Valleylab

SSE3B SERVICE MANUAL

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Effectivity: Serial Numbers H8A010B and above.
April 1, 1978

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List of Illustrations

Section 1
Introduction

This Service Manual covers the installation and basic service instructions for the Valleylab Model SSE-3B Series Electrosurgical Generators. Also included are sections covering the Technical Specifications, Circuit Descriptions and the Testing and Troubleshooting of the Generator. Detailed instructions in the use of electrosurgery is beyond the scope of this manual and the reader is directed to the Operator's Instruction Manual provided by Valleylab.

Valleylab, its dealers and representatives reserve the right to make changes in equipment built and/or sold by them at any time without incurring any obligation to make the same or similar changes on equipment previously built and/or sold by them.

Section 2
Installation

INSTALLING THE SSE3-B

The compact size of the SSE3-B system allows a variety of installations. The unit may be mounted on the mounting stand or mounting cart available from Valleylab, or it may be placed on any convenient and sturdy table or cart.

At high power settings considerable power is dissipated within the unit and it is important that the vents on both sides remain unobstrcuted for proper cooling. For this reason the SSE3-B should not be installed in a closely fitting cabinet or cart which might restrict the free circulation of air. Under continuous use for extended periods of time, it is normal for the top and rear panel to feel warm to the touch.

POWER FOR THE SSE3-B

90 - 140 VAC 50 - 60 Hz

The SSE3-B is designed to operate over an unusually wide range of input voltage with essentially perfect output regulation. This means that in case of brownouts or power surges the output of your SSE3-B will always remain constant. The SSE3-B is normally supplied for operation on 120 volts AC (nominal).

PROPER GROUNDING AND THE POWERITE CIRCUIT

An important consideration in assuring patient safety while using electrical equipment is that of providing proper grounding. The ground wire in the power cable is connected to the generator chassis and insures that no dangerous currents will flow from the cabinet of the unit in the event of an internal electrical failure.

Undesirable 60 Hz leakage currents are also affected by the polarization of the input 60 Hz power to the unit. It is the responsibility of the user to assure proper grounding and polarity in the power outlets furnishing power to the SSE3-B.

The POWERITE circuit is a unique Valleylab feature which monitors the chassis ground connection and the input power polarity. It works by monitoring the voltage between the "neutral" power wire and the chassis. When the power connections are correct, this voltage will be zero. When a fault is detected, the POWERITE circuit turns the power switch on the front of the SSE3-B to OFF. In an emergency the POWERITE circuit can be defeated by turning the POWERITE circuit OFF by means of a switch at the rear of the SSE3-B. The POWERITE switch is located under the small metal cap so that it cannot be disturbed accidentally. Pry off the cap and slide the switch to the desired position. Because the majority of the units are used in isolated operating rooms, SSE3-B generators are shipped with POWERITE turned OFF.

If the operating room is equipped with an isolated power system, the POWERITE circuit cannot be used and must be switched off.

240 volt AC power systems can be either isolated or ground referenced. If ground referenced, the POWERITE circuit will work, but many 240 volt power connectors can be plugged in two ways and do not automatically insure the correct polarity. If this is the case, it may

be necessary to reverse the connector to establish the correct polarity, since the POWERITE will turn the power switch OFF if the polarity is incorrect.

POWER PLUGS FOR THE SSE3-B

Unless an explosion-proof connector is specified, the 120 volt SSE3-B is equipped with an approved hospital duty three-prong connector. This connector meets all requirements for safe grounding. Its purpose should not be defeated by using extension cords or "cheaters" (3-prong to 2-prong adapters). The connector should be periodically disassembled and inspected by qualified maintenance personnel.

240 volt AC versions of the SSE3-B are shipped with a standard U.S.A. 240 volt tandem blade connector of equivalent quality and construction to the Hospital Grade 120 volt connector. At present there are no Hospital Grade 240 volt connectors and we do not have access to all the various 240 volt connectors used in other countries. The Valleylab representative in your country will equip your SSE3-B with proper connector for your operating room.

ROUTINE MAINTENANCE AND INSPECTIONS

The solid-state design of the SSE3-B assures virtually maintenance-free use. Maintenance is limited to periodic inspections and repair should be limited to repairing cords and to replacing indicator bulbs or accessories.

All electrical cords in the SSE3-B system are provided with strain relief to prolong cord life. Should breakage or wear occur, the cords are repairable by qualified personnel. Proper handling will minimize repair and replacement problems. Cords should always be grasped by the plugs designed for that purpose...do not pull on the cord itself.

We recommend that the SSE3-B be inspected by the hospital engineer twice yearly. This SSE3-B Service Manual describes the recommended inspection and check out procedure. For major repairs the SSE3-B can be returned to Valleylab or your Valleylab representative. If desired, Valleylab will supply any parts or information needed to repair the SSE3-B.

Section 3 Operating Controls

FRONT VIEW

1.* POWER ON/OFF SWITCH AND CIRCUIT BREAKER

Rock switch to turn SSE3-B on. Power switch illuminates when the SSE3-B is on. Valleylab's exclusive Powerite circuitry tests for polarity and ground continuity at the wall outlet and will shut off the power switch if the chassis ground or power line polarity is incorrect. The combination power switch and circuit breaker also turns off in case of internal failure or momentary overload. Rock switch to reset.

2. COAG POWER READOUT

This digital LED display is visible above the COAG level control after the generator is switched "ON". The number displayed predicts the level of average monopolar power in watts which will be delivered to a 300 ohm resistive load when the generator is keyed in the COAG mode.

3. CUT POWER READOUT

This digital LED display is visible above the CUT level control after the generator is switched "ON". The number displayed predicts the level of average monopolar power in watts which will be delivered to a 300 ohm resistive load when the generator is keyed in the CUT mode.

4. COAG LEVEL CONTROL

This dial rotates to select coagulation current intensity. The dial is graduated from 0 to 10.

5. CUT LEVEL CONTROL

This dial rotates to select cutting current intensity. The dial is graduated from 0 to 10.

6. CUT MODE SELECTOR BUTTONS

The four push buttons select the type of cutting current, either Pure for minimum hemostasis or BLEND 1, 2 or 3 for increasing hemostasis while cutting. BLEND current intensity is determined solely by the CUT level setting, completely independent of COAG level setting. If none of the buttons has been pressed, BLEND #1 is automatically selected, and keying "CUT" will result in BLEND #1.

7. RETURN FAULT INDICATOR

Indicator illuminates if the SSE3-B is activated without a proper patient plate connection. The SSE3-B is d[illegible]abled as long as the indicator is [illegible]. After correcting the patient connection, the RETURN FAULT circuit must be reset by pushing the RETURN FAULT indicator button. See Section 6 for complete explanation.

8. MONOPOLAR SWITCHING ACTIVE RECEPTACLES

These three position-coded receptacles located on the white plastic "jackstrip" accept the three-prong plug of the Valleylab LectroSwitch pencil or the two-prong plug of a switching forceps cord. CUT mode or COAG mode power may be keyed via these receptacles.

9. MONOPOLAR ACTIVE RECEPTACLE

This is a rectangular receptacle located on the white plastic "jackstrip" which will accept most standard active accessories of other manufacture or adapter plugs for accessories which do not fit directly.

* See p.6 for reference.

10. PATIENT RECEPTACLE

This single conductor receptacle accepts the one prong return electrode connector used for monopolar operation.

11. BIPOLAR RECEPTACLES

These four position-coded receptacles provide an isolated bipolar power output which is electrically separate from the monopolar outputs. Output power is accessed via the horizontally aligned receptacles which accept standard banana plug connectors. The vertically aligned receptacles allow keying of generator power vai the four-prong connector of Valleylab hand-switching bipolar accessories.

12. COAG POWER INDICATOR

The backlighted word "COAG" will be visible above the COAG power readout when the generator is keyed in the COAG mode and usable RF power is available at the output connectors. This indicator will not be illuminated at the zero level setting. Absence of illumination of this indicator upon keying of the COAG mode at level settings greater than 1 may indicate a generator malfunction.

13. CUT POWER INDICATOR

The backlighted word "CUT" will be visible above the CUT power readout when the generator is keyed in the CUT mode and usable RF power is available at the output connectors. This indicator will not be illuminated at the zero level setting. Absence of illumination of this indicator upon keying of the CUT mode at level settings greater than 1 may indicate a generator malfunction.

14. ADJUSTABLE HANDLE RELEASE BUTTON

This button unlocks the handle so that it can be moved to the desired position. Button is on right handle only.

15. AUDIO VOLUME CONTROL

This dial controls the audio volume from 0 to 72 dbA.

16. FOOTSWITCH CONNECTION

This four conductor Amphenol type connector accepts the Valleylab footswitch keying accessory.

17. POWER CORD AND PLUG ASSEMBLY

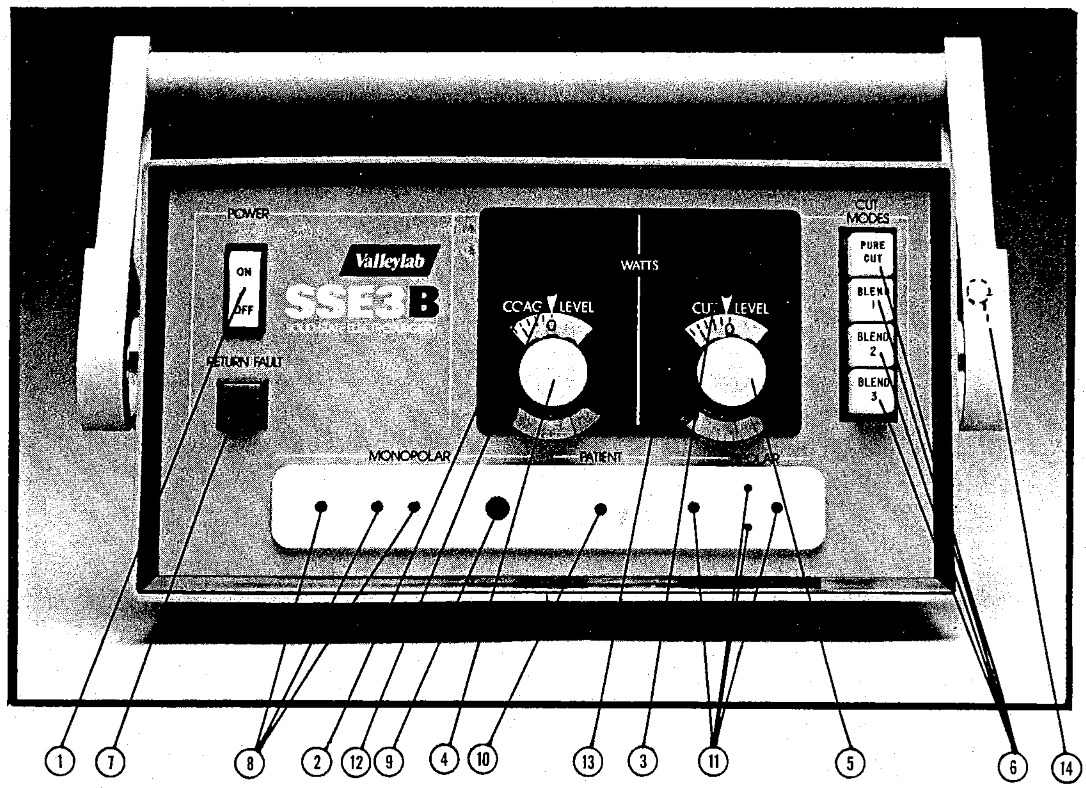
The low leakage type line cord is in a strain relief attached to the rear of the unit. The three-prong plug of the power cord connects to the properly grounded three-prong wall receptacle providing 120 VAC 60 Hz power. The plug is an approved hospital-grade model. Specific models of explosion-proof plugs are available through special order. Extension cords, three prong to two-prong adapters ("cheaters") and extra length power cords should NOT be used. For units operating from 220 VAC 50 Hz input, your Valleylab representative will install the appropriate plug.

18. POWERITE SWITCH

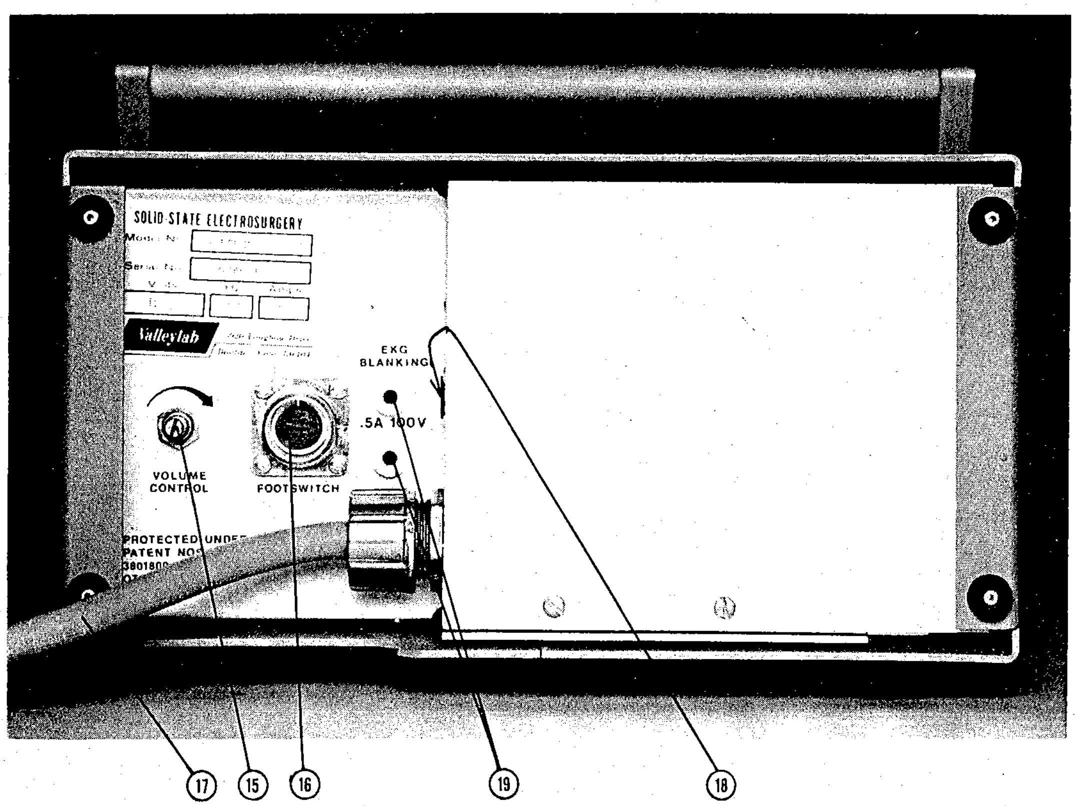
This switch is covered by a metal cap which must be snapped out to gain access to the switch. In the "ON" position, the POWERITE System continuously monitors the ground connection between the generator and the operating room's power system. The System will not function in the presence of an isolation transformer in the operating room. If isolated wiring is present, the switch should be in the "OFF" position.

19. ECG BLANKING OUTPUT

This banana jack output can be used to turn off an electrocardiograph or cardioscope when the generator is active to prevent overload of the monitoring equipment. The two leads are switched together internally whenever the SSE3-B is activated. Refer to Section 6 for an explanation of the circuit.



FRONT VIEW



REAR VIEW

Section 4
Monopolar and Bipolar Electrosurgical Configurations & Accessories

The SSE-3B features three separate outputs which may be activated. Two of these outputs are used primarily in monopolar configurations. The MONOPOLAR HANDSWITCH output is designed for use with either switching forceps or a switching pencil. The MONOPOLAR ACCESSORY output is designed for use with non-switching accessories and is normally activated only by the footswitch. The third output is a reduced power BIPOLAR output which may be used with switching or non-switching bipolar accessories and may be activated by either the switching accessory or by the footswitch.

MONOPOLAR CONFIGURATION

Monopolar Accessories

The SSE-3B has a radio frequency (RF) grounded ouput. In monopolar operation, the radio frequency current passes from the active accessory, through the patient, and returns to the generator via a large patient plate which contacts the patient's skin.

The Valleylab hand-switching LectroSwitch pencil (Model E2502) plugs into the three banana pin jacks at the extreme left of the white plastic front panel jack. All three of these LectroSwitch pins are "active" since there are only low switching voltages between the pins.

The hand switching coagulation forceps (Model E4001 or E4002) plug into the two far left jacks of the accessory panel.

The standard active accessory jack in the center of the panel will accept the plugs of most standard accessories directly or through an appropriate adapter. The footswitch then controls the current flow to the accessory. Both the Model E6003 and E6004 footswitches are designed for operating room use and are connected to the SSE-3B by means of a four-pin footswitch receptacle on the back panel of the generator. The footswitch pedals activate the generator in CUT/BLEND or COAG as needed. The SSE-3B has an override circuit to insure that only COAG is activated in the event that both pedals are pushed simultaneously. The SSE-3 has an "intrinsically safe" footswitch circuit. This means that the switching currents are too low to cause a spark even in the most dangerous mixture of flammable gas and oxygen. To qualify as intrinsically safe, the spark energy which occurs at the switch contacts must be less than 1 millijoule. The energy present in the SSE-3B switching circuits is about 1/5000 of the amount which is a conservative limit for safe open contact operation.

The Return Electrode

In a monopolar configuration, a return electrode is used to limit the current densities to a safe level.

An accepted standard for gelled plate or foil electrodes is 1.5 watts per square centimeter of return electrode area or roughly 9 or 10 square inches per hundred watts of generator output. (NFPA Bulletin No. 76CM, Part II)

A delicate procedure which uses low power settings requires only a few square inches. Valleylab permanent return electrodes (Model E7001) and the disposable Lectro-Plate (E7501) have more than sufficient area for any surgical procedure.

Gelled foam pad electrodes of smaller size, such as Valleylab Model E7502, have come into common usage and with proper adherance to manufacturer's instructions, they can be an effective and safe method of providing the return connection.

The SSE-3B is an RF grounded system with a return fault circuit which continuously monitors the flow of electrosurgical current in the patient circuit and the distribution ground. The circuit prevents SSE-3B operation if the proportion of current returning through ground is excessive, and thus provides a high degree of safety from patient burns under common fault conditions.

BIPOLAR CONFIGURATION

Bipolar Accessories

The most common bipolar instruments are forceps, the jaws of which are connected to the BIPOLAR output jacks. In bipolar operation the current flow is limited to the tissue which is grasped by the jaws. The SSE-3B BIPOLAR output operates at lower power levels than the MONOPOLAR output and has impedance characteristics optimized for desiccation. This means faster coagulation at a given power setting and an automatic reduction of output power when the coagulation is complete.

Section 5 Technical Specifications

OUTPUT WAVEFORM

CUT	750 kHz sinusoid
BLEND 1	750 kHz bursts of sinusoid at 50% duty cycle recurring at 31 kHz.
BLEND 2	750 kHz bursts of sinusoid at 25% duty cycle recurring at 31 kHz.
BLEND 3	750 kHz bursts of sinusoid at 25% duty cycle plus inductive discharge damped sinusoid bursts, all bursts recurring at 31 kHz. Power is adjusted so that the sinusoid bursts account for 75% of the power into a 300 ohm load and the damped sinusoid bursts account for the remainder.
COAG	750 kHz damped sinusoid bursts with a repetition frequency of 31 kHz.

OUTPUT CHARACTERISTICS

MONOPOLAR OUTPUT CHARACTERISTICS (control setting of 10)

Mode	Maximum (open circuit) P-P Voltage	300 ohm load Power (watts)	(300 ohm load) Crest Factor ± 10%
CUT	2000	300 ± 30	1.9 @ 100W
BLEND 1	2500	250 ± 30	2.6 @ 100W
BLEND 2	3000	200 ± 30	3.6 @ 100W
BLEND 3	3400	200 ± 30	4.4 @ 100W
COAG	6400	115 ± 10	10.0 @ 50W

Note: 500 ohm load values differ from 300 ohm values by approximately ± 10% in power and + 10% in crest factor.

BIPOLAR OUTPUT CHARACTERISTICS (control setting of 10)

Mode	Maximum (open circuit) P-P Voltage	Nominal 100 ohm load Power (watts)	Nominal (100 ohm load) Crest Factor
CUT	400	60	1.5
BLEND 1	600	45	2.3
BLEND 2	600	25	3.0
BLEND 3	800	40	3.6
COAG	1000	25	6.5

OUTPUT POWER CONTROL

CUT and COAG output power is essentially linear with control rotation from settings of (1) to (10). BLEND power settings approximately equal the CUT power settings up to their respective maximum output powers.

POWER READOUTS

CUT mode and COAG mode power readouts agree with monopolar output power into 300 ohm resistive load to within ± 15% or 7 watts whichever is greater.

LOW FREQUENCY LEAKAGE (50/60 Hertz)

Source current, patient leads, all outputs tied together
  Normal polarity, intact chassis ground, <2.0μA
  Normal polarity, ground open, < 30μA
  Reverse polarity, ground open, < 30μA
Sink current, 140 volts applied, all inputs < 150μA
Source current (chassis), open ground < 100μA

If a chassis ground is disconnected with "POWERITE™" on, unit automatically switches off. Reset by switching on.

HIGH FREQUENCY RISK PARAMETERS

Bipolar RF leakage current, output to ground, 40 pf open output to ground, ≤ 150 ma rms.
Monopolar active to ground trip capacitance 120 pf ± 20 pf.
Active to ground current after 40 pf accessory capacitance, patient open, less than 250 ma rms.
Patient to chassis voltage, after 40 pf accessory capacitance, less than 30 volts rms.

COOLING

Natural convection cooled. No fan.

INDICATORS

The backlighted words "COAG" and "CUT" will be illuminated only when RF power is available at unit output connections.

High frequency COAG tone or low frequency cut tone will sound when unit is keyed via either footswitch or handswitch.

AUDIO VOLUME

Mode indicator tones 72 dBA at 30 cm (1 foot) maximum
Adjustable external volume control.

INPUT POWER SOURCE

Nominal voltage	120 volts rms
Regulation range	90 - 140 volts rms
Operation range	80 - 140 volts rms

Frequency 45-65 Hertz

Current:	Idle	0.4 amperes maximum at 120V RMS line input
	CUT	9 amperes maximum at 120V RMS line input
	COAG	4 amperes maximum at 120V RMS line input

Power:	Idle	50 watts maximum at 120V RMS line input
	CUT	900 watts maximum at 120V RMS line input
	COAG	375 watts maximum at 120V RMS line input

LINE REGULATION

Between 90 and 140 volts input, output power into a 300 ohm load will vary no more than 2% or 2 watts.

WEIGHT 12.8 Kilograms (28 pounds)

SIZE	Height	21.6	cm (8.5")
	Width	34	cm (13.0")
	Length	41	cm (16.3")

Specifications subject to change without notice.

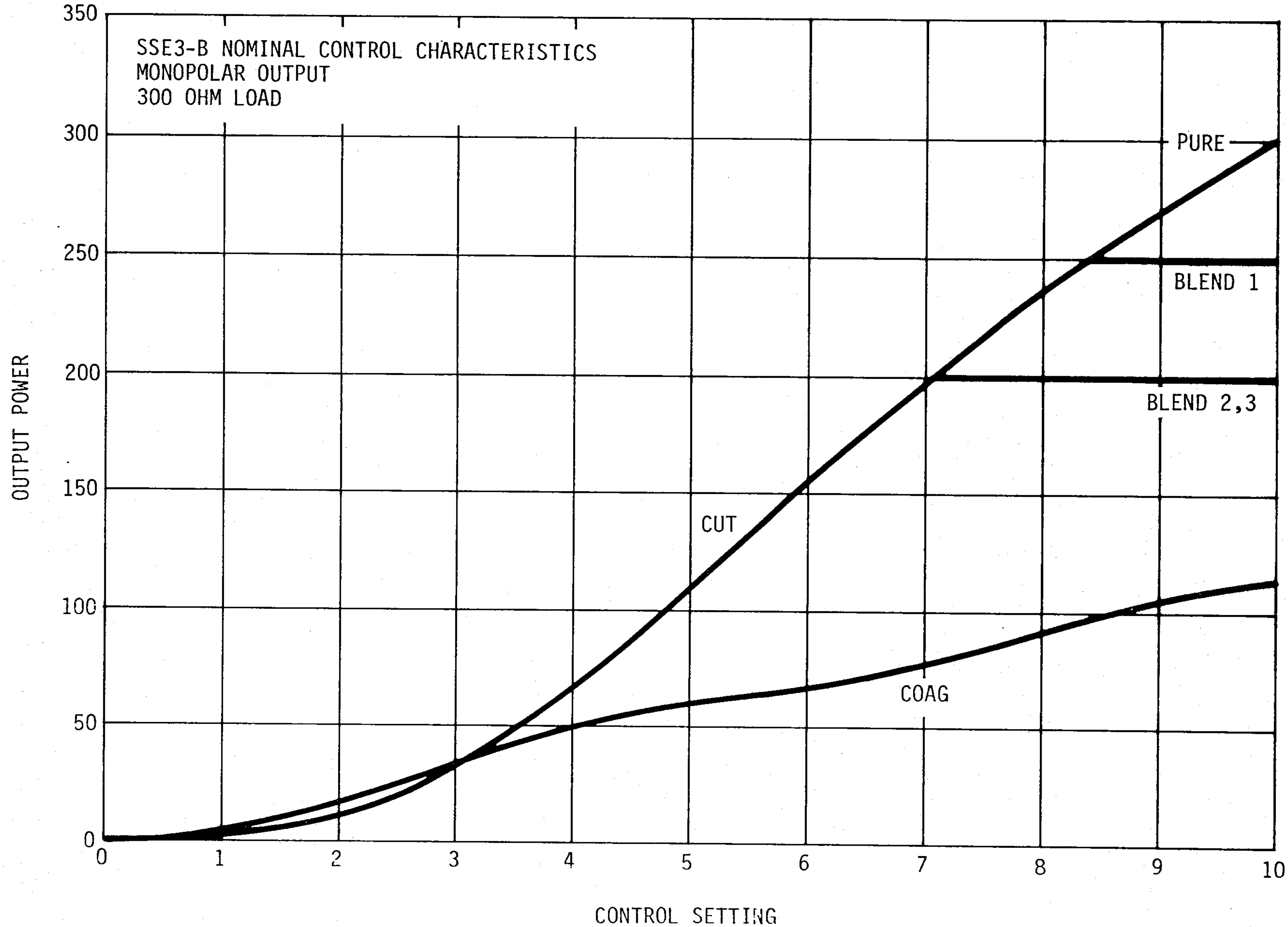


Figure 1 Power vs Control Setting - Monopolar

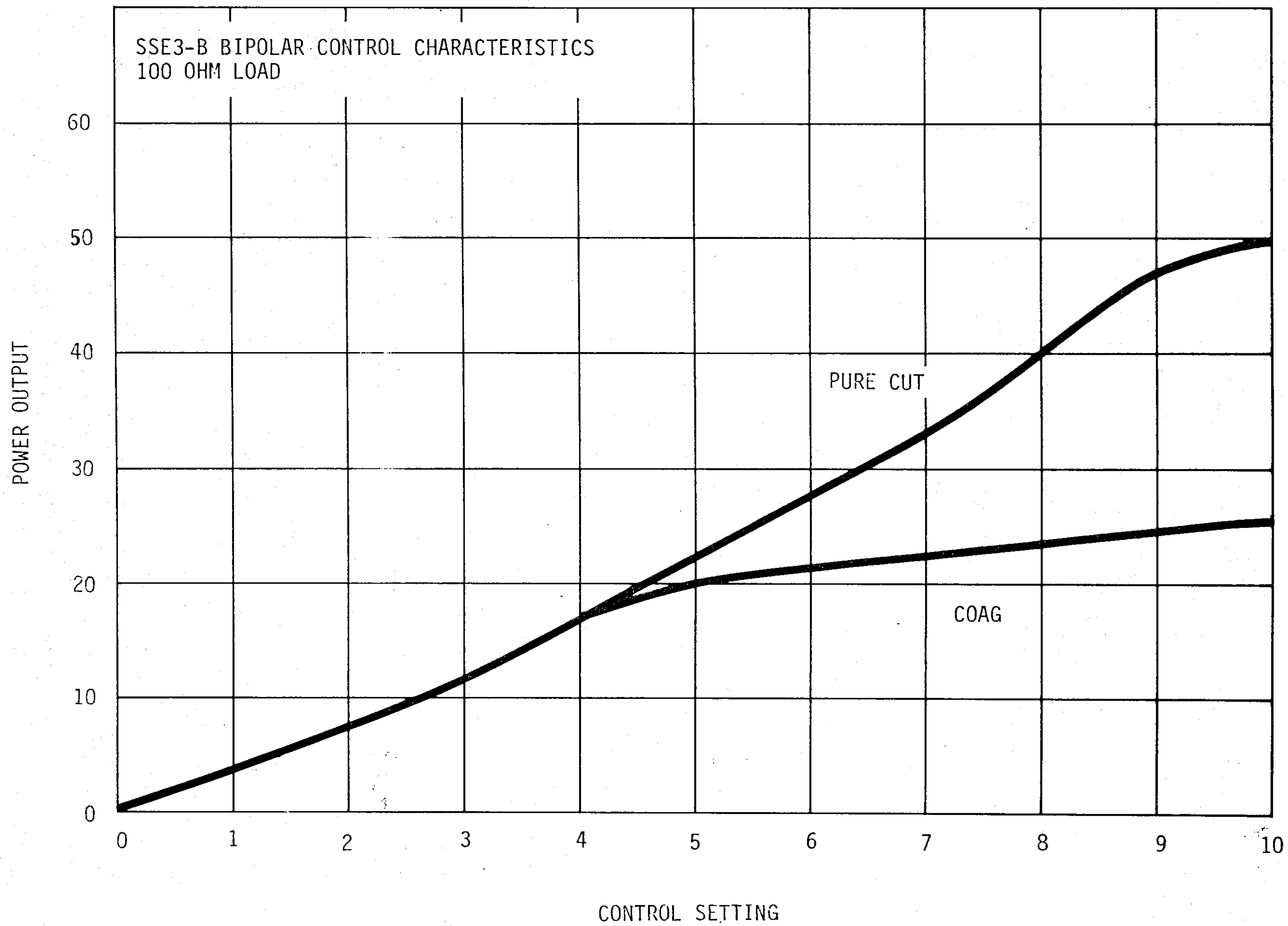
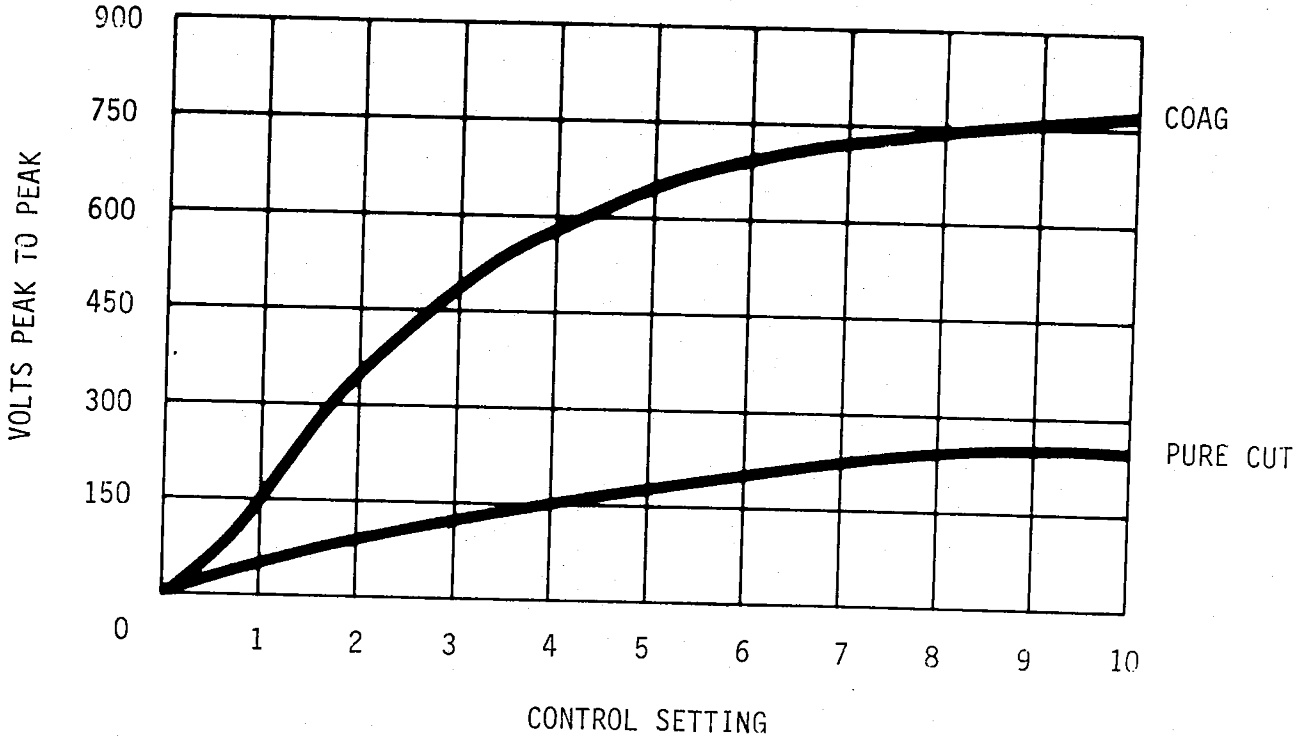
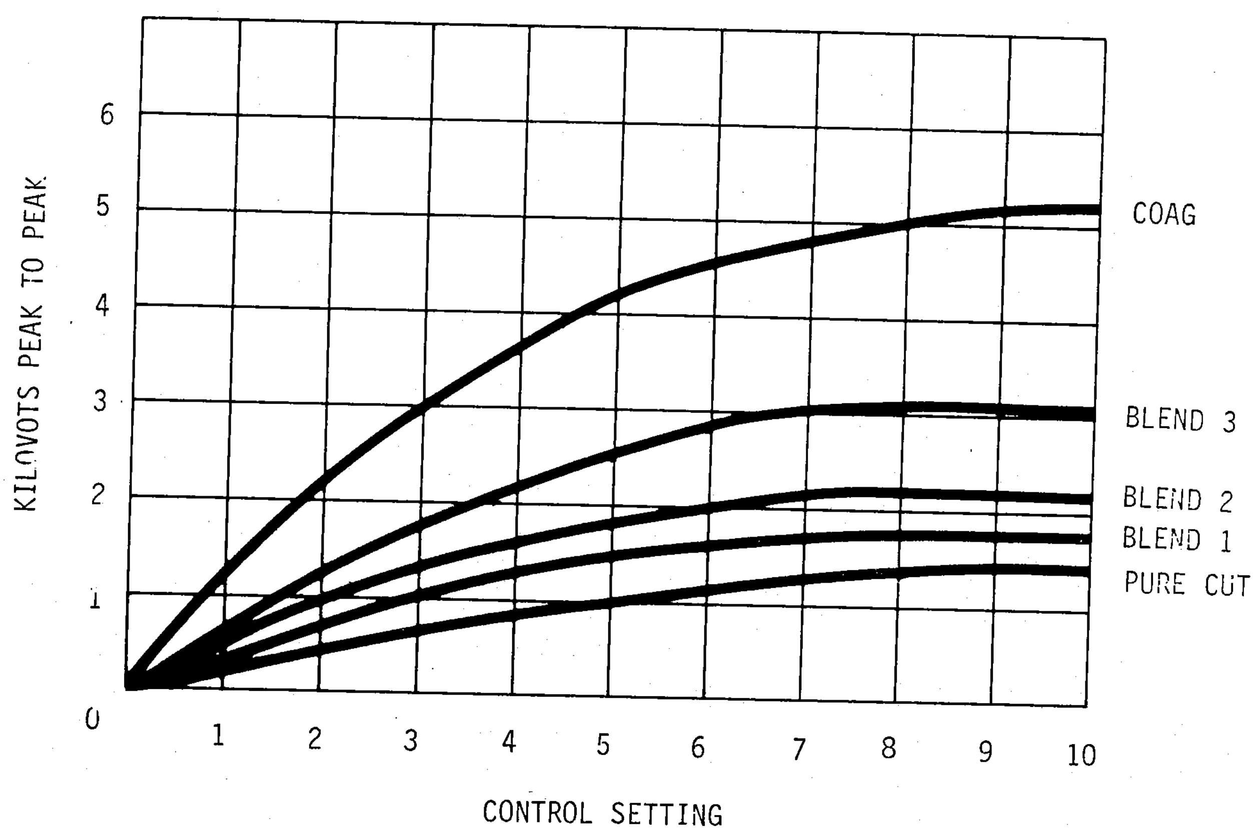


Figure 2 Power vs Control Setting - Bipolar

BIPOLAR



MONOPOLAR



TYPICAL SSE3 OPEN CIRCUIT CHARACTERISTICS

Figure 3 Output Voltage vs Control Setting

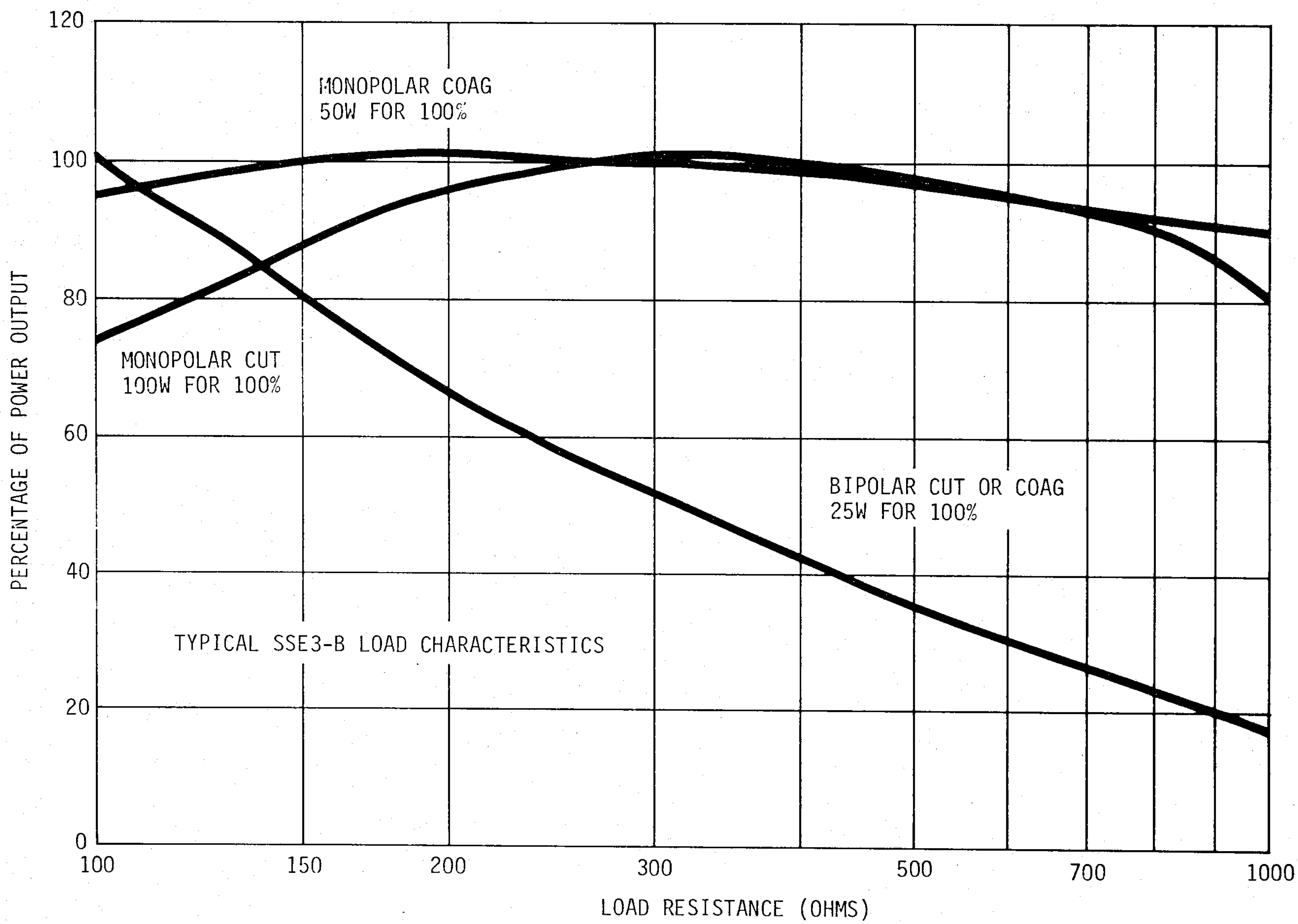


Figure 4 Power Output vs Load Resistance

Section 6 Circuit Description

INTRODUCTION

The operation of the SSE3-B is outlined on Figure 8, the SSE3-B block schematic. CUT or COAG output is selected from a footswitch by means of FSCT or FSCG or by an accessory such as a LectroSwitch through the ACTIVE KEYING circuit in the ISOBLOC module. The desired output level is set by the front panel controls through CGW for COAG and CTW for CUT. In the CUT mode, varying degrees of hemostasis can be selected with the CUT MODE switch. (See Figure 10 and Figure 11 for the SSE3-B output waveforms.)

The signals from the CUT MODE switch (CPE, B1E, B2E, and B3E) are used by the CLOCK module to generate timing pulses, and by the LEVEL board to generate appropriate DC levels (CGPG or CTPG).

The SENSE module processes inputs from the LEVEL module (CGPG, CTPG) and inputs from the output stage (CSH, CSL, COL) which indicate output transistor collector current and voltage. One section of the SENSE module gives an output if the output transistors are saturated ($\overline{S}$) or oversaturated ($\overline{OS}$). The other section of the SENSE module is a pair of comparators which give a low output if the output transistor current is too high. These outputs are $\overline{CSCT}$ for CUT and $\overline{CSCG}$ for COAG. The CONTROL module processes these inputs along with inputs from the CLOCK module ($\overline{f}$, $\overline{VR}$, HW, CL, MC, $\overline{CCE}$) and produces the voltage program input to the power supply (VS) and signals to be the DRIVER module (OND, $\overline{OFD}$).

During normal operation, VS increases when $\overline{S}\cdot CTE\cdot\overline{CCE}$ is present because the output transistors are saturated. The other way for VS to increase if for $\overline{M}$ to be present. (See the CONTROL module schematic.) $\overline{M}$ is present if either the supply voltage is maximum and the output transistors are saturated or the power supply cannot respond fast enough for changing output conditions.

The DRIVER module provides controlled width turn on (T/ON) and turn off (T/OFF) signals to the five OUTPUT modles.

RETURN FAULT MONITOR CIRCUITRY

The return fault monitor consists of a current inbalance detector located on the ISOBLOC board, and a DC comparator circuit and a lamp driver circuit on the LEVEL board.

The patient current is sensed by current transformer T3 and converted to a positive DC current by CR11-14. The active current is sensed by current transformer T4 and converted to a negative DC current by CR15-18. Under normal conditions with very low active to ground leakage, the active and patient current are nearly equal and there is no net current flowing to C14 from the two bridges. A winding on T1 combined with C17 and CR19-22 provides a positive bias current which varies with output. In this way the circuit is sensitive to the active to ground capacitance and will trip at the same capacitance (or impedance) regardless of control setting.

Any active to ground capacitance will cause more current to flow in the active lead than in the patient lead and the voltage across C14 on the ISOBLOC board (GM) will go negative. If the active to ground capacitance is too high (or the impedance is too low), GM will go negative enough to cause the output of U2 on the LEVEL board to go positive and turn on SCR1. Generator output is inhibited and the RETURN FAULT indicator lamp lights. The RETURN FAULT circuit is reset by pushing the RETURN FAULT indicator button. This interrupts the anode current in SCR1. If the fault is no longer present, the generator will return to operation.

ISOBLOC CIRCUIT

The IsoBloc circuit permits keying the generator with hand held accessories such as the Valleylab E2505 Lectro-Switch while maintaining a high degree of RF isolation. Q1 on the Iso-Bloc circuit board is a 100 kHz oscillator. Energy is transferred through T2 to photoisolators PI1-4. When the corresponding light emitting diode anode is connected to an active lead, the diode emits light, and current flows in the phototransistor. For instance if monopolar COAG is selected, PI3 causes Q3 to conduct and FSCG to go low and key the generator in COAG. If monopolar CUT is selected, PI4 causes Q4 to turn on and key the generator in CUT or one of the blended waveforms selected by the CUT MODE switch. Operation from the bipolar jack is similar except that PI1 provides COAG switching and PI2 provides CUT switching.

KEYING LOGIC CIRCUITS

The keying circuitry is on the LEVEL printed circuit board and consists of U1, U4, U5, U6 and associated components. The inputs are FSCG and FSCT from either the footswitch or the Iso-Bloc circuit. The outputs are CGE, CTE and signals to the audio alarm, relay and indicator lamp circuits.

If both CUT and COAG are keyed simultaneously, only COAG will be activated due to the action of U1 and U4.

LEVEL CIRCUITRY

The level circuitry uses the front panel potentiometer settings along with mode control signals to produce appropriate DC levels for use by the sense module to regulate the level of output stage operation. The RETURN FAULT monitor affects the system output through this section of circuitry.

Tapering networks are applied to the wipers of the control potentiometers on the front panel to provide the proper output level versus control setting.

The primary CUT level is passed through a series of attenuators and limiting amplifiers to make possible the close tracking of desired CUT mode control tapers. Voltage selection for both the CUT and COAG modes is done with CMOS analog transmission gates depending on the selected mode.

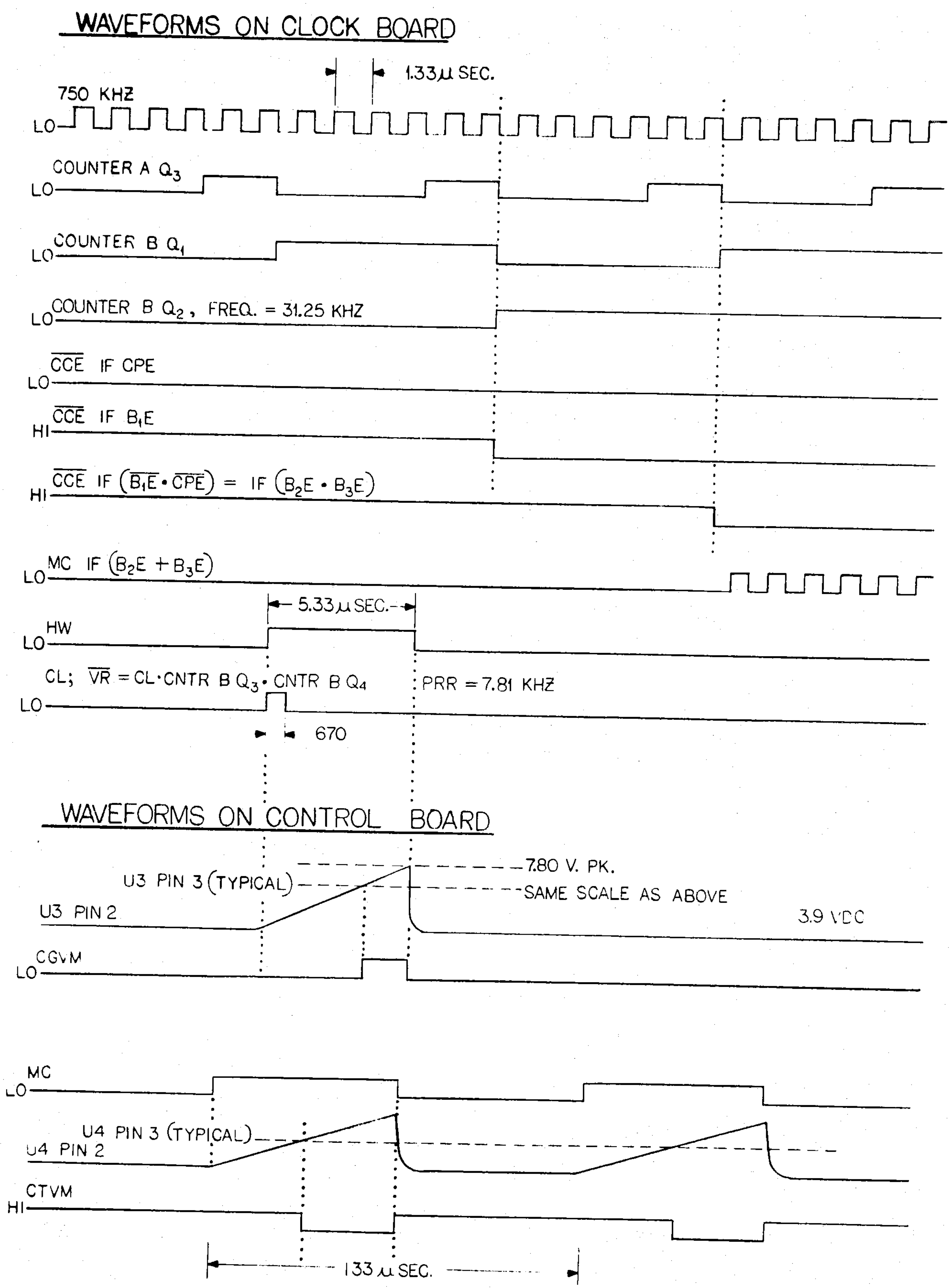
CLOCK MODULE

The function of the clock module is to provide all the necessary timing signals for system operation as functions of the control signals. The two functions $\overline{f}$ and G which are not timing signals per se, are derived within the clock module for reasons of space availability.

Q1 forms a Colpitts oscillator with 750 kHz frequency with U1 following to condition the waveform. U3, a counter, is driven by U1 and its outputs are decoded per the timing diagram to result in the required signal outputs. See Figure 6.

U3A has external logic to cause it to divide by six. U8A decodes the state of 110, sets flop U9A, U8B, and causes a reset signal to U3A. The flop is reset by the next positive oscillator transition.

Each section of U3 is internally but not mutually synchronous. Decoding



NOTE: PROPOGATION DISCREPENCIES NOT SHOWN.

Figure 5 Timing Waveforms

between sections which is done in one instance requires series resistors (R9, R10) and distributed capacitance to delay signals from U3A.

The SSE3-B timing diagram adequately describes the processes by which signals are decoded from the counter outputs. See Figure 6.

SENSE MODULE

The sense module has two distinct sections performing different functions. One is an isolated voltage comparator which takes the differential voltage across a 0.05 ohm current sensing resistor in the output stage which is at the potential of the output power supply, and compares this voltage with a variable input voltage, and gives a logic output which is low if the first voltage exceeds the second. There are comparators of this type each specific to either the cutting or the coagulating mode. The inputs are variable analog reference voltages, CUT program (CTPG) and COAG program (CGPG) from the level board; and current sensing resistor connections, CSH and CSL. The outputs are $\overline{CSCG}$ for the COAG comparator and $\overline{CSCT}$ for the CUT comparator. The second section consists also of a pair of comparators, and these are used to give logic outputs according to the value of output stage collector voltage compared with an adjustable but fixed once adjusted reference in one case, and ground in the other case. The input is a connection to the output stage collectors. The outputs are $\overline{S}$ from the adjustable-reference comparator and $\overline{OS}$ from the grounded comparator.

Circuit Description:

In the case of the first section, it is sufficient to describe only the COAG current sensing comparator. COAG program (CGPG) which varies between 0.6 and 6.0 volts is generated by the level control circuits. CGPG causes a voltage of 0-5.4 volts to be developed at the emitter of Q1 and current to flow in the collector. This causes a voltage of up to 3 volts to appear across R2. C2 is large compared to the collector capacitance of Q1 so that noise from CSH does not appear across R2. Q2 conducts only if the voltage across R9, which is the current sensing resistor voltage, is greater than the voltage across R2. When Q2 conducts, the collector of Q3 goes low and $\overline{CSCG}$ is low. This type of comparator allows the sense resistor voltage which is not referenced to ground, to be compared with a ground-referenced voltage and give a ground referenced output.

The second section consists of two high speed I.C. comparators U2 and U3. The input to the $\overline{S}$ comparator is the output stage collector voltage divided by 25. The $\overline{S}$ comparator U2 has a reference input set by R18. When the collector voltage is lower than the set threshold, the output of U2 is low. U3 operates similarly except that it has a grounded reference.

CONTROL MODULE

The control module processes inputs from the clock module, level board keying circuits and the sense module and produces an appropriate voltage programming input to the power supply, and a multiplexed controlled-width signal to the output driver circuits. See Figure 7.

The voltage programming input to the power supply appears first at pin 1 of an integrator consisting of ½ of U2. It is buffered by a voltage follower and filtered by R1 and C1A. VS has a minimum value determined by the setting of R8. The minimum supply voltage is normally 60 volts DC. The input to the integrator is either +12 volts or 0 volts depending on the operation of a flip-flop. $\overline{VR}$, which is a narrow pulse and is always present at a 31 kHz repetition rate, sets the flip-

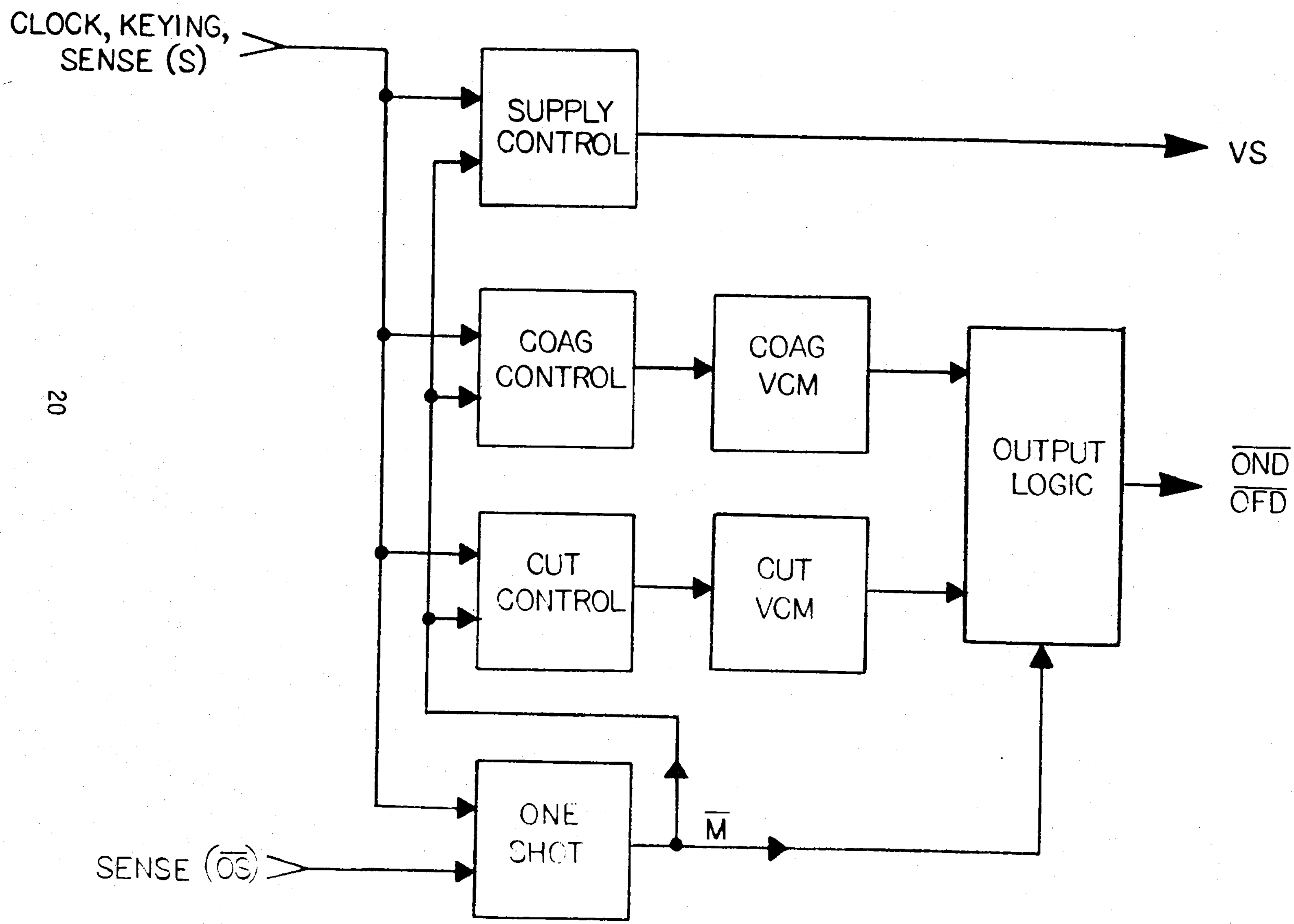


Figure 6 Control Module Block Diagram

flop to a high state which decreases VS. The presence of $\overline{M}$ or $\overline{S}\cdot CTE\cdot\overline{CCE}$ clears the flip-flop so that VS increases. The normal method of increasing VS is for $\overline{S}\cdot CTE\cdot\overline{CCE}$ to be present. This occurs because for the level of output required by the cut control to maintain its set current, a higher supply voltage is necessary to keep the output transistors out of saturation. The other method of increasing VS is for $\overline{M}$ to be present. $\overline{M}$ is present at the output of the one shot if either the supply voltage is maximum and the output transistors have saturated or because the power supply cannot change fast enough for changing input conditions. The length of the $\overline{M}$ pulse is 1 ms and is determined by the time constant of R2 and C1. With $\overline{M}$ present, the supply voltage is stepped upward, output is inhibited and control voltages (VDCT, VDCG) are reset so that when the $\overline{M}$ pulse ends, the system can come to the equilibrium required by the output load and control settings. The supply control is at equilibrium when the phase relation between $\overline{VR}$ and $\overline{S}$ is such that there is no net change of VS.

The COAG and CUT control sections operate in a manner similar to the supply control. Each is connected to a voltage controlled multivibrator (VCM) which gives an output pulse width at a fixed repetition rate according to an analog input voltage, which is the average of a logic waveform applied to a low pass filter. In the case of COAG, CSCG from the sense module causes VDCG to increase, (pulse width to decrease) and CL causes an increase of pulse width. For the cut control the two signals are CSCT and CL respectively. The cut control has a tri-state output through an analog transmission gate (U8) so that the capacitor voltage may be affected only during $\overline{CCE}$. The net effect of both controls is to create an equilibrium condition where the operating level of the output stage is exactly commensurate with the programming input voltage to the sense module from the level circuitry.

Control output logic is provided first to multiplex the signals from CUT and COAG VCMs in the B3 mode, and secondly to inhibit the drive during the presence of $\overline{M}$, the one-shot signal.

DRIVER MODULE CIRCUITRY

The driver module inputs are $\overline{OND}$ and OFD. Transistors Q1-Q7 are used to generate the signals T/ON and T/OFF which go to the stripline module and the five output modules. The driver module also has a comparator, U2, which senses when the output transistor collector voltage reaches 475 volts. When this occurs, a one-shot, U3, turns on and the dissipator transistor Q8 turns on. In this manner the output transistors are protected from excessive collector voltage.

OUTPUT STAGE CIRCUITRY

The fundamental element of the output stage is a set of five Solitron 12SE189 power transistors. Each transistor has a separate module which has a heat sink and a small circuit board. The entire module is easily unplugged from the SSE3-B assembly.

The output modules are interconnected by a large printed circuit board. Three parallel-connected turn-off transistors are mounted on the stripline board. The output transformer has several windings; a single primary, a monopolar secondary, a bipolar secondary, a bipolar secondary, a leakage cancelling winding, and a sense winding for enabling the CUT and COAG indicator lamps.

DISPLAY CIRCUITRY

The SSE3-B features a digital display of the power setting calibrated in watts whose value is derived from analog signals used to program the operating level of the device. Thus the programming signals from the level board, which are compared with output stage current on the sense board, are used to drive analog to digital converters and set the displays.

Output stage current is proportional to the square root of the output power for a given load resistance, so before the linear A-D converter can be driven, the programming signal must be squared. This is accomplished with an analog multiplier connected for squaring (U9).

One multiplier is time shared between the CUT and COAG channels through the action of an oscillator (U2 pins 3, 4) and the transmission gate package U4. Upon the U3 pin 3 high transition of the oscillator, CGPG' (COAG) is immediately connected to U5 pin 5, scaled for the multiplier, then after a delay appropriate for the settling time of these circuits provided by U2 pin 10, the processed signal is stored on C12 after being conducted between U4 pins 10, 11. The U3 pin 3 low transition results in a similar process for CTPG' (CUT). One difference is that the CUT path through U4 pins 8, 9 to C13 first involves transmission gate U6 and scaling pots R21 - R24. This is because there are four separate CUT modes, pure, B1-B3, and each has a different relation between the programming voltage CTPG and the number of watts at the generator output. For the COAG mode there is only a single scaling pot, R20. Within a tolerance of about 10%, the voltages on C12 and C13 are linearly proportional to the COAG and CUT output powers into 300 ohms, and need only to be converted to digital form.

DVM chips U7 and U8 provide digital conversion. CUT (U8) has a range of 0-300 watts and thus uses a 3-3/4 digit convertor extending to a count of 399.9. The COAG range is only 0-125 watts, so a 3-1/2 digit 0-199.9 count chip is adequate. In each case the least significant digit is not used to increase input voltage levels and minimize the effect of electrical noise coupled to U7 pin 11 or U8 pin 11, the DVM inputs. Internally, the DVM chips convert the analog signal to a digital signal usable for driving LED seven segment displays through a single slope conversion technique and logic synchronized to separate clocks whose frequencies are set by C20 and R35 or C21 and R38. Additional noise suppression is obtained by preventing display changes while the SSE3-B is activated. This is caused by U3 pin 10. The DVM chips have outputs capable of driving the individual segments but each digit's common cathode can pass the sum of activated segment currents, and thus the digit driver U1 on the Display Board is required. Display Board R1-R14 set the correct amount of current through the segments.

The display circuitry has power requirements dissimilar to the rest of the SSE3-B circuitry and so four special voltages are derived on the Display Driver Board. U1 is an oscillator circuit which drives a diode capacitor network to provide U9 with -13.5 volts. Q1 and Q2 regulate +5.5 volts from +15 volts to power the DVM chips. CR4 produces a stable reference of 2.0 volts for the DVM chips.

OUTPUT POWER SUPPLY

Incoming AC power is rectified by CR3, filtered by C5, and chopped by Q10-Q13. The chopped DC is passed through T2, rectified by CR4, and filtered by L2 in the power supply module and C101 in the stripline module. The output voltage is controlled by varying the time ratio of conduction of Q10-Q13.

U3C, U4, U5, U6 and associated components cause transistor pairs Q10-Q11 and Q12-Q13 to alternately conduct for very closely equal periods programmed by the voltage at pin 11 and U3.

The output power supply timing diagram, Figure 8, shows how the drive signals for Q10-Q13 are generated. During conduction by a given pair of output transistors, CR6 or CR7 conducts and acts with T2 to prevent the output transistors from saturating and building up excess stored base charge. R30 and C15 damp the ringing which would occur as a result of energy stored in the leakage inductance of T1.

U3 performs several functions in the power supply controller. The input quandrant, U3D, compares the supply input voltage Vs with a fraction of the filtered output voltage. The supply DC gain is determined by a voltage divider consisting of R5, R6, and R7. C5 filters the switching noise from the output voltage. C6 supplies lead-lag compensation for optimum supply performance. The average value of the output of U3D affects the rate of change of the output of U3C which appears across C12. The comparator R19 and C12 form an averaged value switching time ratio amplifier that operates between 20 kHz and 1 mHz. U3B is the part of the pulse period controller which compares the filtered voltage on C14 with the sawtooth voltage from U4 to give a pulse width modulated output. C12 and C14 filter at a sufficiently high frequency that they do not affect the supply loop dynamics.

Protection Circuits:

Overcurrent Protection--
Q5-Q9 and related components form the protection circuitry which has two functions. Q8 and Q9 latch on when the current in the output inductor L2 exceeds 8 amperes. This disables the supply by causing Q5 to conduct and clamp the output of U3B to ground. This protection feature is reset by turning the supply off.

Undervoltage Protection -
Low supply voltage could cause inadequate drive for the output transistors. A circuit consisting of Q6, Q7, CR7 and associated components disables the high voltage supply if the 15 volt power supply produces less than 13.5 volts.

LOW VOLTAGE SUPPLY, 15 VOLT SECTION

Input power is passed through transformer T1 and rectified by CR1 and filtered by C1. The pass transistor, Q3, is connected in series with the load and regulation of the output voltage is accomplished by on-off switching of the pass transistor controlled by a feedback circuit. The comparator U1 samples a fraction of the output voltage determined by R58 and compares it with the reference voltage across C19. The difference between the two voltages is used to control the on-off duty cycle of Q3.

The chopped DC voltage is filtered by an LC filter (L1, C21) and the commutating diode CR1. The output current of the 15 volts supply is limited by Q4 and R53. When the output current is greater than 4A, Q4 turns on and reduces the reference voltage across C19.

LOW VOLTAGE SUPPLY, -5 VOLT SECTION

Input power is passed through T1 and rectified by CR2. The rectified AC is then filtered by C2 and C3 and regulated by U1 of the supply module.

ECG BLANKING

The ECG Blanking circuit shorts J17 and J18 together with the contacts of relay K2 on the stripline board whenever the generator is keyed. Both J17 and J18 are isolated from ground. When the generator is keyed, in CUT of COAG, the output at U1 pin 6 on the level board is high. This turns on Q4 on the stripline board which causes the normally open contracts of K2 to close.

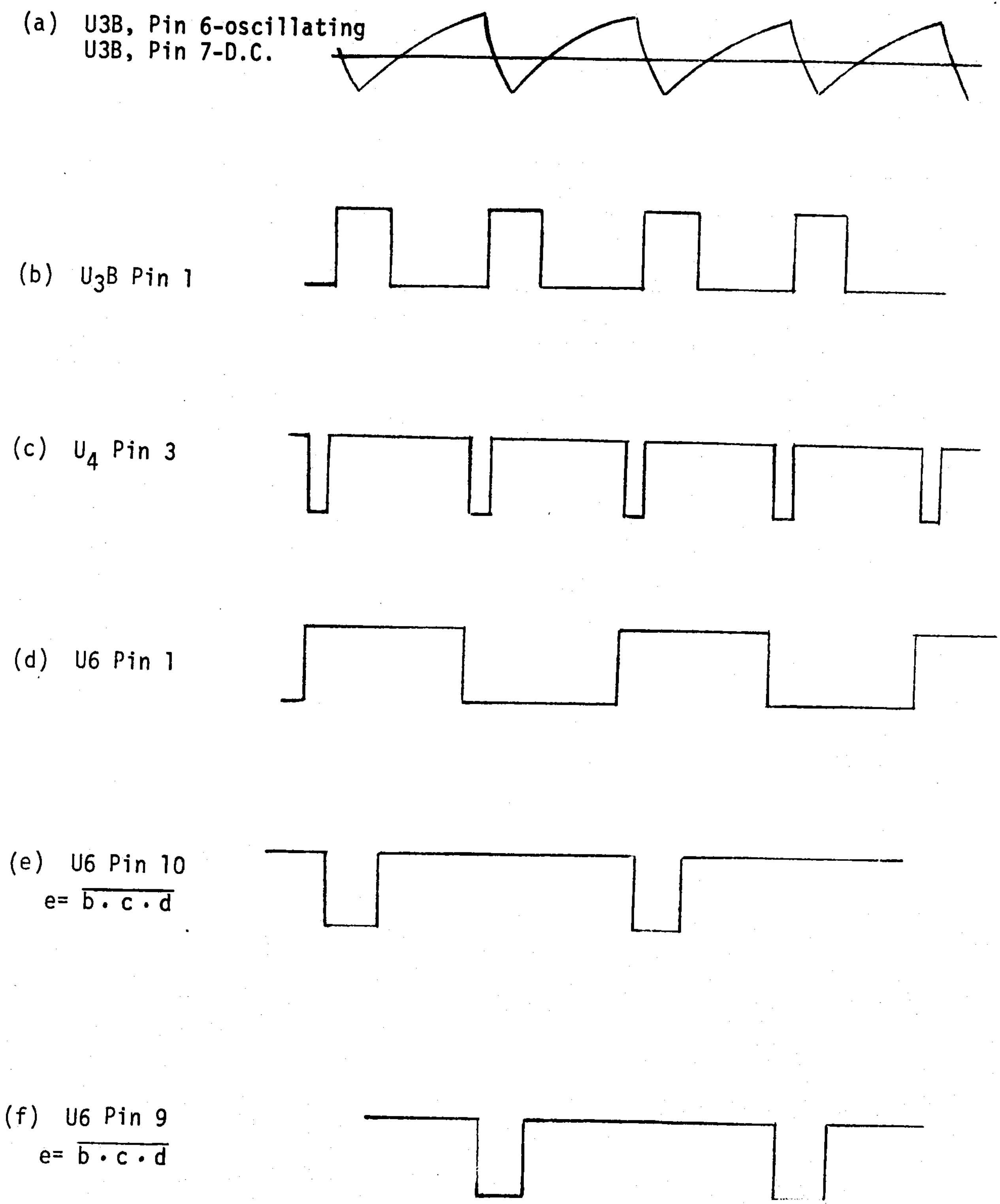


Figure 7 Output Power Supply Timing Diagram

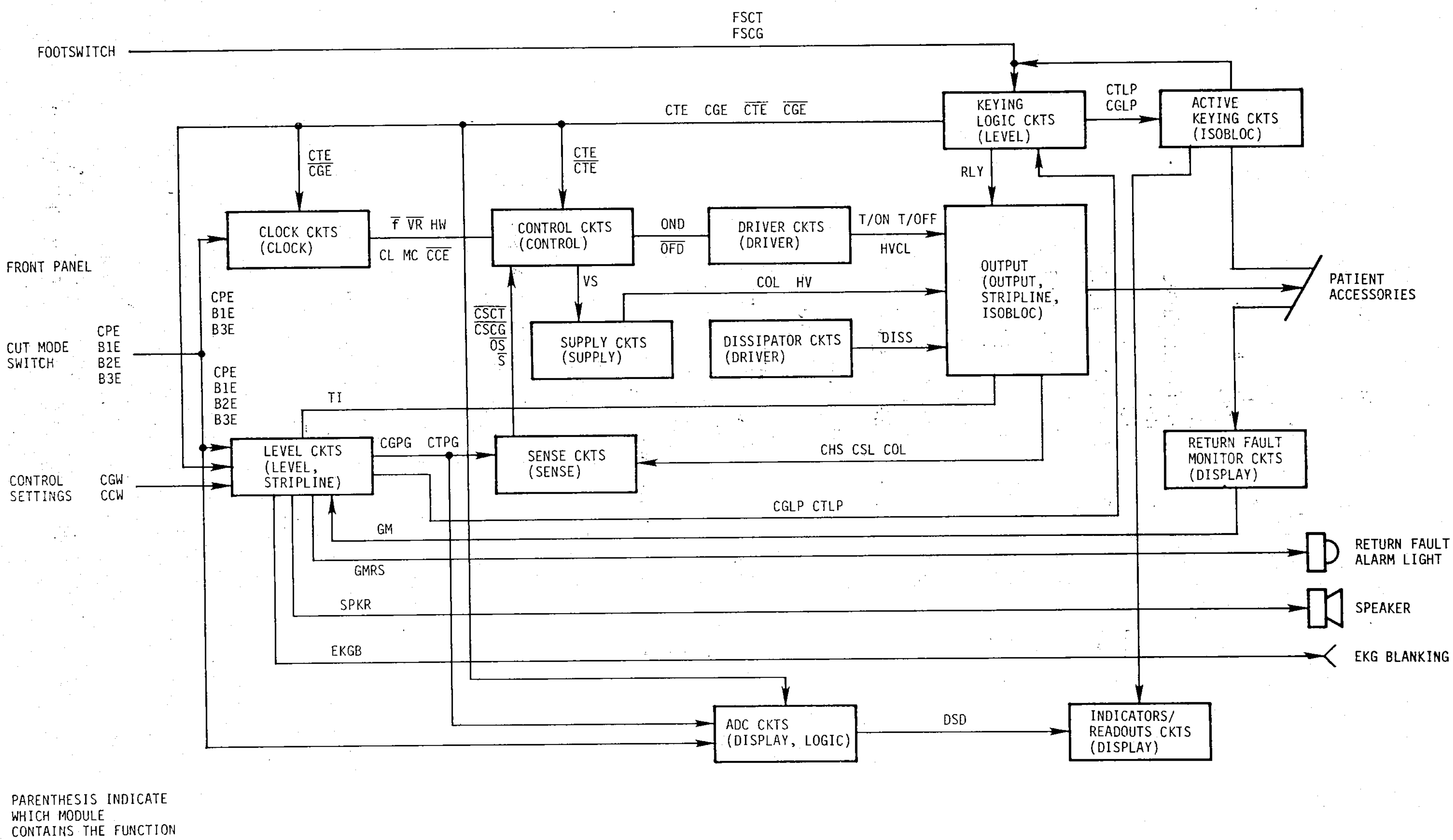


FIGURE 8 SSE3-B BLOCK SCHEMATIC

TABLE 1 SSE3-B SIGNALS

SIGNAL	FUNCTION
B1E	Blend 1 ENABLE
B2E	BLEND 2 ENABLE
B3E	BLEND 3 ENABLE
$\overline{CCE}$	(NOT) CUT CLOCK ENABLE
CGE	COAG ENABLE
$\overline{CGE}$	(NOT) COAG ENABLE
CGLP	COAG LAMP (INDICATOR)
CGPG	COAG PROGRAM
CGW	COAG POTENTIOMETER WIPER
CL	CLOCK
COL	COLLECTORS (OUTPUT TRANSISTORS)
CPE	CUT PURE ENABLE
$\overline{CSCG}$	(NOT) CURRENT SENSE COAG
$\overline{CSCT}$	(NOT) CURRENT SENSE CUT
CSH	CURRENT SENSE HIGH
CSL	CURRENT SENSE LOW
CTE	CUT ENABLE
$\overline{CTE}$	(NOT) CUT ENABLE
CTLP	CUT LAMP (INDICATOR)
CTPG	CUT PROGRAM
CTW	CUT POTENTIOMETER WIPER
DISS	DISSIPATOR
DSD	DIGIT SEGMENT DRIVES
EKGB	ELECTROCARDIOGRAPH BLANKING
f	(NOT DEFINED)
$\overline{f}$	(NOT DEFINED)
FSCG	FOOTSWITCH COAG
FSCT	FOOTSWITCH CUT
G	(NOT DEFINED)
GND	GROUND
GM	GROUND MONITOR (RETURN FAULT)
GMRS	GROUND MONITOR RESET
HV	HIGH VOLTAGE
$\overline{M}$	INHIBIT
MC	MODULATED CLOCK
$\overline{OFD}$	(NOT) OFF DRIVE
$\overline{OND}$	(NOT) ON DRIVE
$\overline{OS}$	(NOT) OVER SATURATED
RLY	RELAY
$\overline{S}$	(NOT) SATURATED
SPKR	SPEAKER
TI	TEMPERATURE INHIBIT
T/OFF	TURN OFF
T/ON	TURN ON
VS	VOLTAGE SIGNAL (PROGRAMS POWER SUPPLY)
$\overline{VR}$	(NOT) VOLTAGE RESET
VDCT	PROGRAMING FOR CTVCM
VDCG	PROGRAMING FOR CGVCM
CTVCM	CUT VOLTAGE CONTROLLED MULTIVIBRATOR
CGVCM	COAG VOLTAGE CONTROLLED MULTIVIBRATOR

Section 7 Testing Procedure

OPERATIONAL TESTING - GENERATOR OUTPUT

The purpose of an operational test is to quickly determine whether the generator is functioning and generating the necessary electrosurgical waveforms. In the Acceptance Test Procedure, measurements are described which accurately determine the condition of the generator.

A significant amount of information can be obtained about the generator's output by a simple arc-test. This test can be used to determine whether the CUT and COAG outputs are present.

To test the output of the generator, a working switching pencil is required, along with a patient plate clamp and patient plate. In order to avoid burning surgical electrodes, a dummy electrode with a 1/8 inch diameter shaft can be used.

Switch the pencil in the COAG mode, starting at a setting of (0), and attempt to start an arc to the patient plate. At low settings a very small arc should occur, growing larger as the front panel control setting is increased. At full output it should be possible to sustain an arc with the electrode about 1/4" from the patient plate.

If this test is repeated in the CUT or BLEND modes, the arc will be stronger and larger. At full output (10) a very strong arc should be obtained.

NOTE: Electrosurgical generators are not rated for continuous duty operation. (Maximum on time at a dial setting of 10 is two minutes.)

ACCEPTANCE TEST PROCEDURE

Equipment Needed
- Tektronix type 453 oscilloscope
- Tektronic type P6013A High Voltage Probe
- Tektronix type P6007 x 100 Probe
- Tektronix type P6010 x 10 Probe
- Hewlet-Packard type 427A Voltmeter
- Simpson Model 1339 RMS RF Ammeter, 0-250mA
- Wattmeter, 0-500 Watts 300 ohm load--with reactive phase angle of less than 20^0 at 750 kHz, 2.5 mHz
- 82 pf 20% 6KV ceramic capacitor
- 150 pf 20% 6KV ceramic capacitor
- General Radio 1192 Frequency Counter

NOTE: In testing RF equipment, proper test procedures must be adhered to in order to have a reasonable chance of duplicating factory test data. Test leads must be kept to the minimum length usable; lead inductance and stray capacitance can affect readings adversely. The selection of suitable "ground" points must be made with care to avoid ground-loop errors. Keep in mind that the meter accuracy of many RF instruments is 5-10% of full scale. Using uncompensated scope probes may cause large errors in the measurement of high-voltage RF waveforms. When fractional microampere leakage currents are measured, accidental capacitive or inductive coupling may cause order of magnitude errors in the observed values. Measurements should be made with the generator in the cover. If the measurements must be made with the cover removed, or the unit is being calibrated, the shielding effects of the cover can be approximated by placing the power supply cover over the right side of the generator near the front.

CALIBRATION PROCEDURE

GENERAL

The best performance will be obtained if each adjustment is made to the exact setting even if the Performance Check is within the allowable tolerance. The following procedure uses equipment listed under Equipment Needed. If substitute equipment is used, it must meet or exceed the specifications of the recommended equipment. Also, all calibrations listed in the procedure, steps one through six, are made in the factory before units are accepted by QA. If just RF output power needs to be recalibrated, proceed directly to step six of the procedure.

NOTE: RF power should be measured with the cover on.

Special care must be taken in Step 5, Section f. The 10X or 100X probe to be used should be closely calibrated with the oscilloscope to be used.

PROCEDURE

1 Remove the SSE3-B from its cover (see disassembly instructions) to expose the internal controls and test points.

2 ADJUST THE ± 15 VOLT SUPPLY
- A Connect the digital multimeter between the ± 15 volt test point F and the ground test point E on the Power Supply Printed Circuit Board.
- B Adjust R58 for a meter reading of exactly +15.0 volts.

3 ADJUST THE COAG LOW VOLTAGE INHIBIT CIRCUIT
- A Set the CUT control to 0 and the COAG control at 3. The PURE BLEND selector switch should be in PURE CUT.
- B Connect the oscilloscope with a 10X or 100X probe between E7 on the stripline board and chasis ground.
- C Adjust R11 on the sense board fully clockwise. Turn unit on, the scope should measure +60 volts DC above ground. Adjust R8 Control Board counterclockwise until DC level is exactly 50 volts DC.
- D Attach a 300 ohm load from the ACTIVE output to the PATIENT output.
- E Key the generator in COAG and slowly rotate R11 counterclockwise until the COAG waveform just reappears.
- F Readjust R8 on the Control Printed Circuit Board to 60 volts DC.
- G COAG RF power at a setting of 3 should read approximately 27 watts.

4 ADJUST THE HIGH VOLTAGE SUPPLY MINIMUM OUTPUT
- A Connect the Digital Multimeter between the High Voltage Test Point D and the Ground Test Point E on the Power Supply Printed Circuit Board.
- B Adjust R8 on the Control Printed Circuit Board for a meter reading of 60 volts.

5 ADJUST THE HIGH VOLTAGE CLAMP
- A Set the COAG control to 3.
- B Attach a 200 ohm load from the ACTIVE output to the PATIENT output
- C Key the generator in COAG. The output power should be 32 ± 5 watts. Adjust R28 on the Level Printed Circuit Board if necessary.
- D Remove the 300 ohm load.
- E Adjust the COAG level control to 0.
- F Attach an oscilloscope with a 10X or 100X probe between E7 on the Stripline Printed Circuit Board and chasis ground. Test point m Figure 16 photo #7. Key the unit in COAG. Slowly increase the COAG power setting and observe the peak positive voltage. Adjust R15 on the Driver Board so that the maximum peak voltage is 475 volts. Do not let the peak voltage exceed

475 volts while making this adjustment.

G Attach a 200 ohm load wattmeter. Set the COAG level control at 10 and adjust R28 on the Level Printed Circuit Board to give 115 watts output. Remove the load and repeat Step 5F.

6 CUT MODES OUTPUT POWER CALIBRATION

See Figure 14

A For best accuracy the SSE3-B should be activated and allowed to idle for 15 minutes before proceeding with this calibration.

B Attach a 300 ohm Load Wattmeter between the ACTIVE and PATIENT OUTPUT JACKS. This Wattmeter should have a reactive phase angle of less than 20^{o} at 750 kHz, 2.5 mHz.

C Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 2. Adjust R46 on the Level Board for output power on 110 ± 20 watts. Now set CUT LEVEL CONTROL at 10 and key the Generator in BLEND 2. Adjust R30 on the Level Board for 200 ± 30 watts.

D Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 3. Adjust R42 on the Level Board for 110 ± 20 watts power output. Then set CUT LEVEL CONTROL at 10 and key the generator in BLEND 3. Readjust R42, if necessary, for 200 ± 30 watts ouput. If R42 had to be readjusted, recheck output power in BLEND 3 at Control Setting 5.

E Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 1. Adjust R39 on the Level Board for 110 ± 20 watts output power. Then set the CUT LEVEL CONTROL at 10 and key the generator in BLEND 1. Readjust R39, if necessary, for 250 ± 30 watts output power. Then recheck power output in BLEND 1 at Control Setting 5.

If output power in BLEND 1 at Control Setting 5 is now out of specification (110 ± 20 watts) then readjust R39 for 110 ± 20 watts power output at BLEND 1 Control Setting 5. Now adjust R30 on Level Board for 250 ± 30 watts output power in BLEND 1 at Control Setting 10. Care must be taken to not rotate R30 past the point where power in BLEND 1 no longer increases. If this is done power output in BLEND 2 will continue to increase past 230 watts.

Finally, if power output in Blend 1 Control Setting 10 is too low even after the above procedure has been followed. This means that R46 on Level Board must be adjusted clockwise until power output in BLEND 1 Control Setting 10 meets specification. No more than 1 turn should be required.

F Set CUT LEVEL CONTROL at 5 and key the generator in PURE CUT. Adjust R57 on the Level Board for 130 ± 30 watts power output. Then set the CUT LEVEL CONTROL at 1 and key the generator in PURE CUT. Adjust R57 on the Level Board for 300 ± 30 watts power output. Then recheck power output at control setting 5.

G Recheck power output in all CUT modes at CUT LEVEL CONTROL settings of 5 and 10. If necessary repeat Steps B through E.

7 DIGITAL DISPLAY CALIBRATION

See Figure 14

A For best accuracy the SSE3-B should be activated and allowed to idle for 15 minutes before proceeding with this calibration.

B Attach a 300 ohm load Wattmeter between the ACTIVE and PATIENT output jacks. This Wattmeter should have a reactive phase angle of less than 20^{o} at 750 kHz, 2.5 mHz.

C Set CUT LEVEL CONTROL at 5 and key the generator in PURE CUT. Measure the power output and note. Now adjust R21 on the Display Driver Board so that digital readout matches measured power output.

Set CUT LEVEL CONTROL at 2, 7, 10 and measure power output with generator keyed in PURE CUT. NOTE these readings. Now compare digital display read-out with power output at Control Settings 2, 7, 10. Error in readout should not exceed 15% or 7 watts, whichever is greater.

D Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 1. Measure the power output and NOTE. Now adjust R22 on the Display Driver Board so that the digital readout matches measured power output. Set CUT LEVEL CONTROL at 2, 7, 10 and measure power output with generator keyed in BLEND 1. NOTE these readings. Now compare digital display readout with power output at Control Settings 2, 7, 10. Error in readout should not exceed 15% or 7 watts, whichever is greater.

E Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 2. Measure the power output and NOTE. Now adjust R23 on Display Driver Board so that digital readout matches measured power output. Set CUT LEVEL CONTROL at 2, 7, 10 and measure power output with generator keyed in BLEND 2. NOTE these readings. Now compare digital display readout with power output at Control Settings 2, 7, 10. Error in readout should not exceed 15% or 7 watts, whichever is greater.

F Set CUT LEVEL CONTROL at 5 and key the generator in BLEND 3. Measure the power output and note. Now adjust R24 on Display Driver Board so that digital readout matches measured power output. Set CUT LEVEL CONTROL at 2, 7, 10 and measure power output with generator keyed in BLEND 3. NOTE these readings. Now compare digital display readout with power output at Control Settings 2, 7, 10. Error in readout should not exceed 15% or 7 watts, whichever is greater.

G Set the COAG LEVEL CONTROL at 5 and key the generator in COAG. Measure the power output and NOTE. Now adjust R20 on Display Driver Board so that digital readout matches measured power output. Set COAG LEVEL CONTROL at 2, 7, 10, and measure power out-out with generator keyed in COAG. Note these readings. Now compare digital display readout with power output at Control Settings 2,7, 10. Error in readout should not exceed 15% or 7 watts, whichever is greater.

H If error in display exceeds 15% or 7 watts in any CUT mode make note of this, and compare all CUT mode display errors. If power output, in general, is lower than readout at a setting of 10 in all CUT modes, then adjust R34 on the Sense Board counter-clockwise about 1 turn for every 1% of error. If power output in all CUT modes is higher than readout at a Control Setting of 10, then adjust R34 on the Sense Board clockwise about 1 turn for every 1% of error.

RETURN FAULT TEST PROCEDURE

Equipment Needed
- 0-250 mA RF meter.
- 300 ohm non-inductive resistance (350 watt rated).
- 1500 and 1000 ohm non-inductive resistance (30 watt rated).
- 90 pf, 110pf, 120pf, 150pf capacitator (3KV rated) or E.F. Johnson, Part No. 154-8 variable capacitor.

PROCEDURE

1 Insert 300 ohm load from ACTIVE to PATIENT. Insert 1500 ohm load from ACTIVE to GROUND. Set CUT and COAG controls at 5, key unit from footswitch. Return fault should not trip in any mode.

2 Insert 1000 ohm resistor from ACTIVE to GROUND. Insert 300 ohm load from ACTIVE to PATIENT. Key unit from footswitch with CUT and COAG Level Control at 10. Return fault should trip indicating excessive current returning through the chassis and not through the patient terminal.

3 Repeat Step 2 for B1, B2, B3 and COAG.

4 Attach a 40 picofarad capacitor from ACTIVE to ground. Attach another 40 picofarad from ACTIVE through a 0-250 RF milliamp meter to ground. Key unit in CUT. Increase Cut Level Control from 0 to 10. Current should be less than 250 mA. Repeat for B1, B2, B3 and COAG.

5 Attach a 40 picofarad capacitor from ACTIVE to ground. Attach another 110 picofarad capacitor from ACTIVE through 0-250 RF milliamp meter to ground. Key unit in CUT. Increase Cut Level Control from 0 to 10. Return fault should trip before current reaches 250 milliamps. Repeat for B1, B2, B3 and Coag.

6 Attach a 90 picofarad capacitor from ACTIVE to ground. Leave patient terminal open. Key the unit in pure cut with Cut Level Control at 5. Return fault should not trip. Now change the capacitor to 150 picofarads. Key unit as above. Return fault should trip. Repeat for B1, B2, B3, Coag.

LINE FREQUENCY (50/60Hz) CURRENT LEAKAGE TEST PROCEDURE

This test measures potentially dangerous 50/60 Hz leakage currents. The POWERITE circuit must be switched OFF and the SSE3-B left ON BUT NOT KEYED. The current is measured indirectly by observing the voltage developed across a 10K ohm resistor to ground from each front jack. A 0.01 microfarad capacitor is connected across the 10K ohm resistor to remove any trace of high frequency noise generated by the oscillator inside the unit. This capacitor has little effect on the 50/60Hz leakage current. Leakage current is calculated from I = E/R, where R = 10K ohms and E is the voltage measured across the resistor. The maximum acceptable voltage across the 10K ohm resistor for 2.0 microamps leakage is 0.020 volts (20 millivolts).

NOTE: Because of the extreme difference in magnitude of the 50/60 Hz leakage current and the RF signals when the generator is keyed, it is very difficult to make a 50/60 Hz leakage measurement when the unit is keyed. When the unit is keyed, there can be as much as 5200 volts peak to peak of RF as compared to 20 millivolts of 50/60 Hz. This ratio (108 db) of voltages would require the use of sophisticated measuring techniques. In practice, the 50/60Hz leakage currents do not change significantly when the unit is keyed.

Third wire leakage current is measured by opening the green grounding wire at the plug and connecting the 10K ohm resistor from chassis to ground. The maximum voltage across the 10K ohm resistor for 50 microamps leakage would be 0.5 volts (500 millivolts). Commercially available leakage testers may be used for this test.

The value of 50 microamps is valid for factory installed 10 foot 18/3 AWG line cords. Longer line cords or extension cords will increase the third-wire leakage and are not recommended. With the SSE3-B turned off, the third wire leakage should be less than 10 microamps.

The line frequency sink leakage is the current that will pass into the PATIENT leads when a 115 volt, 50/60 Hz potential is applied between a PATIENT lead and the chassis. The voltage source should be a 115 volt isolation transfromer with a 120K ohm current limiting resistor in series with a secondary.

The current is calculated from the voltage measured across a 10K ohm resistor in series with the 115 volt source and the PATIENT or ACTIVE jacks. This current should be less than 150 microamps.

BIPOLAR OUTPUT RF LEAKAGE TEST PROCEDURE

In this test the RF leakage current to earth ground from the bipolar output is measured. The readings are made with an RF ammeter from either bipolar output to ground. Accidental connection of the meter from one bipolar output to the other will result in instant destruction of the meter!

Connect a 250 milliamp RF ammeter from one of the bipolar output jacks to ground. Connect a 40 picofarad capacitor from the other output to ground. This may be approximated by draping a 10 foot accessory cord across the test bench. Set the CUT LEVEL and COAG LEVEL to 10 and key the generator. The RF leakage to ground should not exceed 150 milliamps.

CHASSIS GROUND INTEGRITY TEST PROCEDURE

Check for the existence of a low impedance connection between the generator chassis and the third wire ground plug. To avoid any problems with contact resistance when measuring this impedance (0.1 ohm), it is recommended that a four wire resistance measuring technique be used. The recommended maximum impedance of 0.1 ohm is for the standard 10 foot 18/3 AWG line cord. Use of longer cords is not recommended.

Section 8 Troubleshooting Procedure

The SSE3-B is a modularized unit from both the functional and physical standpoints. For this reason any person attempting to troubleshoot the SSE3-B should consider stocking the modules listed in Table 3, Section G. Oftentimes, replacement of a suspected defective module can save hours of time and make troubleshooting the SSE3-B a simple process. At least, replacement of a suspected defective module can help isolate the malfunction. Defective modules can be returned to Valleylab for repair or partial credit.

It is important to pay strict attention to semingly minor dysfunctions such as front panel lamps dead or power lamp dead. These malfunctions often indicate a defective power supply or loss of FR output instead of a defective lamp.

In this procedure the technician is instructed to unplug printed circuit boards or wire connectors. Power should always be OFF when either making or breaking these connections.

For test point identification see Table 2. For instructions on using this troubleshooting section see Figure 9.

SYMPTOM 1

VERY DIM OR NO CUT MODE LAMPS, DIM OR NO DIGITAL DISPLAY. ON/OFF LAMP, AUDIO MAY OR MAY NOT BE NORMAL.

PROCEDURE

1.0 Check F2 on Power Supply Module (See Figure 14, 22). Note whether front panel lamps, display are dim or totally out.

1.1 F2 is OK and all lights, audio completely out. Check for damaged power cable or cable mount. (Figure 22). Check for defective power switch/circuit breaker (Figure 15) by pushing rocker 1/2 way on. If lamps come on normally but when rocker is pushed all the way in lamps go out again then circuit breaker is defective. Check for defective CR2 on Power Supply Module (Figure 22). Check connectors and wiring from P9 in Figure 15 to power supply module interior.

1.2 F2 is OK. Dim lights are noticed on front panel. On/Off lamp and audio are normal. Proceed to Step 1.3.

1.3 F2 open. All lights, audio, dead or conditions in procedure 1.2. Replace F2. If F2 fails again or if test point F on Power Supply board has less than 10V DC (See Figure 24) then disconnect P9 from J9 (See Figure 15). Reactivate unit.

1.31 If F2 fails again or if test point F Figure 24 has less than 10V DC then problem is in power supply module. Replace module or check Qs 1,2,3 and U1 on Power Supply P.C. board (Figure 24).

1.32 If F2 is now OK supply module low voltage sections are OK. Test point F Figure 24 should return to +15V DC. Pin 2 of J9 should be -5V DC. Now reconnect P9 to J9 on Figure 15. Disconnect P8 from J8 and P7 from J7. Activate unit.

1.321 If F2 is intact and test point F is at +15V then problem is in Front Panel module Figure 17, or Isobloc Board (Figure 26). Locate short circuit or replace Front Panel module.

1.322 If F2 fails, disconnect plug in PC Boards P2-P6 and P40 on Figure 14. Reactivate unit.

1.3221 If F2 is not OK and +15V DC is measured at test point F then plug in P2-P6 and P40 one at a time until defective board is isolated. Replace it or check +12V regulator type LM340-T on the PC Board that is defective. Also check for any other shorted components.

1.3222 If F2 fails again remove Parent PC Board from Stripline chassis Figure 14. Leave J9-P9 connected and reactivate unit. If F2 fails again Parent Board should be replaced or short located. If F2 is good, Stripline module is defective. Replace or locate short circuit.

SYMPTOM 2
BLEND MODE LAMPS, DIGITAL DISPLAY OK. NO ON/OFF LAMP OR AUDIO. NO RF OUTPUT IN ANY MODE.

PROCEDURE

2.0 Disconnect P9 from J9 (See Figure 15).

2.1 If On/Off Lamp is still out when power switch is activated, then the -5V power supply is defective. Entire Power Supply module can be replaced. Check connectors and wiring from P9 to interior of Power Supply module Figure 2.2 check wiring from interior of supply module to power supply PC Board.

Also check U1, CR2 on Figure 2.2. When On/Off lamp comes back on after -5V supply has been restored, then an output module(s) will probably have to be replaced due to unit operating without T-OFF (-5V). See Symptom 3.

2.2 If On/Off lamp is now lit when switch is on, problem is an overload somewhere in the chassis, not in the power supply. Reconnect P9 to J9 on Figure 15 but disconnect P2-P6 and P40 on Figure 13.

2.21 If On/Off lamp is lit when switch is on, problem is in a plug in PC Board. Reconnect P2-P6 and P40 one at a time to locate defective PC Board. Check that Board for an overload on the -5V or replace.

2.22 If On/Off lamp is out when switch is on, problem is in Stripline module or Parent Board. Disconnect Parent Board from Stripline module Figure 13. Leave J9, P9 connected If On/Off lamp is out then Parent Board is defective, if On/Off lamp is lit then Stripline Board is defective.

Replace the defective module or locate the -5V overload. Refer to Figures 13,14. When overload is corrected, then an Output module will probably have to be replaced due to unit operating without T-OFF (-5V). See Symptom 3.

SYMPTOM 3
FRONT PANEL LAMPS, DIGITS OK. AUDIO OK. NO RF OUTPUT IN ANY MODE FROM HAND-SWITCH OR FOOTSWITCH.

PROCEDURE

3.0 Check for high voltage, 60-200V DC on test point D on Power Supply PC Board (See Figure 24).

3.1 If high voltage is OK pull out P11-1 the first Output module assembly (See Figure 14). Check Q1, F1, F2, CR2, CR3 on Figure 42 Output Board assembly.

3.11 If all components on this module are OK then proceed to Symptom 4.

3.12 If any parts are defective, then it is likely that every output module is defective. Repair or replace P11-1-5 Figure 14. Activate then key unit in COAG at control setting 2. Check current through each current loop. See Photo 10 Figure 14.

3.121 If RF output returns. Check power out with a Wattmeter in all modes. Start from control setting 9. Check Figure 12 photo #6, photo #7, photo #11 then follow testing procedure Section 6 of this manual.

3.122 If RF output does not return or returns briefly, recheck each output module. If RF output still does not return, proceed to Symptom 4.

3.2 If high voltage is not on Test Point D, check F1 on power supply module Figure 22.

3.21 If fuse is good then power supply high voltage section is probably OK. It is current-limited, however, because of excessive load. Remove the first output module. P-11-1 (See Figure 14). Then reactivate unit and check for high voltage. Repeat this process with each output module P11-1-5 until high voltage returns at test point D. In this manner the defective module(s) can be located. Check Q1, F1, F2, CR2, CR3 (Figure 42) or replace entire module. Then proceed with 3.121. If no defective modules are found, power supply high voltage section is defective. Remove F1 on Figure 14 and proceed to Step 3.22.

3.22 If F1 is bad, check white test point H on Power Supply Board (Figure 24) to verify see Figure 7.1 photo #12. Do not replace fuse. If desired entire power supply module can be replaced at this point.

3.221 If waveform is correct on TPH check Qs 10-13 on Power Supply. PC Board - replace defective transistors, replace F1. Reactivate unit. If F1 fails again, suspect CR4 on power supply module. If fuse stays good but high voltage does not appear on test Point C then go back to Step 3.21. If high voltage returns and RF output returns then proceed with 3.121.

3.222 If waveform is incorrect on TPH replace Qs 14, 15 on power supply PC Board Figure 24. Do not replace F1. If waveform is still incorrect on TPH check TPK on Power Supply Board. It should be at +15V. If it is at +15V, U4 or U5 or U6 is defective. If it is not at +15V then either the feedback loop or the protection circuitry is defective. Eliminate protection circuitry by removing Q6 collector and R23. If TPK then goes to +15V DC protection circuitry is at fault. Check Q5, Q6, Q7, Q8, Q9. IF TPK does not go to +15V then feedback loop is at fault. Check U3. (See Figure 24) When waveform on TPH is correct, proceed to 3.221.

SYMPTOM 4
ALL LAMPS AND AUDIO OK. NO RF OUTPUT IN COAG ONLY OR CUT MODES ONLY.

Note: If some CUT Modes have RF power out and others do not, go to Symptom 5. Also, in some cases this procedure will be used to troubleshoot units with no COAG or CUT RF output. But only after procedure for Symptom 3 is followed first.

PROCEDURE

4.0 Check Clock Board Pin 9 Signal "G" waveforms. For scope location see Figure 34. For waveform photographs see Figure 12 photos 1-5. Unit must be keyed in the mode being measured.

4.1 If any clock signal "G" is defective, Clock Board is defective and can be replaced. If all clock waveforms are wrong, look at MC Pin 10 of Clock Board for CP, B1, B2. If should look identical to "G" signal in photos 1, 2, 3. If it does, replace U11. If not, check Pin 7 of U1. It should be oscillating at 750 kHz. If not, replace U1. If clock Board is still defective, proceed to Figure 5 SSE3-B timing waveforms compare with Figure 34, 35 Clock Board. Check associated logic gates starting with U3. Also check U2.

4.2 If all signals at "G" are OK, observe OND, OFD at Pins 10, 14 of Control Board Figure 36. These waveforms should be similar to "G" waveforms on Clock Board. OND, OFD, however, have only ½ the pulse width of signal "G" at a control setting of 5. Unit must be keyed in the mode be measured. OND is at Test Point Q. OFD is at Test Point R.

4.21 If OND, OFD are correct check T-On, T-Off on Driver Board Pins 14, 17 Figure 40. See Figure 12 Photos 8, 9.

4.211 If these waveforms are OK but there is no RF output then go back to Symptom 3 and also check output transformer connections. See Figure 26.

4.212 If T-ON, T-OFF are not correct, check Q7 on Drive Board Figure 40, 41. If Q7 is OK, check Qs 1-6 on Driver Board. Also check U1.

4.22 If OND, OFD are not correct, check Pin 17 CSC for defective CUT and Pin 12 CSCG for defective COAG on Control Board Figure 36, 37.

4.221 If there is no cut RF output CSCT should be at +12V. If it is not, then Sense Board is defective or CTPG on Level Board is defective. CTPG should be at approximately 2-3V DC at a setting of 5 in pure CUT. Pin 5, Figure 32. If it is at 0V or does not vary with control pot then check level board U2, U8, U9, U7 (Figure 33). Make sure Level Board is making good contact to the Parent Board. If CTPG is OK then Sense Board U1, Q4, Q5, Q6 should be checked.

CSCT is at Test Point S.
CSCG is at Test Point T.
CTPG is at Test Point U.
CGPG is at Test Point V.

4.222 If there is no COAG RF output, CSCG should be at +12V. If it is not, then follow same procedure as 4.221. Look at CGPG on Level Board Pin 4 of Figure 32. If CGPG is OK check Q1, Q2, Q3, Q7, U1 on Sense Board.

4.223 If CSCT, CSCG are correct, i.e., if the defective mode has a CS signal at +12V DC, then the Control Board is probably defective. Replace or refer to Figure 5.4 waveforms on Control Board. Suspect U4 if problem is in CUT, U3 if problem is in COAG. If Pin 2 on U4 does not intersect Pin 3 of U4 when CUT is keyed at a setting of 5, suspect U11, U9, U6, U5, U8 on Figure 36, 37.

If Pin 3 does not intersect Pin 2 on U3 suspect U9.

If there is no FR in CUT or COAG suspect U1.

SYMPTOM 5
LIGHTS, AUDIO OK. RF OUTPUT IN ALL MODES AT LOW SETTINGS, BUT WHEN CONTROL SETTINGS ARE TURNED UP OUTPUT MODULES TEND TO FAIL.

PROCEDURE

5.0 Remove cover. With AC current probe, measure each module's collector current at COAG setting 3. See Figure 14. Compare to Figure 12 photo #10. Peak current will be less than photo #10 because of lower control settings, but waveform should look generally the same. Also put X100 scope probe on T1 primary (Collectors Test

Point M) see Figure 16. Key generator in pure CUT and turn control setting up slowly to 5. Compare waveform with photo #6 Figure 12. Key CUT again at Setting 3. Look at Control Board CR 4 (LED) (See Figure 36) It should come on for about .3 seconds when unit is first keyed in CUT modes only. Proceed to 5.3 if waveforms are correct.

5.1 If Control Board LED does not come on briefly when CUT is keyed, the M circuit is defective. Check U11, Q1, CR4, CR3, U7 on Control Board Figure 36. If all OK, go to Sense Board and check U3 (Figure 38, 39). OS on Sense Board Pin 22 should go HI to enable the circuitry on Control Board for first .3 seconds when CUT is keyed. Check connection of Control Board to Parent Board.

5.2 If Control Board LED comes on and stays on all the time when CUT is keyed, the waveform on Figure 12 photo #6 should look incorrect also. It will show the output transistors over-saturating or the waveform will dip all the way to ground instead of remaining at least 25 ± 10V above ground as shown in photo #6. This indicates that the high voltage power supply is not responding to the over-saturated condition. VS circuitry may be defective on Control Board. Measure Test Point B on Power Supply Board Figure 24. It should be at +3V DC when generator is not keyed. It should go up past +5V DC when unit is keyed in CUT at setting of 5. VS is at Test Point B.

5.21 If VS does ramp up properly then Control Board to Parent Board connection is faulty (See Figure 14) or P9 to J9 connection is faulty (Figure 15) or power supply feedback loop is defective, check U3 on Power Supply Board (Figure 24)

5.22 If VS does not ramp up to 5V or higher then check VR Pin 21 on Control Board against Figure 5 SSE3-B timing diagram. Also check U10, U12, U2, CR2 on Control Board Figure 36, 37.

5.3 If all waveforms look OK in procedure 5.0 then key COAG at setting of 5 open circuit and place probe on Collectors Test Point Figure 16. Calibrate Probe closely before this test. When Control pot is turned up from 5-10 the peak voltage should not exceed 475V. The high voltage clamp should be noticeable; if clamp is set correctly proceed to Section 4 of this manual.

5.31 If clamp does seem to be working but is adjusted too high, (e.g., 500V) simply adjust R15 on Driver Board Figure 40 until clamp is correct.

5.32 If clamp does not seem to hold maximum voltage at all; (e.g., voltage goes way past 500V) the clamp circuitry is defective. Check U2, U3, Q8 on Driver Board Figure 40, 41. Also check R3 item 40 on power supply module Figure 33. R3 is the clamp resistor. Insure that it completes the circuit through its terminals, through P13-J13 (See Figure 13, 15) and through P9-J9. Good connection also depends on P1-J1 or Parent Board to Stripline connection (See Figure 13, 14).

SYMPTOM 6
ONE CUT MODE DEFECTIVE, OTHER CUT MODES AND COAG OK

6.0 Verify which mode is defective.

6.1 Pure CUT defective. Check CPE Pin 5 of P7 (See Figure 13, 15) when CUT is keyed, and mode selector in pure CUT, then PE should be at +12V DC.

6.11 If CPE is not at +12V DC then check Q1, Q2, Q3 on Switch Board Figure 20 and check pure CUT switch itself.

6.12 If CPE is not at +12V DC then check Clock Board U7, Figure 34, 35.

6.2 B1, or B2 defective check B1E or B2E Pins 3, 12 or P7 (See Figure 13, 15. Follow same procedure as 6.1.

6.3 B3 defective. Check B3E Pin 9 of P7 (See Figure 13, 15). Follow same procedure as 6.1. If problem is still apparent after 6.1 procedure, check U10, U11 on Clock Board Figure 34, 35. Also check U3 on Level Board Figure 32, 33.

SYMPTOM 7
HANDSWITCH DOES NOT KEY GENERATOR IN ONE OR BOTH MODES. FOOTSWITCH DOES KEY GENERATOR IN BOTH MODES.

PROCEDURE
7.0 Verify which Mode(s) cannot be keyed with handswitch.

7.1 If COAG cannot be keyed but CUT can be keyed suspect PI-3 or Q3 on IsoBloc Board Figure 26, 27.

7.2 If CUT cannot be keyed but COAG can be keyed suspect PI-4 or Q4 on IsoBloc Board (Figure 26, 27).

7.3 If neither CUT or COAG can be keyed suspect CR2, Q1 on IsoBloc Board.

SYMPTOM 8
FOOTSWITCH WILL NOT KEY GENERATOR IN ONE OR BOTH MODES. HANDSWITCH DOES KEY GENERATOR IN BOTH MODES.

PROCEDURE
8.0 Check J15-P15 connection See Figure 13, 17. Check footswitch jack and associated wiring.

SYMPTOM 9
ONE MODE OR BOTH MODES WILL NOT KEY FROM FOOTSWITCH OR HANDSWITCH. FRONT PANEL LAMPS, DIGITS O.K.

PROCEDURE
9.0 Check U1, U4, U5, U6, U9 on Level Board Figure 32,33.

SYMPTOM 10
ONE OR MORE R.F. INDICATORS WILL NOT LIGHT EVEN THOUGH R.F. OUTPUT IS PRESENT.

PROCEDURE
10.0 Determine whether both indicators are dead, or just one.

10.1 If only the COAG indicator is dead suspect level board U5 or Q4 Figure 32, 33 or replace faulty lamp DS3 on Display Board part #215200000.

10.3 If both R.F. indicators are dead suspect IsoBloc Board Q2 Figure 26, 27.

SYMPTOM 11
FRONT PANEL LAMP(S) BURNED OUT.

PROCEDURE
11.0 Determine which lamps are out.

11.1 If audio functions, but power switch lamp does not, then it is defective. White rocker will pull out from the front. It is not necessary to take the blue cover off to remove this lamp. When rocker is off, lamp can be removed and installed with a small needle nose plier. Lamp is held by small springs. Lamp part # is 215021023. Green filter part # is 215200506.

11.2 If all CUT modes function, but a CUT mode lamp is burned out, it can be replaced by pulling off the white switch button from the front. Lamp part # is 215025027.

11.3 Return fault button should disable power output of unit. If it does, but lamp does not come on, it is defective. Part # is 215030002.

SYMPTOM 12
MALFUNCTION IN DIGITAL DISPLAY.
ALL OTHER FRONT PANEL LAMPS O.K.. R.F. OUTPUT O.K..

PROCEDURE

12.0 Observe display while rotating CUT, COAG from control pots.

12.1 Entire display is blank. Check 6V regulators Q1, Q2 on Display Driver board. Figure 30. Replace or check U1 on Display Board Figure 28.

12.2 Every segment in one or more digits is dead. Some digits work normally. Replace or check U1 on Display board Figure 28. Replace or check DS1, DS2, DS5, DS6 on Display board Figure 28.

12.3 One segment is not working on each digit in the cut display. Check U8 on Display Driver board Figure 30.

12.4 One segment is not working on each digit in the COAG display. Check U7 on Display Driver board Figure 30.

12.5 3 bright eights show on one digital display. Control pot has no effect on display. Check U8 for CUT, U7 for COAG on Display Driver board Figure 30.

12.6 Sometimes display will freeze even though unit is not keyed. Control pot rotation does not affect readout. Check U3 Display Driver board. Figure 30.

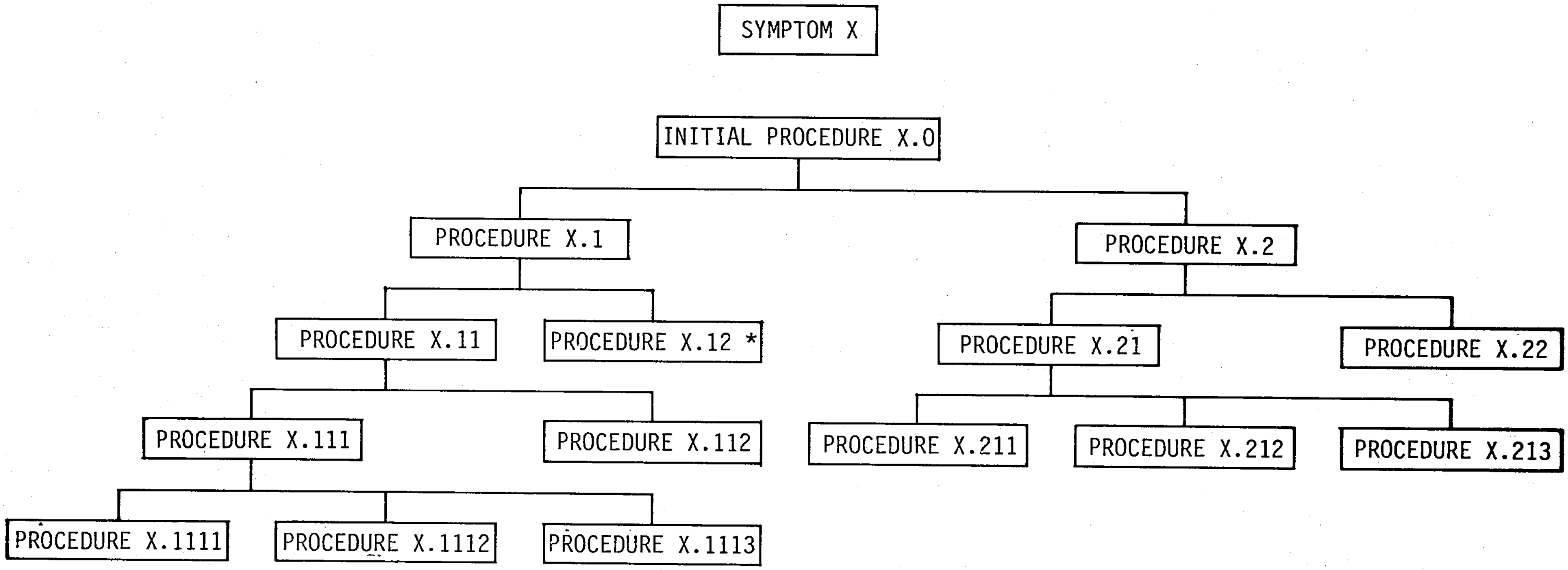
12.7 Display never changes in one mode. Other mode works normally. Suspect oscillator U2, or U3 on Display Driver Board. Also check U4.

12.8 Display changes, but not in correct relation with control pot. It may change rapidly with no control pot change. Measure voltage at pin 4 of BB4213, See Figure 31. Compare to Figure 12 photo #11. Measure output V and input V of BB4213. Vout should equal $(Vin)^2$ /10. Vin cannot exceed 9V DC otherwise BB4213 will be overdriven. Check U5 on Display Driver board.

SYMPTOM 13
ALL FRONT PANEL LAMPS AND R.F. OUTPUT O.K. NO AUDIO IN ONE OR BOTH MODES.

PROCEDURE

13.0 Check U6, Q1, Q3 on Level board. Pin 13 on Level board, (Figure 32) should have at least 3V p-p audio signal. If pin 13 voltage is correct, check J15-P15 connection see Figure 18. Also check speaker LS1 and pot R103. See Figure 13.



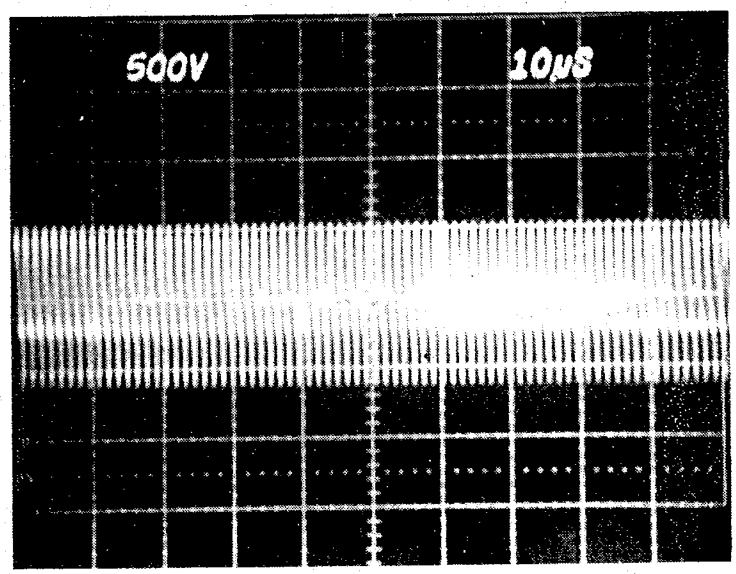
* IF SYMPTOMS LEAD TO PROCEDURE X.12 AND YET SOLUTIONS OFFERED IN THIS PROCEDURE DO NOT FIT THE PROBLEM IN THE SSE3-B, THEN EITHER

1. GO BACK TO THE TOP OF THE LADDER AND START OVER, OR
2. REEXAMINE INITIAL PROBLEM AND TRY TO MATCH IT WITH ANOTHER SYMPTOM IN THE TROUBLESHOOTING SECTION.

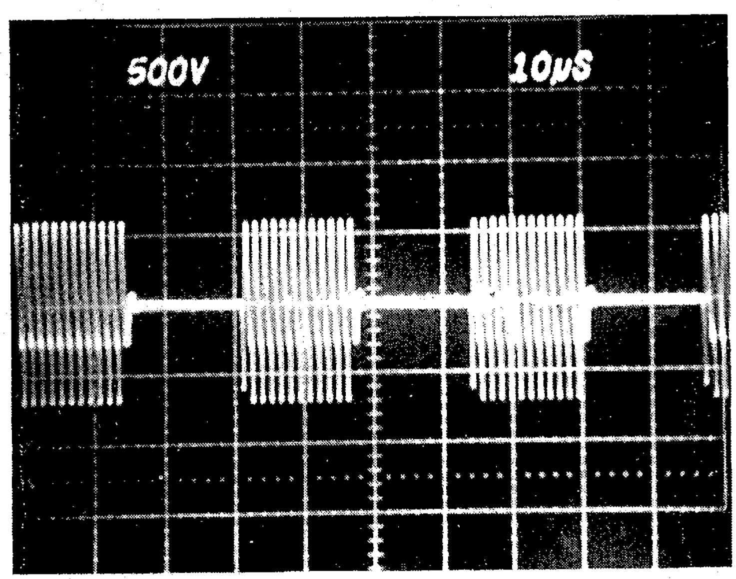
NOTE THAT PROCEDURE X.1111 SHOULD ONLY BE FOLLOWED IF ALL STATEMENTS OF SYMPTOMS IN PROCEDURE X.111 MATCH THE PROBLEM IN THE SSE3-B. LIKEWISE PROCEDURE X.111 IS NOT TO BE FOLLOWED UNLESS STATEMENTS OF SYMPTOMS IN PROCEDURE X.11 MATCH THE PROBLEM IN THE SSE3-B. THIS PROCEDURE LADDER MUST BE CAREFULLY FOLLOWED FROM THE TOP DOWN.

Figure 9 Guide to Troubleshooting Section

All waveforms seen across a 300 ohm load
with a setting of "10".
Horizontal sensitivity - 10μs/cm
Vertical sensitivity - 500V/cm

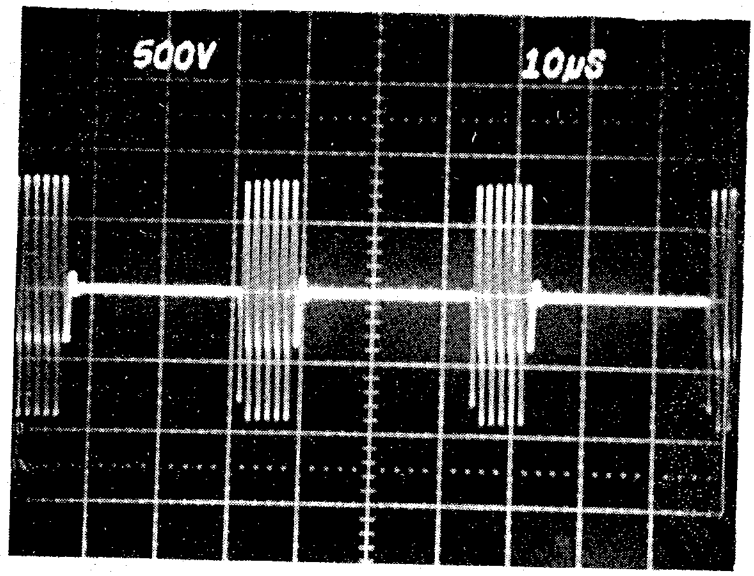


CUT

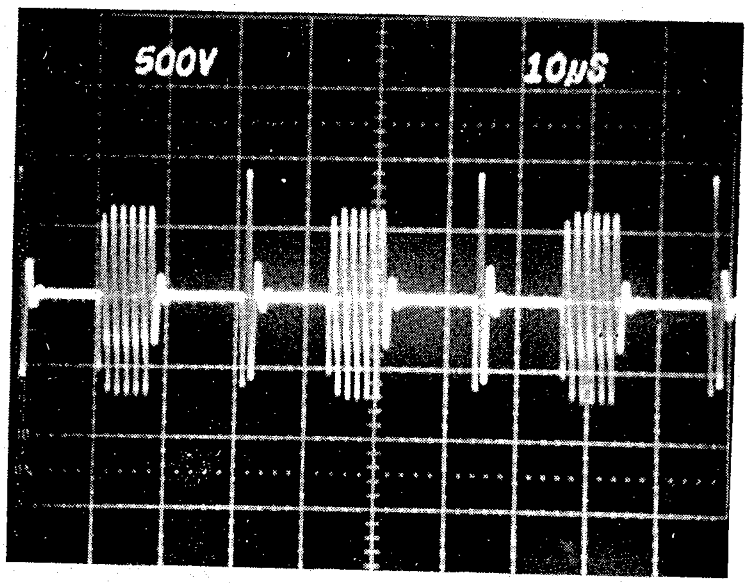


BLEND 1

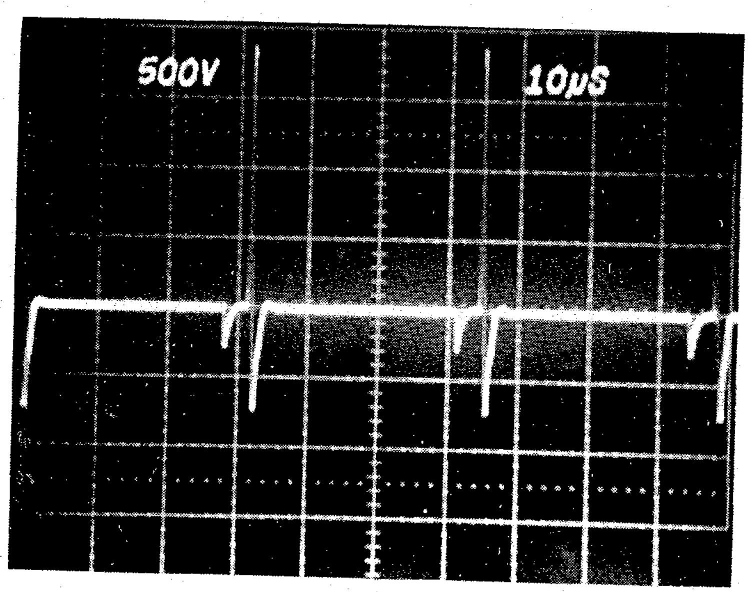
Figure 10 Monopolar Output Waveforms



BLEND 2



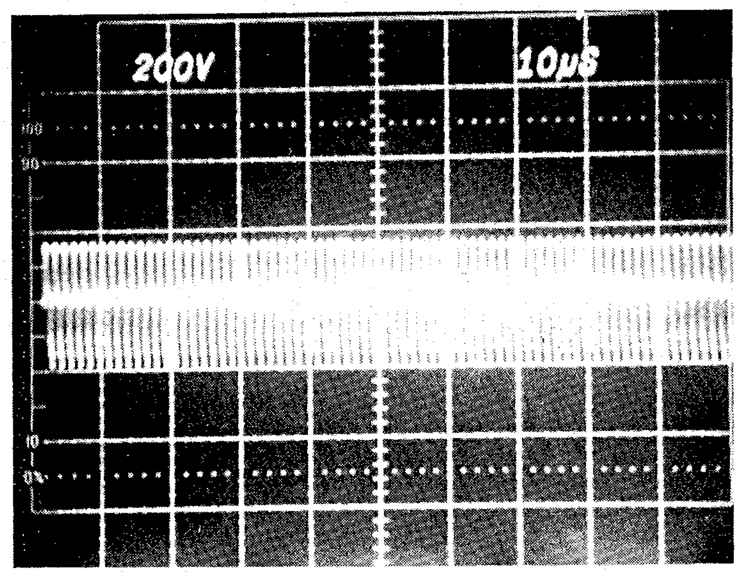
BLEND 3



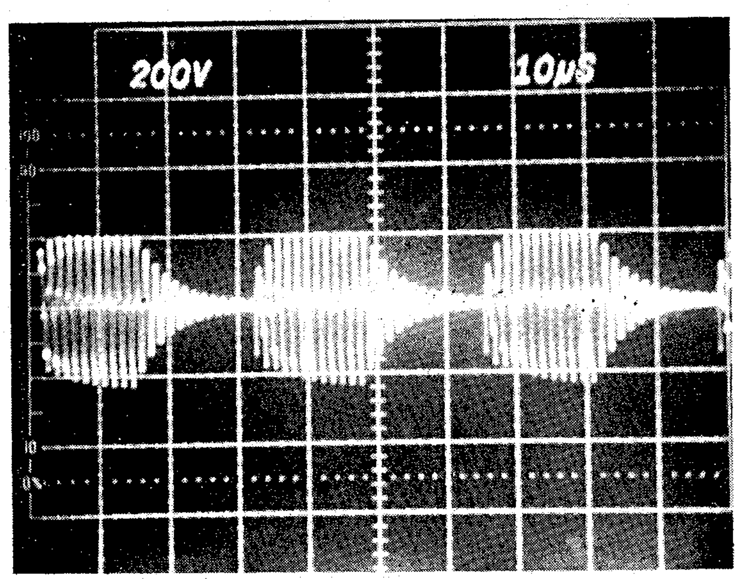
COAG

Figure 10 continued

All waveforms seen across a 100 ohm load
with a setting of "10".
Horizontal sesitivity - 10μs/cm
Vertical sensitivity - 200V/cm

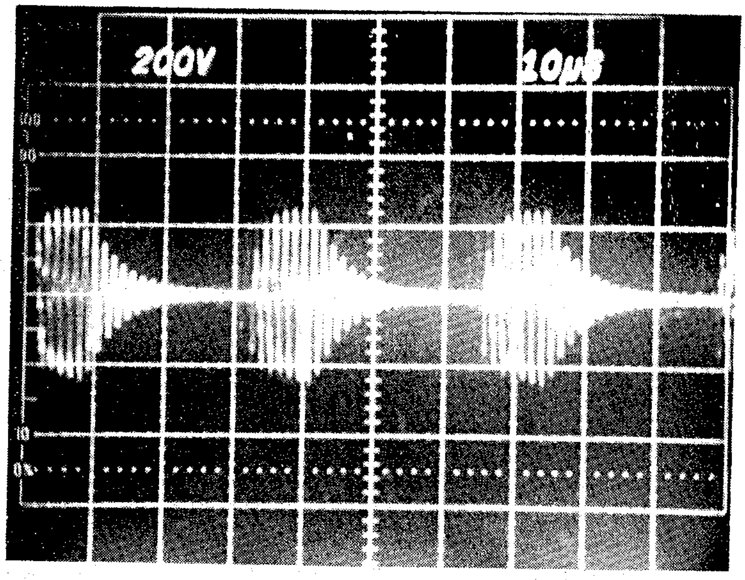


CUT

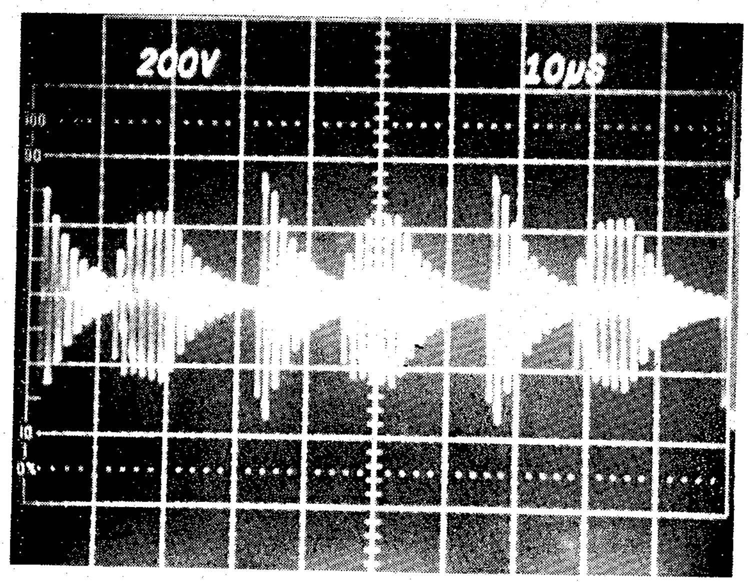


BLEND 1

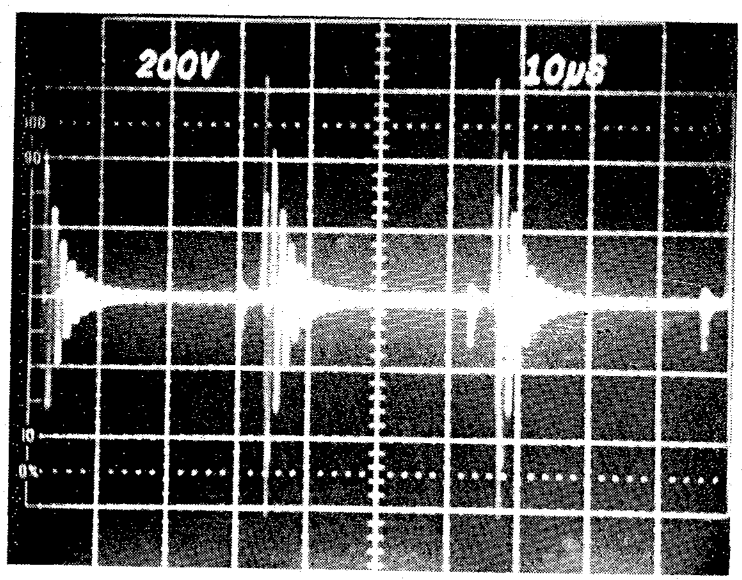
Figure 11 Bipolar Output Waveforms



BLEND 2

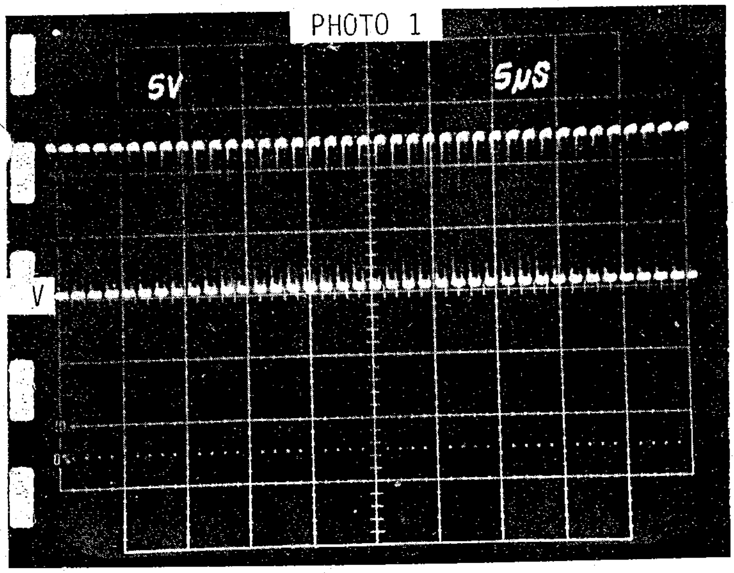


BLEND 3

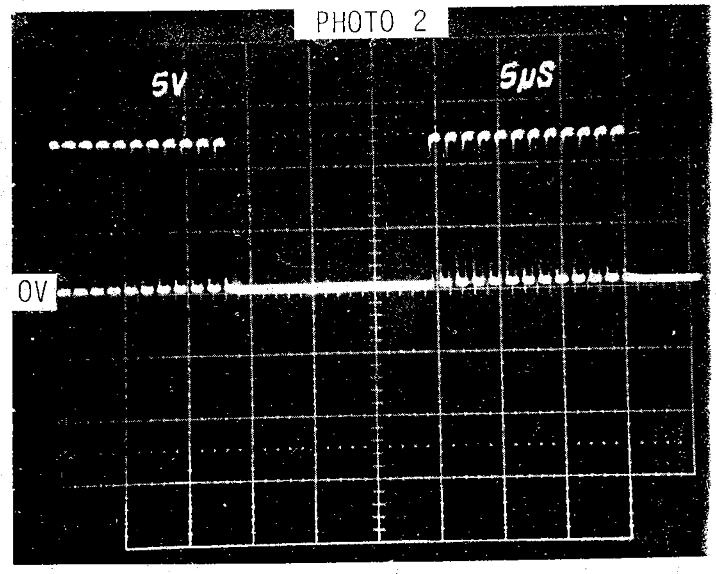


COAG

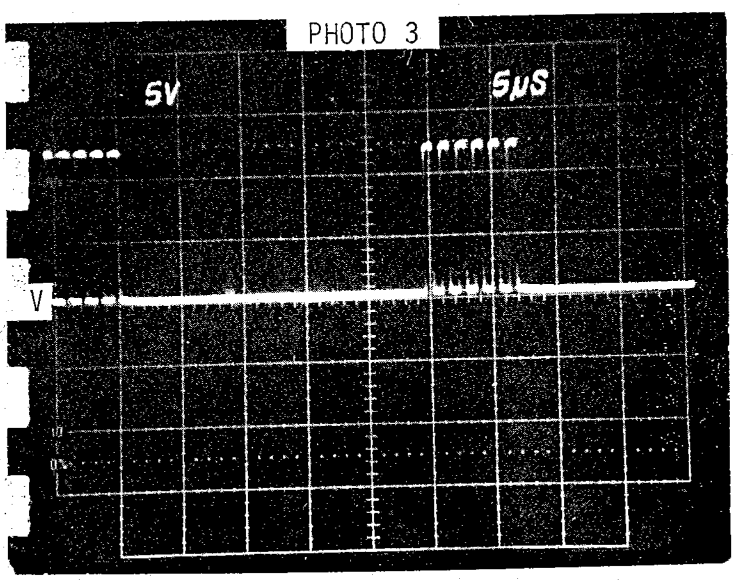
Figure 11 continued



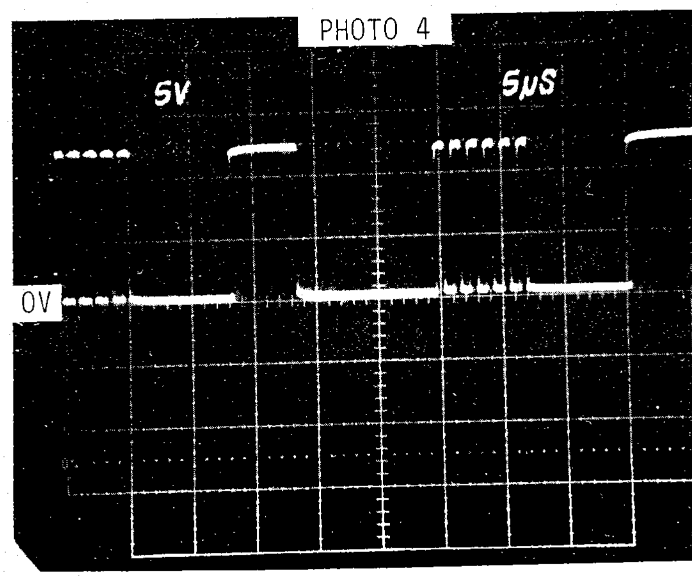
KEY PURE CUT



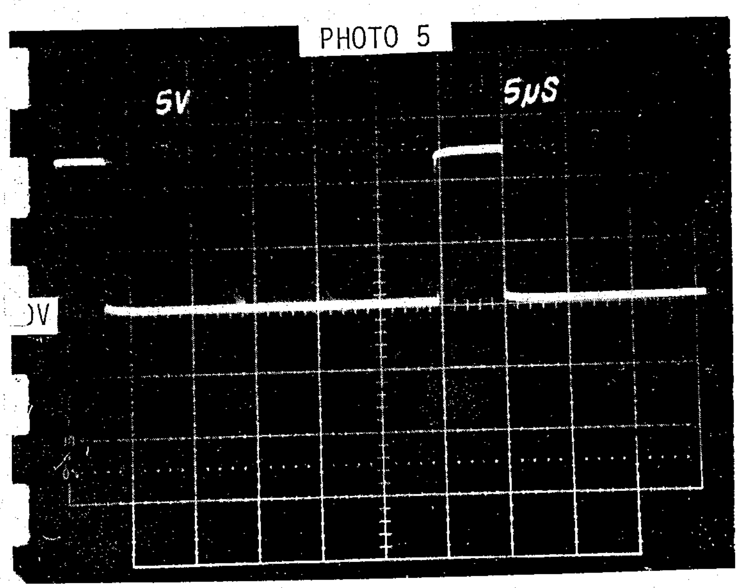
KEY B1



KEY B2



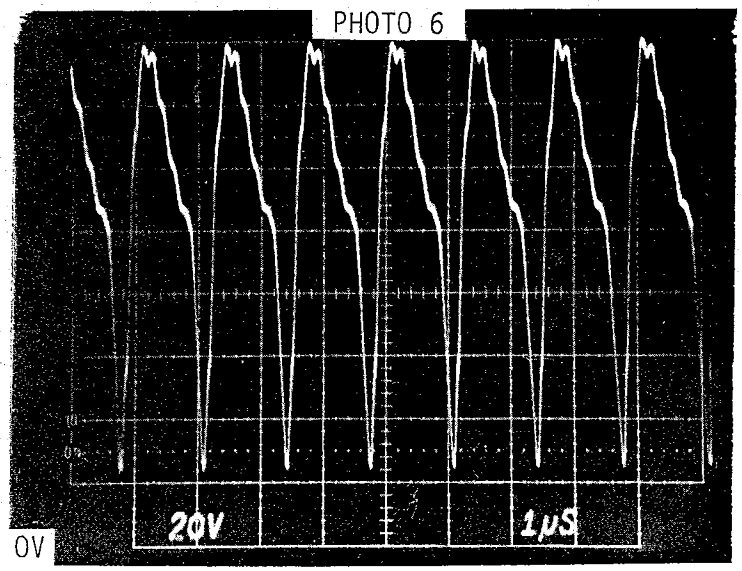
KEY B3



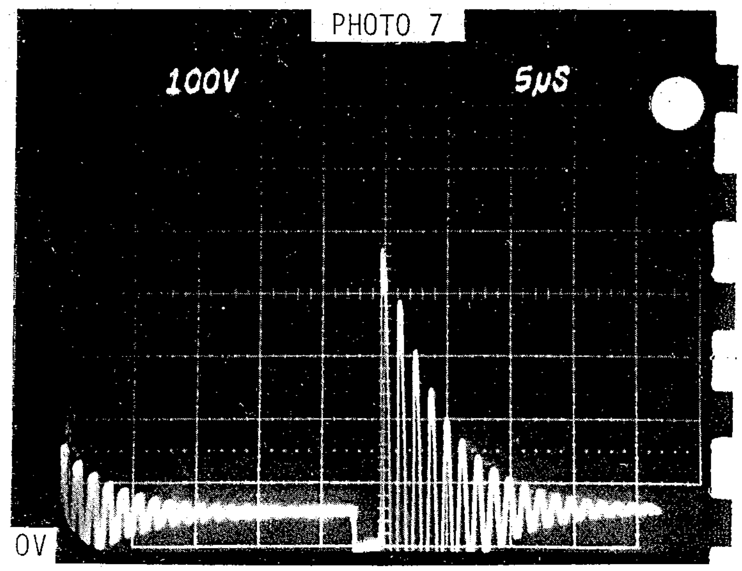
KEY COAG

SIGNAL G
CLOCK BOARD
TEST POINT L
SEE FIGURE 34

Figure 12 Troubleshooting Wavefor

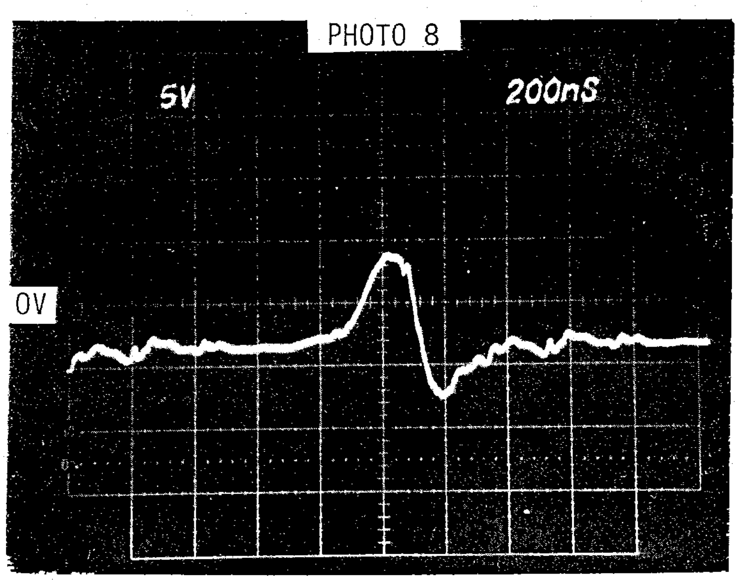


KEY PURE CUT CONTROL SETTING 5 300 OHM LOAD



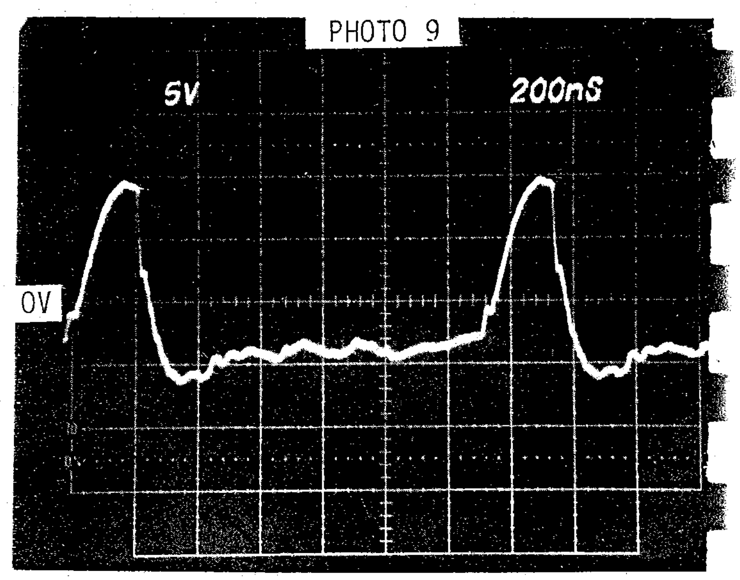
KEY COAG CONTROL SETTING 10 OPEN CIRCUIT

SIGNAL COLLECTORS
STRIPLINE BOARD
TEST POINT M
SEE FIGURE 16



KEY PURE CUT CONTROL SETTING 5 300 OHM LOAD

SIGNAL T/ON
DRIVER BOARD
TEST POINT O
SEE FIGURE 40

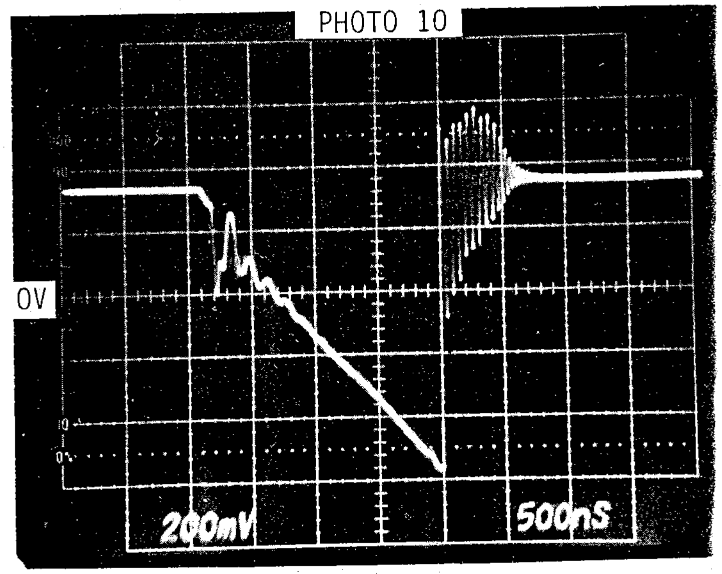


KEY PURE CUT CONTROL SETTING 5 300 OHM LOAD

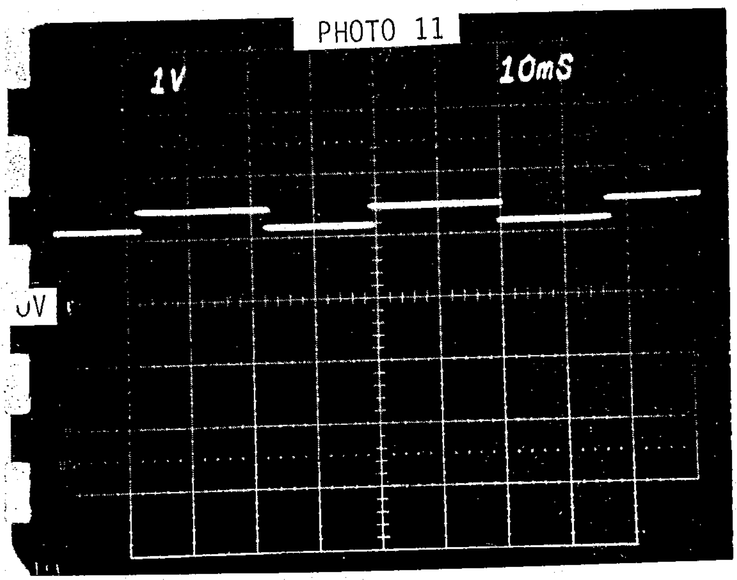
SIGNAL T/OFF
DRIVER BOARD
TEST POINT P
SEE FIGURE 40

Figure 12 continued

SIGNAL COLLECTOR CURRENT
OUTPUT BOARD
TEST POINT N1-N5
SEE FIGURE 14



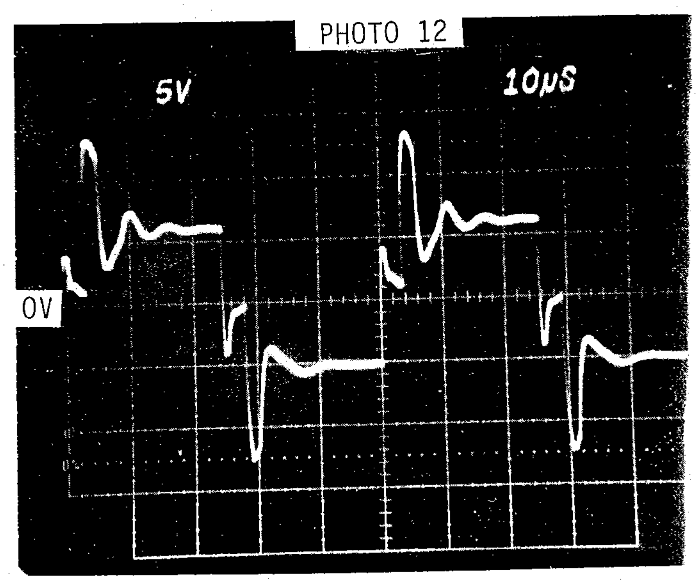
KEY COAG CONTROL SETTING 5 300 OHM LOAD



NOT KEYED CUT CONTROL SETTING 5
COAG CONTROL SETTING 5

SIGNAL MULTIPLIER OUTPUT
DISPLAY DRIVER BOARD
TEST POINT X
SEE FIGURE 31

SIGNAL HV SWITCHING
POWER SUPPLY BOARD
TEST POINT H
SEE FIGURE 24



F1 (8A) REMOVED

Figure 12 continued

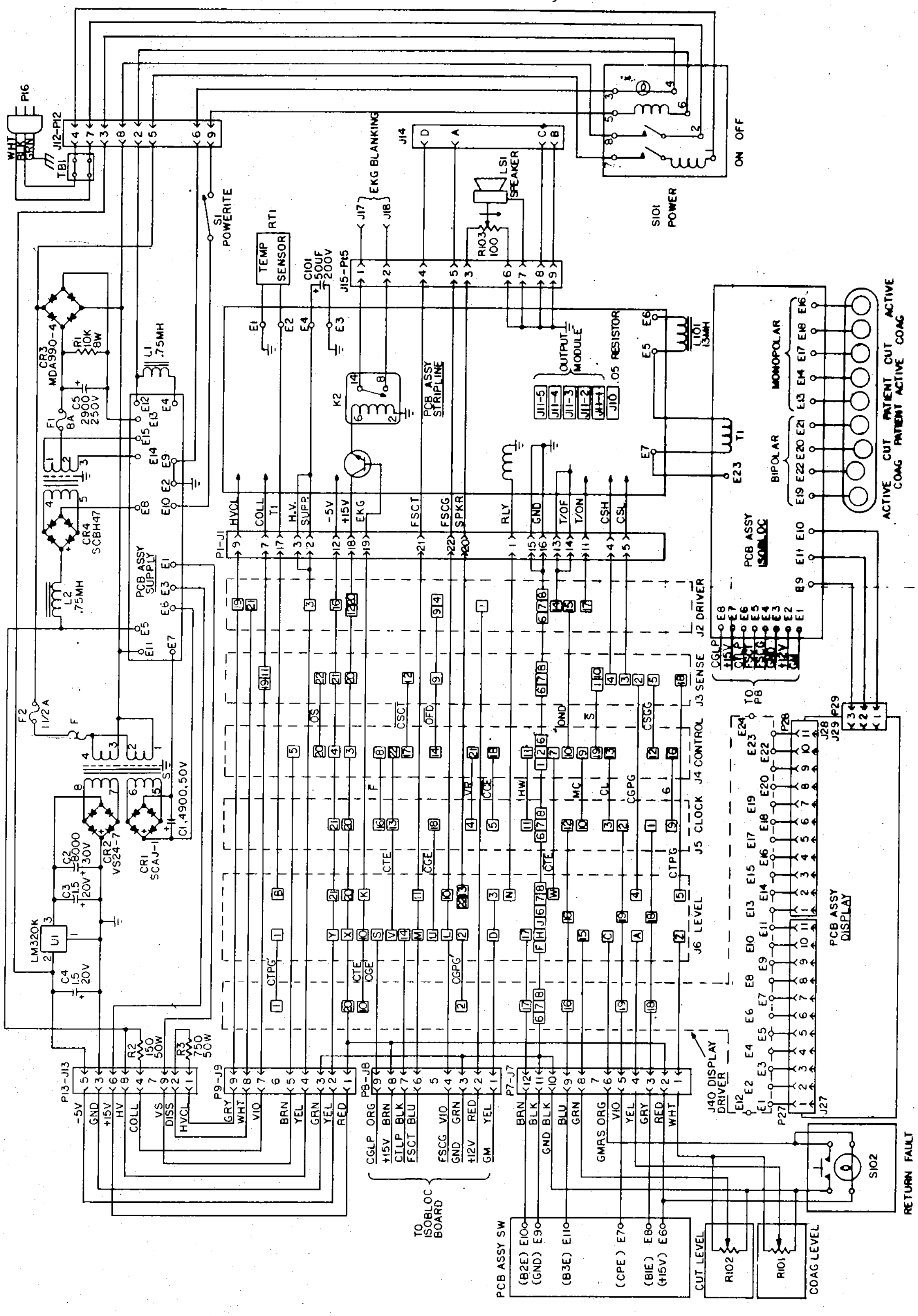


Figure 13 Master Schematic

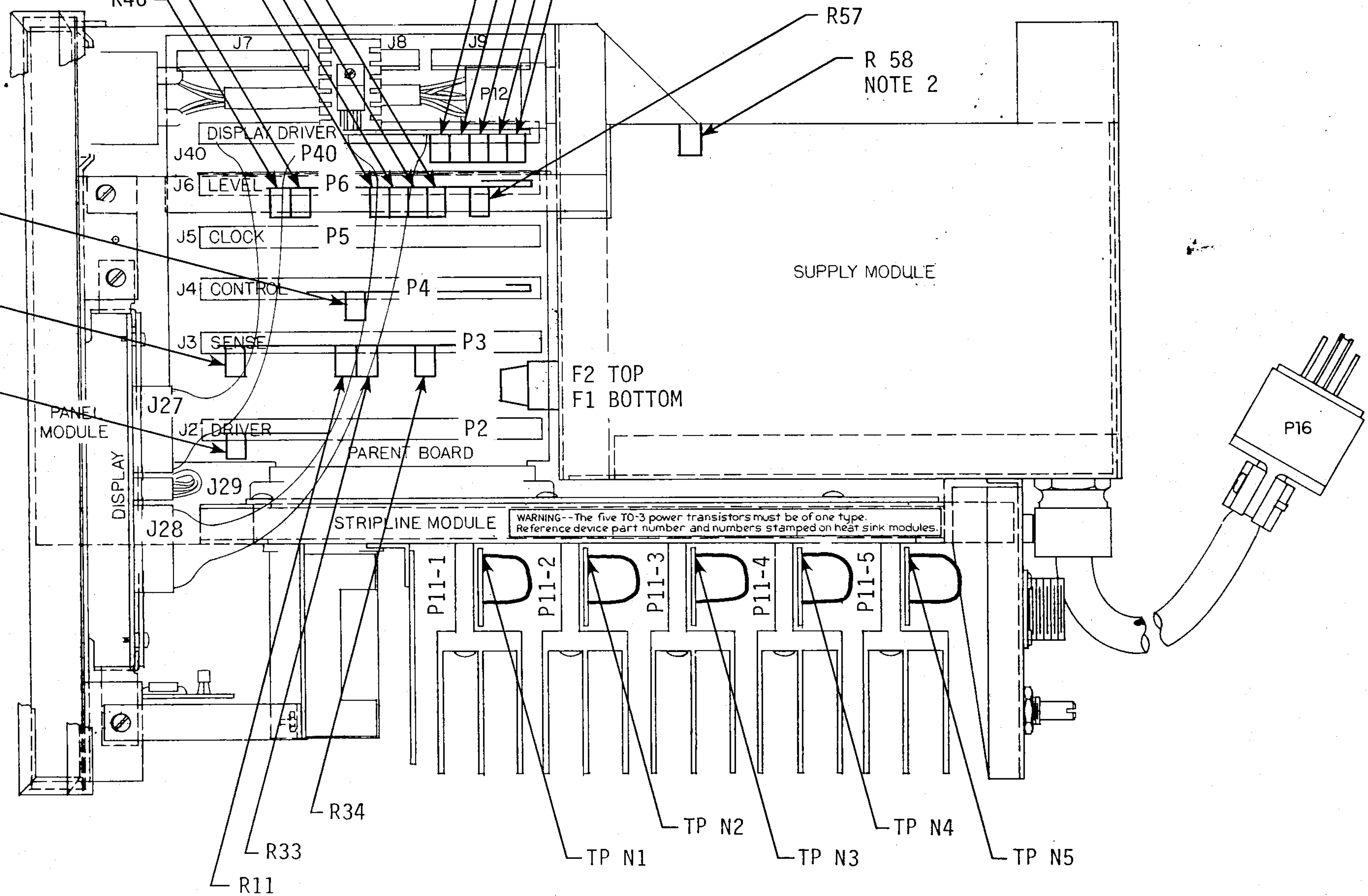


Figure 14 Chassis Assembly Top View

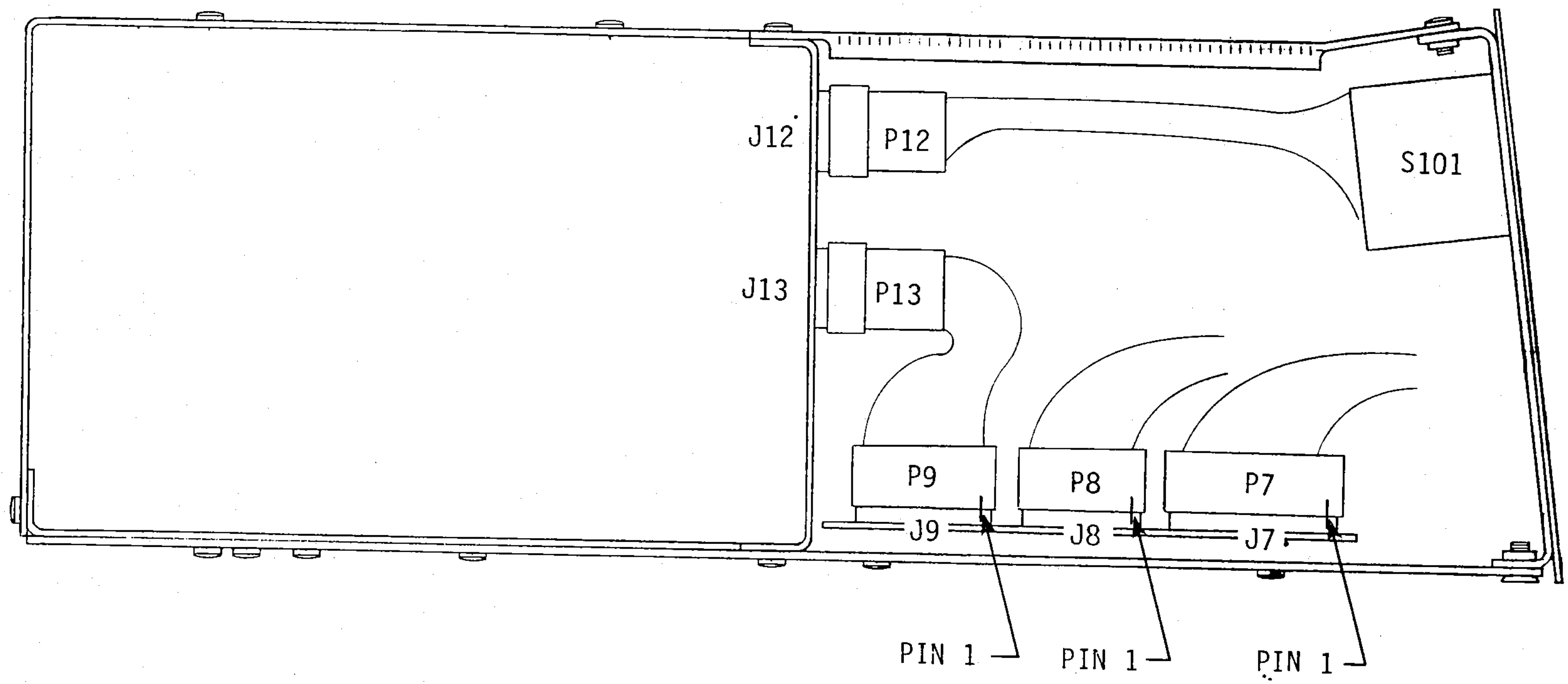


Figure 15 Chassis Assembly Side View

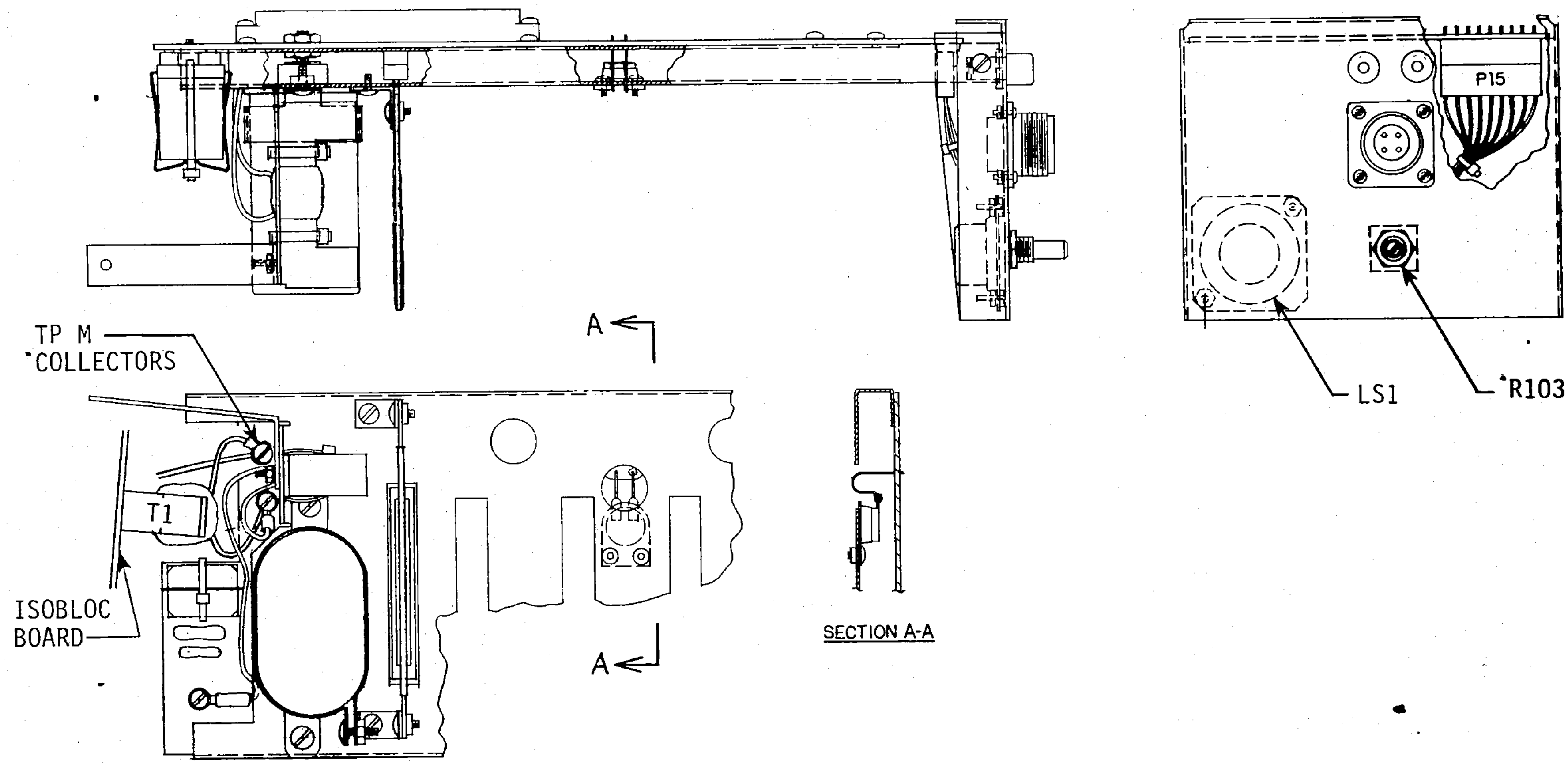


Figure 16 Stripline Module Assembly

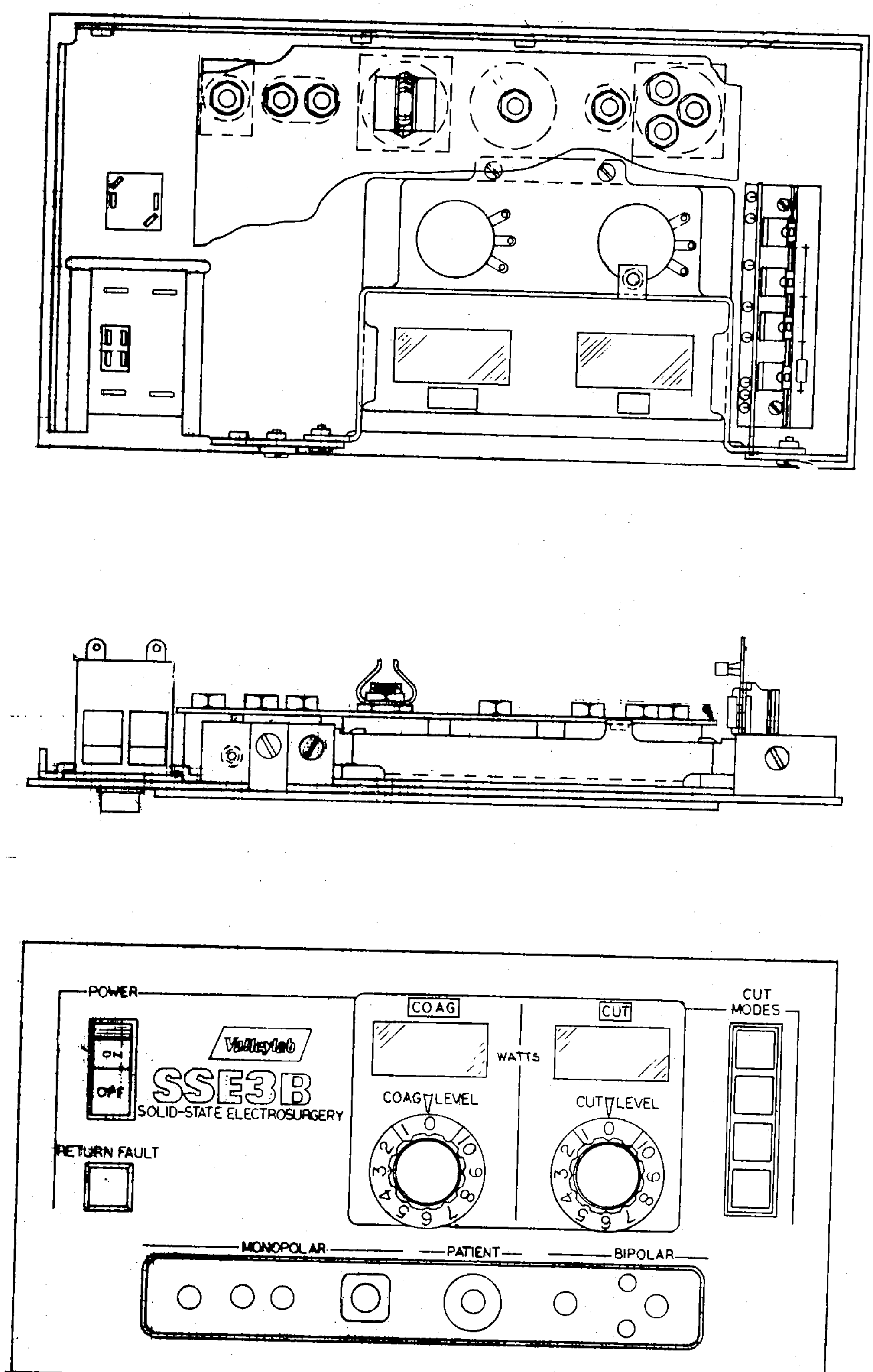


Figure 17 Front Panel Module Assembly

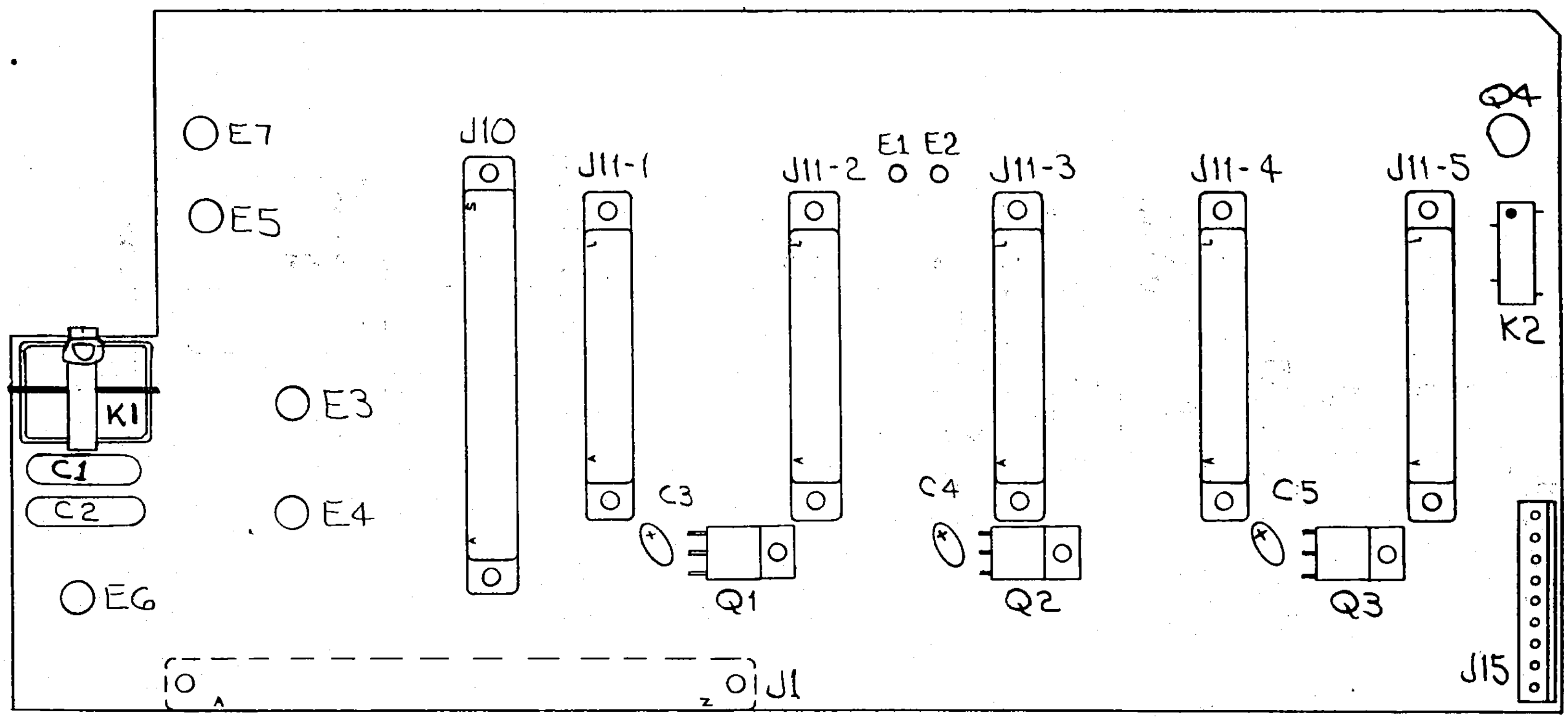
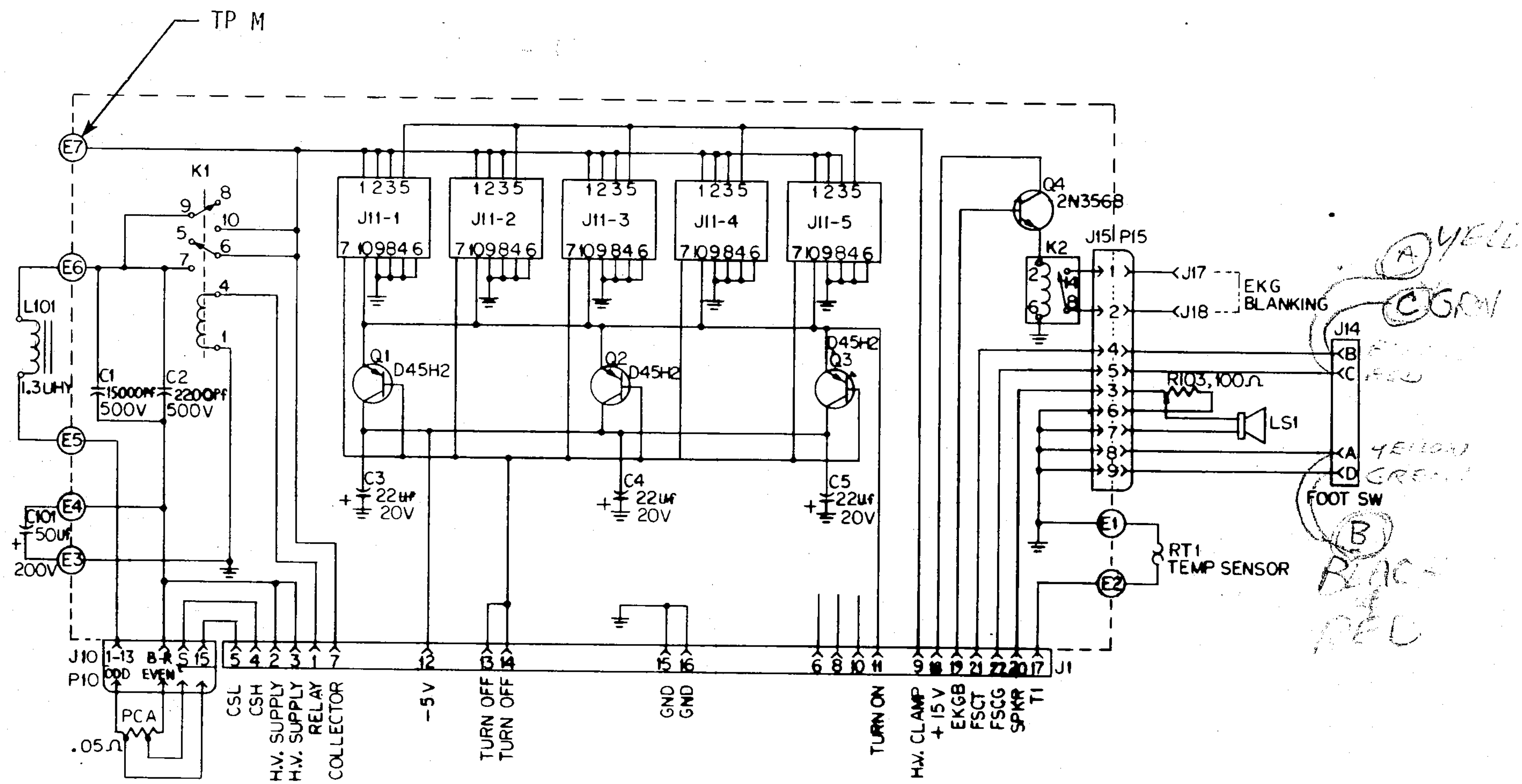


Figure 18 Stripline Board Assembly



1. ALL RELAYS ARE SHOWN IN NON-ACTIVATED POWER OFF MODE.

Figure 19 Stripline Board Schematic

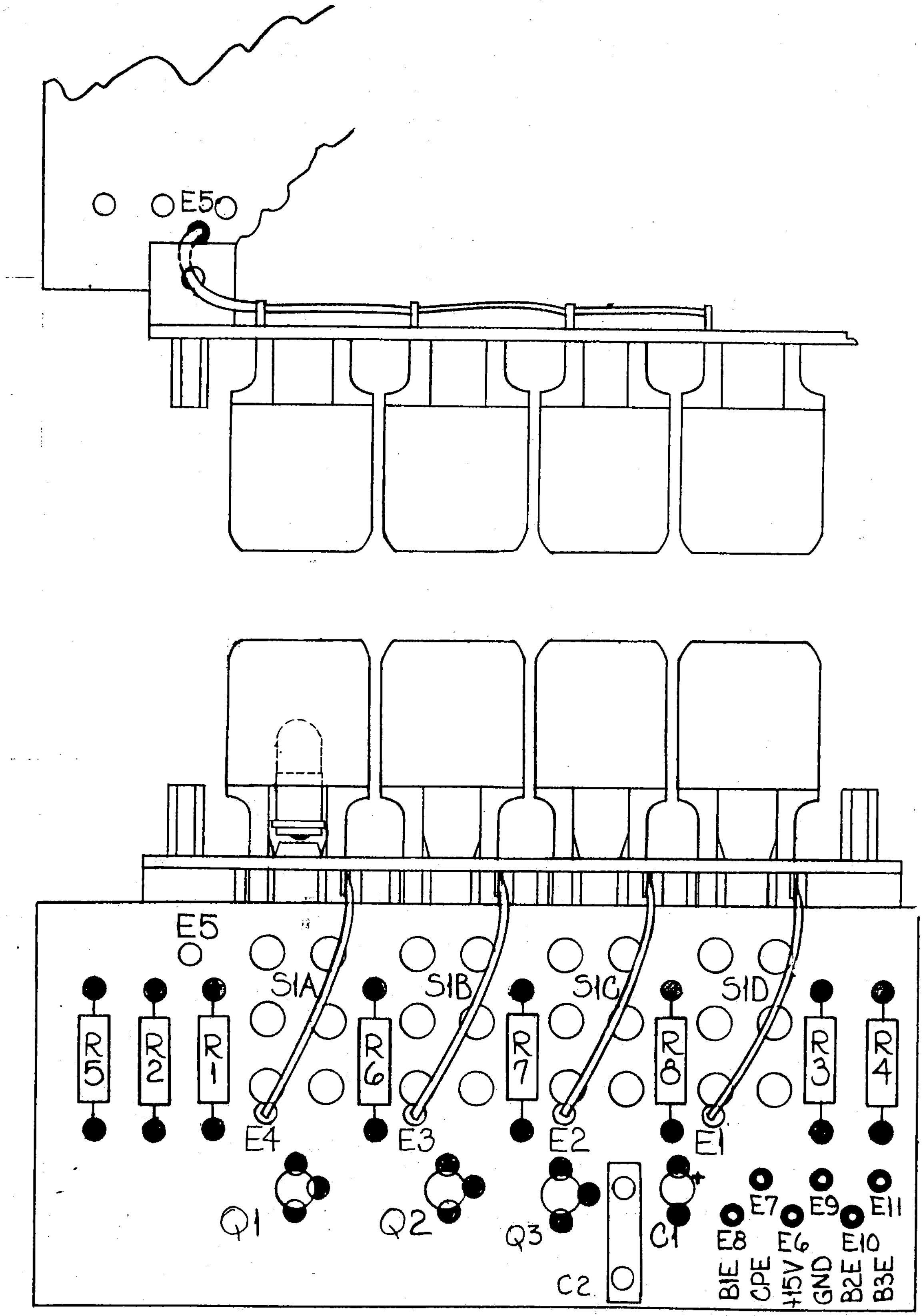
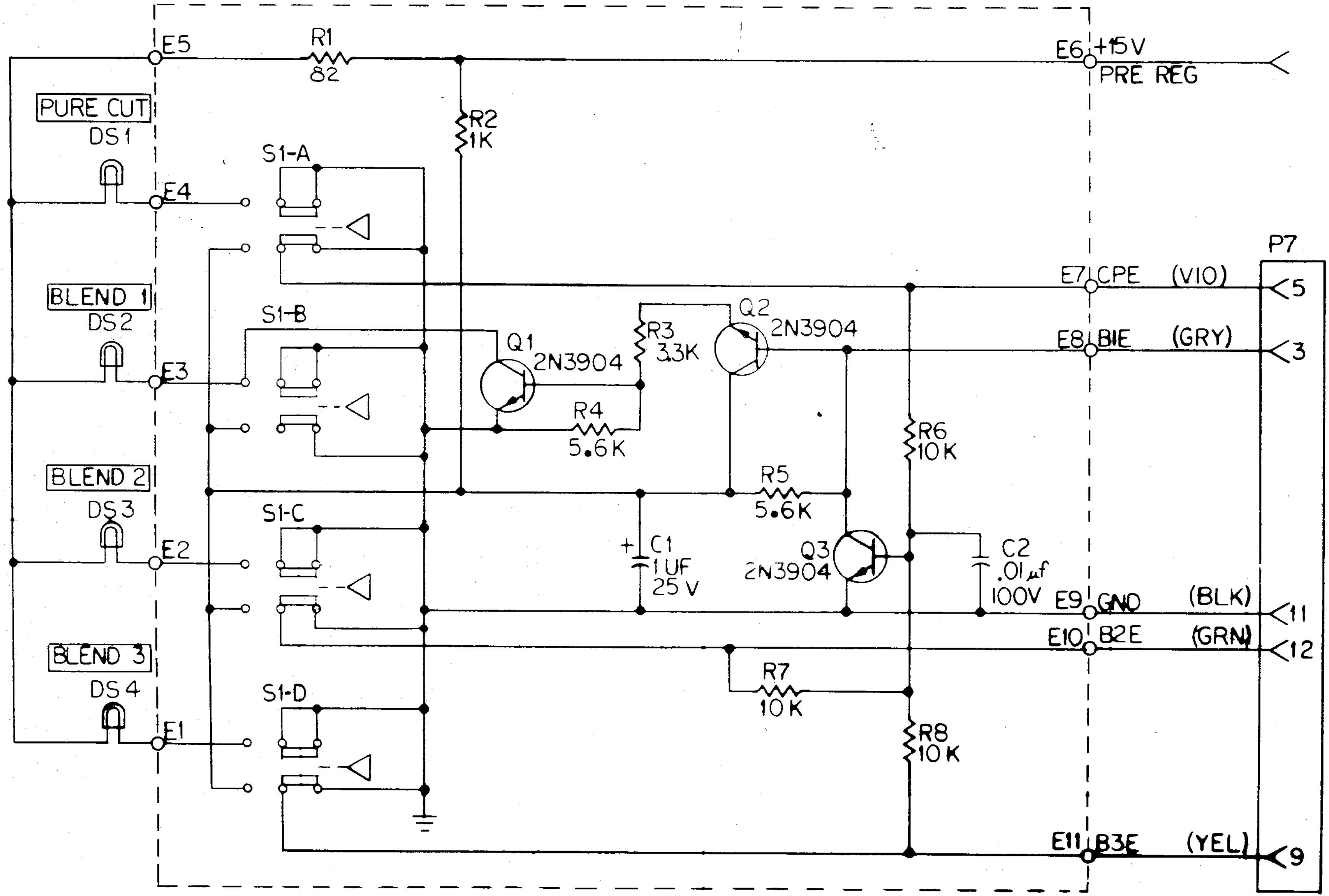


Figure 20 Switch Board Assembly



NOTES UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE VALUES ARE IN OHMS ± 10 %, 1/2 W.
2. DS1 THRU DS4 ARE LOCATED INSIDE PUSH BUTTONS.
3. INTERCONNECTS E6 TO E11 ARE PART OF CABLE, REFER TO MASTER WIRING DIAGRAM D238 060 000 FOR CONTINUITY.

Figure 21 Switch Board Schematic

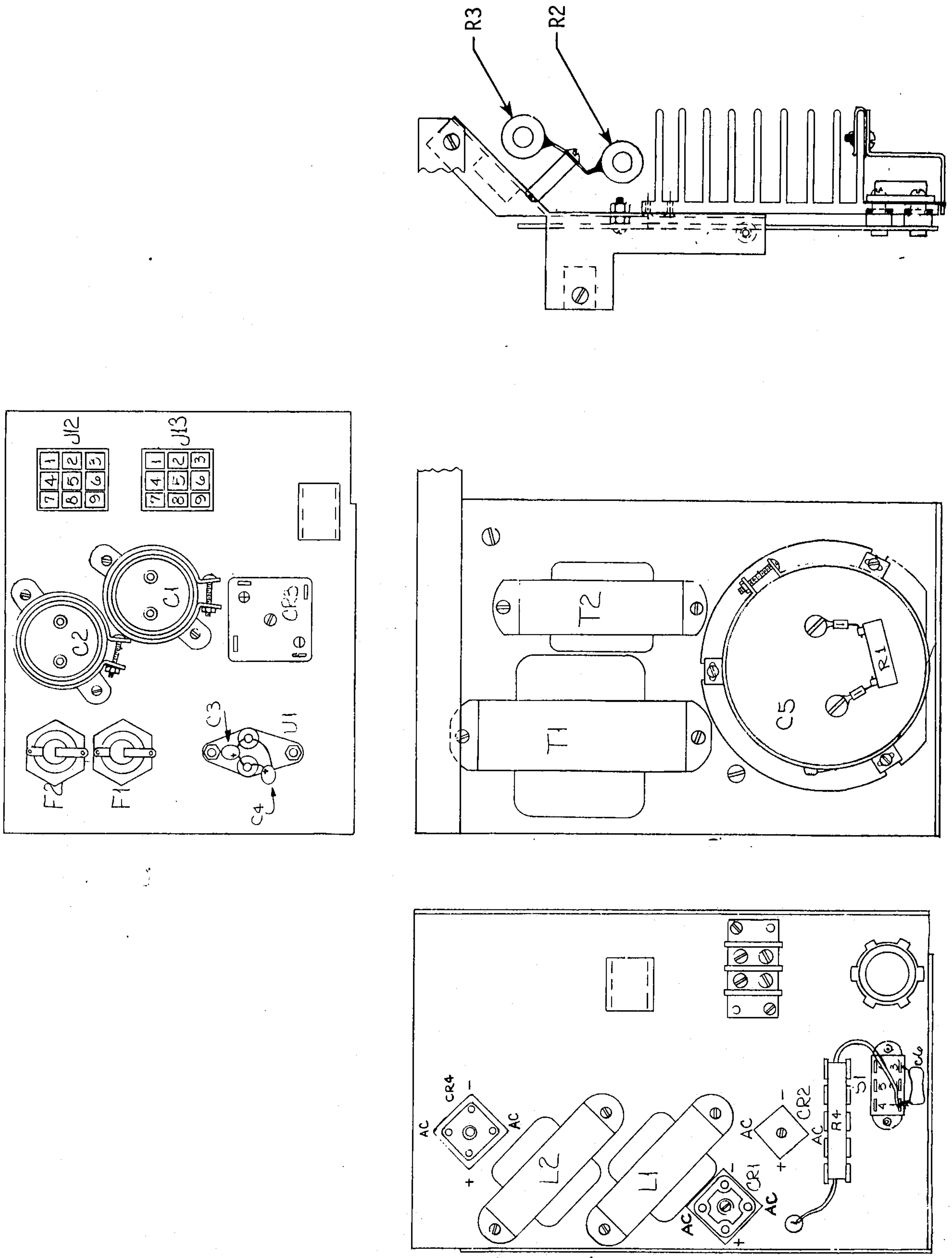
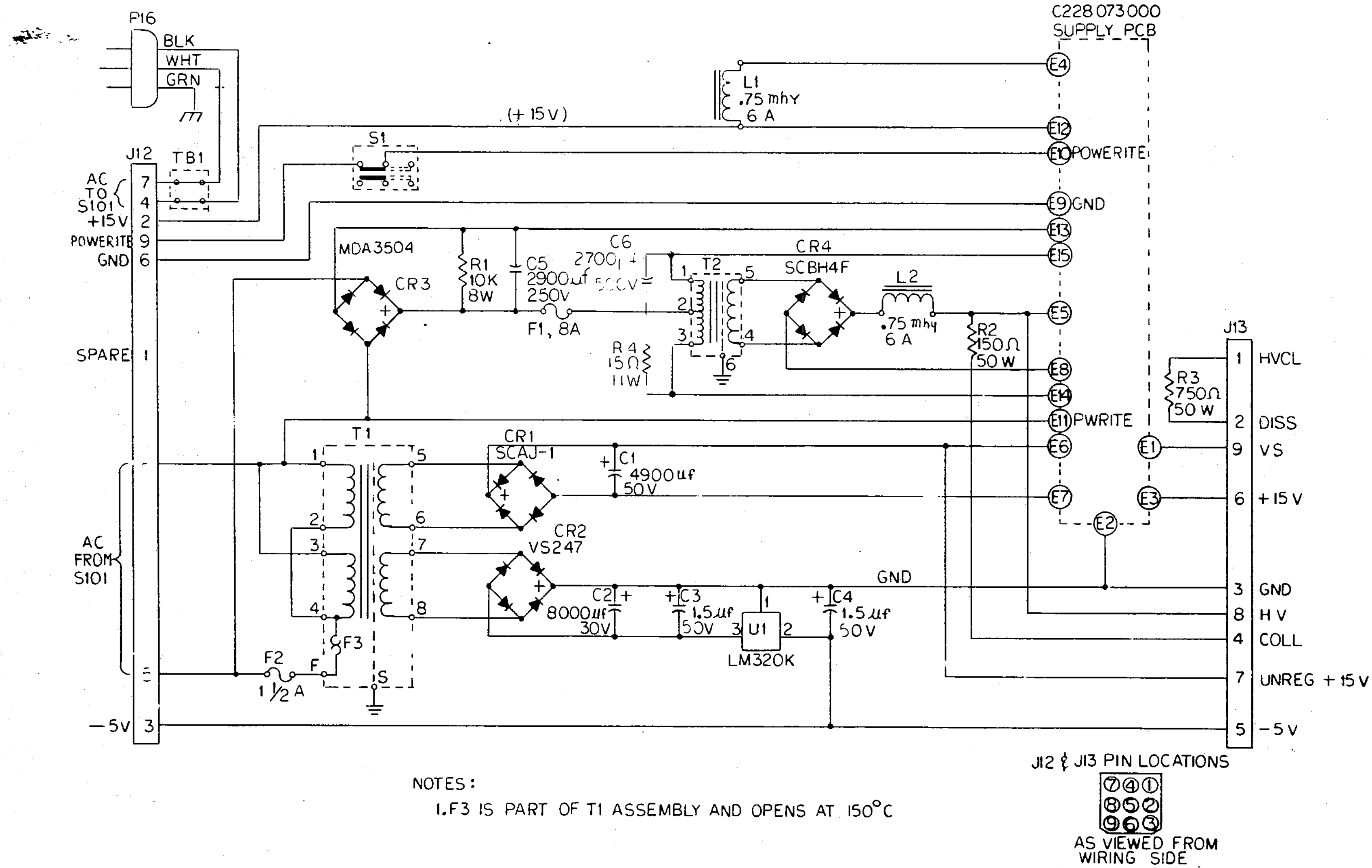


Figure 22 Supply Module Assembly



NOTES:

1. F3 IS PART OF T1 ASSEMBLY AND OPENS AT 150°C

Figure 23 Supply Module Schematic

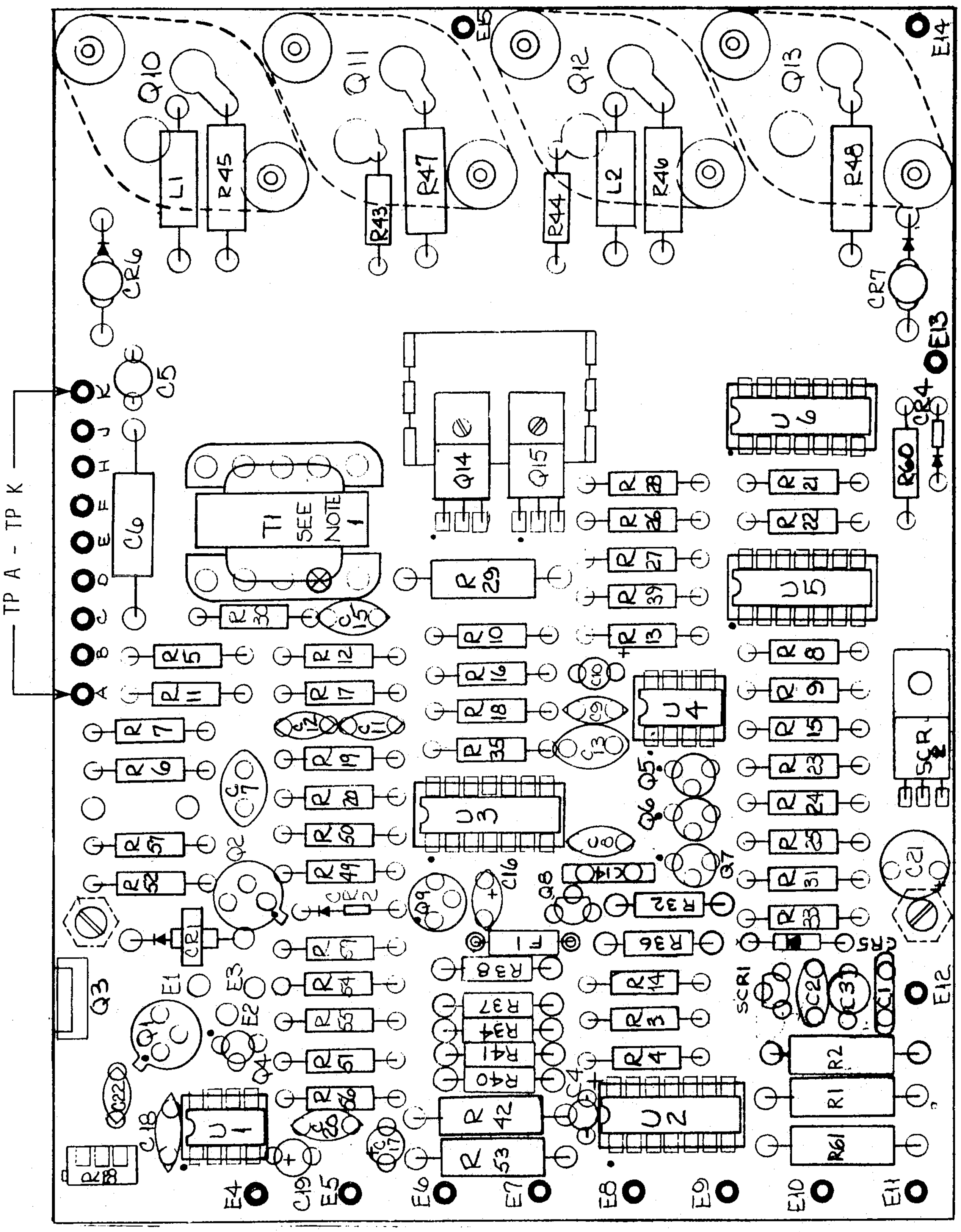
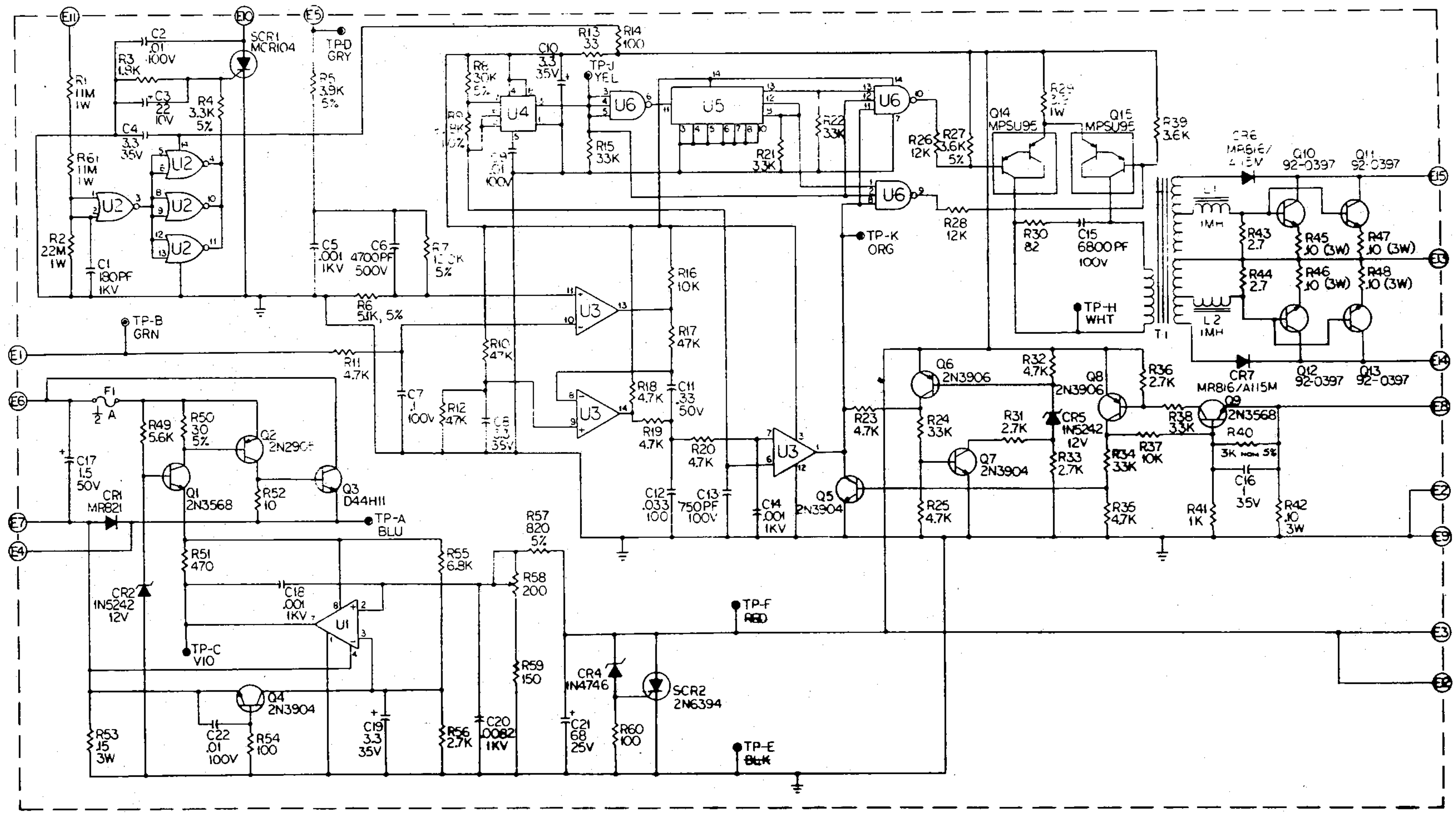


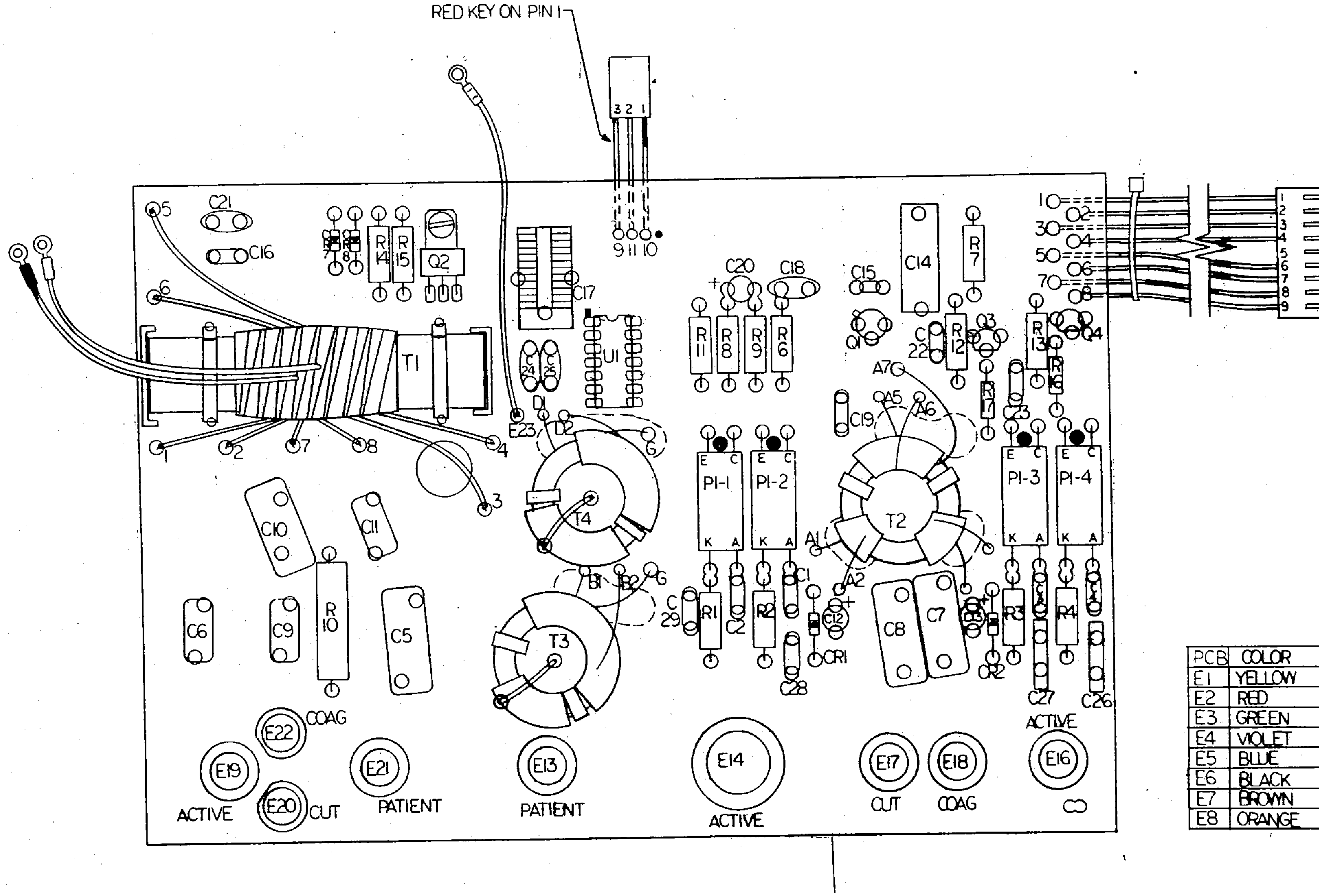
Figure 24 Supply Board Assembly



NOTES: UNLESS OTHERWISE NOTED-
1. ALL RESISTANCE VALUES ARE IN OHMS ±10%, 1/2 WATT.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

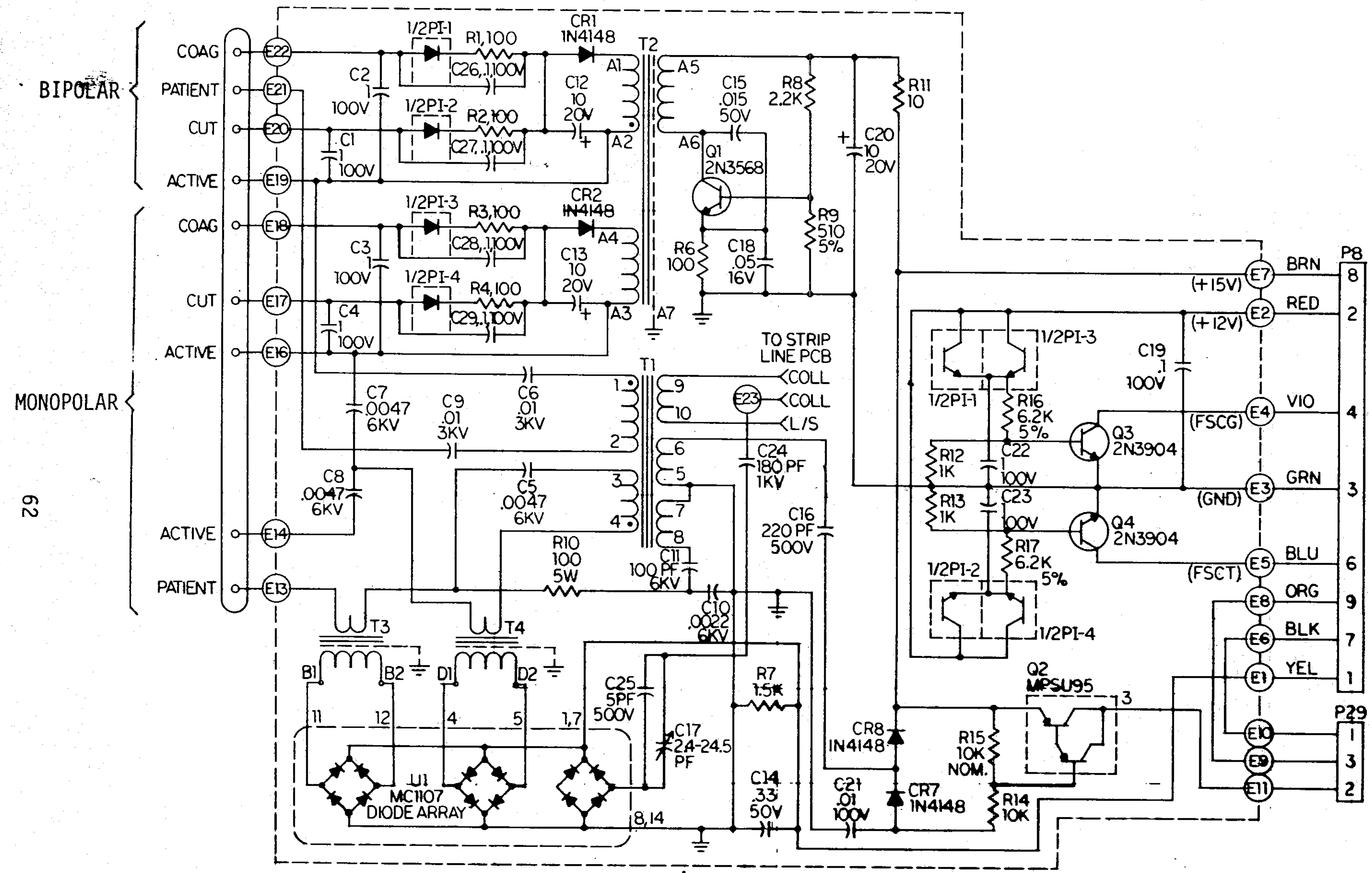
IC	TYPE
U1	LM311N
U2	CD4001AE
U3	LM3302
U4	NE555
U5	MD4013
U6	CD4023AE

Figure 25 Power Supply Board Schematic



PCB	COLOR	PB–
E1	YELLOW	1
E2	RED	2
E3	GREEN	3
E4	VIOLET	4
E5	BLUE	6
E6	BLACK	7
E7	BROWN	8
E8	ORANGE	9

Figure 26 Isobloc Board Assembly



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ±10%, 1/2 WATT.
2. ALL CAPACITOR VALUES IN MICROFARADS.

Figure 27 Isobloc Board Schematic

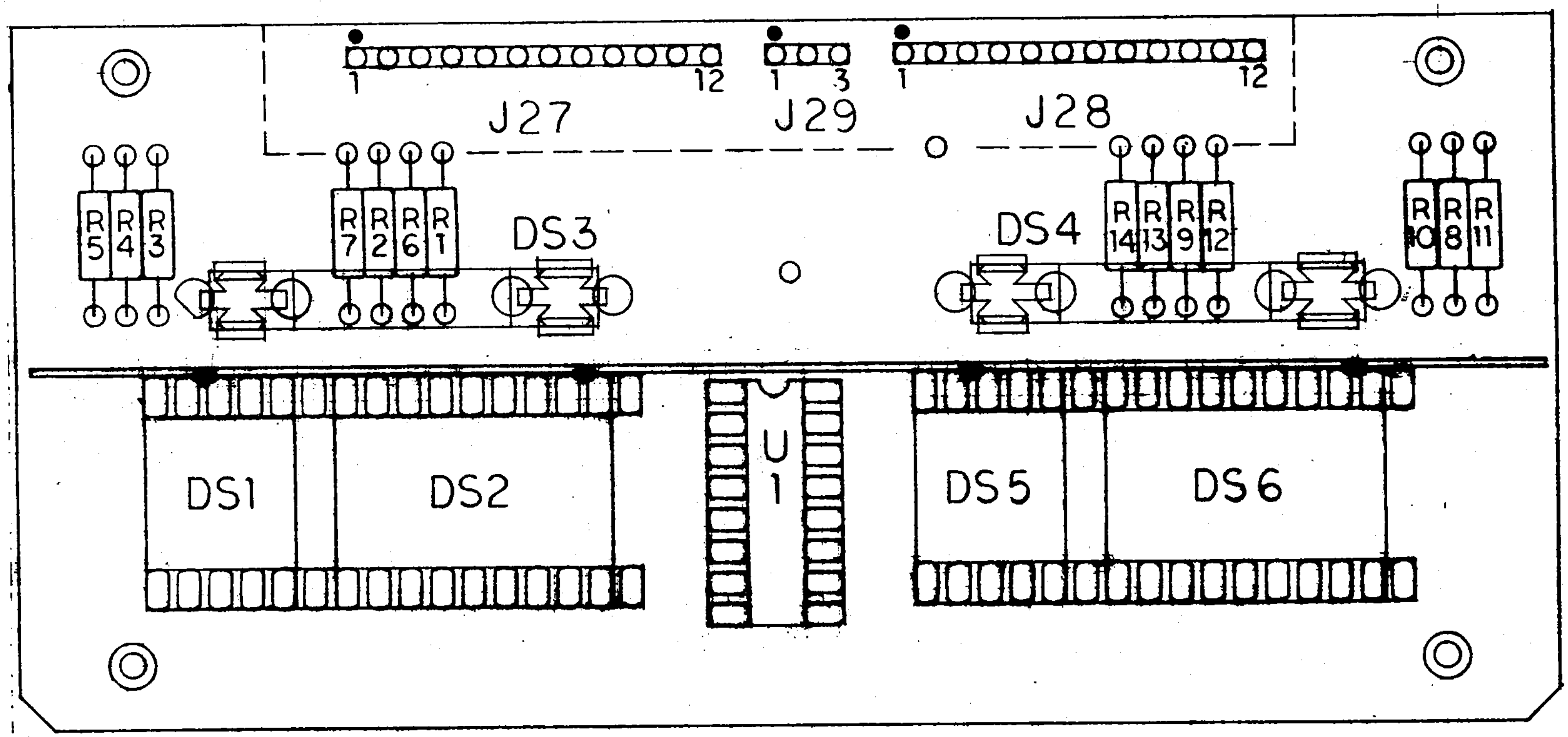
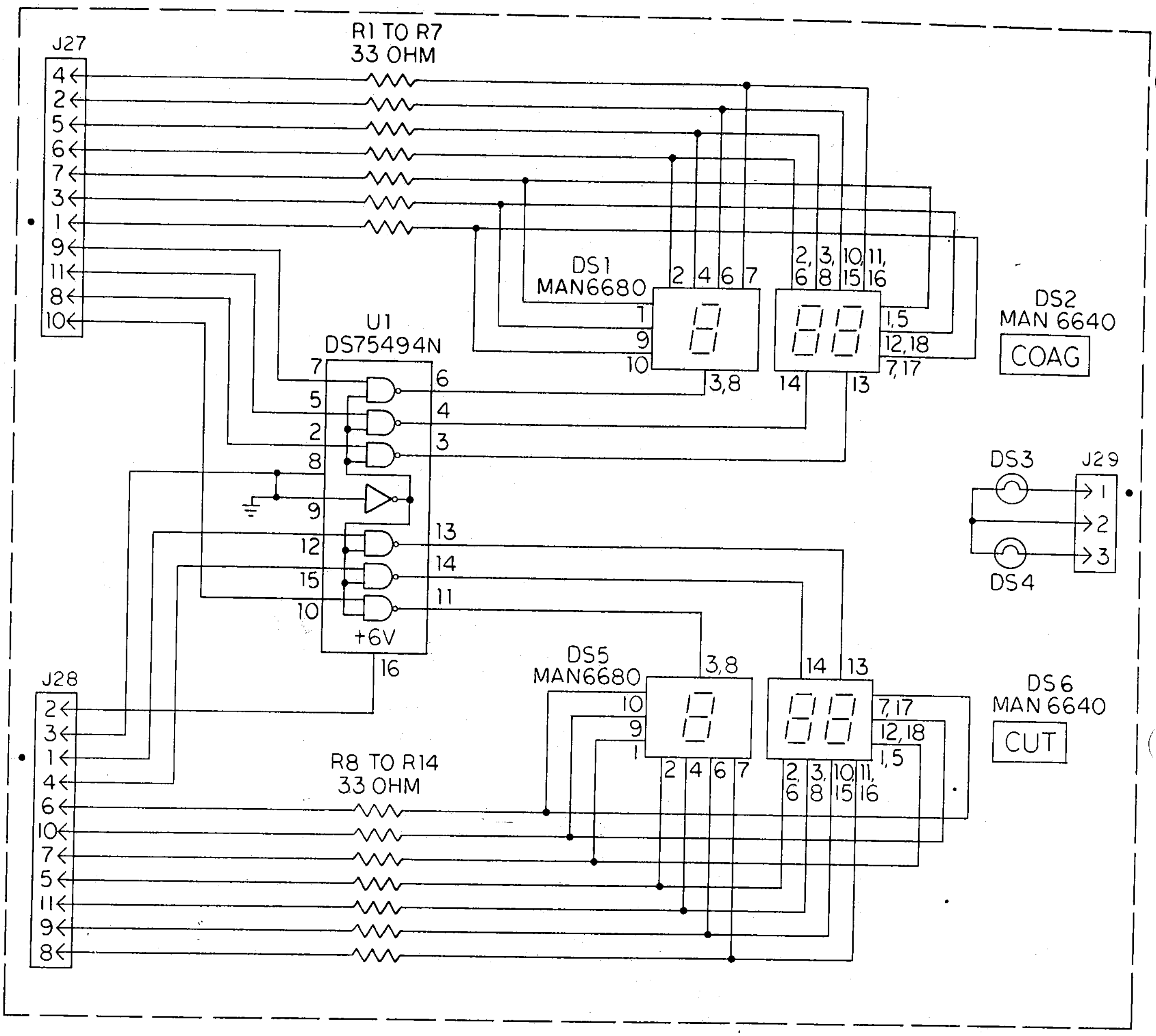


Figure 28 Display Board Assembly



NOTES: UNLESS OTHERWISE SPECIFIED
1 ALL RESISTOR VALUES ±5%, 1/4 W

Figure 29 Display Board Schematic

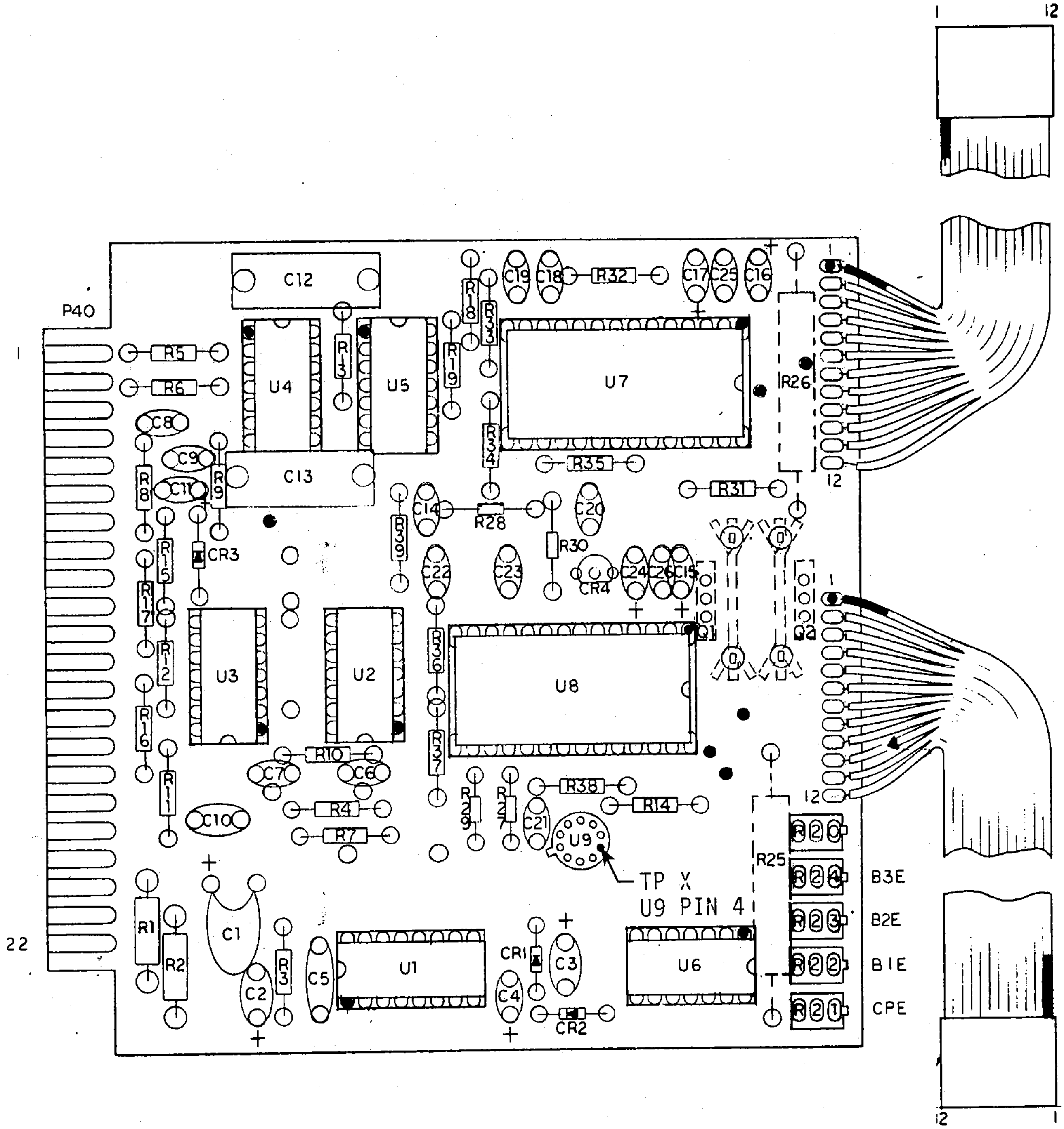
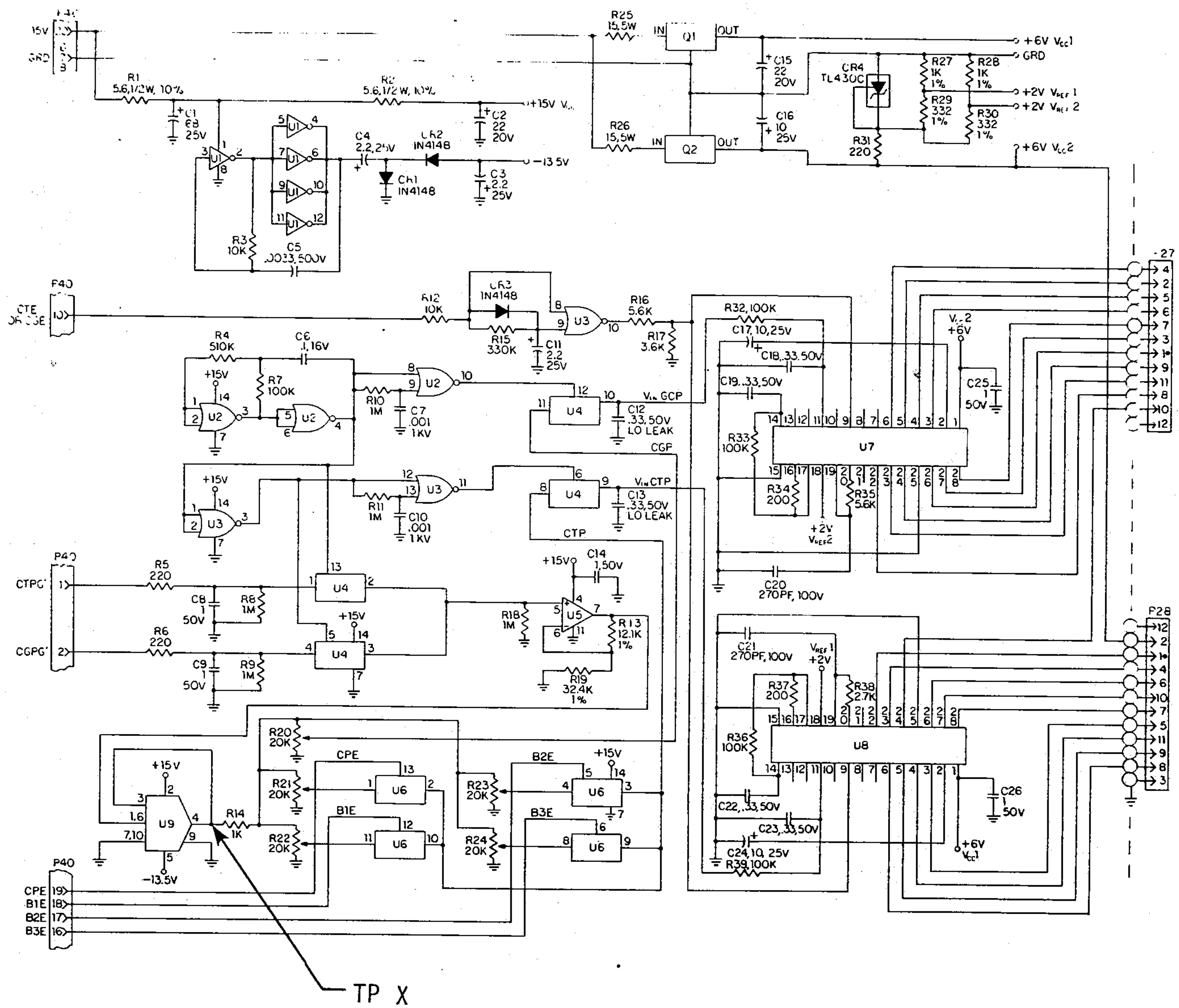


Figure 30 Display Driver Board Assembly



SYM	TYPE
U1	CD4049CN, MC14049CP, CD4049AE
U2, U3	CD4001CN, MC14001CP, CD4001AE
U4, U6	CD4016CN, MC14016CP, MC14016BCP CD4016AE, CD4016BE, F4016PC
U7	MM74C935
U8	MM74C936
U9	BB4213
Q1, Q2	CM340T-06, MC7806CT

NOTES:
1. RESISTORS IN OHMS, ± 5%, 1/4W UNLESS OTHERWISE NOTED.
2. CAPACITORS IN MICROFARADS.
3. 1% RESISTORS ARE 1/8 WATT.

Figure 31 Display Driver Board Schematic

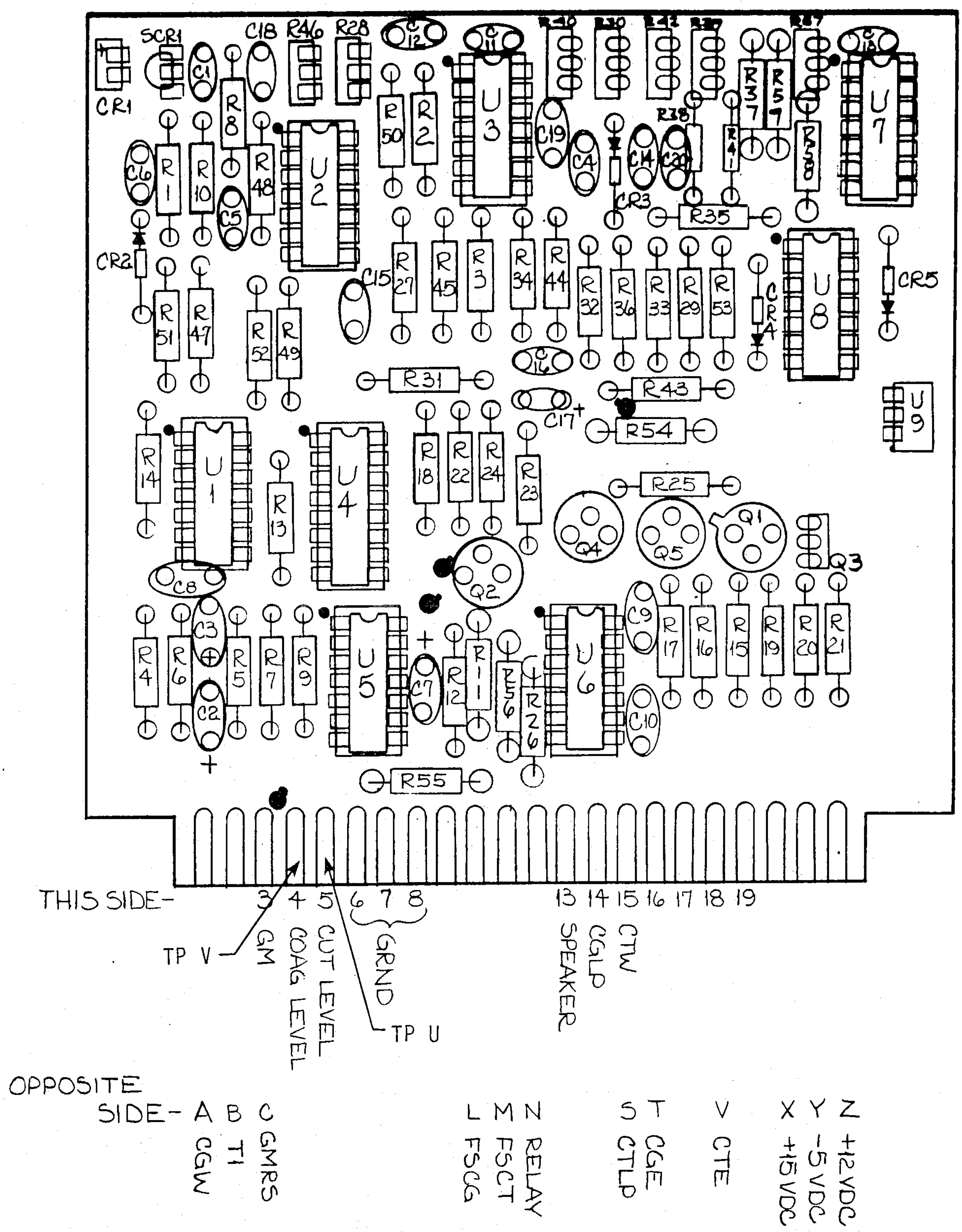
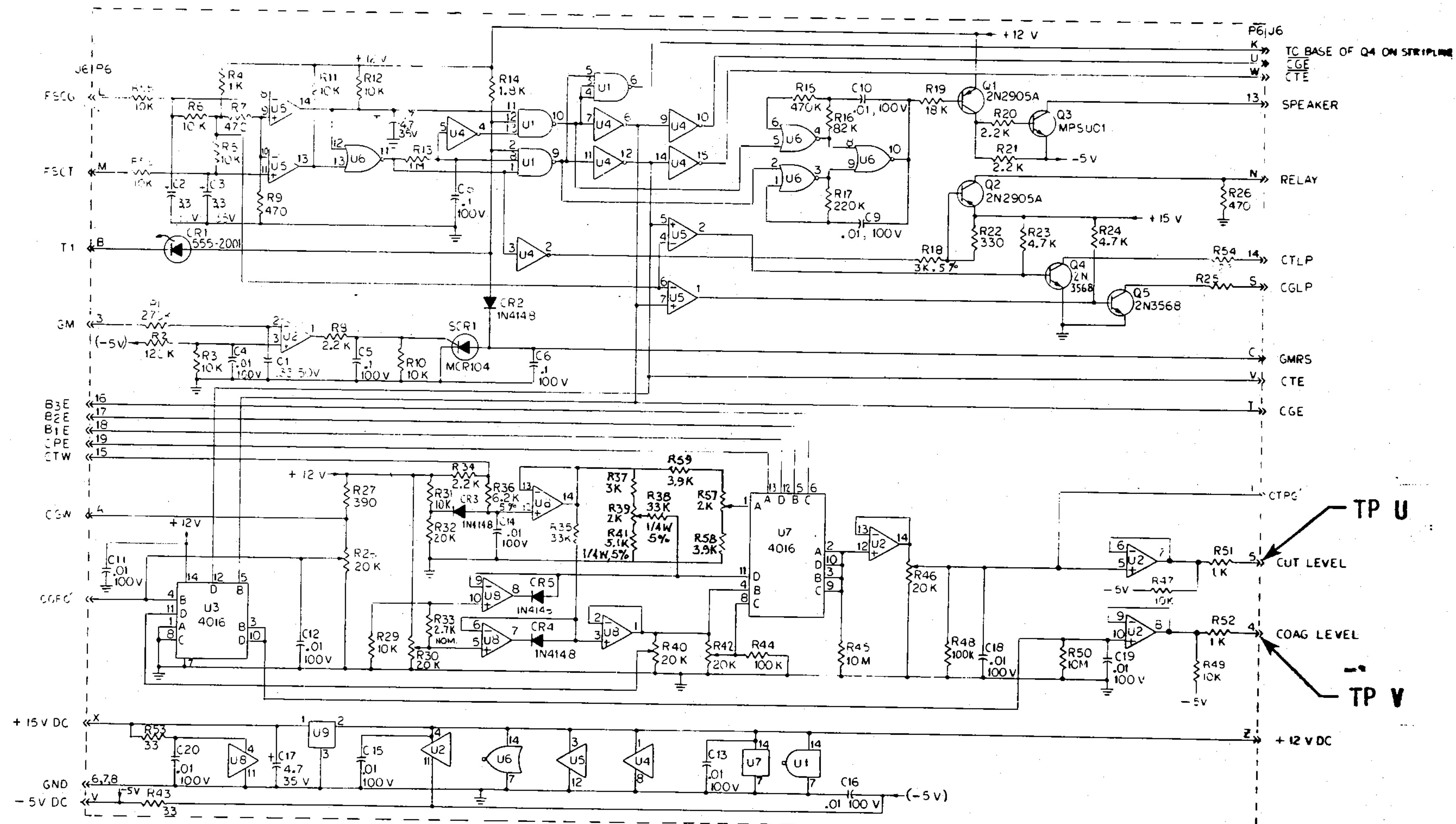


Figure 32 Level Board Assembly



NOTES
1. U1 IS 4023
2. U2, U8 ARE LM324
3. U4 IS MM5649AN (CD4049AE MC14049AN)
4. U5 IS LM3302
5. U6 IS 4001
6. U9 IS LM340T-12
7. ( ) DENOTES DECOUPLED VOLTAGES

UNLESS OTHERWISE SPECIFIED
8. ALL CAPACITOR VALUES IN MICROFARADS
9. ALL RESISTANCE VALUES ± 10 %, 1/2 WATTS

Figure 33 Level Board Schematic

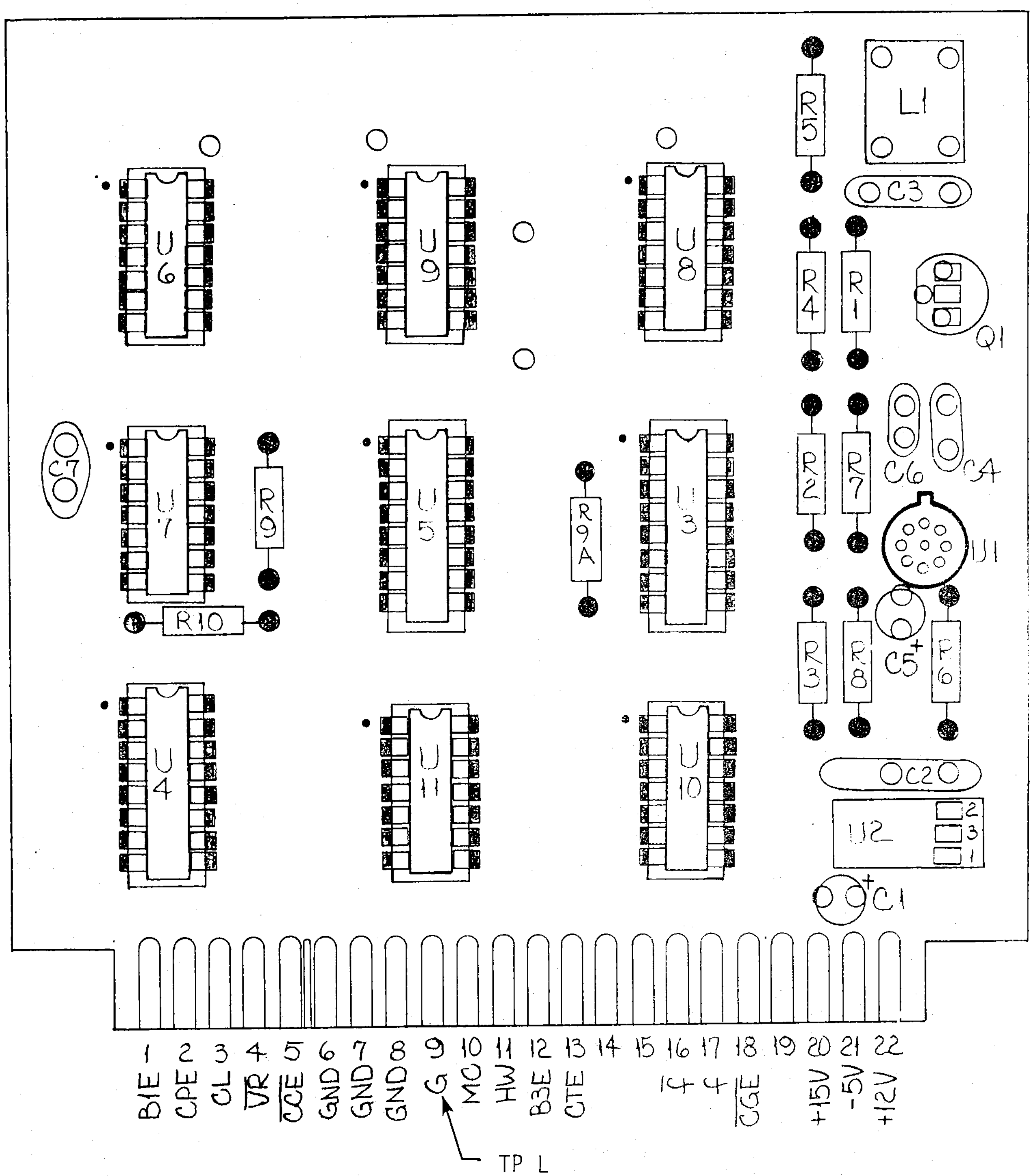
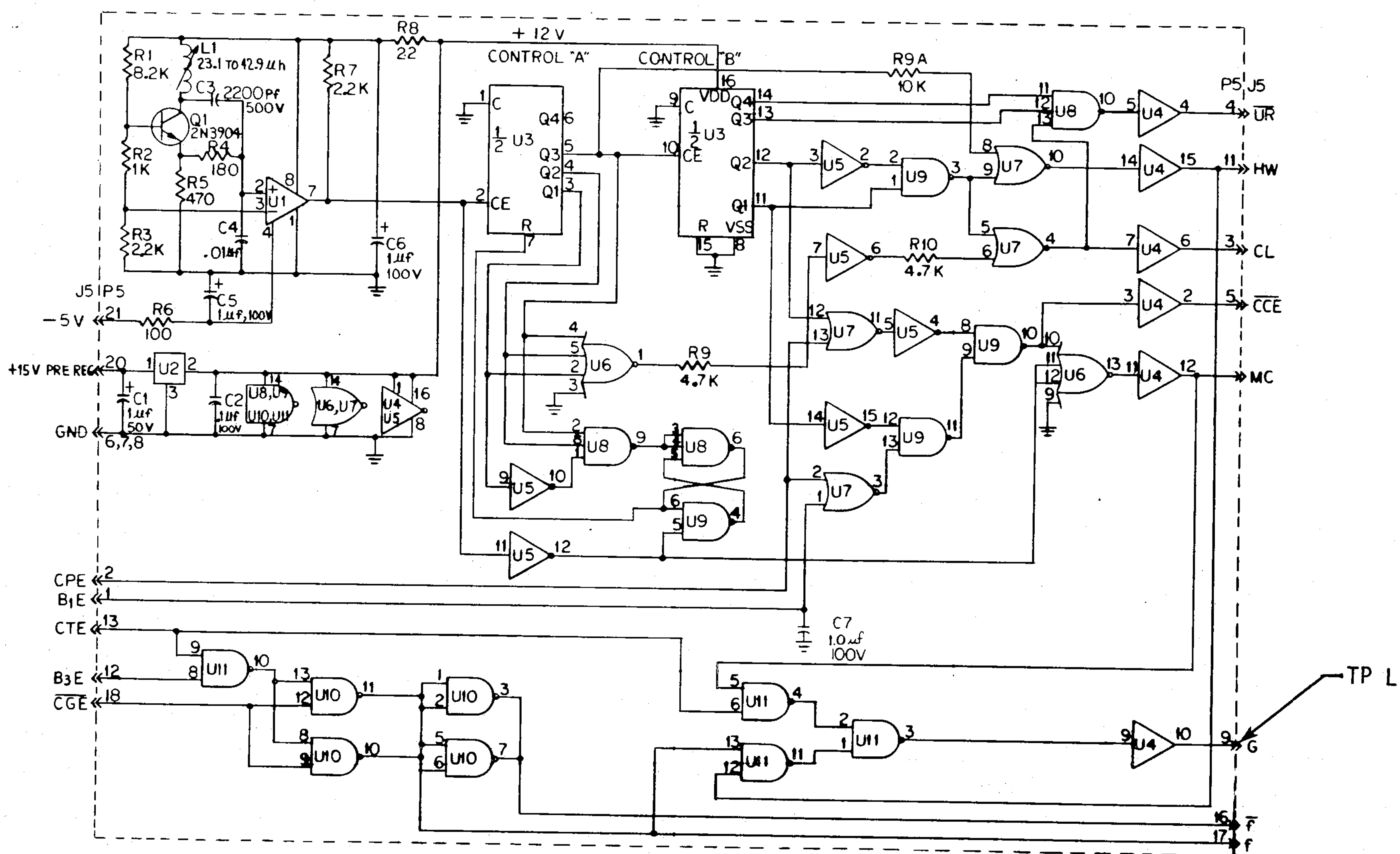


Figure 34 Clock Board Assembly



NOTES:

1. RESISTORS ARE ½ WATT, 10 %
2. U1 IS LM306H/LM206H
3. U2 IS LM340T-12
4. U3 IS MC14520BCP
5. U4 IS CD4010
6. U5 IS CD4009
7. U6 IS CD4002
8. U7 IS CD4001
9. U8 IS CD4023
10. U9, U10, U11 ARE CD4011

Figure 35 Clock Board Schematic

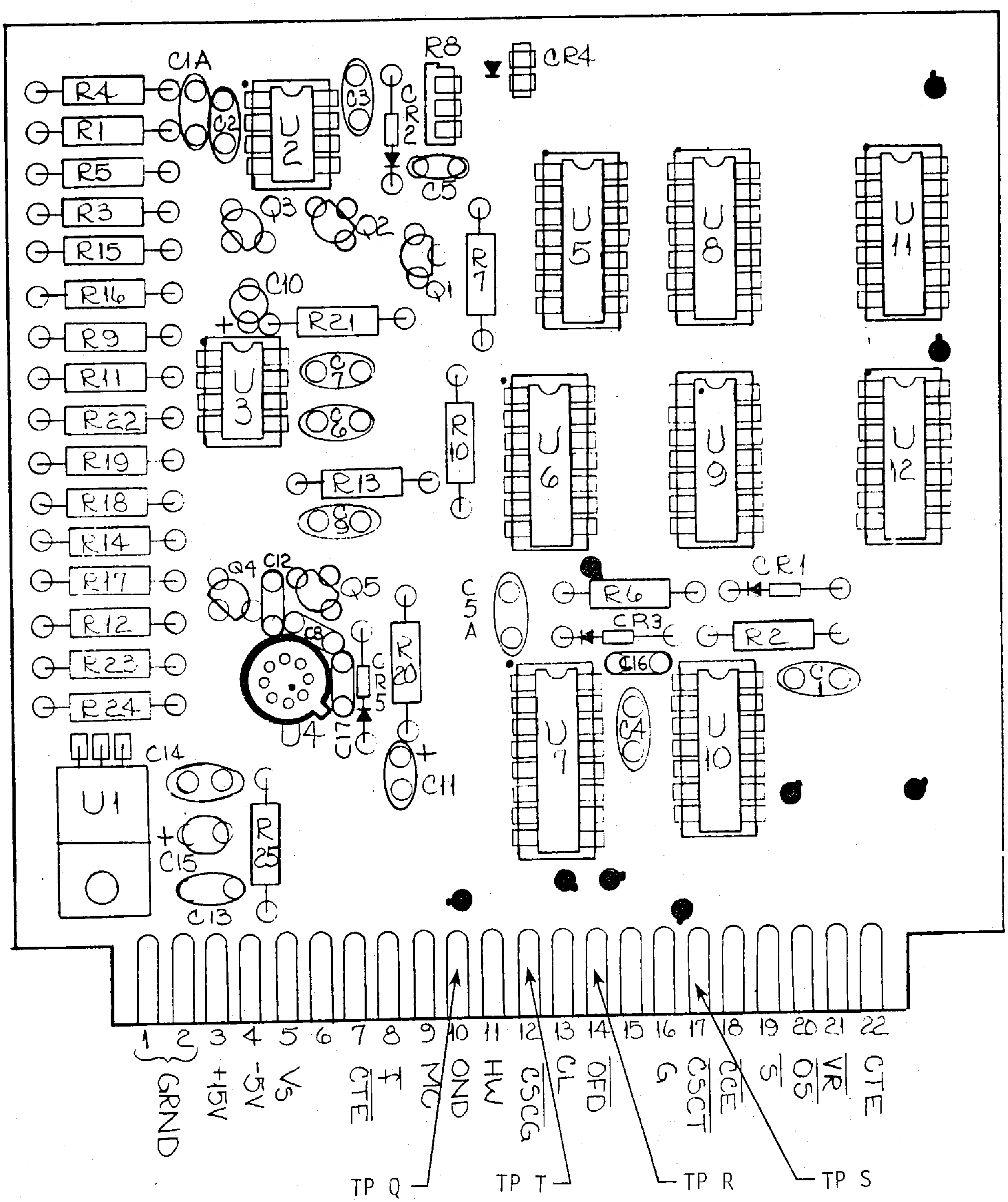
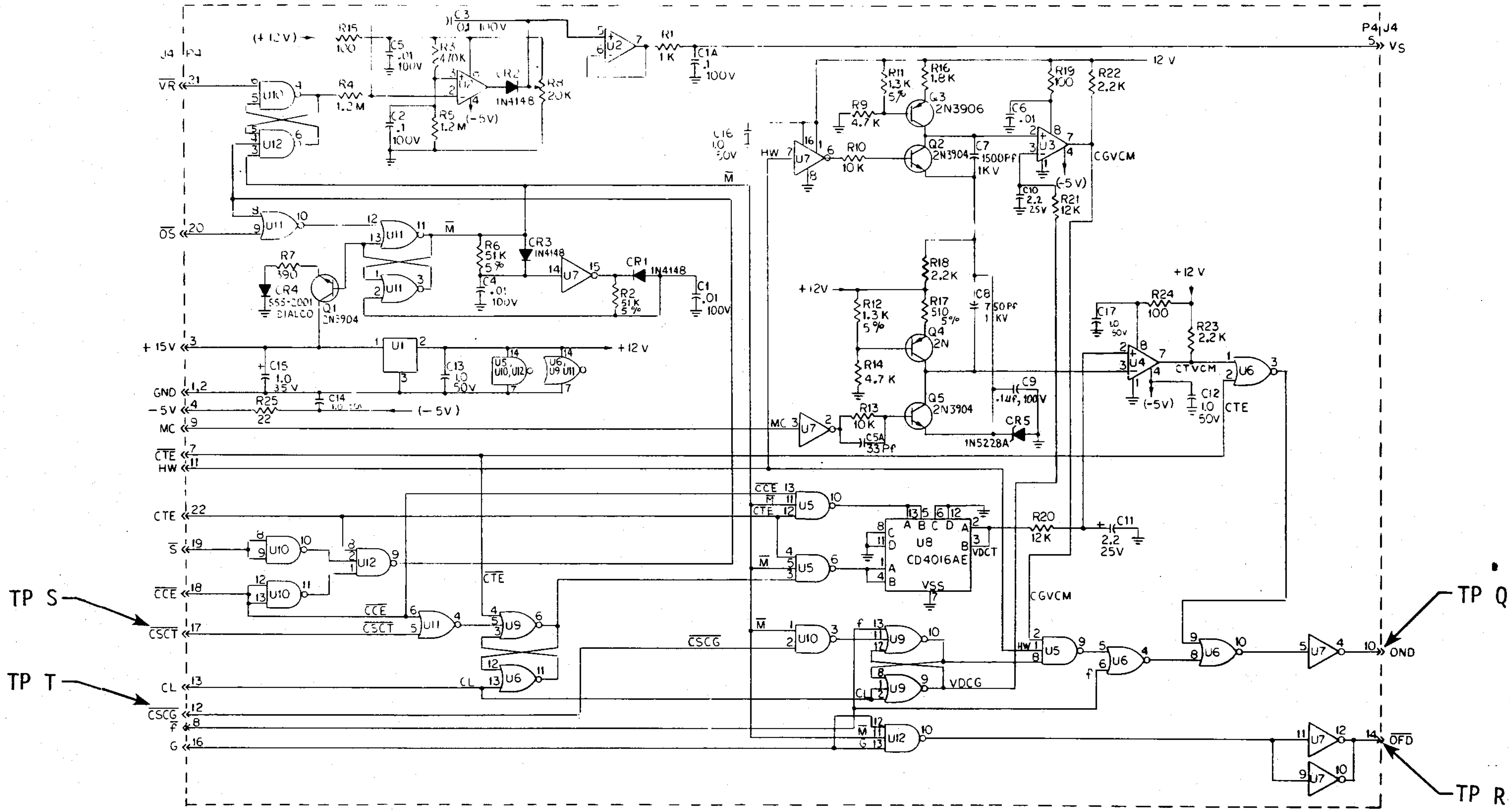


Figure 36 Control Board Assembly



NOTES:

1. ALL RESISTANCE VALUES ARE IN OHMS, ± 10 %, 1/2 WATT UNLESS OTHERWISE NOTED.
2. ALL CAPACITOR VALUES ARE IN MICOFARADS UNLESS OTHERWISE NOTED.
3. U2 IS MC1458C
4. U3 IS LM311N
5. U4 IS LM306H/I M206H
6. U5, U12 ARE HD4023AE
7. U6, U11 ARE HD4001AE
8. U7 IS CD4049CN/MC14049CP/CD4049AE
9. U9 IS HD4025-9
10. U10 IS HD4011AE

Figure 37 Control Board Schematic

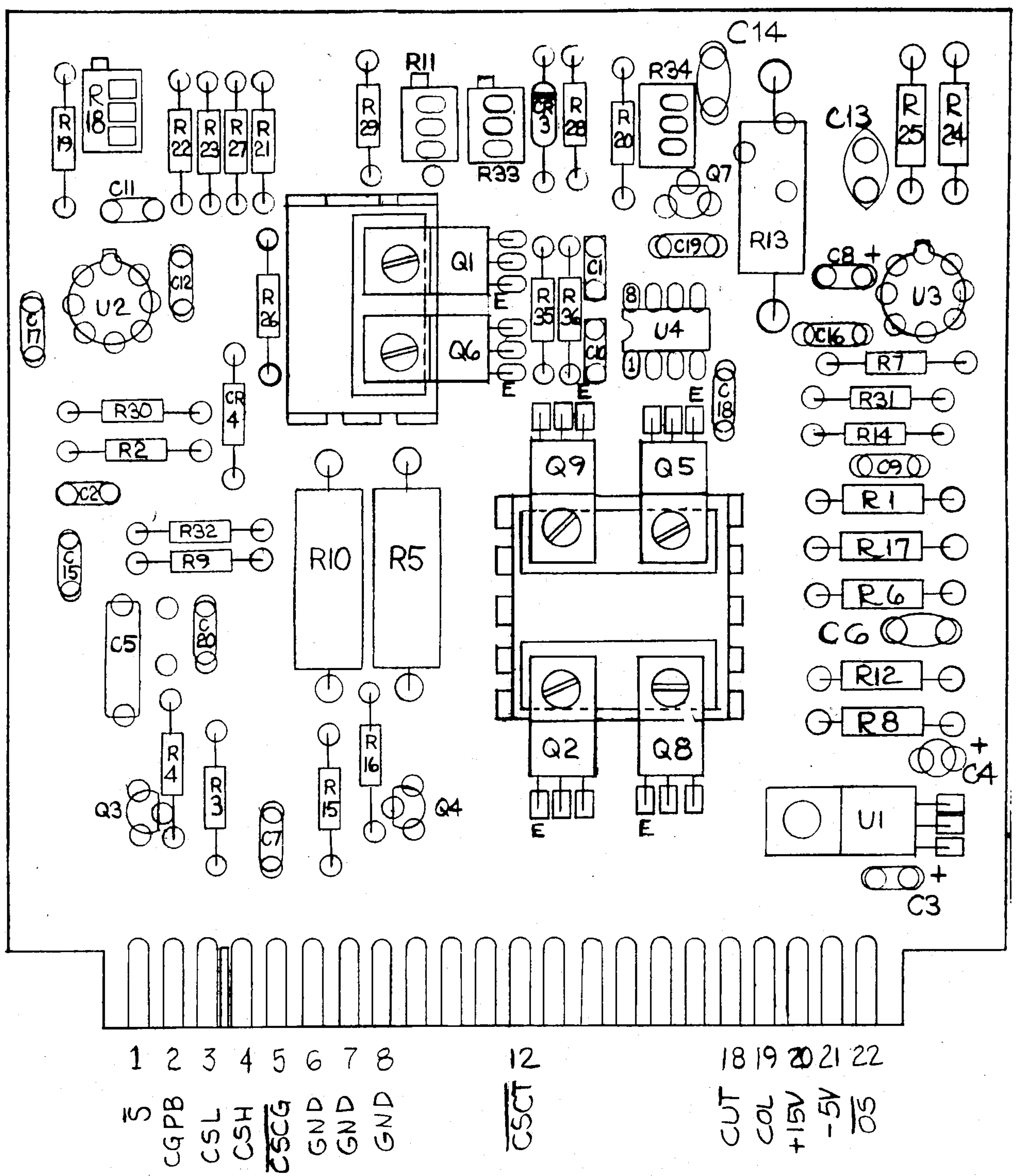
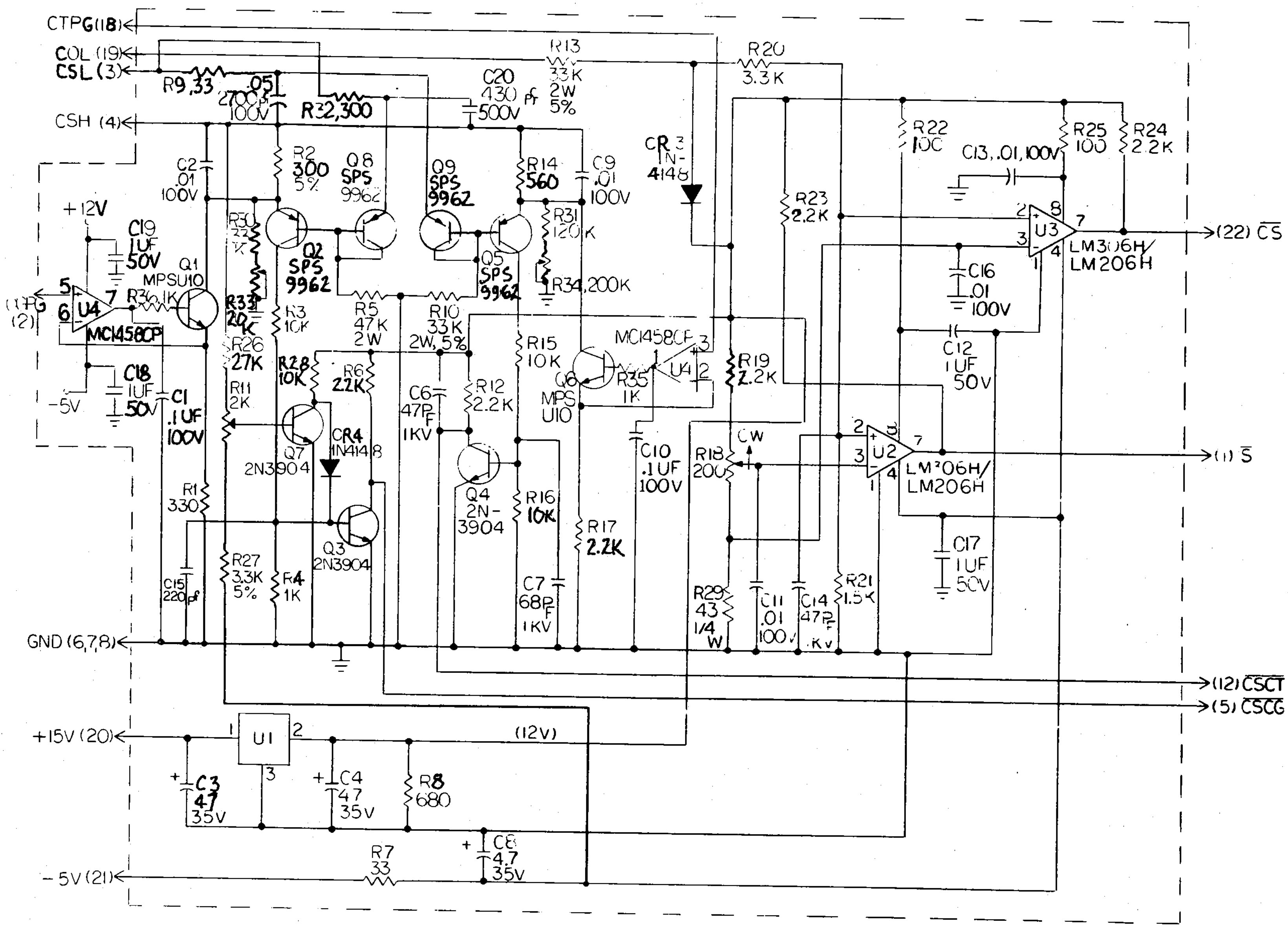


Figure 38 Sense Board Assembly



NOTES: (UNLESS OTHERWISE NOTED.)

1. ALL RESISTANCE VALUES ARE IN OHMS ±10%, 1/2W.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

Figure 39 Sense Board Schematic

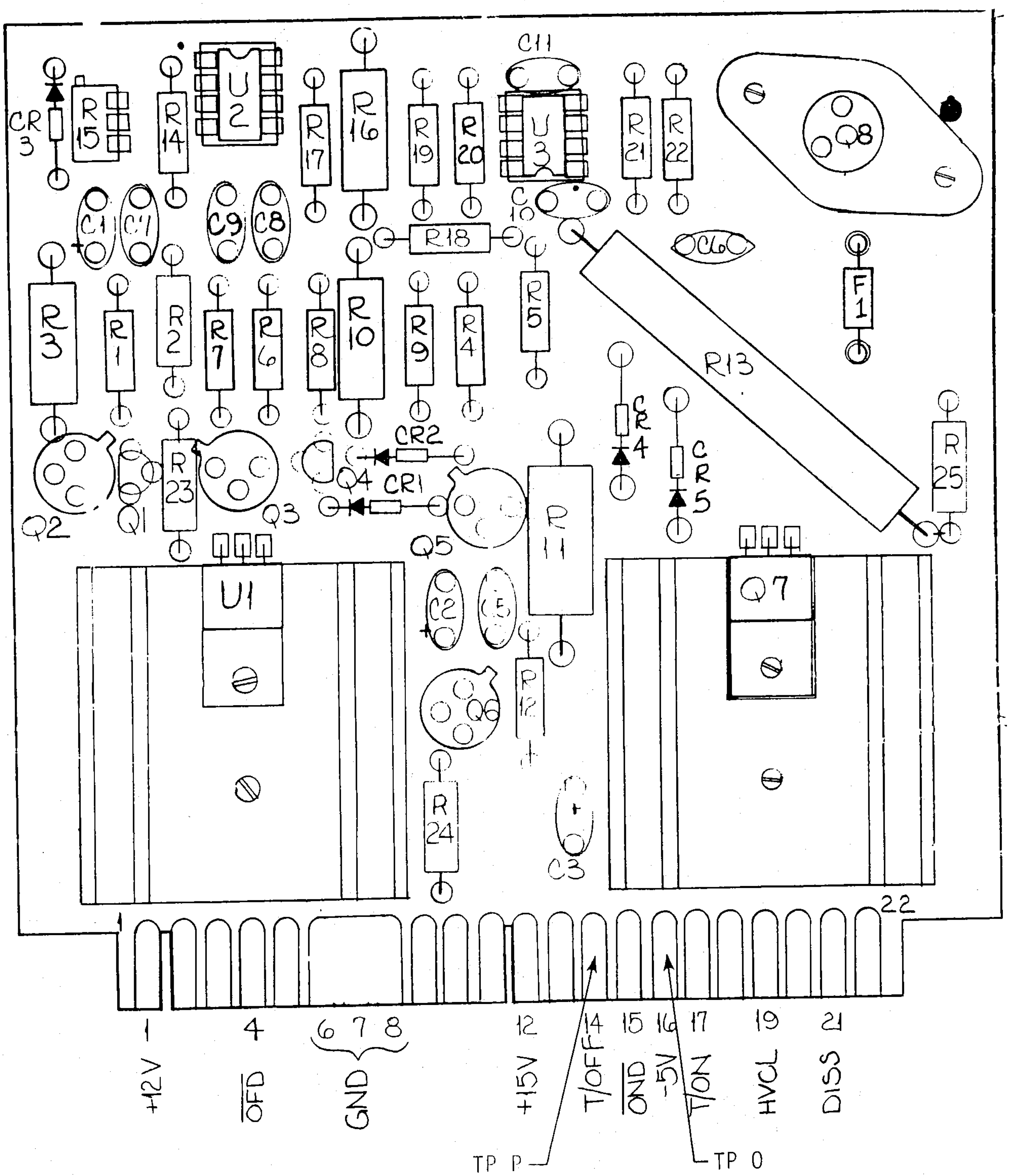
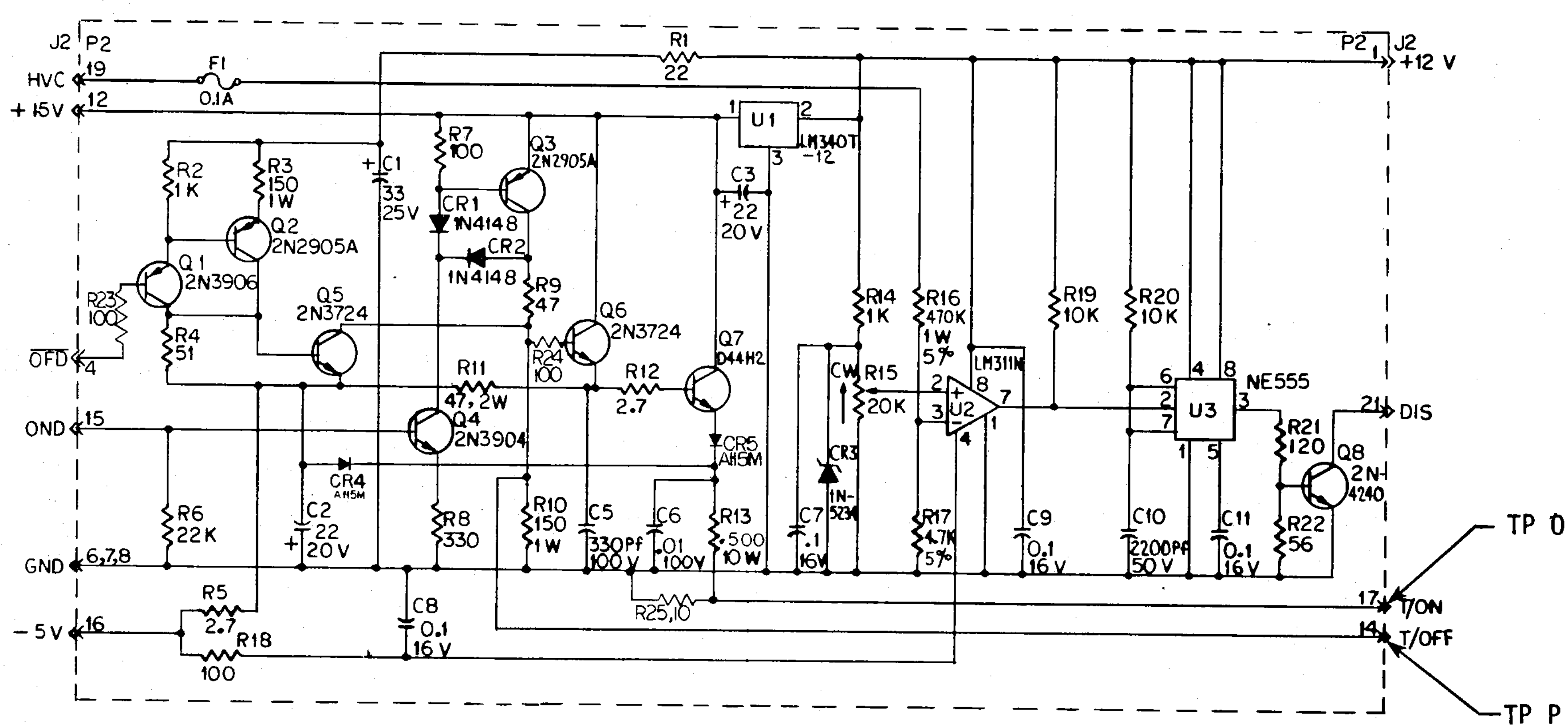


Figure 40 Driver Board Assembly



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCE VALUES ARE IN OHMS ± 10 %.
2. ALL CAPACITOR VALUES ARE IN MICRO-FARADS.

Figure 41 Driver Board Schematic

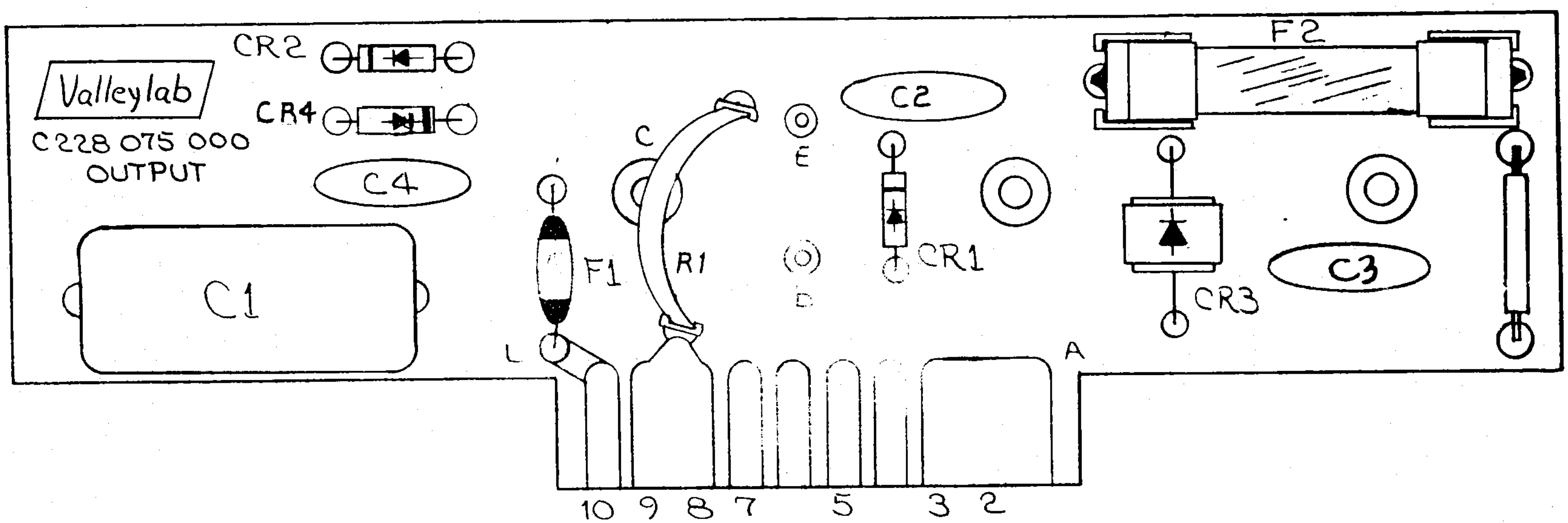


Figure 42 Output Board Assembly

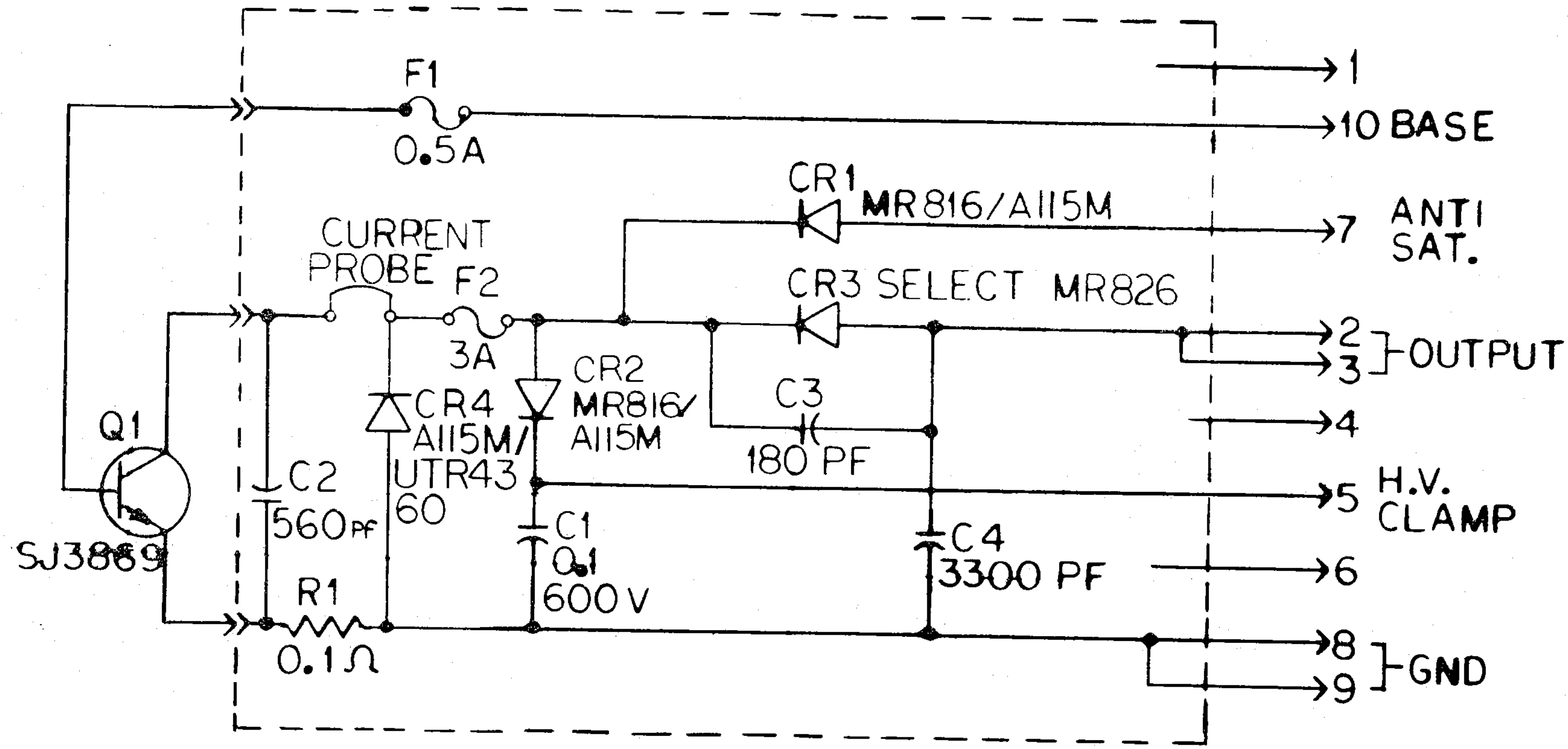


Figure 43 Output Board Schematic

Section 9
Parts List

REPLACEABLE MODULES

ASSEMBLY	SHOWN ON FIGURE NUMBER	VALLEYLAB PART NUMBER	SUGGESTED QUANTITY
Supply Module Assembly	22	202 277 000	2
Output Module Assembly	14	202 280 000	10
Stripline Module Assembly	16	202 700 058	1
Front Panel Assembly	17	202 700 057	2
3 Cond. Ribbon Cable Assembly	14	202 400 018	2
12 Cond. Ribbon Cable Assembly	14	202 400 057	2
PCB Assembly Parent	14	201 065 000	1
PCB Assembly Driver	30	201 066 000	1
PCB Assembly Sense	38	201 067 000	1
PCB Assembly Control	36	201 068 000	1
PCB Assembly Clock	34	201 069 000	1
PCB Assembly Level	32	201 070 000	1
PCB Assembly Output	42	201 075 000	5
PCB Assembly Display	28	201 104 000	1
PCB Assembly Display Driver	30	201 105 000	1
Cable Assembly Power Switch	15	202 274 000	2
PCB Assembly Stripline	18	201 074 000	1
PCB Assembly Switch	20	201 072 000	1

To provide full replacement capability, the sales representative or hospital engineer should stock the quantity shown in the right column.

ASSY SUPPLY MODULE 202 277 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 10K, 8W, 5%	A 234 000 012
R2	RESISTOR 150, 50W	A 234 032 001
R3	RESISTOR 750, 50W	A 234 032 002
R4	RESISTOR 15ohm, 11W	A 234 018 002
CAPACITORS		
C1	CAPACITOR 4900uf, 50V	A 204 117 065
C2	CAPACITOR 8000uf, 30V	A 204 117 047
C3,4	CAPACITOR 1.5uf, 25V	A 204 102 002
C5	CAPACITOR 2900uf, 250V	A 204 119 114
C6	CAPACITOR 2700pf, 500V	A 204 105 036
INTEGRATED CIRCUITS		
U1	REGULATOR LM320K	A 239 086 000
DIODES		
CR1	RECTIFIER SCAJ-1	A 239 079 002
CR2	RECTIFIER VS247	A 239 006 000
CR3	BRIDGE FULL WAVE	A 239 700 003
CR4	RECTIFIER SCBH4F	A 239 085 005
TRANSISTORS		
Q10,11,12,13	TRANSISTOR 92-0397	A 239 100 006
MISCELLANEOUS		
T1	TRANSFORMER	C 251 200 005
T2	TRANSFORMER	C 251 036 000
L1,2	INDUCTOR	B 251 039 000
F1	FUSE 3 AG 8 AMP	A 215 005 041
F2	FUSE 3 AG 1½ AMP	A 215 005 034
	SPACER, SHOULDER	A 213 074 000
	PAD, INSULATING	A 214 100 008
	PAD, MOUNTING	A 214 057 002

PCB ASSY SUPPLY

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1,61	RESISTOR 11 MEG, 1W, 5%	A 234 022 160
R2	RESISTOR 22M, 1W, 10%	A 234 004 084
R3	RESISTOR 1.8K, .5W, 10%	A 234 005 045
R4	RESISTOR 3.3K, .5W, 5%	A 234 014 025
R5	RESISTOR 3.9K, .5W, 5%	A 234 014 011
R6	RESISTOR 5.1K, ½W, 5%	A 234 014 013
R7	RESISTOR 120K .5W, 5%	A 234 005 065
R8	RESISTOR 30K, .5W, 5%	A 234 014 029
R10,12, 17	RESISTOR 47K, .5W, 10%	A 234 005 016
R11,18,19,20,23,25,32,35	RESISTOR 4.7K, .5W, 10%	A 234 005 013
R13	RESISTOR 33, .5W, 10%	A 234 005 032
R14,54,60	RESISTOR 100 .5W, 10%	A 234 005 010
R15,21,22,24,34,38	RESISTOR 33K, .5W, 10%	A 234 005 006
R16,37	RESISTOR 10K, -W, 10%	A 234 005 008
R26,28	RESISTOR 12K, .5W, 10%	A 234 005 007
R27,39	RESISTOR 3.6K, .5W, 5%	A 234 014 010
R29	RESISTOR 3.9, 1W, 10%	A 234 004 017
R30	RESISTOR 82ohm, .5W, 5%	A 234 014 033
R31,33,36,56	RESISTOR 2.7K, .5W, 10%	A 234 005 037
R40	RESISTOR 2.2Kto4.3K, .5W, 5%	A 234 014 XXX
R41	RESISTOR 1K, .5W, 10%	A 234 005 003
R42,45,46,47,48	RESISTOR .1OHM 3W	A 234 028 001
R43,44	RESISTOR 2.7, .5W, 10%	A 234 005 024
R49	RESISTOR 5.6K, .5W, 10%	A 234 005 028
R50	RESISTOR 30, .5W, 5%	A 234 014 023
R51	RESISTOR 470, .5W, 10%	A 234 005 005
R52	RESISTOR 10, .5W, 10%	A 234 005 056
R53	RESISTOR .15, 3W	A 234 028 002
R55, R9	RESISTOR 6.8K, .5W, 10%	A 234 005 001
R57	RESISTOR 820 .5W, 5%	A 234 014 098
R58	POTENTIOMETER 200K, .5W	A 236 010 002
R59	RESISTOR 150, .5W, 10%	A 234 005 033
CAPACITORS		
C1	CAPACITOR 180pf, 1KV, 10%	A 204 079 031
C2,9,22	CAPACITOR .01uf, 100V	A 204 121 041
C3	CAPACITOR 22uf, 10V	A 204 111 003
C4,10,19	CAPACITOR 3.3uf, 35V	A 204 104 045
C5,14,18	CAPACITOR .001uf, 1KV, 10%	A 204 079 054
C6	CAPACITOR MICA 4700pf, 5% 500V	A 204 105 042

PCB ASSY SUPPLY (CONTD) 201 073 000

CAPACITORS

C7	CAPACITOR 1uf, 100V	A 204 121 048
C8,12	CAPACITOR .033uf, 100V	A 204 121 045
C11	CAPACITOR MON. .33mf, 20% 50V	A 204 118 011
C13	CAPACITOR 750pf, 100V MICA	A 204 109 031
C15	CAPACITOR 6800pf, 100V	A 204 101 046
C16	CAPACITOR 1uf, 35V	A 204 104 042
C17	CAPACITOR 1.5uf, 50V	A 204 103 015
C20	CAPACITOR 8200pf, 1KV 10%	A 204 079 079
C21	CAPACITOR 68uf, 25V, TANT	A 204 102 023

INTEGRATED CIRCUITS

U1	I.C. LM311N	A 210 026 000
U2	QUAD 2 INPUT NOR GATE	A 210 011 000
U3	I.C. COMPARATOR BUFFER	A 210 025 001
U4	I.C. TIMER	A 210 006 001
U5	DUAL D TYPE FLIP FLOP	A 210 027 000
U6	TRIPLE 3 INPUT NAND GATE	A 210 002 000

DIODES

CR1	DIODE MR821	A 239 066 002
CR2,5	DIODE IN5242 12V ZENER	A 239 077 000
CR4	DIODE IN4746 18V ZENER	A 239 081 000
CR6,7	DIODE MR816	A 239 088 000

TRANSISTORS

Q1,9	TRANSISTOR 2N3568	A 239 017 000
Q2	TRANSISTOR 2N2905A	A 239 019 000
Q3	TRANSISTOR D44h11	A 239 045 008
Q4,5,7	TRANSISTOR 2N3904	A 239 015 000
Q6,8	TRANSISTOR 2N3906	A 239 047 000
Q14,16	TRANSISTOR MPS U95	A 239 078 000

MISCELLANEOUS

L1,2	R.F. CHOKE	A 251 100 014
SCR1	SCR. MCR 104	A 239 059 000
SCR2	SCR. 2N6394	A 239 083 001
T1	XFORMER DRIVER	C 251 038 000
	SOCKET I.C. 14 PIN	A 208 121 002
	INSULATOR	A 214 052 000
	SOCKET I.C. 8 PIN	A 208 121 001
F1	FUSE SUB MINI ½	A 215 100 004

PCB ASSY OUTPUT 201 075 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR .1Ω, ASSY	A 203 077 000
CAPACITORS		
C1	CAPACITOR .1uf, 600V	A 204 067 040
C2	CAPACITOR 560pf	A 204 105 020
C3	CAPACITOR 180pf, 500V	A 204 105 008
C4	CAPACITOR 3300 pf, 500V	A 204 105 038
DIODES		
CR1	RECTIFIER MR816	A 239 088 000
CR2	RECTIFIER A115M	A 239 029 000
CR3	RECTIFIER SELECTED MR826	A 239 850 010
CR4	DIODE FAST RECOVERY	A 239 850 005
MISCELLANEOUS		
F1	FUSE .5 AMP, PIGTAIL	A 215 017 012
F2	FUSE 3 AMP, 3AG	A 215 005 005

PCB ASSY STRIPLINE 201 074 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
CAPACITORS		
C1	CAPACITOR 1500pf, 500V	A 204 085 012
C2	CAPACITOR 9200pf, 500V, 10%	A 204 047 000
C3,4,5	CAPACITOR 22uf, 20V	A 204 091 000
TRANSISTORS		
Q1,2,3	TRANSISTOR D45H2	A 239 030 000
Q4	TRANSISTOR 2N3568	A 239 017 000
MISCELLANEOUS		
K1	RELAY AZ-420-1011-4HU	A 230 005 004
K2	RELAY - DIP REED	A 230 003 001

STRIPLINE MODULE

202 200 078

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NO.
RESISTORS		
R103	100Ω, 2W	A 236 006 000
CAPACITORS		
C101	CAPACITOR 50uf, 200V	A 204 124 002
MISCELLANEOUS		
RT1	Heat Sensor	A 240 002 003
	Assy. .05Ωresistor P.C. Board	B 201 076 000
LS1	Speaker	241 002 000
J17,18	Jack White Banana	A 208 145 001
L101	Inductor	B 202 294 000

FRONT PANEL ASSY

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NO.
RESISTORS		
R101,102	POTENTIOMETER 1KΩ	A 236 014 000
MISCELLANEOUS		
S102	Switch (return fault)	A 243 023 002
S101	Power Switch & C-ble Assy	B 202 274 000
	Panel Jack Assy	C 202 700 060
	Window	C 223 600 015
	Knob	A 213 072 001
	Skirt	A 213 070 001
	Cap Knob Lt. Gry.	A 213 071 000
	Lamp-Midget Flange (Return Fault)	A 215 030 002
	Lamp On-Off	A 215 021 023
	Lamp Filter Green	A 215 200 506
	Bezel	C 222 529 000

PCB ASSY DRIVER

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NO.
RESISTORS	RESISTOR 22ohm, ½W, 10%	A 234 004 046

PCB ASSY DRIVER (CONTD) 201 066 000

RESISTORS

R2,14	RESISTOR 1K, ½W, 10%	A 234 005 003
R3,10	RESISTOR 150ohm, 1W, 10%	A 234 004 029
R4	RESISTOR 51ohm, ½W, 5%	A 234 014 083
R5,12	RESISTOR 2.7ohm, ½W, 10%	A 234 005 024
R6	RESISTOR 22K, ½W, 5% 1	A 234 005 019
R7,18,23,24	RESISTOR 100ohm, ½W, 10%	A 234 005 010
R8	RESISTOR 330ohm, ½W, 5%	A 234 005 035
R9	RESISTOR 47ohm, ½W, 10%	A 234 005 047
R11	RESISTOR 47ohm, 2W, 5%	A 234 001 025
R13	RESISTOR 500ohm, 10W	A 234 400 040
R15	POTENTIONMETER 20K, ½W	A 236 010 008
R16	RESISTOR 470K, 1W, 5%	A 234 022 127
R17	RESISTOR 4.7K, ½W, 5%	A 234 014 009
R19,20	RESISTOR 10K, ½W, 10%	A 234 005 008
R21	RESISTOR 120ohm, ½W, 10%	A 234 005 042
R22	RESISTOR 56ohm, ½W, 10%	A 234 005 059
R25	RESISTOR 10ohm, ½W, 10%	A 234 005 056

CAPACITORS

C1	CAPACITOR 33uf, 25V	A 204 102 016
C2,3	CAPACITOR 22uf, 20V, TANT	A 204 091 000
C5	CAPACITOR 330pf, 100V	A 204 106 023
C6	CAPACITOR .01uf, 100V	A 204 049 001
C7,8,9,11	CAPACITOR .1uf, 16V	A 204 050 000
C10	CAPACITOR 2200pf, 50V	A 204 089 000

INTEGRATED CIRCUITS

U1	I.C. LM340T - 12	A 210 021 004
U2	I.C. LM311N	A 210 026 000
U3	I.C. TIMER	A 210 006 001

DIODES

CR1,2	DIODE IN4148	A 239 014 000
CR3	DIODE IN5234	A 239 068 000
CR4,5	DIODE A115M	A 239 029 000

TRANSISTORS

Q1	TRANSISTOR 2N3906	A 239 047 000
Q2,3	TRANSISTOR 2N2905	A 239 019 000
Q4	TRANSISTOR 2N3904	A 239 015 000
Q5,6	TRANSISTOR 2N3724	A 239 052 000
Q7	TRANSISTOR D44H2	A 239 045 002
Q8	TRANSISTOR 2N4240	A 239 074 000

MISCELLANEOUS

	FUSE .1A	A 215 017 005

PCB ASSY DISPLAY DRIVER 201 105 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1,2	RESISTOR CARBON 5.6ohm, ½W, 10%	A 234 005 044
R3,12	RESISTOR CARBON 10K, ½W, 5%	A 234 024 087
R4	RESISTOR CARBON 510K, ½W, 5%	A 234 024 128
R5,6,31	RESISTOR CARBON 220ohm, ¼W, 5%	A 234 024 047
R7,32,33,36,39	RESISTOR CARBON 100K, ¼W, 5%	A 234 024 111
R8,9,10,11,18	RESISTOR CARBON 1M, ¼W, 5%	A 234 024 135
R13	RESISTOR FILM 12.1K, 1/8W, 1%	A 234 200 393
R14	RESISTOR CARBON 1K, ¼W, 5%	A 234 024 063
R15	RESISTOR CARBON 330K, ¼W, 5%	A 234 024 123
R16,35	RESISTOR CARBON 5.6K, ¼W, 5%	A 234 024 081
R17	RESISTOR CARBON 3.6K, ¼W, 5%	A 234 024 076
R19	RESISTOR FILM 32.4 K, 1/8W, 1%	A 234 200 434
R20,21,22,23,24	POT TRIM	A 236 010 008
R25,26	RESISTOR VIT. ENAMEL 15ohm, 5W	A 234 010 002
R27,28	RESISTOR FILM 1.0K, 1/8W, 1%	A 234 200 289
R29,30	RESISTOR FILM 332ohm, 1/8W, 1%	A 234 200 243
R34,37	RESISTOR CARBON 200ohm, ¼W, 5%	A 234 024 046
R38	RESISTOR CARBON 2.7K, ¼W, 5%	A 234 024 073
CAPACITORS		
C1	CAP TANTALUM, 68ufd, 25V	A 204 102 023
C2,15	CAP TANTALUM, 22ufd, 20V	A 204 091 000
C3,4,11	CAP TANTALUM, 2.2ufd, 25V	A 204 102 026
C5	CAP DIPPED MICA, .0033ufd, 500V	A 204 105 038
C6	CAP CERAMIC, .1ufd, 16V	A 204 050 000
C7, 10	CAP CERAMIC, .001ufd, 1KV	A 204 079 054
C8,9,14,25,26	CAP MONO. 1ufd, 50V	A 204 121 082
C12,13	CAP, LOW LEAK., .33 ufd, 50V	A 204 133 031
C16,17,24	CAP TANTALUM, 10ufd, 25V	A 204 102 028
C18,19,22,23	CAP MONO. .33 ufd, 50V	A 204 121 079
C20,21	CAP CERAMIC, 270pf, 100V	A 204 065 000
INTEGRATED CIRCUITS		
U1	I.C. HEX BUFFER/INVERTERS	A 210 020 000
U2,3	I.C. QUAD 2 INPUT NOR GATE	A 210 011 000
U4,6	I.C. QUAD BILATERAL SWITCH	A 210 015 000
U5	I.C. OP AMP	A 210 022 000
U7	I.C. A/D CONVERTER	A 210 200 007

PCB ASSY DISPLAY DRIVER (CONTD) 201 105 000

INTEGRATED CIRCUITS		
U8	I.C. A/D CONVERTER	A 210 200 008
U9	I.C. MULTIPLIER	A 210 100 003
DIODES		
CR1,2,3	DIODE IN4148	A 239 014 000
CR4	I.C. ADJ. SHUNT REGULATOR	A 210 300 012
TRANSISTORS		
Q1,2	REGULATOR	A 210 021 002

PC ASSY SENSE 201 067 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 330ohm, ½W, 10%	A 234 005 035
R2,32	RESISTOR 300 ohm, ½W, 5%	A 234 014 094
R3,15,16,28	RESISTOR 10K, ½W, 10%	A 234 005 008
R4,35,36	RESISTOR 1K, ½W, 10%	A 234 005 003
R5	RESISTOR 47K, 2W, 10%	A 234 002 046
R6,12,17, 19,23,24	RESISTOR 2.2K, ½W, 10%	A 234 005 009
R7	RESISTOR 33ohm, ½W, 10%	A 234 005 032
R8	RESISTOR 680ohm, ½W, 10%	A 234 005 030
R9	RESISTOR 33ohm, ½W, 5% NOMINAL	A 234 005 032
R10,13	RESISTOR 33K, 2W, 5%	A 234 001 085
R11	POTENTIOMETER 2K, ½W	A 236 010 005
R14	RESISTOR 560ohm, ½W, 10%	A 234 005 053
R18	POTENTIOMETER 200ohm, ½W	A 236 010 002
R20	RESISTOR 3.3K, ½W, 10%	A 234 005 039
R21	RESISTOR 1.5K, ½W, 10%	A 234 005 025
R22,25	RESISTOR 100ohm, ½W, 10%	A 234 005 010
R26	RESISTOR 27K, ½W, 10%	A 234 005 063
R27	RESISTOR 3.3K, ½W, 5%	A 234 014 025
R30	RESISTOR 33K, ½W	A 234 005 006
R31	RESISTOR 120K, ½W	A 234 005 065
R33	POTENTIONMETER 20K	A 236 010 008
CAPACITORS		
C1,10	CAPACITOR .1uf, 100V 5%	A 204 121 104
C2,9,11,13	CAPACITOR .01uf, 100V, 10%	A 204 121 041
C3,4,8	CAPACITOR 4.7uf, 35V 20%	A 204 104 046
C6,14	CAPACITOR 47pf, 1KV	A 204 079 019
C7	CAPACITOR 68pf, 1KC	A 204 079 023
C12,17,18,19	CAPACITOR 1uf, 50V	A 204 121 082

PC ASSY SENSE (CONTD) 201 067 000

CAPACITORS

C5	CAPACITOR 2700pf, 100V NOMINAL	A 204 101 036
C15	CAPACITOR 220pf, 1KV 10%	A 204 079 033
C20	CAPACITOR 430pf, 500V	A 204 092 000

DIODES

CR3,4	DIODE IN4148	A 239 014 000

TRANSISTORS

Q1,6	TRANSISTOR MPSU10	A 239 072 000
Q2,5,8,9	TRANSISTOR SPS9962	A 239 100 009
Q3,4,7	TRANSISTOR 2N3904	A 239 015 000

INTEGRATED CIRCUITS

U1	IC LM340T-12	A 210 021 004
U2,3	IC LM306H/LM206H	A 210 016 000
U4	IC MC1458CP	A 210 023 000

PCB ASSY CONTROL

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 1K, ½W, 10%	A 234 005 003
R,26	RESISTOR 51K, ½W, 5%	A 234 014 027
R3	RESISTOR 470K, ½W, 10%	A 234 005 071
R4,5	RESISTOR 1.2MEG, ½W, 10%	A 234 005 075
R7	RESISTOR 390ohm, ½W, 10%	A 234 005 062
R8	POTENTIOMETER 20K, ½W	A 236 010 008
R9,14	RESISTOR 4.7K, ½W, 10%	A 234 005 013
R10,13	RESISTOR 10K, ½W, 10%	A 234 005 008
R11,12	RESISTOR 1.3K, ½W, 5%	A 234 014 100
R15,19,24	RESISTOR 100ohm, pW, 10%	A 234 005 010
R16	RESISTOR 1.8K, ½W, 10%	A 234 005 045
R17	RESISTOR 510ohm, ½W, 5%	A 234 014 096
R18,22,23	RESISTOR 2.2K, ½W, 10%	A 234 014 009
R20,21	RESISTOR 12K, ½W, 10%	A 234 005 007
R25	RESISTOR 22ohm, ½W, 10%	A 234 005 046
CAPACITORS		
C1,4,5,6	CAPACITOR .01uf, 100V 20%	A 204 121 041
C1A,2,3,9	CAPACITOR .1uf, 100V, 20%	A 204 121 048
C5A	CAPACITOR 33pf, 600V, 10%	A 204 079 017
C7	CAPACITOR 1500pf, 600V, 10%	A 204 079 059
C8	CAPACITOR 750pf, 1KV, 10%	A 204 079 050
C10,11	CAPACITOR 2.2uf, 25V, 10% TANT	A 204 102 004
C12,13,14,16,17	CAPACITOR MON., 1.0MF, 50V 20%	A 204 121 082
C15	CAPACITOR 1uf, 35V, 20% TANT	A 204 104 042

PCB ASSY CONTROL (CONTD) — 201 068 000

INTEGRATED CIRCUITS

U1	I.C. LM340T -12	A 210 021 004
U2	I.C. MC1458CP	A 210 023 000
U3	I.C. LM311N	A 210 026 000
U4	I.C. LM306H/LM206H	A 210 016 000
U5,12	TRIPLE 3 INPUT NAND GATE	A 210 002 000
U6,11	QUAD 2 INPUT NOR GATE	A 210 011 000
U7	HEX BUFFER/CONVERTER	A 210 020 000
U8	QUAD BILATERAL SWITCH	A 210 015 000
U9	TRIPLE 3 INPUT NOR GATE	A 210 017 000
U10	QUAD 2 INPUT NAND GATE	A 210 003 000

DIODES

CR1,2,3	DIODE IN4148	A 239 014 000
CR4	LED DIALCO, 555-2001	A 239 076 001
CR5	DIODE-ZENER, IN5228A, 3.9V	A 239 075 000

TRANSISTORS

Q1,2,5	TRANSISTOR 2N3904	A 239 015 000
Q3,4	TRANSISTOR 2N3906	A 239 047 000

MISCELLANEOUS

	SOCKET 8 PIN, I.C.	A 208 121 001
	SOCKET 14 PIN, I.C.	A 208 121 002
	SOCKET 16 PIN, I.C.	A 208 121 003

PCB ASSY CLOCK — 201 069 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 8.2K, ½W, 10%	A 234 005 021
R2	RESISTOR 1.0K, ½W, 10%	A 234 005 003
R3,7	RESISTOR 2.2K, ½W, 10%	A 234 005 009
R4	RESISTOR 180ohm, ½W, 10%	A 234 005 034
R5	RESISTOR 470ohm, ½W, 10%	A 234 005 005
R6	RESISTOR 100ohm, ½W, 10%	A 234 005 010
R8	RESISTOR 22ohm, ½W, 10%	A 234 005 046
R9, 10	RESISTOR 4.7K, ½W, 10%	A 234 005 013
R9A	RESISTOR 10K, ½W, 10%	A 234 005 008
CAPACITORS		
C2	CAPACITOR .1uf, 100V, 20%	A 204 121 048
C3	CAPACITOR 2200pf, 500V, 5%	A 204 047 000
C4	CAPACITOR .01uf, 100V, 10%	A 204 121 041
C5,6,	CAPACITOR 1uf, 50V, 10% TANT	A 204 103 013
C7	CAPACITOR 1MF, 100V, 20%	A 204 121 082

PCB ASSY CLOCK (CONTD)		201 069 000
INTEGRATED CIRCUITS		
U1	I.C. LM306H/LM206H	A 210 016 000
U2	I.C. LM340T-12	A 210 021 004
U3	DUAL BINARY UP COUNTER	A 210 024 000
U4	HEX BUFFER/CONVERTER	A 210 019 000
U5	HEX INVERTER	A 210 008 001
U6	DUAL 4 INPUT NOR GATE	A 210 018 000
U7	QUAD 2 INPUT NOR GATE	A 210 011 000
U8	TRIPLE 3 INPUT NAND GATE	A 210 002 000
U9,10,11	QUAD 2 INPUT NAND GATE	A 210 003 000
TRANSISTORS		
Q1	TRANSISTOR 2N3904	A 239 015 000
MISCELLANEOUS		
L1	INDUCTOR - DEC. 9406 - 30	A 251 033 016

PCB ASSY LEVEL — 201 070 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 270K, ½W, 10%	A 234 005 069
R2	RESISTOR 120K, ½W, 10%	A 234 005 065
R4,51,52	RESISTOR 1K, ½W, 10%	A 234 005 003
R5,6,10,11,12,29,31,47,49,3,55,56	RESISTOR 10K, ½W, 10%	A 234 005 008
R7,9,26	RESISTOR 470ohm, ½W, 10%	A 234 005 005
R8	RESISTOR 22K, ½W, 10%	A 234 005 019
R13	RESISTOR 1MEG ½W, 10%	A 234 005 048
R14	RESISTOR 1.8K, ½W, 10%	A 234 005 045
R15	RESISTOR 470K, ½W, 10%	A 234 005 071
R16	RESISTOR 82K, ½W, 10%	A 234 005 027
R17	RESISTOR 220K, ½W, 10%	A 234 005 068
R18,27	RESISTOR 3K, ½W, 5%	A 234 014 104
R19	RESISTOR 18K, ½W, 10%	A 234 005 038
R20,21,34	RESISTOR 2.2K, ½W, 10%	A 234 005 009
R22	RESISTOR 330ohm, ½W, 10%	A 234 005 035
R23,24	RESISTOR 4.7K, ½W, 10%	A 234 005 013
R25	RESISTOR 10ohm, ½W, 10%	A 234 005 056
R27	RESISTOR 390ohm, ½W, 10%	A 234 005 062
R28,30,40,42,46	POTENTIOMETER 20K, ½W	A 236 010 008
R32	RESISTOR 20K, ½W, 5%	A 234 014 045
R33 SELECT	RESISTOR 1K, to 3.3K, ½W	A 234 005 XXX
R35	RESISTOR 33K, ½W, 10%	A 234 005 00[illegible]
R36	RESISTOR 6.2K, ½W, 5%	A 234 014 00[illegible]
R38	RESISTOR 33K, ¼W, 5%	A 234 024 099
R39,57	POTENTIOMETER 2K, ½%	A 236 010 005
R41	RESISTOR 5.1K, ¼W, 5%	A 234 024 080

PCB ASSY LEVEL (CONTD) 201 070 000

RESISTORS

R43,53	RESISTOR 33ohm, ½W, 10%	A 234 005 032
R45,50	RESISTOR 10M, ½W, 10%	A 234 005 086
R48,44	RESISTOR 100K, ½W, 10%	A 234 005 050
R54	RESISTOR 27ohm, ½W, 10%	A 234 005 008

CAPACITORS

C1	CAPACITOR .33uf, 50V	A 204 118 011
C2,3	CAPACITOR 3.3uf, 50V	A 204 104 045
C4,9,10,11,12,13,14,15,16,18,19,20	CAPACITOR .01uf, 100V, 20%	A 204 121 041
C5,6,8	CAP CITOR .1uf, 100V, 20%	A 204 121 048
C17,7	CAPACITOR 4.7uf, 35V, 20% TANT	A 204 104 046

INTEGRATED CIRCUITS

U1	TRIPLE 3 INPUT NAND GATE	A 210 002 000
U2,8	I.C. LM324N	A 210 022 000
U3,7	QUAD BILATERAL SWITCH	A 210 015 000
U4	HEX BUFFERS/CONVERTERS	A 210 020 000
U5	I.C. MC3302P	A 210 025 002
U6	QUAD TWO INPUT NOR GATE	A 210 011 000
U9	I.C. LM340T-12	A 210 021 004

DIODES

CR1	LED 555-2001	A 239 076 001
CR2,3,4,5	DIODE IN4148	A 239 014 000
SCR1	DIODE MCR104	A 239 059 000

TRANSISTORS

Q1,2	TRANSISTOR 2N2905A	A 239 019 000
Q3	TRANSISTOR MPSU01	A 239 065 000
Q4,5	TRANSISTOR 2N3568	A 239 017 000

MISCELLANEOUS

	SOCKETS I.C. 14 PIN	A 208 121 002
	SOCKET I.C. 16 PIN	A 208 121 003
	SCHEMATIC LEVEL -PCB	D 238 070 000

PCB ASSY DISPLAY 201 104 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1 to R14	RESISTOR CARBON 33ohm ¼W, 5%	A 234 024 027

PCB ASSY DISPLAY (CONTD) 201 104 000

INTEGRATED CIRCUITS		
U1	I.C. HEX DIGIT DRIVER	A 210 100 002
MISCELLANEOUS		
DS1,5	LED DISPLAY MAN 6680	A 239 750 008
DS2,6	LED DISPLAY MAN 6640	A 239 750 007
DS3,4	LONG FILAMENT LAMP	A 215 200 000
J29	CONNECTOR 3 PIN	A 208 188 003
J27,28	CONNECTOR 12 PIN	A 208 188 012
	LIGHT SHIELD	A 214 100 010

PCB ASSY SWITCH 201 072 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	RESISTOR 82ohm, ½W, 10%	A 234 005 061
R2	RESISTOR 1K, ½W, 10%	A 234 005 003
R3	RESISTOR 3.3k, ½W, 10%	A 234 005 039
R4,5	RESISTOR 5.6K, ½W, 10%	A 234 005 028
R6,7,8	RESISTOR 10K, ½W, 10%	A 234 005 008
CAPACITORS		
C1	CAPACITOR 1uf, 50V, 10% TANT	A 204 103 013
C2	CAPACITOR CER. 01mf, 100V 20%	A 204 049 001
TRANSISTORS		
Q1,2,3	TRANSISTOR 2N3904	A 239 015 000
MISCELLANEOUS		
S1	SWITCH MULTI	A 243 018 000
DS1,2,3,4	LAMP MIDGET, FLANGE	A 215 025 027

PCB ASSY ISOBLOC 201 107 000

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1,2,3,4,6	RESISTOR 100ohm, ½W, 10%	A 234 005 010
R7	RESISTOR 1.5kohm, ½W, 10%	A 234 005 025
R8	RESISTOR 2.2Kohm, ½W, 10%	A 234 005 009

PCB ASSY ISOBLOC (CONTD) 201 107 000

RESISTORS

R9	RESISTOR 510ohm, ½W, 5%	A 234 014 096
R10	RESISTOR 100ohm, 5W, 5%	A 234 027 055
R11	RESISTOR 10ohm, ½W, 10%	A 234 005 056
R12,13	RESISTOR 1Kohm, ½W, 10%	A 234 005 003
R14	RESISTOR 10Kohm, ½W, 10%	A 234 005 008
R16,17	RESISTOR 6.2Kohm, ¼W, 5%	A 234 024 082
R15	RESISTOR 4.7K-15K, ½W, 10%	A 234 005 XXX

CAPACITORS

C1,2,3,4,22,23	CAPACITOR 1uf, 100V	A 204 121 082
C5,7,8	CAPACITOR .0047uf, 6KV	A 204 025 050
C6,9	CAPACITOR .01, 3KV	A 204 004 000
C10	CAPACITOR .0022uf, 6KV	A 204 025 044
C11	CAPACITOR 100pf, 6KV	A 204 025 023
C12,13,20	CAPACITOR 10uf, 20V	A 204 055 002
C14	CAPACITOR 33uf, 50V FILM	A 204 133 031
C15	CAPACITOR .015uf, 50V	A 204 118 002
C16	CAPACITOR 220pf, 500V	A 204 097 000
C17	CAPACITOR 2.4-24.5pf, Var, Air	A 204 132 007
C18	CAPACITOR .05uf, 16V	A 204 123 004
C19	CAPACITOR .1uf, 100V, 20%	A 204 121 048
C21	CAPACITOR .01uf, 100V	A 204 121 041
C24	CAPACITOR 180pf, 1KV	A 204 079 031
C25	CAPACITOR 5pf, 500V	A 204 079 002
C26,27,28,29	CAPACITOR .1uf, 100V	A 204 121 104

INTEGRATED CIRCUITS

U1	DIODE ARRAY MC1107P	A 239 094 001

DIODES

CR1,2,7,8	DIODE 1N4148	A 239 014 000

TRANSISTORS

PI1,2,3,4	PHOTO ISOLATOR OPI-120	A 239 069 000
Q1	TRANSISTOR 2N3568	A 239 017 000
Q2	TRANSISTOR MPSU95 (Motorola)	A 239 078 000
Q3,4	TRANSISTOR 2N3904	A 239 015 000

MISCELLANEOUS

T2	TOROID ASSY	A 202 224 000
T3,4	TRANSFORMER ASSY TOROID	C 202 302 000
T1	TRANSFORMER ASSY	C 202 287 000

Section 10
Warranty

Valleylab, Inc. ("Manufacturer") warrants each product manufactured by it to be free from defects in material and workmanship under normal use and service. Manufacturer's obligation under this warranty is limited to the repair or replacement, at its option, of any product, or part thereof, which has been returned to it or its Distributor within the applicable time period shown below after delivery of the product to the original purchaser, and which examination discloses, to Manufacturer's satisfaction, that the product is defective. This warranty does not apply to any product, or part thereof, which has been repaired or altered outside of Manufacturer's factory in a way so as, in Manufacturer's judgment, to affect its stability or reliability, or which has been subjected to misuse, negligence or accident.

The warranty periods for Manufacturer's products are as follows:

ELECTROSURGICAL GENERATORS AND PERMANENT ACCESSORIES

Surgistat B	One year
SSE2K	One year
SSE2L	One year
SSE3	One year
SSE3B	One year
Mounting fixtures, all models	One year
Footswitches, all models	One year

INFUSION PUMPS

IV 5000	One year

DISPOSABLE PRODUCTS

Lectrohesive TM	Shelf life only, as stated on packaging
Sterile Disposables	Sterility only, as stated on packaging

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS, AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF THE MANUFACTURER. Manufacturer neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale or use of any of Manufacturer's products. There are no warranties which extend beyond the terms hereof.

This warranty, and the rights and obligations hereunder, shall be construed under and governed by the laws of the State of Colorado, U.S.A.

Valleylab, its dealers and representatives reserve the right to make changes in equipment built and/or sold by them at any time without incurring any obligation to make the same or similar changes on equipment previously built and/or sold by them.