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ATR-100 SERIES RECORDER/REPRODUCER

OPERATION AND MAINTENANCE

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AUDIO-VIDEO SYSTEMS DIVISION**

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13788-35

ATR-100 Series Recorder/Reproducer Mounted in a Cabinet on a
Pedestal with Input/Output Assembly (Accessory)

SECTION 1

GENERAL INFORMATION

This manual provides operation and maintenance instruction for the models ATR-101, ATR-102, and ATR-104 Recorder/Reproducers, Ampex Part No. 4010260 (full track), 4010261 (2 track), and 4010262 (4 track) respectively.

1-1. DESCRIPTION

The ATR-100 series Recorder/Reproducers are professional quality audio tape recorder/reproducers that use 1/4-inch (6.4 mm) or 1/2-inch (12.7 mm) wide magnetic tape on EIA or NAB reels up to 14 inches (35.56 cm) in diameter. The recorder/reproducer can operate in either the NAB or IEC equalization standard at any two speeds selected from the following speeds: 3.75, 7.5, 15, and 30 in/s (9.5, 19.05, 38.1 and 76.2 cm/s).

A plug-in-type head assembly permits easy conversion between one- and two-channel operation using 1/4-inch tape, or four-channel operation using 1/2-inch tape. The system is available in five different mounting configurations: cabinet, cabinet mounted on a roll-around pedestal, fixed-rack mount, slide-rack mount, and portable case.

The recorder/reproducer does not incorporate a capstan pinchroller but controls tape movement in all modes of operation while under capstan and reel servo control. The capstan servo controls speed and direction while the reel servo maintains dynamically constant tape tension in all modes of operation.

The basic system incorporates such standard features as an electronic tape timer, Sel-Sync*, PURC (Pick-up Recording Capability), dynamic braking, ceramic tape guides, and ferrite heads. The tape

timer displays in hours, minutes and seconds (or minutes, seconds, and tenths of seconds by changing a jumper) the distance the tape has moved from a zero reference point. The Sel-Sync feature permits the recording of added channels in perfect synchronization with previously recorded channels. The PURC feature eliminates the problem of overlaps and holes in recordings when inserting (dubbing) new material within previously recorded programs. The system does not have mechanical brakes, but incorporates dynamic braking to control all reel braking functions including stopping tape motion when power is removed.

The basic recorder system (Figure 1-1) consists of a tape transport, head assembly, control unit, electronics assembly, and power supply assembly.

1-2. Tape Transport

All components of the tape transport (Figure 1-2) are mounted on a rigid, precision-machined cast-aluminum base, which also serves as a transistor heatsink for the power supply, tension arm solenoid drivers, and motor drive amplifiers. Mechanical features permit changing from one tape width to the other in less than a minute. The tape transport consists mainly of subassemblies which are easily removed and installed without the need for shims. Electrical connections are made by harness connectors, thereby eliminating the need for soldering.

Basic components of the tape transport are the capstan, supply and takeup motors, supply and takeup constant-tension arms, and tape timer wheel assembly. Tape motion is controlled in all modes of operation (including fast forward, rewind, and spool) by the capstan and reel servos. The capstan turns to meter the tape and the constant-tension arms supply arm position information to the reel servo system. This arrangement results in constant tape tension in all modes of operation.

*Trademark, Ampex Corporation

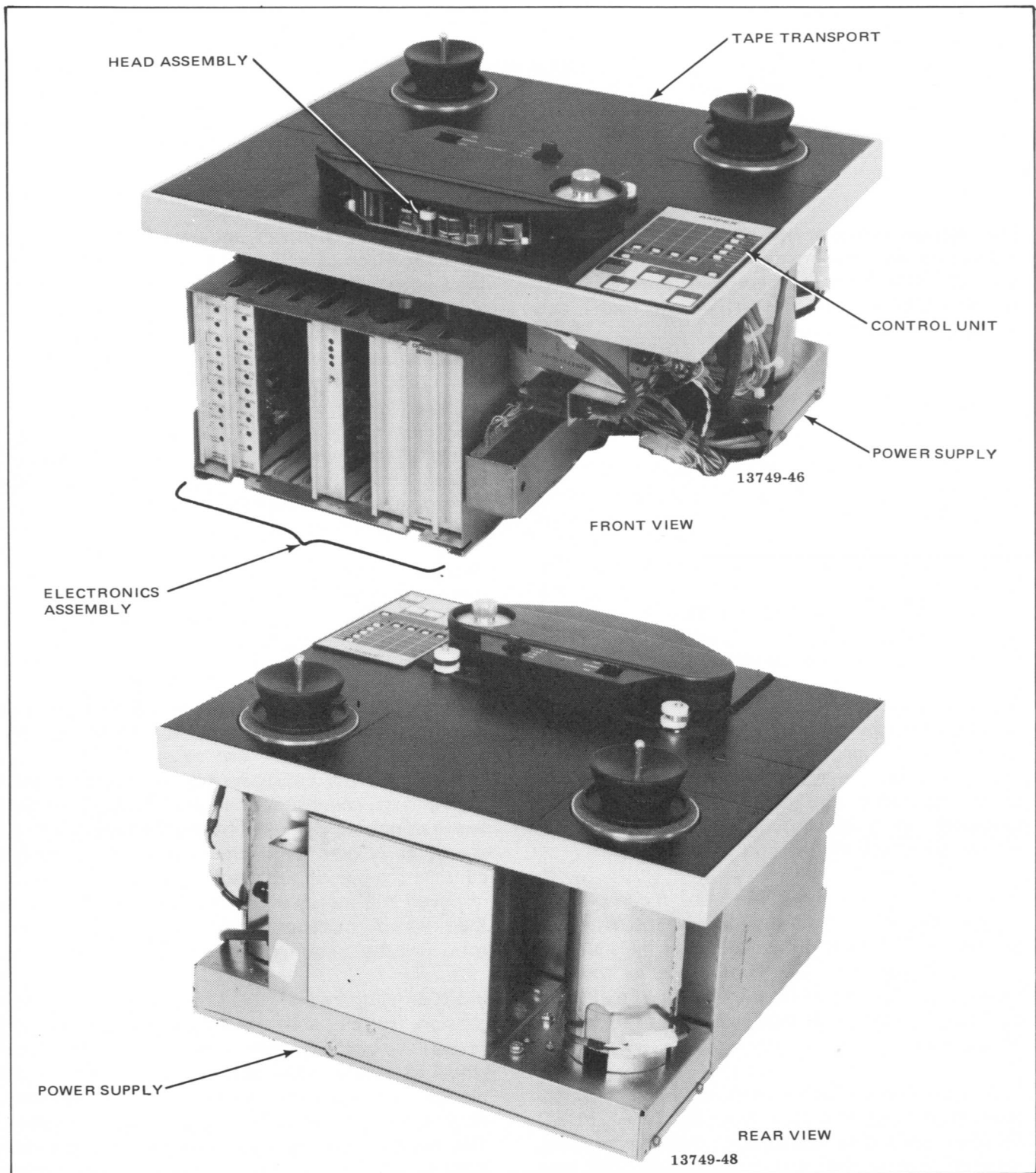


Figure 1-1. Recorder/Reproducer, Unmounted

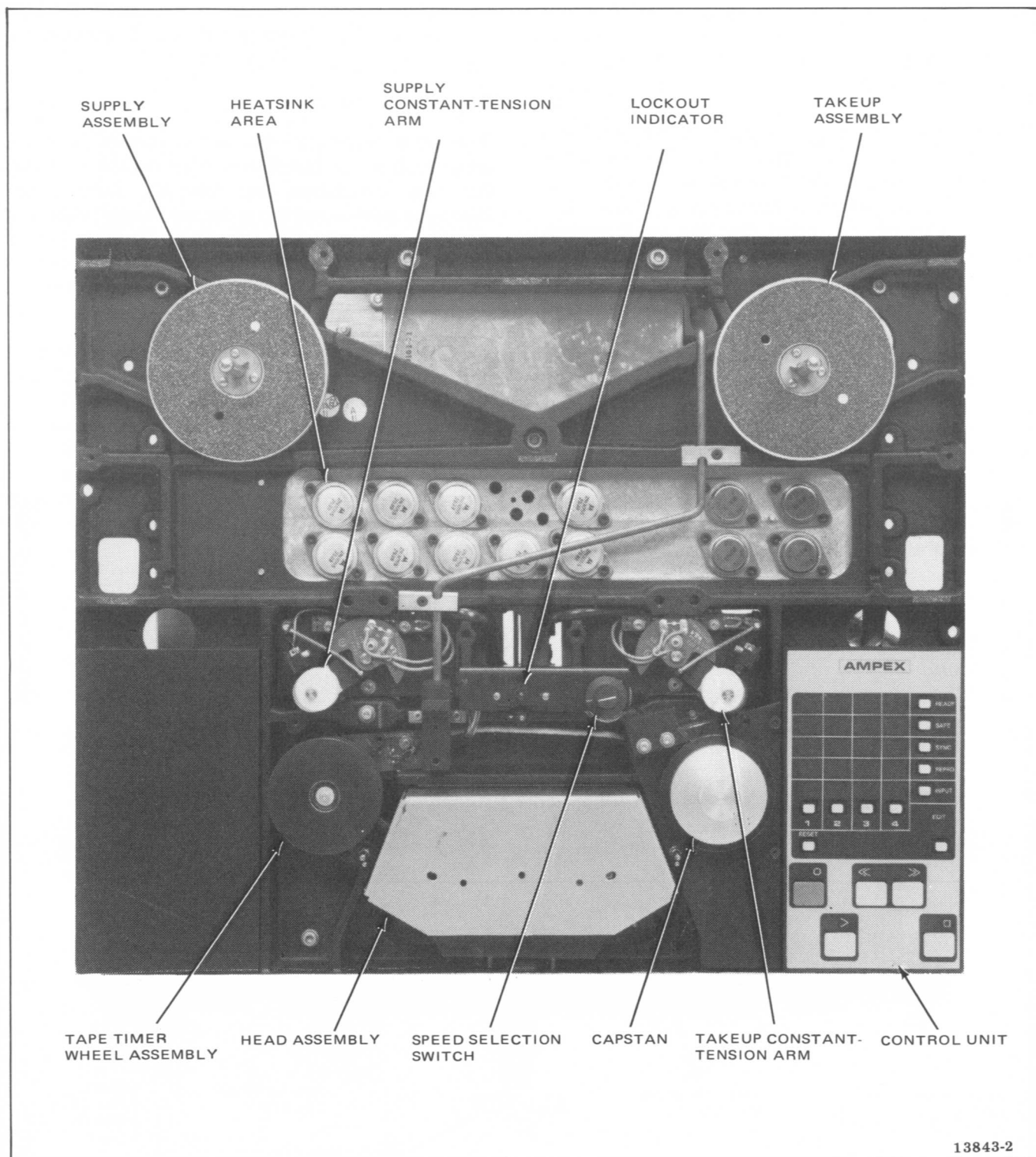


Figure 1-2. Top View of Tape Transport with Front and Rear Overlay Panels and the Head Cover Removed

Tape motion causes the tape timer wheel to rotate and a photo-electric device, located below the tape timer wheel, provides rotational information to the tape timer circuitry.

Tape speed is selected by operating a rotary switch, located on the tape transport, that also causes the equalization bias, PURC timing, and tape timer circuitry to be switched according to speed selection. If a speed is selected that the signal system has not been set for, a LOCKOUT indicator lights and the play and record modes for that speed are inoperative.

The transport will accommodate tape reels up to 14 inches (35.56 cm) in diameter in any combination. When reels larger than 11-1/2 inches (29.21 cm) are used, the reel motors must be repositioned to an outer position.

During fast forward, rewind, and spool modes, two solenoid-actuated tape-lifter arms automatically lift the tape from the heads. For editing and

cueing operations, override of the tape-lifter arms is provided by pressing the EDIT pushbutton during these modes of operation.

1-3. Head Assembly

The head assembly is a self-contained unit and plugs into a receptacle mounted on the transport for easy installation and removal. Tape scrape-flutter is minimized by a scrape-flutter idler that is mounted on jeweled bearings and located between the record and reproduce head stacks. An optional second idler may be installed to the left of the erase head.

Figure 1-3 shows a 2-track (1/4-inch tape) head assembly. The erase, record, and reproduce head stacks are mounted in head mounting positions 2, 3, and 4 respectively, but other combinations are possible. Each head stack is mounted on a precision plate and is easily removed from the head assembly by unplugging the head-stack connector and removing the head-stack mounting screw shown in Figure 1-4.

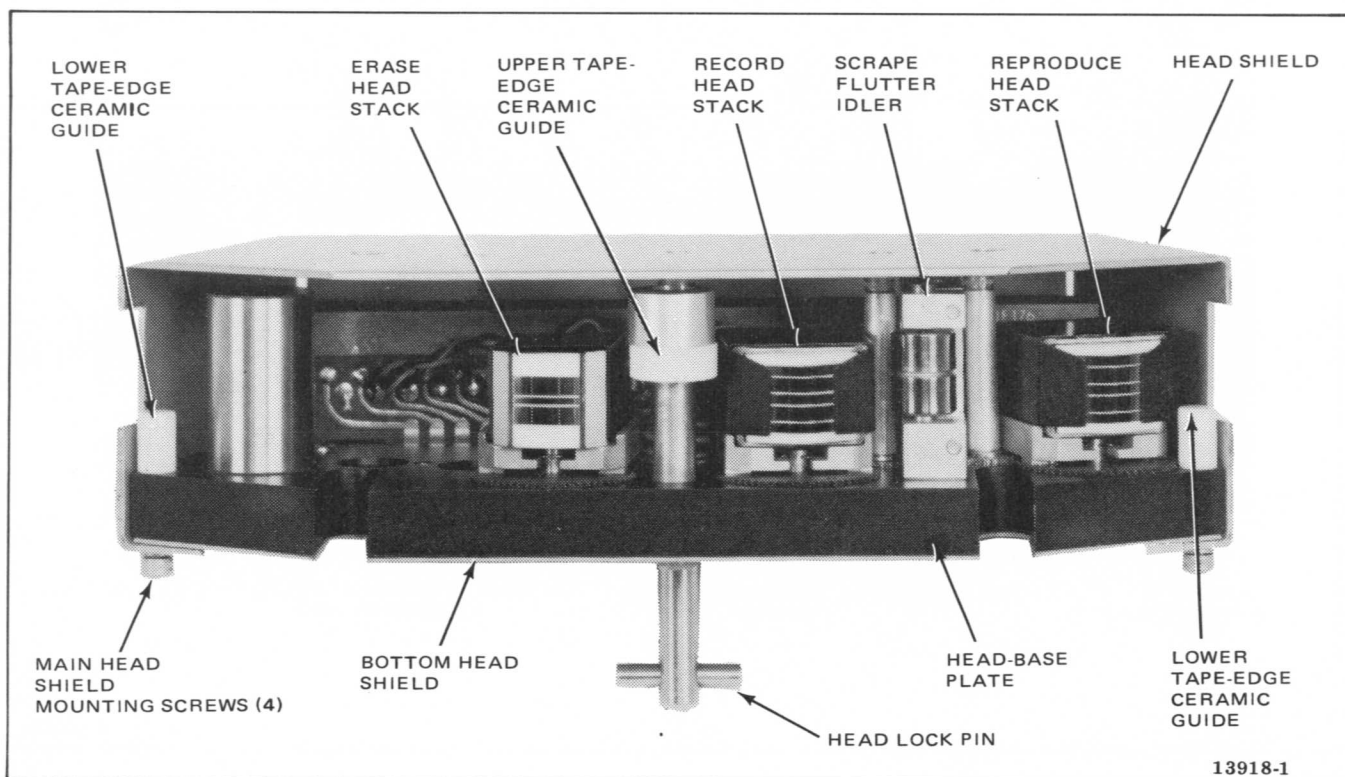


Figure 1-3. Head Assembly

The only head adjustment required is for record and reproduce head-stack azimuth. This adjustment is made by turning a screw which causes a tapered gear to rotate underneath the head-stack precision plate, thereby providing a limited, but adequate, range of adjustment. (The head design has eliminated the need for adjusting tape wrap, height, and zenith.)

The head stacks are made of ferrite material, and the record stack has a dual winding so that record and Sel-Sync functions can be separately optimized.

1-4. Control Unit

The control unit (Figure 1-5) is capable of controlling up to four audio channels, and enables the operator to initiate all transport and signal mode functions from a single control panel. In addition to controlling all transport functions,

such as play, record, fast forward, spool, edit, etc., pushbutton switches associated with each channel enable the operator to program each channel separately for operation in the desired signal mode. This program selection is indicated by light emitting diodes associated with each channel. A tape timer display indicates in hours, minutes, and seconds (or minutes, seconds, and tenths of seconds) the distance the tape has moved from a zero reference point established by pressing a RESET pushbutton switch.

For operator convenience, the control panel may be located either in the left-hand or right-hand position on the transport. An accessory remote control unit with a 25-foot (7.62m) cable is available. This control unit duplicates all functions and displays of the local control unit with the exception that play/edit and stop/edit (unthread) modes may not be initiated.

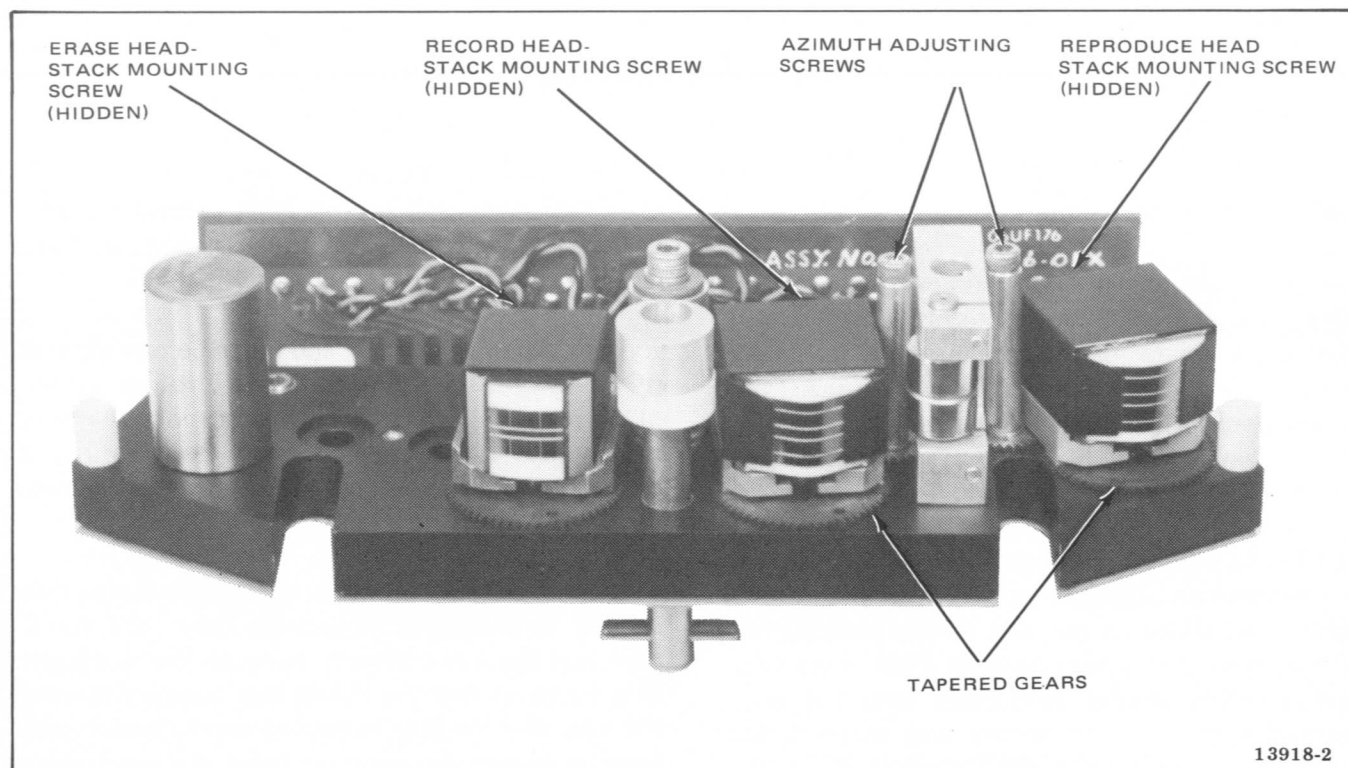


Figure 1-4. Head Assembly with Head Shield Removed

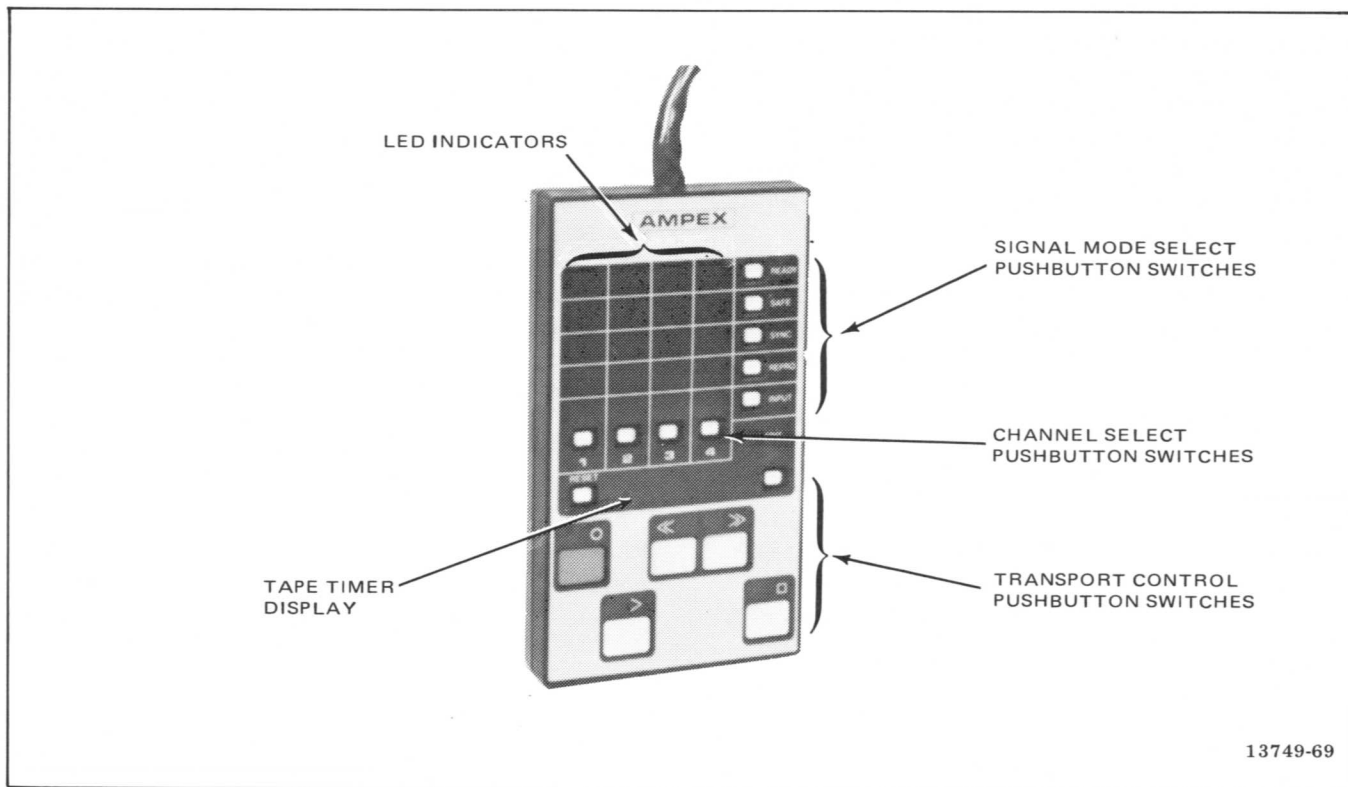


Figure 1-5. Control Unit

1-5. Electronics Assembly

Except for the power supply and motor drive amplifiers, the ATR-100 series Recorder/Reproducer electronics are primarily contained on up to 12 printed wiring assemblies (PWAs) for the four-channel version of the recorder/reproducer. (The four audio channel PWAs are actually double boards.) These PWAs are listed in Table 1-1.

The PWAs plug into a single-row card rack within the electronics assembly as shown in Figure 1-6. Each PWA slides in and out of the assembly on guides; edge connectors on each PWA mate with corresponding female connectors mounted on a motherboard. The connectors and motherboard form part of a harness assembly which routes the PWA signals throughout the recorder/reproducer and to the input/output connectors mounted on

the electronics assembly. A PWA extender board, used for servicing and adjustments, is stored next to the PWAs in the card rack.

In the cabinet, slide rack, and portable case version of the recorder/reproducer, the electronics assembly is mounted directly on the transport as shown in Figure 1-1. The head assembly plugs directly into a connector mounted on the electronics assembly.

In the fixed rack configuration, the electronics chassis is physically separated from the transport and mounted directly beneath the transport in a frame so that the PWAs face outward toward the operator. In this mounting configuration, the head connector is removed from the electronics assembly and is fastened to the transport to receive the head assembly.

Table 1-1. Electronics Assembly Printed Wiring Assemblies

PWA NO.	ASSEMBLY NO.	DESCRIPTION
1-4	4050754 and 4050755	Main Audio PADNET (Parameter Determining Network—plugs into Main Audio PWA.)
5	4050788	Audio Control
6	(Spare)	Can be used to store extender Board Assembly No. 4050800
7	4050787	Transport Control (Transport Logic and Tape Timer)
8	4050776	Capstan Servo
9	4050778	Reel Servo

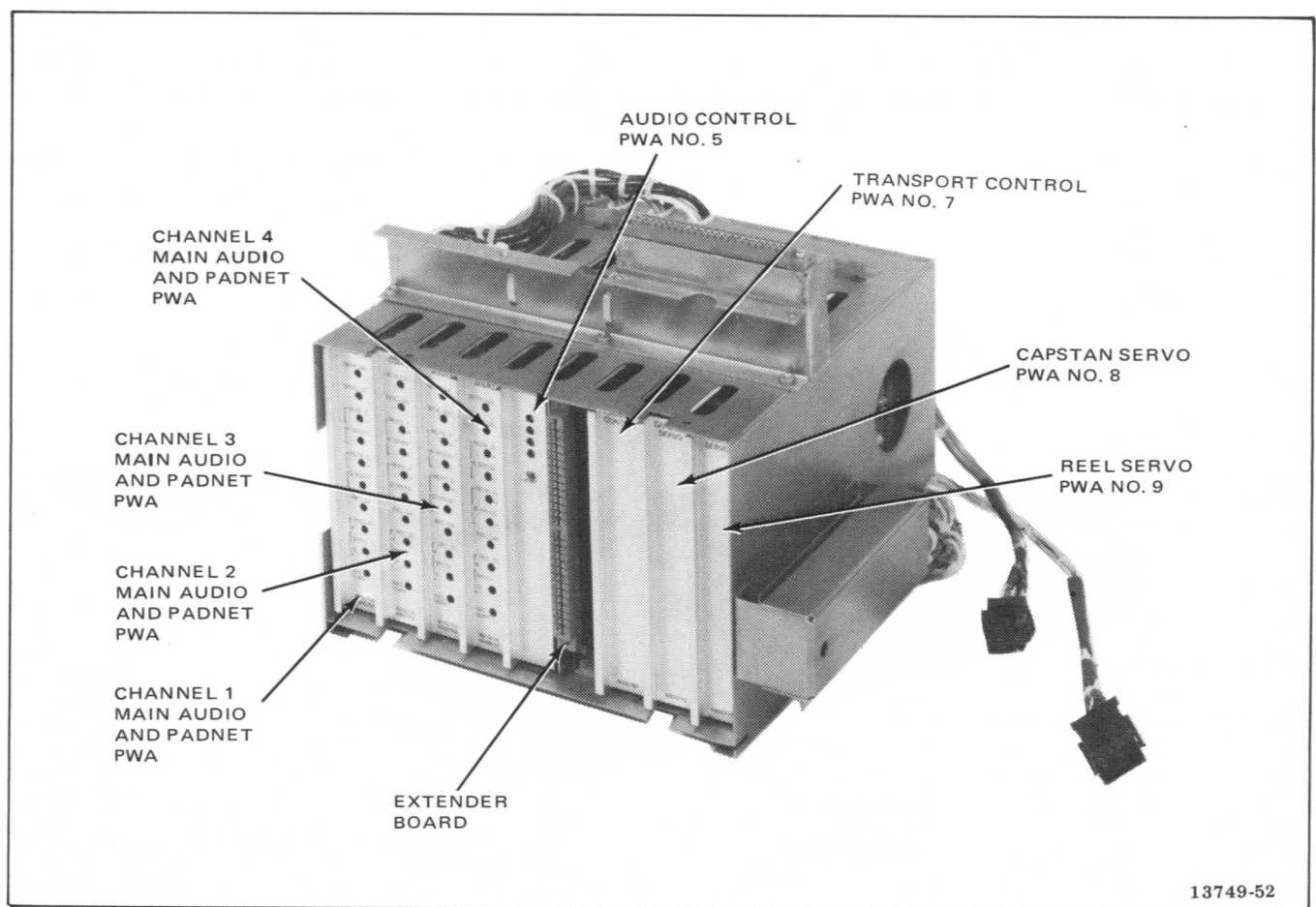


Figure 1-6. Electronics Assembly, Cover Panel Removed

1-6. Power Supply

The power supply is a self-contained unit (except for series pass transistors that are mounted on the transport casting) that is easily removed from the transport by disconnecting two connectors and removing three screws. Figures 1-7 and 1-8 show the basic components of the power supply. Main ac power is connected to the ATR-100 through a captive power cable attached to the power switch bracket. A jumper plug arrangement within the power supply chassis adapts the main power transformer to use any one of four input voltage ranges: 90-115, 110-135, 180-230, and 220-270 Vac (50-60 Hz).

The power supply provides the following basic functions:

1. Houses the main power switch and fuses. A mechanical linkage enables the switch to be operated from the top of the transport.

2. Houses the dynamic brake circuitry used for power failure or control-loss braking for the reel motors.
3. Provides regulated +5.0 Vdc for use throughout the system to operate the TTL circuitry.
4. Provides ± 20 Vdc (nominal) for the reel motors and capstan motor.
5. Provides electronically filtered ± 22 Vdc (nominal) for the audio signal system circuitry.
6. Provides 100 Vac (nominal) for operation of the cabinet fan.

1-7. EQUIPMENT CONFIGURATIONS

The recorder/reproducer is available from the factory in a one-channel, two-channel, or four-channel version and may be easily converted from one version to another. Each basic recorder/reproducer

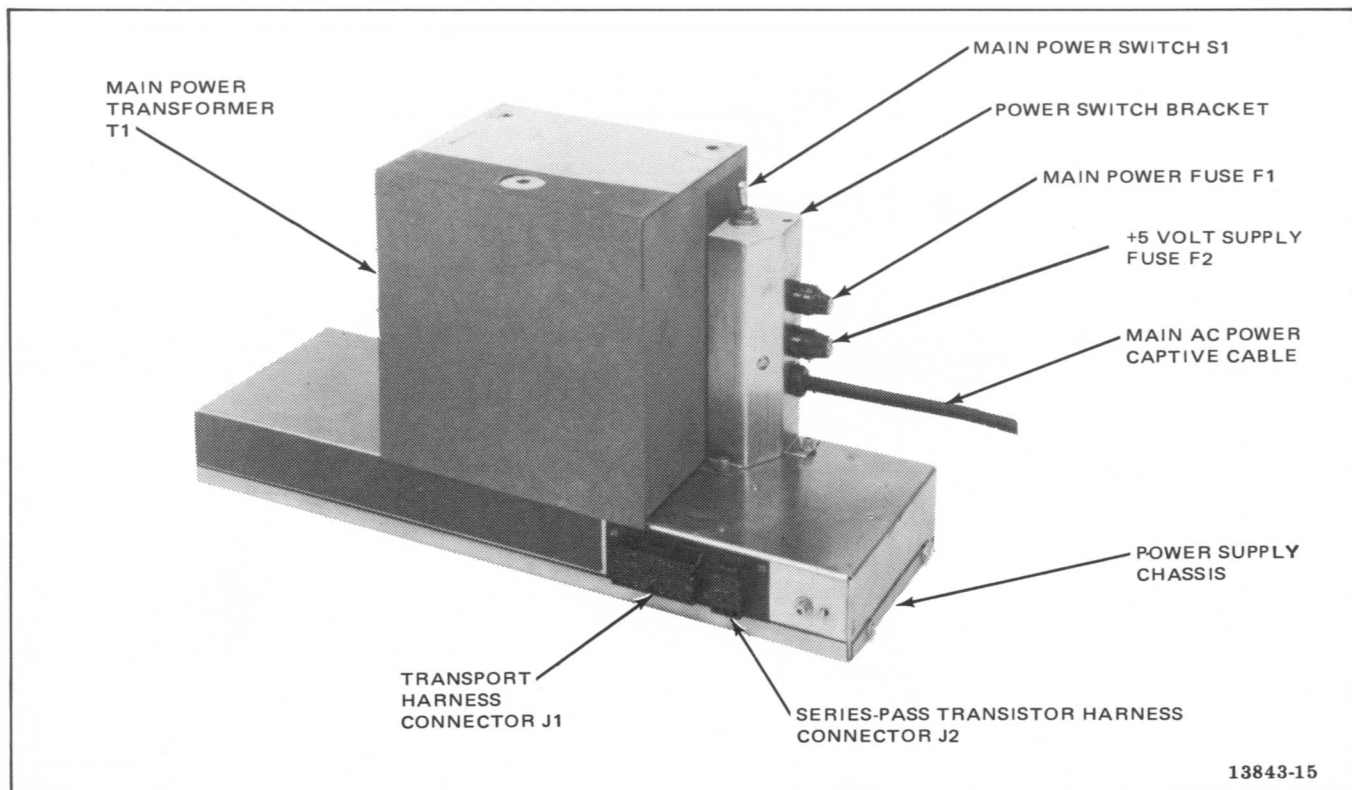


Figure 1-7. Power Supply

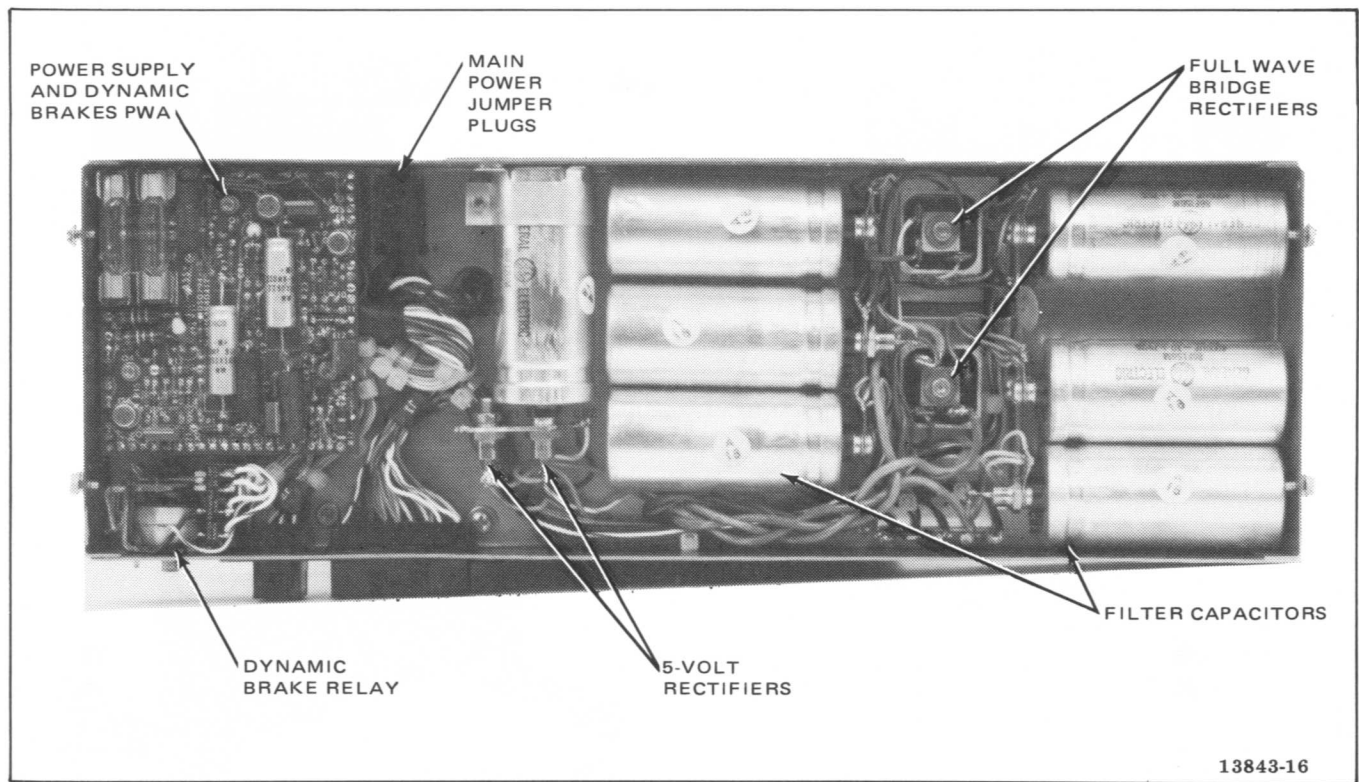


Figure 1-8. Power Supply Chassis with Cover Panel Removed

is prewired for four-channel operation. For example, to convert from two-channel 1/4-inch tape operation to four-channel 1/2-inch tape operation, only the following, easily installed equipment is required: head assembly, supply and takeup guides, two main audio PWAs, and two PADNET PWAs.

In addition, there are five different mounting configurations available: cabinet, cabinet mounted on a roll-around pedestal, fixed-rack mount, slide-rack mount, and portable case. Four of these configurations are shown in Figure 1-9. Available optional equipment that may be used to convert from one channel configuration or mounting configuration to another is listed in Table 1-2.

1-8. ACCESSORIES

Available optional accessories are listed in Table 1-3.

1-9. Input/Output Module and Mainframe

The input/output accessory serves as an interface between the input and output of the ATR-100 to permit the operator to adjust and monitor input and output signal levels. These input and output signals can be balanced or unbalanced line. The accessory includes such features as a switchable peak/vu level meter, input and output line transformers, input and output level controls with preset/manual switch controls, headphone monitoring jack, input amplifier, line output drivers, and bias and erase confidence indicators. One input/output module is used per channel and two input/output modules may be mounted side-by-side in an input/output main frame assembly (Figure 1-10). The main frame accessory may then be installed into an enclosure supplied with the recorder/reproducer cabinet or mounted in a standard 19-inch rack with an optional top cover. Two accessories may be mounted vertically to accommodate a four-channel system.

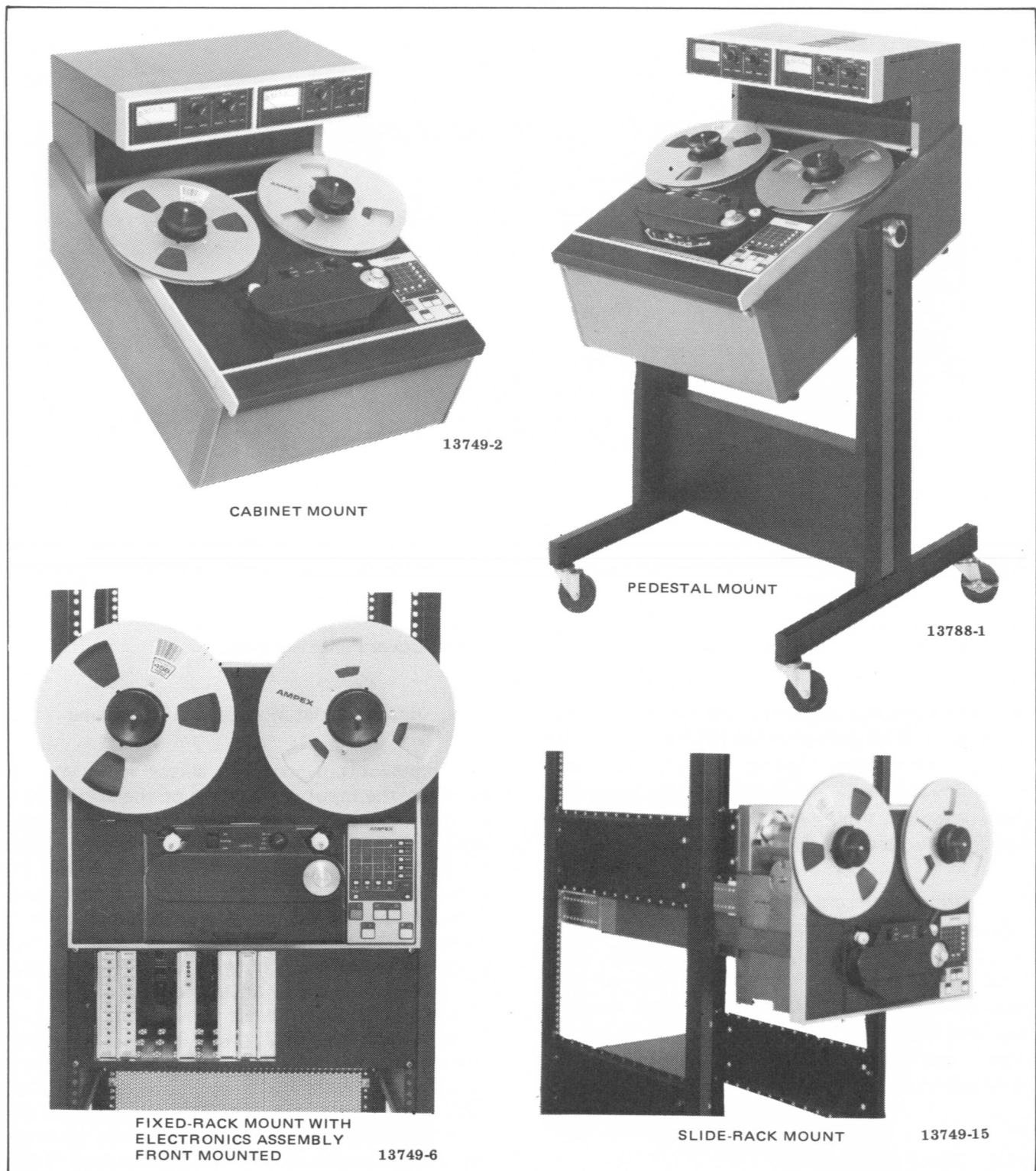


Figure 1-9. ATR-100 Series Mounting Configurations

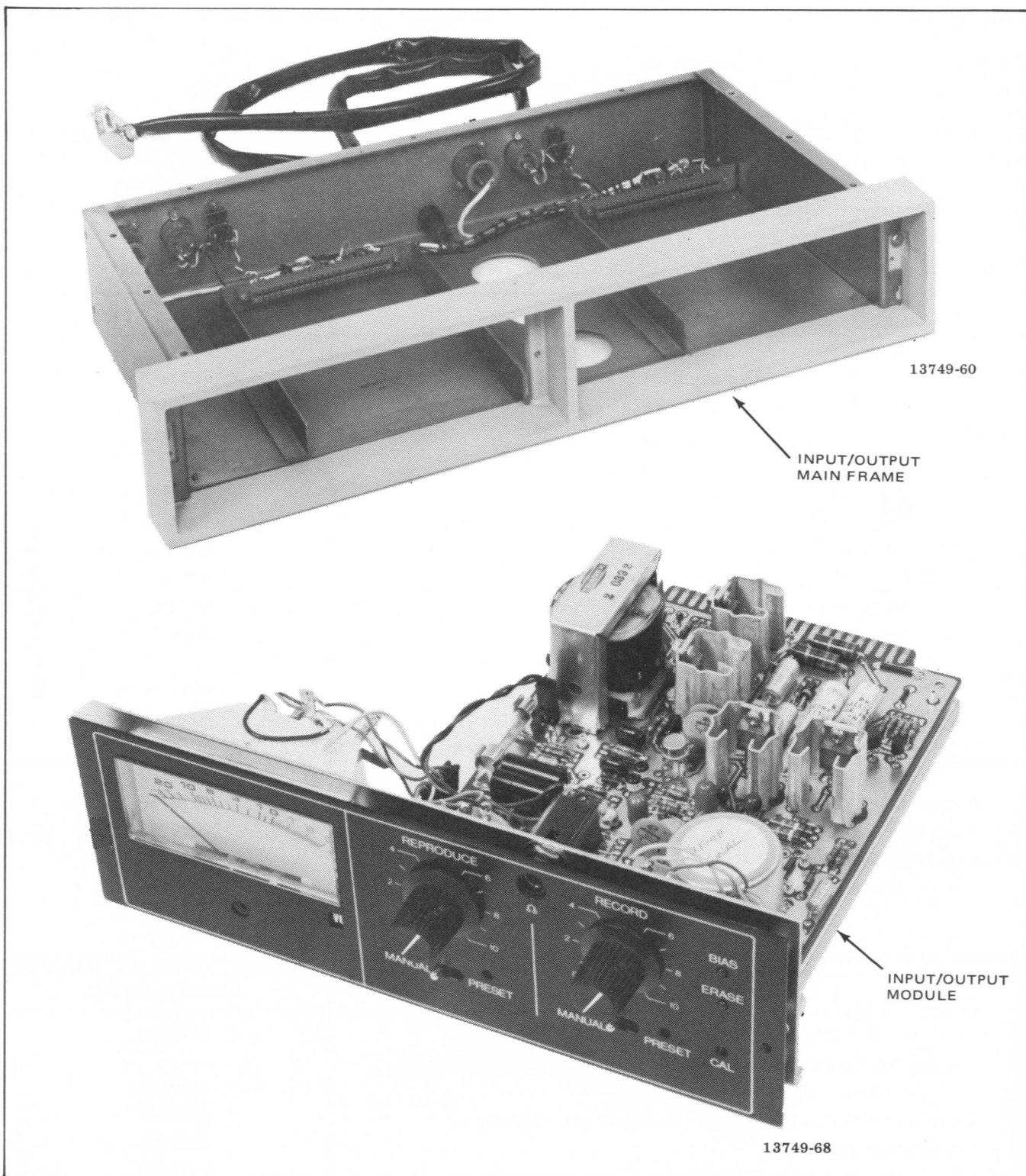


Figure 1-10. Input/Output Assembly

1-10. Remote Control Unit

The remote control unit duplicates all functions and displays of the local control unit with the exception that play/edit and stop/edit (unthread) modes may not be selected. Except for these two modes, the remote control unit operates in parallel with the local control unit at all times. The unit comes equipped with a 25-foot captive cable and

connector for easy connection to the recorder/reproducer.

1-11. SPECIFICATIONS

Specifications for the ATR-100 series Recorder/Reproducers are given in Table 1-4. All specifications are subject to change without notice or obligation.

Table 1-2. Optional Equipment

DESCRIPTION	AMPEX PART NO.
Head Assembly	
Full Track, 1/4-inch (6.4 mm) tape	4020413
Two Track, 1/4-inch (6.4 mm) tape	4020417
Four Track, 1/2-inch (12.7 mm) tape	4020418
Tape Guide Assembly	
Supply 1/4-inch tape	4041239-AA
Takeup 1/4-inch tape	4041239-AB
Supply 1/2-inch tape	4041240-AA
Takeup 1/2-inch tape	4041240-AB
Audio Main Board PWA	4050754
PADNET PWA	4050755
Cabinet Kit Assembly	
1 or 2 Channel	4010258-AC
3 or 4 Channel	4010258-AD
Riser Kit (converts cabinet kit assembly from 1 or 2 channel to a 3 or 4 channel version)	4020429
Portable Case	4010259
Fixed Rack Mount Kit	4010252
Slide Rack Mount Kit	4010253
Pedestal Assembly	4020426

Table 1-3. Accessory Equipment

DESCRIPTION	AMPEX PART NO.
Input/Output Mainframe	4010254
Input/Output Mainframe Cover Kit - used when mounting mainframe into 19-inch (48.26 cm) rack	4020428
Input/Output Module Blank Panel - for Input/Output Mainframe	4041247
Input/Output Module	4020409
Input/Output Module Extender Board	4020430
Input/Output Module Level Set Assembly	4020425

Table 1-3. Accessory Equipment (Continued)

DESCRIPTION	AMPEX PART NO.
Remote Control Unit, Four-Channel — includes 25-foot (7.62 m) captive cable and connector	4010264
Optional Scrape Flutter Idler (not interchangeable with furnished idler)	4030402-AB
Two-Way Extension Accessory Connector Assembly	4020432
Noise Reduction Switching Interface (Dolby/DBX Switcher)	4020433
Flux Loop	4020423
Flux Loop Equalizing Amplifier	4020424
ATR-100 Spare Parts Kits	
“A” Level Spares	1385874
“B” Level Spares	
Full Track	1385875-01
2 Track	1385875-02
4 Track	1385875-03
“C” Level Spares	
1/4-inch (6.4 mm) Tape	1385876-01
1/2-inch (12.7 mm) Tape	1385876-02
VS-10 Variable Speed Oscillator	4010217-07
VS-10 Variable Speed Oscillator with Readout	4010217-08
Edit Code Generator	4010166
Edit Code Reader	4010187

Table 1-4. Specifications

<p>Tape Widths:</p> <p>1/4 inch (6.4 mm) for full-track and 2-track, 2-channel systems, 0.075 inch (1.9 mm) track width.</p> <p>1/2 inch (12.7 mm) for 4-track systems, 0.070 (1.8 mm) track width.</p> <p>Tape Speeds:</p> <p>3.75 in/s (9.5 cm/s)</p> <p>7.5 in/s (19.05 cm/s)</p> <p>15 in/s (38.1 cm/s)</p> <p>30 in/s (76.2 cm/s)</p> <p>(any two speeds may be selected)</p> <p>Reel Size:</p> <p>2-inch to 14-inch diameter (50 mm to 355 mm)</p> <p>Reel Type:</p> <p>NAB, EIA (Cine')</p>
--

Table 1-4. Specifications (Continued)

Inputs (With Input/Output System — Bridging Input Standard):

Balanced, floating

Input impedance:

50 kilohms, resistive $\pm 5.0\%$, 5 Hz — 20 kHz

Input level (variable):

Minimum: -5 dBm, to produce 1,000 nWb/m record flux level

Maximum: +40 dBm

Input clip level, including record amplifier at mid-frequency:

26 dB above system operating level.

Input level (preset):

-1 dBm to +20 dBm to produce 1,000 nWb/m recorded flux level

Outputs (With Input/Output System):

Balanced, floating

Output impedance:

<50 ohms, 5 Hz — 20 kHz

Maximum output level:

With 600-ohm load: +28 dBm

With 200-ohm load: +25 dBm

Preset output level:

Line output level is adjustable over a range of +12 dBm to -2 dBm

Metering:

Meters are switchable, vu or peak

VU ballistics conform to ASA standards

Peak ballistics conform to EBU standards

Zero meter reading is continuously adjustable over a range of

+12 dBm to -2 dBm line level

Inputs (Without Input/Output System):

Unbalanced

Input impedance:

10 kilohms, minimum, 5 Hz — 20 kHz

Input level:

-5 dBm, nominal, for system operating level

(-5 dBm input level provides 26-dB clip level margin at mid-frequency)

Outputs (Without Input/Output System):

Unbalanced

Output impedance:

40 ohms, 5 Hz — 20 kHz

Minimum load impedance:

5 kilohms

Output level:

-5 dBm, nominal, for system operating level

(-5-dBm output level provides 26-dB clip level margin at mid-frequency)

Equalization:

Any two speeds of the four available are jumper selectable. These two speeds are then automatically switched with transport speed switch. Each speed selected provides equalization adjustable over the range of AES/NAB/IEC/CCIR standards.

Overall Frequency Response:

Speed	Ref. Freq.	Within ± 0.75 dB	Within ± 2.00 dB	REFERENCE LEVEL* (0 is operating level)
30 in/s (76.2 cm/s)	1 kHz	200 Hz — 20 kHz	35 Hz — 28 kHz	0
15 in/s (38.1 cm/s)	1 kHz	100 Hz — 15 kHz	20 Hz — 20 kHz	0
7.5 in/s (19.05 cm/s)	500 Hz	100 Hz — 10 kHz	30 Hz — 15 kHz	-10 dB
3.75 in/s (9.52 cm/s)	500 Hz	—	30 Hz — 10 kHz	-20 dB

*Operating level is 370 nWb/m at 700 Hz for Ampex 456 tape, and 260 nWb/m at 700 Hz for Ampex 406/407 tape.

Table 1-4. Specifications (Continued)

Signal-to-Noise Ratio:

Overall signal to noise ratio at 7.5 – 30 in/s is measured with respect to a record level of 1040 nWb/m (9 dB above an operating level of 370 nWb/m) when using Ampex 456 tape or direct equivalent. At 1040 nWb/m mid-frequency, third harmonic distortion is less than 3%.

Tape Speed and Equalization	Track Format	30 Hz – 18 kHz Unweighted	ANSI "A" Weighted	IEC/CCIR Rec 468 Weighted
30 in/s AES	Full track	77 dB	81 dB	73 dB
	2 track & 4 track	72 dB	76 dB	67 dB
15 in/s IEC/CCIR	Full track	74 dB	78 dB	70 dB
	2 track & 4 track	70 dB	74 dB	65 dB
15 in/s (38.1 cm/s) NAB	Full track	73 dB	77 dB	69 dB
	2 track & 4 track	69 dB	73 dB	63 dB
7.5 in/s (19.05 cm/s) NAB	Full track	75 dB	78 dB	70 dB
	2 track & 4 track	71 dB	74 dB	63 dB
7.5 in/s (19.05 cm/s) IEC/CCIR	Full track	71 dB	76 dB	67 dB
	2 track & 4 track	68 dB	71 dB	62 dB
*3.75 in/s (9.52 cm/s) IEC/NAB	Full track	68 dB	72 dB	64 dB
	2 track & 4 track	64 dB	66 dB	57 dB

*At 3.75 in/s, overall signal-to-noise ratio is measured with respect to a record level of 740 nWb/m (6 dB above operating level of 370 nWb/m). At 740 nWb/m, mid-frequency, third harmonic distortion is less than 3%.

System Distortion:**Electronics Distortion:**

System electronics distortion, including record amplifier, reproduce amplifier and Input/Output system, at any operating level up to 20 dB above operating level at mid-frequency is <0.03% total harmonic distortion and <0.05% SMPTE intermodulation distortion.

Overall record/reproduce distortion
(using Ampex 456 tape or direct
equivalent):

At system operating level (0 vu = 370 nWb/m; 6 dB above 185 nWb/m)

Even Order Distortion:

Even order distortion of a 1-kHz signal recorded at 370 nWb/m is less than 0.1%.

7.5 in/s - 30 in/s:

Third Harmonic Distortion at 1 kHz: <0.3% at recorded flux level of 370 nWb/m (0 vu)
<3.0% at recorded flux level of 1040 nWb/m (+9 vu)
SMPTE Intermodulation Distortion: <1.0% at recorded flux level of 370 nWb/m (0 vu)

3.75 in/s

Third Harmonic Distortion at 500 Hz: <0.5% at recorded flux level of 370 nWb/m (0 vu)
<3.0% at recorded flux level of 740 nWb/m (+6 vu)
SMPTE Intermodulation Distortion: <2.0% at recorded flux level of 370 nWb/m (0 vu)

Table 1-4. Specifications (Continued)

Crosstalk:

Crosstalk is measured by simultaneously placing the channel under test, and an adjacent channel in-record mode. The adjacent channel is fed with an operating level signal, the channel under test has its input shorted. The residual signal on the reproduced output of the channel under test relative to operating level, is less than 45 dB, 100 Hz — 15 kHz at 15 in/s for 2-track.

Erase Depth:

Using Ampex 456 tape or direct equivalent at any wavelength shorter than 75 mils (200 Hz @ 15 in/s) recorded 6 dB above system operating level: 85 dB minimum

Erase Frequency: 144 kHz

Bias Frequency: 432 kHz

(Both bias and erase frequencies are derived from master crystal oscillator)

Speed Accuracy:

(Using 1.0 — 1.5-mil base film thickness tape)

Absolute speed accuracy: $\pm 0.03\%$

Speed variation from beginning to end of reel: 0.02% maximum

Flutter and Wow:

Speed	ANSI S 4.3/DIN 45507 Peak Weighted	ANSI/DIN Peak Unweighted	NAB RMS Unweighted
3.75 in/s (9.52 cm/s)	$\pm 0.1\%$	$\pm 0.15\%$	0.1%
7.5 in/s (19.05 cm/s)	$\pm 0.05\%$	$\pm 0.12\%$	0.06%
15 in/s (38.1 cm/s)	$\pm 0.03\%$	$\pm 0.08\%$	0.04%
30 in/s (76.2 cm/s)	$\pm 0.03\%$	$\pm 0.08\%$	0.03%

Start Time:

Speed	Time to attain flutter specification
3.75 in/s	150 ms
7.5 in/s	200 ms
15 in/s	300 ms
30 in/s	500 ms

Stop Time:

5.0 seconds from fast wind modes

2.0 seconds from spooling mode

0.7 second maximum from play mode (30 in/s, 76.2 cm/s)

Rewind Time:

Normal fast wind modes: 60 seconds for 2400-foot (731.52 m) reel

Spooling modes, for 2400-foot (731.52 m) reel: 180 in/s (457.2 cm/s) — 2.7 minutes

60 in/s (152.4 cm/s) — 8.0 minutes

Electronic Tape Timer:

Tape driven; reads in hours, minutes and seconds (option: minutes, seconds and tenths of seconds)

Absolute accuracy: $\pm 0.05\%$ [1 second in 2400-foot (731.52 m) reel at 15 in/s (38.1 cm/s)]

Table 1-4. Specifications (Continued)

Heads:

Ferrite, precision mounted

Full track: 1/4-inch (6.4 mm)

2-track: 1/4-inch (6.4 mm)

4-track: 1/2-inch (12.7 mm)

Size:

Basic machine (including transport, power supply and audio and servo electronics): 19 inches (48.26 cm) wide x 15.72 inches (39.93 cm) high x 12 inches (30.48 cm) deep

Cabinet (1 or 2 channel): 21 inches (53.34 cm) wide x 19 inches (48.26 cm) high x 32 inches (81.28 cm) deep

Cabinet (4 channel): 21 inches (53.34 cm) wide x 23 inches (58.42 cm) high x 34 inches (86.36 cm) deep

Input/Output system (1 or 2 channel): 19 inches (48.26 cm) wide x 3-1/2 inches (8.89 cm) high x 10 inches (25.4 cm) deep

Complete system (including basic machine, 4-channel cabinet, Input/Output system and roll-around pedestal): 26 inches (66.04 cm) wide x 46-1/2 inches (118.11 cm) high x 34 inches (86.36 cm) deep

Weight:

Basic machine: 125 lbs (56 kg)

Cabinet: 15 lbs (7 kg)

Input/Output system (2 channel): 15 lbs (7 kg)

Pedestal: 50 lbs (23 kg)

Power Line Requirements:

90-115, 110-135, 180-230, 220-270 Vac, 50/60 Hz

Power Consumption:

0.6 kVA maximum (with all accessories)

Environmental Operating Specifications:

Temperature: 10° – 50°C (50° – 122°F)

Humidity: 20 – 95%, non-condensing

SECTION 2

INSTALLATION

This section of the manual provides information about unpacking and inspection; choosing the installation site; mounting configurations; equipment connectors and cabling; remote control installation; and initial adjustments including turntable and control unit relocation, spool speed selection, play/edit mode operation lockout, record mode operation lockout, tape timer display selection, and PURC operation selection. Also included is an initial checkout procedure, a discussion of the recorder/reproducer factory-shipped operational configuration, and a procedure for checking operating level.

2-1. UNPACKING AND INSPECTION

The ATR-100 series system is shipped in a specially constructed packing case to protect the equipment during transit. When unpacking the unit, use caution to avoid damage to the recorder finish or accessory parts. Remove all material used to secure certain components during shipment. Check the contents of the packing case and packing materials against the packing list to make sure the shipment is complete. Save the packing case and packing materials for shipment of the equipment to another location.

Carefully examine the contents for damage that may have occurred during shipment. Notify the carrier and the local Ampex representative of any shortage or damage.

2-2. INSTALLATION SITE

The area chosen for operation of the recorder/reproducer should be adequately ventilated and free of vibration. Surrounding air should be dust

free with a temperature range within 60° to 105° Fahrenheit (15.6° to 40.5° Centigrade) and humidity within 50 to 90% (non condensing). The area should not be close to any strong electromagnetic fields. Common sources of interference are fluctuating loads on nearby high current lines, heavy-duty transformers, elevator motors, and radio and television transmitting equipment.

When mounting the equipment, allow sufficient space at the top, bottom, and rear of the unit to permit a flow of cooling air.

2-3. MOUNTING THE RECORDER/REPRODUCER

Use these instructions for mounting the recorder in one of the following configurations: console mount, console mounted on a pedestal, fixed rack mount, and slide-rack mount. Mounting dimensions for rack-mount installation are shown in Figure 2-1.

2-4. Cabinet Mount

In the cabinet mount configuration, the recorder/reproducer transport and electronics are mounted in a cabinet that can be placed on any firm flat surface. To mount the recorder/reproducer in a cabinet, proceed as follows:

NOTE

Prior to mounting the recorder/reproducer in a cabinet, perform any desired *Initial Adjustment* procedures (paragraph 2-21), and perform the *Checking Cables and Components* procedure (paragraph 2-11).

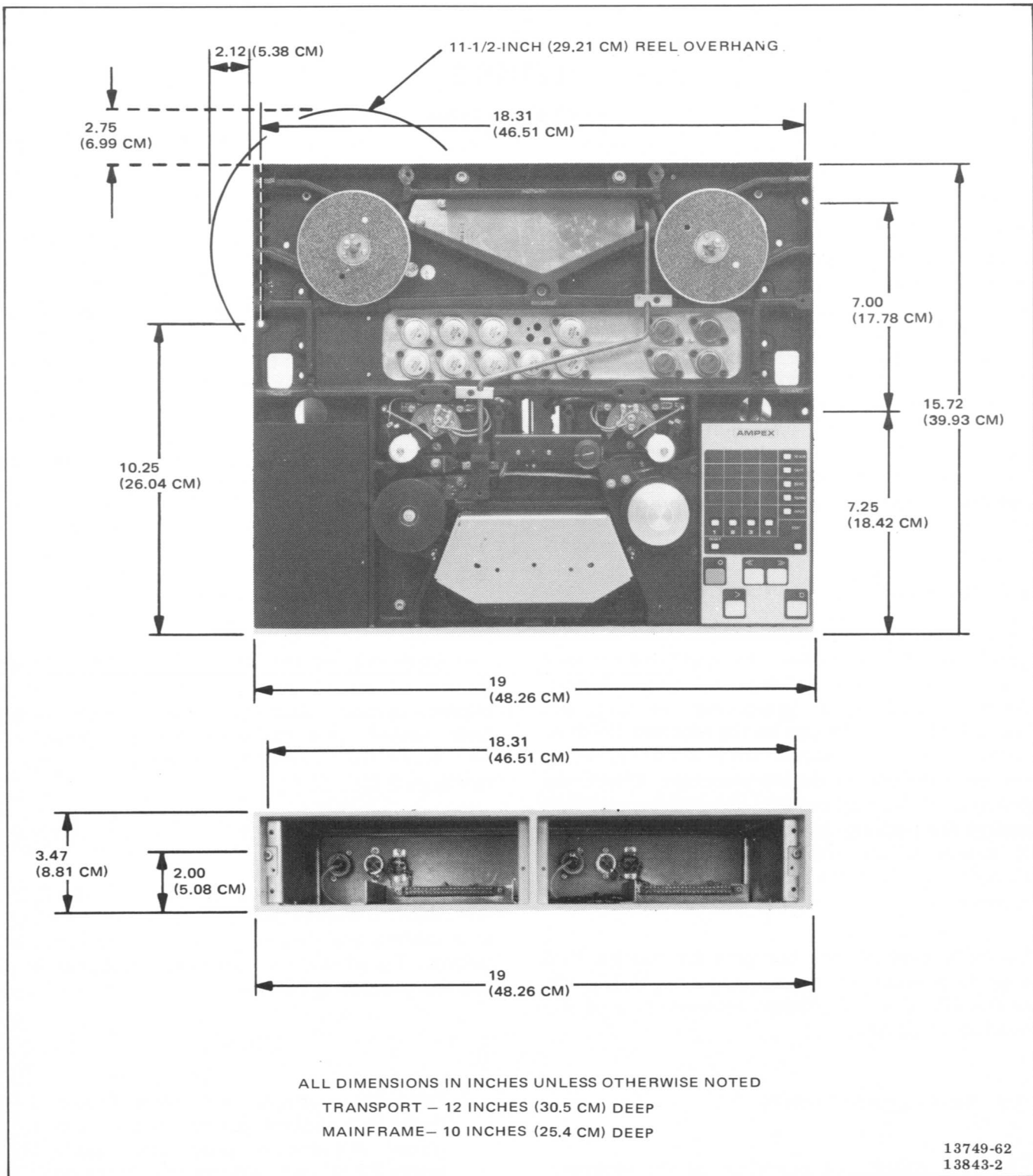


Figure 2-1. Mounting Dimensions

1. At the top of the transport, remove the rear overlay panel (six screws) shown in Figure 2-2.
2. Locate the three transport mounting holes (0.257-inch in diameter) shown in Figure 2-3.
3. For ease of recorder/reproducer installation, remove the front extrusion assembly (arm rest) from cabinet by removing two screws.
4. Mount the transport into the cabinet using three 10-32 socket head screws provided with the cabinet.
5. Connect cabinet fan connector P20 to power supply connector P20.
6. Reinstall rear overlay panel (six screws).
7. Reinstall arm rest (two screws).

2-5. Cabinet Mounted on a Pedestal

In the cabinet mounted on a pedestal configuration, the cabinet is mounted on a pedestal (Figure 2-4) that permits the cabinet to be rotated and placed in any one of five fixed operating positions, or rotated to any desired position for servicing. Proceed as follows:

1. Refer to Figure 2-5 and assemble pedestal as follows:
 - a. Fasten each weldment to the panel assembly using three 1/4-20 \times 1/2 inch long cap-head hex socket screws, 1/4 split lock washers and 1/4 plain washers. (Place lock washer between screw and flat washer.)

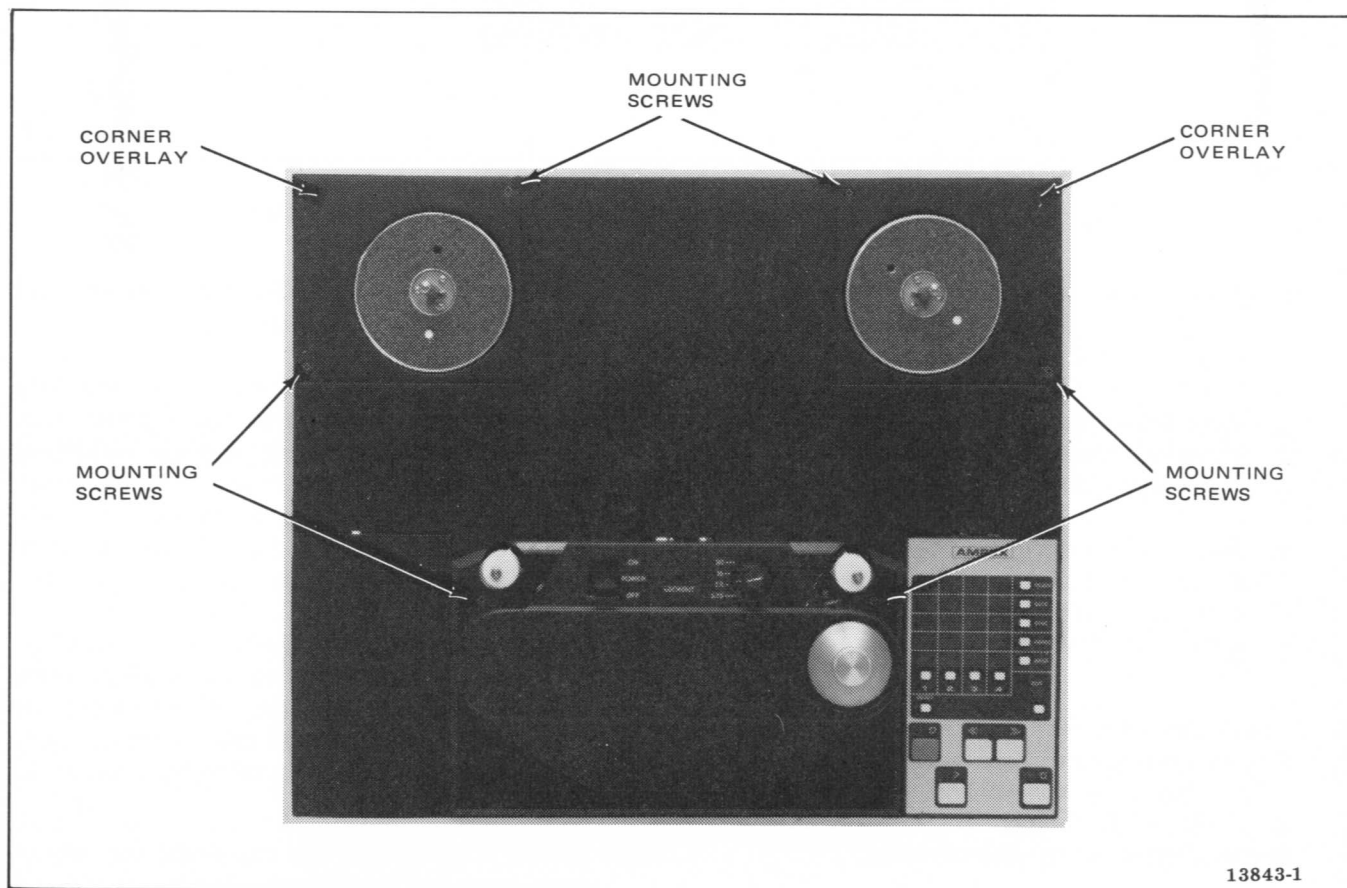


Figure 2-2. Rear Overlay Panel, Six Mounting Screws

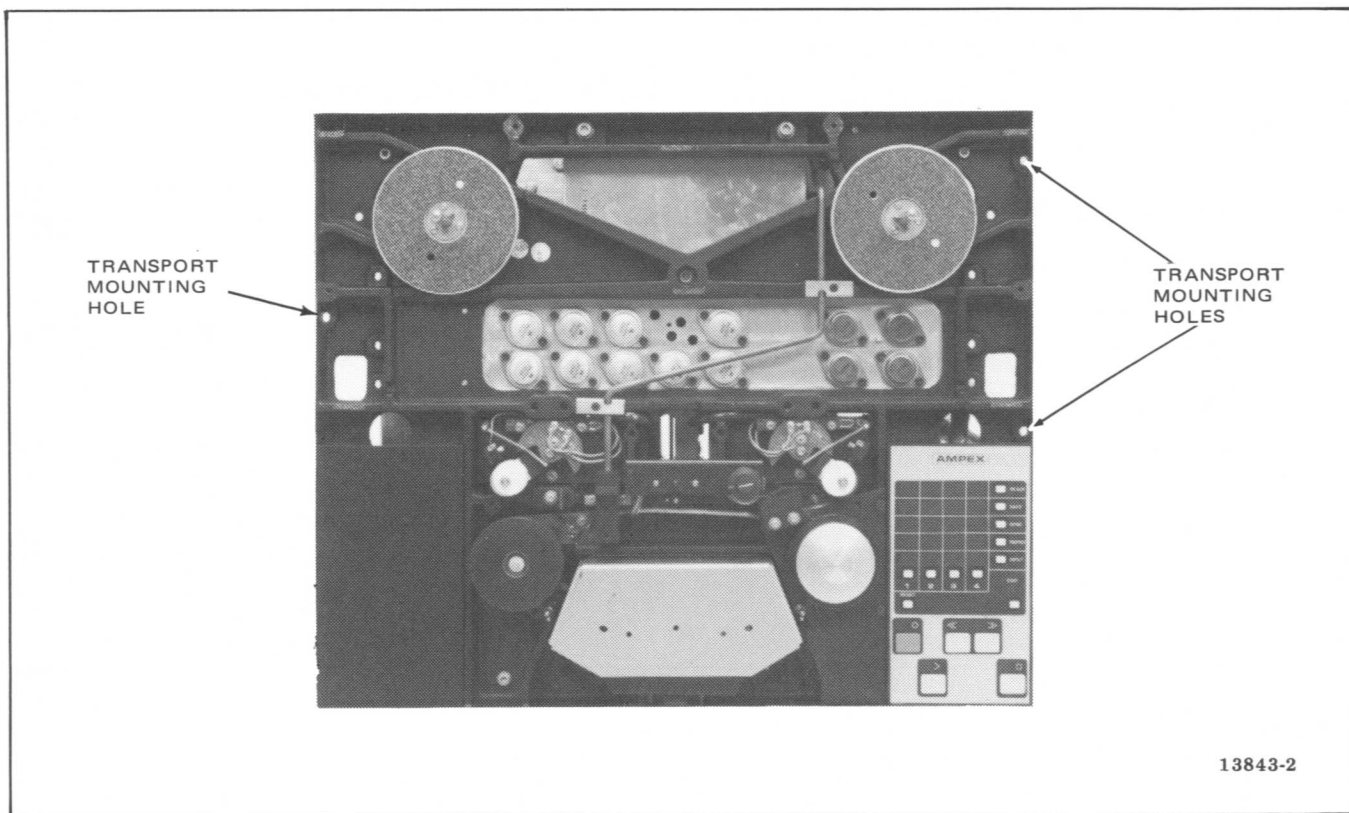


Figure 2-3. Cabinet and Fixed-Rack Mount Transport-Mounting Holes

- b. Install two swivel castors with brakes (front) and two swivel castors without brakes (rear) as shown in Figure 2-5. Castors are installed by screwing the threaded stud of the castor into the threaded insert at the bottom of the pedestal weldment.
- c. Install a trim strip on the outside surface of each pedestal weldment. Secure each trim strip with two 10-32 \times 1/2 inch long button-head hex-socket screws.
2. Install a pivot plate to each side of the cabinet. Secure each pivot plate with two 1/4-20 \times 1-1/4 inch long screws and two 5/8 OD \times 9/32 ID \times 1/16 inch thick plain washers (factory attached to cabinet sides).
3. With the pedestal in an upright position and castors with brakes in the front position, have two people (one in front and one in back) lower cabinet onto pedestal.
4. Install (finger tight) a 1/4-20 \times 1 inch long cap-head hex-socket screw into pivot lock boss on the side of each pedestal weldment (boss extends through hole in trim strip). This screw is used to lock the cabinet pivot plate to any one of five fixed positions; each position is 10 degrees apart.
5. Install a knob and a 0.562 ID \times 1.12 OD plain nylon washer onto each pivot plate stud. The knobs are used to secure cabinet in place on pedestal (and are also convenient handles for pushing the pedestal around on its castor wheels).
6. Install a decorative top cap onto the top of each pedestal weldment. Secure each top cap with two 6-32 \times 0.375 button-head hex-socket screws.



Figure 2-4. Cabinet Mounted on a Pedestal

2-6. Fixed-Rack Mount

In the fixed-rack configuration (Figure 2-6), the electronics assembly chassis is separated from the transport and is mounted directly beneath the transport so that the printed wiring assemblies (PWAs) face forward toward the operator. This equipment is mounted in a standard 19-inch rack or in a custom cabinet as follows:

1. At the top of the transport, remove the rear overlay panel (six screws) shown in Figure 2-2.
2. Locate the three transport mounting holes (Figure 2-3) that are used to mount the transport.
3. Mount the transport onto the rack or custom cabinet using three appropriate size screws, depending on the type of rack or cabinet.
4. Mount the electronics frame furnished in the fixed-rack mount kit directly beneath the transport using four appropriate-size screws, depending on the type of rack or cabinet.
5. Remove the front cover from the electronics assembly and remove all PWAs from the inside of the assembly.

CAUTION

FOR THE FOLLOWING STEPS, DO NOT PUT EXCESSIVE STRAIN ON CABLES OR CONNECTORS. CLIP CABLE TIE DOWNS AS REQUIRED.

6. From the inside of the electronics assembly chassis, remove three 6-32 screws that secure the head cable assembly to the electronics chassis.
7. Carefully unhook electronics assembly chassis, from transport and rotate chassis so that interior of chassis faces forward. Slide chassis into flanges of electronics frame.
8. Secure electronics assembly chassis to electronics frame with four 6-32 screws and a lockwasher under screw head.

9. Reinstall PWAs removed in step 6.

2-7. Slide Rack Mount

In the slide-rack mount configuration (Figure 1-9), the recorder/reproducer is mounted on a pair of slides (Figure 2-7) that are attached to a 19-inch (48.26 cm) rack that has both front and rear rack-mounting members. When installed, the recorder/reproducer may be pulled forward on the slides and rotated 90° upward to permit easy access to the PWAs within the electronics assembly. The slides enable the transport to be extended far enough from the rack to permit 90° rotation of the transport when 14-inch (35.56 cm) reels are mounted on the transport.

WARNING

THE RACK USED TO MOUNT THE RECORDER/REPRODUCER MUST BE SECURELY FASTENED TO THE RACK MOUNTING SURFACE TO PREVENT THE RACK FROM TIPPING FORWARD WHEN THE RECORDER/REPRODUCER IS EXTENDED FORWARD.

All parts and hardware for mounting the recorder/reproducer are furnished in the slide-rack mount kit, Ampex Part No. 4010253. Mount the disassembled slide-rack mount kit parts as follows:

1. At the top of the transport, remove the rear overlay panel (six screws shown in Figure 2-2).
2. Locate the six transport mounting holes (Figure 2-8) that are used to mount the transport to the pivot bracket.
3. Fasten each pivot bracket to the rear of the transport using three 10-32 \times 3/4 inch long socket-head screws with a no. 10 split washer under each screw head (do not use flat washers). Note orientation of pivot bracket flange shown in Figure 2-7.
4. If slide-rack mount parts are not separated, press release button on side of inner slide member (Figure 2-7), and remove inner slide member from middle slide member.

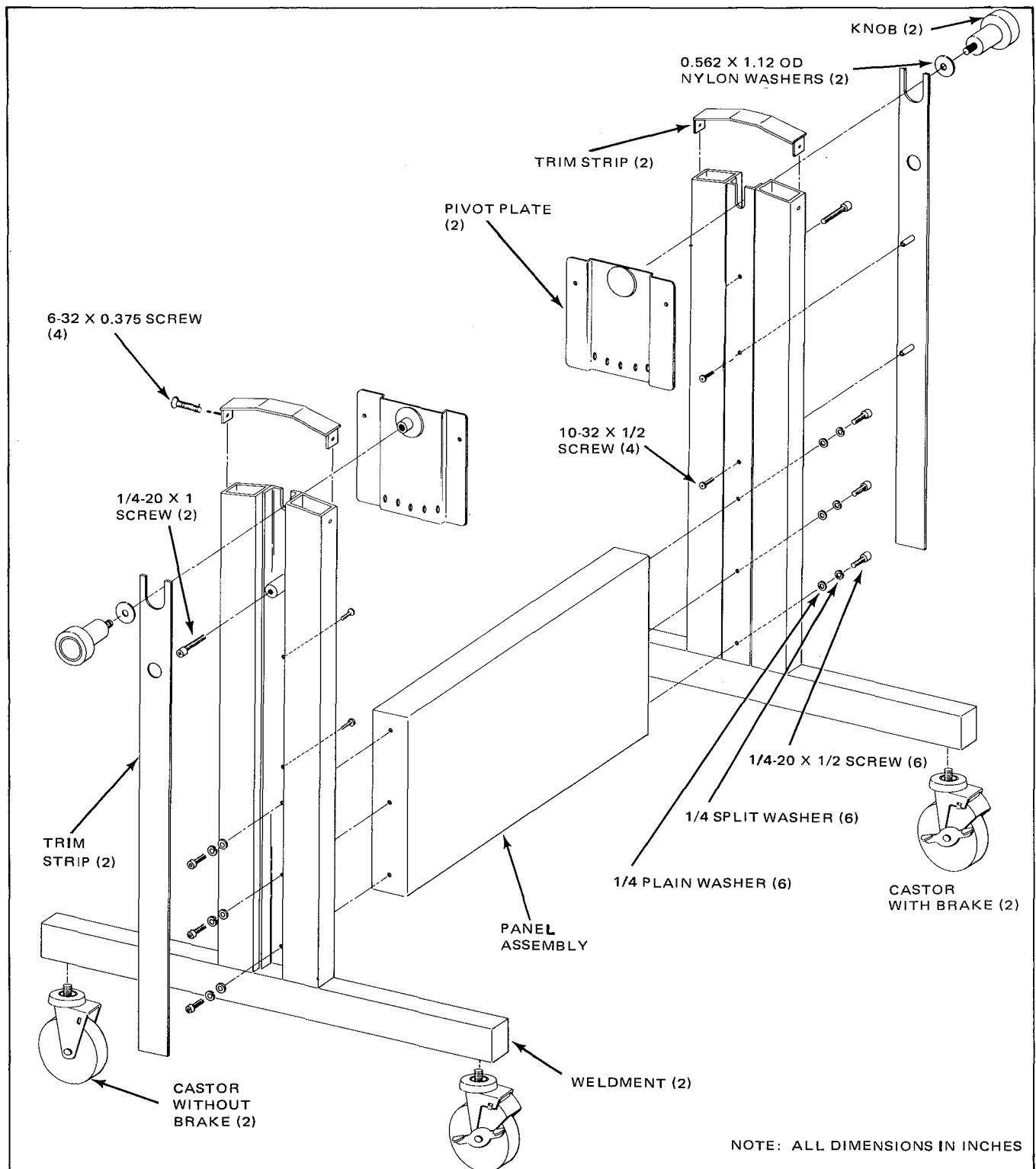


Figure 2-5. Pedestal Assembly, Exploded View

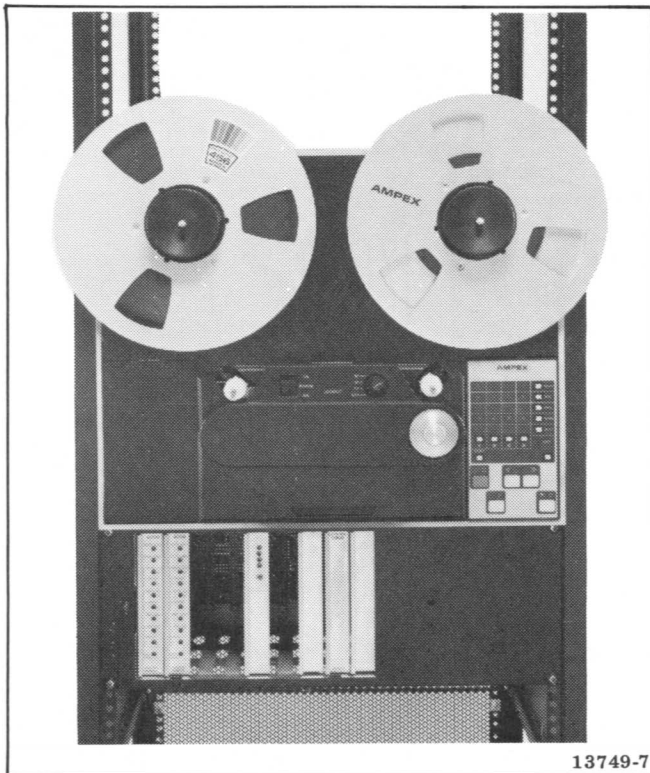


Figure 2-6. Fixed-Rack Mount with Electronics Assembly Cover Panel Removed

5. Attach inner slide member to pivot bracket using two 10-32 X 1/2 inch long flat-head screws and locknuts (nuts have lock washers attached).

NOTE

In the following step, the location of the bar nuts determines the transport vertical position in the 19-inch rack. The transport will extend 4-1/2 inches (11.43 cm) below the lower screw and extend 9-1/2 inches (24.13 cm) above the upper screw.

6. Determine desired vertical mounting location on 19-inch rack. Fasten a threaded bar nut to each front rack-mounting member (Figure 2-9). Orientate the bar nut so that the offset holes in the bar nut are nearest the center of the rack. Use two 10-32 X 1/2 inch long

screws for each bar nut, but do not firmly tighten screws.

7. Mount a threaded bar nut on each rear rack-mounting member (Figure 2-9) in parallel to the bar nuts installed in step 6. Orientate the bar nut so that the offset holes in the bar nut are nearest the center of the rack. Use two 10-32 X 1/2 inch long screws for each bar nut but do not firmly tighten screws.
8. Slide the slotted flange of each outer slide member (Figure 2-7) between the front rack mounting member and the bar nut installed in step 6. Tighten screws.
9. Slide the slotted flange of each rear bracket between the rear rack-mounting member (Figure 2-9) and the bar nut installed in step 7. Tighten screws.
10. Fasten the outer slide member to the rear bracket (as shown in Figure 2-7) using a bar washer, bar nut, and two 10-32 X 1/2 inch long binding-head screws.
11. With two people lifting the transport, insert the inner slide member within the flanges of the middle slide member.
12. Reinstall rear overlay panel removed in step 1.

WARNING

BE CAREFUL NOT TO PINCH FINGERS WHEN SLIDING THE EXTENDED TRANSPORT BACK INTO RACK. ALSO WHEN SLIDES ARE EXTENDED, DO NOT PUSH SLIDE RELEASE BUTTON AND PULL TRANSPORT FORWARD UNLESS IT IS DESIRED TO REMOVE TRANSPORT FROM RACK.

2-8. MOUNTING THE INPUT/OUTPUT MODULE ACCESSORY

Two input/output modules may be mounted side-by-side in an input/output mainframe assembly.

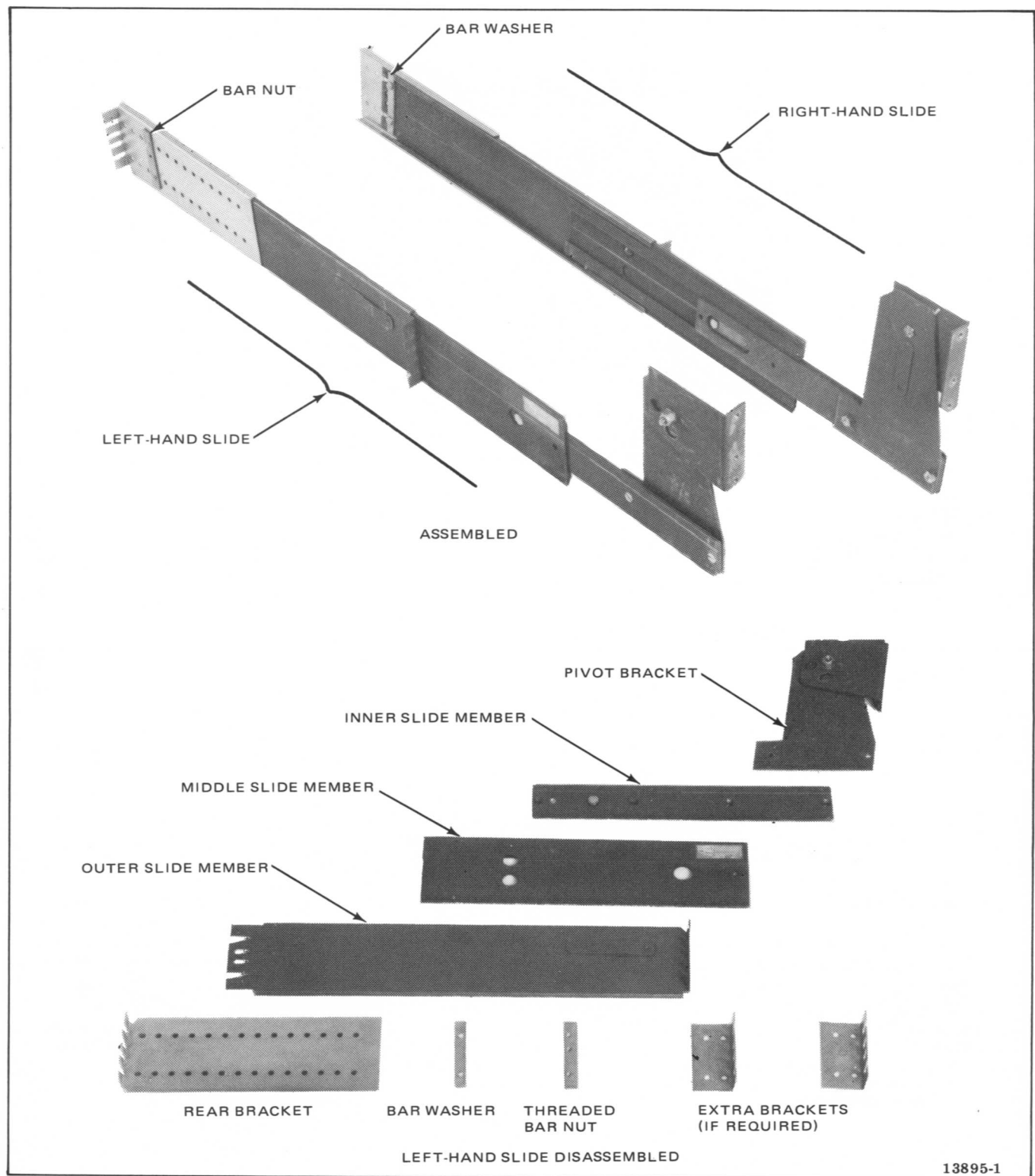


Figure 2-7. Slide Rack Mount Kit

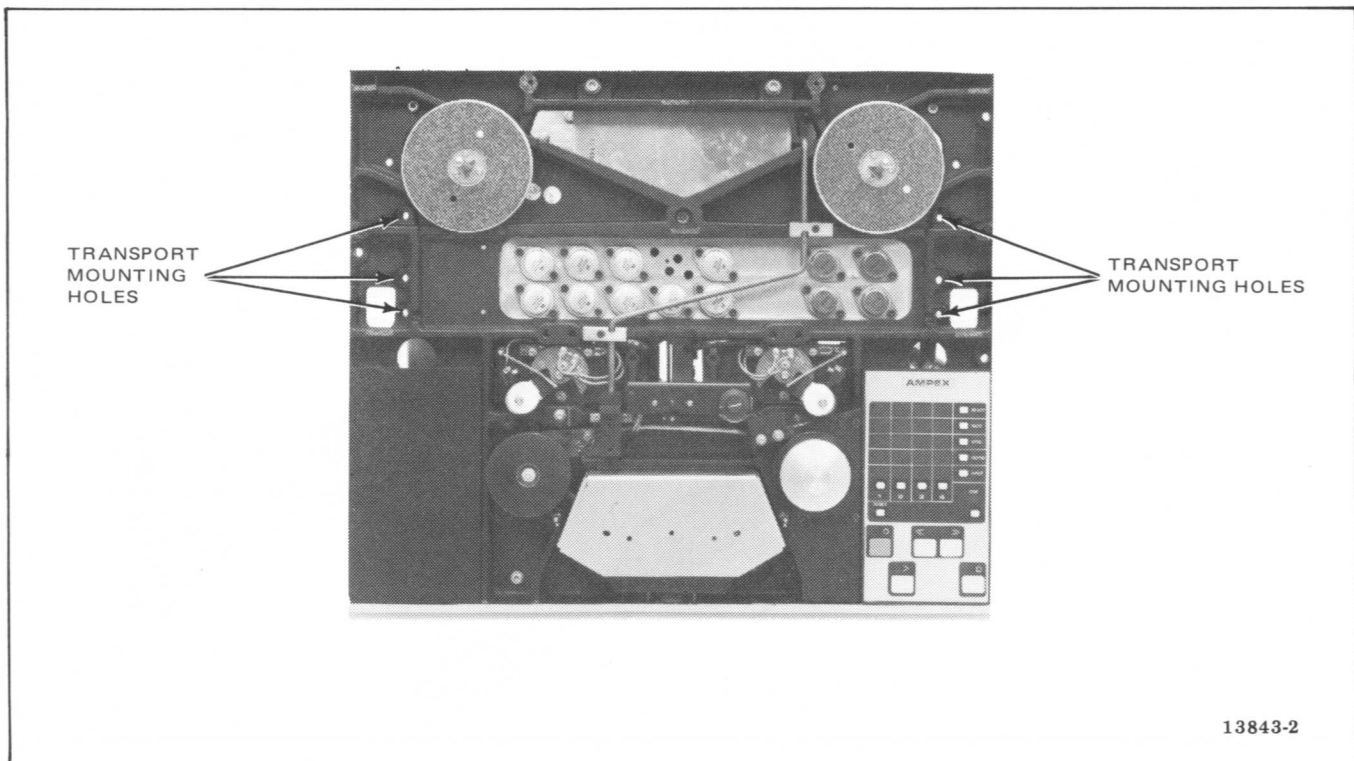


Figure 2-8. Slide-Rack Mount Transport-Mounting Holes

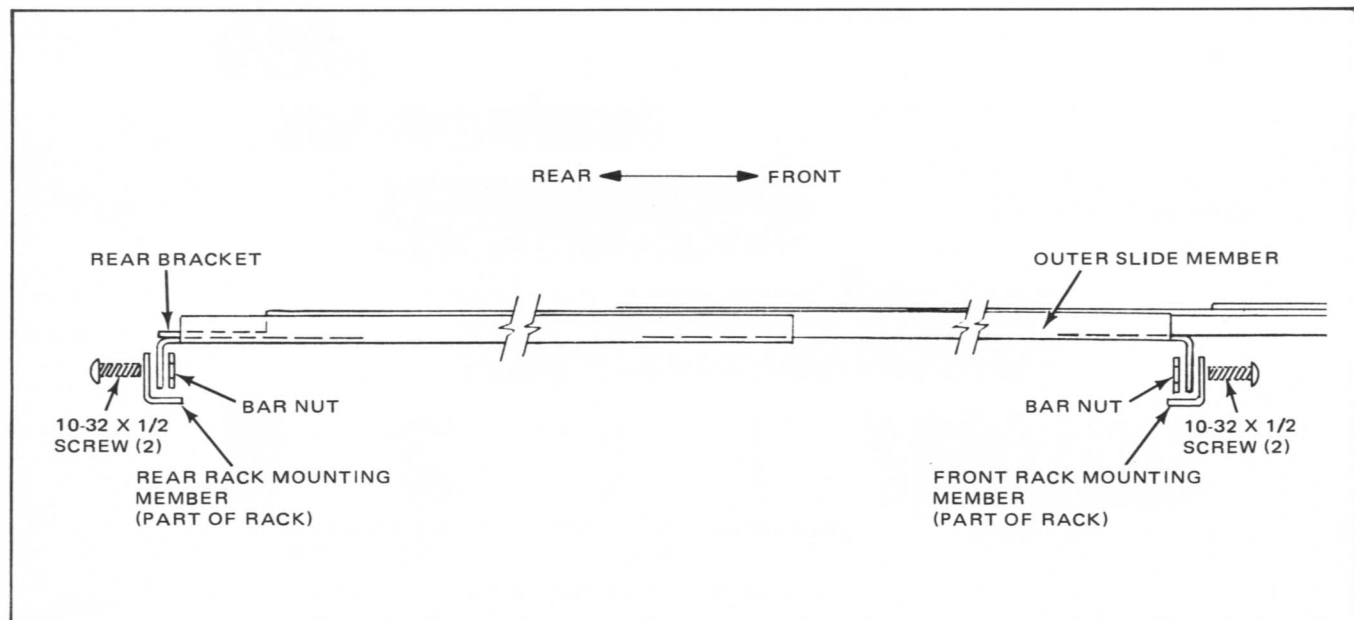


Figure 2-9. Left Hand Slide, Top View

The mainframe assembly may be installed into an enclosure mounted on the recorder/reproducer cabinet, or mounted in a 19-inch (48.26 cm) rack with an accessory top cover. Two mainframes can be mounted vertically to accommodate a four-channel system.

2-9. Cabinet Mount

Proceed as follows:

1. Slide the input/output mainframe assembly into the cabinet enclosure as shown in Figure 2-10.
2. Secure with two 10-32 X 1/2 socket-head screws as shown in Figure 2-10.
3. Slide input/output module(s) into mainframe assembly and secure with captive screw (Figure 2-10).

2-10. Rack Mount

Proceed as follows:

1. Install cover on top of input/output mainframe assembly using nine screws supplied in cover kit (Ampex Part No. 4020428).
2. Mount the input/output mainframe assembly on a standard 19-inch rack or in a custom cabinet using two appropriate-size screws, depending on the type of rack or cabinet.
3. Slide input/output module(s) into mainframe assembly and secure with captive screw(s) shown in Figure 2-10.

2-11. CHECKING CABLES AND COMPONENTS

Connectors on the recorder/reproducer are shown on the electronic wiring diagram 4840422 and on the transport interconnect wiring diagram 4840423. Before attempting to operate the recorder/reproducer, check the following cables and components for security and proper installation. (Note: Connectors that are mounted on a cable or harness are identified as "P". Connectors that are fixed to a chassis are identified as "J".)

1. Control unit connector P11 to electronics assembly connector J11.
2. Reel-drive connector P15 to electronics assembly harness connector P15.
3. Tach sensors connector J16 to electronics assembly harness connector P16.
4. Transport harness connector P1 to J1 on power supply.
5. Transport harness connector P2 to J2 on power supply.
6. Transport harness connector P17 to takeup motor connector P17.
7. Transport harness connector P19 to supply motor connector P19.
8. Transport harness connector P18 to capstan motor connector P18.
9. Fan connector P20 to transport harness connector P20 (if applicable).

2-12. CONNECTING AC POWER

Main ac power is connected to the recorder/reproducer through a captive power cable equipped with a standard 120-volt 3-pin connector. The captive power cable is attached to a power switch bracket mounted on the power supply (Figure 2-11). The main power transformer has various taps that permit the recorder/reproducer to use one of four input voltage ranges: 90-115, 110-135, 180-230, and 220-270 Vac, 50 or 60 Hz.

A jumper plug and socket arrangement (Figure 2-12) accessible inside the power supply, adapts the recorder/reproducer for the various input voltages. The jumpers are factory-set to 110-135 Vac unless specified otherwise on the sales order. However, the line voltage should be measured and, if required, the jumpers reset to correspond to the line voltage. Table 2-1 lists the various voltages and the corresponding jumper-plug position.

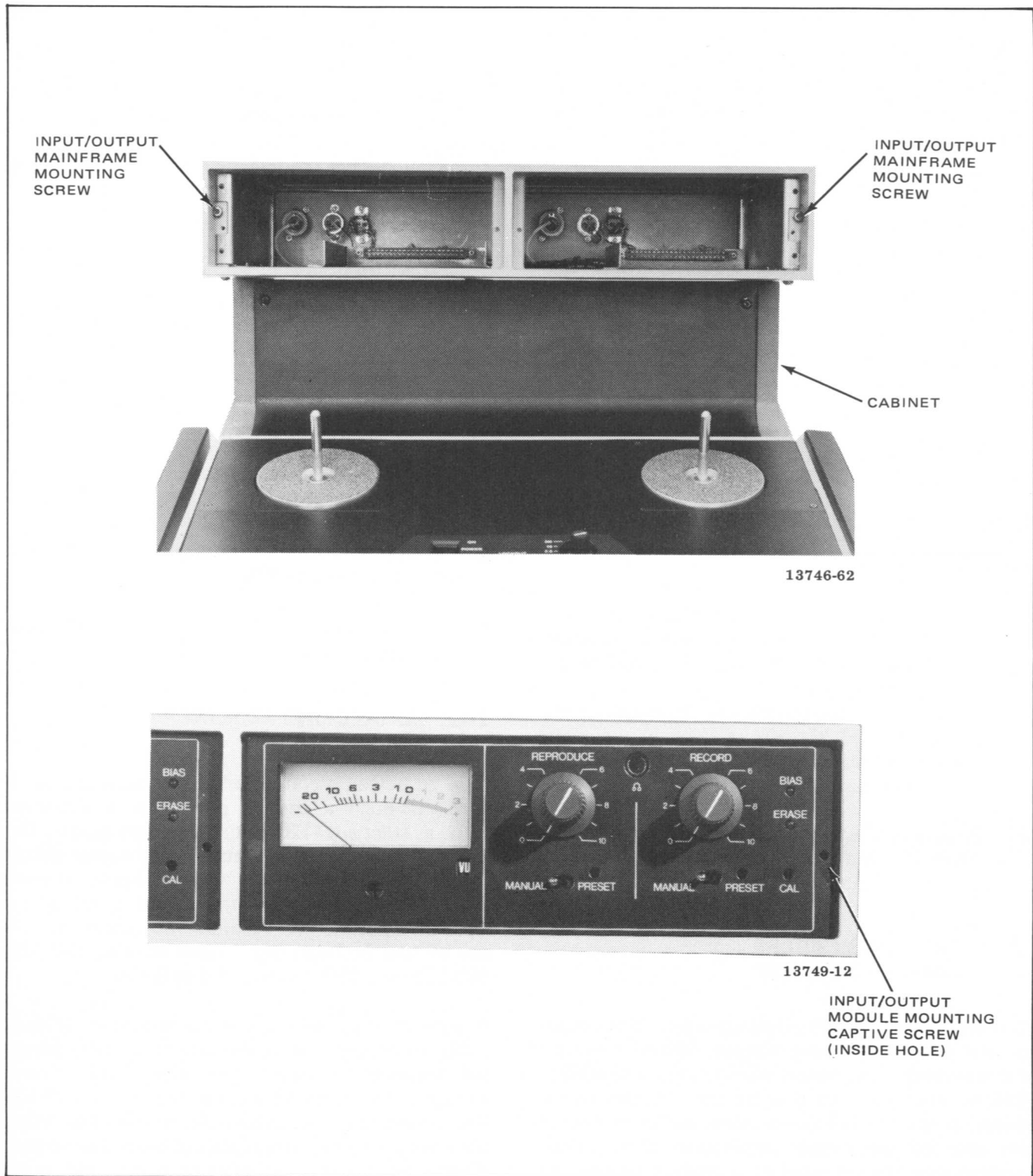


Figure 2-10. Input/Output Assembly Mounting

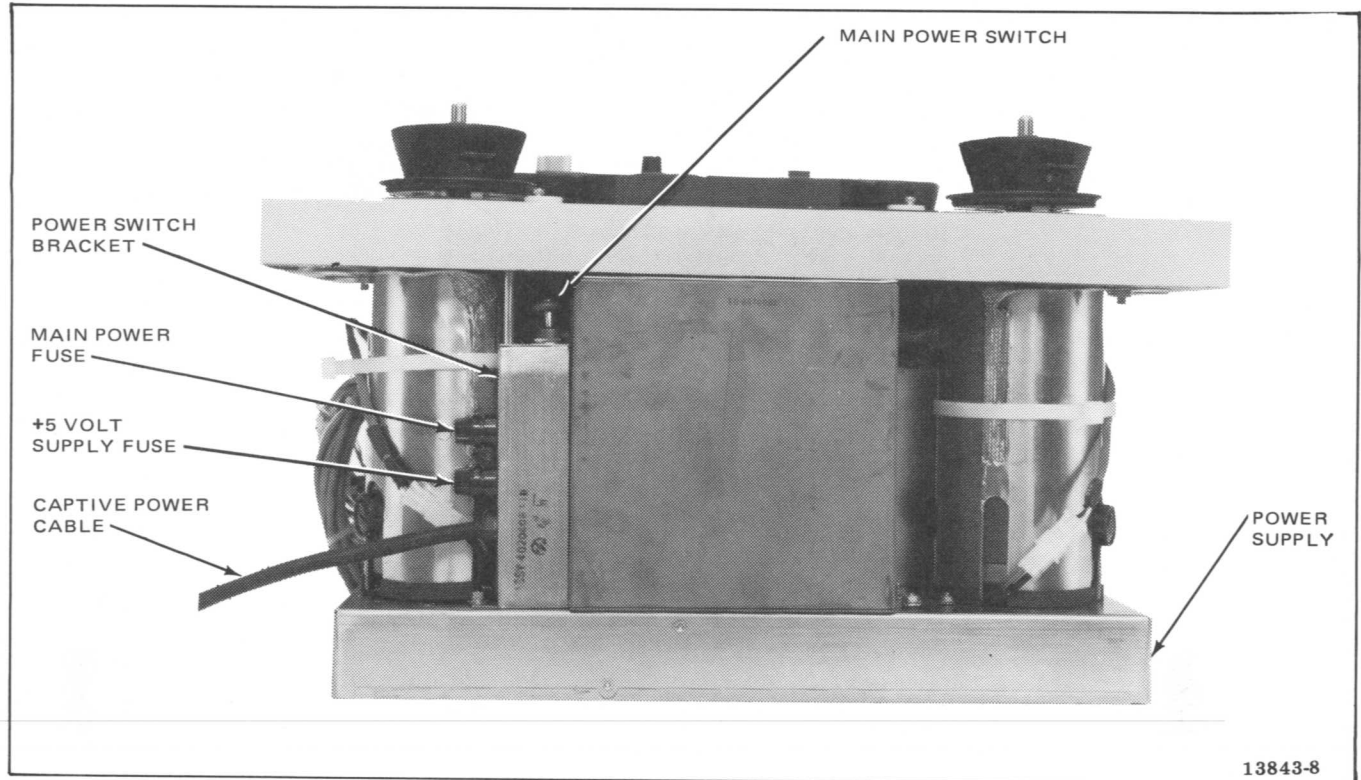


Figure 2-11. Recorder/Reproducer, Rear View

To change jumper plug positions, proceed as follows:

1. At the bottom side of the recorder/reproducer, loosen the four power supply cover screws and remove the cover to gain access to the power jumper socket (Figure 2-12).

CAUTION

WHEN INSTALLING POWER JUMPERS, MAKE CERTAIN THAT THE 3-PIN POWER JUMPER DOES NOT MATE WITH PIN LOCATIONS 1, 2, OR 3 ON JUMPER SOCKET. ONLY THE 4-PIN POWER JUMPER MATES WITH PIN LOCATIONS 1, 2 OR 3.

2. Refer to Table 2-1 and install the three- and four-pin jumper plugs corresponding to the supplied ac line voltage. Note that both jumper plugs are installed vertically in column A, B, or C.

3. Replace power supply cover and secure with four screws.

2-13. AUDIO SIGNAL CONNECTIONS

Audio signal input and output connectors are located on the basic recorder/reproducer and on the input/output assembly (accessory). All audio signal input and output connections to the basic recorder/reproducer are unbalanced line. If an input/output assembly is being used, the audio signal input and output connections may be either balanced or unbalanced line. Audio signal input and output connector wiring instructions for the basic recorder/reproducer and for the input/output assembly are given in the test that follows.

2-14. Recorder/Reproducer Input/Output Connectors

The audio signal input and output connectors (J13 and J14) on the recorder/reproducer are

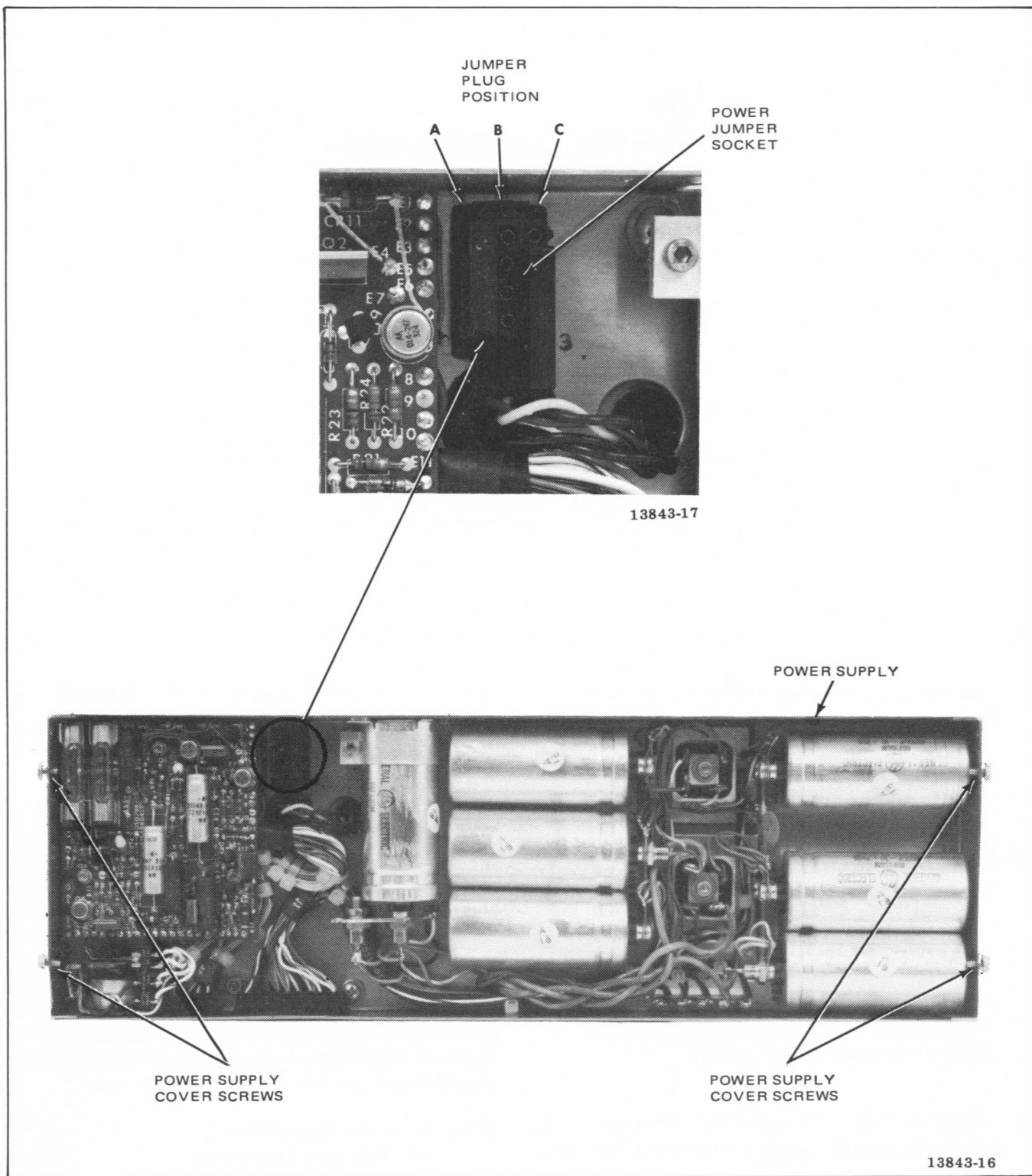


Figure 2-12. Main Power Jumper Location

Table 2-1. Power Jumper Positions

AC LINE VOLTAGE	JUMPER/COLUMN POSITION		
	A	B	C
90-115	4 PIN	3 PIN	
110-135	4 PIN		3 PIN
180-230	3 PIN	4 PIN	
220-270	3 PIN		4 PIN

COLUMN/PIN NUMBERS

A	B	C
3	2	1
6	5	4
9	8	7
12	11	10

POWER JUMPER SOCKET

located at the bottom of the electronics assembly (Figure 2-13). All signal input and output connections for channels 1 and 2 are made to J13, and connections for channels 3 and 4 are made to J14. Use 24-pin Amphenol connectors (Ampex Part No. 139-840) furnished with the recorder/reproducer. Tables 2-2 and 2-3 provide a description of all the connector pin signals. All audio signal input and output connections are wired for unbalanced line. (For balanced input, see wiring instructions in paragraph 2-17.)

2-15. Input-Connector Wiring. Use single-conductor shielded cable. Wire connectors J13 and J14 as follows:

- Channel 1 — connect center conductor to pin 1 and shield to pin 13 of J13.
- Channel 2 — connect center conductor to pin 2 and shield to pin 14 of J13.
- Channel 3 — connect center conductor to pin 1 and shield to pin 13 of J14.

Channel 4 — connect center conductor to pin 2 and shield to pin 14 of J14.

2-16. Output-Connector Wiring. Use single-conductor shielded cable. Wire connectors J13 and J14 as follows:

- Channel 1 — connect center conductor to pin 11 and shield to pin 23 of J13.
- Channel 2 — connect center conductor to pin 12 and shield to pin 24 of J13.
- Channel 3 — connect center conductor to pin 11 and shield to pin 23 of J14.
- Channel 4 — connect center conductor to pin 12 and shield to pin 24 of J14.

2-17. Input/Output Assembly Connectors

The audio signal input and output connectors (J1 through J4) on the input/output assembly are located at the rear of the input/output assembly (Figure 2-14). These connectors permit either balanced or unbalanced line inputs and outputs of the recorder/reproducer depending how the connectors are wired. The connectors are standard three-conductor XLR type. Female contact connectors are used for the input signals and male contact connectors are used for output signals. The mating connectors are supplied with the input/output assembly.

The input/output assembly is connected to the recorder/reproducer by means of a captive cable attached to the input/output assembly. Connect this cable to J13 for channels 1 and 2, and to J14 for channels 3 and 4. To wire the mating plugs, refer to Figure 2-15 and proceed as follows.

2-18. Input-Connector Wiring. For balanced inputs, wire male contact XLR connector as follows:

1. Connect signal leads of two-conductor shielded cable to pin 3 (high) and pin 2 (low) of connector.
2. Connect cable shield to pin 1.

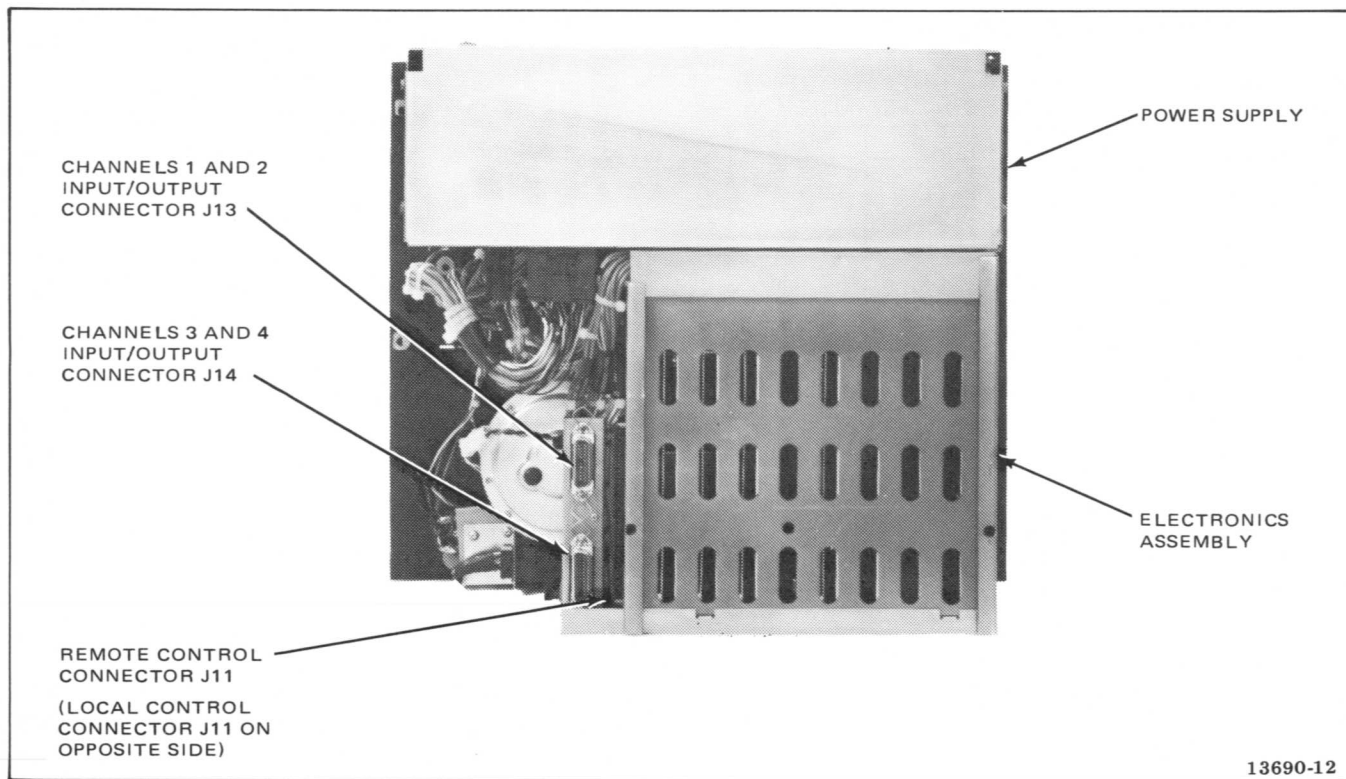


Figure 2-13. Connector Locations, Bottom View of Recorder/Reproducer

For unbalanced inputs, wire male contact XLR connector as follows:

1. Connect center conductor of single-conductor shielded cable to pin 3 of connector.
2. Connect cable shield to pins 2 and 1.

2-19. Output-Connector Wiring. For balanced outputs, wire female contact XLR connector as follows:

1. Connect signal leads of two-conductor shielded cable to pin 3 (high) and pin 2 (low) of connector.
2. Connect cable shield to pin 1.

For unbalanced outputs using two-conductor shielded cable, wire female contact XLR connector as follows:

1. Connect signal leads of cable to pin 3 (high) and pin 2 (low) of connector.
2. Connect cable shield to pin 1 of connector.
3. Connect jumper from pin 1 to pin 2 of connector.

For unbalanced outputs using single-conductor shielded cable, wire female contact XLR connector as follows:

1. Connect center conductor cable to pin 3 of connector.
2. Connect cable shield to pin 2 of connector.
3. Connect jumper between pins 1 and 2 of connector.

Table 2-2. Connector J13 Channel/Signal Identification, Channels 1 and 2

J13 CONNECTOR PINS	CHANNEL	SIGNAL
1	1	Audio input center conductor
2	2	Audio input center conductor
3	—	Chassis ground
4	1	Bias voltage status (BVS)
5	2	Bias voltage status (BVS)
6	1	Erase voltage status (EVS)
7	2	Erase voltage status (EVS)
8	1	Unequalized Sel-Sync output
9	2	Unequalized Sel-Sync output
10	—	Chassis ground
11	1	Audio output center conductor
12	2	Audio output center conductor
13	1	Audio input shield
14	2	Audio input shield
15	—	Chassis ground
16	1 and 2	+22 Vdc
17	1 and 2	Audio power ground
18	1 and 2	-22 Vdc
19	1	TAPE/TAPE
20	1	Unequalized Sel-Sync output ground
21	2	Unequalized Sel-Sync output ground
22	2	TAPE/TAPE
23	1	Audio output shield
24	2	Audio output shield

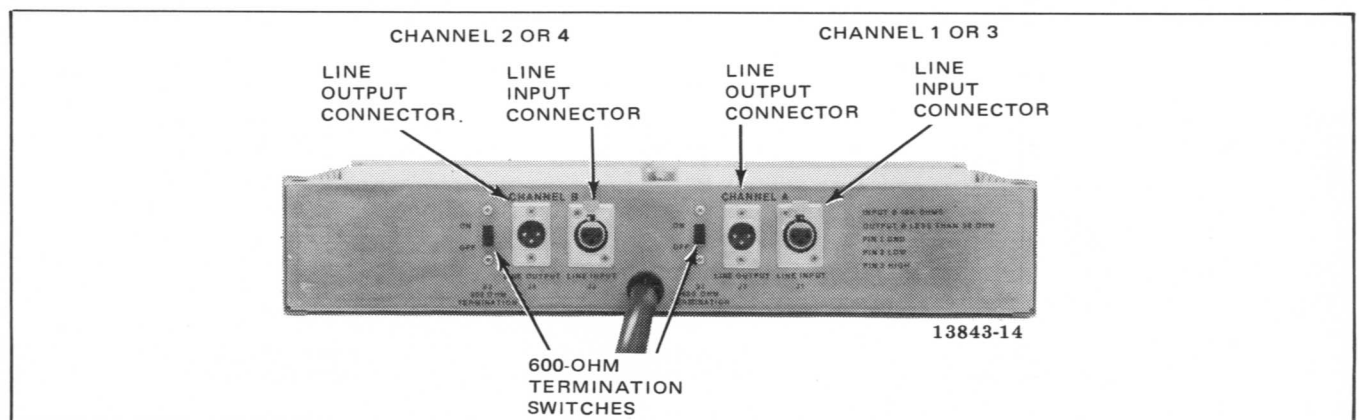


Figure 2-14. Input/Output Assembly, Rear View

Table 2-3. Connector J14 Channel/Signal Identification, Channels 3 and 4

J13 CONNECTOR PINS	CHANNEL	SIGNAL
1	3	Audio input center conductor
2	4	Audio input center conductor
3	—	Chassis ground
4	3	Bias voltage status (BVS)
5	4	Bias voltage status (BVS)
6	3	Erase voltage status (EVS)
7	4	Erase voltage status (EVS)
8	3	Unequalized Sel-Sync output
9	4	Unequalized Sel-Sync output
10	—	Chassis ground
11	3	Audio output center conductor
12	4	Audio output center conductor
13	3	Audio input shield
14	4	Audio input shield
15	—	Chassis ground
16	3 and 4	+22 Vdc
17	3 and 4	Audio power ground
18	3 and 4	-22 Vdc
19	3	TAPE/TAPE
20	3	Unequalized Sel-Sync output ground
21	4	Unequalized Sel-Sync output ground
22	4	TAPE/TAPE
23	3	Audio output shield
24	4	Audio output shield

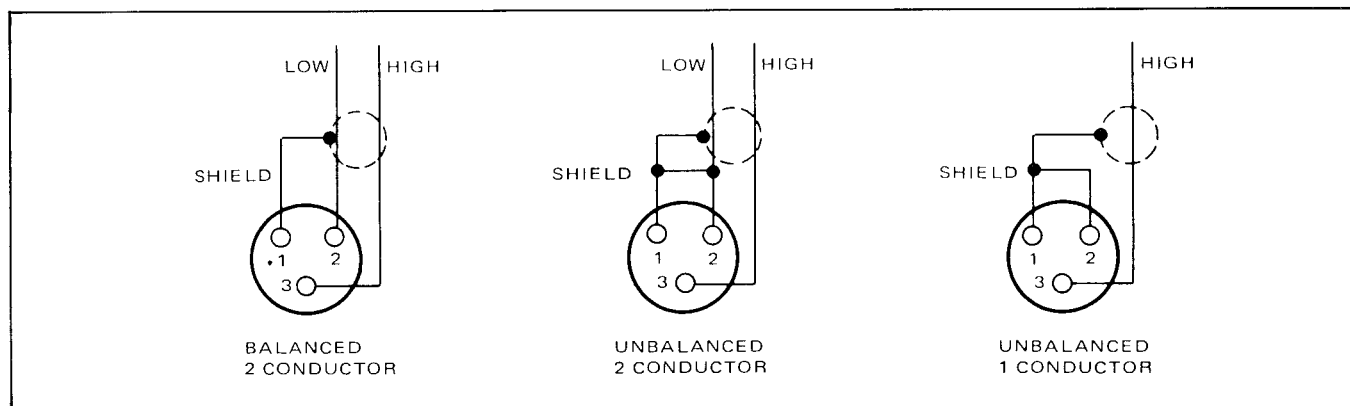


Figure 2-15. Input/Output Assembly Connector Wiring

2-20. REMOTE CONTROL UNIT INSTALLATION

Except for initiating play/edit and stop/edit (unthread) modes, all operational modes of the recorder/reproducer can be controlled from a remote location with an accessory remote control unit (Ampex Part No. 4010264-02). Except for these two modes of operation, the remote control unit operates in parallel with the local control unit at all times. The remote control unit is equipped with a 25-foot captive cable and connector for connection to the recorder/reproducer.

To connect the remote control unit to the recorder/reproducer, proceed as follows:

1. Remove system power.
2. At the bottom side of the recorder/reproducer, locate double-sided connector J11 shown in Figure 2-13. (The local control unit connects to the other side of J11).
3. Plug remote control connector into J11 with the same lead direction as the local control connector and cable dressed out the rear of the transport. No adjustments are required after installing the remote control unit.

2-21. INITIAL ADJUSTMENTS

2-22. Turntable Positioning for Reel Size

The supply and takeup motor assemblies, including turntables, are secured to the transport casting by four hex-head screws. Figure 2-16 shows the supply motor installed in the inner position to accommodate reels up to 11-1/2 (29.21 cm) inches in diameter and in the outer position to accommodate reels larger than 11-1/2 inches in diameter. Separate motor-mounting holes are used to mount the motor in the inner or outer position. No recorder/reproducer electrical adjustments are required when the motor is changed from one position to the other. To relocate the motor assembly to accommodate large reels, proceed as follows:

NOTE

When the supply and takeup motor assemblies are positioned to accommodate reels larger than 11-1/2 inches, transports cannot be mounted side-by-side on standard 19-inch racks, because the reels protrude beyond the edges of the racks.

1. At the top of the transport, remove the rear overlay panel (six screws) shown in Figure 2-2.
2. Loosen the two hex-head screws (Figure 2-17) that clamp the turntable to the motor shaft, and remove turntable from shaft.
3. Remove motor shield ground strap (Figures 2-16 and 2-18) from transport.
4. Remove the four motor-mounting hex-head screws shown in Figure 2-16.
5. Loosen, but do not remove, the three power supply screws (Figure 5-45) to permit clearance between the power supply and motor shields.
6. Relocate the motor and the shield end plate to the outer position of the transport with the ground strap facing inward (180° from its previous position, shown in Figure 2-18).
7. Reinstall screws removed in step 4 to secure the motor in the outer position as shown in Figure 2-16.
8. Install motor shield ground strap to transport.
9. Tighten power supply screws loosened in step 5.
10. When each turntable is reinstalled on the motor shaft, it is necessary to establish turntable height by setting the turntable clamp approximately 9 mils (0.229 mm) above the surface of the motor.

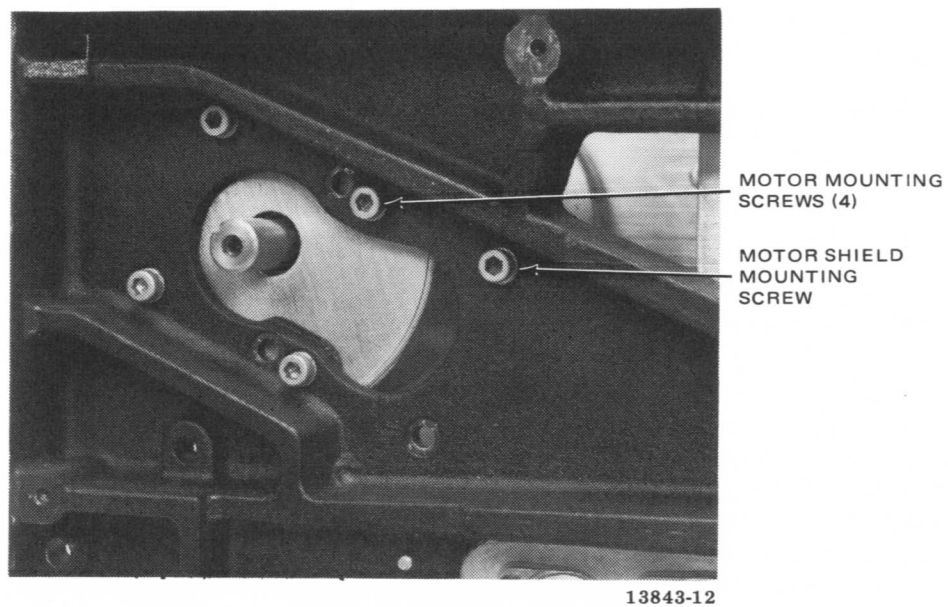
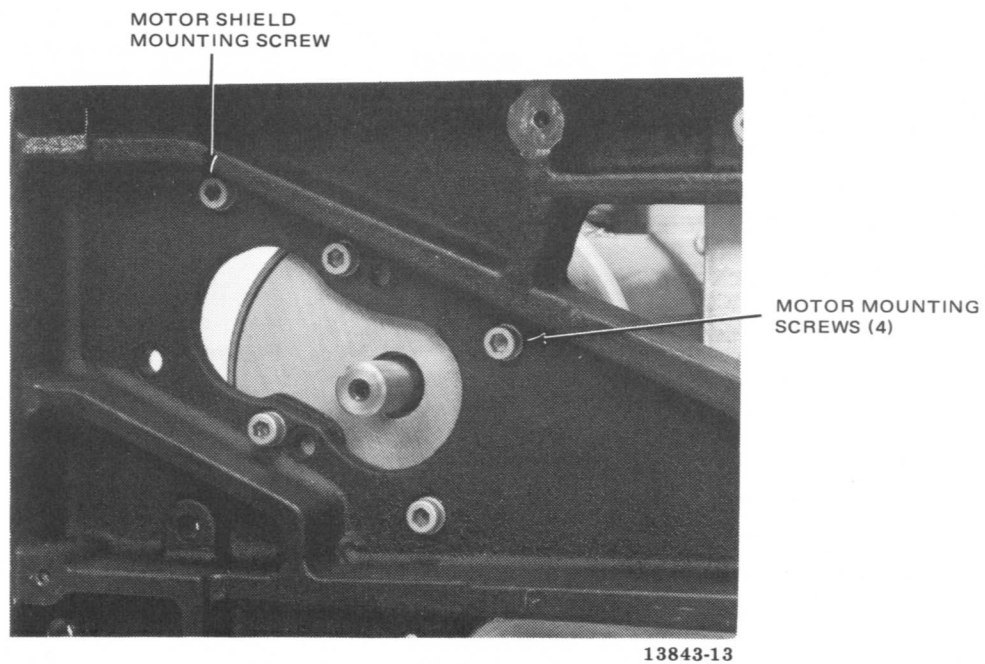


Figure 2-16. Supply Motor Mounting

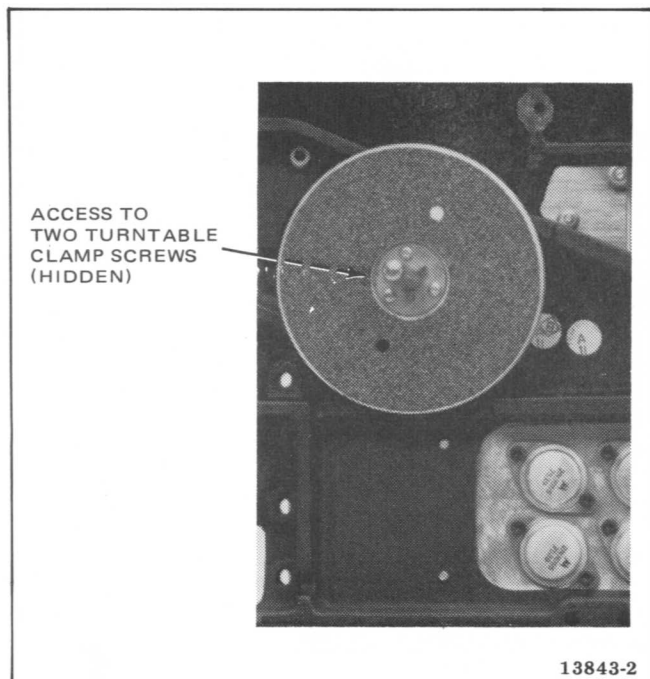


Figure 2-17. Supply Turntable

Proceed as follows:

- a. Place a 0.009-inch (9-mil) thick shim or two strips of paper (each approximately the same thickness as this manual page) on the top surface of the end shield plate to serve as a shim.
 - b. Install the turntable clamp on to the shaft and lower the clamp until contact with the shim is made.
 - c. Tighten the two clamp hex-head screws.
 - d. Remove the shim. Turntable must turn freely without rubbing on motor housing.
11. Reverse the position of each corner overlay attached to the rear overlay panel (Figure 2-2) as follows:
 - a. Remove a single locknut that secures each corner overlay to the rear overlay panel.
 - b. Rotate the corner overlay 180° and re-install locknut.

12. Reinstall rear overlay panel (six screws) to the transport.

2-23. Control Unit Relocation

For operator convenience, the control unit (Figure 2-19) may be relocated from the right-hand position on the top of the transport to the left-hand position. To relocate the control unit, it is also necessary to remove the electronics chassis from the transport to gain access to the screws that secure the filler panel shown in Figure 2-20. Proceed as follows:

1. Remove system power.
2. Unplug control unit PCB connector P11 from the electronics assembly double-sided connector J11 (Figure 2-13).
3. From the bottom of the transport, remove four flat-head screws that secure the control unit to the transport casting.
4. Free the control unit from the right side of the transport by carefully feeding the control unit captive cable and connector P11 through the hole in the transport.
5. Remove the electronics assembly from the transport as follows:
 - a. Remove head cover, head assembly, and the front overlay panel (two screws).
 - b. Remove ground strap, which connects to electronics assembly, from the tape transport.
 - c. Disconnect electronics assembly harness connector P16 that connects to tach sensor connector J16.
 - d. Disconnect electronic assembly harness connector P16 that connects to tach sensor connector J16.
 - e. Disconnect electronic assembly harness connector P15 that connects to reel drive connector P15.
 - f. From the bottom of the transport, lift and move the electronics assembly to the left of the transport.

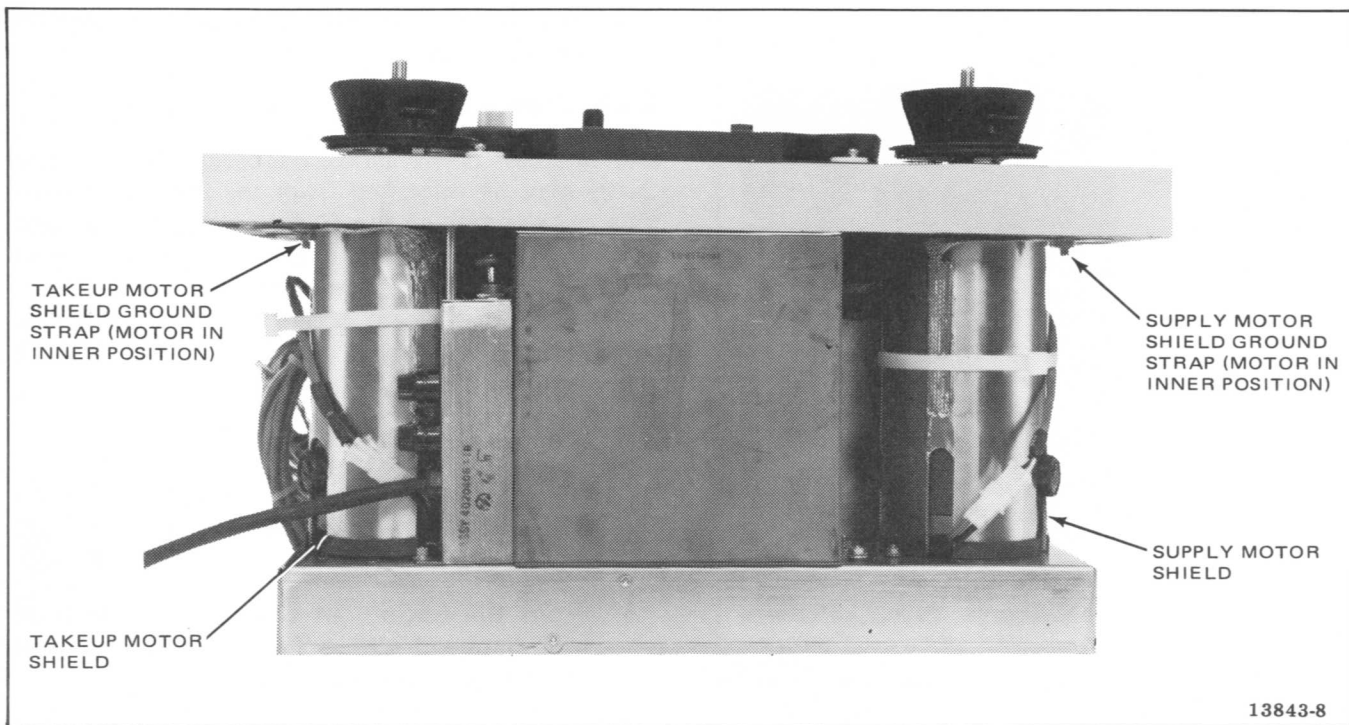


Figure 2-18. Rear View of Transport

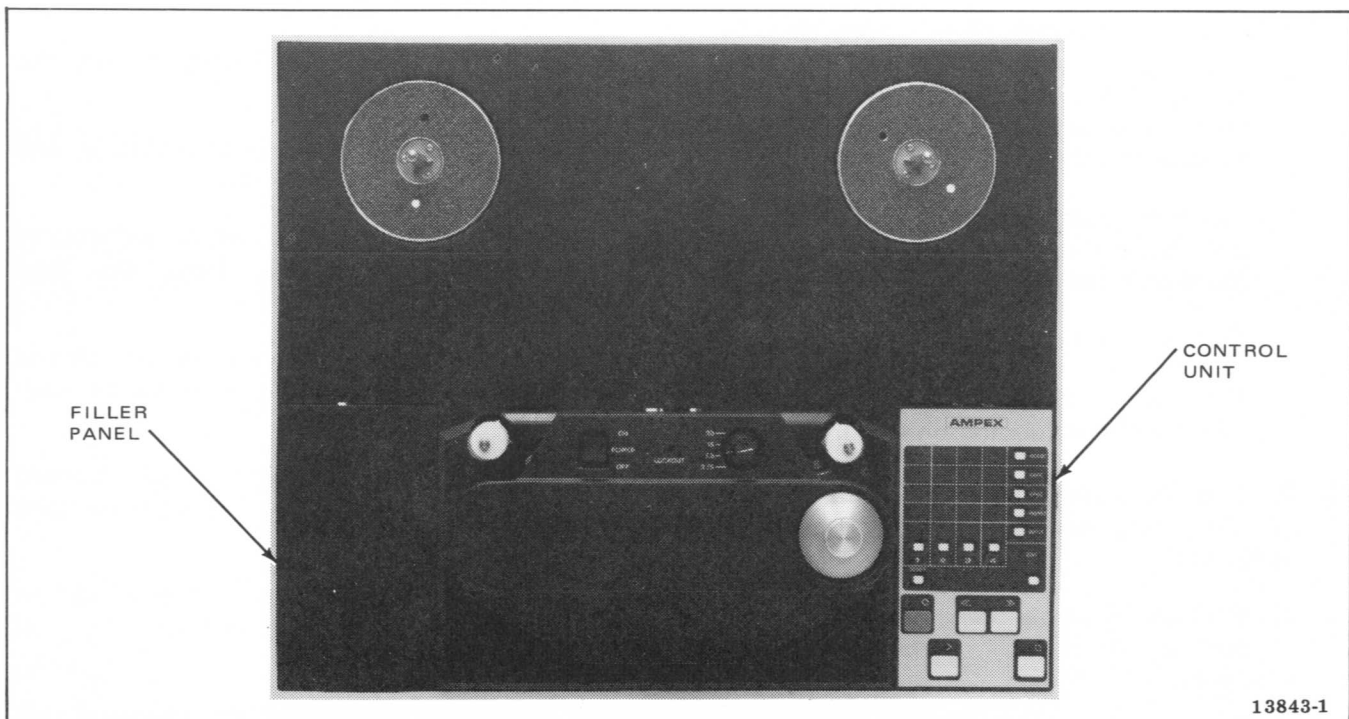


Figure 2-19. Tape Transport

6. Remove left-hand filler panel by removing four flat-head screws accessible from the bottom of the transport casting (Figure 2-20).
7. Feed control unit captive cable connector P11 through hole in the left side of the transport (Figure 2-20) and mount control unit using screws removed in step 3.
8. Route control unit cable connector P11 through the area of the power transistor sockets and leave in this location temporarily.
9. Reinstall electronics assembly in the reverse order of removal (step 5), being careful not to pinch or damage any cables.
10. Plug control unit connector P11 into electronics unit double-sided connector J11.
11. Install filler panel in right-hand position using hardware removed in step 6. Screw down filler panel to bring it even with the transport overlay and outer frame (height is adjustable).

2-24. Spool-Speed Selection

The spool mode speed (60 in/s or 180 in/s) is selected by placement of a solder-in jumper located on the capstan servo PWA. (Machines shipped from the factory are set for 180-in/s operation.) To change spool mode speed, refer to Figure 2-21 and proceed as follows:

1. With power off, remove capstan servo PWA No. 8 from the electronics assembly.
2. For 60-in/s operation, install jumper between E2 and E3 and solder in place.
3. For 180-in/s operation, install jumper between E1 and E2 and solder in place.
4. Reinstall capstan servo PWA No. 8 into electronics assembly.

2-25. Play/Edit Mode Lockout

To prevent play/edit mode from being selected from the local control panel, a jumper can be

repositioned on transport control PWA No. 7. (Machines shipped from the factory are set for play/edit mode operation.) To change jumper position, refer to Figure 2-22 and proceed as follows:

1. With power off, remove transport control PWA No. 7 from the electronics assembly.
2. For normal play/edit operation, install jumper between E12 and E13, and solder in place.
3. To prevent play/edit mode from being enabled, install jumper between E13 and E14, and solder in place.
4. Reinstall transport control PWA No. 7 into electronics assembly.

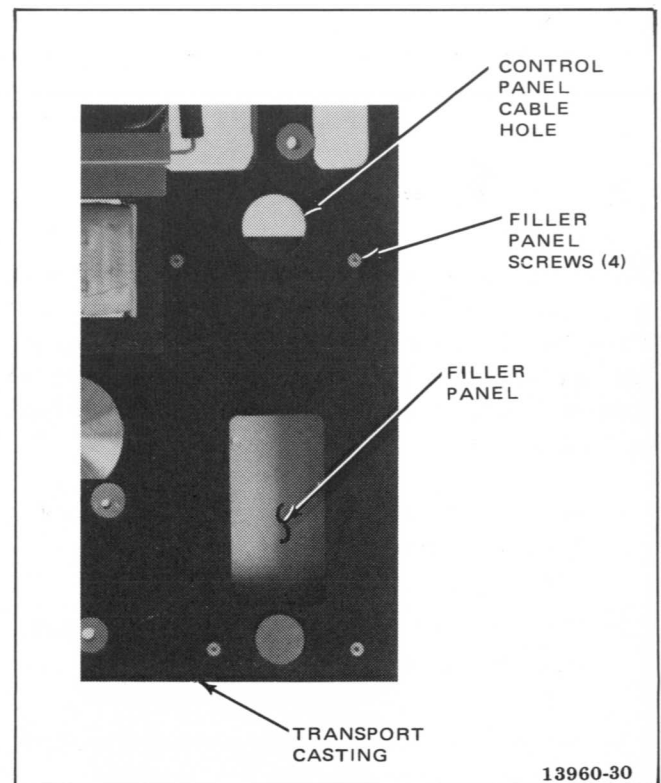


Figure 2-20. Rear View of Filler Panel
(Transport Components Removed for Clarity)

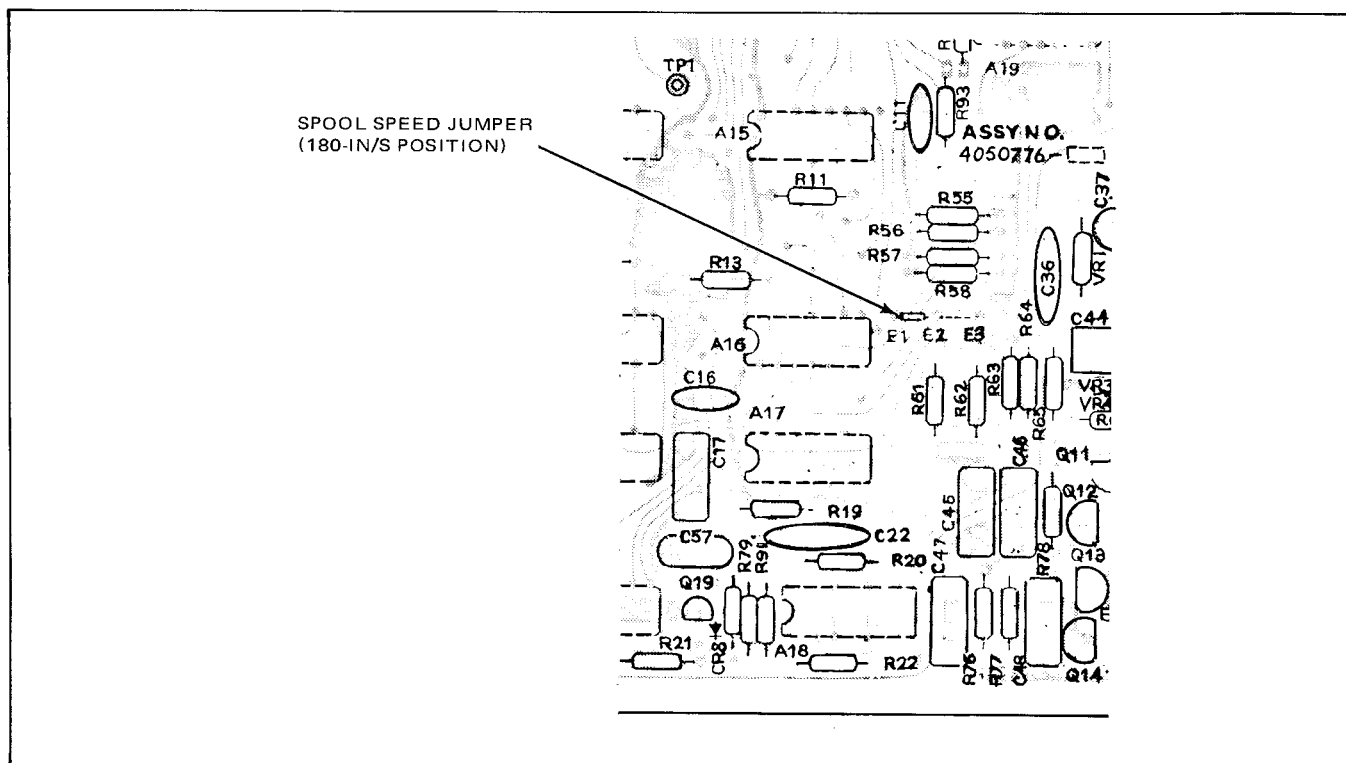


Figure 2-21. Spool Speed Jumper, Capstan Servo PWA No. 8

2-26. Record Mode Lockout

To prevent all channels from entering record mode, a jumper can be repositioned on audio control PWA No. 5. (Machines shipped from the factory are set for record mode operation.) To change jumper position, refer to Figure 2-23 and proceed as follows:

1. With power off, remove audio control PWA No. 5 from the electronics assembly.
2. To enable all channels to enter record mode, position jumper J5 in the REC position.
3. To prevent record mode from being enabled, position jumper J5 in the REC position.
4. Reinstall audio control PWA No. 5 into electronics assembly.

2-27. Tape Timer Display Selection

The tape timer can display elapsed time in hours, minutes, and seconds or minutes, seconds and tenths of seconds. (Machines shipped from the factory are set to display hours, minutes and seconds.) To change the display format, jumpers are repositioned on transport control PWA No. 7 and on control unit PWA No. 1.

2-28. Minutes, Seconds, and Tenths of Seconds Display. To change display to read minutes, seconds, and tenths of seconds, proceed as follows:

1. With power off, remove transport control PWA No. 7 from electronics assembly.
2. Remove existing jumpers and install jumpers between the following terminals (Figure 2-24) and solder in place.

E 1 to E7

E2 to E8

E3 to E9

E4 to E10

E5 to E11

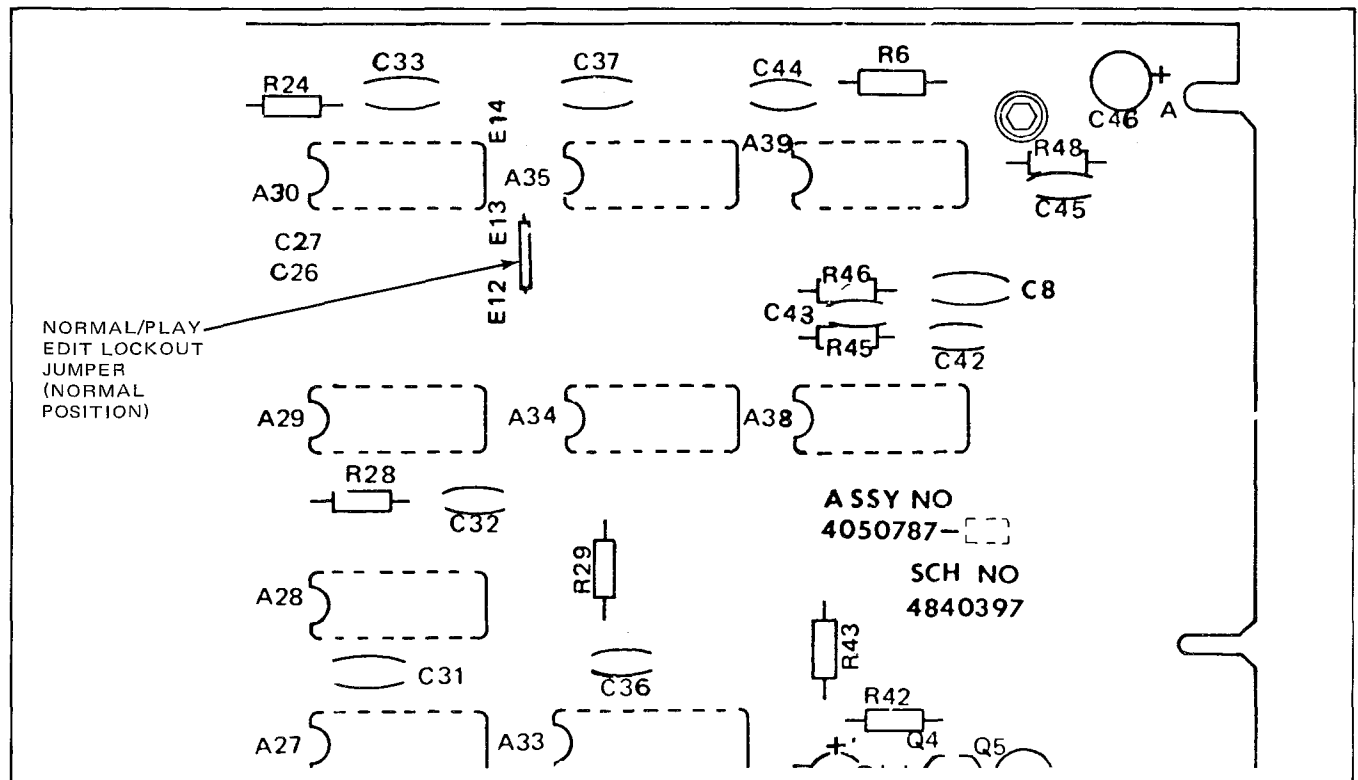


Figure 2-22. Normal/Play Edit-Lockout Jumper, Transport Control PWA No. 7

3. Reinstall transport control PWA No. 7 into electronics assembly.
 4. From the rear of the transport casting, remove four flat-head screws that secure the control unit to the casting, to free the control unit.
 5. Remove the case bottom of the control unit (Figure 2-25).
 6. Remove two screws shown in Figure 2-25 to gain access to six hex spacers shown in Figure 2-26.
 7. Remove the four locking plates (Figure 2-26) that prevent the four outer hex spacers from turning.
 8. Remove the six hex spacers and remove PWA No. 1 from the control unit housing.
 9. Remove jumper on the component side of the board installed between E74 and E76 (Figure 2-27) and install between E74 and E75. Solder in place.
 10. Reassemble control unit in the reverse order of disassembly and reinstall into transport.
- 2-29. Hours, Minutes, and Seconds Display.** To change display to read hours, minutes, and seconds, proceed as follows:
1. With power off, remove transport control PWA No. 7 from the electronics assembly.
 2. Remove existing jumpers and install jumpers between the following terminals (Figure 2-24) and solder in place.

E1 to E6	E4 to E9
E2 to E7	E5 to E10
E3 to E8	

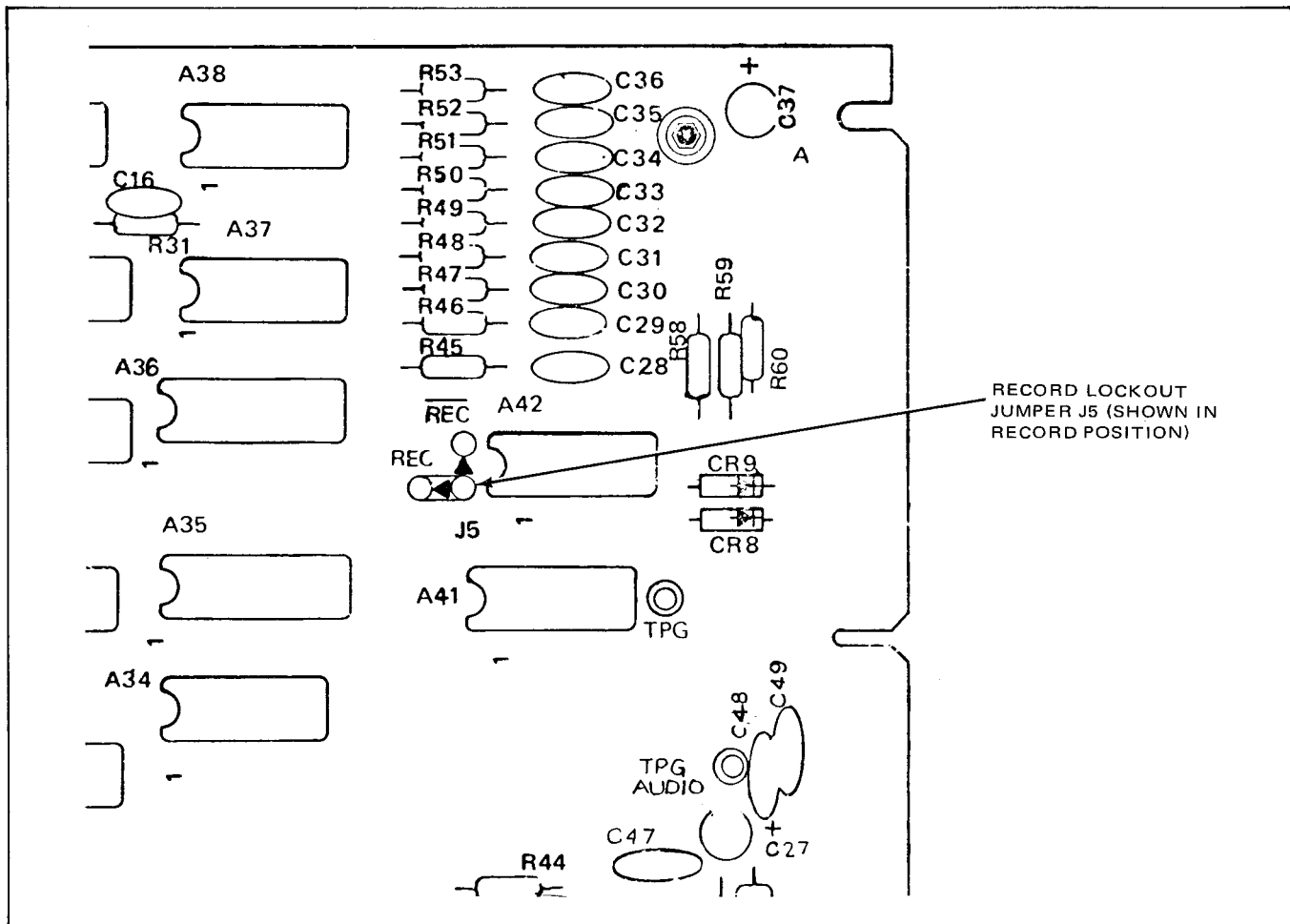


Figure 2-23. Record Lockout Jumper J5, Audio Control PWA No. 5

3. Reinstall transport control PWA No. 7 into electronics assembly.
4. From the rear of the transport casting remove four flat-head screws, that secure the control unit to the casting, to free the control unit.
5. Remove the case bottom of the control unit (Figure 2-25).
6. Remove two screws shown in Figure 2-25 to gain access to six hex spacers shown in Figure 2-26.
7. Remove the four locking plates (Figure 2-26) that prevent the four outer hex spacers from turning.
8. Remove the six hex spacers and remove PWA No. 1 from the control unit housing.
9. Remove jumper on the component side of the board installed between E74 and E75 (Figure 2-27) and install between E74 and E76. Solder in place.
10. Reassemble control unit in the reverse order of disassembly and reinstall into transport.

2-30. PURC Operation Selection

The recorder/reproducer is capable of operating with or without PURC operation as desired by placement of a jumper located on the PADNET PWA. Recorders shipped from the factory are set for normal (non PURC) operation.

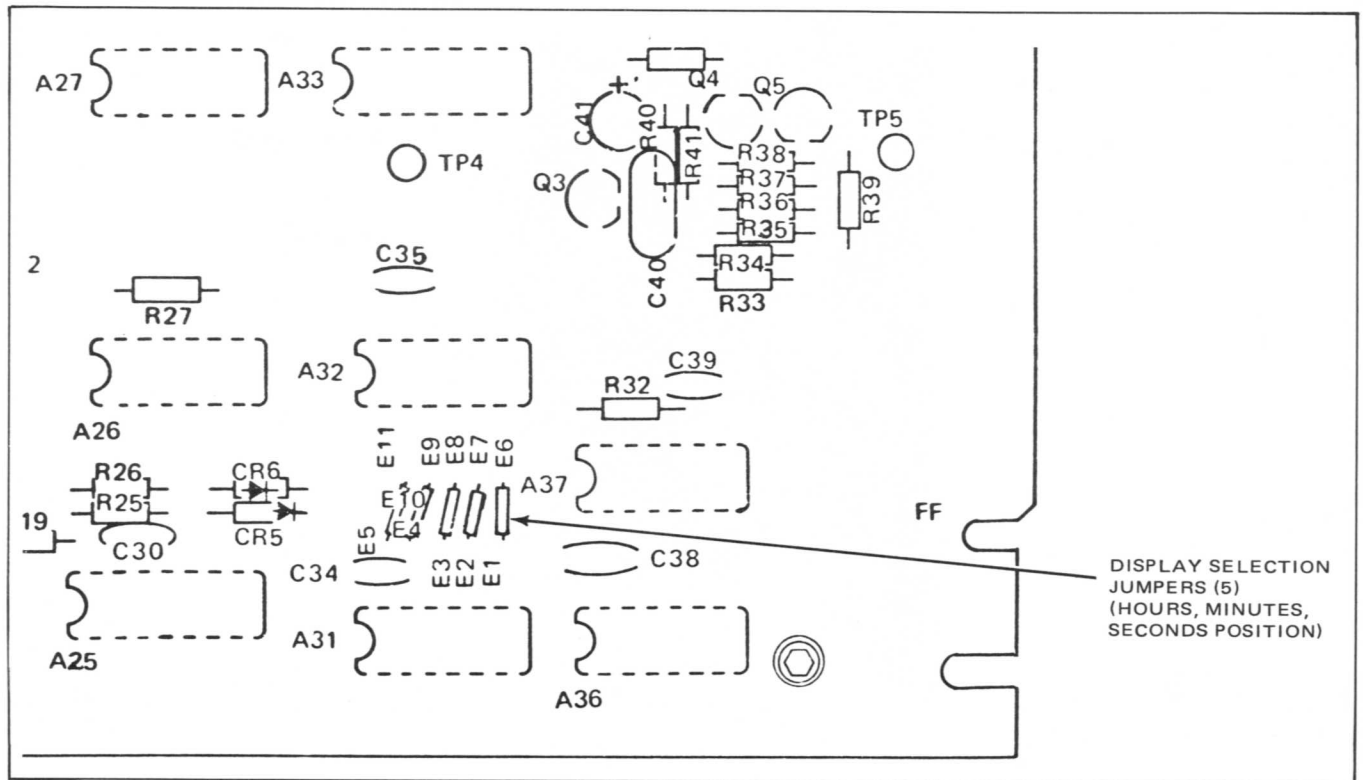


Figure 2-24. Tape Timer Display Selection Jumpers, Transport Control PWA No. 7

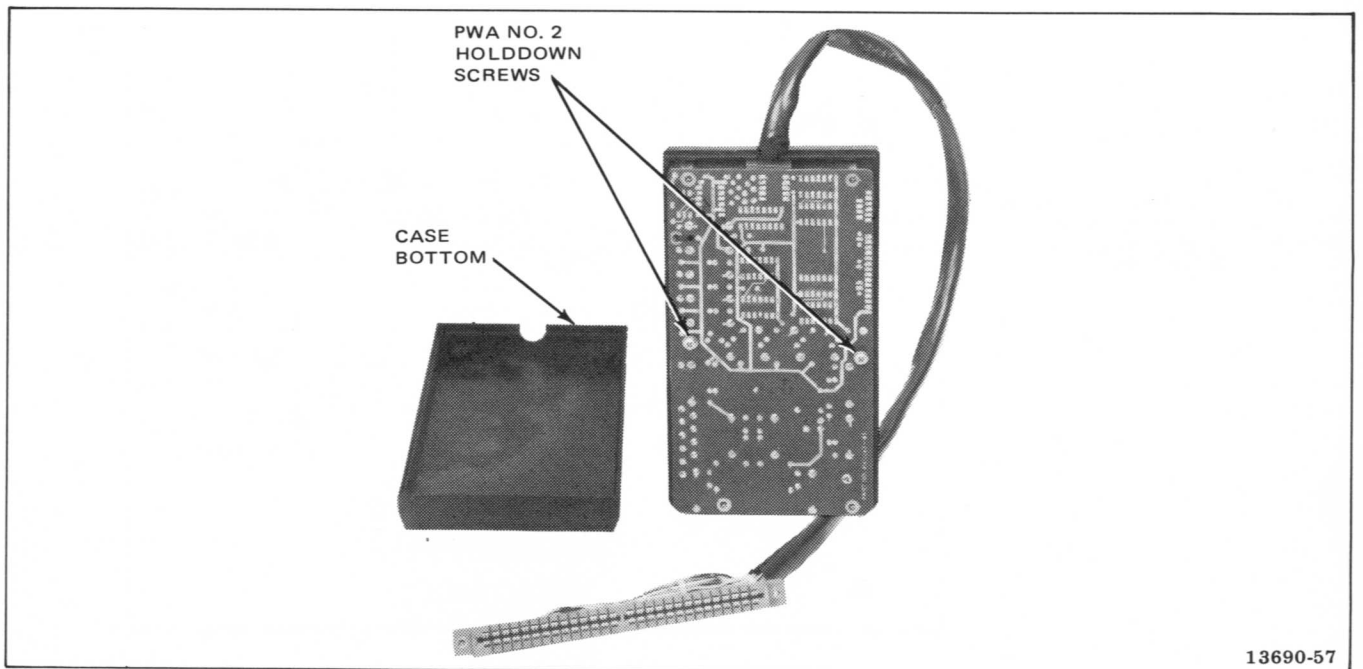


Figure 2-25. Control Unit, Case Bottom Removed

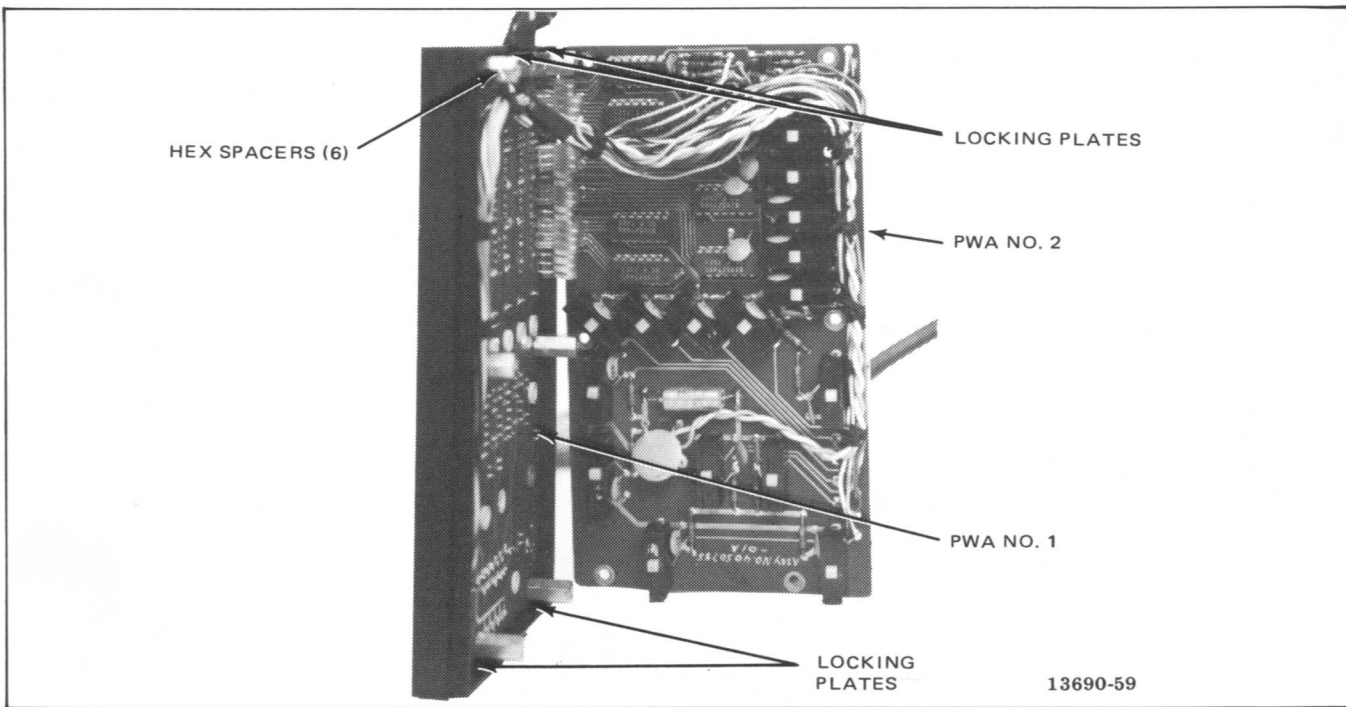


Figure 2-26. Inside View of Control Unit

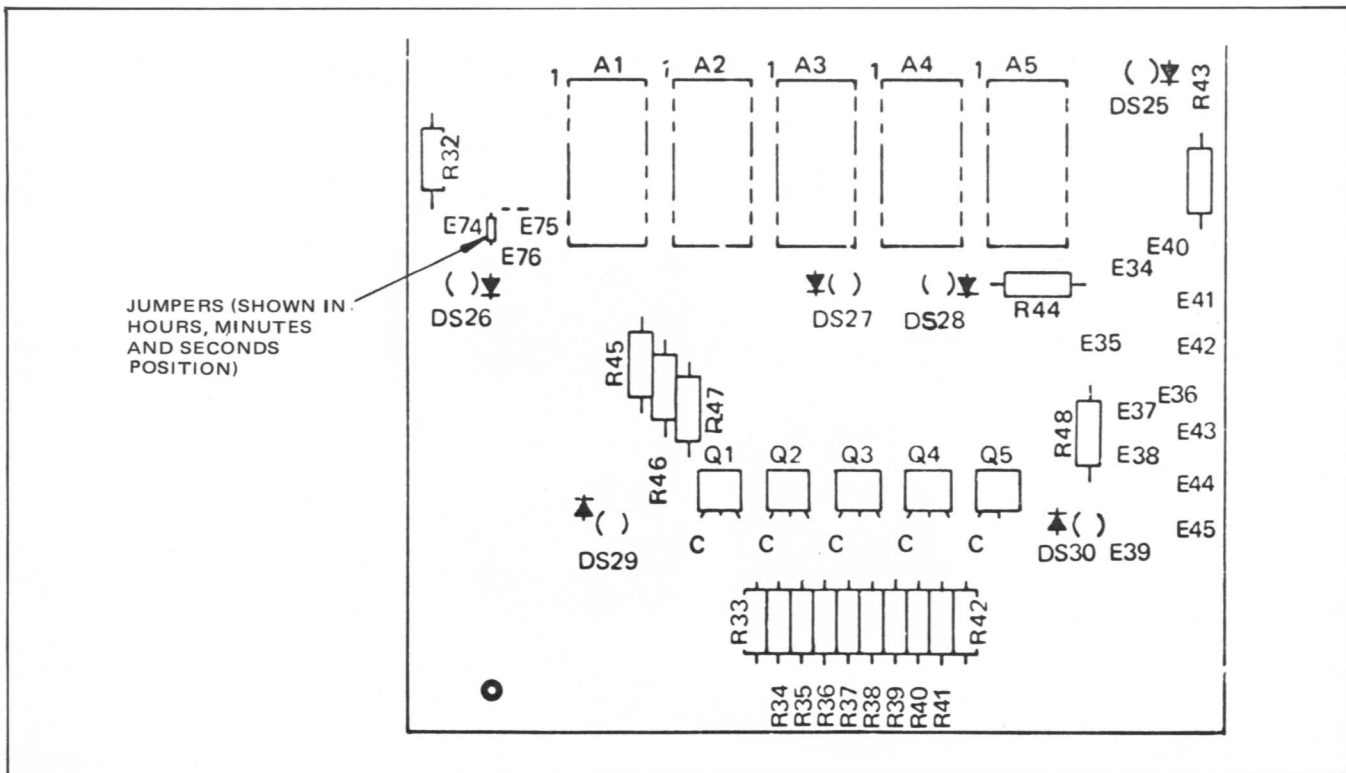


Figure 2-27. Tape Timer Display Selection Jumper, Control Unit PWA No. 1

To select PURC operation, refer to Figure 2-28 and proceed as follows:

1. With power off, remove PADNET PWA from the electronics assembly.
2. Install jumper J3 in the PURC position.
3. Reinstall PADNET PWA into electronics assembly.
4. Repeat steps 1 to 3 for the other channels (if applicable).

2-31. INITIAL CHECKOUT PROCEDURE

Use these instructions to verify that all internal cables have been connected and the system is performing correctly. (Refer to Section 3, Operation for detailed operating instructions as necessary.) Proceed as follows:

CAUTION

BEFORE CONNECTING AC POWER, REFER TO INSTRUCTIONS GIVEN IN PARAGRAPH 2-12, CONNECTING AC POWER.

1. Connect ac power cord to suitable power source.
2. Set POWER switch to the ON position. All safe and repro indicators should light, the stop and EDIT indicators should light, and the tape timer display should indicate 0 00 00. (Note: the LOCKOUT indicator always lights for 2 to 3 seconds after power is first applied.)
3. Set speed-select rotary switch to desired tape speed. If a speed is selected that the signal system of the recorder/reproducer is not set up for, the LOCKOUT indicator should light.
4. Install a reel of tape on the supply turntable and an empty reel on the takeup turntable.
5. Thread tape on transport (refer to paragraph 3-2) and place recorder/reproducer into thread mode.

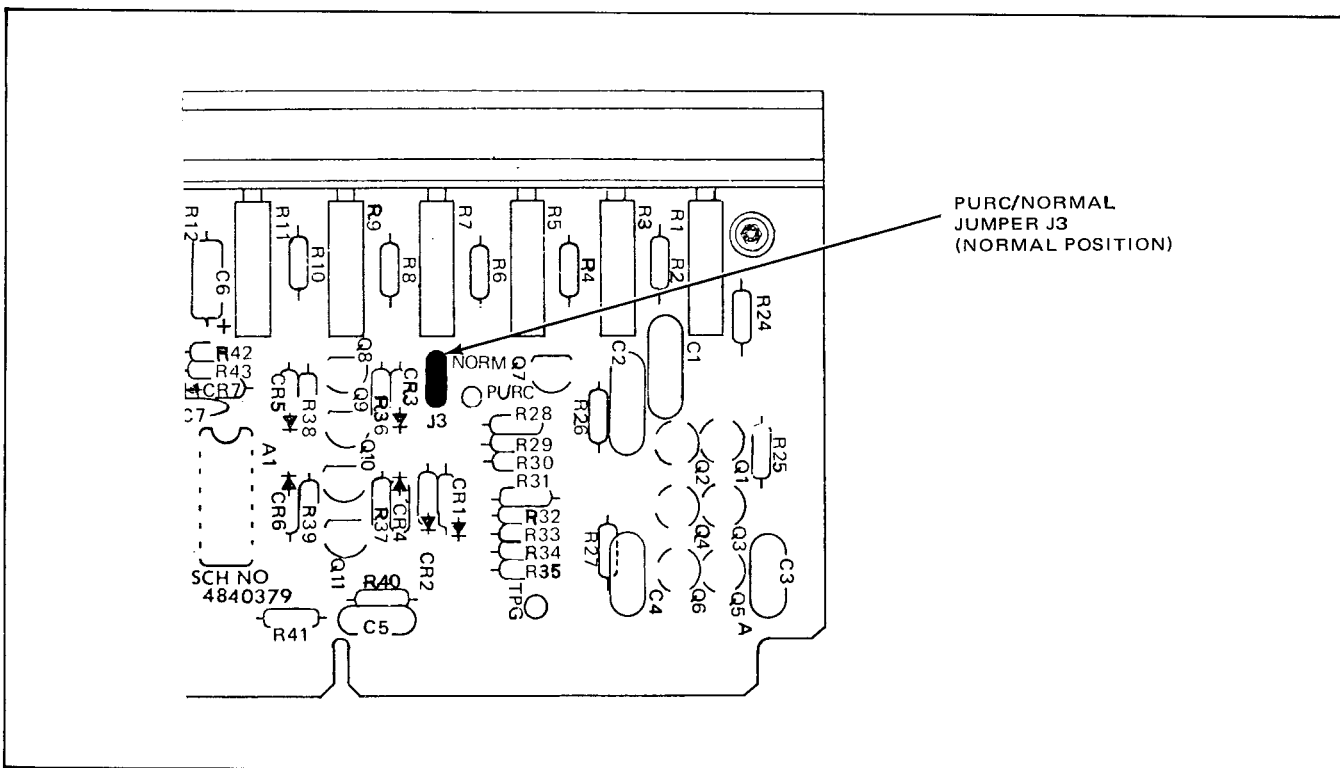


Figure 2-28. PURC Jumper, PADNET PWA

6. Check tape transport operation and control circuitry as follows:
 - a. Press play pushbutton. Transport should operate at speed selected and play indicator should illuminate.
 - b. Press stop pushbutton. Tape should stop and stop indicator should illuminate.
 - c. Press fast forward pushbutton. Transport should enter fast forward mode and fast forward indicator should illuminate.
 - d. Press rewind pushbutton. Transport should enter rewind mode and rewind indicator should illuminate. Press stop pushbutton.
 - e. Simultaneously press play pushbutton and fast forward pushbutton. Transport should enter spool mode in the forward direction. The fast forward indicator should illuminate and the play indicator will illuminate when spool speed is reached.
 - f. Press rewind pushbutton. Transport should enter spool mode in the rewind direction. Rewind indicator should illuminate and play indicator will illuminate when spool speed is reached.
 - g. Press stop pushbutton. Tape should stop and stop indicator should illuminate.
 - h. Turn capstan edit knob by hand in one direction and then the other. Tape should move from reel to reel under reel-servo control.
 - i. Press play pushbutton. Transport should operate at speed selected. Then press EDIT pushbutton. Tape motion should continue in play mode, power is removed from takeup reel, and takeup tension-arm roller engages capstan causing tape to be spilled at takeup side of transport.
 - j. Press stop pushbutton. Tape motion should stop.
 - k. Press play pushbutton. Tape should again be spilled at takeup side of transport.
 - l. Press stop pushbutton. Tape motion should stop.
 - m. Press EDIT pushbutton (after tape has stopped moving). Recorder should enter unthread mode (reel servos disengage) and power should be removed from reel motors.
7. Check signal system control circuitry operation as follows:
 - a. Simultaneously press a channel select pushbutton and the READY pushbutton. The ready indicator (yellow) should illuminate. Repeat this step for all channels as applicable.
 - b. Simultaneously press play and record pushbuttons. The ready indicator should go out, the channel record indicator (red) and the master record indicator (red) should illuminate.
 - c. Press stop pushbutton. The channel record indicator and master record indicator should go out and the ready indicator should illuminate.
 - d. Simultaneously press a channel select pushbutton and the SAFE pushbutton. The safe indicator should illuminate and the ready indicator should go out. Repeat this step for all channels as applicable.
 - e. Simultaneously press play and record pushbuttons. The channel record indicator (red) and the master record indicator should not illuminate.
 - f. Simultaneously press a channel select pushbutton and the SYNC pushbutton. The sync indicator should illuminate. Repeat this step for all channels as applicable.
 - g. Simultaneously press a channel select pushbutton and the REPRO pushbutton.

The repro indicator should illuminate and the SYNC indicator should go out. Repeat this step for all channels as applicable.

- h. Simultaneously press a channel select pushbutton and the INPUT pushbutton. The input indicator should illuminate and the repro indicator should go out. Repeat this step for all channels as applicable.
- i. While holding channel select pushbutton depressed, press READY pushbutton and then press SYNC pushbutton. The ready and sync indicators should illuminate. Simultaneously press play and record pushbuttons. The following action should take place:
 - 1) Transport operates at speed selected.
 - 2) Play and master record indicator illuminates.
 - 3) Channel ready indicator goes out.
 - 4) Channel record indicator illuminates.
 - 5) Sync indicator goes out.
 - 6) Input indicator illuminates.
- j. Press and hold record pushbutton depressed. Momentarily press stop pushbutton. The following action should take place:
 - 1) Transport operates at speed selected.
 - 2) Master record indicator goes out.
 - 3) Channel record indicator goes out.
 - 4) Channel input indicator goes out.
 - 5) Channel ready indicator illuminates.
 - 6) Channel sync indicator illuminates.
- k. Press and hold record and stop pushbuttons depressed. Momentarily press

play pushbutton. Transport should operate at speed selected. Momentarily again press play pushbutton. Channel should enter and stay in record mode (channel record indicator and master record indicator illuminate) as long as play pushbutton is held depressed. Release pushbuttons and then press stop pushbutton. Transport motion should stop.

- l. Repeat steps i, j, and k for all channels as applicable.

2-32. FACTORY SHIPPED OPERATIONAL CONFIGURATION

The basic recorder/reproducer is capable of operating at tape speeds of 3.75, 7.5, 15, and 30 in/s (9.52, 19.05, 38.1, and 76.2 cm/s) in either the NAB or IEC equalization standard. However, the recorder/reproducer is shipped from the factory in the operational configuration given in Table 2-4. Some applications of the recorder/reproducer require a configuration different from those established at the factory. For example, the use of conventional tape requires change of operating level, change of bias, and change of record equalization. To change tape speed or other operational configurations, see Maintenance section of the manual.

2-33. CHECKING OPERATING LEVEL

To check operating level, play back an Ampex standard alignment tape that has the same track format as the recorder/reproducer (full track, 2 track, or 4 track). Proceed as follows:

1. If an input/output assembly is not being used, connect an ac voltmeter to the output of the recorder/reproducer.
2. Reproduce the reference level 500-Hz tone for 3.75 in/s or 700-Hz tone for 7.5, or 30 in/s of an Ampex standard alignment tape (185 nWb/m).
3. If an ac voltmeter is used, the output level should read -11 dBm.

4. If an input/output assembly is being used, set the reproduce MANUAL/PRESET switch to the PRESET position. The input/output assembly level meter should read -6 vu when meter switch is in the vu position, or meter should read -12 when meter switch is in the peak position. The line output level should be -2 dBm.

Table 2-4. Factory Shipped Operational Configuration

ITEM	SETTING
Operating Speed	7.5 – 15 in/s (19.05 cm/s – 38.1 cm/s)
Equalization Standard	NAB or IEC depending on order specifications
Bias Level Setting	For use with Ampex 456 high-output, low noise tape
Input Impedance	Basic Recorder/Reproducer: 18 kilohms, unbalanced Recorder/Reproducer with Input/Output assembly (accessory): 50 kilohms, balanced
Output Impedance	Basic Recorder/Reproducer: 40 ohms, unbalanced Recorder/Reproducer with Input/Output assembly (accessory)- 30 ohms balanced
Operating Level	370 nWb/m (0 vu on Input/Output level meter) which is 6 dB higher than the 185 nWb/m reference level of Ampex standard tapes. (Note: The basic recorder/reproducer is factory adjusted for -5 dBm input and output line levels. The recorder/reproducer with input/output assembly is factory-adjusted in preset mode switch positions for +4 dBm input and output line levels.)
Power Input	110 - 135 Vac (unless specified otherwise on sales order)

SECTION 3

OPERATION

This section of the manual provides locations and functions of the recorder/reproducer operating controls and indicators, a preoperational procedure, and operating instructions for the various modes of operation.

3-1. CONTROLS AND INDICATORS

The location and function of each control and indicator are shown in the following tables. Table 3-1 shows those on the tape transport. Table 3-2 lists the transport controls on the recorder control panel. Table 3-3 lists the signal system controls on the recorder control panel, and Table 3-4 lists those on the input/output assembly (accessory).

3-2. PRE-OPERATING PROCEDURES

See Figure 3-1 and perform the following pre-operational procedure.

1. Clean and demagnetize components in the tape path as described in the Maintenance section of the manual.
2. Set the POWER switch to the ON position. All safe and repro indicators light, the stop and EDIT indicators light and the tape timer indicates zero (0 00 00).
3. Set speed-select rotary switch to desired tape speed; 3.75, 7.5, 15, or 30 in/s. If a speed is selected that the signal system has not been set for, the LOCKOUT indicator lights, play and record modes for that speed are inoperative, and the audio output(s) of the basic recorder/reproducer are muted. If an input/output assembly is connected, the assembly will switch to input signal monitoring.
4. Install reel of tape on supply turntable and empty reel on takeup turntable as shown in

Figure 3-1. Reels up to 14 inches (16.54 cm) in diameter and in any size combination may be used. (Note: If reels larger than 11-1/2 inches (29.21 cm) are used, reel motors must be in the "outer" position. Refer to paragraph 2-22).

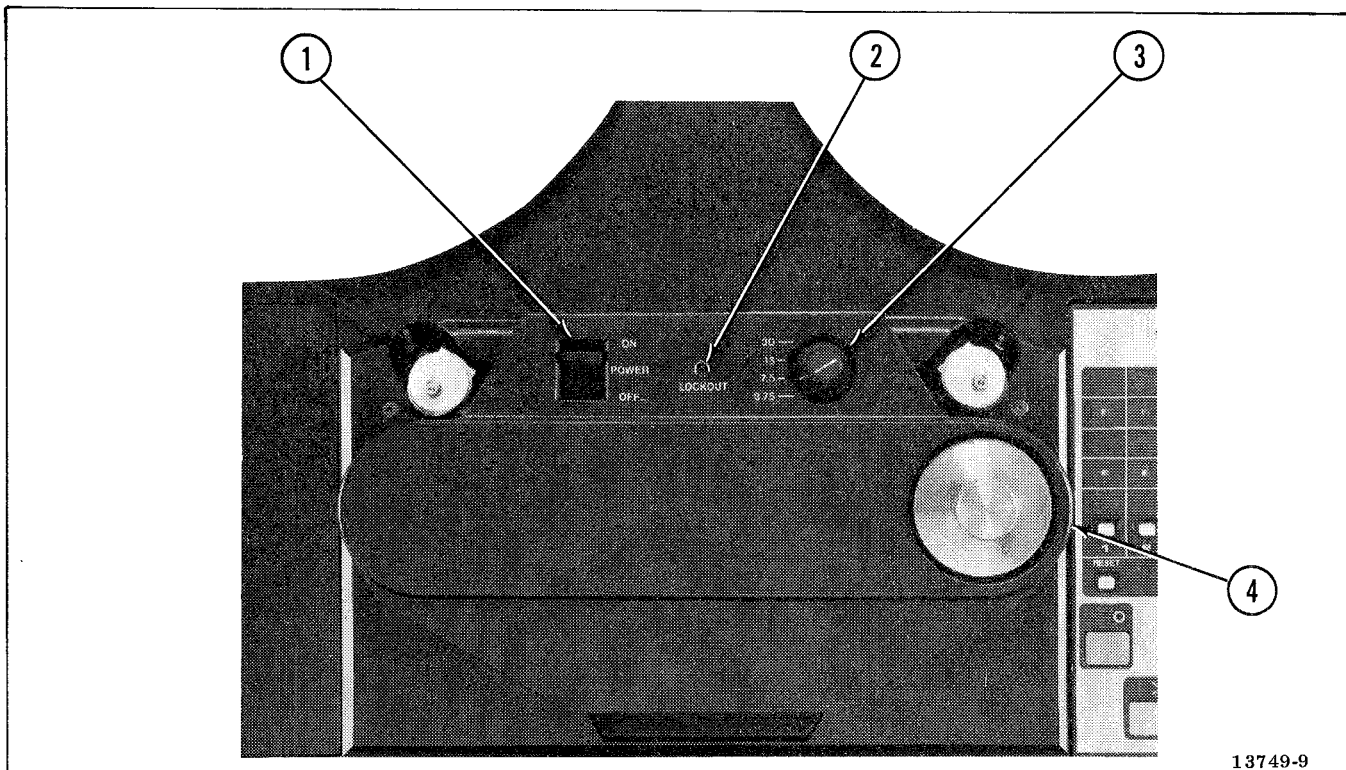
5. Lower head shield by pressing shield downward until it locks.
6. Thread tape on transport as shown in Figure 3-1. The tape path is from the supply reel, around the inside of the supply constant-tension arm, around the tape timer wheel, across the head assembly, around the capstan, around the inside of the takeup constant-tension arm, and onto the takeup reel.
7. Turn one reel to remove all tape slack.

CAUTION

DO NOT TOUCH THE CONSTANT-TENSION ARMS WHEN RECORDER/REPRODUCER IS IN THE ELECTRICAL THREAD CONDITION. TO DO SO WILL INTRODUCE A REEL SERVO ERROR AND POSSIBLY CAUSE TAPE DAMAGE.

8. While holding the stop pushbutton pressed, turn either reel to slacken tape and then tighten tape with a short quick movement to apply tension to the constant-tension arms. This action causes the reel servos to activate and recorder/reproducer enters electrical thread mode. The electrical thread mode is indicated by the EDIT indicator light going out. (To deactivate the thread mode, press EDIT pushbutton when tape is stopped. Reel servos will disengage and tape may be removed from transport if desired.)
9. Release head shield by pressing shield downward.

Table 3-1. Tape Transport Controls and Indicators



13749-9

INDEX NO.	NAME	FUNCTION
1	POWER switch	Used to turn ac power to the recorder on and off. When power is first applied, all Safe and Repro indicators light, Stop and EDIT indicators light, and tape timer indicates zero (0 00 00).
2	LOCKOUT INDICATOR	Lights when a speed is selected that the signal system has not been set up for. Play and record modes for the incorrect speeds are locked out of operation. (Note: Indicator also lights for 2 to 3 seconds after power is first applied.)
3.	Speed-Select rotary switch	Used to select tape speed; 3.75, 7.5, 15, or 30 inches-per-second (9.52, 19.05, 38.1, or 76.2 cm/s)
4.	Capstan Edit knob	When tape is stopped in thread mode, the capstan edit knob may be turned by hand in either direction to move tape from reel to reel under reel-servo control.

Table 3-2. Recorder Control Panel, Transport Controls and Indicators

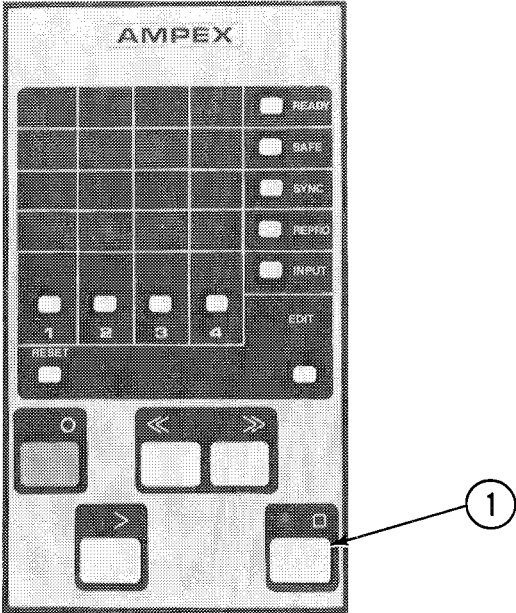

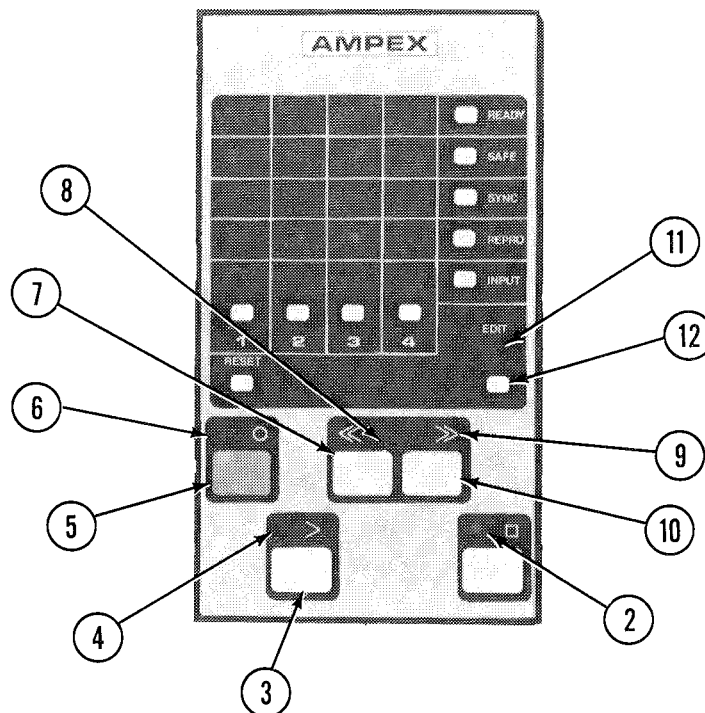
<div></div> <div>13690-5</div>		
INDEX NO.	NAME	FUNCTION
1	<div> Stop pushbutton switch</div>	<p>Used to initiate the following functions:</p> <p><i>Thread.</i> After tape is manually threaded on the transport and tape slack removed, either reel is quickly turned by hand to apply tension to the tension arms while the stop pushbutton is simultaneously pressed. This causes reel servos to activate and place transport in a thread condition. Thread condition is indicated by EDIT indicator light (index no. 11, this table) going out.</p> <p><i>Stop.</i> Switch stops tape transport motion and cancels existing mode of operation. Note: When any channel is in record mode, tape motion does not stop until record signal has decayed.</p> <p><i>Stop Record.</i> Also used to stop recording without stopping transport if record pushbutton (index no. 5) is held pressed while stop pushbutton is momentarily pressed.</p> <p><i>Momentary Record.</i> Also used in conjunction with play and record pushbuttons (index no. 3 and 5, this table). If stop and record pushbuttons are held pressed, record mode is entered when play pushbutton is pressed and held. Record mode stops when play pushbutton is released, but transport motion continues.</p>

Table 3-2. Recorder Control Panel, Transport Controls and Indicators (Continued)



13690-5


INDEX NO.	NAME	FUNCTION
2	Stop indicator (yellow)	Lights when ac power is first applied and when stop mode is active.
3	 Play pushbutton switch	<p>Used to select play mode or used simultaneously with record pushbutton (index no. 5) to select record mode.</p> <p>Pressing the play pushbutton during fast forward or rewind mode causes recorder to enter play mode.</p> <p>Also used to initiate one of the following modes:</p> <p><i>Momentary record.</i> Used to select momentary record mode (see index no. 1).</p> <p><i>Spooling.</i> Simultaneously pressing play pushbutton and a fast forward or rewind pushbutton (index no. 7 or 10) causes transport to enter spool mode.</p>
4	Play indicator (green)	Lights when play or spool mode is selected and capstan servo is locked.

Table 3-2. Recorder Control Panel, Transport Controls and Indicators (Continued)




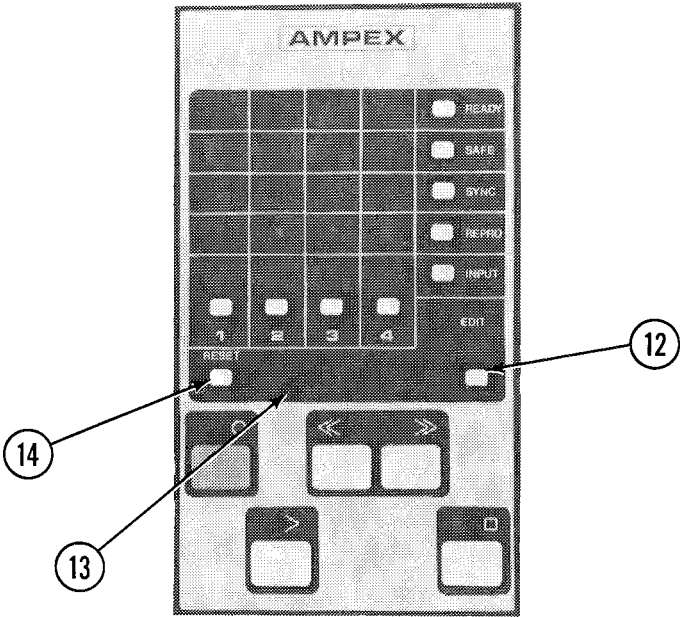
INDEX NO.	NAME	FUNCTION
5	 Record pushbutton switch	Used in conjunction with play pushbutton (index no. 4). Simultaneously pressing play pushbutton and record pushbutton initiates record mode of channel(s) in ready mode. Also used to select momentary record mode (see index no. 1, this table).
6	Master Record indicator (red)	Lights when any channel is recording
7	 Rewind pushbutton switch	Used to select rewind mode. Also used to select spool mode in the rewind direction when the play pushbutton (index no. 3) and the rewind pushbutton are pressed simultaneously.
8	Rewind indicator (yellow)	Lights when rewind or rewind spool mode is selected.
9	Fast Forward indicator (yellow)	Lights when fast forward or forward spool mode is selected.
10	 Fast Forward pushbutton switch	Used to select fast forward mode. Also used to select spool mode in the forward direction when the play pushbutton (index no. 3) and the fast forward pushbutton are pressed simultaneously.
11	EDIT indicator (yellow)	Lights when power is first applied to recorder. Light goes out when stop pushbutton is pressed and thread condition is obtained (refer to index no. 1). Indicator also lights in edit modes of operation.
12	EDIT pushbutton switch	If tape motion is stopped, pressing EDIT causes recorder to go into unthread condition (reel servos disengage) and tape may be removed from transport if desired. Also used to initiate one of the following edit modes: <i>Stop/Edit:</i> If tape is stopped, pressing EDIT disengages reel servos for tape threading, editing, or manual tape movement. <i>Play/Edit:</i> If play or record mode is active, pressing EDIT pushbutton causes the following action: Tape motion continues in play mode; power is removed from takeup reel; and takeup tension-arm roller engages capstan causing tape to be spilled at takeup side of transport. If in Play/Edit mode and stop pushbutton is pressed, tape will stop, edit mode will be retained, and tape can again be spilled by pressing play pushbutton. To cancel play/edit mode, press stop pushbutton and after tape stops, press EDIT.

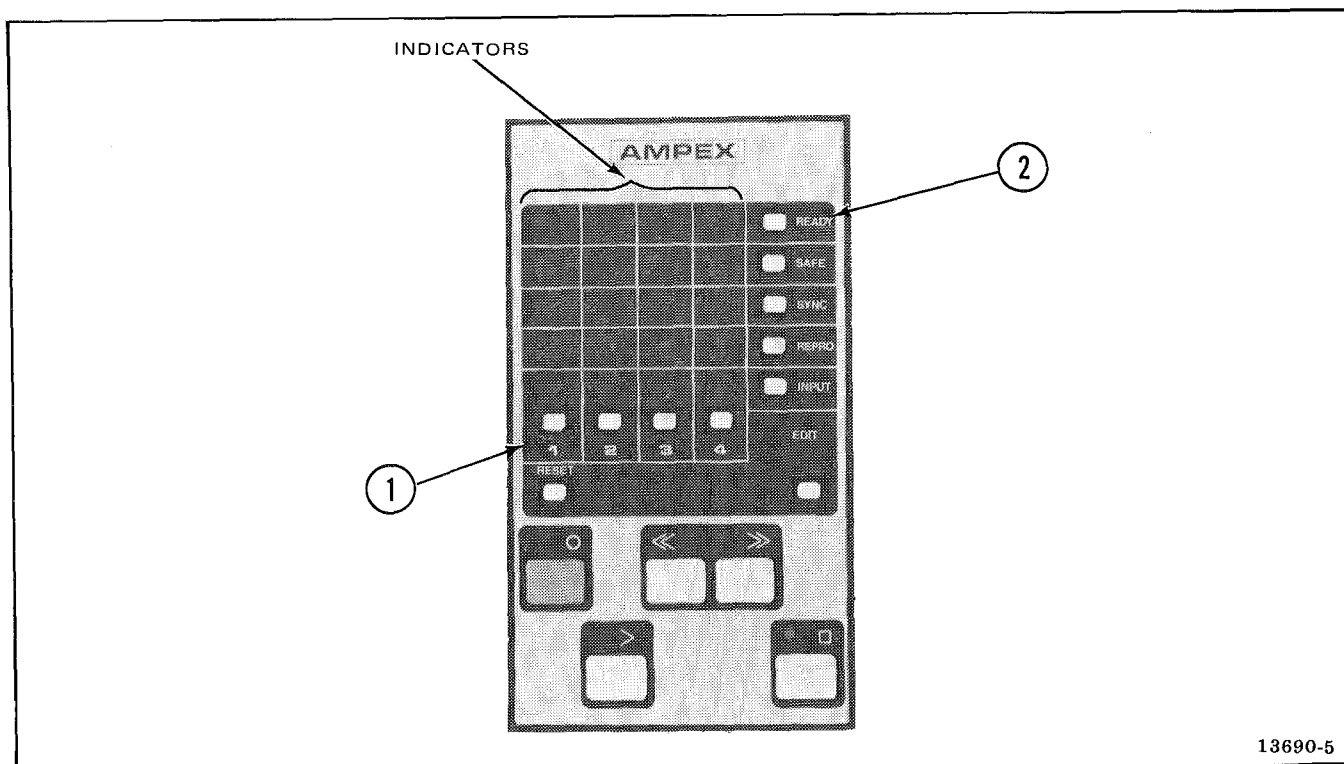
Table 3-2. Recorder Control Panel, Transport Controls and Indicators (Continued)



13690-5

INDEX NO.	NAME	FUNCTION
12 (Continued)		<i>Shuttle/Edit:</i> If fast forward, rewind, or a spool mode is active, pressing EDIT pushbutton will cause tape lifters to retract while pushbutton is held pressed.
13	Tape Timer display	When power in on, the display shows in hours, minutes, and seconds (or minutes, seconds, and tenths of seconds after changing jumpers — see Installation section) the distance that the tape has moved from zero (tape position when tape timer RESET pushbutton is pressed or recorder/ reproducer power is turned on).
14	Tape Timer RESET pushbutton switch	Used to reset the tape timer display to zero (0 00 00).

Table 3-3. Recorder Control Panel, Signal System Controls and Indicators



13690-5

INDEX NO.	NAME	FUNCTION
1	Channel Select pushbutton switches (4)	Switches permit channel (1, 2, 3, 4) selection for various modes of operation. Used in conjunction with the READY, SAFE, SYNC, REPRO, and INPUT pushbutton switches (index no. 2 – 6).
2.	READY pushbutton switch and Ready (yellow) and Record (red) Channel 1 – 4 indicators	<p>Used in conjunction with channel select pushbutton switch (index no. 1 of this table). In ready, channel is enabled for entering record mode.</p> <p>Ready indicator(s) light when READY pushbutton switch and corresponding channel select pushbutton switch (index no. 1, this table) are simultaneously pressed. Record mode is entered by simultaneously pressing play and record pushbutton switches (index no. 3 and 5, Table 3-2). When record mode is entered, ready (yellow) indicator goes out and record (red) indicator lights, indicating the channel(s) in record mode.</p> <p>If channel is in record mode and READY pushbutton and same channel select pushbutton switch are simultaneously pressed, the channel will go out of record and will return to ready mode. Record mode may be reentered by simultaneously pressing play and record pushbutton switches (index no. 3 and 5, Table 3-2). Tape motion and status of other channels are not affected by this action.</p>

Table 3-3. Recorder Control Panel, Signal System Controls and Indicators (Continued)

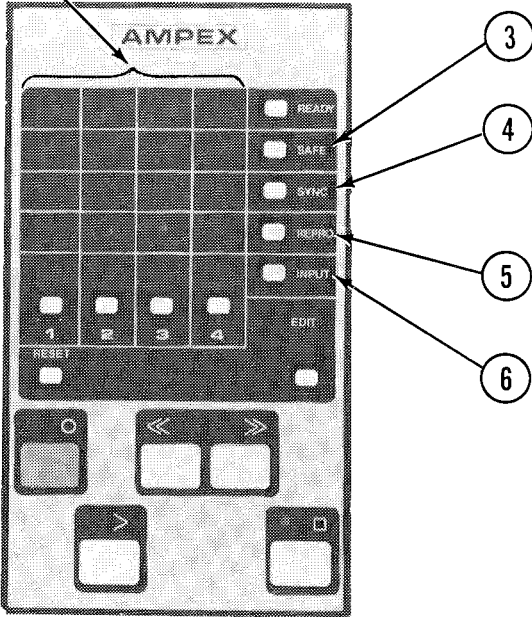
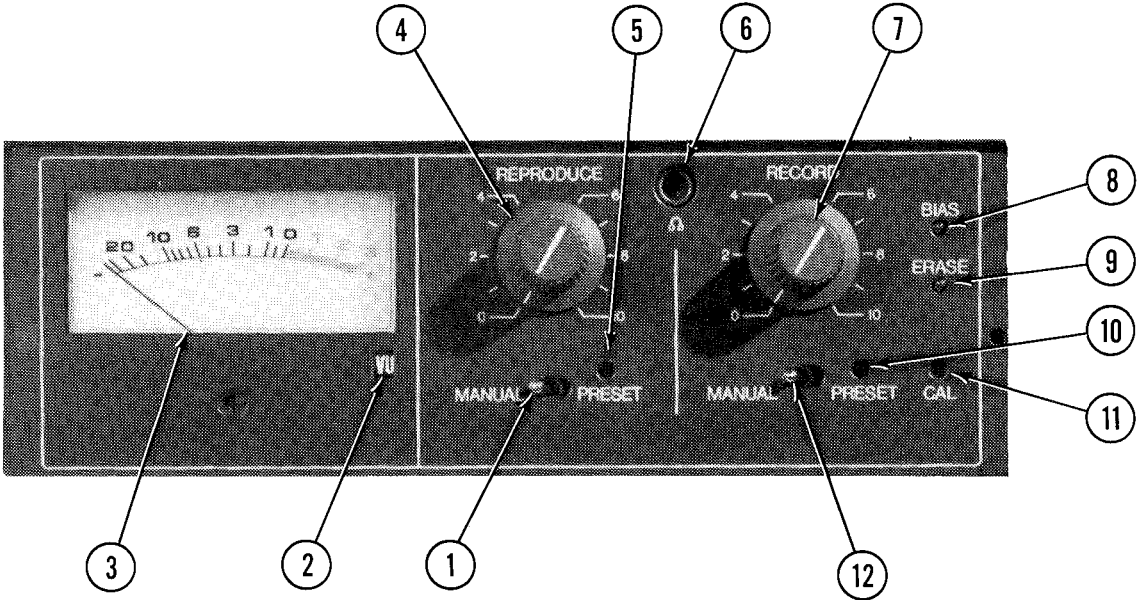
<div><div>INDICATORS</div><div></div></div>			13690-5
INDEX NO.	NAME	FUNCTION	
3	SAFE pushbutton switch and Safe Channel 1 – 4 indicators (green)	<p>Used in conjunction with channel select pushbutton switch (index no. 1). In safe, channel is prevented from entering record mode.</p> <p>Safe indicator(s) light when power is initially applied or when SAFE pushbutton and corresponding channel select pushbutton switch (index no. 1) are simultaneously pressed. When lit, recording on channel indicated is inhibited.</p> <p>If channel is in record mode and SAFE pushbutton and same channel select pushbutton are simultaneously pressed, the channel will go out of record mode and enter safe mode. To reenter record mode, channel must first be placed into ready mode. Tape motion and status of other channels are not affected by this action.</p>	
4	SYNC pushbutton switch and Sync Monitoring Channel 1 – 4 indicators (yellow)	<p>Used in conjunction with channel select pushbutton switch (index no. 1, this table) to select Sel-Sync mode. Sync indicator(s) light when SYNC pushbutton and corresponding channel select pushbutton are simultaneously pressed. When indicator is lit, signal on tape is reproduced by record head of selected channel(s). This reproduced signal is connected to audio output.</p>	

Table 3-3. Recorder Control Panel, Signal System Controls and Indicators (Continued)

INDEX NO.	NAME	FUNCTION
4 (Continued)		In in Sel-Sync mode and ready mode or record mode is entered, input signal being recorded is connected to audio output of that channel. Sync indicator light goes out and input indicator lights. If channel is removed from record mode, system returns to sync mode and sync indicator lights (unless repro or input monitoring were selected while in record mode).
5	REPRO pushbutton switch and Repro Monitoring Channel 1 – 4 indicators (yellow)	<p>Used in conjunction with channel select pushbutton switch (index no. 1). In repro, signal being reproduced by reproduce head is connected to audio output.</p> <p>Repro indicator(s) light when power is initially applied or when REPRO pushbutton and corresponding channel select pushbutton switch (index no. 1) are simultaneously pressed. When lit, signal being reproduced by reproduce head is connected to audio output.</p>
6	INPUT pushbutton switch and Input Monitoring Channel 1 – 4 indicators (yellow)	<p>Used in conjunction with channel select pushbutton switch (index no. 1). Input signal to recorder is connected to audio output.</p> <p>Indicator(s) light when INPUT pushbutton and corresponding channel select pushbutton switch are simultaneously pressed. When lit, input signal to recorder is connected to audio output connector for monitoring purposes (E-E mode).</p> <p>Indicator also lights if record mode is entered while in sync mode.</p>

Table 3-4. Input/Output Module Accessory, Controls and Indicators



13749-12

INDEX NO.	NAME	FUNCTION
1	Reproduce MANUAL/ PRESET toggle switch	Switch used to select MANUAL or PRESET reproduce level. In MANUAL position, REPRODUCE level control (index no. 4) is used to vary reproduce level of associated channel. In PRESET position, reproduce level is controlled by the setting of the reproduce calibrate control (index no. 5).
2	VU/PK indicator	Indicates type of meter operation selected, volume unit (VU) or peak signal level (PK).
3	VU/Peak meter	Indicates signal level present at audio output of associated channel. Internal switch permits selection of vu or peak signal level reading on meter.
4	REPRODUCE level control	Control used, when MANUAL/PRESET toggle switch (index no. 1) is in MANUAL position, to vary reproduce level of associated channel.
5	Reproduce PRESET adjustment control (R1)	Used to set reproduce line output operating level.

Table 3-4. Input/Output Module Accessory, Controls and Indicators (Continued)

INDEX NO.	NAME	FUNCTION
6	Phone jack	Receptacle for headphone plug. Audio of associated channel can be monitored on headphones (600 ohms or greater impedance).
7	RECORD level control	Control used, when MANUAL/PRESET toggle switch (index no. 12) is in MANUAL position, to vary record level of associated channel.
8	BIAS indicator	Indicator lights in record mode to indicate that bias signal is present at the record head.
9	ERASE indicator	Indicator lights in record mode to indicate that erase signal is present at the erase head.
10	Record PRESET adjustment control (R2)	Used to preset record input level.
11	Record CAL adjustment control (R3)	Used to set input monitoring level and meter indication to match reproduced level from tape.
12	Record MANUAL/PRESET toggle switch	Switch used to select MANUAL or PRESET record level. In MANUAL position, RECORD level control (index no. 7) is used to vary record level of associated channel. In PRESET position, record level is controlled by the setting of the record PRESET adjustment control (index no. 10).

3.3. OPERATING PROCEDURES

The following general information is applicable to all modes of operation.

1. If the tape runs completely off the supply or takeup reel, the recorder/reproducer automatically stops and enters unthread mode, and the tape timer display "freezes".
2. The following two groups of functions are mutually exclusive in that only one function in a group may be selected at one time: Record, Ready, or Safe; Sync, Repro, or input.
2. Simultaneously press the channel select pushbutton switch and the READY pushbutton switch for each channel to be recorded. The associated ready indicator (yellow) will light.
3. Simultaneously press the channel select pushbutton switch and SAFE pushbutton switch for each channel that is not to be recorded. (Note: When the recorder is initially turned on, all channels will automatically be in safe mode.) The associated safe indicator (green) will light.
4. Simultaneously press the channel select pushbutton switch and the INPUT pushbutton switch for each channel selected for record mode.
5. Connect signal(s) to be recorded to the appropriate audio input connectors.

3.4. Recording

Proceed as follows:

1. Perform all steps of the pre-operating procedures.

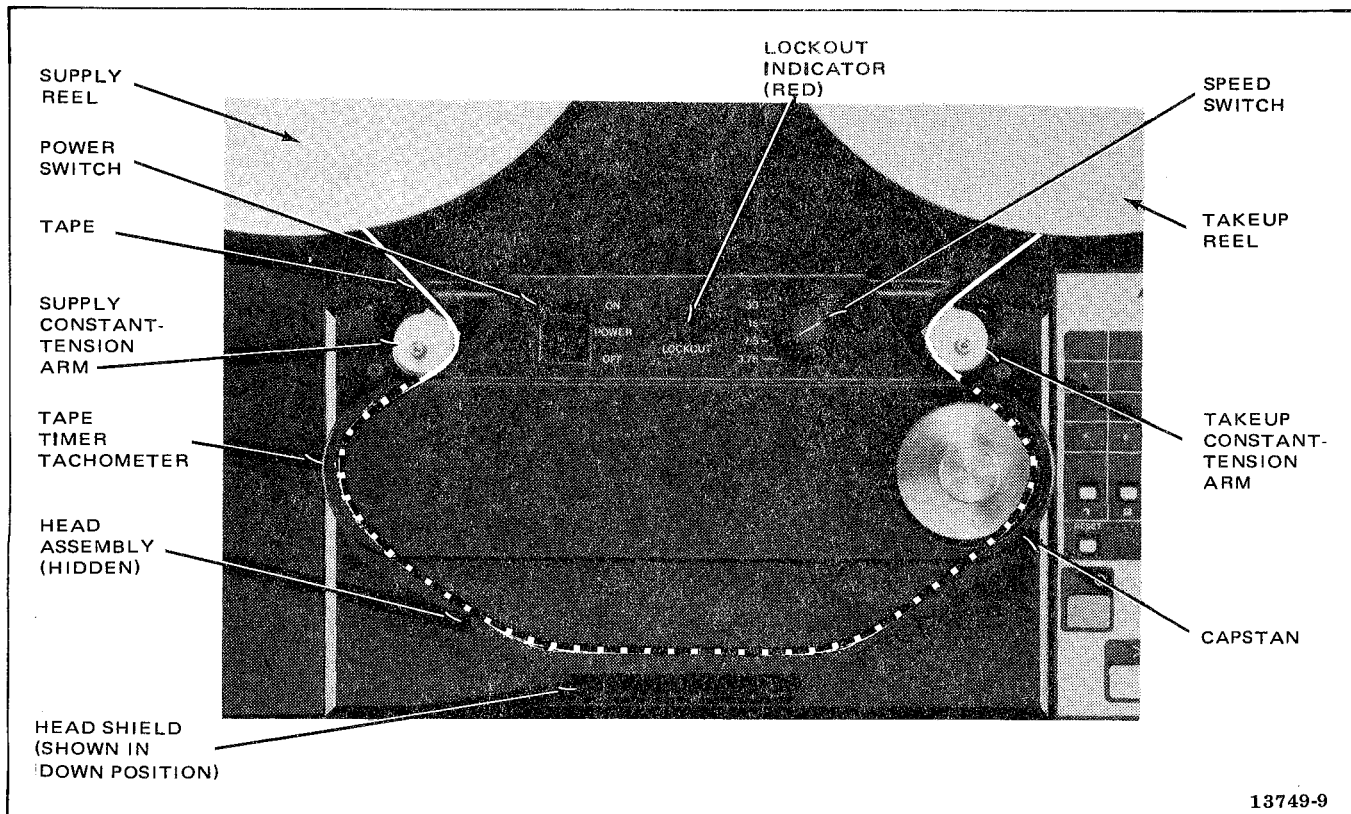


Figure 3-1. Tape Threading Path

6. If system is equipped with an input/output module assembly, perform one of the following steps for each channel to be recorded.
 - a. Set RECORD MANUAL/PRESET switch to PRESET and observe level meter for desired indication. If level is not correct, adjust level fed to input/output assembly or perform step b.
 - b. Set RECORD MANUAL/PRESET switch to MANUAL and adjust RECORD level control for desired indication on meter.
7. Simultaneously press play and record pushbutton switches to start tape motion and begin recording on selected channel(s). (An alternate method is to depress play pushbutton to start tape motion and then, while holding play pushbutton depressed, press record pushbutton.) The master record indicator (red) and the channel record indicator(s) will light.
8. If desired while recording, the input signal for each channel can be compared with the recorded signal on that channel by holding the channel selector pushbutton depressed and alternately pressing the associated INPUT and REPRO pushbutton switches.
9. When recording is complete, record mode may be terminated by performing any one of the following steps. (Note that internal logic control circuitry will delay any commanded change in tape motion direction or velocity until after all channels have completely terminated record mode.)
 - a. Press stop pushbutton to stop tape motion and deactivate record mode.

- b. Depress record pushbutton and momentarily press stop pushbutton. Record mode will be terminated but transport will continue to run at the selected tape speed.
- c. Press rewind or fast forward pushbutton.
- d. Simultaneously press a channel select pushbutton and a SAFE or READY pushbutton to deactivate record on any individual channel as transport continues to run at the selected tape speed.

3-5. Fast Winding

For fast-winding operations (fast forward or rewind modes), press either the rewind or fast forward pushbutton switch. The associated rewind or fast forward indicator (yellow) will illuminate. For editing or cueing operations, these pushbuttons can be pressed alternately without having to press the stop pushbutton between fast-winding selections. Either fast winding mode can be entered from stop, play, or record mode.

Play mode may be entered while in fast forward or rewind mode by pressing the play pushbutton switch. Record mode may only be entered from play mode, provided that capstan servo lock is obtained within 0.8 second.

Two tape lifter arms that move the tape away from the heads are automatically actuated in both fast-winding and spool modes. To monitor audio in either of these modes, press the EDIT pushbutton switch. The tape lifters will retract while the pushbutton is held pressed.

3-6. Reproducing

Proceed as follows:

1. Perform all steps of the pre-operating procedures.
2. Simultaneously press the channel select pushbutton switch and the SAFE pushbutton switch for each channel. The associated safe indicator (green) will illuminate. (Note: When the recorder is initially turned on, all channels will automatically be in safe and repro modes.)

3. Simultaneously press the channel select pushbutton switch and the REPRO pushbutton switch for each channel to be reproduced. The associated indicator (yellow) will illuminate.
4. Press the play pushbutton switch to start tape motion and reproduce recorded material. The play indicator (green) will illuminate.
5. When desired material has been reproduced, perform any one of the following steps to terminate reproduce mode:
 - a. Press stop pushbutton switch to stop tape motion.
 - b. Press rewind or fast forward pushbutton switch to enter a fast-winding mode.

3-7. Tape Timer Operation

The tape timer displays in hours, minutes, and seconds (or minutes, seconds, and tenth of seconds after changing jumpers, as described in paragraph 2-28) the distance the tape has moved from a zero (0 00 00) reference point established by pressing the RESET pushbutton on the control unit. The timer displays 0 00 00 to 9 59 59 when transport operates in the forward direction, and displays 9 59 59 after passing through 0 00 00 when operating in the reverse direction. If the tape runs off either reel or unthread mode is entered, the tape timer display "freezes".

If a remote control unit is also being used, pressing the RESET pushbutton switch on the remote control unit or on the recorder control unit will reset both tape timer displays to zero (0 00 00).

3-8. Sel-Sync Function

In Sel-Sync mode, the audio signal to be reproduced from the tape is derived from the record head rather than the reproduce head. This mode of operation permits recording of new material precisely in time with previously recorded material and is used normally for Sel-Sync recording and overdubbing as described in the following paragraphs.

In Sel-Sync recording, a performer listens to one or more previously recorded tape tracks using the Sel-Sync/reproduce mode while recording material on another track. For example, assume a four-channel recorder/reproducer is equipped with a tape having two prerecorded tracks and two blank tracks. Typically, the two prerecorded tracks are reproduced (using two of the record heads for pickup), mixed together using studio equipment, and fed to a performer's earphones. The performer then listens to the prerecorded material while recording material on one of the blank-track channels. Thus, the new material is recorded in synchronism with the prerecorded material.

In overdubbing, a performer listens to material that he previously recorded on one or more tape tracks using the Sel-Sync/reproduce mode. The performer can repeat his previous performance (but not record it) and get into proper timing with the original material. At that point where the overdub is desired, the track(s) to be overdubbed is (are) switched to the record mode. The audio that the performer hears is automatically switched from the off-tape audio to the input audio the performer is recording when the record mode is selected.

To place a channel in Sel-Sync mode, proceed as follows:

1. Perform all steps of the pre-operating procedures.
2. Simultaneously press the channel select pushbutton switch and the SYNC pushbutton switch for each channel desired to be in the Sel-Sync mode.
3. Simultaneously press the channel select pushbutton switch and a READY or SAFE pushbutton switch corresponding to the desired Sel-Sync mode of operation.
4. Follow instructions for recording or reproducing depending on desired Sel-Sync mode of operation.

3-9. Editing

The following procedures may be used to perform editing functions.

1. Thread Mode. If tape is stopped in thread mode, the capstan edit knob may be turned in either direction to move tape from reel to reel under reel-servo control.
2. Stop/Edit Mode. If tape is stopped in thread mode, pressing the EDIT pushbutton switch causes recorder to enter unthread mode (reel servos disengage) and reels are free to turn for editing, splicing, or manual tape movement. (Note: This function is disabled when operating recorder from a remote control unit.)
3. Play/Edit Mode. If play or record mode is active, pressing EDIT pushbutton switch causes tape motion to continue in play or record mode, removes power to takeup reel, and causes takeup tension-arm roller to engage capstan which causes tape to be spilled at takeup side of transport. (Note: This function is disabled when operating recorder from a remote control unit.)

If in play/edit mode and stop pushbutton switch is pressed, tape will stop, edit mode will be retained, and tape can again be spilled by pressing play pushbutton switch. To cancel play/edit mode, press stop pushbutton and after tape stops, press EDIT pushbutton. To enter record mode from play/edit mode, press play and record pushbutton switches simultaneously.

4. Shuttle/Edit or Spool/Edit Mode. If EDIT pushbutton is pressed while in fast forward, rewind, or spool mode, the tape lifters retract allowing recorded material on tape to be reproduced as long as EDIT pushbutton is held pressed.

3-10. Spooling

Spool mode is used to transfer tape from reel to reel at a constant speed (60 in/s or 180 in/s) to obtain a uniform tape pack. (Refer to paragraph 2-24 for procedure to select spool speed.)

1. To select forward spool mode, simultaneously press the play and the fast forward pushbutton switch. The fast forward indicator

(yellow) will illuminate and the play indicator (green) will illuminate when spool speed is obtained.

2. To select rewind spool mode, simultaneously press the play and rewind pushbutton switch. The rewind indicator (yellow) will illuminate and the play indicator (green) will illuminate when spool speed is obtained.
3. If in either forward or rewind spool mode and it is desired to reverse spool mode direction, only the opposite direction pushbutton switch (fast forward or rewind) need be pressed.
4. To deactivate spool mode, press stop pushbutton switch. Another mode of operation, except record, may then be selected before tape comes to a stop.

3-11. Remote Control Operation

All recorder functions may be controlled from the remote control unit with the exception of initiating play/edit or stop/edit (unthread) modes. Except for these two functions, the remote control unit operates in parallel with the local control unit at all times.

3-12. PURC Operation

The recorder/reproducer is capable of operating with or without PURC (pick-up recording capability) operation as desired, by placement of a jumper located on the PADNET PWA. (Refer to paragraph 2-30.) Recorders shipped from the factory are set for normal (non-PURC) operation.

The use of PURC eliminates the problem of overlaps and holes in recordings when inserting (dubbing) new material within previously recorded programs. In a recorder system without PURC, initiating record mode energizes the erase and record heads simultaneously. Since there is a physical distance between the erase and record head, a period of over-recording on unerased tape occurs. When the dub is terminated, a hole is left in the program. The length of time of this hole is related to the distance between the erase and record head and the speed of the tape.

In a system equipped with PURC, separate erase and bias amplifier circuits are provided, and the turnon and turnoff times of the amplifiers are individually controlled. When record mode is initiated, the erase circuit is energized first; then, after a time interval, the bias amplifier is energized. When the recording is terminated, the erase circuit is de-energized first; and then, after a time interval, the bias amplifier is de-energized. Thus, the problem of an overlap and hole is eliminated in the dubbed portion of the recording. These on and off times are illustrated in Figure 3-2.

3-13. Editing Procedures. The approximate on and off time delay to be considered while performing edit functions is calculated by dividing the distance between the erase and record head (1.46 inches) by the tape speed. These approximate on/off delay times are shown in Table 3-5. Because of the long on/off time delay, insert edits at 3.75-in/s operation are not recommended.

Table 3-5. PURC Edit Delay Times

TAPE SPEED (IN/S)	APPROXIMATE ON/OFF DELAY TIME (MS)
30	48.7
15	97.3
7.5	194.7
3.75	389.3

If a single track insert edit is to be made, such as correcting a single word, use a white felt-tip pen or tape-editing pencil to mark the back side of the tape where the correction should start and where the correction should end. While performing the edit function, start the record mode when the first mark passes the erase head and stop the record mode when the second mark passes the erase head.

If an insert edit is to be made on one or two tracks of a four-track recording, monitor one or two tracks of the tracks in Sel-Sync mode. This will aid in synchronizing the new recording with the tracks being monitored.

The on and off delay times shown in Table 3-5 can be used to anticipate when the start and stop recording times are to take place. If one of the tracks is recorded with a timing signal, such as the

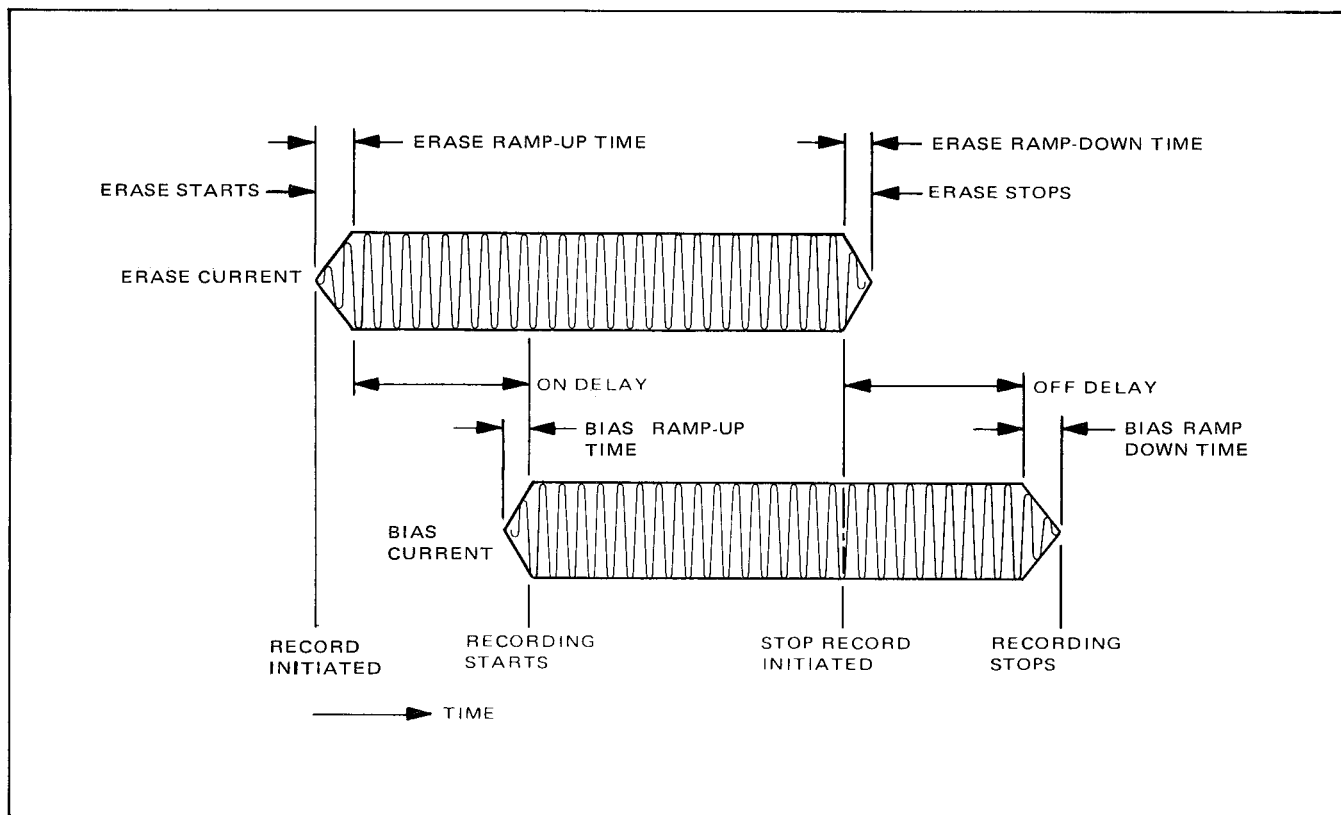


Figure 3-2. PURC On/Off Timing Relationships

SMPTE time-and-control code signal, precise editing can be obtained.

3-14. Insert Edit. A suggested method of performing an insert edit is as follows:

1. For channel(s) to be edited, simultaneously press the channel select pushbutton switch and the READY pushbutton switch.
2. For channel(s) not to be edited, simultaneously press the channel select pushbutton switch and the SAFE pushbutton switch.
3. Rewind the tape to a point before the point to be edited.
4. Press play pushbutton switch to place system in play mode.
5. Press and hold record pushbutton switch, and then press and hold stop pushbutton switch.
6. While still holding the record and stop pushbutton switches depressed, press play pushbutton switch just prior to the edit point (Table 3-5) to start record mode.
7. Continue holding all three pushbutton switches depressed and, just prior to the end of the edit point (Table 3-5), release play pushbutton switch to stop record mode. Transport will continue to run in play mode. Release other pushbuttons and enter any mode desired. (Note that system stays in record mode only as long as play pushbutton switch is held pressed.)

SECTION 4

THEORY OF OPERATION

This section of the manual provides a block diagram oriented discussion of the functional operation of the recorder/reproducer system followed by detailed theory of operation of the recorder/reproducer and input/output assembly (accessory) circuits.

4-1. FUNCTIONAL DESCRIPTION OF TAPE TRANSPORT

Figure 4-1 is a simplified block diagram of the ATR-100 system. The recorder/reproducer does not incorporate a capstan pinch roller but controls tape movement in all modes of operation while under capstan servo and reel servo control. The capstan servo controls tape speed and direction while the reel servo maintains dynamically constant tape tension in all modes of operation.

Tape movement is controlled by a dc capstan motor which is controlled by a closed loop capstan servo. The capstan is driven to control tape motion but the actual work of moving the tape is accomplished by the reel servo, which operates independent of the capstan servo. Tape tension is maintained equally on the takeup and supply side of the capstan for all sizes of tape reels (2 inches through 14 inches in diameter). Since there is no difference in tape tension at the capstan, there is no tendency for tape to slip on the capstan and therefore no pressure roller (pinch roller) is required.

The actual value of tape tension is controlled by the tension arm rotary solenoids which are a component of the constant-tension arms. The solenoids are driven by direct current to result in a particular torque at the mid-position of the arm swing. These solenoids apply a near-constant force to the tension arms that are opposed by the force provided by the reel motors through the tape. The current

in the solenoids is programmed and switched by the tension programming logic (located on reel servo PWA No. 9) depending on tape width, operating condition, and direction of tape movement to result in a given value of equal tape tension across the capstan.

The tension arms have an LED affixed to each arm and the light from the LED is focused on to a stationary photopotentiometer. The output from the photopotentiometer is a voltage indicative of arm position and is the servo error. Tape motion creates an unbalance or position error of the tension arm's position and, by means of a closed-loop reel servo, a tension unbalance is created in the tape path (but not across the capstan) by the reel motors. This tension unbalance causes the reel motors to perform the work of moving the tape at a rate established by the capstan. There are no independent commands supplied to the reel servo to cause such an unbalance. All control of the reels is initiated by capstan movement transmitted through the tape to the tension arm sensors.

The output from the tension arm sensors is amplified, compensated for the mechanical properties of the transport, and used to modulate a 28.8-kHz carrier to develop a pulse-width modulated (PWM) signal with a duty cycle that varies with the magnitude of the servo error signal. This PWM signal is amplified and used to drive the reel dc motors.

4-2. BLOCK DIAGRAM FUNCTIONAL DESCRIPTION

As shown in Figure 4-1, the ATR-100 can be configured to record and reproduce up to four audio channels. Each audio input may come from a line or other audio source, such as another tape reproducer.

4-3. Thread Mode

When power is applied and tape is threaded and taut so that either tape taut switch is closed, pressing the stop pushbutton switch enables the transport control PWA No. 7 logic circuitry to activate the reel servos (reel servo PWA No. 9) and place system into thread mode. After thread mode is established, any other mode may be entered.

4-4. Reproduce Mode

When play mode (or record mode) is selected, the capstan motor is initially driven by a fixed dc current source until a phase-lock condition is achieved, and then the motor is controlled by the output of a phase comparator (capstan servo PWA No. 8). The inputs to the phase comparator are a submultiple of a 9.6-kHz reference frequency (submultiple frequency used depends on selected tape speed) and the capstan tachometer pulses from the capstan motor assembly. As discussed in paragraph 4-1, tape movement is sensed by the supply and takeup sensors on the constant-tension arms and causes the reel servos (reel servo PWA No. 8) to control tape-reel movement.

The audio signal recovered from the tape by the record (Sel-Sync operation) or reproduce head(s) is amplified and equalized on the audio and PAD-NET PWA(s) and routed to the audio output for external processing, or to the optional input/output assembly for further amplification.

4-5. Record Mode

In the record mode, tape is moved across the heads under reel servo and capstan servo control as in play mode. During record mode, an erase signal (144 kHz) and bias signal (432 kHz) from the master oscillator on audio control PWA No. 5 are fed to the audio and PADNET PWA(s). The erase signal is fed to the erase head(s) to erase any previously-recorded signals from the tape before it reaches the record head(s). Information to be recorded is amplified, added to the bias signal, and applied to the record head(s). The information is recorded on the tape as it passes over the record head. However, actual recording on tape is not permitted to begin until the capstan servo is phase

locked and a command signal is routed from the capstan servo (PWA No. 8) via transport control (PWA No. 7) and audio control (PWA No. 5) to the main audio PWA(s). After actual recording on tape has begun, bias and erase status signals are routed to the input/output assembly to cause the BIAS and ERASE confidence indicators to illuminate.

4-6. Spool Mode

In spool mode, capstan and reel servo operation is identical to play and record mode operation except the reference frequency furnished to the phase comparator (capstan servo PWA No. 8) from the audio control PWA No. 5 is either 9.6 kHz for 60-in/s operation, or 28.8 kHz for 180-in/s operation. In spool mode, circuitry on reel servo PWA No. 9 and transport control PWA No. 7 causes the tape lifter solenoid to be energized and lift the tape from the heads.

4-7. Shuttle Modes

In fast forward or rewind modes, the capstan is driven by a dc current driver (capstan servo PWA No. 8) rather than the phase comparator circuit. As in play, record, and spool modes, the tape movement is sensed by the supply and takeup sensors on the constant tension arms and, by means of the closed-loop reel servo, tape is moved from reel to reel.

4-8. Control Unit

The control unit is used to initiate all transport and signal mode functions by means of pushbutton switches which control mode latching circuits on transport control PWA No. 7 and on audio control PWA No. 5, respectively. The control unit also houses LED indicators that indicate system modes of operation. The LED indicators associated with signal mode selection are driven by multiplexer circuitry on audio control PWA No. 5.

The play, stop, record, fast forward, rewind, and edit indicators are driven by logic circuitry on transport control PWA No. 7. These indicator drives are not multiplexed.

Also located on the control unit is the tape timer display which consists of five 7-segment LED display indicators. The transport tape timer tachometer furnishes pulses when tape is in motion to the tape timer circuitry on transport control PWA No. 7. Timer display information, in the form of a serial stream of binary-coded decimal digits, is sent to a decoder in the control unit. Digit select signals are also routed from transport control PWA No. 7 to the control unit in order to select the digit for display in the proper sequence on the tape timer LED display.

4-9. DETAILED THEORY OF OPERATION

Detailed theory of operation of the recorder/reproducer and input/output assembly (accessory) is presented in the text that follows. Simplified functional block diagrams support the text as an aid in understanding the ATR-100 circuitry. For the complete schematic diagrams, see Section 6 of this manual.

Logic elements are identified in the text and block diagrams by their schematic reference designator and output pin number. For example, A3-1 refers to integrated circuit A3, output pin number 1. In the case where there is more than one output pin, the true (high) or active output pin designation is used.

Logic level commands used throughout the system are designated on the schematics and block diagrams by their three-letter abbreviation. All commands are a logic low, except for the LFT command and where complimentary logic is required. For example, the ready/safe command is so identified in the text but is designated $\text{ready}_{\text{L}}\text{safe}$ on the block diagrams. This indicates the ready command is a logic high and the safe command is a logic low. Table 4-1 is an alphabetical list (by abbreviation) of all commands used throughout the system.

Table 4-1. Command Signal Abbreviation

ABBREVIATION	COMMAND
BCD - A - D	Binary-coded decimal drive to 7-segment decoder

Table 4-1. Command Signal Abbreviation (Continued)

ABBREVIATION	COMMAND
BCS	Bias command status
BVS	Bias voltage status
CLK	Clock
CRB	Counter reset button
CS1 - 4	Channel select buttons
DRC	Command direction
DS1 - 5	Digit select lines
EDB	Edit button
EDI	Edit indicator
ERS	Electronics record status
EVS	Erase voltage status
FFB	Fast forward button
FFI	Fast forward indicator
ILM	Inner limit
IPB	Input button
ISL	Illegal speed lockout
LFT	Tape lift command
LKD	Locked
MRB	Main record bus
MTS	Motion sense
OLM	Outer limit
PDR	Play and record
PEC	Play edit command
PLB	Play button
PLC	Play command
PLI	Play indicator
RCB	Record button
RCI	Record indicator
RDB	Ready button
RED	Remote edit
RPB	Reproduce button
RWB	Rewind button
RWI	Rewind indicator
SFB	Safe button
SHC	Shuttle command
SPC	Spool command
SSA	Speed select A
SSB	Speed select B
STB	Stop button
STC	Stop command
STI	Stop indicator
STP	Stop pulse
SVO	Servos on command
SYB	Sync button
TDR	True direction
TLM	Torque limit
TTS	Tape taut switch
WUL	Wake-up line

4-10. Capstan Servo Functional Description

The capstan servo is a closed-loop type of servo that controls the speed and direction of the dc capstan motor during all recorder modes of operation. Figure 4-2 is a general block diagram of the capstan servo system. During operation, tachometer pulses are generated at a rate proportional to speed. These pulses are amplified, shaped, and fed as one input

to a digital phase comparator. The other input to the phase comparator is a reference signal. This reference signal is derived from a master oscillator and determines the record, play, and spool speeds of the recorder. When the phase comparator is locked to the two signals, a rectangular-wave error signal is provided by the phase comparator. This signal is fed through a carrier filter and a compensation amplifier to a motor drive amplifier (MDA) that drives the dc capstan motor.

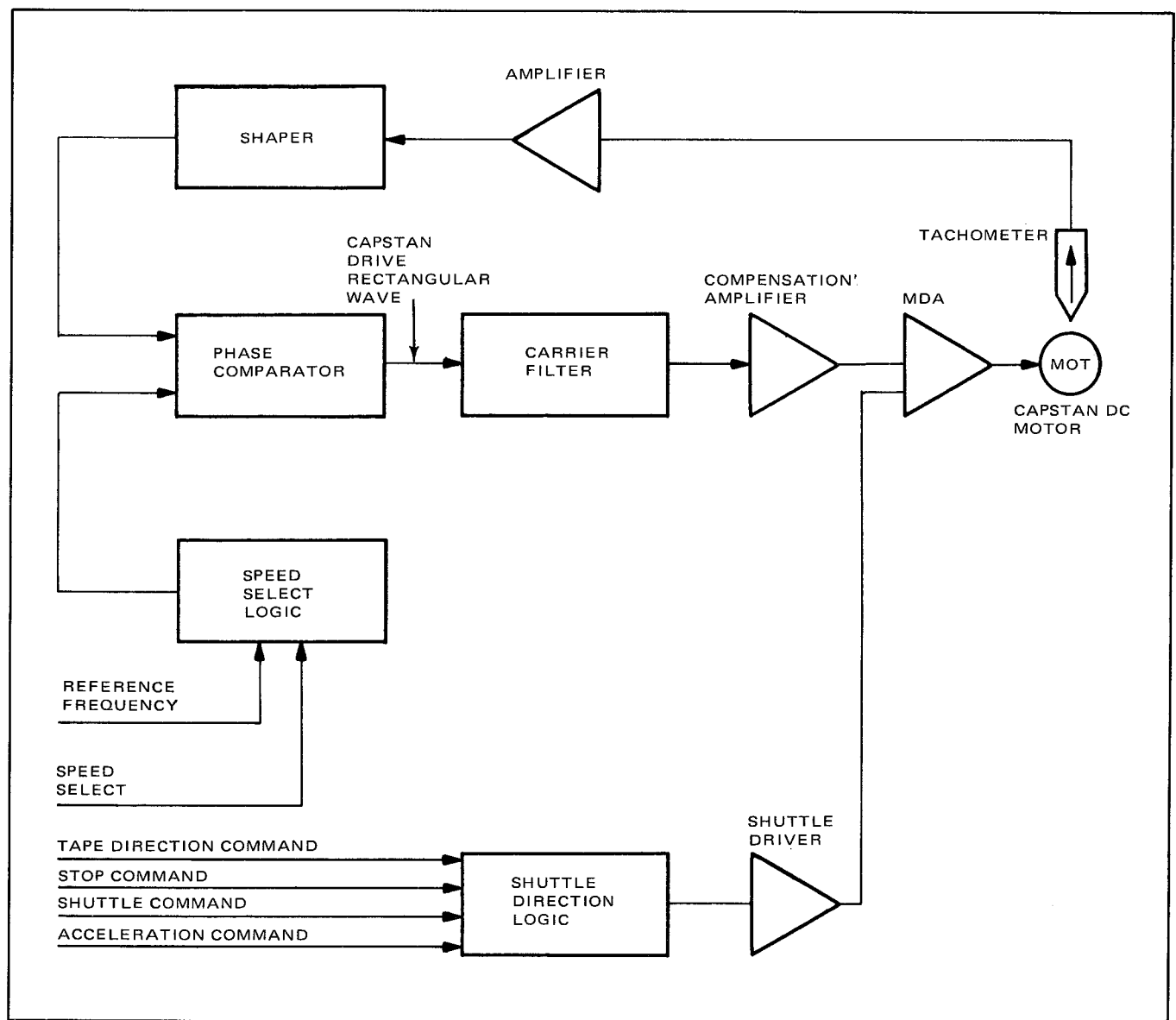


Figure 4-2. Capstan Servo General Simplified Block Diagram

In shuttle modes, initiation of stop mode, and during the initiation of play or record modes before phase lock is achieved, the capstan motor is controlled by a fixed dc current source from the shuttle driver. The direction of current flow, hence motor direction (or motor torque), is controlled by the shuttle direction logic.

4-11. Capstan Servo Circuit Details

The capstan servo circuitry is principally located on capstan servo PWA No. 8 and on the transport assembly. Figure 4-3 is a simplified block diagram of the capstan servo, and drawing number 4840390 is the schematic diagram.

4-12. Capstan Tach Assembly. The capstan tach assembly provides motion sense, rotational, and direction information. The assembly contains an optical disc encoder that generates two tachometer signals as the capstan rotates. Attached to the capstan assembly is a circular glass disc encoder, approximately 2.5 inches in diameter. The disc has 1,200 clear and 1,200 opaque, equal-width segments located near the outer edge of the disc. Located above the rotating disc is a stationary encoder grating that has two groups of like segments but which are displaced 90° from each other. The patterns on the moving and fixed gratings are identical and, as the disc rotates, a shutter effect is obtained. Light from two LEDs, located below the disc, is alternately blocked and allowed to pass to two photosensors located above the fixed grating.

The output signals from the photosensors are 90° out of phase and are amplified by current mode operational amplifiers A20-6 and A21-6. The amplified sine-wave signals are converted to square waves by Q6 and Q7, and applied to D flip-flop A15 which operates as a direction sensor. The output of one photosensor is clocked through the flip-flop by the output of the other photosensor. Therefore, as the capstan moves in one direction, all logic lows are clocked through and, when the capstan turns in the opposite direction, all logic highs are clocked through. These outputs, indicating tape motion direction, are fed to direction logic components A3/A4 and to transport control PWA No. 7. Hysteresis components R31 and C26 provide positive feedback from the output of Q6 to the

input of A20-6 to ensure a clean pulse with a fast rise time for the clock input of flip-flop A15-9. The output of Q6 is also used to clock retriggerable one-shot A6-9, which serves as a motion sense detector. One-shot A6-9 has a long time constant (approximately 0.22 second) and does not change state as long as the capstan is turning. The output of A6-9 is fed to transport control PWA No. 7 and to reel servo PWA No. 9 to provide motion sense information.

4-13. Phase Comparator. The square-wave output of pulse shaper Q7 is also applied to zero crossing detector and pulse generator A5-8/R14/C13, that provides a $1\text{-}\mu\text{s}$ pulse for every transition of the square-wave input. These pulses are fed as one input to a 3-bit bi-directional shift register (A7/A8/A9) which functions as a phase comparator. The other input to the comparator is a precise reference frequency that represents the desired tape speed. The comparator compares the tach frequency with the reference frequency and provides output logic signals that indicate whether the servo is in an underspeed, overspeed, or phase-locked condition. The logic states of these output signals are summarized in Table 4-2. When the phase error is less than 360° , a rectangular wave with a varying duty cycle (depending on the capstan servo error) is present at A8-6. This rectangular wave is used to drive the capstan MDA, via a carrier filter and compensation amplifier, when the phase comparator is locked to the reference signal. The other output lock signals are used to control logic functions described later.

When the phase comparator is locked, A13-6 is low, Q2 does not conduct, and A14-6 provides a logic low that signifies the phase comparator is locked. This signal is routed to transport control PWA No. 7 to enable the play and record modes of operation.

4-14. Speed Reference Frequency. The phase comparator compares the phase of the signal from the capstan tach reader to a submultiple of the 5.184-MHz signal from the master oscillator located on audio control PWA No. 5. For play or record modes, a submultiple of 9,600 Hz is used; and for spool mode, 9,600 Hz or 28.8 kHz is used. These reference frequencies and associated tape speeds and recorder modes of operation are shown in Table 4-3.

Table 4-2. Phase Comparator Output Logic States

GATE	SERVO CONDITION		
	UNDERSPEED	OVERSPEED	PHASE LOCKED —
A9-6	H	L	H
A7-11	L	H	H
A14-8	L	H	L
A14-11	H	L	H
A13-6	H	H	L
A14-3	H	L	L
A13-12	H	L	L

Table 4-3. Tape Speed Reference Frequencies

TAPE SPEED (IN/S)	MODE	REFERENCE FREQUENCY
180	Spool	28.8 kHz
60	Spool	9,600 Hz
30	Play/Record	4,800 Hz
15	Play/Record	2,400 Hz
7.5	Play/Record	1,200 Hz
3.75	Play/Record	600 Hz

As shown on simplified block diagram Figure 4-3, a 9,600-Hz reference signal from audio control PWA No. 5 or an external source is applied to the reference select logic A18. A command signal routed from accessory connector J11 selects either the internal or external reference signal, and the selected signal is applied to the clock input of 4-bit binary divider A12. When play or record mode is selected, the divider is enabled by a low applied to its reset inputs. The 9,600-Hz signal is divided down (4,800 Hz, 2,400 Hz, 1,200 Hz, and 600 Hz) and applied to the play/record speed select logic (A10/A11-8). The speed select signal, in the form of a 2-bit binary encoded signal from the transport speed select switch is applied to the input of the speed select logic A10/A11. The speed select logic permits the selected frequency to pass to the spool/play-record select logic (A17). When in play or record mode, gate A17-8 is enabled and passes

the selected frequency to zero crossing detector and pulse generator A5-11/R19/C17. The generator provides a 1- μ s positive-going pulse for each transition of the reference square-wave signal. These pulses are applied as the reference signal for the phase comparator.

For selection of spool speed, a jumper on PWA No. 8 is positioned to select 60 or 180 in/s (during recorder installation). These speeds correspond to a reference frequency of 9,600 Hz or 28.8 kHz respectively. When spool mode is selected, a low command signal is applied to the spool/play-record select logic (A17) to lockout the play/record frequencies and enable the preselected (jumper) spool frequency. The enabled spool frequency is applied to the zero crossing detector and pulse generator as in play/record modes.

4-15. Direction Logic and MDA Driver. Direction logic A3/A4 accepts input signals from five sources and determines what the polarity of the capstan motor drive voltage should be for the various recorder modes of operation. These input signals are from the phase comparator logic A13/A14; direction sensor A15-9; and the spool, play, and shuttle direction commands from transport control PWA No. 7. The output of the shuttle direction logic (A4-11) is a logic high for forward direction and a logic low for reverse direction. For shuttle modes, for initiation of play or record mode before phase lock is achieved (underspeed condition), and for capstan drive to stop, the level from A4-11 is inverted by A19-6 and applied to shuttle driver Q5 which translates the logic level to +5 Vdc for a forward direction motor rotation and -5 Vdc for reverse direction motor rotation. This voltage level is routed through FET switch Q4, which is enabled by the phase detector logic, to the capstan MDA to drive the capstan motor.

It should be noted that these voltage levels do not necessarily result in the capstan turning in the particular direction of the drive signal, but are sometimes used to stop rotation. For example, when fast forward mode is in operation and a stop command is given, the drive signal polarity is reversed to stop the capstan rotation.

For play, record, or spool modes of operation, the output of the direction logic (A4-11) is applied to EXCLUSIVE OR-gate A5-3 to control the polarity of the rectangular wave output from the phase detector.

4-16. Capstan Motor Edit Offset. In stop/edit mode of operation, power is removed from the takeup reel and the tension arm roller is pressed

against the capstan. To prevent the supply reel holdback tension from pulling the capstan backwards when capstan drive power is removed, a current is sourced into the capstan MDA summing node (pin 6 or A22-7). A low play/edit command (PEC) from transport control PWA No. 7 is inverted by A14-2 on reel servo PWA No. 9 and is routed through R124 as an edit-offset current to the capstan MDA on capstan servo PWA No. 8.

4-17. Play Mode. When play (or record) mode is selected, the capstan motor is initially driven by the shuttle driver (underspeed condition) until phase lock is achieved. After phase lock is achieved, control of the motor is switched to the output of the phase comparator. (See *Direction Logic and MDA Driver*, paragraph 4-15.)

4-18. Underspeed Condition. To prevent motor overshoot when the servo switches to phase-lock control, the compensation amplifier integrator capacitor (C49) is disabled by shunt switch Q11 during motor acceleration. A logic high from the phase detector logic (A14-3) turns Q11 on during the underspeed condition. Also the phase detector logic provides a high (A14-3) to turn FET switch Q15 off, and a high (A13-12) to turn FET switch Q4 on. When Q15 is off, the compensation amplifier output is disconnected from the MDA, and when Q4 is on the capstan motor is driven by shuttle capstan driver Q5. The on/off state of the FET switches is summarized in Table 4-4.

4-19. Phase Lock. When phase lock is achieved, the phase detector logic turns Q4 and Q11 off, and turns Q15 on. Then the MDA drive signal path is from the phase detector through EXCLUSIVE OR gate A5-3, carrier filter Q13/Q14, compensation amplifier A22-1, to the capstan MDA.

Table 4-4. Capstan Servo FET Switch Control

SERVO CONDITION	INTEGRATOR BYPASS SWITCH Q11	PHASE LOCK SWITCH Q15	SHUTTLE DRIVER SWITCH Q4
UNDERSPEED	ON	OFF	ON
OVERSPEED	OFF	ON	OFF
PHASE LOCKED	OFF	ON	OFF
STOPPED	OFF	OFF	OFF

4-20. Spool Mode. For spool mode operation, the circuit operation is identical to play mode operation except for the reference frequency furnished to the phase comparator. For 180-in/s operation, the spool speed jumper is placed in position E1/E2 to select 28.8 kHz as the reference frequency. For 60-in/s operation, the jumper is placed in position E2/E3 to select 9,600 Hz as the reference frequency. As in shuttle or play modes of operation, spool direction is controlled by the output of the shuttle direction logic (A4-11).

4-21. Stop Mode. When the stop mode is selected from any other mode of operation, the capstan servo is placed in the opposite shuttle mode from which the tape is moving until the tape slows to approximately 0.5 in/s. Then the capstan drive power is removed from the MDA.

When the tape is moving and a stop command is entered, the output of the shuttle direction logic (A4-11) causes the MDA to attempt to drive the capstan in a direction opposite to that which it is going. While the tape is still moving, 1.0- μ s pulses from A5-8 are applied to retriggerable one-shot A6-7 which has a short time constant. When the tape almost stops, A6-7 changes state and resets latch A15-5. The low from A15-5 and the low in overspeed from the phase comparator logic turns FET switch Q4 off. When Q4 turns off, capstan MDA power is removed and the tape comes to a stop.

4-22. Reel Servo Functional Description

The reel servo is a closed loop servo that controls the reel motors to maintain constant tape tension across the heads in all modes of operation. Figure 4-4 is a simplified general block diagram of the reel servo system.

The reel servo is not concerned with how much tape is on a reel (as in an open-loop reel servo) but only with what the tape tension is on either side of the capstan. These tensions must be equal in all modes of operation. The tensions are sensed by the position of tension arms which are positioned by the tape. All tape motion is controlled by the capstan, and the reel servo supplies and takes up tape based on information the servo receives from the

tension arm sensors. *The actual value of tape tension is controlled by the tension arm solenoids.* The solenoids apply a near-constant force to the tension arms, that is opposed by the force provided by the reel motors through the tape. This value of tape tension is established by the tension logic and depends on a given operating condition. When the reel servo is activated (pressing the stop pushbutton with tape threaded and taut), the tension arm solenoids and reel motors are activated. The tension arm has an LED affixed to the arm and the light from the LED is focused on a stationary photopotentiometer. The output from the photopotentiometer is a voltage proportional to arm position and is the servo error.

This servo error voltage, which is amplified and compensated, is used to modulate a 28.8-kHz carrier frequency to develop a pulse-width modulated (PWM) signal with a duty cycle that varies with the magnitude of the servo error signal. The PWM signal is fed through a gate, used to turn the reel servo on and off, to a dual-polarity, motor drive amplifier driver, which amplifies the TTL level signal to a level suitable for driving the MDA switching transistors. The switching transistors alternately switch positive and negative 20 Vdc across the motor at a 28.8-kHz rate. Because of the inductance of the dc motor, the 28.8-kHz signal is filtered and only the dc component of the current remains of significance. Motor torque is proportional to the current in the motor. When the duty cycle is exactly 50%, the dc current in the motor is zero and the motor does not turn.

4-23. Reel Servo Circuit Details

The reel servo circuitry is principally located on reel servo PWA No. 9 and on the transport assembly. Figure 4-5 is a simplified block diagram of the reel servo and drawing 4840395 (Section 6) is the schematic diagram.

4-24. Takeup and Supply Tension Sensors. Tension arm position is sensed by light from an LED shining on a photopotentiometer. Light from an LED attached to each arm is focused on an associated stationary photopotentiometer and causes a voltage to be sensed, corresponding to the position of the tension sensor arm. The total voltage range

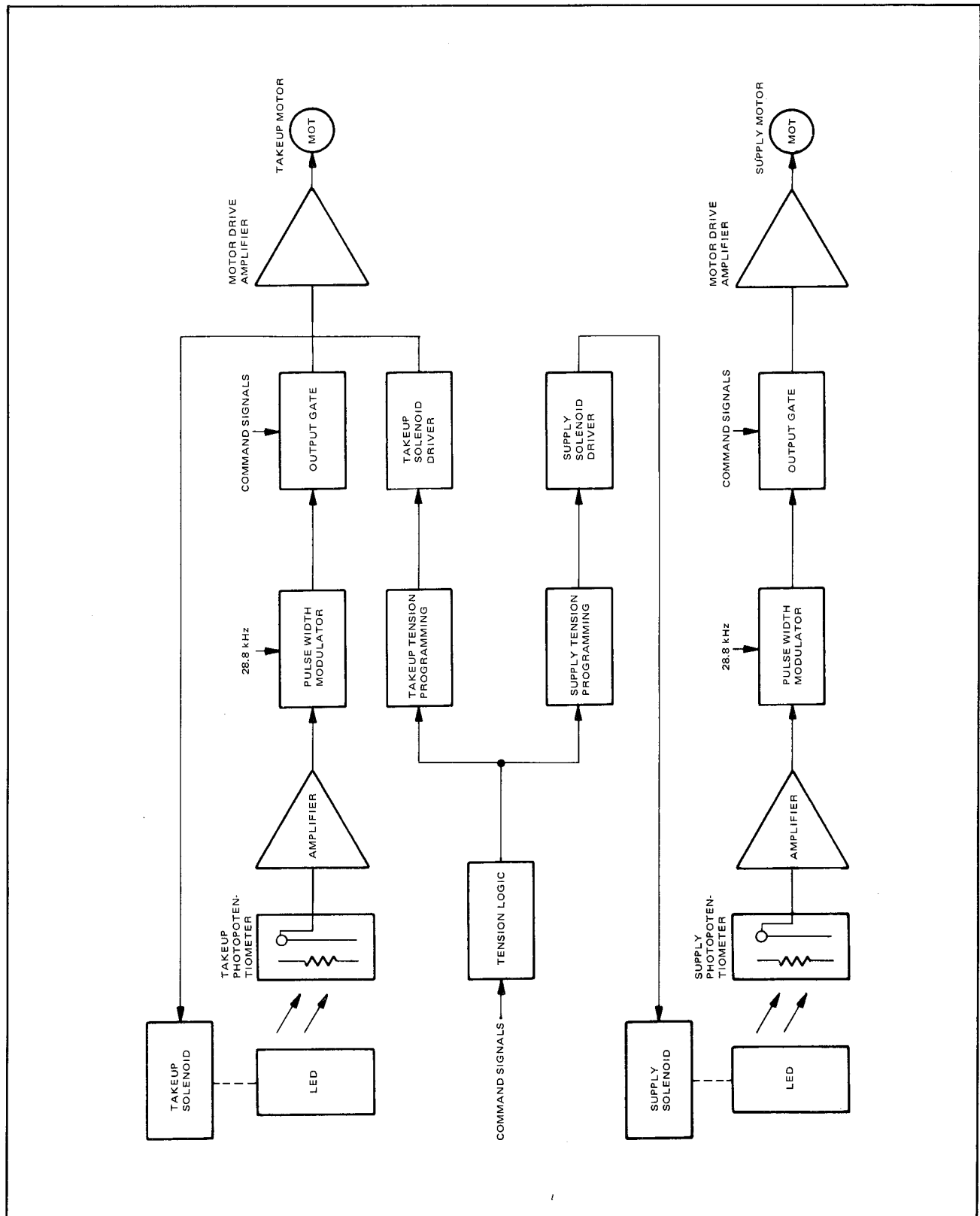


Figure 4-4. Reel Servo General Simplified Block Diagram

is approximately +2.0 to -2.0 Vdc when the arm is moved from one extreme to the other. Under actual servo conditions, the voltage may change only a few tenths of a volt. When the recorder is in the thread condition, the force on the tension arms from the reels (through the tape) is balanced by the torque exerted by the tension arm solenoids (discussed later).

4-25. Compensation Amplifier. The takeup and supply reel servos are similar in operation; therefore, only the takeup reel servo is described. The output dc voltage (error signal) from the takeup photopotentiometer is routed from the transport to feedback compensation amplifier A2-7, which amplifies the error signal and provides compensation for the mechanical properties of the transport. When tape is threaded on the transport and prior to the initiation of thread mode (pressing the stop pushbutton), the tension arms are held by light spring pressure in the maximum up (toward the reels) position. This results in a large servo error when the servo is activated. To prevent tape from being spilled when the reel servos are activated, the gain of the compensation amplifier is temporarily reduced in the reel unwind direction (supply reel counterclockwise, takeup reel clockwise). A logic low torque limit command (TLM) from transport control PWA No. 7 causes FET switch Q3 to turn on and increase the feedback around amplifier A2-7. This reduces the amplifier output in the unwind direction as determined by the voltage drop of diode CR4. After thread mode is obtained and the servo is engaged, the torque limit command is removed and full gain is restored.

4-26. Pulse-Width Modulator. The amplified and compensated signal from feedback amplifier A2-7 is used to modulate a 28.8-kHz carrier signal from audio control PWA No. 5. These two signals are applied to the summing input of pulse-width modulator (PWM) A1-7. The integrating characteristics of the modulator produce a triangular waveform summed with the error signal from amplifier A2-7 (see waveform Figure 4-6). The composite signal is applied to amplifier/limiter Q5 that amplifies and clips the signal to produce a rectangular waveform with transitions corresponding to the zero crossings of the summed signals. The rise time of the rectangular waveform is decreased by gate A6-12 and results in a clean waveform

occurring at a 28.8-kHz rate with a duty cycle that is a function of the error signal. When there is zero servo error, the duty cycle is 50% and the reel motors stand still.

4-27. Output Gates and MDA. The pulse-width modulator signal from A6-12 is fed to the input of output gate A5-6 and through inverter A6-10 to output gate A5-8 to produce two 180° out-of-phase MDA signals. The MDA is a switching type power amplifier. Because of a residual charge that remains on the base of the switching transistors after the drive signal has turned off, the transistors do not turn on and off instantly. Therefore, without correction, it is possible that opposite polarity MDA drive signals can be on at the same time and cause overheating of the output switching transistors (Q1 through Q4). To prevent this situation, the signal from A6-12 is also fed to dead zone generator R34/CR10/C7 and through A6-10 to dead zone generator R33/CR9/C6. The generators modify the PWM signals, and the modified and unmodified signals are combined in gates A5-6 and A5-8 to produce a MDA drive signal with a dead zone as shown in Figure 4-7.

The takeup and supply reel servos are turned on by the logic low reel servo on command (SVO) from transport control PWA No. 7. The logic low is inverted by gate A14-12 and enables gates A5 and A7. In play/edit mode, power is removed from the takeup reel only. A logic low play/edit command (PEC) from transport control PWA No. 7 disables gates A5-6 and A5-8 which prevents the 28.8-kHz MDA drive signal from reaching the MDA.

When gates A5-6 and A5-8 are enabled, opposite phase 28.8-kHz MDA drive signals are fed through the MDA drive transistors (Q7/Q9/Q15 and Q6/Q8/Q14) to the MDA switching transistors Q1/Q2 located on the heatsink area of the transport casting. The transistors are alternately switched on and off to provide a +20V and -20V drive across the reel drive motor. As shown in Figure 4-7, switching transistor Q1 or Q2 conducts when the output at A5-6 or A5-8, respectively, is in a low state.

The output current of the drive motor is sampled across a 0.1-ohm resistor located in the power

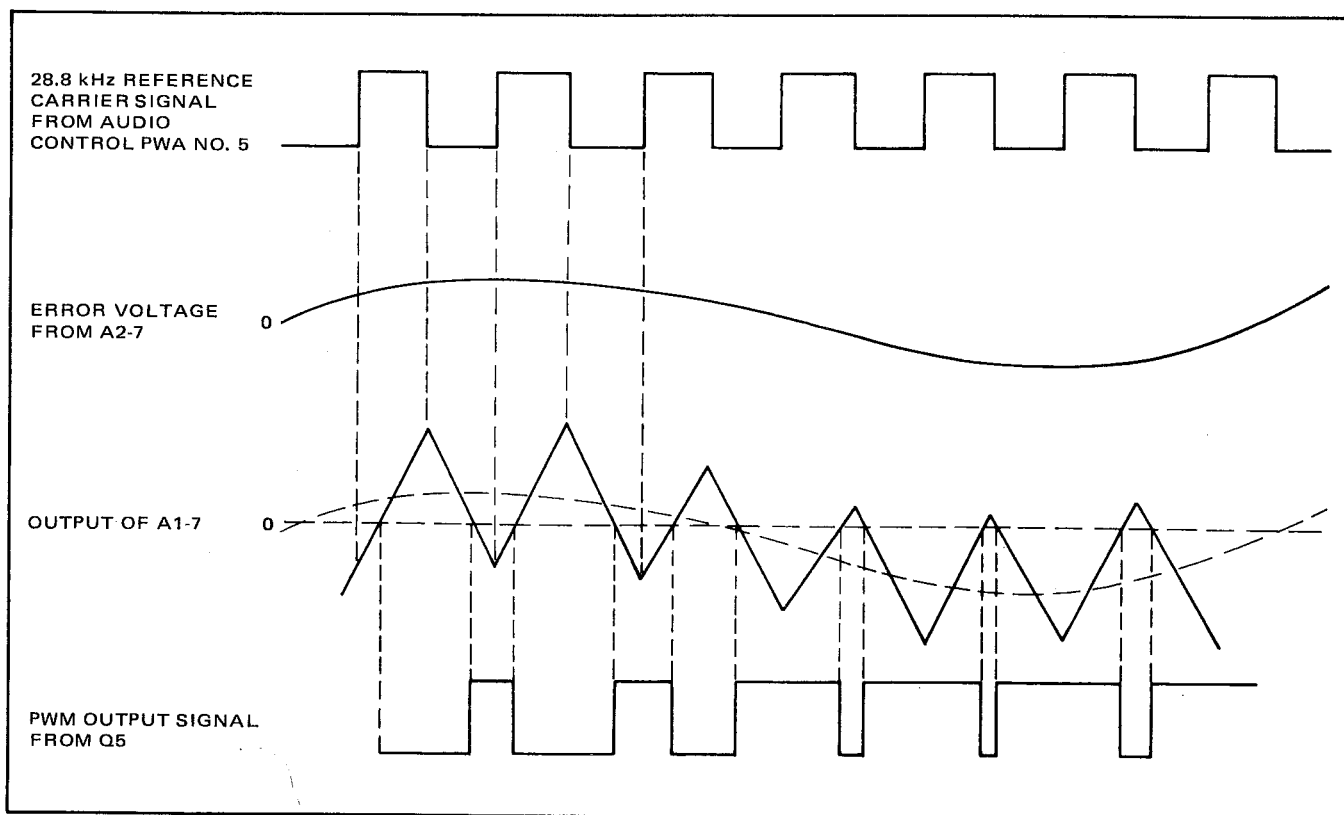


Figure 4-6. Pulse Width Modulator Waveforms, Takeup Reel Servo

supply. The dc component of the sampled signal provides feedback and is applied to the inverting summing input of pulse-width modulator A1-7 to enable the modulator/MDA to be a current source for the motor. For any given error voltage, the feedback provides for constant motor torque at all operating speeds.

4-28. Tension Arm Limit Detector. During recorder operation, if the tension arms should move too far in toward the head assembly (inner limit - ILM) or too far out toward the reels (outer limit - OLM), a logic low ILM or OLM command is generated. These commands are routed to transport control PWA No. 7. The ILM command causes the recorder to immediately enter the stop/edit mode and the OLM command causes the recorder to enter the stop/edit mode after an approximate two-second time delay.

The operation of the takeup and supply tension arm limit detectors are similar in operation,

therefore only the takeup detector circuit is described. The voltage sensed by the photopotentiometer is routed to the non-inverting and inverting input of comparators A8-9 and A8-10 respectively. These comparators are referenced to a zener-controlled reference voltage source. When a tension arm limit voltage is exceeded, the associated comparator changes state and applies +12 Vdc to monolithic transistor array A10, which serves as a translator. The translator provides a logic low ILM or OLM command which is routed to transport control PWA No. 7.

During play/edit mode, the takeup tension arm roller is pressed against the capstan. In this mode the takeup arm ILM command is disabled. The logic low play edit command (PEC) is inverted by A14-2 and is applied to transistor A10-4. The transistor turns on and disables the output from comparator A8-9. This causes the ILM command to remain in a high (inactive) state. (The supply tension arm ILM command is still functional.)

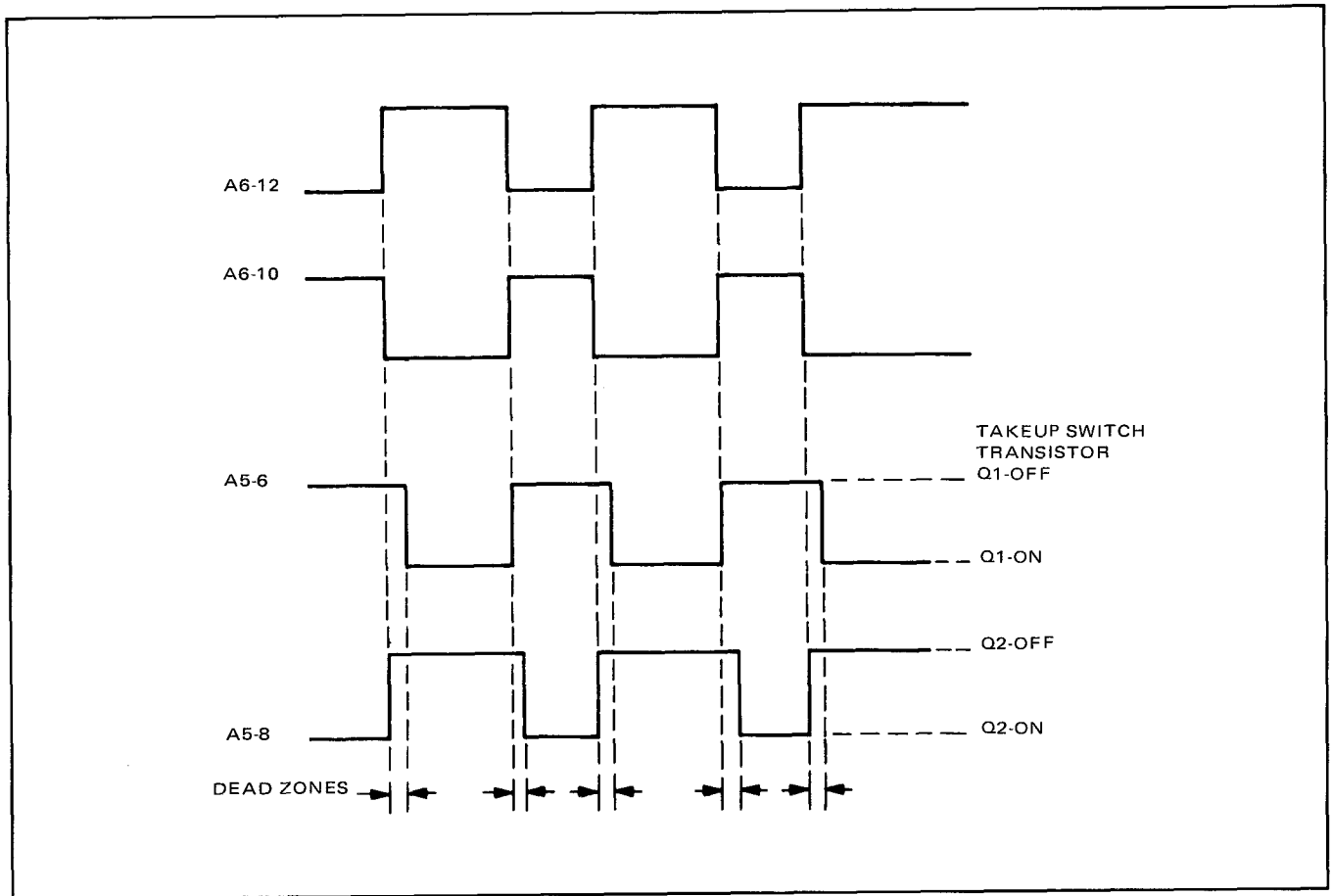


Figure 4-7. Dead Zone Generator Operation and MDA Switch Transistor Conduction State

4-29. Tension Logic. The tension arms exert a constant selected force against the tape, which is balanced through the tape by the torque from the reel motors. This tension has to be the same on the supply and takeup side of the capstan during all modes of operation to prevent tape slippage across the capstan. The tension logic (A3/A4/A7/A9) accepts input signals from six sources and determines what the tape tension should be for a given operating condition. These logic input signals are: motion sense (MTS), stop command (STC), tape width (1/4- or 1/2-inch tape), forward or reverse true direction (TDR), play/edit command (PEC), and reel servo on command (SVO). When 1/2-inch tape is used, the tensions are doubled in forward and reverse modes, but the tension is the same as for 1/4-inch tape when the tape is stopped or when in play/edit mode.

The tension logic performs combinational logic functions and the output is fed to the tension programming. The tension programming consists of six open collector inverters (A11) and associated pull-up resistors (R107 and R112 through R115) for the supply tension; and A12 and R116 through R118, R120, and R121 for the takeup tension. In operation, one of the pull-up resistors is switched into a voltage divider circuit in conjunction with R111 (supply) or R119 (takeup). To select a particular tension, a gate is enabled and the output signal is inverted. The low at the output of the inverter provides a ground return for the selected pull-up resistor. The voltage at the junction of the pull-up resistor and R111 (supply) or R119 (takeup) is applied through a tension adjustment potentiometer R125 (supply) or R128 (takeup) to an operational amplifier A15-7 (supply) or A15-1 (takeup) where the

voltage is converted to drive current for the respective tension solenoid.

In the electrical unthread condition, SVO is inactive (high), A11-8 and A12-6 are low, and zero volts is applied to the input of the operational amplifiers. This results in zero current drive to the solenoids. In play/edit mode, all A12 outputs are high. This results in maximum drive to the takeup solenoid and the tension arm roller is pressed against the capstan.

4-30. Velocity/Acceleration Control. During capstan servo underspeed and overspeed condition and shuttle modes of operation, a velocity/acceleration control signal is developed on the reel servo PWA and is routed to the capstan servo PWA No. 8 to slow the acceleration or velocity of the capstan motor. For example, when small diameter hub reels are used during shuttle mode, the capstan may require the reel motors to turn faster than the available reel motor voltage permits. The velocity/acceleration control circuitry senses this situation and generates an analog voltage that is used to prevent the capstan from turning faster than allowed by the reel size. Similarly, when using 14-inch reels, the velocity/acceleration control signal prevents the capstan motor from accelerating faster than the reel motors can supply or take up the tape.

The velocity/acceleration control signal is developed as follows. The voltage developed across the reel motors, which is proportional to reel velocity, is sampled by R57 and R59 and applied to the summing input of operational amplifier A13-6. Also, the voltage from both tension arm photo-potentiometers, which is proportional to the difference in acceleration between the reels and the capstan, is sampled by R72 and R73 and applied to the summing input of A13-6. The four signals are summed and the output of A13-6 is phase compensated by C28/C29/R68 for mechanical properties of the system. The compensated signal is routed to the capstan servo PWA No. 8.

In play/edit mode, the input from the takeup tension arm sensor is switched off by FET Q16. This is necessary as the output from the takeup photo-potentiometer indicates a large acceleration error which would result in the capstan not starting to

rotate. FET switch A13-6 is activated by the play/edit command from transport control PWA No. 7.

4-31. Edit Offset Command. A low play/edit (PEC) from transport control PWA No. 7 is inverted by A14-2 and is routed through R124 to the capstan MDA on capstan servo PWA No. 8. (See *Capstan Motor Edit Offset*, paragraph 4-16.)

4-32. Dynamic Emergency Braking. In the event of primary power removal or loss of reel servo control while the reels are in motion, the trailing reel is braked to a stop by dynamic emergency braking. (Dynamic braking is employed as the recorder does not have mechanical brakes.)

The takeup and supply reel brake systems are identical in operation; therefore, only the takeup brake system is described. Figure 4-8 is a simplified schematic diagram of the takeup dynamic brake system. When tape is threaded on the recorder and thread mode is entered (pressing the stop pushbutton), the reel servo on command (SVO) goes low and causes Q9 to turn off and Q10 to turn on.

When Q10 turns on, brake relay K1 is energized and power is provided to the takeup motor from the MDA switching transistors via relay contacts 5 and 9. In the event of primary power removal or loss of reel servo control (SVO goes high), relay K1 de-energizes and causes relay contacts 5 and 9 to open, and contacts 2 and 9 to close. If the tape is moving in the rewind direction, steering diode CR13 will conduct and connect lamp DS-1, via relay contacts 2 and 9, across the trailing motor. The coasting motor generates a current through the lamp and results in dynamic braking within the motor until the reels come to a stop. Thus the kinetic energy contained in the moving reels is dissipated.

4-33. Transport Control PWA No. 7

Transport control PWA No. 7 accepts input commands from the recorder control panel (or remote recorder control panel) and status signals from other circuits within the recorder system, and performs combinational logic functions. These combinational logic functions are performed by

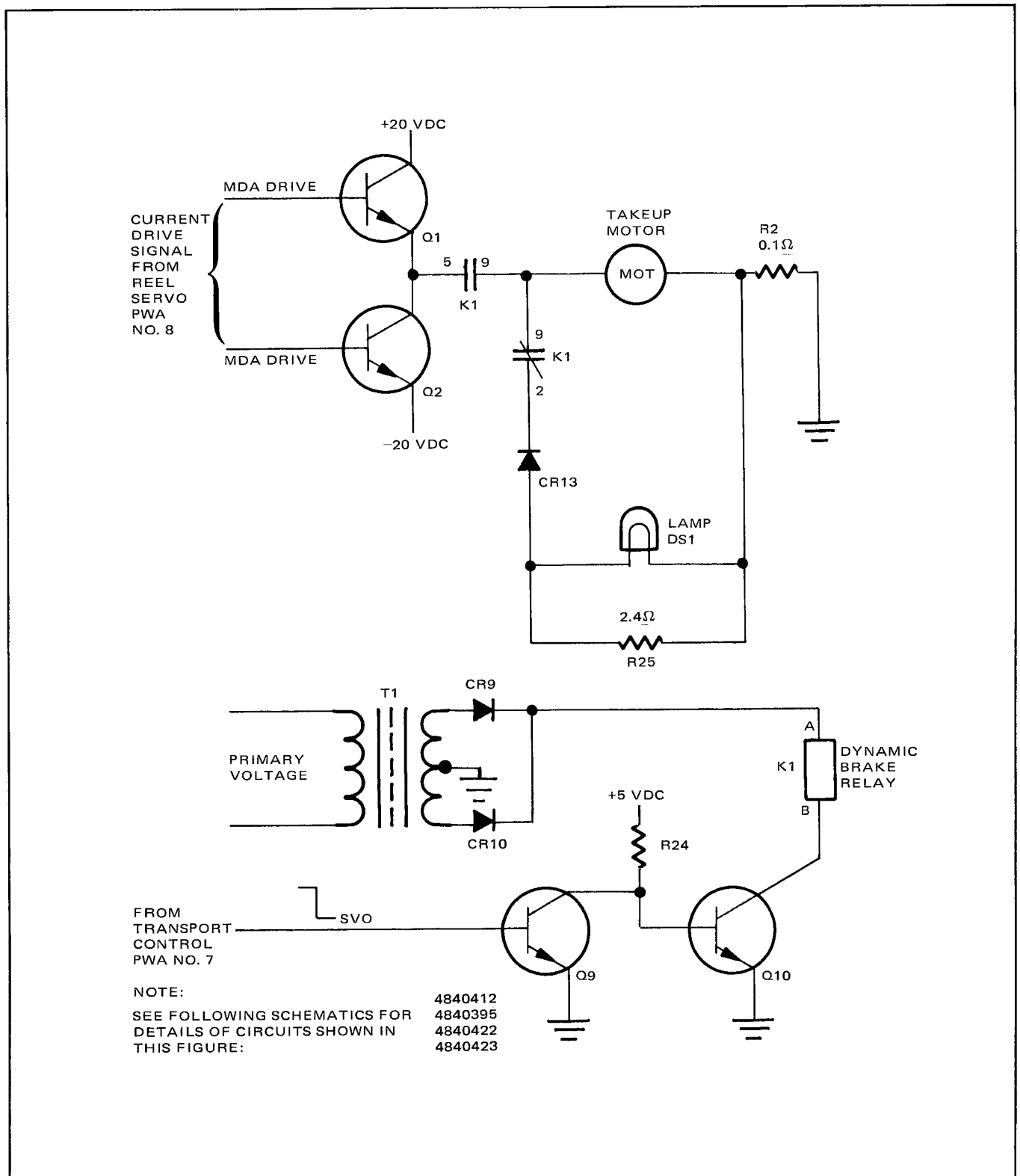


Figure 4-8. Takeup Dynamic Brake, Simplified Schematic

inverters, latches (cross-coupled gates), NAND gates, and time delay circuits to provide logic level command signals that are used to control all transport functions and modes of operation. All input and output commands are a logic low, except for the LFT command (see paragraph 4-9) and where complimentary logic is required. For example, forward tape motion — logic high, reverse tape motion — logic low. These commands are identified in the text and on the schematics by their three-letter abbreviation. (See Table 4-1 for a complete list of abbreviations.)

Figure 4-9 is a simplified functional block diagram of transport control PWA No. 7 and drawing 4840397 (Section 6) is the schematic diagram.

4-34. System Wakeup Circuit. Transistors Q1, Q2 and associated components comprise a system wakeup circuit that causes the recorder to enter the stop/edit (unthread) mode when power is turned on. This circuit also causes all signal channels to enter safe and repro modes; SAFE, REPRO, stop, and EDIT indicators to light; and the tape timer to be reset and indicate 0 00 00.

When power is first applied, capacitor C12 begins to charge through R11 and apply base current to Q2, causing the transistor to turn on. This causes Q1 to turn on and provide a logic low wakeup command (WUL). After approximately five seconds, C12 is charged and causes Q2 to turn off, which causes Q1 to turn off, and the WUL line goes high.

In the event power is lost and reapplied before the cycle is completed, CR7 quickly discharges C12 to permit a complete wakeup cycle when power is applied.

4-35. Control Circuit Operation. A mode of operation is selected by pressing a pushbutton switch on the recorder control panel. Pressing a pushbutton switch generates a logic low that sets an associated latch. These latches are interconnected to make the operation mutually exclusive so that only one mode may be engaged at a time. The output of the latch also causes the associated LED indicator to illuminate. All indicators are activated by a logic low applied through a 390-ohm resistor (located in the control unit) to the cathode of the LED. The anode of the LED is connected to

+5.0 Vdc. These indicators are rewind (RWI), fast forward (FFI), stop (STI), and edit (EDI). The play indicator (PLI) is activated by a logic low locked (LKD) signal from capstan servo PWA No. 8, and the record indicator (RCI) is activated through two inverters by the electronic record status (ERS) signal from audio control PWA No. 5.

4-36. Rewind and Fast Forward Mode. Rewind or fast forward mode (shuttle mode) is entered when the respective pushbutton is pressed. When the rewind pushbutton is pressed, direction latch A4-8/A10-12 and shuttle latch A10-8/A16-8 are set. The logic high from the direction latch is inverted by A29-6 and a logic low signifying reverse direction is routed to the capstan servo PWA No. 8 to cause the capstan to rotate in the rewind direction when the shuttle command is received.

When the fast forward pushbutton is pressed, the direction latch is reset and a logic high is routed to the capstan servo to cause the capstan to rotate in the forward direction. When either pushbutton is pressed, the shuttle latch (A10-8/A16-8) is set and causes a logic low shuttle command (SHC) to be routed to the capstan servo. This command enables the shuttle drive circuitry.

4-37. Spool Mode. Spool mode is entered when the play and either the rewind or fast forward pushbutton switches are simultaneously pressed. Under these conditions, gate A11-3 is enabled and causes spool latch A11-11/A11-8 to set. The low output from A11-8 is inverted by A17-6 and enables gate A29-12, which generates a logic low spool command (SPC) that is routed to the capstan servo PWA No. 8.

4-38. Tape Lifter Operation. The tape lifters lift the tape away from the heads in rewind and fast forward modes (shuttle modes) and spool modes. In shuttle modes, the low from shuttle latch A16-8 is inverted by A17-8 and enables shuttle gate A29-8. The low from A29-8 is inverted by A34-11 to set tape lifter latch A22-8/A28-6. The high from A22-8 enables gate A28-8 and the low from A28-8 is inverted by A38-6. When A38-6 is high (LFT), the tape lifter solenoid is energized and the tape is lifted from the heads. (Note: This is the only high logic-state command in the system.)

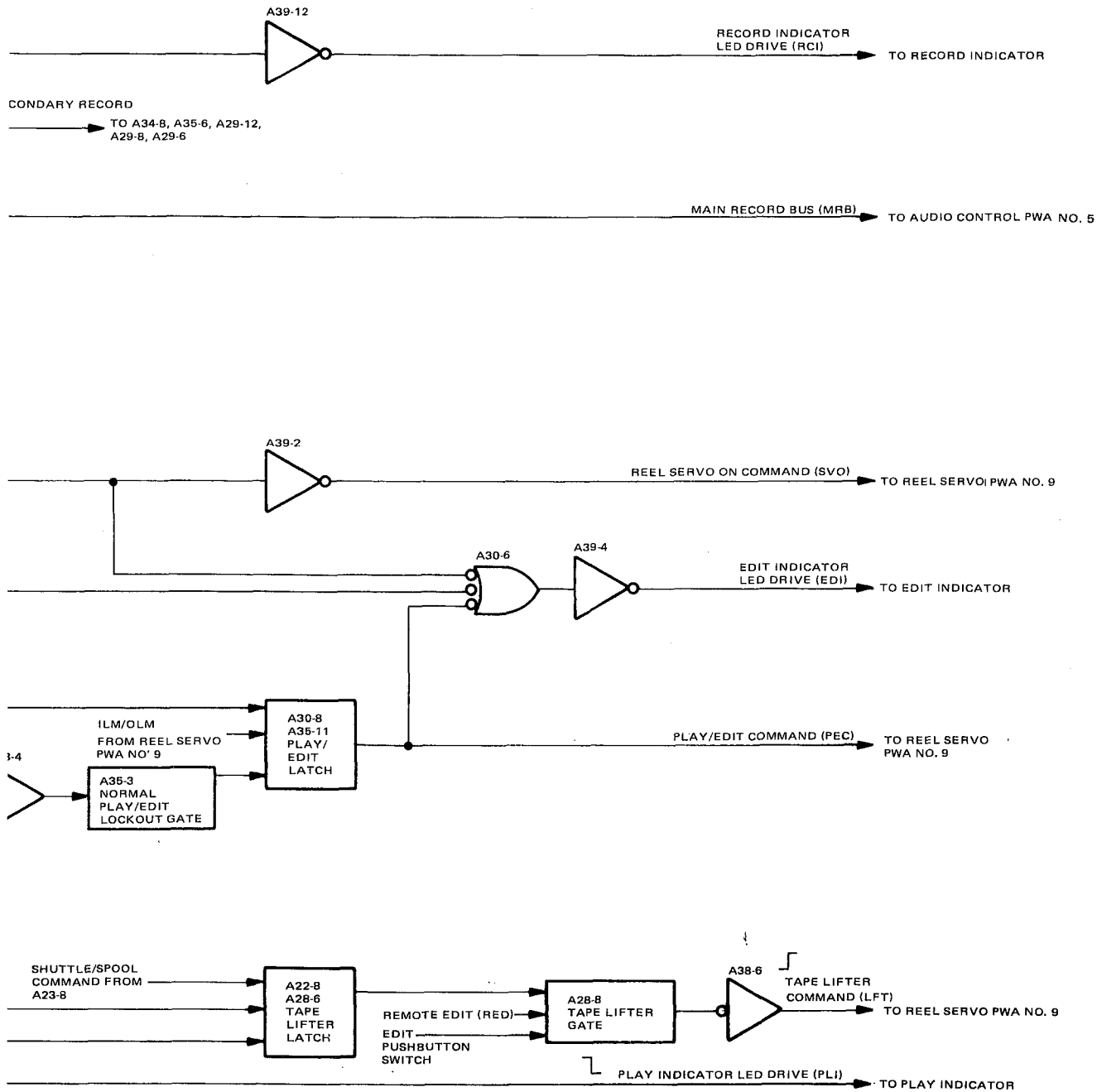


Figure 4-9. Transport Control PWA No. 7,
Simplified Block Diagram (Sheet 2 of 3)

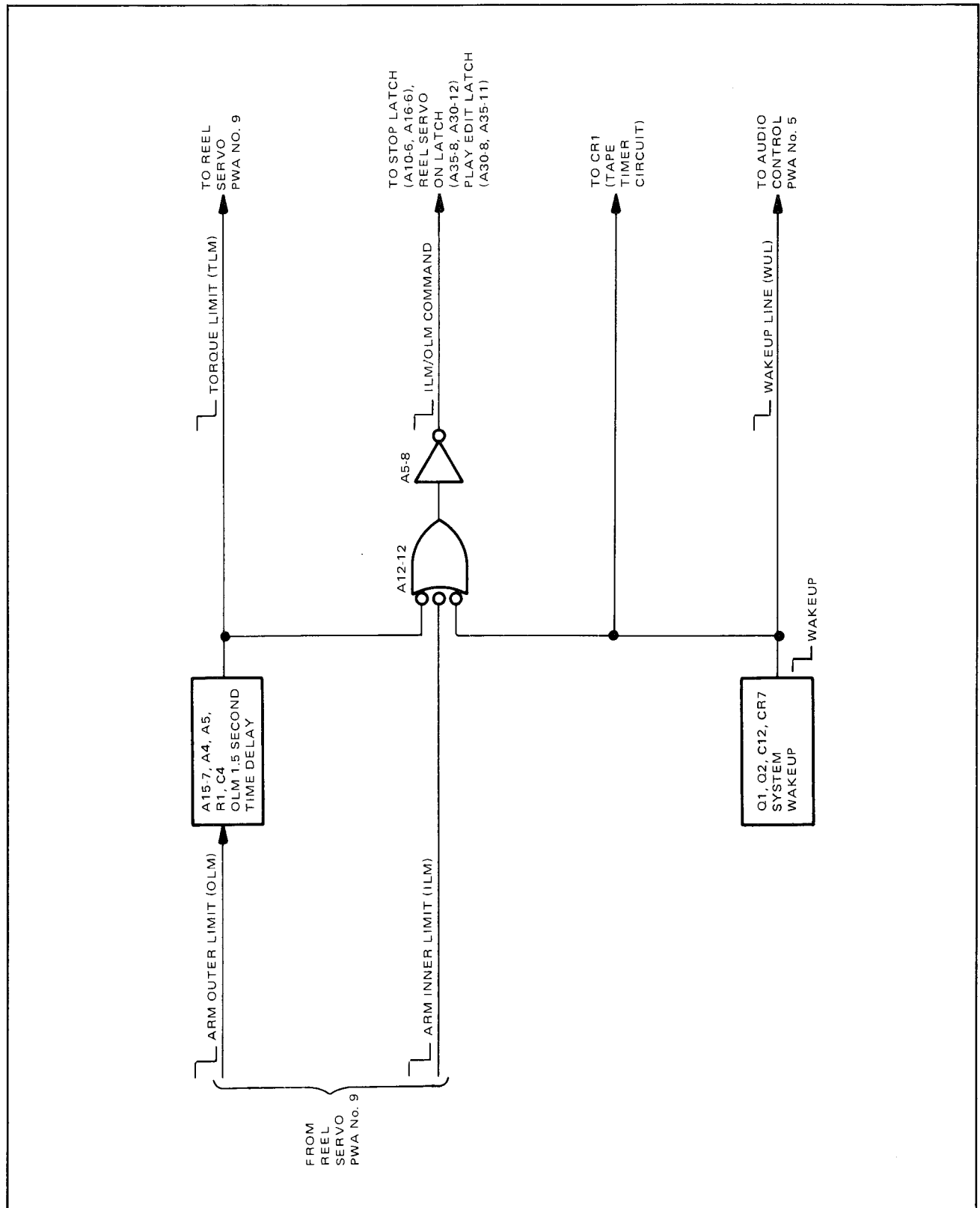


Figure 4-9. Transport Control PWA No. 7, Simplified Block Diagram (Sheet 3 of 3)

In spool modes, the low from A11-8 of the spool latch is inverted by A17-6 and enables spool gate A29-12. The low from A29-12 is inverted by A34-11 and A23-8 to set tape lifter latch A22-8/A28-6 which causes the tape lifter solenoid to be energized (LFT logic high) by the same circuit action as described for shuttle modes.

If shuttle or spool mode is active, pressing the EDIT pushbutton causes the tape lifters to retract (solenoid de-energizes) and the tape to contact the heads as long as the EDIT pushbutton is held pressed. Pressing the EDIT pushbutton switch generates a low which disables gate A28-8. The high from A28-8 is inverted by A38-6 and a low tape lift command (LFT) is routed to reel servo PWA No. 9.

If in fast forward or forward spool mode, and play mode is selected, the tape slows down to play speed (tape does not stop) and the tape lifter solenoid is de-energized (LFT logic low) when the tape reaches play speed. The tape lifter latch A22-8/A28-6 is reset, causing the tape lifter to retract (LFT logic low), by the following circuit action. The high from A11-8 (when not in a spool mode) of spool latch A11-11/A11-8 is applied to pin 13 of A7-11. When coming out of fast forward mode and the tape slows down to play speed, the capstan servo locks and the LKD command from the capstan servo goes low. This signal is inverted by A39-10 and enables gate A7-11. The low from A7-11 is inverted by A23-12 and triggers a 100-ms tape lifter delay circuit consisting of components A15-9/A22-3/A23-2/A22-11/R20/C25. The output of the delay circuit resets the tape lifter latch (pin 4 of A28-6).

To enter play mode from spool mode, the stop pushbutton is pressed followed by the immediate pressing of the play pushbutton. Except for the LKD (servo locked command) the circuit action is the same as described for fast forward to play mode. In spool mode, the capstan servo is phase locked (LKD logic low). When the stop pushbutton is pressed, the capstan servo does not immediately unlock. The 100-ms tape lifter delay circuit has the function of ignoring the LKD command until the servo can unlock when going from spool to stop. Without the time delay, the tape lifter would immediately retract when the stop pushbutton switch was pressed.

If stop mode is selected from any other mode and the tape is permitted to stop, the tape lifter latch is reset by the motion sense command (MTS) which goes high when the tape has stopped. This signal is inverted by A23-6 and resets the tape lifter latch (pin 3 of A28-6).

4-39. Play Mode. Pressing the play pushbutton switch causes play latch A7-3/A6-6 to set, and the low output at A6-6 is inverted by A34-8 and A38-4 to provide a logic low play command (PLC) that is routed to the capstan servo PWA No. 8.

4-40. Record Mode. Record mode is selected by simultaneously pressing the play and record pushbutton switches. Under this condition, gate A12-8 is enabled and sets record latch A18-3/A12-6. The high from A18-3 is applied to gate A18-6 which is enabled by the LKD signal from the capstan servo and signifies the capstan servo is locked.

The low from A18-6 sets secondary record latch A18-11/A18-8 and is also routed as a main record bus (MRB) command to audio control PWA No. 5 to enable the record signal electronics. The low output from A18-11 forces the forward direction (DRC) and play (PLC) commands to be generated. These signals are routed to the capstan servo. When record mode is established, a low electronic record status (ERS) signal from PWA No. 5 is received. This low is inverted by A39-6 and A39-12 and routed to the record indicator (RCI) to illuminate the indicator and signify that record mode has been established. When in record mode and the stop pushbutton switch is pressed, transport motion does not stop until the bias and erase signals applied to the record and erase heads, respectively, have decayed (ERS command goes high).

When the stop pushbutton switch is pressed, stop latch A10-6/A16-6 is set and record latch A18-3/A12-6 is reset. When the record latch resets, gate A18-6 is disabled (MRB goes high), which disables the record signal electronics control on PWA No. 5. A high from stop latch A10-6 is inverted by A17-12 and A7-6 and is applied to stop gate A35-6. After the bias signal has decayed, the ERS signal from PWA No. 5 goes high and resets the secondary record latch, and a high from A18-11 enables stop gate A35-6. When A35-6 is enabled,

a logic low stop command (STC) is generated and routed to the capstan servo and reel servo PWAs to stop tape motion.

4-41. Stop Record Mode. If in record mode and the record pushbutton switch is held pressed while the stop pushbutton switch is momentarily pressed, the recorder will stop recording but the transport will continue to run. Tape motion stop is prevented by inhibiting gate A22-6 with a logic low that is generated when the record pushbutton switch is pressed. The record latch is reset via gates A6-8 and A17-10 when the stop pushbutton switch is pressed.

4-42. Thread Mode. When power is initially applied and tape is threaded and taut so that either parallel connected microswitches S2 (supply) or S3 (takeup) are closed, pushing the stop pushbutton switch causes the reel servos to activate and place transport in a thread mode condition. Thread condition is indicated by the EDIT indicator light going off when the stop pushbutton is pressed.

Pressing the stop pushbutton switch causes one shot A24-6 to generate a 0.5-second logic low pulse which sets reel servo on latch A35-8/A30-12. The one-shot is used to assure ample time for the tension arms to move off the outer limit. The high from A35-8 is inverted by A39-2 to generate a logic low reel servo-on command (SVO), which is routed to reel servo PWA No. 9 to activate the reel servos. When the reel servo-on latch is set, the high from A35-8 is inverted by A30-6 and A39-4 and the EDIT indicator light goes out.

4-43. Unthread (Stop/Edit) Mode. If the tape is stopped, pressing the EDIT pushbutton switch causes the recorder to go into the unthread (same as stop/edit) mode. In this mode, the reel servos disengage. Pressing the EDIT pushbutton switch generates a logic low which is inverted by A23-10 which causes A28-12 to be enabled. The low from A28-12 resets reel servo latch A35-8/A30-12, which causes the reel servo on command (SVO) to be cancelled (SVO logic high). The low from A35-8 is inverted by A30-6 and A39-4 (EDI) to activate the EDIT indicator.

4-44. Edit Modes. If in play or record mode (capstan is phase locked) and the EDIT pushbutton

switch is pressed, power will be removed from the takeup reel and the tension-arm roller will engage the capstan. This is called the play/edit mode.

Pressing the EDIT pushbutton switch generates a logic low, which is inverted by A23-10 and routed through a jumper in the E12/E13 position to enable gate A35-3 when the capstan servo is locked. The output from A35-3 sets play/edit latch A35-11/A30-8, and a low PEC (play/edit) command from A30-8 is routed to the reel servo. The low from A30-8 is inverted by A30-6 and A39-4 (EDI) to activate the EDIT indicator.

If in play/edit mode and the stop pushbutton is pressed, the tape will stop, edit mode will be retained, and tape can again be spliced by pressing the play pushbutton switch.

To cancel play/edit mode, the EDIT pushbutton switch is pressed when the tape is stopped. When the tape is stopped, the motion sense (MTS) line is high and the stop latch is set. Therefore, pressing the EDIT pushbutton switch enables A28-12. The low from A28-12 resets the play/edit latch and the servo-on latch which causes the recorder to enter the stop/edit (or unthread) mode. If desired to lockout the play/edit mode, the jumper may be placed in the E13/E14 play edit lockout position. This disables gate A35-3 and prevents the play/edit latch from being set.

If shuttle or spool mode is active, pressing the EDIT pushbutton switch causes the tape lifters to retract (solenoid de-energizes) and tape contacts the heads as long as the EDIT pushbutton switch is held pressed (see *Tape Lifter Operation* text).

When using the remove control unit to control recorder functions, the only edit function permitted is control of the tape lifters in shuttle or spool modes. The play/edit and stop/edit modes may not be activated from the remote control unit. On the remote control unit, the EDIT pushbutton switch is connected to transport control PWA No. 7 via the remote edit line (RED) rather than the edit button line (EDB).

4-45. Tension Arm Limit Detectors. During recorder operation, if a condition exists where the tension arms should move in too far towards the

head assembly or too far out toward the reels, a logic low ILM (inner limit) or OLM (outer limit) command is generated on the reel servo PWA No. 9 and routed to the transport control PWA No. 7. The ILM command causes the recorder to immediately enter the stop/edit (unthread) mode and the OLM command causes the recorder to enter the stop/edit mode after an approximate 1.5-second time delay.

The ILM command is inverted by A12-12 and A5-8 and sets the stop latch and resets the reel servo on latch and the play/edit latch. The OLM command is applied to a time delay circuit consisting of 1.5-second one-shot A15-7 and components A4-3/A5-4/A4-6/R1/C4. If the OLM command is low for more than 1.5 seconds, the recorder will enter the stop/edit mode as described for the ILM command.

During the start of thread mode, the OLM command is low and the delayed OLM command from A4-6 is routed as a torque limit command (TLM) to reel servo PWA No. 9 to limit the unwinding reel torque during the start of thread mode.

4-46. Audio Control PWA No. 5

The audio control PWA No. 5 performs the following functions:

1. Accepts mode and channel selection commands from the control unit and performs combinational logic functions to establish desired mode of operation.
2. Generates a master frequency of 5.1840 MHz which is divided down and used to provide reference frequencies for the capstan and reel servos, bias and erase amplifiers, and clock frequencies for the tape timer and multiplexer.
3. Conditions master bias bus signals and erase bus signals for distribution to the audio PWAs.

The functions performed by PWA No. 5 are shown on simplified block diagrams. For complete circuit information, refer to PWA No. 5 schematic diagram 4840398.

4-47. Signal Mode Selection. Figure 4-10 is a simplified interconnection block diagram of the signal mode selection circuits and Figure 4-11 is a simplified block diagram of the signal mode selection circuits for channel 1. Figure 4-11 shows the relationship and functions of the various circuits that operate to establish a recorder/reproducer signal mode of operation and associated signal mode monitoring. The desired signal mode and channel(s) are selected by pressing pushbutton switches on the recorder control unit. These command signals are routed to audio control PWA No. 5 to program the desired mode of operation. PWA No. 5 contains four separate mode select circuits, one for each channel. Since each circuit operates identically, only channel 1 is described in detail.

There are four channel-select lines (channels 1-4) and five function-select lines (ready, safe, sync, repro, and input). Pressing the associated pushbutton switch generates a logic low command which is routed to PWA No. 5. These momentary command signals are stored in latch circuits and processed by combinational logic to provide four two-state logic commands which are routed to main audio PWA No. 1 (for channel 1). Output signals for some of the various functions are summarized in Table 4-5.

4-48. Latches. The momentary commands, generated when a channel select and a function select pushbutton switch are simultaneously pressed, cause the command to be stored in a latch. Each of these latch circuits have one output, but some have more than one set or reset input to provide various modes of operation as determined by the combinational state of the latches. The following latches are associated with channel 1 operation.

4-49. Ready/Safe Latch. The ready/safe latch A9-7 is set by a ready command and reset by a safe command.

4-50. Sync/Rep Latch. The sync reproduce latch A9-13 is set by a sync command and reset by a reproduce command.

4-51. Tape/Input Latch. The tape/input latch A9-4 is set by either a reproduce or sync command and is reset by an input command.

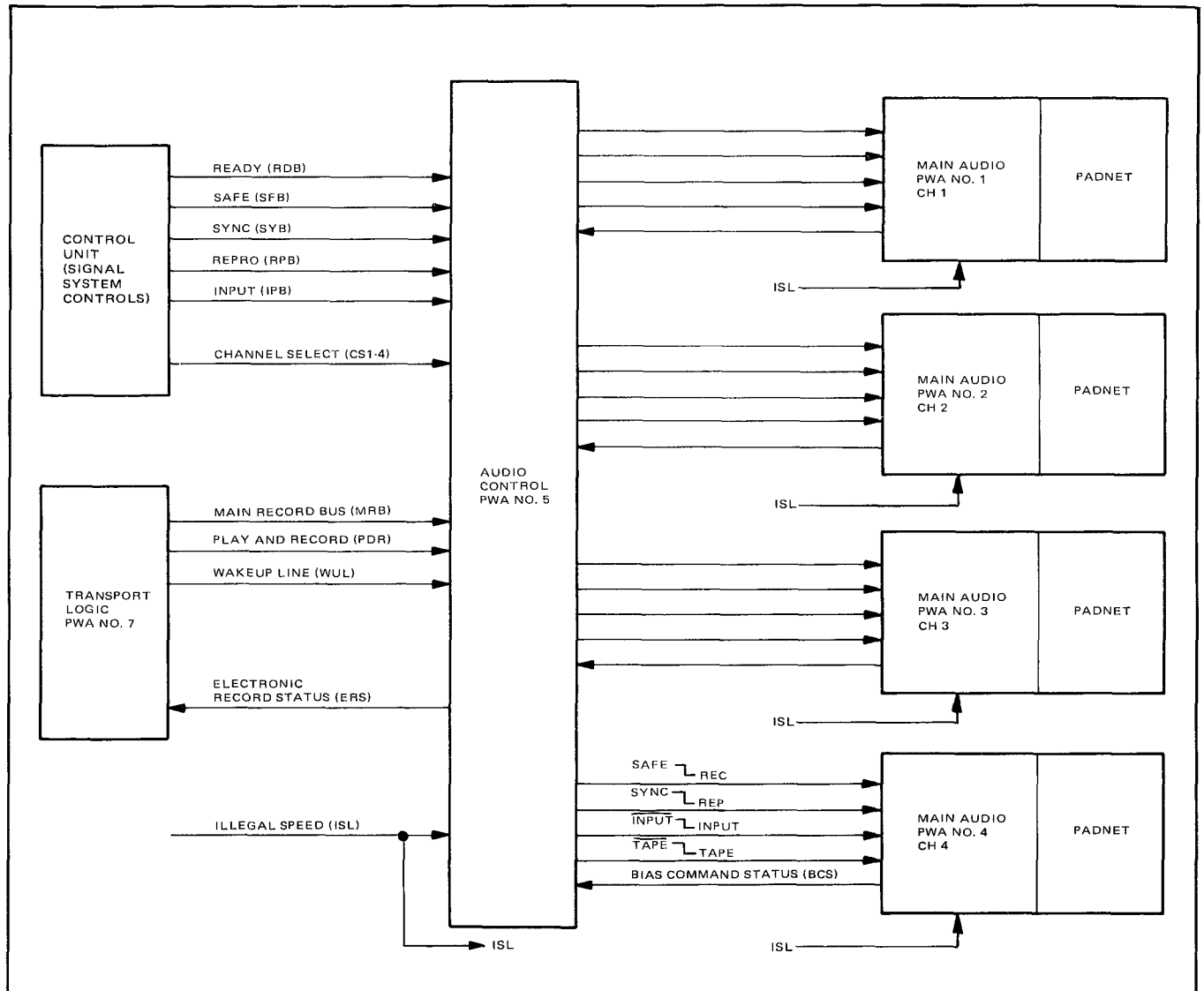


Figure 4-10. Signal Mode Selection, Interconnection Simplified Block Diagram

4-52. *Safe/Record Latch.* The safe/record latch A9-9 is set (to safe) by any one of the following commands: main record bus (MRB), wakeup line (WUL), safe command, or ready command. The latch is reset when the following three conditions are present: ready/safe latch is in the ready (set) state, main record bus (MRB) is active, and play and record (PDR) command is active.

4-53. *Safe Mode.* In safe mode, the channel is prevented from entering record mode. Simultaneously pressing SAFE and channel 1 pushbutton

switches enables gate A10-8. The low from A10-8 resets ready/safe latch A9-7 to the safe state. The low from A10-8 is also inverted by A8-6 and A6-8 and sets safe/record latch A9-9 to the safe state. The high from A9-9 is buffered by A5-8 and routed to PWA No. 1 to place the audio electronics in a safe (record mode inhibited) condition. The low from A9-7 inhibits record interlock gate A8-8. This prevents the safe/record latch A9-9 from being reset to the record state if the play and record pushbuttons are simultaneously pressed to place other channels in the

record mode. The low from A9-7 is also routed to the multiplexer (paragraph 4-61) to cause the SAFE indicator to illuminate.

4-54. Ready Mode. A channel in ready mode can enter record mode. Simultaneously pressing READY and channel 1 pushbutton switches enables gate A10-6. The low from A10-6 causes ready/safe latch A9-7 to set, and the high from A9-7 is applied as one input to three-input record-interlock gate A8-8 to establish conditions for entering record mode (described later). The low from A10-6 is also applied to the multiplexer to cause the channel 1 READY indicator to illuminate. The low from A10-6 is also inverted by A8-6 and A6-8 to set safe/record latch A9-9 to the safe position for the same purpose as described for safe mode. That is, it enables the safe/record latch A9-9 to be temporarily placed in the safe mode with ready/safe latch A9-7 left in ready mode.

4-55. Record Mode. To enter record mode, the channel must be in ready mode and the PDR (play and record) and MRB (main record bus) lines active (logic low). When the play and record pushbuttons are simultaneously pressed, the PDR line becomes active and triggers 900-ms one-shot A32-6. The high from A32-6 is applied as a second input to A8-8. Approximately 150 to 500 ms (up to 500 ms if tape is stationary) after the two pushbuttons are pressed, the MRB line becomes active, indicating the capstan servo has locked. The MRB logic low is inverted by A40-6, A8-8, and resets safe/record latch A9-9 to the record position. The low from A9-9 is buffered by A5-9 and routed to main audio PWA No. 1 to place the audio electronics in the record mode. Immediately prior to the bias signal runup to maximum level, a low BCS (bias command status) command from PWA No. 1 enters PWA No. 5 and is inverted by A6-2, A6-4, A34-6 and A27-6 and routed to transport control PWA No. 5 as a low ERS (electronic record status) command signal. This signal causes the master record indicator to illuminate. Also the low BCS command at the junction of A6-4 and pin 5 of A34-6 is routed to the multiplexer to cause the channel 1 record indicator to illuminate. The illumination of the master record and the channel 1 record indicators is a positive indication that the record process has occurred on PWA No. 1.

If an MRB signal is not received within the 900-ms window established by one-shot A32-6, gate A8-8 is inhibited and the system does not enter record mode. One-shot A32-8 is reset when the MRB signal arrives. The output from the one-shot and the inverted MRB signal are applied to gate A40-3. The gate is enabled by the MRB signal and the output from A40-3 resets one-shot A32-6. The width of the pulse applied to pin 10 of safe/record latch A9-9 is approximately 300 ns long and is equal to the propagation delay through A40-3 and A32-6 plus the time delay caused by R35 and C18, which are used to widen the width of the pulse applied to the clear input of A32-6.

When in record mode and the stop pushbutton is pressed, the transport does not stop until the bias and erase signals have decayed. When the stop pushbutton switch is pressed, MRB goes high and causes the safe/record latch A9-9 to be set to the safe position. The high from A9-9 is buffered by A5-8 and routed to PWA No. 5 to place the signal electronics in the safe mode. After the bias and erase signals have decayed, the BCS command goes high causing the ERS command to go high. The high ERS command is routed to transport control PWA No. 7 to reset the secondary record latch which causes the transport to come to a stop.

If in record mode and the ready and channel 1 pushbutton switches are simultaneously pressed, the channel 1 signal electronics will revert to safe but the transport will continue to run. Pressing the two pushbuttons causes safe/record latch A9-9 to be set to the safe position. The high from A9-9 is buffered by A5-8 and routed to PWA No. 5 to place channel 1 signal electronics in the safe mode. Since the ready/safe latch A9-7 is still in the ready state, channel 1 may be returned to record mode by simultaneously pressing the play and record pushbutton switches. When these pushbuttons are pressed, the safe/record latch A9-9 is reset to the record state.

If in record mode and the safe and channel 1 pushbutton switches are simultaneously pressed, channel 1 signal electronics will revert to safe but the transport will continue to run. Pressing the two pushbuttons causes the ready/safe latch A9-7 to be reset to safe and the safe/record latch A9-9 to be set to safe. To re-enter record mode, channel 1 must be reset to the ready state.

Table 4-5. Channel 1 Signal Mode Selection Output-Signal Logic States

FUNCTIONS	OUTPUT SIGNAL LOGIC STATE			
	SAFE $\overline{\text{L}}$ RECORD (PIN 24)	SYNC $\overline{\text{L}}$ REP (PIN 23)	$\overline{\text{INPUT}}$ $\overline{\text{L}}$ INPUT (PIN R)	$\overline{\text{TAPE}}$ $\overline{\text{L}}$ TAPE (PIN 14)
INPUT	X	X	L	H
REPRODUCE	H	L	H	L
SAFE	H	X	X	X
READY	H	X	X	X
RECORD	L	L	X	X
SYNC AND READY OR SAFE	H	H	H	L
RECORD FROM SYNC MODE	L	L	L	H
L = low H = high X = low or high depending on combination of modes selected				

4-56. Reproduce Mode. In reproduce mode, the signal being reproduced by the reproduce head is connected to the audio output. Simultaneously pressing REPRO and channel 1 pushbutton switches enables gate A10-3 which resets sync/reproduce latch A9-13 to the reproduce state. The low from A9-13 is inverted by A8-12 and A6-12, buffered by A5-10 and routed to PWA No. 1 as a low reproduce (rep) command. Also the low at the output of A6-12 is routed to the multiplexer to cause the REPRO indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. Under this condition, the input/input line is high (input), and the tape/tape is low (tape). Both of these commands are routed to PWA No. 1 to cause the tape signal to be monitored.

4-57. Sync Mode. In sync mode, the signal on tape is reproduced by the record head. Simultaneously pressing SYNC and channel 1 pushbutton switches enables gate A10-11 which sets sync/reproduce latch A9-13 to the sync state. This permits A8-12 to be low and this signal is inverted by A6-12, buffered by A5-10, and routed to PWA No. 1 as a high sync command. The high from A6-12 is routed to the multiplexer to cause the SYNC indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. As in reproduce mode, the input/input line is high (input), and the tape/tape line is low (tape).

If a channel is in sync mode and that same channel is placed into record mode (channel is in ready and the play and record pushbuttons are simultaneously pressed), the logic circuitry on PWA No. 5 will automatically switch the monitoring circuitry on PWA No. 1 from the record head to the input signal. Pressing the play and record pushbutton switches causes the BCS signal entering PWA No. 5 to become active (low). (See *Record Mode* description.) This signal is inverted by A6-2 and enables A7-11. The low from A7-11 is inverted by A8-12 and A6-12, buffered by A5-10, and routed to PWA No. 1 as a low (rep) command. This disconnects the sync preamplifier from the equalizer amplifier and connects the reproduce head to the equalizer amplifier. The low from A7-11 causes the input/input line to be low (input) and the tape/tape line to be high (tape). This enables the input to be monitored. The low from A7-3 is routed to the multiplexer to cause the INPUT indicator to light.

4-58. Input Mode. When input monitoring mode is selected, the input signal to the recorder is connected to the audio output for monitoring

purposes. Simultaneously pressing the INPUT and channel 1 pushbutton switches enables gate A37-8, which resets tape/input latch A9-4 to the input state. The low at A7-3 is routed to the multiplexer to cause the INPUT indicator to light.

4-59. Wakeup Line. When power is first applied to the recorder, the system wakeup circuit (located on transport logic PWA No. 7) causes the recorder to enter stop/edit mode; tape timer to indicate 0 00 00; SAFE, REPRO, stop, and EDIT indicators to light; and audio channels to enter safe and reproduce modes. When power is first applied, the wakeup line (WUL) becomes active (low) for five seconds. This low is applied to gate A40-11 to inhibit the master bias bus (paragraph 4-64), and the low is also applied through buffer A38 to each of the four channel-select lines and to the safe and reproduce function-select lines. This causes the sync/reproduce latch A9-13 to be in the reproduce state (A9-13 low) and the safe/record latch A9-9 to be in the safe state (A9-9 high). In the event that PWA No. 7 is not installed and power is applied, capacitor C11 will charge through R21 and temporarily apply a low through CR6 to A38 to substitute for the WUL logic low command.

4-60. Illegal Speed. If a speed is selected for which the audio channels have not been set up for (and/or speed and bias jumper positions on audio control PWA No. 5 are incorrect), play and record modes of operation at that speed are locked out of operation. If an illegal speed is selected, the illegal speed line (ISL) becomes active (low). This low is inverted by A7-3 and A7-6 to cause the input/input and the tape/tape lines to both go high. This causes the audio output from all audio PWAs (PWA No. 1, 2, 3, and 4) to be muted.

4-61. Multiplexer System. The multiplexer system accepts mode and channel status information and causes the appropriate LED indicators to be illuminated on the control unit. Figure 4-12 is a simplified interconnection block diagram of the multiplexer system circuitry.

The multiplexer system accepts channel and mode select data from the signal mode selection logic circuitry (paragraph 4-47) and sequentially loads this data in parallel form in two shift registers located on PWA No. 5. This data is shifted out in

serial form on a single line to six series-connected shift registers located on the local control unit (and remote control unit if used). The shifted data is used to illuminate the appropriate LED indicator (SYNC, REPRO, INPUT, SAFE, READY and Record). A slow clock rate (4.8 kHz) and a fast clock rate (144 kHz) are alternately used in the multiplexer system circuitry to enable the LED indicators to be illuminated continuously 97% of the time.

Figure 4-13 is a simplified block diagram of the multiplexer system circuitry on PWA No. 5. Recall that each of the four channel and mode selection logic circuits provide four two-state logic commands. These commands are $\overline{\text{rec/rec}}$, ready/safe, tape/input and sync/rep. Since there are four audio channels, 16 lines of data (4×4) are supplied to the input of two multiplexer devices (A35 and A36). Each multiplexer (A35 and A36) is a dual 4-line-to-1-line data selector and in operation, the combination is synonymous to a 4-pole 4-way switch.

These four logic-state inputs to the multiplexers from each channel are selected in sequence (channel 1, channel 2, etc.). This input signal selection is controlled by a 2-bit binary coded signal (binary 0-3 count) applied to the select A and select B inputs of the multiplexer devices. (The source of this binary signal is described later.) The strobe (enable) input to each multiplexer is hard-wired low and therefore the multiplexers are continuously enabled.

The four selected signals from the output of the two multiplexers are applied to four NAND gates (A42-3, -6, -8, and -11) that perform combinational logic to provide six signals. These six signals are applied to the parallel inputs of shift registers A33 and A41, and each signal corresponds to an LED indicator on the control unit (SYNC, REPRO, INPUT, SAFE, READY, and Record). A low state of the input signal signifies that the associated LED indicator is to be illuminated.

In addition to the six data line inputs from the combinational logic, there are three hard-wired inputs applied to shift register A33. Input A and the serial input are hard-wired high (+5 Vdc) and input B is hard-wired low (ground). These inputs

are used to identify when a frame of data has been shifted through the shift registers.

When the mode control input signal (described later) applied to the shift registers goes high, the input data and the high on input A and the low on input B are loaded into the shift registers on the next high-to-low transition of the input clock pulse. During this parallel load sequence, the entry of serial data is inhibited (this is accomplished internally in the shift registers by the high mode-control signal). The loading of data causes the mode control to go low, which permits the data to be shifted serially. The next six clock pulses cause the channel data to be serially shifted through the shift registers and sent in serial form (from pin 10 of A41) to the first six cells of six series-connected serially-loaded shift registers located on the control unit.

As the data is shifted (direction A toward D), the hard-wired high applied to the serial input of A33 is also shifted until there are four adjacent high outputs from the shift register preceded by the hard-wired low. After a frame of data six bits long has been shifted through the shift register, the four adjacent highs enable gate A34-8 which serves as a channel frame detector. (Note that the data input can never be four adjacent highs.)

When A34-8 is enabled, the low from A34-8 is inverted by A2-8 and is applied as a high to the mode control input of the shift registers. This changes the shift register mode of operation from serial shift to parallel load and enables the shift registers to load the next set of data (channel 1) from the multiplexers when the binary-coded select A and select B lines change state.

At the end of a frame of data, the low from A34-8 is also used to clock a binary counter, formed by A4-12 and A25-8, to its next state to enable the multiplexers to select data from the next channel (channel 2). The output from divider A4-12 and A25-8 is supplied to the select A and B inputs of the multiplexers.

In addition, the low from A34-8 is applied to gate A26-11 which inhibits the fast rate clock from divider A4-8 (through gate A26-6) during parallel load time. When A34-8 is high, the fast rate clock

is routed to the control unit to clock the six series-connected shift registers. (Note: Only the fast rate clock is routed to the control unit.) After the data from all four channels has been shifted into the six shift registers on the control unit, the multiplexers and shift registers on PWA No. 5 repeat the four-channel sequence but are controlled by the slow rate clock. Also during this slow rate clock sequence, the gated clock signal normally supplied to the six series-connected shift registers on the control unit is held high (inhibited by a low from A25 pin 6) to prevent the data from being entered during the slow clock sequence. As the ratio of the clock signals (4.8 kHz and 144 kHz) is 30:1, the LED indicators are continuously illuminated 97% (duty cycle) of the time.

As previously stated, the 144-kHz clock and 4.8-kHz clock are alternately used after each four-channel sequence. The output from frame detector A34-8 is divided by A4-12 and A25-8 and fed to D flip-flop A25-5 which provides complementary outputs. These outputs are used to alternately enable gates A26-3 and A26-6, which enable the 4.8 kHz clock and the 144 kHz clock, respectively. The selected clock is inverted by A26-8 and applied to one-shot A32-10 which provides a clean fixed-width pulse used to clock shift registers A33 and A41. The clock-pulse edge used to clock A33 and A41 occurs earlier than the clock edge used to clock the shift registers in the control unit. This permits the data input to the control unit to settle before being strobed.

4-62. Master Oscillator and Counters. The master oscillator generates a frequency of 5.184 MHz which is divided down and used for the following functions: reference frequencies for the capstan servo, switching carrier for the reel servo, audio bias and erase frequencies, and clock frequencies for the multiplexer system circuitry and the tape timer. Figure 4-14 is a simplified block diagram of the master oscillator and counters.

The master oscillator consists of a non-inverting amplifier with positive feedback provided by a crystal resonating at the desired frequency. The non-inverting amplifier consists of inverters A2-2 and A2-4 connected in cascade. Inverter A2-2 serves as a quasi-linear amplifier with inversion between its input and output terminals.

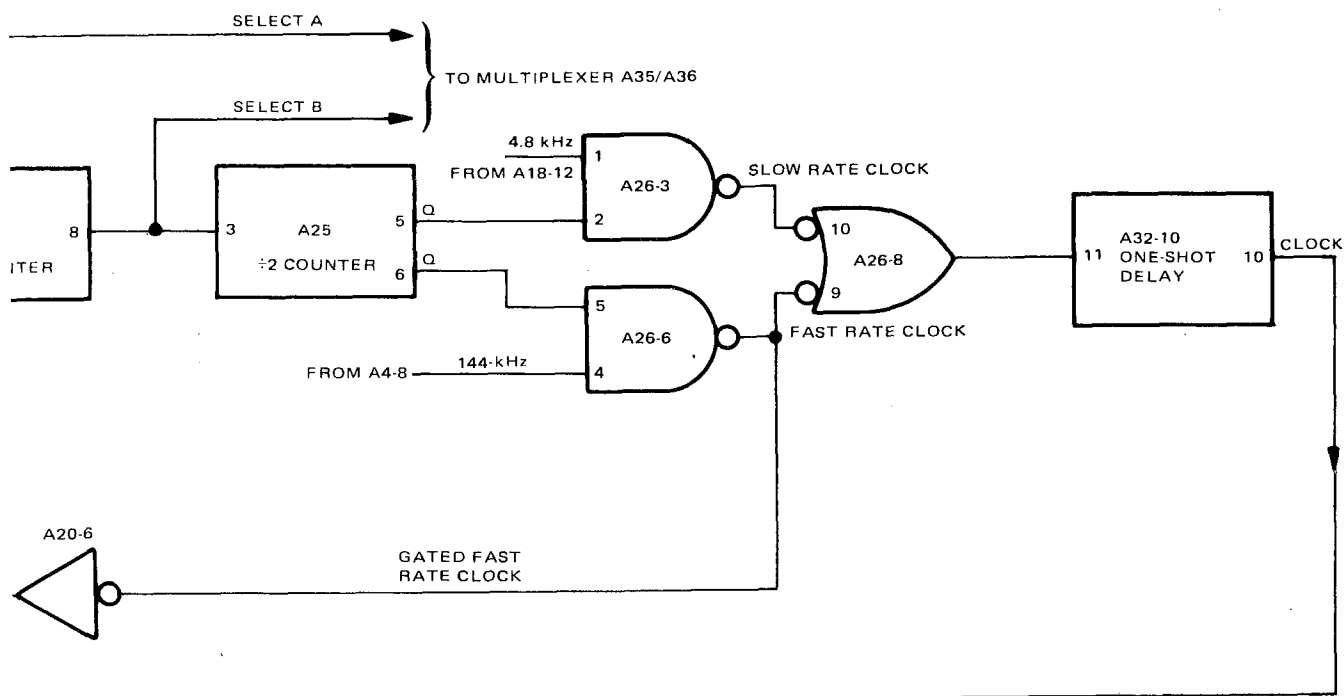


Figure 4-13. Multiplexer Simplified Block Diagram, Audio Control PWA No. 5

Resistor 1, in parallel with inverter A2-2, provides negative feedback and causes the inverter to try to operate as a linear amplifier. Any small disturbance at the input of A2-2 appears as an in-phase transition at the output of A2-4. This signal is applied to divider C1/C3, and the signal at the junction of C1 and C3 is fed back to the input of the amplifier through crystal Y1. Crystal Y1 acts as a very-high-Q tuned series-resonant circuit that passes only the desired frequency of 5.184 MHz. Capacitor C2 bypasses undesired harmonics and inverter A2-6 buffers the 4.184-MHz signal to provide a clean square-wave signal that is applied to the divider chain.

The 5.184-MHz signal is divided down by counters A1-8, A1-12, A4-8, A4-9, A5-2, A11-11, A11-12, A18-8, and A18-12 to provide the various signals shown on simplified block diagram Figure 4-14.

4-63. Master Erase Bus. The master erase bus circuitry accepts the 144-kHz TTL level signal

from the master-oscillator counter and buffers the signal, lengthens the rise time, and provides an adjustable erase signal level that can be verified between the limits of 0 to 12 volts p-p.

As shown in Figure 4-15, the 144-kHz TTL level signal from counter A4-8 is fed through R33 to inverting CMOS amplifier A39-5/1. This amplifier serves as a buffer and ground translator which transfers the 144-kHz TTL level signal from logic ground to the audio system ground. The amplifier provides an output signal that swings between the limits of 0 and +5 Vdc. This output signal is applied across the master erase bus level control R34 which is used to establish the erase bus signal level applied to the main audio PWAs.

In the event that the 15-Vdc operating voltage, applied to the CMOS device A39, should be removed while an input signal is present, R33 will limit the input current and prevent the device from being damaged.

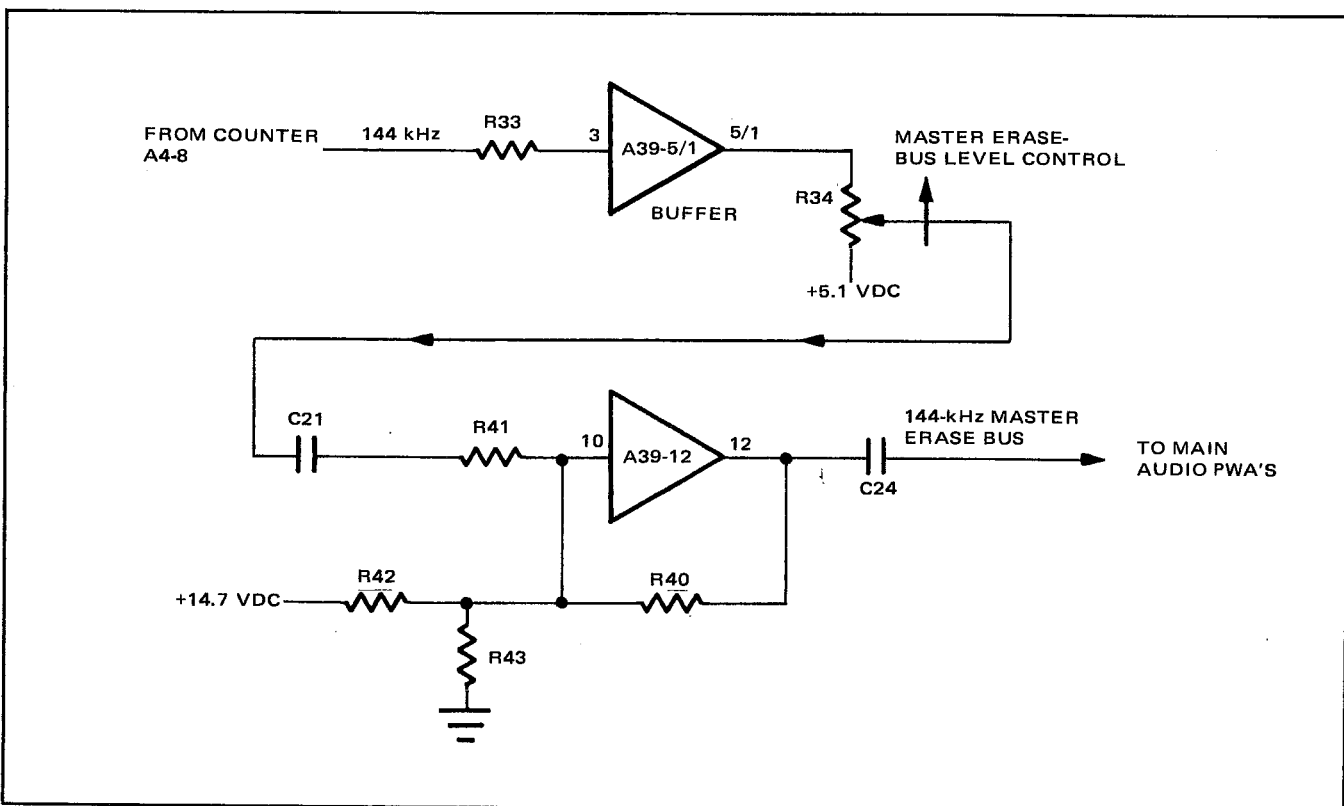


Figure 4-15. Master Erase Bus, Simplified Schematic Diagram, Audio Control PWA No. 5

The signal level selected by R34 is ac-coupled through C21 and through R41 to inverting amplifier A39-12 with feedback provided by R40. This amplifier has a gain of 3 and also serves to reduce the signal rise time which minimizes radiation into adjacent circuitry. The input of the amplifier is biased to a 7.5-Vdc level by voltage divider R42 and R43, which causes the output to be at a 7.5-Vdc nominal level and the amplifier to operate in the center of its linear range. The output signal level at pin 12 of A39 can be varied from 0 to 12 volts p-p by adjustment of master erase bus level control R34. This signal is ac-coupled through C21 and routed to main audio PWAs No. 1, 2, 3, and 4.

4-64. Master Bias Bus. The master bias bus circuitry accepts the 432-kHz TTL level signal from the master oscillator counter and buffers the signal, reduces the rise time, and provides four adjustable bias signal levels that are individually selected by a speed select logic circuit.

As shown in Figure 4-16, the 432-kHz TTL level signal from counter A1-12 is buffered and referenced to audio ground by open collector buffer/driver A5-2. The signal is applied to the junction of a voltage divider consisting of R54 and the bias level adjustment controls R3 through R6.

The other end of the adjustment controls are connected (through switch S1 and a jumper array) to the output of a 1-out-of-4 decoder speed-select logic circuit consisting of quad NAND gate A3 and inverters A2-10 and A2-12. The speed select A and B signal (SSA and SSB) in the form of a 2-bit binary encoded signal from the transport speed select switch is applied to the input of the decoder. Depending on the speed selected, one of the NAND gates (A3) is enabled, and provides a ground return (low) for one of the bias level adjustment controls. Jumper plugs J1 through J4 are used to program the recorder for 2 or 4 speed operation as shown in Table 4-6.

4-65. Two-Speed Operation. The simplified schematic (Figure 4-16) shows jumper plug connections for two-speed (7.5 and 15 in/s) operation. Switch S1 provides operational flexibility by permitting selection of either of two preset bias levels for each speed. Switch S1 in the Equalization I position enables potentiometers R4 and R6,

and the switch in the Equalization II position enables potentiometers R3 and R5 when the associated speed is selected.

Depending on the speed selected, the associated bias level adjustment control is adjusted to the desired 432-kHz signal level, and this level is ac-coupled through C22 and through R39 to inverting amplifier A39-3/8 with feedback provided by R55. The amplifier has a gain of approximately 2, and reduces the signal rise time to minimize radiation into adjacent circuitry. The input to the amplifier is biased to a 7.5-Vdc level by voltage divider R39 and R37 which causes the output signal to be at a 7.5-Vdc nominal level and the amplifier to operate in the center of its linear range. The output signal level at pin 13/8 of A39 can be varied from 0 to 8.0 volts p-p by adjustment of a bias level adjustment control. The output signal is ac-coupled through C25 and routed to main audio PWAs No. 1, 2, 3, and 4.

4-66. Four-Speed Operation. For four-speed operation, jumper plugs J1 through J4 are positioned as shown in Table 4-6. Note that for four-speed operation, switch S1 should remain in the "I" position, as one bias level adjustment control is used for each speed, as shown in the table.

4-67. Illegal Speed Detector. If jumpers J1 through J4 are positioned for two-speed operation (Table 4-6) and one of the other non-programmed speeds is selected by operation of the transport speed select switch, the illegal speed line (ISL) will become active (low) and cause the transport to become inactive in play and record modes at that speed. (The ISL line also becomes active if no jumpers are installed.)

The illegal speed detector circuitry consists of diodes CR1 through CR5, capacitor C5, and transistor Q1. When a speed is selected for which jumpers J1 through J4 have been correctly placed, one diode (CR1 through CR4) will conduct and its anode will be one diode drop (0.7 volt) above the saturated output of A3. This prevents Q1 from turning on and generating an ISL command because of the voltage drop across CR5.

If an incorrect speed is selected, one or more of diodes CR1 through CR4 will open-circuit and

diode CR5 will conduct and charge C5. After C5 is charged, Q1 will turn on and generate a low ISL command. In addition to causing the transport to become inoperative, the low from the collector of Q1 also causes the input/input and tape/tape output lines to both become high. This causes the audio output lines from each audio PWA to become muted.

4-68. Main Audio Functional Description

The main audio consists of up to four identical main audio PWAs and their parameter determining network (PADNET) PWAs. One main audio PWA and its associated PADNET PWA comprise the main audio for each record/reproduce channel. The main audio for channels 1 through 4 is located on PWA No. 1 through PWA No. 4, respectively. The main audio PWA and its associated PADNET PWA contain the erase, record, reproduce, and audio output circuits for one audio channel. Additionally, control logic circuitry located on the main audio board and PADNET provides bias and erase ramping control, pick-up record capability (PURC), tape-speed decoding, and other timing and control signals required by the main audio for that channel. The speed-dependent record and reproduce equalization networks, record and reproduce level presets, bias normalization preset, and tape-speed decoding logic are contained on the PADNET assembly which plugs into the main audio board. The PADNET is capable of being adjusted to provide for record and reproduce equalization and can accommodate all equalization standards at any one of the selected transport tape speeds (30, 15, 7.5 or 3.75 in/s). Figure 4-17 is a simplified block diagram of the main audio for one record/reproduce channel.

The record circuits receive the system audio input and 432-kHz bias, and provide equalization of the received audio signal to match the required recording equalization at the selected tape speed and/or equalization standard. The record circuits also combine the equalized signal with the 432-kHz bias to provide the drive signal to the record head on the tape transport.

The reproduce circuits receive playback audio from the reproduce head or sel sync audio from

the record head, as selected by the operator. The reproduce circuits provide the required playback equalization of either tape signal to match the selected tape speed and/or equalization standard. The selected tape signal is sent to the output amplifier circuits. Additionally, the unequalized sel sync signal is available at the card-edge connector.

The audio output circuits receive the tape and input signals from the reproduce circuits or input circuits, respectively, and provide selection and buffering of the tape or input signals to the input/output module.

The erase circuit receives the 144-kHz erase signal and provides buffering of the erase signal to the erase head via the erase amplifier. The output of the erase amplifier is fed to the erase head via the erase reed relay. The erase reed relay is normally open. When the safe/record signal is low (record) the erase reed relay is energized and the normally-open contacts are closed to provide a current path for the erase signal to the erase head. The control signal for the erase reed relay is provided via the control logic on the main audio board.

The control logic receives the safe/record, tape speed, and tape/input selection signals and generates the control signals to the circuits on the audio main and PADNET assemblies. The control logic provides the tape or input switching signals to the audio output circuits, decoded transport tape-speed selected signals to the record and reproduce circuits, and ramping and control signals to the record circuits. The control logic also contains the pick-up recording capability (PURC) circuits. The PURC circuits eliminate overlaps and erased gaps in recordings when inserting (dubbing) new material within previously-recorded programs. In a recorder system without PURC, initiating the record mode energizes the erase and record heads simultaneously. Since there is a physical distance between the erase head and the record head, a period of over-recording on the unerased tape occurs and, when the dubbing is terminated, an erased gap is left in the program. The length of over-recording and the erased gap on the tape is determined by the distance between the erase and record heads and the transport tape speed.

Table 4-6. Speed Jumper Placement and Bias Switch Setting, Audio Control PWA No. 5

2-SPEED OPERATION			
SPEED	SET JUMPERS TO DESIRED SPEED	MASTER BIAS (ADJUST S1 POSITION I)	MASTER BIAS (ADJUST S1 POSITION II)
HI SPEED	J1 – 30, 15, 7.5	R6	R5
LO SPEED	J2 – 15, 7.5, 3.75	R4	R3
NOTE: J3 and J4 to be jumpered to the S (store) positions.			
4-SPEED OPERATION			
JUMPER	MASTER BIAS (ADJUST S1 POSITION I ONLY)		
J1 – 30	R6		
J3 – 15	R5		
J2 – 7.5	R4		
J4 – 3.75	R3		

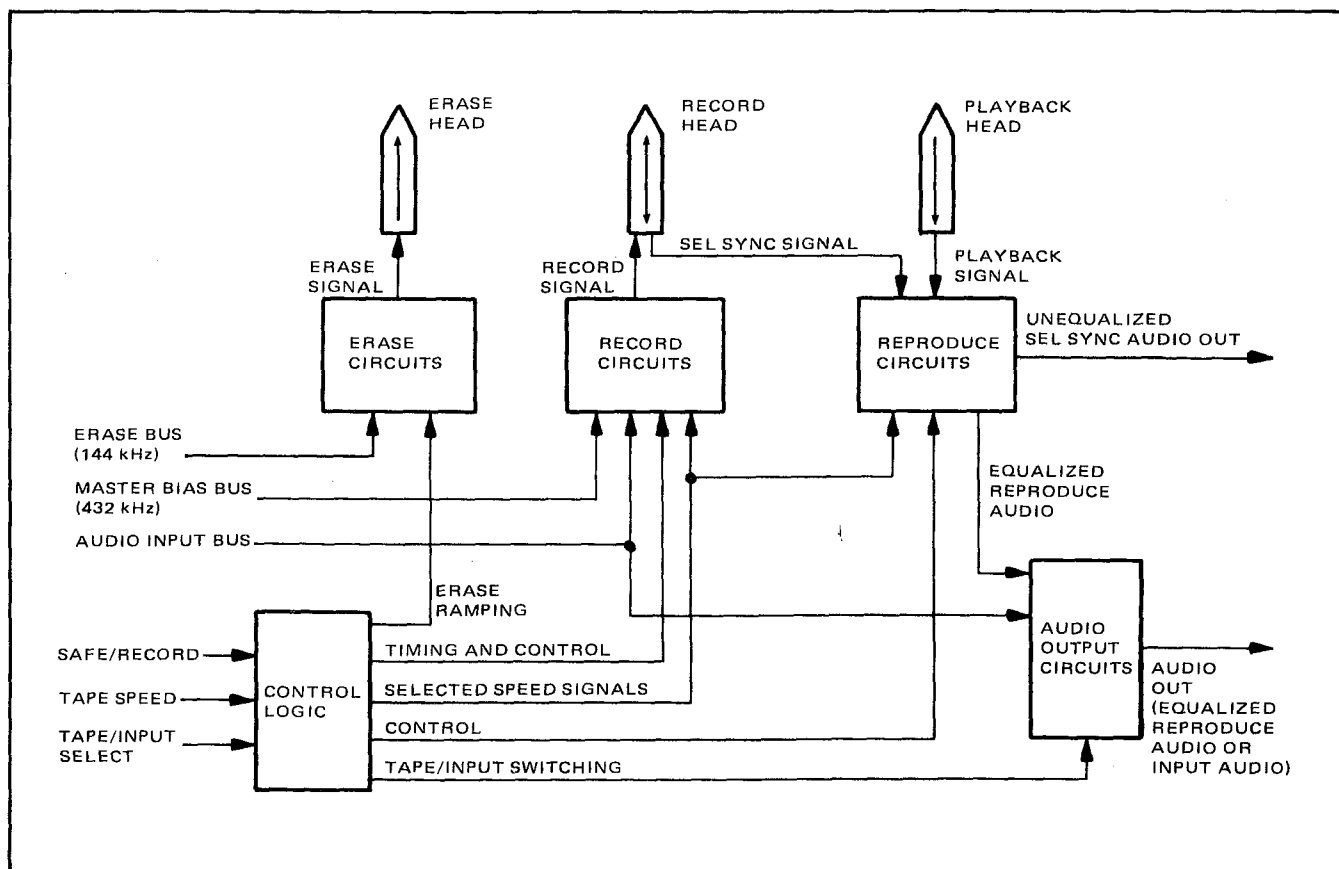


Figure 4-17. Main Audio Simplified Block Diagram

The PURC circuits eliminate the over-recording and erase gap by generating a delay between the time that the erase ramping is initiated and the bias/audio ramping is initiated. When the recorder/reproducer goes into the record mode, the erase ramp up is initiated first; then, after a delay determined by the selected tape operating speed, the bias/audio ramp up is initiated. When the recorder/reproducer is switched out of the record mode, the erase ramp down is initiated first; then, after a delay determined by the selected tape operating speed, the bias/audio ramp down is initiated. In this manner, the effect of the physical difference between the erase and record heads is cancelled and the overlap and gap are eliminated from the dubbed portion of the recording.

4-69. Main Audio Circuit Details

Each of the four channels of the main audio is identical. The main audio circuits for channels 1 through 4 are located on PWA No. 1 through PWA No. 4, respectively for each channel. The following paragraphs describe the main audio circuits that comprise a single channel. Each channel contains one audio main board and plug-in PADNET assembly. Drawing 4840378 is the schematic diagram for the audio main board, and drawing 4840379 is the schematic diagram for the PADNET assembly.

4-70. Control Logic. The control logic generates ramping, timing, and switching signals for the main audio. As shown in Figure 4-18, the control logic contains the ramping, PURC delay, tape-speed decode, and output amplifier switching logic.

4-71. Speed Decode Logic. The speed decode logic is contained on the PADNET assembly. As shown in Figure 4-18, the speed decode logic receives the selected speed signals, SSA and SSB, from the transport unit speed selector and decodes the four possible combinations of the two signals to provide selection of networks within the PADNET assembly. These speed signals are active low. When SSA and SSB are both low (30 in/s), the output of NAND gate A2-11 goes low and NAND gates A2-3, A2-4, and A2-10 are high. In a similar manner, each of the NAND gates provides a low signal which corresponds to a selected tape speed as determined by the selected speed signals from

the tape transport. The individual selected speed signals (30, 15, 7.5, and 3.75 in/s) are used to gate different timing networks in the PURC circuit. The decoded 30 in/s and 15 in/s are also used in the reproduce equalizer circuits to gate additional compensation into the equalization networks. The four decoded speed signals are used on the PADNET for selection of high and low speed equalization network via jumpers P1 and P2 and J1 and J2, respectively.

The standard PADNET assembly provides a choice of any two standard operating speeds that are compensated by the high and low speed equalization networks on the PADNET. The operating tape speeds are selected by jumpers on the PADNET. The high-speed equalization circuits may be enabled at 30, 15, and 7.5 in/s. The low-speed equalization circuits may be enabled at 15, 7.5, and 3.75 in/s. If the tape operating speed selected at the tape transport does not correspond to the speed selected on the PADNET to enable the high or low speed equalization, the recorder/reproducer is inhibited from operating in either play or record modes and the lockout indicator on the control unit is lit. The lockout signal, ISL, is generated by a NAND gate consisting of Q14 and CR8 through CR10. The decoded high- and low-speed equalization network selection signals provide the inputs to NAND gate Q14/CR8-10. If neither high- nor low-speed selected signals are low (0 Vdc), the output of NAND gate Q14/CR8-CR10 goes low denoting that a tape speed has been selected at the transport which does not correspond to a selected speed on the PADNET. All logic integrated circuits (ICs) on the PADNET are CMOS-type circuits; therefore, the logic levels in the circuits range from +15 Vdc (high) to 0 Vdc (low).

4-72. Erase Ramping. The turn on and turn off of the erase signal is controlled by the SAFE/REC signal from the audio control PWA No. 5. When the channel is not in the record mode, the SAFE/REC signal is high. The SAFE/REC signal, through resistor R42, is applied to a summing point at the inverting input of erase ramping amplifier A7-14. Erase ramping amplifier A7-14 and ramping network C36/VR1/VR2/CR11/C38/R44 generate the ramp and control signals for the erase ramping switch Q14 and erase head relay driver Q17/VR5. The ramping network provides feedback from the

output of the erase ramping amplifier A7-14 back to the summing point at the inverting input of the amplifier. When the SAFE/REC signal is high (not record mode), the output of the erase ramping amplifier A7-14 is nominally -10 Vdc. The -10 Vdc, via the PADNET, is applied to erase head relay driver Q17/VR5. The -10 Vdc biases the transistor off, which keeps relay K2 de-energized. The -10 Vdc, via the ramping network, enables a negative bias to be applied through resistor R70 and diode CR17 to the base of erase ramping switch Q14. Transistor Q14 operates in the inverted mode and conducts when the negative bias is applied, thereby shunting the 144-kHz erase signal, at the input to erase amplifier A10/Q18/Q19, to ground.

When the channel is switched into the record mode, the SAFE/REC signal goes low. When the SAFE/REC signal goes low, the low-going input supplied to the inverting input of erase ramping amplifier A7-14 causes the output of the amplifier to start rising toward the $+10$ -Vdc level. The output of erase ramping amplifier A7-14 is fed back to the summing point at the inverting input and to erase switch Q14 via the ramping network. The ramping network, together with erase ramping amplifier A7, forms an active integrating amplifier that generates an erase ramping signal that is applied to the base of Q14. This signal is used to shape the 144-kHz erase signal applied to the emitter of Q14. The controlled base drive produces an amplitude-controlled ramped 144-kHz signal which is applied to erase amplifier A10/Q18/Q19. The erase ramping signal also controls the timing for energizing erase head relay K2 via erase head relay driver Q17/VR5. When the channel is switched out of the record mode, the SAFE/REC signal goes high. The positive-going input to the summing point at the inverting input of erase ramping amplifier A7-14 causes the output of the integrating amplifier formed by the erase ramping amplifier A7-14 and the ramping network to swing towards negative 10 Vdc. The negative-going ramp generated by the integrating amplifier provides the turn-off ramp for the 144-kHz erase signal to the input of the erase amplifier via transistor switch Q14. The negative-going ramp also provides the timing to de-energize erase head relay K2 via erase head relay driver Q17/VR5.

4-73. Record Ramping and PURC Logic. The record ramping and pick-up record capability (PURC) logic generates the appropriate ramping signals for the controlled ramping up and down of the bias to the record circuits and for timing of the PURC delays. All control sequences are initiated when the status of the channel SAFE/REC signal, generated by the audio control PWA, changes. Figure 4-19 is a timing diagram of the ramping and PURC delay signals.

As discussed previously, operational amplifier A7-14 is connected to form an active integrator to generate the erase ramping control for erase ramping switch Q14, and to provide the control for the erase head relay K2 via erase head relay driver Q17/VR5. Operational amplifier A7-8 is connected to form an active integrator that provides the required ramping control to bias ramping switch Q7, and control the operating sequence of the record head reed relay K1, sel sync shunt switch Q6, record audio switch Q9, and bias command status switch Q8/Q10. Operational amplifier A7-1 forms an active integrator which, in conjunction with hysteresis switch A7-7 and timing selection FET Q8 through Q11, provides the selected delay timing for PURC operation.

When the recorder/reproducer goes into the record mode, the SAFE/REC signal goes low and turns on ± 15 V switch Q7 which switches the -15 Vdc at the input to PURC delay amplifier A7-1 to $+15$ Vdc via a selectable resistor network. Jumper plug P3 is used to select PURC operation when the recorder is switched into record mode. When the jumper plug is in the PURC position, $+15$ Vdc from the ± 15 V switch Q7 is supplied to the resistor network comprised of four resistors, R36 through R39. One of the four resistors is selected by the decoded speed select signals specifying the tape operating speed and supplies a constant current, as determined by the selected resistor, to the input of the PURC delay amplifier A7-1. When the jumper is in the NORM (PURC disabled) position, positive 15 Vdc from the 15-Vdc switch Q7 is supplied to PURC delay amplifier A7-1 through resistor R30 independent of the selected tape operating speed. Resistor R30 or resistors R36 through R39, depending on whether PURC operation is selected via jumper plug P3, provide different delay times in conjunction with the integrating

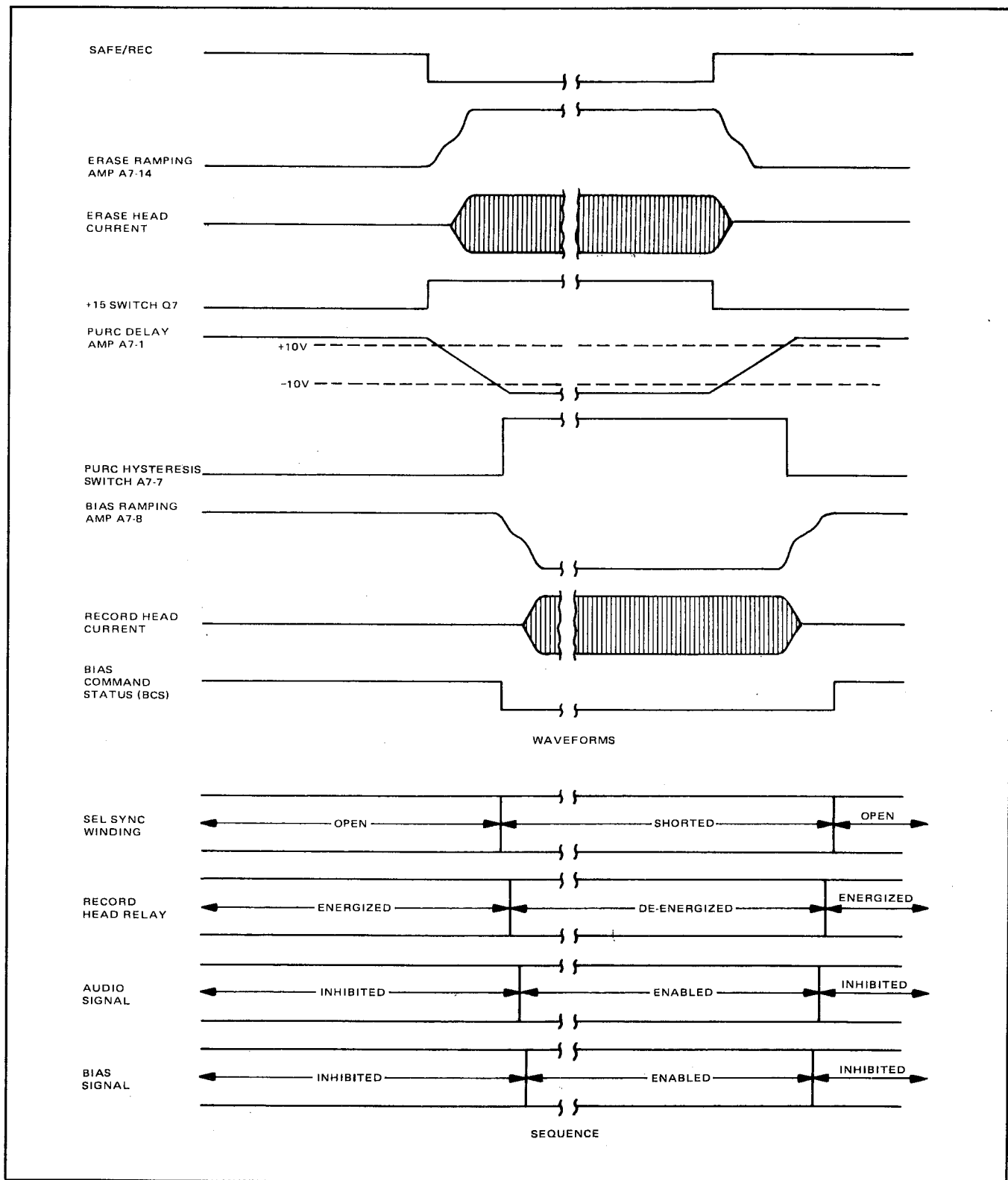


Figure 4-19. Record Ramping and PURC Delay Timing

amplifier formed by PURC delay time amplifier A7-1 with resistor R71 and capacitor C43. Resistors R36 through R39 are individually selected by FET switches Q8 through Q11 by the decoded speed selected signals. When the corresponding selected tape speed signal goes low, the associated FET switch is turned on and provides a current path through the resistor to the input of PURC delay amplifier A7-1.

When the recorder/reproducer is switched into the record mode, the SAFE/REC signal goes low and switches +15 Vdc, via +15V switch Q7 and resistor network R30/R36-R39, to PURC delay amplifier A7-1. PURC delay amplifier A7-1 generates a negative-going ramp. The slope of the ramp is determined by the selected resistor in resistor network R30/R36-R39 and C43/R71. The ramp from PURC delay amplifier A7-1 goes to the PURC hysteresis switch A7-7. The PURC hysteresis switch A7-7 is a comparator, which compares the level of the delay ramp with one of two levels. The two comparison levels are derived by a positive feedback network that decreases the output level of the PURC hysteresis switch A7-7 by approximately two-thirds. When the recorder/reproducer is in the safe mode (SAFE/REC signal is high), the output of the PURC hysteresis switch A7-7 is low (approximately -15 Vdc). The comparison reference level fed back to the input of the comparator is approximately -10 Vdc during the safe mode and remains at -10 Vdc until the level of the negative-going ramp exceeds -10 Vdc, at which time the output of PURC hysteresis switch A7-7 will go to +15 Vdc. The slope of the ramp, therefore, determines the difference between the time that the SAFE/REC signal goes low and the time that the output of PURC hysteresis switch A7-7 goes high.

As long as the recorder/reproducer remains in the record mode (SAFE/REC signal low), the output of the PURC hysteresis switch remains high (+15 Vdc) and a new reference level of +10 Vdc is fed back to the input of the comparator. The positive-going edge of the signal from PURC hysteresis switch A7-7 initiates the bias ramp, which controls the timing of record signals. The bias ramp is generated by active integrator bias-ramping amplifier A7-8. When the output of PURC hysteresis switch A7-7 goes high, a negative-going

ramp voltage is generated by bias-ramping amplifier A7-8. Bias and current-limiting of the signals by electronic switches in the record circuits control the turnon and turnoff sequence of operations. As the bias ramp goes negative, the following operations occur in the order given.

1. Status switch Q8/Q10 is turned on and supplies a logic low to bias command status line — BCS.
2. Sync shunt switch Q6 is turned on and shorts the sel-sync winding on the record head.
3. Record head relay Q11/K1 is de-energized, which removes the short across the record winding of the record head.
4. FET switch Q9 is switched on and enables the audio input to record amplifier A9/Q12/Q13.
5. Bias switch transistor Q7 is ramped off and provides a corresponding ramping up of the bias input to record amplifier A9/Q12/Q13.

When the recorder/reproducer is switched out of the record mode, the SAFE/REC signal goes high and turns off 15-Vdc switch Q7. With the +15-Vdc supply to resistor network R30/R36-R39 turned off, -15 Vdc is applied to the selected input resistor which provides the current to PURC delay amplifier A7-1. With -15 Vdc at the input, PURC delay amplifier A7-1 generates a positive-going ramp from -15 Vdc to +15 Vdc. The slope of the positive-going ramp is determined by the selected resistor in resistor network R30/R36-R39 and C43/R71. Since the -15 Vdc is applied through the same resistor network as the +15 Vdc, the slope of the positive-going ramp when the recorder/reproducer is switched out of the record mode is the same as the slope of the negative-going ramp when the recorder/reproducer is switched into the record mode.

The positive-going ramp goes to hysteresis switch A7-7. During record, the output of hysteresis switch A7-7 is +15 Vdc. Therefore, the comparison reference level for hysteresis switch A7-7 is shifted to +10 Vdc in the same manner that the -10-Vdc reference was generated going into record. When

the level of the positive-going ramp exceeds +10 Vdc, the output of PURC hysteresis switch A7-7 goes rapidly low and initiates a positive-going ramp, which is generated by bias ramping amplifier A7-8. As the bias ramp goes positive, the following operations occur in the order given.

1. Bias switch transistor Q7 is ramped on, which ramps down the bias input to record amplifier A9/Q12/Q13, thereby removing the bias signal to the amplifier.
2. FET switch Q9 is biased off, which removes the audio input to record amplifier A9/Q12/Q13.
3. Record head relay Q11/K1 is energized, thereby shunting the record head windings.
4. Sync shunt switch Q6 is turned off and opens the short across the sel-sync windings of the record head.
5. Status switch Q8/Q10 is turned off, removing the logic low from the bias command status line (BCS), which allows bias command status line BCS to go high.

4-74. Record Circuits. As shown in Figure 4-20, the main part of record equalization is performed by amplifier A6-6 in conjunction with an active differentiator formed by amplifier A5-6, input capacitor C5, and feedback resistor R40.

The audio input signal is split into three paths. The first path is via R39 to the summing node (pin 2 of A6-6). The second path is to the input network C5/R41 of the active differentiator. The third path is to the summing node of A6-6 via C13/R54/R55, with alternate paths selected by S1 and FET switches Q12 and Q13 for high- and low-speed switching equalization, respectively.

The output from the active differentiator A5-6 will, for a constant amplitude signal, rise 6 dB per octave with increasing frequency. Time constant components C5/R41 limit the maximum frequency of the rise. This output signal is then applied to equalizer potentiometer controls R15 and R18, which are the main high-frequency equalizer

controls for high-speed and low-speed operation, respectively. The setting of these equalizer controls determines how much of the differentiated signal is summed with the direct signal, via R39, supplied to the summing node of A6-6. Selection between the output of R15 or R18 is accomplished by FET switches Q12 and Q13, respectively.

A series of switch selectable networks formed by R16/R16/C8/C9 (switched by S1-1 and S1-3 for high speed) and R19/R20/C10/C11 (switched by S1-4 and S1-6 for low speed) form additional frequency dependent feedback around A6-6 to the summing node of A6-7. Selection for high or low speed is also accomplished by FET switches Q12 and Q13.

The network formed by C13/R54/R55 and selected for high-speed operation by S1-2 and for low-speed operation by S1-5, also provides separate frequency dependent preset equalization. In this instance, the network effectively appears in parallel with R39.

The networks switched by S1-1 and S1-4 provide mid- to high-frequency shelf down for high and low speeds, respectively. Switches S1-3 and S1-6 provide selectable constant current or 3,180- μ s low-frequency pre-emphasis for high and low speeds, respectively. Switches S1-2 and S1-5 provide a mid- to high-frequency shelf up for high and low speeds, respectively. Table 4-7 is a list of the switch settings for preset equalization network settings.

The equalized audio from amplifier A6 goes to record gain control R12 on the PADNET assembly. The audio from the gain control potentiometer R12 (REC GAIN) on the PADNET assembly goes through R47 back to the audio main board to FET switch Q9, which gates the audio to the summing junction of amplifier A9 in the recording amplifier. FET switch Q9 gates the audio under control of audio switch control network R62/CR9/C56, which receives a control signal from bias ramping control amplifier A7-8 in the control logic. The recording amplifier A9/Q12/Q13 is a wide-band voltage amplifier consisting of operational amplifier A9 and a complementary driver output amplifier Q12/Q13.

Table 4-7. Preset Equalization Network Settings

PRESET RECORD EQUALIZATION		
S1-1 S1-2 S1-3	SHELF DOWN SHELF UP 3180/ ∞	HI SPEED
S1-4 S1-5 S1-6	SHELF DOWN SHELF UP 3180/ ∞	LO SPEED
Shelf up or shelf down will be selected with the switch in the "ON" position. Infinity (∞), no low frequency boost will be selected with the switch "ON" and low frequency boost (3180- μ s time constant) with the switch "OFF."		

The 432-kHz bias signal is received at the main audio PWA, where it is routed to the bias normalizing and filtering circuits on the PADNET. Bias normalizing resistor R21/R22 provides level setting of the received 432 kHz from the master bias bus via BIAS NORM potentiometer R21. The level normalized bias signal is then filtered by bandpass filter L1/C12 on the PADNET. The filtered bias is sent to bias ramping switch transistor Q7 on the main audio PWA. Bias ramping switch transistor Q7 operates in the inverted mode and, under control of the bias ramp control signal from ramping amplifier A7-8 in the control logic, provides ramping of the bias signal to operational amplifier A9 where it is effectively added to the audio which is applied to the inverting input. The combined audio/bias signal from operational amplifier A9 is sent to complementary driver output amplifier Q12/Q13, which buffers the signal to head drive network C30/C45/L5/R86. Additionally, part of the signal from operational amplifier A9 is also sent to bias voltage switch Q15 and to feedback network R66/R65/C67. This network (R66/R65/C67) provides negative feedback around the record amplifier A9/Q12/Q13. Bias voltage present on the output of the record amplifier also provides the control signal to the base of transistor Q15 which, when bias is present, will provide a low on the bias voltage status (BVS) line from the audio main board.

The output of the record amplifier goes to the record head via head drive network C35/C45/L5/R86 and record head relay K1. The head drive

network provides a constant head current over a wide frequency range of the output of the record amplifier. Inductor L5 decouples resistor R86 so that the head inductance forms a resonant circuit with capacitor C45 at the bias frequency (432 kHz).

Record head relay K1 shunts the record winding of the head except during record mode. Relay driver R68/CR10/CR14/Q11, under control of the head relay control signal from the ramping amplifier in the control circuits, energizes record head relay K1 when the channel is not in the record mode. When the channel is not in the record mode, the head relay control signal from the control circuits is positive. The positive head relay control signal turns transistor Q11 on. With transistor Q11 conducting, relay K1 is energized and the normally-open contact of relay K1 is closed, providing a short across the record windings. When the channel goes into the record mode, the head relay control signal goes low and turns off transistor Q11, which de-energizes relay K1. When relay K1 is de-energized, the contacts across the record winding are opened and the short across the record winding is removed. When the short circuit across the record winding is removed, the output of the head drive network C35/C45/L5/R86 is supplied to the record winding high input. The return lead (low side) of the record winding returns to ground through a 10-ohm resistor R93. Test point TP9 of the high side of resistor R39 is provided to monitor the current through the record head winding.

4-75. Erase Circuit. The erase circuit provides filtering, buffering, and ramping of the 144-kHz erase signal from the master erase bus to the erase head. A simplified block diagram of the erase circuit is shown in Figure 4-21.

As shown in Figure 4-21, the erase circuitry receives 144-kHz from the master erase bus and the erase ramping control from the control logic. The SAFE/REC signal controls, via the erase ramping control amplifier on the control logic, the ramp on and ramp off of the erase signal to the erase amplifier and the erase head. During record mode, the 144-kHz signal goes through resistor R83 to erase ramping switch Q14 and filter C67/L6. Filter C67/L6 is a 144-kHz bandpass filter which removes the harmonics from the received 144-kHz signal.

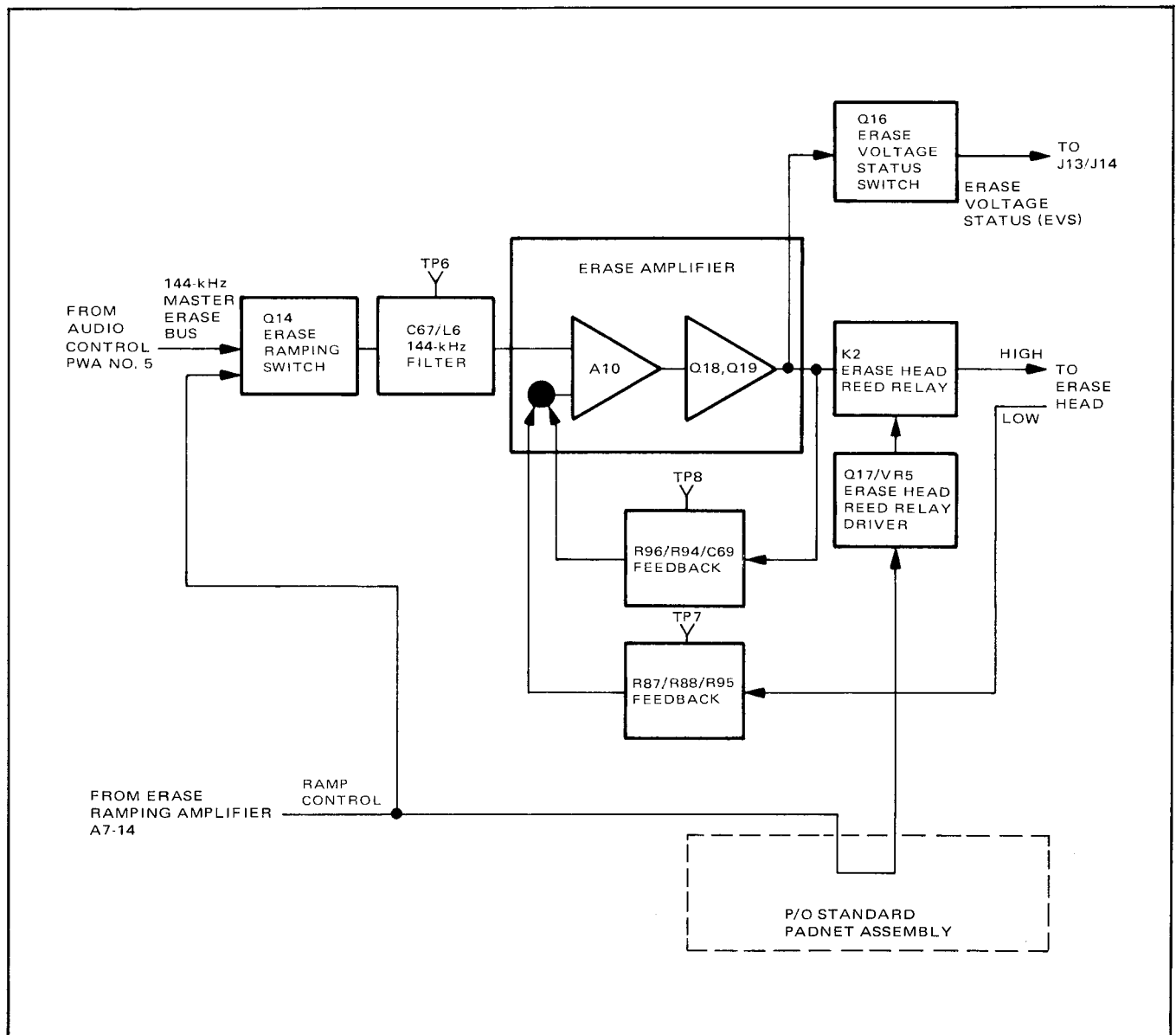


Figure 4-21. Erase Circuit, Simplified Block Diagram

Erase ramping switch Q14, operating in the inverted mode, acts as a shunt across filter C67/L6 which ramps the erase bias on and off. The filtered 144-kHz signal, when ramped on, goes to erase amplifier A10/Q18/Q19.

Erase amplifier A10/Q18/Q19 consists of amplifier A10 and complementary pair transistor driver amplifier Q18/Q19 arranged to form a feedback-controlled current driver to the erase head. The

filtered 144-kHz signal is applied to the non-inverting input of amplifier A10. Feedback voltage from the output of driver amplifier Q18/Q19 via resistor R96 is summed with the current feedback developed across resistor R87 via resistor R88 at the inverting input of amplifier A10. The output 144-kHz erase signal from driver amplifier Q18/Q19 goes through capacitor C71 and contacts of reed relay K2 to the erase head. During record, reed relay K2 is energized by erase head relay

driver Q17/VR5. The output of the driver amplifier Q18/Q19 also goes to the erase voltage status switch Q16 which supplies a low to the erase voltage status line (EVS) when the erase voltage is present at the output of driver amplifier Q18/Q19.

When the channel is not in the record mode, the 144 kHz from the master erase bus through resistor R83 is shunted to ground by erase ramping switch Q14, and erase head relay K2 is de-energized, which opens the circuit to the winding of the erase head.

4-76. Reproduce Circuits. The reproduce circuits provide amplification, selection, and post-equalization of the playback signals. Figure 4-22 shows a simplified block diagram of the reproduce circuits.

As shown in Figure 4-22, the reproduce circuit contains the sel sync head preamplifier, reproduce head preamplifier, and reproduce equalizer amplifier. The reproduce head preamplifier receives the playback signal from the reproduce head and is located on the main audio PWA. The sel sync head preamplifier receives the playback signal from the sel sync winding on the record head and is also located on the audio main board. The outputs of the two head preamplifiers go to the standard PADNET assembly where, via the individual sel sync and reproduce gain controls, the signal is applied to the summing point at the input to the reproduce equalizer amplifier through the sel sync and reproduce switching FETs. The reproduce equalizer amplifier provides post-equalization of the selected playback signal. The output of the reproduce equalizer amplifier is fed back, via speed selected equalization and compensating networks located on the PADNET assembly, to the summing point at the input of the reproduce equalizer amplifier. The output of reproduce equalizer amplifier is also sent to the audio output amplifier via erase frequency trap C3/L1 and input resistors R8/R9.

The signal from the sel sync winding on the record head is connected through capacitor C31 to the input of the sel sync preamplifier. Sel sync winding shunt switch Q6 at the input to the sel sync preamplifier consists of transistor switch Q6, operating

in the inverted mode which shorts out the sel sync winding during record. Transistor switch Q6 is controlled by the output of the bias ramping control amplifier A7-8 in the control logic. Resistor R33, in parallel with the input to the sel sync preamplifier, provides damping of the sel sync winding at resonance. The sel sync preamplifier consists of transistor Q5 and amplifier A4 arranged as a feedback-controlled voltage amplifier. The signal from the sel sync winding of the record head is fed to the base of transistor Q5. The output from transistor Q5 is fed to the inverting input of amplifier A4. Part of the output from amplifier A4 is fed back to the emitter of transistor Q5 via network C11/C12/C18/L2/R15-R17. The network formed by R15, R16, and C18 provides additional negative feedback to attenuate mid-range and high frequencies, thereby providing a low frequency boost in the output of sel sync preamplifier to compensate for the inherent roll-off in the reproduce signal from the sel sync windings. Resistor R17, in conjunction with C28/R37, sets the low-frequency gain of the sel sync head preamplifier. Capacitor C12 and inductor L2 in this network form a series-resonant trap at the bias frequency. The output of the sel sync head preamplifier A4, via resistor R49, goes to the unequalized sel sync output at the PWA-edge connector. From here the signal is routed to connector J13/J14. The output of the sel sync head preamplifier, via capacitor C13, goes to the sync gain control R3/R4 located on the PADNET assembly.

In a similar manner, the audio from the reproduce head is amplified by the reproduce head preamplifier consisting of operational amplifier A3 and transistor Q4 arranged to form a feedback controlled amplifier. The audio from the reproduce head goes to the base of transistor Q4 via inductor L3 which provides RFI filtering. Head damping network R36/R34, in parallel with the audio input to the base of transistor Q4, provides adjustable damping of the high-frequency head resonance. The output from amplifier A3 is fed back to the input of transistor Q4 via RC network C24/R31. This RC network, together with RC network C27/R32, sets the ac gain of the reproduce head preamplifier. Another RC network formed by R23/C23 limits the open loop gain of operational amplifier A3.

The output of the reproduce head preamplifier, via capacitor C7, goes to the reproduce gain control R1 on the PADNET assembly. The PADNET assembly contains the switching for selecting the output of the sel sync head preamplifier or reproduce head preamplifier as the input to the reproduce equalizer amplifier. The PADNET assembly also contains the switching and equalizer networks which provide feedback to the reproduce equalizer amplifier for post-equalization of the reproduce audio. The SYNC/REPRO signal from the audio control assembly, via FET switches Q1 and Q3, selects the signal from either the sync gain control R3 or reproduce gain control R1 as the input to the reproduce equalizer amplifier. The selected playback signal goes to the summing point at the input to the reproduce equalizer amplifier.

The reproduce equalizer amplifier consists of a high-gain, low-noise differential amplifier Q1, operational amplifier A1, and RC network R5-R7/C4/C6. The RC network provides dc feedback to the inverting input of amplifier Q1, which prevents dc output saturation in the event that power is applied with the PADNET not installed. The summing point at the input to amplifier Q1 also receives dc feedback via the selected equalizing network.

The reproduce equalization network contains two post-equalization networks, one for high speed and one for low speed. The high speed and low speed post-equalization feedback networks are selected by FET switch Q4 and FET switch Q2, respectively, which are gated by the decoded high- and low-speed selection signals from the speed decode logic. When 30- or 15-in/s speeds are selected, additional equalization is required to compensate for secondary gap effect which is more pronounced at these speeds.

The 30-in/s and 15-in/s signals from the speed decode logic enable additional equalization, via FET switches Q6 and Q5 respectively, to be inserted in parallel to the high- or low-speed equalizing feedback loop. The output from the reproduce equalizer amplifier is applied to the summing junction of the output amplifier via gain setting resistors R8 and R9 when the tape selection FET switch Q2 is in the tape mode. An LC network L1/C3, in conjunction with R8, forms a

series-resonant trap at the erase frequency for the signal sent to FET switch Q2.

4-77. Audio Output Circuit. The audio output circuit consists of FET switches Q3 and Q2, audio output amplifier A2, and feedback network R11/C9. Figure 4-23 is a simplified block diagram of the audio output circuit. FET switches Q3 and Q2 provide selection of either tape or input signals to be buffered by audio output buffer A2 under control of the TAPE/TAPE and INPUT/INPUT command signals from the audio control PWA No. 5. FET switch Q2 selects the off-tape signal from the reproduce equalizer amplifier when the TAPE/TAPE command goes low. For monitoring, FET switch Q3 selects the audio input signal to the record circuits when the INPUT/INPUT signal goes low. FET switches Q2 and Q3 will never both be turned on at the same time; however, both switches may be turned off simultaneously. Diode CR1 at the input to FET switch Q2 provides limiting, when Q2 is turned off, of positive signal peaks to ensure that FET switch Q2 is not turned on by the signal peaks. When FET switch Q2 is turned on by the TAPE/TAPE signal, diode CR1 will not be forward biased because diode CR1 is essentially at the virtual ground of the summing junction. In a similar manner, diodes CR2 and CR20 at the input of FET switch Q3 provide a symmetrical clamp for the audio input to the switch which prevents the audio peaks from turning on FET switch Q3.

The selected audio, either tape or input, goes to the inverting input of audio output buffer A2 which provides, via resistor R12, the audio output signal from the main audio PWA. Part of the audio output signal is fed back to the input of audio output buffer A2 by feedback network R11/C9. The voltage feedback from this network, together with resistors R22 or R8/R9 selected by FET switches Q3 or Q2, set the required closed loop gain of audio output buffer A2.

4-78. Input/Output Assembly (Accessory)

Up to two input/output modules may be mounted side-by-side in an input/output assembly. One module is required for each audio channel, and each module contains a line input and a line output

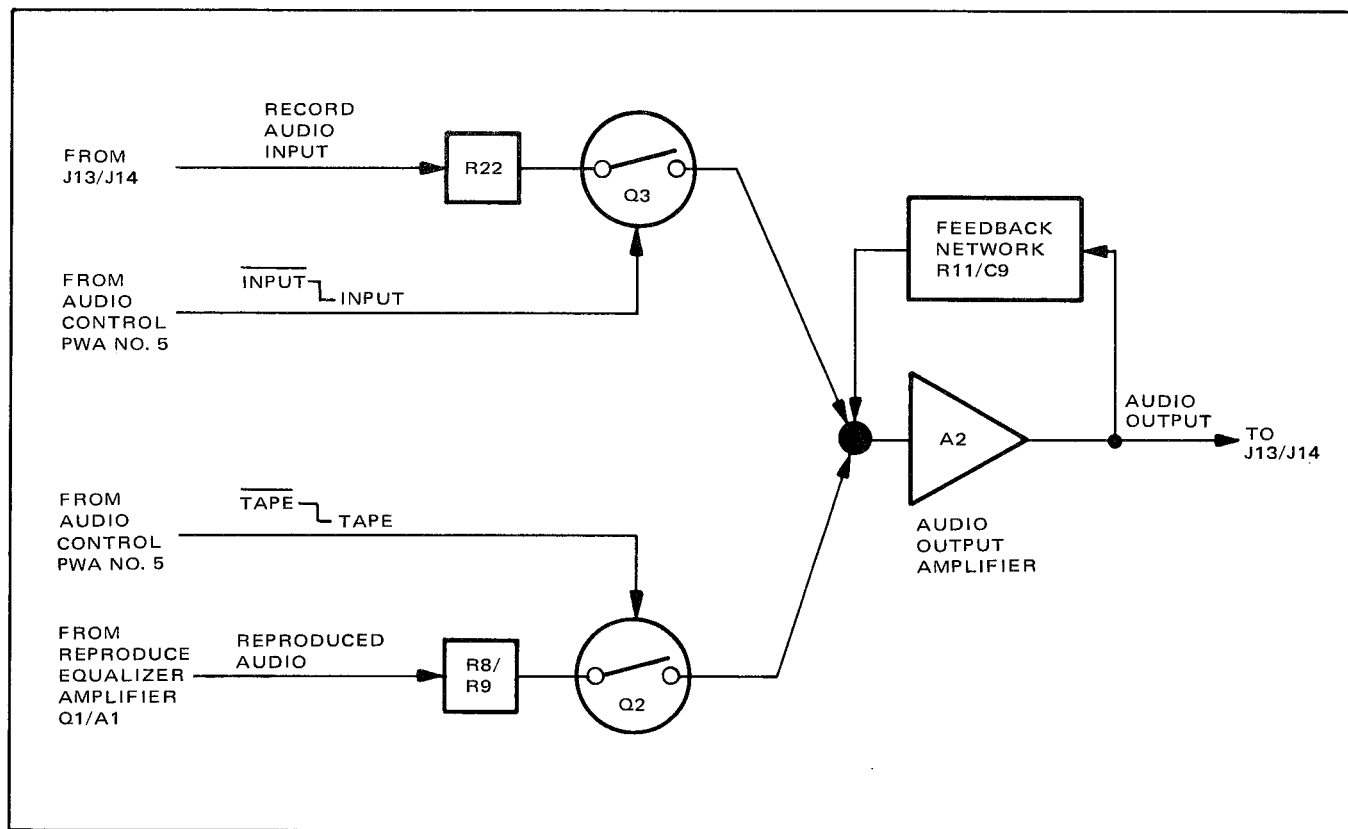


Figure 4-23. Audio Output Circuit, Simplified Block Diagram

transformer that permits balanced line operation, a line driver, switchable peak/vu level meter, and input and output level controls with preset/manual switch controls. Figure 4-24 is a simplified block diagram of the input/output assembly, drawing 4840427 is the schematic of the input/output mainframe assembly, and drawing 4840421 is the schematic of the input/output module (schematics are in Section 6 of this manual).

4-79. Line Input Amplifier. The audio line input signal to be recorded is applied to the input of the input/output assembly. This signal can be either balanced or unbalanced (see Installation section), and the signal is fed through input transformer T2 to RECORD MANUAL/PRESET switch S2. In the PRESET position, the gain of line input operational amplifier is adjusted by record preset potentiometer R2 to provide a -5 dBm output level to the ATR-100 when the input is $+4\text{ dBm}$ (or other input level as selected by the user).

If other than a predetermined input line level is fed to the input, switch S2 is placed in the MANUAL position and the RECORD potentiometer control is used to control the gain of the amplifier A2 to provide a -5 dBm output operating level to the ATR-100. If required, the gain of amplifier A2 may be increased $+6\text{ dB}$ by installing a jumper across series resistors R60 and R63 and changing C20 to 47 pF . (This also changes the input impedance from 50K to 25K ohms .) Offset null control R55 is adjusted so there is zero change in dc voltage when the RECORD potentiometer control is rotated through its range.

4-80. Input Signal Monitoring. In input monitoring mode, the line input signal can be monitored on the level meter and on the line-output line. The line input is sampled at the output of amplifier A2 and is fed through record calibrate potentiometer R3 to the input of FET switch Q2. In input monitoring mode, the TAPE/TAPE command from the

ATR-100 is high ($\overline{\text{tape}}$). This high turns FET switch Q1 off and the high is inverted by Q3. The low from the collector of Q3 turns FET switch Q2 on and the line input signal is fed to the line output amplifier. The output amplifier is formed from operational amplifier A5-6 and complementary symmetry line-driver transistors Q4 and Q5 which feed line output transformer T1. The gain of the output amplifier is set by two feedback loops. The first feedback loop is from the output of Q4/Q5 via R23/C6; and the second feedback loop is derived from a tertiary winding on output transformer T1, which supplies approximately 8 dB of additional feedback, via R22/C5 to the summing node of A5-2. The output signal can be either balanced or unbalanced (see Installation section of manual).

Record calibrate potentiometer R3 is adjusted so that the -5 -dBm level at the output of amplifier A2 is amplified to provide a $+4$ -dBm line-output level (or other output level as selected by the user). Offset null control R40 is adjusted so there is zero volts at TP2 when no input signal is applied to the input/output assembly.

4-81. Reproduce Mode. In reproduce mode, the reproduced audio signal at a -5 -dBm level from the ATR-100 is applied to the REPRODUCE control and the reproduce preset control R1. Control R1 is adjusted so that when REPRODUCE switch S1 is in the PRESET position, the output line level will be $+4$ dBm (or other output level as selected by the user). For manual adjustment of output line level, switch S1 is placed in the MANUAL position and the REPRODUCE potentiometer control is adjusted for the desired line-output level. In reproduce mode, the $\overline{\text{tape}}$ /tape command from the ATR-100 is low (tape). This low enables FET switch Q1 and, via inverter Q3, disables FET switch Q2. When Q1 is enabled, the audio signal from the ATR-100 is applied to the input of operational amplifier A5.

4-82. Meter Circuit Operation. The signal to be displayed on the meter is sampled from the tertiary feedback winding on output transformer T1. This signal is applied to meter calibration potentiometer control R21, which is set so that a $+4$ -dBm line output signal (or other level selected by the user) will indicate 0 vu on the level meter when the

peak/vu switch S3 is in the vu position. (In the peak position the meter will read -6 when R21 has been set to read 0 vu in vu position.) The signal at the wiper of R21 is applied to the non-inverting input of operational amplifier A4. This amplifier has its output connected to the full-wave bridge rectifier formed by CR3-CR6. Current feedback from the lower side of the bridge (junction of CR5/CR6) is applied to the inverting input of A4-6. This feedback linearizes the diode transfer characteristics to produce a precision full-wave rectifier. Components R19/C9/C10 set the ac gain of the circuit in conjunction with resistor R30.

The rectified output of the diode bridge appears across R30 and is applied to the differential inputs of A1-1. The output of A1-1 is a full-wave rectified signal referred to ground level. This signal is fed to amplifier A3-1, which uses Q6 as an output current amplifier. Amplifier A3-1 and Q6 provide a high drive current stage which is required when charging the peak mode holding capacitor C1. Time constant components C1/R24 determine peak mode integration time and time constant components C1/R4 predominately determine the fallback time.

In peak mode, switch S3A connects the input and feedback network R5/R12/R13/C3 around meter drive amplifier A1-7. In vu mode, switch S3B disconnects the integration capacitor C1, and switch S3A connects the other input/feedback network R10/R11/C2 and R9/C4 around meter drive amplifier A1-7. These switched networks provide the necessary gain change for peak and vu metering in addition to providing the correct meter ballistic for both modes.

Offset null control R32 is adjusted so that the level meter will show no deflection (same reading as when power is removed and meter needle is at extreme left-hand dial position) when no signal is applied to the input/output assembly.

4-83. Erase and Bias Voltage Confidence Indicators. The ERASE and BIAS LED indicators illuminate when the ATR-100 is in the record mode. In record mode, the EVS (erase voltage status) and BVS (bias voltage status) commands are low. These commands cause Q9 and Q10 to conduct, which causes the LED indicators to illuminate.

4-84. ± 15 -Vdc Regulator. A ± 15 -Vdc zener diode regulator is used to power the input/output module assembly. Power in the form of ± 24 Vdc is furnished from the ATR-100 and is applied to series-pass transistors Q7 and Q8, which are connected as emitter followers. The output voltage at the emitters of Q7 and Q8 is determined by zener diodes VR1 and VR2, which are connected between the base and ground of Q7 and Q8, respectively.

4-85. Tape Timer Functional Description

The tape timer displays in hours, minutes, and seconds the elapsed time that the tape has moved at the selected speed from a zero reference established by pressing the RESET pushbutton switch on the control unit. The tape timer contains a counter and associated arithmetic logic to detect the relative tape position and provide a time-multiplexed, binary-coded decimal (BCD) output for the display of the tape position in hours, minutes, and seconds of play/record time at the selected tape speed. The tape timer receives a tape direction signal from the control unit, a selected speed signal from the tape transport, and pulses from a tape-driven tachometer (tach) on the tape transport. The tape timer counts the number of tach pulses received, converts the length of tape represented by the tach pulses to record/play time at the selected speed, and adds or subtracts the time represented by the tape motion from the current time being displayed, depending on the direction of tape motion. The tape timer sends five binary-coded decimal digits to the display on the control unit. To minimize the number of interconnecting leads between the tape timer and the control unit, the five digits are transmitted serially over a common 4-bit bus to a BCD-to-7 segment decoder in the control unit. The output of the BCD-to-7 segment decoder is sent in parallel to five 7-segment display indicators that comprise the 5-digit display on the control unit. Five digit select lines are also sent to the control unit. The digit select lines identify the current digit being sent from the tape timer and enable the corresponding one of five 7-segment display indicators.

4-86. Tape Timer Circuit Details

The tape timer circuitry is principally located on transport control PWA No. 7. The display and ancillary BCD-to-7-segment encoder are located on the control unit. Figure 4-25 is a simplified block diagram of the tape timer, and drawings 4840397 and 4840396 are the schematic diagrams, respectively.

4-87. Tape Timer Display. The tape timer display is contained on the control unit assembly and consists of five 7-segment light emitting diode (LED) display indicators (A1 through A5 on control unit PWA No. 1), five driver transistors (Q1 through Q5 on PWA No. 1), and a BCD-to-7-segment encoder (A3 on PWA No. 2). The serial stream of binary-coded decimal digits from the tape timer logic on PWA No. 7 are sent to the BCD-to-7-segment decoder A3 located on the control unit PWA No. 2. The binary-coded decimal digits are sent via 4 lines; BCD-A, BCD-B, BCD-C, BCD-D. The BCD-to-7-segment decoder A3 provides a logic low (ground) to the segments required to form the digit, which is sent in BCD via BCD-A through BCD-D, on the display.

The seven lines that comprise the output of the BCD-to-7-segment decoder A3 are sent to the control unit PWA No. 1, where they are connected in parallel to each of the corresponding segments on the five 7-segment displays, A1 through A5. Each of the five 7-segment displays consists of seven light-emitting diodes with common anodes. Selection of the 7-segment pattern corresponding to the digit sent via the BCD-A through BCD-D is accomplished by applying a positive 5 volts (logic high) to the anode of the selected 7-segment display and keeping the anodes of the other 7-segment displays at ground (logic low). The digit selection signals DS-1 through DS-5 from the tape timer circuits on the transport logic PWA No. 7, via transistor switches, provide a positive 5 volts to the anode of 7-segment display A1 through A5, respectively. When a digit select line goes low (0 Vdc), the associated transistor switch conducts and provides a positive 5 volts to the anode of the corresponding 7-segment display. Since only one digit select line goes low at a time, the remaining transistor switches are not conducting, and the

remaining anodes of the unselected 7-segment displays remain at 0 Vdc. Therefore, only the selected digit is lit.

4-88. Tape Timer Tachometer. The tape timer tachometer is contained on the tape transport assembly and consists of the tape wheel assembly and associated electro-optical switching assembly. The tape wheel assembly is mechanically coupled to the tape to provide one complete rotation of the tape wheel for each 7.5 inches of tape motion. The tape wheel assembly contains a shutter which interrupts the optical path of the electro-optical switch at a rate of 20 times per revolution. The electro-optical switch provides TTL-level pulses to buffer Q3-Q5 on transport control PWA No. 7. Buffer Q3-Q5 provides pulse shaping to improve the rise and fall times of the pulses received from the electro-optical switch. The buffered tachometer (tach) pulses are then sent to the tach pulse synchronizer A33-10/A33-15 that consists of two D-type latches that are clocked by the positive-going edge of the 432-kHz system clock. The tach pulse synchronizer A33-10/A33-15 retimes the tach pulses to provide a single negative-going pulse one clock period wide for each tach pulse received, regardless of the length of the tach pulse.

When the output of the buffer Q3-Q5 goes positive, latch A33-10 is set by the positive-going edge of the 432-kHz clock. The output of latch A33-10 goes to latch A33-15 and NAND gate A27-11. Latch A33-15 is set to the same state as latch A33-10 by the next positive-going edge of the 432-kHz clock. The output of latch A33-10 is combined with the complement of latch A33-15 by NAND gate A27-11 so that during the interval that latch A33-10 is first set and the time that latch A33-15 is set, one clock interval later, the output of NAND gate A27-11 goes low. During all other conditions, NAND gate A27-11 remains high. The output of NAND gate A27-11 goes to tach pulse latch A27/A21. Tach pulse latch A27/A21 is an RS-type flip-flop, which stores the received synchronous tach pulse until required by the arithmetic logic of the tape timer.

4-89. Tape Timer Arithmetic Logic. The tape timer arithmetic logic is contained on transport control PWA No. 7. The tape timer arithmetic logic consists of an up/down counter and associated

control and timing logic. The up/down counter is an 8-digit serial binary adder that circulates data through a 4-bit parallel adder serially by digit. The up/down counter provides the incrementing and decrementing of time in hours, minutes, and seconds and division of the tach pulse rate according to the selected operating speed. An 8-bit ring counter identifies the digit currently at the output of the 8-digit, 4-bit, serial binary adder and provides the control for multiplexing the digits from the adder at the control unit display. The operations within the tape timer arithmetic logic are synchronized by the 432-kHz clock. Table 4-8 shows the format for the eight 4-bit digits contained in the four 8-bit shift registers and the time interval during which each of the 4 bits representing a single digit are available at the output of the register.

As shown in Table 4-8, the first time period (t_0) contains a digit whose modulus varies with the tape speed. Since the tach pulses are generated at a rate of 20 times per 7.5 inches of tape, the modulus of the digit at time t_0 varies with the tape speed selected to divide the tach pulses by a factor which provides 10 pulses per second at the selected operating speed. At a selected operating speed of 30, 15, 7.5, and 3.75 inches per second, the modulus of the digit at t_0 is 8, 4, 2, and 1, respectively. The digits at time t_1 through t_7 represent the operating time in hours, minutes, seconds, and tenths of a second at the selected operating time. Only five digits are displayed on the control unit.

Table 4-8. Counter Data Word Format

MODULO	TIME
Tape-Speed Divider (modulo depends on tape speed selected)	t_0
Tenths of Seconds (modulo 10)	t_1
Units of Seconds (modulo 10)	t_2
Tens of Seconds (modulo 6)	t_3
Units of Minutes (modulo 10)	t_4
Tens of Minutes (modulo 6)	t_5
Units of Hours (modulo 10)	t_6
Tens of Hours (modulo 10)	t_7

The digits at time t_1 through t_5 or at time t_2 through t_6 may be selected by link strapping on the tape timer logic assembly to display tenths of a second, seconds, and minutes or to display seconds, minutes, and hours, respectively, on the control unit display. The output signals from the ring counter are strapped to the enable signal lines, DS-1 through DS-5, to select the appropriate digit on the control unit display.

The tape up/down counter in the tape timer logic consists of shift register A2/A3, adder A1, ones subtractor A9, modulo boundary detector A8, and carry flip-flop A33-7. The up/down counter shifts each digit in the counter data word in a 4-bit slice to the data output lines. If a tach pulse is not received by the tape timer logic within the previous cycle (t_0 through t_7), the data is recirculated through the up/down counter without being modified. If a tach pulse is received by the tape timer logic during the previous cycle (t_0 through t_7), the count in the up/down counter is incremented by one when the tape motion is in a forward direction, or decremented by one when the tape motion is in the reverse direction.

The timing and control logic of the tape timer consists of ring counter A26, direction latch A33-2, modulo logic A19/A25, complementary encoder A13/A14, and tach pulse latch A21/A27. Ring counter A26 is clocked by the positive-going edge of the 432-kHz signal and generates the 8-bit time intervals (t_0 to t_7) for one cycle of operation of the up/down counter. The modulo logic A19/A25 receives the speed selector signals, SSA and SSB, from the tape transport speed selector switch and timing information from the ring counter A26. The modulo logic generates the 15's complement of the modulus for each digit in the counter data word at the corresponding time interval. The modulo information, in 15's complement form, is sent to complementary encoder A13/A14. Complementary encoder A13/A14 provides the modulus or its complement to ones subtractor A9 or modulo boundary detector A8, respectively. Direction latch A33-2, which is set by the tape up/down command TDR, generates the control signal UP to complementary encoder A13/A14. The UP signal, if set (high), gates the complemented modulus to modulo boundary detector A8. If the UP signal is reset (low), the modulus is sent to subtractor A9.

The UP signal is also sent to adder A1 where it provides the control signal to increment or decrement the counter when a tach pulse has been received.

The modulo information is sent to the complementary encoder A13/A14 which provides the modulus or its complement to the ones subtractor A9 or the modulo boundary detector A8, respectively. Tape direction latch A33-2, which is set by the tape up/down command (TDR), generates the control signal (UP) to the complementary encoder A13/A14. The UP signal, if set (high), gates the 4-bit complement of the modulus to modulo boundary detector A8. If the UP signal is reset (low), the modulus is sent to the ones subtractor A9 in BCD. The UP signal is also sent to adder A1 where it provides the control signal to increment or decrement the counter when a tach pulse has been received.

4-90. Initialization. The tape timer is initialized by pressing and releasing the RESET pushbutton on the control unit. Pressing the RESET pushbutton generates a low CRB signal to the tape timer. When CRB is low, the tach and carry pulses from the carry flip-flop A33-7 are inhibited from going to the counter and the contents of 4-by-8-bit shift register A2/A3 are cleared. The tape timer is also initialized by the wakeup signal, which is generated when power is first applied to the unit, via a "wired-OR" that forces the CRB line to the tape timer logic low.

4-91. Count-Up Mode. When the tape is moving forward, the tape timer is in a count-up mode. During this time, the TDR signal (up/down command) is high. When the TDR signal is high, direction latch A33-2 is set by the positive-going edge of the 432-kHz clock. With direction latch A33-2 set, the output of the carry flip-flop A33-7 is directed to the carry input of adder A1 through NOR gate A20-1; the 4-bit data from the modulo logic is gated to modulo boundary detector A8 via the complementary encoder A13/A14; and the 4-bit data to the ones subtractor A9 is low. Figure 4-26 shows a simplified block diagram of the serial adder formed by 4-by-8-bit shift register A2/A3 and associated components A1, A8, and A9.

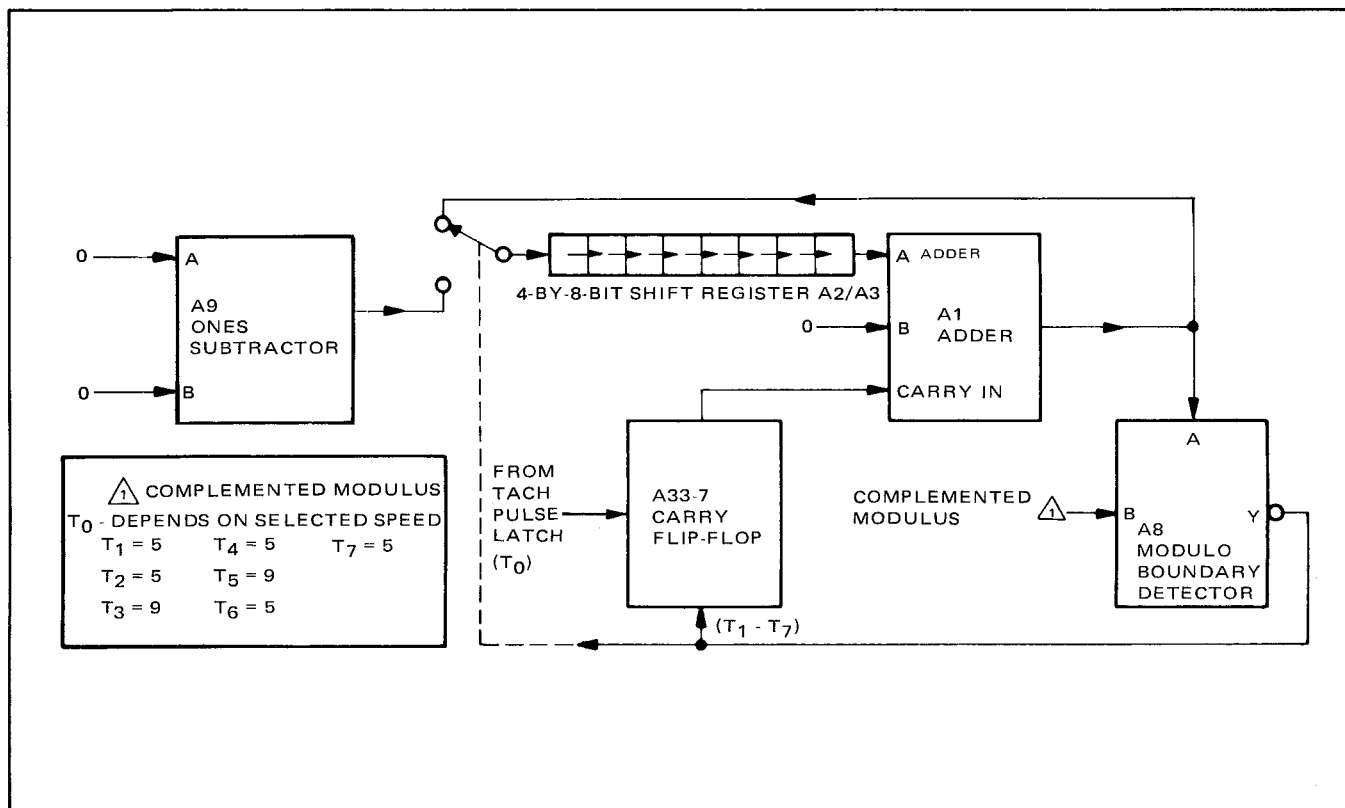


Figure 4-26. Count Up Logic, Simplified Block Diagram

As shown in Figure 4-26, each BCD digit is shifted through the shift register and adders as a parallel 4-bit number. The data through 4-by-8-bit shift register A2/A3 is shifted serially by the 432-kHz signal. At time t_0 , the least significant bit of the eight-digit BCD number is shifted out of the register to the A inputs of adder A1. During the count-up mode, the B inputs to adder A1 from NOR gate A20-13 are low, and the carry in to adder A1 will go high only when a tach pulse had been received during the previous t_0 through t_7 cycle, or a carry is generated at any other period than t_7 . If no tach pulse was received during the previous cycle (t_0 through t_7), the least significant digit which is present at t_0 will be unchanged by adder A1. The output of adder A1 is recirculated back to the input of 4-by-8-bit shift register A2/A3. The output of the adder A1 is also sent to the A input of modulo boundary detector A8. The B input to modulo boundary detector A8 is the 15's complement of the modulus for that specific digit. At time t_0 , the modulus is determined by

the setting of the speed selector on the tape transport. The complemented modulus at the B input to modulo boundary detector A8 during t_0 will be 7, 11, 13, and 14 for selected speeds of 30, 15, 7.5, and 3.75 inches per second, respectively.

The output of adder A8 goes to NAND gate A31-6, which provides a low (0 Vdc) signal to the data selection input of the shift register and, via NAND gate A27-6, to carry flip-flop A33-7. As long as no tach pulses are received by the tape timer logic, the count continues to be recirculated through the shift register unchanged and the output of NAND gate A31-6 remains high. When a tach pulse is received at the end of t_7 , the carry flip-flop A33-7 is set, which generates an input to adder A1 during t_0 . This input increments the least significant digit from the shift register. The incremented output of adder A1 is summed with the complemented modulus by modulo boundary detector A8. If the resulting sum does not equal 15, NAND gate A31-6 remains high. With NAND gate A31-6 high,

the incremented digit is clocked back into the shift register at the start of t_1 and the carry flip-flop A33-7 is not set again. Therefore, the remaining digits at t_1 through t_7 will be recirculated unchanged through the shift register. If at the start of t_0 , a tach pulse had been received and the resulting incremented output of adder A1 plus the complemented modulus equaled 15, the output of NAND gate A31-6 would go low. With the output of A31-6 low, the incremented digit is not recirculated back to the shift register. Instead the output of the ones subtractor A9 is selected. During count up, the output of ones subtractor A9 is always equal to 0.

In addition to selecting the output of ones subtractor A9 as the input of the shift register, the low output of NAND gate A31-6, via NAND gate A27-6, sets carry flip-flop A33-7 at the start of the next time interval (t_1). At t_1 , the second least significant digit is shifted out to adder A1 and, if carry flip-flop A33-7 is set (least significant digit + complemented modulus = 15), the carry in to adder A1 is high and the second least significant bit will be incremented. The sum from adder A1 during time t_1 is added to the complemented (base 16) modulus by modulo boundary detector A8 and, if the sum equals 15, NAND gate A31-6 goes low. If NAND gate A31-6 goes low, zero is loaded into the shift register and the carry flip-flop A33-7 is set to provide a carry in to adder A1 at t_2 . If the sum out of modulo boundary detector A8 did not equal 15, NAND gate A31-6 will remain high and the incremented sum out of adder A1 is recirculated back to the shift register. This process repeats during each successive bit time, t_2 through t_6 . At t_7 , the most significant digit is shifted out of 4-by-8-bit shift register A2/A3 to adder A1. The status of the carry flip-flop A33-7 is inhibited from generating a carry in to adder A1 by the t_7 timing pulse via buffer A37-12, which is "wire-ANDed" with the output of carry flip-flop A33-7 via buffer A37-10. Since during t_7 the most significant digit is never incremented, a carry is not generated into the least significant digit as a result of the most significant digit exceeding the modulus.

4-92. Count-Down Mode. When the tape is moving in a reverse direction, the tape timer is in

a count-down mode. During this time, the TDR signal (up/down command) is low. When the TDR signal is low, direction latch A33-2 is reset by the positive-going edge of the 432-kHz signal. When direction latch A33-2 is reset, the output of carry flip-flop A33-7 is directed to the B inputs of adder A1 through NOR gate A20-13, the 4-bit data from the modulo logic is gated to ones subtractor A9 via complementary encoder A13/A14, and the 4-bit B input to modulo boundary detector A8 is low. Figure 4-27 shows a simplified block diagram of the serial adder formed by 4-by-8-bit shift register A2/A3 and associated logic components A1, A8, and A9.

As shown in Figure 4-27, each BCD digit is shifted through the shift register and logic as a parallel 4-bit number. The data through 4-by-8-bit shift register A2/A3 is shifted serially by the 432-kHz signal. At time t_0 , the least significant digit of the eight-digit BCD number is shifted out of the register to the A inputs of adder A1. During the count-down mode, the carry in to adder A1 from NOR gate A20-1 is held low, and the 4-bit B inputs to adder A1 will go high when a tach pulse has been received during the previous t_0 through t_7 cycle or a carry is generated at any other period than at t_7 . If not tach pulse is received during the previous cycle (t_0 through t_7), the least significant digit which is present at t_0 will be unchanged by adder A1. The output of adder A1 is recirculated back to the input of 4-by-8-bit shift register A2/A3. The output of adder A1 is also sent to the A input of the modulo boundary detector A8. The B input to modulo boundary detector A8 will always be 0 during the count-down mode. Ones subtractor A9 is used to input the data into shift register A2/A3 when a borrow is detected. The A input to ones subtractor A9 is the modulus for that specific digit. During time t_0 , the modulus at the A input to ones subtractor A9 will be 8, 4, 2, or 1 for selected tape speeds of 30, 15, 7.5, and 3.75 inches per second, respectively. All four B inputs will always be high during count down thereby adding 15 (or the sixteens complement of one). Therefore, during count down, the sum output of the ones subtractor A9 will always be equal to the modulus minus 1. This ensures that the correct number is present to succeed zero in the count-down sequence.

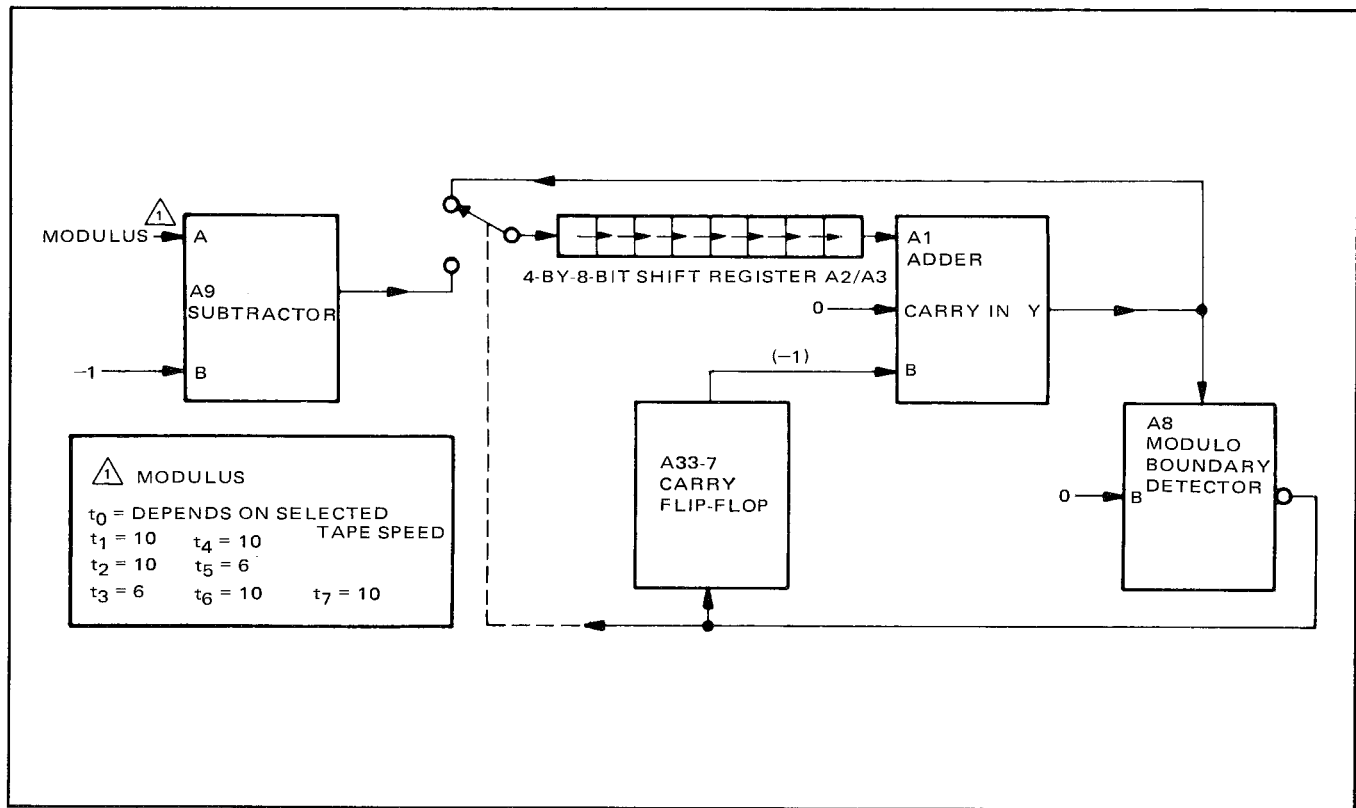


Figure 4-27. Count Down Logic, Simplified Block Diagram

When a tach pulse has been received during the previous cycle (t_0 through t_7), carry flip-flop A33-7 is set at start of t_0 . The set output from carry flip-flop A33-7 is gated to the B inputs of adder A1 via NOR gate A20-13; therefore, when the carry flip-flop is set, all B inputs will be high. When the carry flip-flop A33-7 is reset, all B inputs will be low. At time t_0 , the least significant digit is shifted out of shift register A2/A3 to adder A1. If a tach pulse was not received, the sum output of adder A1 will be recirculated to the input of shift register A2/A3 unchanged. If a tach pulse was received in the previous cycle, carry flip-flop A33-7 is set at t_0 and the least significant digit that is being shifted out at this time is summed with the B input to adder A1, which is all ones. By adding all ones (or the sixteens complement of one) to the output of the shift register, one is subtracted from the count. The sum from adder A1 is sent to modulo boundary detector A8 where it is transferred to the inputs of NAND gate A31-6 unchanged since, during count down, only 0 (all B

inputs low) is added to the sum from adder A1 by A8. If decrementing the least significant digit generates a 15 (0 minus 1 equals 15 in hexadecimal), NAND gate A31-6 goes low and sets carry flip-flop A33-7 at the end of t_0 .

At the same time that NAND gate A31-6 goes low, the output of ones subtractor A9 is substituted for that of adder A1 at the input of 4-by-8-bit shift register A2/A3. This output is always equal to one less than the modulus of the digit currently being processed. At t_1 , the second least significant digit is transferred out of shift register A2/A3 to adder A1. If at t_0 the carry flip-flop A33-7 was set, the second least significant bit will be decremented. The output of adder A1 is checked by modulo boundary detector A8 in the same manner as during t_0 for a count of 15. If the count of 15 is not detected, the output of the adder is recirculated back to 4-by-8 shift register A2/A3.

If 15 (15 equals zero count) is detected as the result of decrementing the digit from the shift register, the output of ones subtractor A9 is shifted into 4-by-8-bit shift register A2/A3 as the correct number to follow zero in the count-down sequence. In a similar manner, the remaining digits, t_2 through t_7 , are processed in the count-down mode with the exception that during t_7 the output of the carry flip-flop A33-7 is disabled.

4-93. Tape Run Out. If the tape runs out, tach pulses may still be generated by the tachometer wheel due to inertia. In order to prevent the tach pulses from being counted, an abort signal, generated by the tape transport when the tape runs out, inhibits the output from carry flip-flop A33-7. The abort signal is received by open-collector buffer A37-8. The output of open-collector buffer A37-8 is "wired-ORed" with buffer A37-10, which buffers the output of the carry flip-flop A33-7. When the abort signal goes low, the buffered output of the carry flip-flop A33-7 is held low by buffer A37-8 and further counting of tach pulses is inhibited.

4-94. Power Supply Functional Description

The power supply assembly, with the exception of three transport mounted transistors, filter capacitors, rectifiers, and transformer, is contained on a single PWA. Main ac power is connected to the ATR-100 through a captive 3-wire power cable attached to the power supply bracket. Power is applied to the primary windings of the transformer via the POWER ON/OFF switch which is mechanically linked to the transport assembly. A jumper plug arrangement in the primary of the power transformer allows selection of any one of four input voltage ranges of 50 or 60 Hertz primary power to be used with the ATR-100. The primary power input voltages that can be accommodated by this arrangement are: 90 to 115 Vac, 110 to 135 Vac, 180 to 230 Vac, and 220 to 270 Vac. The power supply assembly provides unregulated ± 20 Vdc (nominal) for use by the reel and capstan servo motors, electronically filtered ± 20 Vdc (nominal) for use by the audio circuits, and regulated +5 Vdc for use by the TTL circuits. Additionally, the power supply assembly also contains the current sense resistors for the reel motors and

the dynamic braking circuits to stop the reel motors in the event of loss of power or control.

4-95. Power Supply Circuit Details

The power supply assembly is a separate self-contained assembly with the exception of three series-pass transistors located on the transport assembly. Figure 4-28 is a simplified block diagram of the power supply assembly and drawing number 4840412 is the schematic diagram.

4-96. AC Supply. As shown in Figure 4-28, the main ac power to the power supply assembly is supplied to transformer T1 via fuse F1 and switch S1. Taps from transformer T1 to the switched main ac power are accessible via a jumper plug arrangement on the power supply assembly to allow the use of one of four input voltage ranges to be selected as the input to transformer T1 and to provide 115 Vac to the transport. The secondary of transformer T1 consists of three windings. One winding provides ac input to the 5-Vdc regulated supply. The other two windings provide the ac input to the 20-volt electronically filtered supply and 20-volt servo supply.

4-97. 20-Volt Servo Supply. The 20-volt servo supply consists of a rectifier and isolation network which provide the +20 Vdc and -20 Vdc to the reel-motor and capstan servos. Unregulated 20-Vdc rectifier A2 consists of a bridge rectifier assembly and two filter capacitors. The bridge rectifier assembly is connected to the secondary windings of transformer T1 to act as two full-wave rectifiers, one for the +20 Vdc and the other for the -20 Vdc. A filter capacitor at the output of each full-wave rectifier filters the +20 Vdc and -20 Vdc. The filtered +20 Vdc and -20 Vdc is supplied to the capstan motor via an isolation network consisting of diodes CR3/CR4 and filter capacitors C6/C7.

4-98. 20-Volt Electronically Filtered Supply. The 20-volt electronically filtered supply consists of 20-volt rectifier A1, +20-Vdc floating reference capacitor C2, -20-Vdc floating reference capacitor C4, overcurrent shutdown transistors Q1/Q3/Q4/Q6, +20-Vdc driver Q2, -20-Vdc driver Q5, +20-Vdc series-pass transistor Q8, and -20-Vdc series-pass transistor Q9. (These transistors are located

on the transport heatsink.) The 20-volt electronically filtered supply provides +20 Vdc and -20 Vdc (22 Vdc, nominal) for use by the audio circuits. The 20-volt rectifier A1 is a bridge rectifier assembly connected to the secondary winding of transformer T1 to act as two full-wave rectifiers; one rectifier to provide the +20 Vdc and the other rectifier to provide the -20 Vdc. The outputs of 20-volt rectifier A1 provide the +20-Vdc and -20-Vdc floating references via capacitor C2 and driver Q2 for the +20-Vdc and via capacitor C4 and driver Q5 for the -20 Vdc. Drivers Q2 and Q5 provide the electronically filtered +20 Vdc and -20 Vdc to the +20-Vdc series-pass transistor Q8 and -20-Vdc series-pass transistor Q9, respectively. Overcurrent shutdown transistors Q1/Q3/Q4/Q6 provide dual shutdown of the +20-Vdc and -20-Vdc outputs when excessive current is drawn from either output. If excessive current is drawn from either +20-Vdc or -20-Vdc output, overcurrent shutdown transistors Q1/Q3/Q4/Q6 will cause both outputs to go to 0 Vdc and remain at 0 Vdc until power is removed for approximately 10 seconds and reapplied. Transistors Q1 and Q4 and resistors R2 and R10 provide current sensing for the +20-Vdc and -20-Vdc outputs, respectively. The output at the collectors of Q1 and Q4 go to the bases of each other and to the bases of transistors Q3 and Q6, which shunt the floating references to drivers Q2 and Q5 and cause the outputs to go to 0 Vdc for both +20 Vdc and -20 Vdc.

4-99. 5-Vdc Regulated Supply. The 5-Vdc regulated supply consists of +5-Vdc rectifier CR1/CR2, +5-Vdc reference Q7/VR3, +5-Vdc driver Q8, +5-Vdc series-pass transistor Q10, and crowbar Q11. Additionally, reel servo interlock and dynamic brake K1/Q9/Q10 are operated from the 5-Vdc regulated supply. The 5-Vdc regulated supply provides the +5 Vdc to the TTL circuits on the ATR-100. The reel servo interlock and dynamic braking provides dynamic braking of the takeup and supply motors in the event of power failure or loss of reel servo control.

The +5-Vdc rectifier CR1/CR2 consists of a full-wave rectifier and associated filter capacitor. The rectified +5 Vdc goes to +5-Vdc reference Q7/VR3 and +5-Vdc series-pass transistor Q10, via a 3 ampere fuse (F2). The +5-Vdc reference Q7/

VR3 consists of current source Q7 and reference diode VR3. Current source Q7 provides a constant current to reference diode VR3. The reference voltage from reference diode VR3 is supplied to the base of driver Q8, which is connected to +5-Vdc series-pass transistor Q10 in a darlington configuration. Series-pass transistor Q10 provides the current required by the TTL circuits at the reference voltage minus the voltage drop across the base-to-emitter drop of Q8 and Q10. Part of output from +5-Vdc series-pass transistor Q10 is sampled by crowbar Q11 via 5.6V zener diode VR4. When the voltage at the output of series-pass transistor Q10 rises above +5.6V plus the trip voltage required to trigger SCR Q11, the current through zener diode VR4 rises and provides the gate current to SCR Q11 in crowbar Q11/VR4. SCR Q11 is connected across the +5-Vdc input, to series-pass transistor Q10, and ground. When SCR Q11 conducts, the +5-Vdc input to series-pass transistor Q10 is shunted to ground causing fuse F2 to open.

Reel servo interlock and dynamic brake K1/Q9/Q10 contains relay driver Q9/Q10, double-pole double-throw relay K1, full-wave rectifier CR9/CR10, and motor loads DS1/R25 and DS2/R26. Reel servo interlock and dynamic brake K1/Q9/Q10 disconnects the output of supply motor MDA and takeup motor MDA from the supply and takeup motors, respectively, and connects the motor loads to the motor to provide dynamic braking when reel servo on (SVO) goes high or +5 Vdc is lost.

Full-wave rectifier CR9/CR10 provides +24 Vdc from transformer T1 to the high side of relay coil K1. The return for relay coil K1 is provided by relay driver Q9/Q10. When SVO is low (0 Vdc) and +5 Vdc is present at the output of the 5-Vdc regulated supply, relay driver Q9/Q10 provides a return path and energizes relay coil K1. When K1 is energized, the supply motor MDA is connected to the supply motor and the takeup motor MDA is connected to the takeup motor. If SVO goes high or +5 Vdc is lost, K1 is de-energized. When K1 is de-energized, the takeup motor is switched from the takeup motor MDA to motor load DS1/R25 and the supply motor is switched from the supply motor MDA to motor load DS2/R26. Motor loads DS1/R25 and DS2/R26 provide a path for the current generated by the back emf of the motor

when the motor MDA is disconnected, thereby causing a braking action to stop the motor. Diodes CR12 and CR13 are steering diodes that allow

only the following or trailing motor to be used as a brake while the forward, or leading motor, is allowed to run free.

SECTION 5

MAINTENANCE

5-1. GENERAL

This section of the manual provides maintenance information for the ATR-100 Series Recorder/Reproducer and input/output assembly (accessory). Maintenance information is grouped under six main headings: *Overall Test Equipment Requirements*, *Preventive Maintenance*, *Conversion*, *Alignment* and *Adjustments*, *Performance Tests*, and *Corrective Maintenance*.

Under the heading *Overall Test Equipment Requirements*, Table 5-1 lists test equipment (electronic and mechanical) for testing, adjusting, and maintenance of the ATR-100. *Preventive Maintenance* covers procedures for cleaning, demagnetizing, and lubrication. *Conversion* includes procedures for changing channel configuration, tape width, operating speed pair, master bias operation, and input/output assembly operating configuration. Information grouped under the heading *Alignment* and *Adjustments* includes procedures for the audio signal system and the tape transport. Information under the heading *Performance Tests* includes tests for checking tape tension, absolute tape-speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation

distortion, and flutter. *Corrective Maintenance* covers procedures for head maintenance, troubleshooting, and component replacement procedures.

CAUTION

DO NOT USE ANY FORM OF ABRASIVE LAPPING TAPE ON THE ATR-100 FERRITE HEADS AS SERIOUS DAMAGE CAN OCCUR AND HEAD WARRANTY WILL BE VOIDED.

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS, ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A HEAD ASSEMBLY, OR BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) IN THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.

5-2. OVERALL TEST EQUIPMENT REQUIREMENTS

Electronic and mechanical test equipment suggested for use during testing, alignment, adjustment, and maintenance of the recorder/reproducer is listed in Table 5-1. Test Equipment with equivalent or better specifications can be substituted for the equipment suggested in the table.

Table 5-1. Overall Test and Maintenance Equipment Requirements

EQUIPMENT TYPE	SUGGESTED MODEL	USED FOR
AC Voltmeter	Hewlett-Packard Model 400 FL	Performance check and electronic alignment
DC Voltmeter — 20,000 ohms/volt	Any	Electronic checks and adjustments
Audio Oscillator	Hewlett-Packard Model 204C or 209D	Performance check and electronic alignment
Wave Analyzer or Spectrum Analyzer	Wave Analyzer Hewlett-Packard Model 3581A or Spectrum Analyzer Hewlett-Packard Model 3580A	Erasure and distortion measurements

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Audio Oscillator	Hewlett-Packard Model 204C or 209D	Performance check and electronic alignment
Wave Analyzer or Spectrum Analyzer	Wave Analyzer Hewlett-Packard Model 3581A or Spectrum Analyzer Hewlett-Packard Model 3580A	Erasure and distortion measurements

Table 5-1. Overall Test and Maintenance Equipment Requirements (Continued)

EQUIPMENT TYPE		SUGGESTED MODEL		USED FOR	
Intermodulation Analyzer		Crown Model IMA		SMPTE intermodulation distortion measurement	
Oscilloscope (dual trace)		Tektronix Model 465		Head azimuth adjustment and signal system, tachometer, and servo alignment	
Band Limiting Filter — 30 Hz to 18 kHz		See Figure 5-33		Signal-to-noise measurement	
ANSI 'A' Weighted Filter		See Figure 5-34		Signal-to-noise measurement	
Universal Noise Filter (optional)		See Figure 5-35		Signal-to-noise measurement	
Flux Loop		Ampex P/N 4020423-01		Performance check and electronic alignment	
Flux Loop Equalizing Amplifier		Ampex P/N 4020424-01		Performance check and electronic alignment	
Tape Tension Gauge		Tentel P/N T2-H12-1 (0 to 12 oz) or Tentel P/N T2-H20-ML (0 to 20 oz)		Measuring tape tension	
Head Demagnetizer		Ampex P/N 4040575		Demagnetizing head stacks	
Hand Held Bulk Demagnetizer		Any		Demagnetizing tape guides and other components in the tape path	
Head Cleaner		Ampex P/N 4010823 or 087-007		Cleaning heads	
Lubricants		See text (paragraph 5-9)		Lubrication of components	
Isopropyl Alcohol (approximately 92%)		Any		Cleaning tape guiding components	
Technicians Tools					
I/O Level Set Accessory (optional — see text paragraph 5-52)		Ampex P/N 4020425		Alignment of input/output assembly (accessory)	
Automatic Record/Play Cycler (optional)		See text (paragraph 5-57)		PURC timing alignment	
Flutter Meter		Micom Model 8100W with Analyzer		Flutter measurement and trouble-shooting	
Frequency Counter		Hewlett-Packard Model 5300A/5302A		Tape speed and speed variation check	
Extender Board		Ampex P/N 4050800-01 (supplied with recorder/reproducer)		Extends electronics assembly PWAs for test	
Extender Board		Ampex P/N 4020430-01		Extends input/output module for test	
ALIGNMENT/TEST TAPES					
SPEED	EQUALIZATION	STANDARD	TRACKS	PART NUMBER	
1/4" ALIGNMENT TAPE					
3.75 in/s	90 μs and 3180 μs	NAB/IEC	Full	4690037-01	

Table 5-1. Overall Test and Maintenance Equipment Requirements (Continued)

ALIGNMENT/TEST TAPES (Continued)				
SPEED	EQUALIZATION	STANDARD	TRACKS	PART NUMBER
1/4" ALIGNMENT TAPE (Continued)				
7.5 in/s	50 μ s and 3180 μ s	NAB	Full	01-31321-01
7.5 in/s	50 μ s and 3180 μ s	NAB	2	4690010-01
7.5 in/s	70 μ s and ∞	IEC**	Full	4690014-01
15 in/s	50 μ s and 3180 μ s	NAB	Full	01-31311-01
15 in/s	50 μ s and 3180 μ s	NAB	2	4690009-01
15 in/s	35 μ s and ∞	IEC**	Full	01-31313-01
30 in/s	17.5 μ s and ∞	AES	Full	4690093-01
1/2" ALIGNMENT TAPE***				
7.5 in/s	50 μ s and 3180 μ s	NAB	Full	01-31321-05
7.5 in/s	70 μ s and ∞	IEC**	Full	4690015-01
15 in/s	50 μ s and 3180 μ s	NAB	Full	01-31311-05
15 in/s	35 μ s and ∞	IEC**	Full	01-31313-05
30 in/s	17.5 μ s and ∞	AES	Full	4690085-01
SPEED	FREQUENCY	LEVEL	TRACKS	PART NUMBER
1/4" LEVEL TAPES				
7.5 in/s	700 Hz	Operating*	Full	01-31325-01
15 in/s	700 Hz	Operating*	Full	01-31315-01
*OPERATING LEVEL, at 500 and 700 Hz, corresponds to a tape flux per unit width of 185 nWb/m. (Refer to: McKnight, John G., "Flux and Flux-Frequency Measurements and Standardization in Magnetic Recording," Journal of the SMPTE, Vol. 78, June 1969, pp 457-472.) **Also CCIR. ***All listed 1/2-inch alignment tapes have flux/frequency characteristics which include compensation for fringing.				

5-3. PREVENTIVE MAINTENANCE

It is important that preventive maintenance, consisting of cleaning, demagnetizing, and lubrication procedures, be performed at the intervals recommended.

5-4. Cleaning

5-5. Tape Path Cleaning. Oxide particles from the magnetic tape tend to collect on components in the tape path. These oxide accumulations degrade the performance of the recorder/reproducer. The heads and all other components in the tape path should be cleaned after each eight hours of

operation, or more frequently if visual inspection indicates cleaning is needed. Frequency of cleaning required depends greatly on the quality of tape in use.

CAUTION

WHEN CLEANING THE HEADS, USE HEAD CLEANER ONLY AND DO NOT USE METAL OR ANY TOOLS THAT COULD SCRATCH HEADS. DO NOT USE HEAD CLEANER ON THE TAKEUP TENSION ARM ROLLER.

Proceed as follows:

1. Clean each head thoroughly with a cotton-tipped applicator dampened with Ampex

Head Cleaner (part number 4010823 or 087-007).

2. Clean all tape-guiding components, supply tension arm, tape timer wheel, capstan, and tension arm rollers with 92% (approximately) isopropyl alcohol. Do not allow alcohol to enter bearings.
3. Clean scrape-flutter idler (on head assembly) with a dry cotton-tipped applicator.

5-6. Optical Devices. Optical devices on the ATR-100 seldom need cleaning and *should not be cleaned on a routine basis*. However, if required, clean the capstan tach disc and photo sense devices as follows:

1. Clean capstan tach disc with a soft lint-free cloth or Kimwipe moistened with Windex or isopropyl alcohol. Instructions for removal of the capstan/tach assembly are given in paragraph 5-92.

CAUTION

DO NOT USE ANY SOLVENTS, ALCOHOL, WINDEX, OR CLEANER OTHER THAN WATER, ON ANY PHOTOPOTENTIOMETER, LED, OR ANY PHOTO SENSE DEVICE. TO DO SO WILL CAUSE DAMAGE TO THE PLASTIC COVER.

2. Clean the LEDs, photopotentiometers, or any photo sense device with a dry cotton-tipped applicator or, if necessary, an applicator moistened only with water.

5-7. Demagnetizing

The head should be demagnetized after each eight hours of operation.

CAUTION

DO NOT REMOVE THE HEAD ASSEMBLY OR A PRINTED WIRING ASSEMBLY (PWA) WITH POWER ON. TO DO SO WILL CAUSE THE HEAD TO BECOME MAGNETIZED.

Heads and other components in the tape path can acquire permanent magnetization that degrades signal-to-noise, increases distortion, and partially

erases high frequencies on recorded tapes. Use an Ampex Head Demagnetizer (part number 4040575) or equivalent to demagnetize components in the tape path.

CAUTION

REMOVE RECORDED TAPE FROM THE VICINITY OF THE DEMAGNETIZER TO PREVENT ACCIDENTAL TAPE ERASURE.

Proceed as follows:

1. Turn equipment power off and remove any recorded tape that is near the transport.
2. Remove transport head cover assembly.
3. Cover the head demagnetizer tips with an adhesive tape.
4. With demagnetizer at least three feet away from the head assembly, connect demagnetizer to an appropriate ac power source.
5. Slowly move the demagnetizer toward one head stack and lightly place the demagnetizer tips to the base of the stack straddling the head gap.
6. Using a slow, even motion, move the demagnetizer tips up and down the entire face of the stack several times. Then, slowly withdraw the demagnetizer.
7. Repeat steps 5 and 6 for each head stack.
8. Slowly move the demagnetizer at least three feet from the head assembly and then unplug the demagnetizer.

5-8. Scrape Flutter Idler

The only item on the recorder/reproducer that requires periodic lubrication is the scrape flutter idler. Ultrasonically clean and then lubricate the scrape flutter idler once a year or after each 2,000 hours of operation. The idler should be removed from the head assembly and delivered to a local jeweler or watchmaker who has an ultrasonic cleaner and special jewel oil.

Proceed as follows:

1. Remove head assembly from the transport (refer to *Changing Head Assembly* text, paragraph 5-82).
2. Remove head shield (four Allen-head screws shown in Figure 1-3).
3. Loosen scrape flutter idler retaining screw shown in Figure 5-1 and remove idler from head assembly base.
- b. Lubricate each jewel bearing holder assembly with one drop of jewel oil (or Ampex precision instrument oil, part number 087-738). Use a no. 21 gauge hypodermic needle to apply oil to bearing.
- c. Reassemble idler and jewel bearing holder assemblies into the yoke and lightly tighten the two bearing clamp screws.

NOTE

Step 4 should be performed by a jeweler or watchmaker.

4. Loosen the two Allen-head bearing clamp screws (Figure 5-2) in the yoke assembly. Slide the two jewel bearing holder assemblies out of the yoke and remove the idler.
 - a. Ultrasonically clean the two jewel bearing holder assemblies and the idler.
5. With the upper and lower bearing clamp screws loose, set idler height (Figure 5-2) to 0.035 ± 0.005 inch above the yoke base. Lightly tighten lower bearing clamp screw.
6. With upper bearing clamp screw still loose, remount idler on to the head base plate with front and side of yoke even with the two scribed lines on the base plate (Figure 5-1).
7. While pressing upper jewel bearing holder assembly toward idler with very light finger pressure, lightly tighten upper bearing clamp

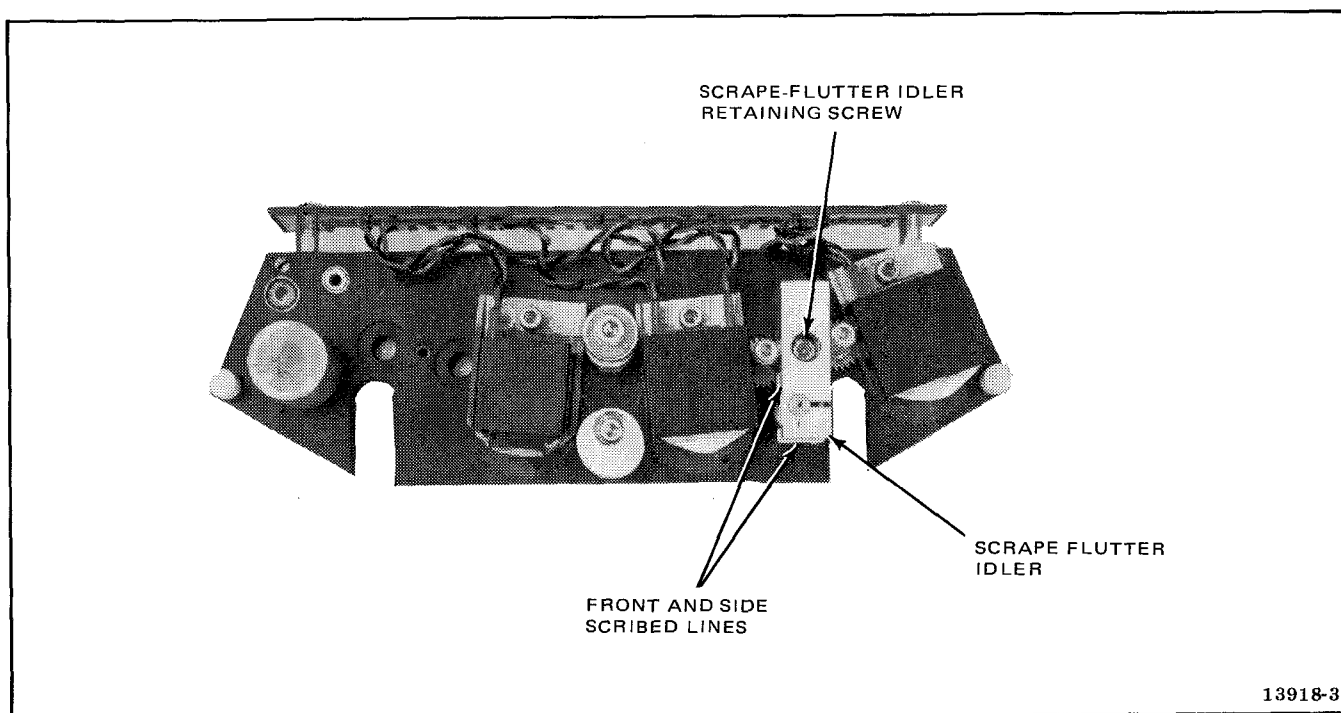


Figure 5-1. Top View of Head Assembly, Head Shield Removed

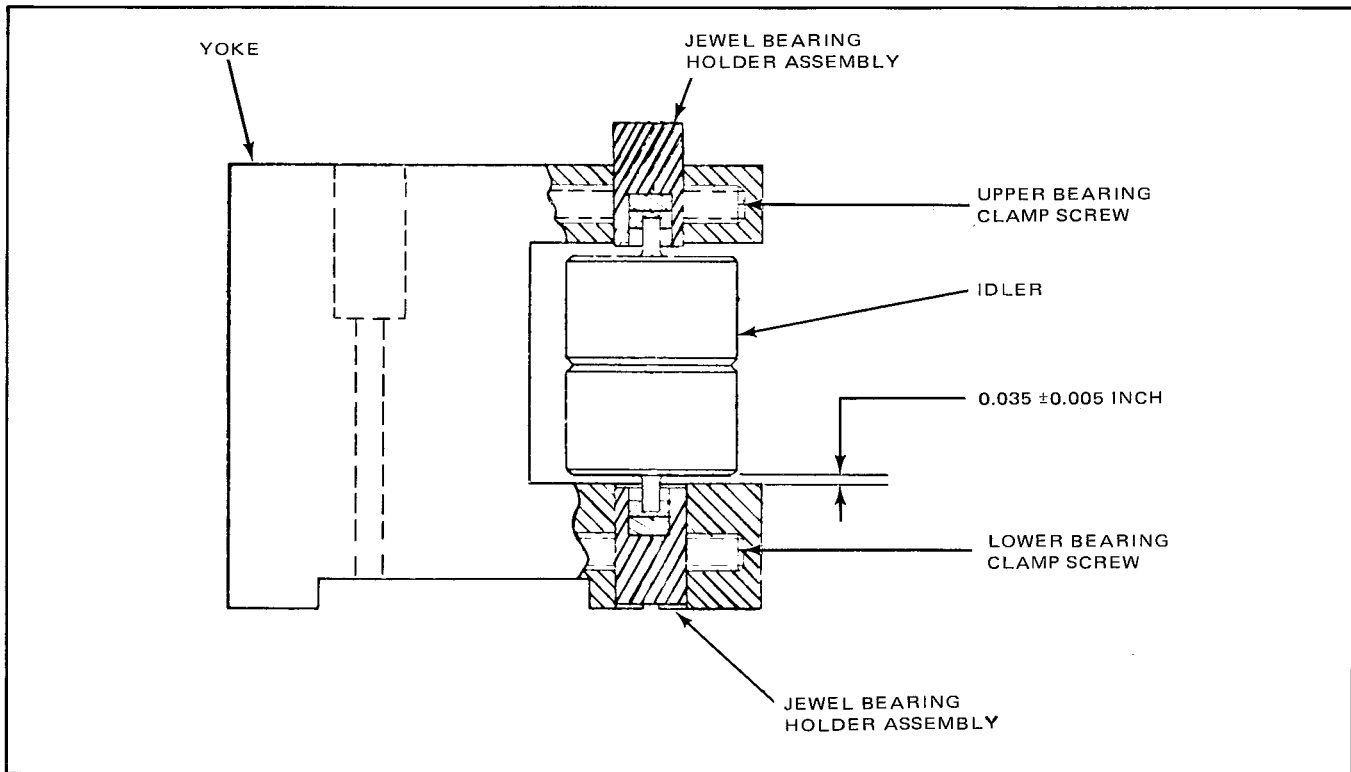


Figure 5-2. Scrape Flutter Idler, Side Cross-Section View

screw. Spin idler with finger. Idler should spin freely with no evidence of binding.

8. Reinstall head shield (four Allen-head screws) and install head assembly on to transport.

5-9. Lubrication

Table 5-2 provides a list of lubricants used on the recorder/reproducer, where the lubricants are used, and application instructions. Note that the capstan motor and tape timer bearings do not require re-lubrication. If these bearings are replaced with non-prelubricated bearings, use the grease suggested in the table. Except for the scrape flutter idler, that should be cleaned and lubricated after each 2,000 hours of operation, the other items shown in the table should be lubricated as required for proper operation.

5-10. Head Gate Support Bushing. There is only one support for the head gate assembly. The support consists of a shaft (Figure 5-30) that slides

inside a bushing that is threaded into the tape transport casting. This bushing has been permanently lubricated; however, if additional lubrication is required, proceed as follows:

1. With the head gate in the latched (down) position, lightly apply MoS₂ high pressure grease (Table 5-2) to the entire surface of the shaft (Figure 5-30).
2. Operate the head gate up and down to distribute the grease inside the bushing bore. Remove any excess grease from shaft or bushing.

5-11. Tape Lifter Arm Bushings. The two tape lifter arm bushings have been permanently lubricated; however, if additional lubrication is required, proceed as follows.

1. Remove the head assembly (paragraph 5-82).
2. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-27) nearest the tape lifter

Table 5-2. Lubricants Used on Recorder/Reproducer

WHERE USED	LUBRICANT DESCRIPTION	APPLICATION INSTRUCTIONS
Tape lifter and head gate support bushings	Grease, MoS ₂ , high pressure, mfd. by Dow Corning Corp., Midland, Michigan	Rub grease into entire surface of bushing bore.
Tape lifter solenoid	Grease, O-ring, mfd. by Parker Seal Co., Culver City, California	Use a small amount around solenoid O-ring.
Scrape flutter idler	Oil, synthetic, jewel bearing, PML-79 oil. Mfd. by William F. Nye Inc., New Bedford, Massachusetts	Ultrasonic clean parts. Use one drop from a #21 Stubbs gauge on each bearing.
Capstan bearings and shaft and tape timer bearing	Grease, general purpose channeling, ANDOK-C. Source: Barden Corp., Danbury, Connecticut	Fill each bearing 30 to 40% if bearings are not prelubricated upon replacement.

solenoid and remove the tape lifter shaft from the roller and the bushing.

3. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-27) furthest away from the tape-lifter solenoid and remove the tape lifter shaft from the roller and the bushing.
4. Rub MoS₂ high pressure grease (Table 5-2) into the entire surface of the bushing bore. Remove any excess from bushing.
5. Reinstall the two tape lifter shafts in the reverse order of removal, but do not firmly tighten screws.
6. Reinstall head assembly (paragraph 5-82).
7. Perform steps 4 through 15 of the *Tape Lifter Arms* adjustment procedure, paragraph 5-64.

5-12. CONVERSION

Procedures for changing channel configuration, tape width, and operating-speed pair are presented in the text that follows. (For Ampex part numbers of components required for conversion, refer to Tables 1-2 and 1-3.)

5-13. Changing Channel Configuration

The ATR-100 Series Recorder/Reproducer is pre-wired to operate with up to four audio channels.

The four-channel control unit is used to operate a one-, two-, or four-channel system. To change channel configuration, proceed as follows:

1. For each audio channel, install a main audio PWA and associated PADNET PWA into the electronics assembly as follows:
 - a. For a full-track, 1/4-inch tape system, install a main audio PWA and PADNET PWA into position 1 in the electronics assembly.
 - b. For a two-channel, 1/4-inch tape system, install a main audio PWA and PADNET PWA into positions 1 and 2 in the electronics assembly.
 - c. For a four-channel, 1/2-inch tape system, install a main audio PWA and PADNET PWA into positions 1, 2, 3, and 4 in the electronics assembly.
2. Install the appropriate head assembly (refer to *Changing Head Assembly* text, paragraph 5-82).
3. If conversion involves changing tape width, refer to *Changing Tape Width* procedure, paragraph 5-14.
4. Perform the appropriate signal system alignment procedures given under *Alignment and Adjustments*, paragraph 5-29.

5-14. Changing Tape Width

Converting the tape transport to accommodate 1/4-inch tape or 1/2-inch tape is accomplished by changing the tape guides on the supply and takeup constant-tension arms and changing the head assembly. After conversion, no electrical tension adjustments are required as a jumper on the head connector causes the tape tensions to be automatically changed. Proceed as follows:

1. Remove tape guide by unscrewing the captive knurled-head screw (Figure 5-3) that secures tape guide to the constant tension arm.
2. Clean top surface of tension arm and bottom surface of tape guide with 92% isopropyl alcohol.
3. Install tape guide on tension arm. Secure (finger tight) to arm with captive knurled-head screw supplied with tape guide. (Do not use a screwdriver to tighten screw.)
4. Install the appropriate head assembly (refer to *Changing Head Assembly* text, paragraph 5-82).

5-15. Changing Operating-Speed Pair and Master Bias Operation

The recorder/reproducer can operate at any tape-speed pair selected from the following speeds: 3.75, 7.5, 15, and 30 in/s. (Machines originally shipped from the factory are set to operate at 7.5 and 15 in/s with four-speed master bias operation.) Note that if a speed is selected on the transport control panel (Table 3-1) for which the signal system or master bias has not been set up for, the LOCKOUT indicator will light, and play and record modes for that speed will be inhibited. In addition, the audio output(s) of the basic recorder/reproducer will be muted. If an input/output assembly is being used, the assembly will switch to input signal monitoring.

To change operating-speed pair and master bias operation, jumper plugs are repositioned on audio control PWA No. 5 and on the PADNET PWA(s). The jumper plugs on the audio control PWA No. 5 permit the user to program the recorder/reproducer for two-speed (dual master bias) operation or four-speed master bias operation. When the

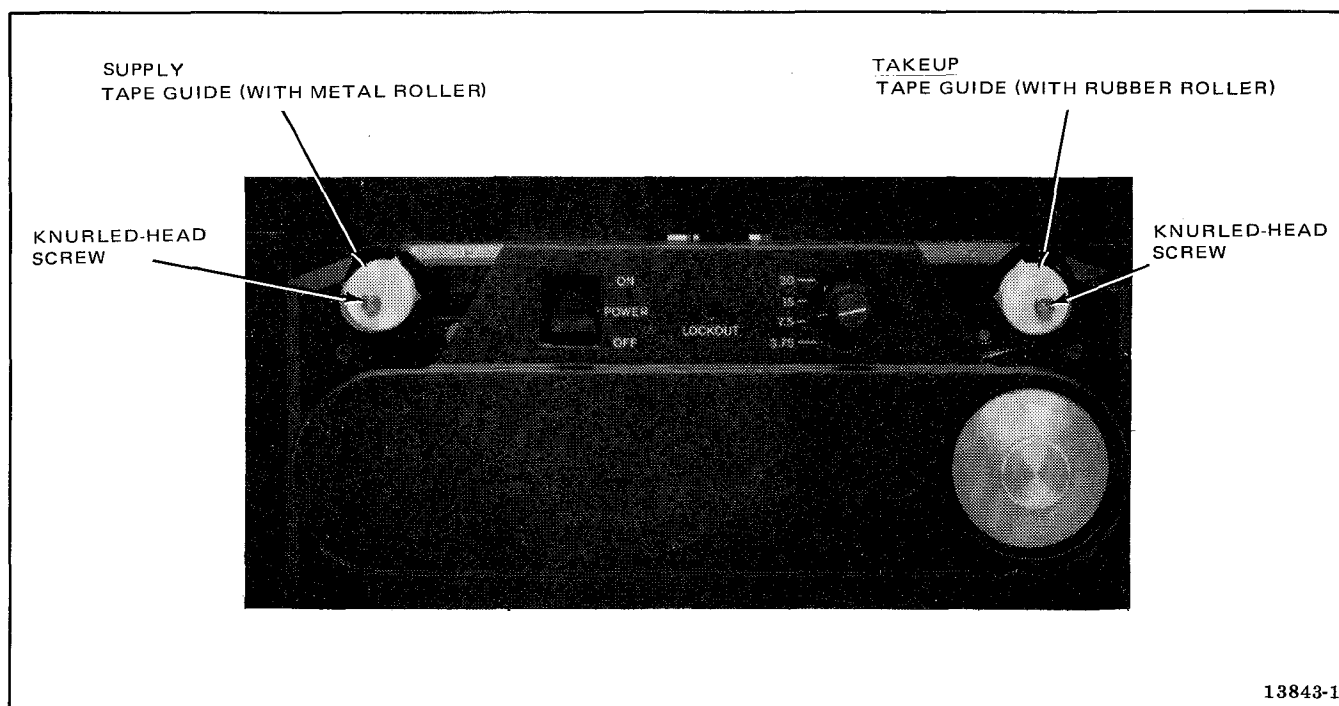


Figure 5-3. Tape Guide Securing Screws

recorder/reproducer is programmed for two-speed master bias operation, a bias switch on the front panel of audio control PWA No. 5 (Figure 5-4) enables the operator to select one of two different master bias levels for each of the two operating speeds.

When the recorder/reproducer is programmed for four-speed operation, the bias switch is permanently placed in the left-hand position and a single master bias level is provided for each speed. This master bias level is automatically switched when a speed is selected on the transport control panel.

NOTE

If the audio control PWA No. 5 jumpers are set for four-speed master bias operation, it is only necessary to reset jumpers

on each PADNET when changing operating-speed pair. If the audio control PWA No. 5 jumpers are set for two-speed (dual master bias) master bias operation, then the two speeds selected on the audio control PWA No. 5 must match those selected on the PADNET PWA(s) or the lockout circuitry will operate.

To change the operating speed pair, proceed as follows:

1. With power off, and for each channel, remove the PADNET PWA from the electronics assembly.
2. Position HI speed jumper J1 to the desired high speed: 30, 15, or 7.5 in/s position (Figure 5-5).

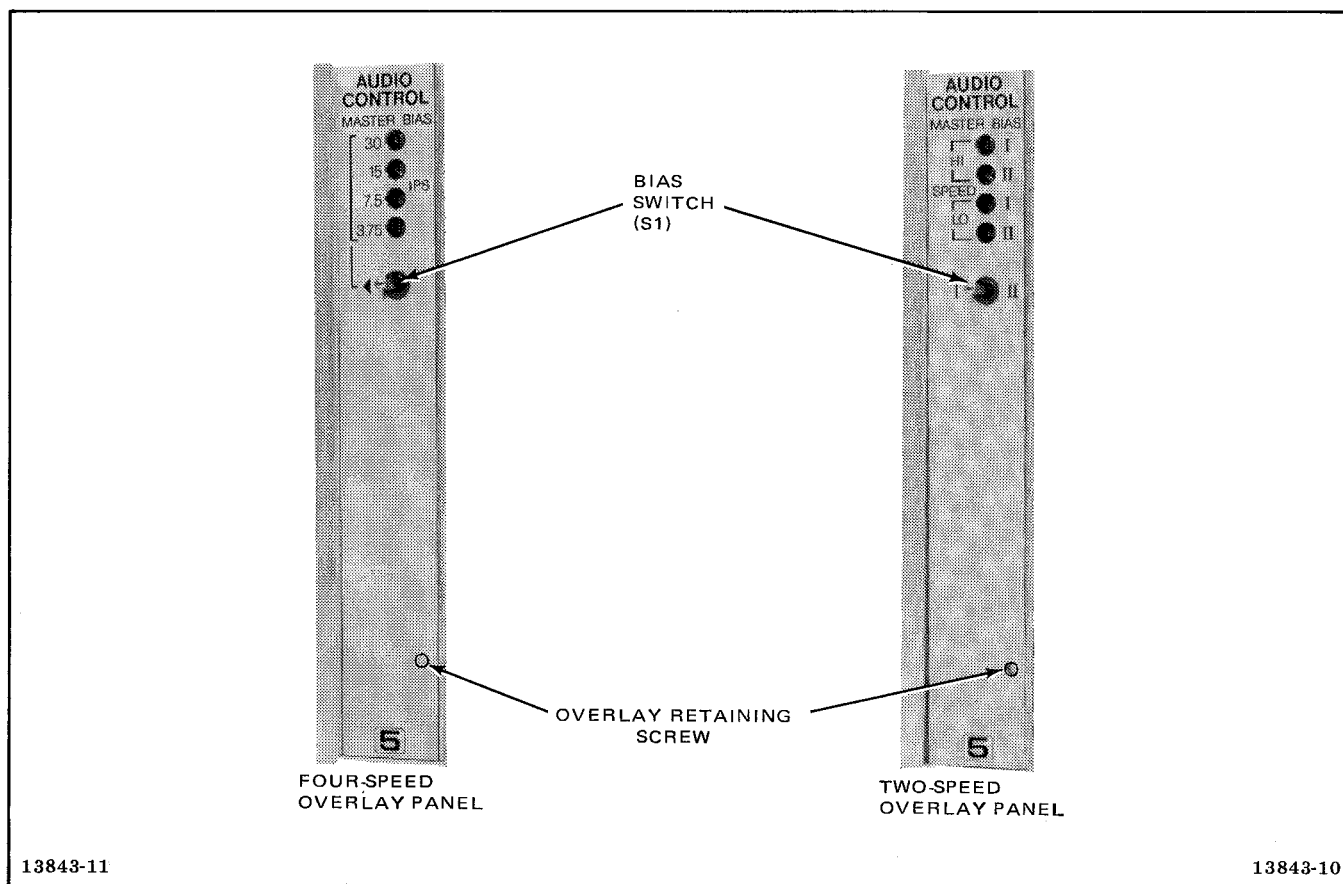


Figure 5-4. Overlay Panels, Audio Control PWA No. 5

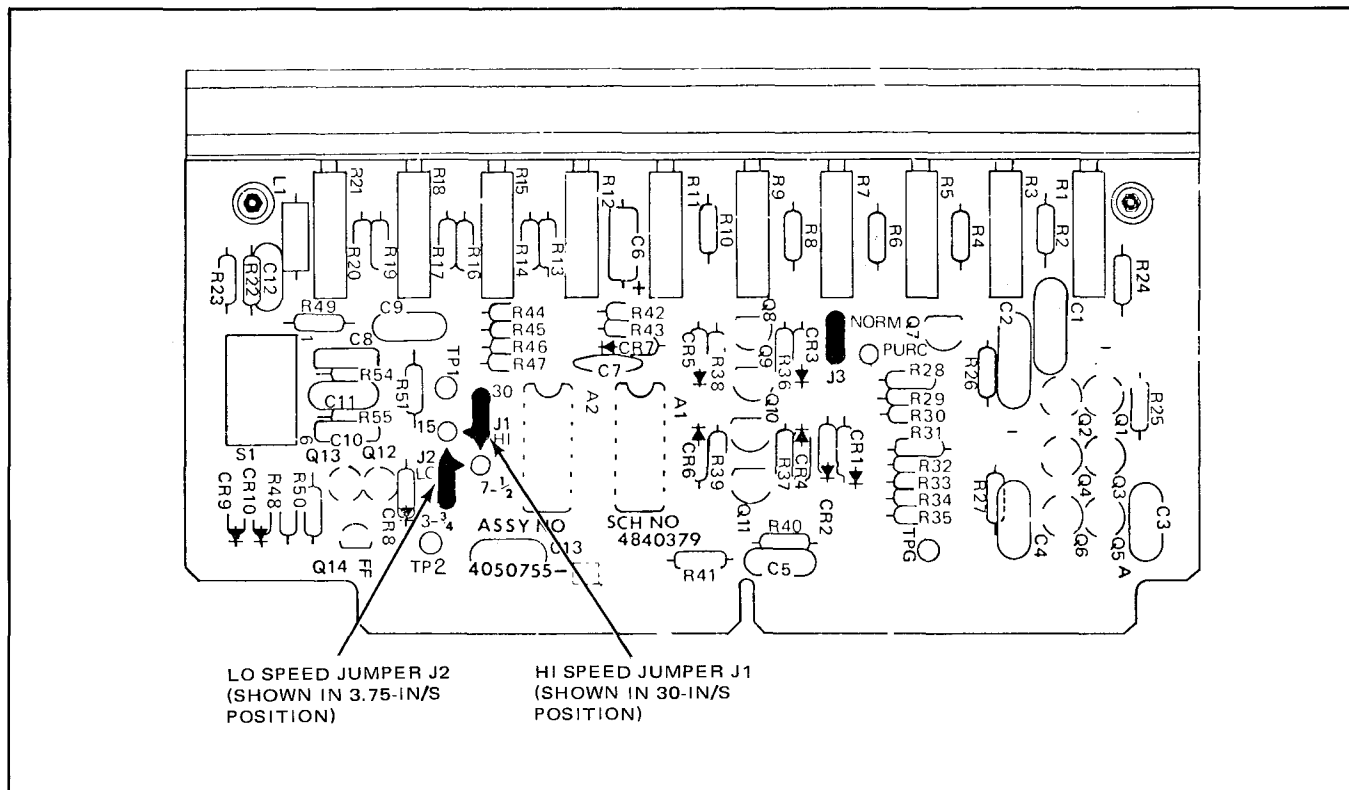


Figure 5-5. Speed Selection Jumpers, PADNET PWA

3. Position LO speed jumper J2 to the desired low speed: 15, 7.5, or 3.75 in/s position. Reinstall PADNET PWA.
4. For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments*, paragraph 5-29.

5-16. Two-Speed Dual Master Bias. For two-speed dual master bias operation, proceed as follows:

1. With power off, remove audio control PWA No. 5 from the electronics assembly.
2. Two overlay panels are furnished with the PWA. If the two-speed overlay panel (Figure 5-4) is not in the front position on the PWA, remove front-panel screw, interchange overlay panels, and reinstall screw.
3. Position HI speed jumper J1 to the desired high speed: 30, 15, or 7.5 in/s position (Figure 5-6).

4. Position LO speed jumper J2 to the desired low speed: 15, 7.5, or 3.75 in/s position.
5. Position jumpers J3 and J4 to the S (stored) position. Reinstall audio control PWA No. 5.
6. For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments*, paragraph 5-29.

5-17. Four-Speed Master Bias. For four-speed master bias operation, proceed as follows:

1. With power off, remove audio control PWA No. 5 from the electronics assembly.
2. Two overlay panels are furnished with the PWA. If the four-speed overlay panel (Figure 5-4) is not in the front position on the PWA, remove front-panel screw, interchange overlay panels, and reinstall screw.
3. Position jumper J1 to the 30-in/s position (Figure 5-6).

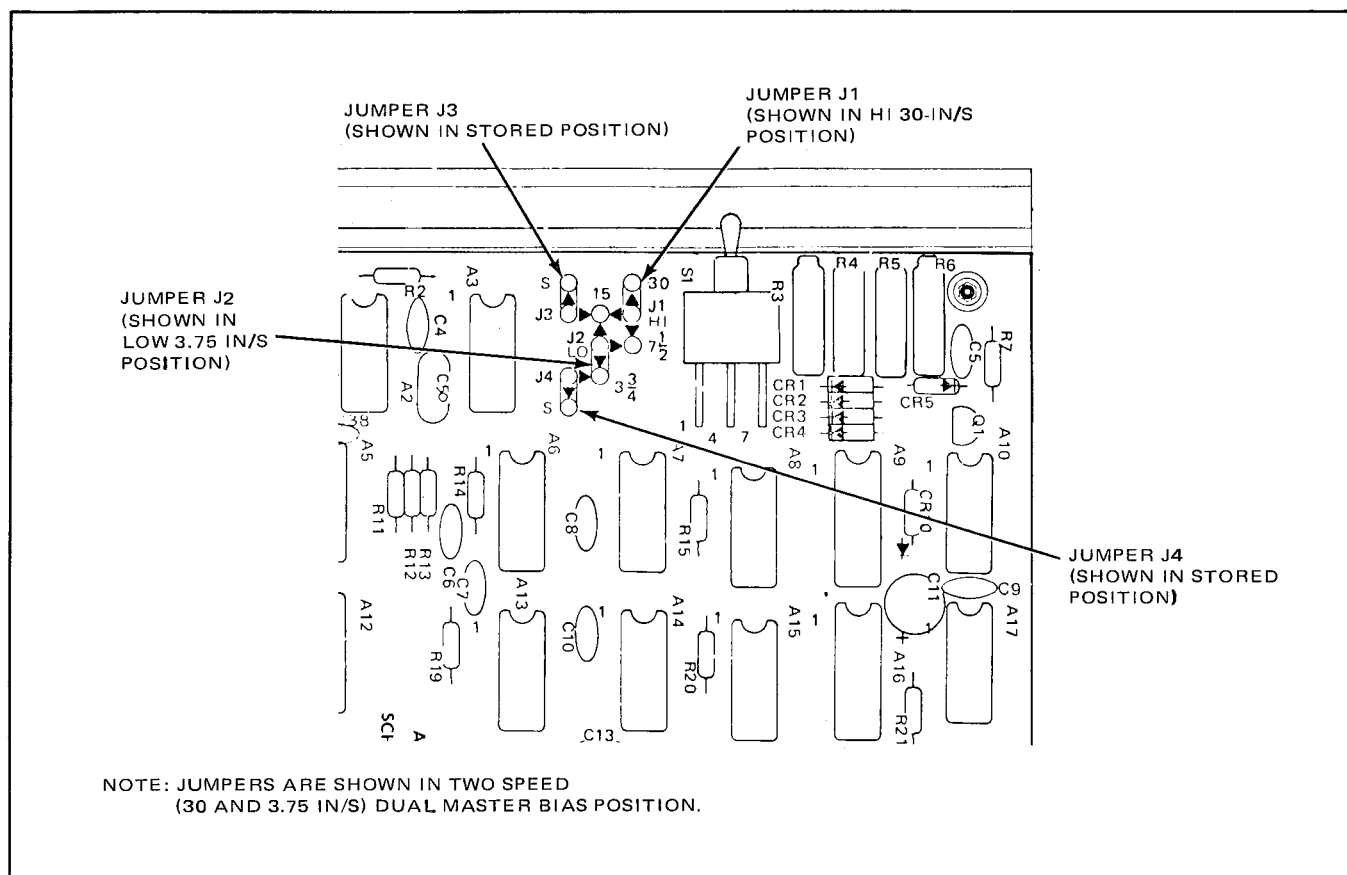


Figure 5-6. Speed/Bias Selection Jumpers, Audio Control PWA No. 5

4. Position jumper J2 to the 7.5-in/s position.
5. Position jumper J3 to the 15-in/s position.
6. Position jumper J4 to the 3.75-in/s position. Reinstall audio control PWA No. 5.
7. For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments*, paragraph 5-29.

5-18. Changing Input/Output Assembly Operating Configuration

The input/output assembly is shipped from the factory with the following input and output operating characteristics:

- Input impedance — 50K ohms balanced
- Output impedance — 30 ohms balanced

The input/output assembly operating characteristics can be changed by adding a capacitor and by adding or removing jumpers from terminals located on the input/output assembly module (Figure 5-7). Separate modification instructions are given for the input and output amplifier sections of the module.

5-19. Input Amplifier. To change the input amplifier operating configuration, proceed as follows:

5-20. Increasing Input Sensitivity. For a balanced input, input impedance of 25K ohms, and input sensitivity increased by 6 dB, perform the following modification.

1. Install a jumper between E16 and E17, and solder in place.

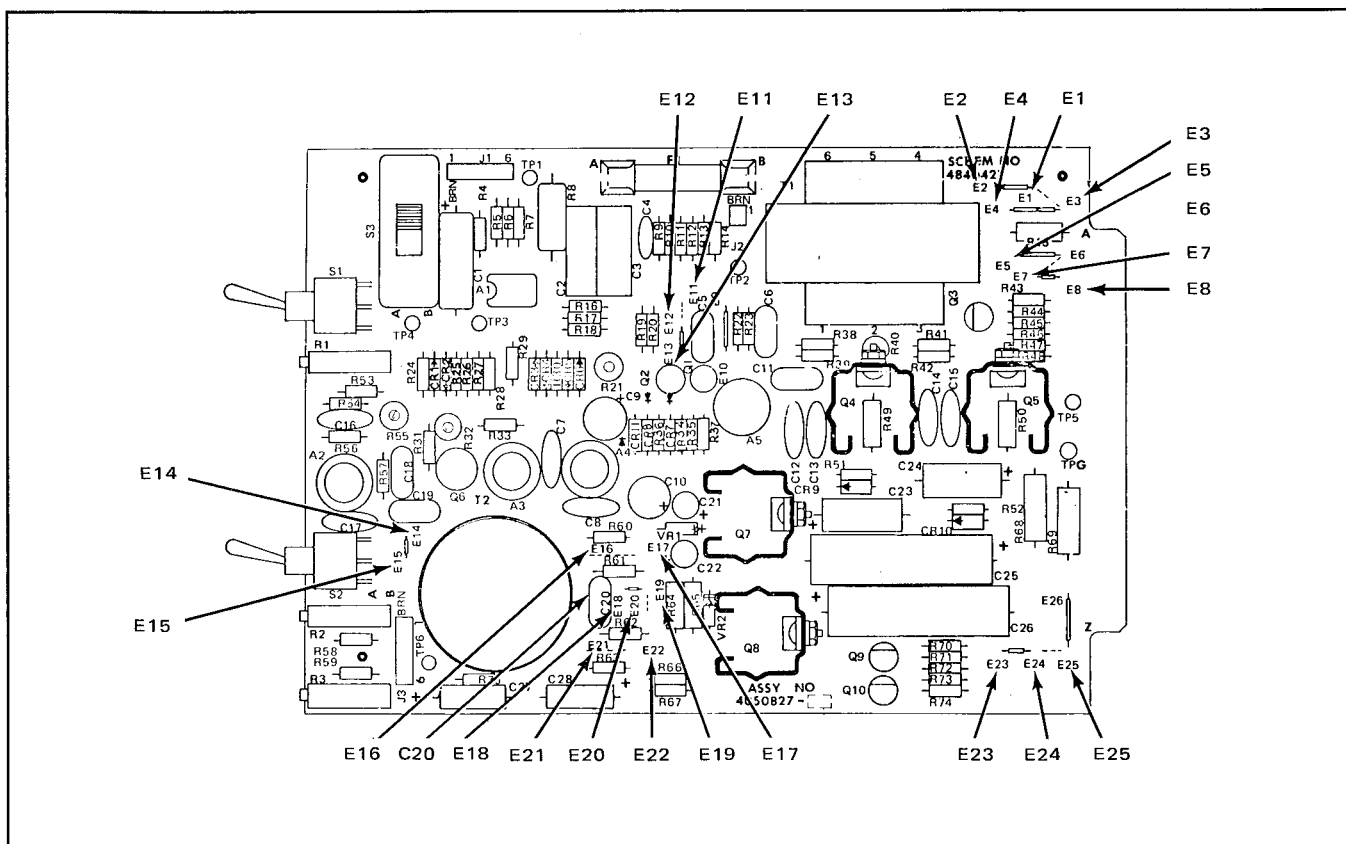


Figure 5-7. Input/Output Assembly Module – Jumper Terminals and Capacitor C20

2. Install a jumper between E21 and E22, and solder in place.
3. Install capacitor C20 (47 pF, 5%, mica – customer furnished) on the input/output module PWA, and solder in place. Install the capacitor in circuit pad location designated on the module PWA. (See note 6 on input/output module PWA schematic no. 4840421, and Figure 5-7.)

5-21. Balanced or Unbalanced Input. The input can be either balanced or unbalanced by the absence or presence of a jumper. For an unbalanced input, place a jumper between E24 and E25, and solder in place. For a balanced input, remove the jumper between E24 and E25.

5-22. Bypassing Input Transformer. If the input transformer is bypassed, the input will be unbalanced. Proceed as follows.

NOTE

If either the input or output transformer is bypassed, the signal phase will shift 180°. However, if both transformers are bypassed, the overall phase will remain the same.

1. Remove the following jumpers:
E14 to E15
E18 to E19
E23 to E24
2. Add the following jumpers and solder in place:
E24 to E25
E19 to E20
3. After performing steps 1 and 2, the input impedance will be 25K ohms. To increase the

gain by 6 dB and provide an input impedance of 12.7K ohms, install a jumper between E16 and E17 and solder in place.

5-23. Shield Grounding. The input connector (XLR type) is shipped from the factory with the shield grounded. If desired to have a "floating" shield, remove jumper between E25 and E26.

5-24. Output Amplifier. To change the output amplifier operating configuration, proceed as follows:

5-25. Balanced or Unbalanced Output. The output can be either balanced or unbalanced by the absence or presence of a jumper. For an unbalanced output, place a jumper between E6 and E7 and solder in place. For a balanced output, remove the jumper between E6 and E7.

5-26. Bypassing Output Transformer. If the output transformer is bypassed, the output will be unbalanced. Proceed as follows:

NOTE

If either the input or output transformer is bypassed, the signal phase will shift 180°. However, if both transformers are bypassed, the overall phase will remain the same.

1. Remove the following jumpers:
E12 to E13
E1 to E2
E3 to E4
E5 to E6
2. Add the following jumpers and solder in place:
E11 to E12
E1 to E3
E6 to E7
3. Change resistor R20 from 10K to 1.5K ohms, 1/4 watt.
4. Recalibrate the level meter as follows:
 - a. Connect an audio oscillator to the line input connector (Figure 2-14).

- b. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other operating level selected by the user).
- c. Set RECORD MANUAL/PRESET switch to PRESET position.
- d. Place input/output module on an extender board and insert board into mainframe.
- e. Apply power and place ATR-100 into input mode.
- f. Adjust meter calibration potentiometer R21 (Figure 5-17) for -6 (meter switch S3 in peak position) or 0 (meter switch S3 in vu position).
- g. With power off, remove input/output module and extender board from mainframe and reinstall input/output module into mainframe.
- h. Disconnect audio oscillator.

5-27. Increasing Output Resistance with Balanced Output. To increase the output resistance of the amplifier, install appropriate equal value resistors between E3 and E4 and between E5 and E6. For example, if a nominal output resistance of 600 ohms is desired, install 300-ohm resistors between E3 and E4 and between E5 and E6. Solder resistors in place.

5-28. Shield Grounding. The output connector (XLR type) is shipped from the factory with the shield grounded. If desired to have a "floating" shield, remove jumper from between E7 and E8.

5-29. ALIGNMENT AND ADJUSTMENTS

5-30. Audio Signal System Alignment

The reproduce alignment procedure must be performed prior to the record alignment procedure. Reproduce alignment consists of setting low and high frequency equalization of each channel, adjusting reproduce head azimuth and phasing (multichannel systems), and setting operating level of each channel. Record alignment consists

of setting bias level, setting record high frequency equalization, and setting system output level.

The alignment procedures are presented step-by-step in serial form for reproduce and record alignment of each channel. For the alignment of 2- or 4-channel systems, and after the reader has become familiar with the procedures, it may be more convenient to perform the steps in parallel for each channel.

The basic recorder/reproducer input and output level is set to -5 dBm, regardless of the actual operating level flux level selected for use. For maximum performance, the use of Ampex 456 tape with an operating level of 370 nWb/m is recommended. (This level is 6 dB higher than the 185 nWb/m-reference level on Ampex Standard Alignment Tapes.) Procedures are included in this manual for setting the operating level to 185 nWb/m, 260 nWb/m, and 370 nWb/m.

When the basic recorder/reproducer is correctly adjusted, the Ampex input/output accessory or any input/output assembly (either one correctly adjusted) can be connected to the recorder/reproducer without any adjustment.

NOTE

All voltage levels are expressed in dB referenced to 0.775 volt rms across 600 ohms. Therefore a level of zero dBm corresponds to 0.775 volt rms.

5-31. Use of Alignment Tapes – General Discussion

The alignment tapes have been precisely recorded and must be correctly handled and stored to retain their accuracy. The following requirements should be especially followed.

1. Clean and demagnetize the heads and other tape-handling components before using the test tape.
2. Never store test tapes in areas where there are temperature or humidity extremes or where magnetic fields may be present.
3. Remove test tapes from equipment only after a normal play or spool mode run (never after a fast-winding mode).

The test tape is threaded on the recorder/reproducer in the normal tape path (from the supply to the takeup reel). During alignment procedures, the rewind and fast forward modes may be used as necessary. After alignment, wind the tape completely on the takeup reel and then place the recorder/reproducer in the rewind spool mode to wind the tape back on its original reel. Note that after extensive use, high frequency tones on the alignment tape may drop as much as 2 dB, particularly at the slower tape speeds.

Operating level and reproduce frequency response can be checked with a standard alignment tape (Table 5-1). When using a standard alignment tape that is recorded the full width of the tape to check a system with heads less than full width, the response readings below approximately 10.0 kHz become progressively invalid as the frequency decreases. This is caused by the low-frequency fringing effect of the reproduce head. The reproduce head picks up additional flux beyond the track width of the head as the frequency decreases. This error, being wavelength dependent, becomes worse as the wavelength increases.

NOTE

All Ampex full track 1/2-inch alignment tapes listed in Table 5-1 have flux/frequency characteristics that include compensation for fringing.

Therefore, if the equalization is correctly adjusted, the reproduce response when using a full-track alignment tape on either a 2-track, 1/4-inch tape system or a 4-track, 1/2-inch tape system should conform to the relative curves shown in Figure 5-8 within the tolerances given in Table 5-3. The curves given in Figure 5-8 display the *relative* fringing frequency response and *do not* include the fixed error due to the wider reproduce core width (as compared to the record head width).

Table 5-4 provides the amplitude correction factors to be used when setting operating level using a full-track alignment tape on a 2-track, 1/4-inch tape system or a 4-track, 1/2-inch tape system.

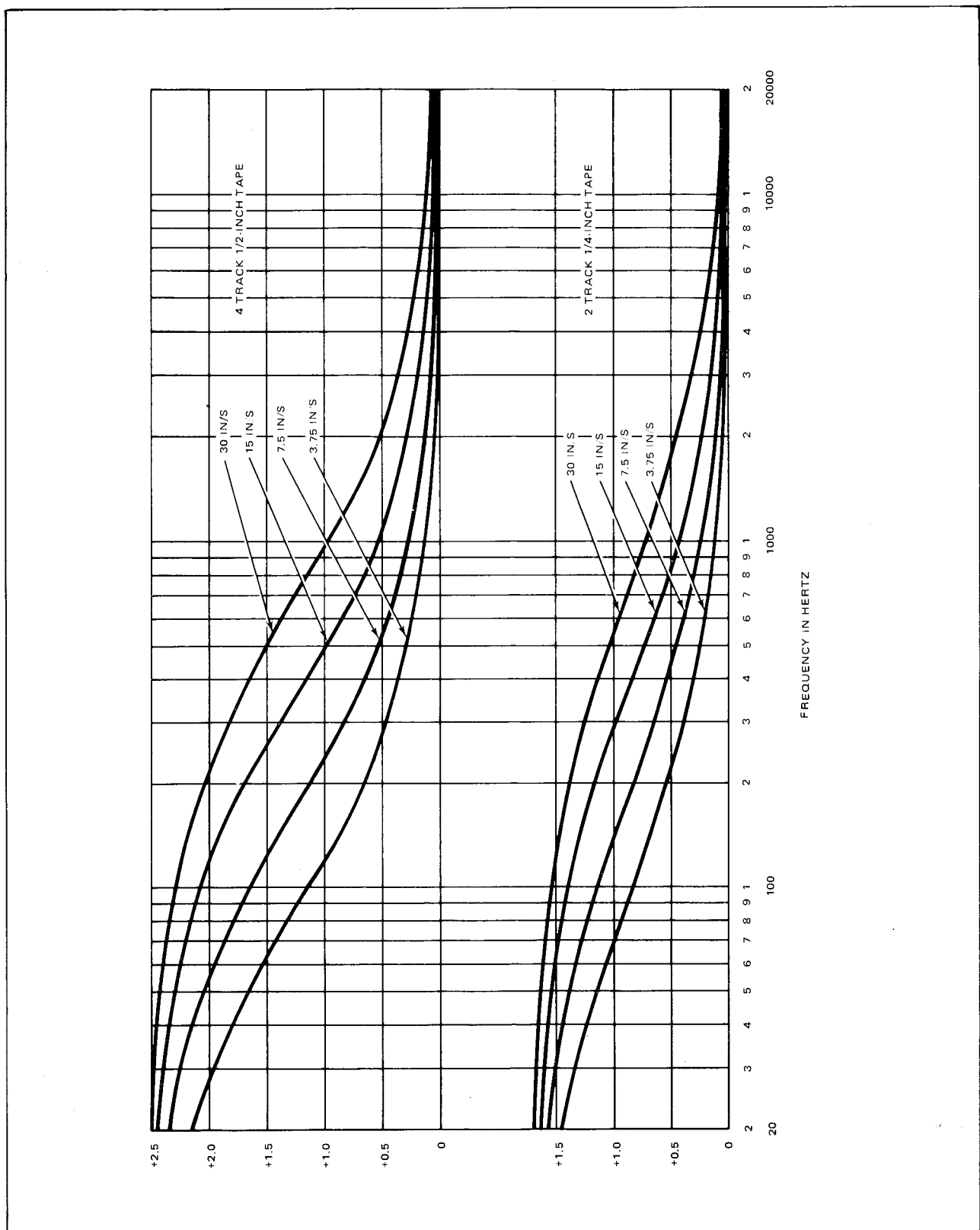


Figure 5-8. Relative Fringing Frequency Response Due to Fringing Effect

Table 5-3. Reproduce Frequency Response Tolerances

SPEED	TOLERANCE ± 0.5 dB	TOLERANCE ± 1.5 dB	SEL SYNC ± 2.0 dB
30 in/s	250 Hz – 20 kHz	35 Hz – 250 Hz 20 kHz – 28 kHz	50 Hz – 15 kHz
15 in/s	125 Hz – 15 kHz	20 Hz – 125 Hz 15 kHz – 20 kHz	40 Hz – 12 kHz
7.5 in/s	125 Hz – 10 kHz	30 Hz – 125 Hz 10 kHz – 15 kHz	—
3.75 in/s	125 Hz – 5 kHz	30 Hz – 125 Hz 5 kHz – 10 kHz	—
NOTE: To the above tolerances, add manufacturing tolerances of the alignment tape and relative fringing frequency response due to fringing effect (Figure 5-8).			

Table 5-4. Amplitude Correction Factors for Setting Operating Level when using Full-Track Alignment Tapes on 2-Track or 4-Track Systems

SPEED	REFERENCE FREQUENCY	CORRECTION FACTOR*	
		2 TRACK	4 TRACK
30 in/s	500 Hz	+1.61 dB	+2.10 dB
	700 Hz	+1.46 dB	+1.85 dB
	1.0 kHz	+1.29 dB	+1.58 dB
15 in/s	500 Hz	+1.29 dB	+1.58 dB
	700 Hz	+1.14 dB	+1.34 dB
	1.0 kHz	+1.01 dB	+1.13 dB
7.5 in/s	500 Hz	+1.01 dB	+1.13 dB
	700 Hz	+0.90 dB	+0.99 dB
	1.0 kHz	+0.81 dB	+0.87 dB
3.75 in/s	500 Hz	+0.81 dB	+0.87 dB
	700 Hz	+0.74 dB	+0.79 dB
	1.0 kHz	+0.69 dB	+0.74 dB
<p>*The amplitude correction factors shown in the table are the sum of the values shown in Figure 5-8 for the frequencies shown in the table, and the fixed errors due to wider reproduce core width as follows:</p> <p>2 track — 0.56 dB due to 80-mil reproduce core on 75-mil track</p> <p>4 track — 0.6 dB due to 75-mil reproduce core on 70-mil track</p>			

NOTE

Ampex full-track, 1/2-inch alignment tapes have compensation for fringing, and therefore only compensation for core width (0.6 dB) is required (Table 5-4).

The correction factors in Table 5-4 are the amounts by which the actual measured reproduce output from a full width alignment tape will exceed the reproduce output of the correct track width recorded to the same fluxivity. The table includes the fixed error due to the wider reproduce core width and the relative fringing error (shown in Figure 5-8) for frequencies of 500 Hz, 700 Hz, and 1.0 kHz. For example, when reproducing the 700-Hz, 185-nWb/m tone on an Ampex 15 in/s full-width alignment tape on a 2-track, 1/4-inch tape system, the output (as read on an ac voltmeter) will be +1.14 dB higher (Table 5-4) as compared to reproducing an alignment tape that has the same track format as the recorder/reproducer.

The amplitude correction factor of 1.14 dB was obtained by adding the following figures:

0.56 dB	— compensation for wide reproduce core width (See asterisk, Table 5-4).
0.58 dB	— relative fringing frequency response due to fringing error effect at 700 Hz and 15 in/s (Figure 5-8).
1.14 dB	— Amplitude correction factor.

Note that if the alignment tape used matches the head track format, the correction factors given in Table 5-4 are not used. Also no corrections are required when using a full-width alignment tape to align a full-track head assembly system.

Another source of error is the reproduce head pole contour effect. This effect is prevalent when using the low-frequency sections of the alignment tape. If the alignment tape track format matches the reproduce head format, the error is not severe. This type of error can be minimized by adjustment of the low frequency reproduce equalizers while performing the overall record/reproduce alignment procedure.

5-32. Using a Flux Loop — General Discussion. An accurate method of setting equalization involves the use of a flux loop driven by an audio oscillator in order to induce an electromagnetic field into the reproduce head. The field produced by the flux loop may be equalized to simulate the short circuit flux/frequency response from an ideally recorded alignment tape. The response of a correctly equalized reproduce system to a correctly equalized flux loop will be an almost constant output with frequency over the audio range of interest. However the use of the flux loop will not disclose the following errors:

- Reproduce head low frequency pole contour and secondary gap effect.
- Reproduce head high frequency gap loss.
- Effects due to head-to-tape contact or azimuth errors.

The ATR-100 incorporates automatically selected preset equalization to correct for secondary gap rise at 15 and 30 in/s. Therefore at 15 and 30 in/s, with the reproduce low frequency and high frequency equalizer controls correctly set, the actual flux-looped low-frequency response will depart from a flat response by a specific amount depending on frequency. Figure 5-9 shows the correct response that should be obtained at 15 and 30 in/s with the reproduce equalizers adjusted to match the equalization standard set on the equalized flux loop. The output frequency response using a correctly equalized flux loop should be flat for 3.75 and 7.5 in/s.

A recommended flux loop for use with the ATR-100 is the Ampex flux loop (Ampex Part No. 4020423) used with an Ampex flux loop equalizing amplifier (Ampex Part No. 4040424). This equalizing amplifier contains inverse compensation for the secondary gap rise for the setting of equalization at 15 and 30 in/s. Therefore Figure 5-9 does not apply when using the Ampex equalizing amplifier.

When an equalizing amplifier is not used, the flux loop may be passively equalized by use of a capacitor connected across the oscillator terminals, to provide the high-frequency transition. Table 5-5 provides capacitor values for specified equalization

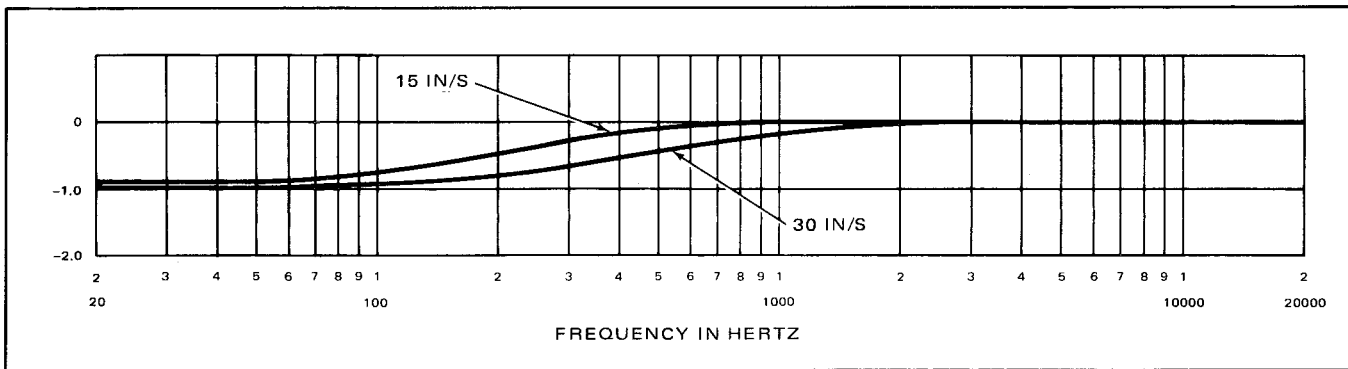


Figure 5-9. Equalized Flux Loop Response for 15 in/s and 30 in/s

Table 5-5. Capacitor Values for Passive Equalization of High Frequency Turnover

TAPE SPEED AND EQUALIZATION STANDARD	HIGH FREQUENCY TRANSITION TIME CONSTANT	-3 dB FREQUENCY	CAPACITOR VALUE*
30 in/s AES	17.5 μ s	9,095 Hz	0.204 μ F
15 in/s IEC/CCIR	35 μ s	4,547 Hz	0.408 μ F
7.5/15 in/s NAB	50 μ s	3,183 Hz	0.583 μ F
7.5 in/s IEC/CCIR	70 μ s	2,274 Hz	0.817 μ F
3.75 in/s	90 μ s	1,768 Hz	1.05 μ F

*Capacitor value when using audio oscillator with 600-ohm output impedance and Ampex flux loop, part number 4020423-01 ($R_{loop} = 100$ ohms).

standards when using an audio oscillator with 600 ohms output and an Ampex flux loop that has a dc resistance of 100 ohms. If a flux loop or audio oscillator with other characteristics is used, a nominal capacitor value may be calculated by the following formula:

$$C = \frac{T(R_0 + R_1)}{R_0 \cdot R_1}$$

Where:

- T = equalization transition time constant (seconds) (Table 5-5)
- R_0 = oscillator output resistance (ohms)
- R_1 = flux loop dc resistance (ohms)
- C = capacity in μ F

Figure 10 shows the desired system response from an unequalized flux loop, with constant current drive, for the most common equalization standards.

5-33. Head Azimuth and Phase — General Discussion.

The only head adjustment required is for record and reproduce head stack azimuth. Precision mounting of the record and reproduce head stack has eliminated the need for adjusting tape wrap, height, and zenith. The azimuth adjustment is made by turning a hex socket screw accessible through the top of the head shield (Figure 5-11) which causes a tapered gear to rotate underneath the head-stack precision plate. The azimuth adjustment is adjustable over a range of ± 15 minutes of arc.

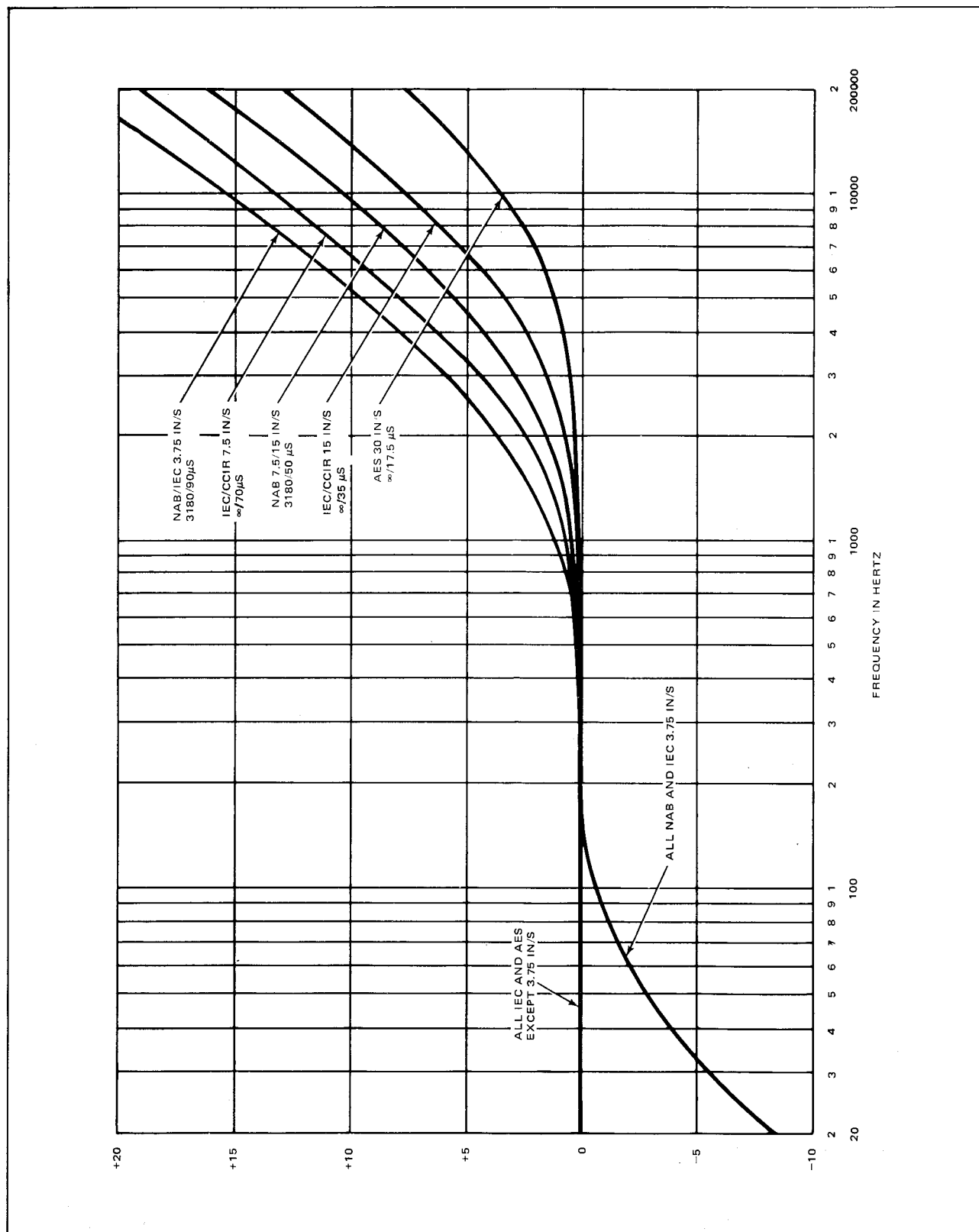


Figure 5-10. Reproduce Response From Unequalized Flux Loop

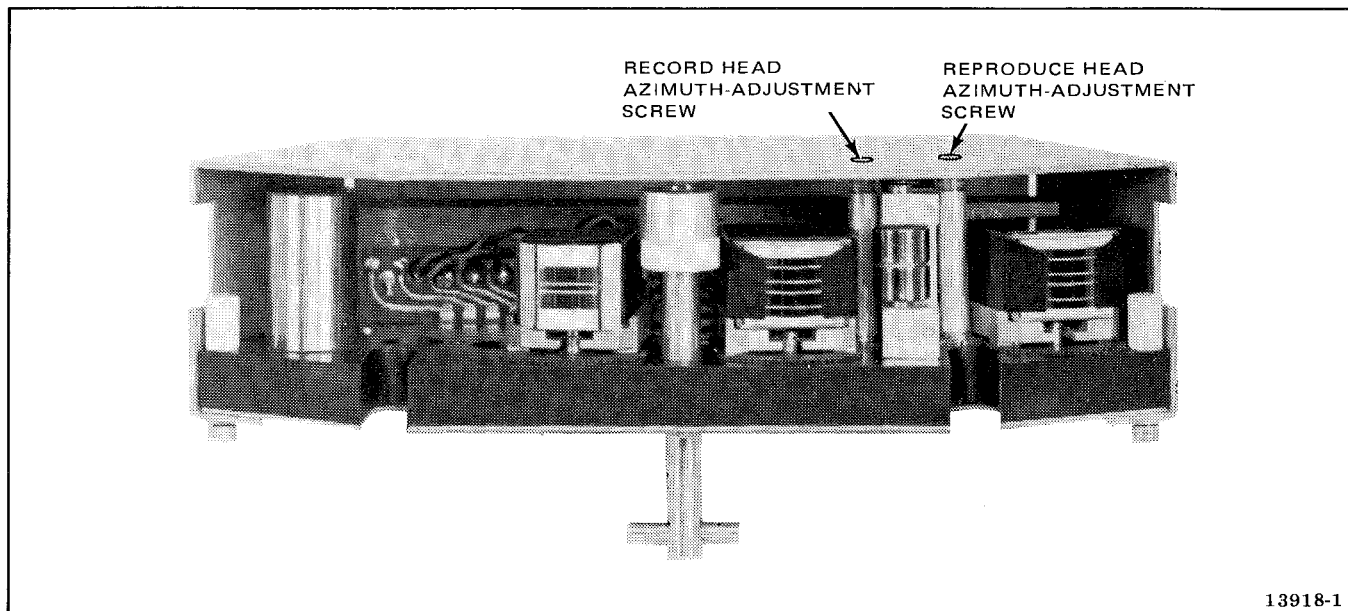


Figure 5-11. Azimuth Adjustment Screw Location

The adjustment of head phase can be considered a fine adjustment of head azimuth and is adjusted to eliminate phase error between tracks of a 2-track or 4-track head assembly. Prior to the adjustment of head phase, the following criteria should be met:

1. Reproduce head — Reproduce equalization is correct.
2. Record head — Reproduce equalization and reproduce head azimuth have been adjusted. Record equalization and bias have been set for overall system high-frequency response and azimuth adjusted for maximum short wavelength output.

Failure to observe the above criteria can result in incorrect mechanical azimuth being set in order to compensate for inter-track phasing errors. These errors are electrical in origin (differences between tracks in reproduce equalization, record equalization and/or record bias).

5-34. Operating Level — General Discussion. The operating level used is a matter of individual preference by the user of the recorder/reproducer. However, the use of Ampex 456 tape (or direct

equivalent) with an operating level of 370 nWb/m is recommended. This level will provide the lowest distortion and adequate headroom prior to tape saturation. Use of Ampex 456 tape with a lower operating level will degrade signal-to-noise ratio but will lower distortion and increase headroom. With other types of tape, other operating levels may be preferable. For example, when using Ampex 406/407 tape, an operating level of not more than 260 nWb/m is recommended.

Operating level is set while reproducing a standard alignment tape of known short circuit fluxivity, and adjusting the recorder/reproducer reproduce gain appropriately. In the case of the Ampex alignment tapes, reference levels of 700 Hz (500 Hz at 3.75 in/s) at 185 nWb/m are used. (Other manufacturers of alignment tapes have standard reference levels at 200 nWb/m or 250 nWb/m at 1.0 kHz, or 320 nWb/m at 1.0 kHz.) Table 5-6 shows the relative differences in level between Ampex reference level (185 nWb/m) and other reference levels in domestic and international use.

If a full width alignment tape is used to set reproduce gain on a 2- or 4-track system, errors in absolute reproduce sensitivity to recorded fluxivity will result due to the fringing effect. This

Table 5-6. Relative Operating Levels

DESCRIPTION	RELATIVE LEVEL	SHORT CIRCUIT FLUXIVITY	FREQUENCY
Ampex reference level (standard operating level)	0 dB	185 nWb/m	700 Hz or 500 Hz
Other U.S. reference levels	+0.7 dB	200 nWb/m	1.0 kHz
Elevated operating level	+3 dB	250/260 nWb/m	1.0 kHz
IEC reference level	+4.8 dB	320 nWb/m	1.0 kHz
Recommended operating level for ATR-100 and 456 tape	+6 dB	370 nWb/m	700 Hz

error becomes more pronounced at the higher tape speeds. Table 5-4 lists the correction factors to be applied when using a full-width alignment tape for setting reference level when using a 2-track or 4-track reproduce head assembly.

The correction factors in Table 5-4 are the amounts by which the actual measured reproduce output from a full-width alignment tape will exceed the reproduce output of the correct track width recorded to the same fluxivity. For example, when reproducing the 700-Hz, 185-nWb/m tone of an Ampex 15 in/s full-width alignment tape on a 2-track, 1/4-inch head assembly, the reproduce gain is set to provide 1.14 dB higher output than actually required. This correction factor provided in Table 5-4 also compensates for the wider-than-normal core head used on the ATR-100. The wider reproduce core minimizes level errors when reproducing tape recorded on other machines with head heights set incorrectly.

Note that if the alignment tape used matches the head track format, the correction factors given in Table 5-4 are not used. Also no corrections are required when using a full-width alignment tape to align a full-track head assembly system.

5-35. Reproduce Equalization Adjustment. Reproduce equalization adjustment consists of setting the low and high frequency equalization of each audio channel, utilizing a standard alignment tape or a flux loop. The more accurate method of setting equalization involves the use of a flux loop driven by an audio oscillator to induce a flux into

the reproduce head. Both methods of setting equalization are given in the procedures. Prior to performing the alignment procedure, refer to the general discussion regarding the use of flux loops, paragraph 5-32.

NOTE

Where input and output line levels pertaining to the input/output assembly are stated, it is assumed that the input/output assembly has been set to the factory-adjusted input and output line level of +4-dBm operating level (0 vu). If another value line input and output operating level is being used, the levels stated in the adjustment procedures should be amended by the amount of deviation from the +4-dBm operating level.

CAUTION

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS ON A PRINTED WIRING ASSEMBLY (PWA), ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A PWA IN THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.

5-36. Equalization Adjustment Using an Alignment Tape. The procedure assumes use of an Ampex alignment tape. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the

Preventive Maintenance portion of the manual, paragraphs 5-4 and 5-7.

2. Remove main audio PWA from electronics assembly corresponding to channel being adjusted.
3. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.
4. Set REPR GAIN control R1 on PADNET PWA (Table 5-7) to full clockwise position.
5. Connect ac voltmeter to one of the following output connectors.
 - a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
 - b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).
6. Select appropriate system tape speed at the transport control panel.
7. Thread appropriate alignment tape (Table 5-1) on the transport and place system in thread mode.

NOTE

If a full-track alignment tape is used to adjust a multitrack system, it will be necessary to correct for the fringing effect. Refer to fringing effect discussion given under *Use of Alignment Tapes*, paragraph 5-31.

8. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
9. Place system in play mode and establish reference frequency level as follows:
 - a. 3.75 in/s — Set REPR GAIN control so that ac voltmeter reads -15 dBm at the 500-Hz reference tone (-10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or -6 dBm at the output of the input/output assembly.
 - b. 7.5 in/s — Set REPR GAIN control so that ac voltmeter reads -15 dBm at the 700-Hz reference tone (-10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or -6 dBm at the output of the input/output assembly.
 - c. 15 or 30 in/s — Set REPR GAIN control so that ac voltmeter reads -5 dBm at the 700-Hz reference tone (185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or $+4$ dBm at the output of the input/output assembly.
10. While reproducing the highest frequency tone on the alignment tape (7.5 kHz at 3.75 in/s or 15 kHz at 7.5, 15, and 30 in/s), adjust the reproduce head azimuth screw (Figure 5-11) for maximum output.
11. While reproducing the 10.0-kHz tone (7.50 kHz at 3.75 in/s), adjust appropriate reproduce equalizer control (HI SPEED HF or LO SPEED HF) on PADNET (Table 5-7) for the same level obtained in step 9 (or to required relative level as indicated in Figure 5-8, if applicable).
12. While reproducing the 50-Hz tone, adjust appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on PADNET for the same level obtained in step 9. (Note: This is an approximate setting, final adjustment will be made during an overall record/reproduce alignment procedure.)
13. Reproduce the frequency response test tones on the alignment tape. Reproduce response should conform to tolerances shown in Table 5-3. If applicable, refer to relative fringing error curves shown in Figure 5-8.
14. Repeat steps 2 through 13 for other audio channels to be adjusted.

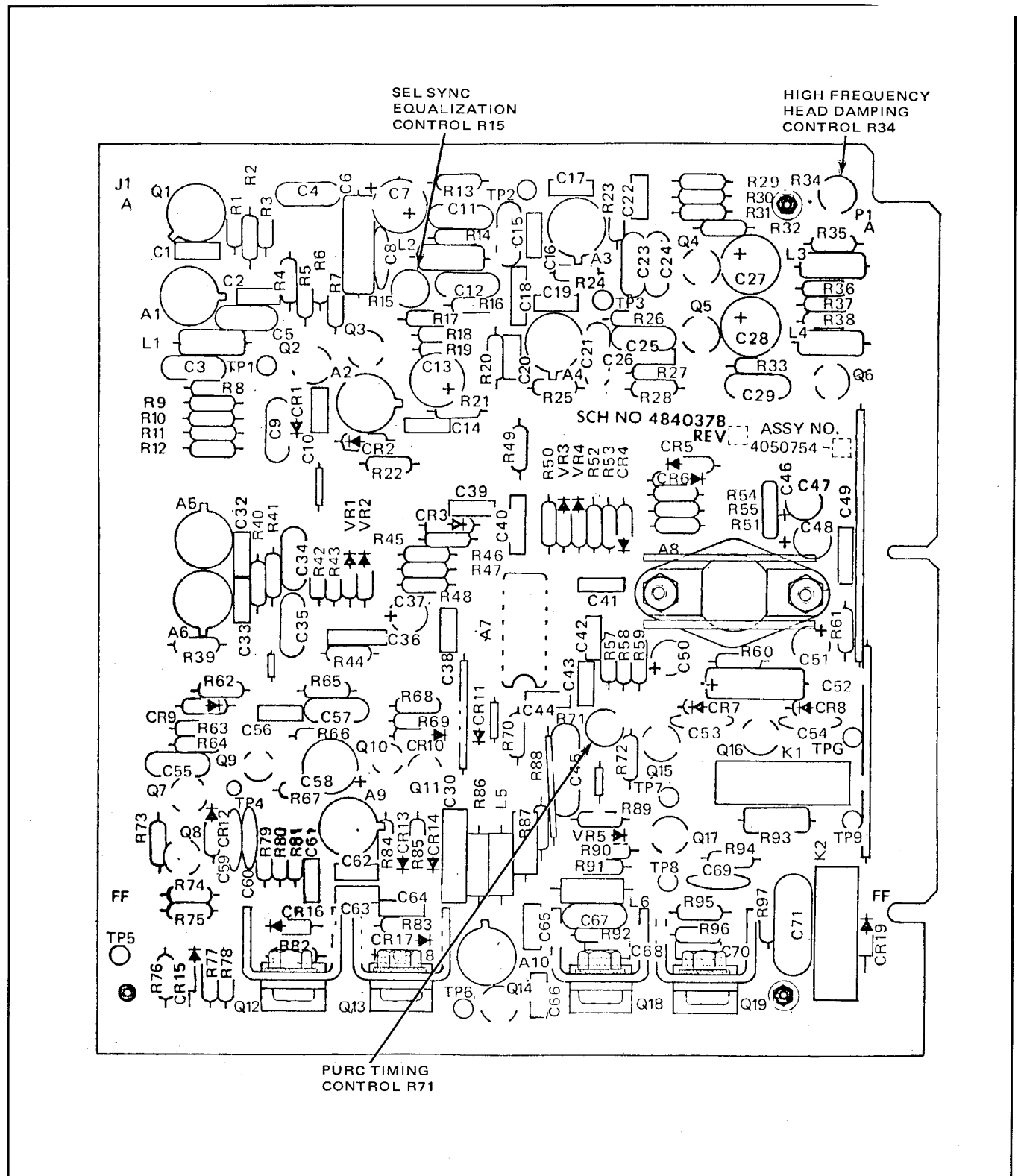


Figure 5-12. Main Audio PWA 1, 2, 3, or 4 – Alignment Controls

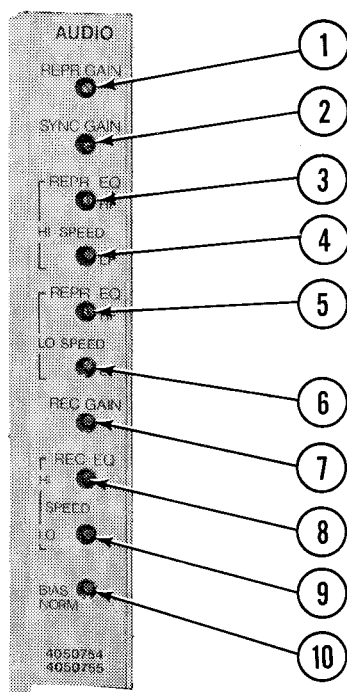
15. Adjust operating level by following instructions given starting with paragraph 5-41.

NOTE

Final adjustment of the reproduce low frequency equalizers for optimum

low-frequency response will be accomplished during an overall record/reproduce alignment procedure given later in this section of the manual.

Table 5-7. PADNET PWA – Alignment Controls



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INDEX NO.	CONTROL	FUNCTION
1	REPR GAIN (R1)	Adjusts basic recorder/reproducer interface reproduce level.
2	SYNC GAIN (R3)	Adjusts basic recorder/reproducer sel sync reproduce interface level.
3	HI SPEED HF (R5)	Adjusts high-speed, high-frequency reproduce equalization.
4	HI SPEED LF (R7)	Adjusts high-speed, low-frequency reproduce equalization.
5	LO SPEED HF (R9)	Adjusts low-speed, high-frequency reproduce equalization.
6	LO SPEED LF (R11)	Adjusts low-speed, low-frequency reproduce equalization.
7	REC GAIN (R12)	Adjusts basic recorder/reproducer interface record level.
8	HI SPEED (R15)	Adjusts high-speed, high-frequency record equalization.
9	LO SPEED (R18)	Adjusts low-speed, high-frequency record equalization.
10	BIAS NORM (R21)	Normalizes bias level for individual channel to common master bias bus level.

5-37. Reproduce Equalization Adjustment Using a Flux Loop. A flux loop is used to induce an electromagnetic field into the reproduce head for the purpose of adjusting reproduce equalization. Prior to performing the alignment procedure, refer to the general discussion concerning the use of flux loops, paragraph 5-32. Proceed as follows:

1. With system power off, remove main audio PWA from electronics assembly corresponding to channel being adjusted.
2. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.
3. Select appropriate system tape speed at the transport control panel.
4. Clip flux loop to reproduce head.
5. If a flux loop equalizing amplifier is being used (Table 5-1), select the appropriate equalization time constant on the amplifier and connect amplifier to audio oscillator. Observe that amplifier is not overdriven so as to cause clipping, particularly of low-frequency signals.
6. If a flux loop equalizing amplifier is not being used, connect an appropriate equalizing capacitor (Table 5-5) across audio oscillator terminals and connect flux loop (Ampex Part No. 4020423) to the oscillator.
7. Set oscillator to +4 dBm output at 1.0 kHz.
8. Connect ac voltmeter to one of the following output connectors:
 - a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 and J14 (Figure 2-13 and Tables 2-2 and 2-3).
 - b. If an input/output assembly is being used, connect ac voltmeter to appropriate recorder/reproducer output connector (Figures 2-14 and 2-15).
9. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET

switch on input/output module to PRESET position.

10. Apply system power and set REPR GAIN control so that ac voltmeter reads -20 dBm at the output of the recorder/reproducer, or -10 dBm at the output of the input/output assembly.
11. Change oscillator frequency to 15.0 kHz.
12. Adjust appropriate reproduce equalizer control (HI SPEED HF or LOW SPEED HF) on PADNET for the same level obtained in step 10.
13. Sweep oscillator through frequency range of 10 kHz to 20 kHz. The response should be within ± 0.25 dB of the level at 10 kHz. If not, remove power and make slight adjustment of R34 on main audio PWA. Reinstall PWA and apply power.
14. Repeat step 13 as necessary to achieve the desired results.
15. Change oscillator frequency to 30 Hz.
16. Adjust appropriate reproduce equalizer control (HI SPEED LF or LOW SPEED LF) on PADNET for same level obtained in step 10 for 3.75 in/s or 7.5 in/s, or for level to conform to response curves in Figure 5-9 for 15 in/s or 30 in/s.

NOTE

The Ampex flux loop equalizing amplifier contains compensation for secondary gap rise. Therefore the equalizer control should be set for flat response and reference to Figure 5-9 is not required.

17. Sweep oscillator through frequency range of 20 Hz to 20 kHz. For speeds 3.75 in/s and 7.5 in/s, response should be flat ± 0.25 dB. For speeds 15 in/s and 30 in/s, response should match curves in Figure 5-9 within ± 0.25 dB.
18. Repeat steps 1 through 17 for the other audio channels to be adjusted.

NOTE

Final adjustment of the reproduce low-frequency equalizers for optimum low-frequency response will be accomplished during an overall record/reproduce alignment procedure given later in this section of the manual.

5-38. Reproduce Head Azimuth and Phase Adjustment. The adjustment of head phase can be considered a fine adjustment of head azimuth and is adjusted to eliminate phase error between tracks of a 2-track or 4-track head assembly. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth and phase adjustment, paragraph 5-33.

5-39. 2-Track or 4-Track Reproduce Head Azimuth and Phase Adjustment. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance*, paragraphs 5-4 and 5-7.
2. As a preliminary adjustment, turn reproduce head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.
3. Connect a dual trace scope as follows:

NOTE

If a dual trace scope is not available, proceed to step 4.

- a. For a 2-track head assembly system, connect scope to channel 1 and channel 2 outputs of the recorder system.
- b. For a 4-track head assembly system, connect scope to channel 1 and channel 4 outputs of the recorder system.
- c. Trigger scope from recorder channel 1 output.
- d. Proceed to step 5.

4. If a dual trace scope is not available, connect a single channel scope to display a Lissajou pattern as follows:
 - a. For a 2-track head assembly system, connect channel 1 output to the vertical input of scope, and connect channel 2 output to the horizontal input of the scope.
 - b. For a 4-track head assembly system, connect channel 1 output to the vertical input of scope, and connect channel 4 output to the horizontal input of the scope.
5. Thread appropriate alignment tape (Table 5-1) on transport and place system in thread mode.
6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust reproduce head azimuth adjusting screw to obtain minimum phase error as viewed on scope (or Lissajou pattern straight line at 45°).
7. Minimize average phase error by carefully adjusting the head azimuth adjusting screw while playing back one of the following higher frequency test tones on the alignment tape.
 - a. 30 in/s — 15 kHz
 - b. 15 in/s — 10 kHz
 - c. 7.5 in/s — 5.0 kHz
 - d. 3.75 in/s — 2.5 kHz

NOTE

The frequencies given in step 7 were chosen to provide a wavelength on tape of 1.5 mils or longer. For use of alignment tapes with other than the above frequencies, wavelength may be calculated by the formula:

$$\lambda = \frac{v}{f}$$

Where:

λ = wavelength on tape (inches)

v = tape speed (in/s)

f = frequency (Hz)

8. Minimize mean phase error by repeating step 7 but playing back the highest frequency test tone on the alignment tape.
9. For a 4-track head assembly system, play back full sequence of test tones and observe that no phase reversal occurs. If phase reversal occurs, repeat steps 6 through 8. (Note that for a 2-track head assembly system, it is not possible to incorrectly set phase if wavelength is 1.5 mil or longer.)
10. For a 4-track head assembly system only while observing a 1.5-mil wavelength, replace the channel 4 output to the oscilloscope with channel 3 and then with channel 2. The mean phase error at this wavelength should be less than $\pm 10^\circ$. (Note: This figure depends on the accuracy that reproduce high-frequency equalization has been set, and upon the quality and mechanical condition of the alignment tape.)

5-40. Full Track Reproduce Head Azimuth Adjustment. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual.
2. As a preliminary adjustment, turn reproduce head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.
3. If an input/output assembly is not being used, connect scope or ac voltmeter to output of recorder system.
4. Select the lower of the two operating speeds selected for recorder operation.
5. Thread the appropriate full-track alignment tape (Table 5-1) on transport, and place system in thread mode.

6. While reproducing the highest tone on the alignment tape (shortest wavelength), adjust the reproduce head azimuth adjusting screw for maximum signal amplitude as read on input/output assembly meter, or on scope or ac voltmeter. (Note: At the slower tape speeds, it may be possible to set azimuth to an incorrect secondary peak. Rotate azimuth adjusting screw through 360° to ensure that the maximum amplitude peak is obtained. Continuous rotation of azimuth adjusting screw provides only ± 15 minute of arc change.)

5-41. Operating Level Adjustment. Operating level is set by reproducing a standard alignment tape of known short circuit fluxivity, and adjusting the recorder/reproducer reproduce gain for the desired operating level. Prior to performing the alignment procedure, refer to the general discussion concerning operating level, paragraph 5-34. Note that on Ampex alignment tapes for 15 and 30 in/s, the 185 nWb/m, 700 Hz reference tone is the first tone on the tape. For 3.75 and 7.5 in/s, the 185 nWb/m, 700 Hz (500 Hz at 3.75 in/s) tone is the last tone on the tape.

NOTE

Where input and output line levels pertaining to the input/output assembly are stated, it is assumed that the input/output assembly has been set to the factory adjusted input and output line level of +4 dBm operating level (0 vu). If another value line input and output operating level is being used, the levels stated in the adjustment procedures should be amended by the amount of deviation from the +4 dBm operating level.

CAUTION

IF THE TAPE IN USE OR LOCAL STANDARDS REQUIRE THE USE OF OPERATING FLUXIVITIES LESS THAN 185 nWb/m, OR IF A HIGHER INTERFACE OUTPUT LEVEL IS DESIRED (GREATER THAN -5-dBm OUTPUT LEVEL), NOTE THAT THE REPRO GAIN ON THE PADNET MUST NOT BE INCREASED ABOVE A SENSITIVITY EQUIVALENT TO -5-dBm OUTPUT FROM THE BASIC RECORDER/REPRODUCER WHEN

REPRODUCING A 185-nWb/m, 700-Hz (500-Hz AT 3.75 in/s) TONE. IF THIS PRECAUTION IS NOT OBSERVED AND A HIGH OUTPUT TAPE, SUCH AS AMPEX 456 TAPE, IS REPRODUCED ON THE ATR-100, ELECTRONIC CLIPPING MAY OCCUR BEFORE TAPE SATURATION. (THE MID BAND SATURATED OUTPUT OF AMPEX 456 TAPE IS APPROXIMATELY +20.5 dB ABOVE 185 nWb/m.)

5-42. 370 nWb/m Operating Level Adjustment.
Use Ampex 456 tape (or direct equivalent) and proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance*, paragraphs 5-4 and 5-7.
2. Select system tape speed at the transport control panel.
3. Connect voltmeter to one of the following output connectors:
 - a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
 - b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).
4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
5. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.
6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPR GAIN control as follows:
 - a. If alignment tape track format matches the head track format, adjust REPR

GAIN control R-1 on PADNET for -11 dBm at the output of the recorder/reproducer, or -2 dBm at the output of the input/output assembly.

- b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the -11 dBm or -2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -11 dBm + (+1.14 dBm) = -9.86 dBm.)

7. Repeat steps 2 through 6 for other audio channels to be adjusted.

5-43. 260 nWb/m Operating Level Adjustment.
Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual.
2. Select system tape speed at the transport control panel.
3. Connect ac voltmeter to one of the following output connectors:
 - a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13).
 - b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figure 2-14).
4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
5. Thread appropriate alignment tape (Table 5-1) on transport and place system in thread mode.
6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPR GAIN control as follows.

- a. If alignment tape track format matches the head track format, adjust REPR GAIN control on PADNET for -8 dBm at the output of the recorder/reproducer, or $+1$ dBm at the output of the input/output assembly.
 - b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the -8 -dBm or $+1$ -dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -8 dBm + $(+1.14$ dBm) = -6.86 dBm.)
7. Repeat steps 2 through 6 for other audio channels to be adjusted.
- 5-44. 185 nWb/m Operating Level Adjustment.** Proceed as follows:
1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance*, paragraphs 5-4 and 5-7.
 2. Select system tape speed at the transport control panel.
 3. Connect ac voltmeter to one of the following output connectors.
 - a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
 - b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).
 4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
 5. Thread appropriate alignment tape (Table 5-1) on transport and place system in thread mode.
 6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPR GAIN control as follows:
 - a. If alignment tape track format matches the head track format, adjust REPR GAIN control R-1 on PADNET for -5 dBm at the output of the recorder/reproducer, or $+4$ dBm at the output of the input/output assembly.
 - b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the -5 -dBm or $+4$ -dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -5 dBm + $(+1.14$ dBm) = -3.86 dBm.)
 7. Repeat steps 2 through 6 for other audio channels to be adjusted.

5-45. Record Alignment. The record alignment procedure should only be performed after reproduce equalization, reproduce gain, and reproduce head azimuth have been set or are known to be correct. Record alignment consists of setting bias level, setting record high frequency equalization, and setting system output level. The alignment procedures include instructions for aligning the record system for the first speed followed by the second speed record alignment procedure. The second speed record alignment procedure is abbreviated, as it does not require the readjustment of BIAS NORM or record head azimuth.

The following general information and conditions are applicable to both record alignment procedures.

1. Operating level is 370 nWb/m when using Ampex 456 tape or direct equivalent.
2. Operating level is 260 nWb/m when using Ampex 406 tape or equivalent.
3. Frequency response alignment is performed at the following operating levels: 15 and 30 in/s at operating level, 7.5 in/s at 10 dB below operating level, and 3.75 in/s at 20 dB below operating level.

4. Master bias operation has been set for either two-speed dual master bias operation or for four-speed master bias operation as desired. See *Changing Operating Speed Pair and Master Bias Operation* text, paragraph 5-15. (Recorder/reproducers shipped from the factory are set for four-speed master bias operation.) If two-speed dual master bias operation is selected, perform the entire record alignment procedure with bias switch S1 (Figure 5-4) in position I or II. The other position may be used to provide a preadjusted bias position for another type of tape.
5. If an input/output assembly is connected to the recorder/reproducer, the assembly is assumed to be correctly calibrated and set for +4-dBm line input and output operating level and at -5-dBm recorder/reproducer interface operating level (see *Input/Output Assembly Adjustment* procedure, paragraph 5-52).

5-46. First Speed Record Alignment. Perform the following alignment procedure for each channel (as applicable).

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. Set preset record equalization standard selector switch S1 (Figure 5-13) on PADNET to equalization standard desired for each of

the two operating speeds, as shown in Table 5-8. Note that switches S1-1 through S1-3 are for the higher speed, and switches S1-4 through S1-6 are for the lower speed.

3. If not already set, set speed select jumpers on PADNET PWA for the two desired operating speeds, and set master bias operation jumpers on audio control PWA No. 5 for either two-speed or four-speed master bias operation. (See *Changing Operating Speed Pair and Master Bias Operation* text, paragraph 5-15.)

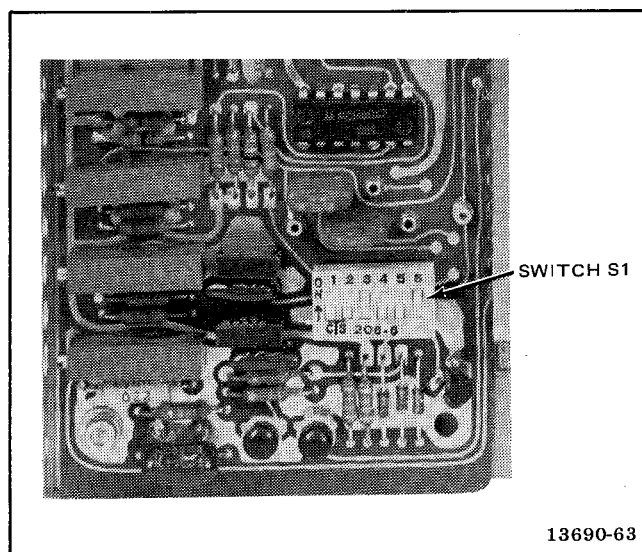


Figure 5-13. Record Equalization Standard Selector Switch S1, PADNET PWA

Table 5-8. Record Equalization Standard Selector Switch S1 Switch Positions (PADNET PWA)

EQUALIZATION STANDARD/ μ s	IN/S	SWITCH S1-1 OR S1-4 (SHELF DOWN)	SWITCH S1-2 OR S1-5 (SHELF UP)	SWITCH S1-3 OR S1-6 (∞ OR 3180 μ s)
AES 17.5/ ∞	30	OFF	OFF	ON
NAB 50/3180	15	ON	OFF	OFF
NAB 50/3180	7.5	OFF	ON	OFF
IEC 35/ ∞	15	OFF	OFF	ON
IEC 70/ ∞	7.5	OFF	OFF	ON
NAB/IEC 90/3180	3.75	OFF	ON	OFF

NOTE: Switches S1-1 through S1-3 are for the higher of the two speeds. Switches S1-4 through S1-6 are for the lower of the two speeds.

4. Select first tape speed to be aligned at the transport control panel.
5. If an input/output assembly is being used, connect an ac voltmeter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15). Set MANUAL/PRESET switch to PRESET.
6. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14, and connect audio oscillator to appropriate input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
7. Set oscillator frequency to 1.0 kHz.
8. If erase alignment has not been performed or is not known to be correct, set master erase bus level control R34 (Figure 5-14), on audio control PWA No. 5, to midrange position.
9. Connect scope probe to one of the following locations to monitor the amplitude of the master bias signal.
 - a. If test point TP1 is present on audio control PWA No. 5 (later versions of the PWA), place PWA on extender board and reinstall into electronics assembly. Connect probe to TP1.
 - b. If TP1 (step 9a) is not present (early versions of the PWA), place a main audio PWA and PADNET on extender board and reinstall into electronics assembly. Connect probe to pin FF on PADNET.
10. Apply power, and adjust appropriate MASTER BIAS level control (Table 5-9 or Table 5-10)

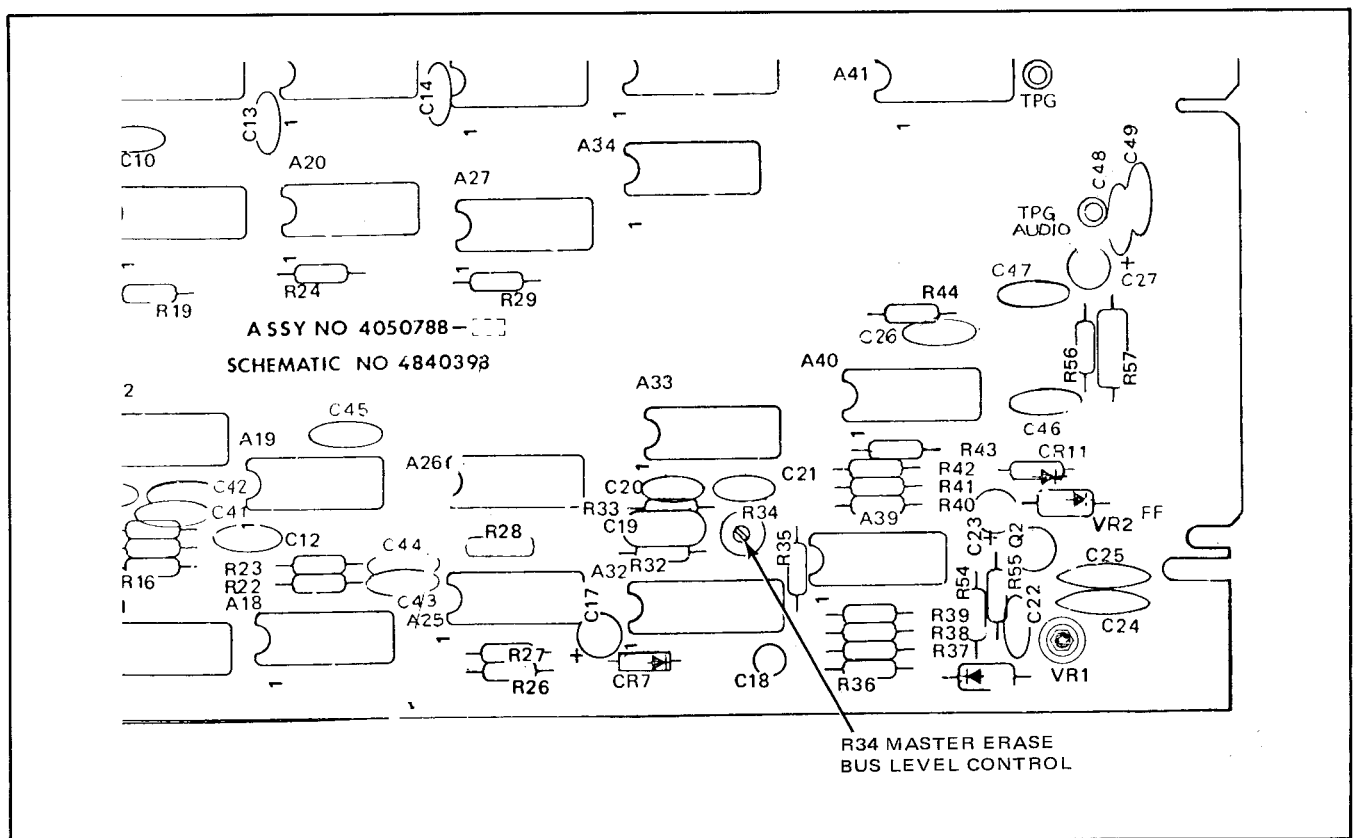
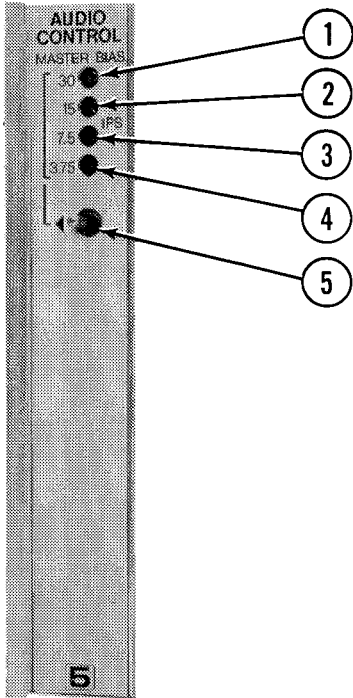


Figure 5-14. Audio Control PWA No. 5

Table 5-9. Audio Control PWA No. 5 — Four-Speed Alignment Controls

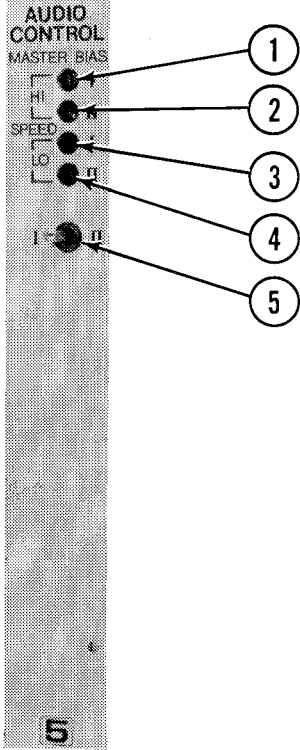
	INDEX NO.	CONTROL	FUNCTION
	1	30 (R6)	Adjusts 30-in/s master bias level.
	2	15 (R5)	Adjusts 15-in/s master bias level.
	3	7.5 (R4)	Adjusts 7.5-in/s master bias level.
	4	3.75 (R3)	Adjusts 3.75-in/s master bias level.
	5	Switch (S1)	(Switch to remain in left-hand position for four-speed operation.)

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for the speed in use to provide a 2.5-Vp-p, 432-kHz square wave on scope.

11. Remove power and scope probe from PWA (step 9). Reinstall PWA into electronics assembly.
12. Apply system power, thread a reel of bulk-erased tape on transport, and place system into thread mode.
13. Select input monitoring for channel being aligned.
14. Adjust audio oscillator output to provide -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
15. Place channel(s) being aligned in ready mode.
16. Place system in record mode.
17. Select repro monitoring for channel being aligned.
18. Adjust BIAS NORM control (Table 5-7) on PADNET for maximum 1.0-kHz output.
19. Adjust REC GAIN control (Table 5-7) on PADNET for -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
20. Set audio oscillator to 25 kHz at 30 in/s, 15 kHz at 15 in/s or 7.5 in/s, or 7.5 kHz at 3.75 in/s.
21. Adjust record head azimuth adjustment screw (Figure 5-11) for maximum signal output.
22. Adjust bias by overbiasing a short wavelength signal (1.5 mils) for the speed in use as follows.

Table 5-10. Audio Control PWA No. 5 – Two-Speed Alignment Controls

	INDEX NO.	CONTROL	FUNCTION
	1	HI I (R6)	Adjusts high-speed I master bias level.
	2	HI II (R5)	Adjusts high-speed II master bias level.
	3	LO I (R4)	Adjusts low-speed I master bias level.
	4	LO II (R3)	Adjusts low-speed II master bias level.
	5	I/II Switch (S1)	Selects master bias I or II.

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- a. Set oscillator to frequency given in Table 5-11 for speed in use.
- b. Reduce oscillator output level to obtain signal output level given in Table 5-11 for speed in use. (The output level is relative to the level set in step 19.)
- c. Adjust BIAS NORM control (Table 5-7) on PADNET counterclockwise until level of signal being reproduced starts to fall. Then turn BIAS NORM slowly clockwise for maximum signal output. (If necessary, reduce oscillator level to maintain level set in step 22b.)
- d. Continue turning BIAS NORM control clockwise until level has dropped from the maximum level obtained in step 22c by the amount specified in Table 5-11 for the speed and tape in use.
23. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).
24. Adjust audio oscillator output level to provide the following system output level:
 - a. If input/output assembly is not being used, adjust oscillator output for -5 dBm at 15 and 30 in/s, -15 dBm at 7.5 in/s, or -25 dBm at 3.75 in/s.
 - b. If input/output assembly is being used, adjust oscillator output for +4 dBm at 15 and 30 in/s, -6 dBm at 7.5 in/s, or -16 dBm at 3.75 in/s.
25. Set oscillator frequency to 20 kHz at 30 in/s, 15 kHz at 15 in/s, 10 kHz at 7.5 in/s, or 7.5 kHz at 3.75 in/s.
26. Adjust appropriate record equalizer control (HI SPEED or LO SPEED) on PADNET (Table 5-7) for same level as in step 24.

Table 5-11. Recommended Frequency, Signal Level, and Overbias Values for Bias and Equalization Adjustment

SPEED	FREQUENCY	LEVEL FOR BIAS AND EQUALIZATION ADJUSTMENT (Relative to 1.0 kHz Operating Level*)	OVERBIAS VALUE	
			406/407 TAPE	456 TAPE
30 in/s	20 kHz	0	1.75 \pm 0.25 dB	2.75 \pm 0.25 dB
15 in/s	10 kHz	0	1.75 \pm 0.25 dB	2.75 \pm 0.25 dB
7.5 in/s	5 kHz	-10 dB	1.75 \pm 0.25 dB	2.75 \pm 0.25 dB
3.75 in/s	2.5 kHz	-20 dB	1.75 \pm 0.25 dB	2.75 \pm 0.25 dB

*Recommended operating level is 370 nWb/m using Ampex 456 tape or 260 nWb/m using Ampex 406/407 tape.
NOTE: Frequency at each tape speed shown in the table has been chosen to provide a short wavelength signal of 1.5 mils.

27. Sweep oscillator through the following frequency range and fine-adjust the appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on PADNET (Table 5-7) to obtain the most uniform low frequency response.
 - a. 30 in/s — 35 Hz to 400 Hz
 - b. 15 in/s, 7.5 in/s, or 3.75 in/s — 20 Hz to 200 Hz
 28. Sweep oscillator through frequency ranges given in Table 5-12 for speed in use. Output should remain within limits shown in Table 5-12 for each frequency range. If necessary, make slight adjustments to the appropriate record high-frequency equalizer control (HI SPEED or LO SPEED) and/or reproduce low-frequency equalizer control (HI SPEED LF or LO SPEED LF) on PADNET PWA (Table 5-7) to obtain flattest midband response consistent with meeting extreme high- and low-frequency tolerances.
 29. Select input monitoring for channel being aligned.
 30. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).
 31. Adjust oscillator output level for -5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.
 32. Select repro monitoring for channel being aligned.
 33. Adjust REC GAIN on PADNET PWA (Table 5-7) for -5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.
 34. For a single-channel system, this completes the record alignment for the first speed selected for adjustment. To adjust for the second speed, proceed to the *Second Speed Record Alignment* procedure, paragraph 5-47.
 35. For a 2-track or 4-track system, align the other channels for the same speed in use by following the *First Speed Record Alignment* procedure, steps 2, 5, 6, 14 through 20, and 22 through 33. Do not readjust MASTER BIAS level control on audio control PWA No. 5 (steps 9 and 10) and do not readjust record head azimuth (steps 20 and 21).
- 5-47. Second Speed Record Alignment.** When aligning the record system for a second speed after all channels have been adjusted for the first speed, none of the BIAS NORM controls are readjusted. Bias level for the second speed is set by adjusting the appropriate MASTER BIAS level control on audio control PWA No. 5. When aligning a 2-track or 4-track system, the MASTER BIAS level need only be set once while monitoring the output of any one channel. The bias level for the other channel(s) is automatically set correctly to the

Table 5-12. Overall Record/Reproduce Frequency Response

SPEED/EQUALIZATION STANDARD	REFERENCE FREQUENCY	TOLERANCE ± 0.75 dB	TOLERANCE ± 2.0 dB	LEVEL FOR FREQUENCY RESPONSE RELATIVE TO OPERATING LEVEL *
30 in/s AES	1 kHz	200 Hz — 20 kHz	35 Hz — 25 kHz	0 dB
15 in/s NAB or IEC	1 kHz	100 Hz — 15 kHz	20 Hz — 20 kHz	0 dB
7.5 in/s NAB or IEC	500 Hz	100 Hz — 10 kHz	30 Hz — 15 kHz	-10 dB
3.75 in/s NAB/IEC	500 Hz	(not specified)	30 Hz — 10 kHz **	-20 dB
*Operating level is 370 nWb/m at 700 Hz for Ampex 456 tape and 260 nWb/m at 700 Hz for Ampex 406/407 tape. **For Ampex 456 tape. For Ampex 406/407 tape specification is: 30 Hz — 7.5 kHz, ± 2.0 dB.				

same biasing point as the channel that was monitored.

To align the record system for a second speed after the first speed has been adjusted, proceed as follows:

1. Set system tape speed at the transport control panel.
2. Set oscillator frequency to 1.0 kHz.
3. Select input monitoring for channel being aligned.
4. Adjust audio oscillator output to provide -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
5. Place channel being aligned in ready mode.
6. Place system in record mode.
7. Select repro monitoring for channel being aligned.
8. Adjust bias by overbiasing a short wavelength signal (1.5 mils) for the speed in use as follows:
 - a. Set oscillator to frequency given in Table 5-11 for speed in use.
 - b. Reduce oscillator output level to obtain signal output level given in Table 5-11 for speed in use.
- c. Adjust appropriate MASTER BIAS control (Table 5-9 or 5-10), on audio control PWA No. 5, counterclockwise until level of signal being reproduced starts to fall. Then turn MASTER BIAS control slowly clockwise for maximum signal output. (If necessary, reduce oscillator level to maintain level set in step 8b.)
- d. Continue turning MASTER BIAS control clockwise until level has dropped from the maximum level obtained in step 8c by the amount specified in Table 5-11 for the speed and tape in use.
9. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).
10. Adjust audio oscillator output level to provide the following system output level:
 - a. If input/output assembly is not being used, adjust oscillator output for -5 dBm at 15 and 30 in/s, -15 dBm at 7.5 in/s, or -25 dBm at 3.75 in/s.
 - b. If input/output assembly is being used, adjust oscillator output for +4 dBm at 15 and 30 in/s, -6 dBm at 7.5 in/s, or -16 dBm at 3.75 in/s.
11. Set oscillator frequency to 20 kHz at 30 in/s, 15 kHz at 15 in/s, 10 kHz at 7.5 in/s, or 7.5 kHz at 3.75 in/s.

12. Adjust appropriate record equalizer control (HI SPEED or LO SPEED) on PADNET (Table 5-7) for same level as in step 10.
13. Sweep oscillator through the following frequency range and fine-adjust the appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on PADNET (Table 5-7) to obtain the most uniform low-frequency response.
 - a. 30 in/s — 35 Hz to 400 Hz.
 - b. 15 in/s, 7.5 in/s, or 3.75 in/s — 20 Hz to 200 Hz.
14. Sweep oscillator through frequency ranges given in Table 5-12 for speed in use. Output should remain within limits shown in Table 5-12 for each frequency range. If necessary, make slight adjustments to the appropriate record high-frequency equalizer control (HI SPEED or LO SPEED) and/or reproduce low-frequency equalizer control (HI SPEED LF or LO SPEED LF) on PADNET PWA (Table 5-7) to obtain flattest midband response consistent with meeting extreme high- and low-frequency tolerances.
15. Select input monitoring for channel being aligned.
16. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).
17. Adjust oscillator output level for -5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.
18. Select repro monitoring for channel being used.
19. Check that reproduced level is -5 dBm ± 0.5 dB at the output of the recorder/reproducer, or is +4 dBm ± 0.5 dB at the output of the input/output assembly.

5-48. 2-Track or 4-Track Record Head Azimuth and Phase Adjustment. The adjustment of record head azimuth and phase (multitrack systems only) should not be attempted unless the following

criteria have been met: reproduce equalization is correct, reproduce head azimuth has been set using a standard alignment tape, and record equalization and bias are known to be correct. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth and phase adjustment, paragraph 5-33. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* section of the manual, paragraphs 5-4 and 5-7.
2. As a preliminary adjustment, turn record head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.
3. Connect a dual trace scope as follows:

NOTE

If a dual trace scope is not available, proceed to step 4.

- a. For a 2-track head assembly system, connect scope to channel 1 and to channel 2 outputs of the recorder system.
- b. For a 4-track head assembly system, connect scope to channel 1 output and to channel 4 output of the recorder system.
- c. Trigger scope from recorder channel 1 output.
- d. Proceed to step 5.
4. If a dual trace scope is not available, connect a single-channel scope to display a Lissajou pattern as follows:
 - a. For a 2-track head assembly system, connect channel 1 output to the vertical input of scope and connect channel 2 output to the horizontal input of the scope.
 - b. For a 4-track head assembly system, connect channel 1 output to the vertical input of scope and connect channel 4 output to the horizontal input of the scope.

5. Connect audio oscillator to input of recorder system to drive all channels simultaneously.
6. Set oscillator frequency to 1.0 kHz.
7. Connect ac voltmeter to any one of the audio outputs.
8. Apply power and thread a reel of tape on transport and place system into thread mode.
9. Select the lower of the two operating speeds.
10. Place all channels into record mode.
11. Select repro monitoring mode.
12. Adjust oscillator output level for -5 dBm at the output of the recorder/reproducer or for $+4$ dBm at the output of the input/output assembly.
13. Adjust record head azimuth adjusting screw (Figure 5-11) for minimum phase error (or straight 45° line on Lissajou display).
14. Increase oscillator frequency to frequency specified in Table 5-11 for speed in use.
15. Reduce oscillator output level as required to provide system output level specified in Table 5-11 relative to level set in step 12 at 1.0 kHz.
16. Fine-adjust record head azimuth adjusting screw to further minimize mean phase error.
17. If system is a 4-track head assembly system, replace channel 4 input to oscilloscope with channel 3 and repeat step 15. Repeat this step and step 15, but with scope connected to channel 2. The maximum mean phase error difference from channel 1 to channel 4 should not exceed $\pm 10^\circ$ at frequencies shown in frequency column of Table 5-11.

NOTE

Dynamic phase errors are mainly dependent upon tape slitting accuracy and other tape related factors. Typical

dynamic phase errors are as follows:

2 track — 1/4 inch tape systems, $\pm 15^\circ$ at 1.5 mil wavelength recorded on tape.

4 track — 1/2 inch tape systems, $\pm 25^\circ$ at 1.5 mil wavelength recorded on tape.

(A 1.5-mil wavelength recorded on tape is equivalent to 20 kHz at 30 in/s, 10 kHz at 15 in/s, 5 kHz at 7.5 in/s, or 2.5 kHz at 3.75 in/s.)

5-49. Full-Track Record Head Azimuth Adjustment. The adjustment of record head azimuth should not be attempted unless the reproduce head azimuth has been set using a standard alignment tape. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth adjustment, paragraph 5-33. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* section of the manual, paragraphs 5-4 and 5-7.
2. As a preliminary adjustment, turn record head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.
3. Connect a scope or ac voltmeter to the output of the recorder system.
4. Connect an audio oscillator to input of recorder system.
5. Apply power and thread a reel of tape on transport and place system into thread mode.
6. Select the lower of the two operating speeds.
7. Place recorder/reproducer into record mode.
8. Select repro monitoring mode.
9. Set oscillator frequency to upper band edge frequency shown in Table 5-12 for speed in use.
10. Adjust oscillator output to level for -5 dBm at the output of the recorder/reproducer,

or for +4 dBm at the output of the input/output assembly.

11. Readjust oscillator output level shown in Table 5-12 for the level for frequency response relative to operating level for the speed in use.
12. Adjust record head azimuth adjusting screw (Figure 5-11) for maximum system output level.

5-50. Sel Sync Equalization and Gain Adjustment.

The sel sync equalization and gain adjustment is made while reproducing a recording made on the recorder/reproducer. The recorder/reproducer has an additional low-frequency reproduce equalizer for the sel-sync mode which must be adjusted prior to the adjustment of SEL SYNC gain. Since sel-sync mode is most commonly used for 15- and 30-in/s operation, adjustment instructions are given for these two speeds. The sel-sync adjustment procedure should only be performed after the reproduce and record alignment procedures have been performed. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. Set sel-sync equalization control R15 on main audio PWA (Figure 5-12) to the center of its range.
3. Place main audio PWA of channel to be aligned on extender board and install into electronics assembly.
4. If an input/output assembly is being used, connect an ac voltmeter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).
5. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14, and connect audio oscillator to appropriate input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

6. Apply power, thread reel of tape on transport, and place system into thread mode.
7. Set oscillator frequency to 1.0 kHz.
8. Select input monitoring for channel being aligned.
9. Adjust audio oscillator output to provide -5 dBm at the output of the recorder/reproducer or +4 dBm at the output of the input/output assembly.
10. Place channel being aligned in ready mode.
11. Select 15- or 30-in/s tape speed and place system into record mode.
12. Select repro monitoring for channel being aligned.
13. Verify that system output level is -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly. If output is not as specified, perform the applicable reproduce or record alignment procedure.
14. Set tape timer to zero and continue to record 1.0-kHz signal for five seconds.
15. Switch oscillator frequency to 100 Hz and note 100-Hz reproduced output level relative to 1.0-kHz output level. Continue alternating oscillator input frequency between 1.0 kHz and 100 Hz at five-second intervals for at least two minutes.
16. Stop recording and rewind tape to tape-timer zero.
17. Place channel being aligned in sync mode.
18. Place system in play mode.
19. Adjust SYNC GAIN control (Table 5-7) on PADNET PWA to obtain output of -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

20. Carefully adjust sel-sync equalization control R15 (Figure 5-12) during 1.0-kHz tone until 100-Hz level and 1.0-kHz level have the same value.
21. Remove system power and replace main audio PWA into electronics assembly without extender board.
22. Reapply system power, select sync mode for channel being aligned, and place system in play mode to reproduce recording made in step 15.
23. Note the relative difference between the 100-Hz signal and the 1.0-kHz signal as compared to relative difference noted in step 15. If relative error differs more than ± 0.5 dB, remove system power and make a small adjustment to R15 on main audio PWA. (Note: Turning R15 clockwise increases 1.0-kHz level relative to 100-Hz level.)
24. Repeat steps 22 and 23 as necessary to reduce error to within ± 0.5 dB.
25. Set tape timer to zero and record a 1.0-kHz signal for 15 seconds.
26. While still recording, record a slow sweep in frequency from 40 Hz to 12 kHz at 15 in/s, or 80 Hz to 15 kHz at 30 in/s.
27. Stop recording and rewind tape to tape-timer zero.
28. Select sync mode for channel being aligned.
29. Place system in play mode.
30. While reproducing the 1-kHz tone, adjust SYNC GAIN for -5 dBm at the output of the recorder/reproducer, or $+4$ dBm output of the input/output assembly.
31. While reproducing the sweep tone recorded in step 26, verify that the output is within ± 2 dB of the 1-kHz level recorded in step 25.

5-51. Erasure Depth Adjustment and Measurement. The erase current supplied to the erase

head is adjustable by means of a master erase bus potentiometer control on audio control PWA No. 5. This is the only adjustment required for the erase system. Because of the extreme erase depth of which the recorder/reproducer is capable, it is mandatory that the tape used for adjustment and depth measurement be thoroughly bulk degaussed. This will prevent any crosstalk from an unerased portion of the tape being interpreted as the erased signal level. For accurate measurement of erasure depth, a spectrum analyzer, wave analyzer, or 1/10 octave filter should be used. If these instruments are unavailable, a reasonably accurate adjustment can be made by listening to the erased signal at an elevated monitoring level. The erase performance specifications given in this procedure apply to Ampex 406, 407, or 456 tape or the exact equivalent. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-3 and 5-7.
2. Set master erase bus level control R34 on audio control PWA No. 5 (Figure 5-14) to the center of its range.
3. Place audio control PWA No. 5 on an extender board and install into electronics assembly.
4. If an input/output assembly is being used, connect a spectrum analyzer, wave analyzer, or 1/10 octave filter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).
5. If an input/output assembly is not being used, connect a spectrum analyzer, wave analyzer, or 1/10 octave filter to appropriate recorder/reproducer output connector J13 or J14, and connect an audio oscillator to appropriate input connector J13 or J14 (Figures 2-13 and Tables 2-2 and 2-3).
6. Apply power, thread a reel of bulk-degaussed tape of the same kind that was used to align the reproduce and record circuits. Place system into thread mode.

7. Set speed select switch to highest operating speed.
8. Place system in record mode (channels not under test should also be placed in record mode).
9. Set oscillator frequency to appropriate frequency as follows: 400 Hz at 30 in/s, 200 Hz at 15 in/s, or 100 Hz at 7.5 in/s. Adjust oscillator output level for +5 dBm at the output of the recorder/reproducer, or +14 dBm at the output of the input/output assembly.
10. Adjust analyzer to zero reference, or note analyzer range setting and meter reading.
11. Reset tape timer display to zero.
12. Record continuously for five minutes and rewind tape to tape timer display zero.
13. Remove oscillator and short signal input terminals (or short input with an impedance not greater than 300 ohms).
14. Again place system into record mode and adjust analyzer range setting to observe residual erase signal level.
15. Adjust R34 (Figure 5-14) slowly counter-clockwise, and note when erased signal amplitude suddenly increases. Then adjust R34 slowly clockwise until erase signal is 85 dB below unerased level established in step 9 (−80 dBm at the output of the recorder/reproducer or −71 dBm at the output of the input/output assembly). If a wave analyzer or spectrum analyzer with a resolution bandwidth less than 5 Hz is being used, continue turning R34 clockwise until a minimum amplitude erased signal is seen.
16. Without disturbing the setting of R34 established in step 15, repeat steps 8 through 14 for the other channel(s). If any channel does not measure at least 85 dB below the unerased level, repeat step 15 for that channel.
17. Connect oscilloscope to TP2 (144 kHz) on audio control PWA No. 5.

18. Note peak-to-peak amplitude of square wave signal. Voltage level at TP2 should not exceed 6 Vp-p. At that setting of R34, the residual erased signal level will normally be greater than 90 dB below unerased level set in step 9.

5-52. Input/Output Assembly Adjustment. Procedures for adjusting offset null, input and output operating level, and level meter calibration are given below. Instructions for setting the operating input and output level to +4 dBm are given, but other values may be selected by the user. Input levels can be from +30 to −5 dBm in the variable mode or +20 dBm to −1 dBm in the preset mode. Output levels can be from +12 dBm to −25 dBm in the variable mode or from +20 dBm to −1 dBm in the preset mode. (However, the interface input and output operating level to and from the ATR-100 should be set to −5 dBm regardless of the levels selected for the input/output assembly line input and line output.)

Two methods for adjusting the input and output levels are presented. Method 1 requires a jumper/clip lead and standard test equipment interconnect cables. Method 2 requires an I/O Level Set Accessory (Ampex Part No. 4020425) shown in Figure 5-15. This accessory consists of a printed circuit board that is plugged into the ATR-100 electronics assembly (on an extender board) in place of the standard audio PWA. The accessory connects the signal input and output of the input/output assembly together and provides a coaxial cable fitted with a GR plug that connects to an ac voltmeter. Each method will enable equal results but method 2 is more convenient for the user and, therefore, is the preferred method. Refer to Figures 5-16 and 5-17 and proceed as follows:

CAUTION

DO NOT REMOVE OR INSERT AN INPUT/OUTPUT MODULE OR ATR-100 PWA WITH POWER ON. TO DO SO MAY CAUSE DAMAGE TO COMPONENTS.

5-53. Offset Null Adjustments. Perform these steps on each input/output module only if repairs have been made or components have been changed on the input/output assembly that may affect circuit operation.

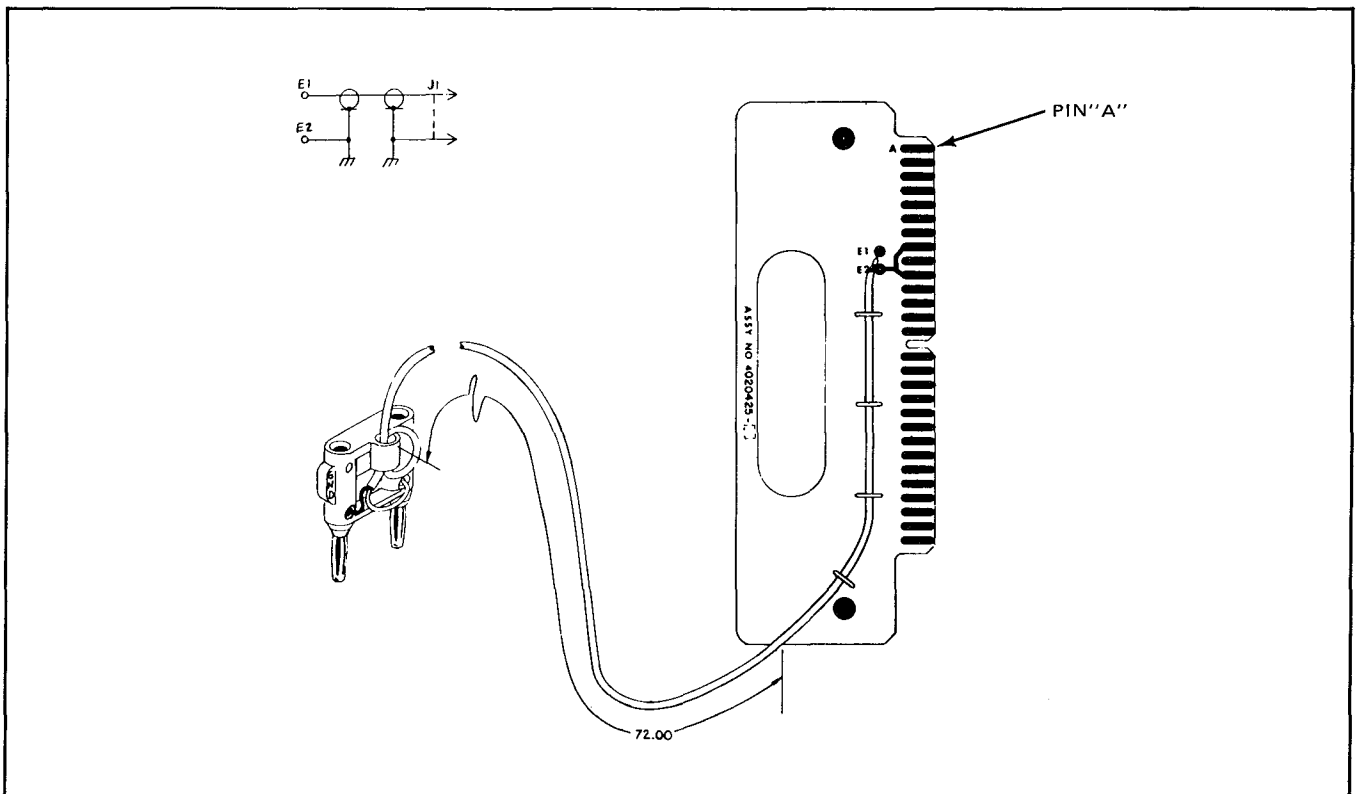


Figure 5-15. I/O Level Set Accessory

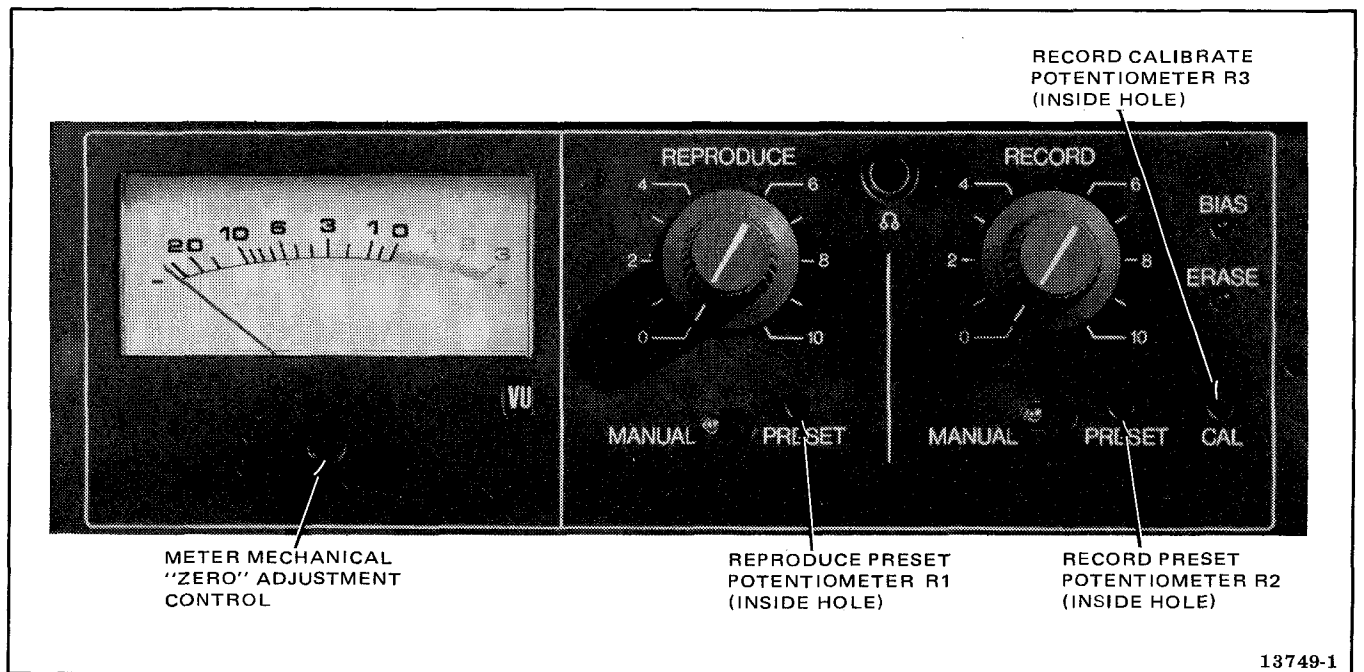


Figure 5-16. Input/Output Module Adjustment Control Locations

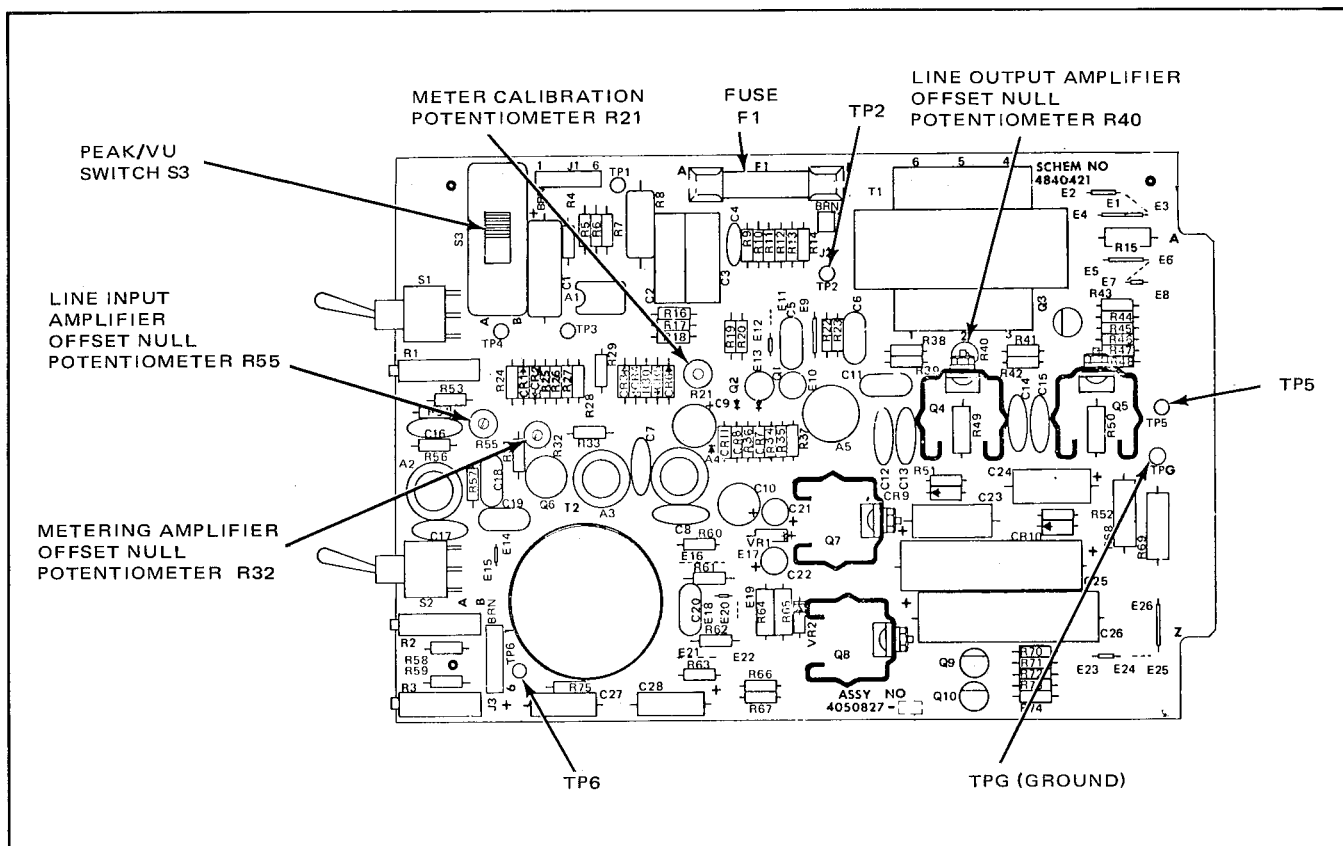


Figure 5-17. Input/Output Module Assembly

1. With power removed, adjust the meter mechanical "zero" adjustment control (Figure 5-16) for mechanical zero (meter at left-hand dial position).
2. Remove input/output module from input/output mainframe and place module on an extender board (Table 5-1). Insert extender board into mainframe.
3. Remove fuse F1 (Figure 5-17).
4. Set peak/vu switch S3 to desired operating position (peak or vu reading on vu/peak meter).
5. Disconnect signal input so that there is no signal being fed to input/output assembly.
6. Apply power and adjust metering amplifier offset null potentiometer R32 (Figure 5-17) for zero indication (same as step 1) on the level meter.
7. Connect a dc voltmeter to TP6 and ground (Figure 5-17).
8. Set RECORD MANUAL/PRESET switch to MANUAL position.
9. Adjust line input amplifier offset null potentiometer R55 for zero change in voltage at TP6 while rotating RECORD potentiometer through its range.
10. Connect dc voltmeter to TP2 and ground (Figure 5-17).
11. Adjust line output amplifier offset null potentiometer R40 (Figure 5-17) for 0 ± 30 mV at TP2. Remove dc voltmeter.
12. Remove power and reinstall fuse F1.

5-54. *Record Level Adjustment (Method 1).* Proceed as follows:

1. Connect an audio oscillator to the line input connector (Figure 2-14). Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other operating level selected by the user).
2. Connect ac voltmeter to TP6 and ground (Figure 5-17).
3. Set RECORD MANUAL/PRESET switch to PRESET position.
4. Adjust record preset potentiometer R2 (Figure 5-16) for -5-dBm level at TP6.
5. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms, or place switch (Figure 2-14) in the terminate position.
6. Select input monitoring for channel being aligned.
7. Adjust record calibrate potentiometer R3 (Figure 5-16) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).
8. Remove power and set peak/vu meter switch S3 (Figure 5-17) to desired operating position, peak or vu. Reapply power.
9. Select input monitoring for channel being aligned.
10. Adjust meter calibration potentiometer R21 (Figure 5-17) for indication of -6 dB (meter switch S3 in peak position) or 0 vu (meter switch S3 in vu position).

5-55. *Reproduce Level Adjustment (Method 1).* Proceed as follows:

1. Remove power and remove all audio PWAs from the recorder/reproducer electronics assembly.
2. Connect a jumper from TP5 to TP6 (Figure 5-17).

3. Connect an audio oscillator to the line input connector (Figure 2-14). Set frequency to 1.0 kHz and output level to +4 dBm (or other operating level selected by the user).
4. Set REPRODUCE MANUAL/PRESET switch to PRESET position.
5. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms or place switch (Figure 2-14) in the terminate position.
6. Apply power and adjust reproduce preset potentiometer R1 (Figure 5-16) for +4-dBm level on the ac voltmeter (or other line operating level selected by the user).
7. Repeat the *Record Level Adjustment (Method 1)* and *Reproduce Level Adjustment (Method 1)* procedures for the other audio channels.
8. With power off, remove input/output module and extender board from input/output mainframe. Remove jumper connected from TP5 to TP6. Reinstall input/output module into mainframe.
9. Reinstall all audio PWAs into the recorder/reproducer electronics assembly.

5-56. *Record and Reproduce Level Adjustment (Method 2).* Proceed as follows:

1. Remove power and remove all audio PWAs from the recorder/reproducer.
2. Install recorder/reproducer extender board into electronics assembly corresponding to channel to be adjusted.
3. Install I/O level set accessory connector (Figure 5-15) into extender board with pin A in the uppermost position. Connect cable to ac voltmeter.
4. Remove input/output module from input/output mainframe and place module on an extender board (Table 5-1). Insert extender board into mainframe.

5. Connect an audio oscillator to line input connector (Figure 2-14). Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other input operating level selected by the user).
6. Set RECORD MANUAL/PRESET switch to PRESET position.
7. Apply power and adjust record preset potentiometer R2 (Figure 5-16) for -5-dBm level on the ac voltmeter connected to the I/O level set accessory.
8. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms or place switch (Figure 2-14) in the terminate position.
9. Select input monitoring for channel being aligned.
10. Adjust record calibrate potentiometer R3 (Figure 5-16) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).
11. Select repro monitoring for channel being aligned.
12. Set REPRODUCE MANUAL/PRESET switch in the PRESET position.
13. Adjust reproduce preset potentiometer R1 (Figure 5-16) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).
14. Remove power and set peak/vu meter switch S3 (Figure 5-17) to desired operation position, peak or vu. Reapply power.
15. Adjust meter calibration potentiometer R21 (Figure 5-17) for indication of -6 dB (meter switch S3 in peak position) or 0 vu (meter switch S3 in vu position).
16. Repeat procedure for the other audio channels.
17. With power off, remove input/output module and extender board from input/output

mainframe. Reinstall input/output module into mainframe.

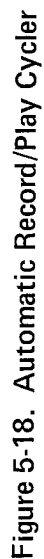
18. Remove extender board from electronics assembly and reinstall audio PWAs removed in step 1.

5-57. PURC Timing Alignment. The recorder/reproducer is capable of operating with or without PURC operation on each channel, as desired, by placement of a jumper located on each PADNET PWA. See Installation section of the manual (paragraph 2-30) for jumpering information. (Note: recorder/reproducers shipped from the factory are set for normal, non-PURC, operation.)

The only adjustment required for PURC alignment is the adjustment of PURC timing to normalize the delay timing to establish correct operation for all speeds. Once the adjustment control has been set for one speed, timing is automatically set when the other speed is selected.

To aid in the alignment of the PURC timing, an optional automatic record/play cycler may be used to cycle the recorder/reproducer for insert-edit operation (paragraph 3-19) while the PURC timing adjustment is being made. (The cycler is constructed by the user. See Figure 5-18 for cycler schematic diagram and parts list.) The PURC alignment procedure should only be performed if the record, reproduce, and erase alignment is known to be correct. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. Connect an audio oscillator to audio input connector corresponding to first channel to be aligned.
3. Set oscillator frequency to 1.0 kHz.
4. Connect scope to audio output connector corresponding to first channel to be aligned.
5. Adjust scope time base for 1.0-second horizontal sweep.



6. Apply power and thread a reel of tape on transport and place system into thread mode.
7. Place all channels into record mode at the speed most commonly used.
8. Adjust oscillator output level for system operating level; -5 dBm at the output of the recorder/reproducer, or $+4$ dBm at the output of the input/output assembly.
9. Set tape timer display to zero and record continuously for five minutes.
10. Rewind tape to tape-timer zero.
11. Remove power and place audio PWA of channel to be aligned on an extender board and reinstall into electronics assembly.
12. If automatic cycler is being used, connect cycler to external remote control connector J11 (Figure 2-13) and trigger scope from scope sync test point on cycler.
13. Change oscillator frequency to 1.5 kHz.
14. Reapply power and place system into play mode with channel being adjusted in ready mode and other channels in safe mode.
15. If cycler is being used, turn cycler power on and adjust cycle rate time control R1 on cycler to show ingoing and outgoing edges of insert on scope. Adjust PURC timing control R71 on main audio PWA (Figure 5-12) to minimize overlap on ingoing insert consistent with minimum gap on outgoing edge, as viewed on scope.
16. If cycler is not being used, perform insert edits manually. While in play mode, press and hold record pushbutton switch and then press and hold stop pushbutton switch. While still holding the record and stop pushbutton switches depressed, slowly press and release play pushbutton switch (system enters record mode when play pushbutton is depressed), and adjust R71 for condition described in step 15. Repeat pressing of play pushbutton switch, and adjust R71 as required to achieve conditions described in step 15.
17. Change transport speed to second speed and perform several insert edits (step 15 or 16). If necessary, readjust R71 for best compromise. Note: if only one speed will be used for PURC operation, then optimize operation at that speed.
18. Repeat steps 2 through 16 for other channel(s) selected for PURC operation.
19. Remove power and remove extender board from electronics assembly. Reinstall audio PWA into electronics assembly.
20. If automatic cycler was used, disconnect cycler from J11.
21. Disconnect audio oscillator from audio input connector.

5-58. Tape Transport Adjustments

5-59. Capstan Tach Sensor. Use the following procedures to check the operation of the capstan tach sensor PWA (Figure 5-19) and capstan tach LED PWA (Figure 5-47) and, if required, adjust the position of the capstan tach sensor PWA (steps 13 through 29). Normally an adjustment is required if the capstan motor "runs away" or if the capstan tach sensor PWA or capstan tach LED PWA is replaced. Proceed as follows:

1. Remove tape from recorder/reproducer.
2. Remove power and unplug reel servo PWA No. 9 within the electronics assembly (disables reel servo so that reel motors do not operate).
3. Place capstan servo PWA No. 8 on an extender board and install into electronics assembly.
4. Connect a dual trace scope to TP5 and TP6. Adjust scope for chop mode and trigger scope from either one of the two signals.
5. Apply power and press play pushbutton switch. Amplitude of sine wave signals on scope should be approximately 15 Vp-p. Note: The signal at TP6 will appear distorted because of hysteresis (distortion near the zero crossings).

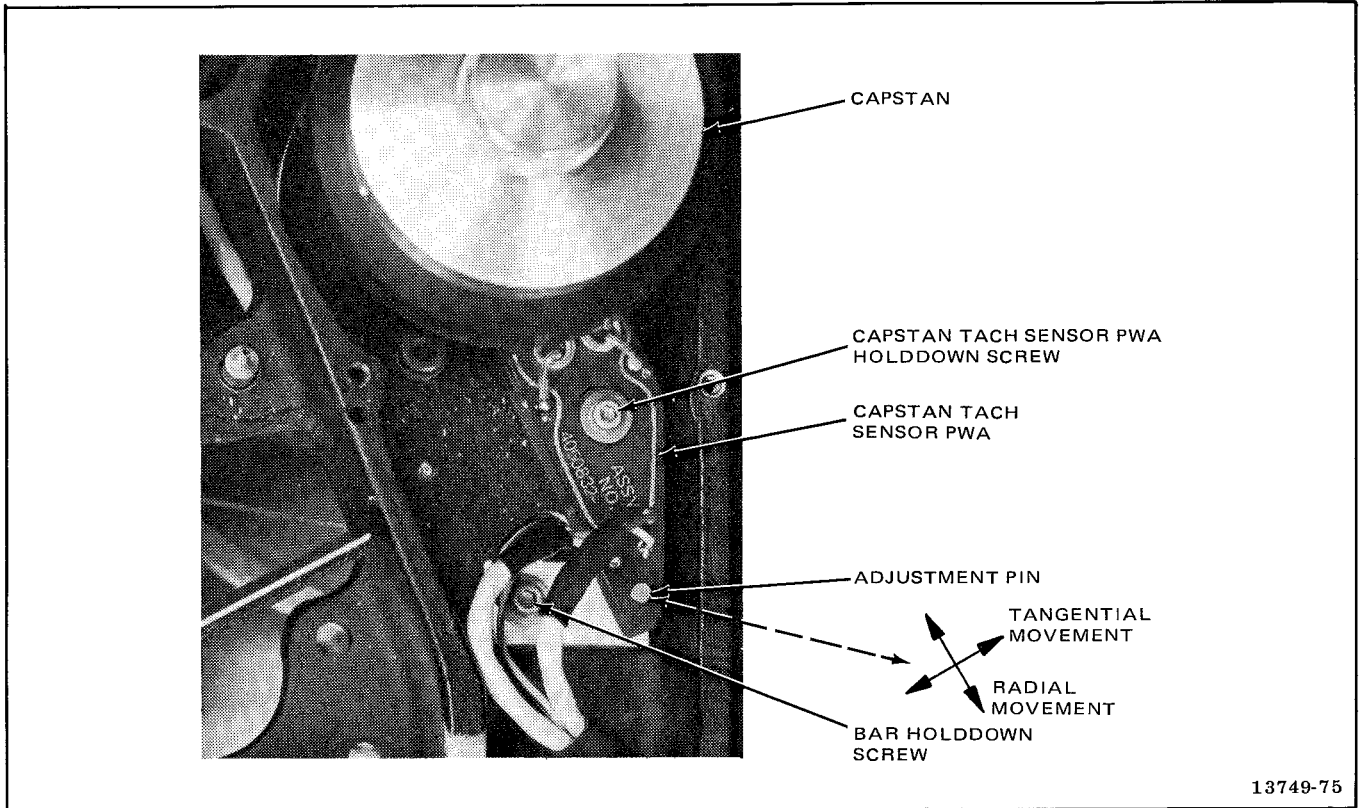


Figure 5-19. Capstan Tach Sensor Adjustment

6. Connect scope to TP3 and TP4. Adjust scope for chop mode and trigger scope from either one of the two signals.
7. The two signals should be 90° out of phase (Figure 5-20A or Figure 5-20B).
8. Check for the correct 90° phase relationship by pressing the stop pushbutton switch, and observe that the capstan quickly stops.
9. Press fast forward pushbutton and observe that the phase relationship of signals at TP3 and TP4 remain fairly constant as the capstan accelerates to full speed.

NOTE

If scope chop rate is too slow to observe the phase relationship, switch scope to algebraically add mode to observe the waveform (Figure 5-20D). The waveform

shelves and spaces should be stable and not disappear or close.

10. Press stop pushbutton and observe that capstan quickly stops.
11. Repeat steps 9 and 10 in rewind mode.
12. If the preceding measurements of amplitude and phase were correct, but the capstan ran faster when the stop pushbutton was pressed, the capstan servo PWA No. 8 may have a malfunction or the capstan tach sensor PWA position may need to be adjusted to obtain the opposite 90° phase relationship of the signals at TP3 and TP4 (see Figure 5-20 and steps 13 through 29). If any of the previous conditions were not met, proceed to adjust the position of the capstan tach sensor PWA to obtain tach signals of proper amplitude and phase relationship by performing steps 13 through 29.

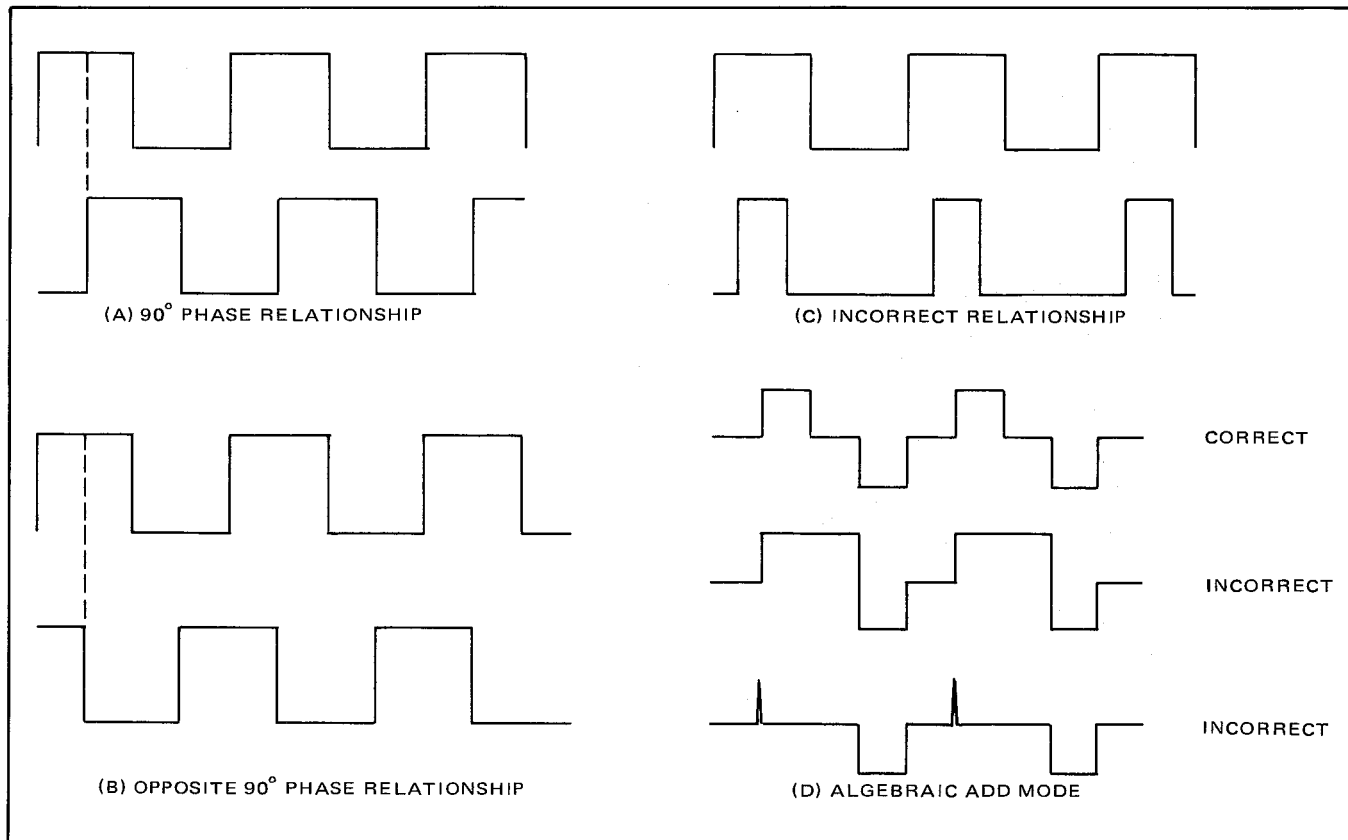


Figure 5-20. TP3 and TP4 Waveforms, PWA No. 8

13. Remove the head cover assembly and head assembly from the top of the transport.
14. Remove the transport front overlay panel from the top of the transport by removing two screws (Figure 5-22).
15. Remove front tach cover panel by removing one flat-head screw and banana plug shown in Figure 5-21.
16. Connect dual trace scope to TP5 and TP6. Adjust scope for chop mode and trigger scope from either one of the two signals.
17. Loosen the two holddown screws shown in Figure 5-19, but so there is still some tension against the lock washers.

CAUTION

FOR THE ADJUSTMENT THAT FOLLOWS
AND WHILE THE TWO SCREWS ARE

LOOSE (STEP 17), DO NOT PERMIT PWA TO CONTACT THE ROTATING CAPSTAN TACHOMETER AS DAMAGE TO THE TACHOMETER COULD OCCUR.

18. Carefully move adjustment pin (Figure 5-19) tangentially (left and right) and radially (in and out) to the capstan to obtain maximum output at TP5 and TP6.
19. Adjust potentiometers R32 and R50, on capstan servo PWA No. 8, to obtain a 15-Vp-p signal (approximately) at TP5 and TP6 respectively.
20. Connect scope to TP3 and TP4. Use chop mode and trigger scope from either one of these two signals.
21. Carefully move adjustment pin a very small amount radially (only) from the capstan to

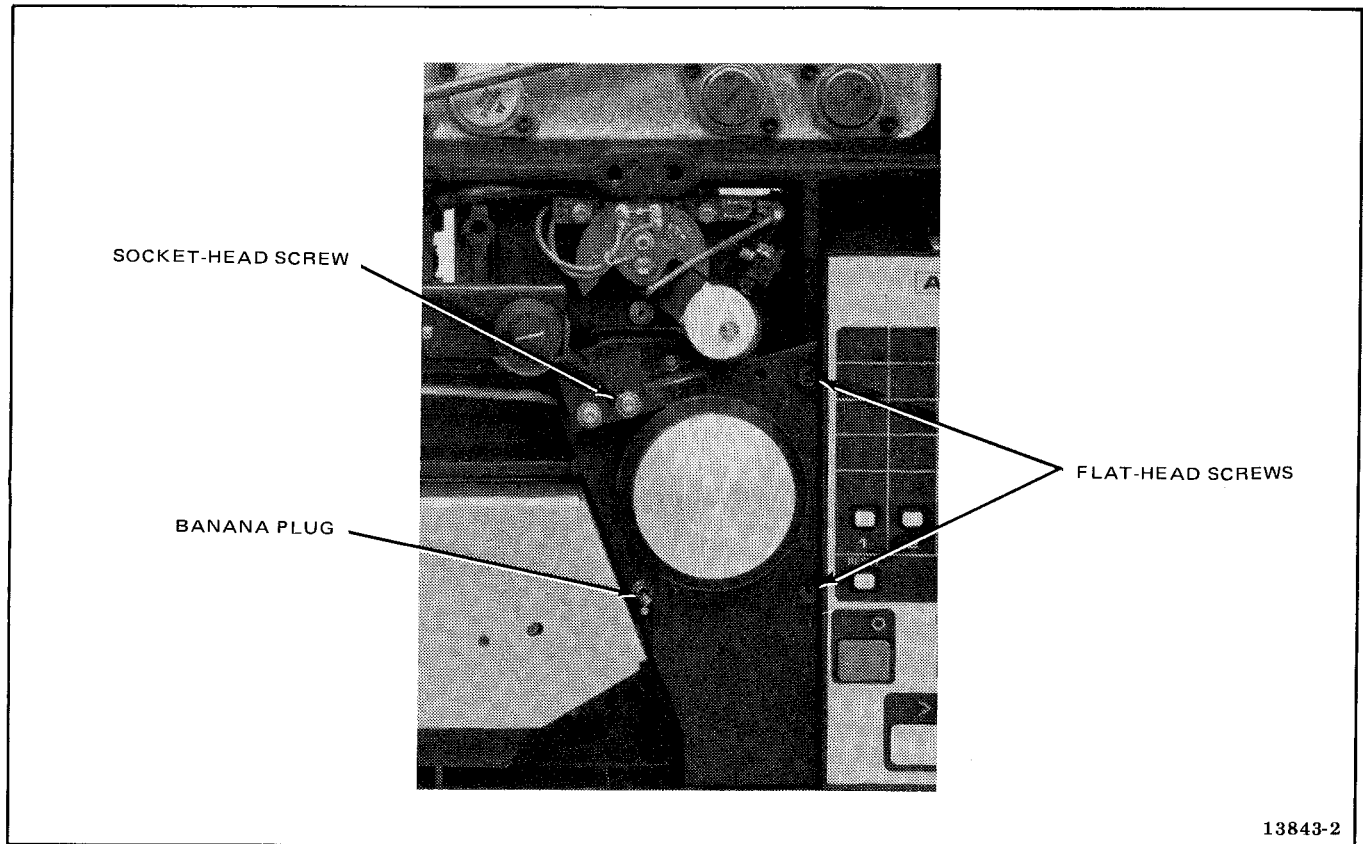


Figure 5-21. Front and Rear Tach, Cover Panel Removal

obtain a 90° phase difference between the two signals (Figure 5-20A or 5-20B).

22. Check for the correct 90° phase relationship by pressing the stop pushbutton switch and observing if the capstan quickly stops. If capstan quickly stopped, proceed to step 24; otherwise perform step 23.
23. If capstan ran faster when stop pushbutton was pressed, press rewind pushbutton to stop capstan and then press play pushbutton. Re-adjust adjustment pin radially (only) for a 90° phase relationship opposite to that previously observed in step 21.

NOTE

Capstan may have to be held by hand to prevent runaway at high speed before proper phase is found. If desired, capstan

motor connector P18 (Figure 5-26) may be temporarily disconnected and capstan rotated by hand until the proper phase relationship is found.

24. After correct phase is established, first tighten the bar holddown screw, and then tighten the capstan tach sensor PWA holddown screw (Figure 5-19).
25. Connect scope to TP5 and TP6. Use chop mode and trigger scope from either one of the two signals.
26. Verify that the level set while performing step 19 has not changed. If level has changed, repeat step 19.
27. Further confirm the correct 90° phase relationship by performing steps 6, 9, 10 and 11.

28. Remove power and reinstall reel servo PWA No. 8, capstan servo PWA No. 9, tach cover panel, transport front overlay panel, head assembly, and head cover assembly.
29. Reconnect capstan motor connector P18 (if disconnected).

5-60. Tension Arm Limits. During recorder/reproducer operation, if a condition exists where either tension arm moves too far in toward the head assembly or too far out toward the reels, the recorder should enter stop/edit (unthread) mode. The supply and takeup potentiometers sense the arm position and cause the recorder to enter stop/edit mode just before the arm reaches its mechanical stop. If the recorder/reproducer fails to meet the tests that follow, adjust the position of the associated LED PWA. The enlarged mounting hole of the LED PWA permits movement of the LED PWA on the tension arm. Proceed as follows:

1. With power off, place reel servo PWA No. 9 on an extender board and reinstall into electronics assembly.
2. Connect a scope probe or dc voltmeter to outer limit test point TP5 of reel servo PWA.
3. With no tape on transport, apply power and hold both tension arms in mid position of travel. Indication should be high (+5 Vdc).
4. Hold both arms in mid position, and then release supply arm. Indication should go low (0 Vdc).
5. Hold both arms in mid position, and then release takeup arm. Indication should go low (0 Vdc).
6. Connect scope probe or dc voltmeter to inner limit test point TP6.
7. With both arms resting in the outer position, indication should be high (+5.0 Vdc).
8. Move supply arm in toward head. Indication should be low (0 Vdc).

9. With supply arm resting in outer position, move takeup arm in toward head. Indication should be low (0 Vdc).
10. If any of the preceding conditions were not met, proceed as follows:
 - a. Remove head cover assembly and transport rear overlay panel (Figure 5-22).

CAUTION

REMOVE POWER BEFORE ADJUSTING THE POSITION OF AN LED PWA. ALSO DO NOT ALLOW METAL LUG UNDER AN LED HOLDDOWN SCREW TO SHORT AGAINST CIRCUIT TRACES ON THE PWA.

- b. Loosen the appropriate LED PWA hold-down screw (Figure 5-23) and rotate the PWA relative to the tension arm. Tighten screw.
 - c. Place overlay panel loosely in place to prevent ambient light affecting photopotentiometer operation.
 - d. Repeat steps 2 through 10c, as necessary.
 - e. Reinstall rear overlay panel and head cover assembly removed in step 10a. Verify that rear overlay panel does not interfere with the free rotation of the tension arms.
11. If any adjustments were made to the position of the LED PWAs, perform the *Tape Tension* adjustment procedure, paragraph 5-61.

5-61. Tape Tension. Adjust tape tension if tape should creep in either direction in stop mode or after changing or adjusting any component associated with the reel servo system. Proceed as follows:

1. Remove head cover assembly, and transport front overlay panel (Figure 5-22).
2. With power off, place reel servo PWA No. 9 (Figure 5-24) on an extender board.
3. Thread tape on recorder/reproducer and advance tape so there is equal tape pack on both reels.

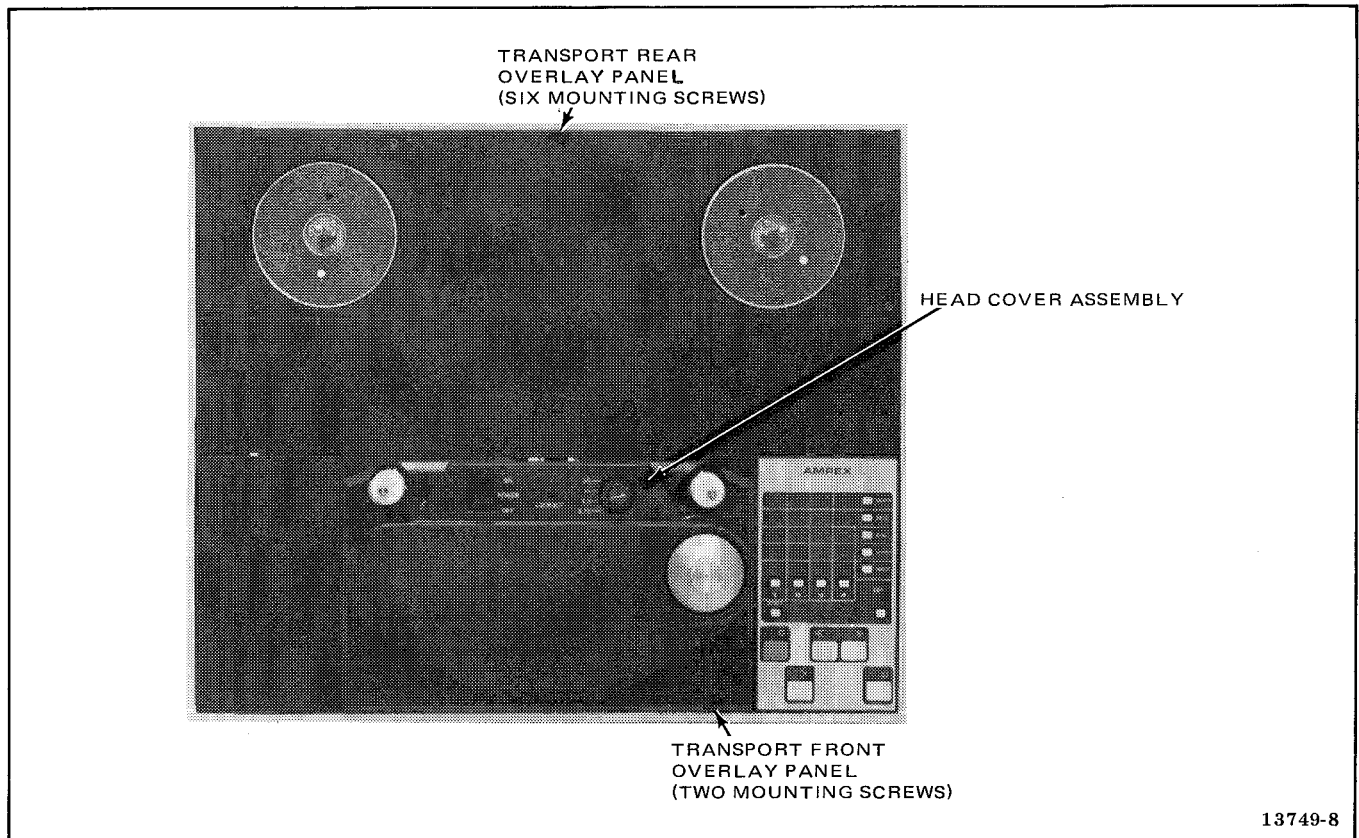


Figure 5-22. Head Cover and Overlay Panels

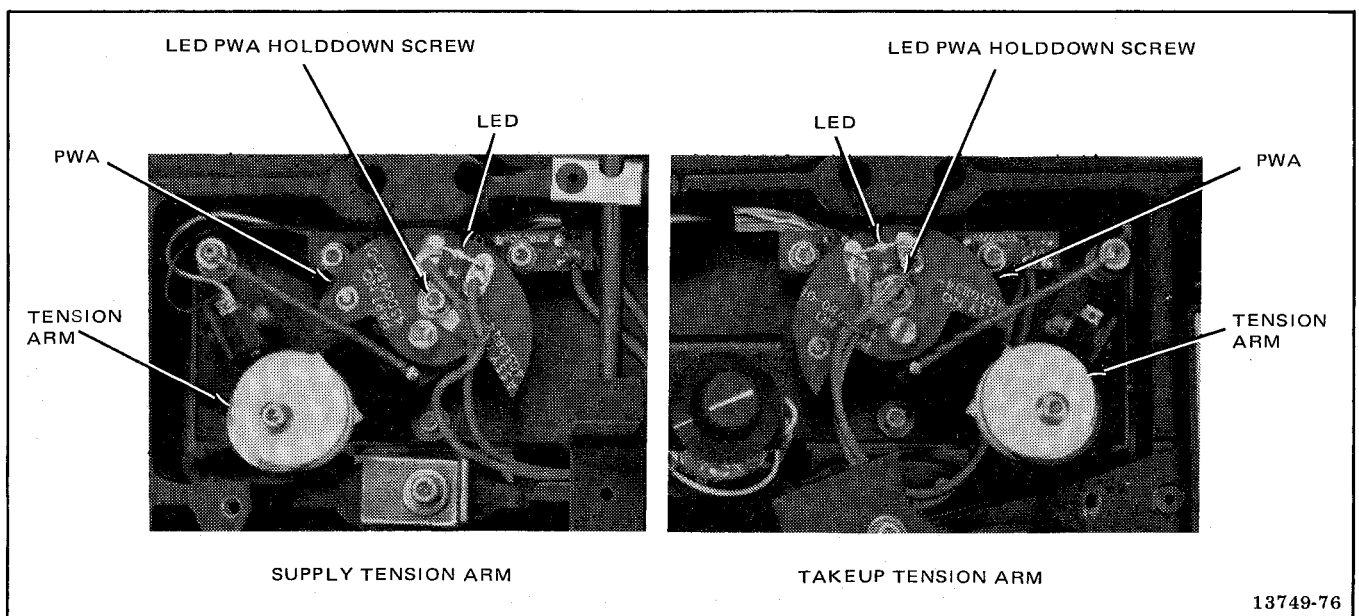


Figure 5-23. Tension Arm Limits Adjustment

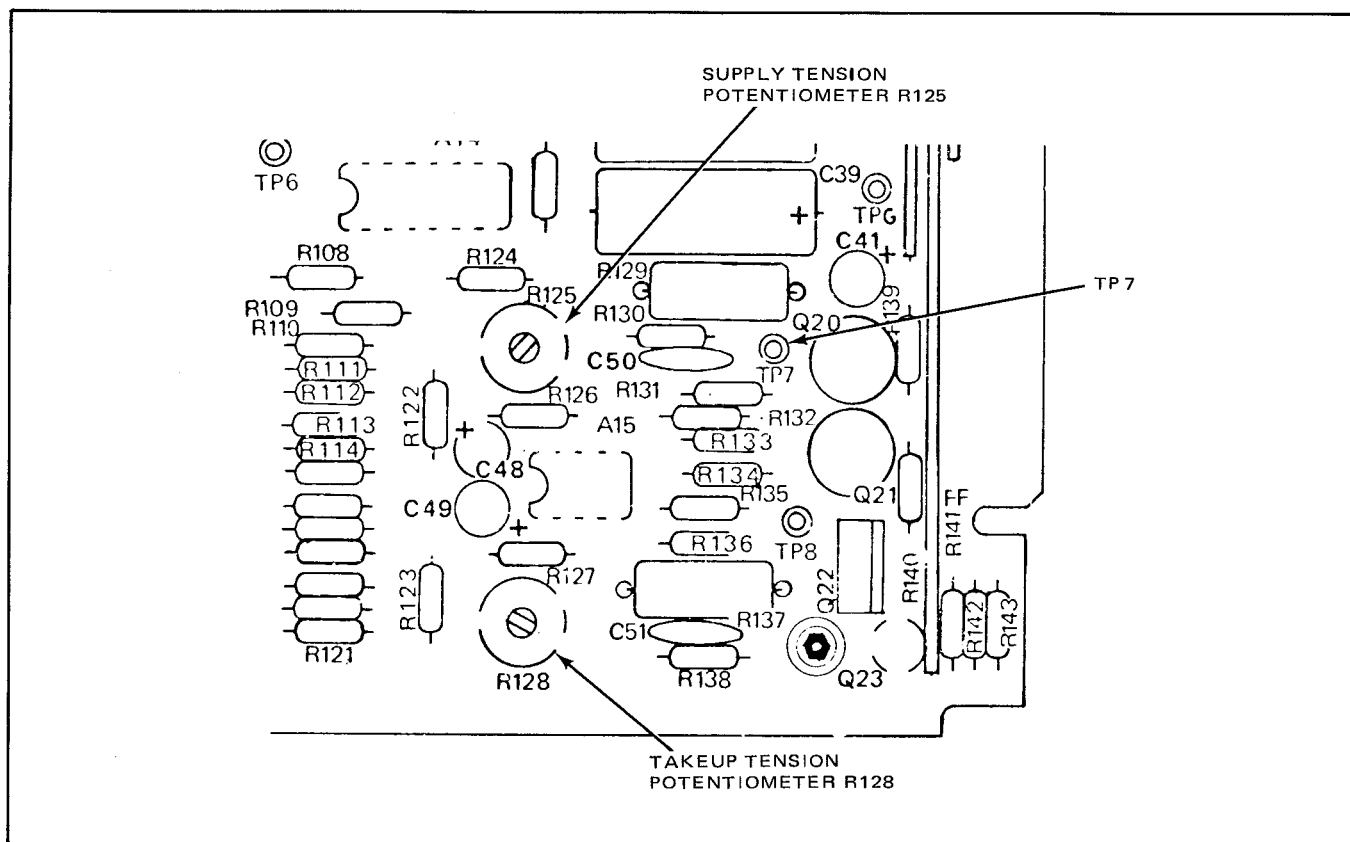
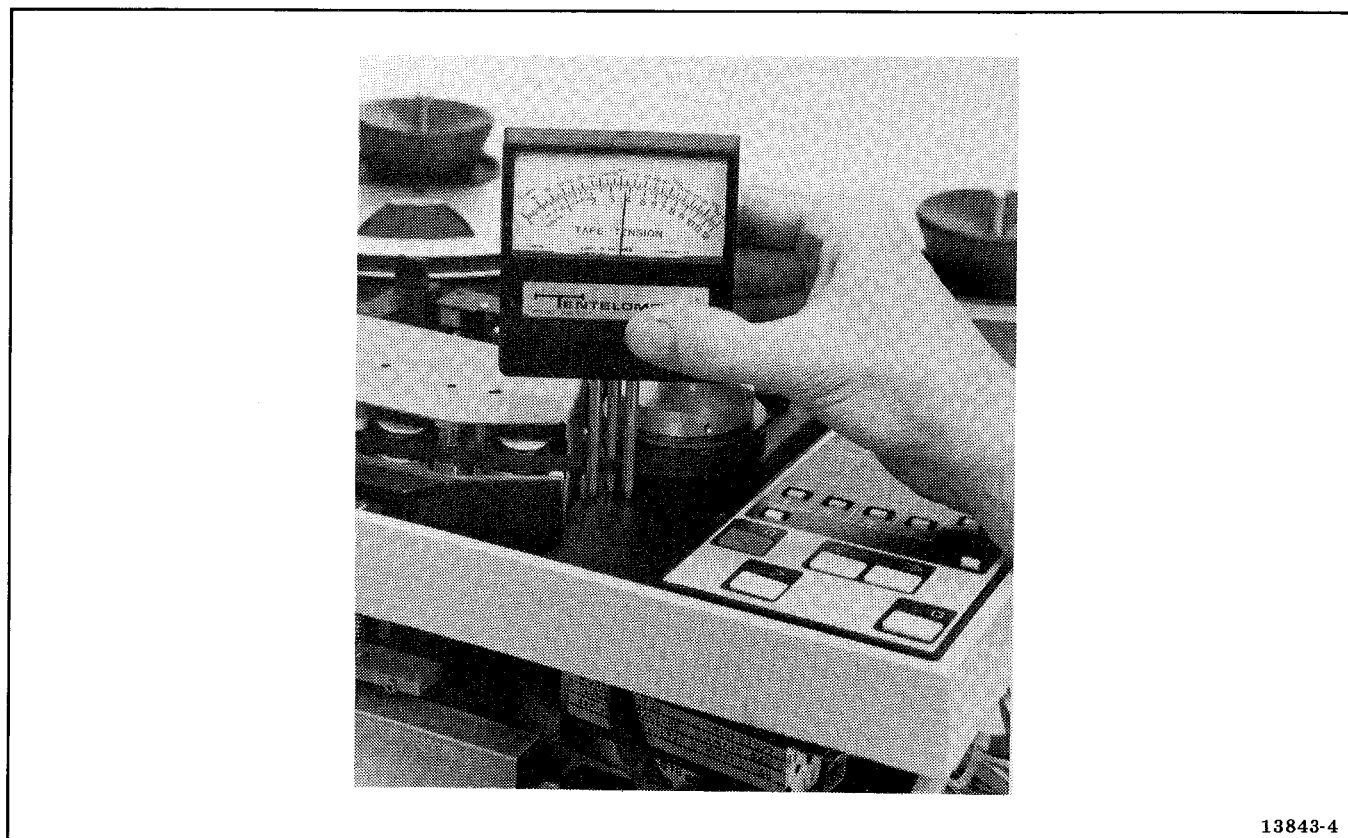


Figure 5-24. Tape Tension Adjustment Controls, PWA No. 9

4. With tape speed set to 7.5, 15, or 30 in/s, place recorder/reproducer into play mode.
5. Place Tentelometer tension sensor arms to straddle tape at the supply side of the capstan (between capstan and head assembly) as shown in Figure 5-25. (If Tentelometer is not available, connect dc voltmeter to TP7 on PWA No. 9.)
6. Observe tape tension on Tentelometer gauge. Tension should be 3.75 ounces (330 mV) for 1/4-inch tape, or 7.5 ounces (440 mV) for 1/2-inch tape.
7. If tension is not as specified, adjust supply tension potentiometer R125 for 3.75 ounces (330 mV) for 1/4-inch tape, or 7.5 ounces (440 mV) for 1/2-inch tape. Press stop pushbutton switch.
8. Press play pushbutton and then press EDIT pushbutton to enter play/edit mode. Then press stop pushbutton. Capstan should stop and remain stopped with no tendency to turn in either direction. If capstan creeps in either direction, slightly readjust supply tension potentiometer R125.
9. Press EDIT pushbutton to cancel play/edit mode. Rethread tape and place system into thread mode. Manually spin capstan edit knob in one direction and then the other direction with equal force. Tape should coast approximately an equal amount in each direction before coming to a stop. If tape does not coast an equal amount, adjust takeup tension potentiometer R128 as required.

5-62. Tape Lifters. Use these instructions to adjust the tape lifter solenoid and the position of the tape lifter arms.



13843-4

Figure 5-25. Measuring Tape Tension

5-63. Tape Lifter Solenoid. When the tape lifter solenoid is energized or de-energized, trapped air between the plunger and solenoid housing is permitted to leak out slowly to provide slow and smooth tape-lifter action. Unless the tape lifter arms and cable linkage have been disassembled, the only adjustment that may be required is the solenoid air leak control. Proceed as follows:

1. Disconnect capstan motor connector P18 (Figure 5-26).
2. Thread tape on transport and place recorder/reproducer into fast forward mode (tape will not move as capstan motor is disconnected).

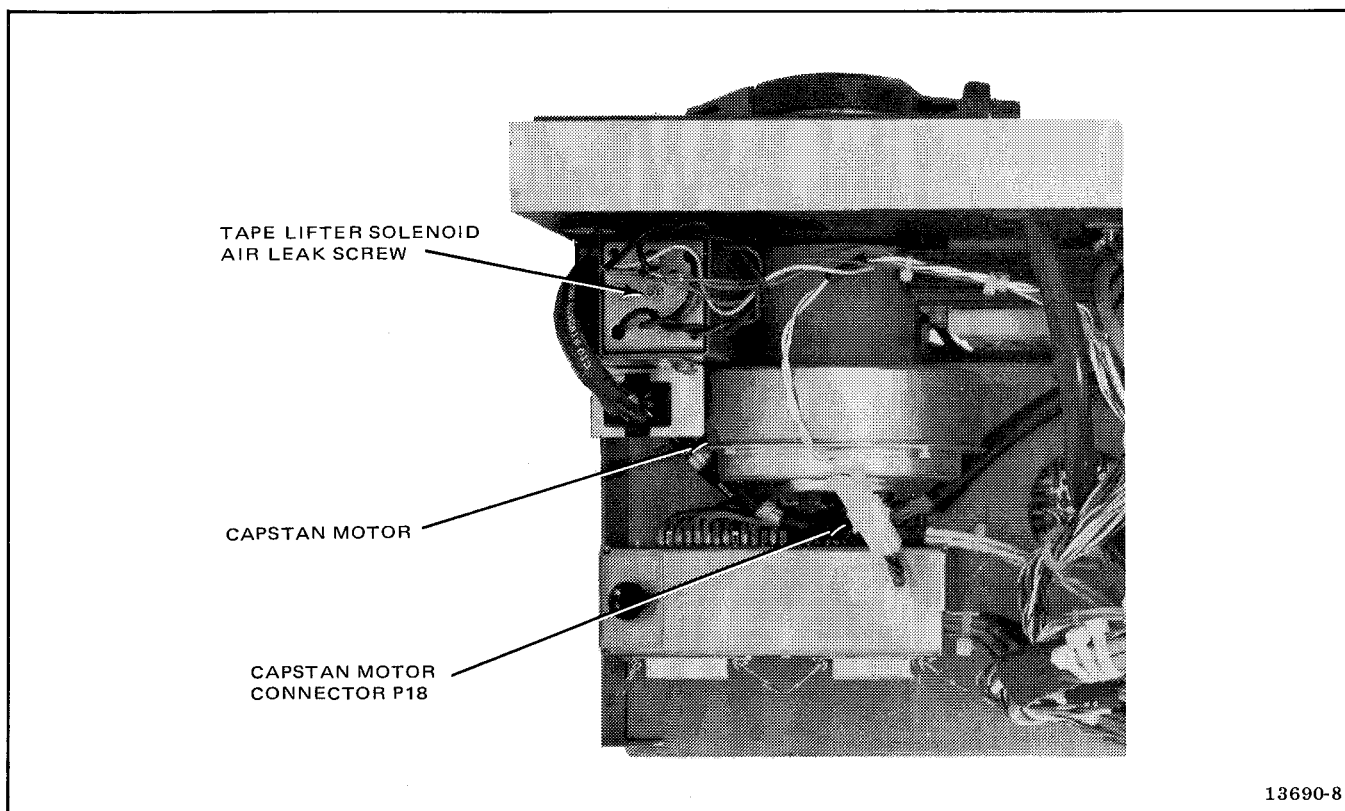
CAUTION

WHILE PERFORMING THE NEXT STEP, BE CAREFUL NOT TO SHORT THE SOLENOID POWER TERMINALS.

3. Adjust the tape lifter solenoid air-leak screw (Figure 5-26) for fast, smooth tape-lifter action when EDIT pushbutton is alternately pressed and released. The solenoid should take approximately 0.5 second to lift or retract tape. (Note: The air-leak screw has a thread-locking device and is held in place by friction.)

4. Reconnect capstan motor connector P18.

5-64. Tape Lifter Arms. The tape lifter arms must retract clear of the tape surface in stop and play/record modes (solenoid de-energized). The tape lifters can be adjusted to permit information on the tape to be monitored by the reproduce or record head (sel-sync mode) while in fast forward, rewind, or spool modes. (Note: The tape does not actually contact the heads in fast modes when the tape lifters are properly adjusted.)



13690-8

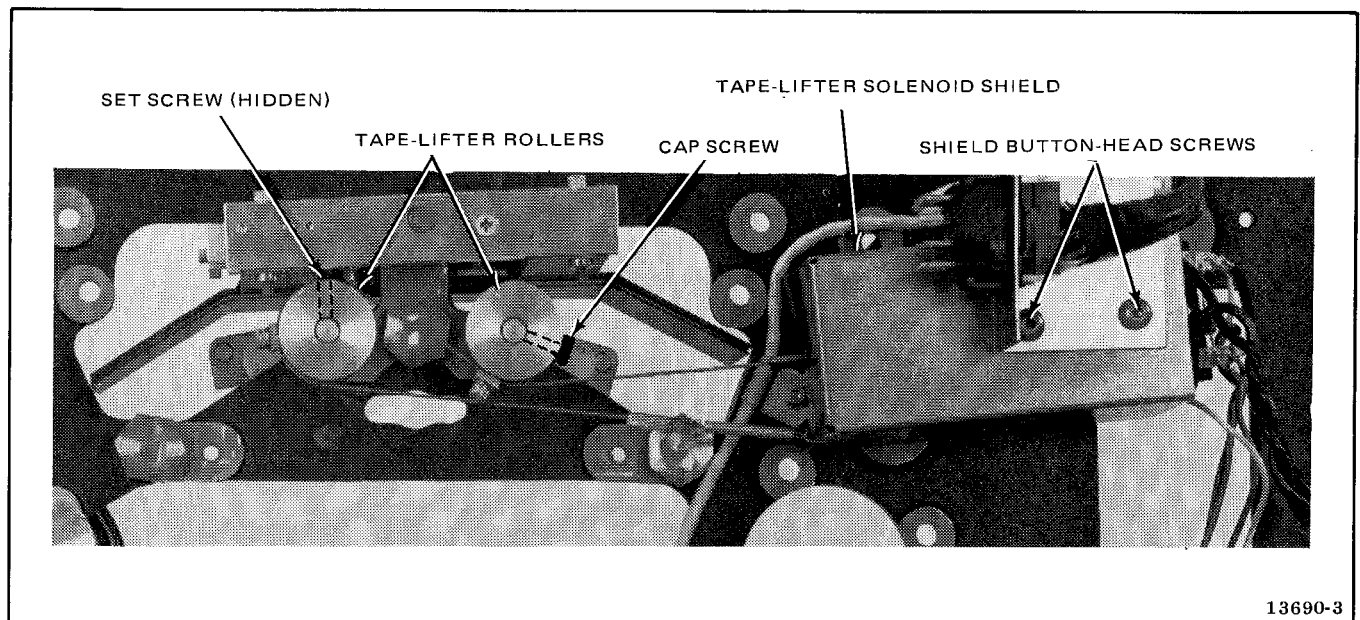
Figure 5-26. Tape Lifter Solenoid Adjustment Screw, Right Side of Tape Transport

If one or both tape-lifter arms contact the tape when solenoid is de-energized, perform steps 1, 2 and 3. If tape monitoring in fast forward, rewind, and spool modes is unsatisfactory, perform steps 4 through 10. Proceed as follows:

NOTE

For the following steps, tape lifters are to be set such that while in fast forward, rewind, and spool modes, tape does not actually contact the heads or contact the scrape flutter idler, causing it to rotate. Also tape lifters must not lift tape so far from heads so as to lose contact with the upper and lower tape-edge ceramic guides shown in Figure 1-3.

1. With power off, thread tape onto transport.
2. Loosen two button-head screws (Figure 5-27) that hold the tape-lifter solenoid shield to the solenoid.
3. Slide the shield towards the head assembly to retract both lifter arms further from the tape, or slide the shield away from the head assembly to advance the arms toward the tape. While maintaining tape tension, adjust the shield position so that there is approximately 1/32-inch clearance between the arms and tape. Tighten the shield button-head screws and recheck clearance.
4. Thread a prerecorded tape on to the transport, select play mode, and adjust signal levels for normal play mode operation. Press stop pushbutton.
5. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-27) nearest the tape-lifter solenoid. Then lightly tighten the screw to provide limited holding power against the tape lifter shaft.



13690-3

Figure 5-27. Tape Lifter Rollers and Solenoid, Rear View of Transport

CAUTION

IN THE FOLLOWING STEP, DO NOT OVERTIGHTEN ROLLER SCREWS, AS DAMAGE TO THREADS MAY OCCUR.

6. Place system into spool mode.
7. Turn lifter shaft nearest the reproduce head, with respect to the roller, to obtain the desired audio level for monitoring purposes.
8. Before tightening cap screw, use a paper shim (about the thickness of this manual page) to establish clearance and prevent binding between the roller and the lifter bushing that is attached to the transport casting. Tighten cap screw while holding roller against paper shim.
9. Select stop mode.
10. Loosen the 6-32 setscrew in the roller (Figure 5-27) furthest away from the tape-lifter solenoid. Then lightly tighten the screw to provide limited holding power against the tape lifter shaft.
11. Place system into sel-sync mode, and transport into spool mode.
12. Turn lifter shaft nearest erase head, with respect to the roller, to obtain an audio level comparable to that set for the reproduce head in step 7.
13. Before tightening setscrew, use a paper shim (about the thickness of this manual page) to establish clearance and prevent binding between the roller and the lifter bushing that is attached to the transport casting. Tighten setscrew while holding roller against paper shim.
14. Check results while operating in spool mode and switching between repro and sync monitoring modes. Readjust lifter shaft positions if necessary.
15. While in spool mode, visually inspect tape path to check that tape does not touch any head stack or the scrape flutter idler(s), and is within the ceramic tape guides.

5-65. Head Gate. The movable head gate (Figure 5-28) shields the head assembly from electromagnetic interface pickup when the recorder/reproducer is in operation. The head gate does not normally need adjustment but, if required, perform the applicable adjustment procedure.

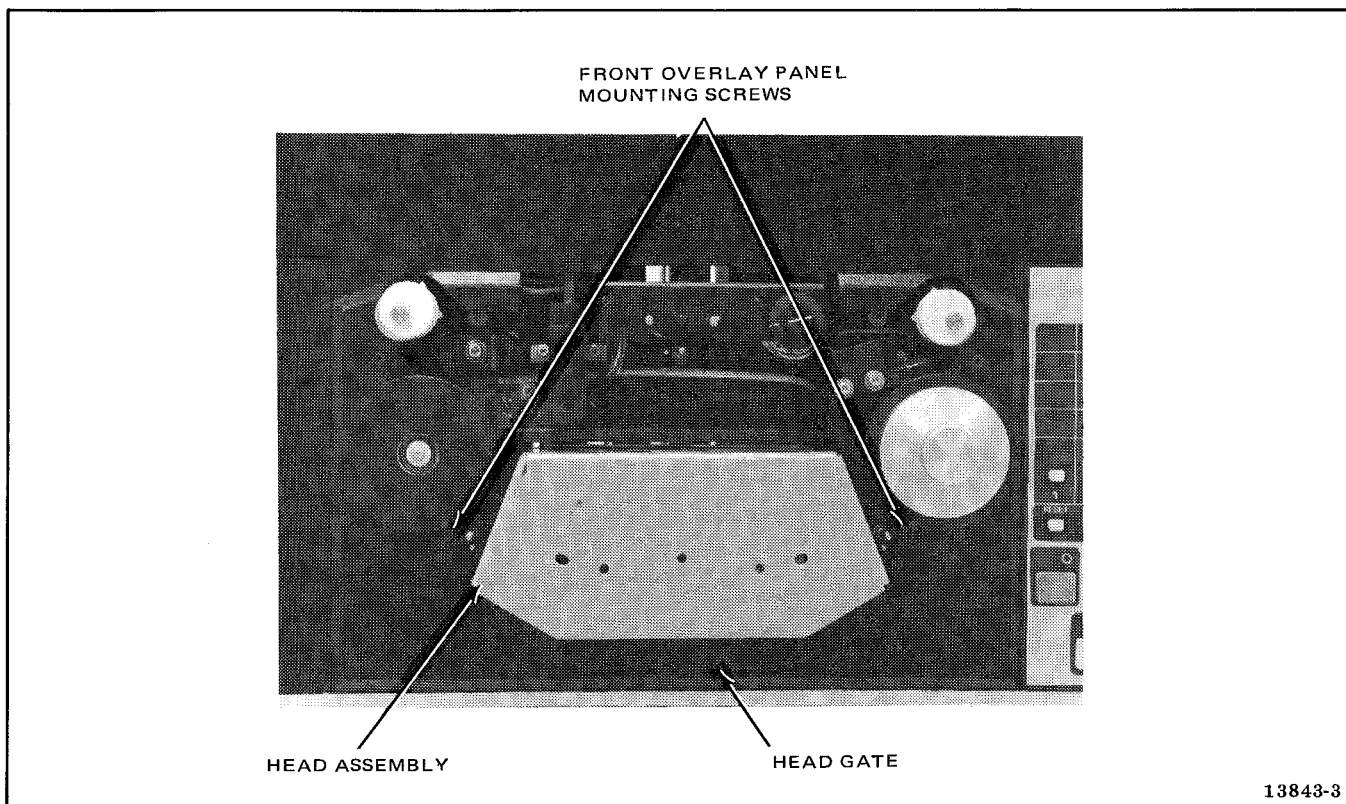


Figure 5-28. Top View of Transport, Head Cover Removed

NOTE

All head gate adjustments are made with power off.

5-66. Head Gate Height in Latched Position. When pressed down, the gate should latch in a position low enough to permit easy removal of tape from the head assembly without catching on the head gate shield. However, the gate must not be too low to prevent the head gate catch (Figure 5-29) from being unlatched. To set head gate height in latched position, proceed as follows:

1. Remove head cover assembly and front overlay panel (Figure 5-22).
2. With tape threaded on transport and head gate in latched (down) position, check that tape can easily be removed from head assembly without catching on head gate shield. If necessary, adjust head-gate height adjustment

setscrew (Figure 5-29) [Turning setscrew counterclockwise one turn raises head gate latched position 0.03 inch (0.76 mm).]

3. After head gate height is adjusted, check gate operation as follows:
 - a. Reinstall front overlay panel.
 - b. Press head gate down to latched (down) position.
 - c. Press head gate down again to verify that head gate catch unlatches allowing head gate to rise. If catch does not unlatch, height may be set too low. Remove front overlay panel and repeat steps 2 and 3 as necessary. If height appears correct but latch does not operate properly, check head gate catch operation (paragraph 5-68).
4. Reinstall front overlay panel and head cover assembly.

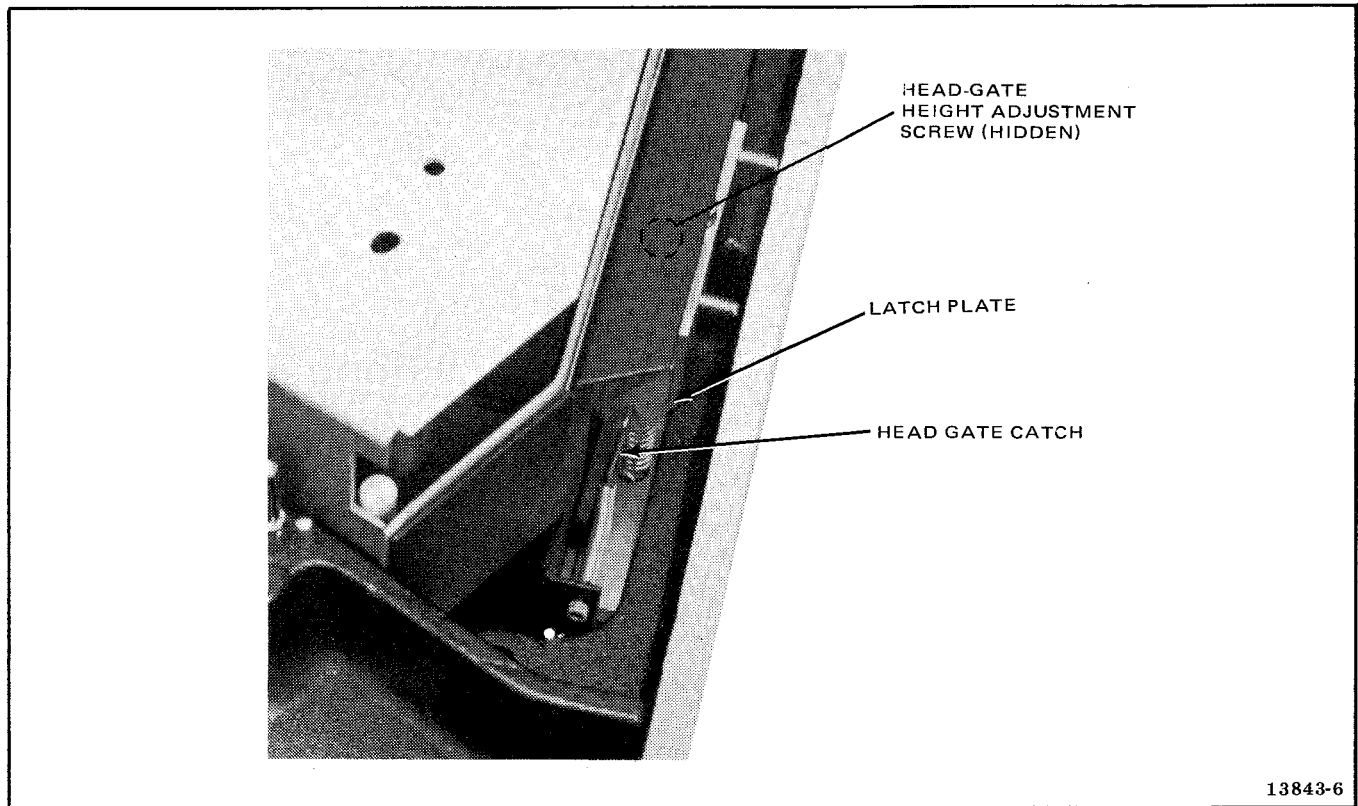


Figure 5-29. Head Gate in Latched (Down) Position

5-67. Head Gate Shield Alignment with Head Assembly Shield. When the head gate is in the unlatched (up) position, the shield of the head gate must close against the shield of the head assembly, especially in the area of the record and reproduce head. Proceed as follows:

1. Place head gate in the unlatched (up) position, and observe head gate shield alignment with head assembly shield.
2. If required, loosen shield-securing screw shown in Figure 5-30 and slightly raise or lower right-hand side of shield (as viewed from the front of recorder/reproducer) to align head gate shield with head shield. Tighten screw.

5-68. Head Gate Catch. The head gate latch is a push-to-set and push-to-release type of latch. The free end of the wire catch must rest in the proper location for the latch to function properly. When

the head gate is in the unlatched (up) position, the free end of the wire catch must nearly contact the face of the latch plate at the location shown in Figure 5-31. Align the wire head gate catch as follows:

1. Remove head cover assembly and front overlay panel.
2. With the aid of a long-nose pliers, slightly bend screw through spring at location shown in Figure 5-31, left or right, as required, so that wire catch rests at location shown (Figure 5-31) when gate is in the unlatched (up) position.
3. Check previous adjustment by operating head gate to the latched (down) and unlatched (up) position. Repeat step 2 as necessary.
4. Reinstall front overlay panel and head cover assembly.

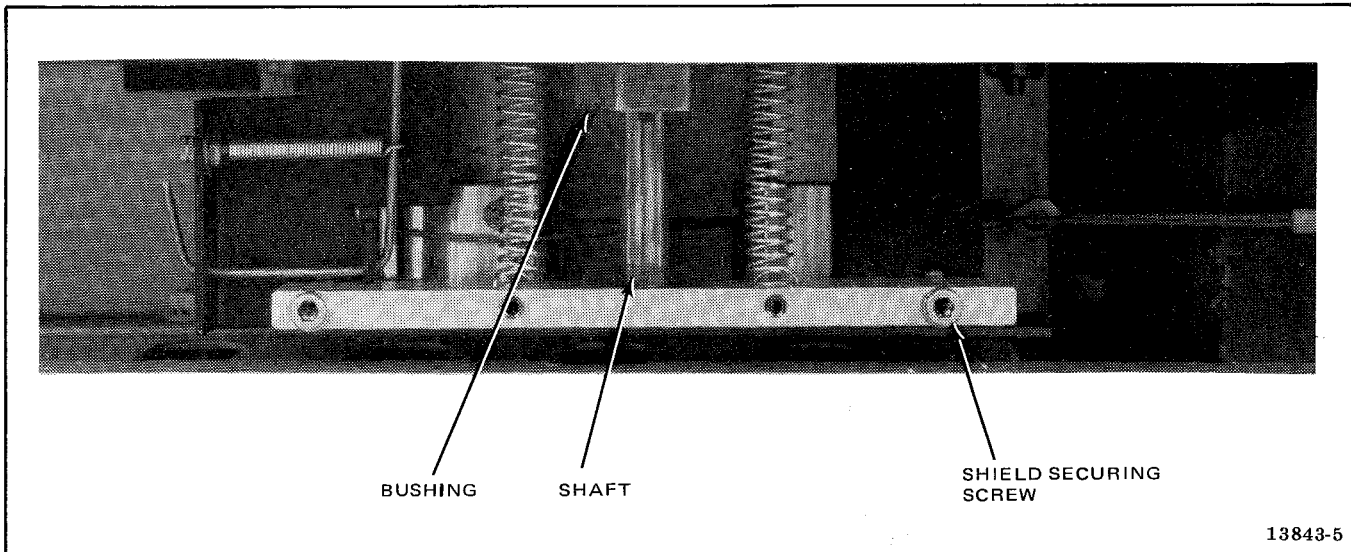


Figure 5-30. Head Gate in Latched (Down) Position, Front View of Transport

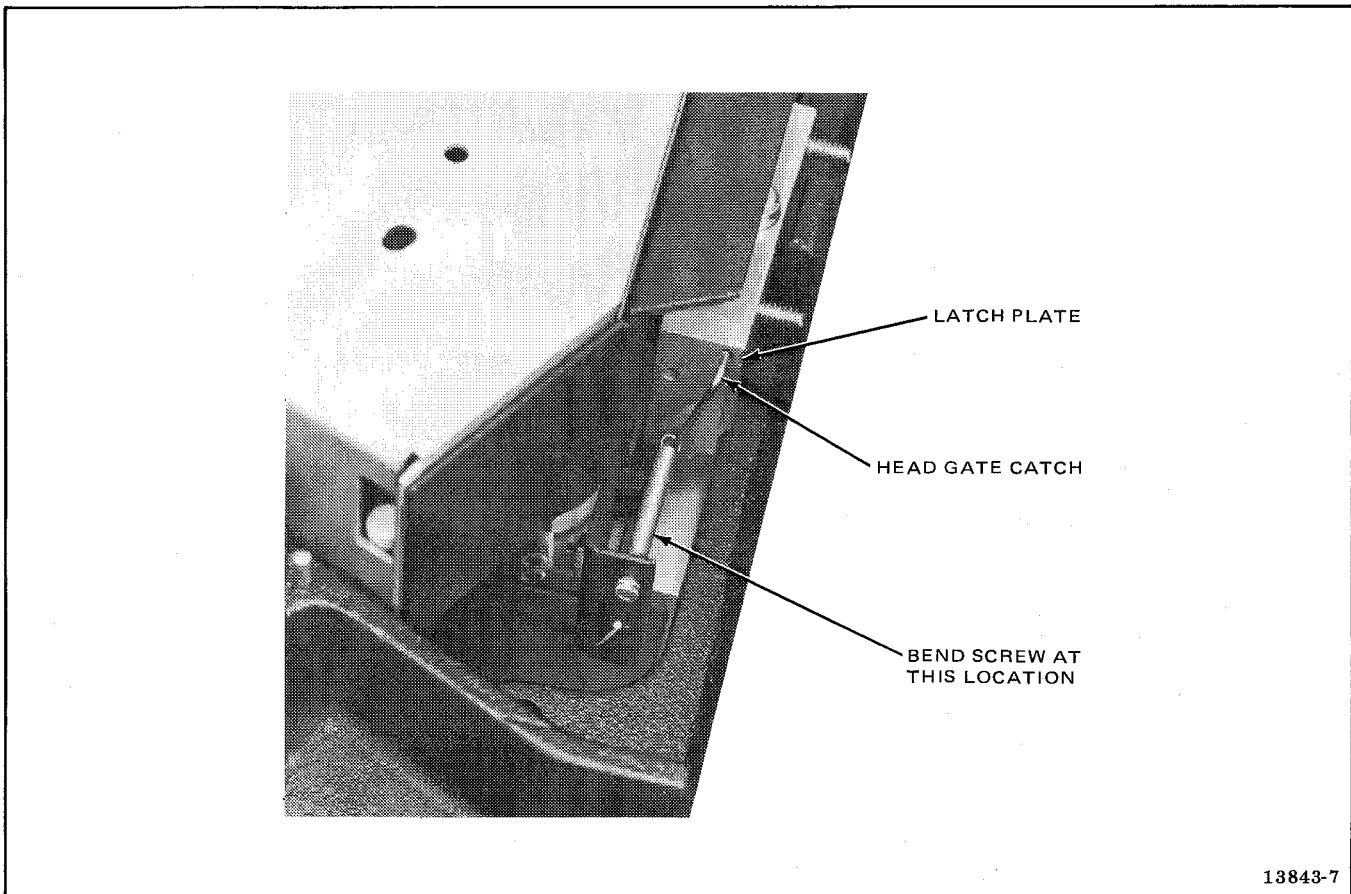


Figure 5-31. Head Gate in Unlatched (Up) Position

5-69. Head Gate Vertical Alignment. In operation, the head gate should not rub on the head assembly or on the front overlay panel. If the head gate does rub on either surface, there may not be enough restoring force in the head gate return springs to fully close the head gate shield against the head assembly shield. Proceed as follows:

1. Operate the head gate and note if the head gate rubs against the head assembly shield or the front overlay panel.
2. If rubbing is noted, remove the head cover assembly and head assembly.
3. With head gate in the unlatched (up) position, carefully bend head gate toward or away from transport as required so that head gate clears front overlay panel with minimum clearance.

4. Reinstall head assembly and check head gate operation for no rubbing.

5-70. Tape Peeler. For proper spilling of tape in the play/edit mode, the tape peeler must be correctly positioned. Proceed as follows:

1. Loosen the two tape peeler mounting screws shown in Figure 5-32.
2. Position the tape peeler so that the following conditions are met:
 - a. There is 1.0 to 4.0 mils clearance between the edge of the peeler and the capstan. (A piece of recording tape can be used as a shim.)
 - b. When the tension arm idler is pressed against the peeler (Figure 5-32), the

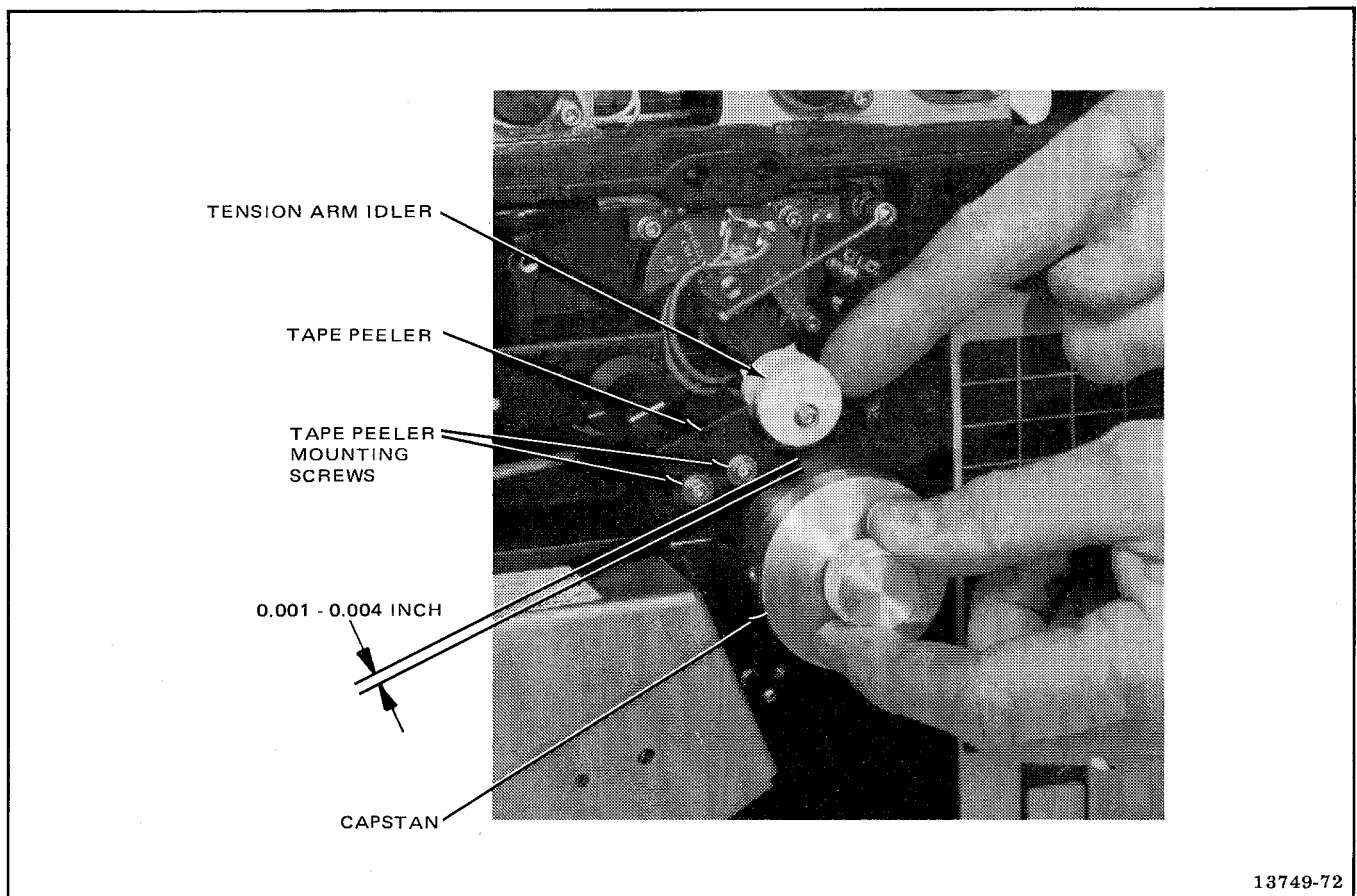


Figure 5-32. Tape Peeler Adjustment

rubber idler is slightly compressed against the capstan, and when released, the arm returns to its rest (up) position.

3. Tighten the two tape peeler mounting screws.
4. Verify that the inner electrical limit circuitry associated with the takeup tension arm is still operational. Check operation by performing steps 1, 7, and 10 through 12 of the *Tension Arms Limits* adjustment procedure, paragraph 5-60.

5-71. PERFORMANCE TESTS

Use the following performance test procedures to check tape tension, absolute tape speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation distortion, and flutter. The performance test should be performed after each 500 hours of operation to ensure the recorder/reproducer is performing in accordance with the specifications given in Table 1-4. Also, an applicable performance test should be performed whenever the equipment appears to be malfunctioning and following repairs to the equipment that could affect performance.

Test equipment required for the performance tests is listed in Table 5-1. In the event a performance test is unsatisfactory, refer to the troubleshooting section of the manual (paragraph 5-84) and perform the appropriate alignment, adjustment, or corrective maintenance procedure.

5-72. Tape Tension

If tape should creep in either direction while in stop mode, or tape tension appears to be incorrect, check tape tension as follows:

1. Remove head cover assembly and the front overlay panel (two screws).
2. Thread tape on recorder/reproducer with approximately even tape pack on both reels.
3. With tape speed set to speed most commonly used, place recorder/reproducer into play mode.

4. Place Tentelometer tension sensor arms to straddle tape at the supply side of the capstan (between capstan and head assembly) as shown in Figure 5-25. (If Tentelometer is not available, see alternate procedure using a dc voltmeter given in paragraph 5-61, steps 2, 5, and 6.)
5. Observe tape tension on gauge. Tension should be 3.75 ± 0.5 ounces for 1/4-inch tape, or 7.5 ± 0.5 ounces for 1/2-inch tape. Remove Tentelometer and press stop pushbutton switch.
6. Manually spin capstan edit knob in one direction and then in the opposite direction with equal force. Tape should coast an equal amount in each direction.

5-73. Absolute Tape-Speed Accuracy

The absolute tape speed of the recorder/reproducer refers to the inches of tape that travels past the reproduce head per unit of time. If the tape tensions are correctly adjusted, there will be no tape slippage at the capstan. Therefore the capstan peripheral velocity may be considered a direct indication of absolute tape speed. The capstan is precisely manufactured to have a diameter of 2.3854 ± 0.0002 inches ($\pm 0.008\%$). Since this tolerance is very small, absolute tape speed can be determined by measuring the frequency of the capstan tachometer signal while the capstan rotates for 30-in/s operation during a precise unit of time. If desired to measure the capstan diameter, the measuring gauge used should be adequately calibrated consistent with the tolerance to be measured.

To determine absolute tape speed, proceed as follows:

1. Select 30-in/s tape speed. If system is not set up for 30-in/s operation, temporarily enable 30-in/s operation as follows:
 - a. Remove power.
 - b. Unplug all audio channel PWAs within the electronics assembly.
 - c. If recorder/reproducer has been set up for two-speed master bias operation

(instead of four-speed master bias operation as shipped from the factory), remove audio control PWA No. 5 from electronics assembly. Place jumper J1 (Figure 5-6) in the 30-in/s position. Reinstall PWA No. 5 into electronics assembly.

2. With power off, place capstan servo PWA No. 8 on an extender board and reinstall into electronics assembly.
3. Use a shielded lead to connect a counter (Table 5-1) to TP1 and ground on PWA No. 8 to measure capstan tachometer rate.
4. Apply power, thread reel of tape on transport, and place system into play mode.
5. Counter should read 9,600 Hz, which is the tach frequency at 30 in/s.
6. Set counter to read a 10-second interval count. The measured count should be $96,000 \pm 6$ counts. This corresponds to an absolute capstan rotational accuracy of $\pm 0.006\%$. The combined speed error caused by the capstan diameter and capstan rotational speed error is the total speed error. Note: Counter accuracy is limited to ± 1 count in the least significant digit.
7. If applicable, remove power and restore jumper J1 on PWA No. 5 to original position. Reinstall audio PWAs within electronics assembly.
8. Remove power and reinstall capstan servo PWA No. 8 into electronics assembly.

5-74. Speed Variation

To measure speed variation, tape speed is measured at the beginning of a reel and is compared to the speed near the end of the reel. This is accomplished by recording and playing back a stable reference frequency and comparing any difference in frequency count over a precise unit of time. To check speed variation, proceed as follows:

1. With power off, place capstan servo PWA No. 8 on an extender board and reinstall into electronics assembly.

2. If an input/output assembly is being used, use a shielded audio lead and connect TP1, on the capstan servo PWA, to a channel input of the input/output assembly. (Note: TP1 supplies a stable reference signal and the frequency of this signal is 9,600 Hz at 30 in/s, 4,800 Hz at 15 in/s, 2,400 Hz at 7.5 in/s, and 1,200 Hz at 3.75 in/s.)
3. If an input/output assembly is not being used, use a shielded audio lead and connect TP1 of the capstan servo PWA to a channel input of the recorder/reproducer at connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3). Connect signal input of a frequency counter to the same channel output on connector J13 or J14 (Figure 2-13).
4. To detect worst case speed variation, use 7-inch diameter EIA reels with a small hub (NAB type B reels) in the supply and takeup position. Apply power, thread a full reel of tape on transport, and place system into thread mode.
5. Select input mode for channel being used and the highest tape speed that recorder/reproducer has been set up for.
6. Place system into record mode and record for approximately two minutes.
7. While recording, set counter to display a 10-second interval count and note reading.
8. Stop recording, turn the reels over end-for-end (interchange reels), and place system into thread mode.
9. If recorder/reproducer is other than a full-track system, reconnect frequency counter to appropriate channel output so recording made in step 6 may be reproduced.
10. Select repro mode for channel being used and place system into play mode.
11. With counter set to display a 10-second interval count, the total count played back in 10 seconds should be within 9 counts of the input count at 30 in/s, 4 counts at 15 in/s, or 2 counts at 7.5 in/s.

12. Remove power and reinstall capstan servo PWA No. 8 into electronics assembly.

5-75. Operating Level

To determine or check the operating level of the recorder/reproducer, play back a standard alignment tape. Preferably use an alignment tape that has the same track format as the recorder/reproducer (full track, 2 track, or 4 track). If this type of alignment tape is not available and a full-track alignment tape is used on a multitrack recorder/reproducer, refer to the amplitude correction factors given in Table 5-4. (Refer to *Use of Alignment Tapes/General Discussion*, paragraph 5-31, and *Operating Level/General Discussion*, paragraph 5-34.)

The following procedures can be used to determine recorder/reproducer operating levels of 370 nWb/m, 260 nWb/m, or 185 nWb/m with the use of a 185-nWb/m reference level alignment tape (Figure 5-1).

NOTE

On Ampex alignment tapes for 15 and 30 in/s, the 185-nWb/m, 700-Hz reference tone is the first tone on the tape. For 3.75 and 7.5 in/s, the 185-nWb/m, 700-Hz (500-Hz, 3.75-in/s) tone is the last tone on the tape.

To check operating level, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual (paragraphs 5-4 and 5-7).
2. Select system tape speed at the transport control panel.
3. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
4. Reproduce the 185-nWb/m operating level 500-Hz tone for 3.75 in/s, or 700-Hz tone for 7.5, 15, or 30 in/s of an Ampex standard alignment tape.

NOTE

For the following step 5 and step 6, apply amplitude correction factor (Table 5-4), if applicable.

5. If an ac voltmeter is being used at the output of the recorder/reproducer, the operating level can be determined from the ac voltmeter reading as follows:
 - a. 370 nWb/m — -11 dBm.
 - b. 260 nWb/m — -8 dBm.
 - c. 185 nWb/m — -5 dBm.

NOTE

Step 6 assumes that the input/output assembly has been calibrated for a line output operating level of +4 dBm (0 vu with meter in vu position or -6 dB with meter in peak position).

6. If an input/output assembly is being used, set the reproduce MANUAL/PRESET switch to PRESET position. The operating level, as read on an ac voltmeter or on the input/output level meter should be as follows:
 - a. 370 nWb/m — -2 dBm or -6 vu (meter in vu position) or -12 (meter in peak position).
 - b. 260 nWb/m — +1 dBm or -3 vu (meter in vu position) or -9 (meter in peak position).
 - c. 185 nWb/m — +4 dBm or 0 vu (meter in vu position) or -6 (meter in peak position).

5-76. Signal-to-Noise Ratio

The signal-to-noise ratio measurement is made using a filter connected to the output of the system to attenuate noise out of the audible-frequency band. Figure 5-33 is a simple passive filter for passing frequencies in the 30 Hz to 18 kHz frequency band and Figure 5-34 is a filter for weighting to the ANSI 'A' characteristic. If desired to use the ANSI 'A' filter shown in Figure 5-34, it is necessary to correct for the insertion loss of the filter at 1 kHz. This is accomplished by adding

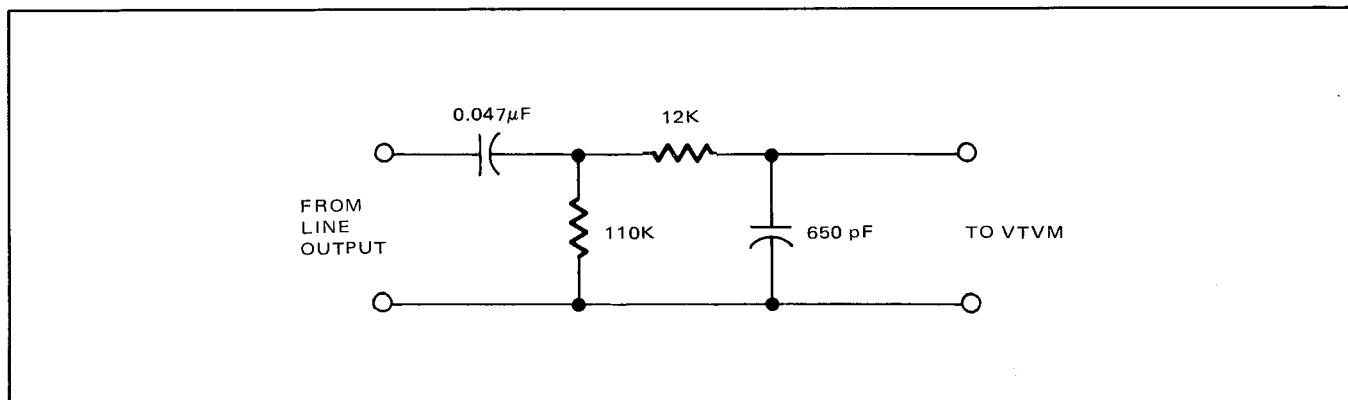


Figure 5-33. 30-Hz to 18-kHz Band Limiting Filter

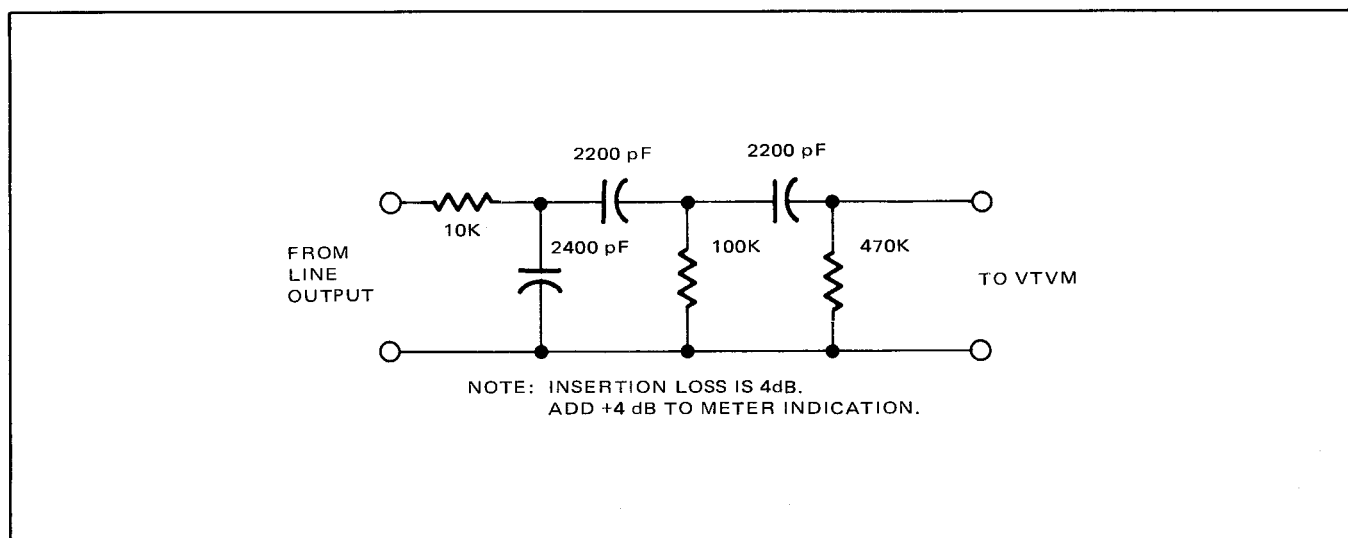


Figure 5-34. ANSI 'A' Weighted Filter

+4 dB to the ac voltmeter indication when making the measurement. For example, if the meter reads -61 dBm through the filter, the actual reading is -57 dBm.

Figure 5-35 is a schematic diagram of a universal noise filter (constructed by the user) that has a four-position selector switch for measurement to standards CCIR, ANSI A Weighted, and 30-18 kHz. The fourth position of the selector switch enables the filter to be used as a buffer. A gain switch permits unity gain or 20 dB gain.

Table 5-13 gives signal-to-noise ratios for tape speed, equalization standard, track format, and

noise measurement weighting filter in use when using Ampex 456 tape (or direct equivalent), and with the recorder adjusted for 370-nWb/m operating level at 700 Hz. Table 5-14 provides signal-to-noise ratios with the system in standby mode. All signal-to-noise ratios given in Tables 5-13 and 5-14 are measured relative to nominal 3% third harmonic distortion which is 9 dB above 370-nWb/m level when using Ampex 456 tape. The signal-to-noise ratio measurement should only be performed if the reproduce, record, and erase system alignment has been performed or is known to be correct.

To measure signal-to-noise ratio, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. If an input/output assembly is being used, connect an ac voltmeter through a band limiting filter (Figure 5-33, 5-34, or 5-35) to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).
3. If an input/output assembly is not being used, connect an ac voltmeter through a band limiting filter (Figure 5-33, 5-34 or 5-35) to appropriate output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3) and connect an audio oscillator to appropriate input connector J13 or J14.
4. Apply power and thread a reel of bulk-degaussed tape on the transport and place system into thread mode.
5. Set speed switch to tape speed selected for measurement.
6. Place system in record mode (channels not under test should also be placed in record mode).
7. Set oscillator frequency to 1.0 kHz and adjust oscillator output level for +5 dBm at the output of the recorder/reproducer, or for +14 dBm at the output of the input/output assembly. (Note: For convenience, these levels are 10 dB above operating level.)
8. Reset tape timer display to zero.
9. Record continuously for at least two minutes and rewind tape to tape timer display zero.
10. Remove oscillator and short signal input terminals (or short input with an impedance not greater than 300 ohms).
11. Again place system into record mode and read residual noise on the ac voltmeter. Calculate the signal-to-noise ratio as follows:
 - a. If an input/output assembly is being used, the ac voltmeter reading should be 13 dB less than the amount (after correction for filter insertion loss) shown in Table 5-13. (This assumes input/output assembly has been aligned to provide a +4-dBm line output level for a -5-dBm interface level at operating level.) For example, if ac meter reads -62 dBm, signal-to-noise ratio is -62 plus -13 or 75 dB.
 - b. If an input/output assembly is not being used, the ac voltmeter reading should be 4 dB less than the amount (after correction for insertion loss) shown in Table 5-13. (This assumes recorder/reproducer has been aligned for -5-dBm interface operating level.)
12. Press stop pushbutton to stop transport and place system into standby mode.
13. Read residual noise on ac voltmeter and compare with readings in standby signal-to-noise ratio table, Table 5-14.
14. Repeat all steps in sync monitor mode. The signal-to-noise ratio should meet or exceed all readings in Table 5-13.

5-77. Harmonic Distortion

It is recommended that harmonic wave levels be measured using a wave or spectrum analyzer (the use of a total harmonic distortion analyzer to measure off-tape distortion is not recommended). The audio oscillator used for measurement should not have a residual second harmonic component greater than 0.03% rms (-70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz. Also the third harmonic component should not be greater than 0.05% rms (-66 dB).

Table 5-15 gives harmonic and intermodulation distortion system specifications when Ampex

Table 5-15. Harmonic and SMPTE Intermodulation System Distortion Specifications

ELECTRONICS DISTORTION:

System electronics distortion, including record amplifier, reproduce amplifier and input/output system, at any operating level up to 20 dB above operating level at mid-frequency is <0.03% total harmonic distortion and <0.05% SMPTE intermodulation distortion.

Overall record/reproduce distortion (using Ampex 456 tape or direct equivalent):	At system operating level (0 vu = 370 nWb/m; 6 dB above 185 nWb/m).
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Even Order Distortion:

Even order distortion of a 1-kHz signal recorded at 370 nWb/m is less than 0.1%.

7.5 in/s – 30 in/s:

Third Harmonic Distortion at 1 kHz:	<0.3% at recorded flux level of 370 nWb/m (0 vu). <3.0% at recorded flux level of 1040 nWb/m (+9 vu).
SMPTE Intermodulation Distortion:	<1.0% at recorded flux level of 370 nWb/m (0 vu).

3.75 in/s:

Third Harmonic Distortion at 500 Hz:	<0.5% at recorded flux level of 370 nWb/m (0 vu). <3.0% at recorded flux level of 740 nWb/m (+6 vu).
SMPTE Intermodulation Distortion:	<2.0% at recorded flux level of 370 nWb/m (0 vu).

456 tape or its direct equivalent is used. The harmonic distortion measurement should only be performed if the reproduce, record, and bias adjustments have been correctly made or are known to be correct. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. If an input/output assembly is being used, connect a spectrum analyzer or wave analyzer to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).
3. If an input/output assembly is not being used, connect a spectrum analyzer or wave analyzer to appropriate recorder/reproducer output connector J13 or J14, and connect an audio oscillator with a source impedance of not greater than 200 ohms to appropriate

input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

4. Apply power and thread a reel of tape on the transport and place system into thread mode.
5. Set speed switch to tape speed selected for measurement.
6. Place system into record mode.
7. Set oscillator frequency to 1 kHz (500 Hz at 3.75 in/s only) and adjust oscillator output level for -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
8. Adjust wave analyzer to measure second harmonic content; this should not exceed -60 dB with respect to the level of the fundamental set in step 7.

9. Adjust wave analyzer to measure third harmonic content. The harmonic content should not exceed levels given in Table 5-15 relative to the level of the fundamental set in step 7.
10. Increase oscillator output level to system peak operating level. This is +4 dBm at the output of the recorder/reproducer or +13 dBm at the output of the input/output assembly.
11. Adjust wave analyzer to measure third harmonic content. The harmonic content should not exceed levels given in Table 5-15 relative to the level of the fundamental set in step 10.
12. Repeat entire procedure for each channel.

5-78. SMPTE Intermodulation Distortion

Intermodulation distortion is produced by non-linearity in the record/reproduce process which produces frequencies in the output signal equal to the sums and differences of integral multiples of the component frequencies present in the input signal (harmonics not included). Measurement of intermodulation distortion is a convenient method of obtaining a qualitative indication of system performance. However, a reading in excess of specifications gives no indication of the possible cause, as a poor or damaged tape may produce amplitude fluctuations in high-frequency carrier which greatly exceed the true intermodulation products. Therefore a judgment is required when attempting to interpret the measurements.

Table 5-15 gives harmonic and intermodulation distortion system specifications when Ampex 456 tape or its direct equivalent is used. The measurement should only be performed if the reproduce, record, and bias adjustments have been performed or are known to be correct. To measure intermodulation distortion as defined by the SMPTE, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.
2. If an input/output assembly is being used, connect intermodulation analyzer test signal

output to appropriate input connector (Figures 2-14 and 2-15), and connect appropriate output connector of input/output assembly to input of intermodulation analyzer.

3. If an input/output assembly is not being used, connect intermodulation analyzer test signal output to appropriate recorder/reproducer connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3), and connect appropriate output connector J13 or J14 to input of intermodulation analyzer.
4. Apply power and thread a reel of bulk-erased tape on the transport and place system into thread mode.
5. Set speed switch to tape speed selected for measurement.
6. Place system into record mode.
7. Adjust intermodulation analyzer composite signal output amplitude for -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
8. Adjust intermodulation analyzer to normalize the input signal, and then read intermodulation distortion. Compare readings with specifications given in Table 5-15 for tape speed and equalization standard in use.
9. If type of intermodulation analyzer permits, verify tape condition and validity of measurement in step 8 as follows:

Remove or switch off the low-frequency test signal. Intermodulation distortion reading should drop at least to 40% of reading obtained in step 8. If the reading did not drop, this is an indication that the tape is mechanically damaged or dirty, or that some element in the tape path is causing excessive amplitude fluctuation of the high-frequency test signal.

5-79. Flutter

Flutter is measured by recording and reproducing a constant frequency tone. Any non-uniform

motion in the recorder/reproducer mechanism frequency modulates the tone. This modulation, called flutter, is measured with an fm demodulator within a flutter meter. The ATR-100 flutter specifications are measured according to standards specified by DIN 45 507 and ANSI S4.3 peak weighted and unweighted. The rms flutter is measured as specified by the NAB standard.

When performing measurements, it is possible for the record mode flutter to add or subtract from the reproduce mode flutter, depending upon the phase relationship of the recorded and reproduced signals; therefore, it is necessary to play the tape several times and average the flutter meter readings.

Prior to making a flutter measurement, perform the following steps.

1. Clean and demagnetize the heads and other tape patch components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7. (Note: Flutter meters are sensitive to amplitude modulation that results from poor head-to-tape contact or from signal dropouts.)
2. Check tape tension and adjust, if necessary, as described under *Tape Tension* adjustments, paragraph 5-61.
3. The audio channel to be used for flutter measurement should be in correct alignment. If necessary, perform the *Audio Signal System Alignment* procedure (paragraph 5-30).
4. Use good quality bulk erase tape (Ampex 456 or equivalent). Use a typical reel size for tape speed in use; i.e., NAB type A reel for 30-in/s operation.

The following procedure applies to the use of a Micom (Bahrs) Model 8100-W flutter meter. If a different flutter meter is used, the manufacturer's instructions should be followed.

To measure flutter, proceed as follows:

1. If an input/output assembly is being used, connect the test oscillator output of the

flutter meter to the input connector of the channel selected for test, and connect signal input connector of flutter meter to appropriate output connector (Figures 2-14 and 2-15).

2. If an input/output assembly is not being used, connect the test oscillator output of the flutter meter to recorder/reproducer input connector J13 or J14 corresponding to the channel selected for test, and connect signal input connector of flutter meter to appropriate output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).
3. Apply power, thread a reel of bulk-erased tape on transport, and place system into thread mode.
4. Select input monitoring for channel being used. Adjust recorder/reproducer output level and/or flutter meter input level for required flutter meter input level.
5. While in input mode (tape not moving), measure static signal flutter and verify that flutter is way below level of flutter anticipated (Table 1-4). Typical levels are below 0.005% peak weighted or 0.01% unweighted.
6. Set flutter meter to measure peak weighted and meter scale to read 0.1% full scale.
7. Select repro monitoring mode for channel being used, place system into record mode, and record for approximately one minute. While recording, note flutter indication on flutter meter.
8. Rewind tape to the beginning of the recording, place system into play mode, and read indication on flutter meter. Repeat this step three times and average the four readings along with the reading obtained while recording (step 7). The average reading should meet the flutter specifications given in Table 1-4.

5-80. CORRECTIVE MAINTENANCE

When a failure is noted, perform the appropriate head maintenance, troubleshooting, or component replacement procedure.

CAUTION

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS, ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A HEAD ASSEMBLY, OR BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) INTO THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.

5-81. Head Maintenance

Head cleaning, demagnetizing, and cleaning and lubrication of the scrape flutter idler was covered under *Preventive Maintenance*, paragraph 5-3, and adjustment of head azimuth was covered under *Alignment and Adjustments*, paragraph 5-29. Use the following instructions to change the entire head assembly or to change an individual head stack on the head assembly.

5-82. Changing Head Assembly. To remove head assembly, proceed as follows:

1. Remove power from ATR-100.

2. Remove head cover assembly (Figure 5-22) from transport by carefully lifting cover straight up.
3. Insert Allen wrench through center hole in head shield (Figure 5-36) and turn spring-loaded screw 1/4-turn clockwise to release head assembly.
4. Carefully lift head assembly straight up from the transport.

To install head assembly, proceed as follows:

1. Carefully lower head assembly over transport to mate the head-centering pins (Figure 5-37) on the transport into the bottom of the head assembly. Lower head assembly onto transport and fully mate the head connector.

NOTE

For removal or installation of head assembly, the spring-loaded screw is always turned 1/4-turn clockwise.

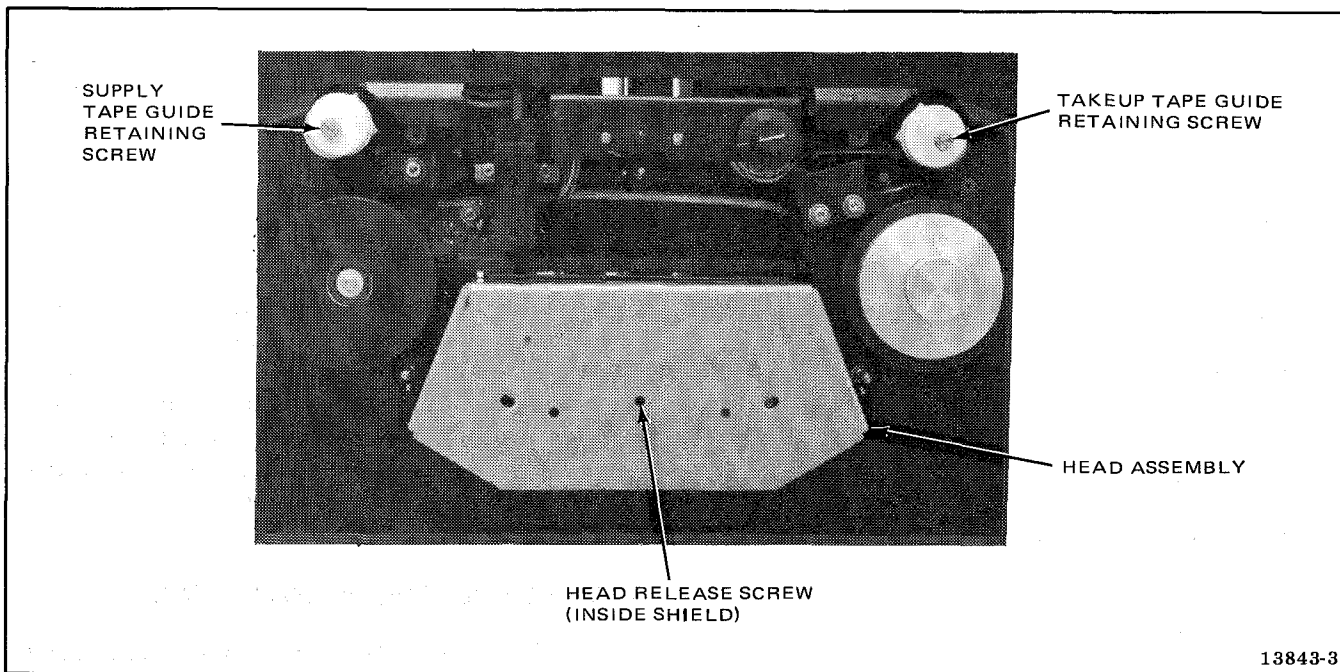


Figure 5-36. Head Assembly and Tape Guides

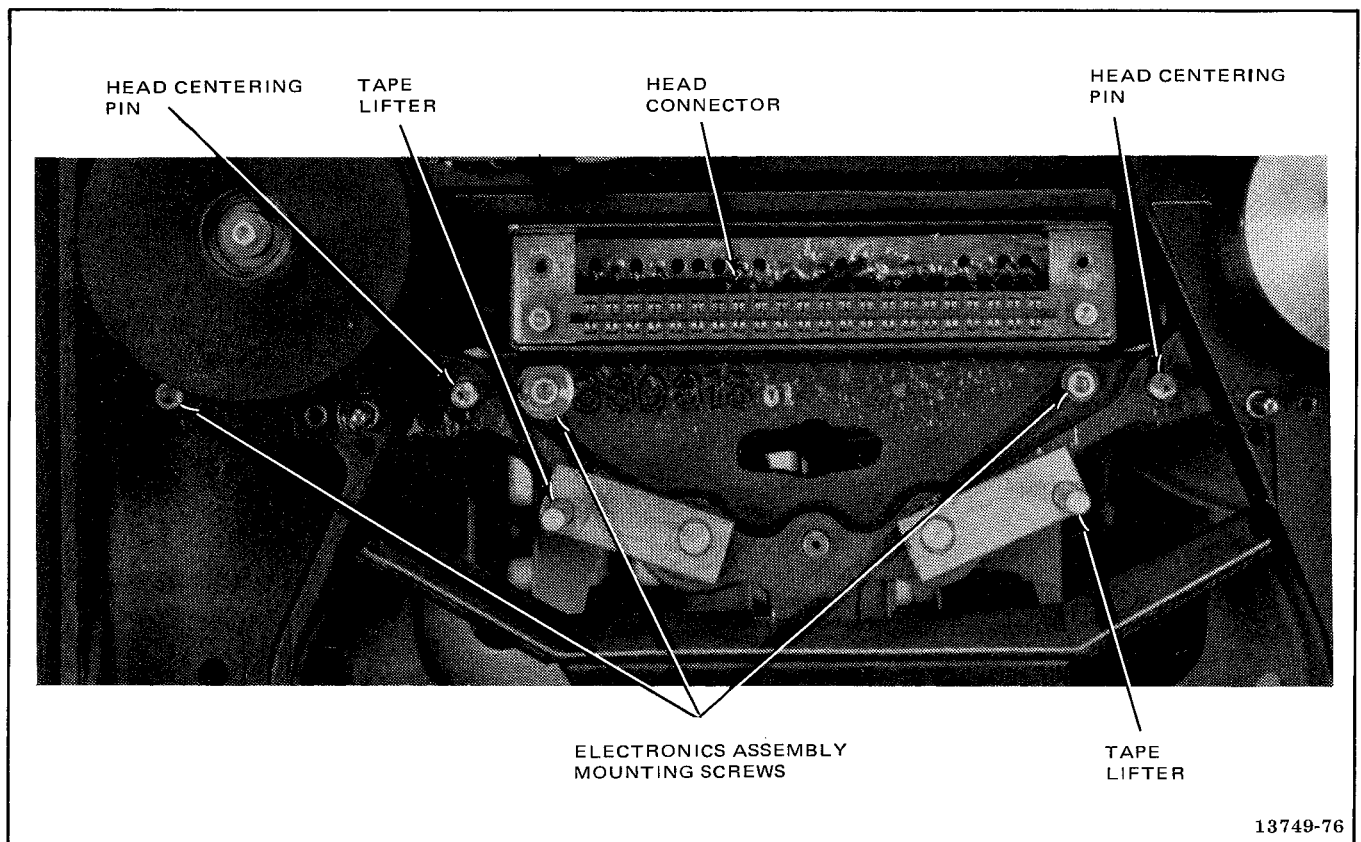


Figure 5-37. Top View of Transport with Head Assembly Removed

2. Lock the head assembly to the transport by inserting an Allen wrench through hole in head shield, and turn spring-loaded screw 1/4-turn clockwise to lock head to transport.

5-83. Changing Head Stacks. To change a record, reproduce, or erase head stack, proceed as follows:

1. Remove power from ATR-100.
2. Remove the entire head assembly from the transport as follows:
 - a. Remove head cover assembly (Figure 5-22) from transport by carefully lifting cover straight up.
 - b. Insert Allen wrench through center hole in head shield (Figure 5-36) and turn spring-loaded screw 1/4-turn clockwise to release head assembly.

- c. Carefully lift head assembly straight up from transport.

3. Remove the main head shield from the head assembly by removing four screws (Figure 1-3) that secure the main head shield to the base plate.
4. Carefully unplug the head-stack connector(s) of the head stack to be changed (Figure 5-38).
5. Remove head-stack mounting screw and spring (Figure 5-38).
6. Remove stack by pressing the spring-loaded pin (Figure 5-39), from underside of head base plate, and carefully sliding stack toward head connector PWA. When removing the reproduce head stack, rotate the stack on the pin to clear the head connector PWA.

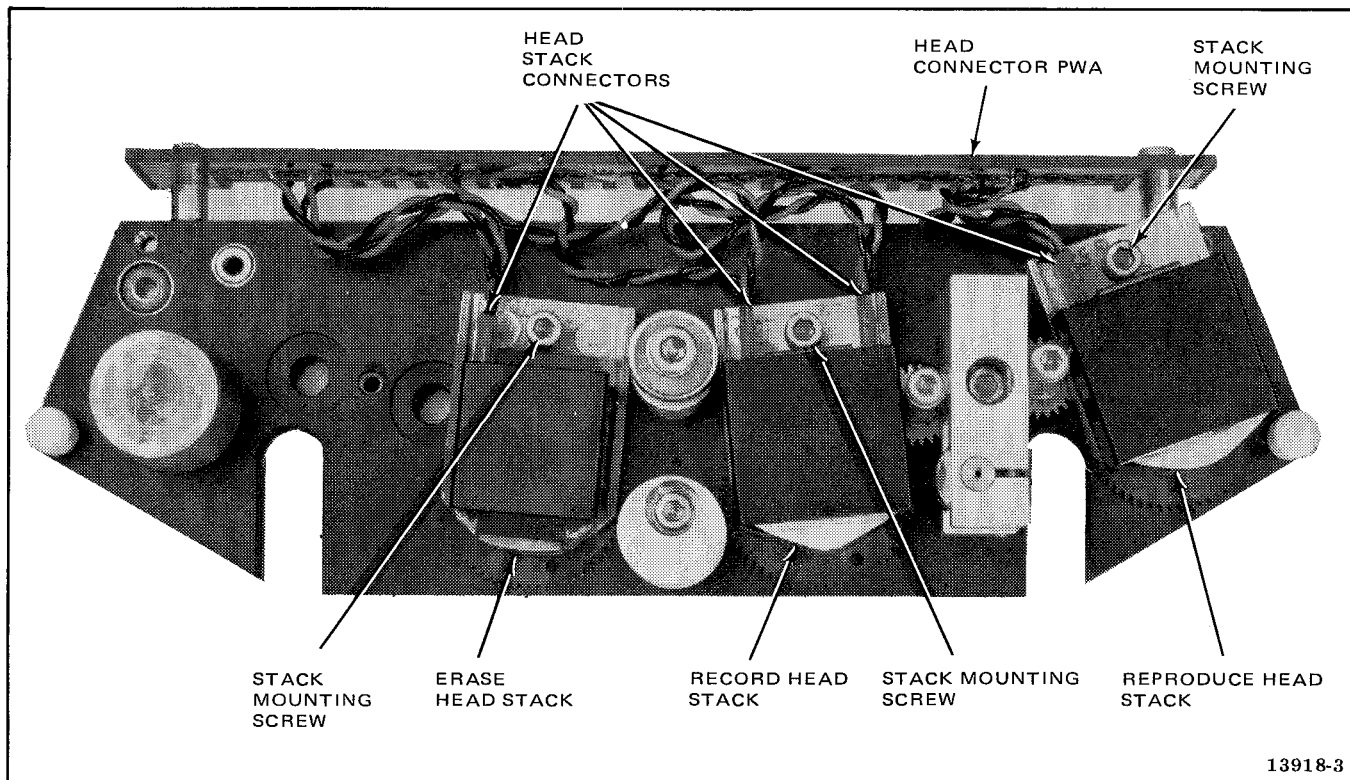


Figure 5-38. Top View of Head Assembly with Main Head Shield Removed

7. Install new stack by pressing spring-loaded pin and sliding new stack forward into place on the tapered gear.
8. Reinstall head-stack mounting screw and spring. Lightly tighten screw to fully compress spring, then turn screw one full turn counterclockwise to permit head azimuth to be adjusted.
9. Carefully reinstall head-stack connector(s).
10. Reinstall main head shield using four screws removed in step 3.
11. Install entire head assembly onto transport as follows:
 - a. Carefully lower head assembly over transport to mate the head centering pins (Figure 5-37) on the transport into the bottom of the head assembly. Lower head assembly onto transport and fully mate the head connector.
 - b. Lock the head assembly to the transport by inserting an Allen head wrench through hole in head shield and turn spring-loaded screw 1/4-turn clockwise to lock head to transport. (Note: For removal or installation of head assembly, the spring-loaded screw is always turned 1/4-turn clockwise.)
12. Perform the appropriate record, reproduce, or erase alignment procedure given in this section of the manual under the heading *Audio Signal System Alignment*, paragraph 5-30. No azimuth adjustment is required for the erase head stack.

5-84. Troubleshooting

Use standard troubleshooting techniques to isolate a fault as mechanical or electrical in origin. Then proceed to isolate the fault to a certain stage or component. As an aid in locating faults, dc voltages and reference frequencies are given at many

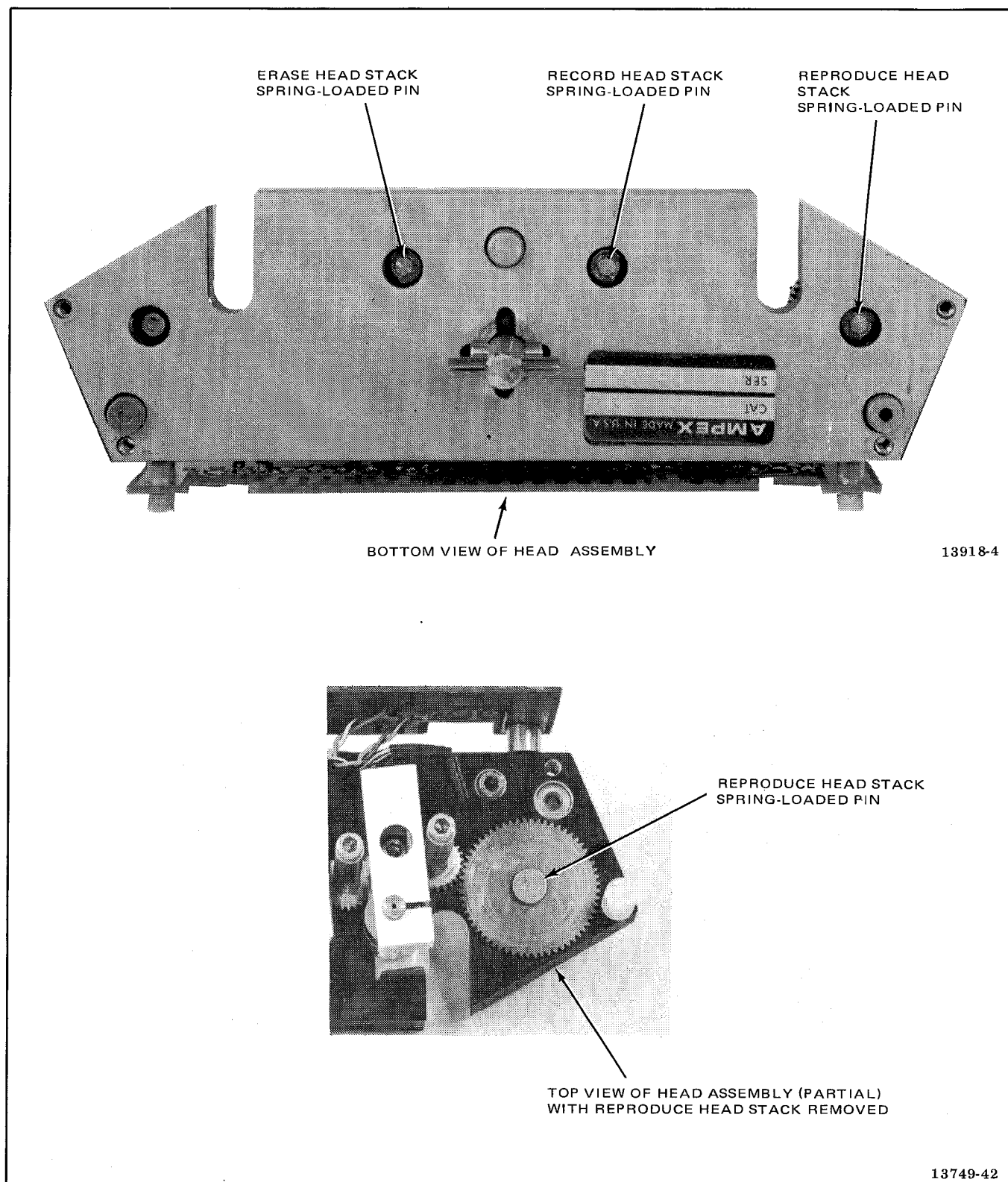


Figure 5-39. Head Assembly Spring Loaded Pin Locations, Main Head Shield Removed

points on the schematic diagrams (Section 6), and in the theory section (Section 4) and associated block diagrams.

The performance tests (paragraph 5-71) can be used as an aid in diagnosing a fault. These procedures include tests for checking tape tension, absolute tape speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation distortion, and flutter. In addition, troubleshooting hint tables and troubleshooting flow diagrams are provided in this section (paragraph 5-88). Any of the corrective actions listed in the Table of Contents for Section 5 may be required. Recommended test equipment that may be required is listed in Table 5-1.

5-85. Extender Boards. Alignment and troubleshooting procedures are greatly simplified by using the electronics assembly extender board (supplied with the recorder/reproducer) and the input/output assembly extender board (accessory). These

boards are listed in Table 5-1. The extender board, when installed between the circuit board and its receptacle, moves the circuit board outside the chassis so all components are accessible for testing or adjustment.

CAUTION

DO NOT REMOVE OR INSERT A CIRCUIT BOARD (PWA) WITH POWER ON. TO DO SO MAY CAUSE DAMAGE TO CIRCUIT COMPONENTS. ALSO, USE EXTREME CARE NOT TO INSERT A PWA ON AN EXTENDER BOARD INTO A WRONG SLOT IN THE ELECTRONICS ASSEMBLY. THE EXTENDER BOARD IS NOT KEYED LIKE THE PWAs.

5-86. Power Transistor Locations. Figure 5-40 shows the locations, by schematic symbol reference on schematic diagram no. 4840423, of the various power supply, solenoid driver, and MDA

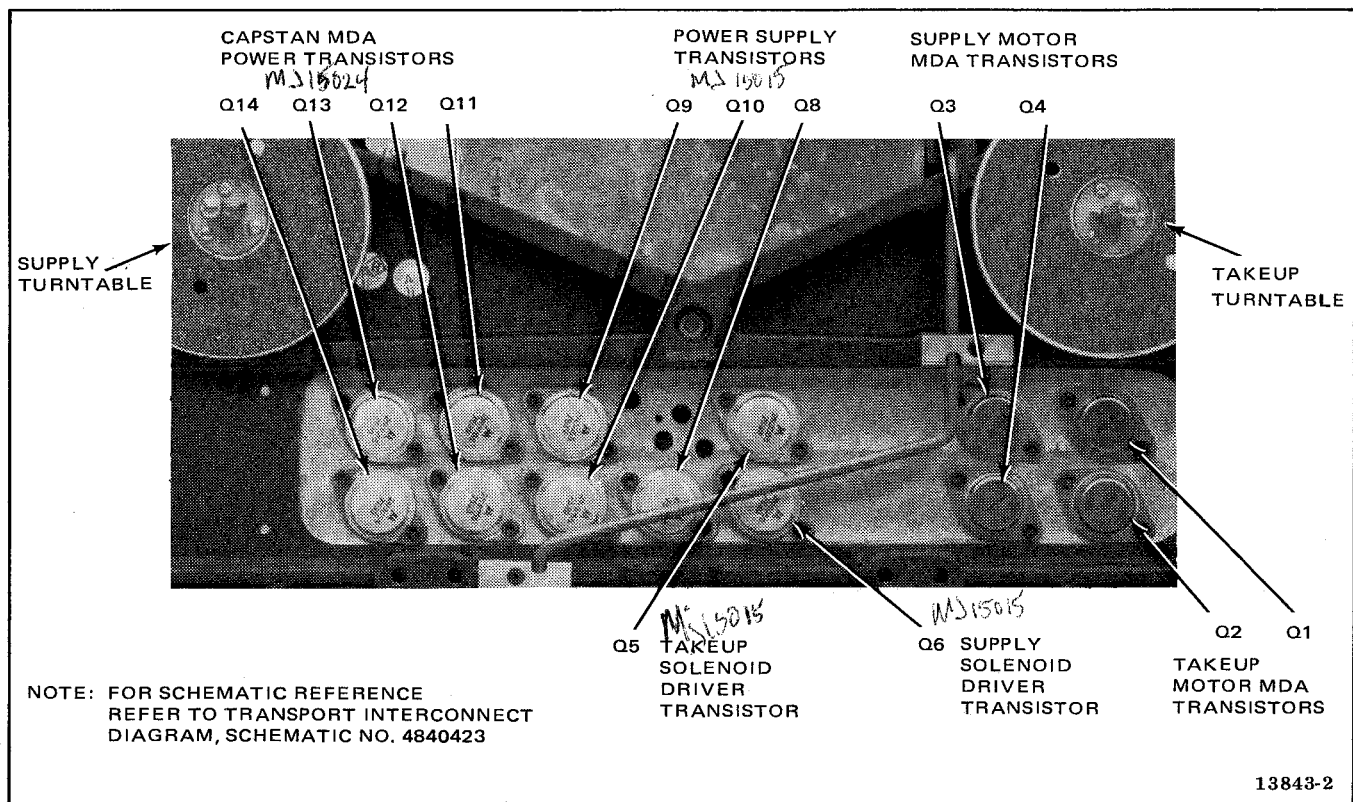


Figure 5-40. Power Transistor Locations on Heatsink

power transistors located on the top surface of the transport heatsink.

5-87. Flutter. The vibration analyzer portion of the flutter meter can be used to help isolate flutter to a certain frequency. Table 5-16 shows normal frequencies generated by the rotating mechanical components for each of the four tape speeds. This table is most useful for flutter evaluation when the weighted flutter measurement is out of specification. Troubleshooting hints for flutter problems are given in Table 5-19.

5-88. Troubleshooting Hints. Troubleshooting hints for problems associated with the tape transport and tape timer are given in Tables 5-17 and 5-18, respectively. Troubleshooting hints pertaining to flutter, excessive noise or poor signal-to-noise ratio, harmonic and intermodulation distortion, and general problems are given in Tables 5-19 through 5-22, respectively. Troubleshooting flow charts pertaining to the audio system are given in Figures 5-41 through 5-44.

Table 5-16. Rotational Rates (Hertz)

COMPONENT	TAPE SPEED			
	3.75 IN/S	7.5 IN/S	15 IN/S	30 IN/S
Capstan	0.50	1.00	2.00	4.00
Tape Timer	0.50	1.00	2.00	4.00
Capstan Second Harmonic	1.00	2.00	4.00	8.00
Takeup Tape Guide	1.43	2.86	5.72	11.45
Supply Tape Guide	1.47	2.93	5.87	11.73
Capstan Third Harmonic	1.50	3.00	6.00	12.00
Takeup Guide Second Harmonic	2.86	5.72	11.45	22.90
Supply Guide Second Harmonic	2.93	5.87	11.73	23.46
Tape Timer Mass Resonance	59 Hz for 1/2-inch tape width 44 Hz for 1/4-inch tape width			Independent of tape speed but slightly dependent on tape type and reel pack.

Table 5-17. Troubleshooting Hints – Tape Transport

PROBLEM	POSSIBLE CAUSE/CHECK
Power will not switch on	Power actuator bar not actuating main power switch (Figure 2-11). No main power from power source. Main power fuse blown.
Power will not switch off	Power actuator bar not actuating main power switch.
Transport will not enter thread mode	Supply or takeup tension arm microswitch not actuating. Relay K1 in power supply not operating.

Table 5-17. Troubleshooting Hints – Tape Transport (Continued)

PROBLEM	POSSIBLE CAUSE/CHECK
Transport will not enter thread mode (continued)	Supply or takeup LED PWA harness wires binding against rear overlay panel. Tension arm torque. Reel servo malfunction. Stop pushbutton switch. Thread control logic circuitry on PWA No. 7. Reel servo PWA No. 9 not plugged into electronics assembly.
Transport will not unthread	EDIT pushbutton switch or associated circuitry. Capstan still rotating when EDIT pushbutton switch pressed. Motion sense circuit malfunction on PWA No. 8.
Tape slips on tape timer during acceleration	Tape tension too low. Tape tension unbalanced. Tape logic direction command wrong because of capstan tach sensor misadjustment.
Tape slips on capstan in forward or reverse direction	Tape tension too low. Tape tension greatly unbalanced. Tape too wide and being pinched by tension arm roller tape guides. Tape logic direction command unstable because of capstan tach sensor misadjustment or insufficient level.
Transport will not enter play edit mode	Tension arm idler not contacting capstan. Play edit control logic on PWA No. 7. Mode locked out on PWA No. 7.
Transport will not come out of play edit mode	Tape peeler misadjusted too far back allowing tension-arm guide to toggle over center of capstan. Capstan still rotating when EDIT pushbutton switch is pressed. Motion sense circuit malfunction on PWA No. 8.
Transport will enter thread mode but no tape motion in mode	Capstan motor power connection. Capstan MDA malfunction.
Tape motion possible in fast forward, rewind and spool modes but not play or record modes	Lockout circuitry activated because inactive recorder/reproducer speed selected.
Tape lifter arms will not fully retract or operate in fast modes	Tape lifter arm shaft binding in pivot bushings.

Table 5-17. Troubleshooting Hints — Tape Transport (Continued)

PROBLEM	POSSIBLE CAUSE/CHECK
Tape lifter arms will not fully retract or operate in fast modes (continued)	O-ring seal inside tape lifter solenoid hanging up in solenoid. Tape lifter solenoid shield not properly adjusted. Tape lifter solenoid driver (Q23, Q24) on PWA No. 9 is defective.
Tape lifter arms out too far or not far enough in fast tape modes	Individual tape lifter arm position not correct.
Tape lifter operates too slow or too fast	Solenoid air-leak control needs adjusting. O-ring seal in solenoid damaged or binding.
Capstan will not stop rotating	Capstan tach sensor misadjusted. Capstan tach sensor gain misadjusted. Tape tension unbalanced.
Capstan runs fast in one direction continuously	Voltage regulator on PWA No. 8 has failed.
In stop mode, capstan creeps in either direction	Tape tension unbalanced.
Capstan will not phase lock	Tape tension incorrect. Tach signal is noisy. Tach gain set too high or too low.
Transport will not enter stop/edit (unthread) mode when a tension arm is moved to an inner or outer limit	Position of tension arm LED PWA incorrect. LED, on PWA, light output is too low.
Poor tape pack in 180-in/s spool mode in either direction	Tape tension too low. Poorly slit tape. Use of non back-coated tape. Tape needs to be re-conditioned by operating in spool mode several times. Reel drive motor shaft damaged and not perpendicular to tape path. Type of tape used will not pack well at 180 in/s; try 60 in/s.
Poor tape pack in fast wind modes	Normal as air becomes entrapped between layers of tape. Use more accurately slit tape. Use spool modes for packing.
Tape pack height within reel incorrect (metal precision reels or plastic reels)	Turntable height wrong. Tape tension arm guide height wrong or arm shaft is bent.

Table 5-17. Troubleshooting Hints — Tape Transport (Continued)

PROBLEM	POSSIBLE CAUSE/CHECK
Tape pack height within reel incorrect (metal precision reels or plastic reels) (continued)	Reel motor axis not perpendicular with tape path — dirt particles under motor mounting. Axis of tape guide nearest reel in question not perpendicular to tape path. Poorly slit or damaged tape; try another tape.
Poor takeup tape pack in play and record modes	Very poorly slit tape. Axis of tapeup reel motor shaft not perpendicular to tape path. Takeup tension arm roller not perpendicular to tape path.

Table 5-18. Troubleshooting Hints — Tape Timer

PROBLEM	POSSIBLE CAUSE/CHECK
Timer display accuracy incorrect in all modes	Check transport direction control logic. Check crystal reference frequency. Check timer tachometer signal.
Timer accuracy incorrect only at high tape speeds	Capstan tach signal level incorrect. Capstan tach sensor incorrectly adjusted. Tape tension too low.
Timer will not reset to zero	Timer reset switch. Timer reset logic.

Table 5-19. Troubleshooting Hints — Flutter

PROBLEM	POSSIBLE CAUSE/CHECK
Weighted flutter at 15 or 30 in/s out of specification	Low-frequency flutter excessive due to capstan tachometer, supply tension arm tape guide, or takeup tension arm tape guide (see Rotational Rates (Hertz), Table 5-16). Poor surface quality of tape used. Tape not bulk erased.
Unweighted flutter at 3.75 or 7.5 in/s out of specification	Tape tension balance incorrect. Capstan tachometer dirty. Poor surface quality of tape used.

Table 5-19. Troubleshooting Hints — Flutter (Continued)

PROBLEM	POSSIBLE CAUSE/CHECK
Unweighted flutter at 3.75 or 7.5 in/s out of specification (continued)	<p>Tape not bulk erased.</p> <p>Tape guide rollers not cleaned.</p> <p>Audio signal system alignment not correct.</p> <p>Capstan tachometer signals not set to proper phase; levels too high or too low.</p> <p>Capstan motor dragging or bearings defective.</p> <p>Capstan motor commutator dirty or damaged.</p>
Excessive scrape flutter (high-frequency flutter)	<p>Dirty or dry scrape flutter idler bearings; clean and lubricate.</p> <p>Tape surface quality poor causing uncontrollable scrape flutter.</p> <p>Scrape flutter idler position incorrect against tape.</p> <p>Scrape flutter idler not perpendicular to tape path causing tape to slide on roller.</p>

Table 5-20. Troubleshooting Hints — Signal-to-Noise Ratio

PROBLEM	POSSIBLE CAUSE/CHECK
Excessive system noise or signal-to-noise ratio is out of specifications	<p>Incorrect operating level is being used.</p> <p>Incorrect noise weighting filter being used for the particular specification being measured.</p> <p>Tape that was used for recordings of a different track format not bulk erased.</p> <p>Check erase depth adjustment.</p> <p>Heads and guides not clean or demagnetized.</p> <p>Check second harmonic distortion. If high, it could indicate magnetized component in tape path which may possibly be defective and cause high noise.</p> <p>Check that grounding straps are secure.</p> <p>Check external test equipment for ground loops.</p> <p>If noise is cyclic over a long period, check for noisy main voltage regulator A8 on main audio PWA.</p>

Table 5-21. Troubleshooting Hints — Harmonic and Intermodulation Distortion

PROBLEM	POSSIBLE CAUSE/CHECK
High second harmonic distortion	<p>Heads and/or tape guides magnetized.</p> <p>Audio oscillator used for measurement has a second harmonic component greater than 0.03% rms (−70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz.</p> <p>DC offset voltage incorrectly set in input/output assembly input amplifier.</p> <p>System output connected to highly nonlinear load, such as overdriven level meters.</p> <p>Record amplifier malfunctioning.</p> <p>Record head in presence of large dc field.</p> <p>Erase circuitry malfunctioning.</p>
High third harmonic distortion	<p>Audio oscillator used for measurement has a third harmonic component greater than 0.05% rms (−66 dB).</p> <p>Record and/or reproduce operating levels not set correctly for type of tape in use.</p> <p>Bias not set correctly (2.75 dB \pm0.5 dB overbias at 1.5-mil wavelength using Ampex 456 tape).</p> <p>DC offset voltage incorrectly set in input/output assembly line output amplifier.</p>
High intermodulation distortion	<p>Same causes as for high second or third harmonic distortion.</p> <p>Physically damaged tape causing excessive amplitude fluctuation of high frequency carrier.</p>

Table 5-22. Troubleshooting Hints — General

PROBLEM	POSSIBLE CAUSE/CHECK
All LEDs illuminated on control unit and transport inoperative	Master oscillator inoperative.
LEDs on control unit will not illuminate	<p>5-Vdc supply inoperative — check fuse F2 (Figure 2-11).</p> <p>Control unit connector P11 disconnected.</p>
Control unit audio status indicators do not match actual system status	<p>System lockout circuit operating as invalid speed has been selected.</p> <p>Multiplex circuitry.</p>
When input/output assembly is connected, system monitors input signal at all times	System lockout circuit operating as invalid speed has been selected.

Table 5-22. Troubleshooting Hints — General (Continued)

PROBLEM	POSSIBLE CAUSE/CHECK
BIAS and/or ERASE indicators on input/output assembly illuminate when system not in record mode	Logic circuitry on audio PWA or audio control PWA. $\pm 15\text{-Vdc}$ supply on input/output assembly out of tolerance.
Transport will not stop or change transport modes when in record mode	ERS logic command failure — audio control PWA. MRB logic command not unlatching — transport control PWA.

5-89. Component Replacement Procedures

5-90. Power Supply. Access to the interior of the power supply is obtained by loosening the four power-supply cover screws (Figure 5-45) and removing the cover. To remove and replace the entire power supply, proceed as follows:

1. If recorder/reproducer is located in a cabinet, remove entire bottom cover of cabinet (ten screws).
2. Disconnect fan connector P20.
3. Remove transport rear overlay panel (six screws shown in Figure 2-2).
4. If a ground strap is connected to the power supply, remove the ground strap on the power supply.
5. Disconnect power supply connectors P1 and P2 (Figure 5-45).

WARNING

THE POWER SUPPLY IS HEAVY AND TWO PEOPLE ARE USUALLY REQUIRED TO SAFELY REMOVE THE SUPPLY FROM THE TRANSPORT.

6. Support the weight of the power supply while removing the three hex-socket power supply mounting screws (Figure 5-45) that secure the power supply to the rear of the transport casting.
7. Reinstall power supply in the reverse order of removal while being careful not to damage any transport harness wires located in the power supply area.

5-91. Electronics Assembly. To remove and replace the electronics assembly, proceed as follows:

1. If recorder/reproducer is in a cabinet, remove entire bottom cover of cabinet (ten screws).
2. Disconnect fan connector P20.
3. Remove head cover assembly, head assembly, and front overlay panel (two screws) shown in Figure 5-22.

4. Remove ground strap that connects to electronics assembly from the tape transport. On early production units, strap is located front left of transport. On later units, strap is located in the rear of the head connector area.
5. Disconnect electronics assembly harness connector P16 that connects to tach sensor connector J16.
6. Disconnect electronic assembly harness connector P15 that connects to reel drive connector P15.
7. Disconnect control panel connector P11 from electronics assembly double-sided connector J11.
8. From the top of the transport, remove three 6-32 cap screws (Figure 5-37) that secure the electronics assembly to the transport.
9. From the bottom of the transport, slide electronics assembly chassis toward the supply reel and lift electronics assembly from the transport.
10. Remove electronics assembly rear cover panel (two screws).
11. Remove transport harness connector P10 from electronics assembly motherboard connector J10 to completely free electronics assembly from transport.
12. Reinstall electronics assembly in the reverse order of removal, being careful not to damage any cables (especially cable/connector P10).

5-92. Capstan/Tach Assembly. The capstan/tach assembly is assembled at the factory and must be replaced as a unit. To remove the capstan/tach assembly, proceed as follows:

1. Remove the head cover assembly and head assembly from the top of the transport.
2. Remove the transport front and rear overlay panels (eight screws) from the top of the recorder/reproducer.

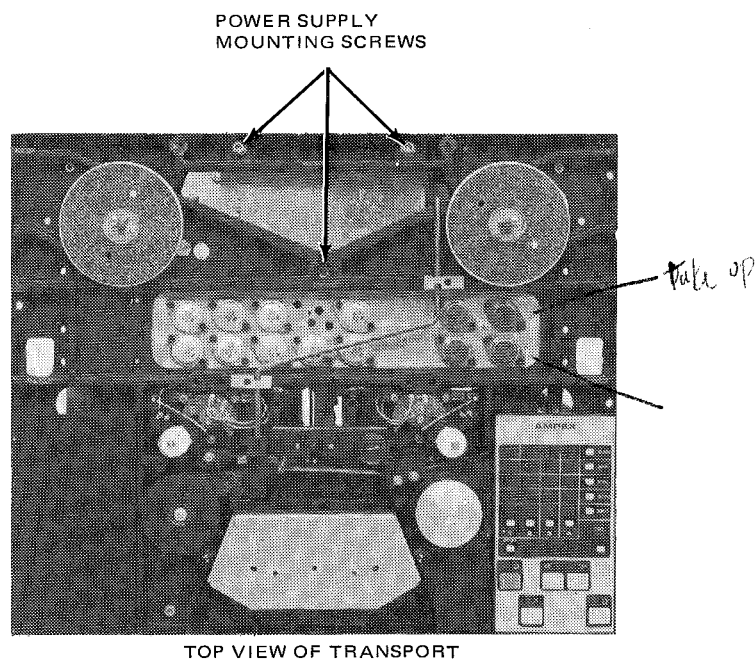
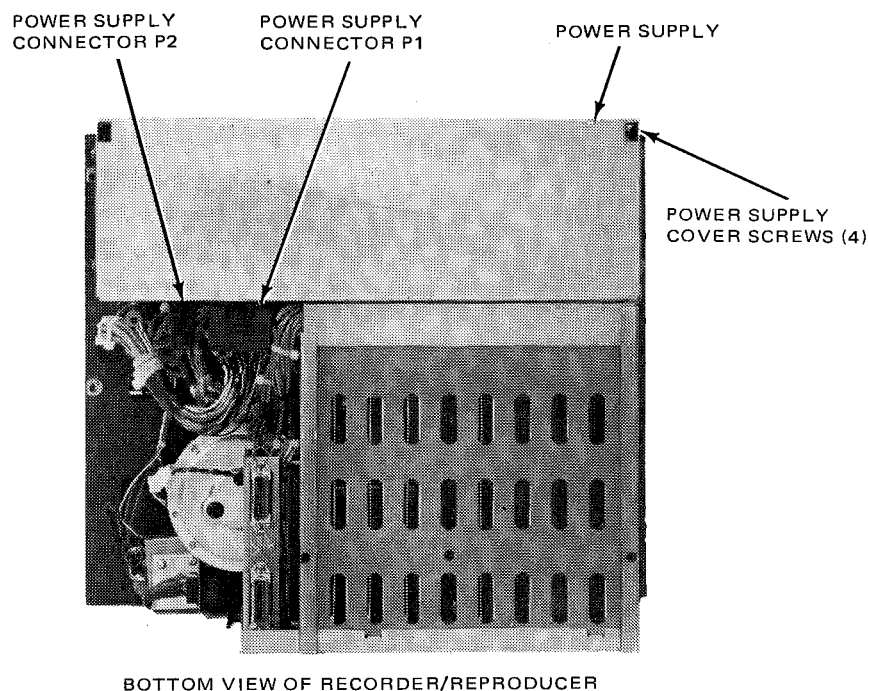


Figure 5-45. Power Supply Removal

3. Remove front and rear tach cover panels by removing two flat-head screws, one socket-head screw, and one banana plug shown in Figure 5-20.
4. Remove socket-head screw, lock washer, and flat washer that secure the capstan tach sensor PWA (Figure 5-19). (Note: Do not loosen or remove the bar holddown screw, shown in Figure 5-19, that secures the capstan sensor bar, or adjustment of the capstan tach sensor PWA position will be required.)
5. Carefully lift capstan tach sensor PWA from adjustment pin and the shoulder of PWA mounting post. Carefully turn PWA out of the way of the glass tach disc.
6. Loosen capstan-edit-knob setscrews (two), and remove knob.
7. Loosen the two capstan/tach assembly setscrews 1/4 turn. Carefully lift the capstan/tach assembly on the capstan motor shaft, then continue loosening the lower setscrew (nearest the tach disc) four full turns to remove the capstan/tach assembly from the motor shaft.

CAUTION

IF TACH DISC NEEDS TO BE CLEANED, USE A SOFT LINT-FREE CLOTH OR KIM-WIPE MOISTENED WITH WINDEX OR ISOPROPYL ALCOHOL. (FOR INSTRUCTIONS REGARDING THE CLEANING OF PHOTOPOTENTIOMETERS, LEDs, OR ANY PHOTO SENSE DEVICE, SEE PARAGRAPH 5-6.)

8. Replace capstan/tach assembly and capstan tach sensor PWA in the reverse order of removal. If a radial alignment mark is on end of motor shaft and on the capstan/tach assembly, line these two marks up before tightening the setscrews. This alignment position has been chosen at the factory for minimum flutter. Do not overtighten setscrews. (Correct setscrew torque is 1.8 ± 0.3 inch pounds.)
9. Before mounting overlay and tach cover panels, verify that tach sensor PWA is in the

proper position by performing the following tests:

- a. With power off, unplug reel servo PWA No. 9 within the electronics unit. (This disables reel servo so that reel motors do not operate.)
- b. Apply power and press play pushbutton switch. Capstan should run at the selected speed.
- c. Press stop pushbutton switch and observe if capstan quickly stops.
- d. Press fast forward pushbutton switch and allow capstan to reach full speed, then press stop pushbutton switch. Capstan should quickly stop.
- e. Press rewind pushbutton switch and allow capstan to reach full speed, then press stop pushbutton switch. Capstan should quickly stop.
- f. If the system did not pass any one of the above tests, perform the capstan tach sensor PWA position adjustment procedure given in this section under the heading *Capstan Tach Sensor*, paragraph 5-59.

10. Adjust the position of the tape peeler by performing the adjustment procedure given under the heading *Tape Peeler*, paragraph 5-70.

5-93. Capstan Motor and Parts Replacement.

Besides the complete capstan motor, component parts that can be replaced are the motor brushes, flywheel and rotor assembly, capstan shaft assembly, and capstan motor bearings (Figure 5-46). It is not necessary to remove the complete motor to replace any of these component parts. The brushes are located within the rear cover. Note that the flywheel and rotor are not separable parts and therefore must be replaced as a unit.

The capstan rotor, rear cover, and brushes are manufactured by two different companies and these parts are not interchangeable on a given motor. Therefore, when parts are to be replaced, be sure the correct replacement part is used.

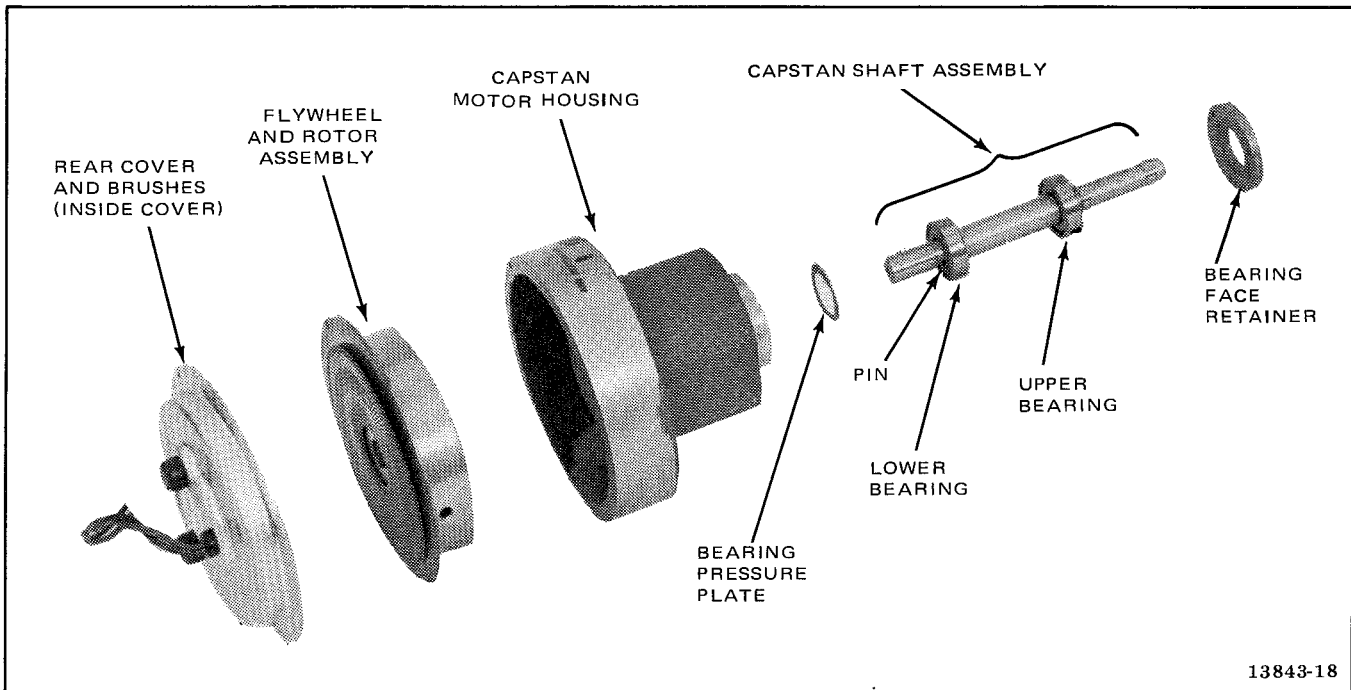


Figure 5-46. Exploded View of Capstan Motor

5-94. *Capstan Motor.* To replace the entire capstan motor, proceed as follows:

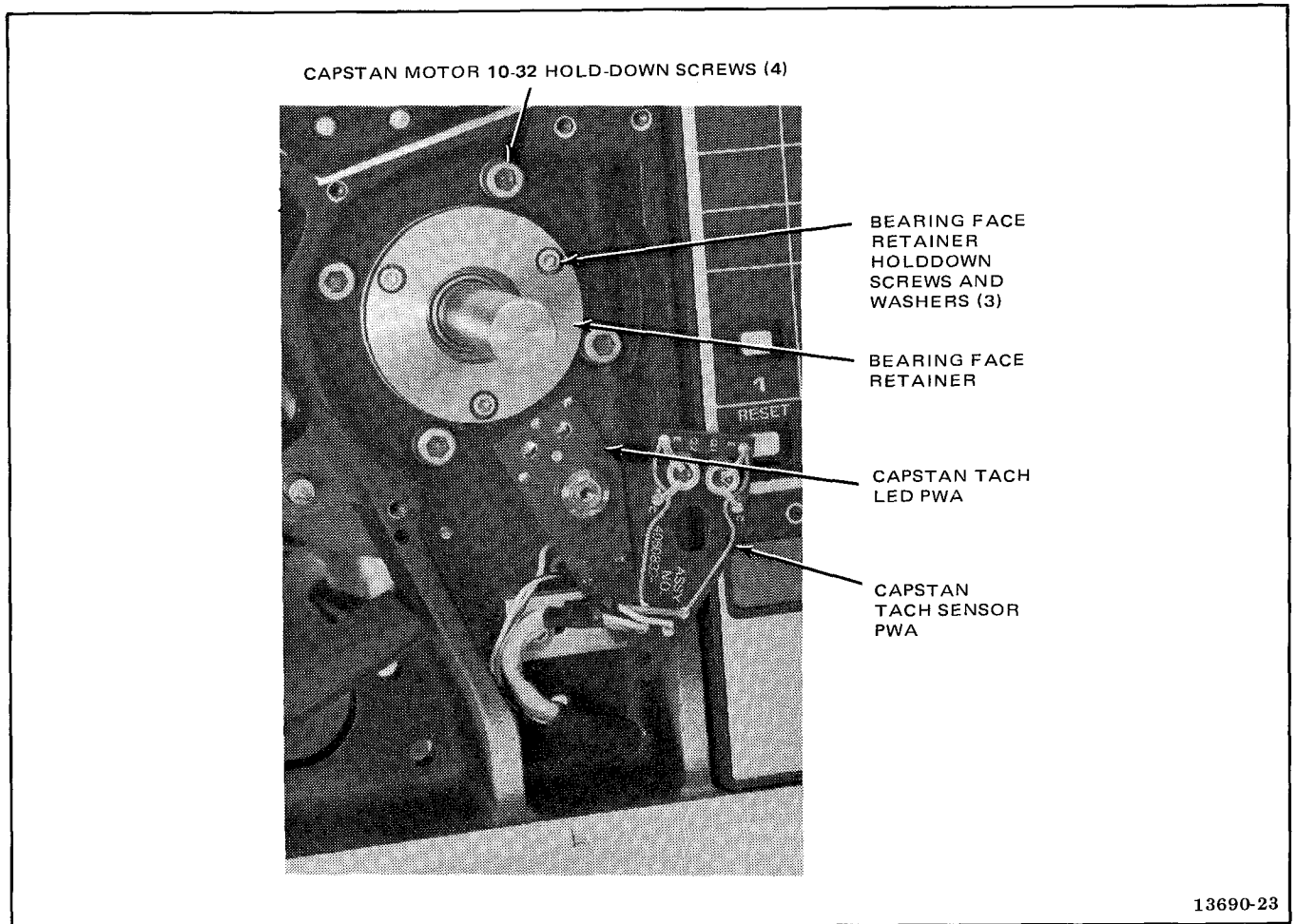
1. Remove the capstan/tach assembly as described under the heading *Capstan/Tach Assembly* in this section of the manual, paragraph 5-92.
2. Disconnect transport harness connector P18 that connects to capstan motor connector P18.
3. Disconnect control unit connector P11 that connects to electronics assembly connector J11.
4. Remove four capstan motor 10-32 holddown screws (Figure 5-47).
5. Carefully slide motor out bottom of transport, tilting motor as required to clear electronics assembly chassis.
6. Reinstall motor in the reverse order of removal with the flat on side of capstan motor housing facing the electronics assembly chassis.

5-95. *Capstan Motor Brushes.* Use the following procedure to replace the capstan motor brushes. The motor brushes (Figure 5-48) are attached to the inside of the capstan motor rear cover. Proceed as follows:

1. To permit more access space at the rear of the capstan motor, disconnect transport harness connector P18 that connects to capstan motor connector P18, and disconnect control unit connector P11 that connects to electronics assembly connector J11.
2. Remove only the two screws and flat washers shown in Figure 5-48 that secure the capstan motor rear cover to the motor (not the plate screws).
3. Note that the permanent magnet within the rear cover tends to hold the cover to the housing. Carefully pull rear cover from the motor.

CAUTION

TAKE CARE TO PREVENT METALLIC PARTICLES FROM GATHERING ON THE PERMANENT MAGNET.



13690-23

Figure 5-47. Capstan Motor Removal

4. Unsolder each brush lead and remove brushes, taking care to save brush springs.
 5. Install new brushes and springs. Before soldering brush leads, adjust lead length so that spring does not force brush from brush holder. While soldering lead, clamp brush lead with a long-nose pliers to prevent solder from entering braid.
 6. Contour the brush ends by placing the rear cover face down on a sheet of 400 grit sandpaper placed on a hard flat surface. Rotate rear cover back and forth approximately 90° about five times. Clean all contamination from the magnet and then clean brush ends with isopropyl alcohol.
 7. Reinstall rear cover onto motor using screws and flat washers removed in step 2.
 8. Reconnect control unit connector P11 to electronics unit connector J11, and reconnect transport harness connector P18 to capstan motor connector P18.
- 5-96. Flywheel and Rotor.** Use the following procedure to replace the flywheel and rotor assembly (Figure 5-46).
1. Perform steps 1, 2, and 3 of the preceding *Capstan Motor Brushes* replacement procedure (paragraph 5-95) to remove the capstan motor rear cover.

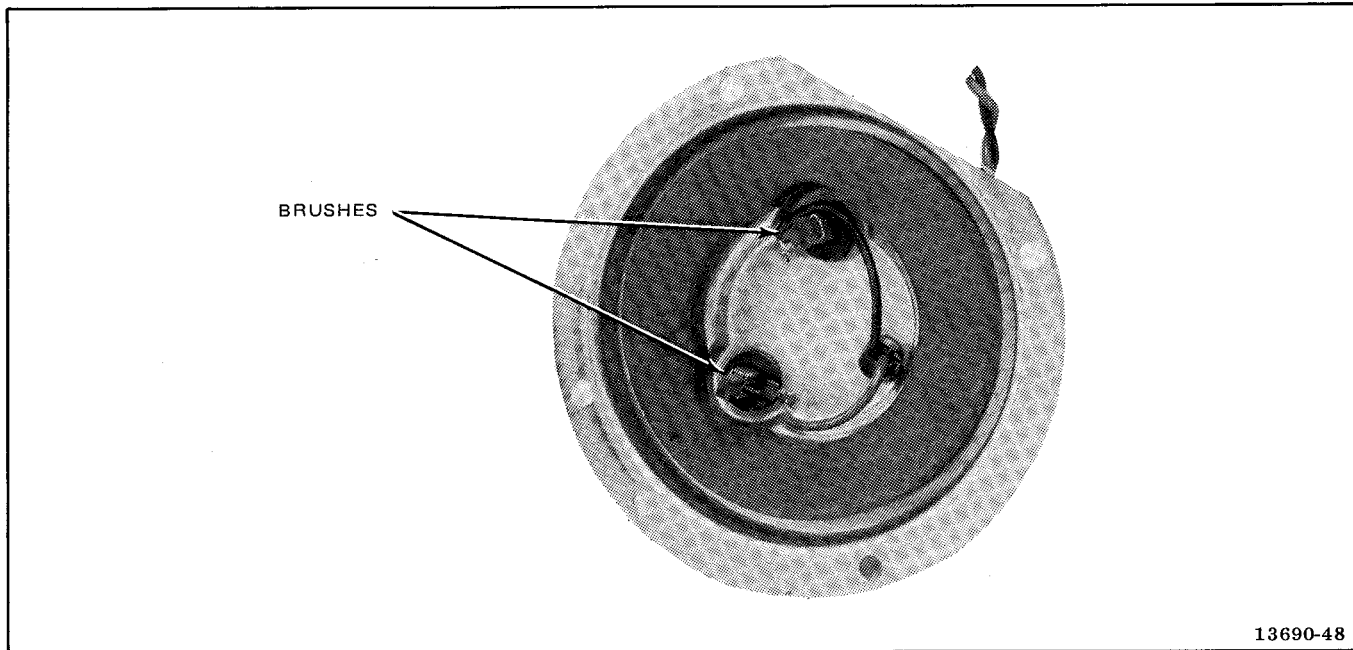


Figure 5-48. Capstan Motor Rear Cover Assembly

2. Remove the two hex-socket plate screws (Figure 5-49) that secure the 1/16-inch thick plate to the capstan housing (Figure 5-46).
3. Disconnect tach sensors connector J16 from electronics assembly connector P16.
4. Turn motor shaft to align hole in flywheel with hole in capstan housing. (Note: There are two holes in flywheel; one hole has a setscrew and the other is a counterbalance hole.) Insert Allen wrench and loosen setscrew about five complete rotations.
5. While supporting flywheel and motor assembly with one hand, remove Allen wrench and carefully slide flywheel and rotor assembly off the shaft.

CAUTION

DO NOT SCRATCH OR TOUCH PRINTED MOTOR SURFACE ESPECIALLY IN AREA WHERE BRUSHES SLIDE.

6. Reassemble motor in the reverse order of disassembly. When installing flywheel and rotor

assembly on shaft, be certain that key slot in flywheel engages with pin in capstan shaft before tightening flywheel setscrew.

5-97. Capstan Shaft Assembly. Remove the capstan shaft assembly from the front of the transport as follows:

1. Remove the capstan/tach assembly as described under the heading *Capstan/Tach Assembly* in this section of the manual, paragraph 5-92.
2. Disconnect tach sensors connector J16 from electronics assembly connector P16.
3. Turn motor shaft to align hole in flywheel with hole in capstan housing. (Note: There are two holes in flywheel; one hole has a setscrew and the other is a counterbalance hole.) Insert Allen wrench to loosen setscrew about five complete turns. Insert a spare Allen wrench in flywheel hole to maintain angular position of flywheel.
4. Remove bearing face retainer (three screws and washers shown in Figure 5-47).

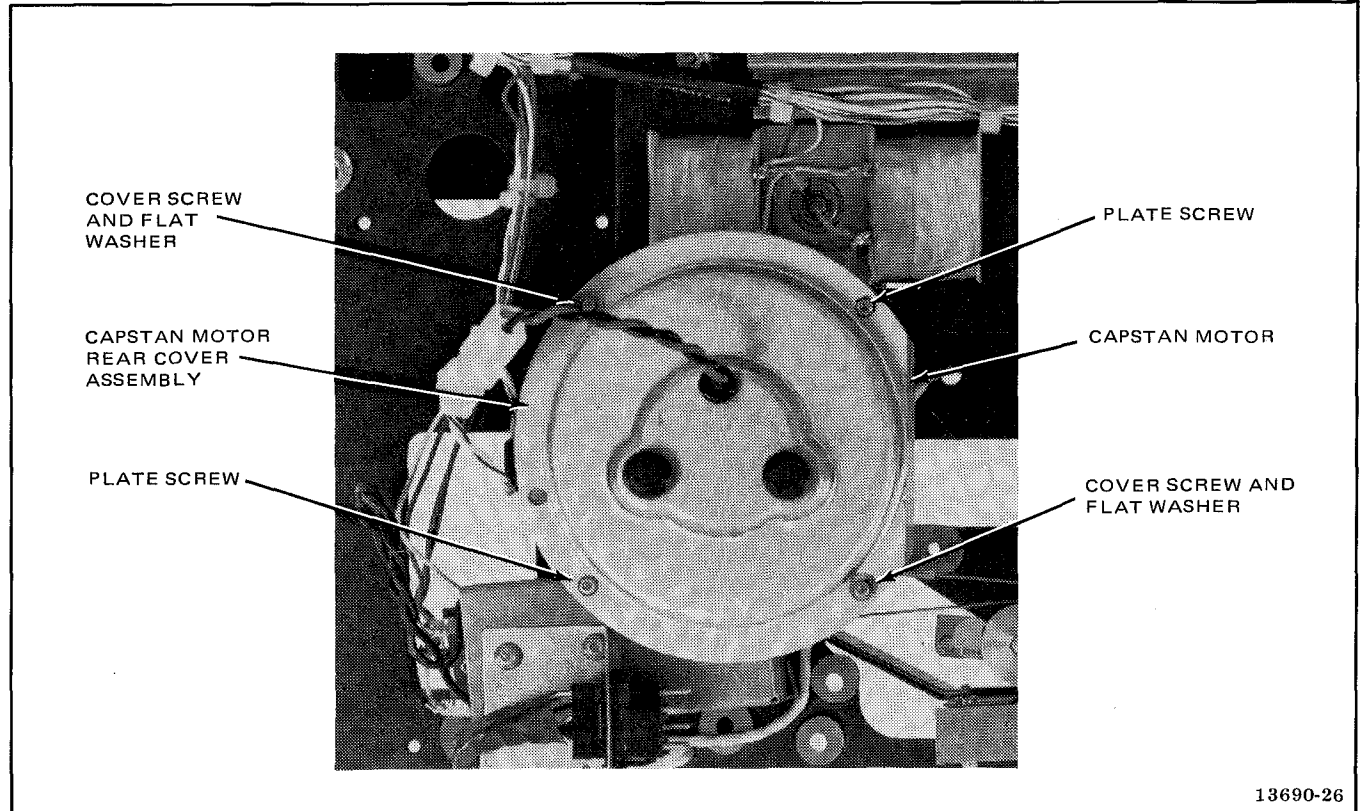


Figure 5-49. Rear View of Capstan Motor Assembly

5. From the top of the transport, carefully pull capstan shaft assembly up and out of the capstan housing. Be careful to retain the three bearing compression springs that fit into holes in the spring retainer attached to the bottom of the capstan housing.
 6. Prior to reinstalling the capstan shaft assembly, be sure that the three bearing compression springs are in the holes in the spring retainer inside the capstan housing.
 7. Check that the bearing pressure plate shown in Figure 5-46 (looks like a large washer) is either resting on the springs or is held by grease film to the lower bearing on the capstan shaft assembly.
 8. Slide capstan shaft assembly into capstan housing so that pin in side of capstan shaft assembly is aligned with setscrew in flywheel.
 9. Place bearing face retainer, removed in step 3, on top of upper bearing and push by hand against end of shaft to fully seat shaft in capstan housing and to compress bearing compression springs. If pin in side of capstan is not aligned with setscrew in flywheel, in order to engage key slot in flywheel, shaft will not fully insert into housing. (Approximately 20 pounds of force are required to fully compress the compression springs.)
 10. After ascertaining that shaft is correctly installed and pin is engaged in slot in flywheel, install the three bearing face retainer screws and washers removed in step 4.
 11. Tighten setscrew in flywheel against the capstan shaft assembly.
- NOTE**
- Do not remove grease coating within the capstan housing bore.**

12. Rotate shaft by hand to check for freedom from rubbing or binding.
13. Reinstall capstan tach assembly as described under the heading *Capstan/Tach Assembly*, paragraph 5-92.
14. Reconnect tach sensor connector J16 to electronics assembly connector P16.

5-98. Capstan Shaft Bearings. With the use of proper tools, new bearings may be pressed onto the capstan motor shaft. If the proper tools are not available and the bearings need replacement, it is suggested that a new capstan motor shaft assembly (includes bearings) be installed (Ampex Part No. 4041264). The two ball bearings used are size R8, ABEC class 5 tolerance grade (Ampex Part No. 4200075) and are pregreased and ready for use. The bearings are double shielded, but not sealed, and are greased with type Andok C grease.

To remove and replace the bearings on the capstan shaft, proceed as follows:

1. Remove the capstan shaft assembly from the capstan motor housing as described in the preceding *Capstan Shaft Assembly* removal procedure, paragraph 5-97.
2. Prior to removing the lower bearing (Figure 5-46), remove the 0.062 flywheel drive pin from the capstan shaft.
3. Each bearing is removed by pressing the bearing off the shaft at the end closest to the bearing. Note: Removing the bearings usually causes permanent damage to the bearings and therefore they should not be reused.
4. Prior to pressing the new bearing on the shaft, coat the shaft with heavy grease to reduce friction while pressing the bearing on the shaft.
5. Press the new bearing on the shaft by pressing squarely against the bearing inner race *only*. If force is applied through the ball bearings, the bearing will be damaged. Press the bearings fully against the shoulders of the shaft to obtain correct axial location relative to the shaft.

6. If the lower bearing (Figure 5-46) was replaced, reinstall the 0.062 pin removed in step 2. Use an adhesive such as Loctite to secure pin. Be sure pin is fully bottomed in hole drilled in side of shaft.
7. Protect capstan shaft assembly against dirt and mechanical damage until reinstalled into capstan motor housing. Reinstall capstan shaft assembly as described in the preceding *Capstan Shaft Assembly* removal procedure, paragraph 5-97.

5-99. Reel Drive Motors and Brush Replacement.

Besides the complete reel drive motor, the only parts that may be replaced on a motor are the motor brushes. The motors are supplied by several vendors and may be used interchangeably in a supply or takeup motor position. However, the brushes are not interchangeable and the correct brush for a given motor must be used.

5-100. Reel Drive Motor Replacement. To remove and reinstall a supply or takeup reel motor, proceed as follows:

1. Remove the power supply by following the instructions given under heading *Component Replacement Procedures* in this section of the manual, paragraph 5-89.
2. Disconnect the appropriate reel drive motor connector P17 (takeup) or P19 (supply).
3. Remove and reinstall reel motor by following the instructions given for *Turntable Repositioning for Reel Size* (paragraph 2-22) given under the heading *Initial Adjustments* in Section 2 of this manual.
4. Reconnect reel motor connector P17 (takeup) or P19 (supply).
5. Reinstall power supply and reconnect power supply connectors P1 and P2.
6. Reinstall transport upper overlay panel.

5-101. Brush Replacement. The two motor brushes seldom wear out; however, a brush may chip or become noisy and therefore need replacing.

Proceed as follows:

1. If the brush that needs to be replaced is facing the power supply, remove the power supply by following the instructions given under the heading *Component Replacement Procedures* in this section of the manual, paragraph 5-89.
2. To remove a brush, use a large bladed screwdriver and unscrew the motor endplug (Figure 5-50). The brush has a spring attached which maintains pressure against the motor commutator. Slide the old brush out of the retaining hole in the motor.
3. Clean the new brush with isopropyl alcohol and install in the motor.
4. Secure new brush and spring with endplug removed in step 2.
5. If power supply was removed, reinstall in the reverse order of removal.

CAUTION

A NEW BRUSH MAY SQUEAK UNTIL THE MOTOR HAS BEEN RUN LONG ENOUGH TO SEAT THE NEW BRUSH TO THE COMMUTATOR. DO NOT APPLY ANY LUBRICANTS TO THE BRUSH.

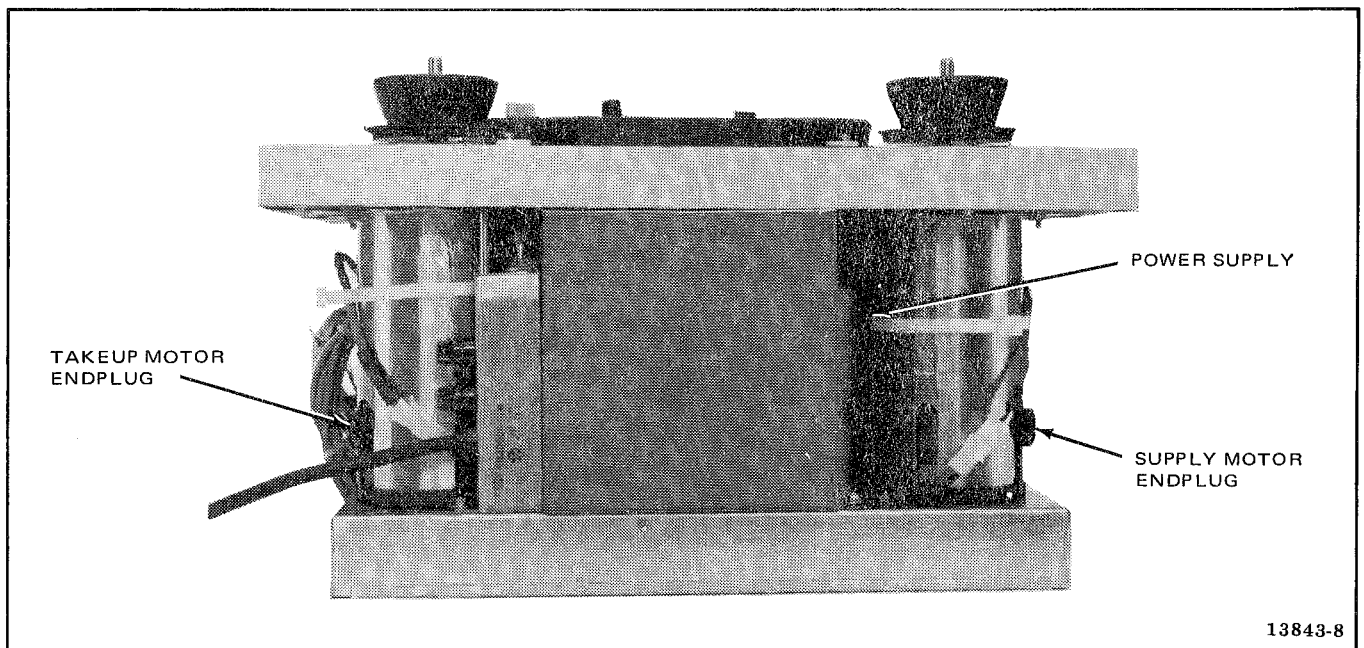


Figure 5-50. Reel Drive Motor Brush Replacement, Rear Side View of Transport

SECTION 6

PARTS LISTS AND SCHEMATICS

This section of the manual provides parts lists, assembly drawings and schematic diagrams for the ATR-100 Series Recorder/Reproducer, Part No. 4010260, 4010261, 4010262.

Three indexes list the assemblies as follows:

- **Indented List of Assemblies** — List of assemblies in sequence of appearance in the manual.
- **Numerical List of Assemblies** — List of assemblies in numeric sequence.
- **Numerical List of Schematics** — List of schematics in numeric sequence.

INDENTURED LIST OF ASSEMBLIES

TITLE	ASSEMBLY NO.	PAGE NO.
SYSTEM		
ATR-100 Tape Recorder/Reproducer, Full Track	4010260	6-1
ATR-100 Tape Recorder/Reproducer, Two Track	4010261	6-2
ATR-100 Tape Recorder/Reproducer, Four Track	4010262	6-3
TRANSPORT		
Transport Assembly	4020400	6-5
Capstan Assembly	4030390	6-9
Capstan Shaft Assembly	4041264	6-10
Tension Arm Solenoid Housing Assembly	4030397	6-11
Head Gate Latch Assembly	4030411	6-12
Turntable Assembly	4030398	6-13
Tape Lifter Assembly	4030400	6-14
Tape Tension Solenoid Assembly	4030412	6-15
Tape Timer Wheel Assembly	4041230	6-16
Speed Switch Bracket Assembly	4041242	6-17
Reel Drive Motor Assembly	4030408	6-18
Transport Harness Assembly	4050814	6-19
Transport to Power Supply Harness Assembly	4050815	6-23
Tachometers No. 2 Harness Assembly	4050818	6-24
Capstan Tachometer Sensor PWA	4050832	6-25
Capstan Tachometer LED PWA	4050833	6-26
Tension Transducer LED PWA	4050834	6-27
Tension Transducer Sensor PWA	4050835	6-28
Timer Tachometer PWA	4050836	6-29
Head Gate Assembly	4041229	6-30
ELECTRONICS		
Electronics Chassis Assembly	4020404	6-31
Motherboard PWA	4050799	6-35
Tachometers No. 1 Harness Assembly	4050817	6-36
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Input/Output Harness Assembly	4050823	6-38
Head Connector and Cable Assembly	4050824	6-39
Main Audio PWA, No. 1, 2, 3, 4	4050754	6-40
PADNET PWA	4050755	6-45
Audio Control PWA, No. 5	4050788	6-49

INDENTURED LIST OF ASSEMBLIES (Continued)

TITLE	ASSEMBLY NO.	PAGE NO.
ATR-100 Tape Recorder/Reproducer (Continued)		
ELECTRONICS (Continued)		
Transport Logic and Tape Timer PWA, No. 7 (Transport Control) . . .	4050787	6-53
Capstan Servo PWA, No. 8	4050776	6-59
Reel Servo PWA, No. 9	4050778	6-65
POWER SUPPLY		
Power Supply Assembly	4020406	6-71
Power Supply and Dynamic Brakes PWA	4050794	6-75
Power Supply Harness Assembly	4050813	6-78
CONTROL UNIT		
Control Unit, 4 Channel	4020405	6-79
Control Unit No. 1 PWA, 4 Channel	4050784	6-81
Control Unit No. 2 PWA, 4 Channel	4050785	6-85
Control Unit Harness Assembly	4050786	6-88
HEAD ASSEMBLIES		
Full Track Head Assembly, 1/4 Inch	4020413	6-89
Scrape Flutter Idler Assembly	4030402	6-91
Head Connector PWA, 1 - 2 Channel	4050846	6-92
Two Track Head Assembly, 1/4 Inch	4020417	6-93
Scrape Flutter Idler Assembly (See Page 6-91)	4030402	
Head Connector PWA (See Page 6-92)	4050846	
Four Track Head Assembly, 1/2 Inch	4020418	6-97
Scrape Flutter Idler Assembly (See Page 6-91)	4030402	
Head Connector PWA, 4 Channel	4050837	6-99
MISCELLANEOUS		
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ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010260-00		ATR-100 TAPE RECORDER/REPRODUCER, FULL TRACK (NHA CATALOG)	
1	4010255-01		MISCELLANEOUS PARTS KIT	
3	4020400-02		TRANSPORT ASSEMBLY	
5	4020405-02		CONTROL UNIT, 4 CHANNEL	
8	4020413-02		FULL TRACK HEAD ASSEMBLY, 1/4 INCH	
9	4041256-01		COVER ASSY, HEAD	
12	4041239-AC		TAPE GUIDE ASSEMBLY, 1/4 INCH, SUPPLY	
13	4041239-AD		TAPE GUIDE ASSEMBLY, 1/4 INCH, TAKE UP	
17	4050754-06		AUDIO MAIN BOARD PWA	
18	4050755-01		PADNET PWA	
19	4050776-07		CAPSTAN SERVO PWA	
20	4050778-03		REEL SERVO PWA	
21	4050787-02		TRANSPORT LOGIC AND TAPE TIMER PWA	
22	4050788-04		AUDIO CONTROL PWA	
23	4050800-01		EXTENDER CARD PWA	
27	4170339-AA		LINE VOLTAGE WARNING CARD, 115V	
28	4170339-AB		LINE VOLTAGE WARNING CARD, 230V	
30	4170330-AA		LABEL, AUDIO BOARD POSITION (1)	
32	4020426-01		PEDESTAL ASSEMBLY	
34	4010258-AC		CABINET (1 & 2 CH) (OPTION) ✕	
35	4010259-01		CASE, PORTABLE —	
36	4010252-01		RACK MOUNT KIT (FIXED)	
37	4010253-01		RACK MOUNT KIT (SLIDES)(OPTION)	
38	4010254-04		INPUT/OUTPUT MAIN FRAME (ACCESSORY)	
39	4020409-04		INPUT/OUTPUT MODULE ASSEMBLY (ACCESSORY)	
40	4041247-02		PANEL, BLANK (ACCESSORY)	
41	4010264-02		REMOTE CONTROL, 4 CHANNEL (ACCESSORY)	
42	4020429-01		RISER KIT (I/O) (ACCESSORY)	
43	4020428-01		COVER KIT (RACK MOUNT ONLY (ACCESSORY)	
46	4041240-AC		TAPE GUIDE ASSY, 1/2 INCH, SUPPLY (ACCESSORY)	
47	4041240-AD		TAPE GUIDE ASSY, 1/2 INCH, TAKE UP (ACCESSORY)	
48	4020417-02		TWO TRACK HEAD ASSEMBLY, 1/4 INCH (ACCESSORY)	
49	4020418-02		FOUR TRACK HEAD ASSEMBLY, 1/2 INCH (ACCESSORY)	
50	4020432-01		TWO WAY EXTENSION CONNECTOR ASSEMBLY (ACCESSORY)	
60	4020404-02		ELECTRONICS CHASSIS ASSEMBLY	
61	4020406-03		POWER SUPPLY ASSEMBLY	

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SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010261-00		ATR-100 TAPE RECORDER/REPRODUCER, TWO TRACK (NHA CATALOG)	
1	4010255-01		MISCELLANEOUS PARTS KIT	
3	4020400-02		TRANSPORT ASSEMBLY	
5	4020405-02		CONTROL UNIT, 4 CHANNEL	
9	4020417-02		TWO TRACK, HEAD ASSEMBLY, 1/4 INCH	
12	4041239-AC		TAPE GUIDE ASSEMBLY, 1/4 INCH SUPPLY	
13	4041239-AD		TAPE GUIDE ASSEMBLY, 1/4 INCH TAKEUP	
14	4041256-01		COVER ASSY, HEAD	
15	4170339-AA		LINE VOLTAGE WARNING CARD, 115V	
16	4170339-AB		LINE VOLTAGE WARNING CARD, 230V	
17	4050754-06		AUDIO MAIN BOARD PWA	
18	4050755-01		PADNET PWA	
19	4050776-07		CAPSTAN SERVO PWA	
20	4050778-03		REEL SERVO PWA	
21	4050787-02		TRANSPORT LOGIC AND TAPE TIMER PWA	
22	4050788-04		AUDIO CONTROL PWA	
23	4050800-01		EXTENDER CARD PWA	
27	4170330-AA		LABEL, AUDIO BOARD POSITION (1)	
28	4170330-AB		LABEL, AUDIO BOARD POSITION (2)	
32	4010252-01		RACK MOUNT KIT (FIXED) (OPTION)	
33	4010253-01		RACK MOUNT KIT (SLIDES) (OPTION)	
34	4010258-AC		CABINET (1 & 2 CH) (OPTION)	
35	4010259-01		CASE, PORTABLE (OPTION)	
37	4020426-01		PEDESTAL ASSEMBLY	
38	4010254-02		INPUT/OUTPUT MAIN FRAME (ACCESSORY)	
39	4020409-01		INPUT/OUTPUT MODULE ASSEMBLY (ACCESSORY)	
42	4010264-02		REMOTE CONTROL, 4 CHANNEL (ACCESSORY)	
43	4020429-01		RISER KIT (I/O) (ACCESSORY)	
44	4020428-01		COVER, KIT (RACK MOUNT ONLY) (ACCESSORY)	
47	4041240-AC		TAPE GUIDE ASSEMBLY, 1/2 INCH, SUPPLY (ACCESSORY)	
48	4041240-AD		TAPE GUIDE ASSEMBLY, 1/2 INCH, TAKE UP (ACCESSORY)	
49	4020413-02		FULL TRACK HEAD ASSEMBLY, 1/4 INCH (ACCESSORY)	
50	4020418-02		FOUR TRACK HEAD ASSEMBLY, 1/2 INCH (ACCESSORY)	
51	4020432-01		TWO WAY EXTENSION CONNECTOR ASSEMBLY (ACCESSORY)	
60	4020404-02		ELECTRONICS CHASSIS ASSEMBLY	
61	4020406-03		POWER SUPPLY ASSEMBLY	

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SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010262-00		ATR-100 TAPE RECORDER/REPRODUCER, FOUR TRACK (NHA CATALOG)	
1	4010267-01		MISCELLANEOUS PARTS KIT	
3	4020400-02		TRANSPORT ASSEMBLY	
5	4020405-02		CONTROL UNIT, 4 CHANNEL	
6	4170330-AA		LABEL, AUDIO BOARD POSITION (1)	
7	4170330-AB		LABEL, AUDIO BOARD POSITION (2)	
8	4170330-AC		LABEL, AUDIO BOARD POSITION (3)	
9	4170330-AD		LABEL, AUDIO BOARD POSITION (4)	
10	4020418-02		FOUR TRACK, HEAD ASSEMBLY, 1/2 INCH	
11	4041256-01		COVER ASSY, HEAD	
12	4170339-AA		LINE VOLTAGE WARNING CARD, 115V	
13	4170339-AB		LINE VOLTAGE WARNING CARD, 230V	
14	4041240-AC		TAPE GUIDE ASSEMBLY, 1/2 INCH, SUPPLY	
15	4041240-AD		TAPE GUIDE ASSEMBLY, 1/2 INCH, TAKE UP	
17	4050754-06		AUDIO MAIN BOARD PWA	
18	4050755-01		PADNET PWA	
19	4050776-07		CAPSTAN SERVO PWA	
20	4050778-03		REEL SERVO PWA	
21	4050787-02		TRANSPORT LOGIC AND TAPE TIMER PWA	
22	4050788-04		AUDIO CONTROL PWA	
23	4050800-01		EXTENDER CARD PWA	
32	4010252-01		RACK MOUNT KIT (FIXED) (OPTION)	
33	4010253-01		RACK MOUNT KIT (SLIDES) (OPTION)	
34	4010258-AD		CABINET (4 CH) (OPTION)	
35	4010259-01		CASE, PORTABLE (OPTION)	
37	4020426-01		PEDESTAL ASSEMBLY (ACCESSORY)	
38	4010254-04		INPUT/OUTPUT MAIN FRAME	
39	4020409-04		INPUT/OUTPUT MODULE ASSEMBLY	
42	4010264-02		REMOTE CONTROL, 4 CHANNEL (ACCESSORY)	
44	4020428-01		COVER, KIT, (RACK MOUNT ONLY) (ACCESSORY)	
46	4041239-AA		TAPE GUIDE ASSY, 1/4 INCH, SUPPLY (ACCESSORY)	
47	4041239-AB		TAPE GUIDE ASSY, 1/4 INCH, TAKE UP (ACCESSORY)	
48	4020413-02		FULL TRACK HEAD ASSEMBLY, 1/4 INCH (ACCESSORY)	
49	4020417-02		TWO TRACK HEAD ASSEMBLY, 1/2 INCH (ACCESSORY)	
50	4020432-01		TWO WAY EXTENSION CONNECTOR ASSEMBLY (ACCESSORY)	
60	4020404-02		ELECTRONICS CHASSIS ASSEMBLY	
61	4020406-03		POWER SUPPLY ASSEMBLY	

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SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020400-02		TRANSPORT ASSEMBLY (NHA 4010260, 4010261, 4010262)	
3	4030390-02		CAPSTAN ASSEMBLY	
4	4030394-AA		ARM ASSY, TAPE LIFTER	
7	4030398-01		TURNABLE ASSEMBLY	
8	4030394-AB		ARM ASSY, TAPE LIFTER	
9	4030400-01		TAPE LIFTER ASSEMBLY	
11	4041232-01		FILLER PANEL ASSY	
12	4041219-01		SHAFT ASSY, TIMER	
13	4041226-01		STOP, ASSY SUPPLY ARM	
14	4041227-02		BAR, CAPSTAN SENSOR	
15	4041229-02		HEAD GATE ASSEMBLY	
16	4041230-01		TAPE TIMER WHEEL ASSEMBLY	
17	4041231-01		CAPSTAN/TACH ASSY	
18	4041241-01		TRANSPORT TOP PLATE ASSEMBLY	
19	4041242-01		SPEED SWITCH BRACKET ASSEMBLY	
20	4050832-02		CAPSTAN TACH SENSOR PWA	
21	4050833-02		CAPSTAN TACH LED PWA	
22	4050834-03		TENSION TRANSDUCER SENSOR LED PWA	
23	4050835-01		TENSION TRANSDUCER SENSOR PWA	
24	4050836-01		TIMER TACHOMETER PWA	
25	4110295-01		OVERLAY, TRANSPORT REAR	
26	4110296-01		OVERLAY, TRANSPORT FRONT	
27	4200076-AA		INSERT, OVERLAY	
28	4200076-AB		INSERT, OVERLAY	
30	4100086-01		KNOB, CAPSTAN	
31	4230258-02		ACTUATOR, SWITCH	
32	4230277-01		ROD, POWER SWITCH	
34	4290872-AA		COVER, REEL INSERT	
35	4290872-AB		COVER, REEL INSERT	
36	4290933-02		COVER, TACH FRONT	
38	4030408-01		MOTOR REEL DRIVE ASSEMBLY	
39	4041258-01		BAR ASSY, HEAD GATE	
40	4260537-01		BRACKET, ELECT, MTG.	
41	4041249-01		PEELER ASSY, TAPE	
42	4041250-02		SHIELD ASSY, REEL DRIVE	
43	4600162-01		SHIELD, REEL MOTOR END	
44	4050814-03		TRANSPORT HARNESS ASSEMBLY	
45	4050815-01		TRANSPORT TO POWER SUPPLY HARNESS ASSEMBLY	
46	4050818-01		TACHOMETERS NO. 2 HARNESS ASSEMBLY	
47	4030411-01		HEAD GATE LATCH LASSY	
49	4130065-01		PAD, TRANSPORT	
51	4260562-01		BRACKET, SWITCH MOUNTING	
53	4290949-01		COVER, TACH REAR	
55	4320057-01		RETAINER, POWER BAR	
56	4320061-01		RETAINER, ACTUATOR	
62	4030412-AC		TAPE TENSION, SOLENOID ASSEMBLY TAKE UP	
63	4030412-AD		TAPE TENSION, SOLENOID ASSEMBLY SUPPLY	
65	013-678		DIODE	IN4005
66	014-630		TRANSISTOR	2N3055
69	059-583		RESISTOR, W W, .33 OHM 5%, 10W	
70	059-584		RESISTOR, W W, 2.5 OHM, 5%, 10W	
75	120-436		SWITCH, SENSITIVE, SPOT ✓	
76	145-539		PLUG, BANANA	SMITH NO. 103
78	172-004		LUG, SOLDER, NO. 4	
79	180-954		TERMINAL STRIP, 4 POS	H

SHEET 1 OF 2

ASSEMBLY NO: 4020400

TITLE: TRANSPORT ASSEMBLY

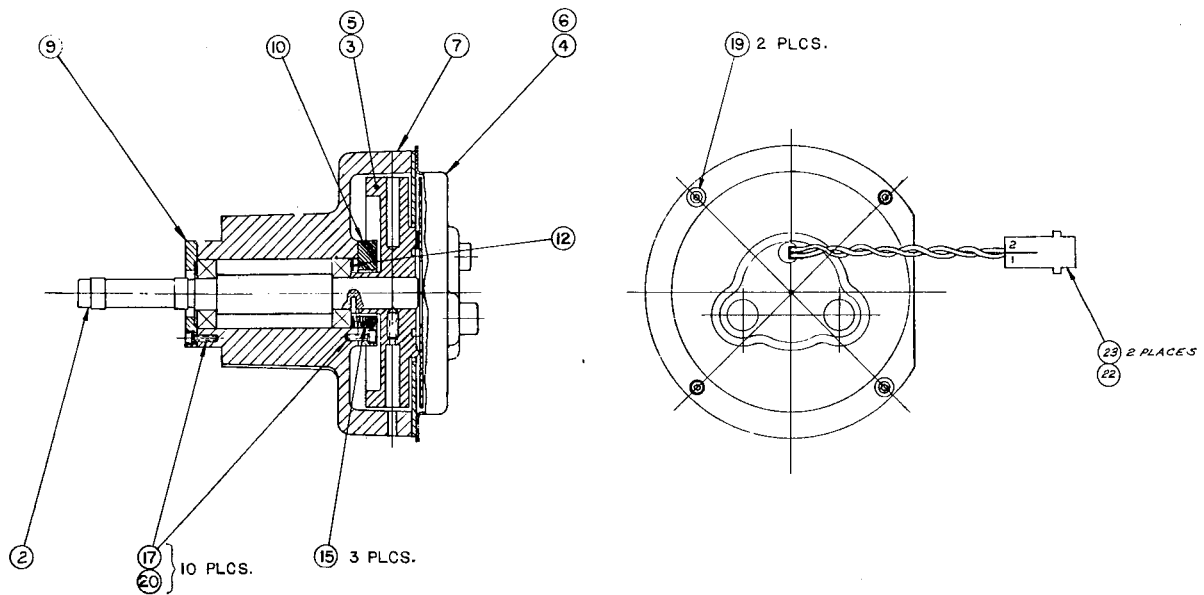
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
88	302-395		STRAP, CABLE "MOUSE TAIL"	TRUARC 5103-37
90	352-290		SPRING, COMPRESSION, 0.480 DIA X 0.50 LG	
91	352-382		SPRING, COMPRESSION, 0.300 DIA X 0.37 LG	
92	352-441		SPRING, EXTENSION, 0.094 DIA X 1.00 LG	
94	430-517		RING, RETAINING	
97	470-005		SCREW, CAP, HEX SOC, NO. 2-56 X 7/16	2N6254
98	470-008		SCREW, CAP, HEX SOC, NO. 4-40 X 1/4	
99	470-009		SCREW, CAP, HEX SOC, NO. 4-40 X 5/16	
100	470-010		SCREW, CAP, HEX SOC, NO. 4-40 X 3/8	
101	470-012		SCREW, CAP, HEX SOC, NO. 4-40 X 1/2	
102	470-018		SCREW, CAP, HEX SOC, NO. 6-32 X 3/8	
103	470-020		SCREW, CAP, HEX SOC, NO. 6-32 X 1/2	
104	470-022		SCREW, CAP, HEX SOC, NO. 6-32 X 3/4	
105	470-039		SCREW, CAP, HEX SOC, NO. 10-32 X 5/8	
106	470-049		SCREW, CAP, HEX SOC, NO. 1/4-20 X 1	
107	470-105		SCREW, CAP, HEX SOC, NO. 10-32 X 1 1/2	
108	470-136		SCREW, CAP, HEX SOC, NO. 4-40 X 7/8	
110	470-536		SCREW, CAP, FLAT HD, HEX SOC, NO. 8-32 X 3/8	
111	470-635		SCREW, CAP, HEX SOC, NO. 4-40 X 1 1/4	
112	470-642		SCREW, CAP, FLAT HD, HEX SOC, NO. 4-40 X 1/2	
113	476-505		SCREW, SELF TAP, NO. 4-40 X 1/4 LG	
114	477-556		SCREW, SET CONE PT, NO. 6-32 X 1/2	
115	477-525		SCREW, SET, CUP PT, NO. 6-32 X 3/8	
117	496-004		NUT, ASSEMBLED WASHER, NO. 4	
119	496-007		NUT, ASSEMBLED WASHER, NO. 10	
120	501-008		WASHER, FLAT, NO. 4	
121	501-009		WASHER, FLAT, NO. 6	
122	501-169		WASHER, FLAT, NO. 4, SM PATT	
123	501-184		WASHER, FLAT, NO. 2	
124	502-001		WASHER, SPRING, NO. 2	
125	502-002		WASHER, SPRING, NO. 4	
126	502-003		WASHER, SPRING, NO. 6	
127	502-005		WASHER, SPRING, NO. 10	
129	502-389		WASHER, FLAT, NO. 4, 0.375 OD	
131	502-014		WASHER, LOCK, EXT TOOTH, NO. 6	
132	502-025		WASHER, LOCK, INT TOOTH, NO. 6	
133	580-781		TRANSISTOR	
134	580-801		INSULATOR, POWER TRANSISTOR	
135	280-327		SPACER, HEX NO. 4-40 X 1/2 LG	
136	502-027		WASHER, LOCK, INT TOOTH NO. 10	
137	302-335		STRAP, CABLE, TY RAP, 0.09 WD	
142	408-170		PIN, GROOVED, 0.094 DIA X 0.50 LG	
145	502-028		WASHER, LOCK, INT, 1/4	
150	4041239-AC		TAPE GUIDE ASSEMBLY, 1/4 INCH, SUPPLY	
151	4041239-AD		TAPE GUIDE ASSEMBLY, 1/4 INCH, TAKEUP	

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SHEET 2 OF 2

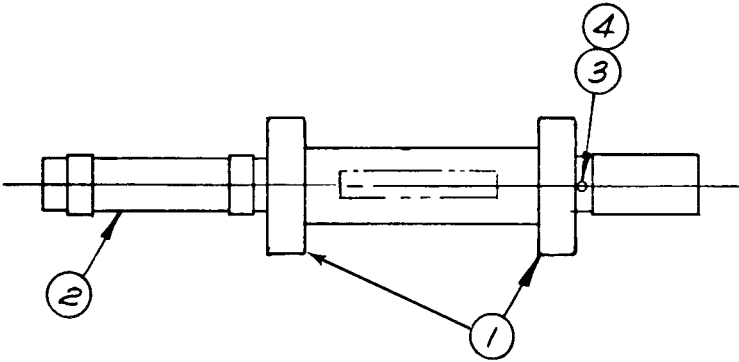
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030390-01		CAPSTAN ASSEMBLY (NHA 4020400)	
2	4041264-01		CAPSTAN SHAFT ASSEMBLY	
3	4041215-01		ROTOR ASSY, CAPSTAN, VENDOR: PMI	
4	4590074-01		PLATE, BRUSH, MOD	
5	4041224-01		ROTOR ASSY, CAPSTAN, VENDOR: YASKAWA	
6	4590080-01		PLATE, BRUSH, MOD	
7	4290832-01		HOUSING, CAPSTAN	
9	4320036-01		RETAINER, BEARING FACE	
10	4320056-01		RETAINER, SPRING	
12	4330342-01		PLATE, BEARING PRESSURE	
15	352-209		SPRING, COMPRESSION, 0.180 OD X 0.500 LG	
17	470-010		SCREW, CAP, HEX SOC, NO. 4-40 X 0.375 LG	
19	501-008		WASHER, PLAIN, NO. 4	
20	502-002		WASHER, LOCK, NO. 4	
22	167-347		CONNECTOR, FEMALE	
23	167-349		CONTACT, PIN	B

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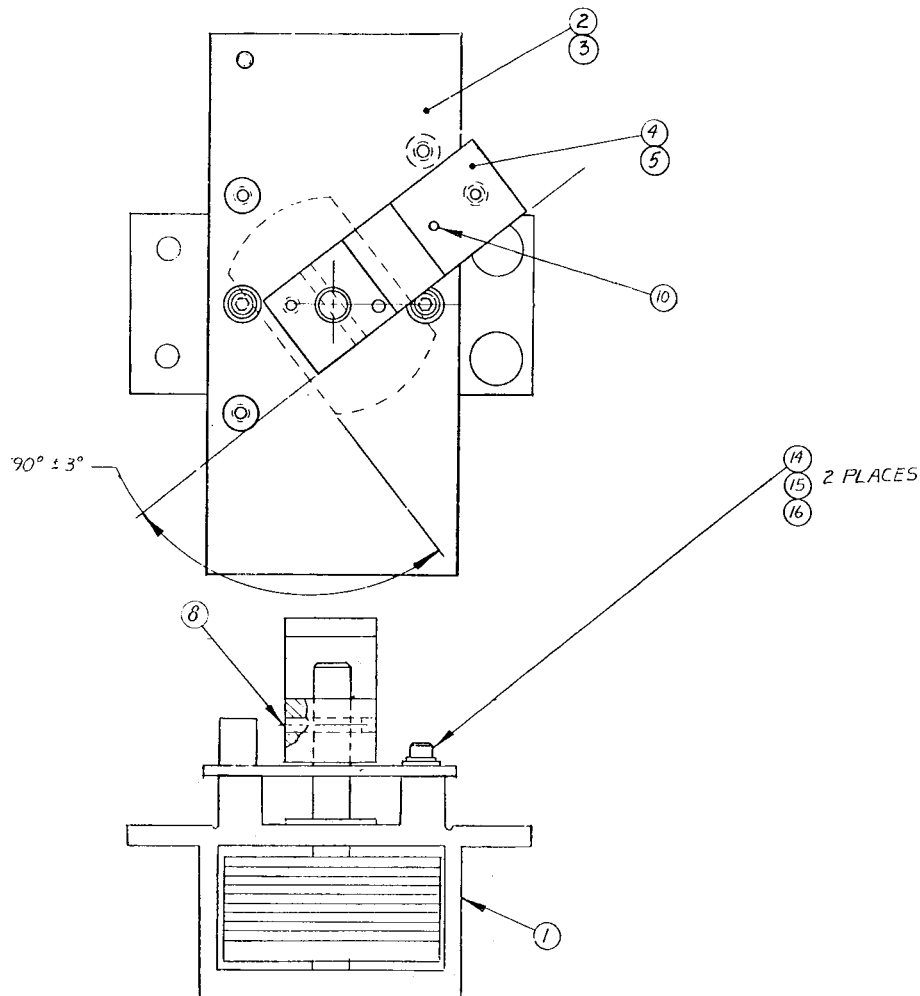
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4041264-01		CAPSTAN SHAFT ASSEMBLY (NHA 4030390)	
1	4200075-01		BEARING, BALL	
2	4210388-01		SHAFT, CAPSTAN	
3	018-450		ADHESIVE, LOCTITE NO. 290	
4	406-020		PIN, SPRING, 0.062 DIA X 0.25 LG	

SHEET 1 OF 1



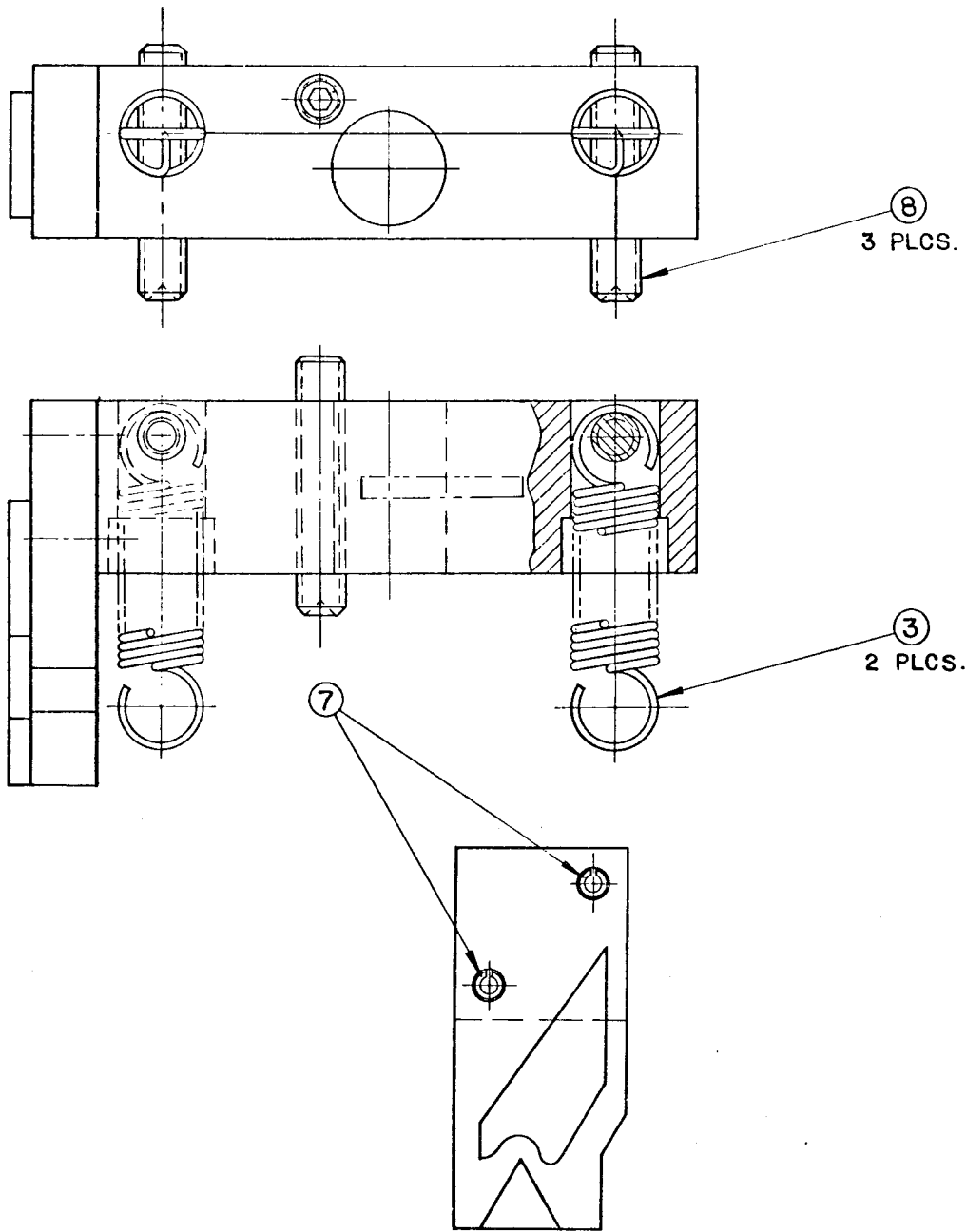
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030397-AA 4030397-AB		TENSION ARM SOLENOID HOUSING ASSEMBLY, TAKEUP TENSION ARM SOLENOID HOUSING ASSEMBLY, SUPPLY (NHA 4020400)	
1	4030391-01		SOLENOID BEARING ASSY	
2	4600094-AA		SHIELD, SOLENOID (TAKEUP)	
3	4600094-AB		SHIELD, SOLENOID (SUPPLY)	
4	4230275-AA		ARM, TAPE TENSION (TAKEUP)	
5	4230275-AB		ARM, TAPE TENSION (SUPPLY)	
8	406-284		PIN, SPRING, 0.094 DIA X 0.50 LG	
10	402-159		PIN, DOWEL, 0.062 DIA X 0.25 LG	
14	470-010		SCREW, CAP, HEX SOC, NO. 4-40 X 3/8 LG	
15	501-008		WASHER, FLAT, NO. 4	
16	502-002		WASHER, LOCK, SPRING, NO. 4	B

SHEET 1 OF 1



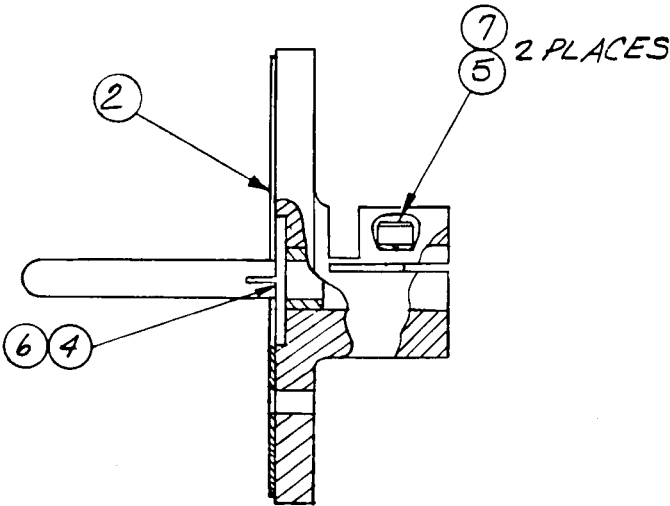
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030411-01		HEAD GATE LATCH ASSEMBLY (NHA 4020400)	
1	4120035-01		LATCH, HEAD GATE	
3	4270271-01		SPRING, EXTENSION, HEAD GATE	
7	406-280		PIN, SPRING, 0.094 DIA X 0.31 LG	
8	477-143		SCREW, SET NO. 6-32 X 0.75 LG	

SHEET 1 OF 1



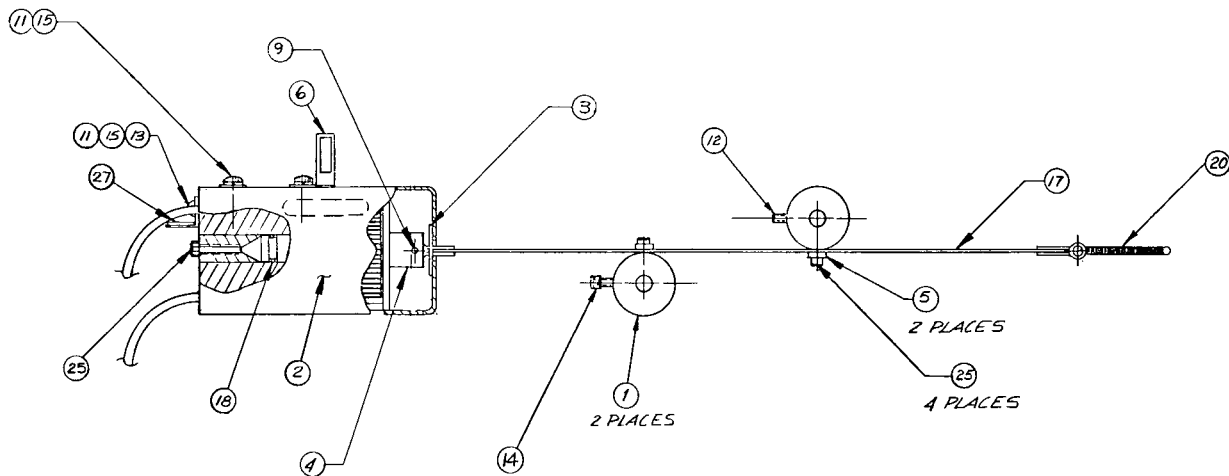
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030398-01		TURNTABLE ASSEMBLY (NHA 4020400)	
2	4130062-01		PAD, TURNTABLE	
4	4320128-10		PLATE, DRIVE	
5	470-040		SCREW, HEX SOC, NO. 10-32 X 0.75 LG	
6	470-382		SCREW, CAP, BUTTON HEAD, NO. 4-40 X 0.19 LG	
7	502-005		WASHER, LOCK, SPLIT, NO. 10	B

SHEET 1 OF 1



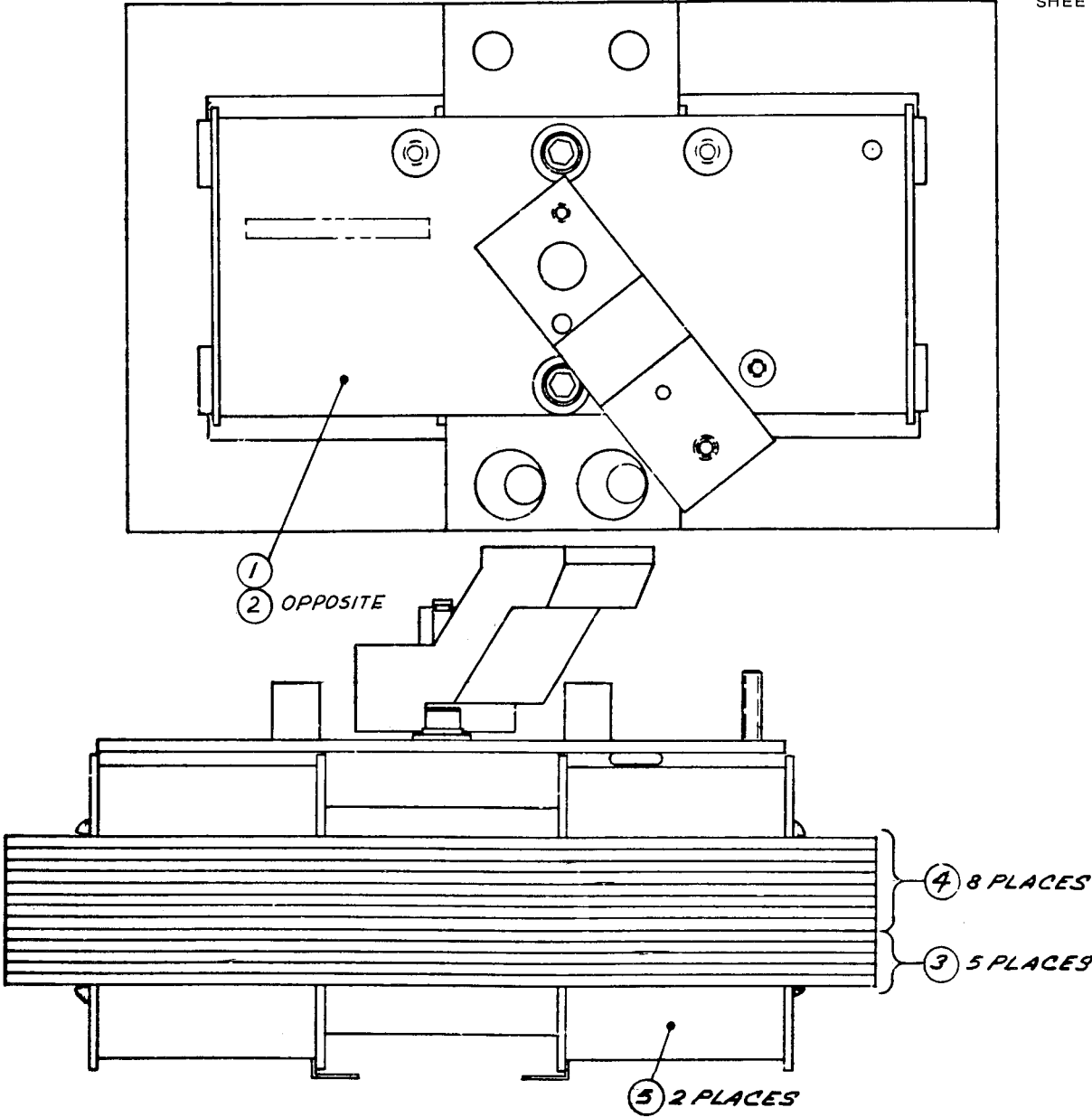
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030400-01		TAPE LIFTER ASSEMBLY	
1	4250092-01		ROLLER, LIFTER	
2	4290899-01		SHIELD, SOLENOID LIFTER	
3	4440319-01		WASHER, CORK COMPOSITION	
4	4590081-01		SOLENOID, TAPE LIFTER	
5	4600096-01		CLAMP, LIFTER CABLE	
6	4260560-02		BRACKET, TACH INTERCONNECT	
8	172-008		LUG, SOLDER, NO. 4	
9	406-013		PIN, SPRING	
11	471-891		SCREW, CAP, BUTTON HD, NO. 8-32 X 1/4	
12	477-524		SCREW, SET, CUT POINT, NO. 6-32 X 5/16 LG	
13	501-190		WASHER, PLAIN, FLAT, NO. 8	
14	470-020		SCREW, CAP, HEX SOC, NO. 6-32 X 1/2 LG	
15	502-004		WASHER, LOCK, SPLIT, NO. 8	
17	4050845-01		CABLE ASSY, LIFTER	
18	432-189		O-RING	
20	352-346		SPRING, EXTENSION, 1.25 LG	
25	470-625		SCREW, LOCKING, CAP, HEX SOC, NO. 4-40 X 3/8	
27	180-265		TERMINAL STRIP	E

SHEET 1 OF 1



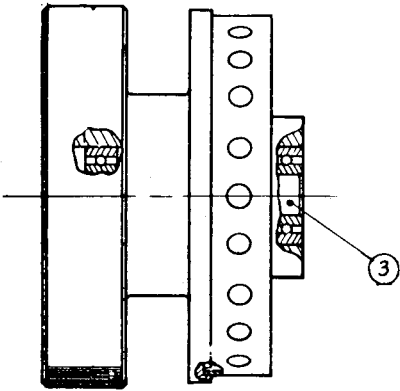
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030412-AC 4030412-AD		TAPE TENSION SOLENOID ASSEMBLY, TAKEUP TAPE TENSION SOLENOID ASSEMBLY, SUPPLY (NHA 4020400)	
1	4030397-AA		SOLENOID HOUSING ASSY, TAKEUP	
2	4030397-AB		SOLENOID HOUSING ASSY, SUPPLY	
3	4590078-01		STATOR, SOLENOID	
4	4590079-01		STATOR, SOLENOID	
5	4590082-01		COIL, SOLENOID	A

SHEET 1 OF 1



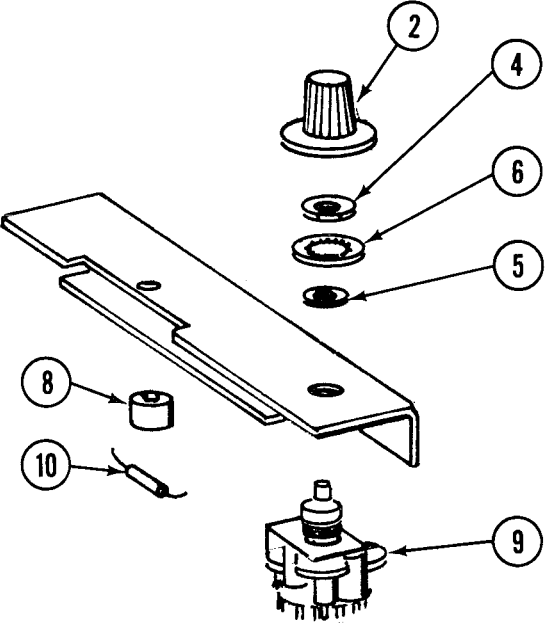
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
3	4041230-01		TAPE TIMER WHEEL ASSEMBLY (NHA 4020400)	ABEC 5 A
	4200082-01		BEARING, BALL, R-4	

SHEET 1 OF 1



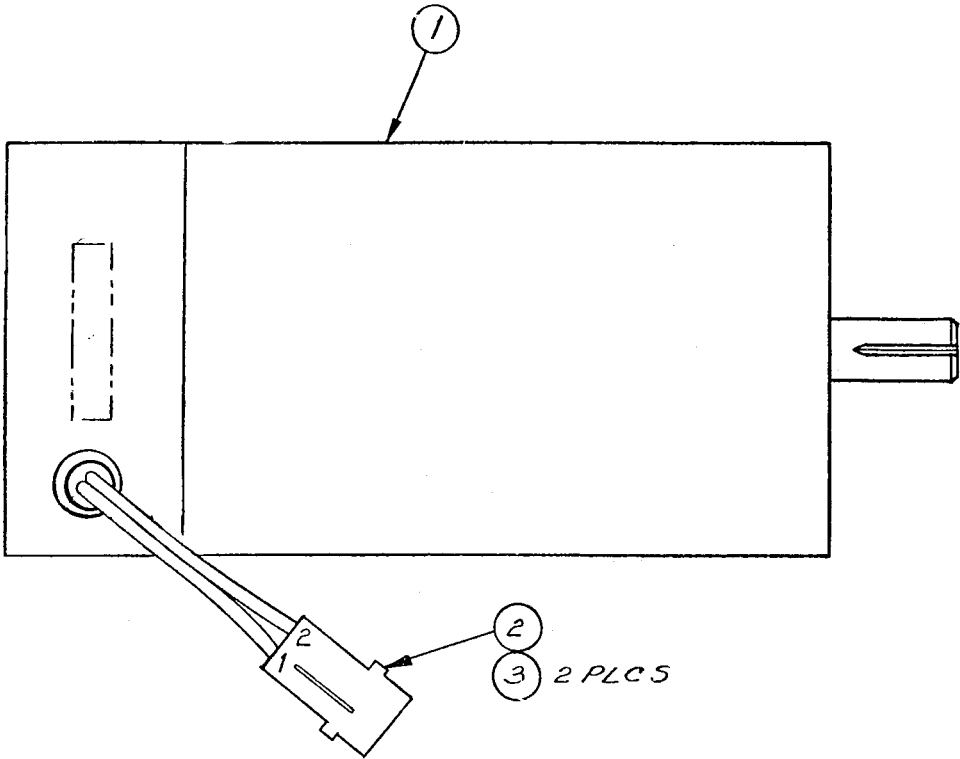
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4041242-01		SPEED SWITCH BRACKET ASSEMBLY (NHA 4020400)	
2	6000002-20		KNOB, SKIRTED, 1/2 INCH SERIES, BLACK	
4	492-095		NUT, HEX, 3/8-32	
5	501-627		WASHER, FLAT, 3/8 ID	
6	502-083		WASHER, LOCK, 3/8 ID, COARSE TOOTH	
8	581-440		DIODE, RED	HP 5082-4850
9	4620088-01		SWITCH, SPEED SELECTOR	
10	076-004		RESISTOR, CF, 180 OHM, 5%, 1/4W	C

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030408-01		REEL DRIVE MOTOR ASSEMBLY (NHA 4020400)	
1	4590031-01		MOTOR, REEL DRIVE	
2	167-347		CONNECTOR, FEMALE	
3	167-349		CONTACT, PIN	A

SHEET 1 OF 1



11

AMPEX 4890407-01

6-19/20

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050815-01		TRANSPORT TO POWER SUPPLY HARNESS ASSEMBLY (NHA 4020400)	
4	167-024		BODY, CONNECTOR, FEMALE SHELL	
5	167-335		CONTACT, PIN, 24 AWG	
6	167-336		CONTACT, PIN 20 AWG	
7	167-337		CONTACT, PIN 18 AWG	
B				

SHEET 1 OF 1

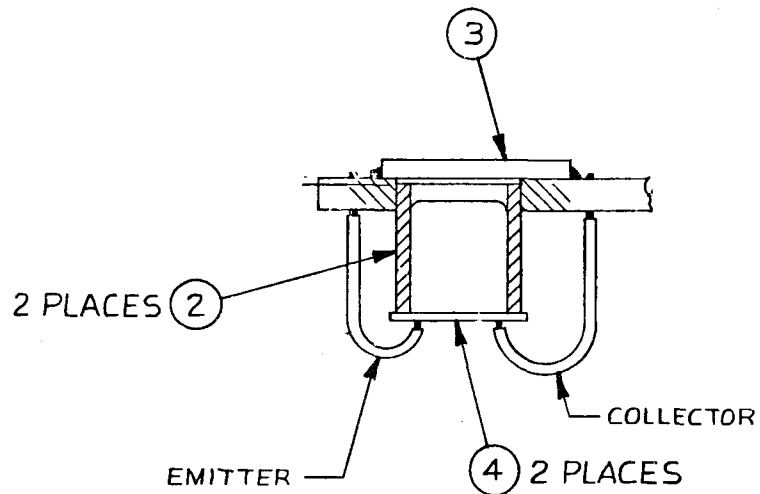
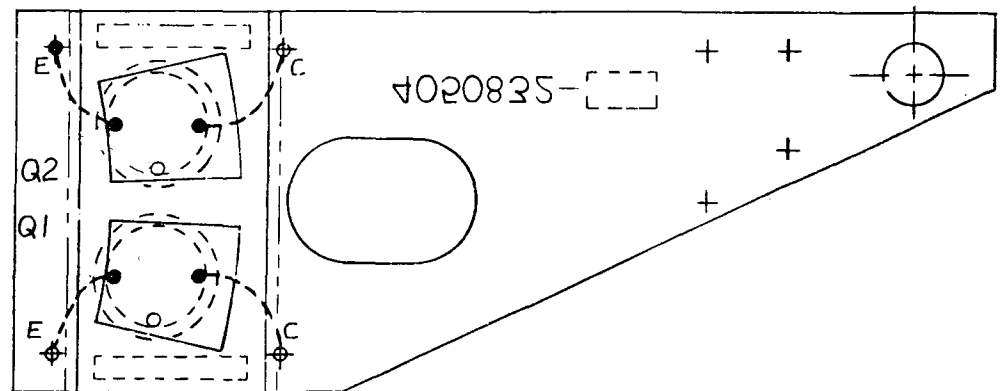
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
4	4050818-01		TACHOMETERS NO. 2 HARNESS ASSEMBLY (NHA 4020400)	
5	167-025	J16	BODY, CONNECTOR, MALE SHELL	
6	167-335		CONTACT, PIN, 24-26 AWG	
	167-337		CONTACT, PIN, 16-18 AWG	

D

SHEET 1 OF 1

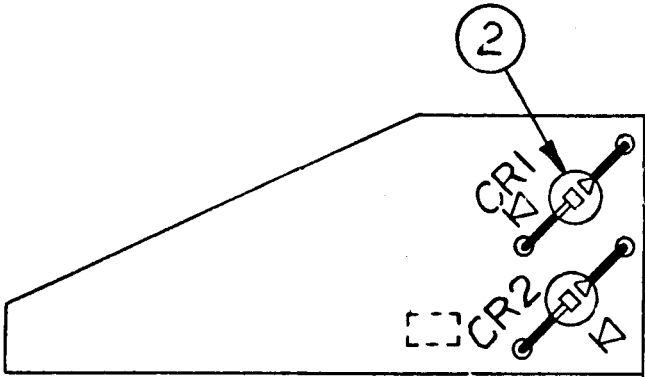
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050832-02		CAPSTAN TACHOMETER SENSOR PWA (NHA 4020400)	
2	4250097-01		TUBE, CAPSTAN SENSOR	
3	4250214-01		GRATING, ENCODER	
4	014-942	Q1,Q2	TRANSISTOR, PHOTO	MRD-300 B

SHEET 1 OF 1



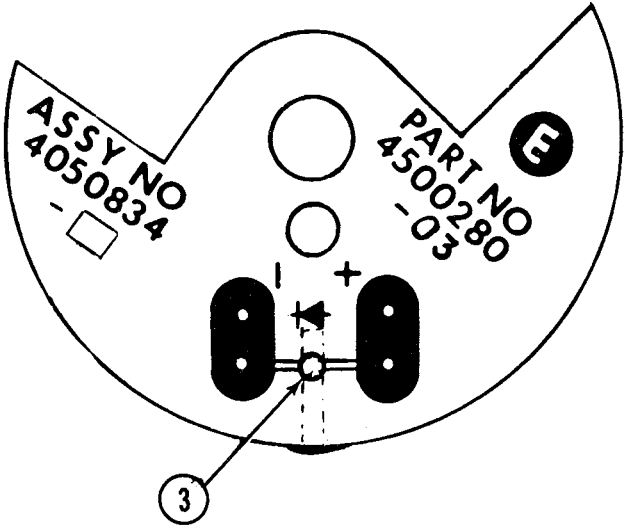
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050833-02 581-276	CR 1,2	CAPSTAN TACHOMETER LED PWA (NHA 4020400) DIODE, LIGHT EMITTING	MLED 900 C

SHEET 1 OF 1



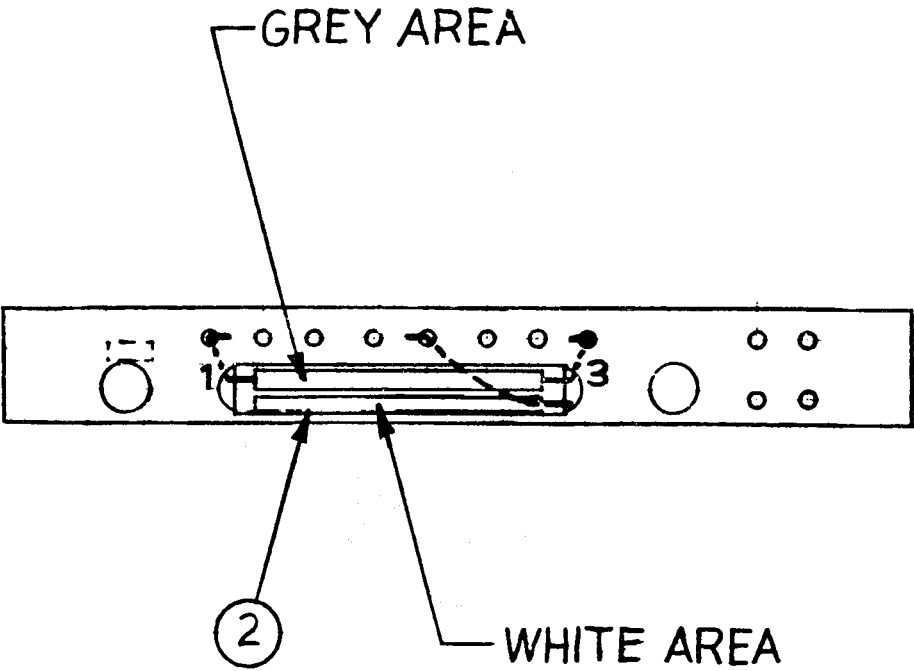
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
3	4050834-03 581-131	CR1	TENSION TRANSDUCER LED PWA (NHA 4020400) DIODE, LIGHT EMITTING, RED	MV50 B

SHEET 1 OF 1



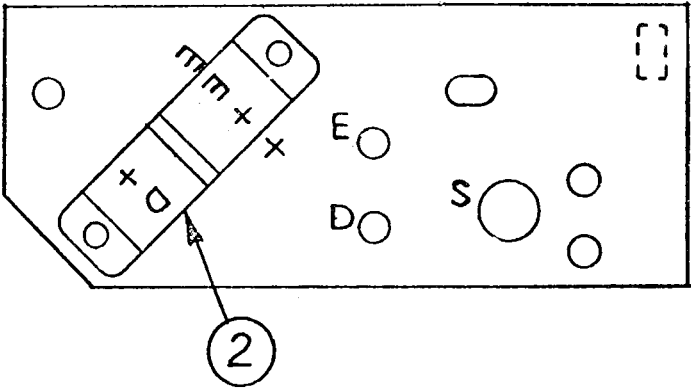
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050835-01 058-978		TENSION TRANSDUCER SENSOR PWA (NHA 4020400) POTENTIOMATIC	MPC1051 B

SHEET 1 OF 1



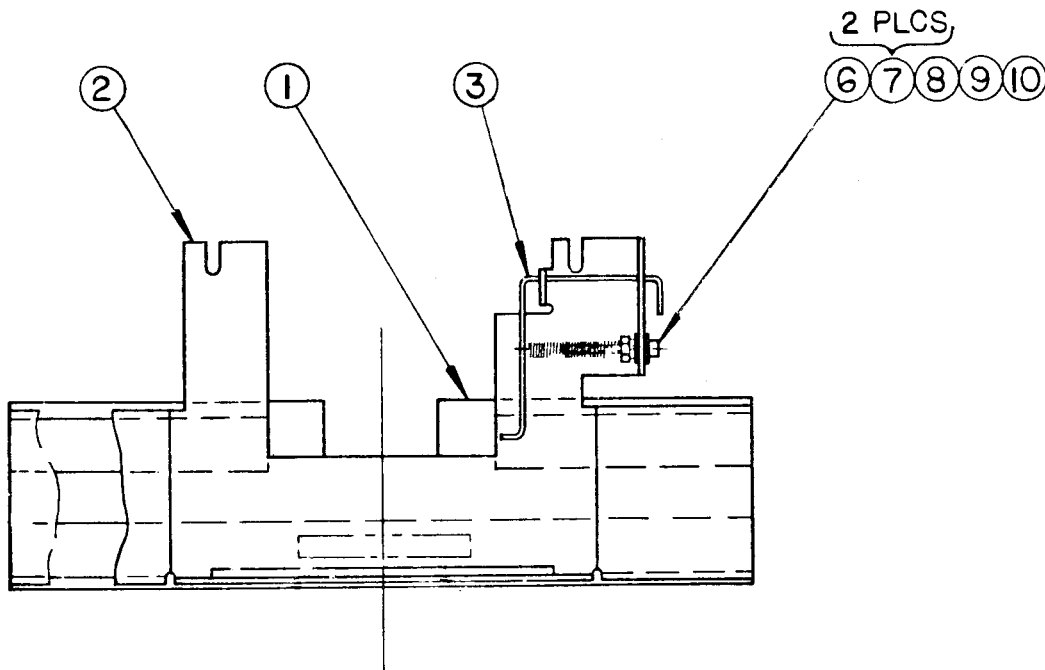
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050836-01 581-337		TIMER TACHOMETER PWA (NHA 4020400) TRANSDUCER	H13B1 B

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4041229-02		HEAD GATE ASSEMBLY (NHA 4020400)	
1	4600095-01		SHIELD, HEAD, FRONT	
2	4290955-01		GATE, HEAD	
3	4120036-01		CATCH, HEAD GATE	
6	470-418		SCREW, CAP, HEX SOC, NO. 2-56 X 0.750 LG	
7	501-155		WASHER, PLAIN, NO. 2	
8	502-001		WASHER, LOCK, NO. 2	
9	492-007		NUT, PLAIN, HEX, NO. 2-56	
10	352-216		SPRING, EXTENSION, 0.125 OD X 1.00 LG	B

SHEET 1 OF 1

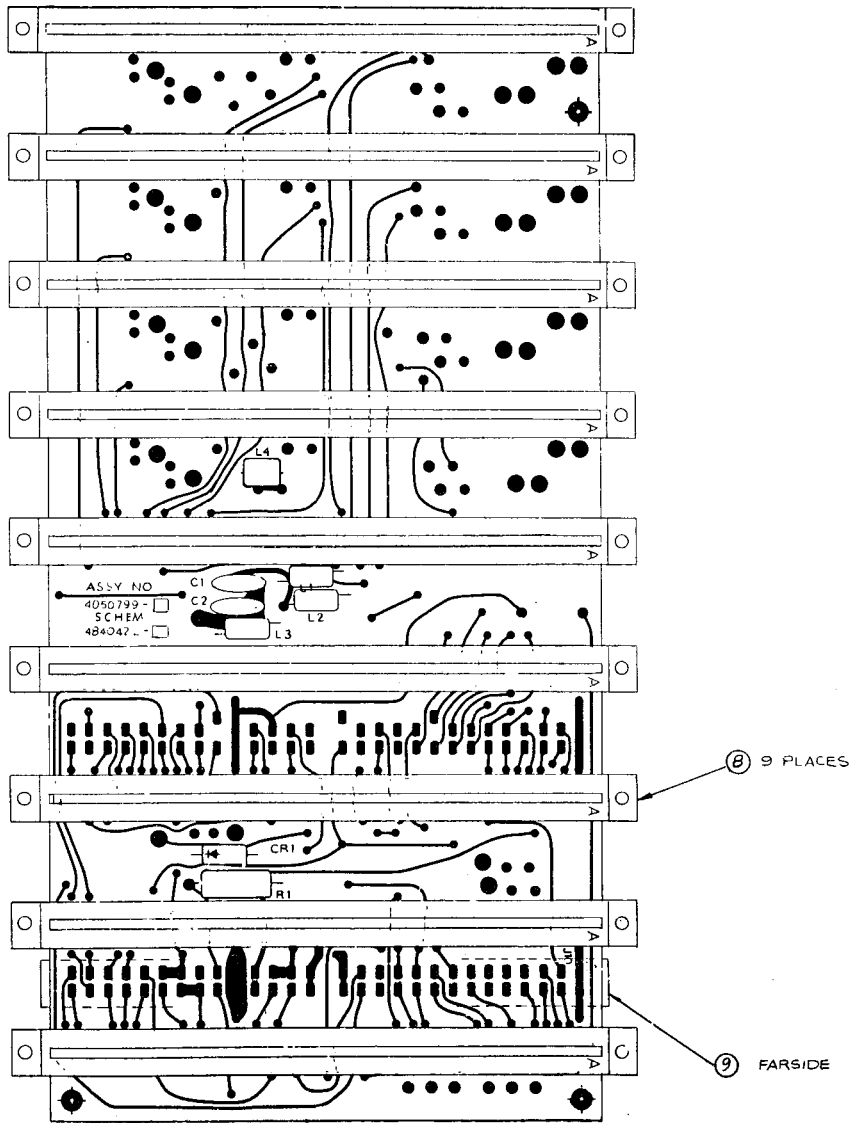


ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020404-02		ELECTRONICS CHASSIS ASSEMBLY (NHA 4020400)	
1	4050799-01		MOTHERBOARD PWA	
2	4050817-01		TACHOMETERS NO. 1 HARNESS ASSEMBLY	
3	4050819-01		REEL DRIVE HARNESS ASSEMBLY	
4	4050820-01		CONTROL/ACCESSORY HARNESS	
5	4050823-01		INPUT/OUTPUT HARNESS	
6	4050824-01		HEAD CONNECTOR AND CABLE ASSEMBLY	
7	4041257-01		REAR PANEL ASSY, ELECTRONICS	
13	171-016		LUG, CRIMP, NO. 10	
14	471-061		SCREW, PAN HEAD, NO. 4-40 X 5/16	
15	471-065		SCREW, PAN HEAD, NO. 4-40 X 5/8	
16	4840422		WIRING DIAGRAM	
17	171-160		LUG, CRIMP	
18	172-004		LUG, SOLDER, NO. 4	
21	302-335		STRAP, CABLE 0.09 WD X 4.0 LG	
22	302-379		STRAP, CABLE, 0.14 WD X 5.4 LG	
23	310-991		PLUNGER, LATCH	
24	310-992		GROMMET, LATCH	
25	421-374		BEARING, SLEEVE, 0.379 ID X 0.56 OD	
28	470-440		SCREW, FLAT HEAD, HEX SOC, NO. 4-40 X 3/8 LG	
29	496-004		NUT, WITH ASSEMBLED WASHER, NO. 4-40	
30	476-998		SCREW, SELF TAPPING, NO. 6	
32	501-008		WASHER, FLAT, NO. 4	
33	502-002		WASHER, SPRING LOCK, NO. 4	
34	530-361		GUIDE, PC	RICHCO-PGG-3 7 1/2 INCH LG
38	4050858-01		STRAP, GROUND	
				E

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050799-01		MOTHERBOARD PWA (NHA 4020404)	
2	4840422		SCHEMATIC	
3	013-678	CR-1	DIODE	IN4005
4	041-141	R1	RESISTOR, COMP, 470 OHM, 1W, 5%	
5	068-025	L4	INDUCTOR, 100 UF, 5%	
6	051-770	L1,2,3	CHOKE, FERRITE	
7	064-115	C1,2	CAPACITOR, CERAMIC, 0.1 UF, 50V	
8	139-841	J1-9	CONNECTOR, PC, 56 PIN	
9	139-844	J10	CONNECTOR, PC, 56 PIN	

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
4	4050817-01		TACHOMETERS NO. 1 HARNESS ASSEMBLY (NHA 4020404)	
5	167-024	P16	BODY, CONNECTOR, FEMALE SHELL	
6	167-338		CONTACT, SOCKET, 24-26 AWG	
	167-340		CONTACT, SOCKET, 16-18 AWG	

D

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
3	4050819-01		REEL DRIVE HARNESS ASSEMBLY (NHA 4020404)	
4	167-025 167-339	P15	BODY, CONNECTOR, MALE SHELL CONTACT, SOCKET	

C

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050823-01		INPUT/OUTPUT HARNESS ASSEMBLY (NHA 4020404)	
3	4840422	013,14	WIRING DIAGRAM	
5	145-079		CONNECTOR, RECEPTACLE, 24 PIN	
6	172-004		LUG, SOLDER, NO. 4	
10	470-002		SCREW, CAP, NO. 2-56 X 1/4	
11	470-008		SCREW, CAP, NO. 4-40 X 1/4	
13	492-008		NUT, PLAIN, HEX, NO. 4-40	
15	502-001		WASHER, SPRING LOCK, NO. 2	
				D

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050824-01		HEAD CONNECTOR AND CABLE ASSEMBLY (NHA 4020404)	
1	4170333-01		INSULATOR, ELECT. HEAD CONN.	
2	4260564-01		BRACKET, CONNECTOR GROUNDING	
4	4290903-01		COVER, SHIELD	
5	4600091-01		SHIELD, HEAD CABLE	
7	143-198		CONNECTOR, 22 PIN	
25	470-008		SCREW, CAP, HEX, SOCKET, NO. 4-40 X 1/4	
26	470-012		SCREW, CAP, HEX, SOCKET, NO. 4-40 X 1/2	
29	502-002		WASHER, LOCK, SPRING, NO. 4	
30	502-024		WASHER, LOCK, INT, NO. 4	
31	501-169		WASHER, PLAIN, FLAT, NO. 4, SM. PATT	
D				

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050754-06		MAIN AUDIO PWA NOS. 1, 2, 3, 4 (NHA 4010260, 4010261, 4010262)	
2	4290857-01		HEATSINK	
3	4600097-01		SHIELD, AUDIO	
4	4840378		SCHEMATIC	
7	013-166	VR5	DIODE	IN764A
8	013-332	VR1	DIODE	IN750A
9	013-450	VR3,4	DIODE	IN961B
10	013-703	VR2	DIODE	IN968B
13	013-689	CR15-CR16	DIODE	CD6016
15	014-631	Q1	TRANSISTOR	2N3536
16	014-652	Q6,8,14	TRANSISTOR	2N3906
17	014-653	Q7,10,11,15-17	TRANSISTOR	2N3904
18	580-304	Q2,3,9	TRANSISTOR	P1087E
19	580-760	Q12,18	TRANSISTOR	D44C9
20	580-761	Q13,19	TRANSISTOR	D45C9
21	580-646	Q4,5	TRANSISTOR	CD701
22	013-599	CR1,2,4-14,17-23	DIODE	IN914
24	014-914	A1-6,9,10,Q1	PAD, MOUNTING, 8-PIN	
25	280-130	Q2-5,9	PAD, TRANSISTOR	
28	020-829	K1,2	RELAY, REED, 12V	
31	034-156	C57	CAPACITOR, MICA, 5pF, $\pm 0.5\text{pF}$, 500V	
32	034-215	C4,15,25,34,35	CAPACITOR, MICA, 10pF, $\pm 0.5\text{pF}$, 500V	
33	034-963	C21,23	CAPACITOR, MICA, 15pF, 5%, 500V	
34	034-180	C9	CAPACITOR, MICA, 39pF, 5%, 500V	
35	034-181	C11,24	CAPACITOR, MICA, 47pF, 5%, 500V	
36	034-940	C5	CAPACITOR, MICA, 82pF, 5%, 500V	
38	034-283	C67	CAPACITOR, MICA, 820pF, 5%, 300V	
39	056-291	C29	CAPACITOR, MICA, 470pF, 1%, 500V	
40	034-222	C55	CAPACITOR, MICA, 100pF, 1%, 500V	
41	034-319	C3	CAPACITOR, MICA, 270pF, 5%, 500V	
42	034-228	C12	CAPACITOR, MICA, 620pF, 5%, 300V	
44	034-363	C71	CAPACITOR, MICA, 2000pF, 1%, 500V	
45	034-730	C45	CAPACITOR, MICA, 1800pF, 1%, 500V	
46	037-812	C13,37,47,50	CAPACITOR, TANT, DIPPED, 10 UF, 25V, 20%	
47	037-740	C52	CAPACITOR, TANT, TUBULAR, 33 UF, 10V, 10%	
50	037-745	C6,31	CAPACITOR, TANT, TUBULAR, 47 UF, 10%, 6V	
52	037-931	C48,51	CAPACITOR, TANT, DIPPED, 6.8 UF, 35V, 20%	
55	037-973	C27,28,58	CAPACITOR, TANT, DIPPED, 330 UF, 6V, 20%	
56	037-970	C7	CAPACITOR, TANT, DIPPED, 150 UF, 6V, 20%	
57	055-712	C30	CAPACITOR, MYLAR, 0.15 UF, 5%, 50V	
58	055-166	C36,40,46,49	CAPACITOR, MYLAR, 0.001 UF, 5%, 50V	
59	064-116	C8,53,54,59,60,69	CAPACITOR, CERAMIC, 0.01 UF, +80-20%, 50V	
60	037-893	C73	CAPACITOR, TANT, DIPPED, 15 UF, 20%, 20V	
61	037-960	C72	CAPACITOR, TANT, DIPPED, 150 UF, 20%, 15V	
64	064-193	C18,38,41,43	CAPACITOR, CER, MONO, 0.22 UF, 10%, 50V	
65	064-062	C1,2,10,14,16,17,19,20,22,26,32,33,42,56,61-66,68,70	CAPACITOR, CER, MONO, 0.1 UF, 20%, 100V	
68	041-657	R87	RESISTOR, CC, 2.7 OHM, 5%, 1/2W	
69	041-002	R93	RESISTOR, CC, 10 OHM, 5%, 1/2W	
70	041-489	R86	RESISTOR, CC, 33 OHM, 5%, 1/2W	
72	041-780	R42	RESISTOR, CC, 2.7 OHM, 5%, 1/4W	
74	041-789	R5	RESISTOR, CC, 6.8 OHM, 5%, 1/4W	
75	041-568	R50	RESISTOR, CC, 4.7 MEGOHM, 5%, 1/4W	
77	044-944	R15	RESISTOR, VARIABLE, 5 K, 20%, 1/2W	
				J

SHEET 1 OF 3

ASSEMBLY NO: 4050754

TITLE: MAIN AUDIO PWA, NOS. 1, 2, 3, 4

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
78	058-611	R71	RESISTOR, VARIABLE, 100K, 20%, 1/2W	
79	058-001	R34	RESISTOR, VARIABLE, 50K, 20%, 1/2W	
81	066-830	R13,19,44,52,55,92,98	RESISTOR, CF, 10K, 5%, 1/4W	
84	042-379	R8	RESISTOR, MF, 5.90K, 1%, 1/8W	
85	062-983	R27-30	RESISTOR, MF, 10.0K, 1%, 1/8W	
86	062-694	R36	RESISTOR, MF, 15.0K, 1%, 1/8W	
87	076-019	R9	RESISTOR, MF, 59.0K, 1%, 1/8W	
88	062-624	R31	RESISTOR, MF, 1.00K, 1%, 1/8W	
89	076-190	R11,22	RESISTOR, MF, 64.9K, 1%, 1/8W	
90	066-655	R24,25,39	RESISTOR, MF, 68.1K, 1%, 1/8W	
91	066-017	R1-3	RESISTOR, MF, 75.0K, 1%, 1/8W	
92	062-601	R40	RESISTOR, MF, 100K, 1%, 1/8W	
93	066-926	R41	RESISTOR, MF, 267K, 1%, 1/8W	
94	076-017	R20,23	RESISTOR, MF, 681K, 1%, 1/8W	
95	062-831	R32	RESISTOR, MF, 68.1 OHM, 1%, 1/8W	
96	062-847	R37	RESISTOR, MF, 100 OHM, 1%, 1/8W	
97	066-810	R76-82	RESISTOR, CF, 10 OHM, 5%, 1/4W	
98	066-834	R12	RESISTOR, CF, 33 OHM, 5%, 1/4W	
99	066-812	R35,38	RESISTOR, CF, 100 OHM, 5%, 1/4W	
100	076-004	R69	RESISTOR, CF, 180 OHM, 5%, 1/4W	
101	066-838	R18,49	RESISTOR, CF, 330 OHM, 5%, 1/4W	
102	066-665	R4	RESISTOR, CF, 1K, 5%, 1/4W	
103	066-816	R94,79,80	RESISTOR, CF, 390 OHM, 5%, 1/4W	
106	066-824	R16	RESISTOR, CF, 1.5K, 5%, 1/4W	
107	066-675	R75	RESISTOR, CF, 1.8K, 5%, 1/4W	
108	066-718	R64	RESISTOR, CF, 5.6K, 5%, 1/4W	
109	066-689	R89	RESISTOR, CF, 2.2K, 5%, 1/4W	
110	066-720	R77	RESISTOR, CF, 3.3K, 5%, 1/4W	
111	066-668	R43	RESISTOR, CF, 4.7K, 5%, 1/4W	
112	066-843	R17,54	RESISTOR, CF, 6.2K, 5%, 1/4W	
113	066-829	R78,81	RESISTOR, CF, 6.8K, 5%, 1/4W	
114	066-666	R53	RESISTOR, CF, 2.7K, 5%, 1/4W	
115	066-711	R59	RESISTOR, CF, 7.5K, 5%, 1/4W	
118	066-712	R57,58,68,73,84,85,88,90,91	RESISTOR, CF, 22K, 5%, 1/4W	
120	066-669	R95	RESISTOR, CF, 8.2K, 5%, 1/4W	
121	066-866	R33	RESISTOR, CF, 27K, 5%, 1/4W	
122	066-846	R10,21	RESISTOR, CF, 30K, 5%, 1/4W	
123	076-046	R65	RESISTOR, CF, 36K, 5%, 1/4W	
124	066-860	R60	RESISTOR, CF, 39K, 5%, 1/4W	
125	066-845	R70,74	RESISTOR, CF, 24K, 5%, 1/4W	
126	066-842	R14,26	RESISTOR, CF, 5.1K, 5%, 1/4W	
127	066-717	R46,47,83	RESISTOR, CF, 47K, 5%, 1/4W	
128	066-833	R6,7	RESISTOR, CF, 56K, 5%, 1/4W	
129	066-958	R61,66	RESISTOR, CF, 75K, 5%, 1/4W	
131	066-974	R48	RESISTOR, CF, 150K, 5%, 1/4W	
132	066-652	R97	RESISTOR, CF, 470K, 5%, 1/4W	
133	066-873	R51	RESISTOR, CF, 20K, 5%, 1/4W	
134	066-849	R62,63,67,96	RESISTOR, CF, 100K, 5%, 1/4W	
136	139-842	O1	CONNECTOR, 56 PIN	
137	066-867	R72	RESISTOR, CF, 51K, 5%, 1/4W	
138	496-002		NUT, WITH ASSEMBLED WASHER, 6-32	
139	470-009		SCREW, CAP, NO. 4-40 X 5/16	
140	471-068		SCREW, PAN HD, NO. 6-32 X 5/16 INCH	
141	496-004		NUT, WITH ASSEMBLED WASHER, NO. 4-40	
142	501-169		WASHER, FLAT HEAD, NO. 4	

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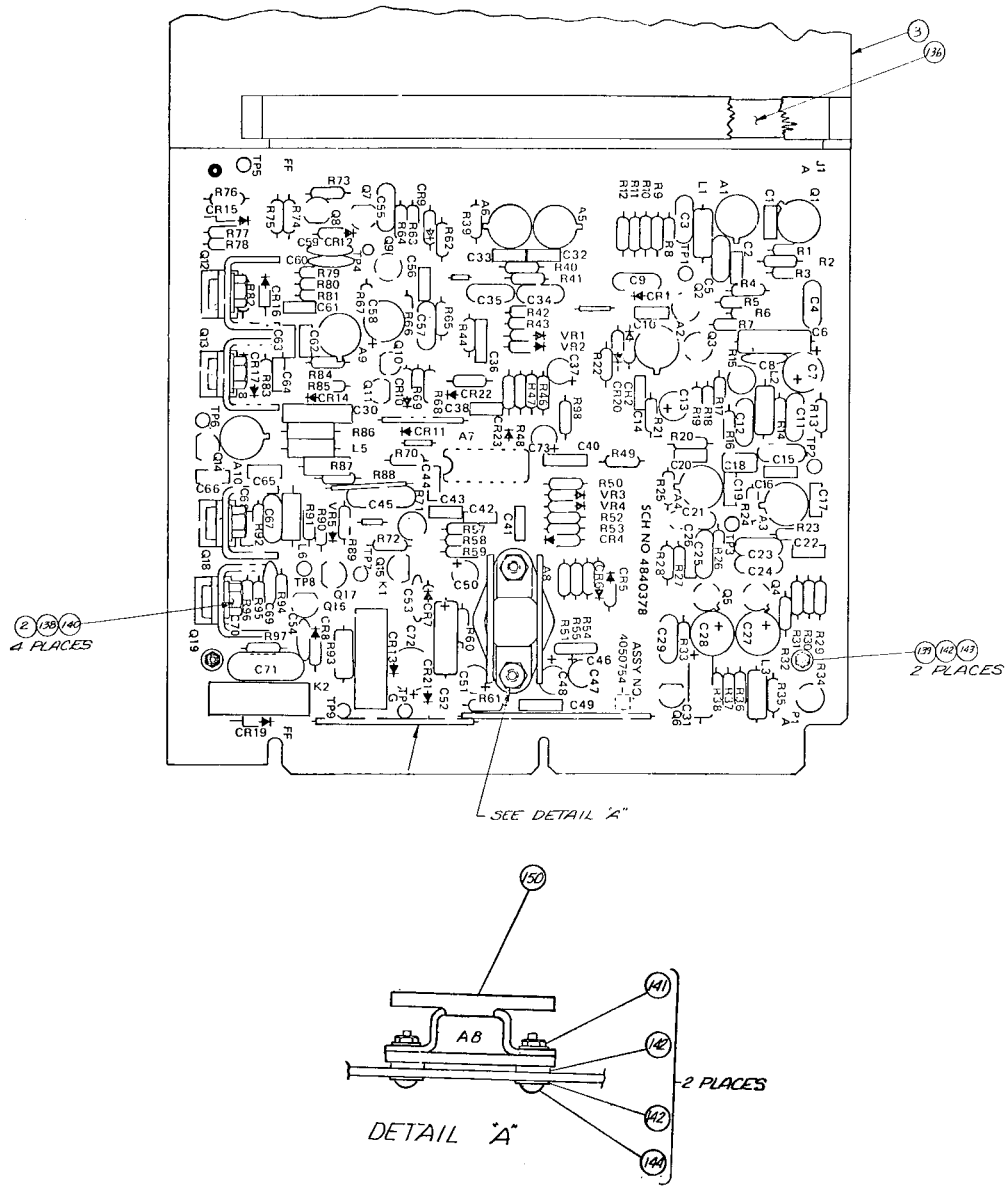
SHEET 2 OF 3

ASSEMBLY NO: 4050754

TITLE: MAIN AUDIO PWA, NOS. 1, 2, 3, 4

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
143	502-002		WASHER, SPRING, LOCK, NO. 4	
144	471-062		SCREW, PAN HD, NO. 4-40 X 3/8	
145	540-011	L3	INDUCTOR, 22 UH, 10%	
147	540-003	L2,5	INDUCTOR, 220 UH, 5%	
148	540-074	L6	INDUCTOR, 1500 UH, 10%	
149	540-059	L1	INDUCTOR, 4700 UH, 10%	
150	580-828		HEATSINK	LM324
152	587-458	A7	INTEGRATED CIRCUIT	LM318H
153	587-478	A1-6,9,10	INTEGRATED CIRCUIT	RC4194TK J
156	587-701	A8	INTEGRATED CIRCUIT	

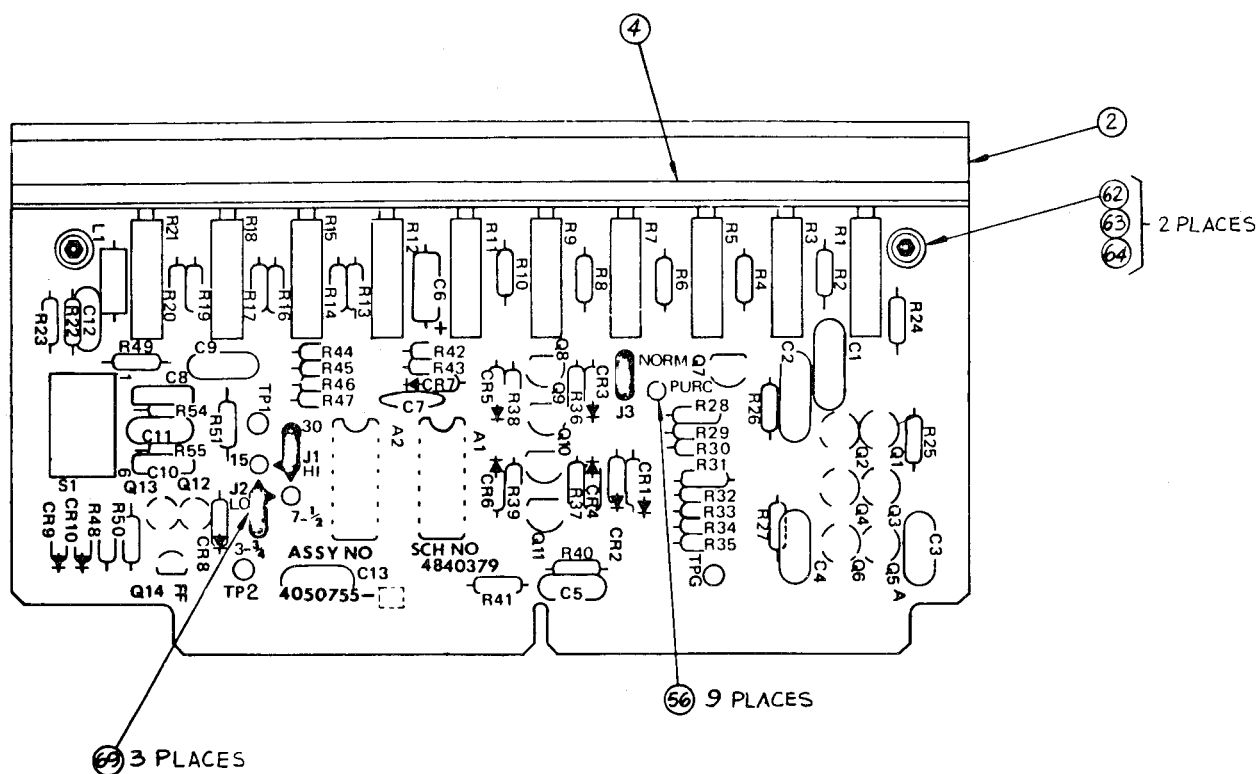
SHEET 3 OF 3



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050755-01		PADNET PWA (NHA 4010260, 4010261, 4010262)	
2	4120030-01		HANDLE, AUDIO	
3	4840379		SCHEMATIC	
4	4170326-01		LABEL, PWB HANDLE, AUDIO	
6	013-599	CR1-10	DIODE	IN914
7	014-652	Q7	TRANSISTOR	2N3906
8	014-653	Q14	TRANSISTOR	2N3904
10	580-156	Q8-11	TRANSISTOR	2N5461
11	580-304	Q1-6,12,13	TRANSISTOR	P1087E
13	034-371	C13	CAPACITOR, MICA, 510 PF, 1%, 300V	
14	034-213	C9,11	CAPACITOR, MICA, 150 PF, 5%, 500V	
15	034-309	C5	CAPACITOR, MICA, 560 PF, 1%, 300V	
16	034-250	C12	CAPACITOR, MICA, 620 PF, 1%, 300V	
17	034-735	C1,2	CAPACITOR, MICA, 3300 PF, 1%, 500V	
18	034-934	C3,4	CAPACITOR, MICA, 360 PF, 5%, 500V	
19	035-815	C8,10	CAPACITOR, MYLAR, 0.027 UF, 5%, 50V	
21	037-164	C6	CAPACITOR, TANT, 1.0 UF, 10%, 35V	
22	064-116	C7	CAPACITOR, CER, 0.01 UF +80-20%, 50V	
24	041-393	R27	RESISTOR, CC, 1.0M, 5%, 1/4W	
25	041-774	R36	RESISTOR, CC, 1.5M, 5%, 1/4W	
26	041-780	R25	RESISTOR, CC, 2.7M, 5%, 1/4W	
29	062-601	R16,17,20	RESISTOR, MF, 100K, 1%, 1/8W	
30	066-022	R54,55	RESISTOR, MF, 200K, 1%, 1/8W	
31	066-660	R13	RESISTOR, CF, 22 OHM, 5%, 1/4W	
32	066-818	R2,4	RESISTOR, CF, 470 OHM, 5%, 1/4W	
33	066-820	R6,8	RESISTOR, 750 OHM, 5%, 1/4W	
34	066-689	R41	RESISTOR, CF, 2.2K, 5%, 1/4W	
35	066-668	R43	RESISTOR, CF, 4.7K, 5%, 1/4W	
39	066-718	R40	RESISTOR, CF, 5.6K, 5%, 1/4W	
40	066-830	R10	RESISTOR, CF, 10K, 5%, 1/4W	
41	066-856	R44,45	RESISTOR, CF, 15K, 5%, 1/4W	
43	066-832	R22,47	RESISTOR, CF, 18K, 5%, 1/4W	
45	066-847	R23,28-34,48-51	RESISTOR, CF, 33K, 5%, 1/4W	
46	066-849	R14,35,46	RESISTOR, CF, 100K, 5%, 1/4W	
47	076-050	R38	RESISTOR, CF, 270K, 5%, 1/4W	
48	076-053	R24,26	RESISTOR, CF, 390K, 5%, 1/4W	
49	066-652	R37	RESISTOR, CF, 470K, 5%, 1/4W	
50	066-858	R42	RESISTOR, CF, 4.7M, 5%, 1/4W	
51	076-055	R39	RESISTOR, CF, 750K, 5%, 1/4W	
52	058-668	R1,3,7,11,12,15,18,21	RESISTOR, VARIABLE, 20K, 10%	
53	058-388	R5,9	RESISTOR, VARIABLE, 50K, 10%	
56	143-981	O1,2,3	CONNECTOR, JACK, PC	
58	119-327	S1	SWITCH, 6 POLE, DUAL-INLINE	
60	280-130	Q1-6,12,13	PAD, TRANSISTOR MOUNT	
62	470-010		SCREW, CAP, NO. 4/40 X 3/8	
63	501-169		WASHER, FLAT, NO. 4	
64	502-002		WASHER, SPRING LOCK, NO. 4	
66	540-003	L1	INDUCTOR, MOULDED, 220 UH 5%	
68	587-319	A1,2	INTEGRATED CIRCUIT	4011
69	602-012	P1-3	PLUG, SHORTING	

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SHEET 1 OF 1



Assembly No. 4050755. PADNET PWA

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050788-04		AUDIO CONTROL PWA, NO. 5 (NHA 4010260, 4010261, 4010262)	
2	4041254-01		SHIELD ASSEMBLY, PWA	
3	4170329-AA		LABEL, AUDIO CONTROL 2 SPEED	
4	4170329-AB		LABEL, AUDIO CONTROL, 4 SPEED	
7	4840398		SCHEMATIC	
10	013-599	CR1-9	DIODE	IN914
11	013-358	VR-1	DIODE	IN751A
12	581-290	VR2	DIODE	IN4744A
13	013-650	CR10	DIODE	IN270
14	013-678	CR11	DIODE	IN4005
15	014-248	Q2	TRANSISTOR	2N2222
16	014-653	Q1	TRANSISTOR	2N3904
19	017-149		CRYSTAL, 5.184 MHZ	
21	034-177	C19,50	CAPACITOR, MICA, 100 PF, 5%, 500V	
22	034-376	C1	CAPACITOR, MICA, 33 PF \pm 0.5 PF, 500V	
24	034-253	C3	CAPACITOR, MICA, 330 PF, 1%, 500V	
25	034-298	C2	CAPACITOR, MICA, 390 PF, 5%, 500V	
27	064-152	C26	CAPACITOR, CERAMIC, 0.001 UF, 10%, 50V	
29	064-115	C24,25	CAPACITOR, CERAMIC, 0.1 UF, +80-20%, 50V	
30	064-116	C4-10,12-16,20-22, 28-36,38-49	CAPACITOR, CERAMIC, 0.01 UF, +80-20%, 50V	
31	037-900	C18	CAPACITOR, TANT, DIPPED, 0.68 UF \pm 20%, 35V	
32	037-812	C23,27	CAPACITOR, TANT, DIPPED, 10 UF, 25V	
33	067-041	C17,37	CAPACITOR, TANT, DIPPED, 68 UF, 6V	
34	037-973	C11	CAPACITOR, TANT, DIPPED, 330 UF, 6V	
38	041-042	R57	RESISTOR, CC, 330 OHM, 10%, 1/2W	
41	066-812	R1,35,56	RESISTOR, CF, 100 OHM, 5%, 1/4W	
42	066-661	R44	RESISTOR, CF, 120 OHM, 5%, 1/4W	
43	066-821	R2	RESISTOR, CF, 820 OHM, 5%, 1/4W	
46	066-665	R11-13	RESISTOR, CF, 1.0K, 5%, 1/4W	
47	066-826	R54	RESISTOR, CF, 2.0K, 5%, 1/4W	
48	066-689	R15,20,21,25,26, 28,30,45-53	RESISTOR, CF, 2.2K, 5%, 1/4W	
49	066-668	R8-10,16-18,22,23 31,36	RESISTOR, CF, 4.7K, 5%, 1/4W	
52	066-718	R14,19,24,29	RESISTOR, CF, 5.6K, 5%, 1/4W	
53	066-829	R33	RESISTOR, CF, 6.8K, 5%, 1/4W	
54	066-856	R7	RESISTOR, CF, 15K, 5%, 1/4W	
57	066-712	R39,41	RESISTOR, CF, 22K, 5%, 1/4W	
58	066-846	R32	RESISTOR, CF, 30K, 5%, 1/4W	
59	066-848	R27	RESISTOR, CF, 43K, 5%, 1/4W	
60	066-717	R55	RESISTOR, CF, 47K, 5%, 1/4W	
61	076-009	R40	RESISTOR, CF, 68K, 5%, 1/4W	
62	066-676	R37,38,42,43	RESISTOR, CF, 560K, 5%, 1/4W	
65	058-611	R34	POTENTIOMETER, 1-TURN, 10K	
66	058-341	R3-6	POTENTIOMETER, 20-TURN, 2K	
73	119-373	S1	SWITCH, TPDT	
75	143-981		CONNECTOR, PC, TIP JACK	
77	470-009		SCREW, CAP., NO. 4-40 X 5/16	
78	473-592		SCREW, BINDER HD, NO. 2-56 X 3/16	
79	501-169		WASHER, FLAT, NO. 4	
80	502-002		WASHER, SPRING LOCK, NO. 4	
81	602-012	P1-5	PLUG, SHORTING	
82	586-075	A7,14,21,26,28, 40,42	INTEGRATED CIRCUIT	7400
83	586-326	A2,6,13,20,27	INTEGRATED CIRCUIT	7404

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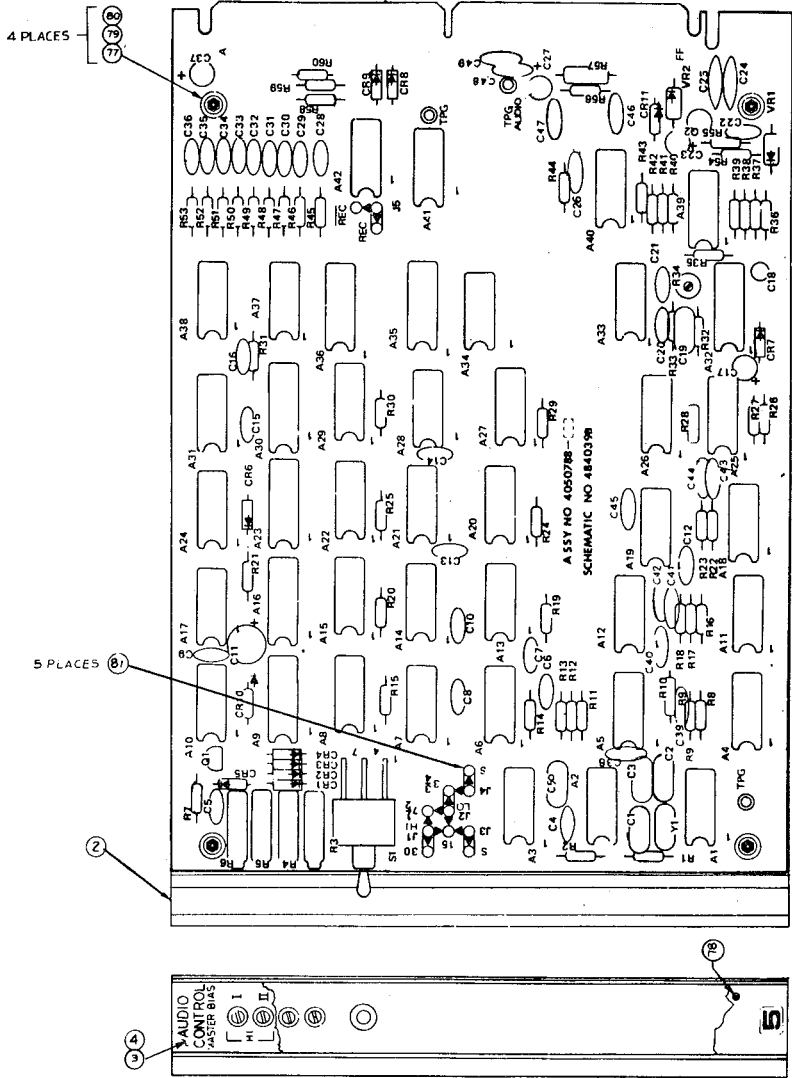
SHEET 1 OF 2

ASSEMBLY NO: 4050788

TITLE: AUDIO CONTROL PWA, NO. 5

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
84	586-713	A5,12,19	INTEGRATED CIRCUIT, OC, HV	7407
85	586-076	A8,15,22,29	INTEGRATED CIRCUIT	7410
87	586-890	A38	INTEGRATED CIRCUIT	7417
88	586-077	A34	INTEGRATED CIRCUIT	7420
89	587-543	A3	INTEGRATED CIRCUIT	7426
90	586-918	A10,17,24,31,37	INTEGRATED CIRCUIT	7432
92	586-108	A25	INTEGRATED CIRCUIT	7474
93	586-248	A11	INTEGRATED CIRCUIT	7490
94	587-084	A1,2,18	INTEGRATED CIRCUIT	7492
95	586-785	A33,41	INTEGRATED CIRCUIT	7495
97	586-948	A35,36	INTEGRATED CIRCUIT	74153
98	587-266	A9,16,23,30	INTEGRATED CIRCUIT	74279
99	587-144	A32	INTEGRATED CIRCUIT	9602
100	587-447	A39	INTEGRATED CIRCUIT	MC14007 H

SHEET 2 OF 2



**TRANSPORT LOGIC
AND TAPE TIMER
(TRANSPORT CONTROL)**

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050787-02		TRANSPORT LOGIC AND TAPE TIMER PWA, NO. 7 (TRANSPORT CONTROL) (NHA 4010260, 4010261, 4010262)	
2	4041244-01		SHIELD ASSY, PWA	
3	4170327-AA		LABEL, PWA	
4	4840397		SCHEMATIC, REV LTR B	
6	013-599	CR2-6	DIODE	IN914
7	013-650	CR1	DIODE	IN270
8	013-678	CR7	DIODE	IN4005
9	014-653	Q4,5	TRANSISTOR	2N3904
10	014-652	Q3	TRANSISTOR	2N3906
12	014-248	Q1	TRANSISTOR	2N2222
13	064-115	C19,28	CAPACITOR, CERAMIC, DISC 0.1 UF, 50V	
14	034-228	C40	CAPACITOR, MICA, DIPPED, 620 PF, 300V	
15	037-954	C12,41	CAPACITOR, TANT, DIPPED, 22 UF, 15V	
16	037-812	C20	CAPACITOR, TANT, DIPPED, 10 UF, 25V	
17	037-298	C29	CAPACITOR, TANT, DIPPED, 47 UF, 6V	
19	067-041	C46	CAPACITOR, TANT, DIPPED, 68 UF, 6V	
20	037-970	C18	CAPACITOR, TANT, 150 UF, 6V	
22	064-116	C1-10,13-17,21-27, 30-37,38,39,42-45	CAPACITOR, CERAMIC, DISC, 0.01 UF	
23	066-827	R38	RESISTOR, CF, 3.9K, 5%, 1/4W	
24	066-660	R43	RESISTOR, CF, 22 OHM, 5%, 1/4W	
25	076-003	R39	RESISTOR, CF, 56 OHM, 5%, 1/4W	
27	066-661	R1,20	RESISTOR, CF, 120 OHM, 5%, 1/4W	
28	076-004	R33	RESISTOR, CF, 180 OHM, 5%, 1/4W	
30	066-689	R4,5,13,14,22,23, 28,45,48	RESISTOR, CF, 2.2K, 5%, 1/4W	
31	066-842	R36,37,41	RESISTOR, CF, 5.1K, 5%, 1/4W	
32	066-843	R2,3,6,7,15,19,21, 25,5,26,27,29,32, 46	RESISTOR, CF, 6.2K, 5%, 1/4W	
34	066-856	R40	RESISTOR, CF, 15K, 5%, 1/4W	
35	066-847	R16,18,24	RESISTOR, CF, 33K, 5%, 1/4W	
38	586-075	A4,7,11,18,21,22, 27,34,35	INTEGRATED CIRCUIT	7400
39	586-109	A14,20	INTEGRATED CIRCUIT	7402
40	586-326	A5,17,23,38,39	INTEGRATED CIRCUIT	7404
41	586-759	A13	INTEGRATED CIRCUIT	7408
42	586-076	A6,10,12,28,29,30	INTEGRATED CIRCUIT	7410
43	586-890	A36,37	INTEGRATED CIRCUIT	7417
44	586-077	A16,31	INTEGRATED CIRCUIT	7420
45	586-078	A32	INTEGRATED CIRCUIT	7430
46	586-423	A25	INTEGRATED CIRCUIT	7442
47	586-554	A1,8,9	INTEGRATED CIRCUIT	7483
48	586-903	A19	INTEGRATED CIRCUIT	74157
49	586-450	A26	INTEGRATED CIRCUIT	74164
50	586-925	A33	INTEGRATED CIRCUIT	74175
51	586-303	A2,3	INTEGRATED CIRCUIT	9328
52	587-144	A15	INTEGRATED CIRCUIT	9602
53	587-416	A24	INTEGRATED CIRCUIT	9600
59	470-009		SCREW, CAP, NO. 4-40-5/16	
62	501-169		WASHER, FLAT, NO. 4	
63	502-002		WASHER, SPRING LOCK, NO. 4	
67	066-812	R35	RESISTOR, CF, 100 OHM, 5%, 1/4W	
68	066-665	R10,12,17,22, 34,42	RESISTOR, CF, 1K, 5%, 1/4W	

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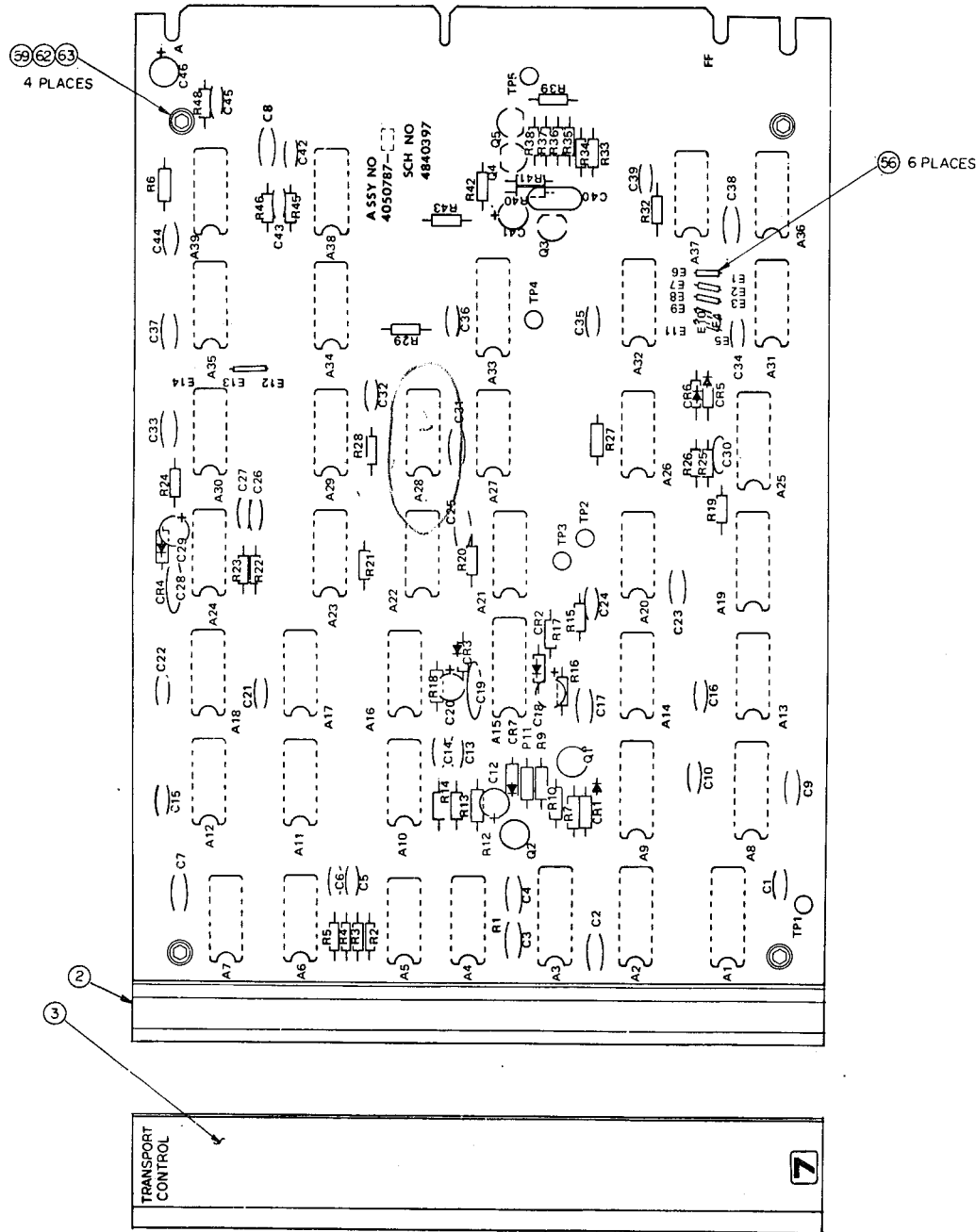
SHEET 1 OF 2

ASSEMBLY NO: 4050787

TITLE: TRANSPORT LOGIC AND TAPE TIMER PWA, NO. 7

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
69	066-830	R9	RESISTOR, CF, 10K, 5%, 1/4W	
70	066-849	R11	RESISTOR, CF, 100K, 5%, 1/4W	
72	014-698	Q2	TRANSISTOR	2N3565 F

SHEET 2 OF 2



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050776-07		CAPSTAN SERVO PWA, NO. 8 (NHA 4010260, 4010261, 4010262)	
2	4041244-01		SHIELD ASSY, PWA	
3	4170327-AC		LABEL, PWA	
4	4290857-01		HEATSINK, TRANSISTOR	
5	4840390		SCHEMATIC, REV H	
9	013-167	VR3,4	DIODE	IN756A
10	013-313	VR7,8	DIODE	IN963B
11	013-371	VR1,2	DIODE	IN864B
12	013-599	CR1-5,8,9	DIODE	IN914
13	013-678	CR6,7	DIODE	IN4005
14	013-983	VR5,6	DIODE	IN752A
16	014-653	Q1-3,6,7,12-14,16 19,20,21	TRANSISTOR	2N3904
17	014-652	Q5,17	TRANSISTOR	2N3906
19	580-760	Q8,18	TRANSISTOR	D44C9
20	580-761	Q9,10	TRANSISTOR	D45C9
22	055-163	C13,17,53	CAPACITOR, MYLAR, 0.0033 UF, 10%, 50V	
24	580-156	Q4,11,15,22	TRANSISTOR	2N5461
25	055-956	C3,5	CAPACITOR, MYLAR, 0.0068 UF, 10%, 50V	
27	037-925	C23	CAPACITOR, TANT, 1.5 UF, $\pm 20\%$, 25V	
28	037-970	C27	CAPACITOR, TANT, 150 UF, $\pm 20\%$, 6V	
29	034-286	C54	CAPACITOR, MICA, 200 PF, 5%, 500V	
30	037-893	C18	CAPACITOR, TANT, 15 UF, $\pm 20\%$, 20V	
31	037-918	C19	CAPACITOR, TANT, 0.22 UF, 20%, 35V	
32	037-954	C25,31,37,41	CAPACITOR, TANT, 22 UF, $\pm 20\%$, 15V	
33	067-041	C29	CAPACITOR, TANT, 68 UF, $\pm 20\%$, 6V	
34	037-957	C24,32	CAPACITOR, TANT, 68 UF, $\pm 20\%$, 15V	
36	055-955	C48	CAPACITOR, MYLAR, 0.0056 UF, $\pm 10\%$, 50V, 75F	
37	055-161	C1,6,45,55	CAPACITOR, MYLAR, 0.01 UF, $\pm 10\%$, 50V, 75F	
38	055-268	C46	CAPACITOR, MYLAR, 0.022 UF, $\pm 10\%$, 50V, 75F	
39	055-159	C51	CAPACITOR, MYLAR, 0.047 UF, $\pm 10\%$, 50V, 75F	
40	055-483	C47	CAPACITOR, MYLAR, 0.056 UF, $\pm 10\%$, 50V, 75F	
41	069-050	C49	CAPACITOR, MYLAR, 0.082 UF, $\pm 10\%$, 50V, 75F	
42	055-157	C44	CAPACITOR, MYLAR, 0.1UF, $\pm 10\%$, 50V, 75F	
43	063-027	C39,43	CAPACITOR, ALUM, 25 UF, $-10 + 75\%$, 50V	
47	064-152	C35	CAPACITOR, CERAMIC, 0.001 UF, $\pm 10\%$, 50V	
48	066-847	R6	RESISTOR, CF, 33K, 5%, 1/4W	
49	041-133	R73,87	RESISTOR, COMP, 27 OHM, 10%, 1W	
50	066-834	R35,74,89	RESISTOR, CF, 33 OHM, 5%, 1/4W	
51	066-855	R34	RESISTOR, CF, 39 OHM, 5%, 1/4W	
52	066-812	R42,48	RESISTOR, CF, 100 OHM, 5%, 1/4W	
53	066-661	R9,14,19	RESISTOR, CF, 120 OHM, 5%, 1/4W	
54	076-004	R88	RESISTOR, CF, 180 OHM, 5%, 1/4W	
55	066-663	R43,53	RESISTOR, CF, 220 OHM, 5%, 1/4W	
56	041-043	R59,60	RESISTOR, CF, 390 OHM, 10%, 1/2W	
59	066-720	R86	RESISTOR, CF, 3.3K, 5%, 1/4W	
60	066-668	R29,41,54,71, 82,85	RESISTOR, CF, 4.7K, 5%, 1/4W	
61	066-842	R1-4,37	RESISTOR, CF, 5.1K, 5%, 1/4W	
62	066-843	R5,8,10,12,13,16, 22,25,28,40,55-58	RESISTOR, CF, 6.2K, 5%, 1/4W	
63	066-711	R51	RESISTOR, CF, 7.5K, 5%, 1/4W	
66	066-845	R90	RESISTOR, CF, 24K, 5%, 1/4W	
67	066-866	R38	RESISTOR, CF, 27K, 5%, 1/4W	
69	066-867	R61,62,76,77	RESISTOR, CF, 51K, 5%, 1/4W	

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SHEET 1 OF 2

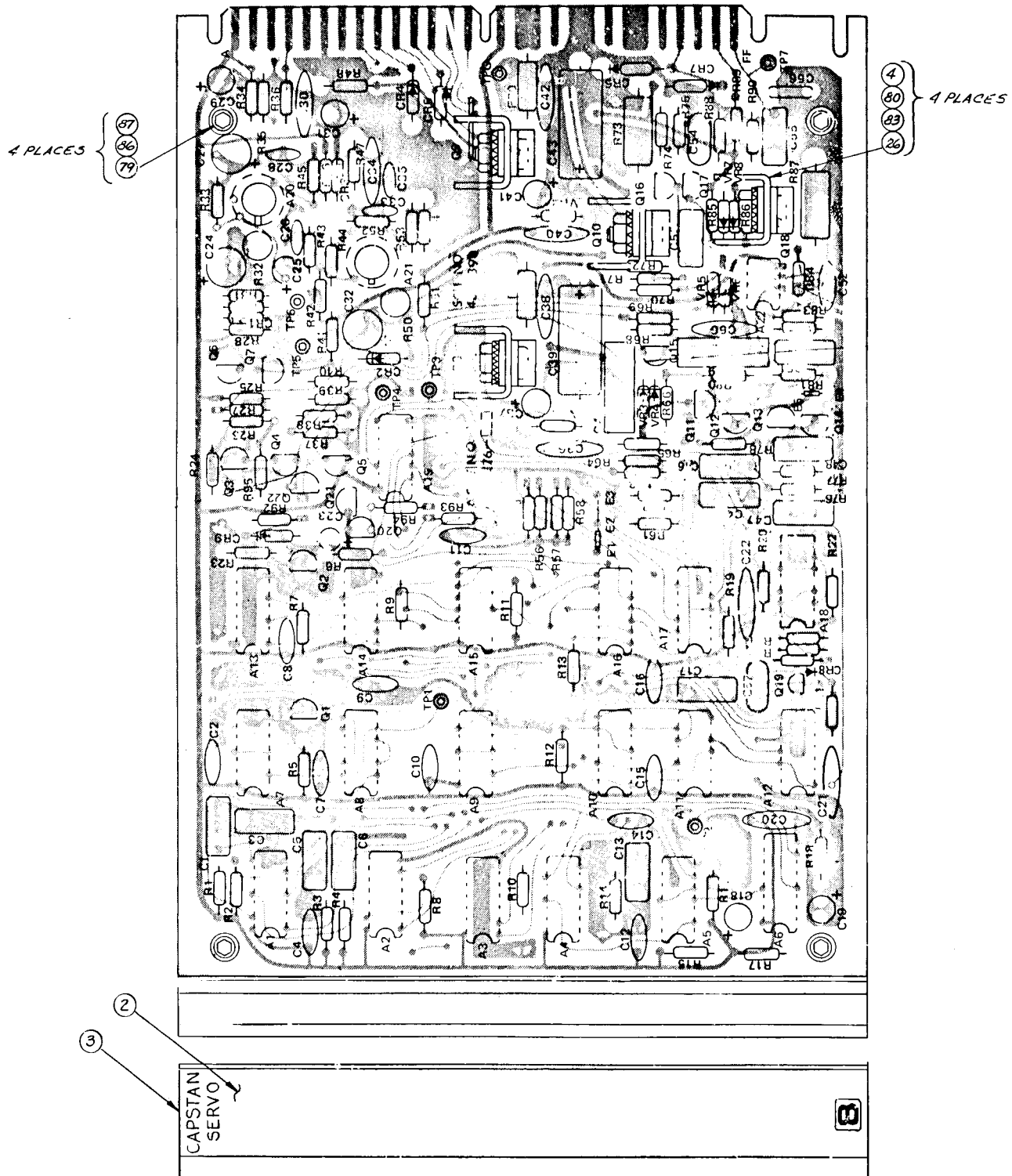
ASSEMBLY NO: 4050776

TITLE: CAPSTAN SERVO PWA, NO. 8

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
70	066-833	R68	RESISTOR, CF, 56K, 5%, 1/4W	
71	066-912	R45,52	RESISTOR, CF, 82K, 5%, 1/4W	
72	076-011	R66	RESISTOR, CF, 180K, 5%, 1/4W	
73	066-850	R84	RESISTOR, CF, 240K, 5%, 1/4W	
74	076-012	R69,83	RESISTOR, CF, 330K, 5%, 1/4W	
78	058-469	R32,50	RESISTOR, VARIABLE, 200K, 1/2W	
79	470-009		SCREW, CAP, NO. 4-40 X 5/16	
80	471-068		SCREW, PAN, HD, NO. 6-32 X 5/16	
83	496-002		NUT, WITH ASSEMBLED WASHER, NO. 6	
86	501-169		WASHER, FLAT, NO. 4	
87	502-002		WASHER, SPRING LOCK, NO. 4	
90	586-075	A2,4,7-9,14,17,18	INTEGRATED CIRCUIT	7400
91	586-326	A16,19	INTEGRATED CIRCUIT	7404
92	586-325	A1	INTEGRATED CIRCUIT	7405
93	586-076	A3,10,13	INTEGRATED CIRCUIT	7410
94	586-077	A11	INTEGRATED CIRCUIT	7420
95	586-108	A15	INTEGRATED CIRCUIT	7474
96	586-705	A5	INTEGRATED CIRCUIT	7486
97	586-283	A12	INTEGRATED CIRCUIT	7493
98	587-144	A6	INTEGRATED CIRCUIT	9602
101	587-478	A20,21	INTEGRATED CIRCUIT	LM318H
102	586-905	A22	INTEGRATED CIRCUIT	1458
104	066-868	R31	RESISTOR, CF, 120K, 5%, 1/4W	
106	066-652	R70	RESISTOR, CF, 470K, 5%, 1/4W	
107	066-717	R15,17,26,27,64 65,95	RESISTOR, CF, 47K, 5%, 1/4W	
109	030-094	C56	CAPACITOR, MONO, 1.0 UF	
110	034-117	C57	CAPACITOR, MICA, 100 PF	
112	064-116	C2,4,7-12,14-16, 26,28,33,52	CAPACITOR, CER, 0.01 UF, +80-20%, 50V	
113	064-115	C20,21,22,30,34, 36,38,40,42,50	CAPACITOR, CER, 0.1 UF, +80-20%, 50V	
114	066-665	R11,18,75,91,92	RESISTOR, CF, 1.0K, 5%, 1/4W	
115	066-689	R7,21,33,44	RESISTOR, CF, 2.2K, 5%, 1/4W	
118	066-712	R20,23,72,78,81	RESISTOR, CF, 22K, 5%, 1/4W	
119	066-673	R80	RESISTOR, CF, 1.0 MEG, 5%, 1/4W	
120	066-830	R24,36,39,46,47, 63,79,93,94	RESISTOR, CF, 10K, 5%, 1/4W	

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Assembly No. 4050776. Capstan Servo PWA, No. 8

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050778-03		REEL SERVO PWA, NO. 9 (NHA 4010260, 4010261, 4010262)	
2	4041244-01		SHIELD ASSY, PWA	
3	4170327-AB		LABEL, PWA	
7	4840395		SCHEMATIC	
11	013-358	VR5,6	DIODE	IN751A
12	013-383	VR1,2,3,4	DIODE	IN757A
13	013-599	CR1-11	DIODE	IN914
14	013-878	CR12,13,14,15	DIODE	IN4935
16	014-247	Q8,13,20,21	TRANSISTOR, TO-5	2N2219
17	014-364	Q9,12	TRANSISTOR, TO-5	2N2905A
18	014-652	Q6,11	TRANSISTOR, TO-92	2N3906
19	014-653	Q2,4,5,7,10,17,23	TRANSISTOR, TO-92	2N3904
20	580-760	Q14,15,18,19,22	TRANSISTOR	D4409
21	580-156	Q1,3,16	TRANSISTOR	2N5461
23	051-971	L1,2	INDUCTOR, 56 UH, 10%	
24	064-152	C42,43,44,45	CAPACITOR, CERAMIC, DISC, 0.001 UF, + 10%, 50V	
25	034-439	C16,17	CAPACITOR, MICA, 130 PF, 5%, 500V	
26	063-027	C38,39	CAPACITOR, ALUM, TUBULAR, 25 UF + 75-10%, 50V	
27	064-116	C18-20,23-27, 30-34,46,47,50,51	CAPACITOR, CERAMIC, DISC, 0.01 UF, + 80-20%	
28	037-790	C8,9	CAPACITOR, TANT, DIPPED, 2.2 UF, 20%, 20V	
29	037-931	C28,29	CAPACITOR, TANT, DIPPED, 6.8 UF, 20%, 35V	
30	037-591	C1,2,4,5	CAPACITOR, TANT, DIPPED, 1.0 UF, 20%, 35V	
31	037-954	C21,22,40,41	CAPACITOR, TANT, DIPPED, 22 UF, 20%, 15V	
32	037-962	C48,49	CAPACITOR, TANT, DIPPED, 4.7 UF, 20%, 10V	
33	067-041	C35,36,37	CAPACITOR, TANT, DIPPED, 68 UF, 20%, 6V	
35	055-157	C10,13	CAPACITOR, MYLAR, 0.1 UF, 10%, 50V	
36	069-047	C6,15	CAPACITOR, MYLAR, 0.027 UF, 10%, 50V	
38	069-051	C7,14	CAPACITOR, MYLAR, 0.039 UF, 10%, 50V	
39	055-163	C11,12	CAPACITOR, MYLAR, 0.0033 UF, 10%, 50V	
41	059-561	R129,137	RESISTOR, WW, 1 OHM, 10%, 2W	
42	041-296	R51,54,64,65	RESISTOR, COMP, 12 OHM, 10%, 2W	
43	041-143	R42,45,46,50	RESISTOR, COMP, 680 OHM, 10%, 1W	
44	066-859	R113	RESISTOR, CF, 240 OHM, 5%, 1/4W	
45	066-664	R112	RESISTOR, CF, 510 OHM, 5%, 1/4W	
46	066-810	R132,134	RESISTOR, CF, 10 OHM, 5%, 1/4W	
47	066-660	R48,52,53,55, 60-62,71,141	RESISTOR, CF, 22 OHM, 5%, 1/4W	
48	066-812	R21,30,43,44,47, 49,139,140	RESISTOR, CF, 100 OHM, 5%, 1/4W	
49	066-661	R33,34,35,16	RESISTOR, CF, 120 OHM, 5%, 1/4W	
50	066-663	R115,118	RESISTOR, CF, 220 OHM, 5%, 1/4W	
51	066-814	R117,121	RESISTOR, CF, 270 OHM, 5%, 1/4W	
52	076-045	R74	RESISTOR, CF, 75 OHM, 5%, 1/4W	
53	066-838	R114	RESISTOR, CF, 330 OHM, 5%, 1/4W	
54	066-872	R107	RESISTOR, CF, 360 OHM, 5%, 1/4W	
55	066-817	R116,120	RESISTOR, CF, 430 OHM, 5%, 1/4W	
56	066-839	R75,76	RESISTOR, CF, 560 OHM, 5%, 1/4W	
57	066-665	R12,36,38-40,110, 111,119,142	RESISTOR, CF, 1.0K, 5%, 1/4W	
58	066-720	R1,2,133,135	RESISTOR, CF, 3.3K, 5%, 1/4W	
61	066-818	R144,145	RESISTOR, CF, 470 OHM, 5%, 1/4W	
63	066-831	R58	RESISTOR, CF, 11K, 5%, 1/4W	
65	066-832	R72	RESISTOR, CF, 18K, 5%, 1/4W	

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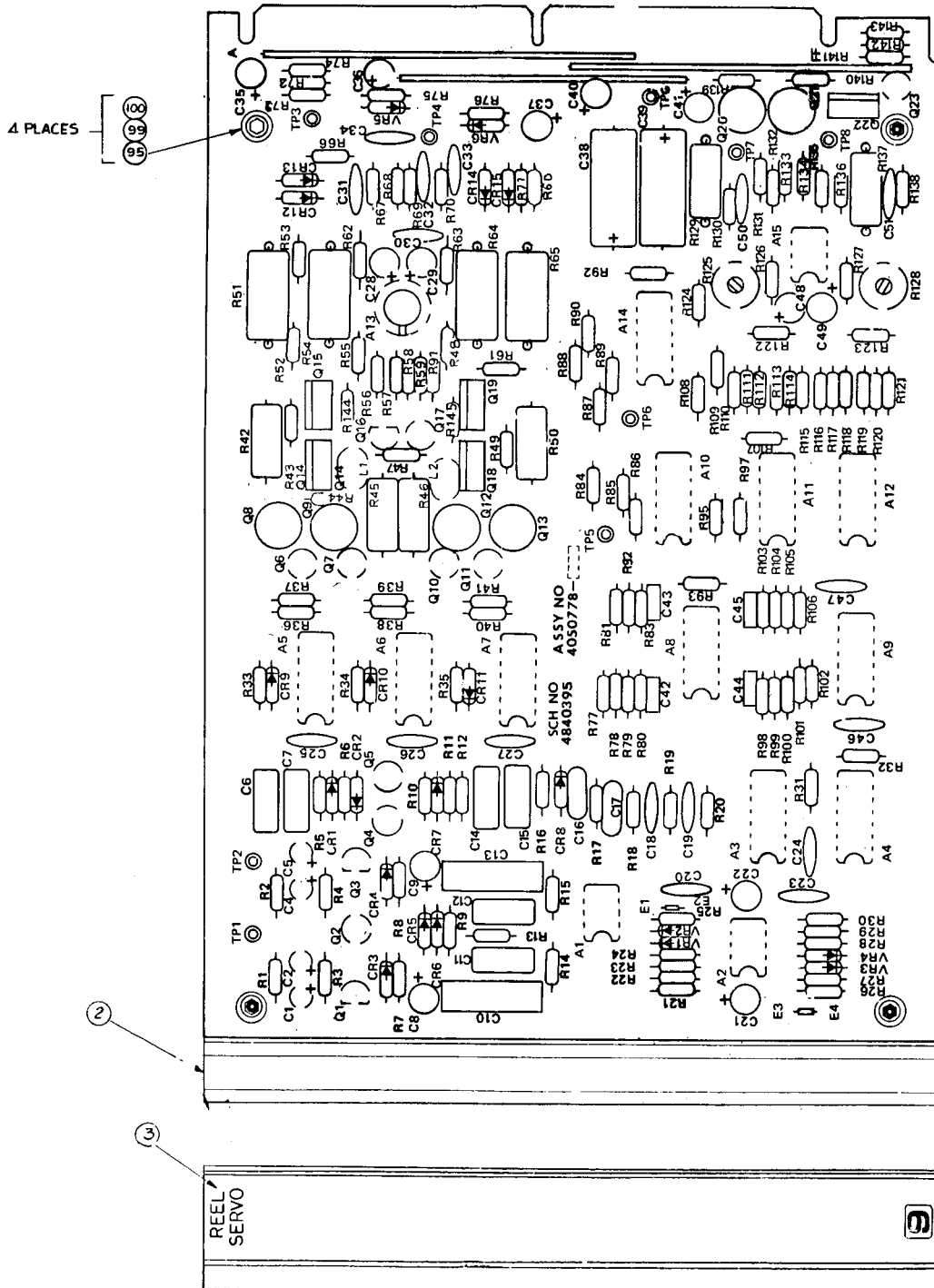
ASSEMBLY NO: 4050778

TITLE: REEL SERVO PWA, NO. 9

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
66	066-712	R108	RESISTOR, CF, 22K, 5%, 1/4W	
67	066-958	R122,123	RESISTOR, CF, 75K, 5%, 1/4W	
68	066-847	R3,4,25,29,73	RESISTOR, CF, 33K, 5%, 1/4W	
69	066-860	R68	RESISTOR, CF, 39K, 5%, 1/4W	
70	066-717	R56	RESISTOR, CF, 47K, 5%, 1/4W	
72	066-866	R130,138	RESISTOR, CF, 27K, 5%, 1/4W	
73	066-849	R126,127,131,136	RESISTOR, CF, 100K, 5%, 1/4W	
74	076-010	R69	RESISTOR, CF, 130K, 5%, 1/4W	
75	076-011	R79	RESISTOR, CF, 180K, 5%, 1/4W	
76	066-913	R14,15,124	RESISTOR, CF, 220K, 5%, 1/4W	
77	066-850	R19,20	RESISTOR, CF, 240K, 5%, 1/4W	
78	076-012	R23,27	RESISTOR, CF, 330K, 5%, 1/4W	
79	066-652	R13,99,100	RESISTOR, CF, 470K, 5%, 1/4W	
80	066-676	R77	RESISTOR, CF, 560K, 5%, 1/4W	
82	066-843	R6,11,31,32,37,41 84-90,92,95,97, 102,109,143	RESISTOR, CF, 6.2K, 5%, 1/4W	
83	066-830	R5,9,10,91	RESISTOR, CF, 10K, 5%, 1/4W	
84	066-673	R17,18,81,82, 105,106	RESISTOR, CF, 1.0 MEG, 5%, 1/4W	
85	076-014	R57,59,78,93, 101,104	RESISTOR, CF, 1.5 MEG, 5%, 1/4W	
86	076-015	R7,8	RESISTOR, CF, 3.3 MEG, 5%, 1/4W	
87	041-789	R80,83,98,103	RESISTOR, COMP, 6.8 MEG, 5%, 1/4W	
88	058-977	R125,128	RESISTOR, VARIABLE, 10K	
89	066-844	R24,28,63,66,67, 70	RESISTOR, CF, 16K, 5%, 1/4W	
90	076-009	R22,26	RESISTOR, CF, 68K, 5%, 1/4W	
92	280-998		PAD, TRANSISTOR MTG, TO-5, REF: Q8,9,12,13, 20,21	
95	470-009		SCREW, CAP, NO. 4-40 X 5/16	
99	501-169		WASHER, FLAT, SM PATTERN, NO. 4	
100	502-002		WASHER, SPRING LOCK, NO. 4	
103	586-269	A13	INTEGRATED CIRCUIT	U741
104	586-905	A1,2,15	INTEGRATED CIRCUIT	1458
105	587-714	A8	INTEGRATED CIRCUIT	LM3900N
107	586-075	A4	INTEGRATED CIRCUIT	7400
108	586-326	A3,6,14	INTEGRATED CIRCUIT	7404
109	586-325	A11,12	INTEGRATED CIRCUIT	7405
110	587-505	A7,9	INTEGRATED CIRCUIT	7411
111	586-077	A5	INTEGRATED CIRCUIT	7420
113	586-276	A10	INTEGRATED CIRCUIT, TRANSISTOR ARRAY	3046

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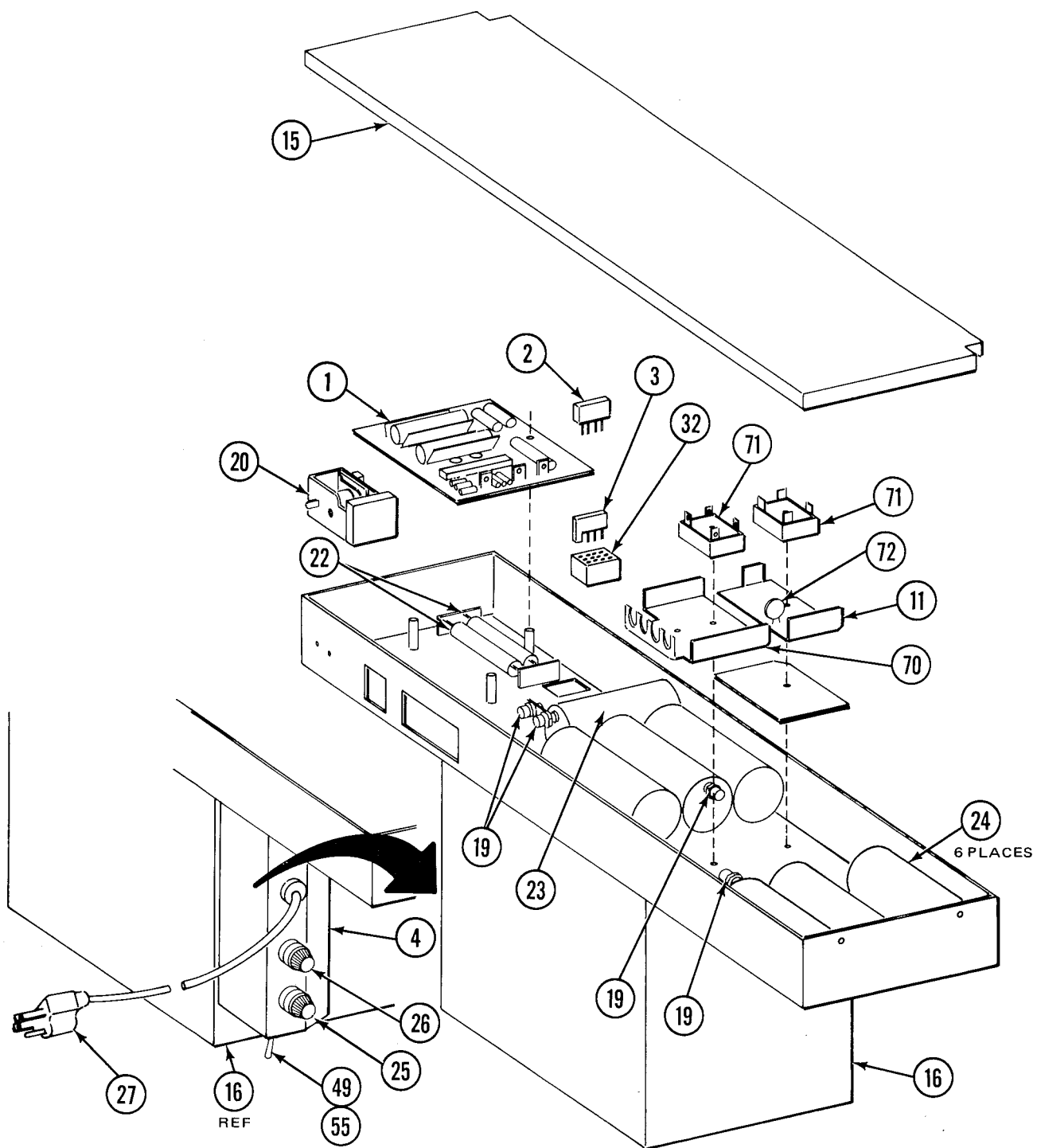


Assembly No. 4050778. Reel Servo PWA, No. 9

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020406-03		POWER SUPPLY ASSEMBLY (NHA 4020400)	
1	4050794-02		POWER SUPPLY AND DYNAMIC BRAKES PWA	
2	1374214-01		PLUG, JUMPER	
3	1374214-02		PLUG, JUMPER	
4	4041266-01		BRACKET, POWER SWITCH	
6	4050813-01		HARNESS, POWER SUPPLY	
11	4160558-01		BRACKET, CAPACITOR MTG	
15	4290932-01		COVER, POWER SUPPLY	
16	4580064-01		TRANSFORMER, POWER	
17	4840412		SCHEMATIC, REV D	
18	4170332-01		INSULATOR, ELECT, REAR COVER	
19	013-231	CR1-4	DIODE, POWER	IN1200
20	020-826	K1	RELAY	
22	059-582	R1,2	RESISTOR, WW, 0.1 OHM, 5%, 10W	
23	063-076	C1	CAPACITOR, AL ELECT, 9200 UF, 15V	
24	063-157	C2-7	CAPACITOR, AL ELECT, 4000 UF, 40V	
25	070-001	F2	FUSE, 3A, FAST BLO	
26	070-020	F1	FUSE, 5A, SLOW BLO	
27	084-030		CORD, POWER, 8 FT W/MOLDED CONNECTOR	
30	085-001		POST, FUSE	
32	167-025		BLOCK, CONNECTOR, CHASSIS MOUNT, 12 POS'N	
33	167-340		CONTACT, FEMALE, 16-18 AWG	
36	4600161-01		SHIELD, TRANSFORMER, TOP	
39	172-009		LUG, SOLDER	
40	260-004		GROMMET	
41	264-019		BUSHING, STRAIN RELIEF	
43	470-010		SCREW, CAP, HEX SOC, NO. 4-40 X 0.37 LG	
45	470-017		SCREW, CAP, HEX SOC, NO. 6-32 X 0.31 LG	
46	470-020		SCREW, CAP, HEX SOC, NO. 6-32 X 0.50 LG	
48	172-012		LUG, SOLDER, NO. 6	
49	119-440		SWITCH, TOGGLE	
50	471-080		SCREW, X-REC, NO. 8-32 X 0.50 LG	
52	470-031		SCREW, CAP, HEX SOC, NO. 8-32 X 0.75 LG	
53	502-027		WASHER, LOCK, INTERNAL TOOTH, NO. 10	
54	476-998		SCREW, SELF TAPPING, NO. 6	
55	121-249		RING, LOCK, POWER SWITCH	
56	498-582		NUT, HEX, POWER SWITCH	
57	502-415		WASHER, LOCK, POWER SWITCH	
58	496-001		NUT, WITH ASSEMBLED WASHER, NO. 8-32	
59	496-002		NUT, WITH ASSEMBLED WASHER, NO. 6-32	
60	496-004		NUT, WITH ASSEMBLED WASHER, NO. 4-40	
62	501-009		WASHER, FLAT, SMALL PATTERN, NO. 6	
63	501-169		WASHER, FLAT, SMALL PATTERN, NO. 4	
64	501-205		WASHER, FLAT, SMALL PATTERN, NO. 8	
65	502-002		WASHER, SPRING LOCK, NO. 4	
66	502-003		WASHER, SPRING LOCK, NO. 6	
67	502-004		WASHER, LOCK, NO. 8	
68	503-016		WASHER, SHOULDER, NO. 4	
69	503-322		WASHER, SHOULDER, NO. 8	
70	4260540-02		BRACKET, CAPACITOR MTG	
71	581-449	A1,2	DIODE ASSY, FULL WAVE BRIDGE	SCBE2
72	064-115	C8	CAPACITOR, CER, 1 UF, 50V	

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Assembly No. 4020406. Power Supply Assembly

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050794-02		POWER SUPPLY AND DYNAMIC BRAKES PWA (NHA 4020406)	
6	013-983	VR4	DIODE	IN752A
7	013-224	VR3	DIODE	IN754A
8	581-019	VR1,2	DIODE	IN972A
9	013-599	CR1-7	DIODE	IN914
10	013-678	CR9-13	DIODE	IN4005
13	014-247	Q3,10	TRANSISTOR	2N2219
14	014-364	Q6	TRANSISTOR	2N2905A
15	014-652	Q7	TRANSISTOR	2N3906
16	014-653	Q9	TRANSISTOR	2N3904
19	580-760	Q2,8	TRANSISTOR	D44C9
20	580-761	Q5	TRANSISTOR	D45C9
21	580-568	Q1	TRANSISTOR	2N5400
22	580-800	Q4	TRANSISTOR	2N5550
23	580-799	Q11	TRANSISTOR	C122F
26	060-307	DS1,2	LAMP	NO. 211-2
29	037-298	C1,3	CAPACITOR, TANT, DIPPED, 47 UF, 6V, 20%	
30	037-894	C6	CAPACITOR, TANT, DIPPED, 100 UF, 10V, 20%	
31	063-031	C2,4	CAPACITOR, ALUM, TUBULAR, 100 UF, 50V	
32	064-116	C5	CAPACITOR, CERAMIC, DISC, 0.01 UF, 50V	
35	041-044	R17	RESISTOR, CC, 470 OHM, 10%, 1/2W	
36	041-052	R1,9	RESISTOR, CC, 2.2K, 10%, 1/2W	
37	041-014	R5,13	RESISTOR, CC, 10K, 5%, 1/2W	
40	066-660	R18	RESISTOR, CF, 22 OHM, 5%, 1/4W	
41	066-812	R20	RESISTOR, CF, 100 OHM, 5%, 1/4W	
42	066-663	R8,16	RESISTOR, CF, 220 OHM, 5%, 1/4W	
43	066-859	R3,11	RESISTOR, CF, 240 OHM, 5%, 1/4W	
44	066-665	R6,14,21,24	RESISTOR, CF, 1K, 5%, 1/4W	
45	066-843	R7,15,22	RESISTOR, CF, 6.2K, 5%, 1/4W	
46	066-830	R4,12,23	RESISTOR, CF, 10K, 5%, 1/4W	
49	059-548	R2,10	RESISTOR, WW, 0.1 OHM, 1%, 5W	
50	059-558	R19	RESISTOR, WW, 0.33 OHM, 1%, 5W	
51	059-562	R25,26	RESISTOR, WW, 2.4 OHM, 10%, 2W	

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AMPEX 4890407-01

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050813-01		POWER SUPPLY HARNESS ASSEMBLY (NHA 4020406)	
3	167-025	J2	CONNECTOR, RECEPTACLE, 12 CONTACT	
4	167-029	J1	CONNECTOR, RECEPTACLE, 36 CONTACT	
5	167-338		CONTACT, SOCKET, 24 AWG	
6	167-339		CONTACT, SOCKET, 20 AWG	
7	167-340		CONTACT, SOCKET, 18 AWG	
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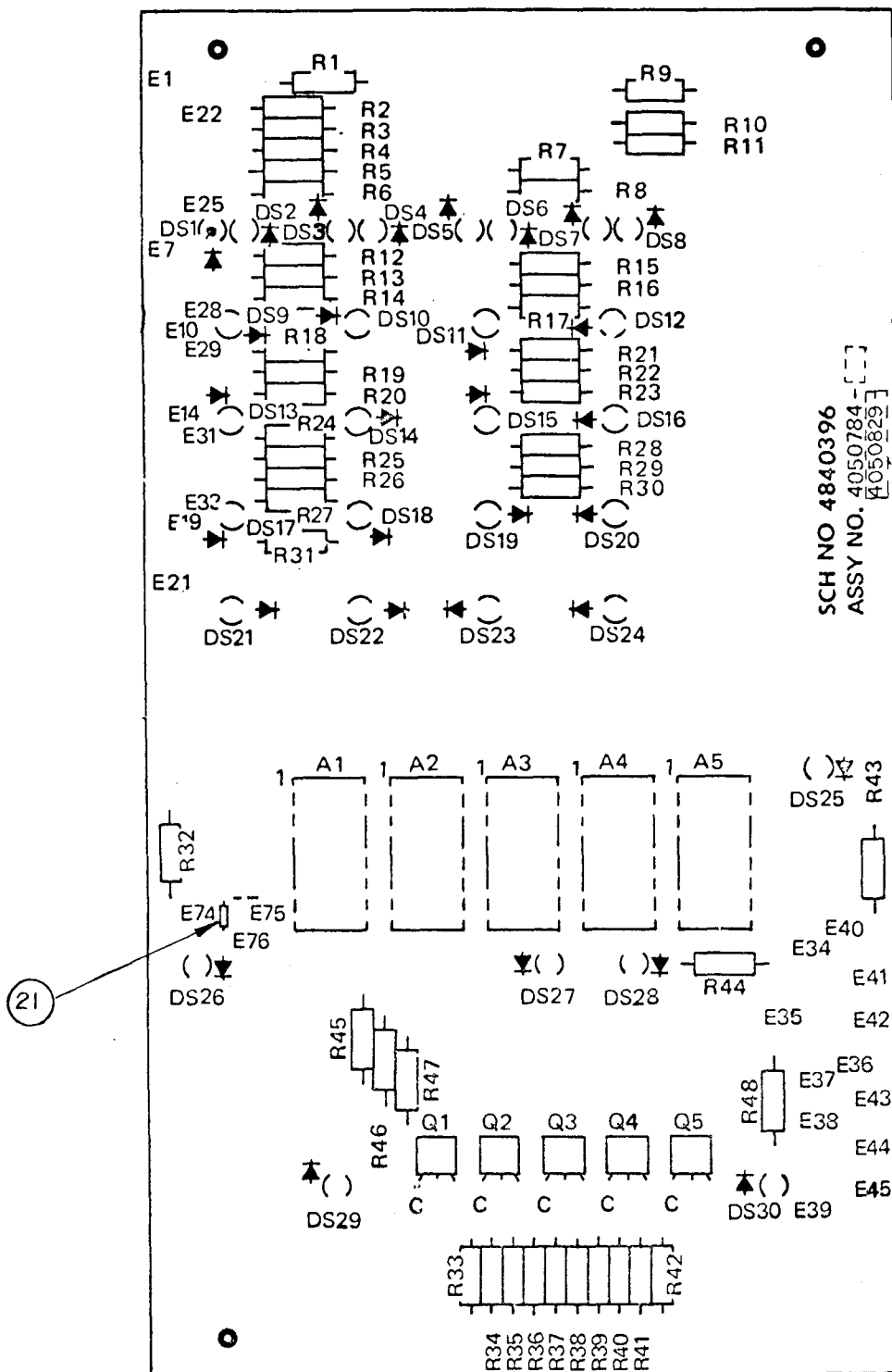
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020405-02		CONTROL UNIT, 4 CHANNEL (NHA 4010260, 4010261, 4010262)	
1	4050786-01		CONTROL UNIT, HARNESS	
4	4100080-AA		PUSHBUTTON, LARGE, (GREY)	
5	4100080-AB		PUSHBUTTON, LARGE, (RED)	
6	4100081-01		PUSHBUTTON, SMALL, (GREY)	
9	4110299-01		OVERLAY	
11	4050784-02		CONTROL UNIT, NO. 1 PWA, 4 CHANNEL	
12	4050785-02		CONTROL UNIT, NO. 2 PWA, 4 CHANNEL	
13	180-327		SPACER, THREADED, NO. 4-40 0.500 LG	
16	501-195		WASHER, NO. 4, 0.209 OD, 0.032 THK	
17	4150351-02		CASE, TOP	
18	4150352-02		CASE, BOTTOM	
20	302-379		STRAP, CABLE, TY RAP	
21	4330357-01		PLATE, LOCKING	
23	471-575		SCREW, BINDER HD, NO. 4-40 X 5/16	

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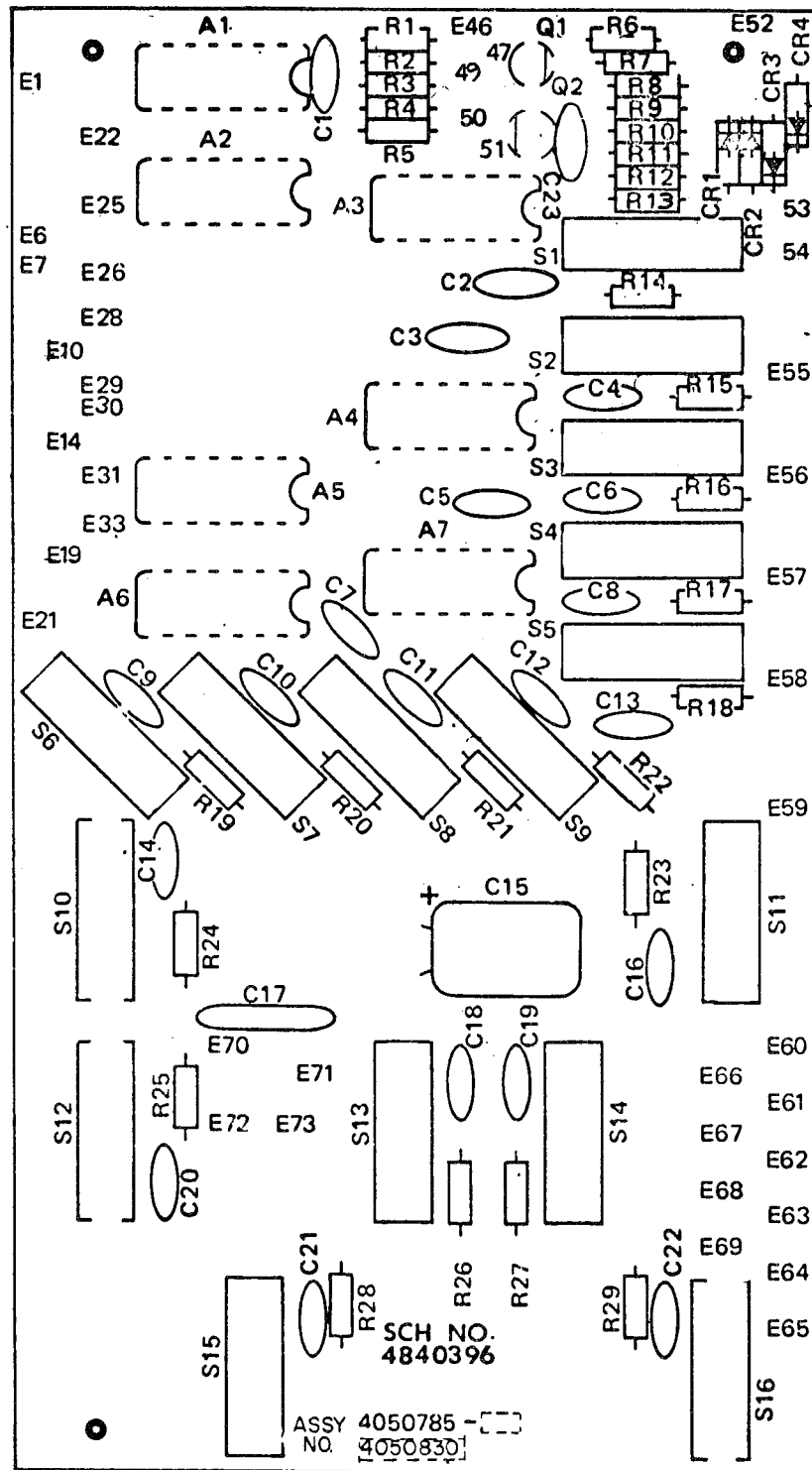
SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050784-02		CONTROL UNIT NO. 1 PWA, 4 CHANNEL (NHA 4010264, 4020405)	
3	4840396		SCHEMATIC, REV D	
5	066-816	R43-48	RESISTOR, CF, 390 OHM, 5%, 1/4W	
6	076-003	R33,35,37,39,41	RESISTOR, CF, 56 OHM, 5%, 1/4W	
7	066-812	R32	RESISTOR, CF, 100 OHM, 5%, 1/4W	
8	066-661	R6,8,12-16	RESISTOR, CF, 120 OHM, 5%, 1/4W	
9	066-859	R34,36,38,40,42	RESISTOR, CF, 240 OHM, 5%, 1/4W	
10	066-838	R1-5,7,9,11,17-21, 23-27,29,30	RESISTOR, CF, 330 OHM, 5%, 1/4W	
11	066-715	R10,22,28,31	RESISTOR, CF, 1.2K, 5%, 1/4W	
13	580-725	Q1-5	TRANSISTOR	MPS 6562
14	581-399	DS1,3,5,7,13-25, 27,28,30	DIODE, LED, YEL	HP 5082-4584
15	581-400	DS2,4,6,8,26	DIODE, LED, RED	HP 5082-4684
16	581-401	DS9,10,11,12,29	DIODE, LED, GRN	HP 5082-4984
18	581-357	A1,2,3,4,5	DIODE, DISPLAY, 7-SEG	HP 5082-7730
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Assembly No. 4050784. Control Unit No. 1 PWA, 4 Channel



Assembly No. 4050785. Control Unit No. 2 PWA, 4 Channel

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
3	4050786-01		CONTROL UNIT HARNESS ASSEMBLY (NHA 4020405)	
4	143-804		CONNECTOR, PCB, 56 PIN	
5	470-013		SCREW, CAP, NO. 4-40 X 5/8 LG	
	496-002		NUT, KEP, NO. 4-40	
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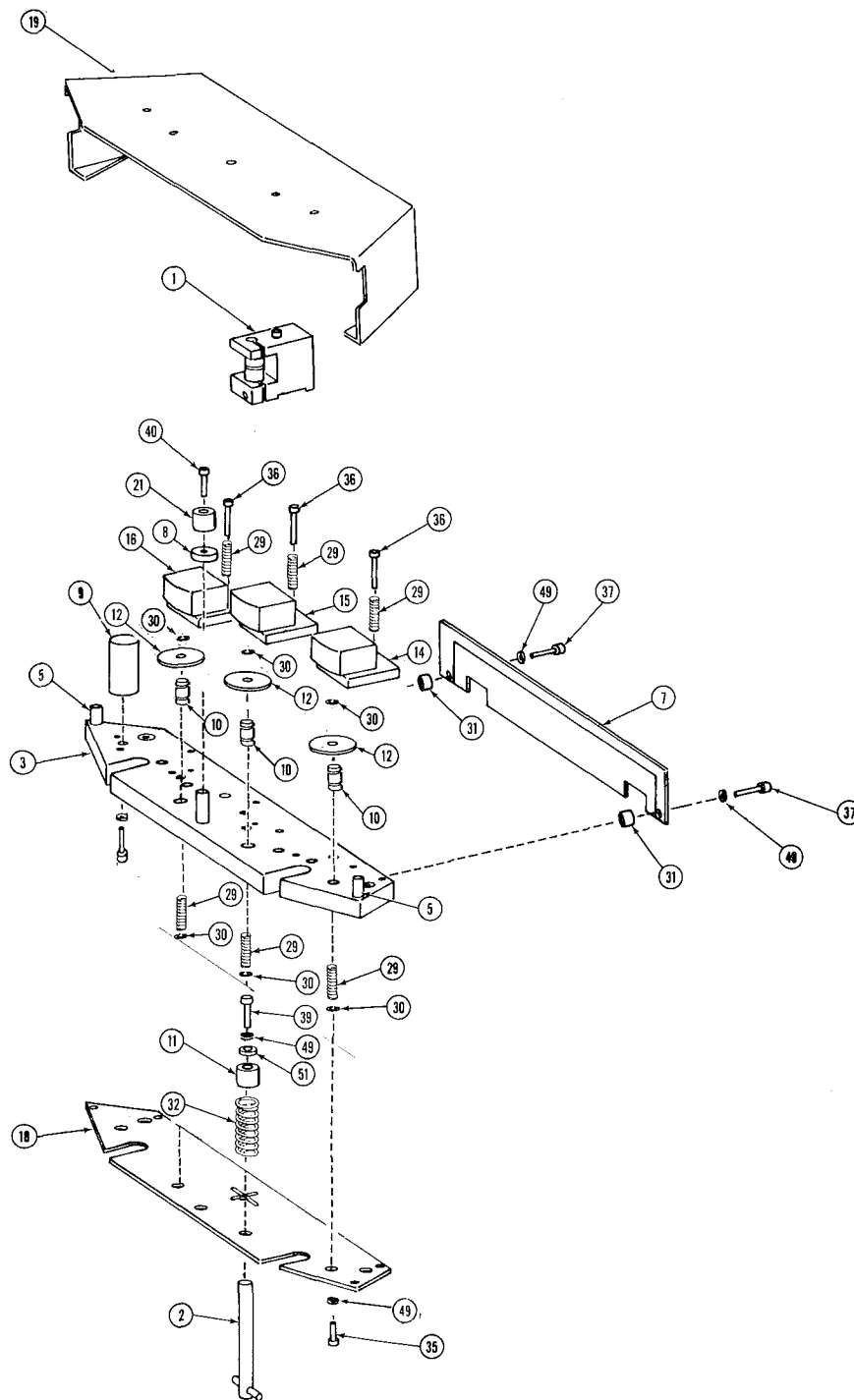
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050785-02		CONTROL UNIT NO. 2 PWA, 4 CHANNEL (NHA 4010264, 4020405)	
3	4840396		SCHEMATIC, REV D	
5	013-599	CR1-4	DIODE	IN914
6	014-653	Q1,2	TRANSISTOR	2N3904
9	037-970	C15	CAPACITOR, TANT, DIPPED, 150 UF, 20%, 6V	
11	064-115	C17	CAPACITOR, CER, DISC, 0.1 UF, + 80-20%, 50V	
13	064-116	C1-14,16,18-23	CAPACITOR, CER, DISC, 0.01 UF, 3 80-20%, 50V	
15	066-814	R1,2,4,5	RESISTOR, CF, 270 OHM, 5%, 1/4W	
16	066-819	R7,9,10,12	RESISTOR, CF, 620 OHM, 5%, 1/4W	
17	066-826	R3	RESISTOR, CF, 2.0K, 5%, 1/4W	
18	066-689	R6,11,13-29	RESISTOR, CF, 2.2K, 5%, 1/4W	
21	119-367	S1-16	SWITCH, MOMENTARY, N.O.	
24	586-785	A1,2,4-7	INTEGRATED CIRCUIT	7495
25	587-544	A3	INTEGRATED CIRCUIT	7447
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ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020413-02		FULL TRACK HEAD ASSEMBLY, 1/4 INCH (NHA 4010260)	
1	4030402-AA		SCRAPE FLUTTER IDLER ASSEMBLY	
2	4041225-01		SHAFT ASSEMBLY, HEAD ASSY LOCK	
3	4041237-01		PLATE ASSEMBLY, HEAD	
5	4041243-01		GUIDE ASSEMBLY, EDGE	
6	4041265-01		PINION GEAR ASSY	
7	4050846-01		HEAD CONNECTOR PWA	
8	4210361-01		GUIDE, EDGE HEAD	
9	4210362-01		POST, DUMMY HEAD	
10	4210385-01		PIN, HEAD RETAINING	
11	4220322-01		SPACER, LOCK SPRING	
12	4240018-01		GEAR, MODIFICATION	
14	4350231-01		HEAD STACK ASSY, FULL TRK, PLAY	
15	4350232-01		HEAD STACK ASSY, FULL TRK, RECORD	
16	4350233-01		HEAD STACK ASSY, FULL TRK, ERASE	
18	4600092-01		SHIELD, HEADS, BOTTOM	
19	4600093-01		SHIELD, HEADS	
21	4210390-01		DEFLECTOR, 1/4 INCH TAPE	
22	6000035-02		LABEL, IDENTIFICATION	
29	352-443		SPRING, COMPRESSION	LEE LC-024B-1-MW
30	430-152		RING, RETAINING	TRUARC NO. 5133-12
31	280-366		SPACER, PLAIN, 0.188 OD X 0.18 LG	
32	352-228		SPRING	C0360-045-1000M
35	470-009		SCREW, CAP, HEX Soc, NO. 4-40 X 5/16	
36	470-011		SCREW, CAP, HEX SOC, NO. 4-40 X 7/16	
37	470-013		SCREW, CAP, HEX SOC, NO. 4-40 X 5/8	
39	470-136		SCREW, CAP, HEX SOC, NO. 4-40 X 7/8	
40	470-476		SCREW, CAP, BUTTON HD, NO. 4-40 X 1/2	
49	502-002		WASHER, SPRING, NO. 4	
51	502-389		WASHER, FLAT, NO. 4	

B

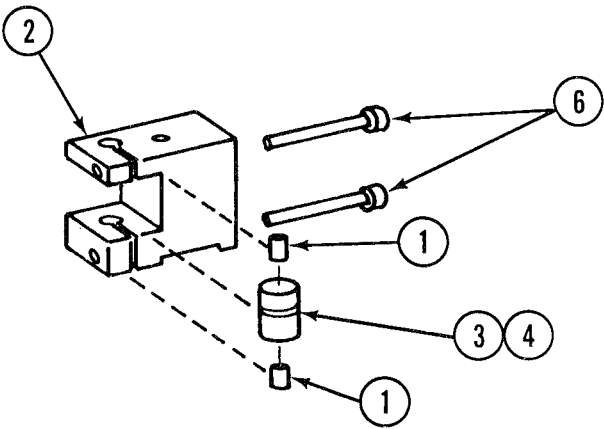
SHEET 1 OF 1



Assembly No. 4020413. Full Track Head Assembly, 1/4 Inch

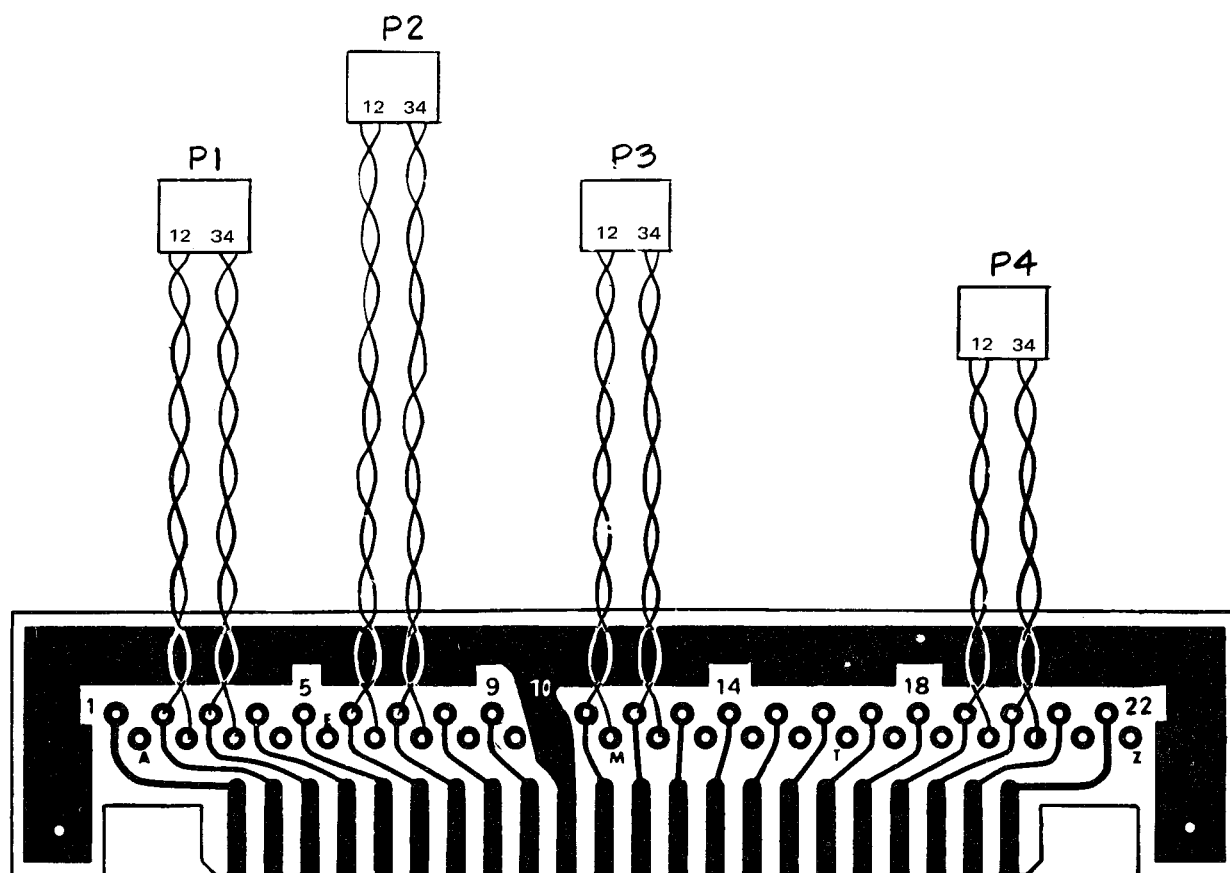
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4030402-AA 4030402-AB		SCRAPE FLUTTER IDLER ASSEMBLY, STANDARD SCRAPE FLUTTER IDLER ASSEMBLY, OPTIONAL (NHA 4020413, 4020417, 4020418)	
1	4041245-01		HOLDER, BEARING ASSY	
2	4230280-01		YOKE, SCRAPE FLUTTER	
3	4250207-01		IDLER, SCRAPE FLUTTER, STANDARD	
4	4250207-02		IDLER, SCRAPE FLUTTER, OPTIONAL	
5	087-738		OIL, PRECISION INSTRUMENT	
6	470-611		SCREW, CAP, HEX SOCKET, NO. 2-56 X 7/8	B

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050846-01 139-864		HEAD CONNECTOR PWA, 1-2 CHANNEL (NHA 4020413, 4020417) CONNECTOR ASSEMBLY	

SHEET 1 OF 1



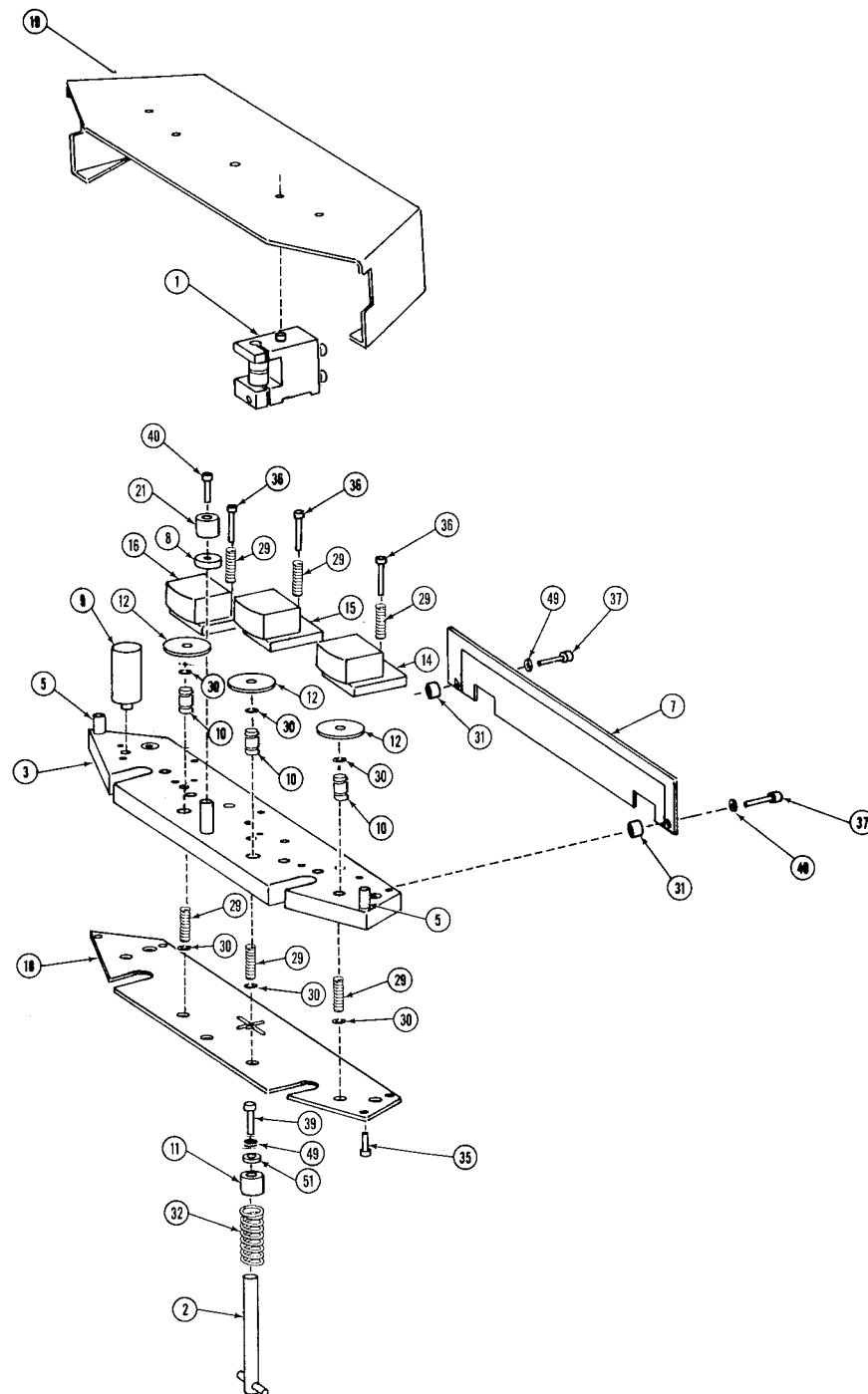
LEAD DIMENSIONS
(PRIOR TO TWISTING)

CONN	DIM A
P1	2.00
P2	2.50
P3	2.00
P4	1.50

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020417-02		TWO TRACK HEAD ASSEMBLY, 1/4 INCH (NHA 4010261)	
1	4030402-AA		SCRAPE FLUTTER, IDLER ASSEMBLY	
2	4041225-01		SHAFT ASSEMBLY, HEAD ASSY LOCK	
3	4041237-01		PLATE ASSEMBLY, HEAD	
5	4041243-01		GUIDE ASSEMBLY, EDGE	
6	4041265-01		PINION GEAR ASSY	
7	4050846-01		HEAD CONNECTOR PWA	
8	4210361-01		GUIDE, EDGE HEAD	
9	4210362-01		POST, DUMMY HEAD	
10	4210385-01		PIN, HEAD RETAINING	
11	4220322-01		SPACER, LOCK SPRING	
12	4240018-01		GEAR, MODIFICATION	
14	4350234-01		HEAD STACK ASSY, TWO TRK, PLAY	
15	4350235-01		HEAD STACK ASSY, TWO TRK, RECORD	
16	4350236-01		HEAD STACK ASSY, TWO TRK, ERASE	
18	4600092-01		SHIELD, HEADS, BOTTOM	
19	4600093-01		SHIELDS, HEADS	
29	352-443		SPRING, COMPRESSION	LEE LC-024B-1-MW
30	430-152		RING, RETAINING	TRUARC NO. 5133-12
31	280-366		SPACER, PLAIN 0.18 OD X 0.18 LG	
32	352-228		SPRING, COMPRESSION	C0360-045-1000M
35	470-009		SCREW, CAP, HEX SOC, NO. 4-40 X 5/16	
36	470-011		SCREW, CAP, HEX SOC, NO. 4-40 X 7/16	
37	470-013		SCREW, CAP, HEX SOC, NO. 4-40 X 5/8	
39	470-136		SCREW, CAP, HEX SOC, NO. 4-40 X 7/8	
40	470-476		SCREW, CAP, BUTTON HD, NO. 4-40 X 1/2	
49	502-002		WASHER, SPRING, NO. 4	
51	502-389		WASHER, FLAT, NO. 4	

B

SHEET 1 OF 1

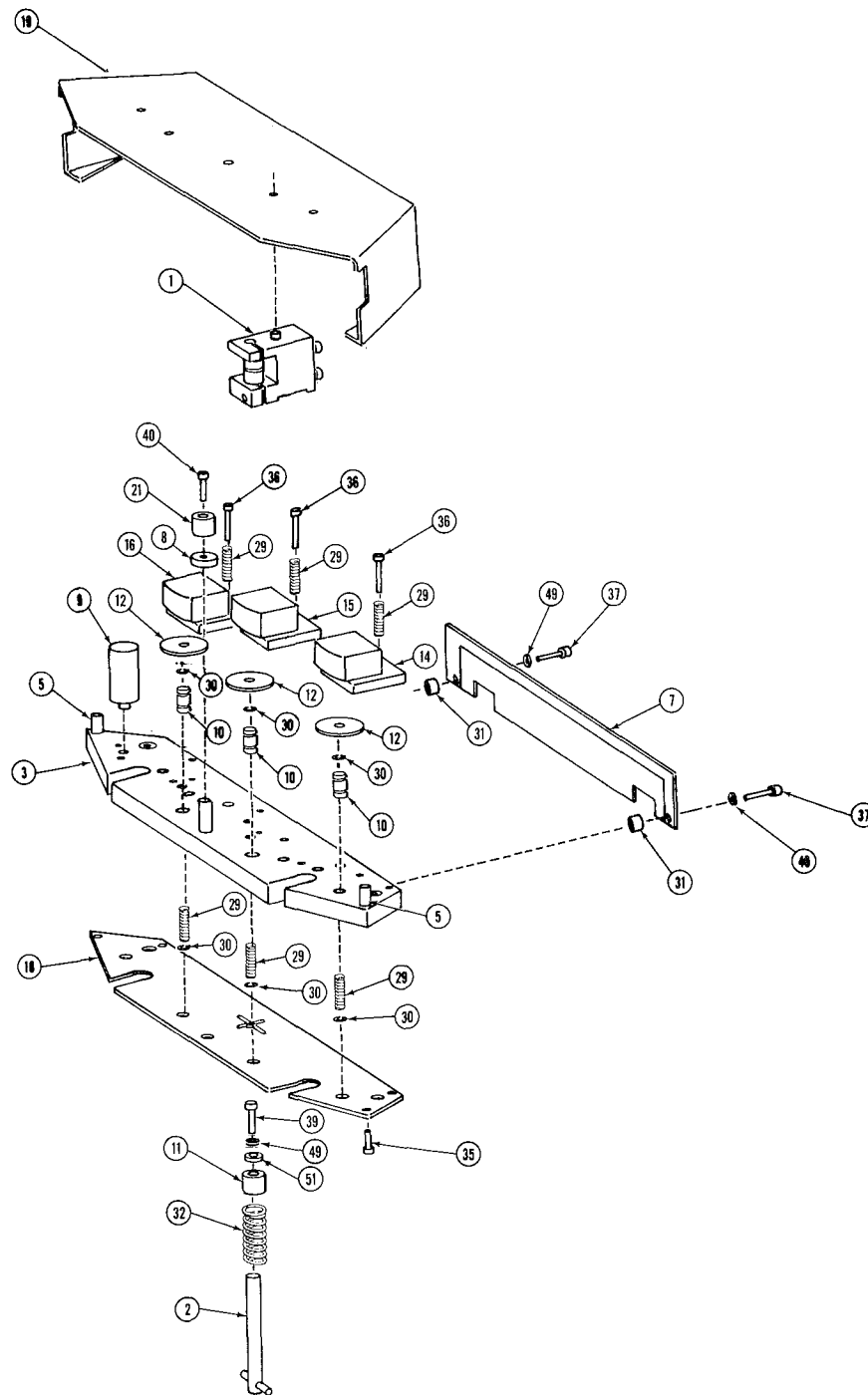


Assembly No. 4020417. Two Track Head Assembly, 1/4 Inch

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020418-02		FOUR TRACK HEAD ASSEMBLY, 1/2 INCH (NHA 4010262)	
1	4030402-AA		SCRAPE FLUTTER, IDLER ASSEMBLY	
2	4041225-01		SHAFT ASSEMBLY, HEAD ASSY LOCK	
3	4041237-01		PLATE ASSEMBLY, HEAD	
5	4041243-01		GUIDE ASSEMBLY, EDGE	
6	4041265-01		PINION GEAR ASSY	
7	4050837-01		HEAD CONNECTOR PWA	
8	4210361-01		GUIDE, EDGE HEAD	
9	4210362-01		POST, DUMMY HEAD	
10	4210385-01		PIN, HEAD RETAINING	
11	4220322-01		SPACER, LOCK SPRING	
12	4240018-01		GEAR, MODIFICATION	
13	4290936-01		ADAPTER, 1/2 INCH TAPE	
14	4350237-01		HEAD STACK ASSY, FOUR TRK, PLAY	
15	4350238-01		HEAD STACK ASSY, FOUR TRK, RECORD	
16	4350239-01		HEAD STACK ASSY, FOUR TRK, ERASE	
18	4600092-01		SHIELD, HEADS, BOTTOM	
19	4600093-01		SHIELD, HEADS	
29	352-443		SPRING, COMPRESSION	LEE LC-024B-1-MW
30	430-152		RING, RETAINING	TRUARC NO. 5133-12
31	280-366		SPACER, PLAIN, 0.18 OD X 0.18 LG	
32	352-228		SPRING, COMPRESSION	C0360-045-1000M
35	470-009		SCREW, CAP, HEX SOC, NO. 4-40 X 5/16	
36	470-011		SCREW, CAP, HEX SOC, NO. 4-40 X 7/16	
37	470-013		SCREW, CAP, HEX SOC, NO. 4-40 X 5/8	
39	470-136		SCREW, CAP, HEX SOC, NO. 4-40 X 7/8	
40	470-643		SCREW, CAP, BUTTON HD, NO. 4-40 X 3/4	
47	501-751		WASHER, FLAT, NO. 4, FIBER	
49	502-002		WASHER, SPRING, NO. 4	
51	502-389		WASHER, FLAT, NO. 4	

B

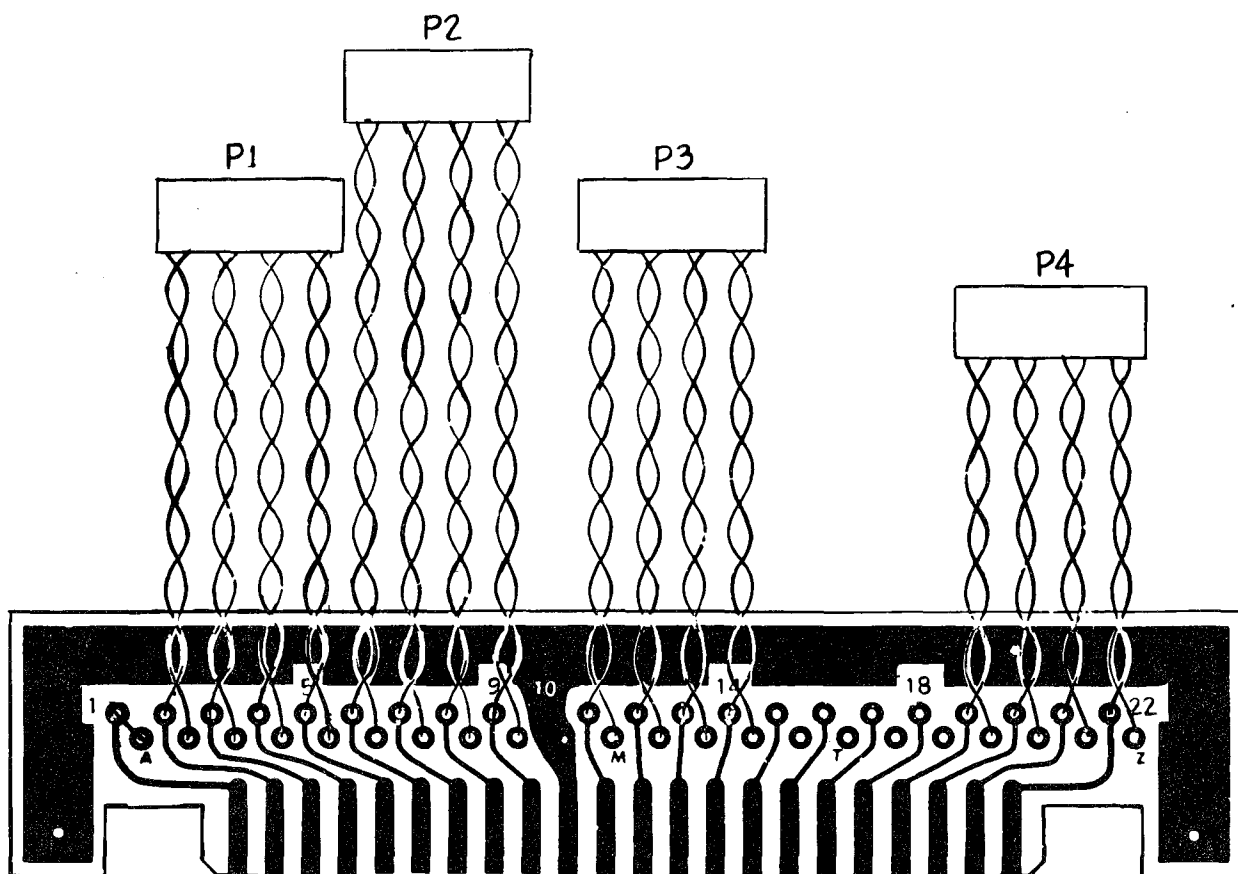
SHEET 1 OF 1



Assembly No. 4020418. Four Track Head Assembly, 1/2 Inch

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050837-01 139-865		HEAD CONNECTOR PWA, 4 CHANNEL (NHA 4020418) CONNECTOR ASSEMBLY	

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010255-01		MISCELLANEOUS PARTS KIT, 1/4 INCH (NHA 4010260, 4010261)	
1	4040492-10		KNOB, HOLDDOWN	
4	4690003-10		REEL, EMPTY, 1/4 INCH X 10 1/2 INCH	
6	4890407		MANUAL, INSTRUCTION	
8	139-840		CONNECTOR, I/O, 24 PIN	
10	360-005		TOOL, KEY, HEX, 0.062 AF	
11	360-006		TOOL, KEY, HEX, 0.078 AF	
12	360-003		TOOL, KEY, HEX, 0.094 AF	
13	360-436		TOOL, KEY, HEX, 0.109 AF	
14	360-435		TOOL, KEY, HEX, 0.156 AF	
15	360-434		TOOL, KEY, HEX, 0.187 AF	
18	718-089		BAG, POLYETHYLENE, 4 X \$	

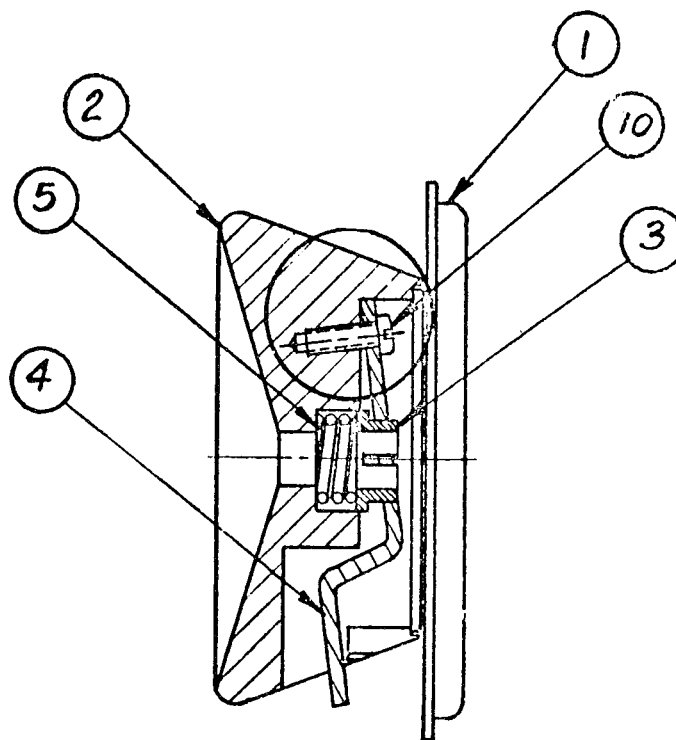
SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010267-01		MISCELLANEOUS PARTS KIT, 1/2 INCH (NHA 4010262)	
1	4040492-10		KNOB, HOLDDOWN	
4	4690003-20		REEL, EMPTY, 1/2 INCH X 10 1/2 INCH	
6	4890407		MANUAL, INSTRUCTION	
8	139-840		CONNECTOR, I/O, 24 PIN	
10	360-005		TOOL, KEY, HEX, 0.062 AF	
11	360-006		TOOL, KEY, HEX, 0.078 AF	
12	360-003		TOOL, KEY, HEX, 0.094 AF	
13	360-436		TOOL, KEY, HEX, 0.109 AF	
14	360-435		TOOL, KEY, HEX, 0.156 AF	
15	360-434		TOOL, KEY, HEX, 0.187 AF	
18	718-089		BAG, POLYETHYLENE, 4 X 4	

SHEET 1 OF 1

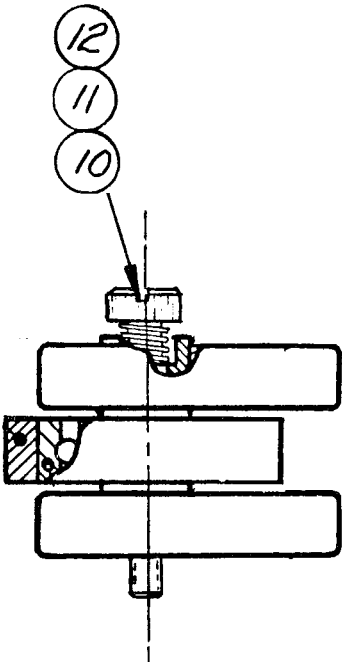
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4040492-10		REEL KNOB ASSEMBLY (NHA 4010267, 4010255)	
1	4040493-10		REEL KNOB, SUB ASSEMBLY	
2	4100136-10		REEL KNOB	
3	4220164-10		COLLET, REEL HOLD DOWN	
4	4230176-10		LEVER, REEL KNOB	
5	4270189-10		SPRING, REEL HOLD DOWN	
10	476-062		SCREW, PAN HEAD, XREC, SELF-TAPPING, NO. 6-32 X 3/8 LG	
11	476-226		SCREW, PAN HD, SLOTTED, SELF-TAPPING, NO. 8-32 X 3/8	L

SHEET 1 OF 1



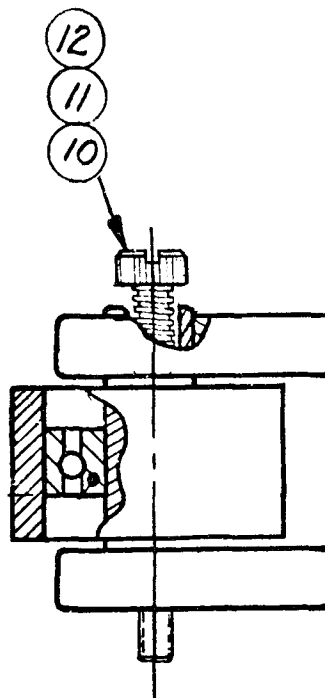
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
10 11 12	4041239-AC 4041239-AD 430-374 352-443 4400271-01		TAPE GUIDE ASSEMBLY, 1/4 INCH, SUPPLY TAPE GUIDE ASSEMBLY, 1/4 INCH, TAKEUP (NHA 4010260, 4010261) RING, RETAINING SPRING, COMPRESSION SCREW, 1/4 INCH TAPE GUIDE	 C

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4041240-AC 4041240-AD		TAPE GUIDE ASSEMBLY, 1/2 INCH, SUPPLY TAPE GUIDE ASSEMBLY, 1/2 INCH, TAKEUP (NHA 4010260, 4010261, 4010262)	
10	430-374		RING, RETAINING	
11	352-443		SPRING, COMPRESSION	
12	4400272-01		SCREW, 1/2 INCH, TAPE GUIDE	C

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010254-04		INPUT/OUTPUT MAIN FRAME ASSEMBLY (NHA 4010260, 4010261, 4010262)	
5	4050840-01		INPUT/OUTPUT MAIN FRAME HARNESS	
6	4260573-01		BRACKET, COVER SUPPORT	
8	4260531-02		BRACKET	
10	4290827-02		CHASSIS, MAIN FRAME	
12	4330341-02		CASTING, FRAME	
13	4840427		SCHEMATIC	
15	041-101	R1,2	RESISTOR, 1W, 620 OHM, 5%	
17	119-196	S1,2	SWITCH, DPDT, SLIDE	
19	143-198	J17,18	CONNECTOR, PCB, 22 PIN, DUAL CONTACT	
20	146-998		CONNECTOR, AUDIO RECP, 3 SOC, XLR	
21	147-999		CONNECTOR, AUDIO RECP, 3 PIN, XLR	
22	471-070		SCREW, PAN HD, 6-32, 0.438 LG	
23	470-012		SCREW, SOCKET HEAD, 4/40 X 1/2 INCH	
25	471-062		SCREW, PAN HD, 4/40 X 3/8 INCH	
26	471-328		SCREW, FLT HD, 4/40 X 3/8 INCH	
27	476-998		SCREW, SELF-TAP, 1/4 INCH, 6/20	
28	476-010		SCREW, SELF-TAP, 3/16 INCH, 6/20	
29	496-004		NUT, KEP, 4/40	
31	496-005		NUT, HEX, KEP, 6/32	
34	501-013		WASHER, PLAIN, NO. 2, CORR RESIST	
35	302-088		CLAMP, LOOP, OFFSET, 0.500 ID, NYLON, BLK	
36	502-003		WASHER, LOCK, NO. 6, HELICAL SPRING	
37	501-009		WASHER, PLAIN, NO. 6	
40	6000035-01		LABEL	
41	470-018		SCREW, CAP, SOCKET HD, 6-32, 0.375 LG	

H

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020409-04		INPUT/OUTPUT MODULE ASSEMBLY (NHA 4010260, 4010261, 4010262)	
2	4050828-01	P3	BIAS AND ERASE INDICATORS PWA	
3	4110292-02		OVERLAY	
6	4140028-01		METER	
7	4290828-02		CHASSIS, MODULE	
9	4840421		SCHEMATIC, REV D	
10	4140026-02		FLAG, SCALE INDICATOR	
12	6000006-20		KNOB, BLACK	
13	058-980	R2	POTENTIOMETER, 50K, Z TAPER (REPRO LEVEL)	
14	058-981	R1	POTENTIOMETER, 100K, Z TAPER (RECORD LEVEL)	
15	060-019	DS3,4	LAMP, (VU METER)	NO. 327
17	139-872	J4	CONNECTOR, SIGNAL CIRCUIT, JACK	
18	167-369		CONTACT, SPRING, PUSH-ON	
19	167-370	P1	BODY, CONNECTOR, PLUG, 6-POSITION	
20	167-404	P2	BODY, CONNECTOR, PLUG, 2-POSITION	
21	280-344		SPACER, UNTHREADED, PLAIN, NO. 6, 0.250 OD X 0.125 LG	
22	172-009		LUG, SOLDER	
24	496-004		NUT, WITH ASSEMBLED WASHER, 4-40	
25	470-010		SCREW, SOCKET HEAD, 4-40 X 3/8	
27	470-023		SCREW, SOCKET HEAD, 6-32 X 7/8	
28	471-061		SCREW, PAN HEAD, 4-40 X 5/16	
29	502-002		WASHER, SPRING LOCK, NO. 4	
30	280-659		SPACER, UNTHREADED, 0.375 LG	
33	4050827-03		INPUT/OUTPUT MODULE PWA	

F

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050827-03		INPUT/OUTPUT MODULE PWA (NHA 4020409)	
2	4840421		SCHEMATIC, REV D	
5	4290941-01		COVER, INPUT TRANSFORMER	
6	4290942-01		CAN, INPUT TRANSFORMER	
7	4580066-01	T2	TRANSFORMER, INPUT	
8	4580067-01	T1	TRANSFORMER, OUTPUT	
10	070-011	F1	FUSE, FAST BLOW, 0.5 AMP	
12	013-599	CR1-8,11	DIODE	IN914
14	013-678	CR9,10	DIODE	IN4005
15	581-291	VR1,2	DIODE	IN4745A
18	014-247	Q6	TRANSISTOR	2N2219
19	014-652	Q3,9,10	TRANSISTOR	2N3906
20	580-304	Q1,2	TRANSISTOR	P1087E
21	580-760	Q7	TRANSISTOR	GE D44C9
22	580-761	Q8	TRANSISTOR	GE D45C9
23	580-859	Q5	TRANSISTOR	TIP41B
24	580-860	Q4	TRANSISTOR	TIP42B
25	587-478	A2-5	INTEGRATED CIRCUIT	318H
26	586-905	A1	INTEGRATED CIRCUIT	1458
29	122-423	S1	SWITCH, TOGGLE, SPDT	
30	119-368	S2	SWITCH, TOGGLE, DPDT	
31	119-377	S3	SWITCH, SLIDE, DPDT	
33	034-215	C19	CAPACITOR, MICA, 10 PF, 500V, ± 0.5 PF	
34	034-156	C6	CAPACITOR, MICA, 5 PF, 500V, ± 0.5 PF	
36	034-181	C5	CAPACITOR, MICA, 47 PF, 500V, 5%	
37	034-182	C11	CAPACITOR, MICA, 56 PF, 500V, 5%	
38	034-183	C18	CAPACITOR, MICA, 62 PF, 500V, 5%	
39	037-996	C23,24	CAPACITOR, TANT, TUBULAR, 10 UF, 35V, 10%	
40	037-991	C27,28	CAPACITOR, TANT, TUBULAR, 22 UF, 15V, 10%	
41	037-812	C21,22	CAPACITOR, TANT, DIPPED, 10 UF, 25V, 10%	
42	037-746	C1	CAPACITOR, TANT, TUBULAR, 47 UF, 20V, 10%	
43	037-967	C9,10	CAPACITOR, TANT, DIPPED, 220 UF, 10V, 10%	
45	055-193	C2	CAPACITOR, MYLAR, 0.27 UF, 50V, 5%	
46	055-853	C3	CAPACITOR, MYLAR, 0.33 UF, 50V, 5%	
48	063-031	C25,26	CAPACITOR, ALUM, 100 UF, 50V, + 75%—10%	
50	064-116	C4	CAPACITOR, CER, 0.01 UF, 50V, + 80—20%	
51	064-115	C7,8,12-17	CAPACITOR, CER, 0.1 UF, 50V, + 80—20%	
54	041-789	R6	RESISTOR, COMP, 6.8M, 1/4W 5%	
55	041-032	R49,50	RESISTOR, COMP, 10 OHM, 1/2W, 10%	
56	049-572	R68,69	RESISTOR, COMP, 18 OHM, 1W, 10%	
57	041-473	R64,65	RESISTOR, COMP, 240 OHM, 1/2W, 5%	
58	041-405	R15	RESISTOR, COMP, 1.2K, 1/2W, 5%	
61	041-885	R8	RESISTOR, COMP, 200 OHM, 1W, 5%	
63	066-599	R60-63	RESISTOR, METAL FILM, 12.7 OHM, 1/4W, 1%	
64	076-019	R16-18,29	RESISTOR, METAL FILM, 59K, 1/4W, 1%	
65	066-803	R5	RESISTOR, METAL FILM, 182K, 1/4W, 1%	
67	076-070	R11	RESISTOR, METAL FILM, 210K, 1/4W, 1%	
68	076-064	R9	RESISTOR, METAL FILM, 309K, 1/4W, 1%	
69	076-063	R12	RESISTOR, METAL FILM, 374K, 1/4W, 1%	
71	066-810	R51,52	RESISTOR, CARBON FILM, 10 OHM, 1/4W, 5%	
72	076-041	R74	RESISTOR, CARBON FILM, 27 OHM, 1/4W, 5%	
73	066-938	R24	RESISTOR, CARBON FILM, 47 OHM, 1/4W, 5%	
74	076-004	R42,48	RESISTOR, CARBON FILM, 180 OHM, 1/4W, 5%	
75	066-663	R14,43	RESISTOR, CARBON FILM, 220 OHM, 1/4W, 5%	
76	066-841	R19	RESISTOR, CARBON FILM, 1.3K, 1/4W, 5%	

D

SHEET 1 OF 2

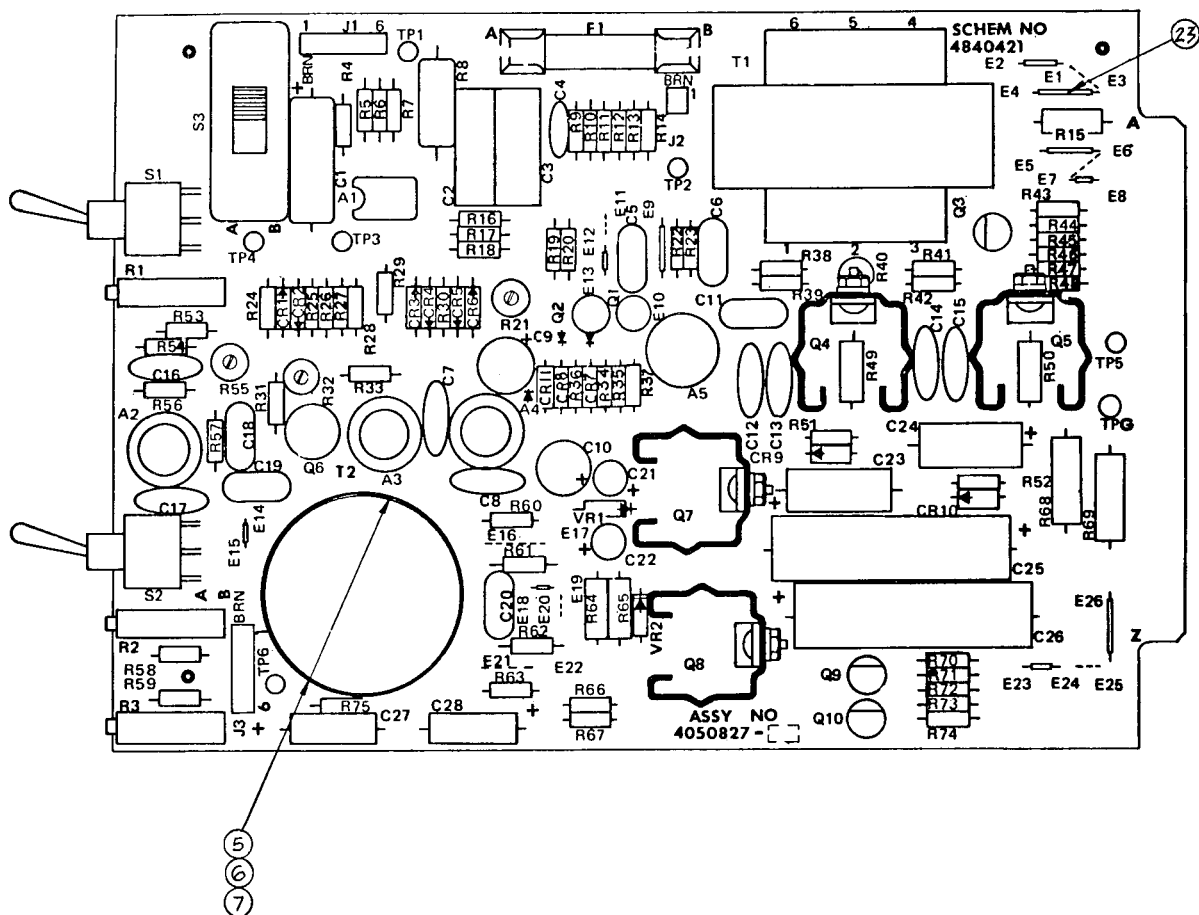
ASSEMBLY NO: 4050827

TITLE: INPUT/OUTPUT MODULE PWA

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
77	066-842	R38,56	RESISTOR, CARBON FILM, 5.1K, 1/4W, 5%	
78	066-715	R66,67	RESISTOR, CARBON FILM, 1.2K, 1/4W, 5%	
79	066-830	R20	RESISTOR, CARBON FILM, 10K, 1/4W, 5%	
80	066-689	R30	RESISTOR, CARBON FILM, 2.2K, 1/4W, 5%	
81	066-666	R58	RESISTOR, CARBON FILM, 2.7K, 1/4W, 5%	
82	066-718	R13	RESISTOR, CARBON FILM, 5.6K, 1/4W, 5%	
83	066-863	R41,47	RESISTOR, CARBON FILM, 3.6K, 1/4W, 5%	
84	066-830	R25,70,72	RESISTOR, CARBON FILM, 10K, 1/4W, 5%	
85	066-865	R33	RESISTOR, CARBON FILM, 12K, 1/4W, 5%	
86	066-856	R28	RESISTOR, CARBON FILM, 15K, 1/4W, 5%	
87	066-832	R34,36	RESISTOR, CARBON FILM, 18K, 1/4W, 5%	
88	066-712	R45,46,71,73	RESISTOR, CARBON FILM, 22K, 1/4W, 5%	
89	066-866	R22	RESISTOR, CARBON FILM, 27K, 1/4W, 5%	
90	066-847	R35,37	RESISTOR, CARBON FILM, 33K, 1/4W, 5%	
91	066-717	R26,27	RESISTOR, CARBON FILM, 47K, 1/4W, 5%	
92	066-833	R4,54,57,59	RESISTOR, CARBON FILM, 56K, 1/4W, 5%	
93	076-009	R44	RESISTOR, CARBON FILM, 68K, 1/4W, 5%	
94	066-868	R7,53	RESISTOR, CARBON FILM, 120K, 1/4W, 5%	
95	076-011	R23,31	RESISTOR, CARBON FILM, 180K, 1/4W, 5%	
96	066-586	R39	RESISTOR, CARBON FILM, 220K, 1/4W, 5%	
97	076-012	R10	RESISTOR, CARBON FILM, 330K, 1/4W, 5%	
98	066-812	R75	RESISTOR, CARBON FILM, 100 OHM, 1/4W, 5%	
100	058-388	R1-3	RESISTOR, VAR, CERMET, 50K, 0.75W	
102	058-001	R21	RESISTOR, VAR, CERMET, 50K, 1/2W, 20%	
103	058-251	R55	RESISTOR, VAR, CERMET, 100K, 1/2W, 20%	
104	058-469	R32,40	RESISTOR, VAR, CERMET, 200K, 1/2W, 10%	
111	070-399	XF1	CLIP, FUSE	
118	471-060		SCREW, PAN HD, XREC, NO. 4-40 X 1/4 LG	
120	496-004		NUT, KEP, NO. 4-40	

D

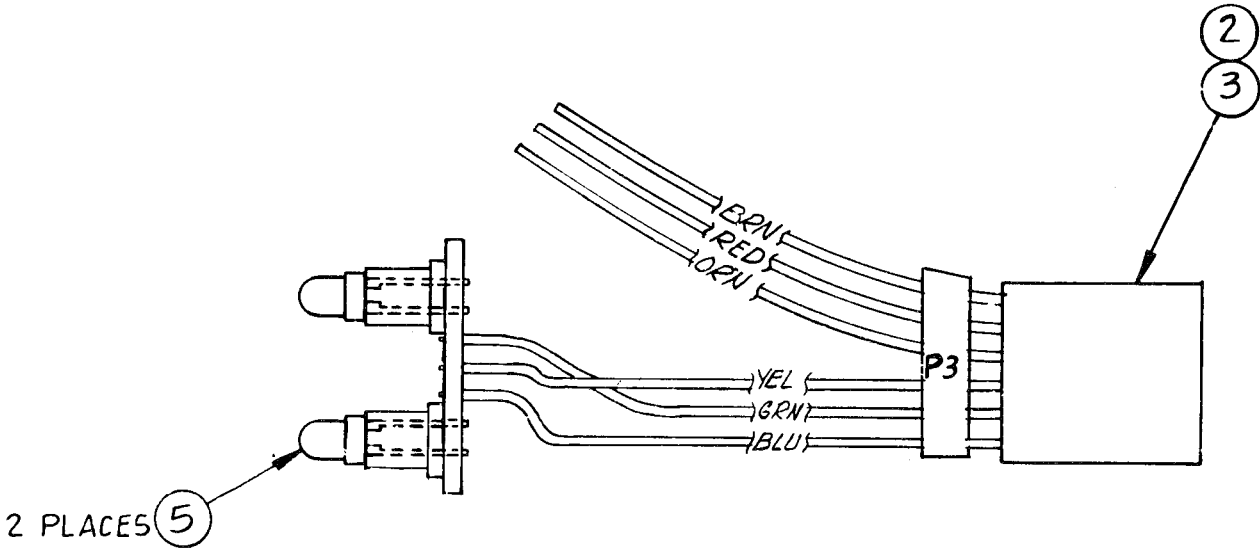
SHEET 2 OF 2



Assembly No. 4050827. Input/Output Module PWA

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
2	4050828-01		BIAS AND ERASE INDICATORS PWA	
3	167-369	P3	CONTACT	
5	167-370	DS1,2	BODY, CONNECTOR	
	581-400		DIODE, LIGHT EMITTING, RED	B

SHEET 1 OF 1



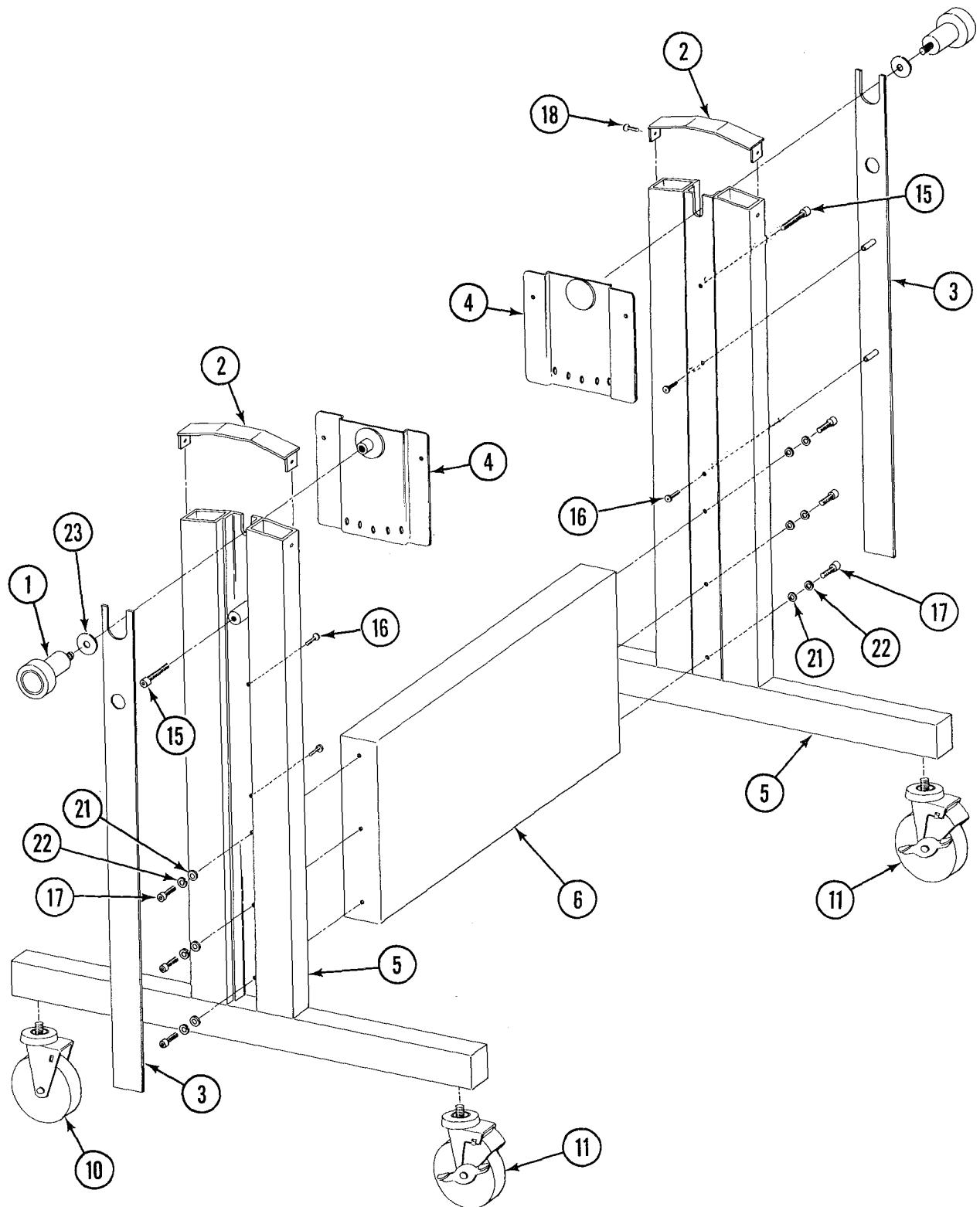
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
1 4 6	4050840-01 4840427 139-840 265-082		INPUT/OUTPUT MAIN FRAME HARNESS SCHEMATIC, REV A CONNECTOR, PLUG, 24 PIN BUSHING, CABLE 7/16 ID	HEYCO SB 625-7
				F

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020426-01		PEDESTAL ASSEMBLY (NHA 4010260, 4010261, 4010262)	
1	4041268-01		KNOB ASSY	
2	4150362-01		CAP, TOP	
3	4150368-01		TRIM STRIP	
4	4150369-01		PLATE, PIVOT	
5	4150370-01		WELDMENT	
6	4041267-01		PANEL ASSY	
10	082-066		CASTER, WITHOUT BRAKE SWIVEL	
11	082-065		CASTER, WITH BRAKE SWIVEL	
15	470-655		SCREW, CAP HD HEX SOC, 1/4-20-1, BLK OXIDE	
16	470-531		SCREW, BUTTON HD HEX SOC, 10-32 X 1/2, BLK OXIDE	
17	470-045		SCREW, CAP HD HEX SOC, 1/4-20 X 1/2 INCH, CAD PLATE	
18	472-954		SCREW, BUTTON HD HEX SOC, 6-32 X 0.375, BLK OXIDE	
21	501-067		WASHER, PLAIN, 1/4	
22	502-006		WASHER, LOCK, SPLIT, 1/4	
23	502-426		WASHER, PLAIN, NYLON, 0.562 ID X 1.12 OD X 0.031	

A

SHEET 1 OF 1



Assembly No. 4020426. Pedestal Assembly

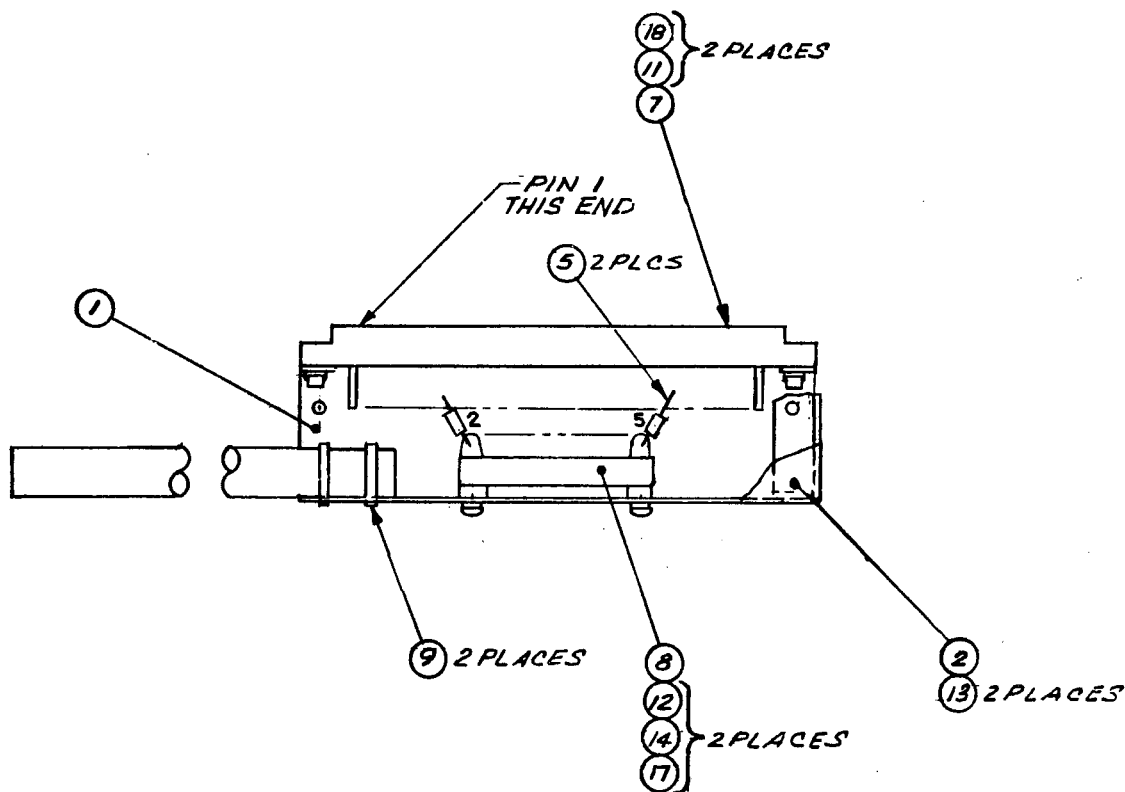
ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4010264-02		REMOTE CONTROL UNIT, 4 CHANNEL (NHA 4010262, 4010261, 4010260)	
4	4100080-AA		PUSHBUTTON, LARGE, GREY	
5	4100080-AB		PUSHBUTTON, LARGE, RED	
6	4100081-01		PUSHBUTTON, SMALL, GREY	
9	4110299-01		OVERLAY	
11	4050784-02		CONTROL UNIT NO. 1 PWA, 4 CHANNEL	
12	4050785-02		CONTROL UNIT NO. 2 PWA, 4 CHANNEL	
13	280-327		SPACER, THREADED, 4-40 0.500 LG	
14	471-061		SCREW, PAN HEAD, 0.312 LG	
16	501-195		WASHER, NO. 4, 0.209 OD, 0.032 THK	
17	4150351-02		CASE, TOP	
18	4150352-02		CASE, BOTTOM	
21	302-379		STRAP, CABLE, TY RAP	
22	4330357-01		PLATE, LOCKING	
24	471-575		SCREW, BINDER HD, NO. 4-40 X 5/16	
25	250-180		BUMPER, RUBBER, SELF ADHESIVE	
				B

SHEET 1 OF 1

ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4050849-02		REMOTE CONTROL CABLE ASSEMBLY (NHA 4010264)	
1	4260574-01	TB-1	BRACKET, ACCESSORY CONNECTOR	
2	4290958-01		COVER, ACCESSORY CONNECTOR	
5	066-938		RESISTOR, CF, 47 OHM, 1/4W, 5%	
7	143-804		CONNECTOR, PCB, 56 PIN	
8	180-223		TERMINAL STRIP, 6 CONTACT	
9	302-379		TIE WRAP	
11	470-008		SCREW, CAP, SKT HEAD, NO. 4-40 X 0.250	
12	472-451		SCREW, PAN HEAD, NO. 2-56 X 0.188 LG	
13	476-998		SCREW, SHEET METAL, NO. 6-20 X 0.125	
14	492-007		NUT, NO. 2-56	
16	501-084		WASHER, PLAIN, NO. 2	
17	502-001		WASHER, LOCK, NO. 2	
18	502-002		WASHER, LOCK, NO. 4	

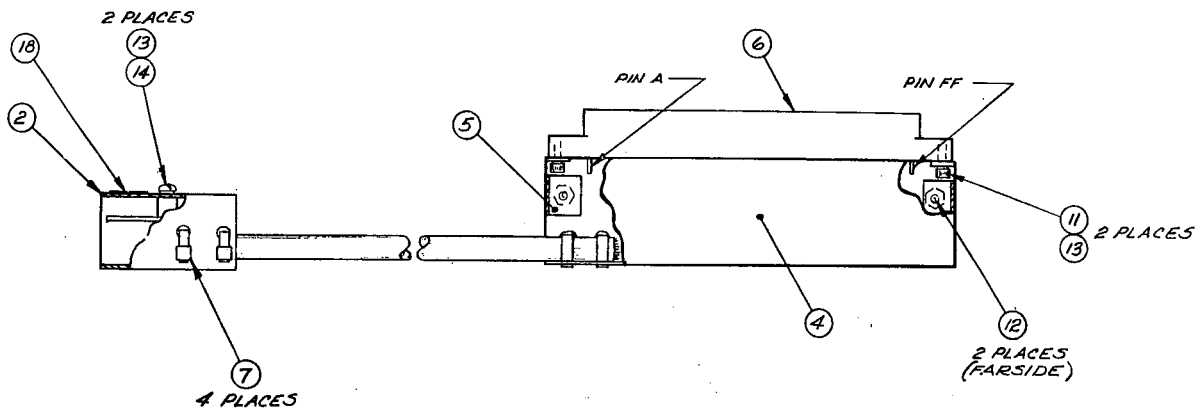
A

SHEET 1 OF 1



ITEM NO.	AMPEX PART NO.	REFERENCE NUMBER	DESCRIPTION	JEDEC NO. OR MFR. PART NO.
	4020432-01		TWO-WAY EXTENSION CONNECTOR ASSEMBLY (NHA 4010260, 4010261, 4010262)	
2	4290960-01		COVER, ACCESSORY CONNEC EXTENSION	
4	4260574-01		BRACKET, ACCESSORY CONNECTOR	
5	4290958-01		COVER, ACCESSORY CONNECTOR	
6	143-804		CONNECTOR, PCB, 56 PIN	
7	302-379		TIE-WRAP	
11	470-008		SCREW, CAP, SKT HEAD, NO. 4-40 X 0.250	
12	476-998		SCREW, SHEET METAL, NO. 6-20 X 0.25	
13	502-002		WASHER, LOCK, NO. 4	
14	471-060		SCREW, PAN HEAD, NO. 4-40 X 0.250	
18	6000035-02		LABEL, IDENTIFICATION	

SHEET 1 OF 1



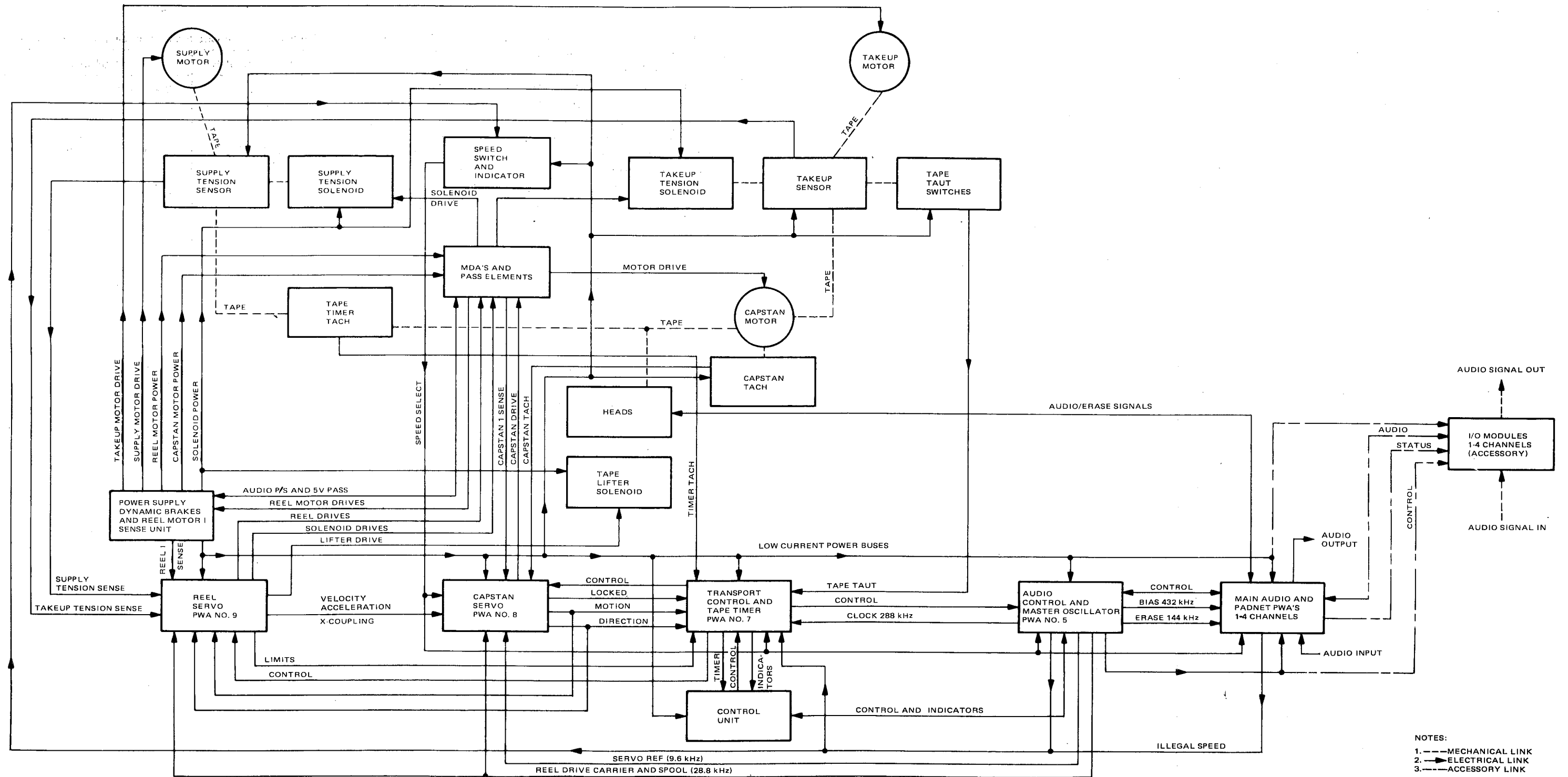
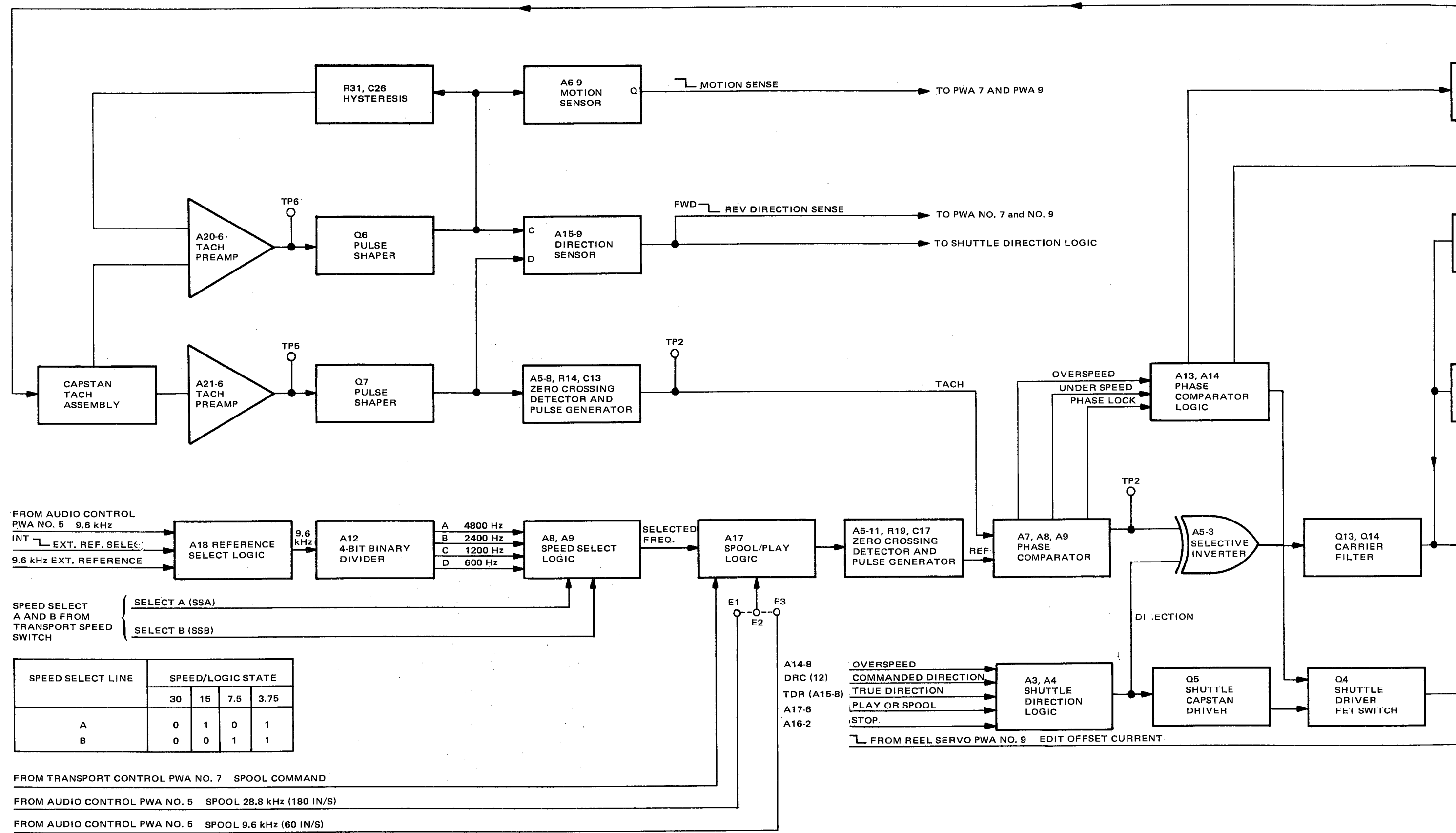


Figure 4-1. ATR-100 System, Simplified Block Diagram



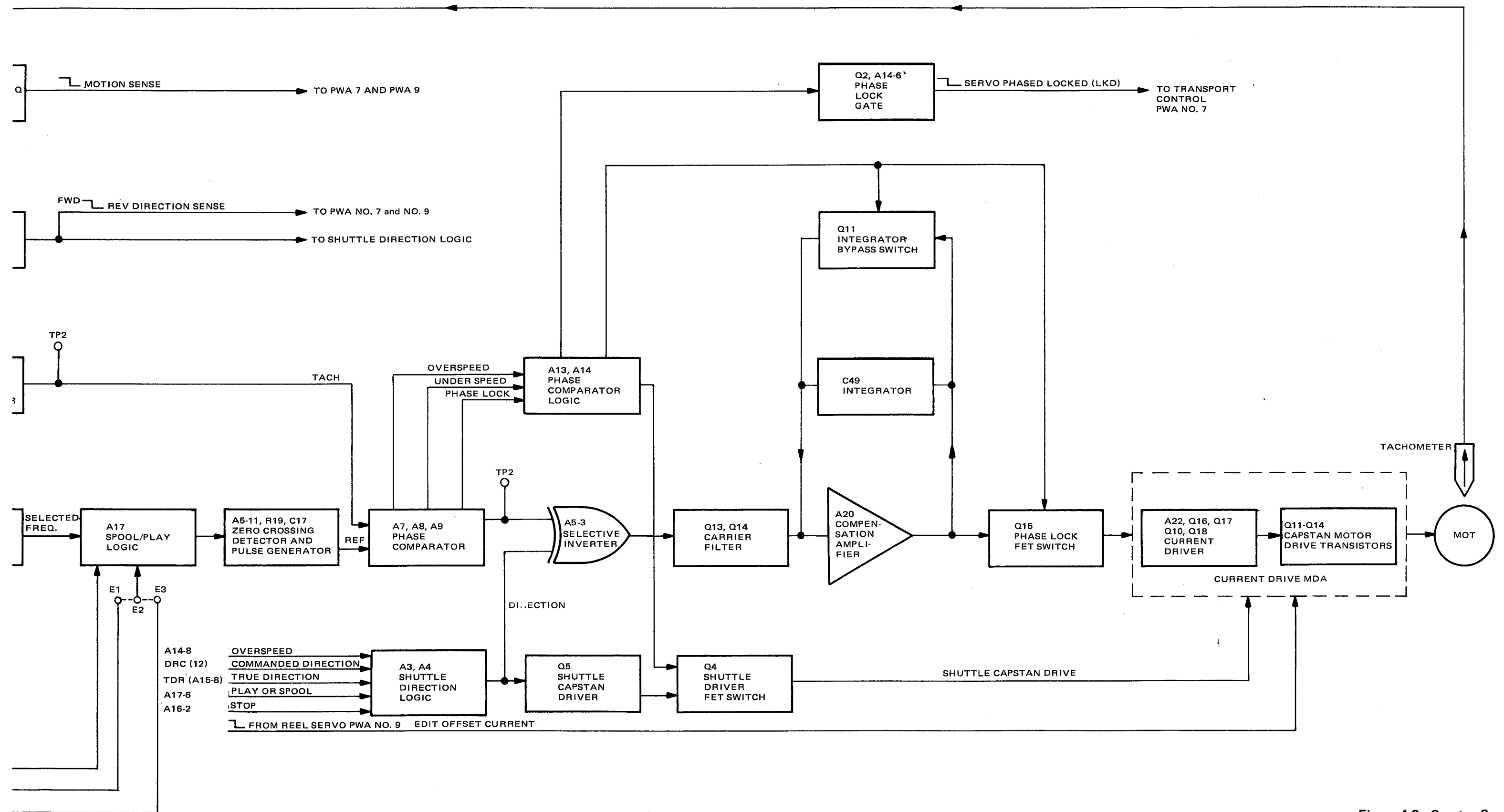


Figure 4-3. Capstan Servo Simplified Block Diagram

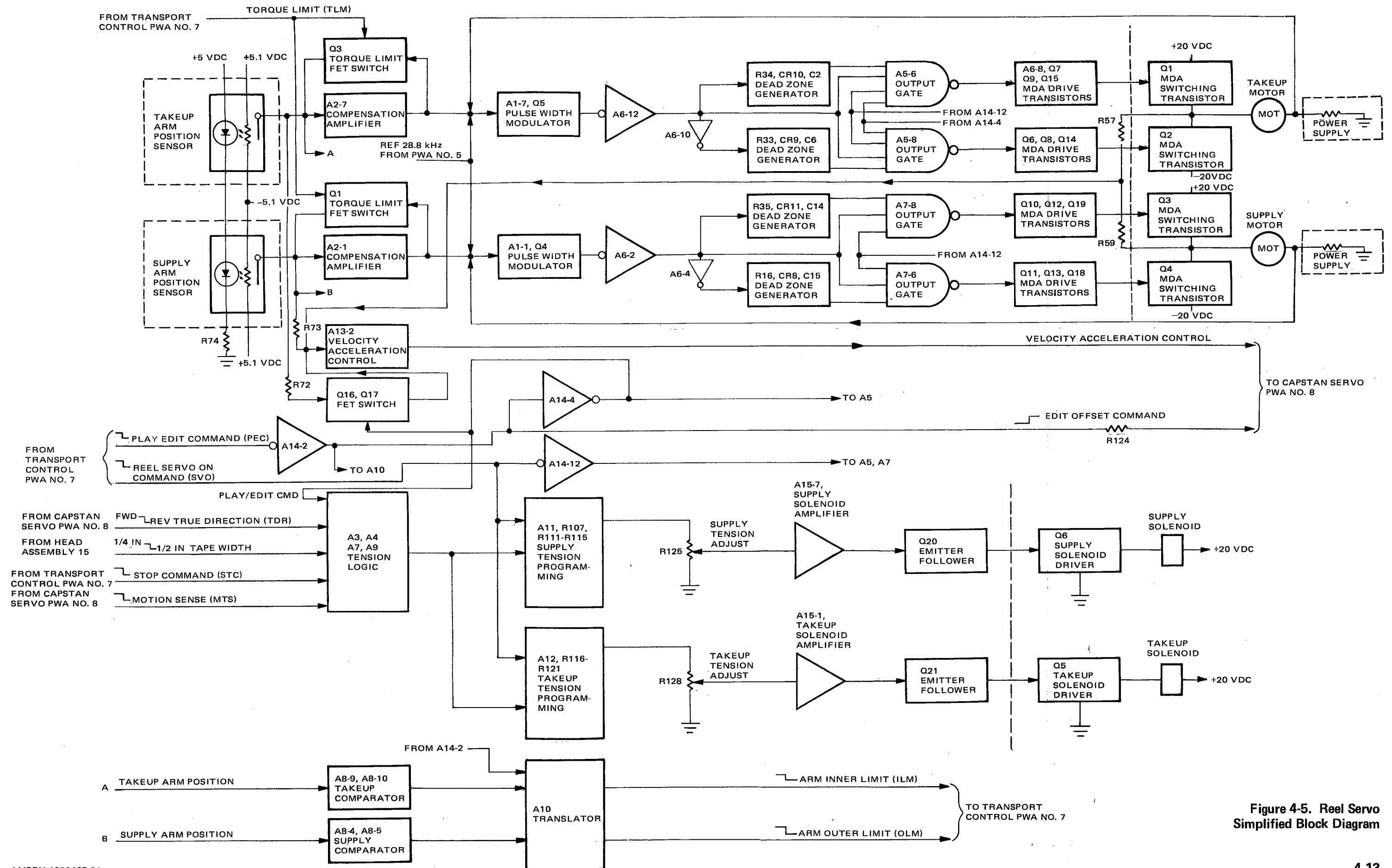


Figure 4-5. Reel Servo Simplified Block Diagram



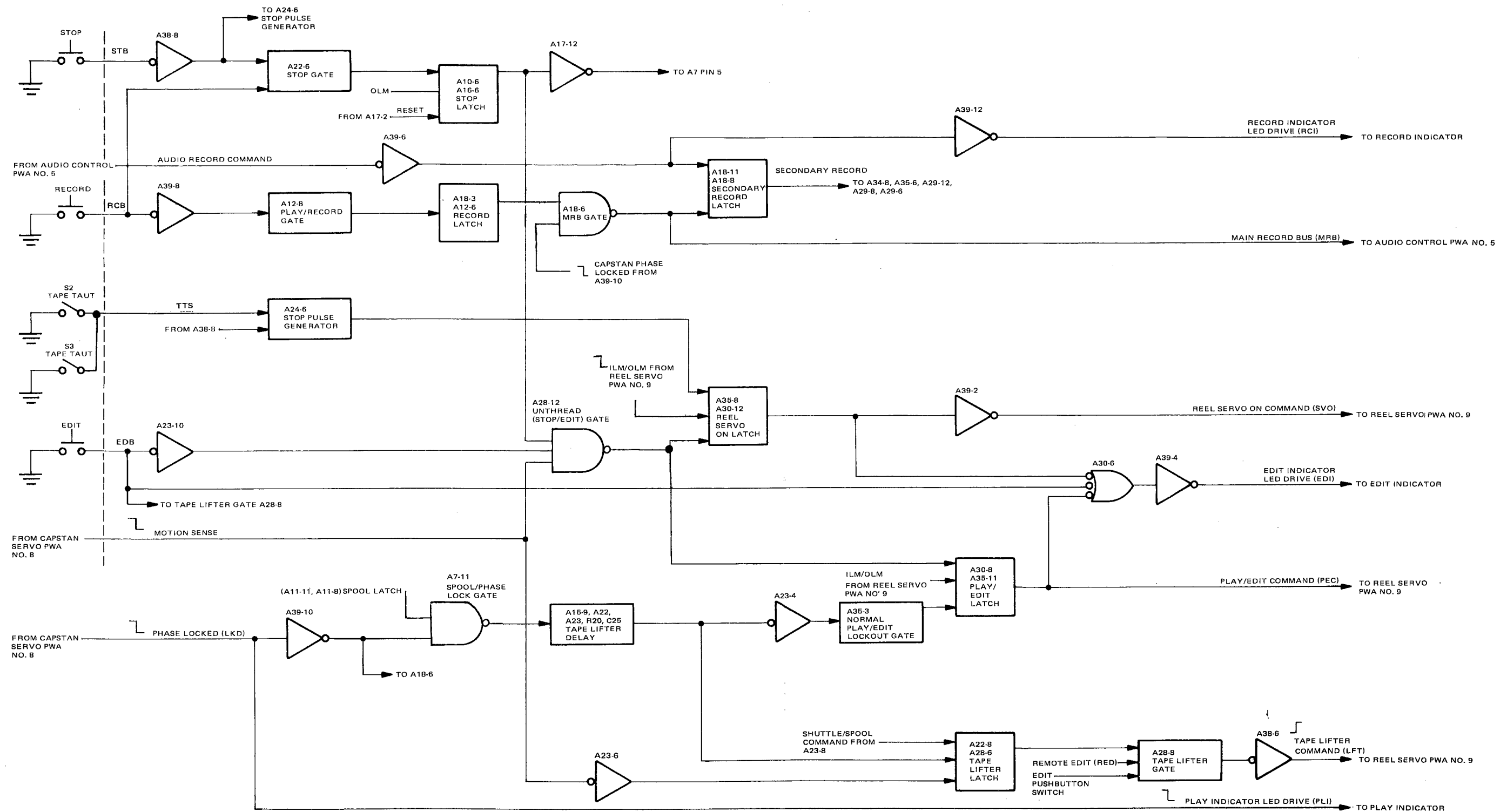
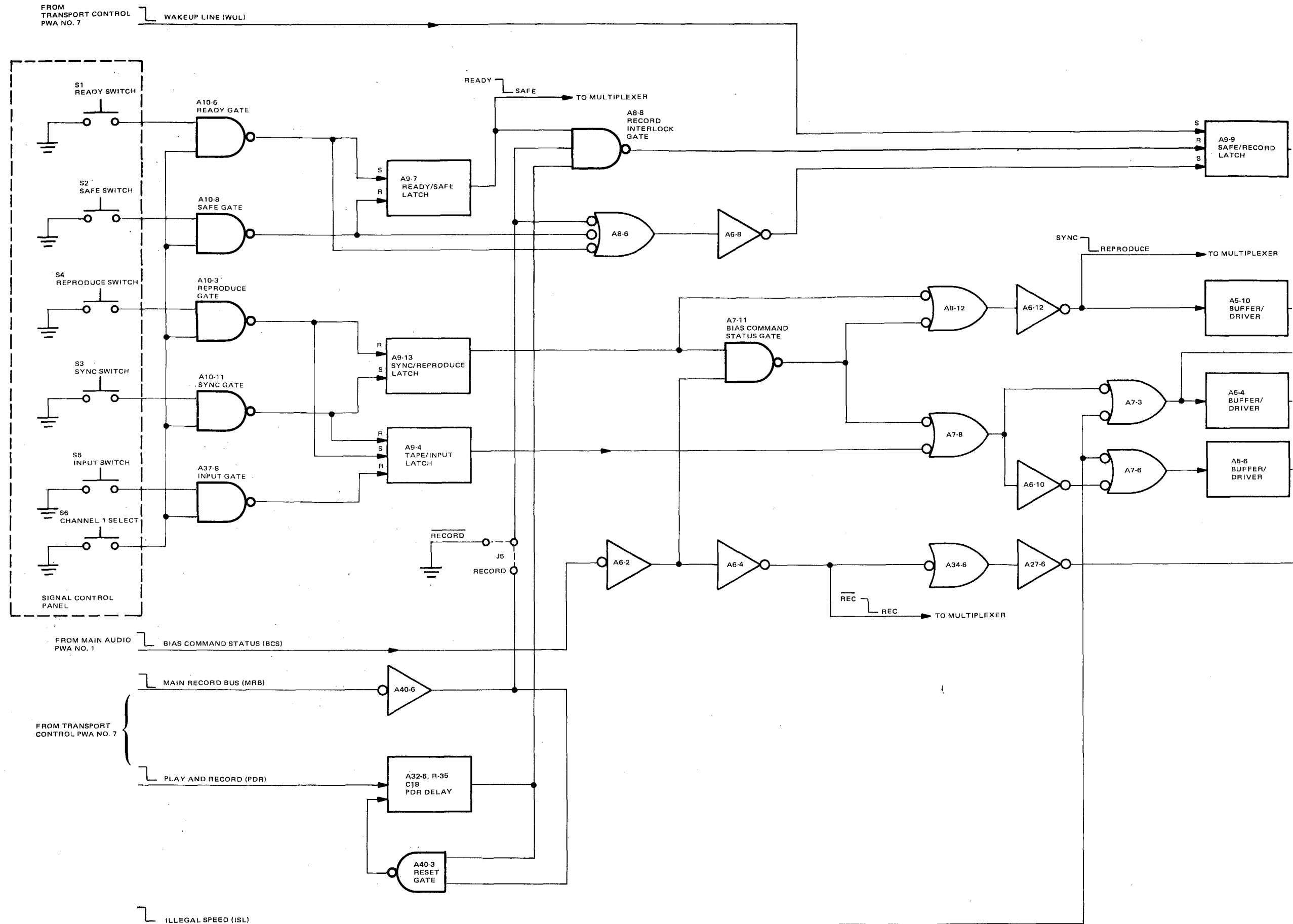
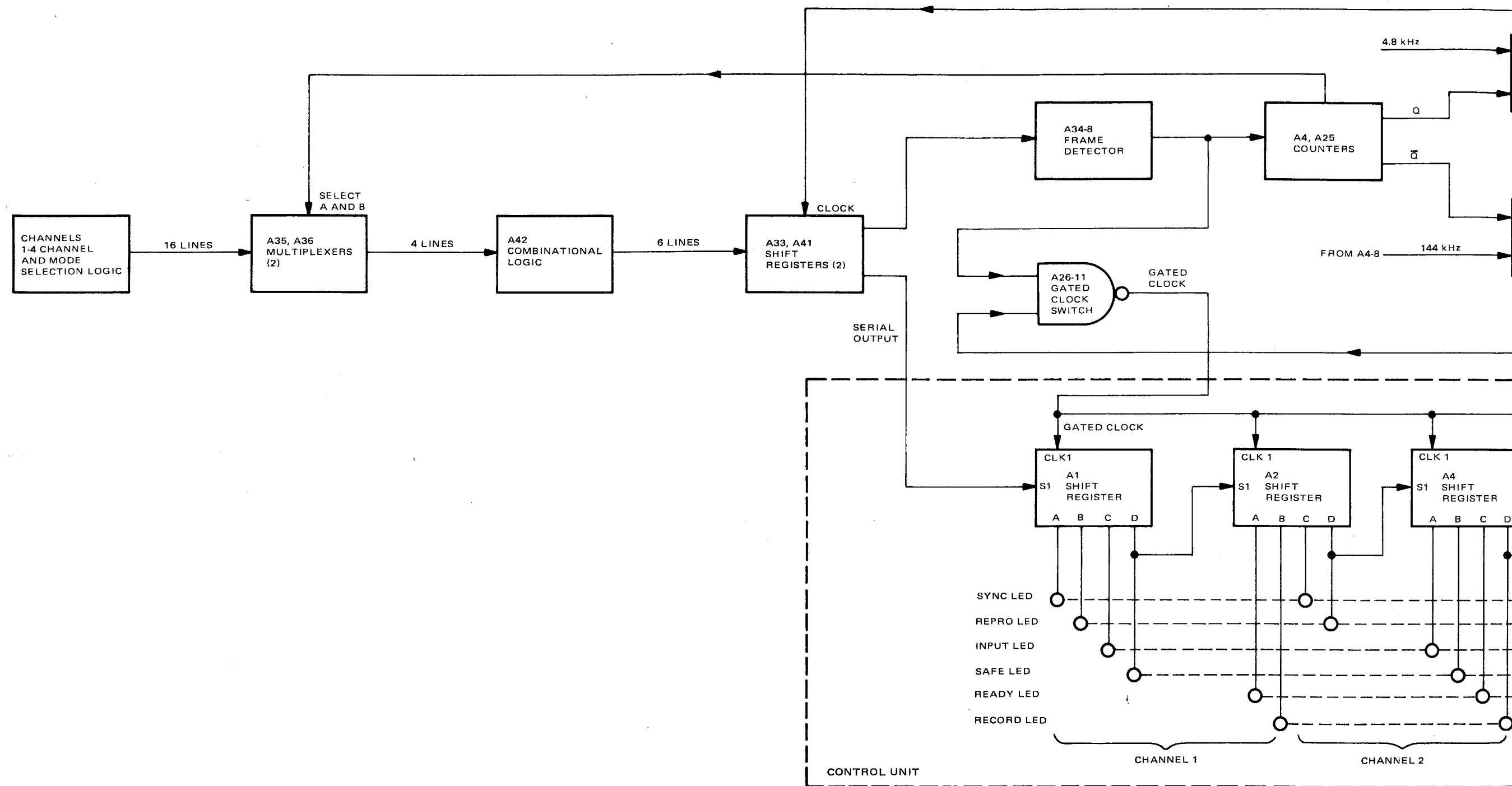


Figure 4-9. Transport Control PWA No. 7, Simplified Block Diagram (Sheet 2 of 3)







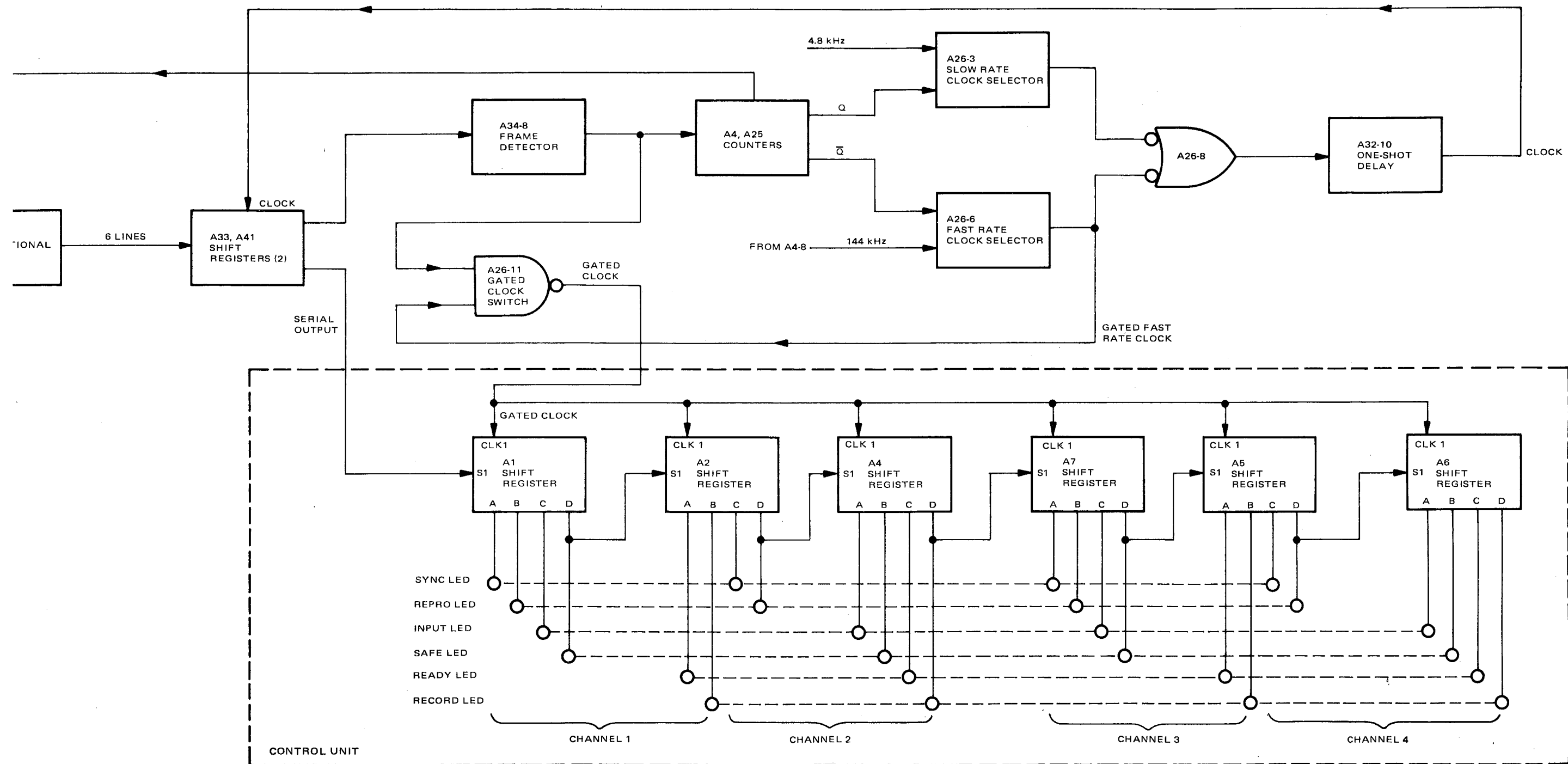
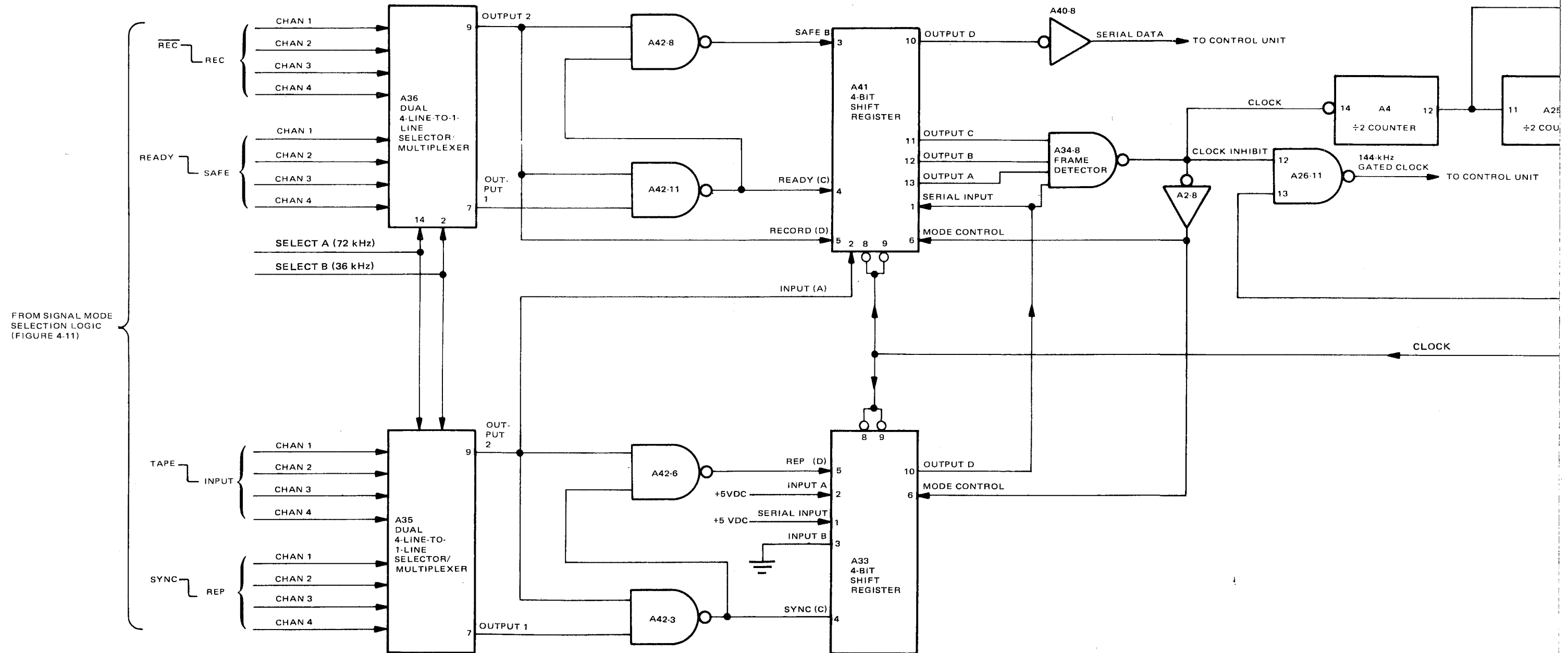


Figure 4-12. Multiplexer Simplified Interconnect Block Diagram, Audio Control PWA No. 5 and Control Unit



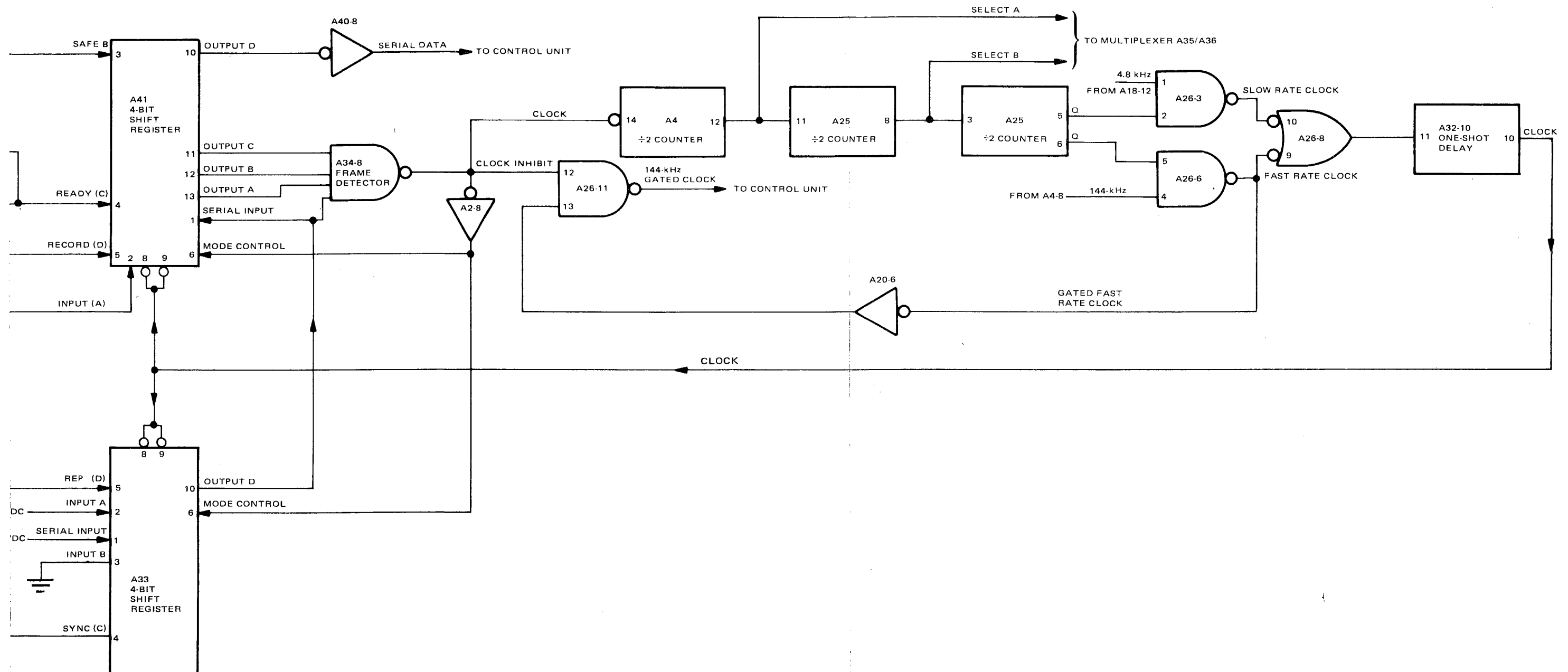


Figure 4-13. Multiplexer Simplified Block Diagram, Audio Control PWA No. 5

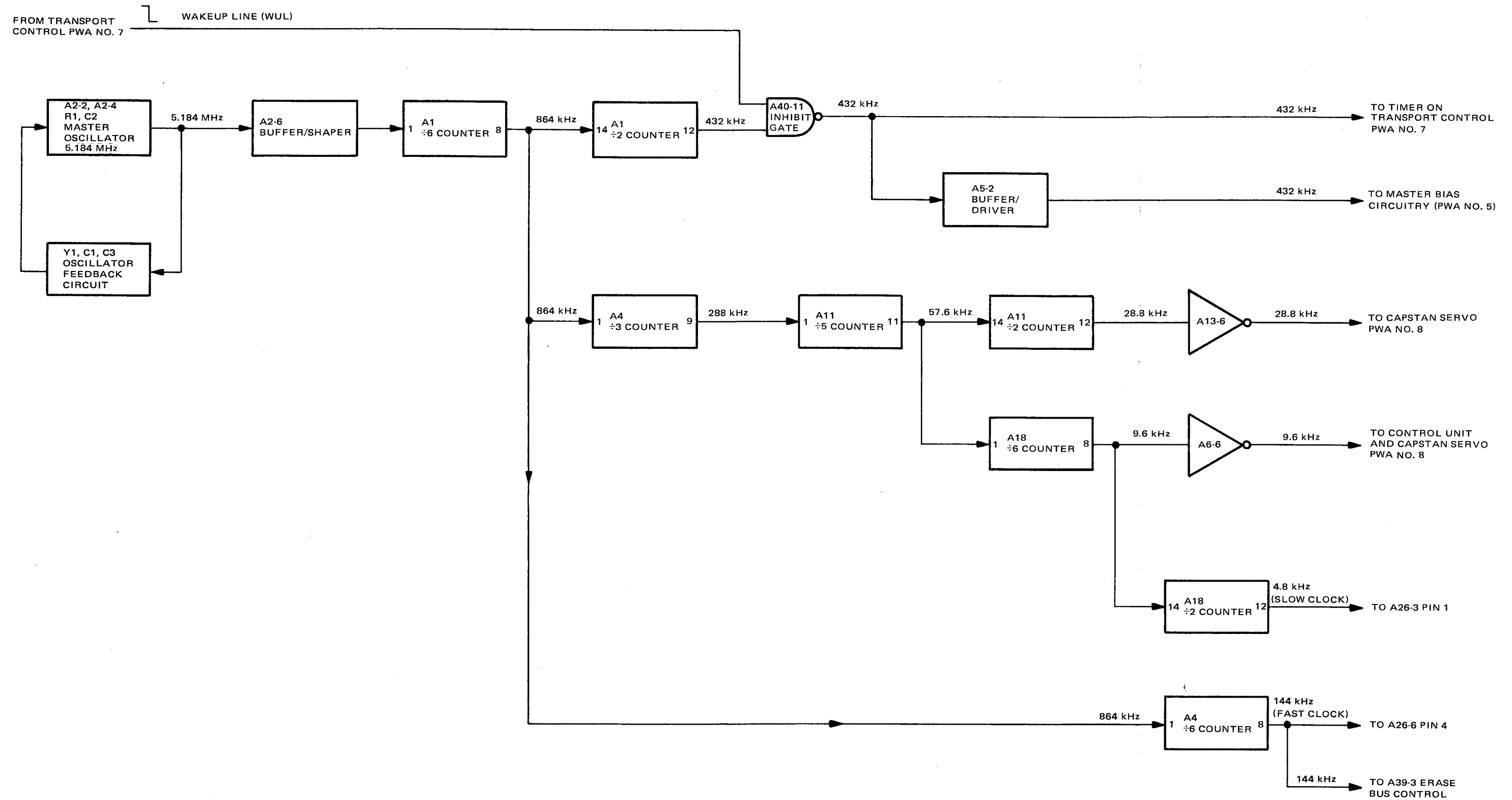


Figure 4-14. Master Oscillator and Counters, Simplified Block Diagram (PWA No. 5)

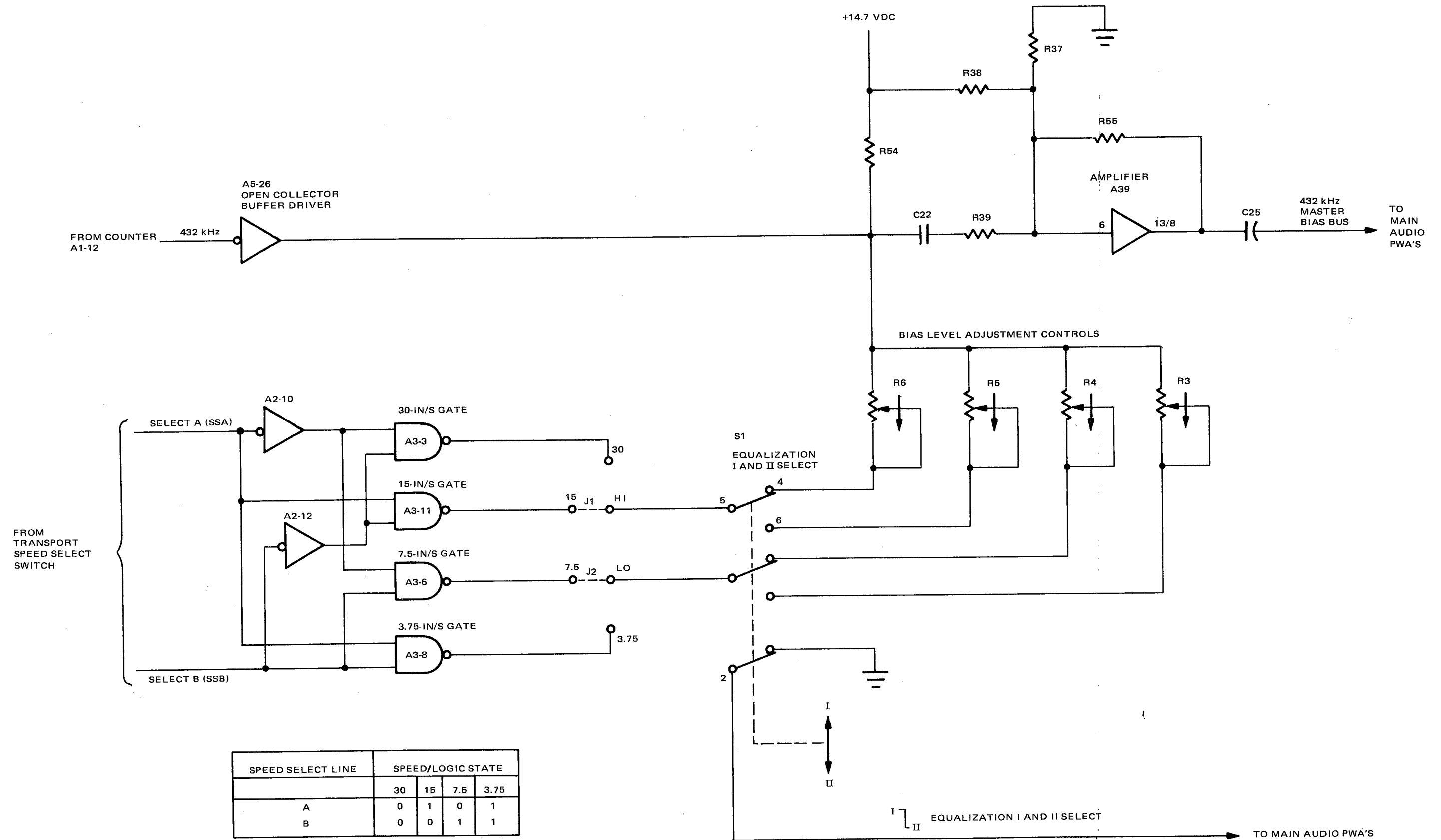
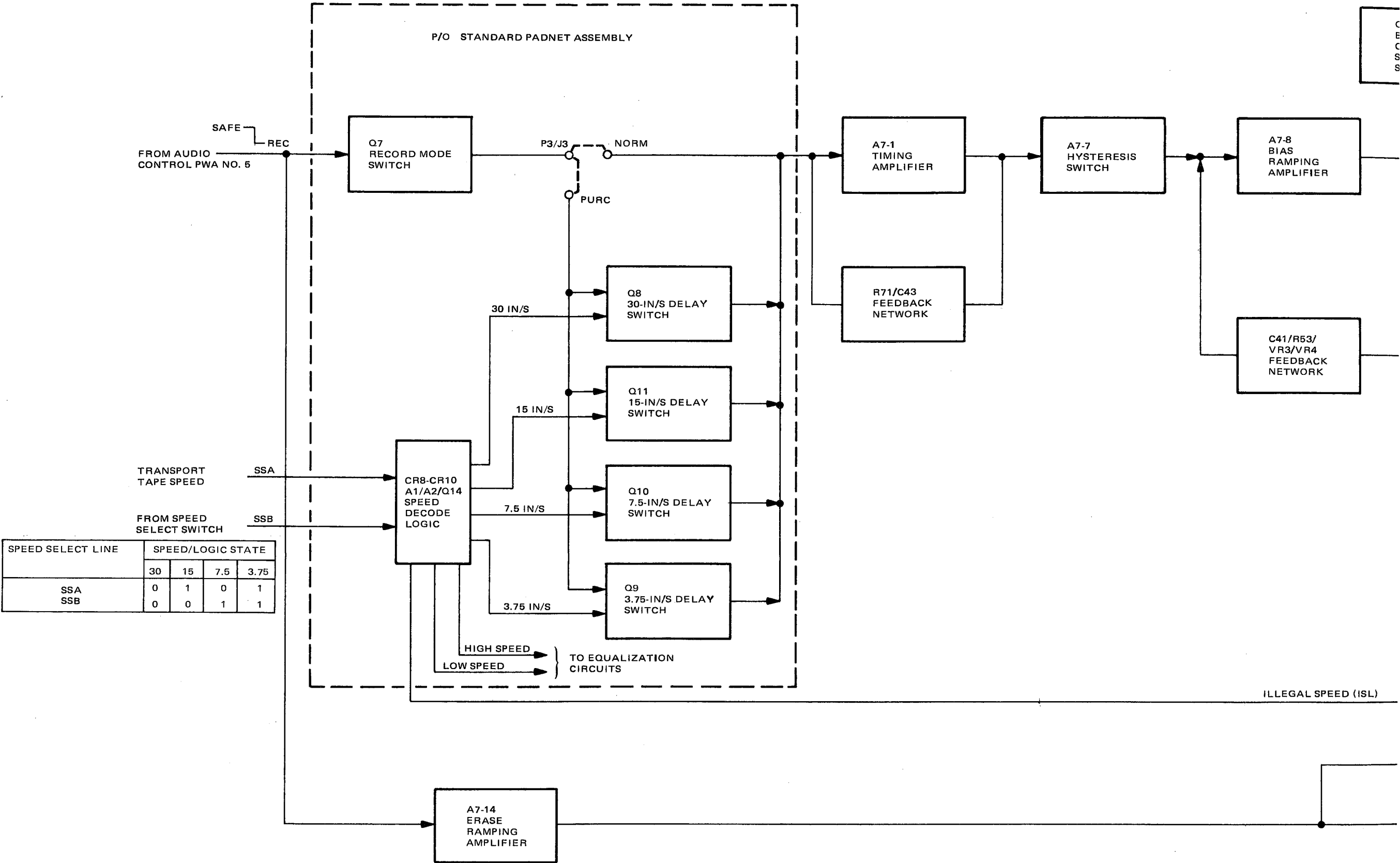


Figure 4-16. Master Bias Bus, Two-Speed Simplified Schematic (PWA No. 5)



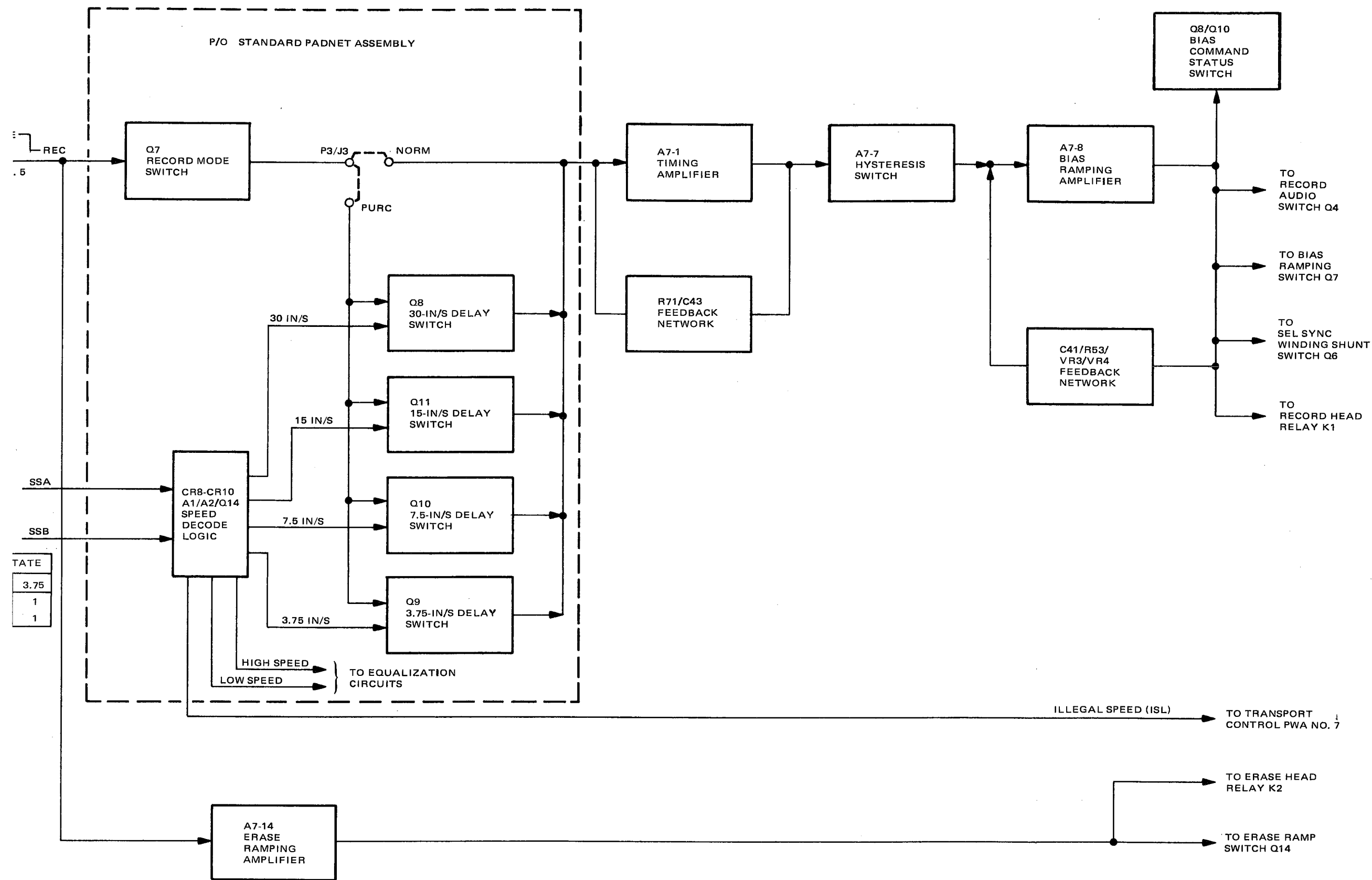
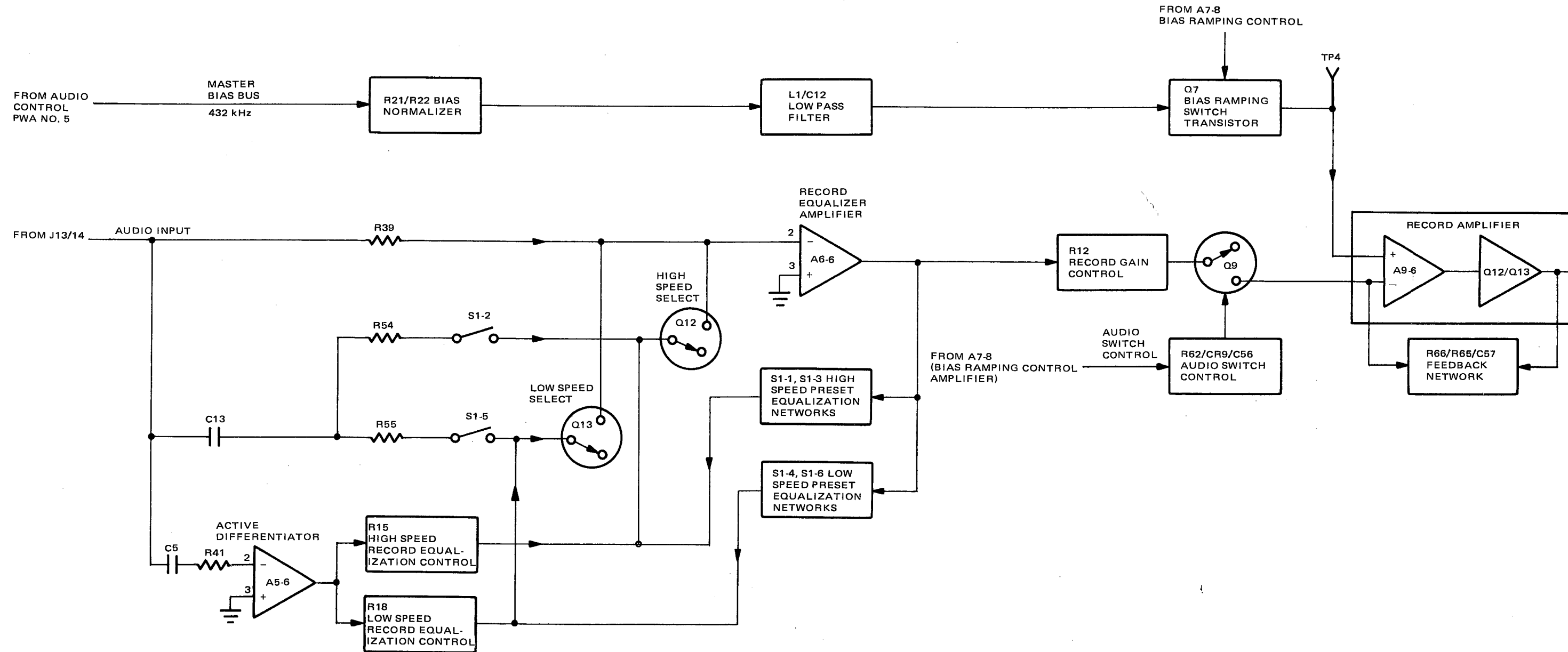


Figure 4-18. Main Audio Control Logic, Simplified Block Diagram



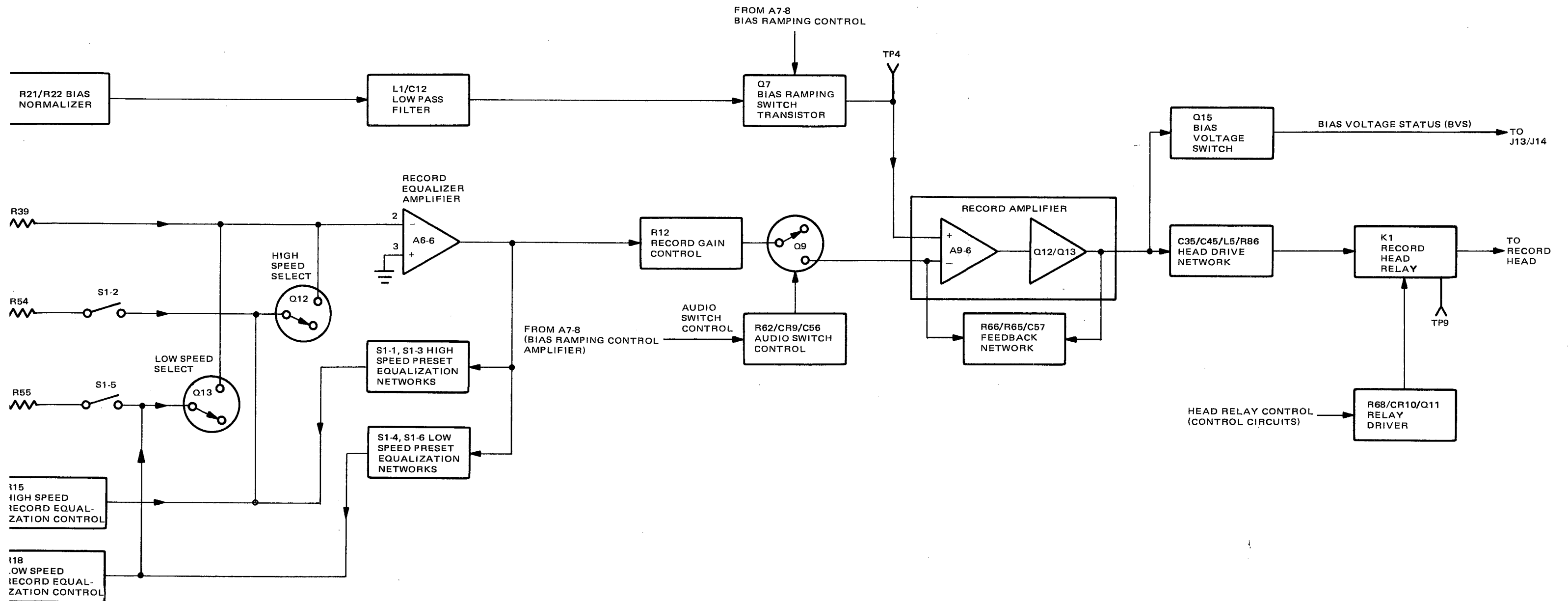
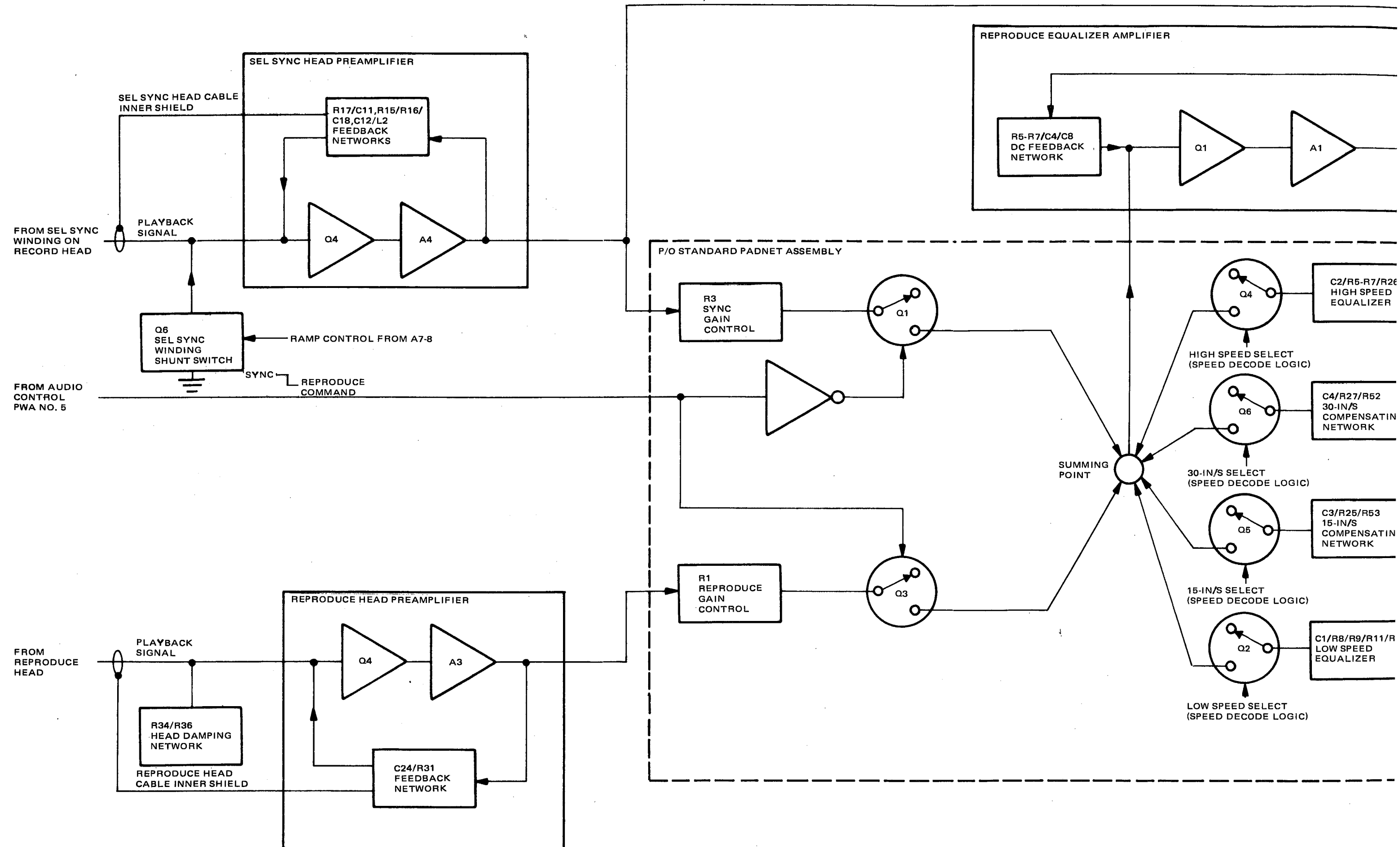


Figure 4-20. Audio Record Circuits, Simplified Block Diagram



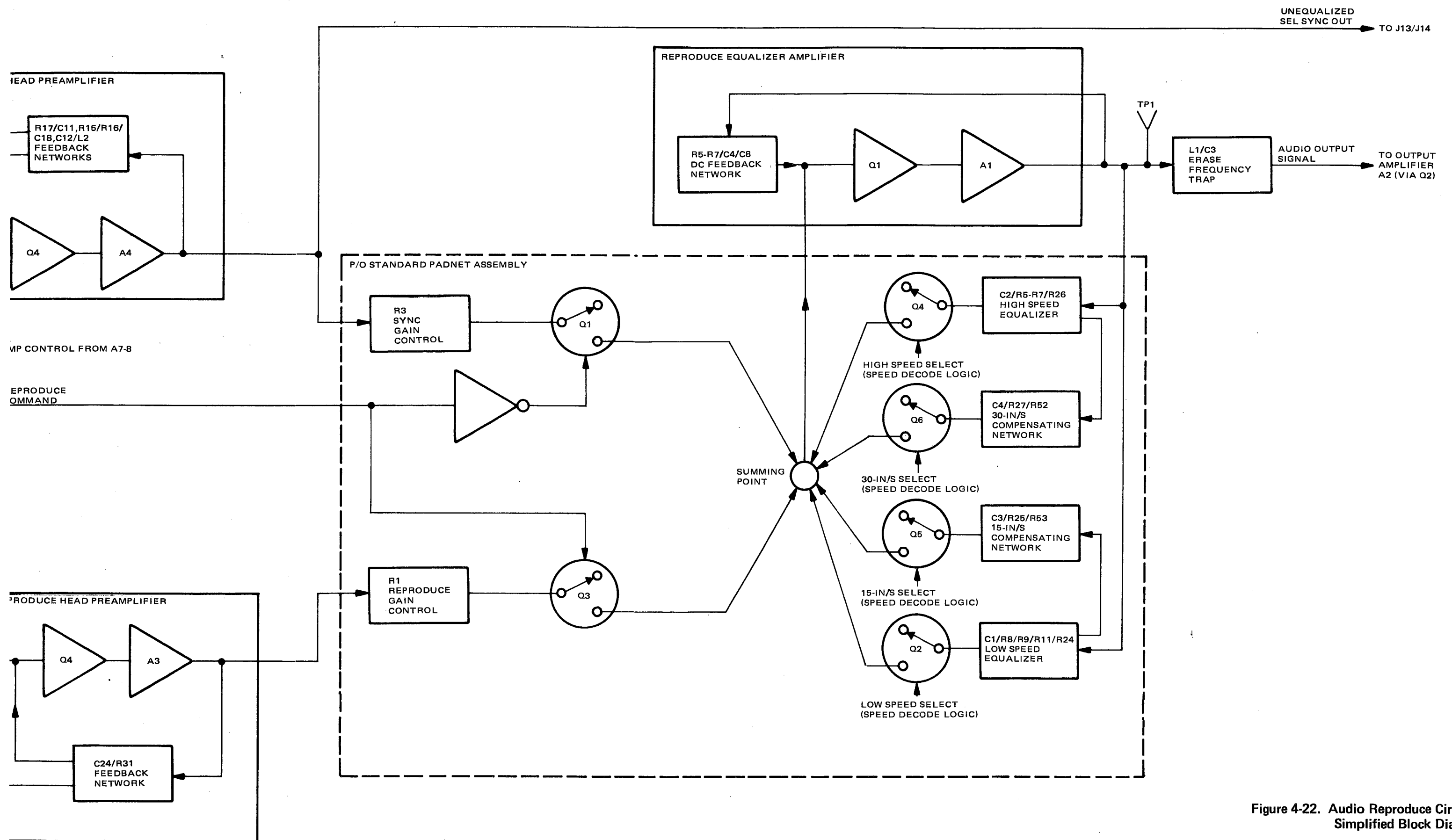
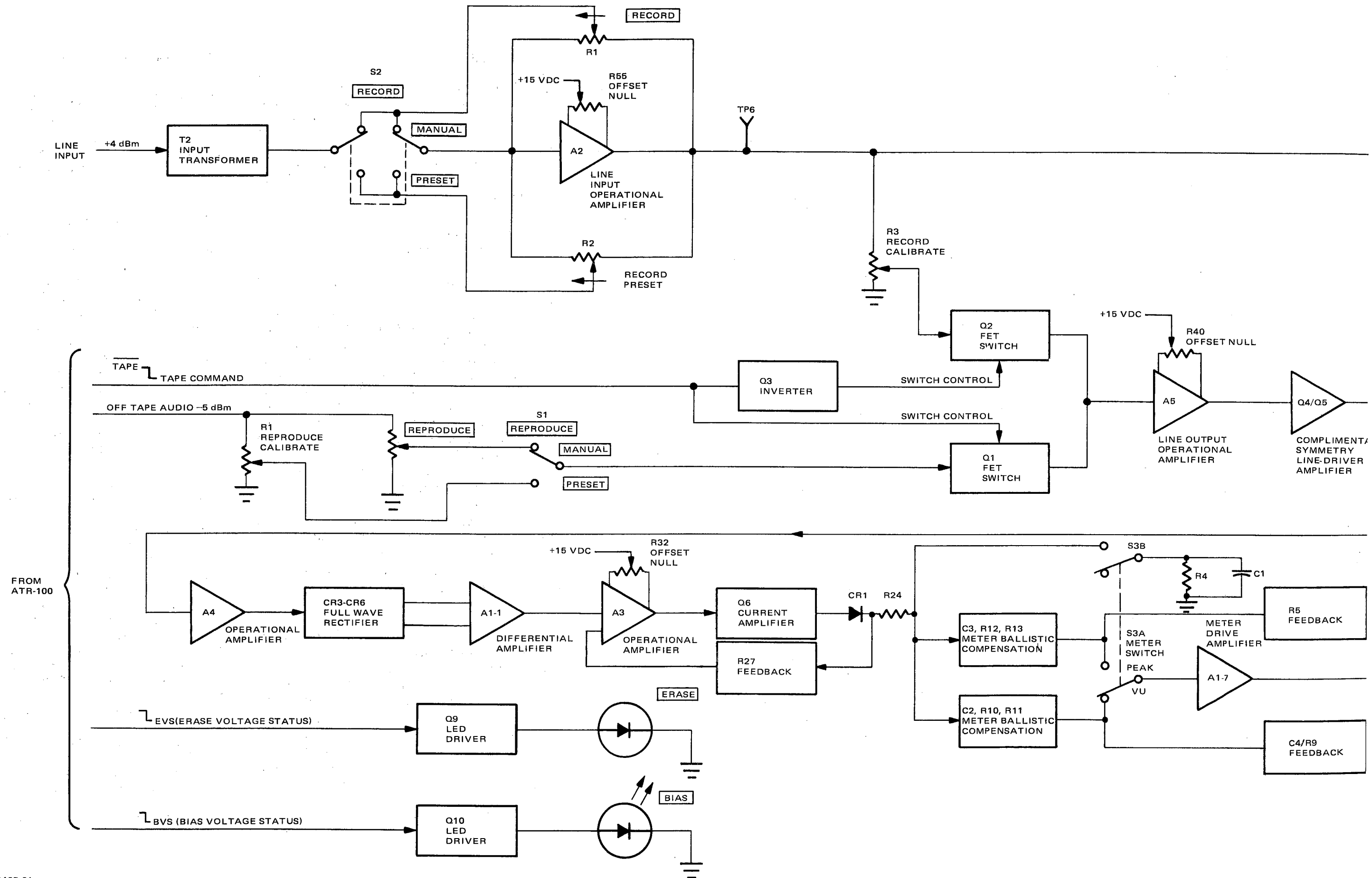


Figure 4-22. Audio Reproduce Circuits, Simplified Block Diagram



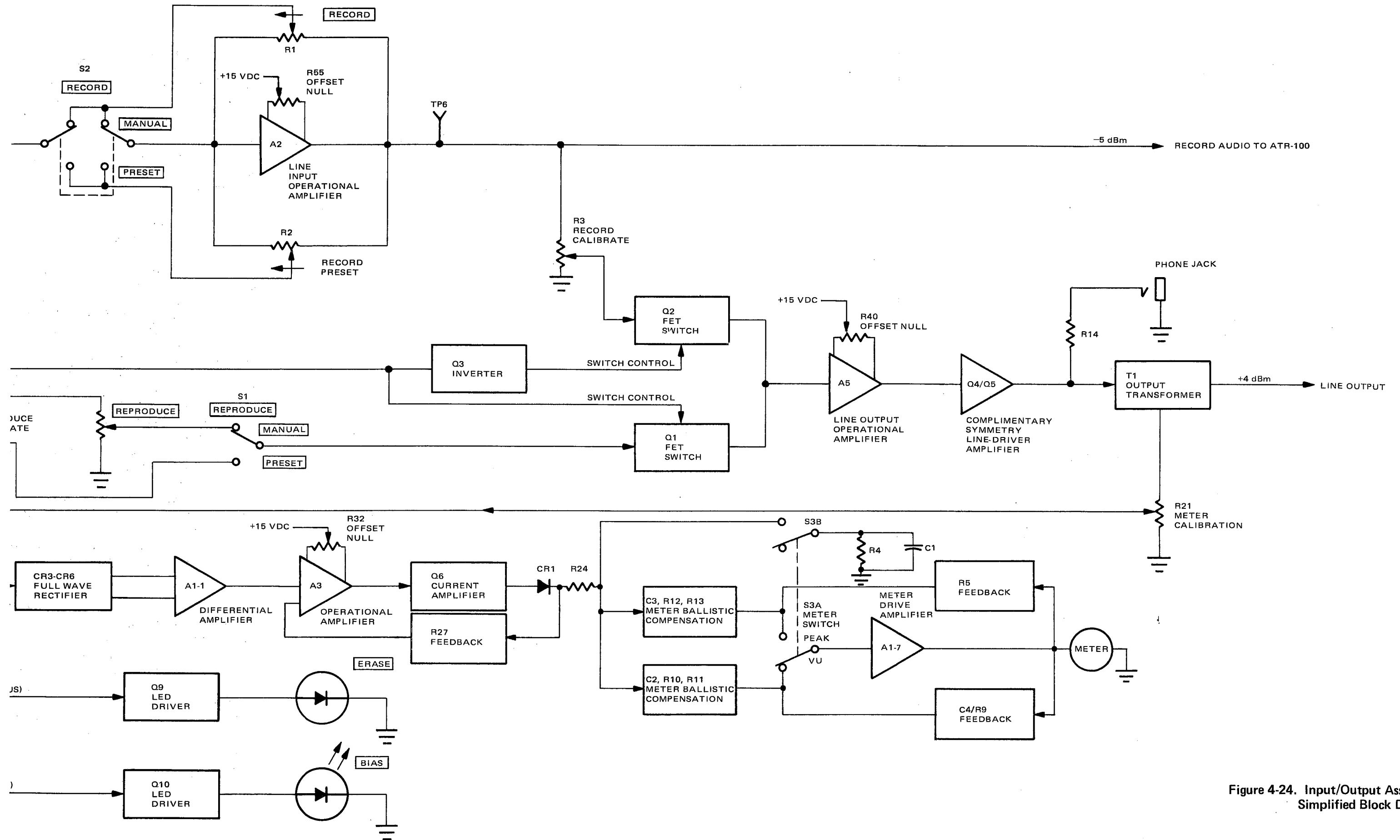


Figure 4-24. Input/Output Assembly, Simplified Block Diagram

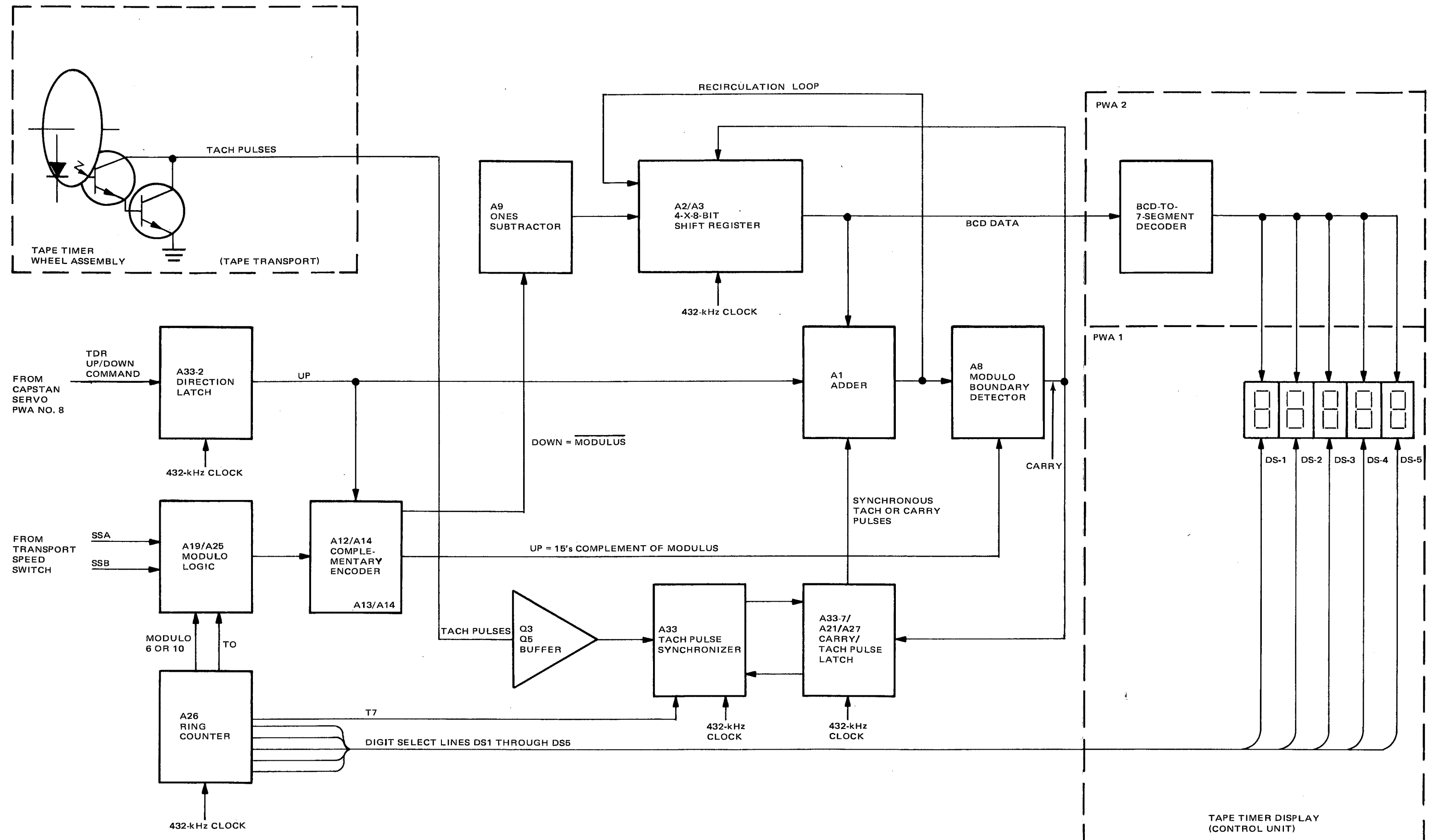


Figure 4-25. Tape Timer, Simplified Block Diagram

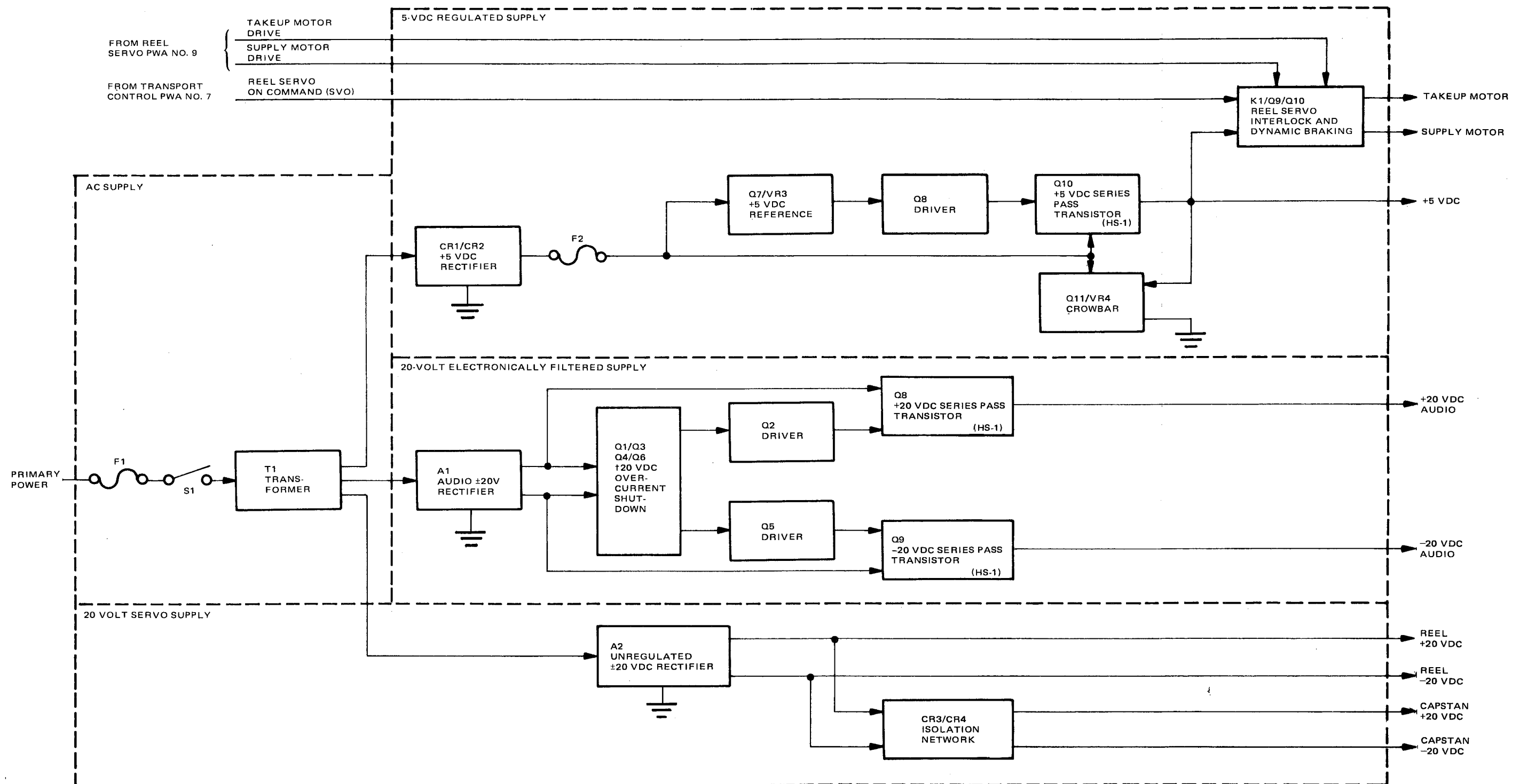


Figure 4-28. Power Supply Assembly, Simplified Block Diagram

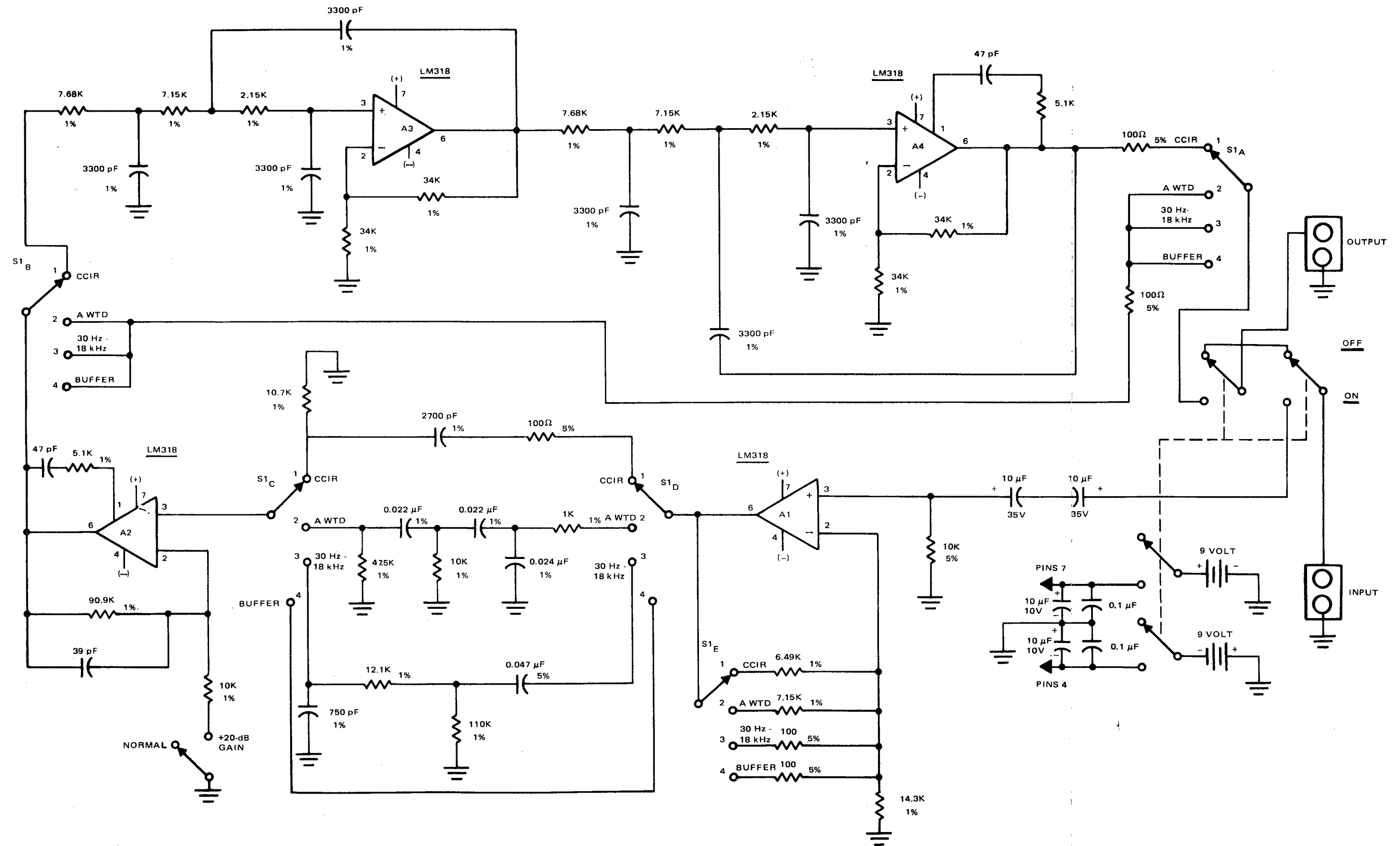


Figure 5-35. Universal Noise Filter Schematic

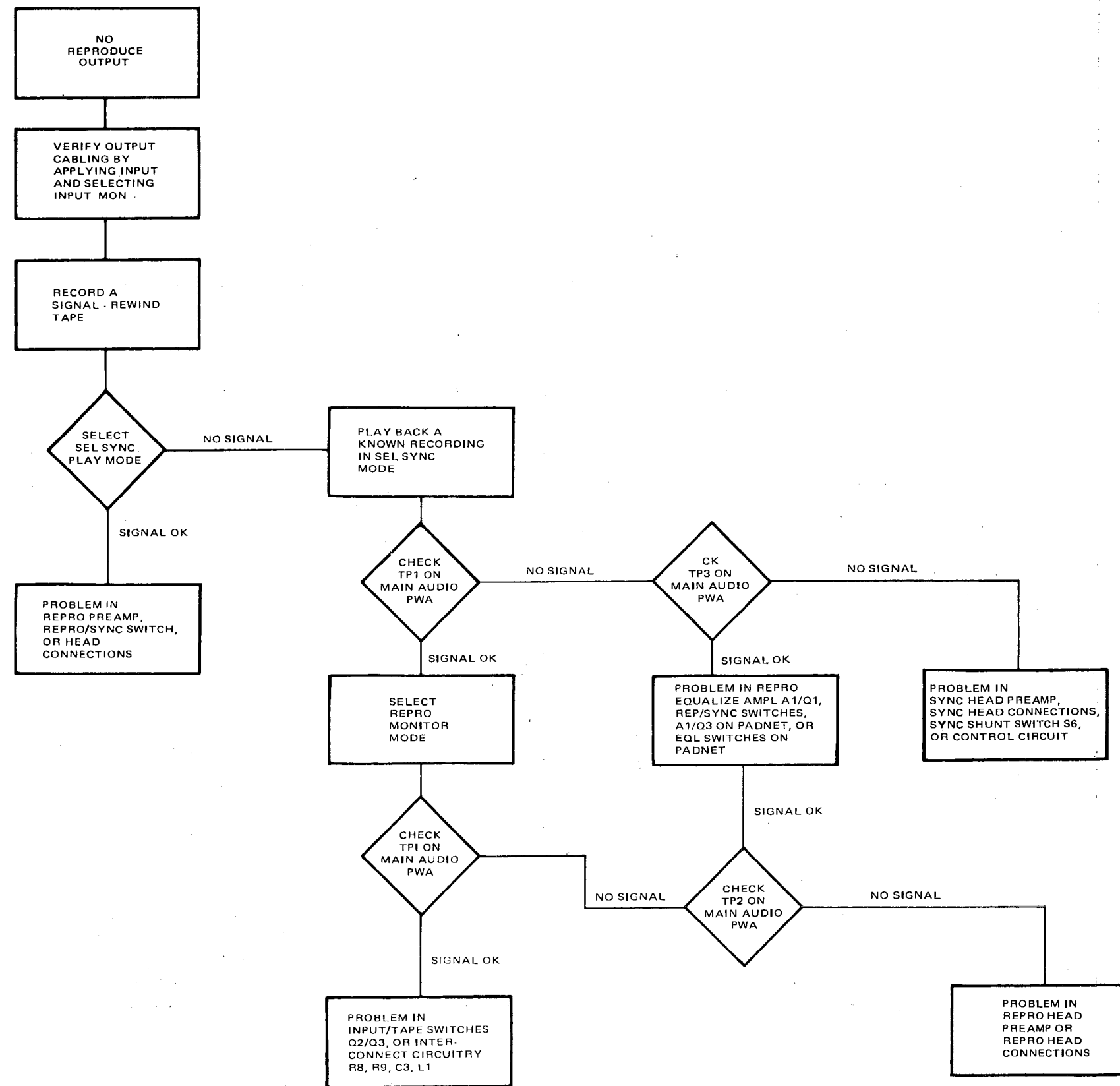


Figure 5-41. No Reproduce Output
— Troubleshooting Flow Chart

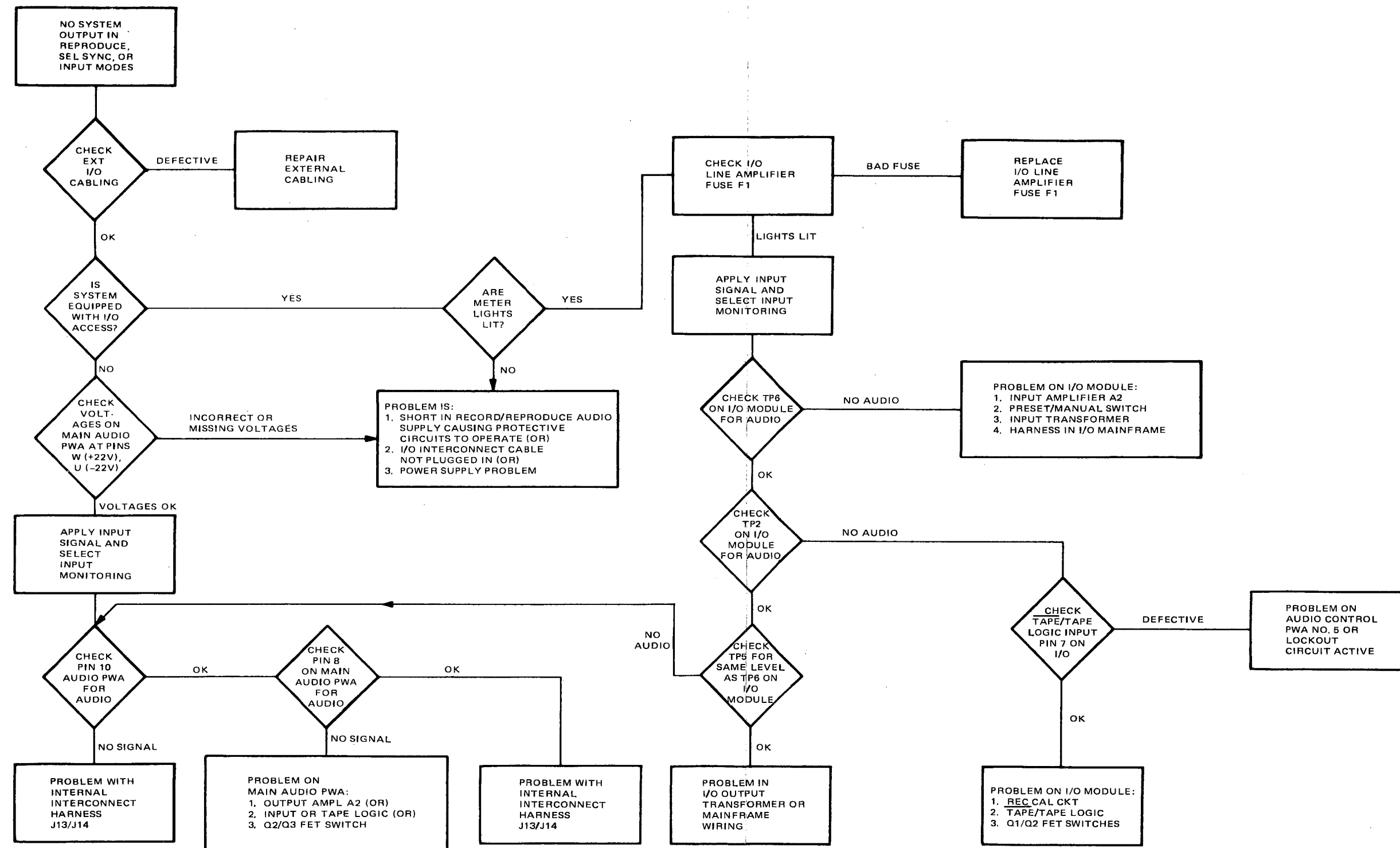


Figure 5-42. No System Output in Reproduce, Sel Sync, or Input Modes — Troubleshooting Flow Chart

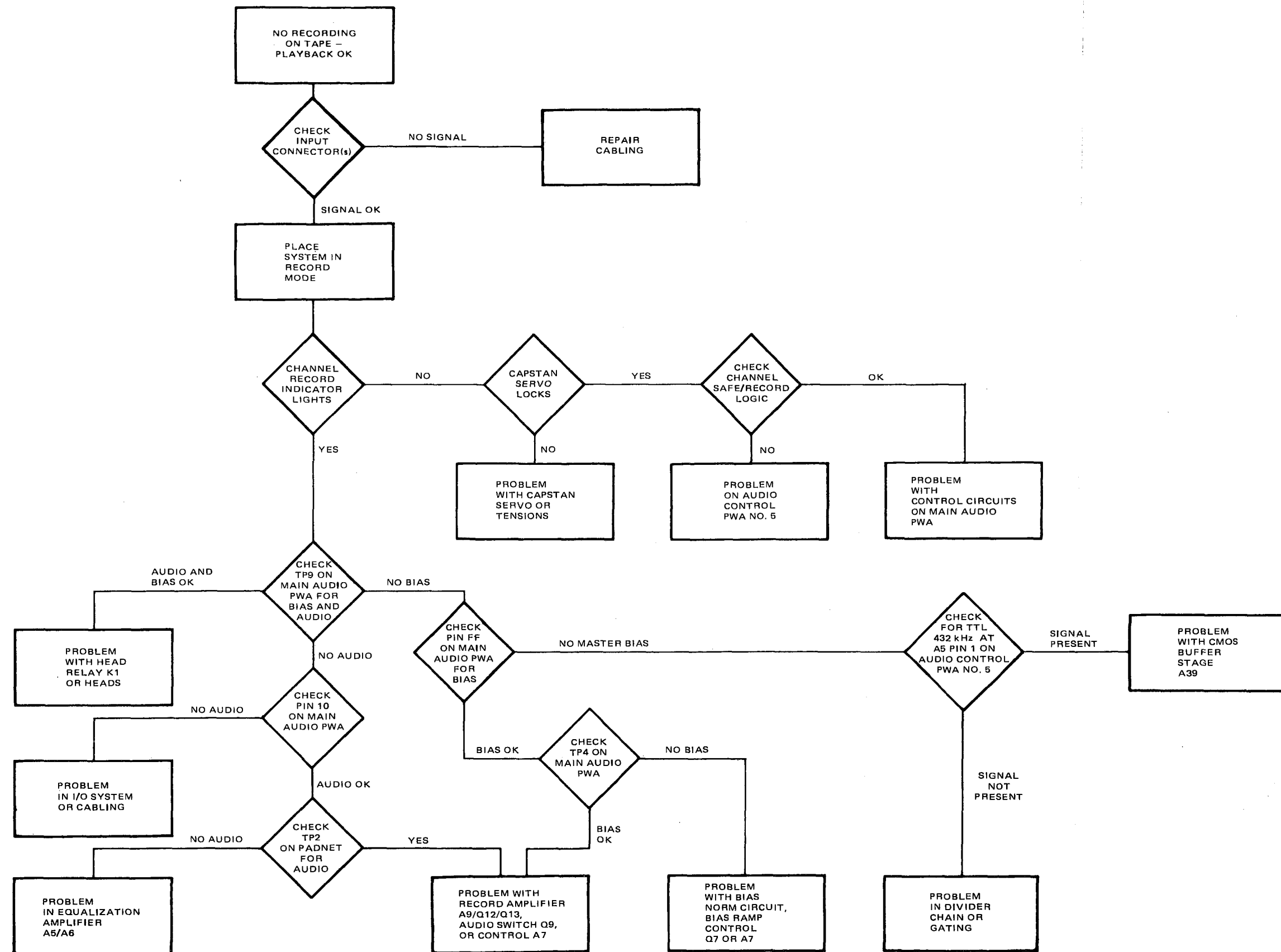


Figure 5-43. No Recording on Tape
- Troubleshooting Flow Chart

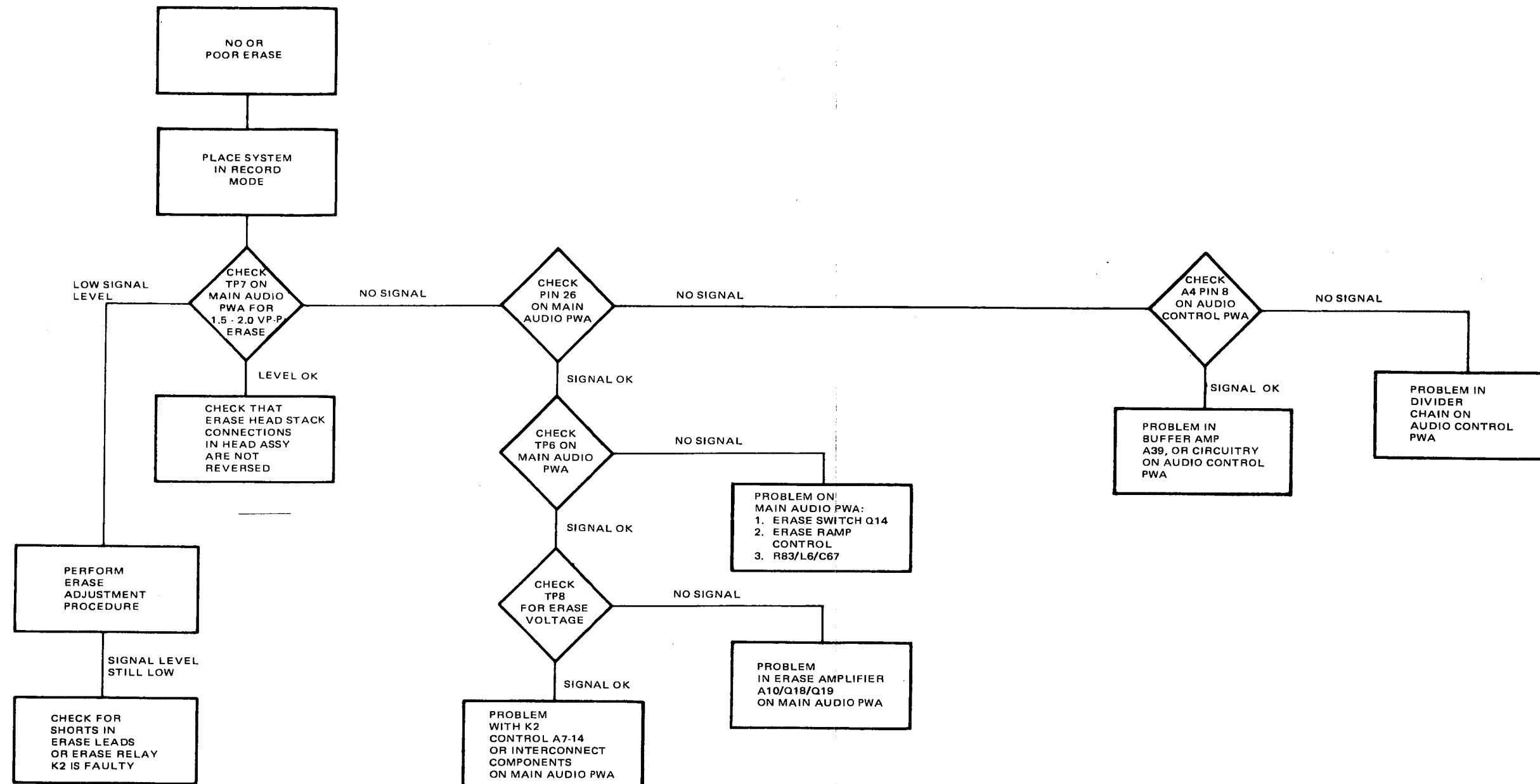
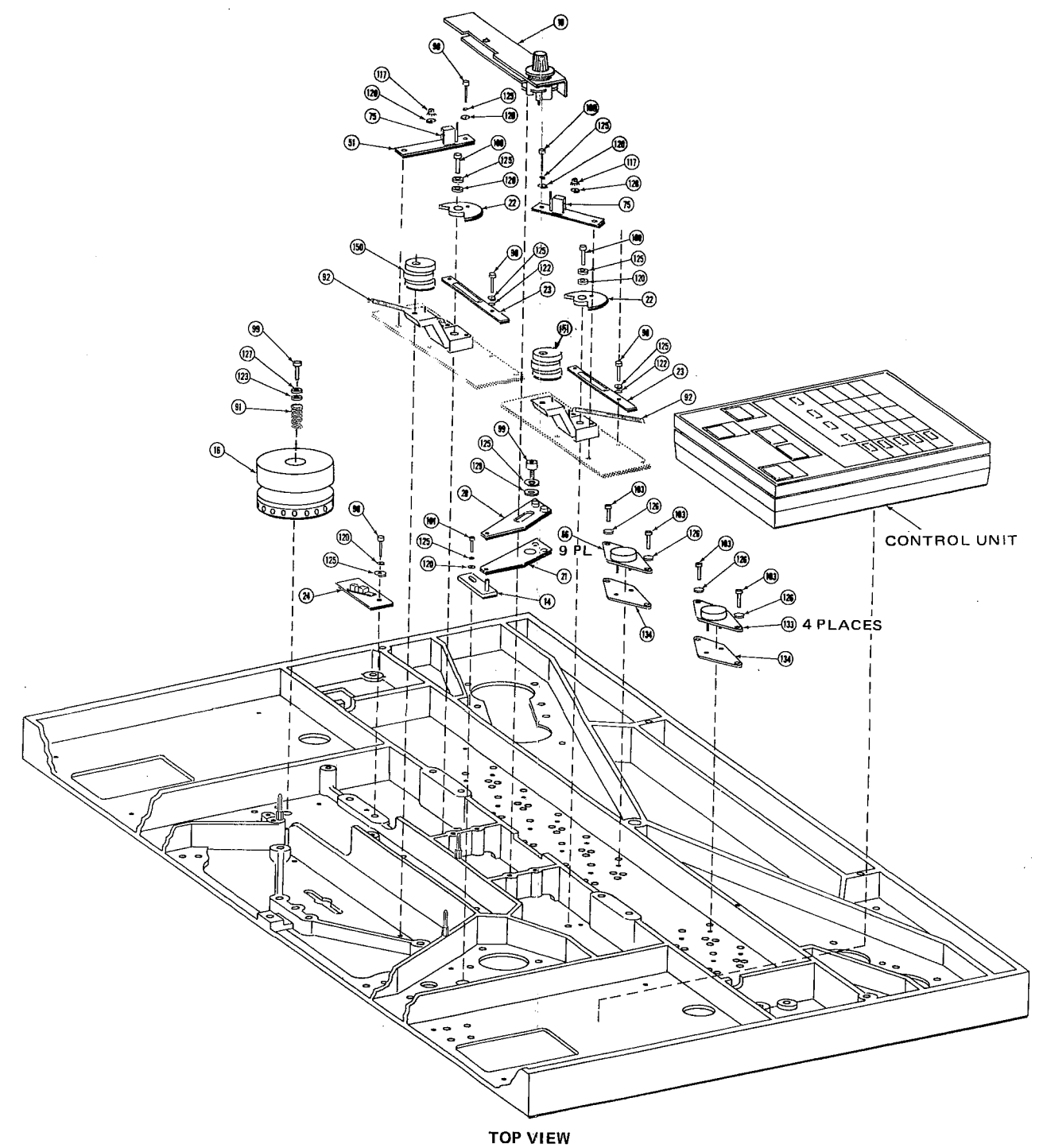
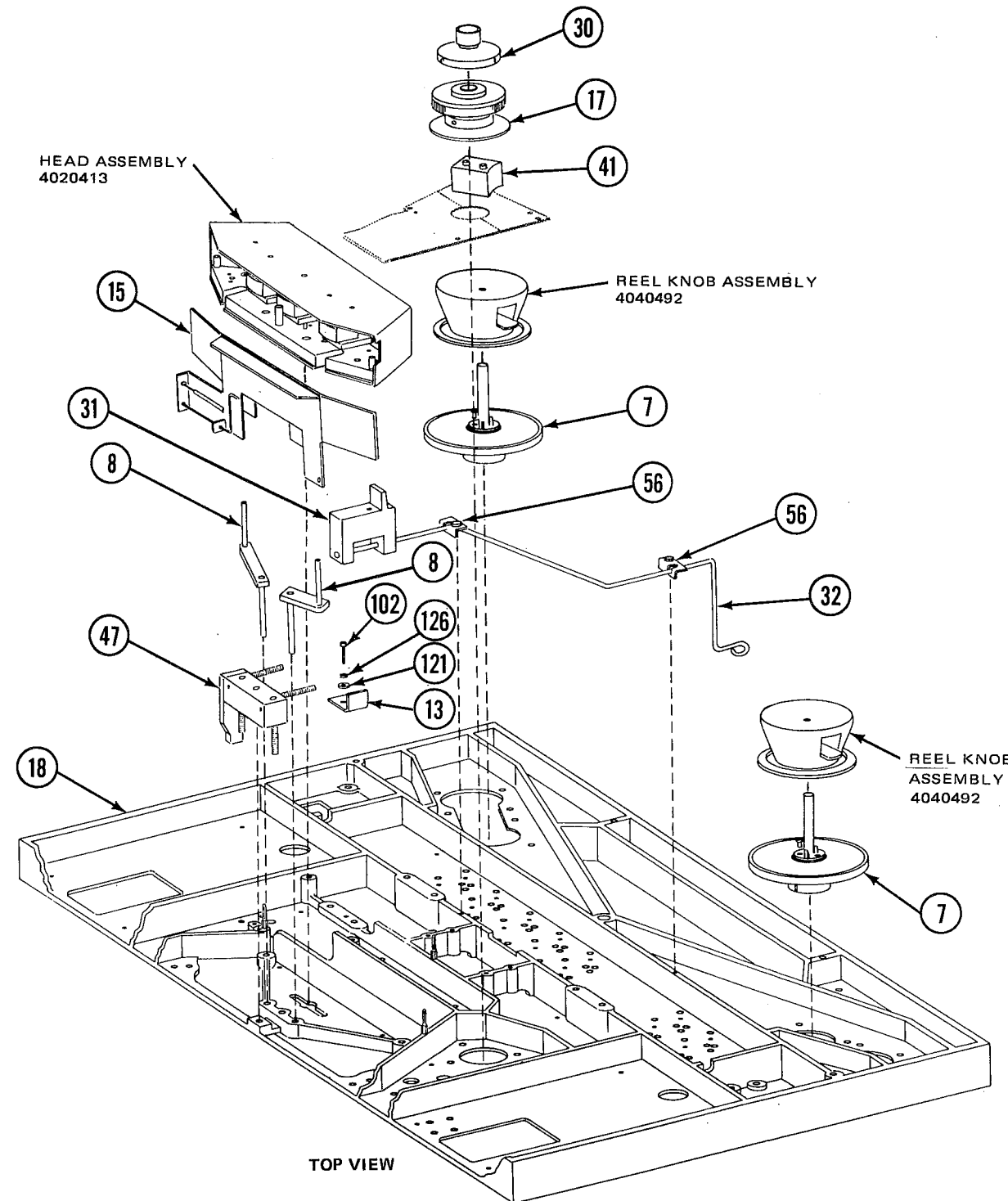
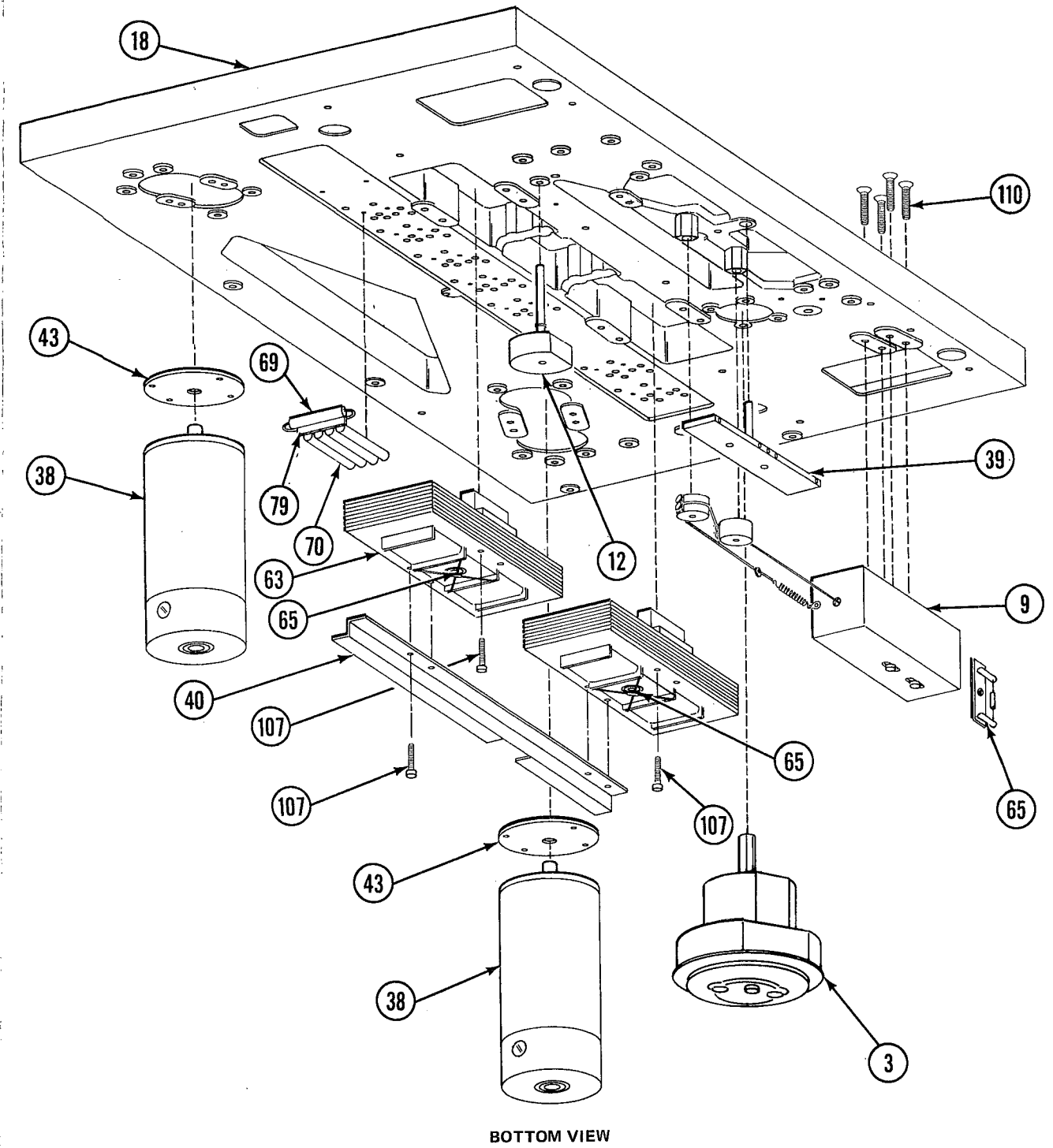
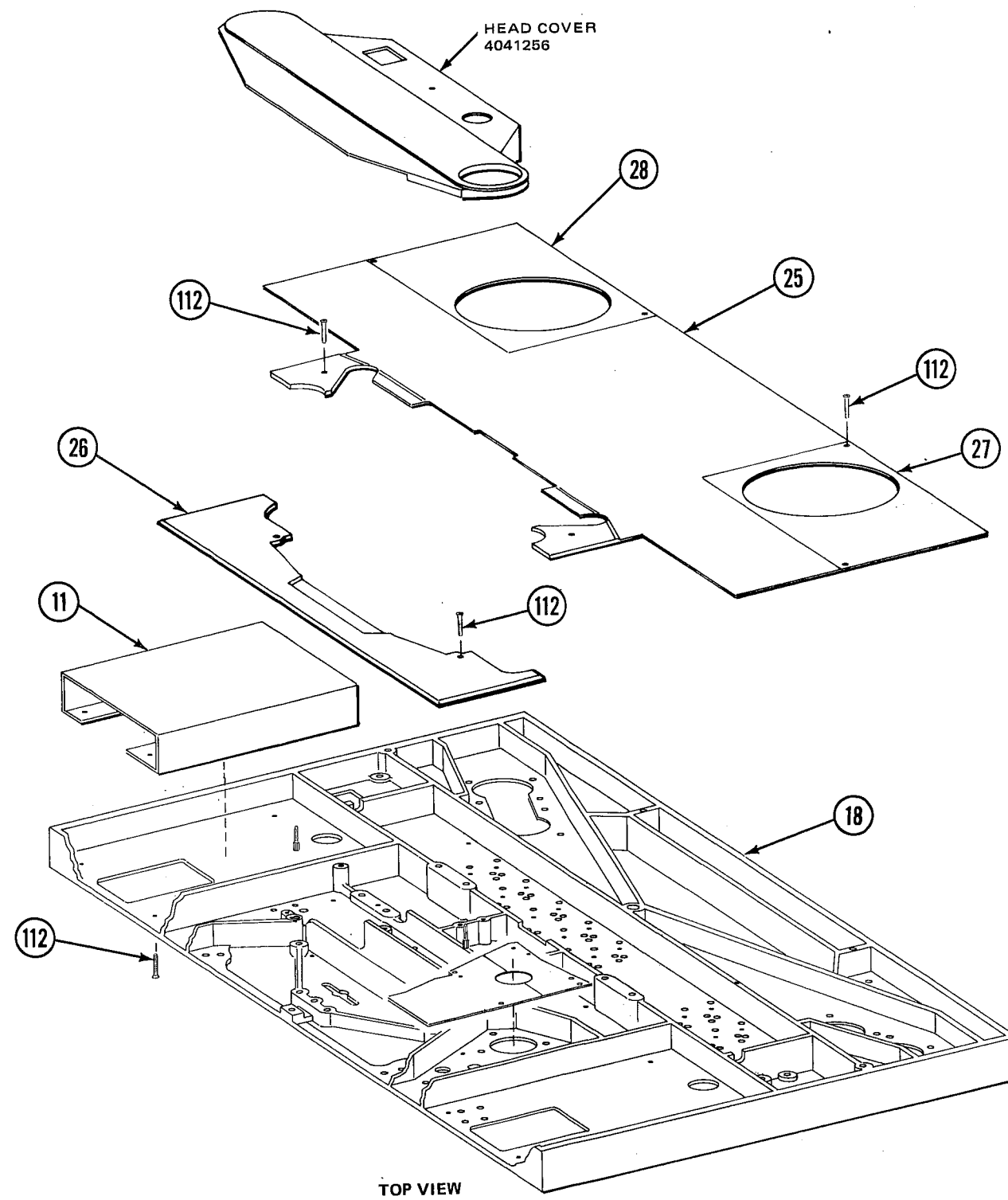


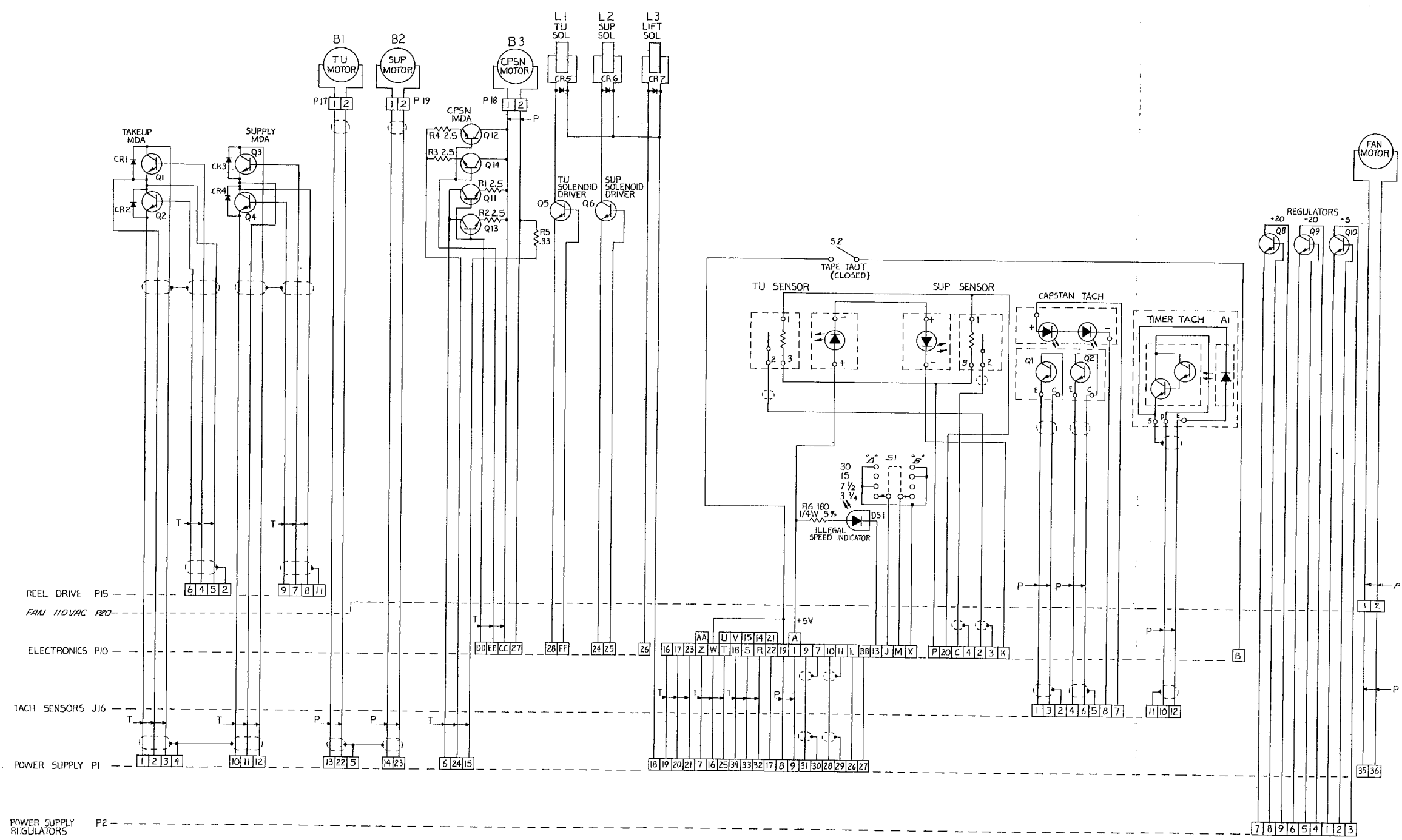
Figure 5-44. No or Poor Erase
— Troubleshooting Flow Chart



Assembly No. 4020400
Transport Assembly
(Sheet 1 of 2)



Assembly No. 4020400
Transport Assembly
(Sheet 2 of 2)

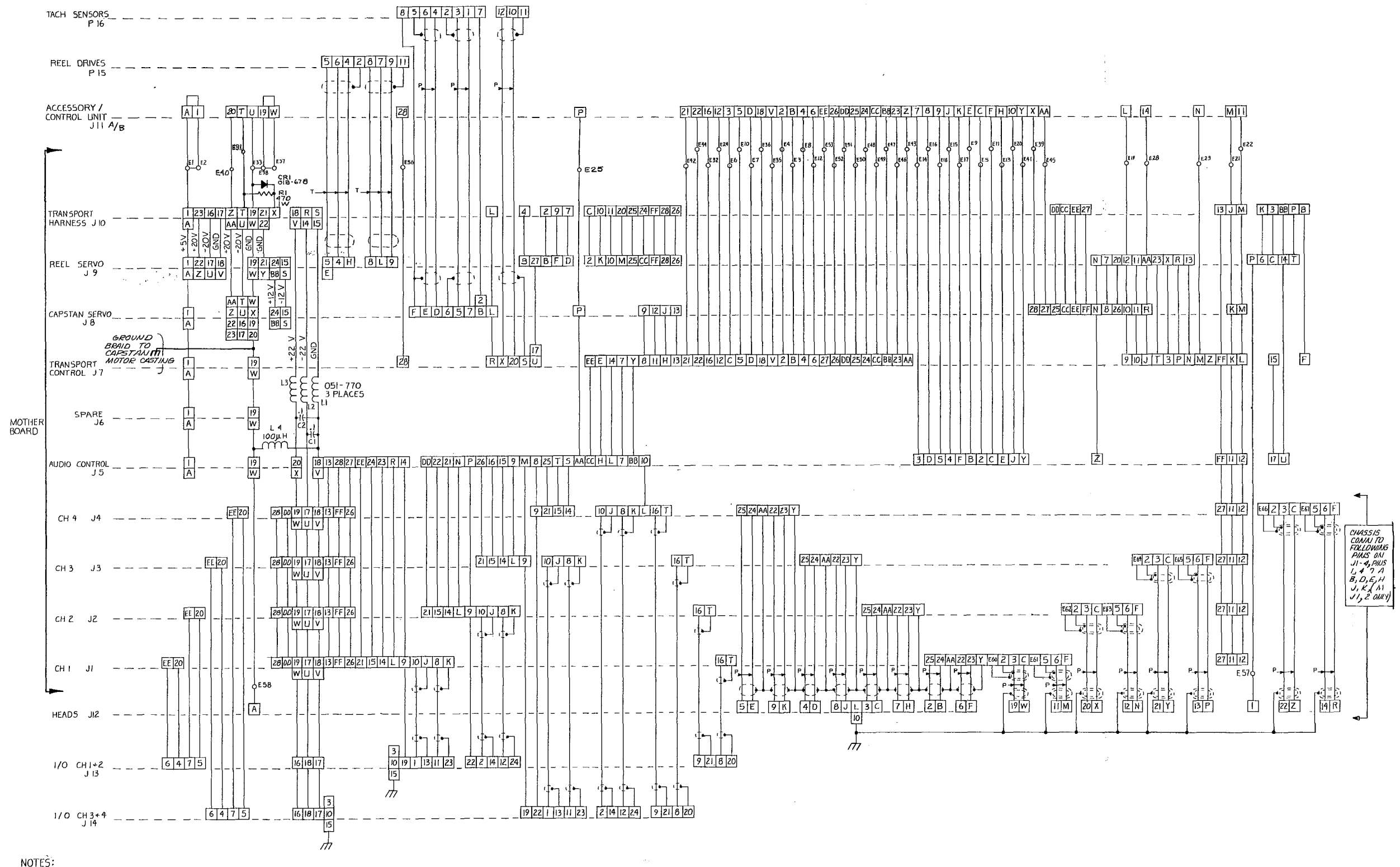


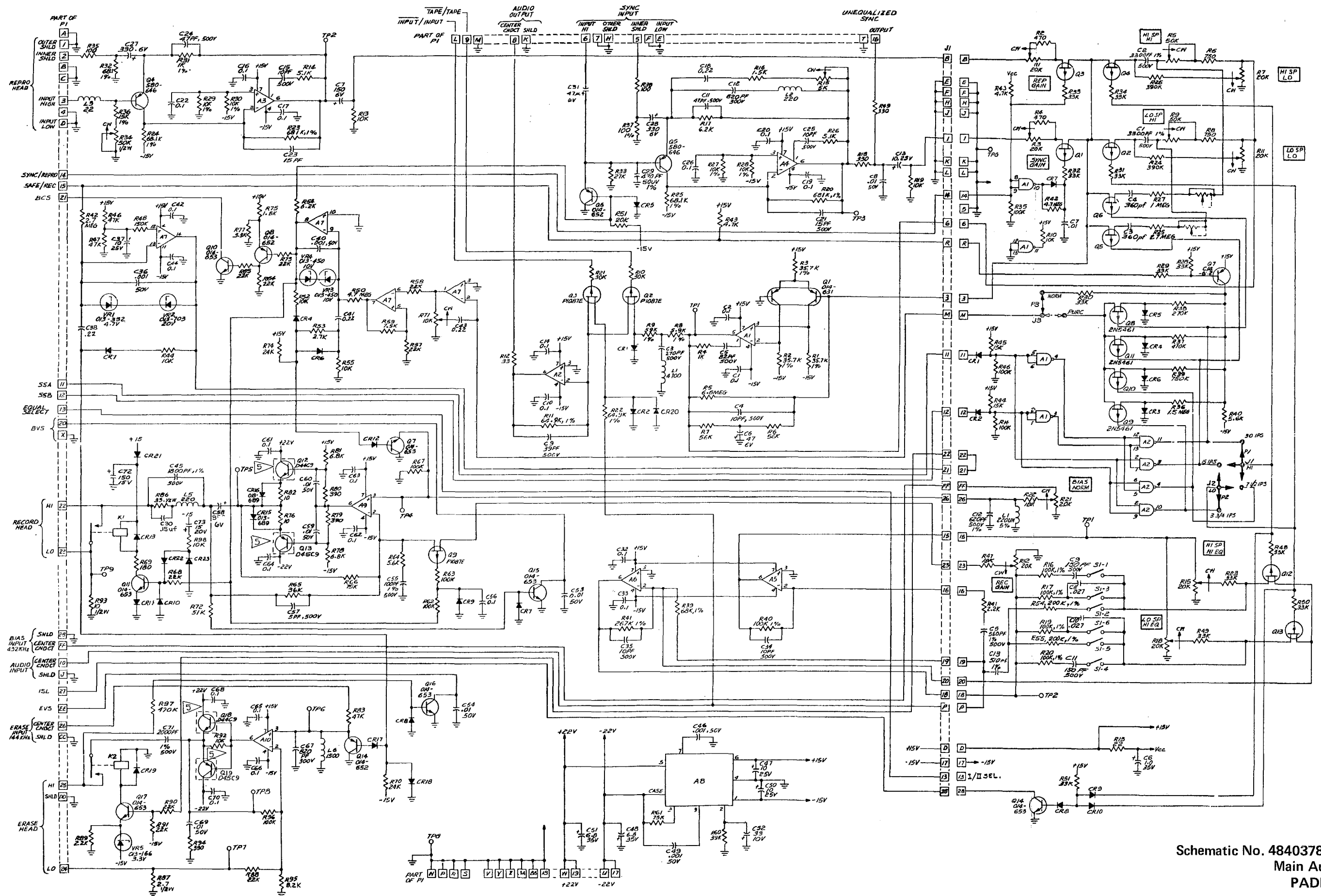
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTANCE VALUES ARE IN OHMS 10W, 1%.

FIELD SERVICE COMPONENT SUBSTITUTION		
REF. DES.	AMPEX P/N	NEAREST COML. EQUIV.
Q1, Q2, Q3, Q4	580 - 781	2N6254
Q5, Q6, Q8, Q9, Q10, Q11, Q12, Q13, Q14	014 - 630	2N3055
CR5, CR6, CR7	013 - 678	1N4005
CR1, CR2, CR3, CR4	013 - 878	1N4935

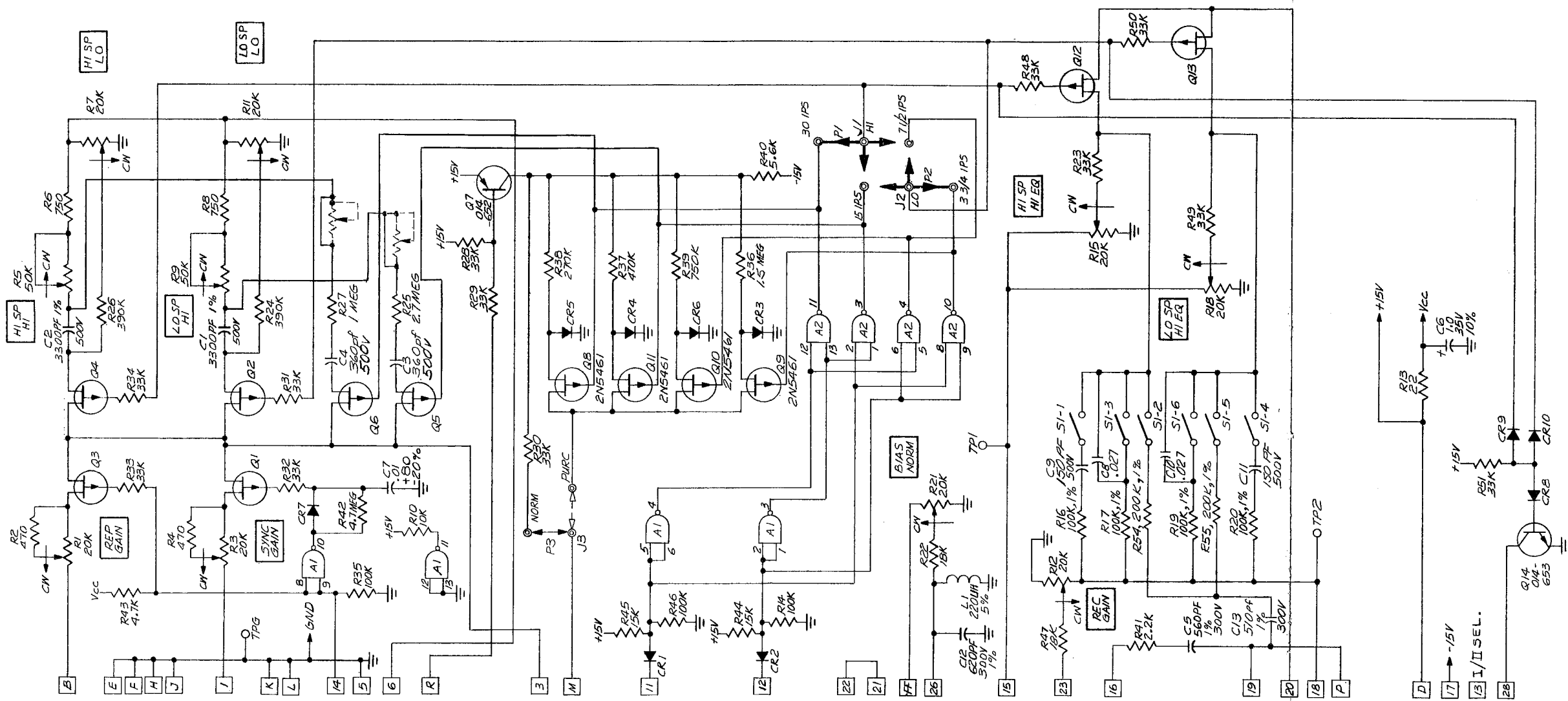
REFERENCE DESIGNATION	
LAST USED	NOT USED
R6, DS1, CR7, Q14, S1	Q7

Schematic No. 4840423B.
Transport Interconnect Diagram





Schematic No. 4840378/4840379
 Main Audio PWA,
 PADNET PWA



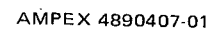
NOTES: UNLESS OTHERWISE SPECIFIED

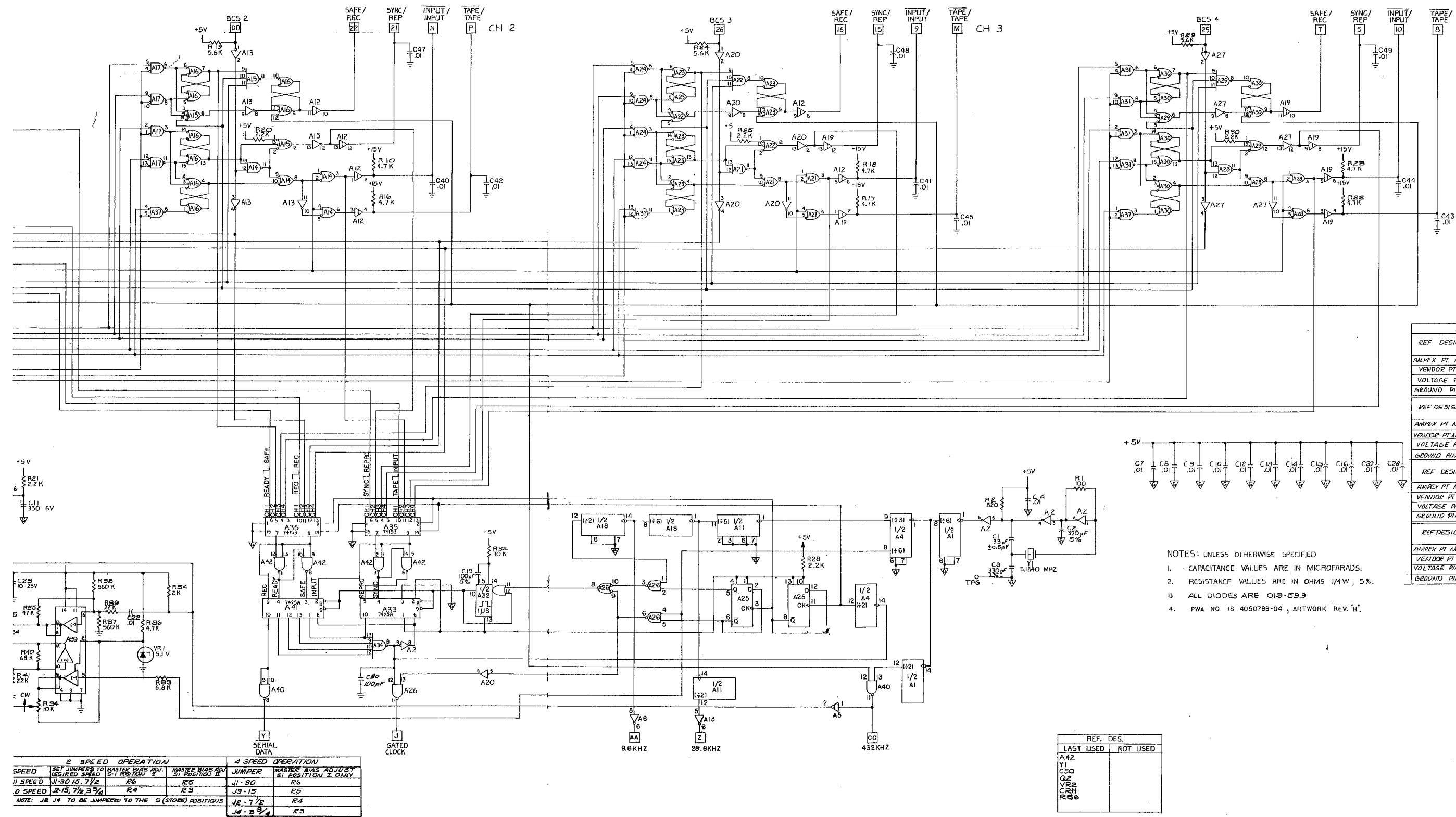
- 1. CAPACITANCE VALUES ARE IN MICROFARADS, 50V, 5%.
 - 2. DIODES ARE AMPEX P/N 013-599
 - 3. RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%.
 - 4. TRANSISTORS ARE TYPE 10B7E
 - 5. INTEGRATED CIRCUITS ARE TYPE 4011, PIN 14 TO Vcc, PIN 7 TO GROUND.
 - 6. FIELD SERVICE COMPONENT SUBSTITUTION LIST
- | AMPEX P/N | NEAREST COMMERCIAL EQUIVALENT |
|-----------|-------------------------------|
| 014-652 | 2N3906 |
| 014-653 | 2N3904 |
7. J1 & J2 SHOWN CONNECTED FOR 30IPS HIGH SPEED AND 3 3/4 IPS LOW SPEED.

SPEED SELECT JUMPER CHART	
HI SPEED	LO SPEED
J1- 30 IPS	J2- 15 IPS
J1- 15 IPS	J2- 7 1/2 IPS
J1- 7 1/2 IPS	J2- 3 3/4 IPS

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
A2 C13 J9 Q14 R55 SI TP2, TPG CR10	R58, 53

PRESET RECORD EQUALIZATION		
SI-1	SHELF DOWN	HI SPEED
SI-2	SHELF UP	
SI-3	3180 / ∞	
SI-4	SHELF DOWN	LO SPEED
SI-5	SHELF UP	
SI-6	3180 / ∞	





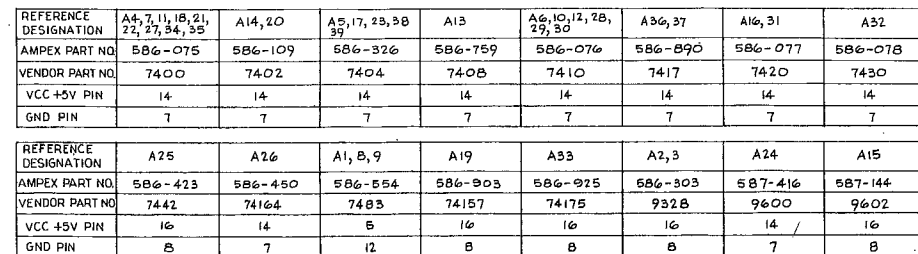
INTEGRATED CIRCUIT LIST				
REF. DESIG.	A1 14 21 26 28 40 42	A2 6 13 20 27	A5 12 19	A8 15 22 29
AMPEX PT. NO.	586-075	586-326	586-713	586-076
VENDOR PT. NO.	7400	7404	7407	7410
VOLTAGE PIN	14 (+5)	14 (+5)	14 (+5)	14 (+5)
GROUND PIN	7	7	7 (AUDIO)	7
REF. DESIG.	A38	A34	A3	A10, 17, 24, 31, 37
AMPEX PT. NO.	586-890	586-077	587-549	586-918
VENDOR PT. NO.	7417	7420	7426	7432
VOLTAGE PIN	14 (+5)	14 (+5)	14 (+5)	14 (+5)
GROUND PIN	7	7	7 (AUDIO)	7
REF. DESIG.	A25	A11	A1, 4, 18	A33, 41
AMPEX PT. NO.	586-108	586-248	587-084	586-785
VENDOR PT. NO.	7474	7490	7492	7495
VOLTAGE PIN	14 (+5)	14 (+5)	14 (+5)	14 (+5)
GROUND PIN	7	7	7	7
REF. DESIG.	A35, 36	A19, 16, 23, 30	A32	A39
AMPEX PT. NO.	586-948	587-266	587-144	587-147
VENDOR PT. NO.	74153	74219	9602	MC14007
VOLTAGE PIN	14 (+5)	14 (+5)	14 (+5)	11 (+5)
GROUND PIN	7	7	7	4, 7, 9 (AUDIO)

- NOTES: UNLESS OTHERWISE SPECIFIED
- CAPACITANCE VALUES ARE IN MICROFARADS.
 - RESISTANCE VALUES ARE IN OHMS 1/4W, 5%.
 - ALL DIODES ARE 01S-599
 - PWA NO. IS 4050788-04, ARTWORK REV. "H".

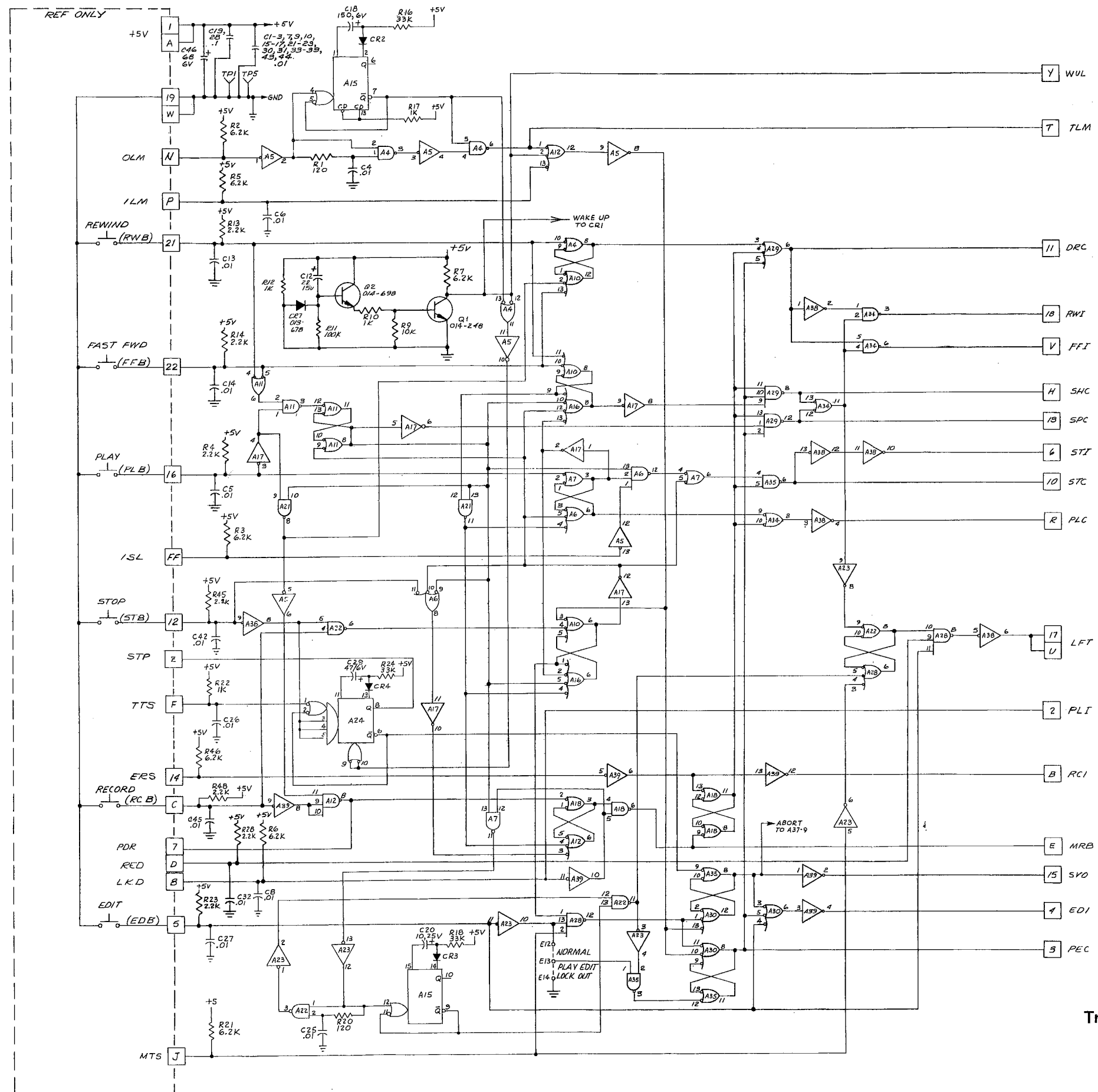
FIELD SERVICE COMPONENT SUBSTITUTION LIST		
REF. DESIG.	AMPEX P/N	COMM. EQUIV.
Q1	014-653	2N3094
Q2	014-248	2N2222
VR1	013-358	1N751A
VR2	581-290	1N4744A
CR1-9	013-599	1N4153
CR10	013-650	1N270
CR11	013-678	1N4005

REF. DES.	
LAST USED	NOT USED
A42	
Y1	
C50	
Q2	
VR2	
CR9	
R36	

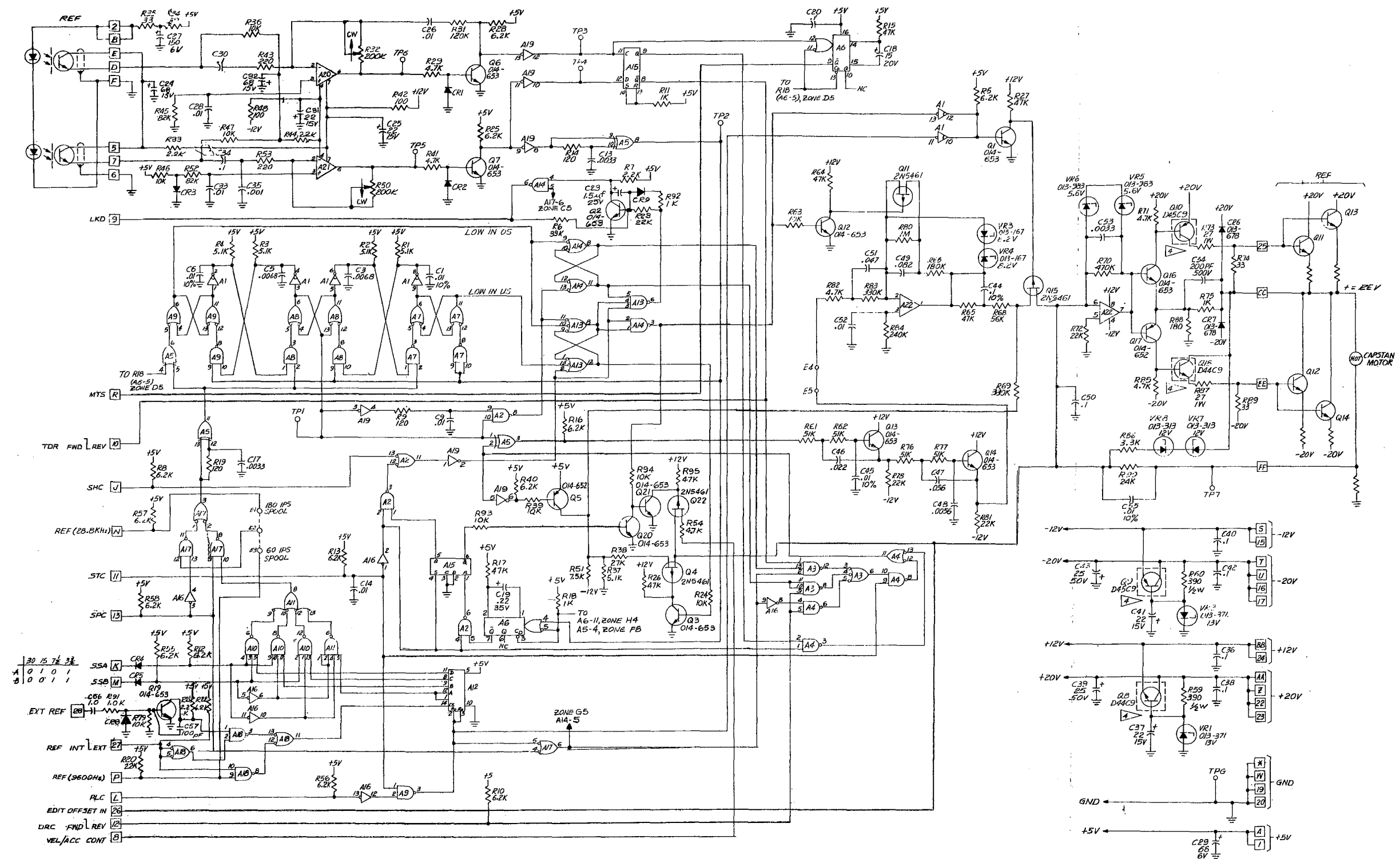
Schematic No. 4840398E.
Audio Control PWA



6-55/56



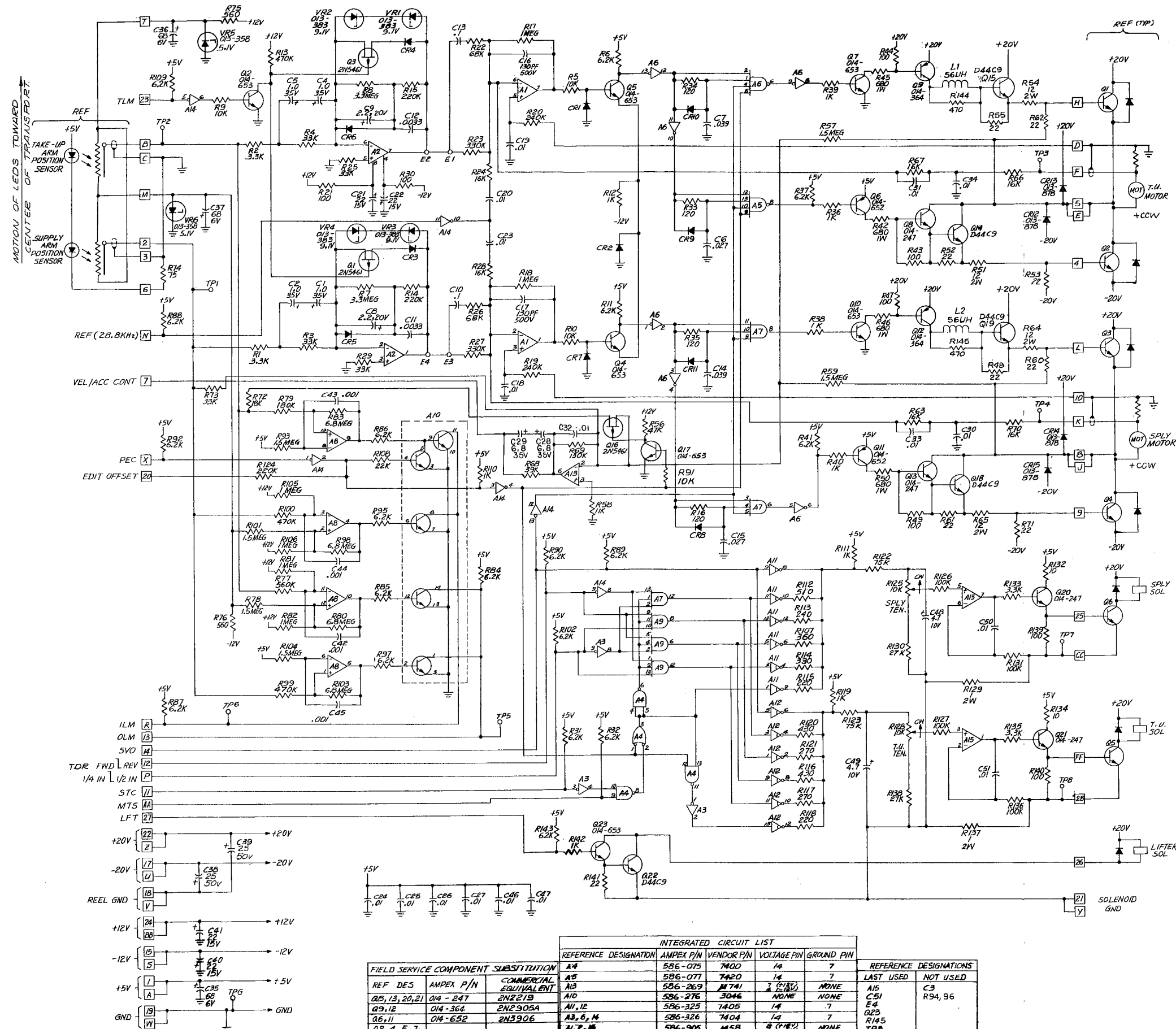
Schematic No. 4840397B.
Transport Logic Tape Timer
(Transport Control)
(Sheet 2 of 2)



- NOTES: UNLESS OTHERWISE SPECIFIED
1. CAPACITANCE VALUES ARE IN MICROFARADS, 50V.
 2. DIODES ARE TYPE 013-599.
 3. RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%.
 4. THESE TRANSISTORS TO HAVE HEAT SINK.
 5. ALL LOGIC INPUT LEVELS ARE LOW TRUE.
 6. PHA 15 4950776-07, A/W REV "J"

INTEGRATED CIRCUIT LIST					
REFERENCE DESIGNATION	AMPEX P/N	VENDOR P/N	VOLTAGE TYP/V	GROUND PIN	
A2, 4, 7, 8, 9, 14, 17, 18	586-075	7400	14	7	
A3, 10, 13	586-076	7410	14	7	
A11	586-077	7420	14	7	
A15	586-108	7474	14	7	
A20, 21	587-178	318A	5 (14V)	NONE	A22
A12	586-283	7493	5	10	C57
A1	586-325	7405	14	7	R35
A16, 19	586-326	7404	14	7	CR9
A5	586-705	7486	14	7	VR3
A22	586-905	1458	5 (14V)	NONE	PPT
A6	587-144	9602	16	8	TP6

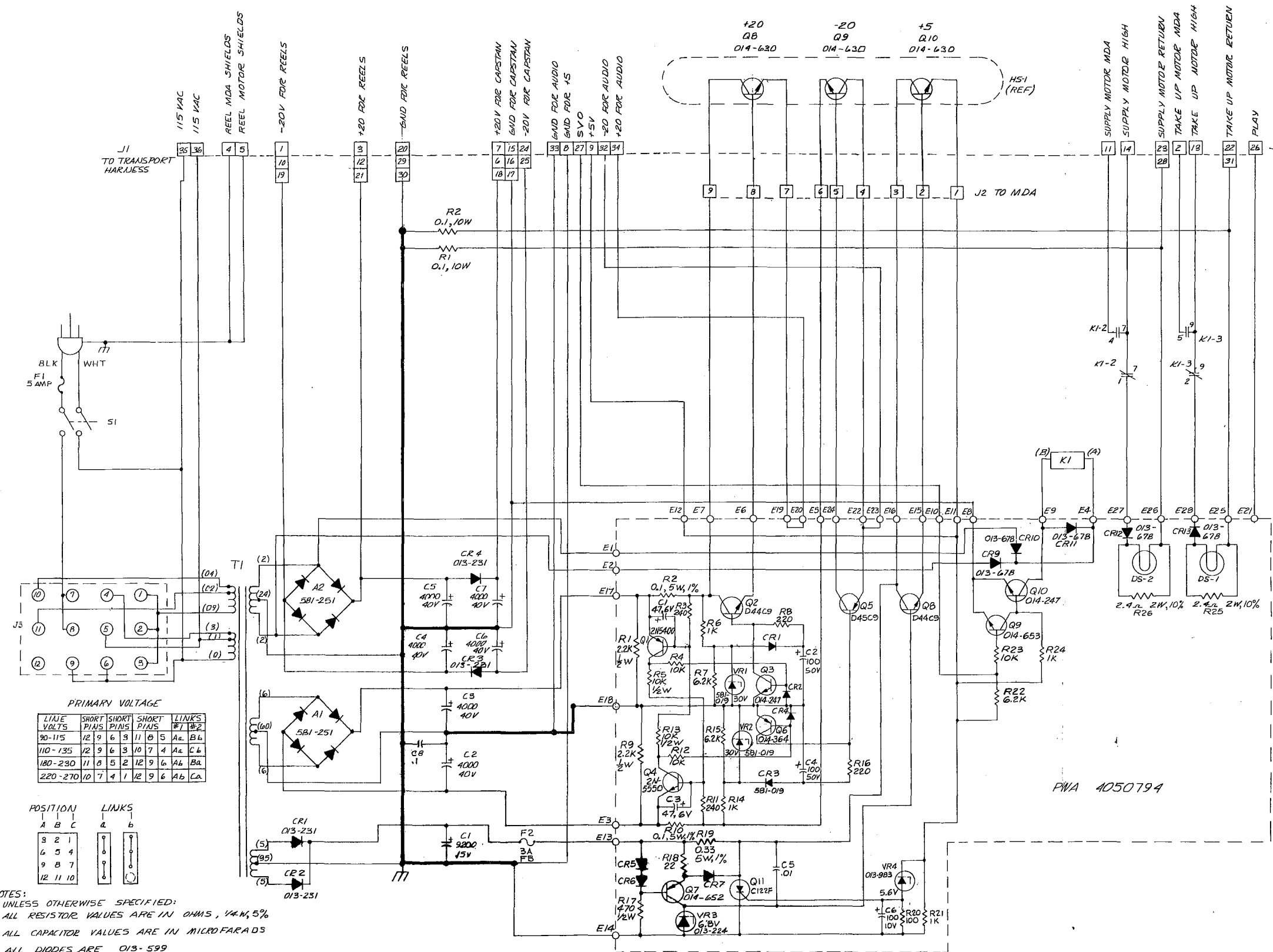
REFERENCE DESIGNATIONS	
LAST USED	NOT USED
R67	



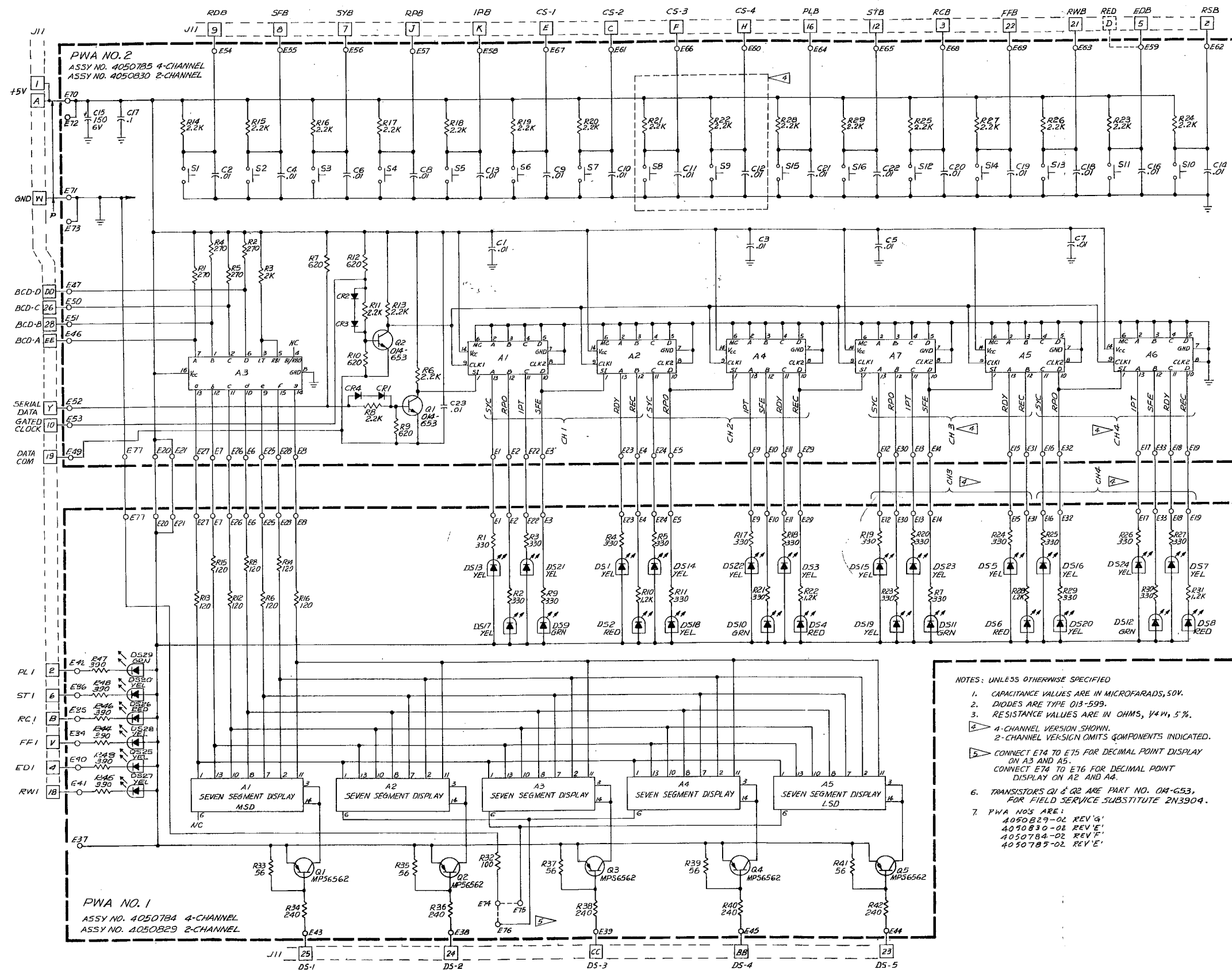
- NOTES: UNLESS OTHERWISE SPECIFIED
1. CAPACITANCE VALUES ARE IN MICROFARADS, 50V.
 2. DIODES ARE TYPE 013-599.
 3. RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%.
 4. PWA IS 4840395-03 REV G.

FIELD SERVICE COMPONENT SUBSTITUTION				INTEGRATED CIRCUIT LIST				REFERENCE DESIGNATIONS	
REF DES	AMPEX P/N	COMMERCIAL EQUIVALENT		REFERENCE DESIGNATION	AMPEX P/N	VENDOR P/N	VOLTAGE PIN	GROUND PIN	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-247	2N2219		A1	586-075	7400	14	7	LAST USED
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-364	2N2305A		A2	586-077	7420	14	7	NOT USED
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-652	2N3906		A3	586-269	7411	14	7	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A4	586-276	3046	NONE	NONE	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A5	586-325	7405	14	7	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A6	586-326	7404	14	7	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A7	586-905	558	14	7	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A8	587-505	7411A	14	7	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	014-653	2N3904		A9	587-77	3900	14	7	

Schematic No. 4840395F.
Reel Servo PWA



Schematic No. 4840412D.
Power Supply and Dynamic Brakes



REF. DESIG.	LAST USED	NOT USED
R29		
A7		
C24		
C23		
S16		
E77	E64-E76	E74-E76

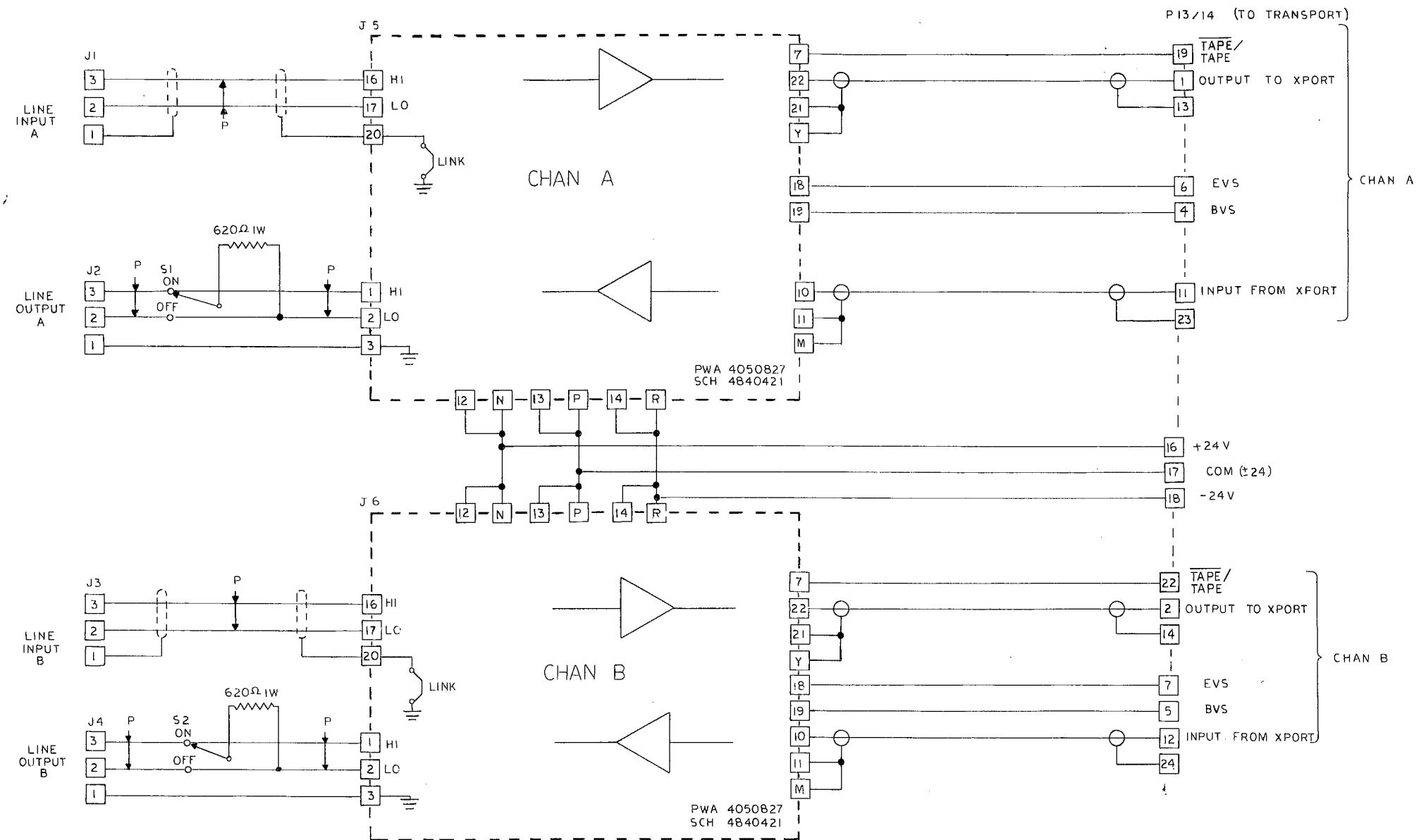
REF. DESIG.	IC LIST
A1	A1 A2 A4 A3
AMPX P/N	586-785 587-544
VENDOR P/N	7495 7447

REF. DESIG.	LAST USED	NOT USED
DS30		
Q5		
A6		
R48		
E77	E46-E73	

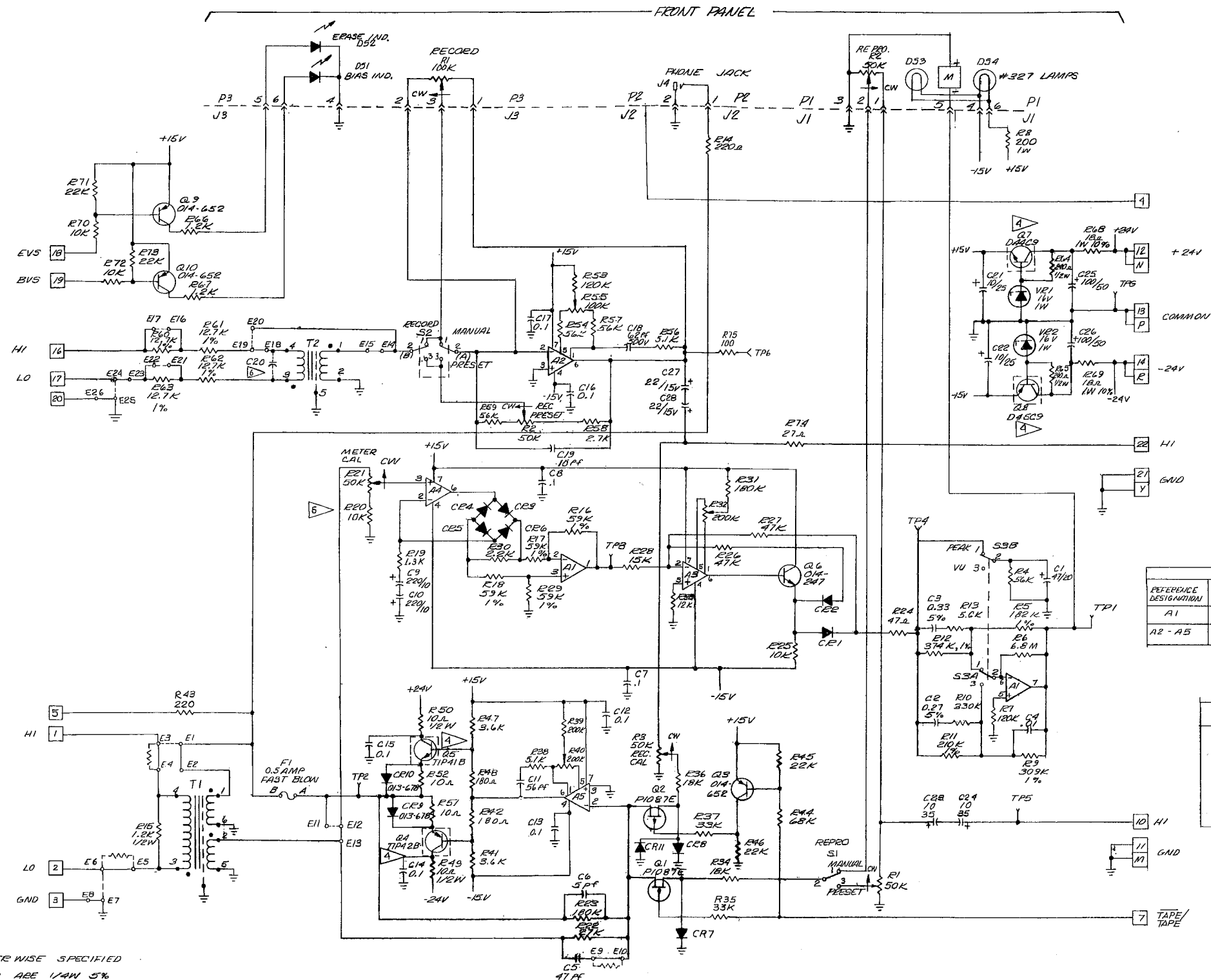
REF. DESIG.	IC LIST
A1-5	
AMPX P/N	581-537
VENDOR P/N	5082-7730

- NOTES: UNLESS OTHERWISE SPECIFIED
1. CAPACITANCE VALUES ARE IN MICROFARADS, 50V.
 2. DIODES ARE TYPE 013-599.
 3. RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%.
 4. 4-CHANNEL VERSION SHOWN. 2-CHANNEL VERSION OMTS COMPONENTS INDICATED.
 5. CONNECT E74 TO E75 FOR DECIMAL POINT DISPLAY ON A3 AND A5. CONNECT E74 TO E76 FOR DECIMAL POINT DISPLAY ON A2 AND A4.
 6. TRANSISTORS Q1 & Q2 ARE PART NO. 0M-G53, FOR FIELD SERVICE SUBSTITUTE 2N3904.
 7. PWA NOS ARE: 4050784-02 REV 'G' 4050785-02 REV 'E' 4050784-02 REV 'F' 4050785-02 REV 'E'

Schematic No. 4840396D.
Control Unit Assembly



Schematic No. 4040427A.
Input/Output Mainframe



IC LIST				
PREFERENCE DESIGNATION	AMPEX P/N	VEICOR P/N	VOLTAGE P/N	
A1	506-305	145B	B(15) 4(-15)	
A2 - A5	507-478	318H	X(15) 4(-15)	

LAST USED	NOT USED
VE2	
CR11	
CR2	
CR5	
CR7	
CR10	
CR15	
CR18	
CR20	

- NOTES
UNLESS OTHERWISE SPECIFIED
- ALL RESISTORS ARE 1/4W 5%.
 - ALL CAPACITORS ARE IN MICROFARADS.
 - ALL DIODES ARE 013-533.
 - THESE TRANSISTORS HAVE HEATSINKS.
R20 TO BE 1.5K IF E12 IS CONNECTED TO E11.
C20 TO BE 47PF IF E17 IS CONNECTED TO E16
AND E22 IS CONNECTED TO E21.
 - PWA IS 4050B27-02 REV 'C'

Schematic No. 4840421D.
Input/Output PWA

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