
- 34 - Rewind
- 38 - Offline/Unload
- 40 - Write Filemark
- 44 - Search Filemark
- 48 - Space
- 4C - Erase Fixed Length
- 50 - Erase Tape
- 70 - Space Filemark
- 94 - Search Multiple Filemarks

Group III. Data Transfer Commands

- 10 - Buffered Read
- 14 - Buffered Write
- 18 - Buffered Edit
- 2C - Direct Read
- 30 - Direct Write
- 3C - Direct Edit
- 60 - Streaming Read
- 64 - Streaming Write

Group IV. Special Commands

- 80 - Block Move
- OC - Exchange

Group V. Diagnostic Commands

- 54 - Short Memory Test
- 58 - Long Memory Test

TAPEMASTER Application Note

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REVISION INFORMATION

Revision Record

Revision	Date	Comments
01	8-1-81	Initial Release

Revision Cross Reference

This document is revision__________________ date__________

This document is valid for:

TAPEMASTER Firmware set________________

TAPEMASTER Board Number________________

Part Number________________

TABLE OF CONTENTS

1.0 OVERVIEW

This document is intended to aid the user in the incorporation of the CPC TAPEMASTER Tape Adaptor into a Multibus-based computer system. This document does not replace the TAPEMASTER Product Specification, but is intended as a supplement to it.

Section 1 provides a brief summary of the outline of this Application Note.

Section 2 is a check list of steps to perform to cause the TAPEMASTER to execute commands in its repertoire.

Section 3,4 and 5 offer examples of various Parameter Blocks, program listings and flow charts for TAPEMASTER command execution.

Section 6 discusses the use of the TAPEMASTER control options.

Section 7 outlines error recovery procedures.

Section 8 outlines a complete TAPEMASTER Command Test.

The Appendices discuss several of the drives which the TAPEMASTER controls.

2.0 TAPEMASTER START UP CHECKLIST

The purpose of this checklist is to aid the user in establishing communications between the CPC TAPEMASTER and the host system, and causing the TAPEMASTER to be ready to accept commands from the host. Refer to the TAPEMASTER Product Specification and other sections of this document for details of the various steps below.

To incorporate the TAPEMASTER into a Multibus-based system, perform the following steps:

I. Before applying power, set these straps on the board. Refer to the TAPEMASTER Product Specification, Appendix D. Retain the factory settings on all other jumpers.

   A. Channel Attention/Board Reset (DIP Switch).

   B. 8/16 bit system data bus (DIP Switch).

   C. 8/16 bit I/O address (15-16).

   D. Initialization Address (31-50).

   E. Bus Arbitration (1-5, 51-53).

II. Insure that the host system properly handles all Multibus signals associated with Bus Priority. The TAPEMASTER will operate in a serial or parallel priority system.

III. Assert a reset to the TAPEMASTER, either by activating the INIT/ line on the Multibus, or by executing an I/O write to the TAPEMASTER Reset address.

IV. Set up the three control blocks necessary for the Initialization sequence and issue a Channel Attention. The TAPEMASTER always executes an Initialization sequence when it recieves the first Channel Attention after a reset. Initialization is executed only once.

V. Set up any command Parameter Block, close the Gate and issue a Channel Attention. When the TAPEMASTER has completed the command, it will open the Gate. Do not proceed until this occurrs.

   Begin with simpler commands (Configure, NOP, Status) until the TAPEMASTER operation becomes familiar.

3.0 INITIALIZATION

Before the TAPEMASTER can execute commands properly, it must be initialized. Initialization is the procedure which assigns permanent values to some of the programmable addresses associated with command execution. It involves setting up three short blocks of data in system memory, and then issuing a Channel Attention to the TAPEMASTER. The Initialization Blocks for a host system with an 8-bit data bus are shown in Fig. 3-1.

The addresses in this example are arbitrary and are all located in the lower 64K of system memory. However, they could be located anywhere in the lower 1M byte.

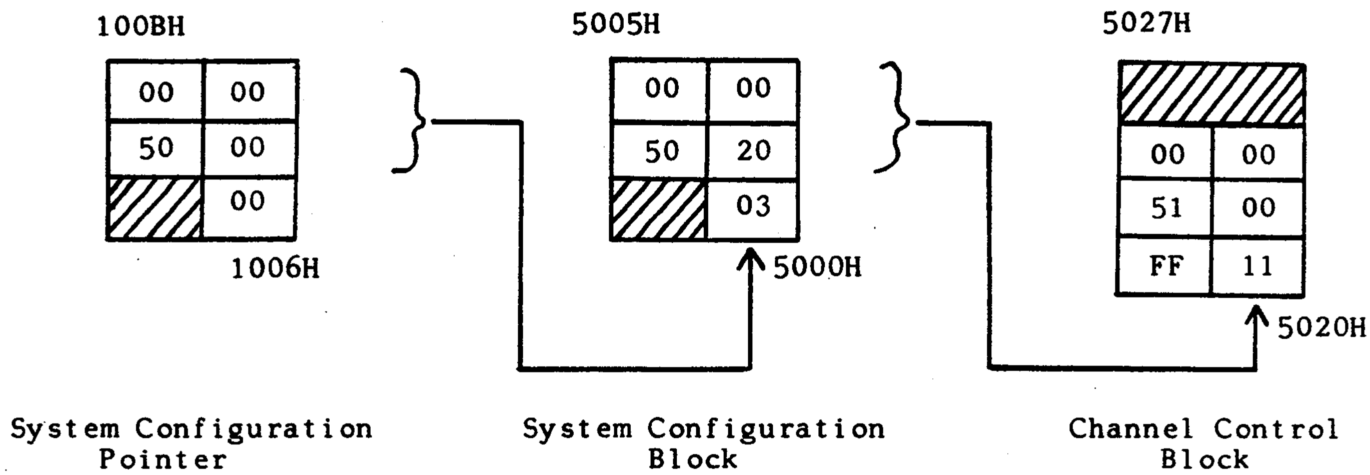

Fig. 3-1 Initialization Blocks for an 8-bit system.

The System Configuration Pointer begins at 01006H, as directed by the associated jumpers. The first byte instructs the TAPEMASTER that the physical width of the system is 8 bits (ØØ). The last four bytes are a Pointer, specifying the location of the System Configuration Block as 05000H to 05005H.

The first byte of the System Configuration Block must be 03H for proper operation. The last four bytes specify the location of the Channel Control Block as 05020H to 05027H.

The first byte of the Channel Control Block is the Channel Control Word (CCW). The CCW is set to 11H, since no interrupts are pending. The Gate, at 05021H, is set closed. The rest of the block is unused during Initialization..

At the completion of the Initialization process, using the example values of Fig. 3-1, the following have been accomplished:

A. The location of the Channel Control Word (CCW) is fixed at 05020H (F5020H in Fig. 3-2).

B. The location of the Gate is fixed at 5021H (F5021H).

C. The location of the Parameter Block (or first Parameter Block in a chain) will be specified by a pointer whose location is fixed at 5022H-5025H (F5020H-F5025H).

D. The TAPEMASTER is ready to accept commands.

Locations 01006H-0100BH and (F)5000H-(F)5005H may now be re-used if needed. Locations (F)5020H-(F)5027H must remain dedicated to TAPEMASTER control.

Shown in Table 3-1 is an 8080/8085 program to execute the Initialization sequence of Fig. 3-1.

The Initialization Blocks for a host system with a 16-bit data bus are shown in Fig. 3-2. These blocks are similar to Fig. 3-1, except that a 16-bit system is specified (01006H=01). This example also indicates how the blocks may be located beyond the 64K byte range by specifying non-zero values in the Pointer Bases.

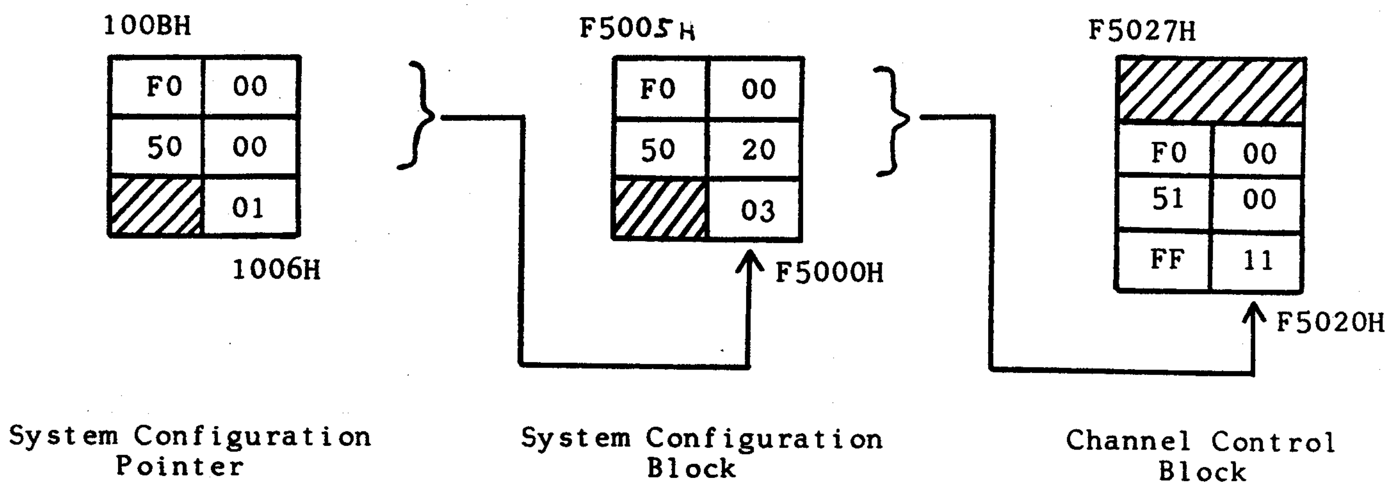

Fig. 3-2 Initialization Blocks for a 16-bit system.

The steps which must be executed by the host CPU to accomplish the Initialization are outlined in Fig. 3-3.

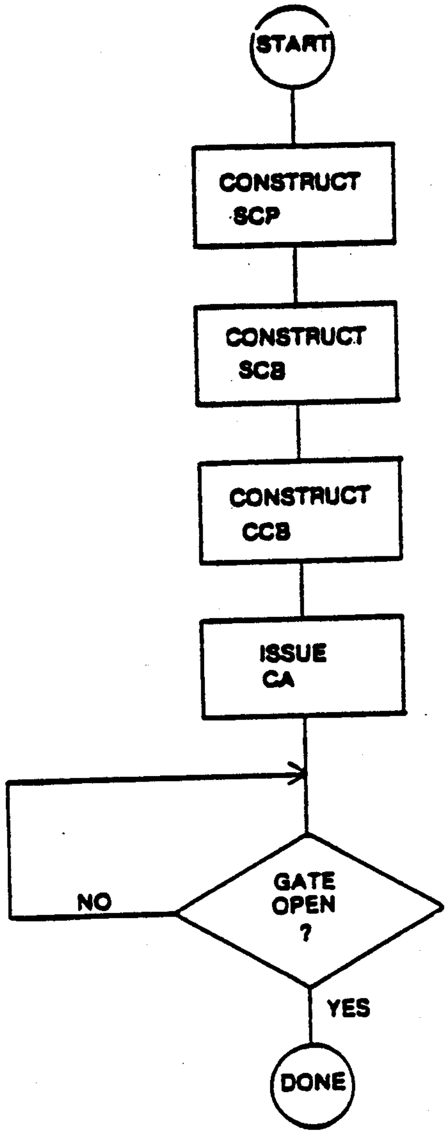

Fig. 3-3 Initialization Process

```
                        ;**************************************************************
                        ;
                        ;       INITIALIZATION OF CPC TAPEMASTER.
                        ;
                        ;**************************************************************
                        ;**************************************************************
                        ;
                        ;       DATA EQUATES
                        ;
1006                    SCP     EQU     01006H          ; SYSTEM CONFIGURATION POINTER.
5000                    SCB     EQU     5000H           ; SYSTEM CONFIGURATION BLOCK.
5020                    CCB     EQU     5020H           ; CHANNEL CONTROL BLOCK.
5100                    PB      EQU     5100H           ; PARAMTER BLOCK ADDRESS.
00BA                    CATADR  EQU     BAH             ; CHANNEL ATTENTION ADDRESS.
                        ;
                        ;**************************************************************
                        ;
                                ORG     100H
0100'                   TMINIT:                         ; TAPEMASTER INITIALIZATION ROUTINE.
                        ;
                        ;       ISSUE BOARD RESET.
                        ;
0100'   D3 BB                   OUT     CATADR + 1      ; RESET = I/O WRITE TO ODD I/O ADDRESS OF TAPEMASTER.
                        ;
                        ;       CONSTRUCT SYSTEM CONFIGURATION POINTER.
                        ;
0102'   21 0000                 LXI     H,0             ; HL = VALUE TO PUT INTO VARIOUS FIELDS.
0105'   22 1006                 SHLD    SCP             ; SYSBUS := 8 BITS WIDE.
0108'   22 100A                 SHLD    SCP + 4         ; BASE OF SCB POINTER := 0000H.
010B'   21 5000                 LXI     H,SCB
010E'   22 1008                 SHLD    SCP + 2         ; OFFSET OF SCB POINTER := SCB ADDRESS.
                        ;
                        ;       CONSTRUCT SYSTEM CONFIGURATION BLOCK.
                        ;
0111'   21 0003                 LXI     H,3
0114'   22 5000                 SHLD    SCB             ; SET SYSTEM CONFIGURATION BLOCK CONSTANT.
0117'   2E 00                   MVI     L,0
0119'   22 5004                 SHLD    SCB + 4         ; BASE OF CCB POINTER := 0000H.
011C'   21 5020                 LXI     H,CCB
011F'   22 5002                 SHLD    SCB + 2         ; OFFSET OF CCB POINTER := CCB ADDRESS.
                        ;
                        ;       CONSTRUCT CHANNEL CONTROL BLOCK.
                        ;
0122'   21 FF11                 LXI     H,0FF11H
0125'   22 5020                 SHLD    CCB             ; CCW := NORMAL OPERATION; GATE := CLOSED.
0128'   21 5100                 LXI     H,PB
012B'   22 5022                 SHLD    CCB + 2         ; OFFSET OF PARAMETER BLOCK POINTER := PARAM. BLK. ADR.
012E'   21 0000                 LXI     H,0             ; BASE OF PARAMTER BLOCK POINTER := 0000H.
0131'   22 5024                 SHLD    CCB + 4
                        ;
                        ;       ISSUE CHANNEL ATTENTION.
                        ;
0134'   D3 BA                   OUT     CATADR
                        ;
```



```
                        ;       WAIT FOR GATE TO OPEN.
                        ;
0136'   21 5021                 LXI     H,CCB + 1       ; HL = ADDRESS OF GATE.
0139'                   ORGATE:
0139'   7E                      MOV     A,M             ; A = GATE.
013A'   FE 00                   CPI     0               ; TEST FOR GATE = OPEN(= 0).
013C'   C2 0139'                JNZ     ORGATE          ; NZ: NOT OPEN - TRY AGAIN.
                                                        ; Z: GATE OPEN.
                        ;
                        ;       RETURN TO USER PROGRAM.
                        ;
013F'   C9                      RET
                        ;
                                END     TMINIT
```

Table 3-1. Initialization Program

```
                        ;****************************************************************
                        ;
                        ;       TAPE WRITE ROUTINE.
                        ;
                        ;****************************************************************
                        ;****************************************************************
                        ;
                        ;       DATA EQUATES
                        ;
5020                    CCB     EQU     5020H           ; CHANNEL CONTROL BLOCK ADDRESS.
0084                    CATADR  EQU     84H             ; CHANNEL ATTENTION ADDRESS.
5100                    PB      EQU     5100H           ; PARAMETER BLOCK ADDRESS.
5100                    COMAND  EQU     PB + 0          ; COMMAND FIELD ADDRESS OF PARAMETER BLOCK.
5104                    CONTRL  EQU     PB + 4          ; CONTROL FIELD ADDRESS OF PARAMETER BLOCK.
5106                    RETCNT  EQU     PB + 6          ; RETURN COUNT FIELD ADR. OF PARAMETER BLOCK.
5108                    BFRSZE  EQU     PB + 8          ; BUFFER SIZE FIELD ADR. OF PARAMETER BLOCK.
510A                    RECORD  EQU     PB + 10         ; RECORDS FIELD ADDRESS OF PARAMETER BLOCK.
510C                    SRCDST  EQU     PB + 12         ; SOURCE/DESTINATION FIELD ADR. OF PARAM. BLOCK.
5110                    STATUS  EQU     PB + 16         ; STATUS FIELD ADDRESS OF PARAMETER BLOCK.
5112                    INTLNK  EQU     PB + 18         ; INTERRUPT/LINK FIELD ADR. OF PARAM. BLOCK.
                        ;
                        ;       ASSUME WRITE BUFFER LOCATED AT 7000H.
                        ;       ASSUME BLOCK SIZE IS 2000H.
                        ;
                                ORG     100H
0100                    TWRITE:
                        ;
                        ;       CONSTRUCT PARAMETER BLOCK.
                        ;
0100    21 0000                 LXI     H,0             ; HL = VALUE TO STORE IN VARIOUS PB FIELDS.
                        ;
                        ;       CLEAR UPPER WORD OF FIELDS THAT ARE OF TYPE 'POINTER'.
                        ;
0103    22 5102                 SHLD    COMAND + 2      ; UPPER WORD OF COMMAND FIELD.
0106    22 510E                 SHLD    SRCDST + 2      ; UPPER WORD OF SOURCE/DESTINATION FIELD.
0109    22 5114                 SHLD    INTLNK + 2      ; UPPER WORD OF INTERRUPT/LINK FIELD.
                        ;
                        ;       CLEAR FIELDS THAT AREN'T USED OR A ZERO VALUE IS APPROPRIATE.
                        ;
010C    22 5104                 SHLD    CONTRL          ; CONTROL FIELD (NO OPTIONS SELECTED).
010F    22 5106                 SHLD    RETCNT          ; RETURN COUNT FIELD - OUTPUT ONLY.
0112    22 510A                 SHLD    RECORD          ; RECORD FIELD - NOT USED ON TAPE WRITE.
0115    22 5110                 SHLD    STATUS          ; STATUS FIELD - OUTPUT ONLY.
0118    22 5112                 SHLD    INTLNK          ; INTERRUPT/LINK - NOT USED(NOTE 0 IN CONTROL FIELD).
                        ;
                        ;       BUILD FIELDS WITH NON-ZERO VALUES.
                        ;
011B    21 0030                 LXI     H,30H
011E    22 5100                 SHLD    COMAND          ; COMMAND FIELD := DIRECT WRITE.
                        ;
0121    21 2000                 LXI     H,2000H
0124    22 5108                 SHLD    BFRSZE          ; BUFFER SIZE FIELD := 2000H.
                        ;
0127    21 7000                 LXI     H,7000H
```



```
012A    22 510C                 SHLD    SRCDST          ; SOURCE/DEST. FIELD := 7000H.
                        ;
                        ;       WAIT FOR GATE = OPEN.
                        ;
012D    21 5021                 LXI     H,CCB + 1       ; HL = GATE ADDRESS.
0130                    OGATE1:
0130    7E                      MOV     A,M             ; A = GATE.
0131    FE 00                   CPI     0               ; TEST FOR GATE = OPEN(= 0).
0133    C2 0130                 JNZ     OGATE1          ; NZ: NOT OPEN - LOOP UNTIL IS OPEN.
                        ;
                        ;       CLOSE GATE.
                        ;
0136    36 FF                   MVI     M,0FFH          ; GATE := CLOSED(0FFH).
                        ;
                        ;       BUILD PARAMETER BLOCK POINTER IN CCB.
                        ;
0138    21 5100                 LXI     H,PB            ; HL = ADDRESS OF PARAMETER BLOCK.
013B    22 5022                 SHLD    CCB + 2         ; OFFSET OF PB POINTER := PB ADDRESS.
013E    21 0000                 LXI     H,0
0141    22 5024                 SHLD    CCB + 4         ; BASE OF PB POINTER := 0000H.
                        ;
                        ;       ISSUE CHANNEL ATTENTION.
                        ;
0144    D3 8A                   OUT     CATADR          ; CHANNEL ATTENTION = I/O WRITE TO CHAN. ATTN. ADR.
                        ;
                        ;       WAIT FOR COMMAND TO FINISH (GATE = OPEN).
                        ;
0146    21 5021                 LXI     H,CCB + 1       ; HL = GATE ADDRESS.
0149                    OGATE2:
0149    7E                      MOV     A,M             ; A = GATE.
014A    FE 00                   CPI     0               ; TEST FOR GATE = OPEN(= 0).
014C    C2 0149                 JNZ     OGATE2          ; NZ: GATE CLOSED - LOOP UNTILL OPEN.
                        ;
                        ;       GET COMMAND STATUS FROM PARAMTER BLOCK.
                        ;
014F    3A 5111                 LDA     STATUS + 1      ; A = COMMAND (NOT DRIVE) STATUS.
                        ;
                        ;       RETURN TO CALLING PROGRAM TO INTERPRET STATUS (STATUS IN A REG.).
                        ;
0152    C9                      RET
                                END     TWRITE
```

Table 4-1. Tape Write Program

4.0 After Initialization, the TAPEMASTER is ready to accept commands. The general sequence of events to begin execution of commands are outlined in Fig. 4-1. Table 4-1 is an 8080/8085 program to execute this sequence for a Tape/Write command outlined in section 4.3. Other commands would be similar.

The remaining paragraphs of this section present examples of several TAPEMASTER commands. It is assumed that the host system has an 8-bit data bus. Section 5 describes how these examples would differ for a 16-bit system.

For the sake of uniformity, all the examples in this section utilize only the lower 64K of system memory (Pointer Base=0000H), for Parameter Blocks and data blocks. However, they may be located anywhere in the lower 1M byte. If the Page Register is loaded with an appropriate value, all data blocks may then be located anywhere in the 16M byte addressing range of the TAPEMASTER.

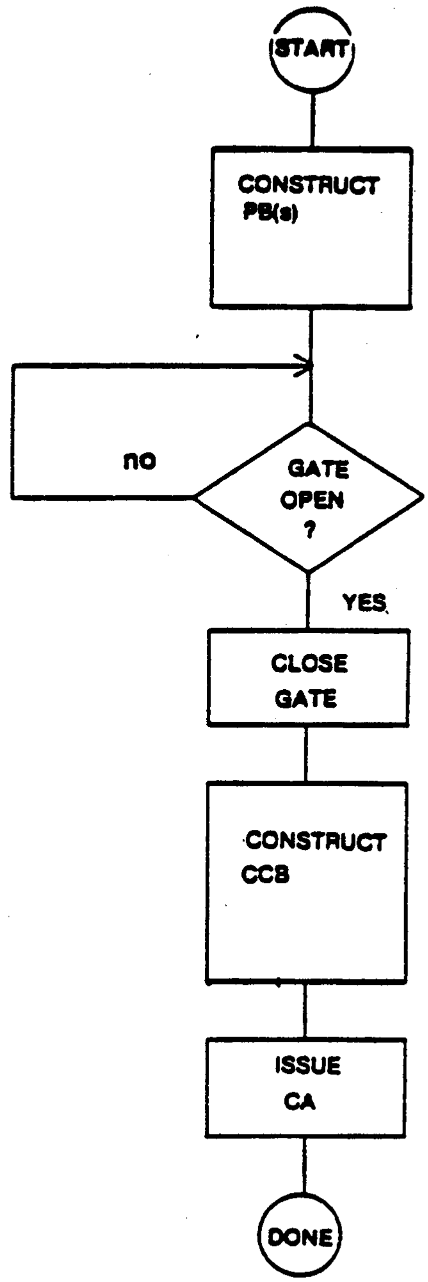

Fig. 4-1 General Command Sequence

4.1 CONFIGURE

After Initialization, any command may be executed first. The Configure command is a logical choice to execute first, because it executes a brief micro-diagnostic, and also returns information of use to the system.

The associated Parameter Block for a Configure command (Fig. 4-2) occupies 22 bytes from 05100H to 05115H in system memory. The Pointer to this Parameter Block is located in the Channel Control Block. If the Parameter Block location is to be moved, the Pointer may be changed after the processor has control of the TAPEMASTER (closes an open Gate), and before issuing a Channel Attention.

Besides the command field, which is all zeros for a Configure command, the only other Parameter Block entry required as input is the Control field. In this example, Control is all zeros. This indicates that no interrupt is to be generated at the completion of the command, and no other Parameter Block is linked. The remaining bits, such as Tape Select, Reverse, etc., are ignored since they do not apply.

After the Configure command has been executed and the Gate opened by the TAPEMASTER, the Parameter Block will have been updated by the TAPEMASTER as in Fig. 4-3a. There are two updates to be noted. First, the Command Status byte contains a C0H. Referring to the TAPEMASTER Product Specification, this indicates that the Parameter Block was entered (E bit set) and successfully completed (C bit set and zero error code).

The second update in the Parameter Block is the Return Count field. The TAPEMASTER in this example has determined that it contains 16K bytes of static RAM which may be used during buffered operations. This value (4000H) is returned in the Return Count field.

Fig 4-3b shows an example of how the Parameter Block might be updated in the case of an error. The Command Status byte (05011H) indicates the Parameter Block was entered (E bit set) but not completed (C bit not set when the Gate was opened). The 5-bit error code indicates that a 0EH error occurred. Referring to Appendix C of the Product Specification, this error indicates that the TAPEMASTER recieved an error when calculating a checksum on the firmware.

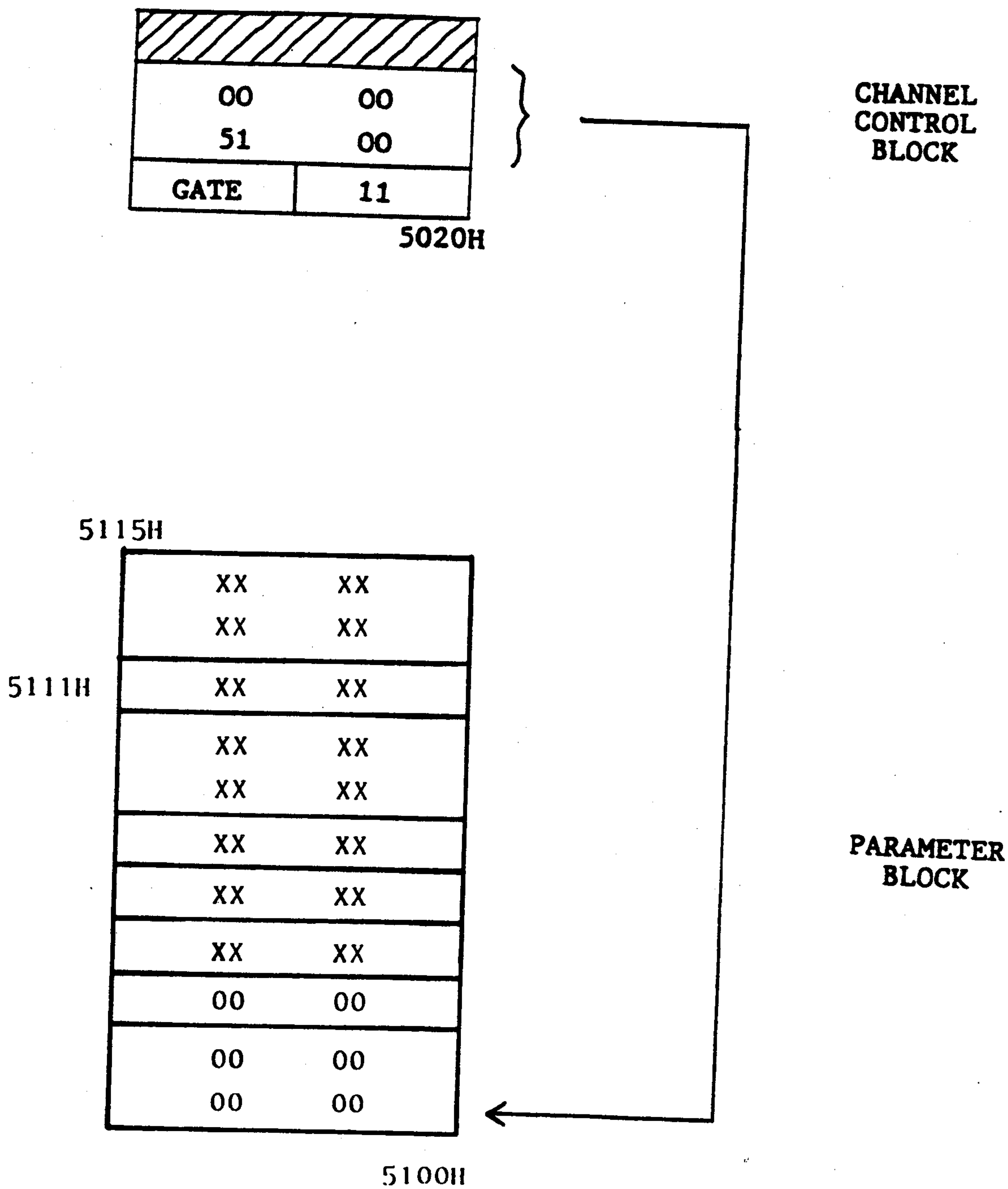

Fig. 4-2 Configure Command

4.2 STATUS

The Status command (28H) is the most basic command to execute. The Parameter Block for Status is shown in Fig. 4-4. After the TAPEMASTER has executed the command it will update the Parameter Block as shown.

a) Before execution

Address		
5115H	XX	XX
	XX	XX
5111H	XX	XX
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	00	00
	00	00
5100H	00	28

b) After execution

Address		
5115H	XX	XX
	XX	XX
5111H	CO	TS
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	00	00
	00	00
5100H	00	28

Fig. 4-4 Status Parameter Block

The upper byte of Status (5111H) contains a COH. Referring to the TAPEMASTER Product Specification, this indicates that the Parameter Block was entered (E bit set), and successfully completed (C bit set and no error code). TS represents Tape Status. In general, all Tape commands will return Tape Status.

Address		
	XX	XX
	XX	XX
5111H	C0	TS
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	40	00
	00	00
	00	00
	00	00
5100H		

a) Correct Completion

Address		
5115H		
	XX	XX
	XX	XX
5111H	8E	XX
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	XX	XX
	00	00
	00	00
	00	00
5100H		

b) Error Completion

Fig. 4-3 Configure Completion Status

4.3 DIRECT READ/WRITE

The Parameter Block for a Direct Read is shown in Fig. 4-5.

5115H

XX	XX
XX	XX
XX	XX
00	00
70	00
XX	XX
20	00
XX	XX
00	00
00	00
00	2C

5100H

a) Before execution

5115H

XX	XX
XX	XX
CO	TS
00	00
70	00
20	00
20	00
20	00
00	00
00	00
00	2C

5100H

b) After execution

Fig. 4-5 Tape Read

This Parameter Block instructs the TAPEMASTER to read the next record on the tape, which has an expected length of 8192 bytes (2000H), and store it in system memory, starting at address 07000H.

After the TAPEMASTER completes the command and opens the Gate, the Parameter Block will have been updated as shown in Fig. 4-5b. Besides the Status bytes, two entries have been updated. The Return Count field (05106-05107H) indicates that 2000H bytes were actually transferred. The Records/Overrun field (0510A-0510BH) indicates that the block size on the tape was 2000H bytes, as expected.

The Parameter Block for a Tape Write command would be similar. The Records/Overrun field is not used for Tape Write.

5.0 PARAMETER BLOCKS FOR 16-BIT SYSTEMS

Most of the examples presented in section 4 have assumed a Multibus system using an 8-bit data bus. Only minor changes to these examples are required so that they apply to a 16-bit host.

First, the Initialization must specify that the host has a 16-bit data bus, by setting byte 1 of System Configuration Pointer to 01H. This is shown in Fig. 3-2.

Secondly, in all Parameter Blocks requiring data transfer, the Width bit in the Control word should be set. This informs the TAPEMASTER that the logical width of the system bus is 16 bits. The TAPEMASTER will automatically optimize the number of memory references by executing word (16-bit) reads and writes whenever possible. For example, if a read data buffer begins on odd address, the TAPEMASTER will execute one byte read, and then continue with word reads.

If the Width bit is not set in the Control Word, the TAPEMASTER will perform all byte operations.

6.0 OPTIONS

In the preceding examples, none of the Parameter Blocks used any of the TAPEMASTER options. This section covers their use. Most options are selected in the Control Word entry in the Parameter Block.

6.1 INTERRUPTS

As discussed in the TAPEMASTER Product Specification, the user may choose to have an interrupt generated at the completion of a command. In general, non-vectored interrupts would be used for single-processor systems, or multi-processor systems in which interrupts are controlled by one processor. In multi-processor, position-independent systems, the Mailbox interrupt would be more useful.

When a non-vectored Multibus interrupt is activated by the TAPEMASTER, it will remain active until cleared by a subsequent command. This is accomplished by setting the Channel Control Word (at location 05020H in our example) to 09H, before issuing the Channel Attention for the next command.

6.2 LINK

The TAPEMASTER allows several commands to be executed in succession by linking them together. Linking and interrupts may not be used in the same Parameter Block--Link takes priority.

Fig 6-1 illustrates a Link operation. The Parameter Block of Fig 6-1a is an Erase command. Upon completion of this command, the TAPEMASTER will check the "L" bit to see if another command is linked. Since the "L" bit is set, it picks up a pointer from Interrupt/Link (locations 05112H-05115H in this example), and executes the Rewind Parameter Block at 06000H.

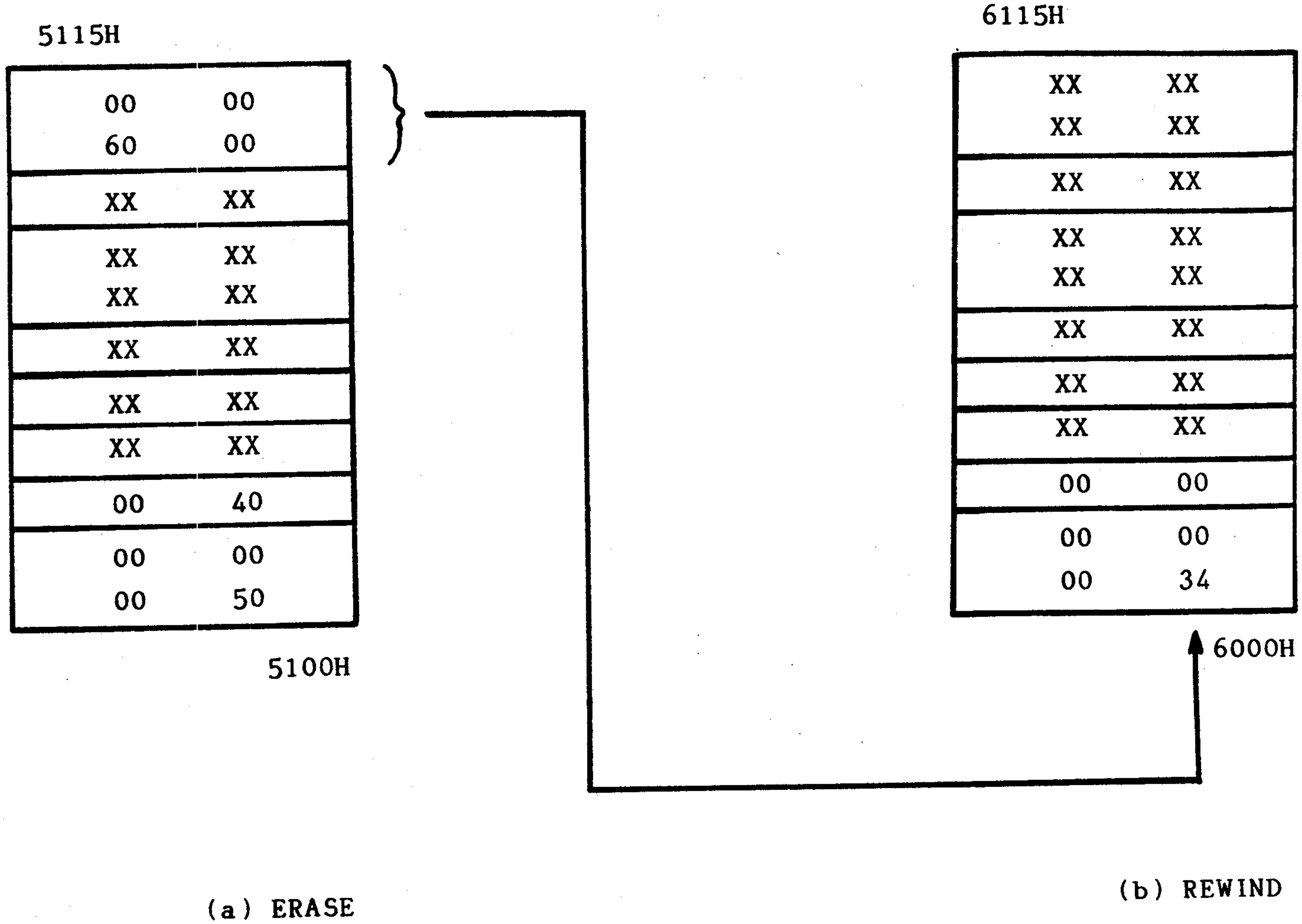

Fig 6-1 Linking Commands

The Gate will not be opened between commands, but only after the last command is completed, or an unrecoverable error is detected.

6.3 BUS LOCK

When the TAPEMASTER transfers a byte or word of data to or from memory, it activates a DMA request, recieves a DMA grant, transfers the data, and then gives up the bus if necessary until the next transfer. If the Bus Lock option is selected, the TAPEMASTER will make only one DMA request. When it recieves the DMA grant, it maintains control of the Multibus until all its data has been transferred, and then gives up the bus. The Bus Lock option eliminates the handshaking between bytes.

6.4 CONTINUOUS TAPE

The Continuous Tape option applies only to the Cipher Microstreamer. If this option is selected, the TAPEMASTER will cause the tape to continue moving after a Write command, in anticipation of another Write, avoiding the repositioning cycle. This will result in longer than normal inter-record gaps (but still ANSI-compatible) and lower tape utilization. However, multiple record writes will be faster as the tape would normally reposition after each record.

The Continuous Tape option should only be used when a Write is being performed, and the following tape is blank (such as during a disk dump operation). It is the responsibility of the user not to leave the tape moving after the last command.

6.5 WIDTH

Thw "W" bit in the Control Word indicates the logical width of the system bus (1=16 bits, Ø=8 bits). In most cases this will be the same as the physical width selected during the Initialization.

The logical bus width cannot be larger than the physical width.

7.0 ERROR RECOVERY

This section outlines the procedures to be executed by the user to recover from various error conditions.

7.1 WRITE DATA ERROR

If a data error is detected by the drive during a read after write operation, it will notify the TAPEMASTER. The TAPEMASTER will in turn space back one record and attempt to rewrite the record. If the record cannot be written successfully after several retries, the TAPEMASTER will exit with an error code of OAH. The user should then execute a Space Reverse one record, erase a section of the tape using the Erase Fixed Length command, and attempt to rewrite the record.

7.2 READ DATA ERROR

If an error is detected during a Read command, the TAPEMASTER will automatically attempt several retries. If the record remains unrecoverable, the TAPEMASTER will exit with an error code of OAH. The user may attempt more read operations by spacing one record in reverse and attempting to read the record again.

7.3 WRITE TIME-OUT

A Time out error code (OFH) during a Write operation indicates that the TAPEMASTER did not recieve the expected number of write strobes from the drive. The TAPEMASTER will not automatically retry in this situation. The user should rewrite the record "down tape" using the procedure of section 7.1.

7.4 READ TIMER-OUT

A Time out error code (OFH) during a Read operation indicates that the TAPEMASTER did not recieve the expected number of read strobes. The TAPEMASTER will not automatically retry this situation. The user may attempt to read the record over by using the procedure of section 7.2.

7.5 OVERRUN

Overrun errors indicate a failure of the system to recieve or supply data at the necessary rate. The user may retry after spacing reverse one record.

7.6 BLANK TAPE READ

A Read on a blank tape will result in either a Blank Tape Error (07H) or a Data Busy Time-out (05H), depending upon the formatter and the density.

7.7 PARITY ERROR

A Parity Error (ODH) indicates that the data recieved by the TAPEMASTER during a Read operation had incorrect parity. Recovery should be as in section 7.2. The TAPEMASTER does not retry automatically after a parity error.

8.0 COMMAND TEST

This section outlines the steps necessary to execute a brief TAPEMASTER command test. It is not intended as a thorough test of all TAPEMASTER functions, but only as an example which may be easily implemented by the user.

On the following pages is the 8080/8085 source code listing for the command test. This program is designed to run on an INTEL 80/20 CPU board. With minor modifications, it may be run on any 8080 or 8085-based system.

The object code for the Command Test may be ordered from Computer Products Corporation. It is available in PROM, magnetic tape, or CP/M-compatible diskette.

```
;***********************************************************************
;*                                                                     *
;*                  COMPUTER PRODUCTS CORPORATION                      *
;*                  2415 ANNAPOLIS LANE                                *
;*                  PLYMOUTH, MN 55441                                 *
;*                                                                     *
;*                                                                     *
;*    TITLE: TMCONFID                                                  *
;*    REVISION: 1.9                                                    *
;*    DATE: 08/11/81                                                   *
;*    AUTHOR: B. MOREN                                                 *
;*                                                                     *
;*    PROGRAM SUMMARY:                                                 *
;*  THIS PROGRAM IS A CONFIDENCE TEST FOR THE TAPEMASTER TAPE          *
;* CONTROLLER.  THE PROGRAM TESTS A MAJORITY OF THE COMMANDS           *
;* AVAILABLE TO THE TAPEMASTER.                                        *
;*                                                                     *
;*  THE PROGRAM RUNS UNDER THE CP/M OPERATING SYSTEM AND MAKES USE     *
;* OF JUST ONE SYSTEM CALL - FUNCTION 9, TO DISPLAY THE VARIOUS        *
;* MESSAGES.                                                           *
;*                                                                     *
;*  THIS PROGRAM CAN ALSO BE RELOCATED TO RUN OUT OF ROM( I.E.         *
;*  USING AN ON-BOARD MONITOR).  THE FOLLOWING EQUATES MAY OR MAY      *
;*  NOT NEED CHANGING TO DO THE RELOCATION:                            *
;*                                                                     *
;*    'TPA'     FOR PROGRAM LOCATION                                   *
;*    'BUFFER'  FOR MAIN TEST BUFFER LOCATION                          *
;*    'SCP'     FOR SYSTEM CONFIGURATION POINTER LOCATION              *
;*    'CCB'     FOR CHANNEL CONTROL BLOCK LOCATION                     *
;*    'PB'      FOR PARAMTER BLOCK LOCATION                            *
;*                                                                     *
;*                                                                     *
;*    HARDWARE REQUIRED:                                               *
;*                                                                     *
;*  THIS PROGRAM WAS DEVELOPED (THOUGH NOT LIMITED TO) ON THE          *
;* FOLLOWING:                                                          *
;*                                                                     *
;*              ISBC 80/20-4  CPU                                      *
;*              ISBC 204      FLOPPY CONTROLLER                        *
;*              62K MULTIBUS RAM                                       *
;*                                                                     *
;***********************************************************************
```

```
                        TITLE  'TAPEMASTER CONFIDENCE TEST.'
 0000'                         ASEG
                        ;      SYSTEM EQUATES
                        ;
 003E                   MSIZE   EQU     62              ; MEMORY SIZE.
 0005                   NODISK  EQU     5               ; NUMBER OF DISKS.
 A800                   BIAS    EQU     (MSIZE-20)*1024 ;
 DC00                   CCP     EQU     3400H + BIAS    ;
 E400                   BDOS    EQU     CCP + 800H      ;
 F200                   BIOS    EQU     CCP + 1600H     ; BASIC I/O SYSTEM ADDRESS.
 0011                   BCALLS  EQU     17              ; NUMBER OF JUMPS IN BIOS JUMP TABLE.
 0000                   BOOT    EQU     0               ; WARM BOOT ADDRESS.
 0005                   CPM     EQU     5               ; CP/M SYSTEM CALLS ADDRESS.
 0100                   TPA     EQU     0100H            ; BASE OF TRANSIENT PROGRAM AREA.
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       TAPEMASTER EQUATES
                        ;
 FFF6                   SCP     EQU     0FFF6H
 FFF0                   SCB     EQU     SCP-6
 D300                   CCB     EQU     0D300H          ; CHANNEL CONTROL BLOCK.
 D301                   GATE    EQU     CCB + 1
 D306                   PB      EQU     CCB + 6         ; PARAMTER BLOCK.
 D306                   COMAND  EQU     PB              ; COMMAND FIELD.
 D30A                   CONTRL  EQU     PB + 4          ; CONTROL FIELD.
 D30C                   TRACK   EQU     PB + 6          ; TRACK FIELD(DISK).
 D30C                   COUNT   EQU     PB + 6          ; BYTE COUNT(TAPE).
 D30E                   SECTOR  EQU     PB + 8          ; SECTOR FIELD(DISK).
 D30E                   BFRSZE  EQU     PB + 8          ; BUFFER SIZE FIELD(TAPE).
 D310                   RECORD  EQU     PB + 10         ; RECORDS FIELD.
 D312                   SRCDST  EQU     PB + 12         ; SOURCE/DESTINATION FIELD.
 D316                   STATUS  EQU     PB + 16         ; STATUS FIELD.
 D318                   INTLNK  EQU     PB + 18         ; INTERRUPT/LINK FIELD.
 D31C                   ENDHD   EQU     PB + 22         ; END HEAD FIELD(BACKUP).
 D31D                   ENDSCT  EQU     PB + 23         ; END SECTOR FIELD(BACKUP).
 D31E                   ENDTRK  EQU     PB + 24         ; END TRACK FIELD(BACKUP).
 D320                   THROTL  EQU     PB + 26         ; THROTTLE FIELD(BLOCK MOVE).
 008A                   CA      EQU     08AH            ; CHANNEL ATTENTION ADDRESS.
 000A                   LF      EQU     0AH
 000D                   CR      EQU     0DH
 0024                   EOF     EQU     '$'
 1000                   BUFFER   EQU    1000H
                        ;
                        ;
                        ;
                                ORG     TPA
 0100                   GO:                             ; INITIAL PROGRAM ENTRY POINT.
 0100    31 00FE                LXI     SP,TPA-2        ; INITIALIZE STACK POINTER.
 0103    C3 0208                JMP     MAIN
                        PAGE
```

```
                     ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                     ;
                     ;      DATA TRANSFER ERROR LOOKUP TABLE.  THIS TABLE IS INDEXED
                     ;      (BY TAPEMASTER COMMAND OP CODE) TO FIND ADDRESS OF ERROR
                     ;      MESSAGE FOR RESPECTIVE COMMAND.
                     ;
0106                 XFERR:
0106    025E                DW      EROR17          ; BREAD ERROR.
0108    0000                DW      0
010A    026D                DW      EROR18          ; BWRITE ERROR.
010C    0000                DW      0
010E    027D                DW      EROR19          ; BEDIT ERROR.
0110    0000                DW      0
0112    028A                DW      EROR23          ; DUMMY.
0114    0000                DW      0
0116    028A                DW      EROR23          ; DUMMY.
0118    0000                DW      0
011A    028A                DW      EROR23          ; DUMMY.
011C    0000                DW      0
011E    028A                DW      EROR23          ; DUMMY.
0120    0000                DW      0
0122    028C                DW      EROR20          ; DREAD ERROR.
0124    0000                DW      0
0126    029B                DW      EROR21          ; DWRITE ERROR.
0128    0000                DW      0
012A    028A                DW      EROR23          ; DUMMY.
012C    0000                DW      0
012E    028A                DW      EROR23          ; DUMMY.
0130    0000                DW      0
0132    02AB                DW      EROR22          ; DEDIT ERROR.
                     ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                     ;
                     ;       ERROR MESSAGE TABLE.
                     ;
0134    43 4F 4E 46  ERROR1: DB     'CONFIGURE ERROR.',CR,LF,EOF
0138    49 47 55 52
013C    45 20 45 52
0140    52 4F 52 2E
0144    0D 0A 24
0147    44 52 49 56  ERROR2: DB     'DRIVE RESET ERROR.',CR,LF,EOF
014B    45 20 52 45
014F    53 45 54 20
0153    45 52 52 4F
0157    52 2E 0D 0A
015B    24
015C    53 45 54 20  ERROR3: DB     'SET PAGE ERROR.',CR,LF,EOF
0160    50 41 47 45
0164    20 45 52 52
0168    4F 52 2E 0D
016C    0A 24
016E    4E 4F 50 20  ERROR4: DB     'NOP ERROR.',CR,LF,EOF
0172    45 52 52 4F
0176    52 2E 0D 0A
017A    24
```

```
017B    53 54 41 54         ERROR5: DB      'STATUS COMMAND ERROR.',CR,LF,EOF
017F    55 53 20 43
0183    4F 4D 4D 41
0187    4E 44 20 45
018B    52 52 4F 52
018F    2E 0D 0A 24
0193    54 41 50 45         ERROR6: DB      'TAPE TYPE ERROR.',CR,LF,EOF
0197    20 54 59 50
019B    45 20 45 52
019F    52 4F 52 2E
01A3    0D 0A 24
01A6    52 45 57 49         ERROR7: DB      'REWIND ERROR.',CR,LF,EOF
01AA    4E 44 20 45
01AE    52 52 4F 52
01B2    2E 0D 0A 24
01B6    45 52 41 53         ERROR8: DB      'ERASE ERROR.',CR,LF,EOF
01BA    45 20 45 52
01BE    52 4F 52 2E
01C2    0D 0A 24
01C5    57 52 49 54         ERROR9: DB      'WRITE FM ERROR.',CR,LF,EOF
01C9    45 20 46 4D
01CD    20 45 52 52
01D1    4F 52 2E 0D
01D5    0A 24
01D7    53 45 41 52         EROR10: DB      'SEARCH FM ERROR.',CR,LF,EOF
01DB    43 48 20 46
01DF    4D 20 45 52
01E3    52 4F 52 2E
01E7    0D 0A 24
01EA    52 45 41 44         EROR11: DB      'READ FOREIGN TAPE ERROR.',CR,LF,EOF
01EE    20 46 4F 52
01F2    45 49 47 4E
01F6    20 54 41 50
01FA    45 20 45 52
01FE    52 4F 52 2E
0202    0D 0A 24
0205    4D 4F 54 49         EROR12: DB      'MOTION ERROR.',CR,LF,EOF
0209    4F 4E 20 45
020D    52 52 4F 52
0211    2E 0D 0A 24
0215    53 54 52 45         EROR13: DB      'STREAMING ERROR.',CR,LF,EOF
0219    41 4D 49 4E
021D    47 20 45 52
0221    52 4F 52 2E
0225    0D 0A 24
0228    56 45 52 49         EROR14: DB      'VERIFY ERROR.',CR,LF,EOF
022C    46 59 20 45
0230    52 52 4F 52
0234    2E 0D 0A 24
0238    42 4C 4F 43         EROR15: DB      'BLOCK MOVE ERROR.',CR,LF,EOF
023C    4B 20 4D 4F
0240    56 45 20 45
0244    52 52 4F 52
0248    2E 0D 0A 24
024C    45 58 43 48         EROR16: DB      'EXCHANGE ERROR.',CR,LF,EOF
0250    41 4E 47 45
```

```
0254     20 45 52 52
0258     4F 52 2E 0D
025C     0A 24
025E     42 52 45 41          EROR17: DB      'BREAD ERROR.',CR,LF,EOF
0262     44 20 45 52
0266     52 4F 52 2E
026A     0D 0A 24
026D     42 57 52 49          EROR18: DB      'BWRITE ERROR.',CR,LF,EOF
0271     54 45 20 45
0275     52 52 4F 52
0279     2E 0D 0A 24
027D     42 45 44 49          EROR19: DB      'BEDIT ERROR.',CR,LF,EOF
0281     54 20 45 52
0285     52 4F 52 2E
0289     0D 0A 24
028C     44 52 45 41          EROR20: DB      'DREAD ERROR.',CR,LF,EOF
0290     44 20 45 52
0294     52 4F 52 2E
0298     0D 0A 24
029B     44 57 52 49          EROR21: DB      'DWRITE ERROR.',CR,LF,EOF
029F     54 45 20 45
02A3     52 52 4F 52
02A7     2E 0D 0A 24
02AB     44 45 44 49          EROR22: DB      'DEDIT ERROR.',CR,LF,EOF
02AF     54 20 45 52
02B3     52 4F 52 2E
02B7     0D 0A 24
02BA     44 55 4D 4D          EROR23: DB      'DUMMY ERROR.',CR,LF,EOF
02BE     59 20 45 52
02C2     52 4F 52 2E
02C6     0D 0A 24
02C9     54 49 4D 45          EROR24: DB      'TIME OUT ERROR.',CR,LF,EOF
02CD     20 4F 55 54
02D1     20 45 52 52
02D5     4F 52 2E 0D
02D9     0A 24
                              PAGE
```

```
                              ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                              ;
                              ;       MAIN PROGRAM
02DB                          MAIN:
02DB    CD 0404                       CALL    INITAL          ; INITIALIZE TAPEMASTER.
02DE    CD 046A                       CALL    CONFIG          ; CONFIGURE TM.
02E1    CD 048F                       CALL    DSKRES          ; RESET DRIVE.
02E4    CD 04BF                       CALL    NOPS            ; NOP COMMAND.
02E7    CD 04EF                       CALL    TPTYPE          ; TAPE TYPE COMMAND.
02EA    CD 04D7                       CALL    TPSTAT          ; TAPE STATUS.
02ED    CD 0507                       CALL    REWIND          ; REWIND TAPE.
02F0                          MAIN10:
02F0    CD 051F                       CALL    ERASE           ; ERASE TAPE.
02F3    CD 0507                       CALL    REWIND          ; REWIND TAPE.
02F6    2A 048D                       LHLD    BDBUFF          ; HL = BUFFER SIZE.
02F9    EB                            XCHG                    ; DE = BUFFER SIZE.
02FA    21 1000                       LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
02FD    06 00                         MVI     B,0             ; B = STARTING PATTERN.
02FF    CD 0831                       CALL    PATERN          ; GENERATE PATTERN.
0302    CD 05B6                       CALL    DWRITE          ; DIRECT TAPE WRITE.
0305    CD 053D                       CALL    FILEMK          ; WRITE FILEMARK.
0308    2A 048D                       LHLD    BDBUFF          ; HL = BUFFER SIZE.
030B    EB                            XCHG                    ; DE = BUFFER SIZE.
030C    21 1000                       LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
030F    06 01                         MVI     B,1             ; B = STARTING PATTERN.
0311    CD 0831                       CALL    PATERN          ; GENERATE PATTERN.
0314    CD 05C5                       CALL    BWRITE          ; BUFFERED TAPE WRITE.
0317    CD 0507                       CALL    REWIND          ; REWIND TAPE.
031A    CD 05C0                       CALL    BREAD           ; BUFFERED TAPE READ.
031D    2A 048D                       LHLD    BDBUFF          ; HL = BUFFER SIZE.
0320    EB                            XCHG                    ; DE = BUFFER SIZE.
0321    21 1000                       LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
0324    06 00                         MVI     B,0             ; B = STARTING PATTERN.
0326    CD 083E                       CALL    VERIFY          ; VERIFY RECORD READ.
0329    11 0000                       LXI     D,0             ; DE = CONTROL FIELD FOR SEARCH.
032C    CD 055B                       CALL    SEARCH          ; SEARCH FOR FILEMARK.
032F    CD 05B1                       CALL    DREAD           ; DIRECT TAPE READ.
0332    2A 048D                       LHLD    BDBUFF          ; HL = BUFFER SIZE.
0335    EB                            XCHG                    ; DE = BUFFER SIZE.
0336    21 1000                       LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
0339    06 01                         MVI     B,1             ; STARTING PATTERN.
033B    CD 083E                       CALL    VERIFY          ; VERIFY RECORD READ.
033E    2A 048D                       LHLD    BDBUFF          ; HL = BUFFER SIZE.
0341    EB                            XCHG
0342    21 1000                       LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
0345    06 04                         MVI     B,4             ; B = STARTING PATTERN.
0347    CD 0831                       CALL    PATERN          ; GENERATE TEST PATTERN.
034A    CD 05B6                       CALL    DWRITE          ; DIRECT WRITE.
034D    CD 053D                       CALL    FILEMK
0350    CD 053D                       CALL    FILEMK
0353    21 0002                       LXI     H,2             ; HL = RECORDS.
0356    11 0400                       LXI     D,400H          ; DE = CONTRL.
0359    CD 0560                       CALL    SPACE
035C    21 0001                       LXI     H,1             ; HL = RECORDS.
```

```
035F    11 0400         LXI     D,400H          ; DE = CONTROL.
0362    CD 0560         CALL    SPACE           ; SPACE COMMAND.
0365    CD 0581         CALL    DREAD           ; DIRECT READ.
0368    2A 048D         LHLD    BDBUFF          ; HL = BUFFER SIZE.
036B    EB              XCHG
036C    21 1000         LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
036F    06 04           MVI     B,4             ; STARTING PATTERN.
0371    CD 083E         CALL    VERIFY          ; VERIFY RECORD JUST READ.
0374    21 0001         LXI     H,1             ; HL = RECORDS.
0377    11 0400         LXI     D,400H          ; DE = CONTROL.
037A    CD 0560         CALL    SPACE           ; SPACE COMMAND.
037D    2A 048D         LHLD    BDBUFF          ; HL = BUFFER SIZE.
0380    EB              XCHG                    ; DE = BUFFER SIZE.
0381    21 1000         LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
0384    06 03           MVI     B,3             ; B = STARTING PATTERN.
0386    CD 0831         CALL    PATERN          ; GENERATE PATTERN.
0389    CD 05B8         CALL    DEDIT           ; DIRECT EDIT.
038C    11 0400         LXI     D,400H          ; CONTROL = REVERSE.
038F    CD 0565         CALL    SPACFM          ; SPACE TO FILEMARK.
0392    21 0001         LXI     H,1             ; RECORDS TO SPACE.
0395    11 0000         LXI     D,0             ; CONTROL.
0398    CD 0560         CALL    SPACE
039B    CD 0581         CALL    DREAD           ; DIRECT TAPE READ.
039E    2A 048D         LHLD    BDBUFF          ; HL = BUFFER SIZE.
03A1    EB              XCHG                    ; DE = BUFFER SIZE.
03A2    21 1000         LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
03A5    06 03           MVI     B,3             ; B =STARTING PATTERN.
03A7    CD 083E         CALL    VERIFY          ; VERIFY RECORD READ.
03AA    CD 0581         CALL    DREAD           ; DIRECT READ.
03AD    21 0001         LXI     H,1             ; HL = RECORDS.
03B0    11 0400         LXI     D,400H          ; DE = CONTROL.
03B3    CD 0560         CALL    SPACE           ; SPACE COMMAND.
03B6    2A 048D         LHLD    BDBUFF          ; HL = BUFFER SIZE.
03B9    EB              XCHG                    ; DE = BUFFER SIZE.
03BA    21 1000         LXI     H,BUFFER        ; HL = BUFFER.
03BD    06 04           MVI     B,4             ; B = STARTING PATTERN.
03BF    CD 0831         CALL    PATERN          ; GENERATE PATTERN.
03C2    CD 05CA         CALL    BEDIT           ; BUFFERED EDIT COMMAND.
03C5    11 0400         LXI     D,400H          ; CONTROL = REVERSE.
03C8    CD 0565         CALL    SPACFM          ; SPACE TO FILEMARK.
03CB    21 0001         LXI     H,1             ; RECORDS TO SPACE.
03CE    11 0000         LXI     D,0             ; CONTROL.
03D1    CD 0560         CALL    SPACE
03D4    CD 05C0         CALL    BREAD           ; BUFFERED TAPE READ.
03D7    2A 048D         LHLD    BDBUFF          ; HL = BUFFER SIZE.
03DA    EB              XCHG                    ; DE = BUFFER SIZE.
03DB    21 1000         LXI     H,BUFFER        ; HL = BUFFER ADDRESS.
03DE    06 04           MVI     B,4             ; B = STARTING PATTERN.
03E0    CD 083E         CALL    VERIFY          ; VERIFY RECORD READ.
03E3    CD 0507         CALL    REWIND          ; REWIND TAPE.
03E6    CD 058C         CALL    RDFRGN          ; READ FOREIGN TAPE.
03E9    21 0002         LXI     H,2             ; RECORDS = 2.
03EC    11 0000         LXI     D,0             ;  DE = 0.
03EF    CD 056A         CALL    MSERCH          ; SEARCH FOR MULTIPLE FILEMARKS.
03F2    CD 0625         CALL    SWRITE          ; STREAMING WRITES.
03F5    CD 0691         CALL    SREAD           ; STREAMING READS.
```

```
03F8    CD 072A         CALL    BLOCKM      ; BLOCK MOVE.
03FB    CD 0781         CALL    EXCHNG      ; EXCHANGE COMMAND.
03FE    CD 0507         CALL    REWIND      ; REWIND TAPE.
0401    C3 02E0         JMP     MAIN10      ; START TEST OVER.
                PAGE
```

```
                                ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                                ;
                                ;       COMMAND SUBROUTINES.
                                ;
                                ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                                ;
                                ;    INITAL - THIS ROUTINE INITIALIZES THE TAPEMASTER.
                                ;
0404                            INITAL:
0404    11 044A                         LXI     D,INITMS
0407    0E 09                           MVI     C,9
0409    CD 0005                         CALL    CPM             ; DISPLAY MESSAGE
                                ;                                 BUILD SCP, SCB, CCB.
040C    21 0000                         LXI     H,0
040F    22 FFF6                         SHLD    SCP
0412    22 FFFA                         SHLD    SCP+4
0415    22 FFF4                         SHLD    SCB+4
0418    22 D304                         SHLD    CCB+4
041B    2E 03                           MVI     L,3
041D    22 FFF0                         SHLD    SCB
0420    21 FFF0                         LXI     H,SCB
0423    22 FFF8                         SHLD    SCP+2
0426    21 D300                         LXI     H,CCB
0429    22 FFF2                         SHLD    SCB+2
042C    21 D306                         LXI     H,PB
042F    22 D302                         SHLD    CCB+2
0432    21 FF11                         LXI     H,0FF11H        ; CLOSE GATE.
0435    22 D300                         SHLD    CCB
0438    D3 8A                           OUT     CA              ; ISSUE CHANNEL ATTENTION.
043A    CD 07D6                         CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
                                ;                                 CLEAR PARAMTER BLOCK.
043D    06 1C                           MVI     B,28
043F    21 D306                         LXI     H,PB
0442    AF                              XRA     A
0443                            INIT10:
0443    77                              MOV     M,A
0444    05                              DCR     B
0445    23                              INX     H
0446    C2 0443                         JNZ     INIT10
0449    C9                              RET
                                ;
044A    0D 0A 54 41             INITMS: DB      CR,LF,'TAPEMASTER CONFIDENCE TEST.',CR,LF,EOF
044E    50 45 4D 41
0452    53 54 45 52
0456    20 43 4F 4E
045A    46 49 44 45
045E    4E 43 45 20
0462    54 45 53 54
0466    2E 0D 0A 24

                                ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                                ;
                                ;    CONFIG - CONFIGURES THE TAPEMASTER - THE AMOUNT OF ON-BOARD RAM
                                ;             IS RETURNED IN THE 'RETURN COUNT' FIELD OF THE PB.
                                ;
```

```
046A                    CONFIG:
046A    AF                      XRA     A
046B    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
046E    21 4000                 LXI     H,4000H
0471    22 D312                 SHLD    SRCDST          ; SET SOURCE/DEST FIELD IN PB.
0474    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0477    2F                      CMA
0478    32 D301                 STA     GATE            ; CLOSE GATE
047B    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
047D    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0480    11 0134                 LXI     D,ERROR1
0483    CD 080B                 CALL    CHKSTS             ; CHECK COMMAND STATUS FOR 0C0H.
0486    2A D30C                 LHLD    COUNT           ; GET RAM SIZE OF TAPEMASTER.
0489    22 048D                 SHLD    BDBUFF          ; SAVE IT.
048C    C9                      RET
                        ;
048D    0000            BDBUFF: DW      0               ; TAPEMASTER BUFFER SIZE.
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       DSKRES: EXECUTES A DRIVE RESET COMMAND.
                        ;
048F                    DSKRES:
048F    3E 90                   MVI     A,90H
0491    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0494    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0497    2F                      CMA
0498    32 D301                 STA     GATE          ; CLOSE GATE.
049B    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
049D    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04A0    11 0147                 LXI     D,ERROR2
04A3    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS.
04A6    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       SETPAG - EXECUTES THE SET PAGE REGISTER COMMAND.
                        ;                PAGE REGISTER := 0.
                        ;
04A7                    SETPAG:
04A7    3E 08                   MVI     A,8              ; SET PAGE REGISTER.
04A9    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
04AC    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04AF    2F                      CMA
04B0    32 D301                 STA     GATE            ; CLOSE GATE
04B3    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
04B5    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04B8    11 015C                 LXI     D,ERROR3
04BB    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
04BE    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       NOPS - EXECUTES THE NOP COMMAND.
                        ;
04BF                    NOPS:
04BF    3E 20                   MVI     A,20H
04C1    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
04C4    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
```

```
04C7    2F                      CMA
04C8    32 D301                 STA     GATE            ; CLOSE GATE.
04CB    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
04CD    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04D0    11 016E                 LXI     D,ERROR4
04D3    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
04D6    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       TPSTAT - EXECUTES THE TAPE STATUS COMMAND.
                        ;
04D7                    TPSTAT:
04D7    3E 28                   MVI     A,28H
04D9    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
04DC    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04DF    2F                      CMA
04E0    32 D301                 STA     GATE            ; CLOSE GATE.
04E3    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
04E5    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04E8    11 017B                 LXI     D,ERROR5
04EB    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
04EE    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       TPTYPE - EXECUTES THE TAPE TYPE COMMAND.
                        ;
04EF                    TPTYPE:
04EF    3E 74                   MVI     A,74H
04F1    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
04F4    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
04F7    2F                      CMA
04F8    32 D301                 STA     GATE            ; CLOSE GATE.
04FB    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
04FD    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0500    11 0193                 LXI     D,ERROR6
0503    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
0506    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       REWIND - EXECUTES THE TAPE REWIND COMMAND.
                        ;
0507                    REWIND:
0507    3E 34                   MVI     A,34H
0509    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
050C    CD 07E0                 CALL    OPEN45
050F    2F                      CMA
0510    32 D301                 STA     GATE
0513    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
0515    CD 07E0                 CALL    OPEN45          ; WAIT FOR GATE = OPEN (45 SEC MAX).
0518    11 01A6                 LXI     D,ERROR7
051B    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
051E    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       ERASE - EXECUTES THE ERASE TAPE COMMMAND.
                        ;
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051F                    ERASE:
051F    3E 50                   MVI     A,50H
0521    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0524    21 0800                 LXI     H,800H
0527    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
052A    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
052D    2F                      CMA
052E    32 D301                 STA     GATE            ; CLOSE GATE.
0531    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
0533    CD 07E0                 CALL    OPEN45          ; WAIT FOR GATE = OPEN (45 SEC MAX).
0536    11 01B6                 LXI     D,ERROR8
0539    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
053C    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       FILEMK - EXECUTES THE WRITE FILEMARK COMMAND.
                        ;
053D                    FILEMK:
053D    3E 40                   MVI     A,40H
053F    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0542    21 0800                 LXI     H,800H
0545    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
0548    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
054B    2F                      CMA
054C    32 D301                 STA     GATE            ; CLOSE GATE.
054F    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
0551    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0554    11 01C5                 LXI     D,ERROR9
0557    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
055A    C9                      RET
                        PAGE
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                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       THE FOLLOWING COMMANDS:
                        ;
                        ;                       SEARCH ( SEARCH FOR FILEMARK)
                        ;                       SPACE  ( SPACE RECORDS)
                        ;                       SPACFM ( SPACE TO FILEMARK)
                        ;                       MSERCH ( MULTIPLE FILEMARK SEARCH)
                        ;
                        ;       ALL USE A COMMON EXECUTION ROUTINE LABLED 'MOTION'. THREE PARAMETERS
                        ;       ARE PASSED TO 'MOTION' IN REGISTERS.  THE ACCUMULATOR CONTAINS THE
                        ;       COMMAND. DE CONTAINS THE CONTROL FIELD. AND HL CONTAINS THE RECORDS
                        ;       FIELD.
                        ;
                        ;
0558                    SEARCH:
0558    3E 44                   MVI     A,44H
055D    C3 056F                 JMP     MOTION
                        ;
0560                    SPACE:
0560    3E 48                   MVI     A,48H
0562    C3 056F                 JMP     MOTION
                        ;
0565                    SPACFM:
0565    3E 70                   MVI     A,70H
0567    C3 056F                 JMP     MOTION
                        ;
056A                    MSERCH:
056A    3E 94                   MVI     A,94H
056C    C3 056F                 JMP     MOTION
                        ;
056F                    MOTION:
056F    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0572    22 D310                 SHLD    RECORD          ; SET RECORD FIELD OF PB.
0575    EB                      XCHG
0576    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
0579    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
057C    2F                      CMA
057D    32 D301                 STA     GATE            ; CLOSE GATE.
0580    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
0582    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0585    11 0205                 LXI     D,EROR12
0588    CD 0808                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
058B    C9                      RET
                        PAGE
```

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                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;;
                        ;       RDFRGN - EXECUTES THE READ FOREIGN TAPE COMMAND.
                        ;
058C                    RDFRGN:
058C    3E 1C                   MVI     A,1CH
058E    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0591    21 0800                 LXI     H,800H
0594    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
0597    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
059A    2F                      CMA
059B    32 D301                 STA     GATE            ; CLOSE GATE.
059E    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
05A0    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
05A3    11 01EA                 LXI     D,EROR11
05A6    CD 0808                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
05A9    2A D30C                 LHLD    COUNT
05AC    EB                      XCHG
05AD    2A D310                 LHLD    RECORD
05B0    C9                      RET
                        PAGE
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                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;   THE FOLLOWING COMMANDS:
                        ;
                        ;                       DREAD    ( DIRECT READ)
                        ;                       DWRITE   ( DIRECT WRITE)
                        ;                       DEDIT    ( DIRECT EDIT)
                        ;                       BREAD    ( BUFFERED READ)
                        ;                       BWRITE   ( BUFFERED WRITE)
                        ;                       BEDIT    ( BUFFERED EDIT)
                        ;
                        ;   ALL USE A COMMON EXECUTION ROUTINE CALLED 'DAXFER' ( FOR DATA
                        ;   TRANSFER).
                        ;
05B1                    DREAD:
05B1    3E 2C                   MVI     A,2CH
05B3    C3 05CF                 JMP     DAXFER
                        ;
05B6                    DWRITE:
05B6    3E 30                   MVI     A,30H
05B8    C3 05CF                 JMP     DAXFER
                        ;
05BB                    DEDIT:
05BB    3E 3C                   MVI     A,3CH
05BD    C3 05CF                 JMP     DAXFER
                        ;
05C0                    BREAD:
05C0    3E 10                   MVI     A,10H
05C2    C3 05CF                 JMP     DAXFER
                        ;
05C5                    BWRITE:
05C5    3E 14                   MVI     A,14H
05C7    C3 05CF                 JMP     DAXFER
                        ;
05CA                    BEDIT:
05CA    3E 18                   MVI     A,18H
05CC    C3 05CF                 JMP     DAXFER
                        ;
05CF                    DAXFER:
05CF    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
05D2    21 0880                 LXI     H,880H
05D5    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
05D8    2A 048D                 LHLD    BDBUFF
05DB    22 D30E                 SHLD    BFRSZE          ; SET BUFFER SIZE FIELD OF PB.
05DE    21 1000                 LXI     H,BUFFER
05E1    22 D312                 SHLD    SRCDST          ; SET SOURCE/DEST FIELD IN PB.
05E4    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
05E7    2F                      CMA
05E8    32 D301                 STA     GATE
05EB    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
05ED    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
05F0    CD 0814                 CALL    CHKDST          ; CHECK COMMAND FOR PROPER COMPLETION.
05F3    C9                      RET
                        PAGE
```

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                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       STREAMING COMMAND EQUATES
                        ;
1000                    SGATE1 EQU      BUFFER
1002                    SCT1   EQU      SGATE1+2
1004                    SPTR1  EQU      SGATE1+4
1008                    SDATA1 EQU      SGATE1+8
1108                    SGATE2 EQU      SDATA1+100H
110A                    SCT2   EQU      SGATE2+2
110C                    SPTR2  EQU      SGATE2+4
1110                    SDATA2 EQU      SGATE2+8
1210                    SGATE3 EQU      SDATA2+100H
1212                    SCT3   EQU      SGATE3+2
1214                    SPTR3  EQU      SGATE3+4
1218                    SDATA3 EQU      SGATE3+8
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       ISTREM - BUILDS THE DATA BLOCKS AND 8 BYTE HEADERS FOR THE
                        ;                STREAMING COMMANDS.
                        ;
05F4                    ISTREM:
05F4    21 0000                 LXI     H,0
05F7    22 1006                 SHLD    SPTR1+2         ; BASE OF POINTER 1.
05FA    22 110E                 SHLD    SPTR2+2         ; BASE OF POINTER 2.
05FD    22 1216                 SHLD    SPTR3+2         ; BASE OF POINTER 3.
0600    23                      INX     H
0601    22 1000                 SHLD    SGATE1          ; GATE OF BLOCK 1.
0604    22 1108                 SHLD    SGATE2          ; GATE OF BLOCK 2.
0607    2E 11                   MVI     L,11H
0609    22 1210                 SHLD    SGATE3          ; GATE OF BLOCK 3.
060C    21 0100                 LXI     H,100H
060F    22 1002                 SHLD    SCT1            ; COUNT OF BLOCK 1.
0612    22 110A                 SHLD    SCT2            ; COUNT OF BLOCK 2.
0615    22 1212                 SHLD    SCT3            ; COUNT OF BLOCK 3.
0618    21 1108                 LXI     H,SGATE2
061B    22 1004                 SHLD    SPTR1           ; OFFSET OF POINTER 1
061E    21 1210                 LXI     H,SGATE3
0621    22 110C                 SHLD    SPTR2           ; OFFSET OF POINTER 2.
0624    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;     SWRITE - PERFORMS THE STREAMING WRITE COMMAND.
                        ;
0625                    SWRITE:
0625    CD 05F4                 CALL    ISTREM          ; INITIALIZE BLOCKS.
                        ;                               ; BUILD TEST PATTERN.
0628    11 0100                 LXI     D,100H
062B    06 01                   MVI     B,1
062D    21 1008                 LXI     H,SDATA1
0630    CD 0831                 CALL    PATERN
0633    11 0100                 LXI     D,100H
0636    06 02                   MVI     B,2
0638    21 1110                 LXI     H,SDATA2
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063B    CD 0831           CALL    PATERN
063E    11 0100           LXI     D,100H
0641    06 03             MVI     B,3
0643    21 1218           LXI     H,SDATA3
0646    CD 0831           CALL    PATERN
                  ;
0649    3E 64             MVI     A,64H
064B    32 D306           STA     COMAND          ; SET COMMAND IN PB.
064E    21 0880           LXI     H,880H
0651    22 D30A           SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
0654    21 1000           LXI     H,SGATE1
0657    22 D312           SHLD    SRCDST          ; SET SOURCE/DEST FIELD IN PB.
065A    CD 07D6           CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
065D    2F                CMA
065E    32 D301           STA     GATE            ; CLOSE GATE.
0661    D3 8A             OUT     CA              ; ISSUE CHANNEL ATTENTION.
0663    CD 07D6           CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0666    CD 0814           CALL    CHKDST          ; CHECK COMMAND FOR PROPER COMPLETION.
                  ;                               ; CHECK BLOCK GATES.
0669    3A 1000           LDA     SGATE1
066C    E6 0F             ANI     0FH
066E    FE 04             CPI     4
0670    11 0215           LXI     D,EROR13
0673    C4 0856           CNZ     ERROR
0676    3A 1108           LDA     SGATE2
0679    E6 0F             ANI     0FH
067B    FE 04             CPI     4
067D    11 0215           LXI     D,EROR13
0680    C4 0856           CNZ     ERROR
0683    3A 1210           LDA     SGATE3
0686    E6 0F             ANI     0FH
0688    FE 04             CPI     4
068A    11 0215           LXI     D,EROR13
068D    C4 0856           CNZ     ERROR
0690    C9                RET
                  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                  ;
                  ;     SREAD - PERFORMS THE STREAMING READS AND VERIFYS.
                  ;
0691              SREAD:
                  ;   ASSUME THERE HAS BEEN (FROM PREVIOUS PARTS OF TEST) TWO
                  ;   PREVIOUSLY WRITTEN FILEMARKS PRIOR TO THE RECORDS TO BE READ
                  ;   IN STREAMING MODE.
0691    CD 0507           CALL    REWIND
0694    21 0002           LXI     H,2
0697    11 0000           LXI     D,0
069A    CD 056A           CALL    MSERCH
                  ;                               INITIALIZE BLOCKS.
069D    CD 05F4           CALL    ISTREM
                  ;                               BUILD DUMMY PATTERNS.
                  ;                               (DIFFERENT THAN EXPECTED DATA.)
06A0    21 1008           LXI     H,SDATA1
06A3    11 0100           LXI     D,100H
06A6    06 80             MVI     B,80H
06A8    CD 0831           CALL    PATERN
06AB    21 1110           LXI     H,SDATA2
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06AE    11 0100             LXI     D,100H
06B1    06 81               MVI     B,81H
06B3    CD 0831             CALL    PATERN
06B6    21 1218             LXI     H,SDATA3
06B9    11 0100             LXI     D,100H
06BC    06 82               MVI     B,82H
06BE    CD 0831             CALL    PATERN
                    ;
06C1    3E 60               MVI     A,60H
06C3    32 D306             STA     COMAND          ; SET COMMAND IN PB.
06C6    21 0880             LXI     H,880H
06C9    22 D30A             SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
06CC    21 1000             LXI     H,SGATE1
06CF    22 D312             SHLD    SRCDST          ; SET SOURCE/DEST FIELD IN PB.
06D2    CD 07D6             CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
06D5    2F                  CMA
06D6    32 D301             STA    GATE
06D9    D3 8A               OUT     CA              ; ISSUE CHANNEL ATTENTION.
06DB    CD 07D6             CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
06DE    CD 0814             CALL    CHKDST          ; CHECK COMMAND FOR PROPER COMPLETION.
                    ;                                 CHECK BLOCK GATES.
06E1    3A 1000             LDA     SGATE1
06E4    E6 0F               ANI     0FH
06E6    FE 04               CPI     4
06E8    11 0215             LXI     D,ERORI3
06EB    C4 0856             CNZ     ERROR
06EE    3A 1108             LDA     SGATE2
06F1    E6 0F               ANI     0FH
06F3    FE 04               CPI     4
06F5    11 0215             LXI     D,ERORI3
06F8    C4 0856             CNZ     ERROR
06FB    3A 1210             LDA     SGATE3
06FE    E6 0F               ANI     0FH
0700    FE 04               CPI     4
0702    11 0215             LXI     D,ERORI3
0705    C4 0856             CNZ     ERROR
                    ;                               VERIFY FIRST BLOCK.
0708    21 1008             LXI     H,SDATA1
070B    11 0100             LXI     D,100H
070E    06 01               MVI     B,1
0710    CD 083E             CALL    VERIFY
                    ;                               VERIFY SECOND BLOCK.
0713    21 1110             LXI     H,SDATA2
0716    11 0100             LXI     D,100H
0719    06 02               MVI     B,2
071B    CD 083E             CALL    VERIFY
                    ;                               VERIFY THIRD BLOCK.
071E    21 1218             LXI     H,SDATA3
0721    11 0100             LXI     D,100H
0724    06 03               MVI     B,3
0726    CD 083E             CALL    VERIFY
0729    C9                  RET
                    PAGE
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                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       BLOCKM - EXECUTES THE BLOCK MOVE COMMAND.
                        ;
072A                    BLOCKM:
                        ;                               BUILD PATTERNS TO MOVE.
072A    21 1000                 LXI     H,BUFFER
072D    11 0100                 LXI     D,100H
0730    06 01                   MVI     B,1
0732    CD 0831                 CALL    PATERN
                        ;                               BUILD DUMMY PATTERN.
0735    21 1100                 LXI     H,BUFFER+100H
0738    11 0100                 LXI     D,100H
073B    06 80                   MVI     B,80H
073D    CD 0831                 CALL    PATERN
0740    3E 80                   MVI     A,80H
0742    32 D306                 STA     COMAND          ; SET COMMAND IN PB.
0745    21 0000                 LXI     H,0
0748    22 D30A                 SHLD    CONTRL          ; SET CONTROL FIELD OF PB.
074B    21 0100                 LXI     H,100H
074E    22 D30C                 SHLD    COUNT
0751    21 1000                 LXI     H,BUFFER
0754    22 D30E                 SHLD    BFRSZE          ; SET BUFFER SIZE FIELD OF PB.
0757    21 0000                 LXI     H,0
075A    22 D310                 SHLD    RECORD          ; SET RECORD FIELD OF PB.
075D    21 1100                 LXI     H,BUFFER+100H
0760    22 D312                 SHLD    SRCDST          ; SET SOURCE/DEST FIELD IN PB.
0763    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
0766    2F                      CMA
0767    32 D301                 STA     GATE            ; CLOSE GATE.
076A    D3 8A                   OUT     CA              ; ISSUE CHANNEL ATTENTION.
076C    CD 07D6                 CALL    OPEN05          ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
076F    21 0238                 LXI     H,EROR15
0772    CD 080B                 CALL    CHKSTS          ; CHECK COMMAND STATUS FOR 0C0H.
                        ;                                 VERIFY BLOCK MOVED.
0775    21 1100                 LXI     H,BUFFER+100H
0778    11 0100                 LXI     D,100H
077B    06 01                   MVI     B,1
077D    CD 083E                 CALL    VERIFY
0780    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;     EXCHNG - SETS UP PATTERNS FOR EXCHANGE COMMAND AND
                        ;              CALLS ROUTINE WHICH EXECUTES EXCHANGE COMMAND.
                        ;
0781                    EXCHNG:
                        ;                               BUILD TEST PATTERN.
0781    21 1000                 LXI     H,BUFFER
0784    11 0100                 LXI     D,100H
0787    06 01                   MVI     B,1
0789    CD 0831                 CALL    PATERN
                        ;                               DO EXCHANGE COMMAND.
078C    CD 07A9                 CALL    GOEXCH
                        ;                               BUILD DUMMY PATTERN.
```

```
078F   21 1000             LXI     H,BUFFER
0792   11 0100             LXI     D,100H
0795   06 80               MVI     B,80H
0797   CD 0831             CALL    PATERN
                   ;                        EXCHANG ORIGINAL PATTERN BACK.
079A   CD 07A9             CALL    GOEXCH
                   ;                        VERIFY ORIGINAL PATTERN.
079D   21 1000             LXI     H,BUFFER
07A0   11 0100             LXI     D,100H
07A3   06 01               MVI     B,1
07A5   CD 083E             CALL    VERIFY
07A8   C9                  RET
                   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                   ;
                   ;    GOEXCH - EXECUTES THE EXCHANGE COMMAND.
                   ;
07A9               GOEXCH:
07A9   3E 0C               MVI     A,0CH
07AB   32 D306             STA     COMAND       ; SET COMMAND IN PB.
07AE   21 0080             LXI     H,80H
07B1   22 D30A             SHLD    CONTRL       ; SET CONTROL FIELD OF PB.
07B4   21 0100             LXI     H,100H
07B7   22 D30C             SHLD    COUNT
07BA   22 D30E             SHLD    BFRSZE       ; SET BUFFER SIZE FIELD OF PB.
07BD   21 1000             LXI     H,BUFFER
07C0   22 D312             SHLD    SRCDST       ; SET SOURCE/DEST FIELD IN PB.
07C3   CD 07D6             CALL    OPEN05       ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
07C6   2F                  CMA
07C7   32 D301             STA     GATE         ; CLOSE GATE.
07CA   D3 8A               OUT     CA           ; ISSUE CHANNEL ATTENTION.
07CC   CD 07D6             CALL    OPEN05       ; WAIT FOR GATE = OPEN ( 5 SEC MAX).
07CF   11 024C             LXI     D,EROR16
07D2   CD 0808             CALL    CHKSTS       ; CHECK COMMAND STATUS FOR 0C0H.
07D5   C9                  RET
                   PAGE
```

```
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;       UTILITY SUBROUTINES
                        ;
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;    OPEN05 - LOOPS UNTIL GATE = OPEN OR TIMED OUT ( APPROX. 5 SEC.)
                        ;
07D6                    OPEN05:
07D6    11 0003                 LXI     D,3
07D9    01 FFFF                 LXI     B,0FFFFH
07DC    CD 07EA                 CALL    OPENGT
07DF    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;     OPEN45 - LOOPS UNTIL GATE = OPEN OR TIMED OUT (APPROX. 45 SEC.)
                        ;
07E0                    OPEN45:
07E0    11 0013                 LXI     D,13H
07E3    01 FFFF                 LXI     B,0FFFFH
07E6    CD 07EA                 CALL    OPENGT
07E9    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;    OPENGT - LOOPS UNTIL GATE = OPEN OR TIMED OUT(TIME OUT COUNT
                        ;             PASSED IN BC AND DE).
                        ;
07EA                    OPENGT:
07EA    C5                      PUSH    B
07EB                    OPEN10:
07EB    0B                      DCX     B
07EC    78                      MOV     A,B
07ED    B1                      ORA     C
07EE    C2 07F9                 JNZ     OPEN20
07F1    C1                      POP     B
07F2    C5                      PUSH    B
07F3    1B                      DCX     D
07F4    7A                      MOV     A,D
07F5    B3                      ORA     E
07F6    CA 0802                 JZ      TERROR
07F9                    OPEN20:
07F9    3A D301                 LDA     GATE
07FC    B7                      ORA     A
07FD    C2 07EB                 JNZ     OPEN10
0800    C1                      POP     B
0801    C9                      RET
0802                    TERROR:
0802    11 02C9                 LXI     D,EROR24
0805    CD 0856                 CALL    ERROR
0808    C3 0000                 JMP     BOOT
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;    CHKSTS - CHECKS COMMAND STATUS FOR 'ENTERED' AND 'COMPLETE'
                        ;             BITS SET.
```

```
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;   PATERN - BUILDS AN INCREMENTING BYTE PATTERN IN MEMORY.
                        ;
                        ;   INPUT
                        ;
                        ;       B = STARTING BYTE.
                        ;       DE = LENGTH OF PATTERN
                        ;       HL = STARTING ADDRESS OF PATTERN.
                        ;
0831                    PATERN:
0831    7A                      MOV     A,D
0832    B3                      ORA     E
0833    C8                      RZ
0834                    PAT10:
0834    70                      MOV     M,B
0835    04                      INR     B
0836    23                      INX     H
0837    1B                      DCX     D
0838    7A                      MOV     A,D
0839    B3                      ORA     E
083A    C2 0834                 JNZ     PAT10
083D    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;   VERIFY - VERIFYS AN INCREMENTAL PATTERN IN MEMORY.
                        ;
                        ;   INPUT
                        ;
                        ;        B = STARTING BYTE.
                        ;        DE = LENGTH OF PATTERN.
                        ;        HL = ADDRESS OF STARTING PATTERN.
                        ;
083E                    VERIFY:
083E    7A                      MOV     A,D
083F    B3                      ORA     E
0840    C8                      RZ
0841                    VER10:
0841    7E                      MOV     A,M
0842    B8                      CMP     B
0843    C2 084F                 JNZ     VERERR
0846    04                      INR     B
0847    23                      INX     H
0848    1B                      DCX     D
0849    7A                      MOV     A,D
084A    B3                      ORA     E
084B    C2 0841                 JNZ     VER10
084E    C9                      RET
                        ;
084F                    VERERR:
084F    11 0228                 LXI     D,ERORI4
0852    CD 0856                 CALL    ERROR
0855    C9                      RET
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
```

```
                          ;
                          ;       ERROR - DISPLAYS ERROR MESSAGE. MESSAGE ADDRESS IN DE.
                          ;
0856                      ERROR:
0856    CF                        RST     1
0857    0E 09                     MVI     C,9
0859    CD 0005                   CALL    CPM
085C    C9                        RET
                          ;
                          ;
                          ;
                          ;
                                  END     GO
```