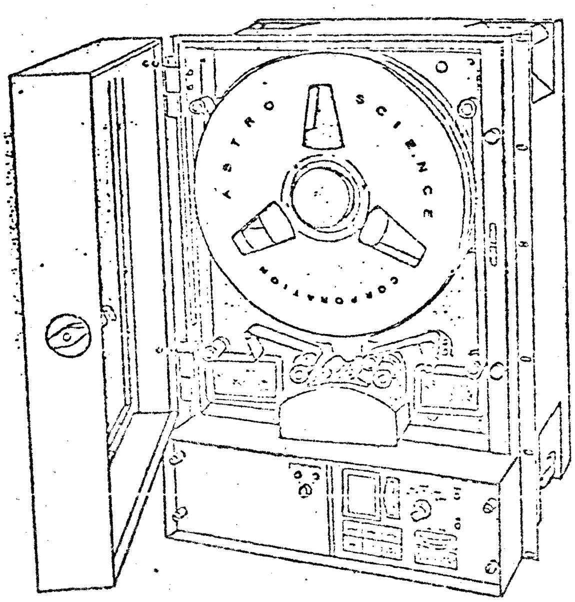
ASTRO-SCIENCE CORPORATION

OPERATION AND MAINTENANCE
INSTRUCTIONS
FOR
MODEL RD-378/U
RECORDER/REPRODUCER
15 NOVEMBER 1972



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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Do not replace components or make adjustments inside the equipment with the high voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid casualties, always remove power and discharge and ground a circuit before touching it.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into or enter the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Such information may be obtained from the Bureau of Medicine and Surgery.

The following warning appears in the text in this volume, and is repeated here for emphasis.

WARNING

> The unit operates at dangerous voltages. Turn off main circuit breaker for all procedures that do not require power to the unit. For those procedures that require power to the unit, observe all precautions normally followed in using and testing electronic equipment. (Page 4-1).

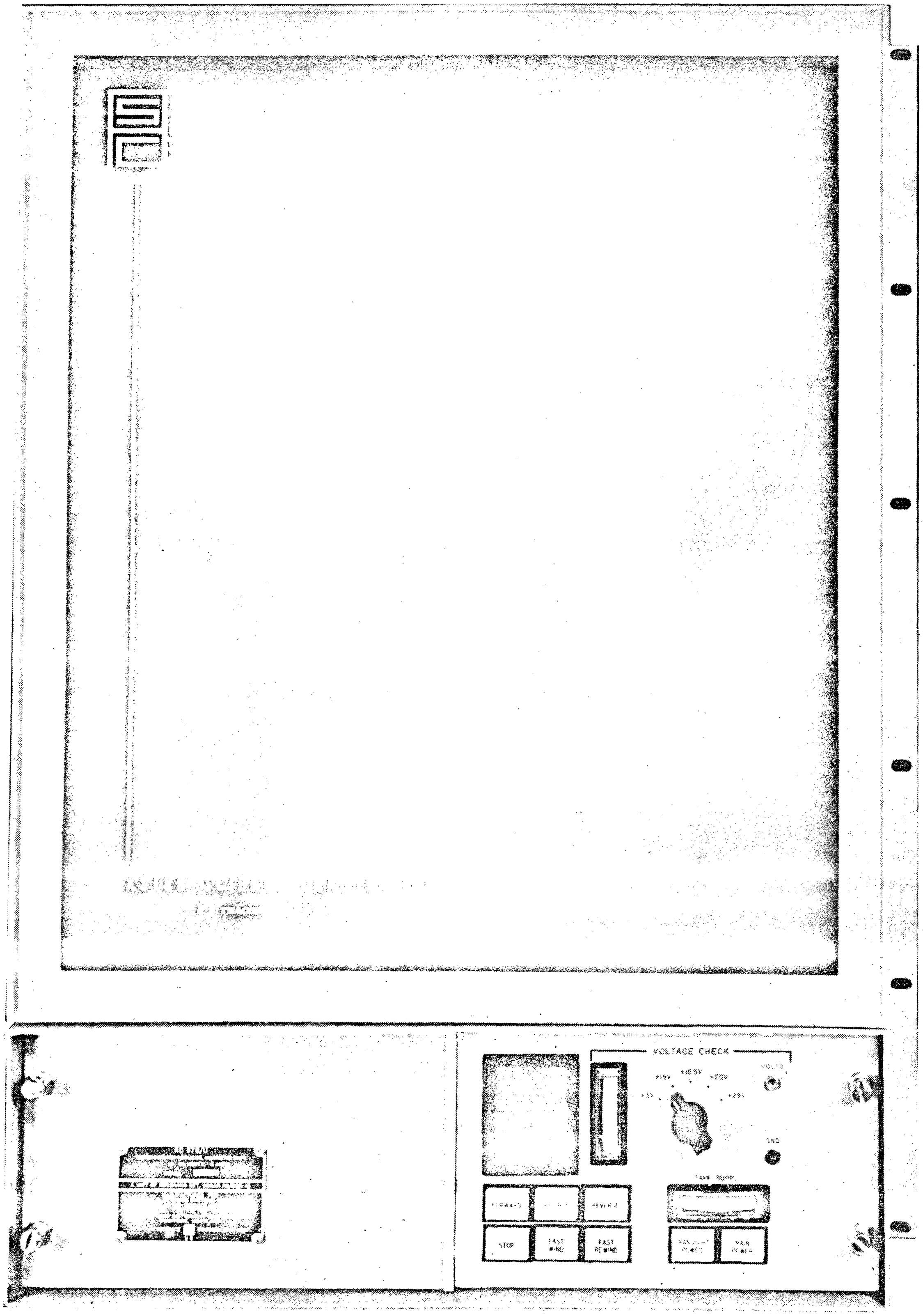

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Figure 1-1. Magnetic Tape Recorder/Reproducer Model RD378/U.

CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This technical manual provides installation, operation, and field level maintenance information for the Model RD378/U Magnetic Tape Recorder/Reproducer, manufactured by Astro-Science Corporation, South El Monte, California. The RD378/U is a self-contained, 14-track recorder/reproducer providing seven tape speeds of 1-7/8 through 120-ips, and may be configured with either wideband direct/analog (2.0 MHz at 120 ips) or wideband Group I FM signal electronics, or any combination of both.

1-3. Signal electronics are provided in two overlapping speed ranges of 1-7/8, 3-3/4, 7-1/2, 15, 30, and 60 ips or 3-3/4, 7-1/2, 15, 30, 60, and 120 ips depending upon application requirements. The tape transport will operate at all seven electrically selectable tape speeds, without modification or mechanical component changes. Direct/analog and FM signal electronics are directly interchangeable, and may be intermixed in any combination of track assignments. Bi-directional tape metering is provided by a dual-differential capstan drive and phase-locked capstan servo. Separate servo-operated reel motors provide uniform tape tension, and gentle tape handling, in all modes of operation.

1-4. PURPOSE.

1-5. The RD378/U is a portable recorder/reproducer designed for data acquisition and reproduction in semi-hostile environments encountered in sub-surface craft, shipboard, aircraft and land vehicle applications. Typical uses include communications, instrumentation, signal analysis, and similar uses requiring information storage on 1-inch-wide magnetic tape.

1-6. SCOPE

1-7. Information in this technical manual is intended for use by U. S. Navy personnel engaged in operation and maintenance of the unit.

Chapter 2: Provides operating instructions.

Chapter 3: Provides functional information.

Chapter 4: Describes preventive maintenance to be performed on a scheduled basis.

Chapter 5: Provides troubleshooting information and procedures to be performed prior to corrective maintenance. (Functional dependency within the unit is the basis of troubleshooting procedures.)

Chapter 6: Describes field corrective maintenance.

Chapter 7: Parts List.

Chapter 8: Provides procedures and

supporting illustrations for installation of the unit.

1-8. SUPERSEDURE DATA.

1-9. This technical manual is the basic issue for the unit and does not supersede any prior publications.

1-10. APPLICABILITY.

1-11. This manual applies to the models, serial numbers, and configuration given below.

1-12. MODEL.

1-13. This technical manual applies to Astro-Science Corporation Magnetic Tape Recorder/Reproducer Model RD378/U.

1-14. SERIAL NUMBERS.

1-15. The unit serial numbers covered by this manual are A1 through A7.

1-16. CONFIGURATIONS COVERED.

1-17. The units covered by this manual are all of the same configuration.

1-18. INTERFACE RELATIONSHIP OF TECHNICAL MANUAL TO OTHER PUBLICATIONS.

1-19. This technical manual is used with the technical manual for Sonar Receiving Set AN/SQR-15.

1-20. RELATIONSHIP OF UNIT TO SYSTEM OR OTHER EQUIPMENT.

1-21. This equipment functions within Sonar Receiving Set AN/SQR-15, interfacing with Tape Recording Switching Unit, Chesapeake Instrument Corporation, Part No. 1083D5238.

1-22. EQUIPMENT DESCRIPTION.

1-23. The RD378/U is designed for mounting within a standard 19-inch electronic rack. The unit is self-contained and requires only a power source and input data cabling for normal operation. The dust cover and tape transport assembly are hinged so that the unit can be opened for tape installation and maintenance. With the unit open, all parts are accessible for maintenance and testing purposes without removing the unit from the rack. The unit has an internal cooling fan. Overload protection is provided by fuses and a main power circuit breaker. Functionally, the unit is capable of operation in two modes: record and reproduce. The direct reproduce electronics are equalized for optimum phase response and amplitude equalized for flat response (±3 db) over six operating speeds; 1-7/8 through 60 or 3-3/4 through 120 ips. The dual differential capstan drive and a phase-lock capstan servo provide forward and reverse capability at all seven selectable tape speeds. The unit can be operated at 1-7/8, 3-3/4, 7-1/2, 15, 30, 60, and 120 ips. Fast wind and fast rewind are accomplished at 240 ips. Servo-operated reel motors provide uniform tape tension and gentle tape handling in all modes of operation. All operator controls (except SPEED SELECT, located on the transport assembly) are conveniently located on the front panel of the reproduce amplifier module. These controls include RECORD, FORWARD, REVERSE, STOP, FAST WIND

FAST REWIND, TRANSPORT POWER, and MAIN POWER. The control panel also has a tape supply indicator, and voltage check control and meter. The status panel indicates speed selected, end-of-tape, and tape break conditions.

1-24. REFERENCE DATA.

1-25. The following tables provide descriptive and functional characteristic data.

Table 1-1. Nameplate Data

Table 1-2. Functional Characteristics

Table 1-3. Capabilities and Limitations

Table 1-4. Rated Outputs

Table 1-5. Environmental Characteristics

1-26. EQUIPMENT, ACCESSORIES, AND DOCUMENTS SUPPLIED.

1-27. Table 1-6 provides the equipment, accessories, and documents supplied with the unit.

1-28. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED.

1-29. Table 1-7 provides a listing of all tools, test equipment, and publications required but not supplied to operate the unit.

1-30. FIELD AND/OR FACTORY CHANGES.

1-31. No field or factory changes are applicable to the unit.

TABLE 1-1. NAMEPLATE DATA

MANUFACTURER	TYPE	MODEL	COMPONENT IDENTIFICATION
ASTRO-SCIENCE CORPORATION	RECORDER-REPRODUCER, MAGNETIC TAPE	RD378/U	95002661

TABLE 1-2. FUNCTIONAL CHARACTERISTICS

Power Requirement:	110 V ac, 60 Hz, single phase	
Modes of Operation:	Record, Reproduce	
Input/Output:	14 channels of data, 400 Hz to 2.0 MHz, at 120-ips for Direct/Analog Recording and Reproducing; or dc to 80 kHz, at 120-ips for Wideband Group I FM Recording and Reproducing	
Frequency Response:		
Selected Speed (ips)	FM	Direct
1-7/8	dc-1.25 kHz	400 Hz - 31.2 kHz
3-3/4	dc-2.5 kHz	400 Hz - 62.5 kHz
7-1/2	dc-5 kHz	400 Hz - 125 kHz
15	dc-10 kHz	400 Hz - 250 kHz
30	dc-20 kHz	400 Hz - 500 kHz
60	dc-40 kHz	400 Hz - 1.0 MHz
120	dc-80 kHz	400 Hz - 2.0 MHz
Bias Frequency:		7.05 MHz
Frequency Response:	±1 dB, all speeds	±3 dB, all speeds
Signal-to-Noise Ratio:	±1 dB, all speeds	
Selected Speed (ips)	FM	Direct
1-7/8	40 dB	20 dB
3-3/4	42 dB	22 dB
7-1/2	44 dB	24 dB
15	46 dB	24 dB
30	47 dB	24 dB
60	48 dB	24 dB
120	49 dB	24 dB

TABLE 1-3. CAPABILITIES AND LIMITATIONS

Tape Speeds	
Operating	1-7/8, 3-3/4, 7-1/2, 15, 30, 60, and 120 ips/
FAST WIND/REWIND	240 ips.
Data Record/Reproduce Channels	14
Recording Methods	Direct and FM (Digital available as an option).
Tape Type	3M type 888/900 or equivalent; 9200 ft. of one-inch-wide tape per 14-inch reel.
Operational Direction	Operates in either forward or reverse direction.
Start Time	Less than 5 seconds at 60 ips.
Stop Time	Less than 3 seconds from 60 ips.
Jitter	Less than 0.5 usec in a 200 usec interval on any track at 60 ips, without tape servo.
Speed Accuracy	$\pm$0.2% of nominal.
End-of-Tape, Tape Remaining, Tape Break Sensors	Photoelectric sensors which stop transport in event of tape breakage or end of tape. Indicators show amount of tape remaining on supply reel and tape break or end-of-tape condition.
Local Controls	MAIN POWER on/off, TRANSPORT POWER on/off, SPEED SELECT, FORWARD, REVERSE, RECORD, FAST WIND, FAST REWIND, STOP.

TABLE 1-3. CAPABILITIES AND LIMITATIONS (Cont'd)

Remote Controls	Provision for all local control functions via J102. Customer supplies remote control panel and switching circuitry.
Magnetic Heads Track Geometry	Width, 0.050 inches $\pm$0.005 inches Spacing, 0.070 inches, Interlace distance, 1.500 inches $\pm$0.001 inches.

TABLE 1-4. RATED OUTPUTS

Data Signal Input Level	
Direct	0.20 to 10 volts rms, adjustable, 1.0 volt rms nominal.
FM	1.0 to 10.0 volts peak-to-peak, 1.0 volts rms nominal
Data Signal Output Level	
Direct	0.2 to 10 volts rms adjustable (1.0 volt rms nominal at normal record level).
FM	Adjustable (2 to 4 volts peak-to-peak with full deviation).
Power Consumption	500 watts (normal).

TABLE 1-5. ENVIRONMENTAL CHARACTERISTICS

Operating Temperature:	$-18^{o}C$ to $+54^{o}C$
Relative Humidity:	15% to 95%
Mechanical Shock:	
Operating:	15 g, 11 ms
Crash Safety:	30 g
Operating Vibration:	(0.8% peak-to-peak flutter at 60 ips).
5 to 15 Hz:	0.06 inches double amplitude
16 to 25 Hz:	0.04 inches double amplitude
26 to 35 Hz:	0.02 inches double amplitude

TABLE 1-6. EQUIPMENT, ACCESSORIES,

AND DOCUMENTS SUPPLIED

Quantity	Nomenclature	CID	Dimensions	Weight	Volume
1	Magnetic Tape Recorder/Reproducer		19.0 in. x 26.22 in. x 16.0 in.	148 lb.	4.6 cu. ft.
1	Container, Shipping, Reusable		22.25 in. x 31.5625 in. x 20.75 in.		6.12 cu. ft.
1	Kit, Accessory Service		(Not Applicable)		
1	Kit, Mating Connector		(Not Applicable)		
1	Manual, Operation and Maintenance		(Not Applicable		

TABLE 1-7. EQUIPMENT AND PUBLICATIONS

REQUIRED BUT NOT SUPPLIED

Category	Recommended Equipment	Alternate Equipment	Equipment Test Parameters	Application
Sine Wave Signal Generator	TS-382-D/U (FSC80058)	HP651A (FSC80104)	0-2 MHz	Corrective maintenance and trouble-shooting.
Harmonic Wave Analyzer	TS-723-C/U (FSC80058)	HP310A (FSC80104)	3.125 kHz-300 kHz	Corrective maintenance and trouble-shooting.
Vacuum Tube Voltmeter	ME-30-A/U (FSC80058)	HP400E (FSC80104)	0-10 V ac (rms) to 2 MHz	Corrective maintenance and trouble-shooting.
Square Wave Signal Generator	SG-299 C/U	HP211A (FSC80104)	50 kHz	Corrective maintenance and trouble-shooting.
Digital DC Vacuum Tube Voltmeter		HP3439A (FSC80104)	0 - ±30 V dc	Corrective maintenance
Frequency Counter	AN/USM-245	HP5216A (FSC80104)	2 kHz - 605 kHz	Corrective maintenance
Oscilloscope	AN/USM-105A	Tektronix 545 with CA plug-in (FSC80009)	Display 100 kHz square wave	Corrective maintenance
Reference Power Supply,	SCAT 4115	HP6113A	0-10 V ac	Corrective maintenance

CHAPTER 2

OPERATION

2-1. INTRODUCTION.

2-2. This chapter provides procedures for operating the RD378/U under normal and emergency conditions.

2-3. CONTROLS AND INDICATORS.

2-4. All local controls, except the tape SPEED SELECT switch, are located on the front panel of the reproduce amplifier module (RAM), directly below the tape transport (Figure 2-1). The tape SPEED SELECT switch is located on the left-hand side of the transport, and is accessible when the transport dust cover-door is opened (Figure 2-2). Table 2-1 lists all controls and indicators, and briefly describs the operation of each. An optional remote control unit may also be connected to the rear connector panel (J-102) to provide selection of all operational modes.

2-5. CIRCUIT BREAKER AND FUSE LOCATION.

2-6. The main power circuit breaker, which controls application of primary AC input power to the equipment, is located directly behind the swing-out transport (Figure 2-3). Circuit protection fuses are located on the left-hand side of the tape transport, and at the rear of the RAM, as shown in Figure 2-2. Table 2-2 lists and describes the function of all fuses and circuit breakers.

2-7. PRELIMINARY NOTES AND PRECAUTIONS.

2-8. DIRTY HEADS OR TAPE PATH. Contamination of either the tape or the head by dust, dirt, oxide, or other foreigh substances will affect recorder performance in three ways, all of which degrade the quality of the recorded data. These ways are:

1. By lifting the tape away from the head, causing temporary signal "dropouts".

2. By becoming imbeded in the oxide surface of the tape, resulting in permanent damage to the tape. The overall effect will be the same as above, but the dropout will be permanent.

3. By accumulating at, and eventually shunting, the head gaps, causing complete and total loss of the signal.

2-9. MAGNETIZED HEADS. Data degradation resulting from magnetized record/reproduce heads is characterized by any, or all, of the following indications.

1. Reduced signal-to-noise ratio.

2. Loss of high-frequency response.

3. Increased signal distortion (especially 2nd order harmonic distortion).

4. Permanent loss of recorded data,

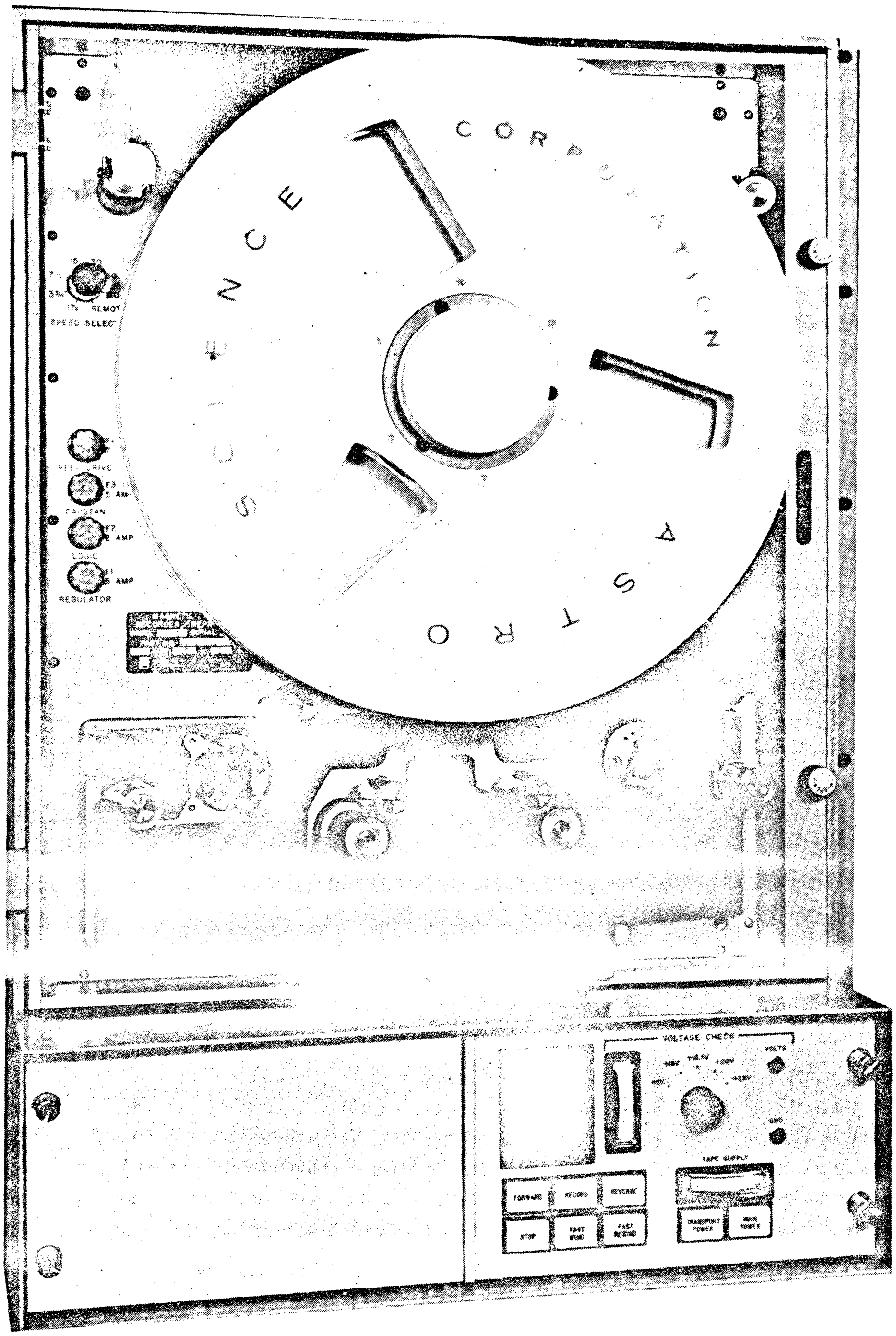
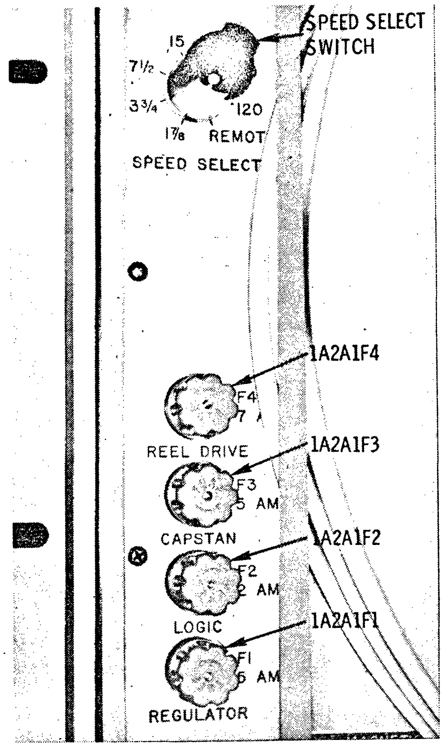


Figure 2-1. Operator's Controls and Indicators



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Fuse 2-2. Fuse Location (Sheet 1 of 2).

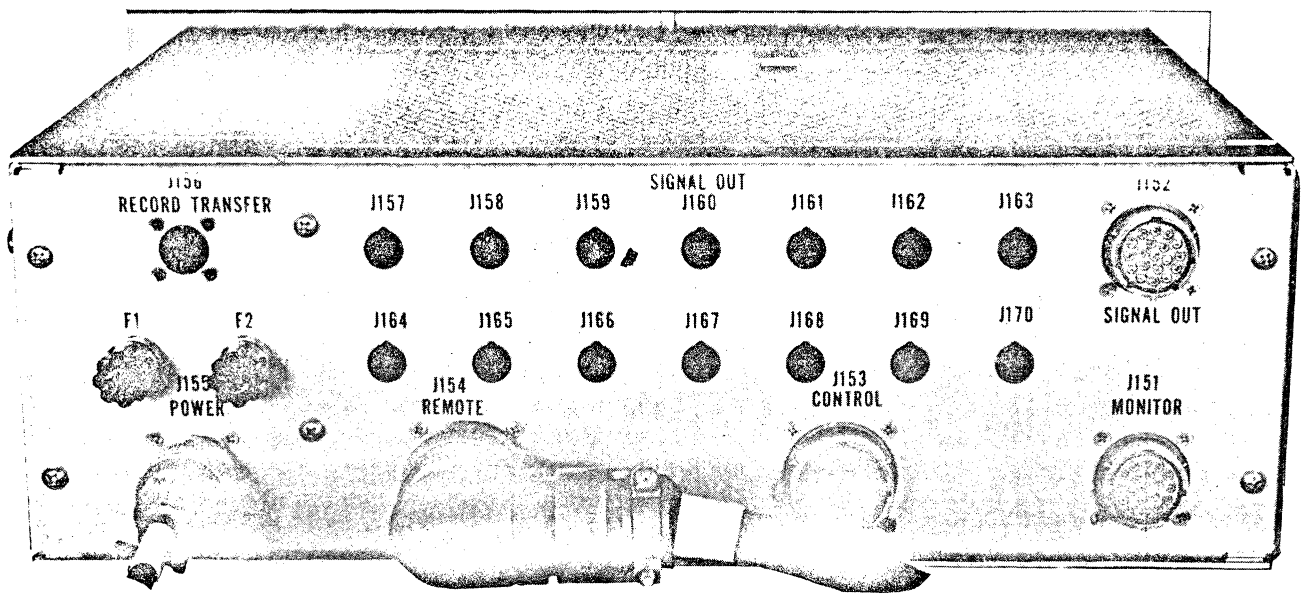


Figure 2-2. Fuse Location (Sheet 2 of 2)

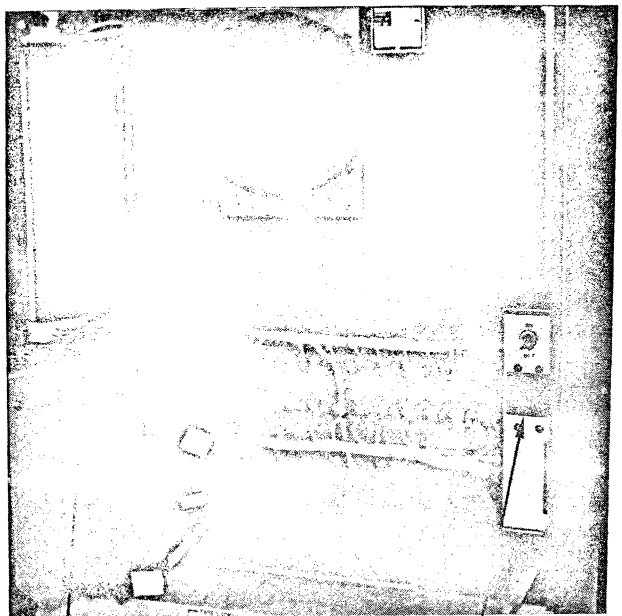


Figure 2-3. Circuit Breaker and Elapsed Time Meter.

TABLE 2-1. OPERATOR CONTROLS AND INDICATORS

Panel Designation	Position and Operating Function	Indicator Normal Operating Condition
MAIN POWER (push-button switch and indicator lamp)	ON-applies 117V ac input power to unit and energizes cooling fan. OFF-removes 117 V ac Power from unit and cooling fan.	Lighted Off
TRANSPORT POWER (pushbutton switch and indicator lamp)	ON-applies +28V dc input power, placing unit in standby mode. OFF-removes +28V dc power from unit.	Lighted Off
STOP (pushbutton switch and indicator lamp)	ON-stops tape motion by resetting memory cells for all other operating modes. OFF-occurs when another operating mode is selected	Lighted, other mode indicators off. OFF. Indicator for selected mode lights.
FORWARD (push-button switch and indicator lamp)	ON-Activates transport to move tape in the forward position at selected speed. Reproduce electronics are activated for monitoring previously recorded data. OFF-occurs when STOP switch is pressed.	Lighted Off. STOP indicator is lighted.

TABLE 2-1. OPERATOR CONTROLS AND INDICATORS (CONT'D)

Panel Designation	Position and Operating Function	Indicator Normal Operating Condition
RECORD (pushbutton switch and indicator lamp)	ON- must be pressed simultaneously with FORWARD switch. Activates record electronics to record data on tape. Reproduce electronics also are activated for monitoring of data while recording	Lighted
	OFF-occurs when STOP switch is pressed.	Off. STOP indicator is lighted.
REVERSE (pushbutton switch and indicator lamp)	ON- activates transport to move tape in reverse direction at selected speed. Reproduce electronics are activated for monitoring previously recorded data.	Lighted
	OFF-occurs when STOP switch is pressed.	Off. STOP indicator is lighted.
FAST WIND (pushbutton switch and indicator lamp)	ON- activates transport to move tape in forward direction at approximately 240 ips.	Lighted
	OFF-occurs when STOP switch is pressed.	Off. STOP indicator is lighted.
FAST REWIND (pushbutton switch and indicator lamp)	ON- activates transport to move tape in reverse direction at approximately 240 ips	Lighted
	OFF-occurs when STOP switch is pressed.	Off. STOP indicator is lighted.

TABLE 2-1. OPERATOR CONTROLS AND INDICATORS (CONT'D)

Panel Designation	Position and Operating Function	Indicator Normal Operating Condition
SPEED SELECT (eight-position rotary switch on tap transport)	Selects tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30, 60, or 120 ips. Eighth position permits selection of tape speed from remote control unit.	Selected speed is displayed on STATUS INDICATOR.
VOLTAGE CHECK (five position rotary switch, volt meter, and two test points)	Switch selects transport operating voltage of 5 V dc, 15 V dc, 18.5 V dc, 20 V dc and 28 V dc for readout on meter. Test points permit attachment of external DC voltmeter for more accurate readouts.	Meter displays selected voltage within ±5%.
STATUS INDICATOR (back-lighted display panel)	Displays selected tape speed and end-of-tape or broken tape conditions.	Lighted display of 1-7/8, 3-3/4, 7-1/2, 15, 30, 60, or 120 ips. Also displays END OF TAPE and BROKEN TAPE when those conditions exist.
TAPE SUPPLY (meter)	Provides visual indication of approximate amount of tape remaining on supply reel.	Displays Full, 3/4, 1/2, 1/4 or EMPTY on linear scale. NOTE TAPE SUPPLY meter is accurate only when using 14-inch-diameter tape reels.
ELAPSED TIME (meter)	Indicates total number of hours tape has been in motion across headstack.	Digital display of total operating hours. Indicator operates only when transport is in FORWARD, RECORD, REVERSE, FAST WIND, and FAST REWIND modes of operation.

TABLE 2-2. PROTECTIVE DEVICES

Protective Device	Reference Designation	Location	Rating	Circuit Protected
Circuit Breaker	CB1	Inside of enclosure	7.5A	Overall protection
Fuse	1A3F1	Rear panel of RAM	5.0A	Record/re-produce amplifiers
Fuse	1A3F2	Rear panel of RAM	5.0A	Front panel indicators; DC/DC con-verter; & speed change logic
Fuse	1A2A1F1	Front of transport	5.0A	Regulator
Fuse	1A2A1F2	Front of transport	2.0A	Logic
Fuse	1A2A1F3	Front of transport	5.0A	Capstan
Fuse	1A2A1F4	Front of transport	7.0A	Reel Drive

due to tape erasure, by the magnetized headstack.

2-10. IMPROPER TAPE TYPE. The overall quality of recorded data depends, to a considerable extent, upon the type of magnetic tape utilized. To ensure optimum data quality, the manufacturer recommends the use of 3M888 tape for all direct/analog or FM recording. For applications requiring extended recording time, 3M990 tape is recommended. For digital recording, where bit packing density exceeds 10 KBI, 3M988 tape is recommended.

CAUTION

Thin-base tape recommended for extended recording time is extremely fragile. Damage to tape ends may result if allowed to wind completely off reel while in the FAST WIND or FAST REWIND modes.

2-11. PRELIMINARY PROCEDURES.

2-12. Before proceeding to the operating procedures, a general inspection of the equipment should be made, and the following preliminary procedures performed.

1. Clean heads and tape path as described in Chapter 4, paragraph 4-8.

2. Degauss heads as described in Chapter 4, paragraph 4-9.

2-13. TAPE THREADING.

CAUTION

TRANSPORT POWER should be OFF when loading and unloading tape, to prevent sudden reel rotation.

1. Turn transport power OFF by depressing the TRANSPORT POWER pushbutton on the front panel of the RAM.

2. Loosen the reel retainer expansion rings by rotating both reel locking-knobs CCW.

3. Manually rotate the inner supply reel hub CCW, until the small, spring-loaded reel alignment pin is at the top of the hub.

4. Rotate the outer take-up reel hub CW, until one of the three fixed turntable tabs is aligned with the spring-loaded alignment pin of the supply reel hub.

5. Place a full reel of tape on the supply reel hub. Guide the alignment slots on the inside center of the tape reel past the three tabs on the outer take-up reel hub, until it rests against the reel-stop flanges on the inner supply hub.

6. If necessary, rotate the reel until the spring-loaded alighment pin is positioned into one of the slots at the center of the tape reel.

7. Hold the reel firmly against the supply stop flange, and turn the inner locking knob CW, until the reel is firmly secured.

8. Remove several turns of tape from the supply reel and thread it through the transport as shown in Figure 3-16.

9. Place an empty reel on the outer take-up hub, centering one of the reel slots over the red spring-loaded alighment pin of the take-up reel hub.

10. Hold reel firmly against the three fixed turntable tabs, and turn the outer locking knob CW, until reel is firmly secured.

11. Wind several turns of tape around the hub of the empty take-up reel, being careful to avoid folding or creasing the tape.

12. Turn transport power ON by depressing the TRANSPORT POWER pushbutton.

2-14. OPERATING PROCEDURES.

2-15. The procedures in Table 2-3 describe initial turn on, tape speed selection, the seven operational modes, and turn off of the RD378/U Recorder/ Reproducer, and the action required by the operator. The descriptions also include the visual indications which denote proper operation. See Figure 2-1 for locations of controls.

2-16. EMERGENCY PROCEDURES.

2-17. Should the RD378/U develop a serious malfunction during operation, such as overheating, erratic operation, etc., the unit should be immediately de-energized by depressing the STOP, TRANSPORT POWER and MAIN POWER pushbuttons - in that order. If another unit is available, operations should be transferred to that equipment until the cause of the malfunction can be determined and corrected.

TABLE 2-3. OPERATING PROCEDURES

PROCEDURE	DESCRIPTION	STEPS
a. Initial Turn On.	Turn on of Main Power Circuit Breaker.	NOTE When loosening the transport latches, apply pressure to hold the transport firmly against the cabinet stop, until the latches are fully loosened. 1. Open the dust cover-door, loosen the two knurled thumbscrew transport latches (see NOTE above), and swing the transport open to the left. 2. Turn ON the main power circuit breaker, located behind the tape transport (Figure 2-3). 3. Close and secure the tape transport, and dust cover-door.
b. TAPE SPEED Selection	Selection of operating tape speed.	CAUTION When operating the tape SPEED SELECT switch, the transport should be in the STOP or POWER OFF mode. Do not change tape speeds while tape is in motion as damage to the equipment will result.

TABLE 2-3. OPERATING PROCEDURES (CONT'D)

PROCEDURE	DESCRIPTION	STEPS
		(continued) 1. Open the dust cover-door to gain access to the tape SPEED SELECT switch, located at the upper left-hand corner of the tape transport. (Fig. 2-2) 2. Select the desired tape speed (1-7/8 through 120 ips) NOTE When SPEED SELECT switch is positioned to the REMOTE setting, tape speed may be selected from a remote control unit, connected to J102 at the rear of the equipment.
c. Standby Mode	The STANDBY mode disables the transport while loading and unloading tape. In this mode, all transport functions are inoperative, and the mechanical brakes are engaged to prevent reel rotation.	1. Momentarily depress the MAIN POWER pushbutton. Pushbutton should light. (main crkt breaker, inside enclosure, must be ON) 2. All other mode indicators, including TRANSPORT POWER, should be OFF. If not, momentarily depress the TRANSPORT POWER pushbutton.

TABLE 2-3. OPERATING PROCEDURES (CONT'D)

PROCEDURE	DESCRIPTION	STEPS
d. STOP Mode	In the STOP mode, all transport functions except the capstan motor are operative. The mechanical brakes are disengaged, but tape is under dynamic tension control from the reel servos.	1. Momentarily depress the TRANSPORT POWER pushbutton. Both the TRANSPORT POWER and STOP pushbuttons, in addition to the MAIN POWER pushbutton, should be lighted. 2. The STOP mode is a true operational mode, and should be selected whenever halting tape motion is necessary, by depressing the STOP pushbutton . CAUTION Do not depress the TRANSPORT POWER pushbutton to stop tape motion! Damage to equipment may result.
e. FORWARD Mode	The FORWARD mode is selected to reproduce data previously recorded on tape. In the FORWARD mode, tape will move in the forward direction at a fixed speed, selected by the TAPE SPEED select switch.	1. To ensure gentle tape handling, the STOP mode should be selected to stop tape motion prior to selecting the FORWARD mode. 2. Momentarily depress the FORWARD pushbutton. The FORWARD indicator will light and all other mode indicators will be extinguished. Both TRANSPORT POWER and MAIN POWER indicators will remain lighted.

TABLE 2-3. OPERATING PROCEDURES (CONT'D)

PROCEDURE	DESCRIPTION	STEPS
f. RECORD Mode	The RECORD mode is selected to record data on tape. In the RECORD mode, tape will move in the forward direction at a fixed speed, selected by the TAPE SPEED select switch. Reproduce electronics are energized to permit monitoring during record operations.	1. The STOP mode should be selected prior to selecting the RECORD mode. The RD-378/U will not record data in the REVERSE mode. 2. Simultaneously depress both the FORWARD and RECORD pushbuttons. Both indicators will light, and all other mode indicators will be extinguished. Both TRANSPORT POWER and MAIN POWER indicators will remain lighted.
g. REVERSE Mode	The REVERSE mode is used primarily as an aid to search a pre-recorded tape for a specific signal data, which may have been passed over in the FORWARD mode. In the REVERSE mode, tape will move in the reverse direction at a fixed speed, selected by the TAPE SPEED select switch.	1. The STOP mode should be selected, prior to selecting the REVERSE mode. 2. Momentarily depress the REVERSE pushbutton. The REVERSE indicator will light, and all other mode indicators will be extinguished. Both the TRANSPORT POWER and MAIN POWER indicators will remain lighted.

TABLE 2-3. OPERATING PROCEDURES (CONT'D)

PROCEDURE	DESCRIPTION	STEPS
h. FAST WIND	When the FAST WIND mode is selected, tape will be wound from the SUPPLY reel to the TAKE-UP reel at approximately 240-IPS. The tape will stop automatically before running completely off the supply reel, to preclude the necessity of rethreading the transport.	1. The STOP mode should be selected, prior to selecting the FAST WIND mode. 2. Momentarily depress the FAST WIND pushbutton. The FAST WIND indicator will light, and all other mode indicators will be extinguished. Both the TRANSPORT POWER and MAIN POWER indicators will remain lighted.
i. FAST REWIND	When the FAST REWIND mode is selected, tape will be wound from the TAKE-UP reel to the SUPPLY reel at approximately 240-IPS. The tape will not stop automatically, before running completely off the take-up reel.	1. The STOP mode should be selected, prior to selecting the FAST REWIND mode, to ensure gentle tape handling. 2. Momentarily depress the FAST REWIND pushbutton. The FAST REWIND indicator will light, and all other mode indicators will be extinguished. Both the TRANSPORT POWER and MAIN POWER indicators will remain lighted.

TABLE 2-3. OPERATING PROCEDURES (CONT'D)

PROCEDURE	DESCRIPTION	STEPS
j. Equipment Turn Off	This procedure describes the steps to be taken when turning off the Recorder/Reproducer.	1. Press the STOP pushbutton. The tape should come to a smooth stop, with tension maintained across the heads. The STOP indicator should be lighted. 2. Press the TRANSPORT POWER pushbutton. The TRANSPORT POWER indicator and STOP indicator should both go out. 3. To completely de-energize the unit (i.e., remove power from the 28 V power supply and blower fan) press the MAIN POWER pushbutton. 4. Open the dust cover-door, loosen the two transport latches (see NOTE, para 2-11), swing the transport to the fully open position, and position the main power circuit breaker to the OFF position.

CHAPTER 3

FUNCTIONAL DESCRIPTION

3-1. INTRODUCTION.

3-2. This chapter provides a functional description of the various circuits and components utilized by the RD378/U Magnetic Tape Recorder/Reproducer (see Paragraph 3-3). For purposes of explanation, the operation of the unit has been divided into five major catagories (see Paragraph 3-5). Additionally, each of the five functional catagories has been further sub-divided to the circuit function level, to provide a complete description of the unit. Both functional and schematic diagrams are provided to support the technical discussions. Figure 3-1 is a functional diagram of the entire unit.

3-3. GENERAL DESCRIPTION.

3-4. The RD378/U Recorder/Reproducer consists of the following circuits and components (see Figure 3-1).

a. A record/reproduce headstack assembly to record signals on, or reproduce signals from, the magnetic tape.

b. Record amplifiers (one for each of the 14 channels) which amplify the input data signals to a level suitable for driving the record heads.

c. Reproduce amplifiers (one for each of the 14 channels) which amplify the data signals from the reproduce head to a level suitable to operate external monitors, or other readout equipments.

d. Control logic assembly which controls and monitors all transport functions.

e. Capstan drive system which moves tape across the heads at a selected, constant velocity.

f. Reel drive system which provides a constant supply of tape to the magnetic heads, and maintains uniform tape tension outside of the immediate head area.

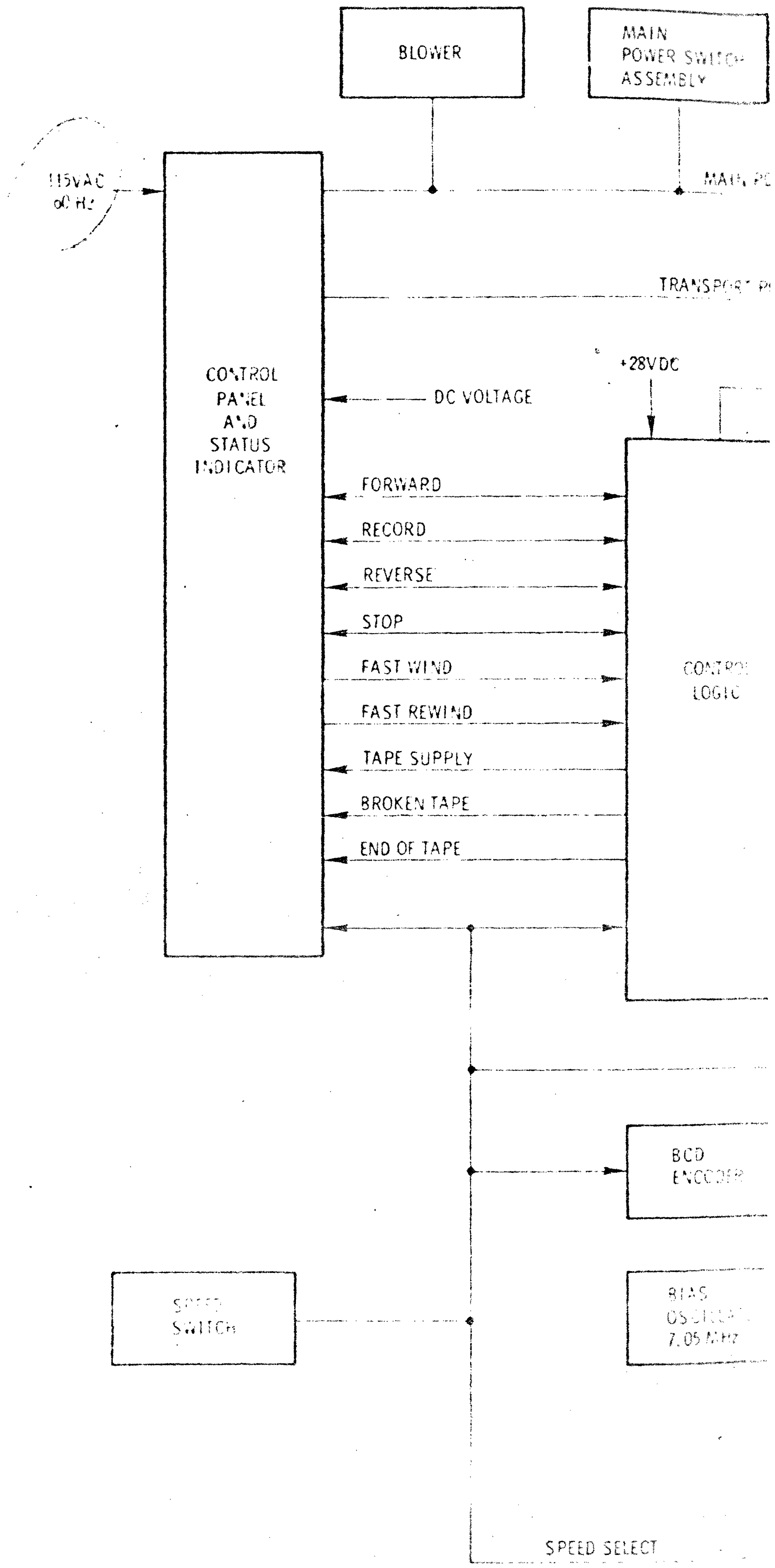
g. Tape break sensor which stops the tape transport in the event of tape breakage.

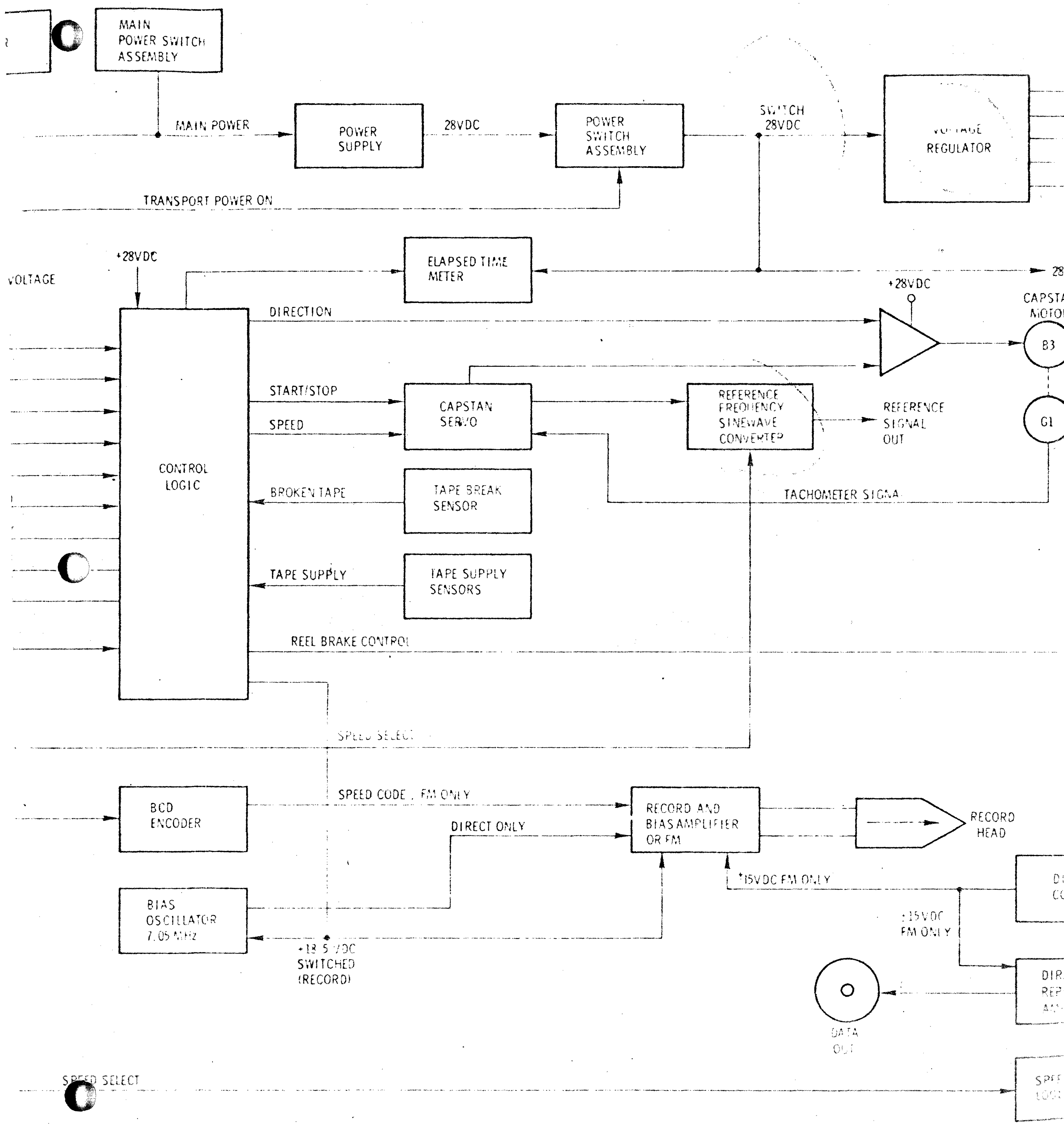
h. Tape supply sensors which provide a readout of the approximate amount of tape remaining on the supply reel.

j. Voltage regulator to convert +28 V dc primary power to lower voltage levels required by the various electronic circuits.

k. Status panel with indicators to indicate mode of operation, selected tape speed, and tape break or end-of-tape conditions.

l. Control panel with pushbutton switches to control all operating modes except speed selection. Speed selection is made by a rotary switch located on the tape transport assembly.


BLOWER
MAIN
POWER SWITCH
ASSEMBLY
115VAC
60 Hz
CONTROL
PANEL
AND
STATUS
INDICATOR
TRANSPORT
+28VDC
DC VOLTAGE
FORWARD
RECORD
REVERSE
STOP
FAST WIND
FAST REWIND
TAPE SUPPLY
BROKEN TAPE
END OF TAPE
CONTROL
LOGIC
BCD
ENCODER
BIAS
7.05 MHz
SPEED
SWITCH
SPEED SELECT


MAIN POWER SWITCH ASSEMBLY
MAIN POWER
POWER SUPPLY
28VDC
POWER SWITCH ASSEMBLY
SWITCH 28VDC
REGULATOR
TRANSPORT POWER ON
VOLTAGE
+28VDC
ELAPSED TIME METER
DIRECTION
+28VDC
B3
START/STOP
SPEED
CAPSTAN SERVO
REFERENCE FREQUENCY SINEWAVE
REFERENCE SIGNAL OUT
G1
CONTROL LOGIC
BROKEN TAPE
TAPE BREAK SENSOR
TAPE SUPPLY
TAPE SUPPLY SENSORS
REEL BRAKE
BCD ENCODER
DIRECT ONLY
RECORD AND BIAS AMPLIFIER OR FM
RECORD HEAD
BIAS OSCILLATOR 7.05 MHz
SWITCHED (RECORD)
DATA OUT
SPEED SELECT

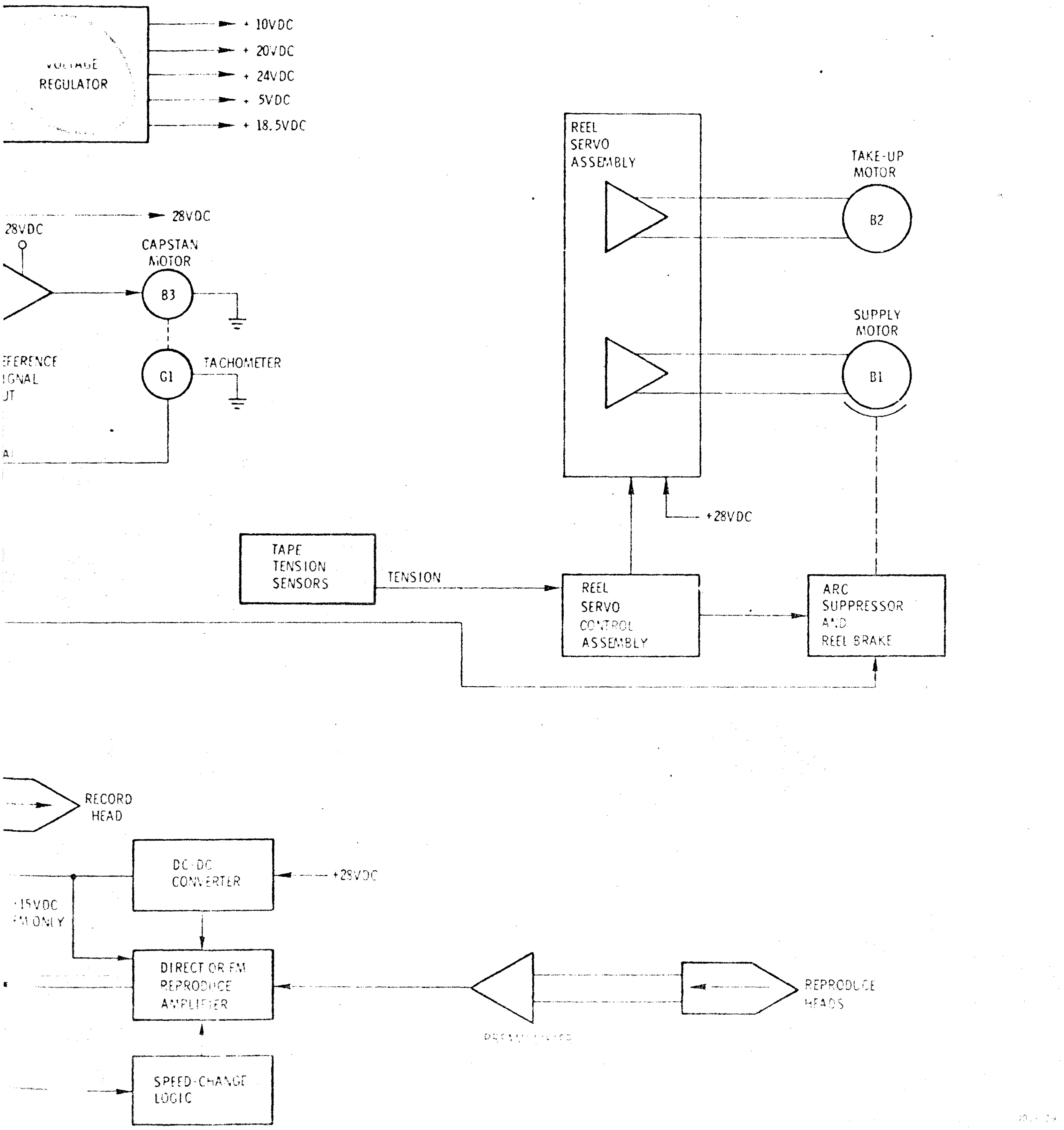


Figure 3-1. Recorder/Reproducer Functional Diagram.

3-5. UNIT FUNCTIONAL DESCRIPTION.

3-6. The M-14G is a self-contained, 14-track recorder/reproducer providing 7 tape speeds of 1-7/8 through 120 ips, and may be configured with either wideband direct/analog (2.0 MHz at 120 ips) or wideband Group I FM signal electronics, or any combination of the two. Signal electronics are provided in 2 overlapping speed ranges of 1-7/8, 3-3/4, 7-1/2, 15, 30 and 60 ips; or 3-3/4, 7-1/2, 15, 30, 60 and 120 ips, depending upon application requirements. The tape transport will operate at all 7 electrically selectable tape speeds without modification or mechanical component changes. Tape speed is selected by a rotary SPEED SELECT switch, located on the tape transport assembly. All other operational controls are located on the front panel of the reproduce amplifier module (RAM). For purposes of explanation, the operation of the unit has been classified into 5 basic functional categories, as follows:

a. Control function.

b. Record function.

c. Reproduce function.

d. Power distribution.

e. Mechanical function.

3-7. CONTROL FUNCTION.

3-8. CONTROL LOGIC. Recorder modes are operator selected by momentarily depressing pushbutton switches, located on the front panel of the RAM. Each pushbutton, when selected, grounds one of the control lines to the control logic PWB, activating integrated circuit logic gates which, in turn, control the transport mechanism. The operator selected modes include: FORWARD, RECORD, REVERSE, FAST WIND, FAST REWIND, and STOP. Separate "memory cells" are provided on the control logic PWB for each mode. These memory cells act as latching circuits to hold the recorder in the selected mode until another mode is selected, or unless overridden by one of the recorder protection circuits. Each memory cell consists of one dual-input NAND gate and one quad-input NAND gate, wired in a flip-flop configuration, and interconnected for automatic reset when another mode is selected. Since the recorder is designed to record only in the FORWARD direction, it is necessary to simultaneously depress both the FORWARD and RECORD pushbuttons when selecting the RECORD mode of operation. In addition to the six operator selected inputs, the control logic also receives inputs from the tape break sensor and from the end-of-tape sensor to automatically stop the transport mechanism whenever the tape supply is nearly exhausted, or in the event tape breaks during operation.

3-9. CONTROL LOGIC FUNCTIONAL DESCRIPTION. Refer to Figure 3-2 and Figure 5-19. The function of the control logic is to control and monitor the operation of the tape transport, in accordance with the mode commands initiated by the operator. Such commands are initiated when the operator manually depresses one or more of the pushbutton mode switches, on the front panel of the RAM. The modes available for selection are: FORWARD, RECORD, REVERSE, WIND, REWIND

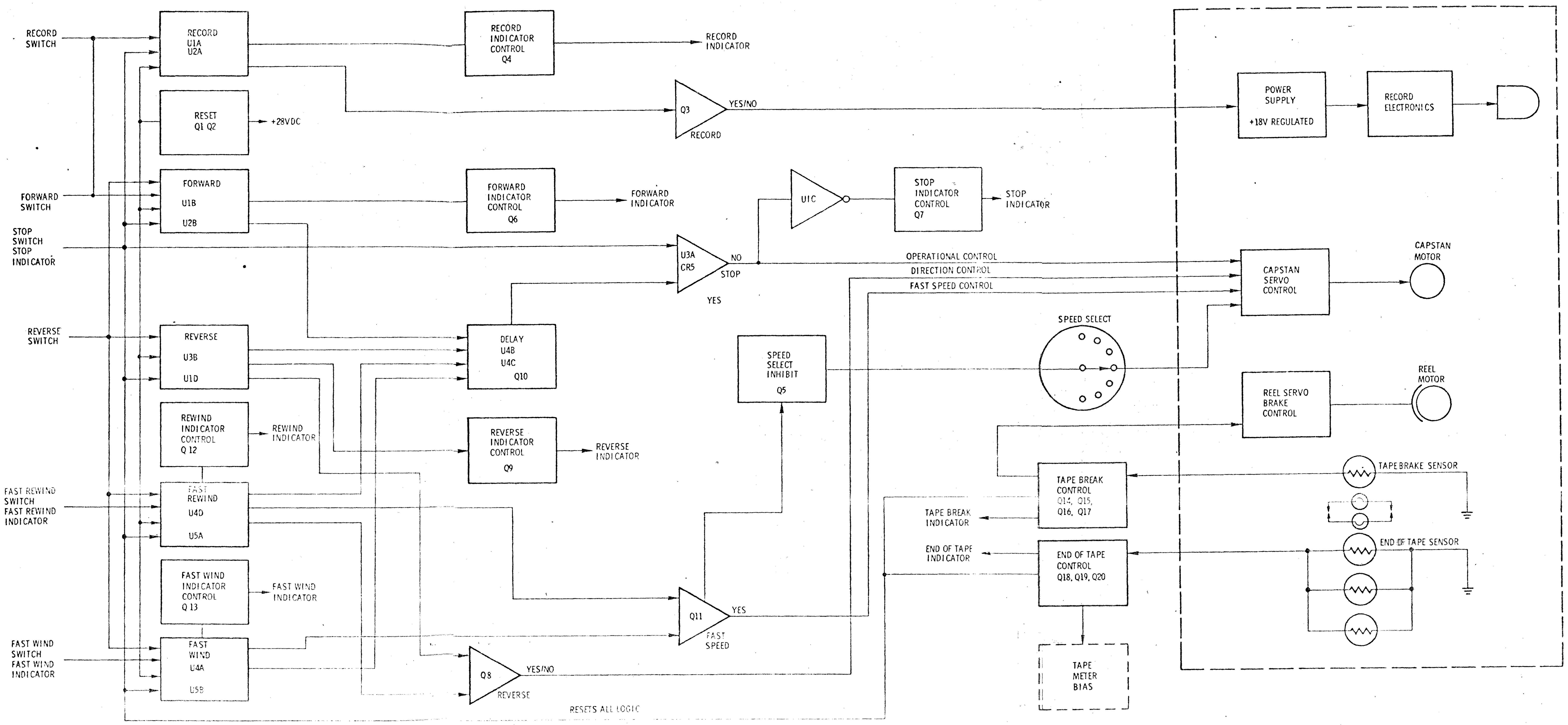


Figure 3-2. Control Logic Functional Diagram.

and STOP. The control logic also monitors the outputs from the end-of-tape and tape break sensors, and automatically stops transport operation when either of these conditions exist.

3-10. Mode Command Storage. With the exception of the STOP mode, each of the operational modes selected from the front panel of the RAM provides a ground (zero-volts) input to an integrated circuit storage element, on the control logic PWB, whenever the associated pushbutton switch is depressed. The storage elements consist of NAND gate pairs, which are connected in a flig-flop configuration, and which function as memory cells to enable the associated control circuits. The memory cells for each selected mode are: U1A and U2A for the RECORD mode, U1B and U2B for the FORWARD mode, U4D and U5A for the REWIND mode, U4A and U5B for the WIND mode, and U1D and U3B for the REVERSE mode. The memory cells are interconnected so that only one mode of operation may exist at any given time. Whenever a mode is initiated, the previously selected mode is automatically reset, except for the RECORD mode which must be selected simultaneously with the FORWARD mode. The STOP mode, when selected, resets all memory cells, which stops transport operation.

3-11. Control Circuits. The control logic contains seven control circuits which determine transport operation, for any given mode selected. These control circuits include: a start/stop control, a direction control, a fast speed control, a speed select control, a tape break control, and an end-of-tape (EOT) control. Each of the control circuits serve to either enable or disable specific transport functions necessary to perform the selected operation.

3-12. Start/Stop Control. The start/stop control circuit consists of NAND gate U3A, NAND gate U1C (connected as an inverter), transistor Q7, and diode CR5, which control the operation of the ramp generator (Q7, Q8, Q9) on the capstan servo PWB. The ramp generator, in turn, controls the operation of the capstan motor, by controlling the output of the compensation amplifier (AR3). Whenever a motion command is initiated, (FORWARD, REVERSE, FAST WIND, of FAST REWIND) the output of NAND gate U3A will go high, causing CR5 to conduct, which turns on the ramp generator on the capstan servo PWB. The turn-on voltage to the ramp generator, through CR5, is delayed for approximately 1/2 second by a one-shot multivibrator made up of NAND gate U4B and U4C and transistor Q10, which is also triggered by the receipt of a motion command through diodes CR14 thru CR17. This prevents erratic transport operation resulting from abrupt mode changes. A STOP command, whether initiated by the operator or by the tape break or EOT sensors, will reset all command memory cells. NAND gate U3A monitors the memory cells and provides a low (ground) output when all cells are reset. This generates a high output from NAND gate inverter U1C, which turns Q7 on to operate the STOP indicator on the front panel of the RAM. The low output of U3A also provides reverse bias to CR5, which stops the capstan motor. Transistors Q1 and Q2 form a delay circuit which resets all memory cells when transport power is first turned on.

3-13. Record Control. The RECORD mode is controlled by transistors Q3 and Q4, and the record memory cell consisting of U1A and U2A. When a RECORD command is initiated, the output of U2A, goes low, which turns Q3 off and enables the +18.5 V dc supply in the voltage regulator circuits, to operate the record amplifiers. The same low output from U2A causes a high output from U1A, which causes Q4 to conduct and light the RECORD indicator on the front panel of the RAM. The return line from the RECORD pushbutton is connected in series with the FORWARD pushbutton so that both a FORWARD and a RECORD command must be initiated to place the unit in the RECORD mode.

3-14. Direction Control. The direction control circuit consists of diodes CR11 and CR12, and transistor Q8. Diode CR11 monitors the output of the REVERSE memory cell (U1D and U3B), and CR12 monitors the output of the rewind memory cell (U4D and U5A). When either memory cell is set, the associated diode will conduct and turn Q8 on. Q8 will, in turn, activate the reverse relay in the capstan motor amplifier circuit, to reverse the direction of motor rotation. Whenever the REVERSE mode is selected, the output of U1D will be high, causing Q9 to conduct to light the REVERSE indicator. Likewise, when the FAST REWIND mode is selected, the output of U4D will go high to light the FAST REWIND indicator through transistor Q12.

3-15. Fast Speed Control. The fast speed control circuit consists of diodes CR30 and CR31, and transistor Q11. Diode CR30 monitors the output of the fast rewind memory cell (U4D and U5A), and CR31 monitors the output of the fast wind memory cell (U4A and U5B). When either memory cell is set, the associated diode will conduct and turn Q11 on. Q11 will, in turn, ground the input to the capstan servo phase comparator (U4A, pin 1, on the capstan servo PWB), causing full accelerating voltage to be applied to the capstan motor. Whenever the FAST REWIND mode is selected, the output of U4D will be high, causing Q12 to conduct, lighting the FAST REWIND indicator lamp on the front panel of the RAM. Likewise, when the FAST WIND mode is selected, the output of U4A will be high, causing Q13 to conduct, lighting the FAST WIND indicator lamp.

3-16. Tape Break Control. The tape break control circuit consists of transistors Q14 thru Q17. The circuit monitors the tape break sensor, and initiates a stop command to the control logic in the event of tape breakage. Under normal conditions, transistor Q16 is biased on through resistor R43. This causes Q17 to conduct, providing current flow through the brake solenoid, keeping the mechanical brakes released. Under a tape break condition, a positive input from the tape break sensor turns Q14 and Q15 on. This causes Q16 and Q17 to turn off, removing power from the reel solenoid, and causing engagement of the reel brakes. When Q15 conducts, diode CR9 conducts, initiating a stop command (ground) input to all mode memory cells. Q15 also provides a ground return path, through R42, to light the TAPE BREAK indicator, on the front panel of the RAM.

3-17. End-of-Tape Control. The end-of-tape control circuit consists of transistors Q18 thru Q20. The circuit mon- the end-of-tape sensor, and initiates a stop command to the control logic, just prior to tape being completely wound off the supply reel. When activated, the EOT sensor provides a positive-going input to the base of transistor Q18, causing it to turn on. This turns unijunction transistor Q19 on, which activates Q20 to light the EOT indicator lamps, on the front panel of the RAM. When Q18 is activated, the negative-going transition at its collector is coupled through capacitor C19, which initiates a stop command (ground) input to all mode memory cells.

3-18. CAPSTAN SERVO CONTROL.

3-19. Reference Oscillator. Refer to Figure 3-3. The reference signal for the capstan servo is provided by crystal-controlled oscillator AR1, operating at 1.6 MHz. The oscillator consists of integrated circuit amplifier AR1, with positive feedback provided by crystal Y1 and capacitor C4. The crystal is operated in the series-resonant mode, making the frequency of oscillation independent of other circuit components, or changes in operating voltages. Oscillator output is coupled to buffer/amplifier Q2, which drives the first stage of the frequency divider.

3-20. Reference Frequency Divider. Refer to Figure 3-4. The reference frequency divider consists of two 4-bit binary counters (ul, U2); one 2-bit binary counter (1/2 of 4-bit binary counter U3); and associated speed control gates (U5 through U8) which form part of the speed control logic. The 1.6 MHz reference oscillator signal from buffer/amplifier Q2 is applied to the input (pin 8) of the first binary countdown (U1), to provide servo reference frequencies of 800 kHz, 400 kHz, 200 kHz, and 100 kHz. The first two initial countdowns (800 kHz and 400 kHz) are not utilized. The next countdown frequency (200 kHz) is utilized to control capstan motor speed at 120 ips. This frequency appears at pin 2 of U1, where it is routed to the first speed select gate (U5B). The fourth countdown (100 kHz) appears at pin 12 of U1, where it is routed to the second speed select gate (U5A). This output is also used to drive the next binary counter (U2), which provides the next four successive countdowns, and so on. Reference frequency selection is controlled by the SPEED SELECT switch (S1), which provides a ground at the input of one of the NAND gate inverters (U7, U8). A low (ground) at the input of the NAND gate inverters results in a high output, which enables the corresponding speed select gate to pass the selected reference frequency. Table 3-1 lists the available reference frequencies from the frequency divider, the associated tape speed, and the corresponding speed select gate.

3-21. The selected reference frequency is routed through limiting resistor R36, and appears at pins (F) and (6) of the capstan servo PWB for routing to the reference frequency sinewave converter (Figure 5-17). Since the capstan motor tachometer output signal frequency is equal to one-half the corresponding IRIG standard frequency, for any given tape speed, the reference frequency is counted down once more by U3, before being routed to the capstan speed control circuits.

3-22. Tachometer Amplifier. Refer to Figure 3-5. The tachometer amplifier amplifies and squares the sinewave

TABLE 3-1. REFERENCE FREQUENCY OUTPUT VS TAPE SPEED

Tape Speed	Reference Frequency	Speed Select Gate
120 ips	200.000 kHz	U5B
60 ips	100.000 kHz	U5A
30 ips	50.000 kHz	U6C
15 ips	25.000 kHz	U6B
7-1/2 ips	12.500 kHz	U5C
3-3/4 ips	6.250 kHz	U5D
1-7/8 ips	3.125 kHz	U6A

signal from the capstan motor tachometer, before applying it to the capstan speed control circuits, for comparison with the fixed reference frequency from the frequency dividers. The signal from the tachometer ranges in frequency from 1.562 kHz at 1-7/8 ips, to 100 kHz at 120 ips, at a level greater than 1.0 V rms. The sinewave signal is amplified by Q1, and routed to the squaring amplifier (AR2), where it is converted to a squarewave before being applied to the pulse synchronizer through buffer/amplifier Q3.

3-23. Pulse Synchronizer. If both a reference and tachometer pulse occur at the same time, the phase comparator (immediately following the pulse synchronizer) would become erratic, and lose phase-lock. To avoid this, the reference and tachometer are alternately gated through the pulse synchronizer (U4, Q4, Q5), before being applied to the comparator circuit. A negative-going reference pulse applied to pin 12 of U4D will cause the synchronizer to change states, applying a high (+5 V dc) to the "reference input" of the phase comparator, and a low (ground) to the "tachometer input." The synchronizer will remain in this state, until a negative-going tachometer pulse appears at pin 2 of U4A, causing the circuit to change state. The comparator will now receive a low at the "reference input," and a high at the "tachometer input."

3-24. Phase Comparator. Refer to Figure 3-6. The phase comparator (U10, U11, U12) alternately accepts reference and tachometer pulses from the pulse synchronizer, and produces pulse-width modulate, constant amplitude pulses equivalent to the difference in phase between the two signals. The phase comparator functions as a three stage up-down counter, in which four possible states may exist - (-)1, 0.

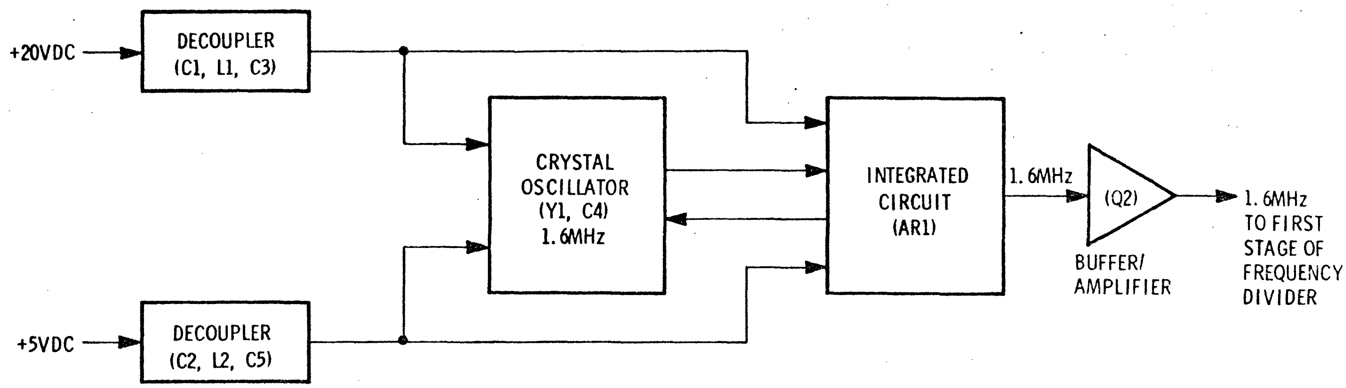
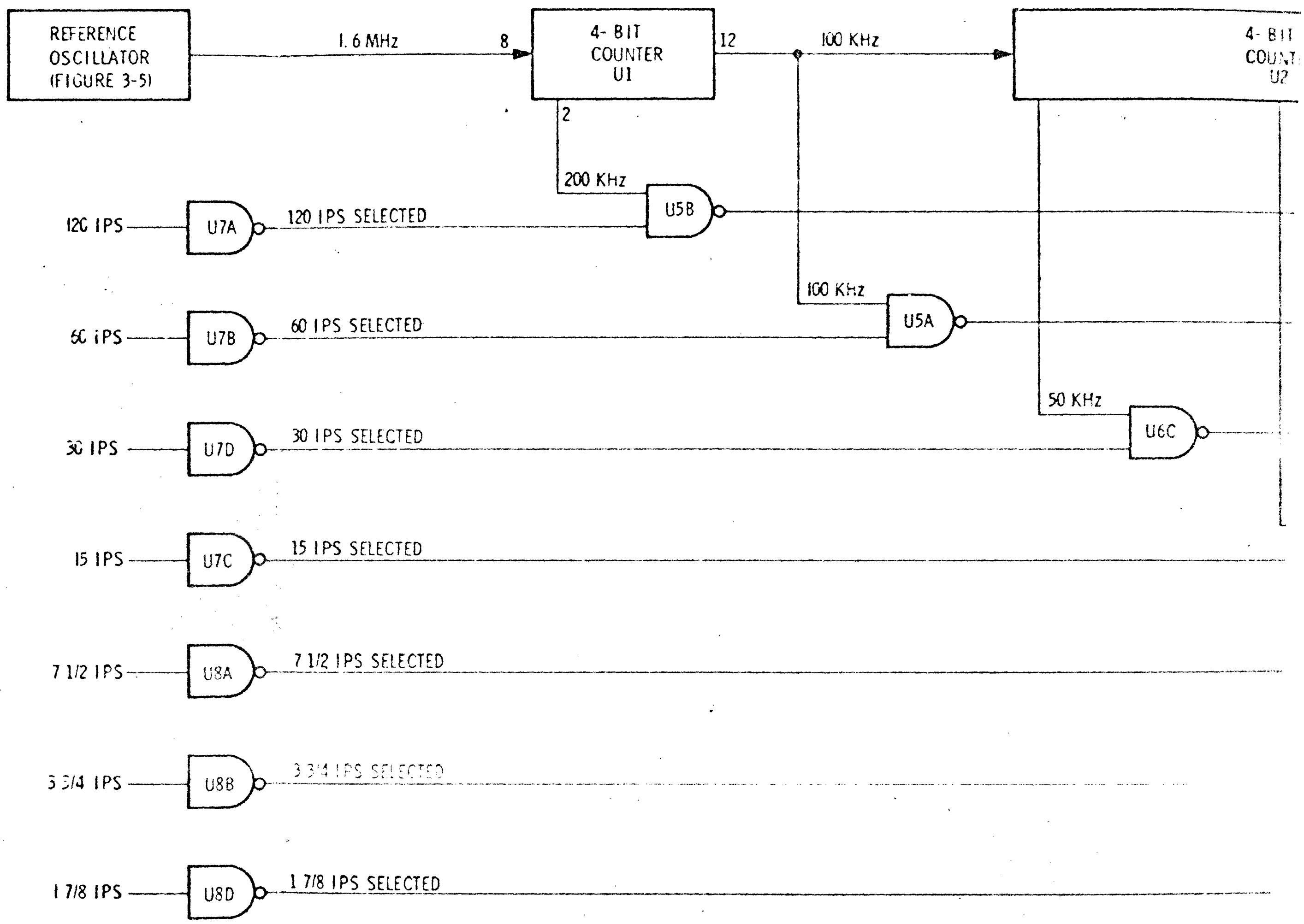


Figure 3-3. Reference Oscillator Functional Diagram.


REFERENCE OSCILLATOR (FIGURE 3-5)
1.6 MHz
8
4-BIT COUNTER U1
12
100 KHz
2
200 KHz
120 IPS
U7A
120 IPS SELECTED
U5B
100 KHz
60 IPS
U7B
60 IPS SELECTED
U5A
50 KHz
30 IPS
U7D
30 IPS SELECTED
U6C
15 IPS
U7C
15 IPS SELECTED
7 1/2 IPS
U8A
7 1/2 IPS SELECTED
3 3/4 IPS
U8B
3 3/4 IPS SELECTED
1 7/8 IPS
U8D
1 7/8 IPS SELECTED

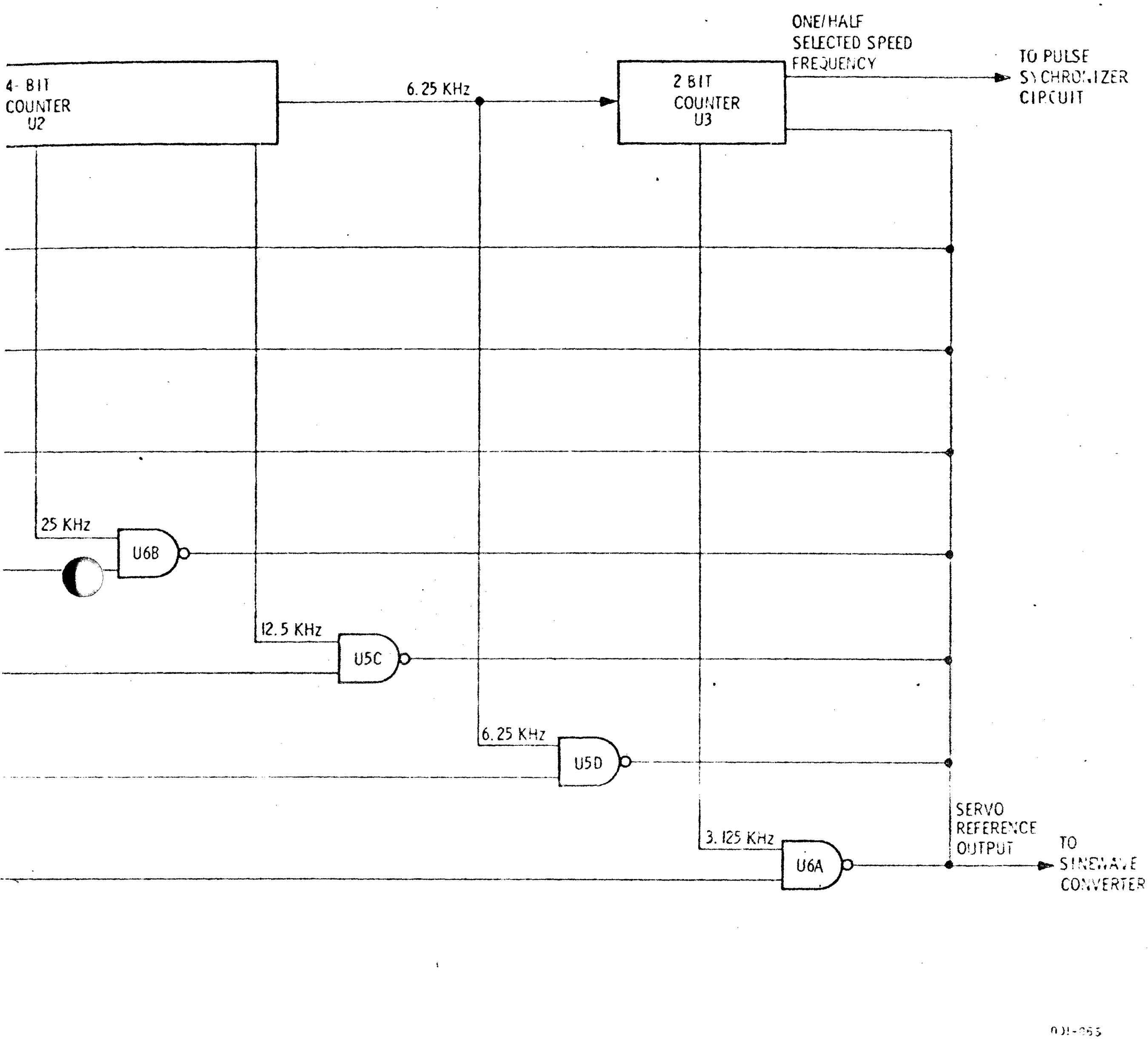


Figure 3-4. Frequency Divider Functional Diagram

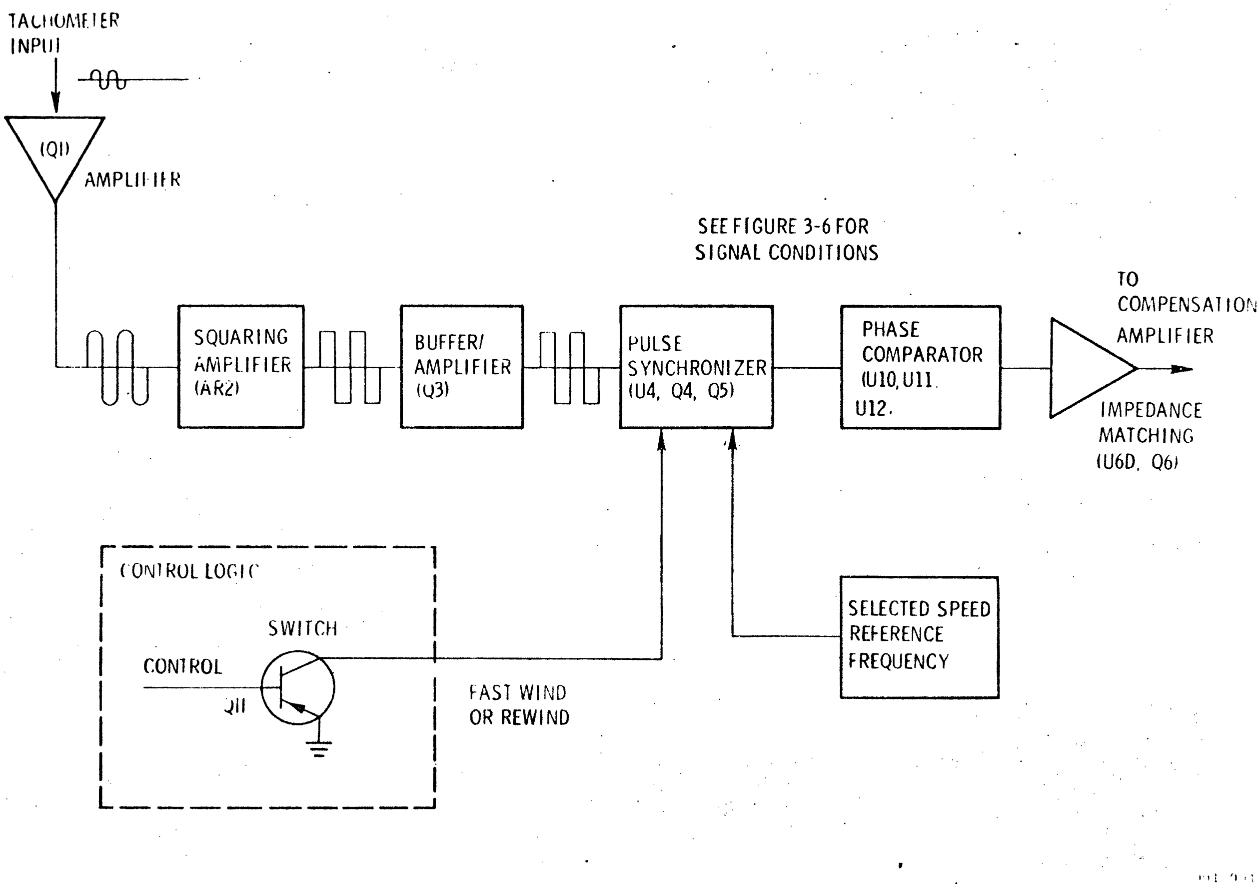


Figure 3-5. Capstan Speed Control Functional Diagram.

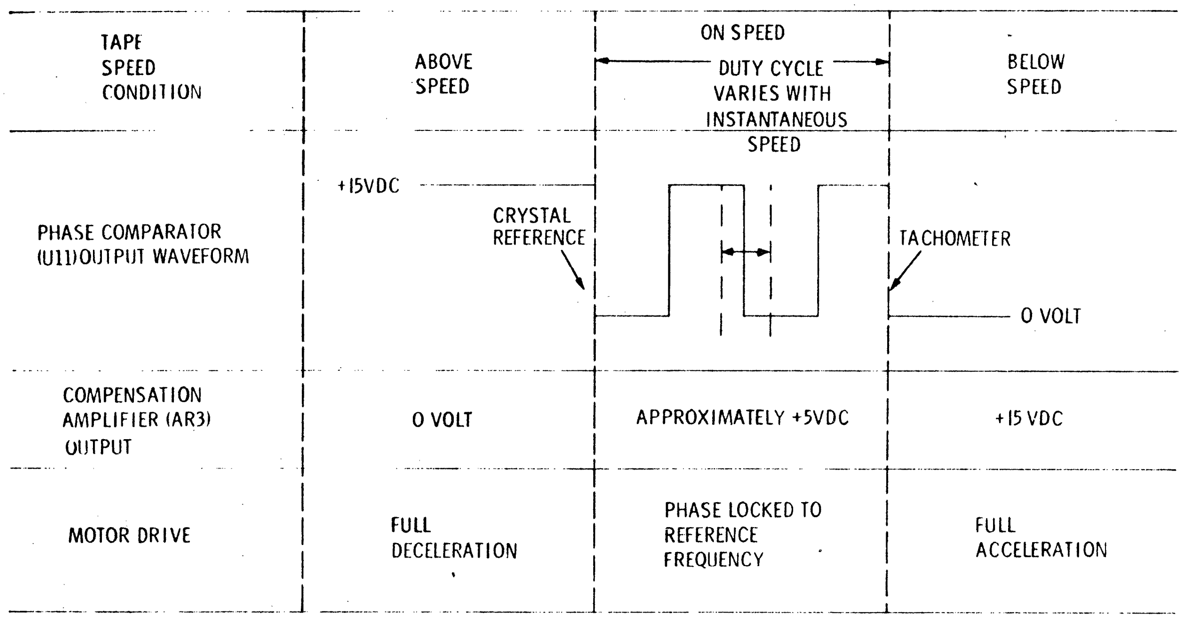


Figure 3-6. Phase Comparator and Compensation Amplifier Outputs.

(+) 1, and (+) 2. During operation, the reference signal clocks the circuit on, and the tachometer signal clocks the circuit off. During phase-lock, the counter alternates between a count of 0 and 1, with only U11 changing state. If the capstan motor is running too slow, the frequency of the tachometer signal becomes less than that of the fixed reference signal. As a result, the comparator would receive two or more reference pulses before receiving the next tachometer pulse. The second successive pulse from the reference input, prior to receipt of a tachometer pulse, will cause the phase comparator to switch to the (-) 1 state, with U11 held in the 0 state (pin 7 low). This causes the capstan motor amplifier to apply full power to the motor, thereby increasing the tachometer frequency and re-establishing a phase-lock condition. Conversely, if the capstan motor is running too fast, the comparator would receive two or more tachometer pulses, before receiving the next reference pulse. This will cause the comparator to switch to the (+) 2 state, with U11 held in the 1 state (pin 7 high), turning the capstan motor amplifier completely off. Normal friction then slows the motor until the tachometer frequency once again equals the reference frequency, and phase-lock is re-established. Figure 3-6 illustrates the output of the phase comparator for the three possible tape-speed conditions. The output of the phase comparator is applied to a phase-lock test point through limiting resistor R38, and through NAND-gate inverter U6D to buffer/amplifier Q6, which provides a low impedance to drive the compensation amplifier.

3-25. Compensation Amplifier. Refer to Figure 3-7. The compensation amplifier is comprised of a low-pass filter, an operational amplifier, and a frequency-sensitive R/C feedback loop. The low-pass filter, consisting of L3, L4, C24, C25, C26 and C27, provides a rolloff at approximately 1.5 kHz. The remaining lower frequencies, representing the output duty-cycle of the phase comparator, are integrated by R42 and C28, and the feedback loop, to provide a quasi-static dc voltage input to the operational amplifier (AR3). The feedback loop (R44, R45, R46, C29, C30, and C31) around AR3 also stabilizes the amplifier to prevent servo overshoot in the motordrive amplifier stages which follow.

3-26. Ramp Generator. The ramp generator (Q7, Q8, Q9) serves to apply power gradually to the capstan motor after an operational mode has been selected. This ensures gentle tape handling by the transport, during the critical period when tape is being accelerated. Before the receipt of a start command, transistor Q9 is cutoff, which removes operating voltage from amplifier AR3. With AR3 inoperative, there is no drive to the motor-drive stages, and the capstan motor is stopped. Upon arrival of a start command, Q9 gradually starts to conduct, increasing the voltage applied to AR3, which starts the capstan motor. The ramp introduced by the ramp generator may be adjusted by variable resistor R51.

3-27. Servo Power Amplifier. Refer to Figure 3-8. The servo power amplifier consists of buffer/amplifier Q10 on the capstan servo PWB, and Q6 through Q9 on the servo heatsink

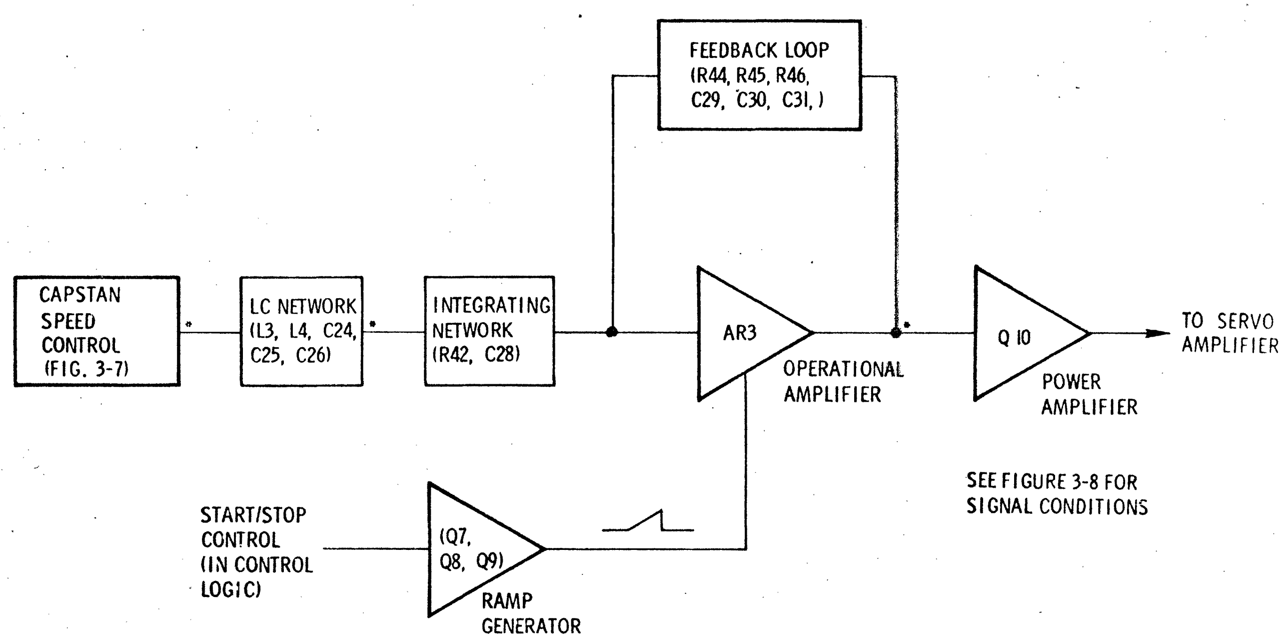
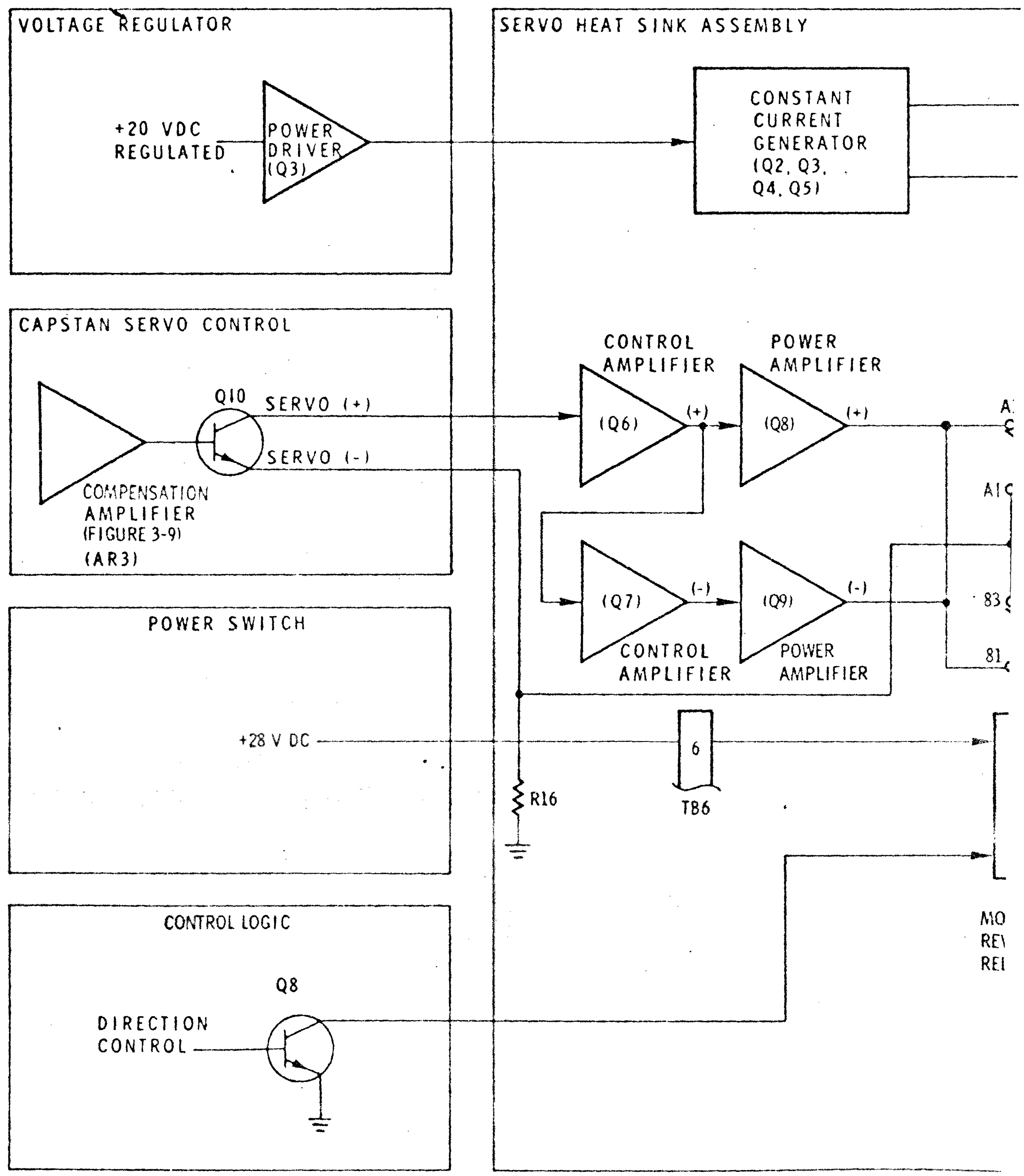


Figure 3-7. Compensation Amplifier and Ramp Generator.



VOLTAGE REGULATOR
+20 VDC
REGULATED
POWER
DRIVER
(Q3)
SERVO HEAT SINK ASSEMBLY
CONSTANT
CURRENT
GENERATOR
(Q2, Q3,
Q4, Q5)
CAPSTAN SERVO CONTROL
Q10
SERVO (+)
SERVO (-)
COMPENSATION
AMPLIFIER
(FIGURE 3-9)
(AR3)
CONTROL
AMPLIFIER
(Q6)
(+)
POWER
AMPLIFIER
(Q8)
(+)
(Q7)
(-)
CONTROL
AMPLIFIER
(Q9)
(-)
POWER
AMPLIFIER
POWER SWITCH
+28 V DC
6
TB6
R16
CONTROL LOGIC
Q8
DIRECTION
CONTROL

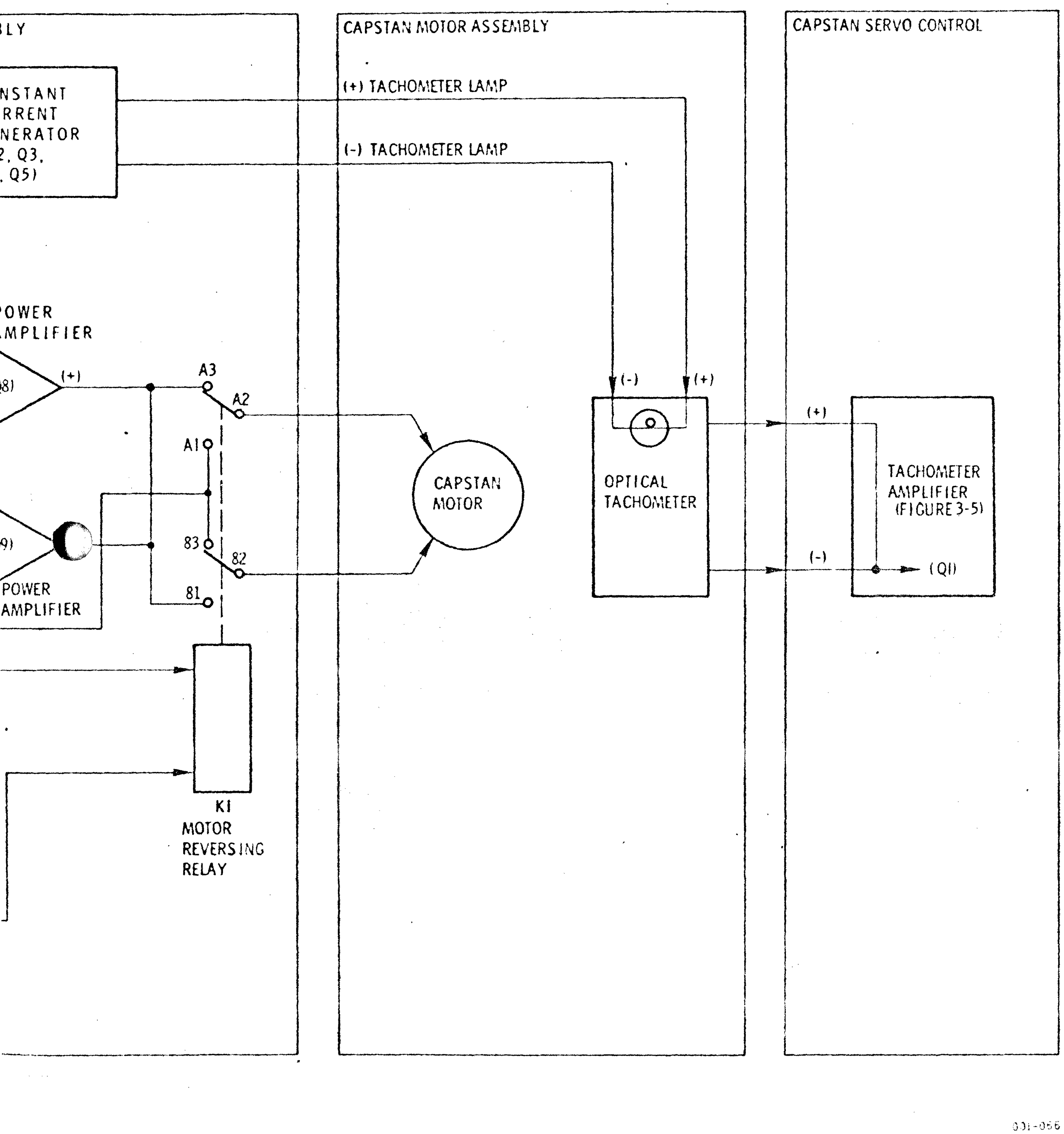


Figure 3-8. Capstan Servo Control Functional Diagram.

assembly. Output power transistors Q8 and Q9 form a quasi-complementary class B output stage, driven by transistors Q6 and Q7. Amplifier output is routed through the contacts of relay K1, which reverses the polarity of the output voltage to the dc capstan motor during REVERSE and REWIND modes of operation.

3-28. REFERENCE FREQUENCY SINEWAVE CONVERTER. Refer to Figure 3-9. The function of the reference frequency sinewave converter is to convert the selected squarewave signal, from the frequency divider, to a more suitable sinewave signal for recording on tape. Sinewave converter circuitry consists of a zero-crossing detector (U1), seven sharp-cutoff, low-pass filters, and an output amplifier stage (U2). Selection of the appropriate filter is accomplished by grounding one of the speed-select lines (J57, pins 15 thru 21), through diodes CR4 thru CR10. Proper filter selection occurs automatically with tape speed selection.

3-29. Zero-Crossing Detector. The input stage (U1) of the sinewave converter consists of an integrated circuit voltage comparator/buffer, configured as a zero-crossing detector, which provides waveform shaping, amplitude limiting, and isolation between the frequency divider and the converter filters.

3-30. Filter Section. Each of the seven low-pass filters correspond to one of the squarewave reference frequencies selected by the tape SPEED SELECT switch. By effectively suppressing all harmonic components from the input squarewave signal, only the fundamental sinewave frequency appears at the filter outputs.

3-31. Filter Select Circuit. FET transistors Q1 thru Q7 serve as on/off switching elements in series with each of the seven filter outputs. In the off (non-selected) state, the FET's are cutoff, preventing signal flow to the output amplifier (U2). Whenever a tape speed is selected, a ground is provided at the cathode of one of the switching diodes (CR4 thru CR10), through the associated series resistor. This causes the selected FET to conduct, allowing the output of the associated filter to pass on to the output amplifier.

3-32. Output Amplifier. Output amplifier U2 amplifies the output of the selected filter to a nominal 1.0 V rms level, and provides a low-impedance output to drive one or more of the record amplifiers. Output level may be adjusted between 0.0 and 2.0 V rms, with the OUTPUT LEVEL ADJ. control (R27).

3-33. REEL DRIVE SYSTEM. The reel drive system consists of two dc reel motors, driven by separate closed-loop servo amplifiers; two electromechanical tension sensors; and a fail-safe mechanical brake system, which halts reel rotation in the event of power interruption. The motors are bi-directional, and are connected to provide opposing torque to maintain a nominal 9 ounces of tension throughout the reel of tape, regardless of tape speed, or direction of tape travel.

3-34. Tension Sensors. Refer to Figure 3-10. Compliance arms (tension sensors), one for each reel, are mounted in the tape path to sense

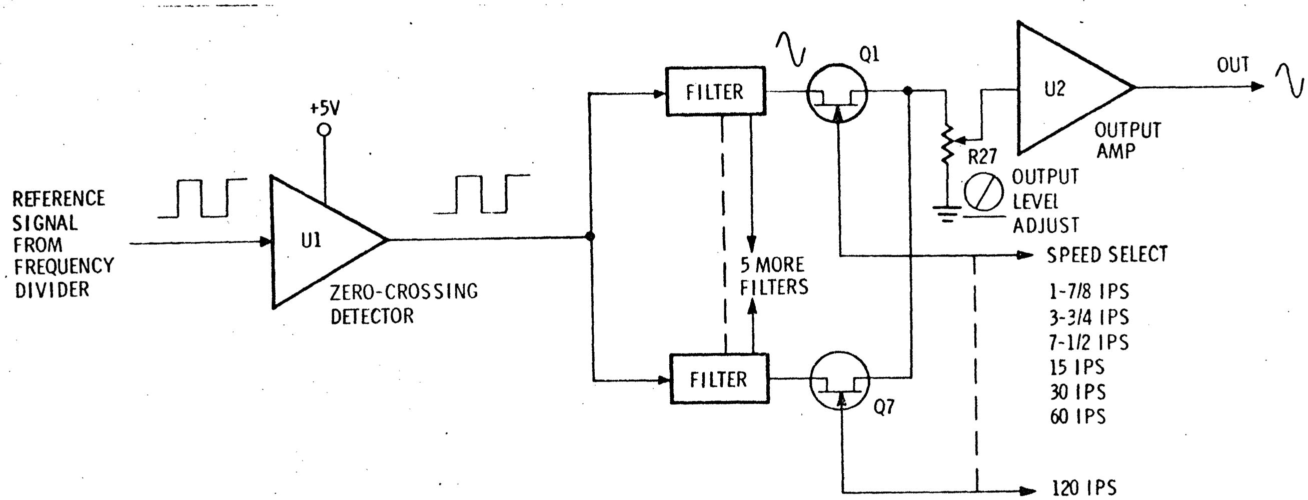


Figure 3-9. Sine Wave Reference Frequency Converter Functional Diagram.

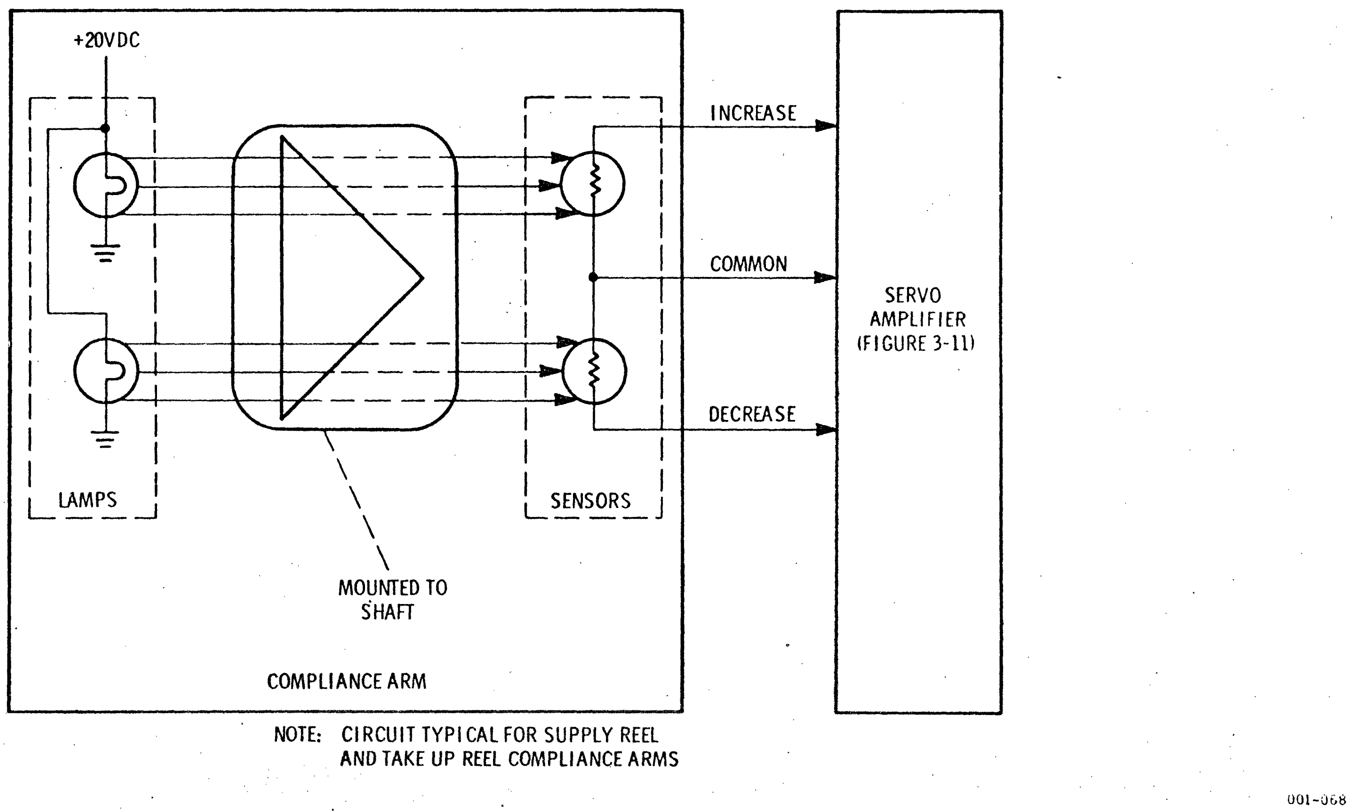


Figure 3-10. Tape Tension Control Functional Diagram.

tape-tension and control operation of the reel servos. Mechanically, each compliance-arm consists of two rollers mounted on a pivot-arm, loaded by spring tension. The spring is adjusted to provide 14 to 15 ounces of tension, when the pivot-arm is centered between its two mechanical stops. The arm is coupled to a light shutter, mounted between a pair of photocells and their associated light sources, so that with tape tension at its nominal value, the shutter is positioned to provide equal illumination to both photocells. If tape tension increases or decreases, the shutter changes position and one photocell is illuminated more than the other. This generates an error signal to the servo amplifier, which increases or decreases motor voltage to correct the error.

3-35. Servo Amplifier. Refer to Figure 3-11. There are two identical reel servo-amplifiers utilized in the RD378/U, although only one is shown in the referenced figure. One servo controls the supply reel motor, and the other controls the take-up reel motor. Since the operation of both is identical, only the supply reel servo is described. The servo amplifier consists of a high-gain amplifier (AR1), a free-running multivibrator (Q1, Q2), a ramp generator (AR4), a comparator stage (AR2, AR3), a bi-stable switch (U1), and a bridge connected power amplifier to drive the reel motor.

3-36. Input Amplifier. The servo amplifier input signal is a quasi-static dc voltage level obtained from the supply reel tension sensor, and applied to pin 3 of AR1. A reference voltage, determined by R10, R11, R7, and CR2 is applied to pin 2. The output of linear amplifier AR1 is, therefore, proportional to the difference between the two inputs. To prevent overloading the comparator circuits which follow, a diode clamp (CR4, CR5, CR9 and CR10) is provided to limit output amplitude to ± 1.5 V peak, relative to the input reference voltage.

3-37. Multivibrator and Ramp Generator. Q1 and Q2 form a free-running multivibrator, operating at a frequency between 8 and 10 kHz. The squarewave output is applied to linear amplifier AR4, through an integrator network consisting of C9 and R19, which together constitute a ramp generator. The resulting sawtooth output signal is capacitively coupled to the comparator circuit (AR2, AR3).

3-38. Comparator and Steering Flip-Flop. The output of the ramp generator (AR4) and input amplifier AR1 are applied to the inputs of comparators AR2 and AR3. The operation of the two comparators is identical, except for the fixed bias levels applied to the non-inverting inputs (pin 3). The ramp signal from AR4 is applied to the non-inverting input of AR2 (pin 3), while the output of AR1 is applied to the inverting input (pin 2). Whenever the input voltage at pin 2 exceeds the voltage at pin 3 (instantaneous ramp voltage plus fixed bias voltage), the output of AR2 will be zero (ground). When the voltage at pin 2 is less than at pin 3, the output will be positive. The resulting output will be a pulse-width modulated (PWM) signal, in which the duration of the pulses represent the magnitude of the error from the tension sensor. The PWM output of AR2 is applied to pins 4 and 5 of the steering flip-flop (U1), through inverter Q33. The PWM output

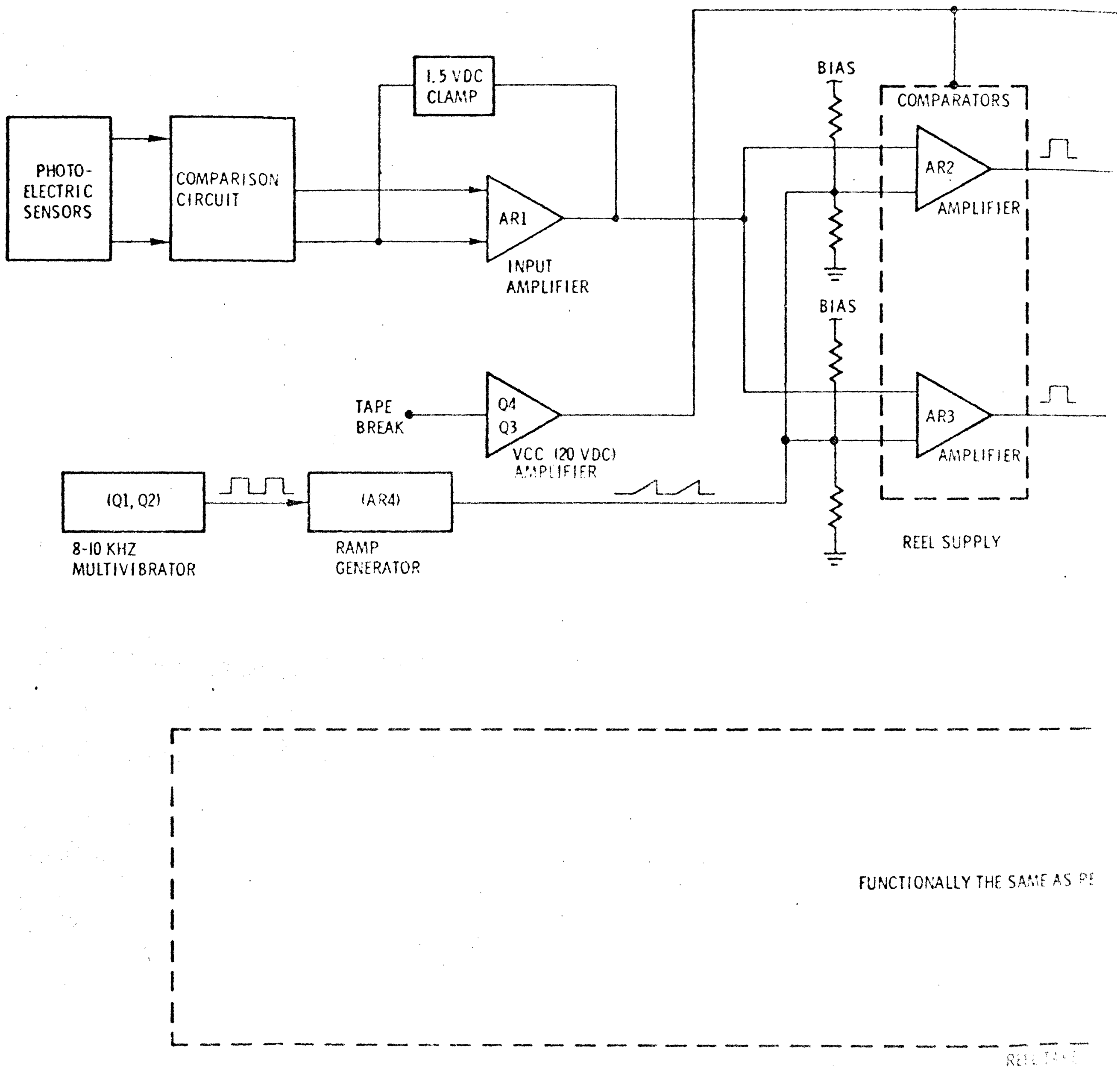


PHOTO-
ELECTRIC
SENSORS
COMPARISON
CIRCUIT
1.5 VDC
CLAMP
AR1
INPUT
AMPLIFIER
TAPE
BREAK
Q4
Q3
VCC (20 VDC)
AMPLIFIER
(Q1, Q2)
8-10 KHZ
MULTIVIBRATOR
(AR4)
RAMP
GENERATOR
BIAS
BIAS
COMPARATORS
AR2
AMPLIFIER
AR3
AMPLIFIER
REEL SUPPLY
FUNCTIONALLY THE SAME AS

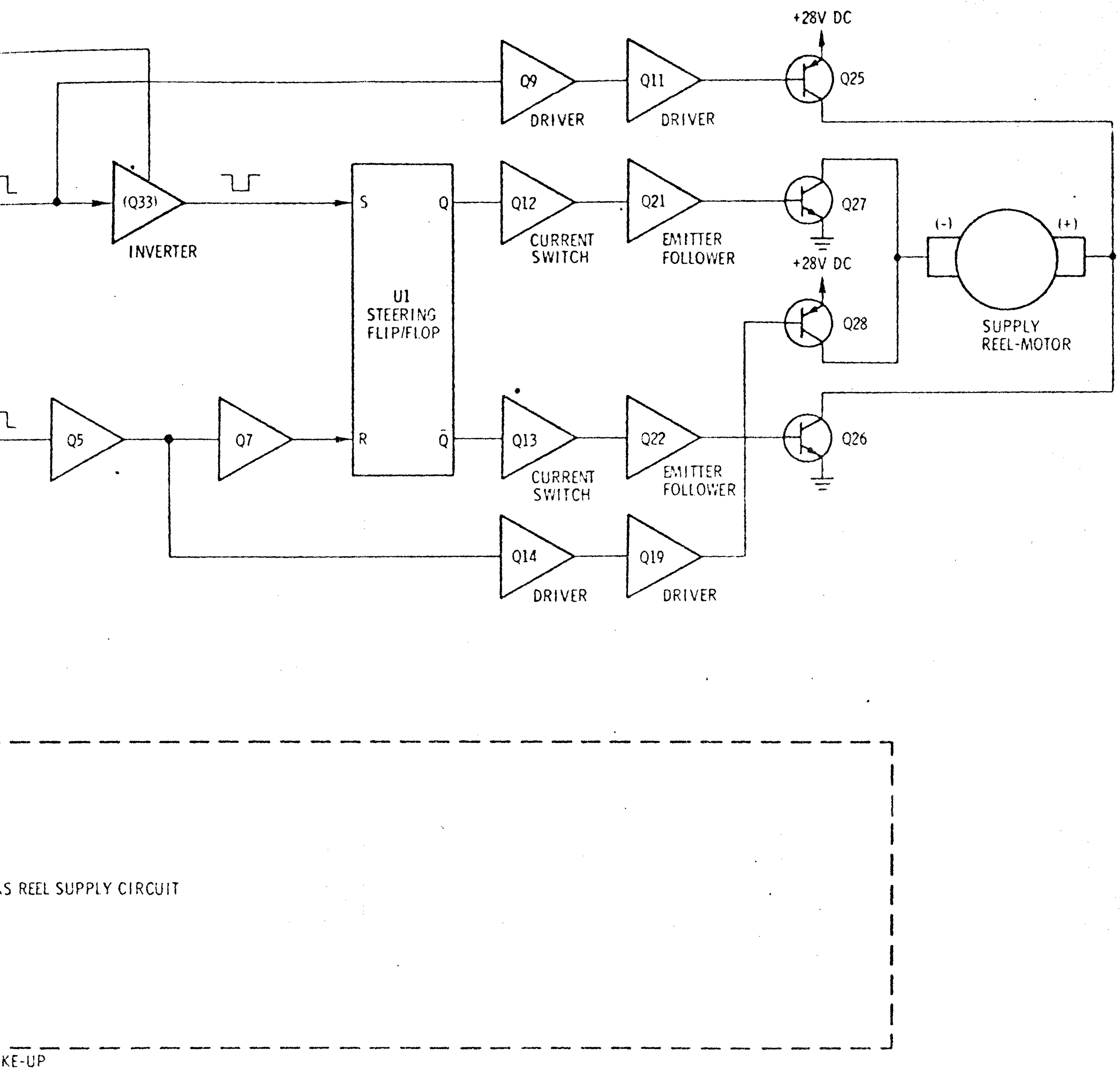


Figure 3-11. Reel Servo Amplifier Functional Diagram.

of AR3 is applied to pins 1 and 2 of U1, through inverters Q5 and Q7. The fixed bias levels at pin 3 of AR2 and AR3 are selected so that only one comparator is active at any given time while the other is switching at the ramp rate. A high at the input to the steering flip-flop will produce a high at the corresponding output. The circuit will remain in this state until a high appears at the opposite input, causing the circuit to switch. U1 thus controls the conduction of the current switches driving the reel motor, and hence the direction of motor rotation.

3-39. Servo Power Amplifier. When the output of AR2 is high, (no PWM) the signal applied to U1, pins 4 & 5, is low, as a result of inverter Q33. Pin 8 of U1 is, therefore, low; Q12 is off; Q21 is off; and Q27 (one leg of the output bridge) is off. At the same time, the high output of AR2 holds Q9 and Q11 on. The conduction of Q11 holds Q25 (in the opposite leg of the output bridge) off. With Q25 and Q27 off, the only remaining path for current is from ground, through Q26, through the motor, and through Q28 to the +28 V dc supply. The magnitude of the voltage applied to the motor will depend upon the drive available at the base of Q28, which is determined by the magnitude of the error signal from the tension sensor. As the error signal varies and AR2 begins to provide PWM signal, the first negative-going transition produces a corresponding positive-going transition at U1, pins 4 and 5. U1 switches state, producing a high at pin 8, causing Q12 to turn on. Q12 turns Q21 and Q27 on. At the same instant, the negative-going transition turns Q9 off, along with Q11, which turns Q25 on. With Q25 and Q27 on (Q26 and Q28 off), the direction of current flow through the motor will reverse, causing rotation in the opposite direction.

3-40. Fail-Safe Brakes. Refer to Figure 3-21. The reel motors are provided with solenoid actuated brake bands that engage to prevent tape spillage whenever input power to the recorder is lost, whenever tape is wound off either tape reel, or if the tape breaks. The brake solenoid is controlled by Q17 in the control logic. The brake solenoid requires approximately 1 amp for actuation. Once actuated, a relatively low current is required. The transition from actuating current to holding current is accomplished by the brake control circuit, located in the reel motor housing.

3-41. Refer to Figure 3-13. When Q17 (in the control logic) turns on, +28 V dc is applied across the brake solenoid and series resistor R1. At the instant power is first applied to the circuit, capacitor C1 begins to charge through resistor R1, placing a positive potential at the base of transistor Q1. Q1 turns on, causing Q2 to turn on. Current now flows from ground through Q2 and through the solenoid to +28 V dc. Capacitor C1 reaches full charge, reducing the current flow through R1 and causing Q1 and Q2 to turn off. The solenoid remains energized, due to the path to ground provided by R1, but at a reduced current level.

3-42. TAPE BREAK SENSOR. Refer to Figure 3-14. The tape break sensor consists of a photocell (V1) and lamp (DS1) assembly, located in the tape path and connected to switching circuits in the control logic. During normal

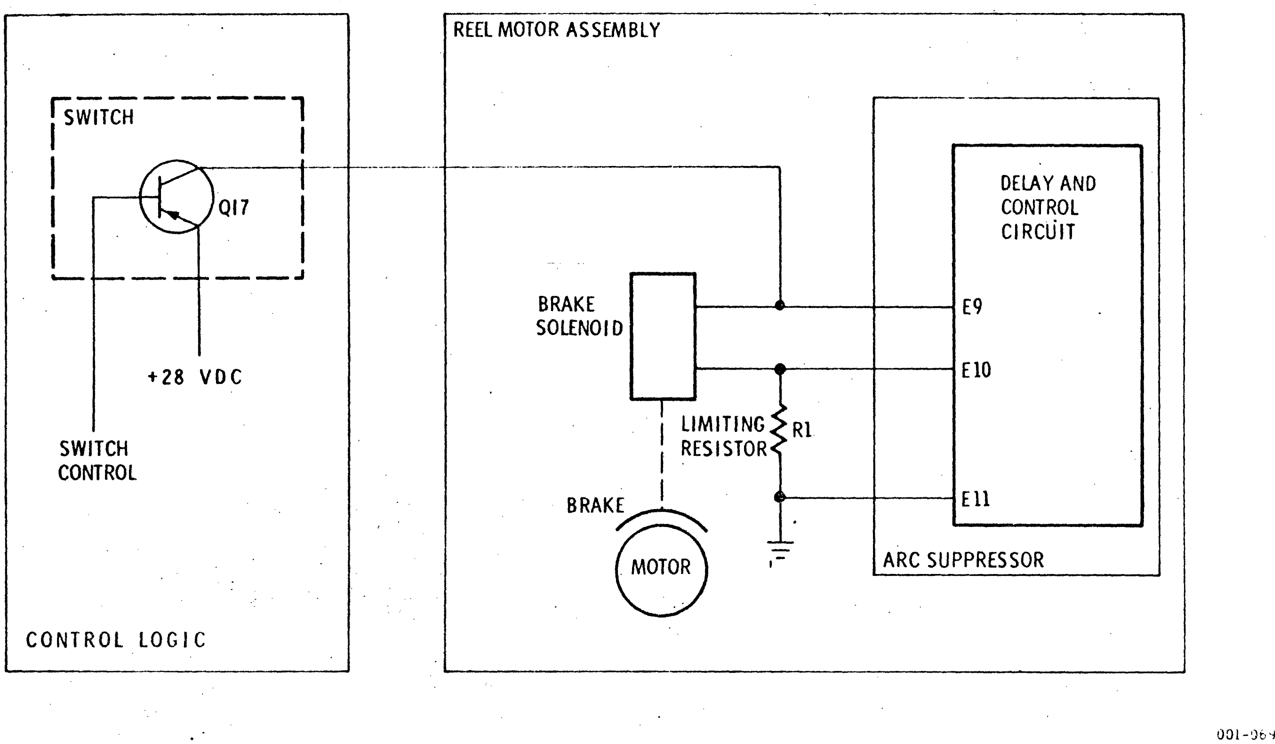


Figure 3-12. Reel Braking System Functional Diagram.

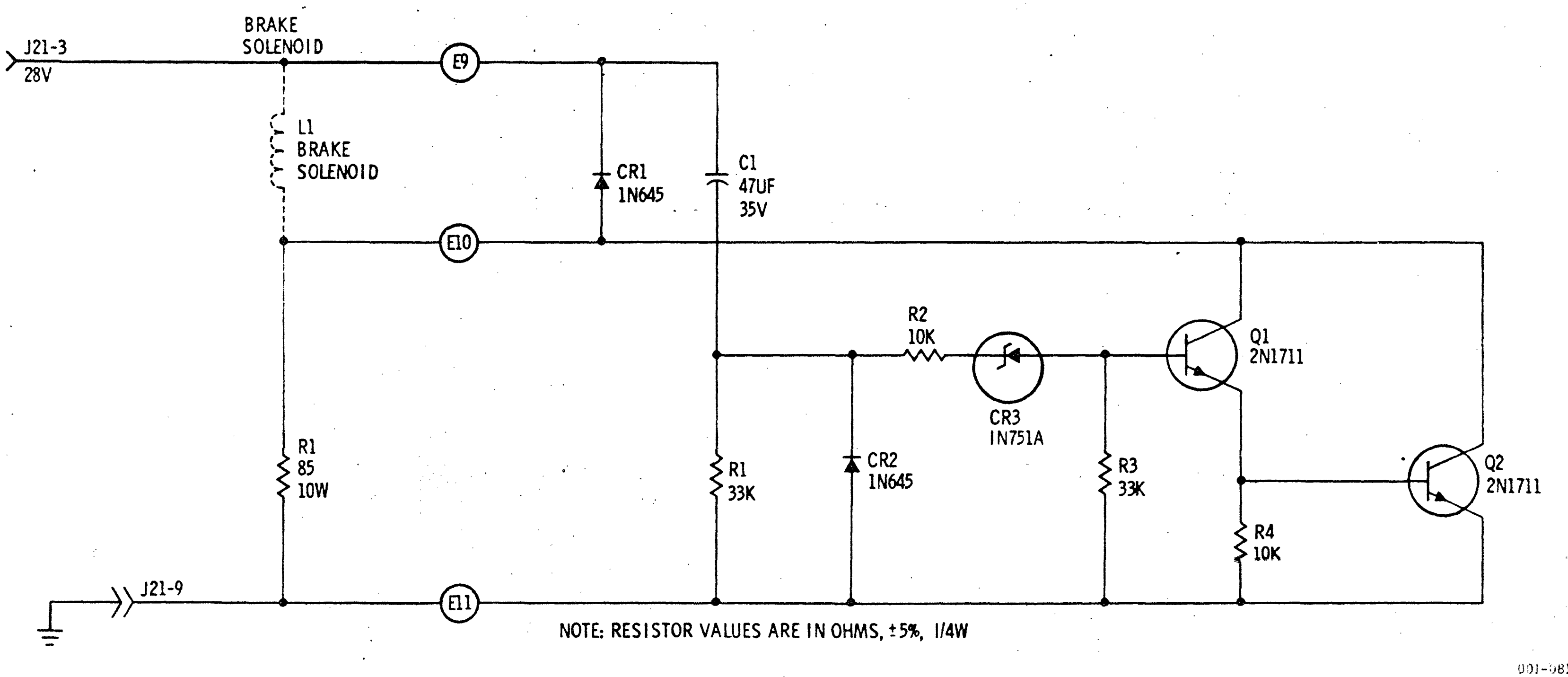


Figure 3-13. Delay and Control System.

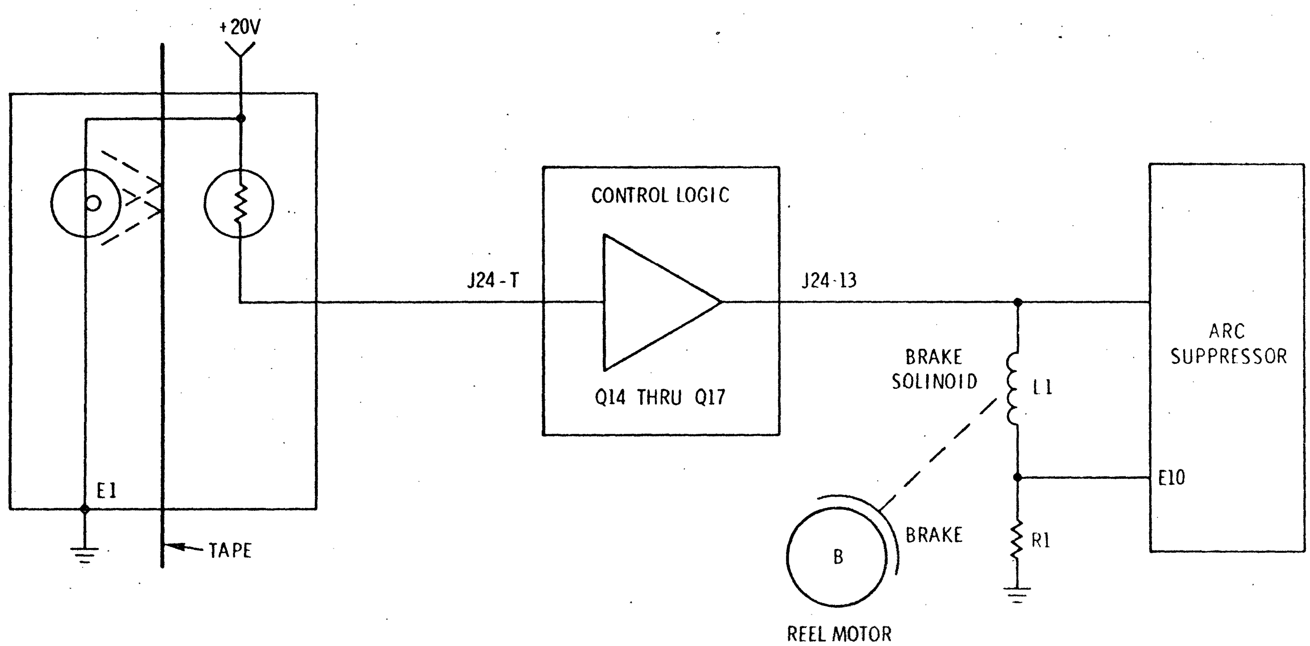


Figure 3-14. Tape Break Sensor Functional Diagram.

operation, tape is threaded through the assembly to prevent light from striking the photocell. With light from DSI blocked by the tape, Vl has high resistance and prevents zener diode CR35 (in the control logic) from conducting. When tape breaks, or is wound completely off either the take-up or supply reel, the photocell is illuminated, causing its resistance to decrease, and the voltage applied to CR35 to increase. CR35 fires, applying a positive voltage to switch-circuit Q14 - Q16, which grounds the base of transistor Q17. Q17 turns off, removing the +28 V dc from the brake solenoid which, in turn, applies the mechanical brakes. The switch-circuit (Q14 - Q16) is also used to provide a stop command to the control logic, which deactivates the capstan drive and also lights the TAPE BREAK indicator on the front panel of the RAM.

3-43. TAPE REMAINING AND END-OF-TAPE SENSORS. Refer to Figure 3-15 and 3-16. Photoelectric circuits are used to sense the approximate amount of tape remaining on the supply reel, to operate the TAPE SUPPLY meter on the front panel of the RAM. An end-of-tape sensor is also provided, to stop the unit just prior to tape winding completely off the supply reel.

3-44. Tape Remaining Sensor. The tape remaining sensor consists of photocell assemblies positioned at the lower right (Vl thru V9), and upper left (V10 thru V18) corners of the tape transport (see Figure 3-16). The photocells are illuminated by lamp DSI, located above and to the right of the take-up compliance arm. This lamp is lighted whenever power is applied to the transport. The sensors are positioned so that light from DSI is directed between the supply reel flanges to strike the photocells. When the supply reel is FULL, the tape pack blocks light from DSI, and the photocells provide a high resistance between the +20 V dc source and the TAPE SUPPLY meter. As tape is spooled from the supply reel, the diameter of the tape pack diminishes, and the photocells are progressively illuminated, causing their resistances to decrease. The photocells are connected in parallel, so that as their total resistance decreases more current is allowed to flow through the meter. Potentiometers R33 and R35 are provided for meter calibration.

3-45. End-of-Tape Sensor. The end-of-tape sensor (V19) is located in the tape supply sensor assembly located at the upper left-hand corner of the transport, and is so positioned that it becomes the last of the photocells to be illuminated, as tape is spooled from the supply reel. Once activated, V19 provides a positive voltage to the end-of-tape switching circuit (Q18 thru Q20) in the control logic circuits. The positive input turns transistor Q18 on, which provides a negative-going transition to the stop logic, through capacitor Q19, causing the transport to stop. Q18 also turns on Q19 and Q20, to provide a ground return for the EOT indicator lamp, on the front panel of the RAM.

3-46. RECORD FUNCTION.

3-47. The RD378/U will record and reproduce in either the direct/analog or FM record modes, depending upon the type of signal electronics installed. The direct/analog and FM signal electronics are directly interchangeable, to permit simultaneous recording, or reproducing, in both modes.

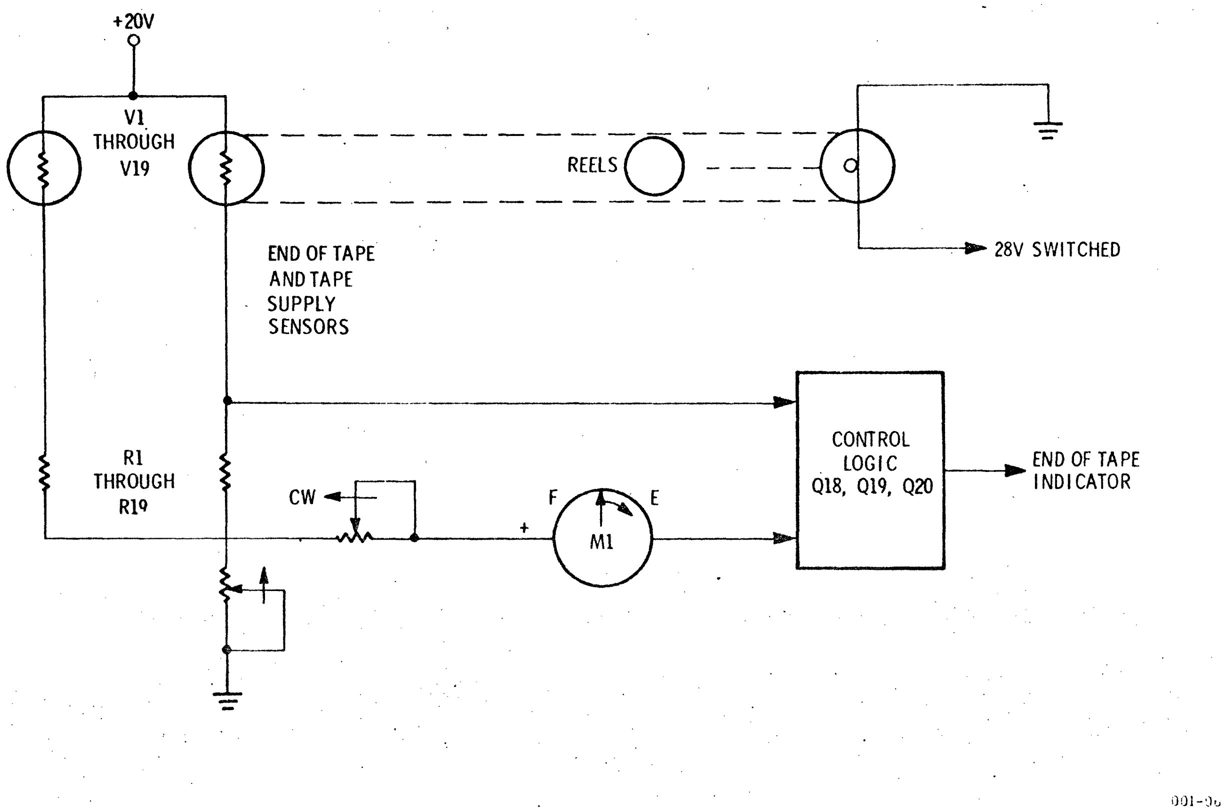


Figure 3-15. End-of-Tape and Tape Supply Sensors Functional Diagram.

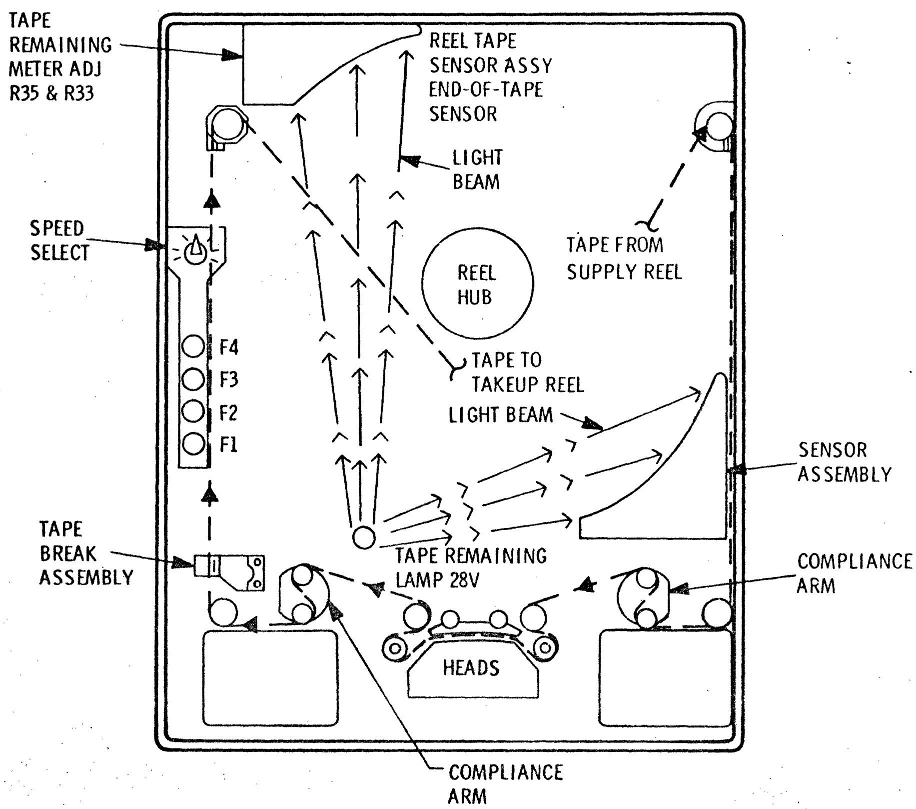


Figure 3-16. End-of-Tape and Tape Break Sensor.

3-48. DIRECT/ANALOG RECORD ELECTRONICS. Refer to Figure 6-2. The direct record electronics consist of up to 14 record amplifier cards (one for each direct channel) and 1 bias oscillator card. The record amplifier cards plug into a motherboard assembly, located in the record amplifier housings directly adjacent to the headstack, and are accessible from the front of the unit. Two motherboards are used, one for all even-numbered, and one for all odd-numbered record amplifiers, with each containing seven amplifier cards. The bias oscillator is located in the amplifier housing containing the even-numbered record amplifiers. Conventional constant-flux direct/analog recording techniques are employed to record data signals in the frequency range of 400 Hz to 2.0 MHz, at 120 ips, with proportionately narrower bandwidths at lower tape speeds. At the record head, the data signal is linearly mixed with a high-frequency (7.05 MHz) bias signal to overcome the inherent nonlinear characteristics of the tape.

3-49. DIRECT/ANALOG RECORD AMPLIFIER. Refer to Figure 3-17. The direct/analog record amplifier consists of a data signal amplifier (Q1, Q2); a bias signal amplifier (Q3); and a bias trap network, to prevent the bias signal from entering the low-level data amplifier stages.

3-50. Data Signal Amplifier. Data signals to be recorded are applied across the RECORD LEVEL ADJ. control (R2), which permits adjusting the gain of the amplifier to produce normal record level[1] output with input levels ranging between 0.2 and 10.0 V rms. Transistors Q1 and Q2 form a complementary Darlington amplifier, which provides a low output impedance, and high current-gain to drive the record head. To compensate for head losses at high frequencies, a small amount of preemphasis is provided by R8 and C3.

3-51. Bias Signal Amplifier. The bias amplifier consists of a single class-C amplifier (Q3), followed by a harmonic filter to assure waveform purity of the output signal. Class-C operation of Q3 minimizes changes in bias amplitude, due to fluctuations in operating voltages. Current limiting resistor R12 limits the amount of bias current drawn from the bias oscillator, and ensures equal bias signal distribution to all channels. BIAS LEVEL ADJ. control (R9) permits adjusting the bias current level, through the record head, for optimum high-frequency response and lowest signal distortion (see Chapter 6).

3-52. Bias Trap. The bias signal (7.05 MHz) and data signal (400 Hz to 2.0 MHz) are mixed linearly (with no resulting modulation products) directly at the high side of the record head. The amplified bias signal, which has an amplitude approximately ten times that of the data signal, is prevented from entering the data amplifier stages by a bias trap consisting of L1, C4, L6, and C11.

[1] Normal record level (NRL) is that level of input signal necessary to produce 2.0 percent 3rd order harmonic distortion (due to tape overload) at the output of the reproduce amplifier.

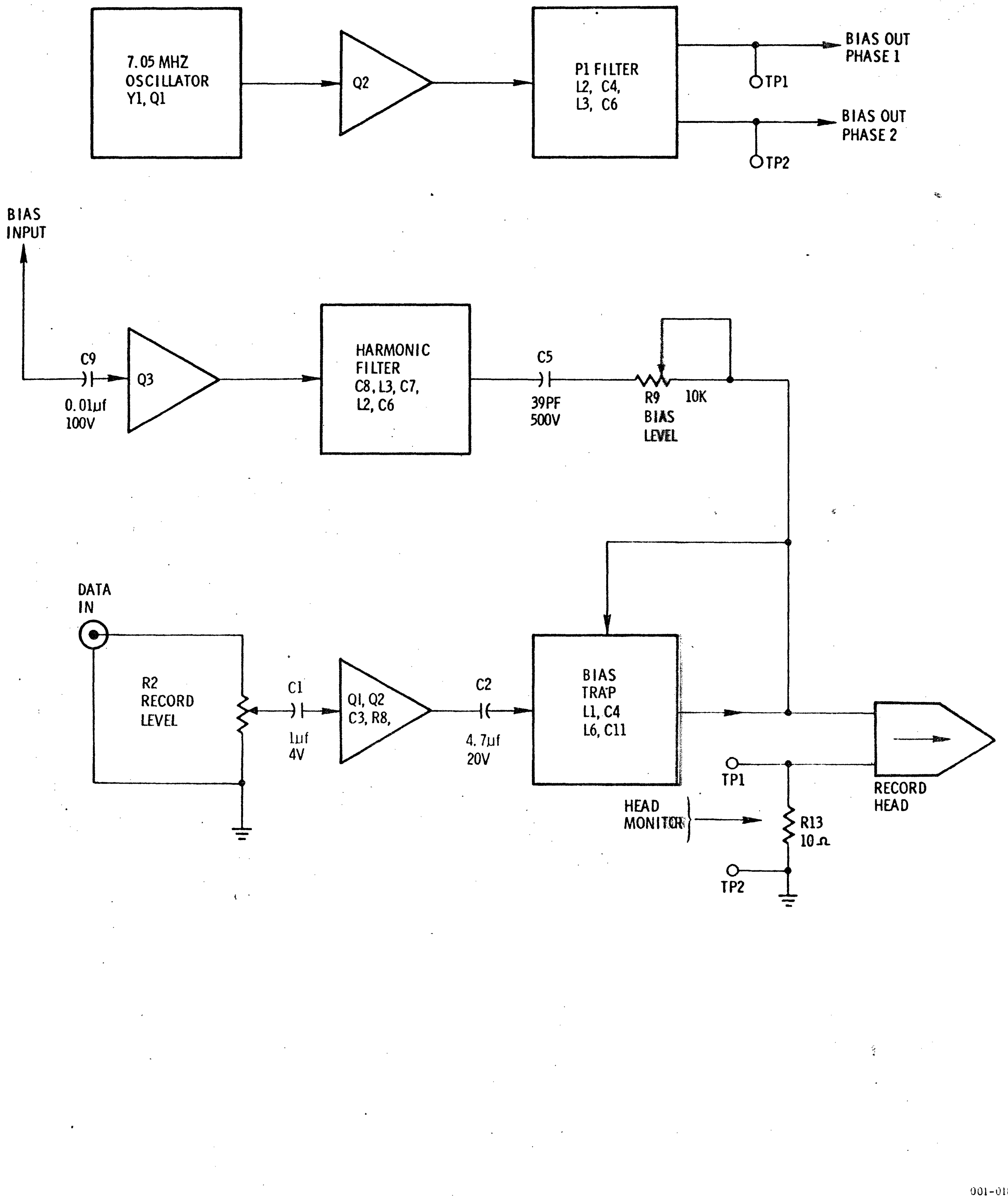


Figure 3-17. Direct Record and Bias Amplifier Functional Diagram.

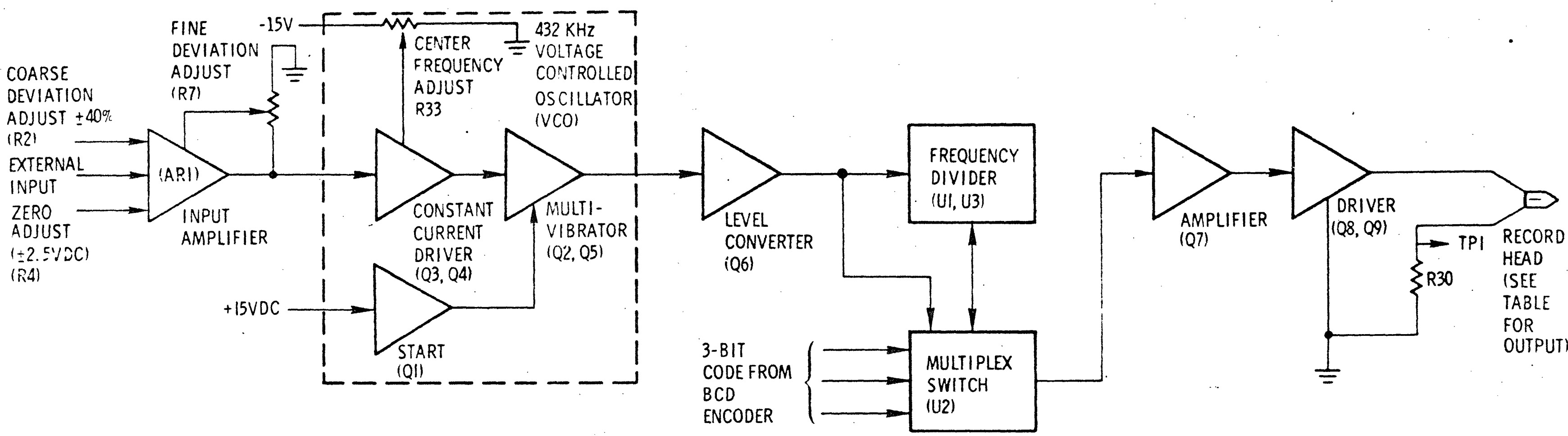
3-53. BIAS OSCILLATOR. Refer to Figure 3-17. The bias oscillator consists of amplifier Q1 with a 7.05 MHz crystal in a positive feedback loop, from collector to base. Oscillator output is coupled to a class-C amplifier (Q2), which acts as a buffer between the oscillator and the filter networks that follow. Class-C operation of Q2 minimizes changes in bias amplitude, due to fluctuations in operating voltages. The pi-configured filter at the output of Q2 removes the harmonics from the bias waveform, and transforms the high impedance collector output of Q2 to a low impedance to drive the bias stages of the record amplifiers. The filter provides two bias signal outputs, which are 180° out of phase with each other. One phase provides bias for channels 1, 5, 9, 13, 4, 8, and 12. The other phase provides bias for channels 2, 3, 6, 7, 10, 11, and 14. This helps to prevent bias crosstalk problems that might otherwise occur in the record heads.

3-54. FM RECORD ELECTRONICS. Refer to Figure 3-18. The FM record electronics consist of up to 14 record amplifier cards (one for each FM channel), which plug into a motherboard assembly, located in the record amplifier housings. These housings are located directly adjacent to the headstack, and are accessible from the front of the unit. Two motherboards are used, one for all even-numbered, and one for all odd-numbered record amplifiers, with each containing seven amplifier cards. The output of the FM record amplifiers is a squarewave signal which saturates the tape in both the positive and negative-going directions, at a rate (frequency) determined by the amplitude of the input data. Because of the saturation techniques used, the high-frequency bias signal, necessary for direct/analog recording, is not required.

3-55. FM RECORD AMPLIFIER. Refer to Figure 5-13. The FM record amplifier provides frequency modulated output signals at 8 separate IRIG center frequencies, determined by the associated speed-select circuitry. The amplifier consists of a high-impedance input amplifier, a voltage-controlled oscillator, a frequency divider, speed-select circuitry, and a head-current driver stage.

3-56. Input Amplifier. Integrated circuit AR1 is a high-impedance, direct-coupled, non-saturating, amplifier, which serves to deviate the center frequency of the voltage-controlled oscillator (VCO). Variable resistors R2 (coarse) and R7 (fine) determine FM carrier deviation limits of ± 40 percent. ZERO ADJ. control R4 is used to balance out residual dc at the amplifier input, which would otherwise cause offset center frequency deviation.

3-57. Voltage-Controlled Oscillator. The VCO circuit consists of a free-running multivibrator (Q2, Q5), driven by constant-current drivers Q3 and Q4. Oscillator frequency is determined by the emitter currents of Q3 and Q4. With no input signal to AR1, the FM center frequency is adjusted by CENTER FREQUENCY ADJ. control R33, which controls the fixed bias potential of the constant-current drivers. The output of AR1 is directly coupled to Q3 and Q4, causing the oscillator frequency to vary in accordance with the amplitude of the input data. With the



SPEED (IPS)	CENTER FREQUENCY (KHz)	DEVIATION FREQUENCIES (KHZ)		SPEED SELECTION INPUT CODES		
				CODING LINES		
		+40%	-40%	LINE A (PIN D)	LINE B (PIN E)	LINE C (PIN H)
1 7/8	6.750	9.450	4.050	0	0	1
3 3/4	13.500	18.900	8.100	0	1	0
7 1/2	27.000	37.800	16.200	0	1	1
15	54.000	75.600	32.400	1	0	0
30	108.000	151.200	64.800	1	0	1
60	216.000	302.400	129.600	1	1	0
120	432.000	604.800	259.200	1	1	1

Figure 3-18. FM Record Amplifier Functional Diagram.

input of the FM record amplifiers grounded, R33 is adjusted for a VCO center frequency of 432.0 kHz. Transistor Q1 functions to ensure oscillator start-up, when power is turned on, by applying a negative-going voltage to the base of multivibrator transistor Q2.

3-58. Frequency Divider and Speed-Select Circuits. The output of the VCO (432.0 kHz $\pm$40 percent) is taken from the collector of Q5 and applied to the input of level converter Q6. The output of Q6 is applied to a series of 8 frequency dividers (U1, U3), which provide output frequencies of 216, 108, 54, 27, 13.5, 6.75, and 3.125 kHz. All outputs from the frequency dividers are routed to the input of the 8-channel digital switch (U2). The digital switch selects one of the eight inputs, depending upon the 3-bit binary word from the speed-select circuitry, and applies it to the input of the head driver stage (Q7 thru Q9). Table 3-2 provides a list of tape speeds, FM center frequencies, deviation limits, and speed-select codes required to operate the digital switch.

3-59. Head-Current Driver. The head-current driver is a complementary emitter-follower, consisting of transistors Q7, Q8 and Q9. The output is single-ended with the head connected to the high side of a 10-ohm resistor (R30) to permit head current monitoring while conducting test and alignment procedures.

3-60. FM SPEED-SELECT ENCODER. Refer to Figure 3-19. The FM speed-select (binary coded decimal (BCD) encoder is used in conjunction with the FM recorder amplifier to select the proper FM carrier frequency.

TABLE 3-2. FM RECORD PARAMETERS

Tape Speed ips	FM Cent. Freq. kHz	Deviation +40% kHz	Deviation -40% kHz	Speed Select Code
120	432.000	604.8	259.2	1 1 1
60	216.000	302.4	129.6	1 1 0
30	108.000	151.2	64.8	1 0 1
15	54.000	75.6	32.4	1 0 0
7-1/2	27.000	37.8	16.2	0 1 1
3-3/4	13.500	18.9	8.1	0 1 0
1-7/8	6.750	9.45	4.05	0 0 1

for the particular tape speed selected. The encoder is contained on a single printed circuit card, which is installed at connector J26 in the electronic housing assembly at the rear of the transport (Figure 7-1).

3-61. The speed-select encoder produces a 3-bit binary output, which is determined by the tape speed selected. Whenever a particular speed is selected, a corresponding input to the encoder (pin 7, 8, 9, 12, 13, 14, or 15) is grounded. All other inputs remain open (high). If no tape speed is selected, all inputs are open, and the bases of Q1, Q2, and Q3 are biased to +5 V dc through resistors R11, R12, and R13. This will forward bias CR15 through CR20 and turn on transistors Q1 through Q3, causing their outputs (pins 4, 5, and 6) to go low (0-volts). For example, assume a tape speed of 30 ips is selected. Input pin 8 will be grounded through the SPEED SELECT switch on the transport. This will forward bias CR7 and CR8, and reverse bias CR15 and CR17. This low input turns Q1 and Q2 off, causing their collectors to go high (+5 V). The collector of Q3 remains low, thus producing a 3-bit binary output of "1-0-1." Table 3-3 lists the binary output for each tape speed selected.

3-62. REPRODUCE FUNCTION.

3-63. The RD378/U will record and reproduce in either the direct/analog or FM record modes, depending upon the type of signal electronics installed. The direct/analog and FM signal electronics are directly interchangeable, to permit simultaneous recording, or reproducing, in both modes.

TABLE 3-3. BINARY CODE

Tape Speed ips	Outputs (A) Pin 4	(B) Pin 5	(C) Pin 6
120	1	1	1
60	1	1	1
30	1	1	1
15	1	1	1
7-1/2	0	1	1
3-3/4	0	1	0
1-7/8	0	0	1

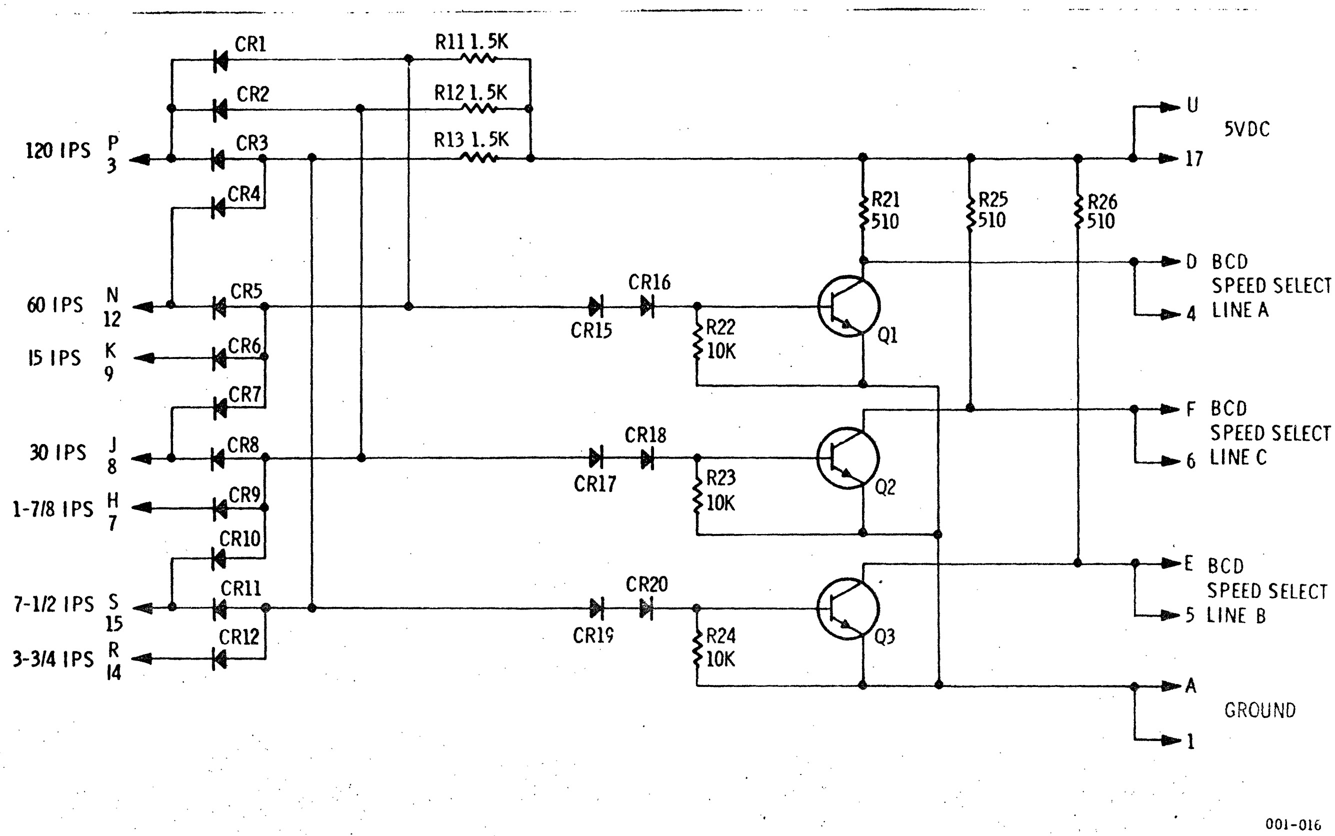


Figure 3-19. FM BCD Encoder Functional Diagram.

3-64. DIRECT/ANALOG REPRODUCE ELECTRONICS. The direct reproduce electronics consist of up to 14 reproduce preamplifiers (one for each channel), up to 14 reproduce amplifier cards, and 1 speed change logic card. The preamplifiers are encapsulated modules, and plug directly into the reproduce heads to minimize system noise, and signal loss due to cable capacitance. The reproduce amplifiers and speed change logic cards plug into the reproduce amplifier module (RAM), located directly below the tape transport, and are accessible fromthe front of the unit by opening the transport and lifting the hinged top-cover of the RAM. Voltage-mode reproduce techniques are employed to reproduce pre-recorded data signals in the frequency range of 400 Hz to 2.0 MHz, at 120 ips, with proportionately narrower bandwidths at lower tape speeds.

3-65. Reproduce Preamplifier. Refer to Figure 3-20. The reproduce preamplifier is a three-stage, direct-coupled amplifier circuit, providing approximately 30 dB of signal gain between the output of the reproduce head and the input of the reproduce amplifier. The amplifier is configured so as to present a high input impedance to the reproduce head, and a comparatively low output impedance to drive the reproduce amplifier which follows. For optimum signal-to-noise ratio, transistors Q1 and Q2 are operated at a very low collector current. With specified output cable capacitance, preamplifier frequency response is flat ($\pm$3.0 dB) from 100 Hz to 3.0 MHz.

3-66. DIRECT/ANALOG REPRODUCE AMPLIFIER. Refer to Figure 5-14. The Direct/analog reproduce amplifier consists of a low-noise, common-base, input stage; several stages of intermediate amplification; electrically selected amplitude and phase equalization; and a low impedance output amplifier.

3-67. Input Stage. The output of the reproduce preamplifier is coupled to the input amplifier (Q2) through resistor R3 and capacitor C4. Transistor Q2 is connected in a common-base configuration, with operating bias derived through Q1 and R4. Q1 serves as a constant-current source to the base of Q2 which, in turn, supplies bias back to the base of Q1. Thus, any change in the dc collector current of either transistor is cancelled by the other. With the collector voltage of Q2 held constant, the amplified ac data signal will be essentially free of distortion, and undesireable noise. Transistor Q3 serves as a ground return path for switching transistors Q4 through Q9, selected by the speed change logic, in the RAM. These switching transistors, when activated, select resistors (R9, 11, 13, 15, 17, or 19) to serve as ac load resistors for amplifier Q2, through series capacitor C3. In this manner, the gain of the input amplifier (Q2) is automatically adjusted for each tape speed selected.

3-68. Low-Frequency Equalization. At low frequencies, (400 Hz to approximately 2.0 kHz), the reactance of capacitor C3 is large, compared to that of the load resistors selected by the speed change logic. Likewise, the reactance of capacitor C2, in parallel with R1, will be large, providing maximum amplifier gain at low frequencies. As frequency increases, the parallel combination of C2 and R1, in series with C1, begins to shunt the series

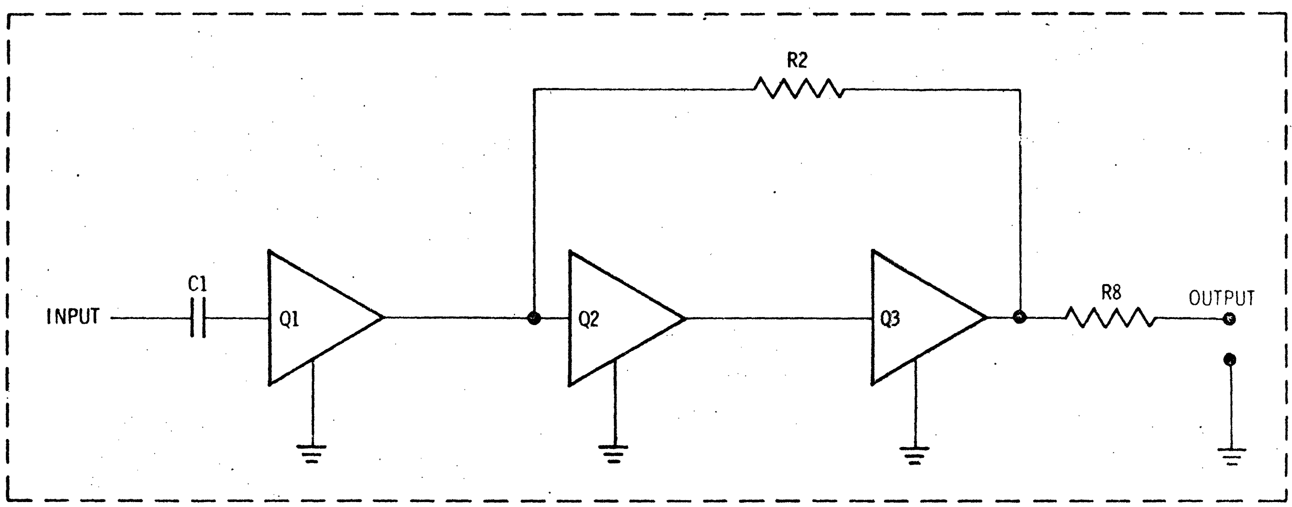


Figure 3-20. Reproduce Preamplifier Functional Diagram.

combination of Q1 and R2, thereby lowering amplifier gain. The reactance of C3 also decreases as frequency increases, which further reduces amplifier gain.

3-69. High-Frequency Equalization. After the initial low frequency boost from the input stage, the data signal is coupled through capacitor C7 to the next stage, consisting of Q10 and Q11. Q10 is an emitter-follower providing isolation between the input stage (Q2) and equalization amplifier Q11. The load impedance of Q11 consists of a selected network that provides mid-band and bandedge equalization for the tape speed selected. A separate equalization network is used for each tape speed, and is connected across the output of Q11 by means of a diode switching matrix, controlled by the speed change logic. If, for example, a tape speed of 3-3/4 ips is selected, the network consisting of R29, L1, C10, R31, and R30 is placed in series with the collector load resistor (R28) of transistor Q11. At mid-band frequencies, R29 and L1 present a rising impedance to Q11, thus increasing the stage gain. Near the upper bandedge frequency, C10 and L1 show a sharp increase in impedance, resulting from approaching resonance. The impedance then decreases sharply above the resonant frequency. R29 provides adjustment of mid-band frequency response, and R31 permits adjustemnt of the high-frequency response, to provide a fully amplitude-compensated (flat) output, over the full frequency range.

3-70. Phase Equalization. The reactive elements used for frequency compensation in the second stage introduce nonlinear phase response characteristics which must be corrected, if the output signal is to be a faithful reproduction of the original recorded data. From the amplitude equalization stage (Q11), the signal is routed through emitter-follower Q12, and then to the phase equalization stage (Q13). Transistor Q13 is a phase spliting amplifier providing two outputs of equal amplitude, but having a 180 degree difference in phase. By connecting a variable resistor (R53) and acitor (C21 thru C26) between the emitter and collector of Q13, it becomes possible to correct for phase non-linearities introduced during the process of amplitude equalization. Switching diodes are used to automatically place the appropriate phase-equalization capacitor in the circuit, for the speed selected. The PHASE ADJ. control (R53) affects the response at all tape speeds.

3-71. Output Amplifier. From the phase equalization stage, the signal is routed through emitter-follower Q23 to a voltage amplifier consisting of transistors Q14 thru Q16, which provide a voltage gain of approximately 100. From the voltage amplifier, the signal is routed to emitter-follower Q18. The OUTPUT LEVEL ADJ. control (R76), in the emitter leg of Q18, controls the output amplitude of the reproduce amplifier. The output stage consists of driver amplifier Q22, bias control transistor Q19, and output transistors Q20 and Q21, connected in a complementary-symmetery configuration. Amplifier gain is normally adjusted to provide a 1.0 V rms output across a load impedance of 75-ohms.

3-72. FM REPRODUCE AMPLIFIER. Refer to Figure 3-21.

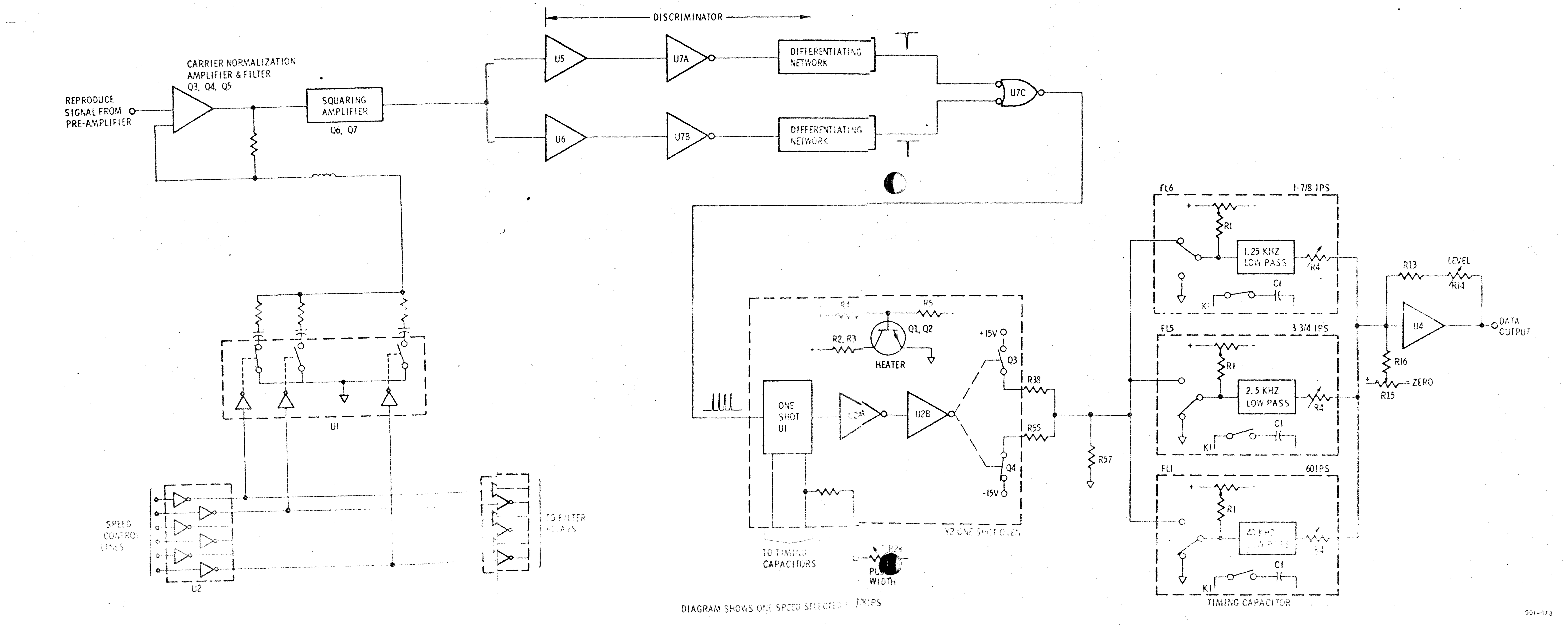


Figure 3-21. FM Reproduce Amplifier Functional Diagram.

The FM reproduce amplifier utilizes an FM discriminator consisting of separate zero-crossing detectors (U5, U6), which detect both the positive-going and negative-going crossovers of the modulated carrier. The detector outputs are combined through a gating circuit (U7), and used to trigger a fixed pulse-width one-shot multivibrator (Y2). The FM signal is thus converted to a pulse-width-modulated (PWM) signal having a constant amplitude, but a varying duty cycle. The output of the one-shot is coupled to a selected low-pass filter (FL-1 through FL-6) which responds to the average duration of the input pulses, to extract the original data signal.

3-73. Normalizing Amplifier. From the preamplifier, the reproduce signal is routed to the normalization amplifier, consisting of Q3 through Q5. Signal normalizing is necessary to compensate for the increased output from the reproduce head as frequency increases at higher tape speeds. The amplifier normalizes the carrier amplitude to approximately 3.0 V p-p at all tape speeds. Amplifier gain changing is accomplished by switching a resistor in the feedback attenuator (R1 through R6) such that as the resistance increases the feedback also increases, which decreases amplifier gain. A series capacitor (C1 through C6) is also switched, along with the resistor, to provide rolloff at low frequencies. The resistor values increase by a factor of approximately two and the capacitor values decrease by a factor of approximately one-half for each lower tape speed selected. Thus, the low frequency cutoff remains constant. High-frequency rolloff is introduced by L5. As the series resistor values double, the high-frequency rolloff point is also doubled. Switching of the feedback resistors and capacitors is accomplished by hex-inverter U1. Each inverter provides a low resistance to ground when the input is high, and an open-circuit when the input is low.

3-74. Squaring Amplifier. Squaring amplifier Q6 and Q7 is a two-stage amplifier which increases the signal slope at the zero-crossover points, and limits the amplitude of the output signal. Slope increase is provided by the high voltage gain of each stage, and amplitude limiting is provided by diode-pairs connected from collector to base of each transistor. The output of the squaring amplifier is a squarewave signal having short rise and fall times, at an amplitude of approximately 1.0 V p-p.

3-75. Zero-Crossing Detectors. The zero-crossing detector consists of voltage comparators U5 and U6, and NAND gate inverters U7A, U7B, and U7C. As the output of the squaring amplifier passes through zero in the positive-going direction, the output of U5 goes positive and is applied to the input of NAND gate inverter U7A. The negative-going output of U7A is differentiated by C35 and R36, and inverted again by U7C to trigger the one-shot multivibrator (Y2). The output of voltage comparator U6 goes positive when the output of the squaring amplifier passes through zero in the negative-going direction. U6 output is inverted by U7B, differentiated by C36 and R37, and OR'ed with the output of U7A (by U7C) to also trigger the one-shot multivibrator.

3-36. One-Shot Multivibrator. Refer to Figure 3-22. The output pulse-width of the monostable multivibrator (U1) is equal to one-half the cyclic period of the

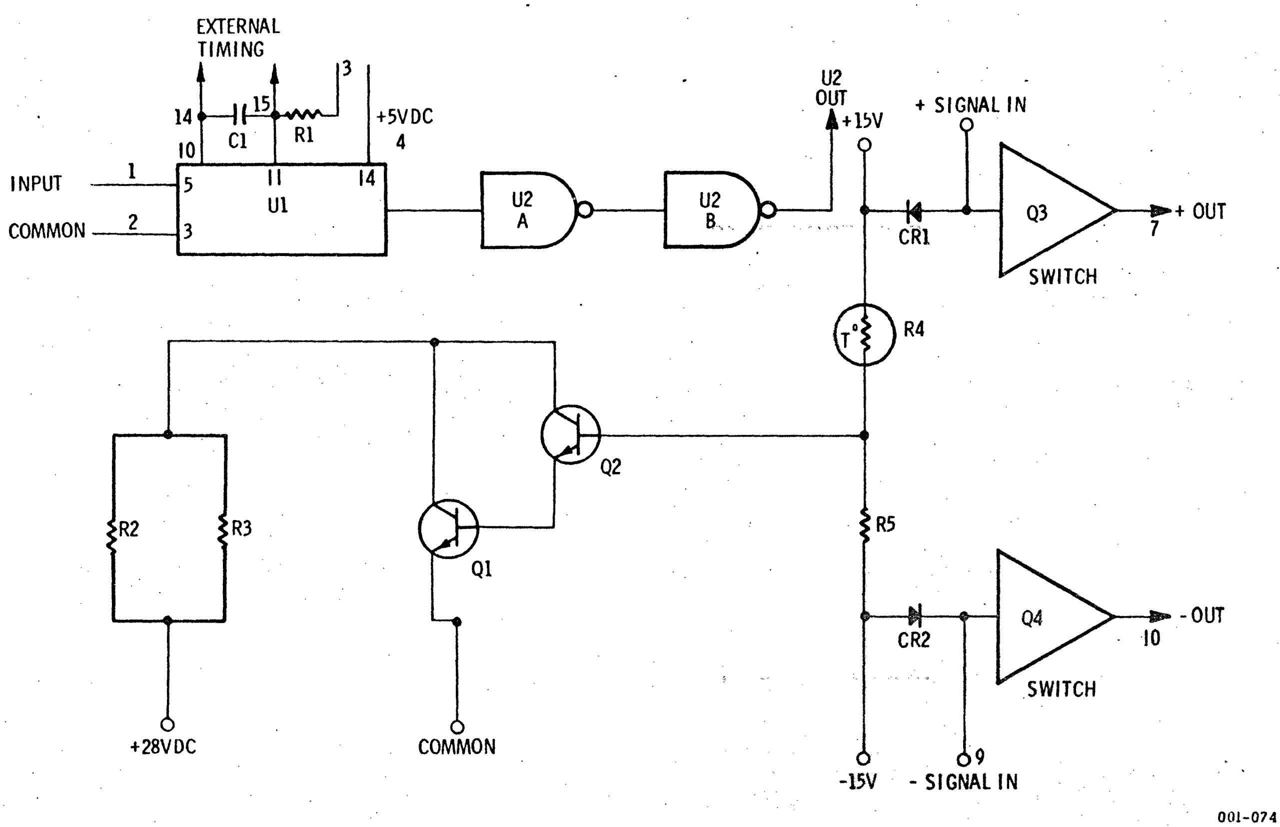


Figure 3-22. One-Shot Timing Functional Diagram.

FM carrier frequency, when the carrier signal is unmodulated. The pulse-width is determined by capacitor Cl, resistor Rl, and variable resistor R28. Capacitor Cl is actually the parallel combination of the 22 pF capacitor (Cl), within the one-shot module, and external capacitors located on the selected low-pass filter (FL-1 through FL-6). Variable resistor R28 is adjusted for a symmetrical squarewave output when the FM carrier is unmodulated. The output of Ul is routed to NAND gate inverters U2A and U2B, which provide the necessary current to drive the output switching transistors (Q3 and Q4). Transistors Q3 and Q4 are connected in a complementary-symmetry switching configuration, such that when the output of U2B is high Q4 is on, and when U2B output is low Q3 is on. This provides an output signal having both negative and positive-going transitions, across the common load resistor R57. The average dc value of the squarewave output across R57 will be zero when the FM carrier is unmodulated. With modulation, the squarewave duty cycle will vary, and the average dc value will change in direct relation to the change in input frequency. To prevent multivibrator instability due to changes in ambient temperature, the entire circuit is housed in a temperature-controlled module. Temperature control is provided by temperature-sensitive resistor R4, which controls the conduction of Darlington-connected transistors Ql and Q2. As temperature decreases, the resistance of R4 also decreases, causing Ql and Q2 to conduct. The module is then heated by the power dissipated by resistors R2 and R3.

3-77. Demodulation Filters. Refer to Figure 3-23. The PWM squarewave signal developed across R57 by the one-shot must be filtered to remove the FM carrier and extract the original modulating data. Since a different carrier frequency and bandwidth is used for each tape speed, a separate filter must be provided for each of these frequencies. Thus, each of the demodulation filters (FL-1 through FL-6) provides the proper cut-off frequency for one particular tape speed. Each of the filters contain a relay (Kl) which, when energized, connects the filter to the common input bus (pin 7). The relay also connects the proper value timing capacitor to the one-shot multivibrator, which alters the output duty cycle to coincide with the cyclic period of the input FM carrier frequency. Filter relays are activated by hex-inverter U3, which provides a ground return path for the selected relay coil. U3 is activated by positive-going inputs from hex-inverter U2, which is activated by the speed change logic. Each filter contains a ZERO ADJ. control (Rl) to correct for any asymmetry in the unmodulated squarewave signal from the one-shot. Rl is adjusted to produce 0.000 V dc at the output of the reproduce amplifier, with an unmodulated FM carrier input corresponding to the tape speed (and filter frequency) selected. Each filter is also provided with an OUTPUT LEVEL ADJ. (R4) to normalize the output of the reproduce amplifier for all tape speeds. The outputs of all six filters are connected to a common output bus, and routed to the input of the output amplifier (U4).

3-78. Output Amplifier. The output amplifier consists of a direct-coupled, operational amplifier with a variable

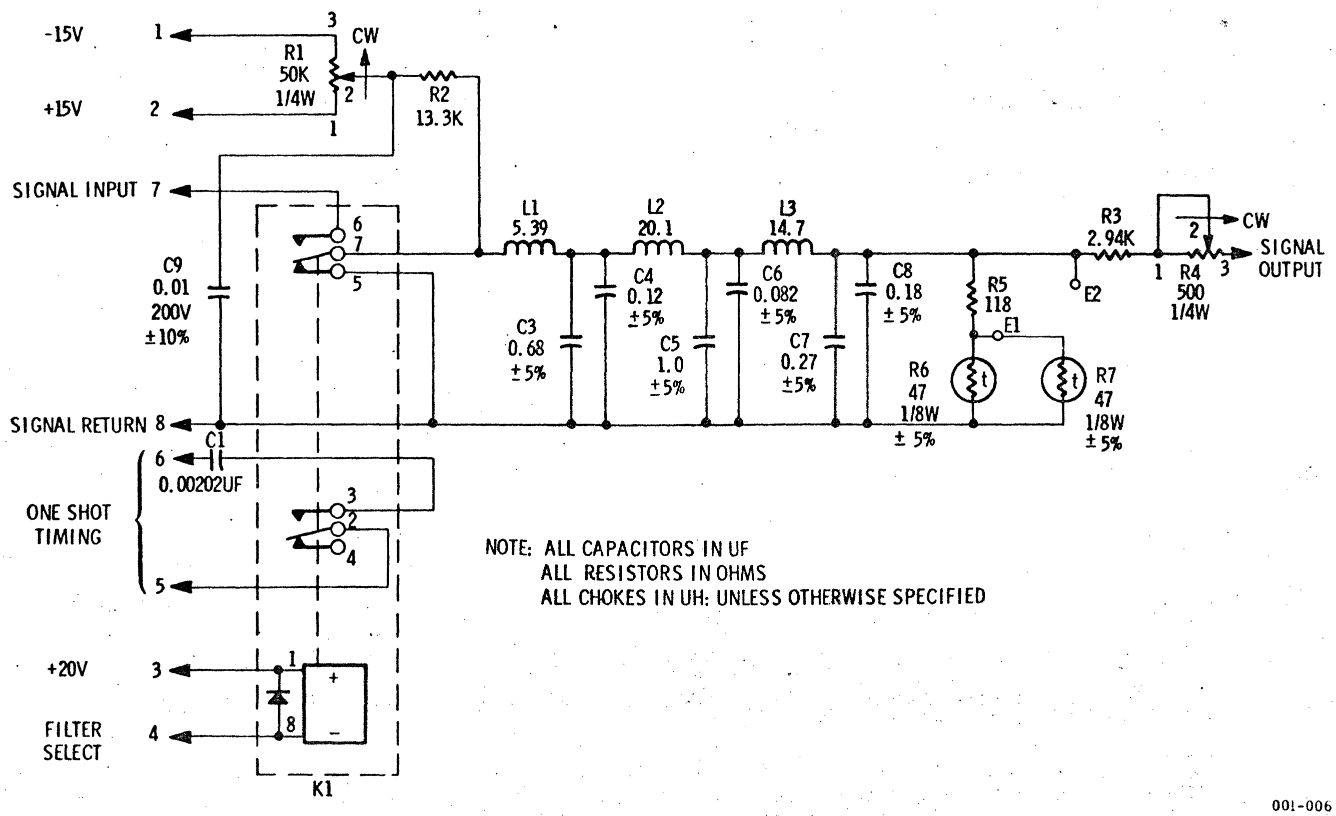


Figure 3-23. 1.25 kHz Filter Schematic Diagram.

resistor (OUTPUT LEVEL, R14) in the feedback loop to vary the gain. ZERO ADJ. control R15 is provided to balance out residual dc at the output of the reproduce amplifier, with the inputs of all demodulation filters grounded. If desired, R15 may be adjusted to provide a dc offset in the output of the reproduce amplifier.

3-79. SPEED CHANGE LOGIC. Refer to Figure 3-24. The function of the speed change logic is to select the proper equalization network in the reproduce amplifiers, which correspond to the tape speed at which the recorded signals are to be reproduced, determined by the position of the SPEED SELECT switch on the tape transport. When a specific tape speed is selected, a corresponding relay (or combination of relays) on the speed logic card is energized. The only exception is the 3-3/4 ips speed, in which case all speed select relays are de-energized, and a ground return signal is provided by the normally-closed contacts of K1, K2, and K3. For 7-1/2 ips, K3 is energized by 28 V dc across pins 5 and 6, and a ground return path is provided through normally-closed contacts of K1 and K2, and through K3A1/K3A2. For 15 ips, K2 is energized (across pins 6 and 14) and signal ground is supplied through normally-closed contacts of K1, through K2A1/K2A2, and normally-closed contacts B2 and B3 of K3. For 30 ips, K2 and K3 are energized (across pins 6 and 9) and signal ground is supplied through K3B1/K3B2, K2A1/K2A2, and through the normally-closed contacts of K1. For 60 ips, K1 is energized (across pins 6 and 11) and signal ground is supplied through the normally-closed contacts of K4 and K2, and through K1A1/K1A2. For 1-7/8 ips, or 120 ips (depending upon how the reproduce amplifiers are configured), relays K1 and K4 are energized (across pins 6 and 15) and signal ground is supplied through K4A1/K4A2, through the normally-closed contacts of K2 and through K1A1/K1A2. In each case, the ground return path provided by the speed change logic selects the proper equalization network on the reproduce amplifier for the speed selected.

3-80. POWER DISTRIBUTION FUNCTION.

3-81. Operation of the RD387/U requires a source of 117 V ac, 60 Hz, single-phase input power. Connection to this source is made through P101, located on the rear connector panel. Once line power is applied, internal power supplies provide all necessary dc voltages required to operate the unit. The paragraphs which follow describe the power distribution within the unit, and provide a functional description of the circuits and assemblies involved.

3-82. General Discussion. Refer to Figure 5-6. Input power is routed from J101 on the rear connector panel to the power distribution assembly through line filters FL-1 and FL-2, and circuit breaker CB-1, to the normally-open contacts of power relay K1. The hot side of the input power is also connected to the MAIN POWER switch (S9), located on the front panel of the reproduce amplifier module (RAM). When S9 is closed, K1 is energized and applies 117 V ac primary power to the blower fan and to the +28 V dc power supply, via pins A and B of P155. The output of the 28 V power supply (P146 pins A and C) is applied to the tape transport via pins A and C of connector J147, located

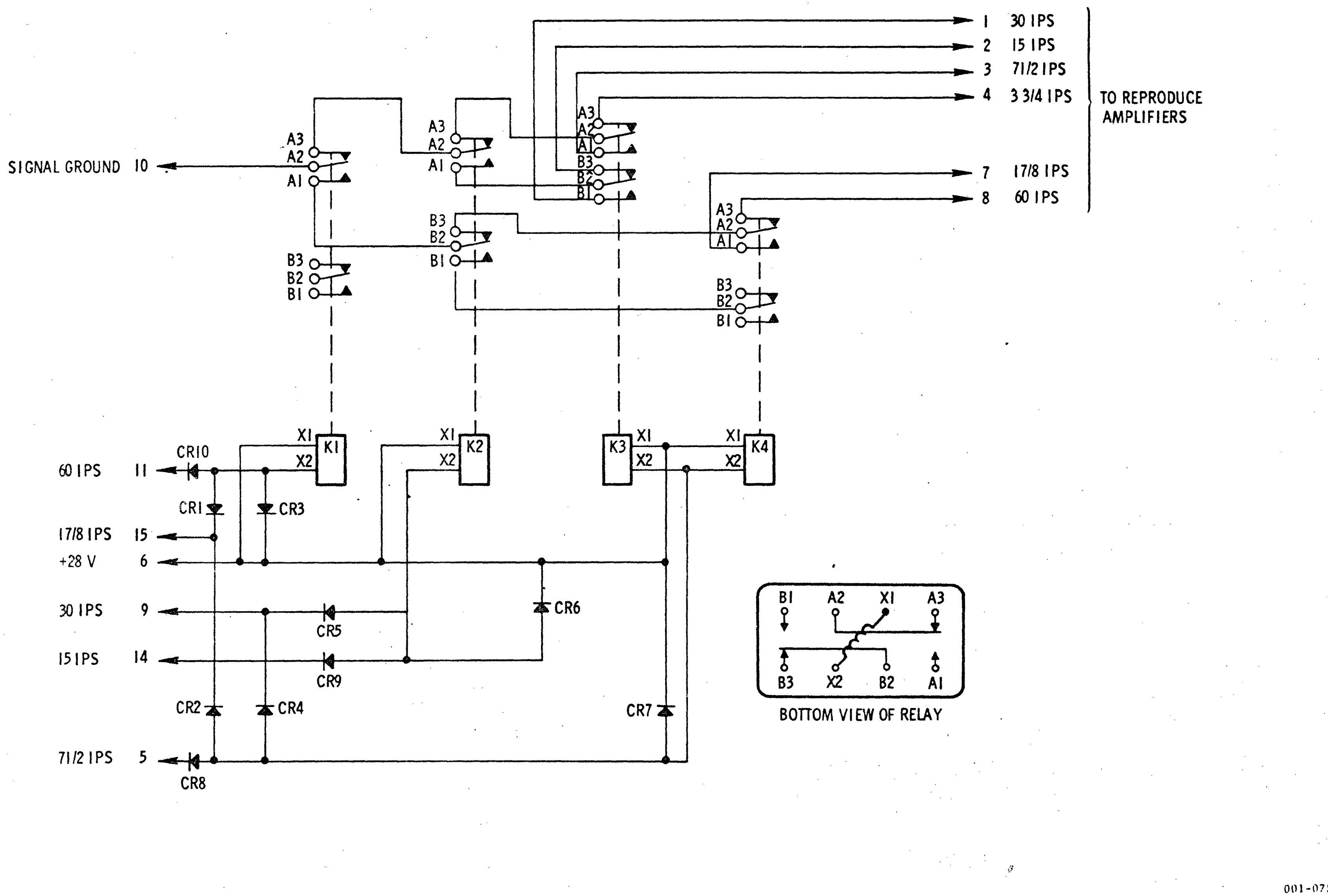


Figure 3-24. Speed Change Relay Logic Schematic Diagram.

on the transport connector bracket. After passing through the dc line filter (FL-1), the +28 V dc is routed to the power switch assembly (TB5, terminal 1) which delays the application of full operating power to the recorder circuits, until proper bias levels have stabilized. Power relays in the power switch assembly must be activated by closing the TRANSPORT POWER switch (S1), on the front panel of the RAM, to fully energize the unit.

3-83. Once the TRANSPORT POWER switch has been closed, +28 V dc is routed from the power switch assembly (TB5, terminals 2 and 3) to the various transport circuits, through fuses F1 through F4. Diodes CR1 through CR4 provide reverse-voltage protection in the event power supply polarity should become reversed. From the power switch, +28 V dc is also applied to the RAM, (P153, pins F and b, and through fuses F1 and F2) to operate the reproduce amplifiers, the dc-dc converter, and the various lamp indicators. The dc-dc converter provides regulated positive and negative 15 V dc to operate the FM signal electronics. The ELAPSED TIME meter, located on the transport connector bracket (Figure 2-3), is connected to +28 V dc through fuse F2. Ground return paths are provided by the control logic, through diodes CR5 through CR8, whenever the unit is placed in the FORWARD, REVERSE, FAST WIND, or FAST REWIND modes of operation. Thus, the ELAPSED TIME meter operates only during the time that tape is actually in motion across the heads.

3-84. From fuse F4, the first leg of the 28 V primary power is routed to the reel drive assembly (P33, pin 9), to operate the reel servo amplifier which, in turn, operates the reel motors. The second leg of the 28 V primary power is routed from fuse F3 to the servo heatsink assembly (TB6, terminal 6) to operate the capstan motor power amplifier stages. Capstan motor power is applied through connector J34, pins 5 (-) and 9 (+). The third leg of the 28 V primary power is routed from fuse F2, through connector P20 (pin 3), to the BCD encoder (J26, pin W), and also to the control logic card (J24, pins 22 and Z), which serves to place the unit in the STOP mode when power is first applied. The fourth leg of the primary power is routed from fuse F1, through connector P20 (pin 1), to the voltage regulator (J25, pins 22 and Z) and to the reference frequency sine-wave converter (J57, pin 1), via connector J59, pin 9 and P56, pin 32.

3-85. The voltage regulator provides regulated voltages of 24 V dc (J25, pins 19 and W), to operate the reproduce preamplifier regulator; 20 V dc (J25, pins 20 and Z), to operate the tape break sensor, end-of-tape sensor, tape supply sensors, and circuits located in the logic, BCD encoder, capstan servo, and reel drive assemblies; 18.5 V dc (J25, pins 8 and J), to operate the record amplifiers; and 5 V dc (J25, pins 17 and U), to operate circuits in the logic, encoder, and capstan servo assemblies. The voltage regulator also supplies 10 V dc (J25, pins 18 and V) to the tachometer transducer, located in the capstan motor housing, via J34, pin 2.

3-86. Primary Power Supply. The +28 V dc power supply is a sealed unit, rated at 14 amperes full load, which serves as the primary power source for the RD378/U. The specifications for this assembly are listed in Table 3-4, and a detailed schematic diagram is provided in Figure 5-6..

3-87. Power Switch Assembly. Refer to Figure 3-25. The power switch assembly permits proper bias levels to be established in the solid-stage circuits, before full operating voltage is applied to the unit. The +28 V dc input is applied through normally-closed contacts of K1 to energize relay K2. With K2 energized, power is routed to the transport circuits through limiting resistor R2. From K2, power is also applied to relay K1, through limiting resistor R1. As a result of the time-constant provided by R1 and C1, activation of relay K1 is delayed for approximately 50 milliseconds, thus allowing circuit bias voltages to stabilize. After this brief delay, K1 energizes and applies full power to the unit. Once energized, K1 remains activated through resistors R1 and R2, now connected in series across the 28 V dc output of the power switch (TB4, terminals 2 and 3).

3-88. DC-DC Converter. The dc-dc converter is used only when the FM record/reproduce signal electronics are installed. The converter accepts +28 V dc primary power input, and provides regulated ±15 V dc outputs. The unit is an encapsulated, non-repairable module, which should be replaced as a complete assembly if a malfunction should develop.

3-89. VOLTAGE REGULATOR. Refer to schematic diagram, Figure 5-16. The voltage regulator operates directly from the +28 V dc primary power to provide the following outputs.

a. +24 V dc for the reproduce preamplifier regulator.

b. +20 V dc for the capstan and reel drive circuits, control logic, BCD encoder, and sensor assemblies.

c. +18.5 V dc for the record amplifiers.

d. +10 V dc for the capstan tachometer.

e. +5 V dc for the capstan servo, BCD encoder, and control logic.

3-90. +24 V dc Regulator. The +24 V regulator is a series regulator, which consists of transistor Q5, zener diode CR8, and associated circuitry. This regulator supplies the reproduce preamplifiers regulator with +24 V dc input power. This regulator is not adjustable.

3-91. +18.5 V dc Regulator. The +18.5 V dc regulator provides operating voltage to the record amplifiers, and is only energized when the unit is in the RECORD mode of operation. The control amplifier (Q1) senses the output voltage across potentiometer R8 (+18.5 V ADJUST), and compares this voltage to a reference voltage across zener diode CR1. Any variation in the output results in a correction voltage from the control amplifier to the base of Q1, on the servo heatsink assembly. The input 28 V dc is clamped by zener diode CR1 to operate the RECORD control circuit, in the control logic. Capacitor C2 is a timing capacitor which controls the turn-on/turn-off time of Q1, to

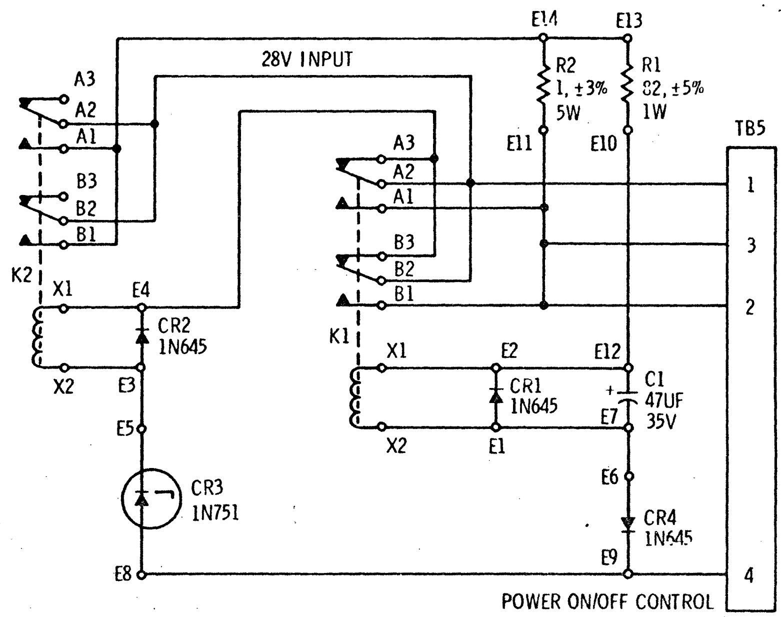


Figure 3-25. Power Switch Schematic Diagram.

TABLE 3-4. POWER SUPPLY SPECIFICATIONS

a. Input Voltage	105 - 125 V ac
b. Input Frequency	47 - 420 Hz
c. Output Voltage	28, ±1.2 V dc
d. Output Current	14.0 A, full load
e. Regulation - Line and Load Combined	±0.5%, for worst case 105 - 125 V ac line and no-load to full-load change.
f. Ripple and Noise	Less than 50 mV peak-to-peak for worst case 110 - 125 V ac line and no-load to full-load change. Less than 500 mV peak-to-peak for worst case 105 - 125 V ac line and no-load to full-load change.
g. Overload Protection	Greater than 20 A output.
h. Magnetic Radiation	Less than 0.5 gauss, 1-inch from top surface.
j. Operating Temp	$-20^{o}C$ to $+55^{o}C$ (circulated air)
k. Storage Temp	$-55^{o}C$ to $+85^{o}C$
l. Maximum Weight	15 lbs

permit a gradual build-up of the +18.5 V dc output, when the circuit is energized. This slow turn-on/turn-off prevents magnetization of the record heads, due to sudden voltage changes.

3-92. +20 V dc Regulator. The +20 V dc regulator consists of transistors Q3 and Q4, plus shunt regulator Q5, located on the servo heatsink assembly. The output of the +20 V regulator is adjusted by R15, located on the voltage regulator PWB.

3-93. +5 V dc Regulator. The +5 V dc required to operate the logic circuitry is developed by emitter-follower Q6. Base bias is established by zener diode CR10 and diode CR11, in the emitter leg, to maintain a constant +5 V dc output.

3-94. +10 V dc Regulator. The +10 V dc supply consists of zener diode CR7, inductor L1, and capacitor C4. CR7 limits the 20 V reference input to a 10 V level, which is supplied to the tachometer transducer in the capstan motor housing.

3-95. Preamplifier Regulator. Refer to Figure 5-6. The reproduce preamplifier regulator consists of an integrated circuit precision voltage regulator (U1) and associated components. The regulator is located on the interconnect PWB for the even numbered reproduce preamplifiers, and is used to supply +15 V dc preamplifier operating voltage.

3-96. <u>MECHANICAL FUNCTION.</u>

3-97. The two primary mechanical functions performed by the tape transport are those performed by the capstan drive assembly and by the reel drive assembly. The function of the capstan drive is to drive the tape past the record/reproduce heads at a selected constant velocity, while maintaining uniform head-to-tape contact. The function of the reel drive is to unwind tape from the supply reel before it enters the head area, and wind it onto the take-up reel after it leaves the head area, while maintaining uniform tape tension at all times.

3-98. TAPE METERING. The tape metering function is accomplished by two elastomer-coated capstans having identical diameters, but driven at slightly different speeds, by a single servo-controlled dc motor. The capstans are driven such that the tape is controlled by the slower turning capstan as it enters the head area, and by the faster turning capstan as it leaves the head area. This creates a slight tension in the section of tape passing over the heads, and ensures uniform head-to-tape contact. The capstans are driven at slightly different velocities through the use of a two-diameter pulley, driven by the capstan motor, and coupled to the capstans by a pair of mylar drive-belts. Belt A is threaded around both capstan pulleys and is driven by the smaller diameter of the two-diameter motor pulley. Belt B is also threaded around both capstan pulleys, but is driven by the larger motor-pulley diameter. The capstans will turn at a velocity determined by the driving source which is "leading" the particular capstan pulley (i. e., the motor pulley which is PULLING the belt from around the capstan pulley). The tape is held in firm contact with the capstans by first passing around the wrap-rollers which provide a wrap-angle of approximately 226 degrees around the capstans.

3-99. REEL DRIVE. The RD378/U uses separate dc motors to turn the supply and take-up reels, each of which is under the control of a separate closed-loop servo. The motors are mounted concentrically and are housed in a single reel motor assembly. The reel servos (and hence the reel motor torque) are controlled by two tension sensors located in the tape path. Refer to Paragraph 3-34 for description of sensor operation.

CHAPTER 4

SCHEDULED MAINTENANCE

4-1. INTRODUCTION.

4-2. Maintenance procedures described in this chapter are to be performed on a scheduled basis to reduce the possibility of catastrophic failure, and to maintain the unit at a satisfactory operating level.

4-3. PURPOSE.

4-4. The purpose of scheduled maintenance is to keep the unit operational at all times under all circumstances.

4-5. SCOPE.

4-6. The information provided in this chapter shall be used by all operator and maintenance personnel responsible for the unit. Operator and Maintenance personnel should have the rank of E-5, or greater.

4-7. ARRANGEMENT OF SCHEDULED MAINTENANCE DATA.

NOTE

The scheduled maintenance instructions in this manual are cancelled when the Planned Maintenance System (PMS) is implemented for this equipment aboard your ship or station.

4-8. The scheduled maintenance procedures are arranged in a logical sequence and are to be done as scheduled.

4-9. SCHEDULED MAINTENANCE ACTION INDEX.

4-10. Table 4-1 provides an index to scheduled maintenance. The table provides the period, required action, and appropriate paragraph to perform the action.

4-11. PREVENTIVE MAINTENANCE PROCEDURES.

4-12. The following information and procedures are to be used when performing scheduled maintenance. Be certain to observe all safety precautions and that all required tools and test equipment are available.

4-13. SAFETY PRECAUTIONS.

CAUTION

The unit operates at dangerous voltages. Turn off main circuit breaker for all procedures that do not require power to the unit. For those procedures that require power to the unit, observe all precautions normally followed in using and testing electronic equipment.

4-14. CLEANING MAGNETIC HEADS.

4-15. To minimize wear to the head surfaces, and to prevent signal degradation, it is very important to keep the magnetic heads clean at all times. This procedure should be performed daily.

TABLE 4-1. SCHEDULED MAINTENANCE ACTION INDEX

Should be Performed	Maintenance Action	Reference Paragraph
Daily	Demagnetize Heads	4-16
Daily	Clean Heads	4-14
Monthly	Inspect and/or replace Capstan Drive-belts	4-18
Quarterly	General Inspection for damage or deterioration	Table 4-2
Every 60 - 100 hours of operation	Perform transport and signal electronics adjustments/alignments as necessary.	Chapter 6, Section I

TABLE 4-2. ITEMS TO BE INSPECTED

Item	Inspect For
Cabinet and Transport (General)	Physical damage. Illegible markings on controls and nameplates. Loose or missing hardware.
Controls, Indicators and Switches	Insecure mounting, missing lenses, loose knobs, proper operation.
Tapeguides and other rotating components	Smooth rotation. Damaged surfaces.
Heads	Dust, oxide or other foreign substances. Scratched tape surface. Damaged or excessive wear.
Connectors	Insecure mounting, bent or missing pins. Damaged shells.
Cables	Damaged insulation. Improper routing, kinks or twists. Loose clamps.
Printed Wiring Boards	Breaks, damaged components, proper seating in sockets.
Terminal Boards	Breaks, cracks, loose terminals. Insecure mounting.
Fuses	Damaged holders. Proper rating.

CAUTION

Avoid prolonged breathing of xylene fumes. Keep xylene away from open flame.

a. Tools, Parts, Material, and Test Equipment.

1. Xylene Federal Specification TT-X-916B.

2. Cotton swabs.

b. Procedure.

1. Refer to Figure 4-1.

2. Loosen two captive screws and remove headshield. Use extreme care so as not to scratch head surfaces.

3. Clean the face of the magnetic heads with a cotton swab dampened (not saturated) with Xylene, by wiping in the vertical direction along the head gaps.

NOTE

Headstack should be degaussed after cleaning, while the headshield is still removed.

4. Reinstall headshield.

4-16. HEAD DEGAUSSING.

4-17. Heads should be degaussed (demagnetized) frequently to prevent loss of high-frequency data signals. Daily degaussing is recommended.

a. Tools, Parts, Material, and Test Equipment.

1. Head demagnetizer - Amplifier Corp. of America, Model 200-C.

b. Procedure.

CAUTION

Do not turn off degausser while it is in the vicinity of the magnetic heads. Resulting directional magnetic field may remagnetize heads.

1. Refer to Figure 4-2.

2. Turn off recorder input power.

3. Remove tape and tape reels from transport.

4. Using a small pocket compass, check and degauss all tools which will be used near the head area.

5. Remove head cover and headshield, being extremely careful not to scratch the head surfaces.

6. Energize the degausser well away from the immediate head area (arms-length will suffice), and slowly bring the degausser into the head area.

7. Bring the degausser close enough to the headstack so that a definite strong attraction is felt. Do not permit physical contact between the degausser and the head surfaces.

8. Slowly move the degausser back and forth above the face of the headstack for 15 to 30 seconds.

9. Slowly remove the degausser from the head area, while at the same

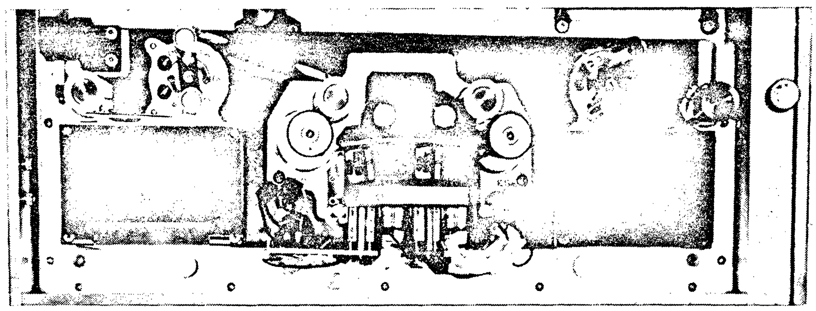


Figure 4-1. Magnetic Head with Cover Removed.

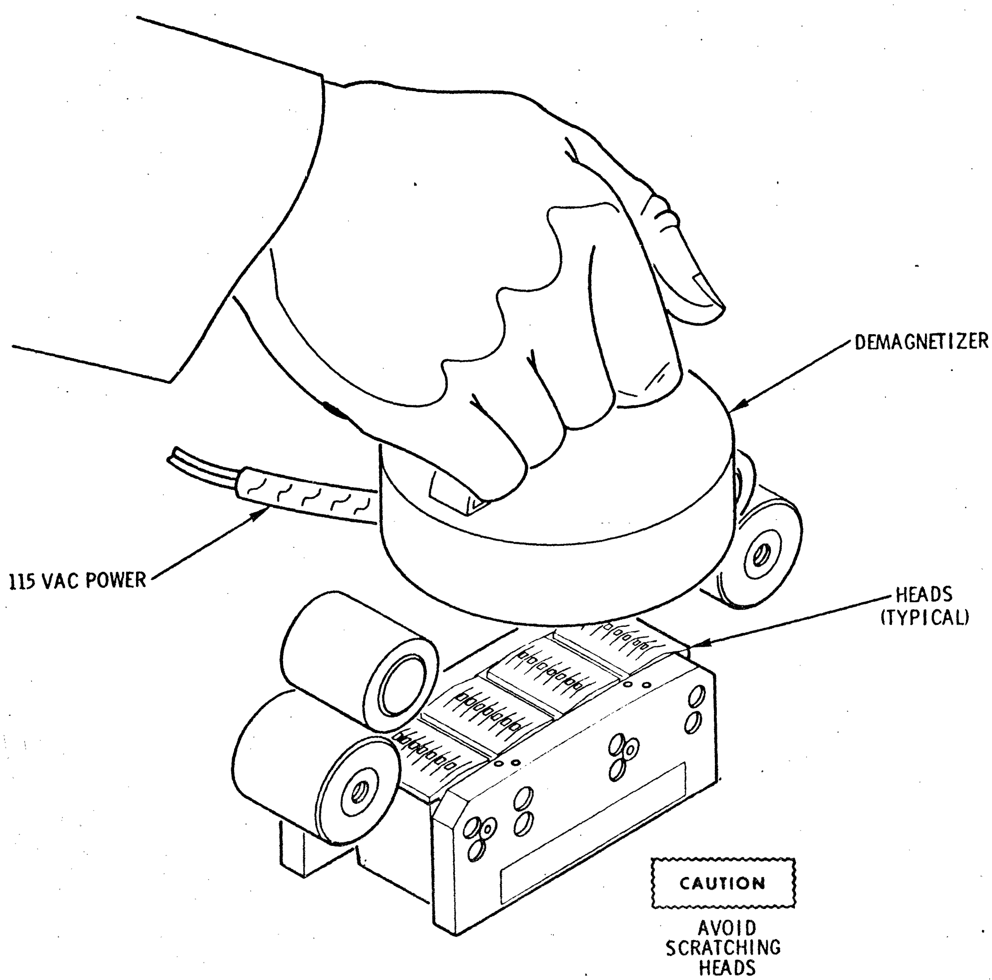


Figure 4-2. Magnetic Head Degaussing.

time continuing a slow back-and-forth, or rotating, motion.

10. De-energize the degausser only after it is well away from the immediate head area.

11. Re-install head-cover and headshield.

4-18. CAPSTAN DRIVE-BELT REPLACEMENT.

4-19. After every 100 hours of operation or once each month, whichever occurs first, the capstan drive-belts should be inspected. If the belts do not show signs of wear or deterioration, simply clean and re-install. If cracks, nicks, or slippage are obvious replace belts as outlined in paragraph 6-53.

CHAPTER 5

TROUBLESHOOTING

5-1. INTRODUCTION.

5-2. This chapter provides troubleshooting instructions for the isolation of malfunctions in the recorder/reproducer. The troubleshooting instructions are limited to the isolation of faults to mechanical or dlectronic subassemblies. Replacement and repair instructions are provided in Chapter 6, Corrective Maintenance. Additional information which will be of value in troubleshooting may be found in Chapter 3, Functional Description. This chapter is divided into eight parts, which are interrelated. They are:

1. Troubleshooting index table.
2. Relay and lamp index table.
3. Protective device index table.
4. Troubleshooting procedures.
5. Maintenance turn-on procedure.
6. Troubleshooting diagrams.
7. Maintenance schematic diagrams.
8. Troubleshooting dependency diagram.

The troubleshooting index (Table 5-1) consists of the following:

1. Functional areas of the unit.
2. Troubleshooting paragraphs, which serve as a help in isolating the malfunction.
3. Troubleshooting diagrams, which serve as an aid in isolating the malfunction.
4. Functional descriptions, which refer to paragraphs in Chapter 3 where the theory of functional areas is described.
5. Alignment/adjustment, which refers to paragraphs in Chapter 6.

5-3. The relay and lamp index (Table 5-2) consists of a table listing all the relays and lamps used in the recorder/reproducer. Each relay and lamp is listed by its functional name and a troubleshooting diagram is provided to facilitate understanding of the function. The protective device index (Table 5-3) lists all fuses and circuit breakers in the unit and describes their functions. Toubleshooting procedures are contained in Table 5-4. This table presents a logical order of fault isolation through the use of measurements and indications of the unit. Maintenance turn-on procedure (Table 5-5)brings the unit from fully OFF to the ON condition and is described in a tabular form. Troubleshooting consist of signal flow (Figures 5-1 through 5-4), control diagram (Figure 5-5), and power distribution (Figure 5-6). These diagrams are presented using logical normal indications to isolate the fault. Figure 5-7 is an intraunit interconnection diagram. Maintenance schematic diagrams, which consist of the overall unit (Figure 5-8), transport assembly schematics (Figure 5-9), RAM assembly schematic (Figure 5-10), and subassemblies of the unit, (Figures 5-11 through 5-19) are provided. All the electronic components are identified. Troubleshooting dependency diagrams (Figure 5-20 through 5-23) show the functional dependency of a function or signal and also show a logical relationship of dependency to the next lower repairable level.

5-4. AC POWER. Power provided to the unit is 115 V ac 60 Hz. The 115 V ac is used to drive a cooling fan and utility lamp, and to supply input power to the +28 V dc power supply. For troubleshooting purposes refer to Table 5-4, step 1.

5-5. DC POWER. A +28 V dc power supply is used in the unit to provide power for all the lamps, relays, voltage regulator, and motors that are used in the transport section. Table 5-4, troubleshooting procedures, under step 1, Power Distribution, gives a step-by-step troubleshooting sequence.

5-6. DIRECT RECORD. Should the unit record, a step-by-step procedure should be followed, as given in Table 5-4 troubleshooting procedure, step 3, and Figure 5-20 troubleshooting dependency diagram.

5-7. DIRECT REPRODUCE. In the event that the unit will not reproduce, a systematic troubleshooting procedure is given in Table 5-4, step 3. Also a dependency chart is given in Figure 5-22.

5-8. FAST WIND. Malfunctions of the fast wind mode are described in troubleshooting procedures, Table 5-4, step 2.

5-9. FAST REWIND. Malfunctions in the fast rewind mode are described in troubleshooting procedure, Table 5-4, step 2.

5-10. FM RECORD. A troubleshooting procedure in Table 5-4, step 4, and Figure 5-21 are provided for assistance in finding problems.

5-11. FM REPRODUCE. Table 5-4, troubleshooting procedures, step 4, describes a number of malfunctions that may correspond to FM reproduce problems. Also provided for assistance is Figure 5-23.

5-12. FORWARD. Table 5-4, troubleshooting procedures, step 2, describes a number of malfunctions that may fit problems in this area.

5-13. REVERSE. Use Table 5-4, troubleshooting procedures, step 2, for assistance in rectifying problems.

5-14. INPUT SIGNAL. Refer to Table 5-4, step 3 (g.), and troublshooting dependency diagram for assistance in finding malfunctions.

5-15. OUTPUT SIGNAL. Refer to Table 5-4, step 3 (g.), and troubleshooting dependency diagram for assistance in finding malfunctions.

5-16. START. Refer to Table 5-4, troubleshooting procedures, step 2.

5-17. STOP. Refer to Table 5-4, troubleshooting procedures, step 2.

5-18. TAPE SPEED CONTROL.
Refer to Table 5-4, troubleshooting procedures, step 2.

5-19. TAPE SPEED INDICATOR.
Refer to Table 5-4, step 2.

5-20. Relay and Lamp Index is shown in Table 5-2, Protective Device Index is shown in Table 5-3. Troubleshooting Procedures are shown in Table 5-4, and Maintenance Turn-On Procedure is shown in Table 5-5.

NOTE

> Before consulting Table 5-4, check all voltages, using the VOLTAGE CHECK meter and control on the front panel of the RAM (except in cases where a known or obvious malfunction exists). This check may provide clues to the location of the malfunction.

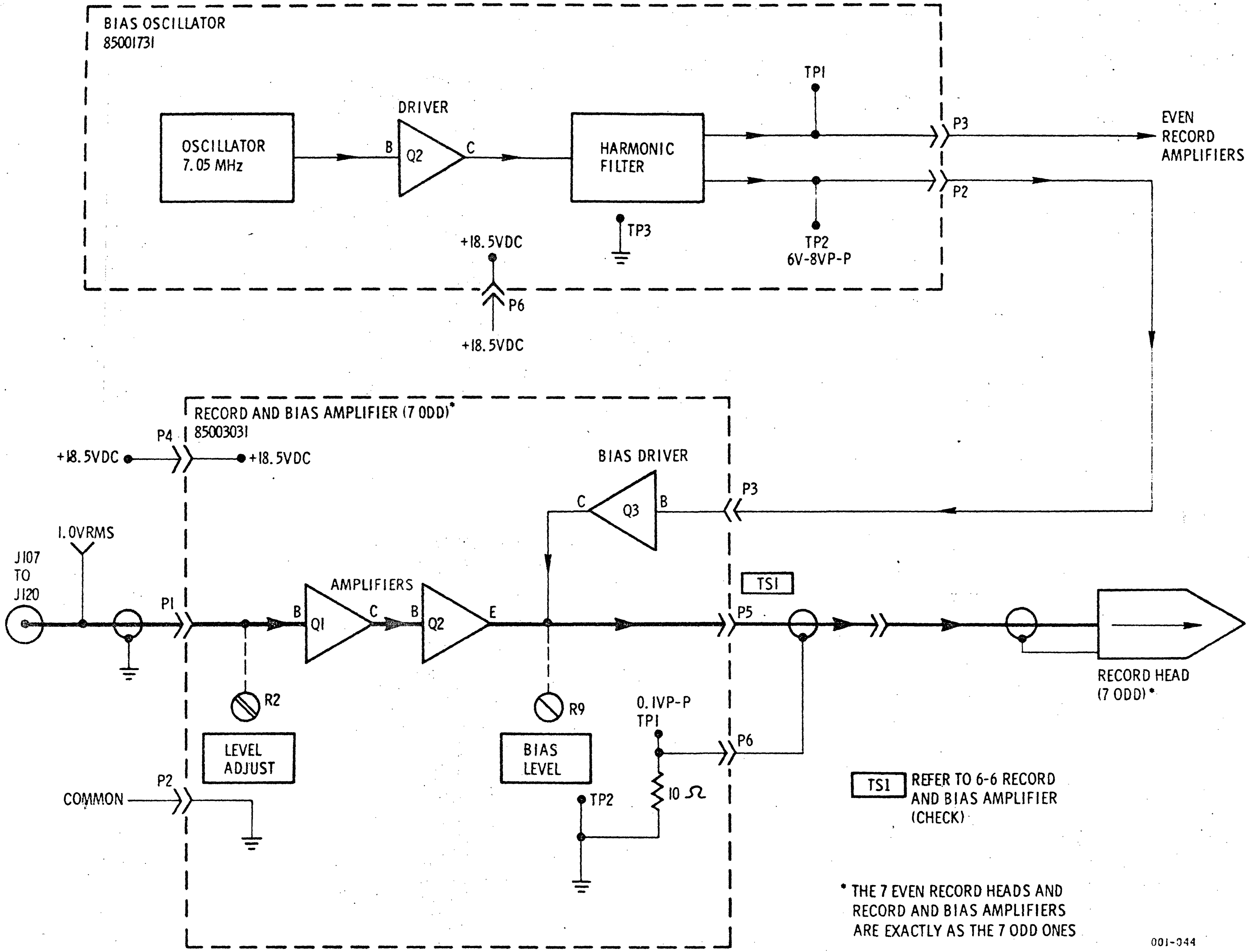
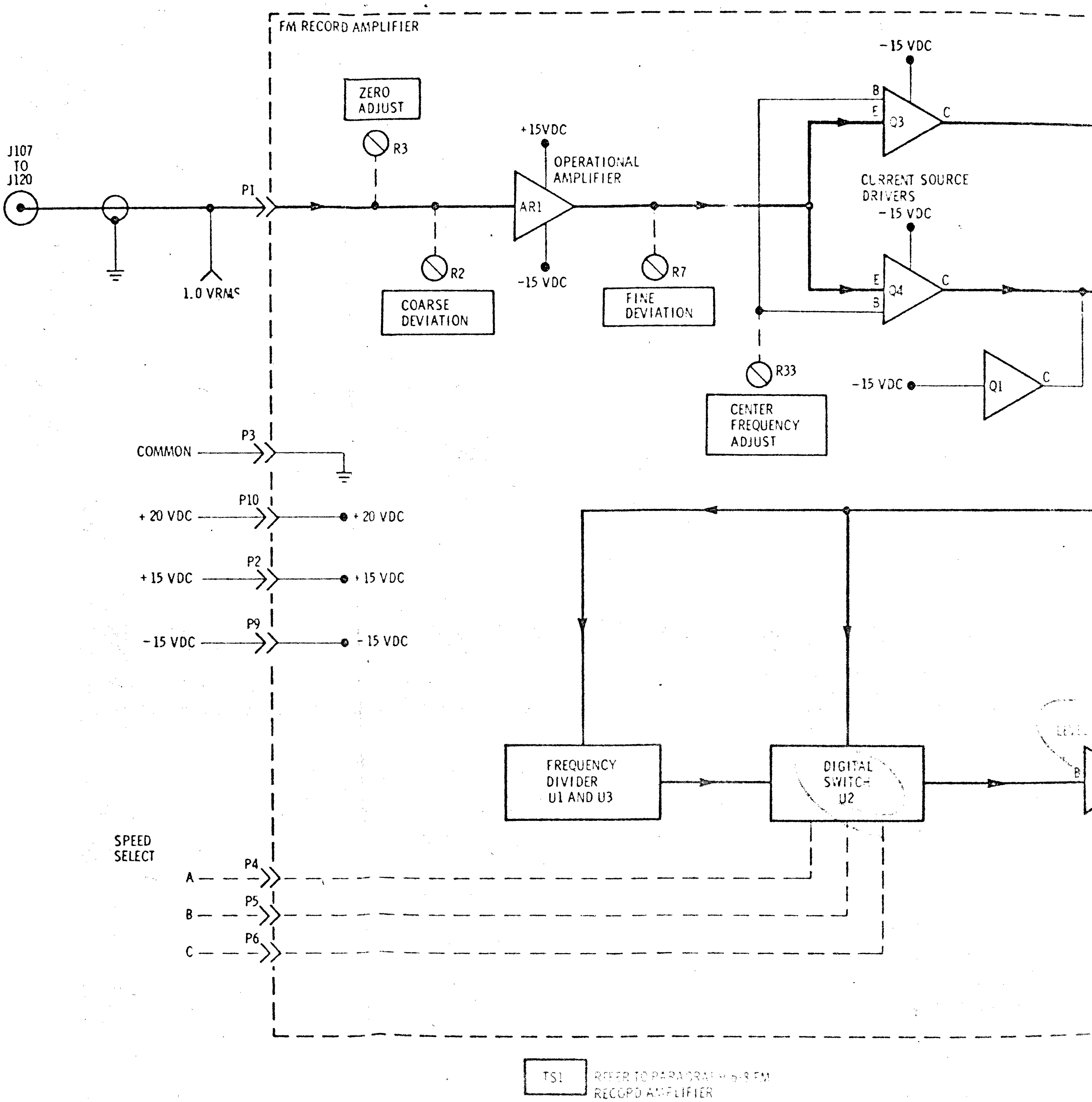


Figure 5-1. Direct Record and Bias Amplifier Signal Flow Diagram.


FM RECORD AMPLIFIER
J107
TO
J120
P1
1.0 VRMS
ZERO
ADJUST
R3
R2
COARSE
DEVIATION
+15VDC
OPERATIONAL
AMPLIFIER
AR1
-15 VDC
R7
FINE
DEVIATION
-15 VDC
B
E
Q3
C
CURRENT SOURCE
DRIVERS
-15 VDC
E
Q4
B
C
R33
CENTER
FREQUENCY
ADJUST
-15 VDC
Q1
C
COMMON
P3
P10
+ 20 VDC
+ 20 VDC
P2
+ 15 VDC
+ 15 VDC
P9
- 15 VDC
- 15 VDC
FREQUENCY
DIVIDER
U1 AND U3
DIGITAL
SWITCH
U2
B
SPEED
SELECT
A
P4
B
P5
C
P6
TS1

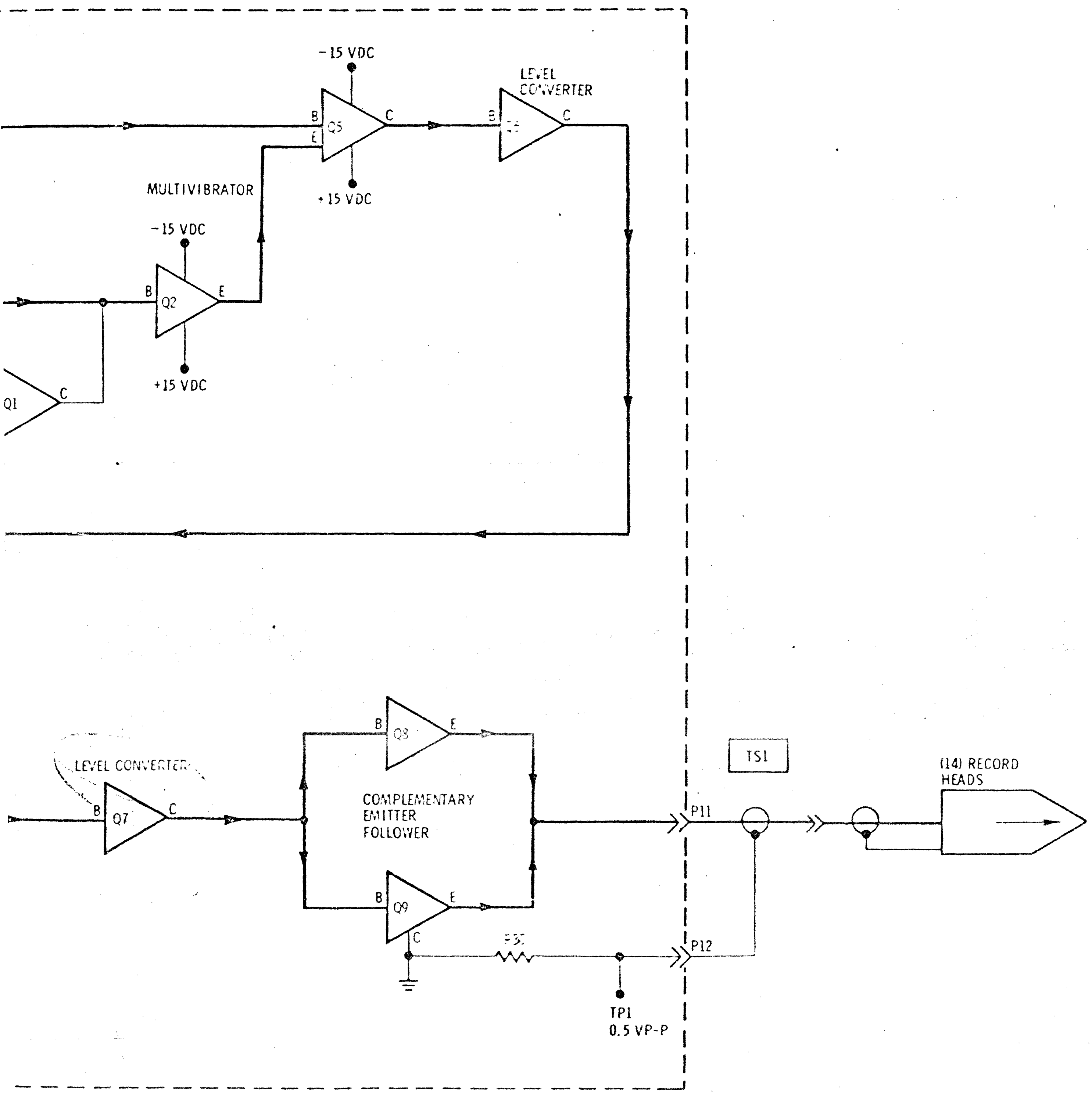


Figure 5-2. FM Record Amplifier Signal Flow Diagram.

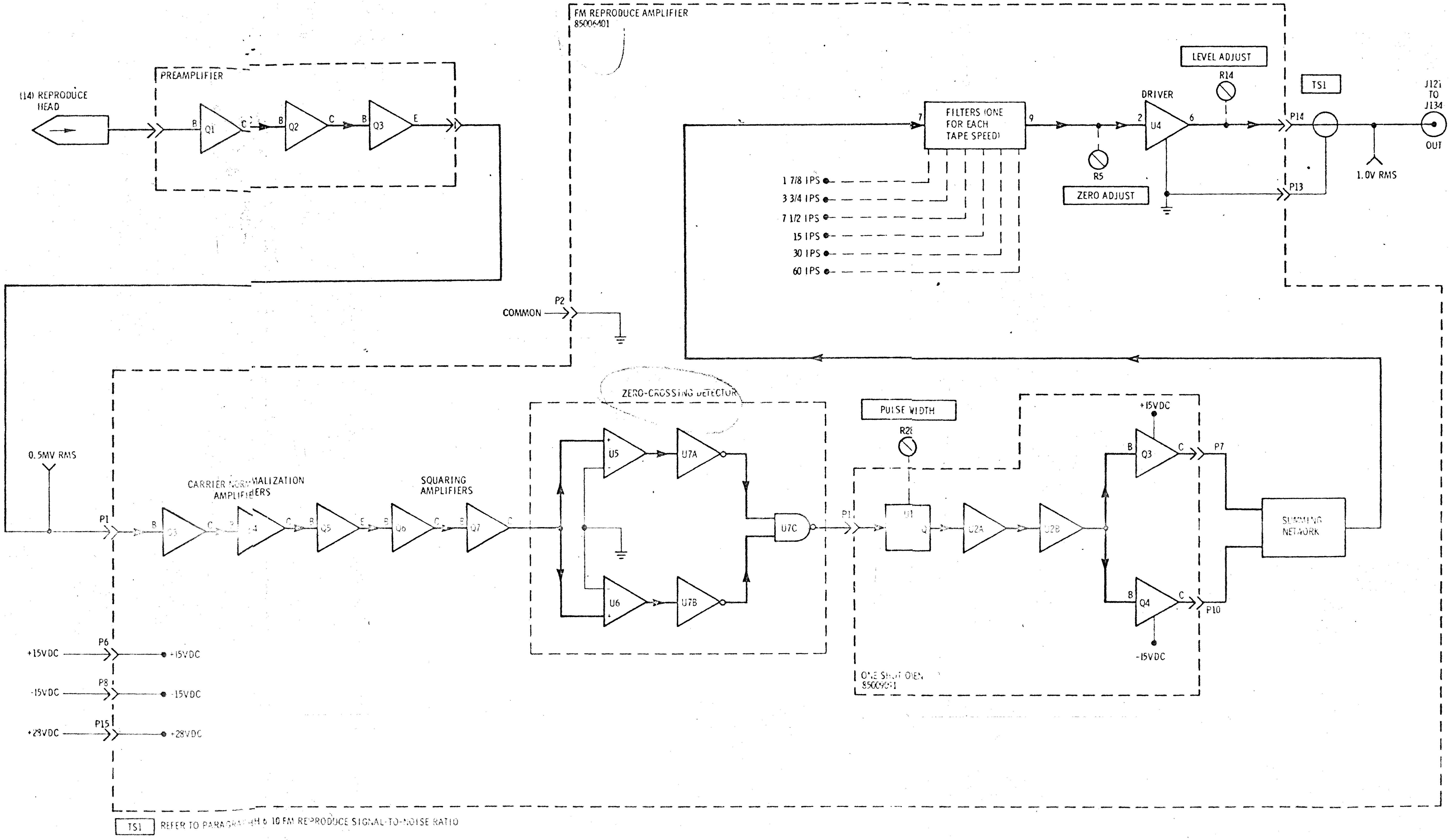
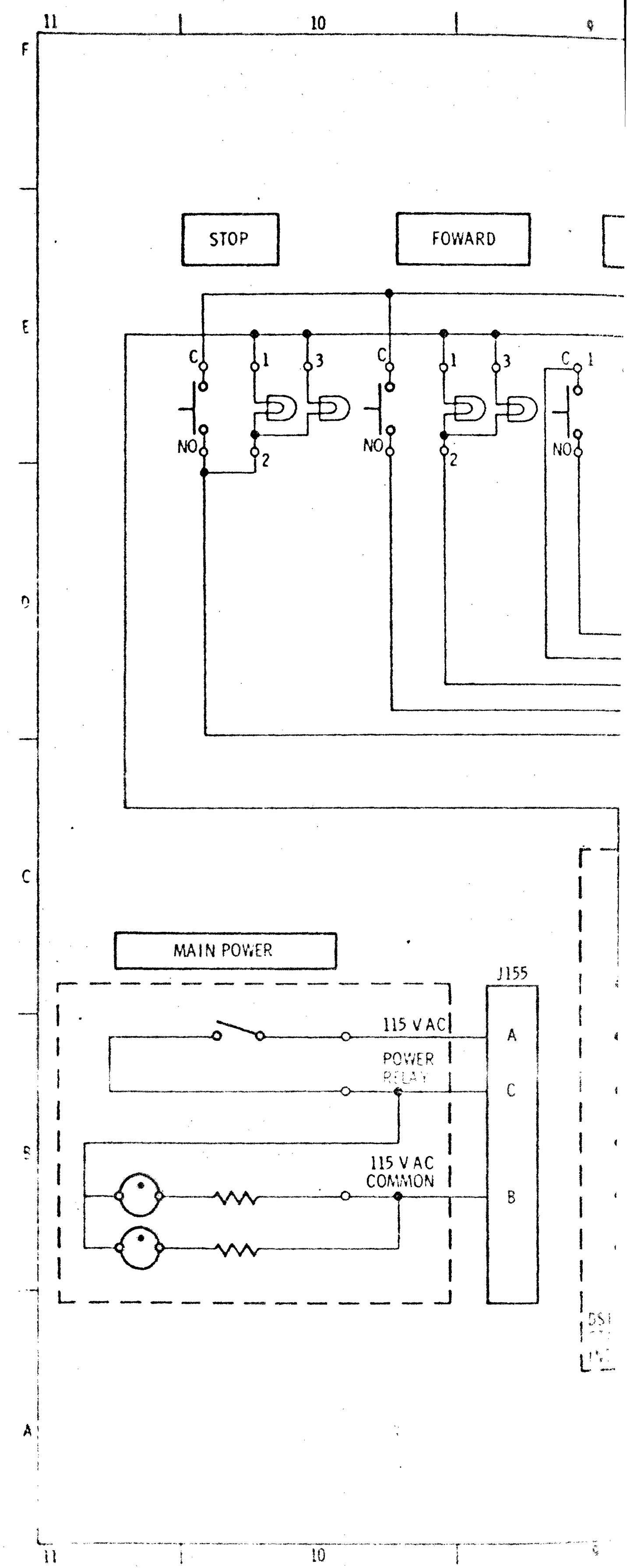
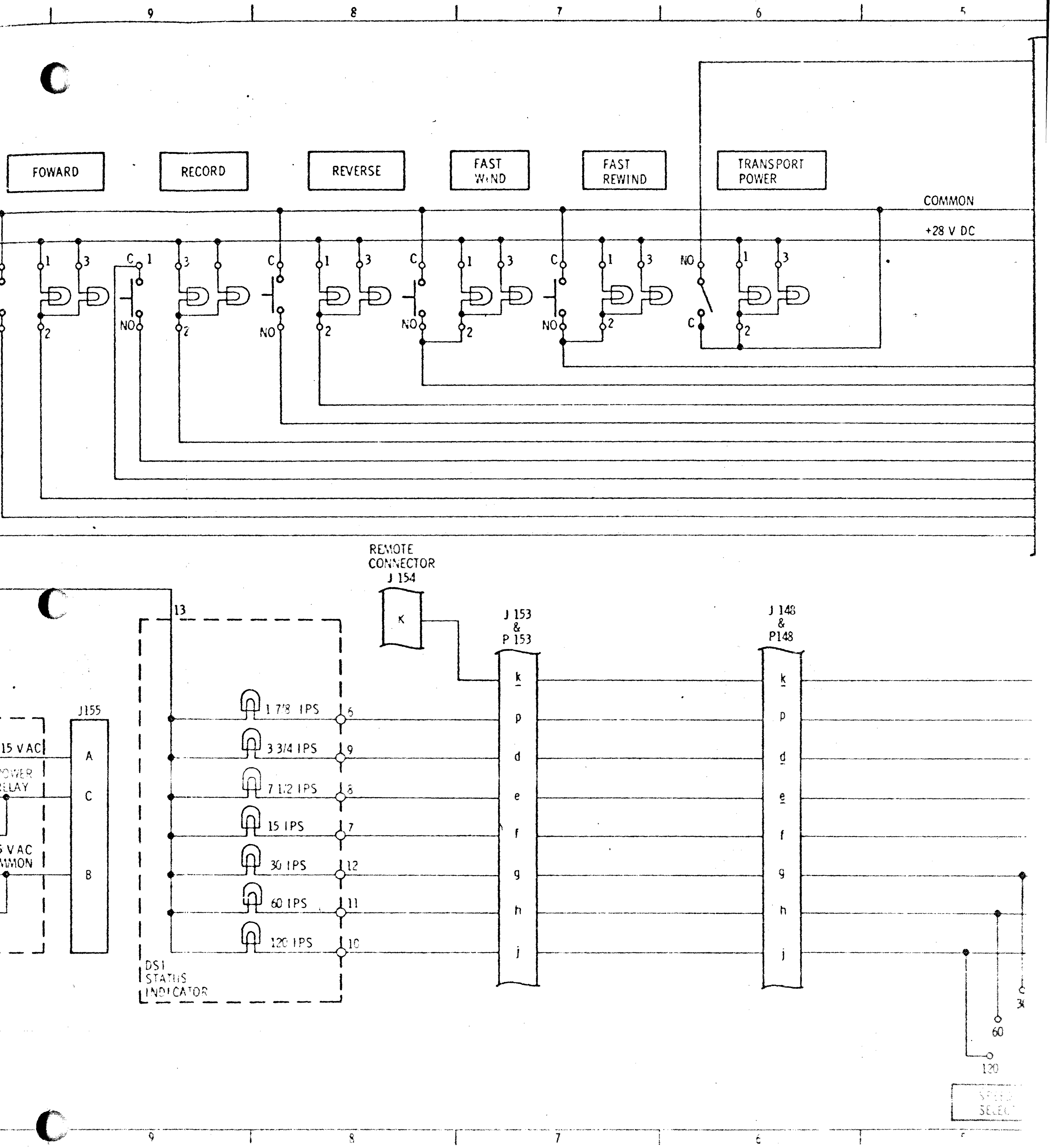


Figure 5-4. FM Reproduce Amplifier Signal Flow Diagram.



11
10
9
F
E
D
C
B
A
STOP
FOWARD
C
1
3
NO
2
MAIN POWER
J155
115 VAC
POWER
RELAY
115 VAC
COMMON
A
C
B



FOWARD
RECORD
REVERSE
FAST WIND
FAST REWIND
TRANSPORT POWER
COMMON
+28 V DC
REMOTE CONNECTOR J 154
J 153 & P 153
J 148 & P148
J155
DS1 STATUS INDICATOR
1 7/8 IPS
3 3/4 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
120 IPS
60
120

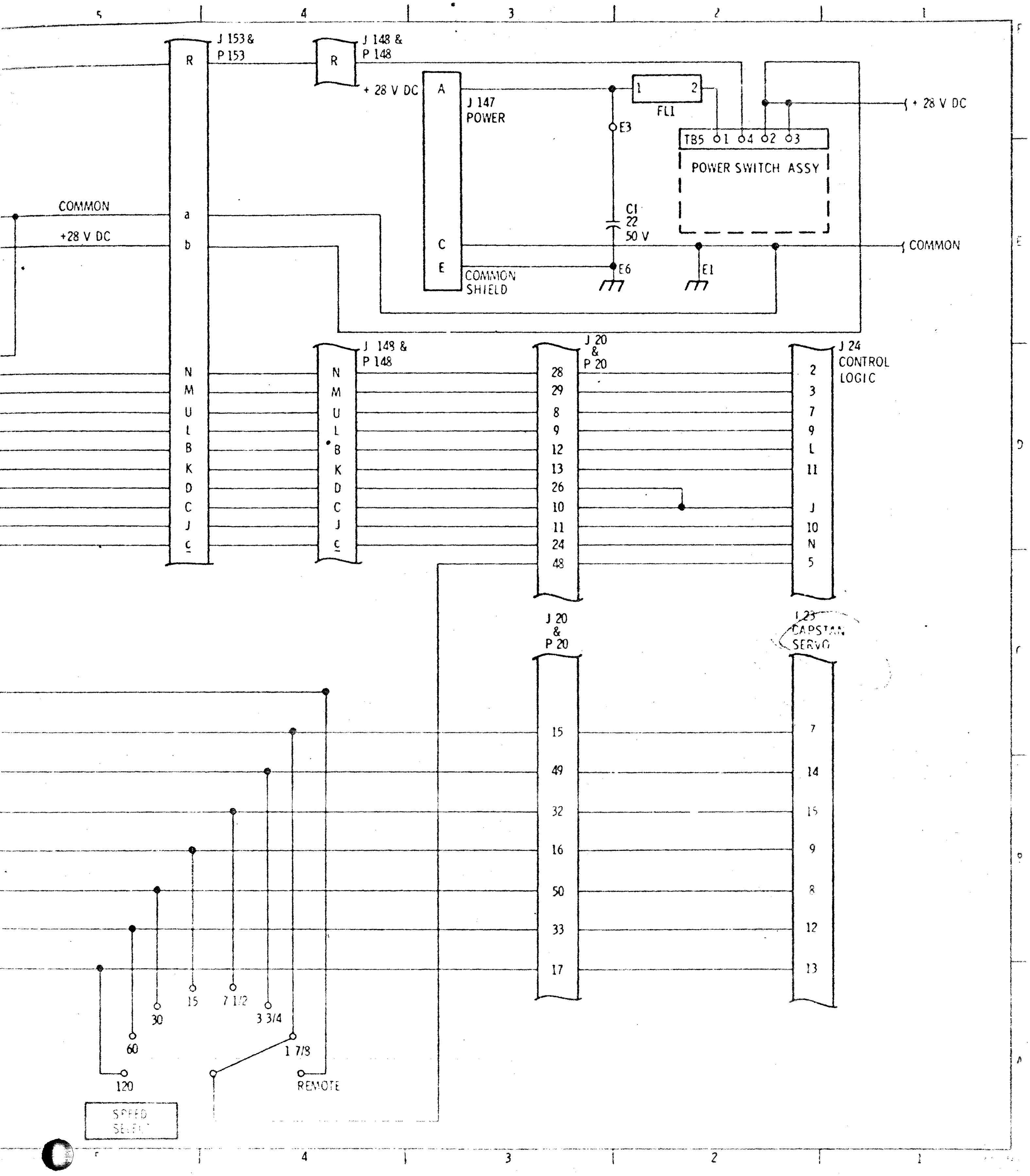
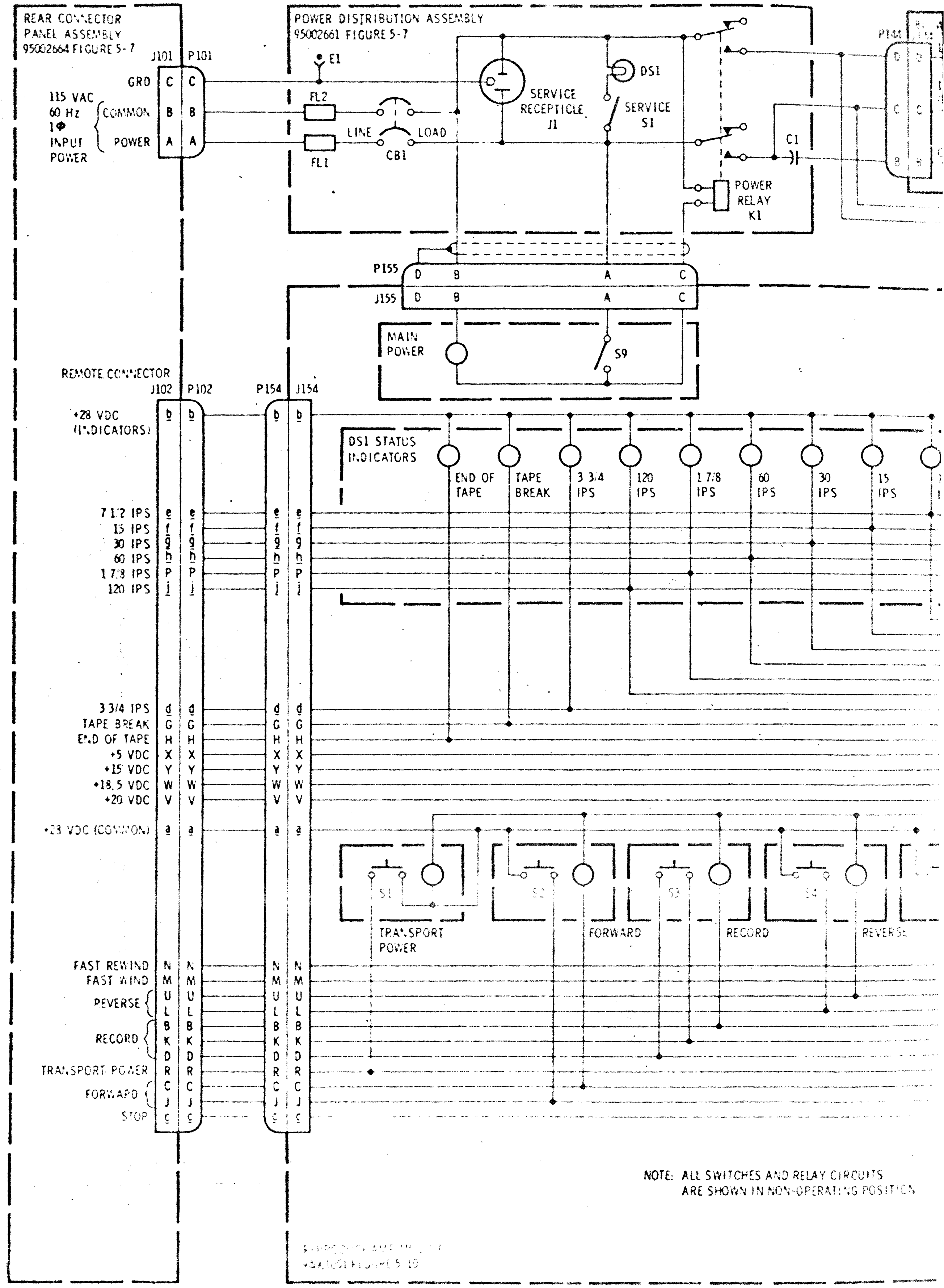
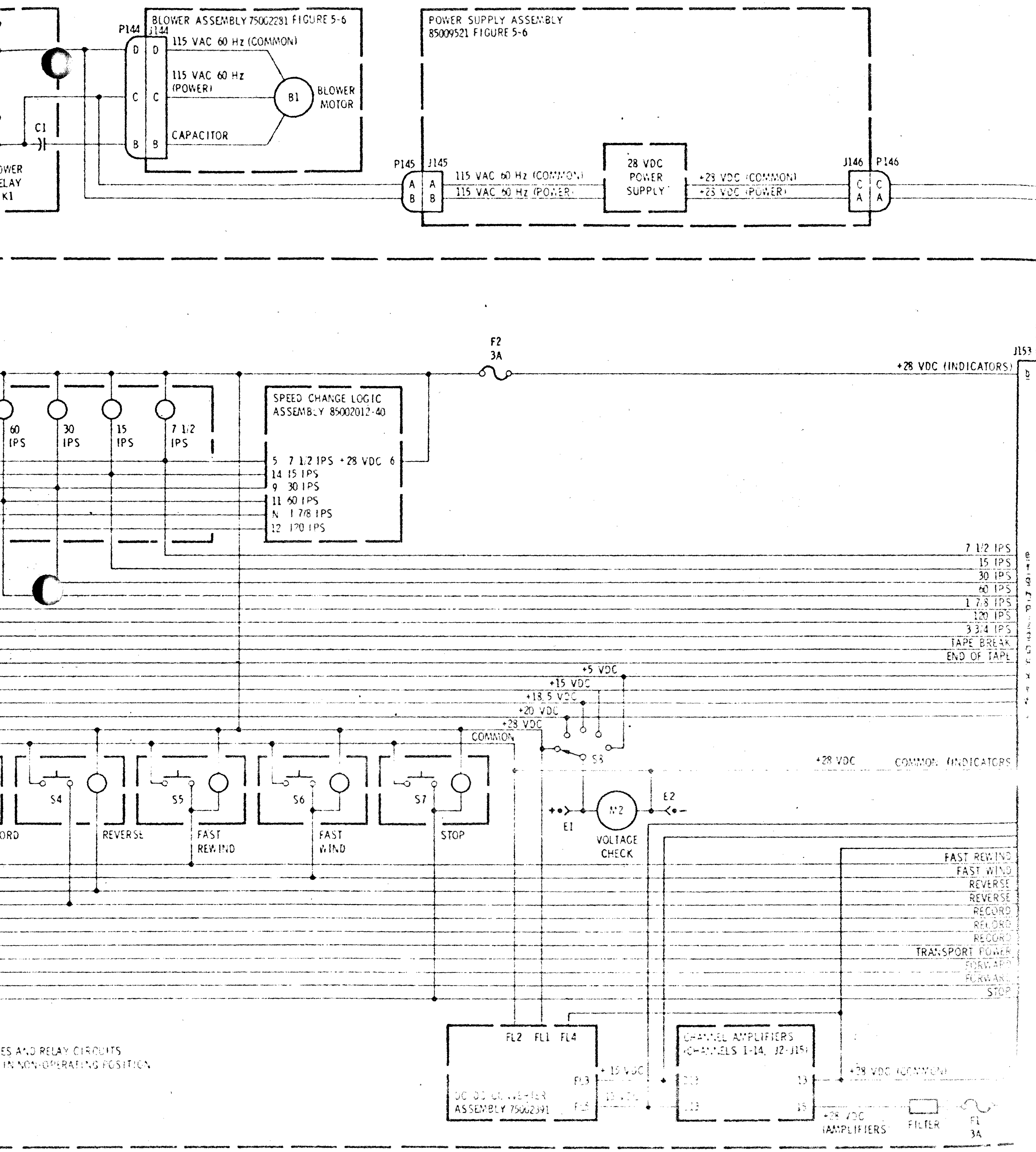
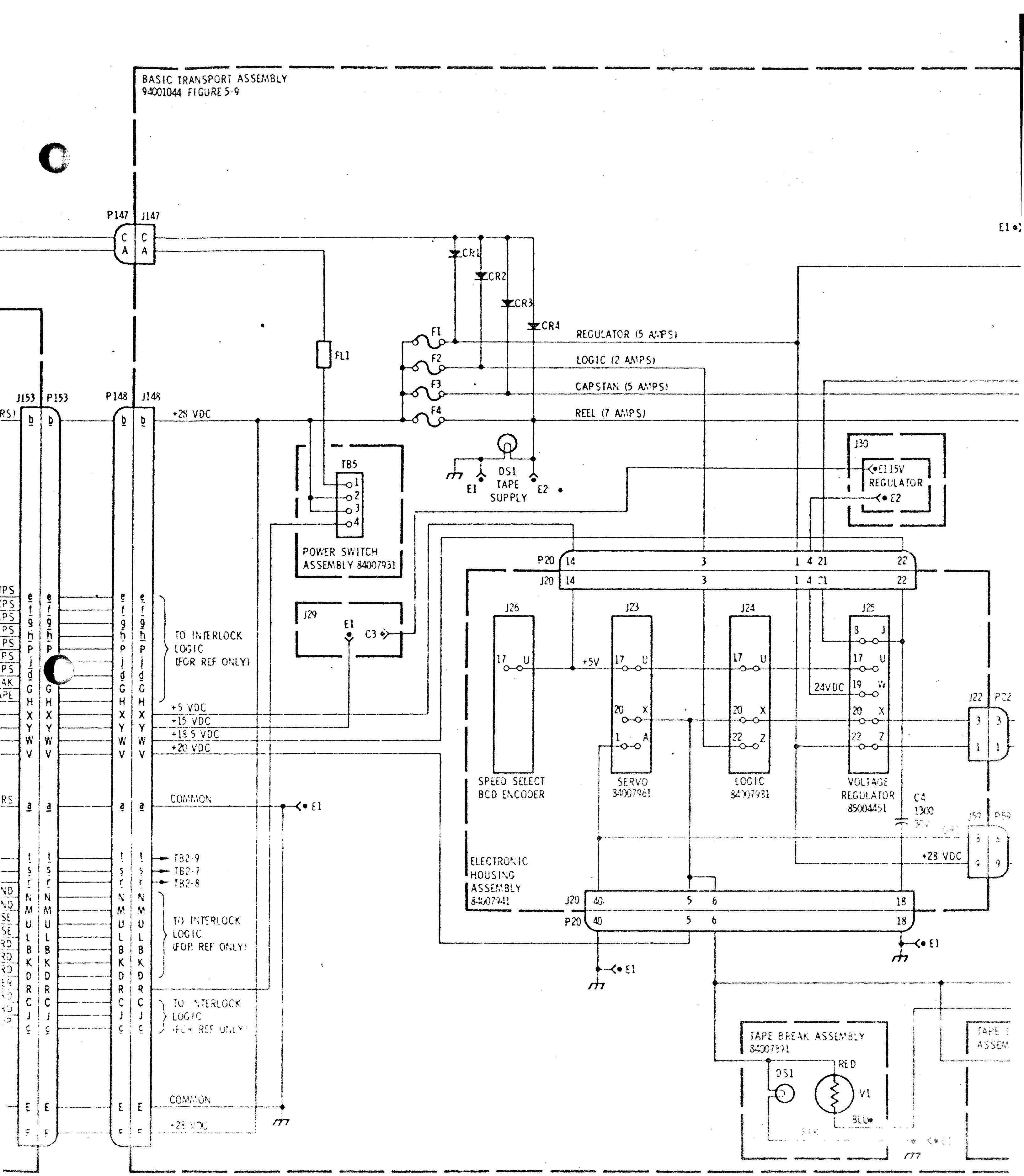


Figure 5-5. Control Diagram.


REAR CONNECTOR
PANEL ASSEMBLY
95002664 FIGURE 5-7
J101
P101
GRD
115 VAC
60 Hz
1Φ
INPUT
POWER
COMMON
POWER
POWER DISTRIBUTION ASSEMBLY
95002661 FIGURE 5-7
E1
FL2
FL1
LINE
LOAD
CB1
SERVICE
RECEPTICLE
J1
DS1
SERVICE
S1
C1
POWER
RELAY
K1
P144
P155
J155
MAIN
POWER
S9
REMOTE CONNECTOR
J102
P102
P154
J154
+28 VDC
(INDICATORS)
DS1 STATUS
INDICATORS
END OF
TAPE
TAPE
BREAK
3 3/4
IPS
120
IPS
1 7/8
IPS
60
IPS
30
IPS
15
IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
1 7/8 IPS
120 IPS
3 3/4 IPS
TAPE BREAK
END OF TAPE
+5 VDC
+15 VDC
+18.5 VDC
+20 VDC
+28 VDC (COMMON)
S1
S2
S3
S4
TRANSPORT
POWER
FORWARD
RECORD
REVERSE
FAST REWIND
FAST WIND
REVERSE
RECORD
TRANSPORT POWER
FORWARD
STOP
NOTE: ALL SWITCHES AND RELAY CIRCUITS
ARE SHOWN IN NON-OPERATING POSITION



BLOWER ASSEMBLY 75002281 FIGURE 5-6
P144 J144
115 VAC 60 Hz (COMMON)
115 VAC 60 Hz (POWER)
CAPACITOR
B1
BLOWER MOTOR
C1
OWER
ELAY
K1
POWER SUPPLY ASSEMBLY 85009521 FIGURE 5-6
P145 J145
115 VAC 60 Hz (COMMON)
115 VAC 60 Hz (POWER)
28 VDC POWER SUPPLY
+28 VDC (COMMON)
+28 VDC (POWER)
J146 P146
F2
3A
J153
+28 VDC (INDICATORS)
60 IPS
30 IPS
15 IPS
7 1/2 IPS
SPEED CHANGE LOGIC ASSEMBLY 85002012-40
5 7 1/2 IPS +28 VDC 6
14 15 IPS
9 30 IPS
11 60 IPS
N 1 7/8 IPS
12 120 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
1 7/8 IPS
120 IPS
3 3/4 IPS
TAPE BREAK
END OF TAPE
+5 VDC
+15 VDC
+18.5 VDC
+20 VDC
+28 VDC
COMMON
S8
+28 VDC
COMMON (INDICATORS)
S4
S5
S6
S7
ORD
REVERSE
FAST REWIND
FAST WIND
STOP
E1
M2
VOLTAGE CHECK
E2
FAST REWIND
FAST WIND
REVERSE
REVERSE
RECORD
RECORD
RECORD
TRANSPORT POWER
FORWARD
FORWARD
STOP
ES AND RELAY CIRCUITS
IN NON-OPERATING POSITION
FL2 FL1 FL4
FL3
FL5
DC-DC CONVERTER ASSEMBLY 75002391
+15 VDC
CHANNEL AMPLIFIERS (CHANNELS 1-14, J2-J15)
13
15
+28 VDC (COMMON)
+28 VDC (AMPLIFIERS)
FILTER
F1
3A



BASIC TRANSPORT ASSEMBLY
94001044 FIGURE 5-9
P147
J147
P153
J153
P148
J148
CR1
CR2
CR3
CR4
F1
F2
F3
F4
FL1
REGULATOR (5 AMPS)
LOGIC (2 AMPS)
CAPSTAN (5 AMPS)
REEL (7 AMPS)
+28 VDC
TB5
POWER SWITCH
ASSEMBLY 84007931
DS1
TAPE
SUPPLY
E1
E2
J29
C3
J30
E1 15V
REGULATOR
TO INTERLOCK
LOGIC
(FOR REF ONLY)
+5 VDC
+15 VDC
+18.5 VDC
+20 VDC
COMMON
TB2-9
TB2-7
TB2-8
P20
J20
J26
J23
J24
J25
+5V
24VDC
SPEED SELECT
BCD ENCODER
SERVO
84007961
LOGIC
84007931
VOLTAGE
REGULATOR
85004451
C4
1300
J22
P22
J59
P59
ELECTRONIC
HOUSING
ASSEMBLY
84007941
TAPE BREAK ASSEMBLY
84007891
DS1
RED
V1
BLU

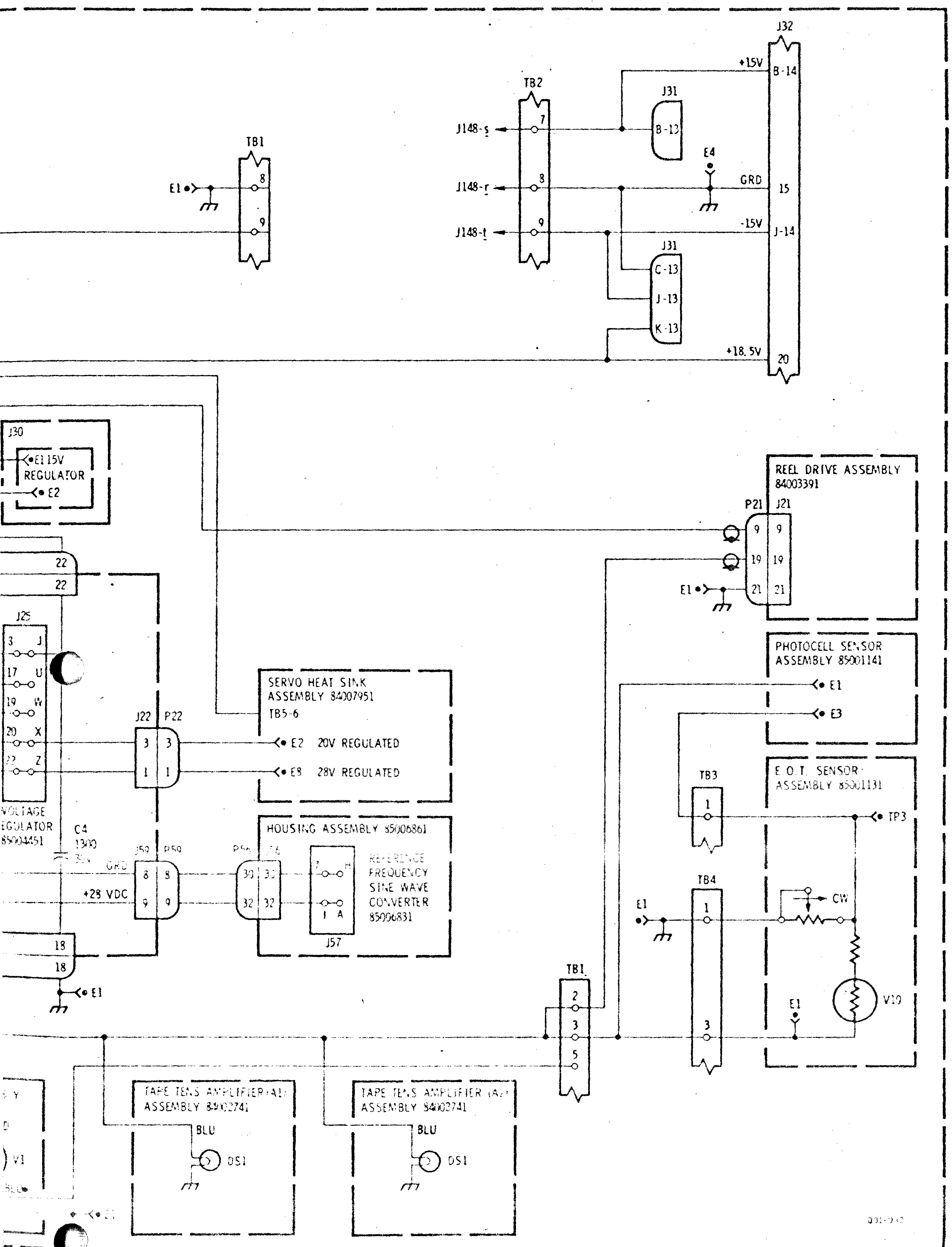
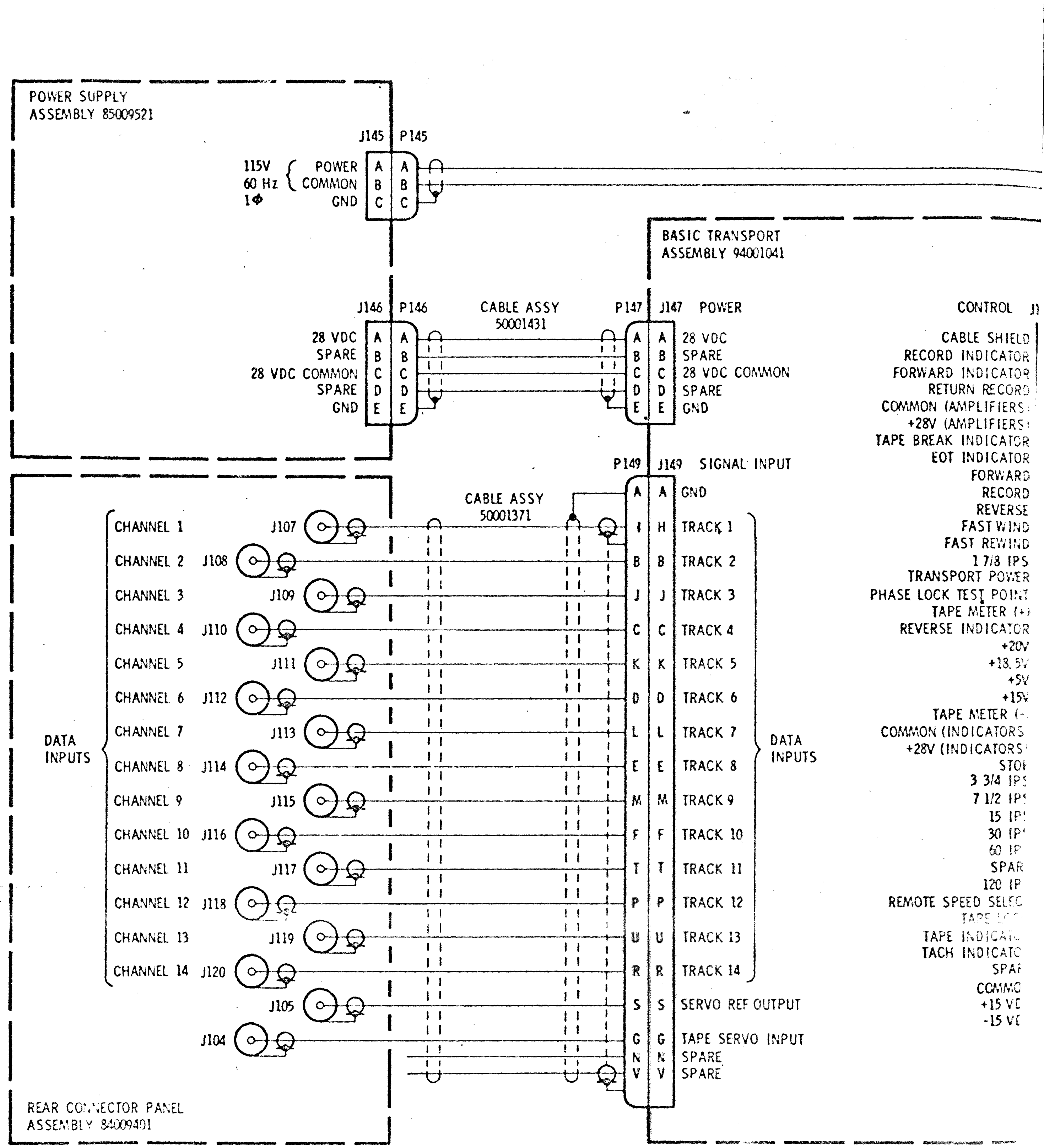
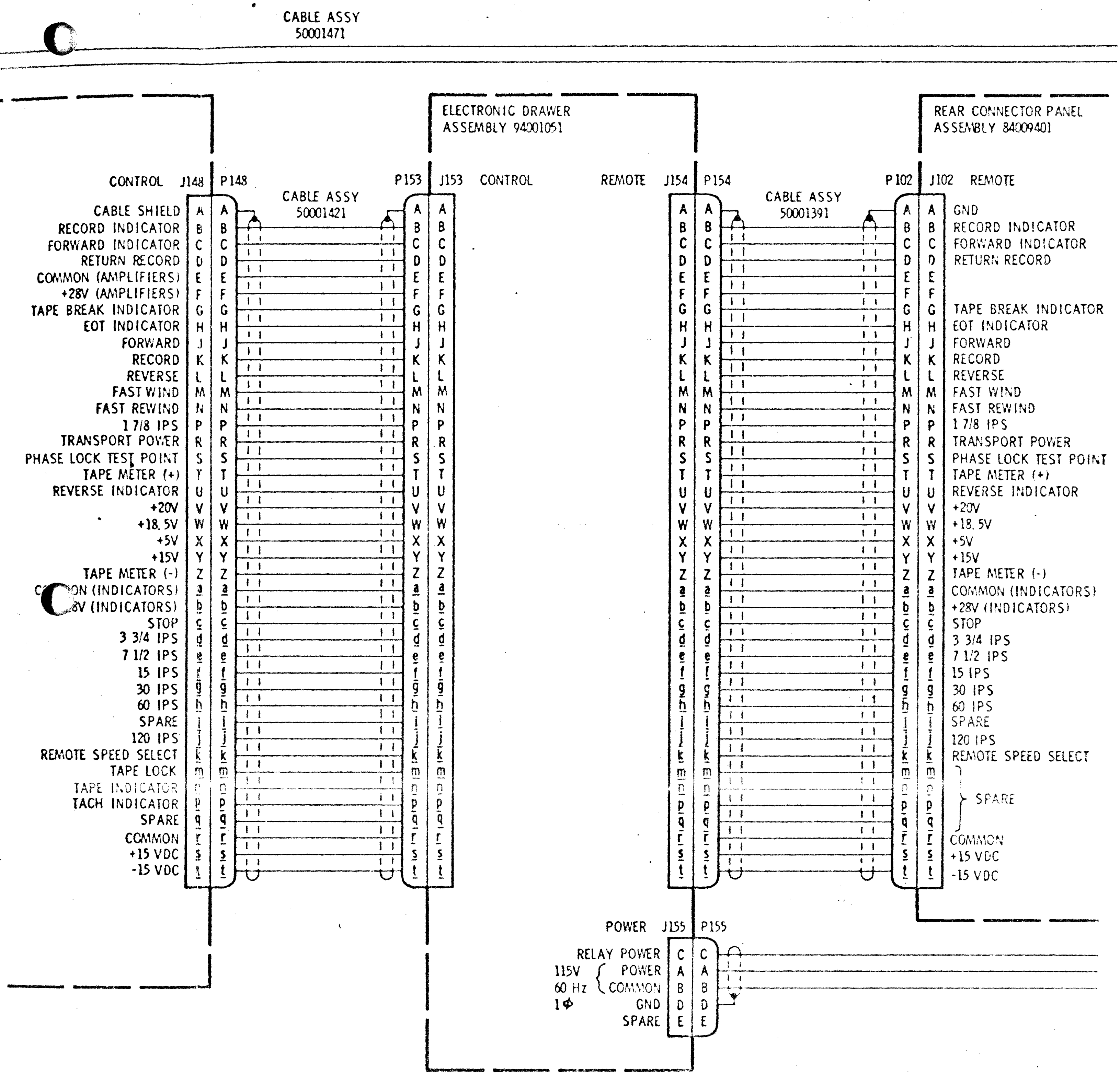
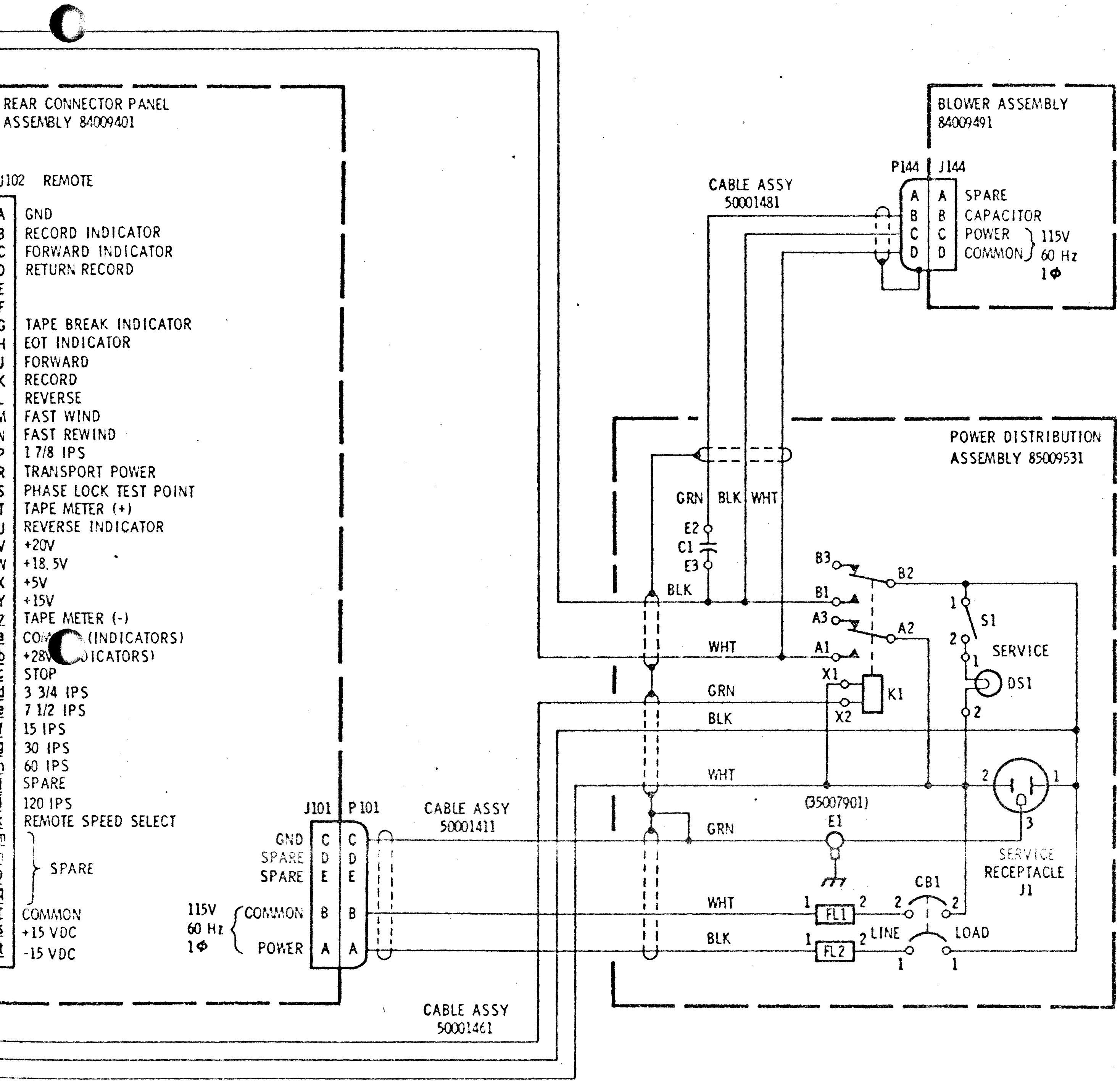


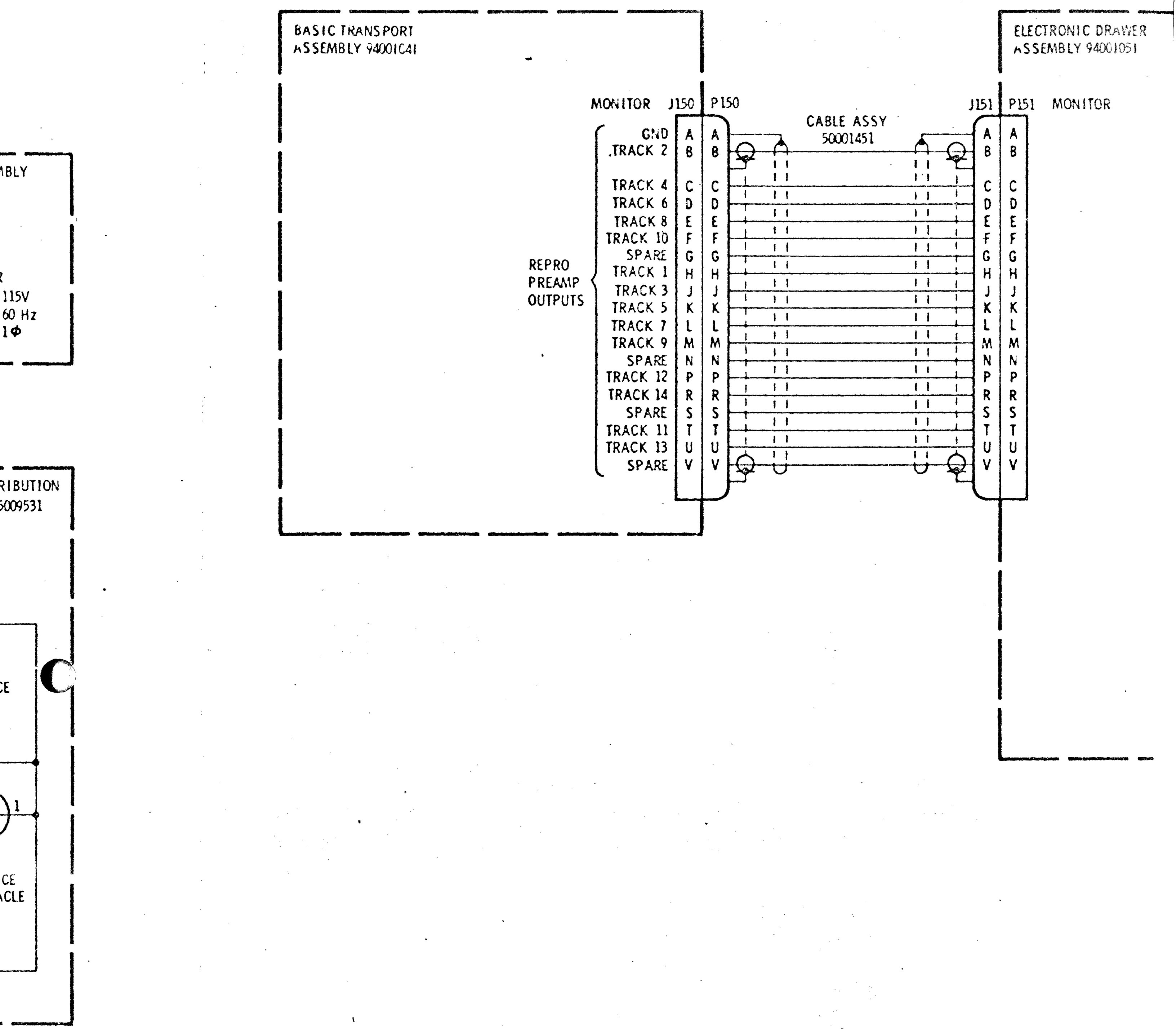
Figure 5-6. Power Distribution Diagram.


POWER SUPPLY
ASSEMBLY 85009521
J145
P145
115V
60 Hz
1Φ
POWER
COMMON
GND
BASIC TRANSPORT
ASSEMBLY 94001041
J146
P146
CABLE ASSY
50001431
P147
J147
POWER
28 VDC
SPARE
28 VDC COMMON
SPARE
GND
CONTROL
CABLE SHIELD
RECORD INDICATOR
FORWARD INDICATOR
RETURN RECORD
COMMON (AMPLIFIERS)
+28V (AMPLIFIERS)
TAPE BREAK INDICATOR
EOT INDICATOR
FORWARD
RECORD
REVERSE
FAST WIND
FAST REWIND
1 7/8 IPS
TRANSPORT POWER
PHASE LOCK TEST POINT
TAPE METER (+)
REVERSE INDICATOR
+20V
+18.5V
+5V
+15V
TAPE METER (-)
COMMON (INDICATORS)
+28V (INDICATORS)
STOP
3 3/4 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
SPARE
120 IPS
REMOTE SPEED SELEC
TAPE INDICATO
TACH INDICATO
SPAR
COMMO
+15 VD
-15 VD
P149
J149
SIGNAL INPUT
GND
CABLE ASSY
50001371
DATA
INPUTS
CHANNEL 1
CHANNEL 2
CHANNEL 3
CHANNEL 4
CHANNEL 5
CHANNEL 6
CHANNEL 7
CHANNEL 8
CHANNEL 9
CHANNEL 10
CHANNEL 11
CHANNEL 12
CHANNEL 13
CHANNEL 14
J107
J108
J109
J110
J111
J112
J113
J114
J115
J116
J117
J118
J119
J120
J105
J104
TRACK 1
TRACK 2
TRACK 3
TRACK 4
TRACK 5
TRACK 6
TRACK 7
TRACK 8
TRACK 9
TRACK 10
TRACK 11
TRACK 12
TRACK 13
TRACK 14
DATA
INPUTS
SERVO REF OUTPUT
TAPE SERVO INPUT
SPARE
SPARE
REAR CONNECTOR PANEL
ASSEMBLY 84009401



CABLE ASSY
50001471
ELECTRONIC DRAWER
ASSEMBLY 94001051
REAR CONNECTOR PANEL
ASSEMBLY 84009401
CONTROL J148
P148
CABLE ASSY
50001421
P153
J153 CONTROL
REMOTE J154
P154
CABLE ASSY
50001391
P102
J102 REMOTE
CABLE SHIELD
RECORD INDICATOR
FORWARD INDICATOR
RETURN RECORD
COMMON (AMPLIFIERS)
+28V (AMPLIFIERS)
TAPE BREAK INDICATOR
EOT INDICATOR
FORWARD
RECORD
REVERSE
FAST WIND
FAST REWIND
1 7/8 IPS
TRANSPORT POWER
PHASE LOCK TEST POINT
TAPE METER (+)
REVERSE INDICATOR
+20V
+18.5V
+5V
+15V
TAPE METER (-)
COMMON (INDICATORS)
+28V (INDICATORS)
STOP
3 3/4 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
SPARE
120 IPS
REMOTE SPEED SELECT
TAPE LOCK
TAPE INDICATOR
TACH INDICATOR
SPARE
COMMON
+15 VDC
-15 VDC
GND
RECORD INDICATOR
FORWARD INDICATOR
RETURN RECORD
TAPE BREAK INDICATOR
EOT INDICATOR
FORWARD
RECORD
REVERSE
FAST WIND
FAST REWIND
1 7/8 IPS
TRANSPORT POWER
PHASE LOCK TEST POINT
TAPE METER (+)
REVERSE INDICATOR
+20V
+18.5V
+5V
+15V
TAPE METER (-)
COMMON (INDICATORS)
+28V (INDICATORS)
STOP
3 3/4 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
SPARE
120 IPS
REMOTE SPEED SELECT
SPARE
COMMON
+15 VDC
-15 VDC
POWER J155
P155
RELAY POWER
115V
60 Hz
1Φ
POWER
COMMON
GND
SPARE


REAR CONNECTOR PANEL
ASSEMBLY 84009401
J102 REMOTE
GND
RECORD INDICATOR
FORWARD INDICATOR
RETURN RECORD
TAPE BREAK INDICATOR
EOT INDICATOR
FORWARD
RECORD
REVERSE
FAST WIND
FAST REWIND
1 7/8 IPS
TRANSPORT POWER
PHASE LOCK TEST POINT
TAPE METER (+)
REVERSE INDICATOR
+20V
+18.5V
+5V
+15V
TAPE METER (-)
(INDICATORS)
STOP
3 3/4 IPS
7 1/2 IPS
15 IPS
30 IPS
60 IPS
SPARE
120 IPS
REMOTE SPEED SELECT
SPARE
COMMON
+15 VDC
-15 VDC
J101
P101
GND
SPARE
SPARE
115V
60 Hz
1Φ
COMMON
POWER
CABLE ASSY
50001411
CABLE ASSY
50001461
CABLE ASSY
50001481
BLOWER ASSEMBLY
84009491
P144
J144
SPARE
CAPACITOR
POWER
COMMON
115V
60 Hz
1Φ
POWER DISTRIBUTION
ASSEMBLY 85009531
GRN
BLK
WHT
E2
C1
E3
B3
B2
B1
A3
A2
A1
X1
X2
K1
S1
SERVICE
DS1
(35007901)
E1
CB1
FL1
FL2
LINE
LOAD
SERVICE
RECEPTACLE
J1



BASIC TRANSPORT ASSEMBLY 94001C41
ELECTRONIC DRAWER ASSEMBLY 94001051
MONITOR J150 P150
J151 P151 MONITOR
CABLE ASSY 50001451
GND
TRACK 2
TRACK 4
TRACK 6
TRACK 8
TRACK 10
SPARE
TRACK 1
TRACK 3
TRACK 5
TRACK 7
TRACK 9
SPARE
TRACK 12
TRACK 14
SPARE
TRACK 11
TRACK 13
SPARE
REPRO PREAMP OUTPUTS
A B C D E F G H J K L M N P R S T U V
MBLY
R
115V
60 Hz
1Φ
RIBUTION
5009531
CE
1
CE
ACLE

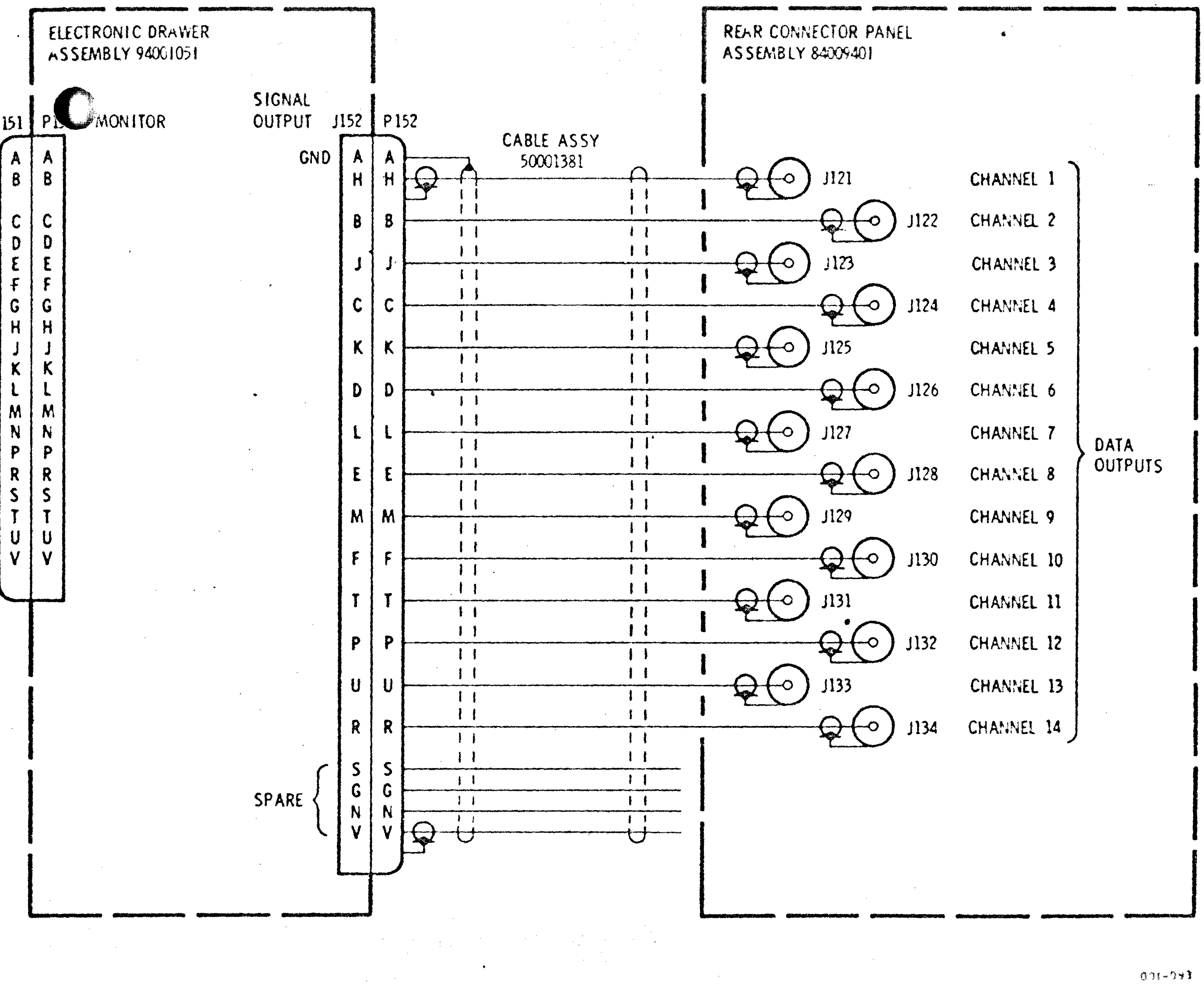


Figure 5-7. Intraunit Interconnection Diagram.

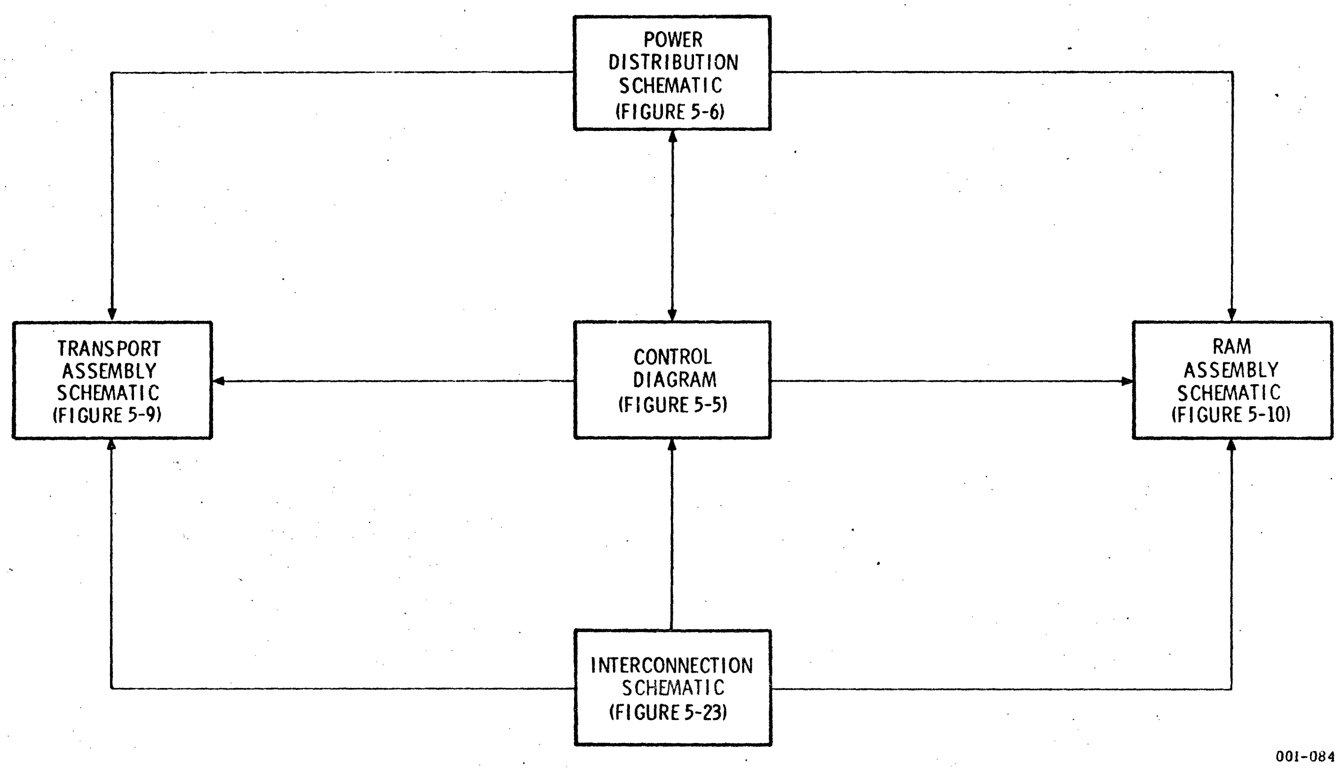
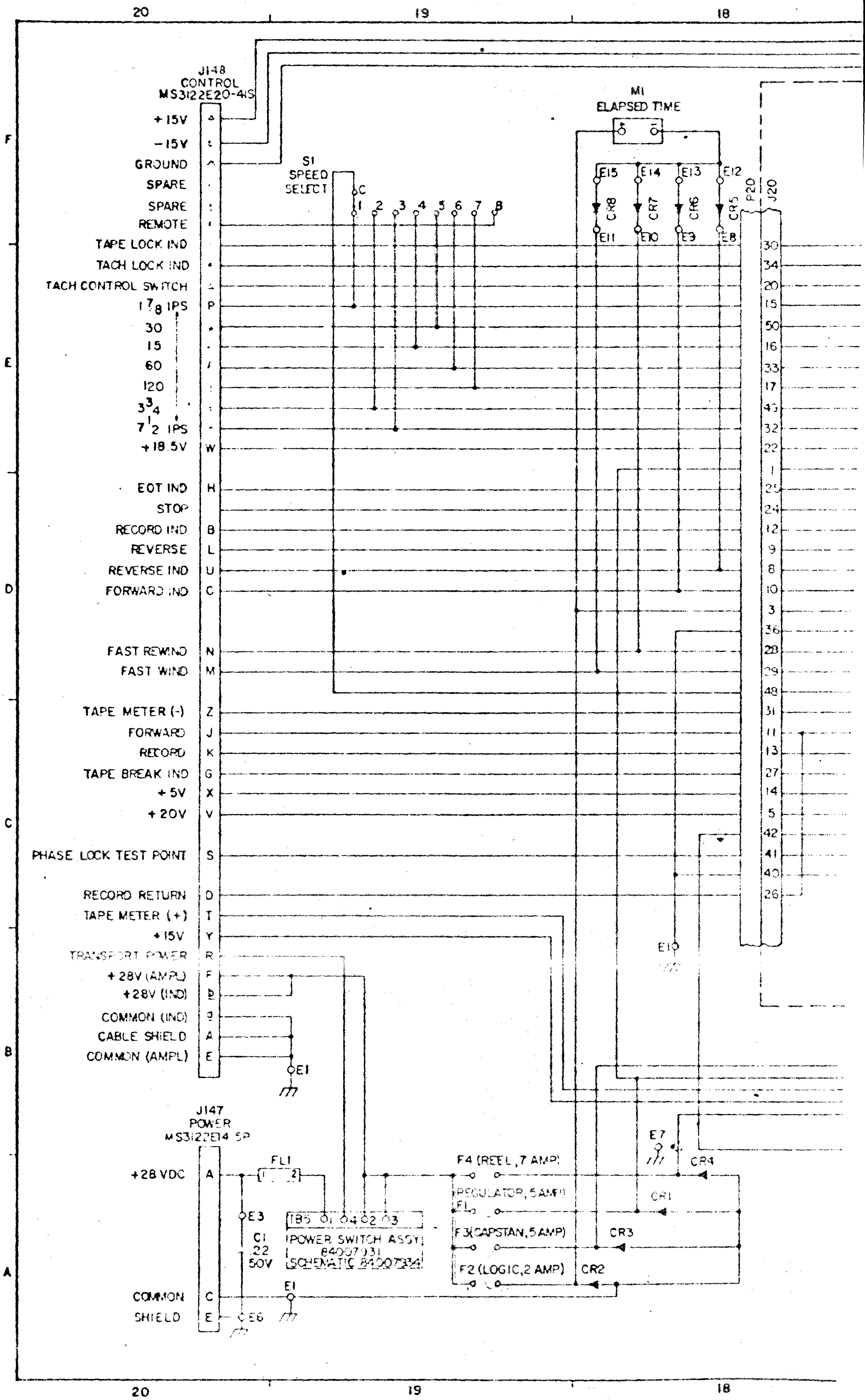
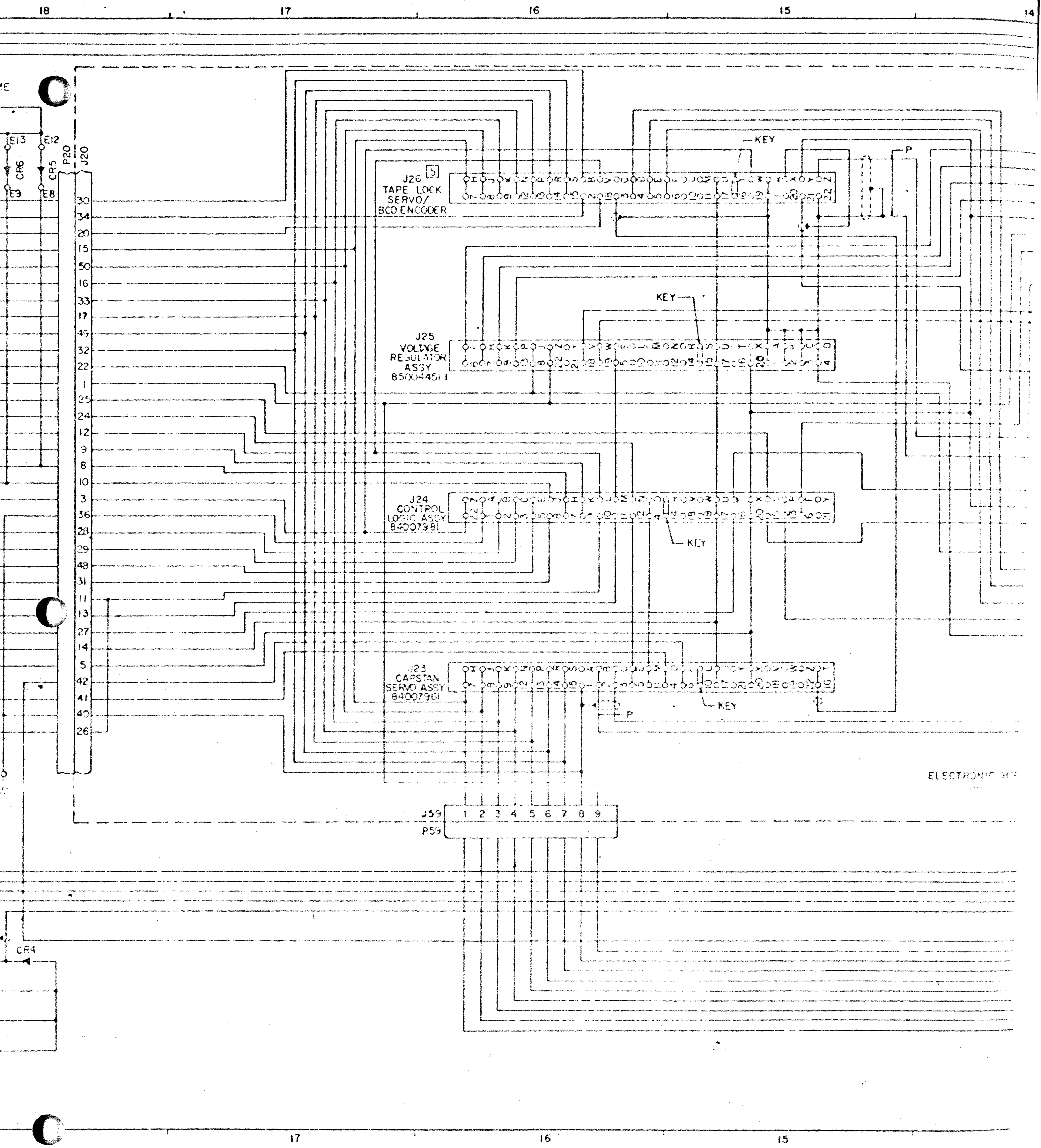
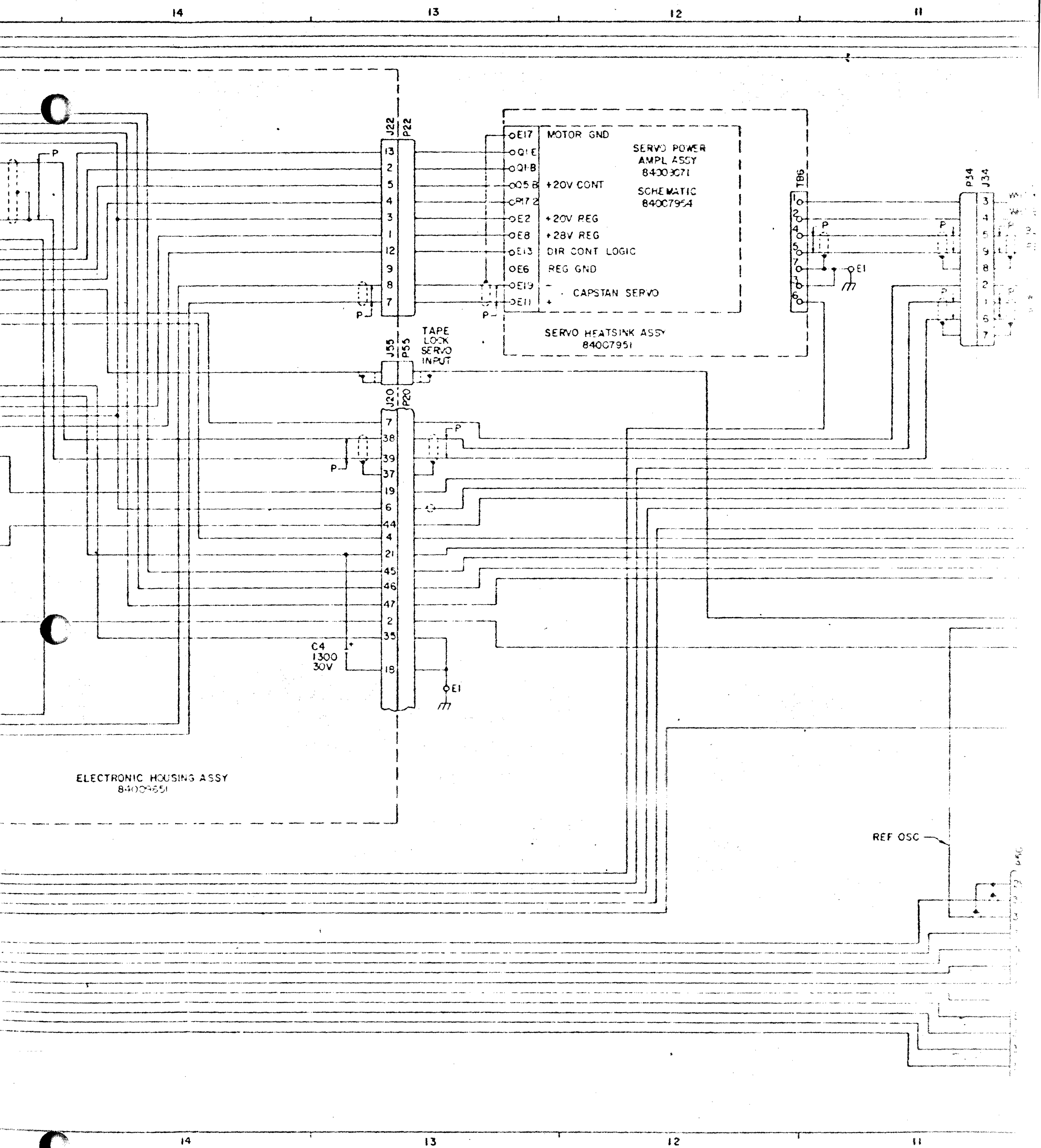
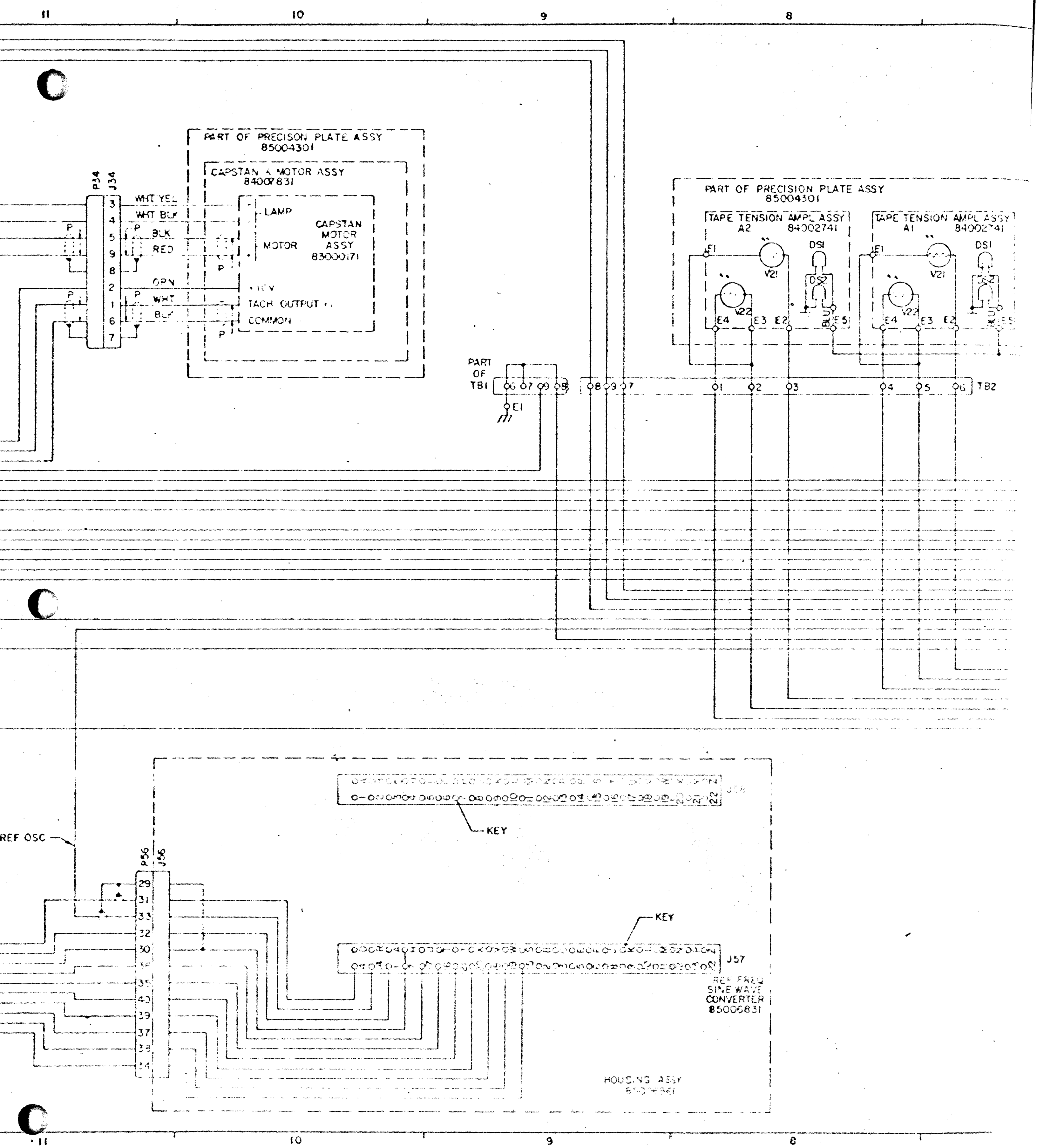


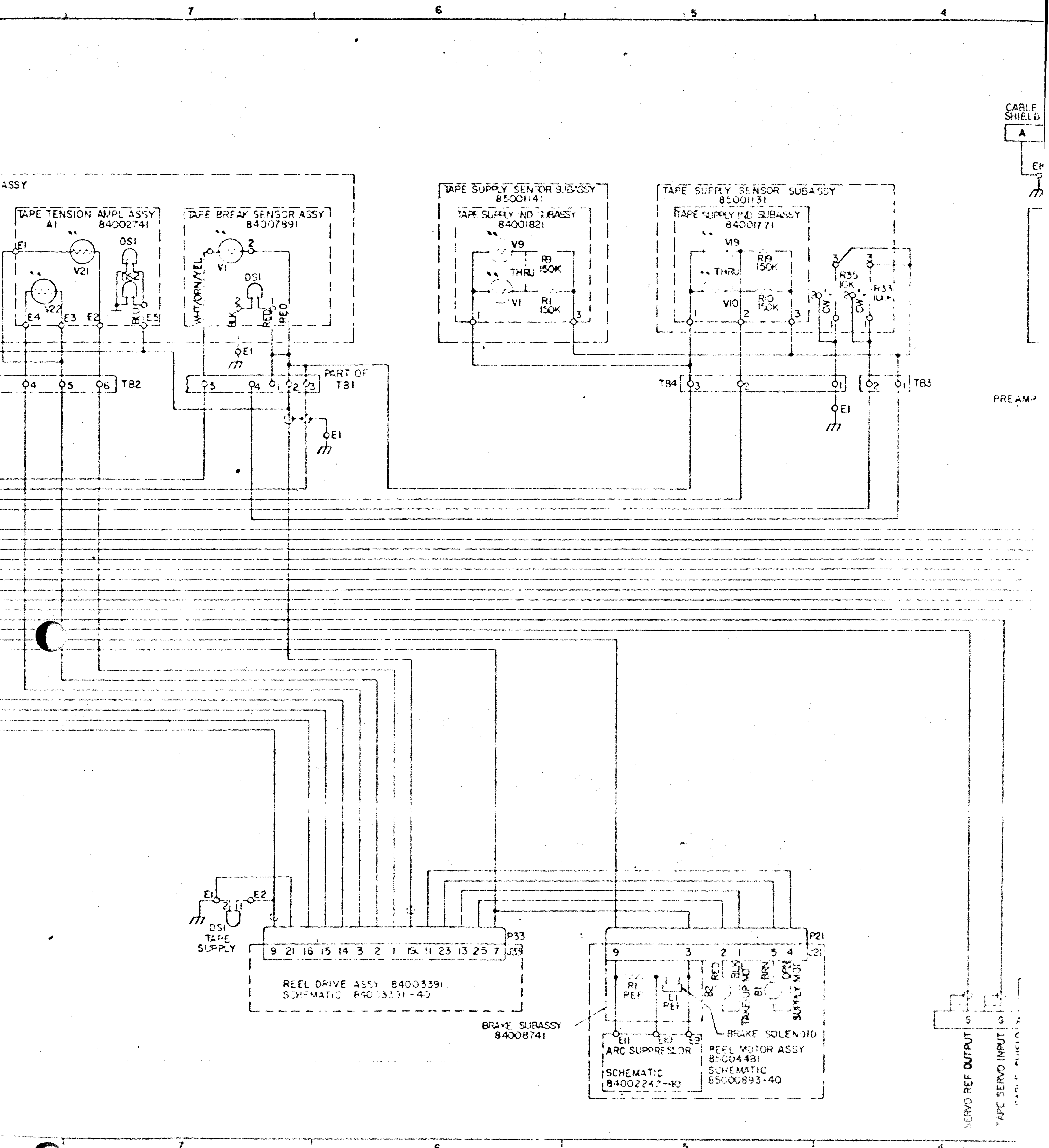
Figure 5-8. Magnetic Tape Recorder/Reproducer Unit Schematic Diagram.


20
19
18
J148
CONTROL
MS3122E20-41S
+15V
−15V
GROUND
SPARE
SPARE
REMOTE
TAPE LOCK IND
TACH LOCK IND
TACH CONTROL SWITCH
1 7/8 IPS
30
15
60
120
3 3/4
7 1/2 IPS
+18.5V
EOT IND
STOP
RECORD IND
REVERSE
REVERSE IND
FORWARD IND
FAST REWIND
FAST WIND
TAPE METER (-)
FORWARD
RECORD
TAPE BREAK IND
+5V
+20V
PHASE LOCK TEST POINT
RECORD RETURN
TAPE METER (+)
+15V
TRANSPORT POWER
+28V (AMPL)
+28V (IND)
COMMON (IND)
CABLE SHIELD
COMMON (AMPL)
S1
SPEED
SELECT
M1
ELAPSED TIME
CR8
CR7
CR6
CR5
P20
J20
J147
POWER
MS3122E14-5P
+28 VDC
COMMON
SHIELD
FL1
C1
.22
50V
TB5
POWER SWITCH ASSY
84007931
SCHEMATIC 84007934
F4 (REEL, 7 AMP)
REGULATOR, 5 AMP
F3 (CAPSTAN, 5 AMP)
F2 (LOGIC, 2 AMP)
CR1
CR2
CR3
CR4
E1
E3
E6
E7


18
17
16
15
14
E13
E12
CR6
CR5
P20
J20
E9
E8
J26
TAPE LOCK
SERVO/
BCD ENCODER
KEY
P
J25
VOLTAGE
REGULATOR
ASSY
85004451-1
J24
CONTROL
LOGIC ASSY
84007981
J23
CAPSTAN
SERVO ASSY
84007961
J59
P59
1 2 3 4 5 6 7 8 9
CR4
17
16
15


14
13
12
11
J22
P22
MOTOR GND
SERVO POWER AMPL ASSY 84003071
+20V CONT
SCHEMATIC 84007954
+20V REG
+28V REG
DIR CONT LOGIC
REG GND
CAPSTAN SERVO
SERVO HEATSINK ASSY 84007951
TB6
P34
J34
E1
J55
P55
TAPE LOCK SERVO INPUT
J20
P20
C4 1300 30V
ELECTRONIC HOUSING ASSY
REF OSC


11
10
9
8
PART OF PRECISON PLATE ASSY
85004301
CAPSTAN & MOTOR ASSY
84007831
P34
J34
WHT YEL
WHT BLK
BLK
RED
ORN
WHT
BLK
LAMP
MOTOR
CAPSTAN
MOTOR
ASSY
83000171
TACH OUTPUT
COMMON
PART OF PRECISION PLATE ASSY
85004301
TAPE TENSION AMPL ASSY
A2
84002741
TAPE TENSION AMPL ASSY
A1
84002741
DS1
DS2
V21
V22
E1
E2
E3
E4
E5
BLU
PART
OF
TB1
TB2
KEY
REF OSC
P56
J56
J57
REF FREQ
SINE WAVE
CONVERTER
85006831
HOUSING ASSY



7
6
5
4
ASSY
TAPE TENSION AMPL ASSY
A1 84002741
V21
V22
DS1
E1
E2
E3
E4
E5
BLU
TB2
TAPE BREAK SENSOR ASSY
84007891
V1
DS1
WHT/ORN/YEL
BLK
RED
PART OF
TB1
TAPE SUPPLY SENSOR SUBASSY
85001141
TAPE SUPPLY IND SUBASSY
84001821
V9
R9
150K
THRU
R1
150K
TAPE SUPPLY SENSOR SUBASSY
85001131
TAPE SUPPLY IND SUBASSY
84001771
V19
R19
150K
THRU
V10
R10
150K
R35
10K
R33
CW
TB4
TB3
CABLE
SHIELD
A
PREAMP
E1
E2
DS1
TAPE
SUPPLY
P33
J33
9 21 16 15 14 3 2 1 19 11 23 13 25 7
REEL DRIVE ASSY 84003391
SCHEMATIC 84003391-40
BRAKE SUBASSY
84008741
P21
J21
9 3 2 1 5 4
R1
REF
L1
REF
RED
BLK
BRN
ORN
B2
B1
TAKE-UP MOT
SUPPLY MOT
BRAKE SOLENOID
E11
E10
E9
ARC SUPPRESSOR
SCHEMATIC
84002242-40
REEL MOTOR ASSY
85004481
SCHEMATIC
85000893-40
S
G
SERVO REF OUTPUT
TAPE SERVO INPUT

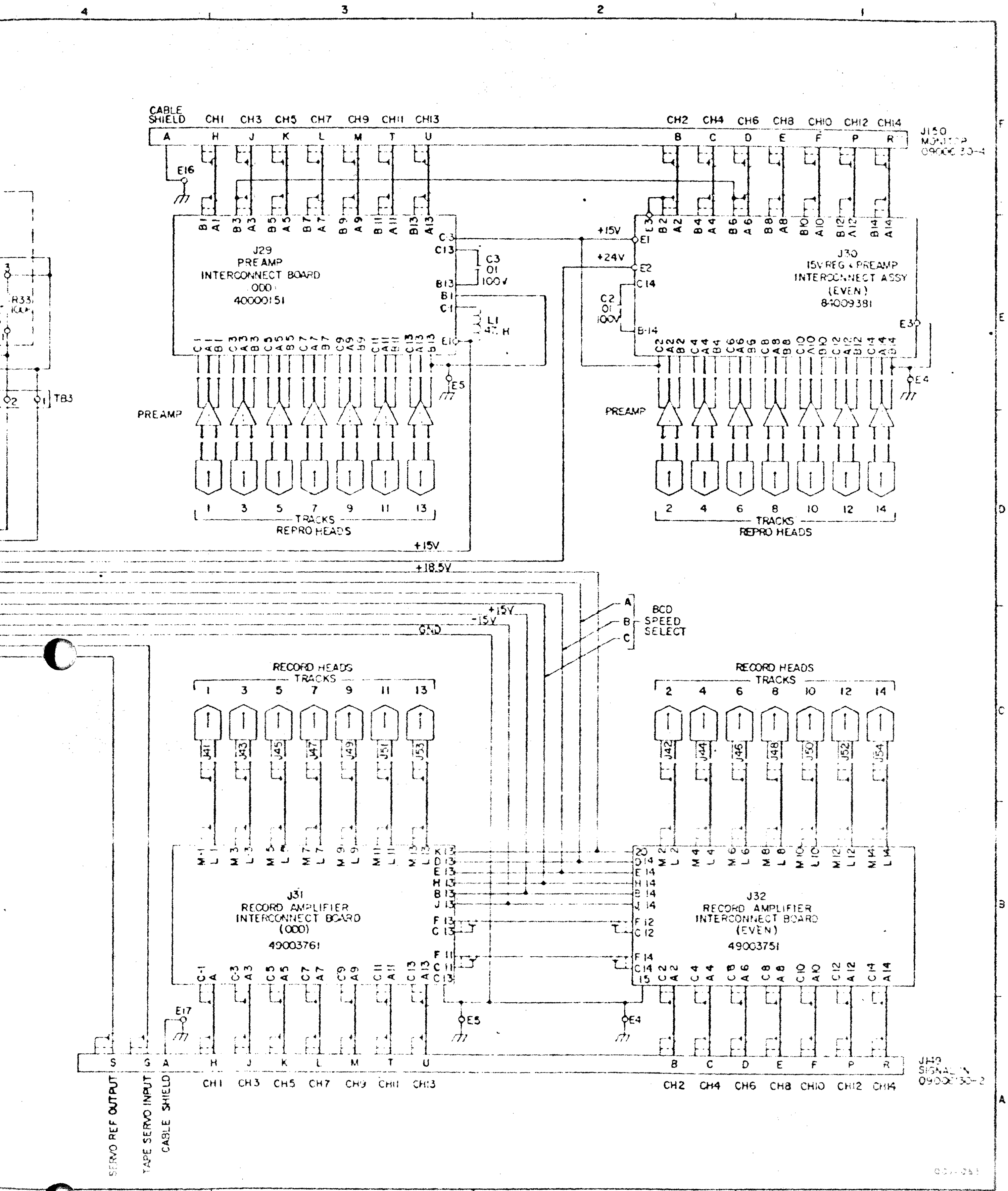


Figure 5-9. Transport Assembly Schematic Diagram.

PECIFIED

ING NO. 94001051

94001055

N MICROFARADS, 40V, +75% -10%

EPRODUCE BOARD DETERMINED BY SALES ORDER

AMPLIFIER: ASSEMBLY 85006591
SCHEMATIC 85006594

LIFIER: ASSEMBLY 85006401
SCHEMATIC 85006404

TS LOCATION INDEX

REF DES	ZONE	REF DES	ZONE
J1	6F	M1	3E
J2	8F	M2	4C
J3	8F		
J4	8F	S1	5B
J5	8F	S2	7B
J6	8F	S3	6B
J7	[illegible]	S4	5B
J8	8F	S5	3B
J9	8F	S6	4B
J10	8F	S7	7B
J11	8F	S8	4D
J12	8F	TP1	4D
J13	8F	TP2	4C
J14	8F		
J15	9F		
J151	11F		
J152	11C		
J153	2F		
J154	1E		
L1	4D		

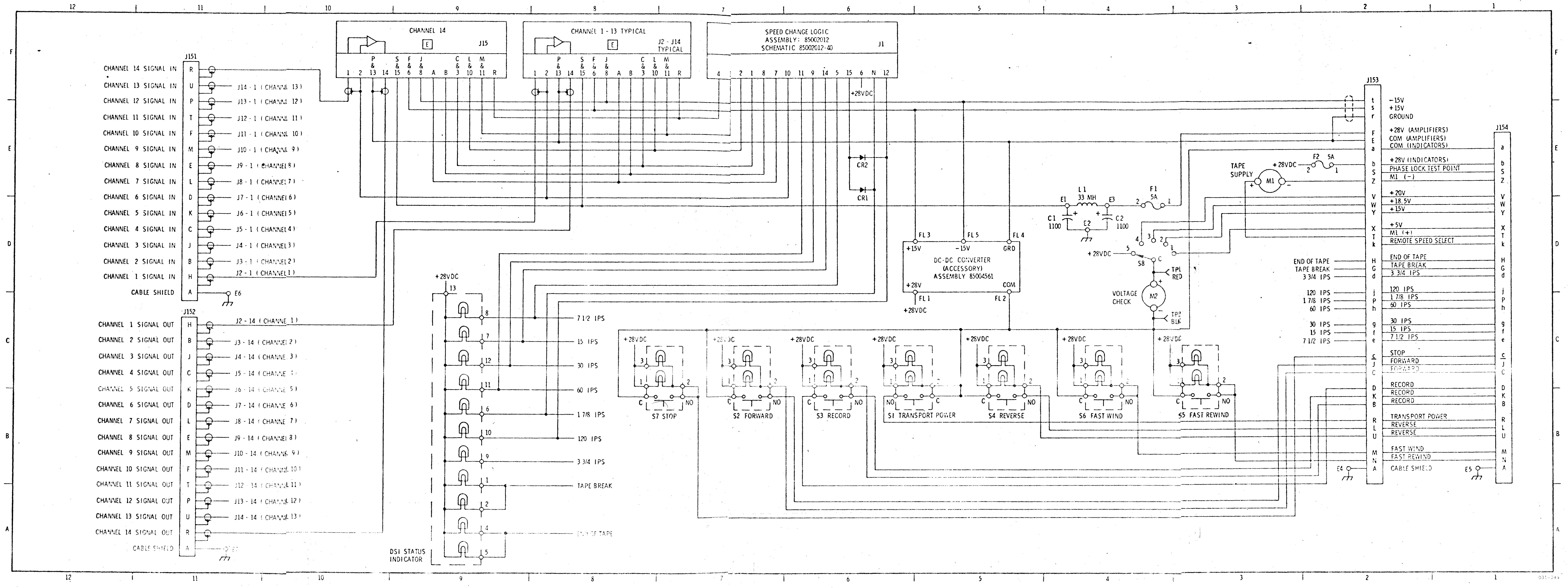


Figure 5-10. Reproduce Amplifier Module (RAM) Schematic Diagram.

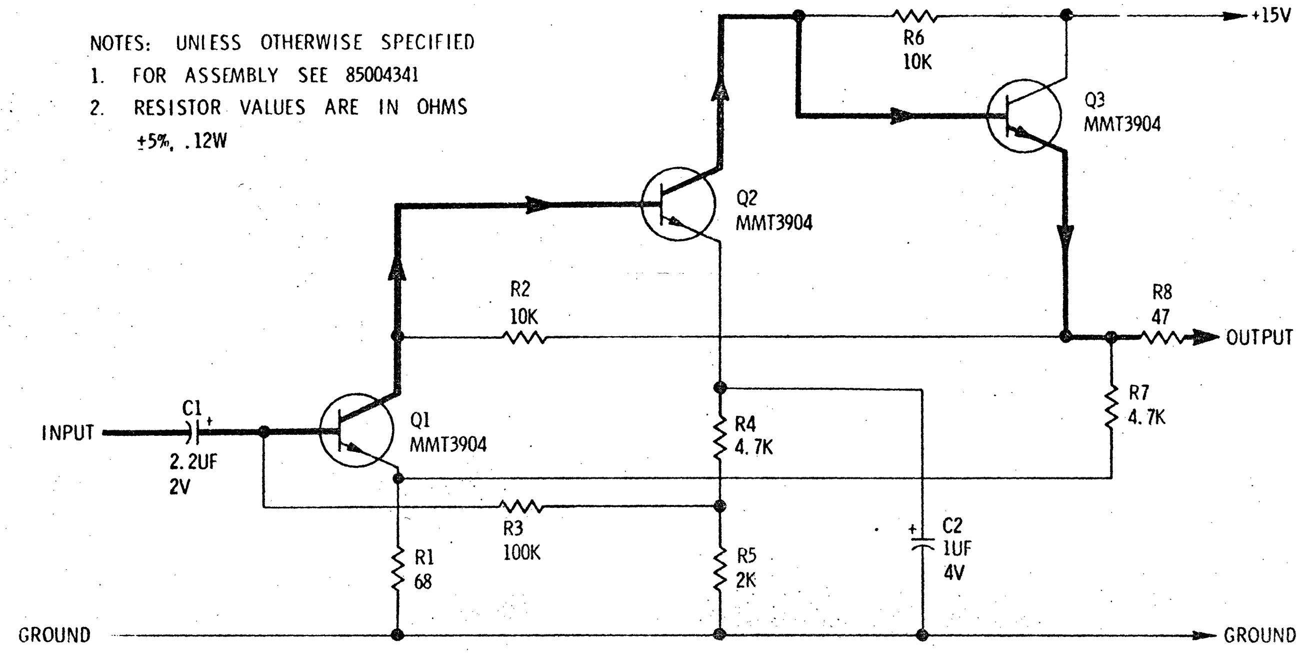
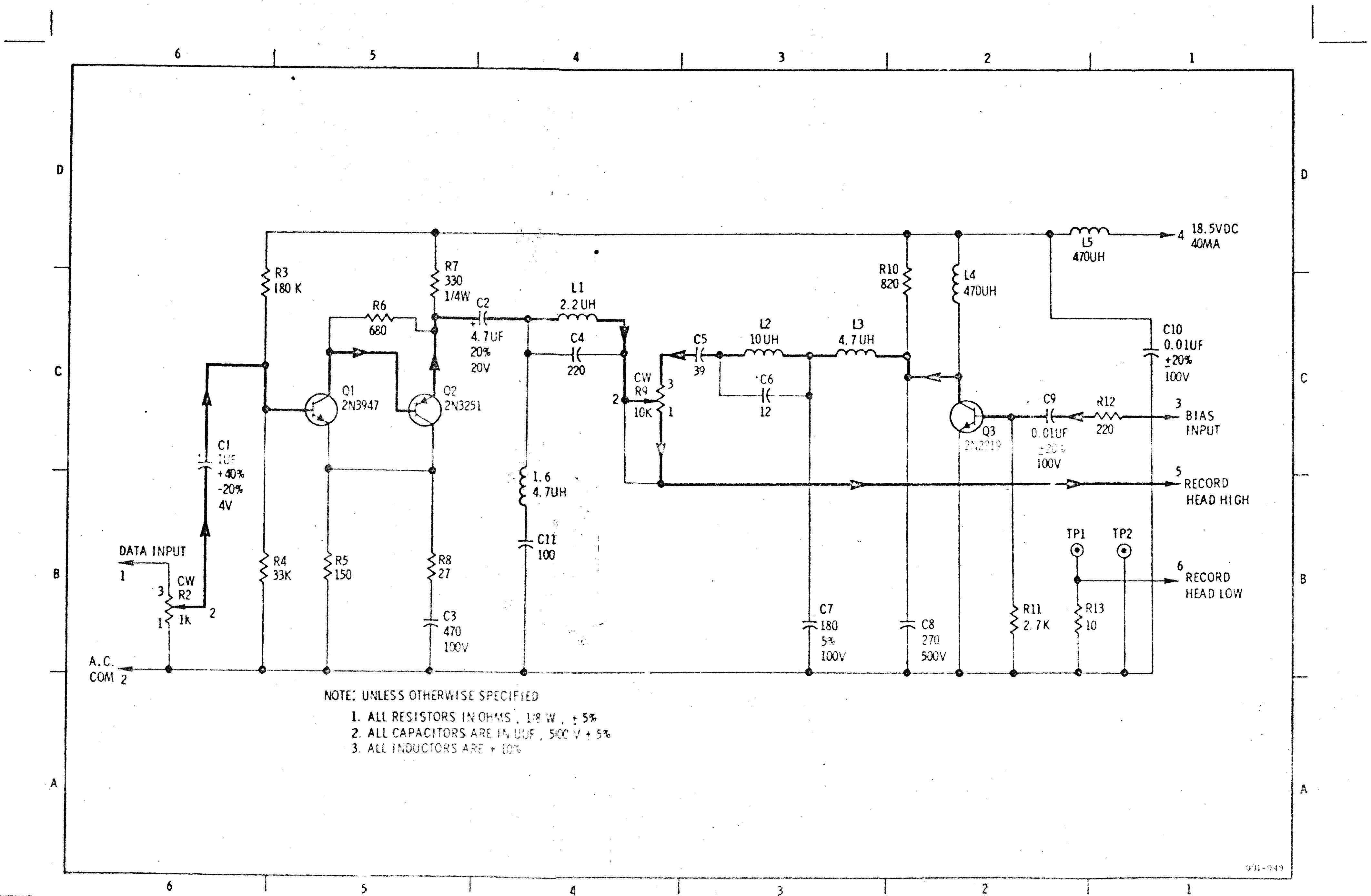


Figure 5-11. Preamplifier Schematic Diagram.



NOTE: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS IN OHMS, 1/8 W, ± 5%
2. ALL CAPACITORS ARE IN UUF, 500 V ± 5%
3. ALL INDUCTORS ARE ± 10%

NOTES: UNLESS OTHERWISE SPECIFIED

A. RESISTOR VALUES ARE IN OHMS, 1/8W, ±5%

B. CAPACITOR VALUES ARE IN MICROFARADS, 100V, ±10%

C. ALL DIODES ARE 1N914

D. ALL TRANSISTORS ARE 2N3227

E. U1 AND U3 ARE DM7533D

PARTS LOCATION INDEX

REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
AR1	7D	L1	3F	R12	6D	TP1	1C
C1	7E	L2	4A	R13	6B		
C2	7D			R14	6C	U1	5E
C3	7E	Q1	7B	R15	6D	U2	4D
C4	8C	Q2	6B	R16	5D	U3	3E
C5	7C	Q3	6C	R17	6B		
C6	6B	Q4	6C	R18	5C		
C7	6C	Q5	5B	R19	6A		
C8	5C	Q6	5C	R20	4C		
C9	2D	Q7	2D	R21	4A		
C10	1D	Q8	2D	R22	5D		
C11	4C	Q9	2D	R23	5D		
		R1	8E	R24	2F		
CR1	6C	R2	8E	R25	2E		
CR2	6B	R3	8E	R26	3D		
CR3	6B	R4	7E	R27	3C		
CR4	6B	R6	7C	R28	2E		
CR5	5B	R7	7D	R29	2D		
CR6	5C	R8	7E	R30	2C		
CR7	5D	R9	7D	R31	6A		
CR8	5B	R10	7A	R32	7B		
CR9	6A	R11	7C	R33	4B		

INLESS OTHERWISE SPECIFIED

.TOR VALUES ARE IN OHMS, 1/8W, ±5%

CITOR VALUES ARE IN MICROFARADS, 100V, ±10%

DIODES ARE 1N914

TRANSISTORS ARE 2N3227

ND U3 ARE DM7533D

PARTS LOCATION INDEX

ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
7D	L1	3F	R12	6D	TP1	1C
7E	L2	4A	R13	6B		
7D			R14	6C	U1	5E
7E	Q1	7B	R15	6D	U2	4D
8C	Q2	6B	R16	5D	U3	3E
7C	Q3	6C	R17	6B		
6B	Q4	6C	R18	5C		
6C	Q5	5B	R19	6A		
5C	Q6	5C	R20	4C		
2D	Q7	2D	R21	4A		
1D	Q8	2D	R22	5D		
4C	Q9	2D	R23	5D		
	R1	8E	R24	2F		
6C	R2	8E	R25	2E		
6B	R3	8E	R26	3D		
6B	R4	7E	R27	3C		
6B	R6	7C	R28	2E		
5B	R7	7D	R29	2D		
5C	R8	7E	R30	2C		
5D	R9	7D	R31	6A		
5B	R10	7A	R32	7B		
6A	R11	7C	R33	4B		

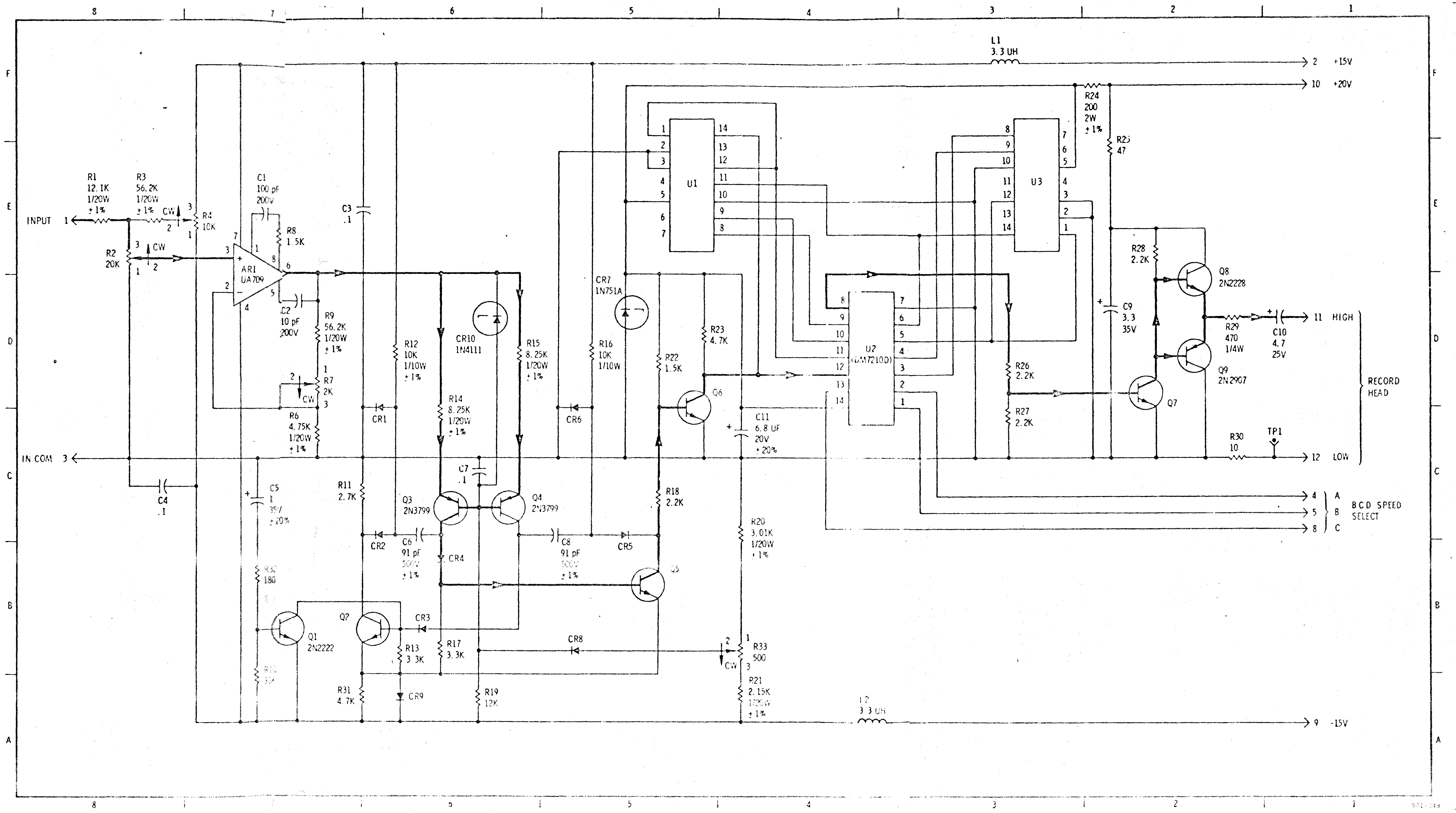


Figure 5-13. FM Record Amplifier Schematic Diagram.

NOTES: UNLESS OTHERWISE SPECIFIED.

A. RESISTOR VALUES ARE IN OHMS, ±5%, 1/8W.

B. CAPACITOR VALUES ARE IN MICROFARADS.

C. DIODES ARE JAN1N4148.

D. LAST REFERENCE DESIGNATIONS USED ARE:
C42, CR16, FL6, L11, Q7, R60, U7, Y2.

E. REFERENCE DESIGNATIONS NOT USED:
C16 THRU C20 Q1, Q2, R20 THRU R25, R29, R39 THRU R42,
L2, L4, AND Y1.

$\boxed{\text{F.}}$ SEE TABLE A FOR VALUES.

G. REFERENCE DRAWINGS: ASSEMBLY 85006401-1
85006401-2

PARTS LOCATION INDEX

REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
C1	13F	C30	5C	CR11	6B	Q4	8B	R21	10C	R52	3A
C2	12F	C31	6B	CR12	5A	Q5	6B	R22	8B	R53	3A
C3	12F	C32	5C	CR13	3C	Q6	7B	R23	7C	R54	2C
C4	12F	C33	4A	CR14	2A	Q7	6B	R26	4C	R55	1B
C5	11F	C34	4A	CR15	10C	R1	13F	R27	3C	R56	1B
C6	11F	C35	3B	CR16	5C	R2	12F	R28	2C	R57	1A
C7	3F	C36	3B	FL1	9F	R3	12F	R30	9B	R58	4F
C8	3E	C37	2B	FL2	8F	R4	12F	R31	8B	R59	4E
C9	3F	C38	2A	FL3	7F	R5	11F	R32	8B	R60	9A
C10	3E	C39	1B	FL4	7F	R6	11F	R33	7B	U1	13F
C11	4E	C40	1B	FL5	6F	R7	13C	R34	6B	U2	13D
C12	7C	C41	1D	FL6	5F	R8	13C	R35	5B	U3	10E
C13	6C	C42	8A	L1	4D	R9	12C	R36	3C	U4	4E
C14	7C	CR1	13C	L3	3D	R10	12C	R37	3C	U5	5B
C15	3C	CR2	12C	L5	9B	R11	11C	R38	3C	U6	5B
C21	11C	CR3	12C	L6	9B	R12	11C	R43	8A	U7A	4B
C22	10B	CR4	12C	L7	9C	R13	4F	R44	8A	U7B	4B
C23	9B	CR5	11C	L8	8C	R14	3F	R45	8A	U7C	3B
C24	8A	CR6	11C	L9	4A	R15	4E	R46	8A	U7D	3A
C25	8B	CR7	10C	L10	2D	R16	4E	R47	7A	Y2	2B
C26	8B	CR8	7B	L11	1C	R17	3E	R48	7A		
C27	7A	CR9	7B	Q3	9B	R18	3E	R49	7A		
C28	6A	CR10	6B			R19	4E	R50	6A		
C29	6A							R51	5B		

TABLE A				
USED ON ASSEMBLY	R6	C6	FL6	
85006401-1	10	15, 10V, ±10%	ASSY 85006421	SCHEM 85006424
85006401-2	1.3K	.027, 100V, ±10%	ASSY [illegible]	SCHEM [illegible]

NOTES: UNLESS OTHERWISE SPECIFIED

A. ALL RESISTOR VALUES ARE IN OHMS, 1/8W, ±5%.

B. ALL NONPOLARISED CAPACITOR VALUES ARE IN PICO FARADS, ±5%, 50V.
ALL POLARISED CAPACITORS ARE ±20%

C. ALL DIODES ARE JAN 1N914.

D. ALL TRANSISTORS ARE JAN3251A.

E. REFERENCE DRAWINGS: ASSEMBLY DRAWINGS 85006591 - BSC AND 85006591 - 1.

F. LAST REFERENCE DESIGNATORS USED: C38, CR29, L6, Q23, R88, TP4.

G. ALL REACTOR VALUES ARE IN MICROHENERYS.

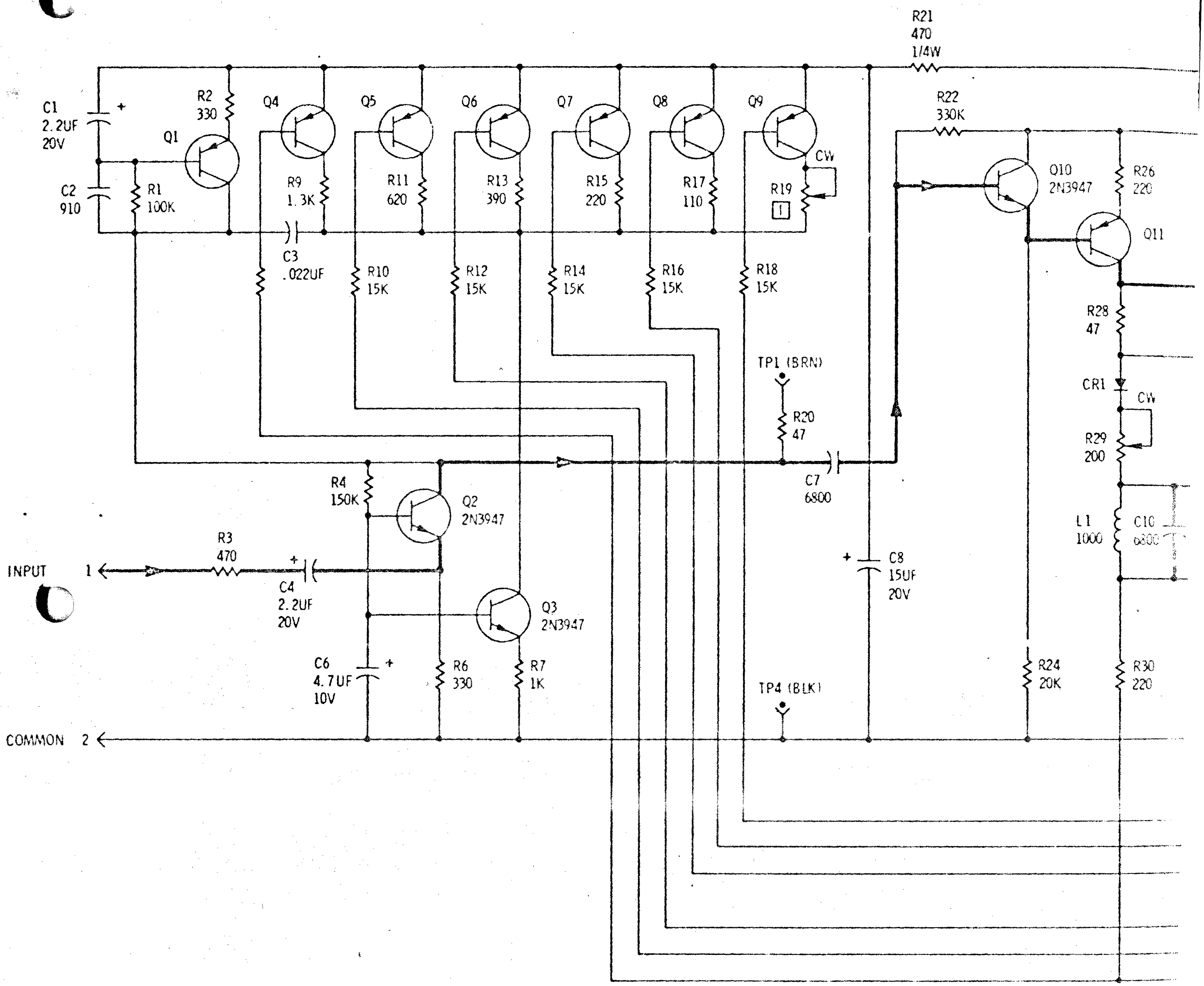
H. REFERENCE DESIGNATIONS NOT USED
R5, 23, 25, 27, & 78. C5, 9, 19, 20, 27, 31, & 33.

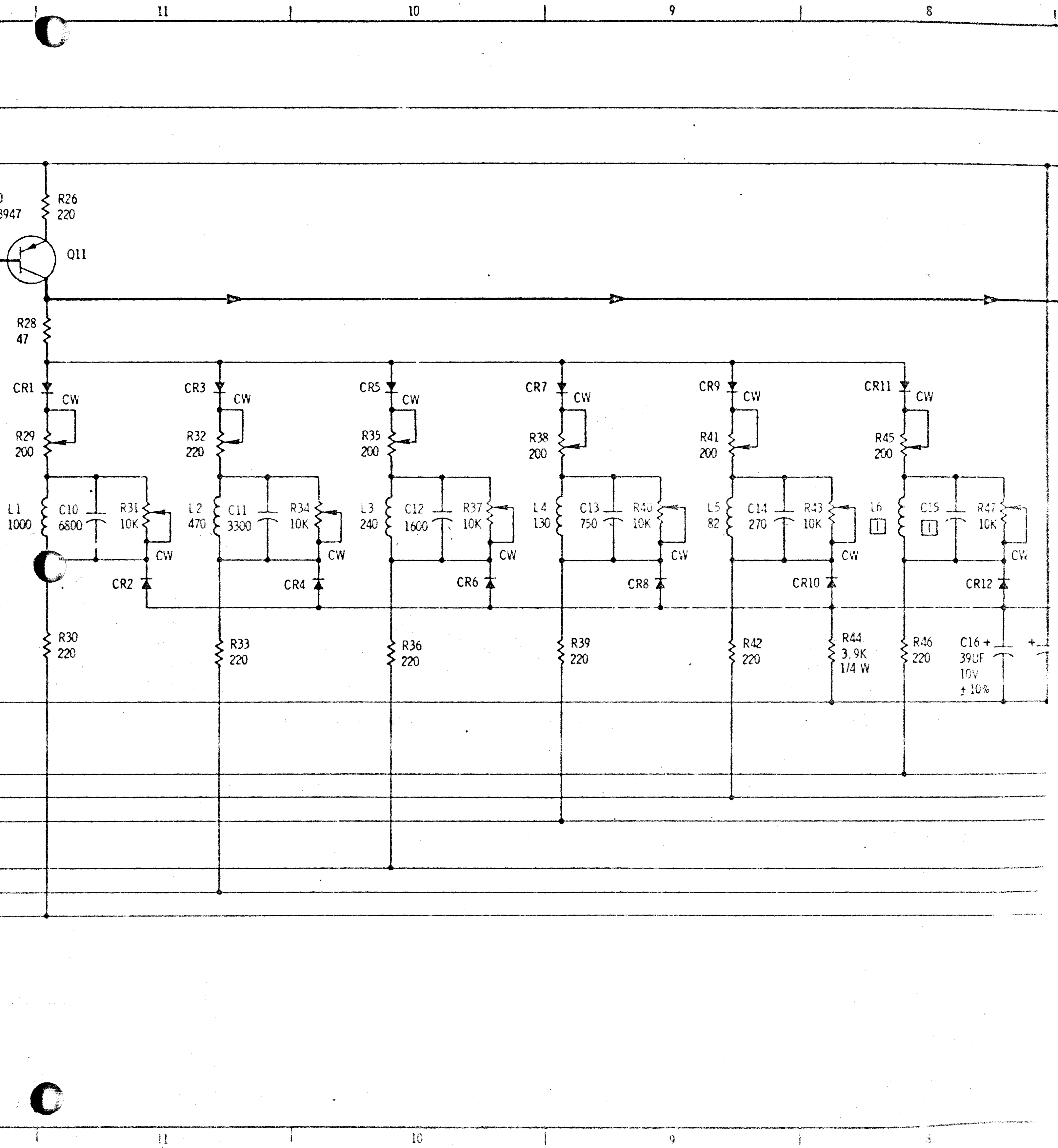
I. SEE TABLE A FOR VALUES (NOTE: R19 IS A VARIABLE RESISTOR ON THE BSC ASSEMBLY AND A FIXED RESISTOR ON THE -1 ASSEMBLY.)

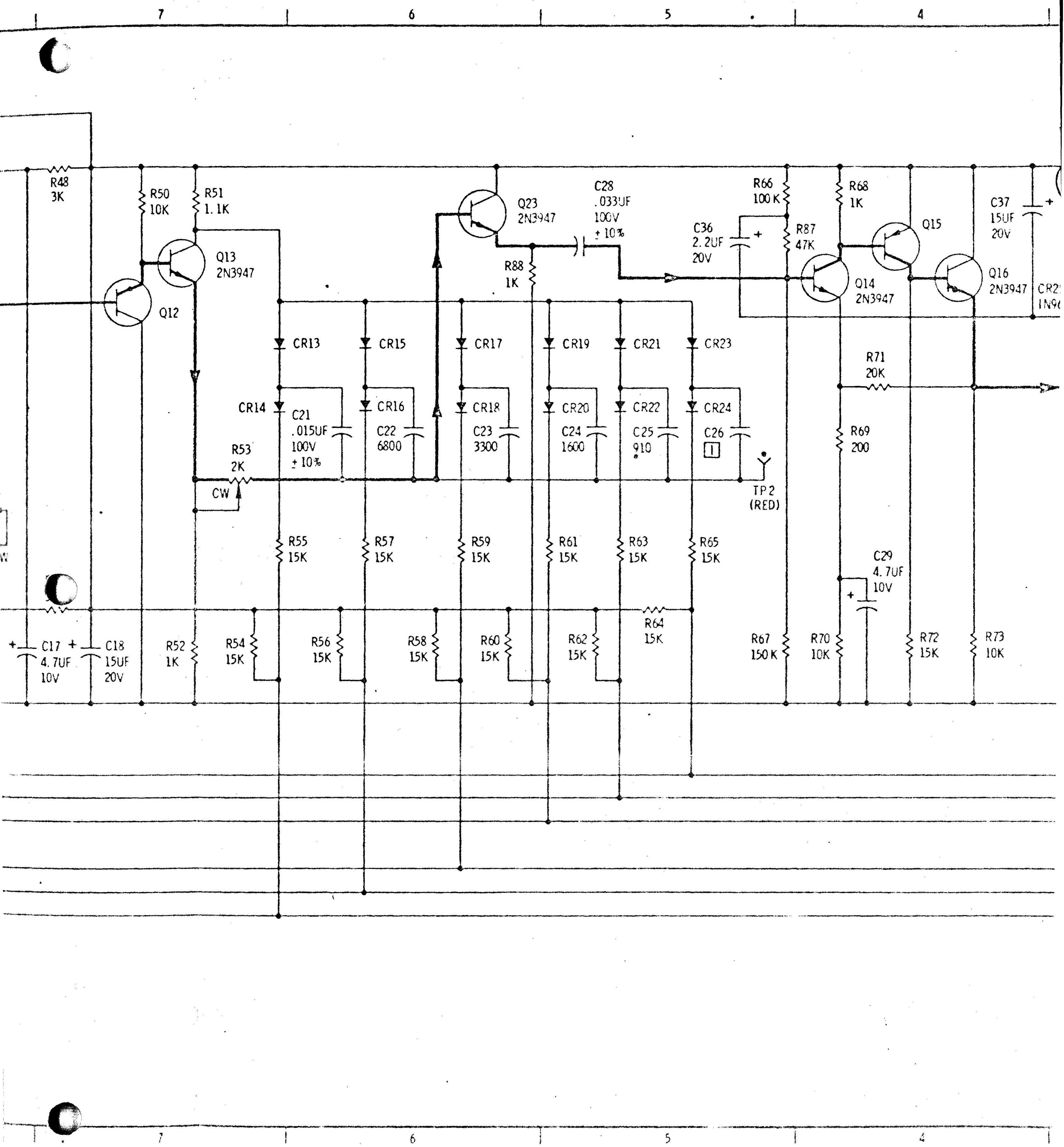
PARTS LOCATION, INDEX

REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
C1	15F	C30	3E	CR17	6E	Q4	14F	R4	14D	R32	11D	R56	6C	R81	3C
C2	15E	C32	3D	CR18	6D	Q5	14F	R6	14C	R33	11C	R57	6D	R82	2F
C3	14E	C34	2D	CR19	5E	Q6	14F	R7	14C	R34	10D	R58	6C	R83	2E
C[illegible]	14D	C35	2D	CR20	5D	Q7	13F	R8	14E	R35	10D	R59	6D	R84	2D
C[illegible]	14C	C36	5E	CR21	5E	Q8	13F	R9	14E	R36	10C	R60	6C	R85	2D
C7	12D	C37	4E	CR22	5D	Q9	13F	R10	14E	R37	10D	R61	5D	R86	2C
C8	12D	C38	3C	CR23	5E	Q10	12E	R11	14E	R38	9D	R62	5C	R87	5E
C10	11D			CR24	5D	Q11	12E	R12	14E	R39	9C	R63	5D	R88	6E
C11	11D	CR1	11D	CR25	3E	Q12	7E	R13	14E	R40	9D	R64	5C		
C12	10D	CR2	11C	CR26	3F	Q13	7E	R14	13E	R41	9D	R65	5D	TP1	13E
C13	9D	CR3	11D	CR27	3E	Q14	4E	R15	13E	R42	9C	R66	5F	TP2	5D
C14	9D	CR4	10C	CR28	2E	Q15	4E	R16	13E	R43	8D	R67	5C	TP3	3D
C15	8D	CR5	10D	CR29	2D	Q16	4E	R17	13E	R44	8C	R68	4F	TP4	13C
C16	8C	CR6	10C			Q17	3F	R18	13E	R45	8D	R69	4D		
C17	8C	CR7	9D	L1	11D	Q18	3E	R19	13E	R46	8C	R70	4C		
C18	7C	CR8	9C	L2	11D	Q19	2E	R20	13D	R47	8D	R71	[illegible]		
C21	6D	CR9	9D	L3	10D	Q20	2E	R21	12F	R48	7F	R72	4C		
C22	6D	CR10	8C	L4	9D	Q21	2D	R22	12F	R49	7C	R73	4C		
C23	6D	CR11	8D	L5	9D	Q22	3D	R24	12C	R50	7E	R74	3E		
C24	5D	CR12	8C	L6	8D	Q23	6E	R26	11E	R51	7E	R75	3D		
C25	5D	CR13	7E					R28	11E	R52	7C	R76	3D		
C26	5D	CR14	7D	Q1	15F	R1	15E	R29	11D	R53	7D	R77	3D		
C28	5E	CR15	6E	Q2	14D	R2	15F	R30	11C	R54	7C	R79	3C		
C29	4C	CR16	6D	Q3	14C	R3	15D	R31	11D	R55	7C	R80	3D		

TABLE A				
ASSEMBLY PART NO.	VALUES			
	L6	R19	C15	C26
85006591-BSC	51uH	100	110pF	470pF
85006591 - 1	2000uH	2.7K, 1/4W	.012uF	.027uF


R21
470
1/4W
C1
2.2UF
20V
R2
330
Q4
Q5
Q6
Q7
Q8
Q9
Q1
R22
330K
CW
Q10
2N3947
R26
220
C2
910
R1
100K
R9
1.3K
R11
620
R13
390
R15
220
R17
110
R19
Q11
C3
.022UF
R10
15K
R12
15K
R14
15K
R16
15K
R18
15K
R28
47
TP1 (BRN)
CR1
R20
47
R29
200
C7
6800
R4
150K
Q2
2N3947
L1
1000
C10
6800
R3
470
INPUT 1
C4
2.2UF
20V
C8
15UF
20V
Q3
2N3947
C6
4.7UF
10V
R6
330
R7
1K
R24
20K
R30
220
TP4 (BLK)
COMMON 2


11
10
9
8
R26
220
Q11
R28
47
CR1
CW
R29
200
CR3
R32
220
CR5
R35
200
CR7
R38
200
CR9
R41
200
CR11
R45
200
L1
1000
C10
6800
R31
10K
L2
470
C11
3300
R34
10K
L3
240
C12
1600
R37
10K
L4
130
C13
750
R40
10K
L5
82
C14
270
R43
10K
L6
C15
R47
10K
CR2
CR4
CR6
CR8
CR10
CR12
R30
220
R33
220
R36
220
R39
220
R42
220
R44
3.9K
1/4 W
R46
220
C16 +
39UF
10V
± 10%


7
6
5
4
R48
3K
R50
10K
R51
1.1K
Q13
2N3947
Q12
Q23
2N3947
C28
.033UF
100V
± 10%
R66
100 K
R68
1K
C37
15UF
20V
C36
2.2UF
20V
R87
47K
Q15
Q14
2N3947
Q16
2N3947
R88
1K
CR13
CR15
CR17
CR19
CR21
CR23
CR14
CR16
CR18
CR20
CR22
CR24
C21
.015UF
100V
± 10%
C22
6800
C23
3300
C24
1600
C25
910
C26
1
R53
2K
CW
TP2
(RED)
R71
20K
R69
200
R55
15K
R57
15K
R59
15K
R61
15K
R63
15K
R65
15K
C29
4.7UF
10V
C17
4.7UF
10V
C18
15UF
20V
R52
1K
R54
15K
R56
15K
R58
15K
R60
15K
R62
15K
R64
15K
R67
150 K
R70
10K
R72
15K
R73
10K

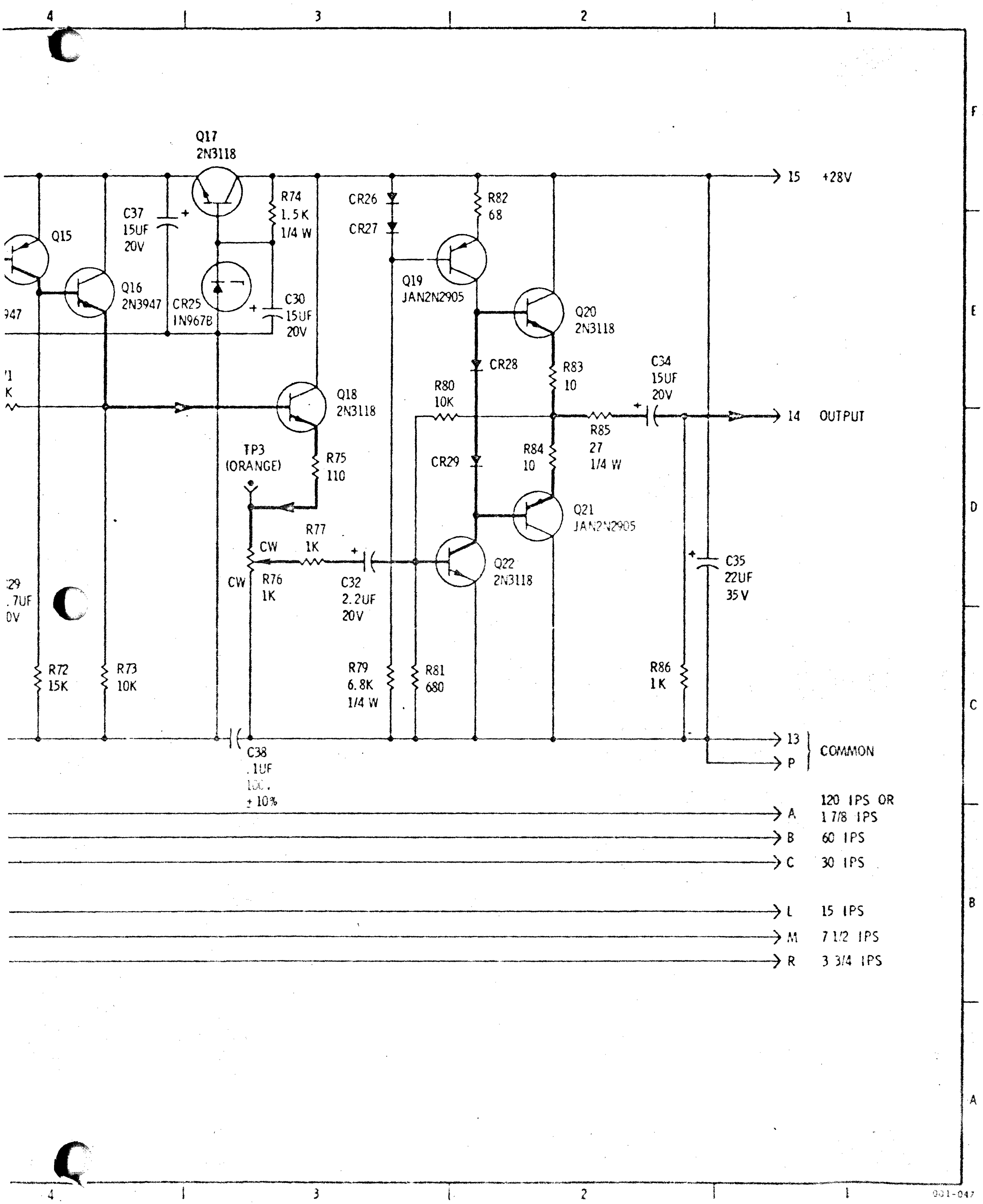
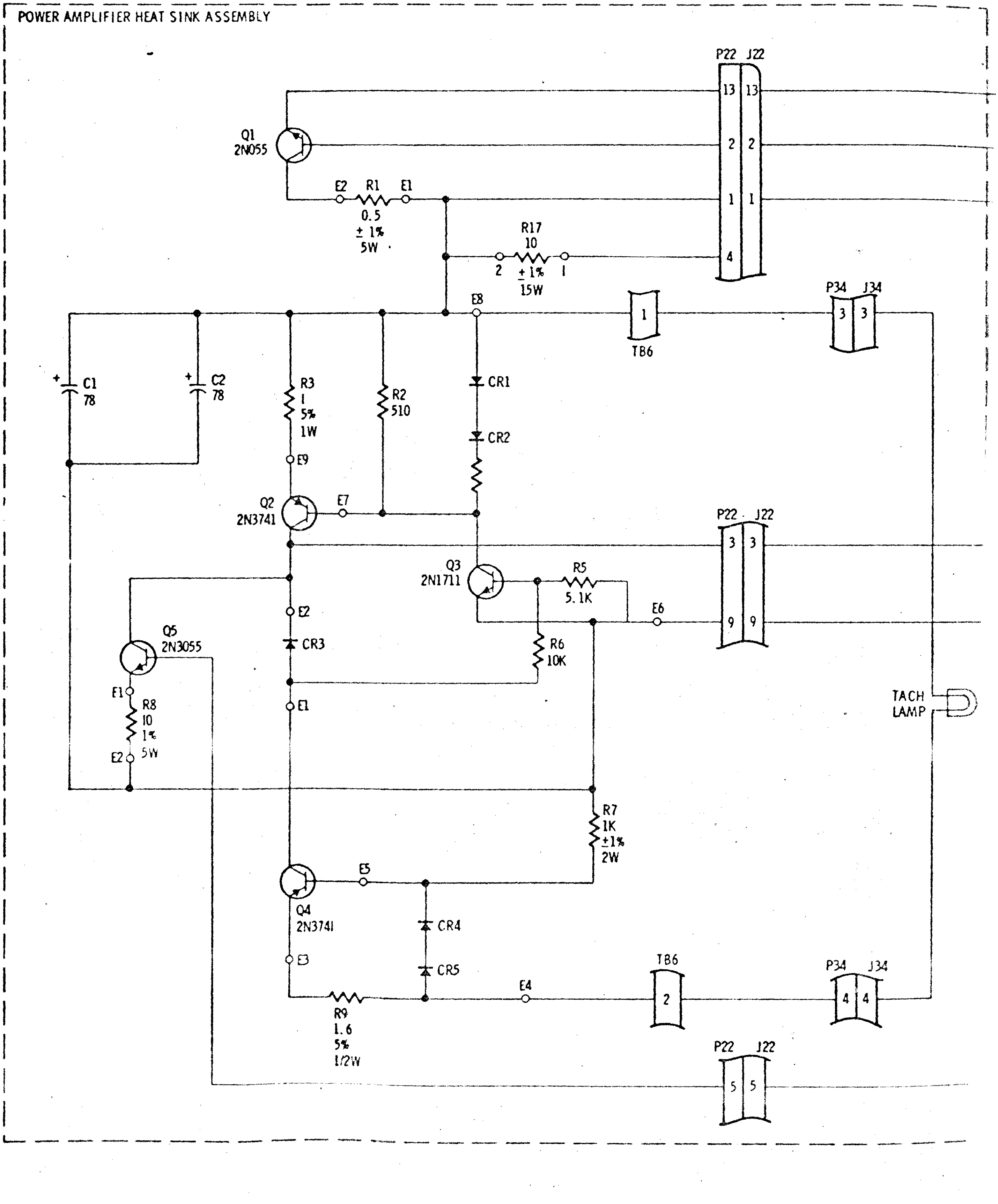
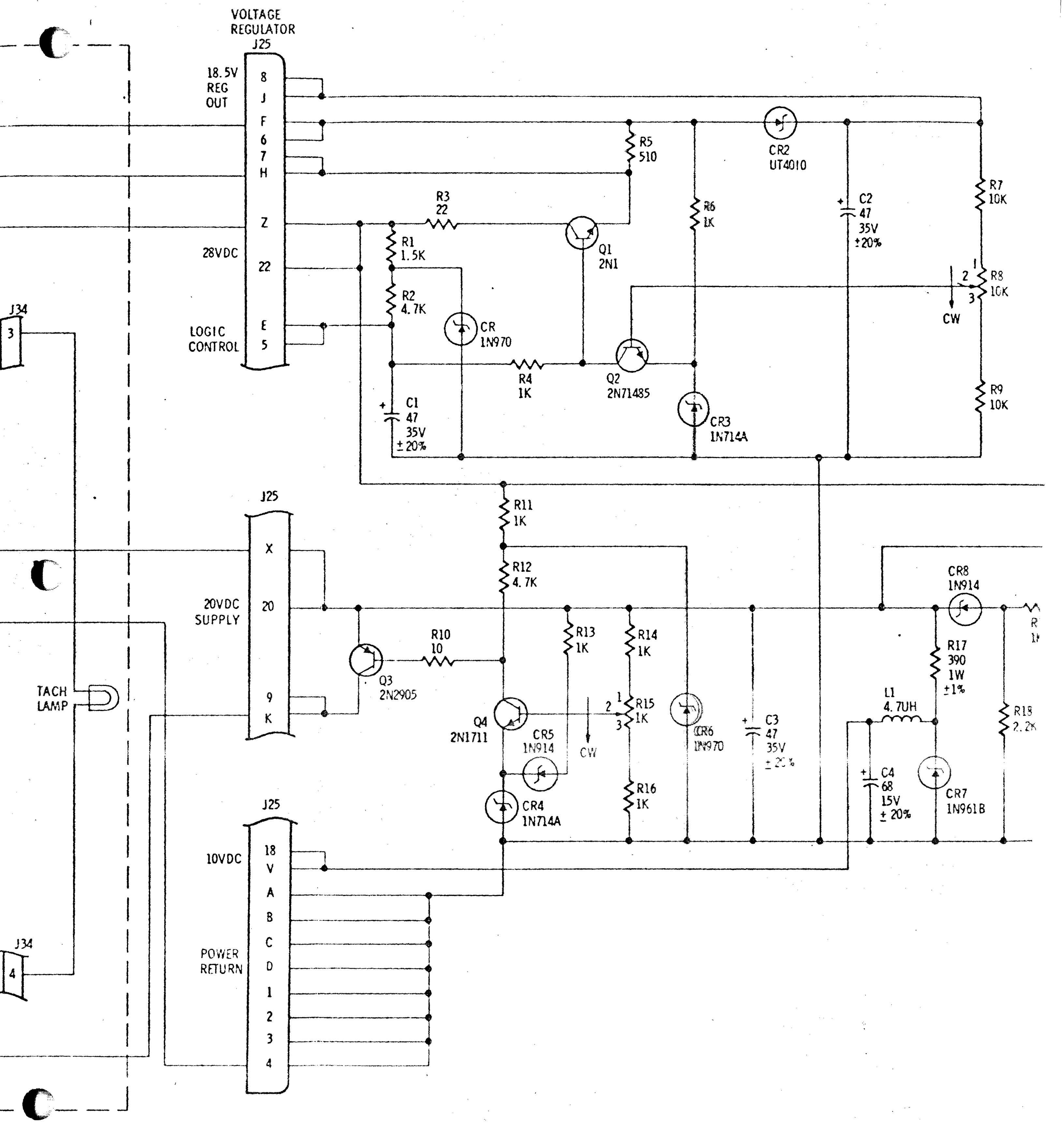
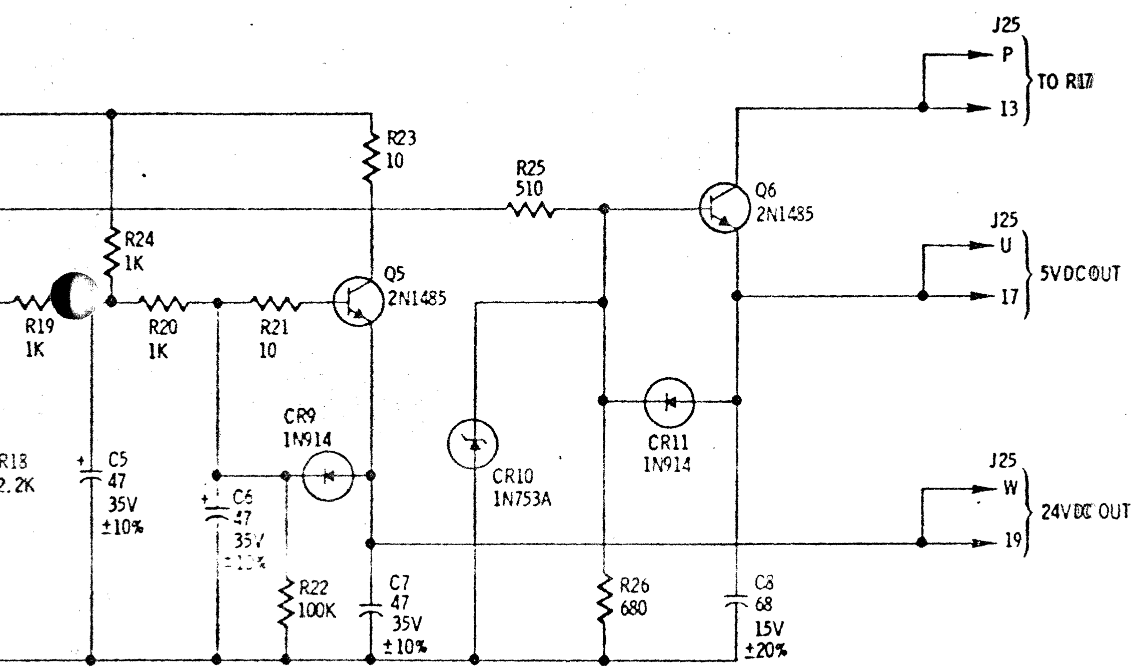


Figure 5-14. Direct Reproduce Amplifier Schematic Diagram.


POWER AMPLIFIER HEAT SINK ASSEMBLY
P22 J22
Q1
2N055
E2 R1 E1
0.5
± 1%
5W
R17
10
± 1%
15W
E8
TB6
P34 J34
C1
78
C2
78
R3
1
5%
1W
E9
R2
510
CR1
CR2
Q2
2N3741
E7
Q3
2N1711
R5
5.1K
E6
Q5
2N3055
E2
CR3
R6
10K
E1
F1
R8
10
1%
5W
E2
TACH
LAMP
R7
1K
±1%
2W
Q4
2N3741
E5
CR4
CR5
E3
E4
R9
1.6
5%
1/2W



VOLTAGE REGULATOR
J25
18.5V REG OUT
28VDC
LOGIC CONTROL
8
J
F
6
7
H
Z
22
E
5
R5 510
R3 22
R1 1.5K
R2 4.7K
Q1 2N1
CR 1N970
R4 1K
Q2 2N71485
R6 1K
CR3 1N714A
CR2 UT4010
C2 47 35V ±20%
R7 10K
R8 10K
CW
R9 10K
C1 47 35V ±20%
J34
3
J25
X
20
9
K
20VDC SUPPLY
TACH LAMP
R11 1K
R12 4.7K
R10 10
Q3 2N2905
Q4 2N1711
R13 1K
CR5 1N914
CW
CR4 1N714A
R14 1K
R15 1K
R16 1K
CR6 1N970
C3 47 35V ±20%
CR8 1N914
R17 390 1W ±1%
L1 4.7UH
C4 68 15V ± 20%
CR7 1N961B
R18 2.2K
J25
10VDC
POWER RETURN
18
V
A
B
C
D
1
2
3
4
J34
4



NOTE: ALL RESISTORS 0.5W, 5%
ALL CAPACITORS UF
UNLESS OTHERWISE SPECIFIED.

I01-090

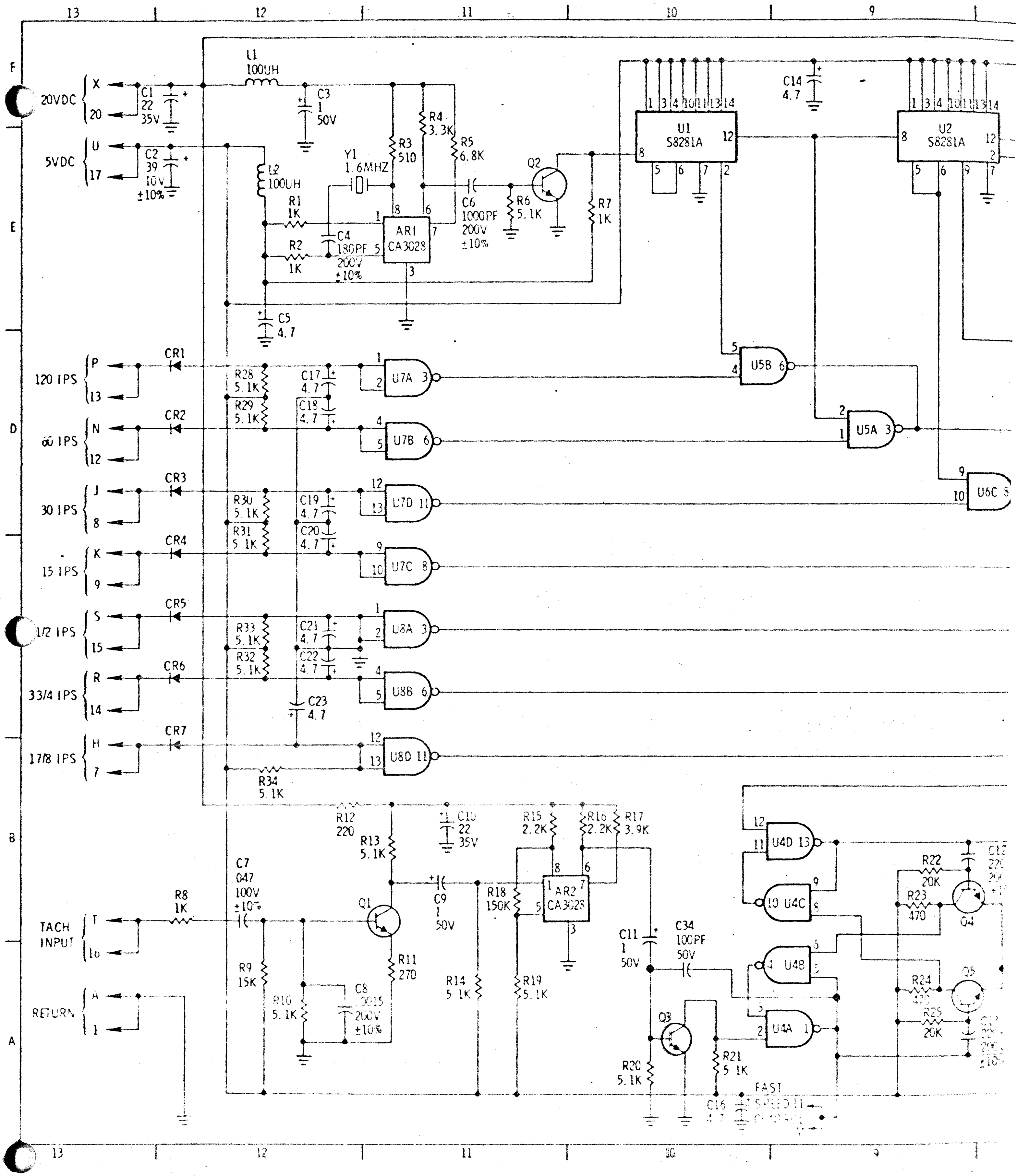
Figure 5-16. Voltage Regulator Schematic Diagram.

NOTES: UNLESS OTHERWISE SPECIFIED

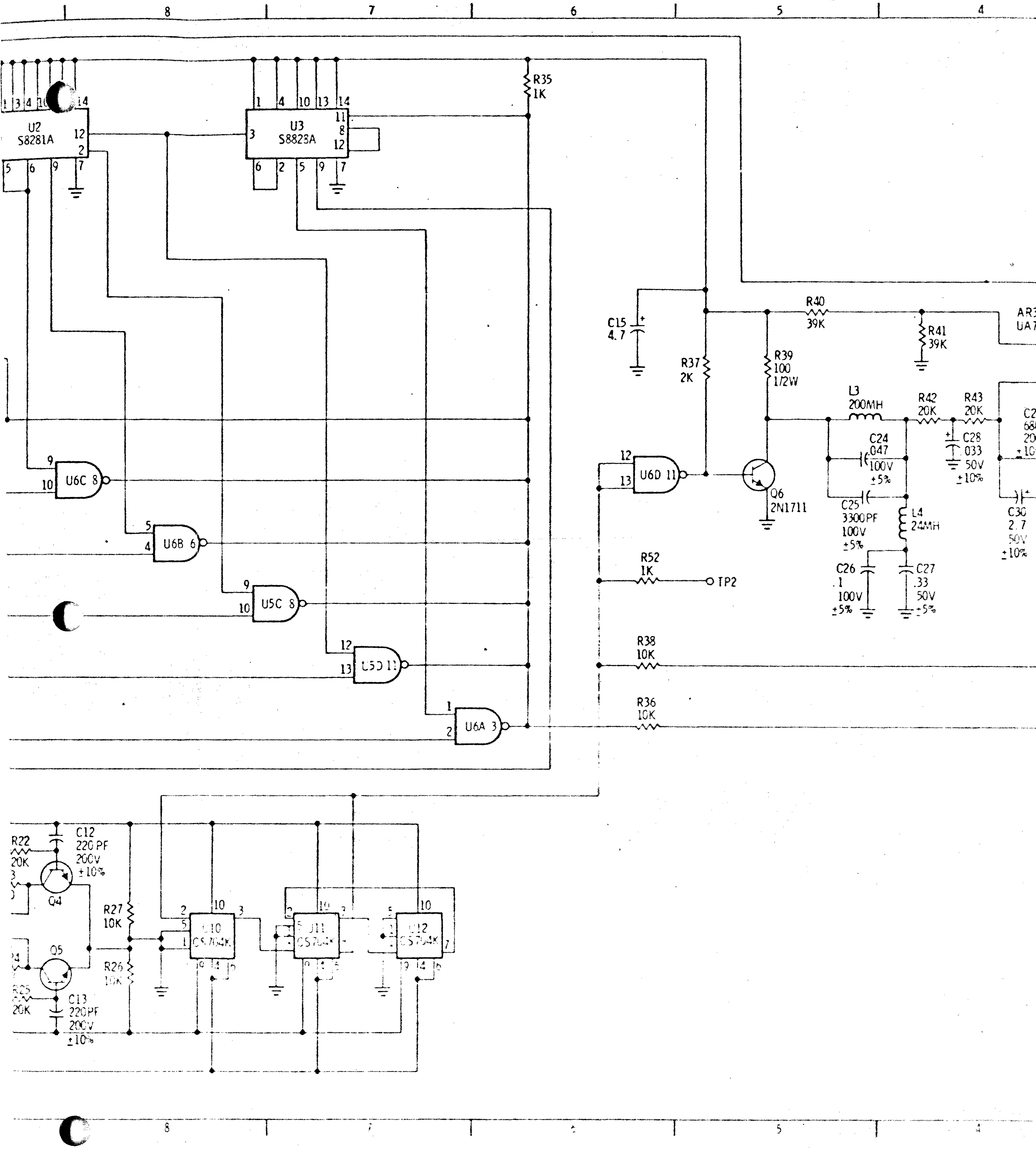
A. RESISTOR VALUES ARE IN OHMS, 1/4W, ±5%
B. CAPACITOR VALUES ARE IN MICROFARADS, 10V, ±20%
C. ALL DIODES ARE TYPE 1N914
D. ALL TRANSISTORS ARE TYPE 2N2222
E. U7 AND U8 ARE 8480A
F. U5 AND U6 ARE S8481A
G. PIN 7 ON U4 THRU U8 IS GROUND
H. PIN 14 ON U4 THRU U8 IS 5VDC
I. Z4 IS S8880A
J. LAST REFERENCE DESIGNATIONS USED, TP2, AR3, C34, CR11, L4 R56, Q10, U12 AND Y1
K. REFERENCE DESIGNATION NOT USED, C32 AND U9

PARTS LOCATION INDEX

REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
AR1	11E	C23	12C	L3	5D	R13	11B	R38	6C	U4A	9A
AR2	10B	C24	4D	L4	4C	R14	11A	R39	5D	U4B	9A
AR3	4D	C25	5C	Q1	11B	R15	11B	R40	5D	U4C	9B
C1	12F	C26	5C	Q2	11E	R16	10B	R41	4D	U4D	9B
C2	12E	C27	4C	Q3	10A	R17	10B	R42	4D	U5A	9D
C3	12F	C28	4D	Q4	9B	R18	11B	R43	4D	U5B	10D
C4	12E	C29	4D	Q5	9A	R19	11A	R44	3C	U5C	7C
C5	12E	C30	4C	Q6	5C	R20	10A	R45	3C	U5D	7C
C6	11E	C31	3C	Q7	2F	R21	10A	R46	3C	U6A	6B
C7	12B	C33	3E	Q8	3E	R22	9B	R47	2E	U6B	8C
C8	12A	C34	10A	Q9	3E	R23	9B	R48	2E	U6C	8D
C9	11B	CR1	12D	Q10	2D	R24	9A	R49	3D	U6D	6C
C10	11B	CR2	12D	R1	12E	R25	9A	R50	2E	U7A	11D
C11	10B	CR3	12D	R2	12E	R26	8A	R51	2F	U7B	11D
C12	9B	CR4	12C	R3	11E	R27	8A	R52	6C	U7C	11C
C13	8A	CR5	12C	R4	11E	R28	12D	R53	2D	U7D	11D
C14	9F	CR6	12C	R5	11E	R29	12D	R54	3F	U8A	11C
C15	6D	CR7	12C	R6	11E	R30	12D	R55	3E	U8B	11C
C16	10A	CR8	2E	R7	10E	R31	12D	R56	3E	U8D	11B
C17	12D	CR9	2E	R8	12B	R32	12C	TP1	3D	U10	8A
C18	12D	CR10	3E	R9	12A	R33	12C	TP2	5C	U11	7A
C19	12D	CR11	3D	R10	12A	R34	12B	U1	10E	U12	7A
C20	12D	L1	12F	R11	11A	R35	6F	U2	9E	Y1	12E
C21	12C	L2	12E	R12	12B	R36	6B	U3	7E		
C22	12C					R37	5D				



20VDC
X
20
5VDC
U
17
C1 22 35V
C2 39 10V ±10%
L1 100UH
L2 100UH
C3 1 50V
R3 510
R4 3.3K
R5 6.8K
Y1 1.6MHZ
R1 1K
R2 1K
C4 180PF 200V ±10%
AR1 CA3028
C5 4.7
C6 1000PF 200V ±10%
R6 5.1K
Q2
R7 1K
U1 S8281A
C14 4.7
U2 S8281A
120 IPS
P
13
60 IPS
N
12
30 IPS
J
8
15 IPS
K
9
1/2 IPS
S
15
33/4 IPS
R
14
17/8 IPS
H
7
CR1
CR2
CR3
CR4
CR5
CR6
CR7
R28 5.1K
R29 5.1K
R30 5.1K
R31 5.1K
R33 5.1K
R32 5.1K
R34 5.1K
C17 4.7
C18 4.7
C19 4.7
C20 4.7
C21 4.7
C22 4.7
C23 4.7
U7A
U7B
U7D
U7C
U8A
U8B
U8D
U5B
U5A
U6C
TACH INPUT
T
16
RETURN
A
1
R8 1K
C7 .047 100V ±10%
R9 15K
R10 5.1K
C8 .0015 200V ±10%
Q1
R11 270
R12 220
R13 5.1K
C10 22 35V
C9 1 50V
R14 5.1K
R15 2.2K
R16 2.2K
R17 3.9K
R18 150K
R19 5.1K
AR2 CA3028
C11 1 50V
C34 100PF 50V
Q3
R20 5.1K
R21 5.1K
C16 4.7
FAST
U4D
U4C
U4B
U4A
R22 20K
R23 470
Q4
R24 470
R25 20K
Q5
13
12
11
10
9
F
E
D
B
A



8
7
6
5
4
U2
S8281A
U3
S8823A
R35
1K
C15
4.7
R37
2K
R39
100
1/2W
R40
39K
R41
39K
AR3
UA7
L3
200MH
R42
20K
R43
20K
C24
.047
100V
±5%
C28
.033
50V
±10%
C25
3300PF
100V
±5%
L4
24MH
C26
.1
100V
±5%
C27
.33
50V
±5%
C30
2.7
50V
±10%
U6C
U6B
U5C
U5D
U6A
U6D
Q6
2N1711
R52
1K
TP2
R38
10K
R36
10K
C12
220 PF
200V
±10%
R22
20K
Q4
Q5
R25
20K
C13
220PF
200V
±10%
R27
10K
R26
10K
U10
CS704K
U11
CS704K
U12
CS704K

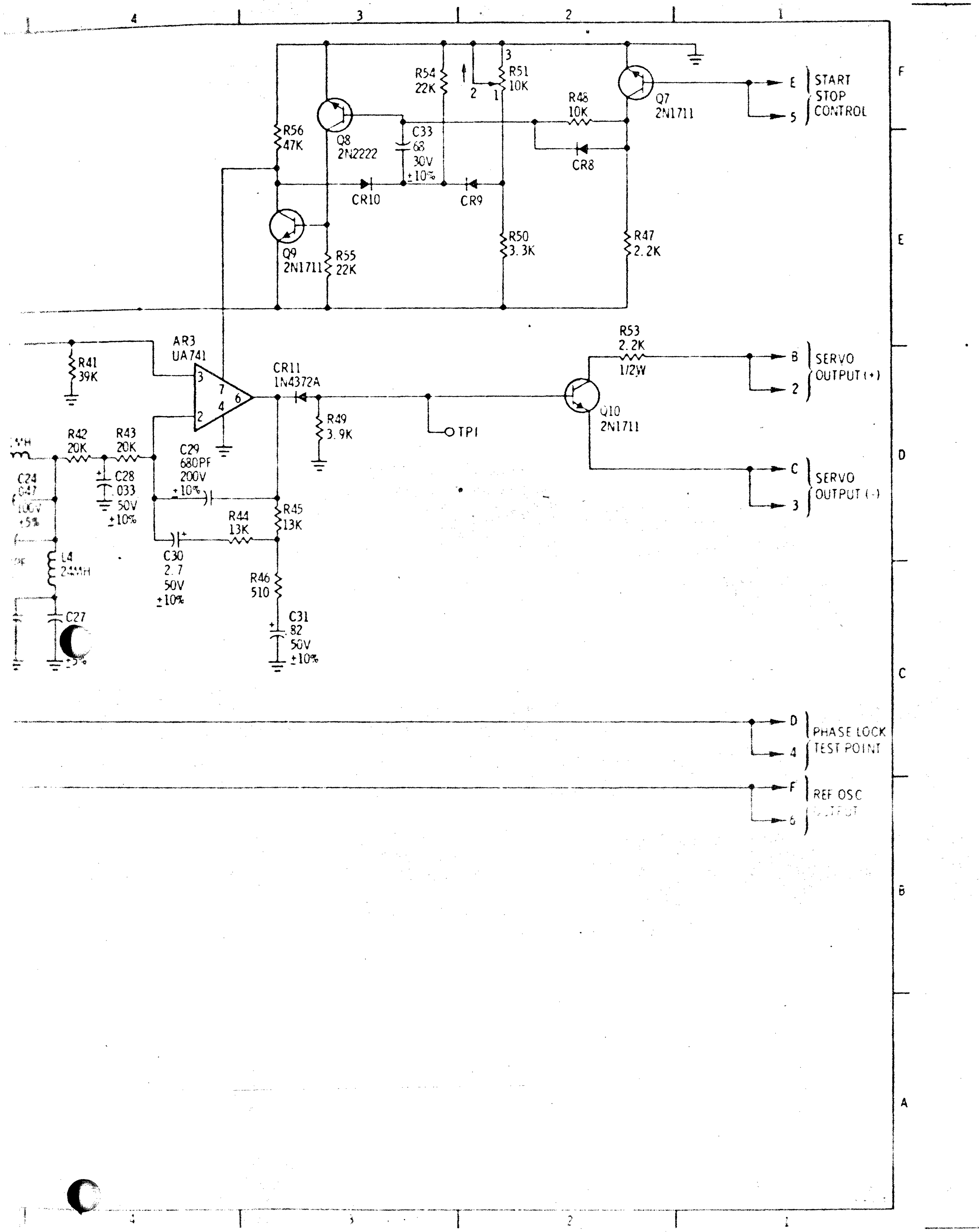


Figure 5-17. Capstan Servo Schematic Diagram.

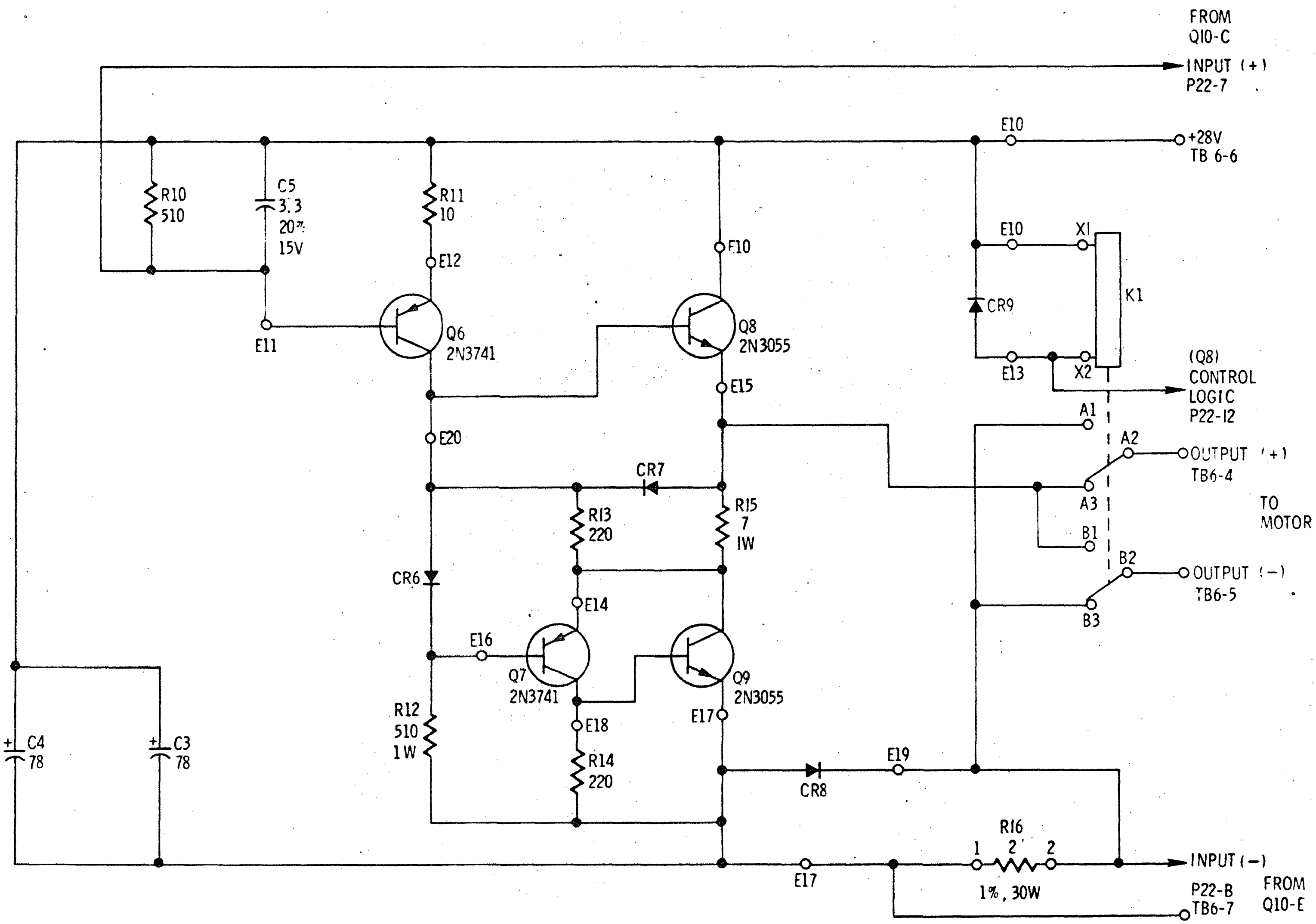


Figure 5-18. Servo Power Amplifier Schematic Diagram.

NOTES: UNLESS OTHERWISE SPECIFIED

A. RESISTOR VALUES ARE IN OHMS, 1/4W, ±5%
B. CAPACITOR VALUES ARE IN MICORFARADS, ±20%
C. ALL DIODES ARE 1N914
D. ALL TRANSISTORS ARE 2N1711
E. U1 AND U4 ARE S8430A
F. U2, U3 AND U5 ARE S8416A
G. U6 IS S8731A
H. PIN NO.1 ON U6 IS CONNECTED TO GROUND
I. PIN NO.7 ON U1 THRU U5 IS CONNECTED TO GROUND
J. PIN NO.14 ON U1 THRU U5 IS CONNECTED TO 5VDC
K. LAST REFERENCE DESIGNATIONS USED ARE Q20, R58, R19, CR40, U6 AND L1.
REFERENCE DESIGNATIONS NOT USED ARE
CR13, CR22 THRU CR29 AND CR33
L. C19 NOT USED ON 84007981-1 ASSEMBLY

PART LOCATION INDEX

REF DES	ZONE	REF DES	ZONE	REF DES	ZONE	REF DES	ZONE
C1	12F	CR20	8C	R3	2E	R40	2B
C2	11F	CR21	8F	R4	3E	R41	2C
C3	2D	CR30	10C	R5	3F	R42	2B
C4	4F	CR31	10C	R6	4D	R43	3B
C5	5F	CR32	12C	R7	4E	R44	3B
C6	6F	CR34	10F	R8	4D	R45	3B
C7	5F	CR35	1B	R9	4D	R46	4B
C8	7F	CR36	2B	R10	5F	R47	4B
C9	9C	CR37	3B	R11	5D	R48	5C
C10	9C	CR38	3C	R12	6C	R49	5B
C11	9C	CR39	4C	R13	6C	R50	5B
C12	10C	CR40	6F	R14	5D	R51	5B
C13	8A			R15	5F	R52	5B
C14	8C	L1	12F	R16	6C	R53	8C
C15	8F			R17	7F	R54	12D
C16	8F	Q1	3D	R18	8C	R55	12C
C17	10F	Q2	3E	R19	7C	R56	6C
C18	10F	Q3	4D	R20	7C	R57	5B
C19	4C	Q4	4D	R21	9C	R58	5B
		Q5	12C				
CR1	3D	Q6	5D	R22	9C	U1A	4D
CR2	2D	Q7	6B	R23	9C	U1B	5D
CR3	3E	Q8	8C	R24	10C	U1C	6C
CR4	7C	Q9	7C	R25	10C	U1D	7D
CR5	7C	Q10	8B	R26	10B	U2A	4D
CR6	11D	Q11	10C	R27	9B	U2B	5D
CR7	11D	Q12	11D	R28	8A	U3A	6D
CR8	5D	Q13	11C	R29	8B	U3B	6D
CR9	6D	Q14	2B	R30	7E	U4A	10D
CR10	5E	Q15	2B	R31	10C	U4B	9B
CR11	7D	Q16	3B	R32	10D	U4C	8B
CR12	8D	Q17	4B	R33	10C	U4D	8D
CR14	9C	Q18	5C	R34	10C	U5A	9D
CR15	9C	Q19	5B	R35	10E	U5B	10D
CR16	9C	Q20	5A	R36	11C	U6A	9E
CR17	10C			R37	11C	U6B	9D
CR18	9B	R1	3D	R38	1B	U6C	7E
CR19	8B	R2	3D	R39	1B	U6D	7D

SI[illegible]ED

IN OHMS, 1/4W, ±5%

E IN MICORFARADS, ±20%

2N1711

A

S8416A

CONNECTED TO GROUND

J U5 IS CONNECTED TO GROUND

U U5 IS CONNECTED TO 5VDC

NATIONS USED ARE Q20, R58, R19,

S NOT USED ARE

AND CR33

07981-1 ASSEMBLY

OCATION INDEX

REF DES	ZONE	REF DES	ZONE
R3	2E	R40	2B
R4	3E	R41	2C
R5	3F	R42	2B
R6	4D	R43	3B
R7	4E	R44	3B
R8	4D	R45	3B
[illegible]	4D	R46	4B
[illegible]	5F	R47	4B
R11	5D	R48	5C
R12	6C	R49	5B
R13	6C	R50	5B
R14	5D	R51	5B
R15	5F	R52	5B
R16	6C	R53	8C
R17	7F	R54	12D
R18	8C	R55	12C
R19	7C	R56	6C
R20	7C	R57	5B
R21	9C	R58	5B
R22	9C		
R23	9C	U1A	4D
R24	10C	U1B	5D
R25	10C	U1C	6C
R26	10B	U1D	7D
R27	9B	U2A	4D
R28	8A	U2B	5D
R29	8B	U3A	6D
R30	7E	U3B	6D
R31	10C	U4A	10D
R32	10D	U4B	9B
R33	10C	U4C	8B
R34	10C	U4D	8D
R35	10E	U5A	9D
R36	11C	U5B	10D
R37	11C	U6A	9E
R38	1B	U6B	9D
R39	1B	U6C	7E
		U6D	7D

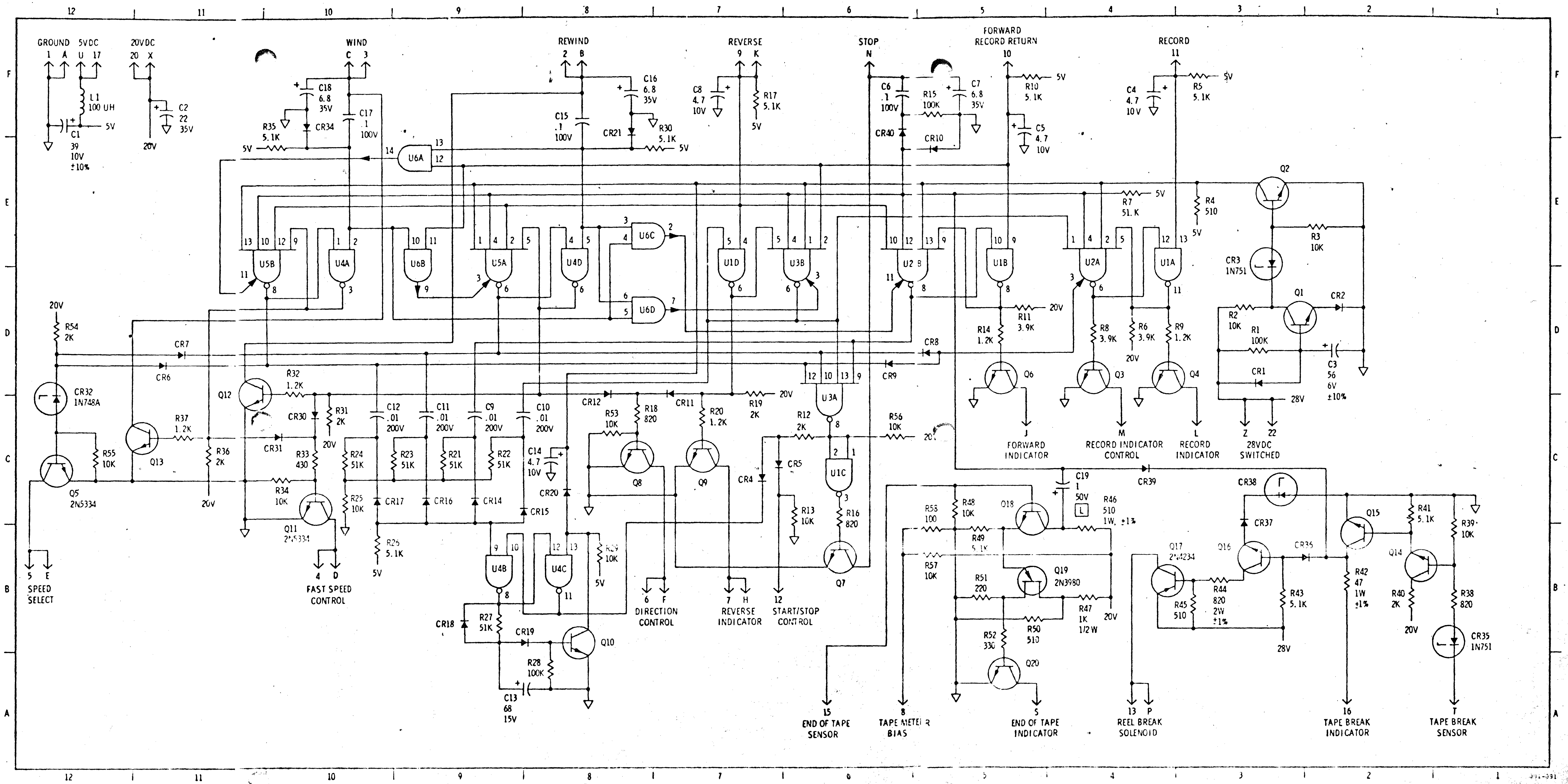


Figure 5-19. Control Logic Schematic Diagram.

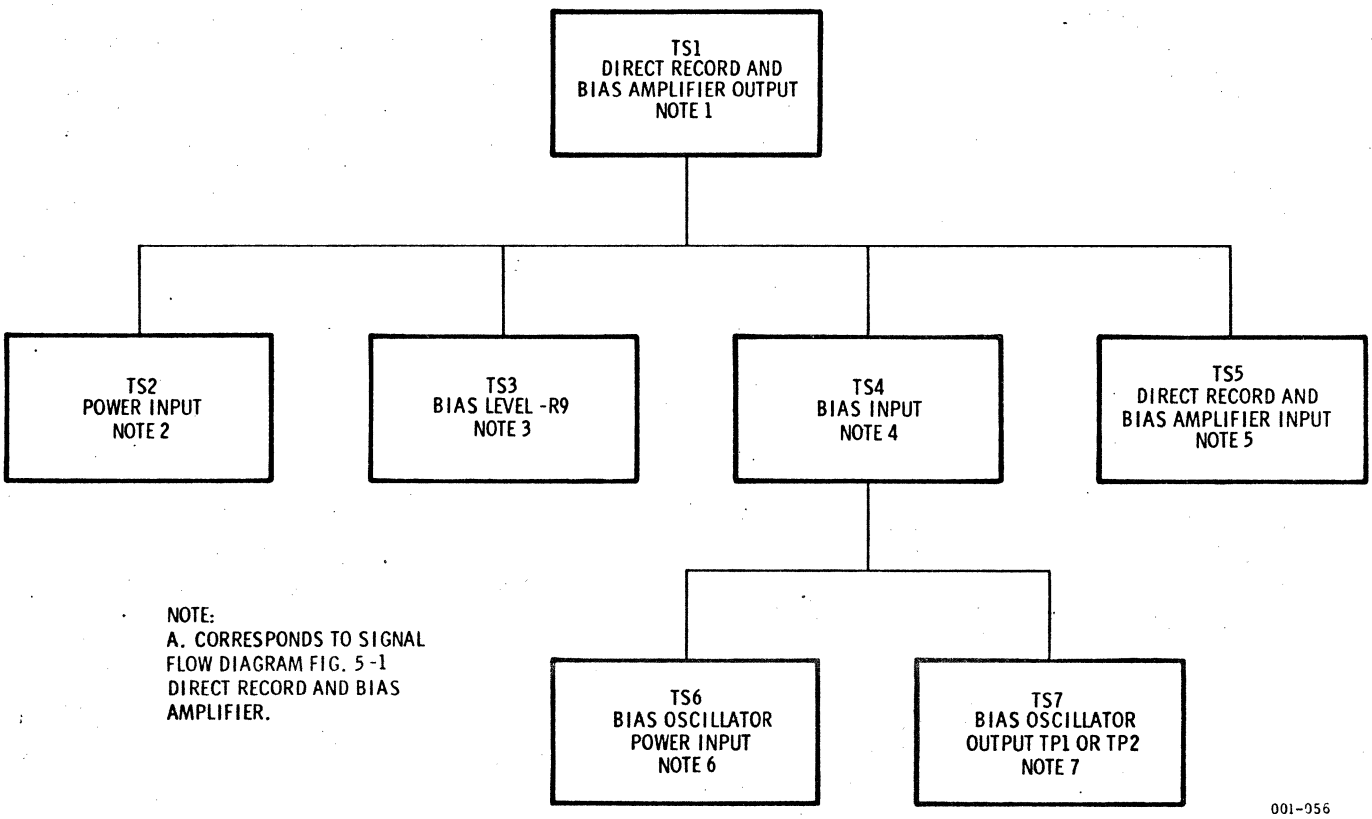


Figure 5-20. Direct Record and Bias Amplifier Dependency Diagram.

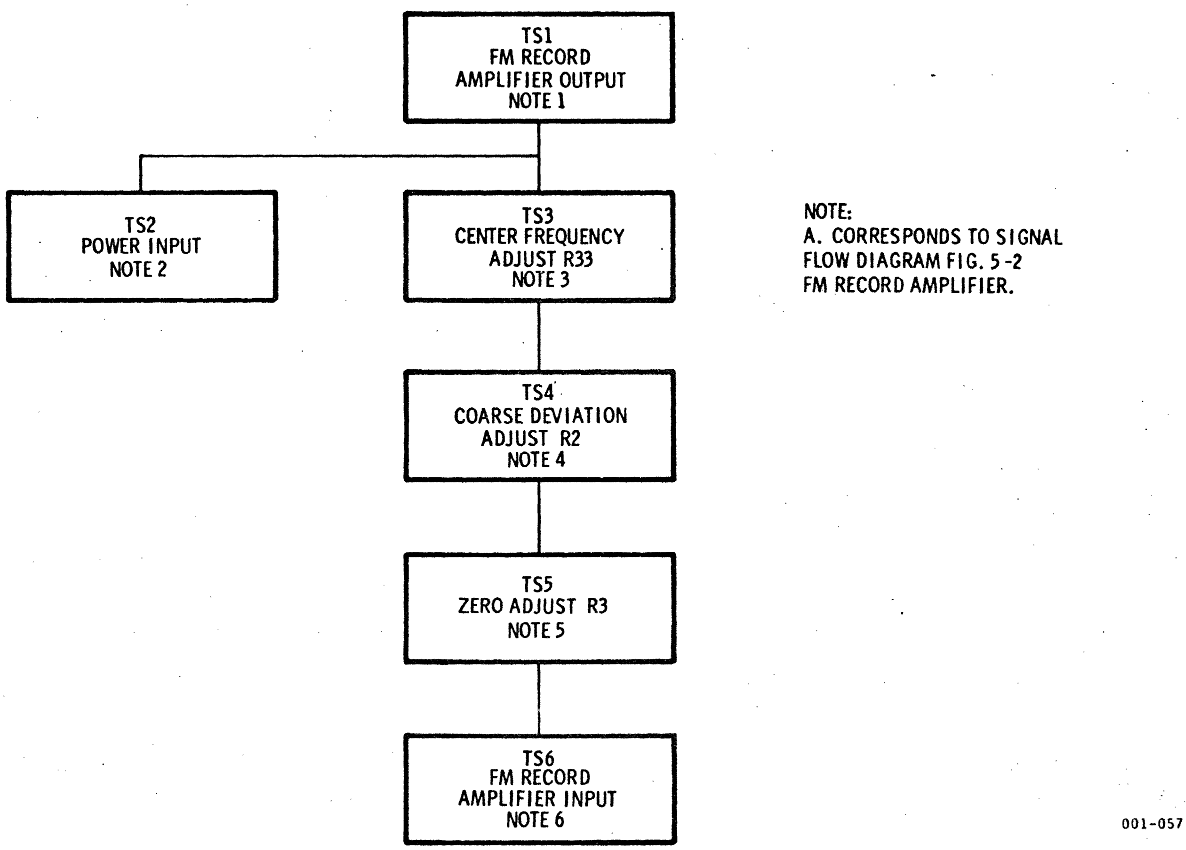


Figure 5-21. FM Record Amplifier Dependency Diagram.

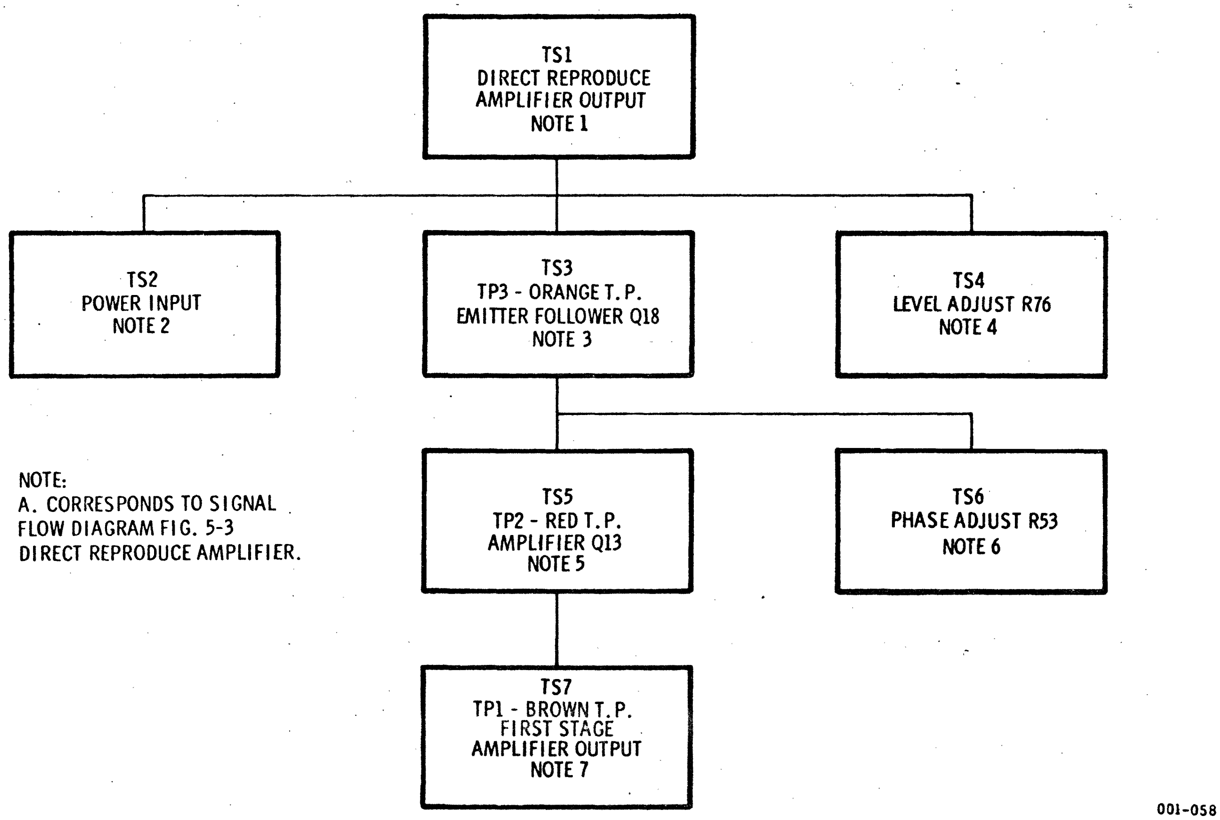


Figure 5-22. Direct Reproduce Amplifier Dependency Diagram.

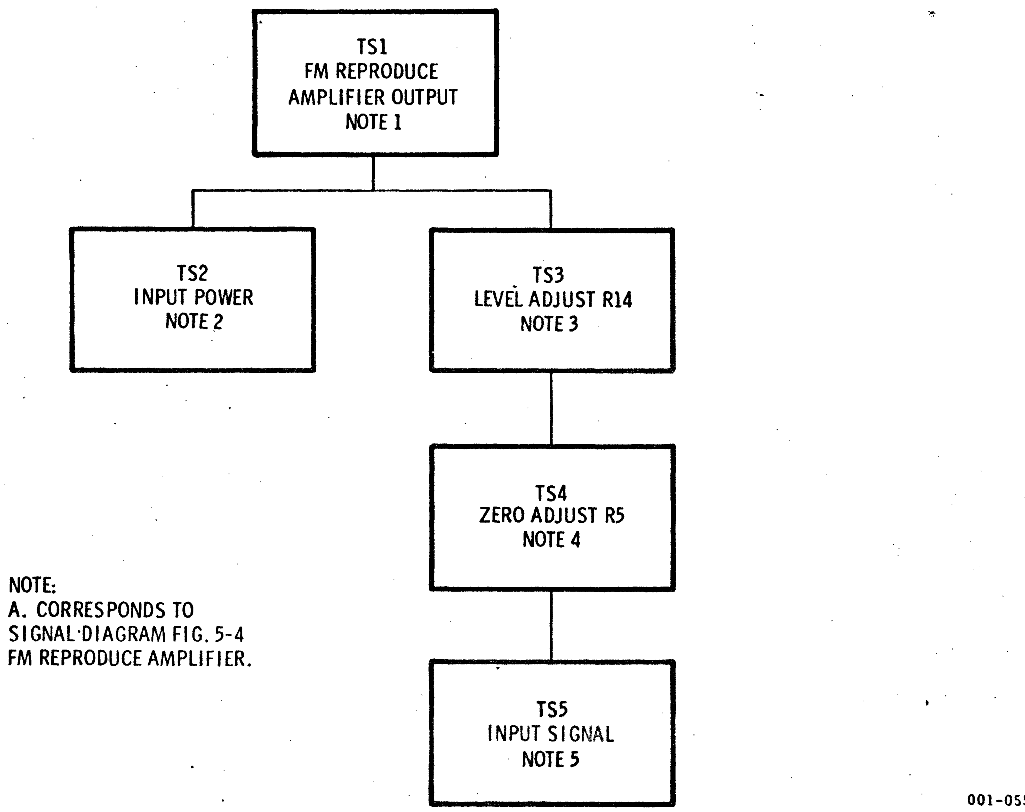


Figure 5-23. FM Reproduce Amplifier Dependency Diagram.

TABLE 5-1. TROUBLESHOOTING INDEX

Functional Area	Trouble-shooting Paragraph	Trouble-shooting Diagram	Functional Description Paragraph	Alighment Adjustment Paragraph
AC Power	5-4	5-6	3-79	Not Adjustabl
DC Power	5-5	5-6	3-80	6-35
Direct Record	5-6	5-12	3-48	6-16
Direct Reproduce	5-7	5-14	3-63	6-19
Fast Wind	5-8	5-19	3-15	Not adjustabl
Fast Rewind	5-9	5-19	3-15	Not adjustabl
FM Record	5-10	5-13	3-54	6-26
FM Reproduce	5-11	5-15	3-71	6-30
Forward	5-12	5-19	3-12	Not adjustabl
Reverse	5-13	5-19	3-14	Not adjustabl
Input Signals	5-14	5-12, 5-13	3-50, 3-54	Not adjustabl
Output Signals	5-15	5-14, 5-15	3-70, 3-77	Not adjustabl
Start	5-16	5-19	3-12	Not adjustabl
Stop	5-17	5-19	3-12	Not adjustabl
Tape Speed Control	5-18	5-9, 5-17	3-20	Not adjustabl
Tape Supply Ind.	5-19	5-19	3-43	6-39

TABLE 5-2. RELAY AND LAMP INDEX

Reference Designation	Functional Name	Energizing Voltage	Troubleshooting Diagram (Figure No.)
1A3S9DS1	MAIN POWER Indicator	+28 V dc	5-10
1A3S1DS1	TRANSPORT POWER Indicator	+28 V dc	5-10
1A3S2DS1	FORWARD Indicator	+28 V dc	5-10
1A3S3DS1	RECORD Indicator	+28 V dc	5-10
1A3S4DS1	REVERSE Indicator	+28 V dc	5-10
1A3S5DS1	FAST REWIND Indicator	+28 V dc	5-10
1A3S6DS1	FAST WIND Indicator	+28 V dc	5-10
1A3S7DS1	STOP Indicator	+28 V dc	5-10
1A1ADS2	Service Lamp	115 V ac	5-6
1A3A2DS1	STATUS Indicator (11 lamps)	+28 V dc	5-10
1A3M1	TAPE SUPPLY Indicator	+5 V dc	5-10
1A2A1A2DS1	Tape Supply Sensor Lamp	+28 V dc	5-6
1A3M2	VOLTAGE CHECK Indicator	Measured Voltage	5-10
1A1PS1K1	Power Distribution	115 V ac	5-6
1A3K1	Power Switch Relay	+28 V dc	3-26
1A3K2	Power Switch Relay	+28 V dc	3-26

TABLE 5-3. PROTECTIVE DEVICE INDEX

Reference Designation	Front Panel Marking	Rating Volts	Rating Amps	Circuit Protected	Troubleshooting Diagram
1A1PS1CB1	None	115	20	Unit Power	Figure 5-6
1A3F1	None (Rear)	28	5	Reproduce Amps.	Figure 5-6
1A3F2	None (Rear)	28	5	Indicator	Figure 5-6
1A2A1F1	REGULATOR F1 5 AMP	28	5	Regulator Circuits	Figure 5-6
1A2A1F2	LOGIC F2 2 AMP	28	2	Logic Circuits	Figure 5-6
1A2AF3	CAPSTAN F3 5 AMP	28	5	Capstan Circuits	Figure 5-6
1A2AF4	REEL DRIVE F4 7 AMP	28	7	Reel Drive Circuits	Figure 5-6

TABLE 5-4. TROUBLESHOOTING PROCEDURE

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
1. Power Distribution				
a. No 115 V ac input to unit.	No input.	After switching CB1 On, switch the utility light On, using the service switch.	Figure 5-6	Check continuity of interconnecting power cable.
	Power Relay malfunction.	Check pin A to B of P145 for 115 V ac after switching the MAIN POWER switch On.	Figure 5-6	Replace power relay if the MAIN POWER switch indicator is On.
b. Power supply faults.				
No +28 V dc on meter.	Defective fuse.	Check fuse 1A3F2 on back panel of RAM.	Figure 2-2 (sheet 2), and 5-6	Replace defective fuse.
	Probable Short.	Check circuit breaker CB1 for tripped condition (OFF).	Figure 5-6	a. Ensure that all switches are Off. b. Locate short and repair or replace as required.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Defective relays.	Check power switch assembly for +28 V dc on TB5-1 with MAIN POWER switch On.		
		Press TRANSPORT POWER switch and check on TB5-3 for +28 V dc.	Figure 5-6	Replace power switch assembly if there is +28 V dc on TB5-1 but not on TB5-3.
	Defective power supply.	Check pin A to B of P145 for 115 V ac.	Figure 5-6	
		Check P146 pin A for +28 V dc coming out of the power supply		Replace power supply if there is 115 V ac on pin A of P145 and no +28 V dc on P146 pin A.
	Defective relay.	Check action of relay K1 (power switch control relay) by pressing MAIN POWER switch off and on.	Figure 5-6	Replace defective relay.
	Power input connections.	Check for 115 V ac on J101 pin A to B.	Figure 5-6	Check continuity of 115 V ac power cable. Repair or replace if necessary.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
c. Power regulation faults.				
No +5 V dc	Defective Fuse.	Check fuse 1A2A1F1 on the front panel of the transport.	Figure 2-2	Replace defective fuse.
	Defective voltage regulator.	Check for +28 V dc on pin 22 of J25.	Figure 5-16	Refer to Trouble Symptom 1A.
		Check that the voltage regulator is seated properly.	Figure 5-16	Replace voltage regulator if card seating does not fix problem
No +20 V dc	Defective fuse.	Check fuse 1A2A1F1 on the front panel of the transport.	Figure 2-2, 5-6.	Replace defective fuse.
	Defective voltage regulator.	Check for +20 V dc, unregulated, on J25, pin 9 of the voltage regulator.	Figure 5-16	Change voltage regulator.
	Defective power amplifier heat sink assembly.	Check E2 on the servo heat sink assembly for +20 V dc regulated.	Figure 5-16	Replace power heat sink if there is no volts or a measurement of +28 V dc.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
No +18.5 V dc when in the RECORD mode.	Defective control	Simultaneously press the RECORD and FORWARD switches, while checking that J25 pin 5 has zero volts.	Figure 5-16	Replace control logic board.
	Defective power amplifier heat sink.	Check regulated +28 V dc on P22 pin 1.	Figure 5-16	Replace power amplifier heat sink.
		Check for +18.0 V dc on P22 pin 2.	Figure 5-16	Replace power amplifier heat sink.
No +15 V dc	Voltage regulator.	Check for +24 V dc on pin 19 of J25.	Figure 5-6	Replace voltage regulator.
		Check for +15 V dc on E1 of J30.	Figure 5-6	Replace the voltage regulator in the 15 V regulator and preamp interconnect assembly (even).
2. Transport				
a. Tape speed malfunction.	Defective servo amplifier.	Check if reference oscillation output at J105 is correct for speed selected, table 3-1.	Figure 3-3	Replace capstan servo amplifier.
		Check for +10 volts from the voltage regulator on J25 pin 18.	Figure 5-16	Replace voltage regulator.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Tachometer	Check tachometer lamp power from power amplifier servo heat sink on TB6-1 (+). and TB6-2 (-).	Figure 5-16	Replace power amplifier heat sink.
		Check for a tachometer signal output at pin Z. J26.	Figure 5-9	Replace motor assembly per paragraph 6-37.
		Check for a tachometer signal input to the capstan servo amplifier on J23 pin 16.	Figure 5-9	Replace BCD encoder.
b. Transport Malfunction				
Tape won't stop.	Defective logic control board.	Check J23 pins 5 and E for zero volts when STOP switch is pressed.	Figure 5-19	Replace logic control board
Runs at high speed when not in FAST WIND mode.	Defective control.	Using a card extender, check if J23 pins 11 or M are at zero volts.	Figure 5-19	Replace control logic board if reading is zero volts.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Defective capstan servo board.	Check reference oscillator output at J105 or J23 pins F or 6 for speed other than selected speed. Table 3-1.	Figure 5-17	Replace capstan servo board
	Defective tachometer.	Check for a tachometer signal input at capstan servo board J23 pins T or 16.	Figure 5-16	
		Check for a tachometer signal output on J26 pin Z.		Check step 2.a (tape speed malfunction) before replacing motor assembly per paragraph 6-53.
Improper tape tension.	Defective tape tension sensor lamp.	Check tape tension lamp	Figure 6-12	Replace tape sensor lamp (paragraph 6-48).
Tape reel will not turn.	Defective control logic board.	Using a card extender, check J24 pins P or 13 for approximately +28 V dc.	Figure 5-19	Replace control logic board.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Capstan servo board.	Check reference frequency oscillator for selected speed at J105.	Figure 5-17	Replace capstan board.
Unit will not go into REVERSE mode.	Control logic board.	Check J24 pin 6 for zero volts.	Figure 5-19	Replace control logic board.
	Servo power amplifier.	Check relay K1 in servo power amplifier.	Figure 5-18	Replace servo power amplifier.
Tape supply meter does not indicate proper tape level.	Tape sensors.	Refer to paragraph 6-39 for adjustment of tape sensors.	Figure 3-16	Adjust or replace as required.
c. Flutter exceeds 0.45% P/P from 0.2 Hz to 2.5 Hz.	Tape-guide bearings.	Inspect bearings. Refer paragraph 6-49.	Figure 7-1	Replace bearings as required.
	Phase lock marginal.	Check capstan, servo phase-lock signal. Refer to paragraph 3-24.	Figure 3-6	Replace capstan servo amplifier.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Capstan drive belt dirty or damaged.	Check capstan belt. Refer to paragraph 4-18.	Figure 6-15	Replace if necessary per paragraph 6-53.
	Reel-drive servos.	Check compliance arms sensor lamps, photocell sensors, and reel motors.	Figure 6-13	Replace reel servo if necessary.
	Tape guides and rollers out of alignment.	Check tape guides. Refer to paragraph 6-49.	Figure 7-1	Replace guides if needed, per paragraph 6-49.
3. Direct Record/Reproduce Functions				
a. Bias and record level.	Record level improperly adjusted.	Check bias and record level per paragraph 6-6.	Figure 6-1	Replace record and bias amplifier.
b. Frequency response is not within $\pm$ 3 dB at all tape speeds	Direct-Reproduce amplifier equalization.	Check direct-reproduce amplifier equalization paragraph 6-19.	Figure 6-3	Adjust or replace reproduce amplifier as required.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
	Head magnetized.	Demagnetize head paragraph 4-16.	Figure 4-2	Demagnetize head.
	Head worn.	If high-frequency response remains out of specification after the above two steps have been performed, and if the head has been in operation for 1,000 hours or more, replace the head.	Figure 6-14	Replace head if required. See paragraph 6-51.
c. Signal-to-noise ratio is not within specification.	Direct-Reproduce amplifier.	Check reproduce amplifier. See paragraph 6-19.	Figure 6-3	Adjust or replace reproduce amplifier if necessary.
	Noisy tape.	Replace tape.		Degauss and retest removed tape.
	Magnetized head.	Refer to paragraph 4-18.	Figure 4-2	Degauss head.
4. FM Record/Reproduce Functions				
a. Improper center frequency deviation.	FM-record amplifier.	Check adjustments. Refer to paragraph 6-23.	Figure 6-6	Adjust or replace FM-record board.

TABLE 5-4. TROUBLESHOOTING PROCEDURE (Cont'd)

Trouble Symptom	Probable Cause	Isolation Procedure	Reference	Corrective Action
b. Output	FM reproduce amplifier.	Check reproduce amplifier. Refer to paragraph 6-30.	Figure 6-8	Replace FM reproduce amplifier if required.

TABLE 5-5. MAINTENANCE TURN-ON PROCEDURE

STEP	OBSERVE	REFERENCE
1. Preliminary procedure for turning power ON.		
a. Open transport and turn circuit breaker to ON position.	Place service lamp switch (located immediately above circuit breaker) in ON position. Service lamp should light. Turn service lamp off.	
b. Close and latch transport and press the MAIN POWER switch.	MAIN POWER switch indicator will light and the fan will come on.	Refer to Table 5-4, Power Distribution
c. Press the TRANSPORT POWER switch.	TRANSPORT POWER and STOP switch indicators will light. Selected speed is indicated on status indicator. (If the tape reels are not on the transport with the tape threaded, the TAPE BREAK and END-OF-TAPE will light on the status indicator.	
d. Position VOLTAGE check switch to 5 V.	Meter should indicate +5 V dc.	Refer to Table 5-4, Power Regulation
e. Position VOLTAGE check switch to 15 V.	Meter should indicate +15 V dc.	
f. Position VOLTAGE check switch to 20 V.	Meter should indicate +20 V dc.	
g. Position VOLTAGE check switch to 28 V.	Meter should indicate +28 V dc.	

TABLE 5-5. MAINTENANCE TURN-ON PROCEDURE (Cont'd)

STEP	OBSERVE	REFERENCE
2. Turn TRANSPORT POWER		
3. Install the supply and tape reels if they are not on the transport and thread accordingly to the diagram on the front right hand side of the transport.	BREAK TAPE and END-OF-TAPE on the status indicator will not be lighted.	Refer to Table 5-4, step 2.
4. Turn TRANSPORT POWER.		
5. Record		
a. Press the switches RECORD and FORWARD.	Record and FORWARD indicators will light and transport will move at the selected speed. Unit will now be recording.	Refer to Table 5-4, step 2.
b. Position the VOLTAGE check switch to 18.5 V.	Meter should indicate +18.5 V dc on its scale. (This measurement can only be taken in the record mode.)	Refer to Table 5-4, Power Regulation faults.
6. Reproduce		
a. Press only the FORWARD switch.	FORWARD indicator will light. Tape will be moving over the heads and unit will be reproducing.	Refer to Table 5-4, steps 3 and 4.

CHAPTER 6

CORRECTIVE MAINTENANCE

6-1. INTRODUCTION.

6-2. This chapter provides corrective maintenance information on the Magnetic Tape Recorder/Reproducer unit. The information is to be used by on-board maintenance personnel to return the unit to fully operational readiness condition after equipment failure.

6-3. PURPOSE.

6-4. The purpose of this chapter is to provide detailed procedures for adjustment and alignment of the unit and for removal, repair, and replacement of malfunctioning parts.

6-5. SCOPE.

6-6. Information in this chapter is to be used by the maintenance technician in the unit's operating environment. Corrective maintenance procedures do not require removal of the unit from the cabinet. The maintenance procedures are based on removal, replacement, adjustment, and alignment, rather than repair of malfunctioning assemblies. Since this manual is not intended to provide instructions for overhaul, defective assebmlies are to be sent through proper channels for depot or factory repair. Shipboard spares are to be used for replacement of defective components or assemblies.

6-7. ARRANGEMENT OF CORRECTIVE MAINTENANCE DATA.

6-8. The main divisions in this chapter are: Section I, Adjustments; and Section II, Repairs and Replacements. Section I describes the detailed step-by-step adjustment procedures and the proper test equipment to perform the prescribed adjustments. Section II describes the disassembly, repair (if applicable), removal and replacement of components.

SECTION 1

ADJUSTMENTS AND ALIGNMENTS

6-9. INTRODUCTION.

6-10. This section contains all adjustments and alignments that are not normally performed by the operator. All procedures are supported with test setups and illustrations, as required. The procedures are given in step-by-step format, and describe how to adjust and align when minimum performance tests or scheduled maintenance conditions are not met.

6-11. PRELIMINARY PROCEDURES.

6-12. Before making any adjustments, perform the following steps.

1. Clean heads and tape path as described in paragraph 4-14.

2. Demagnetize the headstacks as described in paragraph 4-16.

3. Thread transport with a freshly degaussed reel of recommended tape.

6-13. DIRECT/ANALOG SIGNAL ELECTRONICS ADJUSTMENTS.

6-14. The following paragraphs describe the procedure for adjusting the direct/analog signal electronics. These adjustments should be checked, and readjusted if necessary, after every 60 to 100 hours of equipment operation.

6-15. TEST EQUIPMENT REQUIRED. The following test equipment (or equivalent) is required to check and adjust the direct/analog signal electronics.

1. Sinewave Oscillator, H-P 651B.

2. Squarewave Generator, Wavetek Model 130.

3. Oscilloscope, Tektronix 545.

4. Wave Analyzer, H-P 310A.

5. AC VTVM, H-P 400E.

6-16. DIRECT/ANALOG RECORD AMPLIFIER ADJUSTMENTS. To adjust the direct/analog record amplifier, perform the procedures described in the following paragraphs.

1. Perform the preliminary procedures described in paragraph 6-6.

2. Connect test equipment as shown in Figure 6-1.

3. Loosen the four captive-screws and open the hinged covers of the record amplifier housings (Figure 6-2).

NOTE

Odd channel record amplifiers (1, 3, 5, etc.) are located in the right-hand amplifier housing. Even channel record amplifiers (2, 4, 6, etc.) are located in the left-hand amplifier housing.

6-17. Bias Level Adjustment. To adjust the bias level, perform the following steps (Figure 6-3).

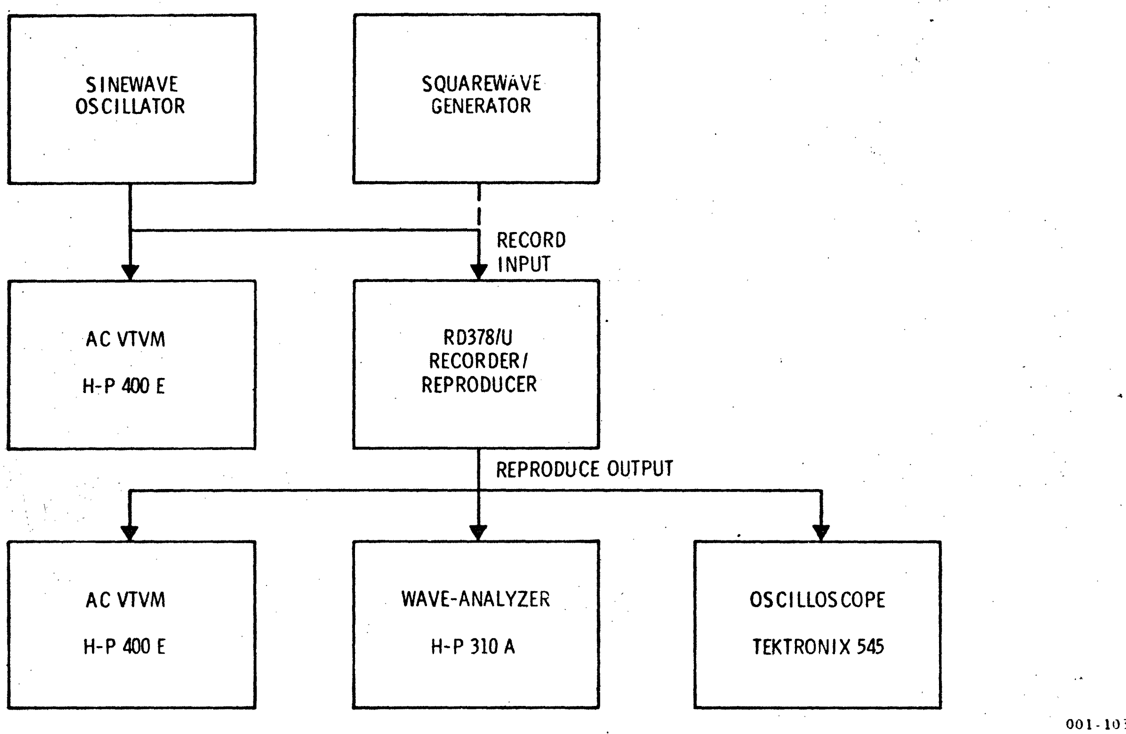


Figure 6-1 **Test Setup for Direct/Analog Signal Electronics Adjustment.**

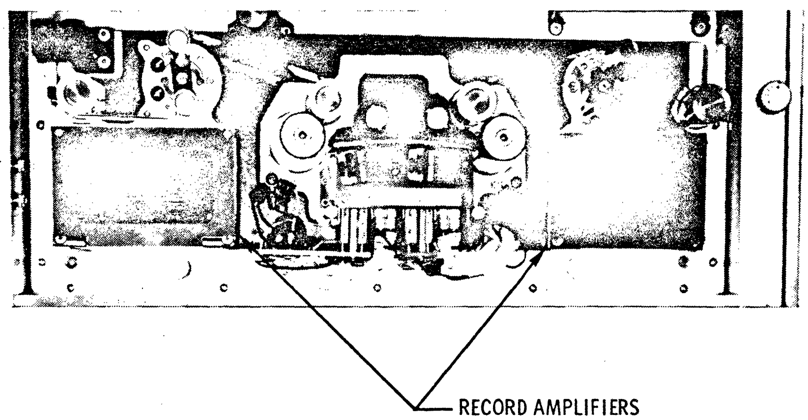


Figure 6-2. Record Amplifier Location.

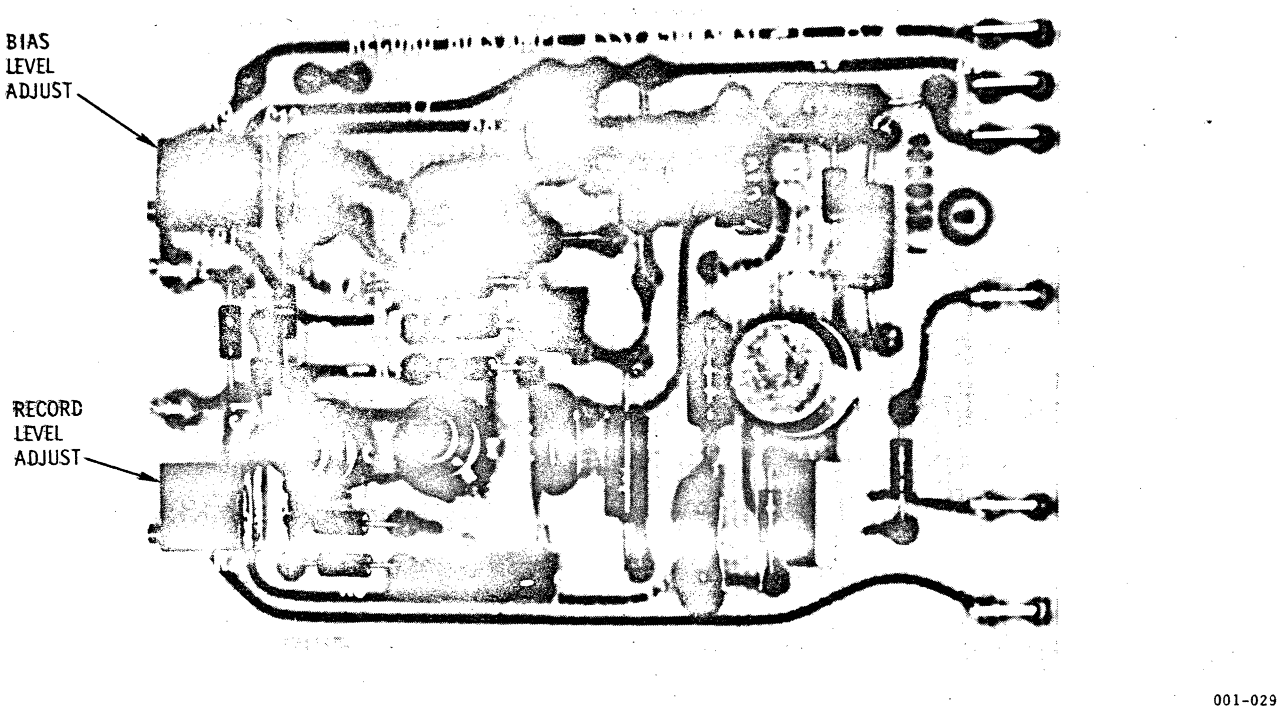


Figure 6-3. Record and Bias Level Adjustments

NOTE

BIAS and RECORD LEVEL controls are normally adjusted at 60 ips, to provide optimum performance at all tape speeds. If only a single tape speed will be used, adjust these controls at that speed, using input frequencies proportional to the tape speed utilized.

1. Place the unit in the RECORD mode at 60 ips.

2. Set the sinewave oscillator to a frequency of 1.0 MHz.

3. Adjust the sinewave oscillator output amplitude equal to 6.0 dB below the normal record level (NRL) that will be used in actual operation.

NOTE

An output amplitude that is 6.0 dB below NRL is equal to 1/2 the value of the data signal amplitude that the unit will be required to record, in normal operation. (i.e., any signal level between 0.2 and 10.0 V rms.)

4. Locate the channel 1 record amplifier. Turn the BIAS LEVEL ADJ. control (R9) several turns CCW, while observing the output indication on the ac VTVM. The meter indication should DECREASE.

5. Turn the BIAS LEVEL ADJ. control slowly CW. The ac VTVM should indicate a steady increase in output level. Continue to turn R9 CW, until a peak reading is indicated, then still further CW until the meter indication decreases 2.0 dB below the peak indication.

6-18. Record Level Adjustment. To adjust the record level, perform the following steps.

1. Set the sinewave oscillator to the frequency equal to 1/10 to upper-bandedge frequency of the recorder. (i.e., 100 kHz at 60 ips.)

2. Adjust the sinewave oscillator output amplitide equal to the normal record level that will be used in actual operation (usually 1.0 V rms).

NOTE

Any input level between 0.2 and 10.0 V rms may be used as the Normal Record Level. The actual level selected should correspond to the normal output level of the device used to drive the recorder under actual operating conditions. As a matter of convenience, the unit was adjusted to accept a record input signal level of 1.0 V rms, prior to shipment from the factory.

3. Adjust the wave analyzer to the same frequency as the sinewave oscillator. Adjust the analyzer gain for a 0.0 dB indication on the front panel level meter. The RD378/U reproduce output level should be maintained at 1.0 V rms, as indicated on the ac VTVM. Adjustment of the channel 1 reproduce amplifier OUTPUT LEVEL control (R76) will normally be required to maintain a constant 1.0 V rms output level (Figure 6-4).

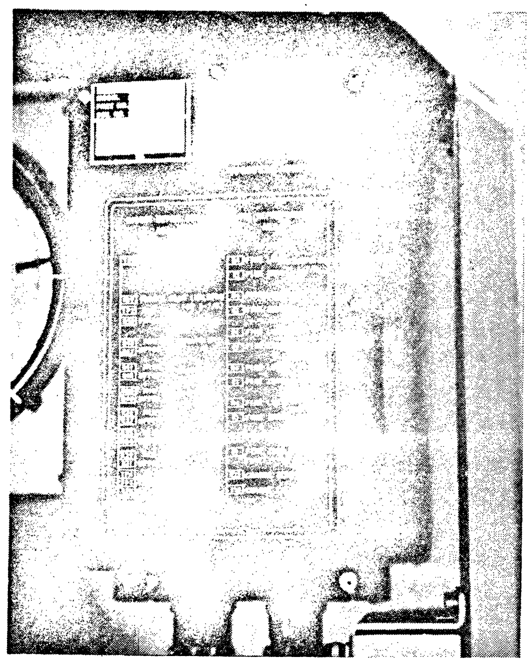


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Figure 6-4. Reproduce Amplifier Adjustment Guide.

4. Adjust the wave analyzer to read the 3rd harmonic of the sinewave oscillator frequency (i. e., 300 kHz). Increase the analyzer sensitivity by 40 dB.

5. Adjust channel 1 RECORD LEVEL ADJ. (R2) for an indication of (-) 34. 0 dB, as read on the wave analyzer meter, while maintaining a reading of 1. 0 V rms on the ac VTVM, through adjustment of OUTPUT LEVEL control R76.

6. Adjust the wave analyzer to read the 2nd harmonic of the sinewave oscillator frequency (i. e., 200 kHz). The 2nd order harmonic should be more than 40 dB below 1. 0 V rms. Higher readings usually indicate a magnetized headstack. Degauss the heads in accordance with the procedure outlined in paragraph 4-16.

7. Repeat bias adjustment and record level adjustment for the remaining direct record channels.

6-19. DIRECT/ANALOG REPRODUCE AMPLIFIER ADJUSTMENTS. To adjust the direct/analog reproduce amplifier, perform the procedures described in the following paragraphs.

6-20. Preliminary Procedures. Before attempting adjustment of the direct/analog reproduce amplifiers, perform the following preliminary procedures.

1. Connect test equipment as shown in Figure 6-1.

2. Remove the dust-cover door loosen the transport latches, and swing the transport out of the cabinet to the full open position.

3. Lift the hinged cover of the reproduce amplifier housing to gain access to the reproduce amplifiers.

6-21. Direct/Analog Reproduce Amplifier Adjustment Procedure. To adjust the direct/analog reproduce amplifiers, perform the following steps.

1. Place the unit in the RECORD mode at 60 ips.

2. Set the sinewave oscillator to a frequency of 100 kHz at an output level of 1. 0 V rms.[1]

3. Refer to Figure 6-4. Adjust OUTPUT LEVEL ADJ. (R76) for 1. 0 V rms, as indicated on the output ac VTVM.

4. Set the sinewave oscillator to a frequency of 2. 0 kHz at an output level of 1. 0 V rms. Adjust 60 ips MIDBAND GAIN ADJ. (R41) for 1. 0 V rms output.

5. While maintaining a 1. 0 V rms oscillator output level, slowly sweep the frequency between 400 Hz and 100 kHz. While monitoring the output ac VTVM, note any dips or peaks in the output signal level.

1. NOTE: For purposes of explanation, 1. 0 V rms is used at the normal record level (NRL). However, any input level between 0. 2 and 10. 0 V rms may be used as the NRL which best satisfies a particular system requirement.

a. If output dips - set oscillator to 2. 0 kHz and adjust MIDBAND GAIN ADJ. (R41) for a 2. 0 dB decrease in output level. Then, without changing oscillator frequency or amplitude, adjust OUTPUT LEVEL ADJ. (R76) for a 2. 0 dB increase in output level.

b. If output peaks - set oscillator to 2. 0 kHz and adjust MIDBAND ADJ. (R41) for a 2. 0 dB increase in output level. Then, without changing oscillator frequency or amplitude, adjust OUTPUT LEVEL ADJ. (R76) for a 2. 0 dB decrease in output level.

c. Recheck frequencies between 400 Hz and 100 kHz and continue to adjust R41 and R76 until frequency response, across this portion of the bandwidth, is flat within $\pm$2. 0 dB.

6. Set the sinewave oscillator to a frequency of 1. 0 MHz at an output level of 1. 0 V rms. Adjust the 60 ips BANDEDGE ADJ. control (R43) for an indication of 2. 0 dB below 1. 0 V rms, as measured on the output ac VTVM.

7. Disconnect the sinewave oscillator and connect the squarewave generator to the record input.

8. Set the squarewave generator to a frequency of 50 kHz at an output level of 3. 0 V p-p.

9. While observing the output waveform on the monitor oscilloscope, adjust PHASE ADJ. control (R53) for proper leading and trailing edge overshoot, as shown in Figure 6-5.

10. Disconnect squarewave generator and reconnect sinewave oscillator.

11. Repeat steps (2) through (10) until both sinewave and squarewave response are correct, as indicated.

12. Place the unit in the RECORD mode at 120 ips.

13. Set the sinewave oscillator to a frequency of 2. 0 kHz at an output level of 1. 0 V rms. Adjust the 120 ips MIDBAND GAIN ADJ. (R45) for 1. 0 V rms output, as measured on the output ac VTVM.

14. Set the sinewave oscillator to a frequency of 200 kHz at an output level of 1. 0 V rms. Adjust the 120 ips COMPENSATION ADJ. control (R19) for 1. 0 V rms output, as measured on the output ac VTVM.

15. Set the sinewave oscillator to a frequency of 2. 0 MHz at an output level of 1. 0 V rms. Adjust the 120 ips BANDEDGE ADJ. control (R47) for an indication of 2. 0 dB below 1. 0 V rms, as measured on the output ac VTVM.

16. Sweep the sinewave oscillator between 400 Hz and 2. 0 MHz, making adjustments as necessary for a flat overall frequency response ($\pm$3. 0 dB).

a. To increase midband gain, turn R19 CW.

b. To increase low frequency gain, turn R45 CW.

c. To increase upper bandedge gain, turn R47 CW.

d. If there is a peak between midband and upper bandedge, turn R45 CW.

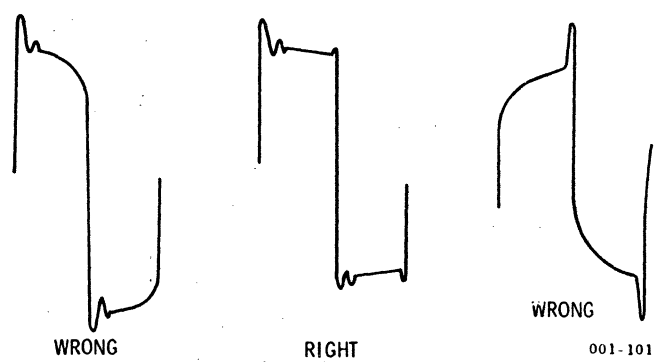


Figure 6-5. Phase Adjustment

17. Using Table 6-1 adjust equalization for the remaining tape speed.

6-22. SIGNAL-TO-NOISE RATIO MEASUREMENT. SNR measurements may be made at any tape speed, using the following procedure.

1. Set sinewave oscillator to a frequency equal to 1/10 the upper-bandedge frequency for the particular tape speed selected. Adjust the oscillator output level equal to the NRL being utilized.

2. Note the output reading on the output ac VTVM.

3. Disconnect the sinewave oscillator and read SNR on the output ac VTVM.

6-23. FM SIGNAL ELECTRONICS ADJUSTMENT.

6-24. The following paragraphs describe the procedure for adjusting the FM signal electronics. These adjustments should be checked, and readjusted if necessary, after every 60 to 100 hours of equipment operation.

6-25. TEST EQUIPMENT REQUIRED. The following test equipment (or equivalent) is required to check and adjust the FM signal electronics.

1. Digital Voltmeter, H-P 3439 A.

2. Frequency Counter, H-P 5512.

3. Reference Power Supply, H-P 6113 A.

4. Oscilloscope, Tektronix 545.

6-26. FM RECORD AMPLIFIER ADJUSTMENTS. To adjust the FM record amplifier, perform the procedures described in the following paragraphs.

1. Perform the preliminary procedures described in paragraph 6-11.

2. Connect test equipment as shown in Figure 6-6.

TABLE 6-1. EQUALIZATION ADJUSTMENTS

Tape Speed	Osc. Freq.	Adjust	Output Indication
30 ips	2 kHz	R38	1.0 V rms
30 ips	500 kHz	R40	-2 dB
15 ips	2 kHz	R35	1.0 V rms
15 ips	250 kHz	R37	-2 dB
7-1/2 ips	2 kHz	R32	1.0 V rms
7-1/2 ips	125 kHz	R34	-2 dB
3-3/4 ips	2 kHz	R29	1.0 V rms
3-3/4 ips	62.5 kHz	R31	-2 dB
1-7/8 ips	2.0 kHz	R45	1.0 V rms
1-7/8 ips	31.2 kHz	R47	-2 dB

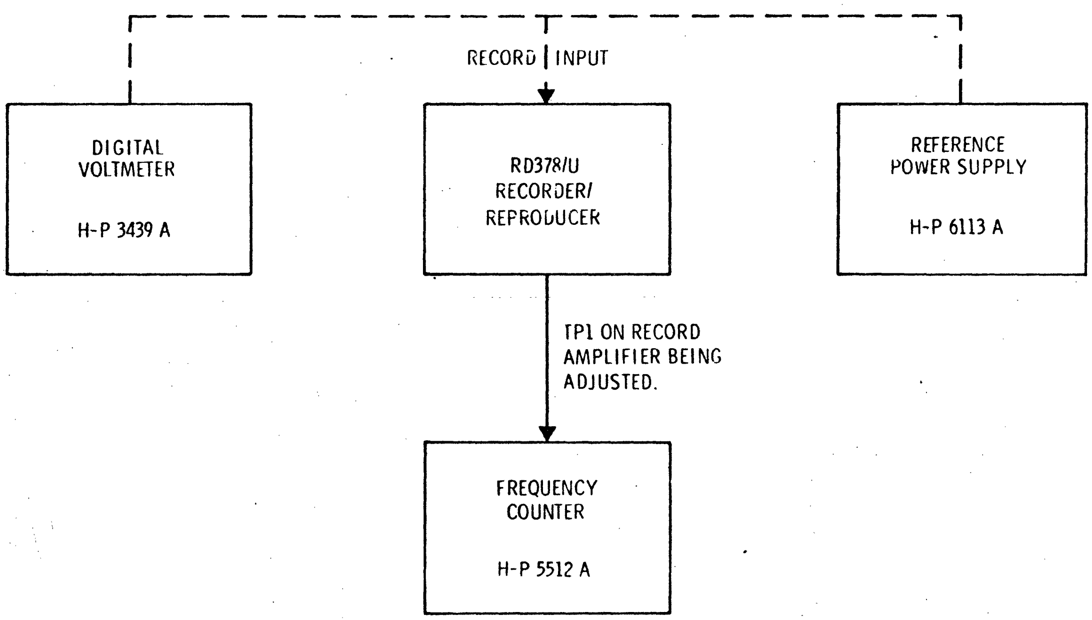


Figure 6-6. Test Setup for FM Record Amplifier Adjustment.

3. Loosen the four captive-screws and open the hinged covers of the record amplifier module (Figure 6-2).

NOTE

Odd channel record amplifiers (1, 3, 5, etc.) are located in the right-hand amplifier housing. Even channel record amplifiers (2, 4, 6, etc.) are located in the left-hand amplifier housing.

6-27. Input Zero Adjustment.

NOTE

Any inherent dc voltage present at the input of the FM Record Amplifier will deviate the VCO carrier frequency away from its center or resting point, causing non-linear distortion at the reproduce output. It is, therefore, important to balance out any residual dc before attempting to adjust the VCO center frequency, or carrier deviation.

1. Place the unit in the RECORD mode at 60 ips.

2. With the digital voltmeter connected to channel 1 Record Input connector, adjust DC ZERO ADJ. (R4) for 0.0 V dc, $\pm$0.001 V dc (Figure 6-7).

6-28. FM Center Frequency Adjustment. To adjust the FM center frequency, perform the following steps.

1. Remove the digital voltmeter from channel 1 record input connector, and replace with a shorting connector.

2. Adjust FM CENTER FREQ. control (R33) for a reading of 216.0 kHz, as read on the frequency counter.

6-29. Deviation Adjustment. To adjust FM carrier deviation, perform the following steps.

1. Remove the shorting connector from the channel 1 record input connector.

2. Connect reference power supply to the channel 1 record input connector.

3. Adjust power supply for an output voltage of (+)1.414 V dc.

4. Adjust DEVIATION ADJ. controls (R2 - coarse and R7 - fine) for +40 percent deviation (302.4 kHz, $\pm$0.01 percent).

5. Adjust power supply for an output voltage of (-)1.414 V dc.

6. Check FREQUENCY COUNTER for -40 percent deviation (129.6 kHz, $\pm$0.01 percent).

7. Repeat steps (2) through (5), as required.

8. Check center frequencies and deviation at remaining tape speeds, in accordance with Table 6-2.

6-30. FM REPRODUCE AMPLIFIER ADJUSTMENTS. To adjust the FM reproduce amplifiers, perform the procedures described in the following paragraphs.

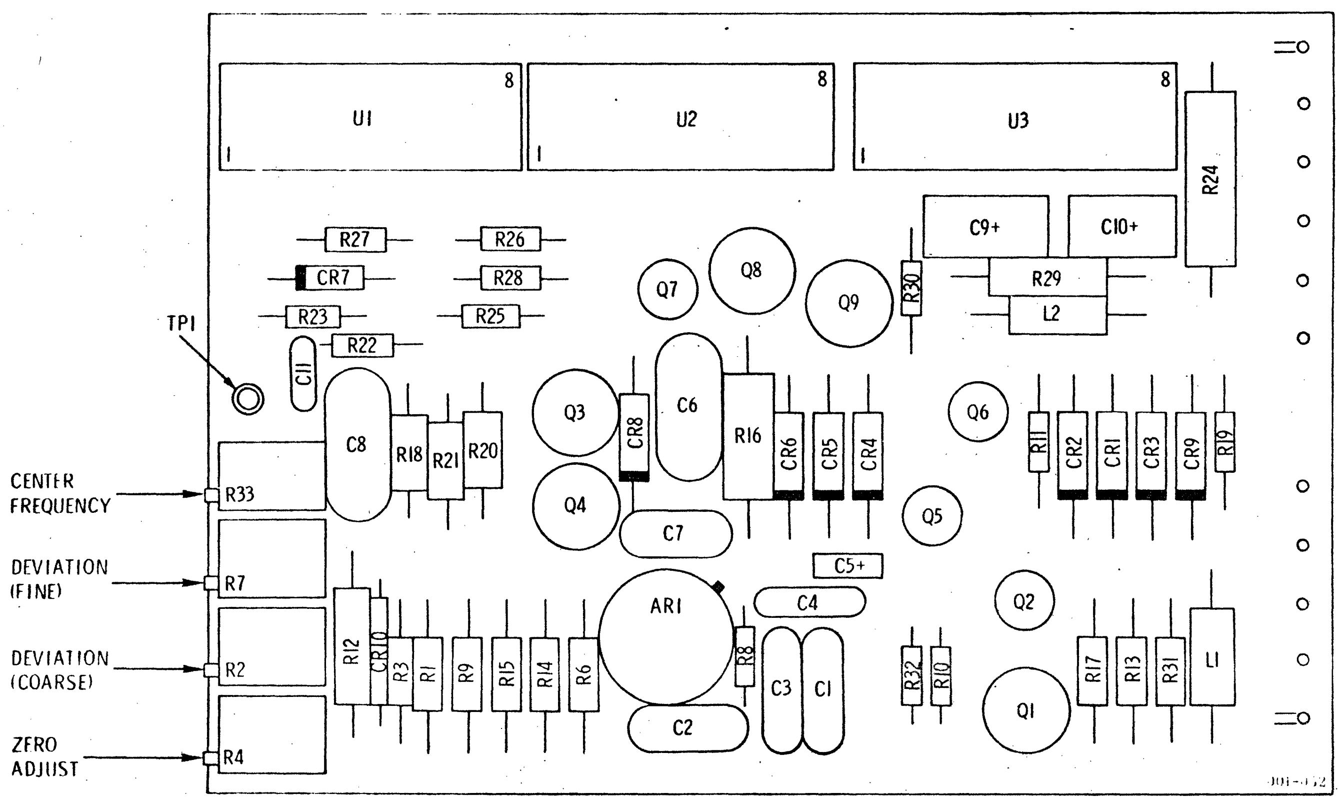


Figure 6-7. FM Record Amplifier Adjustments.

TABLE 6-2. CENTER FREQUENCIES AND DEVIATIONS

Wideband Group I

Tape Speed	Center Freq. (kHz)	+40% (kHz)	-40% (kHz)
120 ips	432.000	604.8	259.2
60 ips	216.000	302.4	129.6
30 ips	108.000	151.2	64.8
15 ips	54.000	75.6	32.4
7-1/2 ips	27.000	37.8	16.2
3-3/4 ips	13.500	18.9	8.1
1-7/8 ips	6.750	9.45	4.05

NOTE

Allow a 15-minute warmup period, to stabilize the one-shot oven, before attempting adjustments to the FM reproduce amplifiers.

NOTE

The FM record amplifiers must be properly adjusted for carrier and deviation before performing adjustments to the FM reproduce amplifiers.

6-31. Preliminary Procedures. Before attempting adjustments to the FM reproduce amplifiers, perform the following preliminary procedures.

1. Connect test equipment as shown in Figure 6-8.

2. Remove the dust-cover door, loosen the transport latches, and swing the transport out of the cabinet to the full open position.

3. Lift the hinged cover of the reproduce amplifier housing to gain access to the reproduce amplifiers.

6-32. FM Reproduce Amplifier Adjustment Procedure. To adjust the FM reproduce amplifiers, perform the following steps (see Figure 6-3).

1. Place the unit in the STOP mode.

2. Remove the speed change logic board from the reproduce amplifier housing.

3. Connect the digital voltmeter to an FM reproduce output connector.

4. Adjust the OVERALL ZERO ADJ. (R14) for an output of 0.000 V dc, as measured on the digital voltmeter.

5. Repeat steps (3) and (4) for all FM channels.

6. Replace speed change logic board.

7. Place a shorting connector on record input connector.

8. Connect digital voltmeter to corresponding reproduce output connector.

9. Place the unit in the RECORD mode at 60 ips.

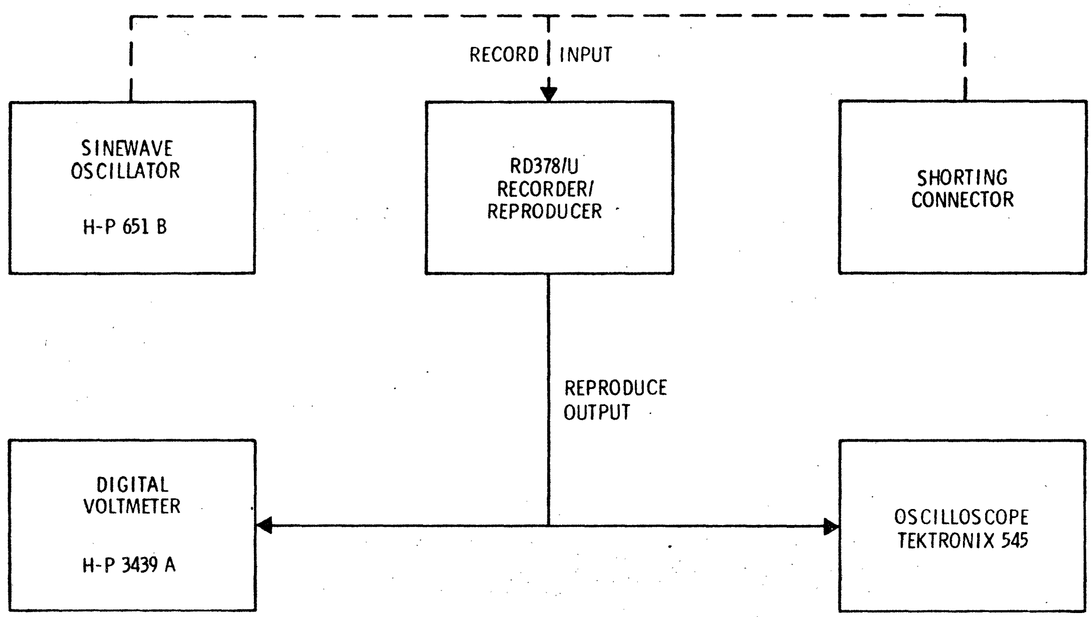


Figure 6-8. Test Setup for FM Reproduce Amplifier Adjustments.

10. Adjust 60 ips ZERO ADJ. control (R4) for 0.000 V dc, as measured on the digital voltmeter.

11. Place the unit in the STOP mode, and change transport speed to 30 ips.

12. Place the unit in the RECORD mode and adjust 30 ips ZERO ADJ. (R4) for 0.000 V dc, as measured on the digital voltmeter.

13. Repeat steps (11) and (12) for the four remaining tape speeds.

14. Repeat steps (9) through (13) for all remaining FM channels.

15. Remove the shorting connector from the record input connector.

16. Set sinewave oscillator to a frequency of 1.0 kHz, at a level of 1.0 V rms.

17. Place the unit in the RECORD mode at 60 ips.

18. Adjust the 60 ips OUTPUT LEVEL ADJ. (R1) for desired output level between 2.0 V p-p and 4.0 V p-p.

19. Repeat steps (17) and (18) for the remaining five tape speeds, adjusting the appropriate OUTPUT LEVEL ADJ. (R1) for each speed.

20. Repeat steps (15) through (19) for all remaining FM channels (2 through 14).

6-33. REPRODUCE HEAD AZIMUTH ADJUSTMENT.

6-34. To ensure optimum high-frequency response during reproduce, the reproduce head-gaps must be exactly parallel with the head-gaps of the record head. This is accomplished by adjusting the azimuth of the reproduce headstack to coincide with the fixed azimuth of the record head. To adjust the reproduce head azimuth, proceed as follows:

NOTE

> Direct/Analog signal electronics must be installed in the channels utilized to adjust reproduce head azimuth. FM signal electronics do not have sufficient bandwidth response for proper azimuth adjustment.

1. Connect test equipment as shown in Figure 6-9.

2. Remove transport head-cover to gain access to the reproduce head azimuth adjustment screws.

3. Adjust sinewave oscillator for a low-frequency output, between 1.0 kHz and 2.0 kHz, with an output amplitude of 1.0 V rms.

4. Adjust oscilloscope for an alternate display, and external triggering on track 1 reproduce output.

5. Place the unit in the RECORD mode at 60 ips.

6. Adjust oscilloscope to display 2 to 4 cycles of the output waveform on each trace. Using the vertical position controls, superimpose the two traces. Adjust the oscilloscope vertical gain controls so that both waveforms are of the same amplitude.

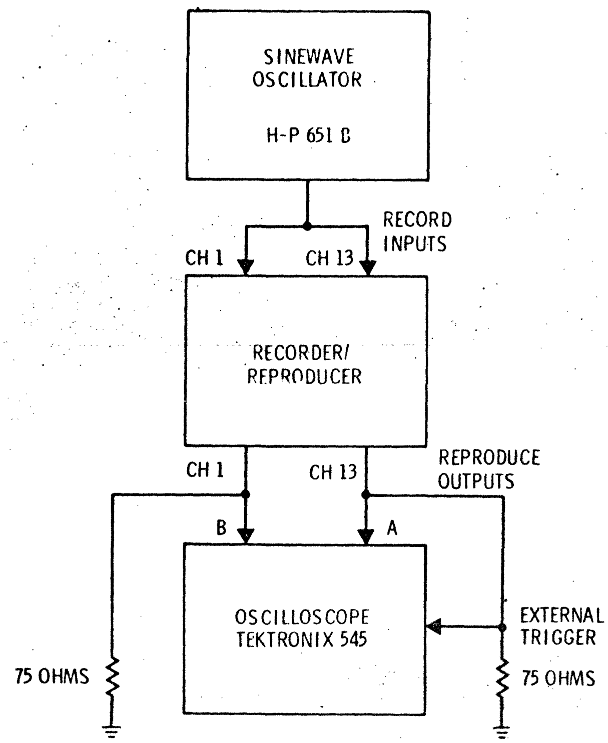


Figure 6-9. Test Setup for Azimuth Adjustment.

7. Using a small Allen-wrench, adjust the ODD CHANNELS AZIMUTH A ADJ. screw - located on the right-hand side of the headstack - until the two reproduce waveforms are exactly in phase.

CAUTION

To prevent magnetizing the headstack, degauss the Allen-wrench before making azimuth adjustments.

8. Slowly increase the oscillator frequency until a phase difference is evident, then re-phase with the azimuth adjustment.

NOTE

It may be necessary to move one of the waveforms back and forth several cycles, before the proper "in-phase" condition is reached.

9. Continue to increase oscillator frequency, and oscilloscope sweep time, while maintaining 2 to 4 cycles on the screen.

10. As upper-bandedge frequency is approached, an increased amount of waveform jitter will be observed, and proper azimuth adjustment will become extremely critical. Carefully readjust the AZIMUTH screw to center the jittering waveform with the fixed (reference) waveform.

NOTE

It is not necessary to continue increasing oscillator frequency all the way to the upper-bandedge limitations of the recorder. However, frequency should continue to increase well into the upper 1/3 of the recorder bandwidth.

11. Now, slowly decrease the oscillator frequency, observing that the two superimposed waveforms remain in phase, all the way to the lower bandedge limit of the recorder.

12. Repeat steps (6) through (11) for the even channels, as follows:

a. Connect oscillator to track 2 and track 14 record inputs.

b. Connect oscilloscope to track 2 and track 14 reproduce outputs.

c. Adjust EVEN CHANNELS AZIMUTH ADJ. screw - located on the left-hand side of the headstack.

13. Replace transport head-cover.

6-35. VOLTAGE REGULATOR ADJUSTMENT.

6-36. Refer to Figure 6-10 for test equipment hook-up.

6-37. TEST EQUIPMENT REQUIRED.

1. Digital Voltmeter, H-P 3439 A.

6-38. PROCEDURE.

1. Connect the digital voltmeter to the voltage test points on the front panel of the RAM (Figure 6-10).

2. Open the tape transport and remove the coverplate from the electronic housing assembly.

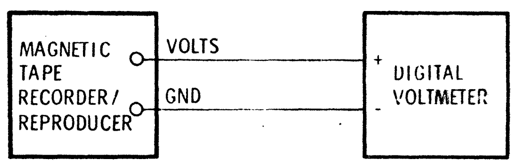


Figure 6-10. Voltage Regulator Test Setup.

3. Thread the transport with tape, and place unit in the RECORD mode at 3-3/4 ips.

4. Select the 18.5 V position of the VOLTAGE SELECT switch, on the front panel of the RAM.

5. Digital voltmeter should indicate +18.5 V dc, $\pm 1\%$. If not, adjust R8 on the voltage regulator (Figure 6-11). for an indication between +18.3 and 18.7 V dc.

6. Select the 20 V position of the VOLTAGE SELECT switch, on the front panel of the RAM.

7. Digital voltmeter should indicate +20 V dc, $\pm 1\%$. If not, adjust R15 on the voltage regulator for an indication between +19.8 and +20.2 V dc.

8. Select the 5 V position of the VOLTAGE SELECT switch. Digital voltmeter should indicate +5.5 V dc, $\pm$0.5 V dc. This voltage is not adjustable. If voltage is not as specified, determine cause of malfunction.

9. Select the 15 V position of the VOLTAGE SELECT switch. Digital voltmeter should indicate +15, $\pm$0.15 V dc. This voltage is not adjustable. If voltage is not as specified, determine cause of malfunction.

6-39. TAPE SUPPLY SENSOR ADJUSTMENT.

6-40. Refer to Figure 3-12. The Tape Supply Sensor adjustments (R33 and R35) are located in the tape-supply/EOT Sensor, at the upper left-hand corner of the tape transport. The current through these sensors should be adjusted periodically, for proper indication on the Tape Supply Meter. To adjust sensors, proceed as follows:

6-41. TEST EQUIPMENT REQUIRED. No test equipment is required.

6-42. PROCEDURE.

1. Remove tape and tape reels from transport.

2. Turn transport power ON. The TAPE SUPPLY indicator meter, on the front panel of the RAM, should read close to empty; the EOT status indicator lamp should be lighted.

3. Adjust R33 until pointer of meter reads EMPTY, on the meter scale. If meter cannot be properly set, adjust R35 - then readjust R33.

4. Cover both tape supply sensor assemblies with masking tape. The TAPE SUPPLY indicator meter should read FULL. If not, adjust R35.

5. Repeat steps (3) and (4) until meter indicates properly for both the EMPTY and FULL conditions.

NOTE

Ambient light may affect proper adjustment of the tape supply sensors. If so, adjustment should be made in a semi-darkened location.

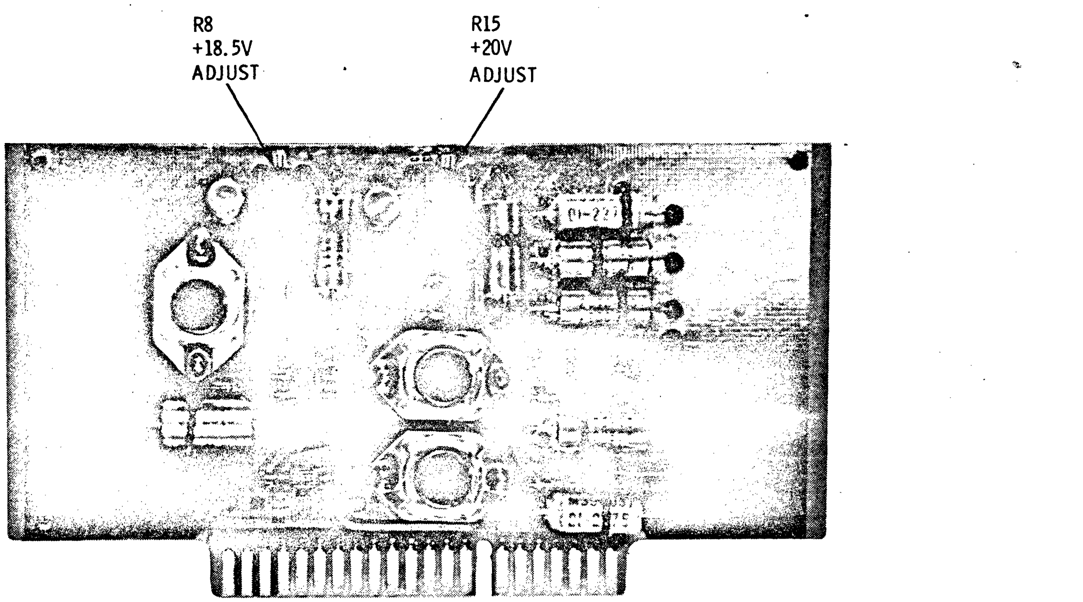


Figure 6-11. Voltage Regulator Adjustment.

SECTION II

REPAIR

6-43. INTRODUCTION.

6-44. This section describes the removal and replacement of component parts and assemblies, but does not include procedures for their repair. Field repairs to major mechanical assemblies is not recommended. Rather, these assemblies should be serviced at the depot level, or returned to the manufacturer for repair at the factory. Electronic repairs described in this section consist only of isolating and replacing faulty printed wiring cards. Should there be a malfunction of one of the printed wiring cards, it should be replaced with a spare card and the defective card sent to the depot, or factory, for repair.

6-45. STATUS INDICATOR LAMP REPLACEMENT.

1. Refer to Figure 6-12. Remove the glass faceplate from the Status Indicator by depressing the two spring-loaded retaining clips, and gently pulling faceplate away from RAM.

2. Replace defective indicator bulb.

3. Replace glass faceplate.

6-46. PUSHBUTTON LAMP REPLACEMENT.

1. Refer to Figure 6-12. Grasp the edges of the pushbutton lens and gently pull straight out - away from RAM.

2. Replace defective bulb.

3. Replace the lens in the pushbutton assembly, and press in firmly until it latches in place.

6-47. TAPE SUPPLY LAMP REPLACEMENT.

1. Refer to Figure 3-16.

NOTE

Carefully note the position of the aperture in the metal shroud that protects the tape supply lamp. This aperture must be correctly repositioned, to properly illuminate the Tape Supply Sensors.

2. Loosen the small Allen screw securing the metal shroud covering the lamp.

3. Remove shroud by gently pulling straight out - away from the tape transport.

4. Replace defective bulb.

5. Replace shroud, reposition, and tighten setscrew.

6. Check tape supply sensor adjustment, paragraph 6-39.

6-48. TENSION SENSOR LAMP REPLACEMENT.

1. Refer to Figure 6-13.

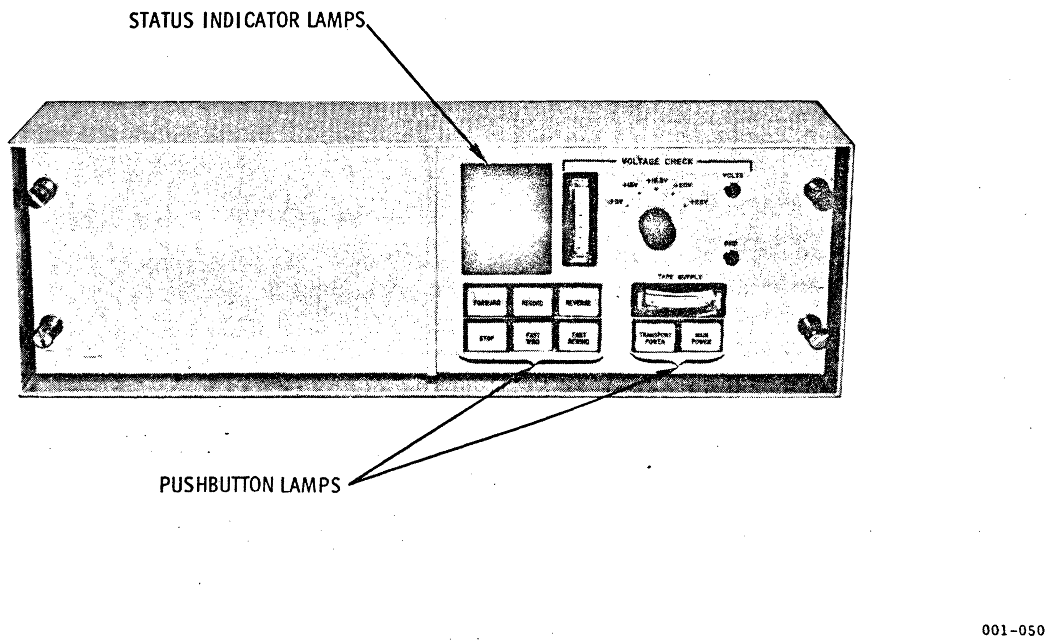


Figure 6-12. Lamp Locations.

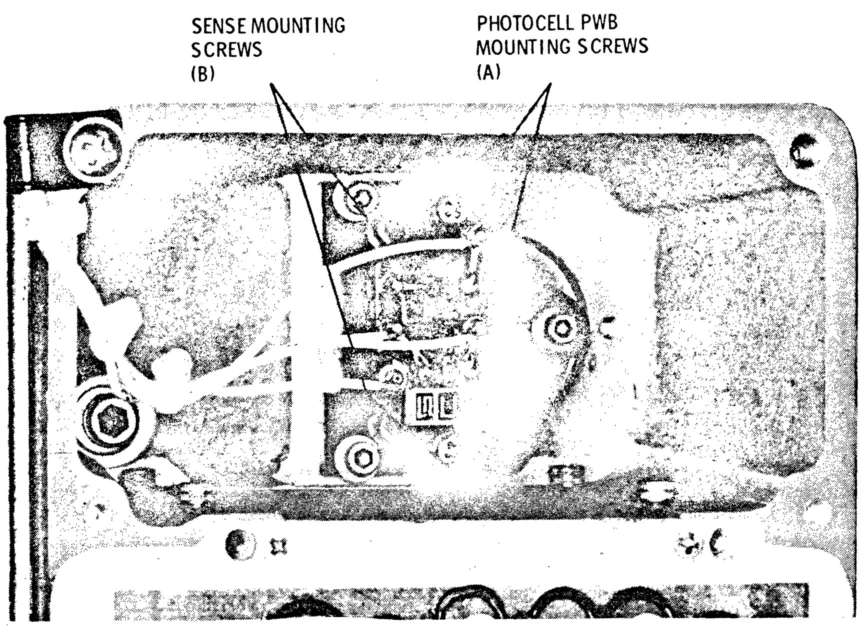


Figure 6-13. Tension Sensor Lamp Replacement.

2. Turn off transport power. Open transport to gain access to the tension sensor assemblies.

3. Remove the two Phillips head screws securing the photocell PWB to the sensor assembly (Figure 6-13, item A).

4. Carefully lift the PWB away from the sensor, and position to one side of the sensor assembly.

5. Remove the two Allen head screws securing the tension sensor assembly to the precision plate.

6. Taking card not to bend the light shutter, remove the sensor assembly, and position so as to gain access to the botton (i. e., side which is mounted to the precision plate).

7. Remove the nylon screw and spring clip assembly which holds the lamps in the sensor housing.

8. Replace defective bulb.

9. Reassemble and re-install tension sensor assembly, taking care not to damage the light shutter.

10. Replace the photocell PWB.

6-49. TAPE GUIDE REPLACEMENT.

6-50. Tape guides are secured to the tape transport with a single 8-32 mounting screw, and should be replaced as a complete component assembly. Guides are provided with a small alighment pin, on their mounting surface, which is used to properly position the component on the transport. Four of the tape guides are fitted with tape-holders, which are not part of the guide assembly, and must be replaced separately.

1. Turn off transport power. Open transport to gain access to the tape guide mounting screws.

NOTE

To replace the wrap rollers located near the capstans, first remove the capstan motor as outlined in paragraph 6-53.

2. Remove tape guide mounting screw.

3. Remove tape guide.

4. Remove tape holder, if present.

5. Install tape holder on replacement guide.

6. Install replacement guide, taking care to align the mounting pin in the hole provided in the tape transport.

7. Reinstall capstan motor and transport connector mounting bracket, if previously removed.

6-51. MAGNETIC HEAD REPLACEMENT.

1. Refer to Figure 6-14. Remove head-cover and headshield.

2. Remove head-cover standoff mounts.

3. Disconnect 14 record signal cables.

4. Remove preamplifier interconnect board mounting screw (2 from each board), and unplug preamplifiers from head assembly. Preamplifiers should remain plugged into interconnect boards.

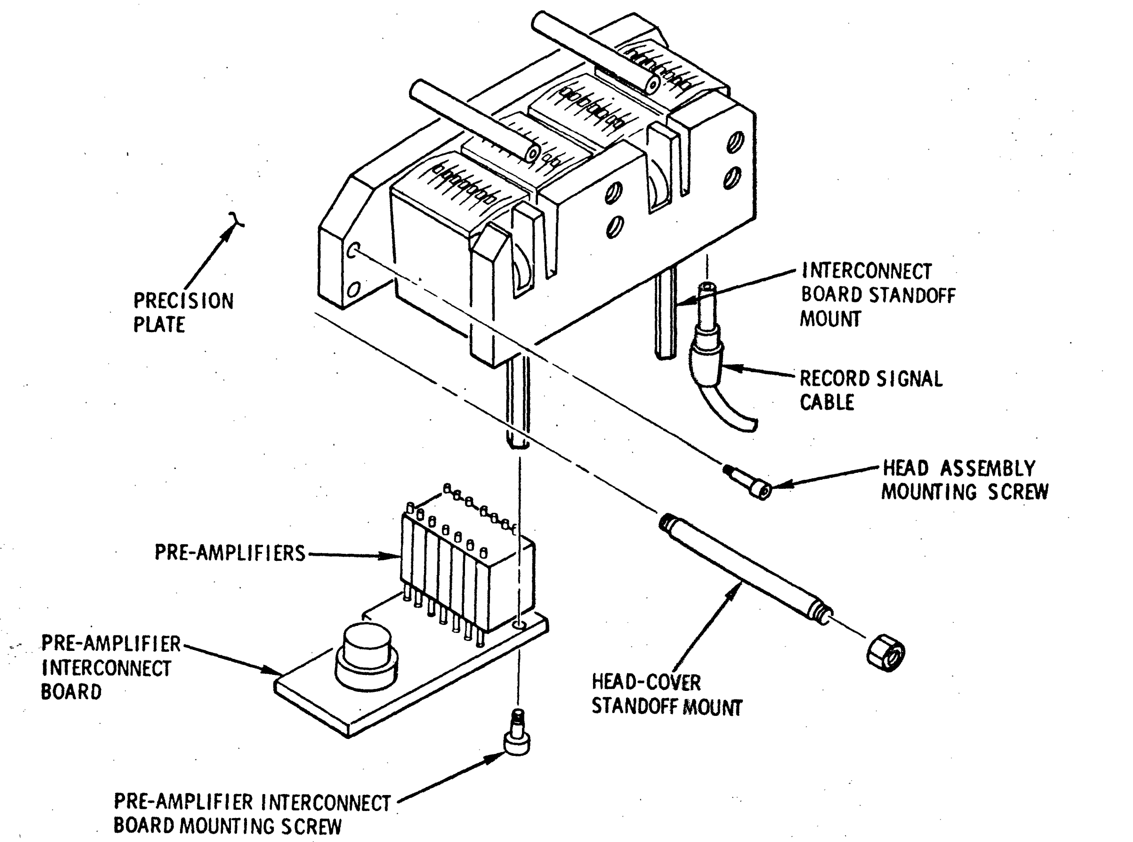


Figure 6-14. Magnetic Head Replacement.

5. Remove 4 head assembly mounting screws.

6. Carefully lift head assembly away from precision plate.

7. Remove interconnect board standoff mounts (4) from old head assembly, and reinstall on replacement head assembly.

8. Plug preamplifier into replacement head assembly, and secure interconnect boards with mounting screws.

9. Degauss replacement headstack as outlined in paragraph 4-16.

10. Install new head assembly on transport precision plate.

11. Reconnect record signal cables. Re-install head-cover standoffs and headshield.

12. Perform reproduce head azimuth adjustment, as outlined in paragraph 6-33.

13. Perform direct/analog signal electronics adjustment procedures, or FM signal electronics adjustment procedures (as appropriate), outlined in Section I of this chapter.

6-52. REEL MOTOR ASSEMBLY REPLACEMENT.

1. Turn off transport power. Remove tape and tape reels from transport.

2. Open transport and latch in the fully open position.

3. Disconnect reel motor connector P21.

4. Holding the rear of the motor, to prevent dropping, remove the 4 motor mounting screws from the front of the transport.

5. Remove motor assembly from the rear of the transport by pulling assembly straight out of the mounting flange.

6. Install replacement reel motor assembly; tighten mounting screws; reconnect P21.

6-53. CAPSTAN DRIVE-BELT REPLACEMENT.

CAUTION

Be extremely careful not to nick or otherwise damage capstan surfaces when removing or replacing capstan motor.

1. Refer to Figure 6-15.

2. Remove tape and tape reels from transport.

3. Open transport and latch in the fully open position.

4. Remove screws securing the transport connector mounting bracket. Position connector bracket so as to permit capstan motor removal.

5. Remove 5 of the 6 screws securing the capstan motor to the precision plate assembly. (Two of the mounting screws are located inside the motor housing.)

6. Holding the capstan motor assembly with one hand, (to prevent dropping) remove the last mounting screw.

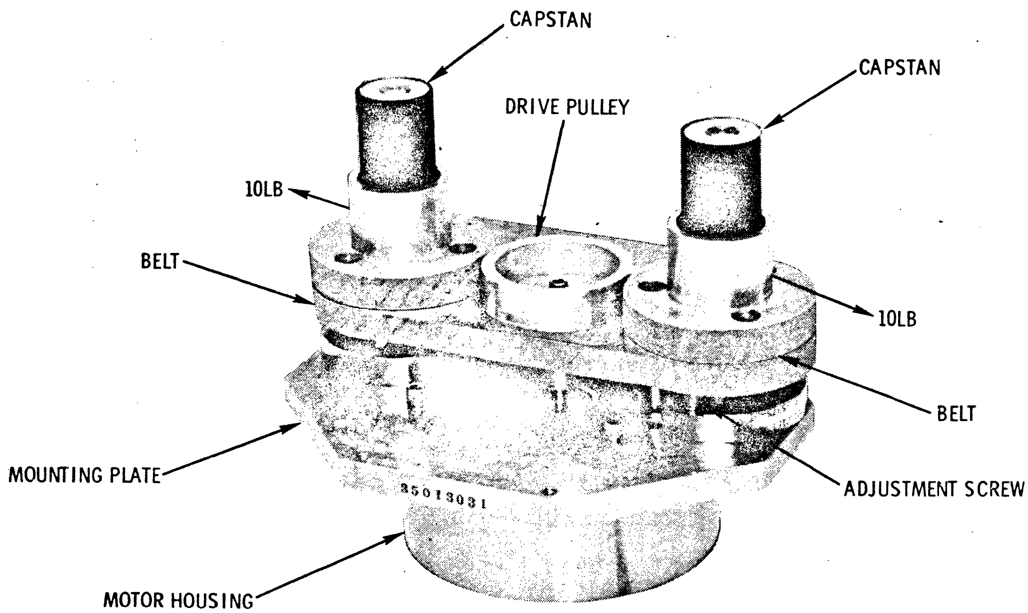


Figure 6-15. Capstan Motor Assembly.

7. With both hands, remove motor assembly by carefully pulling straight out, away from unit.

8. Loosen, but do not remove, the three screws securing each capstan assembly to the motor mounting plate.

9. Loosen, but do not remove, the four screws securing the motor to the motor mounting plate.

10. Remove old drive-belts. Clean pulley surfaces with xylene and cotton swabs.

11. Install new drive-belts. Position belts on pulleys, orienting as shown in Figure 6-15.

12. Apply a 10 lb, ± 2.0 oz force on capstan assemblies, in direction shown. Center housing symmetrically on motor mounting plate, and tighten capstan mounting screws.

13. Position differential pulley equidistant between capstans and tighten motor mounting screws.

14. With the motor still removed from the transport, reconnect motor connector J34 and run motor for one-minute in the FORWARD mode, to stabilize belts.

NOTE

To energize the capstan motor while still removed from the tape transport, proceed as follows:

a. Remove reel drive fuse (F4) (Figure 2-2).

b. Place a small piece of cardboard, or other opaque material, in the tape break sensor.

c. Select a tape speed of 7-1/2 ips, and operate the unit in the normal manner.

d. After performing step (15), secure transport power, remove material from tape break sensor, and re-install reel drive fuse.

15. Run motor in REVERSE direction. Belts should not shift position more than 0.03-inch.

16. Re-install capstan motor and transport connector bracket.

CHAPTER 7

PARTS LIST

7-1. INTRODUCTION.

7-2. This parts list illustrates and describes assemblies, subassemblies and detailed parts to assist supply and maintenance personnel in identifying, ordering, and stocking replaceable parts at the organizational level.

7-3. MODEL AND SERIAL.

7-4. The Magnetic Tape Recorder-Reproducter Model RD378/U, serial numbers A1 through A7, is coveredby this manual.

7-5. SPECIAL NOTES.

7-6. Not Applicable.

7-7. MAJOR COMPONENTS LIST.

7-8. The Magnetic Tape Recorder-Reproducer RD378/U is a unit of AN/SQR-14A Sonar System.

7-9. MAJOR UNIT LIST.

7-10. The major Unit List consists of the Magnetic Tape Recorder-Reproducer unit. The list contains the unit number, nomencalture, name of unit, designation, and the page number of the Parts List where the unit parts listing start.

Unit Number	Nomenclature	Page No.
1	Magnetic Tape Recorder-Reproducer RD378/U	

7-11. PARTS LIST.

7-12. Table 7-1 is a parts list, separated into groups by assemblies and keyed to associated assembly illustrations by figure and index number. The order of list is in reference designator order, with all parts attached to the unit first, followed by unit assemblies with parts, and subassemblies with parts. The relation of each part to its next higher assembly (NHA) is shown in the list by reference designator.

7-13. Parts listing is prepared in tabular form with columns headed as follows:

a. Column 1, Reference Designation.

This column contains the reference designation of parts in accordance with USAS Y32. 16.

b. Column 2, Notes. Options to the basic Recorder-Reproducer are indicated in this column.

c. Column 3, Name and Description.

This column includes description data to identify the parts of the equipment and aid in determining substitutes. Following the item description, the equipment contractor's part number, manufacturer's part number, part manufacturer's federal supply code number are shown.

d. Column 4, Figure and Item Number.

This column references the part location illustration by figure and item number. These numbers have two parts; a figure number which identifies the corresponding illustration, for example "7-1" and an index number which appears on the illustration adjacent to the specific component in question, for example " -11". Thus the figure and index number 7-1 (11) would refer to the part connected by a leadline to index number 11, in figure 7-1.

7-14. COMMON ITEM DESCRIPTION. LIST.

7-15. Not Applicable.

7-16. ATTACHING HARDWARE LIST.

7-17. Not Applicable.

7-18. MANUFACTURER'S LIST.

7-19. Manufacturers are given below in vendor code sequence. Manufacturer code numbers are in accordance with handbooks H4-1 and H4-2.

Vendor's Code	Name and Address
05464	Industrial Electronics Engineers, Inc. Van Nuys, Cal.
13016	Astro-Science Corp. 9700 Factorial Way South El Monte, Cal.
71744	Chicago Minature Lamp Works Chicago, Ill.
74193	Heinemann Electric Co. Trenton, New Jersey
75915	Littlefuse, Inc. Des Plaines, Ill.
81349	Military Specification Promulgated by Standardization Division, Directorate of Logistic Service, DSA
82877	Rotron Inc. Burbank, Cal.

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1		Recorder-Reproducer Magnetic Tape Assembly RD378/U, Dwg. 95002661, Mfr. 13016	7-1
1MP1		Reel, 14 inch precision less tape, taper flange, Dwg. 30004890-4, Mfr. 13016	7-1 (7)
1MP2		Reel, 14 inch precision with 3M888 tape, Dwg. 30008031-2, Mfr. 13016	7-1 (8)
1MP3	Option	Reel, 14 inch precision with 3M988 tape, Dwg. 30008031-9, Mfr. 13016	
1A1		Case Assembly, Dwg. 94001061, Mfr. 13016	7-1
1A1A1		Power Distribution Assembly, Dwg. 85009531, Mfr. 13016	7-1 (37)
1A1A/DS2		Lamp, 125 V, 6 W, Part No. MS1 15579-6, Mfr. 96906	7-1 (38)
1A1PS1		Power Supply, input voltage 105-125 volts ac, frequency 47-420 Hz, output voltage 28 porm 1.2 volts dc, 14 amps full load, Dwg. 85009521, Mfr. 13016	7-1 (27)
1A1W1		Cable Assembly, special purpose, electrical, Dwg. 50001391, Mfr. 13016	7-1 (36)
1A1W2		Cable Assembly, special purpose, electrical, Dwg. 50001421, Mfr. 13016	7-1 (28)
1A1W3		Cable Assembly, special purpose, electrical, Dwg. 50001431, Mfr. 13016	7-1 (29)
1A1W4		Cable Assembly, special purpose, electrical, Dwg. 50001451, Mfr. 13016	7-1 (30)
1A2		Basic Transport Assembly, Dwg. 94001041, Mfr. 13016	7-1
1A2B1		Motor Assembly, Dwg. 85004481, Mfr. 13016	7-1 (23)

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A2A1		Transport Chassis Assembly, Dwg. 85006691, Mfr. 13016	7-1
1A2A1F1		Fuse, cartridge, 125 voltage rating, 5 amperes, Dwg. 11000060-23, Part No. 313005, Mfr. 75915	7-1 (6)
1A2A1F2		Fuse, cartridge, 250 voltage rating, 2 amperes, Dwg. 11000060-16, Part No. 312002, Mfr. 75915	7-1 (5)
1A2A1F3		Fuse, cartridge 125 voltage rating, 5 amperes, Dwg. 11000060-23, Part No. 313005, Mfr. 75915	7-1 (4)
1A2A1F4		Fuse, cartridge 32 voltage rating, 7 amperes, Dwg. 11000060-24, Part No. 313007, Mfr. 75915	7-1 (3)
1A2A1A		Roller Guide Assembly Dwg. 84002701, Mfr. 13016	7-1 (2)
1A2A1A2		Lamp Assembly Dwg. 84007911, Mfr. 13016	7-1
1A2A1A2DS1		Lamp, Incandescent, Dwg. 12000580-1 Part No. , Mfr.	7-1 (9)
1A2A1A3		Tape Guide Assembly, Dwg. 84008041, Mfr. 13016	7-1 (1)
1A2A2		Circuit Card Assembly, control logic, Dwg. 84007981, Mfr. 13016	7-1 (20)
1A2A3		Circuit Card Assembly, capstan servo, Dwg. 84007961, Mfr. 13016	7-1 (21)
1A2A4		Circuit Card Assembly, voltage regulator, Dwg. 85004451-1, Mfr. 13016	7-1 (22)

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A2A5		Precision Plate Assembly, Dwg. 85004301, Mfr. 13016	7-1
1A2A5A1		Sensor Assembly, Tape Break, Dwg. 84007891 Mfr. 13016	7-1
1A2A5A1DS1		Lamp, 28 volts, Dwg. 12000500, Part No. 7387, Mfr. 71744	7-1 (10)
1A2A5A4		Roller Guide Assembly, Dwg. 84002701, Mfr. 13016	7-1 (11)
1A2A5A2		Capstan-Motor Assembly, Dwg. 84007831, Mfr. 13016	7-1
1A2A5A2MP1		Belt, Mylar Dwg. 30007021, Mfr. 13016	7-1 (25)
1A2A5A3		Tape Tension, Amplifier Assembly, Dwg. 84002741, Mfr. 13016	7-1
1A2A5A3DS1		Lamp, Incandescent, Dwg. 12000480, Part No. CM8-632, Mfr. 60640	7-1 (24)
1A3		Reproduce Amplifier Module Assembly, Dwg. 94001051, Mfr. 13016	7-1 (40)
1A3F1, 1A3F2		Fuse, cartridge, Dwg. MS90078-12 Mfr. 96906	7-1 (35)
1A3S1		Switch, pushbutton, transport power, Dwg. 05000770-7, Part No. 90E10A1C 4F3J1 (W) HINZR13, Mfr. 96182	7-1
1A3S2		Switch, pushbutton, forward, Dwg. 05000770-2, Part No. 90E10A1C2F3J1 (G) HIN2R12, Mfr. 96182	7-1
1A3S3		Switch, pushbutton, record, Dwg. 05000770-1, Part No. 90E10A1C2F3J1 (G) HIN2R12, Mfr. 96182	7-1

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A3S4		Switch, pushbutton, reverse, Dwg. 05000770-3, Part No. 90E10A1C2F3J1(G) HIN2R12, Mfr. 96182	7-1
1A3S5		Switch, pushbutton, fast rewind, Dwg. 05000770-6, Part No. 90E10A1C2F3J1(G) HIN2R13, Mfr. 96182	7-1
1A3S6		Switch, pushbutton, fast wind, Dwg. 05000770-5, Part No. 90E10A1C2F3J1(G) HIN2R13, Mfr. 96182	7-1
1A3S7		Switch, pushbutton, stop Dwg. 05000770-4, Part No. 90E10A1C2F3J1(Y)HIN2R12, Mfr. 96182	7-1
1A3S8		Not illuminated	
1A3S9		Switch, pushbutton, main power, Dwg. 05000770-8, Part No. 90E10A1C4F4J1 (W) HIN2R13, Mfr. 96182	7-1
1A3S9FL1, 1A3S9FL2		Lamp, glow, 28 volts, midget flanged base, Part No. F3, Mfr. 96182	7-1 (17)
1A3A1		Circuit Card Assembly, speed change logic, Dwg. 85002012, Mfr. 13016	7-1 (34)
1A3A2		Status Indicator Assembly, Dwg. 84003157, Mfr. 13016	7-1
1A3A2DS1		Indicator, Status, 28 VDC, Dwg. 12000570-2, Part No. 0280-03-4460-1819, Mfr. 05464	7-1
1A3A2DS1		Lamp, 28 VDC, Part No. 1819, Mfr. 05464	7-1 (16)
1A3	Option	Reproduce Amplifier Module, 2 channel, Dwg. 94001121, Mfr. 13016	
1A4		Circuit Card Assembly, speed select encoder, Dwg. 85004741, Mfr. 13016	7-1 (19)

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A5		Circuit Card Assembly, FM reproduce amplifier wideband, Dwg. 85006401-1, Mfr. 13016	7-1 (31)
1A5	Option	Circuit Card Assembly, FM reproduce amplifier wideband, Dwg. 85006401-2	
1A5FL1	Option	Electronic Component Board Assembly, 40.0 kHz, Dwg. 85006471, Mfr. 13016	
1A5FL2	Option	Electronic Component Board Assembly, 20.0 kHz, Dwg. 85006461, Mfr. 13016	
1A5FL3	Option	Electronic Component Board Assembly, 10 kHz, Dwg. 85006451, Mfr. 13016	
1A5FL4	Option	Electronic Component Board Assembly, 5 kHz, Dwg. 85006441, Mfr. 13016	
1A5FL5	Option	Electronic Component Board Assembly, 2.5 kHz, Dwg. 85006431, Mfr. 13016	
1A5FL6		Electronic Component Board Assembly 1.25 kHz, Dwg. 85006421, Mfr. 13016	7-1 (32)
1A5FL6	Option	Electronic Component Board Assembly, 80 kHz, Dwg. 85006481, Mfr. 13016	
1A6		Circuit Card Assembly, reproduce amplifier, 1 MHz, Dwg. 85006591-1, Mfr. 13016	7-1 (33)
1A6	Option	Circuit Card Assembly, reproduce amplifier, 2 MHz, Dwg. 85006591, Mfr. 13016	
1A7		Circuit Card Assembly, FM record amplifier, 8 center frequencies, Dwg. 85004701, Mfr. 13016	7-1 (13)
1A8		Circuit Card Assembly, record-bias amplifer, 1000 ohm impedance, Dwg. 85003031-1, Mfr. 13016	7-1 (14)

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A8	Option	Circuit Card Assembly, record-bias amplifier, 20,000 ohm impedance, Dwg. 85003031-2, Mfr. 13016	
1A9		Circuit Card Assembly, 7.05 MHz bias oscillator, Dwg. 85001731, Mfr. 13016	7-1 (12)
1A10		Head Assembly, 1 MHz, Dwg. 19000701, Mfr. 13016	7-1 (15)
1A10	Option	Head Assembly, 14 track, 2 MHz, Dwg. 19000731, Mfr. 13016	
1A11		DC-DC Converter Kit, reproduce amplifier monitor, Dwg. 75002391, Mfr. 13016	7-1
1A11A1		DC-DC Converter, Dwg. 84009680, Mfr. 13016	7-1 (18)
1A12	Option	Accessory Service Kit, Dwg. 75001731, Mfr. 13016	
1A13		Mating Connector Kit, Dwg. 75002221, Mfr. 13016	7-1
1A13P102		Connector, Plug, electrical, Part No. MS3126F20-41P, Mfr. 96906	7-1
1A13P104, 1A13P105, 1A13P107 Through 1A13P134		Connector, Plug, electrical, Part No. MS3 9012-16-0001, Mfr. 81349	7-1
1A13W1		Cable Assembly, special purpose, electrical, Dwg. 50001531, Mfr. 13016	7-1
1A14	Option	Tape Lock Servo Kit, Dwg. 75002231-1 Mfr. 13016	
1A15	Option	Tape Lock BCD Encoder, Dwg. 75002231-2, Mfr. 13016	

TABLE 7-1. RECORDER-REPRODUCER, MAGNETIC TAPE, RD378/U, PARTS LIST

Reference Designation	Notes	Name and Description	Figure Number (Item)
1A16		Blower Kit, 60 Hz, Dwg. 75002281, Mfr. 13016	7-1
1A16B1		Blower, Fan, Dwg. 52000090-1, Part No. A074681, Mfr. 82877	7-1 (26)
1A16CB1		Circuit Breaker, Dwg. 06000880-1, Part No. AM33MG6-7-5-250-60-4, Mfr. 74193	7-1 (39)
1A26	Option	Blower Kit, 400 Hz, Dwg. 75002281-1, Mfr. 13061	

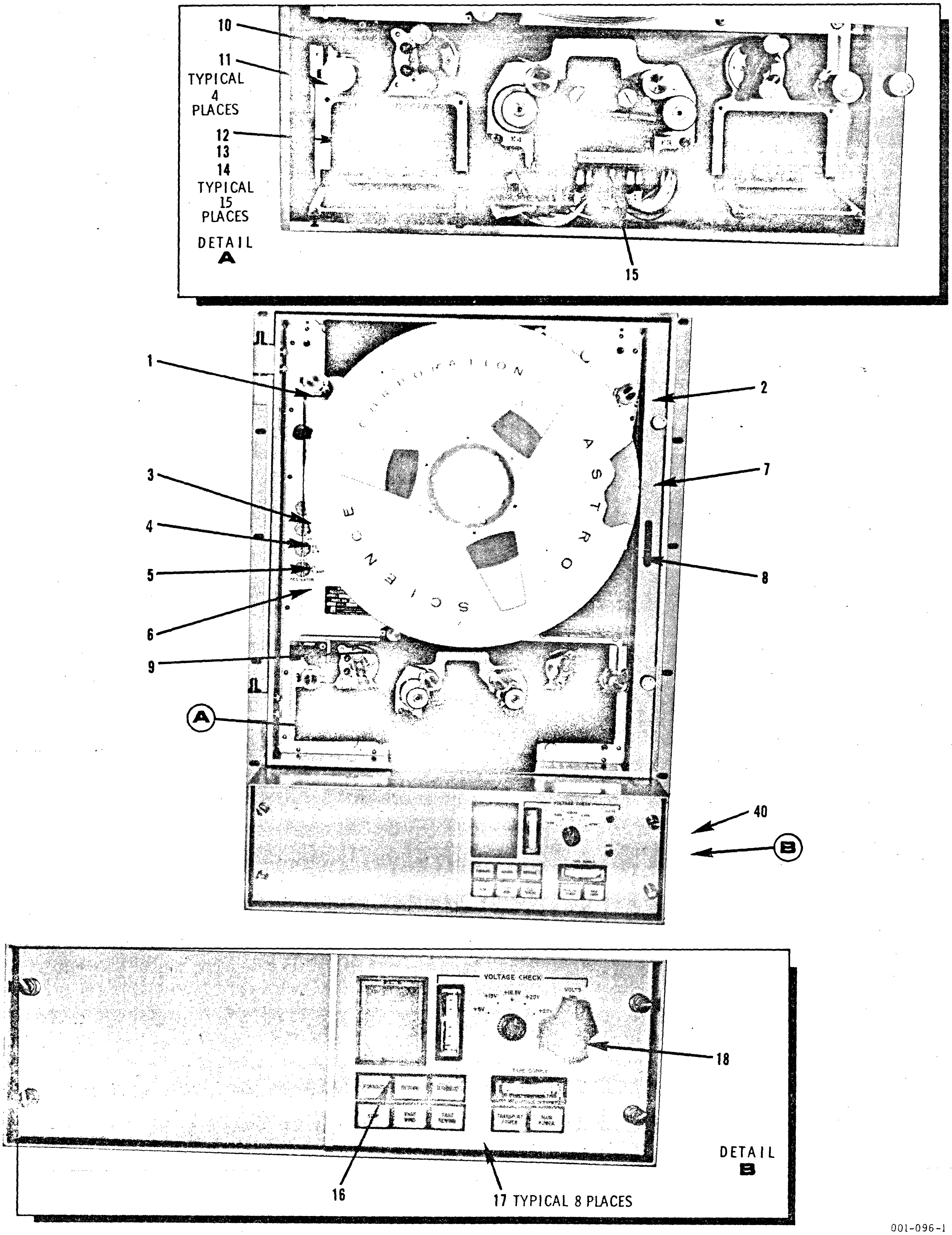
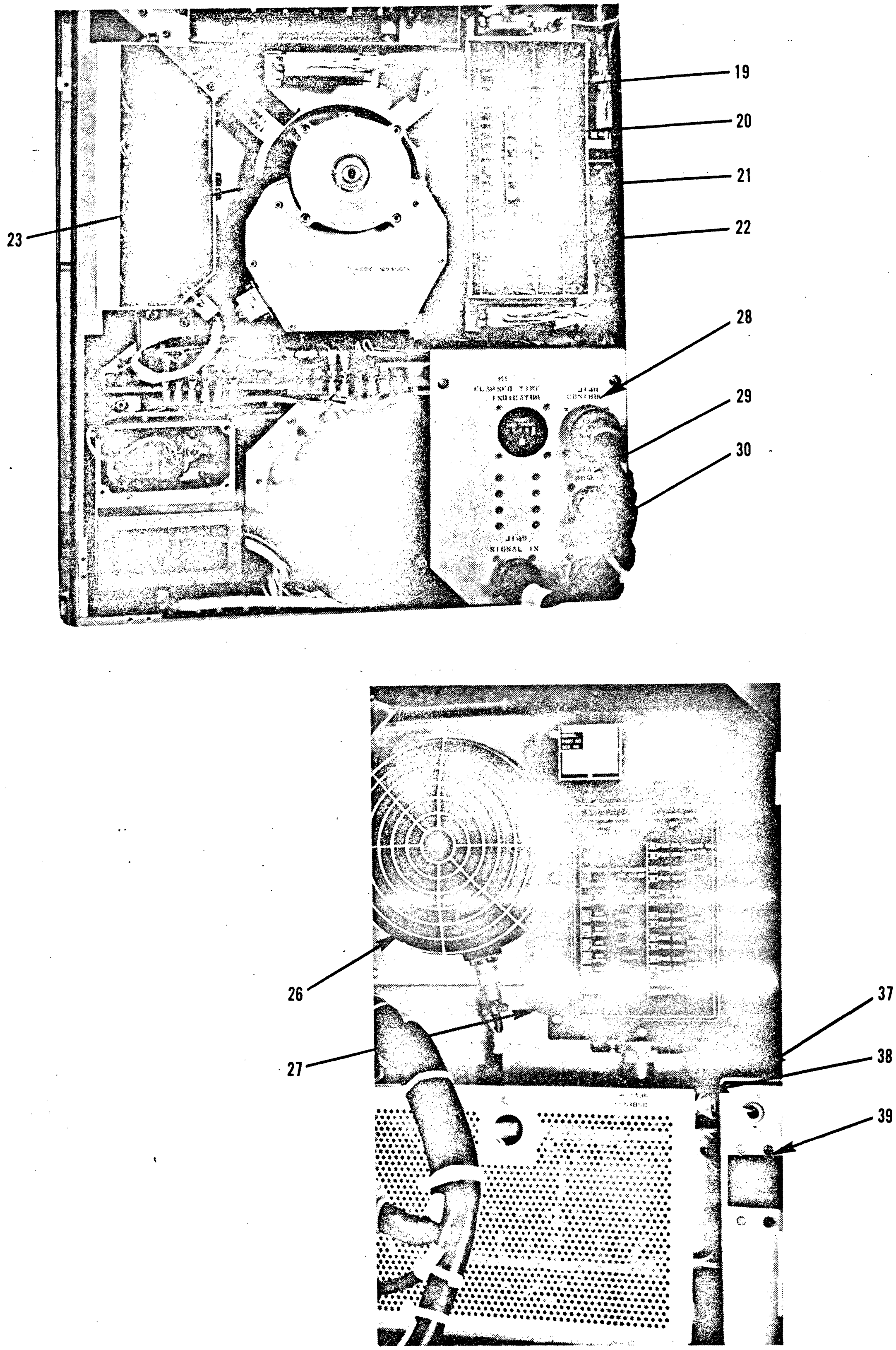


Figure 7-1. Magnetic Tape Recorder/Reproducer Unit Parts Location (Sheet 1 of



001-069-2

Figure 7-2. Magnetic Tape Recorder/Reproducer Unit Parts Location (Sheet 2 of 3)

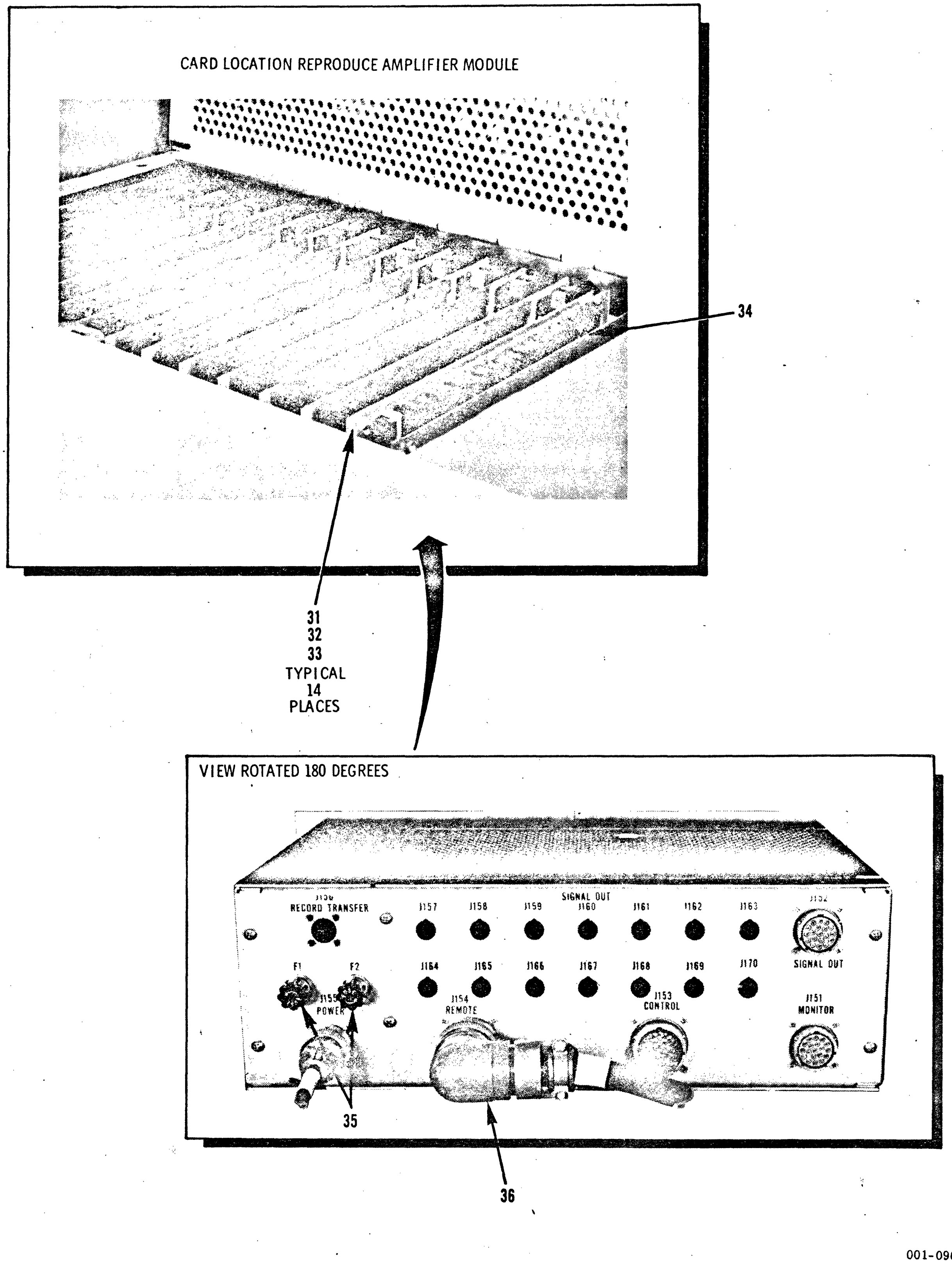


Figure 7-3. Magnetic Tape Recorder/Reproducer Unit Parts Location (Sheet 3 of 3)

CHAPTER 8

INSTALLATION

8-1. INTRODUCTION.

8-2. This chapter contains instructions and procedures for unpacking, repacking, inspecting, installing, and checking out the Magnetic Tape Recorder/Reproducer unit. The unit is designed for installation in the vertical position within a standard 19-inch wide electronic equipment rack. No special tools or materials are required for installation. Figure 8-1 show the Magnetic Tape Recorder/Reproducer unit. Figure 8-2 is an outline and mounting diagram, and Figure 8-3 is an interconnecting and cabling diagram.

8-3. SITE INFORMATION.

8-4. The unit is designed for installation in a standard 19-inch electronic equipment rack. The unit must be installed in a location that is free of strong electrical or magnetic fields, which could affect the quality of recordings. The unit has a built-in blower for internal cooling and requires no external heating or cooling when operated between 0° and +54° C. Installation in a rack with other units that generate excessive heat should be avoided. Attention should be given to placement of the equipment rack to ensure adequate ventilation.

8-5. REFERENCE PUBLICATIONS.

8-6. Refer to the technical manual for Sonar Receiving Set AN/SQR-15 for location of the Magnetic Tape Recorder/Reproducer within the set.

8-7. UNPACKING AND REPACKING.

WARNING

The unit weighs approximately 148 pounds. Two men, and preferably three, are required for removing the unit from the packing case to avoid injury to personnel.

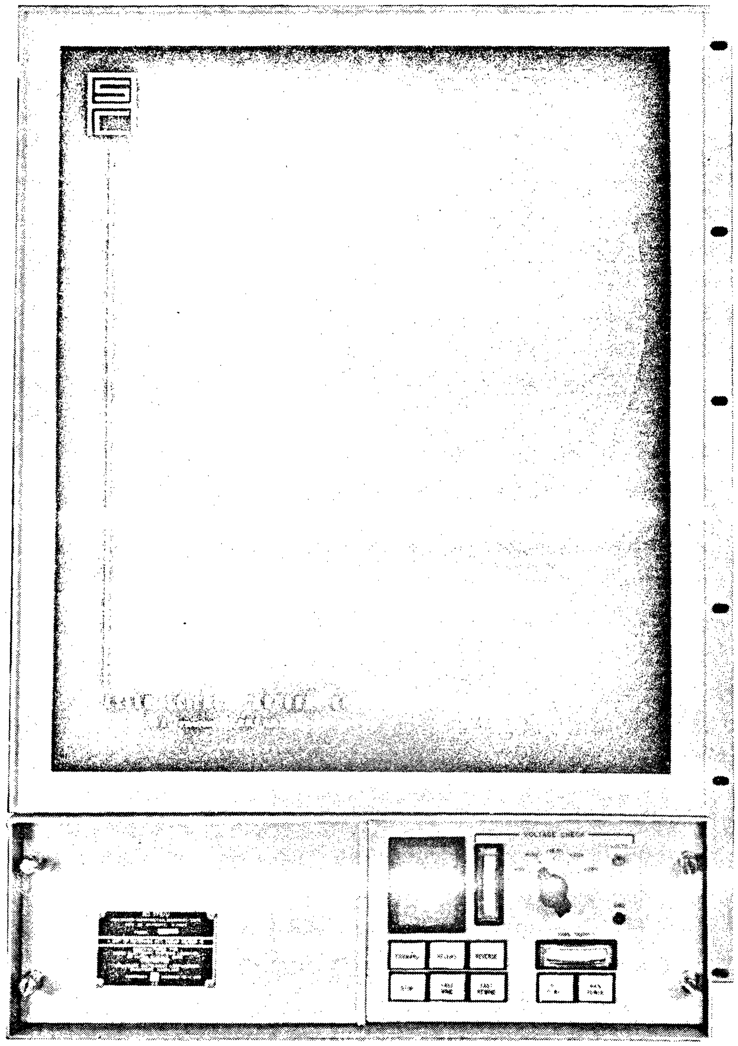
8-8. The unit is packed in a reusable container. The unit is precision made and care should be taken not to drop it, or subject it to severe handling. Carefully remove the unit from the shipping container and check against the packing slip for shortages or damage. Refer to Table 8-1 for initial inspection details.

NOTE

All packing materials, including the shipping container, are reusable. Replace all packing material in the container and store the container for future use.

8-9. INPUT REQUIREMENTS.

8-10. The unit requires single-phase, 115 ($\pm$12) volt, 60 Hz power for operation. Power is supplied to the unit through J101 on the rear panel. Connector P101, which mates to J101, connects to the rack power supply to provide main power to the unit. The unit has an internal cooling fan that provides



001-002

Figure 8-1. Magnetic Tape Recorder/Reproducer Model RD378/U.

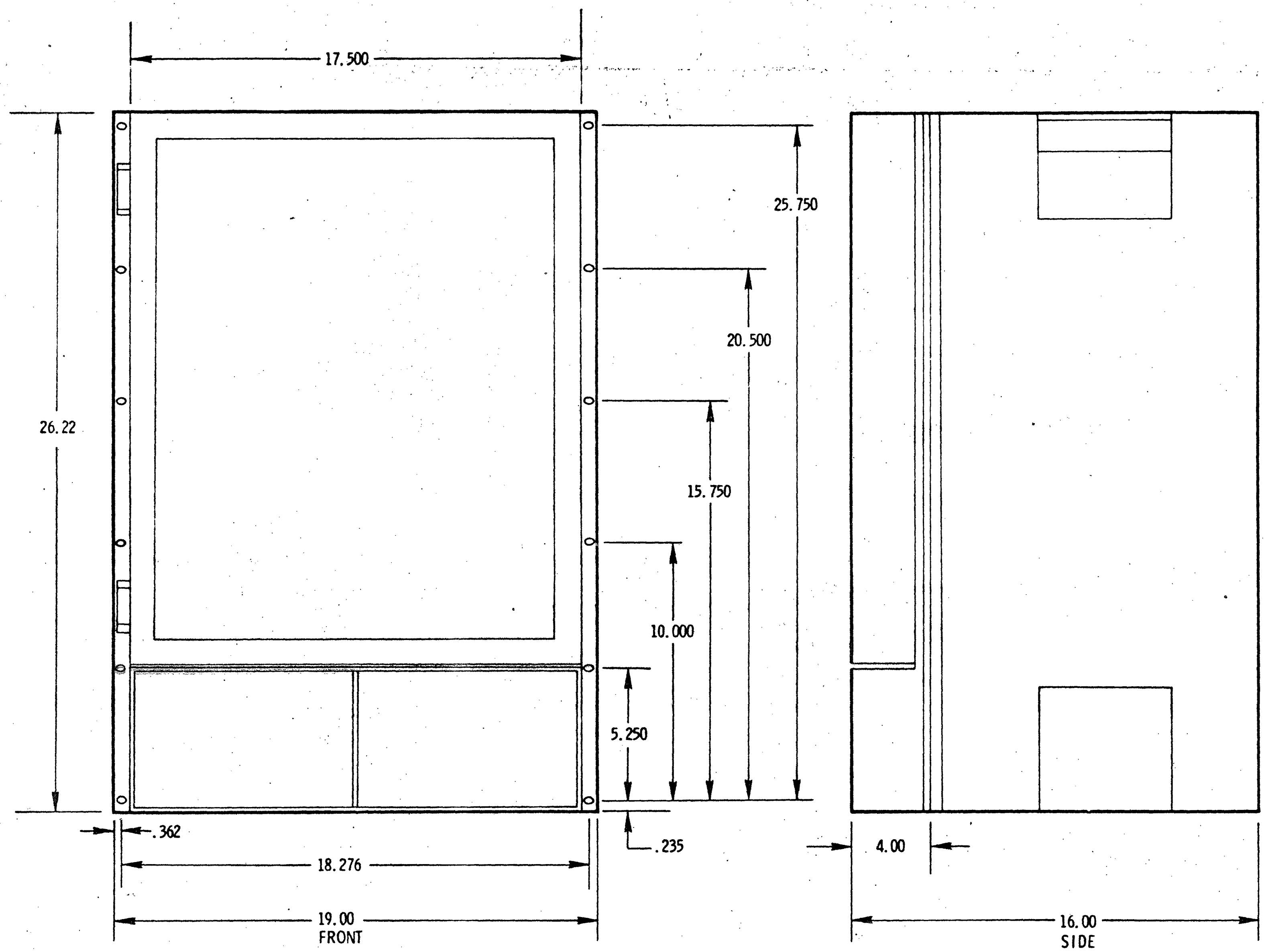


Figure 8-2. Outline and Mounting Drawing

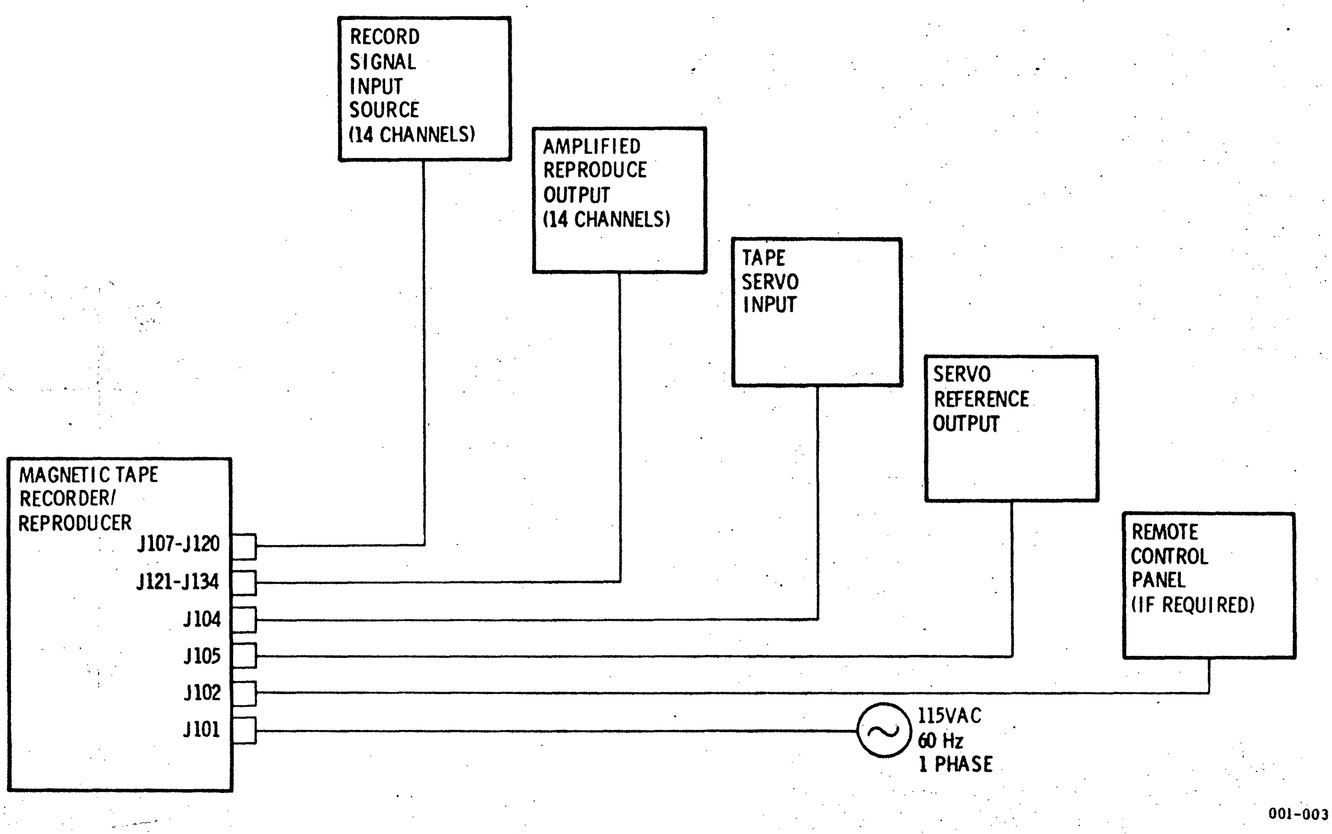


Figure 8-3. Interconnecting and Cabling Diagram.

TABLE 8-1. ITEMS TO BE INSPECTED

Wires, leads, connections, insulation and protective coating	Breaks, burns, corrosion, loosened connections or damage. Cracked or inadequate protective coating.
Printed circuits	Breaks, burnouts, corrosion, loosened eyelets and feed-through terminals, shorts or lack of protective coating.
Mounting screws	For looseness or stripped threads.
Loose particles	Conductive particles, jumper clippings, or solder drops.
Resistors and Capacitors	Burnouts, bubbles, or lack of protective coating.
Power transistors	Missing mica washers, or lack of silicon grease under transsistor mountings.
Solder joints	Cold solder joints, excessive solder.
Connectors and receptacles	Insecure mounting, bent or missing pins, damaged shells.
Cables	Damaged insulation, improper routing, kinking, or twisting, loose or damaged cable clamps.
Terminal boards	Breaks, cracks, or loose terminals, insecure mounting.
Panel controls	Loose or missing controls, improper switching action.
Meter	Cracked, broken, defaced, or missing readout.

TABLE 8-1. ITEMS TO BE INSPECTED (Cont'd)

Panel, cover, and chassis	Loose or missing attaching hardware, physical damage, illegible markings on nameplates.
Transformers and chokes	Leaking potting compounds, wax, or other signs of overheating, damaged or broken connections, insecure mounting.
Drive belts	Lack of tension or dirty belts.
Relays	Loose or broken connections, insecure mounting.
Indicator lamps and sockets	Missing lamps, damaged sockets, damaged or missing lenses, insecure mounting.
Switches	Damaged connections, insecure mounting improper switching action.
Heads	Dust, oxide, foreign material or excessive wear.
Bearings	Smooth rotation with no sticking or binding.
Mechanical parts	Obvious damage or wear.

necessary cooling during operation. Additional cooling is not required as long as an adequate exhaust area is allowed for at the rear of the unit when mounted in the electronic rack.

8-11. INSTALLATION PROCEDURES.

8-12. UNIT ASSEMBLY. The unit requires no assembly other than the connection of the power cable to a power source (see paragraph 8-15).

8-13. UNIT MOUNTING. The unit is designed to install in a standard, 19-inch electronic equipment rack. Mounting flanges are provided on both sides of the equipment case. Each flange is drilled with six holes for mounting the unit to the rack. Two men are required to lift and hold the unit in place while a third man installs and tightens the 12 mounting screws.

8-14. ELECTRICAL CONNECTIONS. All external electrical connections are made with connectors located on the rear connector panel (see Figure 8-2). Power input to the unit is made through J101 (POWER). All control and indicator functions are available through J102 (REMOTE) for control of the unit through a remote control panel (customer supplied). A jack (J103), RECORD TRANSFER, is also provided for transferring the record function from one recorder to another, if this option is installed in the recorder/reproducer. Tape servo input (if so equipped) is made through J104 (TAPE SERVO). Servo reference output is made through J105 (SERVO REF OUTPUT). Jacks J107 through J120 are provided for signal inputs to channel 1 through 14 record amplifiers. Amplified outputs from the reproduce heads are through J121 through J134 for channels 1 through 14 respectively. A mating connector kit is supplied with the recorder/reproducer. This kit consists of a power cable for connecting 115 volts, single phase, 60 Hz power to J101, and connectors to be used in the construction of cables for other external connections. Thirty BNC connectors are provided for constructing cables for mating with J104, J105, and J107 through J134. These cables should be made of single conductor, shielded wire (type UG-88/U) of required length. If remote control is required in the installation, a cable may be fabricated from the supplied connector, and a 40-conductor shielded cable of the required length. Pin assignments are shown in Figure 8-4.

8-15. INTERCONNECTION INSTRUCTIONS. All internal connections in the unit are made at the factory and no further interconnections are necessary.

8-16. SERVICING INSTRUCTIONS BEFORE OPERATION.

NOTE

> Most cleaning solvents are flammable and should be kept away from open flames and hot surfaces. They also should be used only in well-ventilated areas, as many emit toxic fumes. Failure to take these precautions can result in equipment damage and bodily harm or death to personnel.

8-17. Before attempting to operate the unit, it should be carefully inspected (see Table 8-1). The magnetic head assemblies should be cleaned with Xylene (Federal Specification TT-X-916B) or equivalent, using a dampened cotton swab. If the unit has been used previously at another location, or has been in storage for a long period, heads should be demagnetized as described in Chapter 4.

CAUTION

Liquid cleaning solvents can cause damage to the polyurethane surfaces of the capstan shafts, and should not be used. If cleaning is required, use a soft, lint-free cloth.

NOTE

All bearings within the unit are sealed and lubrication is not necessary during the life of the recorder.

8-18. GROUNDING INSTRUCTIONS. The chassis of the unit is grounded through the ground wire of the power cable. No additional grounding or bonding is necessary.

8-19. INSTALLATION CHECKOUT.

8-20. PHASE 1 - INSTALLATION INSPECTION AND PREENERGIZING PROCEDURE. The following procedure should be followed prior to energizing the unit.

Step	Check
1. Visually check the unit for obvious faults, using Table 8-1 as a checklist.	( )
2. Make certain that all plug-in printed wiring board assemblies (record reproduce amplifiers, etc.) are properly seated in the correct connectors.	( )
3. Verify that J101 (POWER) is properly connected to a 115 volt, 60 Hz, single-phase power source, and that continuity exists in power transmission cable wires.	( )
4. Check cables to input and output connectors on the rear connector panel for continuity and proper connections.	( )
5. If provision for remote control is a part of the installation, ensure that continuity exists in all remote control cable wires and that the cable is properly connected to J102 and the remote control panel.	( )
6. Verify that all test equipment listed in Chapter 1 is onboard, operating satisfactorily, and has been calibrated.	( )
7. Verify that the Allowance Parts List (APL) is onboard and the Coordinated Shipboard Allowance List includes the equipment data.	( )
8. Verify that all field changes, shipalts, and mandatory retrofits, if any, have been accomplished.	( )
9. Check for obstructions that might prevent proper rotation of reels and capstans.	( )

CONNECTOR WIRING DATA		
RECEPTACLES	PIN	FUNCTION
J101	A	115 V 60 HZ HOT
	B	115 V 60 HZ COM
POWER	C	GROUND
	D	SPARE
J101	E	SPARE
J102	A	GROUND
	B	RECORD INDICATOR
	C	FORWARD INDICATOR
	D	RETURN RECORD
	E	COMMON (AMPL)
	F	+28V AMPL
	G	TAPE BREAK IND
	H	END OF TAPE IND
	J	FORWARD
	K	RECORD
	L	REVERSE
	M	FAST WIND
	N	FAST REWIND
	P	1-7/8 IPS
REMOTE CONTROL	R	TRANSPORT POWER
	S	PHASE LOCK TEST PT
	T	TAPE METER (+)
	U	REVERSE INDICATOR
	V	+20 V
	W	+18.5 V
	X	+5 V
	Y	+15 V
	Z	TAPE METER (−)
	a	COM (INDICATORS)
	b	+28V (INDICATORS)
	c	STOP
	d	3-3/4 IPS
	e	7-1/2 IPS
	f	15 IPS
	g	30 IPS
	h	60 IPS
J102	j	120 IPS

CONNECTOR WIRING DATA		
RECEPTACLE	PIN	FUNCTION
J102 (CONT.)	k	REMOTE SPEED SEL
	m	SPARE
	n	SPARE
	p	SPARE
	q	SPARE
	r	SPARE
	s	SPARE
J102	t	SPARE

RECEPTACLE	FUNCTION		
J104	TAPE SERVO INPUT		
J105	SERVO REF OUTPUT		
J107	CHANNEL	1	INPUT
J108		2	
J109		3	
J110		4	
J111		5	
J112		6	
J113		7	
J114		8	
J115		9	
J116		10	
J117		11	
J118		12	
J119		13	
J120	CHANNEL	14	INPUT
J121	CHANNEL	1	OUTPUT
J122		2	
J123		3	
J124		4	
J125		5	
J126		6	
J127		7	
J128		8	
J129		9	
J130		10	
J131		11	
J132		12	
J133		13	
J134	CHANNEL	14	OUTPUT

Figure 8-4. Rear Panel Connector and Pin Assignments.

Step	Check
10. Verify that front dust cover and basic transport assembly move freely on their hinges and latch firmly into place.	( )
11. Ensure that the instructions in paragraph 8-16 have been complied with.	( )
12. After steps 1 through 11 have been performed, it should be safe to turn on the unit.	( )

8-21. PHASE 2 - INITIAL TURN-ON AND PRELIMINARY TEST. This procedure provides instructions for energizing the equipment for the first time. Refer to Chapter 2 and Figure 2-1 for a description of operator controls and indicators. The MAIN POWER switch should be off before starting procedure below.

1. Place a full reel of demagnetized tape (supply reel) over reel motor hub, guiding it past the three front mounting pads until it rests on the base of the lower hub.

2. Turn reel in either direction until locking detent locks into a slot on the inner surface of the reel.

3. Holding reel firmly against hub base, thread inner flange on hub and turn clockwise until supply reel is held firmly in place.

4. Place an empty reel (take-up reel) over upper hub, guide it toward inner knob, and allow bottom of reel to rest against three mounting pads. Rotate reel to lock detent into slot on reel inner surface.

5. Thread outer flange on hub and turn clockwise until take-up reel is firmly secured.

6. Remove several turns of tape from supply reel and thread it through tape transport along top tape guides, around capstan drive, across heads, and along bottom tape guides, as shown in Figure 8-5.

7. Secure tape on take-up reel with approximately two turns of tape on the reel. Tape slack will be taken up gently when power is applied.

8. Verify that all steps of the procedure in paragraph 8-20 have been performed.

CAUTION

If unit fails to operate properly at any of the steps in this procedure, press MAIN POWER switch to off and refer to troubleshooting procedures in Chapter 5. Locate symptoms and take corrective action before proceeding.

9. Press MAIN POWER and TRANSPORT POWER switch on. Indicator lamp should light.

10. Allow 15 minutes for warmup and stabilization. Then, using a VTVM connected to Test Points 1 and 2 (VOLTS and GND) on the RAM control panel (voltmeter on panel is accurate only to $\pm 10\%$) and the VOLTAGE CHECK switch, check voltages at all five switch positions (+5 V, +15 V, +18.5 V, +20 V, and +28 V).

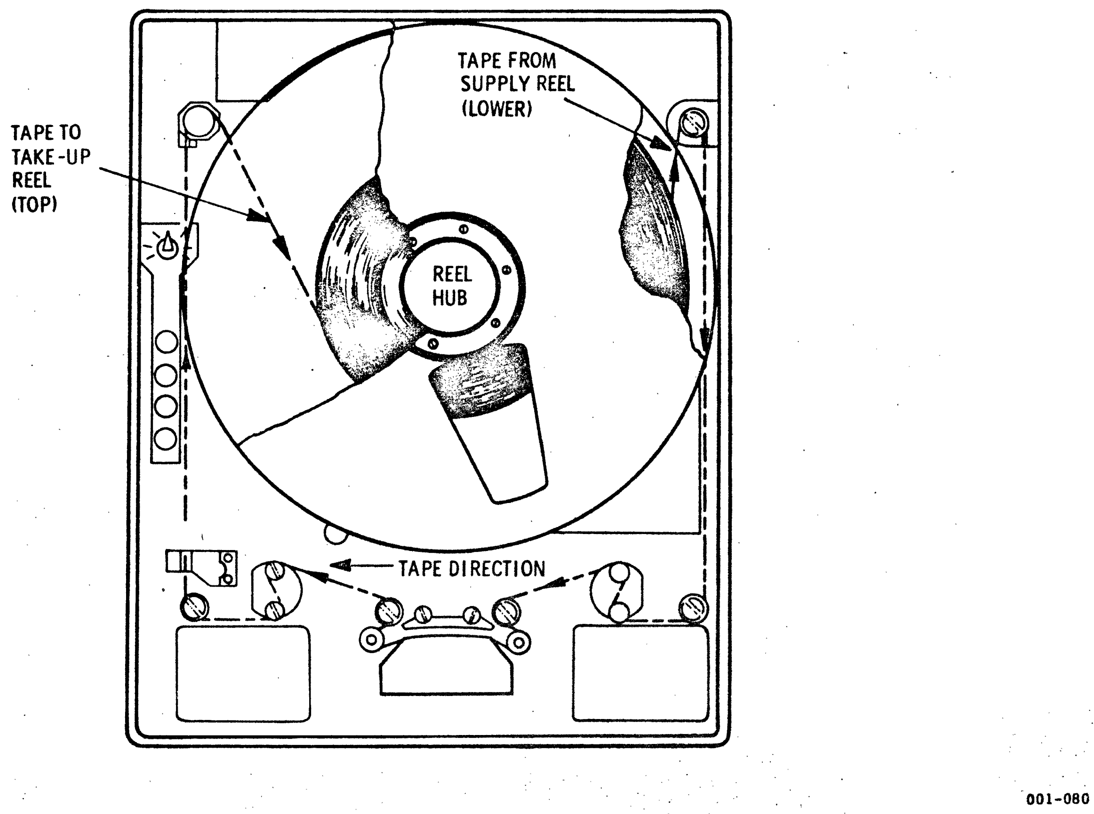


Figure 8-5. Tape Threading Diagram.

NOTE

Tolerances for voltages are: +5.5 V ±10%, +15 V ±5%, +18.5 V ±1%, +20 V ±1%, and +28 V ±5%. The +5 V and +15 V are fixed voltages and if not in tolerance the voltage regulator printed wiring board must be checked. The +18.5 voltage may be adjusted by R8 on the voltage regulator printed wiring board. The +20 voltages may be adjusted by R15. The +28 V power supply is not adjustable.

11. Press TRANSPORT POWER switch on. Indicator should light. Select 1-7/8 ips with transport SPEED SELECT switch. Status panel indicator should indicate 1-7/8.

12. Press FORWARD and RECORD switches on. Indicator lamps should light. Tape should move forward at 1-7/8 ips from supply reel to take-up reel. Check that tape is tracking properly over tape guides, capstans, and head assembly.

13. Press STOP switch. Tape should stop smoothly with tension maintained across head assembly and STOP indicator lamp should light.

14. Provide 10 kHz, 1.0 V rms signals to the inputs of all record channels (J107 through J120). Press FORWARD and RECORD switches.

15. Using a VTVM, check each output connector (J121 through J134) for an output signal.

16. Press FAST WIND switch. Indicator should light and tape speed should accelerate rapidly to 240 ips. Press STOP. Tape should come to a smooth stop with tension maintained across head assembly.

17. Press FAST REWIND switch. Indicator should light and tape should accelerate rapidly to 240 ips. Allow tape to run completely off reel. Reels should come to a smooth stop. Status panel indicator should display END OF TAPE.

18. Repeat steps 12, 13 and 16 for other tape speeds. Observe status indicator for correct display of tape speed.

NOTE

If installation includes a remote control panel with remote speed select, place SPEED SELECT switch in REMOTE position and repeat steps 12 through 17 from remote control position to verify that all switches are functioning properly.

8-22. PHASE III - INSTALLATION VERIFICATION TESTS. Equipment performance checks are contained in Chapter 6. It is not necessary, however, to perform all the tests to verify equipment operation. After the operational control check given in paragraph 8-21 has been completed, the following checks are sufficient to determine that the unit is functioning properly.

a. Bias and record level check, paragraph 6-13.

b. FM deviation and center frequency check, paragraph 6-23.

c. Frequency response check, paragraph 6-19.

Following these checks, and any corrective action required, the unit should be fully operable.

8-23. INSTALLATION STANDARDS SUMMARY SHEET MAGNETIC TAPE RECORDER/REPRODUCER RD378/U NAVSHIPS.

INSTALLATION STANDARDS SUMMARY

Record on this summary sheet the test indications which have been obtained during the installation verification test.

Paragraph Number	Ref. Std.
8-20	1_____ check
	2_____ check
	3_____ check
	4_____ check
	5_____ check
	6_____ check
	7_____ check
	8_____ check
	9_____ check
	10_____ check
	11_____ check
8-21	1_____ check
	2_____ check
	3_____ check
	4_____ check
	5_____ check
	6_____ check
	7_____ check
	8_____ check
	9_____ check

Paragraph Number	Ref. Std
8-21 (cont'd)	10 +5V_____ VDC
	+15V_____ VDC
	+18.5V_____ VDC
	+20V_____ VDC
	+28V_____ VDC
	11._____ check
	12_____ check
	13_____ check
	14_____ check
	15_____ check
	16_____ check
	17_____ check
	18_____ check

THE END

APPENDIX A

ADDENDUM TO OPERATION AND MAINTENANCE MANUAL

AIRBORNE RECORDER/REPRODUCER MODEL M-14G

This addendum provides information covering a specially configured 28-channel Model M-14G Reproduce System. This addendum should be used in conjunction with information contained in the basic M-14G operation and maintenance manual.

SECTION A-1

INTRODUCTION AND DESCRIPTION

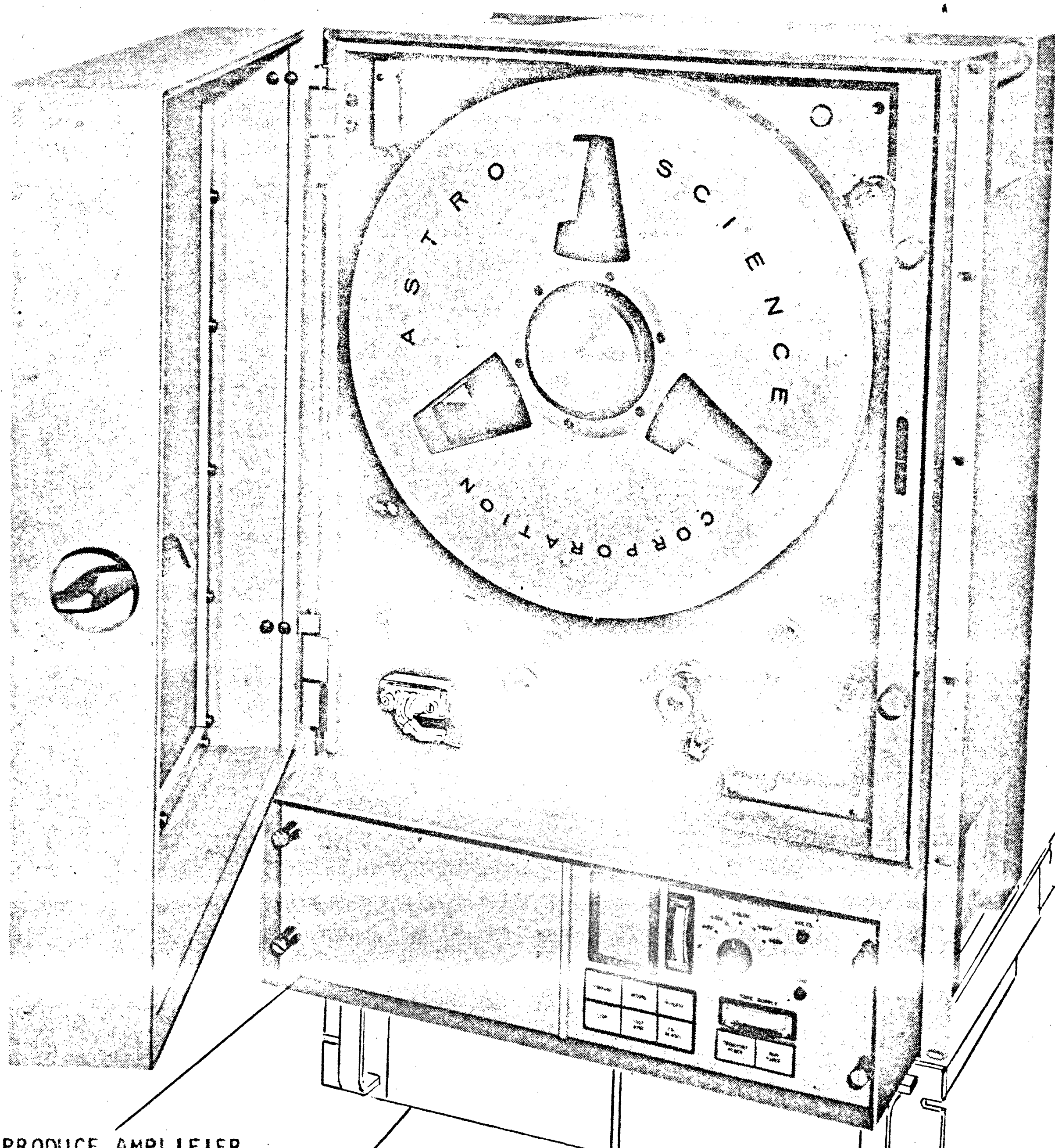
A1.1 INTRODUCTION

A1.1.1 Scope. This appendix supplements information contained in the basic Model M14-G Operation and Maintenance Manual to provide coverage for the Model M14-G 28-Track Wideband Reproduce unit, referred to hereafter as the M14-G Reproducer.

A1.1.2 General Description. The M14-G Reproducer (Figure A1-1) is designed to provide simultaneous 28-channel reproduce capability at any of six electrically selectable tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30, and 60 inches-per-second. The M14-G Reproducer is identical to the M14-G Record/Reproduce system, except that the M-14G 28-Track Reproducer contains a second Reproduce Amplifier Module (RAM) assembly, rack-mounted directly beneath the M14-G Reproducer housing, a 28-Track Magnetic Head Assembly, new Direct Reproduce Amplifiers, Preamplifiers, and voltage regulators. In addition, the original RAM shipped with the M14-G Record/Reproduce system was modified to the configuration of the additional RAM except for the retention of the local control function built into the original RAM. The original RAM was re-identified as part number 94001221-3 while the additional RAM is identified as part number 94001221-4.

A1.1.2.1 Whereas the reproduce preamplifiers are mounted directly beneath the magnetic head assembly on the M14-G Record/Reproduce system, the larger current mode preamplifiers are located within each RAM (-3 and -4). See Figure A1-2. In order to utilize the 28-track head assembly in the M14-G Reproducer, the record amplifier connectors were removed from the standard M14-G. In place of the EVEN numbered record amplifier housing, a connector mounting plate has been installed with a connector to accommodate the new reproduce head outputs. (See Figure A1-1.)

A1.1.2.2 Operation and maintenance instructions for the modifications are contained in this addendum, as well as system interconnect information and parts listing.



REPRODUCE AMPLIFIER
MODULE 94001221-3
(EXISTING)

REPRODUCE AMPLIFIER
MODULE 94001221-4
(SEE FIGURE A1-2)

Figure A1-1

28-TRACK M14-G REPRODUCE SYSTEM

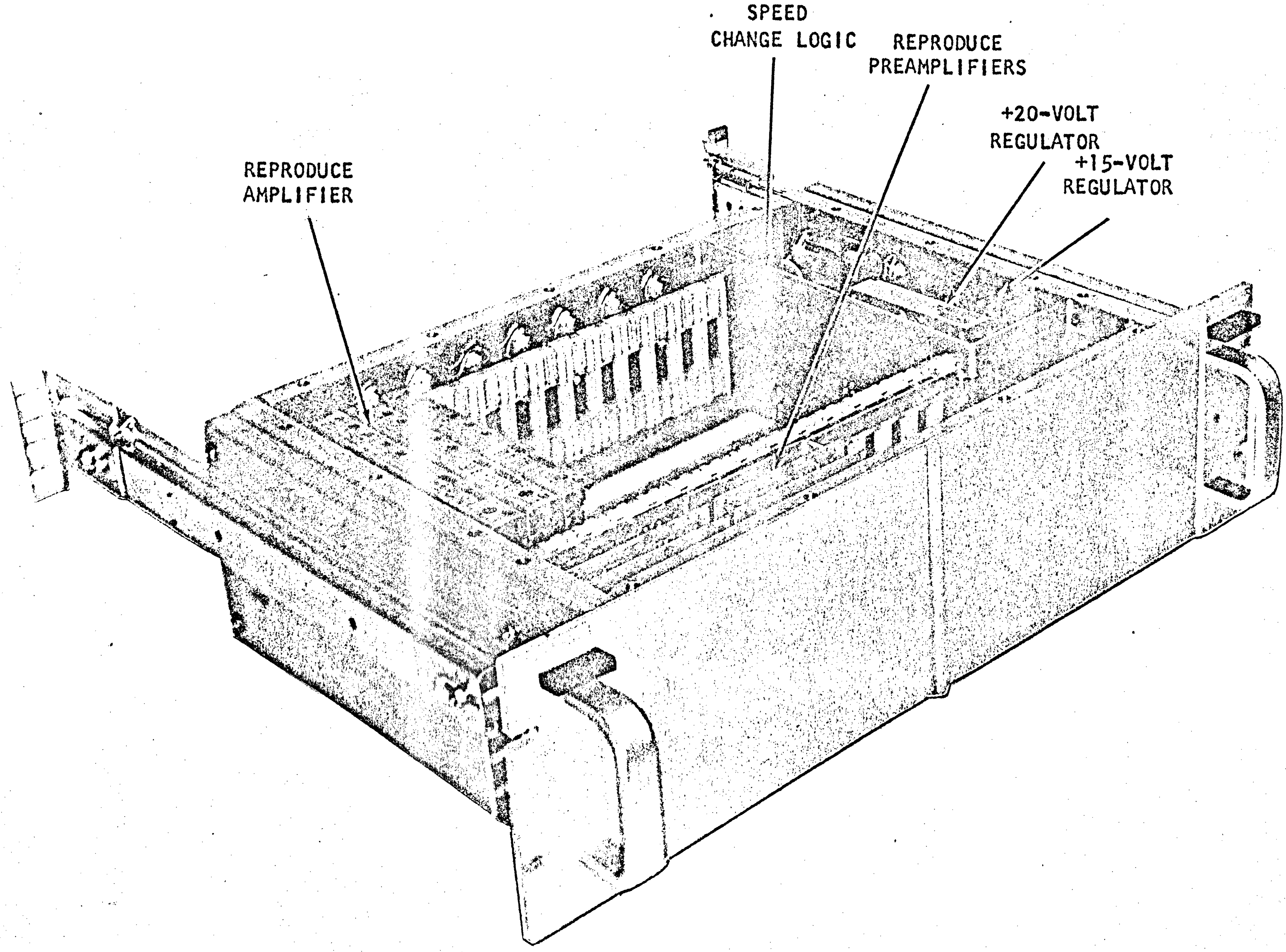


Figure A1-2
Reproduce Amplifier Module (Sheet 1 of 2)
P/N 94001221-4

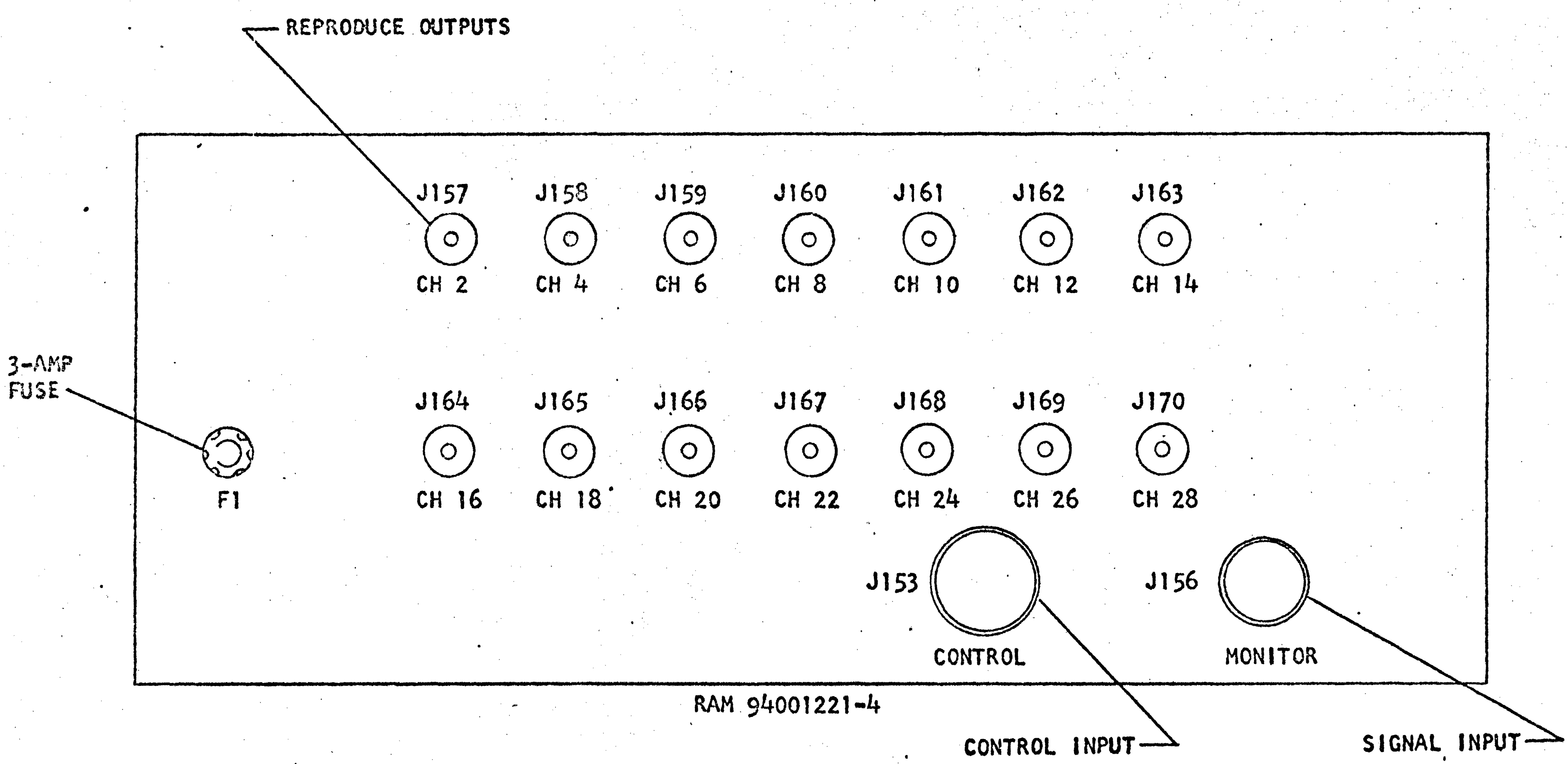


Figure A1-2

Reproduce Amplifier Module (Sheet 2 of 2)

(Rear Panel)

SECTION A-II

INSTALLATION AND OPERATION

A2.1 INTRODUCTION. This section provides instructions for installing and operating the M14-G 28-Track Reproduce Amplifier Modules used in conjunction with the M-14G Recorder/Reproducer, and a table of functional characteristics of the M-14G Reproducer.

A2.2 UNPACKING. System components (including accessories) are packed for shipment in accordance with standard commercial practices for shipment by air freight, rail, or truck. The assemblies should be carefully removed from the shipping container, and the container, complete with all bracing, lining and padding, should be retained for use in the event of reshipment.

A2.2.1 Installation. The slide-mounted M14-G 28-Track Reproduce Amplifier Module (RAM) part number 94001221-4 is designed to be installed directly beneath the M14-G Reproducer in a rack-mounted position. The interconnect cables supplied with the RAM (-4) were designed for this rack-mounted configuration in a standard 19-inch electronic equipment rack. Outline dimensions and mounting information are shown in Figure A2-1. System interconnection cables should be installed as shown in Figure A2-2. When mounting the unit, ensure that adequate space is provided for access to the connectors at the rear of the unit.

A2.2.2 Electrical Connections. Connector type and location are given in Figure A2-2. Connector pin assignments are given in Tables A2-1 through A2-5. Functional characteristics of the 28-track M-14G Reproduce System are listed in Table A2-6.

A2.3 OPERATION. The 28-track Reproduce Assembly has no local controls and is operated, automatically, by control signals from the M-14G control unit. The unit must be interconnected with the recorder for all operation and alignment purposes. For alignment and adjustment procedures, refer to Section A-IV of this addendum.

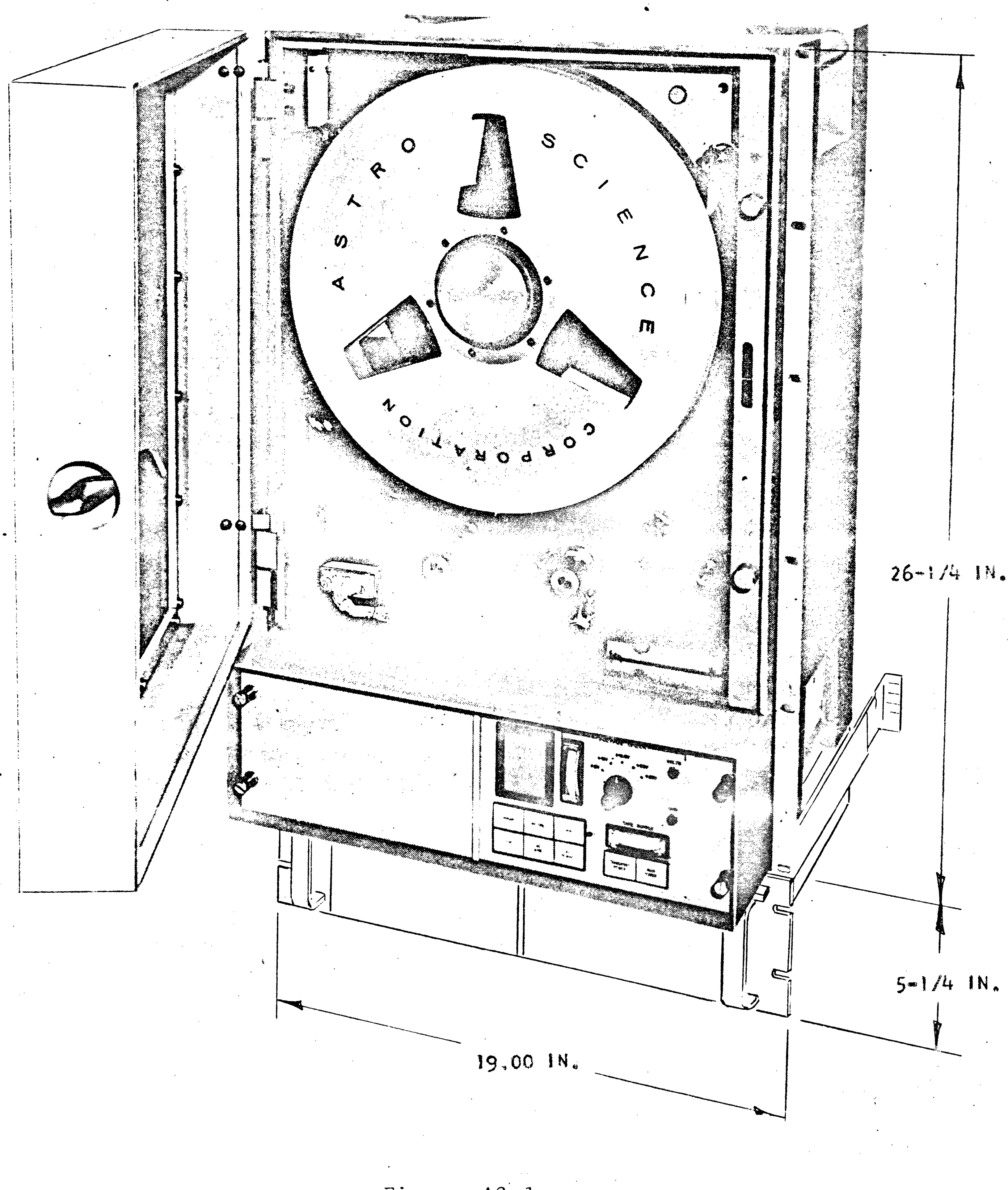


Figure A2-1

Outline and Installation

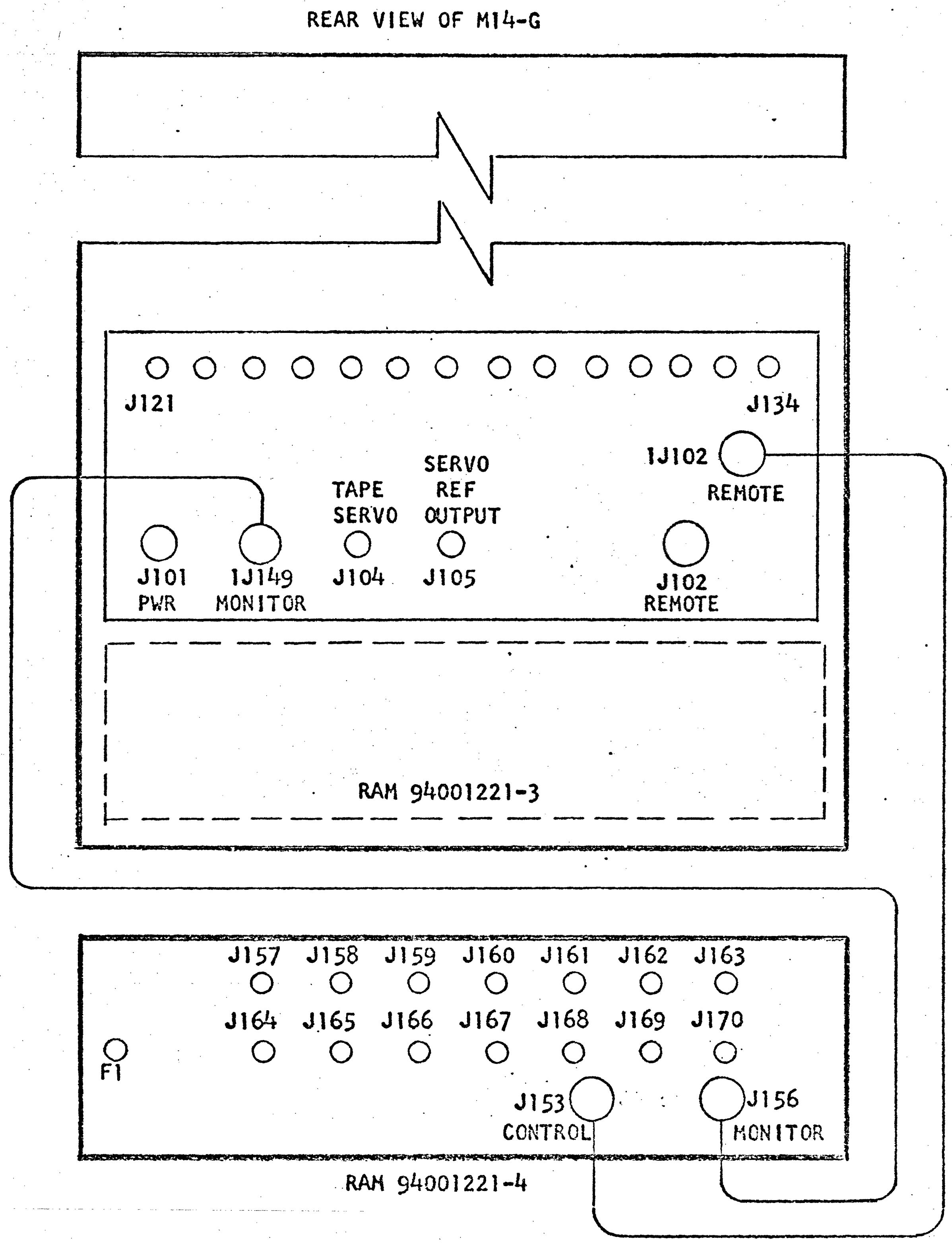


Figure A2-2
System Interconnection Diagram

Table A2-1
28-track Reproduce Assembly Pin Assignments

Signal Input Connectors J151, J156

J151 ODD Channels	J156 EVEN Channels	Connector Pin Numbers
1	2	H
3	4	B
5	6	J
7	8	C
9	10	K
11	12	D
13	14	L
15	16	E
17	18	M
19	20	F
21	22	T
23	24	P
25	26	U
27	28	R
Cable Ground	Cable Ground	A
Spare	Spare	G
Spare	Spare	N
Spare	Spare	S
Spare	Spare	V
(RAM 94001221-3)	(RAM 94001221-4)	

RAM 94001221-3, -4

Table A2-2

28-Track Reproduce Assembly Pin Assignments

Signal Output Connector J152

RAM94001221-3 J152 ODD Channels	RAM94001221-4 J152 EVEN Channels	Connector Pin No.
1	2	H
3	4	B
5	6	J
7	8	C
9	10	K
11	12	D
13	14	L
15	16	E
17	18	M
19	20	F
21	22	T
23	24	P
25	26	U
27	28	R
Cable Ground	Cable Ground	A
Spare	Spare	G
"	"	N
"	"	S
"	"	V

RAM 94001221-3

Table A2-3

28-Track Reproduce Assembly Pin Assignments

Control Connector J153

FUNCTION	PIN NO.
Cable Shield	A
Record	B
Forward	C
Record	D
Common (Amplifier)	E
+28 vdc	F
Broken Tape	G
End of Tape	H
Forward	J
Spare	K
Reverse	L
Fast Wind	M
Fast Rewind	N
1-7/8 ips	P
Spare	Q
Remote Speed Select	R
Phase Lock Test Point	S
M1 (+)	T
Reverse	U
+20 v	V
+18.5 v	W
+5 v	X
+15 v	Y
M1 (-)	Z
Common (Indicators)	a
+28 v (Indicators)	b
Stop	c
3-3/4 ips	d
7-1/2 ips	e
15 ips	f
120 ips	j
60 ips	h
30 ips	g

RAM 94001221-4

Table A2-4

28-Track Reproduce Assembly Pin Assignments

Control Connector J153

FUNCTION	PIN NO.
Cable Shield	A
Spare	B thru D
Common (Amplifier)	E
+28 v (Amplifier)	F
Spare	G thru N
1-7/8 ips	P
Spare	Q thru Z
Spare	a thru d
7-1/2 ips	e
15 ips	f
30 ips	g
60 ips	h

RAM 94001221-3

Table A2-5

28-Track Reproduce Assembly Pin Asignments

Power Input Connector J155

FUNCTION	PIN NO.
115 vac (Hot)	A
Common (115 vac)	B
Power Relay	C
Chassis Ground (Cable Shield)	D

28-Track M14-G Reproduce System

Table A2-6. FUNCTIONAL CHARACTERISTICS

Power Requirement:	115 vac, ± 10%, 50/60 Hz ± 5% single phase
Modes Of Operation:	Reproduce - Forward/Reverse
Input/Output:	28 channels of data, 400 Hz to 1.0 MHz at 60 ips for Direct/Analog reproducing.

Frequency Response & Signal-to-Noise Ratio:

Tape Speed (ips)	Direct Bandwidth ± 3 dB	S/N Ratio
1-7/8	800 Hz - 31.25 KHz	20 dB
3-3/4	800 Hz - 62.5 KHz	20 dB
7-1/2	800 Hz - 125 KHz	20 dB
15	800 Hz - 250 KHz	20 dB
30	800 Hz - 500 KHz	20 dB
60	800 Hz - 1.0 MHz	20 dB

Frequency Response & Signal-to-Noise Ratio: ± 3 dB, all speeds

Tape Speed (ips)	Bandwidth ± 3dB	S/N Ratio
1-7/8	400 Hz to 31.0 KHz	18 dB
3-3/4	400 Hz to 62.5 KHz	18 dB
7-1/2	400 Hz to 125 KHz	18 dB
15	400 Hz to 0.25 MHz	18 dB
30	400 Hz to 0.5 MHz	18 dB
60	400 Hz to 1.0 MHz	18 dB

Reproducing Tapes from ASC GPAR/MARS-1428(LT)-3B

Tape Speed (ips)	Flutter P-P (2-Sigma) Tach Servo	Dynamic Skew Microseconds (Adjacent tracks on same head stacks)	Record Time
1-7/8	2.50%	± 12.8	16 hrs
3-3/4	1.50%	± 6.4	8 hrs
7-1/2	0.85%	± 3.2	4 hrs
15	0.70%	± 1.6	2 hrs
30	0.60%	± 0.8	1 hr
60	0.45%	± 0.4	30 min

Table A2-6. FUNCTIONAL CHARACTERISTICS (Cont)

Tape Speeds:	
Operating	1-7/8, 3-3/4, 7-1/2, 15, 30 and 60 inches-per-second.
FAST WIND/REWIND	240 ips
Data Reproduce Channels:	28
Tape Type:	3M Type 888 or equivalent; 9200 ft. of one-inch-wide tape per 14-inch reel.
Operational Direction:	Operates in either forward or reverse direction.
Start Time:	Less than 5 seconds at 60 ips
Stop Time:	Less than 3 seconds from 60 ips
Jitter:	Less than 0.5 μsec in a 200 μsec interval on any track at 60 ips, without tape servo.
Speed Accuracy:	± 0.2% of nominal
End-of-Tape, Tape Remaining, Tape Break Sensors:	Optical systems which stop transport in event of tape breakage or end of tape. Indicators show amount of tape remaining on supply reel and tape break or end-of-tape condition.
Local Controls	MAIN POWER on/off, TRANSPORT POWER on/off, SPEED SELECT, FORWARD, REVERSE, RECORD, FAST WIND, FAST REWIND.
Remote Controls:	Provision for all local control functions except SPEED SELECT, via J102. Customer supplies remote control panel and switching circuitry.
Magnetic Head Track Geometry: (28-Track Interlaced Reproduce)	Width, 0.025 inches; Spacing, 0.035 inches; Interlace distance, 1.500 inches ± 0.001 inches.

28-Track M14-G Reproduce System

Table A2-6. FUNCTIONAL CHARACTERISTICS (Cont)

Data Signal Output Level:	
Direct	Adjustable (1.0 volt rms nominal at normal record level)
Normal Record Level:	2% Third Harmonic
Power Consumption:	Less than 400 watts
Operating Temperature:	0°C to +54°C
Relative Humidity:	15% to 95% without condensation
Mechanical Shock:	
Operating:	± 15 gravity, 11 ms
Crash Safety:	30 gravity
Operating Vibration:	(0.8% peak-to-peak flutter at 60 ips)
4 to 15 Hz	0.06 inches double amplitude
16 to 25 Hz	0.04 inches double amplitude
26 to 33 Hz	0.02 inches double amplitude

SECTION A-III

THEORY OF OPERATION

A3.1 INTRODUCTION. Since the M14-G 28-Track Reproducer is identical to the basic M14-G Recorder/Reproducer except for differences within the magnetic head assembly and the Reproduce Amplifier Modules (RAM); theoretical discussions herein will be confined to the unique differences between RAM electronics supplied with the basic M14-G Record/Reproduce unit, and the differences between both RAM units supplied with the M14-G Reproducer, 94001221-3 and 94001221-4.

A3.1.1 Scope. The data in this section is presented to familiarize the user with the equipment and as an aid in isolating equipment malfunctions which may occur during operation. Functional subdivisions of the unit are covered separately. Refer to Figures A1-1 and A1-2 for location of major components.

A3.2 SYSTEM DESCRIPTION. Refer to Figure A3-1. The M14-G 28-Track Reproducer, with Reproduce Amplifier Modules 94001221-3 and 94001221-4, provide simultaneous 28-channel reproduce capability at any of six electrically selectable tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30, and 60 inches-per-second. The basic M14-G Record/Reproduce unit provides only 14 channels of reproduction at each of the above tape speeds. Both the 94001221-3 and -4 RAM units contain 14 Reproduce Amplifiers (85004971) and seven Dual-Channel Preamplifiers (85004961) each. A +15-Volt dc Voltage Regulator (85003001) and a +20-Volt dc Voltage Regulator (85002601) are also contained in each RAM unit to provide operating voltages for the Reproduce Amplifiers and Preamplifiers. The larger current mode preamplifiers are located within the RAM (94001221-3 and -4) for the M14-G Reproducer (28-tracks). The 94001221-4 RAM unit has no local controls, and is operated automatically by control signals from the M-14G Reproducer through the control unit 94001221-3. RAM 94001221-4 is separate from the M14-G Reproducer and is slide-mounted in a standard 19-inch rack directly beneath the M14-G Reproducer housing. Mating connector cables 50001721 (Monitor/Remote) and 5001731 (Remote/Power) provide system interconnect between the 94001221-4 and the M14-G Reproducer.

A.3.3 REPRODUCE PREAMPLIFIER (85004961). Refer to Figure A3-2. Each Reproduce Preamplifier consists of two separate preamplifier circuits mounted on a single plug-in printed wiring board. As shown, the output of the reproduce head is capacitor coupled to the base of amplifier Q2. The output of Q2 is directly coupled to the emitter of Q1, with degenerative feedback provided by resistor R1. The output of Q1 is directly coupled to the output emitter-follower (Q3), which provides current gain and impedance

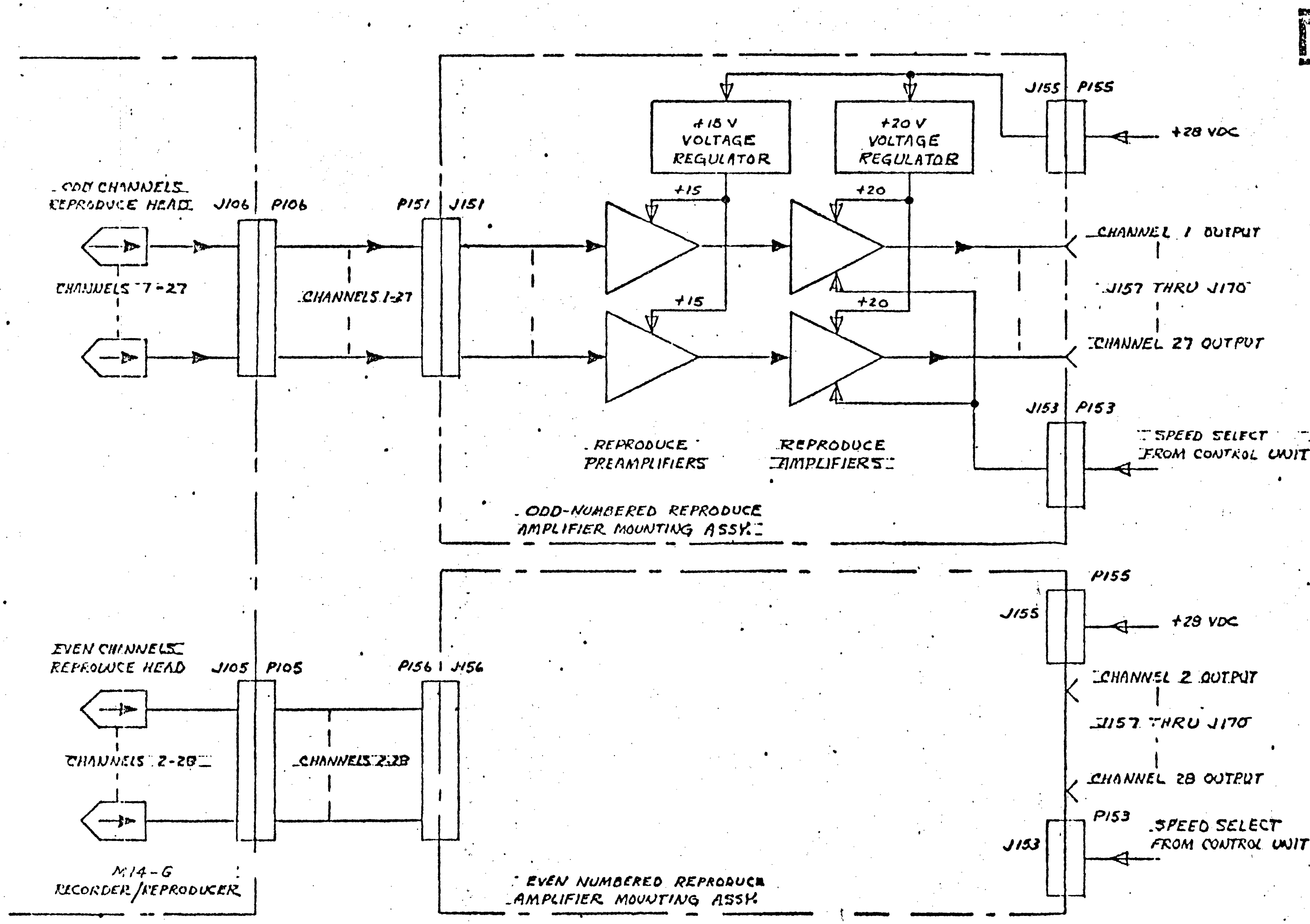


Figure A3-1

M14-G 28-Track Reproducer Functional Block Diagram

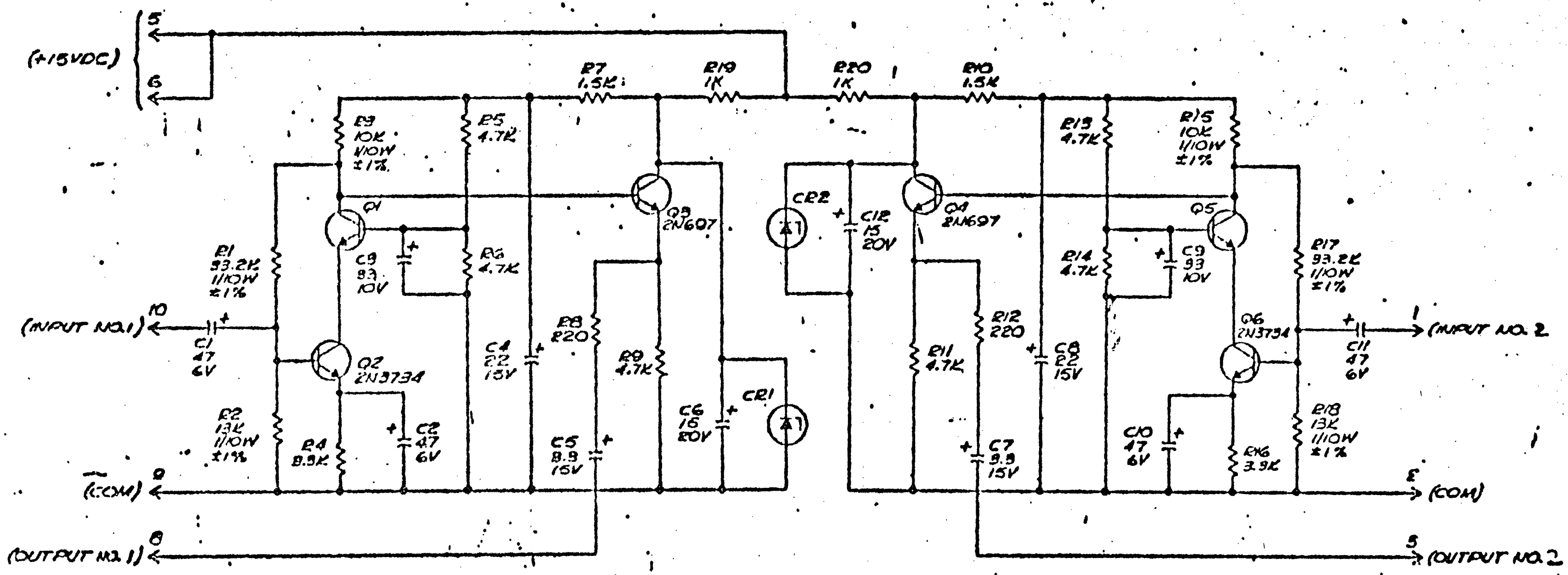


Figure A3-2
Reproduce Preamplifier Schematic Diagram (85004961)

matching to drive the Reproduce Amplifier. Zener diode CR1 and capacitor C6 provide stable operating voltage for output transistor Q3. Transistors Q4, Q5, and Q6 provide similar functions for the second reproduce channel.

A3.4 REPRODUCE AMPLIFIER (85004971)

A3.4.1 General Description. Refer to Figure A3-3. The Reproduce Amplifier provides amplitude and phase equalization for the direct record/reproduce system. As shown, the circuit contains an overall LEVEL control (R1), and separate amplitude and phse equalization circuits for each tape speed (1-7/8 thru 60 ips). Through the utilization of both fixed and variable circuit components, the gain of the amplifier is caused to decrease as input frequency increases. This rolloff occurs at the rate of approximately 6 dB/octave to compensate for the normal 6 dB/octave increase in output from the reproduce head.

A3.4.2 Input Stages. The output signal from the Reproduce Preamplifier is applied to the Reproduce Amplifier across the reproduce LEVEL control (R1), which serves as the overall gain control for the amplifier. After passing through the amplifier input stages (Q10Q4), the unequalized reproduce signal is applied to the amplitude equalization networks, through resistor R11, and through the high-frequency compensation network consisting of R110, C49, and the HIGH FREQ. ADJ. trimmer (C48). MID FREQ. ADJ. control (R28) serves to control the overall signal loss introduced by the reactive equalization components.

A3.4.3 Low-Frequency Equalization. At low-frequencies, when the recorder is operated at 30 or 60 ips, the capacitive reactance of C12 is high compared to the resistance of R29 and R30. Therefore, these resistors become the controlling element in determining low-frequency response. The low-frequency gain of the amplifier, at 30 and 60 ips, is therefore determined by the setting of the LF ADJ. control (R29). As frequency increases, the reactance of C12 decreases, providing a progressive rolloff in amplifier gain, in proportion to input frequency. Separate low-frequency equalization networks are used for the high (60 and 30 ips) and low (15 thru 1-7/8 ips) tape speeds.

A3.4.4 High-Frequency Equalization. At approximately the midpoint in the recorder/reproducer bandwidth, a sharp rolloff (-18 dB/octave) occurs, due to the characteristics of the reproduce head. To compensate for this rolloff, a parallel resonant LCR network, consisting of L1, C14, R33, R34, and R94, is utilized to increase the overall impedance of the equalization circuits, to these frequencies. BANDEDGE ADJ. control R34 serves to adjust the gain of the amplifier at high-frequencies, by controlling the reactance of the LCR network. Since the bandwidth of the recorder/reproducer doubles with each progressive increase in tape speed, a separate high-frequency equalization network is utilized for each speed.

(Sheet 1 of 2)

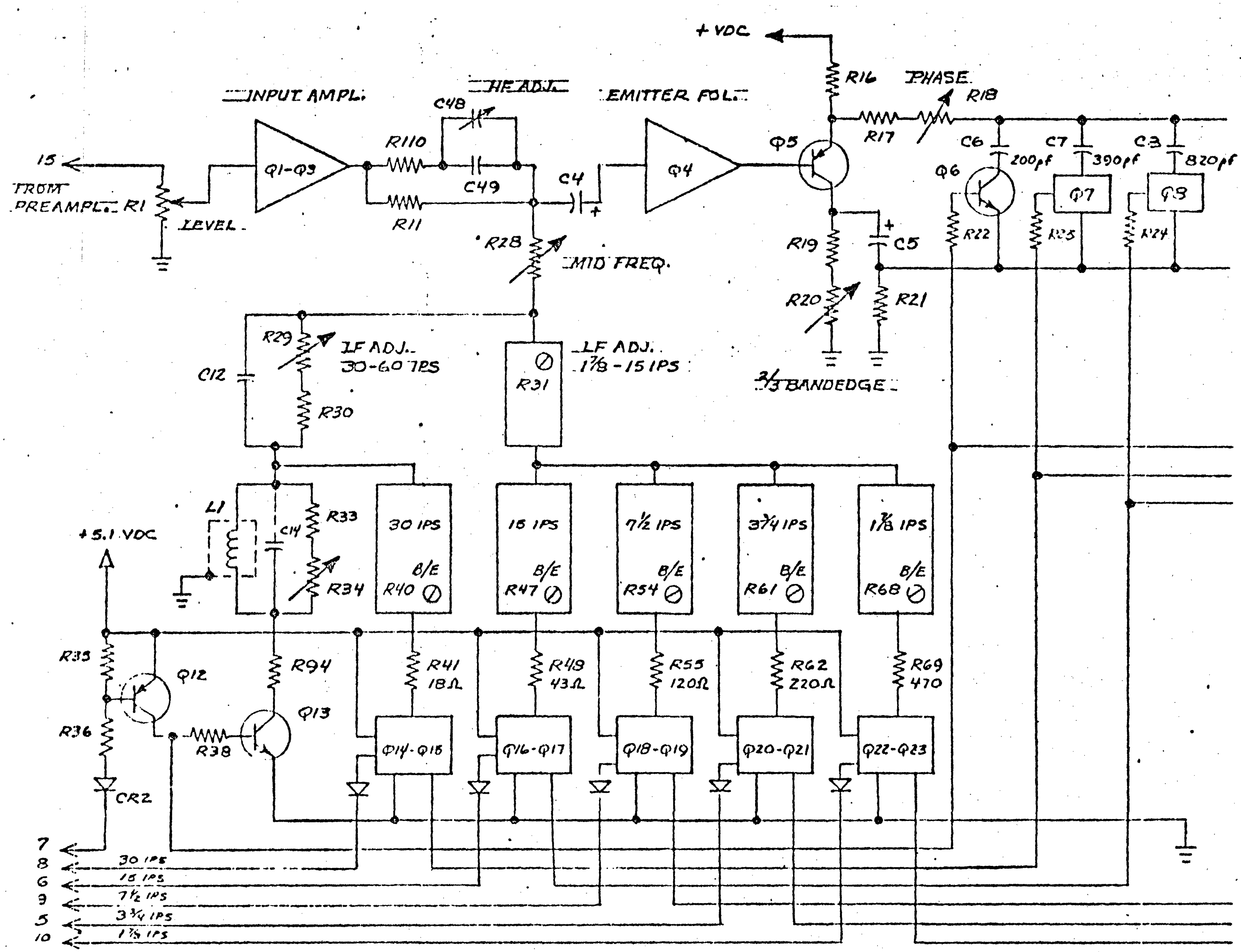
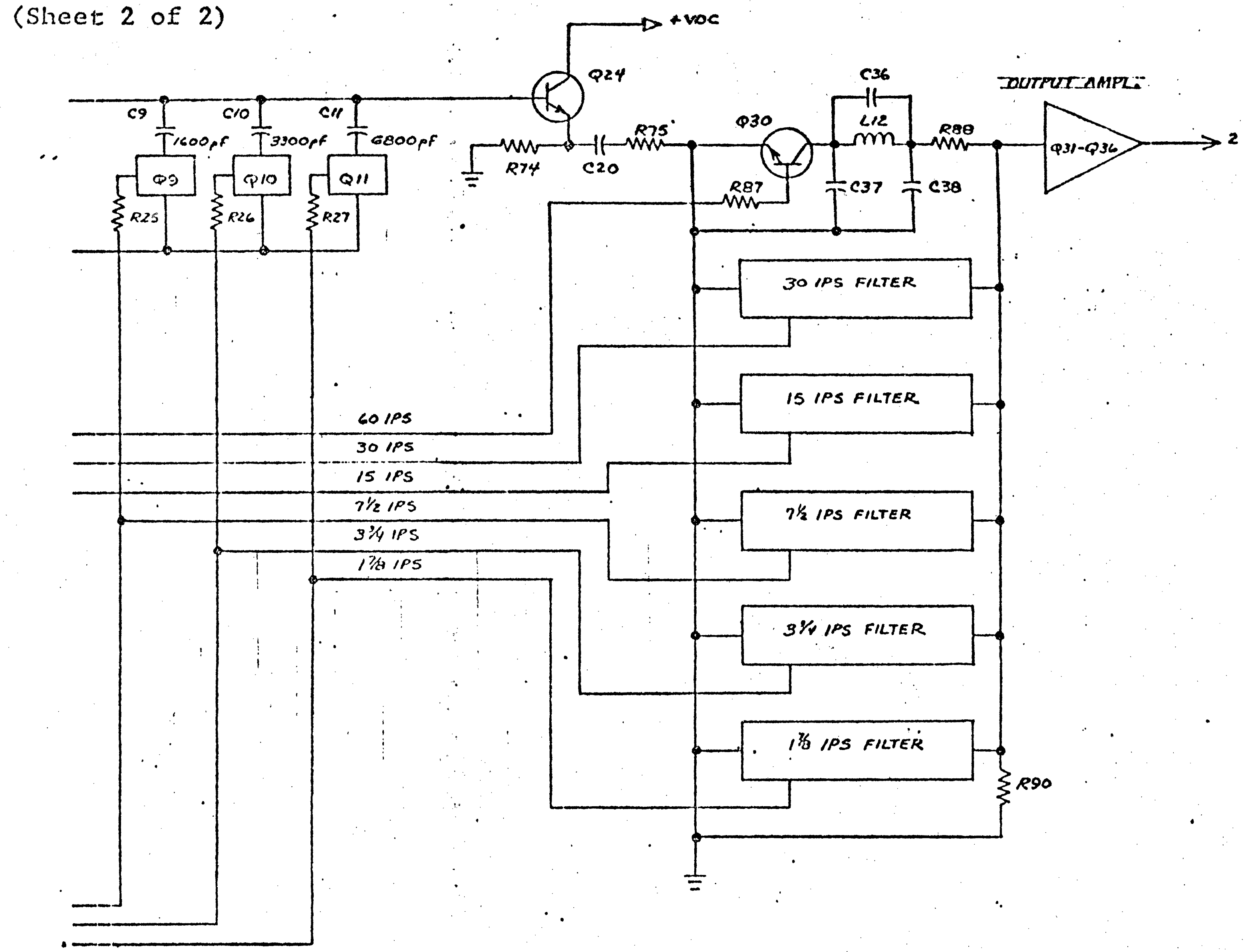


Figure A3-3. Reproduce Amplifier Schematic Diagram (85004971)

(Sheet 2 of 2)



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A TRACOR COMPANY

Figure A3-3. Reproduce Amplifier Schematic Diagram (85004971)

A3.4.5 Equalization Select Circuits. Proper high-frequency equalization circuits are selected, automatically, with tape speed selection, by grounding one of the speed select lines (pins 5 thru 10). When the 60 ips tape speed is selected, for example, ground is provided at pin (7) of the Reproduce Amplifier. This causes transistor Q12 and Q13 to conduct, providing a ground return path to the 60 ips equalizer, through resistor R94. Transistors Q14 thru Q23 perform the same switching function for the 30 thru 1-7/8 ips high-frequency equalization networks, when their respective speed select lines are grounded.

A3.4.6 Phase Equalization. The purpose of the phase equalization circuit is to compensate for the phase distortion introduced by the amplitude equalizers, and to restore proper phase relationships of the various signal frequency components. From the amplitude equalization networks, the signal is routed through capacitor C4 and emitter-follower Q4, to the phase splitter/amplifier Q5. Transistor Q5 provides two identical output signals that are 180° out of phase with each other. The signals are then recombined through the phase restoration network consisting of R17, R18, C6 thru C11, and R21, to restore proper signal phase. Separate phasing capacitors (C6 thru C11) are used for each tape speed, and are automatically connected into the circuit by switching transistors Q6 thru Q11, when one of the speed select lines (pins 5 thru 10) is grounded. Variable resistor R20 (2/3 BANDEDGE ADJ.) serves to balance the amplitude of the two output signals from Q5. PHASE ADJ. control R18 permits adjusting circuit reactance for proper phase resoration.

A3.4.7 Output Stages. From the phase equalizer, the signal is routed through emitter-follower Q24 to a bank of low-pass filters, which remove high-frequency noise outside of the recorder bandwidth. Separate filters are used for each tape speed, and are automatically selected when one of the speed select lines are grounded. After filtering, the signal is amplified in the output amplifiers stages (Q31-Q36), and appears at the output connectors on the rear panel of the RAM.

A3.5 +15-VOLT VOLTAGE REGULATOR (85003001). Refer to Figure A3-4. A +15 Vdc Voltage Regulator is installed in each of the two RAM units to provide regulated operating voltage for the seven dual-channel preamplifiers. Power transistor Q1 is a series-regulator operating directly from the +28 Vdc primary power source, supplied to pin 10 of the regulator printed wiring board. The +15 Vdc output voltage is sensed across a voltage divider network consisting of resistors R5, R7, and variable resistor R6, and applied to the base of control transistor Q2. Transistor Q2 compares the sampled output voltage, from the center arm of R6, with a fixed reference voltage developed across zener diode CR3, and develops an output signal proportional to the difference, to drive the series regulator Q1. Zener diode CR3 and transistor Q2 have opposite temperature coefficients to compensate for changes in operating temperature. Diodes CR1 and CR2, connected between the emitter and base of transistor Q1, protect the transistor from current surges.

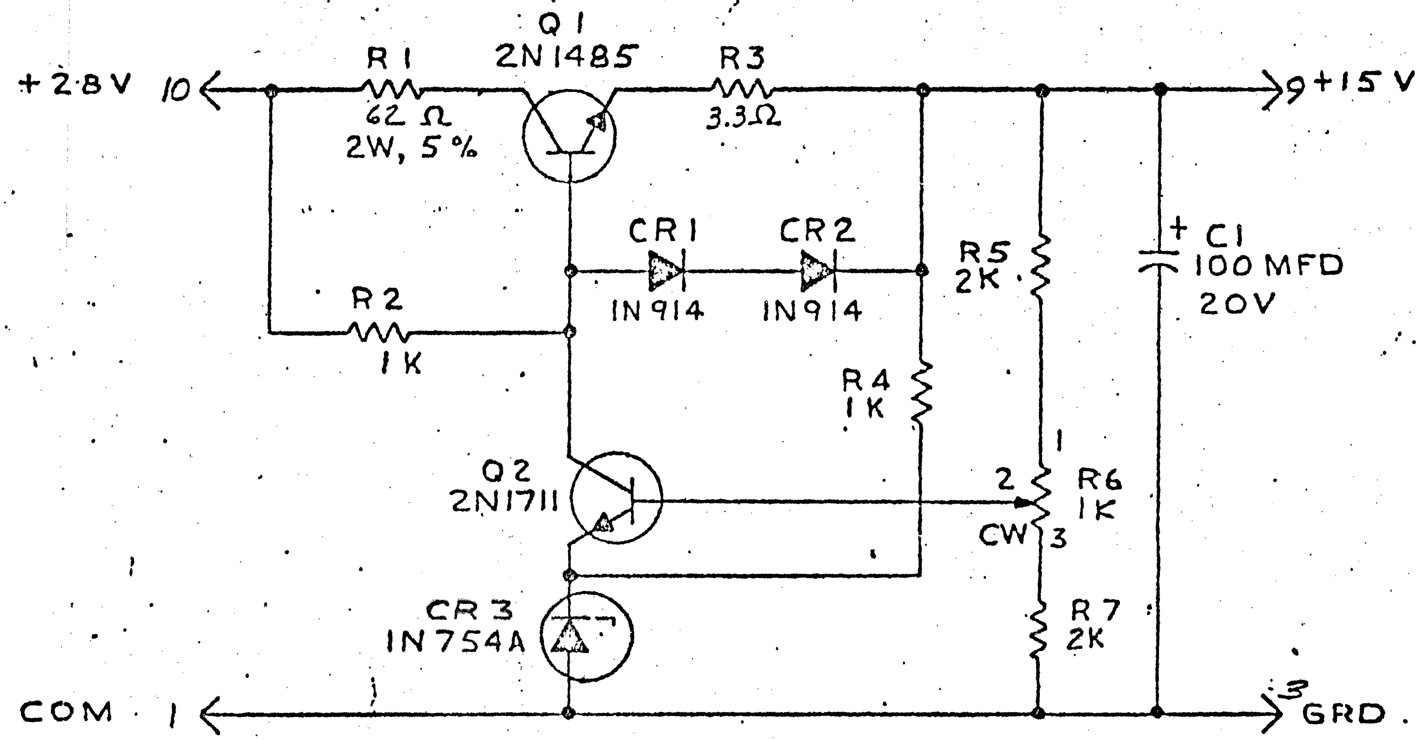


Figure A3-4
+15-Volt Voltage Regulator Schematic Diagram (85003001)

Capacitor C1 provides filtering for the +15 Vdc output voltage, available at pin 9 of the regulator printed wiring board. Variable resistor R6 serves to adjust the output voltage to exactly +15 Vdc.

A3.6 +20-VOLT VOLTAGE REGULATOR (85002601). Refer to Figure A3-5. A +20 Vdc Voltage Regulator is installed in each of the two RAM units to provide regulated operating voltage for the 14 Reproduce Amplifiers. Power transistor Q2 is a series-regulator operating directly from the +28 Vdc primary power source, supplied to pin 10 of the regulator printed wiring board. The +20 Vdc output voltage is sensed across a voltage divider network consisting of resistors R6, R8, and variable resistor R7, and applied to the base of control transistor Q3. Transistor Q3 compares the sampled output voltage, from the center arm of R7, with a fixed reference voltage developed across zener diode CR2, and develops an output signal proportional to the difference, to drive transistor Q1, which, in turn, controls conduction of the series-regulator Q2. Zener diode CR2 and transistor Q3 have opposite temperature coefficients to compensate for changes in operating temperature. The input 28 Vdc is clamped by zener diode CR1 to approximately 24 Vdc, to drive the control circuit. Capacitor C2 provides filtering for the +20 Vdc output voltage, available at pins 1 and 2 of the regulator printed wiring board. Variable resistor R7 is used to adjust the output voltage to exactly +20 Vdc.

A3.7 SPEED CHANGE LOGIC (85002012). Refer to Figure A3-6. The function of the Speed Change Logic is to select the proper equalization network in the Reproduce Amplifiers, which correspond to the tape speed at which the recorded signals are to be reproduced, determined by the position of the SPEED SELECT switch(s) on the recorder Control Unit. When a specific tape speed is selected, a corresponding relay (or combination of relays) on the Speed Logic card is energized. The only exception is the 3-3/4 ips speed, in which case all speed select relays are de-energized, and a ground return path is provided by the normally-closed contacts of K1, K2, and K3. For 7-1/2 ips, K3 is energized by 28 Vdc across pins 5 and 6, and a ground return path is provided through normally-closed contacts of K1 and K2, through K3A1/K3A2. For 15 ips, K2 is energized (across pins 6 and 14) and ground is supplied through normally-closed contacts of K1, through K2A1/K2A2, and normally-closed contacts B2 and B3 of K3. For 30 ips, K2 and K3 are energized (across pins 6 and 9) and ground is supplied through K3B1/K3B2, K2A1/K2A2, and through the normally-closed contacts of K1. For 60 ips, K1 is energized (across pins 6 and 11) and ground is supplied through the normally-closed contacts of K4 and K2, and through K1A1/K1A2. For 1-7/8 ips, relays K1 and K4 are energized (across pins 6 and 15) and ground is supplied through K4A1/K4A2, through the normally-closed contacts of K2, and through K1A1/K1A2. In each case, the ground return path provided by the Speed Change Logic selects the proper equalization networks on the Reproduce Amplifier, for the speed selected.

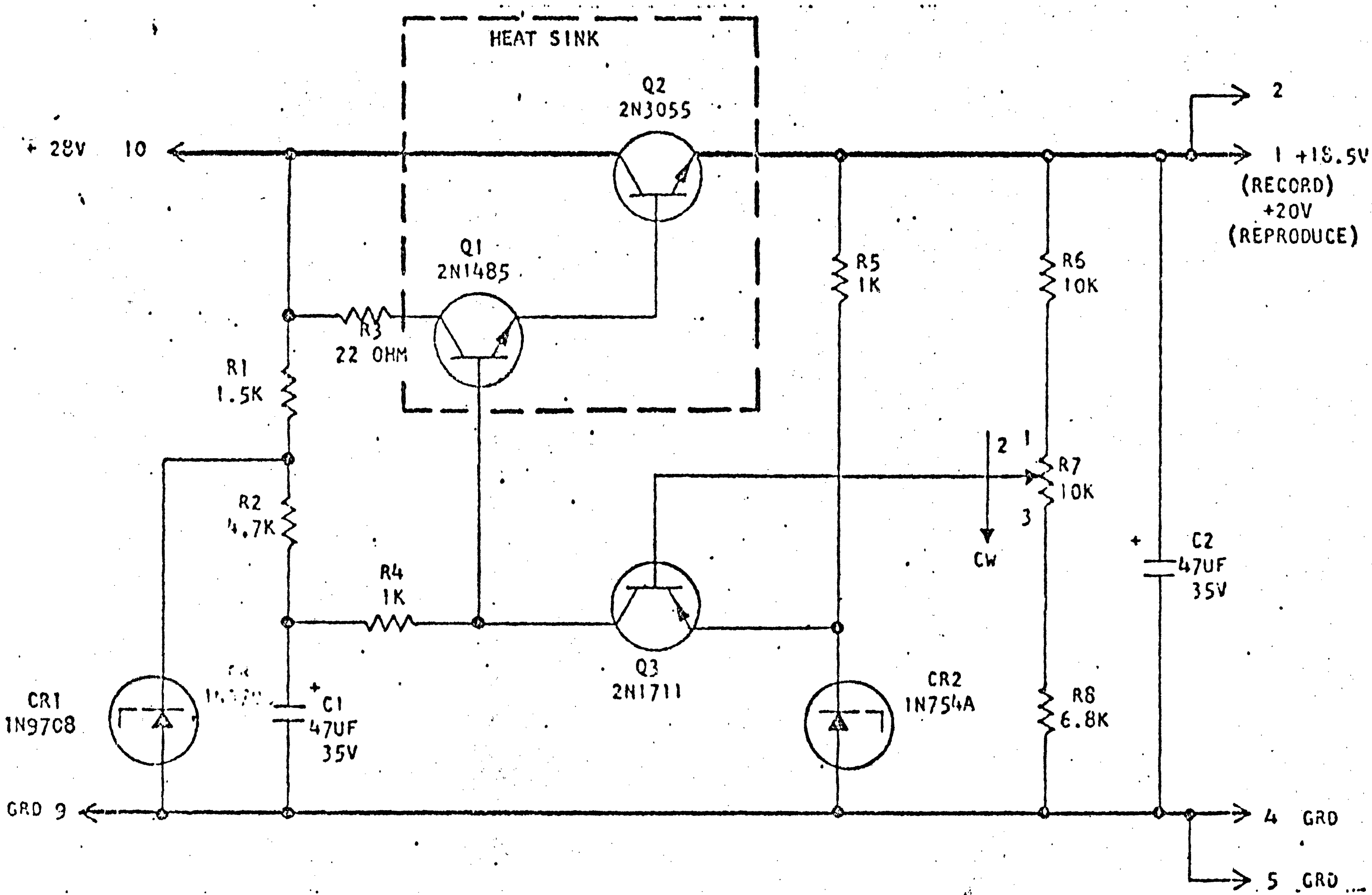


Figure A3-5
+20-Volt Voltage Regulator Schematic Diagram (85002601)

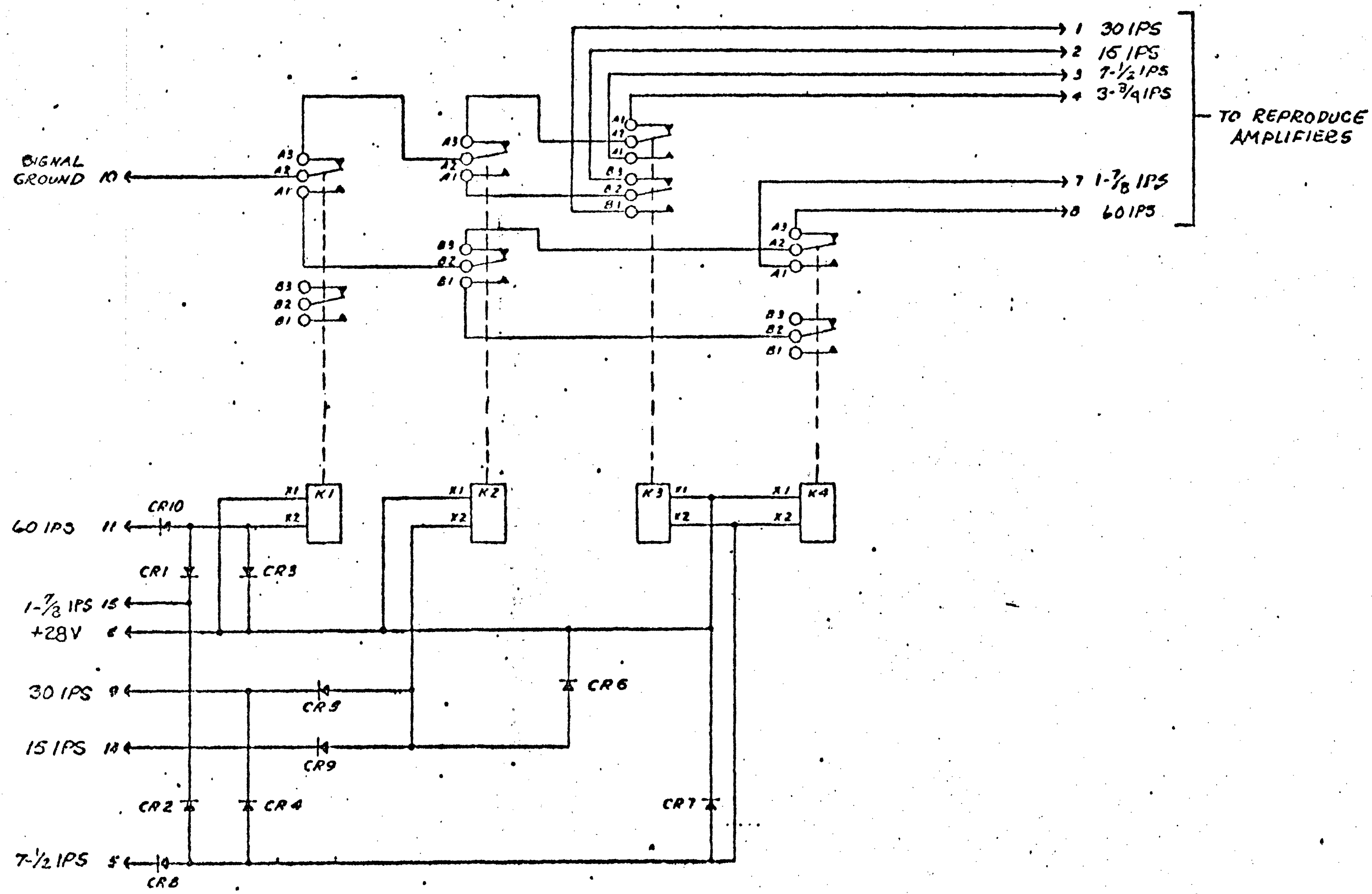
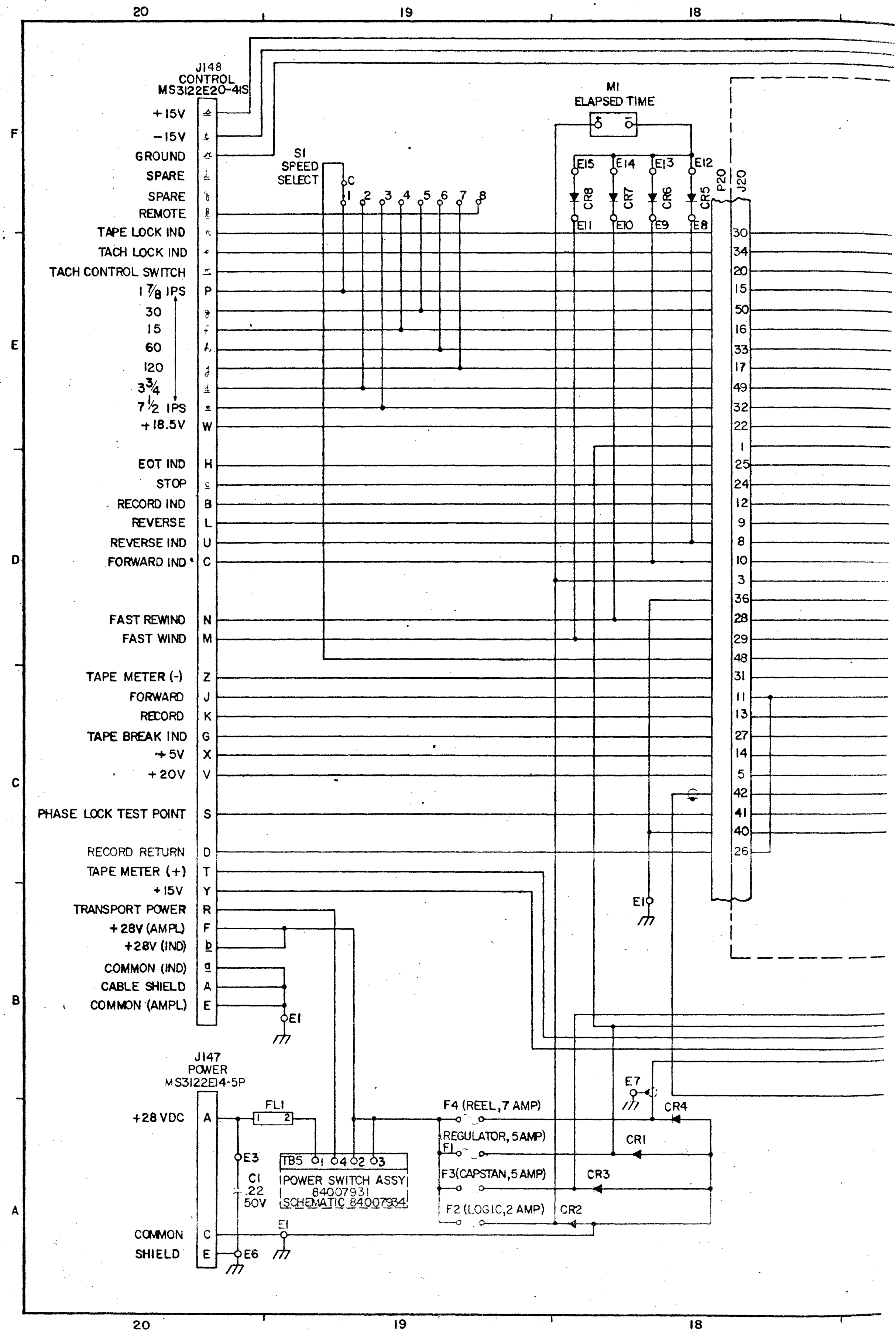
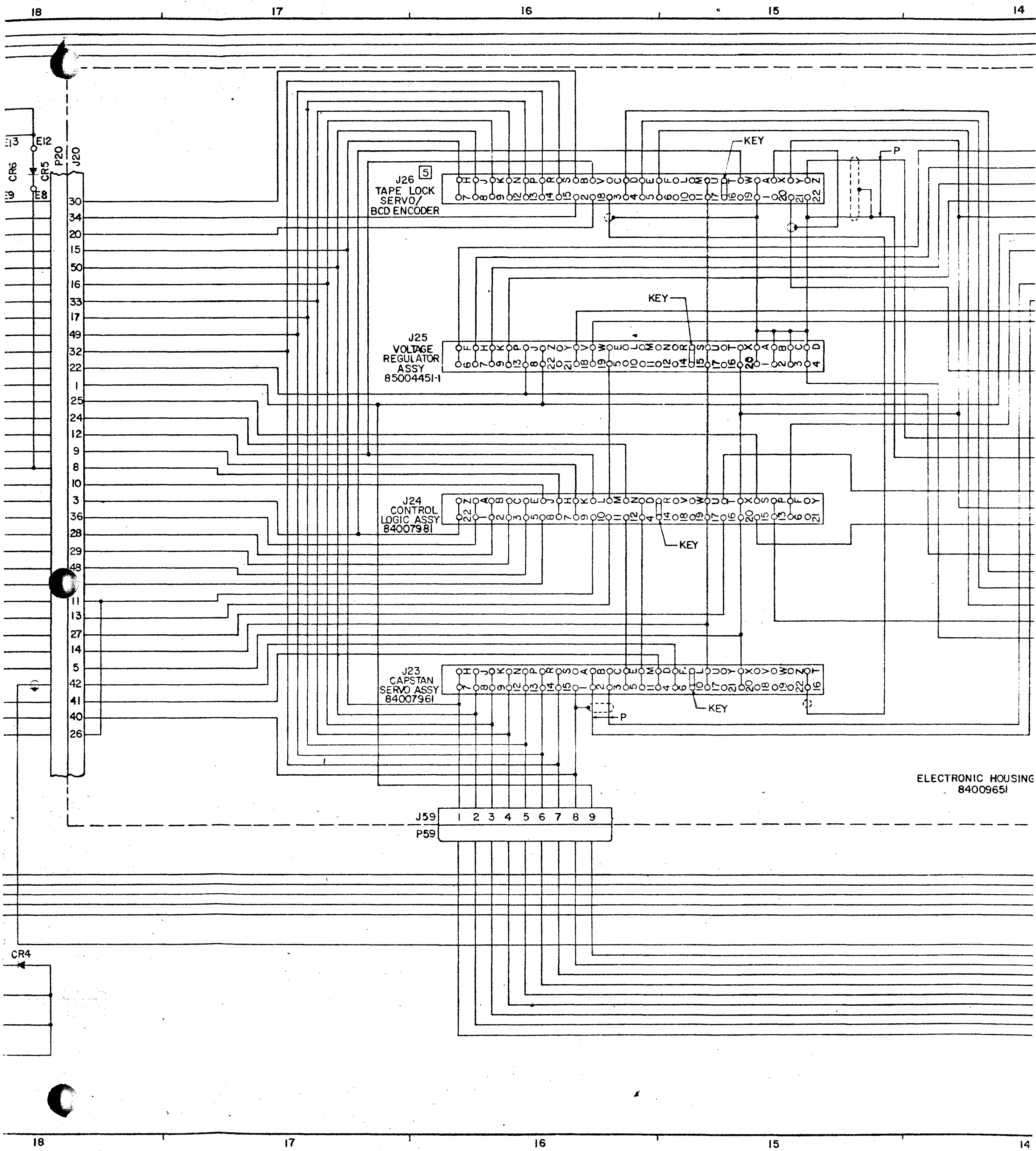


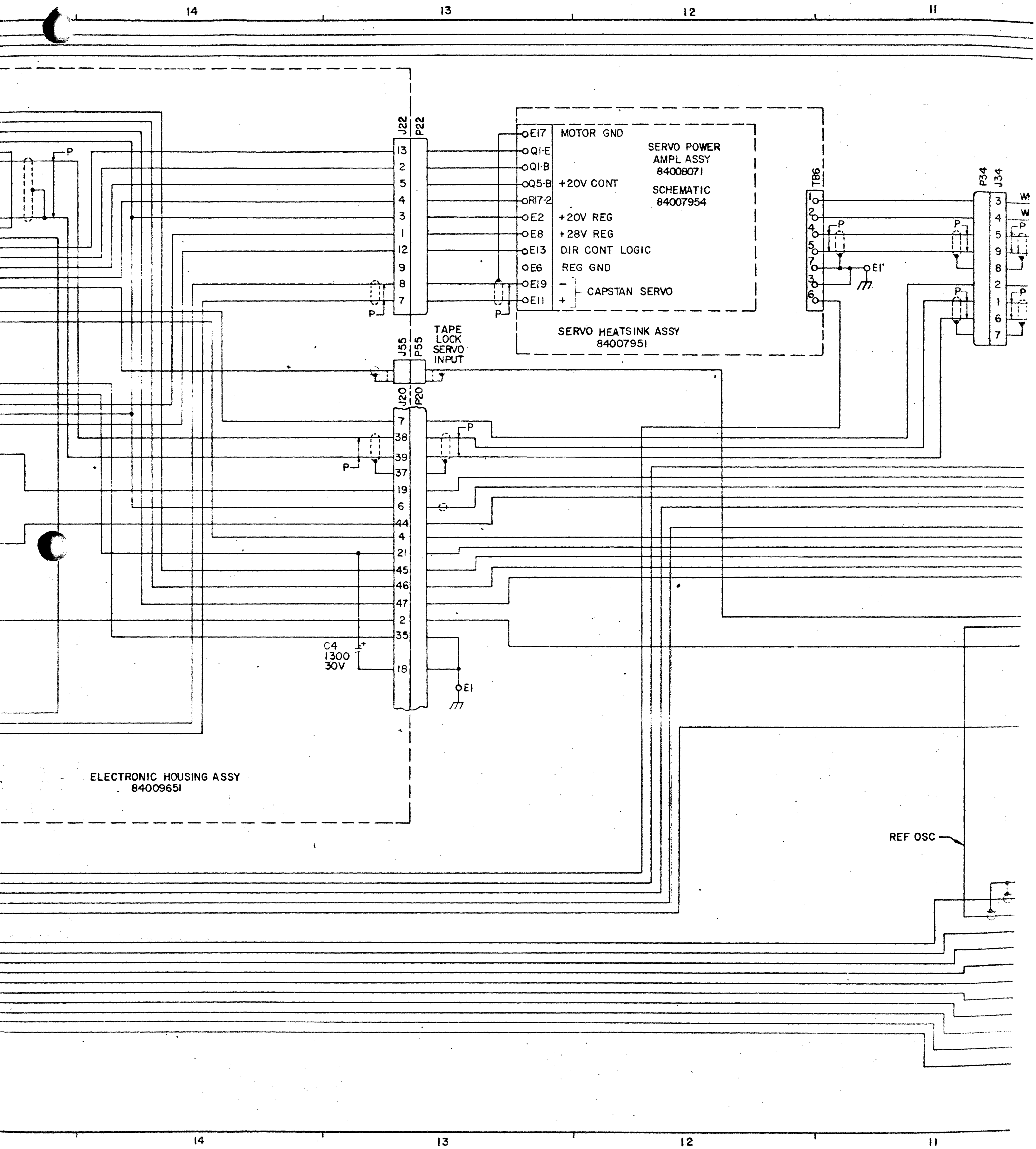
Figure A3-6

Speed Change Logic Schematic Diagram (85002012)

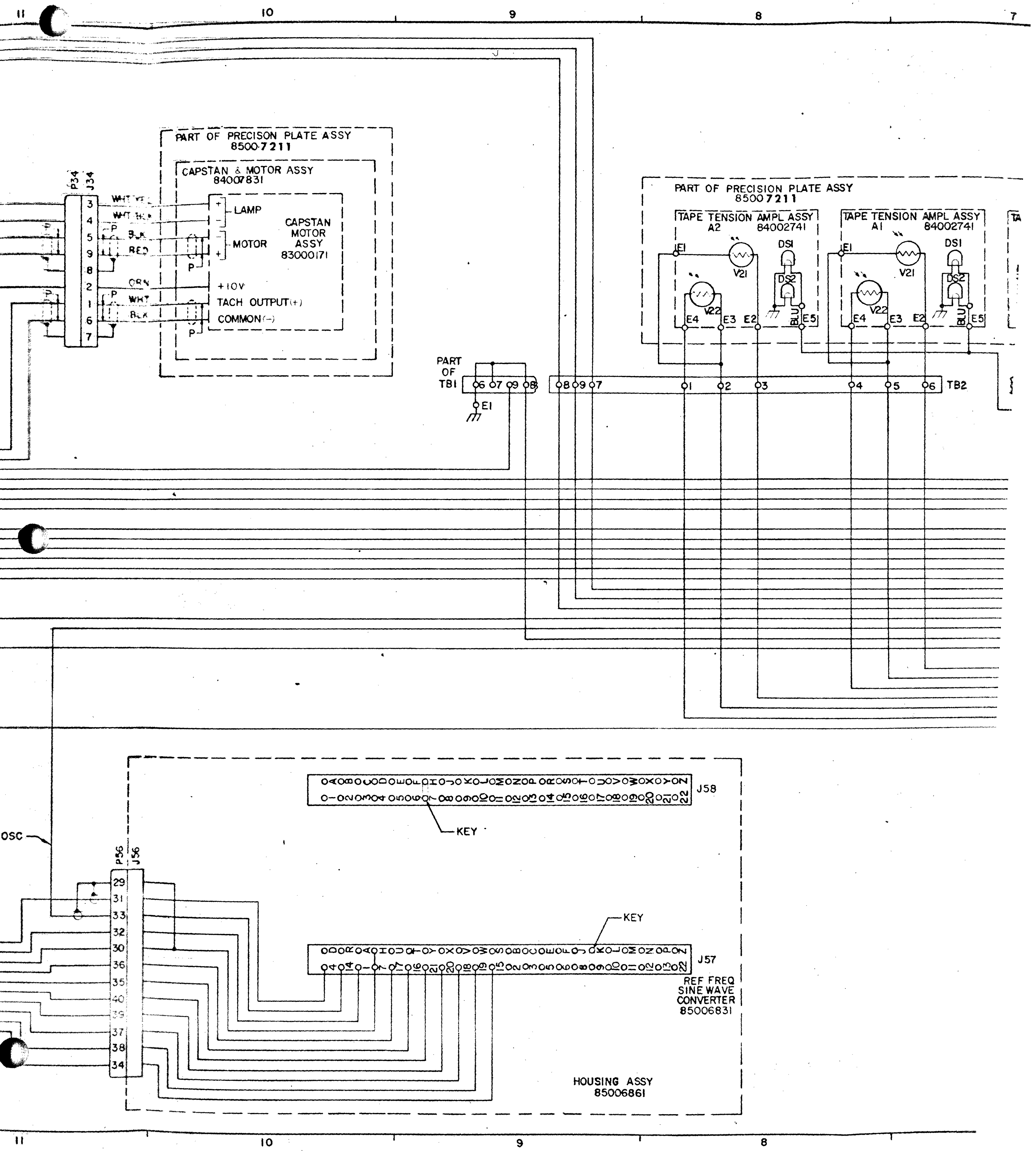


J148
CONTROL
MS3122E20-41S
+15V
-15V
GROUND
SPARE
SPARE
REMOTE
TAPE LOCK IND
TACH LOCK IND
TACH CONTROL SWITCH
1 7/8 IPS
30
15
60
120
3 3/4
7 1/2 IPS
+18.5V
EOT IND
STOP
RECORD IND
REVERSE
REVERSE IND
FORWARD IND
FAST REWIND
FAST WIND
TAPE METER (-)
FORWARD
RECORD
TAPE BREAK IND
+5V
+20V
PHASE LOCK TEST POINT
RECORD RETURN
TAPE METER (+)
+15V
TRANSPORT POWER
+28V (AMPL)
+28V (IND)
COMMON (IND)
CABLE SHIELD
COMMON (AMPL)
S1
SPEED
SELECT
M1
ELAPSED TIME
E15
E14
E13
E12
CR8
CR7
CR6
CR5
E11
E10
E9
E8
P20
J20
E1
J147
POWER
MS3122E14-5P
+28 VDC
COMMON
SHIELD
FL1
E3
C1
.22
50V
E6
TB5
POWER SWITCH ASSY
84007931
SCHEMATIC 84007934
F4 (REEL, 7 AMP)
REGULATOR, 5 AMP)
F1
F3(CAPSTAN, 5 AMP)
F2 (LOGIC, 2 AMP)
CR4
CR1
CR3
CR2
E7

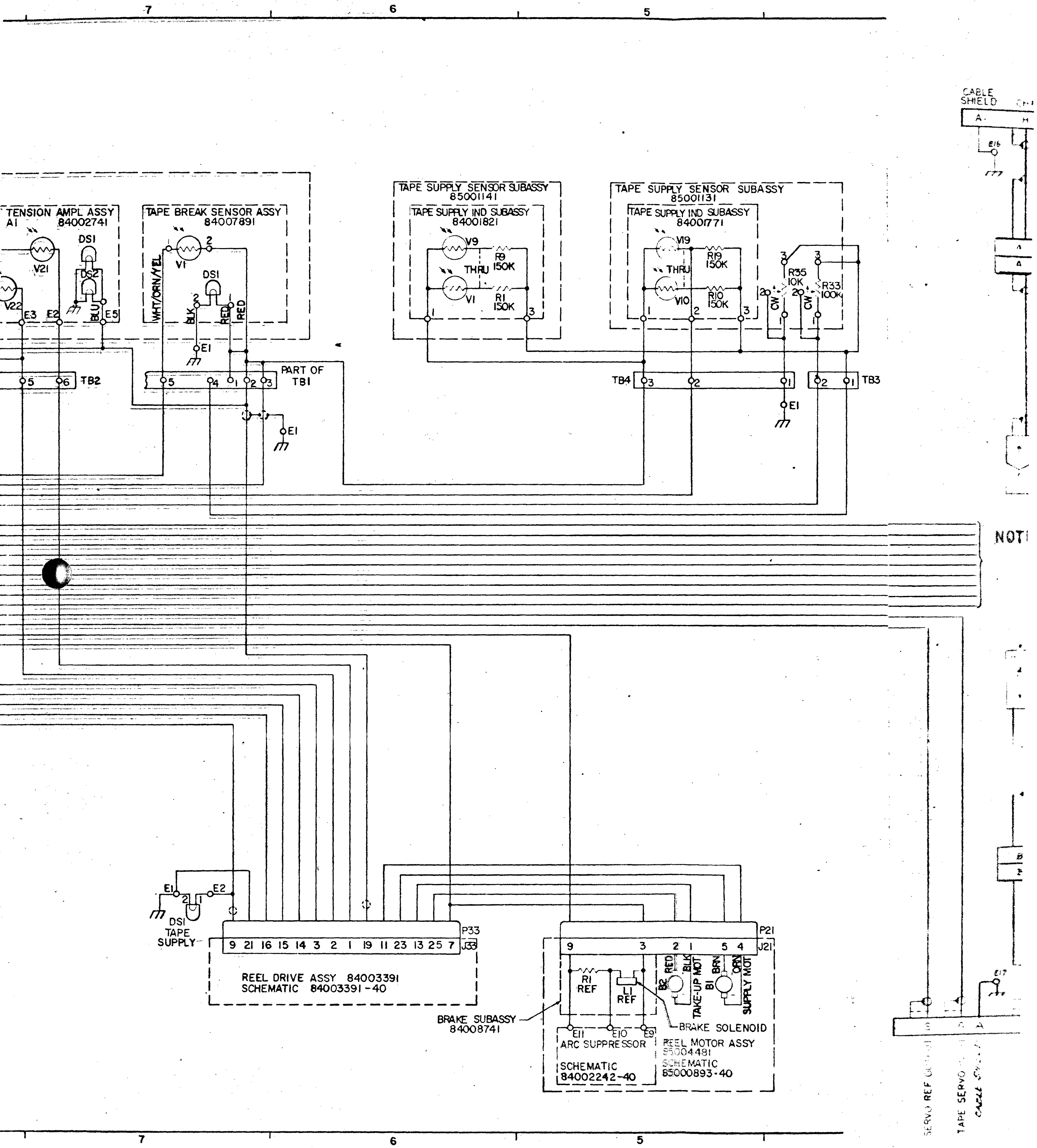

18 17 16 15 14
E13
E12
CR6
CR5
E9
E8
P20
J20
J26 5
TAPE LOCK
SERVO/
BCD ENCODER
KEY
P
J25
VOLTAGE
REGULATOR
ASSY
85004451-1
KEY
J24
CONTROL
LOGIC ASSY
84007981
KEY
J23
CAPSTAN
SERVO ASSY
84007961
KEY
P
ELECTRONIC HOUSING
84009651
J59 1 2 3 4 5 6 7 8 9
P59
CR4
18 17 16 15 14



14
13
12
11
J22
P22
MOTOR GND
SERVO POWER AMPL ASSY 84008071
SCHEMATIC 84007954
+20V CONT
+20V REG
+28V REG
DIR CONT LOGIC
REG GND
CAPSTAN SERVO
SERVO HEATSINK ASSY 84007951
TB6
P34
J34
TAPE LOCK SERVO INPUT
J55
P55
J20
P20
C4 1300 30V
E1
ELECTRONIC HOUSING ASSY 84009651
REF OSC



PART OF PRECISON PLATE ASSY
85007211
CAPSTAN & MOTOR ASSY
84007831
LAMP
MOTOR
CAPSTAN MOTOR ASSY
83000171
+10V
TACH OUTPUT(+)
COMMON(-)
P34
J34
PART OF PRECISION PLATE ASSY
85007211
TAPE TENSION AMPL ASSY
A2
84002741
TAPE TENSION AMPL ASSY
A1
84002741
PART OF TB1
TB2
OSC
P56
J56
KEY
J58
J57
REF FREQ SINE WAVE CONVERTER
85006831
HOUSING ASSY
85006861



7
6
5
CABLE SHIELD
TENSION AMPL ASSY
A1 84002741
V21
V22
DS1
DS2
BLU
E3
E2
E5
TB2
TAPE BREAK SENSOR ASSY
84007891
V1
WHT/ORN/YEL
DS1
BLK
RED
RED
E1
PART OF
TB1
E1
TAPE SUPPLY SENSOR SUBASSY
85001141
TAPE SUPPLY IND SUBASSY
84001821
V9
THRU
V1
R9
150K
R1
150K
TAPE SUPPLY SENSOR SUBASSY
85001131
TAPE SUPPLY IND SUBASSY
84001771
V19
THRU
V10
R19
150K
R10
150K
R35
10K
R33
100K
CW
CW
TB4
TB3
E1
NOTE
E1
E2
DS1
TAPE
SUPPLY
P33
9 21 16 15 14 3 2 1 19 11 23 13 25 7
J33
REEL DRIVE ASSY 84003391
SCHEMATIC 84003391-40
P21
9 3 2 1 5 4
J21
R1
REF
L1
REF
RED
BLK
B2
TAKE-UP MOT
BRN
ORN
B1
SUPPLY MOT
BRAKE SUBASSY
84008741
BRAKE SOLENOID
E11
E10
E9
ARC SUPPRESSOR
SCHEMATIC
84002242-40
REEL MOTOR ASSY
85004481
SCHEMATIC
85000893-40
E16
E17
SERVO REF
TAPE SERVO

NOTES: 1. RESISTOR VALUES IN OHMS, 1/4 W, ± 5%
2. CAPACITOR VALUES IN UF
3. REFERENCE DRAWINGS: Recorder, Basic, 95002881, Transport Housing Assy, 85007291, Wiring Diagram 85007293

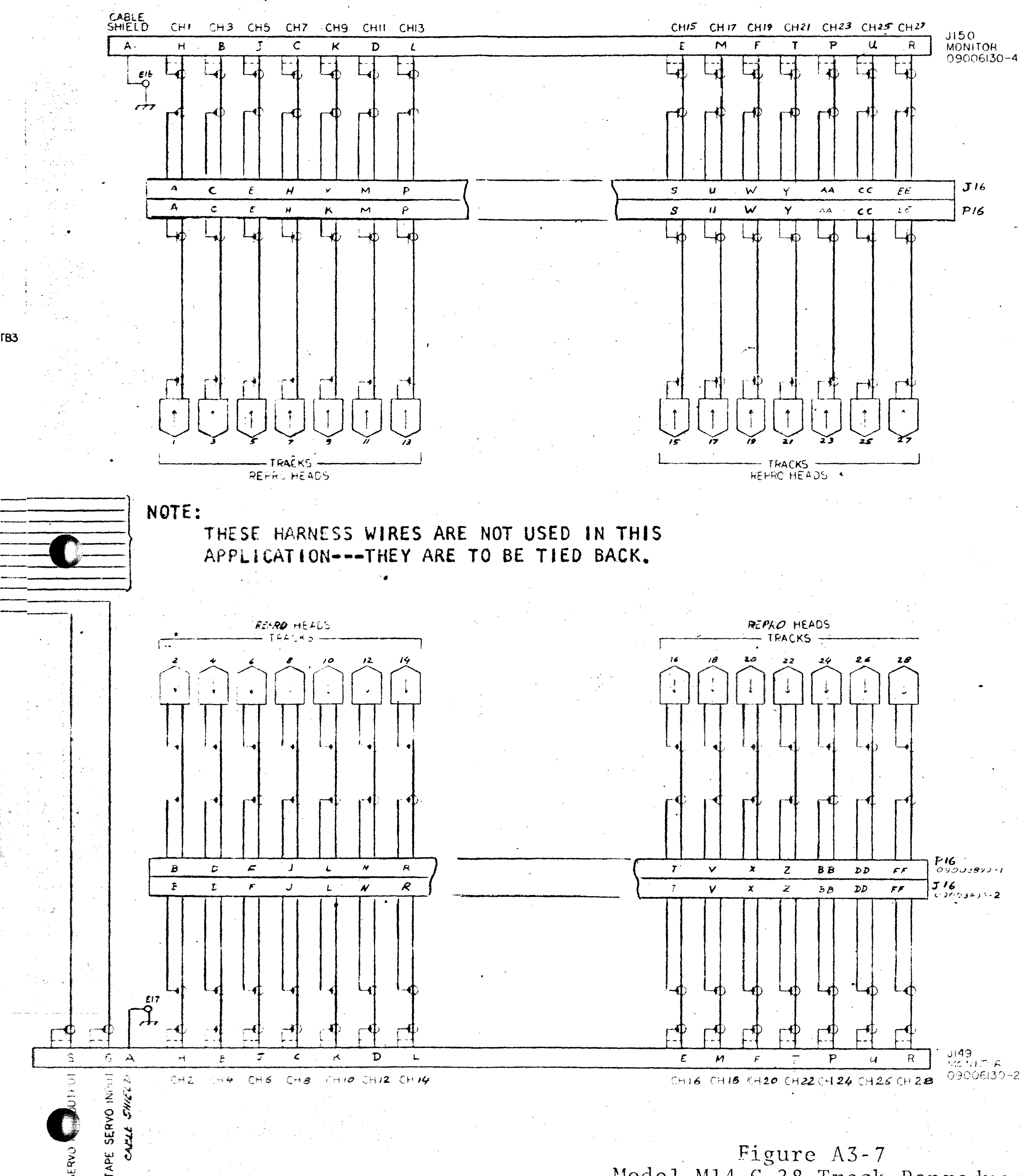


Figure A3-7
Model M14-G 28-Track Reproducer
Schematic Diagram

SECTION A-IV

SYSTEM TEST AND ALIGNMENT

A4.1 INTRODUCTION

A4.1.1 Scope. This section contains subassembly adjustment procedures and system level test procedures which permit aligning the equipment for optimum performance. These tests should be performed prior to initial operation of the equipment, after any equipment repairs, and after every 60 to 100 hours of operation, as part of a regular scheduled Preventive Maintenance program. All testing is based on the use of the M-14G Reproducer. The information contained in this section is intended to supplement the test and alignment procedures contained in Section IV of the basic manual.

A4.1.2 Order of Precedence. Tests described in this section should be performed in the order listed, unless otherwise specified, or unless checking a specific parameter after repair or adjustment.

A4.2 Test Equipment Requirements. The following test equipment, or equivalent, is required to adjust the M14-G Reproducer (See Figure A4-1):

1.	VOM	Triplett Model 630 NS
2.	Sinewave Osc.	H-P 651 B
3.	Squarewave Gen.	Wavetek Model 130
4.	Oscilloscope	Tektronix 545
5.	AC VTVM	H-P 400 E
6.	28-Track Recorder/ Reproducer	MARS/GPAR 1428
7.	Bandpass Filter	400 Hz to 1 MHz
8.	Frequency Counter	

A4.3 +15-VOLT REGULATOR ADJUSTMENT

1. With the equipment connected as shown in Figure A2-2, apply

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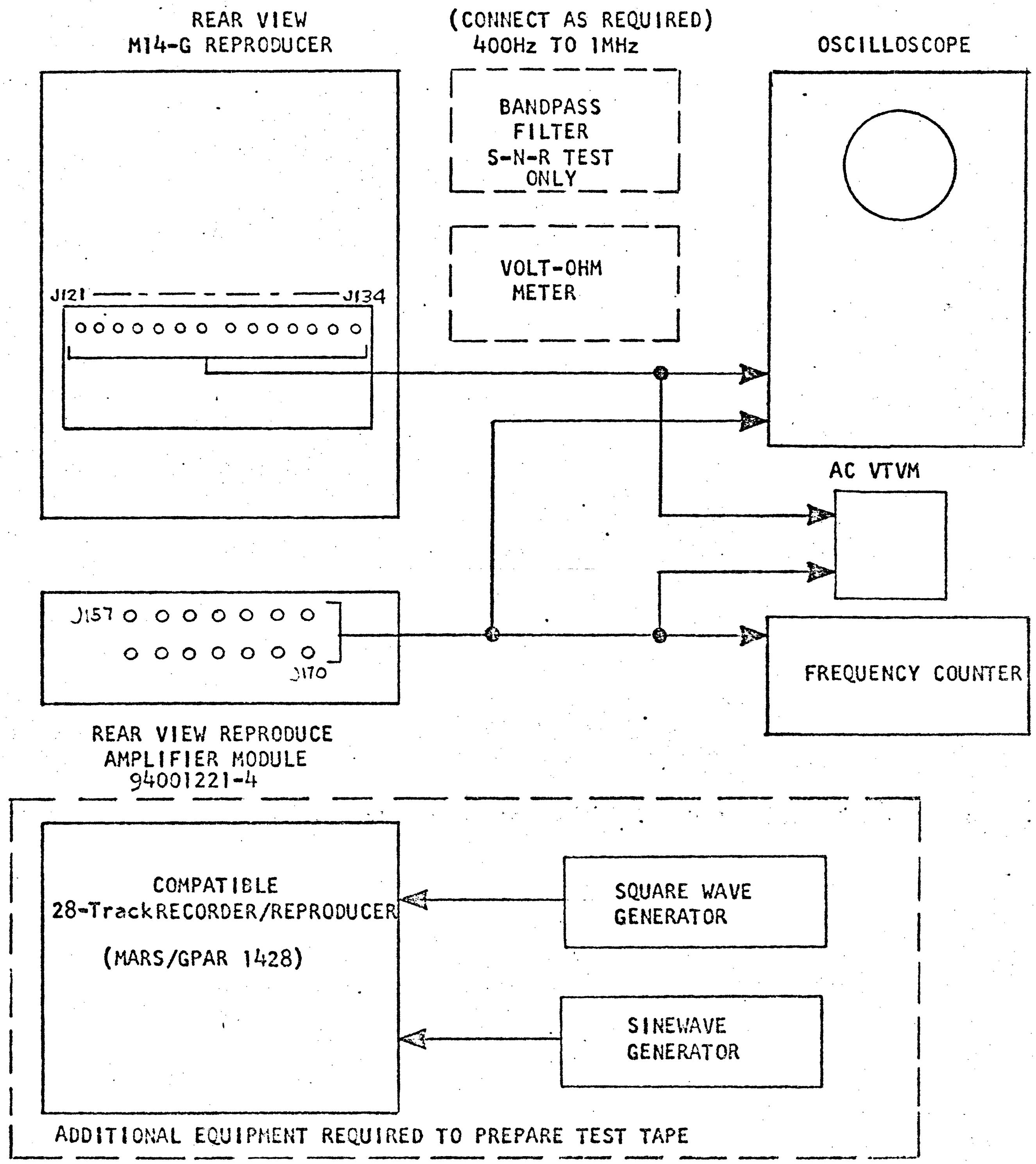


Figure A4-1
Test Setup for Reproduce Amplifier Alignment
and System Testing

primary input power (+28 Vdc) to the system and place the recorder in the STOP mode.

2. Connect VOM between the +15 volt test-point on the ODD channels voltage regulator card and ground. Adjust R6 for an indication of +15 Vdc on the meter. (See Figure A6-3.)

3. Repeat steps (1) and (2) for the EVEN channels +15 volt regulator.

A4.4 +20-VOLT REGULATOR ADJUSTMENT

1. Secure system primary input power (+28 Vdc), and remove one of the Reproduce Amplifiers from the ODD channels RAM.

2. Reapply input power and connect VOM between pin (1) of the Reproduce Amplifier connector and ground. Adjust R7 for an indication of +20 Vdc on the meter. (See Figure A6-4.)

3. Secure system primary input power and replace Reproduce Amplifier in RAM.

4. Repeat steps (1) thru (3) for the EVEN channels RAM.

A4.5 REPRODUCE AMPLIFIER ALIGNMENT PROCEDURE

The following paragraphs describe the procedure for adjusting the Direct Reproduce Amplifier (85004971). These adjustments should be checked and, if necessary, readjusted after every 60 to 100 hours of equipment operation.

A4.5.1 Test Equipment Required. The following test equipment (or equivalent) is required to check and adjust the Direct Reproduce Amplifier.

1.	Sinewave Oscillator	H-P651 B
2.	Squarewave Generator	Wavetek Model 130
3.	Frequency Counter	
4.	Oscilloscope	Tektronix 545
5.	AC VTVM	H-P 400 E
6.	M1428 Rec/Repro	Astro-Science Corporation

A4.5.2 Preliminary Procedures. Before attempting to adjust the Direct Reproduce Amplifiers, perform the following preliminary procedures.

1. To facilitate testing and checkout procedures listed herein, it is recommended that a test tape be prepared using a compatible 28-track recorder such as the MARS/GPAR 1428 under the following format:

   a. Record an input signal of 1.0 Vrms simultaneously on all 28 tracks.

NOTE

Record amplifiers shall be adjusted to produce 2.0% third order harmonic distortion. Refer to Bias Level and Record Level adjustment procedures described in the basic O&M Manual.

   b. Record each frequency for a duration of two minutes at the following tape speeds and frequencies.

NOTE

It is suggested that each tape segment be separated by a 5-second pause. For ease of explanation, individual frequencies and tape speeds are tabulated as "EVENT NUMBERS".

EVENT	TAPE SPEED	FREQUENCY	
1	60 ips	10 KHz	sinewave
2	60 ips	100 KHz	sinewave
3	60 ips	1 MHz	sinewave
4	3-3/4 ips	62.5 KHz	sinewave
5	3-3/4 ips	42 KHz	sinewave
6	60 ips	100 KHz	sinewave
7	60 ips	200 KHz-1 MC	sweep
8	30 ips	400 Hz	sinewave
9	30 ips	500 KHz	sinewave
10	30 ips	50 KHz	squarewave
11	15 ips	250 KHz	sinewave
12	7-1/2 ips	125 KHz	sinewave

EVENT	TAPE SPEED	FREQUENCY	
13	3-3/4 ips	62.5 KHz	sinewave
14	1-7/8 ips	31.2 KHz	sinewave
15	1-7/8 ips	400 Hz	sinewave

c. The test frequencies are followed by a series of sweep tones to be used to check overall frequency response after alignment procedures have been completed. Each sweep tone is recorded for a period of 1 minute. Tape speed and sweep tone frequencies are as follows:

EVENT	TAPE SPEED	SWEEP FREQUENCY
16	60 ips	400 Hz to 1 MHz
	30 ips	400 Hz to 500 KHz
	15 ips	400 Hz to 250 KHz
	7-1/2 ips	400 Hz to 125 KHz
	3-3/4 ips	400 Hz to 62.5 KHz
	1-7/8 ips	400 Hz to 31 KHz

2. Clean heads and tape path as described in basic recorder O & M Manual.

3. Demagnetize the headstack as described in basic recorder O & M Manual.

4. Perform head azimuth adjustment as described in basic manual.

A4.5.3 Alignment Procedure. To adjust the Reproduce Amplifiers, proceed as follows:

1. Connect test equipment as shown in Figure A4-1.

2. Refer to Figure A4-2 for location of adjustment controls.

3. Place the Reproducer (unit) in the FORWARD mode at 60 ips.

4. Event No. 1 (10 KHz):

   Adjust LEVEL ADJ. control (R1) for an indication of 1.0 V rms as read on the output AC VTVM.

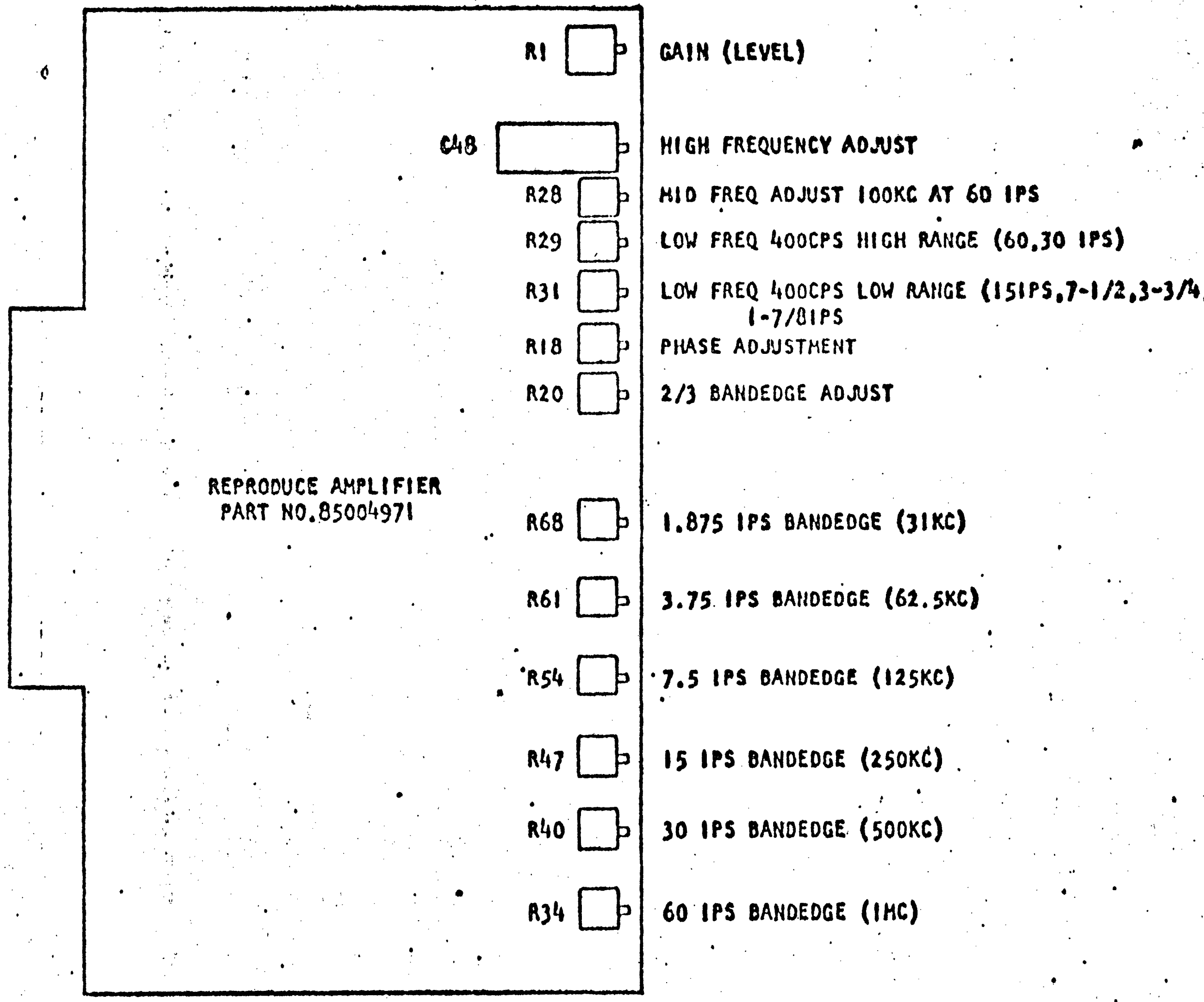


Figure A4-2
Reproduce Amplifier Adjustment Locations

5. Event No. 2 (100 KHz):

   Adjust MID FREQ. ADJ. control (R28) for an output indication of 1.0 V rms.

6. Event No. 3 (1 MHz):

   Adjust the 60 ips BANDEDGE ADJ. control (R34) for an output indication of 2.0 dB below 1.0 V rms.

7. Place unit in the STOP mode. Change tape speed to 3-3/4 ips. Place unit in the FORWARD mode at 3-3/4 ips.

8. Event No. 4 (62.5 KHz):

   Adjust 3-3/4 ips BANDEDGE ADJ. control (R61) for an output indication of 2.0 dB below 1.0 V rms.

9. Event No. 5 (42 KHz):

   Adjust 2/3 BANDEDGE ADJ. control (R20) for an output indication as near as possible to 1.0 dB below 1.0 V rms.

10. Place unit in STOP mode. Change tape speed to 60 ips. Place unit in FORWARD mode at 60 ips.

11. Event No. 6 (100 KHz):

    Repeat step 5.

12. Event No. 7 (200 KHz to 1 MHz sweep):

    Note any peaks in the response as indicated on the output AC VTVM. If the output exceeds 1.0 V rms by more than 3.0 dB, adjust the HIGH FREQ. ADJ. control (C48) for an output indication as near to 1.0 V rms as possible. Repeat steps (5) thru (9) using the prerecorded frequencies as required.

13. Place the unit in the STOP mode. Change tape speed to 30 ips. Place unit in the FORWARD mode at 30 ips.

14. Event No. 8 (400 Hz):

    Adjust LOW FREQ. ADJ. control (R29) (LF 30-60) for an output indication of 2.0 dB below 1.0 V rms.

15. Event No. 9 (500 KHz):

    Adjust the 30 ips BANDEDGE ADJ. control (R40) for an output indication of 2.0 dB below 1.0 V rms.

16. Event No. 10 (50 KHz squarewave at 2.8 V peak-to-peak):

    Adjust PHASE ADJ. control (R18) for the best squarewave response.

17. Place unit in the STOP mode. Change tape speed to 15 ips. Place unit in the FORWARD mode at 15 ips.

18. Event No. 11 (250 KHz):

    Adjust the 15 ips BANDEDGE ADJ. control (R47) for an output indication of 2.0 dB below 1.0 V rms.

19. Place unit in the STOP mode. Change tape speed to 7-1/2 ips. Place unit in the FORWARD mode at 7-1/2 ips.

20. Event No. 12 (125 KHz):

    Adjust the 7-1/2 ips BANDEDGE ADJ. contol (R54) for an output indication of 2.0 dB below 1.0 V rms.

21. Place the unit in the STOP mode. Change tape speed to 3-3/4 ips. Place unit in the FORWARD mode at 3-3/4 ips.

22. Event No. 13 (62.5 KHz):

    Adjust the 3-3/4 ips BANDEDGE ADJ. control (R61) for an output indication of 2.0 dB below 1.0 V rms.

23. Place unit in the STOP mode. Change tape speed to 1-7/8 ips. Place unit in the FORWARD mode at 1-7/8 ips.

24. Event No. 14 (31.2 KHz):

    Adjust 1-7/8 ips BANDEDGE ADJ. control (R68) for an output indication of 2.0 dB below 1.0 V rms.

25. Event No. 15 (400 Hz):

    Adjust LOW FREQ. ADJ. control (R31) (LF1-7/8 - 15) for an output indication of 2.0 dB below 1.0 V rms. Place unit in STOP mode.

26. Event No. 16 (sweep frequency):

Test the frequency response at all tape speeds from 400 Hz to the bandedge frequency to ascertain that the response is flat (± 3.0 dB) over the entire bandwidth.

27. Change tape speed to 60 ips. Place unit in FORWARD mode. Note any bumps or dips on the output AC VTVM as frequency is swept between each segment of the response curve.

NOTE

There is a pause on the test tape at the end of each frequency segment.

28. Repeat step 27 at 30, 15, 7-1/2, 3-3/4 and 1-7/8 ips while reproducing appropriate segment of test tape.

A4.5.4 Signal-to-Noise Ratio Check

1. Connect a bandpass filter to the channel 1 reproduce output. Connect oscilloscope frequency counter, and AC VTVM to output of bandpass filter.

2. Adjust bandpass filter to pass a bandwidth from 400 Hz to 1.0 MHz.

3. Fast wind the tape to the 100 KHz segment of the test tape.

4. Place the unit in the FORWARD mode at 60 ips. Note indication on AC VTVM (should be 1.0 V rms).

5. Allow tape to pass the 100 KHz segment to a blank portion of tape, then again note AC VTVM reading. Note SNR reading.

6. Adjust bandpass filter to a bandwidth of 800 Hz to 1.0 MHz.

7. Repeat steps (3) thru (5). Note results.

8. Repeat steps (1) thru (7) for remaining channels.

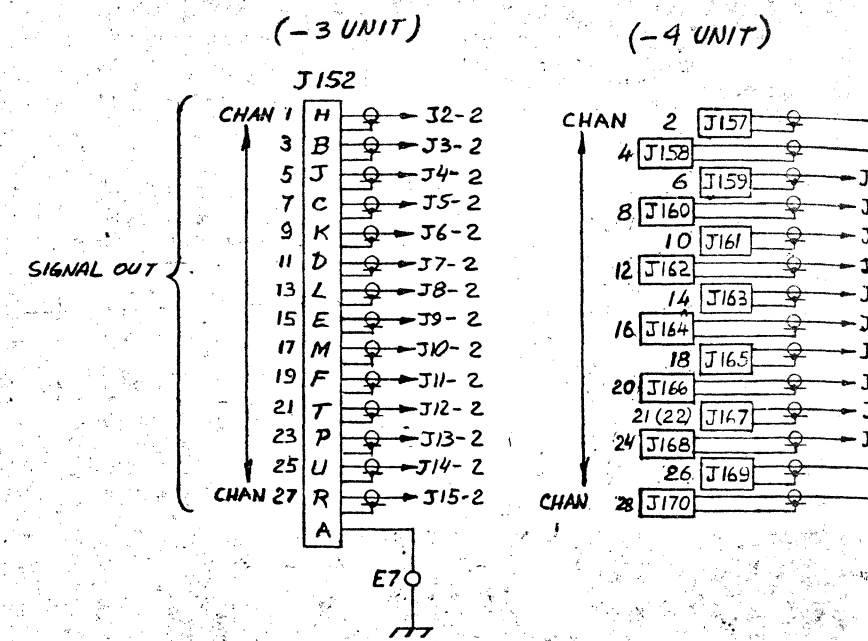
9. Repeat steps (1) thru (8) for remaining tape speeds. Adjust bandwidth of filter to upper band edge for each speed. Note results. The 400 Hz band edge filtered signal should be a minimum of 18 dB at all tape speeds. The 800 Hz band edge should be a minimum of 20 dB at all tape speeds.

SECTION A-V

SYSTEM MAINTENANCE

A5.1 INTRODUCTION

This section contains an overall system schematic diagram for the two 14-channel Reproduce Amplifier Modules and such other diagrams and maintenance information not covered elsewhere in this addendum. The information contained in this section is intended to supplement the maintenance information contained in Section V of the basic manual.

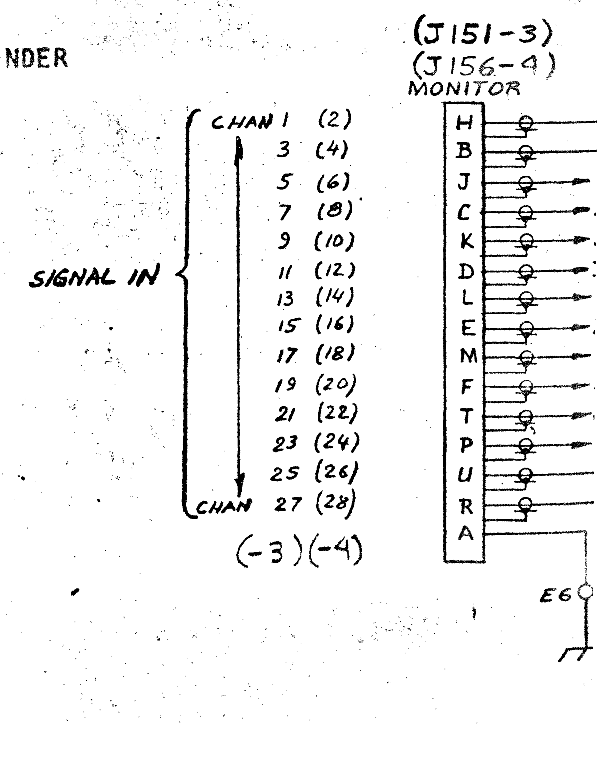


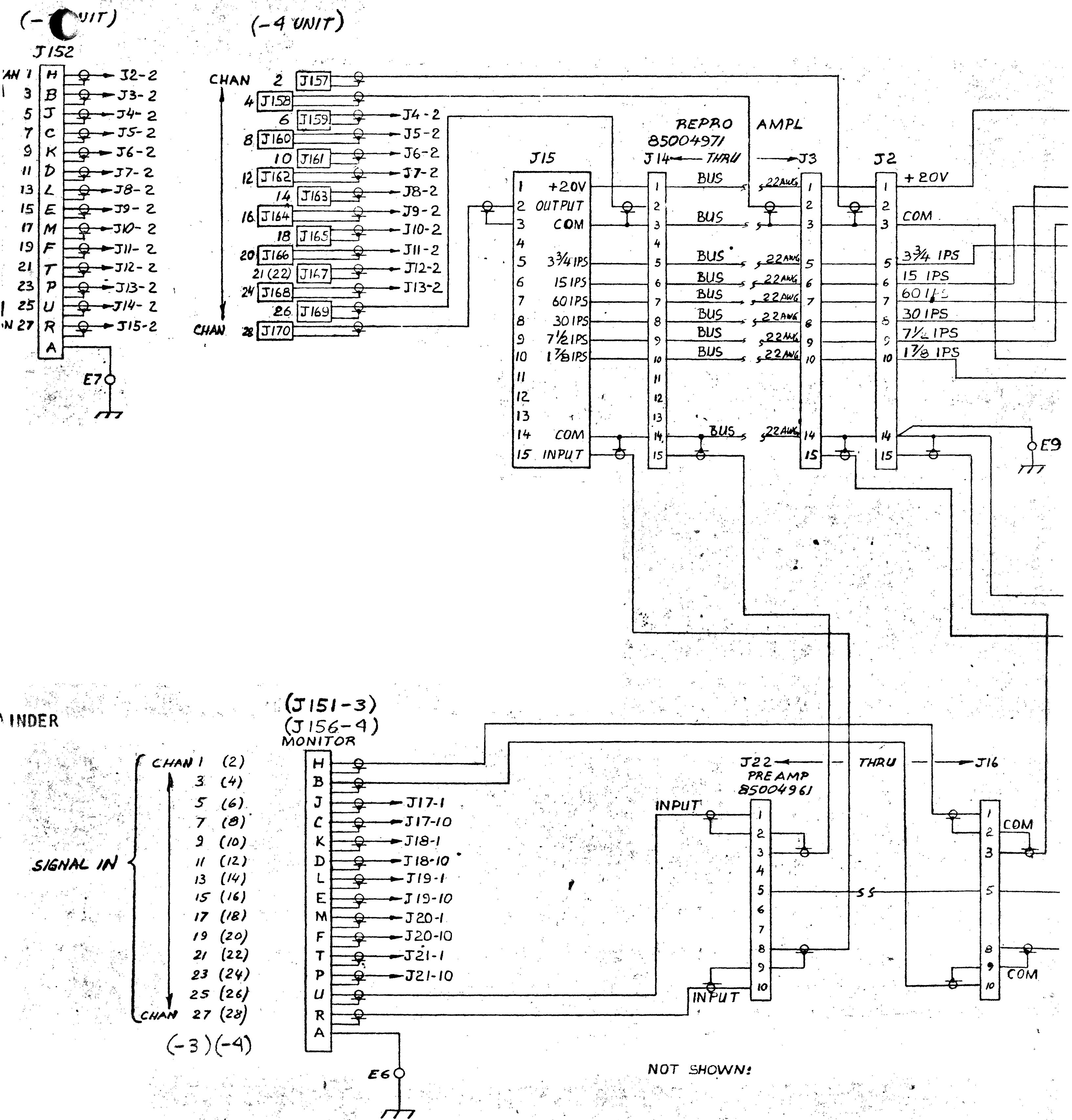
NOTES:

1. NOT SHOWN:

J17-3	TO	J4-15
J17-8	TO	J5-15
J18-3	TO	J6-15
J18-8	TO	J7-15
J19-3	TO	J8-15
J19-8	TO	J9-15
J20-3	TO	J10-15
J20-8	TO	J11-15
J21-3	TO	J12-15
J21-8	TO	J13-15

2. SEE SHEET 2 OF 2 FOR REMAINDER OF 94001221-3 CIRCUITRY.




(-4 UNIT)
J152
CHAN
CHAN
REPRO AMPL
85004971
J14 THRU J3
J15
J2
+20V
OUTPUT
COM
3¾ IPS
15 IPS
60 IPS
30 IPS
7½ IPS
1⅞ IPS
INPUT
BUS
22 AWG
+20V
COM
E7
E9
INDER
(J151-3)
(J156-4)
MONITOR
CHAN 1 (2)
SIGNAL IN
CHAN 27 (28)
(-3)(-4)
J22 THRU J16
PREAMP
85004961
INPUT
INPUT
COM
COM
E6
NOT SHOWN:

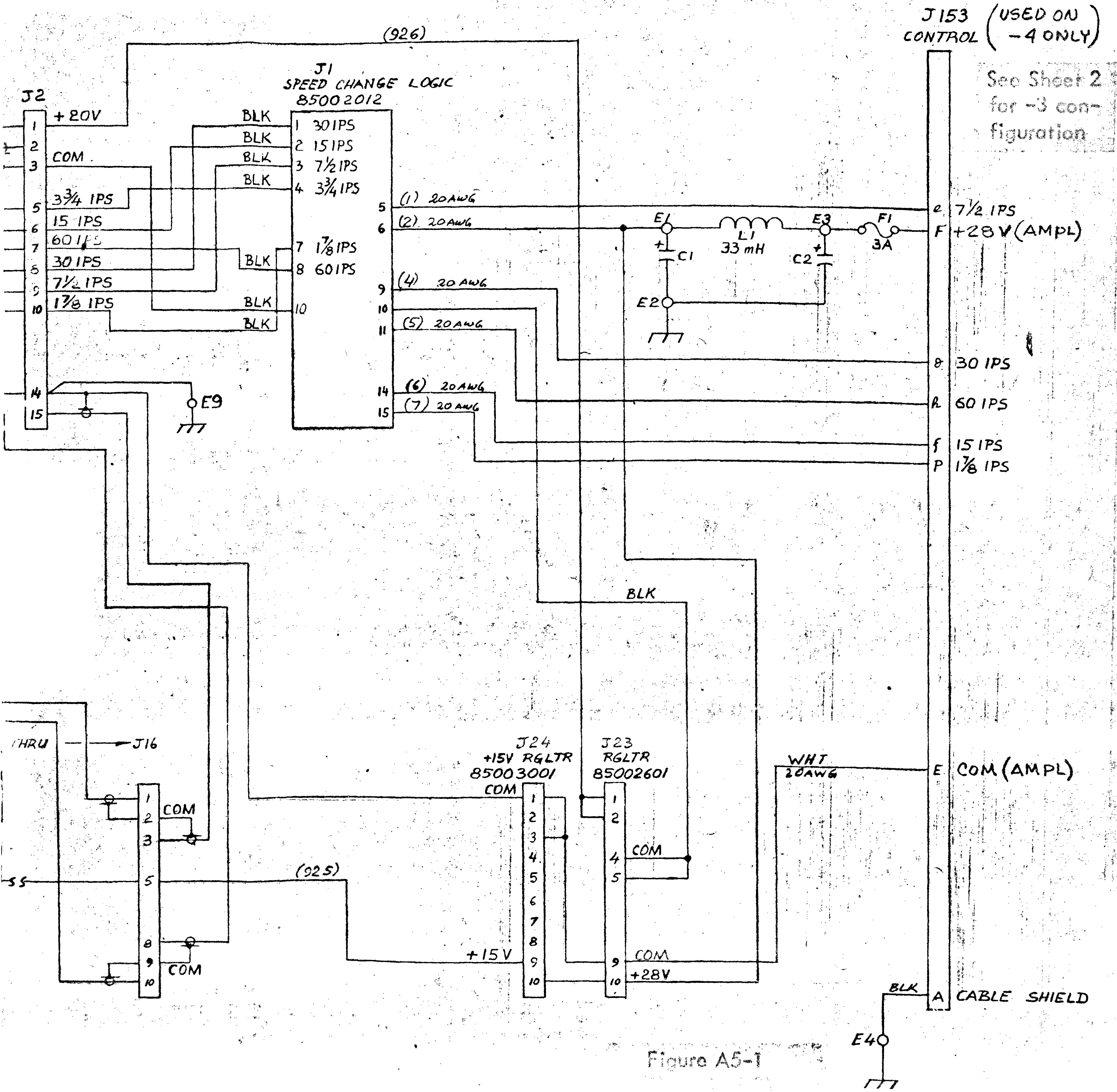
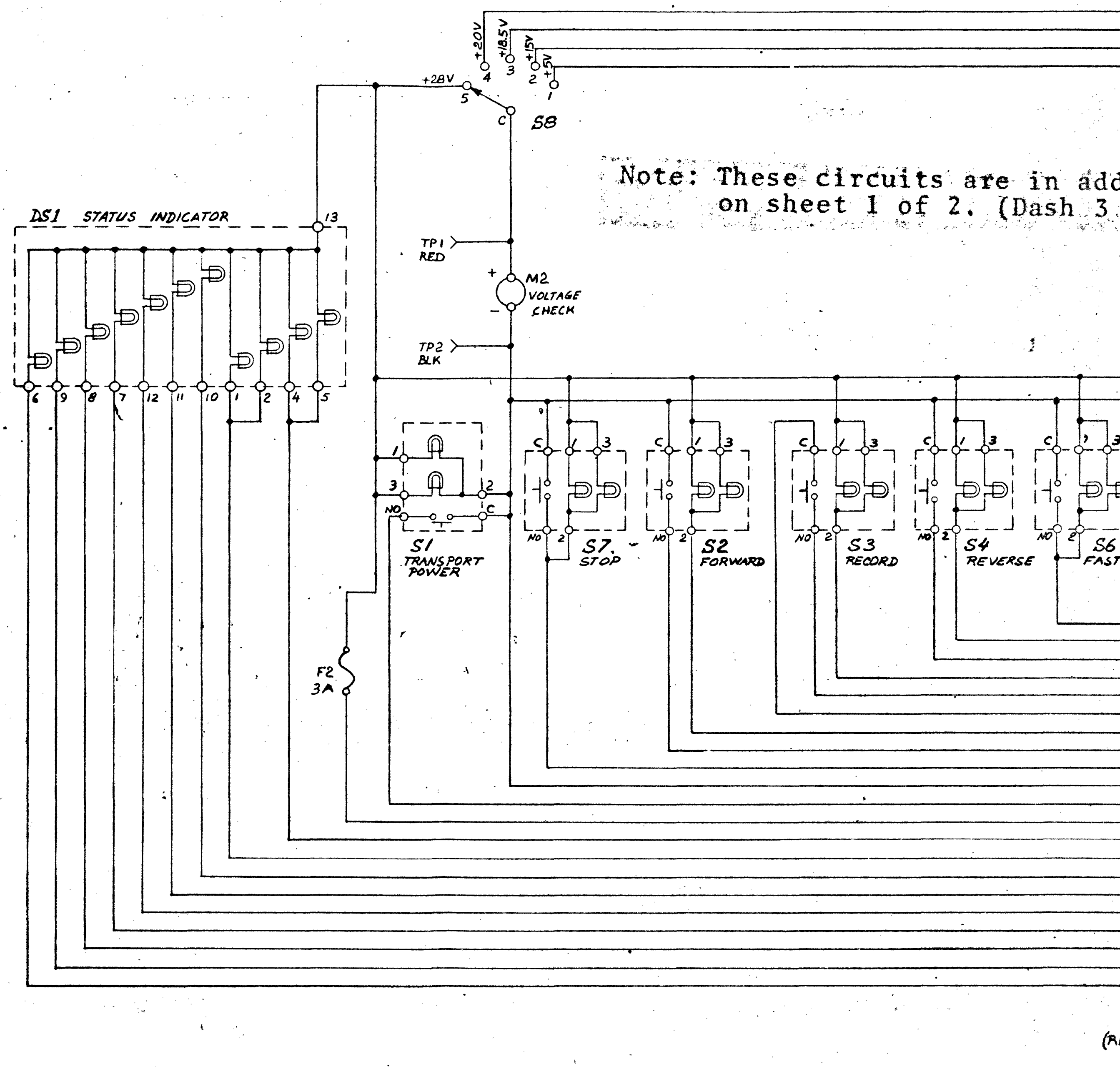


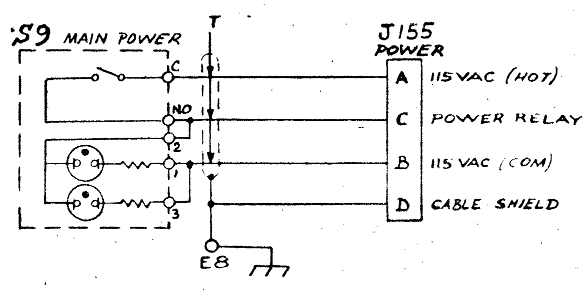
Figure A5-1

Schematic Diagram Reproduce Amplifier Module (94001221-3 and -4)

Note: These circuits are in add
on sheet 1 of 2. (Dash 3



(R



se circuits are in addition to those shown
sheet 1 of 2. (Dash 3 only)

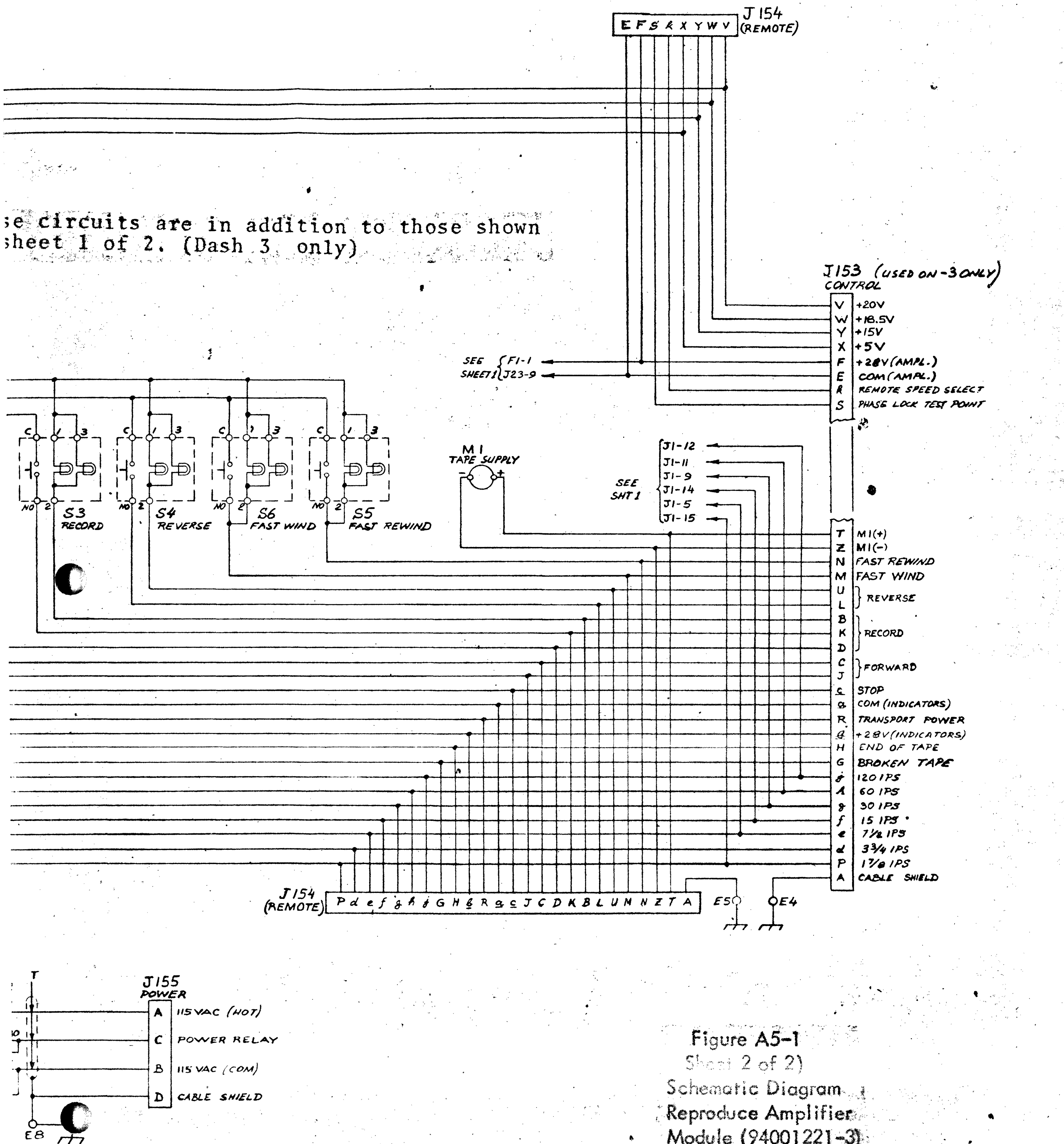
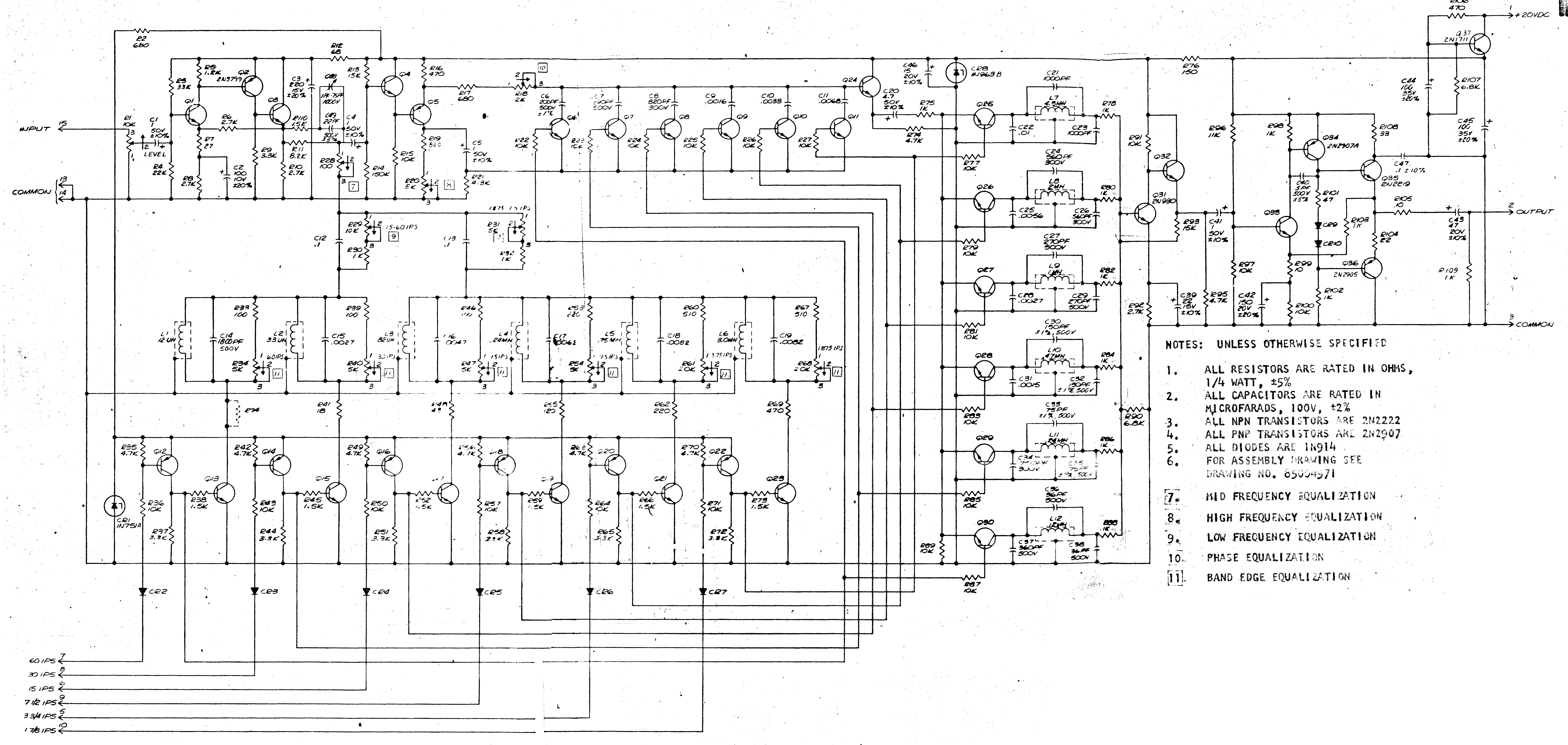


Figure A5-1
Sheet 2 of 2)
Schematic Diagram
Reproduce Amplifier
Module (94001221-3)

AST



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE RATED IN OHMS, 1/4 WATT, ±5%
2. ALL CAPACITORS ARE RATED IN MICROFARADS, 100V, ±2%
3. ALL NPN TRANSISTORS ARE 2N2222
4. ALL PNP TRANSISTORS ARE 2N2907
5. ALL DIODES ARE 1N914
6. FOR ASSEMBLY DRAWING SEE DRAWING NO. 85004571

[7] MID FREQUENCY EQUALIZATION

[8] HIGH FREQUENCY EQUALIZATION

[9] LOW FREQUENCY EQUALIZATION

[10] PHASE EQUALIZATION

[11] BAND EDGE EQUALIZATION

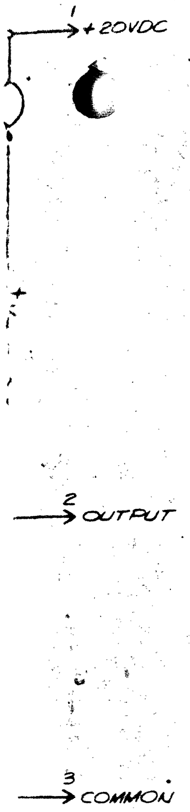
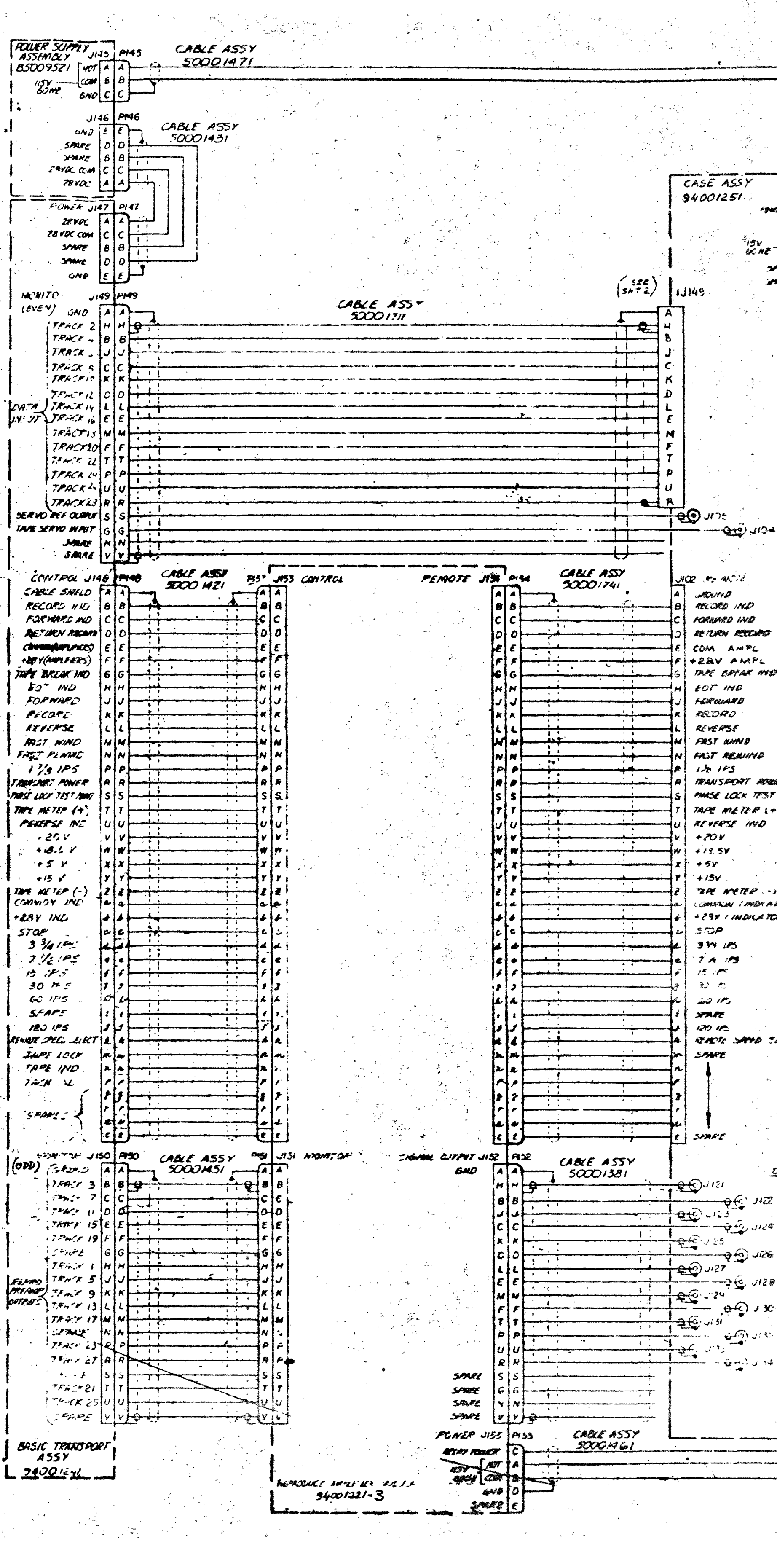
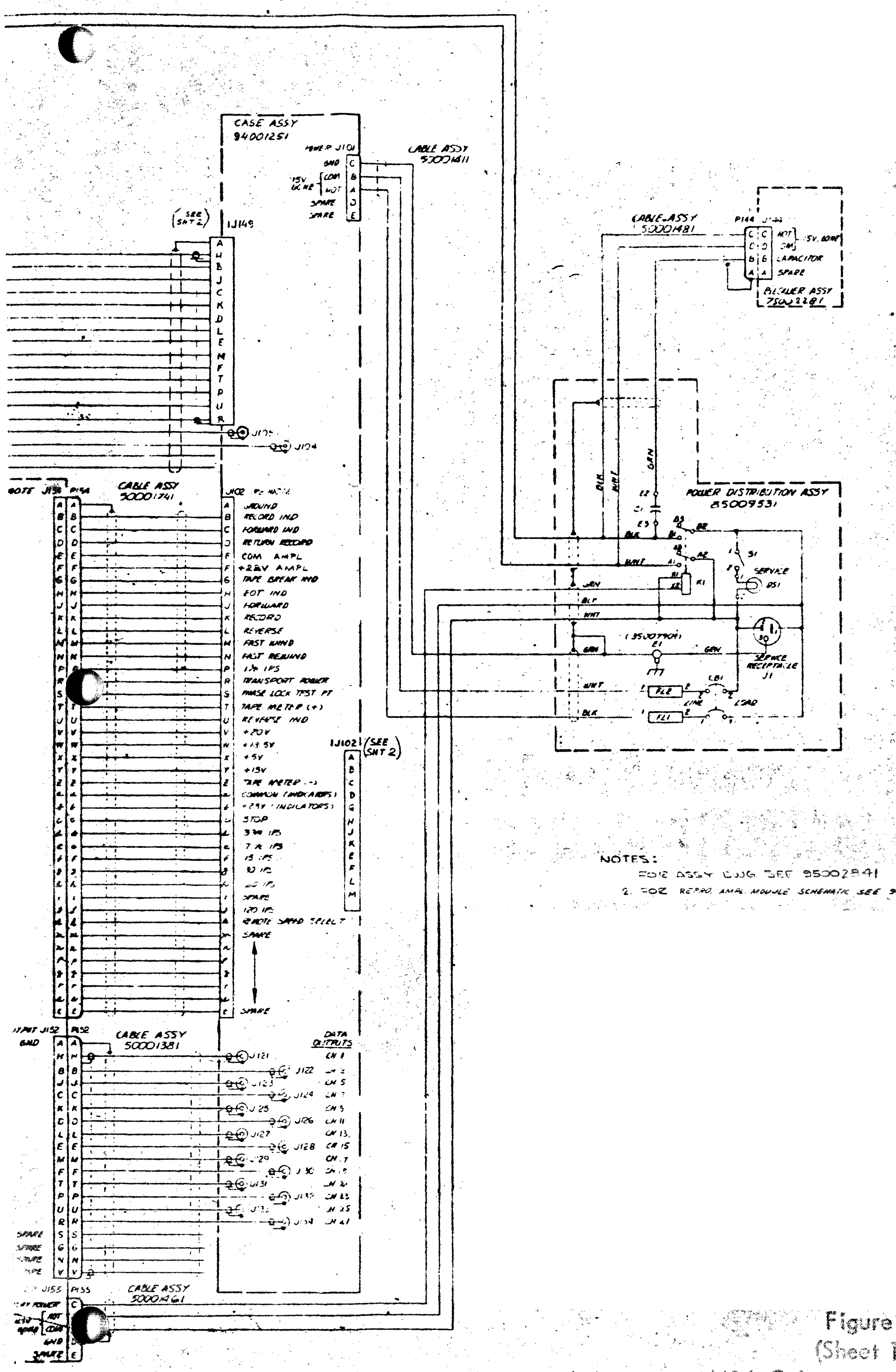


Figure A5-2
Reproduce Amplifier Schematic Diagram (85004971)

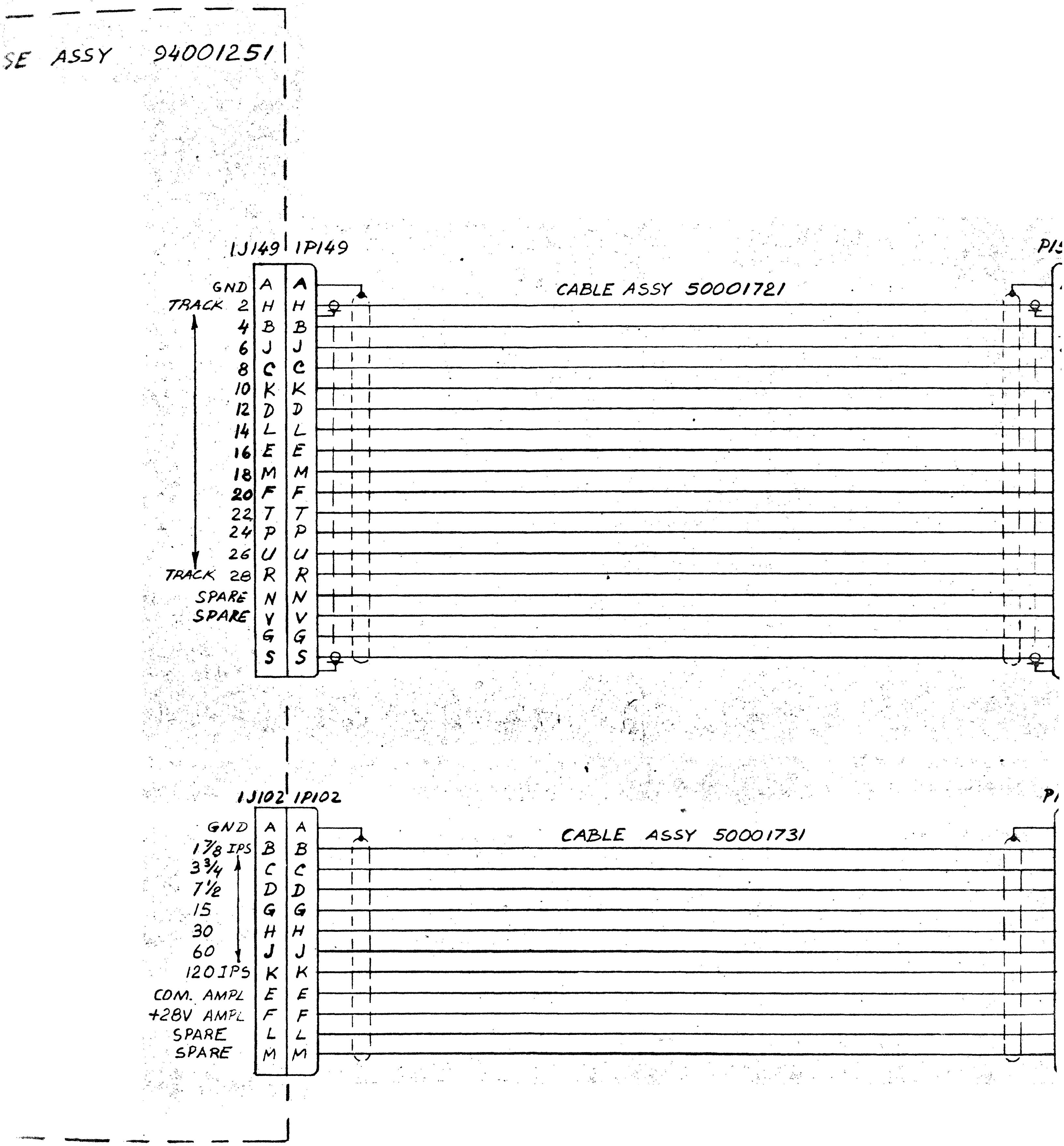
NOTES: UNLESS OTHERWISE SPECIFIED





NOTES:
1. FOR ASSY DWG SEE 95002841
2. FOR REPRO. AMPL. MODULE SCHEMATIC SEE 94001224 (FIG. A5-1)

Figure A5-3
(Sheet 1 of 2)
M14-G Interconnecting Diagram


SE ASSY 94001251
1J149 1P149
P15
CABLE ASSY 50001721
GND A A
TRACK 2 H H
4 B B
6 J J
8 C C
10 K K
12 D D
14 L L
16 E E
18 M M
20 F F
22 T T
24 P P
26 U U
TRACK 28 R R
SPARE N N
SPARE V V
G G
S S
1J102 1P102
P1
CABLE ASSY 50001731
GND A A
1 7/8 IPS B B
3 3/4 C C
7 1/2 D D
15 G G
30 H H
60 J J
120 IPS K K
COM. AMPL E E
+28V AMPL F F
SPARE L L
SPARE M M

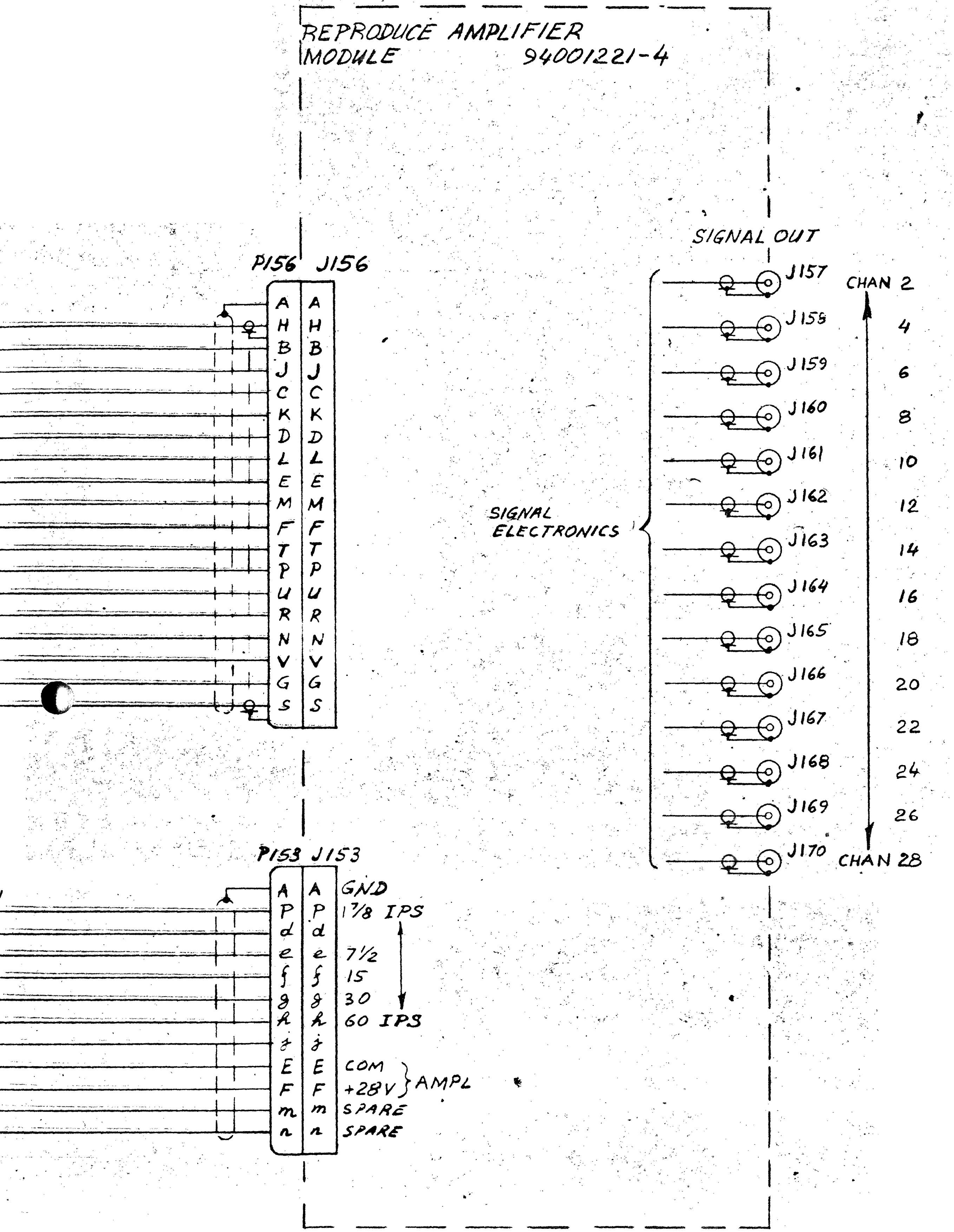


Figure A5-3
(Sheet 2 of 2)
M14-G Interconnecting Diagram

SECTION A-VI
REPLACEMENT PARTS LIST

A6.1 INTRODUCTION

This section contains a major components list for the 28-track M-14G Reproduce System, and an illustrated and indexed parts list for use in locating and identifying replacement parts. For assemblies not listed in this section, refer to Section VI of the basic manual.

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
		MAJOR COMPONENTS LIST	
A1-1	95002841	MODEL M14-G WIDEBAND PORTABLE 28-TRACK REPRODUCER	1
	50001721	. Cable Assembly, Monitor/Remote	(1)
	50001731	. Cable Assembly, Remote, Power	(1)
A1-1	94001221-3	. Reproduce Amplifier Module 14-Channel; includes Controls and Speed Logic	(1)
A1-2	94001221-4	. Reproduce Amplifier Module 14-Channel; includes Speed Logic	(1)
A6-1	85004961	. Reproduce Pre-Amplifier (Installed in RAM)	(14)
A6-2	85004971	. Direct Reproduce Amplifier 1 MHz; 1-7/8 to 60 ips; 1.0 v rms output into 75 ohms (Installed in RAM)	(28)
A6-3	85003001C	. +15 Volt Regualtor Assembly (Installed in RAM)	(2)
A6-4	85002601B	. +20 Volt Regulator Assembly (Installed in RAM)	(2)
A6-5	85002012	. Speed Change Logic (Installed in RAM)	(2)
	85007221	. Head Assembly, 28-Track Reproduce, 1 MHz	(1)
	84009791	. Head Cover Assembly	(1)
	94001251	. Case Assembly (With Portable Field Enclosure and Interconnecting Cables)	(1)
	85009521	. . AC Power Supply for 115/230 vac; 48 to 420 Hz operation	(1)
	75002281	. . Blower Fan Kit; 50- 60 Hz	(1)
	75002281-1	. . Blower Fan Kit; 400 Hz	(1)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
		MAJOR COMPONENTS LIST (cont)	
	94001241	Tape Transport, 1-7/8 to 60 IPS	(1)
	85007211	. Precision Plate Assembly	(1)
	84007831	. Capstan and Motor Assembly	(1)
	85004481	. Reel Motor Assembly	(1)
	84007951-1	. Capstan Servo Heatsink Assembly	(1)
	85005161	. Reel Servo Heatsink Assembly	(1)
	85007961	. Capstan Servo PWB	(1)
	85005181	. Reel Servo PWB	(1)
	84007981	. Control Logic PWB	(1)
	85004451-1	. Voltage Regulator PWB	(1)
	85006691-1	. Transport Chassis Assembly	(1)
	84009711	. Utility Board Assembly	(1)
	85006831	. Sine Wave Reference Board Assy	(1)
		FLY-AWAY KIT	1
	75001731	Service Accessories Kit	(1)
	30007021	. Mylar Drive Belt	(2)
	49005161	. Extender Card, Record Amplifier and Bias Oscillator	(1)
	69000220-1	. Tool, Equalizer Adjustment	(1)
	11000060-16	. Fuse; 2-Amp	(1)
	11000060-20	. Fuse; 5-Amp	(2)
	11000060-24	. Fuse; 7-Amp	(1)
	75001780	. Solvent, Head Cleaning	(1)
		. Cotton Swab (Package)	(1)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
		FLY-AWAY KIT (cont)	
	85005181	Reel Servo	(1)
	85004451	Voltage Regulator	(1)
	84007981	Control Logic	(1)
	84007961	Capstan Servo	(1)
	84002701	Roller Guide	(1)
	84003271-99	Tape Tension Sensor	(1)
	84003271-98	Tape Tension Sensor	(1)
	84008041	Tape Guide	(1)
	84007931	Power Switch	(1)
	84007831	Capstan Motor	(1)
	85004971	Direct Reproduce Amplifier	(2)
	85004961	Direct Reproduce Pre-Amplifier	(1)
	11000060-23	Fuse, 3-Amp	(2)
	11000060-16	Fuse, 2-Amp	(2)
	11000060-24	Fuse, 7-Amp	(2)
	12000480	Lamp	(1)
	75002221	Mating Connector Kit (Includes AC Power Cable)	(1)
	30008031-2	Tape; 3M Type 888, 9200 ft x 1 in	
	30008031-9	Tape; 3M Type 988, 9200 ft x 1 in	
	30004890-4	Reel, Precision, 14-inch (less tape)	(1)
	95002669	Operation and Maintenance Manual (With Appendix A--28-Track Reproducer)	(1)
	13000030	Shipping Container, Reuseable	(1)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
Fig. A6-1	85004961	PREAMPLIFIER ASSEMBLY	REF
C1, C2 C10, C11	CSR13B476KM	. CAPACITOR, Fxd Tant; 47 uf; ± 10%; 6 WVDC; (MIL-C-39003/1)	4
C3, C9	CSR13C336KM	. CAPACITOR, Fxd Tant; 33 uf; ± 10%; 10 WVDC; (MIL-C-39003/1)	2
C4, C8	CSR13D226KM	. CAPACITOR, Fxd Tant: 22 uf; ± 10%; 15 WVDC; (MIL-C-39003/1)	2
C5, C7	CSR13D335KM	. CAPACITOR, Fxt Tant; 3.3 uf; ± 10%; 15 WVDC; (MIL-C-39003/1)	2
C6, C12	CSR13E156KM	. CAPACITOR, Fxd Tant; 15 uf; ± 10%; 20 WVDC; (MIL-C-39003/1)	2
CR1, CR2	26001010-1	. DIODE, Zener; 1N4106	2
Q1, Q5	2N2222	. TRANSISTOR; (MIL-S-19500/225)	2
Q2, Q6	26000930	. TRANSISTOR; 2N3734	2
Q3, Q4	2N697	. TRANSISTOR; (MIL-S-19500/99)	2
R1, R17	RN55C3322F	. RESISTOR; 33.2 K; ± 1%; 1/10 W (MIL-R-10509/7)	2
R2, R18	RN55C1302F	. RESISTOR; 13 K; ± 1%; 1/10 W (MIL-R-10509/7)	2
R3, R15	RN55C1002F	. RESISTOR; 10 K; ± 1%; 1/10 W (MIL-R-10509/7)	2
R4, R16	RC07GF332J	. RESISTOR; 3.3 K; ± 5%; 1/4 W (MIL-R-11/8)	2
R5,R6,R9, R11,R13,R14	RC07GF472J	. RESISTOR; 4.7 K; ± 5%; 1/4 W (MIL-R-11/8)	6
R7, R10	RC07GF152J	. RESISTOR; 1.5 K; ± 5%; 1/4 W (MIL-R-11/8)	2
R8, R12	RC07GF221J	. RESISTOR; 220 ohm; ± 5%; 1/4 W (MIL-R-11/8)	2
R19, R20	RC07GF102J	. RESISTOR; 1 K; ± 5%; 1/4 W (MIL-R-11/8)	2

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
Fig. A6-1			
	41001070	. INSULATOR, TRANSISTOR	4
	41000110	. INSULATOR, TRANSISTOR	6
	49005181	. PRINTED WIRING BOARD	1

ASTRO-SCIENCE CORPORATION

A TRACOR COMPANY

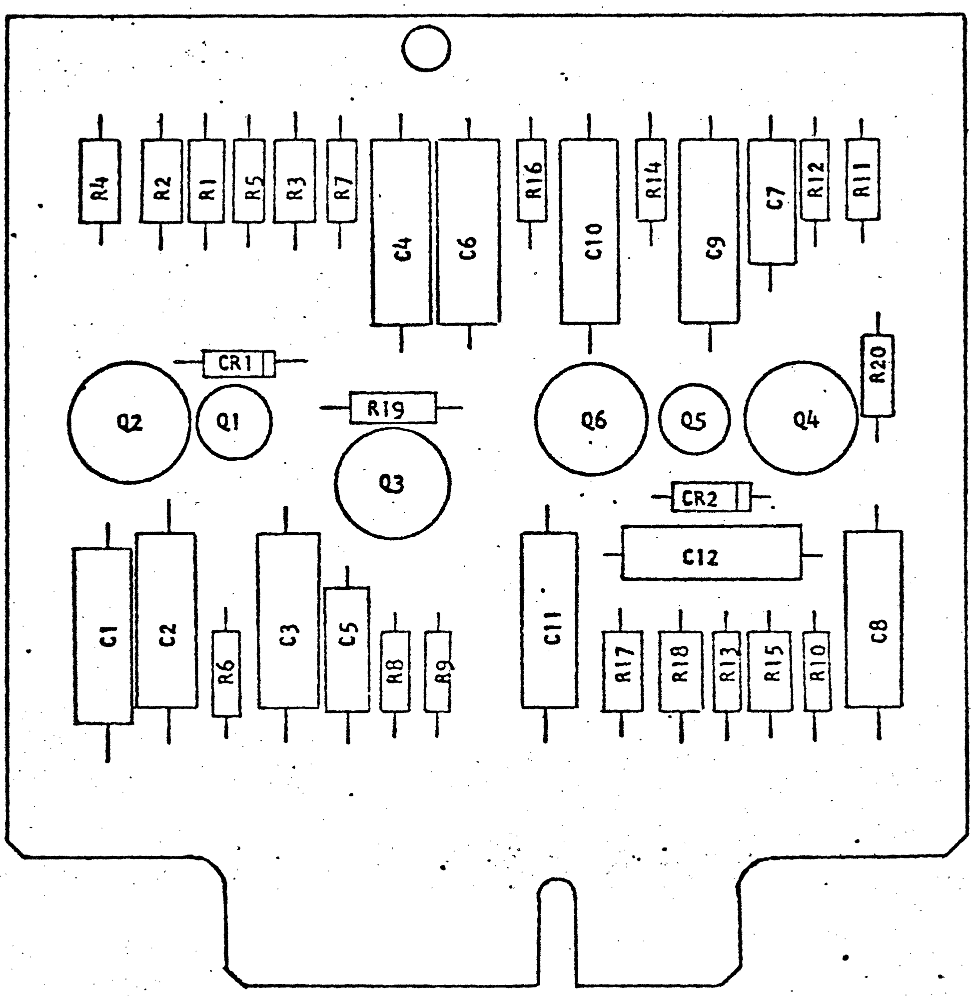


Figure A6-1

Reproduce Preamplifier (85004961)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
A6-2	85004971	REPRODUCE AMPLIFIER ASSEMBLY	REF
C1, 4, 5, 41	M39003/01-2116	. CAPACITOR, Tant, 1 uf, $\pm$10%, 50 V (MIL-C-39003/1)	4
C2	04007900-9	. CAPACITOR, Tant, 100 uf, $\pm$20%, 10 V	1
C3	04007900-17	. CAPACITOR, Tant, 220 uf, $\pm$20%, 15 V	1
C6	04003760	. CAPACITOR, FXD, Mica, 200 PF, $\pm$1%, 500 V	1
C7	04003900	. CAPACITOR, FXD, Mica, 390 PF, $\pm$2%, 500 V	1
C8	04003990	. CAPACITOR, FXD, Mica, 820 PF, $\pm$2%, 300 V	1
C9	04008310-12	. CAPACITOR, Metal, 0.0016 uf, $\pm$2%, 100 V	1
C10	04008310-11	. CAPACITOR, Metal, 0.0033 uf, $\pm$2%, 100 V	1
C11	04008310-10	. CAPACITOR, Metal, 0.0068 uf, $\pm$2%, 100 V	1
C12, 13	04008310-9	. CAPACITOR, Metal, 0.1 uf, $\pm$2%, 100 V	2
C14	04004180	. CAPACITOR, FXD, Mica, 1800 PF, $\pm$2%, 500 V	1
C15, 28	04008310-6	. CAPACITOR, Metal, 0.0027 uf, $\pm$2%, 100 V	2
C16	04008310-13	. CAPACITOR, Metal, 0.0047 uf, $\pm$2%, 100 V	1
C17	04008310-1	. CAPACITOR, Metal, 0.0062 uf, $\pm$2%, 100 V	1

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
C18,19	04008310-3	CAPACITOR, Metal, 0.0082 uf, ±2%, 100 V	2
C20	M39003/01-2128	CAPACITOR, Tant, 4.7 uf, ±10%, 50 V (MIL-C-39003/1)	1
C21,23	04004010	CAPACITOR, FXD, Mica, 1000 PF, ±2%, 100 V	2
C22	04008310-4	CAPACITOR, Metal, 0.0015 uf, ±2%, 100 V	1
C24,26	04003950	CAPACITOR, FXD, Mica, 560 PF, ±2%, 300 V	2
C25	04008310-5	CAPACITOR, Metal, 0.0056 uf, ±2%, 100 V	1
C27,29	04003860	CAPACITOR, FXD, Mica, 270 PF, ±2%, 500 V	2
C30,32	04003730	CAPACITOR, FXD, Mica, 150 PF, ±1%, 500 V	2
C31	04008310-2	CAPACITOR, Metal, 0.0015 uf, ±2%, 100 V	1
C33,35	04003660	CAPACITOR, FXD, Mica, 75 PF, ±1%, 500 V	2
C34	04003980	CAPACITOR, FXD, Mica, 750 PF, ±2%, 300 V	1
C36,38	04008340-1	CAPACITOR, FXD, Mica, 36 PF, ±2%, 500 V	2
C37	04003890	CAPACITOR, FXD, Mica, 360 PF, ±2%, 500 V	1
C39	M39003/01-2031	CAPACITOR, Tant, 22 uf, ±10%, 15 V (MIL-C-39003/1)	1
C40	04002350	CAPACITOR, FXD, Mica, 5 PF, ±5%, 500 V	1

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
C42	04007900-22	. CAPACITOR, Tant, 150 uf, ±20%, 20 V	1
C43	M39003/01-2055	. CAPACITOR, Tant, 47 uf, ±10%, 20V (MIL-C-39003/1)	1
C44,45	04007900-29	. CAPACITOR, Tant, 100 uf, ±20%, 35 V	2
C46	M39003/01-2049	. CAPACITOR, Tant, 15 uf, ±10%, 20 V (MIL-C-39003/1)	1
C47	CK06BX104K	. CAPACITOR, FXD, Cer, 0.1 uf, ±10%, 100 V (MIL-C-11015/19)	1
C48	03000060-3	. CAPACITOR, Variable, 1 PF-75 PF, 1000 V	1
C49	04002410	. CAPACITOR, FXD, Mica, 22 PF, ±5%, 500 V	1
CR1	1N751A	. DIODE, Zener (MIL-S-19500/127)	1
CR2,3, 4,5,6, 7,9,10	1N914	. DIODE (MIL-S-19500/116)	8
CR8	1N963B	. DIODE, Zener (MIL-S-19500/117)	1
L1	21008050-8	. INDUCTOR, 12 UH	1
L2	21008050-13	. INDUCTOR, 33 UH	1
L3	21008050-18	. INDUCTOR, 82 UH	1
L4,11	21008050-28	. INDUCTOR, 0.24 MH	2
L5	21008050-40	. INDUCTOR, 0.75 MH	1
L6	21007990-7	. INDUCTOR, 3 MH	1
L7	21007990-9	. INDUCTOR, 4.3 MH	1
L8	21007990-5	. INDUCTOR, 2 MH	1

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
L9	21007990-1	. INDUCTOR, 1 MH	1
L10	21008050-35	. INDUCTOR, 0.47 MH	1
L12	21008050-21	. INDUCTOR, 0.12 MH	1
Q1,3, 4,6-11, 13,15, 17,19, 21,23, 24,25, 26,27, 28,29, 30,32, 33	2N2222	. TRANSISTOR (MIL-S-19500/255)	24
Q2	26000850-1	. TRANSISTOR	1
Q5,12, 14,16, 18,20, 22	2N2907	. TRANSISTOR (MIL-S-19500/291)	7
Q31	2N930	. TRANSISTOR (MIL-S-19500/253)	1
Q34	2N2907A	. TRANSISTOR (MIL-S-19500/291)	1
Q35	2N2219	. TRANSISTOR (MIL-S-19500/251)	1
Q36	2N2905	. TRANSISTOR (MIL-S-19500/290)	1
Q37	2N1711	. TRANSISTOR (MIL-S-19500/225)	1
	41001080	. DISK, Insulator (Used on L1 thru 12) also (Used on Q35, Q36, Q37)	15
	41001700-1	. DISK, Insulator (Used on Q1 thru Q34)	34
R1,29	01002030-10	. RESISTOR, Variable, 10K	2
R2,17	RC07GF681J	. RESISTOR, FXD. Comp. 680 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	2

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
R3	RC07GF333J	. RESISTOR, FXD, Comp, 33K, ± 5%, 1/4 W (MIL-R-11/8)	1
R4	RC07GF223J	. RESISTOR, FXD, Comp, 22K, ± 5%, 1/4 W (MIL-R-11/8)	1
R5	RC07GF122J	. RESISTOR, FXD, Comp, 1.2K, ± 5%, 1/4 W (MIL-R-11/8)	1
R6, 8, 10, 92	RC07GF272J	. RESISTOR, FXD, Comp, 2.7K, ± 5%, 1/4 W (MIL-R-11/8)	4
R7	RC07GF270J	. RESISTOR, FXD, Comp, 27 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R9, 37, 44, 51, 58, 65, 72	RC07GF332J	. RESISTOR, FXD, Comp, 3.3K, ± 5%, 1/4 W (MIL-R-11/8)	7
R11	RC07GF822J	. RESISTOR, FXD, Comp, 8.2K, ± 5%, 1/4 W (MIL-R-11/8)	1
R12	RC07GF680J	. RESISTOR, FXD, Comp, 68 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R13, 93	RC07GF153J	. RESISTOR, FXD, Comp, 15K, ± 5%, 1/4 W, (MIL-R-11/8)	2
R14	RC07GF154J	. RESISTOR, FXD, Comp, 150K, ± 5%, 1/4 W, (MIL-R-11/8)	1
R15, 22, 23, 24, 25, 26, 27, 36, 43, 50, 57, 64, 71, 77, 79, 81, 83, 85, 87, 89, 91, 97, 100	RC07GF103J	. RESISTOR, FXD, Comp, 10K, ± 5%, 1/4 W, (MIL-R-11/8)	23
R16, 69, 103	RC07GF471J	. RESISTOR, FXD, Comp, 470 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	3

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
R18	01002080-8	RESISTOR, Variable, 2K	1
R19	RC07GF821J	RESISTOR, FXD, Comp, 820 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R20, 31, 34, 40, 47, 54	01002080-9	RESISTOR, Variable, 5K	6
R21	RC07GF432J	RESISTOR, FXD, Comp, 4.3K, ± 5%, 1/4 W (MIL-R-11/8)	1
R28	01002080-4	RESISTOR, Variable, 100 OHMS,	1
R30, 32, 75, 103, 109, 78, 80, 82, 84, 86, 88, 98, 102	RC07GF102J	RESISTOR, FXD, Comp, 1K, ± 5%, 1/4 W (MIL-R-11/8)	13
R33, 39, 46	RC07GF101J	RESISTOR, FXD, Comp, 100 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	3
R35, 42, 49, 56, 63, 70, 74, 95	RC07GF472J	RESISTOR, FXD, Comp, 4.7K, ± 5%, 1/4 W (MIL-R-11/8)	8
R38, 45, 52, 59, 66, 73, 110	RC07GF152J	RESISTOR, FXD, Comp, 1.5K, ± 5%, 1/4 W (MIL-R-11/8)	7
R41	RC07GF180J	RESISTOR, FXD, Comp, 18 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R48	RC07GF430J	RESISTOR, FXD, Comp, 43 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R53, 62	RC07GF221J	RESISTOR, FXD, Comp, 220 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	2
R55	RC07GF121J	RESISTOR, FXD, Comp, 120 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
R60, 67	RC07GF511J	. RESISTOR, FXD, Comp, 510 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	2
R61, 68	01002080-11	. RESISTOR, Variable, 20K	2
R76	RC07GF151J	. RESISTOR, FXD, Comp, 150 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R90, 107	RC07GF682J	. RESISTOR, FXD, Comp, 6.8K, ± 5%, 1/4 W (MIL-R-11/8)	2
R96	RC07GF113J	. RESISTOR, FXD, Comp, 11K, ± 5%, 1/4 W (MIL-R-11/8)	1
R99, 105	RC07GF100J	. RESISTOR, FXD, Comp, 10 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	2
R101	RC07GF470J	. RESISTOR, FXD, Comp, 47 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R104	RC07GF220J	. RESISTOR, FXD, Comp, 22 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
R108	RC07GF330J	. RESISTOR, FXD, Comp, 33 OHMS, ± 5%, 1/4 W (MIL-R-11/8)	1
-1	MS51957-2	. SCREW, Mach, 2-56 x .19 LG	4
	MS35338-134	. WASHER, Lock, No. 2	4
	MS15795-802	. WASHER, Flat, No. 2	4
-2	35013381	. SHIELD, PWB	1
-3	49006011	. BOARD, Printed Wiring	1

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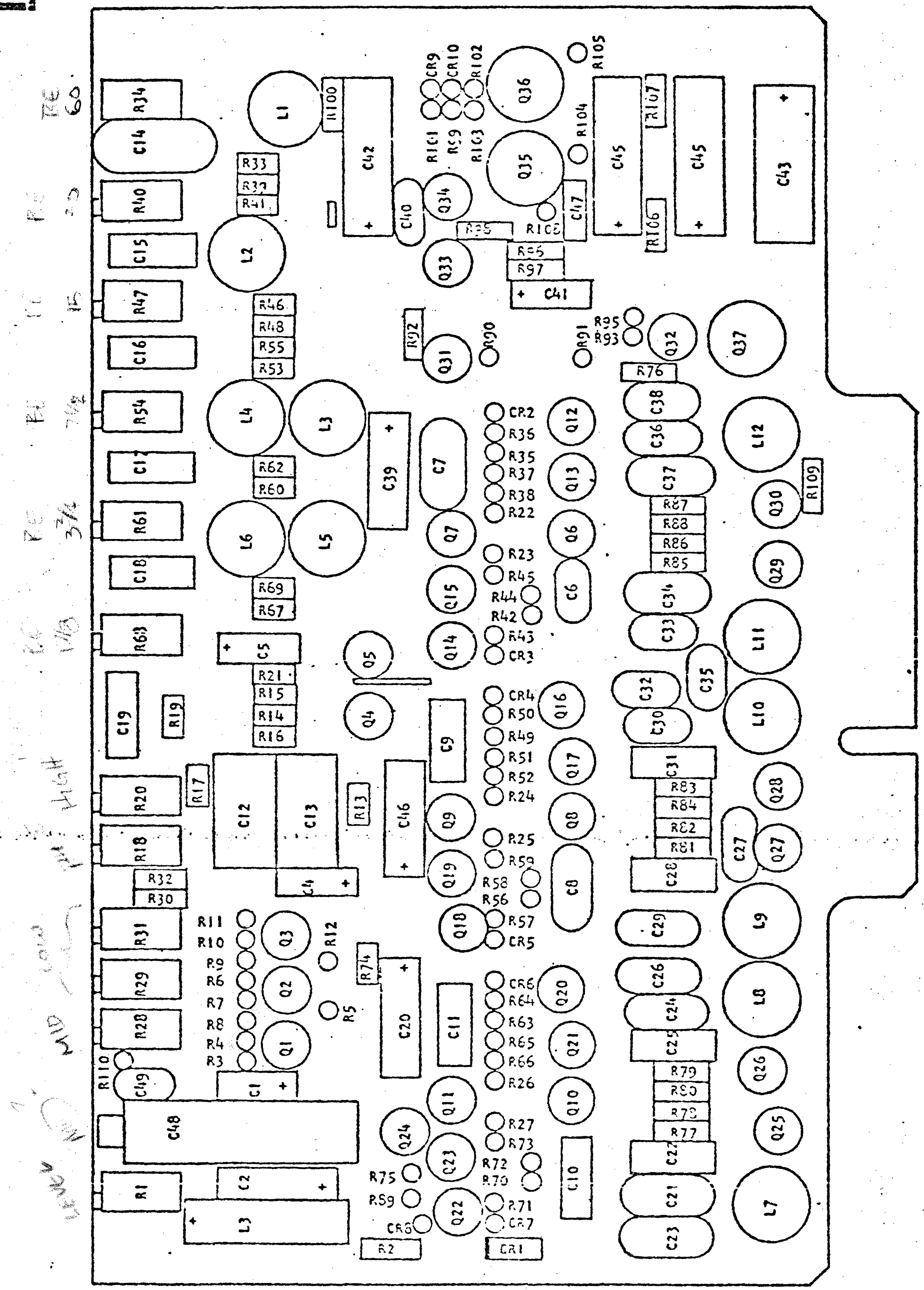

Figure A6-2 Wideband Reproduce Amplifier Assembly 85004971
(Sheet 1 of 2)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
A6-3	85003001 C	REGULATOR ASSY; +15-Volt	REF
C1	CS13BE107K	. CAPACITOR; Fxd Tant; 100 uf; ± 10%; 20 W Vdc	1
CR1, CR2	1N914	. DIODE (MIL-S-19500/116)	2
CR3	1N754A	. DIODE; Zener (MIL-S-19500/127)	1
R1	RC42GF620J	. RESISTOR; Fxd Comp; 62 ohm; ± 5%; 2 W	1
R2, R4	RC20GF102J	. RESISTOR; Fxd Comp; 1 K ohm; ± 5%; 1/2 W	2
R3	RC20GF3R3J	. RESISTOR; Fxd Comp; 3.3 ohm; ± 5%; 1/2 W	1
R5, R7	RC20GF202J	. RESISTOR; Fxd Comp; 2 K ohm; ± 5%; 1/2 W	2
R6	01001350	. RESISTOR, Variable; 1 K ohm; ± 10%; 1/2 W	1
Q1	2N1485	. TRANSISTOR; NPN; (MIL-S-1500/180)	1
Q2	2N1711	. TRANSISTOR; NPN; (MIL-S-1500/1225)	1

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FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
	42000110	. HEATSINK	1
	AN507C440R3	. . SCREW; 100^{o} CSK; 4-40 UNC-2A x 3/16	2
		. . SEALING COMPOUND; Grade E; (MIL-S-22473)	A/R
	49002841	. PRINTED WIRING BOARD	1

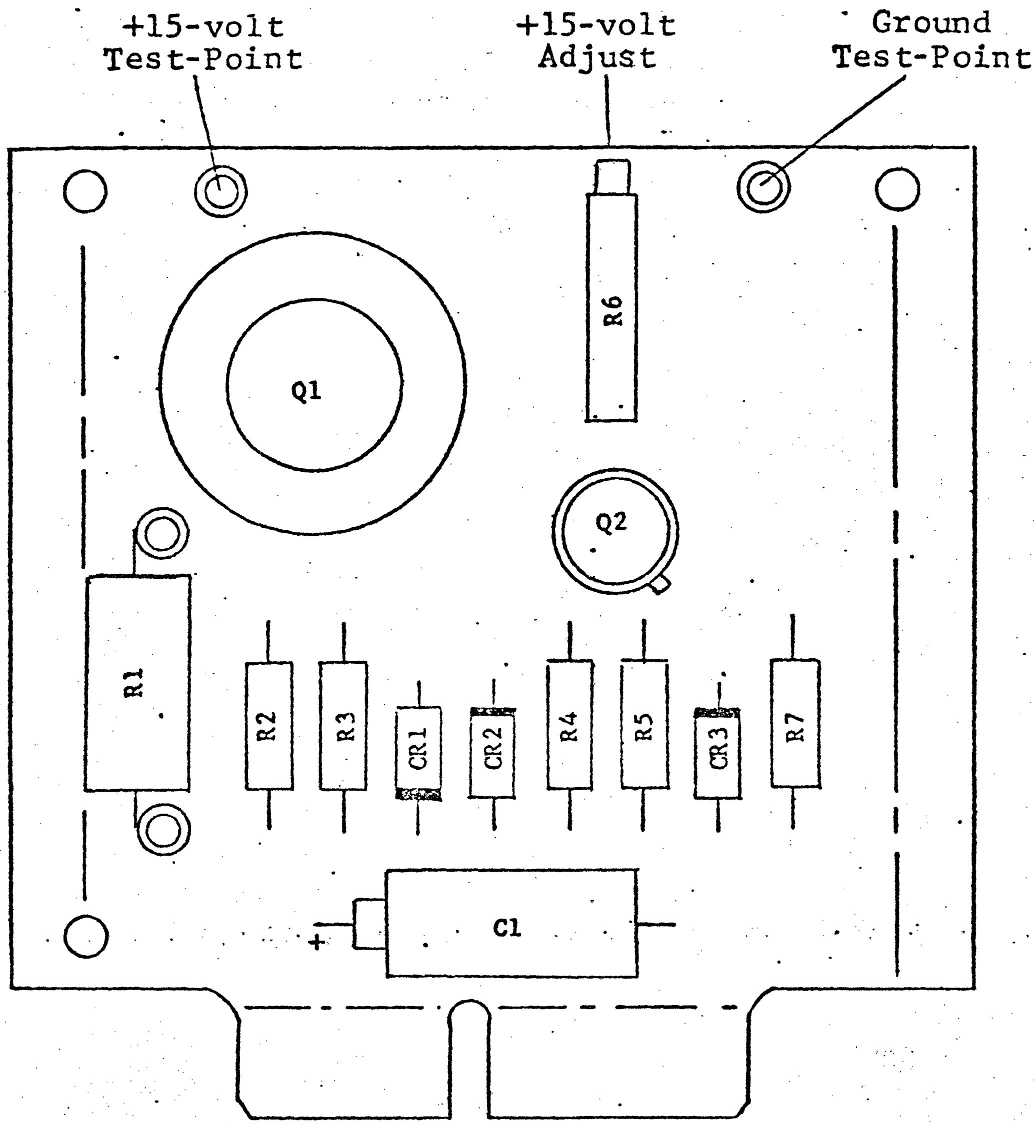

Figure A6-3
+15-Volt Voltage Regulator (85003001 C)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
A6-4	85002601 B	REGULATOR ASSY: +20-Volt	REF
C1, C2	CS13BF476K	. CAPACITOR; Fxd Tant; 47 uf; ± 10%; 35 W Vdc (MIL-C-26655)	2
CR1	1N970B	. DIODE; Zener (MIL-S-19500/117)	1
CR2	1N754A	. DIODE; Zener (MIL-S-19500/127)	1
Q1	2N1485	. TRANSISTOR; (MIL-S-19500/180)	1
Q2	2N3055	. TRANSISTOR	1
Q3	2N1711	. TRANSISTOR; (MIL-S-19500/225)	1
R1	RC20GF152J	. RESISTOR; Fxd Comp; 1.5 K ohm; ± 5%; 1/2 W	1
R2	RC20GF472J	. RESISTOR; Fxd Comp; 4.7 K ohm; ± 5%; 1/2 W	1
R3	RC20GF220J	. RESISTOR; Fxd Comp; 22 ohm; ± 5%; 1/2 W	1
R4, R5	RC20GF102J	. RESISTOR; Fxd Comp; 1 K ohm; ± 5%; 1/2 W	1

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
R6	RC20GF103J	. RESISTOR; Fxd Comp; 10 K ohm; ± 5%; 1/2 W (MIL-R-11)	1
R7	01001380	. RESISTOR, Variable; 10 K ohm; ± 10%; 1/2 W	1
R8	RC20GF682J	. RESISTOR; Fxd Comp; 6.8 K ohm; ± 5%; 1/2 W (MIL-R-11)	1
XQ1	41001170	. INSULATOR	1
XQ2	41000040	. INSULATOR	1
XQ3	41001070	. INSULATOR	1
	41001230	. INSULATOR, SPACER	4
	51000240	. TERMINAL LUG	1
	37000740	. CLAMP	1
	MS51957-30	. SCREW, Mach; Pan Hd; 6-32 x 0.50 LG	2
	MS35649-64	. NUT, HEX; 6-32	4
	MS15795-805	. WASHER, FLAT No. 6	4
	MS35338-79	. WASHER, LOCK, SPLIT; No. 6	3
	MS51957-31	. SCREW, Mach; Pan Hd; 6-32 x 0.62 LG	2
	49002621	. PRINTED WIRING BOARD	1
	42000141	. HEATSINK	1

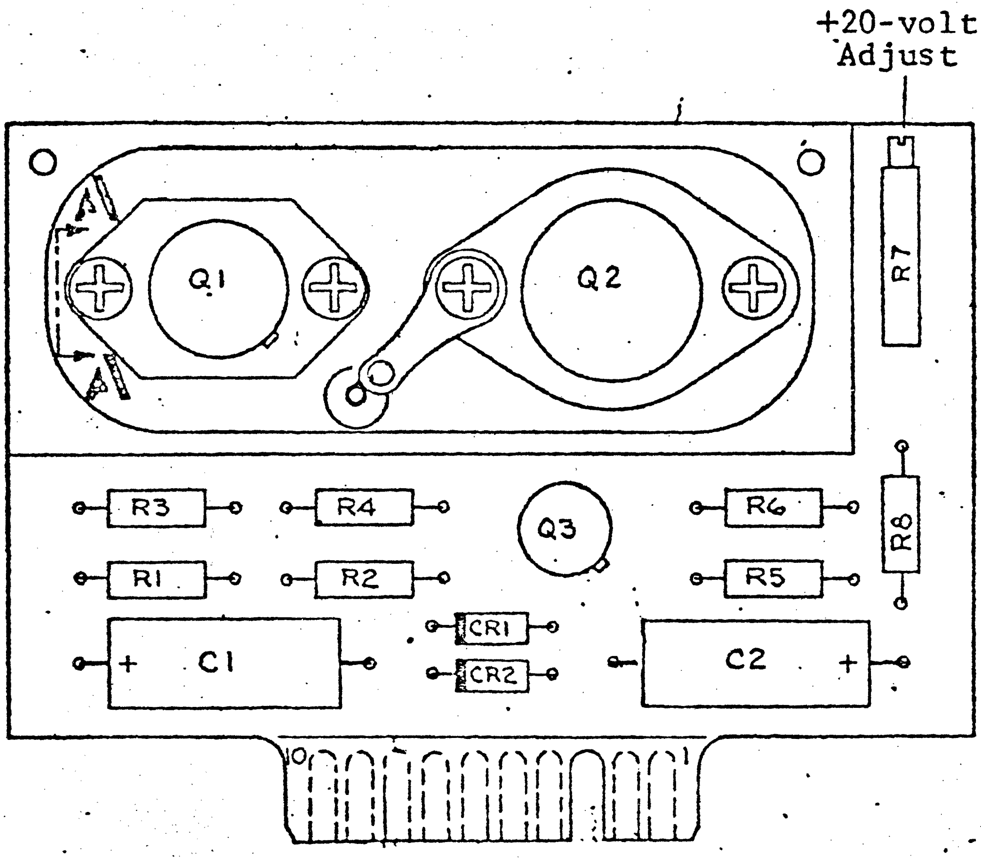

Figure A6-4
+20-Volt Voltage Regulator (85002601 B)

FIG & ITEM NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5	QTY PER ASSY
A6-5	85002012 C	RELAY ASSY, SPEED CHANGE	REF
CR1 - CR10	1N645	. DIODE, (MIL-S-19500/240)	10
K1 - K4	06000440	. RELAY, DPDT (FSC 02289)	4
	49002071	. BOARD, PRINTED WIRING	1

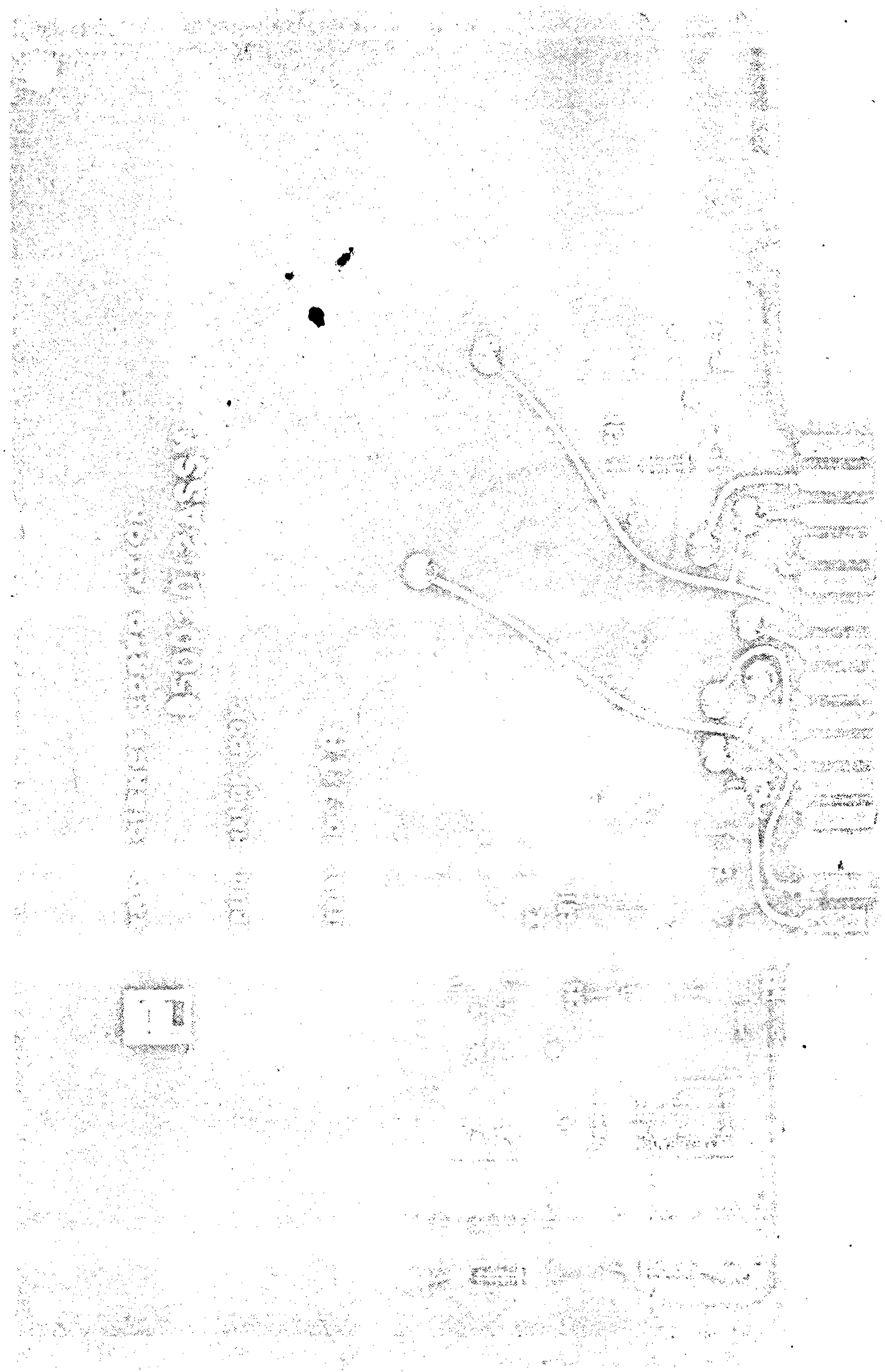

Figure A6-5
Speed Change Logic (85002012)