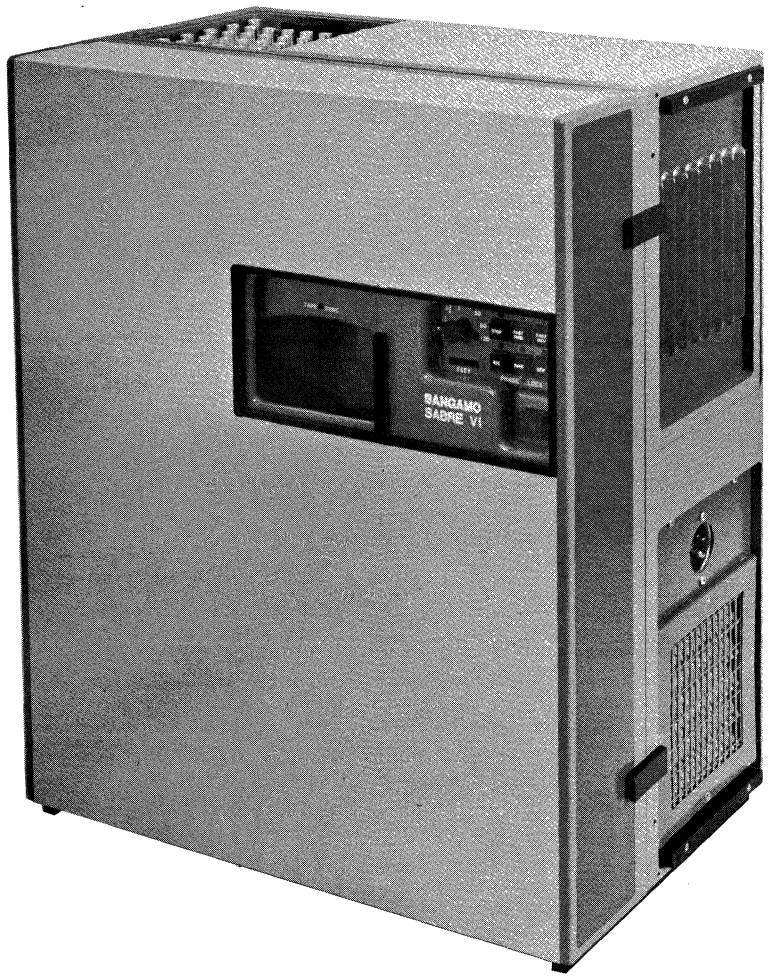
TECHNICAL MANUAL

for

SABRE VI

PORTABLE RECORDER/REPRODUCER



MODELS 631, 632, 633 & 634

SANGAMO WESTON, INC.
P. O. Box 3347
Springfield, Illinois 62714

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SECTION 1
GENERAL INFORMATION

A. SCOPE OF MANUAL

This manual contains information necessary for installation, operation, maintenance and repair of the Sangamo SABRE VI Recorder/Reproducer. Models described herein include 631 (intermediate band, 1/2 inch head), 632 (intermediate band, 1 inch head), 633 (wide band, 1/2 inch head), and 634 (wide band 1 inch head). These models are all housed in the large enclosure. Other models are housed in a smaller enclosure and are described in separate technical manuals.

This technical manual is divided into fifteen (15) sections, with each section containing the following information.

Section 1. GENERAL INFORMATION – Introduces, illustrates, and describes the over-all functions of the large enclosure SABRE VI unit.

Section 2. INSTALLATION – Provides information for unpacking, lite-off, cable connections, power requirements, and a brief inspection. This section also includes mounting and outline dimensions.

Section 3. OPERATION – Describes the procedures for operating the recorder/reproducer. A description of all the controls and indicators, instructions for application of power, tape threading, and instructions for recording and reproducing data is included.

Section 4. PREVENTIVE/MAINTENANCE – Recommends the preventive maintenance procedures needed to care for the tape path, the record/ reproduce heads, and other areas of the unit.

Section 5. THEORY OF OPERATION – Explains the basic concept of theory for each functional area of the recorder/ reproducer.

Section 6. SYSTEM CHECKOUT AND CALIBRATION – Outlines the complete calibration procedures of the SABRE VI to ensure optimum performance of the unit.

Section 7. TAPE TRANSPORT MECHANICS – Describes the removal and replacement of certain electrical, mechanical and electromechanical parts on the tape transport.

Section 8 through Section 14 – Each section describes a function in detail for troubleshooting purposes as well as providing schematics, parts location, parts (numbering) list and test data.

Section 15. MASTER PARTS LIST – Describes the parts used in sections 7 through 14 and the manufacture of these parts. The parts are listed in numerical sequence by Sangamo part number.

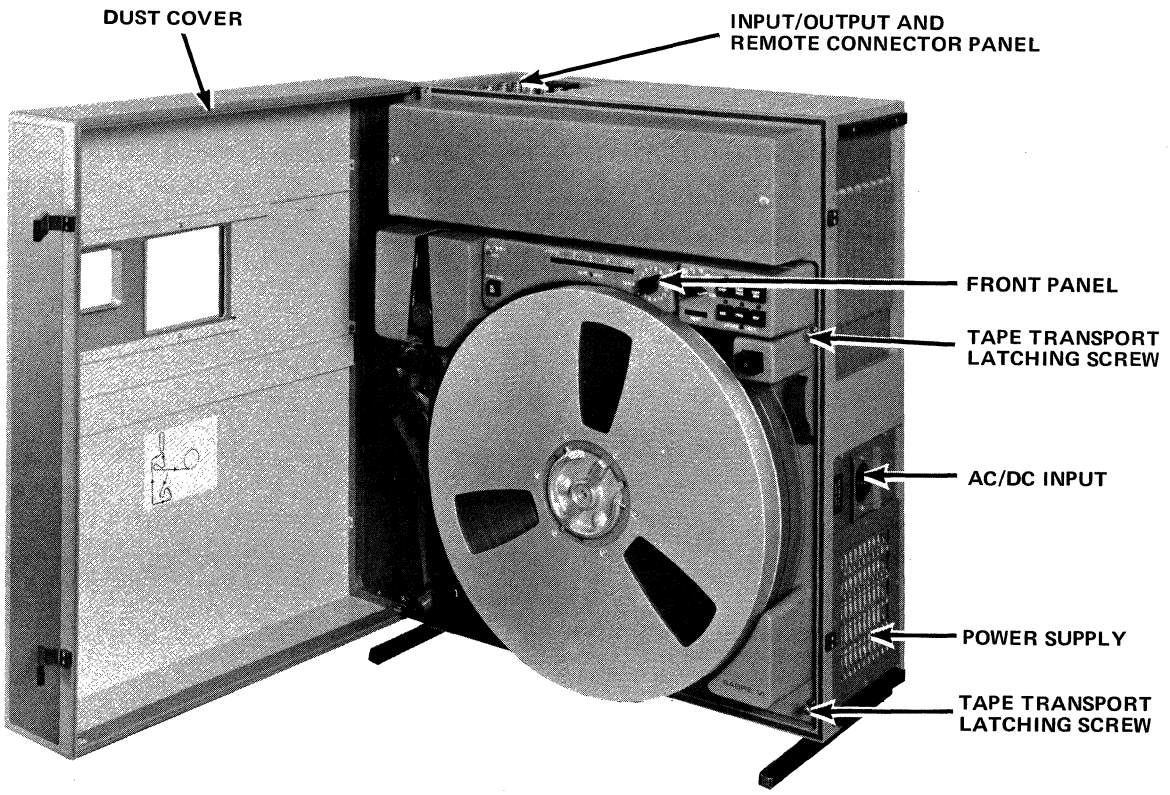


Figure 1-1. Front View, Dust Cover Open

B. EQUIPMENT DESCRIPTION

The Sangamo SABRE VI instrumentation recorder/reproducer is a 7 track (1/2") or 14 track (1") intermediate or wide band portable unit. The unit features a bi-planar reel drive transport capable of bi-directional operation with 14-inch diameter reel capacity. Eight tape speeds consisting of 15/16, 1-7/8, 3-3/4, 7-1/2, 15, 30, 60, and 120 inches per second are available in the record mode, with any three (determined by equalizers installed) electrically switchable during reproduce.

All electronics of the SABRE VI are solid state, with the exception of three relays (plus one in the power supply) used primarily to switch the heavier load currents. An infrared pulsating detecting circuit (to sense an approaching end-of-tape condition) and a LED footage counter are featured on the unit. The complete unit (without reels) weighs approximately 85 pounds, including a self-contained power supply.

The electronics of the unit are accessible from the front by opening the dust cover and the tape transport. The unit is operational in this fashion while making the electronics and certain mechanical components accessible for maintenance and/or calibration. Access to power supplies is gained from the side of the unit.

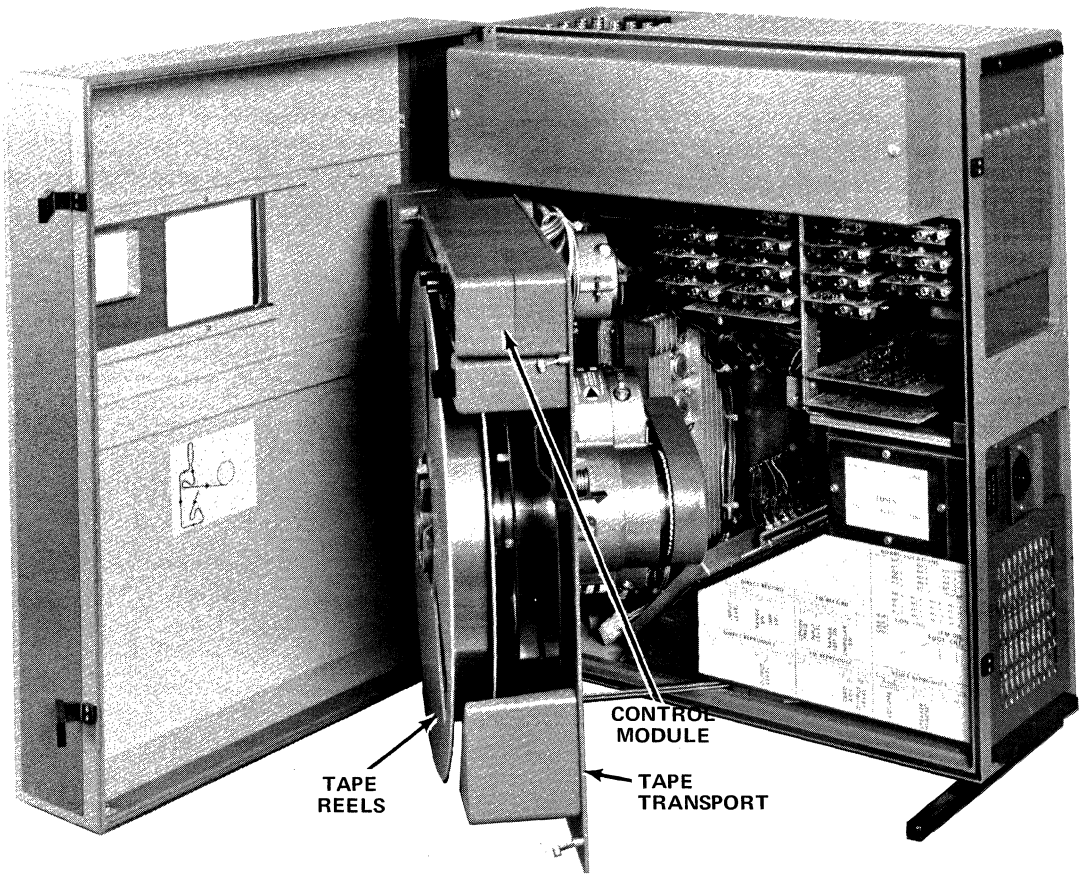


Figure 1-2. Front View, Tape Transport Open

1. TAPE TRANSPORT

Tape handling is controlled by the components on the tape transport. The transport employs two major features; (1) a closed loop metering system to isolate disturbances from the head area, and (2) independent reel drive servos, to maintain constant tape tension during operation.

The accuracy in which data stored on magnetic tape can be reproduced is largely dependent upon the relationship of the reproduce speed to the record speed. Tape speed errors may be grouped into two general categories - real and apparent. Real errors are differences in tape speed caused by shock, vibration, and the difference in speed between any two recorders, even though both transports are within their individual tolerances. Apparent errors are caused by changes in tape dimension due to temperature, humidity, or careless handling. Tape speed accuracy of the recorder is controlled to within ±0.1% of nominal at all speeds by the use of a low mass capstan drive system, coupled with a quick response speed control servo. The components in the tape path are positioned to achieve a very low level of flutter. An inertia damping roller performs the function in tape travel. A special surface on the capstan reduces tape-to-capstan velocity to virtually zero.

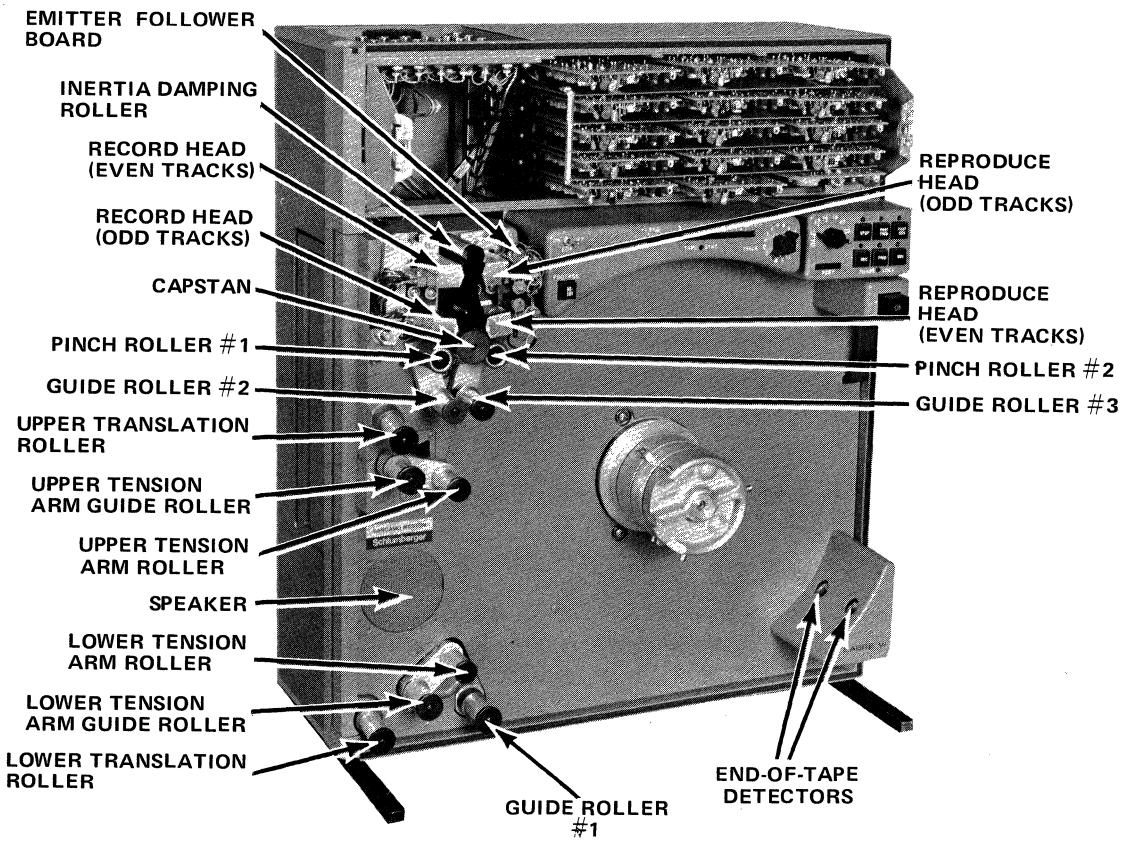


Figure 1-3. Tape Path Component Location

2. SPEED CONTROL

The speed control circuits precisely control the rotational speed of the capstan. The servo-regulated capstan is controlled by an error signal generated from a photo-etched tachometer disc mounted at the opposite end of the motor shaft from the capstan. This disc modulates a light source, producing a signal with a frequency proportional to the rotational speed of the capstan. The signal is compared against a stable crystal oscillator with the differential between the two frequencies determining the increase or decrease of the capstan speed as required. This method of speed control is referred to as CAPSTAN SYNCHRONOUS. For applications in which the speed of the recording may be expected to vary or for any application requiring maximum data accuracy, a TAPE-SYNCHRONOUS method (optional) of servo speed control will further increase tape speed accuracy and assure faithful playback. During the use of tape-synchronous, a reference frequency is recorded on the tape during the record mode. When reproduced, the tachometer signal, which is always available, is electronically switched out of the circuit to allow for phase and frequency comparisons between the crystal oscillator and the reproduced tape signal. Any phase discrepancy represents the servo error signal which is transmitted to the capstan motor to demand an increase or decrease in capstan speed. Thus the reproduce speed is corrected to equal the record speed. Should there be a dropout or loss of tape synchronous during replay, the system automatically reverts to capstan synchronous for speed control.

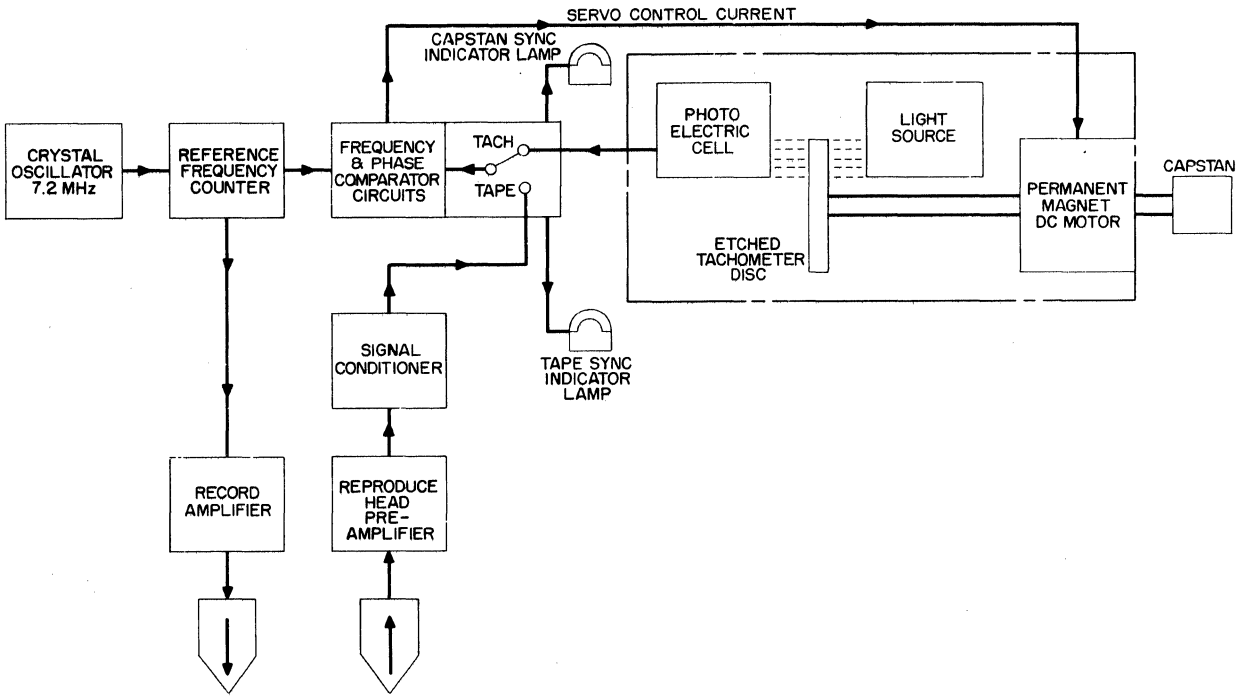


Figure 1-4. Speed Control, Block Diagram

3. REEL DRIVES

Independent reel drive servos control the torque of each reel drive to maintain a precise amount of tension on the tape during all modes of operation. A light sensor on each reel drive, coupled with a tension arm positioned by the pull of the tape, provides feedback to an amplifier for controlling the reel drive motor torque. Each reel is continually monitored by an infrared pulsating end-of-tape (EOT) circuit to detect when a reel is approaching the end-of-tape. Just before the tape reaches the end, the EOT circuits instruct the system to stop.

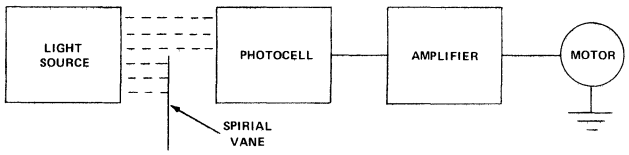


Figure 1-5. Reel Drive, Block Diagram

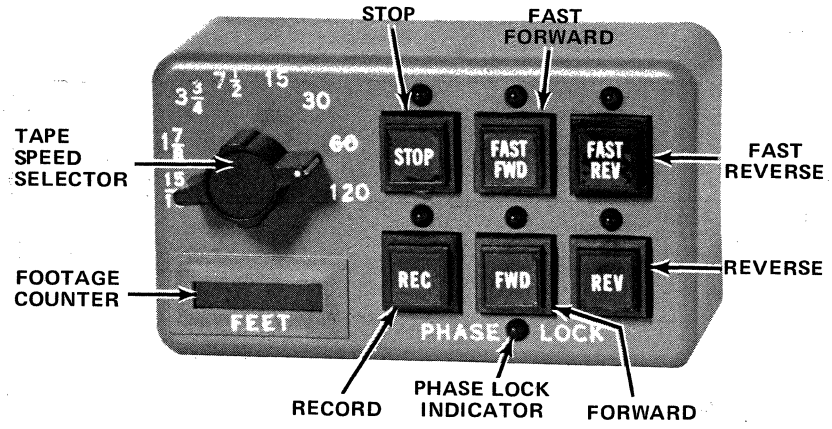


Figure 1-6. Control Module

4. MODE CONTROL CIRCUITS

The mode control circuits command the various functions of the unit. All modes are controlled by means of six fingertip pushbuttons (See Figure 1-6). The modes of operation are divided into; FORWARD RECORD, REVERSE RECORD, FORWARD (reproduce), REVERSE (reproduce), FAST FORWARD, FAST REVERSE, and STOP.

Selection of modes may be performed in any sequence and at any time without concern for damage to the unit. When a mode is selected from any other mode, the logic circuits orderly control the change from one to the other.

The RECORD pushbutton may be depressed during the STOP mode to activate the record electronics without moving tape. This feature allows the operator the option of performing calibration procedures without recording on tape. Because all pushbuttons are electrically interlocked, depressing any other pushbutton automatically disables the RECORD function, thus eliminating the possibility of accidental erasure of tape.

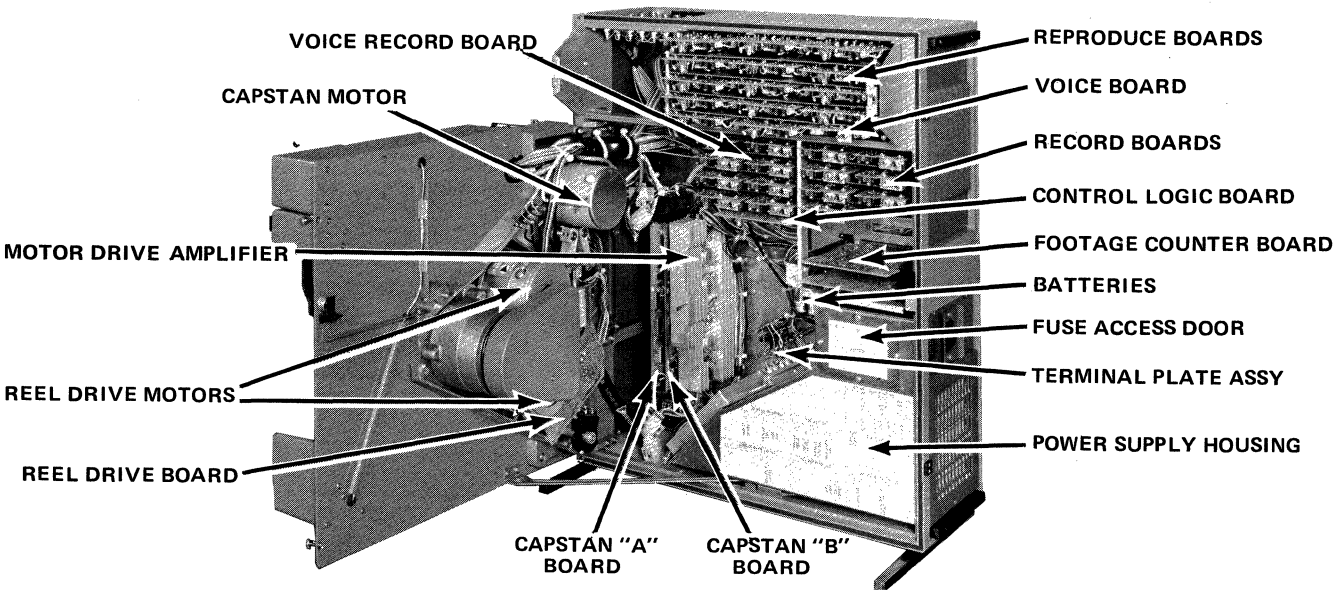


Figure 1-7. Assembly Location Inside

5. RECORD CIRCUITS

Signal inputs to the record circuits are applied through the connector panel and routed to the input of either a direct or FM record channel. Both direct and FM record electronics are electrically switchable through all eight tape speeds.

Each direct record amplifier accepts the input through a two position range switch, with the input voltage ranging from 100 millivolts to 1 volt or 1 volt to 10 volts. A second switch controls the selection of a 10K or 75 ohm input impedance. Data signals from the input are amplified, added with bias, applied through a head driver and recorded on tape. Gain controls for bias and data signals adjust for correct record current through the head.

Each FM record modulator accepts the same amplitude inputs as that of a direct record amplifier. An input level control adjusts the input signal to the proper amplitude for processing. The input signals are amplified and directed to a VCO to create the basic FM signal. The FM signal passes through a countdown chain with each countdown being applied to a data selector gate. Speed select lines from the tape speed selector select the correct gate to allow the proper frequency to pass. The signal is then applied through a head driver and recorded on tape. Both normal and uni-polar modulation is selectable on the board.

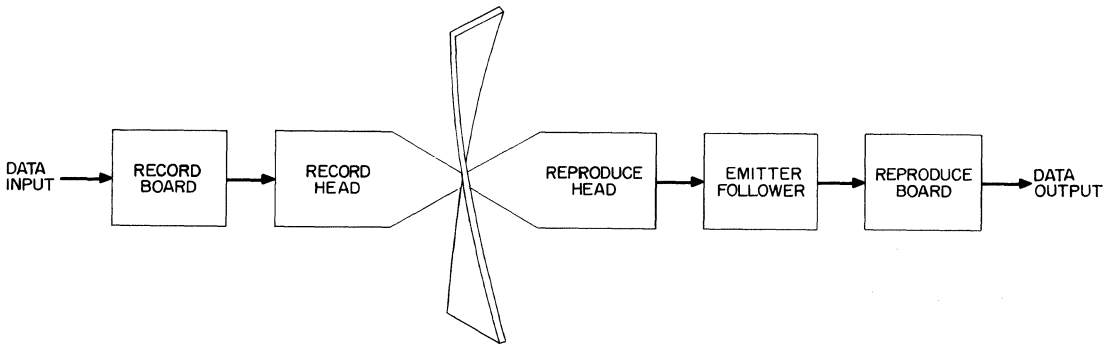


Figure 1-8. Record/Reproduce, Block Diagram

6. REPRODUCE CIRCUITS

The data signal recorded on the tape is recovered by the reproduce heads and applied through emitter followers to the inputs of the respective direct or FM reproduce boards for processing.

Each direct reproduce amplifier board has capacity for three plug-in equalizers to allow for any three reproduce tape speeds. The signals from the input are amplified, filtered, and applied through the selected equalizer which is automatically programmed by the tape speed of the unit. The amplitude and phase response of the equalizer is the inverse of that of the reproduce head, thus re-creating the original signal. The output signal of the equalizer is amplified and routed to a connector on the connector panel.

Each FM reproduce board functions as a demodulator with amplification and output stages. The demodulator contains circuitry for three plug-in active filters with selectable flat amplitude or linear phase response making it operational through any three selected speeds.

The input signal is amplified and applied through the equalizer that is selected by the tape speed selector. The equalized signal is squared and conditioned before being applied to one of three filters. The filter removes the carrier from the original signal to complete the demodulation process. The signal is then amplified and routed to a connector on the I/O Connector Panel.

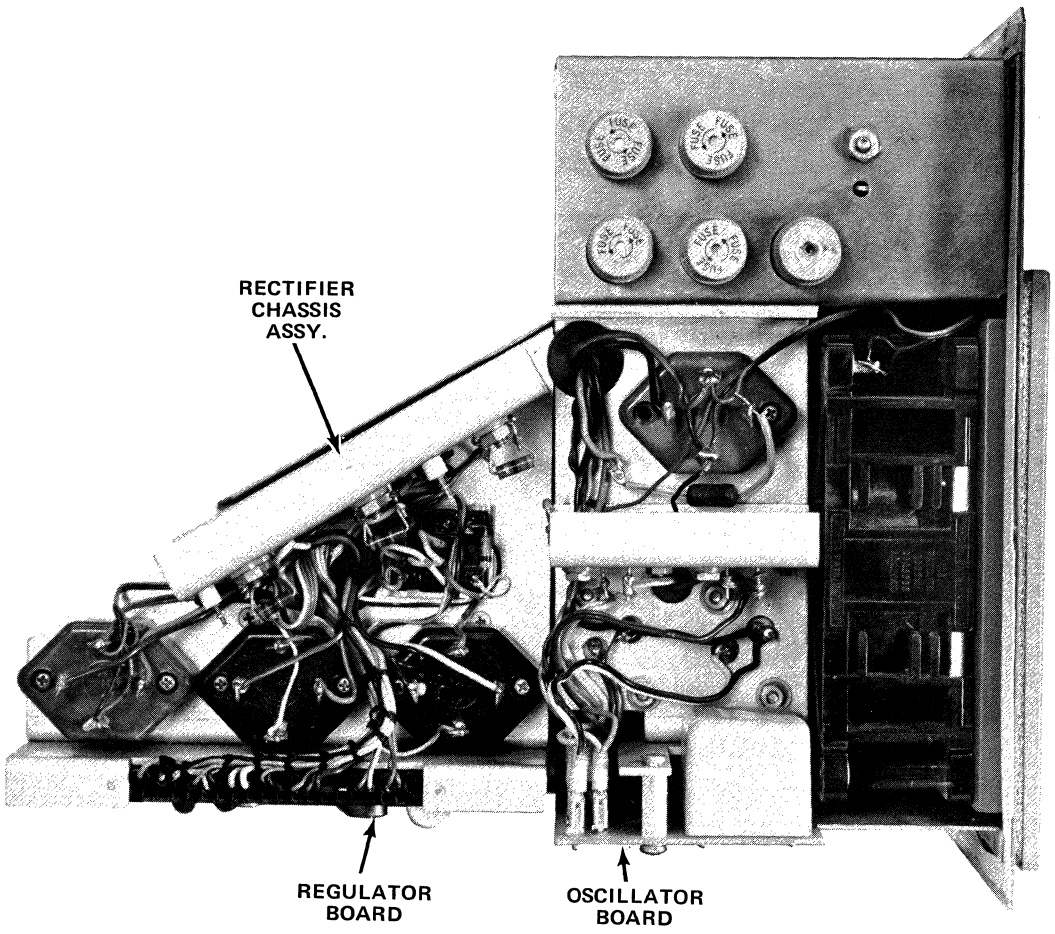


Figure 1-9. Power Supply, Removed from Unit

7. POWER SUPPLIES

Four separate power supplies are available to power the SABRE VI. Only one of the four is installed in the system and is chosen at the time of purchase. The four supplies are; (a) 234 vac, (b) 117 vac, (c) 26 vdc, or (d) 12 vdc. This allows the SABRE VI to use vehicular, shipboard, aircraft, or laboratory power. The power supply is located at the side of the unit and may be removed by removing the mounting screws and unplugging the assembly.

8. OPTIONS

A number of options are available for the SABRE VI and are listed briefly below.

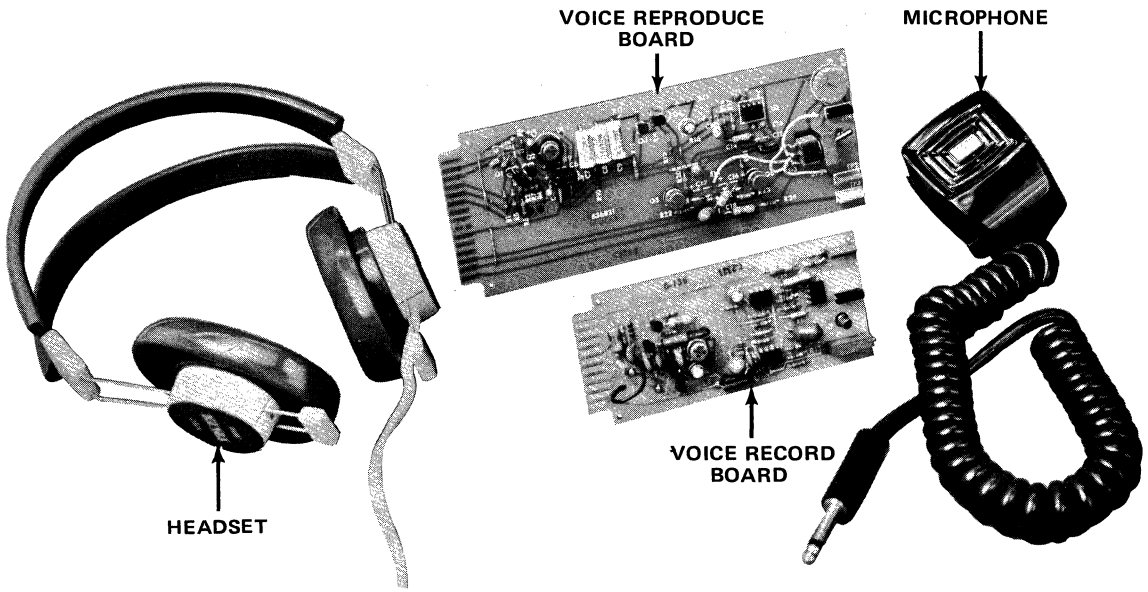


Figure 1-10. Voice/Timing Kit

a. **VOICE/TIMING** — Edge track voice or timing channel electronics eliminates the necessity to waste a data channel for voice documentation. Normal edge track widths are too narrow for reliable operation and many magnetic tape systems do not have edge tracks on both the record and reproduce heads. The SABRE VI utilizes increased edge track widths on both record and reproduce head stacks for reliable operation, with the voice always time correlated to the data channels. The voice option includes a rugged microphone for excellent recording efficiency, a headset for private listening, a voice record board, a reproduce board, and a speaker to allow freedom to move about or for conference listening. A slightly different record and reproduce board is used for time recording.

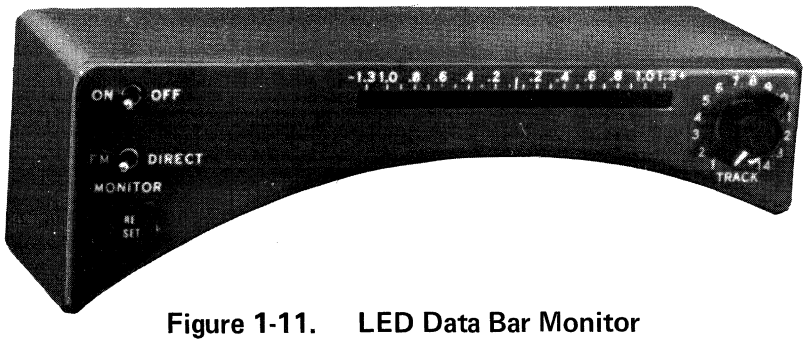


Figure 1-11. LED Data Bar Monitor

b. **LED DATA BAR MONITOR** — Verifies the FM, Direct and Voice input record and reproduce levels, thus eliminating the need for peripheral test/ monitor equipment.

c. **TAPE SYNCHRONOUS SERVO** — Adds additional tape speed accuracy to the speed control servo by increasing the reproduce long term speed stability.

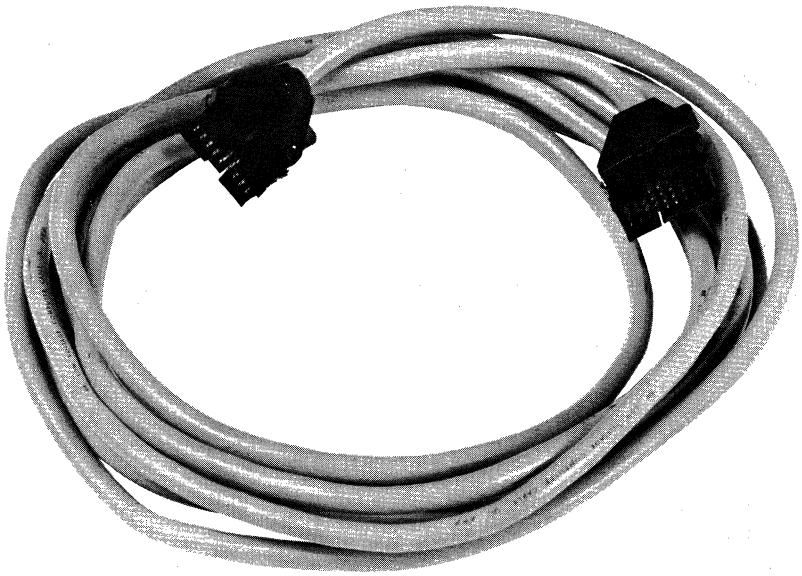


Figure 1-12. Umbilical Cord (Remote Control)

d. **UMBILICAL CORD** – Allows removal of the control module from the unit for use as a hand-held remote control (standard length 25 feet). The umbilical cord is connected to a jack located on the I/O Connector Panel.

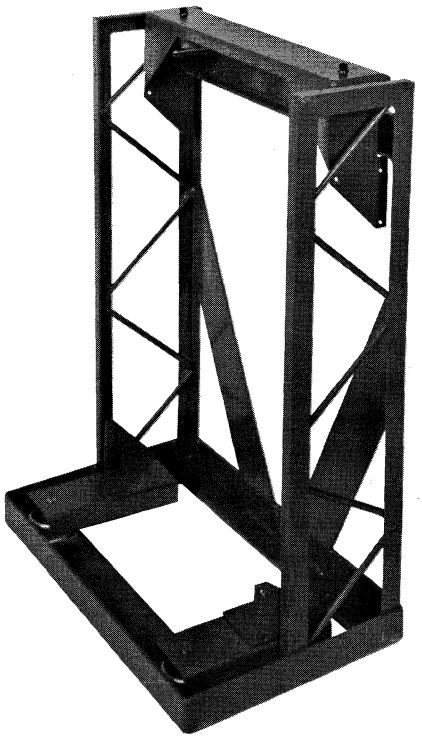


Figure 1-13. Vibration/Isolation Mounting Kit

e. **VIBRATION/ISOLATION MOUNT KIT** – Permits operation in vibratory environments such as vehicular, aircraft, or ship as per MIL-167B.

SECTION 2
INSTALLATION

A. LITE-OFF PROCEDURES

Upon arrival of a unit to the customer's facility, Sangamo should be notified for lite-off (start-up) arrangements. This service is available and is performed by an authorized Sangamo service engineering representative to ensure the system was not affected by shipment and that all contract requirements have been met. The representative will also familiarize the customer with the equipment and the instruction manual. For any unit delivered in the United States call (217) 544-6411, Extension 507 or contact by separate means:

Sangamo Weston, Inc.
P.O. Box 3347
Springfield, Illinois 62714

B. UNPACKING AND HANDLING

Normal precautions for unpacking delicate electromechanical equipment should be observed. The equipment should not be abused while unpacking and handling. Failure to observe this caution may disturb critical adjustments or alignments performed at the factory.

The SABRE VI is shipped in a wooden crate or cardboard carton. To remove, open the side marked OPEN THIS SIDE and slide out the unit. Inspect the unit carefully for any shipping damage. If damage is determined, notify the carrier immediately.

C. CUSTOMER SERVICE

The SABRE VI is an electronically operated precision instrument. The unit is installed and operated according to instructions, it will prove to be a dependable instrument capable of providing many operating benefits.

The SABRE VI is guaranteed as per warranty. If warranty service is required, Sangamo Electric should be contacted immediately for replacement and/or repair.

If re-shipment is to be made to Sangamo, prior arrangements must be made by contacting your nearest Sangamo representative. If re-shipment becomes necessary, it is suggested that the original carton be used.

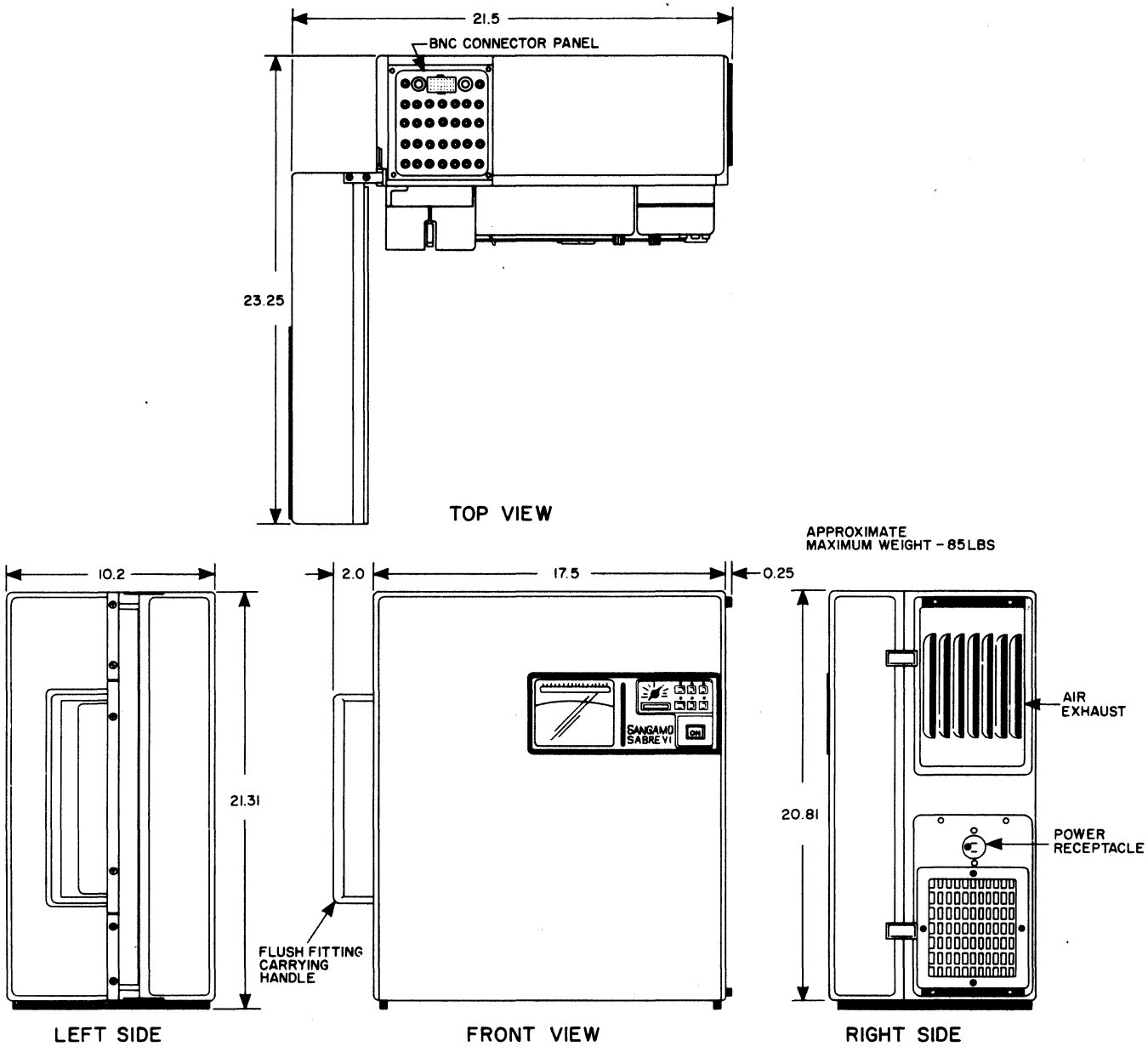


Figure 2-1. Overall Dimensions, 630 Series Enclosure (804855)

If at any time a defective printed circuit board develops, it is recommended that the faulty card be returned to Sangamo Electric Company, Springfield, Illinois, for repair or replacement.

We recommend that advantage be taken of Sangamo's "service Contract" available on this unit. For complete details, contact the Sangamo Electric Field Service Department, P.O. Box 3347, Springfield, Illinois 62714.

D. SITE SELECTION

Overall dimensions of the SABRE VI are shown in Figure 2-1. When choosing a location for installation, choose one with enough space to allow adequate clearance for the dust cover and transport door to open. Adequate space for routing the input and output cables must be provided. Ensure the air vent openings are not obstructed so that proper air flow can be maintained. Also, the unit should not be subjected to exceptionally strong magnetic fields, damaging vibrations, dirt or debris.

E. INSTALLATION REQUIREMENTS

The SABRE VI is ready to install when received. The unit has been completely inspected, calibrated, and checked out before leaving the factory.

F. POWER REQUIREMENTS

The SABRE VI may be equipped with one of four power supplies. The power supplies that the SABRE VI may be operated from are (1) 234 vac, (2) 117 vac, (3) 26 vdc, or (4) 12 vdc. To determine the power supply requirements, read the rating stated on the tag near the power receptacle. All that is required in connecting the unit to its respective power source is the plugging of the power cord into the receptacle on the side of the unit and the other end into the appropriate outlet. The source end of all power cords except the 117 vac version must be properly terminated at the time of the installation.

G. RECORD CHANNELS CABLE CONNECTIONS

The data signals to be recorded are connected through standard BNC connectors on the I/O Connector Panel located on top (back if rack mounted) of the unit. Input cables are connected to the group of input signal connectors. Each individual cable is connected to the desired channel. Each channel number is indicated next to each input (See Figure 2-2).

If the recorder/reproducer is equipped with the optional Tape Synchronous features, a jumper cable (BNC to BNC) should be placed between the REF OUT jack and the desired channel on which it is to be recorded. The track chosen should be an even numbered track and ideally one close to the center of the head (track 6 or 8). If this jumper is not connected, the reference signal from the speed

control circuits will not be recorded and the standard capstan synchronous means will control tape speed when the tape is reproduced. For more detail explanation of tape synchronous, see Speed Control Circuits.

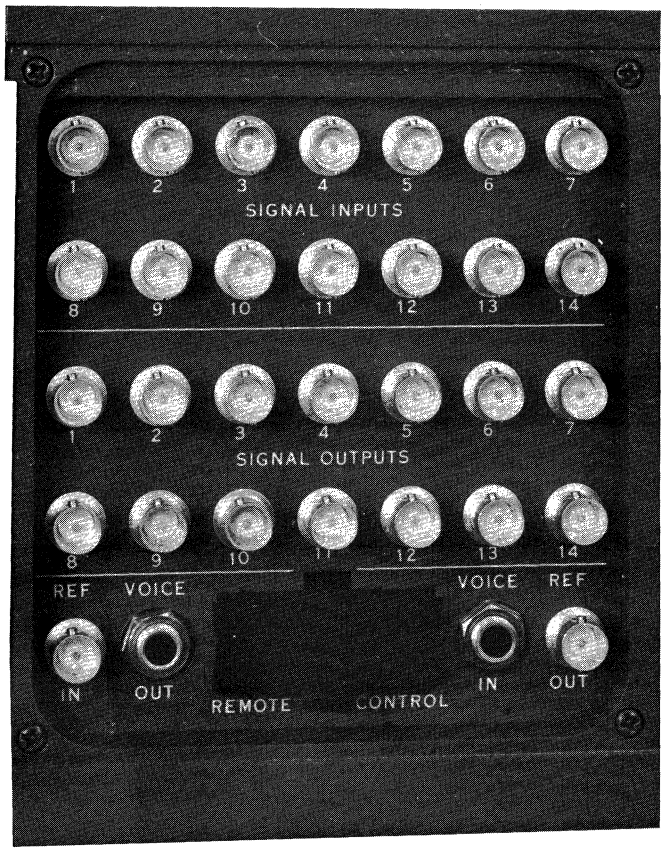


Figure 2-2. I/O Connector Panel

H. REPRODUCE CHANNELS CABLE CONNECTIONS

The reproduced signals from the unit are present on I/O Connector Panel at the OUTPUT SIGNALS connectors (See Figure 2-2). The numbers next to each output connector indicates the channel number of the reproduced data signal. Cables are connected to these outputs through the BNC connectors. If the reference signal was recorded for use with the optional Tape Synchronous feature, then a jumper cable (BNC to BNC) must be connected between the channel output (same as selected during recording) and the REF IN (See Figure 2-2). A tape sync preamp board must be placed in the reproduce slot for the channel selected in lieu of the standard reproduce board.

I. OPTIONAL ITEM CONNECTIONS

1. TAPE SYNCHRONOUS

The tape sync (synchronous) feature is added to the unit as an option. Adding tape sync adds greater tape speed accuracy to the speed control servo during the reproduce mode. This is accomplished by recording an oscillator reference frequency and using this recorded reference to control the capstan speed during playback in lieu of the frequency generated by the capstan.

To use this feature, a tape sync board is mounted on the Capstan A board and a record channel is chosen for recording the reference signal. The reference signal is present at the REF OUT jack on the I/O Connector Panel and is jumped by means of a jumper to the input of one of the record channels. During playback, the output of the chosen reference track must be jumped to the REF IN jack. This jack connects the reproduced reference to the input of a tape sync preamp board with the output being applied to the speed control circuits. Proper connections for these two jumpers are described in the above two paragraphs.

2. REMOTE CONTROL

Remote control is an optional means of controlling the operation of the SABRE VI away from the unit. With the use of an umbilical cord, the control module may be removed from the unit to allow a remote location for the module.

The control module is removed from the unit by opening the transport door and locating the two holes in the cover plate. By inserting a screw driver through these holes and loosening the screws, the control module will unplug from its mating jack. The umbilical cord may be plugged onto the module and the other end may be connected to the jack located on the I/O Connector Panel marked REMOTE CONTROL (See Figure 2-2).

3. VOICE/TIMING

The edge track voice or timing channel electronics eliminates the need of using one of the data tracks for recording this information. If the recorder/reproducer is equipped with this option, all that is required for operation is to plug the microphone into the VOICE IN jack and the earphones into the VOICE OUT jack. Both jacks are located on the I/O Connector Panel (See Figure 2-2). The speaker on all reproduce units may be used in lieu of the earphones for listening.

J. GENERAL INSPECTION

After all connections have been made and before operating the unit, make a final inspection for possible damage in shipping. Check the dust cover for dents or cracks in the glass. Check the cabinet for dents or scratches. See that the tension arms are free. If any damage is found, report it immediately to Sangamo Weston, Inc.

K. INSTALLATION SUMMARY

Upon completion of the inspection procedures, the user is strongly urged to throughly familiarize himself with the equipment. Before operating, carefully read the Operater's Section. It will also prove to be very helpful to study the Theory of Operation Section as soon as possible. Doing so will allow you to use the SABRE VI to its fullest capacity and answer many questions on the operation of the system.

SECTION 3
OPERATION

A. OVERVIEW OF OPERATING PROCEDURES

The SABRE VI recorder/reproducer has three basic modes; (1) recording, (2) reproducing, and (3) fast transfer. Each mode is divided into forward and reverse, making six tape moving modes of operation. The following paragraphs describe how to operate the recorder/reproducer in each of the six modes. The following paragraphs are outlined to illustrate the typical operating procedures of the recorder/reproducer. Variations to these procedures will be learned as experience is gained in the use of the unit.

B. PREPARATION FOR RECORDING

1. TAPE PREPARATION

Before a tape is threaded onto the recorder/reproducer, one of good quality and free from previous data should be selected. If a new tape is to be used, removing it from the carton and any existing wrappers is all that is required in preparation for tape threading. If a used tape is selected, it should be one of good quality, free from stretched edges or other signs of deterioration. Next, the reel of tape should be placed on a bulk eraser and thoroughly erased. When the erasing process is completed, the tape is ready for threading onto the recorder/reproducer.

2. TAPE THREADING

To thread the tape onto the SABRE VI, proceed as follows:

Step 1. Ensure the power is turned off.

NOTE

The tape may be threaded with the power on, provided that the operator does not lift the reel drive tension arms off their stops. By so doing, the reels will energize and jerk the tape out of the operator's hand.

Step 2. Turn the reel lock knob so as to align all the guide pins on the dual reel hub. This action will lock the two hubs together (See Figure 3-1).

Step 3. After aligning the slots on the full reel of tape with the guide pins on the hubs, slide the reel onto the inner hub. The tape should feed over the top of the reel and off the left side as the reel is rotated counterclockwise.

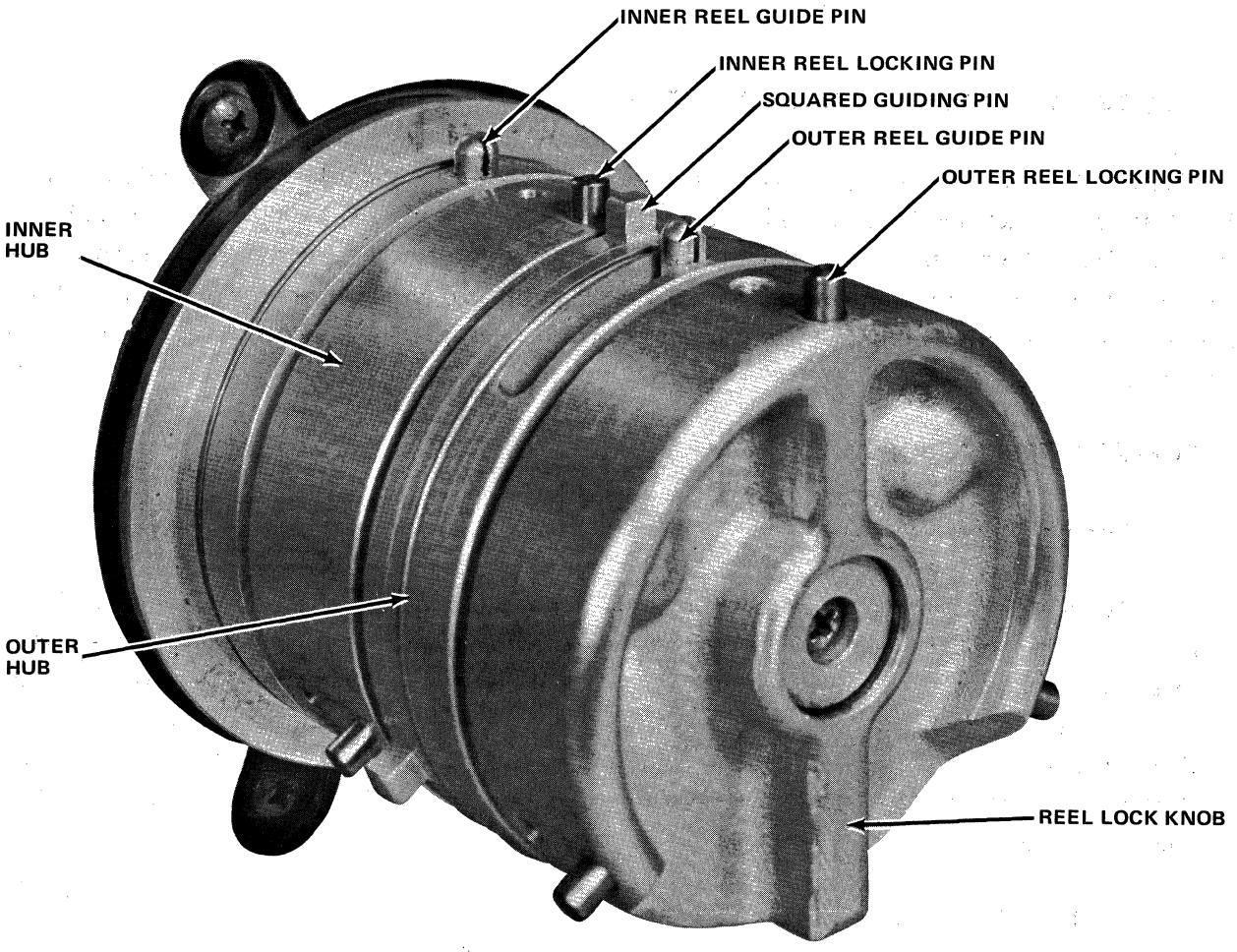


Figure 3-1. Dual Reel Hub (With Guide Pins Aligned)

Step 4. While holding the reel with one hand, turn the inner hub 20° clockwise until the inner locking pin locks the reel into position.

Step 5. Release the hubs from each other by rotating the squared guiding pin clockwise until the outer reel guide pin (the pin in the 1-1/4 inch slot) stops at the opposite end of slot.

Step 6. Place the empty reel onto the outer hub and lock it into place by holding the reels and turning the hub 20° clockwise until secured.

Step 7. Refer to the tape threading diagram in Figure 3-2 or the one located on the inside of the dust cover door. Thread the tape according to the diagram and in the sequence outlined in the following step. Also refer to Figure 1-3 for parts identification.

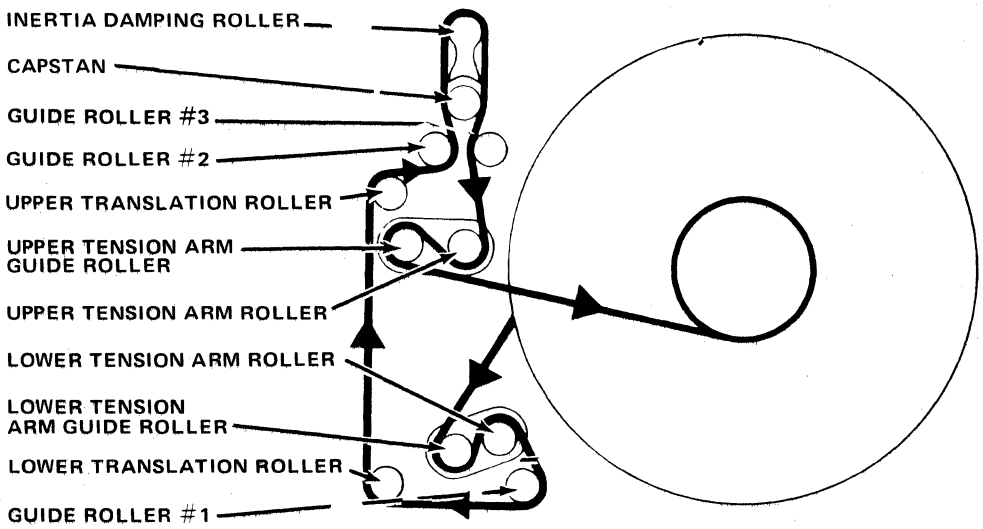


Figure 3-2. Tape Threading Diagram

Step 8. Reel off approximately 5 or 6 feet of tape from the back reel and thread through the tape path in the following fashion:

a. Counterclockwise around and under the Lower Tension Arm Guide Roller.

b. Over and down from the Lower Tension Arm Roller.

c. Around and to the left of the Guide Roller #1.

d. Under and up from the Lower Translation Roller.

e. Over and to the right of the Upper Translation Roller.

f. Under and up from the Guide Roller #2.

g. Between the Pinch Roller #1 and the Capstan.

h. Up past the record heads and over the Inertia Damping Roller.

i. Down past the Reproduce heads and between the Capstan and Pinch Roller #2.

j. Down past Guide Roller #3.

k. Under and to the left of the Upper Tension Arm Roller.

l. Over and around with a counterclockwise turn of the Upper Tension Arm Guide Roller.

m. Under and around the hub of the Take-up Reel.

Step 9. Rotate the Take-up Reel several turns to be certain the tape cannot slip as the reel is turned.

Step 10. Inspect the entire tape path to be certain the tape is correctly threaded.

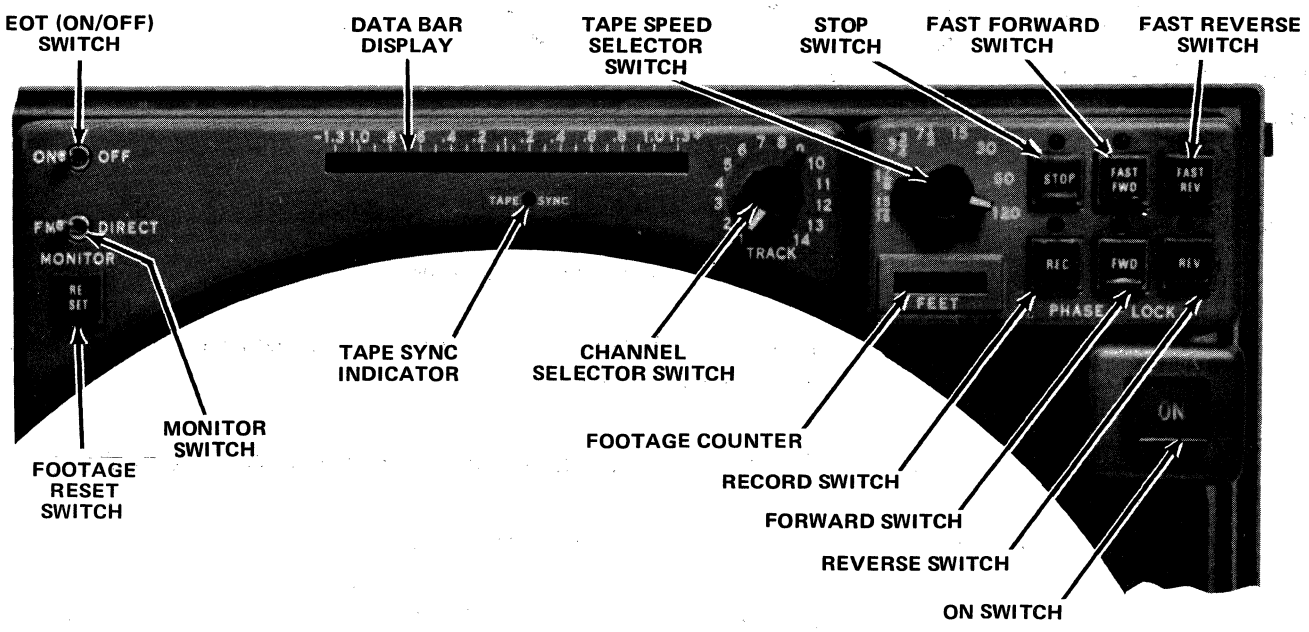


Figure 3-3. Switch and Pushbutton Location

3. APPLICATION OF POWER

After the tape is properly threaded, power to the system is ready to be applied. See Figure 3-3 for pushbutton location.

Step 1. Depress the ON switch (alternate action) located in the upper right corner of the unit. The pushbutton will indicate power and the power supply blower will start.

Step 2. If after the application of power the STOP indicator does not light, the probable cause is a loose tape condition with the reel drive arms resting against their stops. To correct this, simply depress the STOP pushbutton. This action applies power to the reel drive servos to cause the reels to turn until the tape tightens to lift the tension arms off their stops. If tape is extremely slack, it may be necessary to depress the STOP pushbutton several times.

4. SWITCH SETTINGS

All the switches and indicators should be observed at this point for proper positions. See Figure 3-3 for switch and pushbutton location.

Step 1. At the upper left hand side of the control panel, switch the EOT (ON/OFF) switch to the ON position. This activates the circuitry which detects the end-of-tape at each end of the reel and causes the system to stop before the reel is completely spent. It should be noted that with the EOT circuits active, tape can not be completely removed from either reel. Therefore, to do so, the EOT switch must be turned OFF, or can be overriden by holding down the particular button desired.

Step 2. Check the reading on the footage counter. If a zero reading is desired, depress the RESET pushbutton located under the EOT switch (or MONITOR switch if equipped with data bar monitor option).

Step 3. If the unit is equipped with the data bar monitor (optional), then place the MONITOR switch to either the DIRECT or FM position, depending upon the type of electronics the operator wishes to monitor. Also, place the channel selector switch, located to the right end of the data bar display, to the desired channel to be monitored.

Step 4. Select the desired tape speed by turning the speed selector knob. The speed selector is located on the control module.

5. SYNCHRONOUS CONTROL SELECTION

The operator has the option of operating the speed control circuits of the SABRE VI in either CAPSTAN SYNCHRONOUS or TAPE SYNCHRONOUS. If CAPSTAN SYNCHRONOUS is chosen, the speed control system is controlled by a tachometer signal supplied from the capstan motor for both the record and reproduce modes. If TAPE SYNCHRONOUS is desired, then a reference signal must be recorded on an even numbered track at the time the recording is made. During the reproducing process, the reference signal is recovered and used in place of the tachometer signal to control the speed control system. This makes for a very accurate means of reproducing data recorded on tape.

If the equipment has the Tape Synchronous option, it should have been connected in the installation section (Section 2) under the paragraph heading of "Optional Item Connections". Check to see that two short coax jumpers have been placed on the I/O Connector Panel on top of the unit. If these have not been connected, refer to Section 2 for the proper procedure.

6. INTERFACING INPUT/OUTPUT SIGNALS

The input and output signals are made to the recorder/reproducer through BNC connectors located on the connector panel. The connector panel is on top of the unit or may be re-located to the back of the unit if rack mounted. To connect the cables, proceed as follows:

Step 1. Connect the input cables from the signal source to the signal input jacks on the I/O Connector Panel. The channel numbers are identified below each BNC connector.

Step 2. Connect cables from the signal output jacks of the I/O Connector Panel to the external equipment. The channel numbers are identified below each BNC connector.

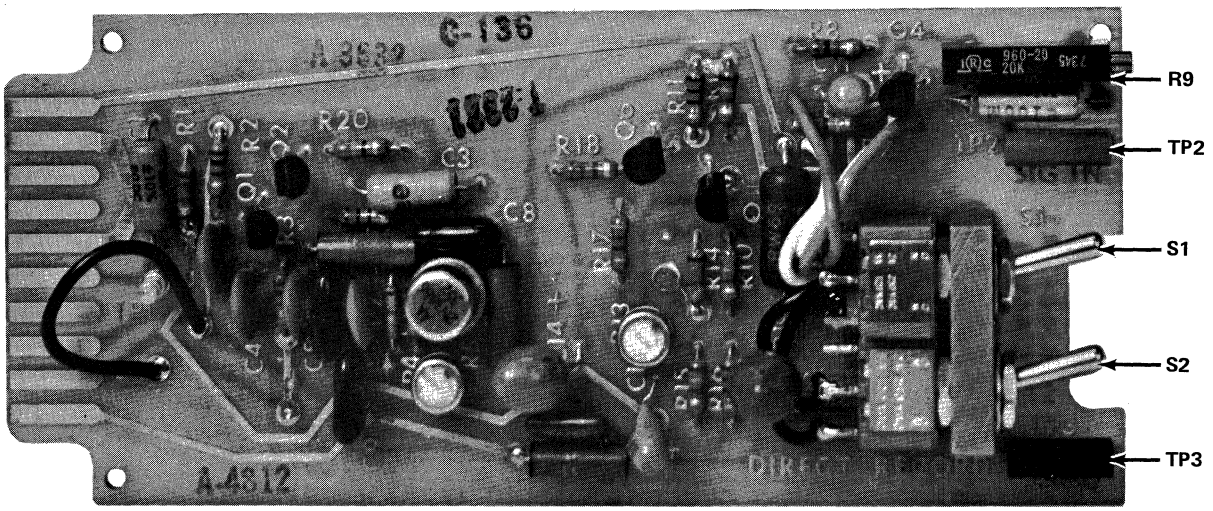


Figure 3-4. Direct Record Board, Checkout Points

7. CHECKOUT OF RECORD ELECTRONICS

The following procedure checks the input level to each record board to ensure proper signal amplitude for recording. It may be desirable to disconnect the input cables from the normal signal and substitute a signal generator to each channel as it is being adjusted. The signal source used should be adjusted to the highest anticipated voltage level for recording.

Step 1. With power applied to the unit, check that the STOP indicator is lit and depress the RECORD pushbutton. This action activates only the record electronics.

Step 2. If the unit is not equipped with direct record boards, go directly to Step 6. If direct record boards are used, check the position of the IMPEDANCE switch S2 on each direct record board. The up position is for a 75 ohm input and the down position is for 10K and higher. Select the appropriate position.

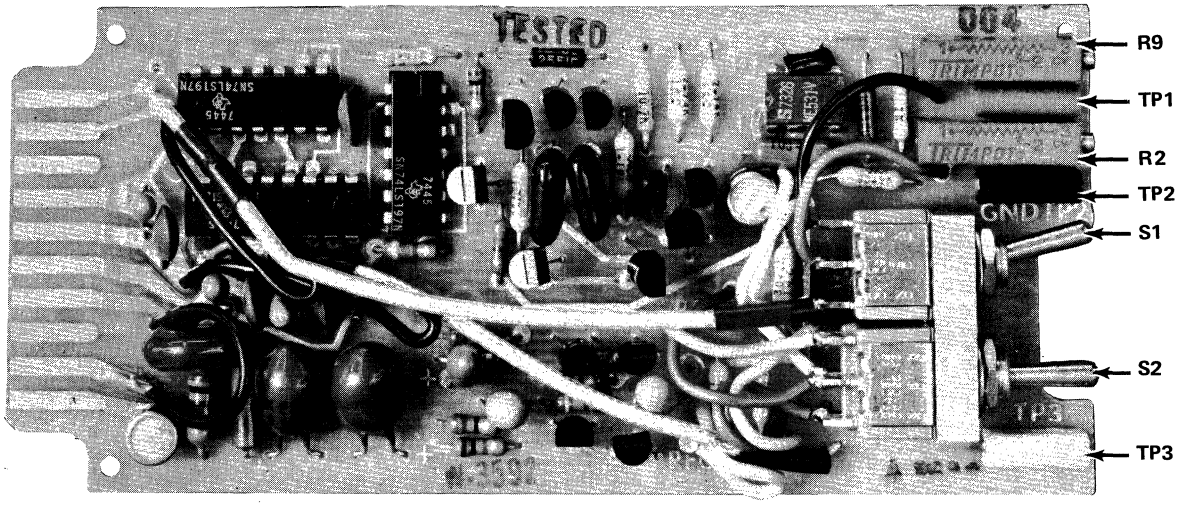


Figure 3-5. FM Record Board, Checkout Points

Step 3. Connect an AC voltmeter between testpoints TP2 (HI) and TP3 (GRD).

Step 4. With the signal source producing the highest anticipated level, the AC voltmeter should read .1 vrms. If not, adjust INPUT LEVEL control R9. If additional gain is still required, place RANGE switch S1 in its HIGH (UP) position and re-adjust R9.

Step 5. Repeat the above procedure for all the remaining direct record boards.

Step 6. If the unit contains FM electronics, check the position of unipolar DEVIATION switch S2 on each board. The + DEVIATION is up, NORMAL is in the center, and – DEVIATION is in the down position. The position of DEVIATION switch S2 determines the frequency of the FM carrier. The + DEV position places the carrier to its minimum frequency allowing only positive going signals to change the carrier. Also, increased amplitudes may be recorded because the total shift in frequency is in one direction. The NORMAL position allows the carrier to operate in the normal fashion of the data swinging the carrier both positive and negative. The – DEV position places the carrier to its maximum frequency allowing only the recording of negative going data.

Step 7. Connect the AC voltmeter between testpoints TP1 (HI) and TP2 (GRD). Adjust the INPUT LEVEL control R2 for the value vrms listed on the head characteristic sheet for this unit located inside the front cover of this manual. If additional gain is required, place ATTEN-TEST switch S1 in its HIGH (UP) position and re-adjust R2.

8. CHECKOUT OF REPRODUCE ELECTRONICS

Step 1. Remove power from the unit by depressing the ON pushbutton.

Step 2. All direct and FM reproduce boards are capable of reproducing at three of the eight tape speeds. The three available speeds are determined by three equalizers and/or filters mounted on each board and the position of the three speed lines on the capstan B board. The three speeds for each reproduce board may be checked in the following procedure.

Step 3. Remove and re-install the reproduce boards from the unit, one at a time, and check the location of each equalizer on the direct reproduce boards and each equalizer and filter on the FM reproduce boards according to Tables 3-1 and 3-2. EQ1, EQ2, and EQ3 are for speed lines 1, 2, and 3 respectively. FL1, FL2, and FL3 are for speed lines 1, 2, and 3 respectively. The equalizer on each direct board is identified by a number stamped on the left end. Equalizers on the FM board are identified by component value and the filters are identified by the bandpass stamped on the back of each filter.

TABLE 3-1. DIRECT EQUALIZER NUMBERS

Tape Speed (ips)	Intermediate	Wide Band I	Wide Band II
120	001	009	017
60	002	010	018
30	003	011	019
15	004	012	020
7-1/2	005	013	021
3-3/4	006	014	022
1-7/8	007	015	023
15/16	008	016	024

TABLE 3-2. FM FILTER AND EQUALIZER NUMBERS

Tape Speed	Bandpass (kHz)			EQ. Comp. Value (Ω + μh)		
	Lo	Intermed.	W.B. I	Lo/Inter.	Wide Band I	
120	20	40	80	150Ω	15μh	22Ω
60	10	20	40	270	68	68
30	5	10	20	470	270	120
15	2.5	5	10	820	1,200	220
7-1/2	1.25	2.5	5	1500	3,900	390
3-3/4	.625	1.25	2.5	3300	22,000	1000
1-7/8	.312	.625	1.25	5600	100,000	1800
15/16	.156	.312	.625	- - -	180,000	2700

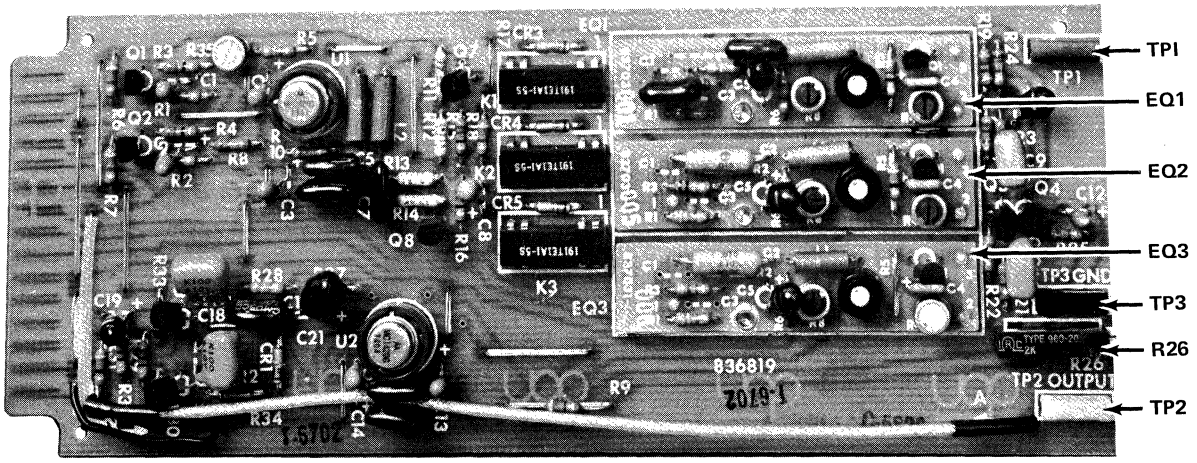


Figure 3-6. Direct Reproduce Board, Checkout Points

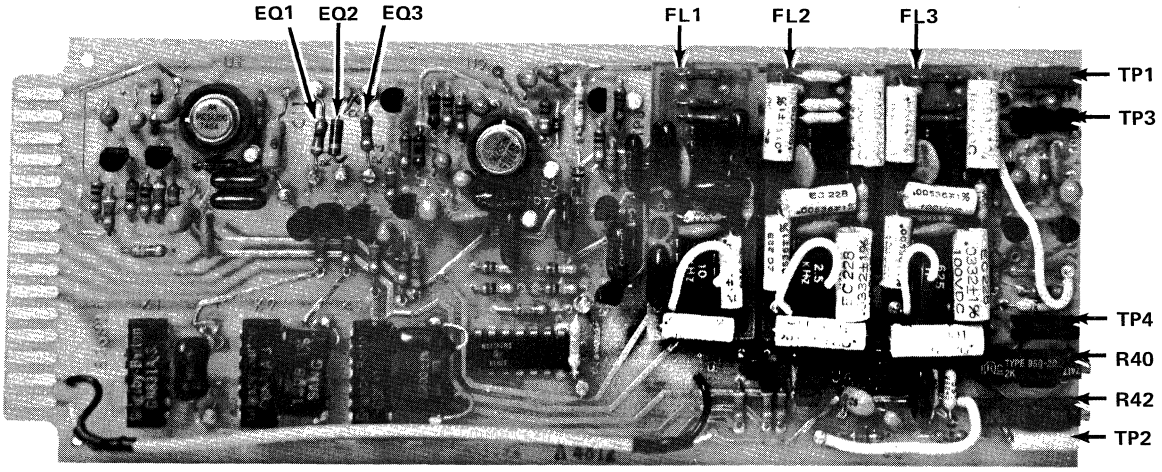


Figure 3-7. FM Reproduce Board, Checkout Points

Step 4. Unplug the capstan B board and check the location of the speed lines. The brown line is speed line 1, red is speed line 2, and the orange is speed line 3. The three lines should be plugged into the jacks corresponding to the speed equalizers on the record boards. The jacks numbering from top to bottom, represent the following speeds:

J1 – 120 ips	J5 – 7 1/2 ips
J2 – 60 ips	J6 – 3 3/4 ips
J3 – 30 ips	J7 – 1 7/8 ips
J4 – 15 ips	J8 – 15/16 ips

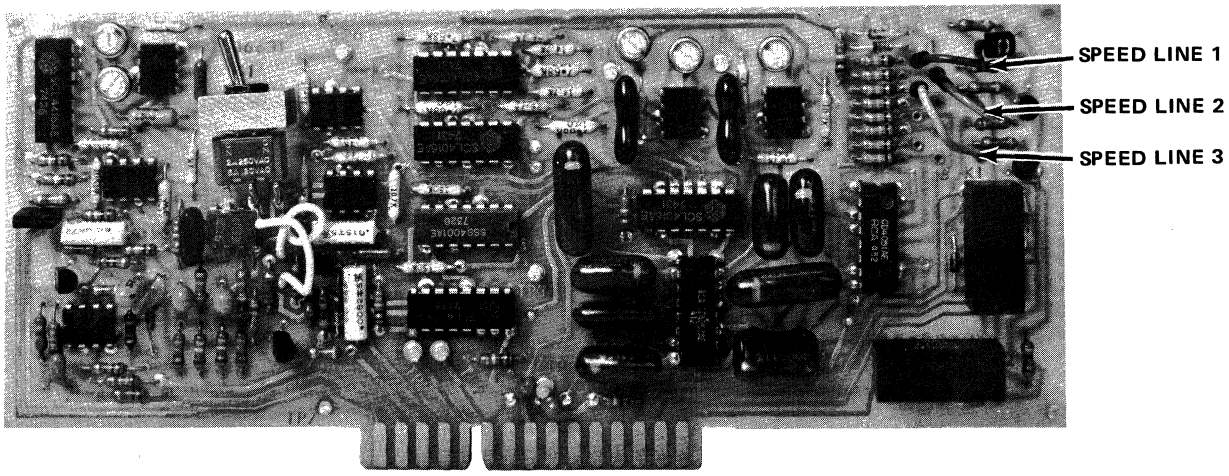


Figure 3-8. Capstan "B" Board, Checkout Points

Step 5. Depress the ON and STOP pushbuttons, and select the desired tape speed, keeping in mind the speed equalizers available.

Step 6. Depress the FWD pushbutton.

NOTE

This step assumes the tape contains a recorded signal. If not, select a tape that does or apply signals to the input of the record circuits and depress the REC and FWD pushbuttons.

Step 7. Connect an AC voltmeter to the output of each direct reproduce board at testpoints TP2 (HI) and TP3 (GRD). Adjust output level control R26 to the desired level.

Step 8. Repeat the above procedure for each direct reproduce board.

Step 9. Connect an AC voltmeter output of each FM reproduce board between testpoints TP2 (HI) and TP4 (GRD). Adjust OUTPUT LEVEL control R42 for the desired output level.

Step 10. Depress the STOP pushbutton.

C. DATA RECORDING

After all the above procedures have been completed, the unit is ready to record data. To record data, proceed as follows:

Step 1. This step assumes that all the "preparation for recording" procedures have been completed. If not, thread a tape onto the unit as previously described and apply power by depressing the ON pushbutton just under the Control Module.

Step 2. If desired, the EOT (end-of-tape) switch may be placed to the ON position. If the ON position is selected, the tape can be moved in the forward direction only because a small amount of tape is on the take-up reel. In this condition, each time the REV pushbutton is depressed the EOT circuits initiates a STOP command. As soon as a few feet of tape is wound onto the take-up reel, the situation becomes normal.

Step 3. If desired for reference, the footage RESET switch may be depressed to set the footage counter to 0000. As long as the tape is threaded, the footage counter accurately measures tape from this point. Any footage count may be referenced for later use. If the tape is wound off the reel during rewind, the problem arises of how to return to the same starting point. One method to accomplish this is by using the voice channel (optional) to announce to the operator the 0000 point. The operator can then reset the footage counter at the announced point.

Step 4. Set the speed selector knob to the desired tape speed. If the LED Data Bar Monitor is to be used, the tape speed selected must be equal to one of the reproduce tape speeds.

Step 5. If the unit is equipped with the LED Data Bar Monitor (optional), place the TRACK selector switch to the channel number desired for monitoring. Set the FM-DIRECT switch to indicate the type of electronics for the channel chosen. When recording begins, the LED indicators indicate in proportion to the output data level.

Step 6. Recording may now begin. Simultaneously depress the FWD and REC pushbuttons on the Control Module. Release the FWD pushbutton slightly prior to releasing the REC pushbutton. Tape should commence moving in the forward direction at the selected tape speed. The FWD and REC pushbuttons should light.

NOTE

When sufficient tape is on the outer reel, recording in the reverse direction may be accomplished by depressing the REV and REC pushbuttons simultaneously.

Step 7. If the unit is equipped with the voice option, voice comments may be placed anywhere along the recording by picking up the microphone, pressing the talk button, and speaking directly into the microphone.

NOTE

The microphone should be plugged into the jack on the I/O Connector Panel labeled VOICE IN.

Step 8. Tape should continue to move in the forward direction until the EOT circuits initiate a STOP command or the operator depresses the STOP pushbutton on the Control Module.

NOTE

While the unit is in the record mode (provided one of the reproduce tape speeds is selected), the reproduce circuits are also functioning. The signals being recorded are present (with a slight delay) at the output jacks on the I/O Connector Panel.

Step 9. Rewind the tape onto the supply reel by depressing the FAST REV pushbutton. Tape motion should continue until the EOT circuits (if activated) initiate a STOP command, the operator depresses the STOP pushbutton, or the tape runs completely off the end of the reel.

NOTE

If the tape is to be completely rewound, the EOT switch may be placed in the OFF position. Otherwise, the tape will continue to stop at the EOT point. A second means is to hold the FAST REV pushbutton in until the tape clears the reel.

D. DATA REPRODUCING

To reproduce data from a previously recorded tape, proceed as follows:

Step 1. The tape containing data must be threaded onto the unit in accordance with previous instructions under the paragraph heading of "Tape Threading".

Step 2. Apply power by depressing the ON pushbutton. If the STOP pushbutton does not light, depress the pushbutton to take up tape slack and lift the reel drive tension arms off their stops.

Step 3. Place the speed selector knob to the desired tape speed suitable for the filters and equalizers.

Step 4. If the EOT feature is desired, place the EOT switch to the ON position.

Step 5. If desired, the footage counter may be reset at this time or may be reset at whatever point has been determined at the time the recording was made. If equipped with the voice option, the voice reproduce circuits may announce "reset footage counter now".

Step 6. Place the unit in the reproduce mode by depressing the FWD switch. Tape should commence moving in the forward direction at the selected tape speed. If the tape reference signal was recorded and the tape sync (optional) feature is being used during the reproduce mode, both the TAPE SYNC light (located above the center of the take-up reel) and the PHASE LOCK light (located on the lower edge of the Control Module) should light.

Step 7. Tape should continue to move in the forward direction until the EOT circuits (if activated) initiate a STOP command or the operator depresses the STOP pushbutton on the Control Module.

NOTE

When sufficient tape is on the outer reel, reproducing in the reverse direction may be accomplished by depressing the REV pushbutton on the Control Module.

Step 8. Tape may be rewound onto the supply reel by depressing the FAST REV pushbuttons. Tape motion should stop when the EOT circuits sense the approaching end-of-tape. If the tape is to be completely rewound, make sure the EOT switch is placed into the OFF position before the tape reaches the EOT detecting point.

E. TAPE SPLICING

Whenever the need for tape splicing arises, proper splicing techniques are essential to avoid loss of tape-to-head contact, tape skew, excessive wear, or 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.

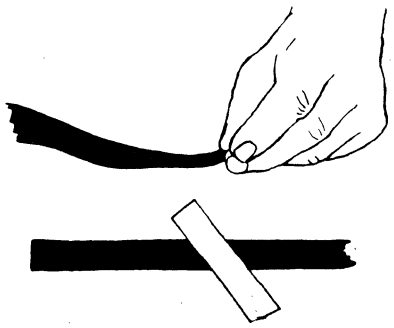


Figure 3-9. Positioning the Tape

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 the second magnetic tape over the first.

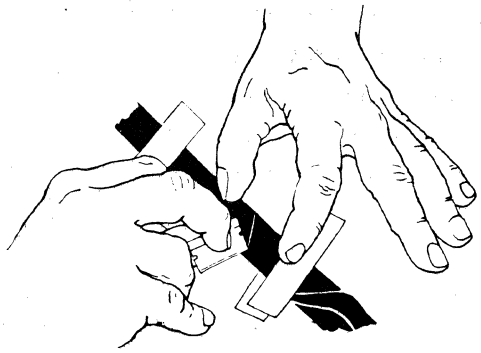


Figure 3-10. Cutting the Tape

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

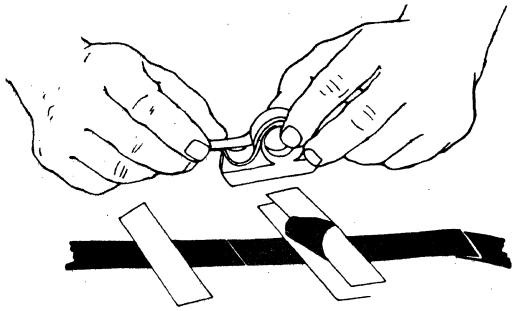


Figure 3-11. Preparing the Splice

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

Figure 3-12. Making the Splice

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.

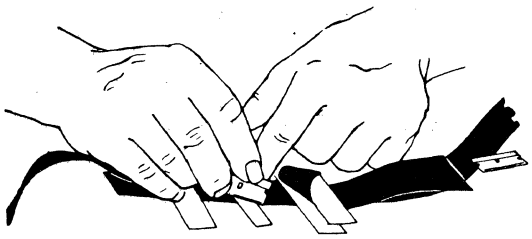


Figure 3-13. Trimming the Splice

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

SECTION 4
PREVENTIVE MAINTENANCE

A. INTRODUCTION

Proper preventive maintenance is required to ensure optimum overall performance of the recorder/reproducer. If a routine preventive maintenance program is established, the overall recording results will be greatly enhanced as well as the life of the unit extended. The objective of this section is to outline procedures that are most pertinent to the operator and technician in maintaining the unit.

B. ROUTINE PREVENTIVE MAINTENANCE

The routine preventive maintenance procedures should be performed by the operator weekly or after every 24 hours of use. The frequency of performance depends to a large extent upon the usage of the unit and the condition and type of tape used. Keeping the heads clean and degaussed ensures a minimum of head wear and optimum performance from the tape.

1. TAPE PATH CLEANING

As tapes are used, the R/R heads, pinch rollers, guide pins, and capstan accumulate small quantities of the brownish-red oxide and other foreign material from the tape. Oxide buildup on the heads cause a slight separation between the heads and the tape resulting in a reduction of data accuracy. Severe buildup on the pinch rollers reduce the ability of the capstan to faithfully drive the tape. Cleaning all components in the tape path are necessary to restore the unit's inherent accuracy and reliability.

A cotton swab mounted on the end of a wooden stick saturated with isopropyl alcohol is recommended to wash tape path components. Use of other solvents, such as some head cleaners and other clorinated solvents may cause damage to certain materials and can affect tape handling characteristics. Refer to the figures in Section 1 to identify the parts called out in the following procedure.

Step 1. Deenergize the unit and remove the tape from the tape transport.

Step 2. Remove the head cover.

Step 3. Using the cotton swab saturated with alcohol, wash the deposited oxide off the surface of the heads. Continue washing the surface and changing the cotton swab until no additional brownish-red oxide is seen on the cotton.

Step 4. After wiping the head area, wipe the inertia damping roller.

Step 5. Wipe the surface of the capstan. Be sure to roll the capstan by hand to get to the entire surface.

Step 6. Carefully wash the two pinch rollers. Be sure to continue until no more oxide comes off.

Step 7. Wash all rollers and guide pins in the tape path.

2. HEAD DEGAUSSING

A magnetized head may cause degradation of the recorded signal and a reduction of the signal-to-noise ratio. Three precautions should be noted to avoid magnetizing the heads; (1) remove or replace plug-in boards only when power has been removed, (2) do not make or break record head lead connections while in the RECORD mode and (3) do not test continuity of the heads with an ohmmeter or any similar test instrument.

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 demagnetizer to a 120 vac power outlet.

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 continous (with no sudden movement).

Step 5. After moving away from the heads as far as possible, unplug the demagnetizer. Unplugging the demagnetizer too near the heads could result in remagnetizing the head.

C. PERIODIC PREVENTIVE MAINTENANCE

Periodic checks on the order of six months should be performed to ensure the unit is operating at optimum standards.

1. TAPE PATH INSPECTION

A static and dynamic inspection of the tape path should be conducted periodically or at any time mechanical misalignment is suspected as evidenced by damaged tape or excessively noisy recordings. Trying to determine the component that may be out of alignment, from the action of the unit, is the most difficult task. This ability in mechanical troubleshooting will primarily be achieved with experience. The following checks should aid in troubleshooting tape path problems.

Step 1. Observe each mechanical component within the tape path, that has a tape guiding surface, to ensure it is "tight", clean and free of abrasions.

Step 2. Place a reel of tape on the recorder, thread in the normal manner, then depress the FWD pushbutton.

Step 3. Observe the tightness of the inner and outer edges of the tape (for uniformity of edge tension) throughout the tape path.

Step 4. Observe where the outboard edge of the tape traverses one stack of the R/R heads. Relate the tape edge to a "mark" on the head and note if the tape appears to be skewing (shifting back and forth) relative to this "mark".

Step 5. Check both edges of all guide posts to ensure that tape does not buckle or attempt to ride up on the edges. This can be detected by noting the irregularity in the light reflected from the surface of the tape near the edge guides. A small flashlight may be helpful in seeing this.

Step 6. Check the tape wrap on the take-up reel, noting particularly if either edge of the tape has a tendency to curl against the side of the reel.

Step 7. If any of the above checks are positive, repeat all checks with tape moving in both the FAST FORWARD and FAST REVERSE modes.

Step 8. If checks are negative in the fast tape modes, check in the area of the capstan and pinch rollers for wear or misalignment.

Step 9. If checks are positive in the fast tape modes, repeat all checks with a new reel of tape due to the possibility of a malfunction caused by an edge stretched tape or bent reels. If checks are still positive, tape path misalignment is indicated.

NOTE

When tape skews back and forth at one component,
it is usually not that component which is misaligned,
but the component just previous to it in the tape path.

Step 10. The offending component can sometimes be isolated by exerting "moderate" finger pressure to the component, while tape is moving, and observing tape behavior.

Step 11. If a component is suspected of being misaligned, DO NOT attempt to make any adjustments. The operation is very delicate and requires special tools and special experience. Attempting to correct the problem will probably result in worsening of the condition. Contact Sangamo Electric Company for service.

2. ELECTRONIC FOOTAGE COUNTER, SUPPLY BATTERIES

The four batteries for the electronic footage counter board should be replaced at 2 year intervals.

3. CAPSTAN MOTOR BRUSH INSPECTION

The four brushes in the capstan motor should be inspected at 2000 hour intervals for excessive wear.

Step 1. Deenergize the unit and open the tape transport to the fully extended position.

Step 2. Remove each of the four brush retaining screws. These are located just in front of the end cap of the motor. With a small screwdriver, work the end of each brush tension spring loose and remove from the motor.

Step 3. Inspect each brush. If the brushes have worn down to 1/4 inch or less, replace them as described in the next two steps. If not, re-install the brushes as removed.

Step 4. Insert each new brush and tension spring, ensuring they are positioned with the concave surface aligned with the armature.

Step 5. Align the tension spring and metal tip completely inside the brush holder and replace the brush retaining screws.

NOTE

The motor will require a minimum of 24 hours break-in time before normal low flutter performance can be achieved.

4. REEL DRIVE MOTOR BRUSH INSPECTION

The four brushes in each of the reel drive motors should be inspected at 6000 hour intervals for excessive wear.

Step 1. Deenergize the unit and open the tape transport to the fully extended position.

Step 2. Remove the two wires connected to each motor. Note the terminal on which each wire is connected. Lay the loose screws aside.

Step 3. With a large screwdriver, unscrew and remove each brass terminal. With a small screwdriver, carefully work the end of each brush tension spring loose and lift spring and brush assembly from the motor.

Step 4. Remove the remaining two brushes of each motor by removing the two black brush retaining screws. Work the brushes free as in the above step.

Step 5. Inspect each brush. If the brushes are worn down to 1/4 inch or less, replace them.

Step 6. Insert each brush into the proper slot, ensuring each is positioned with the concave surface aligned with the armature.

Step 7. Replace the brush retaining screws and brush terminal screws as each brush is placed into position.

Step 8. Reconnect the wires to their respective terminals.

D. PERIODIC PERFORMANCE MEASUREMENTS

From time to time, the dynamic operations of the unit should be checked to determine overall performance. It is a good idea when the unit is still new to make the following measurements and record the results on the Performance Measurements Summary Sheet located on the last page of this section. At a later time when the measurements are repeated, the figures can be quickly compared to determine the degree of degradation in performance which has resulted and, if necessary, what circuits require attention.

In a number of cases, test equipment may not be readily available to make each check. If not, then make the checks with the equipment that is available and keep those figures recorded for later reference.

1. DIRECT RECORDING/REPRODUCING

a. FREQUENCY RESPONSE

Step 1. Select the channel to be tested. Connect a signal generator to the input connector of the record channel on the I/O Connector Panel. Set the signal generator to 1 kHz at a normal input voltage level.

Step 2. Connect an ac voltmeter (with a dB scale) to the output connector of the reproduce channel on the I/O Connector Panel.

Step 3. Set the speed selector knob to one available reproduce tape speed. Select the highest speed first and later the other two speeds will be used.

Step 4. Record the 1 kHz signal on a short section of tape. Rewind and playback the tape while noting the dB scale on the ac voltmeter. Record the reading for later reference.

Step 5. Use Table 4-1 to determine the frequencies to set the signal generator for the remaining portion of this check. Record and play back eight to ten frequencies with frequency response of the speed being tested. Be sure the signal generator maintains a constant input voltage. Repeat the above precedures for the remaining two reproduce tape speeds.

TABLE 4-1. FREQUENCY RESPONSE

Tape Speed (ips)	Frequency Range (kHz)		
	Intermediate Band	Wideband I	Wideband II
120	.3 - 600	.4 - 1600	.4 - 2000
60	.2 - 300	.4 - 800	.4 - 1000
30	.1 - 150	.4 - 400	.4 - 500
15	.1 - 75	.4 - 200	.4 - 250
7-1/2	.1 - 38	.4 - 100	.4 - 125
3-3/4	.1 - 19	.4 - 50	.4 - 62.5
1-7/8	.1 - 10	.4 - 25	.4 - 31.25
15/16	.1 - 5		

Step 6. Compare the results with the reference obtained in Step 4. A response curve should be within ±3 dB for the entire bandpass for each speed tested. Record (or check) the results on the Performance Measurements Summary Sheet at the end of this section.

Step 7. Repeat the above procedures for each track of direct electronics.

b. DISTORTION

Step 1. Select the channel to be tested. Connect a signal generator to the input connector of the record channel on the I/O Connector Panel.

Step 2. Connect a wave analyzer to the OUTPUT testpoints of a direct reproduce board between TP2 (HI) and TP3 (LO).

Step 3. Set the speed selector knob to the highest available reproduce speed. Refer to Table 4-2 and select the fundamental frequency for the same speed. Set the signal generator to that frequency.

Step 4. Place the unit in the record mode by depressing the REC and FWD pushbuttons on the Control Module.

Step 5. Adjust the wave analyzer to read the third harmonic distortion (refer to Table 4-2). The results should be 1% of the fundamental or less. Record (or check) the results on the Performance Measurement Summary Sheet at the end of this section.

TABLE 4-2. THIRD HARMONIC DISTORTION				
Tape Speed (ips)	Fundamental (kHz)		3rd Harmonic (kHz)	
	Intermediate	Wideband II	Intermediate	Wideband II
120	60	200	180	600
60	30	100	90	300
30	15	50	45	150
15	7.5	25	22.5	75
7-1/2	3.8	12.5	11.4	37.5
3-3/4	1.9	6.25	5.7	18.75
1-7/8	1.0	3.13	3.0	9.39
15/16	.5	1.56	1.5	4.68

Step 6. Repeat the above procedures for the remaining two reproduce speeds.

Step 7. Repeat the above procedures for the remaining direct electronic channels.

c. SIGNAL-TO-NOISE RATIO

Step 1. Select the channel to be tested. Connect a signal generator to the input connector of the record channel on the I/O Connector Panel. Set the signal generator to the fundamental frequency listed in Table 4-2 at a normal input voltage level.

Step 2. Connect an 18 dB/octave filter to the output connector of the reproduce channel on the I/O Connector Panel. Set the filter for the frequencies listed in Table 4-1. Connect an ac voltmeter (with dB scale) to the output of the filter.

Step 3. Set the speed selector knob to one available reproduce tape speed. Select the highest speed first and later the other two speeds will be used.

Step 4. Record, rewind and playback a section of tape. Do not record and playback simultaneously for this test.

Step 5. Note the dB level on the ac voltmeter. Record the reading for later reference.

Step 6. Remove the signal generator and short the input connector to ground by using a shorted BNC connector.

TABLE 4-3. SIGNAL-TO-NOISE RATIO							
Tape Speed (ips)	S/N (dB)			Tape Speed (ips)	S/N (dB)		
	I.B.	W.B. I	W.B. II		I.B.	W.B. I	W.B. II
120	40	24	22	7-1/2	36	23	21
60	40	24	22	3-3/4	35	22	20
30	39	24	22	1-7/8	35	21	20
15	38	24	22	15/16	35		

Step 7. Record, rewind and playback the tape again. The indication on the ac voltmeter should be in accordance with Table 4-3. Record (or check) the results on the Performance Measurements Summary Sheet at the end of this section.

Step 8. Repeat the above procedures for the remaining two reproduce speeds.

Step 9. Repeat the above procedures for the remaining direct electronic channels.

d. OUTPUT LEVEL

Step 1. Select the channel to be tested. Connect a signal generator to the input connector of the record channel on the I/O Connector Panel. Set the signal generator to 1 kHz at a normal input voltage level.

Step 2. Connect an ac voltmeter to the output connector of the reproduce channel on the I/O Connector Panel. Connect a 600Ω resistor from the output to ground.

Step 3. Set the speed selector knob to any reproducible tape speed.

Step 4. Note and record for later reference the output voltage on the ac voltmeter. Turn OUTPUT LEVEL R26 fully clockwise. The reading now should be 1 vrms or more. Record (or check) the results on the Performance Measurement Summary Sheet at the end of this section.

Step 5. Return OUTPUT LEVEL R26 to the voltage level noted in Step 4.

Step 6. Repeat the above procedures for each channel of direct electronics.

2. FM RECORDING/REPRODUCING

a. FREQUENCY RESPONSE

Step 1. Select the channel to be tested. Connect a sine wave generator to the input connector of the record channel on the I/O Connector Panel. Set the sine wave generator to 100 Hz.

Step 2. Connect an ac voltmeter across the VCO-INPUT testpoints on the FM record board between TP1 (HI) and TP2 (LO).

Step 3. Set the speed selector knob to one available reproduce tape speed. Select the highest speed first and later the other two speeds will be used.

Step 4. Nominal input voltages for intermediate band and wideband I with 40% deviation should be 510 mv, or 425 mv for wideband II with 30% deviation.

Step 5. Depress the REC pushbutton on the Control Module and adjust the generator output until the ac voltmeter reads the same as the nominal voltage level given in Step 4.

Step 6. Move the ac voltmeter to the OUTPUT testpoints of the FM reproduce board between TP2 (HI) and TP4 (LO).

TABLE 4-4. FM FREQUENCY RESPONSE

Tape Speed (ips)		FM Carrier Frequency (kHz)	Frequency Range (dc to kHz)	Tape Speed (ips)	FM Carrier Frequency (kHz)	Frequency Range (dc to kHz)
Wideband Group I	Intermediate Band			Wideband Group II		
120		432	80	120	900	1000
60	120	216	40	60	450	500
30	60	108	20	30	225	250
15	30	54	10	15	112.5	125
7-1/2	15	27	5	7-1/2	56.25	62.5
3-3/4	7-1/2	13.5	2.5	3-3/4	28.125	31.25
1-7/8	3-3/4	6.75	1.25	1-7/8	14.06	15.62
15/16	1-7/8	3.375	0.625	15/16	7.03	7.81
	15/16	1.688	0.313			

Step 7. Record 8 to 10 frequencies from 100 Hz to beyond the upper limit of the bandpass for the speed being tested. Adjust the signal generator to maintain a constant voltage level at the VCO-INPUT testpoints on the FM record board for each frequency selected. Refer to Table 4-4 to obtain the frequency response for the speed being tested.

Step 8. Note the voltage at the OUTPUT testpoints of the FM reproduce board for each frequency selected. The frequency response should indicate within 1 dB through the bandpass for the flat amplitude filter or within the limits of +1 and -3 dB for linear phase filter. Record the results on the Performance Measurements Summary Sheet at the end of this section.

Step 9. Repeat the above procedures for each available reproduce speed.

Step 10. Repeat the above procedures for each channel of FM electronics.

b. TOTAL HARMONIC DISTORTION

Step 1. Set the speed selector knob to the highest available reproduce tape speed.

Step 2. Connect a signal generator to the input on the I/O Connector Panel of the track being tested. Adjust the signal generator to a generator frequency corresponding to the tape speed chosen as listed in Table 4-5.

TABLE 4-5. FM DISTORTION FREQUENCIES

Tape Speed (ips)		Bandpass	Generator	Tape Speed (ips)	Bandpass	Generator
Wideband Group I	Intermediate Band	Upper Limit (kHz)	Frequency (kHz)	Wideband Group II	Upper Limit (kHz)	Frequency (kHz)
120		80	8	120	900	90
60	120	40	4	60	450	45
30	60	20	2	30	225	22.5
15	30	10	1	15	112.5	11.25
7-1/2	15	5	.5	7-1/2	56.25	5.625
3-3/4	7-1/2	2.5	.25	3-3/4	28.125	2.8
1-7/8	3-3/4	1.25	.125	1-7/8	14.06	1.4
15/16	1-7/8	.625	.062	15/16	7.03	.7
	15/16	.313	.031			

Step 3. Connect an ac voltmeter across the VCO-INPUT testpoints on the FM record board between TP1 (HI) and TP2 (LO).

Step 4. Nominal input voltages for intermediate band and wideband I with 40% deviation should be 510 mv, or 425 mv for wideband II with 30% deviation.

Step 5. Depress the REC pushbutton on the Control Module and adjust the generator output until the ac voltmeter reads the same as the nominal voltage level given in Step 4.

Step 6. Connect a wave analyzer to the OUTPUT testpoints of the FM reproduce board between TP2 (HI) and TP4 (LO)

Step 7. Depress the REC and FWD pushbuttons on the Control Module.

Step 8. Adjust the wave analyzer to measure the second harmonic distortion. Make note of the percent of second harmonic distortion.

Step 9. Adjust the wave analyzer to measure the third harmonic distortion. Make note of the percent of third harmonic distortion. Repeat this procedure for the fourth through the tenth harmonics.

Step 10. Compute the total harmonic distortion using the following formula:

$$THD = \sqrt{(HD_2)^2 + (HD_3)^2 + \ldots (HD_{10})^2}$$

Where:

THD = % of total harmonic distortion
HD_2 = % of second harmonic distortion
HD_3 = % of third harmonic distortion

The results should be less than 1% total harmonic distortion.

Step 11. Repeat the above procedures for the remaining two tape speeds.

Step 12. Repeat the above procedures for each channel of FM electronics.

c. SIGNAL-TO-NOISE RATIO

Step 1. Set the speed selector knob to the highest available reproduce speed.

Step 2. Connect a low frequency function generator to the input on the I/O Connector Panel of the track being tested. Adjust the generator for a 100 Hz sine wave.

Step 3. Connect an ac voltmeter across the VCO-INPUT testpoints on the FM record board between TP1 (HI) and TP2 (LO).

Step 4. Nominal input voltages for intermediate band and wideband I with 40% deviation should be 510 mv, or 425 mv for wideband II with 30% deviation.

Step 5. Depress the REC pushbutton on the Control Module and adjust the generator output until the ac voltmeter reads the same as the nominal voltage level given in Step 4.

Step 6. Move the ac voltmeter to the output BNC connector on the I/O Connector Panel.

Step 7. Depress the REC and FWD pushbuttons on the Control Module.

Step 8. Note the output voltage level (in dB) on the ac voltmeter.

Step 9. Place ATTN-TEST switch S1 into the test position.

Step 10. Note the output voltage level (in dB) on the ac voltmeter. The signal should be at least the number of decibels above the noise as indicated in Table 4-6 for the speed being checked.

Step 11. Repeat the above procedures for the remaining two reproduce speeds.

Step 12. Repeat the above procedures for each channel of FM electronics.

TABLE 4-6. FM SIGNAL-TO-NOISE RATIO

Tape Speed (ips)	Wideband I Flat Amplitude Filters (dB)*	Intermediate Band Flat Amplitude Filters (dB)*	Wideband II
120	48	50	32
60	48	50	32
30	48	50	32
15	48	50	32
7-1/2	47	48	31
3-3/4	46	47	30
1-7/8	44	46	29
15/16	41	44	

* 1 dB less with linear phase filters

d. OUTPUT LEVEL

Step 1. Set the speed selector knob to the highest available reproduce tape speed.

Step 2. Connect a signal generator to the input connector on the I/O Connector Panel of the track being tested. Adjust the signal generator for a 100 Hz sine wave.

Step 3. Connect an ac voltmeter across the VCO-INPUT testpoints on the FM record board between TP1 (HI) and TP2 (LO).

Step 4. Nominal input voltages for intermediate band and wideband I with 40% deviation should be 510 mv, or 425 mv for wideband II with 30% deviation.

Step 5. Depress the REC pushbutton on the Control Module and adjust the generator output until the ac voltmeter reads the same as the nominal voltage level given in Step 4.

Step 6. Move the ac voltmeter to the output BNC connector on the I/O Connector Panel. Also connect a 600 ohm resistor between the testpoints TP2 (HI) and TP4 (LO) to load the output of the board.

Step 7. Depress the REC and FWD pushbuttons on the Control Module.

Step 8. Make note of the output voltage level on the ac voltmeter.

Step 9. Turn OUTPUT LEVEL R42 fully clockwise. The voltage reading should be 1 vrms or more.

Step 10. Return OUTPUT LEVEL R42 to the voltage level as noted in Step 8.

Step 11. Repeat the above procedures for each channel of FM electronics.

3. WOW AND FLUTTER

Step 1. To minimize tape effect during wow and flutter measurements, use a new or nearly new degaussed reel of high quality magnetic tape.

Step 2. Degauss the heads and clean the tape path.

Step 3. Place a direct record board in the center track for the even head stack and a direct reproduce board in the same reproduce channel (track 4 for 1/2 inch unit, track 8 for 1 inch unit).

Step 4. Calibrate the wow and flutter meter as follows:

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

Step 5. Connect the output of the meter to the record input of track chosen.

Step 6. Connect the output of the preamp stage of the reproduce channel at testpoints TP1 (HI) and TP3 (LO) to the input of the flutter meter.

Step 7. With tape moving in the record mode, set the drift meter to zero.

Step 8. Refer to Table 4-7 and ensure that the correct center frequencies and filters are selected.

Step 9. Read the wow and flutter value directly from the flutter meter and compare the results with Table 4-7.

TABLE 4-7. CENTER FREQUENCY AND FILTER SETTINGS			
Tape Speeds (ips)	Carrier (kHz)	Filter (kHz)	Flutter (%)
120	216	10	.20
60	108	10	.25
30	54	5	.25
15	27	2.5	.30
7-1/2	13.5	1.25	.35
3-3/4	6.75	.625	.40
1-7/8	3.375	.313	.40
15/16	1.687	.313	.50

4. D.C. LINEARITY

Step 1. Connect a digital voltmeter across the output of the reproduce board between testpoints TP2 (HI) and TP4 (LO) of the channel being tested. The digital voltmeter should have an accuracy of .05% and capable of reading three places. The following procedures assume the FM channel has previously been calibrated to 1 Vrms.

Step 2. With the tape threaded, depress the REC and FWD pushbuttons on the Control Module. Place ATTENUATOR switch S1 to the TEST position and observe the voltmeter for a zero reading. If not, adjust ZERO adjust R40 on the reproduce board to obtain this indication.

Step 3. Connect a variable dc voltage supply (or battery with a potentiometer connected across it) to the input of the record board. Return ATTENUATOR switch S1 to its normal position. With the voltmeter, adjust dc voltage level to exactly 1.414 volts.

Step 4. Re-connect the voltmeter to the output of the reproduce board. Adjust OUTPUT LEVEL adjust R42 on the reproduce board for exactly the same reading as the input (1.414 v).

Step 5. Without changing the level, reverse the polarity of the voltage at the input of the record board. Read the voltmeter. Find the difference between -1.414 and the present reading. Apply the result to the following formula:

$$\% \text{ ERROR} = \frac{|\text{DIFFERENCE}|}{2.828} \times 100$$

The result should be 0.4% or less.

Step 6. Repeat the above procedures for each channel of FM electronics.

PERFORMANCE MEASUREMENTS
SUMMARY SHEET
FOR
DIRECT ELECTRONICS

Track No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rec. Bd. Serial														
Repro. Bd. Serial														
Frequency Response														
3rd Harmonic Distortion														
Signal-to-Noise Ratio														
Output Level														

PERFORMANCE MEASUREMENTS
SUMMARY SHEET
FOR
FM ELECTRONICS

Track No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rec. Bd. Serial														
Repro. Bd. Serial														
Frequency Response														
Total Harmonic Distortion														
Signal-to-Noise Ratio														
Output Level														
Wow and Flutter														
D.C. Linearity														

SECTION 5
THEORY OF OPERATION

A. INTRODUCTION

A basic understanding of the theory of operation is essential in attaining maximum performance from the recorder/reproducer as well as aiding in the general isolation of a fault in the event of a malfunction. This section describes the basic concepts of the circuits within the SABRE VI based on block diagrams and should be helpful in determining which servicing section to reference whenever isolation of a problem is required. When complete circuit details are required for a given circuit, refer to the specific servicing section which follows this section.

B. FUNCTIONAL OVERVIEW

The SABRE VI recorder/reproducer is capable of recording and reproducing data by means of direct or FM electronics. To perform this function, tape is moved across the record and reproduce heads in either direction at a precise and uniform rate. The tape transport contains the mechanical components, such as tape guides, reel hubs, tension arms, capstan, R/R heads etc. required to accurately handle the tape through the tape path.

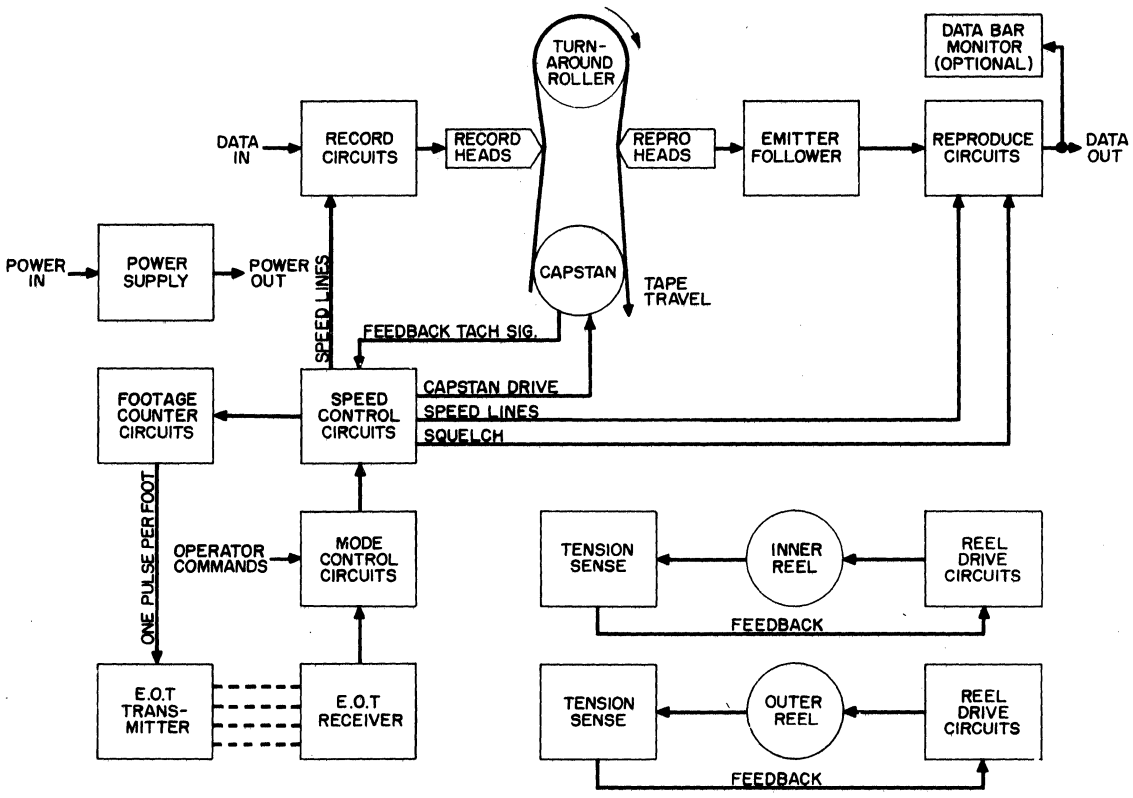


Figure 5-1. Overall Function Block Diagram (804858)

To accomplish accurate tape movement over the heads at a precise rate, the rotational speed of the capstan is carefully controlled by the speed control circuits. This is accomplished by comparing a frequency generated by a photo-etched disc mounted on the rear of the capstan motor to a reference frequency generated by a crystal oscillator. The reel drive circuits feed tape to and take up tape from the capstan as it turns. These circuits maintain constant tape tension by a servo system on each reel which measures the position of the tension arm to govern the amount of current through each reel drive motor.

Data, time code, or voice signals must be conditioned by the record circuits before being recorded on tape. The direct electronics also combines a bias signal to the data before the recording takes place.

In reproducing data, time code, or voice signals, the recovered signal from the head is applied through emitter followers to the reproduce boards that are complementary to the type of recording (FM or direct). The reproduce board conditions the signal to present data to the output in a form like that of the input.

The mode control circuits determine, with the aid of the operator, the mode of operation such as record, fast forward, reverse, etc. In addition, the E.O.T. (end-of-tape) circuits monitor the amount of tape on each reel and initiates a STOP command just before the tape reaches the end. A STOP command may also be initiated if the tape tension arms are at their "at rest" position due to slack tape.

The power supply converts the input power to the voltage and current levels usable by the electronics of the unit.

Other monitoring circuits aid the operator in operation of the unit. The footage counter indicates the number of feet of tape that passes over the capstan. The data bar monitor (optional) indicates the reproduce output level. Voice and time code signals denote specific areas of data on tape.

C. MECHANICS OF THE TAPE TRANSPORT

(See section on TAPE TRANSPORT MECHANICS for servicing and replacement procedures of parts).

The specific function of the tape transport is to accurately move magnetic tape at a precise rate across the record and reproduce heads by means of the capstan motor drive system while the reel drive system maintains proper tape tension. For identification of the parts mentioned in the following paragraphs, refer to Figure 1-3 in the General Information section.

Data is recorded on tape by driving current through the winding of the record heads proportional to the amplitude of the data. This current creates small fluctuating magnetic fields which are directly induced onto the surface of the tape. At playback the magnetic fields induce small voltages into the reproduce head windings. The reproduce circuits amplify and condition the data to the desired levels for use.

In order to maximize the recording and reproducing process, the tape transport must meet several requirements. The first factor is good contact to the heads. To do this, a slight "head wrap" is designed into the tape travel through the head area as shown in Figure 5-2.

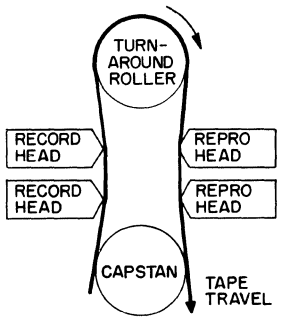


Figure 5-2. Head Area Tape Wrap (804859)

A second factor is the necessity of the heads being perpendicular to the plane of tape travel (the tape deck). The perpendicularity of data across the tape maintains the correct relationship between channels and also ensures the data may be reproduced on another reproducer without unnecessary distortion.

A third factor of correct tape handling is the plane the tape travels must be carefully controlled from reel to reel. The tape must pass across the R/R heads at precisely the correct height (above the tape deck) in relationship to the heads in order for all channels to be in their respective position on the tape. Not only is the plane at the head area important, but also at each reel as the tape enters or leaves the reel. The plane (or height) of the tape is established by the height the reels are mounted above the surface of the deck and carefully controlled by guide rollers throughout the tape path. In order to perform this function, the guide rollers must be a fixed height and perpendicular to the deck. Because of the coaxial drive system used on the SABRE VI (one reel above the other), it is necessary to change planes somewhere between the time the tape leaves one reel and the time it reaches the other. This is accomplished by means of two translation rollers (upper and lower) that tilt the tape travel slightly and then to retilt the tape into the new plane. Tilting is accomplished in an area away from the heads.

Uniform tape movement is the function of the speed control circuits whose output controls the current through the capstan motor. The capstan motor and capstan are a single unit mounted from the back of the tape transport with the capstan protruding through into the tape path. Since the function of the capstan is to move tape, no guiding is required but perpendicularity is necessary so as not to affect the plane of tape travel.

The rotational speed of the capstan is controlled by an opaque disc mounted at the rear of the motor (under the cover) rotating through a light and photocell arrangement. The rotating disc generates a frequency which is compared to a reference in the speed control circuits (See Speed Control Circuits) to determine the amount of current required to turn the capstan at the desired tape speed.

Tape motion is achieved whenever a tape motion command is selected at the Control Module (FORWARD, RECORD, FAST FORWARD, etc.). When the command is selected, tape motion begins with the two pinch rollers, on each side of the capstan, pulling in. In order for the pinch rollers to apply even pressure along the surface of the capstan, each one has a single bearing mounted in its center to allow each pinch roller to tilt as necessary to accomplish the said purpose.

D. POWER DISTRIBUTION

Power is developed for the SABRE VI by the power supplies and the necessary operating voltages are distributed to the electronic circuits of the unit. The following discussion divides the subject of power into (1) the main chassis assembly, (2) the rectifier assembly and regulators, and (3) circuit distribution.

1. MAIN CHASSIS ASSEMBLY

This portion of the power supply includes the circuits from the power source through the power transformer. The function of the circuitry located on the main chassis assembly is to facilitate power switching, to convert the incoming source voltage to a higher frequency, and to transform the high frequency voltage into several usable ac voltage levels by means of a power transformer.

Four separate power supplies, each accepting a different input voltage, may be used to power the SABRE VI. The major differences in the circuitry of the four supplies are found in the main chassis assembly. Figure 5-3 illustrates a typical ac operated supply

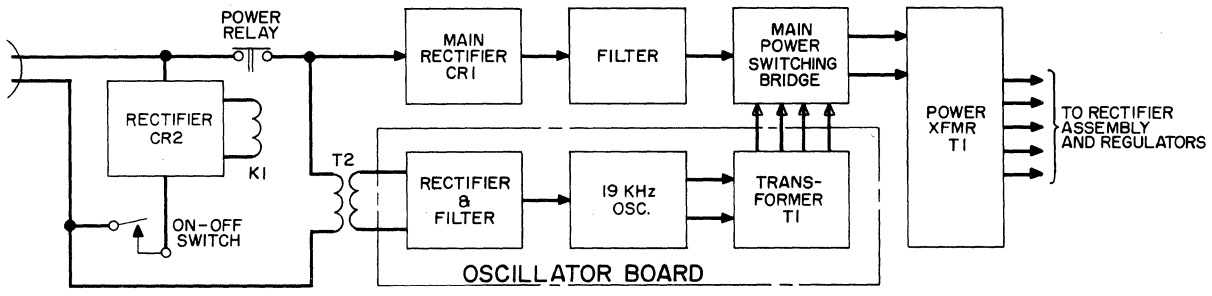


Figure 5-3. Main Chassis Assembly (804860)

AC (117v or 234v) is applied from the convenience outlet through the line cord to the ON-OFF switch. When the ON-OFF switch, located on the front panel just below the Control Module, is closed, the ac voltage is rectified by bridge rectifier CR2 causing power relay K1 to energize. When the power relay closes, voltage is applied to main rectifier CR1 and to transformer T2. The secondary of the transformer is converted to 23 vac which is applied to the circuitry on the oscillator board. Another rectifier and filter arrangement changes the ac voltage to dc to power the oscillator board. An operational amplifier and four transistors comprise a 19 kHz oscillator. The output of the oscillator drives the primary of a transformer with four secondary windings. Each secondary winding drives a transistor in the main power switching bridge.

Power from main rectifier CR1 is filtered and applied to the input of the main power switching bridge. This bridge consists of four switching transistors connected in a bridge fashion. The output of the bridge is connected across the primary of the power transformer. Voltages from the four secondary windings of the transformer on the oscillator board turns two transistors on at a time to drive current through the primary in one direction and then the other two transistors turn on to drive current through the primary in the opposite direction.

The dc input supplies (12v and 26v) operate in a similar manner except that dc voltage is already present, eliminating the need of converting the ac to dc. Power is applied when power relay K1 is closed (no rectifier required). When the relay closes, power is applied directly to a center tapped primary winding of the power transformer. Two switching transistors are used instead of the bridge. These transistors are switched by means of an oscillator circuit (19 kHz) on the oscillator board. The oscillator is simplified inasmuch as feedback for the oscillator is derived from a saturable core transformer.

2. RECTIFIER ASSEMBLY AND REGULATOR

This portion of the power supply develops the regulated and unregulated voltage levels from the secondary of the power transformer to the required levels used in the circuit of the SABRE VI. The rectifiers and regulators in this circuitry are identical for all four available power supplies.

The secondary of power transformer T1 has four secondary windings, with each being fused for overload protection. One of the four windings is tapped to provide two different voltage levels. From this winding, three separate supply voltages are developed. An 18 vdc unregulated voltage is developed from the tap of the winding simply by half wave rectification and filtering. The other two voltage levels are developed through the contacts of relay K1. Relay K1 is connected to switch between the end and the tapped windings. When relay K1 is de-energized, the tapped winding is connected to the output circuits. Relay K1 energizes by a signal derived from the tachometer in the capstan motor. When the capstan motor reaches a predetermined speed (somewhere between 60 ips and 120 ips), circuitry on the reel drive board initiates a command to energize relay K1 to select the higher output voltage.

From the swinger of relay K1, the voltage is rectified and filtered to develop a +28/18 vdc unregulated source (+28 vdc whenever K1 energizes). The unregulated voltage is also applied to the input of a series regulator. The regulator, controlled by a sense amplifier, regulates an output source voltage for +24/14 vdc. The sense amplifier monitors the output voltage level. Whenever the higher output voltage level (+24v) is selected, relay K1 switches in additional circuitry to change the sense level from 14 to 24 volts.

Two secondary windings from the power transformer develop 6 vdc regulated; one +6v, the other -6v. Each supply is rectified, filtered and regulated by means of a series regulator and a sense amplifier. The sense amplifier senses the output voltage which then is used to control the regulator.

The fourth secondary winding from the transformer is rectified and filtered to deliver a +24 vdc unregulated voltage supply. The BATAC unit (small power supply) is connected to this supply to derive power for running the cooling fan. In the power supply using 12 volts as its source, the BATAC is connected to the 12 volt input.

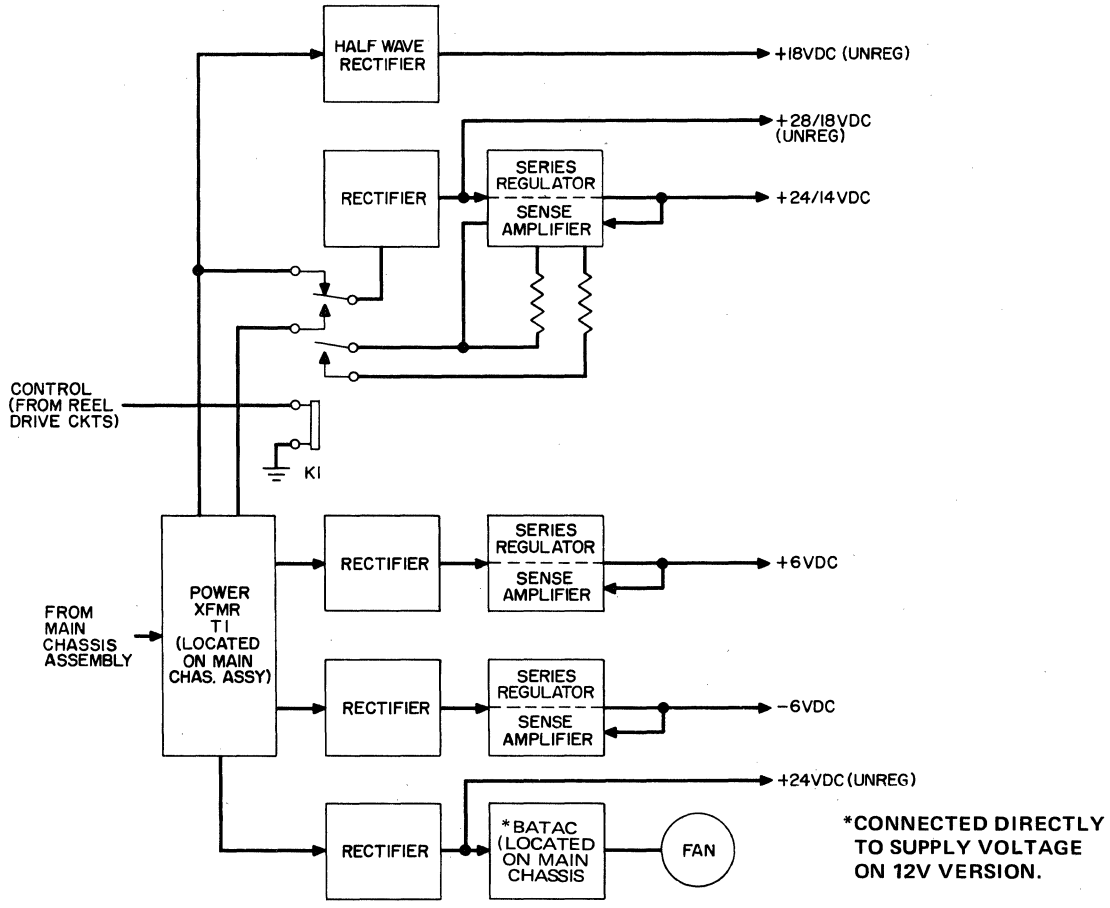


Figure 5-4. Rectifier Assembly and Regulators (804861)

3. CIRCUIT DISTRIBUTION

The six voltages developed in the above circuits power all the electronic circuits in the SABRE VI.

The +18 vdc unregulated supply drives the supply reel drive motor. During forward tape motion, the supply reel is the inner reel while during reverse the supply reel becomes the outer reel. A motor reversing relay K2 (located inside the unit) is responsible for reversing voltage to the reel drive motors.

The +28/18 vdc unregulated supply is a dual voltage source for driving the take-up reel drive motor. The higher voltage (+28 vdc) is selected for tape speeds of 120 ips or for a FAST mode after the capstan rotational speed has exceeded 60 ips in speed. The control line for switching relay K1 (which selects the higher voltage tap on the transformer) is controlled from the reel drive board which derives its input from the tachometer.

The +24/14 vdc regulated supply is a dual voltage source used to drive the capstan motor. The 14 vdc is used for tape speeds of 60 ips and lower. However, when a tape speed of 120 ips or a FAST mode is selected, a transfer to 24 volt occurs after the rotational speed of the capstan has increased beyond 60 ips. This gives the capstan motor additional drive power. The switchover is accomplished from the same relay (K1) as the above voltage transfer.

The +6 volt regulated and the -6 vdc regulated voltages power the major portion of the circuitry located on the circuit boards within the unit. This includes all the record boards, reproduce boards, mode control board, reel drive board, capstan boards, etc.

The +24 vdc unregulated supply energizes three power switching relays in the unit and one in the power supply, the pinch roll solenoid, cooling fan (except 12 volt) and STOP light whenever the proper logic is applied. The relays are located inside the unit to the lower left. Relay K1 energizes when tape is properly threaded, thus supplying voltage to the capstan and reel drive motors. Relay K2 is the motor reversing relay which is energized during any tape reverse mode. Relay K3 is energized to supply +6 vdc and -6 vdc to all record boards during a record mode. The pinch roll solenoid is energized any time tape motion occurs.

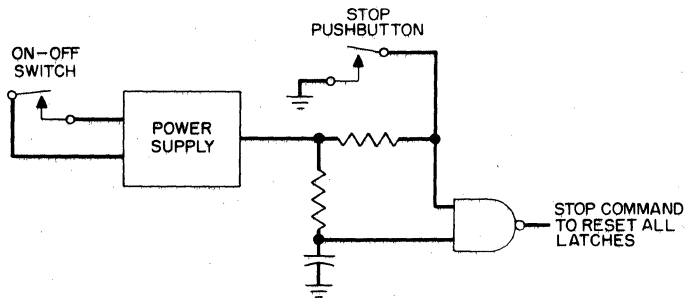


Figure 5-5. Power-on Mode, Simplified Block Diagram (804862)

E. MODE CONTROL CIRCUITS

The mode control circuits respond to operators commands from the control module or certain other internally generated commands to place the unit into a particular mode. The logic of these circuits is designed to prevent double commands and accidental recording over other data. Any time a pushbutton is depressed (except for record), that command takes precedence and the unit assumes that mode. In order to relate the following discussion to the operation of the unit, refer to the block diagram with each description and to the schematic diagram of the control logic board located in the section for Mode Control Servicing.

1. POWER ON

When the ON-OFF switch on the front of the unit is depressed, power to the power supply is applied and the supply voltages begin to "come up". When this happens, a resistor and capacitor (an RC time constant) located on the logic board holds a STOP command on until the power supplies are fully up to operating voltages. Doing this ensures that all latches on the logic board are in their reset condition.

2. STOP

Any time the STOP pushbutton on the Control Module is depressed, a STOP command is applied to the logic board. This command is applied through a gate to reset all three tape motion latches (forward, reverse, and fast). With all three latches reset, tape motion is stopped. Logic levels from the three latches are applied through a NOR gate to drive an indicator driver. The output drives the STOP indicator to indicate all latches are in the reset condition

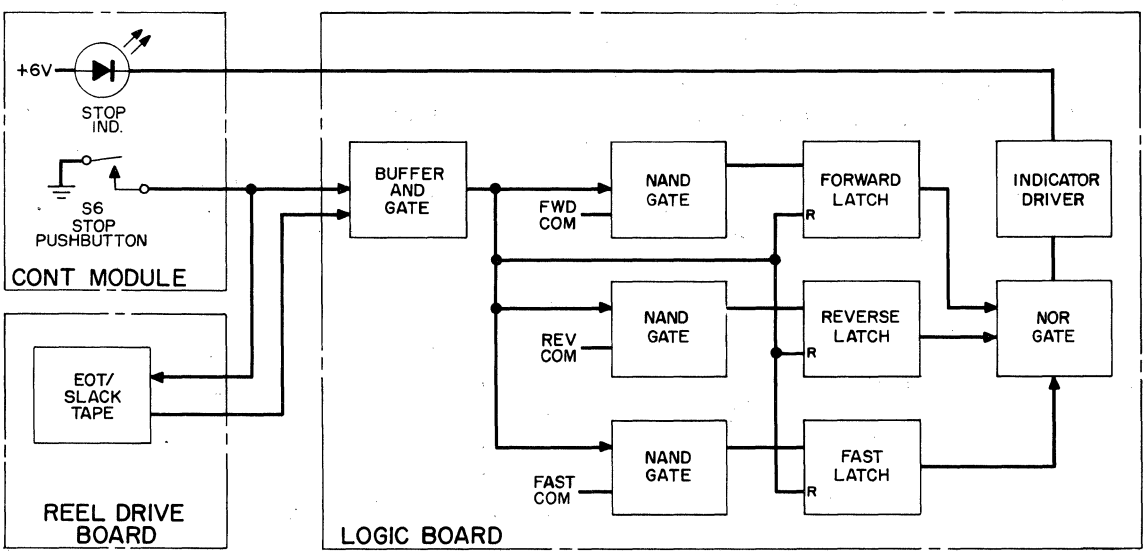


Figure 5-6. Stop Mode, Simplified Block Diagram (804863)

The STOP command is also applied to NAND gates which drive the set inputs of the three latches. During the presence of this command, a FORWARD, REVERSE, or a FAST command is inhibited. After the STOP pushbutton is released, then other commands are possible.

Another source generating a STOP command is loose tape through the tape path when the reel drive tension arms are allowed to reach their "at rest" position. A tight tape sense circuit on the reel drive board sends a STOP command to the logic circuits. This command results in the same action as the STOP pushbutton.

If, when threading the tape or due to some other cause, loose tape does exist, depressing the STOP pushbutton sends a logic signal to the reel drive board. On the reel drive board, a pulse is generated to temporarily (two seconds) energize the motor drive relay K1 (See DC Power Distribution). When this occurs, power is applied to both reel drive motors, resulting in the tape tightening and the lifting of the tension arms off their stops.

3. FORWARD

After the power has been applied, the tape properly threaded, and in the STOP mode, the unit is prepared for operating commands. Depressing the FWD pushbutton results in the following action.

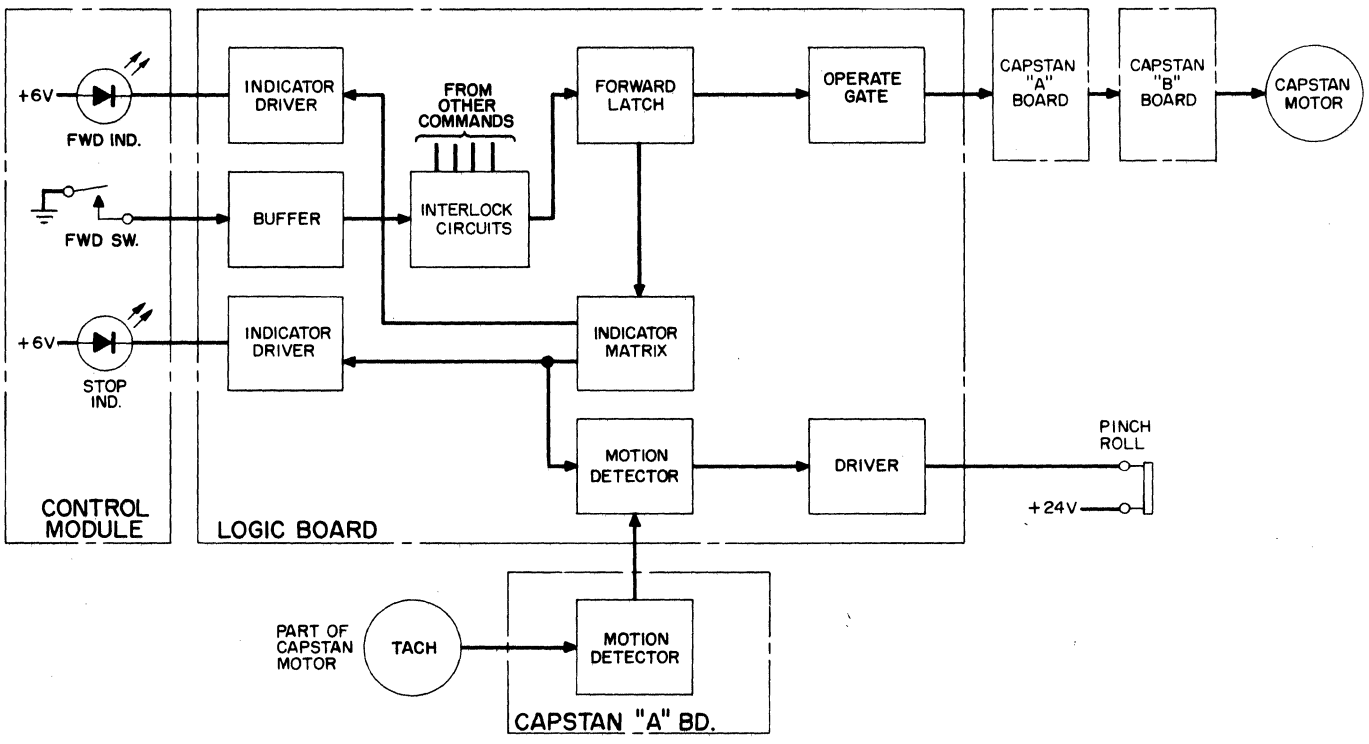


Figure 5-7. Forward Mode, Simplified Block Diagram (804864)

When the FWD pushbutton is depressed, the command passes through a buffer into an interlock circuit. The interlock circuit prevents more than one command from entering the logic at one time. If no other pushbutton is depressed (exception is RECORD) simultaneously with FWD, the command passes through to set the FWD latch. When this is accomplished, several actions take place. The FWD latch instructs the indicator matrix to turn the STOP lamp "off" and to turn the FWD light "on". Also, the output of the indicator matrix is connected to a motion detector circuit to detect a tape motion command. The circuit applies its output to a driver stage causing the pinch roll solenoid to pull-in.

At the same time the pinch roll solenoid is energizing, the fwd latch applies a signal to an operate gate. The operate gate output is directed to the capstan A board to start the capstan into motion. The operate signal starts the capstan A and capstan B boards processing speed control signals to drive the capstan motor. Since the pinch roll solenoid has already been energized, the capstan begins to move tape. As soon as the capstan is rotating, the signal from the capstan motor drives a motion detector circuit on the capstan A board. The output of this circuit is applied to the motion detector circuit on the logic board. This signal ensures that the pinch roll remains engaged as long as the capstan is rotating.

4. REVERSE

The REVERSE mode operates in the same fashion as the FORWARD with the following differences.

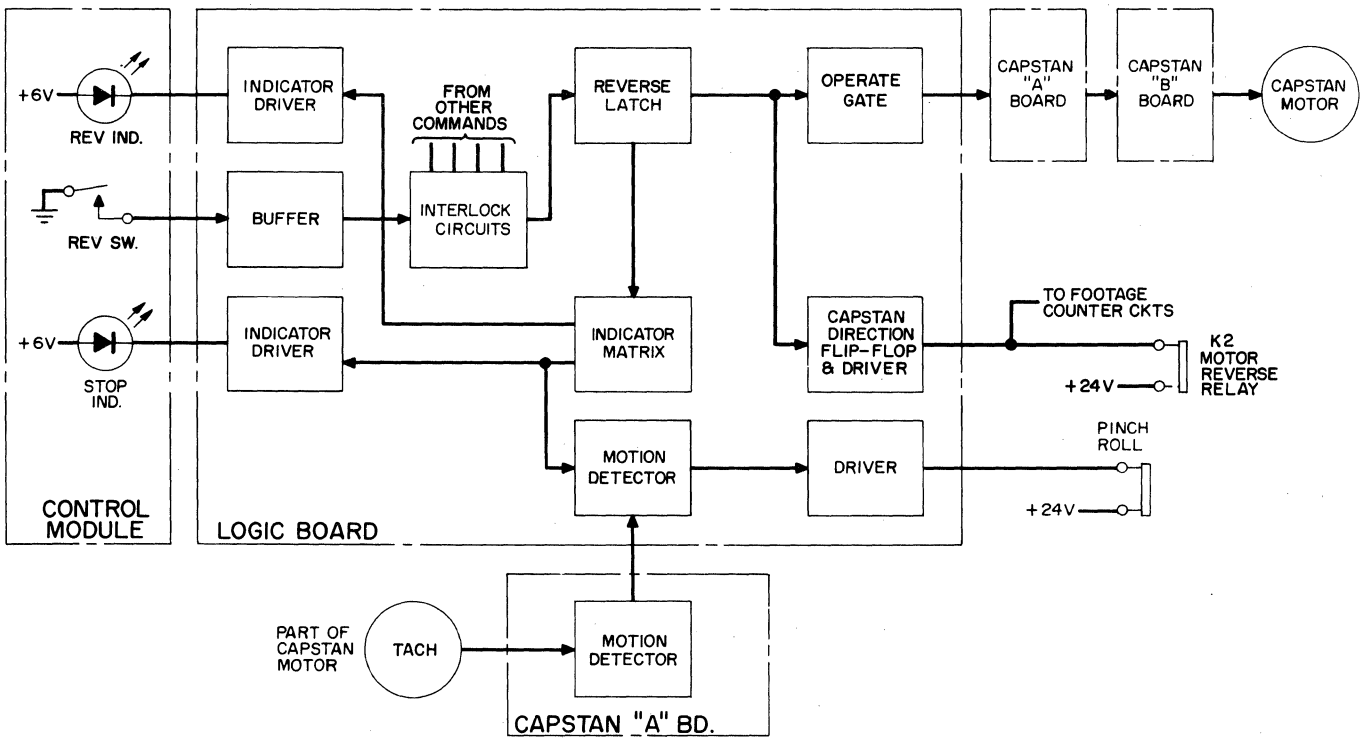


Figure 5-8. Reverse Mode, Simplified Block Diagram (804865)

When the REV latch sets, a capstan direction flip-flop changes state. The output is applied through a driver and then to motor reversing relay K2. When relay K2 energizes, the drive current is reversed through the motor windings to run the capstan in the reverse direction.

The same control line reversing relay K2 is also applied to the footage counter circuit board. The function of this signal is to reverse the counting order of the footage counter causing the readout to count down.

5. FAST FORWARD

When the FAST FWD pushbutton is depressed, the command passes through a buffer into an interlock circuit. The interlock circuit prevents another command from occurring simultaneously. From the interlock circuit, the FAST FWD command is applied to set the fast latch and the fwd latch.

Setting the fast and fwd latches starts a number of actions. The fast latch instructs the indicator matrix to "turn off" any other indicator light on the control module except the FAST FWD indicator. The line causing the STOP indicator to go out also is connected to a motion detector circuit to indicate a tape motion mode is being entered. The output of the motion detector is applied through a driver and then applied to the pinch roll solenoid. This causes the pinch roll solenoid to pull-in.

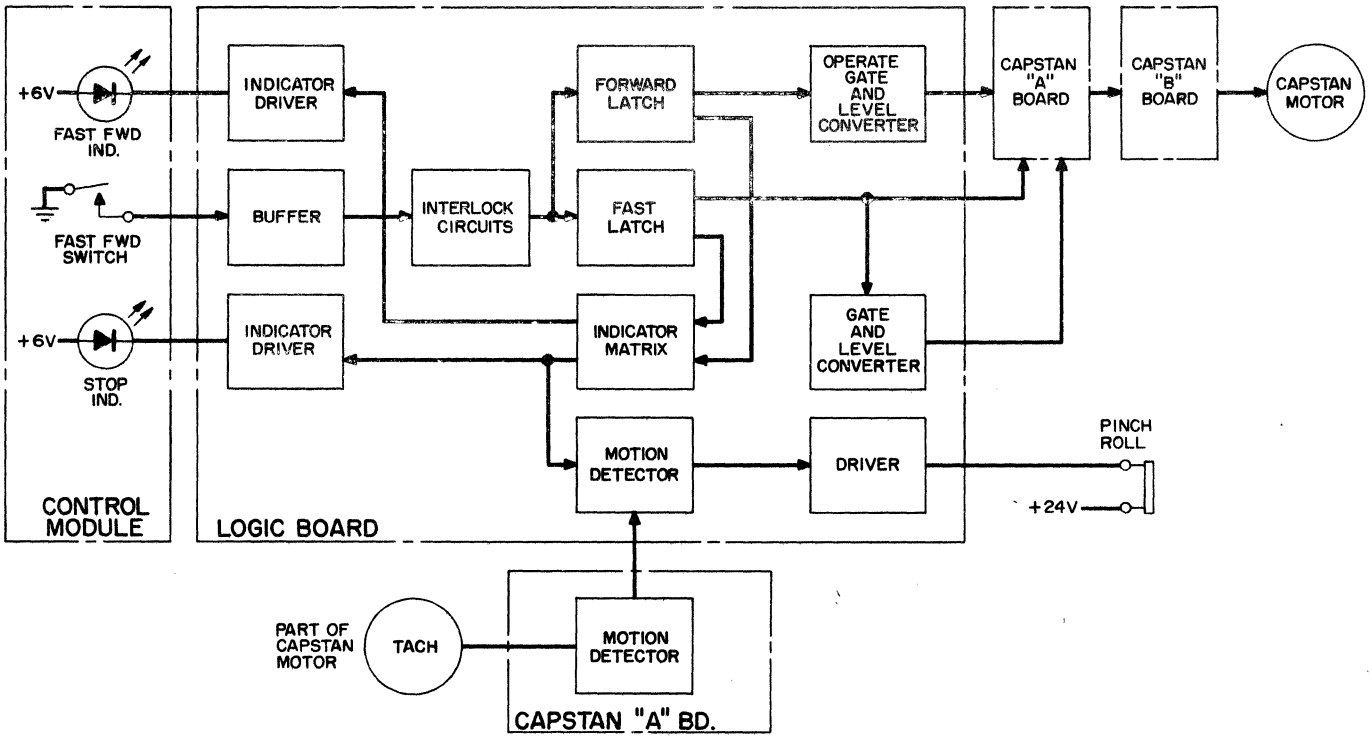


Figure 5-9. Fast Forward, Simplified Block Diagram (804866

At the same time the pinch roll solenoid is energizing, the fwd latch applies a signal to an operate gate and level converter circuit. The output of this circuit is directed to the capstan A board. The capstan A board, along with the capstan B board, begin their function of simultaneously starting and driving the capstan motor. (See Speed Control Circuits). Since the pinch roll solenoid has already been energized, the capstan begins to move tape. When the capstan's rotational speed attains a certain speed, a frequency generated by the tachometer in the capstan motor drives a motion detector circuit located on the capstan A board. The output of this circuit drives the motion detector circuit on the logic board to ensure that the pinch rollers remain engaged as the capstan is rotating.

The fast latch output is applied to two additional circuits. One circuit is a level converter which is applied to the capstan A board. This signal is combined with the operate gate signal to instruct the speed control circuits to drive the capstan motor in a FAST mode. The second circuit is a gate and level converter which is applied to the tape sync board (located on the back of the capstan A board) to disable a tape sync signal on tape from controlling the speed control circuits.

6. FAST REVERSE

The FAST REVERSE mode operates in the same fashion as the FAST FORWARD mode with the following differences.

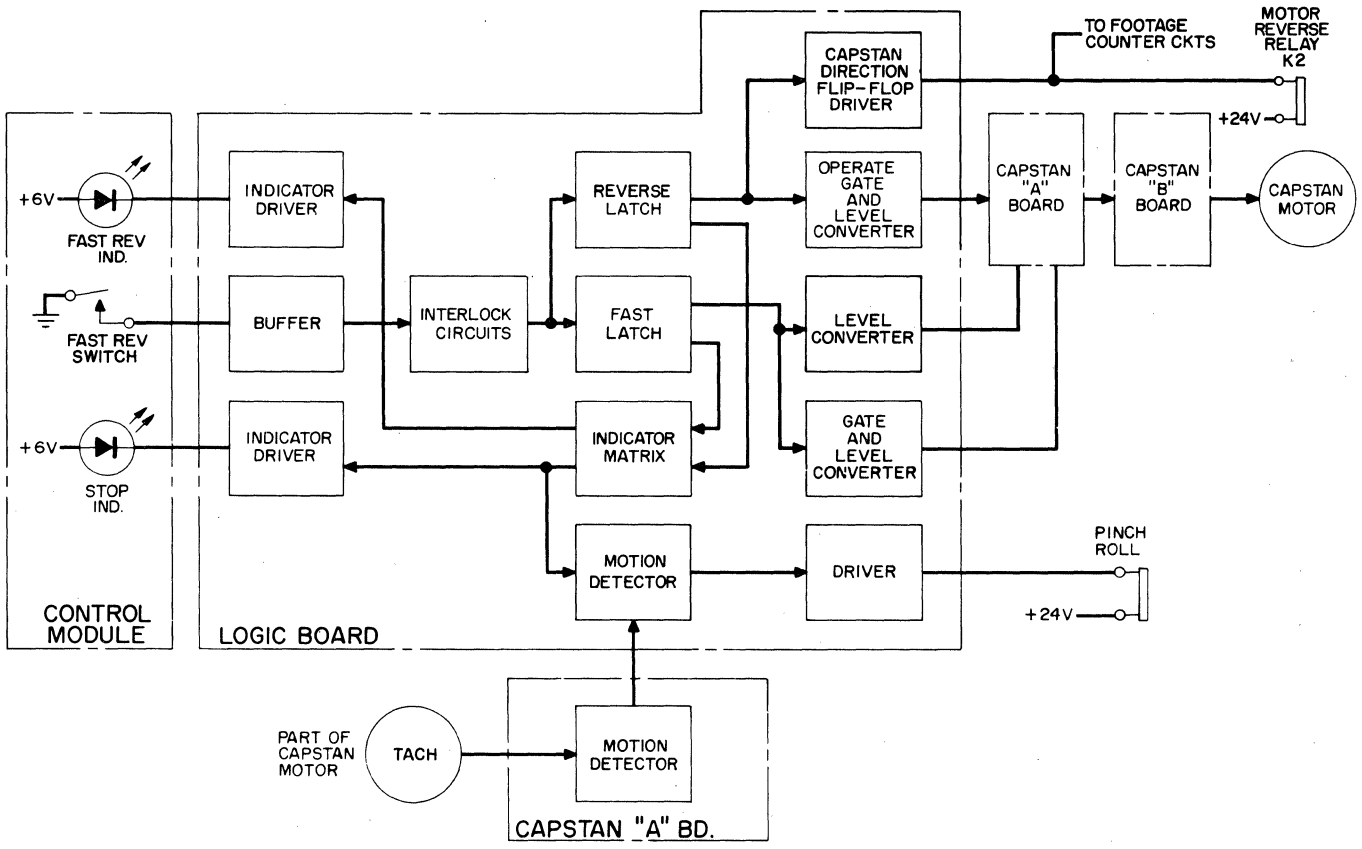


Figure 5-10. Fast Reverse, Simplified Block Diagram (804867)

When the rev latch sets, the capstan direction flip-flop changes state. The output is applied through a driver to energize motor reversing relay K2. When relay K2 energizes, the drive current is reversed through the motor windings to drive the capstan in the reverse direction.

The same control line reversing relay K2 is also applied to the footage counter circuit board. The function of this signal is to cause the counting circuit to count down instead of up.

7. RECORD

Two methods of entering the RECORD mode are accessible to the operator. With the unit in the STOP mode, the operator may depress the RECORD pushbutton placing all the electronics into the RECORD mode without moving tape. This is useful during calibration or troubleshooting. The other method is the normal RECORD mode. To enter this mode, the operator must depress both the RECORD and FWD (or REV) pushbuttons together being sure to release the FWD pushbutton before the RECORD pushbutton is released. If this procedure is not followed, the unit will move tape forward (or reverse) but will not record.

When the RECORD pushbutton is depressed, the signal passes through a buffer into the interlock circuits to set the record latch. The interlock circuits determine the sequence of button pushing to instruct the unit how to respond. Depressing the RECORD pushbutton sets the record latch while depressing the FWD pushbutton sets the fwd (or rev) latch (as described for the forward mode). If the RECORD pushbutton were released before the FWD pushbutton, the fwd command through the interlock circuit resets the record latch.

The output of the record latch drives a tape reference gate. The output of this gate drives a level converter with its output being applied to the capstan A board. The tape reference enable signal is applied to the tape sync board to inhibit a tape signal from controlling the speed control system. This means the speed control circuits are operating from the frequency generated by the tachometer.

An output of the record latch also drives a record relay driver to energize record relay K3. When relay K3 energizes, +6 and -6 volts power is applied to all the record boards to activate for recording. Also, a separate contact causes the RECORD indicator on the control module to light.

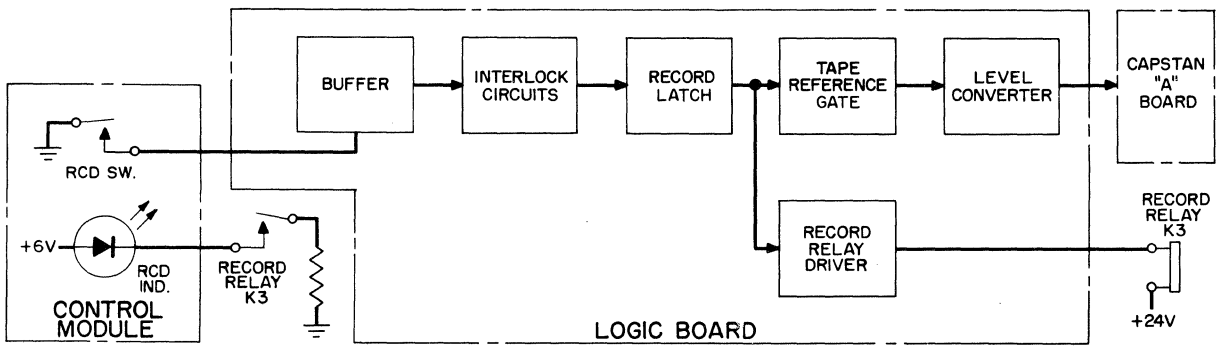


Figure 5-11. Record Mode, Simplified Block Diagram (804868)

8. END-OF-TAPE AND REEL RESET

If the EOT switch is switched ON, the EOT circuits detect the approaching end of tape. The EOT circuits consists of two identical circuits each including a transmitter and a receiver for each reel. The two transmitters are positioned to transmit light through the channel of each reel to the opposite side for striking the receivers. When a reel of tape is nearly spent, light from the transmitter passes to the receiver just before all tape is removed from the reel. When this occurs, the tape stops.

In the FORWARD mode, with the tape just starting to wrap onto the take-up reel, the reverse sense receiver of the EOT circuits send a command to the end of reel sense circuits on the logic board. This is due to the fact of insufficient tape on the take-up reel to block the light from reaching the receiver. However, the end of reel sense circuits inhibit action because the fwd latch has conditioned these circuits to accept only the command from the supply reel. When tape has emptied from the supply reel, the EOT circuit combines its output with the fwd latch output to produce a command for the EOT/slack tape control on the reel drive board. This circuit then returns a command to a buffer and gate circuit on the logic board. The output of this buffer resets all latches causing the unit to come to a stop.

The EOT circuits operate in the same manner in the reverse mode as in the forward except the outer reel becomes the supply reel making that receiver the active circuit. When light is finally sensed by the receiver, the command combines with the rev latch output to initiate a STOP command.

When power is first applied to the unit, or sometimes after threading, the tape may remain loose enough for the tape tension arms to rest on their stops. If this occurs, microswitches remove a grounding signal to the take-up reel control circuits on the reel drive board. The output de-activates a switch to cause motor drive relay K1 to de-energize. This action removes the voltage supply to reel drive motors and the capstan motor.

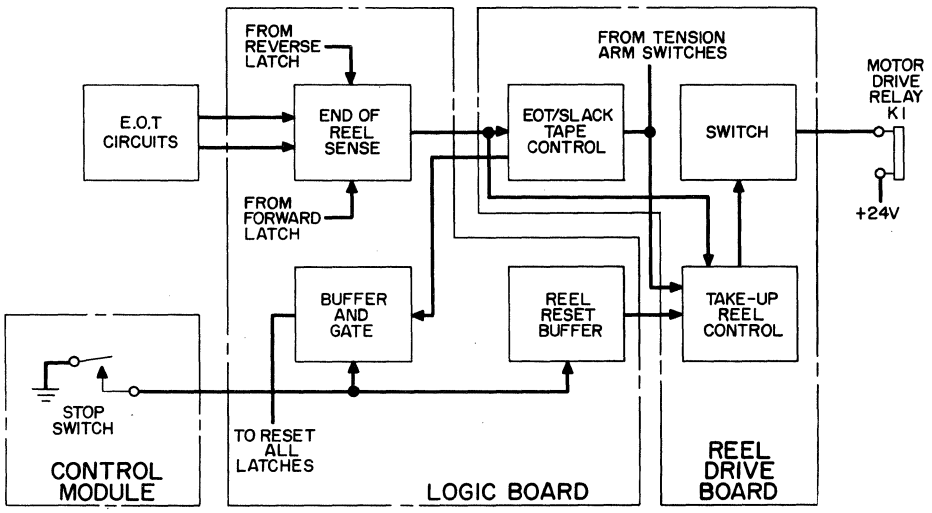


Figure 5-12. EOT and Reel Reset, Simplified Block Diagram (804869)

F. SPEED CONTROL CIRCUITS

The speed control 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 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 by one of the two following methods of servo speed control.

The primary method of controlling tape speed is called CAPSTAN SYNCHRONOUS control. During capstan synchronous, an internally generated crystal signal becomes a reference against which a tachometer signal (generated by 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 which increase or decrease the tape speed.

In order to achieve greater speed control accuracy, a second method called TAPE SYNCHRONOUS control is available as an option. To use this method, the internal reference signal from the crystal oscillator is recorded on tape during the record process. When the tape is reproduced, this signal is recovered from tape and compared (in lieu of the tachometer signal) with the reference frequency of the crystal oscillator. Any difference in frequency and phase is converted into error difference signals to increase or decrease the tape speed.

The capstan synchronous method of speed control is used primarily during the record mode and the tape synchronous method is used during the reproduce mode. During the reproduce mode, if the voltage level of the reproduced reference signal is insufficient or if the signal is lost due to tape drop-outs, the recorder/reproducer instantaneously reverts to capstan synchronous control.

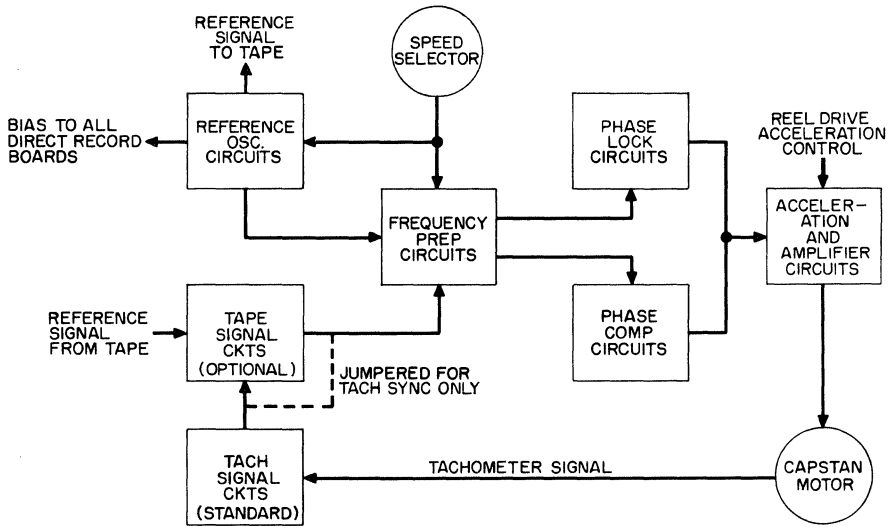


Figure 5-13. Speed Control Basic Block Diagram (804870)

The speed control circuits are divided into the following basic functional circuits. The circuit board or subassembly containing the majority of each function circuit is also listed.

(1) Reference Oscillator Circuits — Capstan A board
(2) Tachometer (Tach) Signal Circuits — Capstan A board
(3) Tape Signal Circuits — Tape sync board and Capstan A board
(4) Frequency Preparation Circuits — Capstan A board
(5) Phase Comparison Circuits — Capstan B board
(6) Phase Lock Circuits — Capstan B board
(7) Acceleration Control Circuits — Capstan B board
(8) Capstan Motor Circuits — Capstan B board and capstan power amplifier

1. REFERENCE OSCILLATOR AND BIAS CIRCUITS

A 7.2 MHz crystal oscillator generates the basic reference frequency for comparison with the tachometer (or tape reference when used) signal. The 7.2 MHz signal is also applied to a bias driver amplifier circuit to develop a bias signal for use with all direct record circuits. The bias signal is only operative during the record mode thus reducing noise during the reproduce mode.

The 7.2 MHz oscillator frequency is also applied through a divide-by-nine circuit to develop the basic 800 kHz reference frequency. The reference is applied to a binary counter to result in eight reference frequencies proportional to the eight tape speeds.These frequencies (800, 400, 200, 100, 50, 25, 12.5, 6.25 kHz) are applied to a frequency selector which selects an output frequency by its position. The selected output is applied to a divider circuit capable of dividing by two or four with the two outputs being applied to a density switch. The density switch is controlled by the position of a jumper in the density input line. When the jumper is placed in the high position, high density is selected and the divide-by-two frequency is selected for recording on tape as the reference frequency. When the jumper is in the low position, the density switch selects the divide-by-four frequency from the frequency selector for recording on tape. The output of the frequency selector is also used to drive additional circuits (frequency preparation) of the speed control circuits.

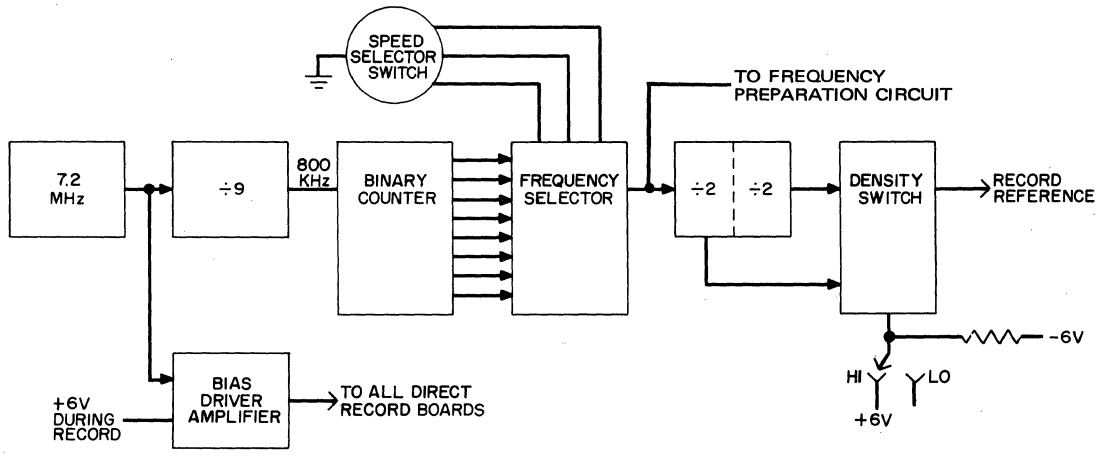


Figure 5-14. Reference Oscillator and Bias Circuits, Simplified Block Diagram (804871)

The output of the density switch is applied to the REF connector on the I/O Connector Panel and is recorded on tape for tape synchronous control (optional). This output is not used for capstan synchronous control. The frequencies available at the REF connector are shown in Table 5-1.

TABLE 5-1. TAPE SPEED VS. REF. FREQUENCY

Tape Speed (ips)	High Density (kHz)	Low Density (kHz)
120	400	200
60	200	100
30	100	50
15	50	25
7-1/2	25	12.5
3-3/4	12	6.25
1-7-8	6.25	3.12
15/16	3.12	1.56

2. TACHOMETER SIGNAL CIRCUITS

A tachometer signal is generated within the capstan motor mounted on the tape transport. A slotted opaque disc, rotating in front of a photocell, produces an output signal that is amplified and quantized (squared) to develop a squarewave within the capstan motor. The frequency of the tachometer output is proportional to the rotational speed of the capstan. The squarewave tachometer output is applied to the capstan A board. On the capstan A board, the tachometer signal is inverted by a buffer and applied to the tape sync board (optional). If the tape sync board is not used, a jumper jumps the tachometer signal directly to the frequency preparation circuits.

From the buffer, the tachometer signal is also applied to the footage counter circuits to indicate feet of tape travel (see monitor circuits) and to a motion detector circuit. This circuit provides no output until the capstan reaches sufficient speed to produce a frequency of approximately 1 kHz. When an output occurs, current is drawn through an elapsed time meter to indicate hours of use. A second output is directed to the mode control circuits to prevent direction changes of the capstan until the capstan rotation is stopped. The same control is also applied to the reel drive circuits.

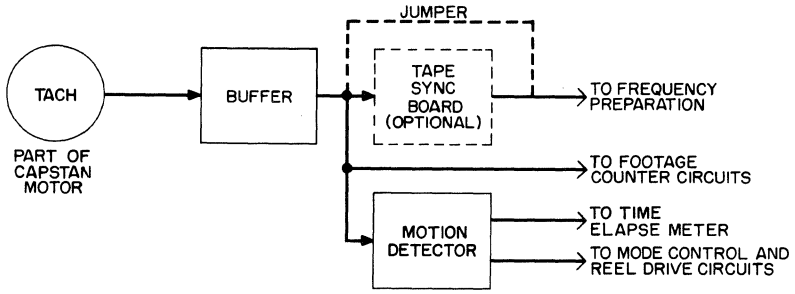


Figure 5-15. Tachometer Signal Circuits, Simplified Block Diagram (804872)

3. TAPE SIGNAL CIRCUITS

During the reproduce process, the recorded tape sync signal is recovered from tape amplified, and applied to the tape sync board via the REF IN jack on the I/O Connector Panel.

Upon entering the tape sync board, the tape signal is applied to two circuits. One circuit receiving the tape signal is a tape detector which indicates by means of a logic level at its output that a tape signal is being received. The second circuit is a Schmitt trigger which squares and adjusts the level of the tape signal. The output of this signal is applied to an output switch and a divide-by-two circuit. The output of the divide-by-two is also applied to the output switch. A third signal being applied to the output switch is the tachometer signal from the buffer on the capstan A board. The function of the output is to select one of these three signals being applied to its three inputs.

The three signals applied to the inputs of the output switch consist of (1) the high density tape sync signal (not divided), (2) the low density tape sync signal (divided-by-two), and (3) the tachometer signal generated by the capstan motor. The signal that is selected to pass through the output switch is controlled by an output selector circuit. When the tape detector indicates a tape reference from tape and a tape enable reference for the logic circuits is present, one of the two tape signals passes to the output. The tape enable reference is present during a reproduce mode. The selection between the two frequencies is accomplished by the position of the jumper controlling the logic level of the density input. If the jumper is placed in the HI position (logic 1) then the higher frequency passes through the output switch. The third possibility, the tachometer signal, is controlled by the tape detector circuit. If no tape signal is recovered, the tape dector produces no output and the output switch selects the tachometer signal as the output.

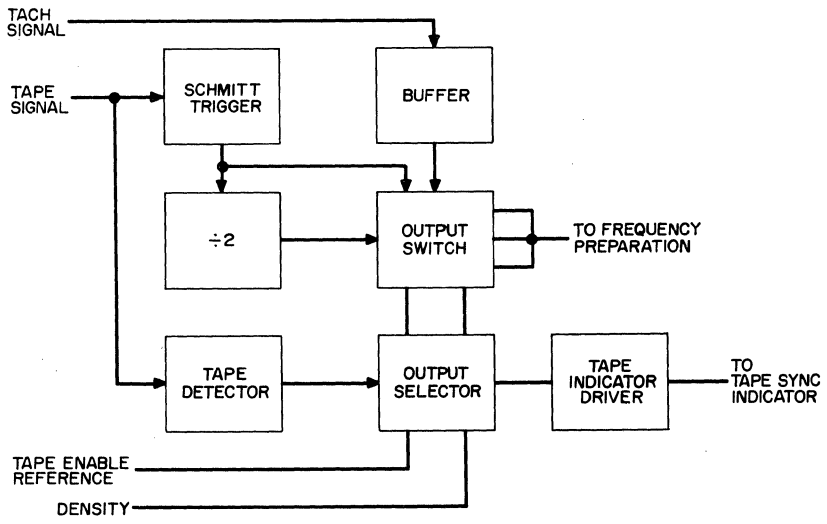


Figure 5-16 Tape Signal Circuits, Simplified Block Diagram (804873)

4. FREQUENCY PREPARATION CIRCUITS

The primary input signals to this portion of the speed control circuits originate with the tape signal or tachometer signal circuits (tape/tach reference) and with the reference oscillator and bias circuits (oscillator reference). The purpose of the frequency preparation circuits is to count down and select the correct frequencies for comparison during the selected modes of operation.

The tape/tach signal is derived from the output switch of the tape signal circuits (or buffer of the tach circuits) is applied directly to a 120 ips select switch. If a tape speed other than 120 ips is selected at the control module, the tape/tach signal passes through without change. If a tape speed of 120 ips is selected, a divide-by-two frequency passes through the select gate (see Table 5-2). The 120 ips select switch is activated by a command from the capstan B board.

The oscillator reference is prepared in the same manner. The frequency, determined by tape speed, at the output of the second divide-by-two is equal in frequency to the operating tape/tach signal. In the operate mode, the reference oscillator frequency passes through mode select switch directly to a reference frequency switch. This switch operates in the same manner as the 120 ips select switch. The reference signal is also divided-by-two at 120 ips resulting in the same frequencies as shown in Table 5-2.

TABLE 5-2. SPEED VS. REFERENCE FREQUENCIES

Tape Speed (ips)	Frequency (kHz)
Fast	266.6
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	1.56

Whenever a fast (slew) mode is selected, a higher oscillator reference is required to drive the phase comparison circuits for a faster rate. The higher frequency is obtained by dividing the 800 kHz frequency by three and applying the 266.6 kHz frequency through the mode select switch to a frequency detector. A second input to the frequency detector is the tape/tach signal. When the FAST pushbutton on the Control Module is depressed, the mode selector switch applies the 266.6 kHz directly to the frequency detector. As long as there is a differnece in frequency at the two inputs of the frequency detector, the output is produced to drive the capstan. As the two

frequencies become equal, the output of the frequency detector reduces. Whenever there is a difference in phase angle between the two signals, a pulse equal in length to the phase angle is produced. The pulse may be either above zero or below, depending on whether the capstan is running slightly too fast or too slow. The pulse is used to adjust capstan speed up or down until the proper speed is attained.

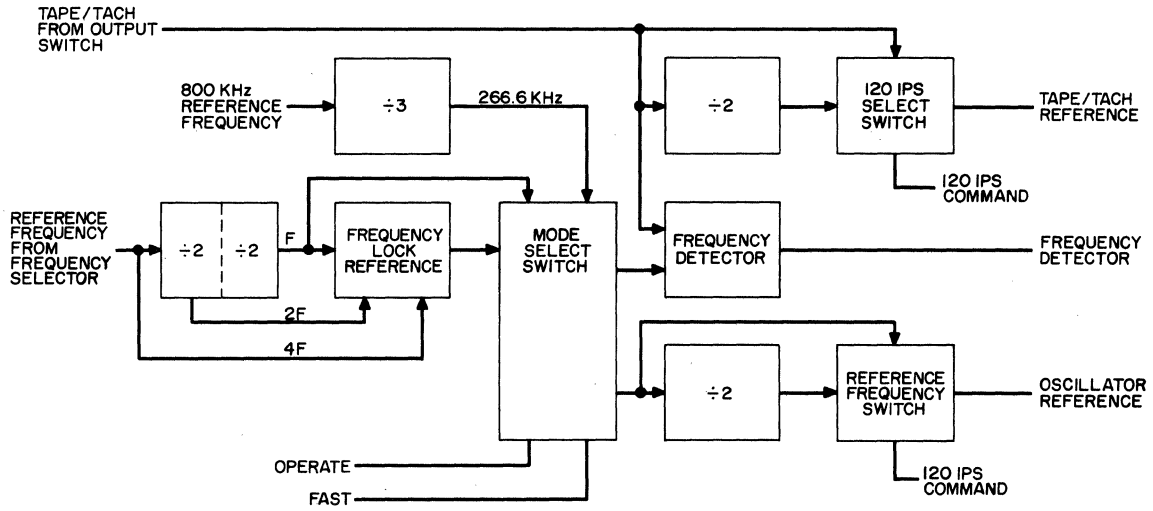


Figure 5-17. Frequency Preparation Circuits (804874)

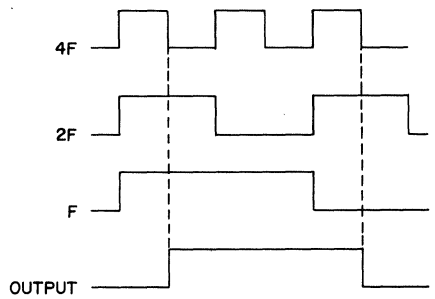


Figure 5-18 Delayed Reference Waveforms (804875)

The frequency detector is also used during normal operation for two additional purposes; (1) start-up time and (2) tape speed change. To do this, a frequency lock reference circuit processed three signals from the oscillator reference (F). The frequency lock reference circuit accepts three inputs (F, 2F, and 4F) from the divide-by-four circuit with timing relations as shown in figure 5-18. The output, which is applied to the mode select switch lags the reference by nominally 1/8 time period. This lag allows the frequency detector to operate at an optimum point.

5. PHASE COMPARISON CIRCUITS

The primary function of this portion of the speed control circuits is to compare the oscillator reference to the tape/tach reference for phase differences and to develop a dc voltage level proportional to tape speed.

Both the oscillator and the tape/tach reference signals are applied to a phase detector circuit located on the capstan B board. This circuit compares the two signals to develop two trapezoidal shaped signals, which are 180 degrees out of phase with one another. The rise and fall time of each signal is equal to the phase difference between the two original reference signals. These two trapezoidal signals are then added together to produce a dc amplitude proportional to the phase difference between the two signals due to speed differences. The summed signals are applied to a dc amplifier to amplify the signal and applied to a driver control circuit which acts as a selector gate for several other signals. The signal selected is the one used to drive the capstan.

Speed lines from the speed selector switch are also applied to the phase detector circuits for the purpose of selecting correct RC time constants. These RC time constants shape the trapezoidal signal with the proper rise times for each tape speed.

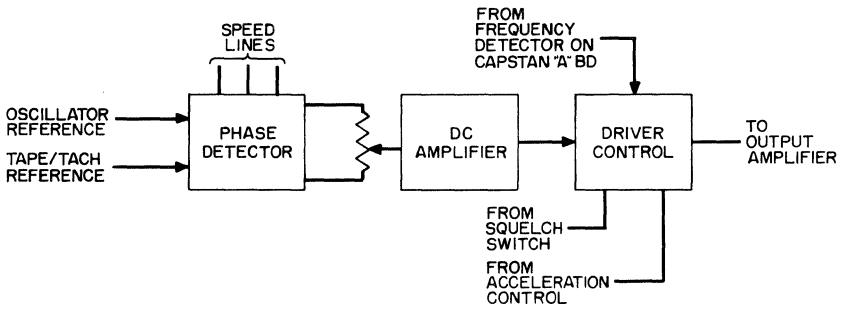


Figure 5-19. Phase Comparison Circuits, Simplified Block Diagram (804876)

6. PHASE LOCK CIRCUITS

The phase lock circuits consist of a phase lock detector, a phase lock enable switch and a phase lock driver. These circuits provide switching inputs to the driver control circuits to select the output from the frequency detector during the period the system is not in phase lock. A squelch signal is also produced to prevent all reproduce boards from having an output until the capstan has attained its proper speed. From the phase detector, the two reference signals are applied to the phase lock detector circuit. During the time the two signals do not match, an output is provided through a phase lock enable switch to the driver control. The driver control selects the signal from the frequency detector on the capstan A board as its output. This signal is greatest when the error between the two reference signals is greatest. The output of the driver control drives the capstan.

A second use for the output of the phase lock enable switch is to drive the squelch driver. The output of the squelch driver is applied to all the reproduce boards to inhibit all outputs until the capstan reaches its proper speed. A phase lock driver also uses the same signal to drive the phase lock indicator on the control module.

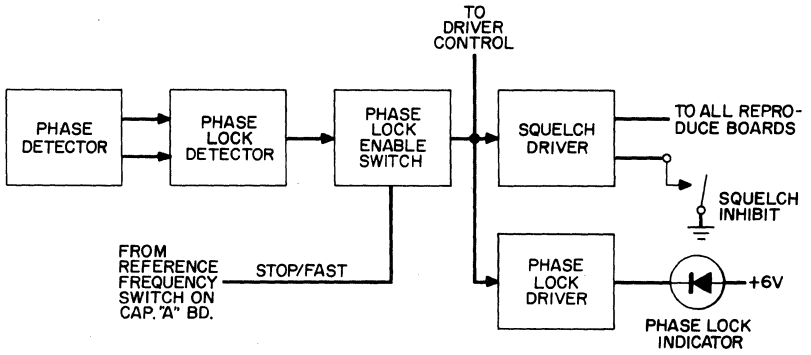


Figure 5-20. Phase Lock Circuits, Simplified Block Diagram (804877)

7. ACCELERATION CONTROL CIRCUITS

The acceleration control circuits 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 acceleration control circuits sense the voltage across the capstan motor. The greater the voltage difference across the inputs of the acceleration circuit, the greater the output. When the tape is gaining velocity, the phase lock enable switch is applying the frequency detector signal through the drive control circuits. During this time, the accelerations control signal is added to the drive control circuits to retard the high acceleration demanded. As the tape gains speed, the acceleration control output reduces until it no longer is required.

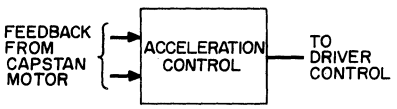


Figure 5-21. Acceleration Control Circuits, Simplified Block Diagram (804878)

8. CAPSTAN MOTOR CIRCUITS

The capstan motor circuits consist of the output amplifier (on capstan B board), a motor drive amplifier (part of), a tape direction relay, and the capstan motor.

The output from the driver control is applied through an output amplifier and level control circuit to a motor drive amplifier. Conduction of the motor drive amplifier regulates the current flow through the capstan motor, thus controlling the capstan rotational speed. A tape direction relay establishes the direction of current flow through the capstan motor, thus controlling the direction of rotation.

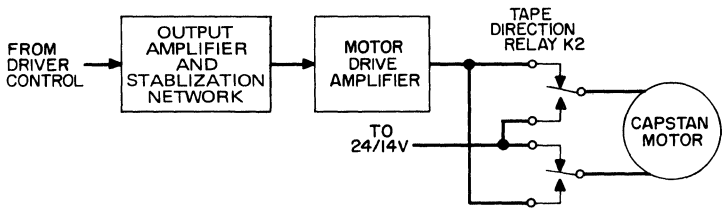


Figure 5-22. Capstan Motor Circuits, Simplified Block Diagram (804879)

G. REEL DRIVE CIRCUITS

The reel drive system incorporates dual control for both the inner and outer reel hubs. 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.

In a slack tape or no tape condition, the tape tension arms are held at their extreme rest positions by springs. When the tension arms are in their extreme rest position, microswitches are activated to disable the recorder/reproducer from normal operation. This is to ensure in the event of a broken tape, empty reels, or an extreme slack condition the recorder/reproducer does not continue to run.

A vane, attached to each tape tension arm, moves between the lamp and the photocell on the 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 attained by the photocell thus varying the output current. With the photocell completely shaded, the current output is near zero and with the photocell completely illuminated the current output is 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 amount of vane movement off center.

The reel drive board consists of two separate channels, one for each reel drive servo system. Each channel consists of a dc servo amplifier with a dynamic braking circuit for each reel drive motor in the event of power failure. The primary function of the circuits on the reel drive board is to respond to inputs from the photocell assemblies associated with the tape tension arms and provide outputs to both reel drive ampifiers. Since both channels of the board are similar, the following discussion pertains only to one channel.

Power is applied to the reel drive circuits upon initial application of power to the recorder. After the tape is threaded and the two microswitches are actuated, relay K1 energizes to apply power to the reel drive motor. If slack tape exists, the two microswitches do not actuate, keeping relay K1 from energizing. In this event, the STOP pushbutton on the Control Module initiates a two second pulse to close relay K1 and start the reel drive motor running to take up slack tape. As soon as no slack tape exists, the reel drive tension arm actuates the two microswitches to result in holding relay K1 energized and the reel drive stops in a null position.

When tight tape is achieved, a dc voltage level from the photocell appears on the input to an amplifier. Since the resistance of the photocell decreases when illuminated and increases when shaded, the dc level varies accordingly and is dependent upon the position of the tape tension arm. The dc voltage is amplifed and applied to an emitter follower. The output of the emitter follower is applied to a current driver transistor (part of motor drive amplifier) to regulate the direction and speed of the reel drive motor.

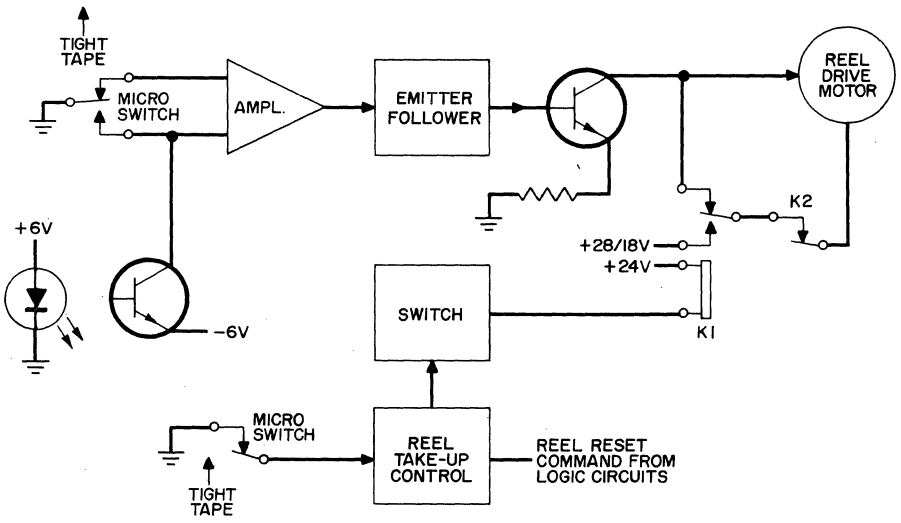


Figure 5-23. Reel Drive Circuits, Simplified Block Diagram (804880)

During normal operation, the take-up reel must take up slack tape. As tape comes from the capstan, the tension arm for the take-up reel moves toward its rest position. Doing this, more light strikes the photocell causing an increase in current through the channel and the reel drive motor. The motor increases in speed and the tension arm is pulled away from its stop resulting in the reel drive motor slowing again. While this is going on, the supply reel is forced to nearly freewheel by the tape being pulled from the reel. As the tape is pulled, the tension arm is pulled away from its at rest position resulting in additional covering of the photocell and less current flow through the reel drive motor. As less and less current is required through the motor, the reel freewheels until the spring tension returns the tension arm toward the at rest position. The result of this action is a slight drag on the supply reel.

The dynamic braking gradually slows down the tape reels in the event of a power failure while tape is moving. With the reels slowly decreasing in speed, chances for tape spillage are greatly reduced. Relay K1 is energized when dc power is applied to the recorder/reproducer and tape is properly threaded. Energizing this relay applies power to both reel drive motors. When power is removed, should the reel be operating, relay K1 (also K2, if energized) drops out to place a short circuit across each motor. With the motors rotating and no power being applied to them, generator action creates a reverse polarity. The loading effect of the generator action, caused by the short circuit, results in a gentle dynamic braking action allowing the reels to come to a smooth STOP.

H. DIRECT RECORD CIRCUITS

The direct record circuits amplify and prepare data and tape sync signals for application to the record head. When the direct record process is used, the data signal to be recorded is amplified, linearly combined with a high frequency bias signal, and applied directly to the record head as a varing ac current. This ac 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 to generate a varying voltage in the coils of the reproduce head.

High frequency bias is necessary 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 and the data signals is a linear mixing process, NOT a modulation process.

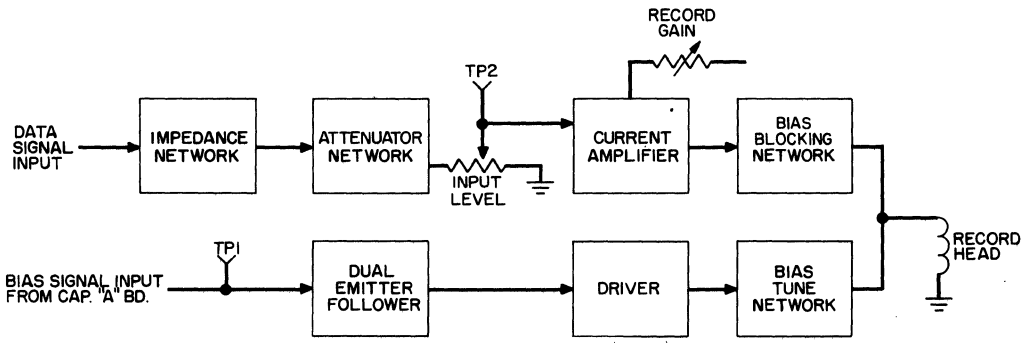


Figure 5-24. Direct Record Circuits, Simplified Block Diagram (804882)

On the boards, the input data signal is applied to an impedance network and to an attenuator network. The impedance network consists of a resistor and a switch. LO and HI positions of the switch provide input impedances of 75 and 10K ohms respectively. The attenuator network consists of a RANGE switch and a voltage divider. This network expands the input capacity of the board, allowing a wider range of input voltage levels to be applied without additional attenuation. The RANGE switch is positioned to encompass the rms level of the input signal to the board.

The output of the attenuator network is applied through input level to the input of a current amplifier stage. Input level establishes the record current through the head and should be adjusted for 0.1 volts rms at TP2, regardless of the amplitude of the input signal. RECORD GAIN adjust establishes a reference current through the head corresponding to the 3rd harmonic of the input signal. This control should be adjusted for 1% 3rd harmonic distortion while observing the reproduced signal from the tape. The output of the current amplifier is applied to a bias blocking network to be combined with the bias signal.

The bias signal is generated on capstan A board. The function of this circuit is to supply a 7.2 MHz signal to add to the direct record signals.

On the direct record board, the bias may be observed at testpoint TP1. The bias is applied through dual emitter followers to driver stage. The driver drives a tuned load consisting of (1) the head winding, (2) the coax cable between the circuit board and the head, (3) two coils and, (4) two capacitors.

I. FM RECORD CIRCUITS

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 produces a changing magnetic flux across the gap in the record head and magnetizes the magnetic tape as it moves across the head.

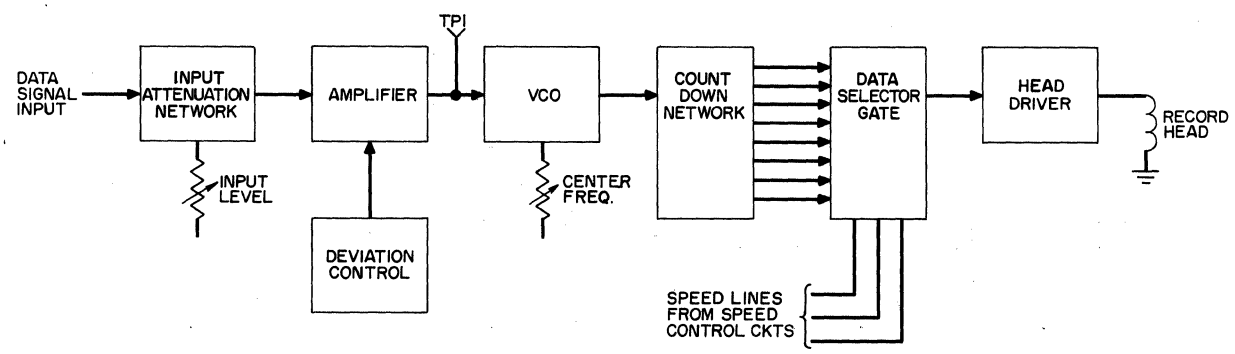


Figure 5-25. FM Record Circuits, Simplified Block Diagram (804883)

A zero voltage signal at the input results in the basic carrier being recorded. A positive dc signal increases the carrier frequency and a negative dc signal lowers the carrier frequency. An alternating data signal deviates the carrier alternately on both sides of the carrier frequency, at a rate equal to the input signal frequency.

The data signal enters the FM record circuits at an attenuation network which produces the proper voltage level for the desired % deviation from the center frequency of the carrier. The data signal is amplified and applied to the VCO (voltage controlled oscillator). A deviation control is a operator control for unipolar deviation. This control can be set for + DEVIATION, NORMAL, or - DEVIATION. The position of the switch determines the center frequency of the VCO operation. In the + or - deviation position, data causes the VCO to swing in only one direction.

The data signal causes the VCO to change frequency. When the data signal raises, the VCO frequency raises. When the data signal drops, the VCO frequency decreases. The amount of frequency change is proportional to amplitude of the data and the rate of frequency change is equal to the frequency of the data.

The output of the VCO is applied to a frequency countdown network with eight outputs being applied to a data selector. The frequency at the output of this gate is selected by the tape speed selected at the Control Module. The frequency selected is applied through a head driver circuit to the record head.

J. DIRECT REPRODUCE CIRCUITS

The function of the direct reproduce circuits is to recover and re-create data from tape recorded with the use of a direct record board and to provide a signal level adequate for use.

The reproduced data is recovered from tape by passing the tape over the head. The magnetic fields on tape induce small voltages into the head windings. The small voltage levels from each side of the head winding passes through an emitter follower for impedance matching. The output of the dual emitter followers is applied through a preamplifier stage to raise the voltage level.

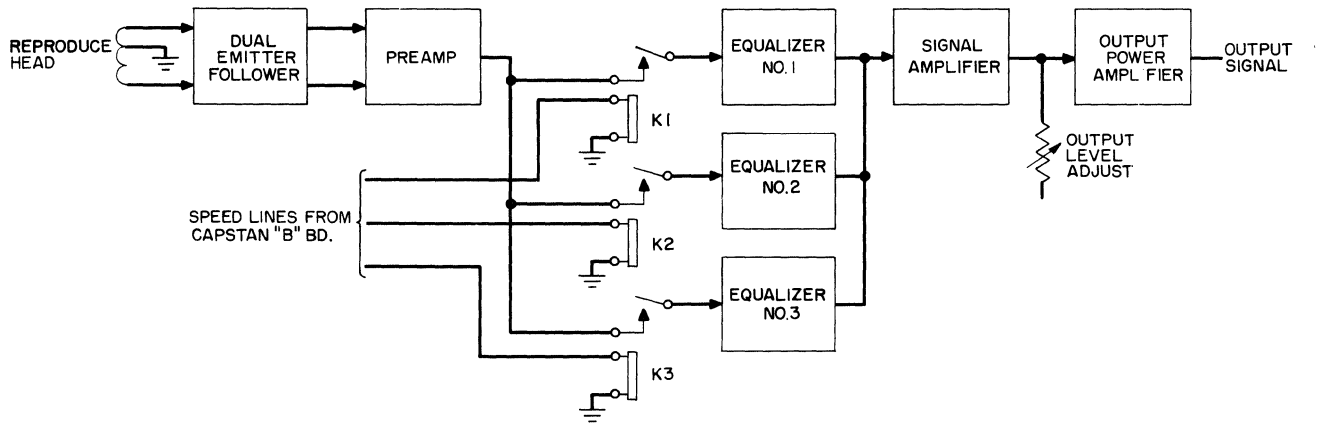


Figure 5-26. Direct Reproduce Circuits, Simplified Block Diagram (804884)

From the preamplifier, the reproduced signal is applied to one of three equalizers. Each equalizer is a plug-in device to provide equalization for a given tape speed. The equalizer selected is controlled from the speed control circuits (capstan B board). The input control to the speed control circuits is from the speed selector switch on the Control Module.

Equalization encompasses two types; amplitude and phase. Amplitude equalization corrects the frequency response of the reproduce head to a flat overall frequency response. Phase equalization corrects for small variations in phase to return the signal to that of the original signal.

The output from the equalizers is applied to two broad-band amplifiers and then to the output. The output level is controlled by the position of an output level adjustment.

K. FM REPRODUCE CIRCUITS

The FM reproduce circuits are used to reproduce frequency modulation data from tape recorded by the use of the FM record board.

The reproduced data is recovered from tape by passing the tape over the head and inducing small voltages into the head windings. The small voltage levels from each side of the head passes through an emitter follower. The output from the dual emitter followers is applied to a preamplifier stage to raise the voltage level.

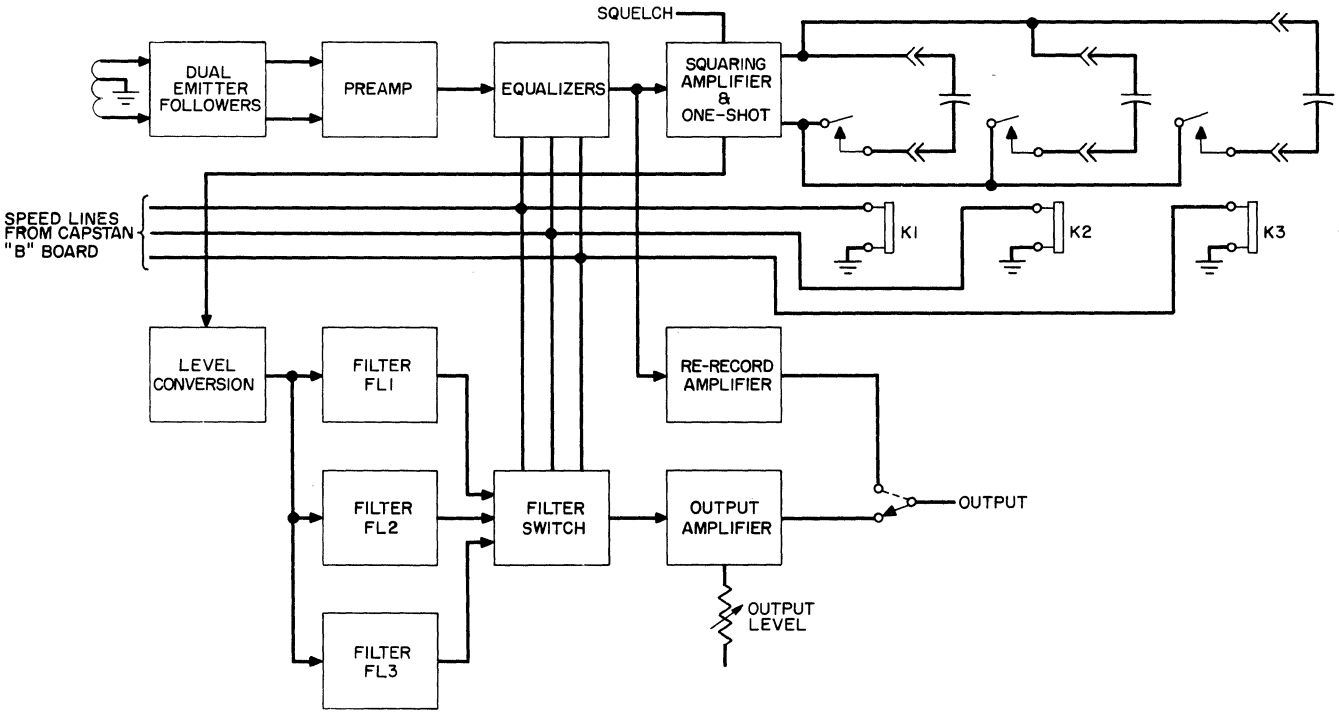


Figure 5-27. FM Reproduce Circuits, Simplified Block Diagram (804885)

From the preamplifier, the reproduced signal is applied to one of three equalizers. The particular equalizer used is selected by the tape speed chosen at the speed selector switch on the Control Module. The three speeds selected by the equalizer are determined by plug-in components. Equalization provides amplitude equalization to correct for the frequency response of the head.

From the equalizer, the signal is applied to a squaring amplifier frequency doubler and a one shot circuit. The circuit is used to square the signal and to make each positive going peak a fixed time length before demodulation takes place. The time length of each pulse is determined by speed sensitive components and speed selective relays.

The signal from the one-shot is applied through a level detector to the three plug-in filters. Each filter is speed sensitive and is selected at the output by a filter switching circuit that is controlled by the speed lines. The function of the filter is to remove or "filter out" the FM carrier leaving only the data signal. The data signal is applied through an output amplifier to the output. An OUTPUT LEVEL control is provided to adjust the amplitude of the output signal. A re-record amplifier may be used to bypass the demodulation process whenever the re-record feature is used.

L. FOOTAGE COUNTER CIRCUITS

The footage counter circuits consist of footage counter board, footage counter display and four rechargeable batteries, all located on the tape transport panel. The footage counter board operates in conjunction with the tachometer of the capstan motor and with the counter display to provide a numerical display (in feet) of the amount of tape that has passed the capstan. Forward or reverse commands from the mode control circuits program the counter circuits to count up or to count down. Battery charging and count retention circuits provide the memory to retain the count in the event the recorder/reproducer is de-energized.

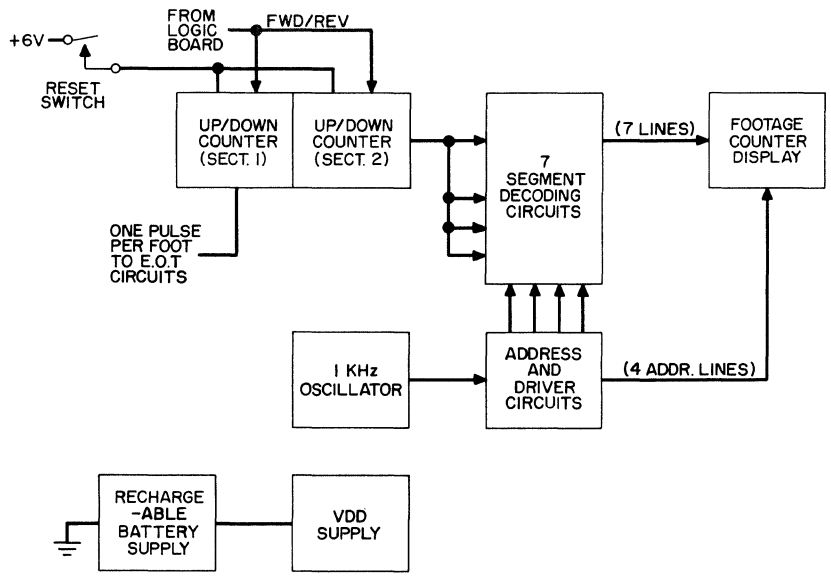


Figure 5-28. Footage Counter Circuits, Simplified Block Diagram (804881)

The tachometer signal processed through the capstan A board, is applied to one section of an up/down counter circuit to develop a one pulse per foot signal. The second section of the up/down counter counts the feet of tape for the display. This section of the counter is further divided into four segments to count tens-of-feet, one hundreds-of-feet, one thousands-of-feet, and ten thousands-of-feet. When the forward/reverse line is at a logic 1, the counter counts down and when it is at 0 volts, the counter counts up.

The 1 kHz oscillator output is divided by four and used to transfer each of the four BCD outputs of the up/down counter to the input of a seven segment decoder, one each second. The decoder converts each BCD input into a signal capable of driving the anodes in the four digit, seven-segment display. At the same time, the driver address output causes the units digit to be displayed. The up/down counter is reset when the RESET switch on the display is depressed.

The battery charging circuits supply 15 to 20 ma of current to the battery supply when the recorder/reproducer is energized. When the recorder/reproducer is de-energized, the last count is retained by applying the output of the battery supply to the V dd line.

M. DATA BAR MONITOR

The data bar monitor is a means of monitoring the record level placed on tape. The monitor consists of a TRACK SELECT switch, a display board, and LED indicators.

Each reproduce board output is connected through the TRACK SELECT switch to the display board. The track to be monitored is selected by the operator by rotating TRACK SELECT switch to the desired channel.

The function of the display board is to measure the plus and minus peak amplitude excursions of the input signal and produce output levels proportional to these peaks.

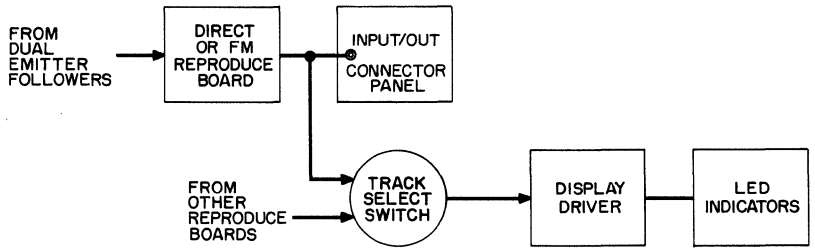


Figure 5-29. Block Diagram for Data Bar Monitor, Record/Reproduce

Amplifiers on the display board detect the negative and positive excursions of the signal. The negative excursions are applied to a voltage divider while the positive excursions are applied to another voltage divider. Each voltage divider is divided into eleven divisions. Each division along the voltage divider is applied to a comparator which conducts whenever the voltage is of sufficient amplitude. The higher the amplitude of the data signal the more comparators conduct. Each comparator's output is connected to an LED on the front panel to indicate amplitude level. The LED's are arranged in a straight line and function from the center toward the two ends. This means a weak signal will light only those LED's near the center while a strong signal will tend to light more causing the light to reach toward the outer edges.

SECTION 6
SYSTEM CHECKOUT AND CALIBRATION

A. GENERAL OVERVIEW

Checkout and calibration procedures should be performed at the time of installation and at periodic intervals to ensure performance.

B. DC POWER CHECKS

Step 1. Thread a freshly erased tape onto the unit and apply power by depressing the ON pushbutton. If the STOP pushbutton does not light, depress the pushbutton to take up tape slack and lift the reel drive tension arms off their stops.

NOTE

The ON pushbutton operates from reflected room light rather than a power indicator. The pushbutton will light even though no power is supplied to the unit.

Step 2. Open the tape transport to its fully extended position and locate the power supply outputs. Refer to Figure 8-4 for terminal board location.

Step 3. Connect a dc voltmeter between the points listed in Table 6-1 and measure the voltages. Compare the results with those in the table.

TABLE 6-1. POWER SUPPLY CHECKPOINTS

HI Side	LO Side	Voltage output (VDC)	Tolerance (VDC)
FL7	Chassis	+6	±.1
FL10	(Gnd)	-6	±.1
*FL11	(Gnd)	+14 (24)	±.15
*FL4	(Gnd)	+20 (29)	Varies
FL3	(Gnd)	+18	with load
FL2	(Gnd)	+24	and line voltage

* The higher voltage is read with the unit operating at 120 ips or FAST mode. If any of the voltages do not check correctly, refer to Step 6.

Step 4. Set the speed selector knob to 120 ips and place the unit into the FORWARD mode by depressing the FWD pushbutton.

Step 5. Recheck the voltages at FL11 and FL4. The results should compare with the values in parentheses in Table 6-1.

Step 6. If the regulated voltages are not within tolerances, turn power off, remove the power supply chassis from the unit, adjust the respective control, reinstall the power supply and recheck the voltage. If necessary, repeat the procedure. The power supply chassis is removed by removing the four screws and unplugging from the unit. To locate the correct adjustment or to troubleshoot a faulty power supply, refer to Section 8, Power Distribution Servicing.

C. MODE CONTROL CHECKS

Step 1. Thread a tape onto the unit and apply power by depressing the ON pushbutton. If the STOP pushbutton does not light, depress the pushbutton to take up tape slack and lift the reel drive tension arms off their stops. With an extreme slack tape condition, the STOP pushbutton should be depressed. This will momentarily start the reel drives for two seconds. If necessary, depress the STOP pushbutton the second time.

Step 2. Observe both tape tension arms. Each reel should be stopped and the tape tension arm should be in the approximate center of its travel. If not, adjust NULL ADJUST R17 and R18 (See Figure 10-3) so that the tension arms null in the center of travel. If troubleshooting is called for, refer to Section 10, Reel Drive Servicing.

Step 3. Momentarily depress and release the FWD pushbutton. Note the STOP lamp goes out and the FWD lamp lights. Observe the tape moves from the inner to the outer reel and that both pinch rollers are engaged with the capstan. Note the footage counter is counting up.

Step 4. Momentarily depress and release the FAST FWD pushbutton and note the FAST FWD lamp lights. Observe that the tape is still moving in the forward direction, but at an accelerated rate. If tape motion is not correct in the last two steps, refer to Section 9, Mode Control Servicing, to troubleshoot the logic. If the problem appears to be mechanical (pinch roller, capstan, etc.), refer to Section 7, Tape Transport Mechanics.

Step 5. Place The EOT switch to the ON position and allow the tape to continue to move toward the end of tape. Tape motion should stop approximately 30 to 50 feet before the end of reel. Repeat the same procedure in the FAST REV mode. The tape should stop as before. If not, refer to Section 7, Tape Transport Mechanics, for alignment of the photocell receiver and transmitter assembly or refer to Section 9, Mode Control Servicing, for troubleshooting of the EOT circuits.

D. SPEED CONTROL CIRCUITS

1. REFERENCE FREQUENCY CHECKS

Step 1. With a tape threaded, place the unit into a forward mode. Remove the coax cable (if used) from RECORD REFERENCE jack J76 on the I/O Connector Panel and connect the input of a frequency counter to this point.

Step 2. Place the TAPE SPEED SELECTOR on the Control Module into the 120 ips position. Refer to Table 6-2 and check the frequency counter reading for each tape speed. Be sure to check the position of the density plug (See Figure 11-7) on the capstan A board. Position J1 equals low density and J2 equals high. If incorrect results are obtained, refer to Section 11 Speed Control Servicing, for troubleshooting procedures. See the reference oscillator and bias circuits portion.

TABLE 6-2. RECORD REFERENCE FREQUENCIES

Tape Speed (ips)	High Density (kHz)	Low Density (kHz)
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
15/16	3.125	1.562

Step 3. Depress the STOP pushbutton. Now depress the POWER pushbutton to remove power from the unit.

Step 4. Open the tape transport and place the capstan B board on the extender board. Connect the input to the frequency counter between testpoints TP1 (HI) and TP8 (LO) (See Figure 11-9).

Step 5. Apply power and place the unit into a operate (FWD or REV) mode.

Step 6. Observe the frequency counter for each tape speed and compare the results with the following table. If incorrect results are obtained, refer to Section 11, Speed Control Servicing for troubleshooting procedures.

TABLE 6-3. REFERENCE FREQUENCY

Tape Speed (ips)	Testpoints TP1 or TP2 (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

Step 7. Move the frequency counter input to TP2 (HI) and TP8 (LO).

Step 8. Observe the frequency counter for each tape speed and compare the results with the above table. If incorrect results are obtained, refer to the Speed Control Servicing Section of this manual for troubleshooting procedures. A fault in the Tape Signal Circuits (if used) or the Tachometer Signal Circuits is indicated.

Step 9. Depress the STOP pushbutton and disconnect the frequency counter.

2. CAPSTAN SERVO CONTROL CALIBRATION

Step 1. Place the recorder/reproducer in operate (FWD or REV) mode at a tape speed of 15/16 ips.

Step 2. Connect the vertical input of an oscilloscope between testpoints TP3 (HI) and TP8 (LO) on the capstan B board (See Figure 11-9).

Step 3. This step is concerned with the proper adjustments of MASTER GAIN adjust R27 and TACH GAIN adjust R28. If the unit is equipped with the tape sync option, perform procedure A. If the unit is not equipped with the tape sync option (capstan synchronous), perform procedure B. DO NOT attempt to perform both procedures.

PROCEDURE A: Operate the recorder/reproducer in the tape sync mode. Record a length of tape at 120 ips with tape sync signal. Adjust MASTER GAIN adjust R27 to a point just below servo oscillation. Check each of the other tape speeds and re-adjust if necessary. Return to 15/16 ips. Place the unit into capstan sync mode such as RECORD. Adjust TACH GAIN adjust R28 to just below servo oscillation. Check each tape speed. Return to 15/16 ips when finished.

PROCEDURE B: Place the recorder/reproducer into an operate mode. Adjust TACH GAIN adjust R28 fully counter-clockwise. Adjust MASTER GAIN adjust R27 to a point just below servo oscillation. Check each of the other tape speeds and re-adjust if necessary. Return to 15/16 ips when finished.

Step 4. Move the vertical input of the oscilloscope to testpoints TP4 (HI) and TP8 (LO). Check that the lower portion of the trapezoidal waveform on the oscilloscope is at 0 volt dc level. If necessary, adjust ZERO ADJUST potentiometer R19 for the correct indication.

Step 5. Move the high lead of the oscilloscope to testpoint TP5 and check that the lower portion of the trapezoidal waveform is at a 0 volt dc level. If necessary, adjust ZERO ADJUST potentiometer R23 for the correct indication.

Step 6. Connect the high lead of the oscilloscope to the collector of the motor drive amplifier. If the signal on the oscilloscope has severe ripple (above 10 volts peak-to-peak), adjust RIPPLE ADJUST potentiometer R22 on the capstan B board to minimize the ripple as much as possible.

Step 7. Repeat the above procedures one time to assure that maximum servo gain with minimum ripple has been attained.

Step 8. Connect the vertical input of the oscilloscope to testpoint TP6 and check for the presence of a logic 1 (+6 volts dc) with stable tape movement. Switch tape speeds and note a momentary change in logic level at testpoint TP6 until tape movement restabilizes to the new speed. Depress the STOP pushbutton and place the capstan B board back into its proper place.

Step 9. If any of the above procedures cannot be successfully accomplished, refer to the Speed Control Servicing Section for troubleshooting procedures.

3. TAPE SYNC CONTROL CHECKS (OPTIONAL FEATURE)

Step 1. On the I/O Connector Panel, check that the interconnect cable is connected between the reproduce channel being used for tape reference and the reference in jack.

Step 2. Thread a tape onto the recorder/reproducer and energize the unit.

Step 3. Place the unit into the record mode. Note the footage counter reading and record a 50 foot section of tape.

Step 4. Rewind the tape to the beginning of the recording and place the unit into the reproduce mode. The PHASE LOCK light and the TAPE SYNC light should light. If not, refer to the Speed Control Servicing Section for troubleshooting procedures.

E. RECORD CHANNELS

1. DIRECT RECORD

The following procedure is outlined for one channel of direct record electronics. The procedure should be repeated for each direct record board contained in the unit.

The main objective for the procedure is to ensure bias and record currents of proper levels for optimum recordings. A proper level for the bias current results when the bias level is set to read 3 dB over (past) a maximum output level at the upper band edge frequency of the tape

speed selected (2dB for W.B. II or 1 dB for W.B.I). The proper level for record current is adjusted for the third harmonic distortion of 1% (-40 dB) of the fundamental at 10% of the upper band edge frequency.

The first four steps may be performed with or without power being applied to the unit.

Step 1. Check the position of IMPEDANCE switch S2. The up position is for a 75 ohm input and the down position is for 10K and higher impedance.

Step 2. Connect an ac voltmeter between testpoints TP2 (HI) and TP3 (LO).

Step 3. Connect a sine wave signal generator to the input connector on the I/O Connector Panel. Set the generator to 10 kHz at the highest anticipated signal level for recording. The ac voltmeter should read .1 vrms.

Step 4. If the ac voltmeter does not read correct, check the position of RANGE switch S1. The LO position is for input voltage levels between .1 vrms to 1 vrms and the HI position is for input voltage levels between 1 vrms and 10 vrms. If necessary also adjust INPUT LEVEL adjust R9 for a meter reading of .1 vrms.

Step 5. Apply power to the unit and check that the STOP indicator is lit. If not, depress the STOP pushbutton to take up slack tape.

Step 6. Connect an oscilloscope between testpoints TP1 (HI) and TP3 (LO) and check for the presence of the bias frequency to the record board. The signal observed should be a 7.2 MHz square wave switching between approximately +6 volt and ground. If the signal is not present, see the capstan A board for a possible fault.

Step 7. Set the tape speed selector knob to the highest available reproduce speed. Set the sinewave signal generator to the band edge of the tape speed selected. See Table 6-4.

TABLE 6-4. BAND EDGE FREQUENCIES

Tape Speed (ips)	Band Edge (kHz)			10% Band Edge (kHz)		
	I.B.	W.B. I	W.B. II	I.B.	W.B. I	W.B. II
120	600	1600	2000	60	160	200
60	300	800	1000	30	80	100
30	150	400	500	15	40	50
15	75	200	250	7.5	20	25
7-1/2	38	100	125	3.8	10	12.5
3-3/4	19	50	62.5	1.9	5	6.25
1-7/8	10	25	31.25	1.0	2.5	3.125
15/16	5			.5		

Step 8. Depress the FWD and REC pushbutton. Tape should now be moving forward in the RECORD mode.

Step 9. Connect a wave analyzer between testpoints TP1 (HI) and TP3 (LO) on the reproduce board for the same channel of the record board being checked.

Step 10. Set the wave analyzer for the band edge frequency shown in Table 6-4 for the tape speed in use.

Step 11. Adjust BIAS LEVEL adjust R5 fully counter-clockwise. Turn the control clockwise until a maximum reading on the wave analyzer is attained. Note the level. Continue to advance the control until the bias level drops 3 dB (2 dB for W.B. II or 1 dB for W.B. ()). The proper bias current into the record head results at this point.

Step 12. The following procedure sets the record current for a third harmonic distortion of 1% (-40 dB) of the fundamental.

Step 13. Set the generator to three times the 10% band edge frequency for the tape speed the unit is operating (See Table 6-4). Example, if the unit is recording and playing back at 60 ips, set the generator to 90 kHz.

Step 14. Set the wave analyzer for the same frequency. Note the level obtained.

Step 15. Change the generator to the 10% band edge frequency. Example, 30 kHz for 60 ips.

Step 16. Adjust RECORD GAIN adjust R13 for -40 dB (1%) of the level noted in Step 14.

Step 17. Recheck the bias level setting and repeat Steps 10 and 11 if necessary. If a change was made, recheck the record gain adjustment. Continue to recheck these adjustments until no further improvement is made.

Step 18. The test equipment may be removed and the next channel may be calibrated.

2. FM RECORD

The following procedure is outlined for one channel of FM record electronics. This procedure should be repeated for each channel of FM record board contained within the unit.

Step 1. Set UNIPOLAR DEVIATION switch S2 to NORMAL.

Step 2. Set ATTENUATOR switch S1 to the TEST position.

Step 3. Connect a frequency counter between testpoints TP3 (HI) and TP2 (LO). Place the unit into the RECORD mode.

Step 4. Adjust CENTER FREQUENCY control R9 for the center frequency indication shown in Table 6-5.

TABLE 6-5. VCO FREQUENCIES

Tape Speed (ips)	Center Frequency (kHz)			
	Lo Band	Intermediate Band	Wide Band I	Wide Band II
120	108	216	432	900
60	54	108	216	450
30	27	54	108	225
15	13.5	27	54	112.5
7-1/2	6.75	13.5	27	56.25
3-3/4	3.38	6.75	13.5	28.125
1-7/8	1.69	3.38	6.75	14.06
15/16	.84	1.69	3.38	

Step 5. Move ATTENUATOR switch S1 off the TEST POSITION. Ensure the input BNC connector on the I/O Connector Panel is open for the following adjustment.

Step 6. Adjust BALANCE ADJUST R28 for the same frequency as was attained in Step 4.

Step 7. Connect a dc voltage supply to the input BNC connector, HI side to HI side, LO side to LO side. Adjust the dc supply voltage to the maximum anticipated positive peak level.

Step 8. Adjust INPUT LEVEL adjust R2 for a frequency reading equal to +40%. See Table 6-6.

Step 9. Return ATTENUATOR switch S1 to the TEST position.

Step 10. Connect an oscilloscope to the output of the reproduce board for the channel being adjusted.

Step 11. Ensure the recorder/reproducer is moving tape in the record mode. On the record board, adjust RECORD CURRENT adjust R27 for minimum noise.

TABLE 6-6. FREQUENCY DEVIATION			
Center Frequency (kHz)	+40% Deviation (kHz)	Center Frequency (kHz)	+30% Deviation (kHz)
432	604.8	900	1260
216	302.4	450	630
108	151.2	225	315
54	75.6	112.5	157.5
27	37.8	56.25	78.75
13.5	18.9	28.125	39.375
6.75	9.42	14.06	19.69
3.38	4.73		
1.69	2.35		
.84	1.28		

Step 12. If UNIPOLAR switch S2 is to be used in either the plus or minus position, the calibration should be checked for that position. Placing the switch in either DEVIATION position allows data to be recorded for the full deviation swing of the VCO for single polarity signals.

3. VOICE OR TIME CODE

This procedure performs both calibration and troubleshooting. If a fault is detected, refer to paragraph B of this section for a functional description of the circuitry to troubleshoot the fault.

Step 1. Place the voice record or time code record board on an extender board and place the unit into the record mode.

Step 2. Connect a voltmeter between pin 6 of U2 (HI) and testpoint TP3 (LO).

Step 3. With no signal applied to the input of the board, adjust BALANCE control R21 for 0 vdc.

Step 4. Adjust bias level adjust R5 fully couter-clockwise.

Step 5. Connect a sinewave generator to the correct input connector on the I/O Connector Panel. Set a generator to 1 kHz. Adjust the amplitude of the generator for 10 mvrms at testpoint TP2.

Step 6. Read the ac voltage at pin 6 of U2. The voltage should read 4 vpp. If not adjust LEVEL SET control R14.

Step 7. Connect the voltmeter between testpoints TP1 (HI) and TP4 (LO) on the reproduce board. Depress the FWD and REC pushbuttons. Tape should now be moving forward in the RECORD mode.

Step 8. Adjust BIAS LEVEL adjust R5 clockwise until a maximum reading on the voltmeter is obtained.

F. REPRODUCE CHANNELS

1. DIRECT REPRODUCE

The following procedure is outlined for one channel of direct reproduce electronics. The procedure should be repeated for each direct reproduce board contained in the unit. For testpoint locations, refer to Figure 13-7 and 13-8.

Step 1. With tape threaded properly connect a function generator (set to sine wave) to the BNC connector input of the I/O Connector Panel for the track being checked. The record board must have been calibrated previously.

Step 2. Place the unit into the FORWARD RECORD mode. Set the generator to the proper level to provide the normal direct record level. (.1 vrms at testpoint TP2 on the record board, measure this value with an ac voltmeter 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 6-7). Connect an ac voltmeter between testpoints TP2 (HI) and TP3 (LO) on the reproduce board. Adjust OUTPUT LEVEL adjust R26 for 1 vrms.

TABLE 6-7. REFERENCE FREQUENCIES

Tape Speed (ips)	Frequency (kHz)		
	Intermediate	Wide Band I	Wide Band 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	3.13
15/16	0.5		

Step 4. Scan the frequencies from 100 Hz (300 Hz for 120 ips, 200 Hz for 60 ips) to the upper band edge at the highest speed dependent on the bandwidth of the equalizers as shown in Table 6-8. While scanning the frequencies, monitor the ac voltmeter at testpoint TP2 and ensure the output is 1 vrms ±3 dB. If the output exceeds the ±3 dB limitations, slight adjustment of HI adjust R8 and/or MID adjust R7, equalizer adjustments, (See Figure 13-9 for control location) should bring the output within the proper limitations. HI adjust R8 is normally adjusted if the limitations are exceeded at the higher frequencies and MID adjust R7 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.

TABLE 6-8. HIGH FREQUENCY ADJUST FREQUENCIES

Tape Speed (ips)	Frequency (kHz)		
	Intermediate	Wide Band I	Wide Band II
120	.3 - 600	.4 - 1600	.4 - 2000
60	.2 - 300	.4 - 800	.4 - 1000
30	.2 - 150	.4 - 400	.4 - 500
15	.2 - 75	.4 - 200	.4 - 250
7-1/2	.2 - 38	.4 - 100	.4 - 125
3-3/4	.2 - 19	.4 - 50	.4 - 62.5
1-7/8	.2 - 10	.4 - 25	.4 - 31.25
15/16	.2 - 5		

Step 5. Change the generator input to a square wave while monitoring the record board input TP2 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 reporduce board output at testpoint TP2 with an oscilloscope at the reference frequency, per Table 6-7, ensure a good representation of a square wave. Adjustment of PHASE potentiometer R4 on each equalizer may improve the square wave representation. If this adjustment is performed, re-check the frequency response in Steps 1 through 4.

NOTE

If complete equalizer calibration is desired, procede with the remaining steps. If equalizers are satifactory with the above adjustments, then remove the test equipment and omit the following steps.

Step 7. With the function generator connected as above, set for sine wave output. Ensure the input level on testpoint TP2 of the record board is at a normal level of .1 vrms.

Step 8. With the unit operating in the FORWARD RECORD mode, monitor the direct reproduce testpoint TP2 with an ac voltmeter.

Step 9. Adjust the three potentiometers (R4, R7, R8) on each equalizer to the mid range position. Change the generator input to a square wave. While monitoring the record board testpoint TP2 with an oscilloscope, adjust the generator for a square wave peak-to-peak value equal to the sine wave level noted in Step 7.

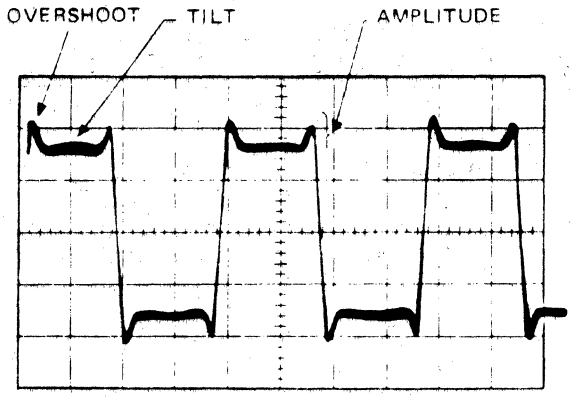


Figure 6-1. Equalization Waveform

Step 10. Record a few minutes, as desired, of each of the Table 6-7 frequencies at the indicated speed. While recording each frequency, monitor the reproduce board output at testpoint TP2 (HI) and TP3 (LO) with an oscilloscope and perform the following adjustments on the proper equalizer associated with the speed. Refer to Figure 6-1.

(a) Adjust the PHASE adjust R4, 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.

Step 11. Change the generator input to a sine wave and ensure .1 vrms at record board input.

Step 12. Record several minutes, as desired, of the Table 6-9 frequencies at the indicated speeds. While recording, monitor the reproduce board output testpoint TP2 with an ac voltmeter and adjust OUTPUT LEVEL adjust R26 for 1 vrms at the highest equalized speed.

TABLE 6-9 EQUALIZATION FREQUENCIES	
Tape Speed (ips)	Frequency (kHz)
120, 60, and 30	10
all other speeds	1

Step 13. Record a few minutes, as desired, of each of the Table 6-10 mid frequencies, at the indicated speed. While recording, monitor the reproduce board output with an ac voltmeter and adjust the proper equalizers MID adjust R7, for a 1 vrms reading.

Step 14. Record a few minutes, as desired, of each of the Table 6-8 high frequencies, at the indicated speed. While recording, monitor the board output with an ac voltmeter and adjust the proper equalizers HI adjust R8, for a 1 vrms reading.

TABLE 6-10. MID FREQUENCY ADJUST FREQUENCIES			
Tape Speed (ips)	Frequency (kHz)		
	Intermediate	Wide Band I	Wide Band 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	15.65
15/16	2.5		

2. FM REPRODUCE

Step 1. On the capstan B board (See Figure 11-9), place SQUELCH INHIBIT switch S1 to the OFF position.

Step 2. Connect a test lead between testpoint TP3 on the FM record board (See Figure 12-7) to testpoint TP1 on the FM reproduce board (See Figure 13-11). The record board must be previously calibrated.

Step 3. Select the desired tape speed at the TAPE SPEED SELECTOR knob.

Step 4. On the record board, place ATTENUATOR switch S1 to the TEST position.

Step 5. On the reproduce board, connect a dc voltmeter between testpoints TP2 (HI) and TP3 (LO).

Step 6. Adjust ZERO ADJUST control R40 for zero volts.

Step 7. Return ATTENUATOR switch S1 on the record board to the proper position.

Step 8. Connect a signal generator to the input of the record board. Set the frequency to any frequency desired within the band limits and adjust the input level to the desired level.

Step 9. Adjust OUTPUT LEVEL adjust R42 to the desired level.

Step 10. Remove the test equipment and return the SQUELCH INHIBIT switch to its normal setting.

3. VOICE REPRODUCE

Step 1. Place the voice reproduce board on the extender board.

Step 2. Connect a sine wave generator to the input of the voice record board at TP2 (See Figure 12-9). Adjust the generator for 1 kHz at 100 mvrms.

Step 3. Depress the FWD and REC pushbuttons.

Step 4. Connect an oscilloscope between testpoints TP2 (HI) and TP4 (LO) on the voice reproduce board.

Step 5. Adjust BAND GAIN control R16 for just below clipping.

Step 6. VOLUME control R19 may be adjusted to any desirable level.

SECTION 7
TAPE TRANSPORT MECHANICS

A. INTRODUCTION

This section of the manual contains information to aid in the removal and replacement of certain electrical, mechanical, and electromechanical parts on the tape transport panel.

CAUTION

THE REMOVAL AND REPLACEMENT OF CERTAIN ITEMS ON THE TRANSPORT PANEL REQUIRES THAT SPECIAL TOOLS AND GAGES BE USED TO RE-ALIGN THE TAPE PATH. CORRECTIVE MAINTENANCE ON THESE ITEMS SHOULD ONLY BE PERFORMED BY AN AUTHORIZED SANGAMO FIELD REPRESENTATIVE.

The following list of parts and assemblies should NEVER be removed and replaced by the customer (See Figures 7-1 and 7-2).

(1) Record and Reproduce Head Mounting Pads
(2) Turn Around Roller and Head Shield Assembly
(3) Left and Right Pinch Roller Arms
(4) Upper and Lower Tension Arms
(5) Reel Drive Hub
(6) Pinch Roll Yoke Arms

B. REMOVAL REPLACEMENT PROCEDURES

1. CAPSTAN MOTOR ASSEMBLY REPLACEMENT – Refer to Figure 7-2

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Locate the five tachometer leads and the three motor leads that extend from the capstan motor assembly. Disconnect the plugs where these leads terminate with their mating connectors. Note the locations within each plug of each lead involved. Using a Molex Automatic Extractor Tool, #HT - 1672, remove the associated pins from the plugs.

Step 3. Locate the two tachometer lamp leads to the motor assembly and unsolder them from the terminal strip.

Step 4. Remove the four phillips head mounting screws from the front of the transport panel. Note the orientation of the motor so that the replacement motor may be rotated to the same physical position.

Step 5. Slowly withdraw the capstan motor assembly from the rear of the transport panel.

Step 6. Position the replacement motor assembly correctly on the transport panel and replace the four phillips head mounting screws.

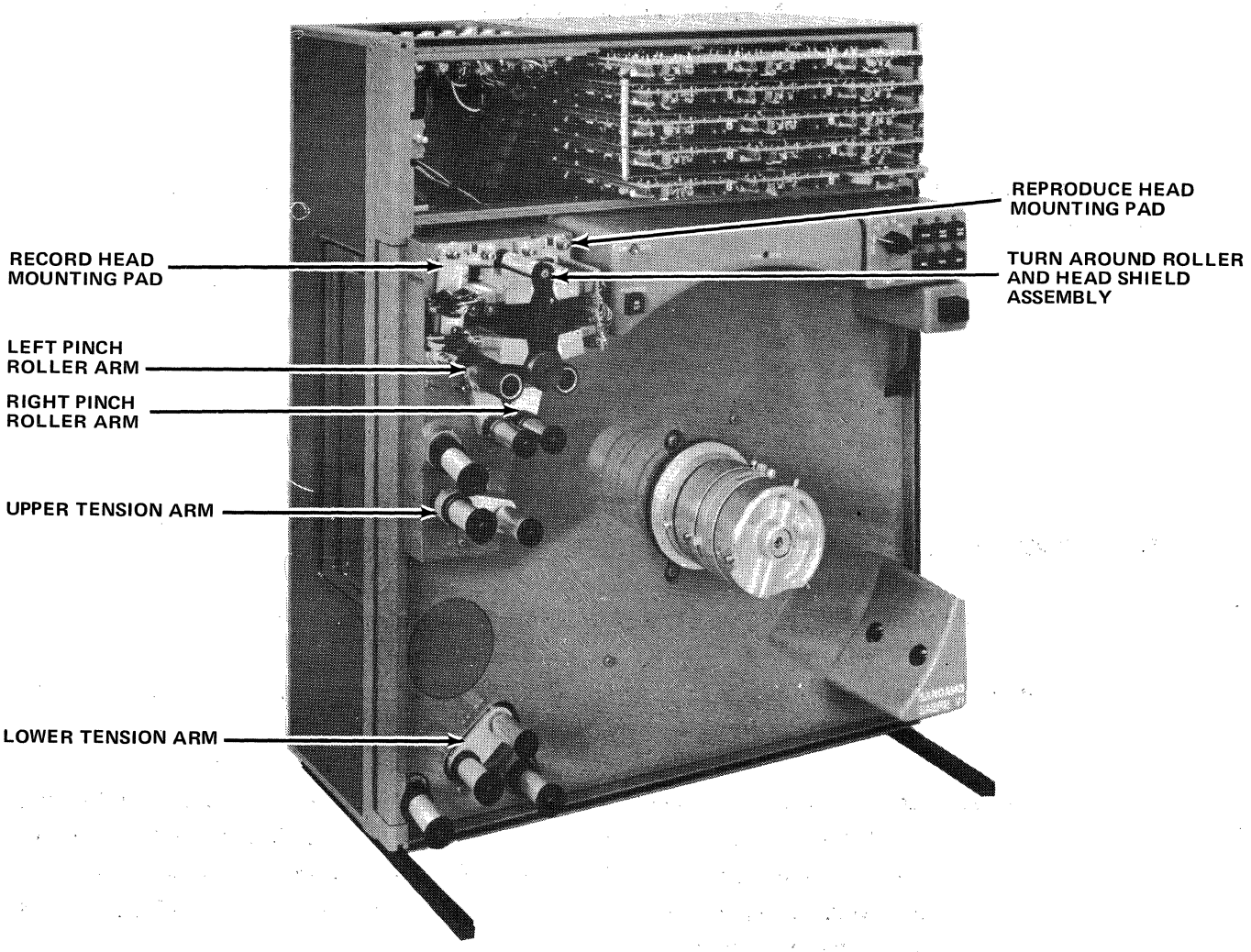


Figure 7-1. Transport Panel, Front View

Step 7. Solder the two tachometer lamp leads to the correct terminals on the terminal strip.

Step 8. Insert the pins on the ends of the five tachometer leads and the three motor leads into the correct locations within their respective plugs. Reconnect each plug with its mating connector.

2. CAPSTAN MOTOR BRUSH REPLACEMENT

Step1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Remove each of the four brush retaining screws. These are located just in front of the end cap of the motor. With a small screwdriver, work the end of each brush tension spring loose and remove from the motor.

Step 3. Inspect each brush. If the brushes have worn down to 1/4 inch or less, replace them as described in the next two steps. If not, re-install the brushes as removed.

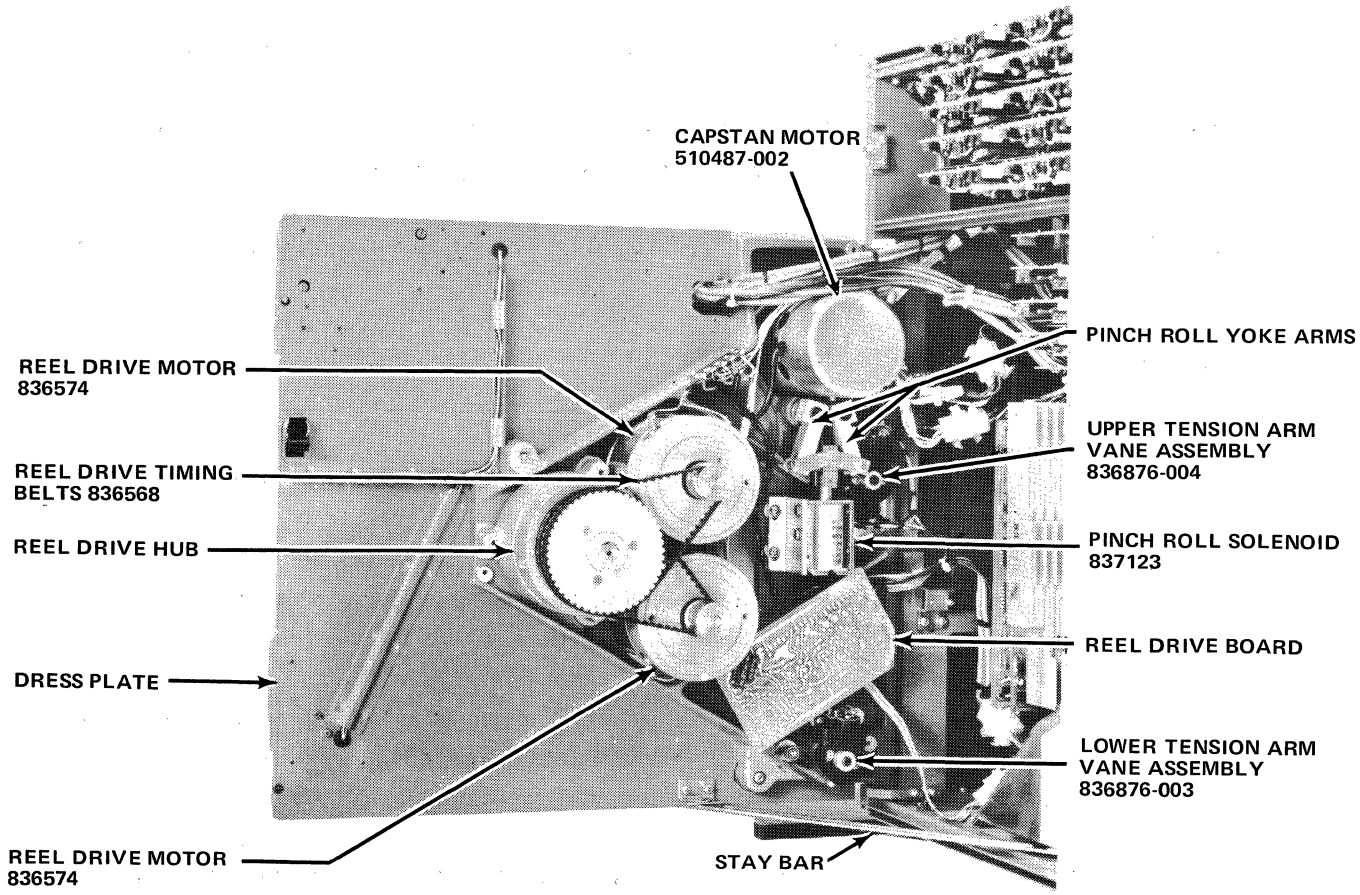


Figure 7-2. Transport Panel, Rear View

Step 4. Insert each new brush and tension spring, ensuring they are positioned with the concave surface aligned with the armature.

Step 5. Align the tension spring and metal tip completely inside the brush holder and replace the brush retaining screws.

NOTE

The motor will require a minimum of 24 hours break-in time before normal low flutter performance can be achieved.

3. CAPSTAN MOTOR TACHOMETER LAMP REPLACEMENT

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Remove the two screws that secure the metal cover over the rear of the motor assembly. Slide the cover to the rear, gaining access to the inner components.

Step 3. Locate the two tachometer lamp leads and unsolder them from the terminal strip.

Step 4. Remove the tachometer lamp assembly mounting screw, with an allen wrench, and withdraw the lamp assembly from its mounting position.

Step 5. Insert the new lamp assembly into position and replace the mounting screw. Do not tighten at this time.

Step 6. Solder the two tachometer lamp leads to the correct terminals on the terminal strip.

Step 7. Energize the recorder/reproducer and, with tape properly threaded, depress the STOP and FORWARD pushbuttons.

Step 8. With an oscilloscope, monitor the tachometer signal on the white lead extending from the printed circuit board mounted on the rear of the motor assembly.

Step 9. Position the tachometer lamp for minimum jitter of the squarewave, as observed on the oscilloscope. This is accomplished by moving the lamp in or out slightly and also by rotating the light. Tighten the lamp mounting screw.

Step 10. De-energize the recorder/reproducer and replace the metal cover over the rear of the motor assembly.

NOTE

DO NOT attempt to disassemble any roller assembly with the recorder/reproducer in its normal upright position as small shim washers may be dropped and lost when the roller cap is removed. To prevent this from happening, lay the unit on its back so that the rollers are in a vertical position.

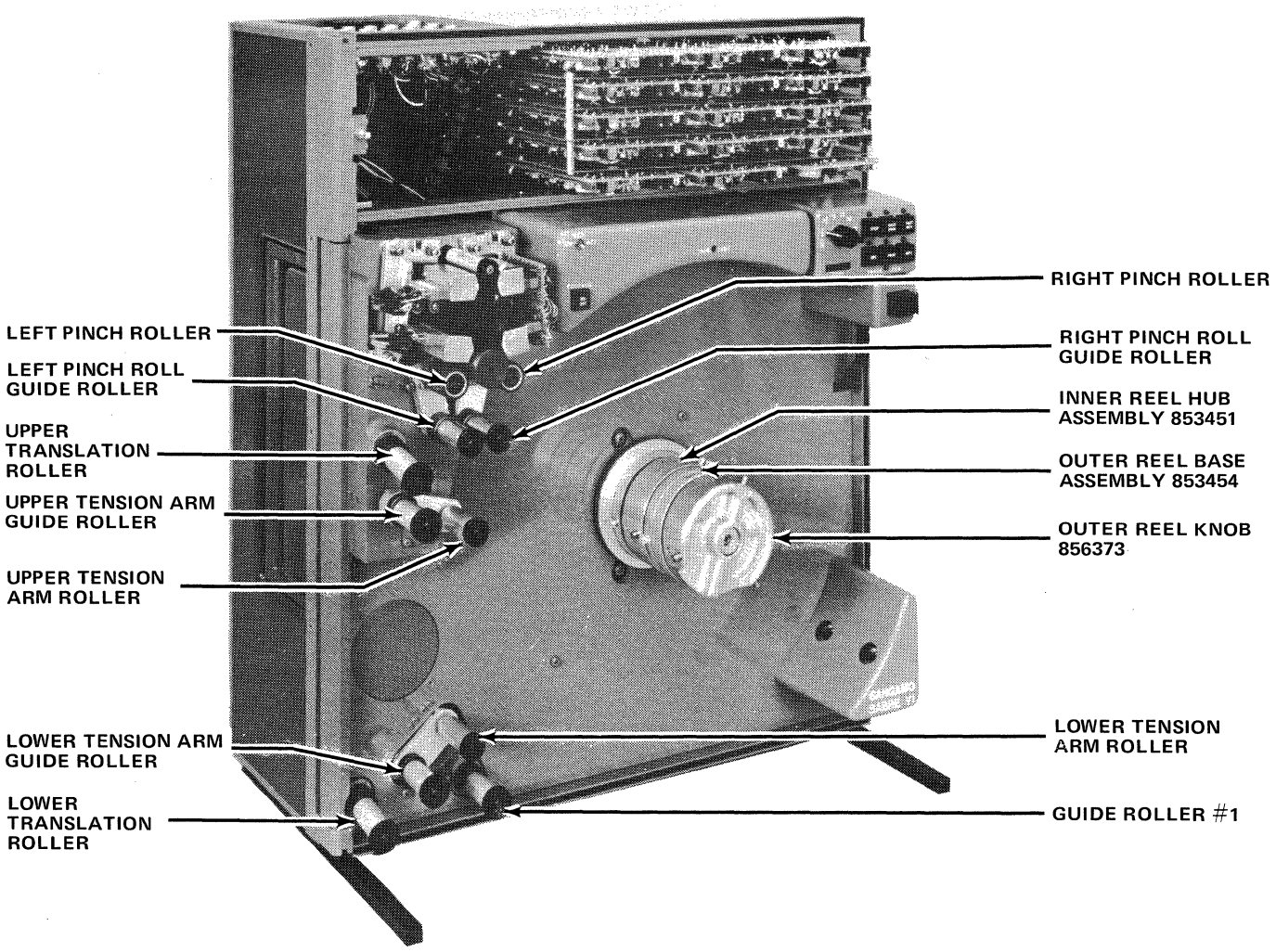


Figure 7-3. Transport Panel, Roller Location

4. ROLLER AND BEARING REPLACEMENT

a. TRANSLATION ROLLERS AND GUIDE ROLLER #1 - Refer to Figures 7-3 and 7-4

Step 1. Remove roller cap retaining screw (6) and lockwasher (10).

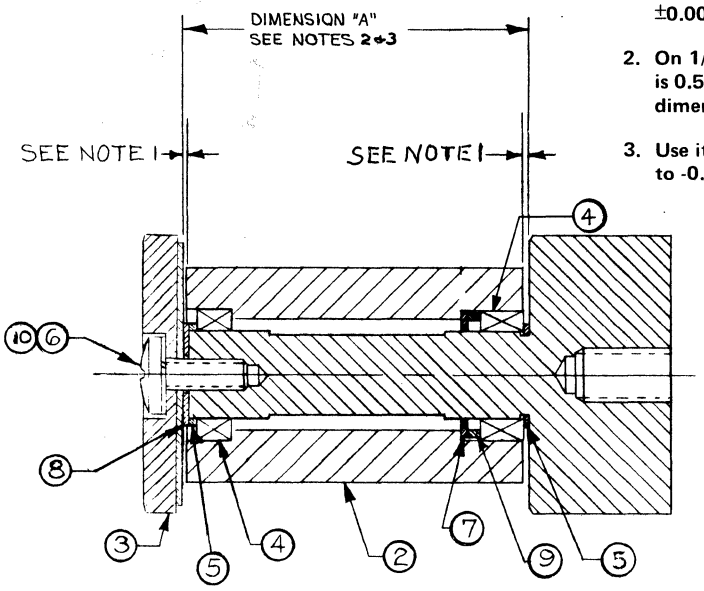
Step 2. Carefully lift off roller cap (3) and remove shim washers (8) and (5). DO NOT misplace these shims.

Step 3. Withdraw the assembly from the shaft, leaving all shim washers (5) at the base of the shaft.

Step 4. Remove front and rear bearings (4), bearing spacer (9), and spring washer (7) from barrel roller (2). Discard the defective roller and/or bearings.

Step 5. Replace the front and rear bearing in the roller. Make certain that spring washer (7) and bearing spacer (9) are placed in the roller before the rear bearing is inserted.

Step 6. Place the roller assembly over the shaft with the spring loaded bearing (rear) on the bottom.



NOTE:

1. Use item 5 as required to obtain equal clearance at each end of item 2 to within ±0.001 inches.
2. On 1/2 inch recorders dimension "A" is 0.504 inches and on 1 inch recorders dimension "A" is 1.004 inches.
3. Use item 8 as required to obtain +0.001 to -0.000 tolerance on dimension "A".

Figure 7-4. Translation and Guide Rollers

Step 7. Place shim washer(s) (5) over the shaft on top of the front bearing.

Step 8. Lay shim washer(s) (8) on top of the assembly and install the roller cap.

Step 9. Tighten the roller cap retaining screw and check that the roller turns freely on the bearings. The clearance at the front and rear of the roller and dimension "A" should be in accordance with the tolerances called out on Figure 7-4. If necessary, disassemble the roller and add or remove shims (5) and (8) to achieve the correct results.

ITEM	DESCRIPTION	PART NO.		
		1/2-in. Recorder		1-in. Recorder
		Guide Roller #1	Trans. Rollers	
2	Barrel Roller	836731-001	836731-001	836731-002
3	Roller Cap	837315-002	837315-001	837315-001
4	Ball Bearing	657506	657506	657506
5	Shim	855010-001 thru 008	855010-001 thru 008	855010-001 thru 008
6	Screw	837042-001	837042-001	837042-001
7	Spring Washer	837479	852987	852987
8	Shim	837479	837479	837479
9	Bearing Spacer	880429	880429	880429
10	Lock Washer	652671	652671	652671

b. TAPE TENSION ARM, GUIDE ROLLERS - Refer to Figures 7-3 and 7-5

Step 1. Remove roller cap retaining screw (6) and lockwasher (10).

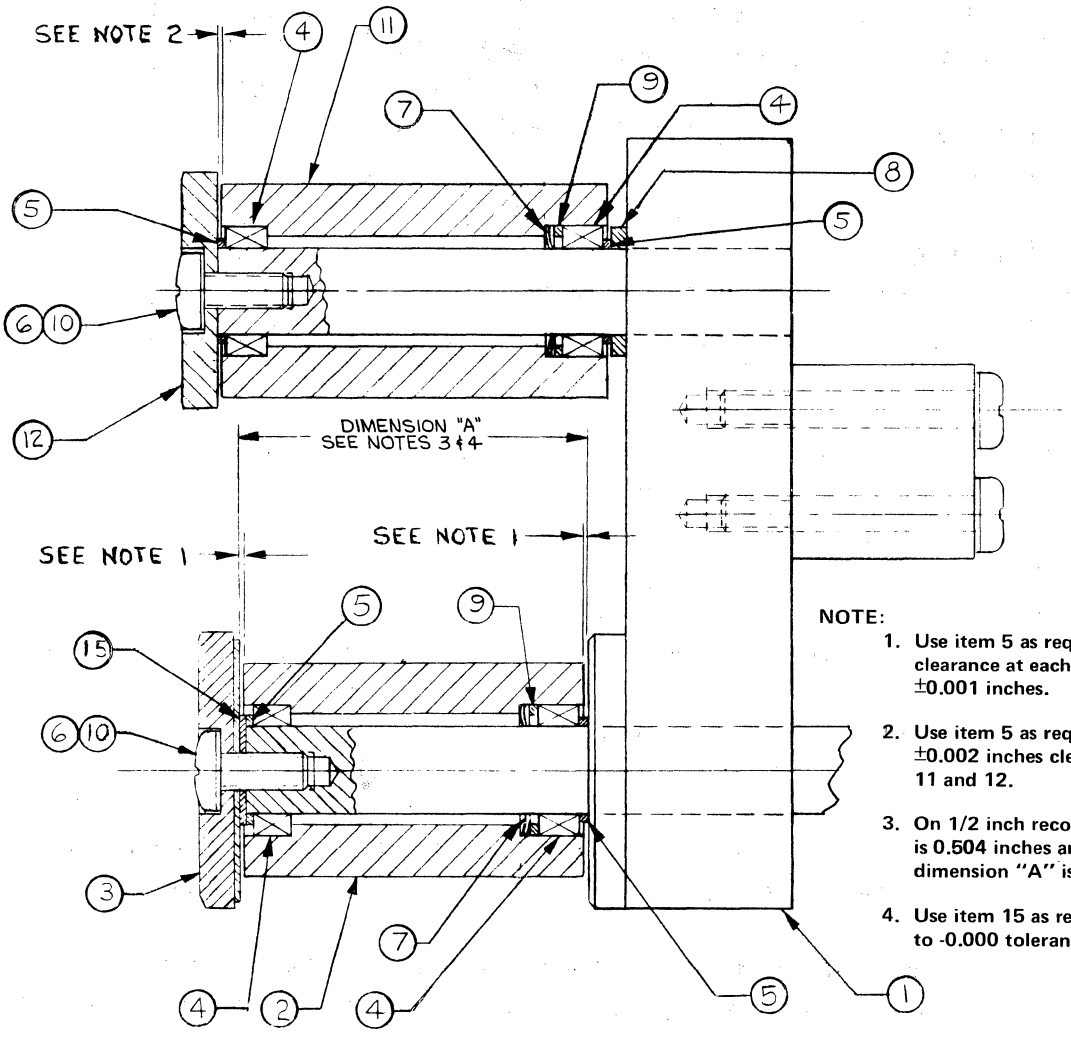
Step 2. Carefully lift off roller cap (3) and remove shim washers (15) and (5). DO NOT misplace these shims.

Step 3. Withdraw the assembly from the shaft, leaving all shim washers (5) at the base of the shaft.

Step 4. Remove front and rear bearings (4), bearing spacer (9), and spring washer (7) from barrel roller (2). Discard the defective roller and/or bearings.

Step 5. Replace the front and rear bearings in the roller. Make certain that spring washer (7) and bearing spacer (9) are placed in the roller before the rear bearing is inserted.

ITEM	DESCRIPTION	PART NO.	
		1/2-in. Recorder	1-in. Recorder
2	Barrel Roller	836731-001	836731-002
3	Roller Cap	837315-001	837315-001
4	Ball Bearing	657506	657506
5	Shim	855010-001 thru	855010-001 thru 008
6	Screw	837042-001	837042-001
7	Spring Washer	852987	852987
8	Flat Washer	43345	43345
9	Bearing Spacer	880429	880429
10	Lock Washer	652671	652671
11	Barrel Roller	836731-006	836731-003
12	Roller Cap	836732-002	836732-002
15	Shim	837479	837479



NOTE:

1. Use item 5 as required to obtain equal clearance at each end of item 2 to within ±0.001 inches.
2. Use item 5 as required to obtain 0.005 ±0.002 inches clearance between items 11 and 12.
3. On 1/2 inch recorders dimension "A" is 0.504 inches and on 1 inch recorders dimension "A" is 1.004 inches.
4. Use item 15 as required to obtain +0.001 to -0.000 tolerance on dimension "A".

Figure 7-5. Tape Tension Arm Rollers

Step 6. Place the roller assembly over the shaft with the spring loaded bearing (rear) on the bottom.

Step 7. Place shim washer(s) (5) over the shaft on top of the front bearing.

Step 8. Lay shim washer(s) (15) on top of the assembly and install the roller cap.

Step 9. Tighten the retaining screw and check that the roller turns freely on the bearings. The clearance at the front and rear of the roller and dimension "A" should be within the tolerances called out on Figure 7-5. If necessary, disassemble the roller and add or remove shims (5) and (15) to achieve the correct results.

c. **TAPE TENSION ARM, ROLLERS. - Refer to Figures 7-3 and 7-5.**

Step 1. Remove roller cap retaining screw (6) and lockwasher (10).

Step 2. Carefully lift off roller cap (12) and remove all shim washers (5). DO NOT misplace these shims.

Step 3. Withdraw the assembly from the shaft, leaving flat washer (8) and all shim washers (5) at the base of the shaft.

Step 4. Remove front and rear bearings (4), bearing spacer (9) and spring washer (7) from barrel roller (11). Discard the defective roller and/or bearings.

Step 5. Replace the front and rear bearings in the roller. Make certain that spring washer (7) and bearing spacer (9) are placed in the roller before the rear bearing is inserted.

Step 6. Place the roller assembly over the shaft with the spring loaded bearing (rear) on the bottom.

Step 7. Place shim washer(s) (5) over the shaft on top of the front bearing and install the roller cap.

Step 8. Tighten the roller cap retaining screw and check that the roller turns freely on the bearings. The clearance between the roller cap and the front of the roller should be within the tolerance called out in Figure 7-5. If necessary, remove the roller cap and add or remove shim washer (5) to obtain the correct results.

d. PINCH ROLL ARM, GUIDE ROLLER - Refer to Figures 7-3 and 7-6

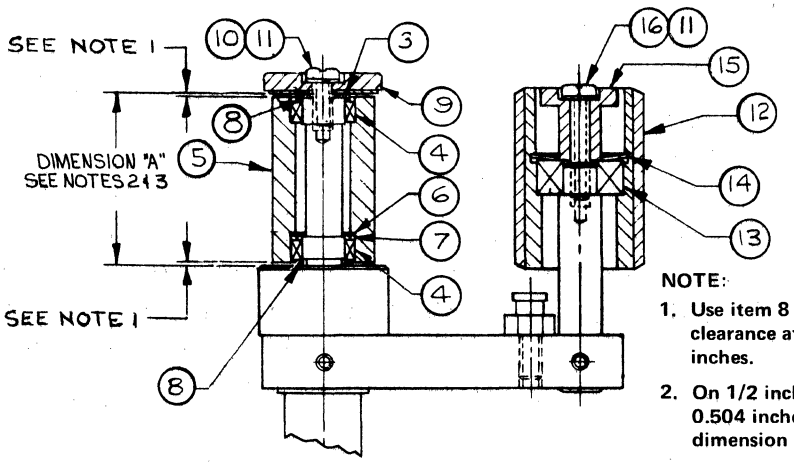
Step 1. Remove roller cap retaining screw (10) and lockwasher (11).

Step 2. Carefully lift off roller cap (9) and remove shim washers (3) and (8). DO NOT misplace these shims.

Step 3. Withdraw the assembly from the shaft, leaving all shim washers (8) at the base of the shaft.

Step 4. Remove front and rear bearings (4), bearing spacer (7), and spring washer (6) from barrel roller (5). Discard the defective roller and/or bearings.

ITEM	DESCRIPTION	PART NO.	
		1/2-in. Recorder	1-in. Recorder
3	Shim	837479	837479
4	Ball Bearing	657506	657506
5	Barrel Roller	836731-004	836731-005
6	Spring Washer	852987	852987
7	Bearing Spacer	880429	880429
8	Shim	855010-001 thru 008	855010-001 thru 008
9	Roller Cap	837315-002	837315-002
10	Screw	837042-001	837042-001
11	Lock Washer	652671	652671
12	Pinch Roller	836736	835018
13	Ball Bearing	897174	897174
14	Retaining Ring	655920	655920
15	Roller Cap	836747-002	836747-001
16	Screw	837042-002	837042-003



NOTE:

1. Use item 8 as required to obtain equal clearance at each end within ±0.001 inches.
2. On 1/2 inch recorders dimension "A" is 0.504 inches and on 1 inch recorders dimension "A" is 1.004 inches.
3. Use item 3 as required to obtain +0.001 to -0.000 tolerance on dimension "A"

Figure 7-6. Pinch Roll Arm Rollers

Step 5. Replace the front and rear bearings in the roller. Make certain that spring washer (6) and bearing spacer (7) are placed in the roller before the rear bearing is inserted.

Step 6. Place the roller assembly over the shaft with the spring loaded bearing (rear) on the bottom.

Step 7. Place shim washer(s) (8) over the shaft on top of the front bearing.

Step 8. Lay shim washer(s) (3) on top of the assembly and install the roller cap.

Step 9. Tighten the roller cap retaining screw and check that the roller turns freely on the bearings. The clearance at the front and rear of the roller and dimension "A" should be within the tolerances called out on Figure 7-6. If necessary, disassemble the roller and add or remove shims (3) and (8) to achieve the correct results.

e. **PINCH ROLLER - Refer to Figures 7-3 and 7-6**

Step 1. Remove roller cap retaining screw (16) and lock washer (11).

Step 2. Lift the pinch roller and roller cap off of the shaft.

Step 3. Remove retaining ring (14) from the inside of pinch roller (12) and remove bearing (13). Discard the defective pinch roller and/or bearing.

Step 4. Insert the bearing into the pinch roller and install the retaining ring.

Step 5. Place the roller assembly over the shaft with the retaining ring facing up. Replace the roller cap and tighten the retaining screw.

5. REEL DRIVE MOTOR REPLACEMENT

Step 1. De-energize the recorder/reproducer. With the unit in its normal upright position, open the transport panel to its fully extended position.

Step 2. Remove the drive belt from the motor to be replaced.

Step 3. Remove the screws that secure the leads to each brush terminal of the motor. Note and tag the leads so they may be reconnected to the correct terminal.

Step 4. Remove the two screws that secure the transport stop bar to the dress plate.

Step 5. Remove all the screws that secure the dress plate to the transport casting. Move the dress plate as far away from the casting as wiring and parts will allow.

Step 6. Remove the three mounting screws that secure the reel drive motor to the transport casting. Note the orientation of the motor so that the replacement may be rotated to the same physical position.

Step 7. Position the replacement motor correctly on the casting and replace the three mounting screws.

Step 8. Replace all screws that secure the dress plate to the casting and the stop bar to the dress plate.

Step 9. Properly connect the leads to the two brush terminals of the motor and replace the drive belt.

6. REEL DRIVE MOTOR BRUSH REPLACEMENT

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Remove the screws that secure the leads to each brush terminal of the motor. Tag the leads so they may be reconnected to the correct terminal.

Step 3. With a large screwdriver, unscrew and remove each brass terminal. With a small screwdriver, carefully work the end of each brush tension spring loose and lift spring and brush assembly from the motor.

Step 4. Remove the remaining two brushes of each motor by removing the two black brush retaining screws. Work the brushes free as in the above step.

Step 5. Inspect each brush. If the brushes are worn down to 1/4 inch or less, replace them.

Step 6. Insert each brush into the proper slot, ensuring each is positioned with the concave surface aligned with the armature.

Step 7. Replace the brush retaining screws and brush terminal screws as each brush is placed into position.

Step 8. Reconnect the wires to their respective terminals.

7. REEL DRIVE HUB MAINTENANCE

CAUTION

ALL MAINTENANCE OF THE REEL DRIVE HUB MUST BE ACCOMPLISHED WITH THIS UNIT ATTACHED TO THE TRANSPORT CASTING. ANY ATTEMPT TO REMOVE THE HUB WILL DISTURB TAPE PATH ALIGNMENT.

a. REEL KNOB REPLACEMENT - Refer to Figure 7-3.

Step 1. Close the transport panel and lay the recorder/reporducer on its back. Turn the knobs to align all the guide pins.

Step 2. Remove the phillips head retaining screw from the center of the outer reel knob. Lift out the retaining cup and coil spring. Leave all shim washers in place that may be at the bottom of the retaining cup recess of the outer knob assembly.

Step 3. Lift off the outer reel knob and outer reel base assembly. Remove the keyed washer from the end of the shaft and the machine key from its slot in the shaft.

Step 4. Remove the three phillips head screws that secure the inner reel hub assembly to the end of the machined sleeve of the reel drive hub. Mark a set of matching holes on each of these pieces so they may be re-mated exactly as they were originally.

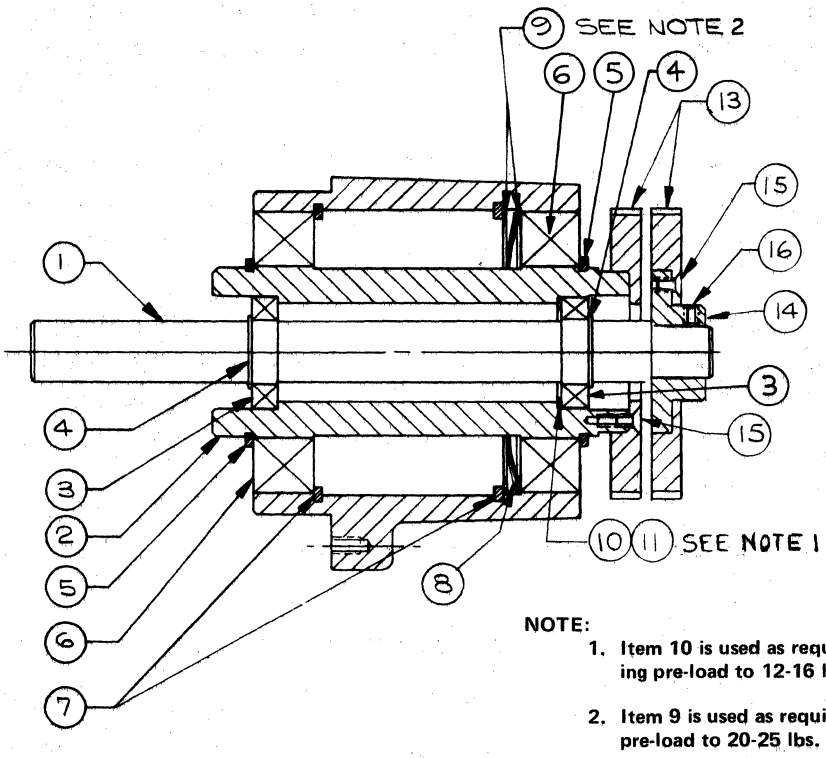
Step 5. Reassemble all pieces in reverse order. Note that the detent pin that protrudes from both sides of the outer reel base must fit into the recess cut into the inner reel hub assembly and into the outer reel knob when the pieces are reassembled.

b. BEARING REPLACEMENT - Refer to Figure 7-7

Step 1. Remove the reel knob assemblies as per the instructions in the preceeding paragraph.

Step 2. With the recorder/reproducer laying on its back, open the transport panel to its fully extended position.

ITEM	DESCRIPTION	PART NO.
1	Outer Reel Shaft	836570
2	Machined Sleeve	836569
3	Bearing	853467
4	Retaining Ring	853460
5	Retaining Ring	853459
6	Bearing	853466
7	Retaining Ring	853462
8	Wavy Washer	853465
9	Washer	853423-001 thru 003
10	Washer	856740-001 thru 003
11	Wavy Washer	853464
13	Timing Belt Pulley	836677
14	Pulley Hub	836678
15	Flat Head Screw	854121-021
16	Set Screw	204715



NOTE:

1. Item 10 is used as required to adjust bearing pre-load to 12-16 lbs.
2. Item 9 is used as required to adjust bearing pre-load to 20-25 lbs.

Figure 7-7. Reel Drive Hub

Step 3. Remove both reel drive timing belts.

Step 4. If an inner bearing (3) is to be replaced, remove retaining ring (4) from the front of shaft (1).

Step 5. Slide the shaft assembly to the rear and remove from the hub. Leave flat washer(s) (10) and wavy washer (11) in place inside machined sleeve (2).

Step 6. If the front bearing is defective it may be replaced at this time. To gain access to the rear bearing, remove the three flat head retaining screws (15) and take off inner timing belt, pulley (13).

Step 7. Reassemble all parts in reverse order. It may be necessary to push forward on the rear of the shaft to fully seat the front retaining ring.

Step 8. If an outer bearing (6) is to be replaced, push forward on the rear of the shaft and remove retaining ring (5) from the front of machined sleeve (2).

Step 9. Slide the machined sleeve and shaft assembly to the rear and remove from the hub. Leave flat washers (9) and wavy washer (8) in place inside the housing.

Step 10. Replace the defective bearing and reassemble in reverse order. It will be necessary to push forward on the rear of the shaft to fully seat the front retaining ring.

8. PINCH ROLL SOLENIOD REPLACEMENT - Refer to Figure 7-2

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Unsolder the two solenoid leads from the terminal strip.

Step 3. Remove the two mounting screws that secure the solenoid bracket to the transport casting.

Step 4. Remove the solenoid, leaving the plunger connected to the pinch roll yoke assembly.

Step 5. Remove the mounting bracket from the old solenoid and install on the replacement.

Step 6. Slip the new solenoid into place and check that the old plunger works freely. If not it may be necessary to replace the plunger also.

Step 7. With the solenoid in place, replace the two mounting screws that secure the solenoid bracket to the transport casting. DO NOT tighten these screws at this time.

Step 8. Place a finger over the end of the solenoid plunger and press toward the solenoid until the pinch rollers just make contact with the capstan. Note that the pinch rollers are held firmly against the capstan by the coil spring between the pinch roll arms. With these conditions satisfied, the plunger should bottom with an additional 1/8 inch of downward movement. Tighten the mounting screws at this position.

Step 9. Solder the two solenoid leads across the diode on the terminal strip.

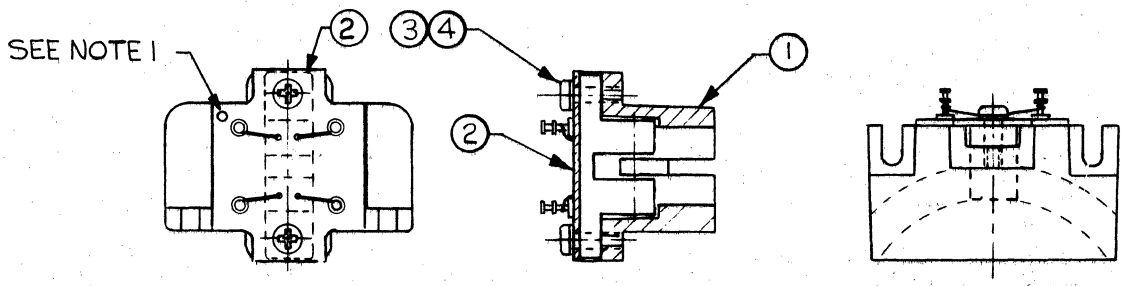
9. PHOTO CELL ASSEMBLY - Refer to Figure 7-8

a. TERMINAL BOARD REPLACEMENT

NOTE

If the terminal board of the lower tension arm photocell assembly is being replaced, it may be necessary to first remove the reel drive board.

ITEM	DESCRIPTION	PART NO.
1	Photo Cell Housing	836871
2	Photo Cell Board Assy.	836870
3	Screw	854104-002
4	Washer	858164



NOTE:
1. White dot identifies (+) plus lead of emitter.

Figure 7-8. Photo Cell Housing and Terminal Board

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Note the white dot on the back of terminal board (2) and its position with respect to photocell housing (1).

Step 3. Remove the two phillips head mounting screws (3) and lift the board from the housing.

Step 4. Using the white dot as a key, tag and unsolder all leads from the four terminal posts. Resolder the leads to the proper terminals on the new board.

Step 5. From the observations in Step 2, position the terminal board properly on the housing and replace the two mounting screws.

Step 6. If required, remount the reel drive board.

Step 7. Refer to the Calibration Section and readjust R17 (upper arm) or R18 (lower arm) on the reel drive board.

b. PHOTO CELL HOUSING REPLACEMENT

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

NOTE

If the lower tension arm photocell housing is being replaced, it will be necessary to remove the reel drive board.

Step 2. Remove the two phillips head screws that secure the housing to its mounting and slide the housing away from the tension arm vane assembly.

Step 3. Note the white dot on the back of terminal board (2) and its position with respect to photo cell housing (1).

Step 4. Remove the two phillips head mounting screws (3) and lift the board from the housing.

Step 5. From the observations in Step 3, position the terminal board properly on the new housing and replace the two mounting screws.

Step 6. Place the housing in position over the tension arm vane assembly.

Step 7. Lift the tape tension arm until the cutouts on the rear of the tension arm vane assembly are evenly spaced (horizontal with) the rear of the housing. Measure the distance between the cutouts and the rear of the housing. Position the housing for a measurement of 0.4 inches and tighten the mounting screws.

Step 8. If required, remount the reel drive board.

Step 9. Refer to the Calibration Section and readjust R17 (upper arm) or R18 (lower arm) on the reel drive board.

10. TAPE TENSION ARM VANE REPLACEMENT - Refer to Figure 7-9

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

NOTE

If the lower tension vane assembly is being replaced, it will be necessary to remove the reel drive board.

Step 2. Remove the two phillips head screws that secure the photocell housing to its mounting and slide the housing away from the tension arm vane assembly.

Step 3. Note the position of the two vane mounting screws (3) with respect to the cutouts in the vane.

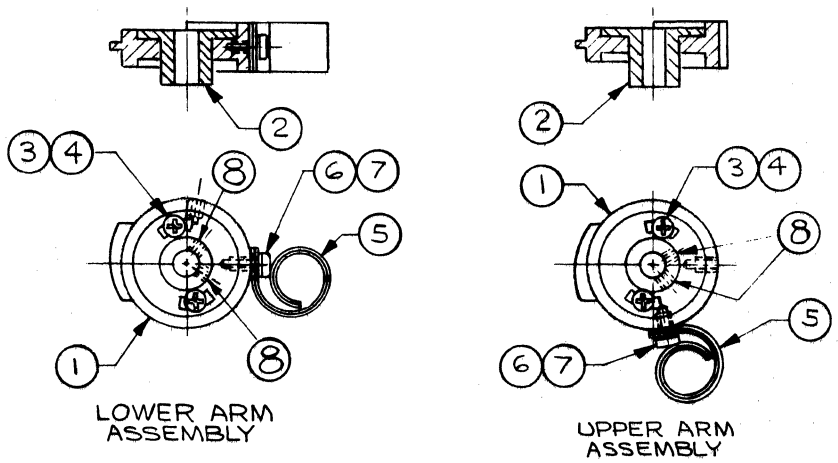


Figure 7-9. Tape Tension Arm Vane

Step 4. Remove the vane mounting screws and remove the vane from hub (8).

Step 5. Remove the screw that mounts negator spring (5) to the vane. Install the negator spring on the new vane.

Step 6. Position the new vane on the hub and install the two mounting screws. Turn the vane to the position noted in Step 4 and tighten the screws.

Step 7. Place the photocell housing in position over the tension arm vane and install the two mounting screws. DO NOT completely tighten these screws at this time. Slide the photocell housing away from the vane assembly as far as it will go.

Step 8. Lift the tension arm to the mid point of its travel. Note that the cutouts on the rear of the vane assembly are evenly spaced (horizontal with) the rear of the photo cell housing. If not, loosen the vane mounting screws and rotate the vane on its hub until this condition is satisfied. Tighten the vane mounting screws.

Step 9. With the tension arm held at the mid point of its travel, measure the distance between the cutouts on the rear of the vane and the rear of the photocell housing. Position the housing for a measurement of 0.4 inches and tighten its mounting screws.

Step 10. Thread the negator spring around its roller.

Step 11. If required, remount the reel drive board.

Step 12. Refer to the Calibration Section and readjust R17 (upper arm) or R18 (lower arm) on the reel drive board.

ITEM	DESCRIPTION	PART NO.
1	Tension Arm Vane	836875
2	Tension Arm Vane Hub	836867
3	Screw	854110-004
4	Lockeasher	878034
5	Negator Spring	837213
6	Screw	854122-003
7	Lockwasher	55248
8	Screw	694529-003

11. TAPE TENSION ARM MICROSWITCH REPLACEMENT - Refer to Figure 7-2

a. UPPER TENSION ARM, MICROSWITCHES S2 and S3.

Step 1. De-energize the recorder/reporducer and open the transport panel to its fully extended position.

Step 2. Remove the two phillips head screws that secure the upper tension arm's stop bar to the tension arm. These screws, and the stop bar, are accessable from the rear of the transport panel and are located in the recess to the left of the tension arm's photocell assembly.

Step 3. From the front of the transport panel, remove the small plate that surrounds the upper tension arm. Lift the plate away from the transport as far as the wiring allows.

Step 4. Remove the two microswitch mounting screws and lift the microswitches free. Note, tag and unsolder the leads from the defective microswitch.

Step 5. Connect the leads properly to the replacement microswitch and remount the two switches.

Step 6. Replace the microswitch mounting plate and secure in position with its mounting screws.

Step 7. Replace the tension arm stop bar. Note that when the tension arm is fully relaxed, both microswitches are actuated and the stop bar is in contact with its metal stop. DO NOT allow the tension arm to come at rest against the case of the microswitch(s).

b. LOWER TENSION ARM, MICROSWITCHES S4 and S5

Step 1. De-energize the recorder/reproducer and open the transport panel to its fully extended position.

Step 2. Remove the four mounting screws that secure the reel drive board to the transport casting. Lay the board aside to gain access to the microswitches.

Step 3. Unsolder the leads from the defective microswitch and properly connect them to the replacement switch.

Step 4. From the front of the transport, remove the four mounting screws that secure the microswitches to the dress plate.

Step 5. Remove the defective switch and remount the new switch using the screws removed in Step 4.

Step 6. Adjust the position of the switches so when the tension arm is fully relaxed, both microswitches are actuated and the tension arm is in contact with the edge of the cutout in the dress plate. DO NOT allow the tension arm to come at rest against the case of the microswitch(s).

Step 7. Tighten the microswitch mounting screws and remount the reel drive board.

12. HEAD REPLACEMENT - Refer to Figure 7-10

a. RECORD HEAD REPLACEMENT AND ALIGNMENT

Step 1. De-energize the recorder/reproducer and remove the head cover.

Step 2. Remove the two phillips 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 ON THE HEAD MOUNTING PAD.

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

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

Step 5. Plug the head lead harness connectors onto each head stack.

CAUTION

HANDLE THE HEAD LEAD HARNESS WITH CARE TO PREVENT DAMAGE TO THE LEADS AT THE HEAD.

NOTE

The following steps will correctly align the record head to the reproduce head, if it is required.

Step 6. Connect a signal generator, in parallel, to the input BNC connectors of tracks 1 and 7 for a 1/2 inch recorder or tracks 1 and 13 for a 1 inch recorder.

Step 7. Connect a dual trace oscilloscope to the output BNC connectors of the same two tracks. Synchronize the oscilloscope on either of the two signals.

Step 8. Thread tape on the recorder/reproducer, apply POWER, and place in the FORWARD RECORD mode at a tape speed of 60 ips.

Step 9. Set the output of the signal generator to 1 kHz at 1.0 vrms.

Step 10. If the signals on the oscilloscope are not in phase, adjust the lower jack screw on the record head mounting pad until the two signals coincide.

CAUTION

THE HEAD MOUNTING PADS ARE PRE-ALIGNED AT THE FACTORY AND SHOULD ONLY BE CHANGED WITH EXTREME CARE AND ONLY WHEN NECESSARY.

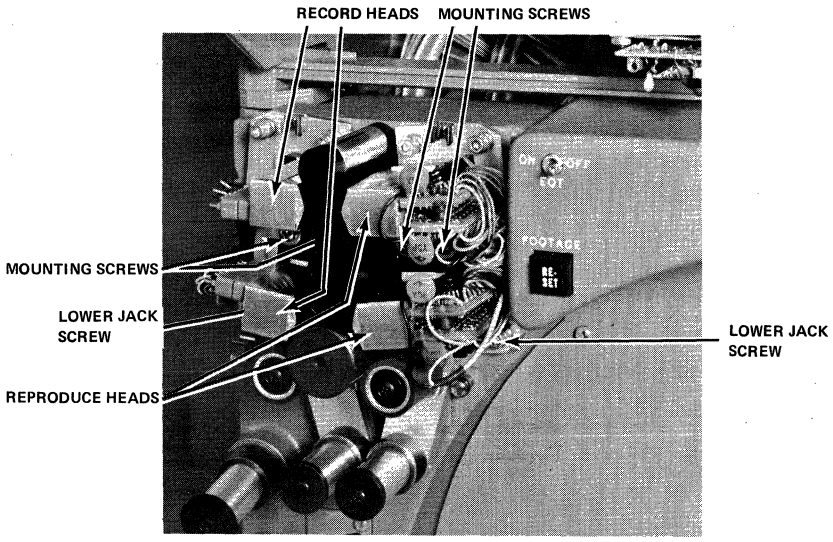


Figure 7-10. - Record/Reproduce Head Area

SECTION 8
POWER DISTRIBUTION–SERVICING

A. INTRODUCTION

The function of the power supply is to develop dc voltages for the SABRE VI unit from a power source. Source voltages the SABRE VI is capable of accepting consists of (1) 234 vac, 47 to 400 Hz, (2) 117 vac, 47 to 400 Hz, (3) 26 vdc, or (4) 12 vdc. The source voltage required is determined by the module selected at the time the unit is purchased. Six output voltage source are developed by the power supply to drive the various circuits of the unit.

B. FUNCTIONAL DESCRIPTION

The power supply unit plugs into the right side of the SABRE VI unit. The power supply may be removed by removing four retaining screws and sliding out of the side. Refer to Figure 1-1 for power supply location. The output of the power supply is cabled through the power supply housing by means of feed-thru capacitors into the unit proper (Refer to Figures 8-4 and 8-5).

The power distribution for the SABRE VI is divided in three separate areas: (1) main chassis assembly, (2) rectifier assembly and regulators, and (3) circuit distribution (Refer to Figure 8-1). The main chassis assembly accepts input power and converts it to several ac voltage levels through the use of a power transformer. Components in the main chassis assembly vary somewhat with the voltage input the unit accepts (117 ac, 234 ac, 12 dc, 26 dc). The figures in this section illustrate the 117 vac version. The remaining versions are similiar and parts identification should be readily apparent. The rectifier assembly and regulators is the second portion of the power supply that accepts ac voltages from the power transformer and converts them into specific and regulated voltage levels for use in the electronics of the recorder/reproducer. The rectifier assembly and regulators are very nearly identical in each of the available power supplies. The third portion of the power supplies is the circuit distribution. This portion distributes the several voltage levels throughout the recorder/reproducer to the points of usage.

1. MAIN CHASSIS ASSEMBLY

For the following discussion, refer to the power supply schematic diagram for 117 vac. The 234 vac power supply is very similiar in operation, therefore, only the one 117 vac supply is described.

Main power is applied to the unit from the line cord through jack J3. The ac voltage is routed through the power supply to jack J1-7, through the ON-OFF switch on the front of the unit, and back into jack J1-19. The ac voltage is applied to rectifier assembly CR2 to supply dc voltage for energizing relay K1. When relay K1 closes, ac voltage is applied to the main rectifier assembly CR1 and to transformer T2. The secondary voltage of transformer T2 is reduced to 23

vac for application to the oscillator driver board at plugs P1 and P2. On the oscillator driver board, the voltage is rectified for power to that board. Eight output lines from jacks J4 through J11 drive the base/emitter junctions of the main power switching bridge consisting of transistors Q1 through Q4. The voltages from the four secondary windings of transformer T1 drive the bases of the four transistors with a 19 kHz square wave signal. The signals applied to the bases of transistors Q1 and Q3 are in phase with each other and 180° out of phase with transistors Q2 and Q4.

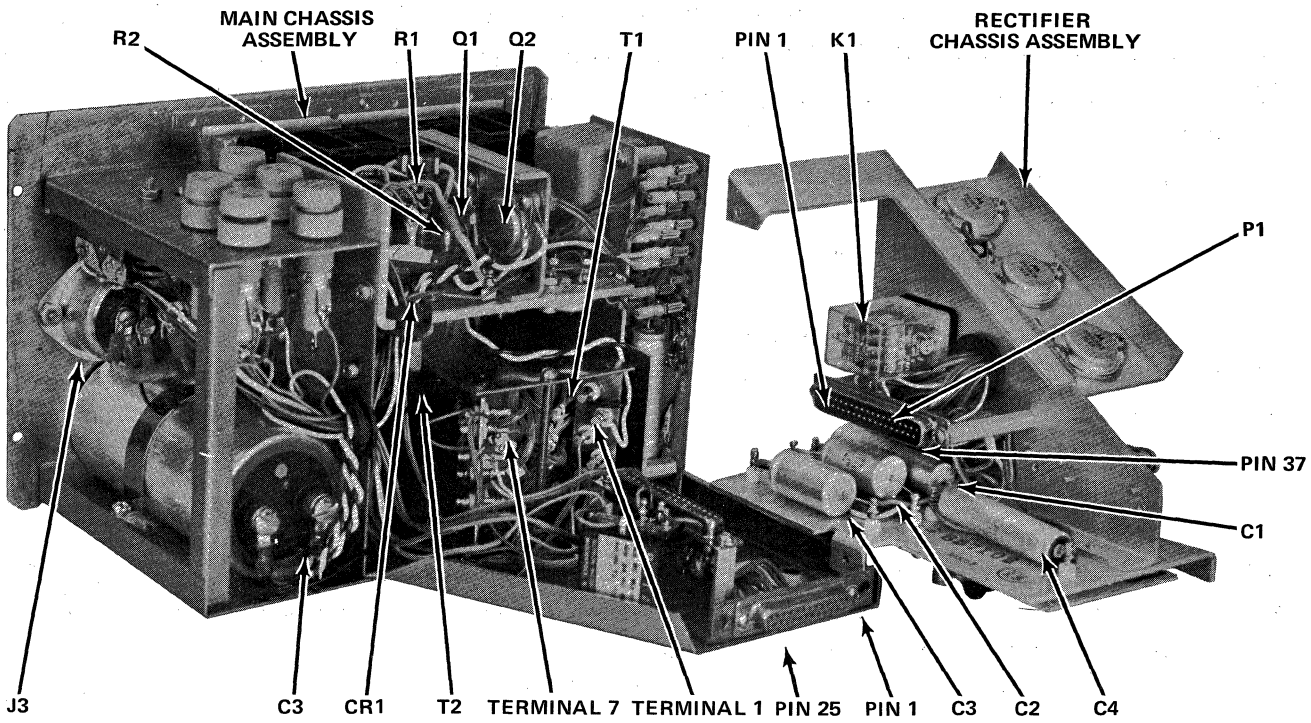


Figure 8-1. Main Chassis and Rectifier Assembly

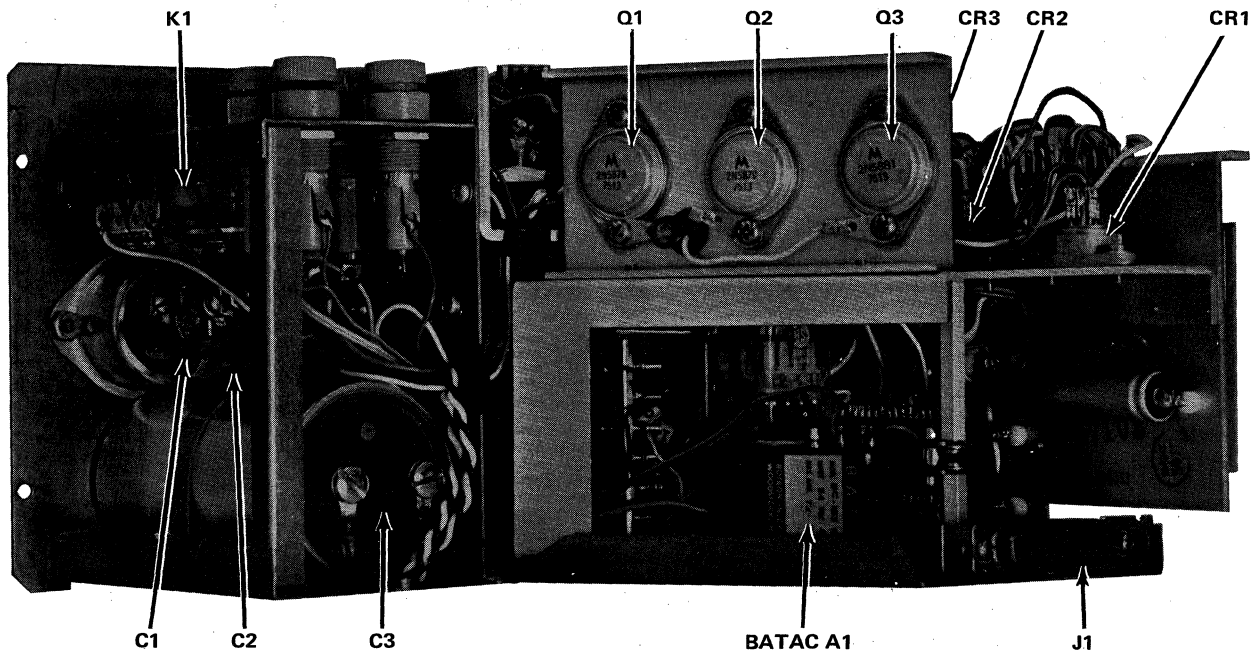


Figure 8-2. Main Chassis and Rectifier Assembly, Side View

When transistors Q1 and Q3 are in the conducting state, the output from the positive side of the rectifier assembly is applied through transistor Q1 to pin 1 of power transformer T1. At the same time, pin 2 of transformer T1 is applied through transistor Q3 to the low side of rectifier assembly CR1. When the polarity of the base drive changes, transistors Q1 and Q3 are turned off and transistors Q2 and Q4 conduct. This applies the positive side of rectifier assembly through transistor Q2 to pin 2 of transformer T1 while pin 1 returns through transistor Q4. Current flow is now in the opposite direction through the primary of transformer T1. The main power bridge continues to alternate current flow through the primary at a 19 kHz rate.

The main chassis assembly for the dc supplies vary as described in the following paragraph. Both the 12v and the 26v supplies are similiar in operation, so only one supply is described.

Power is applied to the unit on J3, through line fuse F1, relay K1, and directly to the center tap of main power transformer T1. Input power is polarity protected via CR1 in series with the coil of K1. Transistors Q1 and Q2 and the associated components on the oscillator board form an oscillating power amplifier to drive main power transformer T1. Feedback from the primary of T1 (terminals 1 and 3). Feed through T1 on the oscillator board and applied to the bases of Q1 and Q2. BATAC power is supplied on the 12v version only directly from the 12v input line.

When power to the power amplifier is applied, one transistor Q1 or Q2 starts to conduct slightly ahead of the other. The biasing network, R1, R2, and C1 (oscillator board), apply an initial pulse to the bases of Q1 and Q2. Assuming Q1 conducts ahead of Q2, a negative going voltage results on terminal 3 of main power transformer T1. This results in a positive going pulse on the base of Q1, driving it into saturation. T1 (oscillator board) cannot supply base current to Q1 indefinitely, causing Q1 to drop out of saturation resulting in a negative pulse on its own base (through the feedback path) to drive it into cutoff. A positive pulse on Q2 causes it to turn on. The oscillation continues in this manner. The turns ratio of both transformers (oscillator board) and R3 determines the frequency of oscillation at a nominal of 19 kHz.

2. RECTIFIER ASSEMBLY AND REGULATOR

Four secondary windings from power transformer T1 provide the voltages for the regulators and output circuits. Six output voltage sources are developed by these circuits: (1) +18 vdc unregulated, (2) +28/18 vdc (dual) unregulated, (3) +24/14 vdc (dual) regulated, (4) +6 vdc regulated, (5) -6 vdc regulated, and (6) +24 vdc unregulated.

The +6 volts is developed from pins 7 and 8 of transformer T1. The voltage level at this winding is approximately 22 vpp and is applied to rectifier CR2. Simultaneously, this voltage is also applied to a voltage doubler circuit consisting of capacitor C12 and diodes CR15 and CR16 to supply power to transistor Q1 and to a reference voltage circuit consisting of resistors R17 and R18, and zener diodes CR17 and CR18. The reference voltage is applied to one input of operational amplifier U1 at pin 3. Potentiometer R15 senses the output voltage level from jacks J1-25 and is used to adjust the level at +6 volts. The output of amplifier U1 drives transistor Q1 to regulate the regulator transistor Q2. The collector of Q2 is applied to jack J1-12 and distributed to the electronic circuits of the unit.

The -6 vdc supply is generated in a similar manner from pins 9 and 10 of transformer T1. The voltage is applied through rectifier CR3 and regulator transistor Q3 to the output at jack J1-10. The regulator circuitry consists of amplifier U3 and transistor Q3.

The +24/14 vdc supply is a dual source governed by the position of relay K1. Relay K1 is energized by switching circuitry located on the reel drive board during high tape speed such as 120 ips or FAST. Whenever the relay is energized, a higher voltage tap is selected from transformer T1 and resistors R11 and R12 are no longer connected in parallel. The regulator is now adjusted to the new voltage level. The regulator control circuits operate in a similar fashion as the +6 vdc supplies except this circuit does not use a voltage doubler circuit.

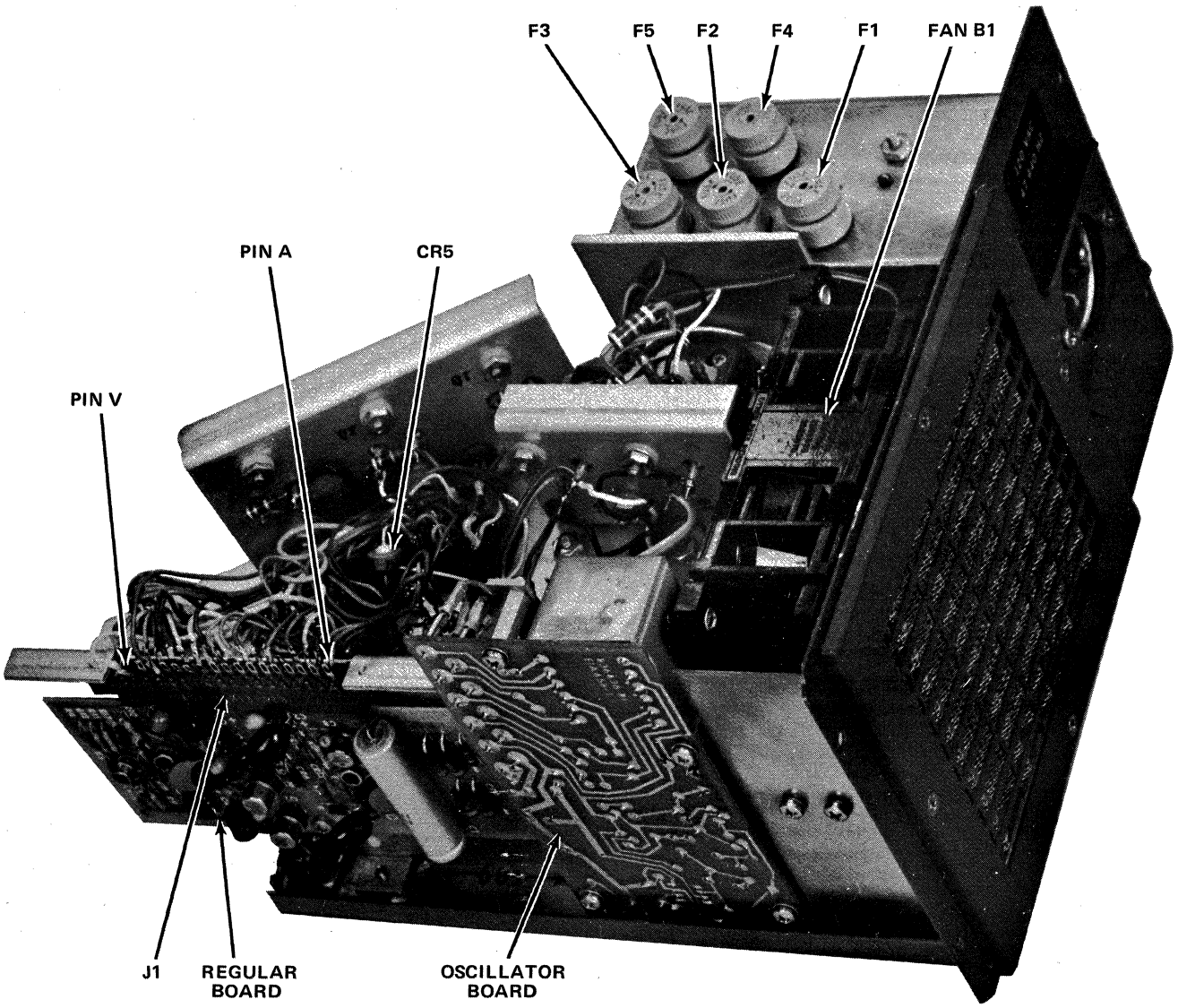


Figure 8-3. Main Chassis and Rectifier Assembly, Top View

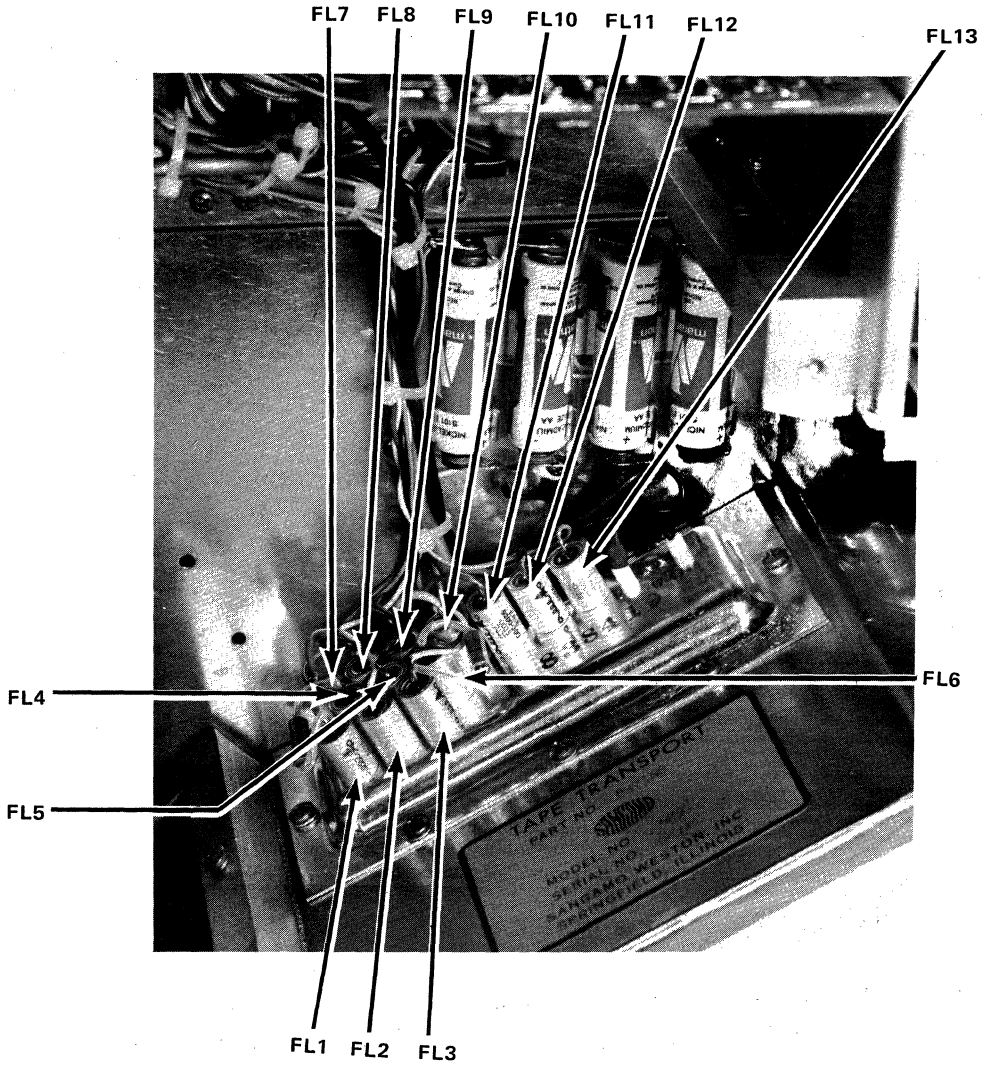


Figure 8-4. Power Supply Enclosure, Showing Feed-Thru Capacitors and Terminal Boards

A +24 vdc unregulated supply is developed from another secondary winding at pins 11 and 12. This winding is applied to a bridge rectifier consisting of diodes CR7 through CR10. The output of this supply also operates the BATAC which drives the fan.

An 18 vdc unregulated supply is produced by half wave rectifier CR5 and capacitor C4. Also a 28/18 vdc unregulated supply is produced by taking the output directly from rectifier CR1 to the output without passing through the regulator.

3. CIRCUIT DISTRIBUTION

For the following discussion, refer to the dc power distribution diagram.

The +18 vdc unregulated supply drives the supply reel drive motor. During forward tape motion, the supply reel is the inner reel while during reverse tape motion, the outer reel becomes the supply. A motor reversing relay K2 (located inside the unit) is responsible for reversing voltage to the reel drive motors.

The +28/18 vdc unregulated supply is a dual voltage source for driving the take-up reel drive motor. The higher voltage (+28 vdc) is selected for tape speeds of 120 ips or for a FAST mode after the capstan rotational speed exceeds 60 ips. The control line for switching relay K1 (which selects the higher voltage tap on the transformer) is a command from the reel drive board which derives its input from the tachometer.

The +24/14 vdc regulated supply is a dual voltage source to drive the capstan motor. The 14 vdc is used for tape speeds of 60 ips and lower. However, when a tape speed of 120 ips or a FAST mode is selected, a transfer to 24 volt occurs after the rotational speed of the capstan has increased beyond 60 ips. This is to give the capstan motor additional drive power. The switchover is accomplished from the same relay (K1) as the above voltage.

The +6 vdc regulated and the -6 vdc regulated voltages power the major portion of the circuitry located on the circuit boards within the unit. This includes all the record boards, reproduce boards, control logic board, reel drive board, capstan board, etc.

The +24 vdc unregulated supply energized three power switching relays and the pinch roll solenoid whenever the proper logic is applied. The relays are located inside the unit to the lower left. Relay K1 energizes when tape is properly threaded to supply voltage to the capstan and reel drive motors. Relay K2 is the motor reversing relay which is energized during any tape reverse mode. Relay K3 is energized to supply +6 volts and -6 volts to all record boards during a record mode. The pinch roll solenoid is energized any time tape motion occurs.

C. POWER SUPPLY REMOVAL

To remove the power supply from the unit, remove the four retaining screws located in each corner of the supply. The power supply should now unplug from its mating jack and slide out of the housing.

CAUTION

WHEN THE POWER SUPPLY IS REMOVED FROM IT'S HOUSING AND PLACED ON AN EXTENDER FOR TROUBLESHOOTING THE UNIT SHOULD NOT BE OPERATED FOR EXTENDED PERIODS OF TIME. TO DO SO MIGHT RESULT IN OVERHEATING BECAUSE OF IMPROPER AIR FLOW.

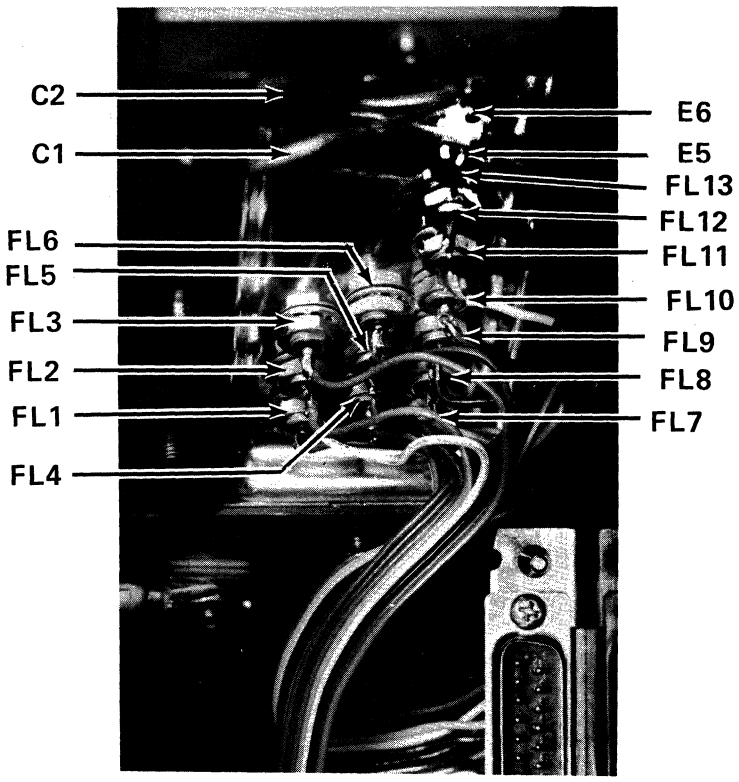


Figure 8-5. Components Inside Power Supply Housing

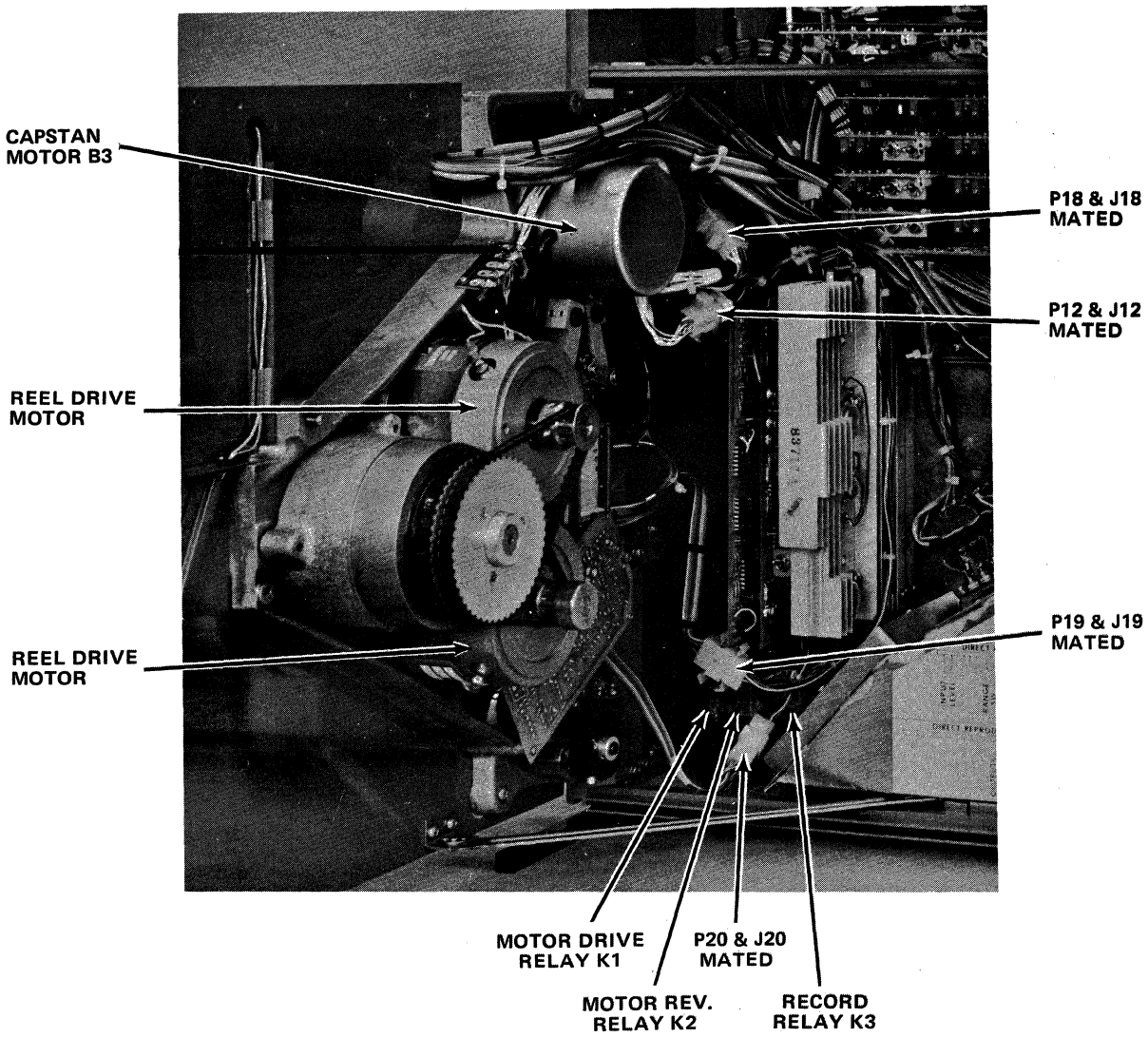
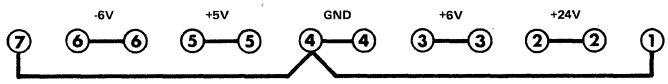


Figure 8-6. Component Location for Power Distribution



DETAIL FOR TERMINAL BOARD TB4
(VIEWED FROM REAR)

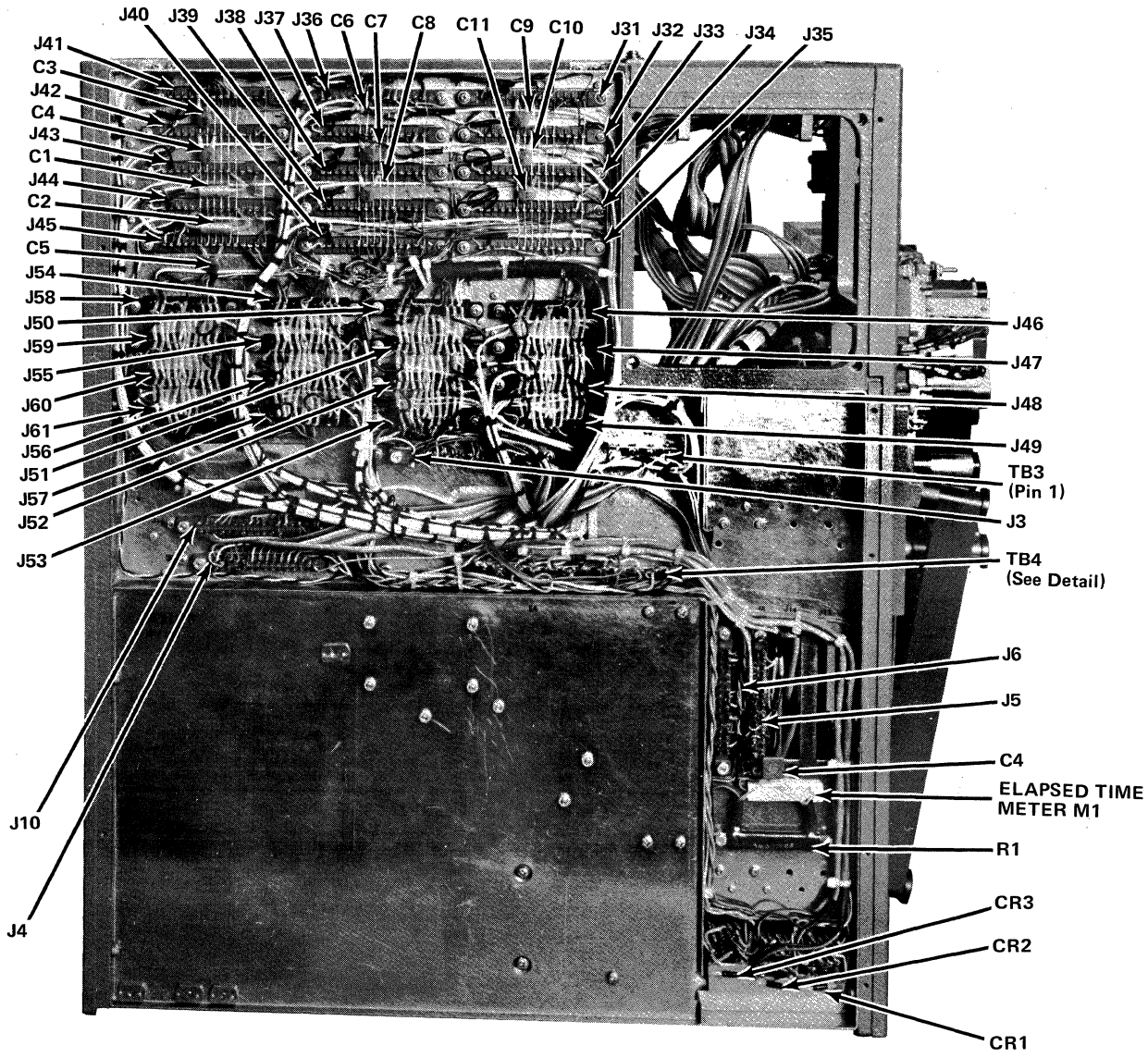


Figure 8-7. Rear View, Parts Location

DC POWER DISTRIBUTION CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL

REF. DESIG.	SANGAMO PART NO.
B1	836574
B2	836574
B3	510487-002
CR23	510509
J1	837115
L1	837123
P12	859254-002
P18	859254-002
P19	859254-003
P20	859255-002
R6	510409-015
S7	510102-003
S8	836907
TB7	837098

ELECTRONIC CHASSIS

REF. DESIG.	SANGAMO PART NO.
C1	691391-050
C2	691391-050
C12	691391-003
C13	691391-003
C15	691391-050
C16	691391-050
C17	691391-050
C19	691391-050
C20	691391-016
CR1	896458
thru	
CR5	
CR6	896458
CR7	896458

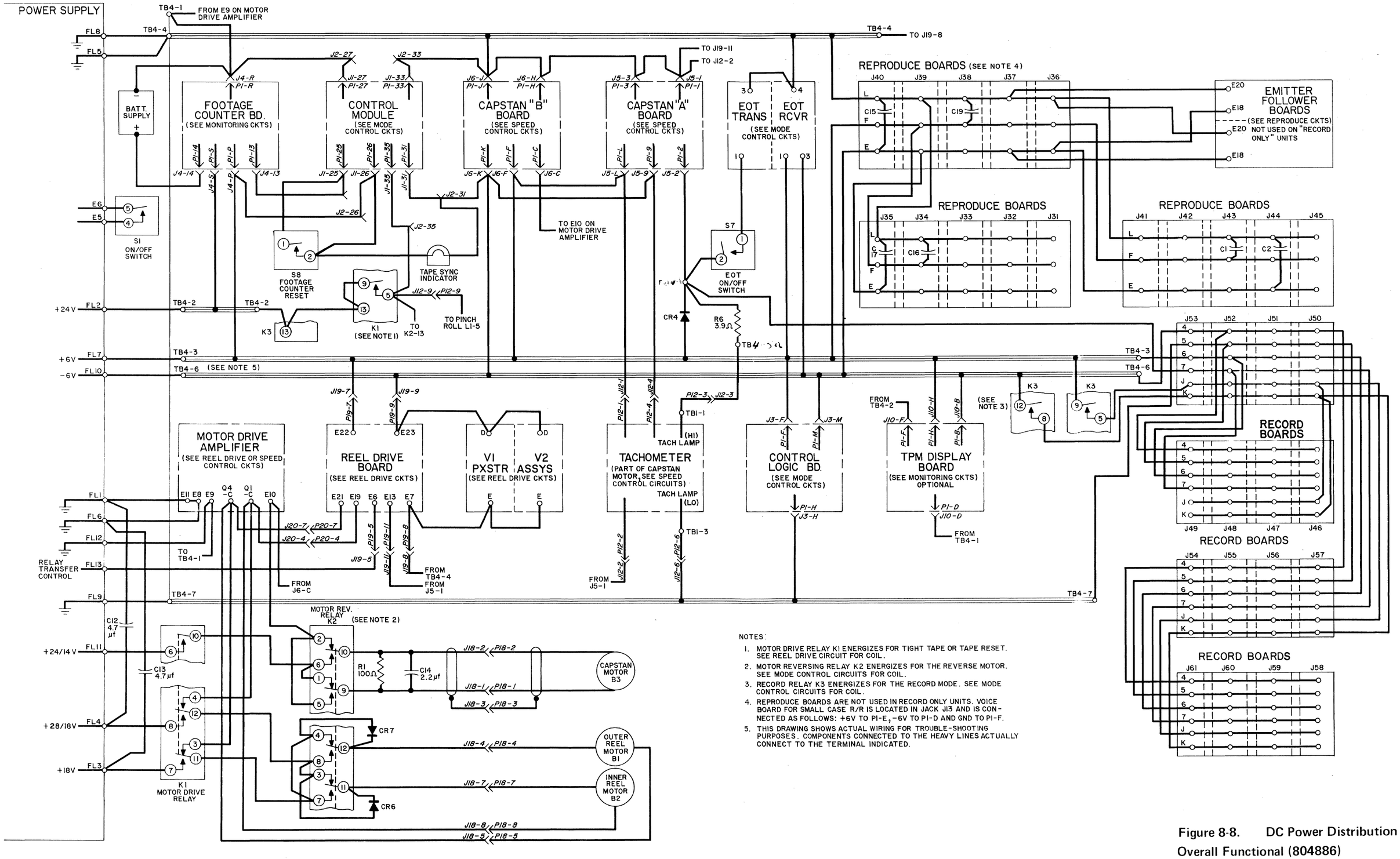
REF. DESIG.	SANGAMO PART NO.
J3	859241-001
thru	
J6	
J12	859255-002
J18	859255-002
J19	859255-003
J20	859254-002
K1	510486-003
thru	
K3	
R7	510408-050
TB1	510734-004
TB4	510497-002
XK1	855563
thru	
XK3	

CONTROL MODULE

REF. DESIG.	SANGAMO PART NO.
CR1	510509
thru	
CR7	
P1	510502

CONNECTOR PANEL

J2	510502



NOTES:

1. MOTOR DRIVE RELAY K1 ENERGIZES FOR TIGHT TAPE OR TAPE RESET. SEE REEL DRIVE CIRCUIT FOR COIL.
2. MOTOR REVERSING RELAY K2 ENERGIZES FOR THE REVERSE MOTOR. SEE MODE CONTROL CIRCUITS FOR COIL.
3. RECORD RELAY K3 ENERGIZES FOR THE RECORD MODE. SEE MODE CONTROL CIRCUITS FOR COIL.
4. REPRODUCE BOARDS ARE NOT USED IN RECORD ONLY UNITS. VOICE BOARD FOR SMALL CASE R/R IS LOCATED IN JACK JI3 AND IS CONNECTED AS FOLLOWS: +6V TO PI-E, -6V TO PI-D AND GND TO PI-F.
5. THIS DRAWING SHOWS ACTUAL WIRING FOR TROUBLE-SHOOTING PURPOSES. COMPONENTS CONNECTED TO THE HEAVY LINES ACTUALLY CONNECT TO THE TERMINAL INDICATED.

Figure 8-8. DC Power Distribution Overall Functional (804886)

REGULATOR BOARD 836639

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	510494-001	CR1	852475-008	CR15	510454	R8	853530-147
C2	859775-026	CR2	844510	CR16	510454	thru	
C3	859775-034	CR3	844510	CR17	852475-030	R10	
C4	859775-034	CR4	510454	CR18	852475-018	R11	853530-204
C5	859775-022	thru		MP1	847825	R12	853530-211
C6	859775-034	CR6		Q1	510446	R13	329151-006
C7	859775-031	CR7	510469	Q2	510446	thru	
C8	859775-007	thru		Q3	510447	R15	
C9	510058-003	CR10		R1	510409-041	R16	510409-089
C10	859775-007	CR11	852475-030	R2	510409-041	R17	510408-067
C11	510058-003	CR12	852475-018	R3	510409-057	R18	510408-067
C12	859775-031	CR13	852475-030	R4	510408-067	U1	510240-002
C13	859775-034	CR14	852475-018	thru		thru	-
				R7		U3	

OSCILLATOR BOARD 836637

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	510494-001	CR1	896458	Q3	510446	R8	853530-268
C2	896871	thru		Q4	510447	R9	853530-180
C3	896475	CR4		R1	853530-272	R10	510409-073
C4	896475	J1	510493	R2	510164-008	R11	510409-041
C5	859775-034	thru		R3	853530-272	R12	510409-041
C6	859775-003	J11		R4	853530-243	R13	510409-031
thru		MP1	847825	R5	853530-243	thru	
C9		Q1	852738	R6	853530-180	R16	
C10	510058-003	Q2	853037	R7	853530-268	T1	837020
						U1	510453

MAIN CHASSIS ASSEMBLY 837101-001

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
B1	837318-001	F1	510542-003	K1	510488-003	R1	864971-003
C1	859960-004	F2	510542-002	P1	859763-015	R2	510022-103
C2	859960-004	F3	510542-004	P2	859763-015	T1	837018
C3	510496	F4	510542-002	P4	859763-015	T2	837019-001
CR1	510007-004	F5	859774-007	thru		XF1	812299
CR2	510087	FL1	836776	P11		thru	
E1	850312	J1	695865-004	PS1	510536-001	XF5	
thru		J2	695865-003	Q1	510495-001		
E5		J3	854725	thru			
				Q4			

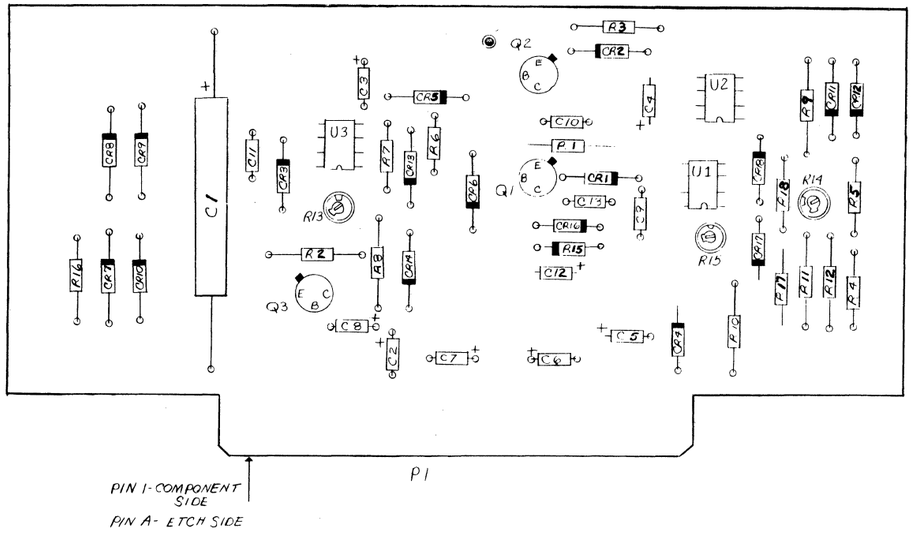


Figure 8-9. Regulator Board Parts Location (836639)

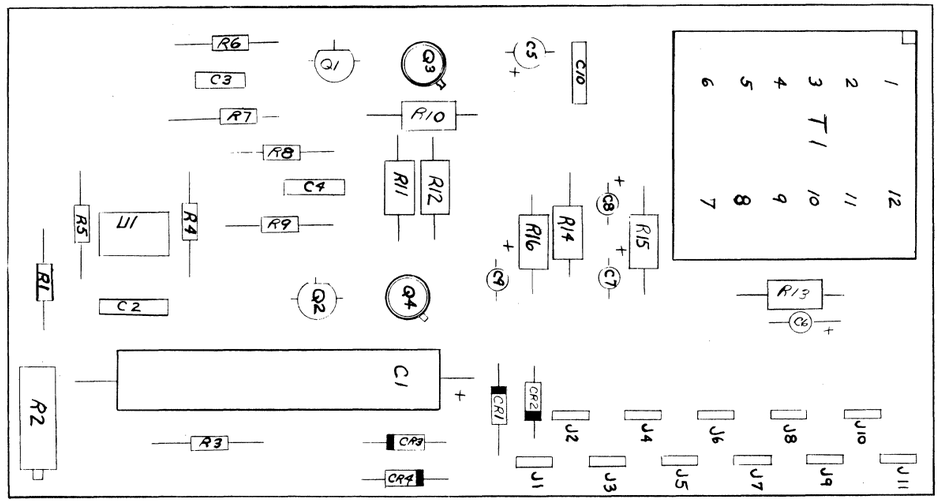


Figure 8-10. Oscillator Board (117 vac) Parts Location (836637)

RECTIFIER CHASSIS ASSEMBLY 837102

Refer to parts list for the 234 vac supply

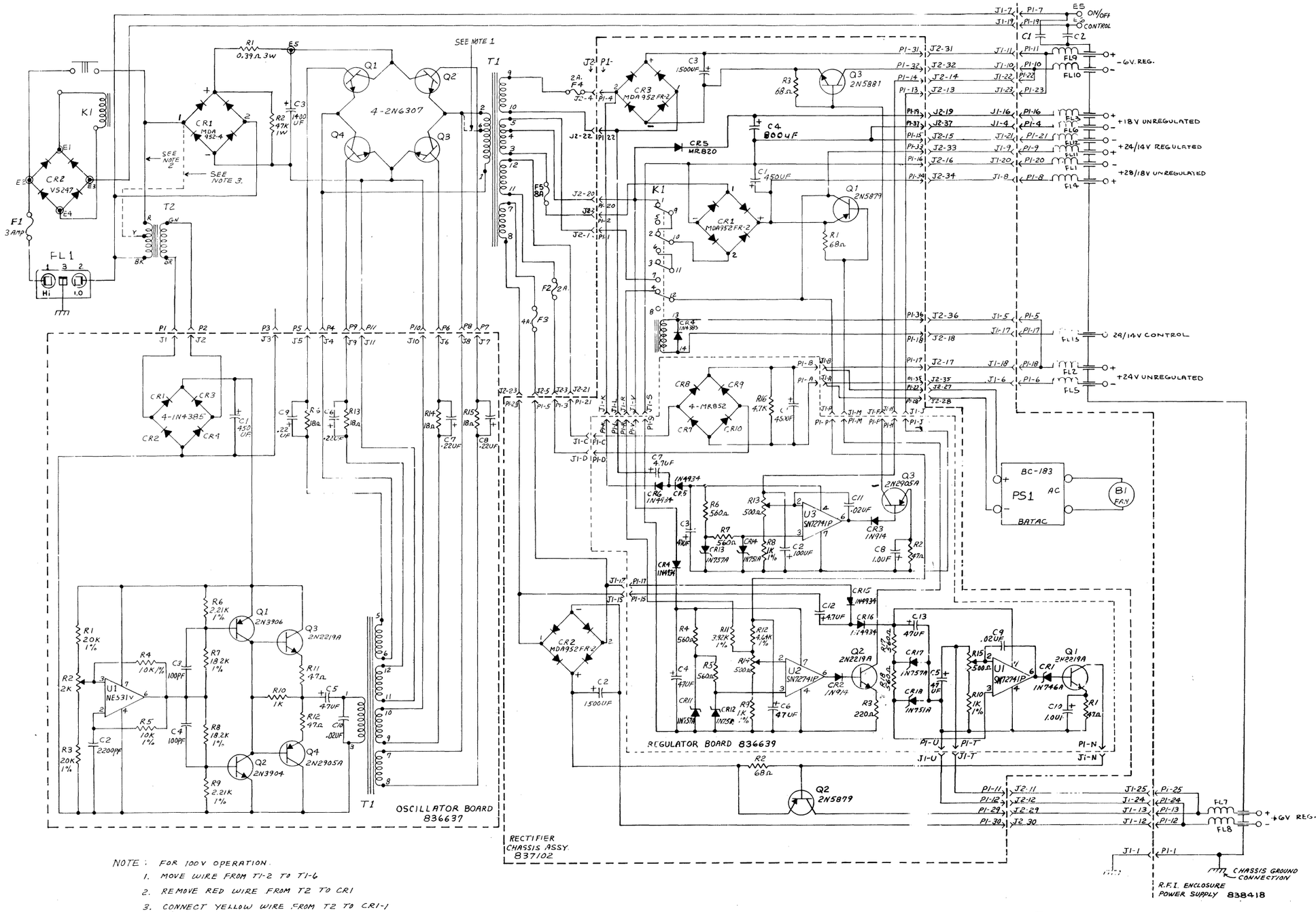


Figure 8-11. Power Supply (117 vac) Schematic Diagram (837101-001)

REGULATOR BOARD 836639
Refer to parts list for 117 vac supply

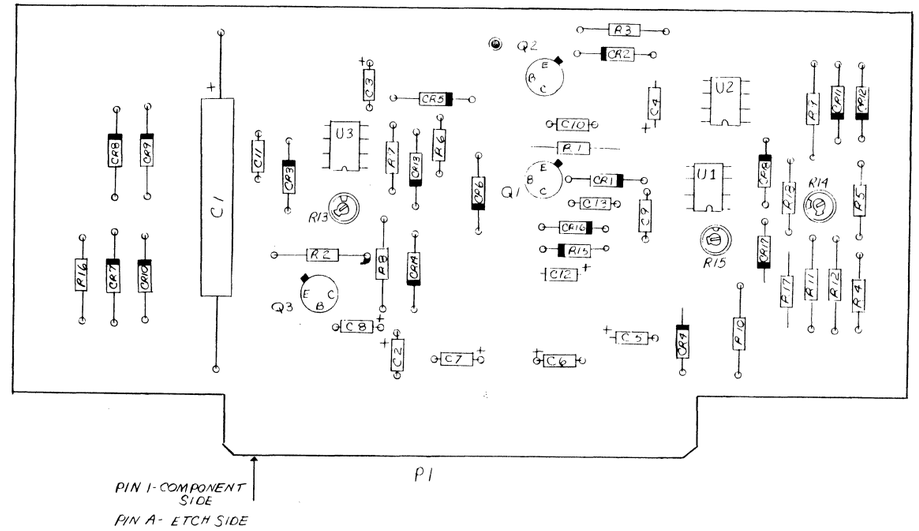


Figure 8-12. Regulator Board Parts Location (836639)

OSCILLATOR BOARD 837300

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	510494-001	CR1	896458	Q3	510446	R8	853530-268
C2	896871	thru		Q4	510447	R9	853530-180
C3	896475	CR4		R1	853530-272	R10	510409-073
C4	896475	J1	510493	R2	510164-008	R11	510409-041
C5	859775-034	thru		R3	853530-272	R12	510409-041
C6	859775-005	J11		R4	853530-243	R13	510409-037
thru		MP1	847825	R5	853530-243	thru	
C9		Q1	852738	R6	853530-180	R16	
C10	510058-003	Q2	853037	R7	853530-268	T1	837020
						U1	510453

MAIN CHASSIS ASSEMBLY 837101-002

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
B1	837318-001	F2	510542-002	K1	510488-003	Q1	510495-002
C1	NOT USED	F3	510542-004	P1	859763-015	thru	
C2	NOT USED	F4	510542-002	P2	859763-015	Q4	
C3	510540	F5	859774-007	P3	NOT USED	R1	510577-001
CR1	510007-006	F6	510542-001	P4	859763-015	R2	510022-111
CR2	402970	FL1	510727	thru		R3	334457
E1	850312	J1	695865-004	P11		T1	837728
thru		J2	695865-003	PS1	510536-001	T2	837247
E6		J3E1	837334-001			XF1	812299
F1	510542-001					thru	
						XF6	

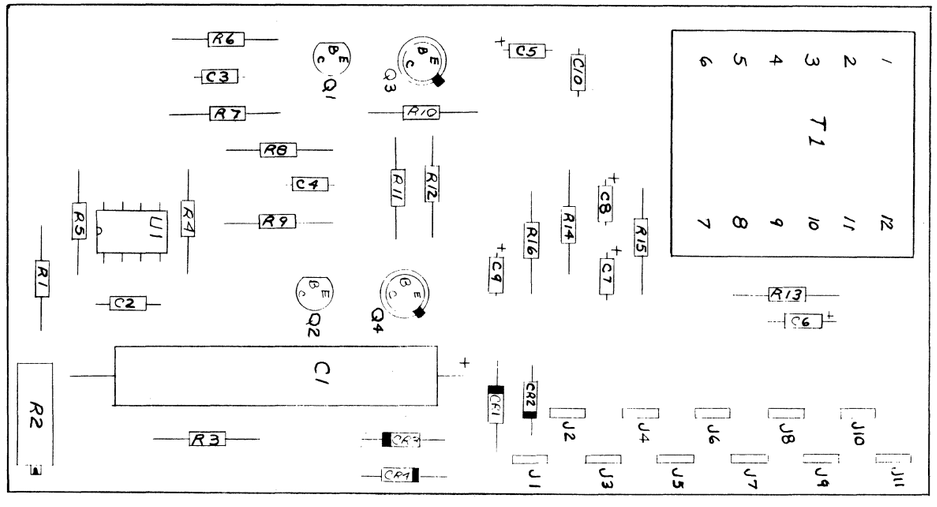


Figure 8-13. Oscillator Board (234 vac) Parts Location (837300)

RECTIFIER CHASSIS ASSEMBLY 837102

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	510494-001	CR3	510545	J1	859241-004	R1	691111-680
C2	510494-003	CR4	896458	K1	510486-003	thru	
C3	510494-003	CR5	510569-001	P1	695865-002	R3	
C4	510494-028	E1	850312	Q1	510465	XK1	855563
CR1	510545	thru		Q2	510465		
CR2	510545	E10		Q3	510467		

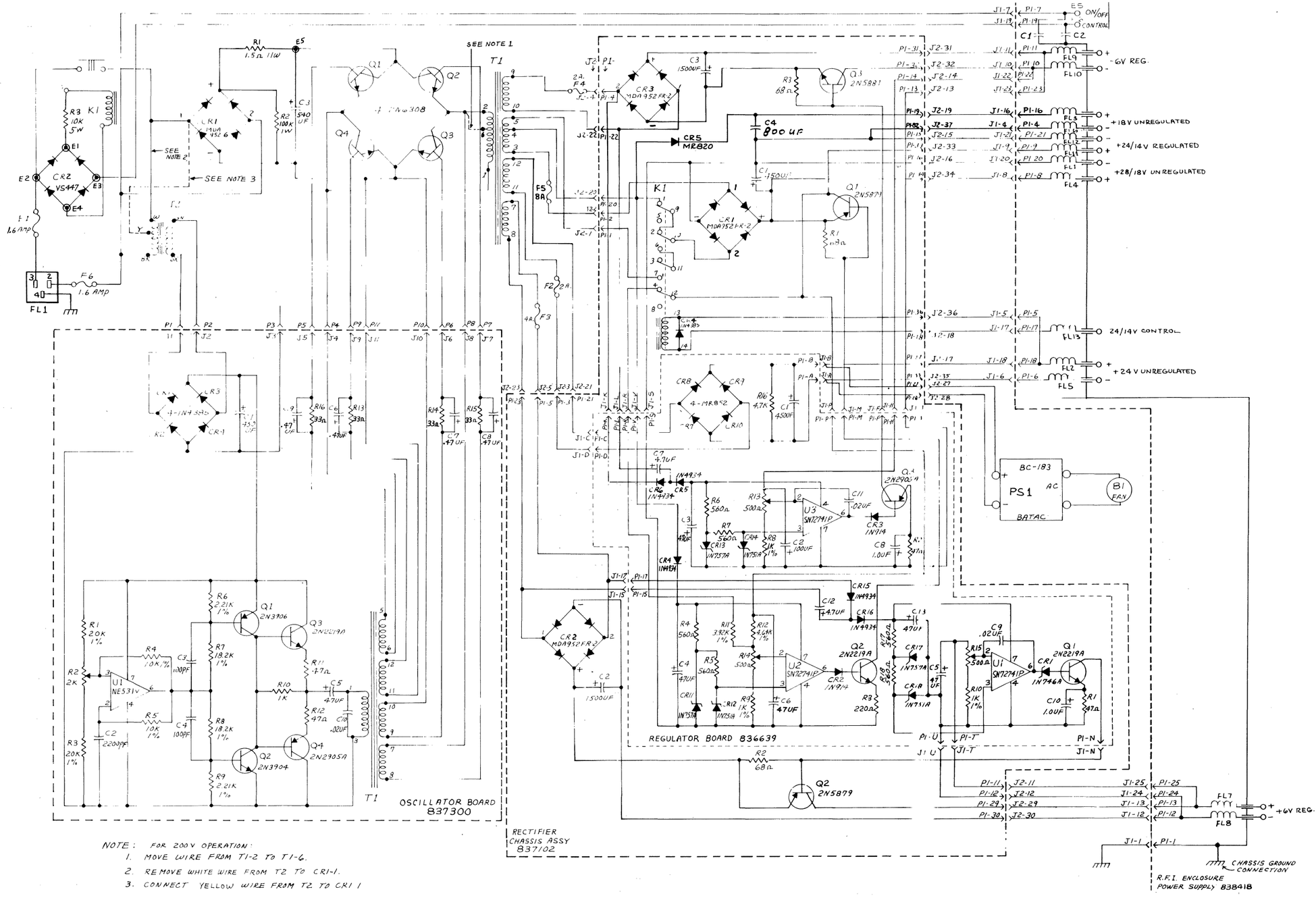


Figure 8-14. Power Supply (234 vac) Schematic Diagram (837101-002)

REGULATOR BOARD 836639
Refer to parts lists for 117 vac supply

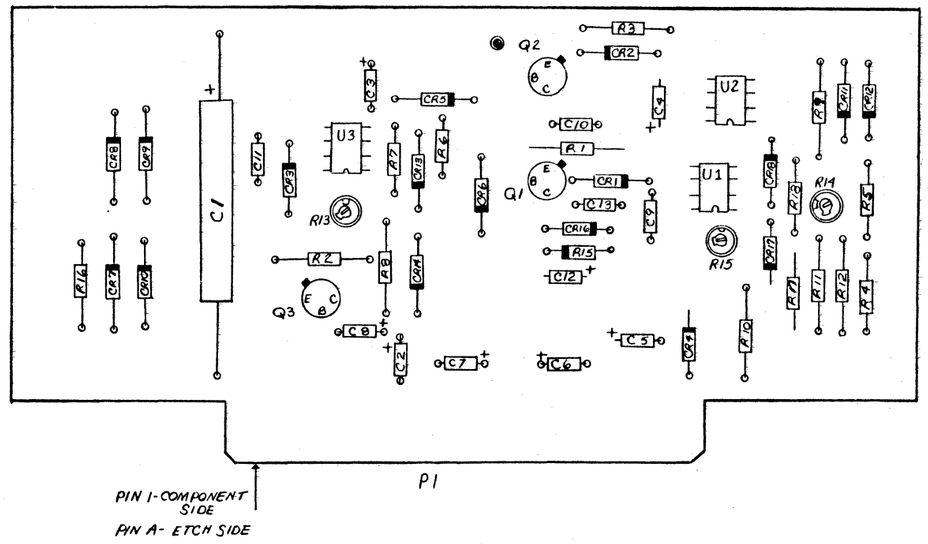


Figure 8-15. Regulator Board Parts Location (836639)

POWER OSCILLATOR 837243

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	691686-061	J1 thru J7	510493	R1 R2	859925-018 859925-021	R3 T1	859925-020 837267

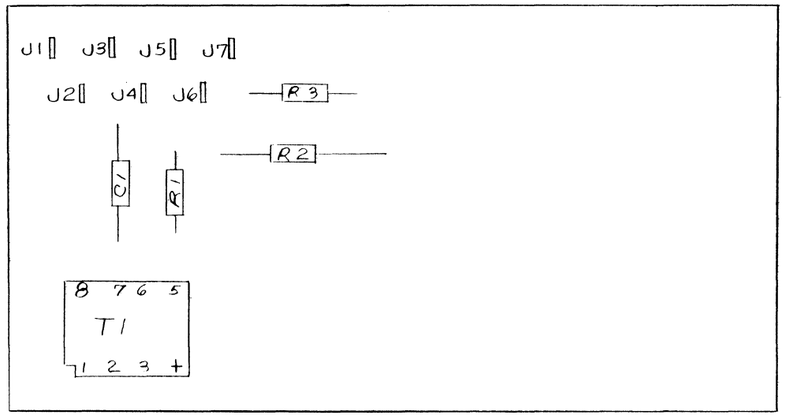


Figure 8-16. Oscillator Board (12 vdc) Parts Location (837243)

MAIN CHASSIS ASSEMBLY 837101-003

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
B1	837318-002	F2	510542-002	J3E1	837332-001	PS1	510536-002
C1	510494-003	F3	510542-004	K1	837328	Q1	510541
C2	510058-003	F4	510542-002	P1	859763-015	Q2	510541
CR1	896458	F5	859774-007	P2	859763-015	R1	851288
CR2	896458	FL1	836776	P3	Not Used	T1	837265
E1	850312	J1	695865-004	P4	859763-015	XF1	812299
E2	510490-005	J2	695865-003	thru		thru	
F1	859774-011	J3	837329-001	P7		XF5	

RECTIFIER CHASSIS ASSEMBLY 837102
Refer to parts list for 234 vac supply

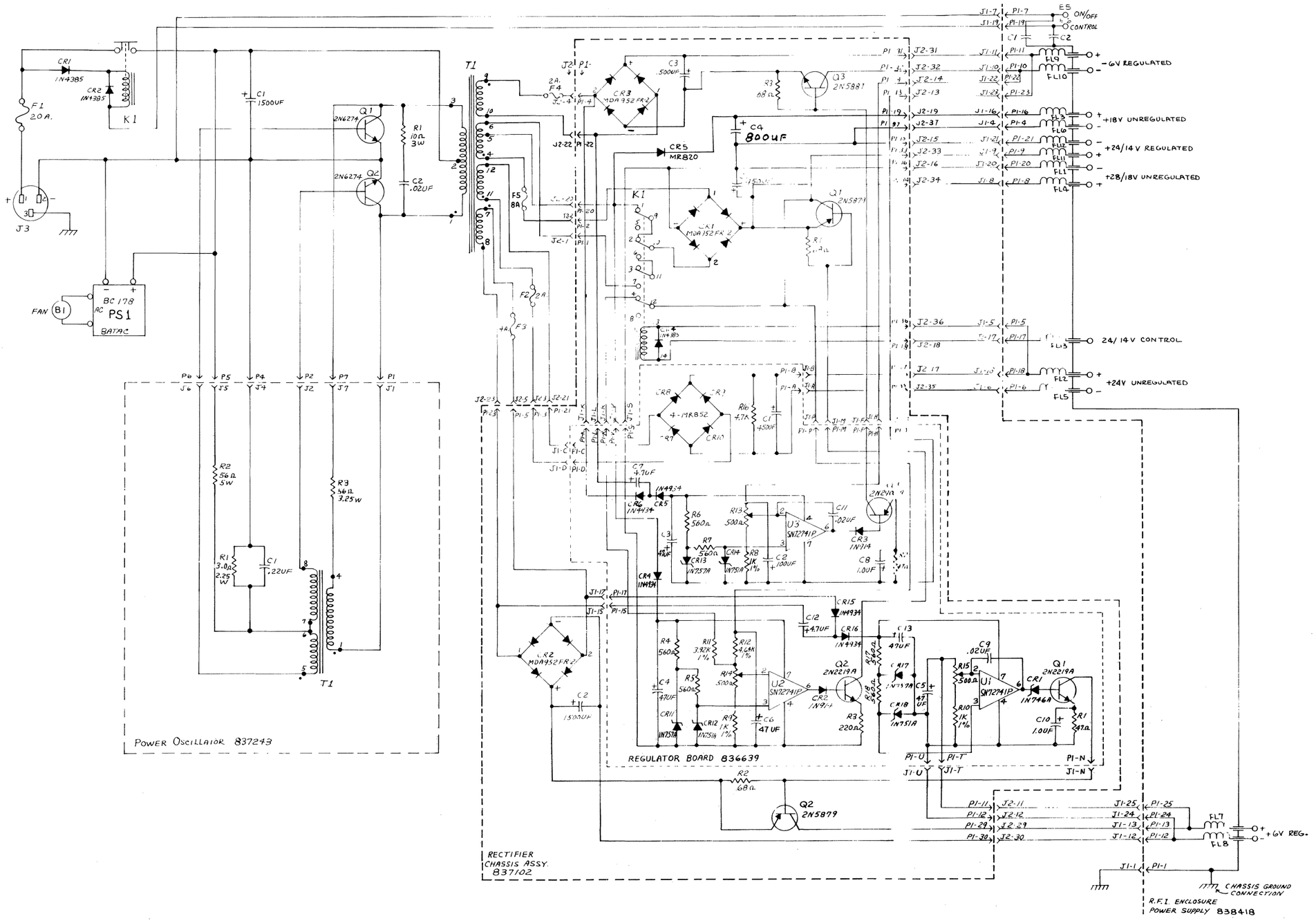


Figure 8-17. Power Supply (12 vdc) Schematic Diagram (837101-003)

REGULATOR BOARD 836639
Refer to parts list for 117 vac supply

POWER OSCILLATOR 837244

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	691686-014	J1 thru J7	510493	R1 R2	859925-019 859925-023	R3 T1	859925-022 837267

MAIN CHASSIS ASSEMBLY 837101-004

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
B1	837318-001	F2	510542-002	J3E1	837332-001	PS1	510536-001
C1	692537-119	F3	510542-004	K1	853623	Q1	510541
C2	510058-003	F4	510542-002	P1	859763-015	Q2	510541
C3	510494-001	F5	859774-007	P2	859763-015	R1	851288
CR1	896458	FL1	836776	P3	Not Used	T1	837263
CR2	896458	J1	695865-004	P4	859763-015	XF1	812299
E1	850312	J2	695865-003	thru		thru	
E2	510490-005	J3	837329-001	P7		XF5	
F1	859774-008						

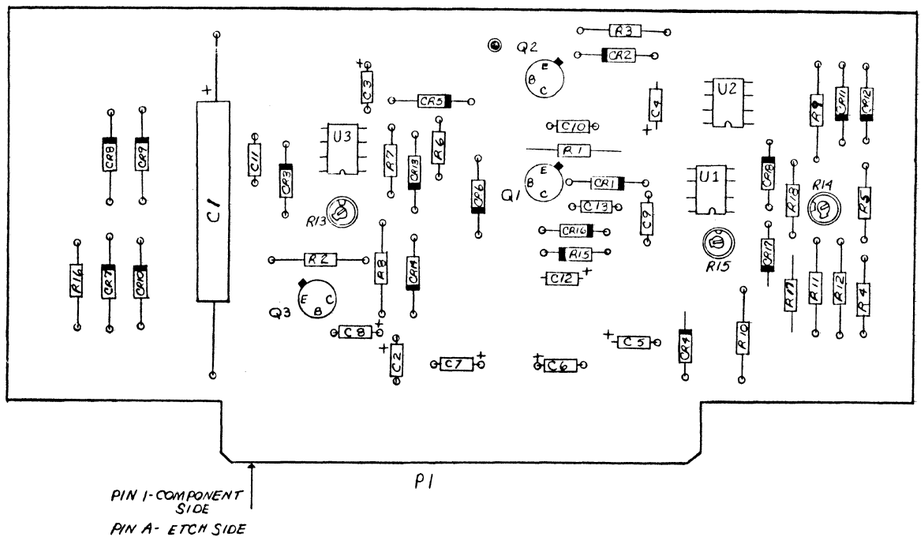


Figure 8-18. Regulator Board Parts Location (836639)

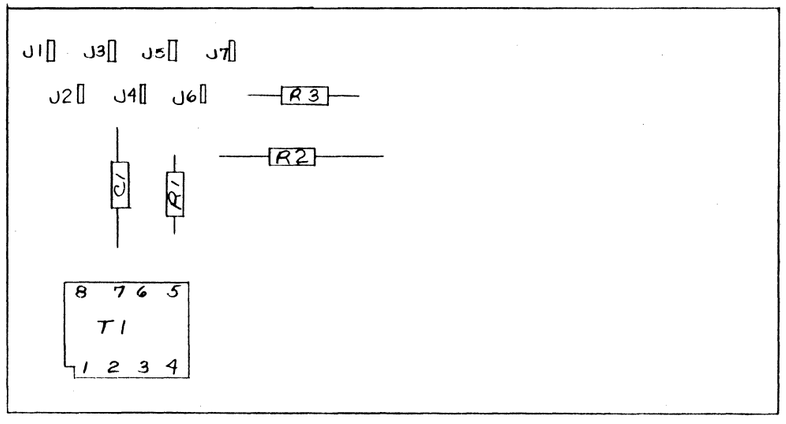


Figure 8-19. Oscillator Board (26 vdc) Parts Location (837244)

RECTIFIER CHASSIS ASSEMBLY 837102
Refer to parts list for 234 vac supply

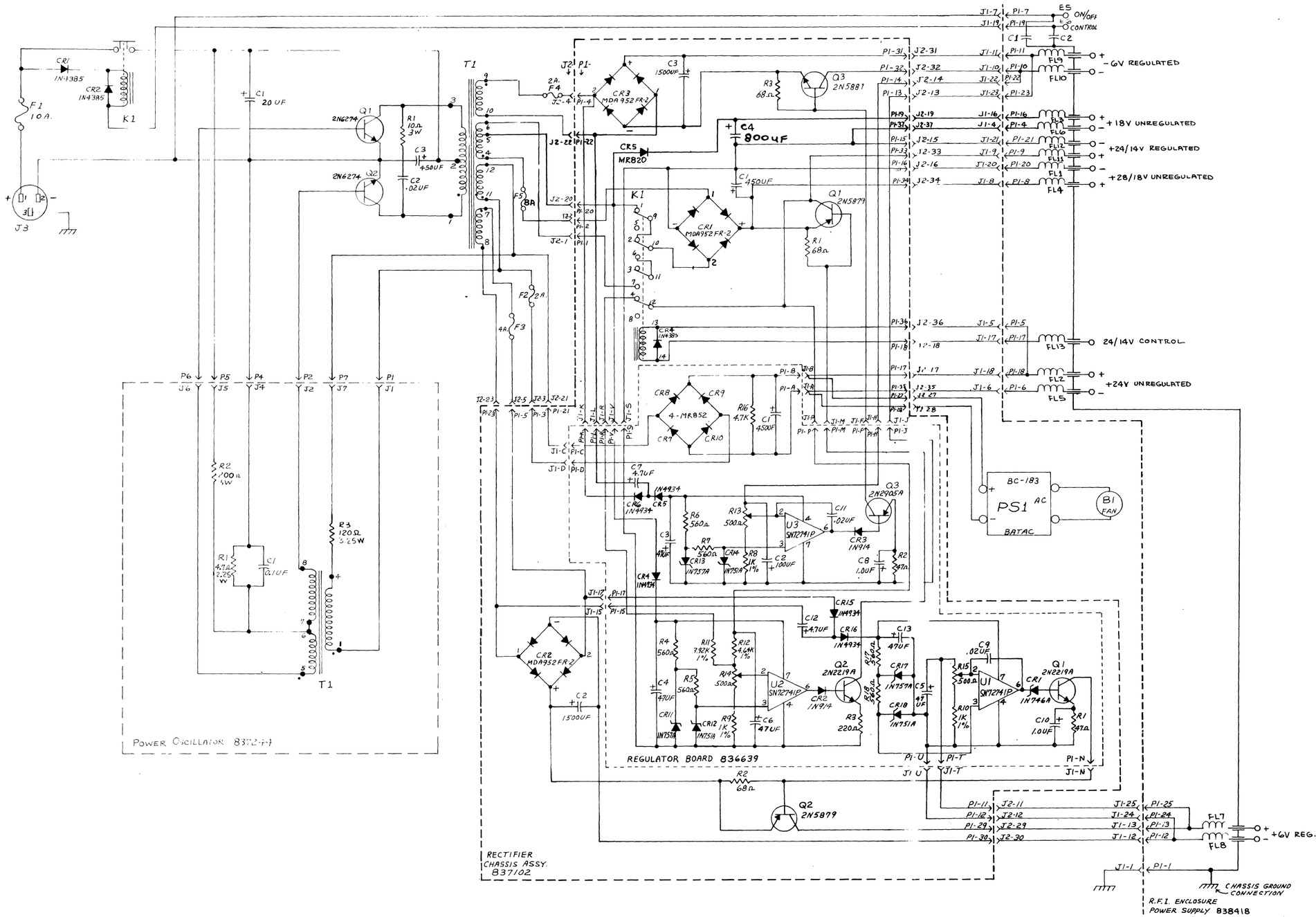


Figure 8-20. Power Supply (26 vdc) Schematic Diagram (837101-004)

SECTION 9
MODE CONTROL – SERVICING

A. INTRODUCTION

The mode control circuits are responsible for initiating and controlling the various functions of the SABRE VI. The control logic board is the heart of these circuits.

The control logic board accepts signals from the mode control switches, speed control system, E.O.T. receiver and reel drive speed change circuits and uses these signals to control the mode indicating lamps, tape motion and capstan direction. It also controls power to the record boards, the initial resetting of the reel drive system, and enables the selection of tape reference in the speed control system.

B. FUNCTIONAL DESCRIPTION

All inputs to the logic board are active when grounded meaning when a switch on the control panel is depressed, the input is momentarily grounded. Refer to the control logic board schematic diagram and the mode control overall functional diagram for the following discussion.

1. POWER ON

When the ON-OFF switch on the front of the unit is depressed, power begins to "come up" resulting in resistor R8 and capacitor C2 (an RC time constant) on the logic board holding a STOP command down until the power supplies are fully up to operating voltages. This ensures that the fwd latch (U2, U2), rev latch (U2, U7), fast latch (U10, U7), and the record latch U5, U15) are all reset to the proper state.

2. STOP

Any time the STOP pushbutton on the control module is depressed, the command is applied through a NAND gate (U10) and inverted (U11) to reset all three tape motion latches. With all three latches reset, tape motion must stop. Logic levels from the three latches are applied through a NOR (U12) gate to drive indicator driver Q3. The output of Q3 drives the STOP indicator on the control module to indicate all latches are in the reset condition.

The STOP command is also applied to inhibiting NAND gates (U1, U5, U5, and U5), which control the set inputs of the three latches. During the presence of the command, a FORWARD, REVERSE, or a FAST command is inhibited. After the STOP pushbutton is released, then other commands are possible. When the reel drive tension arms are allowed to reach their "at rest" position, tight tape sense circuit on the reel drive board sends a STOP command to the logic circuits at U10-12. This command results in the same action as the STOP pushbutton.

Anytime loose tape exist, such as after threading, depressing the STOP pushbutton sends a logic signal to the reel drive board (See reel drive circuits) to generate a two second pulse to energize the motor drive relay K1 (See DC power distribution). When this occurs, power is applied to both reel drive motors resulting in the tape tightening and the lifting of the tension arms off their stops. If more than two seconds worth of tape exist, then relay K1 drops out and the procedure must be repeated.

3. FORWARD

When the FWD pushbutton is depressed, the low command is inverted at U1-4 and is applied to an interlock circuit. NAND gate U1-3 inverts the command to set the fwd latch (U2, U2) provided the STOP command is not active. Also, the command from buffer U1-4 is applied through NOR gate U6-4 to inhibit a FAST command via U5 and to inhibit record via U9 and U11. The REVERSE command is inhibited at the input of U5 via U1-3.

When the STOP indicator goes out via U12-6, the pinch roll solenoid pulls in through a motion detector circuit. This path is through U4-11 which activates the pinch roll solenoid whenever the STOP signal is removed from U4-13 or when the capstan motion signal at U4-12 from the speed control circuits is removed. The capstan motion signal is a logic 0 whenever the capstan is rotating. This means whenever the STOP command returns, the capstan motion keeps the pinch roller engaged until the capstan nearly stops.

At the same time the pinch roll solenoid is energized, the fwd latch also applies a logic 1 to an operate gate at U8-1. This signal passes through to U8-4 and to U13. U13 is a level convertor to adjust the voltage level of the logic signal for application to the speed control circuits. The output of the level converter instructs the speed control circuits to move the capstan at the selected tape speed.

4. REVERSE

The reverse mode operates in much the same fashion as the forward mode with the following exceptions.

When the rev latch sets, a capstan direction flip-flop (U7,U8) changes state. The output of the rev latch at U2-10 is applied through a NAND gate at U4-10 to U8-9. The second input of the NAND gate at U4-8 is the capstan motion signal from the speed control circuits. This signal ensures that the capstan must be stopped before the capstan direction flip-flop can change states.

When the flip-flop is in the reverse position, a logic 1 is applied through the operate gate as for the forward mode and to transistor Q9. The logic 1 turns the transistor on to energize capstan motor reversing relay K2. Whenever relay K2 is energized, current from the speed control circuits is reversed through the capstan motor, driving it in the reverse direction.

The same control line reversing relay K2 is also applied to the footage counter ciruit board. The function of this signal is to reverse the counting order of the footage counter, causing the readout to count down.

5. FAST FORWARD

When the FAST FWD pushbutton is depressed, the low command is inverted at U1-11 and applied to the interlock circuitry at U5-2. The command is again inverted and applied to set the fast latch at U10-3 and the fwd latch at U2-3. The command at U1-11 is also applied through U6-10 to ensure the record latch is reset.

When the fast latch sets, it turns the STOP indicator off through U12-6 by turning transistor Q3 off and turns the FAST FWD indicator on through U14-10 to transistor Q6. U14 requires both the fwd and fast latch signals to cause the FAST indicator to light.

The operate gate and the pinch roll function in the same manner as to that of the FORWARD mode.

6. FAST REVERSE

The FAST REVERSE mode operates in the same fashion as the FAST FORWARD mode with the following differences.

When the rev latch sets, the capstan direction flip-flop changes state as during the REVERSE mode. The output is applied through a driver (transistor Q9) to energize motor reversing relay K2. When relay K2 energizes, the drive current is reversed through the motor windings to drive the capstan in the reverse direction.

The same control line reversing relay K2 is also applied to the footage counter circuit board. The function of this signal is to cause the counting circuit to count down instead of up.

7. RECORD

When the RECORD pushbutton is depressed, the low signal passes through a buffer U9-10 into the interlock circuits at U9-11 to set the record latch (U15, U15). The interlock circuits determine the sequence of button pushing to instruct the unit how to respond. Depressing the RECORD pushbutton sets the record latch while depressing the FWD pushbutton sets the fwd (or rev) latch (as described for the FORWARD mode). If the RECORD pushbutton were released before the FWD pushbutton, the FORWARD command through the interlock circuit resets the record latch.

The output of the record latch drives a tape reference gate at U14-3. The output of this gate drives a level converter U13 with its output being applied to the capstan A board. The tape reference enable signal is applied to the tape sync board to inhibit a tape signal from controlling the speed control system. This means the speed control circuits are operating from the frequency generated by the tachometer.

An output of the record latch also drives record relay driver Q4 which energizes record relay K3. When relay K3 energizes, +6 and -6 volts power is applied to all the record boards to activate for recording. Also, a separate contact causes the RECORD indicator on the control module to light.

8. END-OF-TAPE AND REEL RESET

When the tape is moving, one pulse per foot from the footage counter board enters the E.O.T. transmitter at U1-5. U1 is a one shot multivibrator which develops a 5 microsecond pulse for each pulse entering. The pulses from U1-6 are applied to switching transistor Q1. Each pulse causes the transistor to turn on for the brief 5 microsecond period to light the two infrared LED diodes.

When the supply reel (either inner or outer) is almost empty, the pulses from the respective LED diode reaches the EOT receiver. The respective photo-transistor (Q1 or Q2) detects the infrared light and begins to conduct. The output from the transistor is amplified and applied to the logic board.

The two outputs of the receiver, the rev sense and fwd sense inputs, are applied to U3-6 and U3-1 respectively. These gates select the signal that may pass based on the direction the tape is moving. When the fwd latch is set and the tape is moving forward, only the fwd sense signal can make a logic change at U4-4. This means when a full reel is on the inner hub and the tape is moving forward, the rev sense is activated at the receiver but can not pass through U3-4.

The output at U4-4 (EOR) is applied to the reel drive circuits and inverted at U1-11. If the microswitches on the tension arms are indicating tight tape as is normal when tape is moving, the signal will pass through a NOR gate at U2-11 and back to the logic board at U10-12. The signal passes through U10-10 and is inverted at U11-10 to reset all the latches thus initiating a STOP mode.

C. FAULT ISOLATION

In troubleshooting the mode control circuits, a malfunction must first be isolated to these circuits. Since the mode control circuits provide signals to the speed control circuits, the reel drive circuits, and the footage counter circuits, some confusion may arise as to which functional circuit to approach first. Reviewing the list of mode control functions should aid in making the correct decision. The mode control circuits perform the following functions:

a. Initiate capstan rotation and capstan direction (forward or reverse).

b. Energize the pinch roll solenoid any time capstan motion takes place.

c. Cause footage counter to count up (forward) or count down (reverse).

d. Take up slack tape (reel reset) whenever the STOP pushbutton is depressed.

e. Cause tape to stop near the end of a reel of tape whenever the EOT circuits are activated.

f. Activate the record circuits whenever the RECORD pushbutton is depressed.

g. Inhibit the tape sync signal (if tape sync is used) from controlling the speed control circuits during FAST or RECORD modes.

h. Light correct indicators on the control module.

In order to perform the above functions from the output of the mode control circuits, certain inputs must take place. Those inputs required are:

a. Six pushbuttons on the control module (FWD, REV, FAST FWD, FAST REV, REC, and STOP).

b. EOT receiver board (one signal for forward tape motion and one for reverse).

c. Stop signal from the reel drive board after the EOT circuits have initiated the original command.

d. Capstan motion signal from the capstan A board to indicate the capstan rotating.

To troubleshoot the mode control circuits, procede as follows:

Step 1. Place the logic board on the extender board to expose the pins for voltage reading.

Step 2. With a dc voltmeter, check the power supply voltages to the logic board. The voltmeter should measure -6 vdc at P1-M and +6 vdc at P1-F with P1-H being ground. If incorrect results are obtained, troubleshoot the power supplies. (See power distribution servicing, Section 8).

Step 3. Check the outputs of the logic board by use of Table 9-1. Connect a dc voltmeter between the pin listed and ground (pin H). Perform the action listed while observing the voltmeter. If any of the results are incorrect, make note and procede to Step 4. If the results check correct, check the next action listed in the table.

TABLE 9-1 MODE CONTROL OUTPUT CHECKS

CATEGORY OF FAILURE	VOLTMETER CONNECTION	PUSHBUTTON OPERATION	VOLTMETER READING	CONCLUSION
CAPSTAN	P1-14	FWD, REV, FAST FWD, FAST REV	From logic 0 to logic 1 for each button.	Troubleshoot speed control circuits.
	P1-12	FAST FWD or FAST REV	From logic 0 to logic 1 for each button.	Troubleshoot speed control circuits.
	P1-L	REV or FAST REV	From +24V (before) to 0V.	REV relay K2 should energize. If not, check relay. Footage counter should count down (Monitor circuits).
RECORD COMMAND	P1-15	REC or FAST	From logic 1 to logic 0.	Troubleshoot speed control circuits.
	P1-S	REC	From +24V (before) to 0V.	Record relay K3 should energize, If not check relay.
REEL DRIVE	P1-K	Hold STOP in.	From logic 1 to logic 0	Troubleshoot reel drive circuits.
	P1-C	Set-up so tape sense activates in FWD or REV mode.	From logic 1 to logic 0 when activated.	Troubleshoot reel drive circuits
PINCH ROLL	P1-A	Activate push-button to move tape.	From +24V to 0V.	Pinch roll should energize. If not check pinch roll. Also the 5 and 9 contacts of relay K1.
INDICATORS	P1-R	STOP	Each should change from logic 0 to logic 1.	Correct indicator should light. If not, check indicator in the control module.
	P1-D	FWD		
	P1-E	REV		
	P1-P	FAST-FWD		
	P1-N	FAST-REV		

Step 4. If the output checks in Step 3 are not correct, then the failure is ahead of this point and must be in the logic board or the inputs to the logic board. This step will check the inputs to the logic board by means of a truth table in Table 9-2. Connect a dc voltmeter between the pin listed and ground (pin H). Perform the action listed while observing the voltmeter. If the results check correct, the fault is isolated to the logic (assuming the outputs of the logic board have already proven faulty).

Step 5. If the above checks from Tables 9-1 and 9-2 do not locate the problem, then the logic board should be suspected. If another logic board is available, make a substitution to quickly prove the logic board is at fault.

NOTE

The logic board should not be substituted earlier because certain types of shorts external to the board can cause damage to the new board also. Those shorts should have been located in the previous checks.

TABLE 9-2 MODE CONTROL INPUT CHECKS

VOLTMETER CONNECTION	PUSHBUTTON OPERATION	VOLTMETER READING	CONCLUSION
P1-3 P1-4 P1-5 P1-7 P1-10 P1-9	FWD REV FAST-FWD FAST-REV REC STOP	Each should change from logic 1 to logic 0.	If any pushbutton does not respond correctly, check the switch. If these check correct, troubleshoot the logic board.
P1-1 P1-2	Set-up so EOT transmitter light is striking EOT receiver.	Each should change from logic 1 to logic 0 with light on photocell.	If results incorrect, check EOT receivers. If correct, check logic board.
P1-B	Activate any tape motion button.	Change from logic 1 to logic 0 with tape motion	If incorrect, check speed on control circuits. If correct check logic board.
P1-8	Quickly force one of the tension arms against its "at rest" stop.	Change from logic 1 to logic 0.	If incorrect, check reel drive circuits. If correct, check logic board.

Step 6. To troubleshoot the board, one function at a time should be traced out (except FORWARD, REVERSE, etc.). Refer to the appropriate paragraph under paragraph B. FUNCTIONAL DESCRIPTION of this section to check out the path of each mode. This should explain the logic pathes sufficiently to locate the component It may be necessary to check two or more modes to determine the exact location of the faulty component.

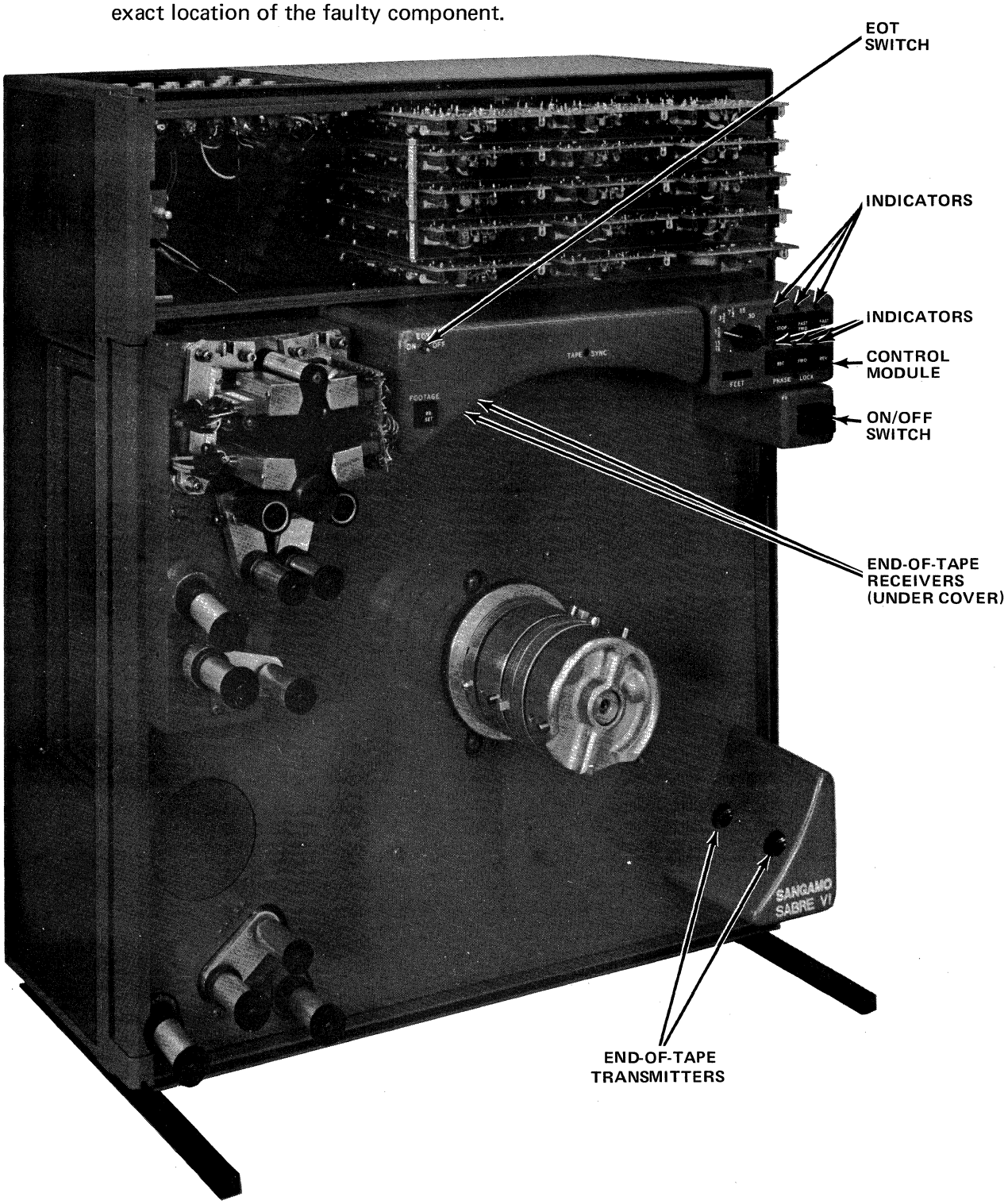


Figure 9-1. Front View Showing Mode Control Items

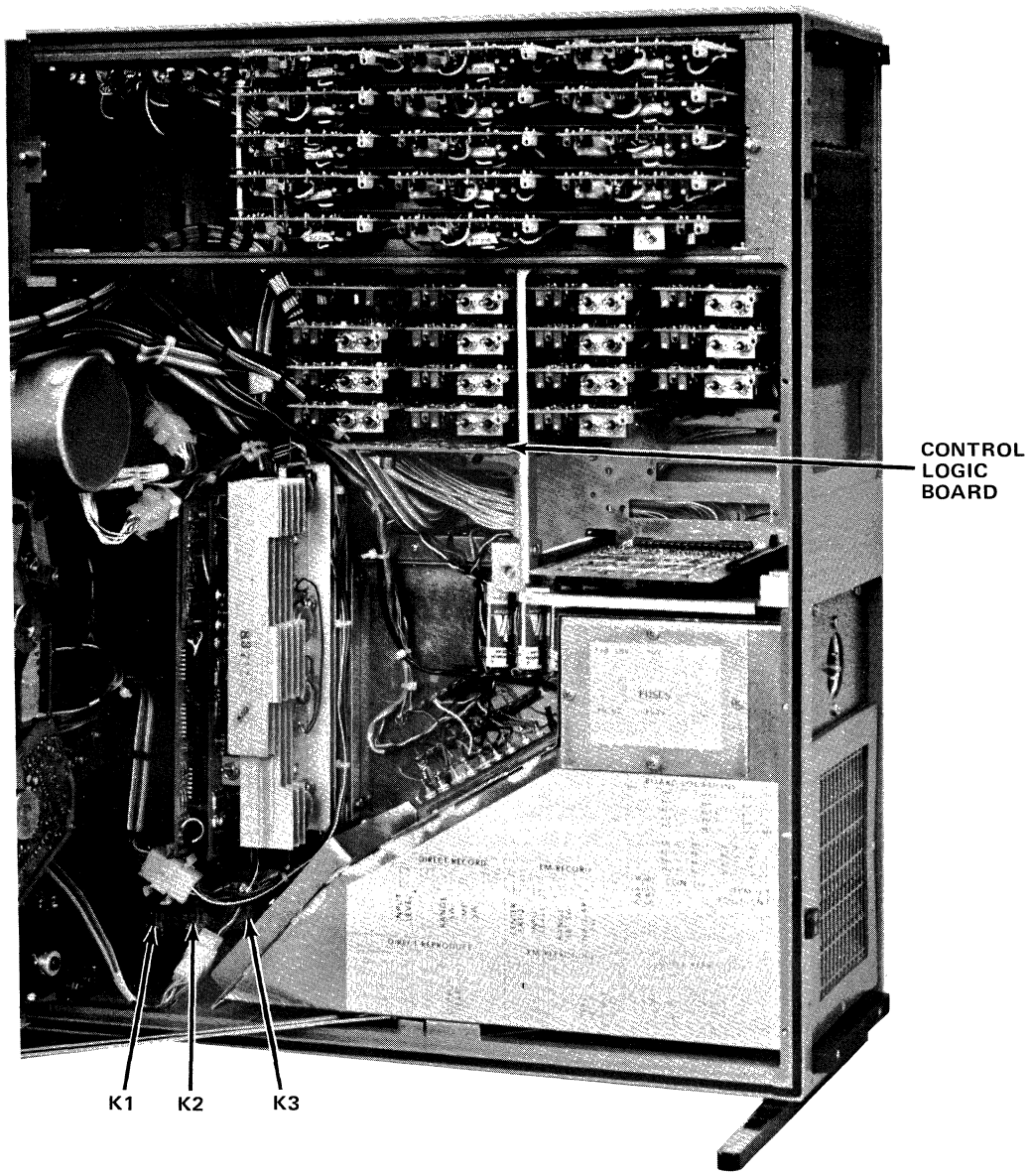


Figure 9-2. Front View Showing Logic Board Location

MODE CONTROL CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL

REF. DESIG.	SANGAMO PART NO.
J1	837115
S7	510102-003

ELECTRONIC CHASSIS

REF. DESIG.	SANGAMO PART NO.
C18	859775-007
J3	859241-001

CONTROL MODULE

REF. DESIG.	SANGAMO PART NO.
CR1 thru CR5	510509
P1	510502
S2 thru S7	510466

CONNECTOR PANEL

REF. DESIG.	SANGAMO PART NO.
J2	510502

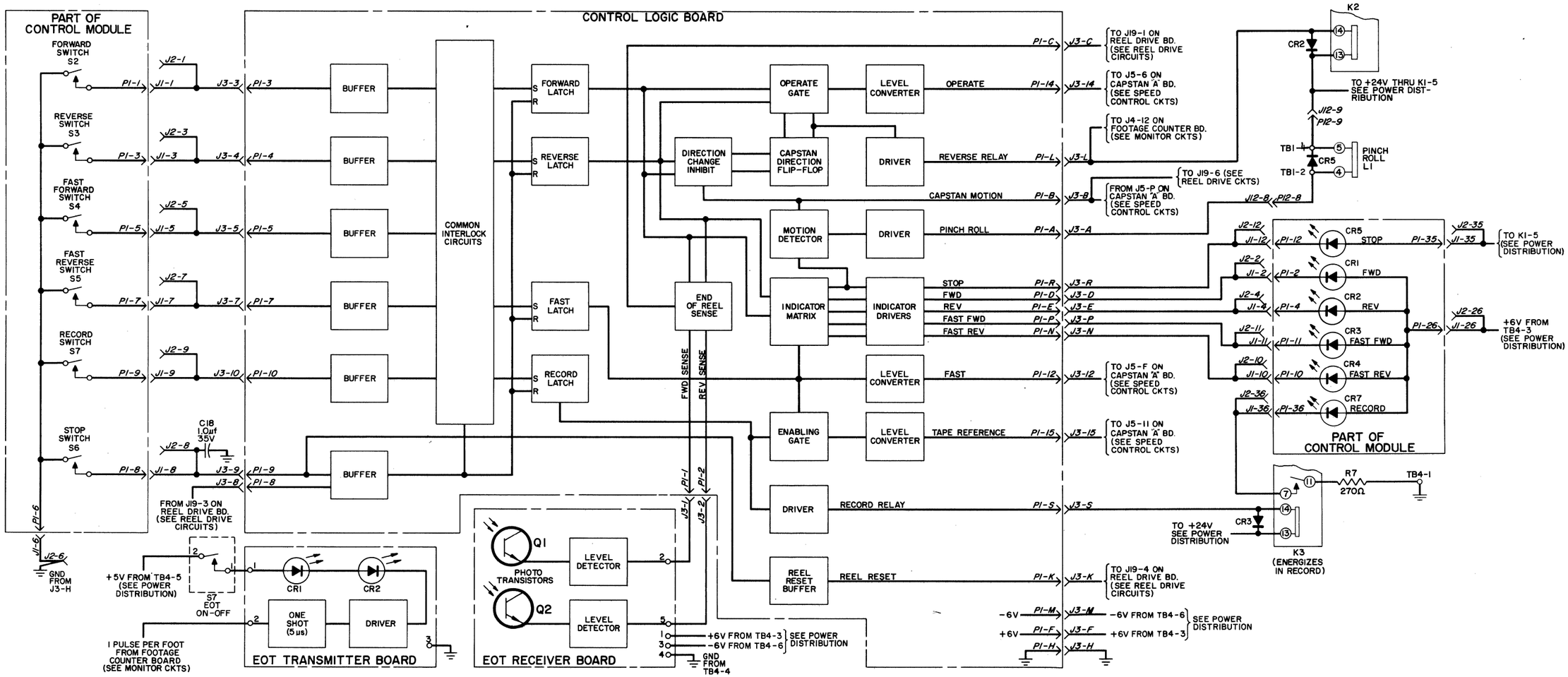


Figure 9-3. Mode Control Overall Functional (804887)

CONTROL LOGIC BOARD 836633

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-019	R1	510408-073	R14	510408-099	U2	510376-024
C2	859775-007	R2	510408-073	thru		U3	510376-012
CR1	844510	R3	510408-073	R18		U4	510376-012
MP1	847825	R4	510408-073	R19	510408-095	U5	510376-024
Q1	854539	R5	510408-073	R20	510408-077	U6	510376-002
thru		R6	510408-073	R21	510408-059	U7	510376-024
Q3		R7	510408-097	R22	510408-059	U8	510376-012
Q4	853037	R8	510408-121	R23	510408-093	U9	510376-012
Q5	854539	R9	510408-109	R24	510408-093	U10	510376-024
Q6	854539	thru		R25	510408-097	U11	510376-012
Q7	853037	R11		R26	510408-061	U12	510376-026
Q8	510446	R12	510408-059	R27	510408-095	U13	510433
Q9	853037	R13	510408-059	U1	510376-012	U14	510376-002
						U15	510376-013

TYPE	VDD	Vss	I.C. NUMBER
4011	14	7	U1, U3, U4, U8, U9, U11
4001	14	7	U6, U14
4012	14	7	U15
4023	14	7	U2, U5, U7, U10
4025	14	7	U12
3302	SEE SCHEM.	SEE SCHEM.	U13

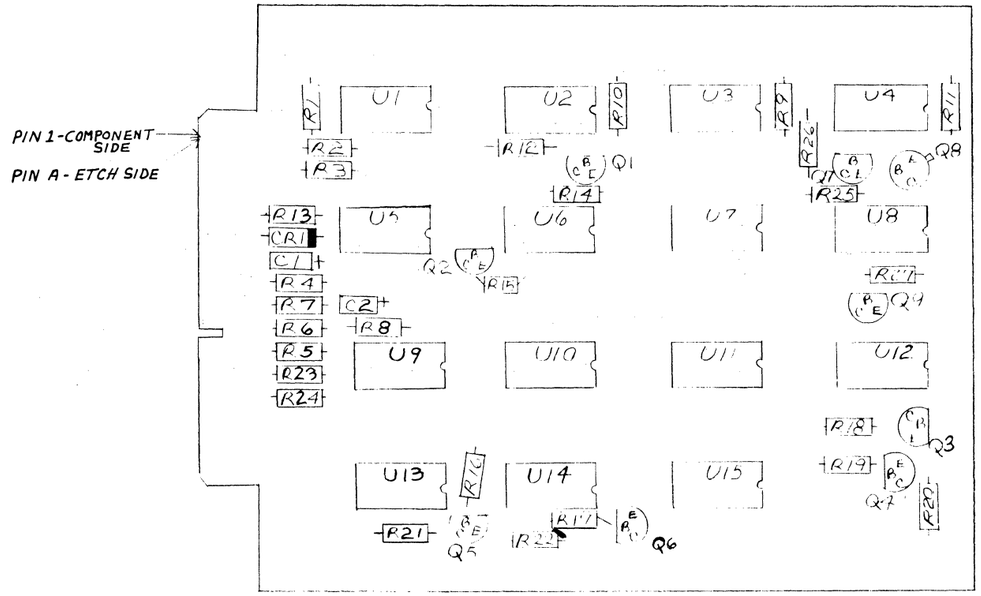


Figure 9-4. Control Logic Board Parts Location (836633)

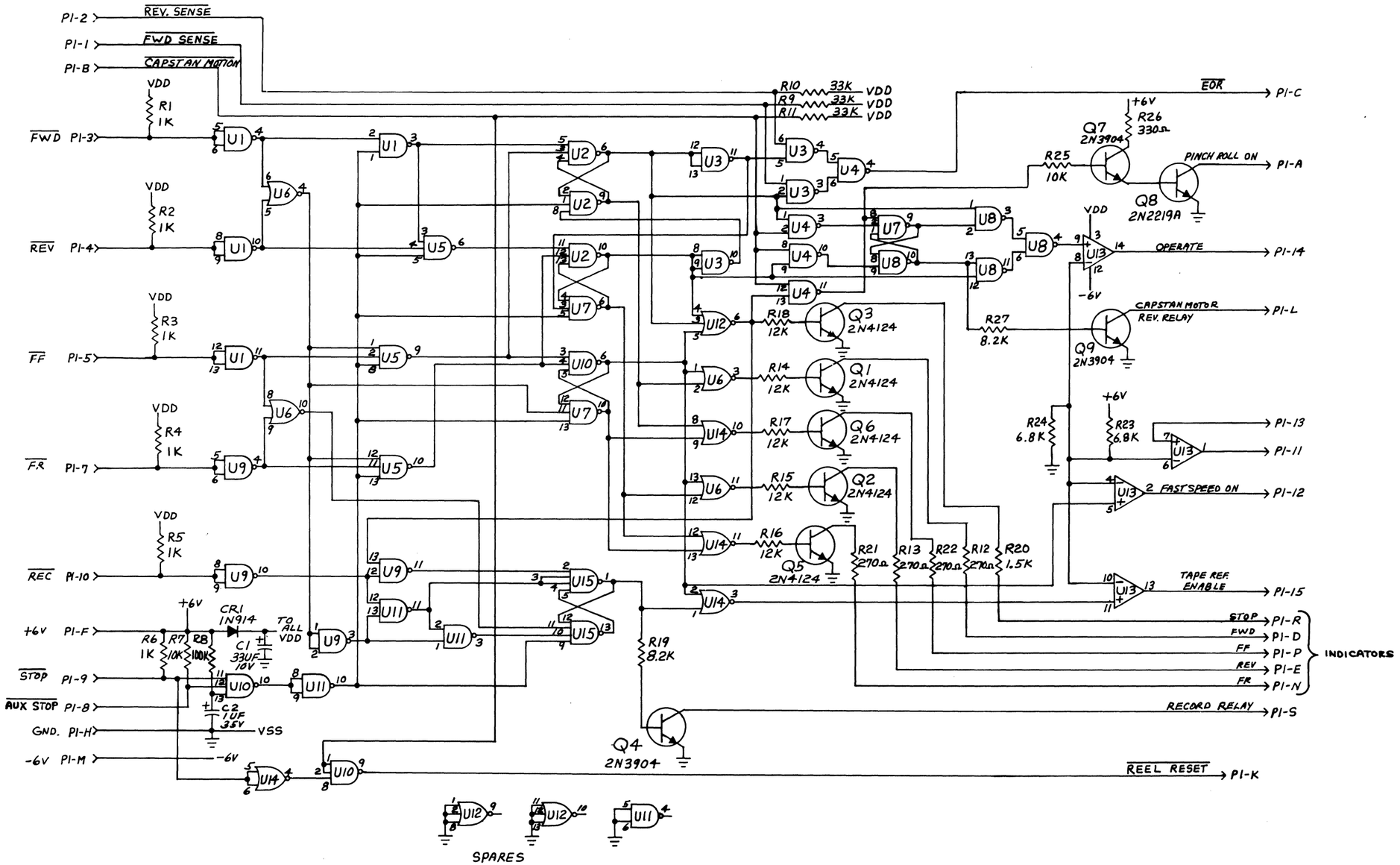
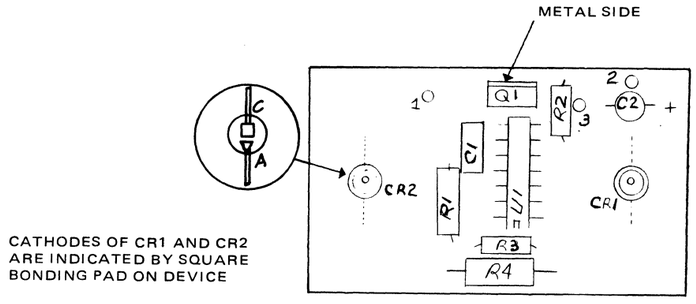


Figure 9-5. Control Logic Board Schematic Diagram (836633)

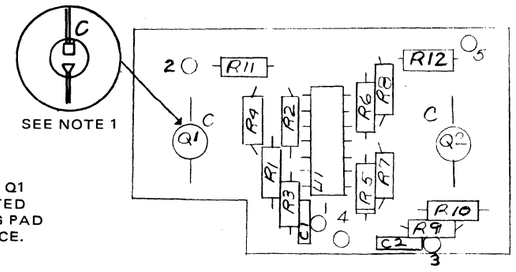


CATHODES OF CR1 AND CR2 ARE INDICATED BY SQUARE BONDING PAD ON DEVICE

Figure 9-6. E.O.T. Xmitter Parts Location (836901)

E.O.T. TRANSMITTER 836901

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
	836901						
C1	197212-200	CR2	510474	Q1	510473	R3	510408-099
C2	859775-007	E1	855913	R1	510408-111	R4	510409-015
CR1	510474	thru		R2	510408-049	U1	859520-042
		E3					



1. COLLECTORS FOR Q1 AND Q2 ARE INDICATED BY SQUARE BONDING PAD ON BOTTOM OF DEVICE. SEE BLOW-UP.

Figure 9-7. E.O.T. Receiver Parts Location (836903)

E.O.T. RECEIVER 836903

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
	836903						
C1	859959-001	Q1	510475	R4	510408-133	R9	510408-125
C2	859959-001	Q2	510475	R5	510408-109	R10	510408-125
E1	855913	R1	510408-109	R6	510408-153	R11	510408-109
thru		R2	510408-153	R7	510408-109	R12	510408-109
E5		R3	510408-109	R8	510408-133	U1	510433

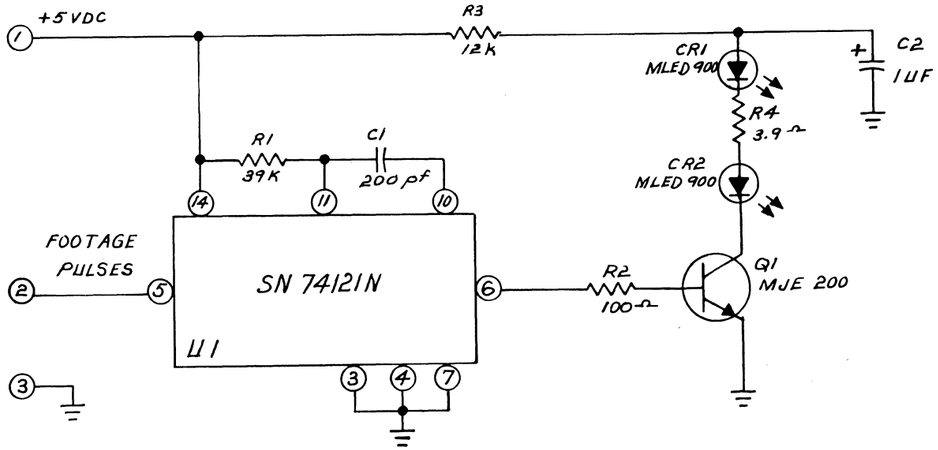


Figure 9-8. E.O.T. Xmitter Schematic Diagram (836901)

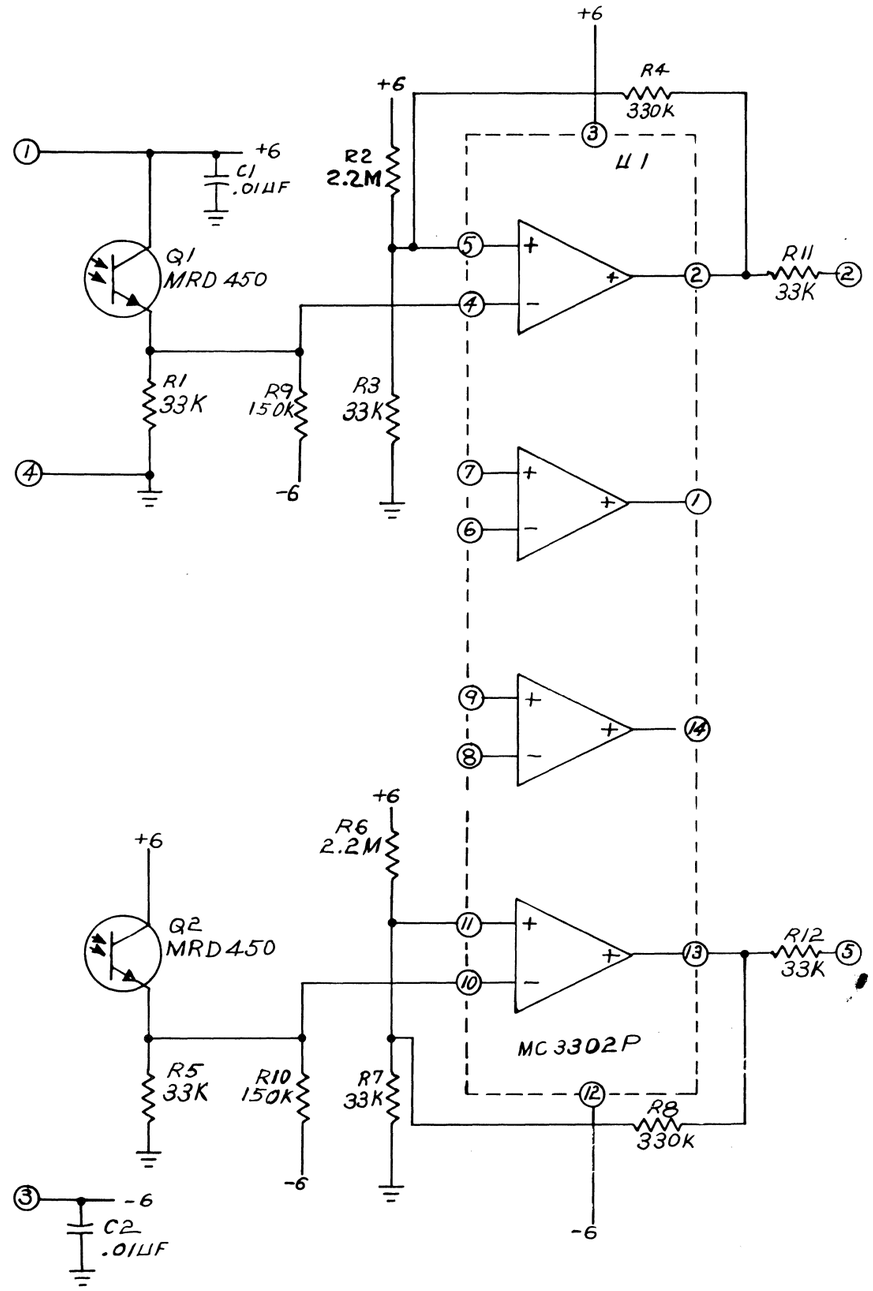


Figure 9-9. E.O.T. Receiver Schematic Diagram (836903)

SECTION 10
REEL DRIVE SERVICING

A. INTRODUCTION

The function of the reel drive circuits is to respond to the inputs from the photocells associated with the tape tension arms and provide outputs to each reel drive motor.

B. FUNCTIONAL DESCRIPTION

The reel drive board consists of two separate channels, one for each reel drive servo system. Each channel consists of an amplifier with an acceleration limiting circuit in its output. The channel used to drive the inner reel consists of photocell and lamp assembly V1, microswitch S4, amplifier U5, emitter follower Q5, power amplifiers Q1 and Q5, and inner reel motor B2. The outer channel consists of identical circuitry which is described in the following paragraph.

When tape is threaded, microswitch S2 closes to ground eyelet E26 on the reel drive board to enable amplifier U4. In this condition, the amplifier responds to the signal from the photocell. Since the resistance of the photocell decreases when illuminated and increases when shaded, the dc level at U4-2 varies accordingly and is dependent upon the position of the tape tension arm. Amplifier U4 amplifies the voltage and applies it through an emitter follower to the output of the reel drive board. The output is applied to a power amplifier, consisting of transistors Q4 and Q6 to drive the reel drive motor. The transistors are mounted on the heat sink of the motor drive amplifier. The collectors of the transistors are connected directly to the motor windings. The other side of the motor is applied through the 4-12 contacts of relay K2 and the 7-11 contacts of relay K1 to the power source.

Relay K1 energizes whenever tight tape occurs. This is accomplished whenever microswitches S5 and S3 close causing a grounding signal to be applied to NAND gate U1-8. This causes the output at U1-10 to turn on transistor switch Q2. The collector is applied to the coil of relay K1 causing it to energize. In the FORWARD mode +18 vdc is applied through the 8-12 contacts of the relay to the inner reel drive motor and the +28/18 vdc source is applied to the outer reel drive motor. Relay K2 reverses these connections during the REVERSE mode.

The 28/18 vdc source changes from 18 volts to 28 volts to give greater drive to the take-up reel during the higher tape speeds. This is accomplished through a speed detector circuit on the reel drive board. The tach signal is applied to a low pass filter at U3-3. The output at U3-6 is rectified by CR1, CR2 and C7 to develop a logic level for driving U2-1. At the lower speeds the low pass filter allows the tach signal to pass and develop a logic 1 level at U2-1. Above 60 ips the filter cuts off and the logic level at U2-1 changes to a logic 0. The capstan motion signal from the speed control circuits combines with this signal through U2-3 to drive transistor switch Q1. The collector of Q1 drives the control line to the power supply to switch the 18 volts to 28 volts.

Transistor Q3 in conjunction with potentiometers R17 and R18 are used to supply current through the LED for each photocell. By adjusting these, the position of the arm for a tight tape condition is determined.

Potentiometers R28 and R29, located in the input circuitry of each channel, adjust the take-up rate of each reel whenever the reel reset circuitry is used. When slack tape exists, depressing the STOP pushbutton initiates a pulse from the logic board to the reel drive board at eyelet E5. The signal is capactive coupled to U1. Two sections of U1 are connected to develop a short pulse. The output is connected through U1-10 to cause transistor Q2 to conduct. This transistor energizes relay K1 for two seconds or until the microswitch take over.

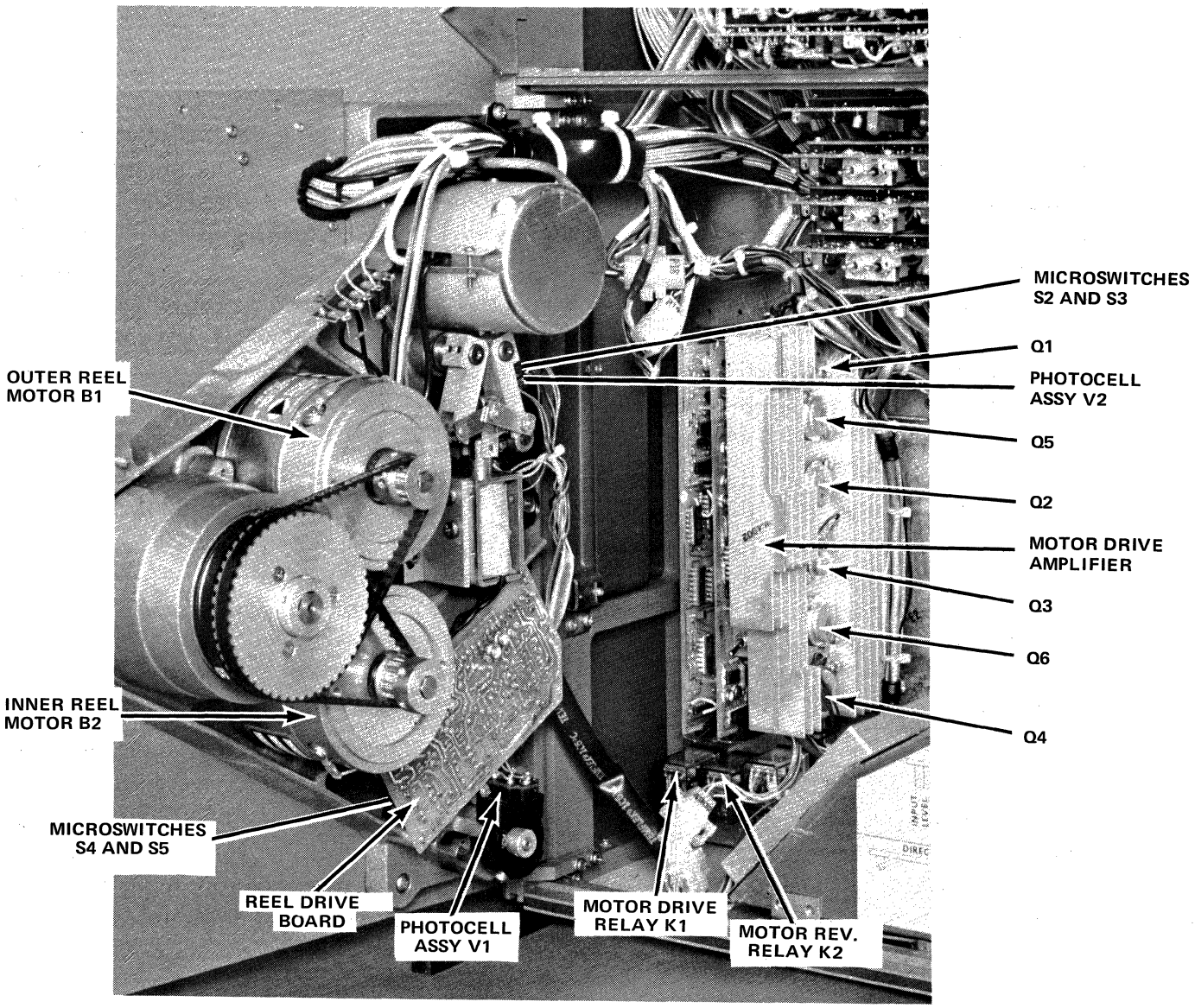


Figure 10-1. Front View Showing Reel Drive Components

C. FAULT ISOLATION

In troubleshooting the reel drive circuits, the malfunction should be classified and isolated to one of the functions of the reel drive circuits. The reel drive circuits are responsible for:

(a) Switching the HI/LO voltage transfer relay within the power supply.

(b) Controlling the time and rate of slack tape take-up.

(c) Stopping tape at end of reel.

(d) Providing source current to the photocell assemblies.

(e) Driving each reel drive motor through the motor drive amplifier.

1. HI/LO VOLTAGE TRANSFER

Symptoms of the power supply not transferring to the higher output voltage for the faster speed probably will be indicated by the take-up reel (the one pulling tape) not moving fast enough. This should be checked out as follows:

Step 1. Connect a voltmeter between E6 (HI) and E15 (LO) on the reel drive board.

Step 2. With tape properly threaded, place the SABRE VI into a FAST mode.

Step 3. As the tape gains speed and after the speed exceeds 60 ips, the voltmeter should change from +24 vdc to near 0 vdc, If the +24 vdc is not present before the switchover, troubleshoot relay K1 in the power supply. If the +24 volt is present but does not switch, proceed with the next step.

Step 4. Depress STOP and move the HI side of the voltmeter to E8. A logic 1 should be present. If not troubleshoot the capstan A board in the speed control circuits. If correct, proceed to next step.

Step 5. Depress the FORWARD pushbutton. As soon as tape begins to move, the voltmeter should change from a logic 1 to a logic 0. If not, troubleshoot the speed control circuits. If correct proceed to next step.

Step 6. Depress STOP and connect an oscilloscope between E12 (HI) and E15 (LO). Depress the FORWARD pushbutton and observe the oscilloscope. A square wave should appear with a frequency proportional to tape speed. If not, troubleshoot the tach circuits in the speed control circuits. If normal, proceed to the next step.

Step 7. This step assumes that all the above steps have been made and have checked normal. If a problem still exists, the problem must be located on the reel drive board. Refer to the functional description, paragraph B to troubleshoot this portion of the board.

2. SLACK TAPE TAKE-UP

The tape reset circuits are activated for a loose tape condition by depressing the STOP pushbutton. This action causes the reels to turn briefly to take up slack tape. To troubleshoot a malfunction, proceed as follows:

Step 1. Remove the tape and the empty reel from the SABRE VI.

Step 2. With power applied, depress the STOP pushbutton while observing the two reel hubs. Each hub should turn as if taking up tape for approximately 3/4 to one full turn.

Step 3. If either reel does not respond properly, adjust OUTER TAKE-UP RATE adjust R28 and/or INNER TAKE-UP RATE adjust R29 for correct operation of each reel.

Step 4. If depressing the STOP pushbutton did not start the reel hubs turning, connect a voltmeter between E2 (HI) and E15 (LO) and depress the STOP pushbutton again. The voltmeter should change from +24 vdc to near 0 vdc.

Step 5. If the +24 vdc is not present or the +24 vdc does change to 0 vdc, checkout power relay K1.

Step 6. If everything appears normal, connect the voltmeter between E5 (HI) and E15 (LO). When the STOP pushbutton is depressed, the voltmeter should change from a logic 1 to a logic 0. If not, troubleshoot the mode control circuits. If normal, troubleshoot the circuitry in and around the area of integrated circuit U1.

Step 7. Move the voltmeter to E4 (HI) and E15 (LO). Lift both tension arms off their stops. Both reels should now turn and the logic level should have changed from logic 1 to a logic 0.

Step 8. If the logic level does not change, troubleshoot the tension arm switches (S3 and S5). If the logic level changed but the reels did not turn troubleshoot integrated circuit U1 and transistor Q2.

3. END OF REEL SENSE

When the EOT circuits are placed in operation, a logic 1 level at E1 changes to a logic 0, passes through U1, and U2 to E3. The logic level at E3 is the same as at E1. If a logic level change does not occur at E1 or a logic level change does occur at E3 and the unit does not stop, troubleshoot the logic circuits for the malfunction.

4. PHOTOCELL ASSEMBLY CURRENT SOURCE

With tape threaded on the unit and in a tight tape condition, the two reel drive tension arms should be in the approximate center of their travel. If not, the position may be changed by adjusting OUTER ARM adjust R17 and/or INNER ARM adjust R18. The position of the arms can also be changed by adjusting the position of the photocell assembly on the back side of the transport (See Section 7, Tape Transport Mechanics for proper adjustment).

If the photocell light(s) is not on, check for some voltage less than +6 vdc at E11 (inner reel) and E9 (outer). If the voltage appears normal, troubleshoot the LED of the respective photocell assembly. If the voltage is not correct, check transistor Q3 and associated circuitry on the reel drive board.

5. REEL DRIVE CHANNELS

Since both reel drive channels are identical, only the outer reel drive channel will be outlined and the inner reel drive channel will be referred to in parenthesis.

Step 1. With tape threaded and in a tight tape condition, check E26 (E17) for 0 vdc. If not correct, check microswitch S2 (S4) for a bad contact.

Step 2. Move the HI side of the voltmeter to E27 (E14). A slight negative voltage should be measured. If not correct, check microswitch S2 (S4) and photocell assembly V2 (V1).

Step 3. Move the HI side of the voltmeter to E25 (E16). With tape stopped the voltmeter should measure approximately +.8 vdc. With the tape moving the voltage should increase slightly to approximately +.85 vdc. If incorrect, troubleshoot U4 (U5), Q4 (Q5), and associated circuitry.

Step 4. Move the HI side of the voltmeter to E21 (E19). With the tape stopped, the voltage should read near +18 vdc. With tape moving the voltage should drop a few volts. If not. troubleshoot transistors Q4 (Q1) and Q6 (Q5) on the motor drive amplifier or the reel drive motor.

REEL DRIVE CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL

REF. DESIG.	SANGAMO PART NO.
B1	836574
B2	836574
P18	859254-002
P19	859254-003
P20	859255-002
S2	857953
thru	
S5	
V1	837077
V2	837077

ELECTRONIC CHASSIS

REF. DESIG.	SANGAMO PART NO.
CR1	896458
J3	859241-001
thru	
J5	
J18	859255-002
J19	859255-003

REF. DESIG.	SANGAMO PART NO.
J20	859254-002
K1	510486-003
K2	510486-003
TB2	510490-005
XK1	855563
XK2	855563

MOTOR DRIVE AMPL.

REF. DESIG.	SANGAMO PART NO.
E8	850312
E11	850312
Q1,Q4	510467
Q5,Q6	510467
R2,R5	897583
R8,R9	897583

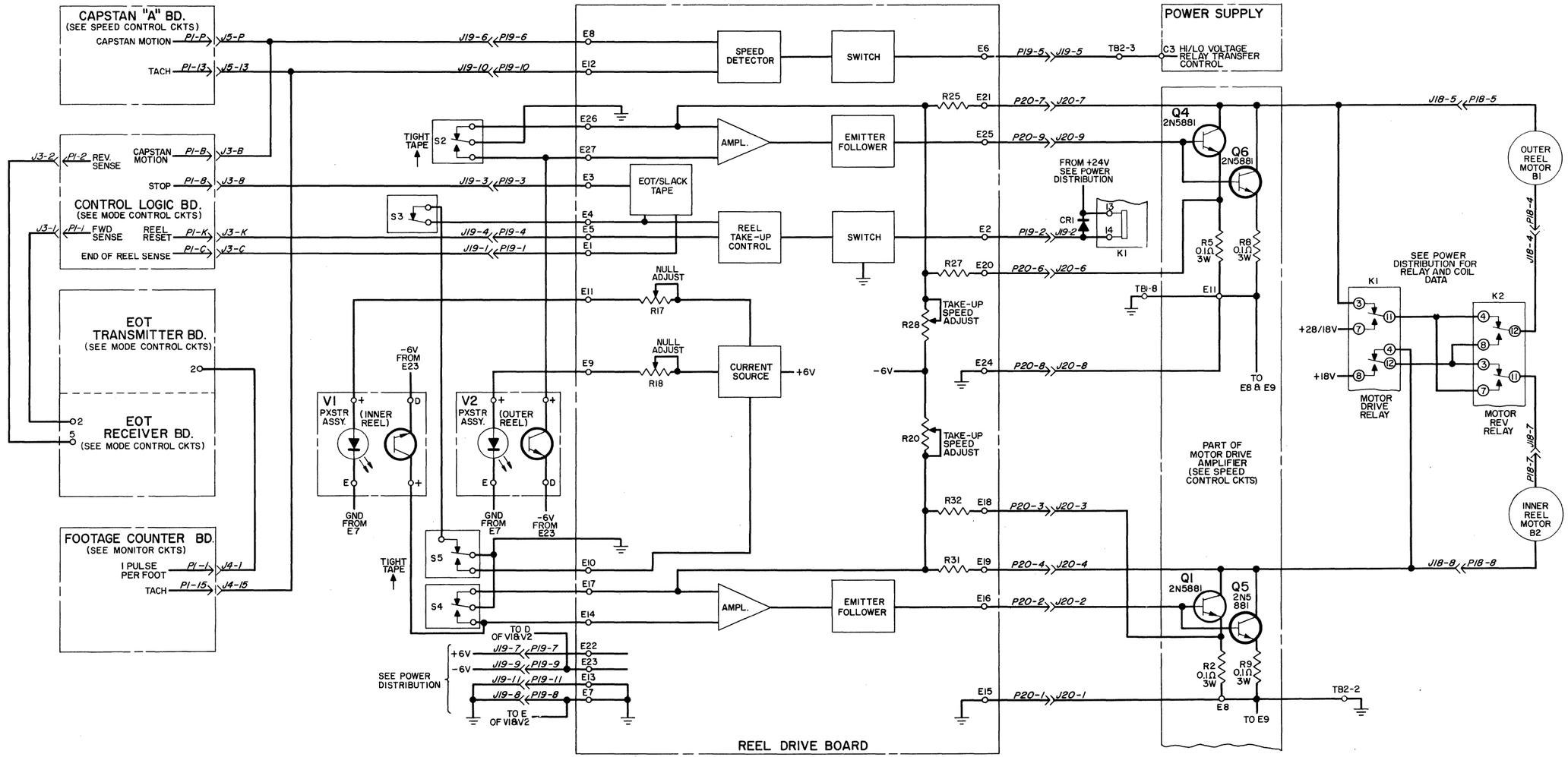
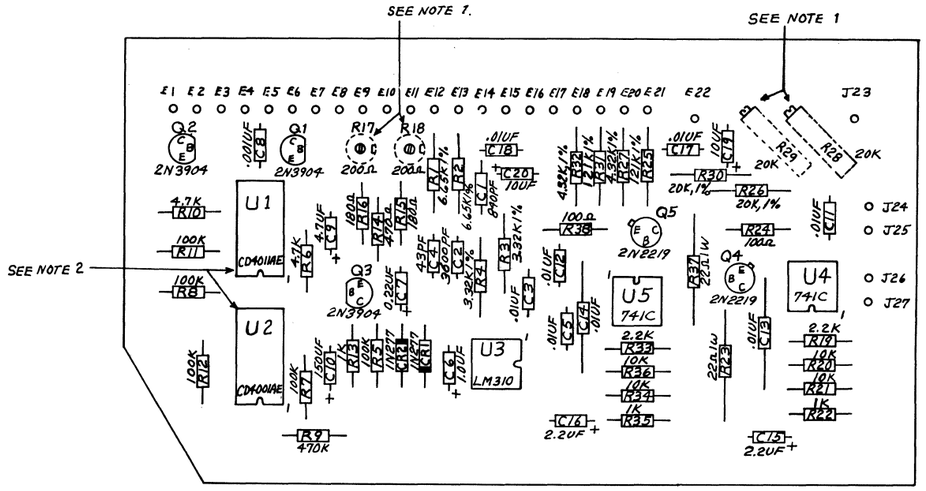


Figure 10-2. Reel Drive Overall Functional (804888)



NOTE 1: Potentiometers R17, R18, R28 and R29 are mounted on the etch side of board.
NOTE 2: For U1 & U2 – VSS is pin 7, VDD is pin 14.

Figure 10-3. Reel Drive Board Parts Location (836635)

REEL DRIVE BOARD 836635

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	847246	C19	859775-014	R9	510408-137	R27	853530-186
C2	899063	C20	859775-014	R10	510408-089	R28	510349-011
C3	510058-002	CR1	850287	R11	510408-121	R29	510349-011
C4	197212-043	CR2	850287	R12	510408-121	R30	853530-308
C5	510058-002	MP1	847825	R13	510408-073	R31	853530-347
C6	859775-007	Q1	853037	R14	510408-065	R32	853530-186
C7	859775-003	thru		R15	510408-055	R33	510408-081
C8	510058-011	Q3		R16	510408-055	R34	510408-097
C9	859775-011	Q4	853533	R17	329151-005	R35	510408-073
C10	859775-027	Q5	853533	R18	329151-005	R36	510408-097
C11	510058-002	R1	853530-226	R19	510408-081	R37	691112-220
C12	510058-002	R2	853530-226	R20	510408-097	R38	510408-049
C13	691686-001	R3	853530-197	R21	510408-097	U1	510376-012
C14	691686-001	R4	853530-197	R22	510408-073	U2	510376-002
C15	859775-009	R5	510408-121	R23	691112-220	U3	510240-006
C16	859775-009	R6	510408-089	R24	510408-049	U4,U5	510240-002
C17	510058-002	R7	510408-121	R25	853530-347		
C18	510058-002	R8	510408-121	R26	853530-308		

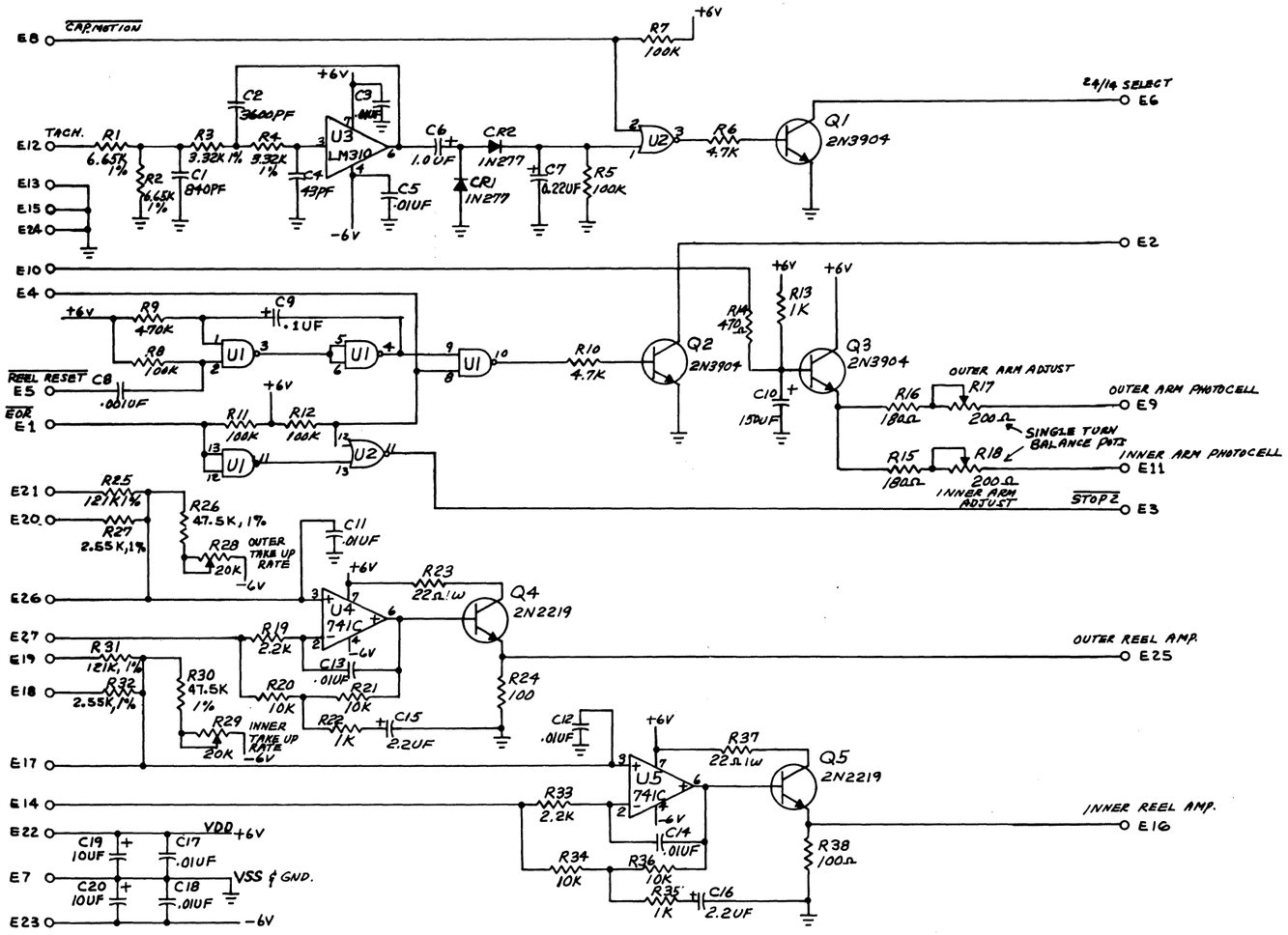


Figure 10-4. Reel Drive Board Schematic Diagram (836635)

SECTION 11
SPEED CONTROL – SERVICING

A. INTRODUCTION

The function of the speed control circuits is to carefully control the rotational speed of the capstan. This is accomplished by two means; capstan synchronous and tape synchronous. Capstan synchronous compares the oscillator reference to the tachometer reference. Tape synchronous compares the oscillator reference to the tape (reproduced from tape) reference.

B. FUNCTIONAL DESCRIPTION

1. REFERENCE OSCILLATOR AND BIAS CIRCUITS (located on the capstan A bd.)

Crystal oscillator Y1 generates a 7.2 MHz reference frequency for comparison with the tachometer (or tape reference, when used) signal. The 7.2 MHz signal is applied to a bias driver amplifier circuit consisting of transistors Q4 through Q8 to develop a bias signal for driving all direct record circuits. The transistors are only operative during the RECORD mode when the +6 volt is applied to the input at pin P1-B.

The 7.2 MHz oscillator frequency also drives a divide-by-nine circuit consisting of divider U1 to develop an 800 kHz reference frequency. The reference is applied through jack J3 (p13), level converting transistor Q1, and inverter U2-3 to binary counter U3 resulting in eight reference frequencies proportional to the eight tape speeds. These frequencies (800, 400, 200, 100, 50, 25, 12.5, 6.25 kHz) are applied to frequency selector U4 to select an output frequency proportional to the speed selector switch (See the truth table on the Speed Control Overall Functional). The selected output frequency is applied through inverter U5-10 to divider circuit U6-3 which is capable of dividing by two or four. The two outputs are applied to a density switch at U7-1 and U7-4. The density switch is controlled by the position of a jumper in the density input line at J1 or J2. When the jumper is placed in the high position (J2), high density is selected and the divide-by-two frequency from the divider is selected for recording on tape as the reference frequency. When the jumper is in the low position (J1), the density switch selects the divide-by-four frequency from the divider for recording on tape. The output of the density switch at U7-3 or U7-2 is applied through inverter U2-11 to the RECORD REFERENCE jack on the I/O Connector Panel.

TABLE 11-1. RECORD REFERENCE FREQUENCY		
Tape Speed (ips)	High Density (kHz)	Low Density (kHz)
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	3.12
15/16	3.12	1.56

2. TACHOMETER SIGNAL CIRCUITS (located on capstan A bd.)

A tachometer signal is generated within the capstan motor. A slotted opaque disc, rotating between a light source and a photocell, produces an output signal that is amplified and quantized to develop a squarewave within the capstan motor. The frequency from the tachometer output is proportional to the rotational speed of the capstan. The squarewave signal is applied to the capstan A board at P1-N. The signal is applied through level converter Q10, and through buffer U13-12 to the tape sync board (optional). The output of the buffer is also applied to a motion detector circuit at the base of emitter follower Q2. The tach signal is converted to a dc voltage via capacitor C5 and resistor R12. At frequencies above I kHz, the dc level saturates transistors Q3 and Q9. The saturation of transistor Q3 establishes a logic level for the capstan motion signal (See mode control circuits) and draws current through the elapsed time meter. When the tachometer frequency falls toward zero, transistor Q9 suddenly drops out of saturation, generating a pulse to cause one-shot multivibrator U14 to trigger and hold transistor Q3 in saturation for an additional 1/4 second.

The tachometer signal from buffer U13-10 is also applied to the footage counter circuits (See monitor circuits) to indicate the amount of tape travel in feet. The frequency generated is 20,000 pulses per foot.

3. TAPE SIGNAL CIRCUITS

During the reproduce process, the recorded tape sync signal is recovered from tape and is amplified by the tape sync pre-amp board located in one of the reproduce slots (See reproduce circuits). The output of the tape sync pre-amp board is applied to the input of the capstan A board via the REF IN jack on the I/O Connector Panel and applied directly to the tape sync board. Unon entering the tape sync board, the tape signal is applied to two circuits. One circuit is the tape detector consisting of transistors Q1 and Q2 which indicates by means of a logic level at its output that a tape signal is being received. The second circuit is a Schmitt trigger (U1) which

squares this signal. A level converter Q4 adjusts the level of the tape signal. The output at the collector of Q4 is applied to an output switch (U4-8) and a divide-by-two circuit (U3-11). The output of the divide-by-two (U3-13) is also applied to the output switch (U4-4). A third signal being applied to the output switch (U4-11) is the tachometer signal from the buffer on the capstan A board. The function of the output switch is to select one of these three signals for application to its output. The signal that is selected is controlled by an output selector circuit (U2). When the tape detector indicates a tape reference from tape at U2-2 and a tape enable reference at U2-1 is present, one of the two tape signals passes to the output. The tape enable reference is always present during a reproduce mode. The selection between the two frequencies is accomplished by the position of the density jumper controlling the logic level of the density input on the capstan A board. If the jumper is placed in the HI position (logic 1) then the divided-by-two signal at U4-4 passes through the output switch. Conversely, if the density input is low, the signal from U4-8 passes through the output switch. The third possiblity, the tachometer signal, is controlled by the tape detector circuit. If no tape signal is recovered, the tape detector produces no output at the collector of Q2 and the output switch selects the tachometer signal at U4-11 as the output signal.

4. FREQUENCY PREPARATION CIRCUITS

The primary input signals to this portion of the speed control circuits consist of the tape signal or tachometer signal (tape/tach reference) and the reference oscillator signal. The purpose of the frequency preparation circuits is to prepare and select the correct frequencies for comparison by the phase comparison circuits. The tape/tach signal from the output switch of the tape sync board at J5 (or buffer of the tach circuits) is applied directly to a 120 ips select switch (U11-4). If a tape speed other than 120 ips is in use, the tape/tach signal passes to the output of the capstan A board at P1-M without change. If a tape speed of 120 ips is selected, a divide-by-two frequency at U10-1 passes through to U11-2 (See Table 11-2). The 120 ips select switch is activated through P1-K by a command from the capstan B board.

TABLE 11-2. TAPE/TACH REFERENCE FREQUENCIES

Tape Speed (ips)	Frequency (kHz)
Fast	266.6
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

The oscillator reference is prepared in the same manner. The frequency, determined by tape speed, at the output of the second divide-by-two at U6-2 is equal in frequency to the operating tape/tach signal. In the operate mode, this reference oscillator frequency passes through mode select switch U9-3 directly to a reference frequency switch at U11-8 and through to P1-J. This switch operates in the same manner as the 120 ips select switch. The reference signal is also divided-by-two for 120 ips through U10-13 resulting in the same frequencies (except for FAST) at U11-9 and 10 as shown in Table 11-2.

Whenever a fast (slew) mode is selected, a higher oscillator reference is required to drive the phase comparison circuits at a faster rate. The higher frequency is obtained by dividing by three the 800 kHz reference frequency (By U8) from the output of U2-3 and applying the 266.6 kHz frequency through the mode select switch at U9-9 to a frequency detector at U12-3. A second input to the same frequency detector is the tape/tach signal at U12-14. When the FAST pushbutton on the control module is depressed, the mode selector gate (U9) removes the speed dependent reference from its output and applies the 266.6 kHz to the frequency detector. Until the capstan reaches full speed, the tach signal remains lower in frequency. When the two finally equal, a switchover occurs to return to a oscillator reference. Whenever there is a difference in phase angle between the two signals, a pulse equal in length to the phase angle is produced. The pulse may be either above or below zero, depending on whether the capstan is running slightly too fast or too slow. The pulse adjusts capstan speed up or down until the proper speed is attained. Switchover does not occur during a FAST mode.

The frequency detector (U12) is used during normal operation for primarily three purposes; (1) start-up time (2) tape speed change and (3) fast tape. To do this, a frequency lock reference circuit processes three signals from the oscillator reference to develop a slightly offset reference frequency. The frequency lock reference circuit accepts three inputs from the divide-by-four circuit with timing relations as shown in the figure 11-1. The output, which is applied to the mode select switch at U9-11, lags the reference by nominally 1/8 time period. This allows the frequency detector to operate at an optimum point.

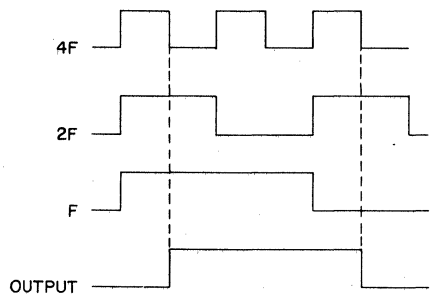


Figure 11-1. Frequency Lock Reference Frequency (804875)

5. PHASE COMPARISON CIRCUITS

The primary function of these circuits is to compare the oscillator reference to the tape/tach reference for phase differences and to develop a dc voltage level proportional to tape speed.

Both the oscillator (TP1) and the tape/tach (TP2) reference signals are applied to the phase comparison circuits located on the capstan B board. This circuit consists of U3, U4, U5, U6, U8, U9, and associated circuitry. For the following discussion, refer to Figure 11-2. The function of this circuit is to use the two input reference signals to develop trapezoidal waveshaped (typical) signals as shown for TP4 and TP5. The two trapezoidal signals are 180 degrees out of phase with one another and of nearly equal amplitude. These two signals are summed together with the resultant being a dc voltage proportional to the phase difference between the two reference signals. As can be seen in the figure, the voltage value, when summed, is 15 vdc or 1/2 the maximum voltage level. The amplitude changes whenever the error between the oscillator and tape/tach reference signals changes. When the phase error increases the rise and fall time of each signal is longer allowing for a higher voltage to result. To understand the development of each trapezoid signal, four separate time periods must be considered; (1) rise time, (2) voltage hold time, (3) fall time, and (4) zero clamp time.

a. RISE TIME

Normally the oscillator reference at TP1 leads the tape/tach reference by approximately 1/8 time period as shown in the waveforms. With this difference in phase angles, a pulse equal in length to the phase difference appears at the output of U4-4. This output is applied to a transmission gate at U5-13 and U5-12. Only the U5-13 action will be followed. When the positive pulse is applied to J5-13, the switch closes to apply -6 vdc to another transmission switch at U6-9 and U6-10. This transmission gate closes according to the tape speed selected. Its function is to parallel resistors U15, R16, and R17 to effect an RC time constant at U9-2. Capacitor(s) are also selected by the tape speed through U2. The capacitor(s) selected are placed across the input and the output of U9.

When the -6 vdc is applied to U9-2 through the resistors, the voltage begins to fall from some positive value. The output at TP5 begins to rise. The rate of rise is determined by the RC time constant selected by the tape speed.

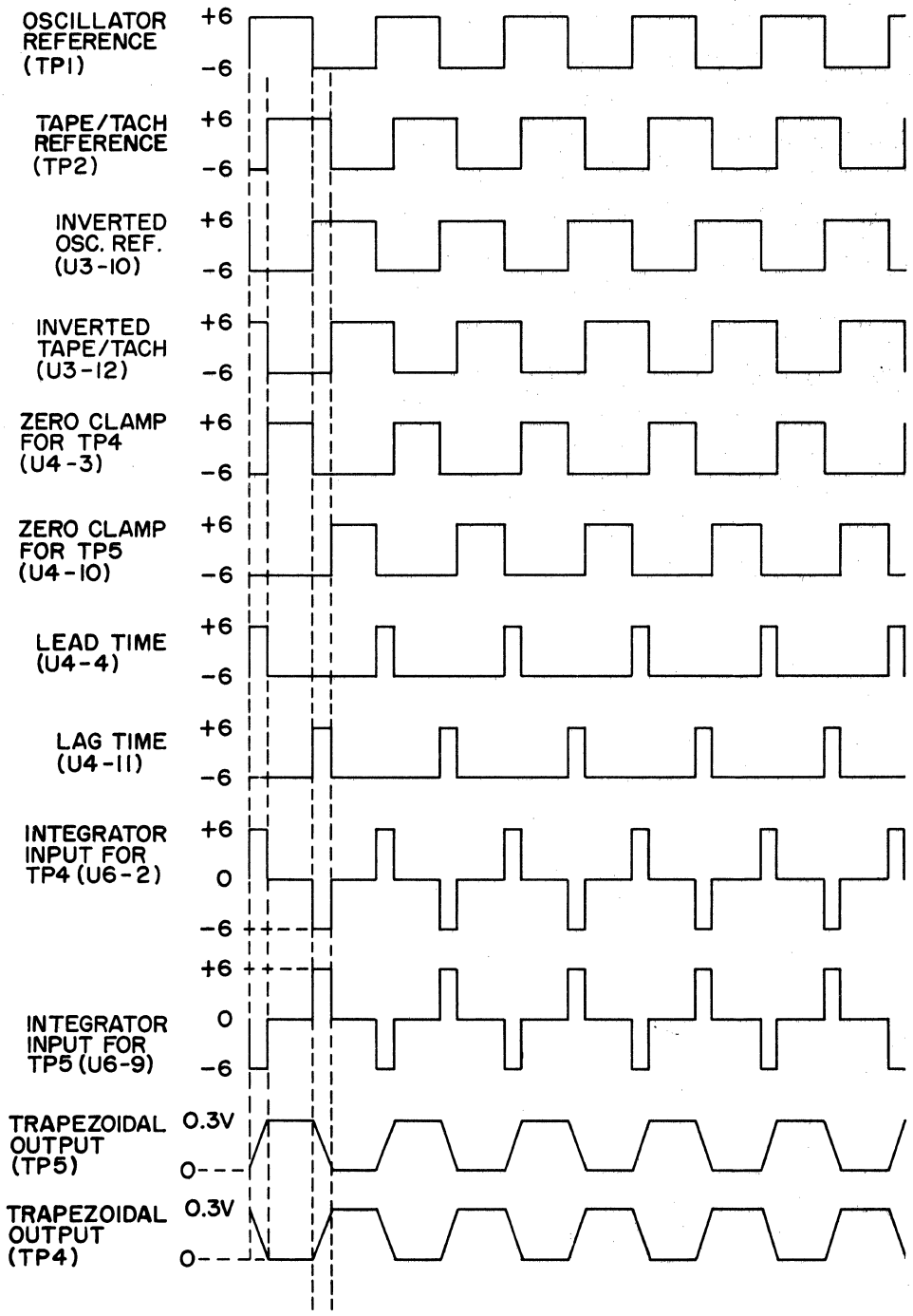


Figure 11-2. Typical Phase Comparison Waveforms (804889)

b. VOLTAGE HOLD TIME

When the rise time ends (controlled by the error difference signal of the two reference signals) at U4-4 the transmission gate (U5-13) opens to remove the -6 vdc source from the charging path. The charge on the capacitor holds a minus voltage on U9-2 to result in a plus voltage at TP5. This time is equal to the time that both the oscillator and the tape/tach reference signals are at a logic 1.

c. FALL TIME

The fall time of the trapezoidal waveform at TP5 is equal to the time the tape/tach signal lags the oscillator reference. This time frame is determined by the length of the pulse at U4-11. The pulse is applied to U5-5 to close the transmission gate. When the gate closes, a +6 vdc is applied through U5-3 to drive the voltage level at U9-2 positive. This results in a decreasing voltage at TP5. The fall time at this testpoint is controlled by the same RC time constant as that used for the rise time. The voltage falls to zero.

d. ZERO CLAMP TIME

When both the oscillator and the tape/tach signals are at a logic 0, a clamp signal is developed at U4-10. This results in a logic 1 at transmission gate U10-6. When the transmission gate closes, the input and output of amplifier U9 are shorted together to clamp TP5 to zero volts. This condition remains until the next rise time.

The second trapezoidal waveform is developed in the same manner but 180 degrees out of phase. The two waveforms are summed together and applied through dc amplifier U11 to develop the drive voltage for the capstan motor.

6. PHASE LOCK CIRCUITS

The phase lock circuits consist of a phase lock detector U7 and U12, a phase lock enable switch U10, squelch circuits U3 and Q2, and a phase lock driver Q3. These circuits provide switching input to the driver control circuits (U13) to select the output from the frequency detector during the period that the frequency error between the two reference signals is the greatest. A squelch signal is also produced to prevent all reproduce boards from having an output during reproduce until the capstan has attained its proper operating speed. The squelch circuits also inhibits during a FAST mode. This circuit consists of buffer U3, SQUELCH INHIBIT switch S1, and squelch driver Q2.

The lead time from U4-4 and the lag time from U4-11 of the oscillator and tape/tach signals are applied to the phase lock detector at U7-3. During the time the signals do not match, such as start-up time, an output is provided through phase enable switch U10-2 to operate three sections of the driver control circuit (transmission gates). First, a logic zero is applied to U13-6 to close

the transmission switch allowing an acceleration control signal through to drive the output amplifier. Second, the logic zero is also applied to U13-5 to close the transmission gate. This allows the signal from the frequency detector on the capstan A board through to also aid the driving of the output amplifier. And third, the logic zero is also applied to U13-12 to open the transmission gate thus removing any signal from the dc amplifier until the two reference frequencies match.

The logic zero at U10-2 is applied to two additional circuits. Phase lock driver transistor Q3 is turned off to prevent the phase lock light on the control module from lighting during this period of time. The other application for the signal is to the squelch driver at the base of transistor Q2. The output of the squelch driver is applied to all the reproduce boards to inhibit all outputs until the capstan reaches its proper speed. The squelch signal is also present during the FAST mode. When the squelch feature is not desired, the SQUELCH INHIBIT switch S1 may be turned on to defeat its action.

7. ACCELERATION CONTROL CIRCUITS

The acceleration control circuits 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 acceleration control circuit and associated components, consisting of U15, sense the voltage across the capstan motor. The greater the voltage difference across the inputs of the acceleration circuits, the greater the output. When the tape is starting to gain velocity, the phase lock enable switch is applying the frequency detector signal through the drive control circuits. During this time, the acceleration control signal is added to the drive control circuits to retard the high acceleration demanded. As the tape gains speed, the acceleration control output reduces until it no longer is required. Finally, when phase lock is attained, transmission gate U13 removes the output of the acceleration control and uses the output from the dc amplifier circuit.

8. CAPSTAN MOTOR CIRCUITS

The capstan motor circuits consist of output amplifier U14, stabilization network consisting of transistor Q1 with associated circuitry, power transistors Q2 and Q3 on the motor drive amplifier, tape direction relay K2, and capstan motor B3.

The output from the driver control is applied through an output amplifier and stabilization network to a motor drive amplifier. Conduction of the motor drive amplifier regulates the current flow through the capstan motor, thus controlling the capstan rotational speed. A tape direction relay establishes the direction of current flow through the capstan motor, thus controlling the direction of rotation.

A current limiting circuit, consisting of U16 and associated circuitry is also connected with the output amplifier to the input of the motor drive amplifier. The function of this circuit is to limit the current through the capstan motor during an excessive load thus preventing damage to the motor. This usually results in the motor "dropping out" of phase lock and coming to a stop.

C. FAULT ISOLATION FOR CAPSTAN B BOARD

The following procedures check the outputs to the capstan B board. If troubleshooting to the capstan B board is indicated, refer to paragraph B, Functional Description of this section for circuit operation of the particular circuit in doubt.

1. PREPARATION FOR TESTING

Step 1. With power off, place the capstan B board on the extender board.

Step 2. Thread tape onto the unit and turn power on. Depress the STOP pushbutton to set the tape tension arms.

2. SPEED LINES

Step 1. In the STOP mode, measure the voltage levels on pins 13, 14, and 15. Only one of the three lines should measure +6 vdc and is dependent upon the position of the speed selector knob.

Step 2. Rotate the speed selector knob through all positions. The remaining two speed lines should be active (+6 vdc) for the tape speed for which they are programmed. Each speed line is activated according to the position of plugs P2, P3, and P4 (See Operators Section, Paragraph B8).

Step 3. If the speed lines do not perform correctly, troubleshoot relays K1 and K2, or transistors Q4, Q5, and Q6 on the capstan B board.

3. PHASE LOCK

Step 1. Measure the voltage at pin 3 of the capstan B board. The voltage should read approximately 4.6 vdc in any operate mode when the phase lock light is on.

Step 2. If the light does not light during an operate mode, check for +5 vdc at pin 31 on remote connector J2 (See Figure 11-3 for pin identification). No voltage indicates a faulty power supply.

Step 3. If the light remains on constantly or intermits, check the circuitry on the capstan B board.

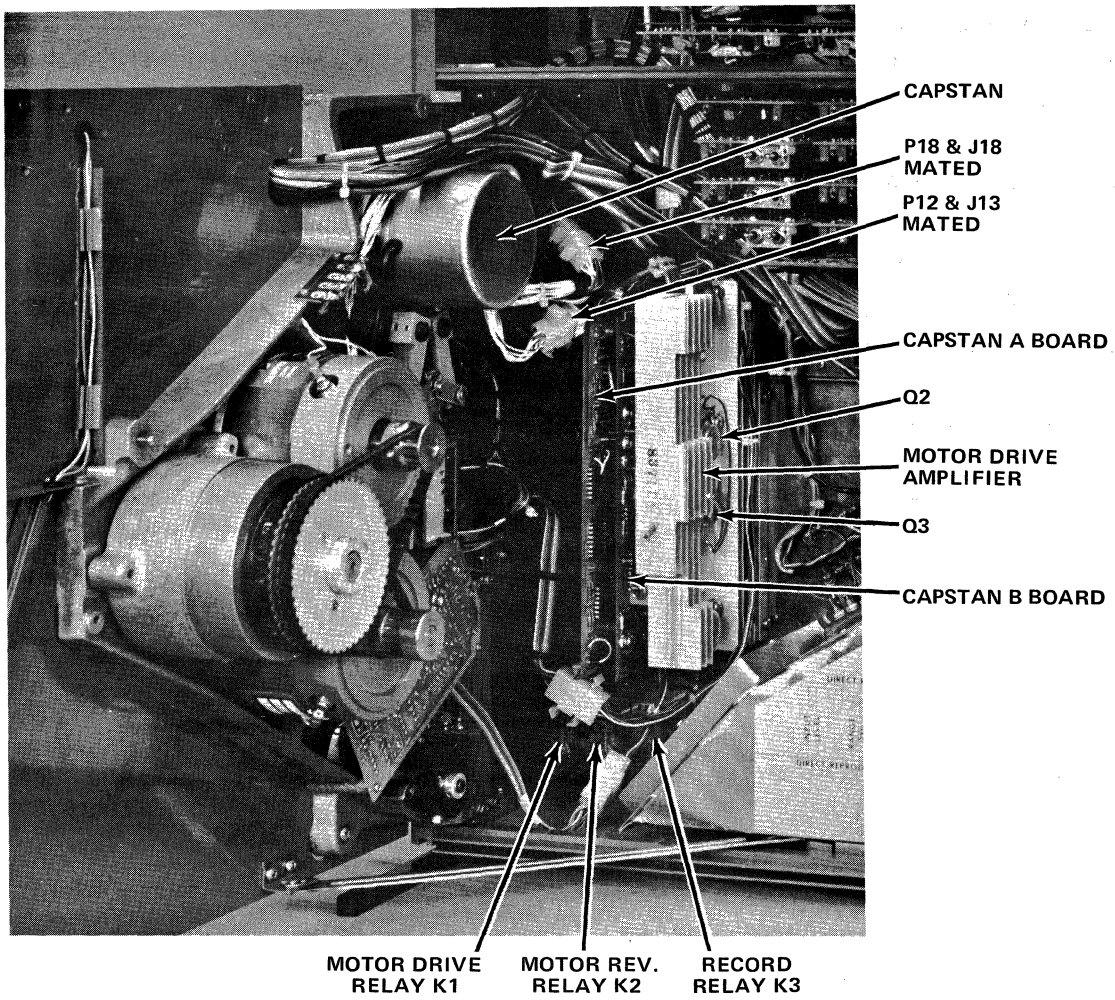


Figure 11-3. Component Location for Speed Control

4. SQUELCH

Step 1. Place SQUELCH switch S1 into the "OFF" position (See Figure 11-9).

Step 2. Measure the voltage at pin 4 of the capstan B board. The voltage should measure +4 vdc (logic 1).

Step 3. Transfer SQUELCH switch S1 to the "on" position. The voltage should change to near zero (logic 0).

Step 4. Depress the FWD pushbutton while observing the logic level. When the unit has reached operating speed, a logic 1 should appear on the squelch line.

Step 5. If the above observations are incorrect, troubleshoot the capstan B board.

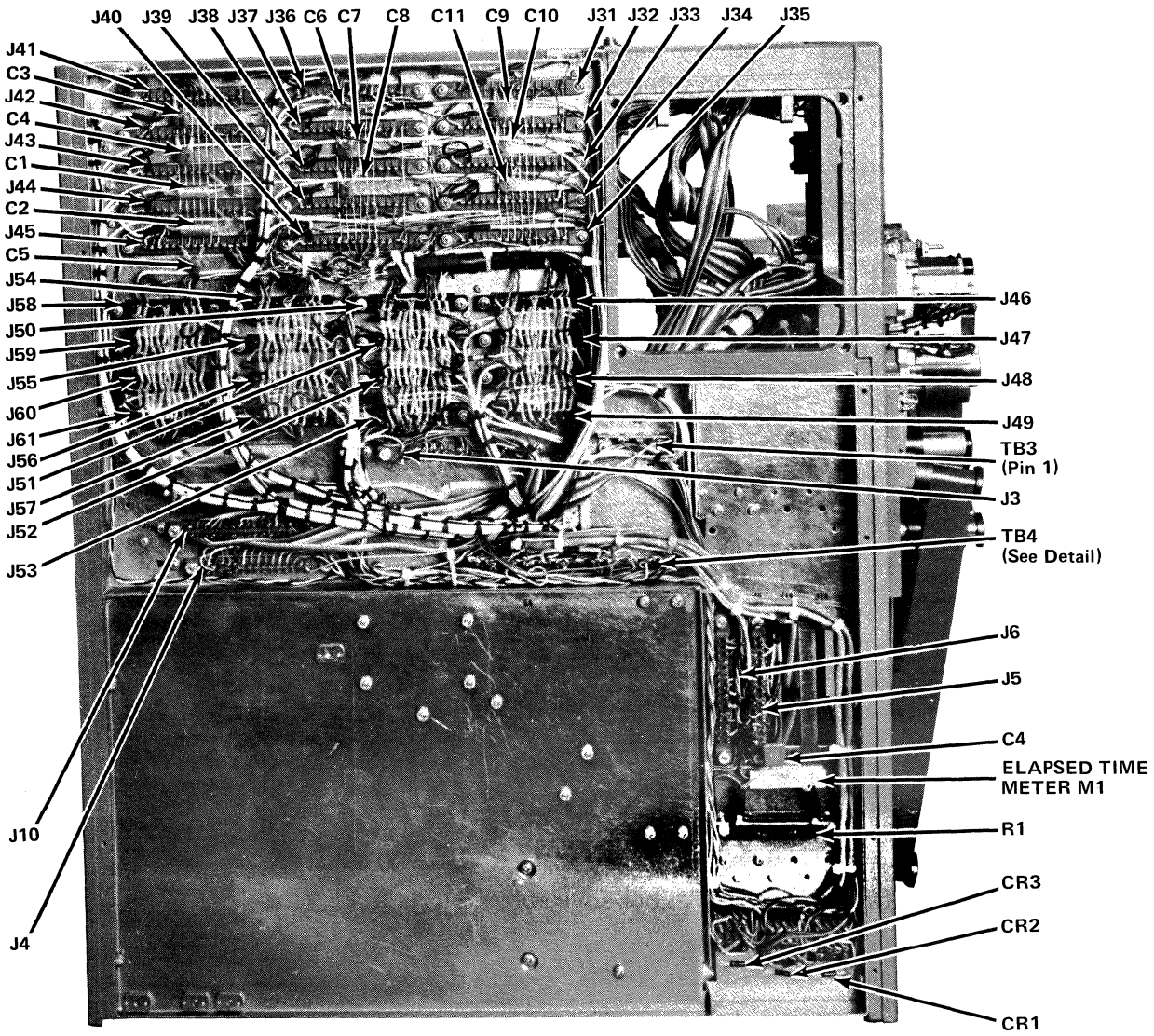


Figure 11-4. Rear View, Parts Location

5. ACCELERATION CONTROL

Step 1. Measure the voltage level at pin 6 of the logic board. The voltage level should be 14 vdc. If not, ensure a tight tape condition exists. The tension arms in their "at rest" position causes relay K1 to "drop out",

Step 2. Place the speed selector knob into the 120 ips position and depress the FWD pushbutton.

Step 3. Observe the voltage level on pin D (See Figure 11-9 for measuring point) as the tape accelerates. When the tape exceeds 60 ips, the voltage level should change to 24 vdc. If not, troubleshoot the power supply.

Step 4. Depress STOP and measure the voltage at pin C (See Figure 11-9 for measuring point). The voltage should measure approximately 14 vdc.

Step 5. Depress the FWD pushbutton while observing the voltage level. As the acceleration increases, the voltage level should continue to drop until the tape has reached full speed. The voltage change over occurring just above 60 ips will be only slightly noticed.

Step 6. If above indications are not correct, troubleshoot the capstan B board or the motor drive amplifier. If no voltage appears at pin C at all, check relay K2 or capstan motor B3.

6. CAPSTAN DRIVE

Step 1. In the STOP mode, measure the voltage at testpoint TP7. The voltage should measure near zero.

Step 2. Depress the FWD pushbutton. The voltage reading should read approximately +.125 vdc.

Step 3. Depress STOP. The voltage should remain until just before a complete stop of the capstan.

Step 4. If the above indications are incorrect, troubleshoot the capstan B board.

7. CAPSTAN MOTOR CURRENT LIMITER

Step 1. Measure the voltage at pin B (See Figure 11-9 for measuring point).

Step 2. Depress the FWD pushbutton. The voltage level should not exceed .33 vdc.

Step 3. Using thumb pressure, press against the end of the capstan to increase capstan load. The voltage indication should not exceed .33 vdc. When sufficient load is applied, the capstan should stop.

Step 4. If the above indications are incorrect, troubleshoot the capstan B board.

D. FAULT ISOLATION FOR THE CAPSTAN A BOARD

The following procedures check the inputs and outputs to the capstan A board. If troubleshooting is indicated, refer to paragraph B, Functional Description of this section for circuit operation of the particular circuit in doubt.

1. PREPARATION FOR TESTING

Step 1. With power off, place the capstan A board on the extender board.

Step 2. Thread tape onto the unit and turn power on. Depress the STOP pushbutton to set the tape tension arms.

2. MODE CHANGE LOGIC LEVELS

Step 1. Measure the voltage level at pin 8. The voltage should be -6 vdc.

Step 2. Depress the FWD (or REV) pushbutton while observing the meter. The -6 vdc should change to +3 vdc at the time the pushbutton is depressed. If not, troubleshoot the capstan A board.

Step 3. Measure the voltage level at pin K (See Figure 11-7 for measuring point). The meter should read -6 vdc for all tape speeds except for 120 ips. Changing the speed selector to 120 ips should change the meter reading to +6 vdc. If not, troubleshoot the capstan A board or the speed selector circuits on the capstan B board. Also check the speed selector switch.

Step 4. Measure the voltage at pin R. The voltage level should be -6 vdc during a RECORD mode. During playback of a tape sync signal (valid only if the capstan A board is equipped with a tape sync board), the voltage level should change to +6 vdc. This signal, when present, is audible and can be heard.

Step 5. Measure the logic level at pin P (See Figure 11-7 for measuring point). In the STOP mode, the voltage should be near +6 vdc (logic 1). During an operate mode, a logic 0 (0 vdc) should appear and remain as long as the capstan is rotating. When the capstan stops, the voltages drop to -2.5 vdc and then returns to +6 vdc.

Step 6. Make the same measurement again at pin 14. The results should be the same. If the results for this step and the previous one are incorrect, troubleshoot the motion detector circuits on the capstan A board.

Step 7. Place the unit in a tape sync mode (if equipped with tape sync). The tape sync indicator should light. If not, check the voltage level at J2-32 (remote control connector) on the I/O Connector Panel. The result should be +4.3 vdc in tape sync. In the STOP mode the voltage level should increase to +4.6 vdc.

Step 8. To check the source voltage to the TAPE SYNC indicator, check J2-16 for +6 vdc. If the voltage checks normal and the voltage above did not, troubleshoot the tape sync board.

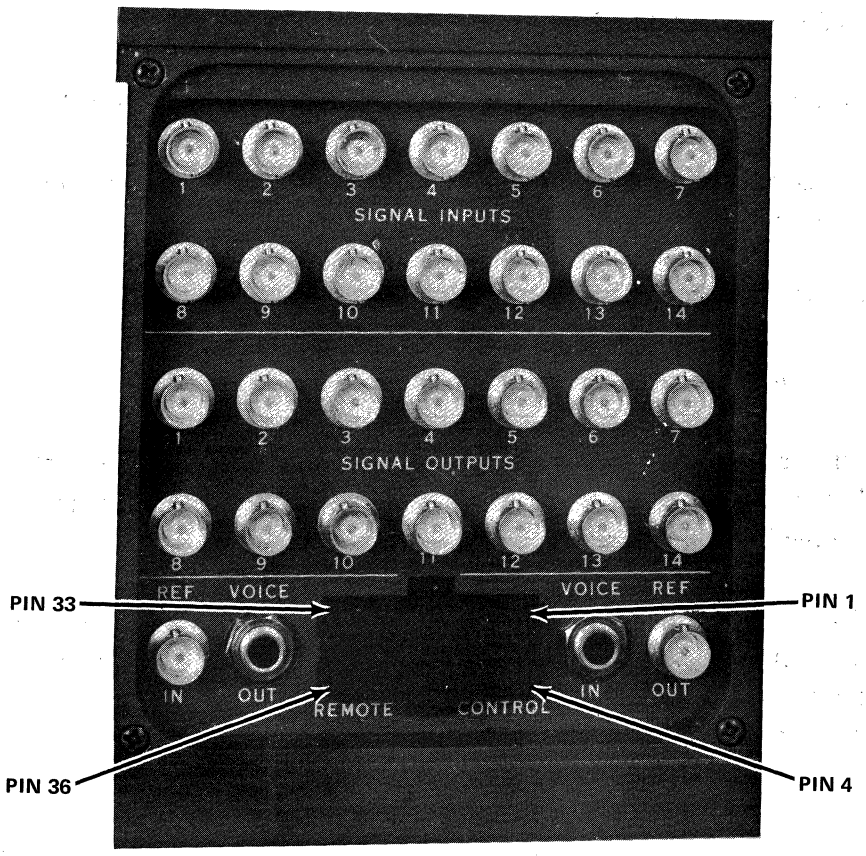


Figure 11-5. 1/0 Panel, Pin Location for Remote Control Connect or J2

3. REFERENCE FREQUENCIES

Step 1. With the oscilloscope, check the signals at pins J and M in accordance with the following table. Operate the unit at the tape speeds indicated in the table below and check the frequencies at each speed. These frequencies may best be checked at TP1 (oscillator reference) and TP2 (tape/tach reference) on the capstan B board.

Each signal should be a squarewave switching between (Approx.) -6 vdc and +6 vdc. If indications are incorrect, troubleshoot the capstan A board.

Step 2. Move the oscilloscope to the RECORD REFERENCE jack on the I/O Connector Panel. This point is equal to pin E on the capstan A board. The frequencies are the same as in the above table with the following two exceptions.

(1) At 120 ips, the frequency is 200 kHz.

(2) In HI density, all frequencies are doubled.

TABLE 11-3. REFERENCE FREQUENCIES	
Tape Speed (ips)	Testpoints TP1 or TP2 (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

Step 3. Move the oscilloscope probe to pin 10 of the capstan A board. In the STOP mode, the voltage level should be +.4 vdc.

Step 4. Depress the FWD pushbutton. The voltage level should change to -.25 vdc.

Step 5. Depress the FAST FWD pushbutton. Whenever the tape has reached maximum speed, a near sinewave should appear on the oscilloscope. If the above indications are not correct, troubleshoot the frequency detector circuit on the capstan A board.

Step 6. Check the signal at pin C of the board. The best connecting point is the collector of transistor Q7 (See Figure 11-7 for measuring point). The frequencies should be the 7.2 MHz bias signal. This signal appears only in the RECORD mode.

Step 7. Check the logic level at pin B. Access to this point may be gained at the junction of resistors R17 and R18 (See Figure 11-7). This point should measure +6 vdc in the RECORD mode. If not, check relay K3 (See Figure 11-3). If the logic level is correct but no bias signal was present in the above step, troubleshoot the bias circuits on the capstan A board.

Step 8 Connect the oscilloscope to pin 13 of the capstan A board. Place the unit into an operate mode. The signal is from the tach in the capstan motor and should be a squarewave equal of a frequency proportional to the tape speed. In STOP, a logic level of +6 vdc or -6 vdc should appear. The logic level is dependent on the stopping position of the disk within the capstan motor.

4. INPUT LINES

Step 1. Check the logic levels from the speed selector at the remote control connector on the I/O Connector Panel as indicated in the following table. The logic levels for each speed is indicated.

TABLE 11-4. SPEED SELECTOR TRUTH TABLE

Tape Speed (ips)	J2 - 29 (C)	J2 - 30 (B)	J2 - 28 (A)
120	1	1	1
60	1	1	0
30	1	0	1
15	1	0	0
7-1/2	0	1	1
3-3/4	0	1	0
1-7/8	0	0	1
15/16	0	0	0

If the logic levels are incorrect, troubleshoot the speed selector switch and related wiring.

Step 2. Connect the oscilloscope to pin N (See Figure 11-7 for measuring point). The signal at this point is from the tachometer in the capstan motor. The signal should be a squarewave proportional to tape speed. In the STOP mode the logic level may be high or low, depending on where the disk stops. If incorrect, troubleshoot the capstan motor.

Step 3. Connect the oscilloscope to pin S (Connect to E1 on the tape sync board).

Step 4. Playback a pre-recorded tape sync signal. The signal should be near a sinewave at approximately 10 vpp. If not check connections and the record circuits.

Step 5. Measure the voltage level on pin 11. The voltage should be +6 vdc during a STOP mode and -6 vdc in the RECORD mode. If not, troubleshoot the mode control circuits.

E. CAPSTAN SERVO CALIBRATION

Step 1. Place the recorder/reproducer in operate (FWD or REV) mode at a tape speed of 15/16 ips.

Step 2. Connect the vertical input of an oscilloscope between testpoints TP3 (HI) and TP8 (LO) on the capstan B board.

Step 3. This step is concerned with the proper adjustments of MASTER GAIN adjust R27 and TACH GAIN adjust R28. If the unit is equipped with the tape sync option, perform procedure A as follows. If the unit is not equipped with the tape sync option (capstan synchronous), perform procedure B. DO NOT attempt to perform both procedures.

PROCEDURE A: Operate the recorder/reproducer in the tape sync mode. Adjust MASTER GAIN adjust R27 to a point just below servo oscillation. Check each of the other tape speeds and re-adjust if necessary. Return to 15/16 ips when finished. Place the unit into capstan synchronous mode such as RECORD. Adjust TACH GAIN adjust R28 to a point just below servo oscillation. Check each tape speed. Return to 15/16 ips when finished.

PROCEDURE B: Place the recorder/reproducer into an operate mode. Adjust TACH GAIN adjust R28 fully counter-clockwise. Adjust MASTER GAIN adjust R27 to a point just below servo oscillation. Check each of the other tape speeds and re-adjust if necessary. Return to 15/16 ips when finished.

Step 4. Move the vertical input of the oscilloscope to testpoints TP4 (HI) and TP8 (LO). Check that the lower portion of the trapezoidal waveform on the oscilloscope is at 0 volt dc level. If necessary, adjust ZERO ADJUST potentiometer R19 for the correct indication.

Step 5. Move the high lead of the oscilloscope to testpoint TP5 and check that the lower portion of the trapezoidal waveform is at a 0 volt dc level. If necessary, adjust ZERO ADJUST potentiometer R23 for the correct indication.

Step 6. Connect the high lead of the oscilloscope to the collectors of transistors Q2 and Q3 of the motor drive amplifier. This point is accessible at the terminal located between the two transistors. If the signal on the oscilloscope has severe ripple (above 10 volts peak-to-peak), adjust RIPPLE ADJUST potentiometer R22 on the capstan B board to minimize the ripple as much as possible.

Step 7. Repeat the above procedures one time to assure that maximum servo gain with minimum ripple has been attained.

Step 8. Connect the vertical input of the oscilloscope to testpoint TP6 and check for the presence of a logic 1 (+6 volts dc) with stable tape movement. Switch tape speeds and note a momentary change in logic level at testpoint TP6 until tape movement restabilizes to the new speed. Depress the STOP pushbutton and place the capstan B board back into its proper place.

SPEED CONTROL CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL

REF. DESIG.	SANGAMO PART NO.
B3	510487-002
CR23	510509
J1	837115
P12	859254-002
CONNECTOR PANEL	
J2	510502
J76	855977
J77	855977

ELECTRONIC CHASSIS

REF. DESIG.	SANGAMO PART NO.
C3	859959-002
thru	
C11	
C14	510334-001
J5	859241-001
J6	859241-001
J12	859255-002
K2	510486-003

REF. DESIG.	SANGAMO PART NO.
K3	510486-003
M1	510517
R1	897581
TB3	510497-001
CONTROL MODULE	
CR6	510509
P1	510502
S1	510484

MOTOR DRIVE AMPL.

REF. DESIG.	SANGAMO PART NO.
E9	850312
E10	896669
Q2	510467
Q3	510485
R3	897583
R4	510408-049

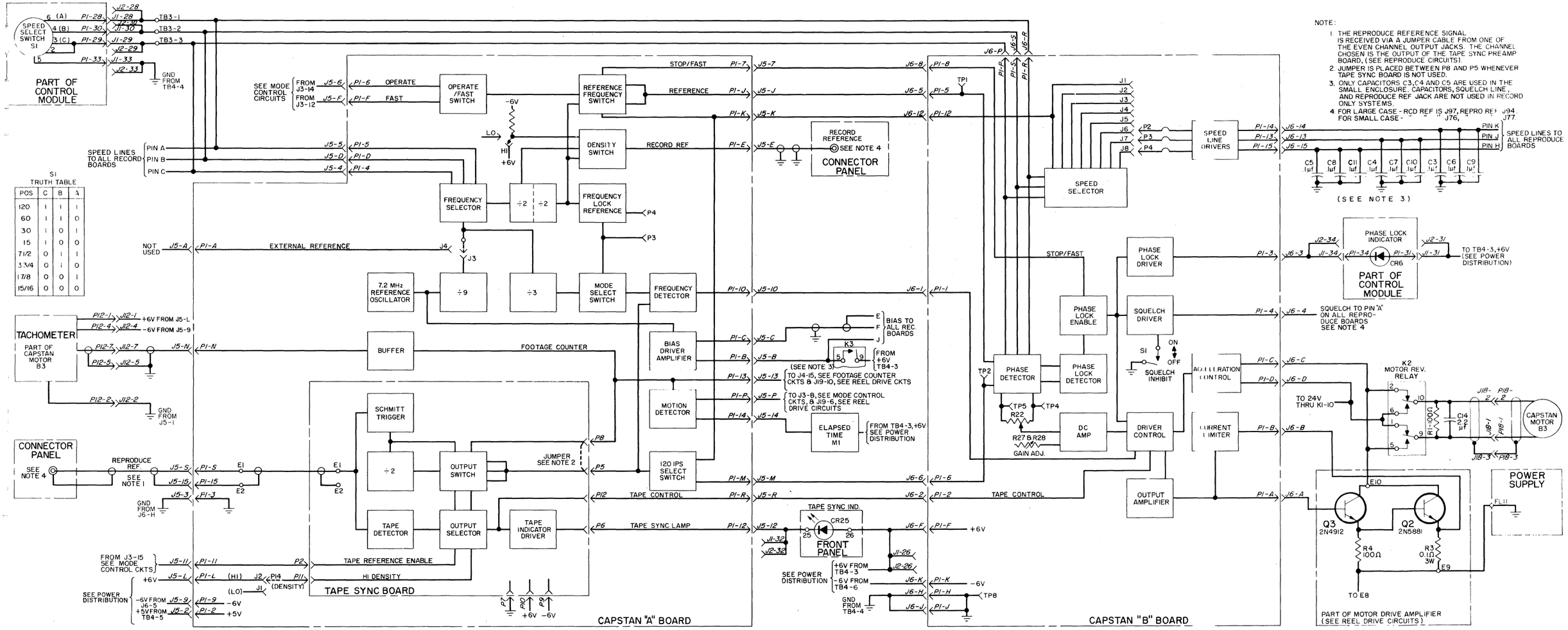


Figure 11-6. Speed Control Overall Functional (804890)

CAPSTAN A BOARD 836629

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-011	P2	836269	R8	510408-101	R28	510408-061
thru		thru		R9	510408-129	R29	510408-073
C3		P12		R10	510408-073	R30	510408-105
C4	691686-021	P13	836694	R11	510408-097	R31	510408-121
C5	859775-021	P14	836694	R12	510408-057	R32	510408-129
C6	510058-002	Q1	854540	R13	510408-097	U1	859520-029
C7	510058-002	Q2	854539	R14	510408-121	U2	510376-012
C8	859959-002	Q3	854539	R15	510408-121	U3	510376-025
C9	859775-026	Q4	510018	R16	510408-145	U4	510376-040
C10	859775-026	thru		R17	510408-083	U5	510376-024
C11	859775-007	Q8		R18	510408-071	U6	510376-014
C12	859775-011	Q9	854539	R19	510408-065	U7	510376-042
CR1	844510	Q10	854540	R20	510408-087	U8	510376-028
thru		R1	510408-073	R21	510408-151	U9	510376-017
CR6		thru		R22	510408-089	U10	510376-014
J1	510489	R3		R23	510408-097	U11	510376-042
thru		R4	510408-087	R24	510408-089	U12	510376-039
J4		R5	510408-077	R25	510408-101	U13	510376-034
		R6	510408-073	R26	510408-121	U14	510240-002
		R7	510408-101	R27	510408-025	Y1	510483

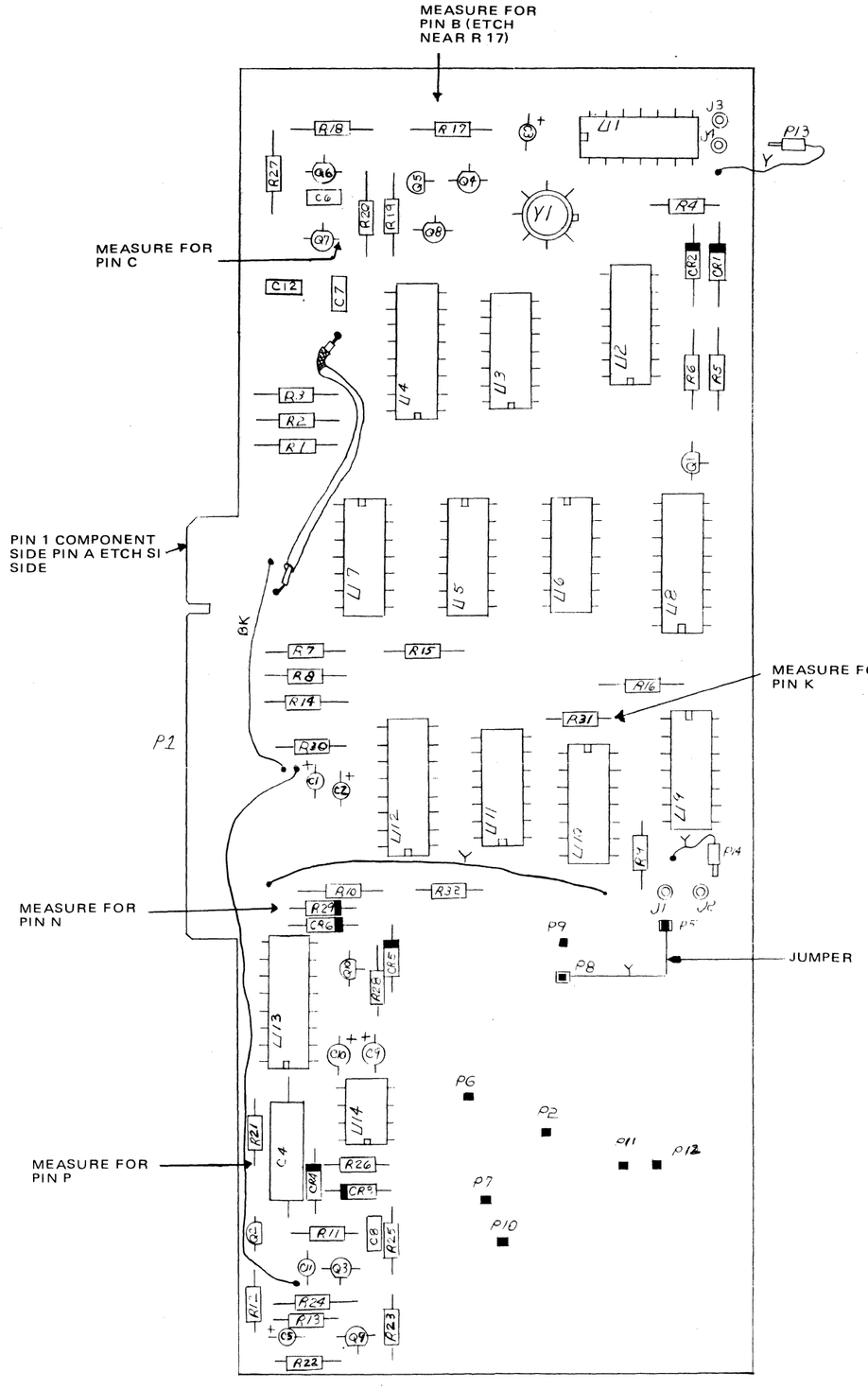


Figure 11-7. Capstan A Board Parts Location (836629)

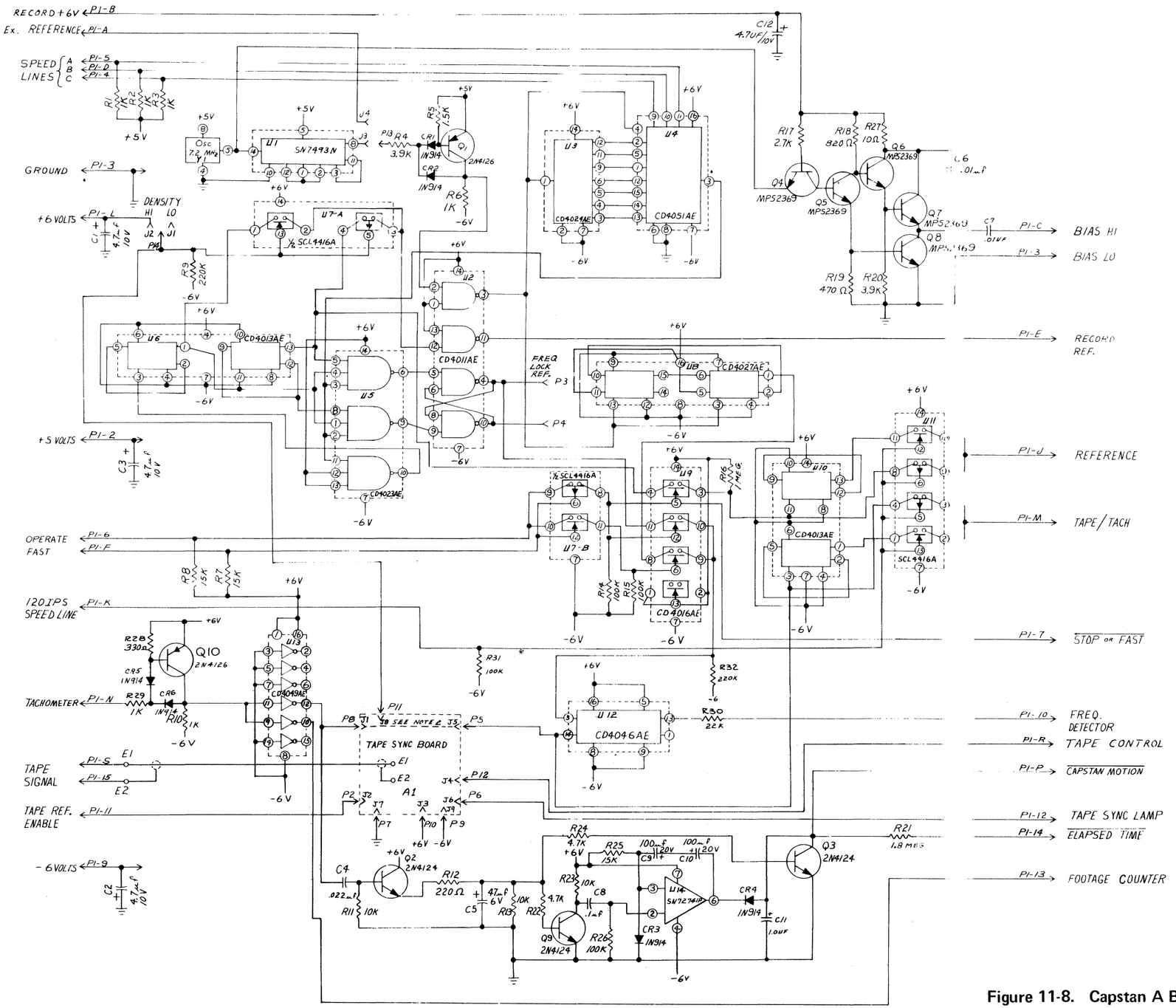


Figure 11-8. Capstan A Board Schematic Diagram (836629)

CAPSTAN B BOARD 836631

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	837021-005	P2	836694	R33	510408-091	R68	510408-121
C2	837021-003	thru		R34	510408-025	R69	510408-065
C3	837021-001	P4		R35	510408-121	R70	510408-121
C4	276212-200	Q1	859971	R36	510408-065	thru	
C5	276212-250	Q2	854539	R37	853530-356	R73	
C6	(P/O C1)	thru		R38	853530-356	R74	853530-232
C7	(P/O C2)	Q6		R39	853530-339	R75	853530-232
C8	(P/O C3)	R1	510408-121	R40	853530-308	R76	510408-073
C9	276212-200	R2	510408-121	R41	853530-176	R77	510408-103
C10	276212-250	R3	510408-097	R42	853530-176	R78	510408-103
C11	691686-015	thru		R43	853530-147	R79	510408-073
C12	691686-047	R10		R44	853530-276	R80	510408-049
C13	859775-014	R11	510408-121	R45	510408-121	R81	329151-011
C14	691686-047	R12	853530-284	R46	510408-081	R82	510408-117
C15	859775-014	R13	853530-259	R47	510408-091	R83	510408-113
C16	859775-014	R14	853530-232	R48	510408-071	S1	510102-003
C17	691686-044	R15	853530-232	R49	510408-081	TP1	691032
C18	197212-100	R16	853530-259	R50	510408-091	thru	
C19	859775-011	R17	853530-284	R51	510408-121	TP8	
C20	510117-026	R18	853530-246	R52	510408-121	U1	510376-040
C21	859775-011	R19	329151-010	R53	510408-099	U2	510376-041
C22	859775-011	R20	853530-176	R54	510408-099	U3	510376-034
C23	510334-001	R21	853530-246	R55	510408-113	U4	510376-002
C24	197212-500	R22	329151-006	R56	510408-113	U5	510376-017
CR1	844510	R23	329151-010	R57	510408-133	U6	510376-017
thru		R24	853530-147	R58	510408-101	U7	510240-002
CR5		R25	853530-300	R59	510408-133	thru	
CR6	852475-016	R26	853530-176	R60	510408-089	U9	
CR7	844510	R27	329151-011	thru		U10	510376-017
J1	836672	R28	329151-010	R62		U11	510240-002
thru		R29	853530-243	R63	510408-033	U12	510240-002
J8		R30	853530-289	thru		U13	510376-042
K1	510479	R31	853530-243	R65		U14	510240-002
K2	510479	R32	510408-097	R66	853530-176	U15	510453
				R67	510408-085	U16	510240-002

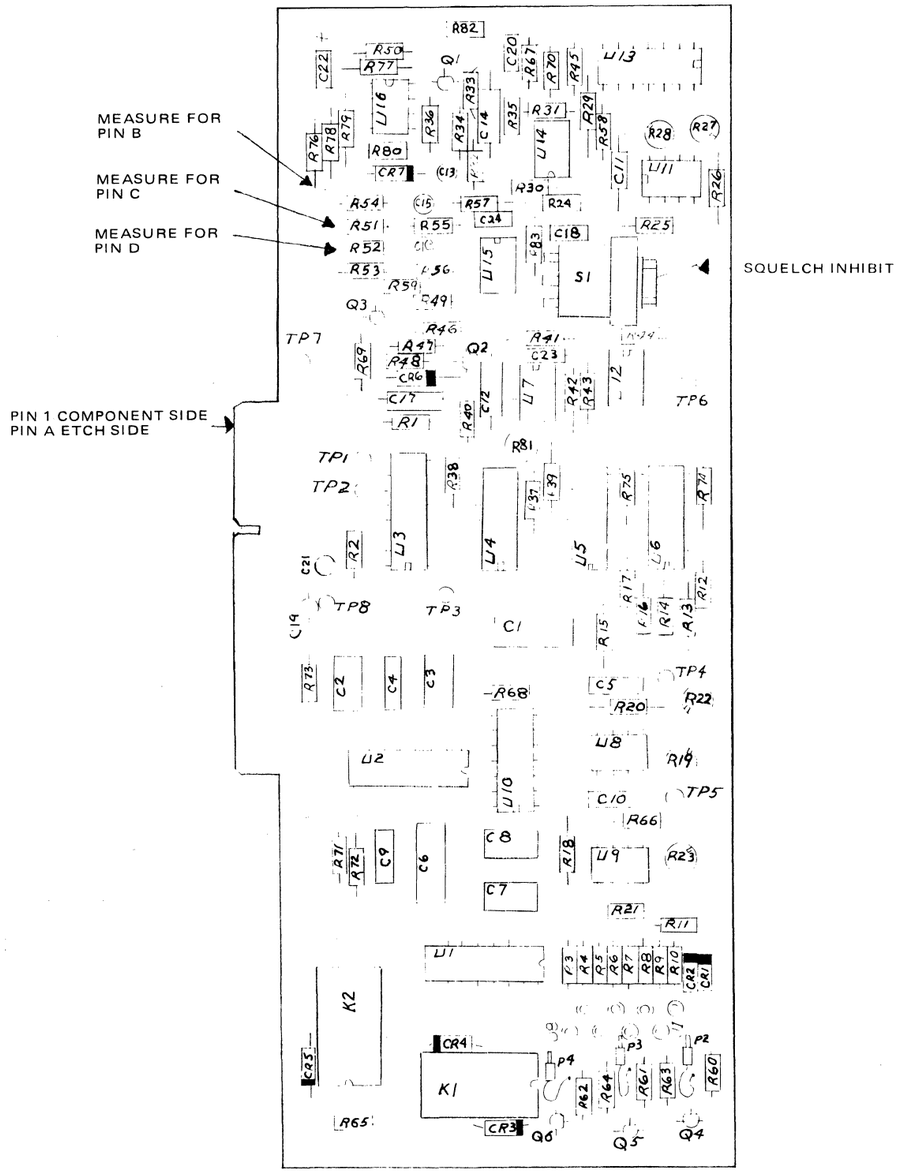


Figure 11-9. Capstan B Board Parts Location (836631)

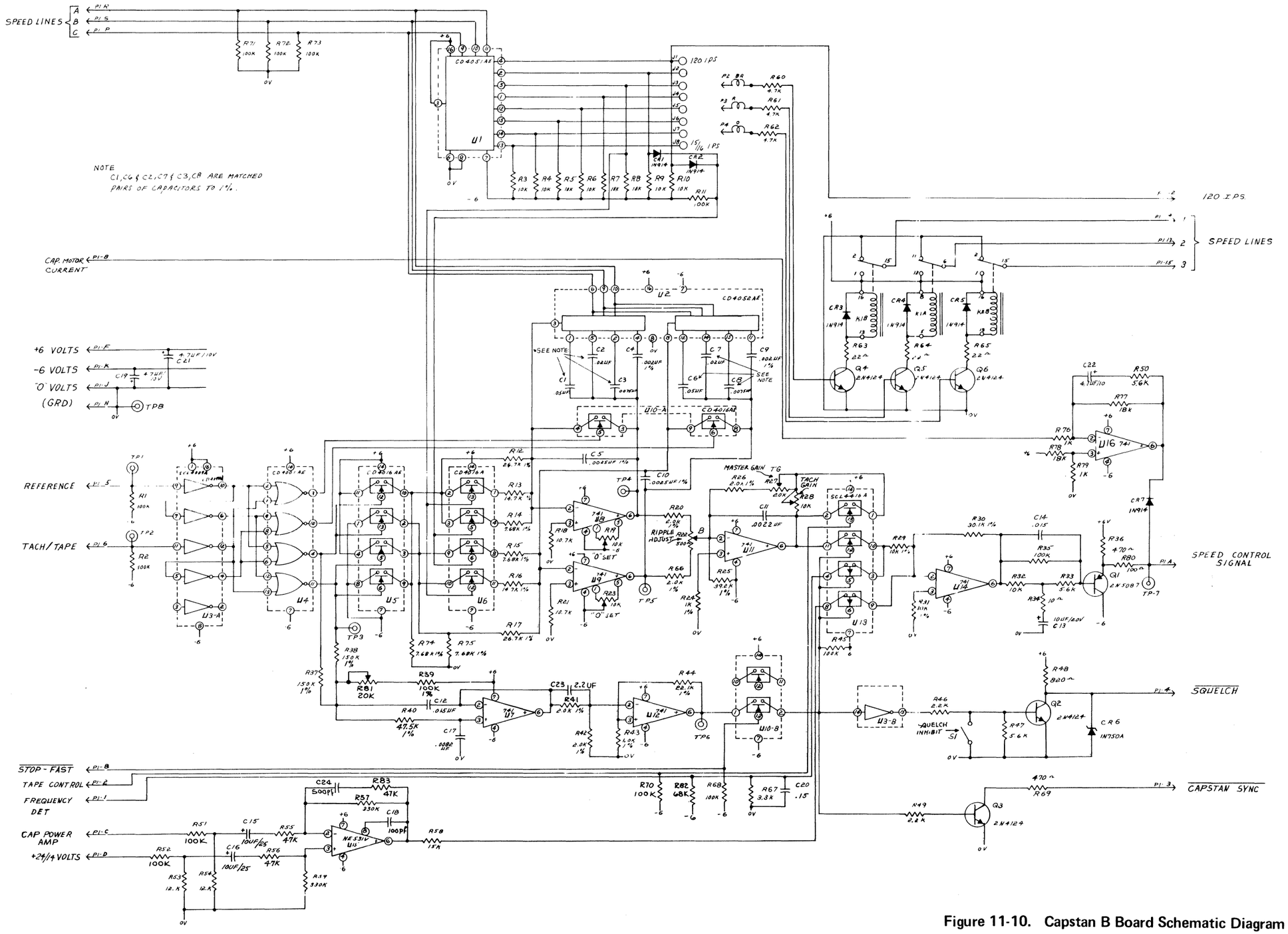


Figure 11-10. Capstan B Board Schematic Diagram (836631)

TAPE SYNC BOARD 836664

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	510117-029	J1	510489	R5	510408-129	R16	510408-089
C2	859775-007	thru		R6	510408-083	R17	510408-081
C3	859775-021	J9		R7	510408-097	R18	510408-065
C4	859959-002	Q1	854540	R8	510408-049	R19	510408-125
C5	859775-011	Q2	854540	R9	510408-097	R20	510408-073
C6	859959-002	Q3	854539	R10	510408-049	R21	510408-087
C7	859775-011	Q4	854540	R11	510408-097	R22	510408-077
C8	859959-002	R1	510408-065	R12	510408-089	U1	510458
CR1	844510	R2	510408-049	R13	510408-089	U2	510376-012
thru		R3	510408-101	R14	510408-133	U3	510376-014
CR4		R4	510408-101	R15	510408-133	U4	510376-042

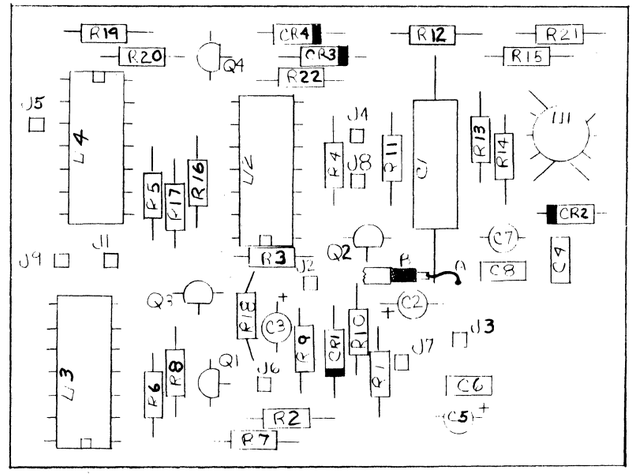


Figure 11-11. Tape Sync Board Parts Location (836664)

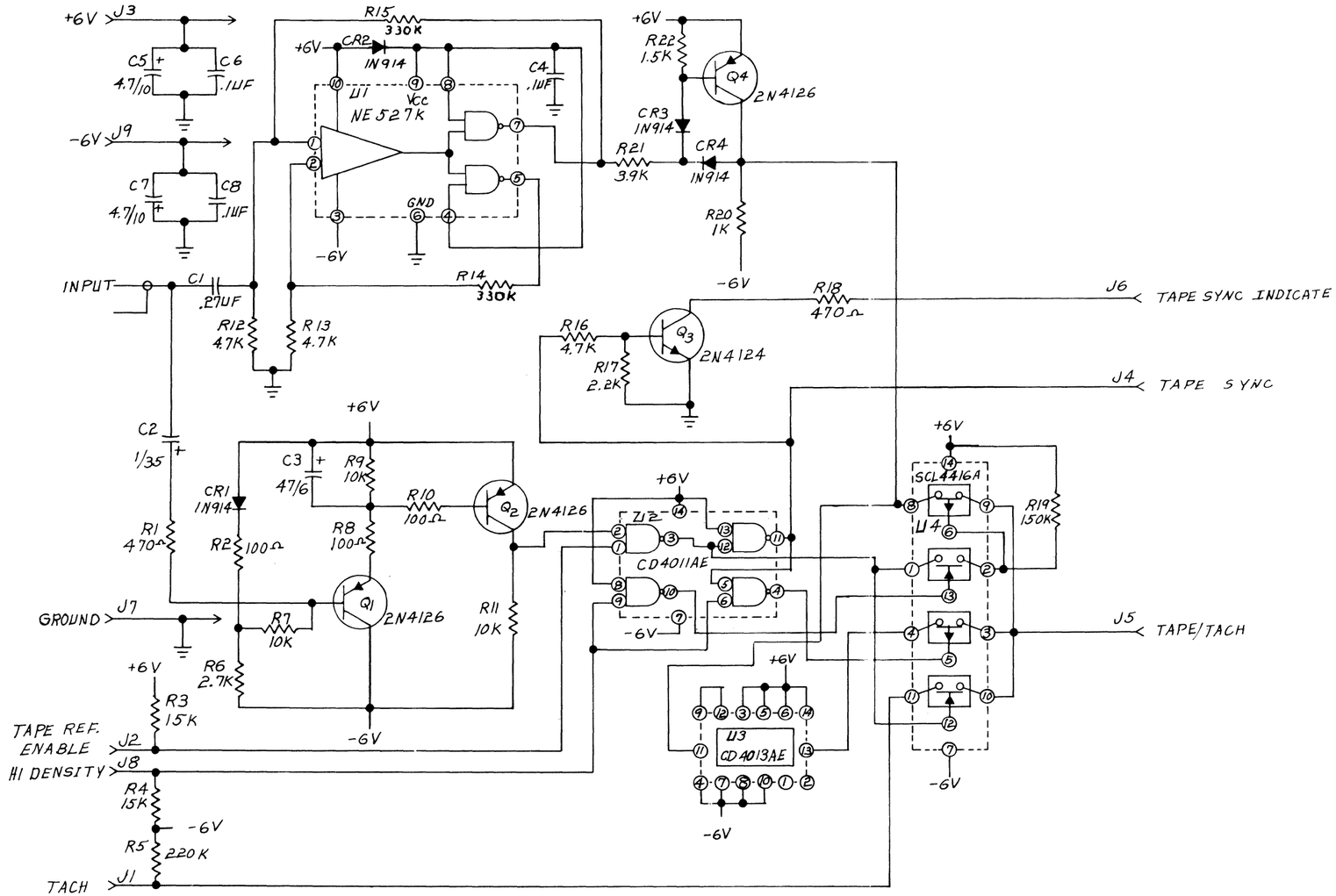


Figure 11-12. Tape Sync Board Schematic Diagram (836664)

SECTION 12
RECORD SERVICING

A. INTRODUCTION

The record circuits prepare the data for recording on tape. These circuits accept the data at the I/O Connector Panel, cable it to the record boards for processing, and then to the record head for recording on tape. The record circuits may be either direct, FM, or voice and may be placed in any record slot (with the exception of voice) in the unit for application. The record boards are located inside and behind the transport in the upper portion of the unit.

B. FUNCTIONAL DESCRIPTION

All data signals are applied to the jacks on the I/O Connector Panel. The track numbers are indicated on the panel. The voice input is located away from the data inputs. Signals from the input jacks are applied directly to the record boards.

1. DIRECT RECORD BOARD

The direct record circuits amplify and prepare data and tape sync signals (optional) for application to the record head. When the direct record process is used, the data signal to be recorded is amplified, linearly combined with a high frequency bias signal,and applied directly to the record head as a varying ac current. This ac current produces a changing magnetic flux across the gap in the record head.

The direct record board consists of two basic circuits; the bias amplifier consisting of transistors Q1 through Q3 and data amplifier consisting of transistors Q4 through Q6.

The bias signal is the 7.2 MHz frequency generated on the capstan A board. This frequency is applied to pin P1-F and TP1 on the direct record board. The signal is ac coupled to emitter followers Q1 and Q2. The output is applied to driver Q3. Transistor Q3 drives a tuned load consisting of the head and head lead, coils L1 and L2, and capacitors C6 and C8.

The input data signal is applied to the board at P1-1 and immediately to an impedance network and to an attenuator network. The impedance network consists of resistor R19 and EMPEDANCE switch S2. LO and HI positions of the switch provide input impedances of 75 ohms or 10/20k ohms respectively. The attenuator network consists of RANGE switch S1 and voltage divider R7 and R8. This network expands the input capacity of the board, allowing a wider range of input voltage levels to be applied without additional attentuation. The RANGE switch is positioned to encompass the rms level of the input signal to the board.

The output of the attenuator network is ac coupled through INPUT LEVEL control R9 and then to the input of current amplifier Q4 through Q6. INPUT LEVEL control R9 establishes the record current through the head and should be adjusted for 0.1 volts rms at TP2, regardless of the amplitude of the input signal. RECORD GAIN adjust R13 establishes a reference current through the head corresponding to 1% 3rd harmonic of the input signal. This control should be adjusted for 1% 3rd harmonic distortion while observing the reproduced signal from the tape. The output of the current amplifier is applied to a summing network to be combined with the bias signal.

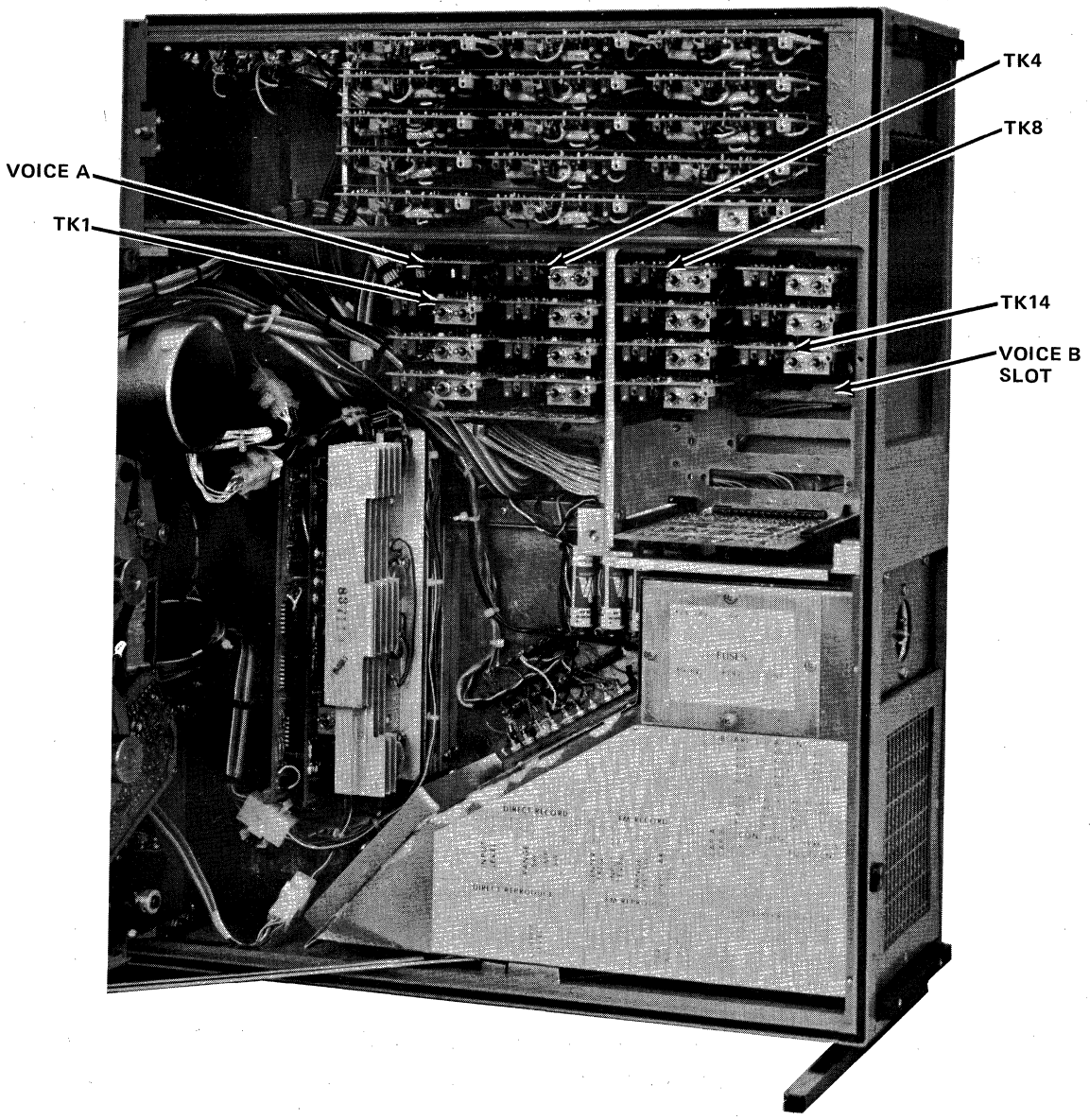


Figure 12-1. Record Boards Location

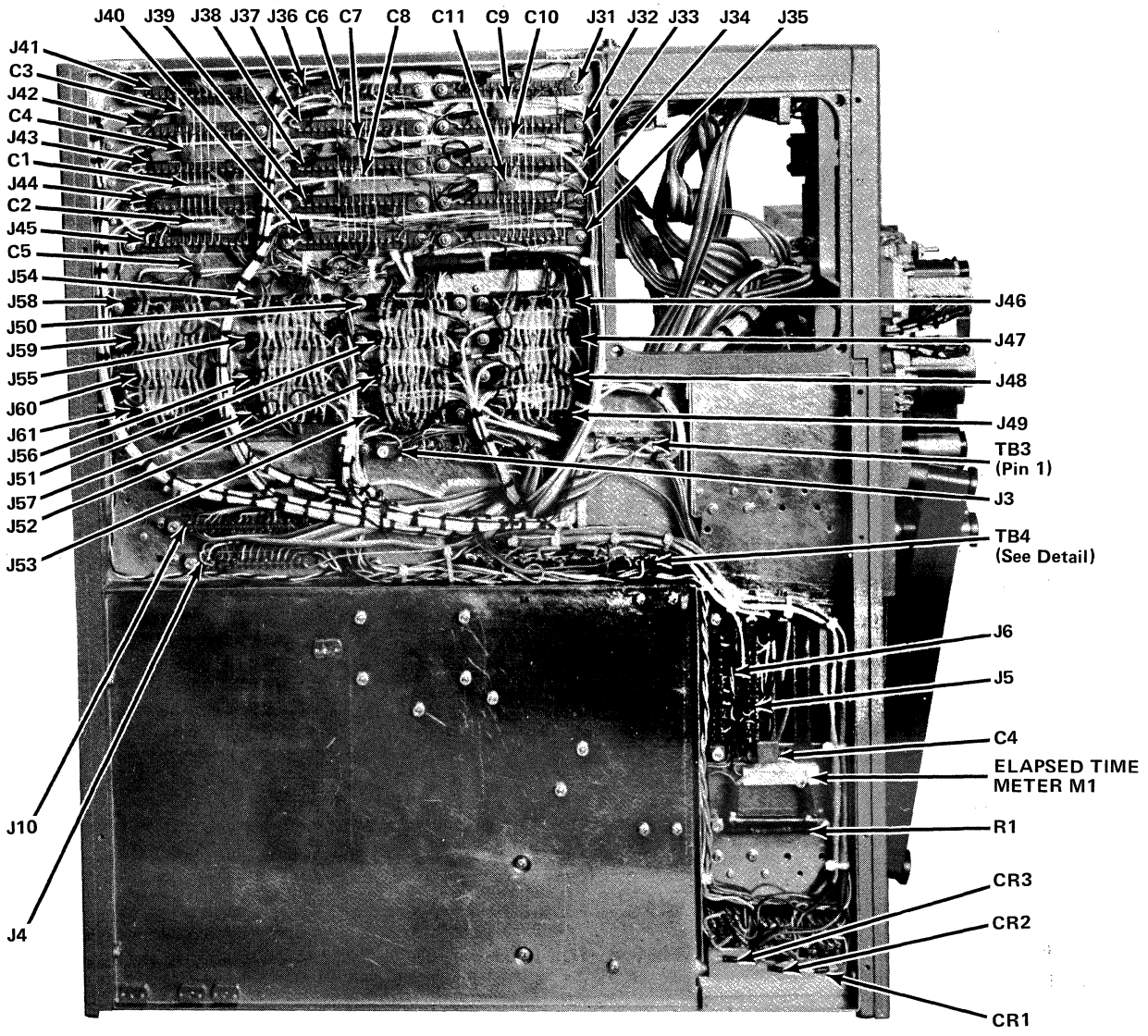


Figure 12-2. Rear View, Parts Location

2. FM RECORD CIRCUITS

With FM recording, the data signal frequency modulates a carrier frequency and the modulated carrier is recorded on the magnetic tape. The modulated carrier 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 voltage signal at the input results in the basic carrier being recorded. A positive dc signal increases the carrier frequency and a negative dc signal lowers the carrier frequency. An alternating data signal deviates the carrier alternately on both sides of the carrier frequency, at a rate equal to the input signal frequency.

The data enters the FM record circuits at P1-1 and is applied through an attenuation network which produces the proper voltage level for the desired % deviation from the carrier frequency. The data signal is amplified by U1 and applied to the VCO (voltage controlled oscillator) consisting of transistors Q1 through Q7. DEVIATION control S2 is a operator control for unipolar deviation. This control can be set for + DEVIATION, NORMAL, or - DEVIATION. The position of the switch determines the unmodulated frequency of the VCO operation.

The data signal causes the VCO to change frequency. When the data signal raises, the VCO frequency raises. When the data signal drops, the VCO frequency decreases. The amount of frequency change is proportional to amplitude of the data and the rate of frequency change is equal to the frequency of the data.

The output of the VCO is applied to frequency countdown network U2 and U3 with eight outputs being applied to data selector U4. The frequency at the output of this gate is selected by the speed select lines. The frequency selected is applied through a head driver circuit consisting of transistor Q11 through Q13 to the record head.

When the re-record feature is used, the input signal to the record board is routed directly to jack J1. If plug P2 is correctly mated with J1, the data signal passes through the head driver circuits to head unchaged.

3. VOICE OR TIME CODE RECORD

The voice record board contains two basic circuits; (1) a bias amplifier consisting of transistors Q1 through Q3, and (2) a signal amplifier consisting of integrated circuits U1 through U3.

The bias amplifier is the same as that used for direct record. The 7.2 MHz signal from the capstan A board (See speed control circuits) is applied to pin P1-F and to the base of transistors Q1 and Q2. These two transistors are emitter followers used to drive driver stage Q3. Transistor Q3 drives a tuned load consisting of the head and head loed, coils L1 and L2, and capacitors C6 and C8.

The voice signal is applied to the input of U1. U1 is a variable gain amplifier with the gain being adjusted by varying the empedance of transistor Q4. The output of amplifier U1 is applied to amplifier U2 which is a fixed-gain amplifier with a gain of approximately 40 dB. The output of U2 is linearily added to bias and recorded on tape. The output of U1 is also rectified through diode CR1 and filter capacitor C13. The rectified voltage is amplified by amplifier U3 as the AGC control voltage for transistor Q4.

LEVEL SET control R14 determines the gain of amplifier U3 which results in the record current level. The time code signal is recorded on time in the same manner as the voice signal.

C. FAULT ISOLATION AND CALIBRATION

1. DIRECT RECORD

This procedure should be performed for both troubleshooting or calibration of a given single channel of direct record electronics and may be repeated for additional channels. If a fault occurs on the record board, refer to paragraph B of this section for a functional description of the circuitry.

The first four steps of the following procedure may be performed with power removed.

Step 1. Check the position of IMPEDANCE switch S2. The up position is selected for a 75 ohm input impedance and the down position is selected for 10K ohms or higher impedance.

Step 2. Connect an ac voltmeter between testpoints TP2 (HI) and TP3 (LO).

Step 3. Connect a sine wave signal generator to the input connector on the I/O Connector Panel for the channel being tested. Set the generator to 10 kHz at the highest anticipated signal level for recording. The ac voltmeter should read .1 vrms.

Step 4. If the ac voltmeter does not read correct, check the position of RANGE switch S1. The LO position is for input voltage levels between .1 vrms to 1 vrms and the HI position is for input voltage levels between 1 vrms and 10 vrms. If necessary also adjust INPUT LEVEL adjust R9 for a meter reading of .1 vrms. If no signal is present at all, check that the signal generator is correctly connected and the signal is present at pin 1 of the record board.

Step 5. Apply power to the unit and check that the STOP indicator is lit. If not, depress the STOP pushbutton to take up slack tape.

Step 6. Connect an oscilloscope between testpoints TP1 (HI) and TP3 (LO) and check for the presence of the bias frequency to the record board. The signal observed should be a 7.2 MHz square wave switching between approximately +6 volt and ground. If the signal is not present, see the capstan A board (speed control circuits) for a possible fault.

Step 7. Set the tape speed selector knob to the highest available reproduce speed. Set the sinewave generator to the band edge of the tape speed selected as per Table 12-1.

Step 8. Depress the FWD and REC pushbuttons. Tape should now be moving forward in the RECORD mode.

TABLE 12-1. BAND EDGE FREQUENCIES

Tape Speed (ips)	Band Edge (kHz)			10% Band Edge (kHz)		
	I.B.	W.B. I	W.B. II	I.B.	W.B. I	W.B. II
120	600	1600	2000	60	160	200
60	300	800	1000	30	80	100
30	150	400	500	15	40	50
15	75	200	250	7.5	20	25
7-1/2	38	100	125	3.8	10	12.5
3-3/4	19	50	62.5	1.9	5	6.25
1-7/8	10	25	31.25	1.0	2.5	3.125
15/16	5			.5		

Step 9. Connect a wave analyzer between testpoints TP1 (HI) and TP3 (LO) on the reproduce board for the same channel of the record board being checked.

Step 10. Set the wave analyzer for the same frequency as the sinewave generator. Failure to obtain a response from the wave analyzer could indicate a fault in one of the following locations:

(a) Output circuitry of the record board
(b) Record head
(c) Reproduce head
(d) Emitter follower board (on repro. head)
(e) Preamplifier on the reproduce board

If the response is normal, proceed with the next step.

Step 11. Adjust BIAS LEVEL adjust R5 fully couter-clockwise. Turn the control clockwise until a maximum reading on the wave analyzer is attained. Note the level. Continue to advance the control until the bias level drops 3 dB (2 dB for W.B. II or 1 dB for W.B. I). The proper bias current into the record head results at this point.

Step 12. The following procedure sets the record current for a third harmonic distortion of 1% (-40 dB) of the fundamental.

Step 13. Set the generator to three times the 10% band edge frequency for the tape speed the unit is operating (Table 12-1). Example, if the unit is recording and playing back at 60 ips, set the generator to 90 kHz.

Step 14. Set the wave analyzer for the same frequency. Note the level obtained.

Step 15. Change the generator to the 10% band edge frequency. Example: 30 kHz for 60 ips.

Step 16. Adjust RECORD GAIN adjust R13 for -40 dB (1%) of the level noted in Step 14.

Step 17. Recheck the bias level setting and repeat Steps 10 and 11 if necessary. If a change was made, recheck the record gain adjustment. Continue to recheck these adjustments until no further improvement is made.

Step 18. The test equipment may be removed and the next channel may be calibrated.

2. FM RECORD

The following procedure is outlined for one channel of FM record electronics. This procedure should be repeated for each channel of FM record board contained within the unit.

Step 1. Set UNIPOLAR DEVIATION switch S2 to NORMAL.

Step 2. Set ATTENUATOR switch S1 to the TEST position.

Step 3. Connect a frequency counter between testpoints TP3 (HI) and TP2 (LO). Place the unit into the RECORD mode.

Step 4. Adjust CENTER FREQUENCY control R9 for the center frequency indication shown in Table 12-2. If the frequencies are not present or are incorrect, troubleshoot the FM record board. Refer to paragraph B of this section for a functional description of the circuitry.

Step 5. Move ATTENUATOR switch S1 off the TEST position. Ensure the input BNC connector on the I/O Connector Panel is open for the following adjustment.

Step 6. Adjust BALANCE ADJUST R28 for the same frequency as was attained in Step 4.

Step 7. Connect a dc voltage supply to the input BNC connector, HI, side to HI side, Lo side to LO side. Adjust the dc supply voltage to the maximum anticipated positive peak level.

TABLE 12-2. VCO FREQUENCIES

Tape Speed (ips)	Center Frequency (kHz)			
	Lo Band	Intermediate Band	Wide Band I	Wide Band II
120	108	216	432	900
60	54	108	216	450
30	27	54	108	225
15	13.5	27	54	112.5
7-1/2	6.75	13.5	27	56.25
3-3/4	3.38	6.75	13.5	28.125
1-7/8	1.69	3.38	6.75	14.06
15/16	.84	1.69	3.38	

Step 8. Adjust INPUT LEVEL adjust R2 for a frequency reading equal to +40%. See Table 12-3.

TABLE 12-3. FREQUENCY DEVIATION

Center Frequency (kHz)	+40% Deviation (kHz)	Center Frequency (kHz)	+30% Deviation (kHz)
432	604.8	900	1260
216	302.4	450	630
108	151.2	225	315
54	75.6	112.5	157.5
27	37.8	56.25	78.75
13.5	18.9	28.125	39.375
6.75	9.42	14.06	19.69
3.38	4.73		
1.69	2.35		
.84	1.28		

Step 9. Return ATTENUATOR switch S1 to the TEST position.

Step 10. Connect an oscilloscope to the output of the reproduce board for the channel being adjusted.

Step 11. Ensure the recorder/reproducer is moving tape in the record mode. On the record board, adjust RECORD CURRENT adjust R27 for minimum noise.

Failure to obtain a response from the wave analyzer could indicate a fault in one of the following locations:

(a) Output circuitry of the record board
(b) Record head
(c) Reproduce head
(d) Emitter follower board (on repro. head)
(e) Preamplifier on the reproduce board

If the response is normal, proceed with the next step.

Step 12. If UNIPOLAR switch S2 is to be used in either the plus or minus position, the calibration should be checked for that position. Placing the switch in either DEVIATION position allows data to be recorded for the full deviation swing of the VCO for single polarity signals.

3. VOICE OR TIME CODE

This procedure performs both calibration and troubleshooting. If a fault is detected, refer to paragraph B of this section for a functional description of the circuitry to troubleshoot the fault.

Step 1. Place the voice record or time code record board on an extender board and place the unit into the record mode.

Step 2. Connect a voltmeter between pin 6 of U2 (HI) and testpoint TP3 (LO).

Step 3. With no signal applied to the input of the board, adjust BALANCE control R21 for 0 vdc.

Step 4. Adjust BIAS LEVEL adjust R5 fully counter-clockwise.

Step 5. Connect a sinewave generator to the correct input connector on the I/O Connector Panel. Set the generator to 1 kHz. Adjust the amplitude of the generator for 10 mvrms at testpoint TP2.

Step 6. Read the ac voltage at pin 6 of U2. The voltage should read 4 vpp. If not adjust LEVEL SET control R14.

Step 7. Connect the voltmeter between testpoints TP1 (HI) and TP4 (LO) on the reproduce board. Depress the FWD and REC pushbuttons. Tape should now be moving forward in the RECORD mode.

Step 8. Adjust BIAS LEVEL adjust R5 clockwise until a maximum reading on the voltmeter is obtained.

RECORD CIRCUIT'S (ASSOCIATED COMPONENTS)

TRANSPORT PANEL				ELECTRONIC CHASSIS		CONNECTOR PANEL	
REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
P47	858914	PU1	837063-001	J31	859241-003	J61	846615
P48	858914		837313-001	thru		J62	855977
				J38		thru	
				K3	510486-003	J68	

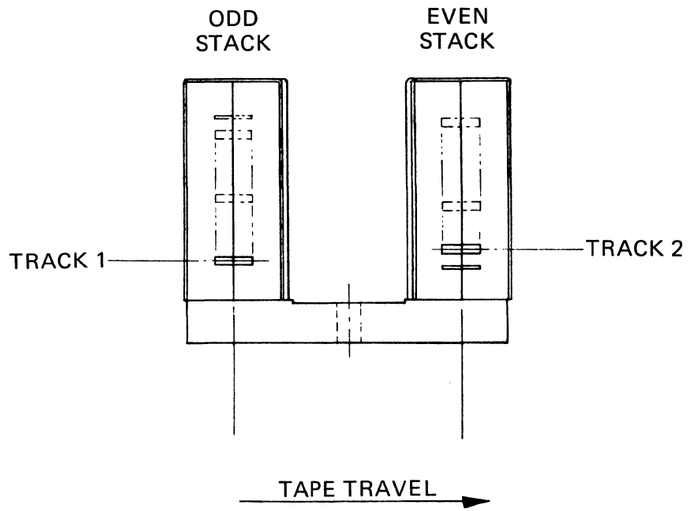
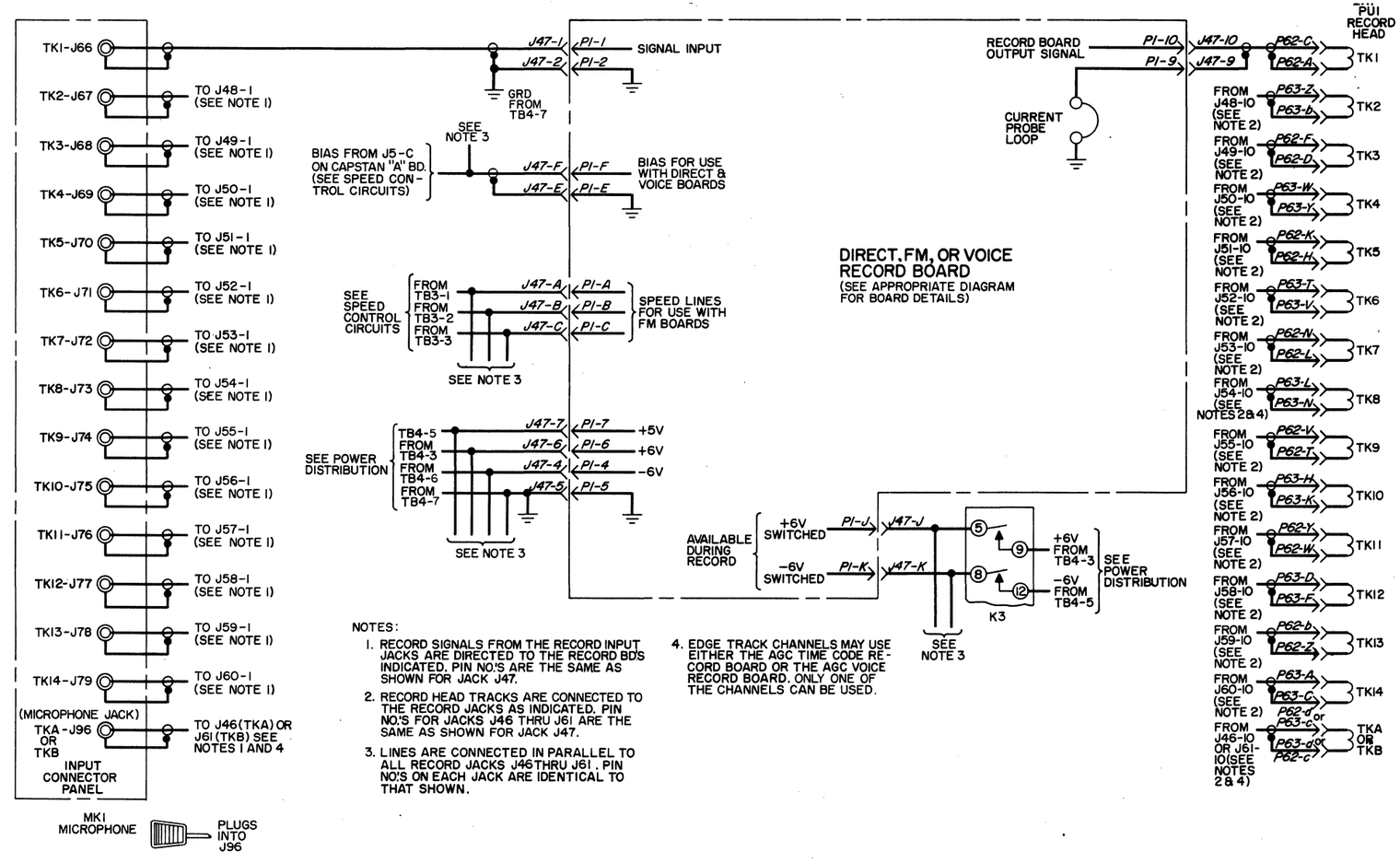


Figure 12-3. Head Track Assignment



NOTES:

1. RECORD SIGNALS FROM THE RECORD INPUT JACKS ARE DIRECTED TO THE RECORD BD'S INDICATED. PIN NO.'S ARE THE SAME AS SHOWN FOR JACK J47.
2. RECORD HEAD TRACKS ARE CONNECTED TO THE RECORD JACKS AS INDICATED. PIN NO.'S FOR JACKS J46 THRU J61 ARE THE SAME AS SHOWN FOR JACK J47.
3. LINES ARE CONNECTED IN PARALLEL TO ALL RECORD JACKS J46 THRU J61. PIN NO.'S ON EACH JACK ARE IDENTICAL TO THAT SHOWN.
4. EDGE TRACK CHANNELS MAY USE EITHER THE AGC TIME CODE RECORD BOARD OR THE AGC VOICE RECORD BOARD. ONLY ONE OF THE CHANNELS CAN BE USED.

Figure 12-4. Record Circuits Overall Functional (804891)

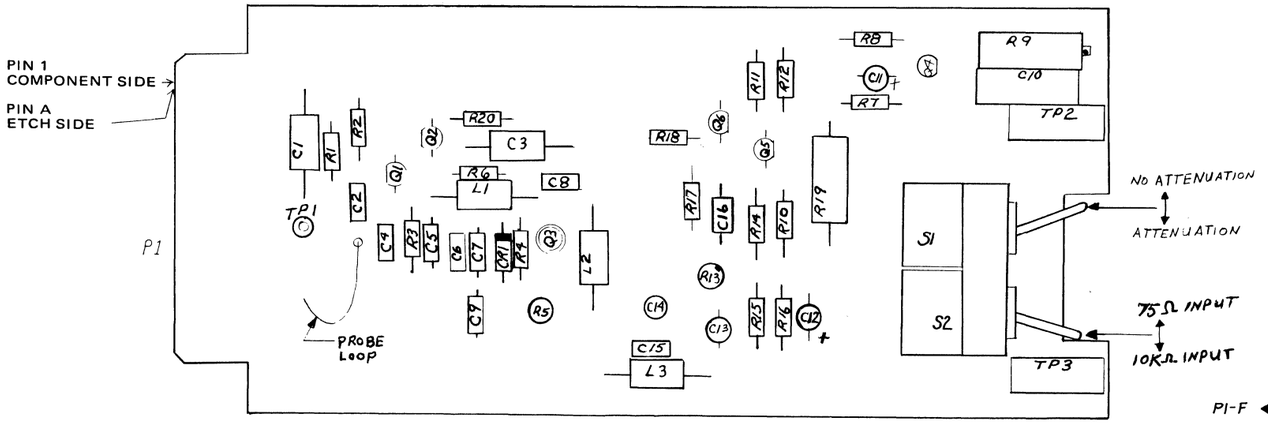


Figure 12-5. Direct Record Board Parts Location (836643)

NOTES:
1. CURRENT PROBE IS 1.5 INCH LOOP BLACK 22GA WIRE

DIRECT RECORD BOARD 836643

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	691686-001	C14	859775-022	R1	510408-081	R14	See Table
C2	510058-002	C15	854528-030	R2	510408-049	R15	510408-079
C3	691686-001	C16	See Table	R3	510408-049	R16	510408-025
C4	510058-002	CR1	844510	R4	510408-057	R17	510408-071
C5	510058-002	L1	853587-028	R5	329151-007	R18	510408-057
C6	197212-100	L2	853587-029	R6	510408-025	R19	864971-018
C7	510058-002	L3	853587-012	R7	510408-097	R20	510408-045
C8	See Table	MP1	847825	R8	510408-073	S1	855432-001
C9	197212-200	Q1	854539	R9	510349-011	S2	510102-003
C10	691391-005	Q2	854540	R10	510408-085	TP1	691032
C11	See Table	Q3	510455	R11	See Table	TP2	853590-002
C12	859775-027	Q4	854539	R12	510408-079	TP3	853590-010
C13	859775-017	thru		R13	329151-005		
		Q6					

836643		R11	R14	C11	C8	C16
-002	INTERBAND	10Ω 510408-025	150Ω 510408-053	22UF/15V 859775-017	50 PF 197212-050	NOT USED
-003	WIDE BAND	100Ω 510408-049	330Ω 510408-061	150UF/6V 859775-027	75 PF 854528-075	500 PF 197212-500

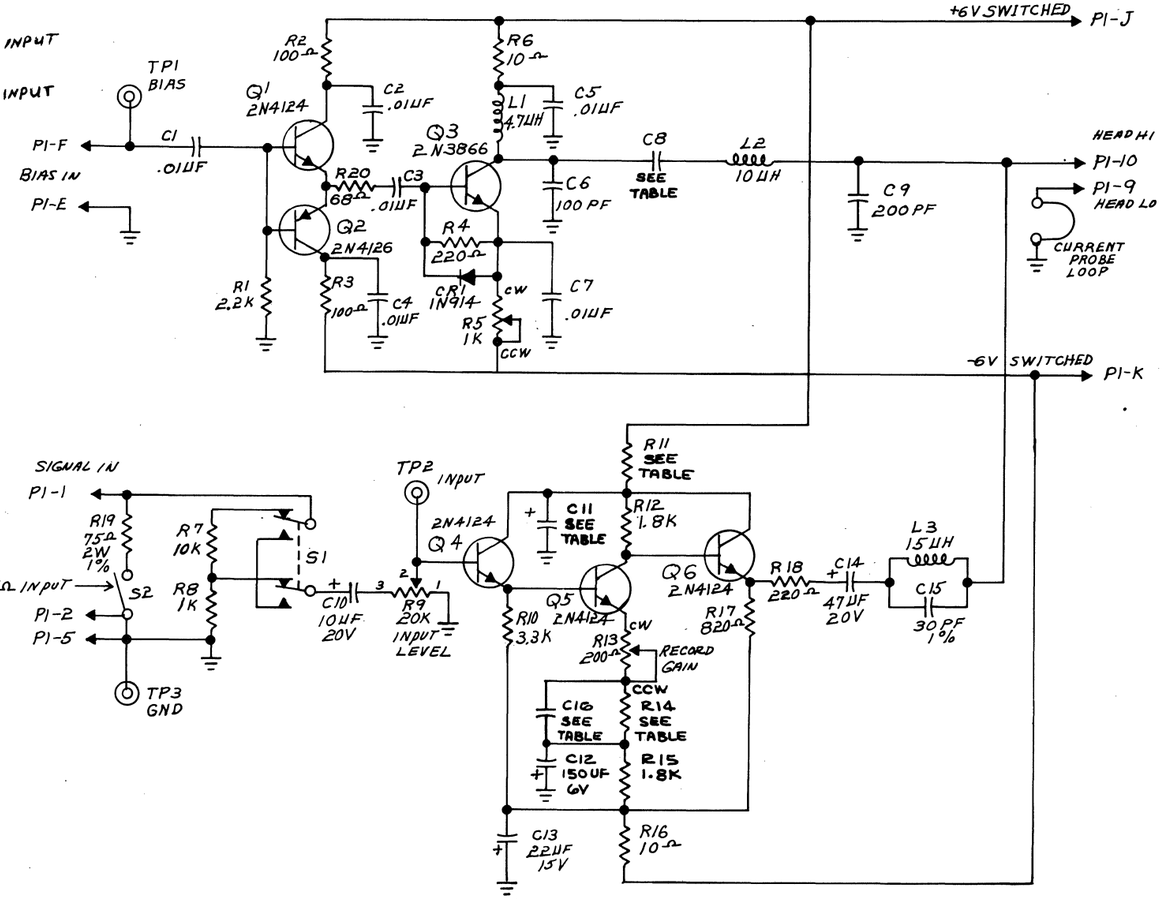


Figure 12-6. Direct Record Board Schematic Diagram (836643)

FM RECORD BOARD 836641

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
	836641						
C1	859775-011	L1	853587-005	R4	853530-147	R21	510408-049
C2	859775-011	P2	836701	R5	853530-214	R22	510408-073
C3	510375-002	Q1	510360	R6	See Chart	R23	510408-033
C4	859775-011	thru		thru		R24	510408-073
C5	510375-002	Q4		R8		R25	510408-033
C6	510114-008	Q5	859971	R9	510164-007	R26	510409-049
C7	See Chart	thru		R10	853530-189	R27	329151-005
C8	See Chart	Q7		R11	853530-189	R28	329151-009
C9	859775-017	Q8	510360	R12	853530-246	S1	510102-002
C10	859775-021	Q9	510364	R13	853530-154	S2	855432-006
C11	859775-021	Q10	510360	R14	853530-154	TP1	853590-002
C12	859775-029	Q11	510364	R15	853530-186	TP2	853590-010
C13	859775-029	Q12	510364	R16	853530-193	TP3	853590-004
C14	898335	Q13	510360	R17	510408-073	U1	510453
C15	510375-002	R1	853530-335	R18	510408-091	U2	510434-054
C16	510375-002	R2	510164-010	R19	510408-089	U3	510434-054
J1	836672	R3	864796-061	R20	510408-089	U4	510434-040
thru							
J6							

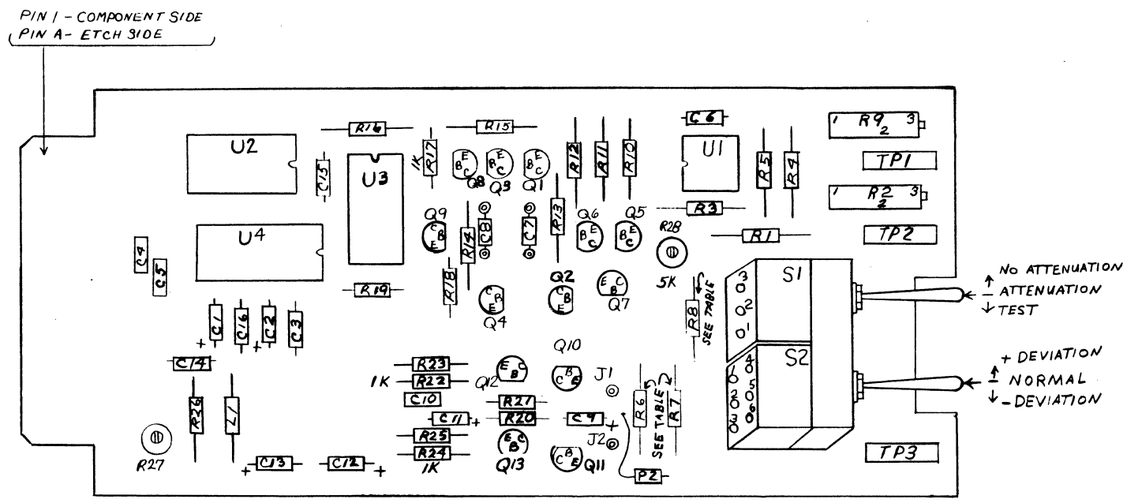
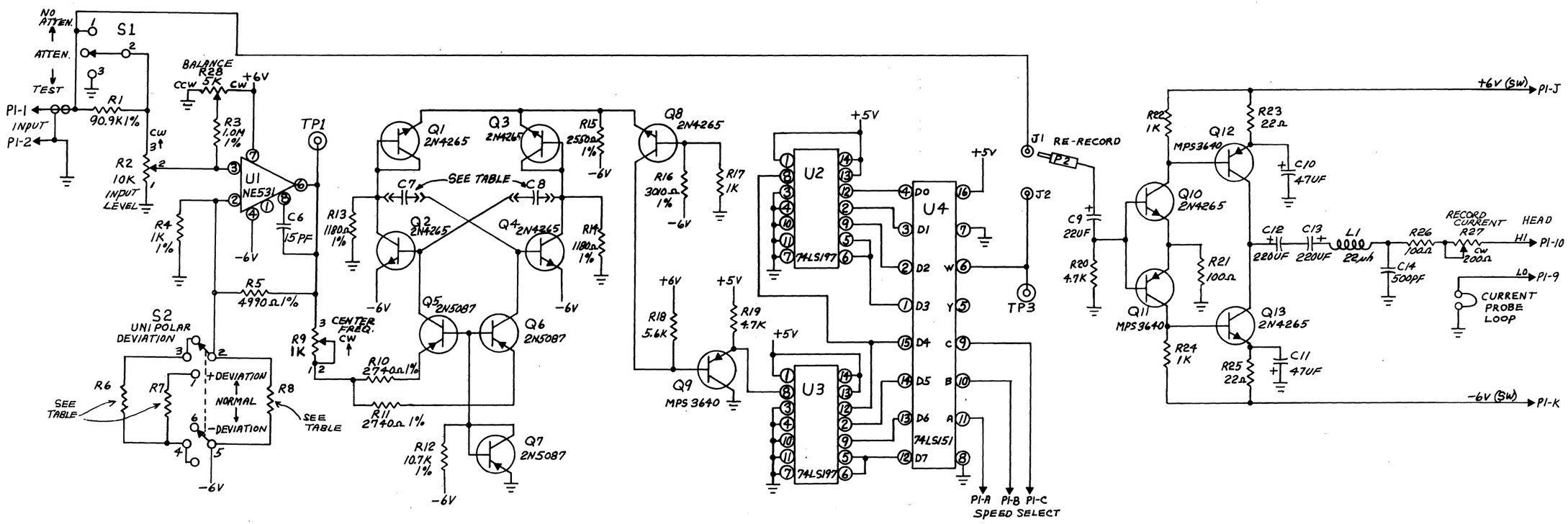


Figure 12-7. FM Record Board Parts Location (836641)



TABLE

836641	DESCRIPTION	C7, C8	R6	R7	R8
-001	BASIC	NOT USED	NOT USED	NOT USED	NOT USED
-002	LO BAND	600 PF 837078-018	42.2K 853530-303	21K 853530-274	30.1K 853530-289
-003	INTERMEDIATE BAND	300 PF 837078-017	42.2K 853530-303	21K 853530-274	30.1K 853530-289
-004	WIDE BAND I	150 PF 837078-016	42.2K 853530-303	21K 853530-274	30.1K 853530-289
-005	WIDE BAND II	70 PF 837078-015	49.9K 853530-310	25.5K 853530-282	22.6K 853530-277

Figure 12-8. FM Record Board Schematic Diagram (836641)

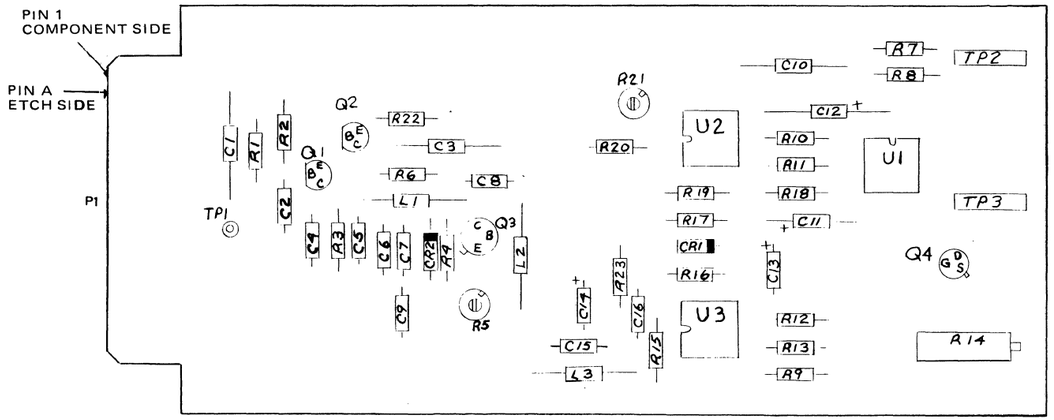


Figure 12-9. Voice Record Board Parts Location (836645)

VOICE RECORD BOARD 836645

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	691686-001	C15	854528-030	R2	510408-049	R18	510408-065
C2	510058-002	C16	510058-002	R3	510408-049	R19	510408-113
C3	691686-001	CR1	844510	R4	510408-057	R20	510408-061
C4	510058-002	CR2	844510	R5	329151-007	R21	329151-010
C5	510058-002	L1	853587-028	R6	510408-025	R22	510408-045
C6	197212-100	L2	853587-029	R7	510408-097	R23	510408-025
C7	510058-002	L3	853587-012	R8	510408-073	TP1	691032
C8	896476	MP1	847825	R9	510408-081	TP2	853590-002
C9	197212-200	MP2	844515	R10	510408-121	TP3	853590-010
C10	691391-033	Q1	854539	R11	510408-073	U1	510240-002
C11	691391-001	Q2	854540	R12	510408-121	thru	
C12	691391-038	Q3	510455	R13	510408-073	U3	
C13	859775-022	Q4	510303-001	R14	510164-012		
C14	859775-022	R1	510408-081	R15	510408-081		
				thru			
				R17			

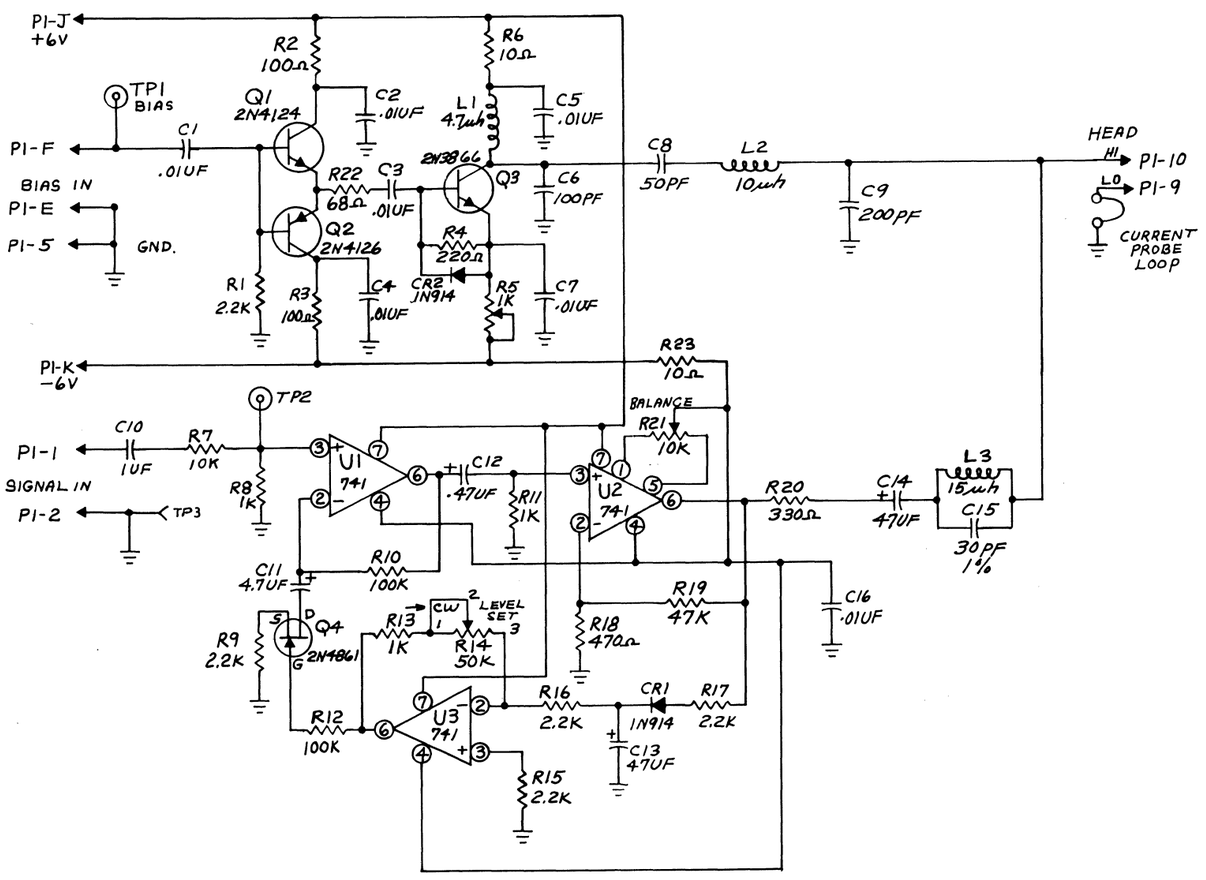


Figure 12-10. Voice Record Board Schematic Diagram (836645)

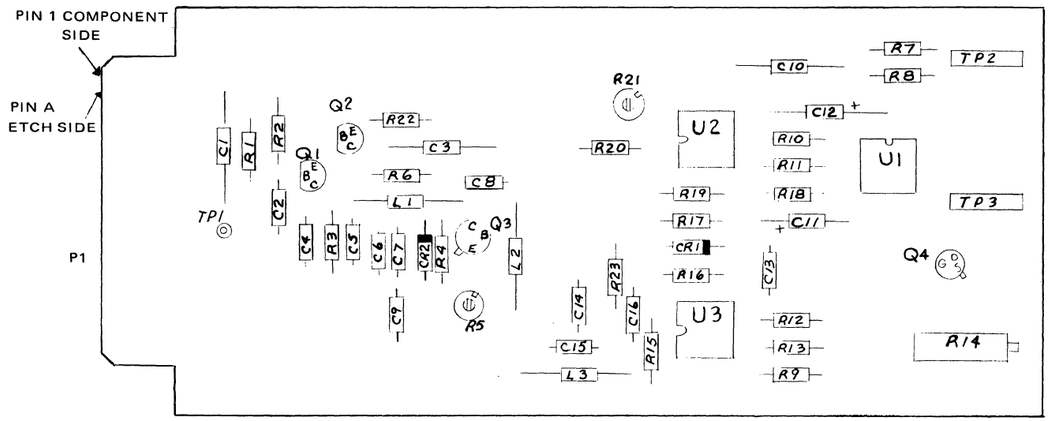


Figure 12-11. Time Code Record Board Parts Location (836646)

TIME CODE RECORD BOARD 836646

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	691686-001	C15	854528-030	R2	510408-049	R16	510408-105
C2	510058-002	C16	510058-002	R3	510408-049	R17	510408-073
C3	691686-001	CR1	844510	R4	510408-057	R18	510408-065
C4	510058-002	CR2	844510	R5	329151-007	R19	510408-113
C5	510058-002	L1	853587-028	R6	510408-025	R20	510408-061
C6	197212-100	L2	853587-029	R7	510408-137	R21	329151-010
C7	510058-002	L3	853587-012	R8	510408-073	R22	510408-045
C8	896476	MP1	847825	R9	510408-081	R23	510408-025
C9	197212-200	MP2	844515	R10	510408-121	TP1	691032
C10	691686-001	Q1	854539	R11	510408-073	TP2	853590-002
C11	691391-001	Q2	854540	R12	510408-121	TP3	853590-010
C12	691391-012	Q3	510455	R13	510408-073	U1	510240-002
C13	859775-029	Q4	510303-001	R14	510349-013	thru	
C14	859775-022	R1	510408-081	R15	510408-097	U3	

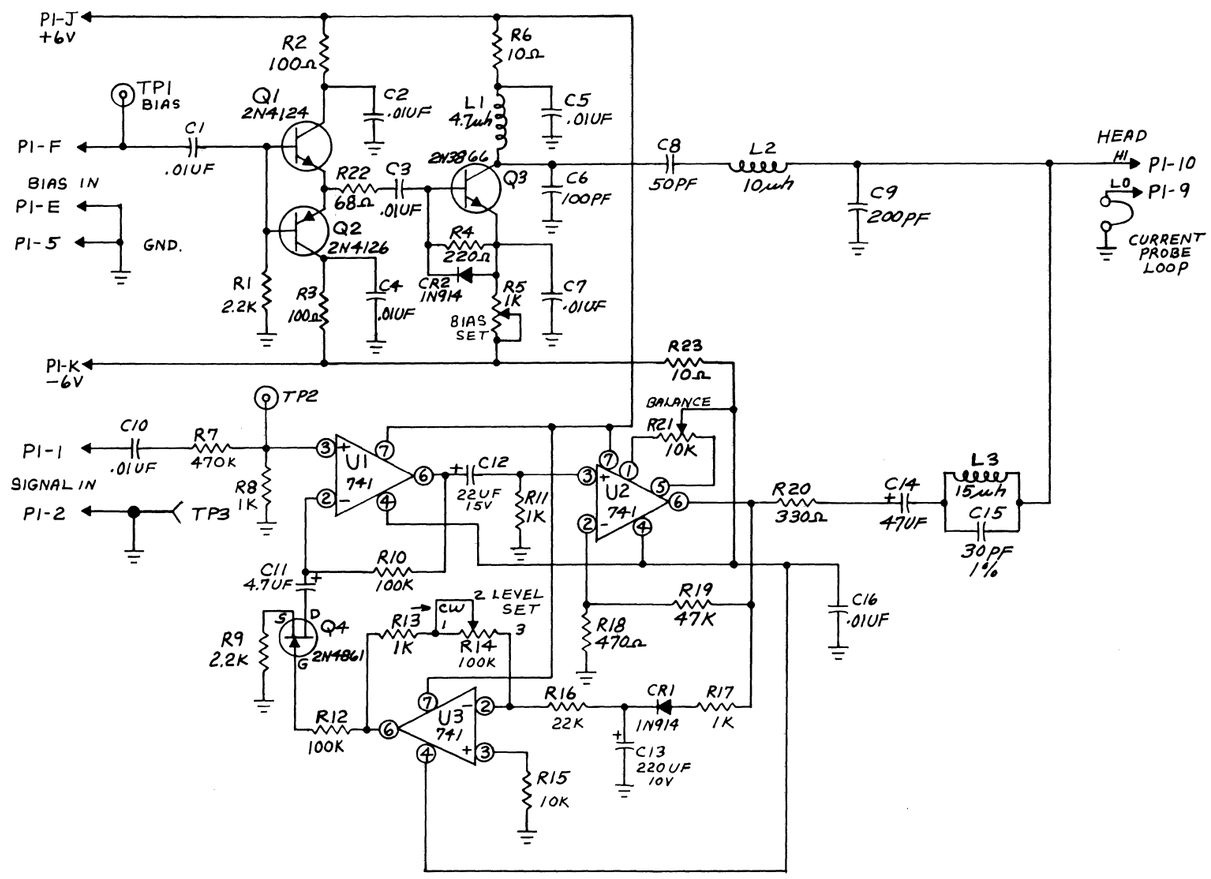


Figure 12-12. Time Code Record Board Schematic Diagram (836646)

SECTION 13
REPRODUCE SERVICING

A. INTRODUCTION

The reproduce circuits recover data from tape and amplify it to a desirable level. Each channel of recovered signal is applied through dual emitter followers, to a reproduce board for processing, and directed to a connector on the I/O Connector Panel. Each channel is identified on the panel. The reproduce boards are located in the slots above the transport and are interchangeable in any slot with the exception that voice, time code, and tape sync preamp boards must be placed into their respective positions.

B. FUNCTIONAL DESCRIPTION

Since all channels are connected in the same fashion, only one channel will be discussed.

1. DUAL EMITTERS

The recovered signal from tape is applied from the head through dual emitter followers located on the back side of the head. Each of the two head stacks contain two boards. Each side of the head winding is connected to the base of an emitter follower. The center tap of the head is grounded. From the emitters of the emitter followers, the signal is cabled to the reproduce boards.

2. DIRECT REPRODUCE

The data signal from the emitter followers is applied to the reproduce board at pins P1-C and P1-D and directed to a preamplifier stage consisting of transistors Q1 and Q2, and amplifier U1. The preamplifier is a low-noise, low-distortion, fixed gain, broadband amplifier with a differential input and single-ended output. BALANCE ADJUST R35 adjusts for imbalances in the amplifier and the head in order to achieve maximum common mode rejection. From the output of the amplifier at U1-5, the signal passes through a low pass filter consisting of coils L1 and L2 and capacitor C7 to provide high frequency noise filtering. This section consists of a dual emitter follower (transistor Q7 and Q8). This amplifier provides buffering between the low-pass filter and the equalizer board.

The reproduced signal next is applied to an equalizer section. From testpoint TP1, the data is applied to one of three equalizer boards. The equalizer boards are plug-in units and are selected for the tape speeds desired for reproduceing. The equalizer selected is controlled by the speed lines from the capstan B board. The line activated energizes either relay K1, K2, or K3. The amplitude and phase response of the equalizer is the inverse of the amplitude and phase response obtained from the reproduce head to produce an equalized signal at the output of the equalizer.

The amplitude response of the equalizer is controlled by R7 and R8. R9 is used to adjust phase. When an all band equalizer is used, the relays (K1, K2, K3) are removed and replaced with a jumper because no speed selection is required.

The output from the equalizers is applied through two fixed-gain broadband amplifiers consisting of transistor Q3, emitter follower Q4, and amplifier U2. OUTPUT LEVEL R26 adjusts the output level. A final driver stage, consisting of transistors Q5 and Q6 provide current-driving capability.

3. FM REPRODUCE

The reproduced signal from the dual emitter followers is applied to the FM board at pins P1-C and P1-D in the same fashion as for direct reproduce. The signal is applied directly to a preamplifier stage consisting of transistors Q1 and Q2, and amplifier U1. The preamplifier is a low-noise, low-distortion, fixed-gain, broadband amplifier with a differential input and single-ended output.

From the preamplifier, the reproduced signal is applied to one of three equalizers, EQ1, EQ2, and EQ3. The particular equalizer employed is selected from the tape speed selector and chosen by the speed lines from capstan B board. Capacitor C11 provides carrier filtering and the equalizers provide amplitude equalization. Only one transistor is switched on at any given tape speed to provide proper attenuation for that speed. The output from the equalizer selected is applied to a fixed-gain amplifier consisting of transistor Q6 and emitter follower Q7.

From emitter follower Q7, the signal is ac coupled to a squaring amplifier and a one-shot consisting of U2 and U3. Squaring amplifier U2 has two outputs, 180 degrees out-of-phase with each other, used to drive the one-shot. By differentiating each output, the one-shot rate doubles. The time length of each pulse is determined by the RC time constant of resistor R30 and capacitors C1, C2, or C3. The specific capacitor chosen is selected by one of the speed lines closing relay K1, K2, or K3.

The signal from the one-shot is applied to a voltage source (Q9 and Q10) to drive the three plug-in filters (FL1, FL2, and FL3). The filters are driven by a signal that is switched by transistors Q9 and Q10 between ground and a referenced voltage established by diode CR2 and transistor Q8. The rate of switching is controlled by the output of one-shot U3. Filter selection is accomplished at the output of the filters by transistors Q11, Q12, or Q13. The transistor selected is controlled by the speed lines. The filter removes the FM carrier from the data signal leaving only the data.

The data signal is applied through an output amplifier, consisting of U4, to the output of the board. OUTPUT LEVEL adjust R42 controls the amplitude of the data signal at TP2.

Transistor Q14, along with diodes CR3 and CR4, squelch the output signal to ground when the carrier signal from the head is lost or the capstan speed is not up to speed. ZERO adjust R40 is used to set the output level of the board to zero when the FM center frequency is applied.

A re-record circuit, consisting of transistor Q15, is used to bypass the demodulation process whenever the re-record feature is used. When plug P2 is placed into jack J1 and plug P3 is placed into jack J4, the signal from the output of the equalizer is applied directly to emitter follower Q15. The output from the emitter is connected to the board output.

4. VOICE OR TIME CODE REPRODUCE

The voice or time code signal is applied to the reproduce board at pins P1-C and P1-D and directed to a preamplifier stage consisting of transistors Q1 and Q2, and amplifier U1. The preamplifier is a low-noise, low-distortion, fixed gain, broadband amplifier with a differential input and single-ended output.

From the output of the amplifier at U1-5, the signal passes through a high pass three pole active filter, consisting of capacitors C7, C8, and C9, resistors R10, R11, and R12, and transistors Q3 and Q4. This filter has a cutoff frequency of 250 Hz.

The output of the filter is applied to a variable-gain amplifier U2. The amplifier gain decreases 6 dB/octave beginning at 300 Hz and extending up to 400 kHz. The gain is adjustable by BAND GAIN adjust R16. The output U2-6 may be used to drive a headset from pin P1-P through VOLUME control R19 and switch S1. When switch S1 is in the speaker position, the signal is applied to a power amplification stage consisting of transistor Q5 and Q6. The output at pin P1-S is applied to the speaker.

5. TAPE SYNC PREAMP BOARD

When the tape sync feature is used as part of the speed control of the capstan, a tape sync preamp board is inserted into a reproduce slot for recovering the record reference. This board is used in lieu of a standard reproduce board and is usually located in one of the even channel slots.

The recovered reference from the head and dual emitter followers is applied to the board at pins P1-C and P1-D in the same fashion as other reproduce boards. The signal is directed to a preamplifier stage consisting of transistors Q1 and Q2, and amplifier U1. The preamplifier is a low-noise, low-distortion, fixed gain, broadband amplifier with a differential input and single-ended output.

From the preamplifier stage at U1-5, the tape signal is applied to an equalizer consisting of U2 and associated components. Gain of the amplifier is changed by the position of plug P2 into

jacks J1 or J2. The two positions are to compensate for the change in signal level from the reproduce head when changing from HIGH density to LO density. With P2 plugged into J2, resistor R15 is shorted out which results in an increase in gain.

C. FAULT ISOLATION AND CALIBRATION

The following procedure is used to locate a fault and/or to calibrate the reproduce electronics of the SABRE VI. If a fault is determined, refer to paragraph B of this section for a functional description of the circuitry.

1. DIRECT REPRODUCE

The following procedure is outlined for one channel of direct reproduce electronics. The procedure should be repeated for each direct reproduce board contained in the unit.

Step 1. With tape threaded properly, connect a function generator (set to sine wave) to the BNC connector input of the I/O Connector Panel for the track being checked. The record board must have been calibrated previously.

Step 2. Place the unit into the FORWARD RECORD mode. Set the generator to the proper level to provide the normal direct record level. (.1 vrms at testpoint TP2 on the record board, measure this value with an ac voltmeter 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 as shown in Table 13-1.

TABLE 13-1. REFERENCE FREQUENCIES

Tape Speed (ips)	Frequency (kHz)		
	Intermediate	Wide Band I	Wide Band 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	3.13
15/16	0.5		

Step 4. Connect an ac voltmeter between testpoints TP2 (HI) and TP3 (LO) on the reproduce board. Adjust OUTPUT LEVEL adjust R26 for 1 vrms. Failure to obtain the correct results at this point may indicate a fault on the reproduce board or prior to reaching the reproduce board. Check for the presence of a reproduced signal at testpoint TP1. If no signal is present, check the input to the board at pins P1-C and P1-D. No signal at this point indicates a fault in the dual emitter followers or the reproduce head. The above assumptions assume the record circuits are functioning normally and are recording signals on tape.

Step 5. Scan the frequencies from 100 Hz (300 Hz for 120 ips, 200 Hz for 60 ips) to the upper band edge at the highest speed dependent on the bandwidth of the equalizers as shown in Table 13-2. While scanning the frequencies, monitor the ac voltmeter at testpoint TP2 and ensure the output is 1 vrms ±3 dB. If the output exceeds the ±3 dB limitations, slight adjustment of HI adjust R8 and/or MID adjust R7 (equalizer adjustments) should bring the output within the proper limitations. HI adjust R8 is normally adjusted if the limitations are exceeded at the higher frequencies and MID adjust R7 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.

TABLE 13-2. HIGH FREQUENCY ADJUST FREQUENCIES

Tape Speed (ips)	Frequency (kHz)		
	Intermediate	Wide Band I	Wide Band 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		

Step 6. Change the generator input to a square wave while monitoring the record board input testpoint TP2 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 7. Monitor the reproduce board output at testpoint TP2 with an oscilloscope at the reference frequency, per Table 13-1, ensure a good representation of a square wave. Slight adjustment of PHASE potentiometer R4 on each equalizer may improve the square wave representation. If this slight adjustment is performed, re-check the frequency response in Steps 1 through 5.

NOTE

If complete equalizer calibration is desired, refer to the calibration portion of this manual (Section 6, paragraph F1).

2. FM REPRODUCE

Step 1. On the capstan B board, place SQUELCH INHIBIT switch S1 to the OFF position.

Step 2. Connect a test lead between testpoint TP3 on the FM record board to testpoint TP1 on the FM reproduce board. The record board must be previously calibrated.

Step 3. Select the desired tape speed at the TAPE SPEED SELECTOR knob.

Step 4. On the record board, place ATTENUATOR switch S1 to the TEST position.

Step 5. On the reproduce board, connect a dc voltmeter between testpoints TP2 (HI) and TP3 (LO).

Step 6. Adjust ZERO ADJUST control R40 for zero volts.

Step 7. Return ATTENUATOR switch S1 on the record board to the proper position.

Step 8. Connect a signal generator to the input of the record board. Set the frequency to any frequency desired within the band limits and adjust the input level to the desired level.

Step 9. Adjust OUTPUT LEVEL adjust R42 to the desired level.

Step 10. Remove the test equipment and return the SQUELCH INHIBIT switch to its normal setting.

3. VOICE REPRODUCE

Step 1. Place the voice reproduce board on the extender board.

Step 2. Connect a sine wave generator to the input of the voice record board. Adjust the generator for 1 kHz at 100 mvrms.

Step 3. Depress the FWD and REC pushbuttons.

Step 4. Connect an oscilloscope between testpoints TP2 (HI) and TP4 (LO).

Step 5. Adjust BAND GAIN control R16 for just below clipping.

Step 6. VOLUME control R19 may be adjusted to any desirable level.

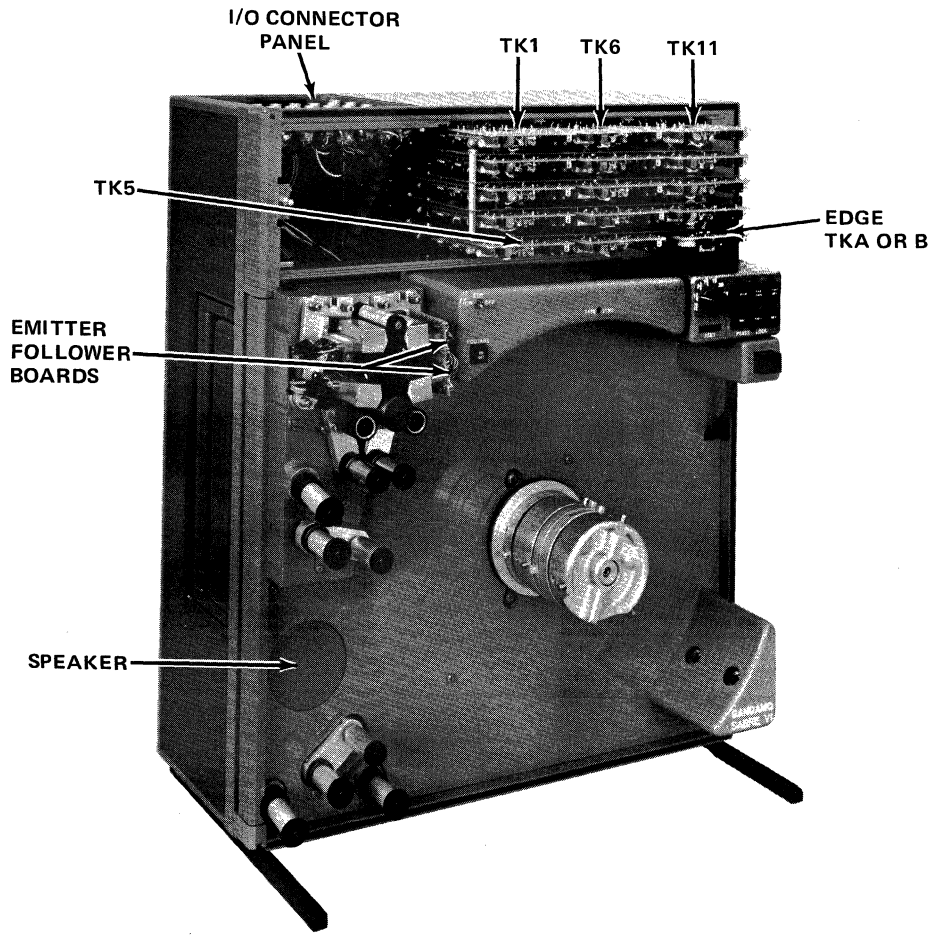


Figure 13-1. Reproduce Boards Location

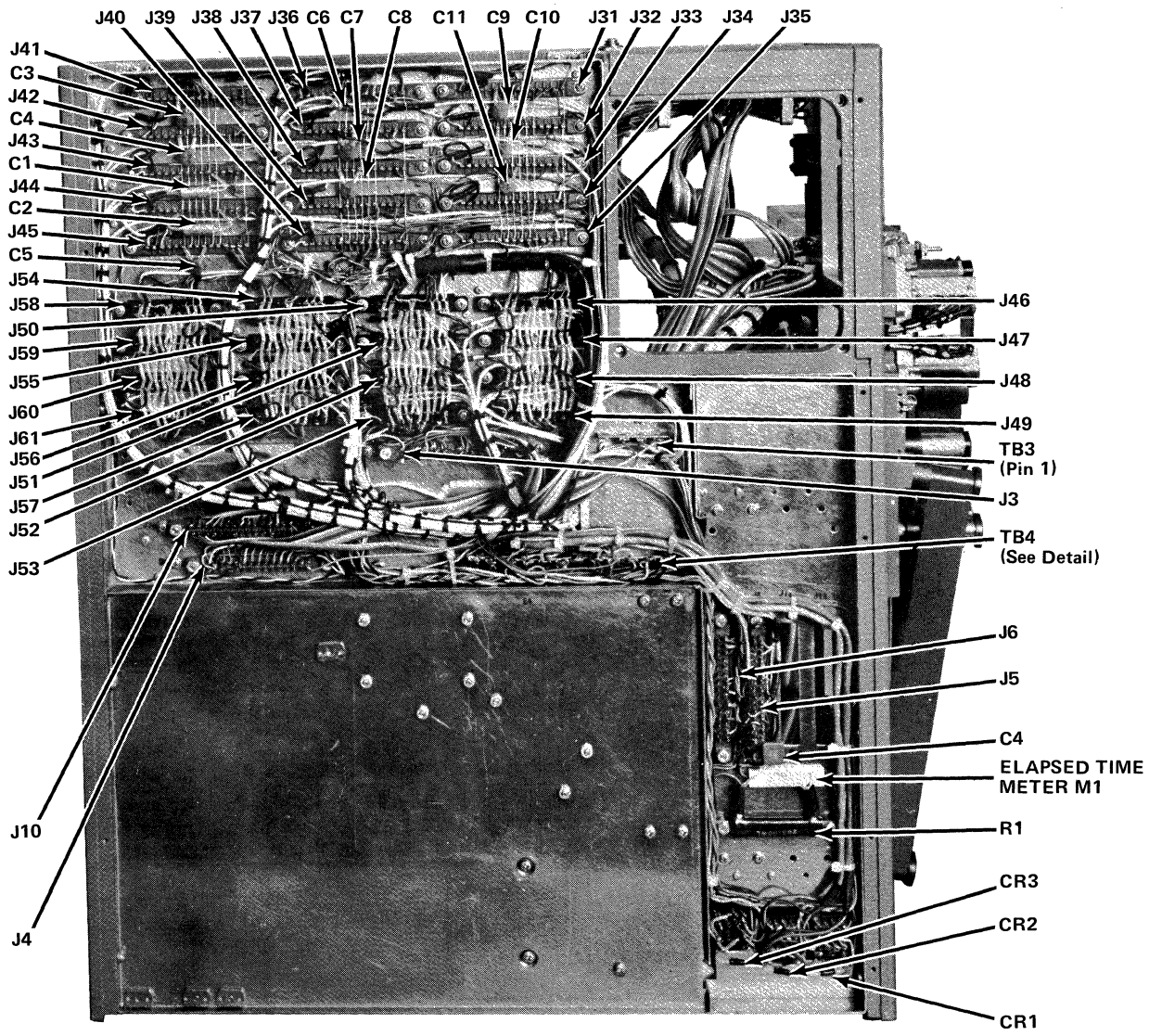


Figure 13-2. Rear Parts Location

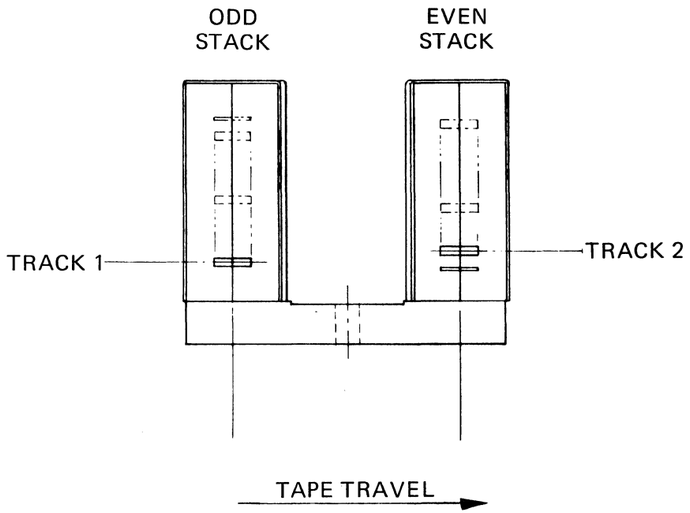


Figure 13-3. Head Track Assignment

REPRODUCE CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL

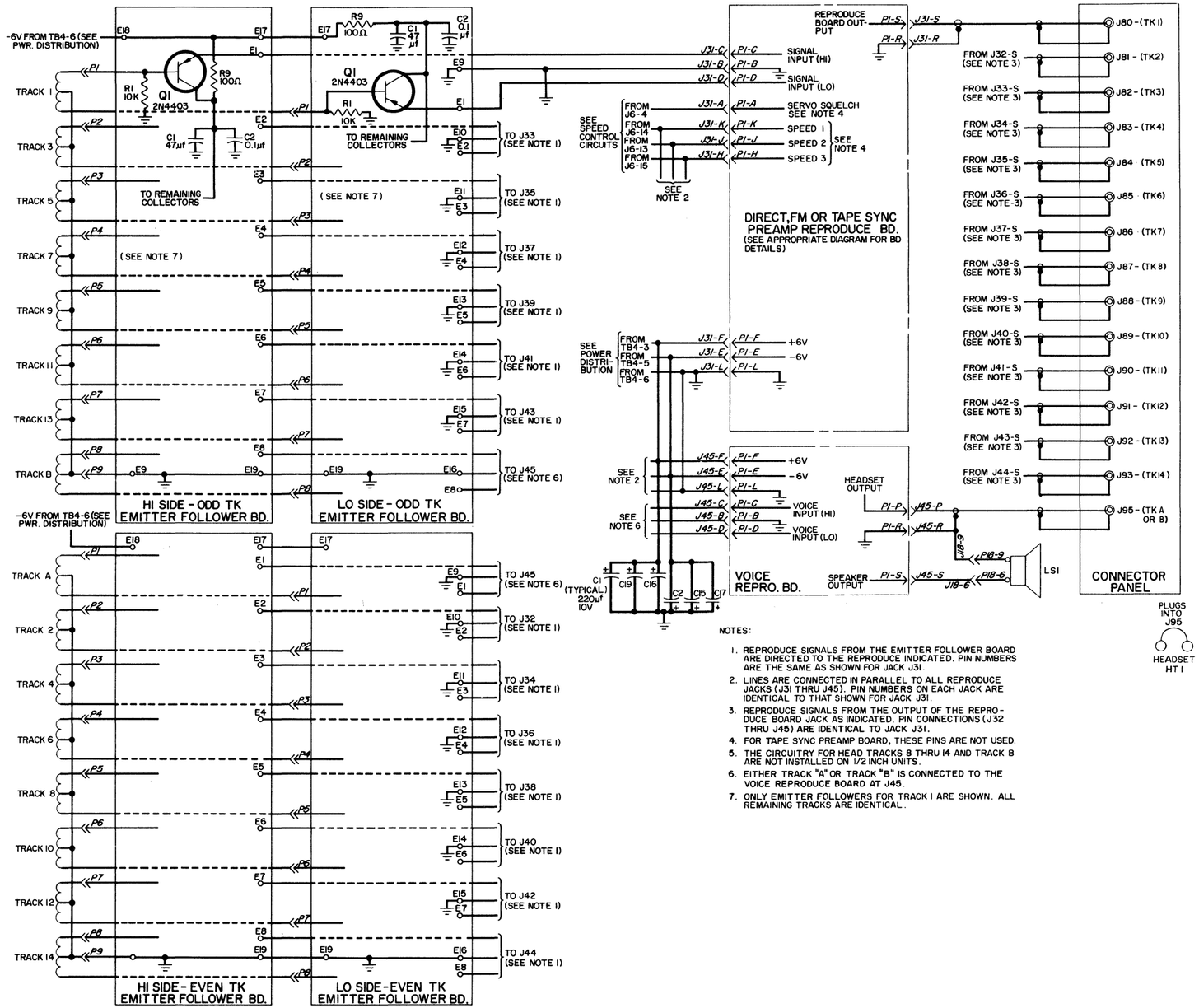
REF. DESIG.	SANGAMO PART NO.
LS1	510500
P18	859254-002
HT1	854950

ELECTRONIC CHASSIS

REF. DESIG.	SANGAMO PART NO.
J18	859255-002
J31	835887-008
thru	
J45	
C1, C2	691391-050
C15, C16	
C17, C19	

CONNECTOR PANEL

REF. DESIG.	SANGAMO PART NO.
J80	855977
thru	
J93	
J95	846615



NOTES:

1. REPRODUCE SIGNALS FROM THE EMITTER FOLLOWER BOARD ARE DIRECTED TO THE REPRODUCE INDICATED. PIN NUMBERS ARE THE SAME AS SHOWN FOR JACK J31.
2. LINES ARE CONNECTED IN PARALLEL TO ALL REPRODUCE JACKS (J31 THRU J45). PIN NUMBERS ON EACH JACK ARE IDENTICAL TO THAT SHOWN FOR JACK J31.
3. REPRODUCE SIGNALS FROM THE OUTPUT OF THE REPRODUCE BOARD JACK AS INDICATED. PIN CONNECTIONS (J32 THRU J45) ARE IDENTICAL TO JACK J31.
4. FOR TAPE SYNC PREAMP BOARD, THESE PINS ARE NOT USED.
5. THE CIRCUITRY FOR HEAD TRACKS 8 THRU 14 AND TRACK B ARE NOT INSTALLED ON 1/2 INCH UNITS.
6. EITHER TRACK "A" OR TRACK "B" IS CONNECTED TO THE VOICE REPRODUCE BOARD AT J45.
7. ONLY EMITTER FOLLOWERS FOR TRACK 1 ARE SHOWN. ALL REMAINING TRACKS ARE IDENTICAL.

Figure 13-4. Reproduce Circuits Overall Functional (804892)

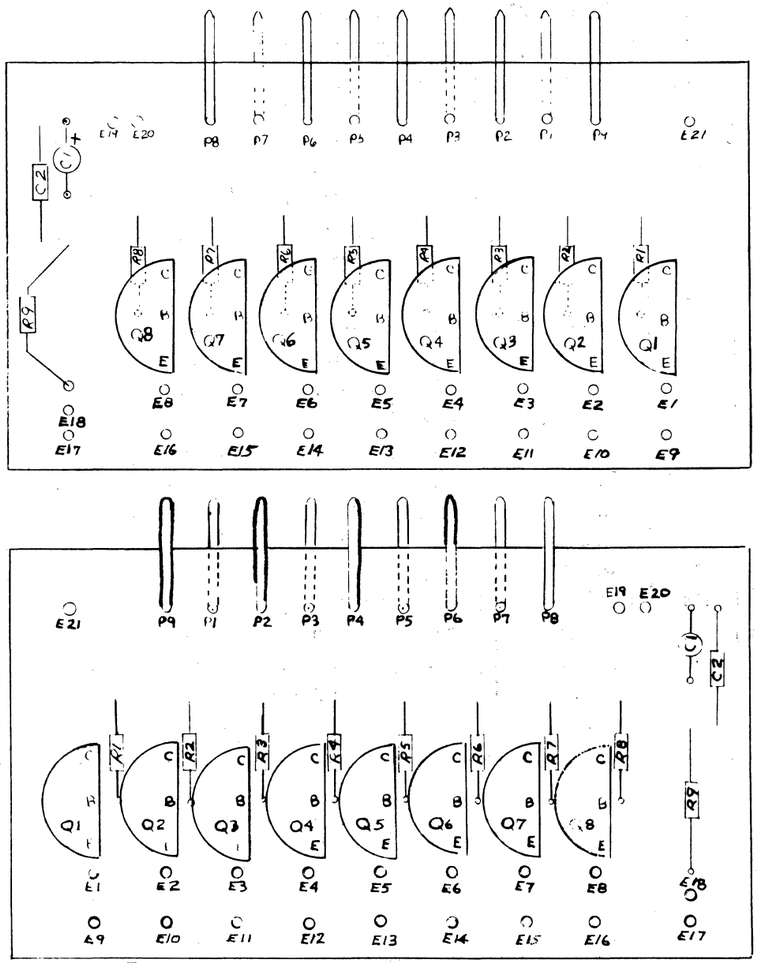


Figure 13-5. Emitter Follower Board Parts Location

NOTE: 837574-001 (HI SIDE) - Use all components.
837574-002 (HI SIDE) - Q5 thru Q8 and R5 thru R8 are not used.

837574-	Q1,Q2,Q3,Q4	Q5,Q6,Q7,Q8	R5,R6,R7,R8	DESCRIPTION
001	2N4403 510460	2N4403 510460	10K, 1/8W, 5% 510120-097	INTERMEDIATE BAND 8 CHANNEL
002	2N4403 510460	NOT USED	NOT USED	INTERMEDIATE BAND 4 CHANNEL
003	2N5087 859971	2N5087 859971	10K, 1/8W, 5% 510120-097	WIDE BAND 8 CHANNEL
004	2N5087 859971	NOT USED	NOT USED	WIDE BAND 4 CHANNEL

NOTE: 837575-001 (LO SIDE) - Use all components.
837575-002 (LO SIDE) - Q5 thru Q8 and R5 thru R8 are not used.

Emitter Follower Boards *837574-xxx and **837575-xxx

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
	*837574-xxx	P1	837569	R1	510120-097	R5	See Table
	*837575-xxx	thru		thru		thru	
C1	859775-021	P9		R4		R8	
C2	859959-002	Q1	See Table			R9	510408-049
		thru					
		Q8					

*837574 used on HI side w/ -001 for 14 track and -002 for 7 track.
**837575 used on LO side w/ -001 for 14 track and -002 for 7 track.
837575-003 and 837575-004 are used for WIDEBAND II recorders.

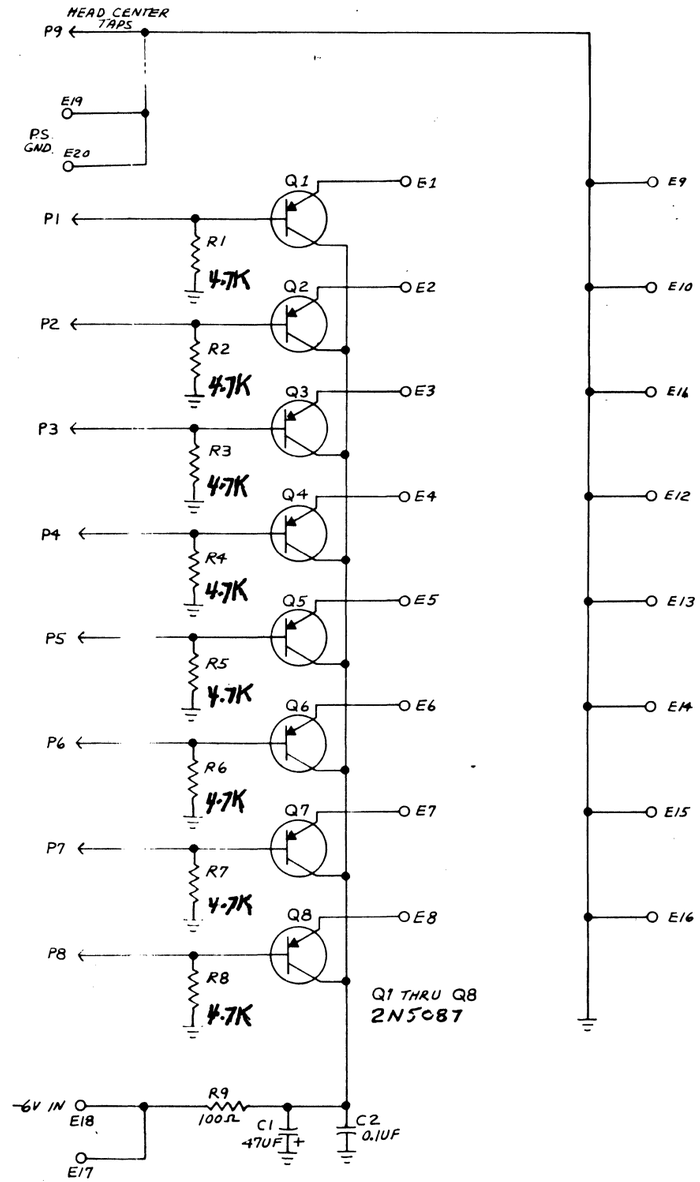


Figure 13-6. Emitter Follower Board Schematic Diagram (837574, 837575)

DIRECT REPRODUCE BOARD 836819

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-011	CR1	844510	R1	510408-073	R22	510408-087
thru		thru		R2	510408-073	R23	510408-067
C4		CR5		R3	510408-033	R24	510408-079
C5	See Chart	J1	836672	R4	510408-033	R25	510408-085
thru		thru		R5	510408-085	R26	510164-008
C7		J9		R6	510408-089	R27	510408-049
C8	859775-014	K1	510388-001	R7	510408-089	R28	510408-085
C9	859775-025	thru		R8	See Chart	R29	510408-025
C10	859775-025	K3		R9	510408-065	R30	510408-049
C11	859775-021	L1	See Chart	R10	See Chart	R31	510408-041
C12	859775-009	L2	See Chart	thru		R32	510408-025
C13	859775-011	MP1	852748	R14		R33	510408-049
C14	859775-011	Q1	510460	R15	510408-033	R34	510408-075
C15	See Chart	Q2	510460	R16	510408-033	R35	329151-004
C16	See Chart	Q3	854540	R17	Not used	TP1	853590-002
C17	Not Used	Q4	854539	R18	510408-089	TP2	853590-004
C18	859775-025	Q5	854539	R19	510408-071	TP3	853590-010
C19	859775-021	Q6	854540	R20	510408-081	U1	510457
C20	859775-025	Q7	854539	R21	510408-067	U2	510457
C21	859775-024	Q8	854540				

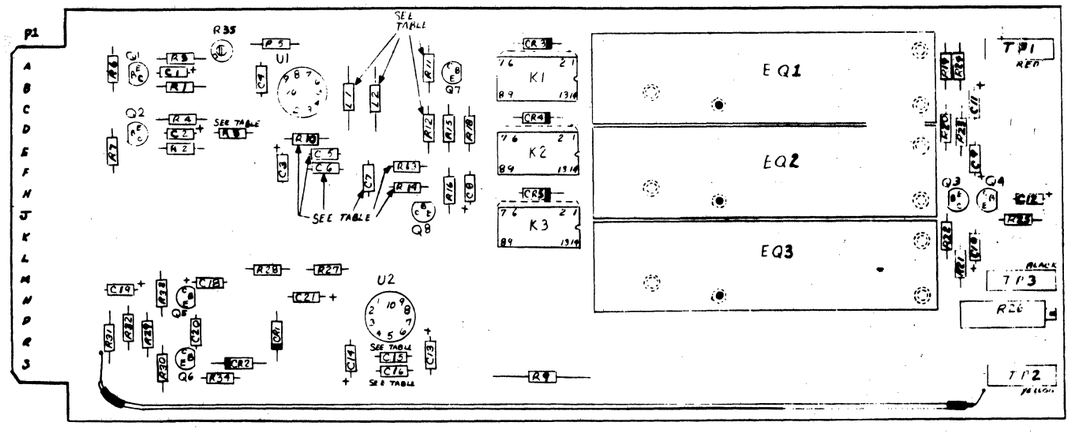
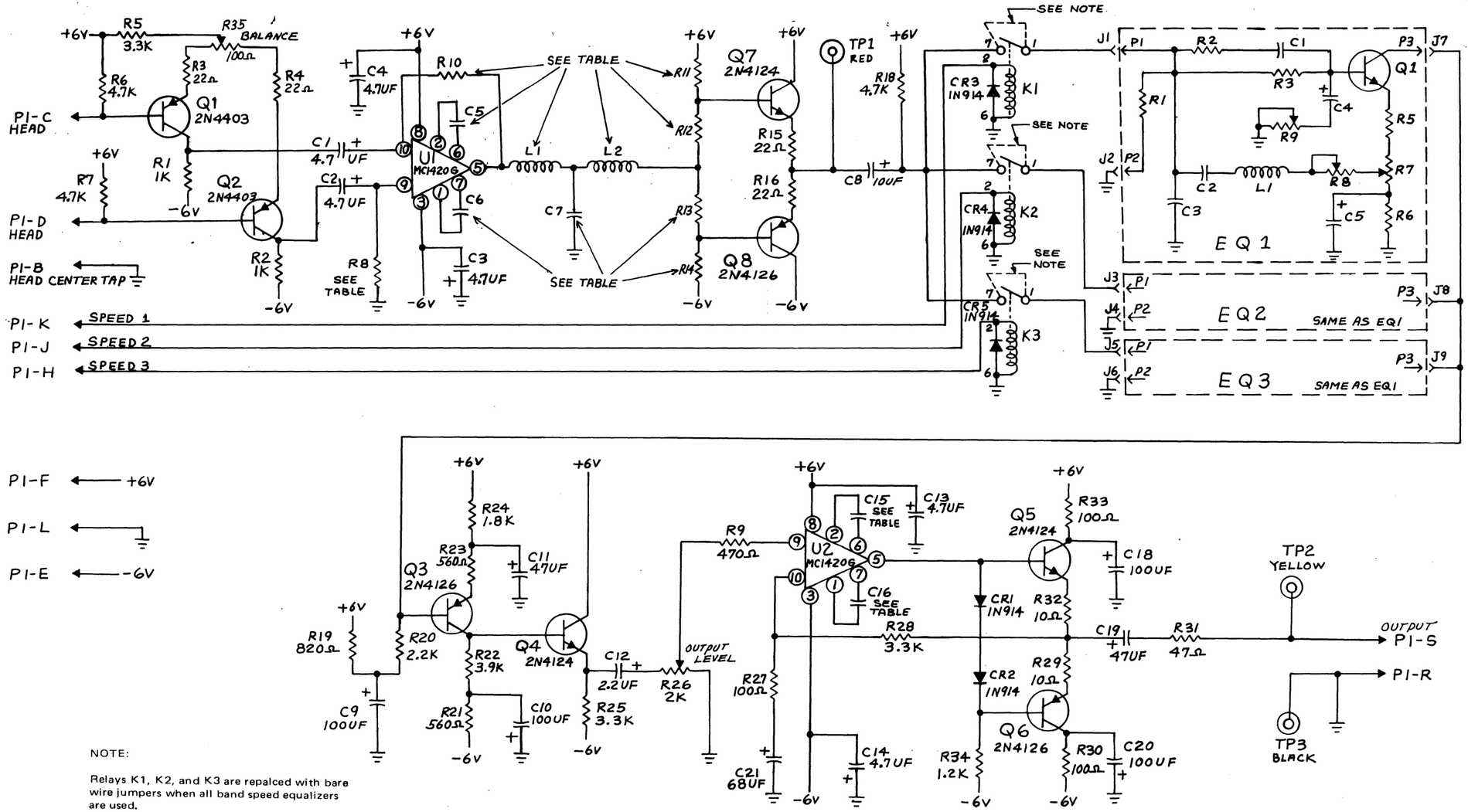


Figure 13-7. Direct Reproduce Board Parts Location (836819)



NOTE:

Relays K1, K2, and K3 are repalced with bare wire jumpers when all band speed equalizers are used.

BOARD NO.	R8, R10	C5, C6, C15, C16	L1	L2	C7	R11, R14	R12, R13	K1, K2, K3
INTERMEDIATE BAND 836819-002	22K, 1/4W, 5% 510408-105	10 PF 197212-010	2700 uh 853587-026	1000 uh 853587-020	20 PF 197212-020	17.8K, 1/4W, 1% 853530-267	2.21K, 1/4W, 1% 853530-180	510388-001
WIDE BAND 836819-003	39K, 1/4W, 5% 510408-111	2PF 197212-002	150 uh 853587-017	68 uh 853587-037	39 PF 197212-039	3.65K, 1/4W, 1% 853530-201	464Ω, 1/4W, 1% 853530-115	510388-001
INTERMEDIATE BAND; ALL SPEED 836819-004	22K, 1/4W, 5% 510408-105	10PF 197212-010	2700 uh 853587-026	1000 uh 853587-020	20 PF 197212-020	17.8K, 1/4W, 1% 853530-267	2.21K, 1/4W, 1% 853530-180	SEE NOTE
WIDE BAND ALL SPEED 836819-005	39K, 1/4W, 5% 510408-111	2PF 197212-002	150 uh 853587-017	68 uh 853587-037	39 PF 197212-039	3.65K, 1/4W, 1% 853530-201	464Ω, 1/4W, 1% 853530-115	SEE NOTE

Figure 13-8. Direct Reproduce Board Schematic Diagram (836819)

DIRECT EQUALIZER BOARD 837031

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1 thru C5	See Chart	P1 thru P3	836693	R1 R2 thru R5	510408-085 See Chart	R6 R7 R8	510408-079 See Chart See Chart
L1	See Chart	Q1	854539				

837031-	DESCRIPTION	R2	R3	R4	R5	R7	R8	C1	C2	C3	C4	C5	L1
001	120 IPS INTER BAND	27K 510408-107	10K 510408-097	20Ω 329151-002	82Ω 510408-047	20Ω 510113-011	5K 329151-009	400PF 197212-400	62PF 197212-062	OMIT	1UF 510429-025	47UF 859775-021	1000 UH 853587-020
002	60 IPS INTER BAND	27K 510408-107	↑	↑	↑	↑	5K 329151-009	600 PF 198249-600	240 PF 197212-240	↑	↑	↑	↑
003	30IPS INTER BAND	OMIT			82Ω 510408-047	20Ω 510113-011	2K 329151-008	OMIT	.001UF 691686-008				
004	15 IPS INTER BAND	↑			47Ω 510408-041	50Ω 510113-001	1K 329151-007	↑	.0039UF 691686-035				
005	7 1/2 IPS INTER BAND		10K 510408-097		47Ω 510408-041	50Ω 510113-001	500Ω 329151-006		.015 UF 691686-012				1000 UH 853587-020
006	3 3/4 IPS INTER BAND		82K 510408-095		JUMPER	100Ω 844994	↑		.015 UF 691686-012				3900 UH 853587-034
007	1 7/8 IPS INTER BAND		↑		↑	↑	500Ω 329151-006		.033 UF 691686-034				8200 UH 853587-040
008	15/16 IPS INTER BAND	OMIT	8.2K 510408-095				200Ω 329151-005	OMIT	.068UF 691686-055		1UF 510429-025	4.7UF 859775-021	12000 UH 853587-027
009	120 IPS WIDE I	27K 510408-107	12K 510408-099				5K 329151-009	820PF 198249-820	4.7 PF 197212-047		.22 UF 510117-028	6.8 UF 859775-012	220 UH 853587-003
010	60 IPS WIDE I	27K 510408-107	12K 510408-099	↓			↑	820 PF 198249-820	8.2 PF 197212-082		↑	6.8UF 859775-012	470 UH 853587-001
011	30 IPS WIDE I	OMIT	10K 510408-097	20Ω 329151-002			5K 329151-009	OMIT	150 PF 197212-150			4.7UF 859775-011	1000 UH 853587-020
012	15 IPS WIDE I	↑	↑	50Ω 329151-003			2K 329151-008	↑	680 PF 198249-680	OMIT	.22UF 510117-028	↑	↑
013	7 1/2 IPS WIDE I		10K 510408-097	50Ω 329151-003			1K 329151-007		.0027UF 691686-025	.01 UF 5100058-002	.22UF 859775-003		
014	3 3/4 IPS WIDE I		8.2K 510408-095	100Ω 329151-004			500Ω 329151-006		.01 UF 691686-001	.022UF 510116-041	↑		
015	1 7/8 IPS WIDE I		↑	↑			200Ω 329151-005		.033UF 691686-034	↑			
016	15/16 IPS WIDE I	OMIT	8.2K 510408-095	100Ω 329151-004			100Ω 329151-004	OMIT	.12 UF 691686-028	.022UF 510116-041	.22 UF 859775-003	4.7UF 859775-011	1000 UH 853587-020
017	120 IPS WIDE II	27K 510408-107	12K 510408-099	20Ω 329151-002			5K 329151-009	820 PF 198249-820	27 PF 197212-027	OMIT	.22UF 510117-028	6.8UF 859775-012	220 UH 853587-003
018	60 IPS WIDE II	27K 510408-107	12K 510408-099	↓			↑	820 PF 198249-820	50PF 197212-050	↑	↑	6.8UF 859775-012	470 UH 853587-001
019	30 IPS WIDE II	OMIT	10K 510408-097	20Ω 329151-002			5K 329151-009	OMIT	7.5PF 854528-075			4.7 UF 859775-011	1000 UH 853587-020
020	15 IPS WIDE II	↑	↑	50Ω 329151-003			2K 329151-008	↑	330 PF 197212-330	OMIT	.22 UF 510117-028	↑	↑
021	7 1/2 IPS WIDE II		10K 510408-097	50Ω 329151-003			1K 329151-007		.0012 UF 691686-026	.01 UF 5100058-002	.22 UF 859775-003		
022	3 3/4 IPS WIDE II		8.2K 510408-095	100Ω 329151-004			500Ω 329151-006		.0056 UF 691686-024	.022 UF 510116-041	↑		
023	1 7/8 IPS WIDE II		↑	100Ω 329151-004			200Ω 329151-005		.022 UF 691686-021	↑			
024	15/16 IPS WIDE I		8.2K 510408-095	100Ω 329151-004			100Ω 329151-004		.082 UF 691686-027	.022 UF 510116-041			1000 UH 853587-020
025	ALL SPEED WIDE BAND	↑	10K 510408-097	20Ω 329151-002	↓	↓	OMIT	↑	O MIT	O MIT	.22 UF 859775-003	↑	OMIT
026	ALL SPEED INTER BAND	OMIT	10K 510408-097	20Ω 329151-002	JUMPER	100Ω 844994	OMIT	OMIT	OMIT	OMIT	1UF 859775-007	4.7UF 859775-011	OMIT

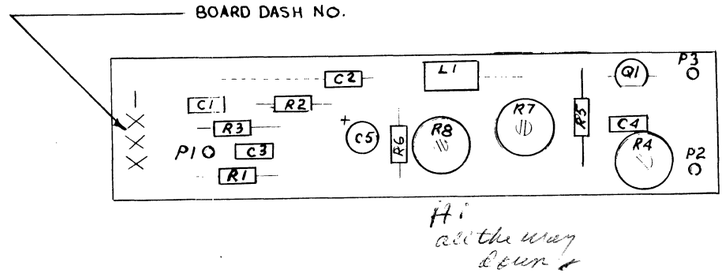
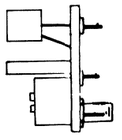


Figure 13-9. Direct Equalizer Board Parts Location (837031)



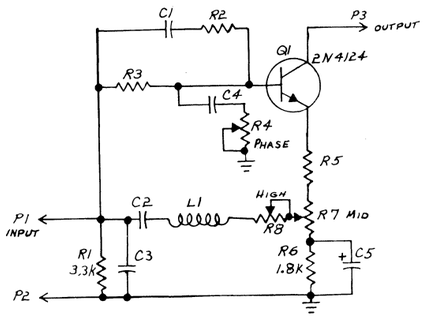


Figure 13-10. Direct Equalizer Board Schematic Diagram (837031)

FM REPRODUCE BOARD 836820

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	See Chart	CR1	844510	R4	510408-073	R35	510408-089
thru		CR2	852475-014	R5	510408-073	thru	
C3		CR3	844510	R6	510408-045	R38	
C4	859775-011	thru		R7	510408-045	R39	510408-025
C5	859775-011	CR7		R8	510408-085	R40	510164-008
C6	510058-002	EQ1	See Chart	R9	510408-089	R41	853530-228
C7	859775-011	thru		R10	510408-089	R42	510164-008
C8	197212-010	EQ3		R11	See Chart	R43	853530-080
C9	197212-010	FL1	See Chart	R12	510408-093	R44	853530-147
C10	859775-014	thru		R13	510408-090	R45	853530-234
C11	See Chart	FL3		R14	510408-089	R46	853530-176
C12	859775-011	K1	510388-001	thru		R47	510408-041
C13	859775-017	thru		R16		R48	510408-089
C14	859775-011	K3		R17	510408-049	R49	510408-081
C15	859775-011	MP1	852748	R18	510408-083	R50	510408-037
C16	510058-002	P2	836701	R19	510408-081	R51	510408-067
C17	859775-011	P3	836701	R20	510408-049	R52	See Chart
C18	197212-012	Q1	510460	R21	510408-073	R53	510408-041
C19	197212-039	Q2	510460	R22	510408-073	TP1	853590-002
C20	197212-039	Q3	854539	R23	510408-121	TP2	853590-004
C21	197212-027	thru		R24	510408-121	TP3	853590-010
C22	197212-027	Q5		R25	510408-097	TP4	853590-010
C23	859775-011	Q6	859970	thru		TP5	691032
C24	197212-015	thru		R28		thru	
C25	859775-014	Q8		R29	510408-083	TP8	
C26	510058-002	Q9	510364	R30	See Chart	U1	510457
C27	859775-014	Q10	510360	R31	853530-147	U2	510458
C28	859775-011	Q11	854539	R32	510408-073	U3	859520-042
C29	510058-002	thru		R33	510408-081	U4	510453
C30	859775-011	Q14		R34	510408-085		
thru		Q15	510360				
C32							

WIDE BAND II 836820-005

POSITION		FL1 or FL2 or FL3	C1 or C2 or C3	EQ1 or EQ2 or EQ3		C11	R30	R11, R52
SPEED I.P.S.	CENTER FREQ. kHz	FILTER BAND WIDTH kHz	TIMING CAP.	L	R	FILTER CAP.	TIMING RESISTOR	GAIN RESISTOR
120	900	500 836698-001	33 PF 837078-001	15uh 837542-009	120Ω	650 PF 837078-022	9.53K Ω 836753-023	22K 510408-105
60	450	250 836698-002	75 PF 837078-002	47uh 837542-010	220Ω			
30	225	125 836698-003	150 PF 837078-003	NOT USED 836753-013	470Ω			
15	112	62.5 836698-004	300 PF 837078-004	NOT USED 836753-016	1000Ω			
7½	56	31.25 836698-005	650 PF 837078-005	NOT USED 836753-025	2700Ω			
3¾	28	15.62 836698-006	1300 PF 837078-006	NOT USED 836753-026	6800Ω			
1⅞	14	7.81 836698-007	2600 PF 837078-007	NOT USED	NOT USED	650 PF 837078-022	9.53K Ω 836753-023	22K 510408-105

WIDE BAND I 836820-004

POSITION		FL1 or FL2 or FL3	C1 or C2 or C3	EQ1 or EQ2 or EQ3		C11	R30	R11, R52
SPEED I.P.S.	CENTER FREQ. kHz	FILTER BAND WIDTH kHz	TIMING CAP.	L	R	FILTER CAP.	TIMING RESISTOR	GAIN RESISTOR
120	432	80 836698-001	93 PF 837078-001	15uh 837542-001	22Ω	2700 PF 837078-011	20K Ω 836753-024	22K 510408-105
60	216	40 836698-010	75 PF 837078-002	68uh 837542-002	68Ω			
30	108	20 836698-011	150 PF 837078-003	270uh 837542-003	120Ω			
15	54	10 836698-012	300 PF 837078-004	1200uh 837542-004	220Ω			
7½	27	5 836698-013	650 PF 837078-005	3900uh 837542-005	390Ω			
3¾	13.5	2.5 836698-014	1300 PF 837078-006	22000uh 837542-006	1000Ω			
1⅞	6.75	1.25 836698-015	2600 PF 837078-007	100,000uh 837542-007	1800Ω			
15/16	3.375	.625 836698-016	5200 PF 837078-008	100,000uh 837542-008	2700Ω	2700 PF 837078-011	20K Ω 836753-024	22K 510408-105

INTERMEDIATE BAND 836820-003

POSITION		FL1 or FL2 or FL3	C1 or C2 or C3	EQ1 or EQ2 or EQ3		C11	R30	R11, R52
SPEED I.P.S.	CENTER FREQ. kHz	FILTER BAND WIDTH kHz	TIMING CAP.	L	R	FILTER CAP.	TIMING RESISTOR	GAIN RESISTOR
120	216	40 836698-010	75 PF 837078-002	NOT USED 836753-027	150Ω	.0015 UF 837078-019	20K Ω 836753-024	10K 510408-097
60	108	20 836698-011	150 PF 837078-003	NOT USED 836753-010	270Ω			
30	54	10 836698-012	300 PF 837078-004	NOT USED 836753-013	470Ω			
15	27	5 836698-013	650 PF 837078-005	NOT USED 836753-015	820Ω			
7½	13.5	2.5 836698-014	1300 PF 837078-006	NOT USED 836753-028	1500Ω			
3¾	6.75	1.25 836698-015	2600 PF 837078-007	NOT USED 836753-020	3300Ω			
1⅞	3.375	.625 836698-016	5200 PF 837078-008	NOT USED 836758-021	5600Ω			
15/16	1.688	.312 836698-017	10,400 PF 837078-009	NOT USED	NOT USED	.0015 UF 837078-019	20K Ω 836753-024	10K 510408-097

LOW BAND 836820-002

POSITION		FL1 or FL2 or FL3	C1 or C2 or C3	EQ1 or EQ2 or EQ3		C11	R30	R11, R52
SPEED I.P.S.	CENTER FREQ. kHz	FILTER BAND WIDTH kHz	TIMING CAP.	L	R	FILTER CAP.	TIMING RESISTOR	GAIN RESISTOR
120	108	20 836698-011	150 PF 837078-003	NOT USED 836753-027	150Ω	.0033 UF 837078-020	20K Ω 836753-024	10K 510408-097
60	54	10 836698-012	300 PF 837078-004	NOT USED 836753-010	270Ω			
30	27	5 836698-013	650 PF 837078-005	NOT USED 836753-013	470Ω			
15	13.5	2.5 836698-014	1300 PF 837078-006	NOT USED 836753-015	820Ω			
7½	6.75	1.25 836698-015	2600 PF 837078-007	NOT USED 836753-028	1500Ω			
3¾	3.375	.625 836698-016	5200 PF 837078-008	NOT USED 836753-020	3300Ω			
1⅞	1.688	.312 836698-017	10,400 PF 837078-009	NOT USED 836753-021	5600Ω			
15/16	.844	.156 836698-018	20,800 PF 837078-010	NOT USED	NOT USED	.0033 UF 837078-020	20K Ω 836753-024	10K 510408-097

NOTE 1.
THE VALUES SHOWN IN THE TABLES ARE FIXED BY THE SPEED AND BAND AS SHOWN. THE POSITIONS OF THE FILTERS, (FL1, FL2, FL3), TIMING CAPACITORS (C1, C2, C3), AND EQUALIZERS (EQ1, EQ2, EQ3) ARE FIXED BY THE SPEEDS SELECTED FOR THE BOARD. SPEED 1 (FL1, C1, EQ1) POSITION WILL ALWAYS BE THE HIGHEST SPEED ON THE BOARD, WITH SPEED 2 (FL2, C2, EQ2,) AND SPEED 3 (FL3, C3, EQ3) FOLLOWING IN DESCENDING ORDER.

NOTE 2.
THE COMPONENTS LISTED IN THE TABLES, EXCEPT C11 & R30, R11, R52, ARE CALLED FOR ON THE ENG. SPEC. SHEET. THE SELECTION OF R11, R52, C11 & R30, CAN BE MADE FROM THE TABLES AFTER SELECTING THE PROPER BOARD DASH NUMBER FROM THE ENG. SPEC. SHEET. PART NO.'S OF COMPONENTS IN THE TABLES, (EXCEPT FOR R11, R52, C11 & R30), ARE LISTED FOR REF. ONLY.

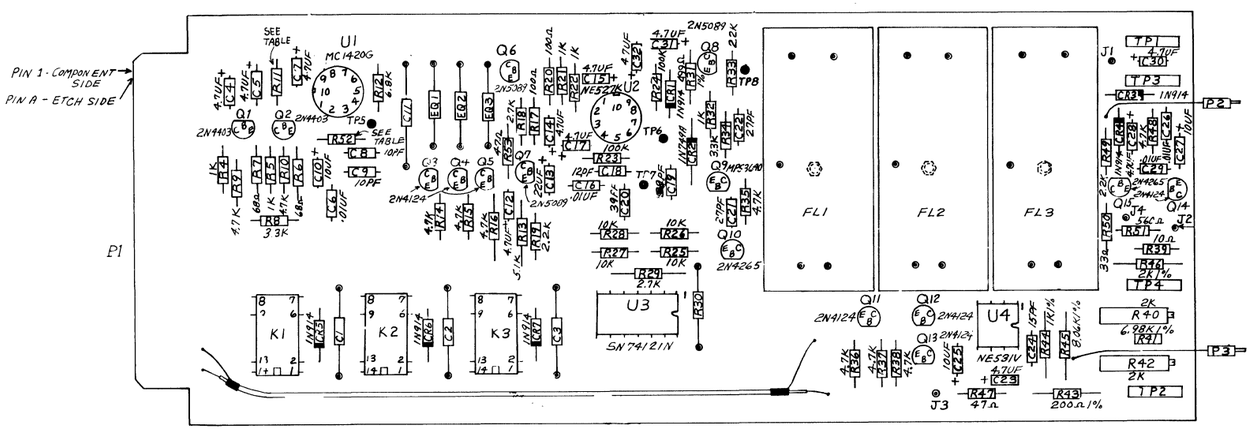


Figure 13-11. FM Reproduce Board Parts Location (836820)

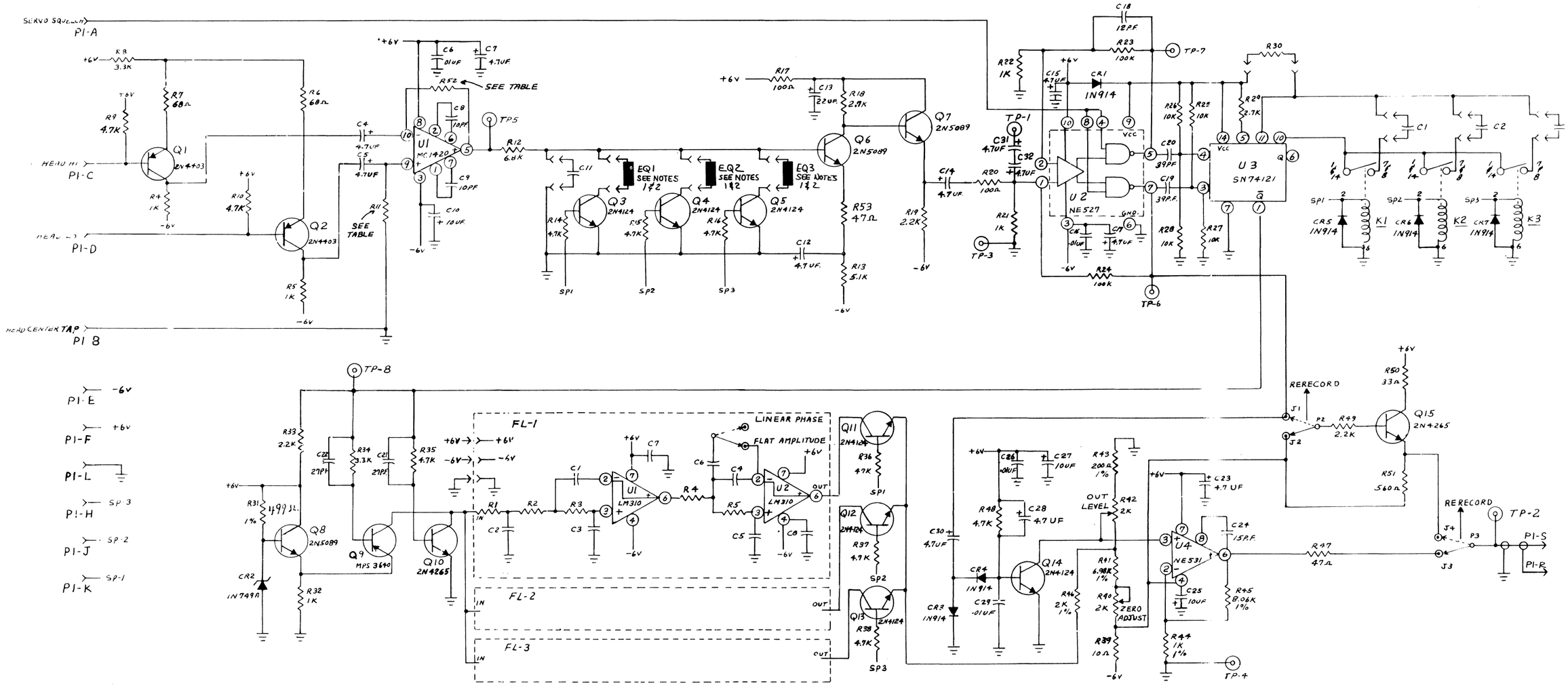


Figure 13-12. FM Reproduce Board Schematic Diagram (836820)

FILTER BOARD 836698

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1 thru C6	See Chart	J1 J2 P1 thru P4	See Chart (P/O P5) 836693	P5 P6 P7	836700 Not Used See Chart	R1 thru R5	See Chart
C7	510058-002					U1	510240-006
C8	510058-002					U2	510240-006

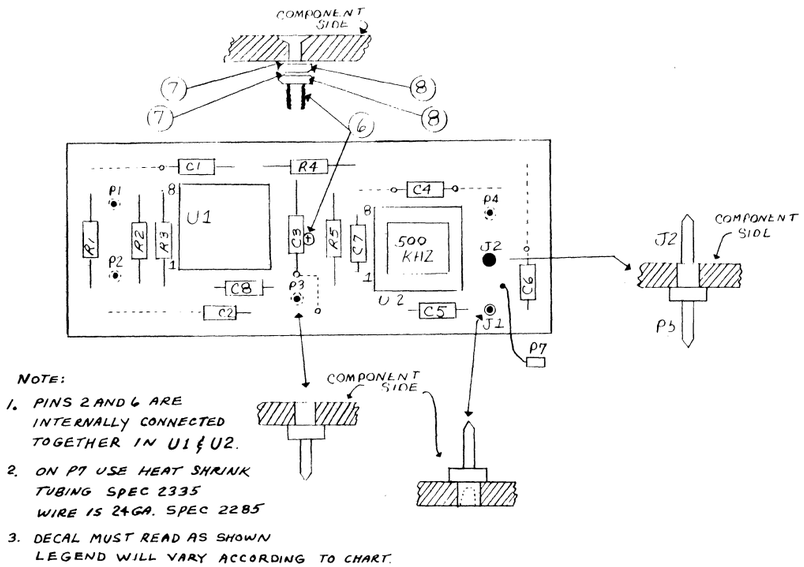


Figure 13-13. Filter Board Parts Location (836698)

836698-	FILTER BANDWIDTH	CARRIER CENTER FREQUENCY	BAND	C1	C2	C3, C5	C4	C6	R1, R2, R3	R4, R5	J1	P7	DECAL 836742-
001	500 kHz	900 kHz	WIDE BAND	261 PF 510472-261	215 PF 510472-215	73 PF 510459-073	750 PF 510472-750	NOT USED	1.96 K 510450-196	1.43K 510450-143	NOT USED	NOT USED	017
002	250 kHz	450 kHz							3.92 K 510450-392	2.87 K 510450-287			016
003	125 kHz	225 kHz							7.87 K 510450-787	5.76 K 510450-576			015
004	62.5 kHz	112.5 kHz		261 PF 510472-261	215 PF 510472-215	73 PF 510459-073	750 PF 510472-750		15.8 K 510451-158	11.5 K 510451-115			014
005	31.2 kHz	56.2 kHz		4120 PF 510478-005	3400 PF 510478-004	1180 PF 510478-001	.0121 UF 510478-007		1.96 K 510450-196	1.43 K 510450-143			013
006	15.6 kHz	28.1 kHz							3.92 K 510450-392	2.87 K 510450-287			012
007	7.8 kHz	14 kHz							7.87 K 510450-787	5.76 K 510450-576			011
008	3.9 kHz	7 kHz		4120 PF 510478-005	3400 PF 510478-004	1180 PF 510478-001	.0121 UF 510478-007	NOT USED	15.8 K 510451-158	11.5 K 510451-115	NOT USED	NOT USED	018
009	80 kHz	432 kHz	WIDE BAND INTERMEDIATE BAND LOW BAND	1180 PF 510478-001	976 PF 510472-976	332 PF 510472-332	2050 PF 510478-003	1370 PF 510478-002	1.96 K 510450-196	1.43 K 510450-143	836694	836672	010
010	40 kHz	216 kHz							3.92 K 510450-392	2.87 K 510450-287			009
011	20 kHz	108 kHz							7.87 K 510450-787	5.76 K 510450-576			008
012	10 kHz	54 kHz		1180 PF 510478-001	976 PF 510472-976	332 PF 510472-332	2050 PF 510478-003	1370 PF 510478-002	15.8 K 510451-158	11.5 K 510451-115			007
013	5 kHz	27 kHz		.0191 UF 510478-009	.0154 UF 510478-008	5360 PF 510478-006	.0332 UF 510478-011	.0215 UF 510478-010	1.96 K 510450-196	1.43 K 510450-143			006
014	2.5 kHz	13.5 kHz							3.92 K 510450-392	2.87 K 510450-287			005
015	1.25 kHz	6.75 kHz							7.87 K 510450-787	5.76 K 510450-576			004
016	625 Hz	3.375 kHz							15.8 K 510451-158	11.5 K 510451-115			003
017	312 Hz	1.688 kHz							31.6 K 510451-316	23.2 K 510451-232			002
018	156 Hz	.844 kHz		.0191 UF 510478-009	.0154 UF 510478-008	5360 PF 510478-006	.0332 UF 510478-011	.0215 UF 510478-010	61.9 K 510451-619	46.4 K 510451-464	836694	836672	001

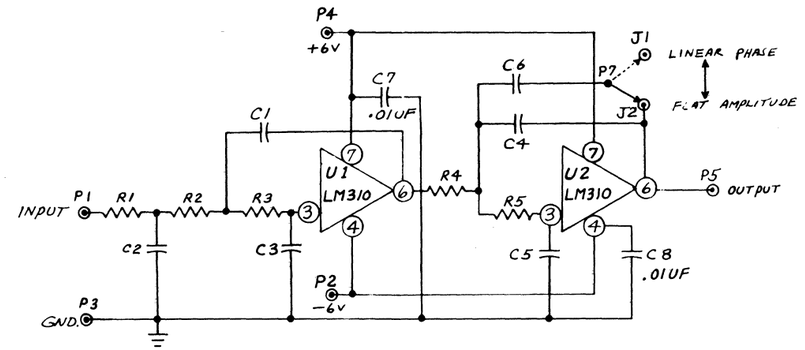


Figure 13-14. Filter Board Schematic Diagram (836698)

VOICE TIME CODE REPRODUCE BOARD 836821

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-011	C17	859775-022	R4	510408-045	R18	510408-033
thru		C18	691686-001	R5	510408-089	R19	855121
C4		CR1	844510	R6	510408-085	R20	510408-089
C5	197212-020	CR2	844510	R7	510408-089	R21	510408-089
C6	197212-020	MP1	852748	R8	510408-103	R22	510408-017
C7	691686-032	MP2	847825	R9	510408-103	R23	510408-017
thru		Q1	510460	R10	853530-186	R24	510408-025
C9		Q2	510460	R11	853530-145	S1	510102-003
C10	859775-014	Q3	859970	R12	853530-263	TP1	691032
C11	859775-011	Q4	859971	R13	510408-089	TP2	853590-006
C12	197212-027	Q5	853533	R14	510408-081	TP3	853590-004
C13	859775-011	Q6	853532	R15	510408-043	TP4	853590-010
C14	691686-022	R1	510408-073	R16	329151-004	U1	510457
C15	859775-014	R2	510408-073	R17	510408-137	U2	510453
C16	859775-014	R3	510408-045				

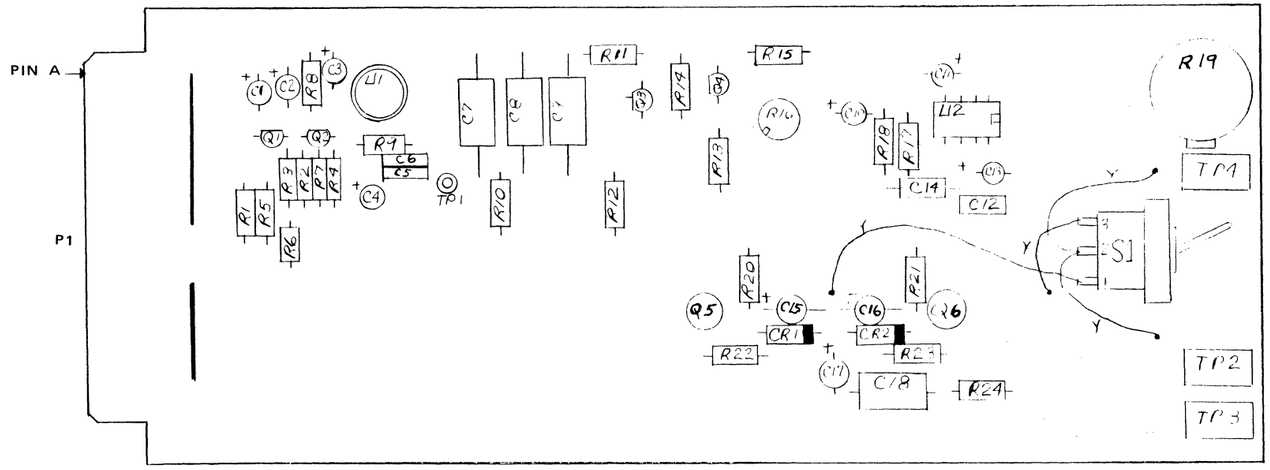


Figure 13-15. Voice Time Code Reproduce Board Parts Location (836821)

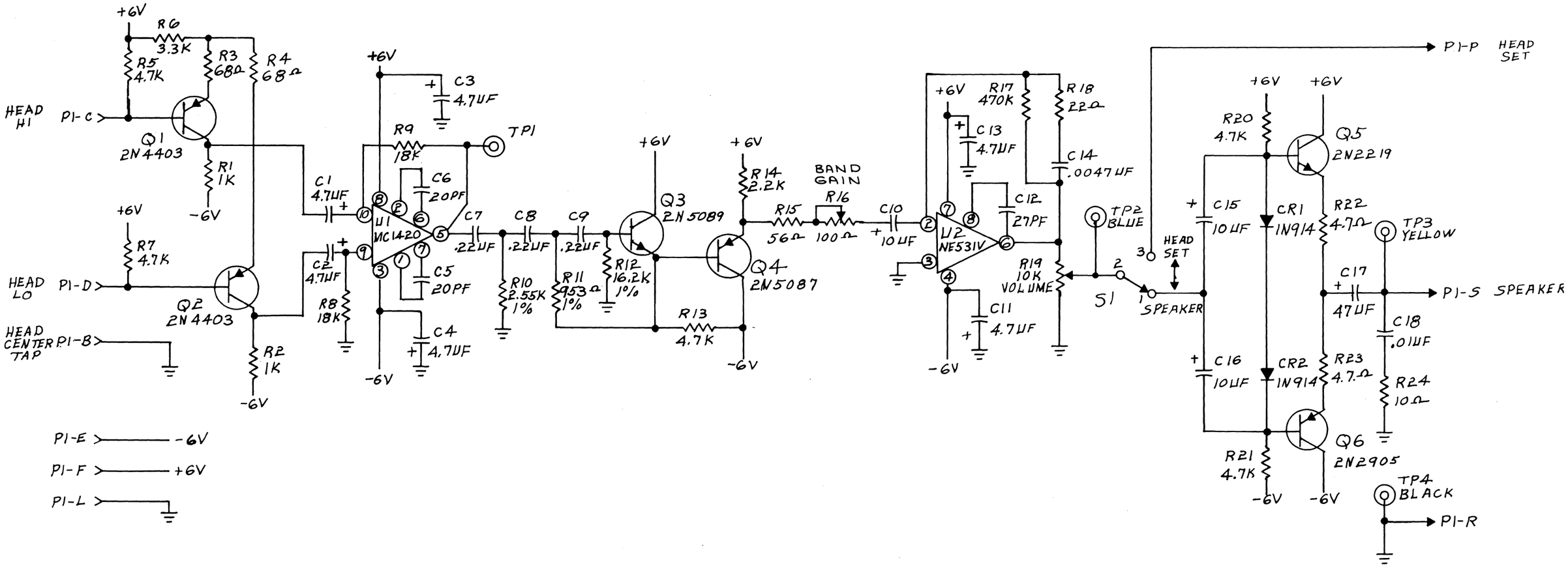


Figure 13-16. Voice Time Code Reproduce Board Schematic Diagram (836821)

TAPE SYNC PRE-AMP BOARD 837029

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-005	C11	510429-025	R3	510408-085	R13	510408-137
C2	859775-005	C12	510429-025	R4	510408-045	R14	510408-065
C3	197212-010	J1	836672	R5	510408-045	R15	510408-069
C4	859775-017	J2	836672	R6	510408-073	R16	510408-033
C5	197212-010	MP1	852748	R7	510408-073	R17	510408-033
C6	859775-017	P2	836701	R8	510408-097	R18	510408-089
C7	859775-005	Q1	510460	R9	510408-097	TP1	853590-002
C8	510058-001	Q2	510460	R10	510408-071	TP2	853590-010
C9	197212-005	R1	510408-089	R11	510408-033	TP3	853590-004
C10	197212-250	R2	510408-089	R12	510408-081	U1	510457
						U2	510453

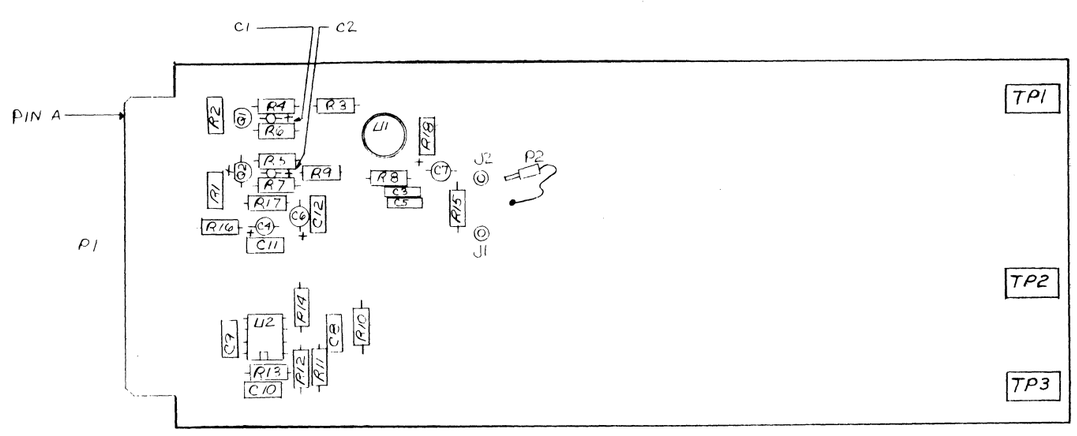
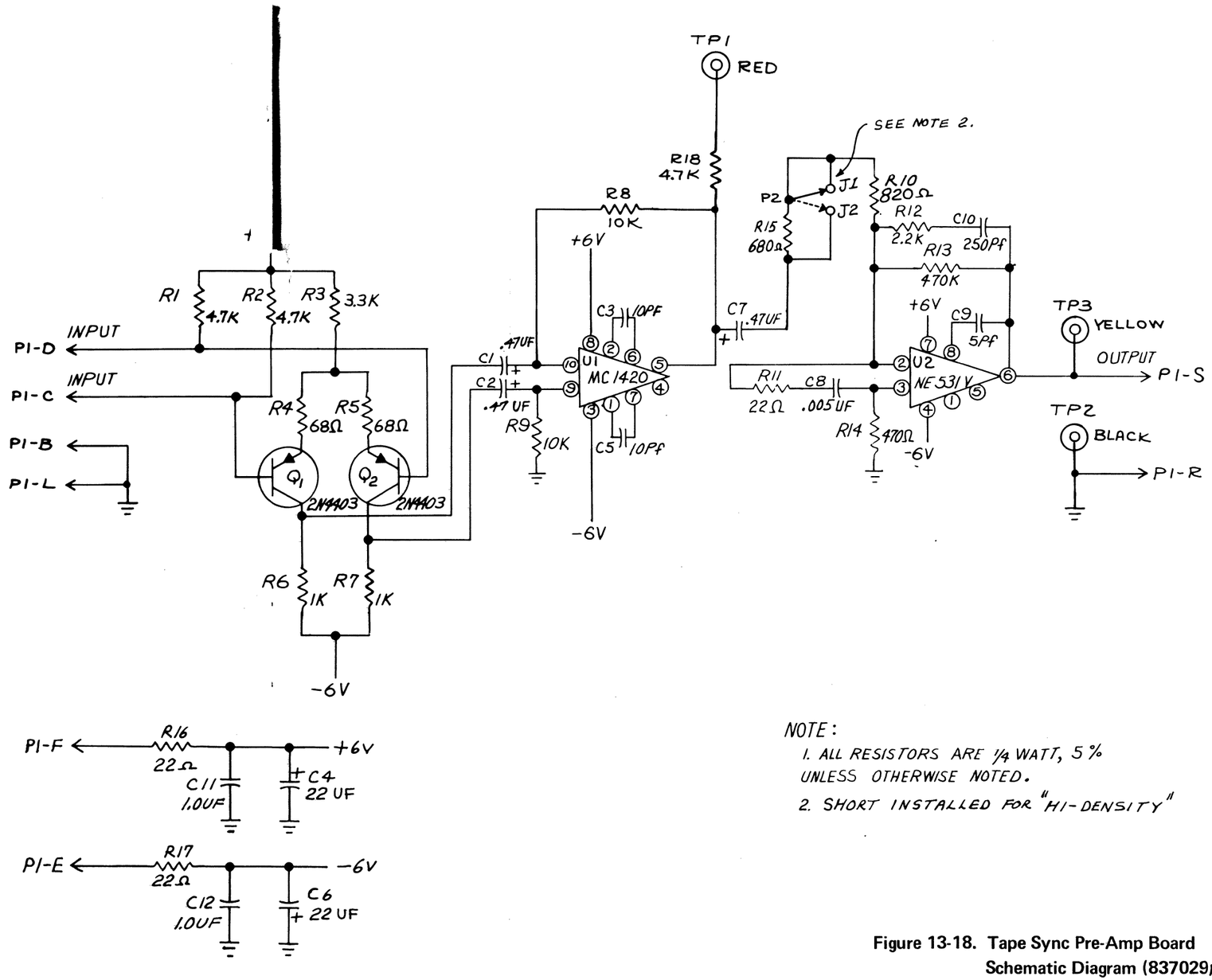


Figure 13-17. Tape Sync Pre-Amp Board Parts Location (837029)



NOTE:

1. ALL RESISTORS ARE 1/4 WATT, 5% UNLESS OTHERWISE NOTED.
2. SHORT INSTALLED FOR "HI-DENSITY"

Figure 13-18. Tape Sync Pre-Amp Board Schematic Diagram (837029)

SECTION 14
MONITOR SERVICING

A. INTRODUCTION

The monitor circuits indicate certain status operations of the SABRE VI to the operator for his information and response. This includes the footage counter circuits for locating points of interest along a tape and the thru-put monitor system for an indication of recording level.

B. FOOTAGE COUNTER CIRCUITS

1. FUNCTIONAL DESCRIPTION

The footage counter circuits operate in conjunction with the tachometer of the capstan motor assembly and with the counter display on the control module to provide a numerical display (in feet) of the amount of tape that has passed the head. Forward or reverse commands to the counter board program the circuits to count up or to count down. Battery charging and count retention circuits provide the memory required to retain the count when the recorder is deenergized.

The tachometer signal from the capstan motor is applied first to the capstan A board. The signal is buffered by U13 and applied as an output to the footage counter board at pin P1-15 and to the reel drive board at eyelet E12.

The footage counter board is divided into three basic divisions: (1) up/down counter circuits, (2) strobe and decode circuits, (3) battery charging and count memory circuits.

The up/down counter circuits are divided into two sections. The first section divides the input signal down to one pulse per foot of tape and the second section counts feet of tape for the display. The first section consists of U13 (1/2), U16, U12, U8, and U4. The tach signal from the capstan motor is applied to the input of U13. U13 divides the signal by two for application to the presettable up/down counters consisting of U16, U12, U8, and U4. Each counter is a divide-by-ten resulting in a short negative pulse that has been divided by 20,000 at the output of U4. The width of the negative pulse is equal to the period of the input tach signal.

The second section of the up/down counter consists of U3, U7, U11, and U15. The one pulse per foot signal is applied to the input of U3. U3 counts units of feet, U7 counts tens of feet, U11 counts 100's of feet and U15 counts 1000's of feet. The second half of U13 is not used.

The fwd/rev input of the board is used to control the direction of the up/down counter. When motor reversing relay K2 energizes, a voltage is applied to pin P1-12 of the footage counter board causing the counter to count down.

The reset button, located on the control module resets all counters except U12, U16 and the first half of U13 to a zero count. A reset condition occurs when a logic 1 level (+5 v) is applied to the reset input.

The BCD outputs of U3, U7, U11, and U15 are applied to the stobe and decoding circuits. These circuits consist of an oscillator and a divide-by-four circuit. The oscillator is composed of C3, R5, Q6, and Q7. The divide-by-four circuit is composed of U1 and U5. U1 divides the signal by four and U5 distributes each of the four sequenced signals to four individual outputs to drive Q2, Q3, Q4, and Q5. The oscillator frequency is approximately 1 kHz.

When U5-3 is high, the BCD information present at the outputs of U3 is connected to the inputs of the BCD-to-seven segment decoder U9 via the quad bi-lateral switch U2. The BCD signal is converted in U9 to a signal capable of driving the anodes in the external four digit seven segment display. At the same time U5-3 also causes Q2 to conduct causing the units digit to be displayed.

In a similar manner, U5-4 goes high to present the four outputs of U7 to the display, while Q3 conducts to enable the tens digit. The hundreds and thousands digits are strobed by U5 pins 10 and 11.

The battery charging circuit consists of CR2, CR3, CR4, and R4. 15 to 20 milliamps of current is furnished to a battery composed of four AA size 500 MAH cells from pin 14 of the footage counter board. R4 limits the charging current. CR3 prevents discharge of the battery into the supply line when unit power is removed and zener diode CR2 clamps the voltage to a safe level if the battery is removed. The battery supplies current thru CR4 to the integrated circuits connected to the Vdd line when power is removed so that these circuits retain the last count. To reduce battery drain, power is removed from U1, U5, U9, Q6, and Q7 when the recorder/reproducer is turned off. This causes all of the outputs of U5 to go low opening all quad bi-lateral switches U2, U6, U10, and U14, removing the load caused by U9 on U3, U7, U11, and U15.

2. FAULT ISOLATION

The footage counter circuits contain no controls, adjustments, or testpoints. The following procedures recommend the use of a frequency counter to determine frequency rates at the outputs of the up/down counters. If these points are viewed using an oscilloscope, the pulses are

difficult to see. The pulses are of very short duration therefore requiring the intensity of the oscilloscope to be increased to see them. The duration of each pulse is equal to one period of the tach signal. To check out the footage counter circuits, proceed as follows:

Step 1. Gain access to the footage counter board by placing it on an extender.

Step 2. Place a tape on the recorder/reproducer and set the tape in motion. select any tape speed.

Step 3. Check dc supply voltage at the following points. If the pin numbers called out are difficult to check, refer to the schematic diagram, locate a component connected to that point and check the end of the component connected to that pin. Pin P1-R is the ground return.

PIN NUMBER	INDICATION
P1-S	+28 vdc
P1-P	+6
P1-14	+5 vdc ±10%

Step 4. With an oscilloscope, check the time interval of the first section of the up/down counter at P1-1. The frequency should be one pulse per foot and must be determined from the tape speed selected. Example: If 60 ips was selected, 5 feet per second is passing the head. This means a frequency of 5 Hz and a period at P1-1 of 200 milliseconds.

Step 5. If the period at P1-1 is incorrect, move the counter to the input of the board at P1-15. The frequency at this point should be 20,000 times the frequency at P1-1. At 60 ips the frequency should be 100 kHz, or a period of 10 microseconds. If incorrect, the input tachometer signal is at fault.

Step 6. If the tach signal is correct, then a fault occurs in one of the counters. Progress down the counter change until the faulty counter is located. Remember, U13 is a divide-by-two and U16, U12, U8, and U4 are divide-by-tens. Check the output of each counter. Refer to the schematic diagram for counter output pin numbers.

Step 7. If the check at P1-1 in Step 4 was correct, then a fault may occur in the second section of the divide chain. If so, check the output of each counter remembering each is a divide-by-ten.

Step 8. If the counter checks normal, check the oscillator frequency at the base of transistor Q6. The frequency should be 1 kHz ±50%. An oscilloscope may be used for the remaining steps.

Step 9. If the frequency is normal, check the four outputs of U5 at pins 3, 4, 10, and 11. The signal at each output is a positive pulse 1/4 the length of the total duty cycle. The pulses are sequenced so that only one output is positive at a time.

Step 10. Check the collector signals of transistors Q2, Q3, Q4, and Q5. These signals should be the same as those found in Step 9 except each is inverted.

Step 11. If all the above checks are normal, check the quad bi-lateral switches U2, U6, U10, and U4 and the seven segment decoder. To do this, reset the footage counter to zero and watch the display. Any digit not normal is probably being affected by that quad bi-lateral latch or the display itself. If all the digits are abnormal, then the seven segment decoder U9 is probably at fault.

C. LED DATA BAR MONITOR

The function of the LED data bar monitor system is to display the data level recorded on tape for any selected channel. The record level is indicated by means of a series of LED's lighting in proportion to signal strength. The monitor input is connected to the output of the reproduce boards.

Each reproduce board output is connected through the TRACK SELECT switch to the display board. The track to be monitoried is selected by the operator at the TRACK SELECT switch.

The function of the display board is to measure the plus and minus peak amplitude excursions of the input signal and produce output levels proportional to these peaks.

Amplifiers U1 and U2 represent the peak detector for the negative excursions of the signal and the second half of U2 represents the peak detector for the positive excursions. Amplifier U1 is a unity gain inverting amplifier. This makes the input a U2-12 180 degrees out-of-phase with U2-5. When the input at U2-12 goes negative the output at U2-1 goes positive to drive the cathode of diode CR1 positive. Hence the cathode has a voltage that is proportional to the peak negative excursion of the input signal. Likewise, the voltage on the cathode of diode CR2 at the output of U2-8 is proportional to the positive excursion of its input signal.

Resistors R6, R7, R8, R11, R12, R15, T18, R21, R24, R27, R30, R33, R36, R39, and R42 comprise a voltage divider with each tap being connected to the positive input of an amplifier. The voltage divider provides reference voltages of .1, .2, .3, etc. through .9, 1 and 1.3 volts. The peak voltage detected from the cathodes of CR1 and CR2 are applied to the inverting inputs of comparators U3 through U8. Each reference voltage level is applied to two comparators, one for positive excursions, one for negative. The outputs of the comparators are open collector devices that are normally "off". Whenever a peak exceeds a reference voltage, the comparator "turns on". The output of each comparator is connected to drive an LED light on the front panel. 0 volts is represented in the center of the display. This means the indication will move out in both directions from this point.

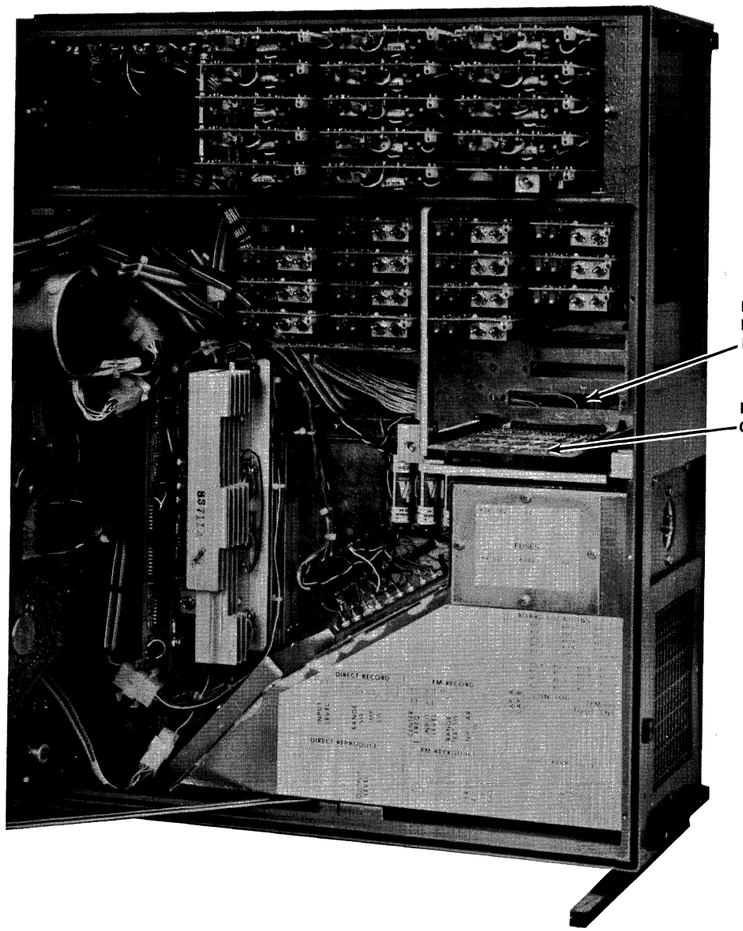


Figure 14-1. Front View Showing Footage Counter and TPM Display Board

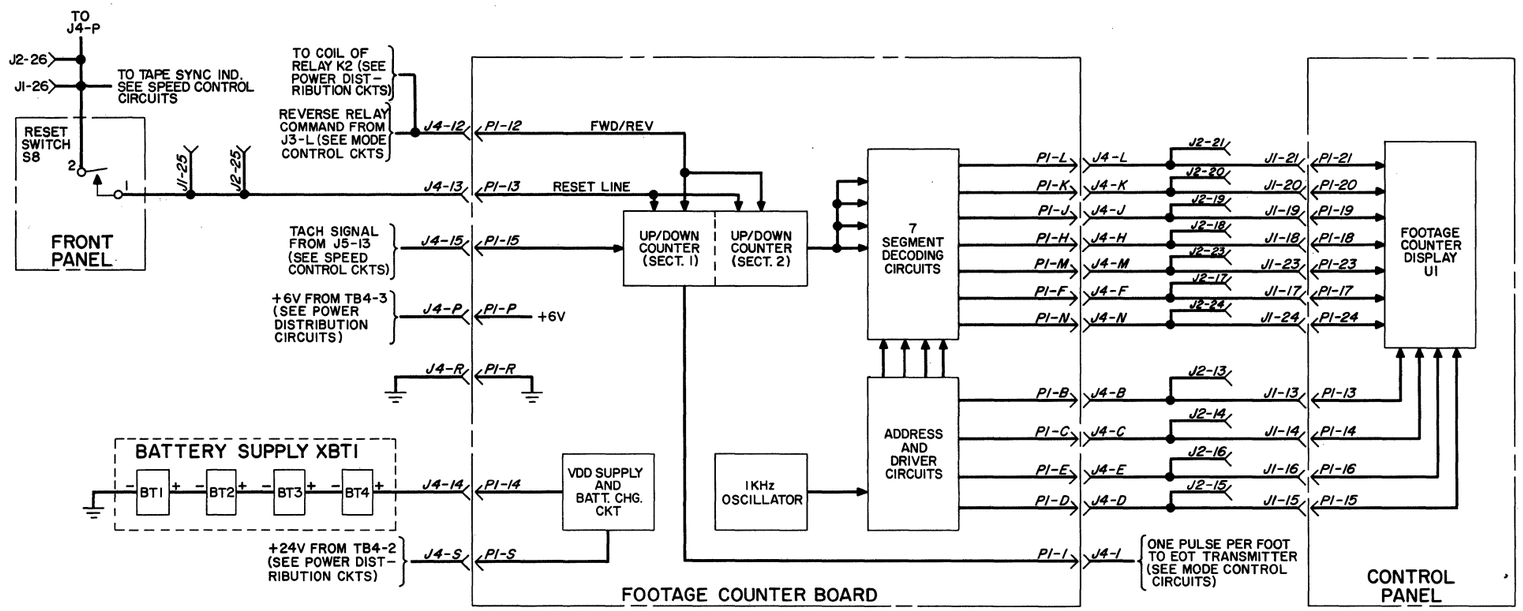


Figure 14-2. Footage Counter Overall Functional (804895)

FOOTAGE COUNTER CIRCUITS (ASSOCIATED COMPONENTS)

TRANSPORT PANEL		ELECTRONIC CHASSIS		CONTROL MODULE		CONNECTOR PANEL	
REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
J1	837115	BT1 thru BT4	510480	P1	510502	J2	510502
S8	836907	J4	859241-001	U1	510461		
		XBT1	510498				

FOOTAGE COUNTER BOARD 836648

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	859775-014	Q6	854540	R11	Not Used	U6	510376-017
C2	859775-014	Q7	854539	R12	510408-109	U7	510376-029
C3	691686-015	R1	510408-105	R13	510408-045	U8	510376-029
CR1	844510	R2	510408-097	thru		U9	510376-038
CR2	852475-024	R3	510408-025	R19		U10	510376-017
CR3	844510	R4	510409-077	R20	510408-091	U11	510376-029
CR4	844510	R5	510408-151	thru		U12	510376-029
CR5	852475-020	R6	510408-073	R23		U13	510376-014
Q1	Not Used	R7	510408-089	U1	510376-014	U14	510376-017
Q2	854539	R8	510408-097	U2	510376-017	U15	510376-029
thru		R9	Not Used	U3	510376-029	U16	510376-029
Q5		R10	510408-073	U4	510376-029		
				U5	510376-002		

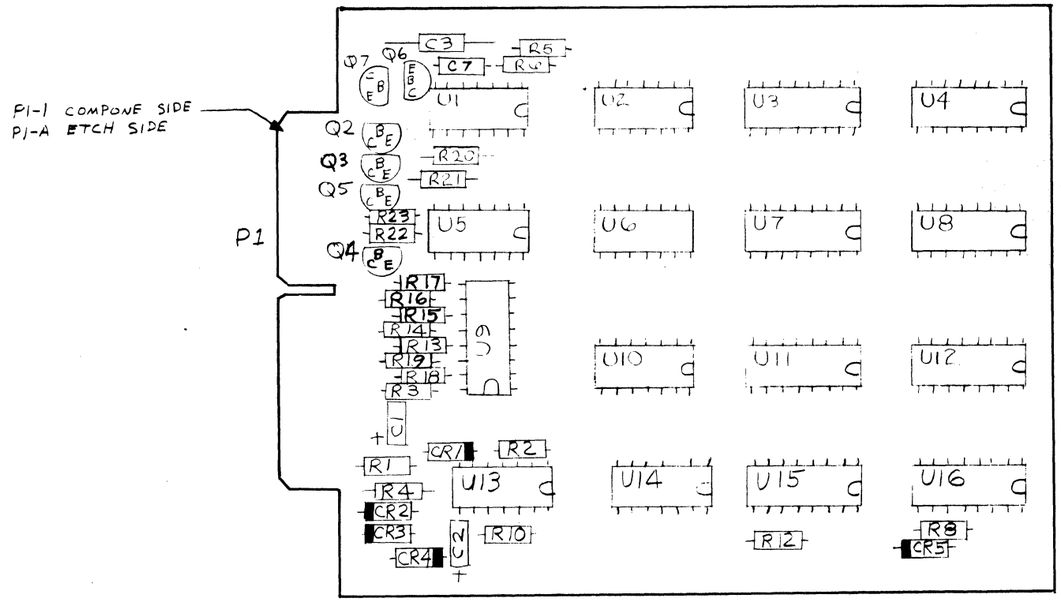
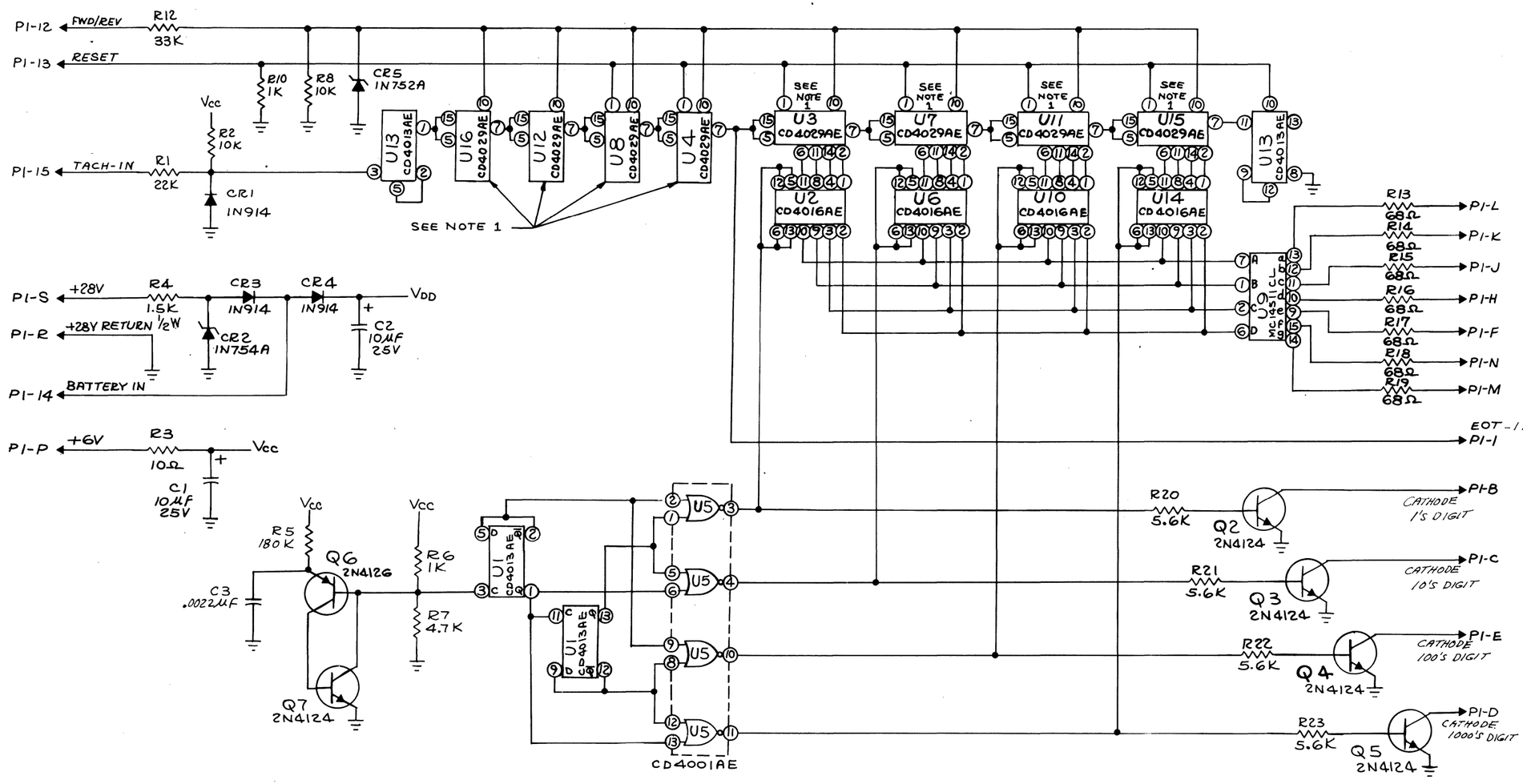


Figure 14-3. Footage Counter Board Parts Location (836648)



NO.	TYPE	VCC	VDD	GROUND PINS
U1	CD4013AE	14	-	4,6,7,8,10
U2	CD4013AE	-	14	7
U3	MC14510CL	-	16	3,4,8,9,12,13
U4	MC14510CL	-	16	3,4,8,9,12,13
U5	CD4001AE	14	-	7
U6	CD4016AE	-	14	7
U7	MC14510CL	-	16	3,4,8,9,12,13
U8	MC14510CL	-	16	3,4,8,9,12,13
U9	MC14511CL	16	-	8,5
U10	CD4016AE	-	14	7
U11	MC14510CL	-	16	3,4,8,9,12,13
U12	MC14510CL	-	16	1,3,4,8,9,12,13
U13	CD4013AE	-	14	4,6,7,8
U14	CD4016AE	-	14	7
U15	MC14510CL	-	16	3,4,8,9,12,13
U16	MC14510CL	-	16	1,3,4,8,9,12,13

NOTE:

1. MC14510CL (510376-037) MAY BE USED AS AN ALTERNATE FOR CD4029AE (510876-029).

Figure 14-4. Footage Counter Board Schematic Diagram (836648)

DATA BAR MONITOR CIRCUITS (ASSOCIATED COMPONENTS)

REF. DESIG.	SANGAMO PART NO.
CR1 thru CR11	510509
CR13 thru CR23	510509
Ind. Assy	836905-003

REF. DESIG.	SANGAMO PART NO.
J10	859241-004
J80 thru J93	855977
J95	846615
S10	510491

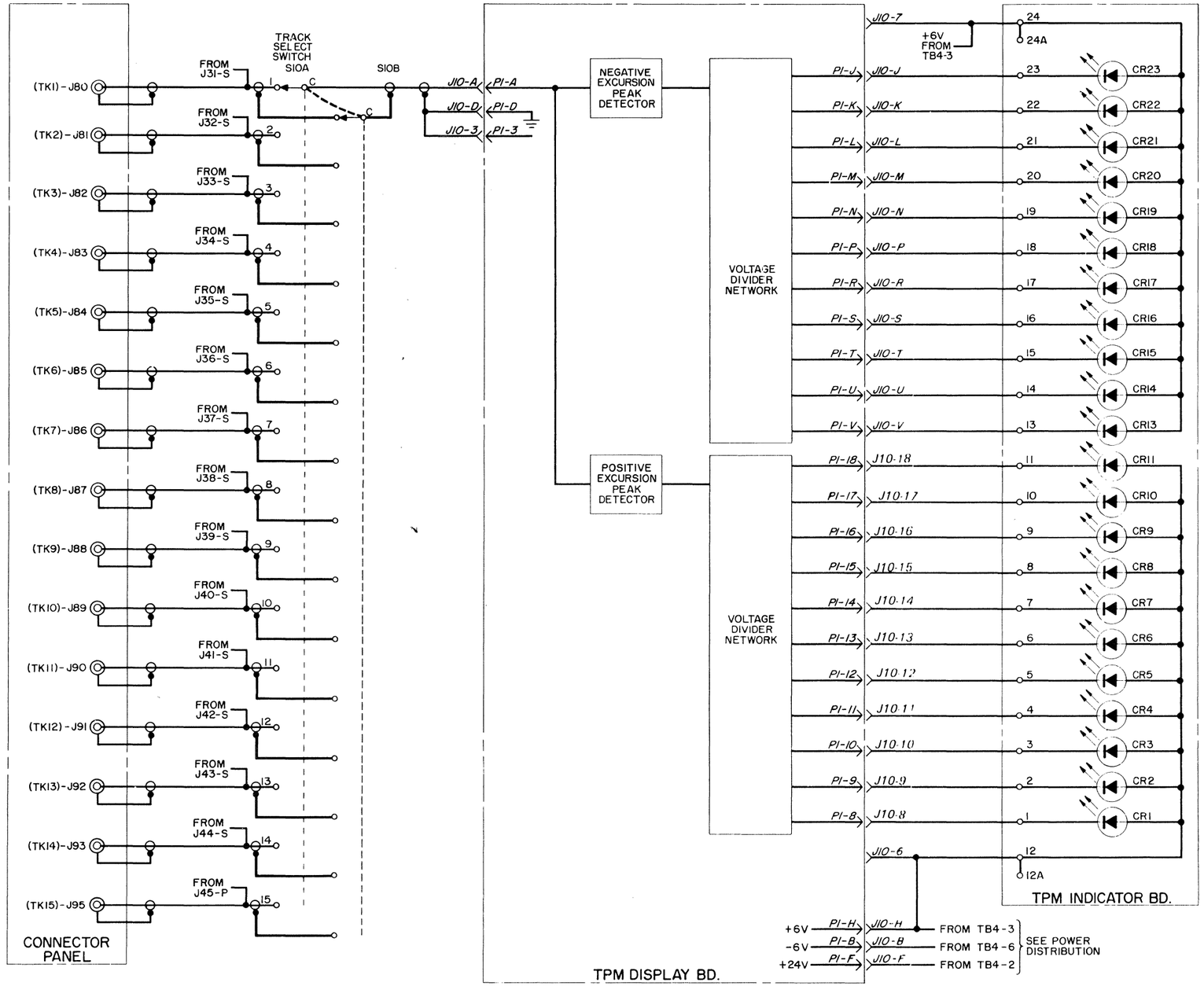


Figure 14-5. Data Bar Monitor, Overall Functional Circuits (804896)

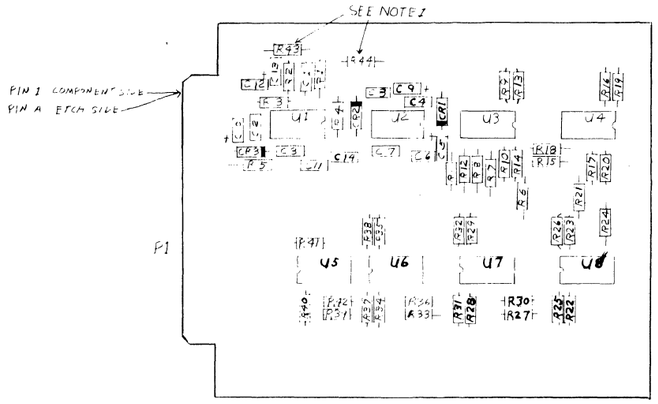
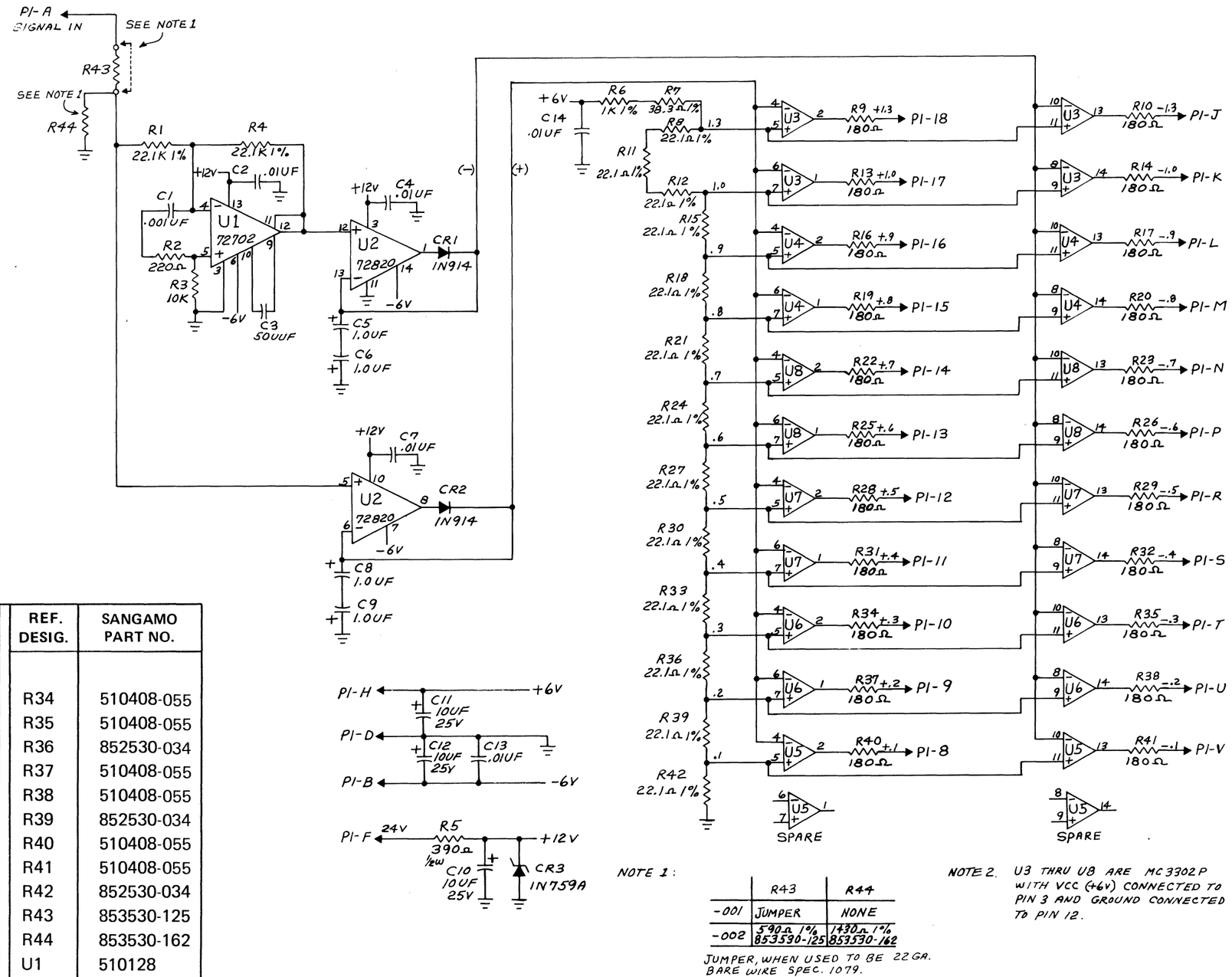


Figure 14-6. TPM Display Board Parts Location (836650)

TPM- DISPLAY BOARD 836650

REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.	REF. DESIG.	SANGAMO PART NO.
C1	846901	R1	853530-276	R18	852530-034	R34	510408-055
C	510058-002	R2	510408-057	R19	510408-055	R35	510408-055
C3	896476	R3	510408-097	R20	510408-055	R36	852530-034
C4	510058-002	R4	853530-276	R21	852530-034	R37	510408-055
C5	859775-007	R5	510409-063	R22	510408-055	R38	510408-055
C6	859775-007	R6	853530-147	R23	510408-055	R39	852530-034
C7	510058-002	R7	853530-011	R24	852530-034	R40	510408-055
C8	859775-007	R8	852530-034	R25	510408-055	R41	510408-055
C9	859775-007	R9	510408-055	R26	510408-055	R42	852530-034
C10	859775-014	R10	510408-055	R27	852530-034	R43	853530-125
thru		R11	852530-034	R28	510408-055	R44	853530-162
C12		R12	852530-034	R29	510408-055	U1	510128
C13	510058-002	R13	510408-055	R30	852530-034	U2	510339-003
C14	510058-002	R14	510408-055	R31	510408-055	U3	510433
CR1	844510	R15	852530-034	R32	510408-055	thru	
CR2	844510	R16	510408-055	R33	852530-034	U8	
CR3	852475-034	R17	510408-055				



NOTE 1:

	R43	R44
-001	JUMPER	NONE
-002	590Ω 1% 853530-125	1430Ω 1% 853530-162

JUMPER, WHEN USED TO BE 22 GA. BARE WIRE SPEC. 1079.

NOTE 2. U3 THRU U8 ARE MC3302P WITH VCC (+6V) CONNECTED TO PIN 3 AND GROUND CONNECTED TO PIN 12.

Figure 14-7. TPM Display Board Schematic Diagram (836650)

SECTION 15
MASTER PARTS LIST

The master parts list is a listing of all Sabre VI parts of maintenance significance. These parts are listed in numerical sequence by Sangamo part number. The name and a brief description of each part is given opposite the Sangamo part number. Included in the description is the true manufacturers' code and part number. A listing is found at the end of this master parts list section, and is listed in numerical order by manufacturers' code number.

In order to identify an individual part number, begin at the assembly in which it is used (see sections 7 through 14 as listed below). Next, locate the desired part on the schematic, line drawing, or picture to obtain the correct reference designation (R1, C14, L3, etc.). Relate the reference designation to the parts list provided for that particular assembly and note the part number. Now, the master parts list may be used to provide the parts information needed.

Section 7 - Tape Transport Mechanics

Transport Panel Assy. (part of)
Reel Drive Assy.
Pinch Roller Assy.
Record and Reproduce Head Assy.
Capstan Motor Assy.

Section 8 - Power Distribution Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Control Module Assy. (part of)
Connector Panel Assy. (part of)
Power Supply Assy.
Rectifier Chassis Assy.
Regulator Board Assy.
Oscillator Board Assy.

Section 9 - Mode Control Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Control Module Assy. (part of)
Connector Panel Assy. (part of)
Control Logic Board Assy.
E.O.T. Transmitter Board Assy.
E.O.T. Receiver Board Assy.

Section 10 - Mode Control Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Motor Drive Amplifier Assy. (part of)
Reel Drive Board Assy.

Section 11 - Speed Control Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Control Module Assy. (part of)
Connector Panel Assy. (part of)
Motor Drive Amplifier Assy. (part of)
Capstan "A" Board Assy.
Capstan "B" Board Assy.
Tape Sync Pre-Amp Board Assy.
Tape Sync Board Assy.

Section 12 - Record Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Connector Panel Assy. (part of)
Direct Record Board Assy.
FM Record Board Assy.
Time Code Record Board Assy.
Voice Record Board Assy.

Section 13 - Reproduce Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Connector Panel Assy. (part of)
Dual Emitter Follower Board Assy.
Filter Board Assy.
Direct Equalizer Board Assy.
Direct Reproduce Board Assy.
Voice Reproduce Board Assy.
FM Reproduce Board Assy.

Section 14 - Monitor Servicing

Transport Panel Assy. (part of)
Electronic Chassis Assy. (part of)
Control Module Assy. (part of)
Connector Panel Assy. (part of)
Footage Counter Board Assy.
T.P.M. Display Board Assy.
T.P.M. Direct Reproduce "A" Board Assy.
T.P.M. Direct Reproduce "B" Board Assy.
T.P.M. FM Reproduce "A" Board Assy.
T.P.M. FM Reproduce "B" Board Assy.

SANGAMO PART NO.	NAME AND DESCRIPTION
197212-001	CAPACITOR, FIXED, MICA: 1 pf, 5%, 500 V; mfr 00853, no. D155C010J0
197212-005	CAPACITOR, FIXED, MICA: 5 pf, 5%, 500 V; mfr 00853, no. D155C050J0
197212-010	CAPACITOR, FIXED, MICA: 10 pf, 5%, 500 V; mfr 00853, no. D155C100J0
197212-012	CAPACITOR, FIXED, MICA: 12 pf, 5%, 500 V; mfr 00853, no. D155C120J0
197212-015	CAPACITOR, FIXED, MICA: 15 pf, 5%, 500 V; mfr 00853, no. D155C150J0
197212-020	CAPACITOR, FIXED, MICA: 20 pf, 5%, 500 V; mfr 00853, no. D155C200J0
197212-027	CAPACITOR, FIXED, MICA: 27 pf, 5%, 500 V; mfr 00853, no. D155C270J0
197212-039	CAPACITOR, FIXED, MICA: 39 pf, 5%, 500 V; mfr 00853, no. D155C390J0
197212-043	CAPACITOR, FIXED, MICA: 43 pf, 5%, 500 V; mfr 00853, no. D155C430J0
197212-047	CAPACITOR, FIXED, MICA: 47 pf, 5%, 500 V; mfr 00853, no. D155C470J0
197212-050	CAPACITOR, FIXED, MICA: 50 pf, 5%, 500 V; mfr 00853, no. D155C500J0
197212-062	CAPACITOR, FIXED, MICA: 62 pf, 5%, 500 V; mfr 00853, no. D155C620J0
197212-082	CAPACITOR, FIXED, MICA: 82 pf, 5%, 500 V; mfr 00853, no. D155C820J0
197212-100	CAPACITOR, FIXED, MICA: 100 pf, 5%, 500 V; mfr 00853, no. D155C101J0
197212-150	CAPACITOR, FIXED, MICA: 150 pf, 5%, 500 V; mfr 00853, no. D155C151J0
197212-200	CAPACITOR, FIXED, MICA: 200 pf, 5%, 500 V; mfr 00853, no. D155C201J0
197212-240	CAPACITOR, FIXED, MICA: 240 pf, 5%, 500 V; mfr 00853, no. D155C241J0
197212-250	CAPACITOR, FIXED, MICA: 250 pf, 5%, 500 V; mfr 00853, no. D155C251J0
197212-330	CAPACITOR, FIXED, MICA: 330 pf, 5%, 500 V; mfr 00853, no. D155C331J0
197212-400	CAPACITOR, FIXED, MICA: 400 pf, 5%, 500 V; mfr 00853, no. D155C401J0
197212-500	CAPACITOR, FIXED, MICA: 500 pf, 5%, 500 V; mfr 00853, no. D155C501J0
198249-600	CAPACITOR, FIXED, MICA: 600 pf, 5%, 300 V; mfr 00853, no. D153E601J0
198249-680	CAPACITOR, FIXED, MICA: 680 pf, 5%, 300 V; mfr 00853, no. D153E681J0
198249-820	CAPACITOR, FIXED, MICA: 820 pf, 5%, 300 V; mfr 00853, no. D153E821J0
198816-650	CAPACITOR, FIXED, MICA: 650 pf, 1%, 300 V; mfr 00853, no. D153E6500F0
276212-200	CAPACITOR, FIXED, MICA: 2,000 pf, 1%, 500 V; mfr 00853, no. D195E202F0
276212-250	CAPACITOR, FIXED, MICA: 2,500 pf, 1%, 500 V; mfr 00853, no. D195E252F0
329151-002	RESISTOR, VARIABLE: 20 ohms, 30%, 1/2 W; mfr 73138, no. 62PR20
329151-003	RESISTOR, VARIABLE: 50 ohms, 30%, 1/2 W; mfr 73138, no. 62PR50
329151-004	RESISTOR, VARIABLE: 100 ohms, 30%, 1/2 W; mfr 73138, no. 62PR100
329151-005	RESISTOR, VARIABLE: 200 ohms, 30%, 1/2 W; mfr 73138, no. 62PR200
329151-006	RESISTOR, VARIABLE: 500 ohms, 30%, 1/2 W; mfr 73138, no. 62PR500
329151-007	RESISTOR, VARIABLE: 1,000 ohms, 30%, 1/2 W; mfr 73138, no. 62PR1K
329151-008	RESISTOR, VARIABLE: 2,000 ohms, 30%, 1/2 W; mfr 73138, no. 62PR2K

SANGAMO PART NO.	NAME AND DESCRIPTION
329151-009	RESISTOR, VARIABLE: 5,000 ohms, 30%, 1/2 W; mfr 73138, no. 62PR5K
329151-010	RESISTOR, VARIABLE: 10,000 ohms, 30%, 1/2 W; mfr 73138, no. 62PR10K
329151-011	RESISTOR, VARIABLE: 20,000 ohms, 30%, 1/2 W; mfr 73138, no. 62PR20K
334457	RESISTOR, FIXED, W W: 10,000 ohms, 5%, 5 W; mfr 44655, no. 77CS10K00J
402970	BRIDGE RECTIFIER: AC; mfr 83003, no. VS447
510007-004	RECTIFIER ASSY, BRIDGE: 300 V, 6A; mfr 04713, no. MDA952-4
510007-006	BRIDGE RECTIFIER: 6A, 600 V; mfr 04713, no. MDA952-6
510018	TRANSISTOR: silicon; mfr 04713, no. MPS2369
510022-103	RESISTOR, FIXED, C: 47,000 ohms, 5%, 1 W; mfr 81349, no. RCR32G473JS
510022-111	RESISTOR, FIXED, COMP: 100,000 ohms, 5%, 1 W; mfr 81349, no. RCR32G104JS
510054-008	RESISTOR, FIXED, W W: .232 ohms, 1%, 10 W; mfr 91637, no. RS-10
510058-001	CAPACITOR, FIXED, CERAMIC: .005 uf, 20%, 100 V; mfr 56289, no. C023B101E502M
510058-002	CAPACITOR, FIXED, CERAMIC: 0.01 uf, 20%, 100 V; mfr 56289, no. C023B101F103M
510058-003	CAPACITOR, FIXED, CERAMIC: .02 uf, 20%, 100 V; mfr 56289, no. C023B101H203M
510058-011	CAPACITOR, FIXED, CERAMIC: .001 uf, 10%, 250 V; mfr 56289, no. C067B251E102K
510087	DIODE ASSY: 1 W, 2 amp, 140 VR RMS; mfr 27777, no. VS247
510102-002	SWITCH, TOGGLE: SPDT; 115 vac, 5 amp; mfr 09353, no. 7103 red
510102-003	SWITCH, TOGGLE: SPDT; 115 vac, 5 amp; mfr 09353, no. 7101 black
510113-011	RESISTOR, VARIABLE, W W: 20 ohms, 5%, 1/2 W; mfr 80294, no. 3305P-1-200
510114-008	CAPACITOR, FIXED, MICA: 15 pf, 10%, 500 V; mfr 09022, no. 6D6-CD150K03
510116-041	CAPACITOR, FIXED, CERAMIC: .022 uf, 10%, 50 V; mfr 96733, no. CK05BX223K
510117-026	CAPACITOR, FIXED, CERAMIC: .15 uf, 10%, 50 V; mfr 96733, no. CK06BX154K
510117-028	CAPACITOR, FIXED, CERAMIC: .22 uf, 10%, 50 V; mfr 96733, no. CK06BX224K
510117-029	CAPACITOR, FIXED, CERAMIC: .27 uf, 10%, 50 V; mfr 96733, no. CK06BX274K
510120-097	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, 5%, 1/8 W; mfr 01121, no. BB1035
510128	INTEGRATED CIRCUIT: opnl ampl; mfr 01295, no. SN72702N
510164-006	RESISTOR, VARIABLE: 500 ohms, 10%, 3/4 W; mfr 80294, no. 3009P-1-501
510164-007	RESISTOR, VARIABLE: 1K ohms, 10%, 3/4 W; mfr 80294, no. 3009P-1-102
510164-008	RESISTOR, VARIABLE: 2,000 ohms, 10%, 3/4 W; mfr 80294, no. 3009P-1-202
510164-010	RESISTOR, VARIABLE: 10,000 ohms, 10%, 3/4 W; mfr 80294, no. 3009P-1-103
510164-012	RESISTOR, VARIABLE: 50,000 ohms, 10%, 3/4 W; mfr 80294, no. 3009P-1-503
510230-008	CAPACITOR, FIXED. MICA: 1,298 pf, 1%, 300V; mfr 00853, no. D19S3D122F0-1298
510230-014	CAPACITOR, FIXED, MICA: 2,600 pf, 1%, 300V; mfr 00853, no. D19S3D262F0
510230-015	CAPACITOR, FIXED, MICA: 5,200 pf, 1%, 300V; mfr 00853, no. D19S3D522F0

SANGAMO PART NO.	NAME AND DESCRIPTION
510240-002	INTEGRATED CIRCUIT: opnl ampl; mfr 01295, no. SN72741P
510240-006	INTEGRATED CIRCUIT: opnl ampl; mfr 01295, no. SN72310P
510303-001	TRANSISTOR: silicon, field effect; mfr 04713, no. 2N4861
510334-001	CAPACITOR, FIXED, CERAMIC: 2.2 uf, 20%, 100 V; mfr 96733, no. DB48BU225M
510339-003	INTEGRATED CIRCUIT: differential comparator, mfr 01295, no. SN72820N
510349-011	RESISTOR, VARIABLE: 20,000 ohms, 5%, 3/4 W; mfr 80294, no. 3009P-N64-203
510349-013	RESISTOR, VARIABLE: 100 K ohms, 5%, 3/4 W; mfr 80294, no. 3009P-N64-104
510360	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N4265
510364	TRANSISTOR: silicon, PNP; mfr 04713, no. MPS3640
510375-002	CAPACITOR, FIXED, CERAMIC: .02 uf, +80 -20, 25 V; mfr 71590, no. CRL.022ZY5F25V
510376-002	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4001AE
510376-012	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4011AE
510376-013	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4012AE
510376-014	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4013AE
510376-017	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4016AE
510376-024	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4023AE
510376-025	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4024AE
510376-026	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4025AE
510376-028	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4027AE
510376-029	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4029AE
510376-034	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4049AE
510376-038	INTEGRATED CIRCUIT: cos mos; mfr 04713, no. MC14511CP
510376-039	INTEGRATED CIRCUIT: cos mos, mfr 95303, no. CD4046AE
510376-040	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4051AE
510376-041	INTEGRATED CIRCUIT: cos mos; mfr 95303, no. CD4052AE
510376-042	INTEGRATED CIRCUIT: cos mos; mfr 31019, no. SCL4416AE
510388-001	RELAY, REED: 8 pin; 4 V, 0.12 amp; mfr 94696, no. W107DIP-1
510388-002	RELAY, REED: 8 pin; 4 V, 0.12 amp; mfr 94696, no. W117DIP-9
510408-017	RESISTOR, FIXED, FILM: 4.7 ohms, 5%, 1/4 W; mfr 91637 no. R25-4.7
510408-025	RESISTOR, FIXED, FILM: 10 ohms, 5%, 1/4 W; mfr 91637 no. R25-10
510408-033	RESISTOR, FIXED, FILM: 22 ohms, 5%, 1/4 W; mfr 91637 no. R25-22
510408-037	RESISTOR, FIXED, FILM: 33 ohms, 5%, 1/4 W; mfr 91637 no. R25-33
510408-041	RESISTOR, FIXED, FILM: 47 ohms, 5%, 1/4 W; mfr 91637 no. R25-47
510408-043	RESISTOR, FIXED, FILM: 56 ohms, 5%, 1/4 W; mfr 91637 no. R25-56

SANGAMO PART NO.	NAME AND DESCRIPTION
510408-045	RESISTOR, FIXED, FILM: 68 ohms, 5%, 1/4 W; mfr 91637 no. R25-68
510408-047	RESISTOR, FIXED, FILM: 82 ohms, 5%, 1/4 W; mfr 91637 no. R25-82
510408-049	RESISTOR, FIXED, FILM: 100 ohms, 5%, 1/4 W; mfr 91637 no. R25-100
510408-051	RESISTOR, FIXED, FILM: 120 ohms, 5%. 1/4 W; mfr 91637 no. R25-120
510408-053	RESISTOR, FIXED, FILM: 150 ohms, 5%, 1/4 W; mfr 91637 no. R25-150
510408-055	RESISTOR, FIXED, FILM: 180 ohms, 5%, 1/4 W; mfr 91637 no. R25-180
510408-057	RESISTOR, FIXED, FILM: 220 ohms, 5%, 1/4 W; mfr 91637 no. R25-220
510408-059	RESISTOR, FIXED, FILM; 270 ohms, 5%, 1/4 W; mfr 91637 no. R25-270
510408-061	RESISTOR, FIXED, FILM: 330 ohms, 5%, 1/4 W; mfr 91637 no. R25-330
510408-065	RESISTOR, FIXED, FILM: 470 ohms, 5%, 1/4 W; mfr 91637 no. R25-470
510408-067	RESISTOR, FIXED, FILM: 560 ohms, 5%, 1/4 W; mfr 91637 no. R25-560
510408-069	RESISTOR, FIXED, FILM: 680 ohms, 5%, 1/4 W; mfr 91637 no. R25-680
510408-071	RESISTOR, FIXED, FILM: 820 ohms, 5%, 1/4 W; mfr 91637 no. R25-820
510408-073	RESISTOR, FIXED, FILM: 1,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-1K
510408-075	RESISTOR, FIXED, FILM: 1,200 ohms, 5%, 1/4 W; mfr 91637 no. R25-1.2K
510408-077	RESISTOR, FIXED, FILM: 1,500 ohms, 5%, 1/4 W; mfr 91637 no. R25-1.5K
510408-079	RESISTOR, FIXED, FILM: 1,800 ohms, 5%, 1/4 W; mfr 91637 no. R25-1.8K
510408-081	RESISTOR, FIXED, FILM: 2,200 ohms, 5%, 1/4 W; mfr 91637 no. R25-2.2K
510408-083	RESISTOR, FIXED, FILM: 2,700 ohms, 5%, 1/4 W; mfr 91637 no. R25-2.7K
510408-085	RESISTOR, FIXED, FILM: 3,300 ohms, 5%, 1/4 W; mfr 91637 no. R25-3.3K
510408-087	RESISTOR, FIXED, FILM: 3,900 ohms, 5%, 1/4 W; mfr 91637 no. R25-3.9K
510408-089	RESISTOR, FIXED, FILM: 4,700 ohms, 5%, 1/4 W; mfr 91637 no. R25-4.7K
510408-090	RESISTOR, FIXED, FILM: 5,100 ohms, 5%, 1/4 W; mfr 91637 no. R25-5.1K
510408-091	RESISTOR, FIXED, FILM: 5,600 ohms, 5%, 1/4 W; mfr 91637 no. R25-5.6K
510408-093	RESISTOR, FIXED, FILM: 6,800 ohms, 5%, 1/4 W; mfr 91637 no. R25-6.8K
510408-095	RESISTOR, FIXED, FILM: 8,200 ohms, 5%, 1/4 W; mfr 91637 no. R25-8.2K
510408-097	RESISTOR, FIXED, FILM: 10,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-10K
510408-099	RESISTOR, FIXED, FILM: 12,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-12K
510408-101	RESISTOR, FIXED, FILM: 15,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-15K
510408-103	RESISTOR, FIXED, FILM: 18,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-18K
510408-105	RESISTOR, FIXED, FILM: 22,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-22K
510408-107	RESISTOR, FIXED, FILM: 27,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-27K
510408-109	RESISTOR, FIXED, FILM: 33,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-33K

SANGAMO PART NO.	NAME AND DESCRIPTION
510408-111	RESISTOR, FIXED, FILM: 39,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-39K
510408-113	RESISTOR, FIXED, FILM: 47,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-47K
510408-117	RESISTOR, FIXED, FILM: 68,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-68K
510408-121	RESISTOR, FIXED, FILM: 100,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-100K
510408-125	RESISTOR, FIXED, FILM: 150,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-150K
510408-129	RESISTOR, FIXED, FILM: 220,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-220K
510408-131	RESISTOR, FIXED, FILM: 270,000 ohms, 5%, 1/4 W; mfr 91637 no. R25-270K
510408-133	RESISTOR, FIXED, FILM: 330,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-330K
510408-135	RESISTOR, FIXED, FILM: 390,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-390K
510408-137	RESISTOR, FIXED, FILM: 470,000 ohms, 5%, 1/4 W; mfr 91637, no. R25-470K
510408-145	RESISTOR, FIXED, FILM: 1 meg ohms, 5%, 1/4 W; mfr 91637, no. R25-1 meg
510408-151	RESISTOR, FIXED, FILM: 1.8 meg ohms, 5%, 1/4 W; mfr 91637, no. R25-1.8 meg
510408-153	RESISTOR, FIXED, FILM: 2.2 meg ohms, 5%, 1/4 W; mfr 91637, no. R25-2.2 meg
510409-015	RESISTOR, FIXED, FILM: 3.9 ohms, 5%, 1/2 W; mfr 91637, no. R50-3.9
510409-031	RESISTOR, FIXED, FILM: 18 ohms, 5%, 1/2 W; mfr 91637, no. R50-18
510409-037	RESISTOR, FIXED, FILM: 33 ohms, 5%, 1/2 W; mfr 91637, no. R50-33
510409-041	RESISTOR, FIXED, FILM: 47 ohms, 5%, 1/2 W; mfr 91637, no. R50-47
510409-049	RESISTOR, FIXED, FILM: 100 ohms, 5%, 1/2 W; mfr 91637, no.R50-100
510409-057	RESISTOR, FIXED, FILM: 220 ohms, 5%, 1/2 W; mfr 91637, no. R50-220
510409-063	RESISTOR, FIXED, FILM: 390 ohms, 5%, 1/2 W; mfr 91637, no. R50-390
510409-073	RESISTOR, FIXED, FILM: 1,000 ohms, 5%, 1/2 W; mfr 91637, no. R50-1K
510409-077	RESISTOR, FIXED, FILM: 1,500 ohms, 5%, 1/2 W; mfr 91637, no. R50-1.5K
510409-089	RESISTOR, FIXED, FILM: 4,700 ohms, 5%, 1/2 W; mfr 91637, no. R50-4.7K
510429-025	CAPACITOR, FIXED, CERAMIC: 1.0 uf, 20%, 50 V; mfr 20932, no. 5030-1
510433	INTEGRATED CIRCUIT: comparator; mfr 04713, no. MC3302P
510434-001	INTEGRATED CIRCUIT: nand gates; mfr 01295, no. SN74LS00N
510434-038	INTEGRATED CIRCUIT: demultiplexer; mfr 01295, no. SN74LS138N
510434-040	INTEGRATED CIRCUIT: multiplexer; mfr 01295, no. SN74LS151N
510434-054	INTEGRATED CIRCUIT: divide by two; mfr 01295, no. SN74LS197N
510446	TRANSISTOR: silicon, NPN; mfr 04713, no. 2219A
510447	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N2905A
510450-143	RESISTOR, FIXED, FILM: 1,430 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD1431F
510450-196	RESISTOR, FIXED, FILM: 1,960 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD1961F
510450-287	RESISTOR, FIXED, FILM: 2,870 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD2871F

SANGAMO PART NO.	NAME AND DESCRIPTION
510450-392	RESISTOR, FIXED, FILM: 3,920 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD3921F
510450-576	RESISTOR, FIXED, FILM: 5,760 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD5761F
510450-787	RESISTOR, FIXED, FILM: 7,870 ohms, 1%, 1/8 W; mfr 19701, no. MF4CD7871F
510451-115	RESISTOR, FIXED, FILM: 11.5 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD1152F
510451-158	RESISTOR, FIXED, FILM: 15.8 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD1582F
510451-232	RESISTOR, FIXED, FILM; 23.2 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD2322F
510451-316	RESISTOR, FIXED, FILM: 31.6 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD3162F
510451-464	RESISTOR, FIXED, FILM: 46.4 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD4642F
510451-619	RESISTOR, FIXED, FILM: 61.9 K ohms, 1%, 1/8 W; mfr 19701, no. MF4CD6192F
510453	INTEGRATED CIRCUIT: opnl ampl; mfr 18324, no. NE531V
510454	SEMICONDUCTOR DEVICE, DIODE: silicon; mfr 04713, no. IN4934
510455	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N3866
510457	INTEGRATED CIRCUIT: opnl ampl; mfr 04713, no. MC1420G
510458	INTEGRATED CIRCUIT: voltage comparator; mfr 18324, no. NE527K
510459-073	CAPACITOR, FIXED, MICA: 73 pf, 1%, 500 V; mfr Miconics Ind, no. RDM15ED730F
510460	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N4403
510461	SEMICONDUCTOR DEVICE, DIODE: LED, 4 digit, 7 seg; mfr 50579, no. DATA-LIT34
510465	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N5879
510466	SWITCH, PUSH: SPST, N.O., momentary; mfr 29090, no. LM
510467	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N5881
510469	DIODE, RECTIFIER: fast recovery; mfr 04713, no. MR852
510472-215	CAPACITOR, FIXED, MICA: 215 pf, 1%, 100 V; mfr Miconics Ind, no. RDM15FD221F
510472-261	CAPACITOR, FIXED, MICA: 261 pf, 1%, 100 V; mfr Miconics Ind, no. RDM15FD261F
510472-332	CAPACITOR, FIXED, MICA: 332 pf, 1%, 100 V; mfr Miconics Ind, no. RDM15FD331F
510472-750	CAPACITOR, FIXED, MICA: 750 pf, 1%, 100 V; mfr Miconics Ind, no. RDM15FC751F
510472-976	CAPACITOR, FIXED, MICA: 976 pf, 1%, 100 V; mfr Miconics Ind, no. RDM15FA102F
510473	TRANSISTOR: silicon, NPN; mfr 04713, no. MJE200
510474	DIODE, INFRARED EMITTING: mfr 04713, no. MLED900
510475	TRANSISTOR: silicon, NPN; mfr 04713, no. MRD450
510477-001	CAPACITOR, FIXED, MICA: 1,180 pf, 1%, 100 V; mfr Miconics, no. RDM15DA1181F03
510478-001	CAPACITOR, FIXED, MYLAR: .00118 uf, 1%, 100 V; mfr 27735, no. PE11-.00118-100-1
510478-002	CAPACITOR, FIXED, MYLAR: .00137 uf, 1%, 100 V; mfr 27735, no. PE11-.00137-100-1
510478-003	CAPACITOR, FIXED, MYLAR: .00205 uf, 1%, 100 V; mfr 27735, no. PE11-.00205-100-1

SANGAMO PART NO.	NAME AND DESCRIPTION
510478-004	CAPACITOR, FIXED, MYLAR: .00340 uf, 1%, 100 V; mfr 27735, no. PE11-.00340-100-1
501478-005	CAPACITOR, FIXED, MYLAR: .00412 uf, 1%, 100 V; mfr 27735, no. PE11-.00412-100-1
510478-006	CAPACITOR, FIXED, MYLAR: .00536 uf, 1%, 100 V; mfr 27735, no. PE11-.00536-100-1
510478-007	CAPACITOR, FIXED, MYLAR: .0121 uf, 1%, 100 V; mfr 27735, no. PE11-.0121-100-1
510478-008	CAPACITOR, FIXED, MYLAR: .0154 uf, 1%, 100 V; mfr 27735, no. PE11-.0154-100-1
510478-009	CAPACITOR, FIXED, MYLAR: .0191 uf, 1%, 100 V; mfr 27735, no. PE11-.0191-100-1
510478-010	CAPACITOR, FIXED, MYLAR: .0215 uf, 1%, 100 V; mfr 27735, no. PE11-.0215-100-1
510478-011	CAPACITOR, FIXED, MYLAR: .0332 uf, 1%, 100 V; mfr 27735, no. PE11-.0332-100-1
510478-012	CAPACITOR, FIXED, MYLAR: .0104 uf, 1%, 100 V; mfr 27735, no. PE11-.0104-100-1
510478-013	CAPACITOR, FIXED, MYLAR: .0208 uf, 1%, 100 V; mfr 27735, no. PE11-.0208-100-1
510479	RELAY, MINIATURE DUAL: 5 V; mfr 00779, no. 53451-1
510480	BATTERY, DRY: 1.25 V; mfr 34122, no. S-101
510482	INTERRUPTER, PHOTON COUPLED: solid state lamp, photo-transistor: mfr 03508, no. H13A1
510483	OSCILLATOR, CRYSTAL: 7.2 MHz; mfr 75378, no. 133-0049-1121
510484	SWITCH, ROTARY: 1 sect, 8 posn; mfr 76854, no. 5-12141-322
510485	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N4912
510486-003	RELAY, ART: 14 cont; mfr 73949, no. 1315-4C-24D
510487-002	MOTOR, TACHOMETER: capstan; 28 V, 3300 rpm; mfr 16858, no. 11431-11343-2
510488-003	RELAY, ART: 110 vdc; mfr 77342, no. KR3DH110
510489	TERMINAL: circuit board; mfr 00779, no. 85864-4
510490-005	TERMINAL STRIP: gnd; 6 term; mfr 83330, no. 3006
510490-009	TERMINAL STRIP: gnd; 10 term; mfr 83330, no. 3010
510491	SWITCH, ROTARY: 2 sect, 16 posn; mfr 81073, no. 57M22-02-1-16NF
510493	TERMINAL: circuit board; mfr 00779, no. 61134-1
510494-001	CAPACITOR, FIXED, ELCTLT: 450 uf, -10% +75%, 50V; mfr 90201, no. TT50X450
510494-003	CAPACITOR, FIXED, ELCTLT: 1,500 uf, -10% +75%, 15 V; mfr 90201, no. TT15X1500
510495-001	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N6307
510495-002	TRANSISTOR: silcon, NPN; mfr 04713, no. 2N6308
510496	CAPACITOR, FIXED, ELCTLT: 1,400 uf, 200 V; mfr 56289, no. 36D142F200BC2A
510497-001	TERMINAL STRIP: 3 term; mfr 83330, no. 853
510497-002	TERMINAL STRIP: 6 term; mfr 83330, no. 854
510498	HOLDER, BATTERY: 4 battery; mfr 91833, no. 2182
510500	SPEAKER: magnetic, 45 ohms, 1.5 W; mfr 74199, no. 25A07Z45
510501	CONNECTOR, PLUG: less 30 pin; mfr 00779, no. 1-480589-9

SANGAMO PART NO.	NAME AND DESCRIPTION
510502	CONNECTOR, PLUG: less 30 sockets; mfr 00779, no. 1-480591-9
510505-002	PIN, CONNECTOR: male; mfr 00779, no. 350036-1
510506-002	SOCKET, CONNECTOR: female; mfr 00779, no. 350037-1
510507-005	CAPACITOR, FIXED, FILTER: .050 uf, 10 amp, 50 V; mfr 71590, no. 9200-503
510509	LAMP, SOLID STATE: 200 mw, 3 V, 70 ma; mfr 50347, no. OPL-1209-A
510517	METER, ELAPSED TIME: 2,000 hrs; mfr 18583, no. 120LA2000HR
510536-001	INVERTER, SOLIDSTATE: batac; 24 V, 22.5 V, 60 Hz; mfr 82877, no. BC183-105
510536-002	INVERTER, SOLIDSTATE: batac; 12 V, 10.5 V, 60 Hz; mfr 82877, no. BC178-100
510540	CAPACITOR, FIXED, ELCTLT: 540 uf, 450 V; mfr 56289, no. 36DX541F450BC2A
510541	TRANSISTOR: NPN, silicon; mfr 04713, no. 2N6274
510542-001	FUSE, CRTG: 1-6/10 amp, 250 V; mfr 71400, no. MDX-1-6/10
510542-002	FUSE, CRTG: 2 amp, 250 V; mfr 74100, no. MDX-2
510542-003	FUSE, CRTG: 3 amp, 125 V; mfr 71400, no. MDX-3
510542-004	FUSE, CRTG: 4 amp, 125 V; mfr 71400, no. MDX-4
510545	RECTIFIER: 100 V; mfr 83003, no. VR100XT
510569-001	DIODE, SUBMINIATURE: mfr 04713, no. MR820
510577-001	RESISTOR, WIREWOUND: 1.5 ohms, ±5%; mfr 44655, no. 4734
510734-004	TERMINAL BOARD: 4 termial, mfr 75382, no. 410-3/4ST-4
510804	DISPLAY, LIGHT EMITTING DIODE: mfr 50434, no. HP5082-7415
657506	BEARING, BALL: SRR, 11 ball, double shield; mfr 70854, no. SR168SS
691032	TERMINAL, STUD: brass; mfr 71279, no. X1558
691111-680	RESISTOR, FIXED, CMPSN: 68 ohms, 5%, 1/2 W; mfr 01121, no. EB6805
691112-220	RESISTOR, FIXED, CMPSN: 22 ohms, 5%, 1 W; mfr 01121, no. GB2205
691113-100	RESISTOR, FIXED, CMPSN: 10 ohms, 5%, 2 W; mfr 01121, no. HB1005
691391-001	CAPACITOR, FIXED, TANTALUM: 4.7 uf, 20%, 10 V; mfr 56289, no. 150D475X0010A2
691391-003	CAPACITOR, FIXED, TANTALUM: 4.7 uf, 20%, 35 V; mfr 56289, no. 150D475X9035B2
691391-005	CAPACITOR, FIXED, TANTALUM: 10 uf, 20%, 20 V; mfr 56289, no. 150D106X0020B2
691391-012	CAPACITOR, FIXED, TANTALUM: 22 uf, 10%, 15 V; mfr 56289, no. 150D226X9015B2
691391-016	CAPACITOR, FIXED, TANTALUM: 47 uf, 10%, 35 V; mfr 56289, no. 150D476X9020R2
691391-018	CAPACITOR, FIXED, TANTALUM: 56 uf, 10%, 15 V; mfr 56289, no. 150D566X9015B2
691391-033	CAPACITOR, FIXED, TANTALUM: 1 uf, 10%, 35 V; mfr 56289, no. 150D105X9035A2
691391-038	CAPACITOR, FIXED, TANTALUM: 0.47 uf, 5%, 35 V; mfr 56289, no. 150D474X0035A2
691391-050	CAPACITOR, FIXED, TANTALUM: 220 uf, 10%, 10 V; mfr 56289, no. 150D227X9010S2
691391-078	CAPACITOR, FIXED, TANTALUM: 2.2 uf, 10%, 20 V; mfr 56289, no. 150D225X0020A2
691686-001	CAPACITOR, FIXED, MYLAR: 0.01 uf, 20%, 80 V; mfr 56289, no. 192P1039R8
691686-008	CAPACITOR, FIXED, MYLAR: 0.001 uf, 10%, 200 V; mfr 56289, no. 192P10292
691686-012	CAPACITOR, FIXED, MYLAR: 0.015 uf, 10%, 80 V; mfr 56289, no. 192P1539R8
691686-014	CAPACITOR, FIXED, MYLAR: 0.10 uf, 10%, 80 V; mfr 56289, no. 192P1049R8
691686-015	CAPACITOR, FIXED, MYLAR: 0.0022 uf, 10%, 80 V; mfr 56289, no. 192P2229R8
691686-017	CAPACITOR, FIXED, MYLAR: .0015 uf, 10%, 200 V; mfr 56289, no. 192P15292

SANGAMO PART NO.	NAME AND DESCRIPTION
691686-018	CAPACITOR, FIXED, MYLAR: .0033 uf, 10%, 80 V; mfr 56289, no. 192P3329R8
691686-021	CAPACITOR, FIXED, MYLAR: 0.022 uf, 10%, 80 V; mfr 56289, no. 192P2239R8
691686-022	CAPACITOR, FIXED, MYLAR: .0047 uf, 10%, 80 V; mfr 56289, no. 192P4729R8
691686-024	CAPACITOR, FIXED, MYLAR: .0056 uf, 10%, 80 V; mfr 56289, no. 192P5629R8
691686-025	CAPACITOR, FIXED, MYLAR: .0027 uf, 10%, 80 V; mfr 56289, no. 192P2729R8
691686-026	CAPACITOR, FIXED, MYLAR: .0012 uf, 10%, 200 V; mfr 56289, no. 192P12292
691686-027	CAPACITOR, FIXED, MYLAR: 0.082 uf, 10%, 80 V; mfr 56289, no. 192P8239R8
691686-028	CAPACITOR, FIXED, MYLAR: .12 uf, 10%, 80 V; mfr 56289, no. 192P1249R8
691686-032	CAPACITOR, FIXED, MYLAR: .22 uf, 10%, 80 V; mfr 56289, no. 192P2249R8
691686-034	CAPACITOR, FIXED, MYLAR: .033 uf, 10%, 80 V; mfr 56289, no. 192P3339R8
691686-035	CAPACITOR, FIXED, MYLAR: 0.0039 uf, 10%, 80 V; mfr 56289, no. 192P3929R8
691686-044	CAPACITOR, FIXED, MYLAR: .0082 uf, 5%, 80 V; mfr 56289, no. 192P8229R8
691686-047	CAPACITOR, FIXED, MYLAR: .015 uf, 5%, 80 V; mfr 56289, no. 192P1539R8
691686-055	CAPACITOR, FIXED, MYLAR: .068 uf, 10%, 80 V; mfr 56289, no. 192P6839R8
691686-061	CAPACITOR, FIXED, MYLAR: .22 uf, 5%, 80 V; mfr 56289, no. 192P2249R8
692537-119	CAPACITOR, FIXED, ELCTLT: 20 uf, 100V; mfr 00853, no. 692537-119
695865-001	CONNECTOR, RCPT: male, 25 pin; mfr 71785, no. DB-19604-432
695865-002	CONNECTOR, RCPT: male, 37 pin; mfr 71785, no. DC-19605-402
695865-003	CONNECTOR, RCPT: female, 37 socket; mfr 71785, no. DC-19605-403
695865-004	CONNECTOR, RCPT: female, 25 socket; mfr 71785, no. DB-25S-C33
812299	FUSEHOLDER: 250 V, 30 amp; mfr 71400, no. FDI
835018	PINCH ROLL ASSY: mfr 53021
835346	LENS: dbl cvx, 14 mm dia; mfr 97197, no. 94707
835887-008	CONNECTOR, RECEPTACLE: female, 15 pin; mfr 29587, no. 143-015-01-1010
836269	CONTACT, ELEC: male; mfr 00779, no. 85931-2
836568	BELT, TIMING: 65 teeth, 4.138 PD; mfr 90179, no. 130XL025T4NI
836573	REEL DRIVE HOUSING ASSY: mfr 53021
836574	MOTOR, DC: reel drive; mfr 33866, no. MH-3210-070 (D)
836629	CIRCUIT CARD ASSY: Capstan "A"; mfr 53021
836631	CIRCUIT CARD ASSY: Capstan "B"; mfr 53021
836633	CIRCUIT CARD ASSY: Control logic; mfr 53021
836635	CIRCUIT CARD ASSY: reel drive amp; mfr 53021
836637	CIRCUIT CARD ASSY: power supply osc; mfr 53021
836639	CIRCUIT CARD ASSY: power supply rgltr; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
836641-002	CIRCUIT CARD ASSY: FM record; mfr 53021
836641-003	CIRCUIT CARD ASSY: FM record, 216 KHz, I.B.; mfr 53021
836641-004	CIRCUIT CARD ASSY: FM record, 432 kHz, W.B.I.; mfr 53021
836641-005	CIRCUIT CARD ASSY: FM record, 900 kHz, W.B.II.; mfr 53021
836643	CIRCUIT CARD ASSY: direct record; mfr 53021
836645	CIRCUIT CARD ASSY: AGC voice; mfr 53021
836646	CIRCUIT CARD ASSY: AGC time code record amp; mfr 53021
836648	CIRCUIT CARD ASSY: footage counter; mfr 53021
836650-001	CIRCUIT CARD ASSY: T.P.M. display, record; mfr 53021
836650-002	CIRCUIT CARD ASSY: T.P.M. display, reproduce; mfr 53021
836652-001	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "A", L.B.; mfr 53021
836652-002	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "A", I.B.; mfr 53021
836652-003	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "A", W.B.I.; mfr 53021
836652-004	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "A", W.B.II; mfr 53021
836654-001	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "B", L.B.; mfr 53021
836654-002	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "B", I.B.; mfr 53021
836654-003	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "B", W.B.I.; mfr 53021
836654-004	CIRCUIT CARD ASSY: T.P.M. – FM Reproduce "B", W.B.II; mfr 53021
836656-002	CIRCUIT CARD ASSY: T.P.M. – direct reproduce "A", I.B.; mfr 53021
836656-003	CIRCUIT CARD ASSY: T.P.M. – direct reproduce "A", W.B.; mfr 53021
836658-002	CIRCUIT CARD ASSY: 1/2 in. direct reproduce, I.B.; mfr 53021
836658-003	CIRCUIT CARD ASSY: 1/2 in. direct reproduce, W.B.; mfr 53021
836660-002	CIRCUIT CARD ASSY: 1/2 in. FM reproduce, I.B.; mfr 53021
836660-003	CIRCUIT CARD ASSY: 1/2 in. FM reproduce, I.B.; mfr 53021
836660-004	CIRCUIT CARD ASSY: 1/2 in. FM reproduce, W.B.I.; mfr 53021
836660-005	CIRCUIT CARD ASSY: 1/2 in. FM reproduce, W.B.II; mfr 53021
836662	CIRCUIT CARD ASSY: 1/2 in. voice reproduce; mfr 53021
836664	CIRCUIT CARD ASSY: tape sync; mfr 53021
836672	SOCKET, PIN: solder - in; mfr 06776, no. 001-004-A
836693	PIN, CONTACT: miniature; mfr 53021
836694	PIN, CONTACT: miniature; mfr 53021
836698-001	CIRCUIT CARD ASSY: lo-pass filter, 900 kHz; mfr 53021
836698-002	CIRCUIT CARD ASSY: lo-pass filter, 450 kHz; mfr 53021
836698-003	CIRCUIT CARD ASSY: lo-pass filter, 225 kHz; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
836698-004	CIRCUIT CARD ASSY: lo-pass filter, 112.5 kHz; mfr 53021
836698-005	CIRCUIT CARD ASSY: lo-pass filter, 56.2 kHz; mfr 53021
836698-006	CIRCUIT CARD ASSY: lo-pass filter, 28.1 kHz; mfr 53021
836698-007	CIRCUIT CARD ASSY: lo-pass filter, 14 kHz; mfr 53021
836698-008	CIRCUIT CARD ASSY: lo-pass filter, 3.9 kHz; mfr 53021
836698-009	CIRCUIT CARD ASSY: lo-pass filter, 432 kHz; mfr 53021
836698-010	CIRCUIT CARD ASSY: lo-pass filter, 216 kHz; mfr 53021
836698-011	CIRCUIT CARD ASSY: lo-pass filter, 108 kHz; mfr 53021
836698-012	CIRCUIT CARD ASSY: lo-pass filter, 54 kHz; mfr 53021
836698-013	CIRCUIT CARD ASSY: lo-pass filter, 27 kHz; mfr 53021
836698-014	CIRCUIT CARD ASSY: lo-pass filter, 13.5 kHz; mfr 53021
836698-015	CIRCUIT CARD ASSY: lo-pass filter, 6.75 kHz; mfr 53021
836698-016	CIRCUIT CARD ASSY: lo-pass filter, 3.375 kHz; mfr 53021
836698-017	CIRCUIT CARD ASSY: lo-pass filter, 1.688 kHz; mfr 53021
836698-018	CIRCUIT CARD ASSY: lo-pass filter, .844 kHz; mfr 53021
836700	PIN, CONNECTOR: male; mfr 53021
836701	PIN, MINIATURE: male; mfr 53021
836712-001	CIRCUIT CARD ASSY: dual emitter follower, 4 chan; mfr 53021
836712-002	CIRCUIT CARD ASSY: dual emitter follower, 4 chan; mfr 53021
836712-003	CIRCUIT CARD ASSY: dual emitter follower, 8 chan; mfr 53021
836712-004	CIRCUIT CARD ASSY: dual emitter follower, 8 chan; mfr 53021
836714	CIRCUIT CARD ASSY: tape sync preamp; mfr 53021
836730-001	ROLLER ASSY: translation; 1 in.; mfr 53021
836730-002	ROLLER ASSY: translation; 1/2 in.; mfr 53021
836730-003	ROLLER ASSY: guide; 1/2 in.; mfr 53021
836731-001	ROLLER: 1/2 in.; mfr 53021
836731-002	ROLLER: 1 in.; mfr 53021
836731-003	ROLLER: 1-1/8 in.; mfr 53021
836731-004	ROLLER: 1/2 in.; mfr 53021
836731-005	ROLLER: 1 in.; mfr 53021
836731-006	ROLLER: 1/2 in.; mfr 53021
836731-007	ROLLER: 1/2 in.; mfr 53021
836736	PINCH ROLL ASSY: 1/2 in.; mfr 53021
836753-008	RESISTOR AND PIN ASSY: 120 ohms; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
836753-009	RESISTOR AND PIN ASSY: 220 ohms; mfr 53021
836753-010	RESISTOR AND PIN ASSY: 270 ohms; mfr 53021
836753-013	RESISTOR AND PIN ASSY: 470 ohms; mfr 53021
836753-015	RESISTOR AND PIN ASSY: 820 ohms; mfr 53021
836753-016	RESISTOR AND PIN ASSY: 1 K ohms; mfr 53021
836753-020	RESISTOR AND PIN ASSY: 3.3 K ohms; mfr 53021
836753-021	RESISTOR AND PIN ASSY: 5.6 K ohms; mfr 53021
836753-023	RESISTOR AND PIN ASSY: 9.53 K ohms; mfr 53021
836753-024	RESISTOR AND PIN ASSY: 20 K ohms; mfr 53021
836753-025	RESISTOR AND PIN ASSY: 2.7 K ohms; mfr 53021
836753-026	RESISTOR AND PIN ASSY: 6.8 K ohms; mfr 53021
836753-027	RESISTOR AND PIN ASSY: 150 ohms; mfr 53021
836753-028	RESISTOR AND PIN ASSY: 1.5 K ohms; mfr 53021
836758	PANEL, VENTILATING: 4-1/4 in. sq; mfr 07700
836776	FILTER, AIR: mfr by 53021
836819-002	CIRCUIT CARD ASSY: 1 in. direct reproduce, I.B.; mfr 53021
836819-003	CIRCUIT CARD ASSY: 1 in. direct reproduce, W.B.; mfr 53021
836820-002	CIRCUIT CARD ASSY: 1 in. FM reproduce, L.B.; mfr 53021
836820-003	CIRCUIT CARD ASSY: 1 in. FM reproduce, I.B.; mfr 53021
836820-004	CIRCUIT CARD ASSY: 1 in. FM reproduce, W.B.I; mfr 53021
836820-005	CIRCUIT CARD ASSY: 1 in. FM reproduce, W.B.II; mfr 53021
836821	CIRCUIT CARD ASSY: 1 in. voice reproduce; mfr 53021
836829	CIRCUIT CARD ASSY: control panel; mfr 53021
836863	SWITCH, DPDT: push lock/push release; mfr 82389, no. 71017-206
836875	VANE, TENSION ARM: mfr 53021
836876-001	TENSION ARM VANE ASSY: lower, 1/2 in.; mfr 53021
836876-002	TENSION ARM VANE ASSY: upper, 1/2 in.; mfr 53021
836876-003	TENSION ARM VANE ASSY: lower, 1 in.; mfr 53021
836876-004	TENSION ARM VANE ASSY: upper, 1 in.; mfr 53021
836901	CIRCUIT CARD ASSY: end of tape xmtr; mfr 53021
836903	CIRCUIT CARD ASSY: end of tape rcvr; mfr 53021
836905-001	CIRCUIT CARD ASSY: light emitting diode, 1 pos; mfr 53021
836905-002	CIRCUIT CARD ASSY: light emitting diode, 22 pos; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
836905-003	CIRCUIT CARD ASSY: light emitting diode; 23 pos; mfr 53021
836907	CIRCUIT CARD ASSY: footage reset; mfr 53021
836909	CIRCUIT CARD ASSY: record extender; mfr 53021
836911	CIRCUIT CARD ASSY: logic extender; mfr 53021
836913	CIRCUIT CARD ASSY: display extender; mfr 53021
836915	CIRCUIT CARD ASSY: 1/2 in. reproduce extender; mfr 53021
836967-001	TENSION ARM ASSY: 1 in., inner; mfr 53021
836967-002	TENSION ARM ASSY: 1 in., outer; mfr 53021
836967-003	TENSION ARM ASSY: 1/2 in., inner; mfr 53021
836967-004	TENSION ARM ASSY: 1/2 in., outer; mfr 53021
836977-001	CIRCUIT CARD ASSY: T.P.M. direct reproduce "B" I.B.; mfr 53021
836977-002	CIRCUIT CARD ASSY: T.P.M. direct reproduce "B", W.B.I; mfr 53021
836977-003	CIRCUIT CARD ASSY: T.P.M. direct reproduce "B", W.B.II; mfr 53021
837019-001	TRANSFORMER, AF: 120 V pri., 18.2 vac sec; mfr 00853, no. 837024-001
837020	TRANSFORMER, DRIVER: 18 kHz; mfr 53021
837021-001	CAPACITOR, FIXED, MATCHED PAIR: .0075 uf, 1%; mfr 53021
837021-003	CAPACITOR, FIXED, MATCHED PAIR: .020 uf, 1%; mfr 53021
837021-005	CAPACITOR, FIXED, MATCHED PAIR: .050 uf, 1%; mfr 53021
837026	CONTROL PANEL ASSY: mfr 53021
837029	CIRCUIT CARD ASSY: 1 in. tape sync preamp; mfr 53021
837031-001	CIRCUIT CARD ASSY: direct equalizer, 120 ips, I.B.; mfr 53021
837031-002	CIRCUIT CARD ASSY: direct equalizer, 60 ips, I.B.; mfr 53021
837031-003	CIRCUIT CARD ASSY: direct equalizer, 30 ips, I.B.; mfr 53021
837031-004	CIRCUIT CARD ASSY: direct equalizer, 15 ips, I.B.; mfr 53021
837031-005	CIRCUIT CARD ASSY: direct equalizer, 7-1/2 ips, I.B.; mfr 53021
837031-006	CIRCUIT CARD ASSY: direct equalizer, 3-3/4 ips, I.B.; mfr 53021
837031-007	CIRCUIT CARD ASSY: direct equalizer, 1-7/8 ips, I.B.; mfr 53021
837031-008	CIRCUIT CARD ASSY: direct equalizer, 15/16 ips, I.B.; mfr 53021
837031-009	CIRCUIT CARD ASSY: direct equalizer, 120 ips, W.B.I; mfr 53021
837031-010	CIRCUIT CARD ASSY: direct equalizer, 60 ips, W.B.I; mfr 53021
837031-011	CIRCUIT CARD ASSY: direct equalizer, 30 ips, W.B.I; mfr 53021
837031-012	CIRCUIT CARD ASSY: direct equalizer, 15 ips, W.B.I; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
837031-013	CIRCUIT CARD ASSY: direct equalizer, 7-1/2 ips, W.B.I; mfr 53021
837031-014	CIRCUIT CARD ASSY: direct equalizer, 3-3/4 ips, W.B.I; mfr 53021
837031-015	CIRCUIT CARD ASSY: direct equalizer, 1-7/8 ips, W.B.I; mfr 53021
837031-016	CIRCUIT CARD ASSY: direct equalizer, 15/16 ips, W.B.I; mfr 53021
837031-017	CIRCUIT CARD ASSY: direct equalizer, 120 ips, W.B.II; mfr 53021
837031-018	CIRCUIT CARD ASSY: direct equalizer, 60 ips, W.B.II; mfr 53021
837031-019	CIRCUIT CARD ASSY: direct equalizer, 30 ips, W.B.II; mfr 53021
837031-020	CIRCUIT CARD ASSY: direct equalizer, 15 ips, W.B.II; mfr 53021
837031-021	CIRCUIT CARD ASSY: direct equalizer, 7-1/2 ips, W.B.II; mfr 53021
837031-022	CIRCUIT CARD ASSY: direct equalizer, 3-3/4 ips, W.B.II; mfr 53021
837031-023	CIRCUIT CARD ASSY: direct equalizer, 1-7/8 ips, W.B.II; mfr 53021
837031-024	CIRCUIT CARD ASSY: direct equalizer, 15/16 ips, W.B.II; mfr 53021
837031-025	CIRCUIT CARD ASSY: direct equalizer, all speed, W.B.; mfr 53021
837031-026	CIRCUIT CARD ASSY: direct equalizer, all speed, I.B.; mfr 53021
837040	CIRCUIT CARD ASSY: 1 in. reproduce extender; mfr 53021
837048-001	PINCH ROLL ARM ASSY: 1 in., L.H.; mfr 53021
837048-002	PINCH ROLL ARM ASSY: 1 in., R.H.; mfr 53021
837048-003	PINCH ROLL ARM ASSY: 1/2 in., L.H.; mfr 53021
837048-004	PINCH ROLL ARM ASSY: 1/2 in., R.H.; mfr 53021
837063-001	RECORD HEAD ASSY: 1/2 in., I.B., 7 trk; mfr 53021
837063-002	REPRODUCE HEAD ASSY: 1/2 in., I.B., 7 trk; mfr 53021
837063-003	RECORD HEAD ASSY: 1 in., I.B., 14 trk; mfr 53021
837063-004	REPRODUCE HEAD ASSY: 1 in., I.B., 14 trk; mfr 53021
837076	BEARING, BALL: SRR, open; mfr 23043 no. R2/2A
837077	PHOTO CELL ASSY: mfr 53021
837078-001	CAPACITOR AND PIN ASSY: 33 pf; mfr 53021
837078-002	CAPACITOR AND PIN ASSY: 75 pf; mfr 53021
837078-003	CAPACITOR AND PIN ASSY: 150 pf; mfr 53021
837078-004	CAPACITOR AND PIN ASSY: 300 pf; mfr 53021
837078-005	CAPACITOR AND PIN ASSY: 650 pf; mfr 53021
837078-006	CAPACITOR AND PIN ASSY: 1,298 pf; mfr 53021
837078-007	CAPACITOR AND PIN ASSY: 2,600 pf; mfr 53021
837078-008	CAPACITOR AND PIN ASSY: 5,200 pf; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
837078-015	CAPACITOR AND PIN ASSY: 70 pf; mfr 53021
837078-016	CAPACITOR AND PIN ASSY: 150 pf; mfr 53021
837078-017	CAPACITOR AND PIN ASSY: 300 pf; mfr 53021
837078-018	CAPACITOR AND PIN ASSY: 600 pf; mfr 53021
837078-019	CAPACITOR AND PIN ASSY: .0015 uf; mfr 53021
837078-020	CAPACITOR AND PIN ASSY: .0033 uf; mfr 53021
837078-022	CAPACITOR AND PIN ASSY: 650 pf; mfr 53021
837080	INERTIA ROLLER ASSY: mfr 53021
837083	ROLLER ASSY: inertia roller; mfr 53021
837089	KNOB, SWITCH: mfr 08730, no. 2-50-2-B
837098	TERMINAL STRIP: 5 term; mfr 53021
837099	FILTER, LIGHT: red; mfr 53021
837101-001	POWER SUPPLY: 117 vac; mfr 53021
837101-002	POWER SUPPLY: 230 vac; mfr 53021
837101-003	POWER SUPPLY: 12 vdc; mfr 53021
837101-004	POWER SUPPLY: 26 vdc; mfr 53021
837102	CHASSIS ASSY: rectifier, power supply; mfr 53021
837105	CHASSIS ASSY: 7 trk, rcd/repro; mfr 53021
837107	REEL KNOB ASSY: mfr 53021
837114	HEAT SINK ASSY: mfr 53021
837115	CONNECTOR, PLUG: male housing, 28 pin; mfr 53021
837118	CONNECTOR PANEL ASSY: 7 trk, rcd/repro; mfr 53021
837123	SOLENOID: 24 vdc; mfr 27190, no. 408
837124	SPRING, EXTENSION: pinch roll; 1.125 in. lg; mfr 84830, no. LE-037CD-2
837129	CONNECTOR PANEL ASSY: 14 trk, rcd; mfr 53021
837132	TERMINAL PLATE ASSY: feed thru; mfr 53021
837138	CONNECTOR PANEL ASSY: 14 trk, rcd/repro; mfr 53021
837162	CABLE ASSY: remote control; mfr 53021
837166	TAPE RECORDER ASSY: 1/2 in. rcd; small case; mfr 53021
837167	TAPE RECORDER ASSY: 1 in. rcd; small case; mfr 53021
837168	TAPE RECORDER ASSY: 1/2 in. rcd/repro; small case; mfr 53021
837169	TAPE RECORDER ASSY: 1/2 in. rcd/repro; large case; mfr 53021
837170	TAPE RECORDER ASSY: 1 in. rcd/repro; large case; mfr 53021

SANGAMO PART NO.	NAME AND DESCRIPTION
837171	THRU PUT MONITOR ASSY: record only; mfr 53021
837172	CHASSIS ASSY: thru put monitor; rcd; mfr 53021
837198	RFI ENCLOSURE: power supply; mfr 53021
837203	FILTER, LIGHT: red; mfr 53021
837213	SPRING, NEGATOR: SS; mfr 80545, no. P12037
837217	THRU PUT MONITOR ASSY: record, reproduce; mfr 53021
837243	CIRCUIT CARD ASSY: 12 vdc power osc; mfr 53021
837244	CIRCUIT CARD ASSY: 26 vdc power osc; mfr 53021
837247	TRANSFORMER, AF: 240 V, 60 Hz; 18.6 V; .06A; mfr 00853, no. 837246
837263	TRANSFORMER, POWER: 28 V, 18 kHz; battery; mfr 53021
837267	TRANSFORMER, DRIVER: saturable core; mfr 53021
837300	CIRCUIT CARD ASSY: 230 vac power supply osc; mfr 53021
837312	MICROPHONE ASSY: mfr 53021
837313-001	RECORD HEAD ASSY: 1/2 in., W.B., 7 trk; mfr 26549
837313-002	REPRODUCE HEAD ASSY: 1/2 in., W.B., 7 trk; mfr 26549
837313-003	RECORD HEAD ASSY: 1 in., W.B., 14 trk; mfr 26549, no. 512600
837313-004	REPRODUCE HEAD ASSY: 1 in., W.B., 14 trk; mfr 26549, no. 512700
837318-001	FAN, VENT: 24 vac; mfr 82877, model 864HS; no. 010002
837318-002	FAN, CIRCULATING: 12 vac; mfr 82877, model 852HS; no. 010037
837328	RELAY, ARMATURE: 12 vdc, SPST, NO; mfr 77342, type MB3D
837329-001	CONNECTOR, RECEPTACLE: shell 17, 3 term.; mfr 00779, no. 206036-2
837329-002	CONNECTOR, RECEPTACLE: shell 11, 4 term.; mfr 00779, no. 206061-1
837332-001	CONTACT, CONNECTOR: pin, 12-16; mfr 00779, no. 66261-3
837334-001	CONTACT, CONNECTOR: pin, 16-18; mfr 00779, no. 66509-2
837728	TRANSFORMER, POWER: 234 V, 18 kHz; line; mfr 53021
837730	TRANSFORMER, POWER: 12 V, 18 kHz; battery; mfr 53021
837732	TRANSFORMER, POWER: 18 kHz; mfr 53021
844510	SEMICONDUCTOR DEVICE, DIODE: silicon; mfr 01295, no. 1N914
844515	TRANSIPAD: 1/4 in. dia; mfr 07047, no. A10042
844548	CAPACITOR, FIXED, MICA: 820 uf, 5%, 300 V; mfr 72136, no. DM15-821
844993	RESISTOR, VARIABLE, WW: 50 ohms, 5%, 1/2 W; mfr 80294, no. 3305P-1-500
844994	RESISTOR, VARIABLE: 100 ohms, 5%, 1/2 W; mfr 80294, no. 3305P-1-101
846615	JACK, JUNIOR PHONE: open circuit; mfr 76055, no. LA-1
846901	CAPACITOR, FIXED, MICA: 1,000 pf, 1%, 500 V; mfr 00853, no. D195F102F

SANGAMO PART NO.	NAME AND DESCRIPTION
847246	CAPACITOR, FIXED, MICA: 840 pf, 1%, 100 V; mfr 00853, no. D151F840FP
847825	TRANSIPAD: transitor mtg; 0.37 in. dia; mfr 53021
847890	TERMINAL: mfr 28198, no. 50B2-B25
850287	SEMICONDUCTOR DEVICE, DIODE: germanium; mfr 14936, no. IN277
850312	TERMINAL, STANDOFF: mfr 98291, no. ST-1000L2
851288	RESISTOR, FIXED: 10 ohms, ±3W, ±5%; mfr 44655, no. 4361
852475-008	SEMICONDUCTOR DEVICE, DIODE: zener, 3.3 V; mfr 99942, no. IN746A
852475-014	SEMICONDUCTOR DEVICE, DIODE: zener, 4.3 V; mfr 99942, no. IN749A
852475-016	SEMICONDUCTOR DEVICE, DIODE: zener, 4.7 V; mfr 99942, no. IN750A
852475-018	SEMICONDUCTOR DEVICE, DIODE: zener, 5.1 V; mfr 99942, no. IN751A
852475-020	SEMICONDUCTOR DEVICE, DIODE: zener, 5.6 V; mfr 99942, no. IN752A
852475-024	SEMICONDUCTOR DEVICE, DIODE: zener, 6.8 V; mfr 99942, no. IN754A
852475-030	SEMICONDUCTOR DEVICE, DIODE: zener, 9.1 V; mfr 99942, no. IN757A
852475-034	SEMICONDUCTOR DEVICE, DIODE: zener, 12 V; mfr 99942, no. IN759A
852530-034	RESISTOR, FIXED, FILM: 22.1 ohms, 1%, 1/4 W; mfr 19701, no. MF52CD22.10F
852738	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N3906
852748	TRANSIPAD: transistor mtg; 1/2 in. dia; mfr 13103, no. 7717-21N
853037	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N3904
853451	HUB ASSY: inner reel; mfr 53021
853454	BASE ASSY: outer reel; mfr 53021
853466	BEARING, BALL: SRR, 13 ball, double shield; mfr 43334, no. 773L09XRIBX
853467	BEARING, BALL: SRR, 11 ball, double shield; mfr 73974, no. 1903SFF
853530-011	RESISTOR, FIXED, FILM: 38.3 ohms, 1%, 1/4 W; mfr 81349, no. RN60C83.30F
853530-080	RESISTOR, FIXED, FILM: 200 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2000F
853530-115	RESISTOR, FIXED, FILM: 464 ohms, 1%, 1/4 W; mfr 81349, no. RN60C4640F
853530-118	RESISTOR, FIXED, FILM: 499 ohms, 1%, 1/4 W; mfr 81349, no. RN60C499F
853530-125	RESISTOR, FIXED, FILM: 590 ohms, 1%, 1/4 W; mfr 81349, no. RN60C5900F
853530-145	RESISTOR, FIXED, FILM: 953 ohms, 1%, 1/4 W; mfr 81349, no. RN60C9530F
853530-147	RESISTOR, FIXED, FILM: 1,000 ohms, 1%, 1/4 W; mfr 81349, no. RN60C1001F
853530-154	RESISTOR, FIXED, FILM: 1,180 ohms, 1%, 1/4 W; mfr 81349, no. RN60C1181F
853530-162	RESISTOR, FIXED, FILM: 1,430 ohms, 1%, 1/4 W; mfr 81349, no. RN60C1431F
853530-176	RESISTOR, FIXED, FILM: 2,000 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2001F
853530-180	RESISTOR, FIXED, FILM: 2,210 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2211F
853530-186	RESISTOR, FIXED, FILM: 2,550 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2551F
853530-189	RESISTOR, FIXED, FILM: 2,740 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2741F
853530-193	RESISTOR, FIXED, FILM: 3,010 ohms, 1%, 1/4 W; mfr 81349, no. RN60C3011F

SANGAMO PART NO.	NAME AND DESCRIPTION
853530-197	RESISTOR, FIXED, FILM: 3,320 ohms, 1%, 1/4 W; mfr 81349, no. RN60C3321F
853530-201	RESISTOR, FIXED, FILM: 3,650 ohms, 1%, 1/4 W; mfr 81349, no. RN60C3651F
853530-204	RESISTOR, FIXED, FILM: 3,920 ohms, 1%, 1/4 W; mfr 81349, no. RN60C3921F
853530-208	RESISTOR, FIXED, FILM: 4,320 ohms, 1%, 1/4 W; mfr 81349, no. RN60C4321F
853530-211	RESISTOR, FIXED, FILM: 4,640 ohms, 1%, 1/4 W; mfr 81349, no. RN60C4641F
853530-214	RESISTOR, FIXED, FILM: 4,990 ohms, 1%, 1/4 W; mfr 81349, no. RN60C4991F
853530-226	RESISTOR, FIXED, FILM: 6,650 ohms, 1%, 1/4 W; mfr 81349, no. RN60C6651F
853530-228	RESISTOR, FIXED, FILM: 6,980 ohms, 1%, 1/4 W; mfr 81349, no. RN60C6981F
853530-232	RESISTOR, FIXED, FILM: 7,680 ohms, 1%, 1/4 W; mfr 81349, no. RN60C7681F
853530-234	RESISTOR, FIXED, FILM: 8,060 ohms, 1%, 1/4 W; mfr 81349, no. RN60C8061
853530-241	RESISTOR, FIXED, FILM: 9,530 ohms, 1%, 1/4 W; mfr 81349, no. RN60C9531F
853530-243	RESISTOR, FIXED, FILM: 10 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1002F
853530-246	RESISTOR, FIXED, FILM: 10.7 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1072F
853530-259	RESISTOR, FIXED, FILM: 14.7 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1472F
853530-263	RESISTOR, FIXED, FILM: 16.2 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1622F
853530-267	RESISTOR, FIXED, FILM: 17.8 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1782F
853530-268	RESISTOR, FIXED, FILM: 18.2 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1822F
853530-272	RESISTOR, FIXED, FILM: 20 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C2002F
853530-274	RESISTOR, FIXED, FILM: 21 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C2102F
853530-276	RESISTOR, FIXED, FILM: 22.1 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C2212F
853530-277	RESISTOR, FIXED, FILM: 22.6 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C2262F
853530-282	RESISTOR, FIXED, FILM: 25.5 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C2552F
853530-284	RESISTOR, FIXED, FILM: 26,700 ohms, 1%, 1/4 W; mfr 81349, no. RN60C2672F
853530-289	RESISTOR, FIXED, FILM: 30.1 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C3012F
853530-296	RESISTOR, FIXED, FILM: 35.7 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C3572F
853530-300	RESISTOR, FIXED, FILM: 39.2 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C3922F
853530-303	RESISTOR, FIXED, FILM: 42.2 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C4222F
853530-308	RESISTOR, FIXED, FILM: 47.5 K ohms, 1%,1/4 W; mfr 81349, no. RN60C4752F
853530-310	RESISTOR, FIXED, FILM: 49.9 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C4992F
853530-315	RESISTOR, FIXED, FILM: 56.2 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C5622F
853530-335	RESISTOR, FIXED, FILM: 90.9 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C9092F
853530-339	RESISTOR, FIXED, FILM: 100 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1003F
853530-342	RESISTOR, FIXED, FILM: 107 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1073F
853530-347	RESISTOR, FIXED, FILM: 121 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1213F

SANGAMO PART NO.	NAME AND DESCRIPTION
853530-356	RESISTOR, FIXED, FILM: 150 K ohms, 1%, 1/4 W; mfr 81349, no. RN60C1503F
853532	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N2905
853533	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N2219
853587-001	INDUCTOR, FIXED: 470 uh, 5%; mfr 24759, no. MR-470
853587-003	INDUCTOR, FIXED: 220 uh, 5%; mfr 24759, no. MR-220
853587-005	INDUCTOR, FIXED: 22 uh, 10%; mfr 24759, no. MR-22
853587-012	INDUCTOR, FIXED: 15 uh, 10%; mfr 24759, no. MR-15
853587-017	INDUCTOR, FIXED: 150 uh, 5%; mfr 24759, no. MR-150
853587-020	INDUCTOR: 1,000 uh, 5%; mfr 24759, no. MR-1000
853587-026	INDUCTOR, FIXED: 2,700 uh, 10%; mfr 24759, no. MR-2700
853587-027	INDUCTOR, FIXED: 12,000 uh, 10%; mfr 24759, no. MR-12000
853587-028	INDUCTOR, FIXED: 4.7 uh, 5%; mfr 24759, no. MR-4.7
853587-029	INDUCTOR, FIXED: 10 uh, 5%; mfr 24759, no. MR-10
853587-034	INDUCTOR, FIXED: 3900 uf, 10%; mfr 24759, no. MR-3900
853587-037	INDUCTOR, FIXED: 68 uf, 5%; mfr 24759, no. MR-68
853587-039	INDUCTOR, FIXED: 5,600 uh, 10%; mfr 24759, no. MR-5600
853587-040	INDUCTOR, FIXED: 8,200 uh, 10%; mfr 24759, no. MR-8200
853590-002	RECEPTACLE, PROBE: red; mfr 00779, no. 3-582118-2
853590-004	RECEPTACLE, PROBE: yellow; mfr 00779, no. 3-582118-4
853590-006	RECEPTACLE, PROBE: blue; mfr 00779, no. 3-582118-6
835390-010	RECEPTACLE, PROBE: black; mfr 00779, no. 3-582118-0
853623	RELAY, ARM: SPST, NO., 24 V; mfr 77342, no. MB3D-24V
854528-025	CAPACITOR, FIXED, MICA: 25 pf, 1%, 500 V; mfr 00853, no. D155C250F0
854528-030	CAPACITOR, FIXED, MICA: 30 pf, 1%, 500 V; mfr 00853, no. D155C300F0
854528-033	CAPACITOR, FIXED, MICA: 33 pf, 1%, 500 V; mfr 00853, no. D155C330F0
854528-075	CAPACITOR, FIXED, MICA: 75 pf, 1%, 500 V; mfr 00853, no. D155C750F0
854528-150	CAPACITOR, FIXED, MICA: 150 pf, 1%, 500 V; mfr 00853, no. D155C151F0
854528-300	CAPACITOR, FIXED, MICA: 300 pf, 1%, 500 V; mfr 00853, no. D155C301F0
854528-330	CAPACITOR, FIXED, MICA: 330 pf, 1%, 500 V; for 00853, no. D155C331F0
854539	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N4124
854540	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N4126
854725	CONNECTOR, PLUG: 125 V, 15 amp; 3 cont; mfr 02660, no. 160-5
854950	HEADSET, MAGNETIC: mfr 22711, no. 610-2
855121	RESISTER, VARIABLE: 10 K ohms, 20%, 1/5 W; mfr 71590, no. 9T-10JM

SANGAMO PART NO.	NAME AND DESCRIPTION
855432-001	SWITCH, TOGGLE: DPDT; mfr 09353, no. 7201
855432-006	SWITCH, TOGGLE: DPDT; mfr 09353, no. 7211
855563	CONNECTOR, PLUG: 14 socket contact; mfr 77342, no. 9KH1
855913	TERMINAL, STUD: brass; mfr 28198, no. 51H-C25
855977	CONNECTOR, RECEPTACLE: BNC; mfr 74868, no. 31-221-1004
856373	KNOB ASSY: outer reel; mfr 53021
857953	SWITCH, SENSITIVE: mfr Micro Switch, no. 2SX1-T
858914	CONNECTOR, RECEPTACLE: female, 26 cont; mfr 81312, no. SRE26S-NSS
859241-001	CONNECTOR, RECEPTACLE: female, 30 pin; mfr 02660, no. 225-21521-101
859241-003	CONNECTOR, RECEPTACLE: female, 20 pin; mfr 02660, no. 225-21021-101
859241-004	CONNECTOR, RECEPTACLE: female, 36 pin; mfr 02660, no. 225-21821-101
859254-002	CONNECTOR, PLUG: 9 cont; mfr 27264, no. 1625-9P
859254-003	CONNECTOR, PLUG: housing, 12 circuit; mfr 27264, no. 1625-12P
859255-002	CONNECTOR, RECEPTACLE: 9 cont; mfr 27264, no. 1625-9R
859255-003	CONNECTOR, RECEPTACLE: 12 cont; mfr 27264, no. 1625-12R
859256-001	TERMINAL, PIN: male 22-30 wire; mfr 27264, no. 1854
859257-001	TERMINAL, PIN: female, 22-30 wire; mfr 27264, no. 1855
859259	CONNECTOR, PLUG: male, 26 pin; mfr 81312, no. SRE26P-NSS
859520-029	INTEGRATED CIRCUIT: counter; mfr 01295, no. SN7493N
859520-042	INTEGRATED CIRCUIT: monostable; mfr 01295, no. SN74121N
859763-015	TERMINAL, PLUG: female, 18-22 wire; mfr 00779, no. 61060-1
859774-007	FUSE, CARTRIDGE: ceramic, 8 amp, 250 V; mfr 71400, no. ABC-8
859774-008	FUSE, CARTRIDGE: ceramic, 10 amp, 250 V; mfr 71400, no. ABC-10
859774-011	FUSE, CARTRIDGE: ceramic, 20 amp, 250 V; mfr 71400, no. ABC-20
859775-001	CAPACITOR, FIXED, TANTALUM: .1 uf, 20%, 35 V; mfr 56289, no. 196D104X9035HAI
859775-003	CAPACITOR, FIXED, TANTALUM: .22 uf, 20%, 35 V; mfr 56289, no. 196D224X9035HAI
859775-005	CAPACITOR, FIXED, TANTALUM: .47 uf, 20%, 35 V; mfr 56289, no. 196D474X9035HAI
859775-007	CAPACITOR, FIXED, TANTALUM: 1.0 uf, 20%, 35 V; mfr 56289, no. 196D105X0035HAI
859775-009	CAPACITOR, FIXED, TANTALUM: 2.2 uf, 20%, 25 V; mfr 56289, no. 196D225X9025HAI
859775-011	CAPACITOR, FIXED, TANTALUM: 4.7 uf, 20%, 10 V; mfr 56289, no. 196D475X0010HAI
859775-012	CAPACITOR, FIXED, TANTALUM: 6.8 uf, 20%, 6 V; mfr 56289, no. 196D685X9006HAI
859775-014	CAPACITOR, FIXED, TANTALUM: 10 uf, 20%, 25 V; mfr 56289, no. 196D106X0025KAI
859775-017	CAPACITOR, FIXED, TANTALUM: 22 uf, 20%, 15 V; mfr 56289, no. 196D226X0015KAI
859775-019	CAPACITOR, FIXED, TANTALUM: 33 uf, 20%, 10 V; mfr 56289, no. 196D336X9010KAI
859775-021	CAPACITOR, FIXED, TANTALUM: 47 uf, 20%, 6 V; mfr 56289, no. 196D476X0006KAI

SANGAMO PART NO.	NAME AND DESCRIPTION
859775-022	CAPACITOR, FIXED, TANTALUM: 47 uf, 20%, 20 V; mfr 56289, no. 196D476X9020PE4
859775-024	CAPACITOR, FIXED, TANTALUM: 68 uf, 20%, 15 V; mfr 56289, no. 196D686X9015E4
859775-025	CAPACITOR, FIXED, TANTALUM: 100 uf, 20%, 10 V; mfr 56289, no. 196D107X9010PE4
859775-026	CAPACITOR, FIXED, TANTALUM: 100 uf, 20%, 20 V; mfr 56289, no. 196D107X9020TE4
859775-027	CAPACITOR, FIXED, TANTALUM: 150 uf, 20%, 6 V; mfr 56289, no. 196D157X9006PE4
859775-029	CAPACITOR, FIXED, TANTALUM: 220 uf, 20%, 10 V; mfr 56289, no. 196D227X0010MA3
859775-031	CAPACITOR, FIXED, TANTALUM: 4.7 uf, 20%, 35 V; mfr 56289, no. 196D475X0035JA1
859775-033	CAPACITOR, FIXED, TANTALUM: 22 uf, 20%, 50 V; mfr 56289, no. 196D226X9050TE4
859775-034	CAPACITOR, FIXED, TANTALUM: 47 uf, 20%, 35 V; mfr 56289, no. 196D476X9035TE4
859925-018	RESISTOR, FIXED, WW: 3 ohms, 5%, 2-1/4 W; mfr 44655, no. 3872
859925-019	RESISTOR, FIXED, WW: 4.7 ohms, 5%, 2-1/4 W; mfr 44655, no. 3878
859925-020	RESISTOR, FIXED, WW: 56 ohms, 5%, 3-1/4 W; mfr 44655, no. 4382
859925-021	RESISTOR, FIXED, WW: 56 ohms, 5%, 5 W; mfr 44655, no. 4582
859925-022	RESISTOR, FIXED, WW: 120 ohms, 5%, 3-1/4 W; mfr 44655, no. 4394
859925-023	RESISTOR, FIXED, WW: 200 ohms, 5%, 5 W; mfr 44655, no. 4599
859959-001	CAPACITOR, FIXED, CERAMIC: 0.01 uf, -20% +8%, 25 V; mfr 56289, no. C069B250F103Z
859959-002	CAPACITOR, FIXED, CERAMIC: 0.1 uf, -20% +80%, 10 V; mfr 56289, no. HY-360
859960-004	CAPACITOR, FIXED, CERAMIC: .005 uf, 20%, 3000 V; mfr 56289, no. 36C124A
859970	TRANSISTOR: silicon, NPN; mfr 04713, no. 2N5089
859971	TRANSISTOR: silicon, PNP; mfr 04713, no. 2N5087
864796-061	RESISTOR, FIXED, FILM: 1 meg ohms, 1%, 1/4 W; mfr 81349, no. RN60D1004F
864971-003	RESISTOR, FIXED, WW: .39 ohms, 10%, 3 W; mfr 81349, no. RW69VR39
864971-018	RESISTOR, FIXED, WW: 75 ohms, 5%, 3 W; mfr 81349, no. RW69V750
868360	TRANSISTOR: NPN, silicon; mfr 81349, no. 2N2219A
896458	SEMICONDUCTOR DEVICE, DIODE: silicon; mfr 01295, no. 1N4385
896475	CAPACITOR, FIXED, MICA: 100 pf, 5%, 300 V; mfr 00853, no. D155F101J
896476	CAPACITOR, FIXED, MICA: 50 pf, 5%, 500 V; mfr 00853, no. D155E500J
896669	TERMINAL, STUD: double feed thru; mfr 98291, no. FT1000DTUR
896871	CAPACITOR, FIXED, MICA: 2,200 pf, 5%, 300 V; mfr 00853, no. D195F222J
897127	BEARING, BALL: SRR, 8 ball, double seal; mfr 43334, no. SSZ99R4XR3025EP15
897174	BEARING, BALL: single row radial; 1/2 in. od; mfr 70854, no. SR3SS2G2
897581	RESISTOR, FIXED, WW: 100 ohms, 20 W; mfr 63743, no. 20S100
897583	RESISTOR, FIXED, WW: 0.1 ohms, 10%, 3 W; mfr 63743, no. 3X

SANGAMO PART NO.	NAME AND DESCRIPTION
898257	BALL, BEARING: 1/2 in. SS; mfr 27545, no. 1/2-100SS440
898264	BALL, BEARING: 5/16 in. SS; mfr 27545, no. 5/16-100SS440
898335	CAPACITOR, FIXED, MICA: 500 pf, 5%, 300 V; mfr 00853, no. D155F501J
899063	CAPACITOR, FIXED, MICA: 3,600 pf, 5%, 300 V; mfr 00853, no. D195F362J

LIST OF MANUFACTURERS

00779	AMP INC	HARRISBURG, PA
00853	SANGAMO WESTON, INC	PICKENS, SC
01121	ALLEN BRADLEY CO	MILWAUKEE, WI
01295	TEXAS INSTRUMENTS INC	DALLAS, TX
02660	AMPHENOL CORP	BROADVIEW, IL
03508	GENERAL ELECTRIC CO., SEMI-CONDUCTOR PRODUCTS DEPT.	SYRACUSE, NY
04713	MOTOROLA SEMICONDUCTOR PRODUCTS INC	PHOENIX, AZ
06776	ROBINSON NUGENT INC	NEW ALBANY, IN
07047	ROSS MILTON CO	SOUTHAMPTON, PA
07700	TECHNICAL WIRE PRODUCTS INC	CRAWFORD, NJ
08730	VEMALINE PRODUCTS CO INC	WYCKOFF, NJ
09022	CORNELL-DUBILIER ELEC CORP	PROVIDENCE, RI
09353	C AND K COMPONENTS INC	NEWTON, MA
13103	THERMALLOY CO	DALLAS, TX
14936	GENERAL INSTRUMENT CORP SEMICONDUCTOR PROD. GROUP	HICKSVILLE, NY
16858	SEQUENTIAL ELECTRONIC SYSTEMS INC	ELMSFORD, NY
18324	SIGNETICS CORP	SUNNYVALE, CA
18583	CURTIS INSTRUMENTS INC	MT. KISCO, NY
19701	ELECTRA/MIDLAND CORP	MINERAL WELLS, TX
20932	ELECTRO MATERIALS INC	SAN DIEGO, CA
23043	N T N BEARING CORP OF AMERICA	LINCOLNWOOD, IL
24759	LENOX-FUGLE ELECTRONICS INC	PLAINFIELD, NJ
26549	G J M INC	GLENDALE, CA
27190	REGDON CORP	BROOKFIELD, IL
27264	MOLEX PRODUCTS CO	DOWNERS GROVE, IL
27545	HARTFORD-UNIVERSAL CO	ROCKY HILL, CT
27735	F-DYNE ELECTRONICS CO	BRIDGEPORT, CT
27777	VARO ELECTRON DEVICES INC	GARLAND, TX
28198	POSITRONIC INDUSTRIES INC	SPRINGFIELD, MO
29090	MECHANICAL ENTERPRISES INC	ALEXANDRIA, VA
29587	BUNKER RAMO CORP AMPHENOL INDUSTRIAL DIV.	CHICAGO, IL
31019	SOLID STATE SCIENTIFIC INC	MONTGOMERYVILLE, PA
33866	TORQUE SYSTEMS INC	WALTHAM, MA
34122	MARATHON BATTERY CO	COLD SPRING, NY
43334	NEW DEPARTURE-HYATT BEARINGS DIV.,G M CORP.	SANDUSKY, OH
44655	OHMITE MFG CO	SKOKIE, IL
50347	OPCOA INC	EDISON, NJ
50434	HEWLETT-PACKARD CO., OPTOELECTRONICS DIV.	PALTO ALTO, CA
50579	LITRONIX INC	CUPERTINO, CA
53021	SANGAMO WESTON, INC	SPRINGFIELD, IL
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MA
63743	WARD LEONARD ELECTRIC CO	MOUNT VERNON, NY
70854	BARDEN CORP	DANBURY, CT
71279	CAMBRIDGE THERMIONIC CORP	CAMBRIDGE, MA
71400	BUSSMANN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS, MO
71590	GLOBE-UNION INC CENTRALAB DIV.	MILWAUKEE, WI
71785	CINCH MFG CO & HOWARD B JONES DIV.	CHICAGO, IL
72136	ELECTRO MOTIVE MFG CO., INC	WILLIMANTIC, CT
73138	BECKMAN INSTRUMENTS INC	FULLERTON, CA
73949	GUARDIAN ELECTRIC MFG CO	CHICAGO, IL
73974	MARLIN-ROCKWELL DIV OF TRW INC	JAMESTOWN, NY
74199	QUAM-NICHOLS CO	CHICAGO, IL
74868	AMPHENOL CORP RF DIV	DANBURY, CT

75378	CTS KNIGHTS INC	SANDWICH, IL
75382	KULKA ELECTRIC CORP.	MT. VERNON, NY
76055	MALLORY CONTROLS DIV OF MALLORY P R & CO., INC	FRANKFORT, IN
76854	OAK MFG CO	CRYSTAL LAKE, IL
77342	AMERICAN MACHINE & FOUNDRY CO	PRINCETON, IN
80294	BOURNS INC	RIVERSIDE, CA
80545	AMETEK/HUNTER SPRING	HATFIELD, PA
81073	GRAYHILL INC	LA GRANGE, IL
81312	WINCHESTER ELECTRONICS INC	OAKVILLE, CT
81349	MILITARY SPECIFICATION PROMULGATED BY MILITARY DEPARTMENTS/ AGENCIES	
82389	SWITCHCRAFT INC	CHICAGO, IL
82877	ROTRON INC	WOODSTOCK, NY
83003	VARO INC	GARLAND, TX
83330	SMITH HERMAN H INC	BROOKLYN, NY
84830	LEE SPRING CO INC	BROOKLYN, NY
90179	U S RUBBER CO CONSUMER & INDUSTRIAL PRODUCTS DIV.	PASSAIC, NJ
90201	MALLORY CAPACITOR CO	INDIANAPOLIS, IN
91637	DALE ELECTRONICS INC	COLUMBUS, NB
91833	KEYSTONE ELECTRONICS CORP	NEW YORK, NY
94696	MAGNECRAFT ELECTRIC CO	CHICAGO, IL
95303	RCA CORP RECEIVING TUBE DIV.	CINCINNATI. OH
96733	SAN FERNANDO ELEC MFG CO	SAN FERNANDO, CA
97197	EDMUND SCIENTIFIC CO	BARRINGTON, NJ
98291	SEALECTRO CORP	MAMARONECK, NY
99942	GLOBE UNION INC	EL MONTE, CA