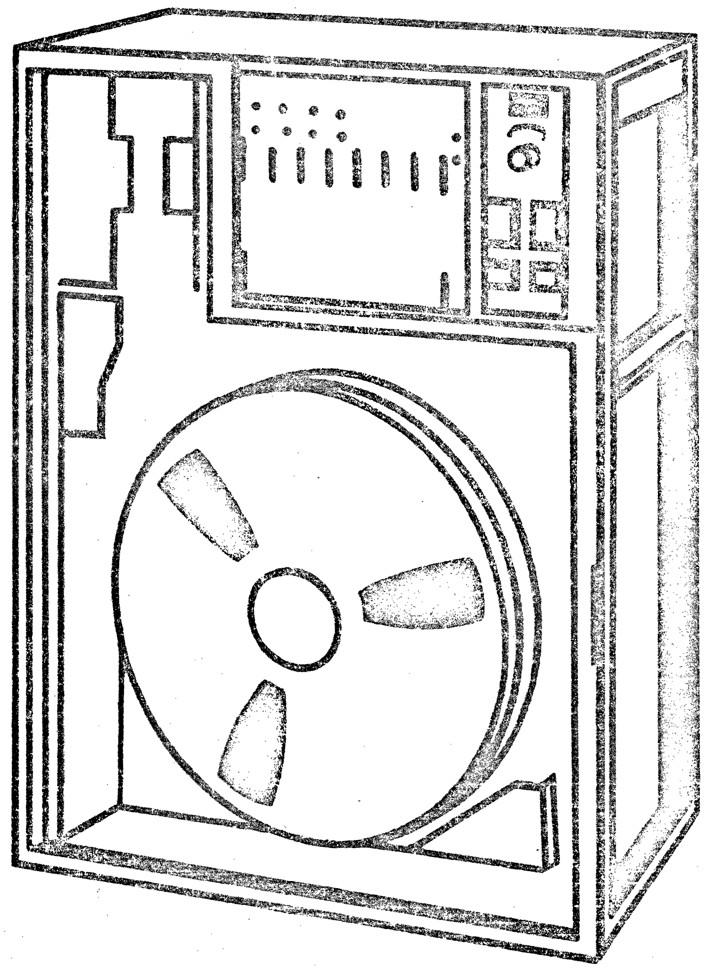
Sangamo

TECHNICAL MANUAL

for

SABRE III
3600 MAGNETIC TAPE
RECORDER/REPRODUCER



SANGAMO ELECTRIC COMPANY
Springfield, Illinois

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LIST OF ILLUSTRATIONS

The remaining tab divided sections contain bulletins as listed and indicated in earlier portions of this table of contents. Each of these bulletins contain diagrams pertaining to the item covered by that bulletin.

SABRE III
3600 RECORDER/REPRODUCER

CONFIGURATION

for serial number

[illegible]498

MODEL NUMBER

3612	
3614	
3618	
3621	
3622	
3630	X

TAPE WIDTH

1/2 Inch	
1 Inch	X

TAPE THICKNESS

1.0 Mil	X
1.5 Mil	

REEL DIAMETER

10 1/2 Inch	
14 Inch	X
15 Inch	
16 Inch	

TAPE SPEEDS *

120 ips	X
60 ips	X
30 ips	X
15 ips	X
7 1/2 ips	X
3 3/4 ips	X
1 7/8 ips	X
15/16 ips	

HEAD

Interleaved	X
Inline	

SERVO TYPE

Capstan Synchronous	X
Tape Synchronous	X

DIRECT ELECTRONICS (QUANTITY)

Record	14
Reproduce	14

FM ELECTRONICS (QUANTITY)

Record	14
Reproduce	14

DIGITAL ELECTRONICS (QUANTITY)

Write	
Read	

VOICE

Edge Track Voice/Timing	X
Edge Track Voice	

POWER SUPPLY 115/230V 47 TO 440Hz	X
AUXILIARY SIGNAL CHASSIS	
REMOTE CONTROL PANEL	
PHOTO END-OF-TAPE SENSE	X
FM CALIBRATOR	X

* Reproduce at — Direct 120 - 1 7/8
FM 60 - 7 1/2
Digital

MAGNETIC HEAD CHARACTERISTICS
and
SIGNAL ELECTRONICS BOARD SERIAL NUMBERS
for
TAPE TRANSPORT SERIAL NO. 7498

HEAD	PART NO.	SERIAL NO.
RECORD	857266	2372
REPRODUCE	836004	032

TAPE TYPE 3M 888 or Equiv.
TRACK NUMBERING
FORMAT IRIG

BIAS BOARD SERIAL NO. 331 BIAS FREQ 8.4 MHz
PCM CLOCK BOARD SERIAL NO:
EDGE A/B OR VOICE RECORD BOARD SERIAL NO. 349
EDGE A/B OR VOICE REPRODUCE BOARD SERIAL NO(S). 585
1 - 740% 586
7 - 1430%

Track No.	Direct Record Serial No.	Direct Repro Serial No.	Direct Record Bias Level (vdc)	Band Classification **	FM Record Serial No.	FM Repro Serial No.	FM Expander Serial No.	FM Input Level ± ___ %Dev. (vrms)	Band Classification **	PCM Write, Encoder Serial No.	PCM Read, Decoder Serial No.	PCM Format Conversion	
1	2489	1543	1.20	W.B. II	2957	2205		0.172	W.B. I				
2	2472	1541	1.80		3125	2202		0.166					
3	2474	1468	1.40		3132	2263		0.172					
4	2481	1537	1.90		3167	2204		0.168					
5	2427	1542	1.20		3168	2201		0.170					
6	2473	1536	1.80		3169	2206		0.168					
7	2441	1494	1.20		3170	2207		0.166					
8	2456	1539	1.80		4024	2214		0.125	W.B. II				
9	2490	1547	1.20		4025	2215		0.130					
10	2484	1545	1.85		4026	2216		0.128					
11	2451	1544	1.10		4027	2217		0.128					
12	2435	1538	1.85		4028	2218		0.124					
13	2397	1540	1.15		4029	2219		0.127					
14	2236	1546	1.80		4030	2220		0.128					

NOTE: DIRECT NORMAL RECORD LEVEL=100 mvrms at TP2. This level is defined as the input level required to produce 1% third harmonic distortion.

* FM input level measured at TP1 on FM record board.
** Refer to the applicable record bulletin for characteristics of band classification.

3600
4900
Rev. 3 3-12-73

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GENERAL INFORMATION

SCOPE

This technical manual has been prepared to provide the necessary information for installation, operation, and maintenance of the SABRE III, 3600, MAGNETIC TAPE RECORDER/REPRODUCER.

The manual is divided into two tab identified sections; Operator's, and Maintenance. The Operator's section is further divided into three sections, generally containing the following information.

GENERAL INFORMATION - This section contains a bulletin covering the use of the technical manual, general description of the system with photographs, general specifications, and optional features.

INSTALLATION - This section contains a bulletin covering Sangamo "LITE-OFF", power requirements, site selection, power connections, inspection (fuses and installation connections), dimensional diagrams, installation summary, and possibly interfacing information.

OPERATOR'S - This section contains a bulletin covering a description of controls and indicators, tape threading, operating procedures, operators theory, operator's maintenance (including checks and adjustments), and system performance measurements.

Additional bulletins may be included in any of these sections.

The Maintenance section is further divided into six sections, generally containing the following information.

TAPE TRANSPORT - This section contains a bulletin covering overall basic theory, maintenance data for each transport related circuit board, assembly, etc., parts removal/replacement data, parts list, and diagrams for the basic tape transport and tape movement circuits.

RECORD - This section contains bulletins covering the recording of signal data onto the moving magnetic tape. Separate bulletins for record chassis, FM record, direct record, bias, etc., each contain operating data, theory, maintenance, parts list, and diagrams.

REPRODUCE - This section contains bulletins covering the recovery and reproduction of signal data recorded on magnetic tape. Separate bulletins for reproduce chassis, FM reproduce, direct reproduce, preamplifiers, etc., each contain operating data, theory, maintenance, parts list, and diagrams.

POWER SUPPLIES - This section contains bulletins covering the optional AC to DC power supply and the DC to DC converter employed with the system. Each bulletin contains operating data, theory, maintenance, parts, and diagrams.

OPTIONAL ITEMS - This section contains a bulletin for each particular option or addition to the recorder/reproducer system. Each bulletin may contain operating procedures, theory, maintenance, parts list, and diagrams. All voice or time code record/reproduce information is found here.

PARTS LIST - This section contains a bulletin, listing and describing the electrical parts used in the recorder/reproducer system. This listing, numerically by Sangamo part number, is provided for cross referencing from a smaller parts list on or near the diagrams for each assembly or subassembly (bulletin).

DESCRIPTION

The SABRE III, 3600, Recorder/Reproducer contains the capability of moving magnetic tape across the record and reproduce heads in either direction at a precise and uniform rate, during the record and/or reproduce process.

To accomplish tape movement over the heads at the most precise speed a capstan drive system with inertia dampening roller and pinch rollers is employed, refer to figure 1. The capstan, which controls all tape movement, is controlled by the speed control and mode control circuits. The reel drive circuits are utilized to provide the proper feeding and taking up of tape to and from the capstan as it turns. In addition to these tape movement circuits are special circuits which provide added features to the standard tape movement capability (end-of-tape sense, etc.).

To record signal data, time code signals, or voice the input signal must be conditioned, and possibly, combined with bias, by the record boards prior to being applied to the head for recording on tape. These record boards are normally capable of recording at any tape speed in various bandwidths.

In reproducing signal data, time code signals, or voice, the reproduced signal must be applied through the preamps to the reproduce board complement of the type signal recorded (FM, direct, etc.). The reproduce board conditions the signal to present it at the system output in a form most like the input signal, prior to recording.

An optional AC to DC regulated power supply is available to provide the necessary dc voltage required by the recorder/reproducer. A standard DC to DC converter assembly converts the input dc voltage to various voltages required by the tape movement circuits, record/reproduce circuits, and for the most part any other circuit or circuits which may be used in the system.

The complete model number of the recorder/reproducer is dependent upon the family of speeds supplied, the type of signal electronics supplied, and the frequency response available as follows:

MODEL	DESCRIPTION
3612	IRIG FM low-band (20 kHz at 120 ips) with 120 through 1 7/8 ips speed range. OR IRIG intermediate-band (20 kHz at 60 ips) with 60 through 15/16 ips speed range.
3614	IRIG FM intermediate-band (40 kHz at 120 ips) with 120 through 1 7/8 ips speed range. OR IRIG wide-band group I (40 kHz at 60 ips) with 60 through 15/16 ips speed range.

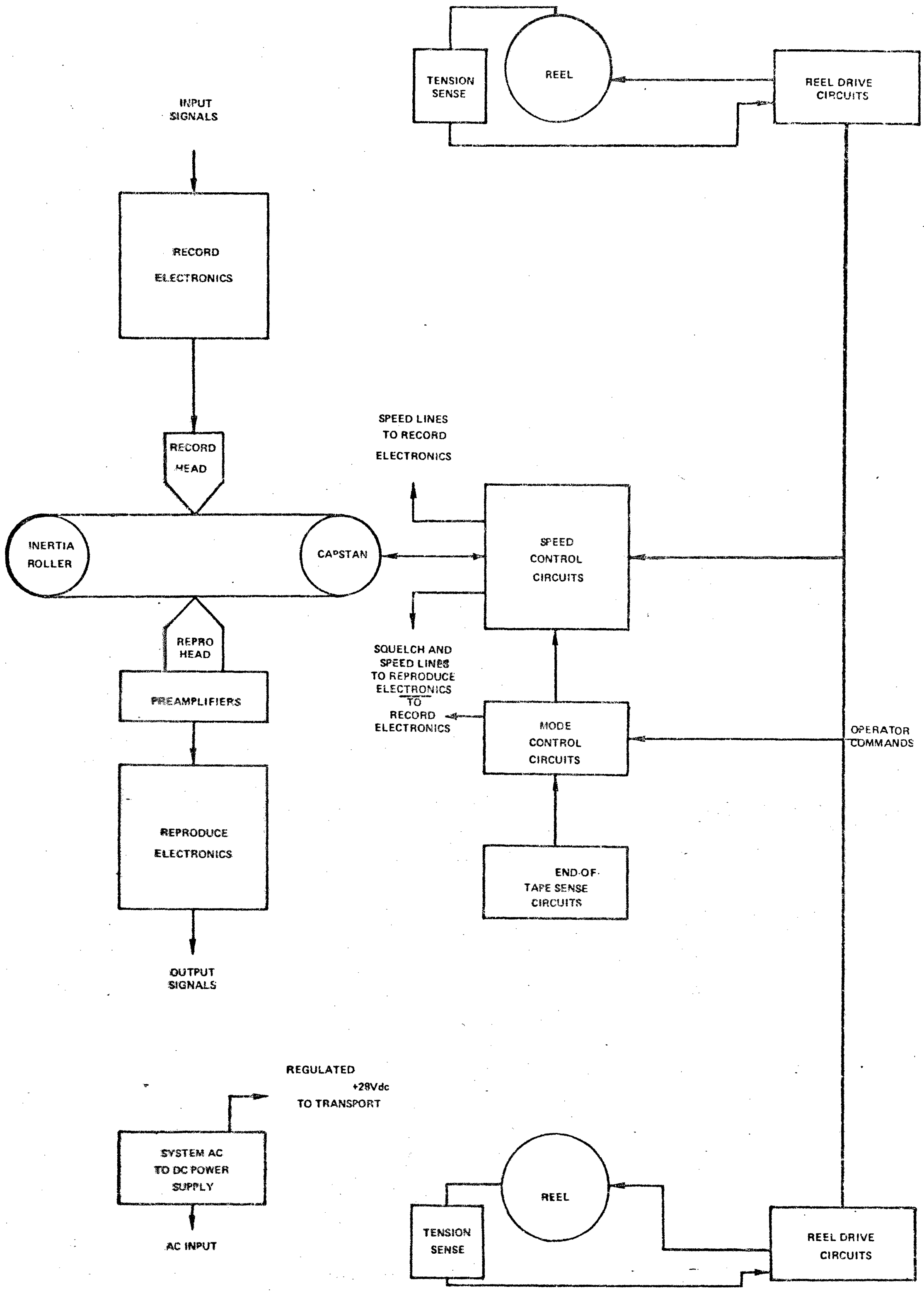


Figure 1. Overall Functional Block Diagram

MODEL	DESCRIPTION
3618	IRIG FM wide-band group I (80 kHz at 120 ips).
3621	IRIG direct wide-band with 1.6 MHz equalizers with FM wide-band group II capability.
3622	IRIG direct wide-band with 2.0 MHz equalizers with FM wide-band group II capability.
3630	IRIG wide-band capability with mixed channel electronics (i.e. 80 kHz FM and 2.0 MHz direct).

GENERAL SPECIFICATIONS OF TYPICAL SYSTEM (See Specification bulletin at the rear of this bulletin)

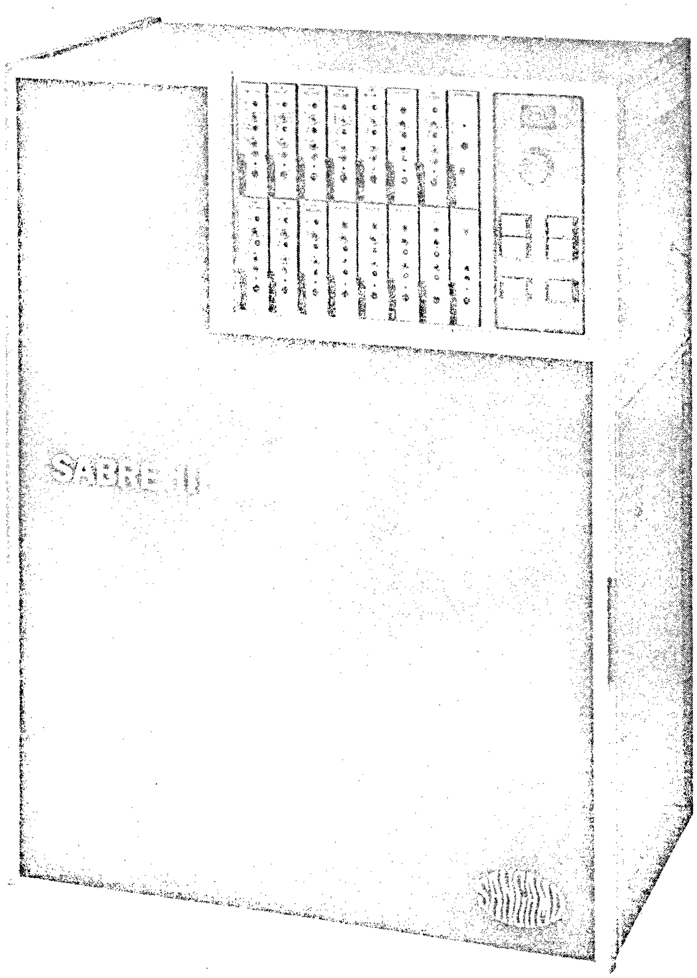


Figure 2. Typical SABRE III

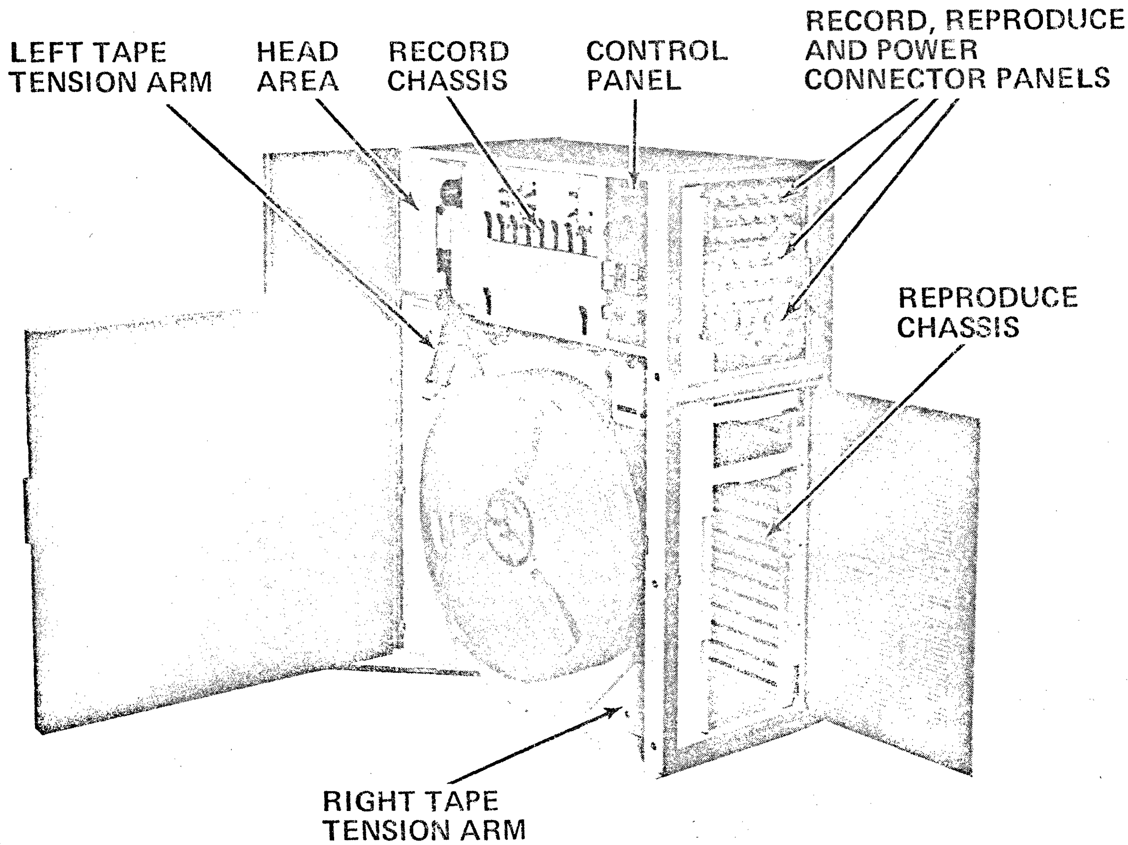


Figure 3. SABRE III With Front Operator Access Doors Open

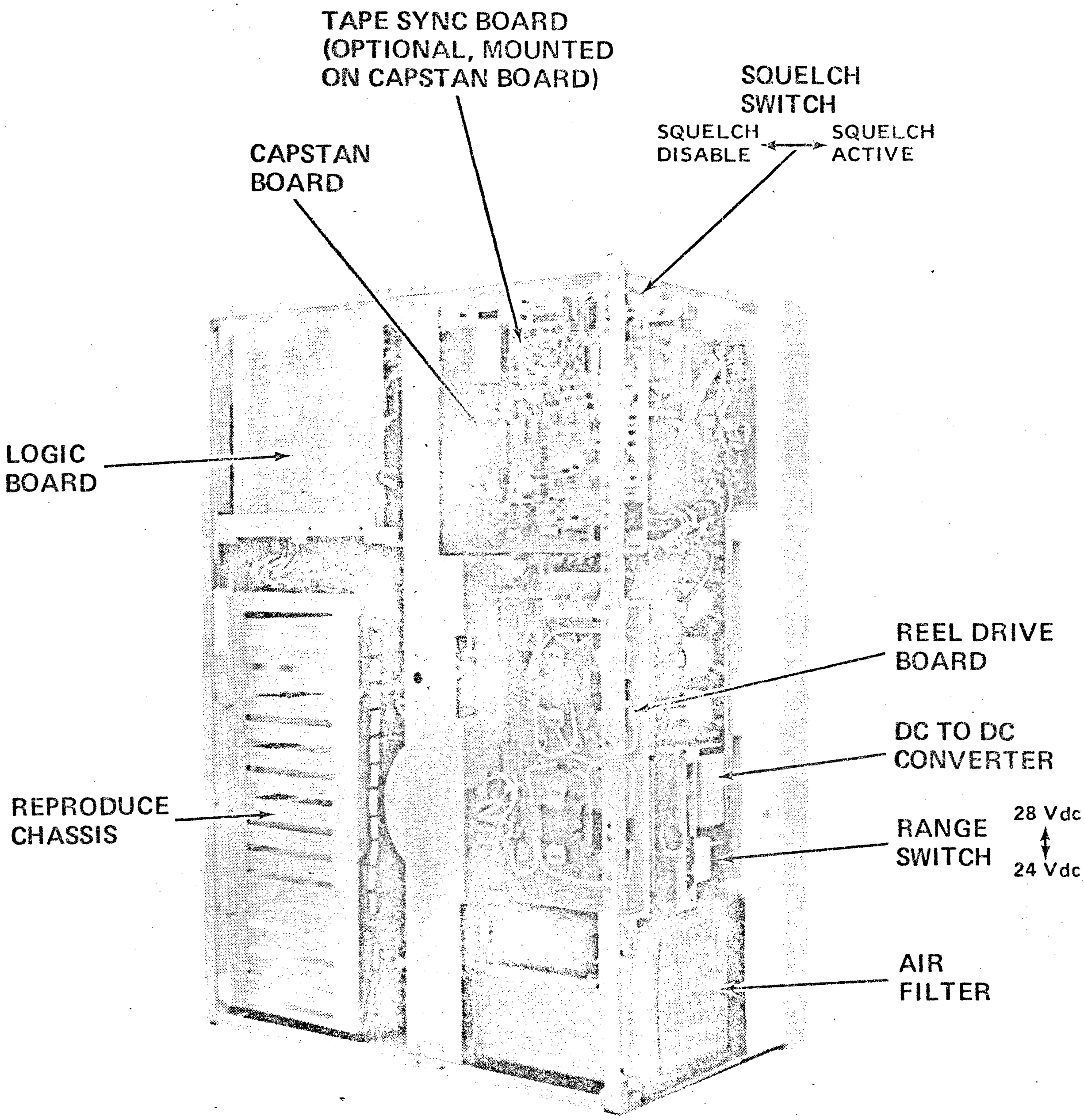
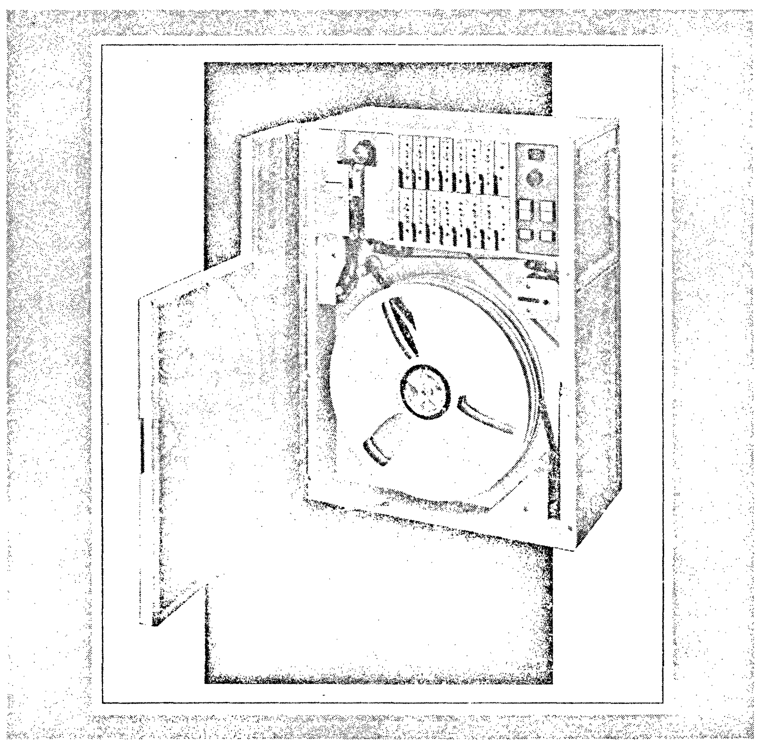


Figure 4. SABRE III, Cabinet Removed, Assembly Orientation

Bulletin 3207A

SABRE III



portable recorder/ reproducer specifications

SANGAMO: THE INNOVATORS OF TAPE INSTRUMENTATION
SANGAMO ELECTRIC COMPANY

SABRE III RECORDER/REPRODUCER SPECIFICATIONS

TAPE TRANSPORT

Tape Speeds: 120, 60, 30, 15, 7-1/2, 3-3/4, 1-7/8 ips or 60, 30, 15, 7-1/2, 3-3/4, 1-7/8, 15/16 ips. All speeds are electrically selectable and bi-directional.

Reel Size: Precision or NAB, 10-1/2, 14, 15 or 16 inch. Performances with precision reels.

Reel Locks: Non-detachable, 20° turn to lock. No removable parts.

Tape Width: 1/2 or 1 inch. Field change kits available.

Footage Counter: Linear 5 digit, bi-directional and resettable.

Tape Thickness: 1.0 or 1.5 mil base may be used interchangeably. Performances measured with Sangamo recommended tapes, IRIG 50 mil tracks, and in capstan synchronous mode.

Start and Stop Times: Less than 5 seconds for all record/reproduce speeds for 14 inch reels. Slightly longer with 15 and 16 inch reels.

Flutter:

Tape Speeds (ips)	Two Sigma Flutter %	Per IRIG 106-71 Bandwidth
120	0.20	0.5 Hz – 10 kHz
60	0.25	0.5 Hz – 10 kHz
30	0.30	0.5 Hz – 5 kHz
15	0.35	0.5 Hz – 2.5 kHz
7–1/2	0.40	0.5 Hz – 1.25 kHz
3–3/4	0.45	0.5 Hz – 625 Hz
1–7/8	0.50	0.5 Hz – 313 Hz
15/16	0.60	0.5 Hz – 156 Hz

Dynamic Interchannel Time Displacement Error (ITDE): Less than ±1.5 microseconds between outside even or odd tracks on one inch tape at 120 ips.

Rewind/Fast Forward Speed: 750 feet per minute for standard system.

Tape Loop Operation (Optional 117 V ac, 60 Hz only): 10 to 150 foot (60 through 15/16 ips) loops can be accommodated when rack mounted. Splice blanking available. Performances available for each application.

Controls: Illuminated pushbuttons for control of: Power, Stop, Record, Forward, Reverse, and Fast. Capstan Sync and Tape Servo Indicator Light. Rotary Tape Speed selector. Tape Speed selector also selects Direct reproduce equalization, FM center frequencies and filters automatically, for any seven adjacent system tape speeds. Provision is included for remote operation except power and speeds. Optional photo end-of-reel sensing and shuttle.

Tape Speed Accuracy: ±0.1% of selected tape speed.

REPRODUCE TAPE SERVO SYSTEM (Optional)

Reference Frequency: 400 kHz or 200 kHz selectable at 120 ips; submultiples at lower speeds. (Other frequencies on special order).

Reference Oscillator Stability: 1 part in 10^5 per day.

Speed Control Correction Rate: ±20% speed change per second without loss of synchronism.

Speed Control Correction Range: ±25% nominal speed, minimum.

Instantaneous Time Base Error (Observed over 10 second period):

Tape Speeds (ips)	TBE (Peak) (Microseconds)
120	± 0.50
60	± 0.50
30	± 0.60
15	± 1.00
7–1/2	± 2.00
3–3/4	± 4.00
1–7/8	± 8.00
15/16	±12.00

Auto Lock: Capstan servo automatically reverts to capstan synchronous mode with loss of tape reference or in record mode.

Long Term Speed Stability: ±0.001% referenced to record speed.

Servo Correction Bandwidth: 200 Hz at 7-1/2 ips.

Servo Sync Dropout Susceptibility: 6 dB dropouts will not cause loss of sync.

MAGNETIC HEADS

Track Geometry: Per IRIG 106-71. One-half inch head, 7 tracks interleaved with edge track A. One-inch head, 14 tracks interleaved with edge tracks A and B. Other formats available on special order.

Configuration and Polarity: Per IRIG 106-71.

Adjustable Reproduce Gap Azimuth: Within ±1 minute of arc standard with IRIG wideband channels.

DIRECT RECORD/REPRODUCE CHANNEL

Input Sensitivity: 0.2 to 10 V rms; adjustable in two ranges with vernier overlap to produce normal record level. Two position selector; 0.2 to 1.5 V, 1.5 to 10 V.

Nominal Input Level: 1.0 V rms.

Nominal Input Impedance: Two position selector; 10,000 ohms (high), 75 ohms (low), unbalanced to ground; shunted by less than 100 pF. Other values available.

Third Harmonic Distortion: IRIG recommended 1% at 10% of upper band edge frequency.

Frequency Response and Signal/Noise (rms/rms):

Tape Speeds (ips)	INTERMEDIATE BAND Bandwidth* (±3 dB)	S/N** (dB)
120	300 Hz – 600 kHz	38
60	200 Hz – 300 kHz	38
30	200 Hz – 150 kHz	37
15	200 Hz – 75 kHz	35
7–1/2	200 Hz – 38 kHz	34
3–3/4	200 Hz – 19 kHz	34
1–7/8	200 Hz – 10 kHz	34
15/16	200 Hz – 5 kHz	31
	WIDEBAND (Option I)	
120	400 Hz – 1.6 MHz	28
60	400 Hz – 0.8 MHz	28
30	400 Hz – 0.4 MHz	28
15	400 Hz – 0.2 MHz	28
7–1/2	400 Hz – 0.1 MHz	26
3–3/4	400 Hz – 50.0 kHz	26
1–7/8	400 Hz – 25.0 kHz	25
	WIDEBAND (Option II)	
120	400 Hz – 2.0 MHz	22
60	400 Hz – 1.0 MHz	22
30	400 Hz – 0.5 MHz	22
15	400 Hz – 0.25 MHz	22
7–1/2	400 Hz – 125 kHz	21
3–3/4	400 Hz – 62.5 kHz	20
1–7/8	400 Hz – 31.25 kHz	20

*All bands amplitude and phase equalized.
**With 18 dB/octave bandpass filter (per IRIG 106-71).

Optional Frequency Response: Wideband (options I and II) at 15/16 ips available on special order.

Output Level: Adjustable to 1.0 V rms into 75 ohms at normal record level.

Output Impedance: 50 ohms nominal, unbalanced to ground.

Group Delay Variation (120 ips): Less than ±250 nanoseconds from 100 kHz to 1.6 MHz.

FREQUENCY MODULATION RECORD/REPRODUCE CHANNEL

Input Sensitivity: 0.2 to 10 V rms; adjustable in two ranges with vernier overlap for full deviation. Three position selector; 0.2 to 1.5 V; 1.5 to 10.0 V, or TEST.

Nominal Input Level: 1.0 V rms.

Nominal Input Impedances: 125,000 ohms resistive (1.5 to 10 V range). 20,000 ohms resistive (0.2 to 1.5 V range). All shunted by less than 100 pF, unbalanced to ground. Other loading values available on special order.

Exclusive FM Density Selection (Optional): A two position switch electronically programs the center frequencies and FM filters to operate at the appropriate band and speed for any two adjacent bands. An X speed record/reproduce system in one band will be a (X-1) speed record/reproduce system in the adjacent band. Performances available for each application.

Tape Speeds (ips)	Center Frequencies (kHz)	(FA or LP) Filter* Response	S/N (dB)** (FA)
	IRIG LOW BAND		
120	108	DC – 20 kHz	52
60	54	DC – 10 kHz	51
30	27	DC – 5 kHz	50
15	13.5	DC – 2.5 kHz	49
7–1/2	6.75	DC – 1.25 kHz	48
3–3/4	3.375	DC – 0.625 kHz	46
1–7/8	1.688	DC – 0.312 kHz	46
	IRIG INTERMEDIATE BAND		
120	216	DC – 40 kHz	51
60	108	DC – 20 kHz	51
30	54	DC – 10 kHz	49
15	27	DC – 5 kHz	48
7–1/2	13.5	DC – 2.5 kHz	47
3–3/4	6.75	DC – 1.25 kHz	46
1–7/8	3.375	DC – 0.625 kHz	45
15/16	1.688	DC – 0.312 kHz	41
	IRIG WIDEBAND GROUP I		
120	432	DC – 80 kHz	48
60	216	DC – 40 kHz	48
30	108	DC – 20 kHz	48
15	54	DC – 10 kHz	47
7–1/2	27	DC – 5 kHz	47
3–3/4	13.5	DC – 2.5 kHz	46
1–7/8	6.75	DC – 1.25 kHz	44
15/16	3.38	DC – 0.625 kHz	40

*Flat Amplitude (FA) within 1 dB; Linear Phase (LP) +1, –3 dB.
**1 dB less with LP filters.

IRIG WIDEBAND GROUP II			
		Filter Response +	S/N (dB)
120	900	DC – 500 kHz	33
60	450	DC – 250 kHz	33
30	225	DC – 125 kHz	32
15	112.5	DC – 62.5 kHz	32
7–1/2	56.25	DC – 31.25 kHz	30
3–3/4	28.125	DC – 15.6 kHz	30
1–7/8	14.06	DC – 7.8 kHz	30

+ DC to 400 kHz +1, –3 dB
DC to 500 kHz +1, –6 dB

Transient Response (120 ips):

	Rise Time (Max)	Overshoot (Max)
500 kHz	2 Microseconds	15%
80 kHz (FA)	5 Microseconds	15%
80 kHz (LP)	6 Microseconds	2%

DC Drift: Less than ±0.5% of peak-to-peak deviation over an 8 hour period for 10°C after 15 minute warmup.

DC Linearity: Less than ±0.5% of peak-to-peak deviation referenced to best straight line.

Total Harmonic Distortion (All Speeds): Less than 0.5% for frequencies lower than $0.1F_{CO}$ for all IRIG low, intermediate, and wideband Group I; less than 1.0% for wideband Group II.

Output Level (Full Deviation): Adjustable to 1.0 V rms nominal into 75 ohms, with shortcircuit protection. (SCP).

Output Impedance: 50 ohms nominal, unbalanced to ground with SCP.

Output Squelch: Automatic for all speeds and activated from FM carrier detector or transport synchronous logic.

DIGITAL (PCM) WRITE/READ CHANNEL

Input Signal Level: 2 volts minimum, 50 volts maximum, peak-to-peak.

Input Formats Acceptable: NRZ-L, NRZ-M, NRZ-S, RZ; B1ϕ-L, B1ϕ-M, B1ϕ-S (serial only).

Input Signal Polarity: Positive, negative, or symmetrical about zero.

Input Impedance: 20,000 ohms (maximum) unbalanced to ground; shunted by less that 100 pF.

Record Mode: Non-bias recording.

Intermediate NRZ Bit Rates and Densities (Maxima)*:

	SERIAL MODE		PARALLEL MODE	
Tape Speeds (ips)	Bit Rate (KBPS)	Density (KBPI)	Bit Rate (KBPS)	Density (KBPI)
120	600	5	240	2
60	300	5	120	2
30	150	5	60	2
15	75	5	30	2
7–1/2	38	5	15	2
3–3/4	19	5	7.50	2
1–7/8	10	5	3.75	2
15/16	5	5	1.88	2

***Optional Bit Rates.** Higher serial and parallel bit rates for special applications with wideband heads optionally available. B1ϕ & RZ formats at half densities.

Dropout Rate: Maximum of 1 in 10^6 with recommended tape at 5 KBPI (serial) and 2 KBPI (parallel).

Output Level: 0 to +6; 0 to −6; or +6 to −6 volts, adjustable downward in each case into 1000 ohm load. TTL compatible.

Output Polarity: Logic "one" may be made either positive or negative with respect to logic "zero".

Output Format: NRZ-L, NRZ-M, NRZ-S, RZ; B1ϕ-L, B1ϕ-M, B1ϕ-S (serial only).

Output Rise and Fall Times: Less than 500 nanoseconds with 1000 ohm load shunted by 150 pF maximum.

Output Impedance: Less than 100 ohms, unbalanced to ground.

PHYSICAL CONFIGURATION

Size: 26 inches high by 19 inches wide by 11-1/2 inches deep. Additional enclosure required (7 inches high) for a 14 channel-7 speed FM switchable record/reproduce system.

DC Power: Switchable between 28±2 VDC and 24±2 VDC (15 and 16 inch reels not applicable on 24 VDC); optional DC power supply for operation from 47 to 440 Hz at 105 to 240 V ac.

DC Power Supply Size: 7 inches high by 19 inches wide by 11-5/8 inches deep.

Weight: Approximately 100 pounds. Optional DC power supply weighs approximately 40 pounds.

GENERAL

Environment: Designed for laboratory, field van, shipboard, automotive and aircraft.

Temperature: Operating Range 5° to 50°C.

Humidity: 5 to 95% relative, non-condensing.

Altitude: 30,000 feet operating; 70,000 feet non-operating.

Standard Colors: Front door and cabinet – Olive. Front trim and card fronts – Beige.

Other Optional Features: Monitor oscilloscopes, FM calibrators, edge voice annotation (local or rack mounted type with speaker), remote control (hand held) or rack mount type), edge track timing, FM re-recording, HDDR PCM encoder, sequential record/reproduce, peak reading monitor meters, head degausser, anti-vibration kits, rack mount kits, special paint, special cabinets, casters with anti-tilt platform, lifting eye bolts, protective covers.

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0273
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Specifications are as of February 15, 1973, and are subject to change without notice.

SANGAMO ELECTRIC COMPANY
DATA SYSTEMS
Box 3347, Springfield, Illinois 62714
217-544-6411

Sangamo

INSTALLATION

GENERAL

Upon delivery of a system to a customers facility, Sangamo provides a "LITE-OFF" (startup) service performed by an authorized Sangamo service engineering representative. This is provided to ensure the system was not affected by shipment and that all contract requirements have been met; as well as familiarizing the customer with the equipment and instruction manuals. Upon receiving the system initially, as shipped from the factory, the Sangamo Service Engineering Department should be contacted concerning "LITE-OFF", unless prior arrangements have been made.

For installation checkout ("LITE-OFF") of systems delivered in the U.S.A. call collect to:

Sangamo Electric Company
P.O. Box 3347
Springfield, Illinois 62708
Tel. 217-544-6411
Ext. 352 Service Engineering

SITE SELECTION

Overall dimensions of the 3600,SABRE III, Recorder / Reproducer are shown in figure 1. If the auxiliary chassis and/or power supply are not supplied, ignore that information. When choosing a site for the installation, ensure enough space is provided for adequate clearance of front and back openings. Ensure the air vent openings are not obstructed, allowing the proper flow of air. Also ensure the unit will not be subjected to exceptionally strong magnetic fields, damaging vibrations, dirt or debris.

INSTALLATION REQUIREMENTS

The recorder/reproducer is ready to install as received. Place the main cabinet on top of the power supply unit (if supplied). The depressions in the black mounting feet fit over the metal projections on the top of the power supply. Place the auxiliary chassis (if supplied) on top of the main cabinet and secure it using the metal clasps fastened on both sides of the auxiliary chassis.

POWER REQUIREMENTS

a. **GENERAL** – The SABRE III, 3600, Recorder/Reproducer requires either 28 Vdc ± 2 Vdc or 24 Vdc ± 2 Vdc at a load of 480 to 840 watts. An optional power supply is available permitting operation from a variety of AC power sources. Refer to the configuration sheet (first page in this manual) to note the power supply supplied.

Note, a range switch, located on the left side of the recorder/reproducer, must be changed when switching from 28 to 24 Vdc input or vice versa.

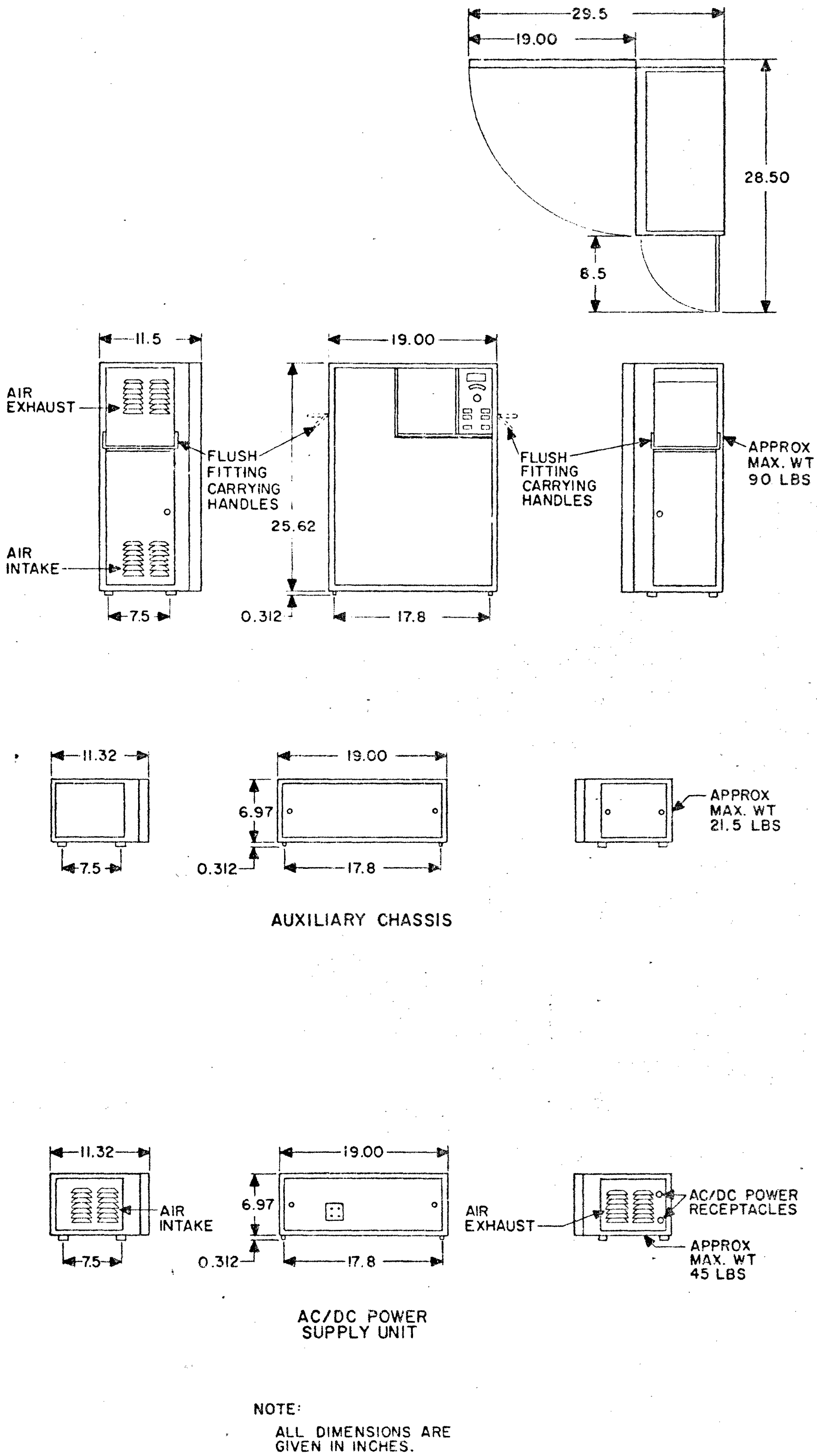


Figure 1. Mounting and Outline Dimensions

b. POWER CONNECTIONS

(1) **WITHOUT OPTIONAL POWER SUPPLY** — When no optional power supply is supplied, it is necessary for the customer to connect the recorder/reproducer to the available DC supply. A power cable may be supplied if ordered by the customer, in which case simply connect it between the POWER connector and the customers available supply observing correct polarity. If no power cable is supplied, complete the following steps.

Step 1. Locate the four pin power connector (normally shipped with the accessories).

Step 2. Remove the hood from this connector.

Step 3. Using sufficient lengths of wire, slip the hood onto the wires and make the following connections:

#14 gage wire to Pin B (+ 28 Vdc) } special,for
#14 gage wire to Pin D (- 28 Vdc) } blower fan
#14 gage wire to Pin A (+ 28 Vdc)
#14 gage wire to Pin C (- 28 Vdc)
#18 gage wire to connector case. (earth ground)

CAUTION

Insure that proper connections are made with no possibility of shorting.

NOTE

Use different colors of wire to distinguish polarity.

Step 4. Slide the hood onto the connector and secure it.

Step 5. Terminate the three wires to the available DC supply observing correct polarity.

(2) **WITH OPTIONAL POWER SUPPLY**

Step 1. Locate the supplied power cable (normally shipped in the air filter cavity of the power supply).

Step 2. Connect this power cable between the power supply and the main power panel, refer to figure 2.

Step 3. Connect the power cord for the power supply to the available AC supply.

SIGNAL CABLE CONNECTIONS

a. **RECORD** — The data signals to be recorded are to be connected to the standard BNC connectors on the record connector panel. The reference signal should be connected to the proper channel if tape synchronous is to be utilized, refer to figure 2.

b. **REPRODUCE** — The reproduce signals appear at the BNC connectors on the reproduce connector panel during the reproduce process. The tape synchronous signal must be applied to the TAPE BNC connector on the power connector panel, refer to figure 2.

INSPECTION

a. GENERAL

Step 1. Check the dust covers for dents or cracks in the glass.

Step 2. Check the cabinet for dents or scratches.

Step 3. Check the tape-tension arms for free movement.

Step 4. Check that the fuses are in place and are of the proper value. Refer to table 1, fuse information.

TABLE 1. FUSE INFORMATION

LOCATION	DESIGNATION	RATING	FUNCTION	PART NO.
Rear of Transport	F1	ABC-20A	Primary DC Power	859774-001
Rear of Transport	F2	F02B-3A	Capstan Motor Power	821926
Left Side of Transport	F3	AGX-8A	DC to DC Power	510279-004
Optional Power Supply Unit	F1	ABC-10A (110 V input)	Primary AC Power	859774-008
		ABC-5A (220 V input)		859774-005
Optional Power Supply Unit	F2	ABC-20A	+28 Vdc output	859774-011

b. CABLE ASSEMBLIES – When the system is installed ensure the following cable connections have been made properly. Refer to figure 2

TABLE 2. CABLES REQUIRED AND SUPPLIED *

FUNCTION	FROM	TO
AC Primary Power (using Optional DC power supply)	Customers AC Source	DC Power Supply
DC Primary Power	DC Power Supply or Customers DC source	Transport Power & Control Connector Panel, Power Connector
Remote Control**	Optional Remote Control Unit	Transport Power & Control Connector Panel, Remote Connector
Record Tape Sync Ref Signal ***	Record Connector Panel, REF Connector	Record Connector Panel, Ref Channel Input (normally even channel)
Reproduce Tape Sync Ref Signal***	Reproduce Connector Panel, Ref Channel Output	Transport Power & Control Connector Panel, TAPE Connector
Record Monitor***	Record Connector Panel Monitor Output Connector	Monitor Device (calibration/monitor meters, scope, etc.)
Reproduce Monitor***	Reproduce Connector Panel and/or Auxiliary Reproduce Connector Panel, Monitor Connector	Monitor Device (calibration/monitor meter, scope, etc.)

* Including all options

***Optional

** If remote control panel is not used, the remote jumper plug must be inserted into the REMOTE jack on the Power & Control Panel before proper operation can be achieved.

NOTE

For voice and edge track cable connections refer to the voice or edge track bulletin in the optional items section.

TABLE 3. CABLES REQUIRED BUT NOT SUPPLIED

FUNCTION	FROM	TO
Record Signals Input	Customers Data Source	Record Connector Panel (normally BNC)
Reproduce Signals Output	Reproduce Connector Panel and/or Auxiliary Reproduce Connector Panel (normally BNC)	Customers Analyzing Equipment.

INSTALLATION SUMMARY

Upon completion of the inspection procedures the user is strongly urged to thoroughly familiarize himself with the equipment, by using this technical manual. Refer to the configuration sheet and contents with list of effective bulletins (front of manual) to determine what the system contains and what bulletins are applicable for this particular configuration.

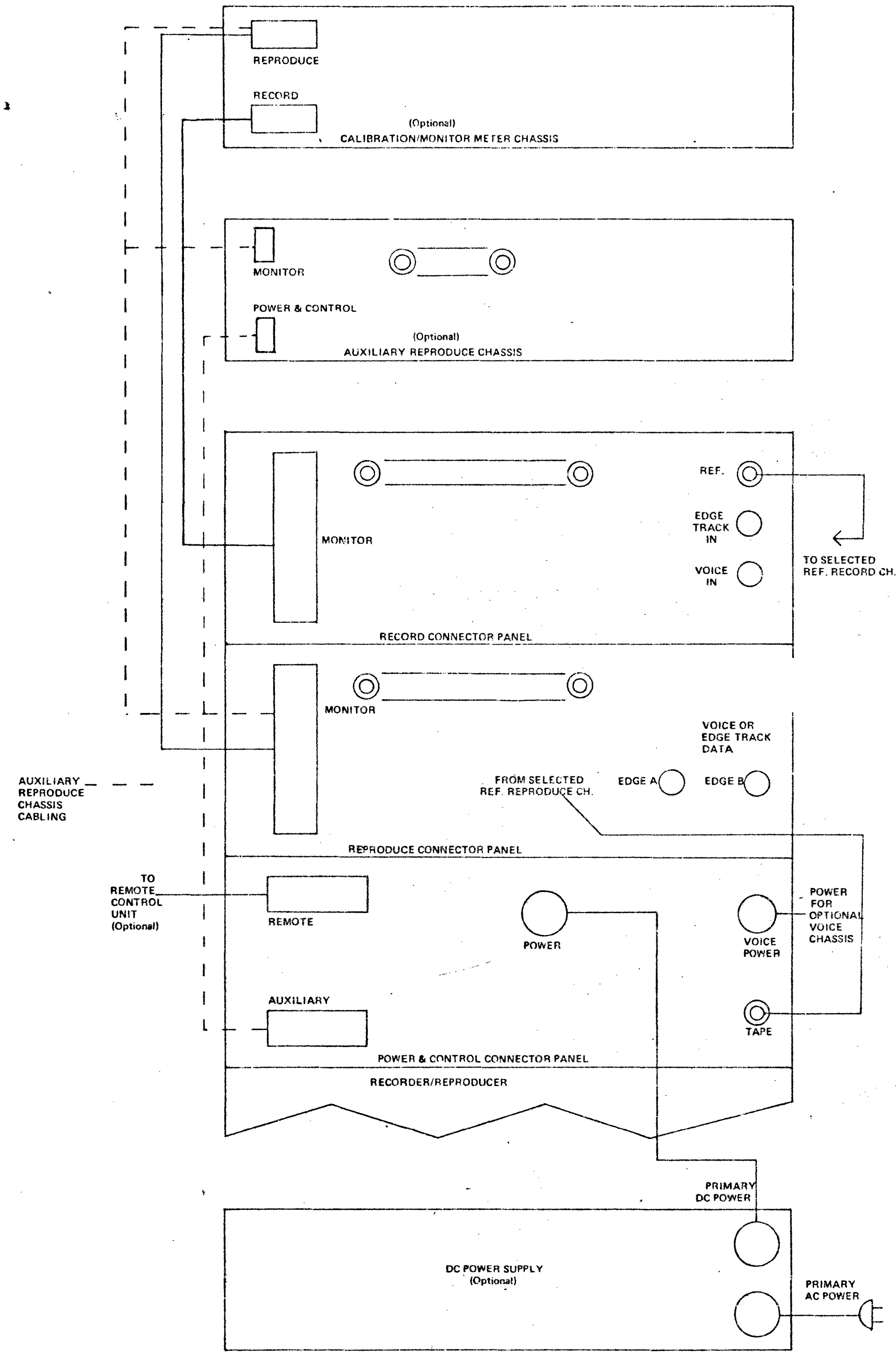


Figure 2. Typical Installation Cable Connections (right side of cabinet)

Sangamo

OPERATOR'S DATA

GENERAL

This bulletin contains the information required to sufficiently operate this Sangamo recorder/reproducer. Information contained consists of description of controls and indicators, tape threading, operating procedures, operator's theory, operator's maintenance, and system performance measurements. Additional and/or more detail operator information for certain subassemblies, optional features, etc., may be found in the appropriate bulletin in the maintenance section. Consult the contents and list of effective bulletins, and configuration sheet at the front of this manual for variable standard items and options present on this particular recorder/reproducer.

TABLE 1. TAPE RECORD TIME WITH FOOTAGE INDEX*

Reel Size (inches)		10-1/2	10-1/2	10-1/2	14	14	14
IRIG Bandwidth**		1 & 2	1 & 2	3	1 & 2	1 & 2	3
Base Thickness (mils)		1.5	1.0	1.0	1.5	1.0	1.0
Length (feet)		2500	3600	4600	5000	7200	9200
Tape Speed (ips)	120	4.2M	6M	7.65M	8.3M	12M	15.3M
	60	8.3M	12M	15.3M	16.6M	24M	30.7M
	30	16.6M	24M	30.6M	33.3M	48M	61.3M
	15	33.3M	48M	1.0H	66.6M	96M	2.0H
	7-1/2	66.6M	96M	2.0H	2.2H	3.2H	4.1H
	3-3/4	2.2H	3.2H	4.1H	4.4H	6.4H	8.2H
	1-7/8	4.4H	6.4H	8.2H	8.8H	12.8H	16.4H
	15/16	8.8H	12.8H	16.4H	17.6H	25.6H	32.8H

*To nearest 1/10 minute (M) or 1/10 hour (H), reel to reel **1. Low
2. Intermediate
3. Wideband

DESCRIPTION OF CONTROLS AND INDICATORS

a. GENERAL – The operator controls and indicators are generally located in the following three areas; (1) AC to DC power supply control panel (optional) at the base of the unit, (2) tape transport control panel, at the right front of the unit, and (3) R/R signal boards. Optional or additional features may or may not require additional operator controls or indicators. Refer to the optional items section, in the maintenance section, to ascertain this.

When the calibration/monitor meter panel (optional) is supplied, it will normally be located above the transport in a separate enclosure. The calibration/monitor meter panel contains db meters which are connected to the monitor outputs of the record and reproduce chassis. Normally a db meter is supplied for each channel of signal electronics and the voice channel (if supplied). Switches on the front panel provide for selection between FM RECORD, DIRECT RECORD, and REPRODUCE. Each db meter, for record, is calibrated to read 0 db for the optimum direct record level (.1 Vrms at REC LEV testpoint) and the proper FM deviation level (±40% or ±30%). During reproduce the db meters are calibrated to read 0 db for 1 Vrms.

b. AC to DC POWER SUPPLY (OPTIONAL)

POWER on-off toggle switch (up-on, down-off)	Controls the application of AC power to the power supply unit, thus controlling the +28 Vdc output of the supply.
28 VOLT INDICATE LAMP	Indicates, when lit, +28 Vdc is present at the power supply output.
28 VOLT RESET SWITCH	Provides for reestablishing +28 Vdc after an overload is sensed and the 28 VOLT INDICATE is not lit.

c. TAPE TRANSPORT

TAPE indicator lamp (always present but functional only with the tape sync option)	Indicates, when lit, tape speed is being controlled by a tape reference signal recorded on tape (optional feature).
SYNC indicator lamp	When individually lit, indicates tape speed is being controlled by tachometer reference signal. Should always be lit when the TAPE indicator lamp is lit.
POWER indicating pushbutton	Controls the application of primary power to the recorder/reproducer. When lit, 24-30 Vdc is applied to all primary power circuits.
SHUTTLE indicating switch (optional)	Used to activate the shuttle control circuitry.
E.O.T. (end-of-tape sense)	Used to activate the end-of-tape sense circuitry.
FWD (forward) indicating pushbutton	Initiates forward tape motion (reels turning clockwise). Indicates forward tape motion when lit.
RANGE switch (dc to dc converter, left side of unit - up is 28 Vdc down is 24 Vdc).	Selects between accepting 28 Vdc power input and 24 Vdc power input.

REV (reverse) indicating pushbutton	Initiates reverse tape motion (reels turning counterclockwise). Indicates reverse tape motion when lit.
FAST indicating pushbutton	Initiates the fast mode after tape direction has been established. Indicates, when lit, tape is moving at the fast speed (faster than 120 ips).
RECORD indicating pushbutton	Initiates the record electronics when depressed and tape is moving at the selected speed. Indicates, when lit, power is supplied to the record electronics.
STOP indicating pushbutton	Stops tape motion when depressed or applies reset power to the reel drive servos. Indicates machine is ready for operation when lit.
SQUELCH selector switch (from the rear of the unit, switch position to the left squelch is disabled and to the right is squelch active).	Provides for disabling the servo squelch feature utilized by the FM reproduce boards.

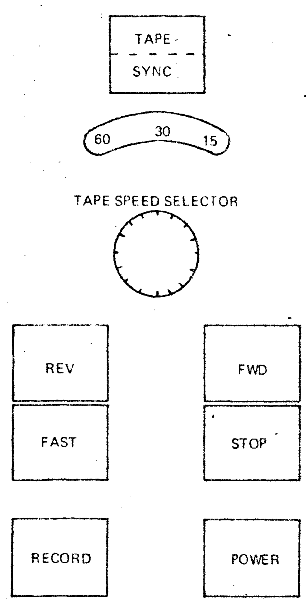


Figure 1. Transport Control Panel

Tape Speed Selector	Establishes the tape movement speed.
DENSITY switch (transport connector panel).	Selects between HIGH or LOW density determining the frequency of the reference signal to be recorded on tape (optional tape sync).
TAPE FOOTAGE COUNTER indicator	Indicates the number of feet passing the capstan.

d. RECORD/REPRODUCE SIGNAL CHASSIS AND SIGNAL BOARDS

1. CHASSIS (contains no operator controls)

2. DIRECT R/R BOARDS (front panel unless otherwise stated)

(a) DIRECT RECORD BOARD (part no. 857033)

RANGE switch	Selects between two standard input level ranges (0.2 to 1.5 Vrms and 1.5 to 10 Vrms).
REC ADJ control	Adjusts the input signal to the board providing the capability of obtaining the direct normal record level (optimum head current) at REC LEV testpoint .
Ƶ switch	Selects between two standard input impedance ranges (LO-75 ohms, HI 10K ohms).

(b) DIRECT REPRODUCE BOARD (part no. 857218)

OUTPUT LEVEL control	Adjusts the output reproduce signal level from the board.

(c) DIRECT REPRODUCE BOARD (part no. 836083, amp and phase equalization)

OUT ADJ control	Adjusts the output reproduce signal level from the board.

3. BIAS OSCILLATOR BOARD (front panel)

BIAS OFF switch	Interrupts the bias signal passing to any or all record electronics (including voice).

4. FM R/R BOARDS (front panel unless otherwise stated)

(a) FM RECORD BOARD (part no. 835326)

ZERO control	Adjusts the carrier frequency generated by the VCO.
RANGE switch	Selects between two input level ranges (0.6 to 2.5 V peak and 2.5 to 12.5V peak) and the test position (shorted input).
IN ADJ control	Adjusts the input signal level to the board, providing the capability of obtaining the proper percent deviation (±40% or ±30%) from the carrier frequency.
Z switch	Selects between two standard input impedance ranges (LO-75 ohms, HI-20K ohms).

(b) FM RECORD BOARD (part no. 836161)

RANGE switch	Selects between two input levels ranges (0.2-1.5Vrms and 1.5-10 Vrms) and the test position (shorted input).
IN ADJ control	Adjusts the input signal level to the board, providing the capability of obtaining the proper percent deviation (±40% or ±30%) from the carrier frequency.
CF (carrier frequency) control	Adjusts the carrier frequency generated by the VCO.
RE-REC (re-record) switch (optional)	Provides selection for type of signal to be recorded. ON provides capability of recording a modulated carrier signal reproduced from another FM track.

(FM reproduce board). OFF provides capability of recording a standard ac or dc signal.

(c) FM REPRODUCE BOARD (part no. 857215)

OUT LEV control	Adjusts the output reproduce signal level from the board.

(d) FM REPRODUCE BOARD (part no. 836154)

OUT LEV control	Adjusts the output reproduce signal level from the board.
RE REC (re-record) switch (optional)	Provides selection of signal form at the board output. ON provides a modulated carrier at the board output (BNC) for re-recording purposes on another FM channel. OFF provides the standard output of a detected and filtered signal.
SQUELCH indicator	Indicates, when lit, the board output is squelched (output signal is not present) by lack of proper servo control speed or possibly lack of carrier.
ZERO control (on filter unit)	Adjusts the board output for 0 Vdc with only carrier input (no modulated carrier input).

5. PCM (Pulse Code Modulation) WRITE/READ BOARDS (front panel unless otherwise stated)

(a) PCM WRITE BOARD (part no. 835982)

BAL control	Adjusts the input to accept positive or negative theshold levels (dc offsets of input data).
DELAY control	Adjusts a delay to compensate for small "gap scatter" and "fixed skew" errors associated with the write head gaps and alignment.
RECORD control	Adjusts the record current applied to the record head to obtain optimum record level.

(b) PCM READ BOARD (part no. 835984)

GAIN control	Adjusts the input level to the board from the reproduce head and pre-amplifiers.
TRIG control	Adjusts the plus and minus firing voltage levels of the Schmitt trigger, for symmetry.
DELAY control	Adjusts the static skew and gap scatter compensation delay.
OUT control	Adjusts the output level from the board.

(c) PCM CLOCK BOARD (part no. 835988)

GATE WIDTH control	Adjusts the length of the system "SKEW GATE" pulse, (virtual clock).
OUTPUT control	Adjusts the clock board output amplitude.

(d) ENCODER BOARD (high density, part no. 836277)

DATA ADJUST	Adjusts the input data reference level for the input trigger circuit.
CLOCK ADJUST	Adjusts the input clock reference level for the input trigger circuit.
RECORD LEVEL ADJUST	Adjusts the record current applied to the record head to obtain optimum record level.

6. VOICE/EDGE A/B RECORD/REPRODUCE BOARDS (front panel unless otherwise stated).

(a) VOICE RECORD BOARD (part no. 856477)

ON/OFF microphone switch	Activates record board and applies bias signal (annotate feature).
VOLUME microphone control	Adjusts output signal level of microphone.
VOICE/TIMING switch (side of board)	Selects between either voice record (annotate feature) or timing record (no annotate feature, power on continuously with RECORD lit).

A/B TRACK SELECTION switch (side of board)	Selects which track, A or B, voice is recorded on.

(b) EDGE A/B RECORD BOARD (part no. 835661)

ON/OFF microphone switch	Activates record board and applies bias signal (annotate feature).
VOLUME microphone control	Adjusts output signal level of microphone.
A/B TRACK SELECTION switch	Selects either A-time code, B-voice, or A-voice, B-time code.
TIME CODE REC ADJ	Adjusts the input signal level to the time code record circuitry on the edge A/B record board.

(c) VOICE/EDGE A/B REPRODUCE BOARD (part no. 856772)

VOLUME control (front panel)	Adjusts the output reproduce signal level from the board.
VOLUME CONTROL (speaker amp enclosure)	Adjusts the signal level to the speaker amp input.

TAPE THREADING

The following procedures, with figure 2, provide the necessary information to correctly thread the recorder/reproducer, in the reel to reel fashion.

Refer to the loop adapter bulletin, maintenance section, for threading diagram and instructions concerning the optional loop adapter.

Step 1. With the power indicating lamp off (power supply unit) or the POWER indicating pushbutton off (control panel), align all the guiding pins on the dual hub. This action will lock the two hubs so that they will not turn independently.

Step 2. By aligning the slots on a full reel of tape with the guiding pins on the hub, place the full reel onto the inner hub. The tape should feed off when the reel turns clockwise (in the forward mode).

Step 3. While holding the reel with one hand, turn the inner hub 20°clockwise until the hub locks the reel into position.

Step 4. To release the hubs from each other, turn the locking pin (the pin in the 1-1/4 inch slot) counterclockwise while holding the squared guiding pin which is located directly behind the locking pin.

Step 5. Place an empty reel onto the outer hub and lock it in place by holding the reel and turning the hub 20°clockwise until secured.

Step 6. Refer to the tape threading diagram and thread the tape over guide #1 and below the lower tape tension arm.

Step 7. Continue with the tape over the right side of the footage counter and the tape sense post, over the right translation post, and under the left translation post.

Step 8. Thread the tape up (to the left of guide #2) between the capstan and the right pinch roller, over the record head and around the inertia dampening roller, then down past the reproduce heads, between the capstan and left pinch roller, and to the right of guide #3.

Step 9. Continue with the tape below the upper tape tension arm, over guide #4, and onto the empty outer reel for several turns.

Step 10. Inspect the entire tape path to ensure that the tape is threaded and aligned correctly.

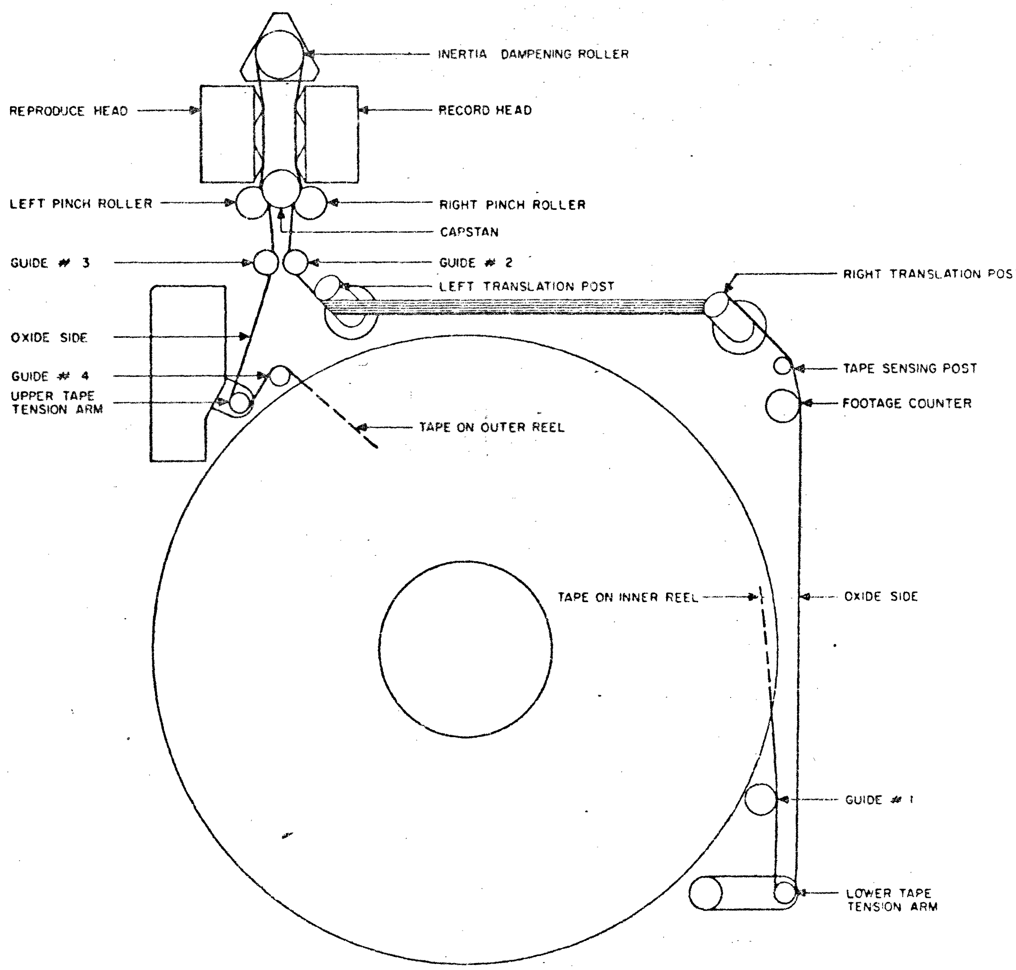


Figure 2. Tape Threading Diagram (reel to reel)

OPERATING PROCEDURES

a. POWER APPLICATION – Primary dc power (24-30 Vdc) is applied to the transport by depressing the POWER pushbutton switch (alternate switch) on the transport control panel. If the optional AC to DC power supply is being used ensure the POWER toggle switch is placed to the ON position.

CAUTION

Ensure that proper power connections are made to the recorder/reproducer as explained in the Installation Bulletin. If an optional power supply is being used, refer to the applicable bulletin for information. If remote control is not being used, the remote connector MUST be inserted into the REMOTE jack on the Power Connector Panel.

Always make certain the dc to dc converter's (left side of recorder/reproducer) range switch is positioned properly (24 Vdc or 28 Vdc) for the input dc voltage to the system.

CAUTION

Always remove POWER prior to switching input voltage ranges with the dc to dc converter range switch.

b. TAPE TRANSPORT – The following information is provided to properly move tape in the standard modes. For optional or special modes (shuttle, tape sync, etc) refer to later paragraphs and possibly bulletins in the maintenance section.

Step 1. After initial application of power, or if a condition of loose tape exists, the STOP lamp will not be lit, in which case STOP should be depressed and held in until it is lit. This action applies reset power to the reel drive servos and prepares the tape path for correct operation. With an extreme slack tape condition the STOP mode button should be pulsed (pressed numerous times in succession) to prevent tape breakage or misaligned tape while feeding to the reel.

NOTE

After application of power, a 20 second warm-up period (with STOP lamp lit) is suggested for stablization of the tape control logic.

Step 2. Whenever the POWER lamp is lit, power is applied to the reproduce electronics. Therefore, it is only necessary to depress FORWARD or REVERSE (allow a few seconds to obtain a phase lock speed control condition to deactivate the FM squelch circuit) to reproduce data at the selected speed. See additional reproduce operating instructions in the Reproduce bulletins, maintenance section.

Step 3. To record information, ensure STOP is lit and depress the RECORD and either FORWARD or REVERSE pushbuttons. The FORWARD or REVERSE pushbutton must be released before the RECORD pushbutton is released. See additional record operating instructions in the Record bulletins, maintenance section.

NOTE

The machine is recording only when the RECORD indicator is lit.

Step 4. To move tape in the FAST mode, depress the direction pushbutton (FORWARD or REVERSE) and then depress the FAST pushbutton. To enter the FAST mode in the same direction as tape is moving, simply push FAST.

Step 5. When in the FAST mode, and the operator wishes to enter the RECORD or REPRODUCE mode, simply push FORWARD or REVERSE as applicable (RECORD must also be depressed for recording).

Step 6. To stop all tape motion, depress STOP. It is not necessary to depress STOP when switching from one mode to another.

c. RECORDING – Recording information onto magnetic tape for storage may be performed in either direction at any available tape speed. Refer to the general information bulletin for record specifications. In order to record the following conditions must be met: (1) Tape must be threaded in accordance with the tape threading procedures (previous paragraph); (2) Proper signal electronics must be installed into the track numbers desired for use; (3) Proper input signal connections must be made in accordance with the installation section; and (4) Record electronics must be adjusted properly for the signal to be recorded. Refer to the maintenance section bulletins for more detail board calibration.

NOTE

If tape synchronous speed control is to be used during the reproduction of tapes being recorded, refer to the applicable paragraphs, found in later portions of this section, before attempting to record.

CAUTION

TAKE THE FOLLOWING PRECAUTIONS TO AVOID MAGNETIZING THE HEADS: (1) REMOVE OR REPLACE SIGNAL BOARDS ONLY WHEN POWER HAS BEEN REMOVED. (2) DO NOT MAKE OR BREAK SIGNAL INPUT OR RECORD HEAD LEAD CONNECTIONS WITH RECORD LAMP LIT; AND (3) DO NOT TEST CONTINUITY OF THE HEADS WITH AN OHMMETER OR ANY SIMILAR TESTER.

1. CHASSIS

Step 1. Refer to the Record Chassis bulletin, in the maintenance section, typical board placement versus head channel.

2. DIRECT RECORD

Step 1. Check that STOP is lit and depress RECORD.

Step 2. If the Calibration/Monitor Meter panel (optional) is supplied set the proper channel selection switch to the DIRECT RECORD position and adjust the REC ADJ control, of the applicable direct record board, for a 0 db reading on the associated db meter. The calibration/monitor meter is calibrated to indicate 0 db for the direct normal record level (optimum).

Step 3. If the Calibration/Monitor Meter option is not supplied, connect an AC VTVM between the red test point, REC LEV, and the black testpoint, GRD, on the applicable direct record board. Adjust the REC ADJ control for a .1 Vrms reading on the VTVM, producing the direct normal record level.

Step 4. Select the desired tape speed.

Step 5. Depress the desired direction pushbutton, FWD or REV, and REC, releasing the FWD or REV pushbutton before REC. Ensure both lamps are lit.

3. FM RECORD

Step 1. When the optional FM density change kit is supplied, refer to information in the optional items section.

Step 2. Check that STOP is lit and depress RECORD.

Step 3. If the Calibration/Monitor Meter panel (optional) is supplied set the proper channel selection switch to the FM RECORD position and adjust the IN ADJ control, of the applicable FM record board, for a 0 db reading on the associated db meter. The calibration/monitor meter is calibrated to indicate 0 db for the proper percent deviation.

Step 4. If the Calibration/Monitor Meter option is not supplied connect an AC VTVM between the red testpoint, IN and the black testpoint, GRD, on the applicable FM record board. Adjust the IN ADJ control for a Vrms reading corresponding to the value listed on the head characteristic sheet at the front of this manual.

Step 5. Select the desired tape speed.

Step 6. Depress the desired direction pushbutton FWD or REV, and REC, releasing the FWD or REV pushbutton before REC. Ensure both lamps are lit.

Step 7. If re-record is supplied (not applicable on early models) and to be used, set the re-record switch to the ON position and ensure the pre-modulated signal is applied to the board input.

d. REPRODUCING – Reproducing information previously recorded on magnetic tape may be performed in either direction at any available tape speed. Refer to the general information bulletin for reproduce specifications. In order to reproduce information the following conditions must be met: (1) The proper tape (containing recorded information) must be threaded in accordance with the tape threading procedures (previous paragraph prior to operating procedures); (2) Proper signal electronics must be installed into the track numbers for use (ensure the proper reproduce board complement of the type signal recorded is used); and (3) Proper output signal connections must be made in accordance with the installation section. Refer to the maintenance section for detail board calibration.

NOTE

If tape synchronous speed control is to be used during reproduction of recorded tapes, refer to the applicable paragraphs found in later portions of this section before attempting to reproduce.

1. CHASSIS

Step 1. When the optional FM density change kit is supplied, refer to information in the optional items section.

Step 2. The squelch circuit must be functioning properly as determined by the speed control system adjustment. Particular emphasis is placed on the 45° phase angle. This must be exactly 45° to ensure proper operation of the squelch circuit (output reproduce signal shorted to ground during STOP, slewing speeds, or any period when the speed is not correct). Later models may contain a squelch selector switch (located on the capstan board).

Step 3. Refer to the Reproduce Chassis bulletin, in the maintenance section, for standard single chassis board placement versus head channel and/or double chassis board placement versus head channel.

2. DIRECT REPRODUCE (7 speeds)

Step 1. Remove all power and remove the reproduce board(s) intended for use.

Step 2. Check the board(s) for correct speed equalizers as well as their correct location on the board. Refer to the maintenance section for board component location and information concerning equalizers.

Step 3. Re-install the boards properly, depress POWER and STOP, and select the desired tape speed (keeping in mind the speed equalizers available).

Step 4. If the Calibration/Monitor Meter panel (optional) is supplied set the proper channel selection switch to the reproduce position. The Calibration/Monitor Meter is calibrated to indicate 0 db with the presence of 1 Vrms.

Step 5. Depress FWD or REV as desired and adjust the applicable reproduce board OUTPUT LEVEL for the desired output.

Step 6. If the optional Calibration/Monitor Meter panel is not supplied, connect an AC VTVM to the proper output connector, or board output testpoint if applicable, and adjust the OUTPUT LEVEL as desired.

3. FM REPRODUCE (3 speeds)

Step 1. Remove all power and remove the reproduce board(s) intended for use.

Step 2. Check the board(s) for correct speed equalizers, timing capacitors, and filters, as well as their correct locations. Check also the speed matrix connections on the board. Refer to the maintenance section for board component locations, matrix connections, and information concerning equalizers, timing capacitors, and filters.

Step 3. Re-install the boards properly, depress POWER and STOP and select the desired tape speed (keeping in mind the speed equalizers, timing capacitors, and filters available).

Step 4. If the Calibration/Monitor Meter panel (optional) is supplied set the proper channel selection switch to the reproduce position. The calibration/monitor meter is calibrated to indicate 0 db with the presence of 1 Vrms.

Step 5. If the optional Calibration/Monitor Meter panel is not supplied, connect an AC VTVM to the proper output connector, or output testpoint if applicable, and adjust the OUT LEVEL as desired.

4. FM 4-7 SPEED EXPANDER (4 speeds) — This board is used in conjunction with FM reproduce (3 speed) board to provide more than three FM reproduce speeds. The only operator requirement is the proper placement of this board with the associated FM reproduce board. The FM reproduce board must be placed in the odd numbered chassis positions (odd board chassis positions) and the expander in the next even numbered chassis position (even board chassis position). The equalizers, timing capacitors, and filters must also be checked to ensure those speed dependent components are available for those speeds desired. Refer to the maintenance section for component locations and information concerning filters, equalizers, ning capacitors, and other speed dependent components.

e. TAPE SYNCHRONOUS SPEED CONTROL (optional) — In order to utilize the optional tape sync method of speed control the reference signal must be recorded on an even numbered direct or FM re-record record data track (tracks 6 or 8 are suggested for 1 inch and 2 or 4 for 1/2 inch) at the same time of normal recording. The following procedures are to be followed in utilizing the tape sync option (tape sync board is optional). Refer to the maintenance paragraphs and maintenance section for tape sync board setup and calibration.

1. REFERENCE RECORDING

Step 1. Ensure a BNC to BNC cable is connected from the REF connector (Power and Control Panel) to the input BNC connector of the proper direct or FM re-record record channel (6 or 8 - 1 inch, 2 or 4 - 1/2 inch). Place a jumper board in the associated reproduce board position.

Step 2. Place the reference density switch (Power and Control Panel) to the desired position (HI - 400 kHz, LO - 200kHz at 120 ips with submultiples at lower speeds). LO is the recommended position.

Step 3. With tape threaded properly, apply POWER and depress STOP, RECORD, and FORWARD. Monitor the reproduced output (BNC connector) with an oscilloscope.

Step 4. Adjust REC ADJ on the direct record board or IN ADJ on the FM record board (note when using the FM record board for this feature the re-record switch must be ON, up position) for a maximum amplitude signal on the oscilloscope. Note the Vrms reading between direct record board testpoints REC LEV, TP 2, (hi) and GRD, TP 1, (lo), or FM record board testpoints CAR, TP8, (hi) and GND, TP2 (lo). Record this value for future reference, if desired.

2. REFERENCE REPRODUCING

Step 1. Ensure a BNC to BNC cable is connected from the reference channel output to the TAPE connector (Power and Control Panel).

Step 2. Place a jumper board in the proper reproduce chassis board position corresponding to the reference record channel.

Step 3. Proceed with normal reproduce procedures ensuring the TAPE and SYNC lamps are lit.

f. TAPE SENSING

Step 1. Place the EOT switch, on the Power Panel, to the ON position. If the optional photo end-of-tape feature is supplied, no further preparation is required to sense the end of tape.

Step 2. For forward motion tape sensing, place a piece of metallic marker on the plastic side of the recording tape, centered on a line parallel to and 1/8 inch from the tape deck edge of the tape.

NOTE

Use W. H. Brady Co., Stock No. QC7-1 (Sangamo Part No. 846462).

Step 3. For reverse motion tape sensing, place a piece of metallic marker on the plastic side of the recording tape, centered on a line parallel to and 3/8 inch from the tape deck edge of the tape.

6. REMOTE CONTROL (OPTIONAL) – When the Remote Control Panel is available, tape movement can be controlled remotely. If the operator desires to utilize remote control of the equipment, the same operational procedures described in the preceding paragraphs should be followed. The Remote Control Panel does not provide for remote power application. The POWER lamp on the Remote Panel is an indicator only.

The Remote Control Panel may be a hand held model or a chassis mounted mode. The chassis mounted model may or may not incorporate the voice speaker enclosure.

To connect the Remote Control Panel, remove the remote-shorting-plug from the REMOTE jack on the Power Connector Panel and insert the remote control panel plug.

NOTE

If remote control is not being used, the remote-shorting-plug MUST be inserted into the REMOTE jack.

The recorder/reproducer may be controlled remotely by external equipment other than the Sangamo Remote Control Panel. This is accomplished by providing proper contact closures to the transport logic. The remote-shorting-plug may be utilized for this purpose. Before beginning any remote set up of this nature, it is absolutely essential to acquire a thorough knowledge of the system logic.

NOTE

Various options are listed and described in the Optional Items section, maintenance section, of this manual.

OPERATOR'S THEORY

a. GENERAL — This recorder/reproducer consists of two major assemblies (tape transport and signal electronics) which constitute a servo speed control system with signal electronics for handling the desired input and output data. Exact speed is maintained by continually comparing a signal derived from the rotational speed of the capstan with a known crystal oscillator reference. The resultant difference is converted to a proportional dc error signal that adds to or subtracts from the voltage supplied to the capstan motor, thus speeding up or slowing down the recorder/reproducer.

For complete theory of any assembly, circuit board, etc., refer to the maintenance section of this manual.

b. POWER — The transport requires 24 - 30 Vdc primary power for proper operation. A DC to DC converter assembly, converts the primary power, to +12 Vdc, -12 Vdc, and +5 Vdc required by the mode control, speed control, reel drive, signal electronics, and other circuits.

The optional AC to DC power supply unit is capable of supplying 28 Vdc from a AC input of approximately 115/230 Vac at 47 to 440 Hz.

c. TAPE TRANSPORT

1. GENERAL — The tape transport panel is the heart of the recorder/reproducer. All of the other assemblies are designed around this panel. The purpose of the transport panel is to move magnetic recording tape at an accurate desired speed. Signals to and from the tape via the record and reproduce heads, are routed from the transport panel to the signal bay for necessary amplification, modulation, or demodulation.

2. MODE CONTROL — The major operating modes of the recorder/reproducer may consist of RECORD-FORWARD, RECORD-REVERSE, FORWARD (reproduce) REVERSE (reproduce), FAST FORWARD, and FAST-REVERSE. Other portions of the control panel operate STOP, EOTS (end-of-tape sense), tape speed and particular optional items. The mode control circuits (primarily the logic board), when properly initiated by the operator control panel, control all modes of the recorder/reproducer.

3. SPEED CONTROL — The speed control speed system and all tape movement is centered around the capstan drive system. The capstan drive is a low mass, high torque, single unit dc motor with integral capstan which eliminates the need for belts, pulleys, or flywheels. The capstan controls the tape speed for all modes of operation.

The magnetic tape is "pulled" across the record and reproduce heads by pinching the tape between the rotating capstan and a pinch roller. To accurately control the tape travel, the rotational speed of the capstan must be carefully controlled. This is accomplished by one of the two following methods of servo speed control.

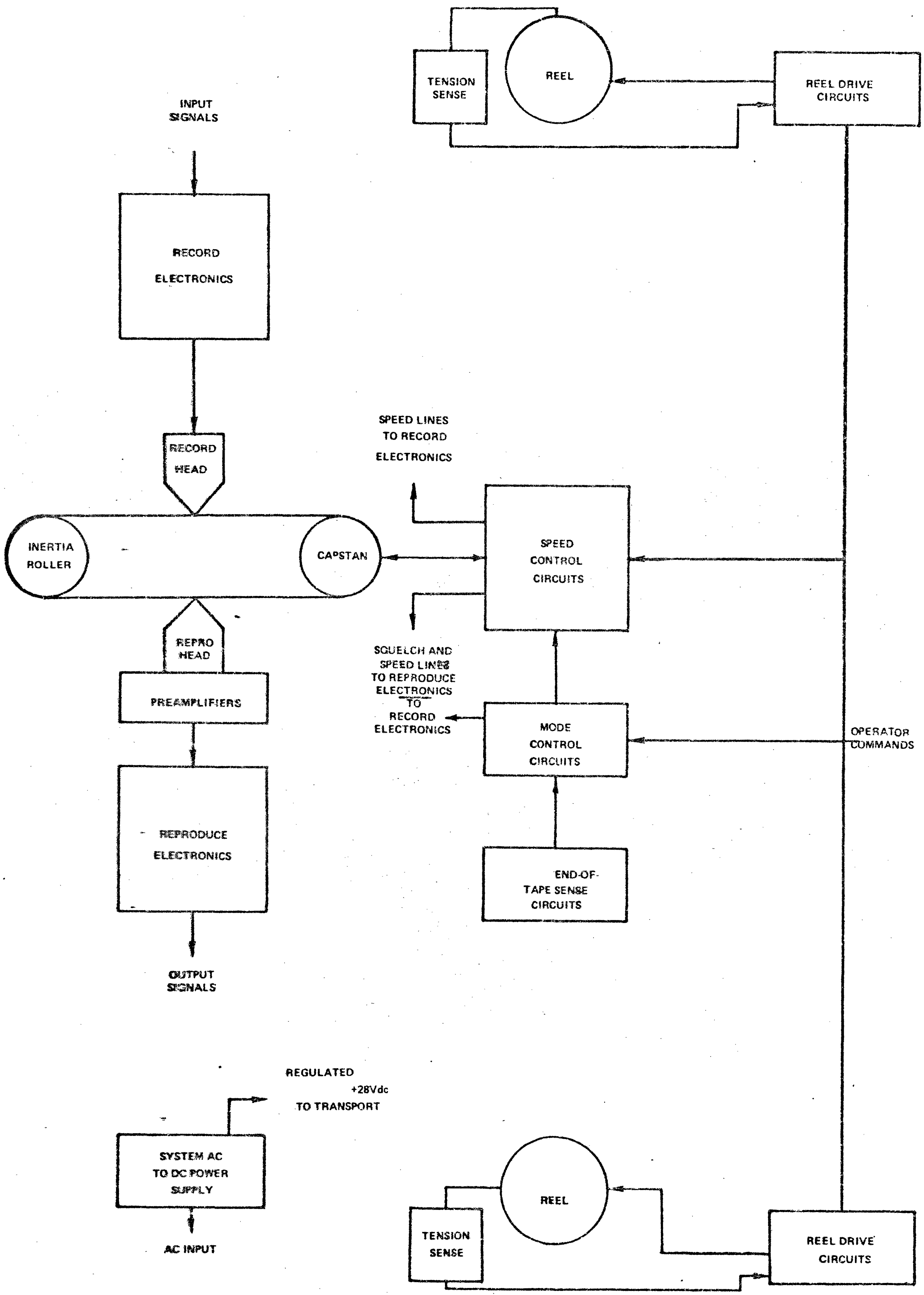


Figure 3. System Functional Block Diagram

(a) **CAPSTAN SYNCHRONOUS CONTROL** — The primary method of controlling tape speed is called CAPSTAN SYNCHRONOUS control. During Capstan Synchronous control, the internally generated crystal oscillator reference signal is compared against a tachometer signal (from the capstan motor). Because the tachometer signal is developed within the capstan motor, the frequency of the tachometer signal is proportional to the rotational speed of the capstan. Any difference in frequency or phase between the crystal oscillator reference and the tachometer signal is converted into an error difference signal to regulate the capstan motor speed. During Capstan Sync the SYNC lamp on the operator's control panel should be lit.

(b) **TAPE SYNCHRONOUS CONTROL (OPTIONAL)** — In order to achieve greater speed control accuracy from a recorded tape, a second method, called TAPE SYNCHRONOUS control, is available as an option. To use this method, a reference signal from a crystal oscillator is recorded on tape during the record process. During reproduce, this reference signal replaces the tachometer signal and is compared with the reference frequency of the crystal oscillator. Any difference in frequency or phase is converted into an error difference signal to increase of decrease the tape speed. If the voltage level of the reproduced reference signal is insufficient or if the signal is lost due to tape dropouts, the recorder/reproducer will instanteously revert to Capstan Synchronous control. During tape sync the TAPE and SYNC lamps on the operator's control panel should be lit.

NOTE

The Tape Sync option consists of a small printed circuit board which plugs onto the capstan board.

During the record time, the Capstan Synchronous method is used to control tape speed.

The tape speed control circuits contain eight basic functional divisions as listed below with the circuit board or subassembly containing each. Refer to figure 4.

1. Reference Oscillator Circuits — Capstan Board
2. Tachometer (Tach) Signal Circuits — Capstan Board
3. Tape Signal Circuits (optional) — Tape Sync Board and Capstan Board
4. Frequency Preparation Circuits — Capstan Board
5. Phase Comparison Circuits — Capstan Board
6. Frequency Comparison — Capstan Board
7. Acceleration and Amplification Circuits — Capstan Board and Capstan Power Amplifier
8. Capstan Motor Circuits — Capstan Board and Capstan Power Amplifier

4. REEL DRIVE — This recorder/reproducer's coxial reel drive system incorporates dual control for inner and outer hub. Each hub is a part of a complete reel drive servo system including a dc motor driven spindle, a tape tension sensing arm with a photocell assembly, a dc servo amplifier located on the reel drive board, and a power amplifier.

Also located on the reel drive board are special features including a dynamic brake in event of power failure, an acceleration control (routed to the speed control system) for forward and reverse, and an acceleration program power mode to stop mode.

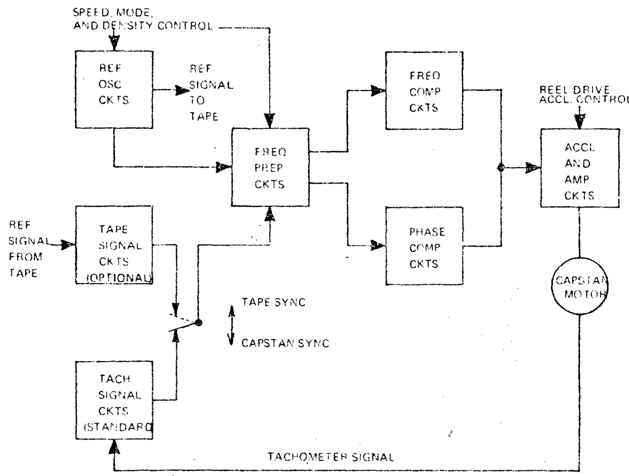


Figure 4. Speed Control System Basic Block Diagram

The entire system is classified single ended since each reel drive hub can be driven in one direction only. In the FORWARD mode the outer reel is driven clockwise while the inner reel free wheels (actually there is a slight voltage applied to the inner reel to provide proper tension). In the REVERSE mode the inner reel is driven counterclockwise while the outer reel free wheels (with some drag).

d. SIGNAL ELECTRONICS

1. **CHASSIS** – Each chassis, record and reproduce, provide sufficient space and electrical connections to contain and operate the desired record boards and reproduce boards. ±12 Vdc and +5 Vdc is supplied to each chassis from the DC to DC converter. These voltages are supplied to each board jack to power each board. Proper connections are provided for routing the input signals (record chassis) to the record head. The reproduced signals are routed from the reproduce head and preamps to the reproduce board and the output of the machine. Other signals involved in the chassis are the bias oscillator signal (record only) and the speed lines for record (carrier freq/speed) and reproduce (equalization and filtering/speed) electronics.

2. **RECORD ELECTRONICS** – All record electronics are utilized to properly prepare the input signal for recording on the magnetic recording tape. Preparation primarily consists of supplying the proper record current to the record head to ensure optimum recording. Varied preparation is dependent on the type of recording, (direct, FM, digital, etc). All speed dependent preparation is automatic. Due to the many types of recording, and types of boards to provide recording, a complete theory is located in the proper record board bulletin in the maintenance section of this manual.

3. **REPRODUCE ELECTRONICS** – All reproduce electronics are utilized for preparation of the reproduced signal as it passes from the reproduce head and preamplifiers. Preparation involves amplification, speed equalization, filtering and possibly others such as demodulation, etc; dependent on the type of recording. All speed dependent preparation (filtering, equalization, etc.) is automatically selected with the selection of tape speed. Due to the many types of reproducing, and the types of reproduce boards, a complete theory is located in the proper reproduce board bulletin in the maintenance section of this manual.

OPERATOR'S MAINTENANCE

a. **GENERAL** – Operator's maintenance provides inspection techniques, preventative maintenance procedures, tape splicing procedures, and checks and adjustments concerning power, tape transport, and signal electronics. Inspection is limited to visual checks and replacement of fuses with preventative maintenance pertaining to care of the tape path and R/R heads. Tape splicing procedures are provided to aid in splicing tape, should the need occur. The checks and adjustments are provided as an aid to ensuring or obtaining proper operation of the various areas of the recorder/reproducer's power tape transport, and signal electronics. Also provided are suggested areas (bulletins), in the maintenance section of this manual, to check if particular indicated results are not obtained properly in these procedures. These suggestions may always be supplemented with various other areas. The ones listed, intended to be the most probable, are in the tape transport bulletin unless otherwise specified. Refer to the transport wiring diagram (rear of tape transport bulletin) and transport overall schematic when referring to these procedures as well as the maintenance procedures.

b. INSPECTION

Step 1. Check to see that no fuses are blown. Refer to Table 2 for transport fuse information and to the Power Supply bulletin for Power Supply (optional) Fuse information.

CAUTION

Never replace a fuse with one of a higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the fault has been corrected.

TABLE 2. FUSE FUNCTIONS*

FUSE	RATING	FUNCTION	LOCATION	PART NO.
F1	ABC-20A	Primary DC Power	Back of Transport	859774-011
F2	F02B-3A	Capstan Motor Power	Back of Transport	821926
F3	AGX-8A	DC to DC Converter	Left Side of Transport	510279-004

NOTE

Additional fusing is contained on the optional power supply unit; refer to the power supply bulletin. Additional fusing may be contained on some auxiliary signal chassis.

Step 2. Check that all plug-in boards and modules are properly seated.

Step 3. Check that all plugs and jacks are properly mated and well seated. Refer to the installation section for information concerning cabling connections.

c. PREVENTATIVE MAINTENANCE

1. TAPE PATH – Periodic cleaning of the tape path is necessary to ensure optimum performance. The frequency of cleaning will depend upon the usage of the machine and the condition and type of tape used. Normally, the transport should be cleaned daily. Materials required for cleaning are lint free cotton swabs, a clean soft cloth, and isopropyl alcohol.

Step 1. Deenerigze the machine and remove the tape from the tape transport.

Step 2. Remove the head cover and the head shield.

Step 3. Moisten a clean cloth with a small amount of isopropyl alcohol and wash all oxide deposits from the tension arm guide pins, all four tape path guide pins, the two pinch rollers, the inertia dampening roller, and the main capstan.

CAUTION

Use only isopropyl alcohol to clean any of the tape path elements or the tape heads. The use of any other solvent may result in possible damage. Alcohol must be completely dry before tape is rethreaded.

Step 4. Moisten a lint free cotton swab with a small amount of isopropyl alcohol and wash all oxide deposits from the heads.

2. R/R HEADS

(a) MAGNETIZED HEADS – A magnetized head may cause degradation of the recorded signal and a reduction of the signal-to-noise ratio. The following precautions should be taken to avoid magnetizing the heads.

Step 1. Remove or replace plug-in boards only when POWER has been removed.

Step 2. Do not make or break signal input or record head lead connections while in the RECORD mode.

Step 3. Do not test continuity of the heads with an ohmmeter or any similar test instrument.

(b) HEAD DEGAUSSING – The heads should be degaussed (demagnetized) when a 4 to 6 db drop in signal-to-noise ratio is detected or whenever the direct second harmonic distortion exceeds one-half per cent. The magnetic field of the head will cause partial erasure reducing the accuracy of the signal handling circuits. Head degaussing may be performed with any good tape head demagnetizer.

NOTE

If the tips of the demagnetizer are not covered with a material to protect the head, cover these tips with a length of vinyl electrical tape.

Step 1. Connect the demagentizer to its proper power source.

Step 2. Place the demagnetizer tips across the head.

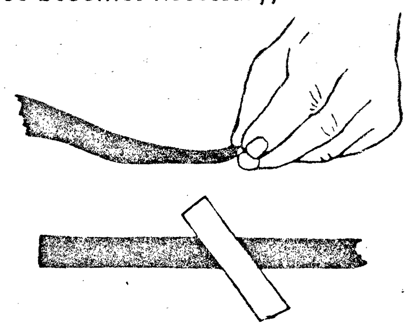
Step 3. Slowly move the demagnetizer back and forth along the entire length of the head stacks at least four times. This operation should take about 30 seconds.

Step 4. Slowly move the tips of the demagnetizer away from the head. Motion of the demagnetizer should be smooth and continuous (with no sudden movement).

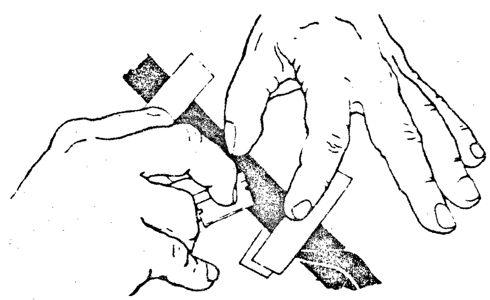
Step 5. Clean heads after degaussing.

d. TAPE SPLICING – Proper tape splicing is essential to avoid loss of tape-to-head contact, tape skew, excessive head wear and other adverse effects. When a tape splice becomes necessary, the following step-by-step procedure is recommended.

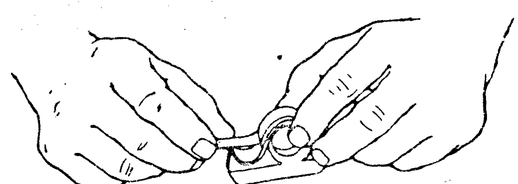
Step 1. With a short piece of masking tape, secure one of the magnetic tapes (in the area to be spliced) to a flat surface (e.g. the rigid back of a paper tablet). The non-oxide (glossy) side of the magnetic tape must be up.



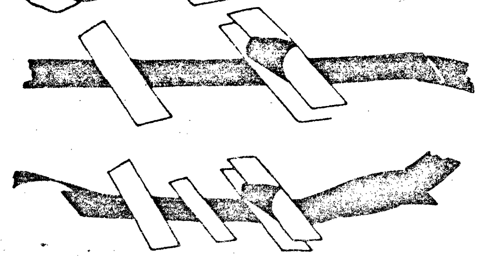
Step 2. Carefully lay the second piece of magnetic tape (in the area to be spliced) over the secured magnetic tape. Ensure that the edges are perfectly aligned and, using two more pieces of masking tape, secure this second magnetic tape over the first.



Step 3. Using a sharp razor slice through both pieces of magnetic tape. The cut should be approximately 60° to the edge of the tape.



Step 4. Peel back the undesired top tape and secure it under an edge of the masking tape.



Step 5. With the two pieces carefully butted together, place a piece of standard splicing tape across the cut. Using a fingernail, or any blunt instrument, ensure that the splicing tape makes 100% contact with the magnetic tape.

Step 6. Carefully trim all splicing tape from the edges of the magnetic tape. A very slight concave cut into the magnetic tape is advisable when trimming.

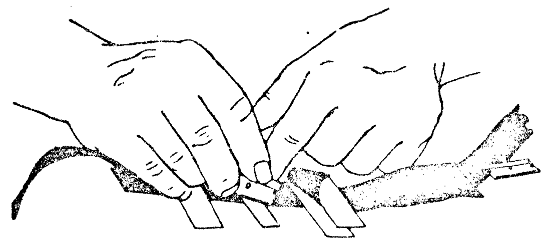


Figure 5. Tape Splicing Procedure

e. CHECKS AND ADJUSTMENTS – The following checks and adjustments are provided as an aid in ensuring or obtaining proper operation of the various areas of the recorder/reproducer's power circuits, tape transport, and signal electronics. Also provided are suggested areas, in the maintenance section, to check if particular indicated results are not obtained properly in these procedures. These suggestions may always be supplemented with various other areas. The ones listed, intended to be the most probable, are in the tape transport bulletin unless otherwise specified. Refer to the transport wiring diagram (rear of tape transport bulletin in the maintenance section) and transport overall schematic when referring to these procedures as well as the maintenance procedures.

1. DC TRANSPORT POWER

Step 1. Ensure primary DC power is applied to the transport. If the optional power supply is supplied, ensure it is turned on, and the indicator lamp is lit. Depress and release the RESET switch (precautionary measure).

Step 2. Depress the POWER pushbutton switch on the control panel and ensure the lamp becomes lit.

Step 3. With a DC voltmeter ensure +28 Vdc between TP1 (hi), red testpoint, and TP2 (lo), black testpoint, (both on the Power and Control Panel, right side of unit). Observe correct polarity with the measuring instrument.

Failure to obtain any or all of the above results suggests the following checks be made.

(1) Power supply bulletin concerning adjustments and/or troubleshooting, maintenance section of this manual.

(2) Cabling connections per the installation bulletin.

2. DC TO DC CONVERTER POWER

Step 1. With satisfactory results obtained in previous DC transport power checks, open the left side door panel of the unit and locate the dc to dc converter assembly (lower portion of unit).

Step 2. With POWER on, use a dc voltmeter and ensure the presence of the following voltages between the indicated point and W3 (LO). Terminals W1, 2, and 3 are arranged in descending order, with W3 at the top.

Indication Point	Voltage
W1	+12 Vdc ±.1 Vdc
W2	-12 Vdc ±.1 Vdc
+ side of C3	+5 Vdc ±.25 Vdc

Failure to obtain any or all of the above results suggests the following checks be made.

(1) DC to DC Converter Fuse F3

(2) DC to DC Converter bulletin concerning adjustments and/or troubleshooting, maintenance section.

3. MODE CONTROL CIRCUITS

Step 1. Thread tape on the recorder/reproducer as explained in the tape threading procedure.

Step 2. Ensure POWER is on and depress STOP, ensuring its indicating lamp is lit. If extreme slack tape is present pulse the STOP pushbutton gently to tighten tape and lift the tension arms. Observe no tape movement with stop lamp lit.

Failure to obtain the above results suggests the following checks be made:

(1) Logic board circuits test, in the maintenance section, concerning stop mode.

(2) Reel drive system test, in the maintenance section, concerning microswitch, photocell, tension arms, etc.

Step 3. Depress FWD, ensuring its indicating lamp is lit, and observe tape moving from the inner reel to the outer reel, with the capstan turning counterclockwise. Ensure both pinch rollers are energized.

Failure to obtain the above results, with reverse tape movement (next step) possible, suggests the following checks be made:

(1) Logic board circuits test, in the maintenance section, concerning forward mode, and the tape direction relay, K2.

Failure to obtain tape movement in either direction at any speed suggests the following checks be made, in sequence:

(1) Fuse F2 (capstan motor fuse).

(2) Logic board circuits test, in the maintenance section.

(3) Capstan board circuits test, in the maintenance section.

(4) Capstan Power Amplifier test, in the maintenance section.

Step 4. Depress REV, ensuring its indicating lamp is lit, and observe tape moving from the outer reel to the inner reel, with the capstan turning clockwise. Ensure both pinch rollers are energized.

Failure to obtain the above results, with forward tape movement possible, suggests the following checks be made.

(1) Logic board circuits test, in the maintenance section, concerning reverse mode, and the tape direction, K2.

Step 5. While moving tape in reverse (step 4), depress FAST, ensuring its indicator lamp is lit, and observe tape movement in the reverse direction at an accelerated rate (greater than 120 ips). Ensure the right pinch roller is energized.

Step 6. Depress FWD, with FAST lamp lit, and observe tape movement in the forward direction at an accelerated rate. Ensure the left pinch roller is energized.

Failure to obtain the above results suggests the following checks be made:

(1) Capstan board circuits test, in the maintenance section.

(2) Logic board circuits test, in the maintenance section.

Step 1. Depress STOP and FWD and place the EOT switch to the IN position. Ensure markers are placed at the end and beginning of tape (standard E.O.T. feature). When the photo end-of-tape sense is used, ensure the sensing lamps are lit on the transport. Continue to move tape in forward and observe tape movement stopping prior to tape becoming completely unwound from the reel (approximately 75 feet left).

Step 2. Complete Step 1 in the reverse mode.

Failure to obtain the preceeding results (Steps 1 and 2) suggests the following checks be made:

(1) Logic board circuits test, in the maintenance section.

(2) Photo End-of-Tape sense (optional) in optional items section.

3. SPEED CONTROL

(a) REFERENCE FREQUENCY CHECKS

Step 1. With POWER removed place the capstan board on its extender (if the cabinet back is removed or cabinet removed, the board need not be extended). Connect a frequency counter between testpoints TP5 (hi) and TP4 (lo). Refer to figure 6 for capstan bboard locations.

Step 2. Apply POWER, depress STOP and either FWD or REV, and ensure the presence of the frequencies (switching through the speeds) as listed in table 3 (TP5).

Step 3. Move the frequency counter hi lead from TP5 to P2-16 (or at A7 pin 8). Ensure the proper frequencies at both high and low densities, while switching through the speeds in either REV or FWD.

NOTE

If the preceding signals are monitored with an oscilloscope, they should be a symmetrical squarewave with a logic "0" level of +0.3 Vdc ±0.3 Vdc and a logic "1" level of +3.7 Vdc ±1.3 Vdc.

TABLE 3. REFERENCE FREQUENCIES

SPEED (ips)	TP5	P2-16 (low density)	P2-16 (high density)
120	100 kHz	200 kHz	400 kHz
60	100 kHz	100 kHz	200 kHz
30	50 kHz	50 kHz	100 kHz
15	25 kHz	25 kHz	50 kHz
7 1/2	12 kHz	12.5 kHz	25 kHz
3 3/4	6.25 kHz	6.25 kHz	12.5 kHz
1 7/8	3.125 kHz	3.125 kHz	6.25 kHz
if applicable 15/16	1.562 kHz	1.562 kHz	3.125 kHz

Step 4. Depress FAST and connect a frequency counter between testpoints TP5 (hi) and TP4 (lo). Ensure a 267 kHz signal.

Failure to obtain any of the preceding results suggests the following checks be made:

(1) Capstan board circuits test, in the maintenance section.

(b) CAPSTAN TACHOMETER CHECKS AND ADJUSTMENTS

Step 1. With the cabinet removed, rear access panel removed, or the capstan board on its extender, depress STOP and FWD, and set to the slowest tape speed.

Step 2. Connect a frequency counter and oscilloscope to the capstan board between testpoints TP6 (hi) and TP4 (lo).

Step 3. Ensure the presence of a symmetrical square wave of approximately 3.125 kHz (1 7/8 ips) or 1.562 kHz (15/16 ips) and SYNC lamp lit. If the symmetrical square wave is not present, locate the adjustment potentiometer on the capstan motor and adjust for best possible symmetrical square wave.

Step 4. Switch through all speeds and check frequency versus speed per previous table 3 (same frequencies as TP5). Note that 120 ips produces a frequency at TP6 one-half that at TP5.

Failure to obtain the preceding results suggests the following checks be made:

(1) Capstan board circuits test, in the maintenance section.

(c) CAPSTAN SERVO CONTROL CHECKS and ADJUSTMENTS

NOTE

Tape must be threaded properly to complete the following.

Step 1. With the cabinet removed, rear access panel removed, or the capstan board on its extender, (left panel door removed), apply POWER and depress STOP and FWD. Set tape speed selector to the slowest speed.

Step 2. Monitor testpoint TP9, refer to figure 6, with an oscilloscope (TP4 lo) and ensure the lower portion of the trapezoidal waveform is at 0 Vdc level. Adjust R40, as necessary, to bring this level to 0 Vdc.

Step 3. Monitor testpoint TP10(TP4 lo) with an oscilloscope and ensure the lower portion of this trapezoidal waveform is at 0 Vdc level. Adjust R43, as necessary, to bring this level to 0 Vdc.

Step 4. Monitor the capstan power amplifier heat sink (hi) with an oscilloscope (TP4 lo) and ensure severe ripple (above 10 Vp-p) is not present. Adjust R45, as necessary, to minimize ripple as much as possible.

Step 5. Monitor the time base error at testpoint TP7 (phase pattern) with an oscilloscope (TP4 lo). Jitter as this point should be minute. Adjust R52 and possibly R50 as necessary to minimize jitter. After the tape sync mode (optional) is set up and adjusted (this consists of adjusting R52) R50 will require readjustment in the capstan sync mode.

NOTE

TP8 may also be used to monitor this measurement and make this adjustment.

Step 6. Remove all POWER and connect an oscilloscope to capstan board P2-20 (hi) and TP4 (lo).

Step 7. Apply POWER and depress STOP, ensuring the presence of a logic 0 level (+0.3 Vdc ± 0.3 Vdc).

Step 8. Depress FWD and ensure the logic 0 level changes to a logic 1 level with stable tape movement. This function, very pertinent to the speed control squelch output for the FM reproduce boards, is adjusted as follows:

(a) With all POWER removed, locate PHASE LOCK adj., R94, on the capstan board (refer to figure 6) and turn completely CW.

(b) Apply POWER and depress STOP and FWD. Turn PHASE LOCK adj., R94, CCW until stable tape movement occurs, then turn slightly more CCW.

Failure to obtain the preceding results suggests the following checks be made:

(1) Capstan board circuits test, in the maintenance section.

(2) Capstan power amplifier circuits test, in the maintenance section.

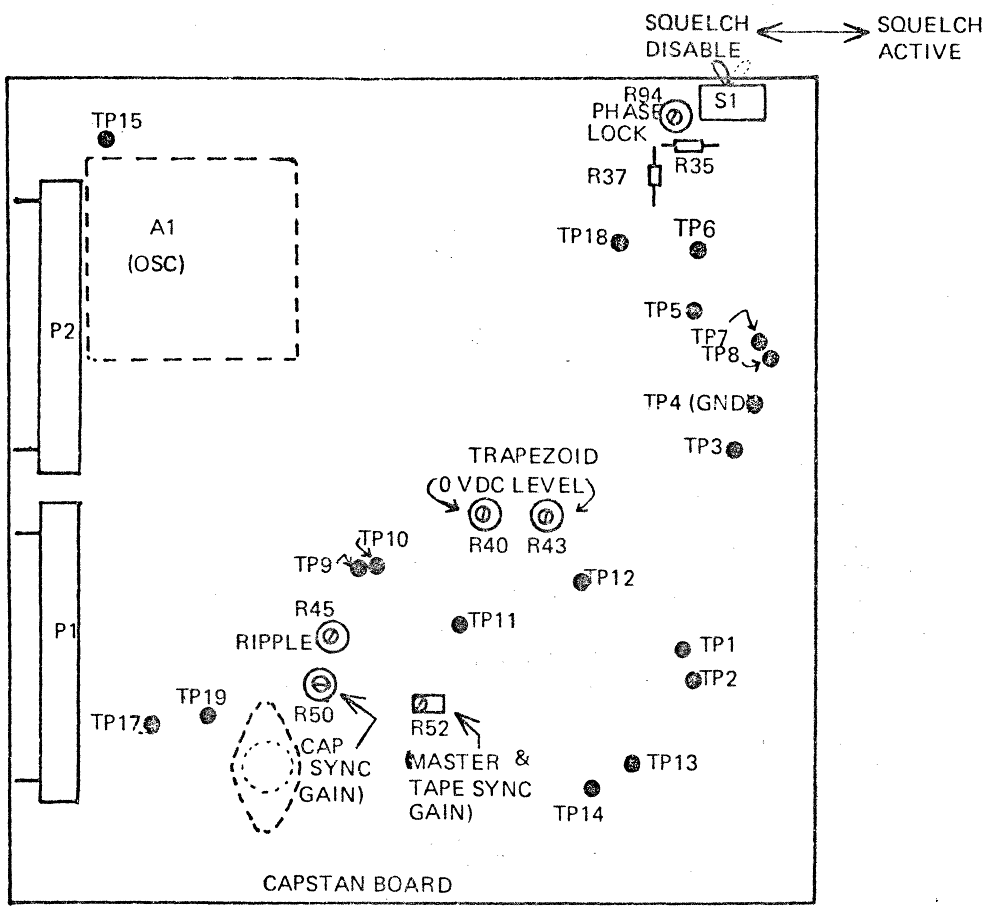


Figure 6. Capstan Board, Location of Testpoints and Adjustments

(d) TAPE SYNC CONTROL CHECKS AND ADJUSTMENTS (OPTIONAL FEATURE)

NOTE

All preceding checks and adjustments in the speed control system must be performed prior to completing the following.

Step 1. Record in forward the tape reference signal at the slowest available speed. Refer to the tape sync operating procedures.

Step 2. Rewind the tape and begin reproducing the reference signal recorded in step 1 (TAPE and SYNC lamps should be lit). Monitor at the same time, the capstan board testpoint TP7, with an oscilloscope, (TP4 lo), and adjust R52 (tape sync gain adjust) for minimum jitter on the oscilloscope. R50 will now require readjustment in the capstan sync mode.

Step 3. Record in forward, bias only on a section of tape (20-30 feet).

Step 4. Rewind and depress FWD reproducing the bias and noise (bias and noise track jumpered to tape sync connector), ensuring the tape sync lamp does not lit.

Failure to obtain the above results suggests the following checks be made:

(1) Direct record board or FM re-record of FM record board (bulletin in maintenance section) and all tape sync cable connections including reproduce jumper board.

(2) Tape sync board circuits test, in the maintenance section.

4. REEL DRIVE CIRCUITS

(a) TENSION CHECKS AND ADJUSTMENTS

Step 1. With POWER ON depress STOP and ensure the tension arms rise off their microswitches.

Step 2. Depress FWD and after tension arms have stabilized ensure they are positioned (with tape moving) midway of their path of travel and no oscillations or jittering of either arm is present.

Step 3. If the tension arms are not positioned properly remove power and gain access to the reel drive board (left side of unit). Apply power, depress STOP and FWD, and adjust each reel drive board balance control, R17 (first potentiometer at top of board) outer reel and R2 (last potentiometer bottom of board) inner reel, until its associated tension arm is positioned midway of its path of travel. Possibly adjust gain control R23 (second potentiometer at top of board) outer reel, and R8 (second potentiometer from bottom of board) inner reel to reduce arm jitter.

(b) PINCH ROLLER PRESSURE

Step 1. With all power off remove the rear access panel and locate and remove the tape direction relay, K2, and the reel drive board.

Step 2. Fasten the tape tension arms away from their "at rest" position.

Step 3. Thread a four foot section of recording tape, and attach the gram gauge, per figure 7.

Step 4. Set the tape speed to the slowest speed available, apply POWER and depress STOP and FWD.

Step 5. Hold capstan firm and pull down on gram gauge until tape begins to slip. The gauge should read 900 to 1100 grams before the tape slips.

Step 6. If the pressure seems to be incorrect, remove the top and rear access panels, or the cabinet, and complete the following:

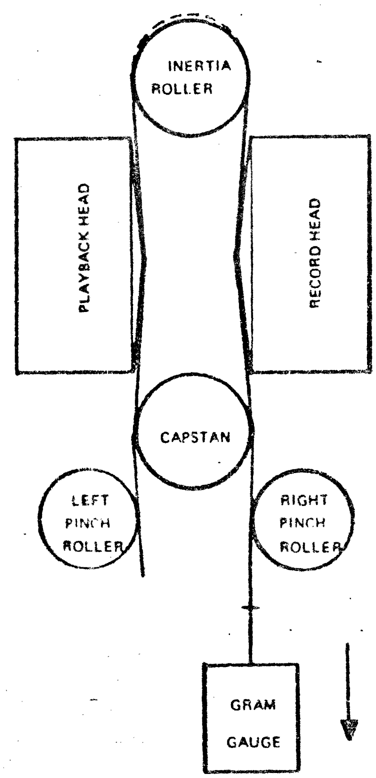


Figure 7. Pinch Roller Pressure Threading

NOTE

Relay K2 and the reel drive board must be replaced.

a. Ensure tape is threaded correctly, set the tape speed selector to the 1 7/8 ips, and depress POWER and FWD.

b. Disable the right hand pinch roller (viewed from the front of the machine) by holding the lever assembly down, thus preventing contact to the capstan.

c. Apply the force gauge (calibrated in pounds) to the top of the left hand pinch roller lever assembly. Apply pressure through the gauge until the tape ceases to move. The reading on the gauge at this point should be 10 lbs. ±1 lb. If this reading is not present adjust the tension adjustment tap at the top of the lever, until this reading is obtained at the same moment the tape ceases to move. CCW decreases pressure and CW increases pressure.

d. For adjustment to the right hand pinch roller move tape in the reverse (REV) direction, disable the left hand pinch roller and repeat c in a similar manner.

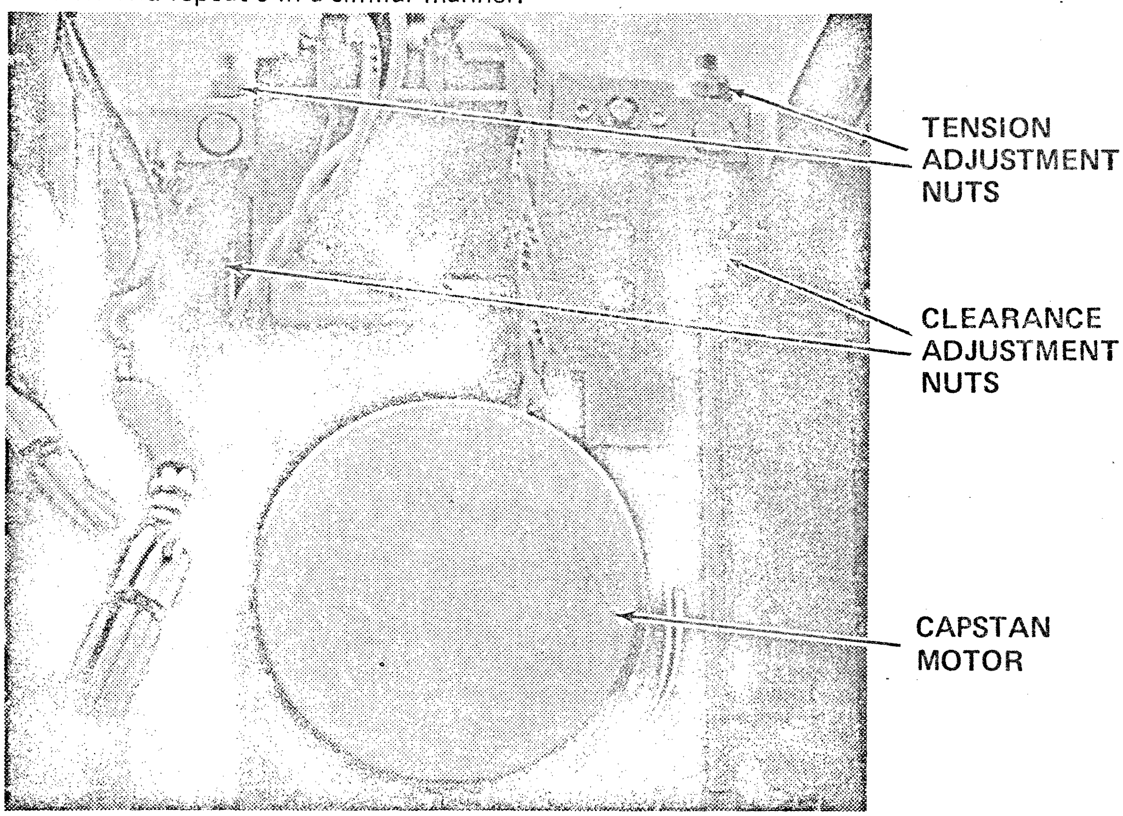


Figure 8. Pinch Roller Pressure Adjustment

Failure to obtain the above results and adjustment cannot be obtained, suggests the following checks be made:

(1) Reel drive system test in the maintenance section.

7. RECORD/REPRODUCE SIGNAL CHASSIS

(a) RECORD CHASSIS

Step 1. Ensure tape is threaded properly and several record boards are removed from the record chassis (every board may be removed if every board jack is to be checked).

Step 2. Depress POWER, STOP and RECORD.

Step 3. With a dc voltmeter lo connected to system ground (black testpoint, Power and Control Panel) ensure +12 Vdc at pin 23 and 0 Vdc at pins 11, 12, and 19 of an accessible record board jack in the record chassis. Refer to chassis wiring in the maintenance section. Remove meter high lead.

NOTE

+12 Vdc is applied to the board jacks after -12 Vdc, due to a time delay relay.

Step 4. Reverse meter polarity and ensure -12 Vdc at pin 1 of the same board jack in the record chassis. Remove hi lead and correct meter polarity.

Step 5. While changing speeds ensure +5 Vdc at the pins corresponding to the tape speed as listed in table 4.

TABLE 4. RECORD/REPRODUCE CHASSIS SPEED LINES

Standard Speed	Non-Standard Speed	Record Chassis Jack Pin	Reproduce Chassis Jack Pin
120	60	6	22
60	30	8	2
30	15	10	3
15	7 1/2	14	4
7 1/2	3 3/4	20	5
3 3/4	1 7/8	22	8
1 7/8	15/16	18	19

Step 6. Remove all power and test connections and replace all boards removed.

Failure to obtain the above results suggest the following checks be made:

(1) Record Chassis bulletin in the maintenance section.

(b) REPRODUCE CHASSIS

Step 1. With POWER off ensure several boards are removed from the reproduce chassis (every board may be removed if every board jack is to be checked).

Step 2. Ensure tape is threaded properly, apply POWER and depress STOP and FWD.

Step 3. After machine has reached speed and the SYNC indicator is lit, connect a dc voltmeter LO to system ground (black testpoint, Power and Control Panel).

Step 4. Connect HI of voltmeter to pin 23 of a reproduce board jack, refer to the reproduce chassis wiring in the maintenance section and ensure +12 Vdc. Connect HI to pins 11, 12, and 15, and ensure 0 Vdc. Remove HI lead connection.

Step 5. Reverse meter polarity and connect to pin 1 of board jack, reproduce chassis. Ensure a -12 Vdc reading.

Step 6. With tape moving, switch through each speed (allowing time for stabilization and SYNC lamp to lite) and ensure +5 Vdc at the pin associated with the corresponding speed as listed in table 4). Earlier systems may utilize +12 Vdc speed lines. Refer to the reproduce board bulletins to determine switching voltage used.

Step 7. With the R/R moving tape at the proper speed (sync lamp lit) always ensure pin 7, of all board jacks, is not grounded.

Step 8. Remove all power and test equipment.

Failure to obtain the above results suggests the following checks be made:

(1) Reproduce Chassis bulletin in the maintenance section.

8. SIGNAL ELECTRONICS — Refer to the maintenance section for bulletins containing maintenance information for record/reproduce signal boards, bias oscillator, preamps, etc.

SYSTEM PERFORMANCE MEASUREMENTS

a. WOW AND FLUTTER — The following equipment is required to perform wow and flutter measurements.

Micom 8300 Wow and Flutter Meter.
One channel of properly calibrated direct record/reproduce electronics.

Step 1. During the following steps use a new or nearly new, thoroughly degaussed, reel of high quality magnetic recording tape. Also ensure the heads are degaussed and the tape path has been cleaned.

Step 2. Select a tape track near the center of tape and ensure that properly calibrated direct record/reproduce electronics are placed in the corresponding slots of their associated chassis.

Step 3. Calibrate the Micom wow and flutter meter as follows:

Drift 1%

Peak-to-Peak	1%
PK Time	2 o
Meter Select	Demod
Drift BW	30 Hz

Step 4. Connect the output of the wow and flutter meter to the input of the track being used, Record Connector Panel.

Step 5. Connect the input of the wow and flutter meter to the reproduce output of the channel being used, Reproduce Connector Panel.

Step 6. With the recorder/reproducer in the STOP mode, the Wow and Flutter meter should present a LOW level indication. If a NORM or HIGH level indication is present adjust the output level of the reproduce board until a LOW level indication appears.

Step 7. With tape moving in the RECORD mode, at the desired tape speed, set the drift meter to zero. A NORM level indication should be present on the meter. If NORM is not present, adjust the output level of the reproduce board until a NORM level indication appears. Recheck drift meter to ensure it is set at zero.

Step 8. Refer to the following tabular listing for filter and carrier characteristics required for the Wow and Flutter meter settings at the various speeds.

	TAPE SPEED (ips)	FILTER (kHz)	CARRIER (kHz)
	120	10	108
	60	10	54
	30	5	27
	15	2.5	13.5
	7 1/2	1.25	6.75
	3 3/4	.625	3.375
	1 7/8	.312	1.688
if applicable	15/16	.156	.844

Step 9. Read the wow and flutter value directly from the meter for each speed and compare to the following typical wow and flutter specifications.

TAPE SPEED	PEAK-TO-PEAK FLUTTER (IRIG) %
120	0.20
60	0.25
30	0.30
15	0.35
7 1/2	0.40
3 3/4	0.45
1 7/8	0.50
15/16	0.80

b. DIRECT RECORD/REPRODUCE

1. FREQUENCY RESPONSE

Step 1. Connect a sine wave generator to the input of the track to be tested.

Step 2. Record a short section of tape with a 1000 cps sine wave at the optimum record level.

Step 3. Record frequencies from 50 cps to at least 20% beyond the upper band limit at the highest speed of the electronics, keeping the output level of the generator constant.

Step 4. Play back the 1000 cps section of tape and set the output level at 0 db. Do not change this setting.

Step 5. Measure the frequency response of the track by playing back the recorded frequencies and referencing the output level to the setting of Step 4.

2. SIGNAL TO NOISE RATIO

Step 1. Record a section of tape with a 1000 cps sine wave at the highest speed of the available electronics, using optimum record current.

Step 2. Depress STOP and remove the input signal.

Step 3. Record a section of tape with BIAS only.

Step 4. Play back the tape and measure the difference between the 1000 cps reproduce level and the no signal reproduce level. (This is measured easiest by setting the output level of the 1000 cps signal to 0 db).

c. FM RECORD/REPRODUCE

1. FREQUENCY RESPONSE

Step 1. Connect a function generator to the input of the track to be tested.

Step 2. Record a section of tape with a 100 cps sine wave at the highest speed of the available electronics at ±40% FM Carrier deviation (low, intermediate, and W.B. I. only - W.B. II use ±30%).

Step 3. Record frequencies from (0.05 cps square wave) up to 100 cps sine wave at the highest speed of the available electronics. Maintain a constant ±40% (or ±30%) deviation level.

Step 4. Replace the function generator with the sine wave generator and record frequencies from 100 cps sine wave to beyond the upper limit of bandpass at the highest speed of the available electronics, maintaining a constant ±40% (or ±30%) deviation level.

Step 5. Reproduce the recorded tape at each of the speeds desired to be tested, setting the output reference (0 db) level during the pass of the initial 100 cps recording. Output should be within 3 db of the reference level at the upper band edge.

2. SIGNAL TO NOISE RATIO

Step 1. Record a portion of tape at ±40% (or ±30%) carrier deviation using a 100 cps sine wave at the highest speed of supplied electronics.

Step 2. During the record process remove the input signal and continue to record the unmodulated FM carrier.

Step 3. Play back and measure the difference between the 100 cps signal level and the no signal level with a VTVM. (This is measured easiest by setting the output level of the 100 cps signal to 0 db).

Step 4. Repeat the above steps for the other speeds, recording and reproducing at each speed.

3. DC LINEARITY

Step 1. Connect a variable dc voltage supply across the input BNC on the Record Connector Panel of the FM track being tested. Connect the positive side of the voltage supply to the center of the BNC connector and the negative side to a convenient ground point.

Step 2. Depress RECORD and allow 15 minutes for warm-up of the record electronics before proceeding.

Step 3. Connect a frequency counter across the VCO (yellow test point) and GROUND (black test point) on the front of the FM record board.

Step 4. Refer to the FM record bulletin for the proper center frequency and the correct deviation for the speed and bandwidth being used.

Step 5. If necessary use the ZERO adjust (front of FM record board) to obtain the correct center frequency.

Step 6. Adjust the variable power supply for 1 Vdc. Use the INPUT ADJUST (front of FM record board) to obtain the proper frequency deviation measured at the VCO testpoint.

Step 7. Position the RANGE switch on the front of the FM record board to the TEST position.

Step 8. Depress FORWARD and while monitoring the playback signal, adjust the FM reproduce board, DC LEVEL ADJ (side of board), for 0 Vdc.

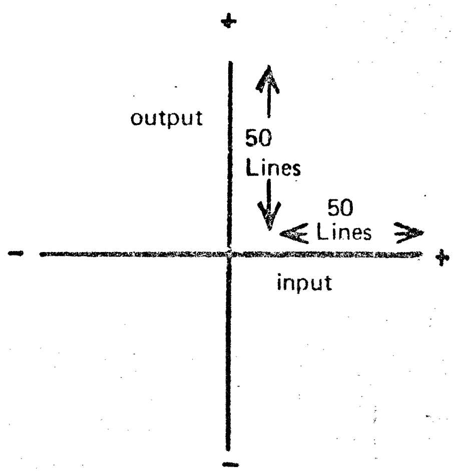
Step 9. Position the RANGE switch to the 2.5 V position.

Step 10. Monitor the output signal and adjust the reproduce board, OUTPUT LEVEL (front of board), for 1 volt DC.

Step 11. Fill in the table below. Before changing input voltages position the RANGE switch to TEST and ensure the center frequency has not changed. Use a digital voltmeter when measuring the output voltages and possibly the input voltages.

Input	Output
+1 volt DC	
+.5 volt DC	
+.25 volt DC	
+0 volt DC	
-.25 volt DC	
-.50 volt DC	
-.75 volt DC	
-1 volt DC	

Step 12. Using the tabular listing of input and output voltages from Step 11, plot the voltages on an ordinary piece of graph paper as shown below.



100% = 1 volt = 50 lines
50% = .5 volt = 25 lines
5% = .05 volt = 2.5 lines
.5% = .005 volt = .25 lines

Step 13. After plotting the graph draw the best straight line through zero. All the points should be at least .5% or .25 divisions from the line.

Sangamo

TAPE TRANSPORT

GENERAL

Information contained in this bulletin consists of maintenance data pertaining to the basic tape transport. This information consists of theory of operation, maintenance, parts removal/replacement, and transport diagrams. The theory covers a general description of the major areas of the basic tape movement circuits. Maintenance is broken down into circuit description, test data, parts list and diagrams for each assembly, circuit board, etc., associated with the tape transport. Parts removal/replacement data contains information for removal/replacement of mechanical parts, tape width kits, head alignment, etc.

THEORY OF OPERATION

a. **GENERAL** — This information covers a systematic theory of the various areas of the tape transport. More detailed theory in the form of circuit description for each circuit board or subassembly is found in the maintenance section of this bulletin. Refer to the transport overall schematic.

b. **DC POWER DISTRIBUTION** — The recorder/reproducer normally operates on +24 or +28 Vdc (two ranges, selectable at the dc to dc converter) which is applied to J6-A (hi) and J6-C (lo). A special 28Vdc input through J6-B and J6-D is routed to the tape transport for powering only the cabinet blower fan. The input primary dc power is fused by F1 and a reverse polarity protection relay protects against accidental reversal of power leads. The 0 Vdc line is tied directly to the 28 volt ground bus, W2. All 28 volt return lines are connected to this bus.

When the POWER pushbutton is depressed, +28 Vdc is applied to the DC to DC converter at A6TB1-1 (hi) and A6TB1-2 (lo). The output of the power supply (A6) is +12 Vdc (on A6W1), -12 Vdc (on A6W3), 0 Vdc (on A6W2), and +5 Vdc (+ side of C3). All return lines for the ±12 Vdc and +5 Vdc are tied (directly or indirectly) to A6W2.

The MAIN POWER relay will not become energized unless: (1) a tight tape condition exists or (2) the STOP pushbutton is depressed. If the machine is in a slack tape condition, depressing the STOP pushbutton bypasses the tape tension microswitches A1S1 and A2S1, and energizes the MAIN POWER relay which applies +28 Vdc to W1 which in turn applies +28 Vdc to the reel drive board. With power applied to the reel drive board, the reel drive servo will attempt to find a null position, thereby pulling the tape tension arms off their stops and closing A1S1 and A1S2. With these microswitches closed, power will be applied to the MAIN POWER relay and the recorder/reproducer will be ready for normal operation.

With the MAIN POWER relay energized, +28 Vdc is applied to the +28 Vdc bus W1. This bus applies power to the voice power plug, the capstan power amplifier, through the capstan motor fuse F2 to relay K2-4 (the TAPE DIRECTION relay), and to the reel drive board.

From A6, lines are routed from A6W1, A6W2 and A6W3 to the signal electronics chassis via P1, P2 and P4. Power to initiate the RECORD mode must pass through the logic board. +12Vdc from A6W1 is applied to the reel drive board, the capstan board, the capstan power amplifier, and the tachometer in the capstan motor. -12 Vdc from A6W3 is applied to the capstan board and the tachometer in the capstan motor. +5Vdc is applied through the speed select switch S3 to select certain speed dependent record circuits and reproduce circuits.

To meet the requirements of certain microcircuits +7Vdc, -7Vdc, +5Vdc, and -5Vdc are provided by regulated supplies on the capstan board.

c. **SYSTEM CONTROL LOGIC** – The following sequence descriptions note the order of events which occur in the machine during a change from one mode of operation to another mode, i. e. STOP to FORWARD, FORWARD to FAST, etc. Refer to the overall system schematic diagram to follow the sequence of events.

The events are explained assuming a tight tape condition, POWER pushbutton depressed, and the MAIN POWER relay energized. When POWER * is depressed, +28 vdc is applied, through A2S1 and A1S1, to J8-22 (logic board). In addition +28 vdc is applied through S5 (5 & 6) ** and through STOP A3S2 (2 & 1), to J7-6 (logic board). For the following discussion it will be beneficial to note that, with the above assumptions, +28 vdc is always applied to J8-22 (logic) and is also applied to J7-6 (logic unless the STOP pushbutton is actually depressed).

1. SEQUENCE: STOP TO FORWARD

Step 1. With the recorder/reproducer in the STOP mode, +28 vdc is applied to the FORWARD switch A3S1-5.

Step 2. When the FORWARD pushbutton is depressed, +28 vdc is applied through J7-9 to CR2 (logic board), to the FORWARD lamp and to the coil of K1 (logic board) energizing that relay. It is also applied through CR1 to pin 2 of the RECORD switch.

Step 3. With K1 (logic) energized, +28 vdc is removed from the STOP lamp, and applied to the coil of K5. K5 will not become energized until the capstan tachometer reaches a point between 1000 and 1500 Hz which activates the transistor switch on the capstan board and grounds the low side of K5 (logic).

Step 4. Before K5 is energized however, +28 vdc is applied to CR23 which places the DIRECTION HOLDING relay K6 in the FORWARD position. This action applies +28 vdc (from K5-11) to the OPERATE relay K10 (capstan board) and to the hour meter assembly A28.

* The POWER switch is alternate and remains in one position until depressed again. STOP, RECORD, FAST, REVERSE and FORWARD are momentary switches which return to their original position when pressure is released.

** If the END-OF-TAPE switch is activated, this voltage passes through K9 (12 & 4).

Step 5. With the OPERATE relay K10 energized, +5 vdc is applied through K10 contacts to activate the divide-by circuits. Other K10 contact closures switch a low potential to the low side of the capstan motor. With this circuit activated, the countdown network and all circuits pertaining to the capstan motor motion are activated, thus the capstan starts turning.

Step 6. When K1 was originally energized +28 vdc was applied, through CR19, to pinch roller #2 (the downstream pinch roller for forward tape movement).

Step 7. With K5 energized, +28 vdc is applied from K5-6, through K3-1 and K3-9, through CR17, to pinch roller #1.

Step 8. With both pinch rollers energized, and with the capstan motor turning and the reel drives operating correctly, tape will move from the inner reel to the outer reel. The capstan will turn in the correct direction because K2 (TAPE DIRECTION relay) is deenergized.

2. SEQUENCE: STOP TO REVERSE

Step 1. With the recorder/reproducer in the STOP mode, +28 volts is applied through A3S1-5 and 4, through P2T and P2N, to pin 5 of the REVERSE pushbutton (A4S1).

Step 2. Depressing REVERSE applies +28 volts through CR7 (logic) to the REVERSE lamp and to the coil of K2 (logic) energizing that relay. It is also applied through CR6 to the RECORD pushbutton.

Step 3. With K2 (logic) energized, +28 vdc (from pin 4) is removed from the STOP lamp and is applied as a holding voltage through CR9 to K2 (logic). This voltage will hold K2 energized until (1) STOP is depressed or (2) FORWARD is depressed.

Step 4. K2 (logic) also applies +28 vdc from pin 7 to the coil of TAPE MOTION relay K5 (logic). However, K5 will not become energized until the capstan tachometer reaches a frequency between 1000 and 1500 Hz, at which point the transistor switch on the capstan board grounds the low side of K5's coil.

Step 5. Before K5 is energized, +28 vdc is applied to CR24 which places K6 (DIRECTION HOLDING relay) in the REVERSE setting.

Step 6. K6 (logic) now performs several functions. It applies +28 vdc to the hour meter assembly, A28, and to the coil of OPERATE relay K10 (capstan board) energizing that relay.

Step 7. With the OPERATE relay K10 energized, +5 vdc is applied through K10 contacts to activate the divide-by circuits. Other K10 contacts closures switch a low potential to the low side of the capstan motor. With this circuit activated, the countdown network and all circuits pertaining to the capstan motor motion are activated. Thus the capstan motor starts turning.

Step 8. When K2 (logic) was originally energized, +28 vdc was applied, through CR16, to pinch roller #1 (the downstream pinch roller for reverse tape motion).

Step 9. When K5 becomes energized, +28 vdc is applied from K5-6, through K3-1 and K3-9, through CR18 to pinch roller #2.

Step 10. With both pinch rollers energized, the capstan motor turning and the reel drives operating correctly, tape will move from the outer reel to the inner reel. The capstan will turn in the correct direction because K2 (TAPE DIRECTION relay) is energized.

3. SEQUENCE: STOP TO RECORD

Step 1. When both K1 (logic) and K2 (logic) are deenergized, +28 vdc from P1-6 is passed through K1 (11 & 3), K2 (12 & 4), CR11 and applied to RECORD switch A4S3-2.

Step 2. When RECORD is depressed, +28 vdc is immediately applied to the RECORD lamp and to the coil of K4 (RECORD) through P1-7.

Step 3. Relay K4 (logic) will remain energized because +28 vdc from P1-6 passes from pin 9 to 5 on K4, through K2 (2 & 10) and K1 (2 & 10), and is applied to P1-7 which energized K4 originally.

Step 4. The circuit described in Step 3 is the holding circuit for RECORD when tape is NOT moving. If either FAST, FORWARD or REVERSE are depressed, this circuit is immediately broken (K1 or K2 energized) and the RECORD relay K4 will become deenergized.

Step 5. With K4 energized, +12 vdc (from P1-20) and -12 vdc (from P1-18) are applied to the record electronics.

4. SEQUENCE: STOP TO FORWARD-RECORD

Step 1. To record in the FORWARD mode, it is necessary to establish forward tape motion before releasing the RECORD pushbutton. The sequence for establishing forward tape motion is identical to sequence 1.

Step 2. With tape moving in the FORWARD mode, +28 vdc is applied to the RECORD pushbutton A4S3-2, (Step 2, STOP to FORWARD sequence).

Step 3. Depressing the RECORD pushbutton applies +28 vdc to the RECORD lamp and also to RECORD relay K4 (logic) through P1-7.

Step 4. Relay K4 will remain energized because +28 vdc from P1-6 passes from pin 9 to 5 on K4, through deenergized K3 (2 & 10), energized K1 (5 & 9), out on P1-4, through FORWARD switch A3S1 (2 & 1) to REVERSE switch A4S1 (2 & 1) and to P1-7 which energized K4 originally.

Step 5. The circuit described in Step 4 is the holding circuit for RECORD when tape is moving in the FORWARD mode only. If either STOP, REVERSE or FAST is depressed, this circuit is immediately broken and K4 will become deenergized.

Step 6. With K4 energized, +12 vdc (from P1-20) and -12 vdc (from P1-18) are applied to the record electronics.

5. SEQUENCE: STOP TO REVERSE-RECORD

Step 1. To record in the REVERSE mode, it is necessary to establish reverse tape motion before releasing the RECORD pushbutton. The sequence for establishing reverse tape motion is identical to sequence 2.

Step 2. With tape moving in the REVERSE mode, +28 vdc is applied to RECORD pushbutton A4S3-2 (Step 2, STOP to REVERSE sequence).

Step 3. Depressing the RECORD pushbutton applies +28 vdc to RECORD relay K4 (logic) through P1-7.

Step 4. Relay K4 will remain energized because +28 vdc from P1-6 passes from pin 9 to 5 on K4, through deenergized K3 (2 & 10), energized K2 (5 & 9), out on P1-4, through FORWARD switch A3S1 (2 & 1) to REVERSE switch A4S1 (2 & 1) and to P1-7 which energized K4 originally.

Step 5. The circuit described in Step 4 is the holding circuit for RECORD when tape is moving in the REVERSE operate mode only. If either STOP, FORWARD or FAST is depressed, this circuit is immediately broken and K4 will become deenergized.

Step 6. With K4 energized, +12 vdc (from P1-20) and -12 vdc (from P1-18) are applied to the record electronics.

6. SEQUENCE: FORWARD TO FAST-FORWARD

Step 1. To move tape in the FAST-FORWARD mode, it is necessary to establish forward tape motion before releasing the FAST pushbutton. The sequence for establishing forward tape motion is identical to sequence 1.

Step 2. With K1 (logic) energized, +28 vdc is received from K2-3, through K1 (12 & 8), out on P1-2 and applied to FAST A4S2-2.

Step 3. When FAST is depressed, +28 vdc is applied to the coil of K3 (logic). Relay K3 receives its holding voltage (through pins 12 & 8) from STOP pushbutton A3S2-1, through FORWARD switch A3S1 (5 & 4) and REVERSE switch A4S1 (5 & 4).

Step 4. With FAST relay K3 energized, +28 vdc is removed from P1-21 (logic) and P1-20. This would deenergize K9 (capstan board) which would lock out the phase lock switch from the speed control servo. In addition a voltage is applied to the base of Q1 (logic) which locks out tape synchronous speed control, if applicable.

Step 5. With FAST relay K3 (logic) energized, +28 vdc (from K5-6) is removed from the anodes of CR17 and CR18. Therefore only pinch roller #2 will remain energized (from K1-7).

Step 6. Relay K3 (logic) also removes the ground from J8-13 (logic) and J9-6 (capstan board) and applies +5 vdc through K3 (11 & 7) to these points. This activates the slew reference signal which places the speed control into the FAST tape (slew) mode.

Step 7. With the capstan turning at a slew rate, the reel drives operating correctly and the downstream (#2) pinch roller engaged, tape will move from the inner reel to the outer reel at a fast (slew) tape speed. It is not possible for the RECORD relay to remain energized since the interlocking circuits in K3 (2 & 10) and K1 (2 & 10) are open.

7. SEQUENCE: REVERSE TO FAST-REVERSE

Step 1. To move tape in the FAST-REVERSE mode, it is necessary to establish reverse tape motion before releasing the FAST pushbutton. The sequence for establishing reverse tape motion is identical to sequence 2.

Step 2. With K2 (logic) energized, +28 vdc is received from K1-3, through K2 (12 & 8), out on P1-2 and applied to FAST A4S2-2.

Step 3. When FAST is depressed, +28 vdc is applied to the coil of K3 (logic). Relay K3 receives its holding voltage (through pins 12 & 8) from STOP pushbutton A3S2-1, through FORWARD switch A3S1 (5 & 4) and REVERSE switch A4S1 (5 & 4).

Step 4. FAST relay K3 also removes +28 vdc from P1-21 (logic) and P1-20. This would deenergize relay K9 (capstan board) which would lock out the phase lock switch from the speed control servo. In addition, a voltage is applied to the base of Q1 (logic) which locks out tape synchronous speed control, if applicable.

Step 5. With FAST relay K3 (logic) energized, +28 vdc (from K5-6) is removed from the anodes of CR17 and CR18. Therefore, only pinch roller #1 will remain energized (from K2-7).

Step 6. Relay K3 also removes the ground from J8-13 (logic) through J9-6 (capstan board) and applies +5 vdc through K3 (11 & 7) to these points. This activates the slew reference signal which places the speed control into the FAST tape (slew) mode.

Step 7. With the capstan turning at a slew rate, the reel drives operating correctly and the downstream (#1) pinch roller engaged, tape will move from the outer reel to the inner reel at a fast (slew) tape speed. It is not possible for the RECORD relay to remain energized since the interlocking circuits in K3 (2 & 10) and K2 (2 & 10) are open.

8. SEQUENCE: FORWARD TO STOP

Step 1. When tape is moving in the forward direction and STOP is depressed, +28 vdc is momentarily removed from P1-6 (logic). This removes the holding voltage (through K2-11 & 3) from the coil of K1 (logic) and the FORWARD relay immediately deenergizes.

Step 2. When K1 is deenergized, +28 vdc is removed from the anode of CR20. However, K5 (logic) will remain energized due to the holding voltage from K5-6.

Step 3. In addition, K1 removes the voltage from OPERATE relay K10 (capstan board) which deenergizes and thereby removes the reference signal. With no reference signal, the capstan motor will immediately begin stopping very quickly due to its low inertia.

Step 4. When the tachometer frequency drops below 1000 to 1500 kHz, the switch on the capstan board is opened which deenergizes K5. With K5 deenergized, voltage is removed from the two pinch rollers (from K5-6 through K3-1 & 9).

Step 5. When the capstan stops turning and the pinch rollers released, tape movement will stop.

9. SEQUENCE: FAST-FORWARD TO STOP – The FAST-FORWARD to STOP sequence is identical to sequence 8 except that FAST relay K3 (logic) is also deenergized immediately when STOP is depressed.

When FAST relay K3 becomes deenergized, both pinch rollers become engaged for the short time it takes for tape movement to stop.

10. SEQUENCE: REVERSE TO STOP

Step 1. When tape is moving in the reverse direction and STOP is depressed, +28 vdc is momentarily removed from P1-6 (logic). This removes the holding voltage (through K1 - 3 & 11) from the coil of K2 (logic) and the REVERSE relay immediately deenergizes.

Step 2. When K2 is deenergized, +28 vdc is removed from the anode of CR21. However, K5 (logic) will remain energized due to the holding voltage from K5-6.

Step 3. In addition, K2 removes the voltage from OPERATE relay K10 (capstan board) which deenergizes and thereby removes the reference signal. With no reference signal, the capstan motor will immediately begin stopping very quickly due to its low inertia.

Step 4. When the tachometer frequency drops below 1000 to 1500 kHz, the switch on the capstan board is opened which deenergizes K5. With K5 deenergized, voltage is removed from the two pinch rollers (from K5-6 through K3-1 & 9).

Step 5. When the capstan stops turning and the pinch rollers released, tape movement will stop.

11. SEQUENCE: FAST-REVERSE TO STOP – The FAST-REVERSE to STOP sequence is identical to the REVERSE to STOP sequence 10, except that FAST relay K3 (logic) is also deenergized immediately when STOP is depressed.

When FAST relay K3 becomes deenergized, both pinch rollers become engaged for the short time it takes tape movement to stop.

12. SEQUENCE: FORWARD TO REVERSE

Step 1. When tape is moving in the forward direction and REVERSE is depressed, +28 vdc is applied to the REVERSE lamp and to the coil of REVERSE relay K2 (logic).

Step 2. Relay K2 breaks the interlock (11 & 3) for the holding voltage of FORWARD relay K1 which becomes deenergized.

Step 3. With K1 deenergized the tape will begin to stop.

Step 4. Relay K2 will remain energized because K1 is now deenergized.

Step 5. When the tachometer frequency falls below 1000 to 1500 kHz, relay K5 will deenergize which applies +28 vdc to K6 (logic).

Step 6. Tape will now begin to move in the reverse direction as explained in sequence 2.

13. SEQUENCE: REVERSE TO FORWARD

Step 1. When tape is moving in the reverse direction and FORWARD is depressed, +28 vdc is applied to the FORWARD lamp and to the coil of FORWARD relay K1 (logic).

Step 2. Relay K1 breaks the interlock (11 & 3) for the holding voltage of REVERSE relay K2 which becomes deenergized.

Step 3. With K2 deenergized the tape will begin to stop.

Step 4. Relay K1 will remain energized because K2 is now deenergized.

Step 5. When the tachometer frequency falls below 1000 to 1500 kHz, relay K5 will deenergize which applies +28 vdc to K6 (logic).

Step 6. Tape will now begin to move in the forward direction as explained in sequence 1.

14. SEQUENCE: FAST-FORWARD TO FORWARD

Step 1. When tape is moving in the FAST-FORWARD (or slew) mode, and FORWARD is depressed, the interlock to the FAST relay K3 (logic) is immediately broken and relay K3 deenergizes. Also, the voltage is removed from the base of Q1 (logic).

Step 2. With the FAST relay deenergized, the slew reference will be replaced by the operate reference and the recorder/reproducer will seek synchronous operation at the selected speed.

15. SEQUENCE: FAST-REVERSE TO REVERSE

Step 1. When tape is moving in the FAST-REVERSE mode, and REVERSE is depressed, the interlock to FAST relay K3 (logic) is immediately broken and relay K3 deenergizes. Also the voltage is removed from the base of Q1 (logic).

Step 2. With the FAST relay deenergized, the slew reference will be replaced by the standard operate reference and the recorder/reproducer will seek synchronous operation at the selected speed.

16. SEQUENCE: END-OF-TAPE SENSE (also used with the optional shuttle feature)

Step 1. When END-OF-TAPE sense switch S5 is in the IN position, the +28 vdc from A1S1C cannot pass through S5, but must be routed through deenergized K9.

Step 2. Whenever FORWARD, REVERSE or STOP is not actually depressed, +28 vdc is applied to resistors R9 and R8 from P1-1.

Step 3. When tape is moving (K5 energized), +28 vdc is applied to the anode of CR32.

Step 4. When a sensing strip passes over the electrode on PU3, the electrode is momentarily grounded, and the voltage on the base of Q3 is less than the voltage on the emitter and the transistor conducts for the short period of time when the sensing strip is on the electrode. With the optional photo end-of-tape sense feature J8-7 (fwd) or J8-6 (rev) is grounded when the associated sense detector is activated by light from the associated photo sense lamp. This produces the same effect as the sensing strip passing over the electrode on PU3. Refer to the Photo End-of-Tape Sense bulletin in the optional items section (tab).

Step 5. When Q3 conducts, it applies a voltage to the gate of silicon controlled rectifier CR32 which now begins conducting. CR32 will continue to conduct (even with no voltage on the gate) as long as +28 vdc is applied to its anode. The silicon controlled rectifier is necessary in the circuitry because the period of time when the sensing strip passes over the electrode is insufficient to energize sense relay K9. However, since CR32 will continue conducting, relay K9 will energize and remain energized until K5 is deenergized which removes the +28 vdc from CR32.

Step 6. When K9 (logic) is energized (and S5 is in the IN position) a stop command will be routed to control logic. When tape movement stops, K5 will deenergize removing the +28 vdc from CR32.

d. SPEED CONTROL SYSTEM – The following theory describes the overall speed control system and its use in the precise movement of tape.

The magnetic tape is "pulled" across the record and reproduce heads by pinching the tape between a rotating capstan and two pinch rollers. To accurately control the tape travel, the rotational speed of the capstan must be carefully controlled. This is accomplished by one of the two following methods of servo speed control.

CAPSTAN SYNCHRONOUS CONTROL – The primary method of controlling tape speed is called CAPSTAN SYNCHRONOUS control. During Capstan Synchronous control, an internally generated, crystal oscillator signal is used as a reference against which a tachometer signal (from the capstan motor) is compared. Because the tachometer is part of the capstan motor, the frequency of the tachometer signal is proportional to the rotational speed of the capstan. Any difference in frequency and phase between the crystal oscillator reference and the tachometer signal is converted into error difference signals to regulate the capstan motor speed. During Capstan Sync the SYNC lamp on the Operators's Control Panel should be lit.

TAPE SYNCHRONOUS CONTROL (OPTIONAL) – In order to achieve greater speed control accuracy from a recorded tape, a second method, called TAPE SYNCHRONOUS control, is available as an option. To use this method the internal reference signal from a crystal oscillator is recorded on tape (even numbered track) during the record process. When the tape is reproduced, this signal in lieu of the tachometer signal is recovered from the tape and compared with the reference frequency of the crystal oscillator. Any difference in frequency and phase is converted into error difference signals which increase or decrease the tape speed. If the voltage level of the reproduced reference signal is insufficient or if the signal is lost due to tape dropouts, the recorder/reproducer will instantaneously revert to Capstan Synchronous Control. During tape sync the TAPE and SYNC lamps on the Operator's Control Panel should be lit.

During the record time, Capstan Synchronous is used to control the speed of the tape.

The tape speed control circuits contain eight basic functional divisions as listed below with the circuit board or subassembly containing each.

1. Reference Oscillator Circuits -- Capstan Board.
2. Tachometer (Tach) Signal Circuits -- Capstan Board.
3. Tape Signal Circuits (Optional) -- Tape Sync Board and Capstan Board
4. Frequency Preparation Circuits -- Capstan Board.
5. Phase Comparison Circuits -- Capstan Board.
6. Frequency Comparison -- Capstan Board.
7. Acceleration and Amplification Circuits -- Capstan Board.
8. Capstan Motor Circuits -- Capstan Board and Capstan Power Amplifier.

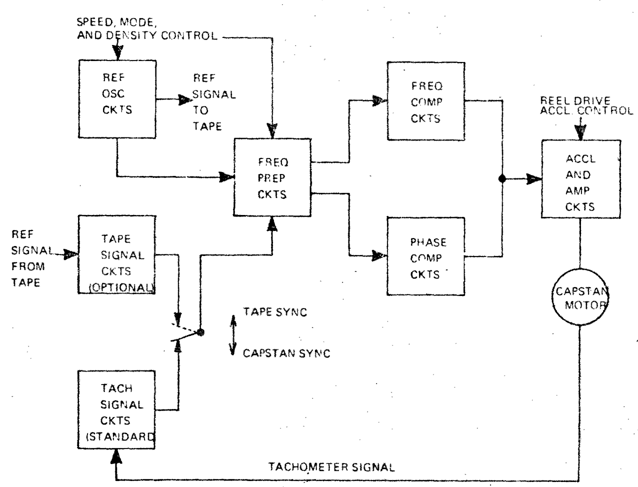


Figure 1. Speed Control System Basic Block Diagram

For discussion, refer to the Speed Control Circuits Overall Block Diagram, Figure 2.

1. REFERENCE OSCILLATOR CIRCUITS – A 3.2 MHz crystal oscillator is used to generate the basic reference frequency for comparison with the tachometer (or tape when used) signal. This same signal (divided down per speed and density) is also recorded on tape when the recorder/reproducer is equipped for the optional Tape Synchronous Control. The output of the reference oscillator is applied to a frequency countdown network and to a frequency select gate with the output dependent upon the tape speed selected at the Operator's Control Panel. The counted down speed dependent frequencies are applied through an operate/fast divider select gate to the density select gate. With the DENSITY switch in the HIGH position, the output of the gate will select the higher of the two inputs to make the output frequency, 400 kHz for 120 ips.

If the LOW position is selected, the input is selected to make the output frequency 200 kHz for 120 ips. The output of this gate will be submultiples of these frequencies for lower tape speeds and is applied to the REF connector on the Record Connector Panel to be recorded on tape for Tape Synchronous control (optional). This output is not utilized for Capstan Synchronous control.

When a FAST mode is desired, the chain of events is slightly different. Upon depressing the FAST push-button on the Operator's Control Panel, the 3.2 MHz oscillator signal is applied to a divide-by-twelve circuit, activated during fast. The output frequency is 267 kHz and is applied directly to the operate select gate, bypassing all the countdown circuitry. The output is applied to the frequency preparation circuits.

2. TACHOMETER SIGNAL CIRCUITS – During Capstan Synchronous operation, a tachometer signal from the capstan motor is generated and gated through to the frequency preparation circuits for comparison against the reference oscillator signal. The frequency of the tachometer signal is porportional to the rotational speed of the capstan motor. A slotted opque disc rotating in front of a photocell produces an output signal which is amplified and quantized to develop a square wave within the capstan motor. The quantized signal is inverted, and gated through to the frequency preparation circuits. When utilizing the tape sync board, this signal is routed through the tape sync board.

The tachometer signal is also shaped to drive a switch which energizes the tape motion relay on the logic board. Because of an RC time constant within the switch circuit, the tape motion relay does not energize until the tachometer reaches a point somewhere between 1000 and 1500 Hz.

3. TAPE SIGNAL CIRCUITS (OPTIONAL) – The tape signal circuits are used only if the recorder/reproducer is equipped with the optional tape sync board. The tape sync board plugs directly onto the capstan board.

During the record process the record reference signal, from the reference oscillator circuits is recorded on tape through a direct record channel. The frequency recorded is proportional to the tape speed selected.

During the reproduce process the tape reference signal passes through the selected preamplifier and bypasses the reproduce electronics through a jumper board. From the jumper board the signal is applied to the tape sync board via the TAPE connector.

Upon entering the tape sync board, the signal passes through an intergrating amplifier and triggers a signal detector circuit. This circuit turns the tape sync lamp on, activates the tape sync gain change on the capstan boards, and is also applied to the tape/tach select gate. The output of the intergrating amplifier also passes through a level detector and a divide-by two circuit to the tape/tach select gate. The function of the level detector is further conditioned by the 15/16 ips thru 7 1/2 ips speed lines, when applicable.

The tape/tach select gate utilizes three data inputs (tach signal, tape reference signal high density, and tape reference signal low denisty), three control inputs (hi density, tape inhibit, and signal detector), and one output. The selected input (tach signal in capstan sync or tape signal- hi or low density) is routed through to the output and on to the capstan board, conditioning and controlling the speed control system as the tachometer signal normally does in the capstan sync speed control function.

4. FREQUENCY PREPARATION CIRCUITS – The reference oscillator signal, upon being counted down by the speed dependent countdown circuits, is applied through an operate/fast divider select gate.

This gate provides a divide-eight and divide-by sixteen output for tape speeds of 120 ips through 1 7/8 ips. For a tape speed of 15/16 ips, a output of divide-by sixteen and divide-by thirty-two are provided. The divide-by sixteen (standard speeds) or the divide-by thirty-two (15/16 ips) is applied through another divide-by two and the operate select gate to the freq/phase lock detector and the function generator network.

Table 1 shows the reference frequencies generated for each tape speed. The oscillator reference signal is referred to as the "A" signal.

The tape reference signal (tape sync option) or the tachometer reference signal is either divided-by two (120 ips only) or divided-by one (all other speeds) and applied to the freq/phase lock detector and the function generator network.

The tape or tach signal is referred to as the "B" signal.

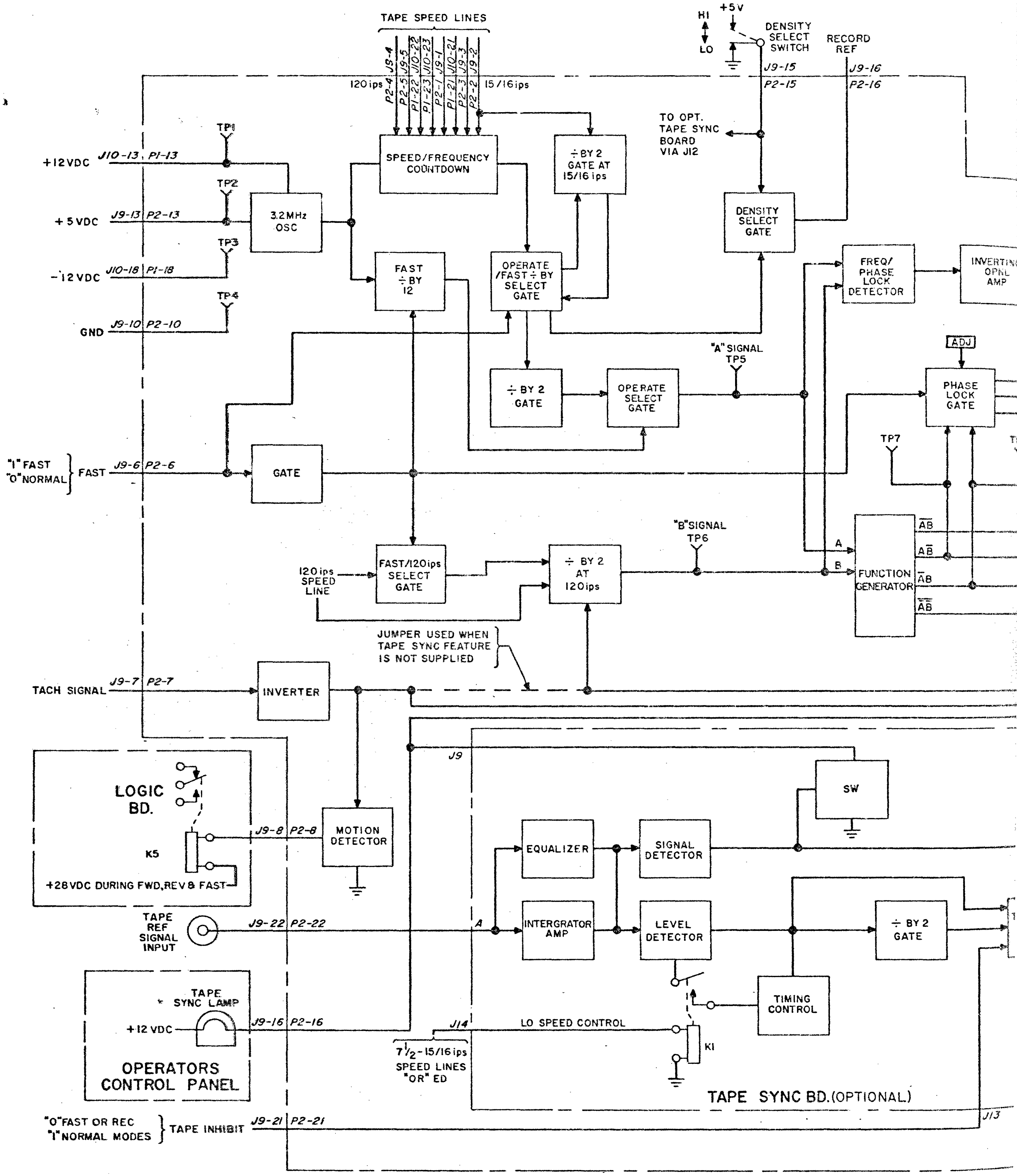
TABLE 1. REFERENCE FREQUENCIES kHz VS TAPE SPEED

Speed (ips)	Osc Ref	Tach Ref	Tape Hi Den	Tape Lo Den
120	100 kHz	200 kHz	400 kHz	200 kHz
60	100	100	200	100
30	50	50	100	50
15	25	25	50	25
7 1/2	12.5	12.5	25	12.5
3 3/4	6.25	6.25	12.5	6.25
1 7/8	3.125	3.125	6.25	3.125
15/16	1.562	1.562	3.125	1.562

5. PHASE COMPARISON CIRCUITS – The phase comparison circuits are used to maintain capstan speed once the selected speed is released.

The A and B signals are applied to the two inputs of the function generator. The output of the function generator develops four basic logic signals, consisting of $\bar{A}\bar{B}$, $\overline{AB}$, $\bar{A}B$ and $A\bar{B}$. The $\bar{A}B$ and the $A\bar{B}$ are applied to two operational integrator circuits. Each of the operational integrators have the same signal at the input, except for a 180° phase shift. The output of each is a trapezoidal wave with a 180° phase shift. Each trapezoidal wave is held to the 0 Vdc reference by the function generator outputs $\bar{A}\bar{B}$ and $\overline{AB}$ via the clamp circuits. The two signals are added together by an operational adder to develop a dc level proportional to the phase relationship of signals A and B. Whenever a phase lock signal is received by the mode select gate, the dc level is allowed to pass to the acceleration and amplification circuits.

6. FREQUENCY COMPARISON CIRCUITS – The frequency comparison circuits are used during the time the frequency error between the oscillator reference signal (referred to as the A signal) and the tape/tach signal (referred to as the B signal) is the greatest. When the A and B signals are running at the same frequencies, the phase comparison circuits are sensed and used to maintain a constant tape speed.


TAPE SPEED LINES
120 ips
15/16 ips
P2-4 J9-4
P2-5 J9-5
P1-22 J10-22
P1-23 J10-23
P2-1 J9-1
P1-21 J10-21
P2-3 J9-3
P2-2 J9-2
HI
LO
+5V
DENSITY SELECT SWITCH
RECORD REF
J9-15
P2-15
J9-16
P2-16
TO OPT. TAPE SYNC BOARD VIA J12
TP1
+12VDC
J10-13
P1-13
TP2
+5 VDC
J9-13
P2-13
TP3
-12 VDC
J10-18
P1-18
TP4
GND
J9-10
P2-10
SPEED/FREQUENCY COUNTDOWN
÷ BY 2 GATE AT 15/16 ips
3.2MHz OSC
DENSITY SELECT GATE
FAST ÷ BY 12
OPERATE /FAST ÷ BY SELECT GATE
FREQ/ PHASE LOCK DETECTOR
INVERTING OPNL AMP
ADJ
"A" SIGNAL
TP5
÷ BY 2 GATE
OPERATE SELECT GATE
PHASE LOCK GATE
TP7
"1" FAST
"0" NORMAL
FAST
J9-6
P2-6
GATE
"B" SIGNAL
TP6
A
B
FUNCTION GENERATOR
120 ips SPEED LINE
FAST/120ips SELECT GATE
÷ BY 2 AT 120ips
JUMPER USED WHEN TAPE SYNC FEATURE IS NOT SUPPLIED
TACH SIGNAL
J9-7
P2-7
INVERTER
J9
SW
LOGIC BD.
K5
+28VDC DURING FWD, REV & FAST
J9-8
P2-8
MOTION DETECTOR
EQUALIZER
SIGNAL DETECTOR
TAPE REF SIGNAL INPUT
J9-22
P2-22
A
INTERGRATOR AMP
LEVEL DETECTOR
÷ BY 2 GATE
TAPE SYNC LAMP
+12 VDC
J9-16
P2-16
J14
LO SPEED CONTROL
TIMING CONTROL
K1
7½-15/16 ips SPEED LINES "OR" ED
OPERATORS CONTROL PANEL
TAPE SYNC BD. (OPTIONAL)
J13
"0" FAST OR REC
"1" NORMAL MODES
TAPE INHIBIT
J9-21
P2-21

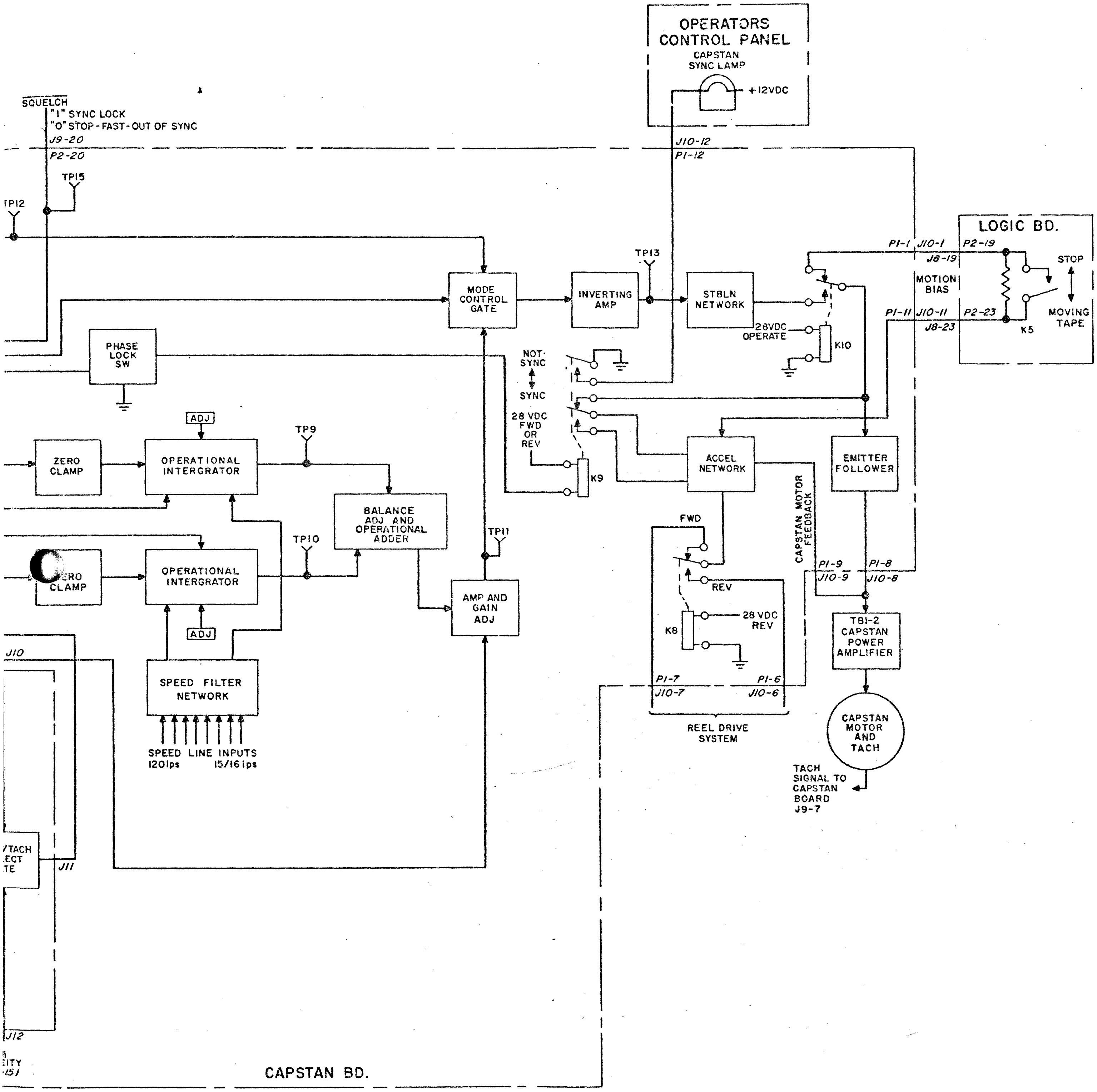


Figure 2. Speed Control Circuits Block Diagram

When the FWD pushbutton is depressed on the Operator's Control Panel and tape starts to move, the B signal starts to increase in frequency. From the output of the frequency preparation circuits, the increasing B signal is applied to the freq/phase detector circuit. In like manner, the A signal is applied also to the freq/phase detector circuit.

When the B signal has reached a frequency approximately equal to the A reference signal, the frequency detector enables the mode select gate to accept the dc voltage from the PHASE COMPARISON circuits. This function also provides a logic 1 level to the SQUELCH output during sync lock.

7. ACCELERATION AND AMPLIFIER CIRCUITS – The acceleration and amplifier circuits are used to retard speed changes of the capstan motor during periods of starting and stopping. This allows time for the reel drive motors to gain sufficient angular velocity and avoids spilling or breaking tape. The reel drive acceleration circuits (FWD and REV) decrease and then slowly increase the dc output voltage of the acceleration network until the reel drive motors have reached proper operating speed. The output of the acceleration network is applied to an emitter follower, the capstan power amplifier, and then the capstan motor.

e. REEL DRIVE – This recorder/reproducer's reel drive system incorporates dual hubs on a coaxial spindle. Each hub is a part of a complete reel drive servo system including a DC motor driven spindle, a tape tension sensing arm with a photocell assembly and a DC servo amplifier located on the reel drive board. Also located on the reel drive board are special features including a dynamic brake in event of a power failure, an acceleration control for forward and reverse, (routed to the speed control system) and an acceleration program power mode to stop mode. The entire reel drive servo provides a complete system which maintains essentially constant tape tension across the heads under all conditions of operation. In addition it provides features for prevention of breaking tape, tape spillage, and possible damage to the reel drive motors.

In a slack tape or no tape condition the tape tension arms are held at their extreme rest positions by their spring systems. For the upper tension arm (associated with the outer reel) the extreme rest position is to the left toward the side of the main transport casting. For the lower tension arm (associated with the inner reel) the extreme rest position is down toward the bottom of the main transport casting. When the tension arms are at their extreme rest position they activate microswitches which disable the recorder/reproducer from normal operation. This is to ensure that in the event of a broken tape, empty reels, or an extreme slack tape condition the recorder/reproducer will not continue to run.

A vane, attached to each tape tension arm, moves between the lamp and the photocell on the photocell assembly. The geometry of the photocell and lamp is such that when the vane is centered, half of the photocell is shaded and half is illuminated. This vane varies the amount of light obtained by the photocell thus varying the output current. With the photocell completely shaded the current output would be zero and with the photocell completely illuminated the output would be maximum. As the vane moves from its centered position it indicates either slack tape or tight tape. Slack tape allows the tension arm and vane to move toward its extreme rest position and tight tape forces it to move off center in the opposite direction. The degree of slack tape or tight tape determines the displacement of vane movement off center.

The reel drive system is classified single ended since each reel drive hub can be driven in one direction only. In the forward mode the outer reel is driven clockwise while the inner reel free wheels (actually there is a slight voltage applied to the inner reel to provide proper tension). In the reverse mode the inner reel is driven counterclockwise while the outer reel free wheels (with the slight drag).

The following discussion will pertain to the FORWARD mode of operation. With a tight tape condition on the upper tension arm the vane would shade the photocell causing a decrease in current from it. With this decrease in current to the reel drive motor, its speed would tend to decrease thus correcting the tight tape condition and strive to center the vane. The inner reel is forced to freewheel by a tight tape condition on the lower tape tension arm which allows very little current to the inner reel drive motor. This tight tape condition is caused by the capstan drive moving tape in opposition of the inner reels tendency to run counterclockwise. This slightly tight tape condition is always present (in the forward mode) allowing the inner reel to free wheel and turn only when pulled by tape. If slack tape should occur at this lower tension arm, the vane would move allowing more light to the photocell producing more current. This increase in current to the inner reel drive motor would cause it to have a greater tendency to turn counterclockwise thus giving it a greater drag and take up the slack. With the slack taken up the vane would return to near its midposition and the inner reel would again be free wheeling.

MAINTENANCE

a. GENERAL – This information consists of maintenance data (circuit description, test data and possibly maintenance adjustments, parts list, and diagrams) for the circuit boards and subassemblies used in the tape transport. Refer to the wiring diagrams and the transport overall schematic for information and location of particular points called out in these maintenance procedures.

b. MODE CONTROL

1. LOGIC BOARD CIRCUITS

(a) CIRCUIT DESCRIPTION – The following list describes the function of each relay on the logic board.

RELAY	FUNCTION
K1	Establishes forward tape motion; provides interlock for reverse, record and fast.
K2	Establishes reverse tape motion; provides interlock for forward, record and fast.
K3	Establishes fast tape motion if either K1 or K2 is energized; provides interlock for record, pinch rolls and reference signals.
K4	Applies ±12 Vdc to the record electronics during the record mode.
K5	Determines if tape is moving or not moving; provides interlock for tape direction relay, end-of-tape sense, pinch rolls.

RELAY (CONT.)	FUNCTION (CONT.)
K6	Establishes which direction tape will move.
K9	Actuates stop mode when energized by sense circuitry.
K10	Selects proper sense detector for forward or reverse tape sense.

(b) TEST DATA

Step 1. With POWER removed, place the logic board on its extender board and ensure the following voltage indications are present at the indicated pin during the proper mode. J7 is the corresponding jack for logic board plug, P1, as J8 is for plug, P2. Connect a dc voltmeter between system ground, TP2 (power and control connector panel) and each indicated plug pin number. Ensure POWER is applied, tape is threaded properly and STOP mode is first depressed.

PLUG PIN NO.	MODE	FUNCTION	VOLTAGE
P1-5	STOP	28 Vdc Return	0 Vdc
P1-6	STOP	Stop Initiate	+28 Vdc
P1-10	STOP	Record Initiate Power	+28 Vdc
P1-15	STOP	28 Vdc Return	0 Vdc
P1-16	STOP	Stop Lamp Power	+28 Vdc
P2-8	STOP	Stop Initiate Power	+28 Vdc
P2-9	STOP	Stop or FAST	+28 Vdc
P2-14	STOP	+5 Vdc	+5 Vdc
P2-15	STOP	+5 Vdc	+5 Vdc
P2-16	STOP	+5 Vdc	+5 Vdc
P2-18	STOP	12 Vdc Return	0 Vdc
P2-22	STOP	+28 Vdc	+28 Vdc
P1-8	FORWARD	Forward Power	+28 Vdc
P1-9	FORWARD	Forward Initiate pushbutton in and do not release	+28 Vdc
P1-21	FORWARD	Pinch Roll Activate	+28 Vdc
P2-7	FORWARD	Forward EOT Sense	+28 Vdc
P2-11	FORWARD	PR NO. 1 Control	+28 Vdc
P2-12	FORWARD	PR NO. 2 Control	+28 Vdc
P2-17	FORWARD	Operate @ 28 Vdc Level	+28 Vdc
P1-14	REVERSE	Reverse Initiate pushbutton in and do not release	+28 Vdc
P1-17	REVERSE	Reverse Lamp and Hold	+28 Vdc
P2-6	REVERSE	Reverse EOT Sense	+28 Vdc
P2-20	REVERSE	Reverse Hold	+28 Vdc
P1-1	FAST	FAST Holding	+28 Vdc
P1-2	FAST	FAST Initiate Power	+28 Vdc

PLUG PIN NO. (CONT.)	MODE (CONT.)	FUNCTION (CONT.)	VOLTAGE (CONT.)
P1-3	FAST	FAST Light Power and FAST Initiate	+28 Vdc
P2-13	FAST	Fast @ 28 Vdc Level	+28 Vdc
P1-4	RECORD	Record Relay Holding Power	+28 Vdc
P1-7	RECORD	Record Holding and Record Light Power	+28 Vdc
P1-18	RECORD	-12 Vdc	-12 Vdc
P1-20	RECORD	+12 Vdc	+12 Vdc
P1-22	RECORD	-12 Vdc Record	-12 Vdc
P1-23	RECORD	+12 Vdc Record	+12 Vdc

Step 2. To check the tape direction relay K2 (not on the logic board) depress FWD and ensure approximately +28 Vdc at terminal board TB4-2. Depress REVERSE and ensure approximately +28 Vdc at TB4-1.

Step 3. The capstan motor may be checked as follows:

(1) Remove POWER, unplug K2, and ensure a 3 ohm or approximate reading between pins 1 and 8 of K2 relay socket. Replace K2 when finished.

(2) Disconnect the lead to TB4-2 and connect a dc ammeter between this lead and TB4-2 Apply POWER, depress STOP and FWD, and ensure an approximate reading of 2.5 to 3 amps. If this current is excessive, check the pinch roller pressure as detailed in the checks and adjustments under maintenance in the Operator's Data bulletin. Replace the proper lead when finished.

(3) Complete (2) above using TB4-1 and REV mode. Replace the proper lead when finished.

(4) The use of a stethoscope or similar instrument may aid in detecting bad capstan motor bearings as the capstan is turning (FWD or REV, slow speed).

Step 4. End-of-Tape Sense Checkout

NOTE

Ensure the metallic marker are properly placed on each end of the tape and the tape is threaded properly.

(1) Ensure the EOT switch is set to the IN position, and POWER is applied.

(2) Depress STOP, FORWARD, and FAST, in that sequence.

(3) The recorder/reproducer should automatically revert to STOP mode prior to the inner reel becoming completely empty of tape. There should be approximately 60 to 100 feet, (approximately 1/8 inch tape wrap) of tape left on the inner reel.

(4) Depress REVERSE and FAST.

(5) The Recorder/Reproducer should automatically revert to STOP mode prior to the outer reel becoming completely empty of tape. There should be approximately 60 to 100 feet (approximately 1/8 inch tape wrap) of tape left on the outer reel.

(6) If satisfactory results are not obtained in the previous (1) through (5) refer to the following test and adjustments.

(a) Gain access to the logic board, right rear of recorder/reproducer, by removing the top and rear access panels. Place the logic board on its extender.

(b) Ensure tape is threaded properly, apply POWER, and depress STOP and FORWARD. Ensure the EOT switch is set to the IN position.

(c) Connect various resistors, ranging in value from 22 K ohm to 27 K ohm, between logic board pin J8-7 and system ground. Ensure STOP mode is activated with the application of one of these values. Ensure with a VOM, the presence of 12 to 14 Vdc at J8-7 when the recorder/reproducer reverts to STOP mode. This ensures the logic board sensitivity adjustment is approximately set to a satisfactory level for either forward or reverse. Slight adjustment of sensitivity adjust, R12 may be required to bring the sense circuitry firing level within the above resistance ranges, providing the 12 to 14 Vdc.

NOTE

When the optional Photo-End-Of-Tape Sense feature is supplied, refer to the appropriate bulletin in the optional items sections.

(c) PARTS LIST

Logic Board 835785

A1	510142-001	K8	See Note
C1	898406	K9	853515-003
C2	See Note	K10	855130-004
CR1	896458	P1	853518
thru		P2	853518
CR24		Q1	853037
CR25	See Note	Q2	852738
CR26	896458	R1	198200-102
CR27	896458	R2	198200-102
CR28	See Note	R3	198200-123
CR29	See Note	R4	198200-822
CR30	896458	R5	198200-222
CR31	896458	R6	198200-102
CR32	846164	R7	198200-470

Logic Board 835785 (Cont.)

CR33	896458	R8	198200-103
CR34	896458	R9	198200-331
CR35	See Note	R10	198200-223
CR36	See Note	R11	See Note
K1	853515-003	R12	329151-007
thru		XK1	853516
K5		thru	
K6	843788	XK5	
K7	See Note	XK9	853516

NOTE

These components comprise the shuttle kit (835792)

C2	691391-016	CR36	896458
CR25	896458	R11	691111-823
CR28	896458	K7	855130-004
CR29	896458	K8	855130-004
CR35	896458		

(d) DIAGRAMS - For schematic diagram of the logic board refer to the transport overall schematic.

2. SHUTTLE CIRCUITS (optional) - Refer to bulletin 3629 in the optional items section.

C. SPEED CONTROL

1. CAPSTAN BOARD

(a) CIRCUIT DESCRIPTION

INPUTS

Power		
+12 Vdc		P1-13
-12 Vdc		P1-18
12 Vdc Common		P1-20, P2-10, 11, 12
28 Vdc Common		P1-4, 5
+5 Vdc		P2-13,14
Speed Lines		
120	ips	P2-4
60	ips	P2-5
30	ips	P1-22
15	ips	P1-23
7 1/2	ips	P2-1
3 3/4	ips	P1-21
1 7/8	ips	P2-3
15/16	ips	P2-2
Servo Signals		
Tachometer		P2-7
Tape Reference - Hi		P2-22
Lo		P2-23
Acceleration Control		
Motion Bias		P1-1
Motion Bias		P1-11
Reel Drive Forward		P1-6
Reel Drive Reverse		P1-6
Capstan Motor Feed back		P1-9
Status and Control		
Operate-28 Vdc Level		P1-3
Fast-5 Vdc level		P2-6
Reverse-28 Vdc Level		P1-2
Pinch Roll Activate 28 Vdc Level		P1-10
Hi-Density Control		P2-15
Tape Inhibit		P2-21

OUTPUTS

Power	
Lamp Supply (Tachometer) +5 Vdc	P1-15
Lamp Supply (Reel Drive)	P1-14
Status and Control	
Phase Lock or Squelch	P2-20
Sync Lamp (Contact Closure to Ground)	P1-12
Tape Sync	P1-16, P2-19
Capstan Motion	P2-8
Signal	
Servo Error and Servo Control	P1-8
Reference (Record)	P2-16
Tachometer	P2-9
Tape Sync Board Provisions	
Power	
+12 Vdc	J7
-12 Vdc	J8
+5 Vdc	J6
Supply Common	J5
Status and Control	
Tape Inhibit	J13
Hi-Density	J12
Low Speed Group	J14
Tape Sync	J9
Signal	
Tachometer In	J-10
Tape Signal In Hi	A
Lo	B
Tach/Tape Output	J11

(1) POWER SUPPLY CIRCUITS - Q23, CR21, and associated circuitry provide +10 Vdc at P1-14 (reel drive photo-cell lamp voltage) and +5 Vdc at P1-15 (tachometer lamp voltage). Both voltages are produced from the +12 Vdc input to the capstan board.

(2) REFERENCE OSCILLATOR CIRCUITS - This portion of the capstan board consists of crystal oscillator A1, frequency countdown circuit A2, and divide-by-twelve circuit A4.

One output of the crystal oscillator, operating at 3.2 MHz, is applied to the frequency countdown circuit (normal tape speeds) at A2-9. The output of this circuit, at A2-5, is a submultiple of 3.2 MHz, dependent (proportional) on tape speed. The speed line input pins to A2 are 4 (1 7/8 ips), 1 (3 3/4 ips), 14 (7 1/2 ips), 15 (15 ips.) 2 (30 ips), 13 (120 ips), and 3 (60 ips). When a tape speed is selected, +5 Vdc is applied to the proper input of A2; all other speed line inputs to A2 will be grounded. The particular output of A2 is applied to the Frequency Preparation circuits for further processing.

The other output of the crystal oscillator is applied to fast divide-by-twelve gate A4, at pin 14. This circuit provides a divided-by-twelve output at A4-8, when activated by a logic 0 level at A4-6 and 7. This logic 0 level is present from A8-11 due to the logic 1 level applied to P2-6 during Fast mode. The divided output is applied to the frequency preparation circuits for further processing, allowing the recorder/reproducer to rapidly move tape.

(3) FREQUENCY PREPARATION CIRCUITS - These circuits consist of divide-by and gating circuits A3, A5, A6, A7, A8, A9, A10, and A11.

The divided frequency (during normal tape speed) from A2 is applied to divide-by circuit A3, at pin 14. This circuit is enabled by a logic 0 level at A3-2 and 3, present from P2-6 during any normal operating mode. A3, during tape speeds 120 - 1 7/8 ips, provides a divide-by-eight output at A3-8 and a divide-by-sixteen output at A3-11. During a tape speed of 15/16 ips, a divide-by-sixteen output is provided at A3-8 and a divide-by-thirty-two output at A3-11.

The various divided outputs of A3 are provided by divide-by-two A5 and gate A6. A5, activated by the 15/16 ips speed line, controls the degree of A3 division by dividing-by two the frequency at A3-12 prior to A3-1. Gate A6, during 120 - 1 7/8 ips tape speeds, lowers the degree of A3 division by providing no division from A3-12 to A3-1.

Both A3 outputs, A3-8 and A3-11, are applied to density select gate A7, with only one output, A3-11, being applied to divide-by-two A9 and gate A10.

A7, functioning as a density select gate, provides either a HI density frequency (400 kHz at 120 ips), submultiples at lower speeds or a LO density frequency (200 kHz at 120 ips), submultiples of lower speeds, for recording on tape (optional tape sync method of speed control). With a logic 1 level, from the HI position of the density switch, applied to P2-15, NAND gate A7-12, 13, 11 is enabled. NAND gate A7-3 produces a logic 0 level from the logic 1 levels at pins A7-2 and 3 (from P2-15). This logic 0 level, when applied to A7-4, inhibites that NAND gate, thus preventing the signal at A3-11 from passing. The signal at A3-8 passes through NAND gates A7-13, 11, 10, 8, to the reference output at P2-16. With a logic 0 level applied to P2-15 from the LO position of the density switch, NAND gate, A7-4, 5, 6 is enabled and NAND gate, A7-12, 13, 11, is inhibited. Thus the signal at A3-8 passes through NAND gates A7-5, 6, 9, 8 , to the reference output at P2-16.

The single output at A3-11 is applied to a divide-by-two circuit at A9-3 and a gate at A10-2.

At 120 ips, the divide-by-two is activated by a logic 1 level from A8-6. This is due to a logic 1 level from P2-4 NANDED with a logic 0 level at P2-6 to produce a logic 0 level at A8-3. This logic 0 level produces a logic 1 level at A8-4, 5, 6, activating A9-3, and inhibiting NAND gate A10-1, 2, 3. With this NAND gate inhibited the frequency at A10-2 passes no further (while at 120 ips). The divided output of A9, at pin 6, passes through enabled A10-4, 5, 6, to operate/fast select gate A11.

At speeds other than 120 ips the divide-by-two circuit A9-3 is not activated and the signal from A3-11 passes through enabled NAND gates A10-2, 3, 4, 6, to A11. A10-1, 2, 3, is enabled by a logic 1 level from A8-3, produced by NANDING a logic 1 level from A8-11 with a logic 0 level from P2-4. A10-4, 5, 6, is enabled by the logic 1 level produced by A9-6 during its inactive state.

At A11, the signal applied to pin 2 is passed through enabled NAND gates A11-1, 2, 3, 8, 9, 10, to TP5 and the Frequency Comparison Circuits/Phase comparison circuits. A11-1, 2, 3 is enabled by a logic 1 level to A11-1. This level is present via energized operate relay K10. A logic 1 level, enabling A11-8, 9, 10, is produced by a logic 1 level to A11-13 (via K10) and a logic 0 level to A11-12 (from inactive A4).

(4) TACHOMETER SIGNAL CIRCUITS - These circuits consist of partial gates A8 and A10 and one-half of a divide-by-two circuit A9.

The tachometer signal from the capstan motor is applied to the board at pin P2-7 and is inverted by A8-9, 10, 11. The signal is then applied to a tape sync board connecotr, J10, and to a tape motor detector switch.

The signal applied to J10 may control the tape/tach select gate (selects either the tach signal or the tape signal, refer to tape signal circuits) on the tape sync board (optional feature), when supplied. When the tape sync board is not supplied, the signal at J10 is jumpered to J11 and applied to divide-by-circuit A9, at pin 11. This circuit functions as a divide-by-two circuit only at 120 ips. The divided output is gated through A10-9 and 8 to the phase comparison/frequency comparison circuits (A12, A13, A14, etc). At all speeds other than 120 ips, the divide-by-two circuit is disabled and the tachometer signal is gated through A10-13 and 11 (no frequency division) to the phase comparison/frequency comparison circuits.

The tape motion detector switch consists of Q21, Q22, and associated circuitry. This switch circuit simply detects when the tachometer circuit is between 1000 and 1500 Hz. At this point Q22 conducts allowing a path to ground for the low side of tape motion relay K5. With K5 energized, the recorder/reproducer's mode control circuitry is assured that tape is moving.

(5) TAPE SIGNAL CIRCUITS (optional) - Refer to the tape sync board circuits in later portions of this speed control section.

(6) PHASE COMPARISON CIRCUITS (refer to the waveforms in the test data section) - These circuits consist of function generator gates A13 and A14, constant current generators Q3 through Q10, clamp circuits Q11 and Q12, and operational intergrators A17 and A18.

The following discussion refers to the oscillator reference signal as the "A" signal and the tape or tachometer reference signal as the "B" signal.

The two signals, A and B, are applied to the function generator; with four resultant outputs. The A signal is applied to A13-10, 12, 13 and A14-4, with the B signal applied to A13-9, 1, 2 and A14-1. The A and B signals are NANDED to produce $\overline{AB}$ at A13-8. Each A and B signal is NANDED separately to produce $\overline{A}$ at A13-11 and $\overline{B}$ at A13-3. The $\overline{A}$ and $\overline{B}$ are NANDED to produce $\overline{\overline{A}\,\overline{B}}$ at A13-6. $\overline{\overline{A}B}$ is produced at A14-3 by NANDING $\overline{A}$ and B, and $\overline{A\overline{B}}$ is produced at A14-6 by NANDING A and $\overline{B}$. $A\overline{B}$ is produced at A14-8 by inverting $\overline{A\overline{B}}$ and $\overline{A}B$ is produced at A14-11 by inverting $\overline{\overline{A}B}$. $\overline{A}B$ and $A\overline{B}$, in conjunction with constant current drivers, provide the charging currents required by operational intergrators A17 and A18. $A\overline{B}$ and $\overline{A}B$, in conjunction with contant current drivers Q7 through Q10, provide the discharging currents required by operational intergrators A17 and A18. Each signal, when applied to either A17-2 or A18-2, is intergrated using the selected speed dependent capacitor, C3 through C14, resulting in a trapezoidal wave output at A17-6 or A18-6. The selected capacitor determines the charge time and thus the rise angle and the dc voltage level reached before the charging time is shut-off by the $\overline{A}B$ input signal (A17) circuit. The $A\overline{B}$ (A17 circuit) signal discharges the capacitor proportional to the charge rate. $\overline{AB}$ with clamp Q11 and $\overline{\overline{A}\,\overline{B}}$ with Q12 is used to clamp the outputs to a 0 level until the beginning of the next trapezoidal wave. This 0 level is also adjustable by R40 (A18) and R43 (A7).

The Two trapezoidal waveforms, 180° out of phase, are summed through potentiometer R45 and inverted and amplified by A20 to develop a dc level proportional to the phase relationship of the A and B signals. Gain adjustments R52 and R50 vary the gain of A20. R52 is used alone in the tape sync mode, with R50 and R52 used together in the capstan sync mode.

The dc voltage level is applied to the mode gate circuitry through resistors R70 and R62. When a phase lock condition is attained as described in the later frequency comparison circuit paragraph, transistor Q14 is "turned off" and the dc voltage is amplified at A21. The output is applied to a stablization filter network, energized relay K10 and an emitter follower circuit to the capstan power amplifier.

(7) FREQUENCY COMPARISON CIRCUITS - These circuits consist of frequency/phase lock detector A12, optional amplifier A19, select gating circuits Q13 through Q16, phase lock switch Q19 and A15, and gate A16.

The A and B signals from TP5 and TP6 are applied to A12-1 and 3, respectively. When FWD is depressed on the Operators Control Panel and tape starts to move, the B signal begins to increase in frequency. With the B frequency lower than A (frequency coming up to speed), the output at A12-13 goes to a logic 0 level. This signal, when applied through A19, provides negative pulses at TP12. These pulse, when applied through A21, etc., to the capstan, increase tape speed. When the B signal frequency increases past the A signal frequency (over speed), the output at A12-2 goes to a logic 0 level. This signal, when inverted by A19, provides positive pulses at TP12. These pulses, when applied through A21, etc., to the capstan, decrease tape speed.

These dc levels produce capstan motion until a phase lock condition is obtained. At this point the mode gate circuit selects the dc level from the phase comparison circuits.

The mode gate circuit is controlled by Q19, A15, and A16, Q19 and A15 accept the $\overline{A}B$ and $A\overline{B}$ signals from the function generator (TP7 and 8). A logic 1 level is produced at A15-7 when the A and B signal match, producing phase lock. R94 is provided for adjustment of the phase lock point. This level is NANDED, at A16-2 and 1, with the logic 1 level from A8-11 (present during all modes except FAST), producing a logic 0 level to Q18 preventing conduction. This action produces +5 Vdc to P2-20 $\overline{\text{(squelch)}}$ inhibiting the servo squelch function to the FM reproduce bds (outputs will not be squelched during phase lock). Squelch switch S1, when depressed, places a continuous logic 0 level to the base of Q18. This allows an FM reproduce board output during STOP or other non-phase lock modes.

The logic 0 level at A16-3 is also NANDED by A16-4, 5, 6, to produce a logic 1 level at A16-6. This logic 1 level, present during phase lock, is applied to Q15 causing conduction of Q15, Q16, and Q13, along with inhibiting Q14. With Q13 conducting, the output of the inverting amplifier at A19-6 is shorted to ground. With Q14 "off" the output of the phase comparison circuits, at A20-6, is allowed to control capstan motion via the amplification and acceleration circuits.

The logic 1 level output at A16-6 is also applied to the base of Q20, causing conduction. This action energizes K9 causing the capstan sync lamp to lite.

(8) AMPLIFICATION AND ACCELERATION CIRCUITS - The input to A21 at pin 2, whether from A19 or A20, is inverted and applied through the stablization network, consisting of C18, C19, R65, R66, R67, and R68, to relay K10. When K10 is energized, this dc level is applied through emitter follower Q17 and P1-8 to the capstan power amplifier and capstan motor.

The acceleration control circuits consist of C26, C27, and related components. In a STOP mode, capacitors C26 and C27 are charged with +28 volts via the capstan motor feedback from the capstan power amplifier. Upon depressing the FWD or REV pushbuttons, the +28 volts instantaneously drops and is coupled to the base of transistor, Q17, to reduce the output at the emitter. As capacitor C26 discharges, transistor, Q17 is allowed to conduct as the frequency and phase comparison circuits require.

The reel drive circuits perform a similar action through capacitor C27 when tape motion begins as does the capstan. This action is necessary to retard speed changes of the capstan motor to allow time for the reel drive motors to gain sufficient angular velocity so that tape spilling does not occur.

(b) TEST DATA

Step 1. Place the capstan board on its extender, apply power, and depress STOP. Enusre with an oscilloscope, or voltmeter, the presence of the following approximate indications between the indicated point and TP4 (lo), during the proper mode. Refer to the capstan board component location diagram for location of pins and testpoints.

NOTE

A logic 1 level is considered +3.7 Vdc ±1.3 Vdc and a logic 0 level is considered +0.3 Vdc ±0.3 Vdc.

(1) POWER AND CONTROL

INDICATION POINT	MODE	INDICATION
TP1	STOP	+12 Vdc approx.
TP2	STOP	+5 Vdc approx.
TP3	STOP	-12 Vdc approx.
P1-15	STOP	+5 Vdc approx.
P1-14	STOP	+10 Vdc approx.
P1-3	FWD or REV	+28 Vdc approx.
P1-2	REV	+28 Vdc approx.
P2-15	STOP (density set to HI)	+5 Vdc approx.
P2-15	STOP (density set to LO)	0 Vdc approx.
P2-4	STOP - tape speed 120 ips.	+5 Vdc approx.*
P2-5	STOP - tape speed 60 ips.	+5 Vdc approx.*
P1-22	STOP - tape speed 30 ips.	+5 Vdc approx.*
P1-23	STOP - tape speed 15 ips.	+5 Vdc approx.*
P2-1	STOP - tape speed 7 1/2 ips.	+5 Vdc approx.*
P1-21	STOP - tape speed 3 3/4 ips.	+5 Vdc approx.*
P2-3	STOP - tape speed 1 7/8 ips.	+5 Vdc approx.*
P2-2	STOP - tape speed 15/16 ips.	+5 Vdc approx.* **

* With each individual speed line activated, all other speed lines should be grounded.

**Optional Speed.

(2) REFERENCE OSCILLATOR AND FREQUENCY PREPARATION CIRCUITS

INDICATION POINT	MODE	INDICATION
P2-6	FWD or REV	Logic 0 level
TP5	FWD (switching through speeds)	

SPEED (ips)	FREQ.(kHz)
120	100
60	100
30	50
15	25
7 1/2	12.5
3 3/4	6.25
1 7/8	3.125
15/16	1.562

INDICATION POINT (CONT.)	MODE	INDICATION		
P2-16	FWD (switching through speeds, either density)	SPEED (ips)	FREQ. (kHz)	
			HI	LO
		120	400	200
		60	200	100
		30	100	50
		15	50	25
		7 1/2	25	12.5
		3 3/4	12.5	6.250
		1 7/8	6.25	3.125
		15/16	3.125	1.562
P2-6	FAST	Logic 1 level		
TP5	FAST	267 kHz		

(3) TACHOMETER REFERENCE CIRCUITS

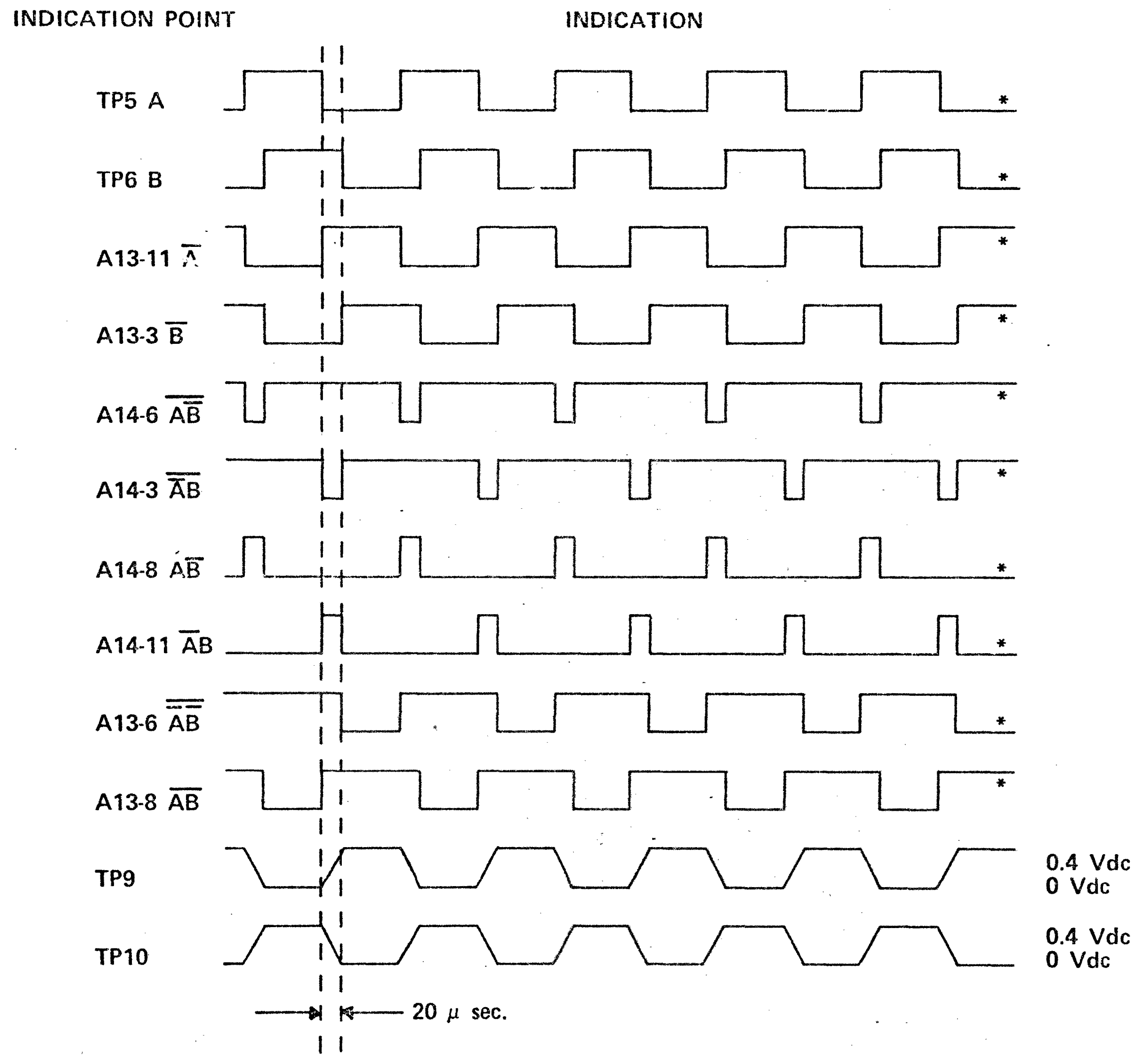
INDICATION POINT	MODE	INDICATION
P2-7	STOP (turning capstan by hand)	a squarewave (output of tach on capstan motor)
P2-7	FWD (any speed)	a well defined square-wave (adjustable by potentiometer on cap-stan)
P2-8	FWD or REV	0 Vdc approx.
P2-9	FWD (switching through speeds)	same as P2-16 in previous paragraph (2), except 120 ips is 200 kHz
TP6	FWD (switching through speeds)	same as TP5 in previous paragraph (2),
P2-8	FWD	0 Vdc

(4) FREQUENCY/PHASE COMPARISON CIRCUITS

NOTE

Adjustment per the checkout and adjustments in the maintenance section of the Operator's Data bulletin should always be attempted prior to trying to obtain these indications.

Depress FWD and move tape at 3 3/4 ips. Ensure, with an oscilloscope, the following waveforms, or approximates, between the indicated point (hi) and TP4 (lo). All waveforms are at a frequency of approximately 6.25 kHz.



* These indicated waveforms are at Logic 1 Levels (+3.7 Vdc ±1.3 Vdc) and Logic 0 Levels (+0.3 Vdc ±0.3 Vdc).

CAPSTAN BOARD 836248

A1	510118-002	C24	859959-002	J5	836268
A2	859520-053	C25	329157-001	thru	
A3	859520-029	C26	691391-008	J14	
A4	859520-028	C27	691391-009	K1	510388-002
A5	859520-020	C28	691391-033	thru	
A6	859520-001	C29	859775-021	K6	
A7	510376-036	C30	859959-002	K7	510388-001
A8	859520-001	C31	859959-002	K8	855130-004
A9	859520-020	C32	859959-002	thru	
A10	859520-001	thru		K10	
A11	859520-001	C39		MP	854220 (22 used)
A12	510387	C40	859959-002	P1	853518
A13	859520-001	C41	859959-002	P2	853518
A14	859520-001	C42	859959-002	Q1	854540
A15	510339-002			thru	
A16	859520-001	CR1	844510	Q6	
A17	510240-002	thru		Q7	854539
thru		CR4		thru	
A21		CR5	Not Used	Q10	
C1	859775-017	thru		Q11	510336
C2	859775-017	CR10		Q12	510336
C3	854555-026	CR11	853531	Q13	854539
C4	854555-026	CR12	853531	Q14	854540
C5	854555-014	CR13	844510	Q15	854539
C6	854555-014	CR14	844510	Q16	854539
C7	854555-010	CR15	852475-022	Q17	859971
C8	854555-010	CR16	844510	Q18	854539
C9	276212-450	CR17	844510	Q19	854540
C10	276212-450	CR18	852475-022	Q20	853037
C11	276212-200	CR19	896458	Q21	854539
C12	276212-200	CR20	896458	Q22	854539
C13	198816-621	CR21	852475-020	Q23	851271
C14	198816-621	CR22	844510	R1	198200-121
C15	198816-561	CR23	844510	R2	198200-391
C16	198816-561	CR24	844510	R3	198200-391
C17	854555-116	CR25	844510	R4	198200-182
C18	691391-011	CR26	850287	R5	198200-822
C19	854555-116	CR27	850287	R6	198200-103
C20	691686-027	CR28	844510	R7	198200-103
C21	854555-127	J1	846601	R8	853530-292
C22	854555-127	thru			
C23	859775-021	J4			

R9	198200-822	R39	853530-284	R70	853530-176
R10	198200-821	R40	329151-010	R71	198200-472
R11	198200-103	R41	853530-284	R72	198200-332
R12	198200-103	R42	853530-284	R73	198200-103
R13	198200-222	R43	329151-010	R74	198200-182
R14	198200-222	R44	853530-176	R75	198200-821
R15	198200-272	R45	329151-006	R76	198200-222
R16	198200-272	R46	853530-176	R77	198200-221
R17	198200-332	R47	198200-473	R78	198200-103
R18	198200-392	R48	198200-102	R79	198200-821
R19	198200-392	R49	198200-102	R80	864971-014
R20	198200-332	R50	329151-010	R81	198200-102
R21	198200-822	R51	853530-193	R82	198200-270
R22	198200-822	R52	510143-008	R83	198200-472
R23	198200-821	R53	198200-681	R84	198200-151
R24	853530-292	R54	853530-176	R85	198200-151
R25	198200-223	thru		R86	198200-470
R26	198200-223	R57		R87	198200-181
R27	198200-182	R58	853530-193	R88	198200-332
R28	198200-822	R59	853530-147	R89	198200-103
R29	198200-103	R60	198200-331	R90	198200-103
thru		R61	198200-102	R91	198200-822
R31		R62	853530-176	R92	198200-152
R32	198200-102	R63	853530-193	R93	198200-682
R33	853530-605	R64	853530-155	R94	329151-008
R34	198200-102	R65	198200-103	R95	198200-103
R35	853530-176	R66	198200-562	S1	510102-003
R36	198200-471	R67	198200-104	TP1	691032
R37	853530-292	R68	198200-100	thru	
R38	853530-284	R69	198200-471	TP18	

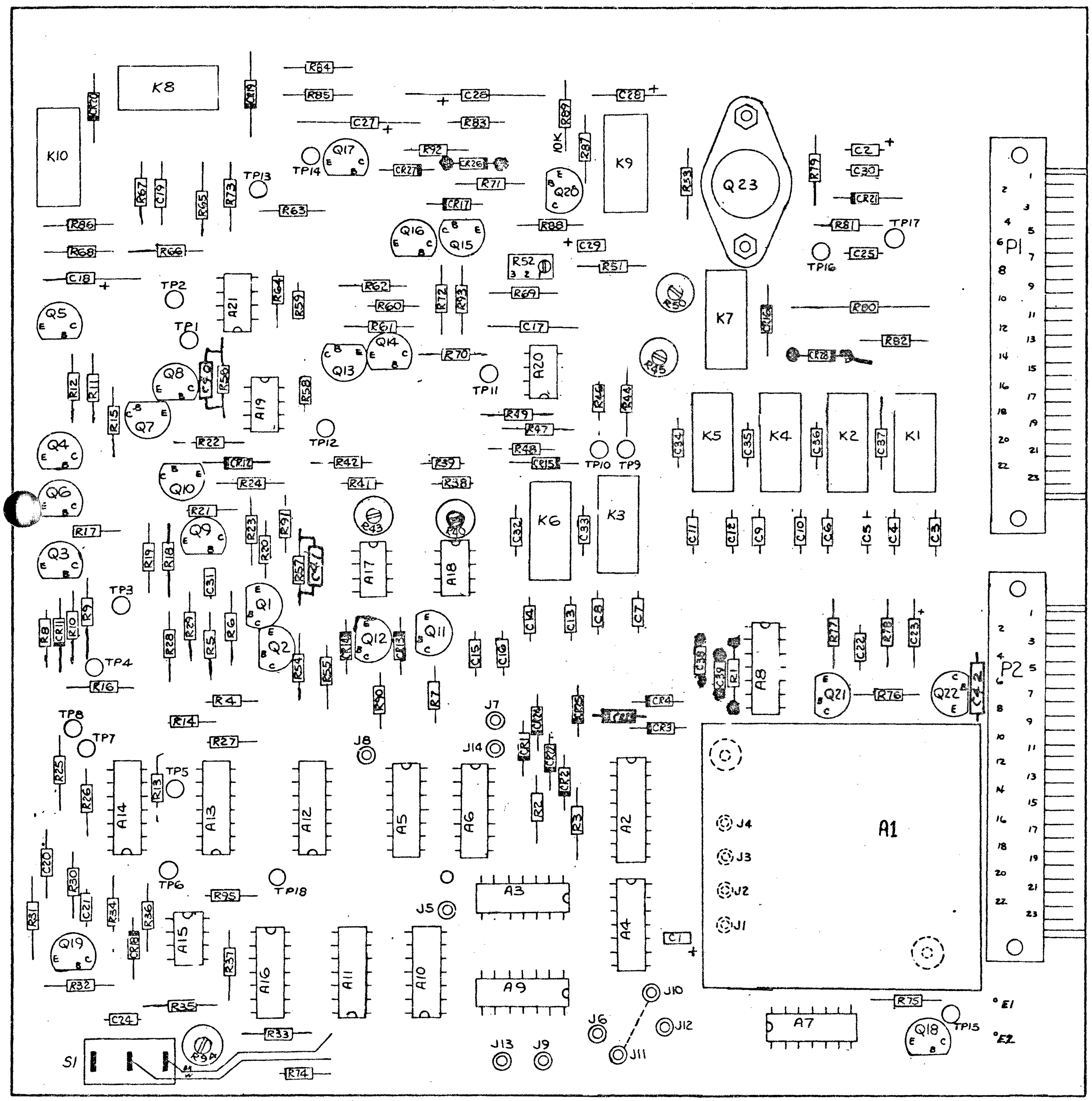
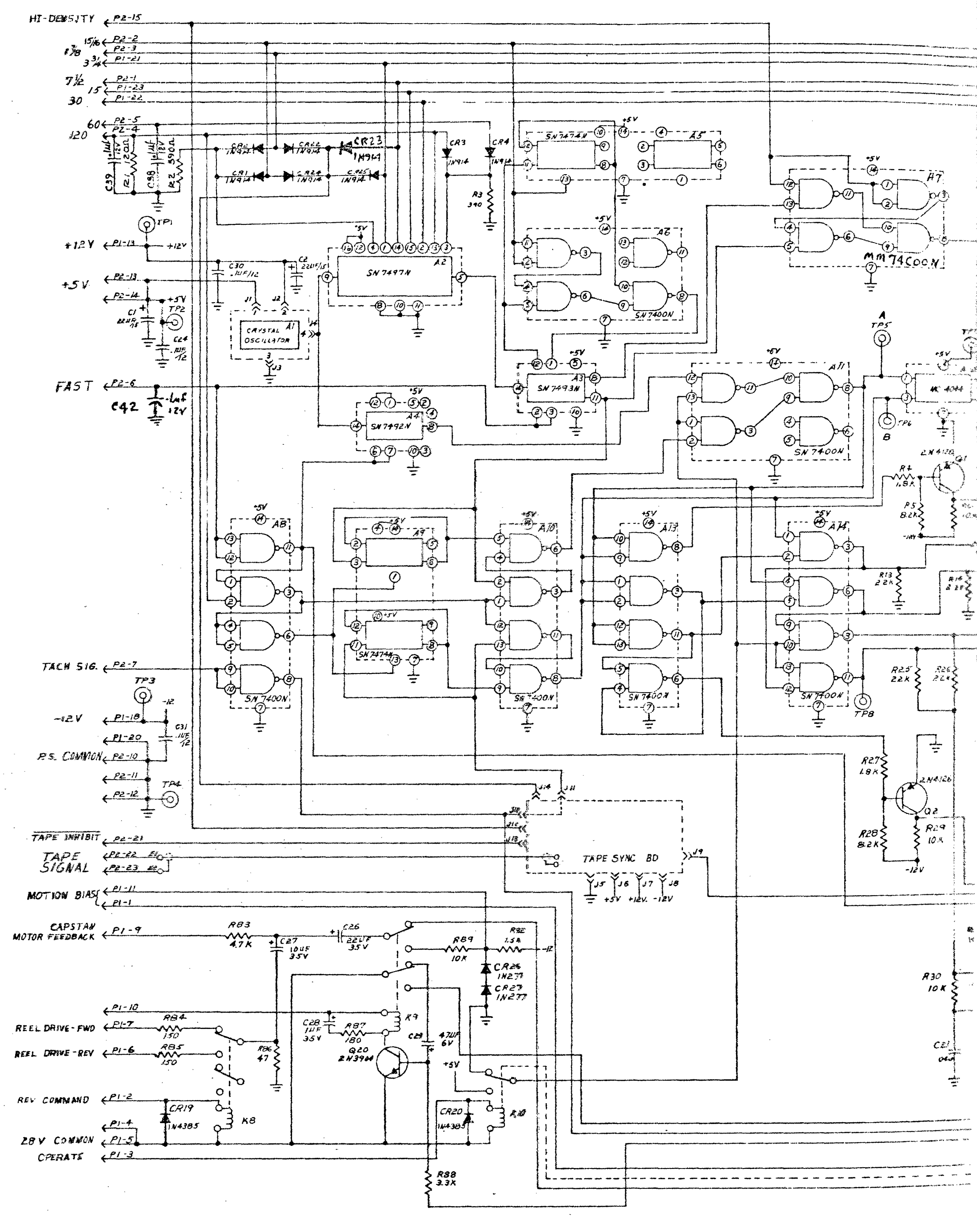


Figure 3. Capstan Board, Component Location



HI-DENSITY
15/16
1 7/8
3 3/4
7 1/2
15
30
60
120
+12V
+5V
FAST
C42
TACH SIG.
-12V
P.S. COMMON
TAPE INHIBIT
TAPE SIGNAL
MOTION BIAS
CAPSTAN MOTOR FEEDBACK
REEL DRIVE-FWD
REEL DRIVE-REV
REV COMMAND
28V COMMON
OPERATE
SN7497N
SN7493N
SN7492N
SN7474N
SN7400N
MM74C00N
CRYSTAL OSCILLATOR
TAPE SYNC BD
2N4126
2N3904

836248-TTS

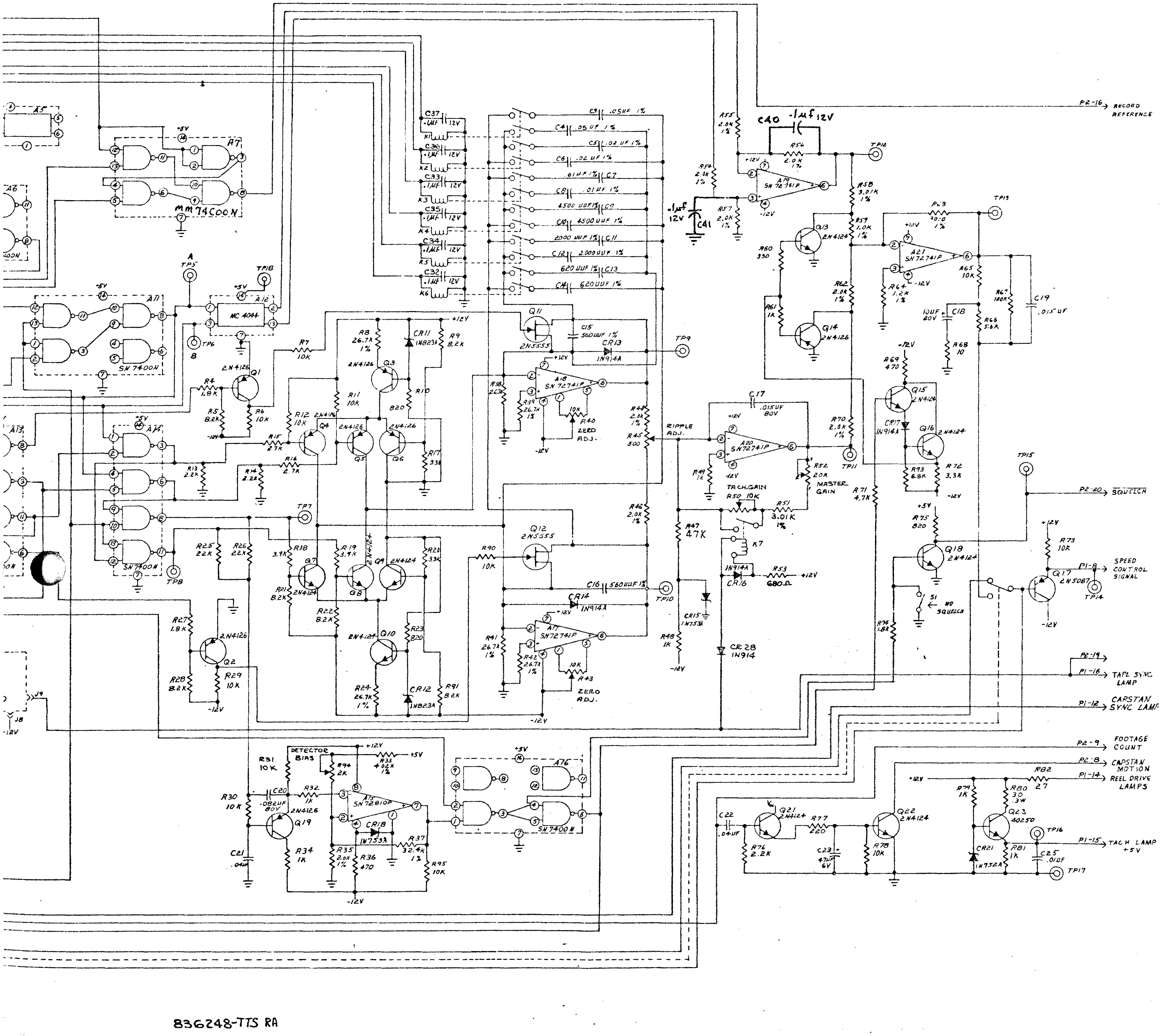


Figure 4. Capstan Board, Schematic Diagram

2. TAPE SYNC BOARD

(a) CIRCUIT DESCRIPTION

INPUTS

+12 Vdc	P7
-12 Vdc	P8
+5 Vdc	P6
Ground	P5
Tape Inhibit	P13
Hi Density	P12
Low Speed Group	P14
Tach In	P10
Tape In hi	E1
Tape In lo	E2

OUTPUTS

Tape Sync	P9
Tape/Tach Output	P11

The tape sync board, an optional item, mounts directly onto the standard capstan board (P/N 836248. This board provides the tape synchronous method of speed control, in addition to the standard capstan synchronous method. The board contains integrating amplifier A1, detector Q3 and Q4, level detector A2, divide-by-two A3, tape/tach select gate A4, and inverter A5.

The tape reference signal, applied to the board at E1, is integrated and amplified by A1. One function of the output at A1-6 triggers detector circuit Q3 and Q4. This circuit, when activated, provides a positive voltage to Q1 causing conduction, and to A4-9.

Conduction of Q1 turns the tape sync lamp "on" by grounding P9. The level applied to A4-9 activates select capabilities, discussed later.

The other function of the output at A1-6 is applied to level detector A2, at A2-3. The sensitivity of this detector circuit is further controlled by the combined 15/16 ips through 7 1/2 ips speed lines at P14, when applicable. The squarewave output, at A2-7, is inverted by A5-3 and divided-by-two at A3-5. The input to A3, at A3-3 and the output of A3, at A3-5 are applied to the tape/tach select gate A4 at A4-13 and A4-12, respectively.

The tape/tach select gate functions by switching one of three inputs to P11, providing control of tape motion. The three inputs consist of: (1) HI density, tape reference at A4-13 signal, (2) LO density tape, reference signal at A4-12, and (3) tachometer signal at A4-1, 2,3,4, 14,15. The selection function of A4 is controlled by the following three inputs: (1) tape inhibit at A4-10, (2) HI density A4-11, and (3) signal detector at A4-9.

A tape inhibit logic 0 level, at A4-10 (present during RECORD and FAST modes), allows the tachometer signal at A4-1, 2, 3, 4, 14, 15, to be transferred to A4-5 and P11, to control tape motion (capstan sync mode).

A signal detector logic 1 level, at A4-9, activates the tape signal selection capabilities of A4. With a logic 1 level at A4-9 and a logic 0 level at A4-11 (from P12 via the LO density position of the density switch), the lo density tape signal at A4-12 is transferred to A4-5 and P11, to control tape motion in place of the tachometer signal. With a logic 1 level to A4-9 and A4-11 (from P12 via the HI density position of the density switch), the hi density tape signal at A4-13 is transferred to A4-5 and P11.

During any period when tape inhibit is a logic 1 level (standard operating mode) and a signal detector level is not available at A4-9, the tachometer signal from P10 is made available at A4-5 and P11, for controlling tape motion.

(b) TEST DATA

NOTE

No controls or adjustments are utilized on the tape sync board. R52, on the capstan board, concerns the tape adjustments. Prior to completing the following procedures, ensure the speed control system (including tape sync portions) is setup properly per the maintenance section of the Operator's Data Bulletin.

Step 1. Record, in forward, 50-75 feet of reference signal, per the operating procedures (operator's Data Bulletin).

Step 2. Ensure POWER is removed. Gain access to the tape sync board area on the capstan board (removal of the top and rear access panels may provide greater access).

Step 3. Apply power, rewind the tape to the beginning of the recorded reference and depress FWD.

Step 4. Using a voltmeter, oscilloscope or frequency counter, ensure the presence of the following indications in the proper mode, between the indicated point and capstan board ground, TP4. Refer to the tape sync board component location diagram for location of indication points.

NOTE

A logic 1 level is considered +3.7 Vdc ±1.3 Vdc and a logic 0 level is considered +0.3 Vdc ±0.3 Vdc.

INDICATION POINT	MODE	INDICATION
P8	STOP	-12 Vdc approx.
P7	STOP	+12 Vdc approx.
P6	STOP	+5 Vdc approx.

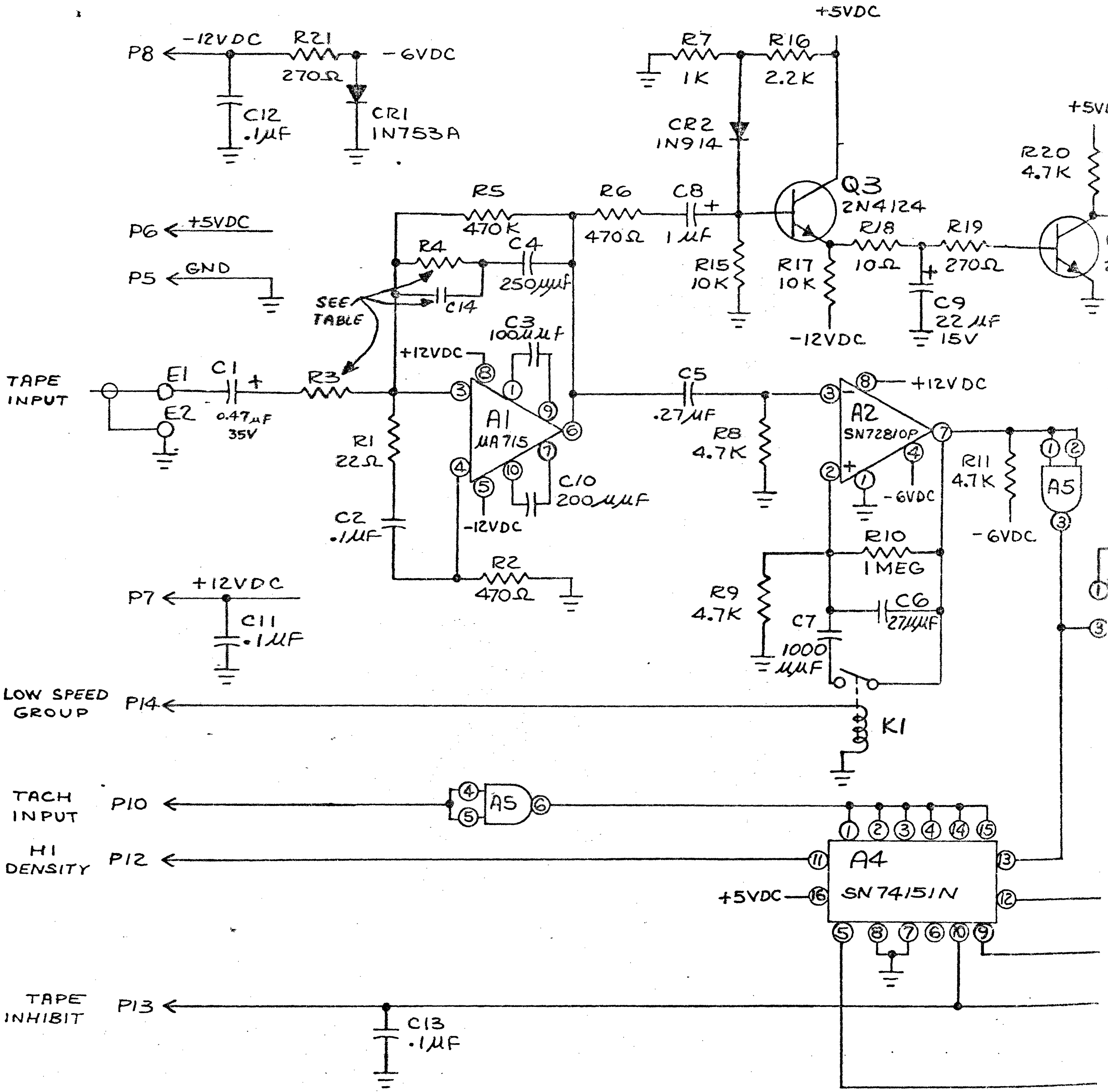
INDICATION POINT	MODE	INDICATION		
A (tape input signal)	FWD (at the same speed as recorded)	SPEED (ips)	FREQ. (kHz) HI Den.	LO Den.
		120	400	200
		60	200	100
		30	100	50
		15	50	25
		7 1/2	25	12.5
		3 3/4	12.5	6.25
		1 7/8	6.25	3.125
		1 15/16	3.125	1.562
P9	FWD (with tape indicator lamp lit)	0 Vdc		
P14	FWD (check at tape speeds of 15/16 ips through 7 1/2 ips)	logic 1 level		
P14	FWD (check at tape speeds of 120 ips through 15 ips)	logic 0 level		
P12	FWD (density switch set to HI position)	logic 1 level		
P12	FWD (density switch set to LO position)	logic 0 level		
P14	STOP and FAST	logic 0 level		
P14	FWD or REV (any speed)	logic 1 level		
P10	FWD (switching through the speeds)	SPEED (ips)	FREQ. (kHz)	
		120	200	
		60	100	
		30	50	
		15	25	
		7 1/2	12.5	
		3 3/4	6.25	
		1 7/8	3.125	
		15/16	1.562	
P11	FWD (switching through the speeds, tape sync lamp lit)	0 to 4 Vdc squarewave, same frequency as P10.		

(C) PARTS LIST

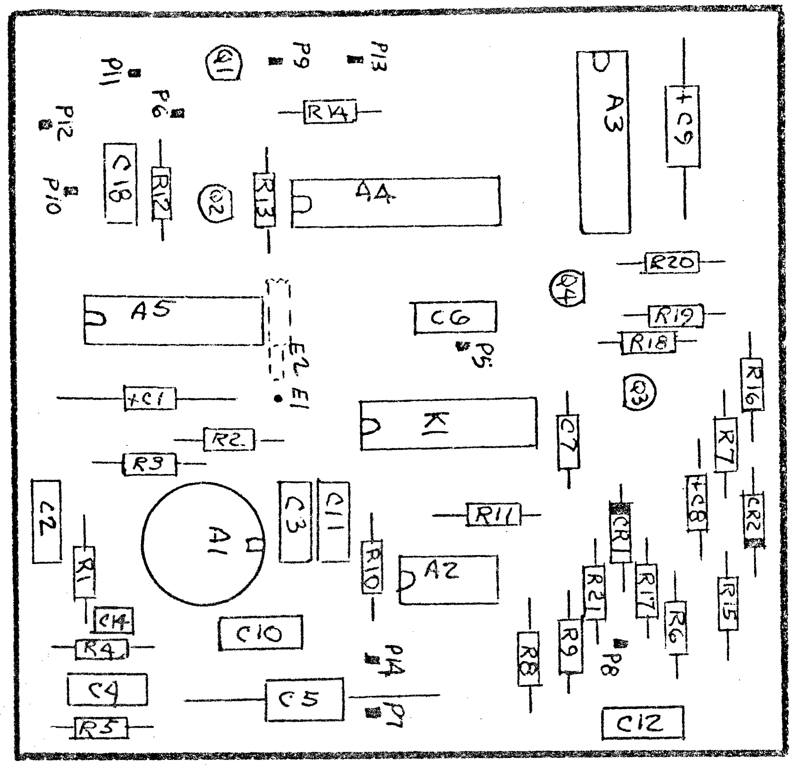
TAPE SYNC BOARD 836249 -001 or -002 (See Table below)

	A1	510428-001	Q1	853037
	A2	510339-002	Q2	854539
	A3	859520-020	thru	
	A4	859520-047	Q4	
	A5	859520-001	R1	198200-220
	C1	691391-012	R2	198200-471
	C2	859959-002	R3	See Table
	C3	197212-100	R4	See Table
	C4	197212-250	R5	198200-474
	C5	691686-062	R6	198200-471
	C6	197212-027	R7	198200-102
	C7	691686-008	R8	198200-472
	C8	691391-030	R9	198200-472
	C9	691391-012	R10	198200-105
	C10	197212-200	R11	198200-472
	C11	859959-002	R12	198200-102
	C12	859959-002	R13	198200-471
	C13	859959-002	R14	198200-471
	C14	See Table	R15	198200-103
	CR1	852475-002	R16	198200-222
	CR2	844510	R17	198200-103
	K1	510388-001	R18	198200-100
	P5	836269	R19	198200-271
	thru		R20	198200-472
	P14		R21	198200-271
(transipads)	MP1	854220 (4 used)		

TAPE SYNC BOARD PART VARIATIONS				
USE	836249	R3	R4	C14
Standard	-001	150Ω 198200-151	220Ω 198200-221	Not Used
Narrow Track Heads	-002	150Ω 198200-151	2.2KΩ 198200-222	100PF 197212-100



P8
-12VDC
R21
270Ω
-6VDC
C12
.1μF
CR1
1N753A
+5VDC
R7
1K
R16
2.2K
CR2
1N914
Q3
2N4124
R20
4.7K
P6
+5VDC
P5
GND
R5
470K
R6
470Ω
C8
1μF
R4
C4
250μμF
R15
10K
R17
10K
R18
10Ω
R19
270Ω
C9
22μF
15V
-12VDC
SEE TABLE
C14
C3
100μμF
+12VDC
TAPE INPUT
E1
E2
C1
0.47μF
35V
R3
A1
μA715
C5
.27μF
R8
4.7K
A2
SN72810P
+12VDC
-6VDC
R11
4.7K
A5
-6VDC
R1
22Ω
C2
.1μF
-12VDC
C10
200μμF
R2
470Ω
R10
1MEG
P7
+12VDC
C11
.1μF
R9
4.7K
C7
1000μμF
C6
27μμF
LOW SPEED GROUP
P14
K1
TACH INPUT
P10
A5
HI DENSITY
P12
A4
SN74151N
+5VDC
TAPE INHIBIT
P13
C13
.1μF



USE	836249	R3	R4	C14
STANDARD	– 001	150Ω 198200-151	220 Ω 198200-221	NOT USED
NARROW TRACK HEADS	– 002	150Ω 198200-151	2.2KΩ 198200-222	100 pf 197212-100

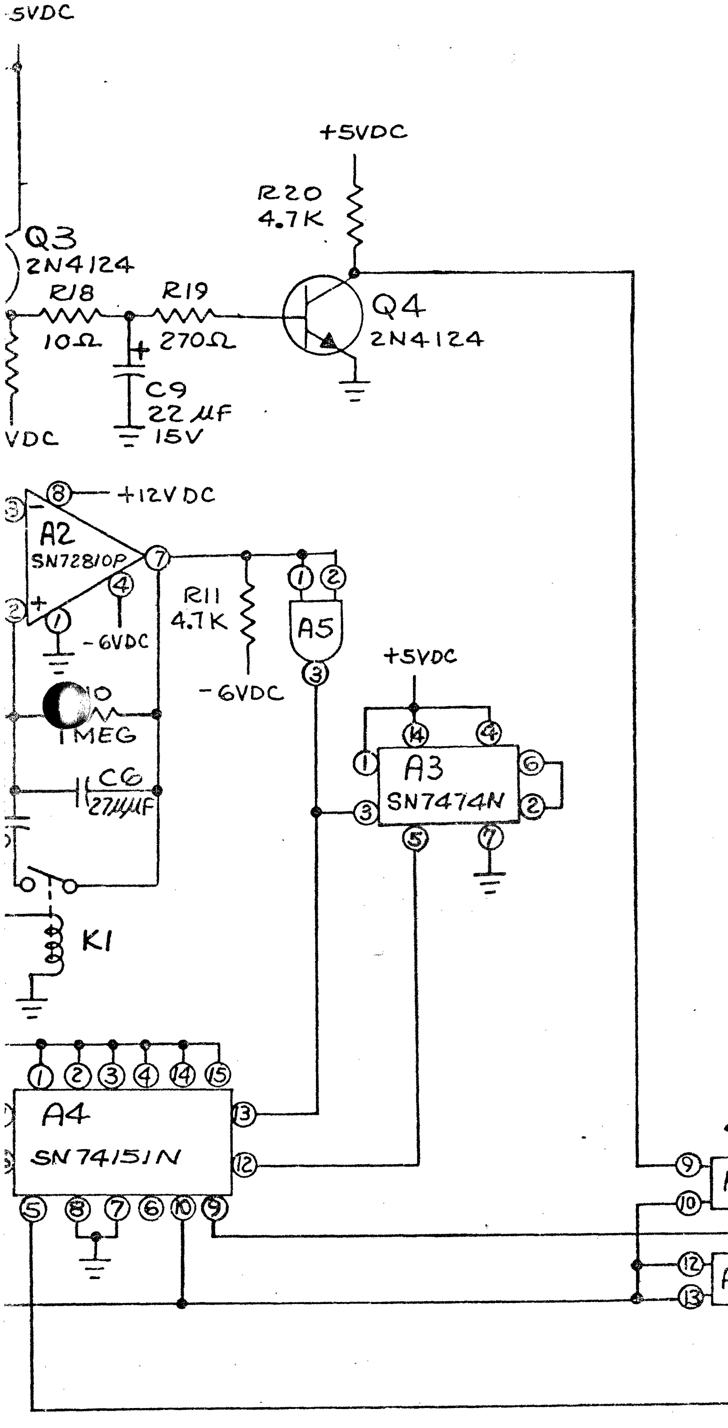
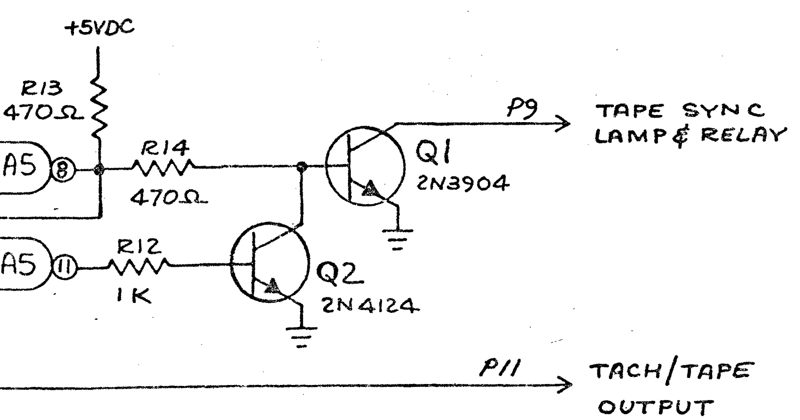



Figure 5. Tape Sync Board, Schematic Diagram and Component Location

3. CAPSTAN POWER AMPLIFIER

(a) CIRCUIT DESCRIPTION - The capstan power amplifier circuitry requires three voltage input as listed below.

TB1-2	DC Voltage Input From Speed Servo
TB1-3	+12 Vdc
TB1-4	+28 Vdc

With a negative voltage to the base of Q1 (indicating the capstan motor is turning too fast), greater conduction of Q1 is experienced providing a more negative voltage to Q2. This allows Q2 to conduct less, providing a more negative voltage to the base of Q3. Q3 will then conduct less, providing less current flow and decreasing the speed of the capstan motor.

With a positive voltage to the base of Q1 (indicating the capstan motor is not turning fast enough) the opposite of the above occurs.

(b) TEST DATA

Step 1. Locate the capstan power amplifier (heatsink, the rear access panel must be removed), and visually inspect it for loose connections, or mounting and physically defective components.

CAUTION

The capstan power amplifier heatsink is at a positive potential with respect to the transport.

Step 2. Apply POWER, depress STOP, and ensure the presence of the following voltages at the indicated points: TB1-3 – +12 Vdc, TB1-4 – +28 Vdc.

Step 3. Remove POWER and connect an oscilloscope to TB1-2.

Step 4. Apply power, depress STOP. Ensure -7 Vdc at TB1-1 and 1 Vdc at TB1-2.

Step 5. Depress FWD and ensure an increase of approximately .5 Vdc at TB1-2.

Step 6. Remove all power and test connections.

External testing – If the above steps provide unsatisfactory results, complete the following to determine if the capstan power amplifier is at fault or some preceding circuitry.

Step 1. Disconnect the lead to TB1-2 and connect a dc source to this point with the low side to ground. Connect a dc ammeter between the output connector (collector of Q1 on heatsink) and tape direction relay, K2, pin 3.

Step 2. Apply power and adjust input dc source for .5 Vdc between TB1-2 and ground. The ammeter should read approximately 100 milliamps.

Step 3. Increase the input dc source to 4 Vdc and ensure the ammeter reads approximately 6 amps.

(c) PARTS LIST

Capstan Power Amplifier 836259

C1	691391-016	Q2	851271	R4	844155
C2	844549	Q3	854540	R5	844675
C3	898406	R1	853603-001	R6	896602
Q1	510260	R2	844165	TB1	853615-004
		R3	844174		

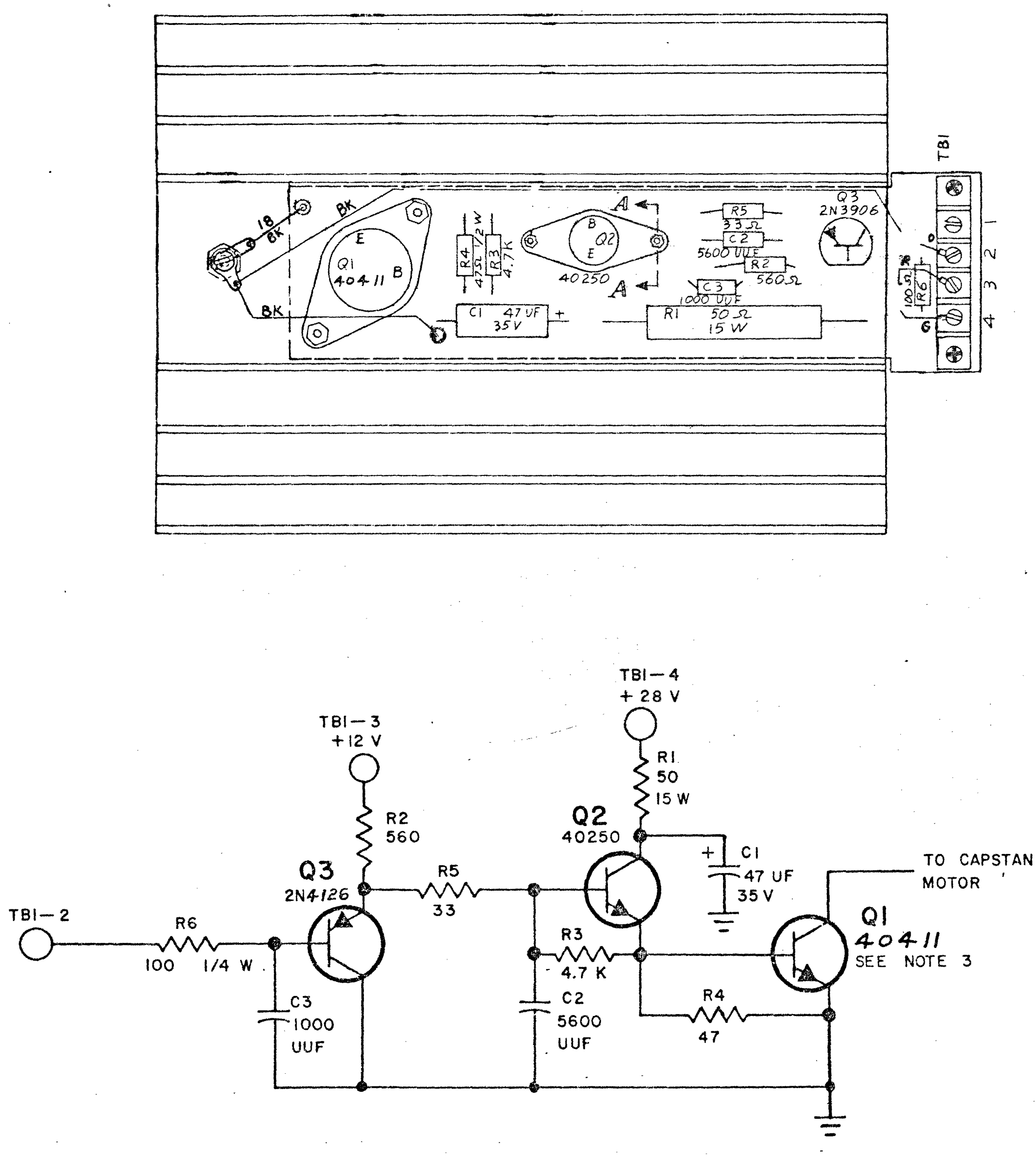


Figure 6. Capstan Power Amplifier Schematic and Wiring Diagram

d. REEL DRIVE

1. PHOTOCELL ASSEMBLY

(a) CIRCUIT DESCRIPTION - Each of the two photocell assemblies contain a 5 Vdc lamp and a photocell. When the photocell senses light from its associated lamp it produces current.

(b) TEST DATA

Step 1. Gain access to the photocell area (tension arm covers must be removed) and with power applied, ensure the presence of 5 Vdc across each lamp (normally grey and black leads). Visually observe the lamps being lit.

Step 2. Enusre no tape is threaded on the recorder/reproducer and power is applied. Connect a meter, capable of reading 1 ma, across each photocell (other two terminals on assembly) and ensure 200 to 350 microamps with the photocell completely illuminated (no shading). With photocell completely shaded less than 40 microamps should be present:

(c) PARTS LIST

Photocell and Lamp Assembly A1 or A2 855874

(d) DIAGRAMS - Refer to the transport wiring diagram at the rear of this bulletin and transport overall schematic at the rear of this manual.

2. MICROSWITCH

(a) CIRCUIT DESCRIPTION - Each of the two microswitches function as an open circuit when the tension arm allows pressure on them (slack tape), and closed circuit with no pressure on them.

(b) TEST DATA

Step 1. With all power removed connect an ohmmeter across each microswitch, individually, and ensure an open reading. Move each tension arm off its microswitch and ensure a shorted reading.

(c) PARTS LIST

Microswitch S17 or S18 898807

(d) DIAGRAMS - Refer to the transport wiring diagrams at the rear of this bulletin and transport overall schematic at the rear of this manual.

3. PINCH ROLLERS

(a) CIRCUIT DESCRIPTION - The pinch rollers, when activated by approximately +28 Vdc applied to their associated solenoids, are forced against the capstan causing the tape, between the capstan and pinch rollers, to move in the direction the capstan turns.

(b) TEST DATA - Refer to the checkout and adjustments in the maintenance section of the Operator's Data Bulletin for adjustment of pinch roller pressure.

Step 1. With the recorder/reproducer moving tape in the FWD mode at a standard speed, ensure +24 to +28 Vdc across each solenoid.

4. REEL DRIVE BOARD AND POWER AMPLIFIER CIRCUITS

(a) **CIRCUIT DESCRIPTION** - The reel drive board consists of two complete channels, one for each reel drive motor. Each channel consists of a DC servo amplifier, an acceleration program power mode to stop mode, acceleration control to capstan control, and a power amplifier. One power failure brake is employed for both channels.

The DC servo amplifier is a differential amplifier which receives and amplifies the current produced by the photocell. A negative feedback is incorporated to dampen the effect of AC signals (produced by oscillations from the photocell) on the amplifier. A gain control, R8 or R23, is incorporated with this feedback to control the output of the differential amplifier. A balance control, R2 or R17, is employed at the input of the differential amplifier to adjust the DC offset of the amplifier. By adjusting this DC offset of the amplifier the center position of the tape tension arm and vane may be varied.

The acceleration program power mode to stop mode is composed of Q1, C6 and R12 for the inner reel channel, and Q5, C12 and R27 for the outer reel channel. The prime function of this feature is to avoid tape breakage when going from the POWER mode to the STOP mode, with a slack tape condition present.

The following discussion, concerning the acceleration program power mode to stop mode, pertains to the inner reel channel. With the machine in the POWER mode no power is applied to P1-20 and P1-22. When STOP mode is activated +28 Vdc is immediately applied to P1-20, P1-22 and to one side of the reel drive motor. The current output of the differential amplifier is near maximum due to the slack tape condition present when stop mode is activated. +28 Vdc is applied (from P1-20 and P1-22) to C6 which begins to charge. Power is also applied to the base of Q1. When C6 begins to charge, the current on the base of Q1 is low and acts to hold the maximum current that would normally pass from the differential amplifier to the power amplifier. As C6 continues to charge, the current on the base of Q1 continues to rise allowing more current to pass between the amplifiers. Thus current to the reel drive motor begins small and increases until it reaches maximum or C6 ceases to charge. This means the reel starts moving slowly to take up the slack and increases its speed gradually. This process eliminates a maximum current surge to the reel drive motor which would cause tape breakage. After C6 has charged completely or another mode is activated this circuit becomes ineffective.

P1-18 and P1-9 (acceleration control leads for forward and reverse) route current to the capstan control to inhibit starting and stopping of the capstan motor. This is done in order that the reel drive servo will have time to respond properly during periods of acceleration or decelleration. These leads are taken off the emitter of the middle transistor of the power amplifier. The power amplifier amplifies the output current from the differential amplifier and passes it to the reel drive motor.

The power failure brake is employed to gradually slow down the tape reel in event of a power failure to the machine, during tape movement. With the reels slowly decreasing in speed, chances for tape spillage are greatly reduced.

With power applied to the machine, relay K1 is energized. When power is removed, K1 opens, creating a current path from the CR6 and CR5 junction to the +28 Vdc side of the reel drive motors. At this point the two leads on each of the reel drive motors are shorted together (with diodes CR5 and CR6 in series) to allow current to flow in only one direction. With both motors rotating and no power being applied to them, they act as a generator with reverse polarity. With these leads shorted, this opposite current passes through the motor coils causing an opposition to its rotating, thus slowing down gradually.

(b) TEST DATA - Refer to the checkout and adjustments in the maintenance section of the Operator's Data bulletin, for simplified adjustment of the balance controls located on the reel drive board.

Step 1. Gain access to the reel drive board area (remove the rear access panel) and place the reel drive board on its extender.

Step 2. With POWER applied and in the STOP mode ensure the following approximate voltages between the indicated point and ground (P1-21).

INDICATION POINT	INDICATION
P1-6, P1-7, and P1-20	+28 Vdc
Junction of R1 and CR1	+12 Vdc
Junction of CR1 and CR2	+6 Vdc
Junction of R16 and CR3	+12 Vdc
Junction of CR3 and CR4	+6 Vdc

Step 3. Complete reel drive board calibration is as follows:

a. With the tape and reels removed, fasten each tape tension arm to its extreme tight tape position, completely shading the photocell.

b. Depress POWER and STOP. Adjust each balance control (R2 - inner reel, R17 - outer reel) until each associated reel hub begins to turn. Note the position of each of these controls when this condition is reached and turn each slightly.

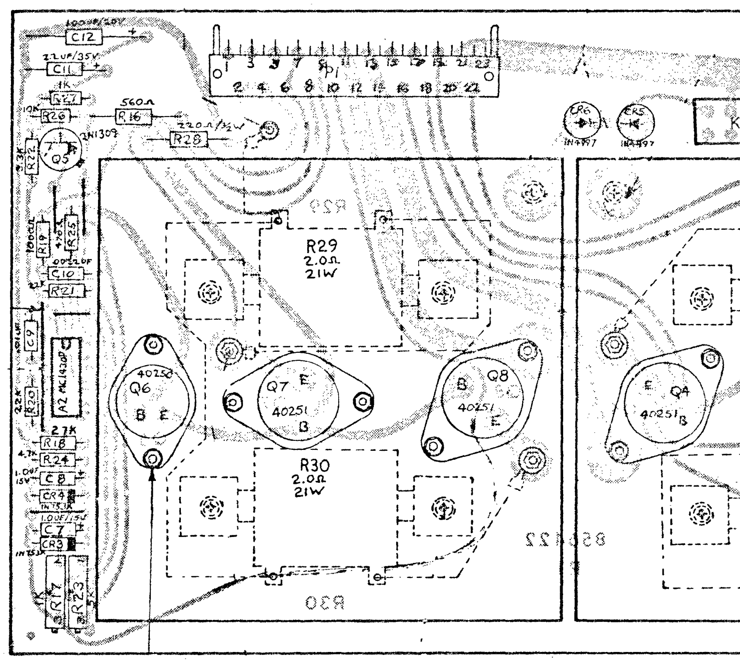
c. Remove POWER and unfasten each tape tension arm allowing it to return to its "at rest" position. Tape path cleaning may be required due to the fastening device used.

d. Replace the reels and thread a tape on the recorder/reproducer.

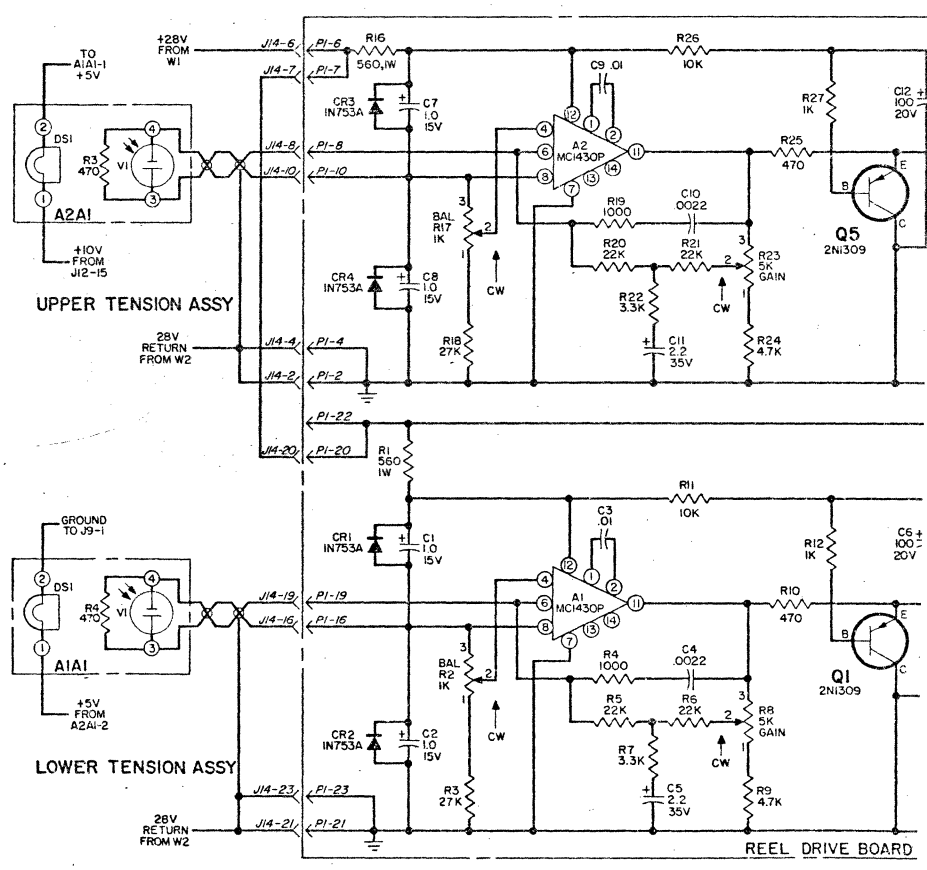
e. Depress STOP and FORWARD, and after proper warm-up, adjust each balance control until its associated tape tension arm remains in a position midway of its path of travel. This may be done while in the STOP mode only, if desired.

PARTS LIST
REEL DRIVE BOARD 856424

A1	859843	R2	854535-007
A2	859843	R3	198200-273
C1	691391-030	R4	198200-102
C2	691391-030	R5	198200-223
C3	691686-001	R6	198200-223
C4	691686-015	R7	198200-332
C5	691391-052	R8	854535-009
C6	691391-019	R9	198200-472
C7	691391-030	R10	198200-471
C8	691391-030	R11	198200-103
C9	691686-001	R12	198200-102
C10	691686-015	R13	691111-221
C11	691391-052	R14	867686
C12	691391-019	R15	867686
CR1	852475-022	R16	691112-561
thru		R17	854535-007
CR4		R18	198200-273
CR5	510029-001	R19	198200-102
CR6	510029-001	R20	198200-223
K1	855130-004	R21	198200-223
Q1	850289	R22	198200-332
Q2	851271	R23	854535-009
Q3	853507	R24	198200-472
Q4	853507	R25	198200-471
Q5	850289	R26	198200-103
Q6	851271	R27	198200-102
Q7	853507	R28	691111-221
Q8	853507	R29	867686
R1	691112-561	R30	867686



R29
2.0Ω
21W
R30
2.0Ω
21W
Q6
40250
Q7
40251
Q8
40251
Q4
40251
A2 MC1430P



+28V
FROM
W1
TO
A1A1-1
+5V
A2A1
+10V
FROM
J12-15
UPPER TENSION ASSY
28V
RETURN
FROM W2
GROUND
TO J9-1
A1A1
+5V
FROM
A2A1-2
LOWER TENSION ASSY
28V
RETURN
FROM W2
A2
MC1430P
A1
MC1430P
Q5
2N1309
Q1
2N1309
REEL DRIVE BOARD

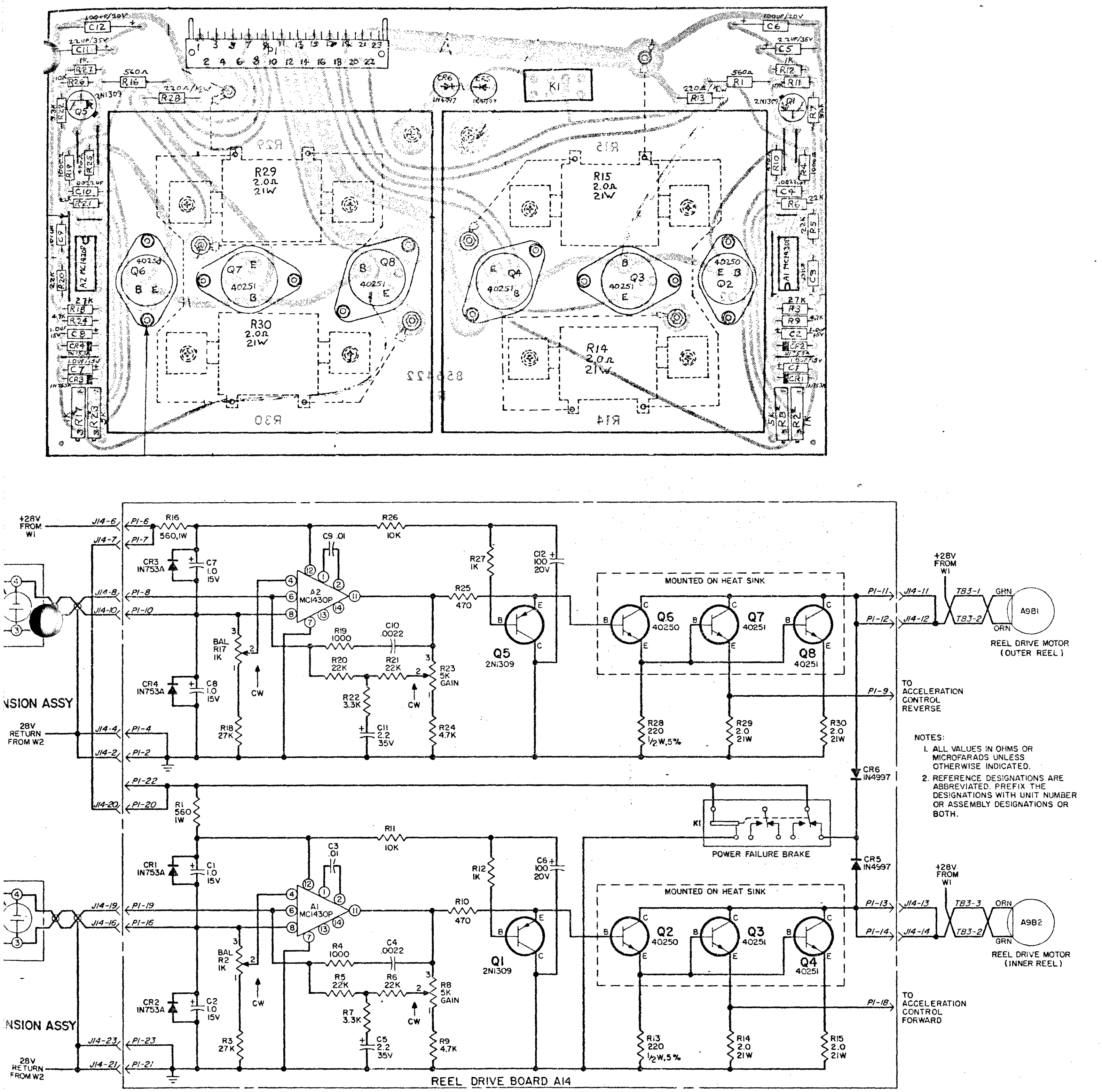


Figure 7. Reel Drive System Overall Schematic and Board Component Location

PARTS REMOVABLE/REPLACEMENT DATA - This section contains information to aid in the removal/replacement of certain mechanical and electromechanical parts pertinent to the tape transport. Reference may be made to the rear of this bulletin for mechanical parts listing.

a. CABINET REMOVAL

Step 1. Remove the side panels on the upper left and right sides of the cabinet. The panel on the right side simply pulls loose and is lifted out. The panel on the left is released by a fastener and is lifted out.

Step 2. Open the side doors by unscrewing the panel fasteners and pulling open.

Step 3. Remove the fuse located on the Power and Control Connector Panel.

Step 4. With a Phillips screwdriver, remove the seven screws on the left and right edges of the front of the transport and the four screws at the rear of the transport (one at each rear corner).

Step 5. Slide the cabinet back gently and remove while firmly holding the transport.

NOTE

Much of the maintenance, cleaning, board removal, etc., may be accomplished by removing only the rear and top access panels of the cabinet. For certain assemblies and overall maintenance, the removal of the entire cabinet may be necessary.

b. BOARD AND REPLACEMENT - To remove any mode control, speed control, reel drive, or other transport associated board or subassembly, ALWAYS ENSURE POWER IS OFF. Rocking of the board against its jack, may be necessary to start movement of the board from its jack. To replace the board, align the guide pins of the board with the associated guides on the board jack. Reference may be made to the General Information Bulletin photo's concerning board locations.

c. CAPSTAN MOTOR ASSEMBLY

1. CAPSTAN MOTOR REPLACEMENT

Step 1. Remove the cabinet (or remove the top and rear access panels) capstan board front door, and both reels, including tape.

Step 2. Disconnect the lead harness to the capstan motor. Note the orientation and terminal connection of each wire.

Step 3. Lay the entire transport face down.

Step 4. Remove the three mounting screws holding the motor assembly to the tape transport. Note the location of each shim between the motor mounting plate and the tape transport. Do not disturb these shims.

Step 5. Remove the four mounting screws holding the mounting plate to the face of the motor. Remove the mounting plate from the motor and install the mounting plate on the face of the new capstan motor using the same four screws.

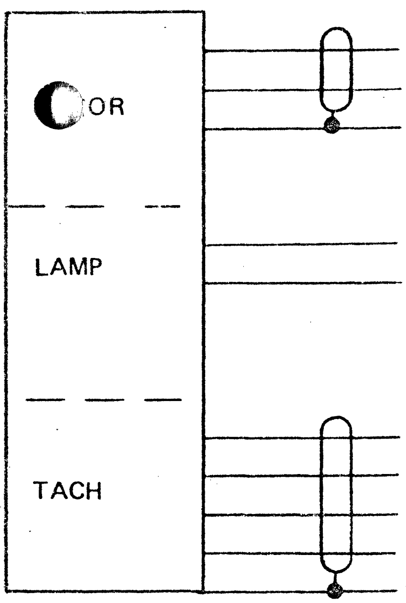
Step 6. Insert the capstan motor into position and use the three mounting screws, removed in Step 4, to tighten in place. Ensure the shims are in the same position. Tape will not track if the shims are not properly located.

Step 7. Connect the lead harness to the terminals noted in Step 2. Refer to figure 8 various motor wiring.

Step 8. Reinstall the capstan board.

Step 9. Thread a tape on the recorder/reproducer and place it in an OPERATE mode to determine if the tape will track. If tape does not, recheck the location of the shims.

Step 10. Reinstall the cabinet (or access panels) and front door.



CAPSTAN
MOTOR
ASSEMBLY
A21

	TO		
TERMINAL	BALDWIN (857362) WIRE COLOR	SEQUENTIAL (857363) WIRE COLOR	DRC (835800) WIRE COLOR
TB2-3	BLACK	BLACK	BLACK
TB2-4	RED	WHITE	WHITE
TB2-5	GRAY	GRAY	GRAY
TB2-6	YELLOW	WHITE	RED
TB2-7	PURPLE	BLACK	BLACK
TB1-5	ORANGE	RED	RED
TB1-6	BLUE	GREEN	GREEN
TB1-7	WHITE	BLACK	BLACK
TB1-8	BROWN	WHITE	WHITE
TB1-4	GRAY	GRAY	GRAY

Figure 8. Capstan Motor Wiring Variations

2. CAPSTAN MOTOR BRUSH REPLACEMENT

Step 1. Gain access to the Capstan motor and remove the four brush retaining screws. Refer to figure 9.

Step 2. With a small screwdriver work the end of each brush and tension spring loose, and remove.

Step 3. Insert each new brush and tension spring, ensuring they are positioned with the concave surface aligned with the armature.

Step 4. Align the tension spring and metal tip completely inside the brush holder and replace the brush retaining screws.

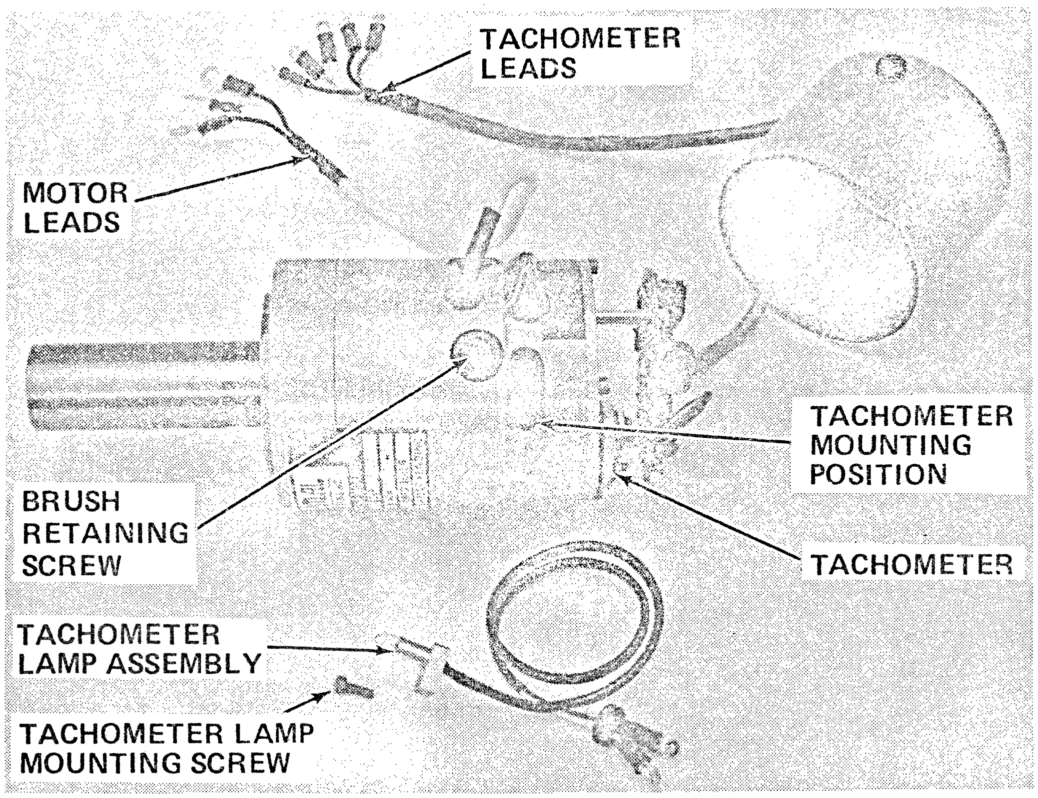


Figure 9. Capstan Motor, Disassembled

3. CAPSTAN MOTOR TACHOMETER LAMP REPLACEMENT

Step 1. Gain access to the Capstan motor and remove the two screws securing the metal cover to the motor end opposite the capstan. Slide the cover off, gaining access to the inner components.

CAUTION

Exercise extreme caution when sliding the tachometer leads through the grommet in the metal cover.

Step 2. Remove the tachometer lamp mounting screw, with an Allen wrench, and remove the lamp assembly, including leads, from the mounting position.

Step 3. Insert the new lamp assembly into the mounting position and replace the mounting screw. Do not tighten.

Step 4. Monitor, with an oscilloscope, the output of the capstan motor tachometer at TB1-6.

Step 5. Apply POWER and, with tape properly threaded, depress STOP and FORWARD. Prior to completely tightening the tachometer Lamp mounting, position the mounting to provide maximum tachometer output amplitude, as measured with the oscilloscope.

Step 6. Remove POWER and replace the metal cover, ensuring all leads and grommets are positioned properly.

d. PINCH ROLLER ASSEMBLY

1. PINCH ROLLER AND BEARING REPLACEMENT (refer to figure 10)

Step 1. Remove the head cover and the screw securing the pinch roller.

Step 2. Slide the pinch roller assembly from the pinch roller shaft. Remove the spacer and retaining ring from inside of the roller assembly and remove the bearing. Discard the pinch roller ball bearing, if worn.

Step 3. Insert the bearing into the end of the pinch roller that has the recessed notch for the retaining ring. Insert the retaining ring so the retaining ring clips DO NOT touch the bearing shield. The stamped numbers on the retaining ring are to face the bearing shield.

Step 4. Slide the pinch roller onto the shaft and insert the spacer – small diameter – towards the bearing. Replace the securing screw.

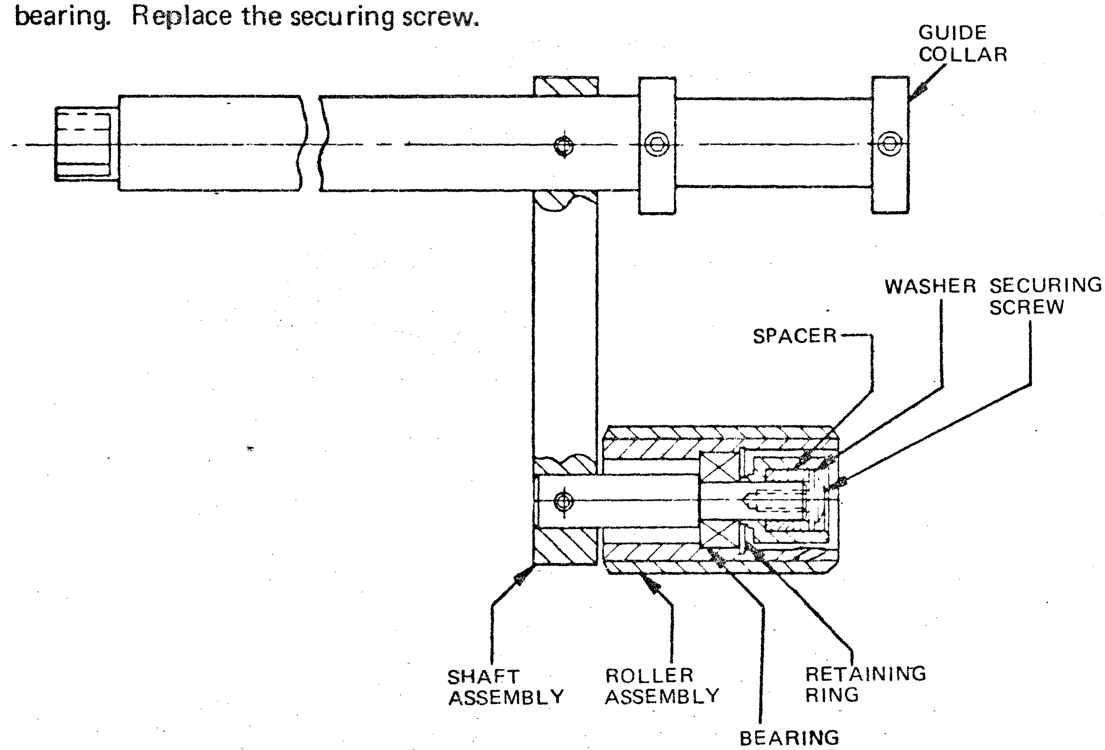


Figure 10. Shaft and Pinch Roller Assembly

2. PINCH ROLLER SOLENOID REPLACEMENT (refer to figure 11)

Step 1. Remove the cabinet or the top and rear access panels.

Step 2. Remove the capstan board, terminal board TB2, and tag and disconnect all leads from TB2.

Step 3. Disconnect the lever assemblies from their pivot arms by loosening the locking nut next to the elongated nut, and turning the adjustment tape (the entire threaded rod turns) counter-clockwise.

Step 4. Remove the four screws (two on each side of the solenoids) holding the solenoid mounting bracket to the transport, and move the entire assembly free.

Step 5. With the assembly free, remove the retaining ring holding the pivot arm to the bracket. With this removed the arm assembly should slide away from the solenoid.

Step 6. Remove the four screws holding the solenoid and slide it free of the entire bracket.

Step 7. Place the new solenoid in position and replace the four mounting screws.

Step 8. Place the lever assembly back into bracket and replace the retaining ring.

Step 9. Replace the entire solenoid mounting bracket and secure it to the transport with the four mounting screws removed in Step 5.

Step 10. Remove tags, reconnect the solenoid leads, and replace terminal board TB2 and the capstan.

NOTE

The pinch roller pressure adjustment procedures, in the checks and adjustments section of the Operator's Data bulletin, must be following after replacing either or both solenoids.

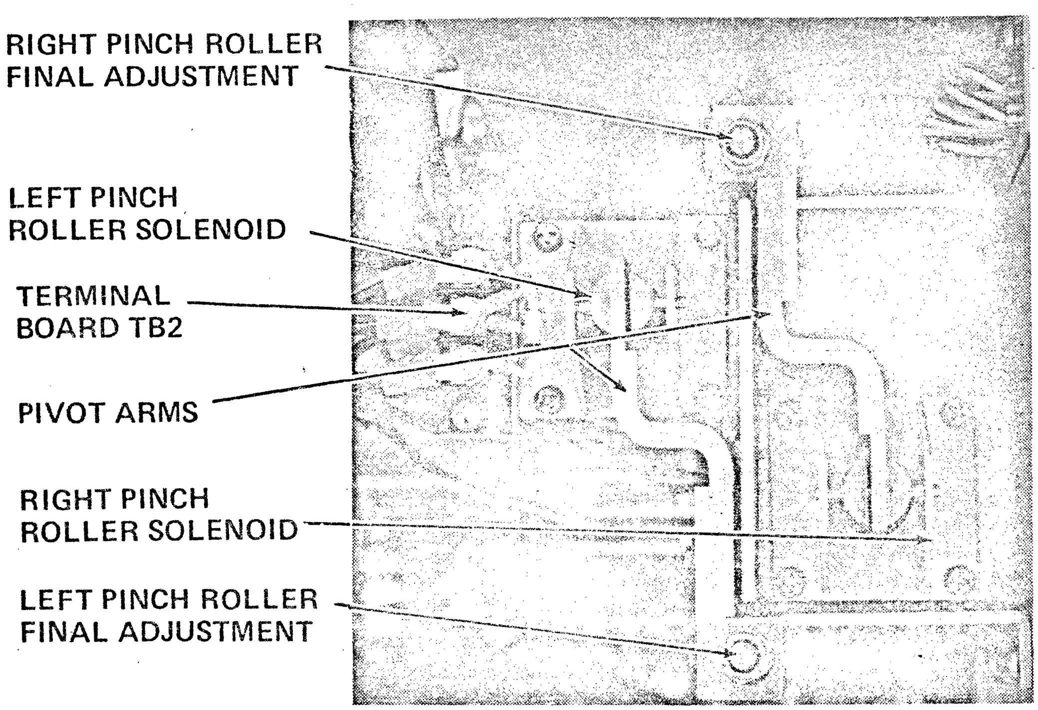


Figure 11. Pinch Roller Solenoid Mounting Details

e. REEL DRIVE ASSEMBLY

1. TENSION ARM SPRING REPLACEMENT (refer to figure 12)

Step 1. Remove the cover from the tension arm assembly.

Step 2. Remove the spring securing screw, with a small Phillips screwdriver, while holding the multi-leaf spring with needle nose pliers.

NOTE

Use extreme care when screw is completely removed. Spring will relax causing screw to possible fly free of assembly.

Step 3. Remove old spring and place new spring in relaxed position. With screw replaced and partially tightened, stretch spring into correct position. Completely tighten screw.

Step 4. Replace the tension arm assembly cover.

2. PHOTOCELL ASSEMBLY REPLACEMENT (refer to figure 12)

Step 1. Remove cover from tension arm assembly.

Step 2. Note, tag and unsolder the four leads connected to the photocell assembly.

Step 3. Remove the one adjustment screw and lift the photocell assembly out.

Step 4. Install the new photocell assembly with the adjustment screw removed in Step 3.

Step 5. Align the photocell assembly by lining the two screws on the assembly with the center of tension arm hub.

Step 6. Replace tension arm assembly cover.

3. MICROSWITCH REPLACEMENT (refer to figure 12)

Step 1. Remove the tape tension arm cover and remove the two screws that hold the microswitch in position.

Step 2. Unsolder the wires from the microswitch.

Step 3. Solder the wires onto the new microswitch and remount in position.

Step 4. Tighten the two screws and ensure that the microswitch is activated when the tension arm is at its extreme rest position.

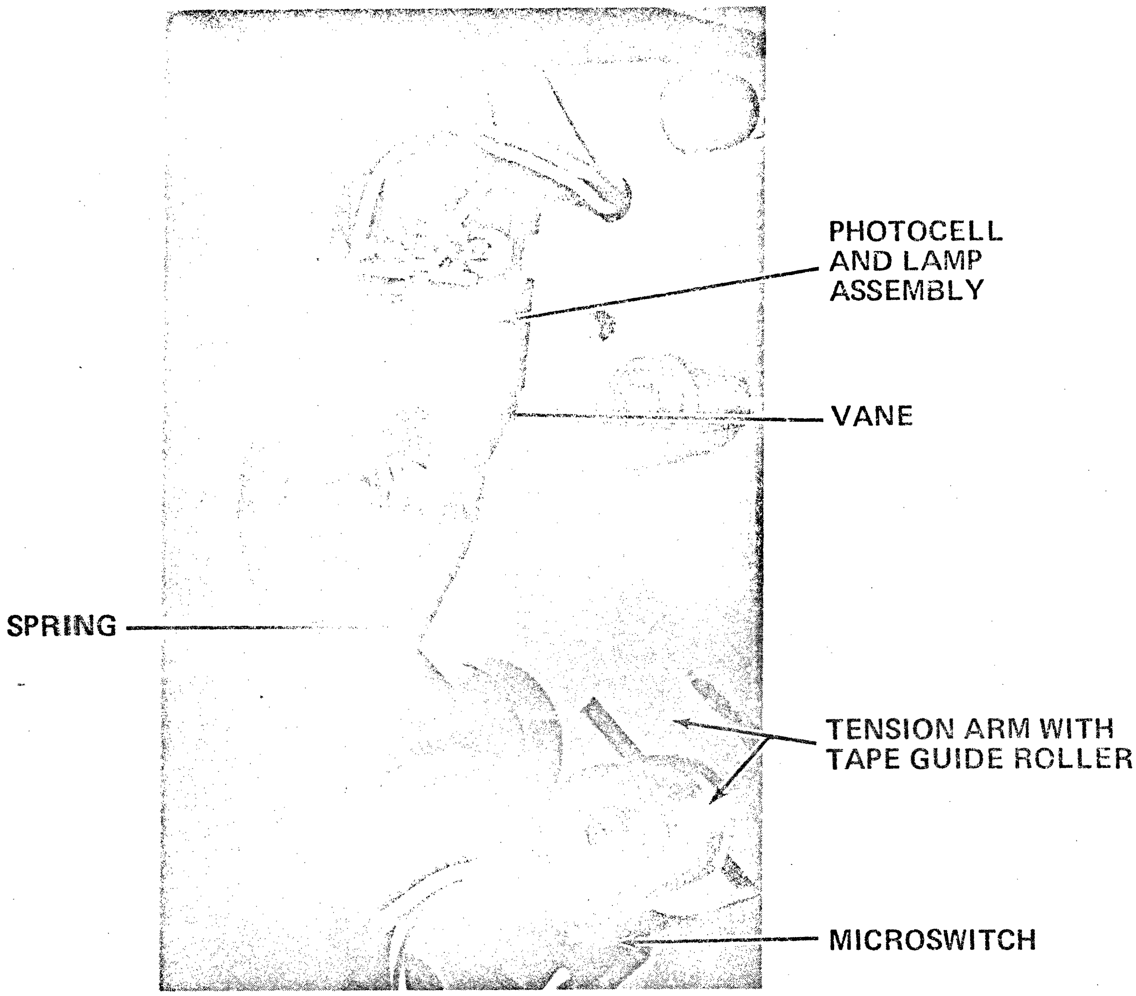


Figure 12. Tension Arm and Photocell Assembly

f. INERTIA DAMPENING ROLLER AND BEARING REPLACEMENT (refer to figure 13)

Step 1. Remove the head cover.

Step 2. Remove the two screws at the base of the roller and remove the roller. Do not lose the two wavy washers behind the roller shaft.

Step 3. If the complete roller assembly is being replaced, reinstall the two wavy washers behind the shaft assembly and reinstall the roller using the screws removed.

Step 4. To replace the bearings, remove the retaining ring and washer and any spacers supplied.

Step 5. Slide the roller off the shaft. Remove the worn bearings and replace with a new set as was removed.

Step 6. Reinstall the washer, spacers and retaining ring removed in Step 4.

Step 7. Reinstall the inertia roller using the two wavy washers removed in Step 2.

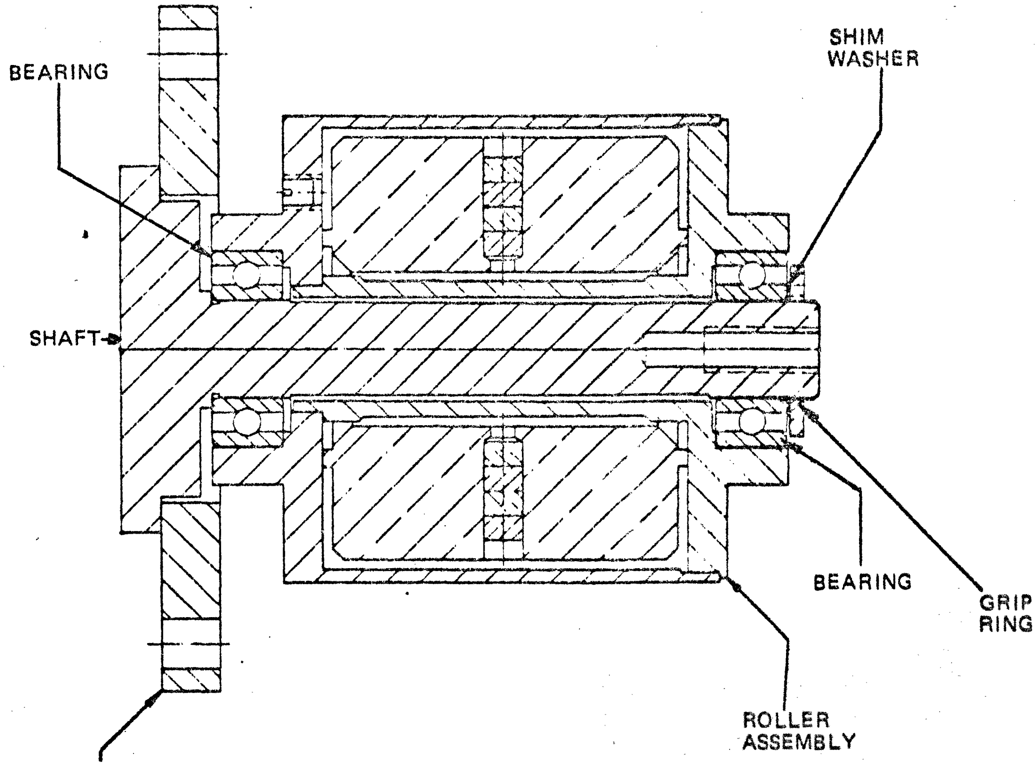


Figure 13. Inertia Roller

g. **RECORD AND REPRODUCE HEAD ASSEMBLIES REPLACEMENT** (refer to figure 14)

1. RECORD HEAD REPLACEMENT AND ALIGNMENT

Step 1. Remove the head cover. Remove the head shield located between the reproduce and record heads.

Step 2. Remove the two head mounting screws, located between the upper and lower head stacks.

CAUTION

Do not touch the jack screws at the base of the head on the head mounting pad.

Step 3. Unplug the head lead harness from connector and remove head from recorder/reproducer.

Step 4. Mount the new record head using the screws removed in Step 2. Be sure to place the record head tight against the head alignment guide block.

Step 5. Plug the head lead harness into the connector.

CAUTION

Handle the head lead harness with care to prevent damage to the leads at the head.

NOTE

The following steps are provided for head alignment when required.

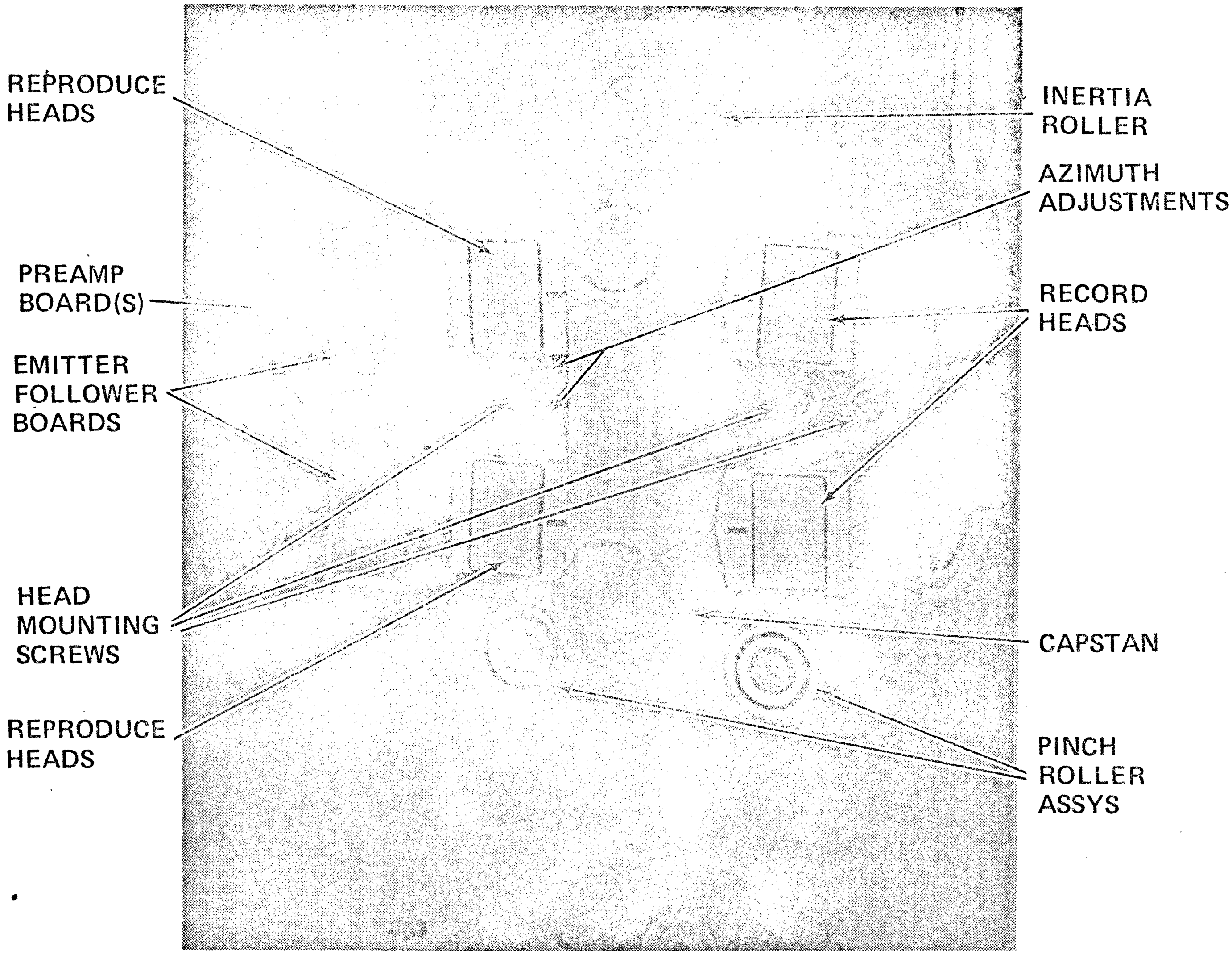


Figure 14. Tape Head Mounting Details

Step 6. Select the two outside tracks (opposite ends) on the same head stack.

Step 7. Connect a signal generator, set at 1.0 vrms, to the inputs of both tracks at the input connector on the Record Connector Panel. Use properly calibrated direct record boards, refer to the Direct Record Bulletin. Install jumper boards in the reproduce chassis for the correct channels.

Step 8. Connect a dual trace oscilloscope to the output BNC connectors on the Reproduce Connector Panel for the proper channels.

Step 9. Thread tape on the recorder/reproducer and place the Tape Speed Selector to the 60 ips position.

Step 10. Depress the POWER, STOP, RECORD and FORWARD pushbuttons.

Step 11. Sweep the generator over 10 kHz to 100 kHz for wideband heads or 10 kHz to 40 kHz for intermediate band heads and observe the signals on the oscilloscope.

Step 12. If the time relationship is not correct, adjust the two outside jack screws on the mounting pad slightly, until the two signals coincide.

CAUTION

The head mounting pads are prealigned at the factory and should only be changed with extreme care and only when necessary.

Step 13. Repeat the above procedures with the opposite record head stack, striving for a compromise between the two stacks. Compromise being the position of the head which provides the best possible signal time relationships for both head stacks.

Step 14. Remove power and test equipment.

(b) REPRODUCE HEAD REPLACEMENT AND ALIGNMENT

Step 1. Remove the head cover. Remove the head shield located between the record and reproduce heads.

Step 2. Unplug the preamplifier board(s) from their connector(s) (newer models). Older models require unpluging the head lead harness from the connector and the preamp power leads from the preamp power supply.

Step 3. Remove the two head mounting screws located between the upper and lower head stacks. Carefully remove the head assembly including the attached preamp assembly (Wideband only).

Step 4. Normally reproduce heads and preamps are both replaced as one assembly. If this is not the case the preamp assemblies must be disconnected from the old heads and connected to the new head.

Step 5. Install the new reproduce heads, including the preamp assemblies, with the two screws removed in Step 3. Be sure to place the reproduce head tight against the head alignment blocks. Plug the preamplifier board(s) into their connector(s) (newer models) or plug the head lead harness into its connector (older models).

CAUTION

With the reproduce head assembly removed the head mounting pads and jack screws are visible and accessible. These are aligned at the factory and are not to be tampered with.

NOTE

The following steps will correctly align the heads if required.

Step 6. Select the two outside tracks (opposite ends) on the same head stack.

Step 7. Thread tape on the recorder/reproducer.

Step 8. Connect a signal generator, set a 1.0 vrms, to the inputs of both tracks at the input connector on the Record Connector Panel. Refer to the previous Step 7 in record head alignment.

Step 9. Connect a dual track oscilloscope to the output BNC connectors on the Reproduce Connector Panel for the proper channels.

Step 10. Place the TAPE SPEED SELECTOR in the 60 ips position.

Step 11. Sweep the generator over 10 kHz to 100 kHz for Wideband heads or 10 kHz to 40 kHz for intermediate band heads and observe the signals on the oscilloscope.

Step 12. If the time relationship is not correct, for wideband heads, adjust the two azimuth adjustment screws located between the reproduce head stacks, slightly until the two signals coincide. For intermediate band heads adjust the two outside jack screws on the mounting pad, slightly until the signals coincide.

Step 13. Repeat the above procedures with the opposite head stack, striving for a compromist between the two stacks. Compromise being the position of the head which provides the best possible signal time relationships for both head stacks.

Step 14. (Wideband only). Apply 1.0 vrms signal at 1 MHz individually to each of the four outside tracks of each stack. Monitor individually and adjust azimuth for peak out of each channel. Strive for compromise between all four channels.

Step 15. Remove the test equipment.

h. TAPE WIDTH CHANGE

1. ONE INCH TO ONE-HALF INCH CHANGE

Step 1. Loosen the allen screws on the outside collar of the guide roller shafts. Slide the collar in to measure one-half inch from the inside collar and tighten the allen screws. Remove the pinch rollers and their spacers (behind the pinch rollers).

Step 2. Place the pinch rollers back on their shafts and place the spacers on the outside.

Step 3. Loosen the allen screws on the outside end of the tape tension arm. Remove the one inch guide rollers and replace with new one half inch guide rollers.

Step 4. Insert the three stops into the holes located 120° apart on the reel drive hub to accommodate the one-half inch tape reels.

Step 5. Replace the one inch record and reproduce heads with new one-half inch heads, as described in record and reproduce head assemblies procedures.

2. ONE-HALF INCH TO ONE INCH CHANGE

Step 1. Loosen the allen screws on the outside collar of the guide roller shafts. Slide the collar out to measure one inch from the inside collar and tighten the allen screws.

Step 2. Remove the pinch rollers and their spacers (outside). Place the spacers on their shafts and replace the pinch rollers (spacers behind pinch rollers).

Step 3. Loosen the allen screws on the outside end of the tape tension arm. Remove the one-half inch guide rollers and replace with new one inch guide rollers.

Step 4. Remove the three stops located 120° apart on the reel drive hubs to accomodate the one inch tape reels.

Step 5. Replace the one-half inch record and reproduce heads with new one inch heads as described in the record and reproduce head assemblies replacement procedures.

i. ASSEMBLY REFERENCE DESIGNATION AND MECHANICAL PARTS LIST

1. ASSEMBLY NUMBERS - The following is a list of the standard basic assembly numbers. All of the listed assemblies may not be present on any one machine.

Unit – Transport

A1	Tension Arm Assembly (lower)
A1	Photocell & Lamp Assembly
A2	Tension Arm Assembly (upper)
A1	Photocell & Lamp Assembly
A3	Switch Assembly (Forward, Stop, Thread)
A4	Switch Assembly (Reverse, Fast, Record)
A5	Capstan Power Amplifier
A6	DC to DC Converter Assembly
A1	DC to DC Converter Board
A7	Preamp Power Supply
A8	Capstan Motor Assembly
A9	Reel Drive Motor and Hub
A10	Logic Board
A12	Capstan A Board
A13	Tape Sync Board
A14	Reel Drive Board
A15	Record Connector Panel*
A16	Reproduce Connector Panel*
A17	Power and Control Connector Panel
A18	Preamp Chassis
A1-A7 or A1-A14	Preamplifiers
A19	Record Chassis
A1-A14	Direct and/or FM Record Boards
A15	Bias Board
A16	Voice Record Board
A17	Record Connector Board

* Connector Panel refers to the BNC panels used for signal and power connections. Connector Board refers to the etched circuit board on which the printed circuit board jacks are mounted.

Unit 1 – Transport (Cont.)

A20	Reproduce Chassis	
	A1-A14	Direct or FM 3 sp. or 7 sp. Reproduce Boards
	A16	Voice Reproduce Board
	A17	Reproduce Connector Board
	A18	Phase Equalizer Board
	A21	Accessory Kit (Extender Boards, Grease, etc.)
	A22	Voice Kit
	A26	FM Density Change Kit

Unit 2 – Power Supply

A1	Regulator Module/Bridge Assembly	
	A1	Regulator Module
	A2	Bridge Network
A2	Control Amplifier Board	

Unit 3 – Auxiliary Chassis

A1-A14	Direct and/or FM 3 sp. or 7 sp. Reproduce Boards
A15	Connector Board
A16	Connector Panel

Unit 4 – Remote Control Panel

2. **MECHANICAL REPLACEMENT PARTS** - The following list contains selected mechanical parts listed by name and cross referenced to the Sangamo part number.

Description	Sangamo Part No.
Record Head Assy	See Head Sheet
Reproduce Head Assy	See Head Sheet
Tension Arm Assy (Parts of) Lower	857225
Main Hub Securing "E" Ring	300699-018
Washer	808561
Vane	855864
Bearing	300027
Bushing	855851
Spring	855876
Tension Arm Assy (Parts of) Upper	857232
Main Hub Securing "E" Ring	300699-018
Washer	808561
Vane	856629
Bearing	300027
Bushing	855868
Spring	855876
1" Tension Arm (upper or lower) Roller Assy Complete (1" Tape Kit)	855879
Shaft	855856
Cap	855858
Roller	855857
Bearing	657506
Spacer	880429
Washer	852987

Description	Sangamo Part No.
1/2" Tension Arm (upper or lower) roller Assy Complete (1/2" Tape Kit)	856458
Shaft	856455
Cap	856456
Roller	856454
Bearing	657506
Spacer	856457
Washer	852987
Shaft and Pinch Roller Assy (parts of)	857096
Guide Collars	855839
Set Screw	899628
Pinch Roller Assy	835018
Bearing	897174
Retaining Ring	655920
Spacer	857328
Cap Roller	857131
Pinch Roller Splenoid	857094
Inertia Dampening Roller Complete	855003-002
Bearing	846745
Washer	855010-008
Grip Ring	850942
Roller Assy	855004-002
Reel Drive	
Inner Hub	853451

Outer Hub	856373
Footage Counter Roller	857239
Bearing	657506
Snap Ring	850942
"O" Ring	835008-001
Footage Counter Meter	857098
Front Door Cover	836061
Capstan Motor "D.R.C."	835800
Brushes	867624
Tach Lamp Assy	836534
Capstan Motor "Baldwin"	857362
Brushes	836443
Tach Lamp Assy	836442
Capstan Motor "Sequential"	857363
Brushes	867624 or 855218-001
Tach Lamp Assy	867615

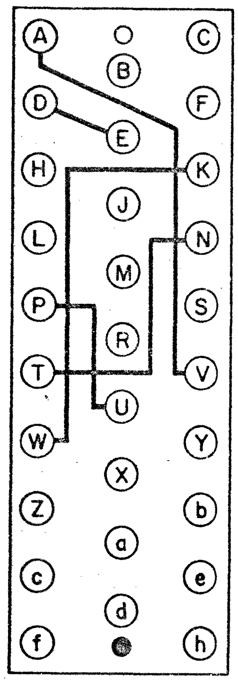
DIAGRAMS

The following is a list of transport diagrams contained at the rear of this bulletin.

Remote Control Shorting Plug Wiring Diagram
Remote Control Panel and Cable Wiring Diagram
Record and Reproduce Head Wiring Diagrams
Transport Wiring Diagram Sheets 1 and 2
Transport Overall Schematic *

*The Transport Overall Schematic may be located in the pocket at the rear of the manual instead of the rear of this bulletin.

Remote Control Shorting Plug
Plug P1 complete 857260
Plug P1 (not wired) 854536-005



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Remote Control Shorting Plug Wiring Diagram

Unit 4 Remote Control Panel

857085 - Hand Held Model

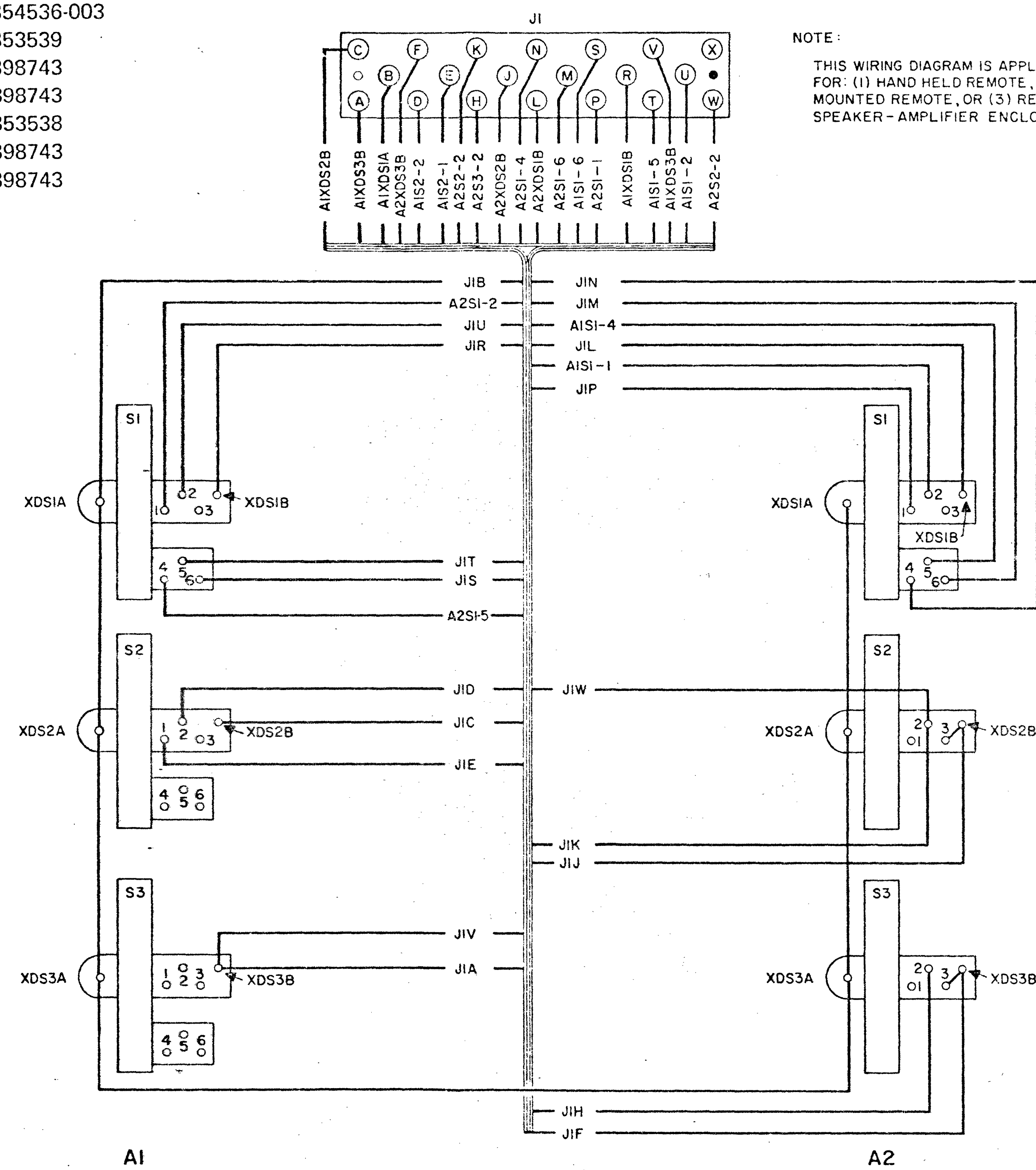
857209 - Chassis Mounted Model

857222 - Mounted in Speak-Amp Enclosure

J1	854536-003
A1	853539
A1DS1	898743
A1DS2	898743
A2	853538
A2DS1	898743
A2DS2	898743

NOTE:

THIS WIRING DIAGRAM IS APPLICABLE FOR: (1) HAND HELD REMOTE, (2) CHASSIS MOUNTED REMOTE, OR (3) REMOTE IN THE SPEAKER-AMPLIFIER ENCLOSURE.

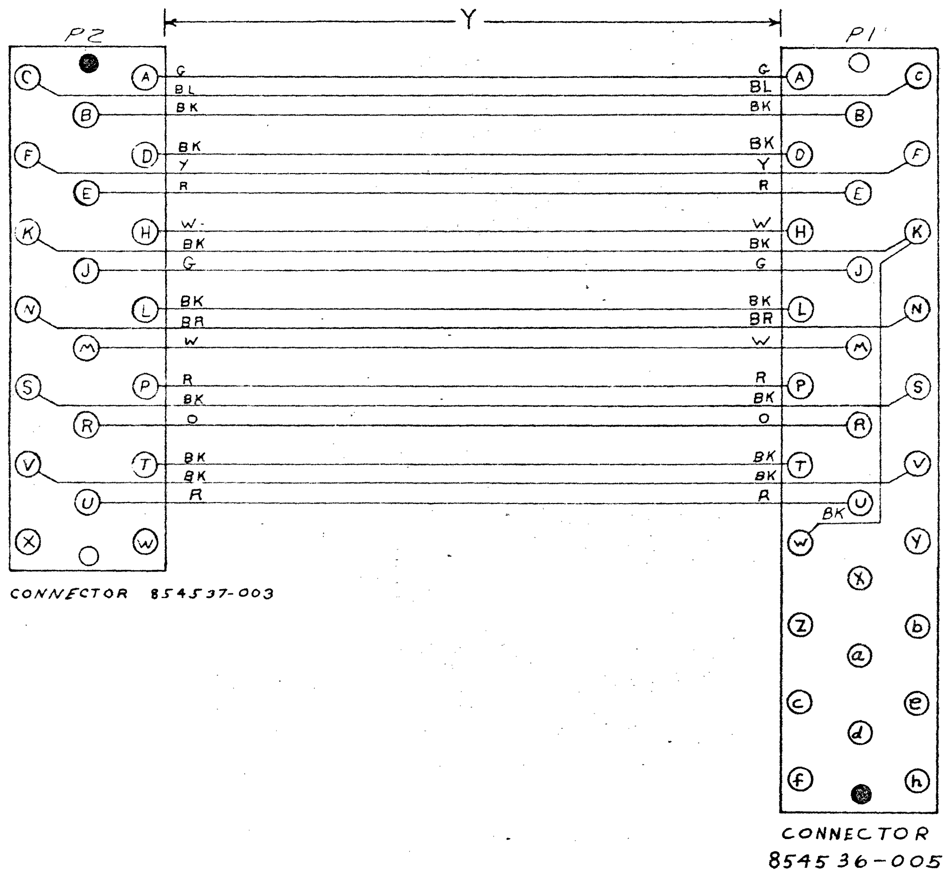


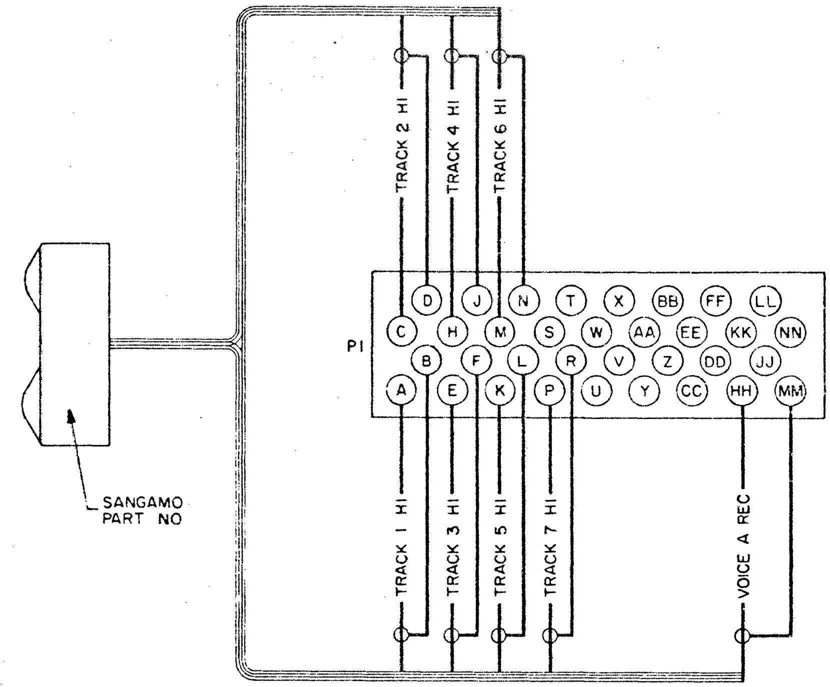
Remote Control Panel and Interconnecting Cable Wiring Diagram

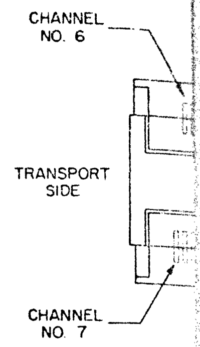
857084 OTTL

851715-2

Remote Control Interconnecting Cable 857084
P1 854536-005
P2 854537-003







7 Channel (½ inch)

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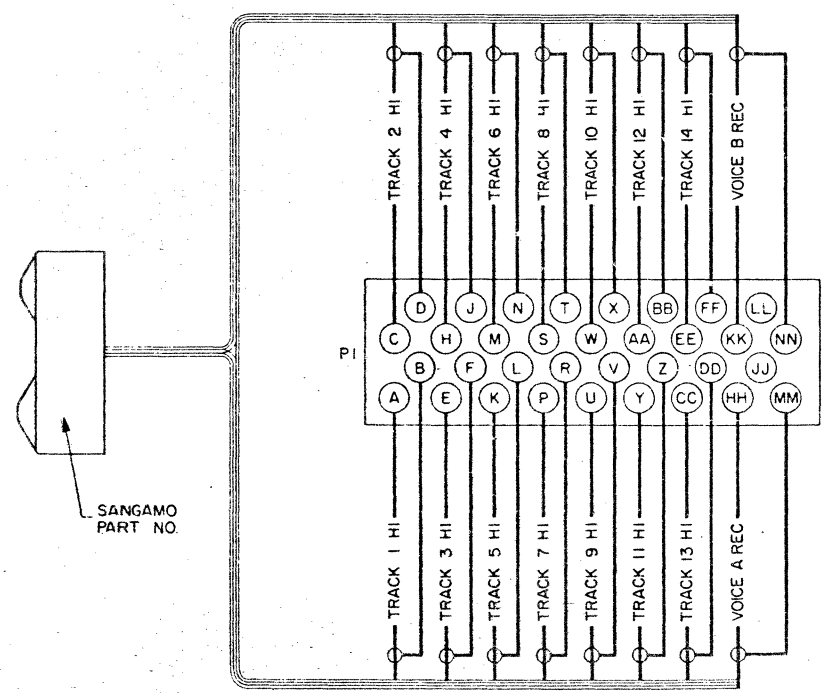
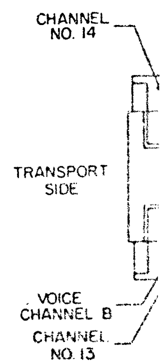
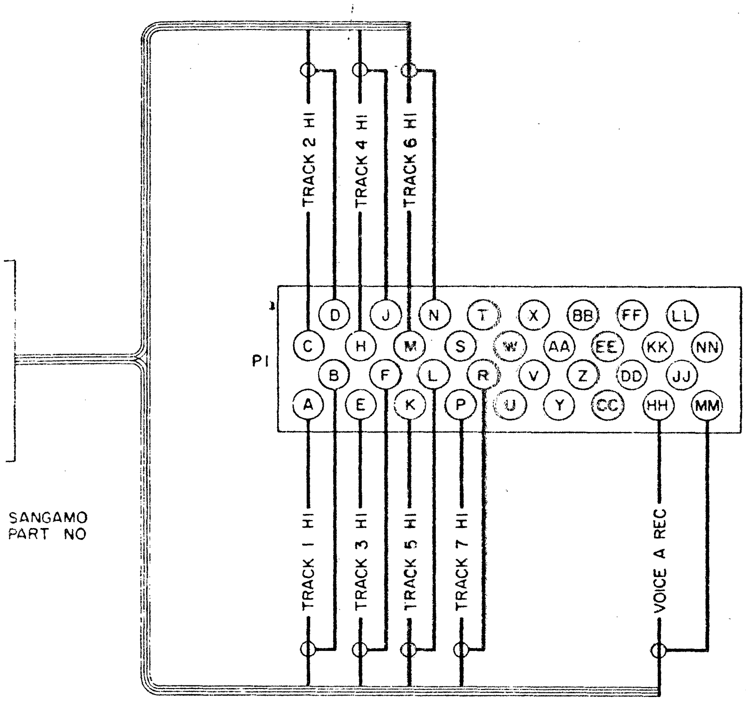
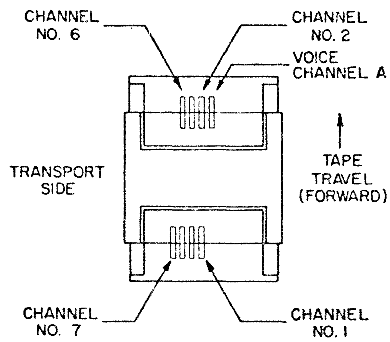




14 Channel (1 inch)

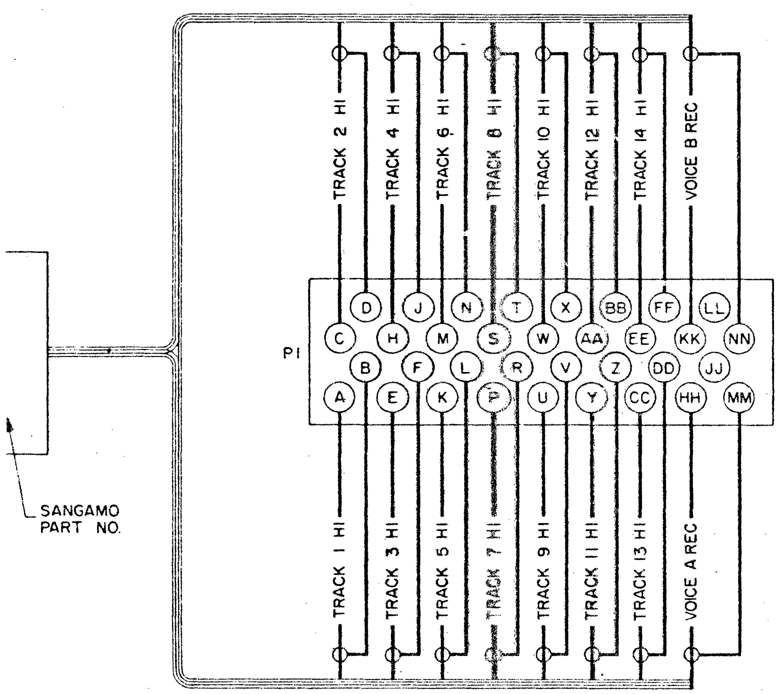


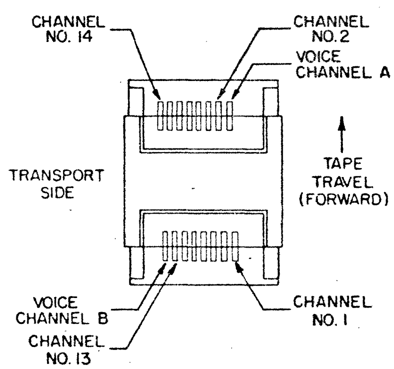


7 Channel (½ inch)

NOTE

To obtain the head part number for the machine this man accompanied, refer to the head characteristics sheet locate in the front of this manual.





14 Channel (1 inch)

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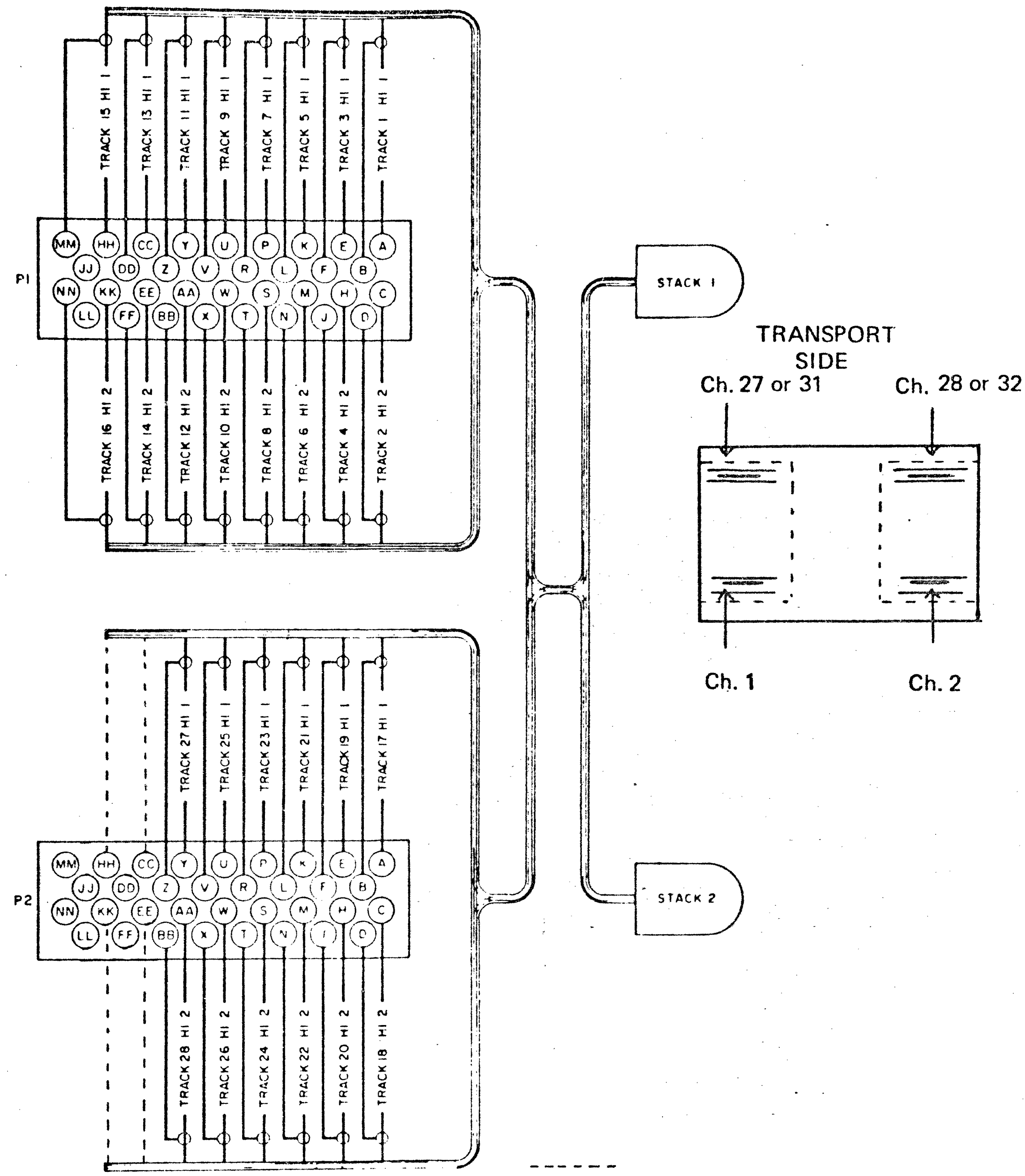

------ Indicates wiring not used on 28 track heads.

28/32 Channel (1 inch)

Typical Record Head Wiring Diagrams

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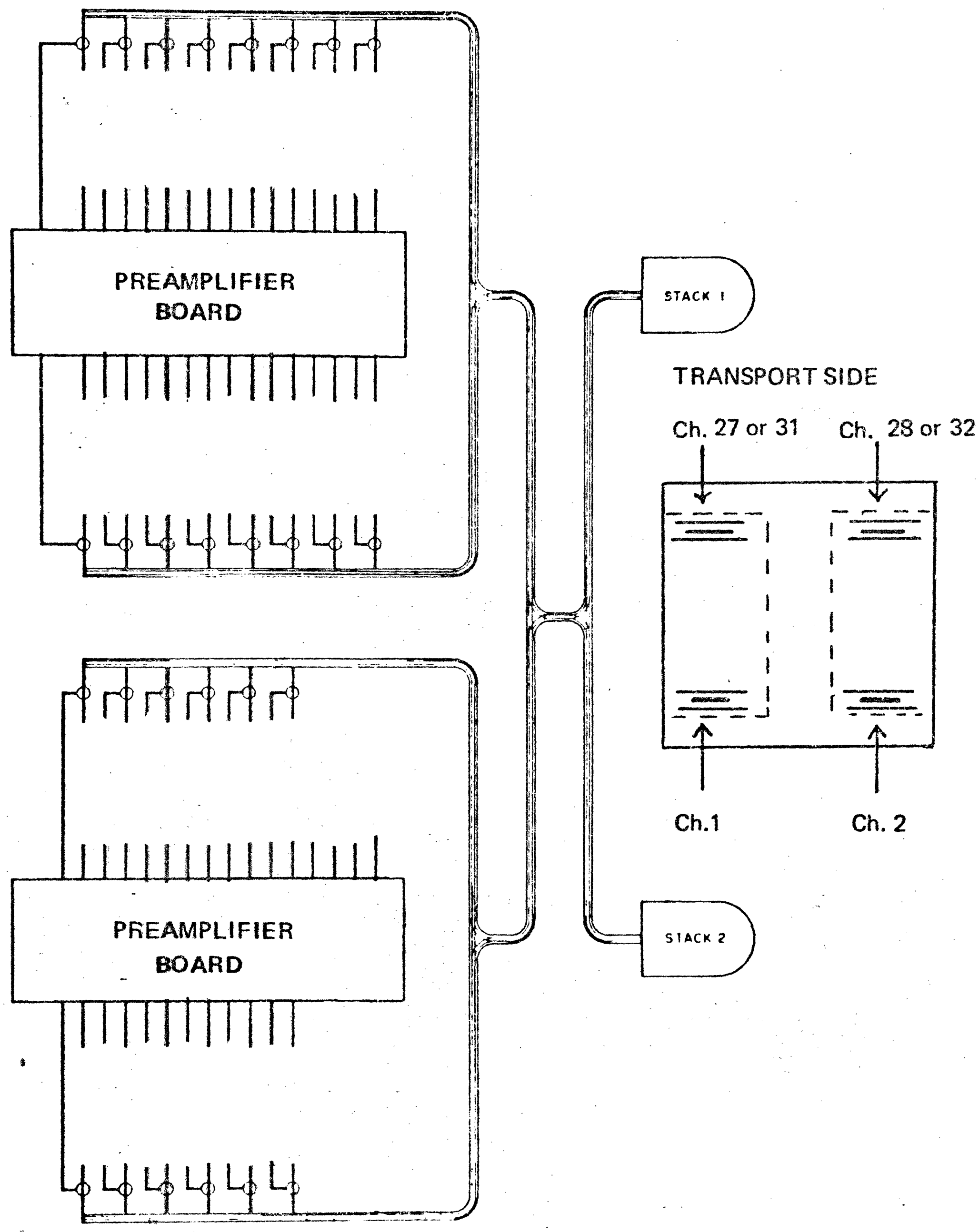
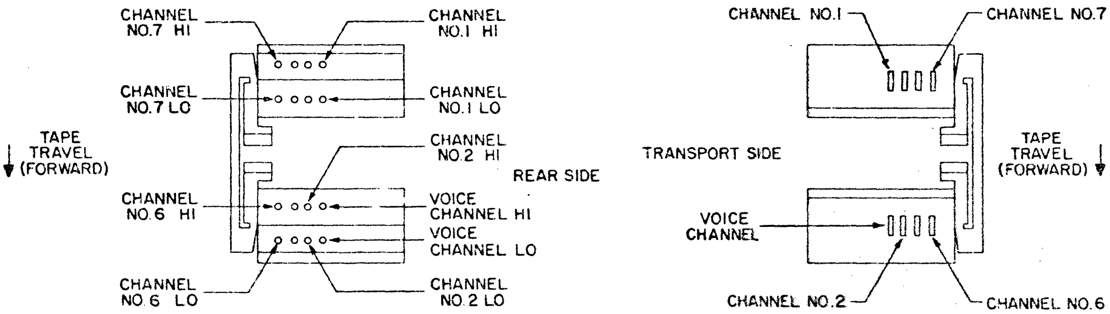
1.



28/32 Channel (1 inch)



7 Channel (½ inch)

NOTE

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part number for the machine this manua
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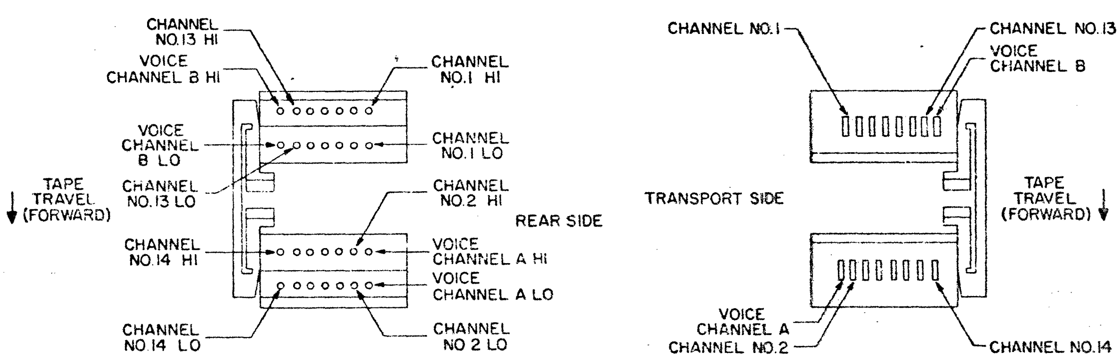
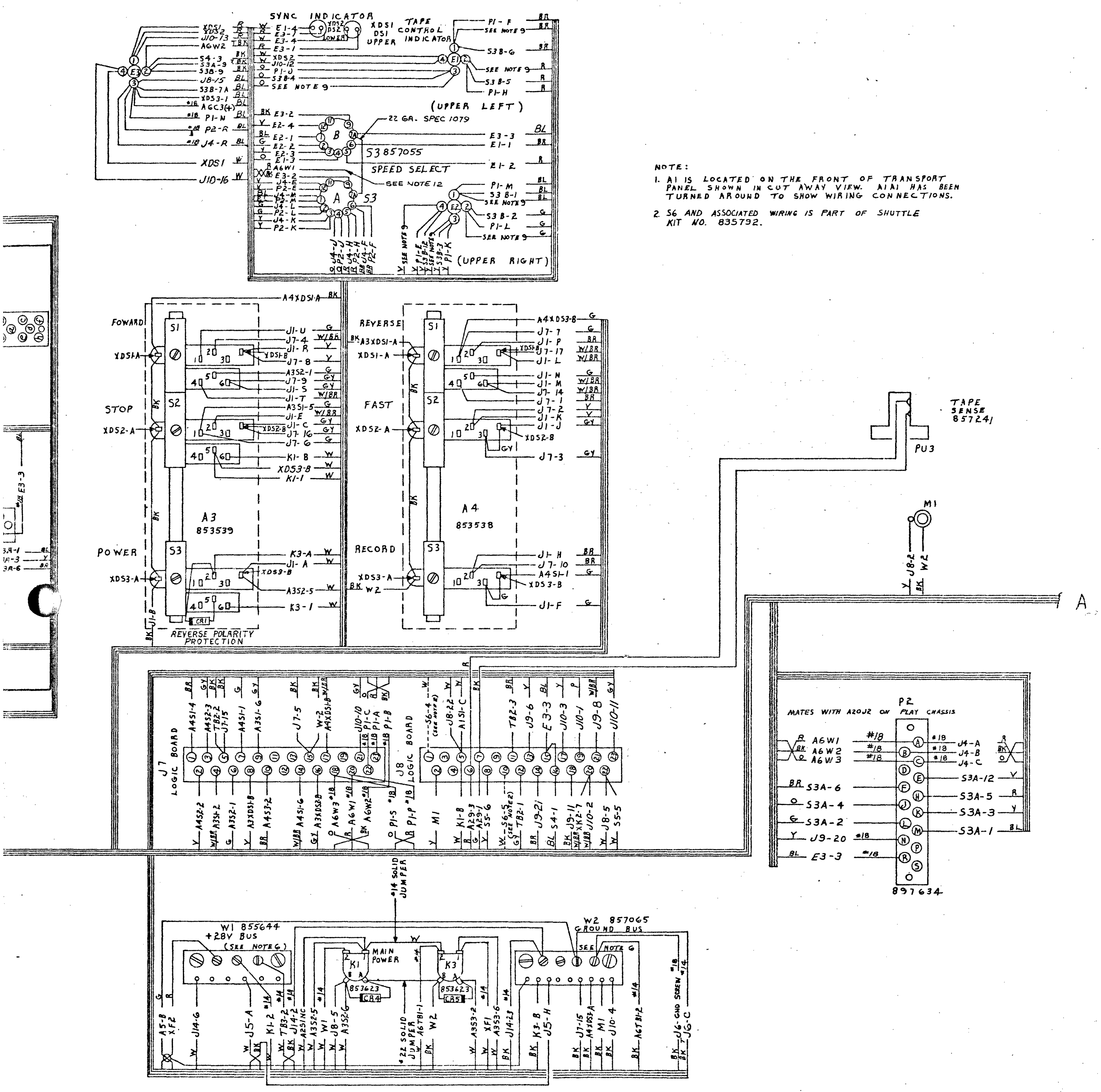
of this manual.
To obtain channel interconnection infor
the Preamplifier bulletin, bulletin 3639-



14 Channel (1 inch)

NOTE:

1. A1 IS LOCATED ON THE FRONT OF TRANSPORT PANEL SHOWN IN CUT AWAY VIEW. A1A1 HAS BEEN TURNED AROUND TO SHOW WIRING CONNECTIONS.
2. S6 AND ASSOCIATED WIRING IS PART OF SHUTTLE KIT NO. 835792.

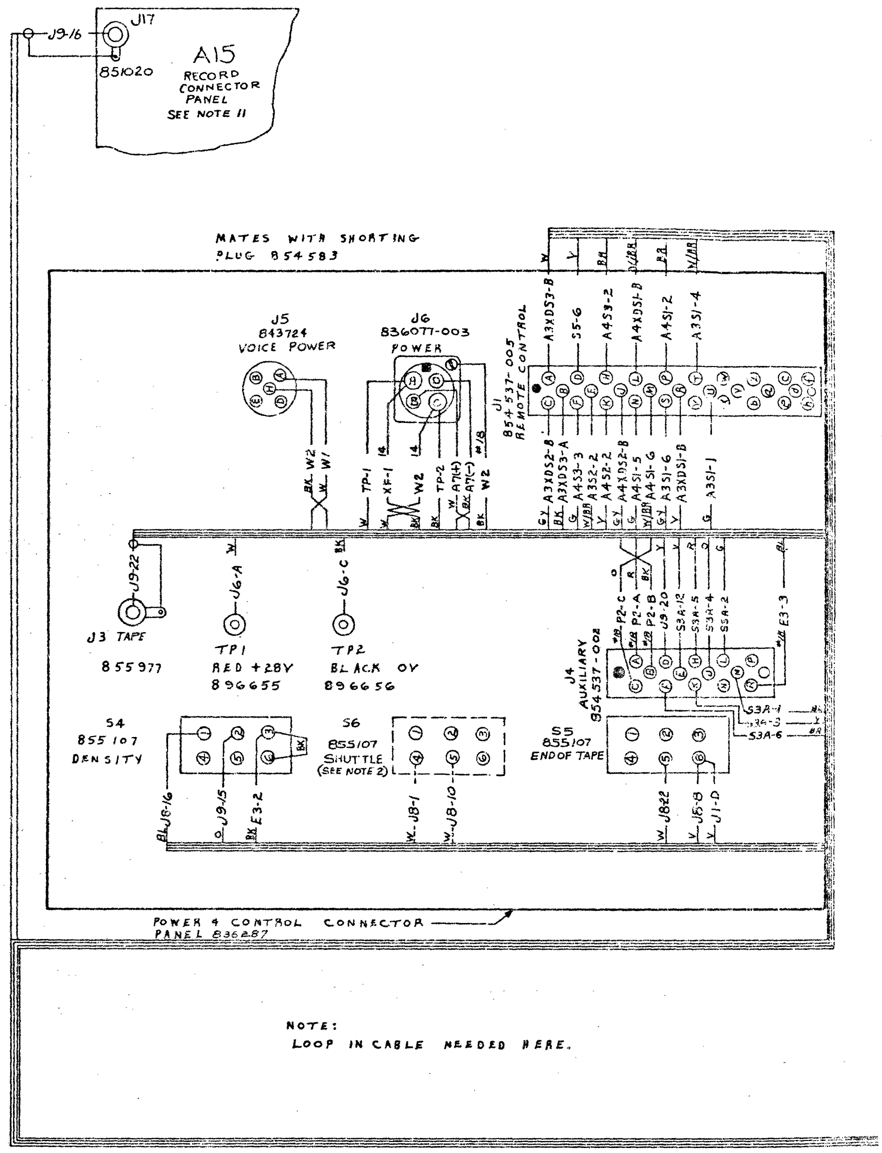


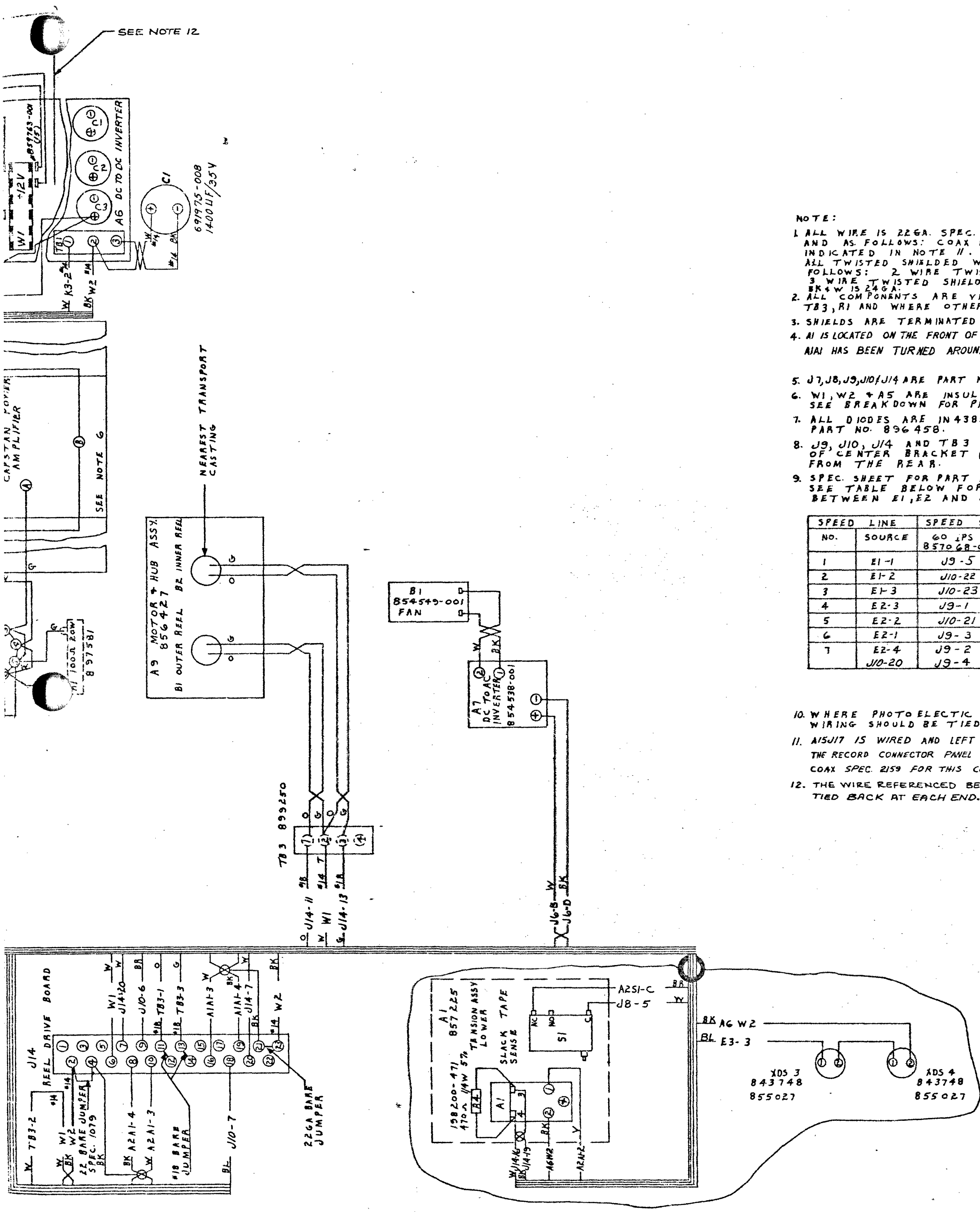
Main Transport Wiring Diagram, Sheet 1

Unit 1 Main Transport	
CR1	896458
CR4	896458
CR5	896458
DS1	510377
DS2	510377
E1 thru E3	877885
J1	854537-005
J3	855977
J4	854537-002
J5	843724
J6	836077-003
J7	856221
J8	856221
K1	853623
K3	853623
M1	510141-001
P2	897634
PU3	857241
S3	857055
S4 thru S6	855107
TP1	896655
TP2	896656
W1	855644
W2	857065[
XDS1	835451
XDS2	835451
XM1	857377
A3	853539
A3DS1 thru A3DS3	856256
A4	853538
A4DS1 thru A4DS3	856256
A15J17	851020
B1	854549-001
C1	691975-008
F1	859774-011
F2	821926
J9	856221
J10	856221
J14	853657
K2	853657
L1	857094
L2	857094
P1	897634
R1	897581
TB1	853615-007
TB2	896190
TB3	899250
TB4	835055-001
XF1	812299
XF2	812299
XK2	812385
A1	857225
A1S1	898807
A1A1	855874
A1A1R4	198200-471
A2	857232
A2S1	898807
A2A1	855874
A2A1R3	198200-471
A5	836259
A6	835680, See Bulletin
A7	854538-001
A8	** 835800
	857363
A9	856427
*A29	835571

* Present only with optional Photo End-of-Tape Sense feature.

**OPTIONS: 857362; 857363





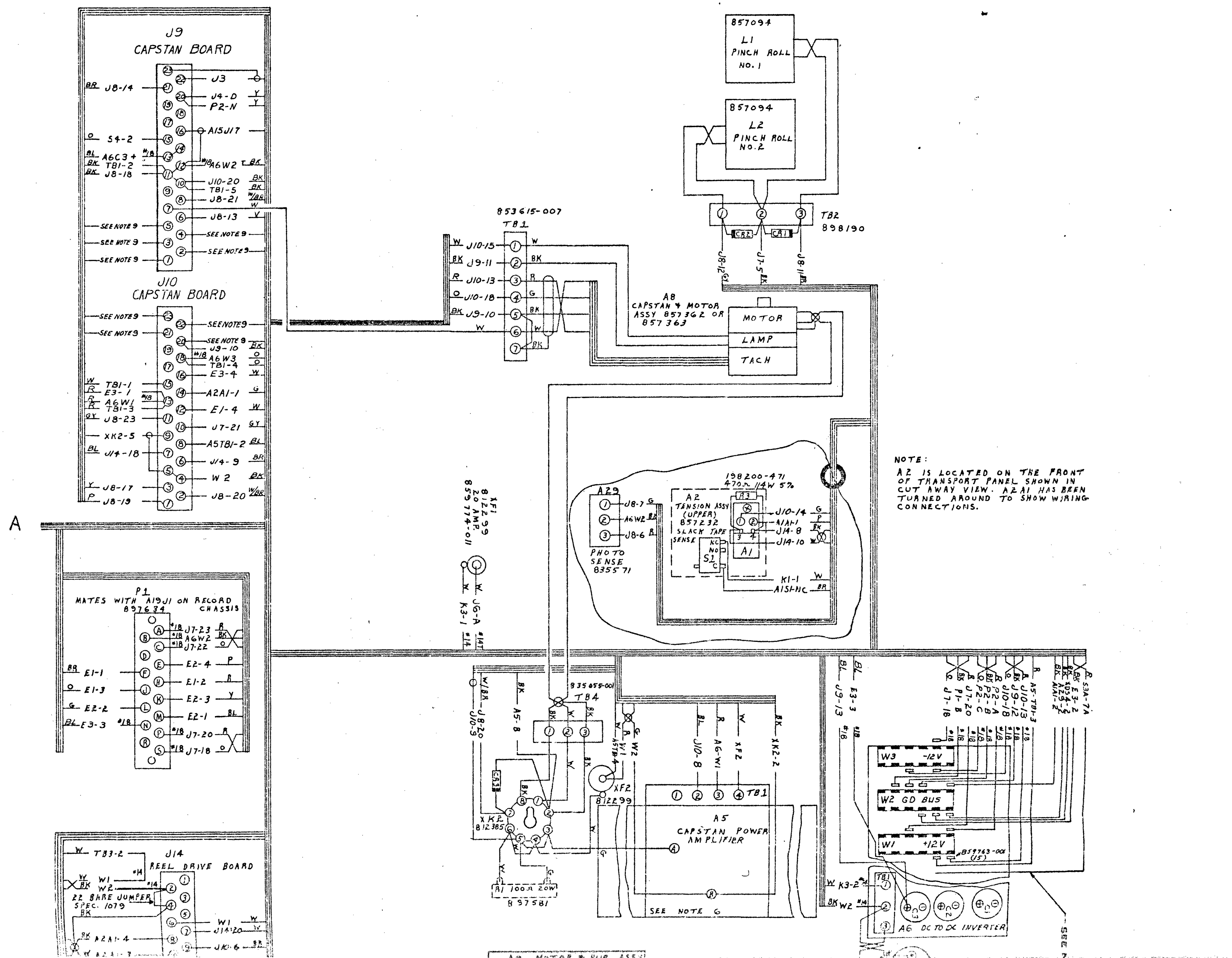
NOTE:

1. ALL WIRE IS 22GA. SPEC. 2285 UNLESS OTHERWISE INDICATED AND AS FOLLOWS: COAX IS RG.-196/U SPEC. 2350 EXCEPT AS INDICATED IN NOTE 11.
   ALL TWISTED SHIELDED WIRE IS SPEC. 2155; WIRE GAGE AS FOLLOWS: 2 WIRE TWISTED SHIELDED RED + GREEN IS 20GA. 3 WIRE TWISTED SHIELDED IS 24 GA. 2 WIRE TWISTED SHIELDED BK + W IS 24GA.
2. ALL COMPONENTS ARE VIEWED FROM WIRING SIDE EXCEPT TB3, R1 AND WHERE OTHERWISE INDICATED.
3. SHIELDS ARE TERMINATED WITH BLACK #22 GA WIRE SPEC. 2285.
4. A1 IS LOCATED ON THE FRONT OF TRANSPORT PANEL SHOWN IN CUT AWAY VIEW. A1A1 HAS BEEN TURNED AROUND TO SHOW WIRING CONNECTIONS.
5. J7, J8, J9, J10 + J14 ARE PART NO. 856221.
6. W1, W2 + A5 ARE INSULATED FROM THE TRANSPORT. SEE BREAKDOWN FOR PROPER INSULATORS.
7. ALL DIODES ARE 1N4385 UNLESS OTHERWISE INDICATED PART NO. 896458.
8. J9, J10, J14 AND TB3 ARE MOUNTED ON THE RIGHT SIDE OF CENTER BRACKET (PART NO. 854692) AS VIEWED FROM THE REAR.
9. SPEC. SHEET FOR PART NO. OF SPEED SELECTOR DIAL ASSY. SEE TABLE BELOW FOR SPEED LINE CONNECTIONS BETWEEN E1, E2 AND J10.

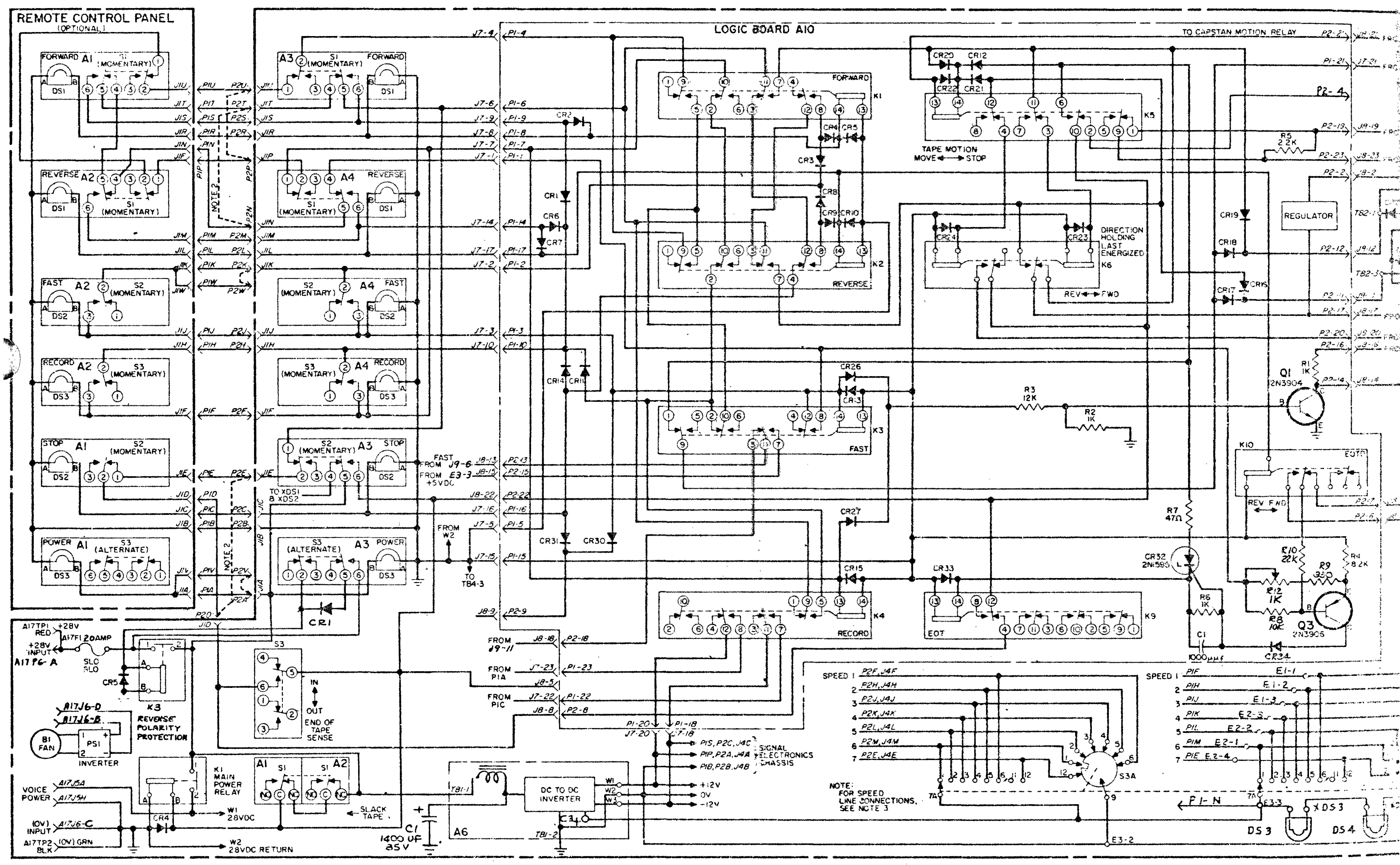
SPEED LINE		SPEED SELECT DIAL ASSY.	
NO.	SOURCE	60 IPS 857068-002	120 IPS 857068-001
1	E1-1	J9-5	J9-4
2	E1-2	J10-22	J9-5
3	E1-3	J10-23	J10-22
4	E2-3	J9-1	J10-23
5	E2-2	J10-21	J9-1
6	E2-1	J9-3	J10-21
7	E2-4 J10-20	J9-2 J9-4	J9-3 J9-2

10. WHERE PHOTOELECTRIC END OF TAPE SENSE IS NOT SUPPLIED, WIRING SHOULD BE TIED BACK AT LAMP + PHOTO SENSE ENDS.
11. A15J17 IS WIRED AND LEFT UNATTACHED ON THIS ASSY BUT IS MOUNTED TO THE RECORD CONNECTOR PANEL AS PART OF FINAL ASSEMBLY. USE AMPHENOL COAX SPEC. 2159 FOR THIS CONNECTION.
12. THE WIRE REFERENCED BETWEEN S3A7A AND A6W1 IS TO BE TIED BACK AT EACH END.

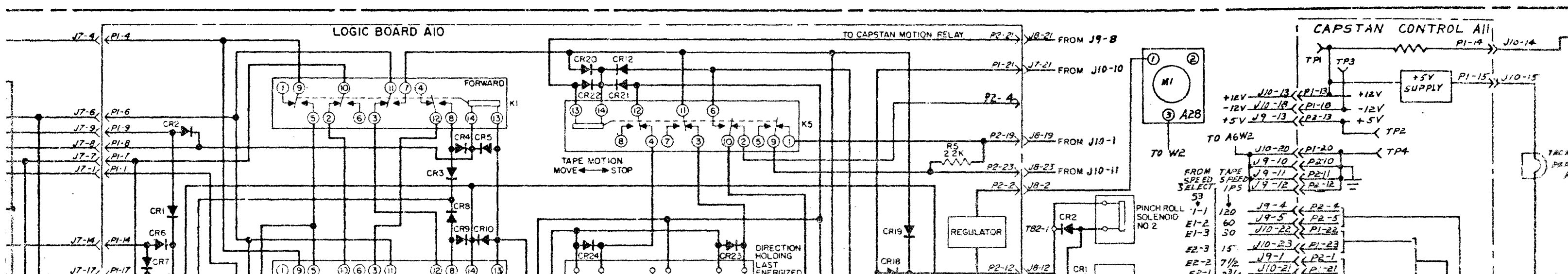
Main Transport Wiring Diagram, Sheet 2

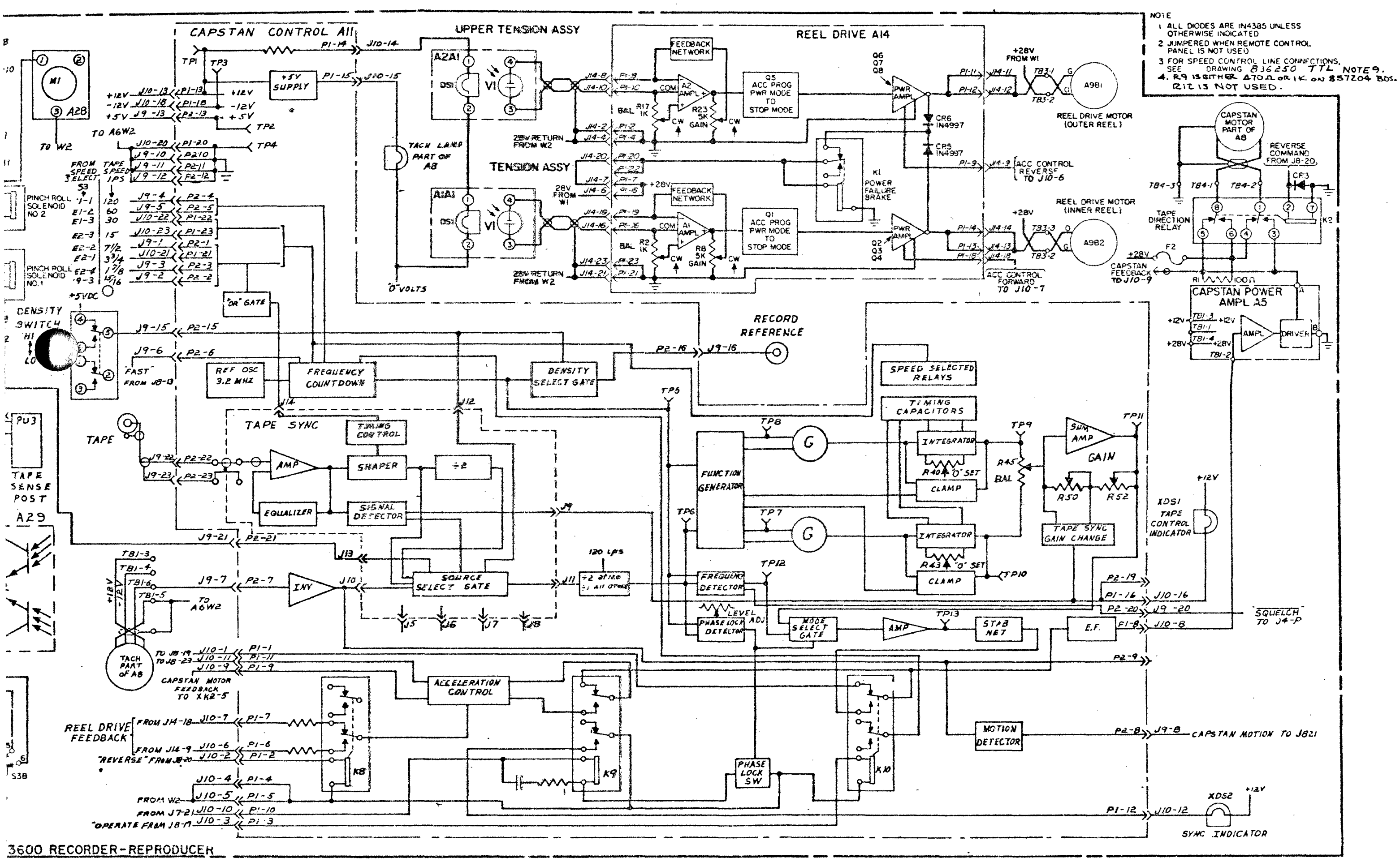


J9
CAPSTAN BOARD
J10
CAPSTAN BOARD
857094
L1
PINCH ROLL
NO. 1
857094
L2
PINCH ROLL
NO. 2
TB2
898190
853615-007
TB1
A8
CAPSTAN & MOTOR
ASSY 857362 OR
857363
MOTOR
LAMP
TACH
NOTE:
A2 IS LOCATED ON THE FRONT OF TRANSPORT PANEL SHOWN IN CUT AWAY VIEW. A2A1 HAS BEEN TURNED AROUND TO SHOW WIRING CONNECTIONS.
A29
PHOTO
SENSE
835571
198200-471
470Ω 1/4W 5%
A2
TENSION ASSY
(UPPER)
857232
SLACK TAPE
SENSE
XF1
812299
20 AMP.
859774-011
A
P1
MATES WITH A19J1 ON RECORD CHASSIS
857634
J14
REEL DRIVE BOARD
22 BARE JUMPER
SPEC. 1079
835055-001
TB4
XK2
812385
XF2
812299
R1 100Ω 20W
857581
TB1
A5
CAPSTAN POWER
AMPLIFIER
SEE NOTE 6
W3 -12V
W2 GD BUS
W1 +12V
859763-001
A6 DC TO DC INVERTER



REMOTE CONTROL PANEL
(OPTIONAL)
LOGIC BOARD A10
TO CAPSTAN MOTION RELAY
FORWARD
REVERSE
FAST
RECORD
STOP
POWER
TAPE MOTION
MOVE STOP
DIRECTION HOLDING LAST ENERGIZED
REV FWD
REGULATOR
EOT
END OF TAPE SENSE
REVERSE POLARITY PROTECTION
MAIN POWER RELAY
SLACK TAPE
DC TO DC INVERTER
SIGNAL ELECTRONICS CHASSIS
NOTE: FOR SPEED LINE CONNECTIONS, SEE NOTE 3


LOGIC BOARD A10
TO CAPSTAN MOTION RELAY
FORWARD
REVERSE
FAST
RECORD
EOT
TAPE MOTION
MOVE STOP
DIRECTION HOLDING LAST ENERGIZED
REV FWD
EOTD
REGULATOR
PINCH ROLL SOLENOID NO 2
PINCH ROLL SOLENOID NO 1
DENSITY SWITCH
HI
LO
TAPE SENSE POST
A29
PU3
A28
M1
TO W2
CAPSTAN CONTROL A11
+5V SUPPLY
"OR" GATE
REF OSC 3.2 MHZ
FREQUENCY COUNTDOWN
TAPE SYNC
TIMING CONTROL
AMP
SHAPER
EQUALIZER
SIGNAL DETECTOR
INV
TACH PART OF A8
CAPSTAN MOTOR FEEDBACK TO XK2-5
REEL DRIVE FEEDBACK
"REVERSE"
"OPERATE"
"FAST"
FROM SPEED SELECT
TAPE SPEED IPS
120
60
30
15
7 1/2
3 3/4
1 7/8
15/16
DC TO DC INVERTER
A6
SIGNAL ELECTRONICS CHASSIS
+12V
0V
-12V
NOTE: FOR SPEED LINE CONNECTIONS, SEE NOTE 3
SPEED
S3A
S3B
DS3
DS4
Q1 2N3904
Q3 2N3906
CR32 2N1595
R3 12K
R2 1K
R7 47Ω
R5 2.2K
3600 RECORDER-REPRODUCER



Transport Overall Schematic

836250-1 TTS

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RECORD CHASSIS

GENERAL

This bulletin contains information pertaining to the record chassis employed with this recorder/reproducer. The record chassis houses all the record electronics utilized with this recorder/reproducer. Also provisions are normally made for housing of the voice or edge track record board and bias oscillator board.

Due to certain circuit component requirements on the record boards, +12 Vdc input to the chassis must be applied to the boards after -12 Vdc is applied. This is accomplished with the use of a time delay relay circuit, K1.

A printed circuit board, with jacks mounted, provide the appropriate wiring for each record board. The input signal connections are provided by BNC connectors on the record connector panel.

OPERATING DATA

a. **CONTROLS** — No effective controls are located on this chassis.

b. **BOARD PLACEMENT** — Standard board arrangement should conform to Figure 1.

Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	BIAS
Ch. 8	Ch. 9	Ch. 10	Ch. 11	Ch. 12	Ch. 13	Ch. 14	Voice or Edge Track

Figure 1. Board Placement Diagram, Front View

A19 Record Chassis 835135

J1	897633
J2	843734
K1	855130-002
XK1	835327

A1917 Record Connector Board (upper & lower) 856999

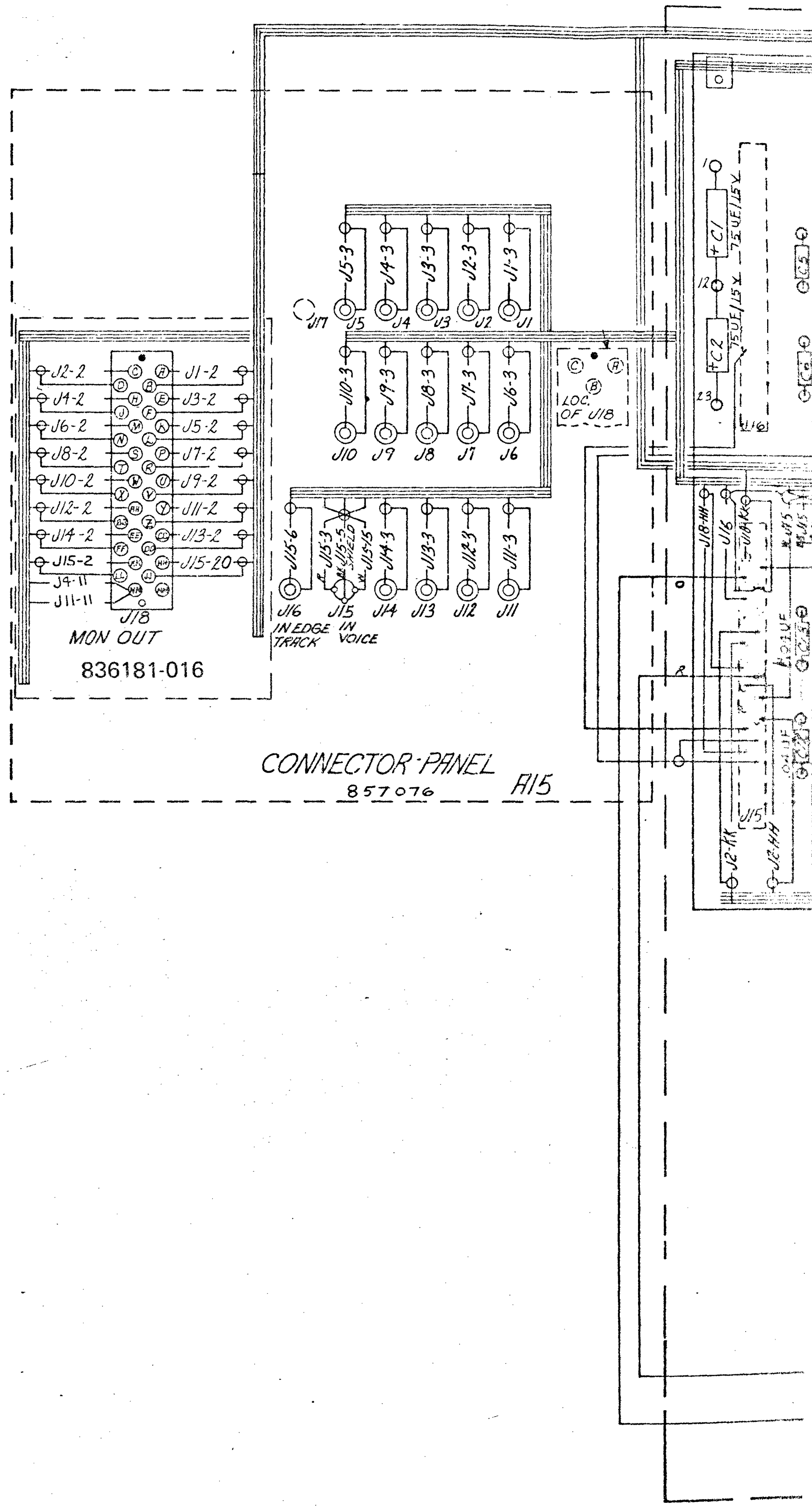
C1 thru C4	851139-007
C5 thru C18	896477
J1 thru J16	855894

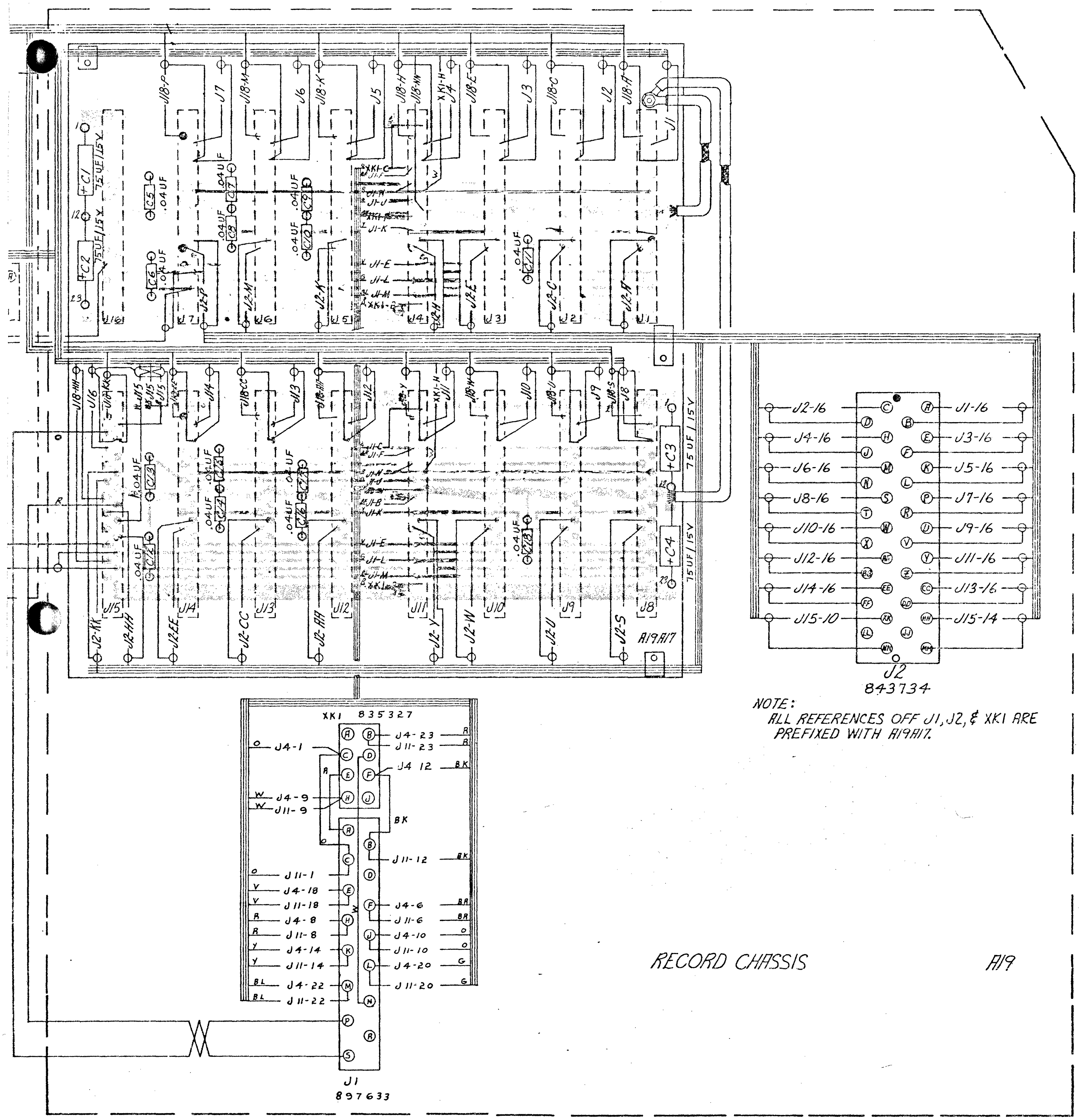
A15 Record Connector Panel

J1 thru J16	855977
J17	Not Used
J18	843734 (used only with monitor kit, 835460)

NOTES:

1. All references off A15J18 are prefixed with A19A17.





Record Chassis Wiring Diagram

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DIRECT RECORD

GENERAL

This bulletin contains complete information on the direct record operating and servicing procedures. The direct record is utilized to amplify and prepare the input data signal for the magnetic tape record head. The board amplifies the bias signal and linearly combines it with the amplified input data signal. The direct record boards are located in the record chassis and are easily accessible from the front of the machine.

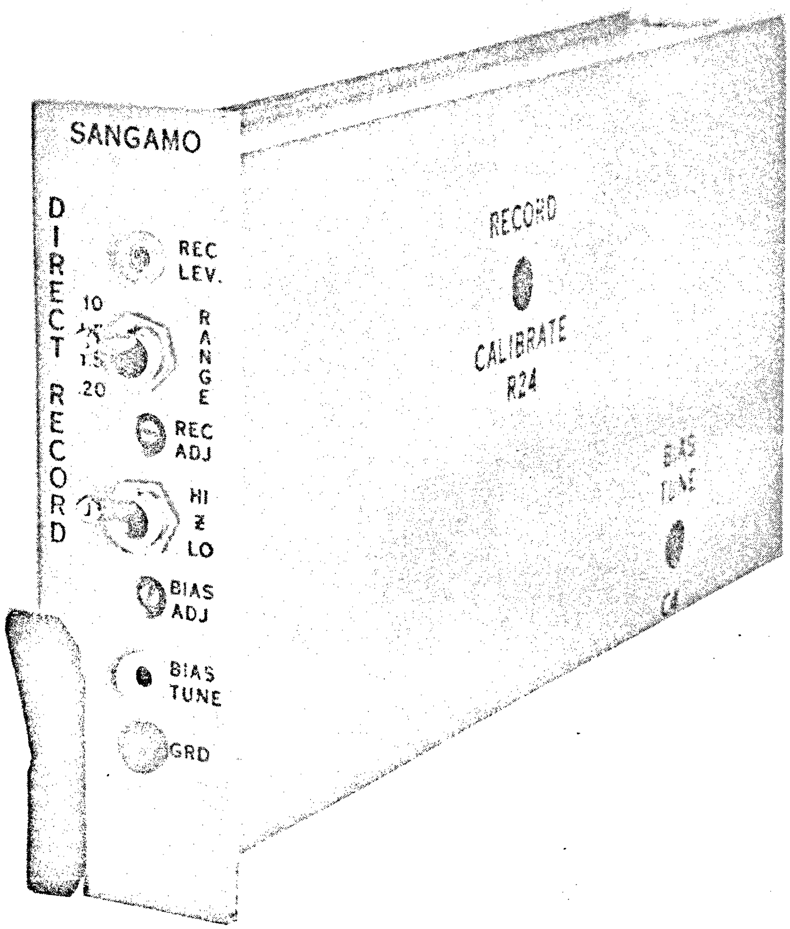


Figure 1. Direct Record Board

CHARACTERISTICS

Input Signal Level	0.2 to 10 Vrms
Input Signal Attenuation Levels	.2 to 1.5 Vrms, and 1.5 to 10 Vrms
Input Impedance Levels	LO 75 ohm HI 10,000 ohm
Input Bias Level	1 Vrms at 8.4 MHz
Output Signal Level	1 ma rms nominal
Output Bias Level	30 ma max.
Frequency Response	100 Hz to 2.0 MHz
Power Requirements	+12 Vdc ±0.5 Vdc @ 17 ma. -12 Vdc ±0.5 Vdc @ 17 ma.

OPERATING PROCEDURES

a. **CONTROLS** – The following, Table 1, lists those controls and adjustments employed on the direct record board and associated with the direct record process. These controls are vital in respect to optimum performance in direct recording. For complete, maintenance adjustment procedures refer to the maintenance section of this bulletin.

TABLE 1. DIRECT RECORD CONTROLS & ADJUSTMENTS

CONTROL	LOCATION AND FUNCTION
RANGE (S1)	Located on the front of each direct record board, it selects the input levels, .2 to 1.5 Vrms and 1.5 to 10 Vrms.
REC ADJ (R14)	Located on the front of each direct record board, it determines the level of the record signal applied to the head.
RECORD CALIBRATE (R24)	Located on the side of the direct record board it provides for adjustment of the record reference current.
Ƶ (S2)	Located on the front of each direct record board, it selects the input impedance to the board. LO 75 ohm and HI 10,000 ohm.
BIAS ADJ. (R2)	Located on the front of each direct record board, it determines the level of the bias signal applied to the head.
BIAS TUNE (C4)	Located on the side of the direct record board (shield not removed), it provides adjustment for maximum transfer between bias driver and load.

b. **STEP-BY-STEP OPERATING PROCEDURES** – For proper utilization of the recorder/reproducer in the RECORD mode, ensure the presence of the following functions.

NOTE

If tape synchronous speed control is to be used during reproduction of the tapes being recorded, refer to the applicable paragraphs before attempting to record.

Step 1. Tape must be threaded in accordance with those procedures set forth in the Tape Transport Bulletin.

Step 2. Proper signal electronics must be installed into the track numbers for use.

Step 3. Proper input signal connections must be made in accordance with information found in the Installation Bulletin.

Step 4. Proper adjustment of direct record board including record current and bias level is necessary.

If any of the following conditions exist, a complete bias and record current calibration is necessary.

Step 1. Direct record boards have been relocated.

Step 2. Heads have been replaced (in which case, all tracks require recalibration).

Step 3. Parts affecting frequency are changed.

Step 4. Magnetic head characteristics sheet is not available.

Step 5. Parts have been replaced on the bias board.

To properly adjust a direct record board it is necessary to set the bias level, then set the record level, and then reset the bias level. The optimum bias level is dependent on the particular head track, the individual record board, and (to a lesser degree) the magnetic tape being used. In the front of this manual is a head characteristics sheet which lists the bias (and record) levels for each channel which were established at the factory. These values may be utilized to correctly adjust the bias and record levels of the board as explained below. When peak performance is desired refer to the maintenance section of this bulletin where the adjustments are made by establishing voltage levels.

1. BIAS LEVEL (using Head Characteristics Sheet)

Step 1. Depress POWER and RECORD and monitor BIAS TUNE TP3 (hi) and GRD TP1 (lo) with a dc voltmeter. This indicates the bias level and should correspond to the appropriate value given in the bias level column of the head characteristics sheet.

Step 2. If the voltmeter reading in Step 1 was incorrect, adjust BIAS ADJ (R2) until the correct reading is obtained.

Step 3. Remove the voltmeter and check the remaining channels.

2. RECORD CURRENT ADJUST – With the RECORD CALIBRATE ADJUST (R24) properly adjusted as set at the factory (1% 3rd harmonic normal), a .1 Vrms reading at REC LEV TP2 ensures the proper record current is applied to the record head. REC ADJ. (R14) is used to attain this .1 Vrms reading at TP2 independent of the input signal level to the board.

Step 1. Connect a signal generator to the input BNC connector of the track being adjusted. Adjust the generator for the frequency and level equal to nearest the anticipated frequency and level.

Step 2. Connect an AC VTVM to TP2 (hi) and TP1 (lo) and depress POWER and RECORD.

Step 3. Set REC ADJ. (R14) for a .1 Vrms reading on the VTVM.

Step 4. Recheck the bias level to ensure no change has taken place.

Step 5. Remove the VTVM and check the remaining channels.

NOTE

The RECORD CURRENT ADJ (R14) must be readjusted for a .1 Vrms or approximate reading at TP2 for each different input level applied to the board. Also ensure the correct setting of the RANGE switch for each different input level.

THEORY OF OPERATION

When the direct record process is used, the data signal to be recorded is amplified, linearly combined with a high frequency bias, and applied directly to the record head as a varying electric current. This electric current produces a changing magnetic flux across the gap in the record head. Upon playback, the magnetized surface of the tape passes over the gap of the reproduce head and generates a varying voltage in the coils of the reproduce head.

High frequency bias is necessary in the direct process to overcome the inherent nonlinear relation between the magnetic force applied to the tape and the resulting state of magnetization of the tape. The combining of the bias signal and the data signal is a linear combining process, NOT a modulation process.

With the POWER and RECORD modes activated power is applied to the bias board, generating a bias signal which is applied to the direct record board through P1-21. ±12 Vdc are also applied to the board through P1-1 (-12 Vdc) and P1-23 (+12 Vdc) during the RECORD mode. The bias signal passes through R2 bias level adjustment, and is applied to the base of emitter follower Q1. Q1 acts as a buffer and passes the bias signal to transformer T1 where it is separated and applied to the inputs of a push-pull amplifier, Q2 and Q3. The signal is then amplified and applied to transformer T2 for adding with the data record signal. C14 (across the output of T2) provides adjustment for maximum transfer between the bias driver and load. Part of the signal is rectified by CR2 and supplied to TP3 for minitoring when tuning C14 for maximum or matching T2 to the head inductance.

The data signal to be recorded from the Record Connector Panel enters the board through P1-3 (hi) and P1-5 (lo). The signal then passes through a two position impedance switch (S2) to the two position attenuation network R11 and R12, which is controlled by S1. From this attenuator the signal passes to Q4 and Q5 acting as a current amplifier. R14, Record Current Adj. controls the level of the input signal passing to Q4. R24, Record Calibrate, controls the second current amplification stage Q5. In this process R24 establishes the reference current corresponding to the 3rd harmonic of the nominal input frequency. This allows for the smallest amount of distortion possible. With Record Calibrate correctly adjusted it is commended to adjust R14 for a .1 Vrms at TP2.

Q6, the current source, in conjunction with C13 and R18, provide a network for protecting the record head against spikes occuring in the input data signal. From this point the data signal passes to the bias trap, bias tune and T2, adding transformer for adding with the bias signal. The output signal passes to the head through P1-16 (hi) and P1-15 (lo).

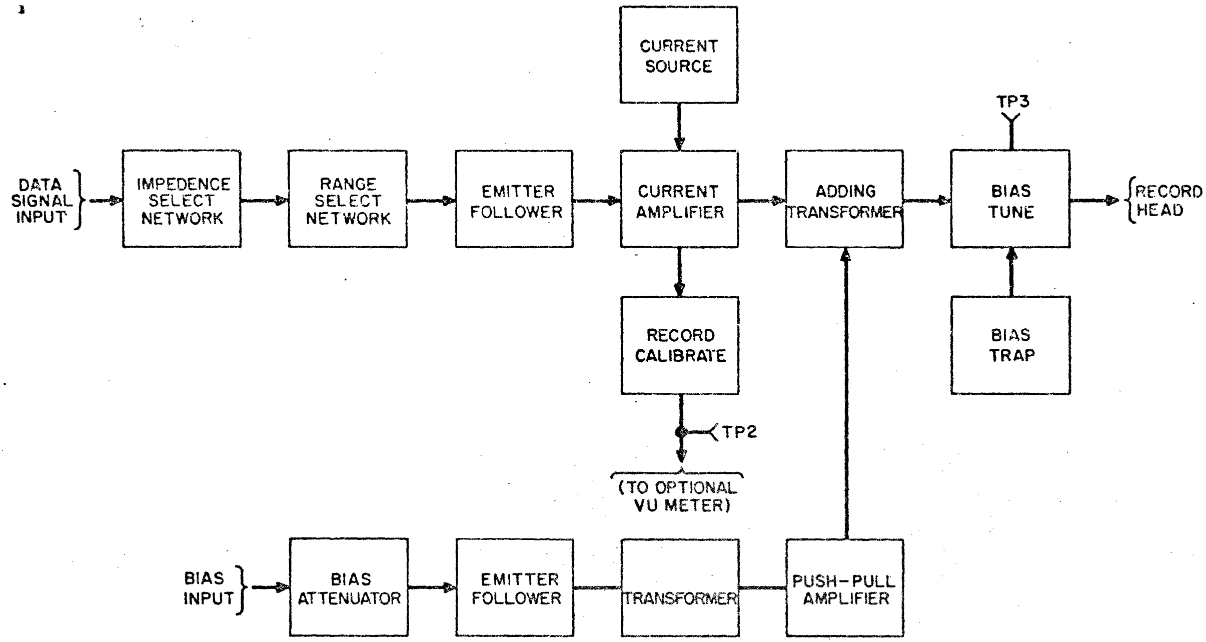


Figure 2. Direct Record Block Diagram

MAINTENANCE

If the need for maintenance arrises due to a malfunction in the board the following procedures will assist in locating the malfunction. Failure to attain a certain indication or condition is a clue to a particular problem.

All adjustments contained herein pertain to normal machine operation. Although these adjustments are performed at the factory the need for their re-adjustment may be evident to ensure optimum machine performance.

a. EQUIPMENT REQUIRED

Simpson Model 260 VOM or equivalent
Tektronix 503 Oscilloscope or equivalent
HP Model 400 E VTVM or equivalent
HP Model 310 Wave Analyzer or equivalent

b. DIRECT RECORD BOARD CHECKOUT AND CALIBRATION

Step 1. With the direct record board removed from the recorder/reproducer, and its shield removed, visually inspect it for loose connections or mountings, dented, misshaped, or broken components, foreign material, and signs of overheating.

Step 2. Mount the board on its extender board and depress POWER, STOP and RECORD. Use a shorted BNC connector at the Record Connector Panel input, for the channel under test, to ensure that no data signal is being applied to the record circuits input.

Step 3. Ensure the bias board output is 8.4 MHz at approximately 1-2 V p-p.

Step 4. Monitor TP3, BIAS TUNE testpoint, with a VOM and adjust C4, BIAS TUNE, for a maximum dc voltage. R2, BIAS ADJ, may require adjustment to attain this maximum.

Step 5. Adjust R2, BIAS ADJ, for a 2 Vdc reading at TP3, BIAS TUNE.

Step 6. Remove POWER and place the TAPE SPEED SELECTOR to 60 ips. Remove the shorted BNC connector and connect a signal generator to the channel being adjusted. Adjust the generator for a sine wave output of 100 kHz at .2 Vrms. Place the RANGE switch to the correct position (.2 to 1.5 V range) and ensure .1 Vrms at REC LEC, TP2.

Step 7. Ensure a direct reproduce board is properly placed in the reproduce chassis for the channel under test.

Step 8. Connect an AC VTVM and an oscilloscope to the output BNC connector on the Reproduce Connector Panel for the channel under test.

Step 9. Apply POWER and depress STOP, RECORD, and FORWARD.

Step 10. Adjust the reproduce board OUTPUT LEVEL for a 0 db reading.

Step 11. Set generator to the bias set frequency, per table 2 (300 kHz - Inter, 800 kHz - W.B. I, or 1 MHz - WB II, all at 60 ips).

Step 12. Adjust BIAS ADJ counterclockwise until a drop is reached. Note this level and turn clockwise until the reproduced signal is 3 db below the peak reading.

c. **RECORD CALIBRATE ADJUST** – The RECORD CALIBRATE ADJ (R24) has been set at the factory. However, due to head changes, head wear or placement of new boards it may become necessary to recalibrate, thus recalibrating record current. The following steps are necessary for recalibration.

Step 1. Clean and demagnetize the record and reproduce heads as explained in the Tape Transport Bulletin.

Step 2. Set bias level as explained in the preceding paragraph.

Step 3. Set the TAPE SPEED SELECTOR to 60 ips and connect a signal generator to the input BNC connector for the track being adjusted. Set generator to .2 Vrms at the proper record calibrate frequency per Table 2.

Step 4. Adjust REC ADJ (R14) maximum clockwise.

Step 5. Connect HP 310 Wave Analyzer to the output BNC connector (Reproduce Connector Panel) of the track being adjusted. Adjust the wave analyzer for the same frequency as the input generator frequency. Depress POWER, STOP, RECORD, and FORWARD.

Step 6. Adjust the reproduce board OUTPUT LEVEL for a 0 db reading on the wave analyzer. This is the reference and is not to be readjusted until later steps.

Step 7. Adjust the wave analyzer for 300 kHz or the 3rd harmonic of the input signal. The greatest concern at this point is distortion. Adjust RECORD CALIBRATE (R24) for a reading of -40 db from the 0 db reference.

Step 8. Readjust the wave analyzer to the same frequency as the input generator frequency and readjust the reproduce board OUTPUT LEVEL for a reading of 0 db.

Step 9. Adjust the wave analyzer back to 300 kHz (or the 3rd harmonic) and ensure a reading of -40 db from the 0 db reference. If reading is the same record calibrate is correct, if reading is different continue until correct reading is obtained.

Step 10. It may be necessary to reset the BIAS ADJ as explained in the preceding paragraph, to attain maximum efficiency. If this is done recheck the RECORD CALIBRATE to ensure it has not changed.

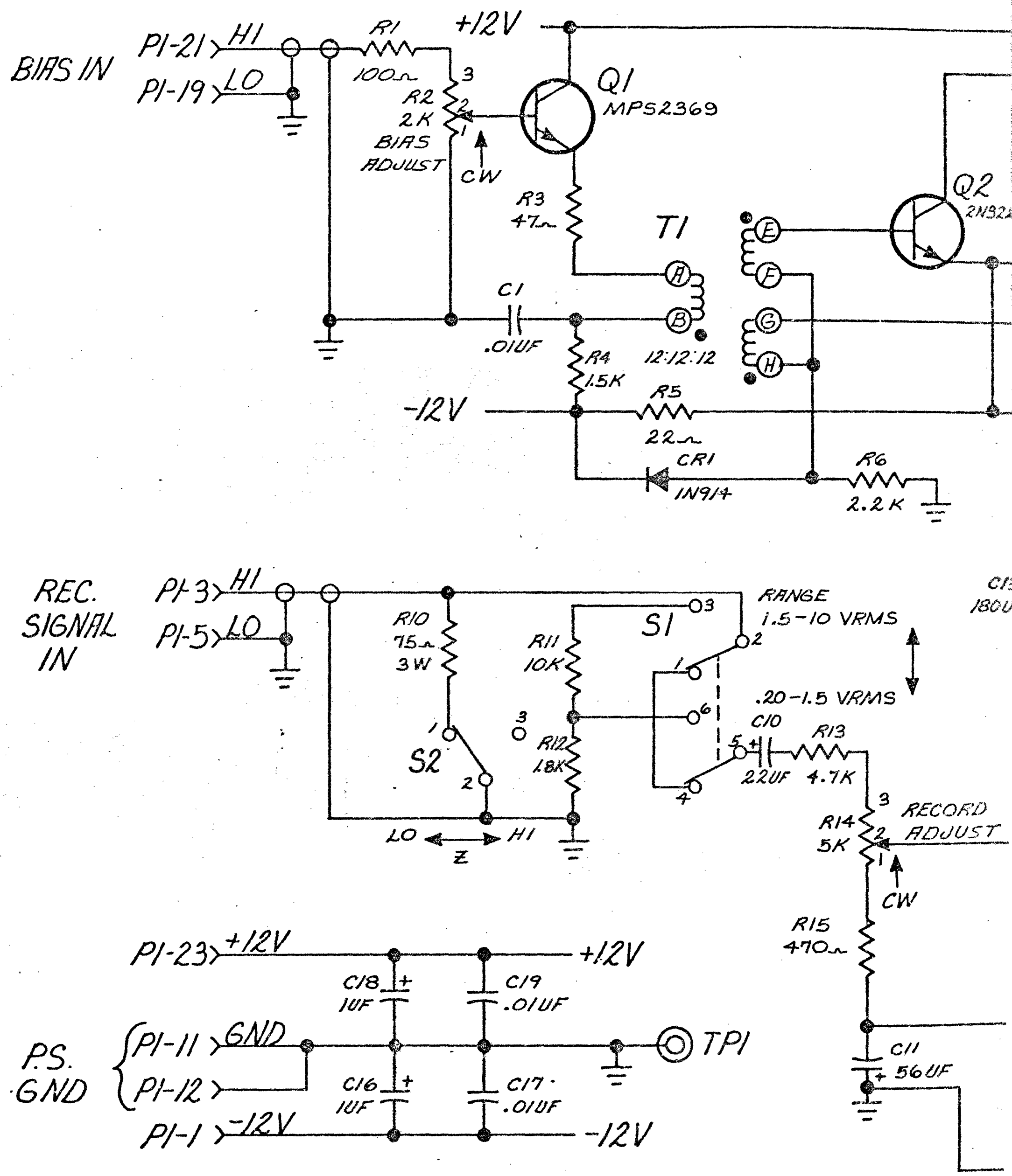
PARTS LIST

Direct Record Board 857033

C1	691686-001	L1	853587-029	R13	198200-472
C2	691686-001	L2	853587-028	R14	854535-009
C3	691686-001	L3	853587-029	R15	198200-471
C4	850862	Q1	510018	R16	198200-333
C5	898330	Q2	510076	R17	198200-123
C6	854528-033	Q3	510076	R18	198200-104
C7	854528-075	Q4	854540	R19	198200-151
C8	854528-033	Q5	854539	R20	198200-152
C9	694686-001	Q6	854539	R21	198200-103
C10	896294	R1	198200-101	R22	198200-102
C11	691391-017	R2	854535-008	R23	198200-470
C12	691391-073	R3	198200-470	R24	844994
C13	691391-073	R4	198200-152	R25	198200-471
C14	896294	R5	198200-220	T1	510015-001
C15	896294	R6	198200-222	T2	510015-001
C16	691391-062	R7	198200-101	P1	853518
C17	691686-001	R8	198200-103	TP1	855812-010
C18	691391-062	R9	198200-222	TP2	855812-002
C19	691686-001	R10	864971-018	TP3	855812-004
CR1	844510	R11	198200-103	S1	855432-008
CR2	844510	R12	198200-182	S2	510102-003

TABLE 2. DIRECT RECORD FREQUENCIES

Classification	Speed Ips	Pass Band	Bias Set Frequency	Record Calibrate Set Frequency
IRIG INTERMEDIATE BAND	120	400 Hz to 600 kHz	600 kHz	1000 Hz
	60	400 Hz to 300 kHz	300 kHz	1000 Hz
	30	400 Hz to 150 kHz	150 kHz	1000 Hz
	15	400 Hz to 75 kHz	75 kHz	1000 Hz
	7 1/2	400 Hz to 37.5 kHz	37.5 kHz	500 Hz
	3 3/4	400 Hz to 18.7 kHz	18.7 kHz	500 Hz
	1 7/8	400 Hz to 9.3 kHz	9.3 kHz	500 Hz
	15/16	400 Hz to 4.6 kHz	4.6 kHz	500 Hz
IRIG WIDEBAND GROUP I	120	400 Hz to 1600 kHz	1600 kHz	160 kHz
	60	400 Hz to 800 kHz	800 kHz	80 kHz
	30	400 Hz to 400 kHz	400 kHz	40 kHz
	15	400 Hz to 200 kHz	200 kHz	20 kHz
	7 1/2	400 Hz to 100 kHz	100 kHz	10 kHz
	3 3/4	400 Hz to 50 kHz	50 kHz	5 kHz
	1 7/8	400 Hz to 25 kHz	25 kHz	2.5 kHz
IRIG WIDEBAND GROUP II	120	400 Hz to 2000 kHz	2000 kHz	200 kHz
	60	400 Hz to 1000 kHz	1000 kHz	100 kHz
	30	400 Hz to 500 kHz	500 kHz	50 kHz
	15	400 Hz to 250 kHz	250 kHz	25 kHz
	7 1/2	400 Hz to 125 kHz	125 kHz	12.5 kHz
	3 3/4	400 Hz to 62.5 kHz	62.5 kHz	6.25 kHz
	1 7/8	400 Hz to 31.25 kHz	31.25 kHz	3.125 kHz



BIAS IN
P1-21 HI
P1-19 LO
R1 100Ω
R2 2K BIAS ADJUST
CW
+12V
Q1 MPS2369
R3 47Ω
T1
12:12:12
C1 .01UF
R4 1.5K
-12V
R5 22Ω
CR1 1N914
R6 2.2K
Q2
REC. SIGNAL IN
P1-3 HI
P1-5 LO
R10 75Ω 3W
S2
LO Z HI
R11 10K
R12 1.8K
S1
RANGE 1.5-10 VRMS
.20-1.5 VRMS
C10 22UF
R13 4.7K
R14 5K
RECORD ADJUST
CW
R15 470Ω
C11 56UF
P1-23 +12V
+12V
C18 1UF
C19 .01UF
P.S. GND
P1-11 GND
P1-12
TP1
C16 1UF
C17 .01UF
P1-1 -12V
-12V

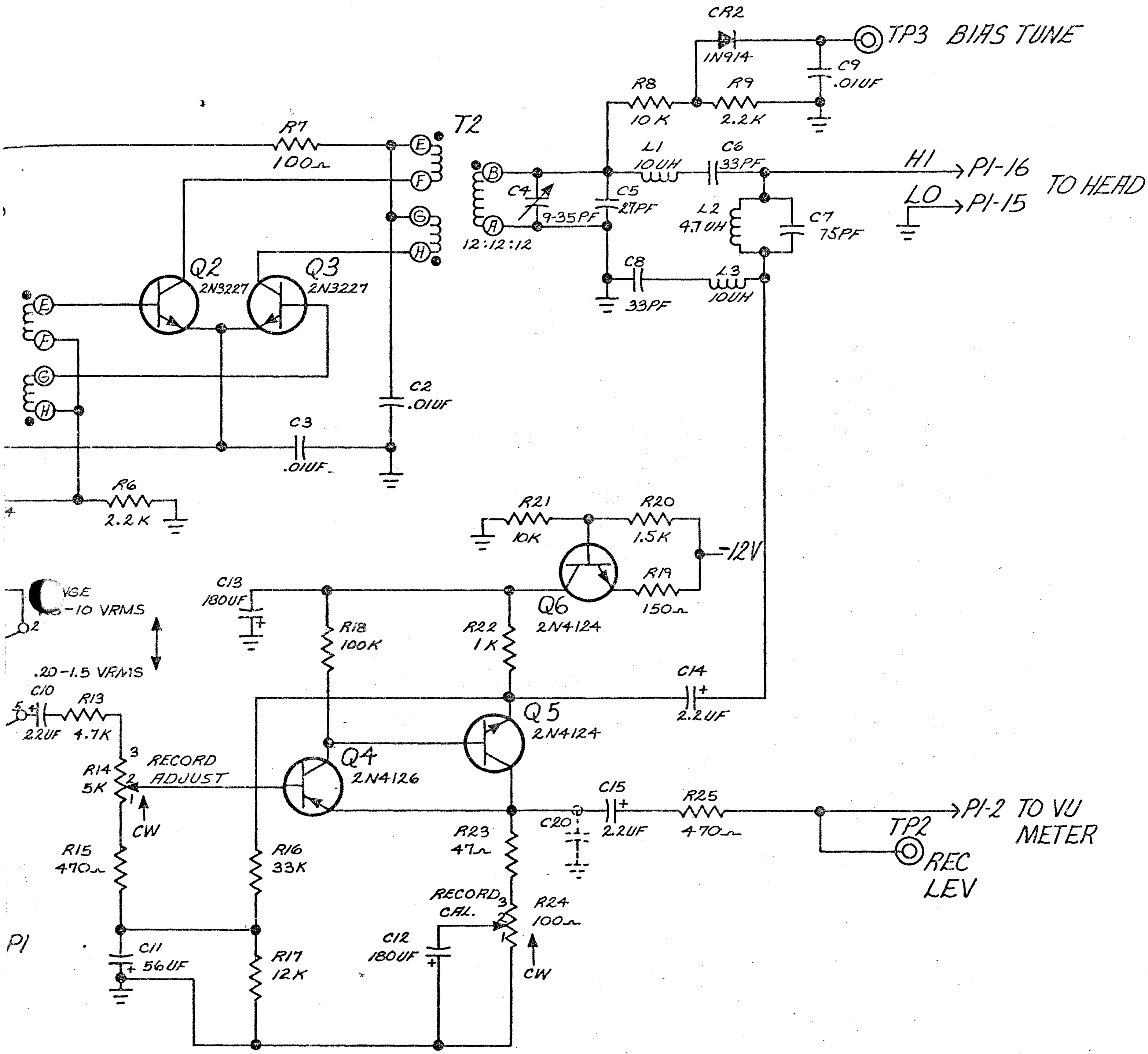


Figure 3. Direct Record Board, Schematic Diagram

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FM RECORD

GENERAL

This bulletin contains information on the FM record board operating and servicing procedures. The information consists of characteristics, operating data, theory of operation, maintenance, parts list, and diagrams.

The FM record board is utilized to frequency modulate the carrier frequency with the input data signal, amplify it, and apply it to the tape record head. The carrier frequency is automatically selected by the TAPE SPEED SELECTOR, on the Operator's Control Panel, for each individual tape speed.

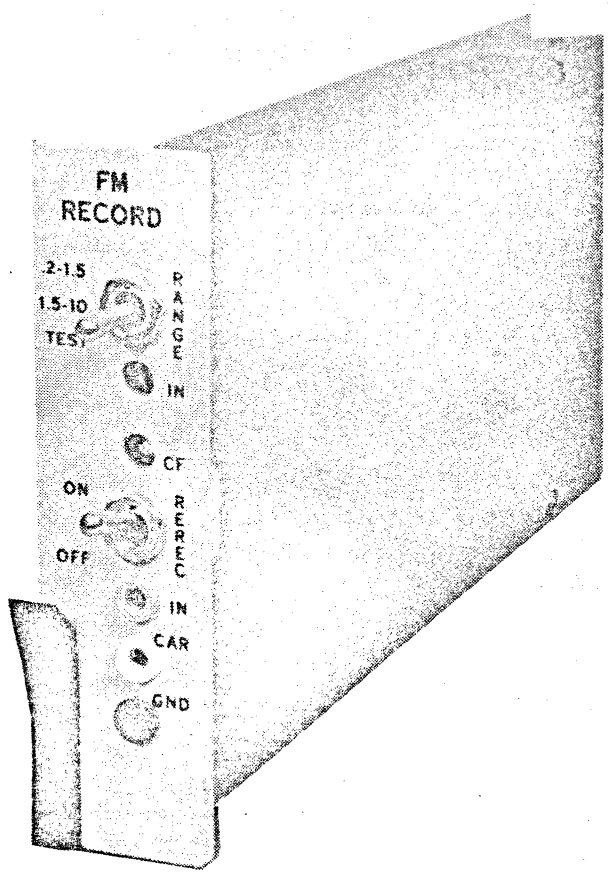


Figure 1. FM Record Board

The FM record boards are located in the record chassis and are easily accessible from the front of the machine.

CHARACTERISTICS

Nominal Input Level	1.0 vrms
Power Requirements	+12 Vdc ± .1 Vdc @ 36 ma
	-12 Vdc ± .1 Vdc @ 33 ma
	+5 Vdc ± .5 Vdc @ 127 ma
Input Signal Attenuation Levels (RANGE switch)	.2 to 1.5 Vrms
	1.5 to 10 Vrms
	TEST (internal grounded input)
Input Impedance	20 K ohm nominal
	(others available)
Re-Record Input Level (pre-modulated signal)	TTL Compatible

TABLE 1. FM FREQUENCY RESPONSE

TAPE SPEED IPS	+ DEVIATION	CENTER FREQUENCY kHz	-DEVIATION	FREQUENCY RANGE kHz
	+40% kHz	IRIG LOW BAND	-40% kHz	
120	151.2	108	64.8	Dc to 20
60	75.6	54	33.4	Dc to 10
30	37.8	27	16.2	Dc to 5
15	18.9	13.5	8.1	Dc to 2.5
7 1/2	9.42	6.75	4.02	Dc to 1.25
3 3/4	4.725	3.375	2.02	Dc to .625
1 7/8	2.35	1.688	1.01	Dc to .312
15/16	1.17	.844	.507	Dc to .156
	+40% kHz	IRIG INTERMEDIATE BAND	-40% kHz	
120	302.4	216	129.6	Dc to 40
60	151.2	108	64.8	Dc to 20
30	75.6	54	33.4	Dc to 10
15	37.8	27	16.2	Dc to 5
7 1/2	18.9	13.5	8.1	Dc to 2.5
3 3/4	9.42	6.75	4.02	Dc to 1.25
1 7/8	4.725	3.375	2.02	Dc to .625
15/16	2.35	1.688	1.01	Dc to .312

TABLE 1. FM FREQUENCY RESPONSE (CONT)				
	+40% kHz	IRIG WIDEBAND GROUP 1	-40% kHz	
120	604.8	432	260.2	Dc to 80
60	302.4	216	125.6	Dc to 40
30	151.2	108	64.8	Dc to 20
15	75.6	54	33.4	Dc to 10
7 1/2	37.8	27	16.2	Dc to 5
3 3/4	18.9	13.5	8.1	Dc to 2.5
1 7/8	9.42	6.75	4.02	Dc to 1.25
	+30% kHz	IRIG WIDEBAND GROUP II	-30% kHz	
120	1170	900	630	Dc to 500
60	585	450	315	Dc to 250
30	292.5	225	157.5	Dc to 125
15	146.25	112.5	78.75	Dc to 62.5
7 1/2	73.13	56.25	39.38	Dc to 31.25
3 3/4	36.56	28.125	19.69	Dc to 15.6
1 7/8	18.29	14.06	9.84	Dc to 7.8

OPERATING DATA

a. **CONTROLS** – The following Table 2 lists those controls and adjustments employed on the FM record board. These controls are vital in respect to optimum performance in FM recording. For complete maintenance and calibration procedures refer to the maintenance section of this bulletin.

TABLE 2. FM RECORD CONTROLS & ADJUSTMENTS	
CONTROLS	LOCATION AND FUNCTION
RANGE switch	Located on the front of the board, it selects the input voltage range levels of 0.2 to 1.5 Vrms, 1.5 to 10 Vrms and TEST (grounded internal input)
IN adj control	Located on the front of the board, it determines the level of the data signal passing to the first amplification stage and VCO. This allows adjustment of the desired modulation (0 to 40%) over an input range of .2 to 10 Vrms.
BALANCE control	Located on the side of the board, it is used for stabilization adjustment of the carrier frequency independent of the input data signal condition.
CF control	Located on the front of the board, it provides adjustment of the carrier center frequency generated by the VCO (RANGE switch in TEST position).
RECORD CURRENT control	Located on the side of the board, it controls the record current applied to the head.
Re-Record Switch (optional)	Provides selection for type of signal to be recorded (modulated or unmodulated). ON provides capability of recording a modulated carrier signal reproduced from another FM channel. OFF provides capability of recording standard AC or DC signals.

b. STEP-BY-STEP OPERATING PROCEDURES – For proper utilization of the recorder/reproducer in the FM RECORD mode, ensure the presence of the following functions.

NOTE

If tape synchronous speed control is to be used during reproduction of the tapes being recorded, refer to the applicable paragraphs before attempting to record.

Step 1. Tape must be threaded in accordance with the tape threading procedures set forth in earlier portions of this manual.

Step 2. Proper signal electronics (FM record board) must be installed into the track numbers being used.

Step 3. Proper input signal connections must be made in accordance with information found in the Installation Bulletin.

Step 4. Proper adjustment of FM record board must be made including record level, and center frequency.

If any of the following conditions exist, a complete calibration is necessary as detailed in the maintenance section of this bulletin.

(a) Parts affecting frequency are changed.
(b) Magnetic head characteristics sheet is not available.
(c) Heads have been replaced (in which case all tracks required recalibration).

To properly adjust an FM record board it is necessary to ensure the correct center frequency and set the input level to produce the proper % deviation. In the front of the manual is a head characteristics sheet which lists for each channel the input level (Vrms), required to obtain the proper deviation (±40%, ±30%), which was established at the factory. These values may be utilized to correctly adjust the input levels as explained below. When any of the previously listed conditions exist, refer to the maintenance section of this bulletin where the adjustments are made by establishing voltage levels.

1. CENTER FREQUENCY CHECK

Step 1. Connect a frequency counter across CAR, TP3, and GND, TP2. Apply POWER and depress STOP and RECORD.

Step 2. Set the Tape Speed Selector to the highest possible speed, and set the record board RANGE switch to the TEST position.

Step 3. Ensure the frequency counter reads the appropriate center frequency for the particular speed. Refer to Table 1.

Step 4. If the reading in Step 3 is incorrect, adjust CF, R11, until the correct reading is obtained.

Step 5. Check the remaining channels in a similar manner.

2. INPUT LEVEL (using Head Characteristics sheet) – Each FM record board input level is adjusted at the factory for the proper Vrms level to attain the proper % deviation. This Vrms value is listed on the head characteristics sheet in the front of this manual. To obtain the recommended % deviation in recording always ensure this Vrms value is present between IN, TP1, and GND, TP2, on the front of the board. As the anticipated input level to the board changes (originally 1 Vrms, set at the factory) IN, R1 on the front of the board, will require readjustment to ensure the head sheet value at IN, TP1. Readjustment is required only if the deviation recommended is to be used. If this % deviation is not used an under record or over record condition will exist.

The following procedures will assist in adjusting the IN adj control on the FM record board.

Step 1. Connect the signal generator, set at 1 kHz at the highest anticipated voltage, to the proper input BNC connector (Record Connector Panel). Connect an AC VTVM to IN, TP1, and GND, TP2.

NOTE

Ensure the RANGE and RE-RECORD (re-record optional) switches are set properly.

Step 2. Apply POWER, depress STOP and RECORD, and adjust input IN adj, R1, for a Vrms reading corresponding to the value listed on the head characteristics sheet for the FM record board being adjusted. Repeat each of the preceding for each channel as required. This adjustment is required each time the input level is changed, if the recommended deviation is to be attained.

c. FM RE-RECORD (OPTIONAL, KIT PART NO. 836176) – If the optional re-record feature is supplied (re-record switch) and is to be used, the pre-modulated signal must be connected to the BNC connector input of the FM record board. Ensure the RE-RECORD switch, S2, is set to the ON position and the pre-modulated signal is TTL compatible.

THEORY OF OPERATION

When the FM recording process is used, the data signal frequency modulates a carrier frequency and the modulated carrier is recorded on the magnetic tape. The modulated carrier is recorded in much the same way as the direct record process, in that it produces a changing magnetic flux across the gap in the record head and magnetizes the magnetic tape as it moves across the head. A zero input signal will result in the basic carrier being recorded. A positive dc signal will increase the carrier frequency and a negative dc signal will lower the carrier frequency. An alternating data signal will deviate the carrier alternately on both sides of the carrier frequency, at a rate equal to the input signal frequency, see Figure 3.

The input data signal from the Record Connector Panel enters the board through P1-3 (hi) and P1-5 (lo). The signal then passes through an attenuation network, R1, R2, and S1, which provides the proper voltage level to produce the desired % deviation from the carrier frequency.

From the input attenuation network the signal passes to the VCO (voltage controlled oscillator), consisting of Q1 thru Q8 and associated components. Q1 and Q4, emitter followers, are used as current drivers for the next stage, Q2 and Q3. Q2 and Q3 are utilized as current sources for the multivibrator, composed of Q5 and Q6. Q7 functions as an output emitter follower for summing the outputs of the multivibrator. By summing these outputs (collectors of Q5 and Q6) the frequency at the collector of Q7 is doubled.

The frequency of the multivibrator is dependent upon the following three factors; the value of capacitors C1 and C2, the voltage on the bases of Q5 and Q6 and the current through Q2 and Q3. The calculated frequency of the multivibrator or VCO is expressed as $F=I/2CV$. I is the current through Q2 and Q3, C is the value of C1 and C2, and V is the voltage swing on the bases of Q5 and Q6. V for practical purposes is always near 5 volts, with the value of capacitors C1 and C2 selectable depending on the particular bandwidth being utilized. Thus the frequency of the multivibrator is dependent upon the current through Q2 and Q3. This current depends on the input signal voltage level. If the input voltage is raised, the voltage on the bases of Q1 and Q4 will rise, thus increasing the voltage at the junction of R5 and R6, and R8 and R10. With an increase in voltage, an increase in current is present through Q2 and Q3. This, in reference to the expression $F=1/2CV$, increases the frequency of the VCO. Consequently with a decrease in input voltage, a decrease in VCO frequency is produced. Thus the frequency of the VCO is directly proportional to the input signal voltage level, producing a frequency modulated signal.

With the input grounded the current through Q2 and Q3 is determined by the setting of CF adjust, R11. This potentiometer controls the voltage on the bases of Q2 and Q3, thus controlling the frequency of the VCO with a grounded input or no input signal. Balance adjust R36, is provided for compensation of the error voltages, present at the input, due to the base currents of Q1 and Q4.

Q11, connected to the emitter of Q4, is utilized to drive an external monitor circuit, used to monitor the conditioned input signal.

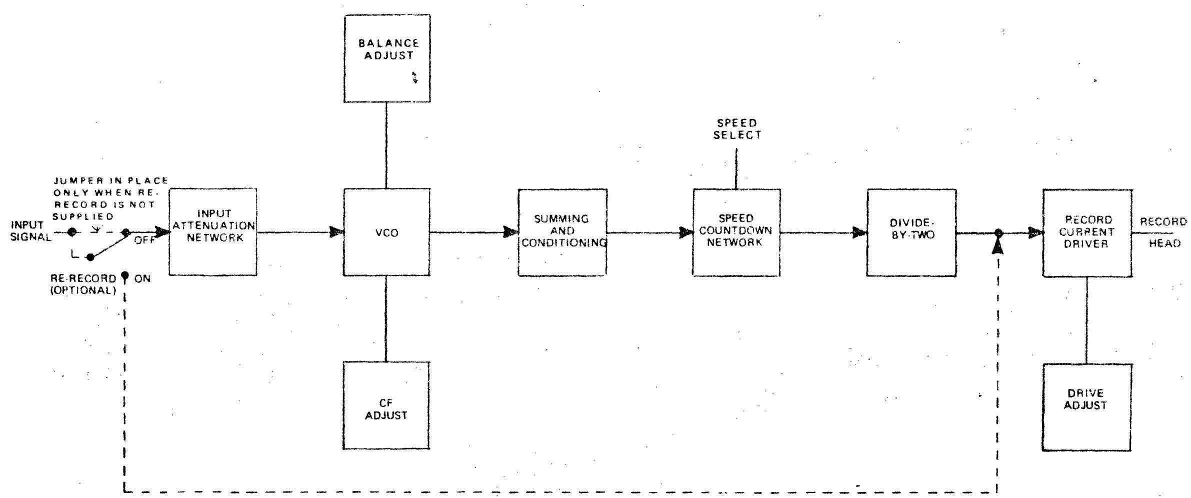


Figure 2. FM Record Board Block Diagram

The frequency modulated output of the VCO is counted down and conditioned by Q8, A1, and A2, prior to be applied to the current driver output stage and record head. Q8 is utilized to condition the frequency modulated signal to the proper logic levels for acceptance by A1, at pin 9. A1, a rate multiplier, functions by dividing the VCO frequency by 1, 2, 4, 8, 16, 32, or 64, dependent on the tape speed selected through board pins 18, 22, 20, 14, 10, 8, or 6. The speed lines connected to the speed select switch are all grounded except the line corresponding to the particular speed the Tape Speed Select is set at. This line has approximately 5 Vdc applied to it which activates the proper countdown sequence of A1. The divided output of A1, at pin 5, is applied to A2, pin 12, to be divided by 2. This ensures symmetry of the carrier frequency. The output of A2, at pin 8, is applied to the current driver circuit, through drive control, R20.

The current driver circuit consists of Q12, Q9, Q10, and associated circuitry. Emitter follower, Q12, functions as an isolation coupling to push-pull amplifier Q9 and Q10. Drive control, R20, controls the signal level applied to the driver circuit, thus the signal (current) level to the record head.

±6.2 Vdc, required by the VCO, are supplied by CR3, CR4, and associated circuitry. Due to the large time constant provided by R32 and C10, the application of the +6.2 Vdc is delayed. This ensures the proper start-up of the VCO.

The optional Re-Record feature, when supplied, consists of S2 and Q13. This feature provides the capability of recording a pre-modulated signal, by bypassing the VCO and countdown circuits. Q13 is utilized to condition the input signal, from P1-3 and S2 (ON position), providing compatable logic levels to A2.

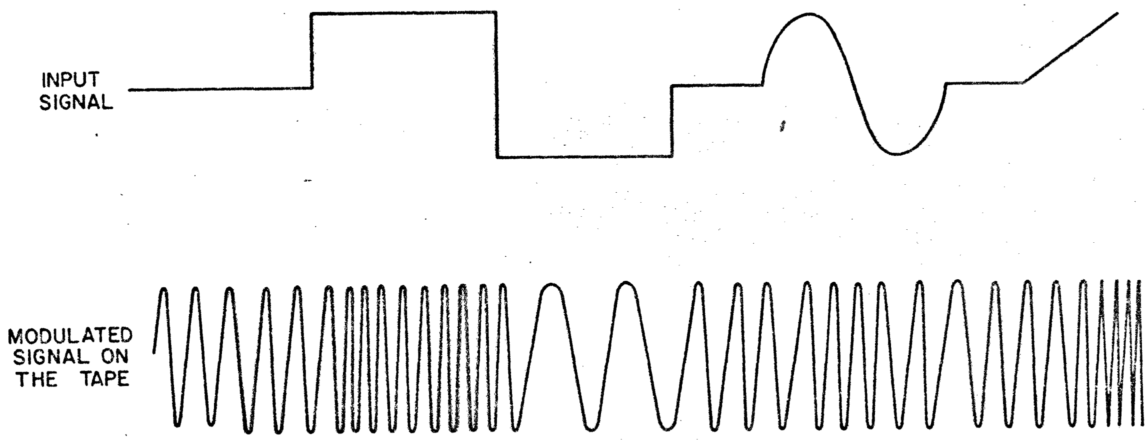


Figure 3. FM Carrier Deviation

MAINTENANCE

If the need for maintenance arises due to a malfunction on the board, the following procedures will assist in locating the malfunction. Failure to attain a certain indication or condition is a clue to a particular problem.

All adjustments contained herein pertain to normal machine operation. Although these adjustments are performed at the factory, the need for their readjustment or recalibration may be evident to ensure optimum machine performance.

a. EQUIPMENT REQUIRED

HP 400E VTVM or equivalent
General Radio 1130-A Frequency Counter or equivalent
Tektronix 53S Oscilloscope or equivalent
HP 200 CD Signal Generator or equivalent
Simpson 260 VOM or equivalent

b. TEST AND VCO CALIBRATION

Step 1. With the FM record board removed from the recorder/reproducer and its shield removed, visually inspect it for loose connections or mountings, dented, misshaped or broken components, foreign material or signs of overheating.

Step 2. Place the board on its extender, in the proper record chassis position, apply POWER, and depress STOP and RECORD.

Step 3. Ensure the presence of the following dc voltages between the indicated points.

HI	LO	DC VOLTAGE
TP4	TP2	+6.2 Vdc
TP2	TP5	-6.2 Vdc

Step 4. Set the Tape Speed Selector to the highest possible speed, set the record board RANGE switch to TEST, apply POWER, and depress STOP and RECORD.

Step 5. Connect a frequency counter between GND, TP2, and CAR, TP3, and ensure the presence of the correct carrier frequency. Refer to Table 1. Switch through the speeds ensuring the frequencies per Table 1.

Step 6. If the frequency in Step 5 is incorrect, adjust CF, R11, until the correct reading is obtained.

Step 7. Place the RANGE switch in a position other than TEST and ensure the frequency does not change. If the frequency does change, adjust BALANCE adjust, R36, until the correct ency frequency is obtained.

Step 8. Place the RANGE switch back into TEST position and ensure the presence of the correct frequency. If necessary, readjust CF adjust, R11, and balance adjust, R6, until the frequency remains constant with the RANGE switch placed in TEST and out of TEST.

c. FM DEVIATION CALIBRATION – The following procedures assist in setting the % deviation, from the carrier frequency for the FM record board. ±40% for Intermediate band and Wideband Group 1, and ±30% for Wideband Group II are the values utilized in the factory calibration with a 1 vrms input. Different input levels will produce a different % deviation unless adjustment of IN adjust, R1, is made.

Step 1. If the FM reproduce board is not correctly calibrated refer to the reproduce bulletin for calibration after the record board is calibrated according to the following:

a. Connect the frequency counter between CAR, TP3, and GND, TP2.

b. Apply ±1.414 Vdc* to the proper input BNC connector (Record Connector Panel). Ensure the RANGE switch is placed in the .2 to 1.5 V position. Apply POWER and depress STOP and RECORD.

*Either +1.414 Vdc or -1.414 Vdc may be used. With -1.414 Vdc ensure -% deviation and +1.414 Vdc +% deviation.

c. Adjust R1 for a ±40% (30% for Wideband Group II) deviation reading from the carrier frequency, on the frequency counter. Refer to Table 1.

d. Repeat each of the preceding for each channel as required.

d. **RECORD CURRENT CALIBRATION** -- The drive adjust, R20, has been set at the factory for optimum signal to noise ratio. However, due to head changes, headwear, board replacement and other factors, readjustment may be necessary to ensure optimum efficiency in FM recording. The following steps will assist in correctly adjusting drive adjust, R20.

Step 1. Clean and demagnetize the record and reproduce heads.

Step 2. Ensure tape is threaded properly.

Step 3. Place the RANGE switch in the TEST position, apply POWER and depress STOP, RECORD, and FORWARD. Ensure the use of a properly calibrated FM reproduce board in the associated channel position.

Step 4. Monitor the channel BNC output (or FM reproduce board output testpoint, if applicable) with an oscilloscope and adjust record board drive adjust, R20, for minimum noise.

Step 5. Remove POWER and test equipment and continue in similar manner for all channels as desired.

TABLE 3. FM RECORD BOARD CONFIGURATION AND PART DIFFERENCES

BOARD PART NO.	CARRIER FREQUENCY	C1 and C2	CAPACITOR PART NO.
836161-001	basic board		
-002	900 kHz	32 μμfd	835341-023
-003	432 kHz	62 μμfd	835341-024
-004	216 kHz	120 μμfd	835341-025
-005	108 kHz	250 μμfd	835341-026

PARTS LIST

FM RECORD BOARD 836161

A1	859520-053	C10	691391-018	Q1	859971
A2	859520-018	C11	691391-062	thru	
C1	See Chart	C12	859959-001	Q4	
C2	See Chart	C13	859775-017	Q5	510360
C3	859775-017	C14	859775-017	thru	
thru		C15	691686-024	Q8	
C5		C16	691686-024	Q9	854540
C6	691391-057	C17	854528-036	Q10	854539
C7	859959-001	CR1	844510	Q11	859970
C8	691391-062	CR2	844510	Q12	854539
C9	859959-001	CR3	853531	Q13	510360
		CR4	853531		
		L1	853587-029		
		P1	853518		

PARTS LIST

FM RECORD BOARD 836161 (Cont'd)

R1	510349-011	R17	198200-153	R33	198200-471
R2	853530-342	R18	198200-681	R34	691111-271
R3	198200-102	R19	198200-472	R35	510313-419
R4	853530-164	R20	329151-008	R36	329151-010
R5	853530-147	R21	691111-271	R37	198200-471
R6	853530-147	R22	198200-153	R38	198200-391
R7	853530-236	R23	198200-102	R39	198200-151
R8	853530-147	R24	198200-100	R40	198200-100
R9	853530-236	R25	198200-153	S1	855432-006
R10	853530-147	R26	198200-102	TP1	855812-002
R11	510164-007	R27	198200-100	TP2	855812-010
R12	853530-176	R28	198200-102	TP3	855812-004
R13	853530-176	R29	198200-153	TP4	691032
R14	198200-332	R30	198200-181	thru	
R15	198200-222	R31	198200-471	TP6	
R16	198200-221	R32	198200-101	TP8	691032

FM RE-RECORD KIT 836176

S1	855432-001

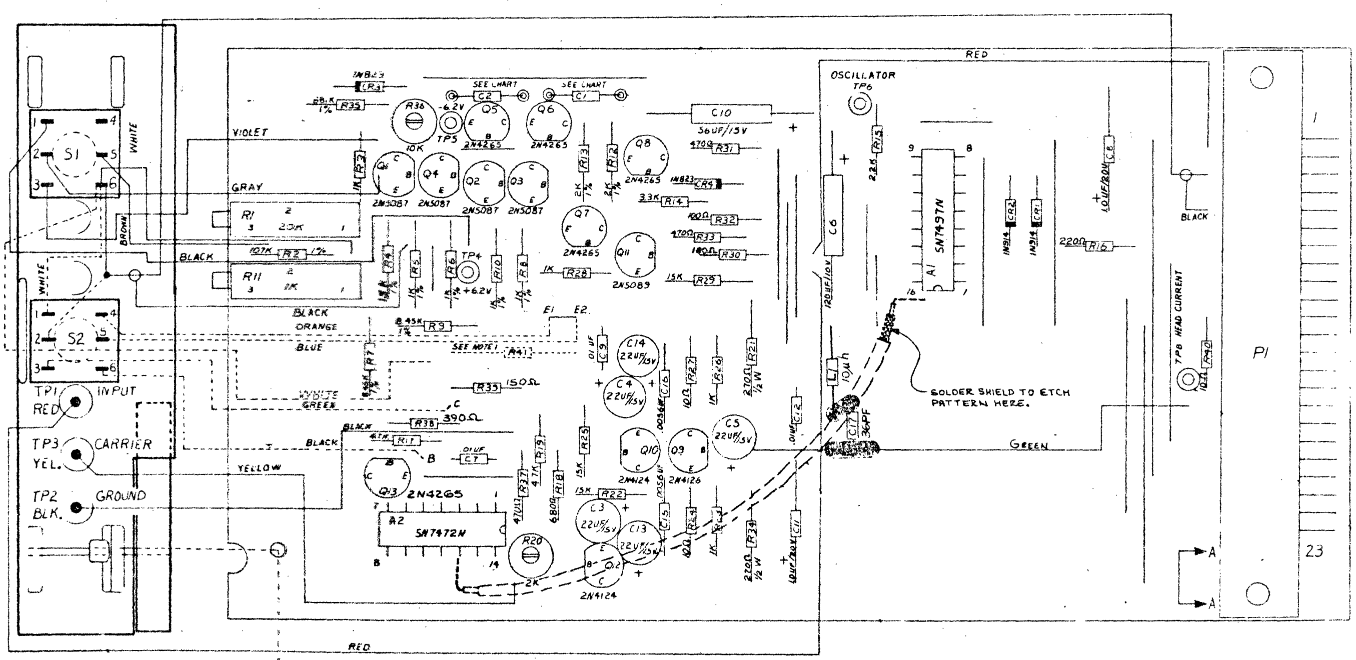
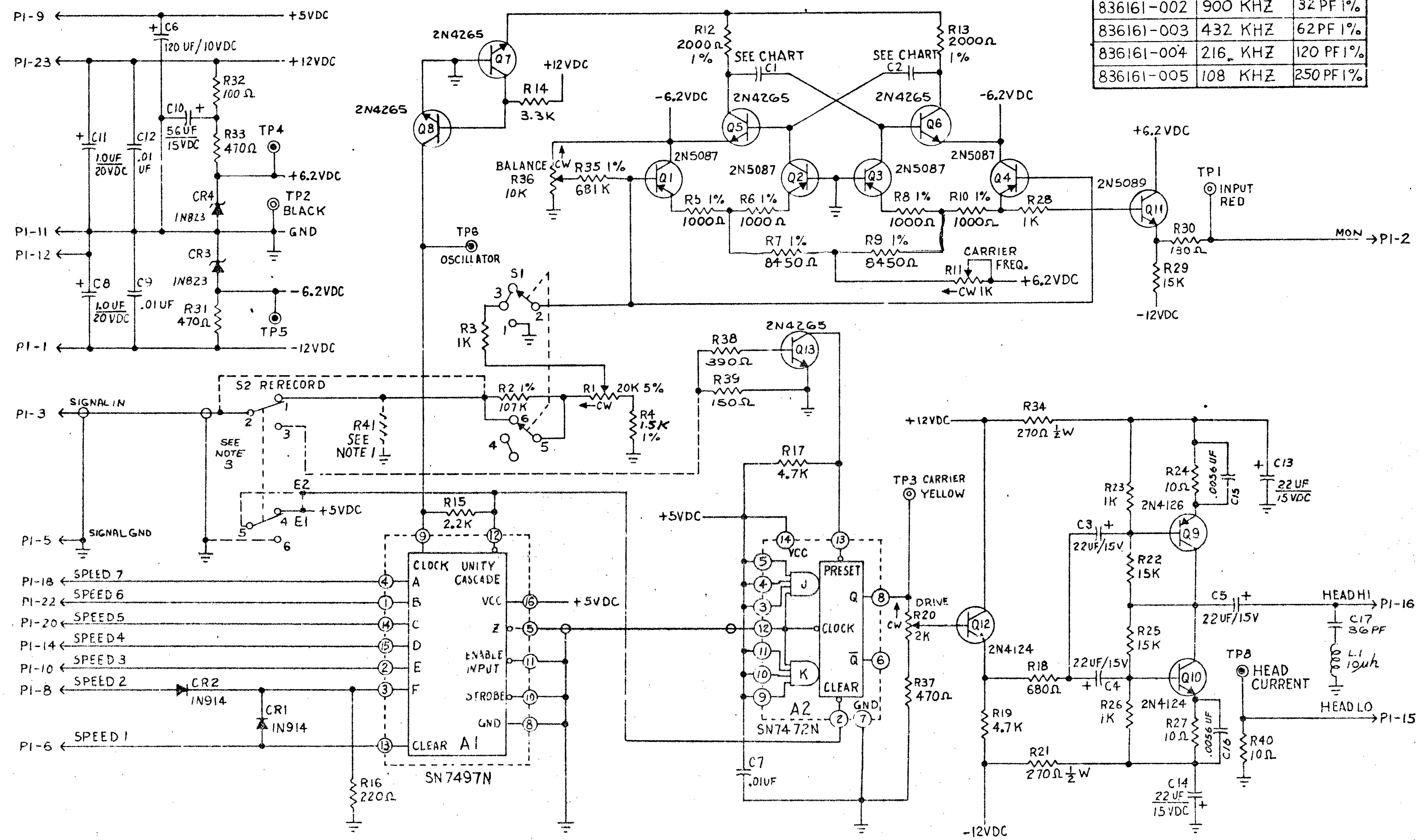


Figure 4. FM Record Board Component Location

TIMING CAPACITOR CHART		
BOARD PART NO.	CF	C1 & C2
836161-001	BASIC BOARD	NOT USED
836161-002	900 KHZ	32 PF 1%
836161-003	432 KHZ	62 PF 1%
836161-004	216 KHZ	120 PF 1%
836161-005	108 KHZ	250 PF 1%



NOTES:

1. Optional input impedance.

Figure 5. FM Record Board Schematic Diagram

BULLETIN NO. 3613-1

Sangamo

BIAS OSCILLATOR BOARD

GENERAL

This bulletin contains complete information on the bias operating and servicing procedures.

The bias board generates an 8.4 mHz signal which is linearly mixed with the analog data signals (also voice signals) on the direct record board. The bias board becomes powered (and begins generating a bias signal) when recording signal data and/or voice data. Under normal conditions the board is located in the record chassis and is easily accessible from the front of the main transport.

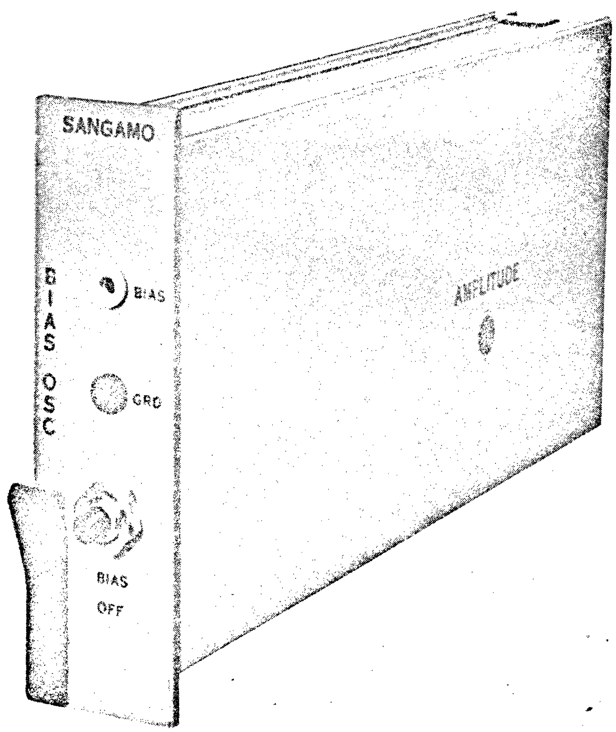


Figure 1. Bias Oscillator Board

CHARACTERISTICS

Output Level	1 V p-p nominal. Across 100 ohm load.
Output Frequency	8.4 MHz
Power Requirement	+12 Vdc $\pm$.5 vdc @ 25 ma
Temperature Range	0^{o}F. to 130^{o}F.

OPERATING DATA

To properly utilize the bias oscillator board, ensure it is properly placed in the record chassis. All interconnections are made possible by the record chassis printed circuit board etch.

Refer to the maintenance section of this bulletin for adjustments.

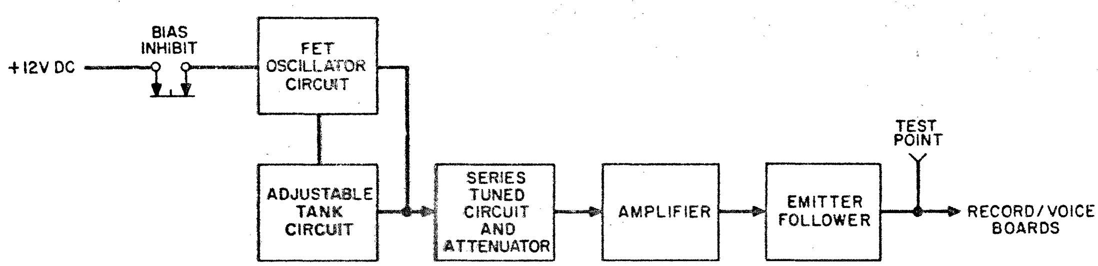


Figure 2. Bias Oscillator Block Diagram

THEORY OF OPERATION

Power is supplied to the board by either P1-23 (direct recording) or P1-18 (voice recording). When a voltage is applied to field effect transistor (FET) Q1 it triggers. A positive feedback is incorporated through C3 and C4, similar to a colpitts oscillator, and fed to tank circuit L1 and C1. L1 provides adjustment for the oscillator frequency which has a range of 8 MHz to 8.8 MHz with 8.4 MHz as its center frequency. With L1 adjusted for resonance at 8.4 MHz, this tank circuit becomes a high impedance circuit forcing the signal to enter the gate terminal of the FET. With this resonant frequency signal applied to the gate of Q1, the oscillations will occur at this resonant frequency and continue so long as power is applied. This oscillator signal passes through C5 and L4 a series tuned circuit for 8.4 MHz and through R8 amplitude control. Q2 amplifies the bias signal and passes it to emitter follower Q3. The output signal is supplied through P1-21 (hi) and P1-19 (lo). TP1 and TP2 are provided for monitoring the signal without removal of the board from the chassis. Switch S1 (BIAS INHIBIT) is provided to disable the output.

Board part number 835844 contains additional amplifier stages, consisting of Q4 through Q7.

MAINTENANCE

When maintenance becomes necessary in the event of the board malfunctioning, the following procedures will assist in locating the trouble. Failure to attain a particular check is a clue to a certain malfunction. This section makes no attempt to be exhaustive as a troubleshooting guide.

a. EQUIPMENT REQUIRED

Tektronix 531 Oscilloscope
General Radio 1130-A Frequency Meter or equivalent

b. BIAS BOARD CHECKOUT

Step 1. Mount the bias oscillator board on its extender board, in the record chassis.

Step 2. Connect scope hi lead (Hi Z probe) and frequency meter hi lead (Hi Z probe) to BIAS, TP1, and their lo's to GRD, TP2.

Step 3. Apply power and while monitoring the frequency on the frequency meter, adjust L1 (side of board) for 8.4 MHz±10 kHz.

Step 4. With the output signal monitored on the oscilloscope, adjust R8, AMPLITUDE, for a 1 V p-p output with no distortion.

Step 5. Ensure the output dc level is 0Vdc±0.1Vdc.

Step 6. Depress BIAS OFF switch S1. Signal should disappear during this operation.

PARTS LIST
BIAS BOARD 855809

R1	896615	C3	896475
R3	896466	C4	899171
R4	896468	C5	854528 018
R5	896608	C6 to C8	691686-001
R6	691111-331	L1	855811-001
R7	896607	L2, L3	850858
R8	845443	L4	853587-005
R9	898315	CR1, CR2	844510
R10	896602	Q1	855810
C1	195701-050	Q2, Q3	510076
C2	844981	S1	867638

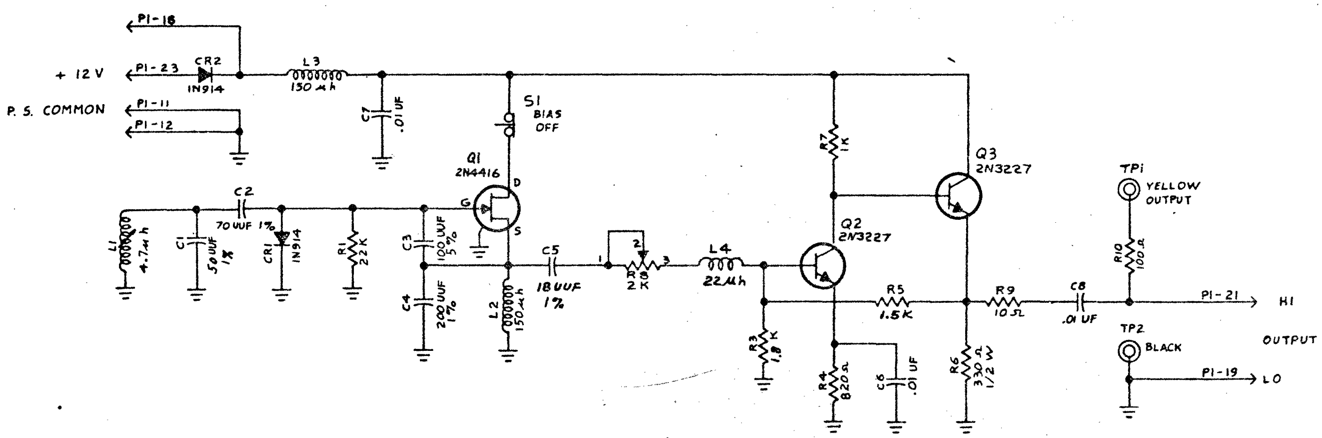


Figure 3. Bias Oscillator Board Schematic Diagram (part no. 855809)

PARTS LIST
BIAS BOARD 835844

R1	198200-223	C2	844981
R2	844013	C3	854528-100
R3	198200-182	C4	899171
R4	198200-821	C5	854528-018
R5	853530-164	C6 to C8	691686-001
R6	198200-152	L1	855811-001
R7	198200-152	L2, L3	850858
R8	845443	L4	853587-005
R9	896601	CR1, CR2	844510
R10	198200-101	Q1	855810
R11	691111-330	Q2, Q3	854539
R12	691111-330	Q4	854540
R13	844013	Q5, Q6	854539
C1	854528-050	Q7	854540
		S1	867638

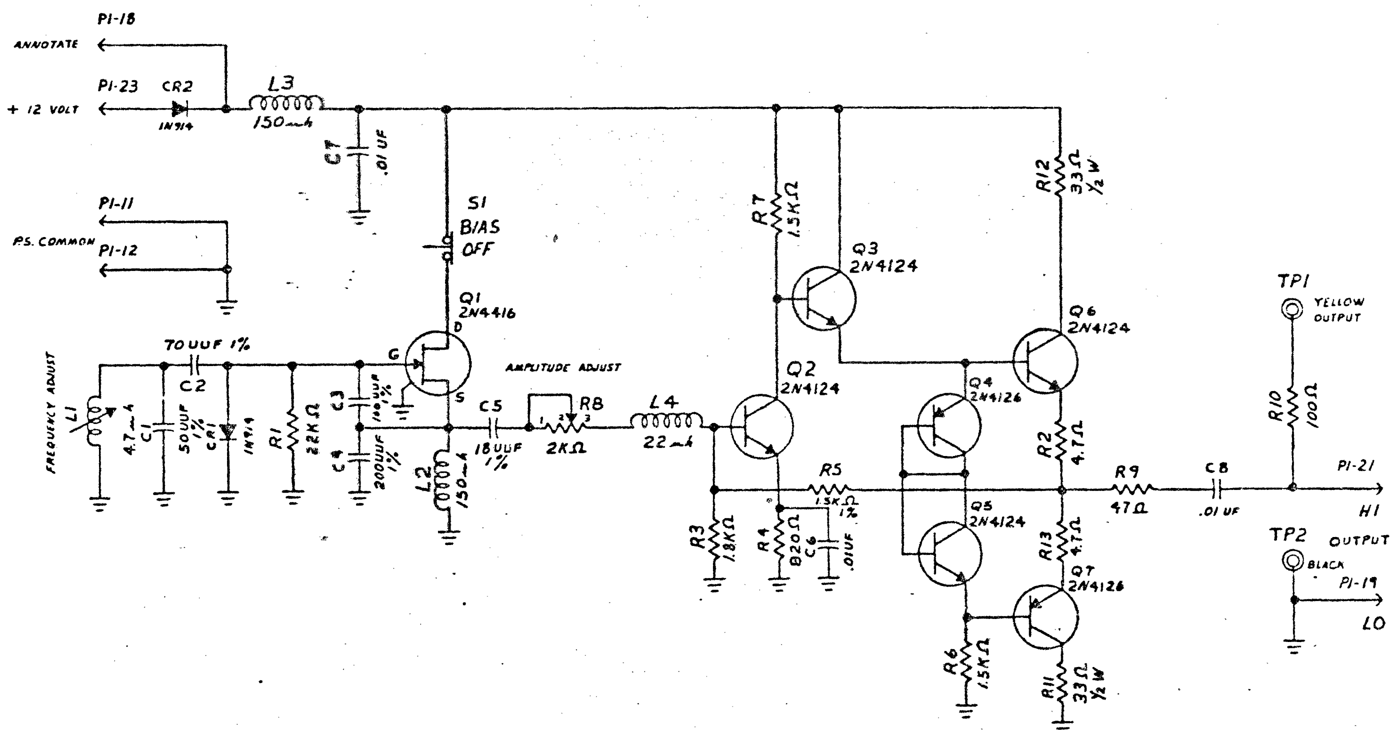


Figure 4. Bias Oscillator Board Schematic Diagram (part no. 835844)

Sangamo

REPRODUCE CHASSIS

GENERAL

This bulletin contains information pertaining to the reproduce chassis employed with this recorder/reproducer. The reproduce chassis (possibly an auxiliary reproduce chassis also) houses all the reproduce electronics utilized with this recorder/reproducer. Also provisions are normally made for housing of the voice or edge track reproduce board and FM expander board.

An addition feature employed on this chassis is an FM squelch network. The squelch network functions by shorting the FM reproduce signal to ground during that period of time the recorder/reproducer is not through operating and at its proper speed (stop, fast, etc.). This is accomplished by a logia 0 (ground, present during STOP, FAST, or any time tape speed is not correct) from J9-20, capstan board, P2-D and J17-D to the pin #7 etch bus. This logic 0 or ground brings all jack pins 7 to ground. This activates circuitry on the FM reproduce board causing the reproduced signal to be shorted to ground. When the recorder/reproducer is operating at its proper speed, sync lock (sync lamp lit), a logic 1 is present allowing the reproduced signal to pass uninterrupted.

A printed circuit board, with jacks mounted, provide the appropriate wiring for each reproduce board. The output signal connections are provided by BNC connectors on the reproduce connector panel.

OPERATING DATA

a. **CONTROLS** – No effective controls are located on this chassis.

b. **BOARD PLACEMENT** – Standard board arrangement should conform to figure 1 or figure 2.

MAINTENANCE

a. **GENERAL** – Standard procedures for maintenance and troubleshooting of the chassis and associated components should prove to be sufficient.

b. **SQUELCH** – To ensure proper operation of the squelch circuitry, the speed control system must be adjusted properly according to the checks and adjustments in the operator's data bulletin. Particular emphasis is placed on the phase lock adjustment on the capstan board.

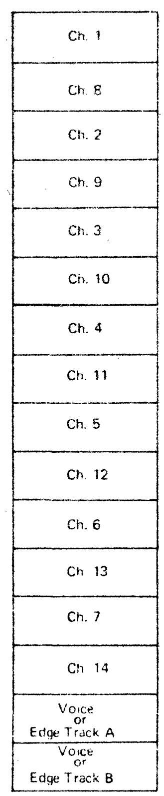


Figure 1. Single Chassis Board Placement Diagram

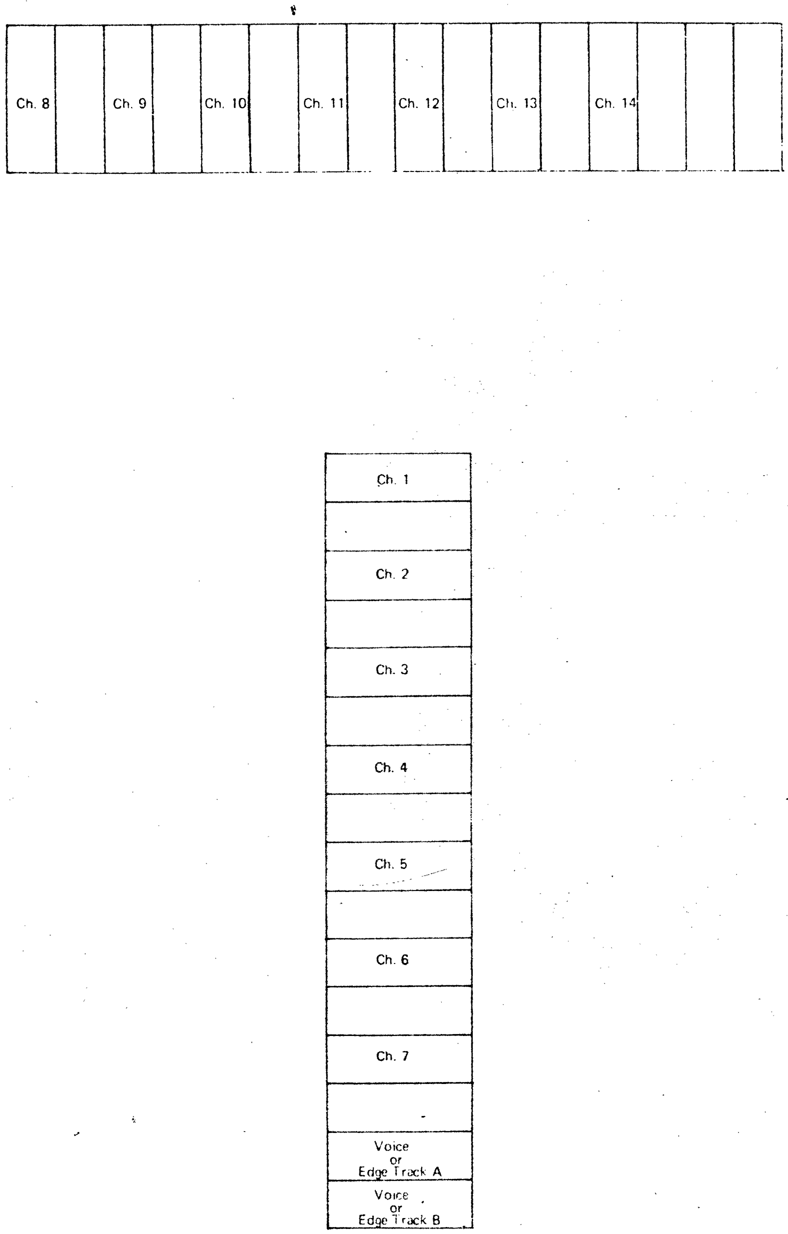


Figure 2. Double Chassis, Board Placement Diagram

PARTS LIST
MAIN REPRODUCE CHASSIS

A20 Main Reproduce Chassis 836529

J1	897633
P1	835966-001
P2	835966-001

A20A17 Reproduce Connector Board 857343

C1 thru C7	899258
C8 thru C11	851139-007
C12	899258
C13 thru C28	854528-150
C29	851139-007
J1 thru J16	856222
L1 thru L16	853587-030

A16 Reproduce Connector Panel 857077

J1 thru J14	855977
J15	846615
J16	846615
J17	836181-016 (used only with monitor kit, 836068)

AUXILIARY REPRODUCE CHASSIS (OPTIONAL)

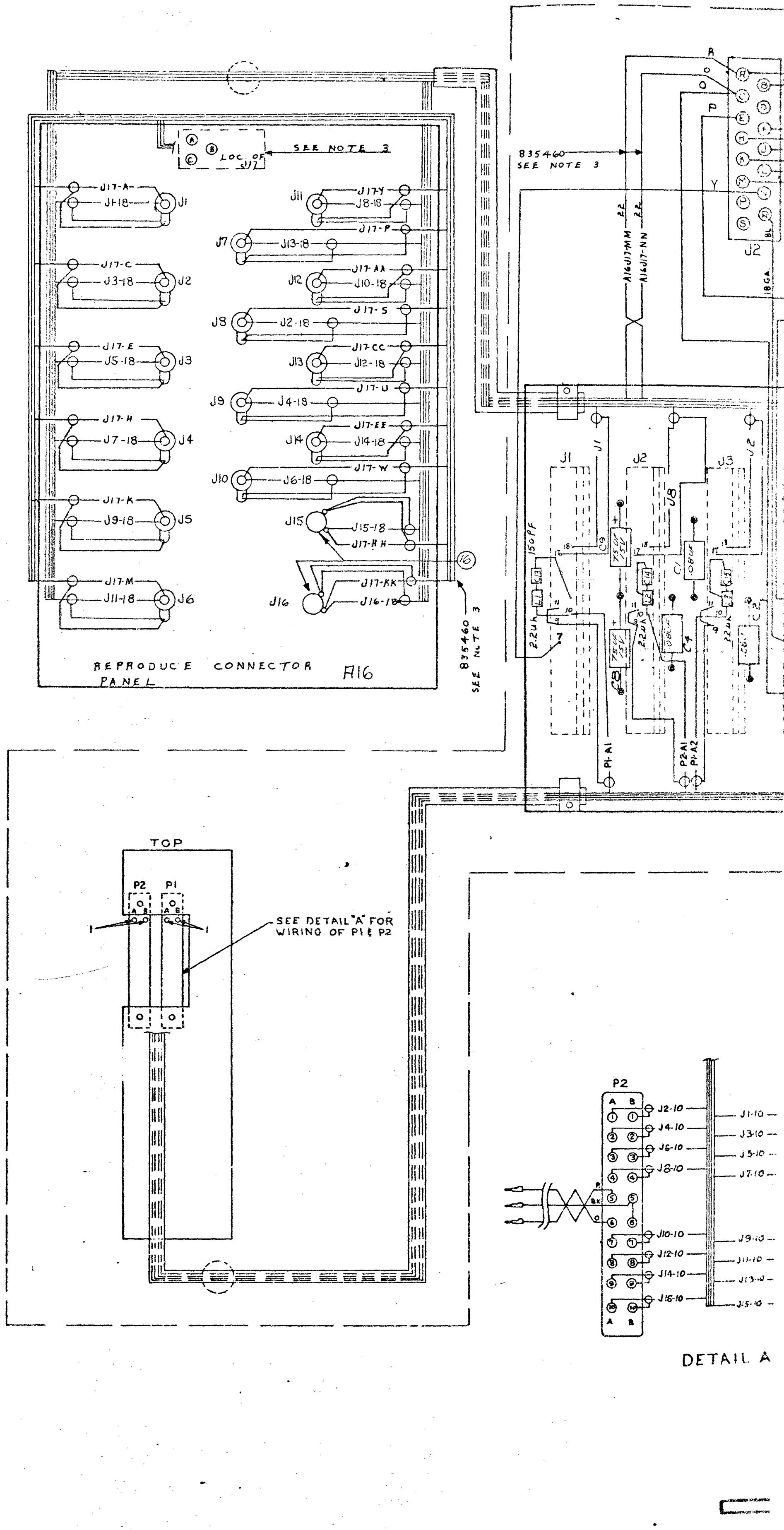
Unit 3 Auxiliary Reproduce Chassis 836530

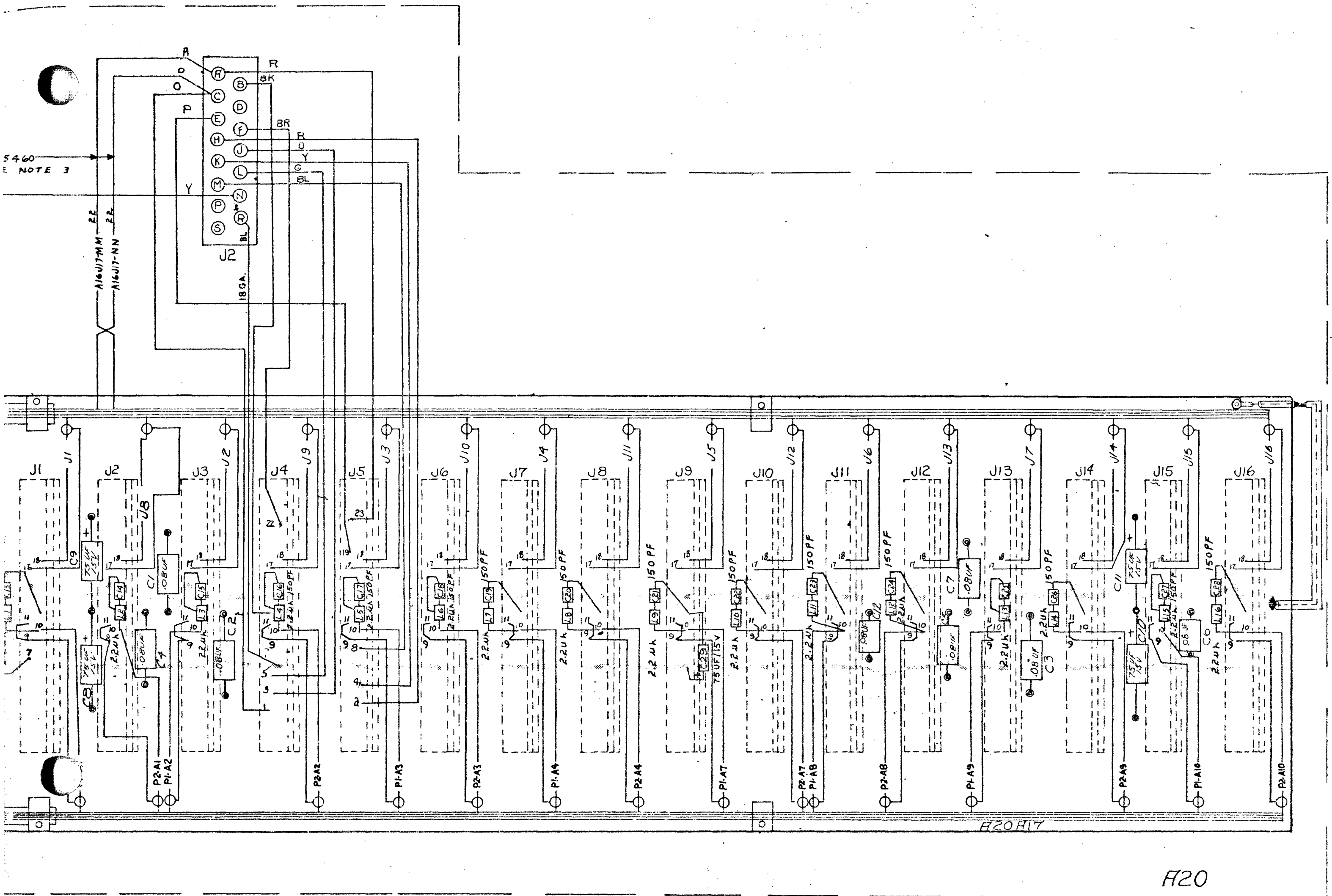
A15 Reproduce Connector Board 857343

C1 thru C7	899258
C8 thru C11	851139-007
C12	899258
C29	851139-007
J1 thru J16	856222

A16 Auxiliary Reproduce Connector Panel 836184

J1 thru J16	855977
J17	836181-007
J18	836181-016 (used only with monitor kit, 836069)


SEE NOTE 3
LOC. OF J17
835460
SEE NOTE 3
REPRODUCE CONNECTOR PANEL
A16
835460
SEE NOTE 3
J2
TOP
P2
P1
SEE DETAIL "A" FOR WIRING OF P1 & P2
P2
DETAIL A



NOTE:

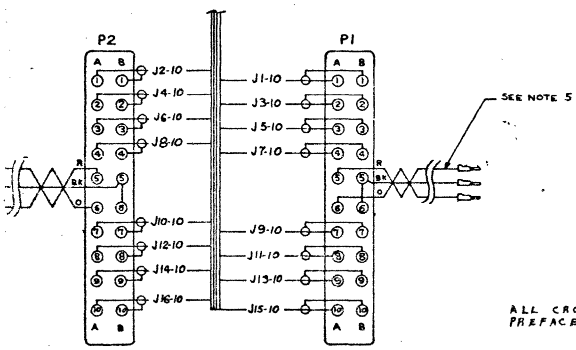
1.

2.

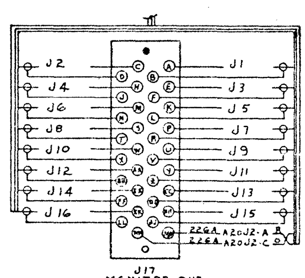
3. J17 IS PART OF SPECIAL KIT 835460 USED ONLY IF CALLED FOR ON SPEC. SHEET. COVER HOLE IN PANEL WITH COVER PLATE 835458 WHEN KIT IS NOT USED. ALL COAX IN KIT IS RG-196/U SPEC. 2350.

4.

5. WIRES CONNECT TO 835910 PREAMP REGULATOR WHEN CHASSIS IS ASSEMBLED TO TRANSPORT. RED WIRES CONNECT TO J3 OR J4; BLACK TO J7 OR J8; ORANGE TO J11 OR J12.



DETAIL A

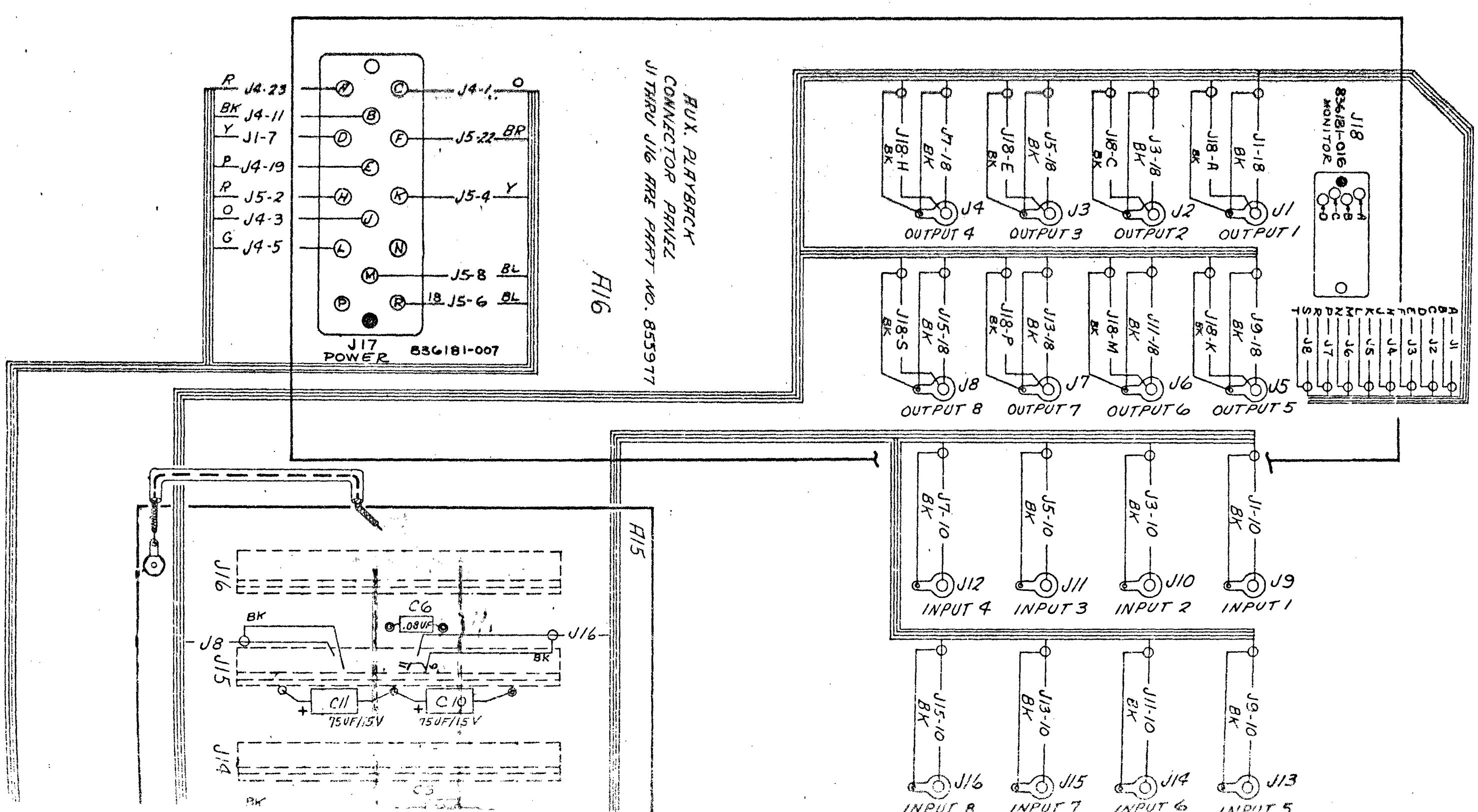


J17
MONITOR OUT
836181-016

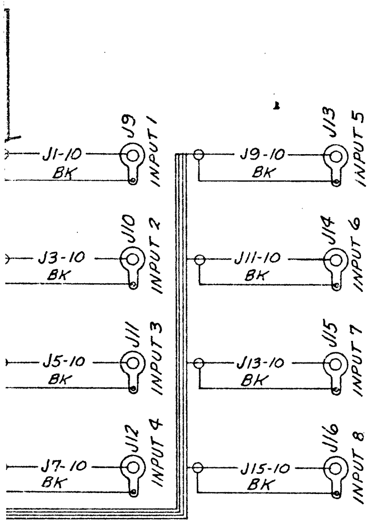
ALL CROSS REFERENCES ON J17 SHOULD BE PREFACED WITH A16, EXCEPT PINS MM + NN.

Main Reproduce Chassis Wiring Diagram

836529-0 TTL



AUX. PLAYBACK CONNECTOR PANEL
J1 THRU J16 ARE PART NO. 855977
A16
J17
POWER
836181-007
J4-23
J4-11
J1-7
J4-19
J5-2
J4-3
J4-5
J4-1
J5-22
J5-4
J5-8
J5-6
J18
836181-016
MONITOR
OUTPUT 4
OUTPUT 3
OUTPUT 2
OUTPUT 1
OUTPUT 8
OUTPUT 7
OUTPUT 6
OUTPUT 5
INPUT 4
INPUT 3
INPUT 2
INPUT 1
J12
J11
J10
J9
J16
J15
J14
J13
A15
C6
.08UF
C11
C10
75UF/15V
J8
J16
J15
J14



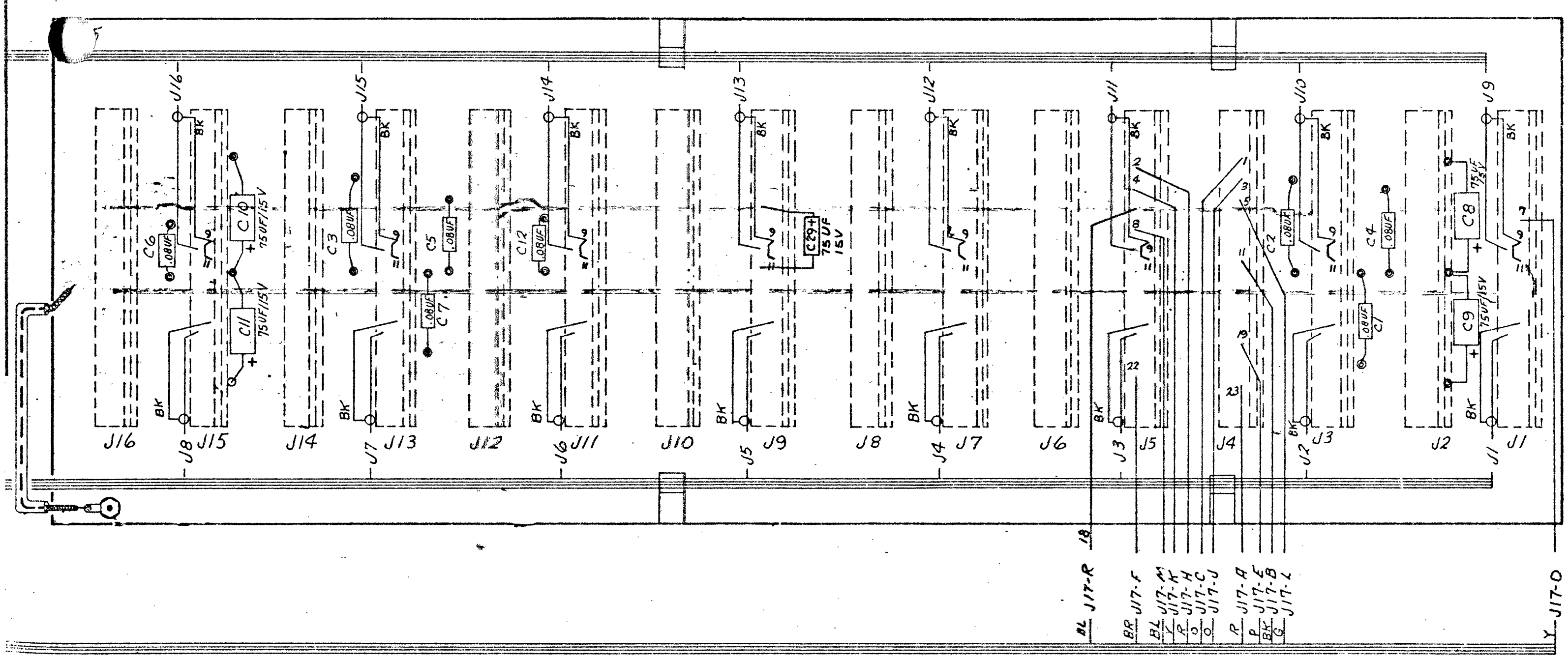
NOTE:

1.

2.

3. J18 AND ASSOCIATED WIRING IS PART OF KIT 836069

4.



Auxiliary Reproduce Chassis Wiring Diagram

836530-0 TTL

Sangamo

FM REPRODUCE

GENERAL

The Frequency Modulation (FM) reproduce board is used for reproducing frequency modulated data previously recorded on magnetic tape. The board, located in the reproduce chassis and possibly the auxiliary reproduce chassis (one board per FM channel), accepts the recovered FM data from the reproduce head and tape, via the preamplifiers, and equalizes, demodulates, filters and amplifies this data for application to the board output and customer's equipment. Information contained in the bulletin consists of general, characteristics, operating data, theory of operation, maintenance, parts list, and diagrams.

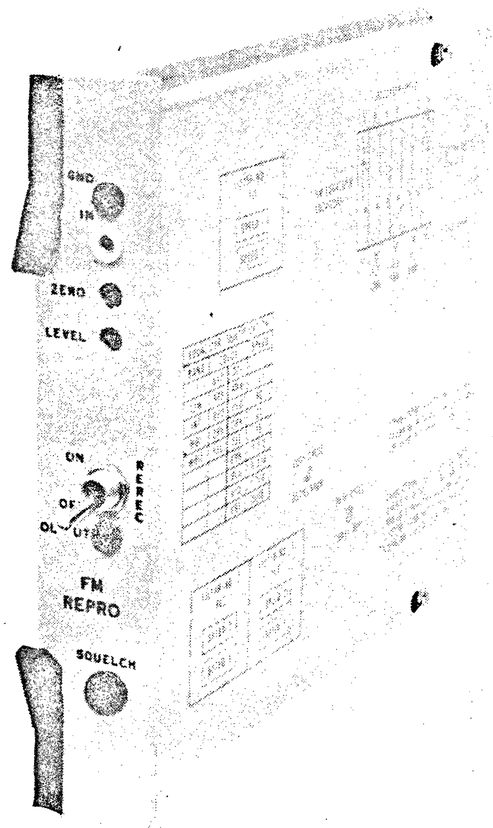


Figure 1. FM Reproduce Board

Variations incorporated on this board consist of four bandwidth possibilities, operation at any three tape speeds out of a possible seven, and an optional FM Re-Record feature. These variations are described in the following paragraphs.

TABLE 1. FM FREQUENCY RESPONSE

TAPE SPEED IPS	+ DEVIATION	CENTER FREQUENCY kHz	- DEVIATION	FREQUENCY RANGE kHz
	+40% kHz	IRIG LOW BAND	-40% kHz	
120	151.2	108	64.8	Dc to 20
60	75.6	54	33.4	Dc to 10
30	37.8	27	16.2	Dc to 5
15	18.9	13.5	8.1	Dc to 2.5
7 1/2	9.42	6.75	4.02	Dc to 1.25
3 3/4	4.725	3.375	2.02	Dc to .625
1 7/8	2.35	1.688	1.01	Dc to .312
15/16	1.17	.844	.507	Dc to .156
	+40% kHz	IRIG INTERMEDIATE BAND	-40% kHz	
120	302.4	216	129.6	Dc to 40
60	151.2	108	64.8	Dc to 20
30	75.6	54	33.4	Dc to 10
15	37.8	27	16.2	Dc to 5
7 1/2	18.9	13.5	8.1	Dc to 2.5
3 3/4	9.42	6.75	4.02	Dc to 1.25
1 7/8	4.725	3.375	2.02	Dc to .625
15/16	2.35	1.688	1.01	Dc to .312
	+40% kHz	IRIG WIDEBAND GROUP I	-40% kHz	
120	604.8	432	260.2	Dc to 80
60	302.4	216	125.6	Dc to 40
30	151.2	108	64.8	Dc to 20
15	75.6	54	33.4	Dc to 10
7 1/2	37.8	27	16.2	Dc to 5
3 3/4	18.9	13.5	8.1	Dc to 2.5
1 7/8	9.42	6.75	4.02	Dc to 1.25
	+30% kHz	IRIG WIDEBAND GROUP II	-30% kHz	
120	1170	900	630	Dc to 500
60	585	450	315	Dc to 250
30	292.5	225	157.5	Dc to 125
15	146.25	112.5	78.75	Dc to 62.5
7 1/2	73.13	56.25	39.38	Dc to 31.25
3 3/4	36.56	28.125	19.69	Dc to 15.6
1 7/8	18.29	14.06	9.84	Dc to 7.8

a. **BANDWIDTHS** - Low, Intermediate, Wideband I, and Wideband II are the four bandwidth selections available. The desired bandwidth is usually determined by the frequency of the signal to be reproduced. Refer to table 1 for correlation of bandwidths to speeds, carrier frequencies, and deviation frequencies.

Bandwidth selection components consist of equalizers, filters, and four circuit components (three capacitors and 1 inductor). Refer to table 3 and figures 2, 4, 5, and 6.

b. **OPERATING SPEEDS** - A speed line matrix and the three speed dependent filter networks govern which three reproduce speeds are accomodated on the FM reproduce board. The optional FM 4-7 Speed Expander board (bulletin 3648-1) is required when all seven reproduce speeds are desired. Refer to figures 2, 5 and 6.

c. **FM RE-RECORD FEATURE - (optional)** - This optional feature provides for routing the modulated signal directly to the board output OR through the demodulating, detecting, and amplifier circuits to the board output.

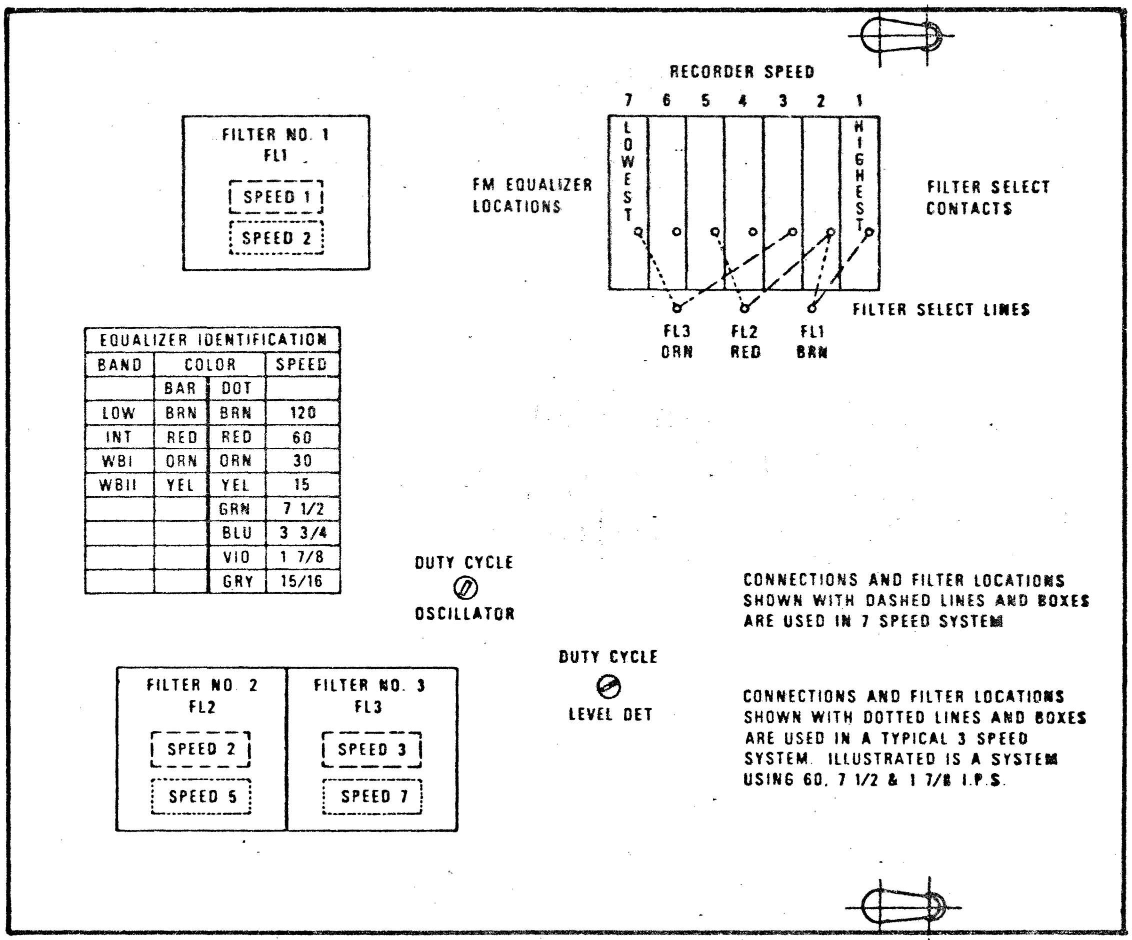


Figure 2. Variation Locations and Matrix Lines

CHARACTERISTICS

Frequency Response	See Table 1
Speeds	Three-Selectable
Power Requirements	+12Vdc at 70ma. max. -12Vdc at 100ma. max. +5Vdc at 150ma. max.
Output Level	Adjustable, 1Vrms nominal
Output Impedance	75 ohms, unbalanced to ground with SCP.

OPERATING DATA

a. **BANDWIDTH AND SPEED VARIATIONS** – Figure 2 details the various filter select lines, equalizer locations and identifications, and filter locations and identifications.

b. **DESCRIPTION OF CONTROLS AND INDICATORS**

TABLE 2. FM REPRODUCE BOARD CONTROLS AND INDICATORS

CONTROL OR INDICATOR	LOCATION AND FUNCTION
ZERO adjust control	Located on the front panel. This control is used to adjust the output amplifier to obtain 0Vdc out, with only the carrier frequency present at the input.
OUTPUT adjust control	Located on the front panel. This control is used to adjust the level of the output signal.
RE-RECORD switch (optional)	Located on the front panel. Provides selection of signal form at the board output. ON provides a modulated carrier at the board output (BNC) for re-recording purposes. OFF provides the standard output of a detected and filtered signal.
SQUELCH indicator	Located on the front panel. Indicates, when lit, the board output is squelched (output signal is not present) by lack of proper servo control speed or lack of carrier.
LEVEL DETECTOR DUTY CYCLE adjust control	Located on the side of the board. This control is used to balance the inputs to the input level detector stages.
OSCILLATOR DUTY CYCLE adjust control	Located on the side of the board. This control is used to adjust the duty cycle (symmetry) of the oscillator.

c. OPERATING PROCEDURES

1. PRE-OPERATING CHECKS AND CONSIDERATIONS - Prior to reproducing FM data with the FM reproduce boards, observe the following checks.

(a) Ensure the speed dependent matrix jumpers are positioned properly for those three speeds desired. Refer to figure 2.

(b) Ensure the FM reproduce boards contain the desired speed and bandwidth dependent equalizers, filters, and timing components. Refer to figures 2, 5, and 6.

(c) Ensure the FM reproduce boards are properly located in the reproduce chassis or auxiliary reproduce chassis, for the desired tracks. Also, if used, ensure the FM 4-7 speed expander boards are properly positioned (refer to the expander board bulletin). Refer to the head characteristics sheet, front of manual, where board serial numbers are correlated to track numbers as originally positioned at the factory.

(d) Ensure all output connections are made to the associated BNC connectors on the reproduce connector panel.

(e) If the RE-RECORD switch (optional) is supplied, ensure it is positioned properly. If the FM reproduce board is being used for re-recording purposes, ensure the output is connected properly for recording on another channel.

(f) Ensure the FM reproduce boards are properly adjusted. Operator adjustments consist of the ZERO adj. and the OUTPUT adj., as detailed in the following paragraphs. Overall adjustments concerning the two previous adjustments and the duty cycle adjustments of the oscillator and the input detectors are detailed in the maintenance section of this bulletin.

NOTE

The Servo Squelch switch must be set to the NORMAL position to utilize the Servo Squelch feature. (Output signal is squelched when the recorder/reproducer speed control has not established a stable accurate tape speed).

2. OPERATING CHECKS AND ADJUSTMENTS - The following adjustment procedures require use of a digital voltmeter and an FM record board. The Sangamo Calibrator unit, part number 836352, provides all adjustment capability in one package.

(a) **ZERO ADJUST** - The following procedures are provided for adjustment of the FM reproduce ZERO adj., using a calibrated FM record board (VCO calibrated) of the same bandwidth. If an FM record board is not available refer to the maintenance section of this bulletin where complete calibration is performed by supplying a voltage input. Special equipment is required for complete calibration.

Step 1. Connect a jumper from the FM record board VCO (yellow) testpoint to the FM reproduce board IN (yellow) testpoint. Ensure the FM record board RANGE switch to set to the TEST position.

Step 2. Set the tape speed to one of the desired speeds, apply POWER, depress RECORD, and set the Servo Squelch switch to the TEST position.

Step 3. Monitor the FM reproduce board OUTPUT (red) testpoint with a digital dc voltmeter.

Step 4. Ensure a reading of 0 Vdc is present on the voltmeter. If this reading is not present, adjust ZERO adj. until 0 Vdc is obtained. Possibly check all desired speeds and ensure output is 0 Vdc ± 50 MVdc. If this tolerance cannot be met, refer to detail calibration in the maintenance section of this bulletin.

Step 5. Proceed with steps 1 thru 4 on other FM reproduce boards as desired.

(b) OUTPUT ADJUST - To adjust the output level, simply monitor the output BNC connector or OUTPUT (red) testpoint with an AC VTVM while reproducing data, and adjust OUTPUT adj. for the desired output (normally 1 Vrms). Return the Servo Squelch switch to the NORMAL position, prior to reproducing data.

THEORY OF OPERATION

The recovery of frequency modulated data recorded on magnetic tape is accomplished via the reproduce head, preamplifier, FM reproduce board, and possibly the FM 4-7 speed expander board. The FM reproduce board functions by equalizing, detecting, demodulating, filtering, and amplifying the recovered FM data signal at any three tape speeds. The optional FM 4-7 speed expander board is utilized for the filtering of the remaining four tape speeds.

The FM reproduce board is separated into the following three divisions:

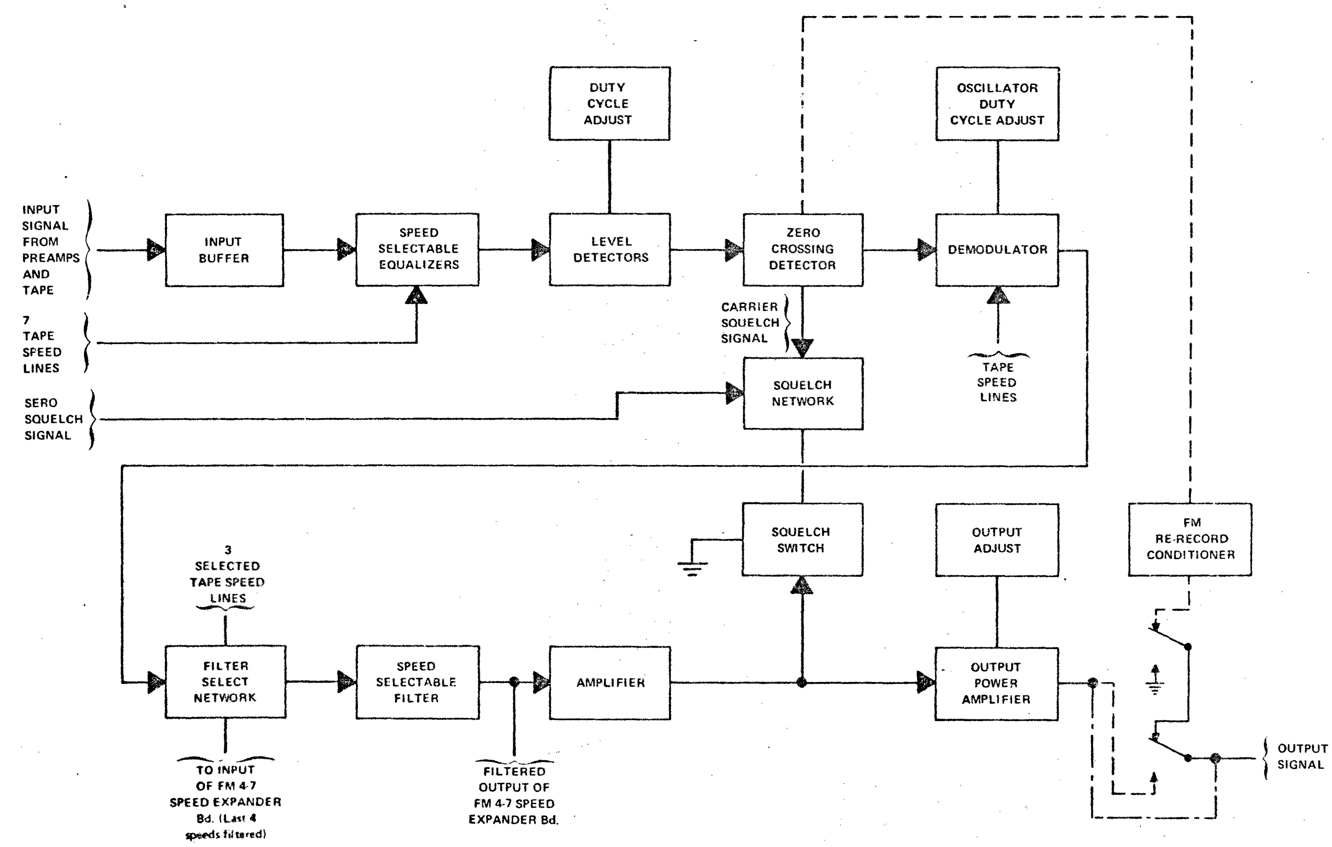
(1) Demodulator
(2) Squelch
(3) Re-Record

These divisions will be described separately in the following paragraphs. Refer to figures 3 and 6.

a. DEMODULATOR - The reproduced frequency modulated data signal from the preamplifier is applied to the FM reproduce board input at P4-10 (hi) and P4-9 (lo). The signal is then applied through emitter follower Q1 to the proper speed dependent equalizer, EQ1 through EQ7. The equalizer, selected by +5 Vdc on the desired speed select line, is used to provide a more constant input to the next stage, consisting of emitter follower, Q2. From the emitter of Q2, the signal is applied to the inputs of two level detectors at LD1-13 and LD2-16. LD1 is biased to change output state when the input drops to nearly 0 Vdc, with LD2 biased to change with an input of larger dc voltage. Each detector produces a square wave output with the LD1 transition occuring prior to the LD2 transition. Potentiometer R7, is used to adjust the balance of LD1, helping to reduce the carrier frequency component at the demodulator output.

Both detector outputs are applied to the EXCLUSIVE OR gate A1, at A1-5 and A1-2. A1 functions as a zero crossing detector by producing a narrow logic 1 level pulse at each zero crossing of the signal input to the level detectors. That is, a logic 1 level will be produced at A1-8 each time the detector outputs are dissimilar, and a logic 0 level each time the outputs are similar. This signal is differentiated by C7 and applied to the input of a flip-flop circuit A2, at A2-2. Each logic 1 level input to A2 produces a logic 1 level output with a longer time duration.

The pulse output at A2-8 ($\overline{\text{clamp}}$) removes the clear signal from A3a, at A3a-13, and activates the oscillator circuit by causing Q6 to be biased to cut off. With Q6 not conducting the effective short between the emitter and base of Q7 is removed, allowing Q7, Q8, C16, C17, R32, R33, and R54 to function as an oscillator circuit.



- — - — Indicates variable wiring provided without FM RE-RECORD KIT (part no. 836256).

— — — — Indicates variable wiring provided with FM RE-RECORD KIT (part no. 836256).

Figure 3. FM Reproduce Board Block Diagram

The oscillator output connected to the emitter of Q5 causes Q5 to further conduct with each successive conduction of Q7 and Q8. Each conduction of Q5 momentarily inhibites the conduction of Q4. This action produces a logic 1 level of short duration on the clock line to A4, at A4-9, and A3a, at A3a-11.

Binary rate multiplier A4 functions as a positive edge clock triggered divide-by-device, controlled by the seven speed line inputs, the clock signal, and the strobe and enable input. The speed line inputs select the divide-by function of A4 as follows: 120 ips = ÷ 1, 60 ips = ÷ 2, 30 ips = ÷ 4, 15 ips = ÷ 8, 7 1/2 ips = ÷ 16, 3 3/4 ips = ÷ 32, and 1 7/8 ips = ÷ 64.

The Ƶ output of A4, at A4-5, (7 1/2 ips providing the ÷ 16 function will be used for this explanation) remains at a logic 1 level until the trailing edge of the sixteenth clock pulse. At the leading edge of the seventeenth clock pulse the logic 0 level (Ƶ output) is applied to the D input of the demodulator flip-flop A3a, at A3a-12. This action would produce a logic 1 level on the Q output of A3a, at A3a-9 and a logic 0 level at the $\overline{Q}$ output, at A3a-8. The logic 0 level on the $\overline{Q}$ output of A3a would deactivate the strobe and enable inputs of A4 causing the Ƶ output to return to a logic 1 level. This $\overline{Q}$ output is also differentiated by C6 and applied to the reset input of A2, at A2-5. A2 is now reset causing the oscillator to stop and a clear signal to be applied to A3a, holding the Q and $\overline{Q}$ outputs to their present states. This present condition would remain until A2 is again set causing the sequence to function.

The Q output of A3a, at A3a-9, is applied to a constant current generator, consisting of Q18, CR10, and associated circuitry. Q10 and associated circuitry function as a switch, conditioning the signal prior to application to the Q18.

The output of Q18 is applied to the three JFET's, Q19 through Q20. This signal is also available at P4-15 for application to the optional expander board. With all speed lines grounded, except the selected speed, the associated control transistor Q17, Q22, or Q23 will not conduct. Thus the associated JFET will not conduct, eliminating that particular filter. With +5 Vdc on the selected speed line the associated control transistor will conduct removing the negative voltage from the associated JFET. This action causes the JFET to conduct, allowing the output at Q18 to pass through the associated speed dependent filter to the next stage. This voltage at the filter inputs is either positive or zero, causing the filter output to be positive.

The next stage consists of operational amplifier A6, the input at A6-4. The filtered outputs of the expander board are also applied at this point, from P4-20. A6 functions to provide 0 Vdc output when only the carrier frequency is present at the input. Potentiometer R62, ZERO adjust, is used to achieve this output by adjusting the negative offset current to the summing junction of A6.

The output of A6, at A6-11, is applied through a low pass filter network, consisting of L1 and C15, to potentiometer R49, OUTPUT adjust. R49 adjusts the signal level passing through the power amplifier, consisting of Q9 and Q13 through Q16, to the board output at P4-18 (hi) and P4-17 (lo).

b. SQUELCH - Two squelch systems are utilized with this FM reproduce board. "Servo" squelch, dependent on the recorder/reproducer speed control accuracy, and "carrier" squelch, dependent on the input signal level, are the two types.

"Servo" squelch is controlled by a speed control signal applied to board pin P4-7. When the recorder/reproducer's speed control system is not "phase and frequency locked" to the crystal oscillator reference, a logic 0 level is applied to all FM reproduce board pins P4-7. This level when applied to the preset input of squelch flip-flop A3b, at A3b-4, causes the Q output, at A3b-5, to go to a logic 1 level. Q11 and Q12 will now conduct shorting the output signal, at the base of Q9, to ground. The logic 0 level at the $\overline{Q}$ output grounds the cathode of light emitting diode, CR8, causing it to become illuminated indicating the board output is squelched.

A "Servo" squelch disable switch, located on the recorder/reproducer, is provided for disabling the squelch line at P4-7, for test and calibration purposes.

When a logic 1 level becomes present at P4-7, by the speed control system lock condition, the Q and $\overline{Q}$ outputs of A3b will remain in the squelch state. The squelch condition will be released when the second squelch method requirements are fulfilled as described in the following paragraphs.

When the signal inputs to the level detectors are of sufficient amplitude, a logic 1 level will be produced by the EXCLUSIVE OR output at A1-8. This will set flip-flop A2, allow the oscillator to run, allow A4 to function, and allow A3a to function. At the end of the first timing period, the $\overline{Q}$ output of A3a will go to a logic 1 level causing the Q output of A3b to go to a logic 0 level. Q11 and Q12 will not conduct thus removing the short between the base of Q9 and ground. The squelch lamp (CR8) will not be illuminated due to the logic 1 level at the $\overline{Q}$ output of A3b.

The input signal sensitivity levels are determined by the signal amplitudes effect on LD2 (level detector 2). LD2 is less sensitive than LD1, thus with a loss of signal or low signal input, the output of LD2 will go to and remain at a logic 1 level. LD1 will continue to change state by the application of the low level signal or noise. This action by both level detectors will produce an output at A1-8, containing logic 1 level pulses of a longer time duration. A2, the oscillator circuit A4, and A3a will all function. However, these functions create a condition by which a logic 1 level at A1-8 will be present at the D input of A3b, at A3b-2, at the same instant the $\overline{Q}$ output of A3a goes to a logic level. This action clocks the squelch flip-flop at A3b-4, producing a logic 1 level at the Q output of A3b. Q11 and Q12 will now conduct shorting the base of Q9 to ground. The squelch lamp will also become illuminated, indicating the output is squelched.

c. FM RE-RECORD - The optional re-record feature functions by routing the modulated signal from the level detector outputs through emitter follower Q3 to the board outputs. The demodulated output signal is still available at TP2 when utilizing the re-record feature. The re-record switch simply selects between a modulated or demodulated output.

MAINTENANCE

The maintenance section contains information to properly test and calibrate the FM reproduce board. Refer to the theory of operation section schematic diagram (figure 6), and waveforms (figure 6), for detail circuit operation.

a. **EQUIPMENT REQUIRED**

HP Model 400E VTVM or equivalent
Tektronix 531 Oscilloscope or equivalent
IEC F51 Function Generator or equivalent
HP Model 310 Wave Analyzer or equivalent
General Radio 1130-A Frequency Counter or equivalent
Fluke 8100 Digital Multimeter or equivalent

b. **TEST AND CALIBRATION** - Refer to the operator's data section of this bulletin for minor operating checks and adjustments prior to completing the following procedures.

Step 1. With the FM reproduce board removed from the recorder/reproducer and its shield removed, visually inspect if for loose connections or mountings, dented, misshaped or broken components, foreign material and signs of overheating. Check the board for the proper equalizers, equalizer positions, proper filters, filter position, speed matrix connections, and bandwidth variable components.

Step 2. Mount the board on its extender, in the reproduce chassis, (shield removed) and apply POWER.

Step 3. Ensure the presence of the following approximate voltages between TP3 (GND) and the indicated point.

+ Side of C13	+5 Vdc
+ Side of C20	+12 Vdc
- Side of C24	-12 Vdc

Step 4. Connect a sine wave generator, AC VTVM, and frequency counter between the IN (yellow) testpoint, TP1 and GND (black) testpoint, TP3. Set the generator level at .5 to 1 Vrms as monitored with the AC VTVM. Set the generator frequency for the correct frequency per tape speed and bandwidth, as listed in table 1. Monitor frequency with the frequency counter.

Step 5. Ensure the "Servo Squelch" switch is set to the TEST position (tape movement will not be required for a board output), POWER is applied, STOP depressed, and the RE-RECORD switch, (if applicable) is OFF.

Step 6. Set tape speed to 30 ips and monitor with an oscilloscope the collector of transistor Q4. Adjust potentiometer R54, oscillator duty cycle adjust, as necessary to provide equal time intervals between the pulses.

Step 7. Select the highest desired tape speed and change the generator accordingly to produce the proper carrier frequency for the speed selected.

Step 8. Adjust R49, OUTPUT adjust, fully clockwise.

Step 9. Monitor the OUTPUT (red) testpoint, TP2, with a digital dc voltmeter, and ensure a reading of 0 Vdc ±5 MVdc. Adjust R62, ZERO adjust, as necessary to obtain the 0 Vdc reading.

Step 10. Connect a wave analyzer between the OUTPUT (red) testpoint, TP2, and the GND (black) testpoint, TP3. Adjust the wave analyzer for the carrier frequency applied to the board. While observing the indicator on the wave analyzer, adjust potentiometer R7, level detector duty cycle adjust, as necessary to produce a minimum reading.

Step 11. Change the generator frequency to the plus % deviation, per table 1. While monitoring the OUTPUT (red) testpoint, TP2, with a digital dc voltmeter, adjust potentiometer R49, OUTPUT adjust for a 1.5 Vdc reading.

Step 12. Change the generator frequency to the minus % deviation and ensure a reading of 1.5 Vdc ±15 MVdc is present.

Step 13. Repeat steps 10 through 13 for those speeds desired. Compromising adjustments may be performed to make entire board performance more satisfactory. The potentiometer on the filter unit may be slightly adjusted to obtain the 0 Vdc output at the lowest speed.

Step 14. With the plus % deviation input, position the "Servo Squelch" switch to the NORMAL position (No tape movement). Ensure the board output is squelched (drops to 0 Vdc ±50 MVdc) and the squelch indicator lamp is lit. Sweep input frequency to minus % deviation and ensure output remains the same.

Step 15. Place the "Servo Squelch" switch to the TEST position and remove the generator input at the IN testpoint. Ensure the output signal is squelched (drops to 0 Vdc ±50 MVdc) and the squelch indicator lamp is lit.

Step 16. Repeat steps 1 through 16 for all FM reproduce boards, as desired or required.

PARTS LIST

FM Reproduce Board 836154-(*)

A1	859520-001	C11	329157-001	C27	898330
A2	859520-001	C12	Not Used	C28	329157-001
A3	859520-020	C13	859775-021	C29	329157-001
A4	859520-053	C14	329157-001	C30	859775-017
A5	510339	C15	See Table 3	CR1	853531
A6	510128	thru		CR2	844510
C1	859775-009	C17		CR3	844510
C2	896475	C18	510114-020	CR4	852475-018
C3	859775-021	C19	510116-025	CR5	852475-024
C4	329157-001	C20	859775-017	CR6	844510
C5	859775-017	C21	329157-001	CR7	853531
C6	844115	C22	Not Used	CR8	510345
C7	844115	C23	845258	CR9	844510
C8	859775-010	C24	859775-017	CR10	852475-014
C9	859775-013	C25	510116-027	CR11	844510
C10	329157-001	C26	510058-003	CR12	844510

*See table 3 for dash number description.

PARTS LIST

FM Reproduce Board 836154- (*) (Cont.)

L1	See Table 3	R6	198200-102	R39	198200-512
P1	855981-001	R7	329151-006	R40	198200-102
thru		R8	198200-222	R41	198200-221
P3		R9	198200-154	R42	198200-102
P4	853518	R10	198200-182	R43	198200-103
Q1	854540	R11*	198200-472	R44	853530-254
Q2	854540	R12	198200-222	R45	198200-471
Q3*	854539	R13	198200-105	R46	198200-472
Q4	510360	R14	198200-561	R47	853530-147
Q5	510360	R15	198200-271	R48	853530-212
Q6	510364	R16	198200-561	R49	510164-008
Q7	510360	R17	198200-361	R50	198200-102
Q8	510360	R18	198200-124	R51	198200-271
Q9	859970	R19	198200-471	R52*	198200-151
Q10	510360	R20	198200-471	R53	198200-470
Q11	854540	R21	198200-391	R54	329151-007
Q12	854539	R22	198200-181	R55	198200-472
Q13	859970	R23	198200-561	R56	198200-223
Q14	854539	R24	198200-472	R57	198200-472
Q15	854539	R25	198200-223	R58	198200-223
Q16	854540	R26	853530-108	R59	198200-101
Q17	854540	R27	198200-103	R60	198200-563
Q18	**	R28	198200-562	R61	198200-622
Q19	510336	R29	198200-221	R62	510164-008
thru		R30	198200-221	R63	198200-273
Q21		R31	198200-331	R64	198200-271
Q22	854540	R32	853530-254	R65	198200-151
Q23	854540	R33	853530-254	R66***	198200-222
R1	198200-471	R34	198200-332	R67***	198200-222
R2	198200-562	R35	198200-102	R68***	198200-222
R3	198200-471	R36	198200-102	S1*	510399-001
R4	198200-222	R37	198200-103		
R5	198200-472	R38	198200-271		

FM Re-Record Kit 836256

Q3	854539	R52	198200-151
R11	198200-472	S1	855432-001

* Part of optional Re-Record Kit 836256.

** May be either 510364 (MPS 3640) or 854540 (2N4126).

*** These resistors always used with Linear phase filters.

TABLE 3. PARTS LIST VARIATIONS

836154–	Carrier Frequency	C15	C16	C17	L1	Band-width
001	Basic Board	Not Used	Not Used	Not Used	Not Used	Not Used
002	900 kHz	27 PF 835341-031	32 PF 835341-023	32 PF 835341-023	330µh 836242-001	W.B. II
003	432 kHz	150 PF 835341-029	70 PF 835341-027	70 PF 835341-027	1500µh 836242-002	W.B. I
004	216 kHz	150 PF 835341-029	130 PF 835341-028	130 PF 835341-028	1500µh 836242-002	Inter-mediate
005	108 kHz	150 PF 835341-029	270 PF 835341-030	270 PF 835341-030	1500µh 836242-002	Low
006	450 kHz	27 PF 835341-031	70 PF 835341-027	70 PF 835341-027	330µh 836242-001	W.B. II (60 ips top speed)
007	54 kHz	150 PF 835341-029	560 PF 835341-032	560 PF 835341-032	1500µh 836242-002	Low (60 ips top speed)

TABLE 4. EQUALIZER PARTS LIST

836240-	TAPE SPEED	L1 VAL.	L1 SECO	C1 VAL.	C1 SECO	C2 VAL.	C2 SECO	R2 VAL.	R2 SECO	R3 VAL.	R3 SECO	R1 VAL.	R1 SECO	Q1 TYPE	Q1 SECO	Fc KHz	COLOR IDENTIFICATION BAR	COLOR IDENTIFICATION DOT
INTERMEDIATE BAND																		
001	120	JUMPER	—	270 PF	510116-018	10 MFD	691391-005	1.8K	198200-182	JUMPER	—	1K	198200-102	2N5087	859971	216	RED	BRN.
002	60	↑	—	560 PF	-022	10 MFD	-005	1.8K	-182	JUMPER	—	↑	↑	↑	↑	108	RED	RED
003	30		—	.001 MFD	-025	10 MFD	-005	820Ω	-821	1K	198200-102					54	RED	ORN.
004	15		—	.0022 MFD	-029	10 MFD	-005	390Ω	-391	1.5K	-152					27	RED	YEL
005	7½		—	.0039 MFD	-032	10 MFD	-005	180Ω	-181	1.8K	-182					13.5	RED	GRN.
006	3¾		—	.0082 MFD	-036	22 MFD	-012	100Ω	-101	1.8K	182					6.75	RED	BLU.
007	1⅞	↓	—	.015 MFD	-039	56 MFD	-017	33Ω	-330	1.8K	182	↓	↓	↓	↓	3.375	RED	VIO.
008	15/16	JUMPER	—	.027 MFD	-042	56 MFD	-017	10Ω	-100	1.8K	182	1K	198200-102	2N5087	859971	1.688	RED	GRY.
WIDE BAND GROUP 1																		
009	120	JUMPER	—	120 PF	510116-014	10 MFD	691391-005	820Ω	198200-821	1.0K	198200-102	1K	198200-102	2N5087	859971	432	ORN.	BRN.
010	60	↑	—	270 PF	-018	↑	↑	680Ω	-681	1.2K	-122	↑	↑	↑	↑	216	ORN.	RED
011	30		—	560 PF	-022			390Ω	-391	1.5K	-152					108	ORN.	ORN.
012	15		—	.001 MFD.	-025			220Ω	-221	1.5K	-152					54	ORN.	YEL.
013	7½		—	.0022 MFD.	-029	↓	↓	100Ω	-101	1.8K	-182					27	ORN.	GRN.
014	3¾	↓	—	.0039 MFD.	-032	10 MFD	-005	47Ω	-470	1.8K	-182	↓	↓	↓	↓	13.5	ORN.	BLU.
015	1⅞	JUMPER	—	.0082 MFD.	-036	22 MFD	-012	10Ω	-100	1.8K	-182	1K	198200-102	2N5087	859971	6.75	ORN.	VIO
WIDE BAND GROUP 2																		
016	120	33 µH	853587-016	270 PF	510116-018	10 MFD	691391-005	470Ω	198200-471	1.2K	198200-122	330Ω	198200-331	2N5087	859971	900	YEL.	BRN.
017	60	68 µH	-037	660 PF	-022	↑	↑	330Ω	-331	1.5K	-152	↑	↑	↑	↑	450	YEL.	RED
018	30	150 µH	-017	.0012 MFD	-026			180Ω	-181	1.8K	-182					225	YEL.	ORN.
019	15	270 µH	-018	.0022 MFD	-029			100Ω	-101	1.8K	-182					112.5	YEL.	YEL.
020	7½	560 µH	-019	.0039 MFD	-032	↓	↓	47Ω	-470	1.8K	-182					56.25	YEL.	GRN
021	3¾	1200 µH	-025	.0082 MFD	-036	10 MFD	-005	10Ω	-100	1.8K	-182	↓	↓	↓	↓	28.13	YEL.	BLU.
022	1⅞	2200 µH	021	.018 MFD	-040	22 MFD	-012	JUMPER	—	1.8K	-182	330Ω	-331	2N5087	859971	14.06	YEL.	VIO.
LO BAND																		
023	120	JUMPER	—	560 PF	610116-022	10 MFD	691391-005	1.8K	198200-182	JUMPER	—	1K	198200-102	2N5087	859971	108	BRN.	BRN.
024	60	↑	—	.001 MFD	-023	10 MFD	-005	1.8K	-182	JUMPER	—	↑	↑	↑	↑	54	BRN.	RED
025	30		—	.0022 MFD	-029	10 MFD	-005	1.2K	-122	560Ω	198200-561					27	BRN.	ORN.
026	15		—	.0039 MFD	-032	10 MFD	-005	560Ω	-561	1.2K	-122					13.5	BRN.	YEL.
027	7½		—	.0082 MFD	-036	22 MFD	-012	270Ω	-271	1.5K	-152					6.75	BRN.	GRN.
028	3¾	↓	—	.015 MFD	-039	56 MFD	-017	120Ω	-121	1.8K	-182	↓	↓	↓	↓	3.375	BRN.	BLU.
029	1⅞	JUMPER	—	.027 MFD	-042	56 MFD	-017	68Ω	-680	1.8K	-182	1K	198200-102	2N5087	859971	1.688	BRN.	VIO.

TABLE 5. FILTER AND EQUALIZER PARTS LIST

SPEED IPS	FREQ.	**FLAT AMP FILTER PART NO.	LINEAR PHASE FILTER PART NO.	EQUALIZER PART NO.
IRIG INTERMEDIATE BAND				
120	40 kHz	277272-002	277181-002	836240-001
60	20	277272-003	277181-003	836240-002
30	10	277272-004	277181-004	836240-003
15	5	277272-005	277181-005	836240-004
7 1/2	2.5	277272-006	277181-006	836240-005
3 3/4	1.25	277272-007	277181-007	836240-006
1 7/8	.625	277272-008	277181-008	836240-007
* 15/16	.312	277272-009	277181-009	836240-008
IRIG WIDEBAND GROUP I				
120	80 kHz	277272-001	277181-001	836240-009
60	40	277272-002	277181-002	836240-010
30	20	277272-003	277181-003	836240-011
15	10	277272-004	277181-004	836240-012
7 1/2	5	277272-005	277181-005	836240-013
3 3/4	2.5	277272-006	277181-006	836240-014
1 7/8	1.25	277272-007	277181-007	836240-015
IRIG WIDEBAND GROUP II				
120	500 kHz	277273-001		836240-016
60	250	277273-002		836240-017
30	125	277273-003		836240-018
15	67.5	277273-004		836240-019
7 1/2	31.25	277273-005		836240-020
3 3/4	15.6	277273-006		836240-021
1 7/8	7.8	277273-007		836240-022
LOW BAND				
120	20 kHz	277272-003	277181-003	836240-023
60	10	277272-004	277181-004	836240-024
30	5	277272-005	277181-005	836240-025
15	2.5	277272-006	277181-006	836240-026
7 1/2	1.25	277272-007	277181-007	836240-027
3 3/4	0.625	277272-008	277181-008	836240-028
1 7/8	0.312	277272-009	277181-009	836240-029

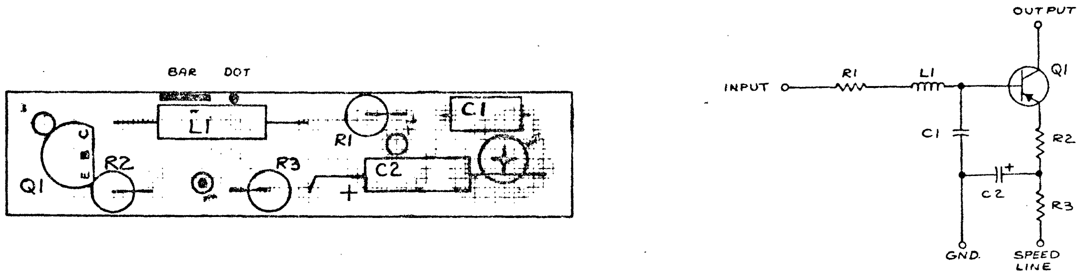


Figure 4. FM Equalizer Schmetic Diagram and Component Location

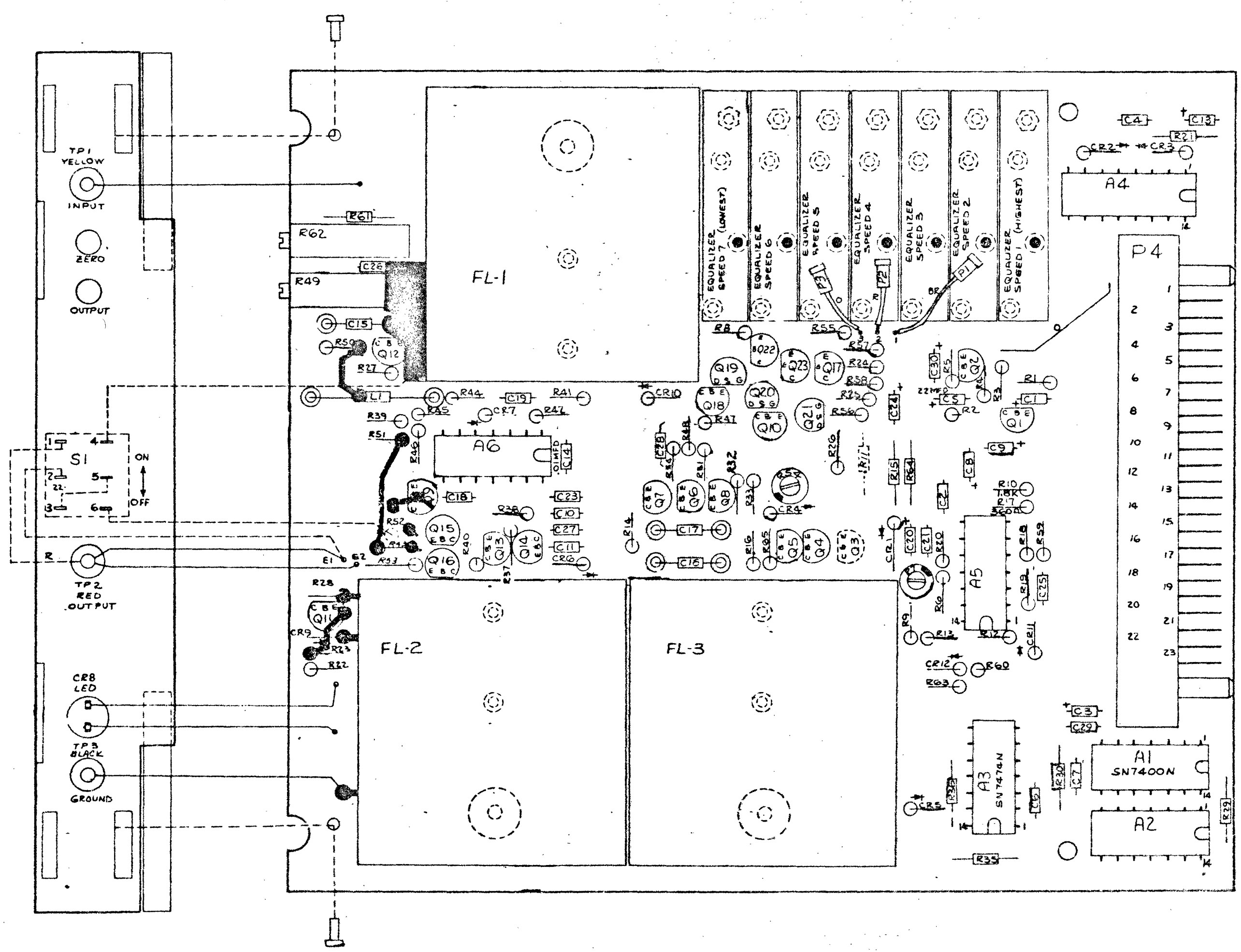
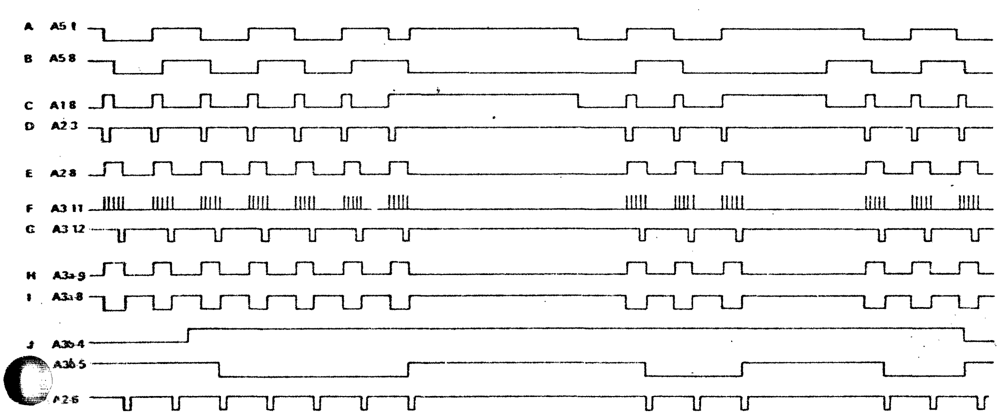
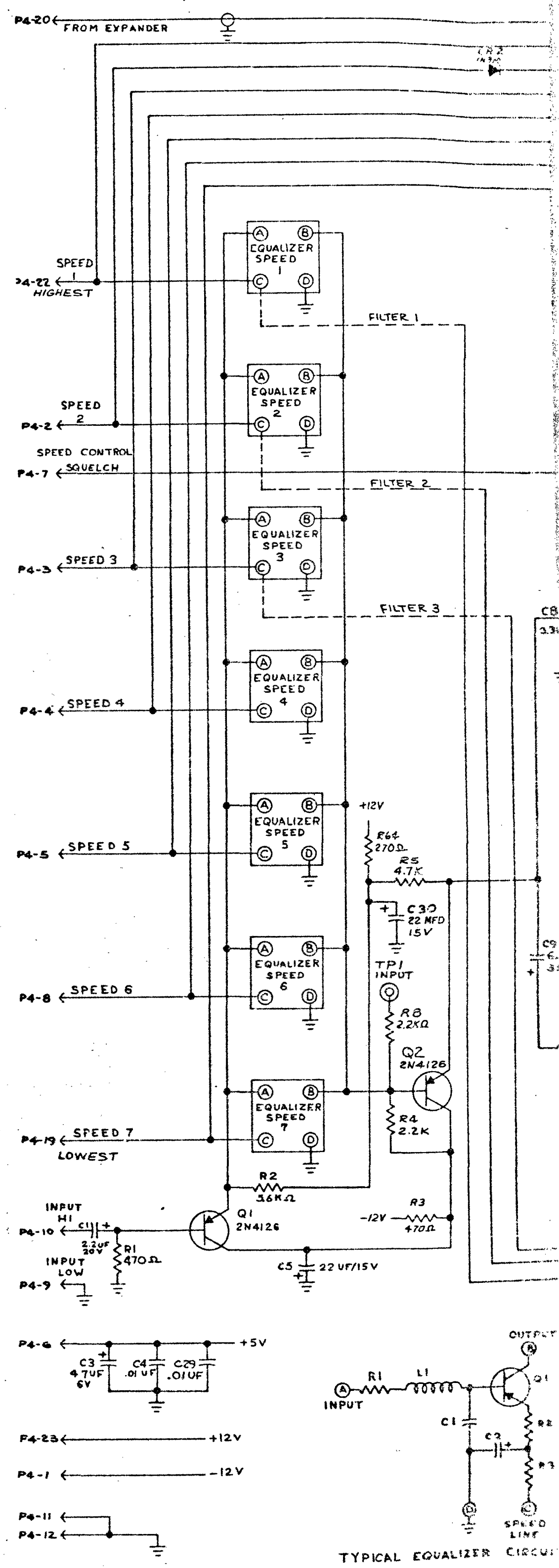
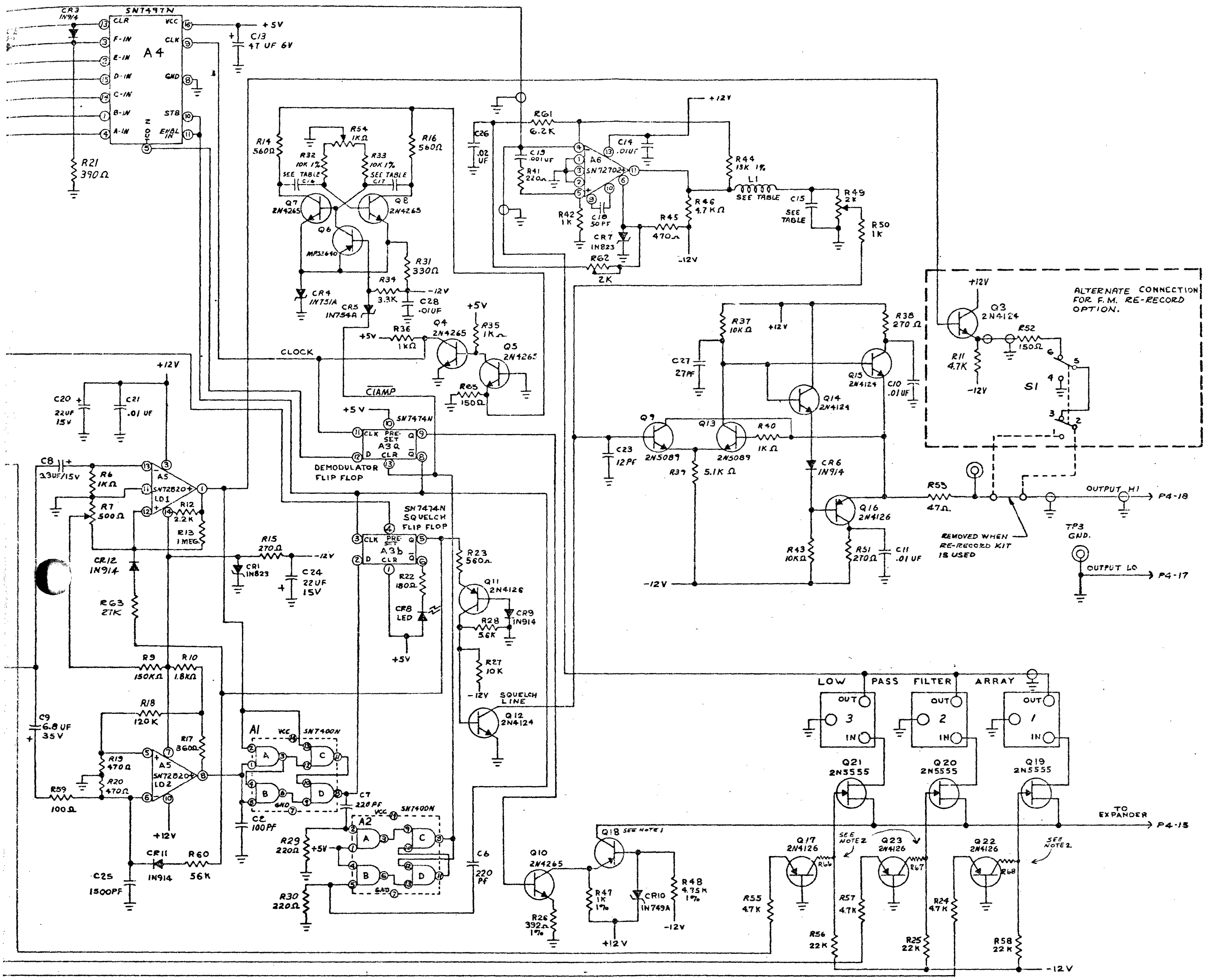


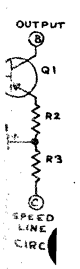
Figure 5. FM Reproduce Board Component Location

WAVEFORM A.	Typical output of level detector 1 (LD1).
WAVEFORM B.	Typical output of level detector 2 (LD2).
WAVEFORM C.	The exclusive OR of LD1 and LD2.
WAVEFORM D.	Negative pulses of approximately 50 N sec.
WAVEFORM E.	Positive edge of $\overline{\text{CLAMP}}$ pulse, caused by negative edge of waveform D.
WAVEFORM F.	Clock generator pulses, produced as long as $\overline{\text{CLAMP}}$ is high.
WAVEFORM G.	Rate multiplier Ƶ output.
WAVEFORM H & I	With waveform G high when a clock pulse occurs, the Q output at A3a-9 will go high and the $\overline{\text{Q}}$ output at A3a-8 will go low. This activates the strobe enable inputs of A4. If waveform G is low when the leading edge of the clock pulse occurs, Q will go low and $\overline{\text{Q}}$ will go high.
WAVEFORM J.	Servo squelch signal.
WAVEFORM K.	With waveform J high and waveform C low, this signal will go low when waveform I goes high. This action removes the squelch from the board. With waveform J high and waveform C high, this signal will go high when waveform I goes high, thus squelching the board output.
WAVEFORM L.	This signal produced by waveform I causing waveform E to go low, stopping the generator.









836154	CENTER FREQUENCY	C15	C16	C17	L1	HIGHEST SPEED
-001	BASIC BOARD	NOT USED	NOT USED	NOT USED	NOT USED	
-002	900 KHZ	27 PF	32 PF	32 PF	330μh	120ips
-003	432 KHZ	150 PF	70 PF	70 PF	1500μh	120ips
-004	216 KHZ	150 PF	130PF	130 PF	1500μh	120ips/60ips
-005	108 KHZ	150PF	270PF	270 PF	1500μh	120ips/60ips
-006	450 KHZ	27 PF	70PF	70 PF	330μh	60ips
-007	54 KHZ	150PF	560 PF	560 PF	1500μh	60ips

NOTES:

1. Q18 may be MPS3640 or 2N4126.
2. Resistors R66, R67, and R68 are always used with linear phase filters.

Figure 6. FM Reproduce Board Schematic Diagram

Sangamo

DIRECT REPRODUCE

GENERAL

This bulletin contains information on the direct reproduce board operating and servicing procedures.

This recorder/reproducer requires one direct reproduce board for each channel employing direct reproducing. Each board is utilized to amplify and equalize (amplitude and phase) the reproduced signal as it passes from the reproduce head and preamplifier. This board is adaptable (with slight changes) to IRIG Intermediate Band and IRIG Wideband Groups I and II.

Each board can accommodate a maximum of seven equalizers providing for seven tape speeds. The correct equalizer is automatically selected by the TAPE SPEED SELECTOR on the Operator Control Panel. There are three equalizer options available for the following bands: IRIG Intermediate Band, IRIG Wideband Group I and IRIG Wideband Group II.

The direct reproduce boards are located in the reproduce chassis (or the auxiliary reproduce chassis) and are easily accessible.

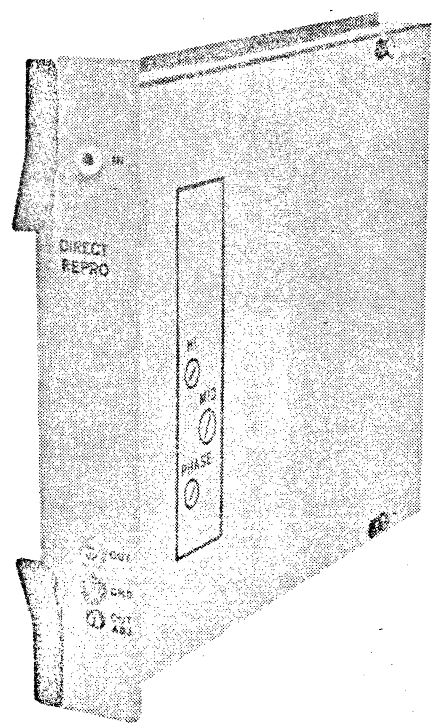


Figure 1. Direct Reproduce Board

CHARACTERISTICS

Output Level	1 vrms into 75 ohms at normal record level
Output Impedance	Less than 50 ohms unbalanced to ground
Power Requirements	+12 vdc $\pm$.5 vdc at 25 ma -12 vdc $\pm$.5 vdc at 28 ma

OPERATING DATA

a. CONTROLS – The only operator control employed on this board is OUT ADJ, R43. To adjust the output level, simply monitor the output BNC or output testpoint, while reproducing data, and adjust OUT ADJ for the desired output (normally 1.0 Vrms). All other controls are maintenance calibration controls detailed in the maintenance section of this bulletin.

b. STEP-BY-STEP OPERATING PROCEDURES – For proper utilization of the recorder/reproducer in the REPRODUCE mode, ensure the presence of the following functions.

1. Tape must be threaded in accordance with those procedures set forth in the Tape Transport Bulletin.

2. Proper signal electronics must be installed in the track numbers employed.

3. Proper signal connections must be made at the Reproduce Connector Panel in accordance with information found in the Installation Bulletin.

4. Proper adjustment of the equalizers must be made.

Refer to the maintenance section of this bulletin for equalizer adjustment procedures.

NOTE

The reproduce boards are activated each time power is applied to the machine. Thus when recording signal data this recorded signal is present at the Reproduce Connector Panel.

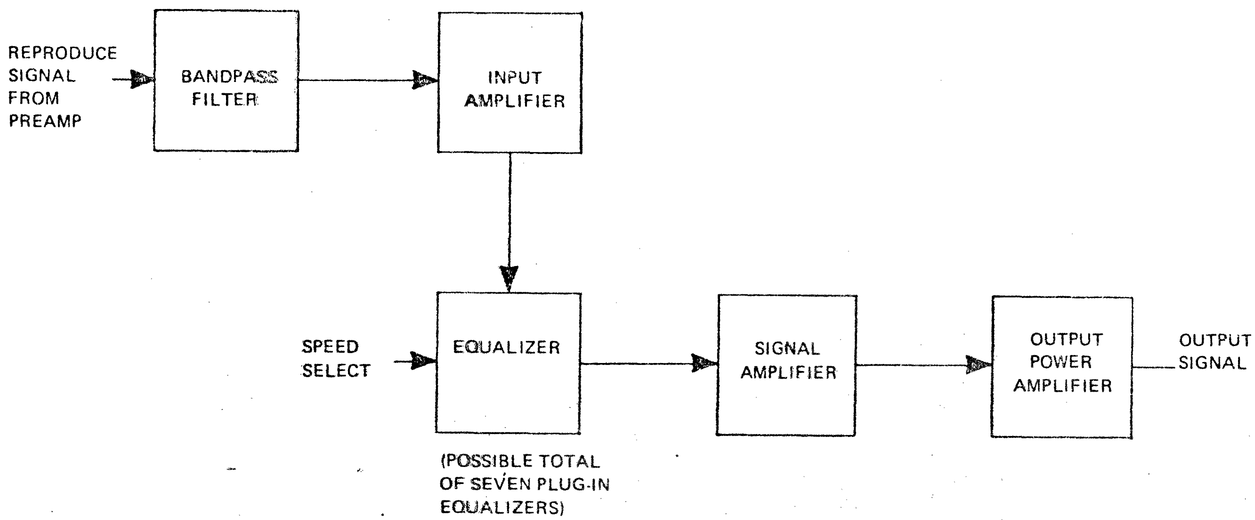


Figure 2. Direct Reproduce Board Block Diagram

THEORY OF OPERATION

The direct reproduce board contains sufficient circuitry to properly amplify, phase equalize (per speed), and amplitude equalize (per speed) the reproduce signal (recorded by the direct record process) accepted from the reproduce head and preamplifiers. Each board is capable of conditioning one head channel at any or all seven tape speeds.

The reproduce signal from the preamp, entering the board through P1-10(hi) and P1-9(lo), is applied to a bandpass filter consisting of C1, C2, L1, and L2. Refer to figure 6 for circuit schematic diagram. This filter removes all unwanted noise outside the 100Hz to 2.0MHz bandwidth. A variable gain amplifier Q1, R4, and associated circuitry, is used to condition and control the signal prior to application to emitter, follower Q2, and the speed dependent amplitude and phase equalizers. The appropriate plug-in equalizer module is activated by the recorder/reproducer speed select switch and board pins 22,2,3,4,5,8, and 19.

The equalizers provide two types of equalization; amplitude and phase. Amplitude equalization is employed to provide a flat overall response, refer to figure 2, of the reproduced data signal. Without such equalization the amplitude of the reproduced data signal would vary with the frequency of the reproduced signal.

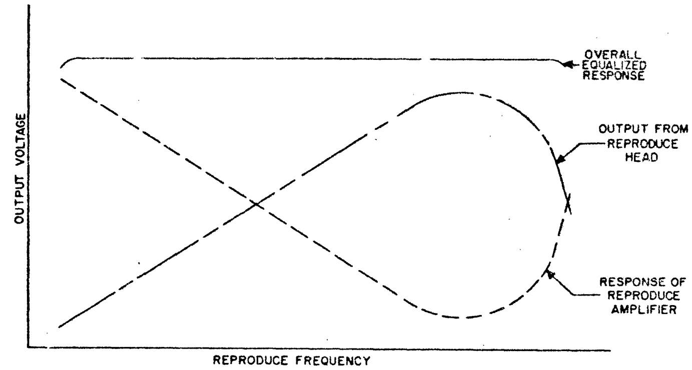


Figure 3. Direct Reproduce Amplitude Equalized Response

Phase equalization is employed to condition the output reproduce signal to obtain a signal most like the signal prior to recording on tape.

The output of the equalizer is applied through emitter follower, Q3, to signal amplifier A1. R5, OUT ADJ, controls the level of the input signal to A1, thus controlling the level present at the output of the board. The value of capacitor C8 varies dependent of the bandwidth usage (intermediate or wideband). Output power amplifier, Q4 and Q5, amplify the output of A1 and apply it to the board output at P1-18(hi) and P1-17(lo).

MAINTENANCE

This maintenance section contains sufficient information to properly test and calibrate the direct reproduce board. Failure to obtain the proper indications upon calibration is an indication of a particular malfunction, discrepency, etc.

a. EQUIPMENT REQUIRED

HP Model 400 E VTVM or equivalent
Tektronix 531 Oscilloscope or equivalent
IEC F51 Function Generator or Equivalent

NOTE

All direct reproduce checkout and calibration is based on the use of a properly calibrated direct record board utilized in the channel associated with the reproduce board being checked or calibrated.

b. CHECKOUT – Failure to obtain satisfactory results in the following checkout procedure suggests the test and calibration procedures be followed.

Step 1. With tape threaded properly connect a function generator (set to sine wave) to the BNC connector input of the Record Connector Panel, for the track being checked.

Step 2. Apply POWER and depress STOP, RECORD, and FORWARD. Set the generator to the proper level to provide the normal direct record level (.1 Vrms at REC LEV testpoint on the record board, measure this value with a VTVM and observe and note with an oscilloscope the peak-to-peak value of the sine wave).

Step 3. Set the generator to the reference frequency for the proper speed and bandwidth (see table 1). Ensure with a VTVM, the board output is 1 Vrms. Adjust OUT ADJ, R43, as needed to obtain this level for futher checkout.

Step 4. Scan the frequencies from approximately 400 Hz to the upper band edge at the highest speed dependent on the bandwidth of the equalizers as shown in Table 4. While scanning the frequencies, monitor the proper reproduce board output BNC connector or the board output testpoint, TP2, and ensure the output is 1 Vrms ±3 dB. If the output exceeds the ±3 dB limitations, slight adjustment of HI adj and/or MID adj (equalizer adjustments) should bring the output within the proper limitations. HI adj is normally adjusted if the limitations are exceeded at the higher frequencies and MID adj at the mid to lower frequencies. After all adjustments, completely scan the frequencies again ensuring 1 Vrms ±3 dB is present. Repeat as necessary for all equalized speeds.

Step 5. Change the generator input to a square wave and while monitoring the record board, REC LEV testpoint, with an oscilloscope, adjust the generator for a square wave peak-to-peak level equal to the sine wave peak-to-peak level noted in Step 2.

Step 6. Monitor the reproduce board output at the output BNC connector or the board output testpoint, TP2, with an oscilloscope and check randomly frequencies from approximately 400 Hz to the upper band edge for each speed as shown in Table 4. At the reference frequency, per Table 1, ensure a good representation of a square wave similar to the ideal square wave in figure 4. Slight adjustment of the phase potentiometer on each equalizer may improve the square wave representation. If this slight adjustment is performed, re-check the frequency response in Steps 1 through 4.

c. TEST AND CALIBRATION

Step 1. With the direct reproduce board removed from the recorder/reproducer and its shield removed, visually inspect it for loose connections or mountings, dented, misshaped or broken components, foreign material and signs of overheating.

Step 2. Mount the board on its extender, in the reproduce chassis, and apply POWER.

Step 3. Ensure the presence of the following voltages between TP3 (GND) and the indicated point.

P1-23	+12 Vdc
P1-1	-12 Vdc
P1-11, 12	GND

Step 4. Check the reproduce board for the proper speed equalizers and their correct position on the board. Refer to figure 6. The board is capable of housing and utilizing seven equalizers, although a fewer amount (one, two, etc., any combination of available speeds) may be used.

Step 5. Connect a function wave generator (set to sine wave) to the BNC input of the Record Connector Panel for the track under test. Set the generator to the proper level to provide the normal direct record level (.1 Vrms at REC LEV testpoint on the record board, measure this value with a VTVM and observe and note with an oscilloscope the peak-to-peak value of the sine wave) and a frequency of 300 kHz (wideband) or 130 kHz (intermediate band).

Step 6. With tape properly threaded apply POWER and depress STOP, RECORD, and FORWARD.

Step 7. Monitor the direct reproduce testpoint TP4 with an AC VTVM and adjust input gain, R4, for a -1.0 dB (referenced to 0.78 Vrms) reading.

Step 8. Adjust the three potentiometers on each equalizer to the mid range position, and OUT ADJ, R14, fully clockwise. Change the generator input to a square wave and, while monitoring the record board, REC LEV testpoint, with an oscilloscope, adjust the generator for a square wave peak-to-peak value equal to the sine wave level noted in Step 5.

Step 9. Record a few minutes, as desired, of each of the Table 1 frequencies at the indicated speed. While recording each frequency monitor the board output (BNC connector or output testpoint, TP2) with an oscilloscope and perform the following adjustments on the proper equalizer associated with the speed. Refer to figure 4.

(a) Adjust the phase adj, R9, for an approximate horizontal top and bottom portion (minimum tilt) of the square wave between the overshoots.
(b) Adjust the MID adjust, R7, until the overshoots are 10% to 20% of the amplitude of the total peak-to-peak square wave.
(c) Adjust the HI adjust, R8, until the overshoots are approximately equal in amplitude.

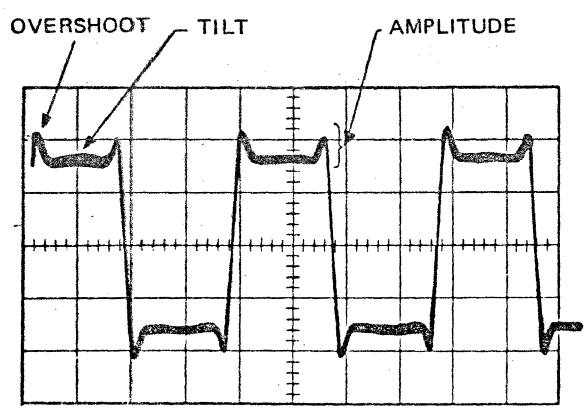


Figure 4. Equalization Waveform

Step 10. Change generator input to a sine wave and ensure .1 Vrms at record board, REC LEV testpoint.

Step 11 Record several minutes, as desired, of the Table 2 frequencies at the indicated speeds. While recording, monitor the board output (BNC connector or output testpoint, TP2) with an AC VTVM and adjust OUT ADJ, R14, for 1 Vrms at the highest equalized speed.

TABLE 1. REFERENCE FREQUENCIES			
SPEED (ips)	FREQUENCY (kHz)		
	INTER	W.B.I	W.B.II
120	60	160	200
60	30	80	100
30	15	40	50
15	7.5	20	25
7 1/2	3.75	10	12.5
3 3/4	1.9	5	6.25
1 7/8	1.0	2.5	3.12
15/16	0.5		

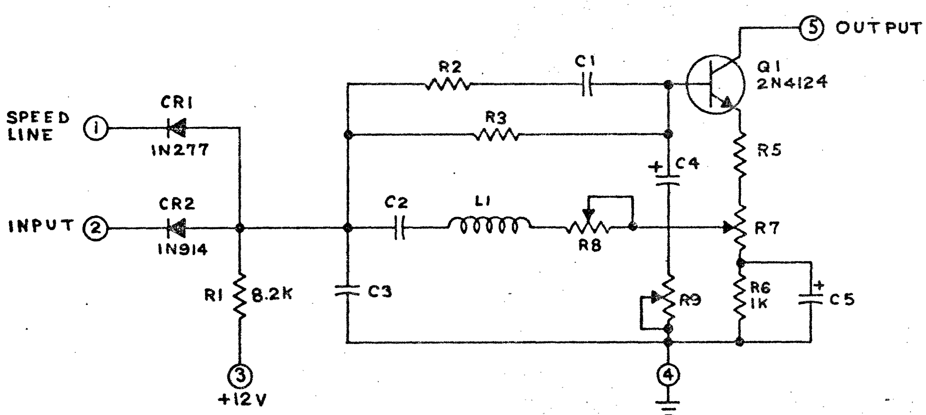
TABLE 2. EQUALIZATION FREQUENCIES	
SPEED (ips)	FREQUENCY (kHz)
120, 60, and 30	10
all other speeds	1

Step 12. Record a few minutes, as desired, of each of the Table 3 mid frequenices, at the indicated speed. While recording, monitor the board output with an AC VTVM and adjust the proper equalizers MID adj, R7, for a 1 Vrms reading.

TABLE 3. MID FREQUENCY ADJUST FREQUENCIES			
SPEED (ips)	FREQUENCY (kHz)		
	INTER	W.B.I	W.B.II
120	300	800	1000
60	150	400	500
30	75	200	250
15	37.5	100	125
7 1/2	19	50	62.5
3 3/4	10	25	31.25
1 7/8	5	12.5	15.6
15/16	2.5		

Step 13. Record a few minutes, as desired, of each of the Table 4 high frequencies, at the indicated speed. While recording, monitor the board output with an AC VTVM and adjust the proper equalizers HI adj, R8, for a 1 Vrms reading.

TABLE 4. HIGH FREQUENCY ADJUST FREQUENCIES			
SPEED (ips)	FREQUENCY (kHz)		
	INTER	W. B. I	W. B. II
120	600	1600	2000
60	300	800	1000
30	150	400	500
15	75	200	250
7 1/2	38	100	125
3 3/4	19	50	62.5
1 7/8	10	25	31.25
15/16	5		



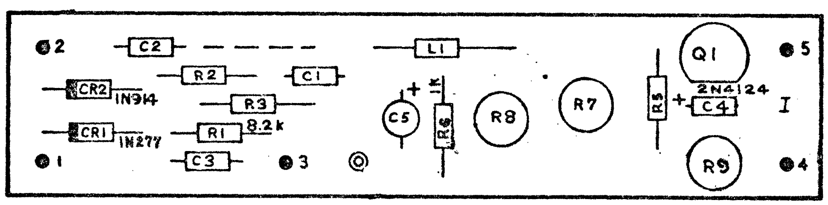


Figure 5. Equalizer Schematic Diagram and Component Location

NOTE: Refer to Table 5 for equalizer parts listing.

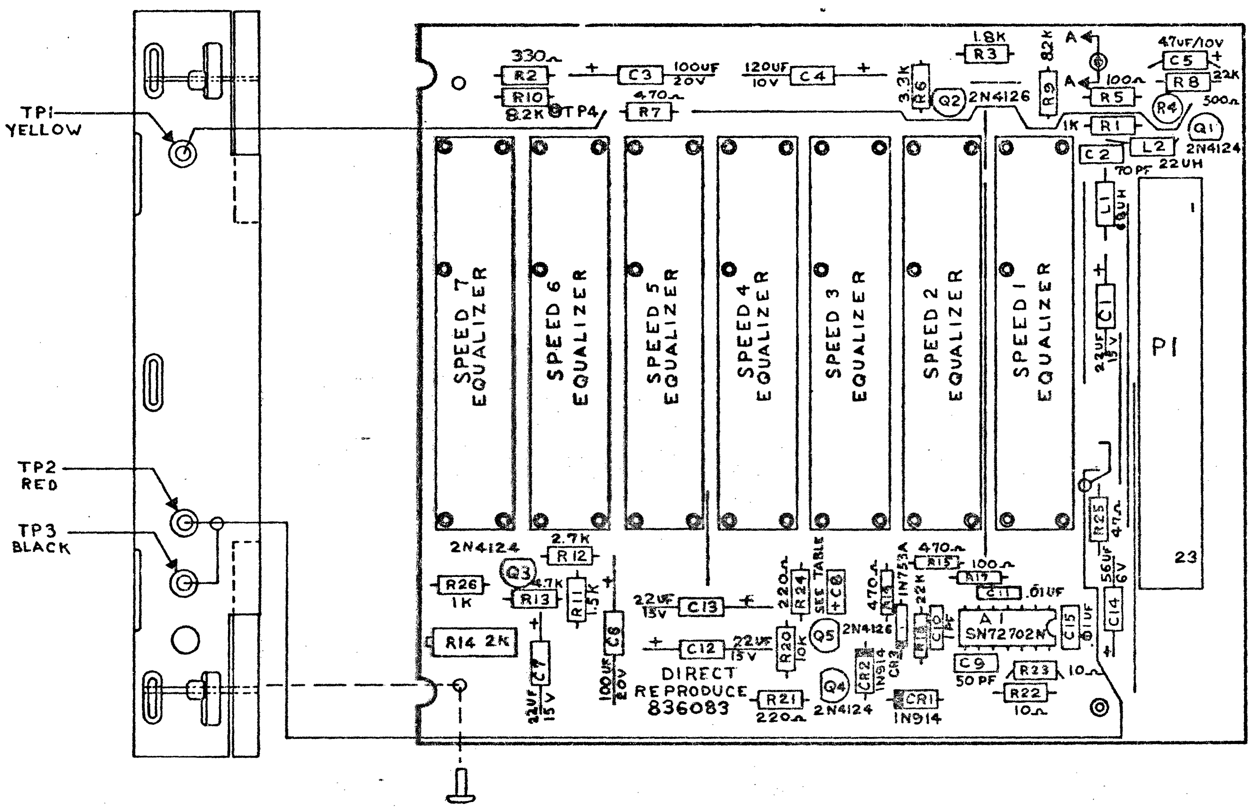
PARTS LIST

Direct Reproduce Board 836083

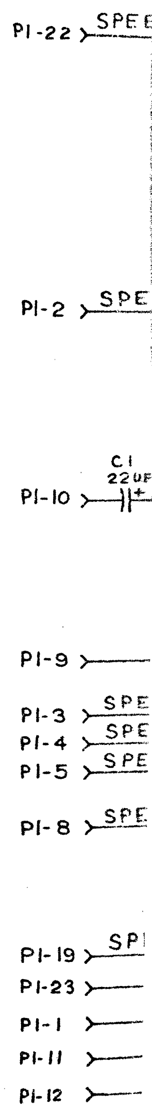
A1	510128	R2	198200-331
C1	691391-012	R3	198200-182
C2	197212-070	R4	329151-006
C3	691391-019	R5	198200-101
C4	691391-057	R6	198200-332
C5	691391-001	R7	198200-471
C6	691391-019	R8	198200-223
C7	691391-012	R9	198200-822
C8	See Table	R10	198200-822
C9	197212-050	R11	198200-152
C10	197212-001	R12	198200-272
C11	329157-001	R13	198200-472
C12	691391-012	R14	854535-008
C13	691391-012	R15	198200-471
C14	691391-017	R16	Not Used
C15	329157-001	R17	198200-101
CR1	844510	R18	198200-223
CR2	844510	R19	198200-471
CR3	852475-022	R20	198200-103
L1	853587-037	R21	198200-221
L2	853587-005	R22	198200-100
MP1	854220	R23	198200-100
P1	853518	R24	198200-221
Q1	854539	R25	198200-470
Q2	854540	R26	198200-102
Q3	854539	TP1	855812-004
Q4	8545439	TP2	855812-002
Q5	854540	TP3	855812-010
R1	198200-102	TP4	691032

TABLE 5. EQUALIZER PARTS LISTING

836085	DESCRIPTION	R2	R3	R5	R7	R8	R9	C1	C2	C3	C4	C5	L1
-001	120 IPS INTER. BAND	27 K 198200-273	10 K 198200-103	82 Ω 198200-820	20 Ω 510113-011	5 K 329151-009	20 Ω 329151-002	400 PF 197212-400	62 PF 197212-062	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	1000 UH 853587-020
-002	60 IPS INTER. BAND	27 K 198200-273	10 K 198200-103	82 Ω 198200-820	20 Ω 510113-011	5 K 329151-009	20 Ω 329151-002	600 PF 198249-600	240 PF 197212-240	OMIT	1UF/35V 510429-025	47 UF/10V 859775-021	1000 UH 853587-020
-003	30 IPS INTER. BAND	OMIT	10 K 198200-103	82 Ω 198200-820	20 Ω 510113-011	2 K 329151-008	20 Ω 329151-002	OMIT	1000 PF 691686-008	OMIT	1UF/35V 510429-025	47 UF/10V 859775-021	1000 UH 853587-020
-004	15 IPS INTER. BAND	OMIT	10 K 198200-103	47 Ω 198200-470	50 Ω 844993	1 K 329151-007	20 Ω 329151-002	OMIT	.0039UF 691686-035	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	1000 UH 853587-020
-005	7 ½ IPS INTER. BAND	OMIT	10 K 198200-103	47 Ω 198200-470	50 Ω 844993	500 Ω 329151-006	20 Ω 329151-002	OMIT	.015 UF 691686-012	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	1000 UH 853587-020
-006	3 ¾ IPS INTER. BAND	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	500 Ω 329151-006	20 Ω 329151-002	OMIT	.015 UF 691686-012	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	3900 UH 853587-034
-007	1 7/8 IPS INTER. BAND	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	500 Ω 329151-006	20 Ω 329151-002	OMIT	.033UF 691686-034	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	8200 UH 853587-040
-008	15/16 IPS INTER. BAND	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	200 Ω 329151-005	20 Ω 329151-002	OMIT	.068 UF 691686-055	OMIT	1UF/35V 510429-025	47UF/10V 859775-021	2000 UH 853587-0
-009	120 IPS WIDEBAND I	27 K 198200-273	12 K 198200-123	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	820 PF 197212-820	47 PF 197212-047	OMIT	.22 UF 510117-028	6.8 UF/15V 859775-012	220 UH 853587-003
-010	60 IPS WIDEBAND I	27 K 198200-273	12 K 198200-123	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	820 PF 198249-820	82 PF 197212-082	OMIT	.22 UF 510117-028	6.8 UF/15V 859775-012	470 UH 853587-001
-011	30 IPS WIDEBAND I	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	OMIT	150 PF 197212-150	OMIT	.22 UF 510117-028	4.7 UF/15V 859775-011	1000 UH 853587-020
-012	15 IPS WIDEBAND I	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	2 K 329151-008	50 Ω 329151-003	OMIT	680 PF 198249-680	OMIT	.22 UF/35V 859775-028	4.7 UF/15V 859775-011	1000 UH 853587-020
-013	7 ½ IPS WIDEBAND I	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	1K 329151-007	50 Ω 329151-003	OMIT	.0027 UF 691686-025	.01 UF 329157-001	.22UF/35V 859775-003	4.7UF/15V 859775-011	1000 UH 853587-020
-014	3 ¾ IPS WIDEBAND I	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	500 Ω 329151-006	100 Ω 329151-004	OMIT	.01 UF 691686-001	.022 UF 510116-041	.22 UF/35V 859775-003	4.7 UF/15V 859775-011	1000 UH 853587-020
-015	1 7/8 IPS WIDEBAND I	OMIT	8.2K 198200-822	JUMPER	100 Ω 844994	200 Ω 329151-005	100 Ω 329151-004	OMIT	.033 UF 691686-034	.022 UF 510116-041	.22 UF/35V 859775-003	4.7 UF/15V 859775-011	1000 UH 853587-020
-016	120 IPS WIDEBAND II	27 K 198200-273	12 K 198200-123	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	820 PF 197212-820	27 PF 197212-027	OMIT	.22 UF 510117-028	6.8 UF/15V 859775-012	220 UH 853587-003
-017	60 IPS WIDEBAND II	27 K 198200-273	12 K 198200-123	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	820 PF 198249-820	50 PF 197212-050	OMIT	.22 UF 510117-028	6.8 UF/15V 859775-012	470 UH 853587-001
-018	30 IPS WIDEBAND II	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	5 K 329151-009	20 Ω 329151-002	OMIT	75 PF 854528-075	OMIT	.22 UF 510117-028	4.7 UF/15V 859775-011	1000 UH 853587-020
-019	15 IPS WIDEBAND II	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	2 K 329151-008	50 Ω 329151-003	OMIT	330 PF 197212-330	OMIT	.22UF/35V 859775-028	4.7 UF/15V 859775-011	1000 UH 853587-020
-020	7 ½ IPS WIDEBAND II	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	1K 329151-007	50 Ω 329151-003	OMIT	.0012 UF 691686-026	.01 UF 329157-001	.22UF/35V 859775-003	4.7UF/15V 859775-011	1000 UH 853587-020
-021	3 ¾ IPS WIDEBAND II	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	500 Ω 329151-006	100 Ω 329151-004	OMIT	.0056 UF 691686-024	.022 UF 510116-041	.22 UF/35V 859775-003	4.7 UF/15V 859775-011	1000 UH 853587-020
-022	1 7/8 IPS WIDEBAND II	OMIT	8.2 K 198200-822	JUMPER	100 Ω 844994	200 Ω 329151-005	100 Ω 329151-004	OMIT	.022 UF 691686-021	.022 UF 510116-041	.22 UF/35V 859775-003	4.7 UF/15V 859775-011	1000 UH 853587-020
-023	ALL SPEEDS WIDEBAND	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	OMIT	20 Ω 329151-002	OMIT	OMIT	OMIT	.22 UF/35V 859775-003	4.7UF/15V 859775-011	OMIT
-024	ALL SPEEDS INTER. BAND	OMIT	10 K 198200-103	JUMPER	100 Ω 844994	OMIT	20 Ω 329151-002	OMIT	OMIT	OMIT	1UF/35V 859775-007	4.7 UF/10V 859775-011	OMIT



836083	C8	PART NO.	REMARKS
-001	47UF 6V	859775-021	INTERMEDIATE
-002	22 UF 25V	859775-017	WIDE BAND



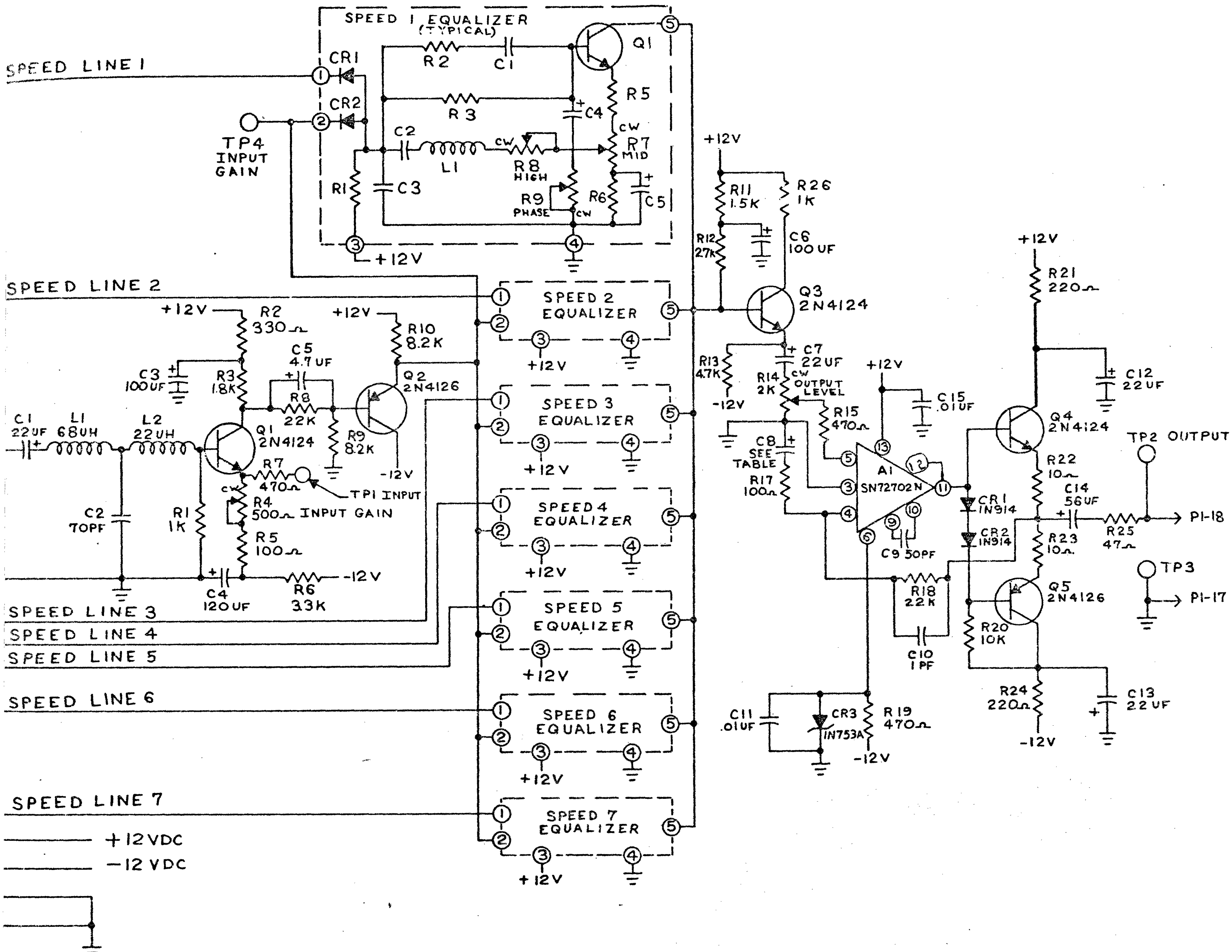


Figure 6. Direct Reproduce Board Schematic Diagram and Component Location

Sangamo

PREAMPLIFIERS AND PREAMPLIFIER POWER SUPPLY

GENERAL

The preamplifiers amplify the recovered signal directly from the tape reproduce head before it is passed to the reproduce boards. The complete preamplifier consists of an emitter follower board, directly adjacent to the reproduce head, and a preamplifier board, in the head area. Each channel consists of an emitter follower circuit (emitter follower bd.) and the two transistor preamp circuit (preamp board). Normally each preamp board provides sufficient circuitry for eight channels (½ inch 7 channel system - 1 board, 1 inch 14 channel system - 2 boards). In special cases two boards may be physically joined for mounting convenience.

The preamplifier power supply and regulator board provides regulated voltages for all preamplifiers. This board is composed of a printed circuit board with inputs of ±12 Vdc and outputs of -8.2 Vdc, ground, and +6.2 Vdc.

CHARACTERISTICS (PREAMP POWER SUPPLY)

Power Requirement	±11.5 Vdc ±0.5 Vdc @ 4.5 ma/ channel plus 10 ma
Temperature Range	0° to 130° F
Output Power Level	+6.2 Vdc ±0.25 Vdc @ 147 ma max -8.2 Vdc ±0.25 Vdc @ 147 ma max

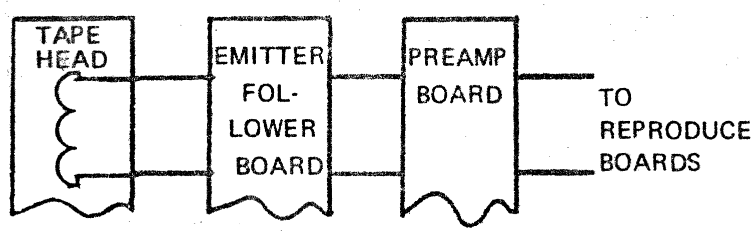


Figure 1. Typical Channel

THEORY OF OPERATION

The preamplifier power supply and regulator board converts +12 Vdc and -12 Vdc into regulated +6.2 Vdc and -8.2 Vdc.

The circuitry is divided into two sections; one producing +6.2 Vdc and one producing -8.2 Vdc. R3 and zener diode CR1 provide the necessary dc biasing for Q1 which has an output of +6.2 Vdc. R5 and CR2 provide the proper biasing for Q2 which has an output of -8.2 Vdc. Capacitors C1 through C4 are provided for filtering of the dc; Output connectors provide +6.2 Vdc at J1, 2, 3, and 4, ground at J5, 6, 7, and 8, and -8.2 Vdc at J9, 10, 11, and 12.

The preamplifier circuits consist of the emitter follower board (one mounted directly to each reproduce head stack) and the preamplifier board (normally mounted adjacent to the heads in the head area). Refer to figure 2, typical channel schematic. The emitter follower board may contain from 4 to 16 emitter follower circuits, dependent on the number of reproduce head stack channels. Each circuits prime function is to provide isolation between the reproduce head and the preamplifier circuits. Resistor R1 is used to limit current through the head in event of a transistor malfunction. -8.2 Vdc is the only power required with C1 used for filtering of this dc voltage. Correlation of the emitter follower circuits to head channels is shown in figures 7, 8 and possibly other as new configurations are used.

Each preamplifier board normally contains from 7 to 8 low noise, dc coupled, inverting amplifier stages. With a 7 channel system one board (7 stages) is used. A 14 data channel, two edge track system would use two boards (8 stages each). Each stage consists of a transistor amplifier and a low impedance output emitter follower stage. Refer to figures 7, 8 and possibly others, for correlating board channel circuits to head channels. -8.2 Vdc and +6.2 Vdc are the dc voltages required by this board.

MAINTENANCE

a. EQUIPMENT REQUIRED

Digital Voltmeter HP3440A or equivalent
Two 40 ohm, 1 watt resistors

b. PREAMPLIFIER POWER SUPPLY - The following checks are provided to determine the operational status of the preamplifier power supply.

Step 1. With the board remaining on the recorder/reproducer, visually inspect the component side for loose connections or mountings, dented, misshaped, missing or broken components, foreign material and signs of overheating.

Step 2. Remove the power leads (to preamps) and apply power.

Step 3. With a digital voltmeter ensure the presence of +12 Vdc at the + side of C1, -12 Vdc at the - side of C3, +6.2 Vdc between J1 and J5, and -8.2 Vdc between J9 and J5.

Step 4. Remove all power and connect the two 40 ohm resistors between J1 and J5, and J9 and J5.

Step 5. Apply power and measure voltages as in Step 3. The readings should coincide with those in Step 3.

c. EMITTER FOLLOWER BOARD - The operation of any circuit on the emitter follower board may be checked by monitoring the channel (corresponding to the emitter follower circuit in question) output while reproducing recorded data. Either the output of the preamp board or the emitter follower board may be monitored.

d. PREAMPLIFIER BOARD - The operation of any circuit on the preamp board may be checked by monitoring the particular circuit channel output while reproducing recorded data.

CAUTION

After soldering on the emitter follower boards or preamplifier boards the record/reproduce heads must be de-magnetized.

PARTS LIST

Preamp Power Supply 835910 (portable) 836017 (laboratory)

C1	691391-005	L1	510077-001
C2	691391-033	L2	510077-001
C3	691391-005	Q1	853533
C4	691391-033	Q2	510381
C5	859775-029	R1	198200-102
C6	859775-029	R2	198204-220
CR1	852475-024	R3	198200-102
CR2	844762	R4	198200-471
J1 thru J12	855772	R5	198200-102

Emitter Follower Board 835856
-001 (4 ckts), -002 (7 ckts), -003 (8 ckts), -004 (14 ckts), -005 (16 ckts)

All transistors 2N5087	859971
All resistors 100 ohm	198200-101
All capacitors 47 mfd	859775-021

Preamplifier Board 835886
-001 (7 ckts), -002 (8 ckts)

C1 thru C8	859775-021	R1	198200-562
		R2	198200-332
		R3	198200-470
C9	329157-001	R4	198200-332
C10	859775-031	R5	198200-472
C11	329157-001	R6	198200-470
C12	859775-031	R7	198200-562
Q1 thru Q16	859971	R8	198200-332
		R9	198200-470
		R10	198200-332

PARTS LIST (CONT)

Preamplifier Board 835886
-001 (7 ckts), -002 (8 ckts)

R11	198200-472	R30	198200-470
R12	198200-470	R31	198200-562
R13	198200-562	R32	198200-332
R14	198200-332	R33	198200-470
R15	198200-470	R34	198200-332
R16	198200-332	R35	198200-472
R17	198200-472	R36	198200-470
R18	198200-470	R37	198200-562
R19	198200-562	R38	198200-470
R20	198200-332	R39	198200-470
R21	198200-470	R40	198200-332
R22	198200-332	R41	198200-472
R23	198200-472	R42	198200-470
R24	198200-470	R43	198200-562
R25	198200-562	R44	198200-332
R26	198200-332	R45	198200-470
R27	198200-470	R46	198200-332
R28	198200-332	R47	198200-472
R29	198200-472	R48	198200-470

Preamplifier Board 835953
-001 (14 ckts), -002 (16 ckts)

C1 thru C16	859775-021	R2	198200-332
		R3	198200-470
		R4	198200-332
C17	329157-001	R5	198200-472
C18	859775-031	R6	198200-470
C19	329157-001	R7	198200-562
C20	859775-031	R8	198200-332
C21	329157-001	R9	198200-470
C22	859775-031	R10	198200-332
C23	329157-001	R11	198200-472
C24	859775-031	R12	198200-470
Q1 thru Q32	855971	R13	198200-562
		R14	198200-332
		R15	198200-470
R1	198200-562	R16	198200-332

PARTS LIST (CONT)

Preamplifier Board 835953
-001 (14 ckts), -002 (16 ckts)

R17	198200-472	R57	198200-470
R18	198200-470	R58	198200-332
R19	198200-562	R59	198200-472
R20	198200-332	R60	198200-470
R21	198200-470	R61	198200-562
R22	198200-332	R62	198200-332
R23	198200-472	R63	198200-470
R24	198200-470	R64	198200-332
R25	198200-562	R65	198200-472
R26	198200-332	R66	198200-470
R27	198200-470	R67	198200-562
R28	198200-332	R68	198200-332
R29	198200-472	R69	198200-470
R30	198200-470	R70	198200-332
R31	198200-562	R71	198200-472
R32	198200-332	R72	198200-470
R33	198200-470	R73	198200-562
R34	198200-332	R74	198200-332
R35	198200-472	R75	198200-470
R36	198200-470	R76	198200-332
R37	198200-562	R77	198200-472
R38	198200-332	R78	198200-470
R39	198200-470	R79	198200-562
R40	198200-332	R80	198200-332
R41	198200-472	R81	198200-470
R42	198200-470	R82	198200-332
R43	198200-562	R83	198200-472
R44	198200-332	R84	198200-470
R45	198200-470	R85	198200-562
R46	198200-332	R86	198200-332
R47	198200-472	R87	198200-470
R48	198200-470	R88	198200-332
R49	198200-562	R89	198200-472
R50	198200-332	R90	198200-470
R51	198200-470	R91	198200-562
R52	198200-332	R92	198200-332
R53	198200-472	R93	198200-470
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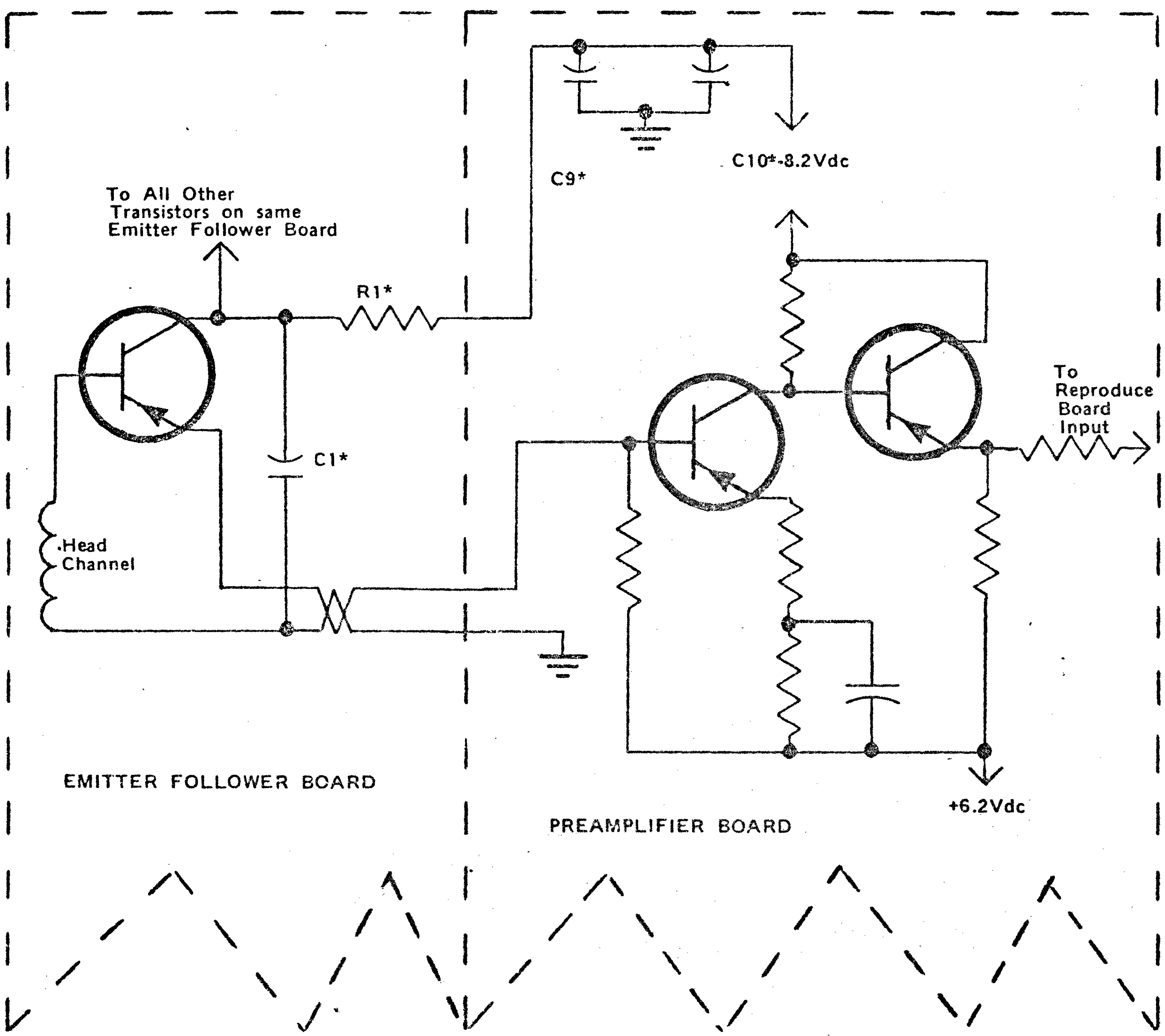
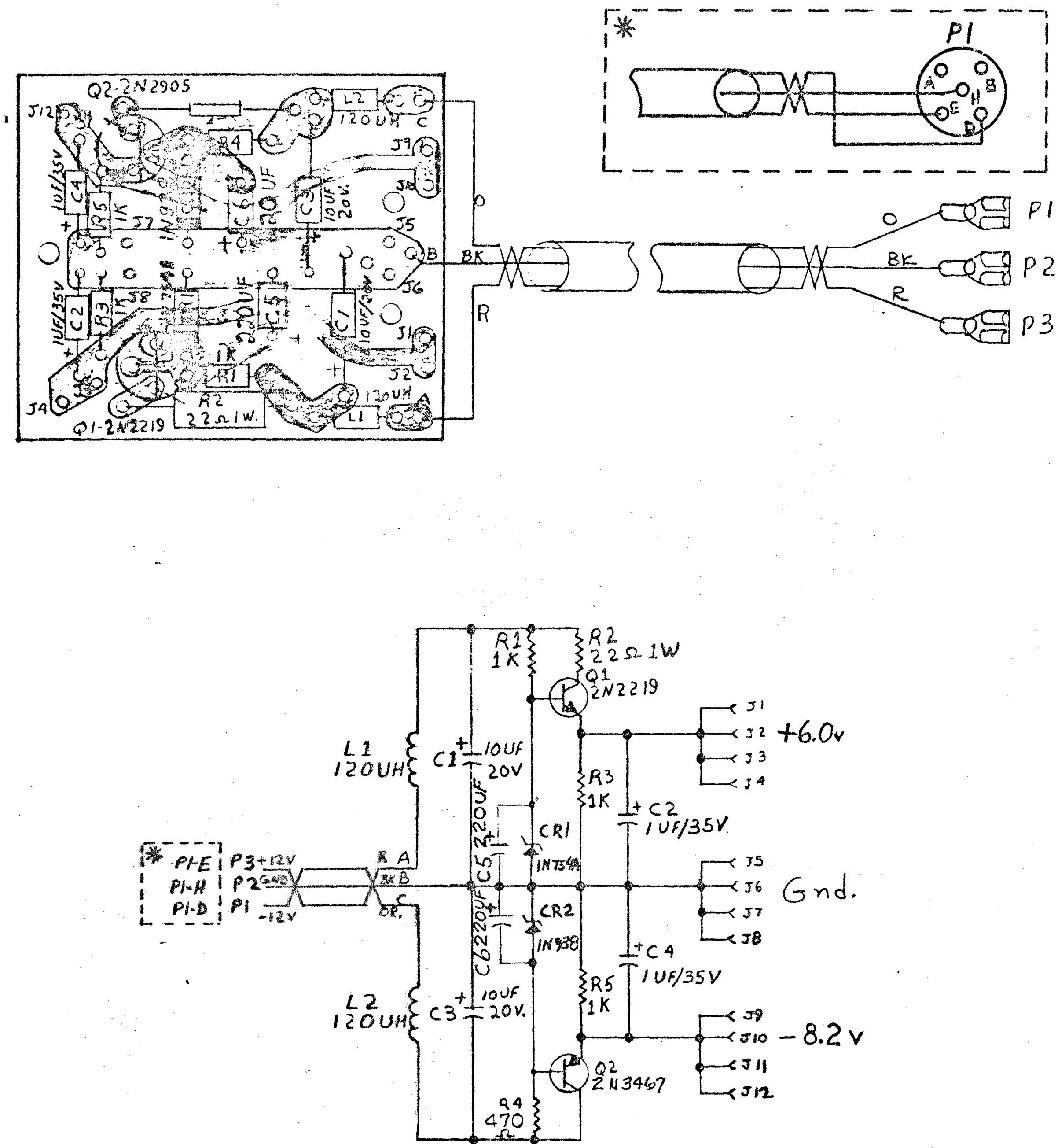
R55	198200-562	R95	198200-472
R56	198200-332	R96	198200-470



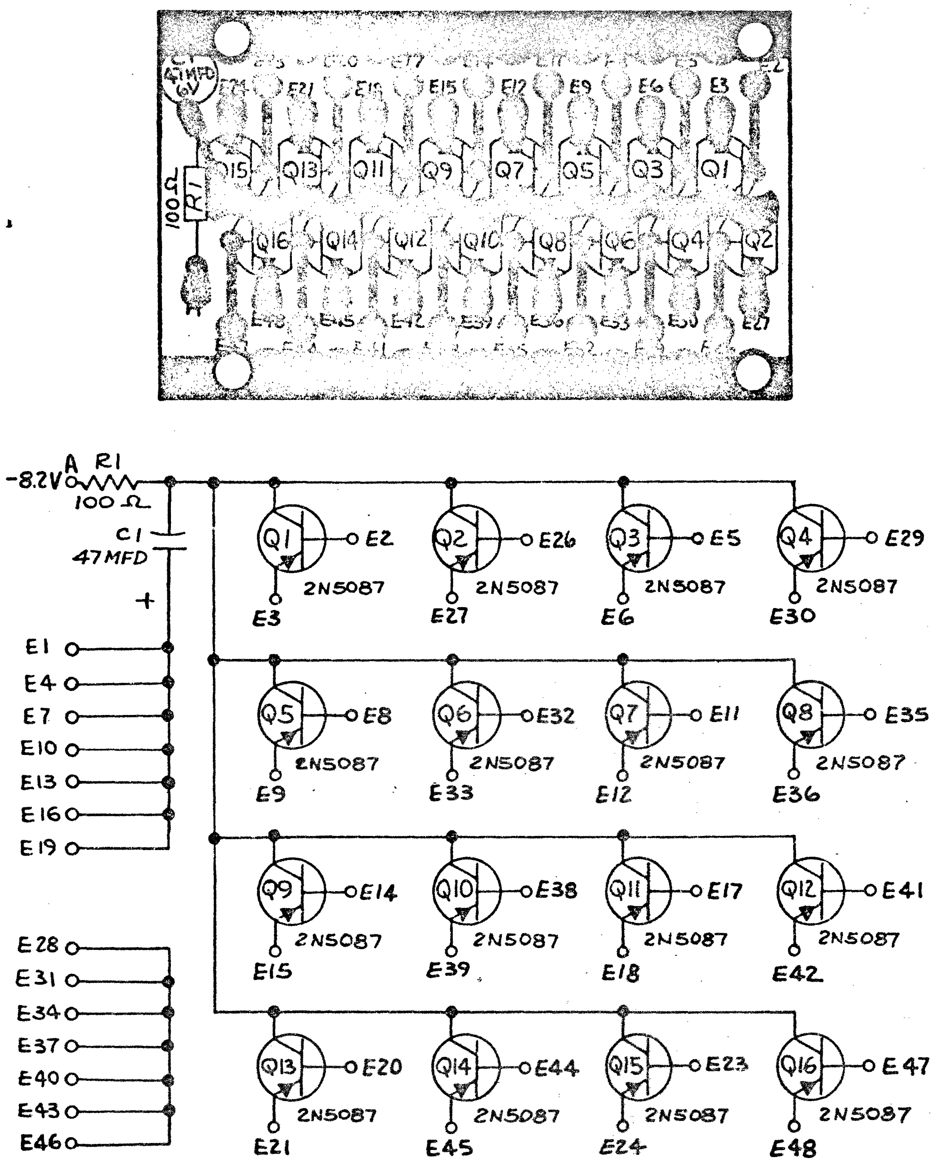
*THESE COMPONENTS USED ONCE PER BOARD, FOR ALL CIRCUITS ON THAT BOARD.

Figure 2. Typical Channel Schematic



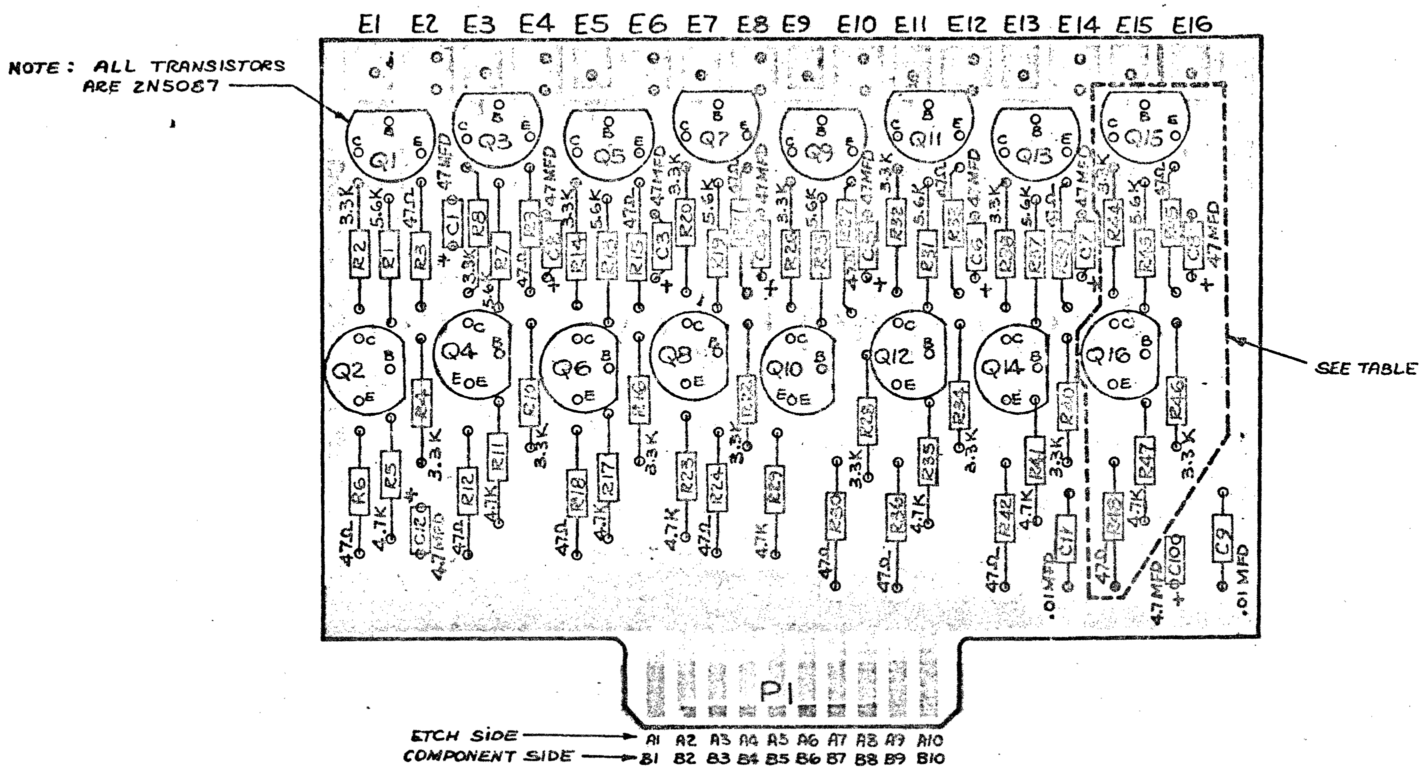
* Used for laboratory model (preamp power supply part no. 836017)

Figure 3. Preamp Power Supply, Schematic Diagram and Component Location

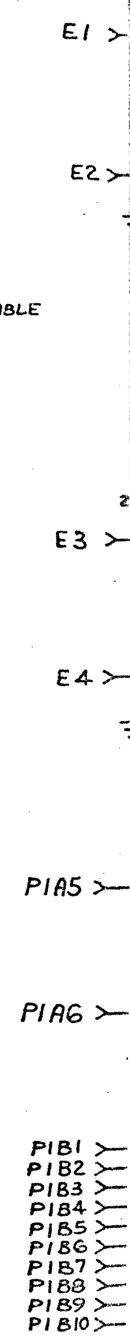


BOARD PART NO.	DESCRIPTION	COMPONENTS USED
835856-001	4 ckts	Q10, Q11, Q14, and Q15
835856-002	7 ckts	Q3, Q6, Q7, Q10, Q11, Q14, and Q15
835856-003	8 ckts	Q2, Q3, Q6, Q7, Q10, Q11, Q14, and Q15
835856-004	14 ckts	Q1 through Q14
835856-005	16 ckts	Q1 through Q16

Figure 4. Emitter Follower Board, Schematic and Wiring Diagram



BOARD PART NO.	DESCRIPTION
835886-001	Contains 7 circuits by the omission of those components enclosed in the dotted lines.
835886-002	Contains 8 circuits by the use of those components enclosed in the dotted lines.



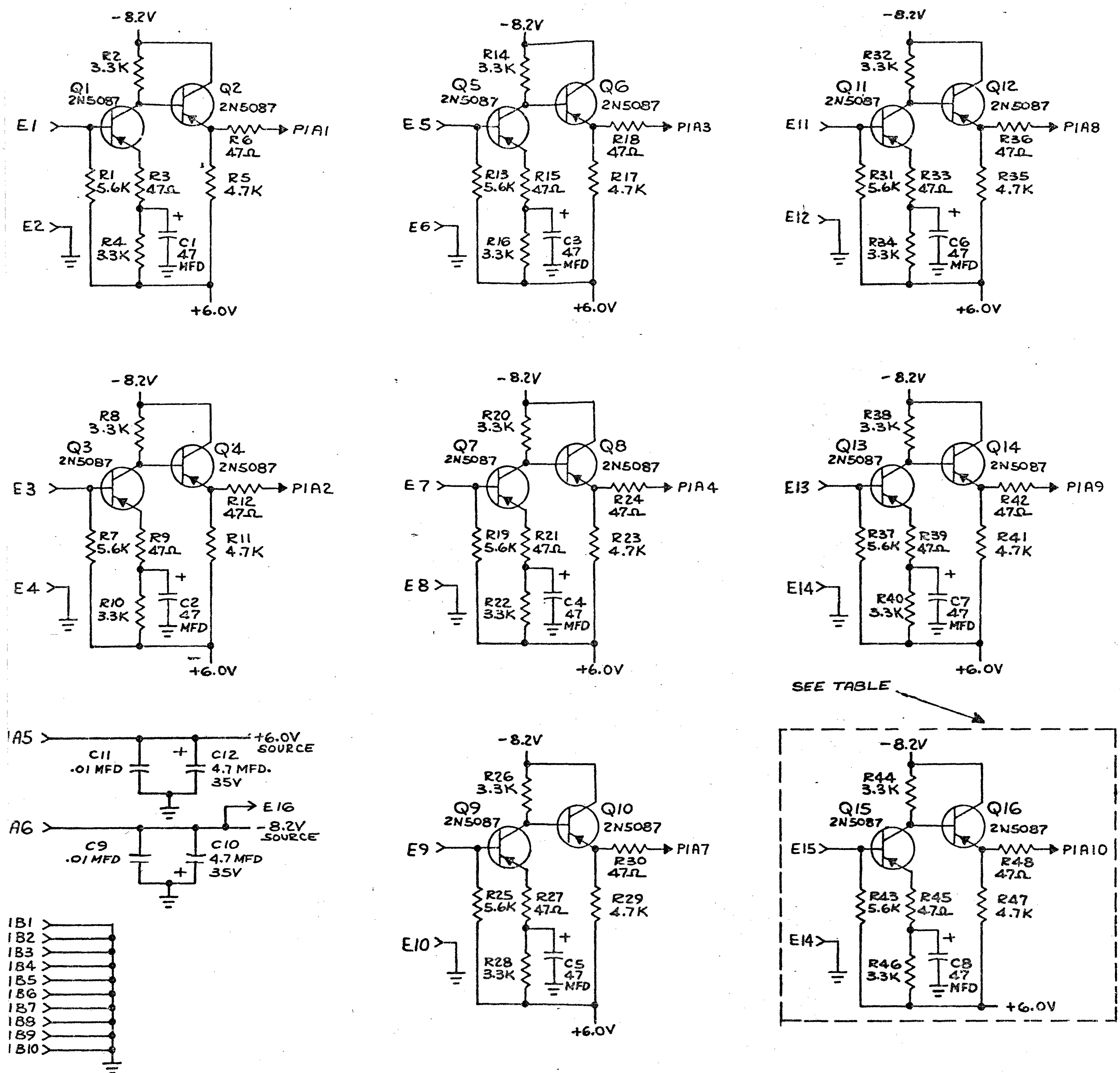
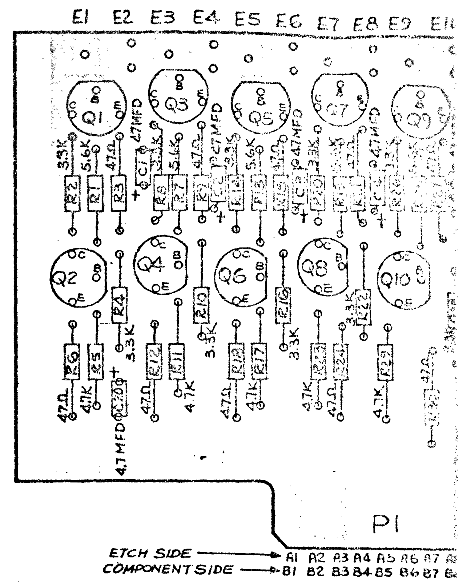
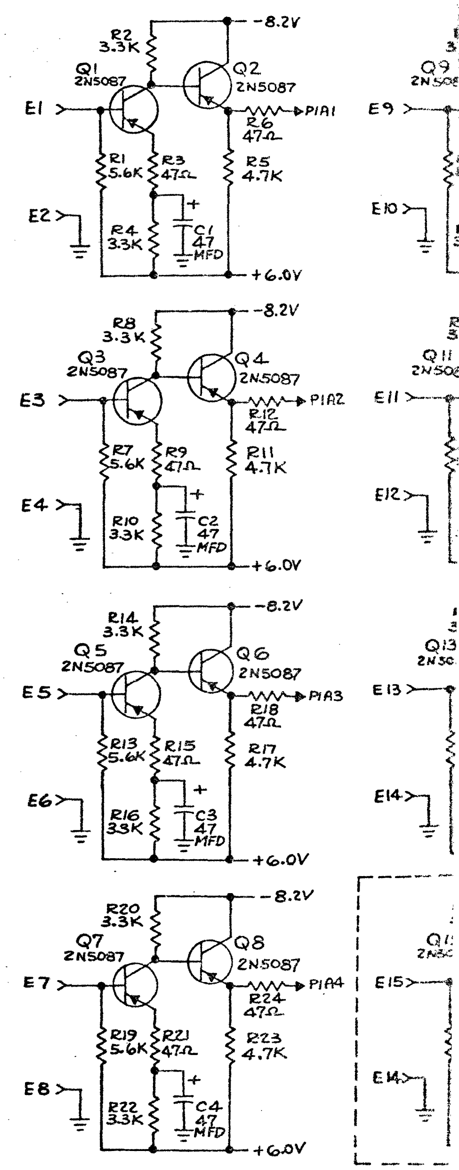


Figure 5. Preamplifier Board, Schematic and Wiring Diagram (7-8 channel, 14-16 channel)

BOARD PART NO.	DESCRIPTION
835953-001	Contains 14 circuits by the omission of those components enclosed in the dotted lines.
835953-002	Contains 16 circuits by the use of those components enclosed in the dotted lines.





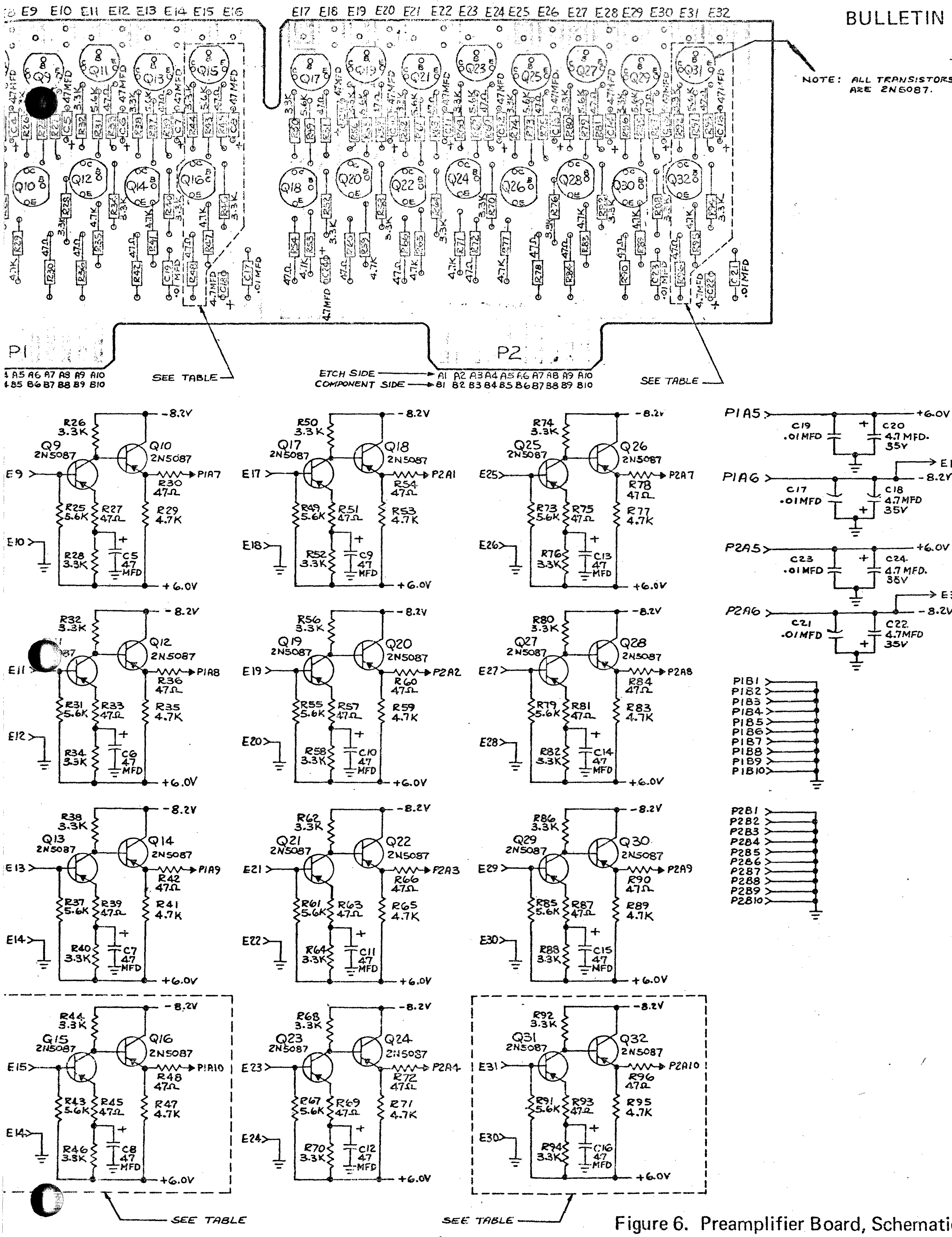
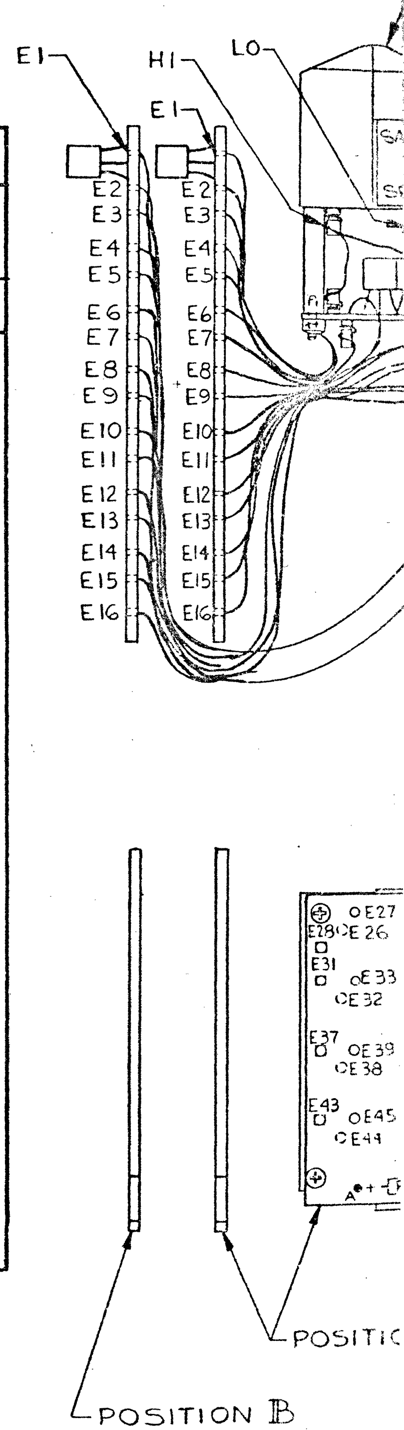
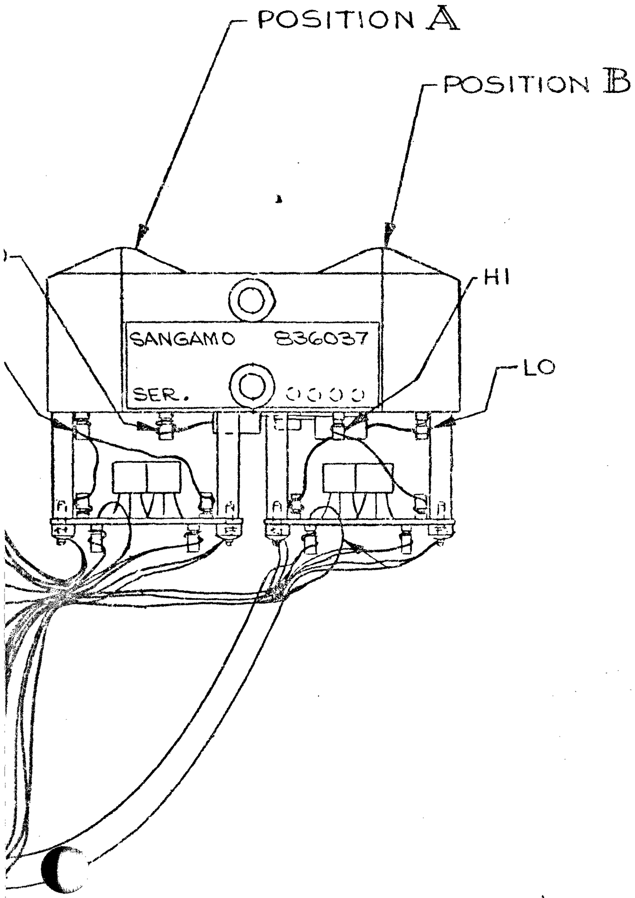
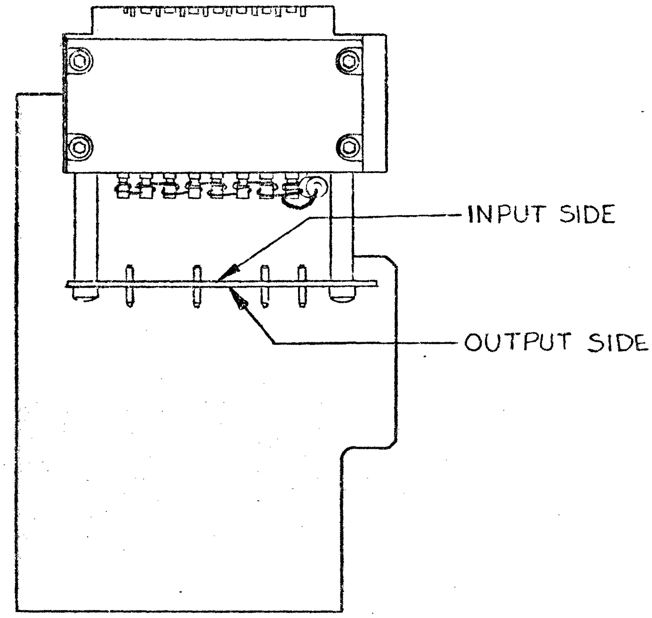


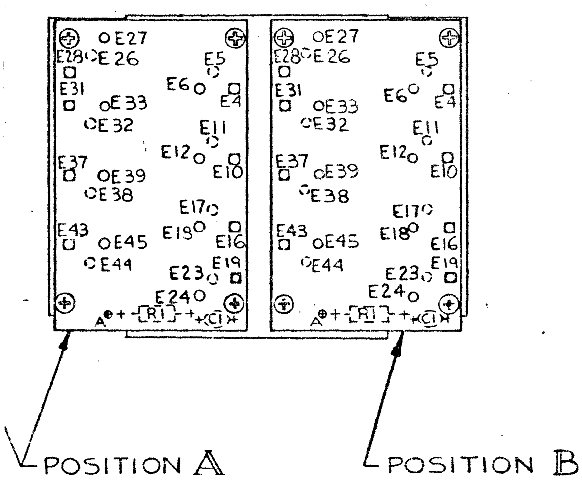
Figure 6. Preamplifier Board, Schematic and Wiring Diagram (28 channel, 32 channel)

ONE INCH – 14 TRACK, WITH EDGE A & B, REPRODUCE LEAD INTERCONNECTIONS						
Channel No.	Emitter Follower Board, Item 4, Inputs		Emitter Follower Board, Item 4, Outputs		Preamplifier Board, Item 5, Inputs	
	Position A	Position B	Position A	Position B	Position A	Position B
1	E26		E27			E1
3	E5		E6			E5
5	E32		E33			E9
7	E11		E12			E13
9	E38		E39		E3	
11	E17		E18		E7	
13	E44		E45		E11	
B	E23		E24		E15	
2		E26		E27		E3
4		E5		E6		E7
6		E32		E33		E11
8		E11		E12	E1	
10		E38		E39	E5	
12		E17		E18	E9	
14		E44		E45	E13	
A		E23		E24		E15





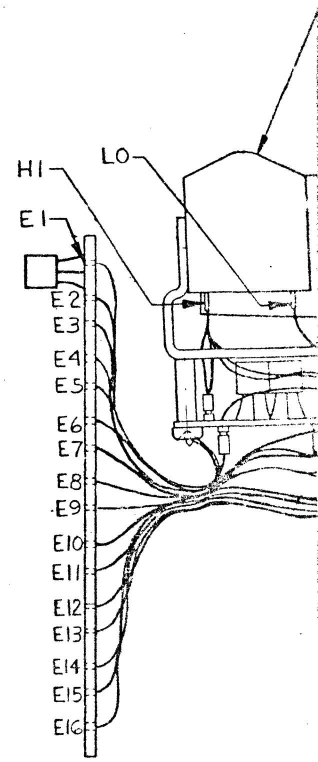


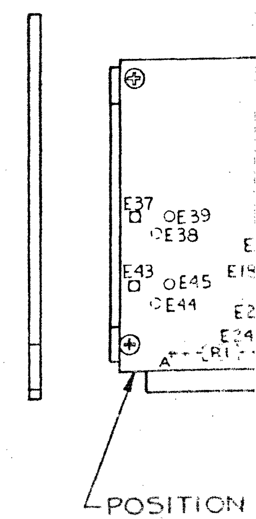


B

Figure 7. One Inch - 14 Track Reproduce Interconnections

ONE-HALF INCH – 7 TRACK, WITH EDGE A, REPRODUCE LEAD INTERCONNECTIONS					
Channel No.	Emitter Follower Board, Item 4, Inputs		Emitter Follower Board, Item 4, Outputs		Preamplifier Board, Item 5, Inputs
	Position A	Position B	Position A	Position B	
1	E38		E39		E1
3	E17		E18		E5
5	E44		E45		E9
7	E23		E24		E13
2		E17		E18	E3
4		E44		E45	E7
6		E23		E24	E11
A		E38		E39	E12





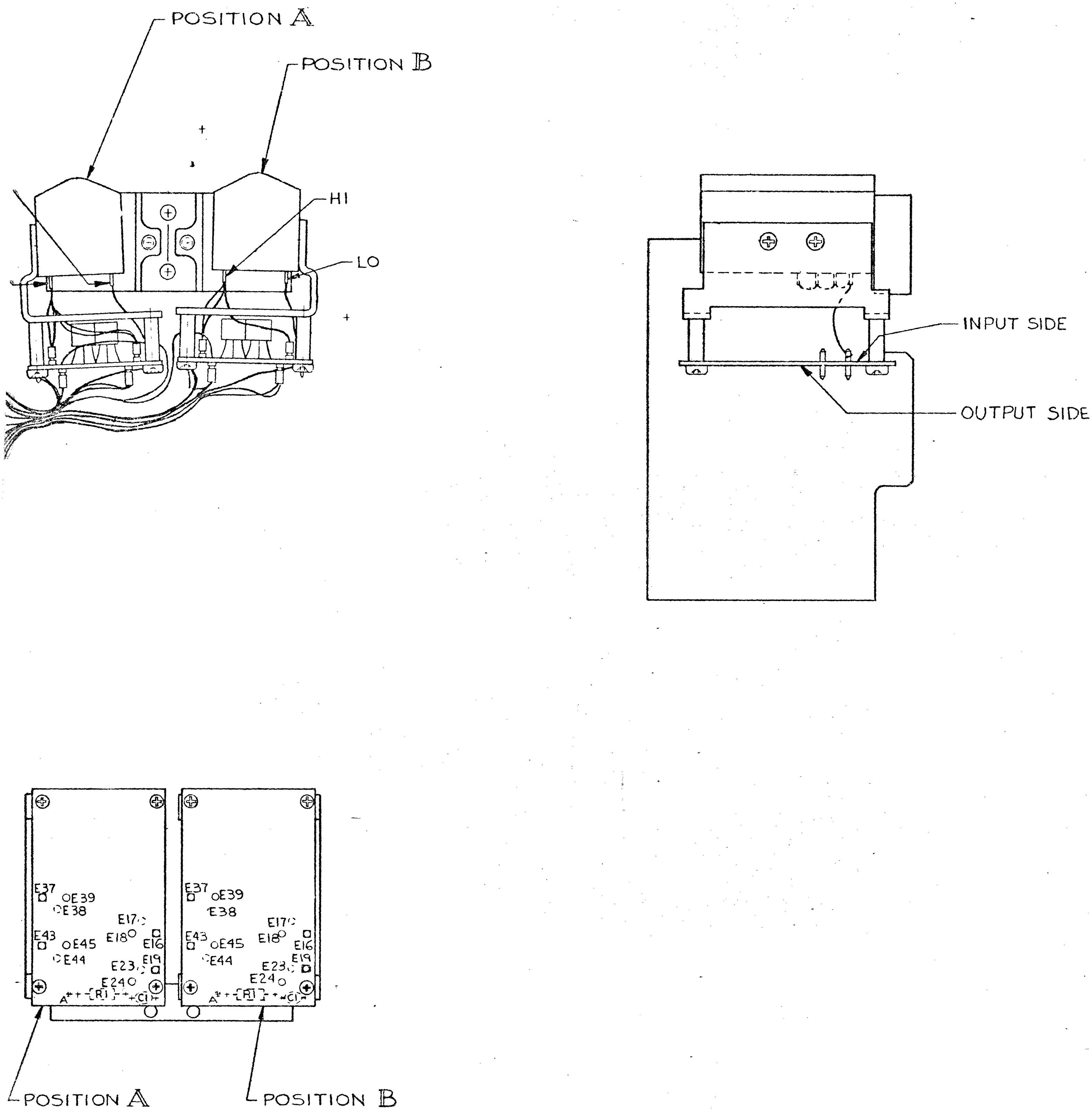
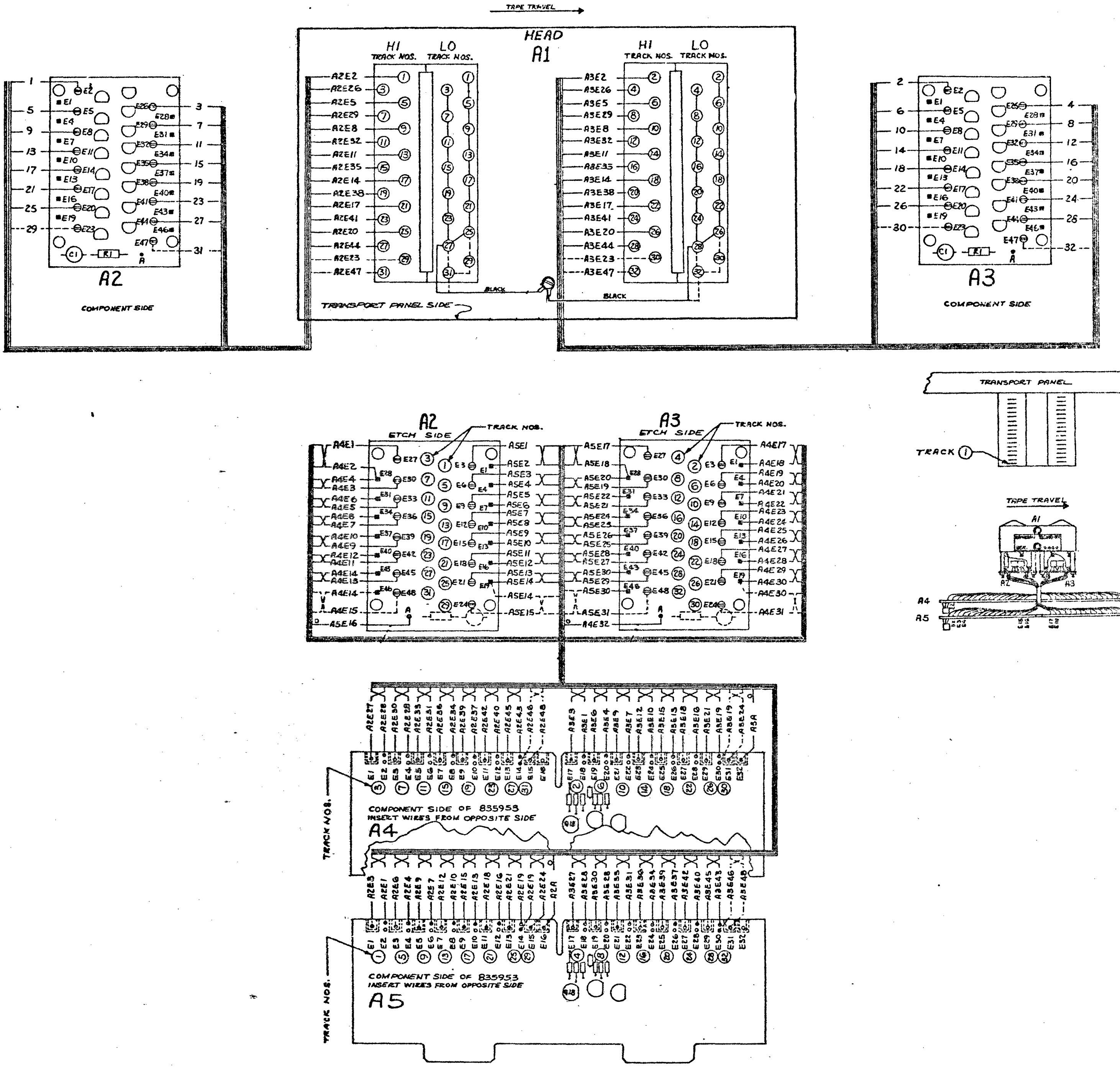
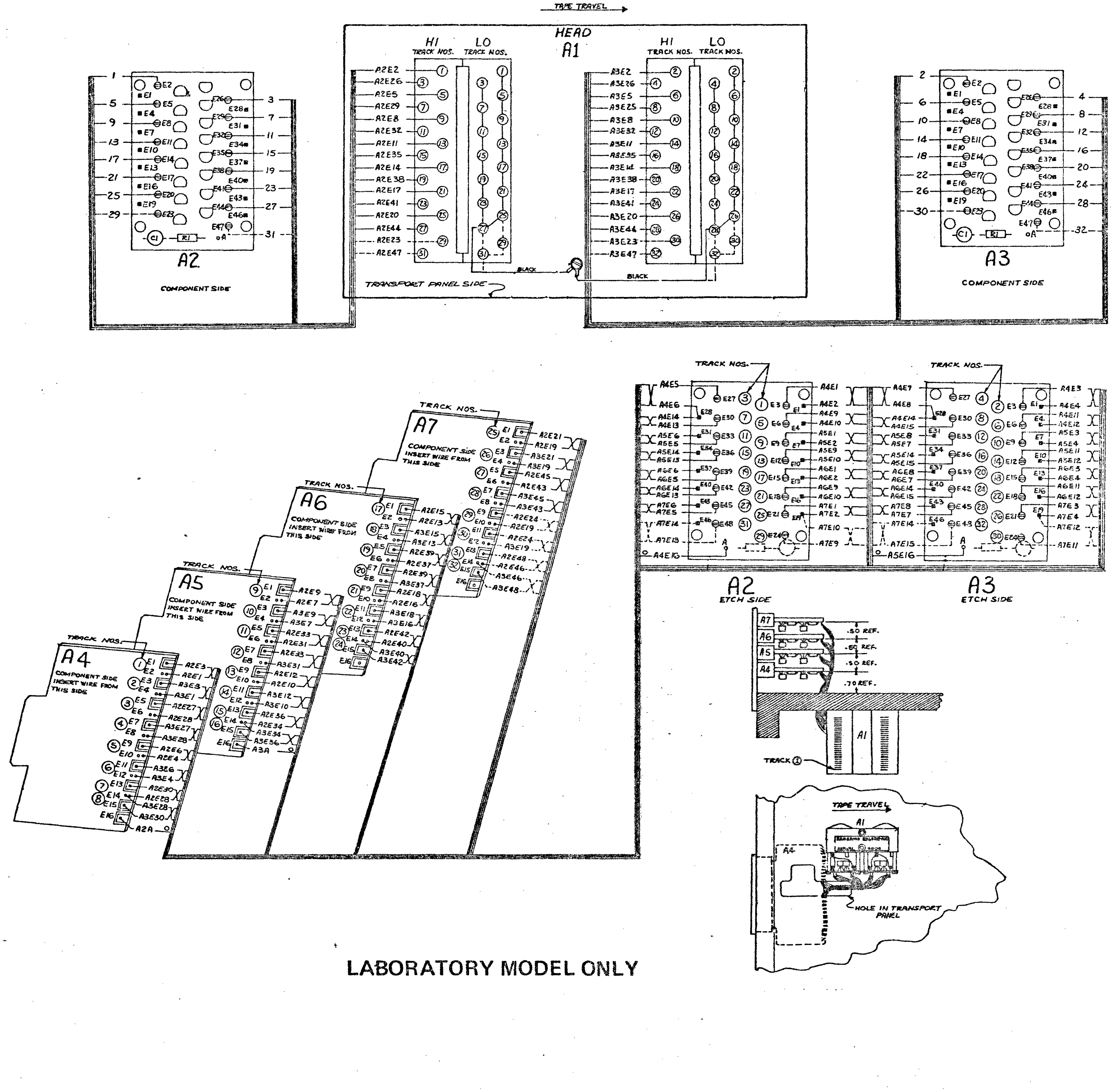


Figure 8. One-Half Inch - 7 Track Reproduce Interconnections



PORTABLE MODEL ONLY



LABORATORY MODEL ONLY

Figure 9. One Inch, 28/32 Track Reproduce Interconnections

Sangamo

REGULATED AC TO DC POWER SUPPLY

GENERAL

This bulletin contains complete information on the optional ac to dc power supply unit. Contained are characteristics, operating procedures, theory of operation, maintenance and adjustment procedures, parts list, and diagrams.

This power supply unit contains the capability of producing, with good regulation, +28 Vdc, from a 110 or 220 Vac source of 47-63 Hz.* The supply being completely solid state in design is composed of one removeable circuit board and one module (heat sink). Proper fusing, reset capabilities, POWER indicator lamp and ON/OFF POWER switch are all conveniently located on the front panel of the unit. The unit may be installed in any convenient location but is normally placed beneath the recorder/reproducer tape transport. A five conductor cable, employing the proper connectors, is provided for installation between the power supply and the transport. +28 Vdc is ran separately from the power supply to the transport for the blower fan. A power cord is provided for connection between a convenience outlet and the power supply unit.

Refer to the INSTALLATION BULLETIN for information concerning the connection and installation of this unit.

CHARACTERISTICS

Input Voltage	110 Vac or 220 Vac at 47-63 Hz*
Input Current	0-10 amps rms
Temperature	5°C to 50°C
Output Voltage	28 Vdc ± .1 Vdc
Output Current	0-20 amps continuous

OPERATING PROCEDURES

a. **CONTROLS** – The following table 1 lists those operator controls employed with the power supply unit. For adjustment procedures refer to the maintenance section of this bulletin.

TABLE 1. CONTROLS AND ADJUSTMENTS

CONTROLS OR ADJUSTMENTS	LOCATION AND FUNCTION
ON/OFF POWER switch (S1) (Up is ON down is OFF)	Located on the front panel of the unit it controls the application of primary power to the entire power supply.

* Mod kit (835496) available for operation from 47-400 Hz.

TABLE 1. CONTROLS AND ADJUSTMENTS (CONT')	
CONTROLS OR ADJUSTMENTS	LOCATION AND FUNCTION
Reset Switch (S2)	Located on the front panel of the unit it provides for reestablishing the output voltage after the overload protector has detected an overload condition and the regulator ceases to develop an output.

b. FUSING – The following table 2 lists those fuses employed by their circuit designation, rating and function. All fuses are mounted on the front of the unit and are easily accessable for checking and changing.

CAUTION

Never replace a fuse with one of a higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement do not replace it a second time until the fault is located and has been corrected.

TABLE 2. POWER SUPPLY FUSE FUNCTIONS			
FUSE	RATING (amp)	FUNCTION	PART NO.
F1	ABC-10A (110 V input)	Primary Power	859774-008
	ABC-5A (220 V input)		859774-005
F2	ABC-20A	+28 volt	859774-011

THEORY OF OPERATION

a. GENERAL – The entire unit consists of an ON/OFF POWER switch S1, cooling fan, power transformer, bridge rectifier, one regulator module (A2) and one regulator board (A1). Refer to figures 1 and 2 for schematic and wiring diagrams. Proper fusing is employed at the input and output of the power transformer. Upon rectification by a full wave bridge a filter network is employed. Power input to the unit is obtained through J3 and output through J2. +28 Vdc is ran separately to the transport for powering only the transport blower fan.

b. CIRCUIT DESCRIPTION – The primary power is applied through F1 and S1 to the primary winding of power transformer T1 and to lamp DS1. The output of the secondary winding is rectified by a full-wave rectifier, on regulator module A2, consisting of diodes A2CR1 thru A2CR4. The dc output of the rectifier is filtered by capacitors C1 and C2 and applied, through fuse F2, to the regulator circuit on regulator board A1 and to the reset switch.

The voltage regulator circuits on A1 consist of differential amplifiers A1Q1 and A1Q2, regulator A1Q3 and series regulator A1Q4. The differential amplifier will provide an output at the collector of A1Q2 that is representative of the difference between the voltages applied to the bases of transistors A1Q2 and A1Q1. The voltage at the base of A1Q2 is set by A1R6 and A1CR1 connected across the regulated output. Another voltage divider, consisting of resistors A1R9, A1R10 and A1R11, is connected across the regulated output. The voltage at the base of transistor A1Q1 is set by potentiometer A1R10. When the power supply is operating normally, the voltage at the bases of differential amplifier A1Q1 and A1Q2 will be equal.

Should the output of the regulator vary, a portion of the voltage change will appear at the base of A1A1. The voltage at the base of transistor A1Q2 varies slightly with the output change but not to the extent as the base of transistor A1Q1, due to CR1. The difference in voltage at the two bases is amplified and directly coupled from the collector of A1Q2 to the base of series driver A1Q3. The emitter of A1Q3 regulates series regulator A1Q4 and thus regulates the amount of conduction by each of the series-parallel regulators, A2Q1 through A2Q6, on the regulator module, A2. This brings the regulated output back to its proper level.

When a high load or short condition is sensed the output of the regulator goes to zero due to the short circuit protection feature. During this period the bases of differential amplifier A1Q1 and A1Q2 return to 0 Vdc. When the reset switch, S2, is depressed, regulator board pin H is connected to pin J, discharging capacitor, C1. When S2 is released pin A is again connected to pin J applying a positive pulse to the base of A1Q2. The base of A1Q1 also goes positive due to the time delay of A1C2. This action establishes the normal operation of the regulator, producing the proper the proper output voltage.

MAINTENANCE

a. EQUIPMENT REQUIRED

Tektronix 503 Oscilloscope or Equiv.
Fluke 2800-A Digital Voltmeter or Equiv.

b. ADJUSTMENTS – These procedures are to be followed for adjustment of the +28 Vdc supply output. Prior to adjustment, the supply output may be checked at the power and control connector panel, at the right side of the recorder/reproducer.

Step 1. Ensure the front panel ring is removed and the chassis and front panel are slid out of the unit cabinet. Ensure the proper fuses are in place, the proper ac and dc cables are connected, and T1 is wired properly for the proper input voltage (See figures 1 and 2).

Step 2. Position the ON/OFF POWER switch at the front of the unit, to the ON (up) position.

Step 3. Connect a digital voltmeter between A1TP3 (hi) and A1TP2 (on printed circuit board at rear of power supply).

Step 4. Adjust A1R10 (on printed circuit board) for a +28 Vdc ±.1 Vdc reading on the voltmeter.

c. TEST

Step 1. With all power off visually inspect the power supply (cabinet removed), printed circuit board, and module for loose connections or mountings, dented misshaped, missing, or broken components, foreign material, and signs of overheating.

Step 2. Check continuity as follows:

HI	LO	READING
J2-A	J2C	1K ohms or greater

Step 3. Apply POWER, and in sequence ensure the presence of the following approximate readings at the indicated points.

HI	LO	READING
T1 pin 8	T1 pin 9	34 Vac ±2 Vac
+ side of C1	- side of C1	44 Vdc ±2 Vdc
A1TP2	A1TP3	+28 Vdc
A1TP1	A1TP3	+21 Vdc
A1TP5	A1TP3	+21 Vdc
A1TP4	A1TP3	-17 Vdc
A1TP6	A1TP3	-16 Vdc

Step 4. Connect oscilloscope between A1TP3 (hi) and A1TP2 (lo) and ensure ac ripple is less than 100 mVp-p.

PARTS LIST

Power Supply 28 Vdc 835564

Unit #2 – Power Supply	835564	**F1		S1	822087
*B1	858820-001	F2	859774-011	S2	851264
C1	691975-035	J1	835887-007	T1	270445
C2	691975-035	J2	836077-004	XF1	812299
DS1	510225	J3	854725	XF2	812299

28 V Regulator Board A1 835563

C1	847013	Q2	852738	R7	198200-122
C2	898235	Q3	853533	R8	198200-122
C3	851139-008	Q4	851271	R9	198200-272
C4	851139-016	R1	691112-220	R10	329151-006
CR1	853531	R2	198200-103	R11	198200-103
MP1	854220	R3	198200-221	R12	198200-470
	(for Q3)	R4	691112-102	TP1	855913
MP2	847825	R5	844164	thru	
	(for Q4	R6	198200-272	TP6	
Q1	852738				

* Uses 854549-001 if 47-400 Hz Mod Kit 835496 is used.

** 110 V input uses a 10 amp fuse, part no. 859774-008
220 V input uses a 5 amp fuse, part no. 859774-005

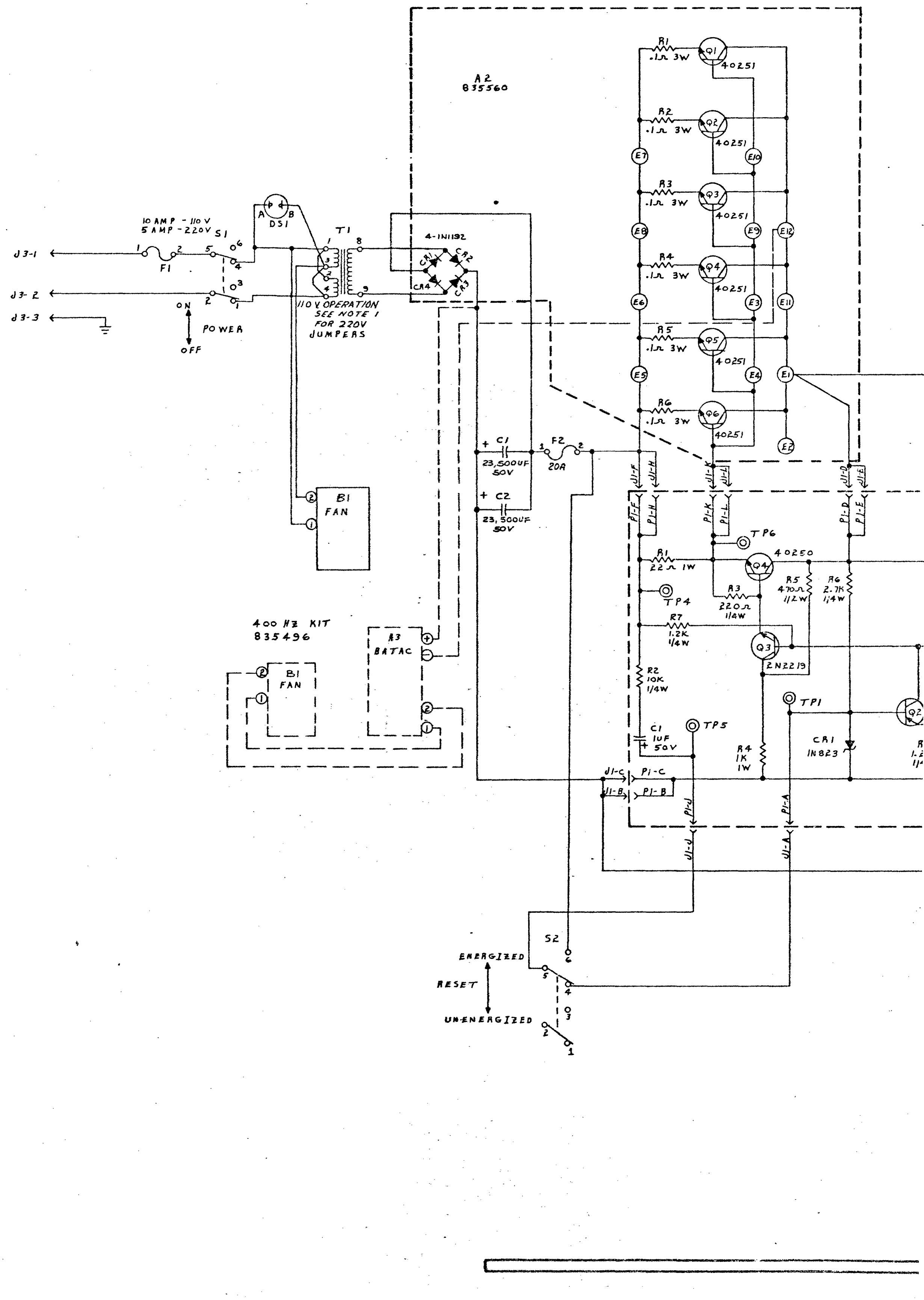
PARTS LIST (CONT')

28 V Regulator Module A2 835560

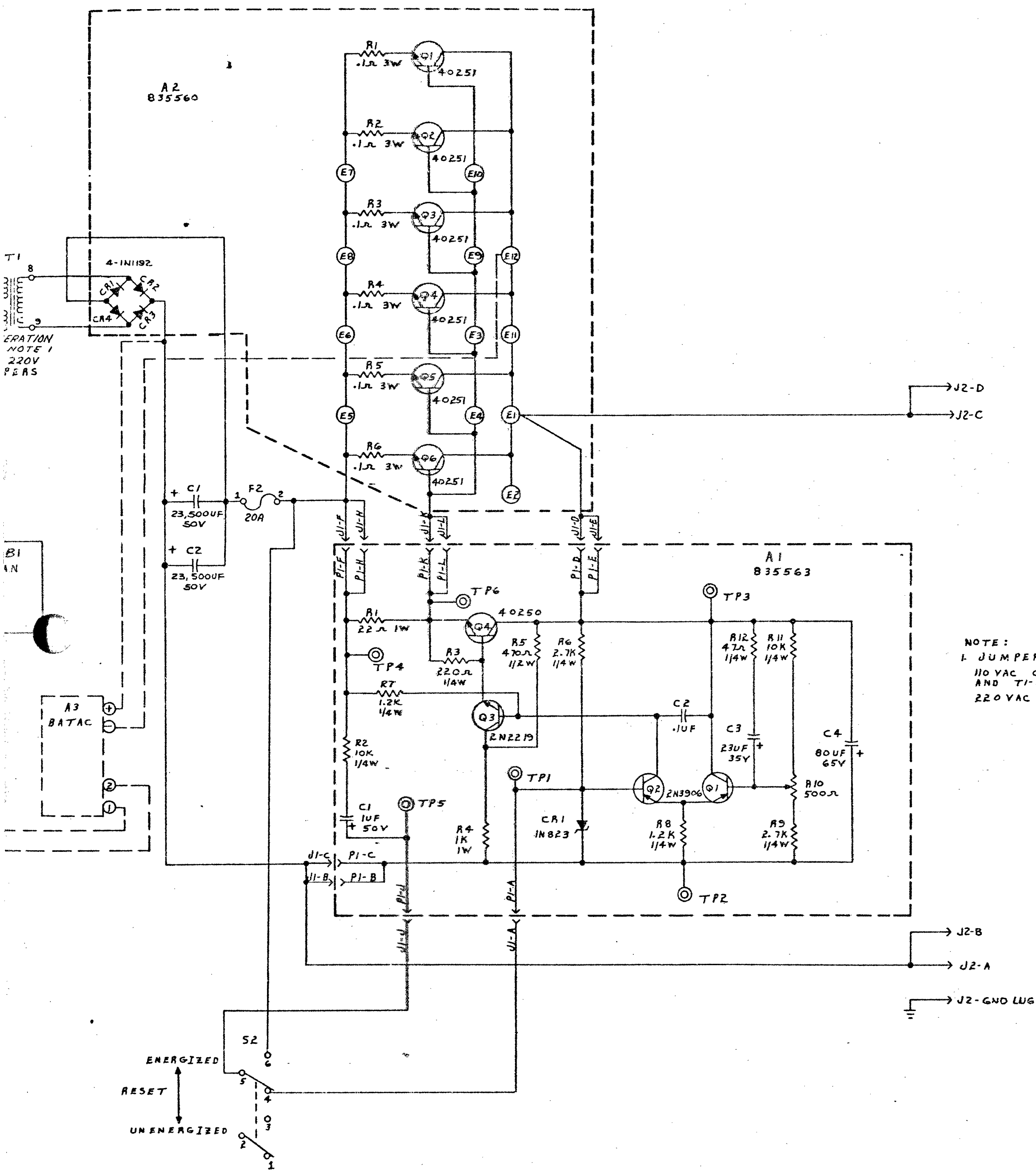
CR1 thru CR4	859759	MP2	835558
E1 thru E12	825575	Q1 thru Q6	853507
MP1	835558	R1 thru R6	897583

47-440 Hz Input Mod kit 835496

Batac	854538-001
B1	854549-001

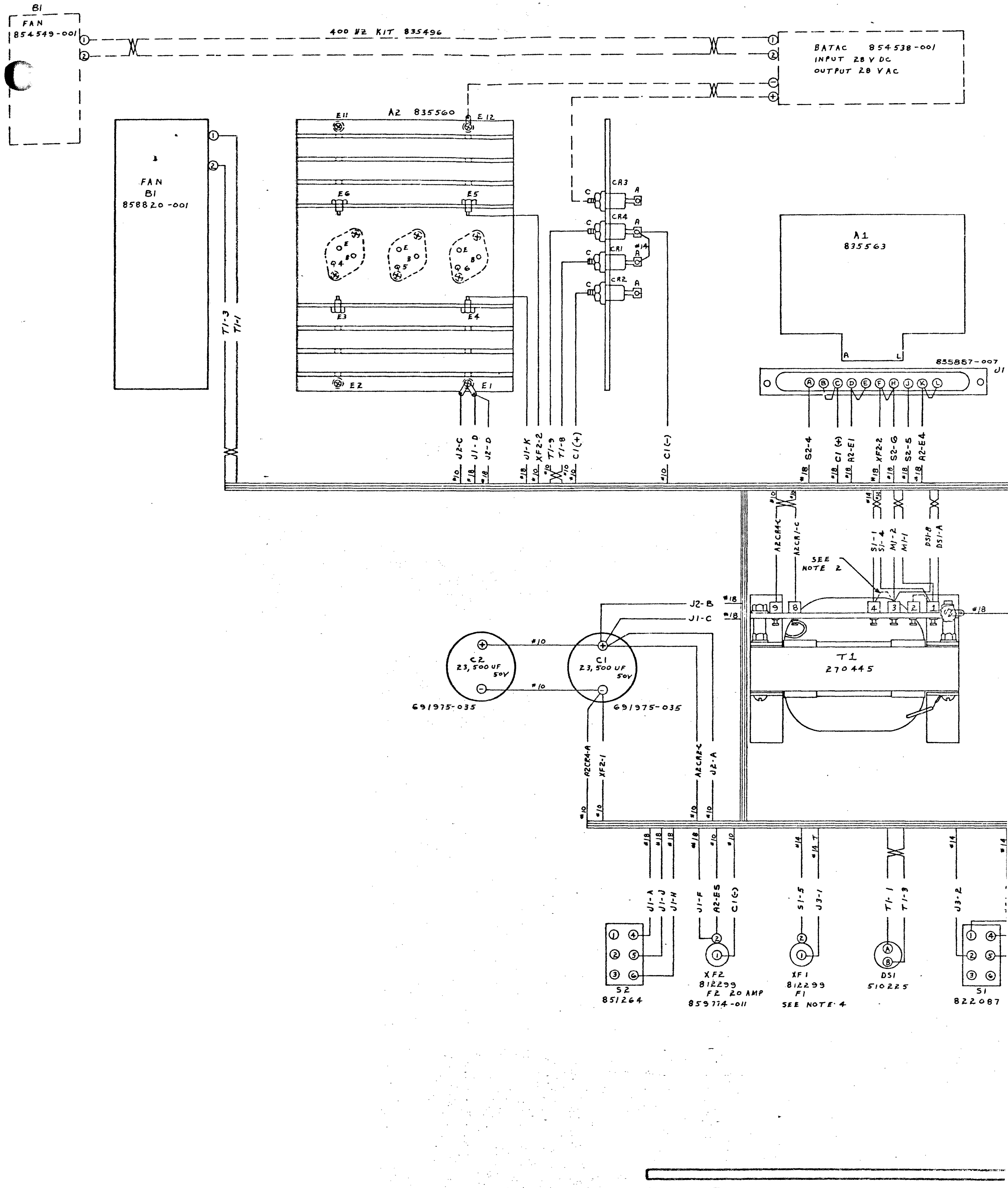


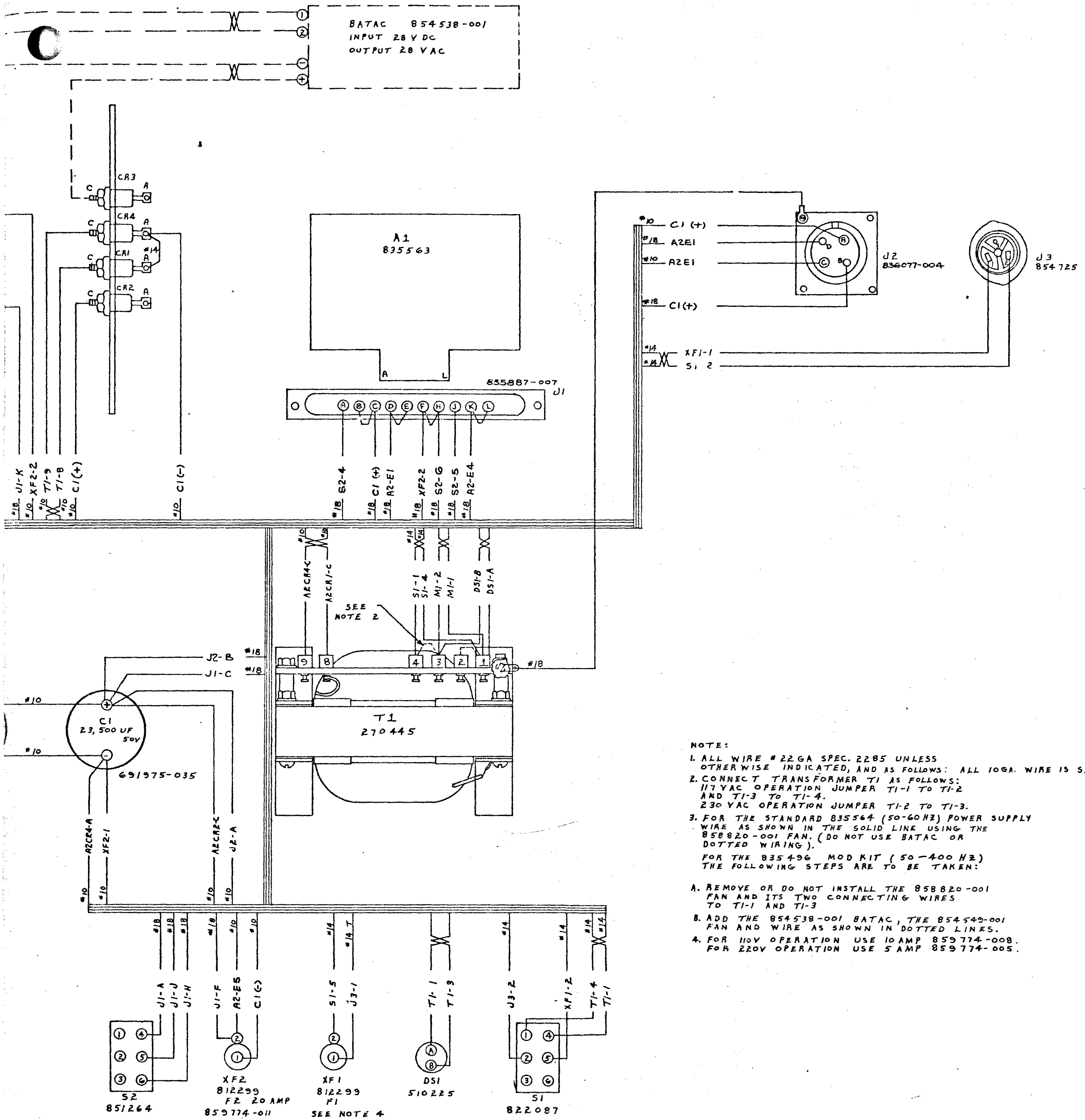
A2
835560
R1 .1Ω 3W
Q1 40251
R2 .1Ω 3W
Q2 40251
R3 .1Ω 3W
Q3 40251
R4 .1Ω 3W
Q4 40251
R5 .1Ω 3W
Q5 40251
R6 .1Ω 3W
Q6 40251
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
10 AMP - 110 V
5 AMP - 220 V
S1
F1
DS1
T1
4-1N1192
CR1
CR2
CR3
CR4
J3-1
J3-2
J3-3
ON
POWER
OFF
110 V OPERATION
SEE NOTE 1
FOR 220V
JUMPERS
C1 23,500UF 50V
C2 23,500UF 50V
F2 20A
B1
FAN
400 HZ KIT
835496
A3
BATAC
J1-F
J1-H
J1-K
J1-L
J1-D
J1-E
P1-F
P1-H
P1-K
P1-L
P1-D
P1-E
TP6
R1 22Ω 1W
Q4 40250
TP4
R3 220Ω 1/4W
R5 470Ω 1/2W
R6 2.7K 1/4W
R7 1.2K 1/4W
Q3 2N2219
R2 10K 1/4W
TP1
TP5
C1 1UF 50V
R4 1K 1W
CR1 1N823
J1-C
P1-C
J1-B
P1-B
P1-J
P1-A
J1-J
J1-A
S2
ENERGIZED
RESET
UN-ENERGIZED



NOTE:
1. JUMPER TRANSFORMER T1 AS FOLLOWS:
110 VAC OPERATION - JUMPER T1-1 TO T1-2 AND T1-3 TO T1-4.
220 VAC OPERATION - JUMPER T1-2 TO T1-3

Figure 1. Power Supply Schematic Diagram


B1
FAN
854549-001
400 HZ KIT 835496
BATAC 854538-001
INPUT 28 V DC
OUTPUT 28 VAC
FAN
B1
858820-001
A2 835560
E11
E12
E6
E5
E3
E4
E2
E1
Q4
Q5
Q6
CR3
CR4
CR1
CR2
A1
835563
835887-007
J1
T1-3
T1-1
J2-C
J1-D
J2-D
J1-K
XF2-2
T1-9
T1-8
C1(+)
C1(-)
S2-4
C1(+)
A2-E1
XF2-2
S2-G
S2-5
A2-E4
A2CR4-C
A2CR1-C
S1-1
S1-4
M1-2
M1-1
DS1-B
DS1-A
SEE NOTE 2
J2-B
J1-C
T1
270445
C2
23,500 UF
50V
691975-035
C1
23,500 UF
50V
691975-035
A2CR4-A
XF2-1
A2CR2-C
J2-A
J1-A
J1-J
J1-H
J1-F
A2-E5
C1(-)
S1-5
J3-1
T1-1
T1-3
J3-2
S2
851264
XF2
812299
F2 20 AMP
859774-011
XF1
812299
F1
SEE NOTE 4
DS1
510225
S1
822087



NOTE:

1. ALL WIRE #22 GA SPEC. 2285 UNLESS OTHERWISE INDICATED, AND AS FOLLOWS: ALL 10GA. WIRE IS SPEC 2223.
2. CONNECT TRANSFORMER T1 AS FOLLOWS:
   117 VAC OPERATION JUMPER T1-1 TO T1-2 AND T1-3 TO T1-4.
   230 VAC OPERATION JUMPER T1-2 TO T1-3.
3. FOR THE STANDARD 835564 (50-60 HZ) POWER SUPPLY WIRE AS SHOWN IN THE SOLID LINE USING THE 858820-001 FAN. (DO NOT USE BATAC OR DOTTED WIRING).

   FOR THE 835496 MOD KIT (50–400 HZ) THE FOLLOWING STEPS ARE TO BE TAKEN:

   A. REMOVE OR DO NOT INSTALL THE 858820-001 FAN AND ITS TWO CONNECTING WIRES TO T1-1 AND T1-3
   B. ADD THE 854538-001 BATAC, THE 854549-001 FAN AND WIRE AS SHOWN IN DOTTED LINES.
4. FOR 110V OPERATION USE 10 AMP 859774-008.
   FOR 220V OPERATION USE 5 AMP 859774-005.

Figure 2. Power Supply Wiring Diagram

Sangamo

DC TO DC CONVERTER

GENERAL

This bulletin contains complete information on the dc to dc converter assembly, A6. Contained are characteristics, operating procedures, theory of operation, maintenance and adjustment procedures, parts list, and diagrams.

The primary function of this assembly is to convert the +24 Vdc or +28 Vdc (two ranges) input to the recorder/reproducer into regulated outputs of ±12 Vdc and +5 Vdc.

The entire assembly consists of a transformer, filter and bridge rectifier networks, and two printed circuit boards; regulator board and driver board. The assembly, especially the printed circuit boards, are accessable by opening the left side door of the recorder/reproducer.

CHARACTERISTICS

Input	+24 Vdc range ±2 Vdc +28 Vdc range ±2 Vdc both at 8 amps max.
Output	
12 Vdc.	12±.1 Vdc at 4 amp max.
5 Vdc	5±.25 Vdc at 3 amp max.

OPERATING PROCEDURES

a. **CONTROLS** – The only operator control is the input voltage range switch at the lower portion of the assembly, accessable by opening the left side door of the recorder/reproducer. With +28 Vdc input to the recorder/reproducer this switch should be set to the 28 volt position and with +24 Vdc input it should be set to the 24 volt position. For adjustment procedures, refer to the maintenance section of this bulletin.

CAUTION

When switching input voltage ranges always remove power.

b. **FUSING** – The only fuse encorporated with this assembly is F1, located below the input voltage range switch at the lower portion of the assembly. F1, an AGX-8A (part no. 510279-004), fuses the input voltage to the entire assembly. Note, a spare fuse is found in the spare fuse holder at the top of the assembly.

THEORY OF OPERATION

a. GENERAL – The entire dc to dc converter assembly, A6, consists of the regulator board A2 (835682), driver board A1 (835684), range switch S1, output transformer T1, bridge rectifier assemblies CR1 and CR2, and filter networks of L1 through L3 and C1 through C3. Briefly the converter functions by changing the input dc voltage to ac and applying it through a step-down transformer and driver circuits to rectifiers and filters, producing an output of ±12 Vdc and +5 Vdc.

b. **CIRCUIT DESCRIPTION** – The input dc voltage is applied through TB1-1 (hi) and fuse F1 to regulator board A2, at P1-C and D. This voltage is applied to a multivibrator circuit consisting of A2Q1 and A2Q2, and associated circuitry. The multivibrator output, a square wave with its symmetry adjustable by potentiometer A2R6, is applied through emitter followers A2Q3 and A2Q4 to a push-pull amplifier, A2Q5 and A2Q6. This circuit amplifies the square wave to present an output from the regulator board, P1-A and B, of approximately 27V p-p. This square wave output is applied to the driver board, A1, through P1-K and L, to step-down transformer A1T1. The outputs at the secondary windings of A1T1 are applied to push-pull amplifiers A1Q1 and A1Q2, and A1Q3 and A1Q4. The amplified output of the driver board, at P1-E and F, is applied to the primary of T1. One secondary of T1 is rectified and filtered to provide +12 Vdc at W1 and -12 Vdc at W3. The other secondary is rectified, filtered, and divided to provide +5 Vdc at the + side of C3.

The regulator capability of the converter is provided by reference amplifier A2Q8 and associated circuitry. The reference amplifier, A2Q8, will provide an output at the collector that is representative of the change in the output of the bridge, CR1, or the dc output of the converter. The change is sensed by resistors R13, R16 and R17 which develop the voltage at the base of A2Q8. R16, output voltage adjust, is used to vary the voltage applied to the base of A2Q8, thus varying the output from the converter. Should the output of the regulator vary due to load, A2Q8 and associated circuitry senses the variation and amplifies the difference. The amplified difference is applied to the base of A2Q7, regulator driver, and either aids or hinders its conduction. The output of A2Q7 determines the amount of conduction by A1Q5 and A1Q6, controlling the amount of voltage drop across these transistors. This effectively controls the voltage to the primary of T1 and the output of the converter.

MAINTENANCE

a. **EQUIPMENT REQUIRED**

Tektronix 503 Oscilloscope or Equiv.
Fluke 8100-A Digital Voltmeter or Equiv.

b. **ADJUSTMENT**

Step 1. Ensure all power is off. Open the left side door of the recorder/reproducer and locate the dc to dc converter assembly.

Step 2. Place the regulator board on its extender, ensure the range switch is positioned properly according to the input voltage, and apply POWER.

Step 3. Monitor, with an oscilloscope, the collectors of transistors A2Q1 and A2Q2, and adjust balance potentiometer R6 for the best possible square wave (least ripple).

Step 4. Connect a dc voltmeter to W1 (hi) and W2 (lo) (terminals W1, 2, and 3 are located at the top of the assembly across from the spare fuse and are arranged in descending order, W3 at the top). Adjust output voltage adj, R16, for a reading of 12 Vdc ±.1 Vdc.

Step 5. Connect a dc voltmeter to W2 (hi) and W3 (lo), reading negative voltage, and ensure a reading of -12 Vdc ±.1 Vdc.

Step 6. Connect a dc voltmeter to W2 (lo) and the + side of C3, and ensure a reading of +5 Vdc ±.25 Vdc.

c. TEST

Step 1. With all power off visually inspect the dc to dc converter assembly and each associated printed circuit board for loose connections or mountings, dented, misshaped, missing or broken components, foreign material, and signs of overheating.

Step 2. Tag and remove all output connections from W1, W2, W3, and C3(+); and check continuity as follows:

HI	LO	READING
TB1-1	TB1-2	1 K ohm or greater
W1	W2	1 K ohm or greater
W2	W3	3 K ohm or greater
+ side of C3	W2	10 K ohm or greater

Step 3. Replace the output connections to W1, W2, W3, and C3(+); and place the regulator board, A2 (p/n 835682), on its extender. Apply POWER and, in sequence, ensure the presence of the following approximate readings at the indicated points.

HI	LO	READING
TP3	TP1	input voltage of approximately +24 Vdc or +28 Vdc.
TP2	TP1	6.25 Vdc

Step 4. Remove POWER and place the driver board, A1 (p/n 835684), on its extender.

Step 5. Apply POWER and ensure the following approximate readings.

HI	LO	READING
TP7	TP5	48 V p-p square wave
TP8	TP5	48 V p-p square wave
TP1	TP5	28 V p-p square wave
TP4	TP5	3 V p-p irregular waveform with possible spikes to 28 V.
TP6	TP5	Nearly 0 Vdc under continuous load
TP2	TP5	28 V p-p square wave
TP3	TP5	28 V p-p square wave

Step 6. Monitor the output voltages as follows and ensure ripple does not exceed 40 mVp-p for the 12 V outputs and 20 mVp-p for the 5 V output. Refer to step 4, under b. adjustments, and figure 1 for locations of W1, W2, W3, and + side of C3.

HI	LO	OUTPUT
W1	W2	+12 Vdc
W2	W3	-12 Vdc
+ side of C3	W2	+5 Vdc

PARTS LIST

Basic Assembly A6 835680

C1	691975-017	J2	835887-007	T1	270449
thru		L1	270175	TB1	835055-001
C3		thru		W1	859834-017
CR1	854547	L4		thru	
CR2	510007-002	R1	691112-181	W3	
F1	510279-004	S1	691664	XF1	835004
J1	835887-007				

Driver Board A6A1 835684

C1	847013	R1	844157	T1	270447
MP1	835593 (for Q1-6)	R2	897583	TP1	855913
Q1	867618	R3	897583	thru	
thru		R4	691113-220	TP8	
Q6					

Regulator Board A6A2 835682

C1	896798	thru		R9	198200-102
C2	896294	Q4		R10	691113-470
C3	896478	Q5	851280	R11	198200-222
C4	896478	Q6	851280	R12	198200-222
C5	691686-027	Q7	853533	R13	198200-392
CR1	853531	Q8	854539	R14	198200-103
CR2	844510	R1	691112-102	R15	198200-102
CR3	844510	R2	198200-222	R16	854535-006
CR4	853531	R3	198200-102	R17	198200-152
MP1	854220 (for Q5, 6)	R4	198200-332	R18	691113-221
MP2	847825 (for Q7)	R5	198200-223	R19	198200-222
MP3	854441-004	R6	854535-008	TP1	855913
	(for TP1-3)	R7	198200-223	thru	
Q1	854539	R8	198200-332	TP3	

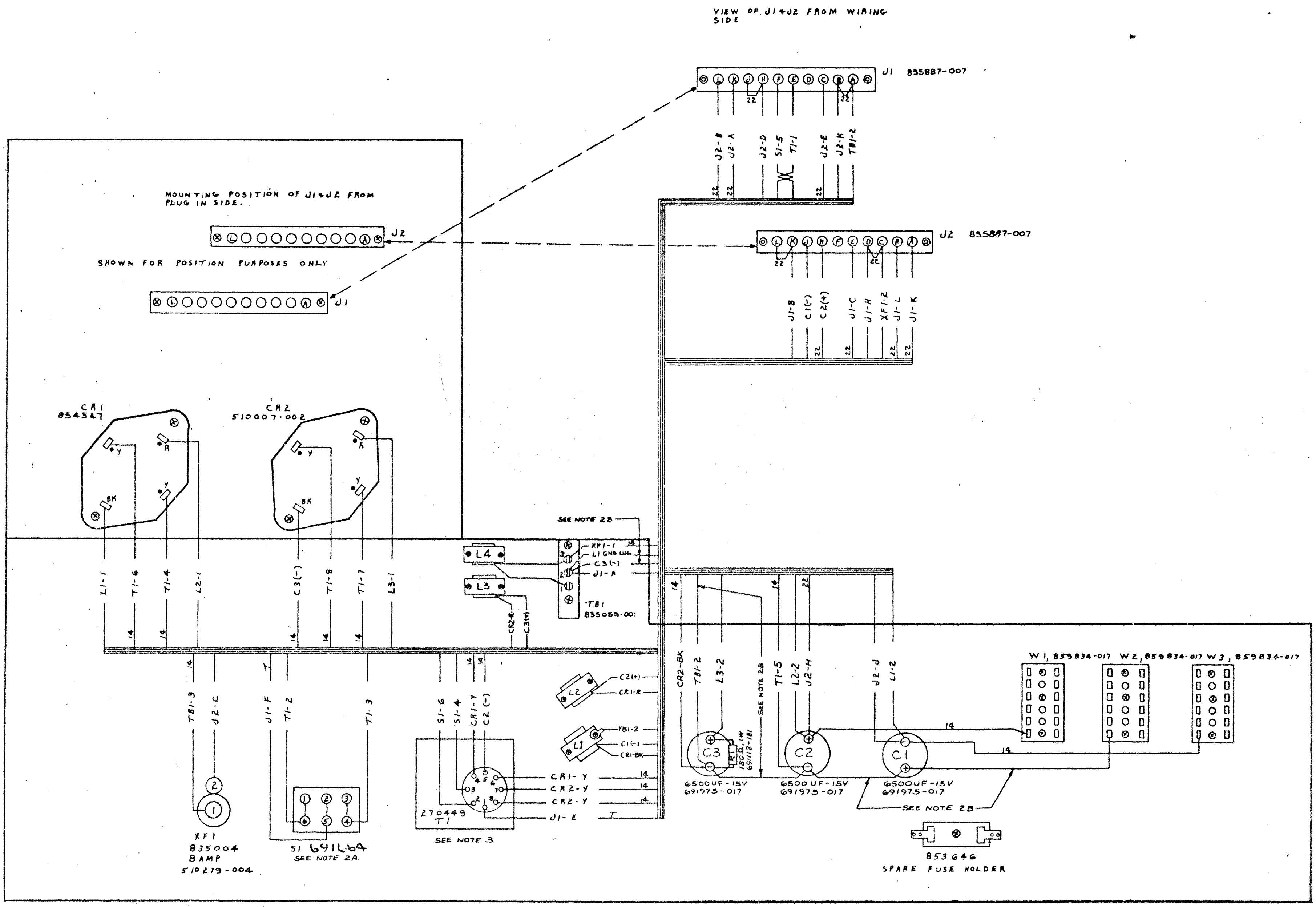
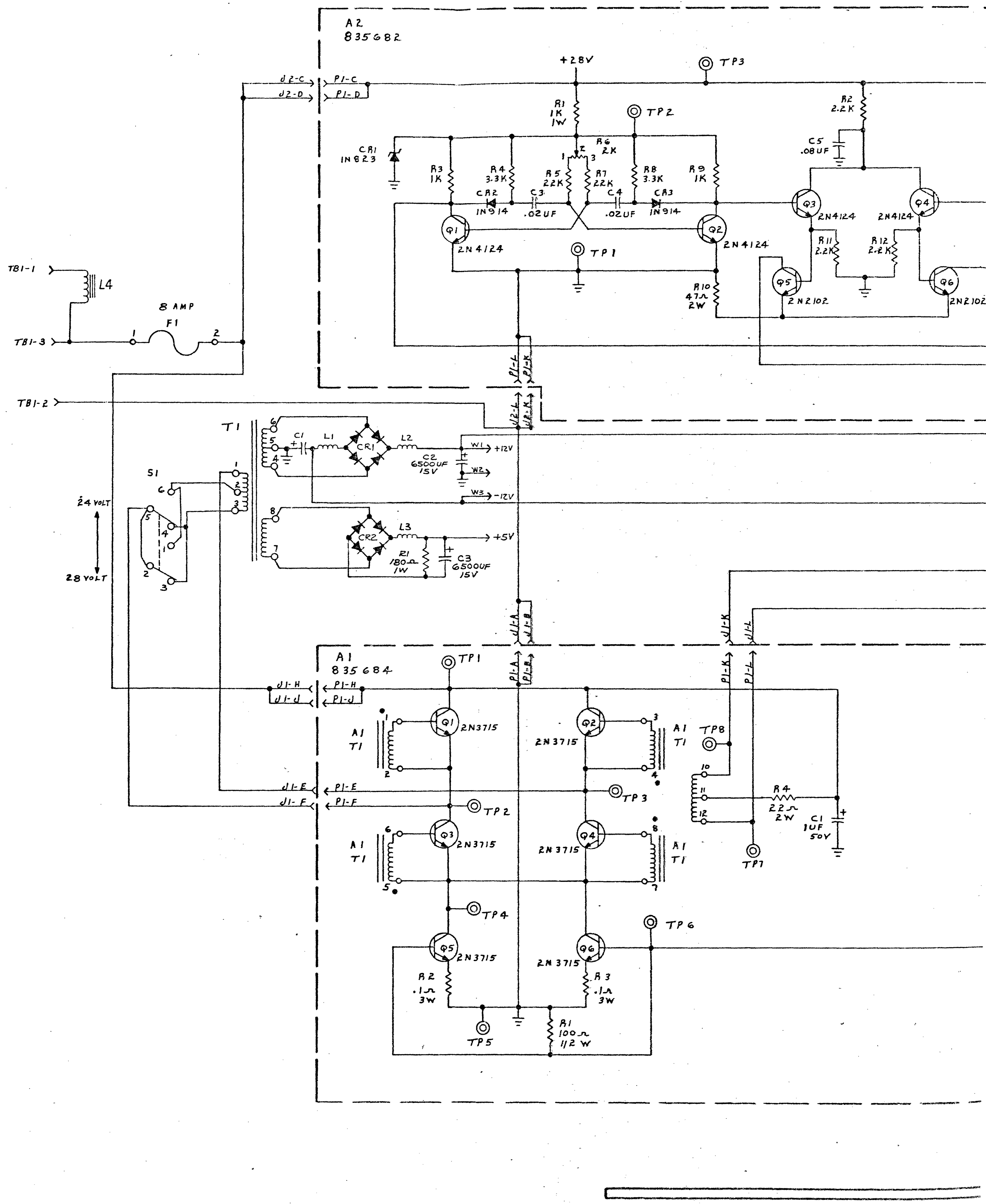


Figure 1. DC to DC Converter Wiring Diagram



A2
835682
+28V
TP3
TP2
TP1
R1 1K 1W
R2 2.2K
R3 1K
R4 3.3K
R5 22K
R6 2K
R7 22K
R8 3.3K
R9 1K
R10 47Ω 2W
R11 2.2K
R12 2.2K
C3 .02UF
C4 .02UF
C5 .08UF
CR1 1N823
CR2 1N914
CR3 1N914
Q1 2N4124
Q2 2N4124
Q3 2N4124
Q4 2N4124
Q5 2N2102
Q6 2N2102
J2-C P1-C
J2-D P1-D
P1-L P1-K
J2-L J2-K
TB1-1
TB1-2
TB1-3
L4
8 AMP
F1
S1
24 VOLT
28 VOLT
T1
C1
L1
CR1
L2
C2 6500UF 15V
W1 +12V
W2
W3 -12V
CR2
L3
R1 180Ω 1W
C3 6500UF 15V
+5V
J1-A J1-B
J1-K J1-L
A1
835684
P1-A P1-B
P1-K P1-L
J1-H P1-H
J1-J P1-J
J1-E P1-E
J1-F P1-F
Q1 2N3715
Q2 2N3715
Q3 2N3715
Q4 2N3715
Q5 2N3715
Q6 2N3715
A1 T1
TP4
TP5
TP6
TP7
TP8
R2 .1Ω 3W
R3 .1Ω 3W
R1 100Ω 1/2 W
R4 22Ω 2W
C1 1UF 50V

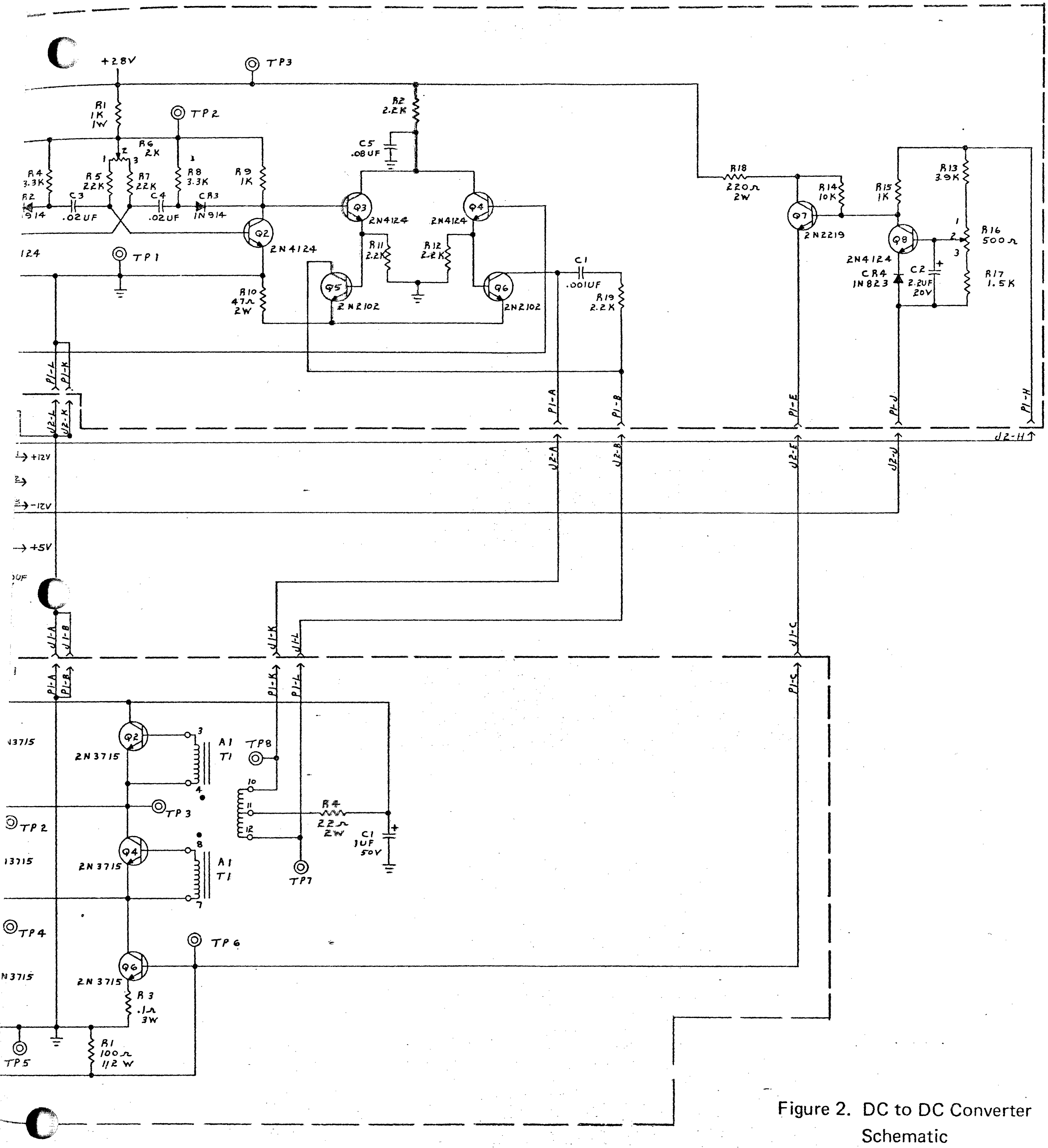


Figure 2. DC to DC Converter Schematic

Sangamo

EDGE A/B RECORD/REPRODUCE

GENERAL

This recorder/reproducer, with the edge A/B record/reproduce option, has the capability of recording and reproducing both voice commentary and time code signals, simultaneously. Actual recording and reproducing of the voice commentary is independent of which operate mode (Record or Reproduce) the machine is in. Time code signals are handled much the same as data signals. RECORD must be activated to record time code signals.

Each individual component of the edge A/B record/reproduce feature for this machine is an option. A full complement of components would consist of the following five principle assemblies:

1. Edge A/B Record Board
2. Reproduce Board (used for reproducing voice and time code signals)
3. Microphone
4. Head Set
5. Remote Speaker/Amplifier Enclosure

CHARACTERISTICS

a. EDGE A/B RECORD BOARD

1. Bias

Bias Input Level	1Vp-p min.
Bias Frequency	8.4 MHz

2. Voice Circuitry

Voice Input Level (from microphone)	10mVrms min.
Voice Input Impedance	47K Ohm
Voice Frequency Range	300 Hz to 3kHz
Voice Output Level (to head)	50 ma p-p bias with 3 ma p-p voice
Voice Circuits Power Requirements	+12Vdc±.1Vdc at 70 ma -12Vdc±.1Vdc at 60 ma

CHARACTERISTICS (cont'd)

3. Time Code Circuitry

Time Code Input Level	100 mVrms min. with a range of .1 to 1 Vrms
Time Code Input Impedance	20K max.
Time Code Frequency Range	IRIG B Signals—100 Hz to 10 kHz
Time Code Output Level (to head)	50 ma p-p bias with 5.5 ma p-p time code

b. VOICE REPRODUCE BOARD

Input Signal Level (from Head)	1 mVrms min.
Input Impedance (to Head)	150 Ohm
Ouput Signal Level	1 Vrms
Output Impedance (to Speak-Amp Encl.)	2.5 K Ohm Max.
Frequency Response	300 Hz to 3 kHz
Power Requirement	+12 Vdc ± .5Vdc -12 Vdc ± .5Vdc

c. SPEAKER/AMPLIFIER ENCLOSURE

Loudspeaker Power Output	Approximately 2 Watts min. across 45 Ohm load
Headphone Power Output (Phone Plug inserted in J2)	Approximately 0.05 Watts min. across 2 K Ohm load power.
Power Requirements	28Vdc @ 250 ma Max. Continuous.
Temperature Range	0°F. to 130°F.

d. MICROPHONE

Element Type	Ceramic
Amplifier Voltage Gain	0 to 15 db
Frequency Response	300 Hz to 3 kHz
Battery	7 Volt

OPERATING PROCEDURES

a. OPERATOR CONTROLS AND ADJUSTMENTS

1. RECORD – The following table lists the controls and adjustments associated with the microphone and record board of this feature. For adjustment procedures refer to the maintenance section of this bulletin.

TABLE 1. RECORD BOARD AND MICROPHONE CONTROLS	
CONTROL OR ADJUSTMENT	LOCATION AND FUNCTION
On/Off Pushbutton	Located on side of microphone, this control applies the voice signal and bias signal to the board (annotate feature).
Volume	Located at top rear of microphone, this control determines the output signal level from the microphone.
A/B Track Selection Switch (S1)	Located on the side of the edge A/B board, this switch selects either track A voice and track B time code or track A time code and track B voice.
Voice Bias Adj (R2)	Located on the lower front of the edge A/B board, this adjustment controls the input bias level to the voice record circuitry.
Voice Bias Tune (C5)	Located on the side of the edge A/B board, this control provides adjustment for maximum power transfer between bias driver (voice circuitry) and the load (head).
Time Code Bias Adj (R22)	Located on the upper front of the edge A/B board, this adjustment controls the input bias level to the time code record circuitry.
Time Code Bias Tune (C22)	Located on the side of the edge A/B board, this control provides adjustment for maximum power transfer between bias driver and load (head).
Time Code Rec Adj (R22)	Locate on the upper front of the edge A/B board, this controls provides adjustment of the record current (time code signals) applied to the head.

2. **REPRODUCE** – The following table lists those controls associated with the voice reproduce board and speaker/amplifier.

TABLE 2. REPRODUCE BOARD AND SPEAKER-AMP CONTROLS	
CONTROL	FUNCTION
Volume (R8)	Located directly on voice reproduce board, this control determines the output signal level from the board.
Volume (R1)	Volume control Located on Speaker/Amp enclosure, this control determines the volume of the reproduced signal at the Speaker/Amplifier input.

b. VOICE/TIME CODE OPERATING PROCEDURES

1. RECORD

Step 1. Ensure the edge A/B record board is positioned properly in the record chassis. Refer to the proper record chassis wiring diagram and/or bulletin.

Step 2. The microphone plug is inserted into one of the following jacks, dependent on the listed situations.

(1) Standard portable models only— plug into the IN VOICE jack on the record connector panel.

(2) Standard laboratory models only— plug into the VOICE A/B jack on the record connector panel (rear of record chassis).

(3) Standard portable or laboratory models with a speaker/amplifier enclosure— plug into the IN VOICE jack on the speaker/amplifier enclosure.

To record time code signals or other compatible signals, connect the time code source (normally a BNC connector) to one of the following connectors, dependent on the listed situations.

(1) Standard portable models only— connect to J16, labeled IN EDGE track, on the record connector panel.

(2) Standard laboratory models only— connect to J15 on the record connector panel.

Step 3. Place the A/B Track Selection switch (S1), located on the side of the edge A/B record board, in the desired position (edge track B not normally available on one half inch heads). VOICE A indicates voice will be recorded on track A and time code, if applicable, on track B. VOICE B indicates voice on B and time code on A.

Step 4. Place the recorder/reproducer into the desired operate mode at the correct speed. When recording time code signals the RECORD pushbutton must be depressed.

Step 5. Set the microphone volume/gain control (located on the microphone) to 6 initially. This should produce approximately 100 mVrms at VOICE REC LEV testpoint, TP1; if not, readjust to obtain this level. With the microphone approximately 8 inches from the mouth, depress the pushbutton and speak into microphone at a normal level. This level may need resetting as determined on reproducing or to compensate for a weak battery.

Step 6. The voice record level on the voice record circuitry is set at the factory and requires no operator adjustment. When recording time code signals ensure a 100 mVrms reading at the TIME CODE REC LEV testpoint, TP2, located on the front of the board. Adjust TIME CODE REC ADJ, R17, if necessary to obtain 100 mVrms.

2. **REPRODUCE**—Reproducing voice and/or time code signals is detailed in the following paragraphs, dependent on the situation.

(a) **STANDARD PORTABLE MODELS**—Track selection for reproducing is obtained by the placement of the voice reproduce board in the reproduce chassis. With the board plugged into EDGE A, J15, Track A is employed. With the board plugged into EDGE B, J16, Track B is employed. Note that a one-half inch tape system normally does not have a Track B. Both J15 and J16 are phone jacks. If a BNC output is required a phone jack to BNC adapter is supplied in the accessory kit. This adapter is to be used only in reproducing. If both tracks A and B are to reproduce simultaneously an optional voice reproduce board must be employed. Check jumper placement, as desired, in Table 3.

Step 1. If the speaker-amplifier enclosure is supplied, ensure the voice power cable is inserted into the VOICE POWER jack on the power connector panel.

Step 2. Insert the speaker-amplifier (or head set) phone plug into the proper phone jack. Use J15 if voice is recorded on edge track A or J16 if voice is recorded on edge track B. If time code signals were recorded on edge track A the reproduced signal would be available at phone jack J15. If time code signals were recorded on edge track B the reproduced signal would be available at phone jack, J16. All of the previously listed connections in step 2 are made on the Reproduce Connector Panel.

Step 3. Place the machine in the desired operate mode at the same speed at which voice or time code signals were recorded.

Step 4. Adjust the reproduce board VOLUME and, if applicable, the speaker-amplifier VOLUME, for an adequate playback level.

(b) **STANDARD LABORATORY MODELS**—Track selection is obtained by the placement of the voice reproduce board in the reproduce chassis. With the board plugged into J15 (third slot from end—single or double chassis) track A is employed. With the board plugged into J16 (second slot from the end—single chassis) or J15 (third slot from the second chassis end—double chassis) track B is employed.

Step 1. Ensure the speaker-amplifier voice power cable is connected to the VOICE POWER jack on the reproduce connector panel.

Step 2. Ensure that:

(1) The time code output, if applicable, is connected to external equipment as desired.

(2) The voice output is connected to the speaker-amplifier.

Step 3. If the headset is to be used, connect it to the phone jack on the front speaker-amplifier.

Step 4. Place the machine in the desired operate mode, at the same speed voice or time code was was recorded at.

Step 5. Adjust the reproduce board VOLUME and speaker-amplifier VOLUME for an adequate playback level.

c. **MICROPHONE BATTERY REPLACEMENT PROCEDURE**—To replace the battery of the M+2U microphone complete the following steps:

Step 1. Place microphone face down on a clean surface, possibly on a bench cloth to prevent scratches to case.

Step 2. Carefully remove the four screws securing the back.

Step 3. Slowly remove the back of the microphone case, making sure the circuit board, with the volume control, remains in the front section of the case.

Step 4. Carefully pull the battery from the battery holder, while holding down on the circuit board.

Step 5. Place a new Mallory TR-175 7 volt battery, or equivalent, into the battery holder, observing correct polarity.

Step 6. Carefully reverse the disassembly steps. Be sure the cable wires loop around the battery when the back is placed in position.

THEORY OF OPERATION

The entire edge A/B option consists of the microphone, edge A/B record board, voice reproduce board, and speaker/amplifier enclosure. The following theory of operation covers all available options for this feature.

The microphone assembly consists of a ceramic element, a two stage amplifier, a volume control and and on/off pushbutton annotate switch. This assembly may be used to record voice on edge A or B, and possible on a data track.

The edge A/B record board consists of two separate record circuits, voice and time code. Each circuit consists of a bias driver, signal driver, and adding circuit. The following functional description concerns the voice record circuitry. With the pushbutton on the microphone depressed, the voice signal from the microphone, is fed to the edge A/B record board. Also as this pushbutton is depressed, relay K1 is activated providing +12 Vdc to the bias board and ±12Vdc to the voice record circuits. This feature (annotate) enables voice annotation of pre-recorded tapes. With the bias board activated during this voice annotate period, a bias signal is fed into the voice record circuits at P1-21. This bias signal is applied through VOICE BIAS ADJ, R2, to emitter follower Q1. Q1 provides current gain for push-pull amplifier Q2 and Q3, via transformer T1. Coupling transformer T2 is used for impedance matching between the voice record circuits and the head. The voice signal (during the annotate period) enters the edge A/B record board through P1-15. The voice signal amplifier consists of Q4 and Q5 with an ac voltage, proportional to the record current, provided at TP1. The current into the head is determined by the input voltage at P1-15, which is adjustable by the volume control on the microphone. The ac voltage at TP1, suggested for optimum voice recording, should be adjusted for approximately 100 mVrms. This voltage is also available at P1-20 for use with external monitoring equipment.

The voice adding circuit, used to combine the bias signal current and voice signal current, consists of L1, C4, C5, L2, and C7. L1 and C4 are series resonant at the bias frequency. This filter circuit is utilizied to reduce harmonics, of the bias frequency, passing the head. Parallel resonant filter, C7 and L2, is used to prevent bias from entering the voice signal amplifier stage.

THEORY OF OPERATION (cont'd)

L2 also provides a low impedance path to the head for the voice signal current. VOICE BIAS TUNE, C5, is used to tune the secondary of transformer T2 to the particular edge track being used. This adjustment provides for maximum power transfer between the voice record circuits and the head. Diode CR2 rectifies the bias signal providing a dc indicating voltage used to adjust C5.

The following explanation pertains to the time code record circuitry. The bias driver and signal adding circuits of the time code record section function identically to the bias and adding circuits of the voice record circuitry, previously explained. Note that the RECORD mode must be activated to ensure a bias signal to the time code bias driver circuit. The time code signal record circuits function much the same as the voice signal record circuits with the addition of the TIME CODE REC ADJ, R22. The signal driver is comprised of a two stage amplifier, Q9 and Q10, with the current to the head determined by R22, at the input of the amplifier. The ac voltage, proportional to the head current, at TP1, suggested for optimum time code signal recording, should be adjusted, by R22, for 100 mVrms. This voltage is also available at P1-2 for use with external monitoring equipment.

The outputs of both the voice record circuits and the time code record circuits are routed through the A/B TRACK SELECTION SWITCH, S1, to the head. S1 provides either voice recording on track A and time code on track B, or time code on track A and voice on track B.

On reproducing the signal passes from the reproduce head through the pre-amplifier and into the voice reproduce board located in the reproduce chassis. The signal is amplified by A1 and passes through R8, output level control (VOLUME).

The amplified reproduced signal enters the speaker/amplifier (when supplied) through P-2 and is applied to R1, VOLUME control. R1 controls the level of the signal being fed into the power amplifier board. On the amplifier board R1, R2, and R3 provide the necessary DC bias for Q1. The signal is amplified by Q1 and applied to the base of Q2 where it is amplified again and applied to the push-pull amplifier Q3 and Q4. R5 and R6 provide a negative feedback circuit which determines the overall gain of the amplifier.

The power amplifier applies the amplified voice signal through the normally closed contacts of J2 to the louspeaker. If the head set phone plug is inserted into J2 the signal to the louspeaker is interrupted and applied to the head set. A resistor in parellel with the head set provides the proper impedance match to the amplifier.

MAINTENANCE

When maintenance becomes necessary the following procedures will assist in locating the malfunction. Failure to obtain the proper test indication is a clue to a particular malfunction. These procedures make no attempt to be a complete troubleshooting guide.

All adjustments contained herein pertain to normal machine operation. Although these adjustments are performed at the factory the need for their re-adjustment may be evident for correct machine performance.

a. EQUIPMENT REQUIRED – The following equipment is required for those maintenance procedures set forth in this section. In the event of deeply involved maintenance or repair, more advanced equipment may be employed.

Simpson Model 260 VOM or equivalent
HP Model 200 CD Signal Generator or equivalent
HP Model 400 E VTVM or equivalent
HP Model 411 RF Millivoltmeter or equivalent
Tektronic 503 Oscilloscope or equivalent

b. EDGE A/B RECORD BOARD TEST PROCEDURES

Step 1. With the edge A/B record board removed from the recorder/reproducer, and its shield removed, visually inspect it for loose connections or mountings, dented, misshaped, or broken components, foreign material, and signs of overheating.

Step 2. Mount the edge A/B record board on the extender board and insert the microphone plug into the phone jack on the record connector panel.

Step 3. Depress POWER, STOP, and the microphone pushbutton, and ensure the presence of the following readings and conditions.

+12 Vdc at pin X2 of relay K1
-12 Vdc at pin A2 of relay K1
Ground at TP5
Approx. 1Vp-p bias signal at 8.4 MHz at R1, with TP5 grounded

Step 4. Short the + side of C8 and C16 to TP5, ground.

Step 5. Monitor the signals individually at VOICE BIAS TUNE MONITOR, TP3, and TIME CODE BIAS TUNE MONITOR, TP4, with a VOM.

Step 6. Adjust VOICE BIAS TUNE C5 (TP3) and TIME CODE BIAS TUNE C22 (TP4) individually for maximum dc voltages.

Step 7. Adjust VOICE BIAS ADJ R2 and TIME CODE BIAS ADJ, R17, for 2 Vrms at TP3 (R2) and TP4 (R17). Readjustment may be necessary upon observation of reproduced signal. Bias should be adjusted for maximum level of reproduced signal.

Step 8. Remove the short between the + side of C8 and TP5, and connect the signal generator to these two points.

Step 9. Adjust signal generator for 10 mVrms at 1 kHz.

Step 10. Connect the VTVM between VOICE REC LEV TP1 (hi) and GND TP5 (lo).

Step 11. Ensure a reading of approximately 100 mVrms.

Step 12. Remove the signal generator connections and replace the short between the + side of C8 and TP5.

Step 13. Remove the short between the + side of C16 and TP5 and connect the signal generator to these two points.

Step 14. Adjust signal generator for 100 mVrms at 1 kHz.

MAINTENANCE (cont'd)

Step 15. Connect a VTVM between TIME CODE REC LEV, TP2 (hi) and GND, TP5 (lo).

Step 16. Ensure a reading of approximately 100 mVrms. Adjust TIME CODE REC LEV ADJ, R22, to obtain this reading.

Step 17. Increase the signal generator output level to approximately 1 Vrms and ensure the capability of obtaining 100 mVrms at TP2, by adjustment of R22.

Step 18. Set R22 for 100 mVrms at nearest the anticipated time code input level.

c. VOICE REPRODUCE BOARD TEST PROCEDURE

Step 1. With voice reproduce board removed from the recorder/reproducer, visually inspect it for loose connections or mountings, dented, misshaped, missing, or broken components, foreign material and signs of overheating.

Step 2. Apply power after the following connections are made.

a. Connect +12 Vdc lead to R5.

b. Connect -12 Vdc lead to R6.

c. Connect signal generator output to R1 (hi) and board ground.

d. Connect a 1.8 K Ohm resistor across the swinger of R8 and ground, output of board.

e. Connect Hi of vtvm to swinger of R8 and Lo to ground.

f. Connect oscilloscope across output (1.8K resistor).

Step 3. Adjust the signal generator output to 1 mVrms at 250 Hz.

Step 4. Adjust volume control R8 between upper and lower limits. The output should be undistorted and range from 0 volts (R8 full clockwise) to about 1 Vrms (R8 full counterclockwise).

d. SPEAKER/AMPLIFIER ENCLOSURE TEST PROCEDURES

Step 1. Visually inspect the chassis and amplifier board for loose connections or mountings, dented, misshaped, missing, or broken components, foreign material and signs of overheating.

Step 2. Ensure the following ohmic measurements between the indicated points, being sure to observe correct polarity.

POSITIVE	NEGATIVE	RESISTANCE
J1-1	P1-Ring	0Ω
J1-2	P1-Tip	0Ω
J1-3	P1-Body	0Ω
TB2-7	TB2-4	≈120KΩ
LS1-1	J2-2	0Ω
LS1-2	J2-4	0Ω
P3-D	Chassis	0Ω

MAINTENANCE (cont'd)

Step 3. Ensure connection of power cable to chassis and apply power (+28 Vdc) through J5A and P3A.

Step 4. Insert head set phone into J2.

Step 5. Connect signal generator to P2 (Hi and Lo), and adjust for a 1 Vrms 1 kHz signal.

Step 6. By adjusting R1, an undistorted signal of 10 Vrms should be obtained.

PARTS LIST

Dual Headset	854950
Microphone	856635

A4 Speak-Amp Encl. 854521

F1	821618
XF1	812299
J1	853631
J2	855129
LS1	855339
R1	843680
R2	691113-680

A4A1 Voice Amplifier Board 855078

C1	691391-038	Q2	853532	R4	896613
C2	851139-015	Q3	853533	R5	853530-101
C3	691391-038	Q4	853532	R6	853530-212
C4	851139-015	R1	853530-336	R7	896196
CR1	93240	R2	853530-335	R8	844323
Q1	853037	R3	853530-246	R9	898314

A20A 16 Voice Reproduce Board 856772

R1	510020-043
R2,R4	510020-031
R3	510020-127
R5,R6	510020-059
R7	510020-023
R8	855121
C1	691391-002
C2	691686-015
C3	691686-011
C4,C5	691391-012
C6	197212-004
A1	859843

A19A 16 Edge A/B Record Board 835661

C1	859959-001	C6	859959-001	C11	859959-001	C16	859959-002
C2	859959-001	C7	854528-075	C12	691391-030	C17	691391-017
C3	197212-027	C8	859959-002	C13	859959-001	C18	691391-004
C4	197212-050	C9	691391-017	C14	859959-001	C19	691686-030
C5	850862	C10	691391-004	C15	197212-027	C20	854528-075

A19A 16 Edge A/B Record Board 835661

C21	197212-050	P1	853518	R5	198200-100	R20	198200-100
C22	850862	Q1	510018	R6	198200-472	R21	198200-472
C23	859959-011	Q2	510076	R7	198200-103	R22	854535-011
C24	may or may	Q3	510076	R8	198200-222	R23	198200-103
C25	not be present	Q4	859971	R9	198200-473	R24	198200-681
C26	859960-001	Q5	859970	R10	198200-272	R25	198200-220
C27	859959-001	Q6	510018	R11	198200-680	R26	198200-152
CR1	844510	Q7	510076	R12	198200-152	R27	198200-101
thru		Q8	510076	R13	198200-470	R28	198200-103
CR4		Q9	859971	R14	198200-470	R29	198200-222
K1	855130-002	Q10	859970	R15	198200-681	*R30	See Table 3
L1	853587-029	R1	198200-101	R16	198200-101	S1	510277
L2	853587-028	R2	854535-008	R17	854535-008	T1	510015-001
L3	853587-029	R3	198200-470	R18	198200-470	thru	
L4	853587-028	R4	198200-152	R19	198200-152	T4	

*Used only on 1/2 inch heads.

TABLE 3. EDGE A/B RECORD BOARD CONFIGURATIONS

PART NO.	RESISTOR R30	JUMPER	CONFIGURATION
835661-001	Not Used	A to A, B to B, C to C	Voice and Time Code, 1 inch
835661-002	1 K ohm, 870037	A to A, B to B, C to C	Voice and Time Code, 1/2 inch
835661-003	Not used	Not Used	Voice only, 1 inch
835661-004	1 K ohm, 870037	Not Used	Voice only, 1/2 inch

NOTE

If voice recording only is desired the jumpers (Table 3) should always be removed to prevent accidental erasure of voice by the time code circuitry during RECORD mode. If time code recording is desired either with or without voice, the jumper should always be present.

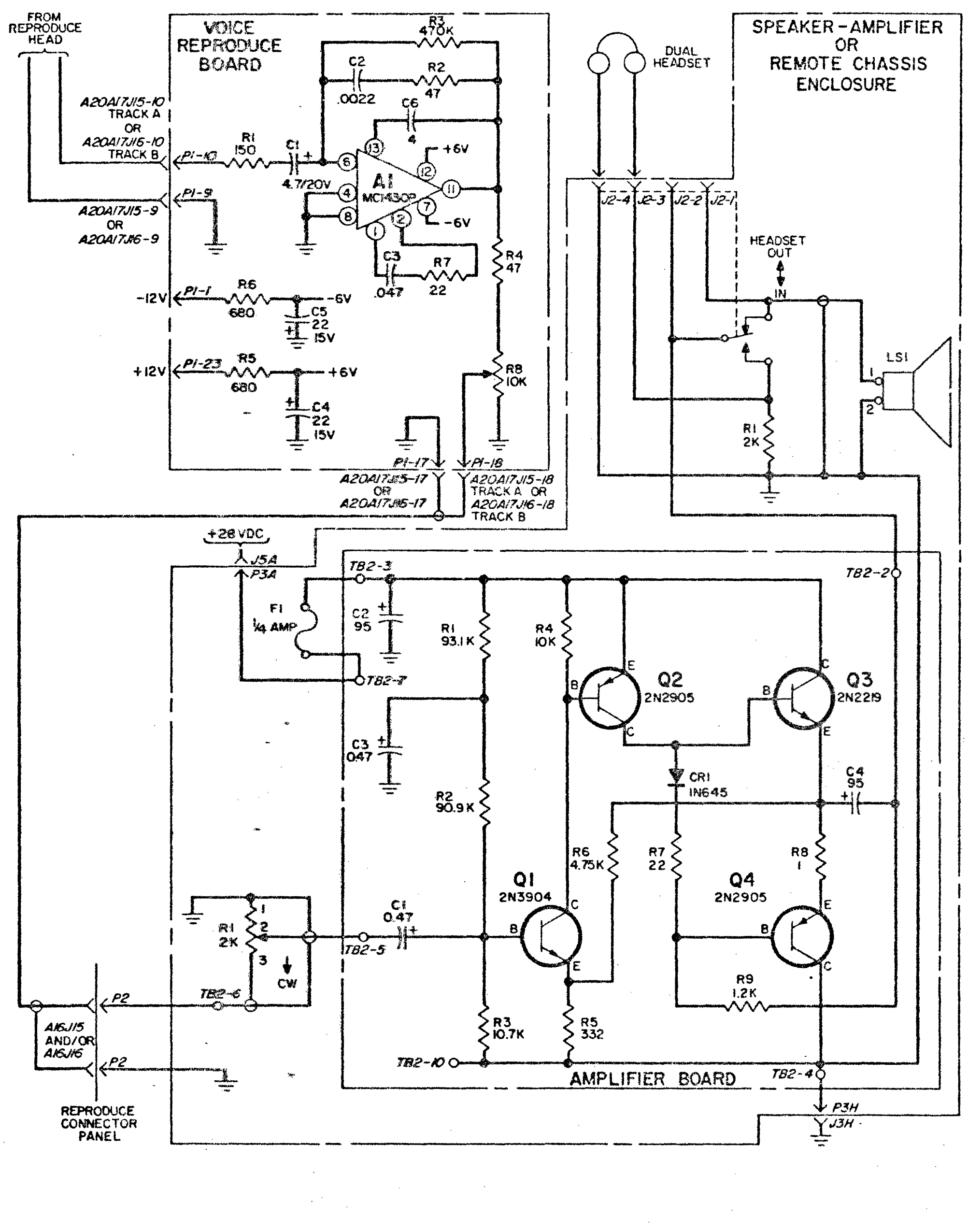
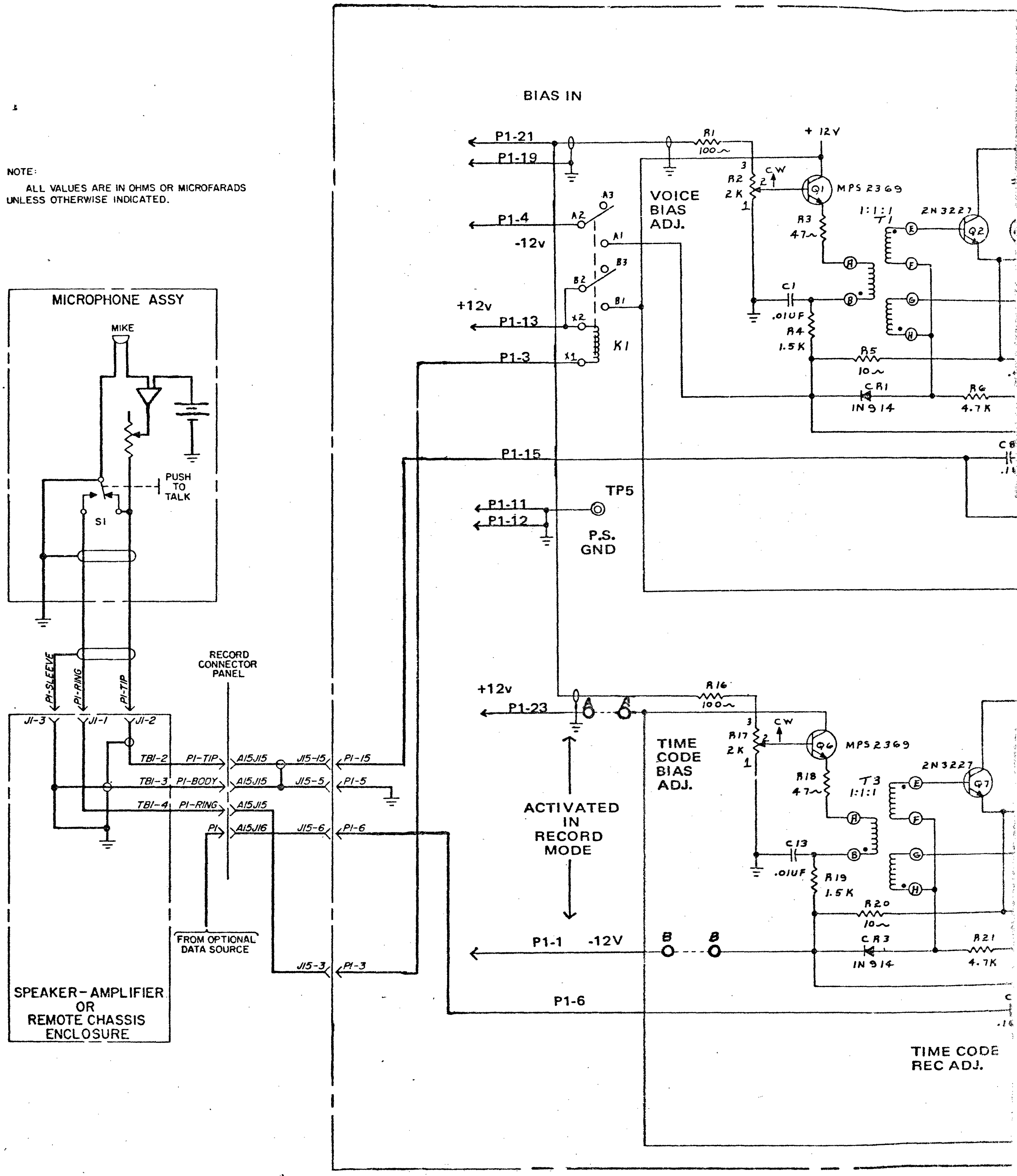


Figure 1. Reproduce Board and Speak/Amp, Schematic Diagram

NOTE:

ALL VALUES ARE IN OHMS OR MICROFARADS UNLESS OTHERWISE INDICATED.



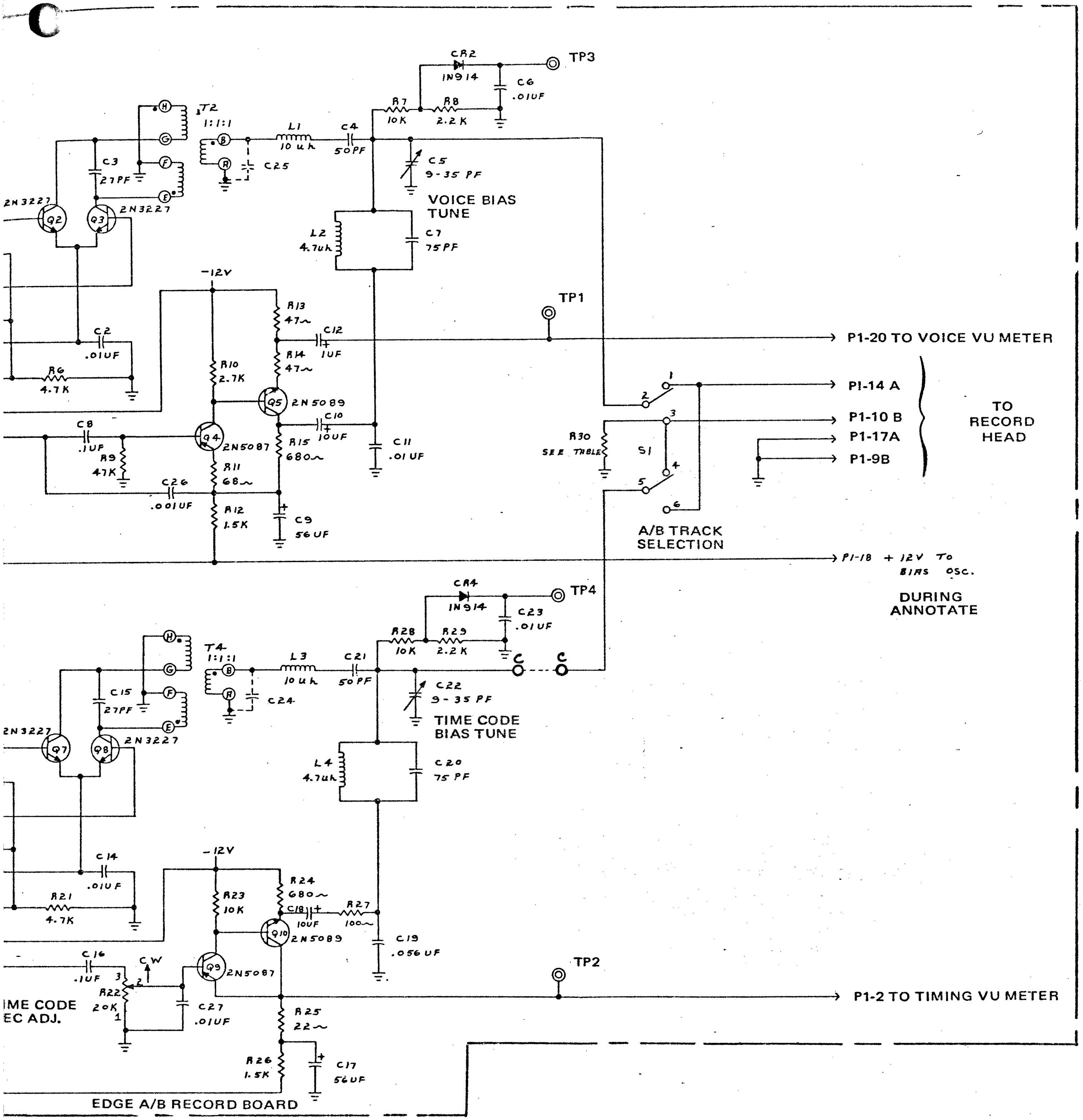


Figure 2. Edge A/B Record Board and Microphone, Schematic Diagram

Sangamo

PHOTO END-OF-TAPE SENSE

GENERAL

The optional PHOTO END-OF-TAPE SENSE feature is provided to accomplish automatic stop for this recorder/reproducer, without the use of metallic markers or other devices. This tape sense feature is in addition to the standard tape sense feature (marker strips) utilizing the sense post.

The entire option consists of a sense lamp and a sense detector for each tape reel. Refer to figure 1, below. The sense lamp and detector are positioned such that a full or partly full reel of tape does not allow the lamp emitted light to pass to the associated sense detector. As the tape becomes unwound from the reel to a determined amount (approx. 60 to 100 ft. of 1.5 mil tape left) the light passes to the sense detector and activates it. The sense detector when activated energizes the same tape sense circuitry (logic board) that the standard tape sense feature uses, and all tape movement is stopped.

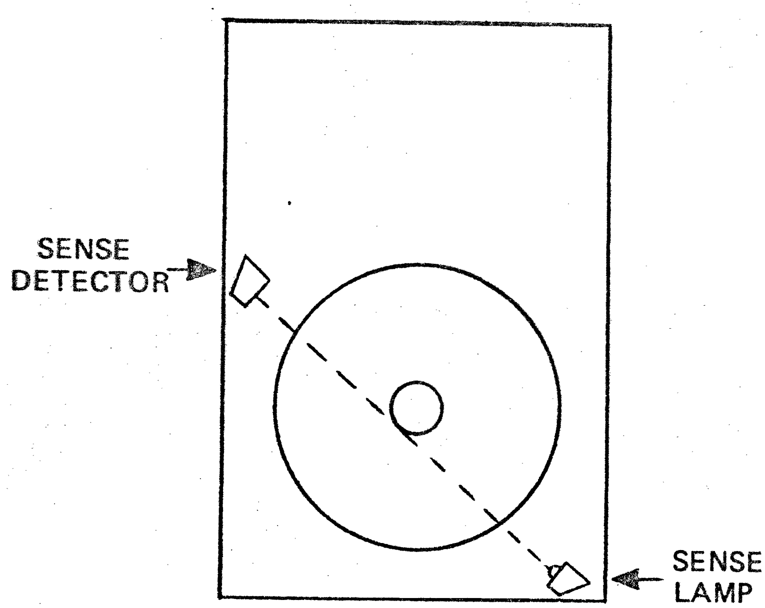


Figure 1. Photo End-Of-Tape Sense, Functional Block Diagram

OPERATING PROCEDURES

a. CONTROLS – The only operator control present is the EOT switch, on the Power and Control Connector Panel (right side of the Recorder/Reproducer). This switch, labeled IN and OUT, energizes or de-energizes the sense circuitry on the Logic Board, (utilized also for the sense post method of tape sense). The sense lamps are lit continuously, independent of the EOT switch.

b. CHECKOUT – The following checkout procedures are provided for determining the operational status of the photo end-of-tape sense feature. If satisfactory results are not obtained, refer to the test and adjustments in the maintenance portion of this bulletin.

Step 1. Ensure tape is threaded properly and the EOT switch is set to the IN position.

Step 2. Apply power and ensure that both sense lamps (lower right side of Recorder/Reproducer) are lit and no obstructions (except tape on reels) are present between the sense lamps and sense detectors.

Step 3. Depress STOP, FORWARD, and FAST, in that sequence.

Step 4. The Recorder/Reproducer should automatically revert to STOP mode prior to the inner reel becoming completely empty of tape. There should be approximately 60 to 100 feet, (approximately 1/8 inch tape wrap) of tape left on the inner reel.

Step 5. Depress REVERSE and FAST.

Step 6. The Recorder/Reproducer should automatically revert to STOP mode prior to the outer reel becoming completely empty of tape. There should be approximately 60 to 100 feet (approximately 1/8 inch tape wrap) of tape left on the outer reel.

MAINTENANCE

Should the photo end-of-tape sense feature fail to operate properly, the test and adjustment procedures should be followed. The following areas are of major concern with respect to proper operation of this feature.

(1) Logic board sense circuitry, including the sensitivity adjustment potentiometer.

(2) Sense lamps, sense detectors, and their alignment.

a. EQUIPMENT REQUIRED
Simpson 260 VOM or equivalent

b. TEST AND ADJUSTMENT

Step 1. Gain access to the Logic Board, right rear of Recorder/Reproducer, by removing the top and rear access panels. Place the Logic Board on its extender.

Step 2. Ensure tape is threaded properly, apply POWER, and depress STOP and FORWARD. Cover the sense detectors with masking tape, or other material, to prevent any light from activating them. Ensure the EOT switch is set to the IN position.

Step 3. Connect various resistors, ranging in value from 22 K ohm to 27 K ohm, between logic board pin J8-7 and system ground. Ensure STOP mode is activated with the application of one of these values. Ensure with a VOM, the presence of 12 to 14 Vdc at J8-7 when the Recorder/Reproducer reverts to STOP mode. This ensures the logic board sensitivity adjustment is approximately set to a satisfactory level for either forward or reverse. Slight adjustment of sensitivity adjust, R9, may be required to bring the sense circuitry firing level within the above resistance ranges, providing the 12 to 14 Vdc. This resistance range, when met should also be appropriate for the sense post feature of tape sense.

Step 4. Complete the following to determine if the sense lamps are aligned properly. If the conditions and voltage measurements below are not obtained, refer to step 5, lamp alignment.

a. Remove the material convering the sense detectors and move tape in forward until approximately 60 to 100 feet (approximately 1/8 inch of tape wrap) of tape is left on the inner reel. At this point move tape at the slowest speed and ensure that approximately one-half of the light beam is shaded (at the detector) by the tape on the reel. With this approximate condition present ensure, with a VOM, 12 to 14 Vdc between logic board pin J8-7 and ground.
b. Remove POWER and physically move tape until the inner reel is nearly empty (three to four layers). Ensure the reading at J8-7 has changed to less than 5 Vdc.
c. Complete the preceding a and b for the outer reel (reverse tape movement) using logic board pin J8-6.

Step 5. If satisfactory results are not obtained in step 4, slight adjustment of the sense lamps and possibly detectors, will be required to produce the proper voltages with each of the two conditions. Adjustment of the lamp is accomplished by moving the lamp mounting bracket, possibly bending the lamp mounting bracket, and/or rotating the lamp holder. While adjusting the lamp beam, first strive to provide the less than 5 Vdc at J8-7 (inner) and J8-6 (outer) with nearly empty reels. After this has been accomplished ensure approximately 60 to 100 feet (approximately 1/8 inch of tape wrap) of tape on each reel produces 12 to 14 Vdc at J8-7 (inner reel) and J8-6 (outer reel). Slight adjustment of the sensitivity control on the logic board may help achieve improved final results.

Step 6. In extreme cases, or when replacing lamps or detectors, complete the following:

a. Remove the reels and replace with completely empty reels.
b. Tape the tension arms off their stops with masking tape or other material.
c. Apply POWER and depress STOP and FORWARD.
d. Adjust the lamps and detectors as required to produce less than 5 Vdc at J8-7 (inner reel) and J8-6 (outer reel).
e. With masking tape, place an obstruction on each reel hub simulating 1/8 inch tape wrap.
f. Check and possibly adjust for the one-half shading effect producing the 12 to 14 Vdc at J8-7 (inner reel) and J8-6 (outer reel, with REVERSE mode activated).

Step 7. Upon completion of alignment and adjustment, complete the previous operating checkout procedures to ensure proper operation.

PARTS LIST

Photo End-of-Tape Sense Kit	835586
Sense Detector Assembly (1) A29	835571
Sense Lamp (2) DS3 and DS4	855027
Sense Lamp Socket Assembly (2) XDS3 and XDS4	843728

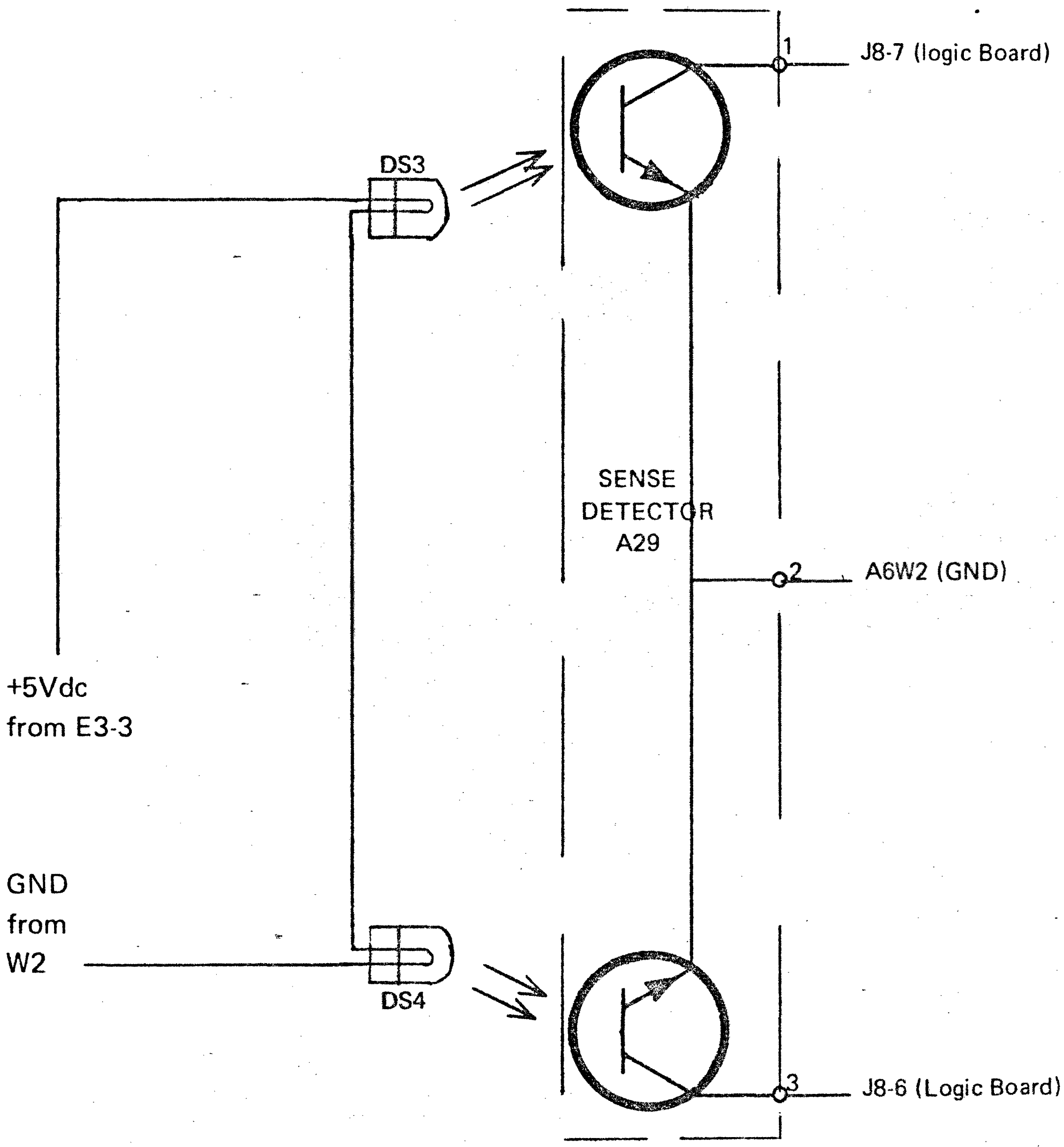


Figure 2. Photo End-Of-Tape Sense, Schematic Diagram

Sangamo

FM CALIBRATOR

GENERAL

This bulletin contains information pertaining to the optional SANGAMO FM CALIBRATOR unit. Information contained consists of general (with specifications), operating-use data, theory of operation, maintenance, parts list, and diagrams.

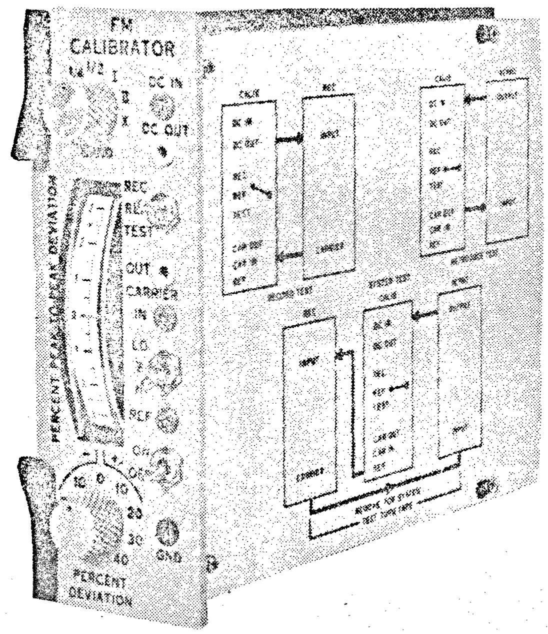


Figure 1. FM Calibrator Unit

The SANGAMO FM CALIBRATOR unit is used to conveniently check and/or calibrate any IRIG FM record/reproduce system. Capabilities of this unit include, (1) individual FM record channel calibration, (2) individual FM reproduce channel calibration, and (3) overall FM record/reproduce channel check. All AC and DC errors are displayed directly on a front panel meter.

Operating features of the unit include five selectable FM bands (at any tape speed), nine deviation settings, record-reproduce-test selection, impedance selection, and power on-off selection; all easily operated by front panel switches. Mounting is conveniently provided by insertion into any two adjacent reproduce board slots. This mounting feature also provides power acquisition and automatic speed selection from the reproduce chassis (as with a standard reproduce board), as selected at the recorder/reproducer control panel. Connections from the calibrator unit to the FM record or reproduce boards are possible via patch-cords.

The calibrator unit is adaptable to all SANGAMO SABRE record/reproduce systems, as well as the 3500 series (adapter required for 3500 series). Calibration of any IRIG FM record/reproduce system may be performed with this unit, providing a SANGAMO system is available for mounting, power acquisition, and speed selection.

SPECIFICATIONS

Band Selection Frequencies	Refer to Table 1
Center Frequency Deviation Selection	9 switch selected positions in 10% increments. ±30% is full scale dev. for bands X and II, ±40% for others.
Accuracy	±0.2 of full scale deviation, in the applicable band.
Meter Error	Front panel zero center ±3% for full scale.
Input Impedance	Selectable - LO - 75 ohms HI - over 100 K ohms
DC Reference Voltages	9 equally spaced values from +1.414 (±0.5 mv) to -1.414 (±0.5 mv), selectable via deviation switch.
Temperature Range	5°C to 50°C
DC Power Requirements	+12 Vdc at 250 ma and -12 Vdc at 30 ma, supplied by any SANGAMO SABRE system or 3500 series system.
Dimensions	Approximate size of two adjacent reproduce boards.

OPERATING-USE DATA

a. **INSTALLATION** - For proper operation the FM Calibrator unit must be inserted into any two adjacent reproduce board slots, not separated by a partition. If two empty slots are not available, remove one or two FM reproduce boards, as necessary. The removed boards may be calibrated in another slot.

With SABRE series recorders the calibrator adapts directly. With 3500 series recorders an adapter (part no. 836390) is required between the calibrator and the reproduce chassis jacks. This adapter transposes the recorder's speed lines to properly interface to the calibrator unit.

TABLE 1. FREQUENCY PER SPEED, BAND, AND DEVIATION

SPEED/BAND*				FREQUENCY (kHz)								
60 - 15/16 ips Speed Range		120 - 1-7/8 ips Speed Range		DEVIATION (%)								
SPEED (ips)	BAND	SPEED (ips)	BAND	-40	-30	-20	-10	0	+10	+20	+30	+40
60	X	120	X	720	840	960	1080	1200	1320	1440	1560	1680
	II		II (W.B.II)	540	630	720	810	900	990	1080	1170	1260
	I		I (W.B.I)	259.2	302.4	345.6	388.8	432	475.2	518.4	561.6	604.8
	1/2 (W.B.I)		1/2 (INTER)	129.6	151.2	172.8	194.4	216	237.6	259.2	280.8	302.4
	1/4 (INTER)		1/4 (LOW)	64.8	75.6	86.4	97.2	108	118.8	129.6	140.4	151.2
	1/8 (LOW*)		1/8	32.4	37.8	43.2	48.6	54	59.4	64.8	70.2	75.6
30	X	60	X	360	420	480	540	600	660	720	780	840
	II		II (W.B.II)	270	315	360	405	450	495	540	585	630
	I		I (W.B.I)	129.6	151.2	172.8	194.4	216	237.6	259.2	280.8	302.4
	1/2 (W.B.I)		1/2 (INTER)	64.8	75.6	86.4	97.2	108	118.8	129.6	140.4	151.2
	1/4 (INTER)		1/4 (LOW)	32.4	37.8	43.2	48.6	54	59.4	64.8	70.2	75.6
	1/8 (LOW*)		1/8	16.2	18.9	21.6	24.3	27	29.7	32.4	35.1	37.8
15	X	30	X	180	210	240	270	300	330	360	390	420
	II		II (W.B.II)	135	157.5	180	202.5	225	247.5	270	292.5	315
	I		I (W.B.I)	64.8	75.6	86.4	97.2	108	118.8	129.6	140.4	151.2
	1/2 (W.B.I)		1/2 (INTER)	32.4	37.8	43.2	48.6	54	59.4	64.8	70.2	75.6
	1/4 (INTER)		1/4 (LOW)	16.2	18.9	21.6	24.3	27	29.7	32.4	35.1	37.8
	1/8 (LOW*)		1/8	8.1	9.45	10.8	12.15	13.5	14.85	16.2	17.55	18.9
7-1/2	X	15	X	90	105	120	135	150	165	180	195	210
	II		II (W.B.II)	67.5	78.75	90	101.25	112.5	123.75	135	146.25	157.5
	I		I (W.B.I)	32.4	37.8	43.2	48.6	54	59.4	64.8	70.2	75.6
	1/2 (W.B.I)		1/2 (INTER)	16.2	18.9	21.6	24.3	27	29.7	32.4	35.1	37.8
	1/4 (INTER)		1/4 (LOW)	8.1	9.45	10.8	12.15	13.5	14.85	16.2	17.55	18.9
	1/8 (LOW*)		1/8	4.05	4.725	5.4	6.075	6.75	7.425	8.1	8.775	9.45
3-3/4	X	7-1/2	X	45	52.5	60	67.5	75	82.5	90	97.5	105
	II		II (W.B.II)	33.75	39.375	45	50.625	56.25	61.875	67.5	73.125	78.75
	I		I (W.B.I)	16.2	18.9	21.6	24.3	27	29.7	32.4	35.1	37.8
	1/2 (W.B.I)		1/2 (INTER)	8.1	9.45	10.8	12.15	13.5	14.85	16.2	17.55	18.9
	1/4 (INTER)		1/4 (LOW)	4.05	4.725	5.4	6.075	6.75	7.425	8.1	8.775	9.45
	1/8 (LOW*)		1/8	2.025	2.362	2.7	3.037	3.375	3.712	4.05	4.387	4.725
1-7/8	X	3-3/4	X	22.5	26.25	30	33.75	37.5	41.25	45	48.75	52.5
	II		II (W.B.II)	16.875	19.687	22.5	25.312	28.125	30.937	33.75	36.562	39.375
	I		I (W.B.I)	8.1	9.45	10.8	12.15	13.5	14.85	16.2	17.55	18.9
	1/2 (W.B.I)		1/2 (INTER)	4.05	4.725	5.4	6.075	6.75	7.425	8.1	8.775	9.45
	1/4 (INTER)		1/4 (LOW)	2.025	2.362	2.7	3.037	3.375	3.712	4.05	4.387	4.725
	1/8 (LOW*)		1/8	1.012	1.18	1.349	1.518	1.687	1.855	2.024	2.193	2.361
15/16	X	1-7/8	X	11.25	13.125	15	16.875	18.75	20.625	225	24.375	26.25
	II		II (W.B.II)	8.437	9.843	11.249	12.655	14.062	15.468	16.874	18.28	19.686
	I		I (W.B.I)	4.05	4.725	5.4	6.075	6.75	7.425	8.1	8.775	9.45
	1/2 (W.B.I)		1/2 (INTER)	2.025	2.362	2.7	3.037	3.375	3.712	4.05	4.387	4.725
	1/4 (INTER)		1/4 (LOW)	1.012	1.18	1.349	1.518	1.687	1.855	2.024	2.193	2.361
	1/8 (LOW*)		1/8	.505	.59	.674	.758	.843	.927	1.011	1.095	1.18

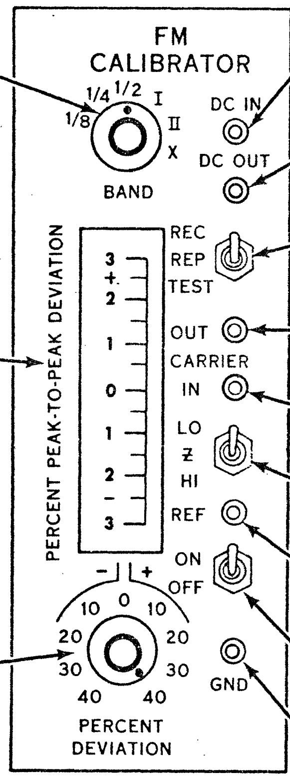
* 1/8 band effective only on low band recorders with 60-15/16 ips speed range.

b. CONTROLS, INDICATORS, and CONNECTIONS

BAND Selector Sw (S1) – Selects the proper carrier frequency for the bandwidth desired (see table 1).

METER (M1) – Reads the error in the output of the boards under test. Error is calibrated in percent of peak-to-peak deviation.

DEVIATION Sw (S2) – Selects the percentage of frequency deviation from the carrier frequency in 10% increments (+40% to -40%). Also changes the DC calibrating voltage through a range of +1.414 Vdc to -1.414 Vdc (9 steps).



DC IN (TP1) – Accepts the DC output of the FM reproduce board under test. This voltage is compared to the DC reference of the calibrator unit.

DC OUT (TP2) – Applies a DC voltage to the FM record board under test. This DC voltage is representative of the comparison of the calibrator carrier frequency and the FM record board carrier frequency.

REC-REP-TEST Sw (S3) – Selects calibrator operating modes of RECORD CALIBRATE, REPRODUCE CALIBRATE or calibrator internal test.

CARRIER OUT (TP3) – Applies a reference carrier frequency to the FM reproduce board under test.

CARRIER IN (TP4) – Accepts the carrier frequency output of the FM record board under test.

Z Sw (S4) – Changes the DC IN input impedance. LO is 75 ohms and HI is 100k ohms.

REF (TP5) – Used to provide a DC voltage input to an FM record board during record/reproduce system test.

POWER Sw (S5) – Controls the application of ±12 Vdc (from the reproduce chassis) to the calibrator unit.

GND (TP5) – Ground testpoint of calibrator unit.

Figure 2. Calibrator Front Panel

c. **USING CALIBRATOR UNIT** - Use of the calibrator unit requires cable connections from the calibrator unit to the applicable FM record or reproduce boards. The FM Calibrator Accessory Kit (part no. 836400) includes all necessary cables as listed below.

(2) Patch-cords, BNC to Pin (1 red - 1 black)
(2) Patch-cords, Pin to Pin (both red)

The maintenance section of this bulletin provides calibrator unit test and adjustment to aid in determining proper operation prior to use.

NOTE

A 5 minute warm-up period (with power on) is recommended for stablization of some operating characteristics.

1. **FM RECORD BOARD CALIBRATION - (refer to figure 3)**

Step 1. Ensuring all POWER is off, connect a patch-cord from the input BNC of the record board to the DC OUT jack of the calibrator.

Step 2. Connect a patch cord from the CARRIER testpoint of the record board to the CARRIER IN jack of the calibrator. Also, connect a patch-cord between grounds on the calibrator and record board.

Step 3. Select, on the calibrator, the correct band setting (determined by band of record board, refer to table 1), zero deviation setting, and REC-REP-TEST switch to the REC position. Select highest speed or speed desired.

Step 4. Apply recorder power, and depress STOP and RECORD (tape movement not required). Ensure the calibrator POWER switch is set to the ON position.

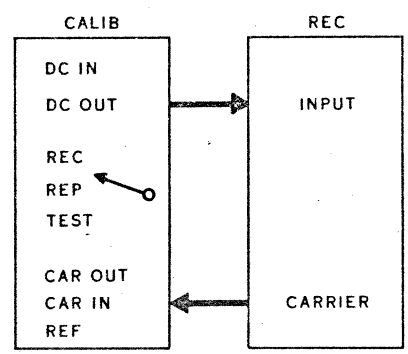


Figure 3. Record Board Calibration Scheme

Step 5. Ensure the calibrator meter reads zero. If not, adjust the ZERO or CENTERING control of the record board, to bring meter to zero.

Step 6. Place deviation switch to the maximum +% deviation (+30% for X and II bands, +40% for all others). Adjust, if necessary, the input gain control of the record board for zero on the meter.

Step 7. Check at -% deviation, and adjust for compromise as necessary.

Step 8. Check at all other speeds and deviations, as desired.

2. **FM REPRODUCE BOARD CALIBRATION - (refer to figure 4)** - This procedure details calibration of FM reproduce boards having an input testpoint. For those boards not having an input testpoint, refer to paragraph 4 concerning reproduce calibration via tape.

Step 1. Ensuring all power is off, connect a patch-cord from the reproduce board input testpoint to the CARRIER OUT jack of the calibrator.

Step 2. Connect a patch-cord from the reproduce board output testpoint to the DC IN jack of the calibrator. Also, connect a patch-cord between grounds on the reproduce board and calibrator.

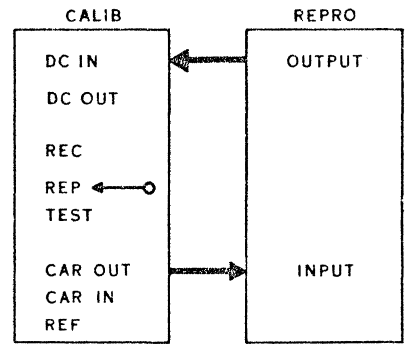


Figure 4. Reproduce Board Calibration Scheme

Step 3. Select, on the calibrator, the correct band (determined by band of reproduce board, refer to table 1), zero deviation setting. REC-REP-TEST switch to the REP position, and the Ƶ switch to the desired setting. Select the highest speed or speed desired.

Step 4. Apply recorder power (tape movement not normally required) and place the switch disable switch to the ON position (no squelch action). Systems having servo squelch and not having a squelch disable switch, normally require tape movement.

Step 5. Ensure meter reads zero. If not, adjust zero control of reproduce board to bring meter to zero.

Step 6. Place deviation switch to maximum +% position (+30% for bands X and II, +40% for all other bands). Adjust, if necessary, the output gain control of the reproduce board for zero on the meter.

Step 7. Check at -% deviation, and adjust for compromise, as desired.

Step 8. Check at all other speeds and deviations, as desired.

3. OVERALL FM RECORD/REPRODUCE CHECK - (refer to figure 5) - Proper tape threading and tape movement are required for this check via tape. With tape bypassed, ensure the squelch disable switch is set to ON. Bypass method not applicable when squelch is present without disable switch.

Step 1. With all power off, connect a patch-cord from the input BNC of the record board to the REF [redacted] jack of the calibrator.

Step 2. Connect a patch-cord from the reproduce board output testpoint to the DC IN jack of the calibrator.

Step 3. Set the REC-REP-TEST switch to the REP position and the BAND switch to the correct setting (determined by the band of the record and reproduce boards, refer to table 1).

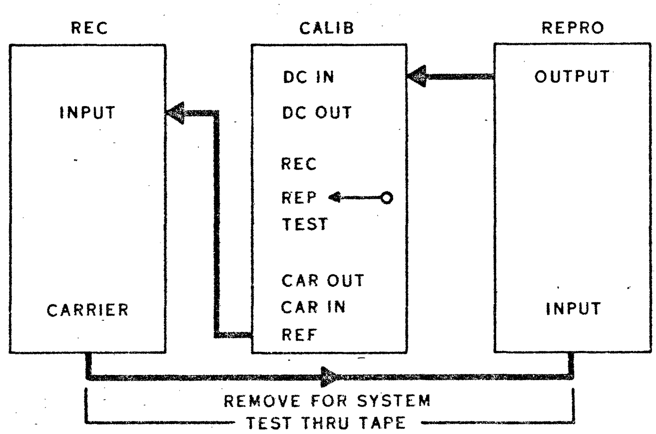


Figure 5. Record/Reproduce System Test Scheme

Step 4. Select the desired tape speed and apply power. Depress STOP, RECORD, and FORWARD, recording and reproducing. For bypass method connect a patch-cord from the record board CARRIER testpoint to the reproduce board input testpoint (tape movement not required).

Step 5. The error will be displayed directly on the calibrator meter.

NOTE

This method provides adequate checking of the FM record/reproduce system. It is not recommended to make any correctional adjustment during this check, as the record and reproduce errors are combined.

4. FM REPRODUCE BOARD CALIBRATION-VIA TAPE - Proper tape threading and tape movement are required for this calibration.

Step 1. Connect a patch-cord from the input BNC of the record board (record channel associated with the reproduce board under test) to the DC OUT jack of the calibrator.

Step 2. Connect a patch-cord from the record board CARRIER testpoint to the CARRIER IN jack of the calibrator.

Step 3. Connect a patch-cord from the BNC output of the reproduce board to the DC IN jack of the calibrator.

Step 4. Select the proper band (refer to table 1) and the proper % deviation. Set tape speed as desired and the REC-REP-TEST switch to the REP position.

Step 5. Apply power and depress STOP, RECORD, and FORWARD, recording and reproducing.

Step 6. Ensure meter reads zero. If not, adjust zero control of reproduce board to bring meter to zero.

Step 7. Place deviation switch to maximum +% position (+30% for bands X and II, +40% for all other bands). Adjust, if necessary, the output gain control of the reproduce board for zero on the meter.

Step 8. Check at -% deviation, and adjust for compromise, as desired.

Step 9. Check at all other speeds and deviations, as desired.

Step 10. Note, by switching the REC-REP-TEST switch to the REC position, the record errors are read.

THEORY OF OPERATION

The FM calibrator unit is composed of two printed circuit boards (A and B), a meter assembly (M1), and a front panel assembly with switches and testpoints. The B board contains a regulated +5 Vdc power supply and the reference oscillator circuitry. The A board contains the DC reference voltage circuits, DC voltage comparison circuits, reference carrier frequency circuits, and the frequency comparison circuits.

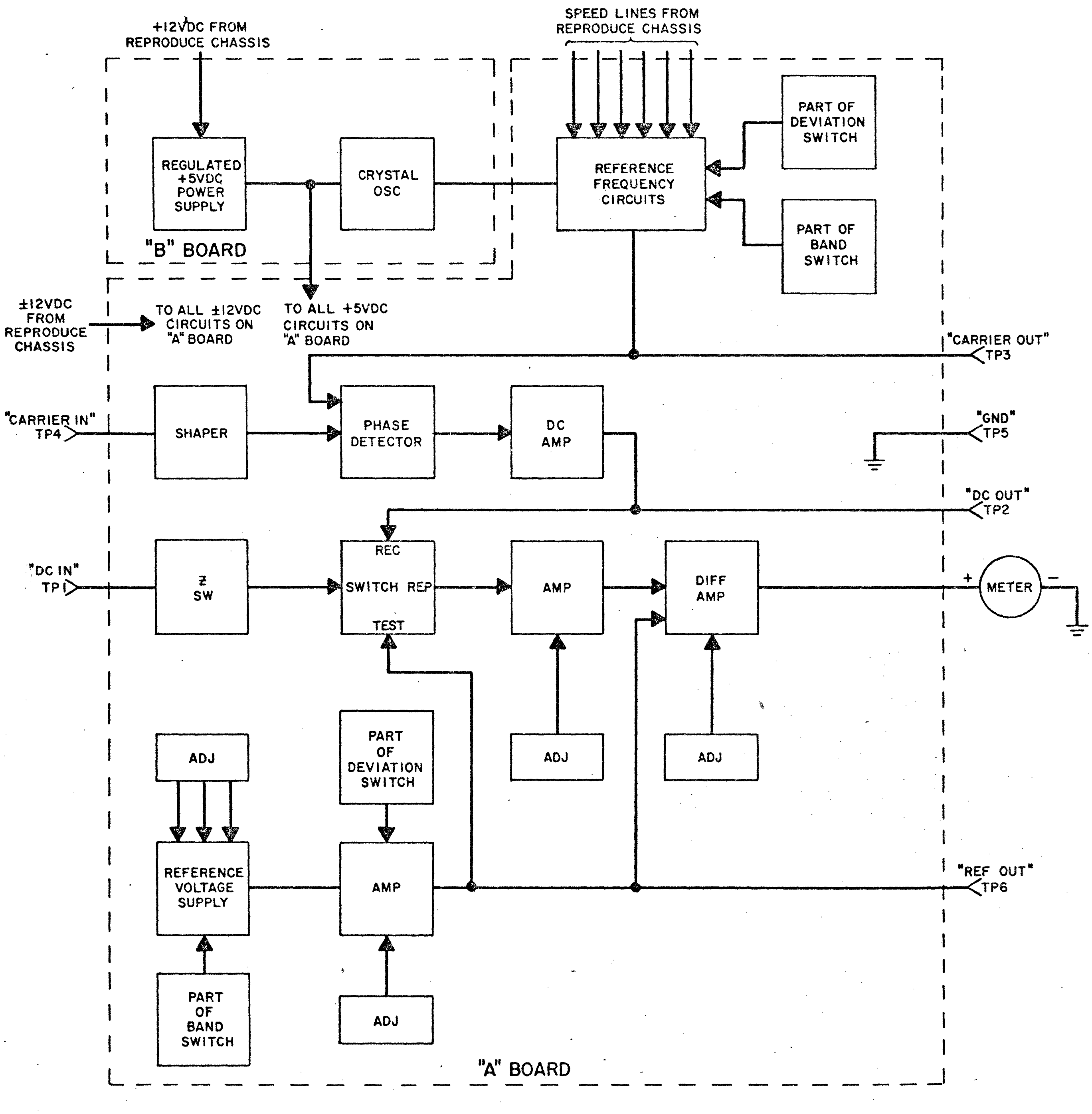


Figure 6. Calibrator Block Diagram

Basically the calibrator generates three outputs; (1) carrier frequency out, (2) DC out, and (3) reference out. The two inputs accepted by the calibrator are DC IN and CARRIER IN. During the reproduce mode (REC-REP-TEST switch set to the REP position) the DC output of the reproduce board (with the reference carrier input) is compared to the DC reference voltage of the calibrator. During the record mode the carrier frequency output of the record board (with the calibrator DC voltage as an input) is compared to the reference carrier frequency of the calibrator.

The following paragraphs describe the various circuit sections of the calibrator. Refer to figure 6, block diagram, and figure 8, schematic diagram.

a. **DC POWER SUPPLY AND OSCILLATOR CIRCUITS (B board)** - The +12 Vdc from P1-23, via the POWER switch S5, is applied to the B board. Zener diode CR1, amplifier A3, and associated circuitry produce +5 Vdc by dropping and regulating the +12 Vdc input. This +5 Vdc is used to power all +5 Vdc circuits on the A and B boards.

Crystal oscillator Y1, in conjunction with gates A1, produces a 3.2 MHz signal. This signal is applied to divide-by-eight circuit A2, at A2-1, producing a 400 kHz output for use by the A board.

b. **DC REFERENCE VOLTAGE CIRCUITS** - Reference diode CR8, amplifier A26, and associated circuitry produce the basic DC reference voltage from the +12 Vdc. R44 provides adjustment of the current through CR8 (optimum 7 ma.). Adjustable voltage divider networks R47 - R48 and R50 - R51 are used to adjust the voltage input to A24 under the high band and low band settings. This is accomplished via part of band switch S1 (c wafer). The voltage output of A24, at pin 6, is adjusted for 1.414 Vdc (4 lower bands) or 1.885 Vdc (2 higher bands). Amplifier A25 and the associated voltage divider switch network (deviation switch S2 b wafer and resistors R33 through R40) provides a sequence of equally spaced voltages symetrical about zero. R41 provides balance adjustment of the voltage divider network. The selected voltage is applied through A23 to the REF testpoint TP6 and through R27 to differential amplifier A22. This voltage is also applied through R31 to the TEST position of S3, providing a -3% meter deflection voltage.

c. **DC VOLTAGE COMPARISON CIRCUITS** - With the REC-REP-TEST switch, S3, in the REP position the DC output of the demodulator (connections made for reproduce board calibration) is applied through A21 and gain adjust R23 to differential amplifier A22. This DC voltage is compared to the selected DC reference voltage at A22-3. The difference between these two voltages is amplified 100 times and indicated by the meter. A22 also serves as a limiter circuit protecting the meter from high current.

With S3 in the TEST position, the DC reference voltage is applied to both inputs of A22, checking the meter setting and accuracy. R28 is used to compensate for dc offset errors.

When S3 is placed to the REC position (connections made for record board calibration) the detected DC voltage from the frequency comparison circuits is compared to the standard DC reference voltage, providing a meter indication.

d. **CARRIER FREQUENCY CIRCUITS** - All carrier frequencies (table 1) are derived from the 400 kHz output of the B board.

Observe that the top three band carrier frequencies at 120 ips are 1200, 900, and 432 kHz, illustrating that frequencies above 400 kHz are required in certain instances. This is accomplished, briefly, by a voltage controlled oscillator in conjunction with a phase-lock detector in a phase-locked loop.

Divider circuits A3, A4, A11 and A12 provide three ratios of 27/25 (432 kHz), 27/12 (900 kHz), and 27/9 (1200 kHz): A1 functions as a shaper circuit prior to the divide-by circuits. The divided outputs of A3 and A4 are decoded by A5 and applied to the phase detector, A6, via the band selection switch S1. This switch provides A5 outputs with divisions of 9 (pin 6), 12 (pin 5), or 25 (pin 4). The divide-by-two section of A3, with all of A4, provides a potential division of 32. This provides decoding and resetting at count 25.

Apparent multiplication by the number 27 (2 7/9, 27/12, and 27/25) is produced by using a divide-by-27 circuit in the feedback line of the phase-locked loop. The frequency in this loop is produced by voltage controlled oscillator (VCO) A7, which is controlled by the DC voltage output of the phase-lock detector, A6. While briefly disregarding A8, A9, and A10, note that outputs of A11 and A12 are decoded by A13, resetting A11 on each 3rd count and A12 on each 9th count. This action divides the VCO frequency by 27 prior to being applied to the phase-lock detector, A6. When the phase-lock detector senses equal frequencies at A6-1 and 3, the loop is in the "locked" state, producing a constant frequency at the VCO output (A7-6) equal to 27 times the frequency at A6-1.

The 10% steps of frequency deviation from the center frequencies is accomplished by the deviation switch S2, dividers and gates A2, A3 (part of), A8, A9, and A10.

A2 and the divide-by-5 section of A3 provide an effective divide-by-10 of the input 400 kHz signal. Divide-by-16 circuit A8 is decoded by A10 providing VCO frequency divisions of 6, 7, 8, 9, 10, 11, 12, 13, or 14. These ratios of 6 through 14 become multiplying factors of 0.6 through 1.4, when combined with the divide-by-10 action of A2 and A3. Thus 9 10% deviation steps are provided (4 positive from zero and 4 negative from zero).

The effect of all previously described circuitry produces the proper carrier and deviated frequencies at A7-6 for the top speed of any of the three highest bands. Divide-by-circuits A14 and A15 and gating circuits A16 and A17, provide the proper frequency division for the lower speeds. The speed divided frequency is applied to divide-by circuit A18, with the output selected by the band selection switch for the three lower bands.

The final selected frequency, per band, speed, and deviation, is applied through A5 to the CARRIER OUT testpoint, TP3, for application to the reproduce board. This frequency is also applied to the frequency comparison circuits.

e. FREQUENCY COMPARISON CIRCUITS - The frequency comparison circuits function by comparing the record board carrier frequency output (with a DC input from the calibrator) to the calibrator reference carrier frequency.

The record board carrier frequency is applied to the calibrator at CARRIER IN testpoint, TP4. A1 shapes and buffers the signal for application to one input of the phase-lock detector, A19, at pin 1. The other input to A19, at pin 3, is the selected reference carrier frequency (previous paragraph), also available at TP3. The output of A19 is amplified and detected, producing a DC voltage which is routed to the input of the record board via TP2. A19 causes this DC voltage to seek a value which will make the record board carrier frequency equal to the selected reference frequency. The DC voltage (TP2) required for this purpose is applied to the DC comparator circuit to produce an error reading on the meter.

MAINTENANCE

a. EQUIPMENT REQUIRED

Digital Voltmeter - HP 3440A or Equiv.
Frequency Counter - HP 5216A or Equiv.
Signal Generator - HP 200CD or Equiv.

b. TEST - The following tests are provided assuming the calibrator unit is properly positioned in a reproduce chassis. See operating section for details.

NOTE

A normal 5 minute warm-up period (power applied to all calibrator circuits) is suggested for stabilization of selected calibrator circuits.

Step 1. Connect a frequency counter to calibrator testpoints TP3 hi (CARRIER OUT) and TP5 Lo (GND).

Step 2. Apply recorder power and place the calibrator POWER switch to ON.

Step 3. Randomly switch through the various band and deviation settings (band switch and percent deviation switch) at any speed. Ensure the presence of the corresponding frequency per table 1.

Step 4. Remove the frequency counter and connect a digital voltmeter to testpoints TP6 hi (REF) and TP5 lo (GND). Ensure the presence of the DC voltages of table 2 per band and deviation.

TABLE 2. DC VOLTAGES PER BAND AND DEVIATION

BAND	Vdc per % DEVIATION									
	-40	-30	-20	-10	0	+10	+20	+30	+40	
X, II	-1.885	-1.414	-.943	-.471	0	.471	.943	1.414	1.885	
I, 1/2, 1/4,1/8	-1.414	-1.061	-.707	-.354	0	.354	.707	1.061	1.414	

Step 5. Remove the voltmeter connections and jumper (using a patch-cord) TP1 (DC IN) to TP6 (REF). Set the REC-REP-TEST switch to the REP position. Observe a zero meter indication (±0.2) for each of the nine deviation settings of band I. Slight errors may be corrected during adjustment (following section).

Step 6. Set the REC-REP-TEST switch to TEST and observe the proper meter indication, per table 3, for the two bands at each deviation.

TABLE 3. METER INDICATIONS

BAND	% DEVIATION									
	-40	-30	-20	-10	0	+10	+20	+30	+40	
I	-3	-2.25	-1.5	-.75	0	+.75	+1.5	+2.25	+3	
II		-3	-2	-1	0	+1	+2	+3		

Step 7. To test the frequency comparison circuit, connect a signal generator to the CARRIER IN testpoint. Set the generator to 1 Vrms at test frequency (select from table 1 and set the calibrator deviation and band switches accordingly). Monitor, with a voltmeter, the DC OUT jack of the calibrator, ensuring either +10 Vdc or -10 Vdc. Raise or lower the generator frequency slightly and ensure the DC level changes (from either +10 to -10 or -10 to +10).

c. ADJUSTMENT - No adjustment is provided for the standard frequencies generated by the calibrator unit. If these frequencies are not within 0.05% of those specified in Table 1, a component failure is indicated.

1. DC CIRCUITRY ADJUST - Remove the board shield.

Step 1. With all power off, adjust meter for a zero reading by turning the adjustment screw at the rear of the meter. For this adjustment the calibrator unit should be in the same position (vertical or horizontal) as it will in actual use.

Step 2. Make certain the calibrator is properly placed in the reproduce chassis, apply recorder power, place the POWER switch to ON, and allow 5 minutes for warm-up.

Step 3. Monitor the voltage drop across R42, and adjust R44 to obtain a 1.74 Vdc drop.

Step 4. Set band switch to I, and deviation switch to +40%. Monitor, with a digital voltmeter, REF testpoint TP6 and adjust R51 (top edge of board) for a 1.414 Vdc reading.

Step 5. Set deviation to -40% and adjust R41 for a -1.414 Vdc reading.

Step 6. Check for deviation readings/voltage as follows: 0% = 0 Vdc, ±10% = ±0.354 Vdc, ±20% = ±0.707 Vdc, ±30% = ±1.060, and ±40 = ±1.414.

Step 7. Set band switch to II and deviation to +30%. Monitor, with a digital voltmeter, the REF testpoint and adjust R48 (top edge of board) for 1.414 Vdc.

Step 8. Check for deviation readings/voltages as follows: 0% = 0 Vdc, ±10%, = 0.471 Vdc, ±20% = 0.943 Vdc, and ±30% = 1.414 Vdc.

2. METER ADJUST - Remove the board shield.

Step 1. Set the deviation switch to zero, band switch to II, and REC-REP-TEST switch to TEST. Trim R28 (near connector) slightly, to zero meter.

Step 2. Set the deviation switch to +30%. Trim R23 (near connector) slightly to make meter indicate +3%. Check at other deviation as follows +20% = +2%, +10% = +1%, 0% = 0%, -10% = 1%, -20% = 2%, and -30% = 3%.

PARTS LIST

FM Calibrator Accessory Kit 836400

(1) Patch-cords, BNC to Pin 836398-072
(2) Patch-cord, Pin to Pin 836399-072
(3) Adapter 836390 (used only for 3500 series systems)

Calibrator Complete 836352

A Bd	836342	S3	510399-009	TP2	855812-004
B Bd	836346	S4	510398-001	TP3	855812-004
S1	836423-001	S5	510399-001	TP4	855812-002
S2	836423-002	TP1	855812-002	TP5	855812-010
				TP6	855812-005

A Bd 836342

A1	859520-056	A20	510240-002	C20	859775-027
A2	510103-009	thru		C21	859959-002
A3	510103-020	A26		CR1	850287
A4	510103-013	C1	197212-100	thru	
A5	859520-038	C2	859775-005	CR7	
A6	510387	C3	691686-012	CR8	510402
A7	510401	C4	197212-250	CR9	844510
A8	510103-013	C5	197212-330	P1	853518
A9	510103-016	C6	198816-680	Q1	854539
A10	510103-019	C7	691686-001	thru	
A11	510103-013	C8	859775-005	Q3	
A12	510103-013	C9	691686-012	R1	198200-472
A13	510103-001	C10	859959-001	R2	198200-472
A14	510103-013	thru		R3	198200-102
A15	510103-013	C15		R4	198200-102
A16	510103-018	C16	197212-330	R5	198200-101
A17	510103-018	C17	859959-001	R6	198200-103
A18	510103-013	C18	859775-009	R7	198200-392
A19	510387	C19	859959-001		

R8	198200-472	R26	853530-281	R43	853530-176
thru		R27	853530-089	R44	329151-008
R16		R28	329151-010	R45	853530-219
R17	198200-102	R29	853530-330	R46	853530-301
R18	198200-102	R30	853530-204	R47	853530-219
R19	198200-472	R31	853530-186	R48	854535-010
R20	198200-223	R32	853530-301	R49	853530-164
R21	198200-153	R33	836351*	R50	853530-204
R22	864971-018	thru		R51	854535-010
R23	329151-003	R40		R52	853530-251
R24	853530-087	R41	329151-007	R53	198200-472
R25	853530-281	R42	853530-089	R54	198200-102
				R55	198200-471

B Bd 836346

A1	859520-001	C4	691391-012	Q1	853507
A2	859520-029	C5	859959-001	R1	198200-471
A3	510240-002	C6	197212-220	R2	198200-471
C1	691686-001	C7	197212-220	R3	198200-561
C2	854528-033	CR1	852475-018	R4	694111-012
C3	691391-012	M1	510395	Y1	510403

* RESISTOR KIT

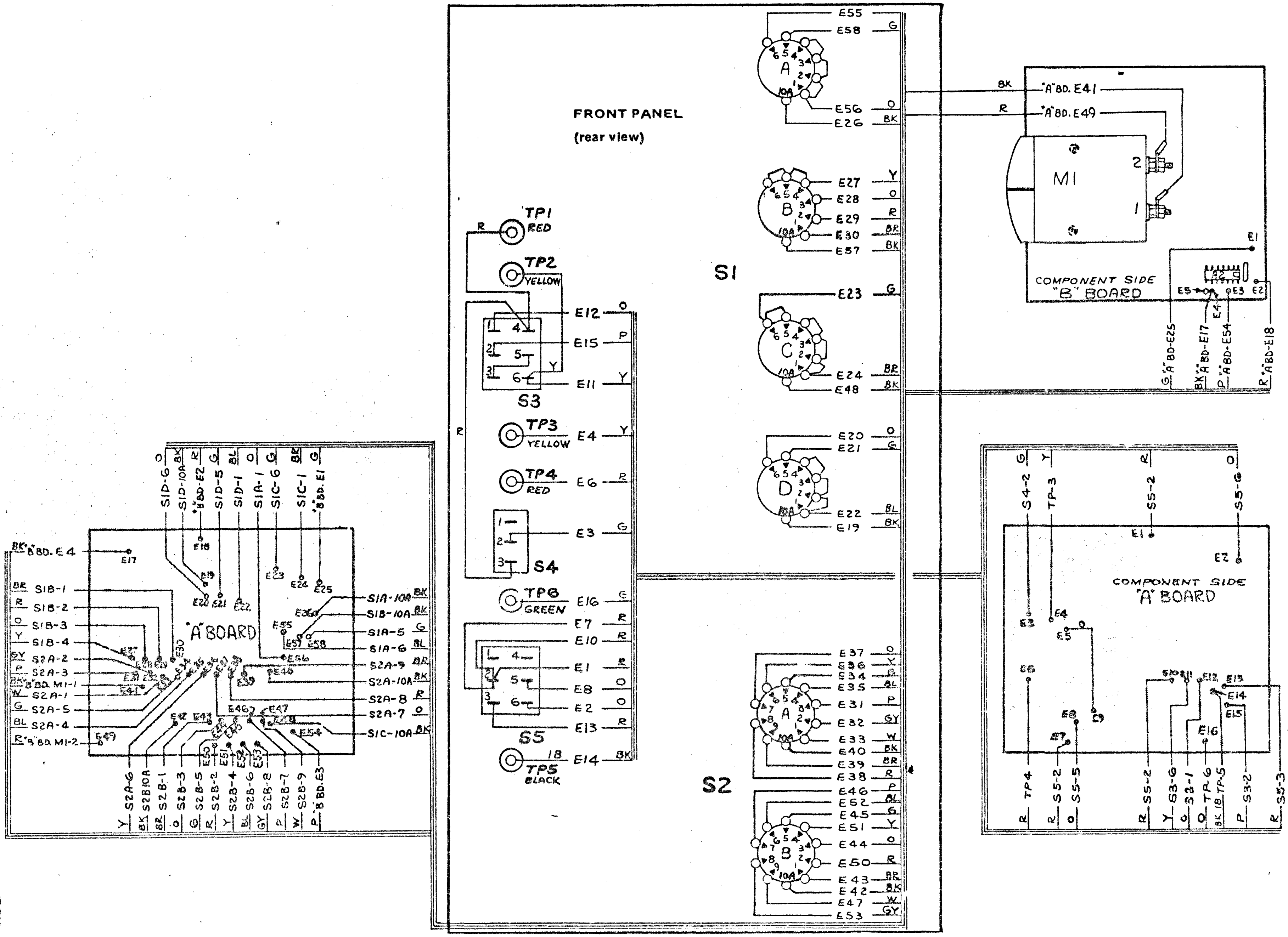


Figure 7. Calibrator Unit, Wiring Diagram

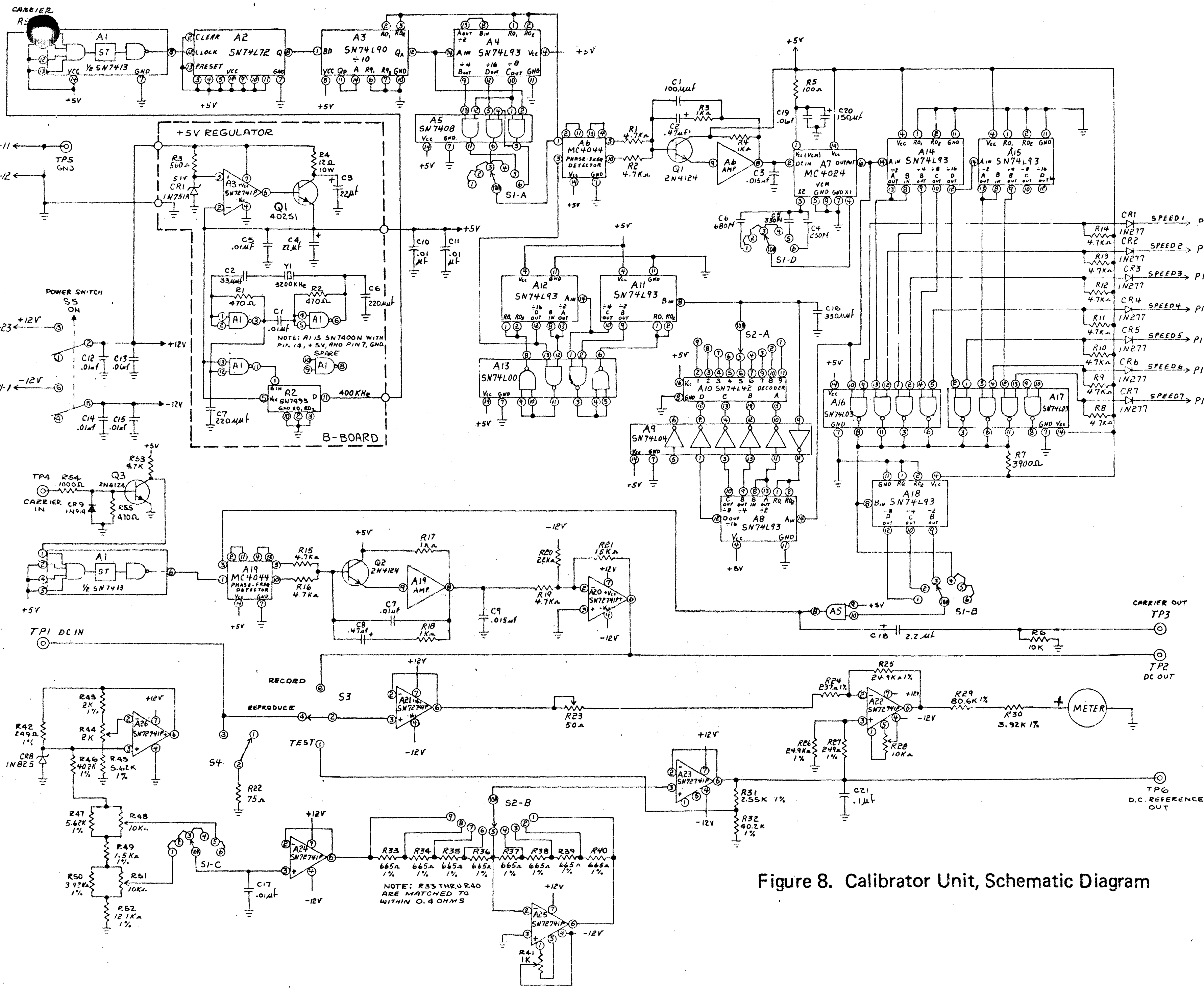
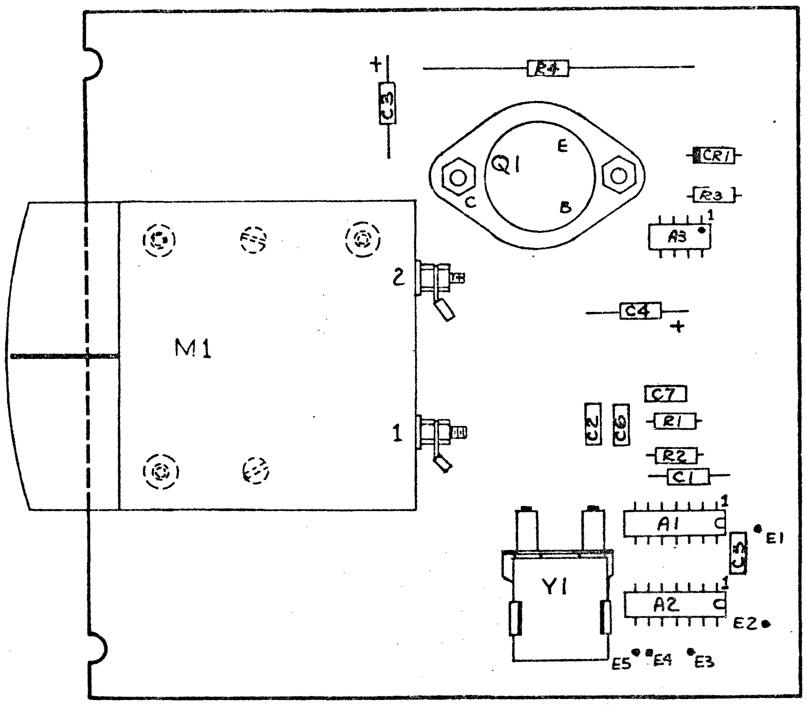
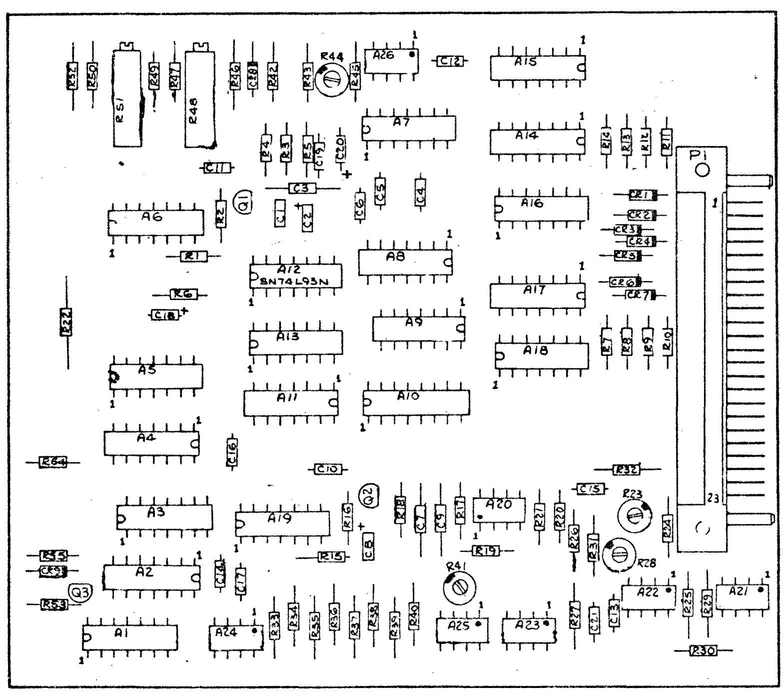


Figure 8. Calibrator Unit, Schematic Diagram



B BOARD



A BOARD

Figure 9. A and B Board, Component Locations

Sangamo

PARTS LIST

GENERAL

This bulletin contains the parts list for the Sangamo 3600 Recorder/Reproducer system. This bulletin is divided into the following sections:

a. **ELECTRICAL PARTS LIST** – This list gives the description of electrical components used in the 3600 Recorder/Reproducer.

b. **LIST OF MANUFACTURERS** – This list matches the manufacturers federal code number with the manufacturers name and city.

c. **SUPPLEMENTARY PARTS LIST** – This list may or may not be present in a particular manual. It lists those parts which, due to design improvements, have been added between printings of this manual. When the manual is reprinted, these parts are incorporated into the Electrical Parts List.

HOW TO USE THIS PARTS LIST

This parts list has been designed to give the customer the necessary information he seeks in the easiest and fastest manner possible. On every wiring diagram in the tape transport bulletin the proper Sangamo part number is given for every component on that wiring diagram. In addition, most every bulletin lists the proper Sangamo part number for each component covered by that bulletin. The list in this bulletin gives a complete description of every electrical part used in the 3600 system. The parts are arranged in numerical order using the Sangamo part number.

To find the description of any component the technician simply finds the Sangamo part number on the wiring diagram or bulletin and then finds the description of that part number in this chapter. No searching through complex assembly numbers is required.

To find the manufacturer, note the federal code number given in the description and then find this number in the list of manufacturers.

If a Sangamo part number is not found in the Electrical Parts List, look in the Supplementary Parts List.

ORDERING REPLACEMENT, SPARE OR EXPANSION PARTS

Price and delivery information on parts may be obtained either directly from the Sangamo Electric Company in Springfield, Illinois, or from your nearest Sangamo Sales Office.

Parts orders should be issued directly to the Sangamo Electric Company in Springfield, Illinois, or to the Sangamo Electric Company in care of your nearest Sangamo Sales Office. To assist in making this contact, a list of Sales Offices is included in the pocket in the rear of this manual.

Sangamo recommends that whenever possible, and particularly when a system is used in a critical application, a minimum stock of spare parts should be maintained. Sangamo's Data Systems Department has specialized personnel who can assist the user in making a selection of spares, at any time, to fit their individual requirements.

In addition to providing quotations for replacement and spare parts, the Data Systems Department personnel are also capable of preparing quotations for expansion or modification of your systems, as well as ccepting any resulting order.

All written inquiries for prices, availability or technical information regarding parts being directed to the Data Systems Department should be addressed to:

Sangamo Electric Company
P.O. Box 3347
Springfield, Illinois 62705
Attn: Data Systems Department

Contact can also be made by calling Area Code 217/544-6411, Extension 350.

When issuing inquiries or orders for parts, the following information must always be provided in order to assure that the correct parts will be supplied.

System Model Number
System Serial Number
Sangamo Part or Assembly Number
Description of Part or Assembly
The Circuit Designation, if any

FACTORY REPAIR SERVICE

If desired, basic subassemblies may be returned to the factory for repair, and in special instances, entire systems may also be returned for repair, expansion or modification. If the latter case is necessary, prior rangements must be made by writing or calling as directed in the above paragraph. The following paragraphs outline the necessary instructions when returning equipment to the factory.

DESCRIBE SYSTEM FAILINGS

Indicate the trouble symptom or defect stating this information as completely as possible on the advance shipping documents, instrument tag or order form. If an intermittent trouble exists, please be specific in pointing out any intermittent problems and describe the problem as fully as possible; otherwise, the intermittent may not appear during testing and would be overlooked.

Too much information is better than too little and will help to reduce the time and effort required to locate and correct the defect thereby insuring lower cost and smaller down time.

SPECIAL INSTRUCTIONS

If the user has made any changes in the returned part and it is desired to retain these changes, please indicate this specifically.

INVOICING AND SHIPPING

In the first correspondence, please state the desired invoicing and shipping procedures.

Indicate whether repair work may begin immediately with billing in accordance with Sangamo's standard pricing system or whether Sangamo should secure prior approval of repair charges before proceeding. The price will be identical in both cases, but any delay will be minimized by permission to begin repairs mediately.

PACKAGING AND LABELING

Properly package and label the part to be returned to the factory. Address all shipments to:

Sangamo Electric Company
Data Systems Department
11th and Converse Streets
Springfield, Illinois 62705
Attn: Receiving Department

Show return address on repair correspondence, indicating the exact address to which the equipment should be returned upon completion of repairs. All shipping costs must be borne by the owner of the equipment.

SANGAMO PART NO.	NAME AND DESCRIPTION
87799	FUSE: CERAMIC TUBE, 10 AMP, 250 VOLT MAX, MFR 71400, CAT. NO. ABC-10
93240	SEMICONDUCTOR, DIODE: SILICON; MFR 01295, TYPE 1N645
195701-050	CAPACITOR, FIXED: MICA; 50UUF 1%, 500 VDCW; MFR 00853
196740-016	CAPACITOR, FIXED: MYLAR; 0.230UF 1%, 100 VDCW; MFR 53021
197212-001	CAPACITOR, FIXED: MICA; 1UUF 5%, 500 VDC; MFR 00853
197212-004	CAPACITOR, FIXED: MICA; 4UUF 5%, 500 VDCW; MFR 00853
197212-005	CAPACITOR, FIXED: MICA; 5UUF 5%, 500 VDCW; MFR 53021
197212-010	CAPACITOR, FIXED: MICA; 10UUF 5%, 500 VDC; MFR 00853
197212-022	CAPACITOR, FIXED: MICA; 22UUF 5%, 500 VDCW; MFR 53021
197212-027	CAPACITOR, FIXED: MICA; 27UUF 5%, 500 VDC; MFR 00853
197212-047	CAPACITOR, FIXED: MICA; 47UUF 5%, 500 VDC; MFR 00853
197212-050	CAPACITOR, FIXED: MICA; 50UUF 5%, 500 VDC; MFR 00853
197212-062	CAPACITOR, FIXED: MICA; 62UUF 5%, 500 VDC; MFR 00853
197212-068	CAPACITOR, FIXED: MICA; 68UUF 5%, 500 VDC; MFR 00853
197212-070	CAPACITOR, FIXED: MICA; 70UUF 5%, 500 VDC; MFR 00853
197212-082	CAPACITOR, FIXED: MICA; 82UUF 5%, 500 VDCW; MFR 00853
197212-100	CAPACITOR, FIXED: MICA; 100UUF 5%, 500 VDC; MFR 00853
197212-120	CAPACITOR, FIXED: MICA; 120UUF 5%, 500 VDCW; MFR 00853
197212-150	CAPACITOR, FIXED: MICA; 150UUF 5%, 500 VDC; MFR 00853
197212-200	CAPACITOR, FIXED: MICA; 220UUF 5%, 500 VDC; MFR 00853
197212-220	CAPACITOR, FIXED: MICA; 220UUF 5%, 500 VDC; MFR 00853
197212-240	CAPACITOR, FIXED: MICA; 240UUF 5%, 500 VDC; MFR 00853
197212-250	CAPACITOR, FIXED: MICA, 250UUF 5%, 500 VDC; MFR 00853
197212-270	CAPACITOR, FIXED: MICA, 270UUF 1/2%, 500 VDC; MFR 00853
197212-330	CAPACITOR, FIXED: MICA, 330UF 5%, 500 VDC; MFR 00853
197212-400	CAPACITOR, FIXED: MICA; 400UUF 5%, 500 VDC; MFR 00853
197212-470	CAPACITOR, FIXED: MICA; 470UUF 5%, 500VDCW; MFR 00853
197212-500	CAPACITOR, FIXED: MICA; 500UUF 5%, 500VDCW; MFR 00853
197227-100	CAPACITOR, FIXED: MICA; 1000UUF 5%, 500 VDC; MFR 00853
197227-120	CAPACITOR, FIXED: MICA; 1200UUF 5%, 500 VDC; MFR 00853
197227-390	CAPACITOR, FIXED: MICA; 3900 UUF 5%, 500 VDC; MFR 53021
197228-200	CAPACITOR, FIXED: MICA; 2,000UUF 2%, 500 VDCW; MFR 00853
197228-390	CAPACITOR, FIXED: MICA; 3,900UUF 2%, 500 VDCW; MFR 00853
197236-192	CAPACITOR, FIXED: MICA; 19,200UUF 10%, 300 VDCW; MFR 53021
198200-100	RESISTOR, FIXED: COMP; 10 OHMS 5%, 1/4 W; MFR 53021
198200-101	RESISTOR, FIXED: COMP; 100 OHMS 5%, 1/4 W; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
198200-102	RESISTOR, FIXED: COMP; 1000 OHMS 5%, 1/4 W; MFR 53021
198200-103	RESISTOR, FIXED: COMP; 10,000 OHMS 5%, 1/4 W; MFR 53021
198200-104	RESISTOR, FIXED: COMP; 100,000 OHMS 5%, 1/4 W; MFR 53021
198200-105	RESISTOR, FIXED: COMP; 1 MEG 5%, 1/4 W; MFR 53021
198200-121	RESISTOR, FIXED: COMP; 120 OHMS 5%, 1/4 W; MFR 53021
198200-122	RESISTOR, FIXED: COMP; 1200 OHMS 5%, 1/4 W; MFR 53021
198200-123	RESISTOR, FIXED: COMP; 12,000 OHMS 5%, 1/4 W; MFR 53021
198200-124	RESISTOR, FIXED: COMP; 120,000 OHMS 5%, 1/4 W; MFR 53021
198200-151	RESISTOR, FIXED: COMP; 150 OHMS 5%, 1/4W; MFR 53021
198200-152	RESISTOR, FIXED: COMP; 1500 OHMS 5%, 1/4 W; MFR 53021
198200-153	RESISTOR, FIXED: COMP; 15,000 OHMS 5%, 1/4W; MFR 53021
198200-154	RESISTOR, FIXED: COMP; 150,000 OHMS 5%, 1/4W; MFR 53021
198200-181	RESISTOR, FIXED: COMP; 180 OHMS 5%, 1/4W; MFR 53021
198200-182	RESISTOR, FIXED: COMP; 1800 OHMS 5%, 1/4 W; MFR 53021
198200-183	RESISTOR, FIXED: COMP; 18,000 OHMS 5%, 1/4 W; MFR 53021
198200-220	RESISTOR, FIXED: COMP; 22 OHMS 5%, 1/4 W; MFR 53021
198200-221	RESISTOR, FIXED: COMP; 220 OHMS 5%, 1/4 W; MFR 53021
198200-222	RESISTOR, FIXED: COMP; 2200 OHMS 5%, 1/4 W; MFR 53021
198200-223	RESISTOR, FIXED: COMP; 22,000 OHMS 5%, 1/4 W; MFR 53021
198200-270	RESISTOR, FIXED: COMP; 27 OHMS 5%, 1/4 W; MFR 53021
198200-271	RESISTOR, FIXED: COMP; 270 OHMS 5%, 1/4 W; MFR 53021
198200-272	RESISTOR, FIXED: COMP; 2700 OHMS 5%, 1/4 W; MFR 53021
198200-273	RESISTOR, FIXED: COMP; 27,000 OHMS 5%, 1/4 W; MFR 53021
198200-330	RESISTOR, FIXED: COMP; 33 OHMS 5%, 1/4 W; MFR 53021
198200-331	RESISTOR, FIXED: COMP; 330 OHMS 5%, 1/4 W; MFR 53021
198200-332	RESISTOR, FIXED: COMP; 3,300 OHMS 5%, 1/4 W; MFR 53021
198200-333	RESISTOR, FIXED: COMP; 33,000 OHMS 5%, 1/4 W; MFR 53021
198200-361	RESISTOR, FIXED: COMP; 360 OHMS 5%, 1/4 W; MFR 53021
198200-391	RESISTOR, FIXED: COMP; 390 OHMS 5%, 1/4 W; MFR 53021
198200-392	RESISTOR, FIXED: COMP; 3900 OHMS 5%, 1/4 W; MFR 53021
198200-393	RESISTOR, FIXED: COMP; 39,000 OHMS 5%, 1/4 W; MFR 53021
198200-470	RESISTOR, FIXED: COMP; 47 OHMS 5%, 1/4 W; MFR 53021
198200-471	RESISTOR, FIXED: COMP; 470 OHMS 5%, 1/4 W; MFR 53021
198200-472	RESISTOR, FIXED: COMP; 4700 OHMS 5%, 1/4 W; MFR 53021
198200-473	RESISTOR, FIXED: COMP; 47,000 OHMS 5%, 1/4W; MFR 53021
198200-474	RESISTOR, FIXED: COMP; 470,000 OHMS 5%, 1/4 W; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
198200-512	RESISTOR, FIXED: COMP; 5100 OHMS 5%, 1/4 W; MFR 53021
198200-561	RESISTOR, FIXED: COMP; 560 OHMS 5%, 1/4W; MFR 53021
198200-562	RESISTOR, FIXED: COMP; 5600 OHMS 5%, 1/4 W; MFR 53021
198200-563	RESISTOR, FIXED: COMP; 56,000 OHMS 5%, 1/4 W; MFR 53021
198200-622	RESISTOR, FIXED: COMP; 6200 OHMS 5%, 1/4 W; MFR 53021
198200-624	RESISTOR, FIXED: COMP; 620,000 OHMS 5%, 1/4 W; MFR 53021
198200-680	RESISTOR, FIXED: COMP; 68 OHMS 5%, 1/4W; MFR 53021
198200-681	RESISTOR, FIXED: COMP; 680 OHMS 5%, 1/4W; MFR 53021
198200-682	RESISTOR, FIXED: COMP; 6800 OHMS 5%, 1/4 W; MFR 53021
198200-683	RESISTOR, FIXED: COMP; 68,000 OHMS 5%, 1/4 W; MFR 53021
198200-750	RESISTOR, FIXED: COMP; 75 OHMS 5%, 1/4 W; MFR 53021
198200-820	RESISTOR, FIXED: COMP; 82 OHMS 5%, 1/4 W; MFR 53021
198200-821	RESISTOR, FIXED: COMP; 820 OHMS 5%, 1/4 W; MFR 53021
198200-822	RESISTOR, FIXED: COMP; 8200 OHMS 5%, 1/4W; MFR 53021
198200-823	RESISTOR, FIXED: COMP; 82,000 OHMS 5%, 1/4W; MFR 53021
198202-102	RESISTOR, FIXED: COMP; 1000 OHMS 5%, 1/2 W; MFR 53021
198202-181	RESISTOR, FIXED: COMP; 180 OHMS 5%, 1/2 W; MFR 53021
198202-331	RESISTOR, FIXED: COMP; 330 OHMS 5%, 1/2 W; MFR 53021
198202-470	RESISTOR, FIXED: COMP; 47 OHMS 5% 1/2 W; MFR 53021
198204-101	RESISTOR, FIXED: COMP; 100 OHMS 5%, 1 W; MFR 53021
198204-220	RESISTOR, FIXED: COMP; 22 OHMS 5%, 1 W; MFR 53021
198229-480	CAPACITOR, FIXED: MICA; 4800UUF 1%, 300 VDCW; MFR 53021
198232-150	CAPACITOR, FIXED: MCR, .0150 UF 5%, 100 VDC; MFR 00853
198249-560	CAPACITOR, FIXED: MICA; 56UUF 5%, 300 WVDC; MFR 00853
198249-600	CAPACITOR, FIXED: MICA; 600UUF 5%, VDCW; MFR 00853
198249-680	CAPACITOR, FIXED: MICA; 680UUF 5%, 300VDCW; MFR 00853
198249-820	CAPACITOR, FIXED: MICA; 820UUF 5%, 300VDCW; MFR 00853
198816-420	CAPACITOR, FIXED: MICA; 420UUF 1%, 300 VDCW; MFR 00853
198816-561	CAPACITOR, FIXED: MICA; 561UUF 1%, 300 VDCW; MFR 00853
198816-600	CAPACITOR, FIXED: MICA; 600UUF 1%, 300 VDCW; MFR 00853
198816-621	CAPACITOR, FIXED: MICA; 621UUF 1%, 300 VDCW; MFR 00853
198816-680	CAPACITOR, FIXED: MICA; 680UUF 1%, 300 VDCW; MFR 00853
198839-960	CAPACITOR, FIXED: MICA; 960UUF 2%, 500 VDCW; MFR 00853
270144	FILTER, LOW PASS: 312 KHZ, SHARP CUTOFF; MFR 53021
270145	FILTER, LOW PASS: 625 KHZ, SHARP CUTOFF; MFR 53021
270146	FILTER, LOW PASS: 1.25 KHZ, SHARP CUTOFF; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
270147	FILTER, LOW PASS: 2.5 KHZ, SHARP CUTOFF; MFR 53021
270148	FILTER, LOW PASS: 5.0 KHZ, SHARP CUTOFF; MFR 53021
270149	FILTER, LOW PASS: 10.0 KHZ, SHARP CUTOFF; MFR 53021
270150	FILTER, LOW PASS: 20.0 KHZ, SHARP CUTOFF; MFR 53021
270151	FILTER, LOW PASS: 40.0 KHZ, SHARP CUTOFF; MFR 53021
270173	TRANSFORMER, DRIVER: 20 KHZ; MFR 53021
270174	TRANSFORMER, DRIVER: 20 KHZ; MFR 53021
270175	REACTOR, FILTER: IND., 80UH, 0.1 VRMS, 1.0 KHZ; MFR 53021
270184	TRANSFORMER, POWER: PRIM. 115/230V; SEC. 1, 6.72V, SEC. 2, 35.9V; MFR53021
270186	INDUCTOR, FIXED: POT CORE; 30 MH, 2% AT 10 KHZ; MFR 53021
270188	FILTER, LOW PASS: 80 KHZ, SHARP CUTOFF; MFR 53021
270225	FILTER, LOW PASS: 312.5 Hz, LINEAR PHASE; MFR 53021
270226	FILTER, LOW PASS: 625 Hz, LINEAR PHASE; MFR 53021
270227	FILTER, LOW PASS: 1.25 kHz, LINEAR PHASE; MFR 53021
270228	FILTER, LOW PASS: 2.5 kHz, LINEAR PHASE; MFR 53021
270229	FILTER, LOW PASS: 5.0 kHz, LINEAR PHASE; MFR 53021
270230	FILTER, LOW PASS: 10.0 kHz, LINEAR PHASE; MFR 53021
270231	FILTER, LOW PASS: 20.0 kHz, LINEAR PHASE; MFR 53021
270232	FILTER, LOW PASS: 40.0 kHz, LINEAR PHASE; MFR 53021
270233	FILTER, LOW PASS: 80.0 kHz, LINEAR PHASE; MFR 53021
270280	TRANSFORMER, POWER: PRI. 115V, SEC. 1, 17.2 V, SEC. 2, 17.2V; MFR 53021
270402	INDUCTOR: 20 MH IND AT 2 VRMS, 130 HZ, 0.5 AMPS DC; MFR 53021
270405	XFMR, PWR: 1-2, 2-4, 115/230 V, 50/60 HZ; SEC 20 V, 2.8 AMP; MFR 53021
270406	XFMR, PWR: PRI 115 V, SEC 1, 40.5 V, SEC 2, 3, 21.8 V; MFR 53021
270439	INDUCTOR: 8 MH MIN IND AT 3 VRMS, 400 HZ W/500 MA DC; MFR 53021
270445	XFMR, PWR: PRI 1-3, 2-4, 115 V; SEC 8-9, 31.4 V 0.1%; MFR 53021
270447	XFMR, DRIVER: PRI 10-12, 11 CT, SEC 1-2, 3-4, 5-6, 7-8; MFR 53021
270449	XFMR: 1-3, 4-6, 7-8, 1-2, 10 V; 4-5, 6-7, 5.25 V; MFR 53021
276212-110	CAPACITOR, FIXED: MICA; 1100UUF 1%, 500 VDC; MFR 00853
276212-163	CAPACITOR, FIXED: MICA; 1630UUF 1%, 500 VDCW; MFR 53021
276212-200	CAPACITOR, FIXED: MICA; 2,000UUF 1%, 500 VDCW; MFR 00853
276212-330	CAPACITOR, FIXED: MICA; 3300UUF 1%, 500 VDCW; MFR 53021
276212-450	CAPACITOR, FIXED: MICA; 4,500UUF 1%, 500 VDCW; MFR 00853
276230-430	CAPACITOR, FIXED: MICA; 430UUF 2%, 300 VDC; MFR 00853
276231-047	CAPACITOR, FIXED: MICA; 47UUF 1/2%, 500 VDC; MFR 00853
276231-062	CAPACITOR, FIXED: MICA; 62UUF 1/2%, 500 VDC; MFR 00853

SANGAMO PART NO.	NAME AND DESCRIPTION
276231-180	CAPACITOR, FIXED: MICA; 180UUF 1/2%, 500 VDC; MFR 00853
276241-120	CAPACITOR, FIXED: MICA; 1200UUF 1%, 500 VDC; MFR 00853
276241-240	CAPACITOR, FIXED: MICA; 2400UUF 1%, 500 VDC; MFR 00853
276241-960	CAPACITOR, FIXED: MICA; 9600UUF 1%, 500 VDCW, MFR 53021
276245-100	RESISTOR, FIXED: FILM; 1000 OHMS ±1%, 1/8 W; MFR 53021
276245-274	RESISTOR; FIXED: FILM; 2740 OHMS 1%, 1/8W; MFR 53021
276245-287	RESISTOR, FIXED: FILM; 2870 OHMS 1%, 1/8 W; MFR 53021
276245-348	RESISTOR, FIXED: FILM; 3480 OHMS 1%, 1/8 W; MFR 53021
276245-475	RESISTOR, FIXED: FILM, 4750 OHMS 1%, 1/8 W; MFR 53021
276245-499	RESISTOR, FIXED: FILM; 4990 OHMS 1%, 1/8 W; MFR 53021
276246-806	RESISTOR, FIXED: FILM; 80.6 K OHMS 1%, 1/8 W; MFR 53021
276247-301	RESISTOR, FIXED: FILM; 301 K OHMS 1%, 1/8 W; MFR 53021
277181-001	FILTER, LOW PASS: 80 kHz, LINEAR PHASE; MFR 53021
277181-002	FILTER, LOW PASS: 40 kHz, LINEAR PHASE, MFR 53021
277181-003	FILTER, LOW PASS: 20 kHz, LINEAR PHASE; MFR 53021
277181-004	FILTER, LOW PASS: 10 kHz, LINEAR PHASE; MFR 53021
277181-005	FILTER, LOW PASS: 5 kHz, LINEAR PHASE; MFR 53021
277181-006	FILTER, LOW PASS; 2.5 kHz, LINEAR PHASE; MFR 53021
277181-007	FILTER, LOW PASS: 1.25 kHz, LINEAR PHASE; MFR 53021
277181-008	FILTER, LOW PASS: 0.625 kHz, LINEAR PHASE; MFR 53021
277181-009	FILTER, LOW PASS: 0.312 kHz, LINEAR PHASE; MFR 53021
277272-001	FILTER, LOW PASS: 80 kHz, MFR 53021
277272-002	FILTER, LOW PASS: 40 kHz, MFR 53021
277272-003	FILTER, LOW PASS: 20 kHz, MFR 53021
277272-004	FILTER, LOW PASS: 10 kHz, MFR 53021
277272-005	FILTER, LOW PASS: 5 kHz, MFR 53021
277272-006	FILTER, LOW PASS: 2.5 kHz, MFR 53021
277272-007	FILTER, LOW PASS: 1.25 kHz, MFR 53021
277272-008	FILTER, LOW PASS: 0.625 kHz, MFR 53021
277272-009	FILTER, LOW PASS: 0.312 kHz, MFR 53021
277273-001	FILTER, LOW PASS: 500 kHz, MFR 53021
277273-002	FILTER, LOW PASS: 250 kHz, MFR 53021
277273-003	FILTER, LOW PASS: 125 kHz, MFR 53021
277273-004	FILTER, LOW PASS: 62.5 kHz, MFR 53021
277273-005	FILTER, LOW PASS: 31.2 kHz, MFR 53021

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277273-006	FILTER, LOW PASS: 15.6 kHz, MFR 53021
277273-007	FILTER, LOW PASS: 7.81 kHz, MFR 53021
329151-002	RESISTOR, VAR: 20 OHMS ±30%, 1/2 W; MFR 73138, PART NO. 62PR20
329151-003	RESISTOR, VAR: 50 OHMS 30%, 1/2W; 2 TERM PINS; MFR73138, PART NO 62PR50
329151-004	RESISTOR, VAR: 100 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR100
329151-005	RESISTOR, VAR: 200 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR200
329151-006	RESISTOR, VAR: 500 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR500
329151-007	RESISTOR, VAR: 1000 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR1K
329151-008	RESISTOR, VAR: 2000 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR2K
329151-009	RESISTOR, VAR: 5000 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR5K
329151-010	RESISTOR, VAR: 10,000 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR10K
329151-011	RESISTOR, VAR: 20,000 OHMS 30%, 1/2W; MFR 73138, PART NO. 62PR20K
329157-001	CAPACITOR, FIXED: CER; 0.01UF + 80%, = 20%, 50 VDCW; MFR 71590, NO. CK-103
329218-007	CONNECTOR, RECEPTACLE: 10 CONTACTS, SLDR TYPE; MFR 02660
329233	SEMICONDUCTOR, DIODE: MFR 04713, TYPE 1N4720
402925-002	SEMICONDUCTOR, DIODE: GLASS PACKAGE; MFR 01295 TYPE 1N4148
510007-002	RECTIFIER ASSY: SILICON, 1PH FW BRDG; MFR 04713, TYPE MDA952-2
510015-001	TRANSFORMER: MFR 53021
510018	TRANSISTOR: SILICON; MFR 04713, TYPE MPS2369
510020-023	RESISTOR, FIXED: COMP; 22 OHMS 5%, 1/4 W; MFR 53021
510020-031	RESISTOR, FIXED: COMP; 47 OHMS 5%, 1/4W; MFR 53021
510020-043	RESISTOR, FIXED: COMP; 150 OHMS 5%, 1/4W; MFR 53021
510020-059	RESISTOR, FIXED: COMP; 680 OHMS 5%, 1/4W; MFR 53021
510020-127	RESISTOR, FIXED: COMP; 470,000 OHMS 5%, 1/4W; MFR 53021
510021-039	RESISTOR, FIXED: CARBON; 100 OHMS 5%, 1/2 W; MFR 53021
510021-051	RESISTOR, FIXED: COMP; 330 OHMS 5%, 1/2W; MFR 53021
510023	RELAY, DRY REED: COIL 24 VDC, RES 800 OHMS 10%; MFR 04221, TYPE170-0135
510025	SOLENOID: 28 VDC, 200 OHMS, 3 W; MFR 29238 TYPE 41DC-271
510029-001	SEMICONDUCTOR, DIODE: SILICON; MFR 04713, TYPE 1N4997
510033-006	RESISTOR, VAR: 5000 OHMS 5%, MFR 80294 TYPE 224L
510038-019	SEMICONDUCTOR, DIODE: ZENER; SILICON; 9.1V; MFR 04713, TYPE 1N5239A
510045	METER, ELAPSED TIME: MFR 18583, MODEL 120-SP2
510058-002	CAPACITOR, FIXED: CER; .01UF 20%, 100VDCW; MFR 56289 NO. CO23B101F103M
510058-003	CAPACITOR, FIXED: CER; .02UUF 20%, 100 VDCW; MFR 56289 NO. CO23B101H203M
510072-001	CAPACITOR, FIXED: CER; 0.010 UF 30%, 25 VDC; MFR 99942 TYPE ULTRA-KAP

SANGAMO PART NO.	NAME AND DESCRIPTION
510076	TRANSISTOR: SILICON; NPN; MFR 04713, TYPE 2N3227
510077-001	INDUCTOR, FIXED: 120MH 10%, MFR 72259, PART NO. WEE-WEE120
510081-028	CAPACITOR, FIXED: ELECTLT; TANTALUM; 4.7UF 10%, 35 VDCW; MFR 05397
510081-035	CAPACITOR, FIXED: ELECTLT; TANTALUM; 8.2UF 10%, 20 VDCW; MFR 05397
510081-037	CAPACITOR, FIXED: ELECTLT; TANTALUM; 10.0UF 10%, 20 VDCW; MFR 05397
510081-041	CAPACITOR, FIXED: ELECTLT; TANTALUM; 15.0UF 10%, 20 VDCW; MFR 05397
510081-060	CAPACITOR, FIXED: ELECTLT; TANTALUM; 58.0UF 10%, 20 VDCW; MFR 05397
510081-063	CAPACITOR, FIXED: ELCTLT; TANTALUM; 68.0UF 10%, 20 VDCW; MFR 05397
510091	INTEGRATED CIRCUIT: MFR 07263, PART NO. U6E7741393
510097-004	INTEGRATED CIRCUIT: DUAL LINE DRIVER; MFR 01295 PART NO. SN75150P
510102-003	SWITCH, TOGGLE: SPDT, 5 AMPS, 115 VAC; MFR 09353, MODEL NO. 7101
510103-001	INTEGRATED CIRCUIT: QUADR 2-INPUT POS-NAND GATE; TYPE SN74LOON; MFR 01295
510103-009	INTEGRATED CIRCUIT: J-K MASTER SLAVE FLIP-FLOP; MFR 01295 NO. SN74L72N
510103-013	INTEGRATED CIRCUIT: 4-BIT BINARY COUNTER; TYPE SN74L93N MFR 01295
510103-016	INTEGRATED CIRCUIT: HEX INVERTER; TYPE SN74LO4N; MFR 01295
510103-017	INTEGRATED CIRCUIT: DUAL D EDGE-TRIGGERED F-F; TYPE SN74L78N MFR 01295
510103-018	INTEGRATED CIRCUIT: QUAD AND GATE OPEN COLL; TYPE SN74LO3N; MFR 01295
510103-019	INTEGRATED CIRCUIT: BCD TO DECIMAL DECODER; TYPE SN74L42N; MFR 01295
510103-020	INTEGRATED CIRCUIT: DECADE COUNTER DIV-BY 10; TYPE SN74L90N; MFR 01295
510113-001	RESISTOR, VAR: WW; 50 OHMS 5%, 1/2W; MFR 80294 PART NO. 33059-1-500
510113-011	RESISTOR, VAR: WW; 20 OHMS 5%, 1/2 W; MFR 80294 NO. 3305P-1-200
510114-002	CAPACITOR, FIXED: MICA; 5UUF 1%, 500V; MFR 09022 TYPE NO. CD050C03
510114-010	CAPACITOR, FIXED: MICA; 20UUF 1%, 500 VDC; MFR 09023 TYPE 6D6CD200K03.
510114-017	CAPACITOR, FIXED: MICA; 39 UUF 10%, 500 VDC; MFR 93790 NO 6D6ED390K03
510114-020	CAPACITOR, FIXED: MICA; 50UUF 10%, 500 VDC; MFR 09022 TYPE NO. 6D6ED500K03
510116-014	CAPACITOR, FIXED: CER; 120UUF 10%, 200 VDC; MFR 96733, NO. CK05BX121K
510116-018	CAPACITOR, FIXED: CER; 270UUF 10%, 200V; MFR 96733 NO. CK05BX271K
510116-022	CAPACITOR, FIXED: CER; 560UUF 10%, 200V; MFR 96733 NO. CK05BX561K
510116-025	CAPACITOR, FIXED: CER; 0.001UF 10%, 200 VDC; MFR 96733 NO. CK05BX102K
510116-026	CAPACITOR, FIXED: CER; 0.0012UUF 10%, 100V; MFR 96733 NO. CK05BX122K
510116-027	CAPACITOR, FIXED: CER; 0.0015UF 10%, 100 VDC; MFR 96733, NO. CK05BX152K
510116-029	CAPACITOR, FIXED: CER; 0.0022UF 10%, 100V, MFR 96733 NO. CK05BX222K
510116-032	CAPACITOR, FIXED: CER; 0.0039UF 10%, 100V; MFR 96733 NO. CK05BX392K
510116-036	CAPACITOR, FIXED: CER; 0.0082UF 10%, 100V; MFR 96733 NO. CK05BX822K
510116-037	CAPACITOR, FIXED: CER; .01UF 10%, 100VDCW; MFR 96733, PART NO. CK05BX103K

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510116-039	CAPACITOR, FIXED: CER; 0.015UF 10%, 50VDC; MFR 96733, NO. CKD5BX153K
510116-040	CAPACITOR, FIXED: CER; 0.018UF 10%, 50V; MFR 96733 NO. CK05BX183K
510116-041	CAPACITOR, FIXED: CER; 0.022UF 10%, 50 VDC; MFR 96733 NO. CK05BX223K
510116-042	CAPACITOR, FIXED: CER; 0.027UF 10%, 50 V; MFR 96733 PART NO. CK05BX273K
510116-049	CAPACITOR, FIXED: CER; 0.10UF 1%, 50VDCW; MFR 96733, PART NO. CK05BX104K
510117-028	CAPACITOR, FIXED: CER; 0.22UF 10%, 50 VDC; MFR 96733 NO. CK06BX224K
510118-002	OSCILLATOR, CRYSTAL: FREQ. 3.2 MHZ, SQW BSC.; MFR 75378 NO. 970-3071-0
510120-057	RESISTOR, FIXED: COMP; 220 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-081	RESISTOR, FIXED: COMP; 2,200 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-083	RESISTOR, FIXED: COMP; 2,700 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-085	RESISTOR, FIXED: COMP; 3,300 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-087	RESISTOR, FIXED: COMP; 3,900 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-089	RESISTOR, FIXED: COMP; 4700 OHMS 5%, 1/8 W; MFR 01121
510120-091	RESISTOR, FIXED: COMP; 5,600 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-099	RESISTOR, FIXED: COMP; 12,000 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-103	RESISTOR, FIXED: COMP; 18,000 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-113	RESISTOR, FIXED: COMP; 47,000 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-117	RESISTOR, FIXED: COMP; 68,000 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510120-125	RESISTOR, FIXED: COMP; 150,000 OHMS 5%, 1/8W; MFR 01121 TYPE BB
510121-002	SWITCH, ROTARY: 0.55 AMPS AT 28 VDC, 170 MA AT 115 VDC; 2 POSN; MFR 53021
510121-004	SWITCH, ROTARY: 0.55 AMPS AT 28 VDC; 170 MA AT 115 VDC; 5 POSN; MFR 53021
510128	INTEGRATED CIRCUIT: OPNL AMPL; MFR 01295, TYPE SN72702N
510141-001	CELL, INDICATING: 2000 HRS FIR; MFR 89597 PART NO. 8002
510142-001	REGULATOR: INPUT 23/29 D.C.V; MFR 89597 PART NO. 8100-53
510143-003	RESISTOR, VAR: 500 OHMS 10%, 0.5W; MFR 96791 PART NO. 3610W-501
510143-005	RESISTOR, VAR: 2000 OHMS 10%, 0.5W; MFR 96791 PART NO. 3600W-202
510143-007	RESISTOR, VAR: LEAD SCREW ADJ; 10KOHMS 10%; MFR 96791 NO. 3610W-103
510143-008	RESISTOR, VAR 20,000 OHMS 10%, 0.5W; MFR 96791 PART NO. 3610W-203
510164-007	RESISTOR, VAR: 1000 OHMS 10%, 0.75W; MFR 80294 NO. 3009P-1-102
510164-008	RESISTOR, VAR: 2000 OHMS 10%, 0.75W; MFR 80294, PART NO. 3009P-1-202
510164-013	RESISTOR, VAR: 100,000 OHMS 10%, 3/4 W; MFR 80294 PART NO. 3009P-1-104
510172-001	RESISTOR, FIXED: WW; 2 OHMS 5%, 10 W; MFR 11502 PART NO. PW10
510189-999	CAPACITOR, FIXED: MYLAR; 999 UF 5%, 100 VDC; MFR 00853
510190-250	CAPACITOR, FIXED: MYLAR; 250 UF 5%, 100 VDC; MFR 00853
510191-680	CAPACITOR, FIXED: MYLAR; .0680 UF 5%, 100 VDC; MFR 00853
510212	INDICATOR, ET: 9999.9 HRS, 110 VAC, 3 M AMPS, 35 W; MFR 33203 TYPE T4B

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510221	LAMP, INCAND: 36 V, 0.10 AMPS, CP 2.5; MFR 08806 NO. 1822
510225	LAMP, NEON: 110/125 V; 1/3 W; MFR 95263 PART NO. 32R2911T
510229	SEMICONDUCTOR, DIODE: GERMANIUM; MFR 04713 TYPE 1N91
510240-002	INTEGRATED CIRCUIT: OPERATIONAL AMPLIFIERS; MFR 01295, NO. SN 72741P
510244-003	TRANSISTOR, PHOTO: SILICON; MFR 01295 PART NO. T1L65
510247	LAMP, INCAND: 12 V, .04 AMPS; MFR 08806 NO. 394
510251	COUNTER: BI-DIR; 24 VDC, MFR 30892 NO. FB043.006-6-16-024-DC-M82-N
510252	COUNTER ELMCH: 24 VDC; MFR 30892 NO. FB043.00-6-1-25-024-DC-M82-N
510260	TRANSISTOR: SILICON; NPN; MFR 86684, TYPE 40411
510263	LOUDSPEAKER, PM: COIL IMPD 45 OHMS HDLG 2.5 W; MFR 74199 NO. 3A07Z45
510265	METER, VU: MICAM DC; RANGE 0-200 U AMP; MVT 310 OHMS; MFR 55026 NO. 18038
510271	LAMP, INCAND: BI-PIN; 28 V, .04 AMPS; 25 K HRS; MFR 71744 NO. CM7-7387
510277	SWITCH, SLIDE: DPDT; 125 V, AC-DC, 0.5 AMPS; MFR 79727 TYPE G-126
510279-003	FUSE, CARTRIDGE: 125 V, 5 AMP; MFR 71400, TYPE AGX
510279-004	FUSE, CTG: 8 AMPS, 32V; GLASS TUBE; MFR 71400 TYPE AGX
510294-001	RELAY, AMT: 4PDT; COIL 24 VDC, 800 OHMS; MFR 77342 NO. R40-E1-Y4-V800
510294-002	RELAY, AMT: 4PDT; COIL 12 VDC, 200 OHMS; MFR 77342 NO. R40-E1-Y4-V200
510295	ADAPTER, BNC RCPT TO PHONE PLUG: MFR 05276 MODEL NO. 1297
510306-001	INTEGRATED CIRCUIT: COMPARATOR 810; MFR 01295 PART NO. SN52810U
510313-419	RESISTOR, FIXED: FILM; 681,000 OHMS 1%, 1/8W; MFR 19701 NO. MF52C
510326	SWITCH, MICRO: CONT.-ARR.-SPNO-MOMENTARY MFR 91929 CAT. NO. YZ-2R
510333-008	CAPACITOR, FIXED: CER.; 1000UUF 5%, 25 VDC; MFR 96733 NO. L205BY102J
510333-012	CAPACITOR, FIXED: CER.; 2200UUF 5%, 25 VDC; MFR 96733 NO. L206BY222J
510333-015	CAPACITOR, FIXED: CER.; 4700UUF 5%, 25 VDC; MFR 96733 NO. L206BY472J
510333-018	CAPACITOR, FIXED: CER.; 10,000UUF 5%, 25 VDC; MFR 96733 NO. L206BY103J
510334-001	CAPACITOR, FIXED: CER.; 2.2UF 20%, 100 VDC; MFR 96733 NO. DB48BU225M
510336	TRANSISTOR: SILICON N-CHAN JCT FIELD-EFFECT; MFR 04713, TYPE 2N5555
510339-002	INTEGRATED CIRCUIT: DIFFERENTIAL COMPARATOR; MFR 01295, No. SN72810
510339-003	INTEGRATED CIRCUIT: DIFFERENTIAL COMPARATOR; MFR 01295, TYPE SN72820
510345-001	DIODE, LIGHT EMITTING: MFR 28480 TYPE NO. 5082-4403
510349-011	RESISTOR, VAR: CERMET; 20K OHMS 5%, 3/4W; MFR 80294 NO. 3009P-N64-203
510360	TRANSISTOR: SILICON; NPN; MFR 04713 TYPE 2N4265
510364	TRANSISTOR: SILICON; PNP; ANNULAR; MFR 04713, TYPE MPS3640
510375-002	CAPACITOR, FIXED: CERAMIC; 0.02UF -20/+80%, 25 WVDC; MFR 53021
510377	LAMP, ICAND: BI-PIN; 12V, 0.04 AMPS, 0.12 CP; MFR 71744, NO. CM 7-7371

SANGAMO PART NO.	NAME AND DESCRIPTION
510381	TRANSISTOR: SILICON; PNP; MFR 01295, TYPE 2N3467
510387	INTEGRATED CIRCUIT: PHASE FREQ. DETECTOR; TYPE MC4044P; MFR 04713
510388-001	RELAY, REED DRY: 8 PIN; 4 V MAX., 0.12 AMP MAX., MFR 94696, NO. W10701P-1
510388-002	RELAY, REED DRY: 8 PIN; COIL PICKUP 4V MAX., NOM 5V; RES. 200 OHMS 10%, MFR 94696 NO. W117D1P-9
510395	MICRO AMMETER - D.C.: FM CAL/BD; 3600/4900 SERIES; MODEL 1622, MFR 55026
510396-001	SWITCH, ROTARY: 4 DECKS CONT'S 1/4 AMP, 115 VAC; MFR 81073, NO. 8A36-5-1-6-S
510396-003	SWITCH, ROTARY: 2 DECKS, CONT'S 1/4 AMP, 115 VAC; MFR 81073, NO. 8A36-2-1-9-S
510398-001	SWITCH, TOGGLE: SPDT; MC; 3 TERM.; MFR 09353, MODEL NO. 7101
510399-001	SWITCH, TOGGLE: DPDT; MC; 6 TERM.; MFR 09353, MODEL NO. 7201
510399-009	SWITCH, TOGGLE: DPDT; MC; 6 TERM.; MFR 09353, MODEL NO. 7213
510401	INTEGRATED CIRCUIT: VCM; TYPE MC 4024P; MFR 04713
510402	DIODE, ZENER: TYPE 1N825; MFR 04713
510403	CRYSTAL UNIT: 3200 KHZ; TYPE NO. GP-05; MFR 01766
510428-001	INTEGRATED CIRCUIT: OPERATIONAL AMPLIFIER TYPE 715; MFR 07263, NO. U5F7715393
510429-025	CAPACITOR, FIXED: CERAMIC; 1UF, 20%, 50V; MFR 20932 NO. 5030
691032	TERMINAL, TURRET: BRASS ROD; MFR 71279
691111-100	RESISTOR, FIXED: CARBON; 10 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691111-101	RESISTOR, FIXED: CARBON; 100 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691111-181	RESISTOR, FIXED: CARBON; 180 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691111-221	RESISTOR, FIXED: CARBON; 220 OHMS 5%, 1/2W; MFR 01121
691111-271	RESISTOR, FIXED: CARBON; 270 OHMS 5%, 1/2 W; MFR 44655
691111-330	RESISTOR, FIXED: CARBON; 33 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691111-331	RESISTOR, FIXED: CARBON; 330 OHMS 5%, 1/2W; MFR 01121
691111-470	RESISTOR, FIXED: CARBON; 47 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691111-622	RESISTOR, FIXED: CARBON; 6200 OHMS 5%, 1/2W; MFR 01121
691111-822	RESISTOR, FIXED: CARBON; 8200 OHMS 5%, 1/2 W; MFR 01121, TYPE EB
691112-101	RESISTOR, FIXED: CARBON; 100 OHMS 5%, 1W; MFR 44655
691112-102	RESISTOR, FIXED: CARBON; 1000 OHMS 5%, 1 W; MFR 01121, TYPE GB
691112-152	RESISTOR, FIXED: CARBON; 1500 OHMS 5%, 1W; MFR 44655
691112-181	RESISTOR, FIXED: CARBON; 180 OHMS 5%, 1 W; MFR 01121, TYPE GB
691112-220	RESISTOR, FIXED: CARBON; 22 OHMS 5%, 1 W; MFR 01121, TYPE GB
691112-271	RESISTOR, FIXED: CARBON; 270 OHMS 5%, 1W; MFR 44655
691112-561	RESISTOR, FIXED: CARBON; 560 OHMS 5%, 1W; MFR 01121
691112-680	RESISTOR, FIXED: CARBON; 68 OHMS 5%, 1W; MFR 44655
691113-102	RESISTOR, FIXED: CARBON; 1000 OHMS 5%, 2W; MFR 01121, TYPE HB

SANGAMO PART NO.	NAME AND DESCRIPTION
691113-220	RESISTOR, FIXED: CARBON; 22 OHMS 5%, 2 W; MFR 01121, TYPE HB
691113-221	RESISTOR, FIXED: CARBON; 220 OHMS 5%, 2 W; MFR 01121, TYPE HB
691113-470	RESISTOR, FIXED: CARBON; 47 OHMS 5%, 2 W; MFR 01121, TYPE HB
691113-560	RESISTOR, FIXED: CARBON; 56 OHMS 5%, 2W; MFR 44655
691113-680	RESISTOR, FIXED: CARBON; 68 OHMS 5%, 2W; MFR 44655
691391-001	CAPACITOR, FIXED: TANTALUM; 4.7UF 20%, 10VDCW; MFR 56289, TYPE 150D
691391-002	CAPACITOR, FIXED: TANTALUM; 4.7UF 20%, 20 VDCW; MFR 21520
691391-004	CAPACITOR, FIXED: TANTALUM; 10 UF 20%, 10 VDC; MFR 00853
691391-005	CAPACITOR, FIXED: TANTALUM; 10.0UF 20%, 20 VDCW; MFR 53021
691391-008	CAPACITOR, FIXED: TANTALUM; 22UF 10%, 35 VDCW; MFR 21520
691391-009	CAPACITOR, FIXED: TANTALUM; 10.0UF 10%, 35 VDCW; MFR 56289
691391-011	CAPACITOR, FIXED: TANTALUM; 10.0UF 10%, 20VDCW; MFR 56289, TYPE 150D
691391-012	CAPACITOR, FIXED: TANTALUM; 22UF 10%, 15 VDCW; MFR 21520
691391-016	CAPACITOR, FIXED: TANTALUM, 47UF 10%, 35 VDCW; MFR 21520
691391-017	CAPACITOR, FIXED: ELCTLT; TANTALUM; 56.0UF 10%, 6 VDCW; MFR 21520
691391-018	CAPACITOR, FIXED: ELCTLT; TANTALUM; 56.0UF 10%, 15 VDCW; MFR 53021
691391-019	CAPACITOR, FIXED: TANTALUM; 100UF 10%, 6 VDCW; MFR 21520
691391-028	CAPACITOR, FIXED: TANTALUM; 22UF 20%, 35VDCW; MFR 56289, TYPE 150D
691391-029	CAPACITOR, FIXED: TANTALUM; 33UF ±20%, 20 WVDC; MFR 56289, TYPE 150D
691391-030	CAPACITOR, FIXED: TANTALUM; 1.0UF 10%, 15 VDCW; MFR 21520
691391-033	CAPACITOR, FIXED: TANTALUM; 1.0UF 10%, 35 VDCW; MFR 56289
691391-038	CAPACITOR, FIXED: TANTALUM; 0.47UF 5%, 35 VDCW; MFR 21520
691391-052	CAPACITOR, FIXED: TANTALUM; 2.2UF 10%, 35VDCW; MFR 56289, TYPE 150D
691391-057	CAPACITOR, FIXED: TANTALUM; 120UF 10%, 10 VDCW; MFR 21520
691391-062	CAPACITOR, FIXED: TANTALUM; 1.0UF 10% 20VDCW; MFR 56289, TYPE 150D
691391-073	CAPACITOR, FIXED: TANTALUM; 180UF 10%, 10VDCW; MFR 56289, TYPE 150D
691391-078	CAPACITOR, FIXED: TANTALUM; 2.2 UF 10%, 20 VDC; MFR 21520
691664	SWITCH, TOGGLE: DPDT; MFR 88140, NO. 8908K453
691686-001	CAPACITOR, FIXED: MYLAR; 0.01UF 20%, 80 VDCW; MFR 00853
691686-008	CAPACITOR, FIXED: MYLAR; .001UF 10%, 200 VDCW; MFR 56289
691686-011	CAPACITOR, FIXED: MYLAR; 0.047UF 5%, 200 VDCW; MFR 00853
691686-012	CAPACITOR, FIXED: MYLAR; 0.15UF 10%, 80 VDCW; MFR 56289
691686-014	CAPACITOR, FIXED: MYLAR; 0.10UF 10%, 80 VDCW; MFR 00853
691686-015	CAPACITOR, FIXED: MYLAR; 0.0022UF 10%, 80 VDCW; MFR 00853
691686-016	CAPACITOR, FIXED: MYLAR; 0.0082UF 10%, 200 V; MFR 00853, TYPE MCF
691686-018	CAPACITOR, FIXED: MYLAR; 0.0033UF 10%, 80VDCW; MFR 00853

SANGAMO PART NO.	NAME AND DESCRIPTION
691686-019	CAPACITOR, FIXED: MYLAR; 0.0068UF 10%, 80VDCW; MFR 00853
691686-020	CAPACITOR, FIXED: MYLAR; 0.012UF 10%, 80VDCW; MFR 00853
691686-021	CAPACITOR, FIXED: MYLAR; 0.022UF 10%, 80VDCW; MFR 00853
691686-022	CAPACITOR, FIXED: MYLAR; 0.0047UF 10%, 80 V; MFR 00853, TYPE MCF
691686-024	CAPACITOR, FIXED: MYLAR; 0.0056UF 10%, 80VDCW; MFR 00853
691686-026	CAPACITOR, FIXED: MYLAR; 0.0012UF 10%, 200V; MFR 56289, TYPE 192P
691686-027	CAPACITOR, FIXED: MYLAR; 0.082 UF 10%, 80 V; MFR 00853, TYPE MCF
691686-030	CAPACITOR, FIXED: MYLAR; 0.056 UF 10%, 80 V; MFR 00853, TYPE MCF
691686-031	CAPACITOR, FIXED: MYLAR; 0.0018UF 10%, 200V; MFR 00853, TYPE MCF
691686-034	CAPACITOR, FIXED: MYLAR; 0.033UF 10%, 80V; MFR 00853, TYPE MCF
691686-035	CAPACITOR, FIXED: MYLAR; 0.0039UF 10%, 80V; MFR 00853, TYPE MCF
691686-048	CAPACITOR, FIXED: MYLAR; 0.018UF 10%, 80V; MFR 00853, TYPE MCF
691686-053	CAPACITOR, FIXED: MYLAR; 0.047UF 10%, 80V; MFR 00853, TYPE MCF
691686-055	CAPACITOR, FIXED: MYLAR; 0.068UF 10%, 80V; MFR 00853, TYPE MCF
691686-062	CAPACITOR, FIXED: MYLAR 0.27UF 5%, 80V; MFR 00853, TYPE MCF
691975-008	CAPACITOR: ELCTLT; 1400 UF, 35 V; MFR 00853
691975-017	CAPACITOR, FIXED: ELCTLT; 6500UF, 15 VDCW; MFR 53021
691975-018	CAPACITOR, FIXED: ELCTLT; 24,000UF, 75 VDCW; MFR 53021
691975-019	CAPACITOR, FIXED: ELCTLT; 1500UF, 50 VDCW; MFR 53021
691975-031	CAPACITOR, FIXED: ELCTLT; 6500 UF, 35 VDC; MFR 53021
691975-033	CAPACITOR, FIXED: ELCTLT; 9400 UF, 50 VDC; MFR 53021
691975-035	CAPACITOR, FIXED: ELCTLT; 23,500 UF, 50 VDC; MFR 00853
692153-002	CARTRIDGE, FUSE: 250V, 0.5 AMP. FAST; MFR 75915 CAT. NO. 312.500
692153-006	FUSE, CARTRIDGE: 250 V, 3 AMP MED; MFR 75915 CAT. NO. 312002
692153-007	FUSE, CARTRIDGE: 250 V, 3/4 AMP. FAST; MFR 75915 CAT. NO. 312.750
692153-010	FUSE, CARTRIDGE: 250V; 1.5 AMP., FAST; MFR 75915 CAT. NO. 31201.5
692537-034	CAPACITOR, FIXED: ELCTLT; 75UF 10%, 15 VDCW; MFR 00853
692826-414	RESISTOR, FIXED: FILM; 1.00 MEGOHM 1%, 1/4W; MFR 19701
694111-012	RESISTOR, FIXED: WW; 12 OHMS 5%, 10 W; TYPES 239E thru 255E; MFR 56289
694186-009	RESISTOR, FIXED: FILM; 6.490 OHMS 1%, 1/4 W; MFR 07716 TYPE MEA
808432	TERMINAL, CONN: MALE, WG 22, 24 & 26; MFR 81312, NO. 100-0907
808433	TERMINAL, CONN: FEMALE; WG 22, 24 & 26; MFR 81312 NO. 100-0908
808434	TERMINAL, CONN: MALE; WG 18, 20 & 22; MFR 81312 NO. 100-0913
808435	TERMINAL, CONN: FEMALE; WG 18, 20 & 22; MFR 81312 NO. 100-0923
808436	TERMINAL, CONN: MALE; WG 14 & 16; MFR 81312 NO. 100-1014P
808437	TERMINAL, CONN: FEMALE; WG 14, 16; MFR 81312 NO. 100-1014S

SANGAMO PART NO.	NAME AND DESCRIPTION
809186	TRANSISTOR: SILICON; NPN; TYPE 2N1613; MFR 53021
812299	FUSEHOLDER: MIL TYPE FD-1; PLASTIC, 250 V, 30 AMP; MFR 53021
812301	FUSE, CTG: 250 V, 1 AMP; MFR 71400
812385	SOCKET, OCTAL: ONE PIECE SADDLE MTG; MFR 71785, NO. 9865
820547	RECEPTACLE: 2 CONTACT GROUNDED; MFR 74545 NO. 5284
821618	FUSE, CARTRIDGE: 0.25 AMP, 250 V; MFR 71400
821926	FUSE, CARTRIDGE: 3.0 AMP; 125V; MFR 53021
822087	SWITCH, TOGGLE: DPDT; 125 VAC, 25 AMP; MFR 91929, NO. 12TS11-3
827242	RESISTOR, FIXED: COMP; 100 OHMS 5%, 2W; MFR 53021
827814	CAPACITOR, FIXED: ELCTLT; 10,000UF, 50 VDC; METAL SEALED; MFR 53021
827852	SEMICONDUCTOR, DIODE: SILICON. TYPE JAN-1N1202A; MFR 53021
828806	SEMICONDUCTOR, DIODE: SILICON; TYPE 1M645M; MFR 53021
835004	FUSE HOLDER: 30 AMPS; PHEN; MFR 71400 TYPE HJM
835012	REEL DRIVE AMPLIFIER: MFR 53021
835037	CONNECTOR, BOARD ASSY: MFR 53021
835044	CONNECTOR, BOARD ASSY: MFR 53021
835050	RECORD, CHASSIS ASSY: MFR 53021
835055-001	TERMINAL BD: PHEN.; 3 TERM;, MFR 75382 PART NO. 599-Z-3
835098	MOTOR ASSY: REEL DRIVE; AL HUB ASSEMBLED TO MOTOR SHAFT; MFR 53021
835110	12 VOLT REGULATOR BOARD: MFR 53021
835111	28 VOLT REGULATOR BOARD: MFR 53021
835130	HEAD ASSY: 1 IN RECORD W/LEAD HARNESS; MFR 53021
835131	HEAD ASSY: 1/2 IN RECORD W/LEAD HARNESS; MFR 53021
835134	CONNECTOR BD: RECORD; MFR 53021
835135	RECORD, CHASSIS: AL FR; MFR 53021
835136	CHASSIS ASSY, PLAYBACK: MFR 53021
835157	KIT, 1/2 IN TAPE; C/O TWO ROLLER ASSYS, ASSOC HDW; MFR 53021
835158	KIT, 1 IN TAPE: C/O ROLLER ASSYS AND ASSOC HDW; MFR 53021
835159-001	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-002	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-003	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-004	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-006	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-008	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-009	SWITCH ASSY, PUSHBUTTON: MFR 82389
835159-011	PUSHBUTTON SWITCH ASSY: MFR 82389

SANGAMO PART NO.	NAME AND DESCRIPTION
835188	CABLE, RECORD: 4900 SERIES; MFR 53021
835196	CABLE, RECORD/PLAY POWER: 4900 SERIES; MFR 53021
835199	VACUUM PUMP ASSY: C/O MOT, VAC PMP, VAC TK, ASSOC HDW; MFR 53021
835239	BOARD ASSEMBLY: TIME CODE GENERATOR; MFR 53021
835263	HEAD ASSY: 1 IN RECORD W/BOARD ASSY; MFR 53021
835264	28 V REGULATOR MODULE: 4900 SERIES; MFR 53021
835271	POWER SUPPLY EXPANDER: 47 CPS TO 63 CPS; 4900 SERIES; MFR 53021
835272	KIT, TOTAL TIME METER: 4900 SERIES; MFR 53021
835274-002	MOTOR: 115 V, 50/60 HZ, 1/50 HP, .9 AMPS, 3000 AMPS, 65 W; MFR 62119 NO. 34
835286	CONNECTOR, RECEPTACLE: 18 FEMALE CONT; MFR 97954 NO. MI18FL1SL
835287	CONNECTOR, PLUG: 18 MALE CONT W/HOOD; MFR 97954 NO. MI18ML1HRSL
835288	CONNECTOR, RECEPTACLE: 20 FEMALE CONT; MFR 97954 NO. MI20FL1SL
835289	CONNECTOR, MALE: HOODED, 20 PIN; MFR 97954 NO. MI20ML1HRSL
835290	CONNECTOR, RECEPTACLE: 34 FEMALE CONT; MFR 97954 NO. M134FL1SL
835291	CONNECTOR, MALE: HOODED, 34 PIN; MFR 97954 NO. MI34ML1HRSL
835292	CONNECTOR, PLUG: 18 MALE CONT; MFR 97954 NO. MI18ML1SL
835293	CONNECTOR, RECEPTACLE: 18 FEMALE CONT W/HOOD; MFR 97954 NO. MI18FLIHRSL
835295	CALIBRATION/MONITOR METER BOARD ASSY: MFR 53021
835321	PLAYBACK EXTENDER BOARD: C/O 2 CONN, 23 PINS EA; MFR 53021
835326-009	FM RECORD BOARD: BASIC; 002 THRU 008 MADE FROM THE BASIC; MFR 53021
835327	SOCKET & RETAINER: FOR 8 TERM RELAY; MFR 77342 TYPE 9HP1
835333	PUSHBUTTON: YELLOW LEGEND; MFR 53021
835341-023	CAPACITOR ASSY: C/O 32UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835341-024	CAPACITOR ASSY: C/O 62UUF 1%, 3 CAP. SLDRD ON TWO PINS: MFR 53021
835341-025	CAPACITOR ASSY: C/O 120UUF 1% CAP. SLDRD ON TWO PINS: MFR 53021
835341-026	CAPACITOR ASSY: C/O 250UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835341-027	CAPACITOR ASSY: C/O 70UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835341-028	CAPACITOR ASSY: C/O 120UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835341-029	CAPACITOR ASSY: C/O 150UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835341-030	CAPACITOR ASSY: C/O 270UUF 1%, CAP, SLDRD ON TWO PINS: MFR 53021
835341-031	CAPACITOR ASSY: C/O 27UUF 1%, CAP. SLDRD ON TWO PINS: MFR 53021
835346	LENS: DBL CVX LENS, 14 MM DIA, 14MM FL; MFR 97197 NO. 94707
835349	SENSOR ASSY: C/O ONE TRANSISTOR MTD ON PLSTC BD; 4900 SERIES; MFR 53021
835350	KIT-EOT SENSE: 4900 SERIES; MFR 53021
835451	LAMPHOLDER: QTR TURN LAMP TYPE; TWO SLDR TERMS; MFR 71744 NO. CM21-2
835460	VU MONITOR, CONNECTOR KIT: MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
835462	CHASSIS ASSEMBLY, RECORD TRACK 17-32; 4900 SERIES; MFR 53021
835470	KIT-SHUTTLE: 4900 SERIES; MFR 53021
835473	COUNTER: ELMCH; BI-DIR; SIX-DIGIT, 24 VDC; CNTR SP, 25 CPS; MFR 53021
835475	DRIVER AMPLIFIER BOARD ASSY: 4900 SERIES; MFR 53021
835477	KIT-TAPE FOOTAGE COUNTER: 4900 SERIES; MFR 53021
835496	MOD KIT: 50-400 HZ; FOR POWER SUPPLY; MFR 53021
835498	HEAD ASSY: 1 IN RECORD W/LEAD HARNESS; 4900 SERIES: MFR 53021
835499	HEAD ASSY: 1/2 IN RECORD W/LEAD HARNESS; 4900 SERIES; MFR 53021
835500-001	CHASSIS ASSEMBLY - PANEL: MFR 53021
835500-002	CHASSIS ASSEMBLY-VOICE: MFR 53021
835500-003	7 VU METER-PANEL ASSY: 4900 SERIES; MFR 53021
835500-004	14 VU METER-PANEL ASSY: 4900 SERIES; MFR 53021
835500-005	8 VU METER-PANEL ASSY: 4900 SERIES; MFR 53021
835500-006	15 VU METER-PANEL ASSY: 4900 SERIES; MFR 53021
835500-013	CHASSIS ASSEMBLY: CALIBRATION MONITOR, 7 METER: MFR 53021
835500-014	CHASSIS ASSEMBLY: CALIBRATION MONITOR, 14 METER; MFR 53021
835500-015	CHASSIS ASSEMBLY: CALIBRATION MONITOR, 8 METER/VOICE; MFR 53021
835500-016	CHASSIS ASSEMBLY: CALIBRATION MONITOR, 15 METER/VOICE; MFR 53021
835514-000	LOOP ADAPTER; BASIC FOR 1/2 IN., 1 IN; 3600 SERIES; MFR 53021
835514-001	LOOP ADAPTER - 1/2 INCH TAPE: 3600 SERIES; MFR 53021
835514-002	LOOP ADAPTER - 1 INCH TAPE: 3600 SERIES; MFR 53021
835515	REMOTE CONTROL SHORTING PLUG: WIRING AND ASSY; 4900 SERIES; MFR 53021
835560	28V REGULATOR MODULE: MFR 53021
835561	ACCESSORY KIT: 4900 SERIES; MFR 53021
835563	28V REGULATOR BOARD: MFR 53021
835564	POWER SUPPLY 28 VDC: 47 TO 63 CPS; MFR 53021
835571	SENSOR ASSY-EOT: MFR 53021
835573	SENSOR BOARD ASSY; C/O TERMS, PHOTO TRANSISTORS; MFR 53021
835586	KIT-PE EOT SENSE: MFR 53021
835594	CONTACT, RCPT: PH BRZ; FNSH GLD OVER NKL; MFR 00779 NO 85423-2
835600-003	CALIBRATION/MONITOR-CHASSIS ASSY: 7 METERS; W/O VOICE; MFR 53021
835600-004	CALIBRATION/MONITOR-CHASSIS ASSY: 14 MTRS; W/O VOICE, MFR 53021
835600-005	CALIBRATION/MONITOR-CHASSIS ASSY: 8 MTRS; W/VOICE; MFR 53021
835600-006	CALIBRATION/MONITOR-CHASSIS ASSY: 15 MTR; W/VOICE; MFR 53021
835600-013	CHASSIS ASSY: CALIBRATION MONITOR; 7 METERS; MFR 53021
835600-014	CHASSIS ASSY: CALIBRATION MONITOR; 14 METERS; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
835600-015	CHASSIS ASSY: CALIBRATION MONITOR; 8 METERS; W/VOICE; MFR 53021
835600-016	CHASSIS ASSY: CALIBRATION MONITOR; 15 METERS; W/VOICE; MFR 53021
835661-001	EDGE A/B RECORD BOARD: 1 IN HEAD; MFR 53021
835661-002	EDGE A/B RECORD BOARD: 1/2 IN HEAD; MFR 53021
835670	SPLICE BLANKING KIT: 3600 SERIES; MFR 53021
835680	DC TO DC CONVERTER: C/O TWO CKT BDS AND ELCTRN CMPNT; MFR 53021
835682	REGULATOR BOARD: MFR 53021
835684	DRIVER BOARD ASSY: MFR 53021
835690	CABLE, REMOTE INTERCONNECTING: 4900 SERIES; MFR 53021
835692	RELAY BOARD ASSY: REMOTE CONTROL PANEL; 4900 SERIES; MFR 53021
835699	REMOTE CONTROL PANEL: 4900 SERIES; MFR 53021
835703	EXTENDER BOARD: DC TO DC CONVERTER; MFR 53021
835716	DUMMY REPRODUCE BD: 4900/3600 SERIES; MFR 53021
835722	SOCKET, RELAY: 15 CONT; MFR 77342 PART NO R40-S410
835724-003	CONNECTOR, PLUG: 4 CONT.; 2 NO. 12, 2 NO. 16; MFR 13511 TYPE MS106A16-9PW
835724-004	CONNECTOR, PLUG: 4 CONT.; 2 NO. 12, 2 NO. 16; MFR 13511 TYPE MS3106A 16-9SW
835725	CABLE POWER, 28 VDC: 3600 SERIES TAPE TRANSPORT; MFR 53021
835741	ACCESSORY KIT: 3600 SERIES; MFR 53021
835742	AUXILIARY POWER CABLE: 28 V, 3600 SERIES; MFR 53021
835763	HEAD ASSY: RECORD; 1 IN.; 32 TRACK; W/LEAD HARNESS; 3600 SERIES; MFR 53021
835785	LOGIC BOARD: 3600 SERIES 32 TRACK; MFR 53021
835792	KIT-SHUTTLE: 3600 SERIES; MFR 53021
835800	MOTOR, TACH: D.R.C.; 28 VDC, 3300 RPM; 4900 SERIES; MFR 23383 MODEL A4602
835810	RECORD, CHASSIS: 3600 SERIES; MFR 53021
835820	RECORD, CHASSIS - ODD CHANNEL: 3600 SERIES; MFR 53021
835844	BIAS OSCILLATOR BOARD: 3600 SERIES; MFR 53021
835854	INTERCONNECTING CABLE ASSY, CAL/MON: 36 SERIES; MFR 53021
835856-001	EMITTER FOLLOWER BOARD ASSY: 4 CHAN., 3600/4900 SERIES; MFR 53021
835856-002	EMITTER FOLLOWER BOARD ASSY: 7 CHAN., 3600/4900 SERIES; MFR 53021
835856-003	EMITTER FOLLOWER BOARD ASSY: 8 CHAN., 3600/4900 SERIES; MFR 53021
835856-004	EMITTER FOLLOWER BOARD ASSY: 14 CHAN., 3600/4900 SERIES; MFR 53021
835856-005	EMITTER FOLLOWER BOARD ASSY: 16 CHAN., 3600/4900 SERIES; MFR 53021
835859	INVERTER BOARD: P/O INVERTER ASSY, ± 12V; 3600 SERIES; MFR 53021
835860	INVERTER: REDUCE 28V to 12 V; 32 TRACK; 3600 SERIES; MFR 53021
835864	PLUG, STRAIGHT: MFR 74868 NO. 27-189
835865	RECEPTACLE: CUP TYPE SLDR TERM.; NUT MTD. MFR 74868, NO. 27-3
835868	CABLE-PLAYBACK 8 TRACK: 3600 TAPE; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
835882	RESET - COUNTER: 24 VDC, 29 OHMS 20 W; 4900 SERIES; MFR 30892 NO. G/405104
835883	FRONT SHUTTLE SET KIT: 4900 SERIES; MFR 53021
835886-001	PRE-AMP BOARD ASSY: 7 CHANNEL; 3600/4900 SERIES; MFR 53021
835886-002	PRE-AMP BOARD ASSY; 8 CHANNEL; 3600/4900 SERIES; MFR 53021
835887-007	CONNECTOR, RECEPTACLE: 10 CONT, SLDR TYPE CONTS; MFR 53021
835890	REPRODUCE MONITOR CHASSIS: 3600 SERIES; MFR 53021
835893	CONNECTOR PANEL-PREAMP OUTPUT: 3600 SERIES 32 TRACK; MFR 53021
835900-001	KIT, LOOP ADAPTER: 1/2 IN.; 4900 SERIES; MFR 53021
835900-002	KIT, LOOP ADAPTER 1 IN.; 4900 SERIES; MFR 53021
835910-001	PREAMP-REGULATOR BOARD: 3600 SERIES 32 TRACK; MFR 53021
835910-002	PREAMP-REGULATOR PLUG-IN OUTPUT: C/O CMPNT BD & CONNS; MFR 53021
835915	TRANSPORT MOD KIT: FOR LOOP ADAPTER KIT; 4900 SERIES; MFR 53021
835953-001	PRE-AMP BOARD ASSY: 14 CHANNEL; 3600/4900 SERIES; MFR 53021
835953-002	PRE-AMP BOARD ASSY: 16 CHANNEL; 3600/4900 SERIES, MFR 53021
835966-001	CONNECTOR: 10/20 CONT., SLDR TYPE; MFR 05574 PART NO. 2 VH10/1IN.-5
835975	SHUTTLE KIT: REMOTE CONTROL PANEL, 4900 SERIES; MFR 53021
835976-048	CABLE-PLAYBACK; 14 TRACK; 4900 SERIES; MFR 53021
835978	HEAD: 1 IN; H/RESOLN, PLAYBACK, 32 TRACK, 120 IPS; 3600 SERIES; MFR 53021
835982-XXX	WRITE BD ASSY: BASIC; SUFF'S/CORRES, TO US; 3600/4900 SERIES; MFR 53021
835984-001	PCM READ BOARD ASSY: BASIC: 3600/4900 SERIES; MFR 53021
835984-003	PCM READ BOARD: DATA OPTION; 3600/4900 SERIES; MFR 53021
835986-XXX	PLS SHAPER BD: SUFF/CORRES, TO IPS 3600/4900 SERIES; MFR 53021
835988	PCM CLOCK BOARD: 3600/4900 SERIES; MFR 53021
836000-001	HEAD & PREAMP ASSY: INTER-BAND 1 IN. 28 CHAN., 3600 SERIES; MFR 53021
836000-002	HEAD & PREAMP ASSY: INTER-BAND 1 IN. 32 CHAN., 3600 SERIES; MFR 53021
836004	HEAD & PREAMP ASSY: 1 IN. 14 CHAN., 3600/4900 SERIES; MFR 53021
836014	HEAD: 1 IN. H/RESOLN; PLAYBACK; 28 TRACK; 3600 SERIES; MFR 53021
836017	PREAMP REGULATOR ASSY: 4900 SERIES; MFR 53021
836023	MICROPHONE ASSY: MIC AND CORD ASSY; 3600 SERIES; MFR 53021
836024	HEAD SET, MAGNETIC: 32 TRACK, MULTIBAND, 3600 SERIES; MFR 53021
836025	ACTUATOR, MICRO SWITCH: 4900 SERIES; MFR 91929 NO. MC2711B
836028	CAPACITOR MTG BOARD: 32 TRACK PLAYBACK; 3600 SERIES; MFR 53021
836030	KIT-REMOTE FOOTAGE COUNTER: 4900 SERIES; MFR 53021
836034	HEAD & PREAMP ASSY: INTERBD. 1/2 IN. 7 CHANN., 3600/4900 SERIES; MFR 53021
836037	HEAD & PREAMP ASSY: INTERBD. 1 IN., 14 CHAN., 3600/4900 SERIES; MFR 53021
836038-001	HEAD & PREAMP ASSY: INTER-BAND 1 IN., 28 CHAN., 4900 SERIES; MFR 53021
836038-002	HEAD & PREAMP ASSY: INTER-BAND 1 IN., 32 CHAN.; 4900 SERIES MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
836039	HEAD & PREAMP ASSY: WB 1/2" 7 CHANNEL; 3600/4900 SERIES; MFR 53021
836044	REEL DRIVE BOARD: 4900 SERIES; MFR 53021
836067-001	CAL/MON KIT: 7 TRACK; W/O VOICE; 3600 SERIES; MFR 53021
836067-002	CAL/MON KIT: 7 TRACK; W/VOICE; 3600 SERIES; MFR 53021
836067-003	CAL/MON KIT: 14 TRACK; W/O VOICE; W/O AUX; 3600 SERIES; MFR 53021
836067-004	CAL/MON KIT: 14 TRACK; W/O VOICE, W/AUX.; 3600 SERIES; MFR 53021
836067-005	CAL/MON KIT: 14 TRACK; W/VOICE, W/O AUX.; 3600 SERIES; MFR 53021
836067-006	CAL/MON KIT: 14 TRACK; W/VOICE, W/AUX.; 3600 SERIES; MFR 53021
836068	CAL/MON CONNECTOR KIT, REPRODUCE CHASSIS; 3600 SERIES; MFR 53021
836069	CAL/MON KIT, AUX. REPRODUCE CHASSIS; 3600 SERIES; MFR 53021
836073	INDICATOR ASSY: TAPE/SYNC; 3600 SERIES; MFR 53021
836075	PUSHBUTTON, DUAL LEGEND,: 4900 SERIES; MFR 53021
836077-003	CONNECTOR, PLUG: 4 CONT.; 2 NO. 12, 2 NO. 16; MFR 71468 TYPE MS3102A16-9PW
836077-004	CONNECTOR, RCPT: 4 CONT.; 2 NO. 12, 2 NO. 16; MFR 71468; TYPE MS3102A16-9SW
836083-001	DIRECT REPRODUCE BOARD: INTMD BOND; 3600/4900 SERIES; MFR 53021
836083-002	DIRECT REPRODUCE BOARD: WB; 3600/4900 SERIES; MFR 53021
836085-XXX	DIR EQL BD: INTMD BND; SUFF/CORRES, TO IPS; 3600/4900 SERIES; MFR 53021
836103	FOOTAGE COUNTER BOARD: 4900 SERIES; MFR 53021
836148	SOCKET, CONN: SINGLE CONTACT; MFR 99779 NO. LH-01
836149	CHASSIS, PALYBACK: 3600 SERIES; MFR 53021
836154-XXX	F.M. REPRODUCE BOARD: SUFF/CORRES. TO FREQ'S, 3600/4900 SERIES; MFR 53021
836156	F.M. EXPANDER BOARD ASSY: 3600/4900 SERIES; MFR 53021
836161-XXX	FM RECORD BD: BASIC; SUFF'S/CORRES, TO KHZ; 3600/4900 SERIES; MFR 53021
836163	CHASSIS ASSY: RECORD TRACK 1-16, 4900 SERIES; MFR 53021
836164	CABLE RECORD/PLAY POWER: 4900 SERIES: MFR 53021
836169	HEAD ASSEMBLY: 1 IN. RECORD; 32 TRACK; MFR 53021
836176	RE-RECORD KIT, FM RECORD: 3600/4900 SERIES; MFR 53021
836178	BOARD, HIGH SPEED SLEW: 4900 SERIES; MFR 53021
836179	KIT, HIGH SPEED SLEW: 4900 SERIES; MFR 53021
836180-007	CONNECTOR, HOODED: 14 CONT'S; MFR 81312, PART NO. SRM14PCO300X
836180-008	CONNECTOR, HOODED: 14 CONT'S; MFR 81312, PART NO. SRM14SCO300X
836180-015	CONNECTOR, HOODED: 34 CONT'S; MFR 81312, PART NO. SRM34PCO300X
836180-016	CONNECTOR, HOODED: 34 CONT'S; MFR 81312, PART NO. SRM34SCO300X
836181-005	CONNECTOR: 11 CONT'S; MFR 81312, PART NO. SRM11PF0000
836181-006	CONNECTOR: 11 CONT'S; MFR 81312, PART NO. SRM11SF0000
836181-007	CONNECTOR: 14 CONT'S; MFR 81312, PART NO. SRM14PF0000

SANGAMO PART NO.	NAME AND DESCRIPTION
836181-008	CONNECTOR: 14 CONT'S; MFR 81312, PART NO. SRM14SF0000
836181-009	CONNECTOR: 20 CONT'S; MFR 81312, PART NO. SRM20PF0000
836181-010	CONNECTOR: 20 CONT'S; MFR 81312, PART NO. SRM20SF0000
836181-013	CONNECTOR: 29 CONT'S; MFR 97954, PART NO. SM1-29MISL
836181-014	CONNECTOR: 29 CONT'S; MFR 97954, PART NO. SM1-29FISL
836181-016	CONNECTOR: 34 CONT'S; MFR 81312; PART NO. SRM34SF 0000
836201	HEAD ASSEMBLY, RECORD: 1 IN., 28 TRACK, H/RESOLN; MFR 53021
836202	HEAD, RECORD 1 IN.; 28 TRACK H/RESOLN; 3600 SERIES; MFR 53021
836205	HEAD ASSEMBLY, RECORD: 1 IN., 28 TRACK, WIDE BAND; MFR 53021
836208	HEAD ASSEMBLY, RECORD: 1 IN., 28 TRACK, WIDE BAND; MFR 53021
836209	HEAD ASSEMBLY, RECORD: 1 IN., 28 TRACK; MFR 53021
836212-001	INDICATOR ASSY: PUSHBUTTON SWITCH, YELLOW LEGEND INSERT; MFR 53021
836212-002	INDICATOR ASSY: PUSHBUTTON SWITCH, CLEAR LEGEND; MFR 53021
836240-XXX	F.M. EQL BD: SUFF 001 THRU 008 CORRES, TO IPS; INTMD BND; 3600/4900 SERIES; MFR 53021
836240-XXX	F.M. EQL BD: SUFF 009 THRU 015 CORRES.; TO IPS; WB, GROUP I; 3600/4900 SERIES; MFR 53021
836240-XXX	F.M. EQL BD: SUFF 016 THRU 022 CORRES., TO IPS; WB GROUP II; 3600/4900 SERIES; MFR 53021
836242-001	INDUCTOR ASSY: C/O 330UH 5% INDUCTOR SLDR ON TWO PINS; MFR 53021
836242-002	INDUCTOR ASSY: C/O 1500UH 10% INDUCTOR SLDR ON TWO PINS; MFR 53021
836248	CAPSTAN DRIVE BOARD: 3600/4900 SERIES; MFR 53021
836249	TAPE SYNC BOARD: 3600/4900 SERIES; MFR 53021
836250	TRANSPORT PANEL ASSY: BASIC; SUPERCEDES ALL PANELS; 3600 SERIES; MFR 53021
836256	F.M. RE-RECORD KIT: 3600/4900 SERIES; MFR 53021
836257	TAPE REFERENCE MULTIPLEX BOARD: 4900 SERIES; MFR 53021
836259	CAPSTAN POWER AMPLIFIER ASSY; 3600/4900 SERIES; MFR 53021
836270	KIT, TAPE REFERENCE MULTIPLEX; 4900 SERIES; MFR 53021
836277	ENCODER: 3600/4900 SERIES; MFR 53021
836342	FM CALIBRATOR A-BOARD: 3600/4900 SERIES; MFR 53021
836346	FM CALIBRATOR B-BOARD: 3600/4900 SERIES; MFR 53021
836351	RESISTOR, KIT: MATCHED RES. SEL. FROM 853530-130; MFR 9701 TYPE MF5C
836352	FM CALIBRATOR - FINAL ASSY: 3600/4900 SERIES; MFR 53021
836359	CONNECTOR, RECEPTACLE: COAXIAL, MB SERIES; MFR 74868 NO. 46025
836365-001	POWER SUPPLY (BASIC): 47 HZ TO 63 HZ; 4900 SERIES; MFR 53021
836365-002	POWER SUPPLY, 47 HZ TO 63 HZ: FOR THE 5V-6A, PS; 4900 SERIES; MFR 53021
836365-003	POWER SUPPLY, 47 HZ TO 63 HZ; FOR THE 5V - 12A, PS; 4900 SERIES; MFR 53021
836369	POWER SUPPLY: 5V, 6A; ELEXON MODEL OLV-30-5
836370	POWER SUPPLY: 5V, 12A; ELEXON MODEL OLV-60-5

SANGAMO PART NO.	NAME AND DESCRIPTION
836392	AUXILIARY ELECTRONICS CHASSIS: 3600 SERIES; MFR 53021
836393	CABLE, POWER AND CONTROL AUX. PLAYBACK CHASSIS: 3600 SERIES; MFR 53021
836398	PATCH CORD ASSY: BNC TO PIN; MFR 53021
836399	PATCH CORD ASSY: PIN TO PIN; MFR 53021
836400	ACCESSORY KIT: FM CALIBRATOR: 3600/4900 SERIES; MFR 53021
836411-001	HARDWARE KIT - 14 TRACK RECORD: 4900 SERIES; MFR 53021
836411-002	HARDWARE KIT - 28/32 TRACK RECORD: 4900 SERIES; MFR 53021
836411-004	HARDWARE KIT - 28/32 TRACK REPRODUCE: 4900 SERIES; MFR 53021
836423-001	SWITCH, ROTARY: 4 DESKS; CONT'S 1/4 AMP, 115 VAC; MFR 53021
836423-003	SWITCH, ROTARY: 2 DESKS; CONT'S 1/4 AMP, 115 VAC; MFR 53021
836424	PUMP-VACUUM: 4900 SERIES; MFR 24123 PART NO. 0333
836454	BOARD ASSY: CALIBRATION/MONITOR; 3600/4900 SERIES; MFR 53021
836457	SPLICE BLANKING KIT: 3600 SERIES; MFR 53021
836533	FM SENSITY KIT: 3600 SERIES; MFR 53021
841121	CAPACITOR, FIXED: TANTALUM; 2.2UF 10%, 20V; POLARIZED; MFR 53021
843680	RESISTOR, VAR: LOGRITHMIC TAPER; 2000 OHMS 10%; 0.4W; MFR 01121
843721	CONNECTOR, PLUG: 5 CONT PINS MOLDED IN BAKELITE; MFR 02660, NO. 126-217
843724	RECEPTACLE: 5 CONT MIN HEX; MFR 07999, NO. 126-218
843728	LAMPHOLDER, SINGLE: TAPE CONTROL INDICATOR; MFR 72619, NO. 7538
843729	LAMP CARTRIDGE: INCAND, RED; MFR 72619, NO. 39-14-1471
843730	LAMP CARTRIDGE: INCAND, GREEN; MFR 72619, NO. 39-14-1472
843733	CONNECTOR, PLUG: 34 PIN; MFR 95238, NO. SM34-20PGD
843734	CONNECTOR, RECEPTACLE: 34 PIN; MFR 95238, CAT. NO. SM34-20S8D
843788	RELAY: MAGNETIC LATCHING; 24 VDCW, DPDT; MFR 77342
843829	REISITOR, FIXED: COMP; 390 OHMS 5%, 1/2W; MFR 53021
843837	CAPACITOR, FIXED: MICA; 3000UUF 5%, 300 VDCW; MFR 53021
843934	SOCKET, CRYSTAL: MFR 91506, PART NO. 8000-DG-3
843996	CONNECTOR, RECEPTACLE: 34 PIN REM; MFR 81312 NO MRAC34S-J6
843997	CONNECTOR, PLUG: C/O HOOD, 34 REMOVABLE CONTACTS; MFR 81312, NO. MRAC 34P JTDH-491
844013	RESISTOR, FIXED: COMP; 4.7 OHMS ±5%, 1/4 W; MFR 53021
844114	CAPACITOR, FIXED: MICA; 62UUF 1%, 500 VDCW; MFR 72136, TYPE DM-15-620F
844115	CAPACITOR, FIXED: MICA; 220UUF 1%, 500 VDCW; MFR 72136, TYPE DM-15-221
844118	CAPACITOR, FIXED: MICA; 2500UUF 1%, 500VDCW; MFR 72136, TYPE DM-19-252F
844119	CAPACITOR, FIXED: MICA; 5100UUF 1%, 300VDCW; MFR 72136, TYPE DM-19-512F
844152	RESISTOR, FIXED: COMP; 10 OHMS 5%, 0.5W; MFR 53021
844155	RESISTOR, FIXED: COMP; 47 OHMS 5%, 1/2W; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
844156	RESISTOR, FIXED: COMP; 68 OHMS 5%, 1/2W; MFR 53021
844160	RESISTOR, FIXED: COMP; 180 OHMS 5%, 1/2 W; MFR 53021
844161	RESISTOR, FIXED: COMP; 220 OHMS 5%, 1/2W; MFR 53021
844162	RESISTOR, FIXED: COMP; 270 OHMS 5%, 1/2W; MFR 53021
844163	RESISTOR, FIXED: COMP; 330 OHMS 5%, 1/2W; MFR 53021
844164	RESISTOR, FIXED: COMP; 470 OHMS 5%, 1/2W; MFR 53021
844165	RESISTOR, FIXED: COMP; 560 OHMS 5%, 1/2W; MFR 53021
844166	RESISTOR, FIXED: COMP; 680 OHMS 5%, 1/2W; MFR 53021
844167	RESISTOR, FIXED: COMP; 1000 OHMS 5%, 1/2W; MFR 53021
844169	RESISTOR, FIXED: COMP; 1500 OHMS 5%, 1/2W; MFR 53021
844170	RESISTOR, FIXED: COMP; 1800 OHMS 5%, 1/2W; MFR 53021
844171	RESISTOR, FIXED: COMP; 2200 OHMS 5%, 1/2W; MFR 53021
844173	RESISTOR, FIXED: COMP; 3300 OHMS 5%, 1/2W; MFR 53021
844174	RESISTOR, FIXED: COMP; 4700 OHMS 5%, 1/2W; MFR 53021
844178	RESISTOR, FIXED: COMP; 8200 OHMS 5%, 1/2W; MFR 53021
844179	RESISTOR, FIXED: COMP; 10,000 OHMS 5%, 0.5W; MFR 53021
844183	RESISTOR, FIXED: COMP; 22,000 OHMS 5%, 1/2W; MFR 53021
844192	RESISTOR, FIXED: COMP; 0.22 MEG, 5%, 0.5W; MFR 53021
844193	RESISTOR, FIXED: COMP; 0.33 MEG, 5%, 0.5W; MFR 53021
844244	CAPACITOR, FIXED: MYLAR; 4700 UUF 5%, 600 VDCW; MFR 53021
844269	CAPACITOR, FIXED: MYLAR; 0.05UF 5%, 100VDCW; MFR 72136, TYPE 10P-2-503J
844323	RESISTOR, FIXED: WW; INSULATED; 1.5 OHMS 5%, 1/2W; MFR 53021
844325	RESISTOR, FIXED: WW; INSULATED; 1.5 OHMS 5%, 1/2W; MFR 53021
844331	RESISTOR, FIXED: COMP; 3.0 OHMS 5%, 1/2W; MFR 53021
844510	SEMICONDUCTOR, DIODE: SILICON; MFR 06668, TYPE 1N914
844548	CAPACITOR, FIXED: MICA; 820UUF, 5%, 300 VDCW; MFR 53021
844549	CAPACITOR, FIXED: MICA; 5600UUF 5%, 300 VDCW; MFR 72136, TYPE DM-20-562
844666	CAPACITOR, FIXED: MICA; 470UUF 5%, 300 VDCW; MFR 72136, TYPE DM-15-471
844675	RESISTOR, FIXED: COMP; 33 OHMS 5%, 1/2W; MFR 53021
844695	CAPACITOR, FIXED: MICA; 620UUF 1%, 300 VDCW; MFR 72136, TYPE DM-15-621
844699	CAPACITOR, FIXED: MICA; 2800UUF 1%, 500 VDCW; MFR 53021
844762	SEMICONDUCTOR, DIODE: MAX ZENER 9.45 V; MFR 04713, TYPE 1N938
844769	CAPACITOR, FIXED: MICA; 270UUF 1%, 500 VDCW; MFR 72136, TYPE DM-19-271F
844848	CAPACITOR, FIXED: TANTALUM; 22UF 10%, 15 VDCW; MFR 53021
844981	CAPACITOR, FIXED: MICA; 70UUF 1%, 500 VDCW; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
844993	RESISTOR, VAR: 50 OHM, ±5%, 1/2W; MFR 80294 NO. 3305P-1-500
844994	RESISTOR, VAR: 100 OHMS 5%, 1/2W; MFR 80294 NO. 3305P-1-101
844995	RESISTOR, VAR: 500 OHMS 5%, 1/2W; MFR 80294, NO. 33079-1-501
845038	CAPACITOR, FIXED: TANTALUM; 0.47UF 10%, 35VDCW; MFR 53021
845046	CAPACITOR, FIXED: MICA; 200 UUF 1%, 500 VDCW; MFR 53021
845141	RESISTOR, VAR: 10,000 OHMS 5%, 1/2W; MFR 80294, NO. 3307P-1-103
845193	FUSE, CARTRIDGE: 2 AMP, 250 V; MFR 71400, NO AGC-2
845257	CAPACITOR, FIXED: MICA; 400UUF 1%, 500 VDCW; MFR 00853
845258	CAPACITOR, FIXED: MICA; 12UUF 5%, 500 VDCW; MFR 00853
845329	RESISTOR, VAR: 200 OHMS 5%, 1/2W; MFR 80294, NO. 3507P-1-201
845443	RESISTOR, VAR: 2000 OHMS 5%, 1/2W; MFR 80294, NO. 3305P-1-202
846160	RESISTOR, FIXED: WW; 75 OHMS, 5W; MFR 53021
846164	SEMICONDUCTOR, UNIJUNCTION-TRANSISTOR: SILICON; PNPN; MFR 53021
846500	SEMICONDUCTOR, TRANSISTOR: SILICON; MFR 53021
846502	CONNECTOR, PLUG: MALE, 66 REM PINS; MFR 81312 NO MRAC66P-JTD-H
846550	CONNECTOR, RCPT: W/O HOOD, 66 REMOVABLE CONTACTS; MFR 81312, NO. MRAC 66S-J6
846551	CAPACITOR, FIXED: MICA; 39UUF, 1%, 300 VDCW; MFR 53021
846552	CAPACITOR, FIXED: MICA; 180UUF 1%, 500 VDCW; MFR 53021
846601	PIN SOCKET, MINIATURE: MFR 06776, PART NO. PS-402-44
846602	CONNECTOR, PIN: USE WITH SOCKET 846601; 0.311 IN. LG; MFR 53021
846615	JACK, JUNIOR PHONE: 64/84 IN. LG; MFR 90201, NO. LA-1
846744	OSCILLATOR: 400,000 KC; 30 VDC OPR; MFR 75378
846759	CONNECTOR, COAXIAL: TEE ADAPTER; MFR 96791 NO. UG-274/U
846776	RELAY, DC: 12 VDCW; DPDT, 210 OHMS 10%; MFR 77342
846901	CAPACITOR, FIXED: MICA; 1000UUF 1%, 500 VDCW; MFR 53021
847013	CAPACITOR, FIXED: TAN; 1.0UF 20%, 50 V; MFR 01295, NO. SCM105FP050CA
847039	CAPACITOR, FIXED: MYLAR; 0.15UF 5%, 100 VDCW; MFR 72136, NO 1DP-3-154J
847065	RESISTOR, FIXED: 10 OHMS 1%, 1/8W; MFR 53021
847246	CAPACITOR, FIXED: MICA; 840UUF 1%, 300VDCW; MFR 53021
847529	FILTER: GRAY FELT 1/8 IN THK, 0.75 DIA; MFR 53021
847532	MOTOR, ELECTRIC: 115VAC, 3000RPM; MFR 62119, NO. 82AEG
847548	CONNECTOR, RECEPTACLE: FEMALE, 66 REM PINS; MFR 81312 NO. MRAC66SJTDH
847549	CONNECTOR, PLUG: MALE, 66 REM PINS; MFR 81312 NO MRAC66PJ6
847723	SEMICONDUCTOR, DIODE: SILICON; ZENER IS 10. V 5% MFR 01295, TYPE 1N758A
848159	PLUG, SUB MINATURE: RED; MFR 02929, NO. 39F846
848160	PLUG, SUB MINIATURE: BLACK; MFR 02929, NO. 39F847

SANGAMO PART NO.	NAME AND DESCRIPTION
850287	SEMICONDUCTOR, DIODE: GERMANIUM; TYPE 1N277; MFR 53021
850288	TRANSISTOR: NPN; SILICON; MFR 01295, TYPE 2N2222
850289	TRANSISTOR: PNP; GERMANIUM; MFR 04713, TYPE 2N1309
850290	TRANSISTOR: SILICON; PNP; MFR 01295, TYPE 2N2907
850305	SEMICONDUCTOR, DIODE: SILICON; ZENER; TYPE 1N752A; MFR 53021
850357	RESISTOR, VAR: CARBON; 2500 OHMS 10%; MFR 53021
850445	RELAY, PLUG-IN: 3 PDT; 12 VDC, 10 AMPS; MFR 77342, TYPE KRP14DG
850503	SOCKET: 11 SOLDER TERM LUGS; METAL BASE; MFR 07999, NO. 78RS11
850642	INDUCTOR, FIXED: CHOKE; 470MH; MFR 72259, PART NO. RFC-M-470
850643	RECEPTACLE, PLUG: 9 PIN, MALE; MFR 07999 NO. 126-221
850644	RECEPTACLE, CONN: 9 PIN, FEMALE; MFR 07999 NO. 126-220
850858	INDUCTOR: 150MH 5%; MFR 72259, PART NO. RFC-M-150
850860	INDUCTOR, FIXED: CHOKE; 1000 MH; 5%; MFR 72259 PART NO. RFC-M-1000
850862	CAPACITOR, VAR: 9-35UUF RANGE; MFR 15450, TYPE 538-011-09.0-35PF
850873	TRANSFORMER: MFR 53021
851018	PLUG,COAXIAL: SINGLE CONT; MFR 02660, PART NO. FXR-99600
851020	CONNECTOR, PLUG: ELEC; MFR 02660, PART NO. FXR-99750
851084	SEMICONDUCTOR, DIODE: SILICON; ZENER, 12 VDC 5%, TYPE 1N759A; MFR 53021
851139-001	CAPACITOR, FIXED: ELCTLT; 125UF, 3 VDCW; MFR 00853, TYPE 556
851139-003	CAPACITOR, FIXED: ELCTLT; 435UF, 3 VDCW; MFR 00853, TYPE 556
851139-004	CAPACITOR, FIXED: ELCTLT; 110UF, 6 VDCW; MFR 00853, TYPE 556
851139-007	CAPACITOR, FIXED: ELCTLT; 75UF, 15 VDCW; MFR 00853, TYPE 556
851139-008	CAPACITOR, FIXED: ELCTLT; 23UF, 35 VDCW; MFR 00853, TYPE 556
851139-009	CAPACITOR, FIXED: ELCTLT; 40 UF, 65 VDCW; MFR 00853
851139-010	CAPACITOR, FIXED; ELCTLT; 55UF; 20 VDCW; MFR 00853
851139-012	CAPACITOR, FIXED: ELCTLT; 5UF; 100 VDCW; MFR 00853
851139-014	CAPACITOR, FIXED: ELCTLT; 275 UF; 10 VDCW; MFR 00853
851139-015	CAPACITOR, FIXED: ELCTLT; 95UF; 35 VDCW; MFR 00853
851139-016	CAPACITOR, FIXED: ELECTLT; 80UF, 65VDCW; MFR 00853
851264	SWITCH, TOGGLE: DPDT, MC; MFR 04009, PART NO. 81057-N
851265	LAMPHOLDER: BAYONET TYPE; MFR 72619, CAT. NO. 8578-111
851271	TRANSISTOR: SILICON; NPN, POWER; MFR 02735, PART NO. 40250
851280	TRANSISTOR: TYPE 2N2102; MFR 02735
851288	RESISTOR, FIXED: 10 OHMS 5%, 3 W; MFR 44655, NO. 4361
852273	INTEGRATED CIRCUIT: DIFF. COMP; 8 TERMS; MFR 01295, TYPE SN52710
852475-008	SEMICONDUCTOR, DIODE: ZENER; 3.3 VDC, 5%; MFR 99942, TYPE 1N746A

SANGAMO PART NO.	NAME AND DESCRIPTION
852475-014	DIODE, ZENER: 400 MW; 4.3 V 5%; MFR 99942, TYPE 1N749A
852475-016	SEMICONDUCTOR, DIODE: ZENER; 4.7 VDC; 5%; MFR 99942, TYPE 1N750A
852475-018	SEMICONDUCTOR, DIODE: ZENER; 5.1 V, 5%; MFR 99942, TYPE 1N751A
852475-020	SEMICONDUCTOR, DIODE: ZENER; 5.6 VDC 5%; MFR 99942, TYPE 1N752A
852475-022	SEMICONDUCTOR, DIODE: ZENER; 6.2 VDC 5%; MFR 99942, TYPE 1N753A
852475-024	SEMICONDUCTOR, DIODE: ZENER; 6.8VDC 5%; MFR 99942, TYPE 1N754A
852475-028	SEMICONDUCTOR, DIODE: ZENER; 8.2 VDC 5%; MFR 99942, TYPE 1N756A
852525	METER, VU: 3600 SERIES; MFR 53021
852532-073	RESISTOR, FIXED: FILM; 5620 OHMS 1%, 1/4 W; MFR 07716 TYPE MEA, T-O
852738	TRANSISTOR: SILICON; PNP; MFR 04713, PART NO. 2N3906
852801-002	TERMINAL BD: PHEN; 2 TERM; MFR 71785 NO 2-140Y
852801-006	TERMINAL BD: PHEN; 6 TERM; MFR 71785 NO 6-140Y
853037	TRANSISTOR: SILICON; NPN; MFR 04713, TYPE 2N3904
853038	INTEGRATED CIRCUIT, MICRO: MFR 04713, PART NO. MC718G
853473	MOTOR: 0.043 HP/11,000 RPM, 27V 1.85 AMPS, MFR 05624, NO. BYLM92802-4
853474	MOTOR ASSY: MFR 53021
853502	SEMICONDUCTOR, DIODE: SILICON; RECTIFIER; MFR 04713, TYPE 1N3209
853507	TRANSISTOR: SILICON; NPN; POWER; MFR 02735, PART NO. 40251
853512	TRANSISTOR: SILICON; NPN; MFR 04713, PART NO. MPS834
853513	TRANSISTOR: SILICON; NPN; MFR 04713, PART NO. 2N3713
853515-002	RELAY, 4 PDT: COIL 12 VDC, 160 OHMS; MFR 77342, PART NO. KHP17D11
853515-003	RELAY, 4PDT: COIL 24 VDC, 650 OHMS; MFR 77342, PART NO. KHP17D11
853516	SOCKET, RELAY: 14 PINS; MFR 77342, PART NO. 9KH2
853518	CONNECTOR, PLUG: 23 CONT; MFR 91662, PART NO. 00-7023-023-000-001
853525	INTEGRATED CIRCUIT: MLOPNL AMPL; MFR 04713, PART NO. MC143OG
853527	RESISTOR, VAR: CARBON; 100 K OHMS 20%, 0.25 W; MFR 80294, NO. 215L-1-104
853528	INTEGRATED CIRCUIT: MLOPNL AMPL; MFR 04713, PART NO. MC1531G
853529	RESISTOR, VAR: WW; 200 OHMS 10%, 0.25 W; MFR 80294, PART NO. 200L-1-201
853530-051	RESISTOR, FIXED: FILM; 100 OHMS, 1%, 1/4 W; MFR 19701
853530-087	RESISTOR, FIXED: FILM; 237 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-089	RESISTOR, FIXED: FILM; 249 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-101	RESISTOR, FIXED: FILM; 332 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-108	RESISTOR, FIXED: FILM; 392 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-118	RESISTOR, FIXED: FILM; 499 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-130	RESISTOR, FIXED: FILM; 665 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C

SANGAMO PART NO.	NAME AND DESCRIPTION
853530-131	RESISTOR, FIXED: FILM; 681 OHMS 1%, 1/4 W; MFR 07716, TYPE CEATZ
853530-143	RESISTOR, FIXED: FILM; 909 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-147	RESISTOR, FIXED: FILM; 1000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-155	RESISTOR, FIXED: FILM; 1210 OHMS 1%, 1/4 W; MFR 07716, TYPE CEATZ
853530-164	RESISTOR, FIXED: FILM; 1500 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-172	RESISTOR, FIXED: FILM; 1820 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-176	RESISTOR, FIXED: FILM; 2000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-186	RESISTOR, FIXED: FILM; 2550 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-193	RESISTOR, FIXED: FILM; 3010 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-196	RESISTOR, FIXED: FILM; 3240 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-204	RESISTOR, FIXED: FILM; 3920 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-205	RESISTOR, FIXED: FILM; 4020 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-208	RESISTOR, FIXED: FILM; 4320 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-211	RESISTOR, FIXED: FILM; 4640 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-212	RESISTOR, FIXED: FILM; 4750 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-214	RESISTOR, FIXED: FILM; 4990 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-219	RESISTOR, FIXED: FILM; 5620 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-232	RESISTOR, FIXED: FILM; 7680 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-234	RESISTOR, FIXED: FILM; 8060 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-236	RESISTOR, FIXED: FILM; 8450 OHMS 1%, 1/4 W; MFR 07716, TYPE CEATZ
853530-243	RESISTOR, FIXED: FILM; 10,000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-246	RESISTOR, FIXED: FILM; 10,700 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-251	RESISTOR, FIXED: FILM; 12.1 K OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-254	RESISTOR, FIXED: FILM; 13,000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-260	RESISTOR, FIXED: FILM; 15,000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-263	RESISTOR, FIXED: FILM; 16,200 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-281	RESISTOR, FIXED: FILM; 24,900 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-284	RESISTOR, FIXED: FILM; 26,700 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-292	RESISTOR, FIXED: FILM; 32,400 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-293	RESISTOR, FIXED: FILM; 33,200 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-301	RESISTOR, FIXED: FILM; 40.2 K OHMS 1%, 1/4 W; MFR 19701 TYPE MF5C
853530-321	RESISTOR, FIXED: FILM; 64,900 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-330	RESISTOR, FIXED: FILM; 80.6 K OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-335	RESISTOR, FIXED: FILM; 90,900 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-336	RESISTOR, FIXED: FILM; 93,100 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C

SANGAMO PART NO.	NAME AND DESCRIPTION
853530-342	RESISTOR, FIXED: FILM; 107,000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853530-350	RESISTOR, FIXED: FILM; 130,000 OHMS 1%, 1/4 W; MFR 19701, TYPE MF5C
853531	SEMICONDUCTOR, DIODE; MFR 04713, TYPE 1N823
853532	TRANSISTOR: SILICON; PNP; MFR 04713, PART NO. 2N2905
853533	TRANSISTOR: SILICON; NPN; MFR 04713, PART NO. 2N2219
853536	SWITCH, ROTARY: PHENOLIC INSULATED: ONE SEC, 2 POLE, 6 POS; MFR 76854
853538	SWITCH ASSY: PUSHBUTTON; MFR 82389
853539	SWITCH ASSY: PUSHBUTTON; MFR 82389
853567	PLAYBACK, CHASSIS: AL. FRAME ASSY, MFR 53021
853568	RECORD, CHASSIS: AL. FRAME ASSY, MFR 53021
853578	REGULATOR, MODULE: 117 VOLT POWER SUPPLY; MFR 53021
853584	TRANSFORMER, TUNING: MFR 00853, PART NO. EV-141-5001-5
853587-001	INDUCTOR, FIXED: 470MH; Q OF 66 MIN; 180 MA; MFR 72259, PART NO. WEE470
853587-002	INDUCTOR, FIXED: 47 MH; Q OF 46 MIN; 420 MA; MFR 72259, PART NO. WEE47
853587-003	INDUCTOR, FIXED: 220 MH, 5%, Q OF 57; 280 MA; MFR 72259, PART NO. WEE220
853587-004	INDUCTOR, FIXED: 330 MH, 5%, Q OF 50; 240 MA; MFR 72259, PART NO. WEE 330
853587-005	INDUCTOR, FIXED: 22 MH, 10%, Q MIN. 47 MA; MFR 72259, PART NO. WEE22
853587-009	INDUCTOR, FIXED: 1500 MH, 10%, Q MIN. 51; MFR 72259, NO. WEE1500
853587-010	INDUCTOR, FIXED: 6800 MH, 10%, Q MIN. 45; MFR 72259, PART NO. WEE6800
853587-011	INDUCTOR, FIXED: 27K, MH, 10%, Q MIN. 32; MFR 72259, PART NO. WEE 27000
853587-013	INDUCTOR, FIXED: 100,000 MH 10%, Q MIN. 20; MFR 72259, NO. WEE100000
853587-014	INDUCTOR, FIXED: 4700 MH 10%, Q MIN. 48, 68 MA; MFR 72259 NO. WEE4700
853587-015	INDUCTOR: 22,000UH, 10%, 219 OHMS RES.: MFR 72259 NO. WEE 22,000
853587-016	INDUCTOR, FIXED: 33 MH 5%, Q MIN. 43; 520 MA; MFR 72259, PART NO. WEE33
853587-017	INDUCTOR, FIXED: 150 UH, 5%, Q MIN. 63; MFR 72259 PART NO. WEE150
853587-018	INDUCTOR, FIXED: 270 UH, 5%, Q MIN. 52; MFR 72259 PART NO. WEE270
853587-019	INDUCTOR, FIXED: 560 UH, 5%, Q MIN. 64; MFR 72259 PART NO. WEE560
853587-020	INDUCTOR, FIXED: 1000 UH, 5%, Q MIN. 62; MFR 72259 PART NO. WEE1000
853587-021	INDUCTOR, FIXED: 2200 UH, 10%, Q MIN. 50; MFR 72259 PART NO. WEE2200
853587-023	INDUCTOR, FIXED: 3300 UH, 10%, Q MIN. 52; MFR 72259 PART NO. WEE3300
853587-024	INDUCTOR, FIXED: 680 UH, 10%, Q; MIN. 71; MFR 72259 PART NO. WEE680
853587-025	INDUCTOR, FIXED: 1200 UH, 10%, Q MIN. 52; MFR 72259 PART NO. WEE1200
853587-026	INDUCTOR, FIXED: 2700UH, 10%, Q MIN. 51; MFR 72259, PART NO. WEE 2700
853587-027	INDUCTOR, FIXED: 12K, UH, 10%, Q MIN. 36; MFR 72259 PART NO. WEE12000
853587-028	INDUCTOR, FIXED: 4.7 UH, 5%, Q MIN. 40; MFR 72259 PART NO. WEE4.7

SANGAMO PART NO.	NAME AND DESCRIPTION
853587-029	INDUCTOR, FIXED: 10 UH, 5%, Q MIN. 46; MFR 72259 PART NO. WEE10
853587-030	INDUCTOR, FIXED: 2.2UH 10%; Q MIN. 42; MFR 72259 PART NO. WEE2.2
853587-031	INDUCTOR, FIXED: 47K, UH, 10%, Q MIN. 25; MFR 72259, PART NO. WEE47K
853587-032	INDUCTOR, FIXED: 820 UH, 5%, Q MIN. 67; MFR 72259 PART NO. WEE820
853587-034	INDUCTOR, FIXED: 3900 UH, 10%, Q MIN. 48; MFR 72259 PART NO. WEE3900
853587-035	INDUCTOR, FIXED: 15K, UH, 10%, Q MIN. 38; MFR 72259 PART NO. WEE15K
853587-037	INDUCTOR, FIXED: 68 UH, 5%, Q MIN. 40; MFR 72259 PART NO. WEE68
853587-039	INDUCTOR, 5600UH, 10%, 104 OHMS RES.; MFR 72259 NO. WEE 5600
853587-040	INDUCTOR, FIXED: 8200UH, 10%, Q MIN. 38; MFR 72259, PART NO. WEE 8200
853590-002	RECEPTACLE, PROBE: RED; MFR 00779, PART NO. 3-582118-2
853590-004	RECEPTACLE, PROBE: YELLOW; MFR 00779, PART NO. 3-582118-4
853590-006	RECEPTACLE, PROBE: BLUE; MFR 00779, PART NO. 3-582118-6
853590-010	RECEPTACLE, PROBE: BLACK; MFR 00779, PART NO. 3-582118-10
853591-023	RESISTOR, FIXED: WW; 300 OHMS 5%, 6.5 W; MFR 44655
853592	RESISTOR, FIXED: COMP; 33 OHMS 5%, 1/4 W; MFR 75042
853593	RESISTOR, VAR: 10,000 OHMS 5%, 1 W; MFR 02660, PART NO. 2900W-1-103
853597	POWER CABLE: C/O BELDEN CABLE, TWO CONN; MFR 53021
853603-001	RESISTOR, FIXED: WW; 50 OHMS 5%, 15 W; MFR 11502
853604	PLAYBACK CONN BOARD: MFR 53021
853606	1/2 INCH TAPE KIT: C/O PINCH ROLLER ASSY; PERTINENT HDW; MFR 53021
853607	1 INCH TAPE KIT: C/O ROLLER ASSY; PERTINENT HDW; MFR 53021
853611	TAPE KIT: C/O SPECIAL EXT. BDS AND GREASE TUBE; MFR 53021
853612	PREAMP BOARD: MFR 53021
853615-004	TERMINAL BOARD: 4 TERM; MFR 75382, PART NO. 411-4-P
852615-007	TERMINAL BLOCK: 7 TERM., MFR 75382 PART NO. 411-7-P
853615-008	TERMINAL BLOCK: 8 TERM., MFR 75382 PART NO. 411-8-P
853623	RELAY: SPST NORMALLY OPEN, 24 VDC; MFR 77342, PART NO. MB 3D
853624	REEL DRIVE BOARD: MFR 53021
853627-001	CAPACITOR, TRIMMER: 5-25UUF; MFR 72982, PART NO. 557-013COPO 39R
853628	PREAMP CONN BOARD: MFR 53021
853631	JACK, 3 CONNECTOR: MFR 82389, PART NO. 12B
853635	PLUG, PHONE, 3 CONDUCTOR: MFR 82389, PART NO. 267
853636	FM CONVERTER BOARD: MFR 53021
853643	RELAY: MFR 71482, PART NO. MRMX-1039
853644	PREAMP BOARD: POWER SUPPLY; MFR 53021
853646	FUSEHOLDER: BAKELITE; MFR 75915, NO. 387001

SANGAMO PART NO.	NAME AND DESCRIPTION
853647	EXTENDER BOARD: RECORD; MFR 53021
853649	FUSE, CARTRIDE: AGX, 3 AMP, 125 V OR LESS; MFR 71400
853650	EXTENDER BOARD: PLAYBACK; MFR 53021
853657	RELAY, DPDT: 24 VDC, 10 AMP; MFR 77342
853658-001	DIRECT RECORD BOARD: W/O HANDLE; MFR 53021
853662	DIRECT PLAYBACK BOARD: MFR 53021
853665	CONNECTOR, RECEPTACLE: FEM; SLDR PINS; MFR 71468, PART NO. RWK-S4-31S
853670-002	CONNECTOR BOARD: MFR 53021
853672	SWITCH, TOGGLE: SPST, MFR 04009, PART NO. 7501
853674-002	TERMINAL BOARD: 14 CONT; MFR 91662, PART NO. 60 8200 0623
853677-007	TERMINAL BOARD: 7 TERM, MFR 71785, PART NO. 353-14-07-001
853677-010	TERMINAL BOARD: 10 TERM, MFR 71785, PART NO. 353-14-10-001
853681	CAPACITOR, FIXED: PPR OIL; 10UF 5%, 100VDCW; MFR 96733, NO. 12R53J1106
853682-001	BIAS OSCILLATOR BOARD: W/O HANDLE; MFR 53021
853685-001	CAPACITOR ASSY: 854528-075 CAP. SLDR MTD TO MEL PL; MFR 53021
853685-002	CAPACITOR ASSY: 854528-150 CAP. SLDR MTD TO MEL PL; MFR 53021
853685-003	CAPACITOR ASSY: 854528-300 CAP. SLDR MTD TO MEL PL; MFR 53021
853685-004	CAPACITOR ASSY: 198816-600 CAP. SLDR MTD TO MEL PL; MFR 53021
853685-005	CAPACITOR ASSY: 276241-120 CPA, SLDR MTD TO MEL PL; MFR 53021
853690-001	VOICE BOARD ASSY: MFR 53021
853694	CONTROL AMPL BOARD: MFR 53021
853696	BOARD ASSY: REGULATOR; MFR 53021
853700	DC TO DC INVERTER BOARD: MFR 53021
854304	RECORD CONNECTOR BOARD: GLASS MEL; MFR 53021
854305	PLAYBACK CONNECTOR BOARD: GLASS MEL; MFR 53021
854306	POWER AND CONTROL CONNECTOR PANEL: GLASS MEL; MFR 53021
854362-001	BLOCK ASSY, PHOTOCELL AND LAMP: UPPER; MFR 53021
854362-002	BLOCK ASSY, PHOTOCELL AND LAMP: LOWER; MFR 53021
854362-003	BLOCK ASSY, PHOTOCELL AND LAMP: LOOP ADAPTER; MFR 53021
854502	CRYSTAL UNIT: 252,000 CPS 1%; MFR 75378
854505	CONNECTOR, MALE: 4 CONT; MFR 71468, PART NO. WK-S4-325
854508-001	SOLENOID: 66 OHMS, 24 VDCW; MFR 53021
854509	SWITCH, ROTARY; 6 POSITION, NON SHORTING; MFR 81073, PART NO. 5001-6
854510	SWITCH, ROTARY; 6 POSITION; MFR 53021
854512-001	CONTACT, ELECTRICAL: MFR 91662, NO. 6082000513
854512-002	CONTACT, ELECTRICAL: MFR 91662, NO. 6082000533

SANGAMO PART NO.	NAME AND DESCRIPTION
854513-001	CONTACT, ELECTRICAL: MFR 91662, NO. 6082000253
854513-002	CONTACT, ELECTRICAL: MFR 91662, NO. 6082000623
854514	CONTACT, ELECTRICAL: MFR 91662, NO. 6082000313
854515	CONTACT, ELECTRICAL: MFR 91662, NO. 6082002623
854517-001	CRYSTAL UNIT: 2.40 MHZ 005%, MFR 75378
854519	CAPASTAN POWER AMPL BOARD: MFR 53021
854527-004	RESISTOR, VAR: WW; 500 OHMS 10%, 1/4 W; MFR 80294, PART NO. 271-1-501
854528-005	CAPACITOR, FIXED: MICA; 5UUF 1%, 500 VDCW; MFR 00853
854528-018	CAPACITOR, FIXED: MICA; 18UUF 1%, 500 VDCW; MFR 00853
854528-027	CAPACITOR, FIXED: MICA; 27 UUF 1%, 500 VDCW; MFR 00853
854528-032	CAPACITOR, FIXED: MICA; 32UUF, 1%, 500 VDCW; MFR 00853
854528-033	CAPACITOR, FIXED: MICA; 33UUF 1%, 500 VDCW; MFR 00853
854528-036	CAPACITOR, FIXED: MICA; 36UUF ±1%, 500 VDCW; MFR 00853
854528-050	CAPACITOR, FIXED: MICA; 50UUF ±1%, 500 VDCW; MFR 00853
854528-062	CAPACITOR, FIXED: MICA; 62UUF 1%, 500 VDCW; MFR 00853
854528-070	CAPACITOR, FIXED: MICA; 70UUF 1%, 500 VDCW; MFR 00853
854528-075	CAPACITOR, FIXED: MICA; 75UUF 1%, 500 VDCW; MFR 00853
854528-091	CAPACITOR, FIXED: MICA; 91UUF 1%, 500 VDCW; MFR 00853
854528-100	CAPACITOR, FIXED: MICA; 100UUF 1%, 500 VDCW; MFR 00853
854528-120	CAPACITOR, FIXED: MICA; 120UUF 1%, 500 VDC; MFR 00853
854528-130	CAPACITOR, FIXED: MICA; 130UUF 1%, 500 VDC; MFR 00853
854528-150	CAPACITOR, FIXED: MICA; 150UUF 1%, 500 VDCW; MFR 00853
854528-190	CAPACITOR, FIXED: MICA; 190UUF 1%, 500 VDCW; MFR 00853
854528-230	CAPACITOR, FIXED: MICA; 230UUF 1%, 500 VDCW; MFR 00853
854528-250	CAPACITOR, FIXED: MICA; 250UUF 1%, 500 VDCW; MFR 00853
854528-270	CAPACITOR, FIXED: MICA; 270UUF 1%, 500 VDCW; MFR 00853
854533	TRANSISTOR, MEDIUM POWER: PNP; MFR 04713, PART NO. MJ3701
854535-003	RESISTOR, VAR: WW; 50 OHMS 1 W; MFR 02660, PART NO. 2600P-500
854535-005	RESISTOR, VAR: WW; 200 OHMS 1 W; MFR 02660, PART NO. 2600P-201
854535-006	RESISTOR, VAR: WW; 500 OHMS, 1 W; MFR 02660, PART NO. 2600P-501
854535-007	RESISTOR, VAR : WW; 1000 OHMS, 1 W; MFR 02660, PART NO. 2600P-102
854535-008	RESISTOR, VAR: WW; 2000 OHMS, 1 W; MFR 02660, PART NO. 2600P-2002
854535-009	RESISTOR, VAR: WW; 5000 OHMS, 1 W; MFR 02660, PART NO. 2600P-502
854535-010	RESISTOR, VAR: WW; 10,000 OHMS, 1 W; MFR 02660, PART NO. 2600P-103
854535-011	RESISTOR, VAR: WW; 20,000 OHMS, 1 W; MFR 80294, PART NO. 3007P-1-203
854538-001	INVERTER, DC TO AC: SOLID STATE; 28 VOLTS; MFR 82877

SANGAMO PART NO.	NAME AND DESCRIPTION
854539	TRANSISTOR: SILICON; NPN; MFR 04713, PART NO. 2N4124
854540	TRANSISTOR: SILICON; PNP; MFR 04713, PART NO. 2N4126
854541	THERMOSTAT, FIXED TEMPERATURE: MFR 82647, PART NO. KLIXON 06786
854544	DC TO DC CONV. ASSY: MFR 53021
854547	RECTIFIER, DIODE STACK: MFR 04713
854548	SEMICONDUCTOR, DIODE: ZENER; 5.5 V; MFR 12954, PART NO. 1N2214
854549-001	FAN: 28 VAC; MFR 82877, PART NO. AO-19994
854550-003	HOOD, CONNECTOR ASSY: 11 PIN, MFR 97954, PART NO. SM1-11H-1RSL
854550-005	HOOD, CONNECTOR ASSY: 20 PIN, MFR 97954, PART NO. SM1-20H-1RSL
854550-007	HOOD, CONNECTOR ASSY: 29 PIN, MFR 97954, PART NO. SM1-29H-1RSL
854551-003	RESISTOR, VAR: 100,000 OHMS 20%, MFR 80294, PART NO. 3368P-1-104
854555-010	CAPACITOR, FIXED: MYLAR; 0.01 UF 1%, MFR 84171, PART NO. 1MD-1-103-F
854555-014	CAPACITOR, FIXED: MYLAR; 0.02UF 1%, MFR 84171, PART NO. 1-MD-1-203-F
854555-022	CAPACITOR, FIXED: MYLAR; .039UF 1%, MFR 84171, PART NO. 1-MD-1-393-F
854555-023	CAPACITOR, FIXED: MYLAR; 0.04UF 1%, MFR 84171, PART NO. 1-MD-1-403-F
854555-026	CAPACITOR, FIXED: MYLAR; 0.05UF 1%, 100 VDCW; MFR 84171 NO. IMD-2-503-F
854555-114	CAPACITOR, FIXED: MYLAR; 0.01UF 5%, 100 VDCW; MFR 84171 NO. 1MD-1-103-J
854555-116	CAPACITOR, FIXED: MYLAR; 0.015UF 5%, 100 VDCW; MFR 72136 NO. 1MD-1-153-J
854555-127	CAPACITOR, FIXED: MYLAR; 0.04UF 5%, 100 VDCW; MFR 84171, NO. IMD-1-403-J
854555-130	CAPACITOR, FIXED: MYLAR; 0.05UF 5%, 100 VDCW; MFR 72136 NO. 1MD-2-503-J
854570	EXTENDER BOARD: SPEED CONT; MFR 53021
854578	POWER SUPPLY: BASIC; MFR 53021
854579-002	INDUCTOR, FIXED: 22UH 5%, Q OF 65 MFR 72259, PART NO. RFC-M-22
854582	PLAYBACK CHASSIS KIT: INSTL HDW; MFR 53021
854583	PLUG, MALE; SHORTING; A THRU W; MFR 53021
854585	FM PLAYBACK BOARD; 2 SPEED; MFR 53021
854588	LEAD HARNESS ASSY; INPUT, PLAYBACK CHASSIS; MFR 53021
854589	LEAD HARNESS ASSY: OUTPUT, PLAYBACK CHASSIS; MFR 53021
854590	LEAD HARNESS ASSY: POWER AND CONTROL; PLAYBACK CHASSIS; MFR 53021
854595	LEAD HARNESS ASSY: INPUT, RECORD CHASSIS; MFR 53021
854596	LEAD HARNESS ASSY: OUTPUT, RECORD CHASSIS; MFR 53021
854598	LEAD HARNESS ASSY: POWER AND CONTROL; RECORD CHASSIS; MFR 53021
854703	BUS BAR: 0.125 THK; 2.25 LG, 4 TERM HOLES 6-32 THD; MFR 53021
854725	PLUG, FLUSH MTG: 125 V, 15 AMPS; MFR 02660, PART NO. 160-5
854734	TERMINAL BOARD, 7 CONNECTOR: MFR 75382
854922	STANDOFF: CKT BD; MLD NYL; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
854950	HEAD SET, MAGNETIC: DUAL PHONES, 2,000 OHMS; MFR 22711, PART NO. 610-2
855027	LAMP: 2.5 V; 0.350 AMPS; MFR 71744, PART NO. CM20-1
855058	RACK MTG KIT: FOR POWER SUPPLY MOUNTING; MFR 53021
855060	RACK MTG KIT: AUX. ELEC.; MFR 53021
855078	VOICE AMPLIFIER BOARD: MFR 53021
855107	SWITCH, ROCKER: SIX SOLDER TERMS,; MFR 22753, PART NO. RSWC322
855121	RESISTOR, VAR: 10,000 OHMS; LINEAR TAPER; MFR 71590, MODEL 9
855128	EXTENDER BOARD: FLEX; MFR 53021
855129	JACK, 3 CONNECTOR: MFR 82389, NO. 13A
855130-002	RELAY: DPDT; 12 V; COIL RES. 218 OHMS 10%, MFR 77342, TYPE HP11D6V
855130-004	RELAY, ARMT: DPDT; 28VNOM; COIL RES 1400 OHMS 10% MFR 77342, TYPE HP4007
855144	POWER SUPPLY: 115/230 VAC; 47-63 HZ; MFR 53021
855150	KIT, SENSING: C/O 2 RELAYS; MFR 53021
855301	EXTENDER BOARD ASSY: FLEXIBLE; MFR 53021
855339	LOUDSPEAKER: VOICE COIL IMP. 45 OHMS 10%, 3.5W; MFR 74199 MODEL 5A1Z45
855341	PLUG, PHONE, 2 CONDUCTOR: MFR 82389, PART NO. 250
855342	CONTROL ASSY: REMOTE CONTROL; MFR 53021
855344	SIGNAL, CABLE: INTERCONNECTING VOICE CABLE; MFR 53021
855432-001	SWITCH, TOGGLE: DPDT; MC; MFR 09353 MODEL NO. 7201
855432-006	SWITCH, TOGGLE: DPDT; MC; MFR 09353 MODEL NO. 7211
855432-008	SWITCH, TOGGLE: DPDT; MC; MFR 09353 MODEL NO. 7201
855449	AC POWER CORD: RATED 15 AMP, 125 V; MFR 82076 TYPE 14/3 SPT
855451	CORD, POWER: RATED 15A, 125 V, TYPE 14/3 SPT; MFR 82076, NO. 409
855504-XXX	EQUALIZER BOARD: BASIC; SUFFIX -001 THRU -009; MFR 53021
855523	TRANSISTOR: SILICON; PNP; MFR 04713, TYPE 2N3740
855536	EXTENDER BOARD: PLAYBACK; MFR 53021
855540-001	SWITCH, SLIDE: 4 PDT; MFR 71590
855542	KIT, FM RE-RECORD: MFR 53021
8555455-XXX	FM RECORD BOARD: SUFFIX 001 THRU 008 FOR FREQ.; MFR 53021
855546	RELAY, DPDT: COIL, 24 VDC 10%; MFR 73949, TYPE 905-2C-24VDC
855547	SWITCH, ROTARY: 1 SECT., 6 POLE, 2 POS.; MFR 76854 NO. 399433K
855563	RELAY, SOCKET: 14 TERMS, MLD INTO BAKELITE BASE; MFR 77342, NO. 9KH1
855580	INTEGRATED CIRCUIT, DEVICE: OPER AMPL; MFR 07263, PART NO. U5B770939X
855608	REFERENCE COUNTER BOARD: MOD 2; MFR 53021
855610	CAPSTAN A BOARD: MOD 2; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
855612	CAPSTAN B BOARD: MOD 2; MFR 53021
855613	CAPSTAN B BOARD: MOD 2; CPSN SYN ONLY; MFR 53021
855672	CAPSTAN ASSY: PULL-OUT; MFR 53021
855673	CAPSTAN ASSY: STUFFING; MFR 53021
855674	MOTOR, CAPSTAN: RATED 24 VDC, RATED SPEED 3650 RPM; MFR 04191, NO. U9M4
855694	COMPONENT BOARD; MFR 53021
855695	COMPONENT BOARD; MFR 53021
855696	BOARD ASSY: MFR 53021
855706	POWER SUPPLY ASSY; REG; MFR 53021
855707	STUFFING SERVO AMPL ASSY: MFR 53021
855708	PULL-OUT SERVO AMPL ASSY: MFR 53021
855709	DIODE LIMITER ASSY: MFR 53021
855710	SWITCH, ROTARY: ONE SECT, 6 POLE, 2 POSN, MFR 76854, PART NO. 399433K
855772	CONNECTOR: PLUG JACK, BRASS; MFR 71279, PART NO. 3301
855809	BIAS OSCILLATOR BOARD: MFR 53021
855810	TRANSISTOR: SILICON; MFR 04713, TYPE 2N4416
855811-001	INDUCTOR, VAR: UH 4.70; Q 75; MFR 72259, PART NO. V1H-4.70
855812-002	JACK, TESTPOINT: RED; MFR 98291, PART NO. SKT-0804
855812-004	JACK, TESTPOINT: YELLOW; MFR 98291, PART NO. SKT-0804
855812-005	JACK, TESTPOINT: GREEN; MFR 98291, PART NO. SKT-0804
855812-010	JACK, TESTPOINT: BLACK; MFR 98291, PART NO. SKT-0804
855872	BLOCK, PHOTO-CELL: AL; W/LAMP; MFR 53021
855874	PHOTO-CELL ASSY: MFR 53021
855889	MOTOR, TORQUE: 8 AMP, 81 W; MFR 11384 NO. TT-2925
855894	RECEPTACLE, MODIFIED: 23 PINS; MFR 53021
855902	HEAD ASSY; 1 IN. RECORD; W/LEAD HARNESS; MFR 53021
855908	LOGIC BOARD: MFR 53021
855977	RECEPTACLE, BNC: MFR 74868, PART NO. 31-221
855981-001	SOCKET, PIN: BRASS; MFR 06776 NO. 0001144
855981-002	SOCKET, PIN: BRASS; MFR 06776 NO. 0001145
855985	PIN SOCKET: MFR 06776, PART NO. 0001146
856221	CONNECTOR, 23 PIN RECEPTACLE: MFR 91662, PART NO. 00-7024-023-163-002
856222	RECEPTACLE: 23 CONT; MFR 91662, PART NO. 00-7024-023-139-002
856223-001	CAPACITOR, FIXED: TANTA; 22UF 20%, 20 VDCW; MFR 80183, NO. 196D226X002
856224-011	RESISTOR, VAR: TAPES RES., 1000 OHMS 20%, 1/4 W; MFR 90201
856256	LAMP: 28V, 0.04 AMPS, 30W; MFR 08806 PART NO. 387

SANGAMO PART NO.	NAME AND DESCRIPTION
856265-001	BLOCK ASSY, PHOTOCELL: UPPER; MFR 53021
856265-002	BLOCK ASSY, PHOTOCELL; LOWER; MFR 53021
856265-003	BLOCK ASSY, PHOTOCELL: LOOP ADAPTER; MFR 53021
856292	MOD KIT: FOR LOOP ADAPTER; MFR 53021
856385-XXX	PCM READ EQUALIZER BOARD: SUFFIX -001 THRU -008; MFR 53021
856387-001	JACK, TESTPOINT: BLACK; MFR 98291
856387-005	JACK, TESTPOINT: RED; MFR 98291
856387-007	JACK, TESTPOINT: YELLOW; MFR 98291
856397	HEAD ASSY: 1 IN., PLAYBACK; W/LEAD HARNESS; MFR 53021
856424	REEL DRIVE BOARD ASSY: MFR 53021
856427	MOTOR AND HUB ASSY: MFR 53021
856494	BLOCK, CONNECTOR: HOLD CONT; MATL PHEN; MFR 00779 PART NO. 200345-2
856495	BLOCK, CONNECTOR: MATL PHEN; MFR 00779 NO. 200346-2
856530	VIBRATION MOD KIT: MFR 53021
856618-001	FM RECORD BOARD: BASIC; W/O HANDLE; OPT 855545-001 THRU 008; MFR 53021
856634	MICROPHONE: W/5 FT. CORD; MFR 74384, MODEL NO. M + 2U
856635	MICROPHONE ASSY: MFR 53021
856718	PIN, COAXICON = SUB-MINIATURE, SHORT; MFR 00779 NO. 51563-2
856772	VOICE PLAYBACK BOARD: MFR 53021
856835-001	KIT, RACK MTG: FM DENSITY CHANGE; MFR 53021
856856	BLOCK ASSY, LAMP: MFR 53021
856916	SENSOR: MFR 07263, PART NO. FPA210
856918	SPLICE DETECTOR BOARD: MFR 53021
856920	RELAY MTG BOARD: 1/2 IN.; 3500 SERIES; MFR 53021
856921	RELAY MTG BOARD ASSY: 1 IN. TAPE; MFR 53021
856923	RELAY MTG AUXILIARY BOARD ASSY: MFR 53021
856997	SWITCH ROTARY: 2 POLES 1 SEC, 9 POSITION; MFR 76854, PART NO. 274686-A1
857023-001	HOUR METER ASSY: MFR 53021
857027	COUNTER: MECHANICAL; 5 DRUM, 10 COUNT; MFR 33203 NO. D4335
857033	DIRECT RECORD BOARD: MFR 53021
857055	SWITCH, ROTARY: TWO SECT, 2 POLE, 7 POSN; MFR 76854 TYPE F
857065	BUS, BAR: BRASS; 9 TERMINAL HOLES; MFR 53021
857084	LEAD HARNESS: RC; INTERCON; MFR 53021
857085	REMOTE CONTROL KIT: MFR 53021
857087	PREAMP REG. BOARD: MFR 53021
857098	COUNTER: FOOTAGE CNTR; 4 DIGIT; MECH CPLD; MFR 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
857122	HEAD: 1 IN. RECORD; 16 CHANNEL; MFR 26549 NO. 502300
857123	HEAD: 1 IN PLAYBACK; MFR 26549 PART NO. 502400
857124	HEAD: 1 IN. RECORD; 8 CHANNEL; MFR 26549 NO. 501300
857125	TAPE HEAD: PLAYBACK; 1/2 IN.; 2 MHZ; 3600/4900 SERIES; MFR 26549 NO. 501400
857144	KIT, 1 IN. TAPE: ROLLER ASSY'S TO CONVERT 3600 SERIES; MFR 53021
857145	KIT, 1/2 IN. TAPE: ROLLER ASSY'S FOR 3600 SERIES; MFR 53021
857211	REMOTE VOICE CHASSIS: MFR 53021
857215	MULTIBAND FM REPRODUCE BOARD: MFR 53021
857222	REMOTE CONT & VOICE CHASSIS: MFR 53021
857241	SENSING POST ASSY: TWO SST CONTS, & LEADS W/IN SST POST; MFR 53021
857260	REMOTE SHORTING PLUG: MFR 53021
857266	RECORD HEAD ASSY: 1 INC, W/LEAD HARNESS; MFR 53021
857267	RECORD HEAD ASSY: 1/2 INCH, W/LEAD HARNESS; MFR 53021
857268	RECORD HEAD ASSY: 1 INCH, W/LEAD HARNESS; MFR 53021
857269	RECORD HEAD ASSY: 1/2 INCH, W/LEAD HARNESS; MFR 53021
857276	CONNECTOR, PANEL: RECORD; GL MEL; MFR 53021
857317	JUMPER BOARD: PLAYBACK; MFR 53021
857343	CONNECTOR, BOARD: PLAYBACK; MFR 53021
857363	MOTOR & CAPSTAN ASSY: 28 VDC, 2.8A, MFR 16858 MODEL 200A-1-5000G
857377	HOLDER, TIMER: MFR 89597 NO. 9200-6
857453	HEAD: 1 IN PLAYBACK, 14 TRACK W/TERM BDS; MFR 53021
857461	TAPE HEAD - 1/2 IN: 7 TRACK, RECORD; 3600 SERIES; MFR 53021
857476	MOTOR, TORQUE = 8 AMP, 81 W; MFR 86197, NO. DH-4530-A-1
857478	CONNECTOR, PANEL ASSY: 4900 SERIES; MFR 53021
857487	HEAD: 1 IN. RECORD, 14 TRACK; MFR 53021
857488	TAPE HEAD - 1 IN: 14 TRACK, RECORD; 3600 SERIES; MFR 53021
857491	HEAD: 1/2 IN PLAYBACK, 7 TRACK W/TERM BDS; MFR 53021
857492	TAPE HEAD - 1/2 IN: 7 TRACK, PLAYBACK; 3600 SERIES; MFR 53021
858820-001	FAN: 115 VAC, 50-60 CPS, 1PH MFR 82877, PART NO. M747115VAC
858820-002	FILTER ASSY: MFR 82877, PART NO. 15449
859389	SOCKET, COAXICON: MFR 00779, PART NO. 51564-2
859457-002	POWER CORD: 4900 SERIES; MFR 81774 PART NO. 4949
859520-001	NETWORK, SEMICONDUCTOR: POSITIVE NAND GATE; MFR 01295, TYPE SN7400N
859520-002	NETWORK, SEMICONDUCTOR: POSITIVE NAND GATE; MFR 01295, TYPE SN7401N
859520-003	NETWORK, SEMICONDUCTOR: POSITIVE NOR GATE; MFR 01295, TYPE SN7402N
859520-006	NETWORK, SEMICONDUCTOR: POSITIVE NAND GATE; MFR 01295, TYPE SN7430N

SANGAMO PART NO.	NAME AND DESCRIPTION
859520-018	NETWORK, SEMICONDUCTOR: FLIP-FLOP; MFR 01295, TYPE SN7472N
859520-019	NETWORK, SEMICONDUCTOR: FLIP-FLOP; MFR 01295, TYPE SN7473N
859520-020	INTEGRATED CIRCUIT: DUAL D-TYPE EDGE-TRIGGERED FLIP-FLOP; MFR 01295 NO. SN7474N
859520-028	INTEGRATED CIRCUIT: DIV-BY-TWELVE CNTR; MFR 01295 PART NO. SN7492N
859520-029	NETWORK, SEMICONDUCTOR: 4-BIT BINARY COUNTER; MFR 01295, TYPE SN7493N
859520-034	INTEGRATED CIRCUIT: HEX INVERTER; MFR 01295 TYPE SN7404N
859520-038	INTEGRATED CIRCUIT: QUADR 2-INPUT POS AND GATE; TYPE SN7408N; MFR 01295
859520-042	NETWORK, SEMICONDUCTOR: TTL MONOSTABLE; MFR 01295, TYPE SN74121N
859520-047	INTEGRATED CIRCUIT: B-BIT DATA SEL/MULTIPLEXER; NO. SN74151N MFR 01295
859520-048	INTEGRATED CKT: SYN DECADE UP/DOWN CNTR; MFR 01295 NO. SN74192N
859520-053	INTEGRATED CIRCUIT: 6-BIT BINARY MULTIPLIER; TYPE SN7497N MFR 01295
859520-056	INTEGRATED CIRCUIT: DUAL SCHMITT TRIGGER; TYPE SN7413N; MFR 01295
859759	SEMICONDUCTOR, DIODE: MFR 05277 TYPE 1N1192
859763-001	PLUG CONN: BRASS, RED INSUL WIRE SIZE 22-18; MFR 00779 NO. 42599-2
859763-009	PLUG CONN: BRASS, BLUE INSUL WIRE SIZE 16-14; MFR 00779 NO. 60365-2
859763-015	PLUG CONN: BRASS, TRANS INSUL WIRE 22-18; MFR 00779 NO. 61060-1
859774-005	FUSE: CER TUBE; 250V, 5 AMPS; MFR 71400 TYPE ABC
859774-008	FUSE, CERAMIC TUBE: 250 V, 10 AMPS; MFR 71400 TYPE ABC
859774-011	FUSE, CERAMIC TUBE: 250 V, 20 AMPS; MFR 71400 TYPE ABC
859775-003	CAPACITOR, FIXED: TANTALUM; 0.22UF 20%, 35 VDCW; MFR 56289 TYPE 196D
859775-005	CAPACITOR, FIXED: TANTALUM; 0.47UF 20%, 35 WVDC; MFR 56289 TYPE 196D
859775-007	CAPACITOR, FIXED: TANTALUM; 1.0UF 20%, 35 VDCW; MFR 56289, TYPE 196D
859775-009	CAPACITOR, FIXED: TANTALUM; 2.2UF 20%, 20 VDCW; MFR 56289, TYPE 196D
859775-010	CAPACITOR, FIXED: TANTALUM; 3.3UF 20%, 15 VDCW; MFR 56289, TYPE 196D
859775-011	CAPACITOR, FIXED: TANTALUM; 4.7UF 20%, 10 VDCW; MFR 56289, TYPE 196D
859775-012	CAPACITOR, FIXED: TANTALUM; 6.8UF 20%, 6 VDCW; MFR 56289, TYPE 196D
859775-013	CAPACITOR, FIXED: TANTALUM; 6.8UF 20%, 35 VDCW; MFR 56289, TYPE 196D
859775-014	CAPACITOR, FIXED: TANTALUM; 10UF 20%, 25 VDCW; MFR 56289, TYPE 196D
859775-017	CAPACITOR, FIXED: TANTALUM; 22UF 20%, 15 VDCW; MFR 56289, TYPE 196D
859775-021	CAPACITOR, FIXED: TANTALUM; 47UF 20%, 6 VDCW; MFR 56289, TYPE 196D
859775-026	CAPACITOR, FIXED: TANTALUM; 100UF 20%, 20 VDCW; MFR 56289, TYPE 196D
859775-027	CAPACITOR, FIXED: TANTALUM; 150UF 20%, 6 VDCW; MFR 56289, TYPE 196D
859775-029	CAPACITOR, FIXED: TANTALUM; 220UF 20%, 10 VWDC; MFR 56289, TYPE 196D
859775-031	CAPACITOR, FIXED: TANTALUM; 4.7 UF 20%, 35 VDC; MFR 56289, TYPE 196D
859775-032	CAPACITOR, FIXED: TANTALUM; 33UF 20%, 25 VDCW; MFR 56289, TYPE 196D

SANGAMO PART NO.	NAME AND DESCRIPTION
859843	INTEGRATED CIRCUIT: OPR. AMPL; MFR 04713, TYPE MC143OP
859959-001	CAPACITOR, FIXED: CER; 0.01UF -20, + 80%, 25V; MFR 56289, NO. CO69B250F103Z
859959-002	CAPACITOR, FIXED: CER; 0.1UF -20 + 80%, 10V; MFR 56289, NO. CO52B100G104Z
859960-001	CAPACITOR, FIXED: CER; 0.001UF MIN % 1000V; MFR 56289, NO. C023B102E102P
859970	TRANSISTOR: NPN, SILICON; MFR 04713 TYPE 2N5089
859971	TRANSISTOR, PNP: SILICON; MFR 04713, TYPE 2N5087
864752-002	TERMINAL BOARD: 2 TERM, 5-40 TERM SCREW; MIL TYPE 37TB2
864752-004	TERMINAL BOARD: 4 TERM, 5-40 TERM SCREW; MIL TYPE 37TB4
864795-060	RESISTOR, FIXED: FILM; 7870 OHMS 1%, 1/8 W; MFR 53021
864971-003	RESISTOR, FIXED: WW; 0.39 OHMS 10%, 3 W; MFR 53021
864971-014	RESISTOR, FIXED: WW; 30 OHMS 5%, 3 W; MFR 53021
864971-018	RESISTOR, FIXED: WW; 75 OHMS 5%, 3W; MFR 53021
864971-034	RESISTOR, FIXED: WW; 2.2 OHMS 5%, 3 W; MFR 53021
864972-014	RESISTOR, FIXED: WW; 30 OHMS 5%, 6.5 W; MFR 53021
865206-005	TERMINAL BOARD: 5 TERM, 6-32 TERM SCREW; MIL TYPE 41TB-5
865257	MOTOR, PUMP: 3000 RPM; 115 V, 50/60 CY, 1 PH; MFR 62119; MODEL AB1C032
865610-008	INDUCTOR, FIXED: 50UH 1%, MFR 00853, NO. ET-106-1280-2
865610-009	INDUCTOR, FIXED: 72UH 1%, MFR 00853, NO. ET-106-1300-2
865610-010	INDUCTOR, FIXED: 100UH 1%, MFR 00853, NO. ET-106-1330-2
867618	TRANSISTOR: NPN, SILICON; MFR 04713, TYPE 2N3715
867638	SWITCH, SUB-MINIATURE: MFR 81073
867647	CONNECTOR, PLUG: 2 CONT., MALE; MFR 81312 NO. JF-2P
867648	CONNECTOR, RECEPTACLE: 2 CONT., FEMALE; MFR 81312 NO. JF-2S
867682	SOLENOID: 24 VDC COIL; MFR 29238, PART NO. 38C24DC-AY
867685	PHOTO-CELL: MFR 21370 NO. SS-23
867686	RESISTOR, FIXED: WW; 2 OHMS 5%, 21 W; MFR 53021
870037	RESISTOR, FIXED: COMP; 1000 OHMS 5%, 2 W; MFR 01121, PART NO. HB1025
877885	TERMINAL POST ASSY: 4 TERM.; MFR 53021
878687	TERMINAL POST ASSY: 3 TERM.; MFR 53021
896196	RESISTOR, FIXED: COMP; 22 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF220J
896197	RESISTOR, FIXED: COMP; 150 OHMS, 1/4 W; MFR 01121, TYPE RC07GF151J
896198	RESISTOR, FIXED: COMP; 12000 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF123J
896269	RESISTOR, VAR: 5000 OHMS 10%, MFR 91637, SERIES 295
896282	RESISTOR, FIXED: COMP; 6200 OHMS 5%, 1/4 W; MFR 01121
896293	CAPACITOR, FIXED: TANTALUM; 270 UF 20%, 6 V; MFR 01295, NO. SCM277HP006C4
896294	CAPACITOR, FIXED: TANT; 2.2UF 20%, 20 V; MFR 01295, #SCM225FP020C4

SANGAMO PART NO.	NAME AND DESCRIPTION
896297	CAPACITOR, FIXED: TANT; 33UF 20%, 20 V; MFR 01295, #SCM336GP020C4
896298	CAPACITOR, FIXED: TANT; 1.0UF 20%, 35 V; MFR 01295, #SCM105FP035C4
896299	CAPACITOR, FIXED: TANT; 4.7UF 20%, 35 V; MFR 01295, #SCM475BP035C4
896458	SEMICONDUCTOR, DIODE: SILICON; MFR 01295, TYPE 1N4385
896464	RESISTOR, FIXED: COMP; 5600 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF562J
896465	RESISTOR, FIXED: COMP; 68 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF680J
896466	RESISTOR, FIXED: COMP; 1800 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF182J
896467	RESISTOR, FIXED: COMP; 8200 OHMS 5%, 1/4 W; MFR 01121
896468	RESISTOR, FIXED: COMP; 820 OHMS 5%, 1/4 W; MFR 53021
896470	RESISTOR, FIXED: COMP; 180 OHMS 5%, 1/4 W; MFR 01121
896474	RESISTOR, VAR: 500 OHMS 10%, MFR 91637, PART NO. A-10-W-500-L
896475	CAPACITOR, FIXED: MICA; 100UUF 5%, 300 VDCW; MFR 53021
896476	CAPACITOR, FIXED: MICA; 50UUF 5%, 500 VDCW; MFR 53021
896477	CAPACITOR, FIXED: MYLAR; 0.04 UF 5%, 100 VDCW; MFR 72136, NO. 1DP-1-403J
896478	CAPACITOR, FIXED: MYLAR; 0.02UF 5%, 100 V; MFR 72136, TYPE 1DP-1-203J
896479	CAPACITOR, FIXED: MYLAR; 0.005UF 5%, 100 V; MFR 72136, TYPE 1DP-1-502J
896492	CAPACITOR, FIXED: MYLAR; 0.03UF 5%, 100 V; MFR 72136, TYPE 1DP-1-303J
896601	RESISTOR, FIXED: COMP; 47 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF470J
896602	RESISTOR, FIXED: COMP; 100 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF101J
896603	RESISTOR, FIXED: COMP; 220 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF221J
896604	RESISTOR, FIXED: COMP; 330 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF331J
896605	RESISTOR, FIXED: COMP; 470 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF471J
896606	RESISTOR, FIXED: COMP; 680 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF681J
896607	RESISTOR, FIXED: COMP; 1000 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF102J
896608	RESISTOR, FIXED: COMP; 1500 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF152J
896609	RESISTOR, FIXED: COMP; 2200 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF222J
896610	RESISTOR, FIXED: COMP; 3300 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF332J
896611	RESISTOR, FIXED: COMP; 4700 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF472J
896612	RESISTOR, FIXED: COMP; 6800 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF682J
896613	RESISTOR, FIXED: COMP; 10K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF103J
896614	RESISTOR, FIXED: COMP; 15K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF153J
896615	RESISTOR, FIXED: COMP; 22K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF223J
896616	RESISTOR, FIXED: COMP; 33K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF333J
896617	RESISTOR, FIXED: COMP; 47K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF473J
896619	RESISTOR, FIXED: COMP; 100K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF104J

SANGAMO PART NO.	NAME AND DESCRIPTION
896620	RESISTOR, FIXED: COMP; 150K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF154J
896621	RESISTOR, FIXED: COMP; 220K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF224J
896622	RESISTOR, FIXED: COMP; 330K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF334J
896623	RESISTOR, FIXED: COMP; 470K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF474J
896625	RESISTOR, FIXED: COMP; 1.0 MEGOHMS 5%, 1/4 W; MFR 01121
896626	RESISTOR, FIXED: COMP; 2700 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF272J
896627	RESISTOR, FIXED: COMP; 27K OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF273J
896628	RESISTOR, FIXED: COMP; 560 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF561J
896629	RESISTOR, FIXED: COMP; 3900 OHMS 5%, 1/4 W; MFR 01121, TYPE RC07GF392J
896633	SEMICONDUCTOR, DIODE: MFR 73293, TYPE 1N625
896642	RESISTOR, FIXED: 250 OHMS 5%, 2 W; MFR 63743, PART NO. 20S250
896655	CONNECTOR, JACK: RED; MFR 53021
896656	CONNECTOR, JACK: BLACK; MFR 53021
896658	CONNECTOR, JACK: GREEN; MFR 53021
896709	FUSE: 2.5 AMP, 125 V; MFR 71400, PART NO. MDL 2.5
896717	CAPACITOR, FIXED: MICA; 10UUF 10%, 500 VDCW; MFR 53021
896740	TRANSISTOR, NPN, GERMANIUM; MFR 01295, TYPE 2N1304
896742	TRANSISTOR: PNP, GERMANIUM; MFR 01295, TYPE 2N1305
896798	CAPACITOR, FIXED: MYLAR; 0.001UF 5%, 600 V; MFR 72136, TYPE 6DP-1-102
896835	STANDOFF: BRASS TERM. MFR 71279, PART NO. CAMBION 140-1785-02-00-00
896870	CAPACITOR, FIXED: MICA; 680UUF 5%, 300 VDCW; MFR 53021
897384	VALVE-SOL: 24 VDC, 3 WAY, PUMP PORT 1/4-18NPT; MFR 96487 NO. 54P3103B-32
897386	GAUGE, VACUUM: 0-30; MFR 61349 NO. 516V
897581	RESISTOR, FIXED: 100 OHMS, 20 W; MFR 63743, PART NO. 20S100
897583	RESISTOR, FIXED: WW; 0.1 OHMS 10%, 3 W; MFR 63743, PART NO. 3X
897596	SEMICONDUCTOR, DIODE: SILICON; MFR 05277, TYPE 1N1199
897604	CAPACITOR, FIXED: 4000UF, 40 VDC; MFR 53021
897605	CAPACITOR, FIXED: 2500UF, 12 VDCW; MFR 53021
897633	CONNECTOR, PLUG, 15 MALE CONT, MFR 02660, NO. 126-204
897634	CONNECTOR, RECEPTACLE: 15 FEMALE CONT; MFR 02660, NO. 126-205
897772	RESISTOR, FIXED: COMP; 820 OHMS 5%, 0.5 W; MFR 01121, PART NO. EB8215
898053	COUNTER, MECH: DIRECT DR, 4 FIG. RESET; MFR 18911, NO. 4X71LAC
898076	RV-VACUUM: SPRING LOADED; 3/8 NPT HEX HEAD; MFR 24123 NO. AA840
898234	CAPACITOR, FIXED: MYLSR; 0.01UF5%, 100V; MFR 72136, TYPE 1DP-1-103J
898235	CAPACITOR, FIXED: MYLAR; 0.1UF 5%, 100 VDCW; MFR 72136
898241	LAMP, INCAND: MINTR INT. LTG; MFR 08806, NO. 680

SANGAMO PART NO.	NAME AND DESCRIPTION
898314	RESISTOR, FIXED: COMP; 1200 OHMS 5%, 1/4 W; MFR 53021
898315	RESISTOR, FIXED: COMP; 10 OHMS 5%, 1/4 W; MFR 53021
898323	TERMINAL STRIP: 2 TERMINALS; MFR 75382, PART NO. 599-2-GMF
898330	CAPACITOR, FIXED: MICA; 27UUF 5%, 300 VDCW; MFR 53021
898331	CAPACITOR, FIXED: ELECTLT; 2UF, -10%, +100%, 50 V; MFR 02567, TYPE APD
898333	CAPACITOR, FIXED: ELECTLT; 4UF, -10%, +100%, 50 V; MFR 02567, TYPE APD
898335	CAPACITOR, FIXED: MICA; 500UUF 5%, 300 V; MFR 53021
898339	CAPACITOR, FIXED: MICA; 250UUF 5%, 500 VDCW; MFR 53021
898406	CAPACITOR, FIXED: MICA; 1000UUF 5%, 500 VDCW; MFR 53021
898743	LAMP: 28 VOLTS; 0.04 AMPS MFR 72619, CAT; NO. 327
898807	SWITCH, MICRO: 5 AMPS, 250 VAC; MFR 91929, TYPE 1SM1
899055	TRANSISTOR: NPN; GERMANIUM; MFR 01295, TYPE 2N697
899112	RESISTOR, FIXED: COMP; 39,000 OHMS 5%, 1/4 W; MFR 01121
899161	CAPACITOR, FIXED: MICA, 2700UUF 5%, 500 VDCW; MFR 53021
899171	CAPACITOR, FIXED: MICA; 200UUF 1%, 300 VDCW; MFR 53021
899172	CAPACITOR, FIXED: MICA; 2000UUF 1%, 500 VDCW; MFR 53021
899250	TERMINAL BOARD: BLACK PHEN., H TERM.; MFR 75382 PART NO. 599-4-GMF
899258	CAPACITOR, FIXED: MYLAR; 0.08UF 5%, 100 V; MFR 72136, TYPE 1DP-2-803
899443	CAPACITOR, FIXED: MICA; 1525 UUF 1%, 500 VDCW; MFR 53021
899464	CAPACITOR, FIXED: MYLAR; 0.0002UF 5%, 600 V; MFR 72136, TYPE 6DP-1-202J
899465	CAPACITOR, FIXED: MYLAR; 0.004UF 5%, 600 V; MFR 72136, TYPE 6DP-1-402J
899466	CAPACITOR, FIXED: MYLAR; 0.008UF 5%, 600 V; MFR 72136, TYPE 6DP-2-802J
899467	CAPACITOR, FIXED: MYLAR; 0.015UF 5%, 100 V; MFR 72136, TYPE 1DP-1-153J
899509	MOTOR, DC: 27V, 1.2 AMP, 9800 RPM; MFR 05624 NO. BYLM 92902-12
899548	CAPACITOR, FIXED: MICA; 600UUF 5%, 300 VDCW; MFR 00853
899554	MOTOR ASSY: 27 VDC, 1.2 AMP, 9800 RPM; MFR 53021
899957	CAPACITOR, FIXED: MICA; 150UUF 5%, 500 VDCW; MFR 53021

LIST OF MANUFACTURERS

00779	AMP INC	HARRISBURG, PA
00853	SANGAMO ELECTRIC CO., (CAP. DIV.)	PICKENS, SC
01121	ALLEN BRADLEY CO	MILWAUKEE, WI
01295	TEXAS INSTRUMENTS INC	DALLAS, TX
01766	INTERNATIONAL CRYSTAL MFG CO INC	OKLAHOMA CITY, OK
02567	INTERNATIONAL ELECTRONIC INDUSTRIES INC	NASHVILLE, TN
02660	AMPHENOL CORP	BROADVIEW, IL
02735	RCA CORP	SOMERVILLE, NJ
02929	NEWARK ELECTRONICS CORP	CHICAGO, IL
04009	ARROW-HART AND HEGEMAN ELECTRIC CO	HARTFORD, CT
04191	PHOTOCIRCUITS CORP	GLEN COVE, NY
04221	AEMCO DIV OF MIDTEX INC	MANKATO, MN
04713	MOTOROLA SEMICONDUCTOR PRODUCTS INC	PHOENIX, AZ
05276	POMONA ELECTRONICS CO INC	POMONA, CA
05277	WESTINGHOUSE ELECTRIC CORP	YOUNGWOOD, PA
05397	UNION CARBIDE CORP ELECTRONICS DIV	NEW YORK, NY
05574	VIKING INDUSTRIES INC	CHATSWORTH, CA
05624	BARBER & COLMAN CO	ROCKFORD, IL
06668	TEXAS INSTRUMENTS INC	HOUSTON, TX
06776	ROBINSON NUGENT INC	NEW ALBANY, IN
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP	MOUNTAIN VIEW, CA
07716	IRC DIVISION OF TAW INC	BURLINGTON, IA
07999	AMPHENOL CORP	DELAVAN, WI
08806	GENERAL ELECTRIC CO	CLEVELAND, OH
09022	CORNELL-DUBILIER ELEC CORP	PROVIDENCE, RI
09023	CORNELL-DUBILIER ELECTRIC CORP	SANFORD, NC
09353	C AND K COMPONENTS INC	NEWTON, MA
11384	INLAND MOTOR CORP	ROCKFORD, VA
11502	IRC DIVISION OF TRW INC	BOONE, NC
12954	DICKSON ELECTRONICS CORP	SCOTTSDALE, AZ
13511	BUNKERRAMO CORP	LOS GATOS, CA
15449	ACCURATE DIAL & NAMEPLATE INC	GLENDALE, CA
16858	SEQUENTIAL ELECTRONIC SYSTEMS INC	ELMSFORD, NY
18583	CURTIS INSTRUMENTS INC	MT. KISCO, NY
18911	DURANT MFG CO	MILWAUKEE, WI
19701	ELECTRA/MIDLAND CORP	MINERAL WELLS, TX
[illegible]932	ELECTRO MATERIALS INC	SAN DIEGO, CA
[illegible]370	SOLAR SYSTEMS INC	SKOKIE, IL
21520	FANSTEEL METALLURGICAL CORP	CHICAGO, IL
22711	TELEX-ACOUSTIC PRODUCTS DIV TELEX CORP	MINNEAPOLIS, MN
22753	UID ELECTRONICS CORP	HOLLYWOOD, FL
23383	DYNAMICS RESEARCH CORP	STONEHAM, MA
24123	GAST MFG CORP	BENTON HARBOR, MI
26549	G J M INC	GLENDALE, CA
28480	HEWLETT-PACKARD CO	PALO ALTO, CA
29238	HART-ADVANCE RELAY DIV	ELKHORN, WI
30892	HECON CORP	NEW SHREWSBURY, NJ
33203	ENM CO	CHICAGO, IL
44655	OHMITE MFG CO	SKOKIE, IL
53021	SANGAMO ELECTRIC CO	SPRINGFIELD, IL
55026	SIMPSON ELECTRIC CO	CHICAGO, IL
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MA
61349	AMETEK INC/U.S. GUAGE DIV	SELLERSBURG, PA
62119	UNIVERSAL ELECTRIC CO	OWOSSO, MI
63743	WARD LEONARD ELECTRIC CO	MOUNT VERNON, NY
71279	CAMBRIDGE THERMIONIC CORP	CAMBRIDGE, MA
71400	BUSSMANN MFG DIV OF MCGRAW & EDISON CO	ST. LOUIS, MO
71468	ITT CANNON ELECTRIC INC	LOS ANGELES, CA
71482	CLARE CP AND CB	CHICAGO, IL
71590	GLOBE-UNION INC CENTRALAB DIV	MILWAUKEE, WI
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO, IL
71785	CINCH MFG CO & HOWARD B JONES DIV	CHICAGO, IL
72136	ELECTRO MOTIVE MFG CO., INC	WILLIMANTIC, CT
72259	NYTRONICS INC	BERKELEY HEIGHTS, NJ
72619	DIALIGHT CORP	BROOKLYN, NY

72982	ERIE TECHNOLOGICAL PRODUCTS, INC	ERIE, PA
73138	BECKMAN INSTRUMENTS INC	FULLERTON, CA
73293	HUGHES AIRCRAFT CO	TORRANCE, CA
73949	GUARDIAN ELECTRIC MFG CO	CHICAGO, IL
74199	QUAM-NICHOLS CO	CHICAGO, IL
74384	TURNER CO INC	CEDAR RAPIDS, IA
74545	HUBBELL HARVEY INC	BRIDGEPORT, CT
74868	AMPHENOL CORP RF DIV	DANBURY, CT
75042	IRC DIV OF TRW INC	PHILADELPHIA, PA
75378	CTS KNIGHTS INC	SANDWICH, IL
75382	KULKA ELECTRIC CORP	MT VERNON, NY
75915	LITTELFUSE INC	DES PLAINES, IL
76854	OAK MFG CO	CRYSTAL LAKE, IL
77342	AMERICAN MACHINE & FOUNDRY CO	PRINCETON, IN
79727	CONTINENTAL-WIRT ELECTRONICS CORP	PHILADELPHIA, PA
80183	SPRAGUE PRODUCTS CO	NORTH ADAMS, MA
80294	BOURNS INC	RIVERSIDE, CA
81073	GRAYHILL INC	LA GRANGE, IL
81312	WINCHESTER ELECTRONICS INC	OAKVILLE, CT
81774	CAROL WIRE AND CABLE CORP	PAWTUCKET, NJ
82076	CAROL ELCTRONICS INC	MARTINSBURG, WV
82389	SWITCHCRAFT INC	CHICAGO, IL
82647	TEXAS INSTRUMENT INC	ATTLEBORO, MA
82877	ROTRON INC	WOODSTOCK, NY
84171	ARCO ELECTRONICS INC	GREAT NECK, NY
86197	LITTON PRECISION PROD INC	CLIFTON HEIGHTS, PA
86684	RCA CORP ELECTRONIC COMPONENTS	HARRISON, NJ
88140	CUTLERHAMMER INC	LINCOLN, IL
89597	FREDERICKS CO	HUNTINGDON VALLEY, PA
90201	MALLORY CAPACITOR CO	INDIANAPOLIS, IN
91506	AUGAT INC	ATTLEBORO, MA
91637	DALE ELECTRONICS INC	COLUMBUS, NB
91662	ELCO CORP	WILLOW GROVE, PA
91929	HONEYWELL INC	FREEPORT, IL
93790	CORNELLDUBILIER ELECTRONICS	NEW BEDFORD, MA
94696	MAGNECRAFT ELECTRIC CO	CHICAGO, IL
94707	STORY MARINE RAILWAY	PORTLAND, ME
95238	CONTINENTAL CONNECTOR CORP	WOODSIDE, NY
95263	LEECRAFT MFG CO INC	LONG ISLAND, NY
96487	VALCOR ENGINEERING CORP	KEAILWORTH, NJ
96733	SAN FERNANDO ELEC MFG CO	SAN FERNANDO, CA
96791	BUNKERRAMO CORP	JANESVILLE, WI
97954	U S COMPONENTS INC	BRONX, NY
98291	SEALECTRO CORP	MAMARONECK, NY
99779	BARNES CORP	LANSDOWNE, PA
99942	GLOBEUNION INC	EL MONTE, CA