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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

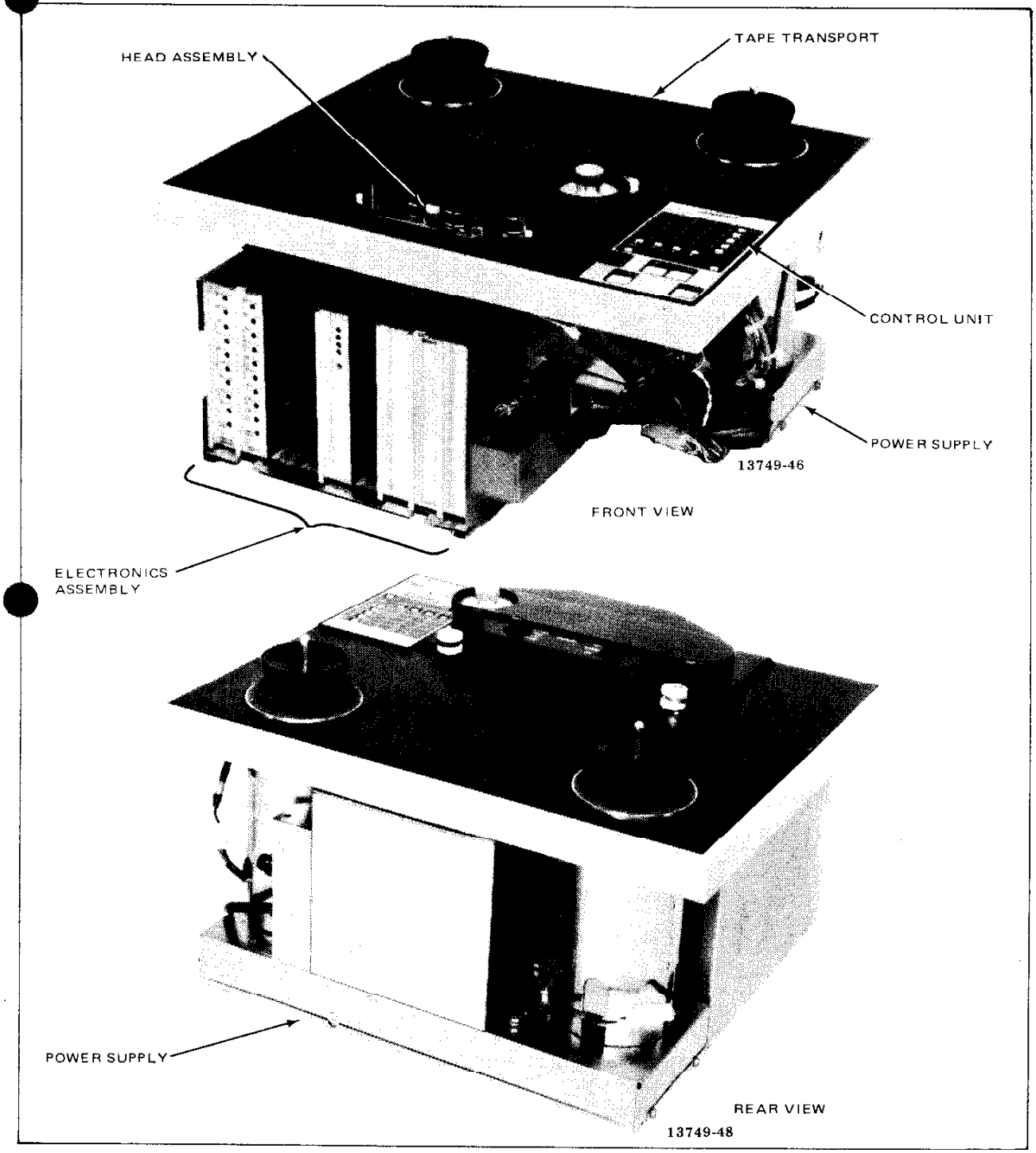


Figure 1-1. Recorder/Reproducer, Unmounted

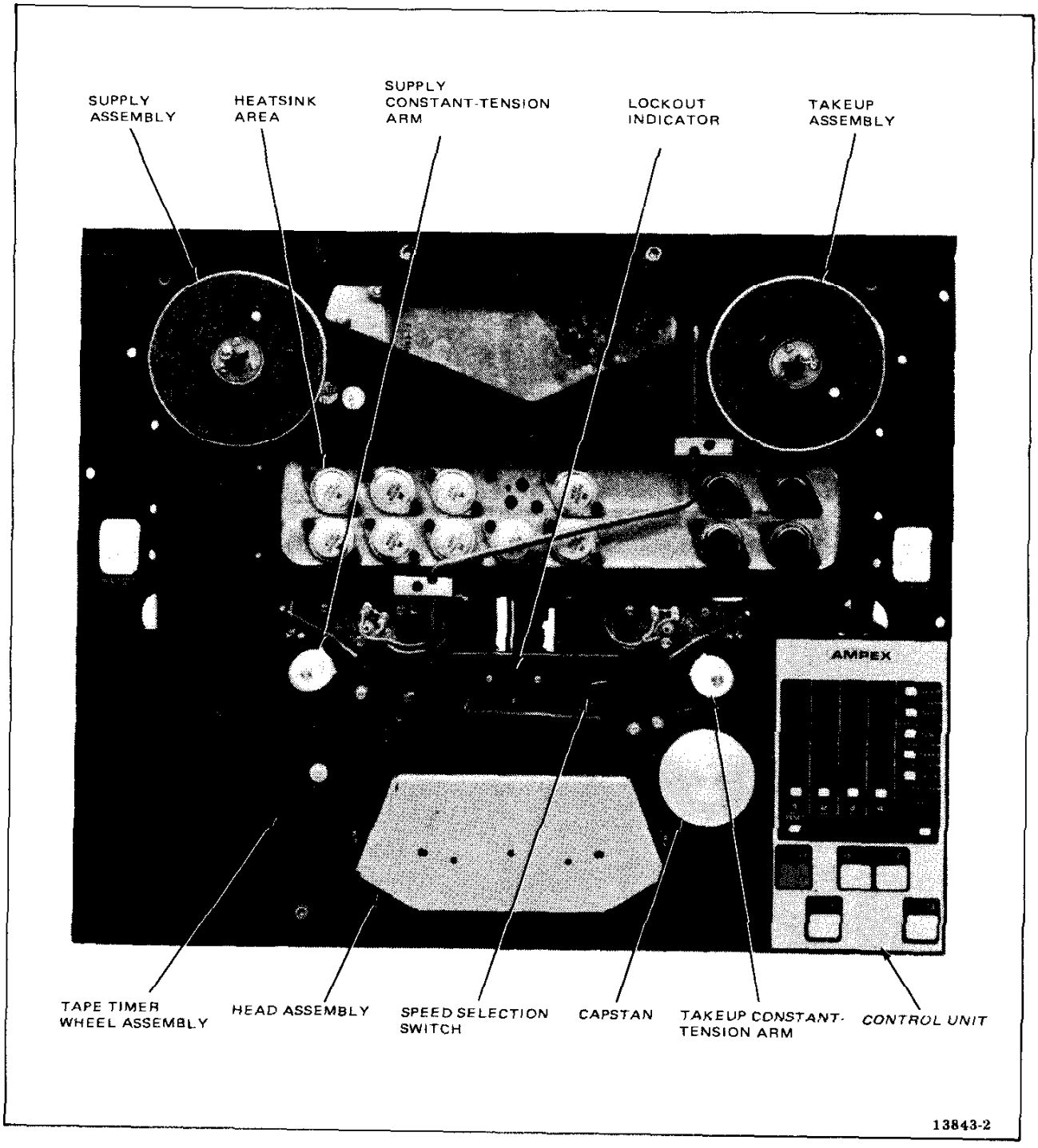


Figure 1-2. Top View of Tape Transport with Front and Rear Overlay Panels and the Head Cover Removed

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.

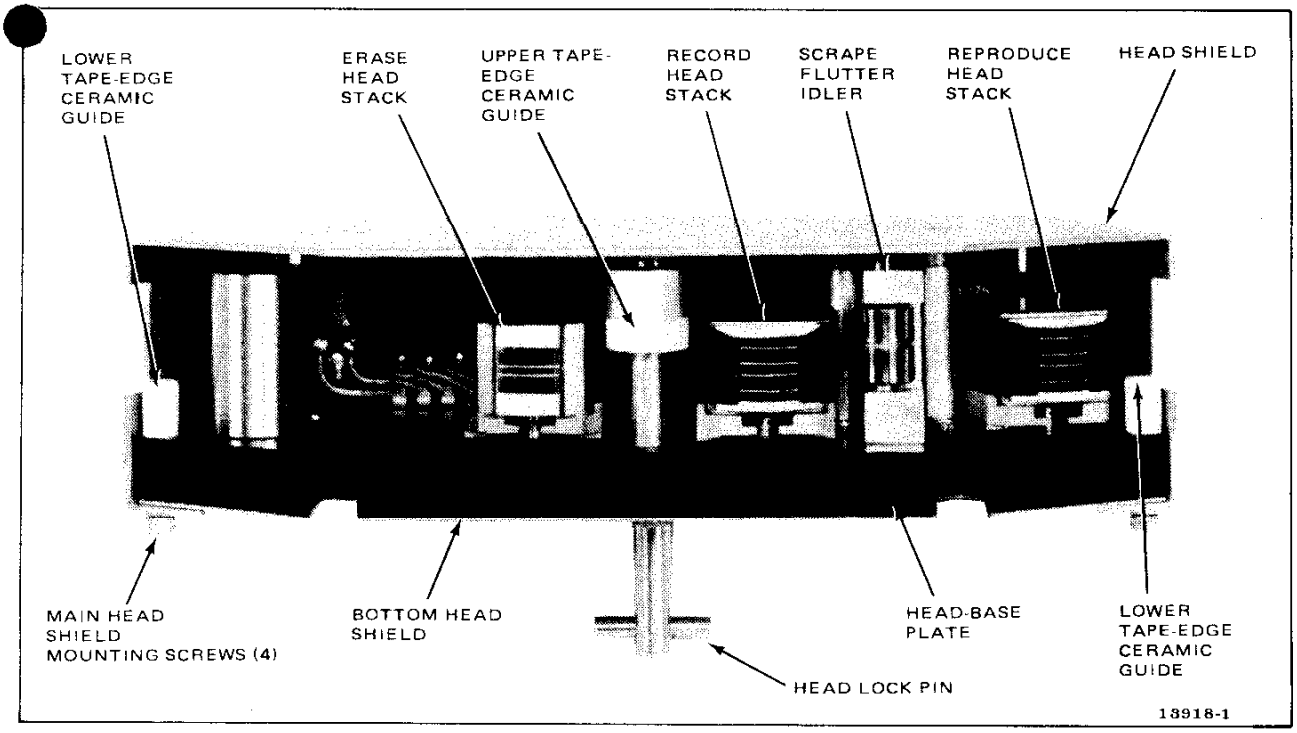


Figure 1-3. Head Assembly

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.

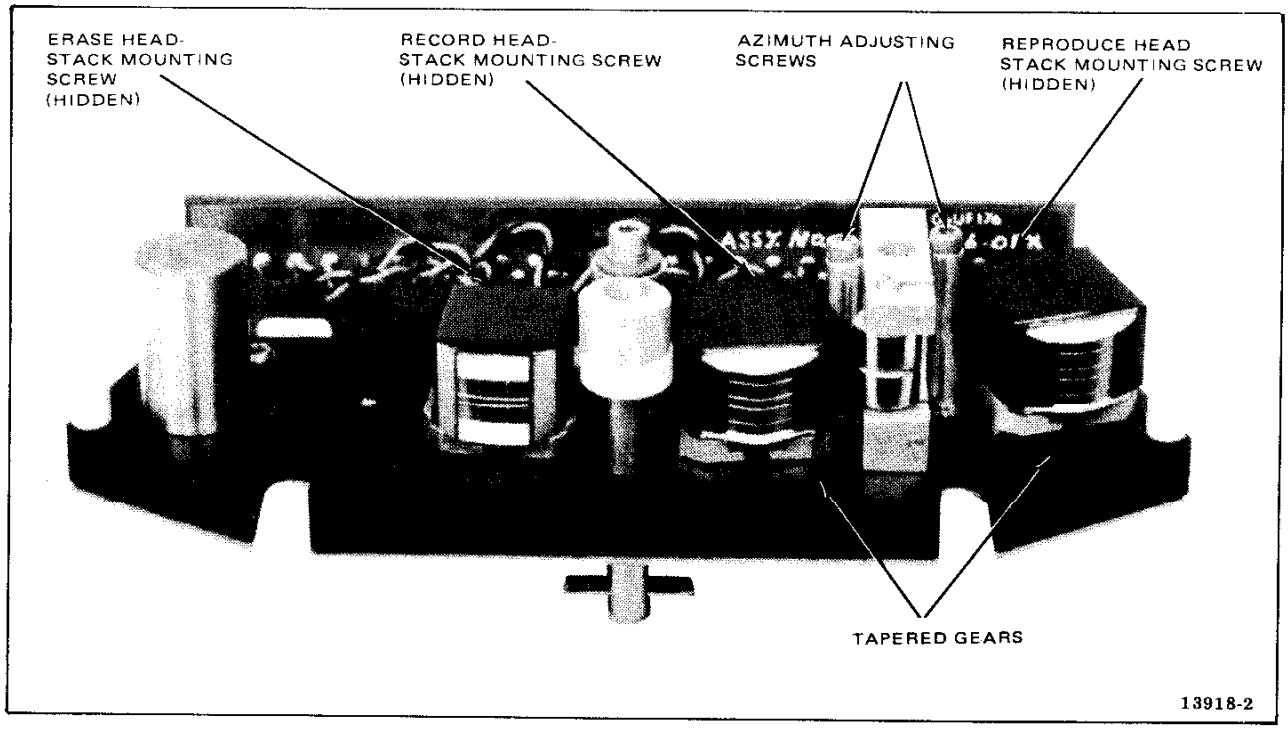


Figure 1-4. Head Assembly with Head Shield Removed

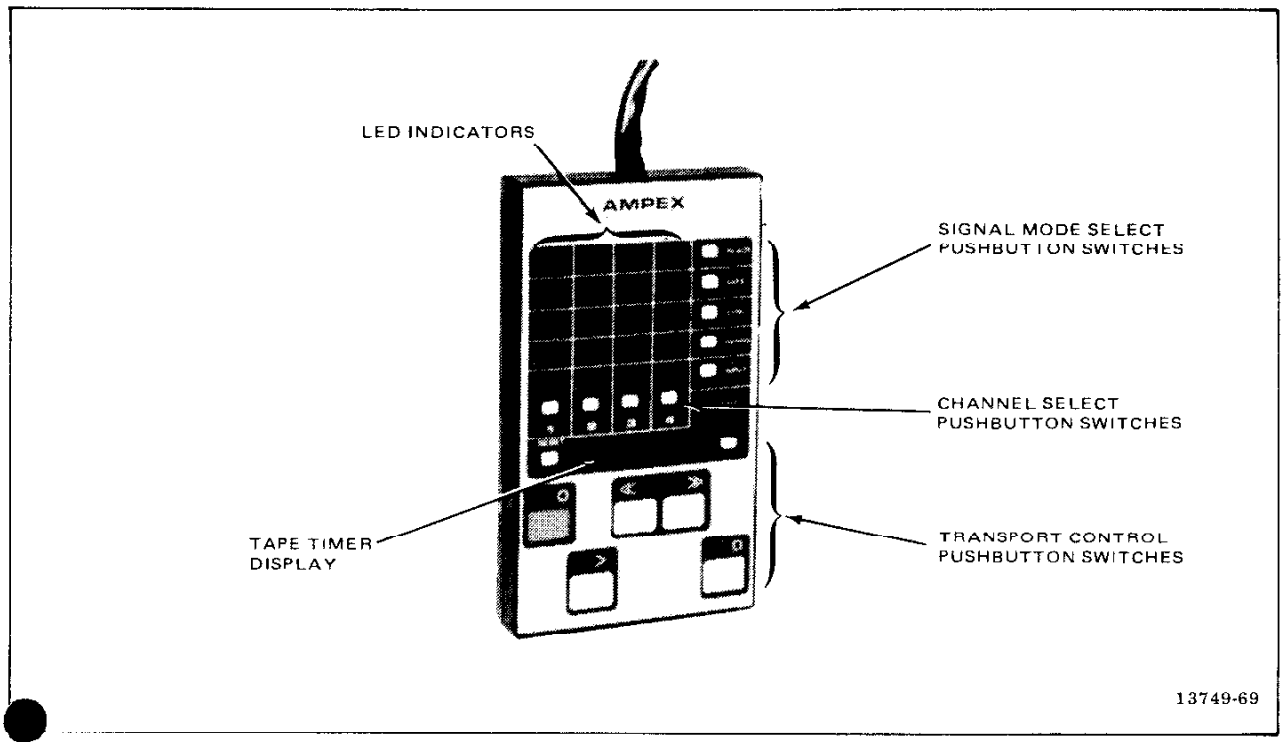


Figure 1-5. Control Unit

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 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

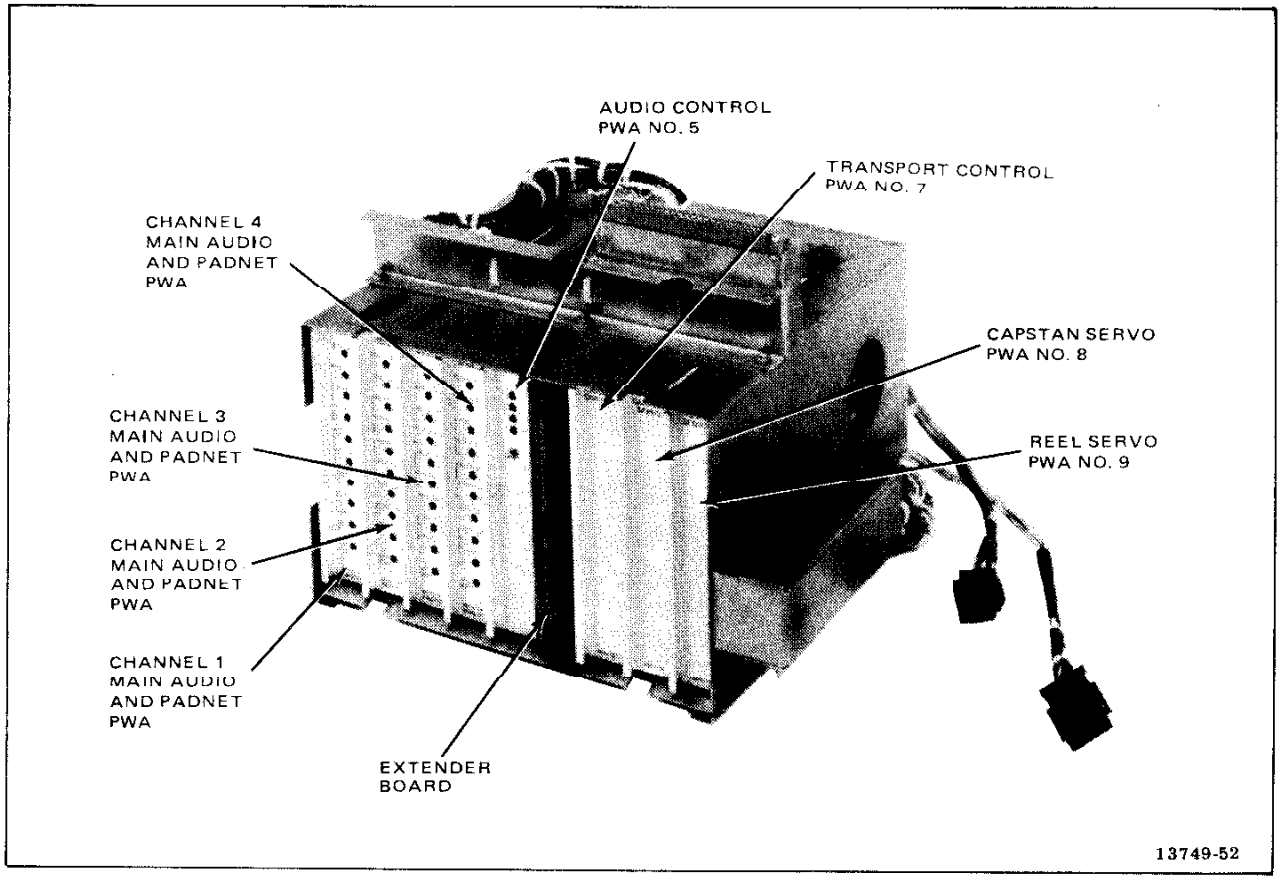


Figure 1-6. Electronics Assembly, Cover Panel Removed

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

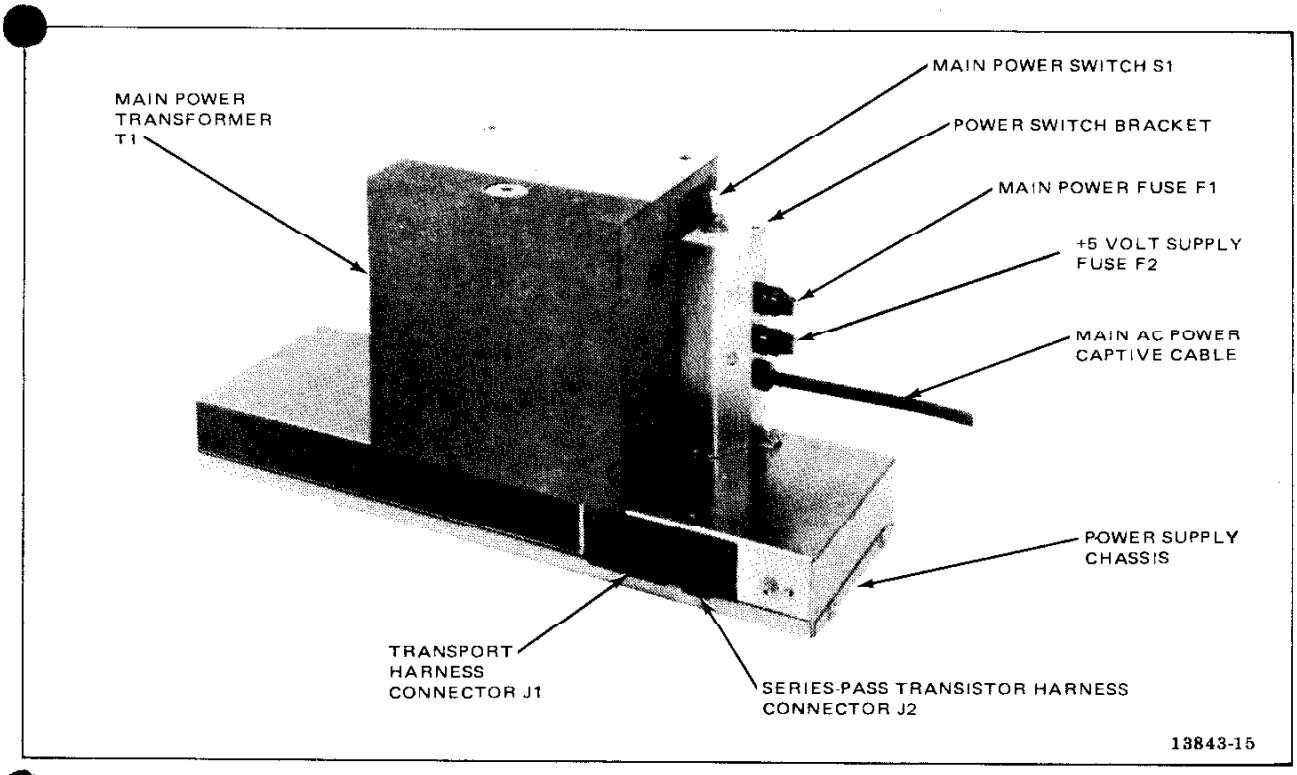


Figure 1 7. Power Supply

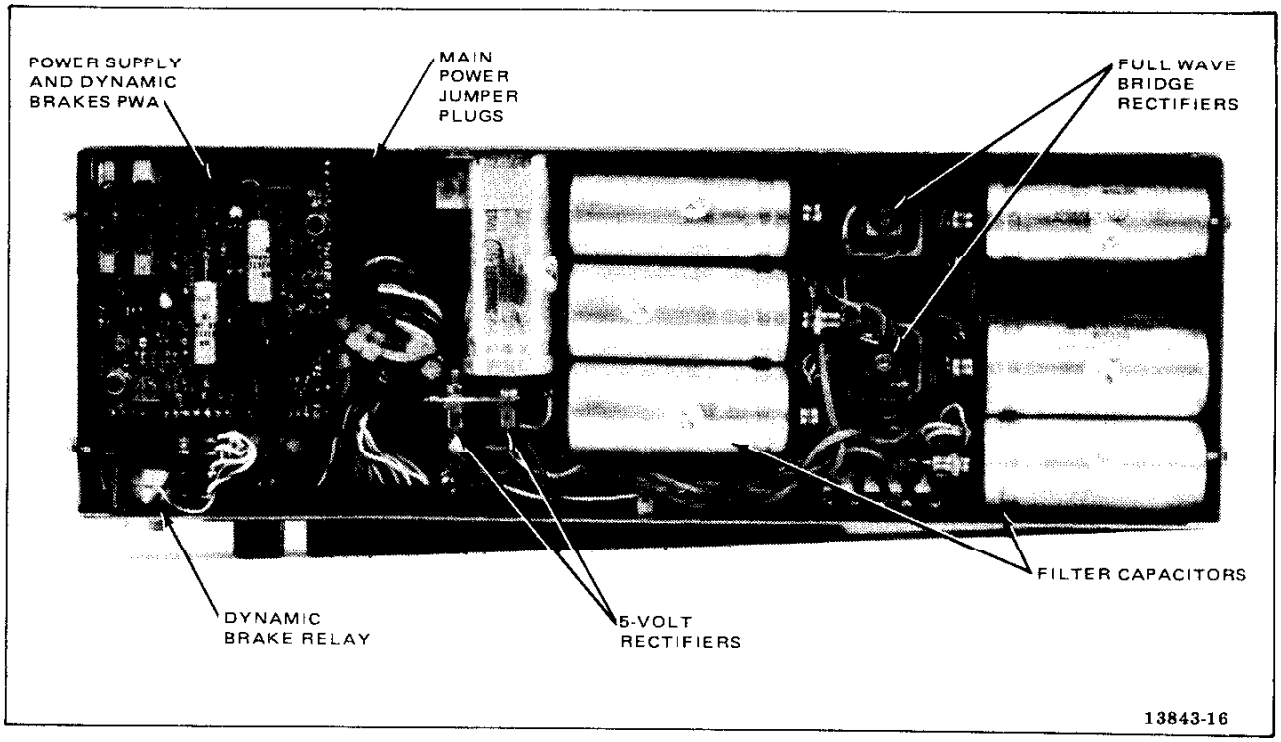


Figure 1-8. Power Supply Chassis with Cover Panel Removed

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.

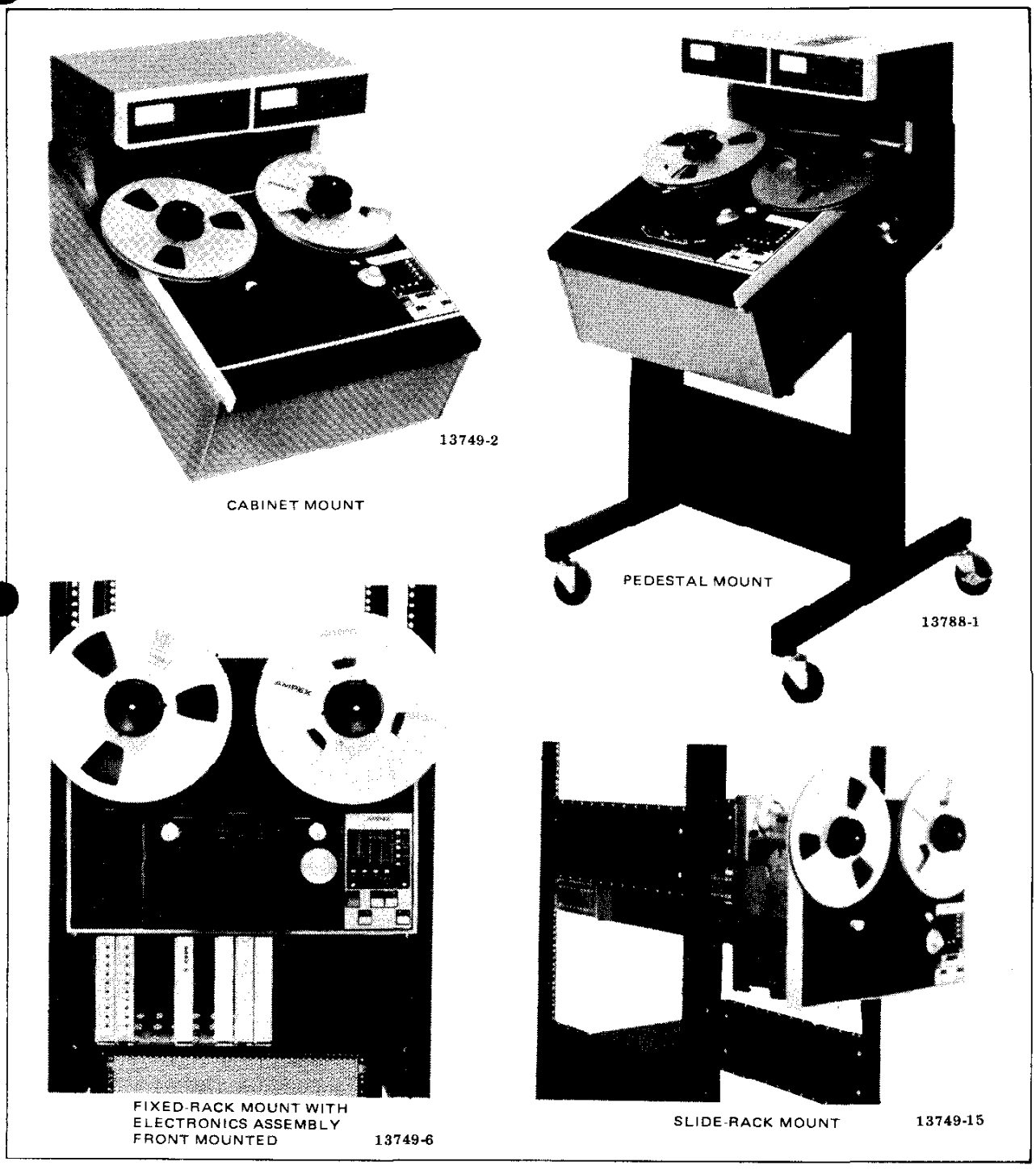


Figure 1-9. ATR-100 Series Mounting Configurations

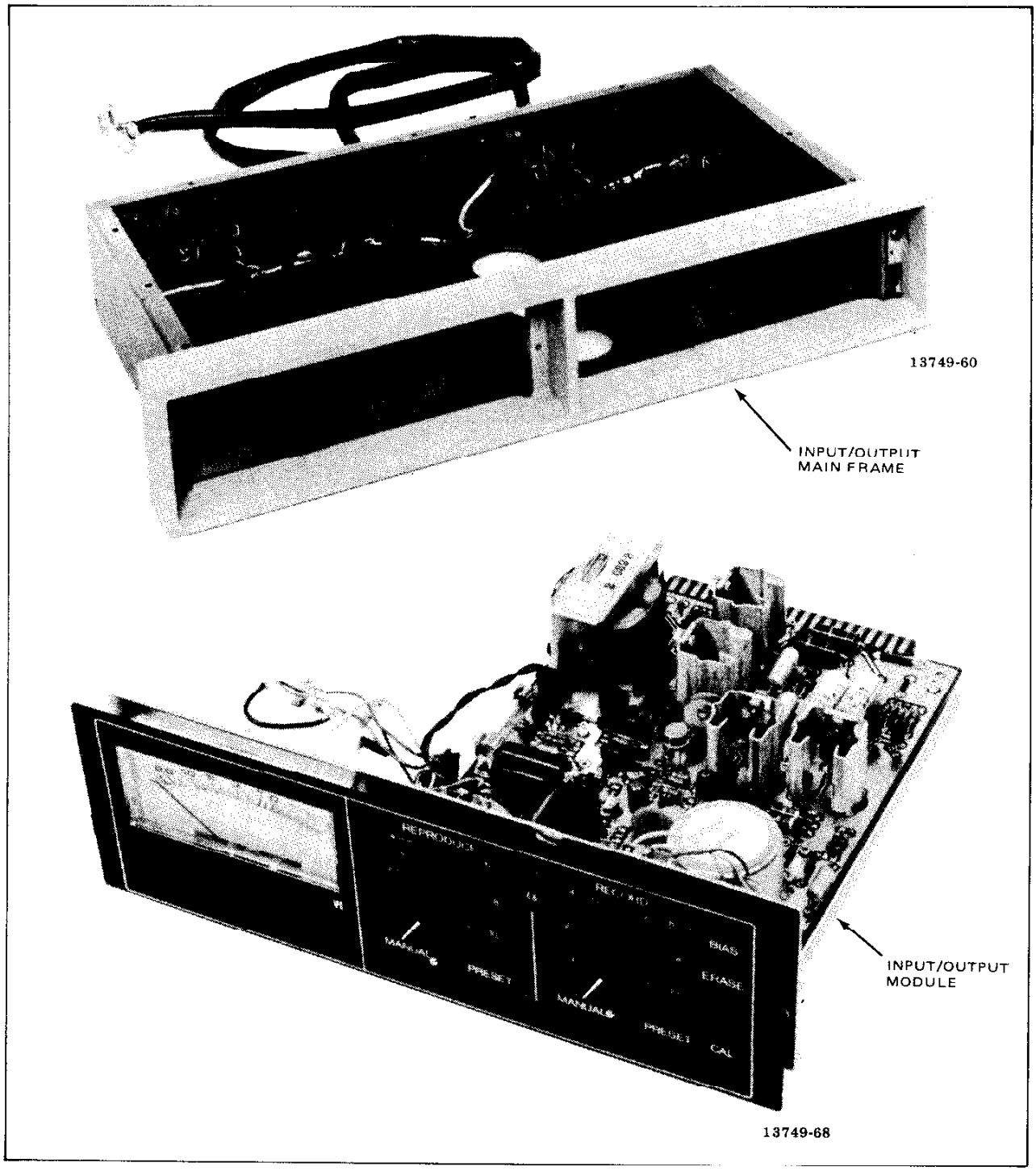


Figure 1-10. Input/Output Assembly

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

Tape Widths:

1/4 inch (6.4 mm) for full-track and 2-track, 2-channel systems, 0.075 inch (1.9 mm) track width.

1/2 inch (12.7 mm) for 4-track systems, 0.070 (1.8 mm) track width.

Tape Speeds:

3.75 in/s (9.5 cm/s)

7.5 in/s (19.05 cm/s)

15 in/s (38.1 cm/s)

30 in/s (76.2 cm/s)

(any two speeds may be selected)

Reel Size:

2-inch to 14-inch diameter (50 mm to 355 mm)

Reel Type:

NAB, EIA (Cine')

Table 1-4. Specifications (Continued)

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

Balanced, floating	
Input impedance:	50 kilohms, resistive +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 740nWb/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: ±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)	±0.1%	±0.15%	0.1%
7.5 in/s (19.05 cm/s)	±0.05%	±0.12%	0.06%
15 in/s (38.1 cm/s)	±0.03%	±0.08%	0.04%
30 in/s (76.2 cm/s)	±0.03%	±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: ±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).

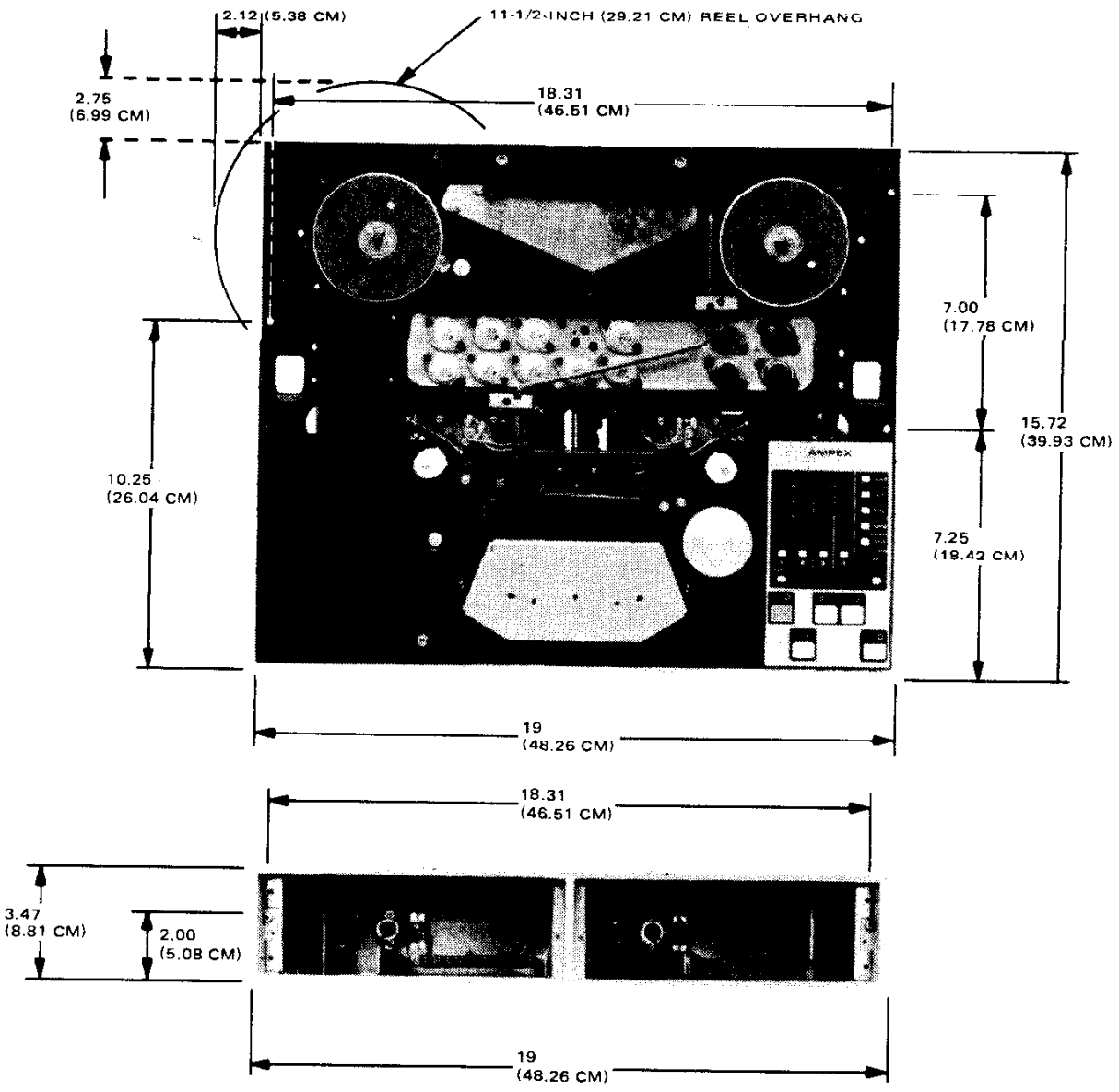


Figure 2-1. Mounting Dimensions

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 × 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.)

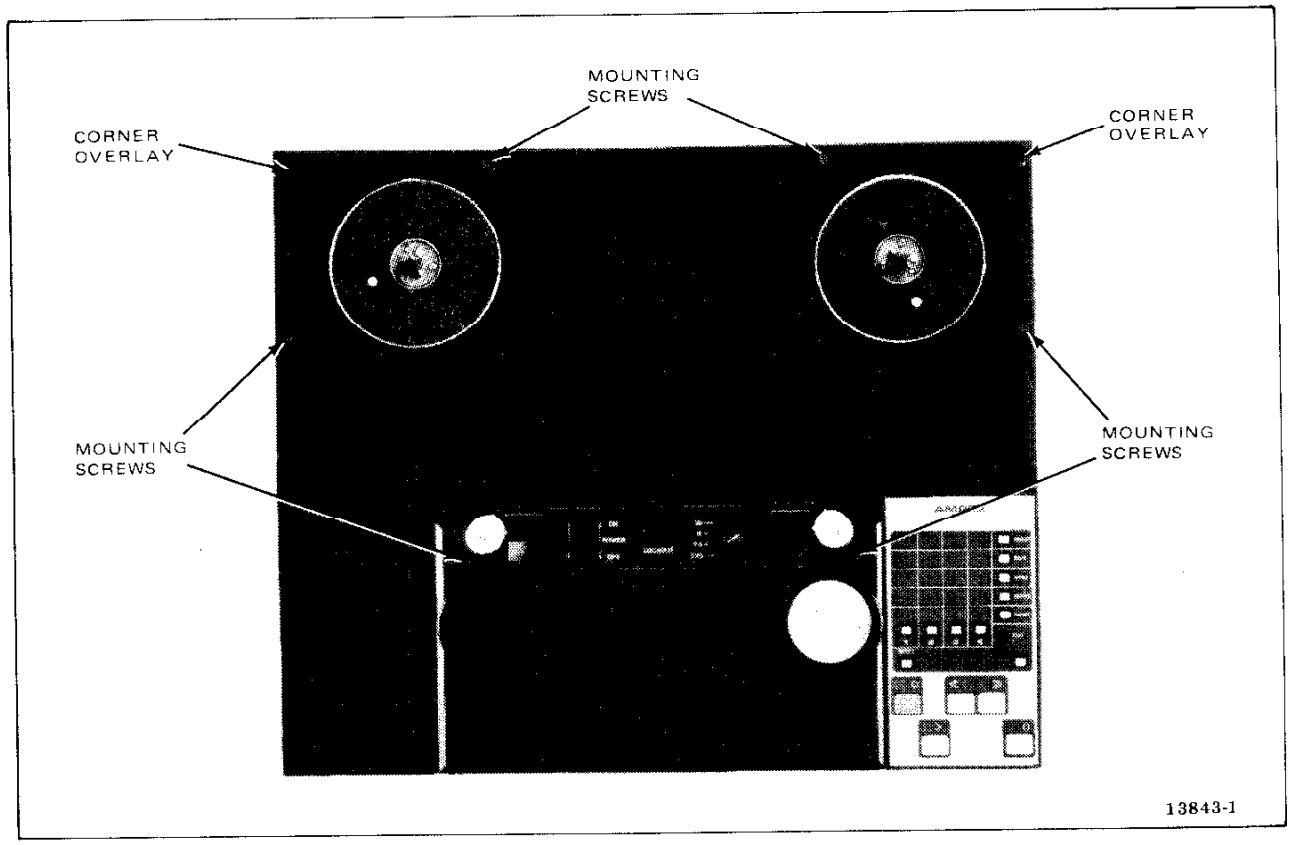


Figure 2-2. Rear Overlay Panel, Six Mounting Screws

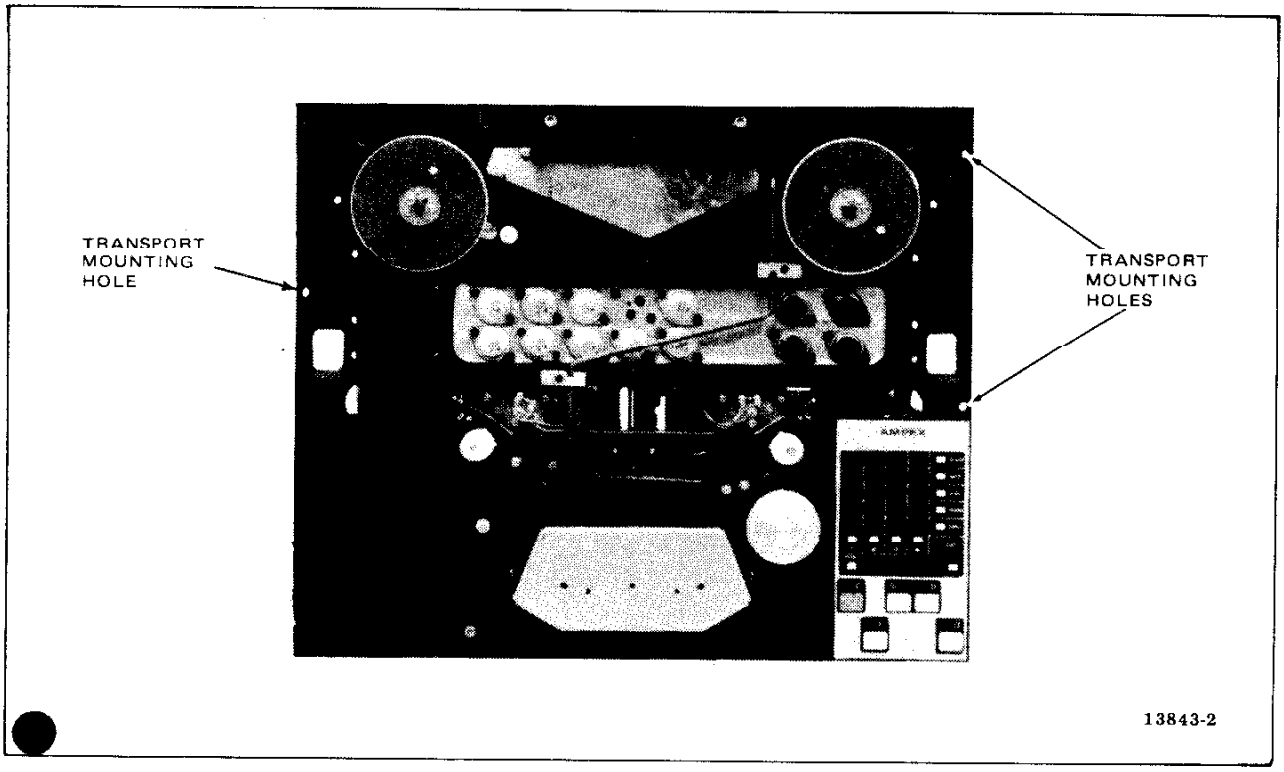


Figure 2-3. Cabinet and Fixed-Rack Mount Transport-Mounting Holes

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 X 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 X 1-1/4 inch long screws and two 5/8 OD X 9/32 ID X 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 X 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 X 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 X 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 X 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.

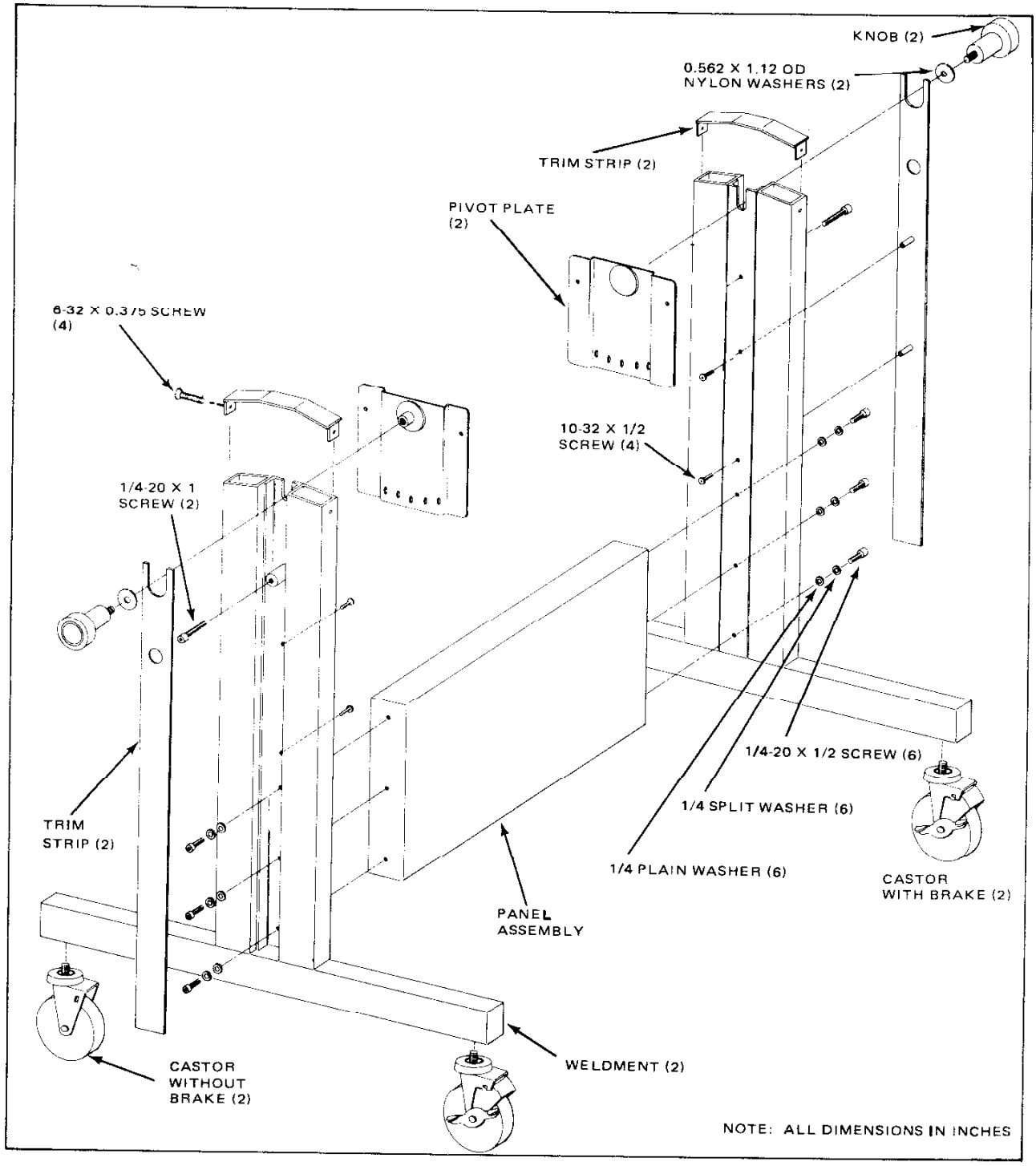


Figure 2-5. Pedestal Assembly, Exploded View

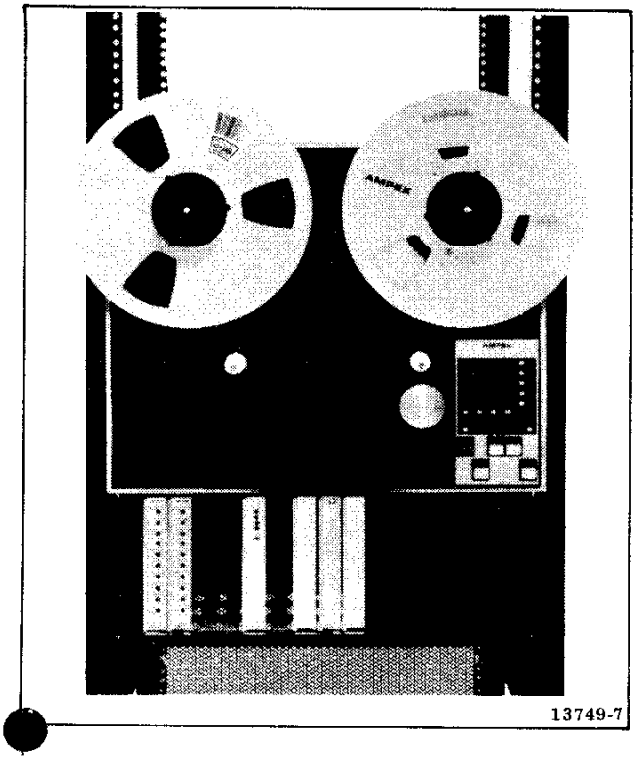


Figure 2-6. Fixed-Rack Mount with Electronics Assembly Cover Panel Removed

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.

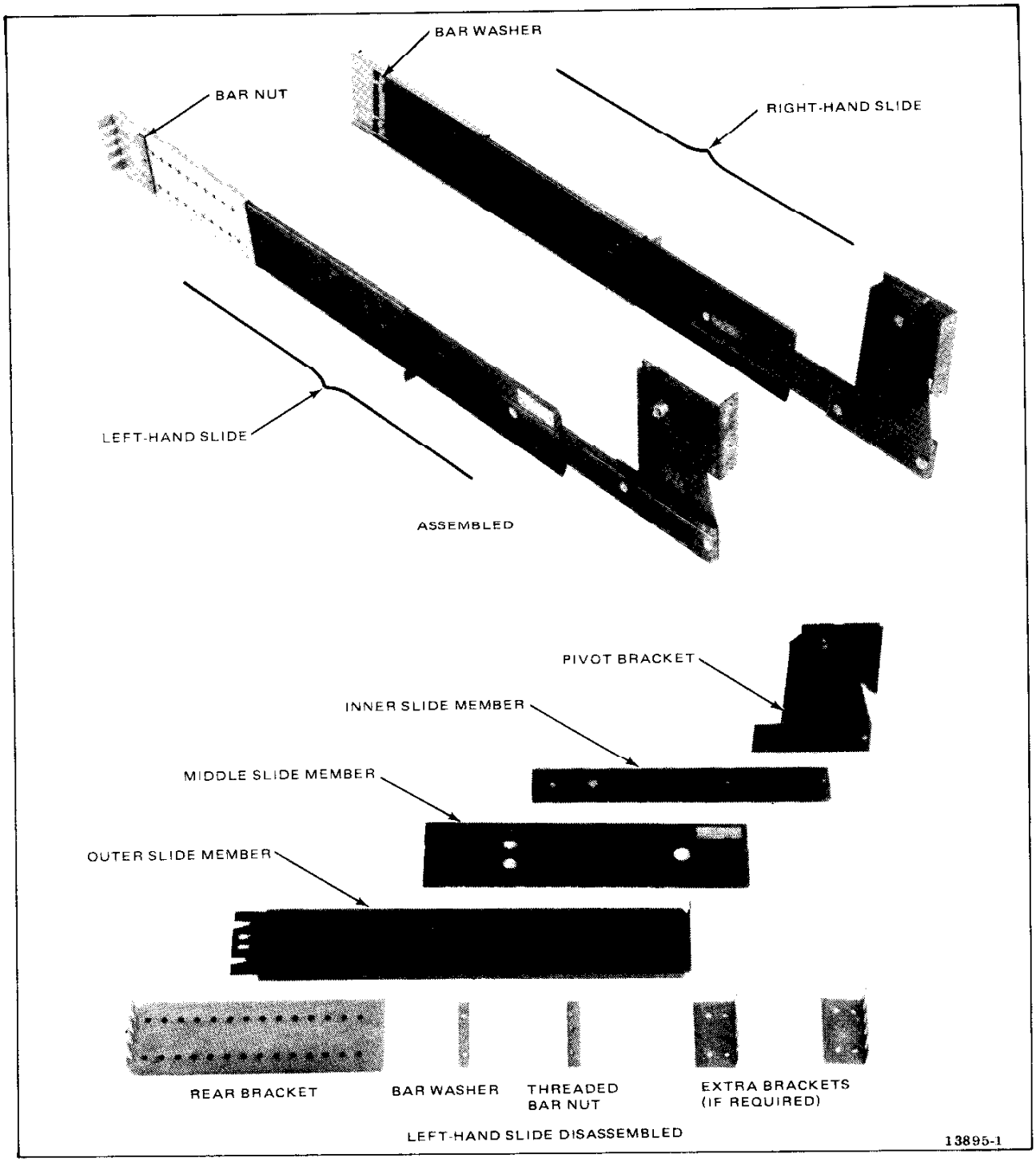


Figure 2-7. Slide Rack Mount Kit

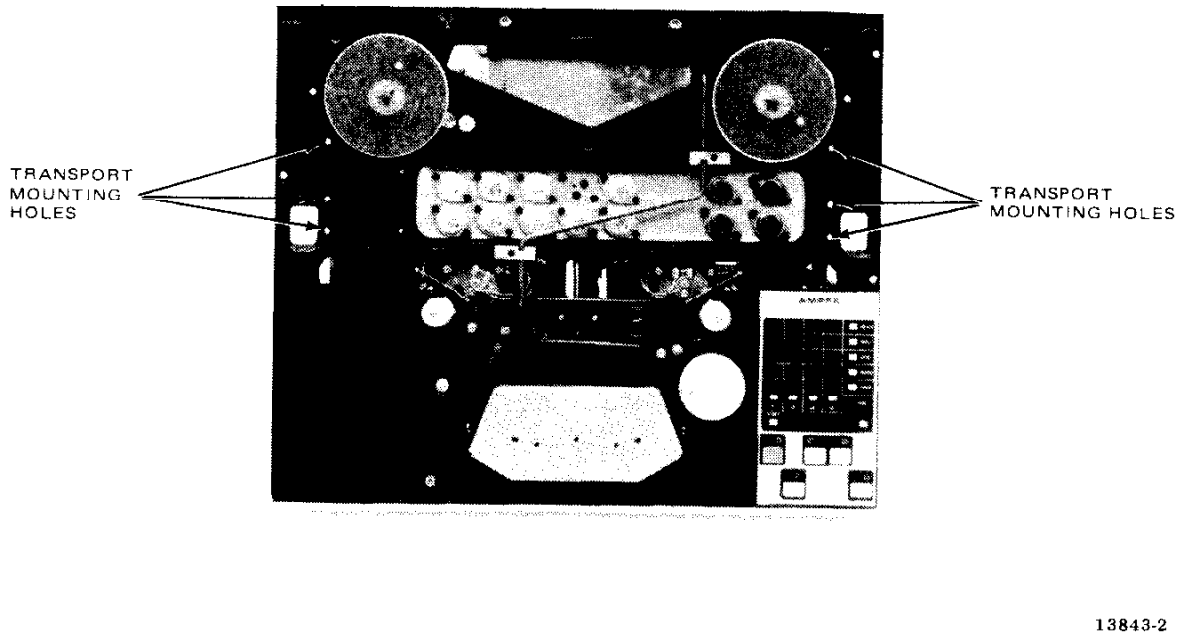


Figure 2-8. Slide-Rack Mount Transport-Mounting Holes

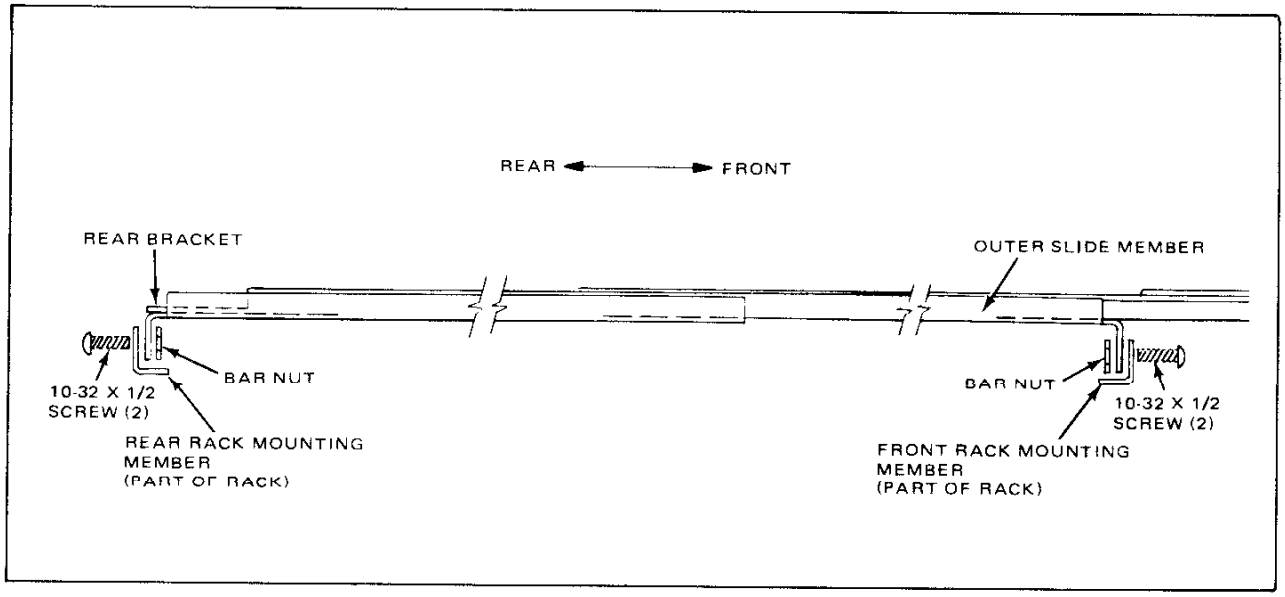


Figure 2-9. Left Hand Slide, Top View

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.

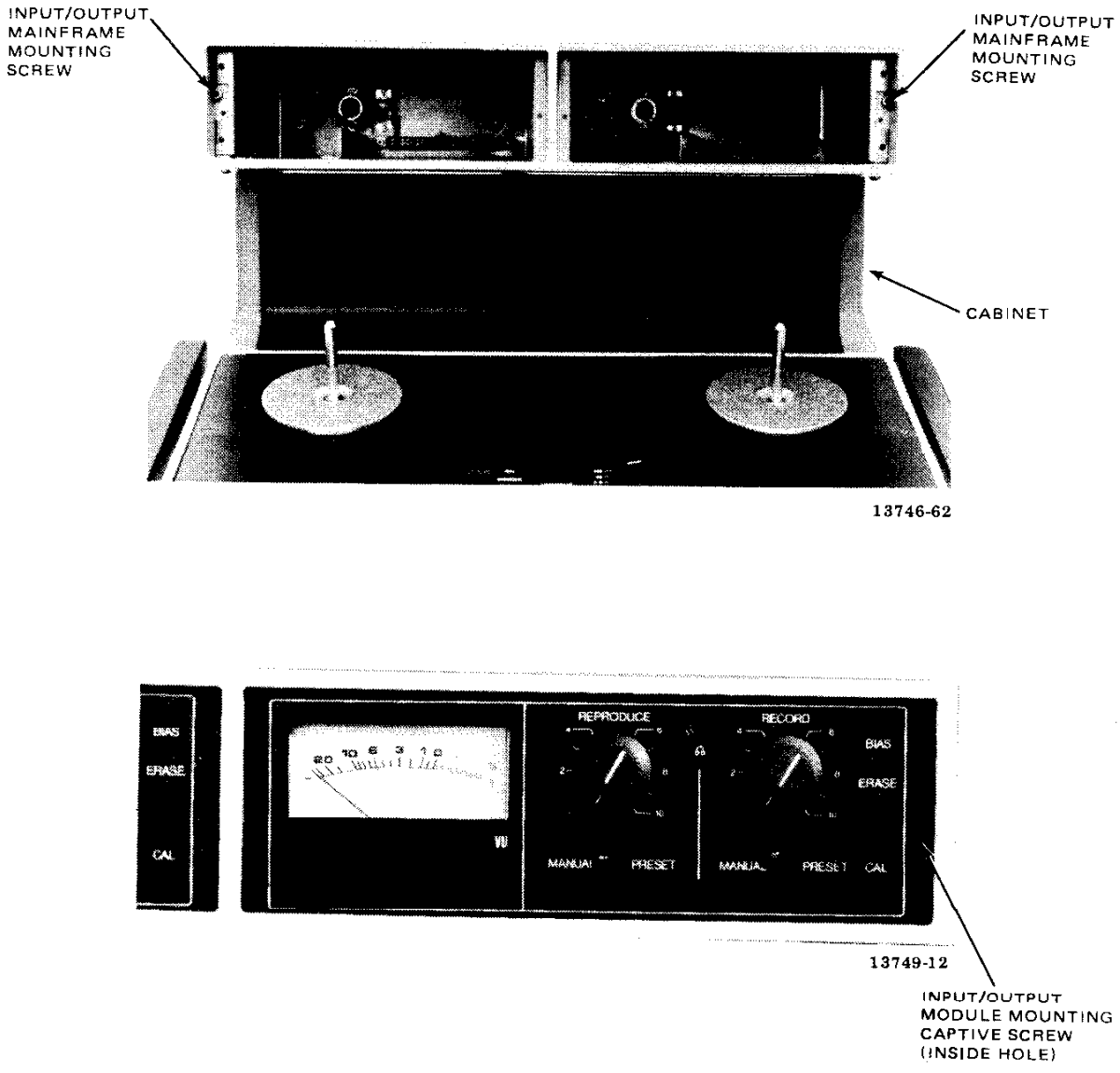


Figure 2-10. Input/Output Assembly Mounting

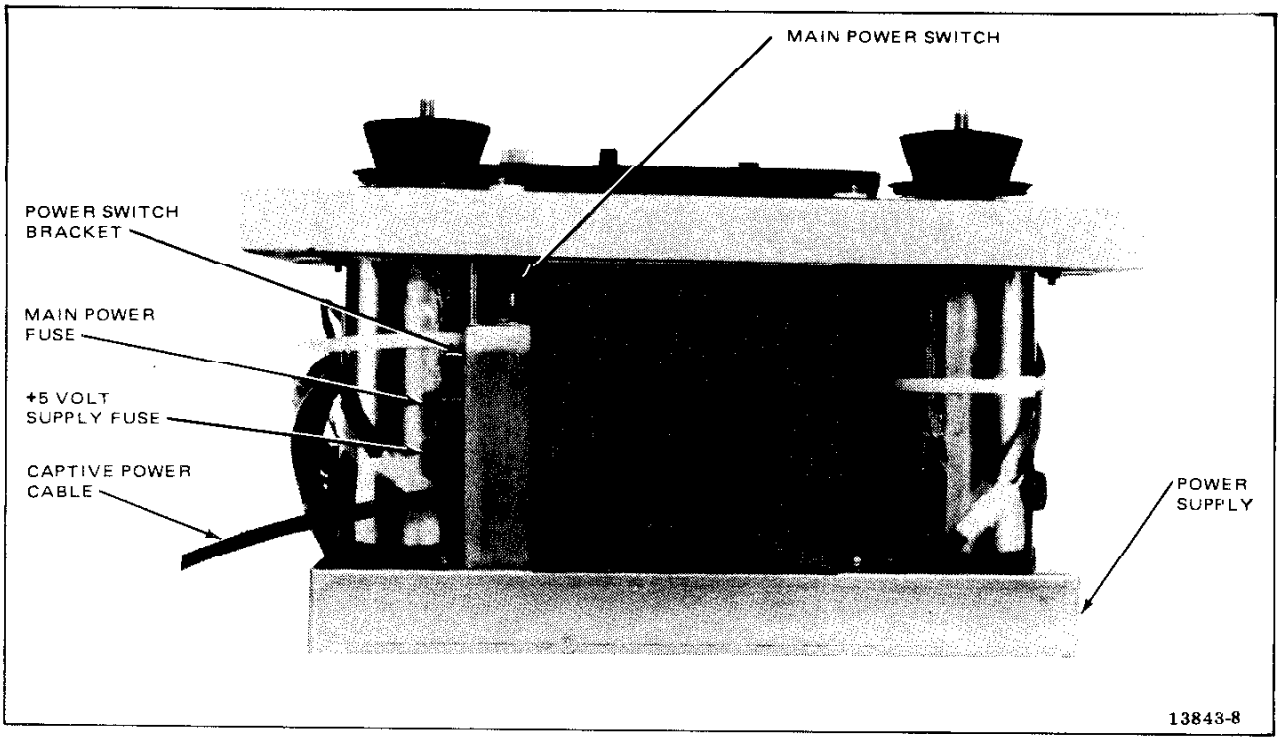


Figure 2-11. Recorder/Reproducer, Rear View

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

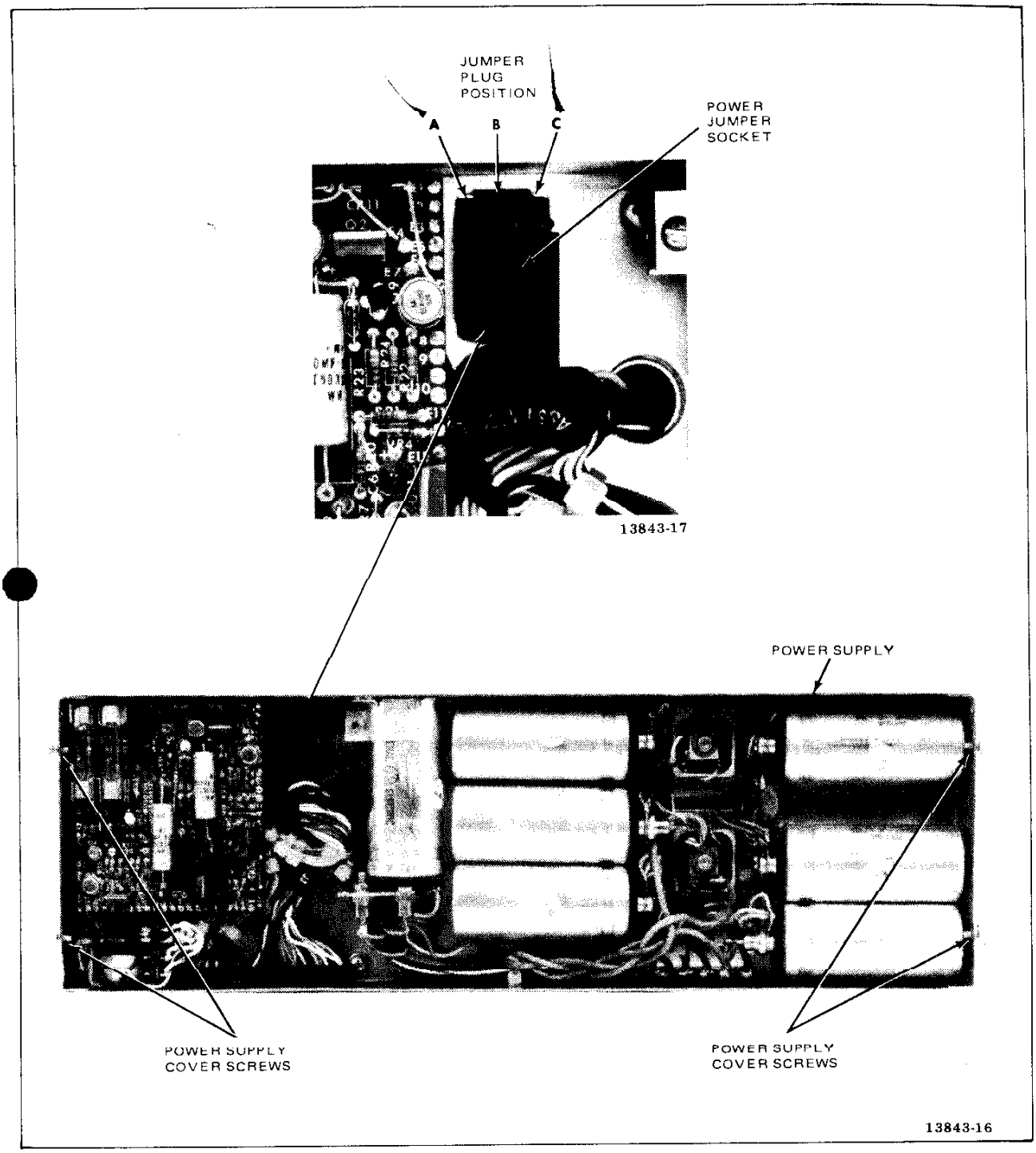
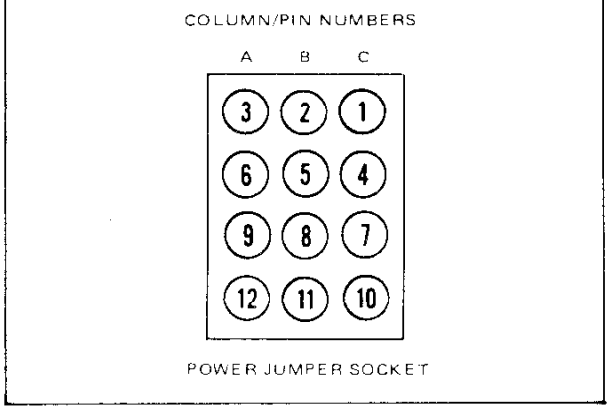


Figure 2-12. Main Power Jumper Location

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



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.

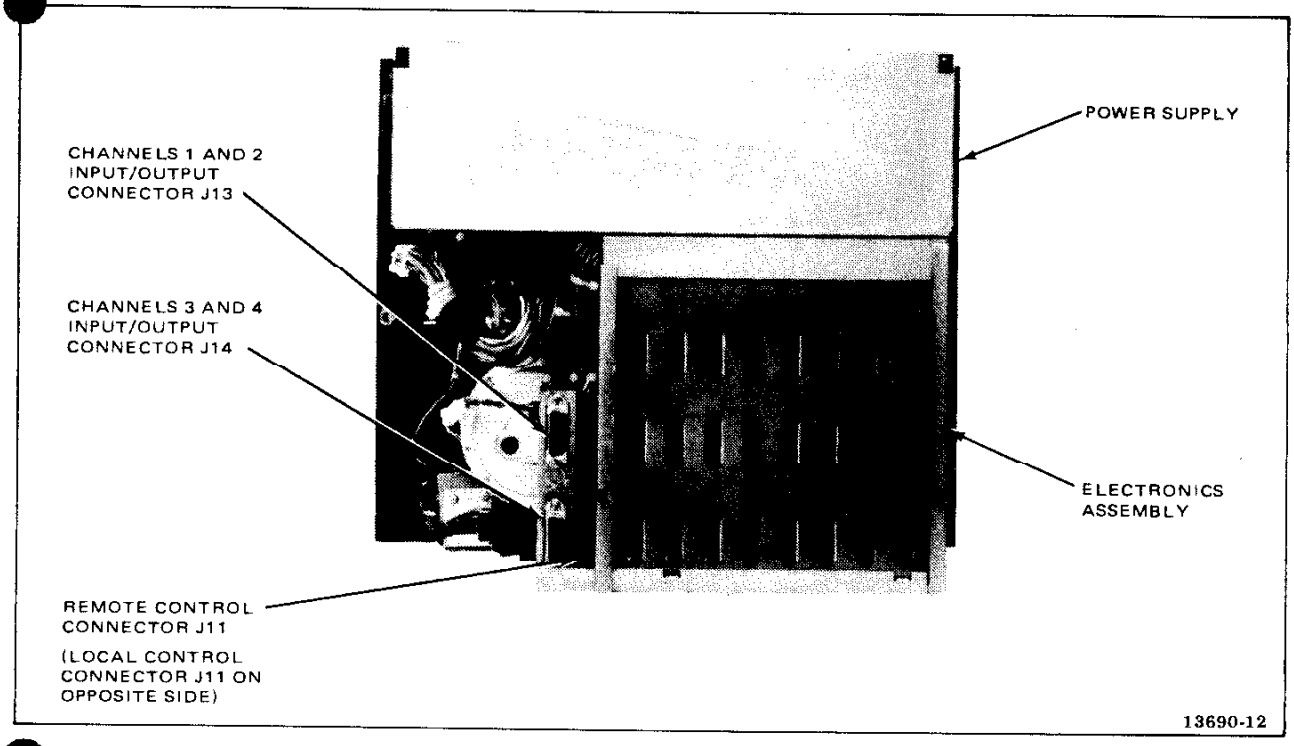


Figure 2-13. Connector Locations, Bottom View of Recorder/Reproducer

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	$\overline{\text{TAPE/TAPE}}$
20	1	Unequalized Sel-Sync output ground
21	2	Unequalized Sel-Sync output ground
22	2	$\overline{\text{TAPE/TAPE}}$
23	1	Audio output shield
24	2	Audio output shield

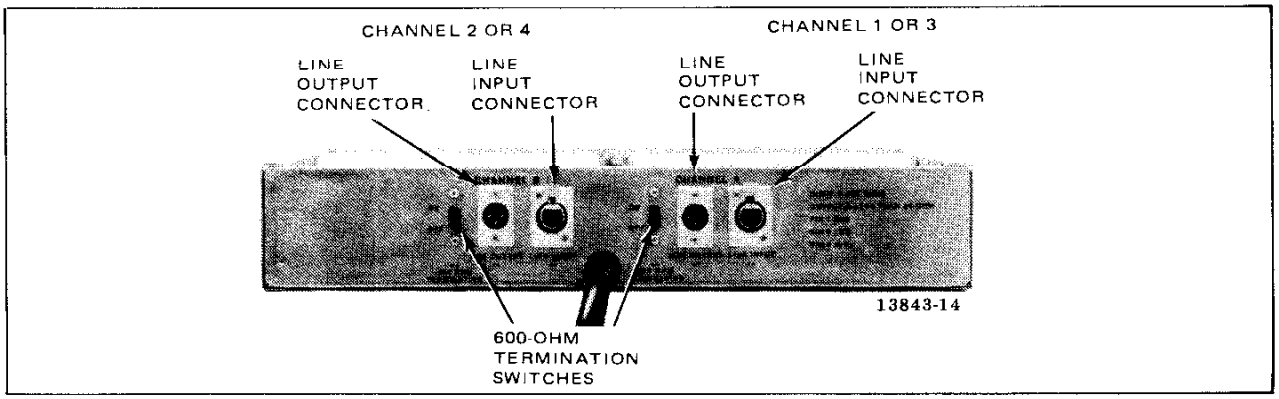


Figure 2-14. Input/Output Assembly, Rear View

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	$\overline{\text{TAPE}}$/TAPE
20	3	Unequalized Sel-Sync output ground
21	4	Unequalized Sel-Sync output ground
22	4	$\overline{\text{TAPE}}$/TAPE
23	3	Audio output shield
24	4	Audio output shield

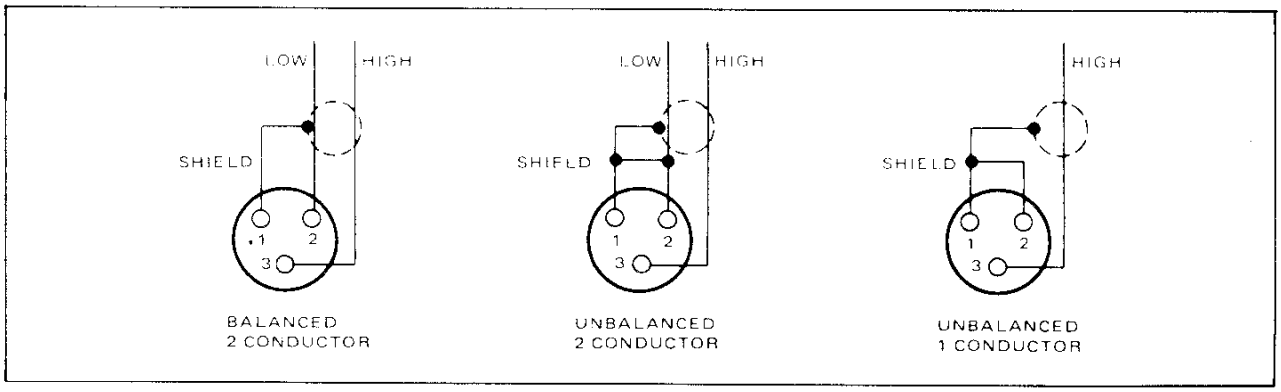


Figure 2-15. Input/Output Assembly Connector Wiring

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.

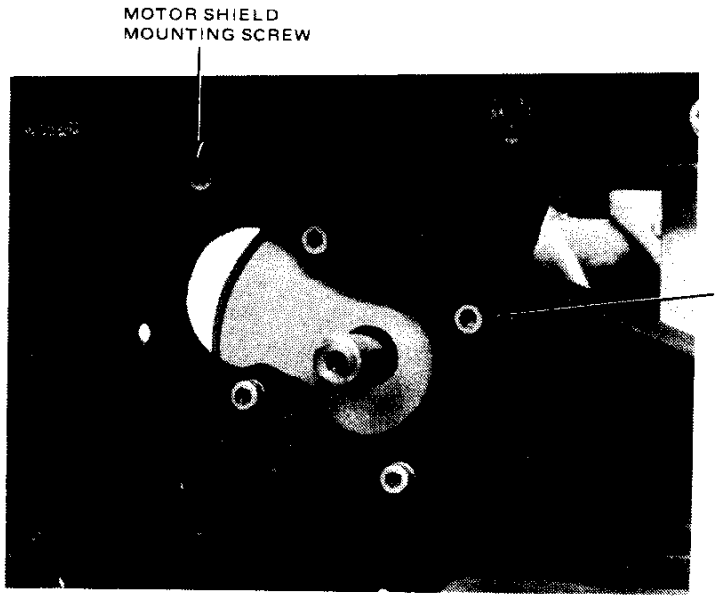
6. Relocate the motor and the shield end plate to the outer position of the transport with the ground strap facing inward (180° from its previous position, shown in Figure 2-18).

7. Reinstall screws removed in step 4 to secure the motor in the outer position as shown in Figure 2-16.

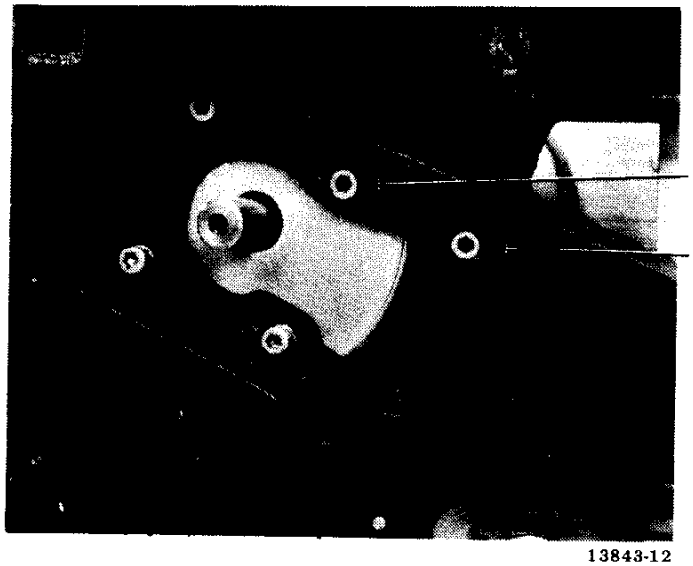
8. Install motor shield ground strap to transport.

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.



13843-13



13843-12

Figure 2-16. Supply Motor Mounting

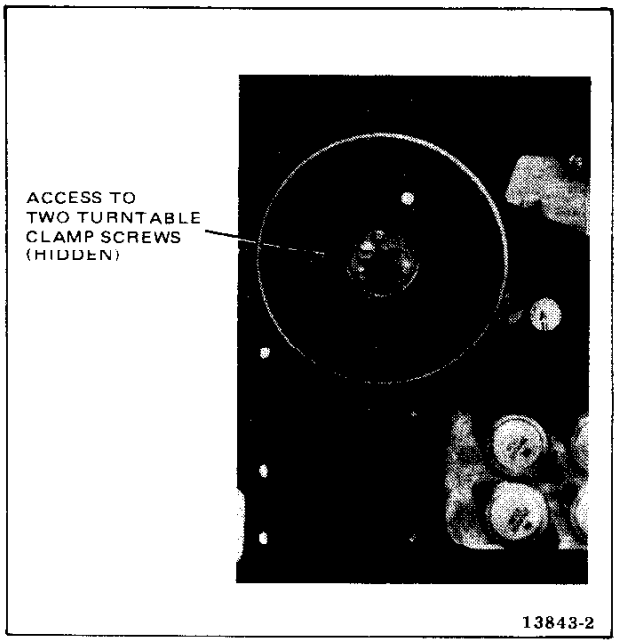


Figure 2-17. Supply Turntable

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.

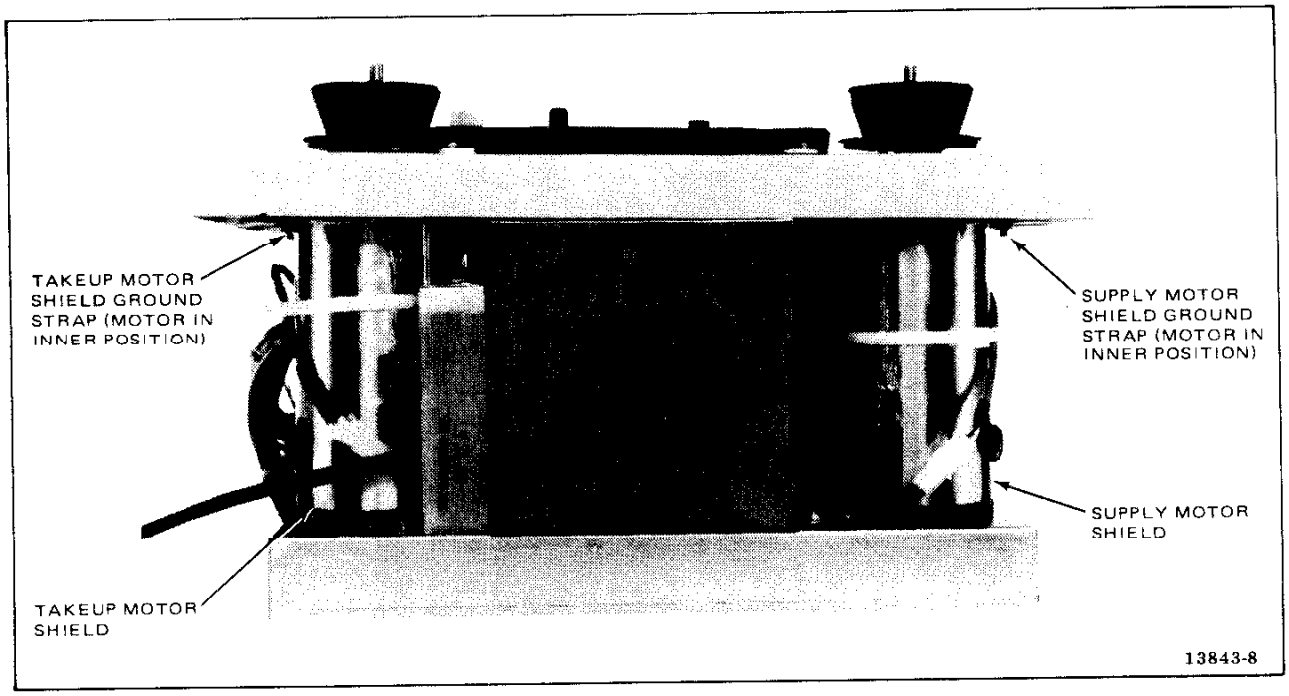


Figure 2-18. Rear View of Transport

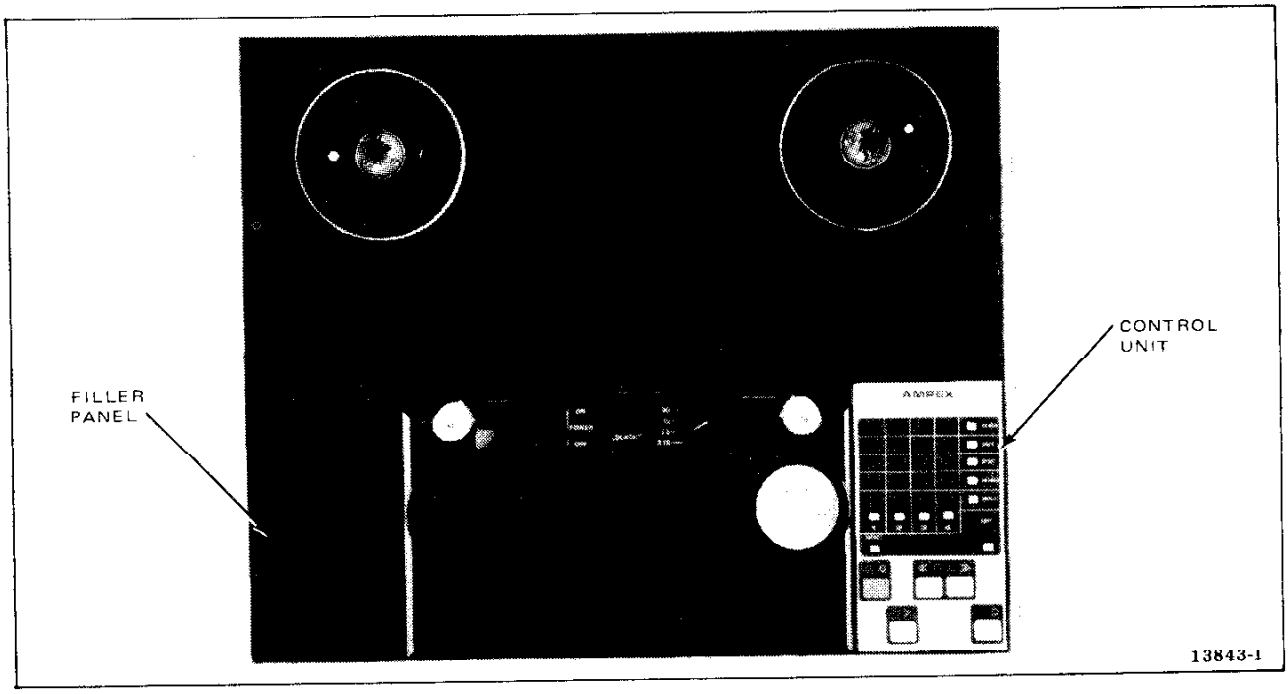


Figure 2-19. Tape Transport

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.

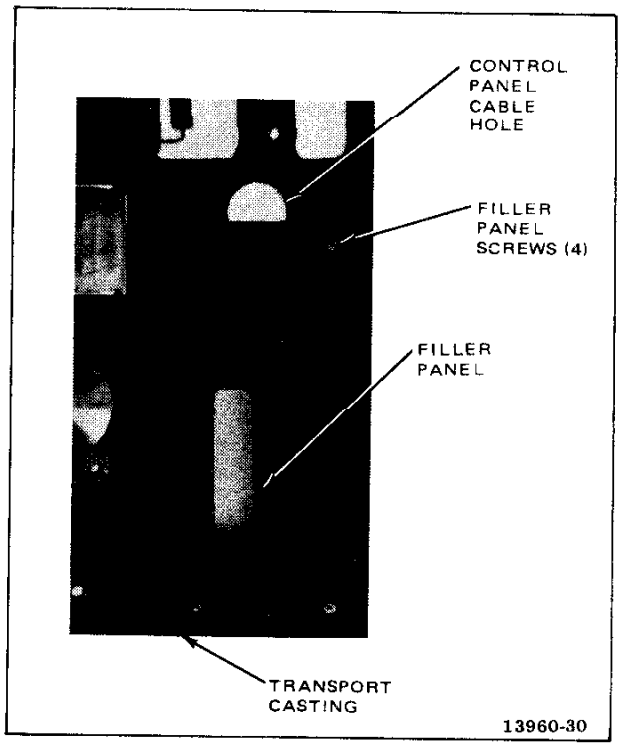


Figure 2-20. Rear View of Filler Panel (Transport Components Removed for Clarity)

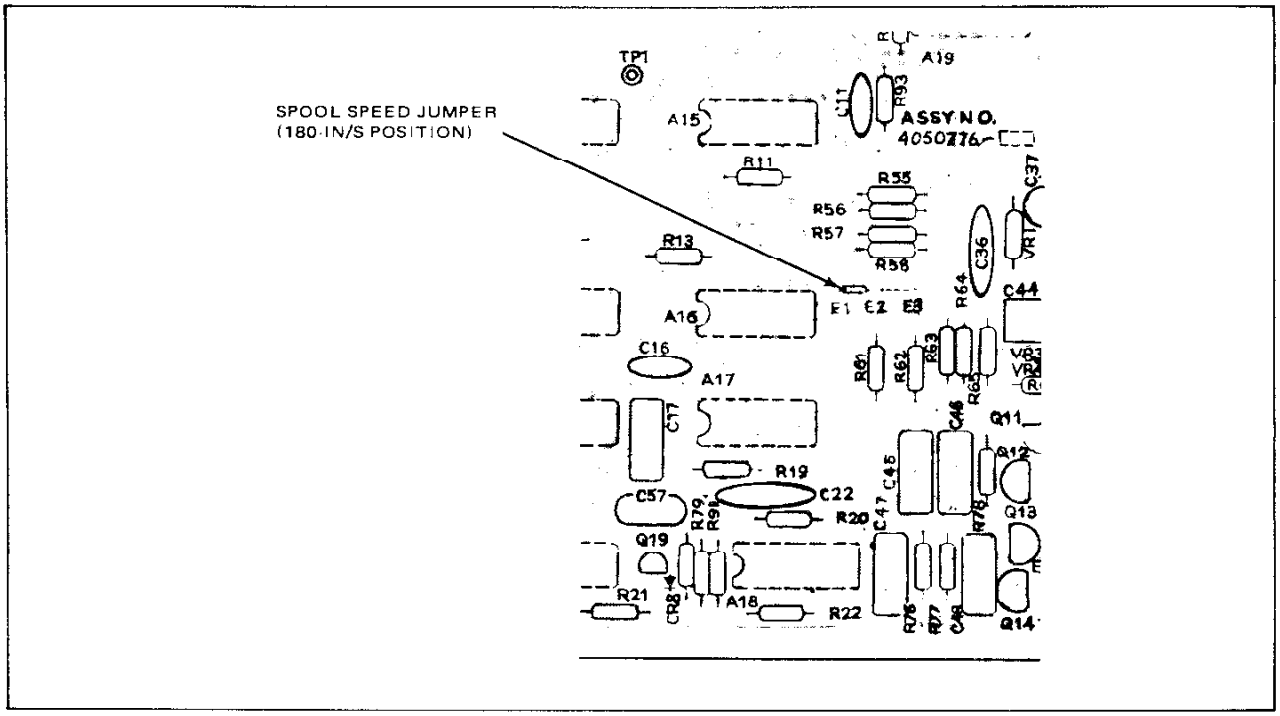


Figure 2-21. Spool Speed Jumper, Capstan Servo PWA No. 8

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 $\overline{\text{REC}}$ 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	E4 to E10
E2 to E8	E5 to E11
E3 to E9	

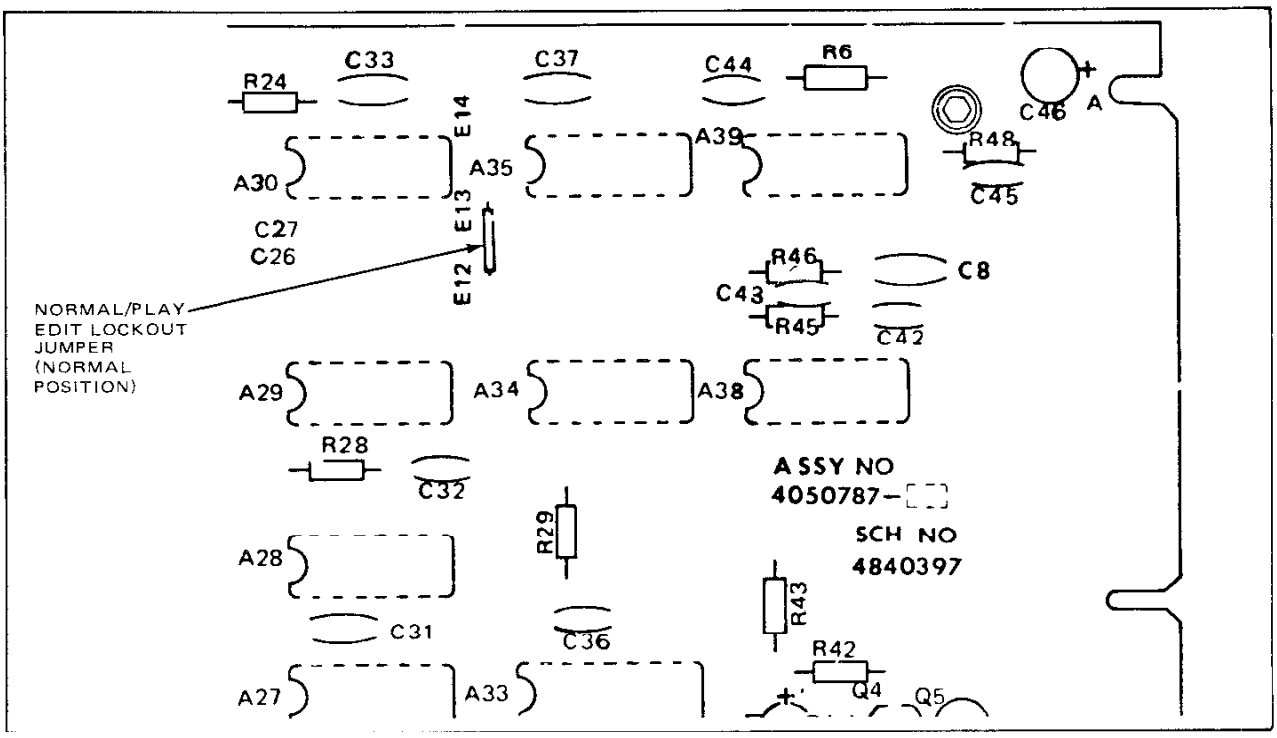


Figure 2-22. Normal/Play Edit-Lockout Jumper, Transport Control PWA No. 7

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	

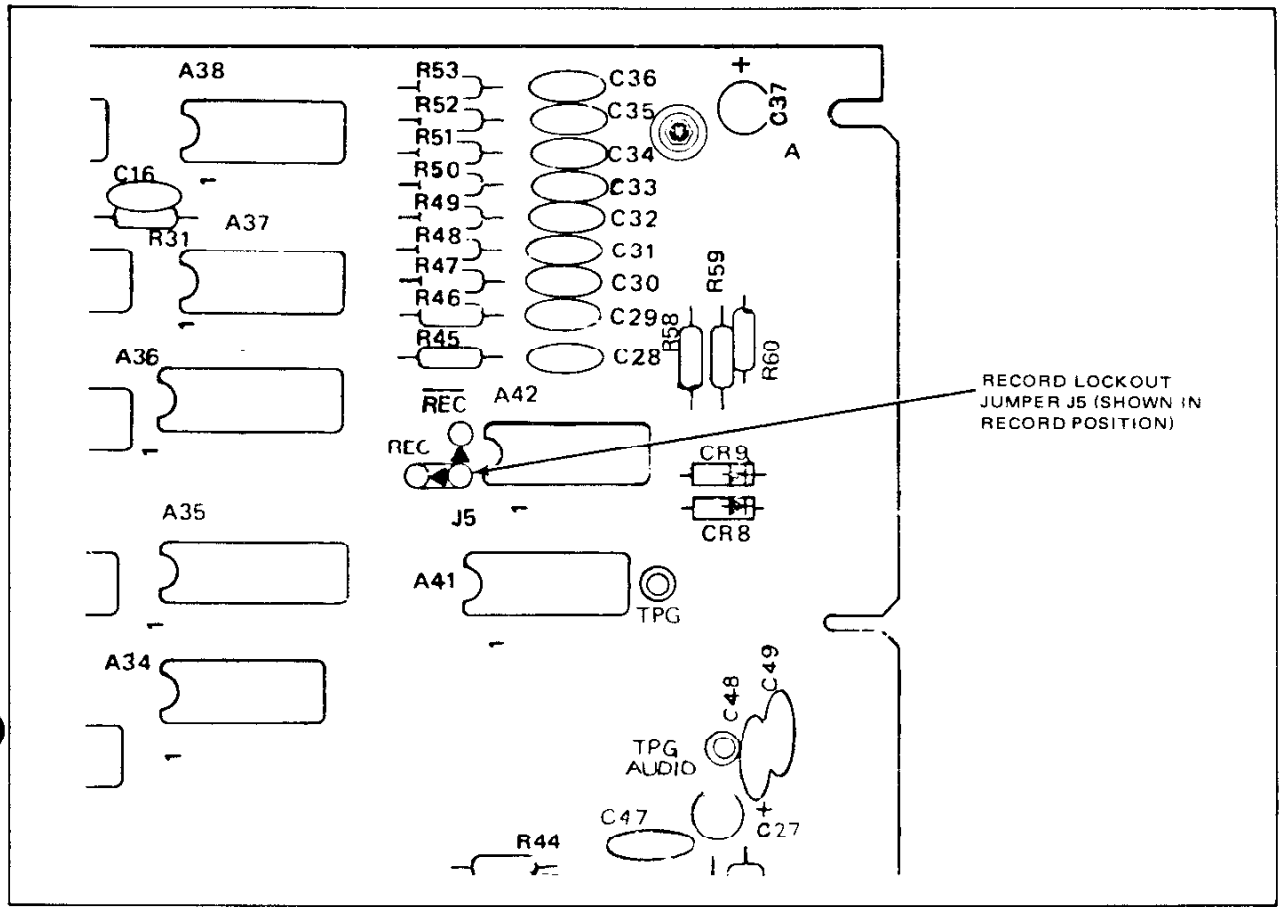


Figure 2-23. Record Lockout Jumper J5, Audio Control PWA No. 5

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.

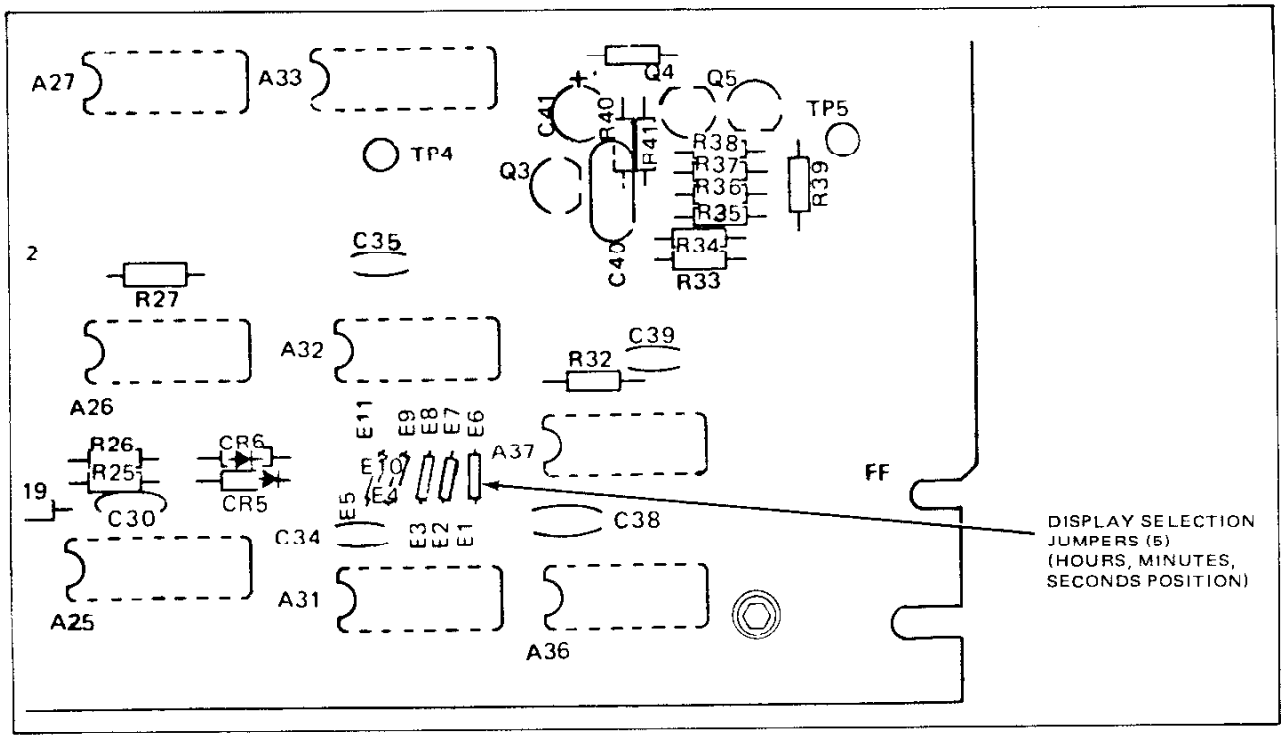


Figure 2-24. Tape Timer Display Selection Jumpers, Transport Control PWA No. 7

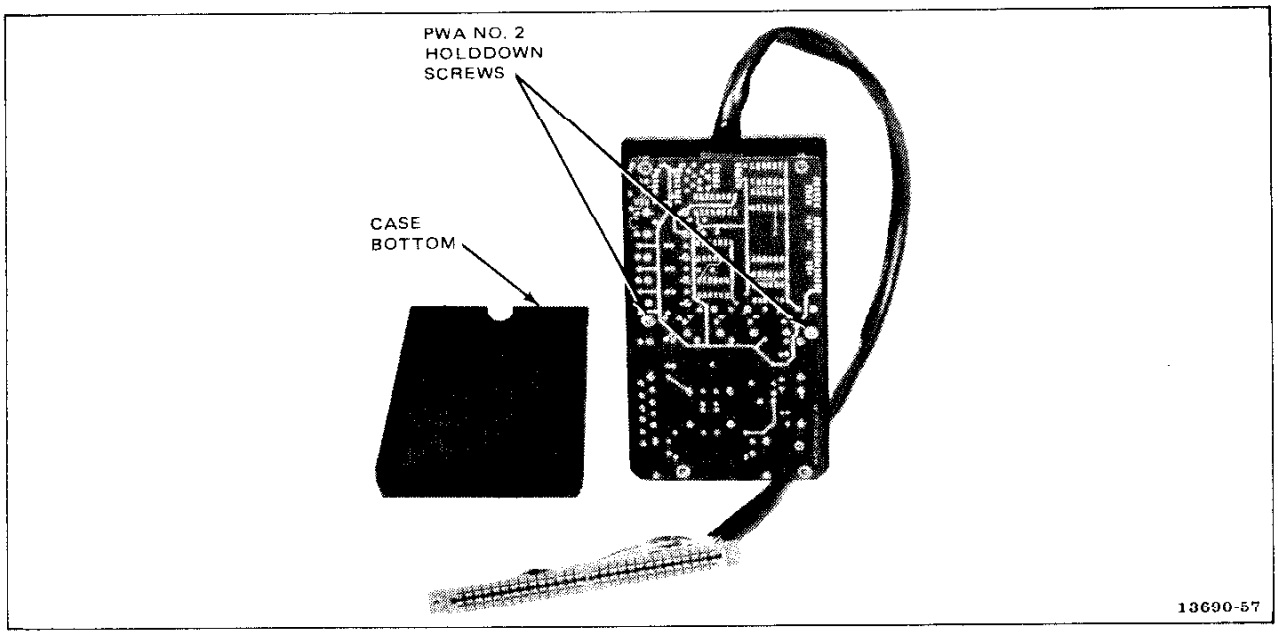


Figure 2-25. Control Unit, Case Bottom Removed

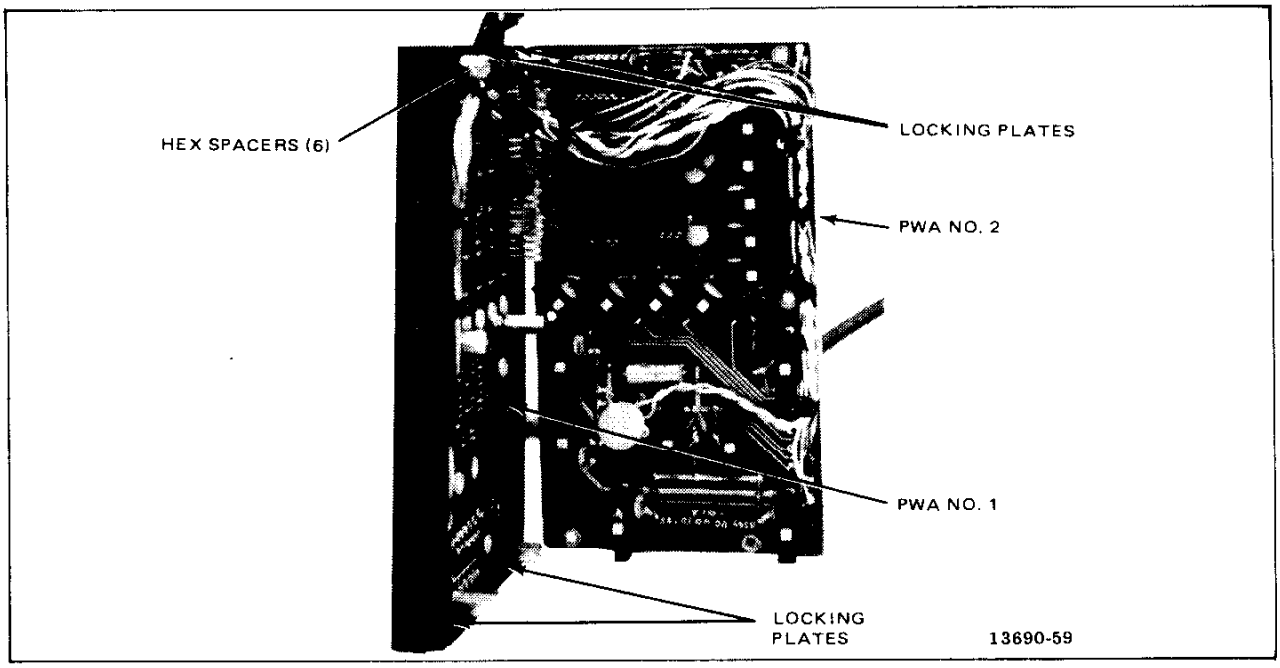


Figure 2-26. Inside View of Control Unit

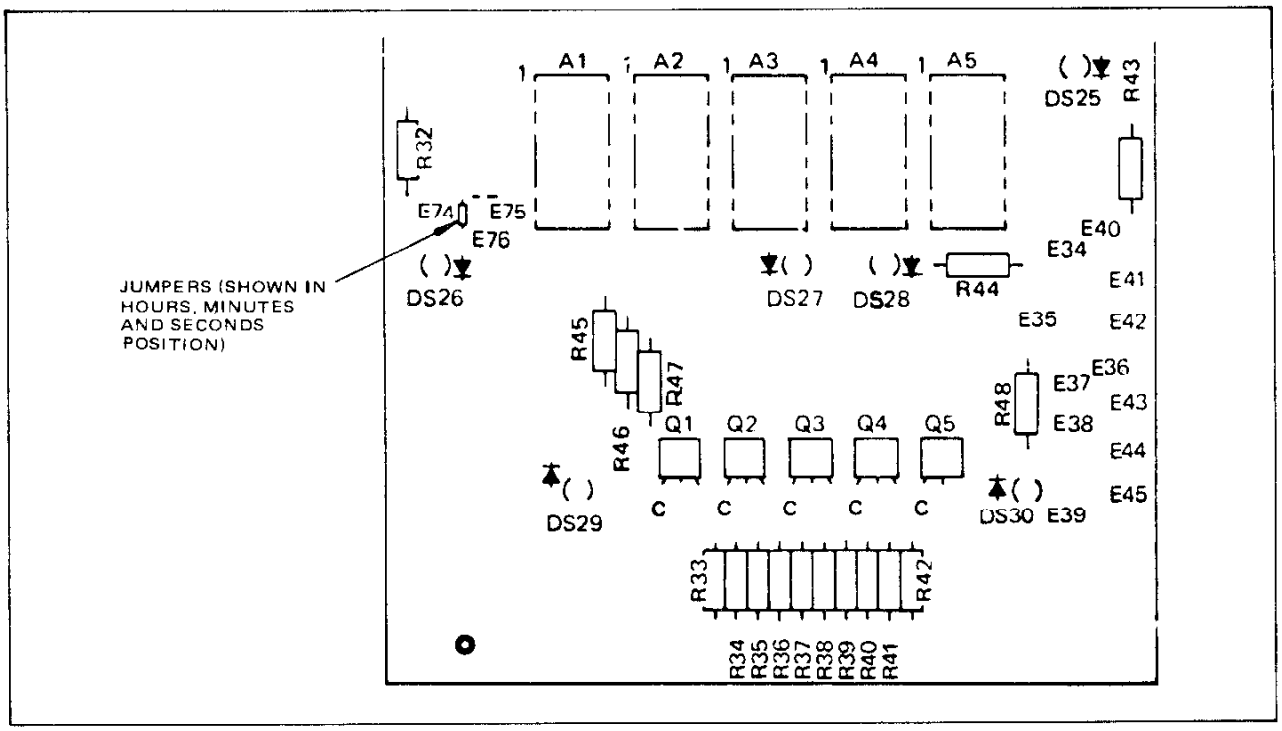


Figure 2-27. Tape Timer Display Selection Jumper, Control Unit PWA No. 1

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.

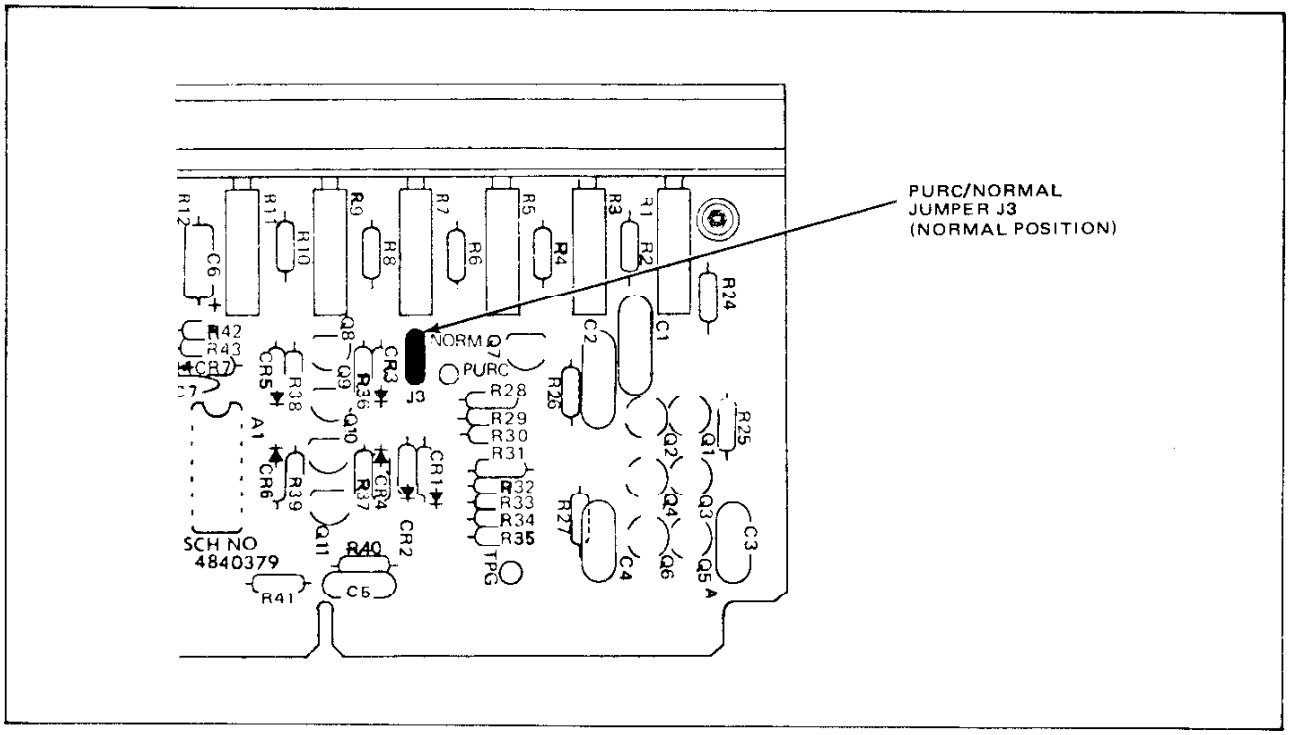


Figure 2-28. PURC Jumper, PADNET PWA

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 push button 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 preoperational 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.

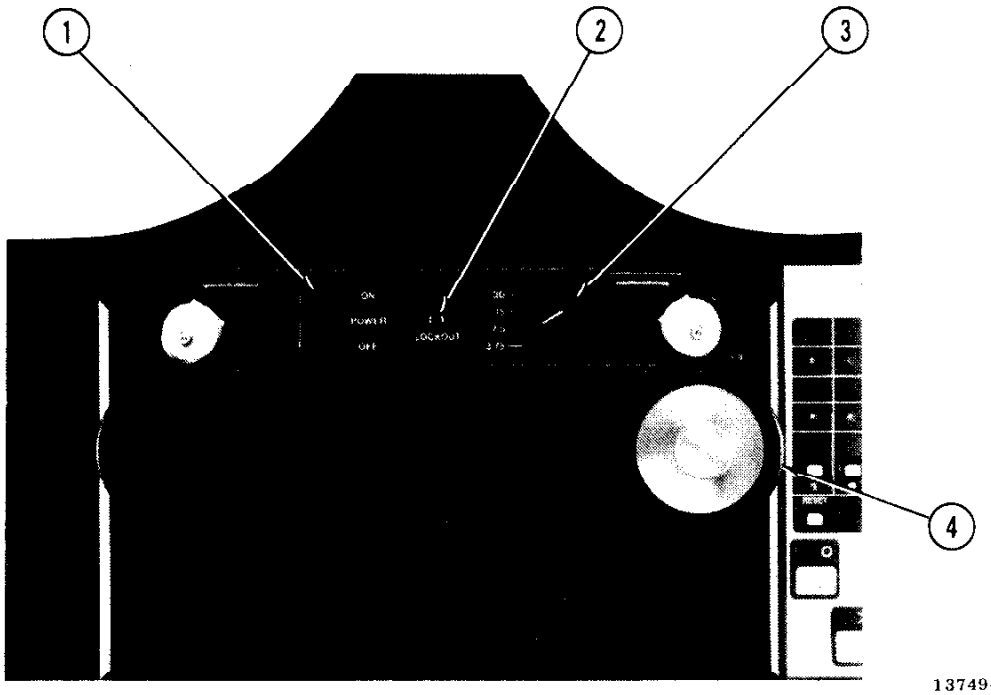
CAUTION

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.)

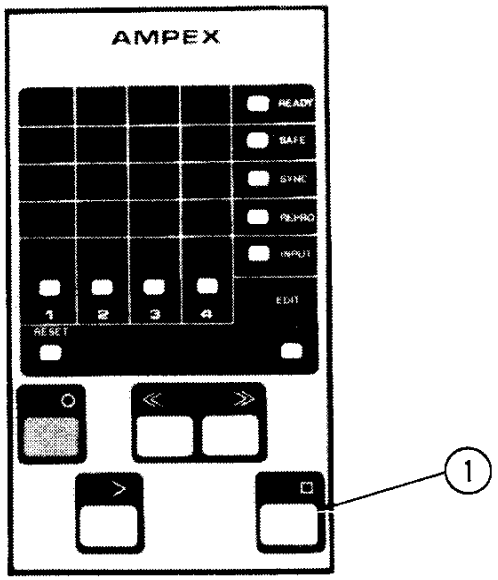
9. Release head shield by pressing shield downward.

Table 3-1. Tape Transport Controls and Indicators



INDEX NO.	NAME	FUNCTION
1	POWER swtich	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



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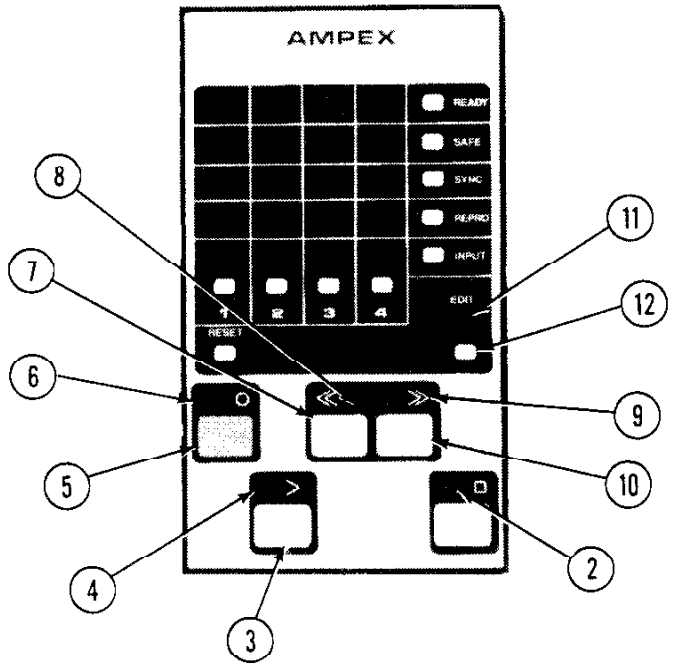
INDEX NO.	NAME	FUNCTION
1	Stop pushbutton switch	Used to initiate the following functions: *Thread.* After tape is manually threaded on the transport and tape slack removed, either reel is quickly turned by hand to apply tension to the tension arms while the stop pushbutton is simultaneously pressed. 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. *Stop.* 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. *Stop Record.* Also used to stop recording without stopping transport if record pushbutton (index no. 5) is held pressed while stop pushbutton is momentarily pressed. *Momentary Record.* 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.

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

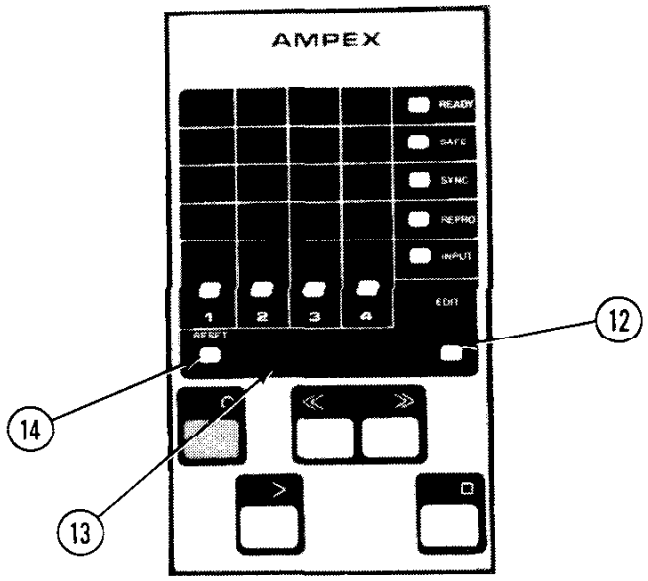


INDEX NO.	NAME	FUNCTION
2	Stop indicator (yellow)	Lights when ac power is first applied and when stop mode is active.
3	▷ Play pushbutton switch	Used to select play mode or used simultaneously with record pushbutton (index no. 5) to select record mode. Pressing the play pushbutton during fast forward or rewind mode causes recorder to enter play mode. Also used to initiate one of the following modes: *Momentary record.* Used to select momentary record mode (see index no. 1). *Spooling.* Simultaneously pressing play pushbutton and a fast forward or rewind pushbutton (index no. 7 or 10) causes transport to enter spool mode.
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: *Stop/Edit:* If tape is stopped, pressing EDIT disengages reel servos for tape threading, editing, or manual tape movement. *Play/Edit:* If play or record mode is active, pressing EDIT pushbotton 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)



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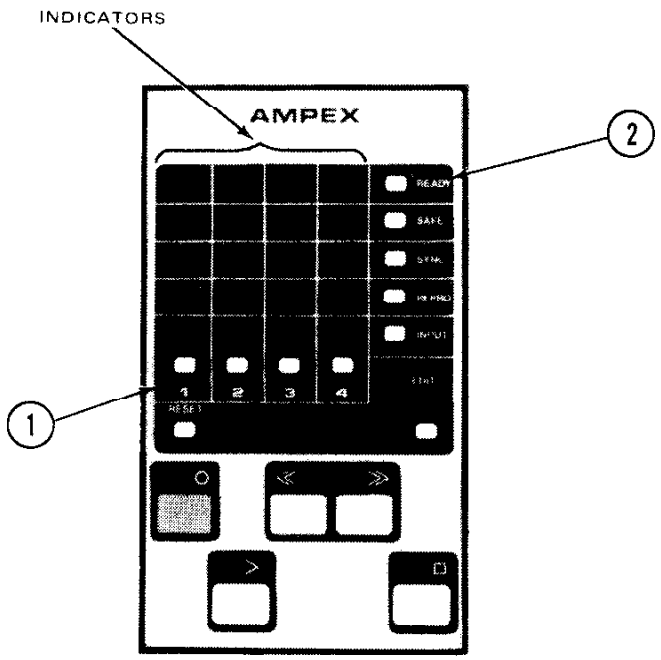
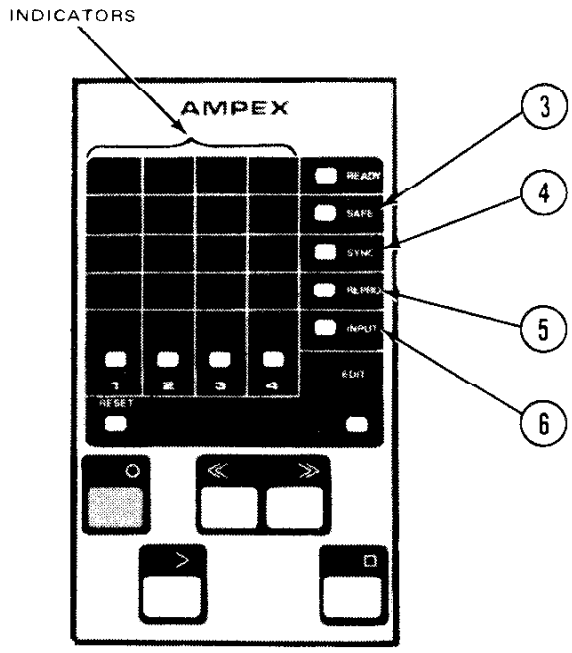
INDEX NO.	NAME	FUNCTION
12 (Continued)		*Shuttle/Edit:* If fast forward, rewind, or a spool mode is active, pressing EDIT pushbutton will cause tape lifters to retract while pushbutton is held pressed.
13	Tape Timer display	When power in on, the display shows in hours, minutes, and seconds (or minutes, 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



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	Used in conjunction with channel select pushbutton switch (index no. 1 of this table). In ready, channel is enabled for entering record mode. 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. 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.

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



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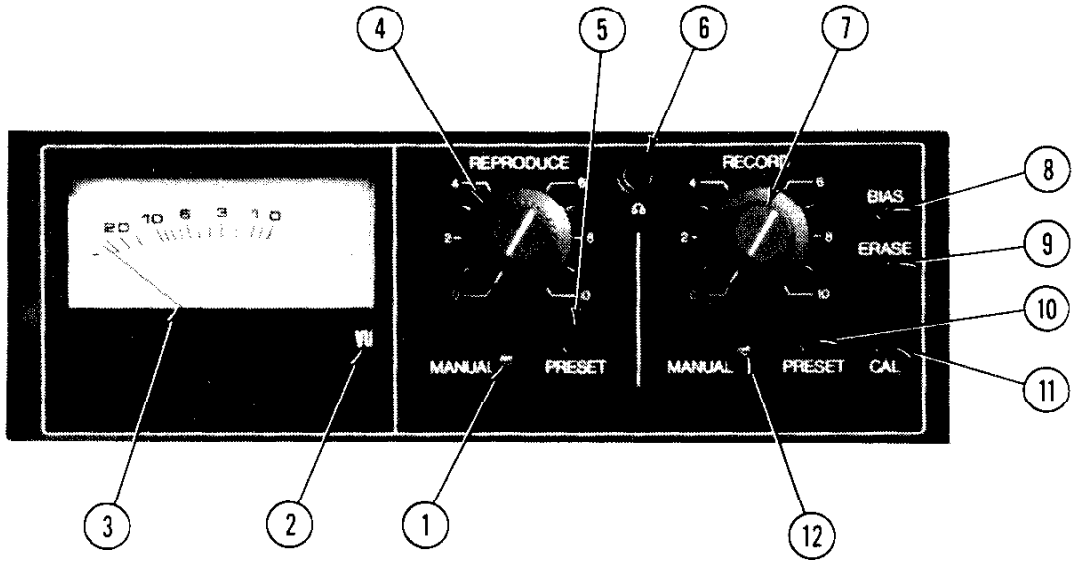
INDEX NO.	NAME	FUNCTION
3	SAFE pushbutton switch and Safe Channel 1 – 4 indicators (green)	Used in conjunction with channel select pushbutton switch (index no. 1). In safe, channel is prevented from entering record mode. Safe indicator(s) light when power is initially applied or when SAFE pushbutton and corresponding channel select pushbutton switch (index no. 1) are simultaneously pressed. When lit, recording on channel indicated is inhibited. 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.
4	SYNC pushbutton switch and Sync Monitoring Channel 1 – 4 indicators (yellow)	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.

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)	Used in conjunction with channel select pushbutton switch (index no no. 1). In repro, signal being reproduced by reproduce head is connected to audio output. 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.
6	INPUT pushbutton switch and Input Monitoring Channel 1 – 4 indicators (yellow)	Used in conjunction with channel select pushbutton switch (index no. 1). Input signal to recorder is connected to audio output. 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). Indicator also lights if record mode is entered while in sync mode.

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



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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.

3-4. Recording

Proceed as follows:

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

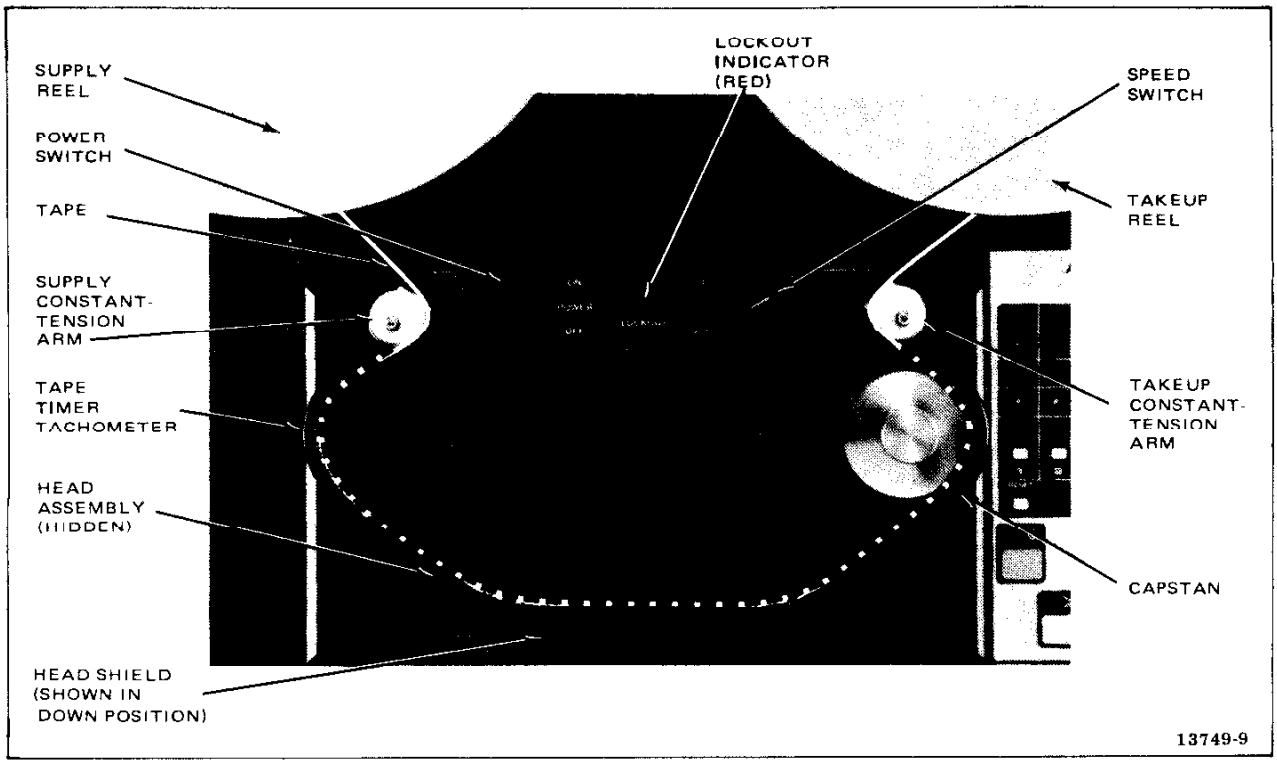


Figure 3-1. Tape Threading Path

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

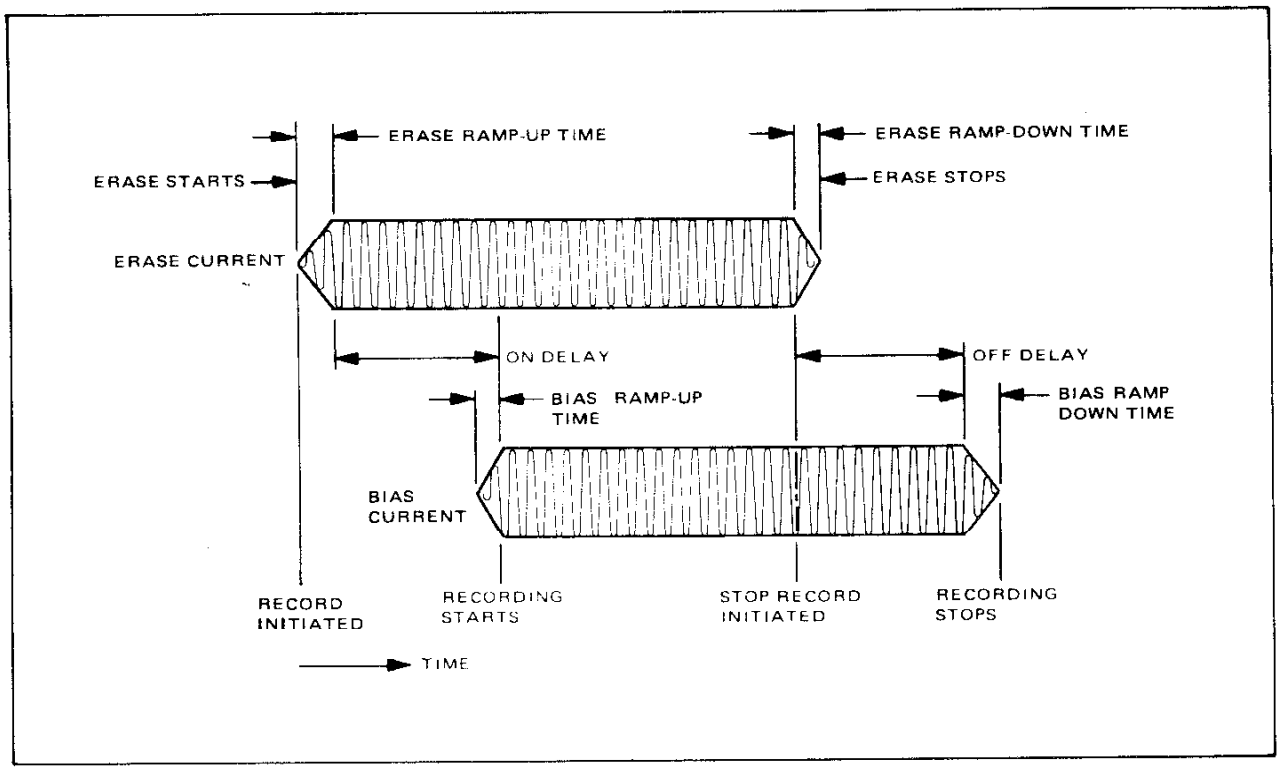


Figure 3-2. PURC On/Off Timing Relationships

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.

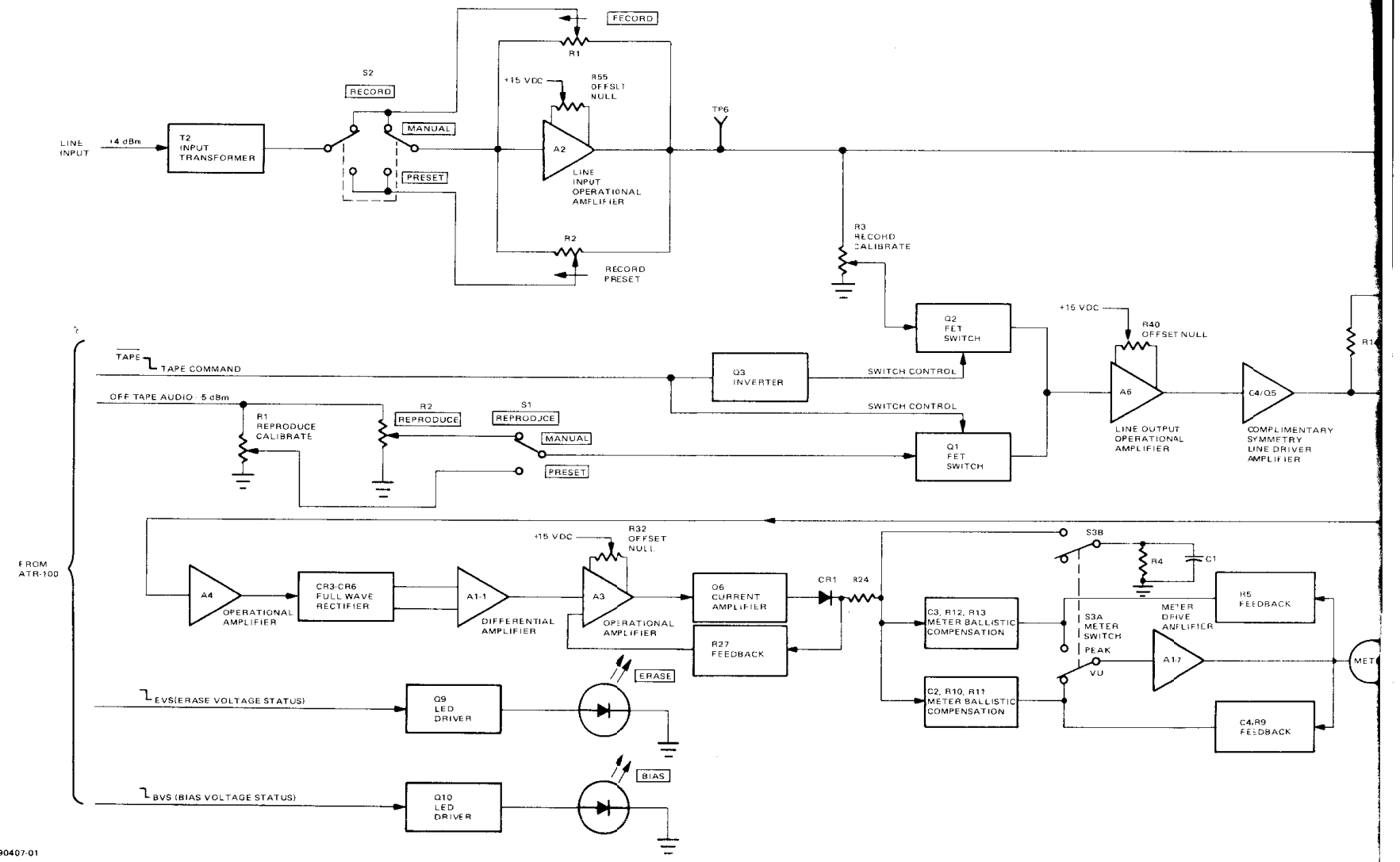
The actual value of tape tension is controlled by the tension arm rotary solenoids which are a component of the constant-tension arms. The solenoids are driven by direct current to result in a particular torque at the mid-position of the arm swing. These solenoids apply a near-constant force to the tension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



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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

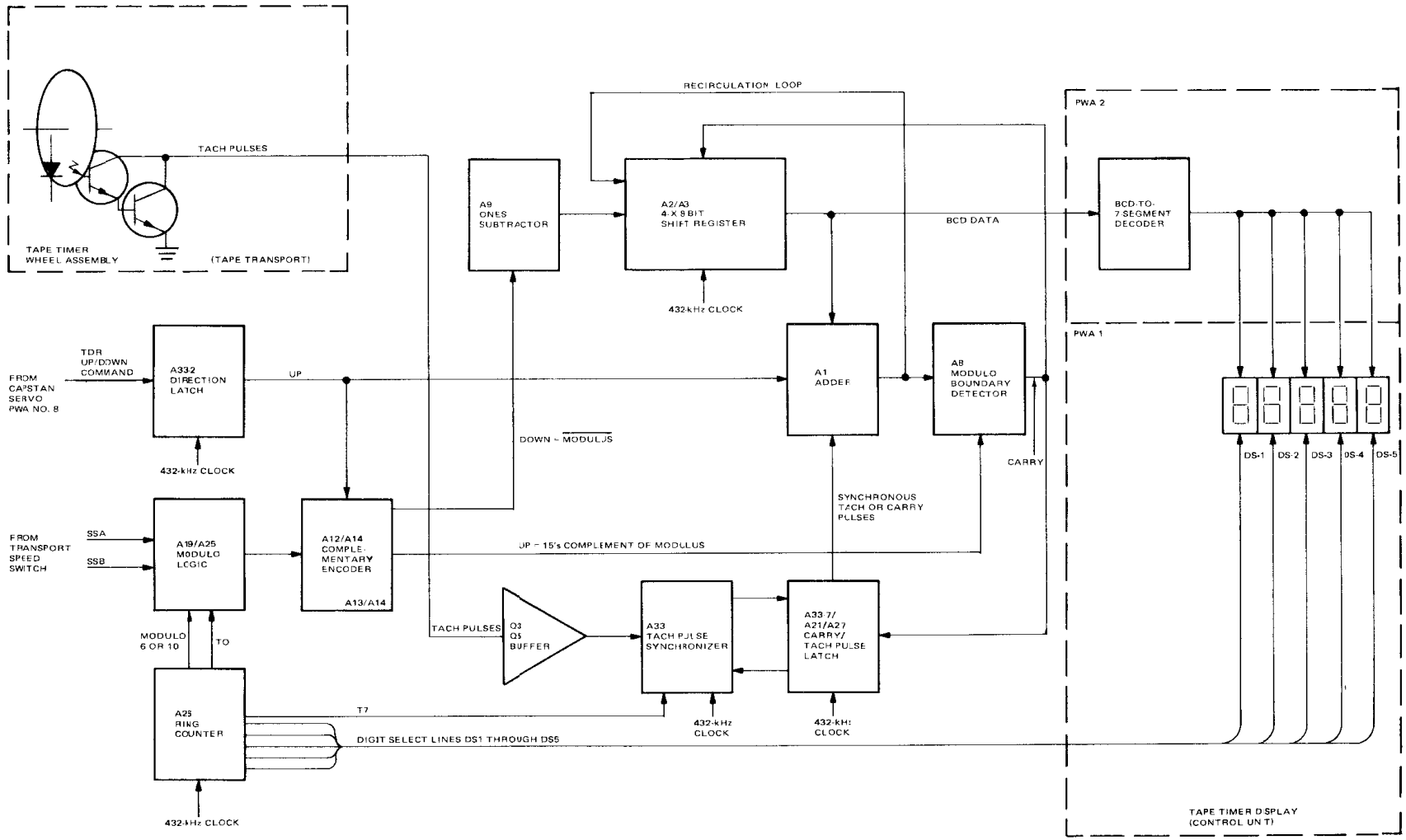


Figure 4-25. Tape Timer, Simplified Block Diagram

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.

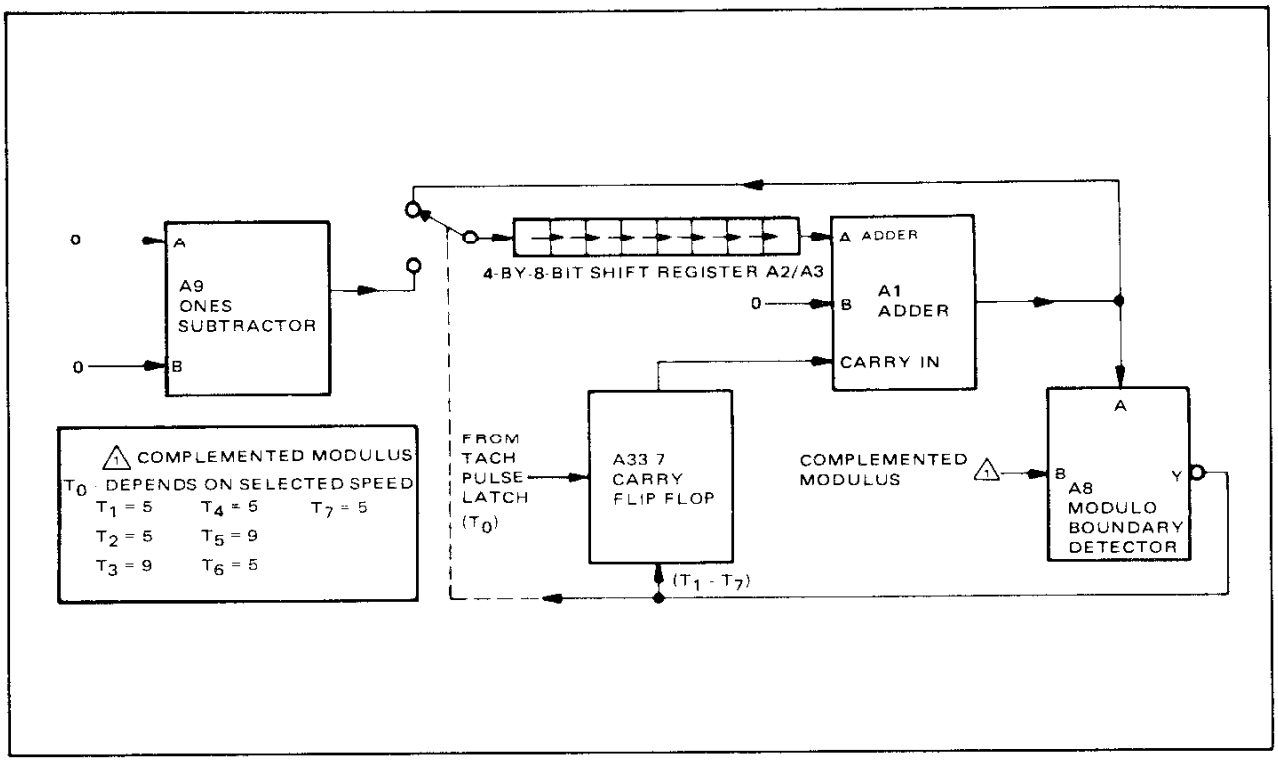


Figure 4-26. Count Up Logic, Simplified Block Diagram

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.

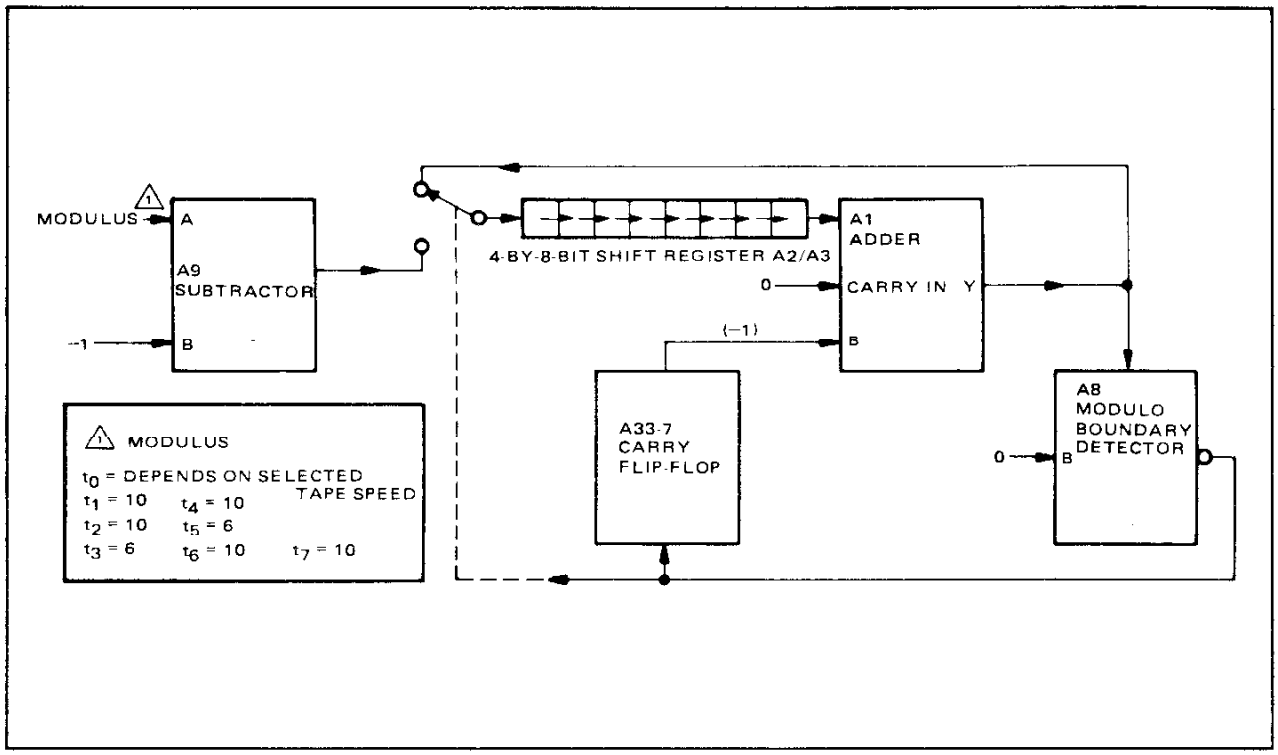


Figure 4-27. Count Down Logic, Simplified Block Diagram

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 modulus 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

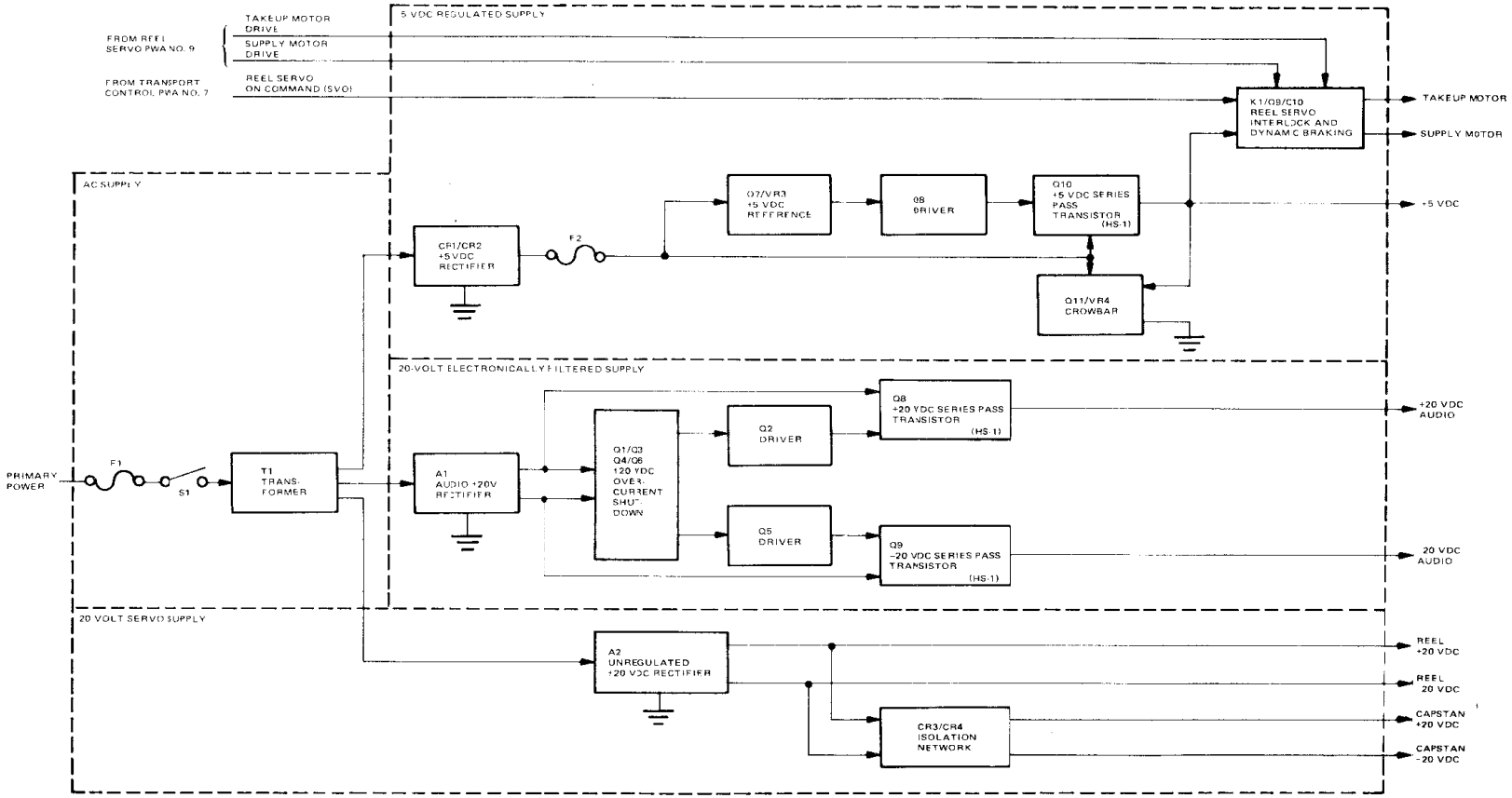


Figure 4-28. Power Supply Assembly, Simplified Block Diagram

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 PADNET 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.

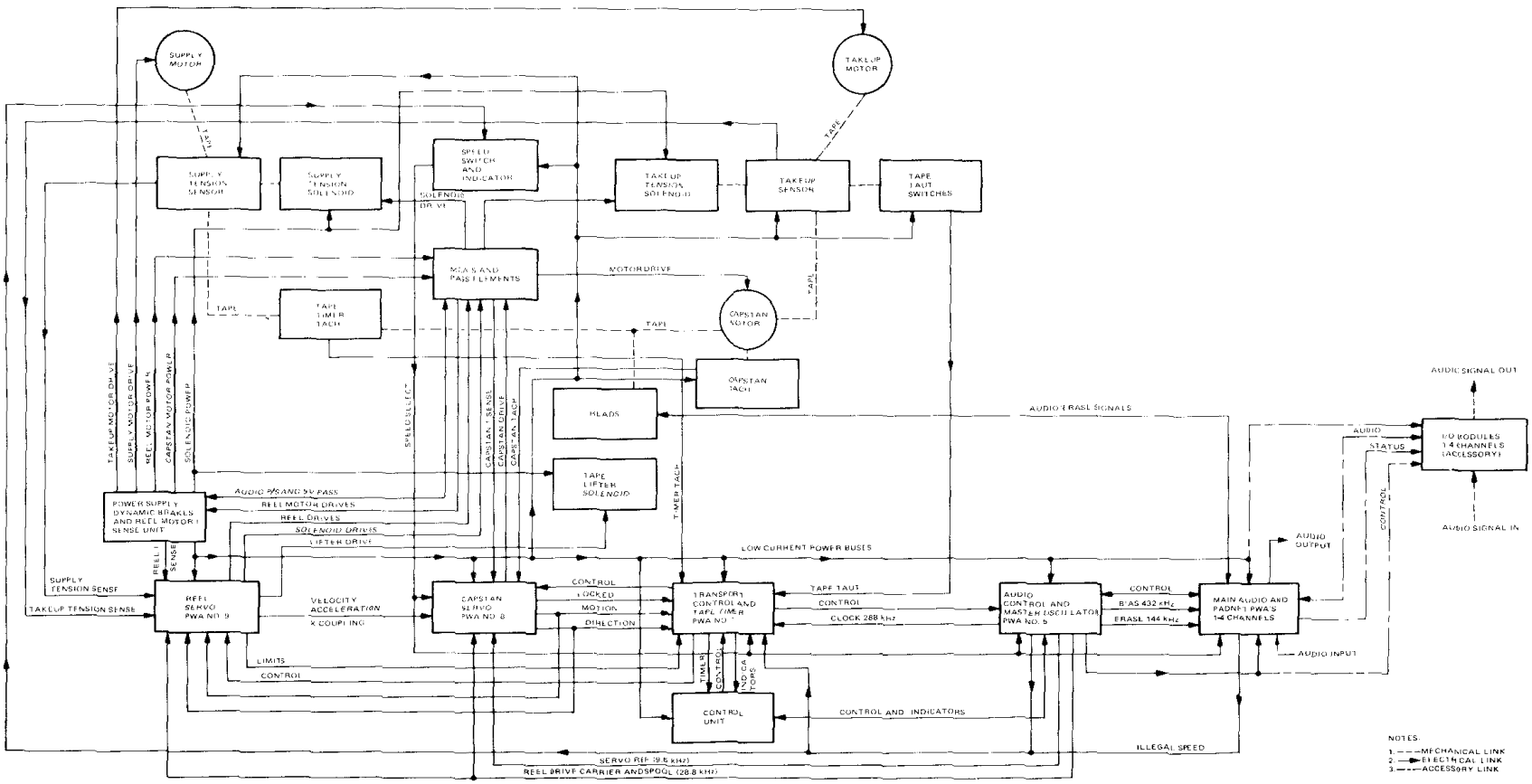


Figure 4-1. ATR-100 System, Simplified Block Diagram

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 ready¬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.

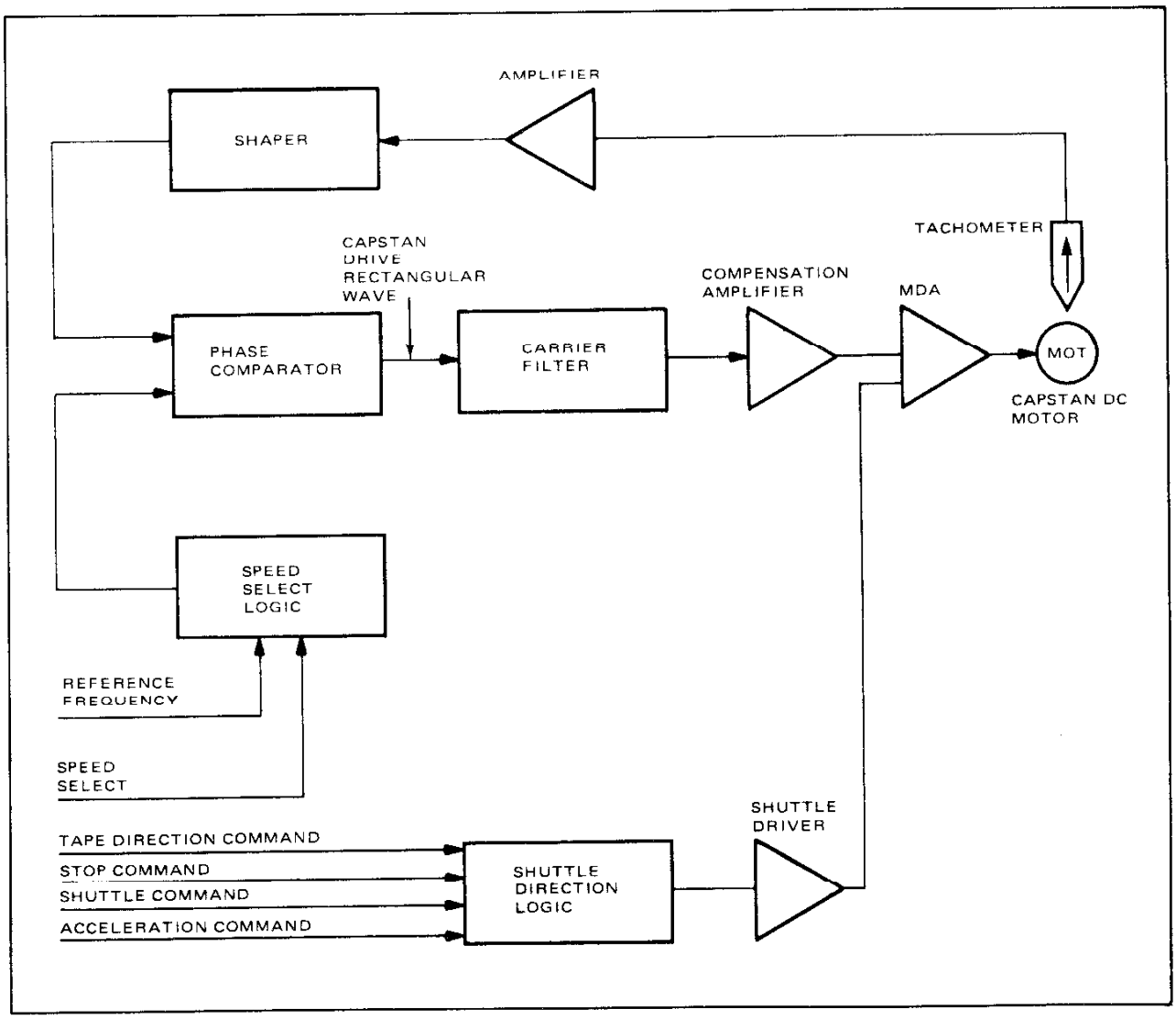
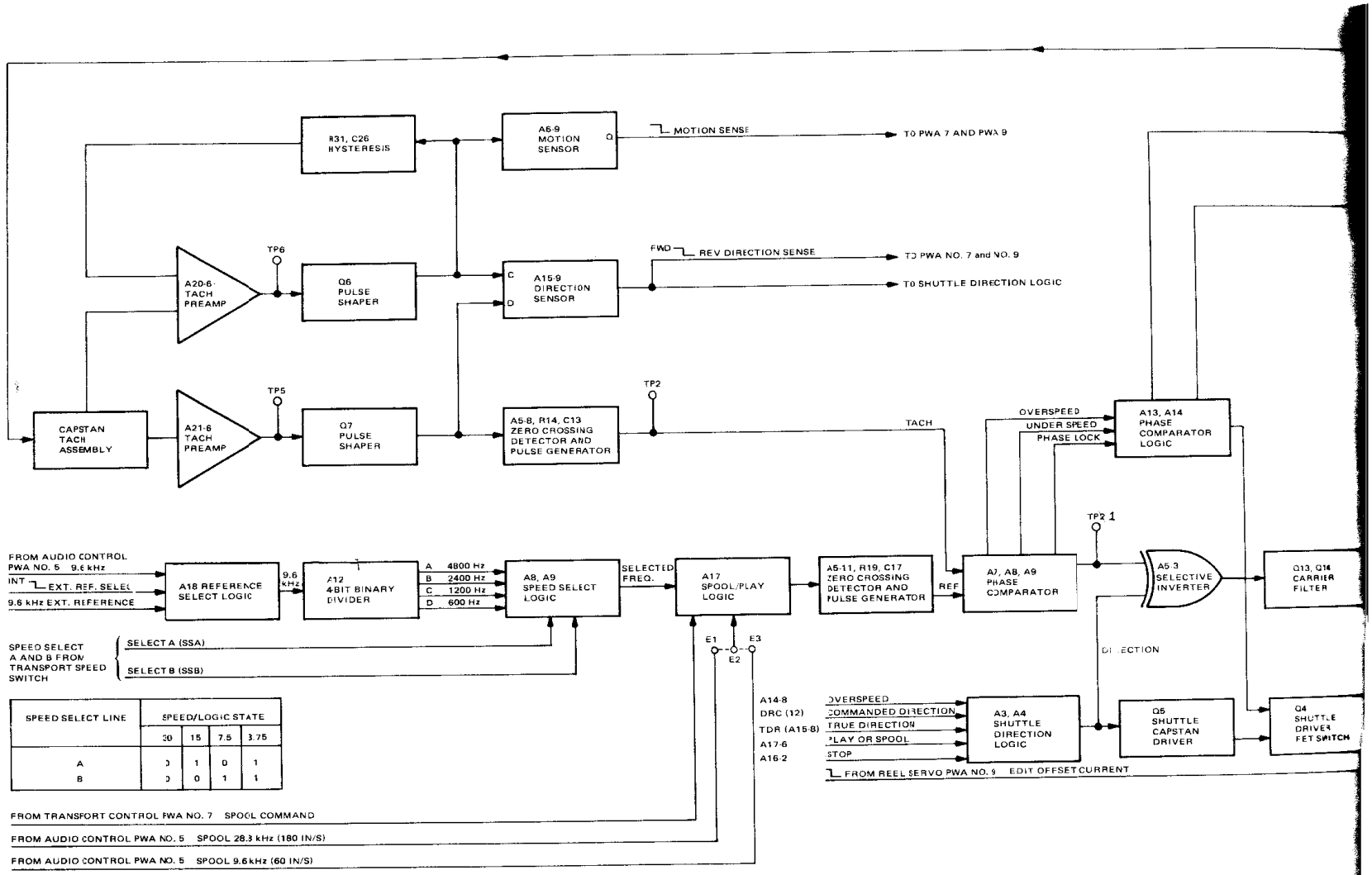


Figure 4-2. Capstan Servo General Simplified Block Diagram



SPEED SELECT LINE	SPEED/LOGIC STATE			
	30	15	7.5	3.75
A	0	1	0	1
B	0	0	1	1

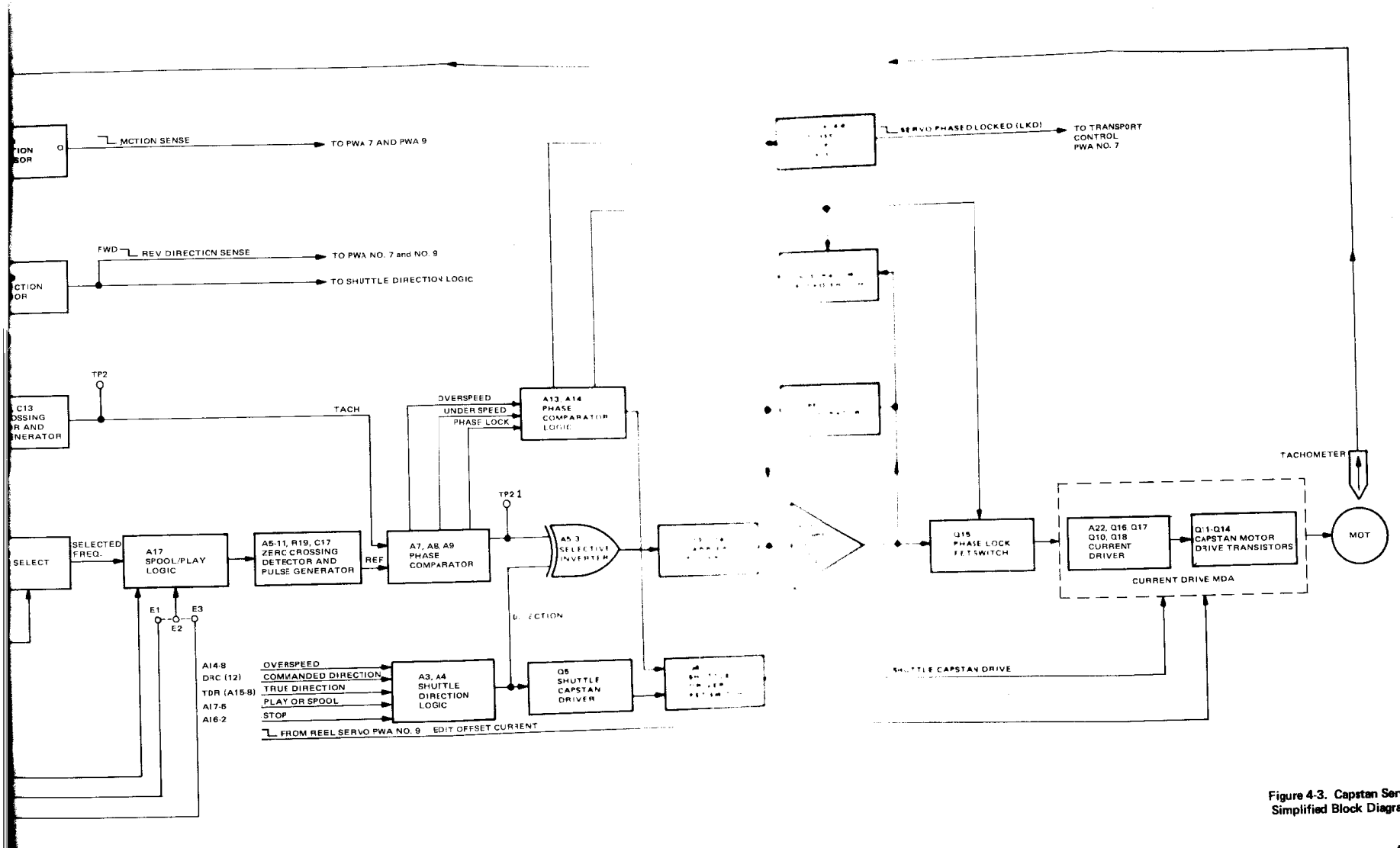


Figure 4-3. Capstan Servo Simplified Block Diagram

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-μs 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

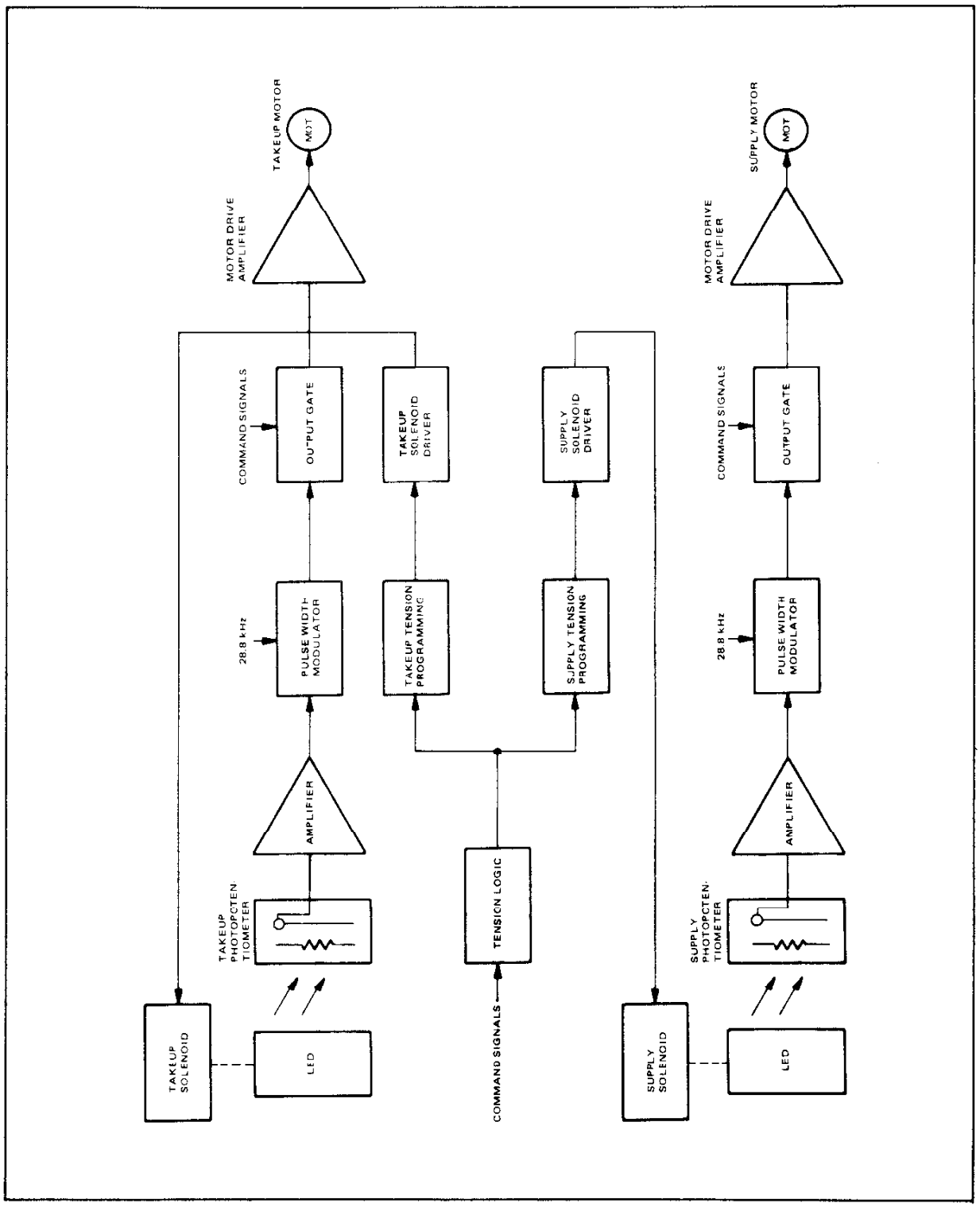


Figure 4-4. Reel Servo General Simplified Block Diagram

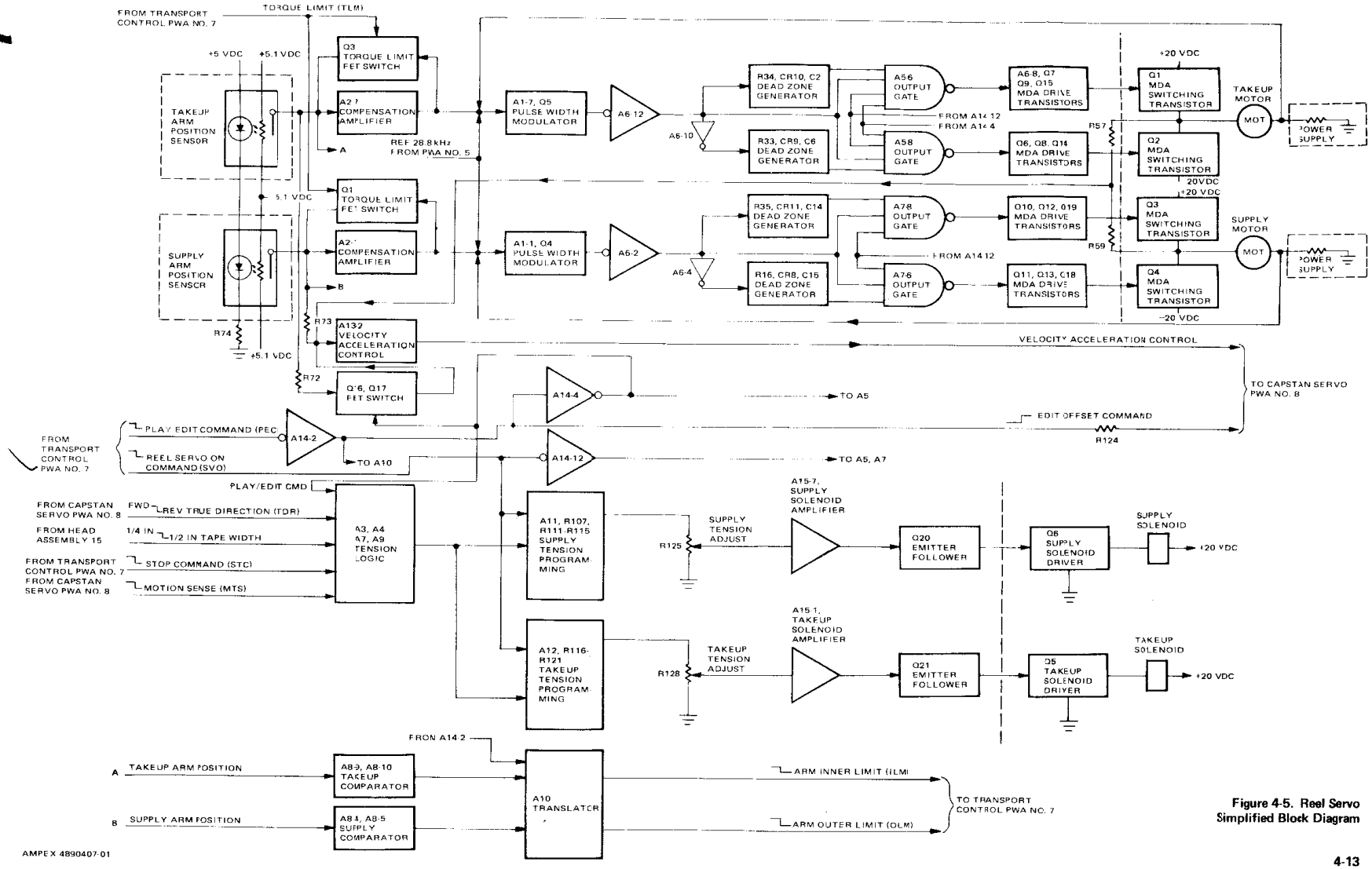


Figure 4-5. Reel Servo Simplified Block Diagram

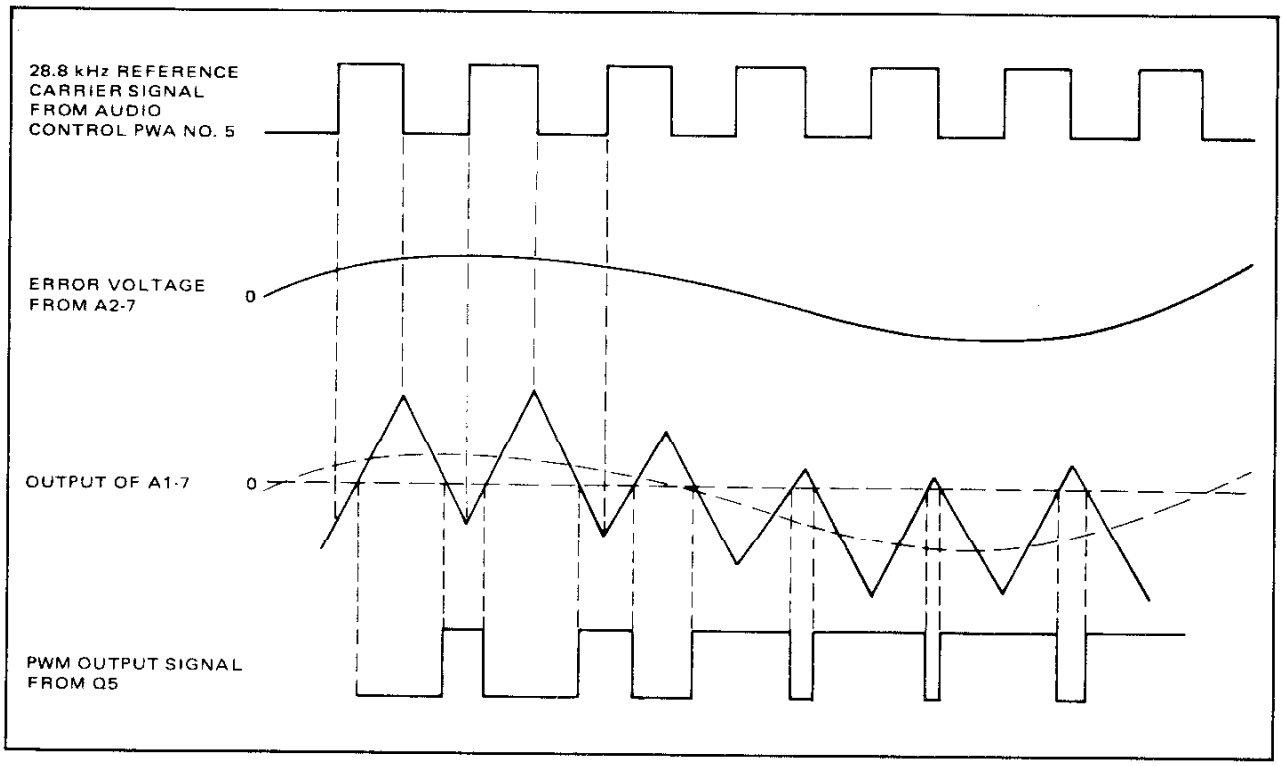


Figure 4-6. Pulse Width Modulator Waveforms, Takeup Reel Servo

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.)

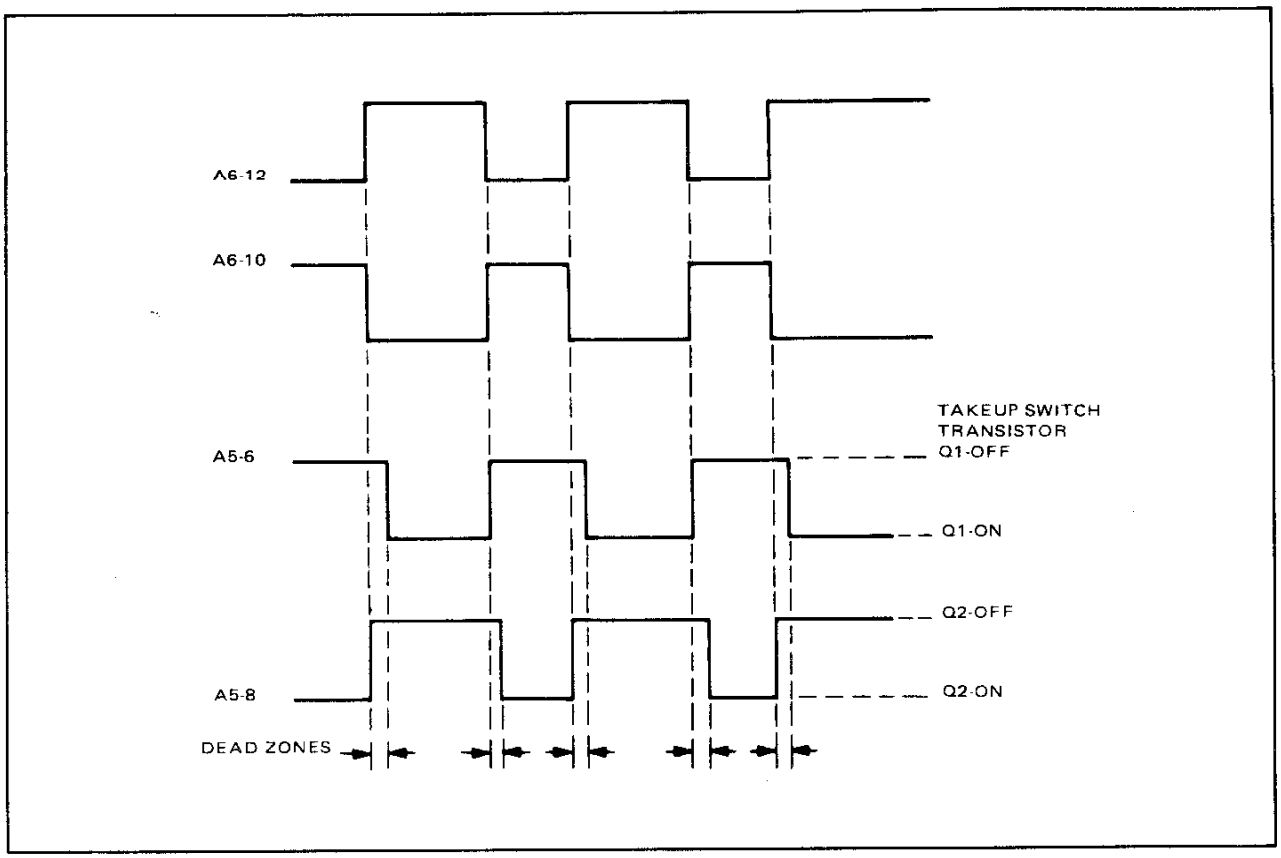


Figure 4-7. Dead Zone Generator Operation and MDA Switch Transistor Conduction State

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

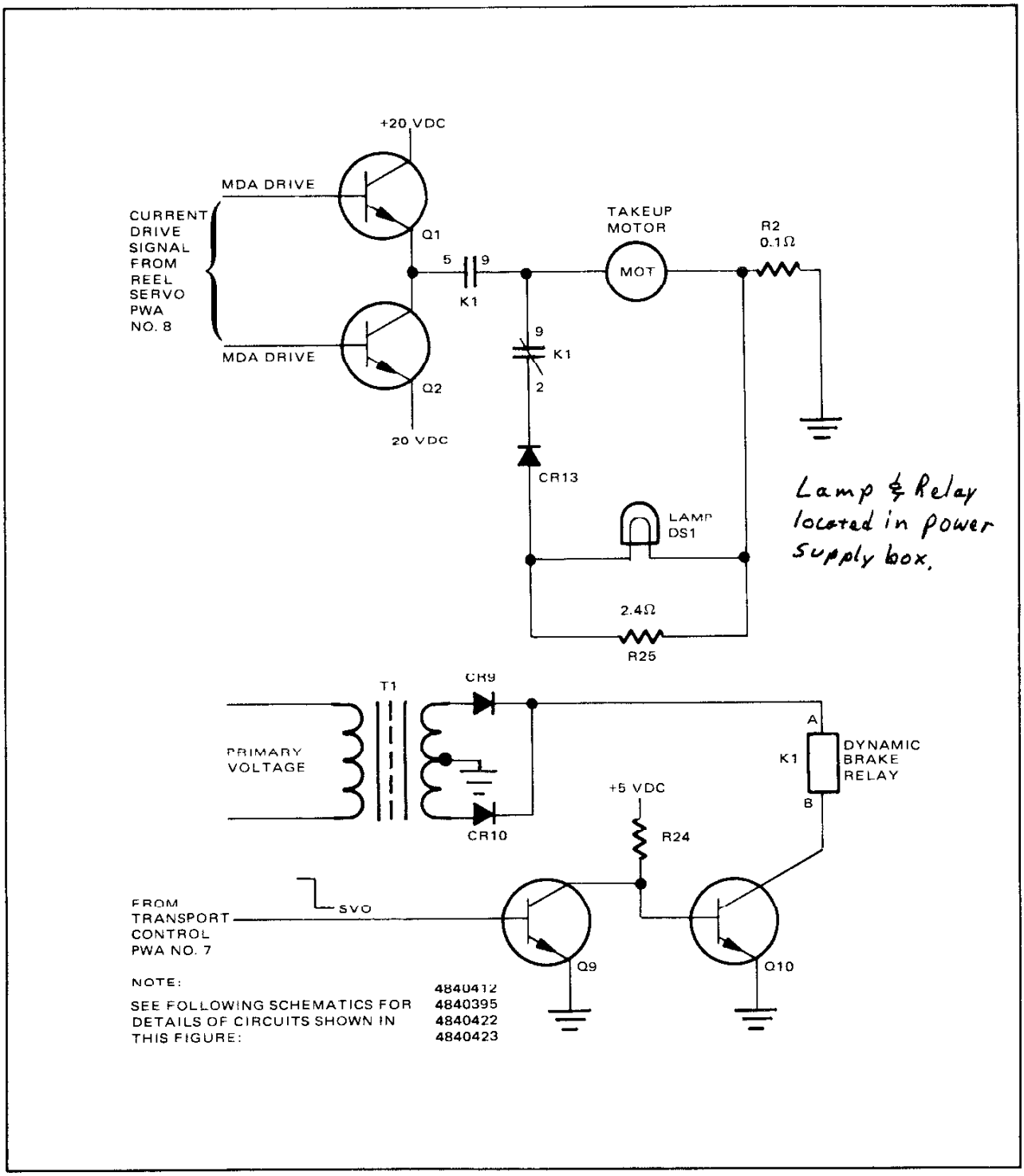


Figure 4-8. Takeup Dynamic Brake, Simplified Schematic

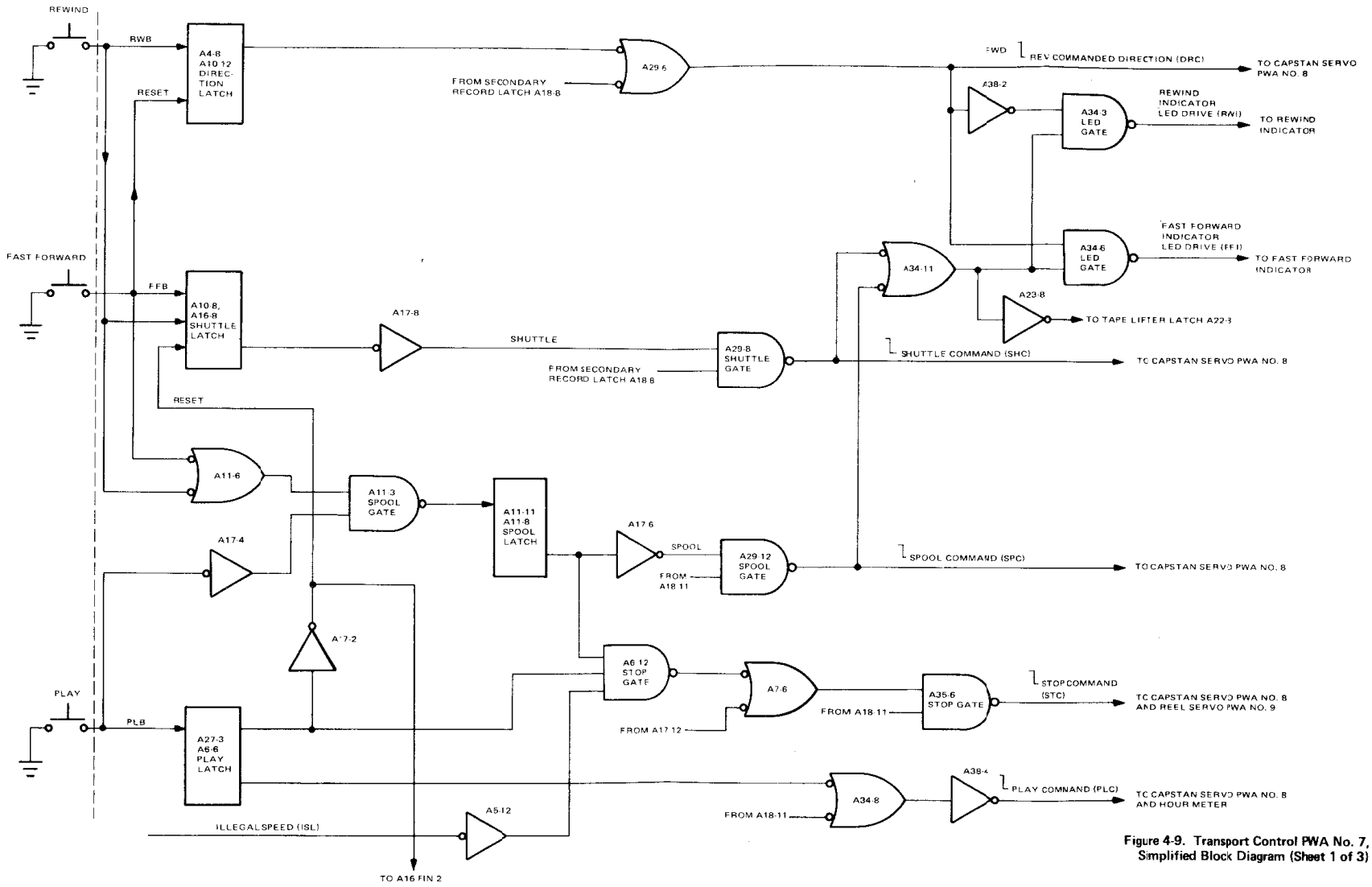


Figure 4-9. Transport Control PWA No. 7, Simplified Block Diagram (Sheet 1 of 3)

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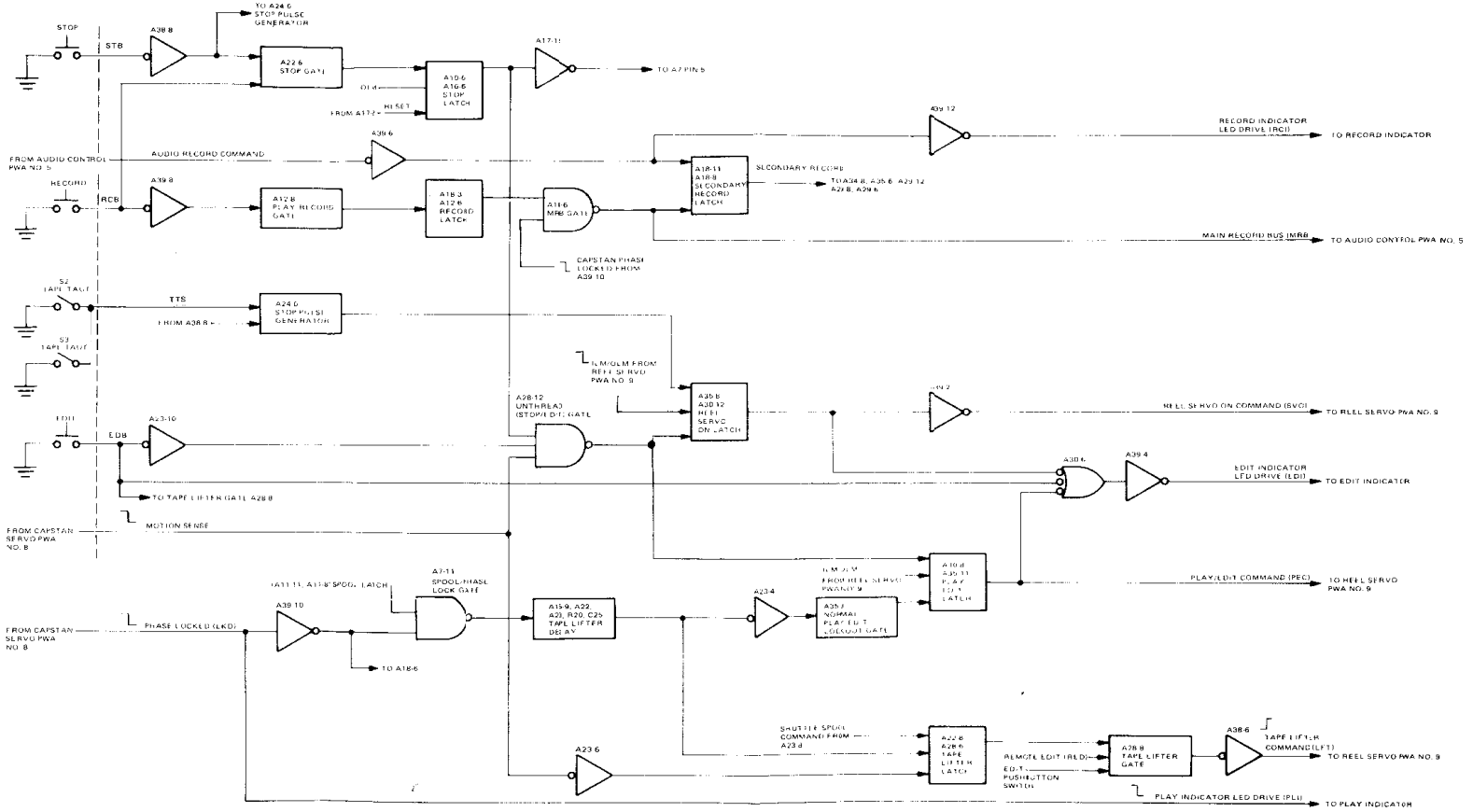

Figure 4-9. Transport Control PWA No. 7, Simplified Block Diagram (Sheet 2 of 3)

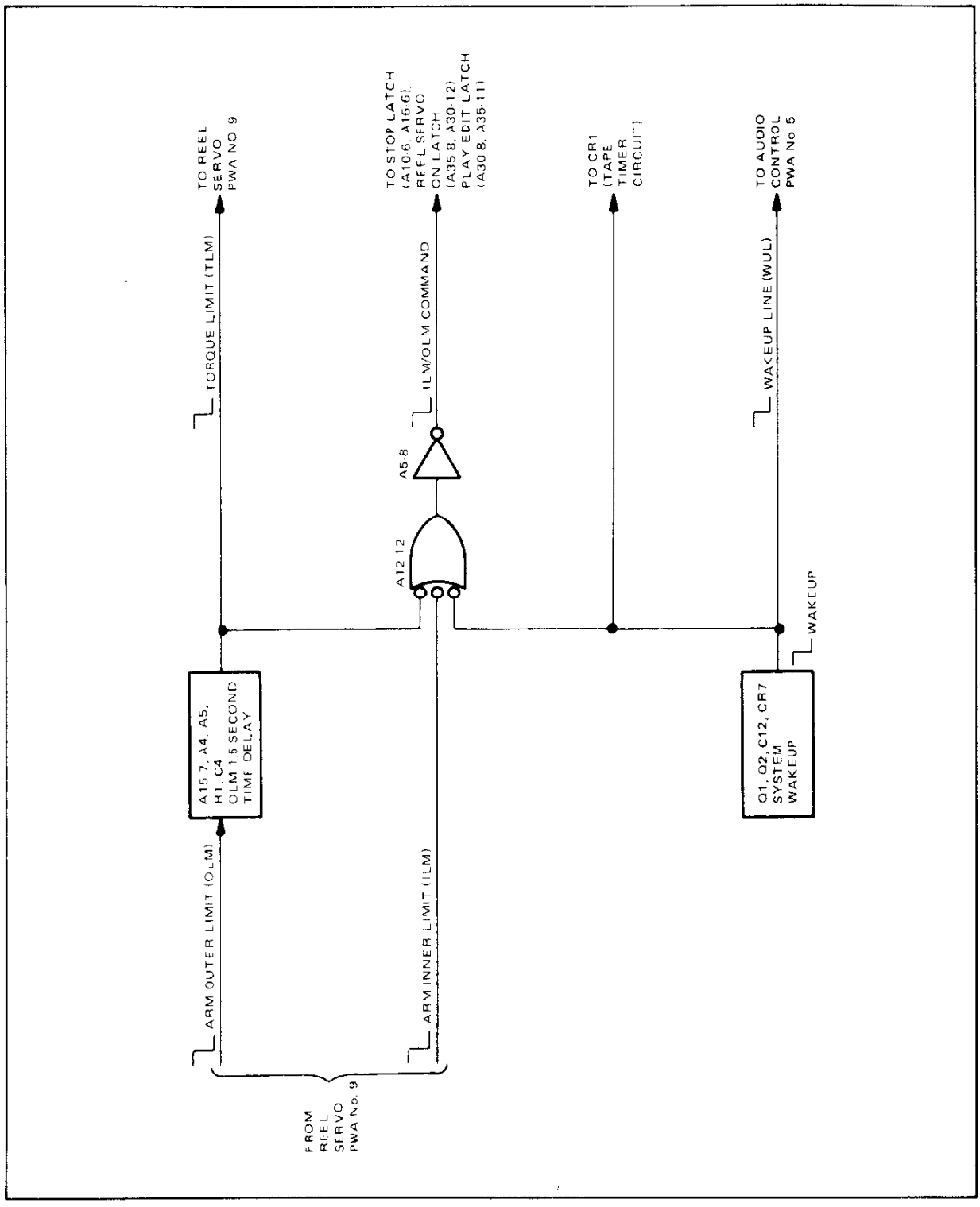

Figure 4-9. Transport Control PWA No. 7, Simplified Block Diagram (Sheet 3 of 3)

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 spilled 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.

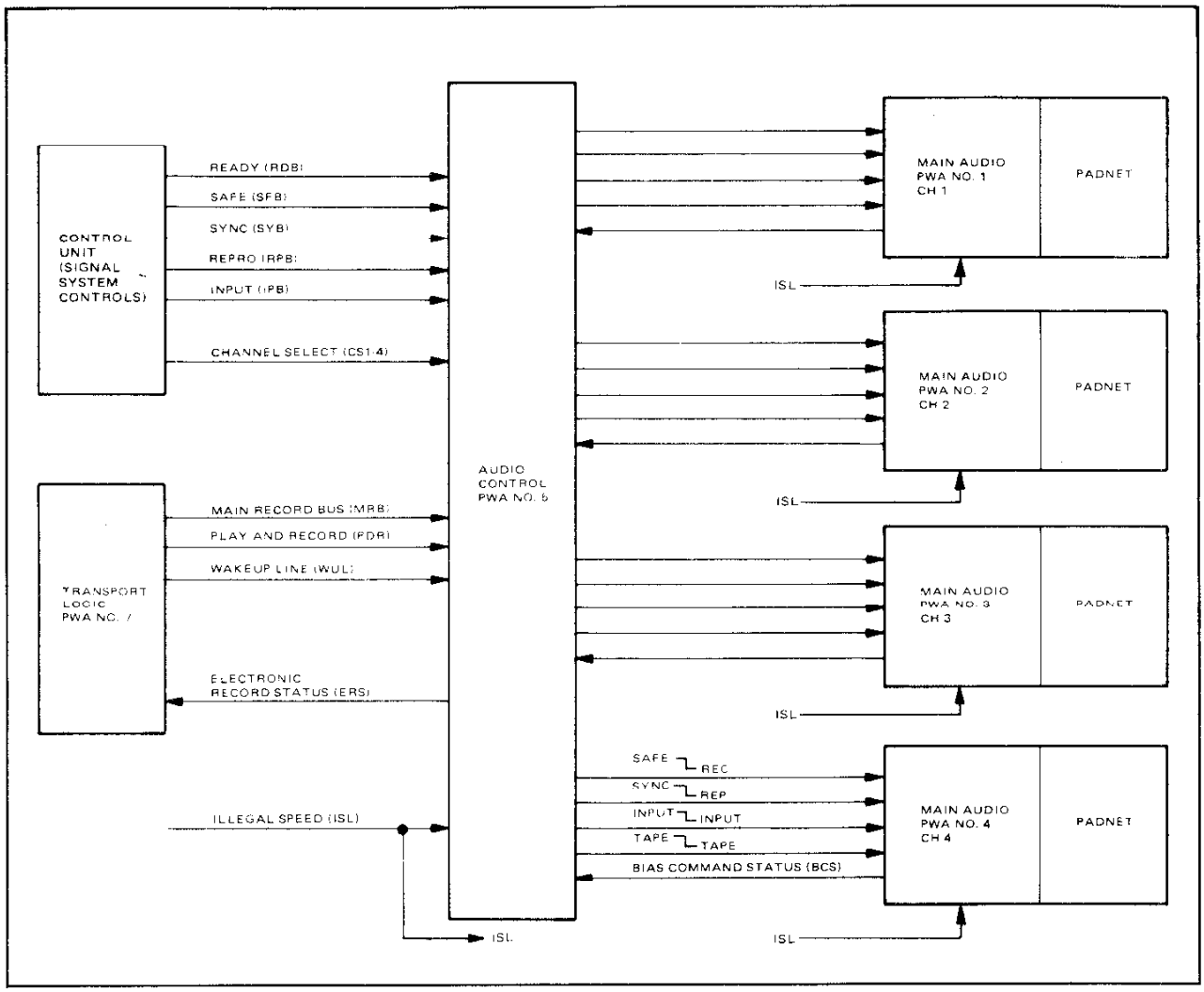

Figure 4-10. Signal Mode Selection, Interconnection Simplified Block Diagram

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), wakup 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.

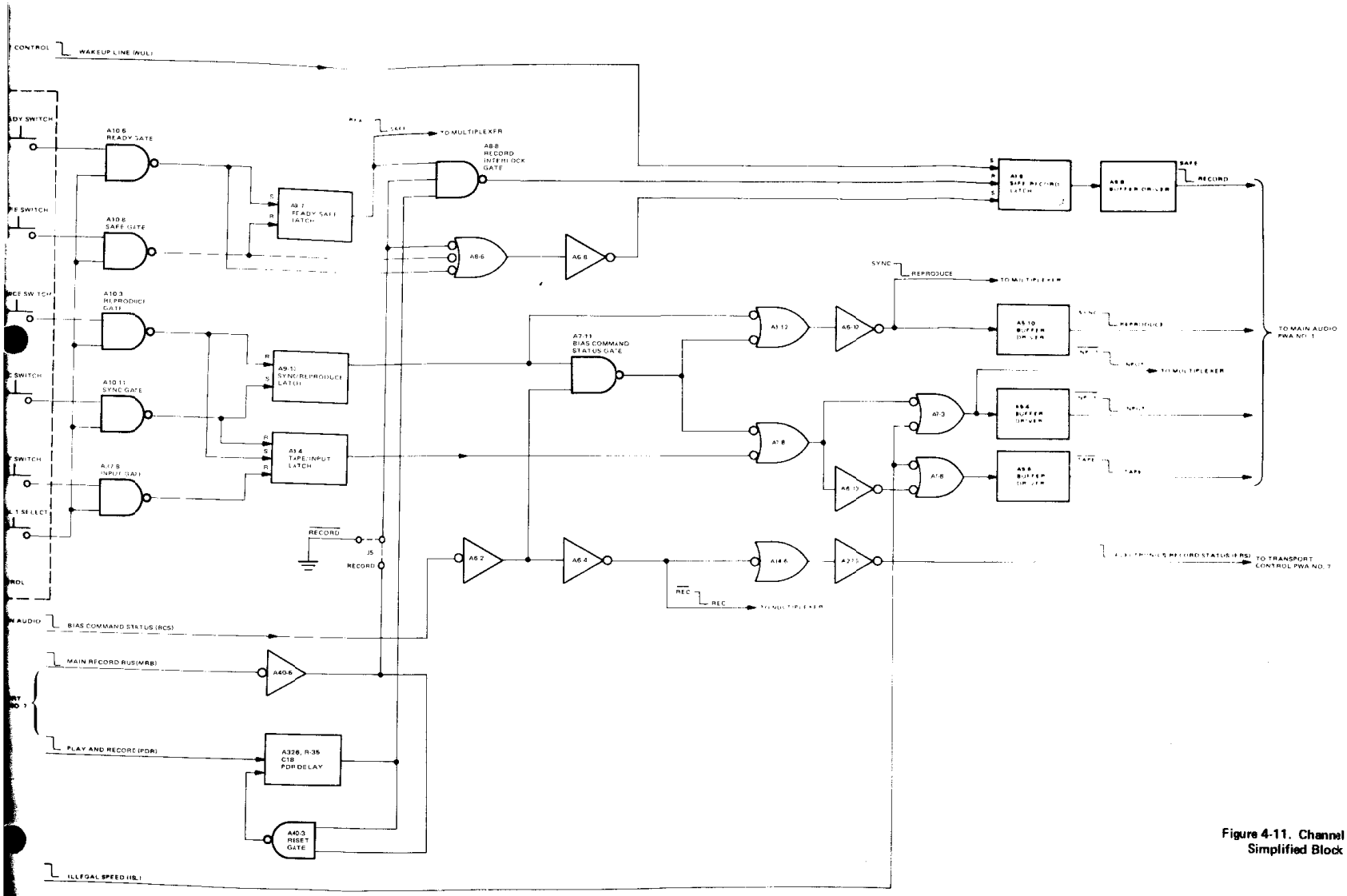

Figure 4-11. Channel 1 Signal-Mode Selection Simplified Block Diagram, Audio Control PWA No. 5

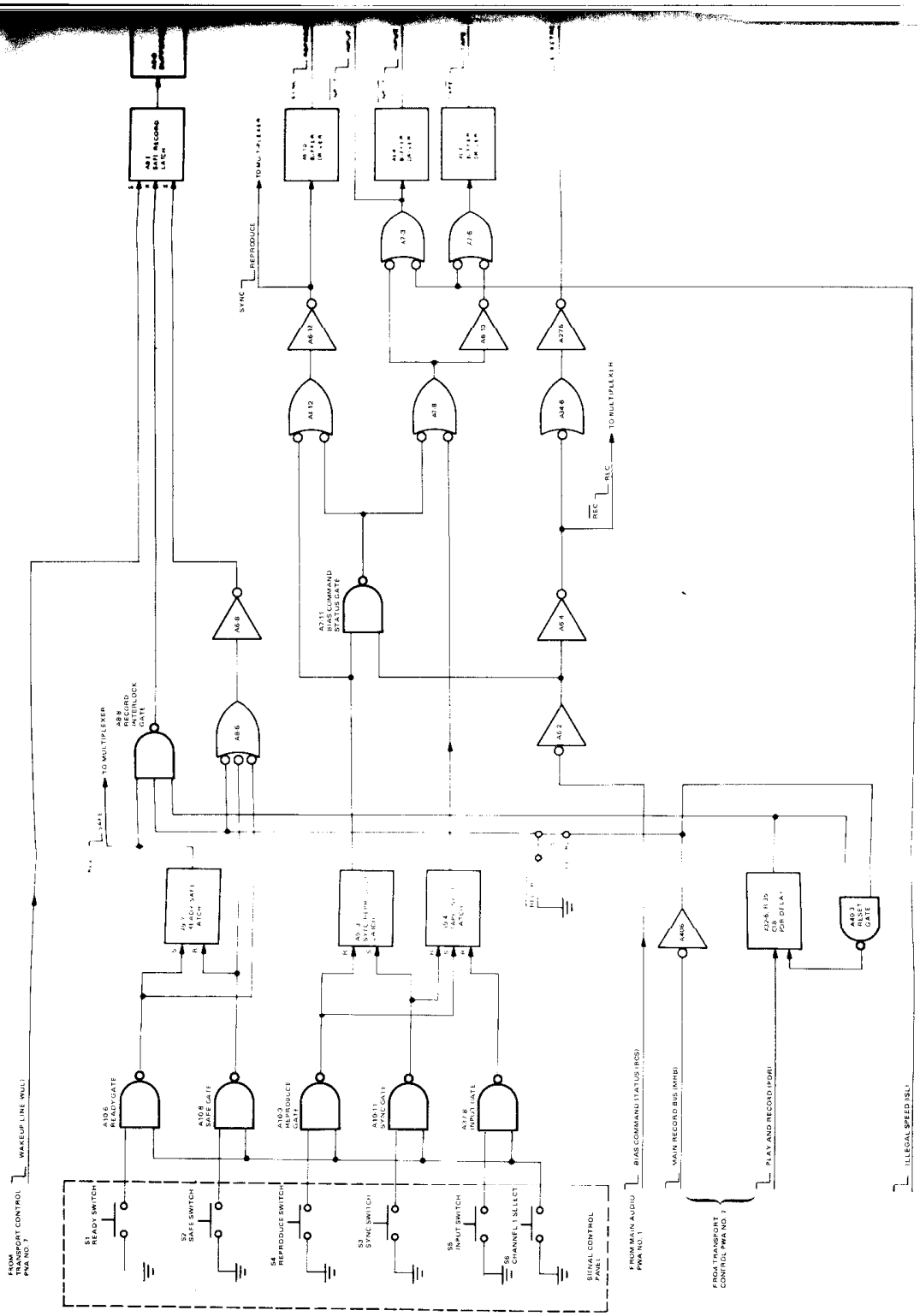

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Table 4-5. Channel 1 Signal Mode Selection Output-Signal Logic States

FUNCTIONS	OUTPUT SIGNAL LOGIC STATE			
	SAFE⌐RECORD (PIN 24)	SYNC⌐REP (PIN 23)	$\overline{\text{INPUT}}$⌐INPUT (PIN R)	$\overline{\text{TAPE}}$⌐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 $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/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 $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/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 $\overline{\text{input}}$/input line to be low (input) and the $\overline{\text{tape}}$/tape line to be high ($\overline{\text{tape}}$). 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 X 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.

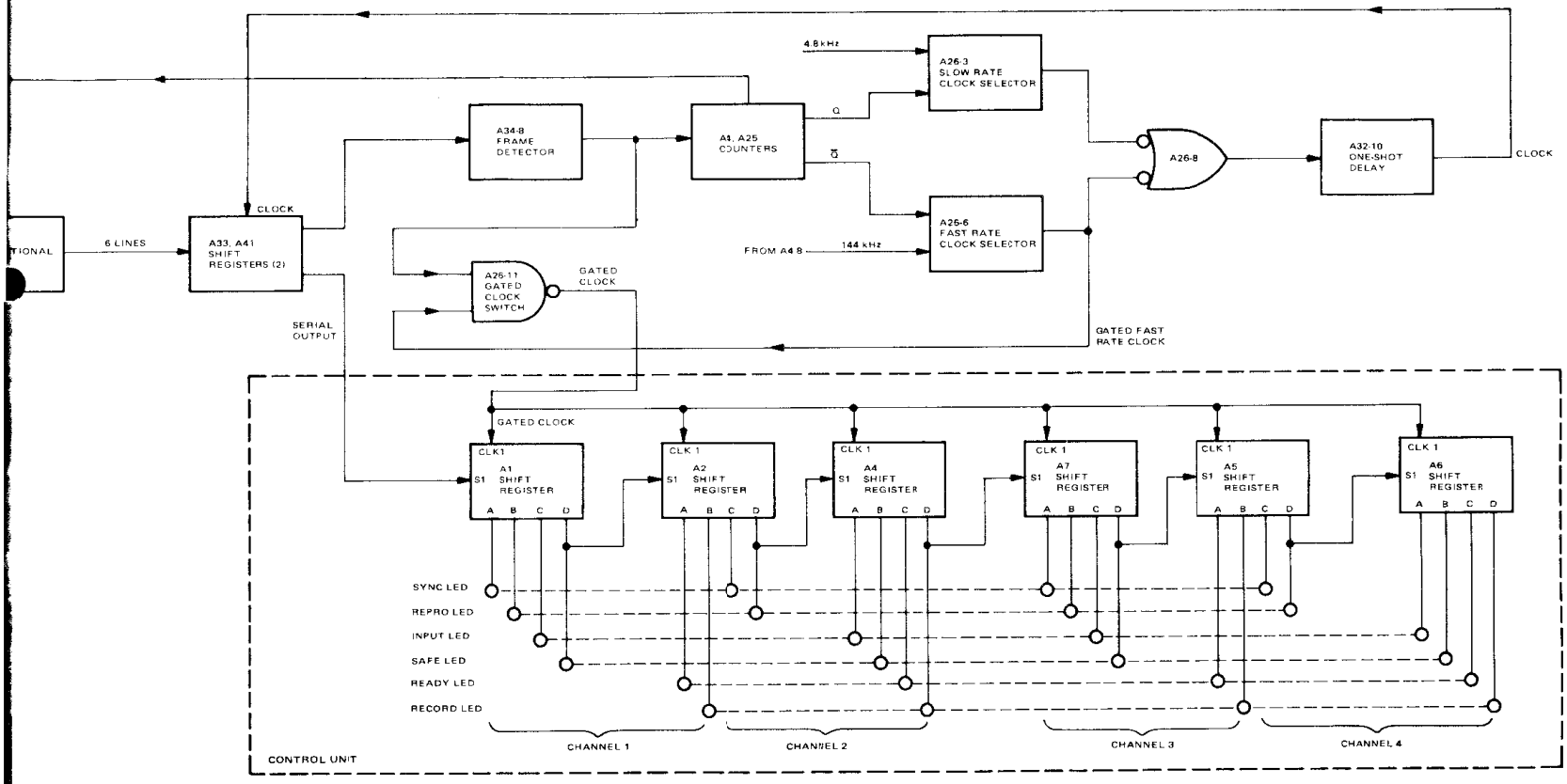
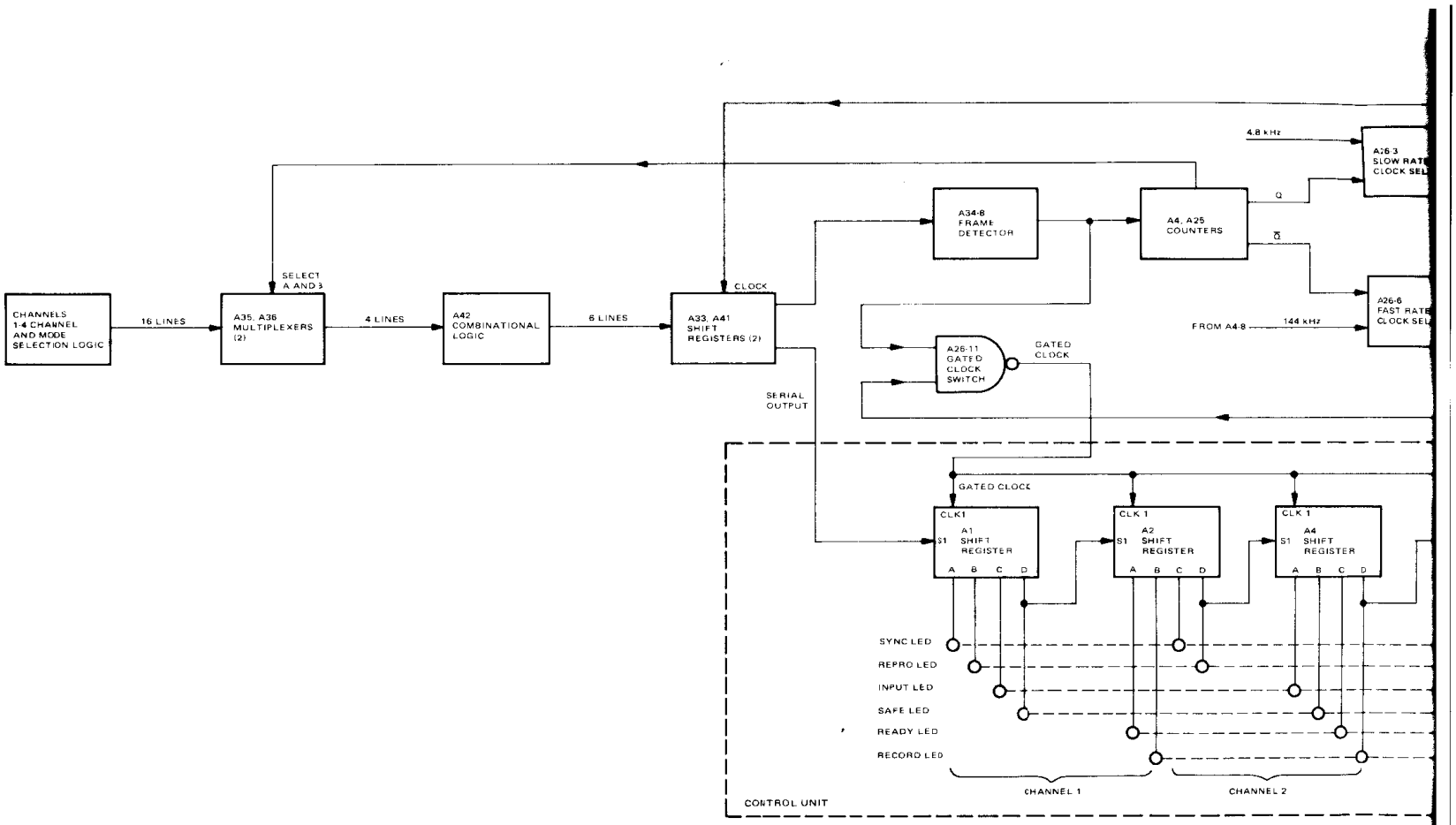


Figure 4-12. Multiplexer Simplified Interconnect Block Diagram, Audio Control PWA No. 5 and Control Unit


CHANNELS 1-4 CHANNEL AND MODE SELECTION LOGIC
16 LINES
A35, A36 MULTIPLEXERS (2)
SELECT A AND B
4 LINES
A42 COMBINATIONAL LOGIC
6 LINES
A33, A41 SHIFT REGISTERS (2)
CLOCK
SERIAL OUTPUT
A34-8 FRAME DETECTOR
A4, A25 COUNTERS
Q
Q̄
4.8 kHz
A26-3 SLOW RATE CLOCK SEL
A26-6 FAST RATE CLOCK SEL
FROM A4-8
144 kHz
A26-11 GATED CLOCK SWITCH
GATED CLOCK
GATED CLOCK
CLK1
S1
A1 SHIFT REGISTER
A2 SHIFT REGISTER
A4 SHIFT REGISTER
A B C D
SYNC LED
REPRO LED
INPUT LED
SAFE LED
READY LED
RECORD LED
CHANNEL 1
CHANNEL 2
CONTROL UNIT

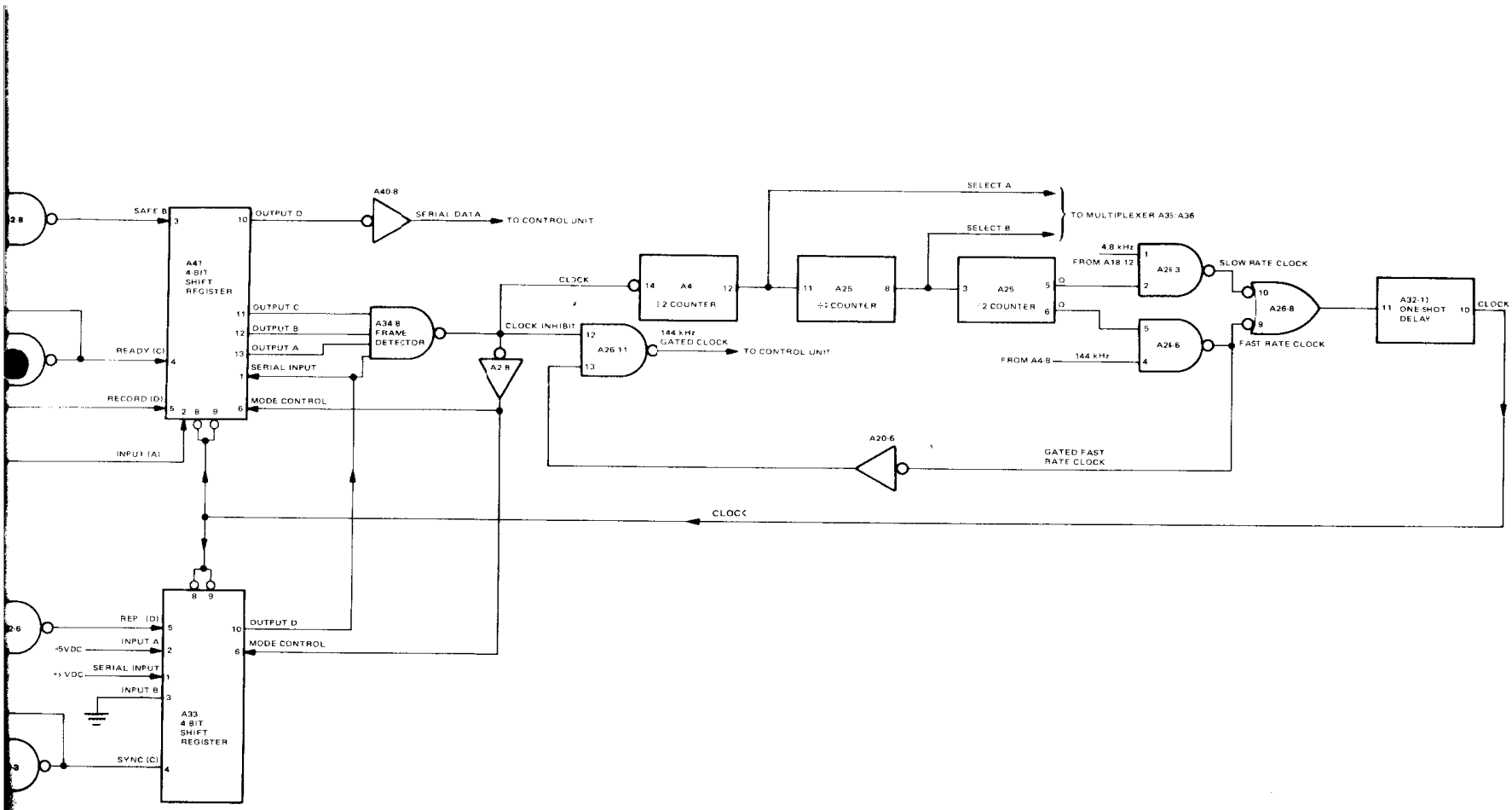
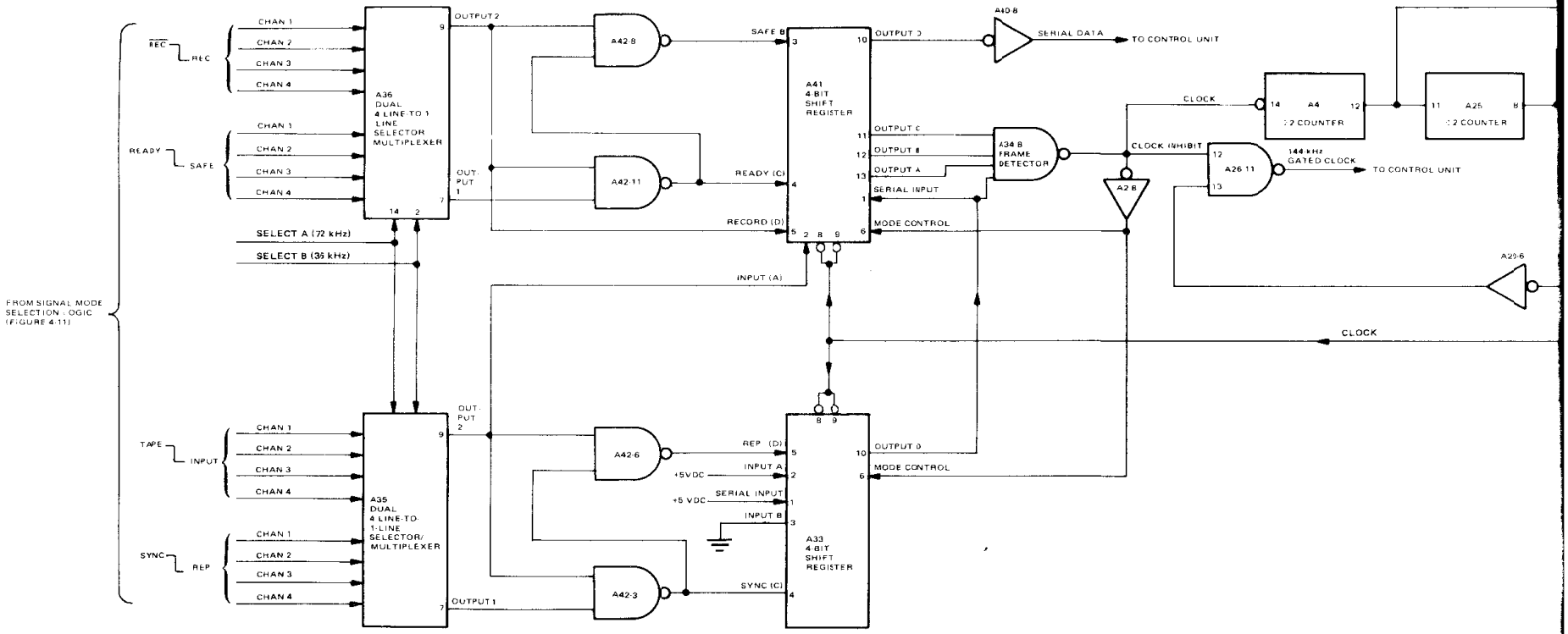


Figure 4-13. Multiplexer Simplified Block Diagram, Audio Control PWA No. 5



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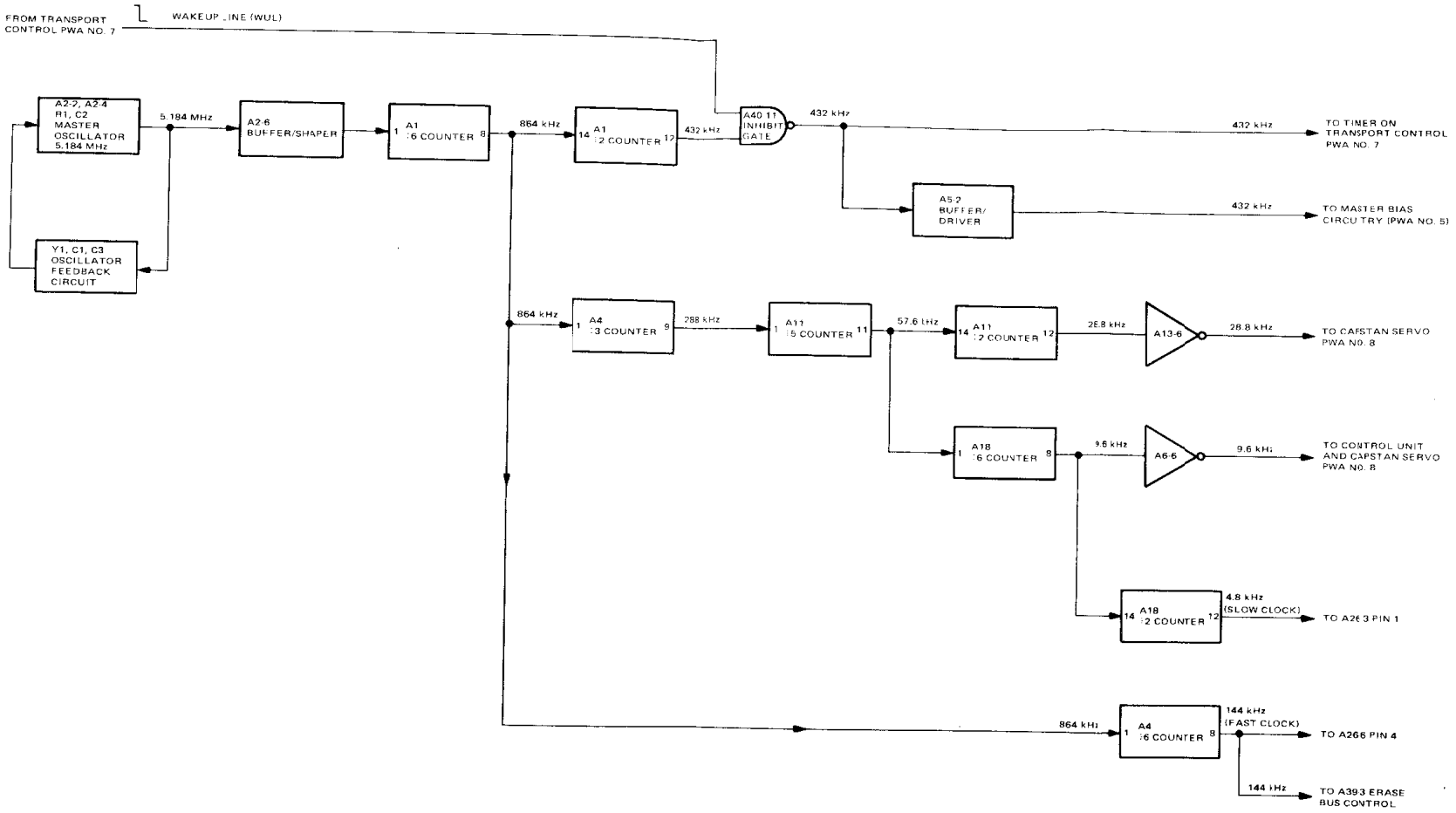


Figure 4-14. Master Oscillator and Counters, Simplified Block Diagram (PWA No. 5)

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.

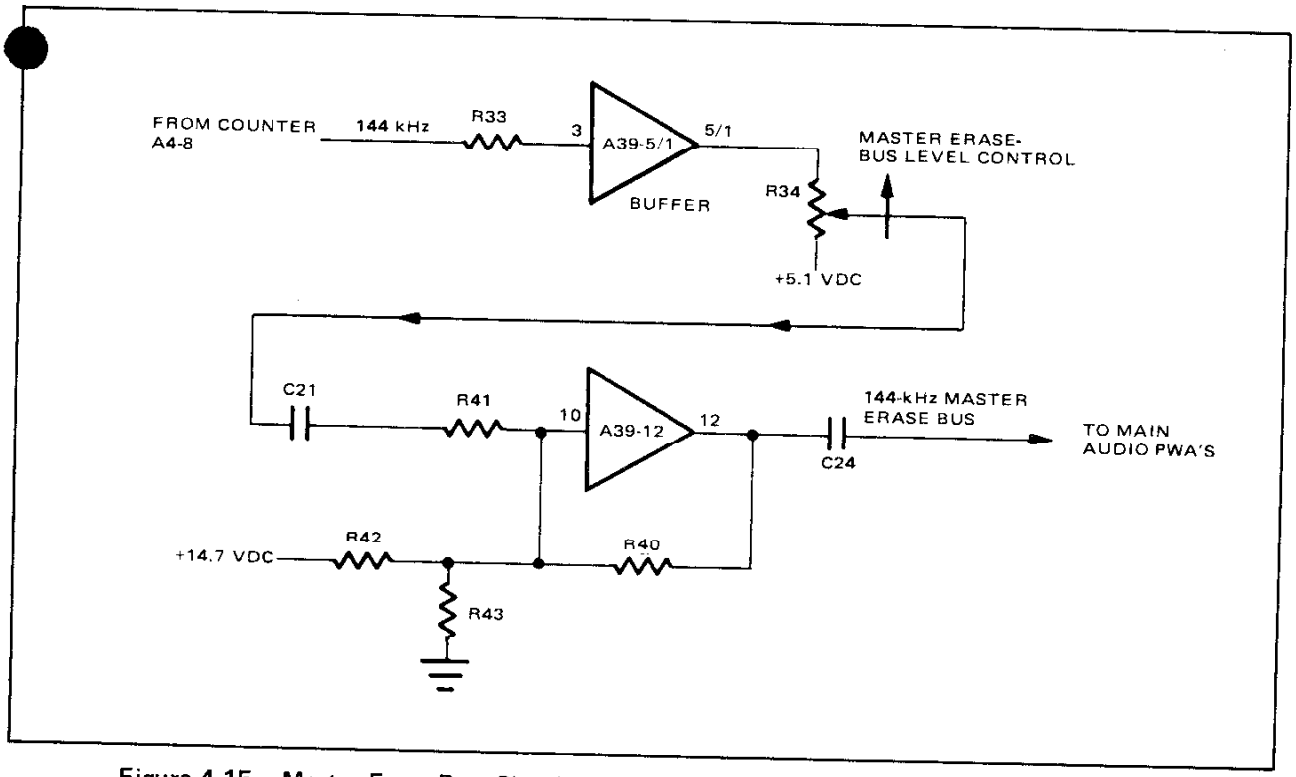


Figure 4-15. Master Erase Bus, Simplified Schematic Diagram, Audio Control PWA No. 5

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 provideo 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.

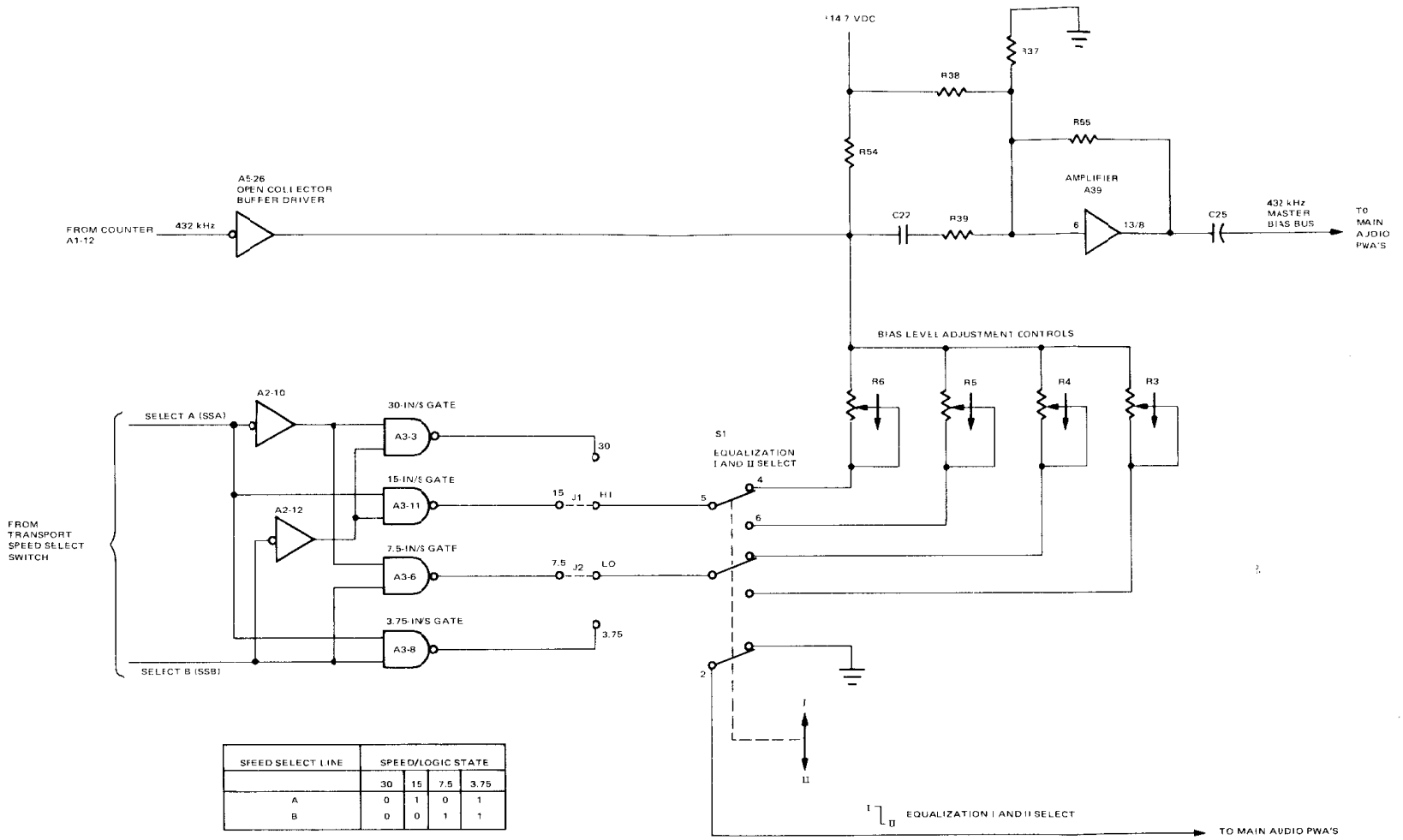
The record circuits receive the system audio input and 432-kHz bias, and provide equalization of the received audio signal to match the required recording equalization at the selected tape speed and/or equalization standard. The record circuits also combine the equalized signal with the 432-kHz bias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



SPEED SELECT LINE	SPEED/LOGIC STATE			
	30	15	7.5	3.75
A	0	1	0	1
B	0	0	1	1

Figure 4-16. Master Bias Bus, Two-Speed Simplified Schematic (PWA No. 5)

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 LO SPEED	J1 – 30, 15, 7.5 J2 – 15, 7.5, 3.75	R6 R4	R5 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 J3 – 15 J2 – 7.5 J4 – 3.75	R6 R5 R4 R3

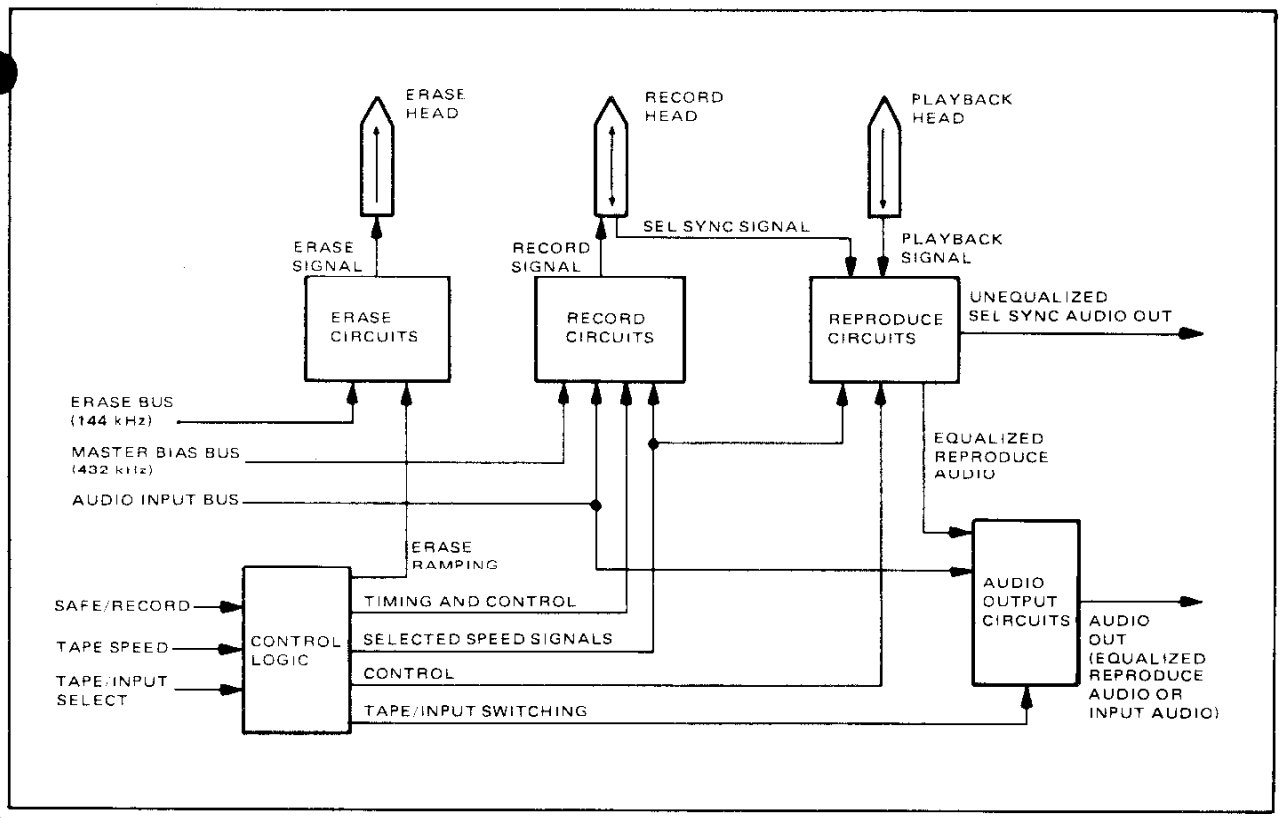


Figure 4-17. Main Audio Simplified Block Diagram

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 ±15V 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 ±15V 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

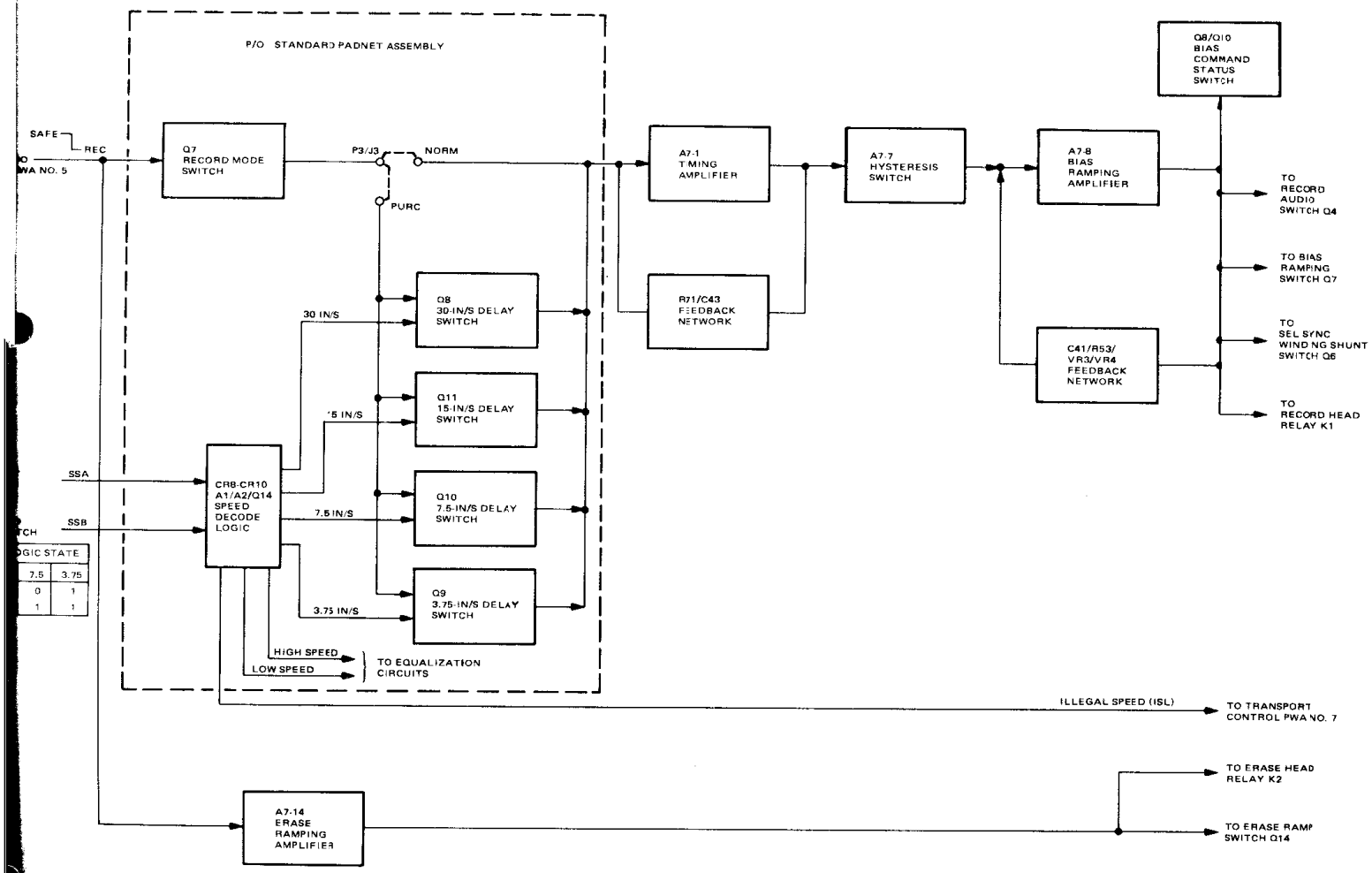
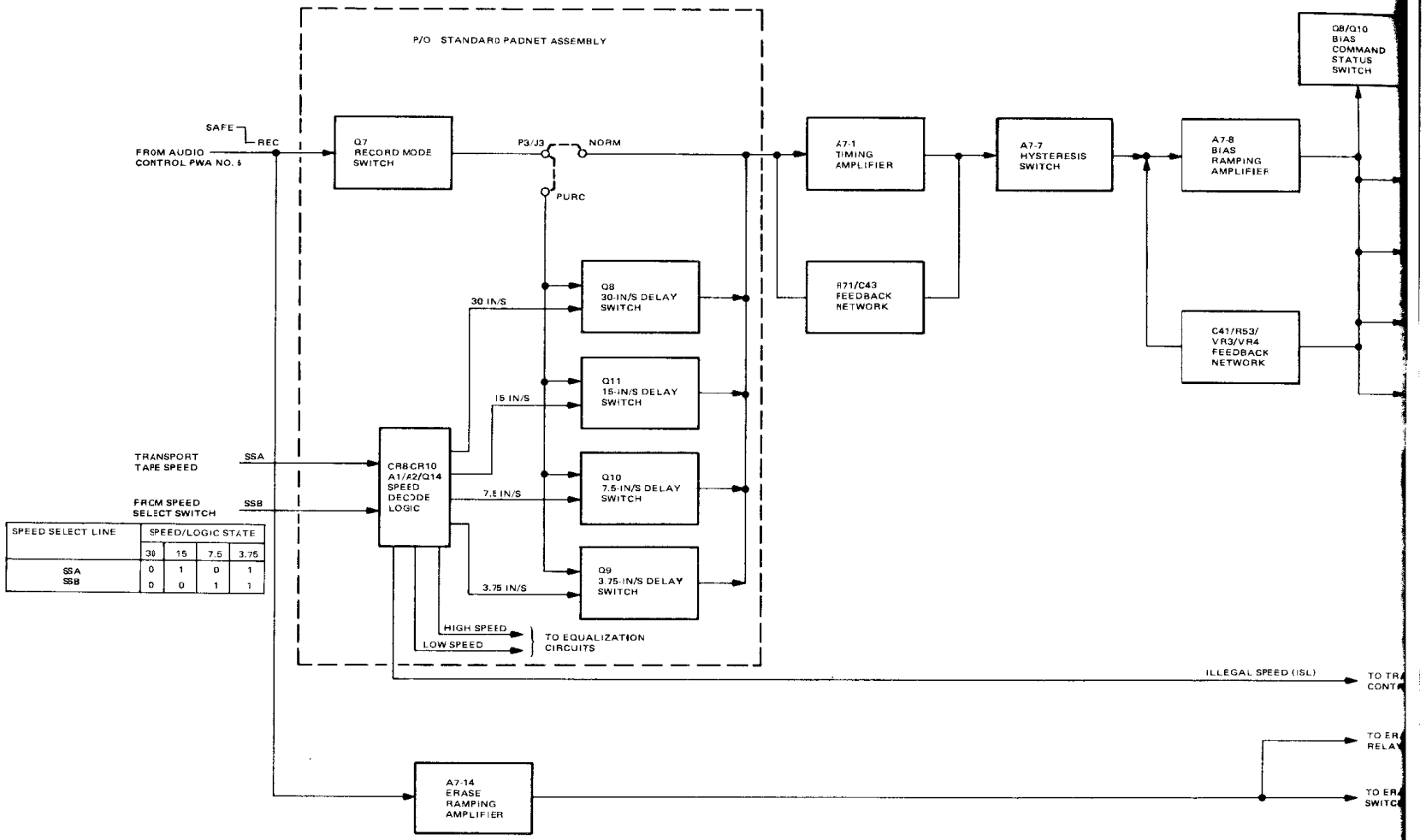


Figure 4-18. Main Audio Control Logic, Simplified Block Diagram



SPEED SELECT LINE	SPEED/LOGIC STATE			
	30	15	7.5	3.75
SSA	0	1	0	1
SSB	0	0	1	1

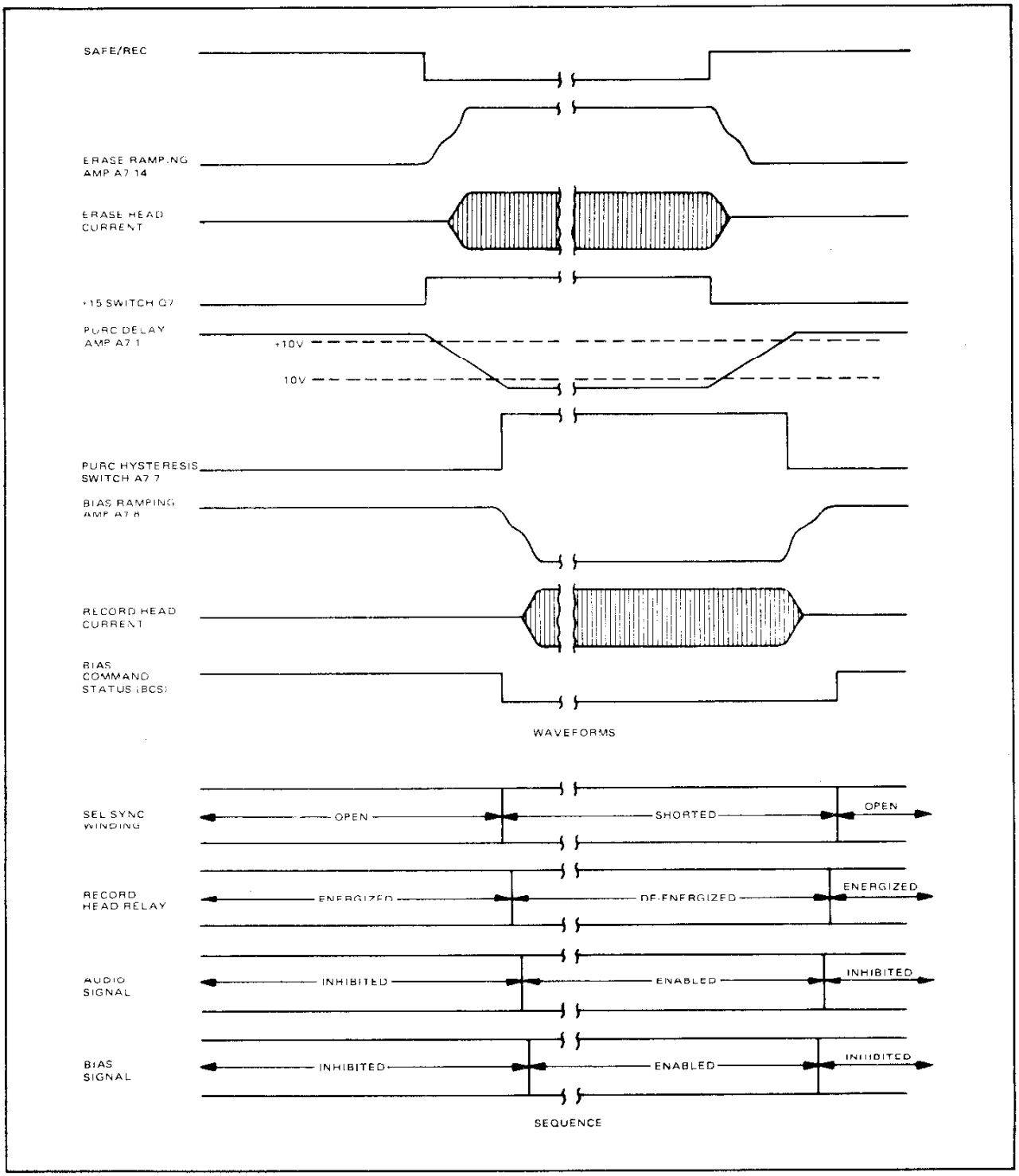


Figure 4-19. Record Ramping and PURC Delay Timing

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-μs 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.

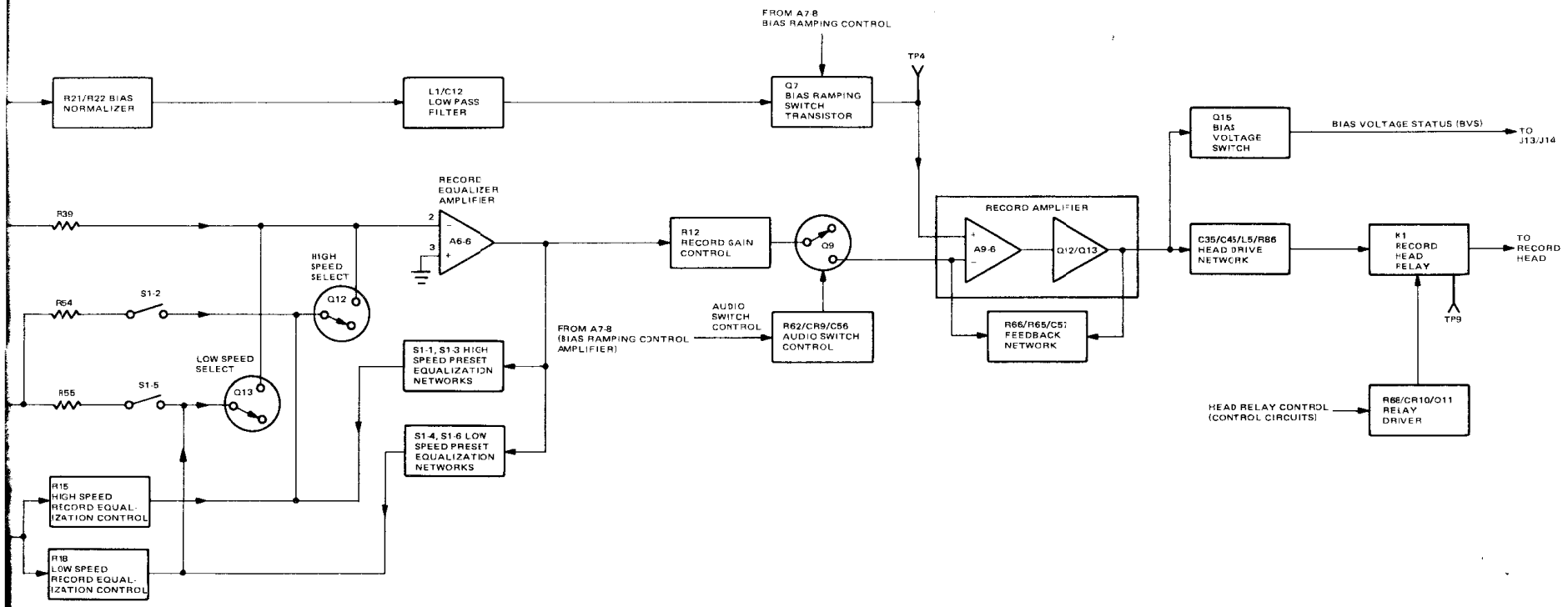


Figure 4-20. Audio Record Circuits, Simplified Block Diagram

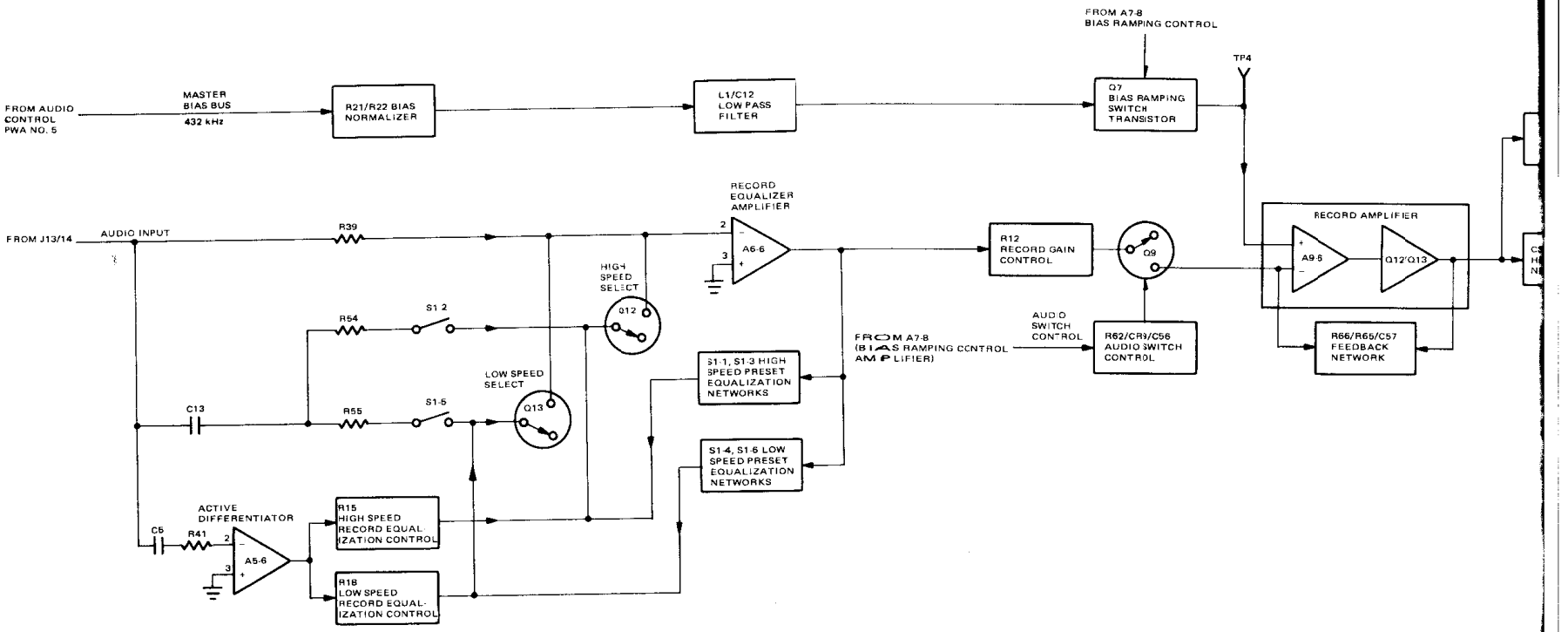

FROM AUDIO CONTROL PWA NO. 5
MASTER BIAS BUS
432 kHz
R21/R22 BIAS NORMALIZER
L1/C12 LOW PASS FILTER
FROM A7-8 BIAS RAMPING CONTROL
Q7 BIAS RAMPING SWITCH TRANSISTOR
TP4
FROM J13/14
AUDIO INPUT
R39
RECORD EQUALIZER AMPLIFIER
A6-6
HIGH SPEED SELECT
Q12
R54
S1-2
LOW SPEED SELECT
Q13
C13
R55
S1-6
S1-1, S1-3 HIGH SPEED PRESET EQUALIZATION NETWORKS
S1-4, S1-6 LOW SPEED PRESET EQUALIZATION NETWORKS
ACTIVE DIFFERENTIATOR
C6
R41
A5-6
R15 HIGH SPEED RECORD EQUALIZATION CONTROL
R18 LOW SPEED RECORD EQUALIZATION CONTROL
R12 RECORD GAIN CONTROL
Q9
FROM A7-8 (BIAS RAMPING CONTROL AMPLIFIER)
AUDIO SWITCH CONTROL
R62/CR9/C56 AUDIO SWITCH CONTROL
RECORD AMPLIFIER
A9-5
Q12'Q13
R66/R65/C57 FEEDBACK NETWORK

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-μs 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.

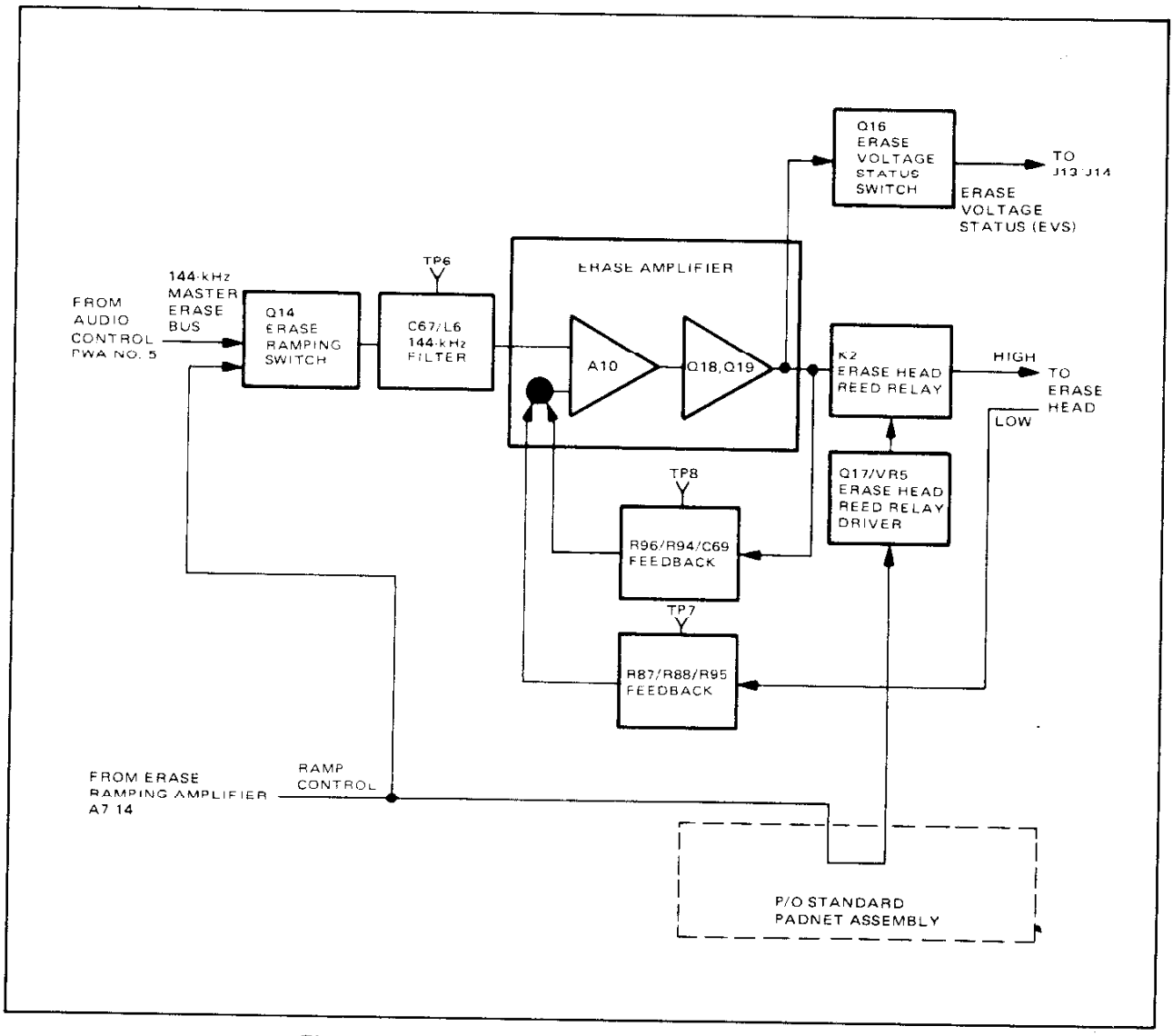


Figure 4-21. Erase Circuit, Simplified Block Diagram

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/R12/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.

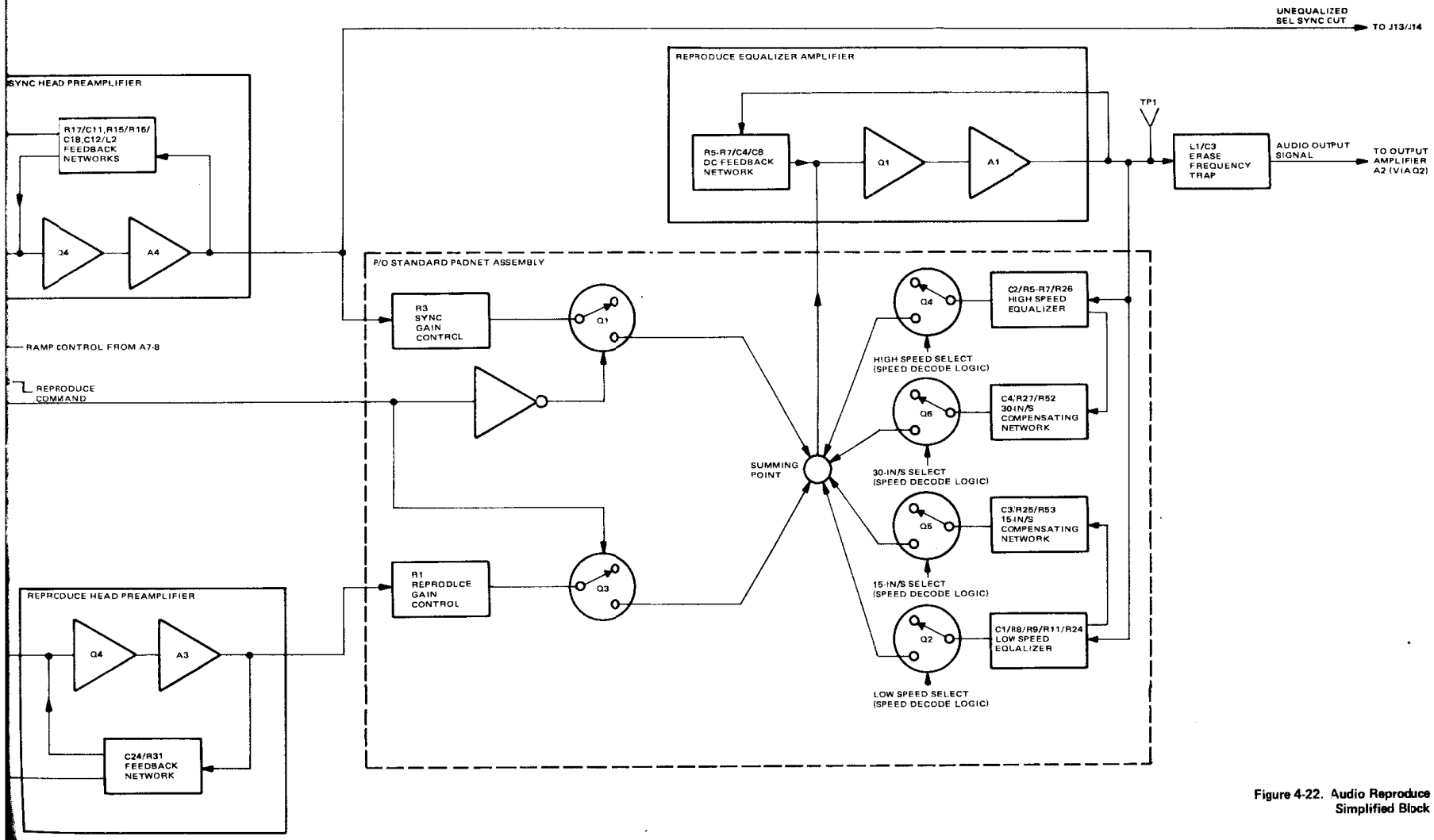
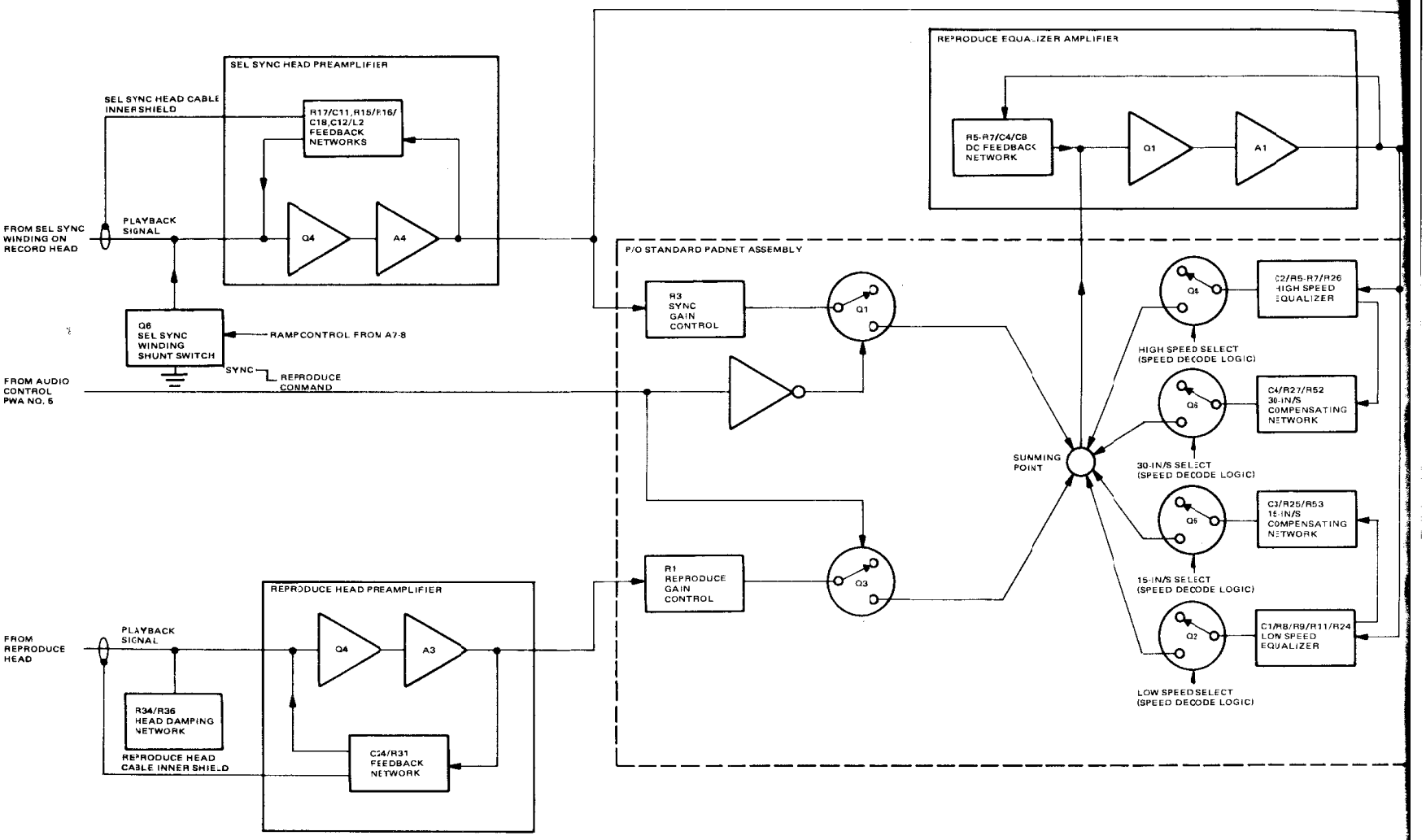


Figure 4-22. Audio Reproduce Circuits, Simplified Block Diagram



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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 $\overline{\text{TAPE}}$/TAPE and $\overline{\text{INPUT}}$/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 $\overline{\text{TAPE}}$/TAPE command goes low. For monitoring, FET switch Q3 selects the audio input signal to the record circuits when the $\overline{\text{INPUT}}$/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 $\overline{\text{TAPE}}$/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

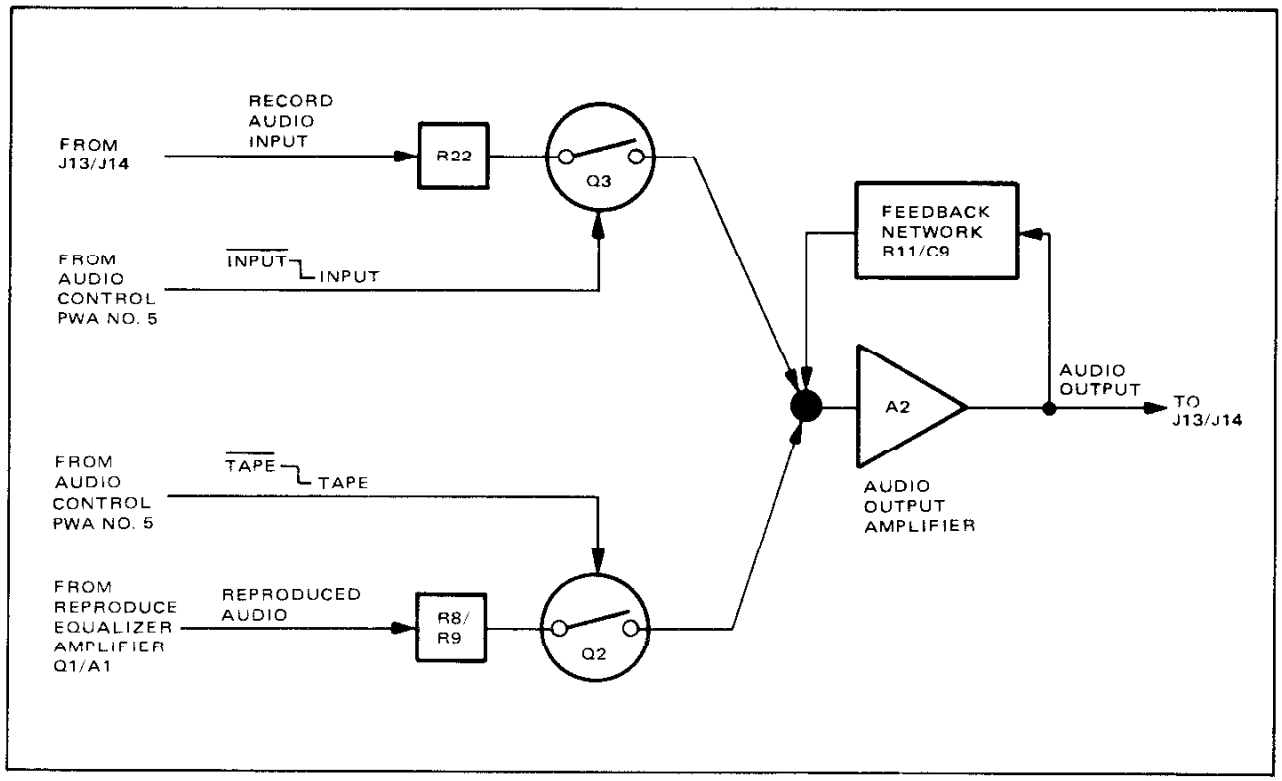

Figure 4-23. Audio Output Circuit, Simplified Block Diagram

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 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 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 $\overline{\text{tape}}$/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.

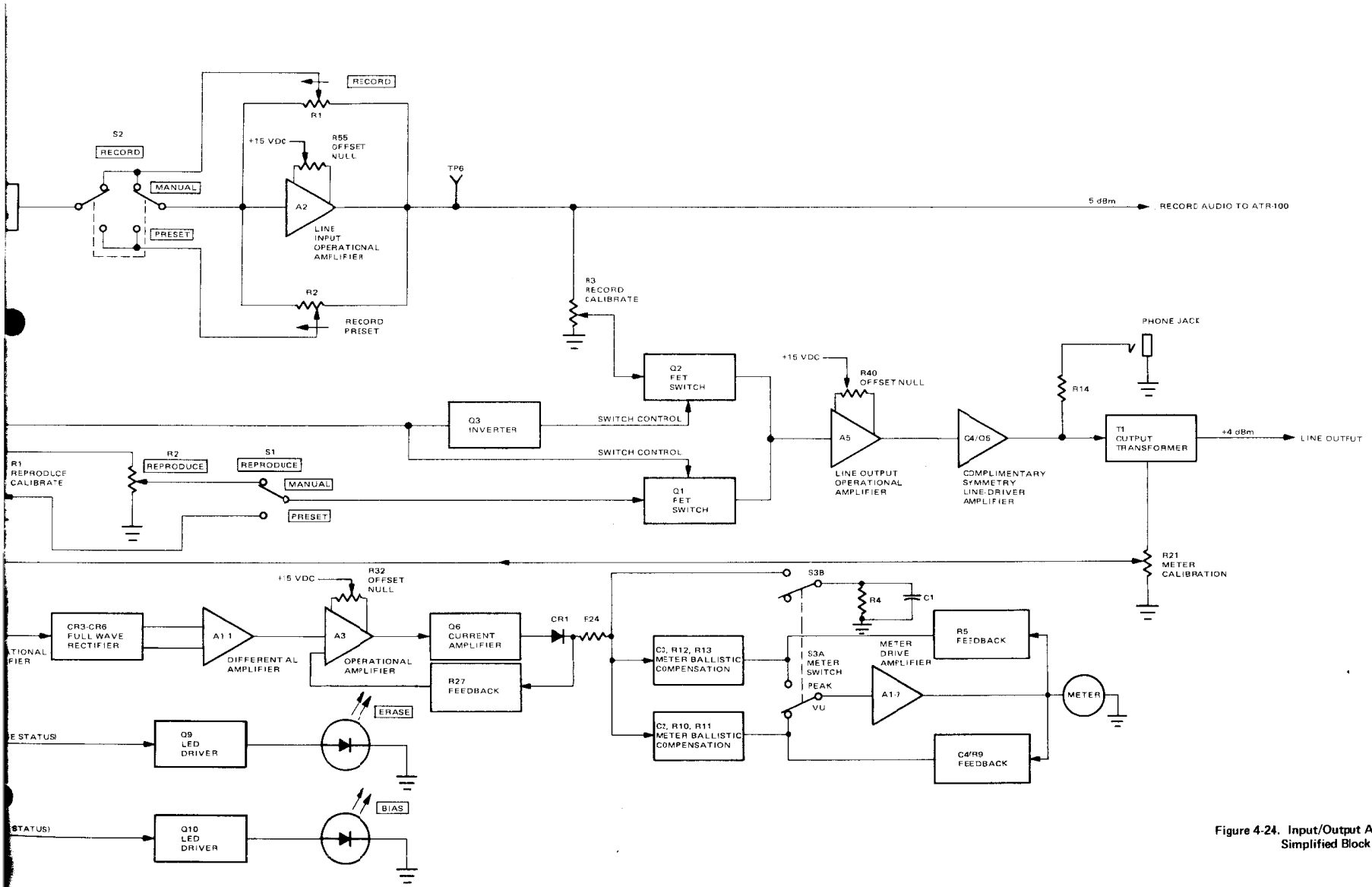

Figure 4-24. Input/Output Assembly, Simplified Block Diagram