Force 1B

Electrosurgical
Generator

Service
Manual

Valleylab

FORCE 1B

SERVICE MANUAL

Notice: This manual and the equipment it describes are for use only by qualified medical professionals trained in the particular technique and surgical procedure to be performed.

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SECTION 1

INTRODUCTION

This Service Manual covers the installation and basic service instructions for the Valleylab Model Force 1B Electrosurgical Generator. Also included are sections covering the Technical Specifications, Circuit Descriptions and the Testing of the generator. Detailed instructions in the use of electrosurgery is beyond the scope of this manual and the reader is directed to the FORCE Instruction Manual provided by Valleylab.

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SECTION 2

INSTALLATION

INSTALLING THE FORCE 1B

The compact size of the Force 1B system allows a variety of installations. The unit may be placed on the mounting cart available from Valleylab, or 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 the bottom and sides remain unobstructed for proper cooling. For this reason the Force 1B 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 FORCE 1B

85 - 135 VAC, 50 - 60 Hz

The Force 1B is designed to operate over an unusually wide range of input voltages within specified output regulation. This means that in case of brownouts or power surges the output of the Force 1B will remain constant.

PROPER GROUNDING

An important consideration in assuring patient safety while using electrical equipment is 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 Force 1B.

POWER PLUGS

The Force 1B is shipped with an approved hospital grade three-prong connector. This connector meets all requirements for safe grounding. Its purpose should not be defeated by using extension cords or 3-prong to 2-prong adapters. The connector should be periodically disassembled and inspected by qualified service personnel. Cords should always be grasped by the plug. DO NOT PULL ON THE CORD ITSELF.

ROUTINE MAINTENANCE AND INSPECTIONS

We recommend that the Force 1B be inspected by qualified service personnel twice a year. This Service Manual describes the recommended inspection, testing and calibration procedures. For major repairs the Force 1B can be returned to Valleylab or your Valleylab representative. If desired, Valleylab will supply any parts or information needed to repair the Force 1B.

CLEANING INSTRUCTIONS

Use a mild detergent and damp cloth to clean the generator cover, keyboard, and cord. The generator is not sterilizable. Do not allow fluids to enter the generator.

SECTION 3

DESCRIPTION OF CONTROLS, INDICATORS, ALERTS AND RECEPTACLES

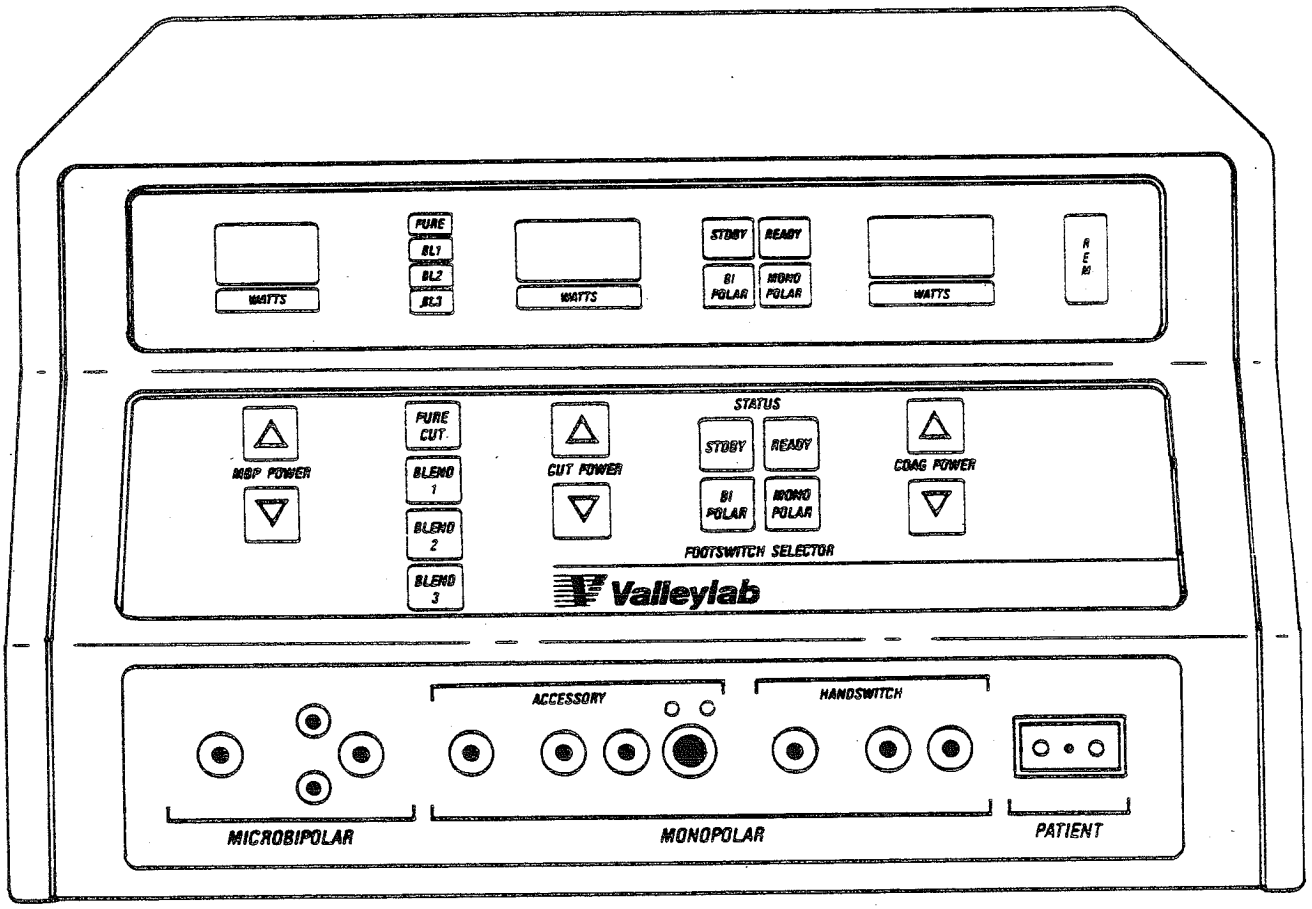


FIGURE 1

FRONT PANEL

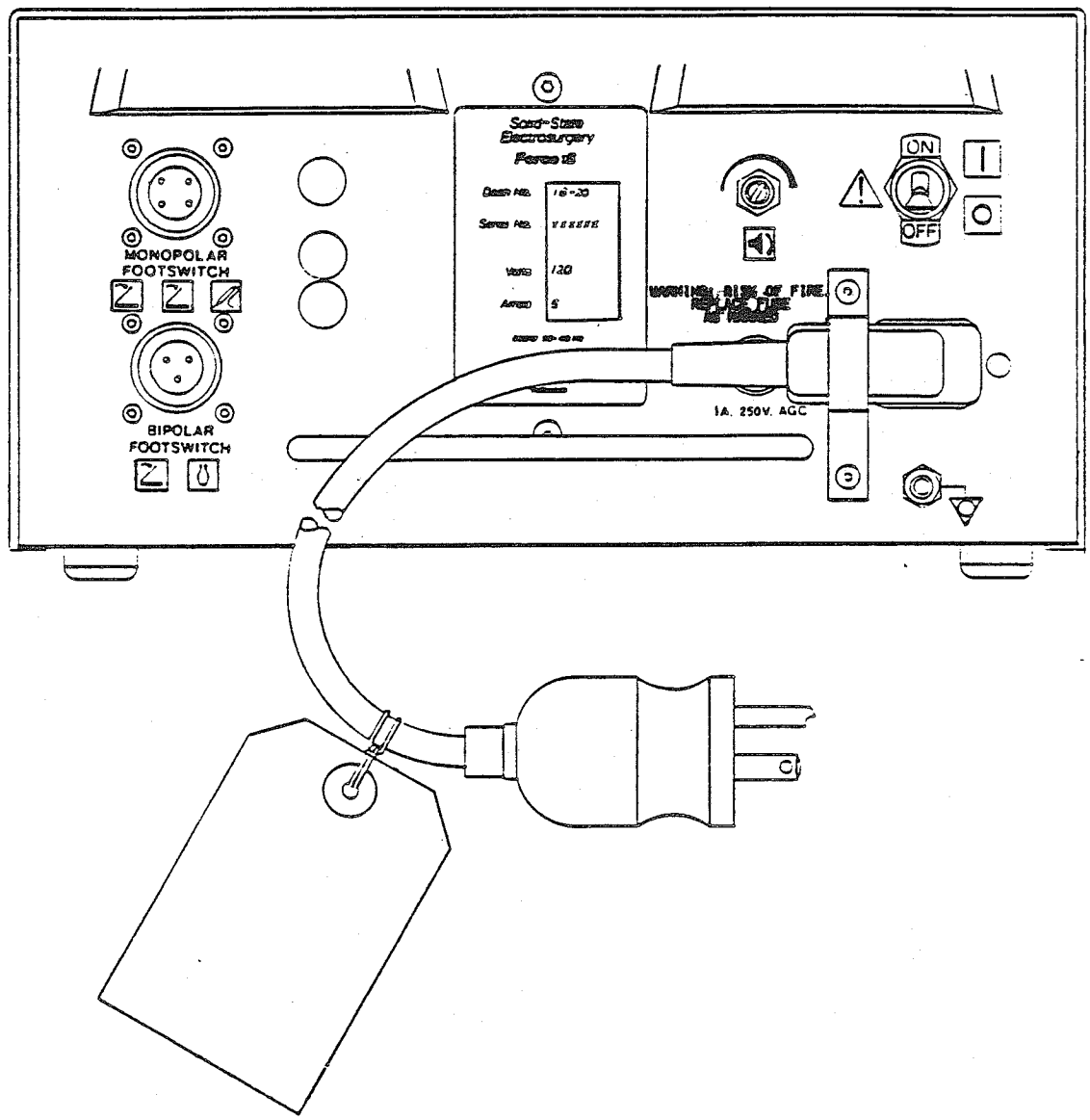


FIGURE 2

REAR PANEL

CONTROLS

STATUS

Standby - Depressing this button places the generator in a hold mode. The generator cannot be activated and all audio alarms are silenced. Power settings are retained in memory and the display shows "dashes".

Ready - Depressing this button places the generator into service with power outputs, displays and alarms fully functional.

FOOTSWITCH SELECTOR

Monopolar - Selects monopolar footswitch control for activating accessory output

Bipolar - Selects bipolar output when using the monopolar footswitch.

Up - Increases power in the selected mode. A single depression of the key increases the power setting by one watt. Continuous depression gradually increases the power to maximum.

Down - Decreases power in the appropriate mode. A single depression lowers the power setting by one watt. Continuous depression gradually decreases the power to minimum.

Cut - Selects pure cut with lowest level of hemostasis.

Blend 1 - Selects cut with minimum hemostasis.

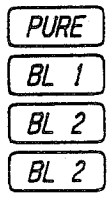
Blend 2 - Selects cut with average hemostasis.

Blend 3 - Selects cut with maximum hemostasis.

INDICATORS

Standby Indicator - Indicates generator is on, but cannot activate outputs.

Ready Indicator - Indicates generator is ready for use.



Mode Indicator Lamps - One of four CUT mode indicators is illuminated to show the selected Cut mode.

Power Setting Display - The digital power setting display is visible on the generator in the Ready mode. The number displayed indicates the nominal power, in watts, which will be delivered to the patient when the mode is activated. In Standby mode "dashes" are displayed.

Output Power Indicators - The indicator labeled "Watts" illuminates when that output (Cut, Coag, Bipolar) has been activated by the surgeon. An audio keying tone will sound in conjunction with the visual output power indicator.

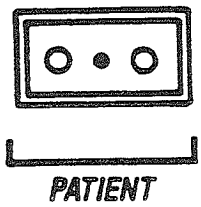
Bipolar Indicator - This indicator is illuminated when the generator's Monopolar footswitch control is selected to activate the Bipolar output.

Monopolar Indicator - This indicator is illuminated when the generator's monopolar footswitch is selected for Monopolar Accessory activation.

ALERTS

REM Fault Indicator - This indicator illuminates when the patient return electrode monitor senses that contact between the patient electrode and the patient is not adequate. The audio tone will sound twice when the condition is first detected. The generator will not produce output power when this alert condition exists. The alarm condition is cleared when the REM system senses that the patient/pad contact resistance is within the acceptance range.

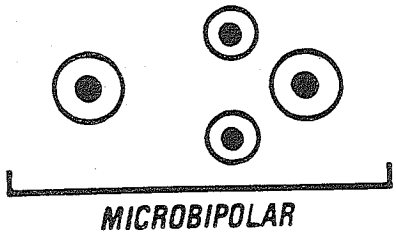
RECEPTACLES



Patient Return Electrode Receptacle - This 2-pin receptacle accepts the return electrode connector used in monopolar procedures. The receptacle will accept both REM and standard patient electrode connectors.

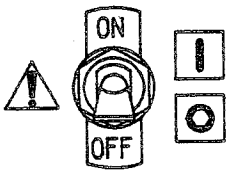
Monopolar Active Receptacle (Accessory) - This receptacle will accept 3-pin handswitching active accessories or standard 1-pin accessories which can be activated by the monopolar footswitch. Cut and Coag modes may be activated at this receptacle. The handswitching pencil can be footswitch activated when connected to this output jack.

Monopolar Active Receptacle (Handswitch) - This receptacle will accept the 3-pin handswitching active accessories. Power output from this receptacle is activated only by using the handswitch mechanism. No power is available through use of the footswitch. Cut and Coag modes may be activated at this receptacle.

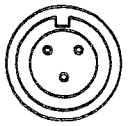


Bipolar Active Receptacle - This receptacle will accept 3-pin handswitching bipolar accessories. These accessories can also be footswitch activated. This receptacle will also accept 2-pin bipolar footswitching accessories.

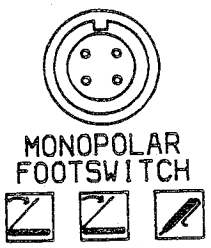
REAR PANEL FUNCTIONS



Power Switch - This switch includes a circuit breaker. Press the toggle upward to turn power on and down to shut power off.

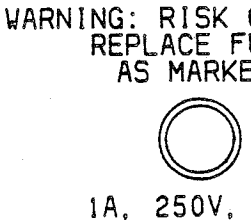


Bipolar Footswitch Receptacle - This 3-pin receptacle accepts a single-treadle Bipolar footswitch connector.

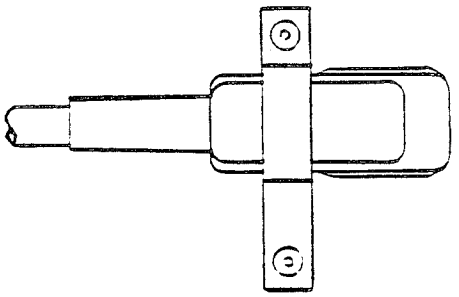


Monopolar Footswitch Receptacle - This 4-pin receptacle accepts a two-treadle Monopolar footswitch connector.

Audio Volume Control - The volume of the Cut, Coag, and Bipolar audio keying tones may be adjusted with this control. The volume of the audio alarm for alert conditions is not adjustable.



Fuse (Low Voltage Power Supply) - The low voltage power supply transformer is connected to the AC mains via this fuse. Replace only with 1 Amp, 250V AGC-type fuse, as indicated.



Power Cord - The line cord is terminated in a 3-pin plug and should be connected to a properly grounded receptacle.

SECTION 4

FORCE 1B TECHNICAL SPECIFICATIONS *

OUTPUT WAVEFORM

CUT 500 kHz sinusoid

BLEND 1 500 kHz bursts of sinusoid at 50% duty cycle recurring at 31 kHz.

BLEND 2 500 kHz bursts of sinusoid at 37.5% duty cycle recurring at 31 kHz.

BLEND 3 500 kHz bursts of sinusoid at 25% duty cycle recurring at 31 kHz.

COAG 500 kHz damped sinusoidal bursts with a repetition frequency of 31 kHz.

MICROBIPOLAR 500 kHz sinusoid, unmodulated

OUTPUT CHARACTERISTICS

Mode	Maximum (open circuit) P-P Voltage	Rated Load (Ohms)	Maximum Power at Rated Load (Watts)	Crest Factor at Rated Load (Typical*)
CUT	2400	300	200	1.8 @ 100W
BLEND 1	2800	300	175	2.6 @ 100W
BLEND 2	3200	300	150	3.2 @ 100W
BLEND 3	3600	300	125	4.4 @ 100W
COAG	5000	300	75	8.0 @ 50W
MICROBIPOLAR	800	100	50	1.8 @ 40W

Power readouts agree with actual power into rated load to within ± 15% or 5 watts, whichever is greater.

LOW FREQUENCY LEAKAGE (50/60 Hertz)

Source current, patient leads, all outputs tied together.

Normal polarity, intact chassis ground: less than 10uA
Normal polarity, ground open: less than 50uA
Reverse polarity, ground open: less than 50uA
Sink current, at high line, all inputs: less than 20uA

* In this Section, "Typical" refers to a specification that is within 20% of a stated value.

HIGH FREQUENCY RISK PARAMETERS

Bipolar RF leakage current: less than 50mA.

Monopolar RF leakage current: less than 150mA.

RETURN ELECTRODE MONITOR (REM)

Measurement Frequency: 140 kHz ± 10 kHz
Measurement Current: 1.5 mA ± 0.5 mA
Acceptable resistance ranges:
Effective RF pad resistance: 5 - 30 ohms.
Dual-area mode: 5 - 135 ohms
Single-area mode: less than 20 ohms

Mode selected automatically by return electrode connector. Outside the acceptance range a REM fault condition will occur.

COOLING

Natural convection cooled. No fan.

CONTROL PANEL

The control panel is a flat sealed unit with no openings thus preventing fluids from entering the system.

AUDIO VOLUME

The audio keying tones are adjustable to a maximum level of 65 dba at 1 meter. The alarm tones are not adjustable and are set at a maximum level.

INPUT POWER SOURCE

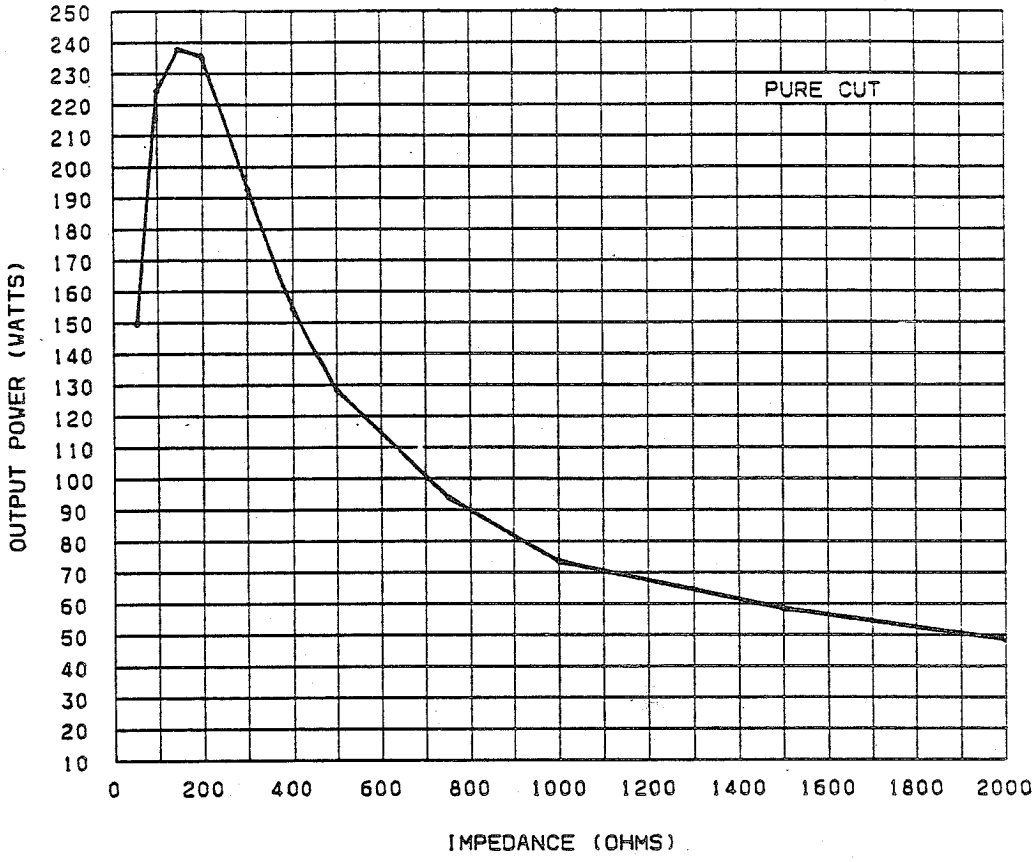
Nominal input line voltage is 120 VAC with a full regulation range of 85 - 135 VAC. The frequency of the line may vary from 45 - 65 Hz.

Current (Max):	Idle:	0.5 amperes
	Cut:	5.0 amperes
	Coag:	3.0 amperes
	Bipolar:	2.0 amperes

WEIGHT: 15 lb (6.4 kg)

SIZE: 6 x 11 x 17 inches (15 x 28 x 43 cm)

Specifications subject to change without notice.



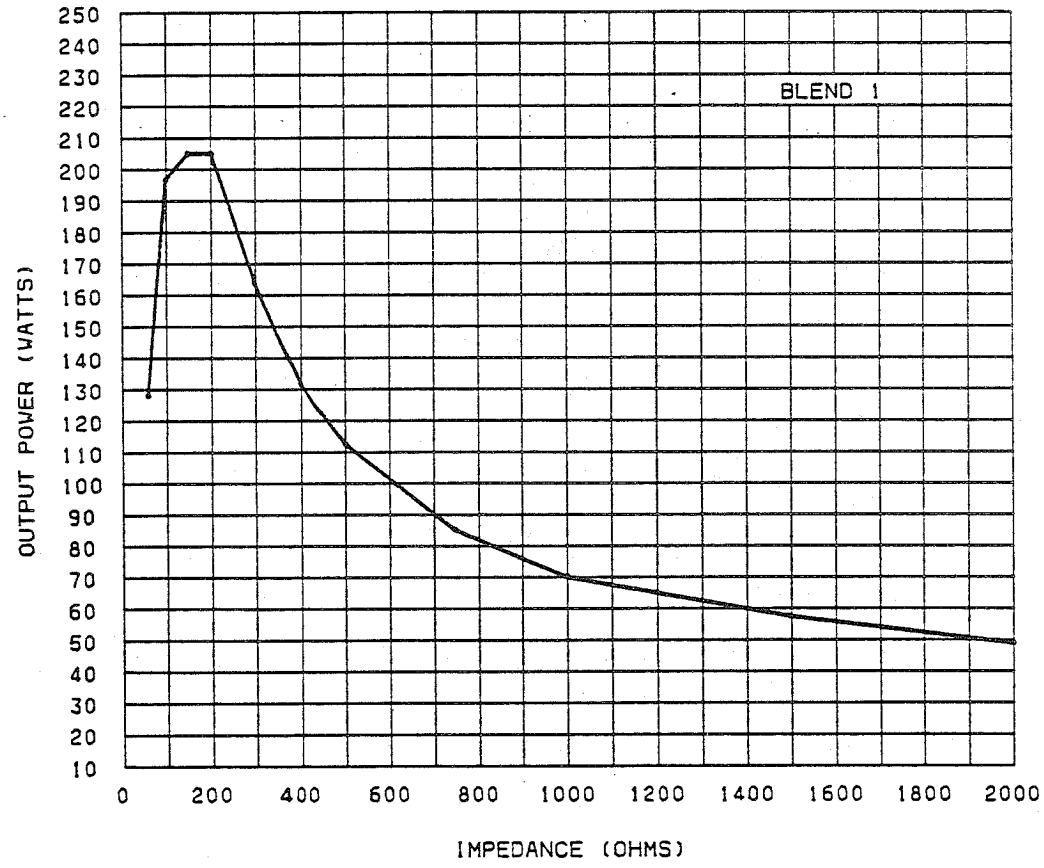
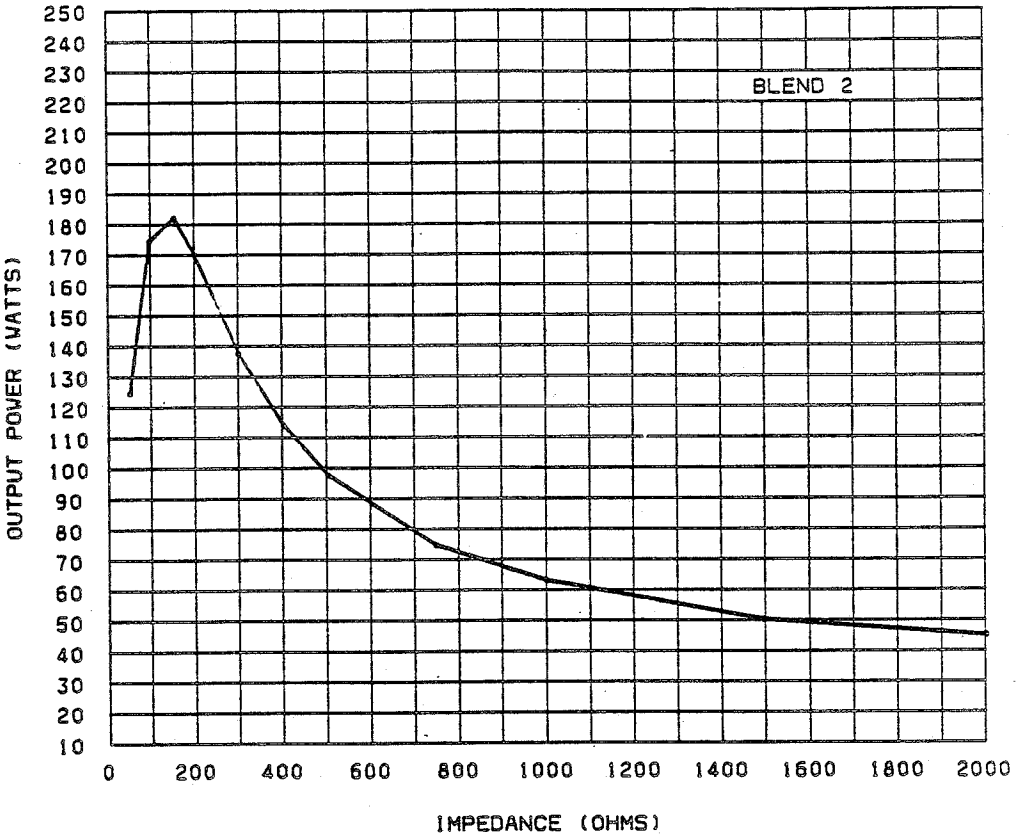


FIGURE 3

TYPICAL OUTPUT POWER VS LOAD - MONOPOLAR CUT MODES



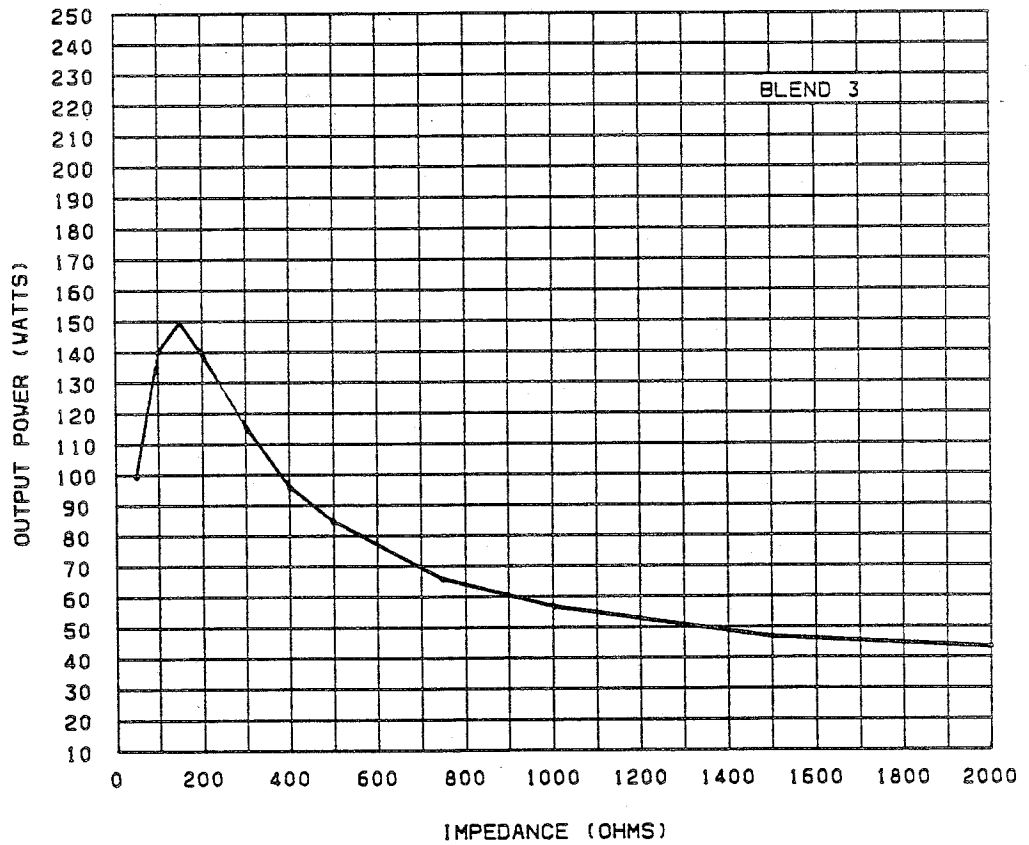
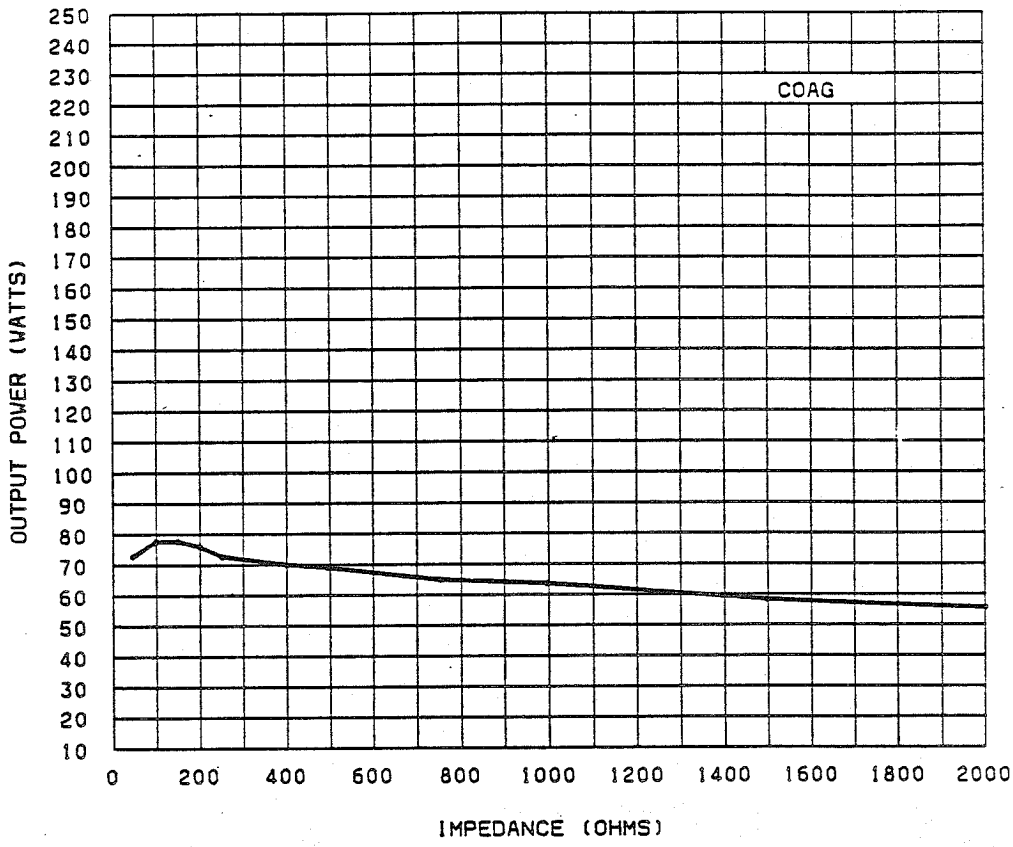


FIGURE 3 (CONT'D)



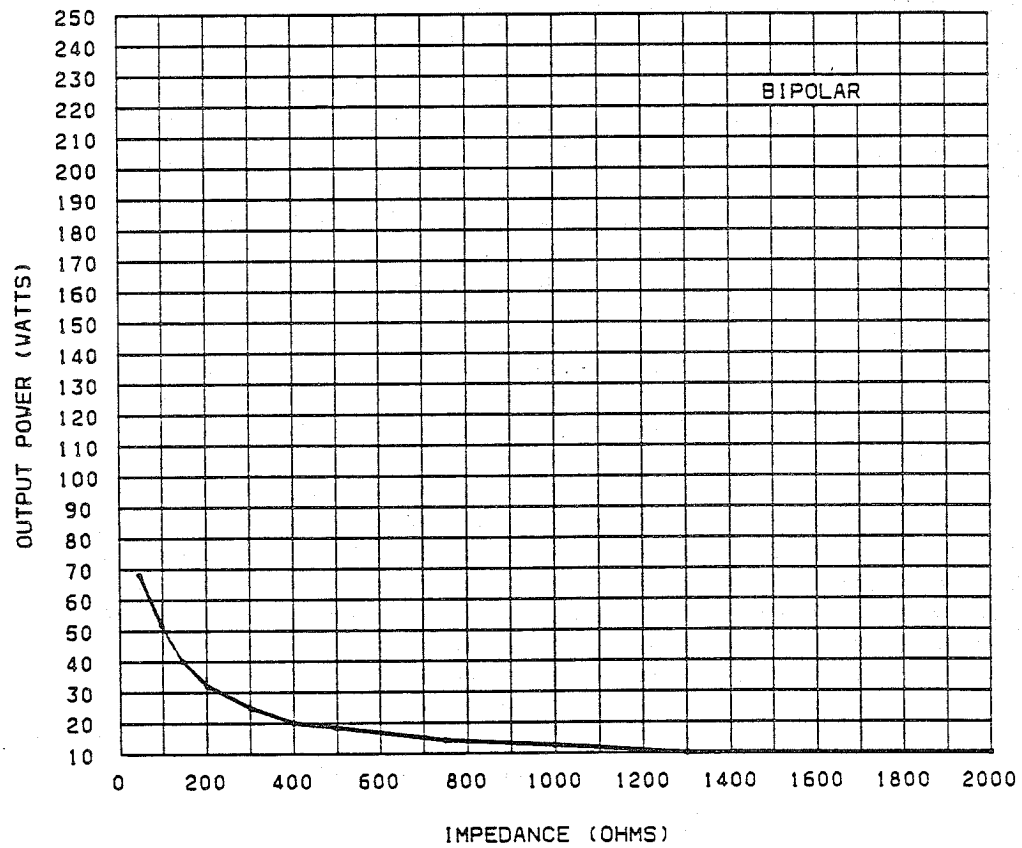


FIGURE 4

TYPICAL OUTPUT POWER VS LOAD - COAG AND BIPOLAR

SECTION 5

CIRCUIT DESCRIPTIONS

DISPLAY/CONTROL

The Display/Control Board, hereafter referred to as the CPU Board, has two main functions in the Force 1B generator. The first is to act as an interface between the user inputs and the generator. The second is as the main control element of the generator.

In acting as the interface between user and generator the CPU Board receives all operator keyboard inputs and performs the proper functional response (i.e. increment power registers and displays, change cut mode, etc.). It further accepts all keying signals after they have been decoded by the keying circuitry on the RF PCB and performs the proper algorithm to initiate the desired RF output.

The main control element of the CPU Board is the 8749 microprocessor with 2K of onboard EPROM. It is this chip with its host of dedicated peripherals that performs the functional responses required of the CPU Board. The actual software program is stored in the EPROM internal to 8749. For purposes of this hardware description of the board the software program will only be outlined.

The major display requirements of the CPU Board are performed using an Intersil display multiplexer, an ICM7218C (U12). The device is a universal eight digit LED driver system. Internally it contains all the circuitry necessary to interface a microprocessor to an LED display. Included on the chip is an 8 by 8 static memory array with storage for the displayed information, 7 segment decoders, all the multiplex scan circuitry and the digit and segment drivers.

The CPU uses port line P15, coded DSPWR (Display Write), to select the ICM7218 to receive data. The microprocessor writes the display information to this chip in BCD format and the display multiplexer performs the necessary timing and digit scanning functions. This stand-alone display controller drives the seven segment displays, the Cut mode indicators, the Standby/Ready indicators and the Footswitch Selector indicators directly. The RF Watt lamps and the REM lamp are individually driven by the Programmable Logic Device (U3). The ICM7218C is not capable of driving the mode indicator lights with sufficient power to make them fully visible through the translucent display windows. To overcome this deficiency, segment H, the decimal point drive output of the ICM7218C, is individually gated with each of the eight digit drives to externally multiplex the mode lamp indicator information. The resultant mode lamp drives are current boosted by U11, a ULN2803A, to drive the indicator LEDs.

The audio alert circuit is a single gate oscillator (U6) with two operating frequencies determined by Q3. This audio signal is amplified by Q4 which drives loudspeaker SPK1. Volume control is accomplished with a potentiometer in series with the speaker. Transistor Q6 in parallel with the volume control pot is turned on during a REM alert causing the audio alarm to be sounded at full volume.

The Watt lamps are controlled by transistors Q1, Q2 and Q11. Q9 is normally activated by the presence of signal RF SENSE. This signal is only present when the unit is keyed and there is RF energy in the output transformer. Q1, Q2 and Q11 are driven by enable signals BIPEN, CUTEN or COGEN, respectively and light the lamp which corresponds to the mode being keyed.

When the Force 1B is first turned on, all displays are illuminated for a short time to allow visual check of proper operation.

The CPU also writes to U7, a digital to analog converter which is used to create the signals ECON and ICON. These signals go to the RF and the Power Supply Boards to control power supply voltage and output current limiting. The DAC is enabled to receive information only when signal RFNABL is not present. The output of the DAC is then amplified by U2 generating analog signals ECON and ICON.

U3 is an EP1210, an electronically programmable logic device. It contains the equivalent of several thousand logic gates and is programmed to replace a large number of discrete circuits. Its main functions are to decode keying and keyboard signals, activate the REM alert, enable various internal control signals and to latch these signals while the microprocessor is inactive. The EP1210 multiplexes the keyboard's signals onto the microprocessor on port lines P10, P11 and P12. The group of keyboard switches or logic signals selected by EP1210 is determined by the bank select signals coming from the microprocessor on port lines P20, P21 and P22. When a bank line is driven to a high state it activates an FET which pulls one side of the switches low. When a switch is closed it causes the corresponding MUX line to be pulled low. Essentially the same thing occurs on the keying buffer U4, an octal tri-state line driver, except that when the bank control is low U4 is placed in a tri-state output mode.

When the Force 1B is keyed, from either a handswitch or footswitch, this is encoded by U3 as signals A0, A1 and A2. This is interpreted by the microprocessor which then writes data back to U3 on port lines P23, P24 and P25 (SEL0, SEL1 and SEL2) and P26 and P27 (SW1 and SW2). These signals cause U3 to generate the correct drive waveform for the mode keyed as signal TON, as well as to set the appropriate mode enables and relay drives. The last operation the microprocessor performs in response to a keying input is to clock the set input of one section of U5 causing its own SS (Single Step) line to be latched low, thus inhibiting further operation of the microprocessor. The microprocessor will remain shut down until the SS line is switched high by resetting U5 via signal SSRST (Single Step Reset) from U3. SSRST will be generated by U3 when either a REM alert is sensed (except when keyed in Bipolar) or when the keying input is terminated. When the microprocessor is re-enabled the SW, SEL and RFNABL signals to the EP1210 are cleared causing the TON RF drive to cease and the mode and relay enables to be cleared.

The EP1210 generates a REM alert when one of the three lines are high. These lines are coded RMDPHI (REM Dual Pad High), RMDPLO (REM Dual Pad Low) and RMSPHI (REM Single Pad High). These signals are developed by using U1, a comparator, to compare the voltage EREM, which is developed on the RF Board, to a threshold voltage equivalent to the required trip points. When one of these limits is exceeded the EP1210 generates a signal, REMFLT (REM Fault) which disables the RF output and reactivates the microprocessor. The EP1210 also demultiplexes the select lines from the microprocessor to create the RF drive for each of the Cut modes, Coag and Bipolar. It also decodes the keying signal to create the relay drives and the mode enables.

RF OUTPUT

The RF Output Board is mounted to the chassis of the Force 1B and supports the HV, LV and RF Heatsinks. It contains the circuitry which controls the RF output levels, the keying interface circuits and the REM circuit.

The RF generating circuitry accepts a drive signal, TON, from the Display/Control Board. This signal is level-shifted by U6 and gated through U3. It is then amplified by U7, drivers Q11-Q12 and output FETs Q7-Q10.

Signal /INH is a drive pulse inhibit which will be set if the current in the output FETs exceeds a preset level. The current limit circuit which generates /INH is an edge-triggered set-reset flip-flop that is set by the output of comparator U13 if current in the output devices exceeds a predetermined limit. This limit is set by comparison of the voltage developed across current sense resistors R87-R89 with reference level ICONV. ICONV is developed from ICON which originates on the Display/Control Board. It is scaled by potentiometers R75-R77 for each of the three modes of operation and then multiplexed by U8 to according to the mode enabled.

RF power generated by the output stage is controlled directly by the high voltage power supply HVDC. RF output power for each mode is proportional to the square of HVDC. The output voltage of the high voltage power supply is a function of analog control voltage ECONV. ECONV is developed from ECON, which originates on the Display/Control Board. It is scaled by potentiometers R78-80 for each of the three modes of operation and then multiplexed by U8 according to the mode enabled.

During open circuit Coag operation it may be necessary to limit the peak voltage on the output FETs. This is accomplished by limiting ECONV via clamp transistor Q13 when the peak voltage on the output devices, RF VSEN, exceeds a predetermined level. RF VSEN also senses extreme negative swings on the primary of RF output transformer T3 when operating in open circuit Coag mode. As a means of limiting excessive RF leakage current which may accompany this operating condition, negative swings exceeding approximately -75V will trigger one-shot U3. The output of the one-shot is level-shifted by U6 and forces /INH low inhibiting further drive pulses for the duration of the one-shot period. This period is set to be such that every other Coag drive pulse is eliminated thus cutting the RF leakage current approximately in half.

Four power FETs act as RF switching elements driving transformer T3. Two diodes, CR14 and CR15, are placed in series with the drains of the output FETs to allow the output transformer primary voltage to swing negative in Coag. The output tuning and turns ratio is different for Cut and Coag and the selection is done by relay K4. The Cut drive waveform is a 50% duty cycle with a 1 uS on time. The Coag drive waveform is a 2 uS pulse repeated every 32 uS. RF SENSE is derived from RF VSEN when there is current in the output transformer. Its purpose is to illuminate the front panel power lamps whenever power is available.

There are four isolated keying circuits each with its own transformer winding for power. Two flyback converters and toroid transformers comprise the isolated power source for the keying circuitry. Handswitch keying is accomplished by sensing Active to CUT or Active to COAG switch closure in a hand-held accessory. The footswitch keying is done in a similar manner using a footswitch common in place of Active. Opto-isolators with current limiting resistors detect switch closure and provide isolation between the keying input and ground referenced circuitry.

This generator has three RF output jacks labeled HANDSWITCH, ACCESSORY AND MICROBIPOLAR. Selection of the active jack(s) is done by single pole, normally open, high voltage relays. The Display/Control Board turns actuate the relays via bipolar drivers. 0.0047uf capacitors in series with the RF output and return are the primary patient protection against 60Hz leakage current and must be high voltage parts.

The Return Electrode Monitor circuitry measures the pad to pad resistance of dual pad electrodes or the wiring resistance of single pad electrodes. A microswitch in the connector is opened for dual pad electrodes and selects one of two alert signal paths on the Display/Control Board. This resistance is measured as the reflected load on the REM transformer primary and is sensed by an asynchronous detector comprised of U11 and U12. The detector output is amplified and is processed on the Display/Control Board as signal EREM. Potentiometer R47 is provided to tune REM oscillator U10 to peak EREM under open input conditions.

POWER SUPPLY

CAUTION: Because the high voltage power supply operates directly off the AC mains, EXTREME CARE must be exercised when probing or testing this circuit. The use of an isolation transformer between the generator and the AC line is highly recommended.

The Power Supply PCB assembly is mounted component side down to the LV and HV heatsinks and is accessable from the circuit side when the generator cover is removed.

The HV supply is an off-line DC-DC switching converter operating at 80kHz. Raw HV DC is supplied via bridge rectifier (220V) or voltage doubler (120V) to filter capacitors C1 and C2 and four power FETs, Q5-Q8, arranged in a bridge configuration. The FETs drive the power transformer T2 at 320V peak with varying duty cycles. The secondary voltage of T2 is rectified by bridge rectifier CR6 and is filtered by inductor L1 and capacitors C12 and C13 located on the RF Board. The DC output voltage is a function of the duty cycle of the chopped primary input voltage.

The output voltage of the HV power supply is programmed by the microprocessor on the Display/Control Board via input ECONV. This voltage will be scaled differently for the various modes and will vary proportionately with the square root of the power indicated on the front panel displays. The relationship between ECONV and the HV output is linear.

Duty cycle control is performed by a 3526 IC regulator which drives the power FETs via transistors Q1-Q4 and isolating transformers T3 and T4. The IC contains a sawtooth oscillator, a comparator and pulse steering logic. The ECONV input is compared with the feedback voltage from the HV power supply output and an error voltage is produced which is then imposed on the ERR input of the 3526. This voltage is compared with a sawtooth waveform generated internally within the 3526. The result of this comparison is then routed through the pulse steering logic to become the drive pulses OUT A and OUT B.

A DC current limit circuit is implemented with a comparator and ECONV clamp circuit. This circuit senses the voltage developed across sense resistors R1 and R2. If the maximum allowable current is sensed, the comparator shuts down the supply's control IC and aborts any output pulse present. The ECONV shut-down circuit clamps ECONV to 0V and then soft starts this voltage.

Low voltage power supplies at +12 and +5 volts are regulated with three pin ICs. The raw DC voltage is generated by a transformer, rectifier and capacitor circuit. There are no low voltage adjustments.

SECTION 6

TESTING PROCEDURE

OPERATIONAL TESTING - GENERATOR OUTPUT

The purpose of an operational test is to determine whether the generator is functioning and generating the necessary electrosurgical waveforms.
Note: Electrosurgical generators are not rated for continuous duty operation. (Maximum keying time at a power setting of 100 is two minutes.)

Recommended Equipment Needed:

Tektronix type 465 Oscilloscope
Tektronix type P6013A High Voltage Probe
Tektronix type P6007 X100 Probe
Tektronix type P6010 X10 Probe
Fluke type 8920A Voltmeter with Pearson Model 411 Current Transformer
Simpson Model 1339 RMS RF Ammeter, 0 - 250mA
Wattmeter, 0 - 500 Watts 300 ohm load and 100 ohm load, with reactive phase angle of less than 20^{0} at 500 kHz (Valleylab E3002)
General Radio 1192 Frequency Counter
Fluke type 8020B DMM

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. If substitute equipment is used it must meet or exceed the specifications of the recommended equipment listed.

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 inductance coupling may cause order-of-magnitude errors in the observed values.

CALIBRATION PROCEDURE

All calibrations listed in this procedure are made at the factory before units are accepted by QA. If only RF output power needs to be re-calibrated, proceed directly to Step 6 of the procedure.

1. Remove the cover from the Force 1B to expose the internal controls and test points.

2. Verify proper operation of low voltage power supplies.

   a) +12 Volt Supply: Connect the digital multimeter between H0304A Pin 2 on the RF Board and chassis ground. The meter should read +12V ± .5V.

   b) +5 Volt Supply: Connect the digital multimeter between H0304A Pin 3 on the RF Board and chassis ground. The meter should read +5V ± .2V.

   c) -5 Volt Supply: Connect the digital multimeter between Test Point TP3 on the RF Board and chassis. The meter should read 4.5V ± .5V.

3. Verify proper idle condition operation of the high voltage power supply.

CAUTION: Precautions should be taken when working on the exposed high voltage board as the heatsinks and many of the components are floating at potentially harmful voltage potentials.

---

a) Connect the digital multimeter between H0304A, Pin 7 on the RF Board and chassis ground. The meter should read less than 5V.

Special care must be taken in Step 4. The X10 or X100 probe to be used should be closely calibrated with the oscilloscope to be used.

4. Adjust the High Voltage Clamp.

   a) Set the Coag display to 30 watts.

   b) Attach a 300 ohm load from the Monopolar output to the Patient input.

   c) Key the generator in Coag. Output power should be 30W ± 5W.

   d) Remove the 300 ohm load.

   e) Adjust the Coag display to 1.

   f) Attach an oscilloscope with a X10 or X100 probe between the anode of CR14 on the RF Board and ground. Key the generator in Coag. Slowly increase the Coag power display and observe the peak positive voltage. Adjust R74 on the RF Board so that the maximum peak voltage is 300 volts. Do not let the peak voltage exceed 325 volts while making this adjustment.

5. Adjust Coag Output Power.

Potentiometers R77 and R80 on the RF Board are critical to the output power adjustments for Coag. Follow Steps a) through d) using a 300 ohm wattmeter.

a) Set R80 (Coag ECON) to mid-setting. Turn R77 (Coag ICON) fully clockwise.

b) Set Coag display at 75W and adjust R80 for 75W output in Coag.

c) Change wattmeter load to 100 ohms. Turn R77 to mid-setting before proceeding.

d) With the Coag display at 75W, adjust R77 for 60W ± 20W output in Coag.

6. Adjust Cut Output Power.

Potentiometer R76 and R79 on the RF Board are the output power adjustments in Pure Cut. Follow Steps a) through d) using a 300 ohm wattmeter.

a) Set R79 (Cut ECON) to mid-setting. Turn R76 (Cut ICON) fully clockwise.

b) Set Cut display at 200 watts and adjust R79 for 200 watts output on Pure Cut.

c) Change wattmeter load to 100 ohms. Turn R76 counterclockwise to mid-setting before proceeding.

d) With Cut display at 200 watts, adjust R76 for 200W ± 40W output in Pure Cut.

7. Adjust Bipolar Output Power.

Potentiometers R78 and R75 on the RF Board are for the output power adjustments for Bipolar. Follow Steps a) through c) using a 100 ohm wattmeter.

a) Set R78 (Bipolar ECON) to mid-setting. Turn R75 (Bipolar ICON) fully clockwise.

b) Set Bipolar display at 50 watts and adjust R78 for 50 watts output in Bipolar with wattmeter load set at 100 ohms.

c) Turn R75 counterclockwise until it affects Bipolar output in Step B. Then turn R75 clockwise one turn.

8. Adjust Return Electrode Monitor

a) Connect a variable resistance across the Patient terminals using a REM-type connector.

b) Set the resistance to 135 ohms and adjust R47 on the RF Board for the highest possible voltage on Test Point TP2.

c) Turn R46 counterclockwise until EREM is below 4 volts.

d) Turn R46 clockwise until the REM alerts.

e) Decrease the resistance and record the value at which the REM alert again turns on (5 $\pm$ 2 ohms).

f) Repeat Step a using a non-REM type connector.

g) Set the variable resistance to 5 ohms. Note that the REM alert is off.

h) Gradually increase resistance and record the value at which the REM alert turns on (20 $\pm$ 5 ohms). The REM alert should remain off below this value and turn on again if above this value.

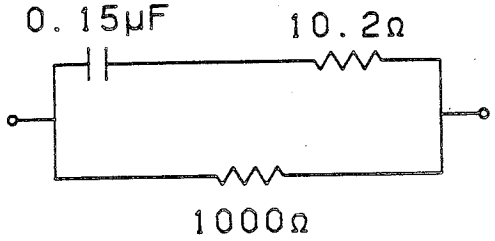
LINE FREQUENCY (50/60Hz) CURRENT LEAKAGE TEST PROCEDURE

This test measures potentially dangerous 50/60Hz leakage currents.

The Force 1B is left ON, but NOT KEYED, during this test.

The current is measured indirectly by observing the voltage developed across a 1k ohm resistor to ground from each front panel jack. A 0.15uf capacitor is connected across the 1k ohm resistor to remove any trace of high frequency noise generated by the oscillator inside the generator. This capacitor has little effect on the 50/60Hz leakage current. Leakage current is calculated from I = E/R, where R = 1k ohms and E is the voltage measured across the resistor. The maximum acceptable voltage across the 1k ohm resistor for 2.0uA leakage is 0.002 volts (2 mV).

INPUT CIRCUIT:



Note: Because of the difference in magnitude of the 50/60Hz leakage current in the RF signals when the generator is keyed, it is very difficult to make a 50/60Hz leakage measurement. When the unit is keyed there can be as much as 9000 volts peak to peak of RF compared to 20mV of 50/60Hz. This ratio (110db) 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 1k ohm resistor from chassis to ground. The maximum voltage across the 1k ohm resistor for 50mA leakage would be 50mV. Commercially available leakage testers may be used for this test.

The typical value of 50uA is valid for factory installed 15 foot 18/3 AWG line cords. Longer cords or extension cords will increase third wire leakage and are not recommended. With the Force 1B turned off, the third wire leakage should be less than 10uA.

The line frequency sink leakage is the current that will pass into the patient leads when a 120V, 50/60Hz potential is applied between a Patient lead and the chassis. The voltage source should be a 110V isolation transformer with a 120k ohm current limiting resistor in series with a secondary.

The current is calculated from the voltage measured across a 1k ohm resistor in series with the 120V source and the Patient or Monopolar jacks. This current should be less than 100uA.

MONOPOLAR AND BIPOLAR OUTPUT RF LEAKAGE TEST PROCEDURE

In this test the RF leakage current to earth ground from the Monopolar output is measured. The readings are made with an RF ammeter or 300 ohm wattmeter from a Monopolar output to ground.

Caution: Accidental connection of the meter from one Monopolar output to Patient will result in damage to the meter.

---

1. Monopolar Active to Ground RF Leakage.

   a) Connect a 250mA RF ammeter in series with a 200 ohm non-inductive resistor from the Accessory output jack to ground using a 20 ft. wire.

   b) Connect the Patient jack to a 10 ft. wire held straight in front of the generator on a thick insulating surface.

   c) Set Cut and Coag levels to 200W and 75W, respectively.

   d) Key the generator by shorting the active to keying jacks using a short insulated jumper wire. The RF leakage should not exceed 150mA.

   e) Repeat Steps a) through d) for the Handswitch output jack.

2. Monopolar Patient to Ground RF Leakage

   a) Connect a 250mA RF ammeter in series with a 200 ohm non-inductive resistor from the Patient jack to ground using a 20 ft. wire.

   b) Connect one Accessory output jack to a 10 ft. wire held straight in front of the generator on a thick insulating surface.

   c) Set Cut and Coag levels to 200W and 75W, respectively.

   d) Key the generator by shorting the active to keying jacks using a short insulated jumper wire. The RF leakage should not exceed 150mA.

   e) Repeat Steps a) through d) for the Handswitch output jack.

3. Bipolar to Ground RF Leakage

a) Connect a 250mA RF ammeter in series with a 200 ohm non-inductive resistor from one Bipolar output jack to ground using a 20 ft. wire.

b) Connect the other Bipolar output jack to a 10 ft. wire held straight in front of the generator on a thick insulating surface.

c) Set Bipolar level to 50W.

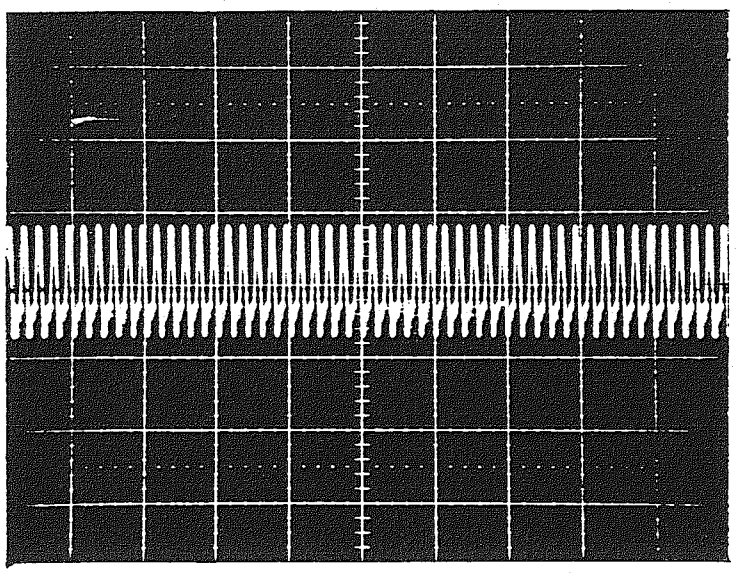
d) Key the generator in Bipolar mode. The RF leakage should not exceed 150mA.

e) Swap the two Bipolar output connections and repeat Steps a) through d).

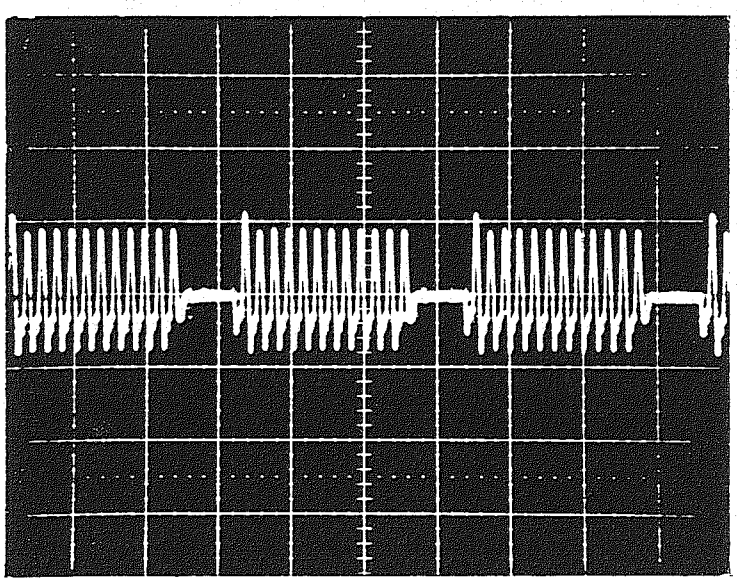
This test set-up is described in more detail in Publication IEC 601.2.2, from the Internal Electrotechnical Commission.

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 15 foot, 18/3 AWG line cord. Use of longer cords is not recommended.



Pure Cut Output @ 200W
R_{Load} = 300 ohms
Horizontal = 10uS/cm
Vertical = 500V/cm

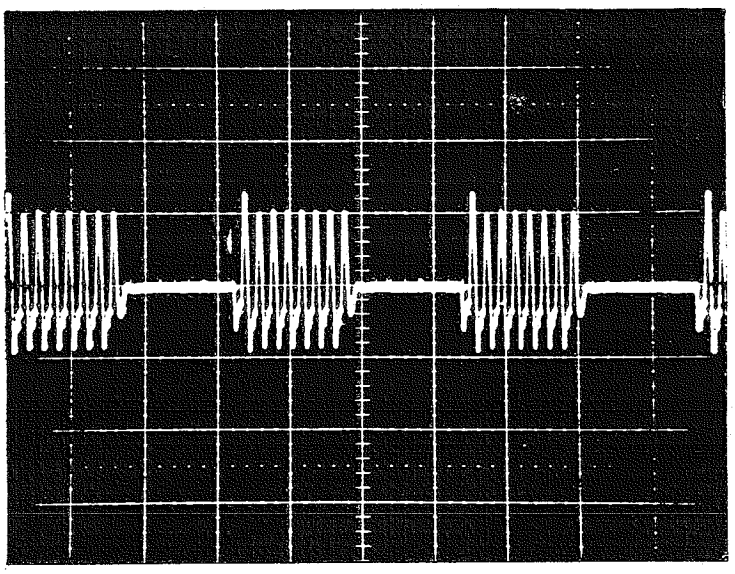


Blend 1 Output @ 175W
R_{Load} = 300 ohms
Horizontal = 10uS/cm
Vertical = 500V/cm

FIGURE 5

OUTPUT WAVEFORMS

Blend 2 Output @ 150W
R_{Load} = 300 ohms
Horizontal = 10uS/cm
Vertical = 500V/cm



Blend 3 Output @ 125W
R_{Load} = 300 ohms
Horizontal = 10uS/cm
Vertical = 500V/cm

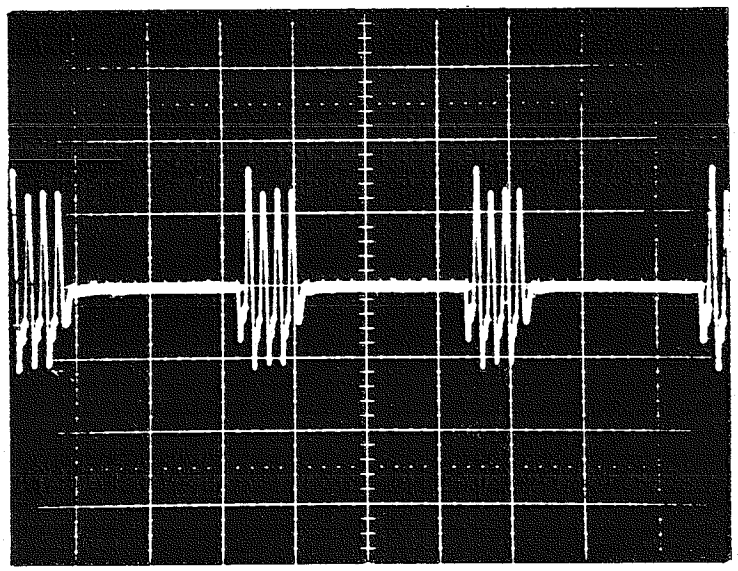
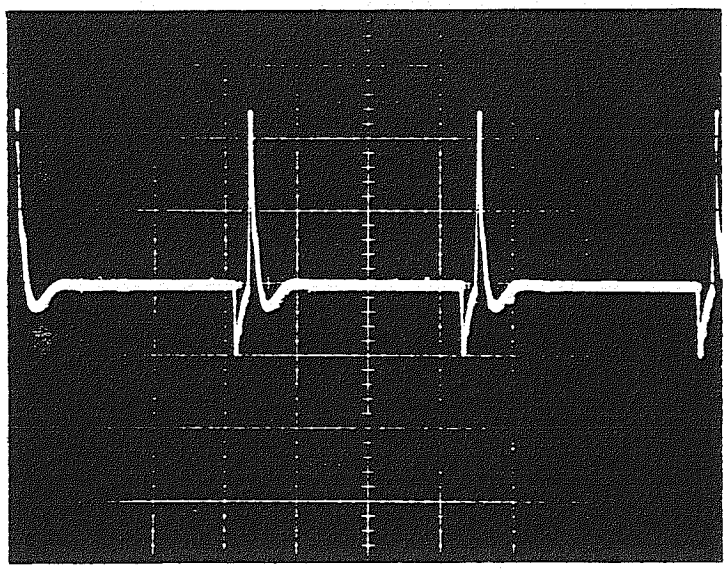
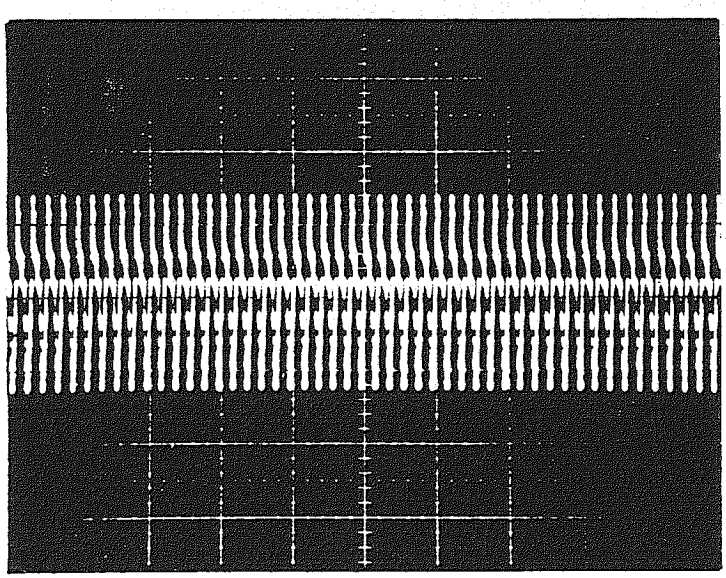


FIGURE 5 (CONT'D)

OUTPUT WAVEFORMS



Coag Output @ 75W
R_{Load} = 300 ohms
Horizontal = 10uS/cm
Vertical = 550V/cm



Bipolar Output @ 50W
R_{Load} = 100 ohms
Horizontal = 10uS/cm
Vertical = 200V/cm

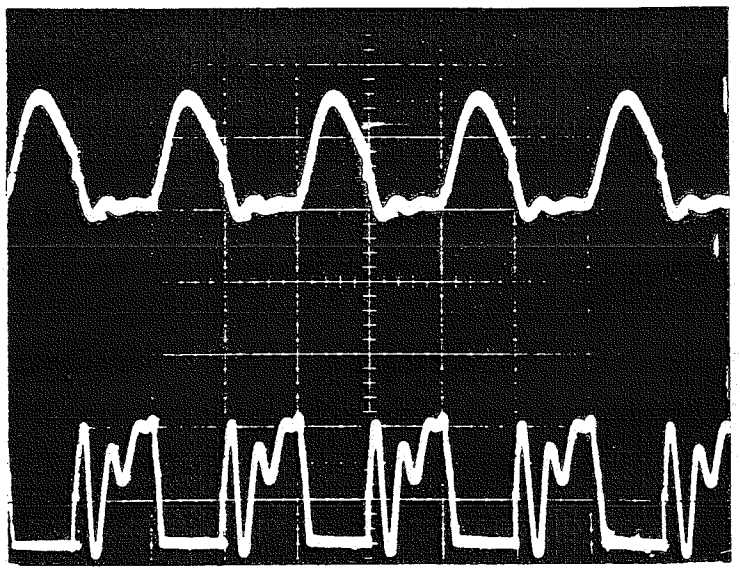
FIGURE 5 (CONT'D)

OUTPUT WAVEFORMS

Pure Cut Output @ 75W
R_{Load} = 300 ohms
Horizontal = 1uS/cm

Top Trace
E_D Q207 - Q210
Vertical = 100V/cm

Bottom Trace
I_S Q207 - Q210
Vertical = 2A/cm



Coag Output @ 30W
R_{Load} = 500 ohms
Horizontal = 10uS/cm

Top Trace
E_D Q207 - Q210
Vertical = 100V/cm

Bottom Trace
I_S Q207 - 210
Vertical = 1A/cm

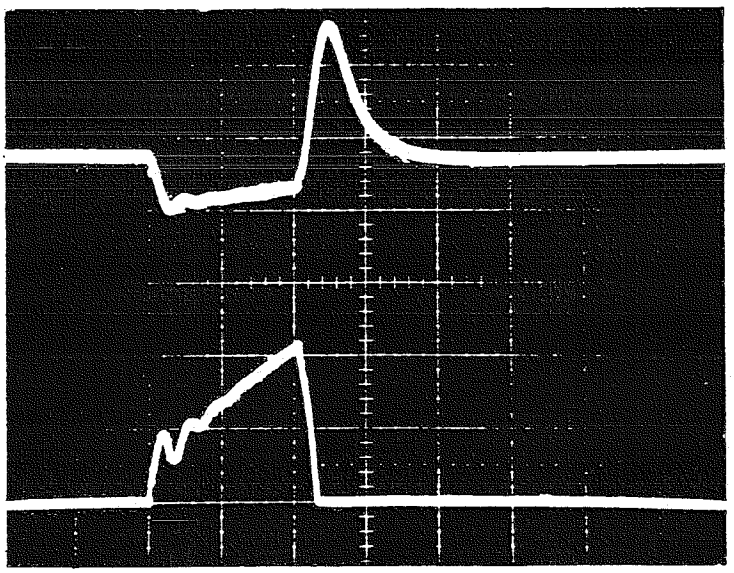
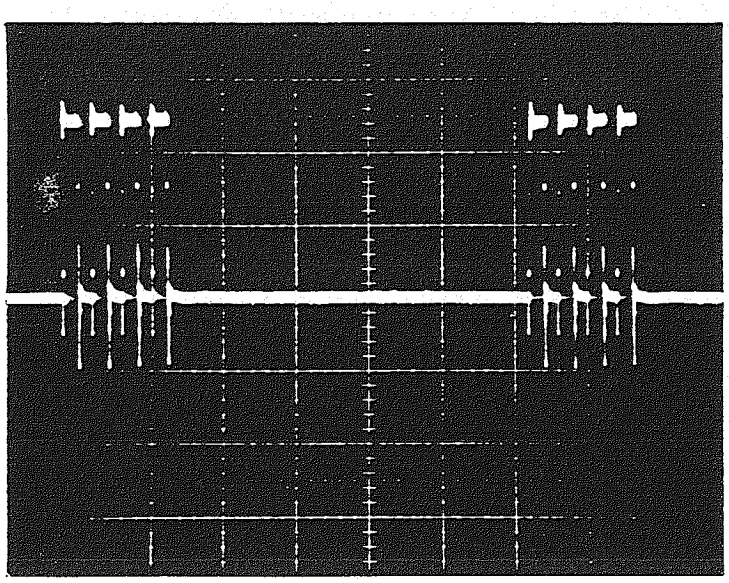
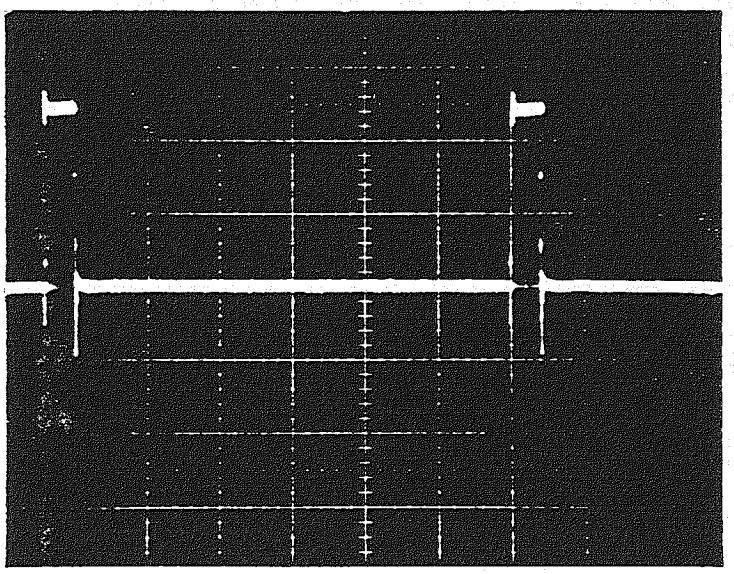


FIGURE 6

RF OUTPUT FET WAVEFORMS



Blend 3 RF Drive
U206, Pin 13
Horizontal = 5uS/cm
Vertical = 5V/cm



Coag RF Drive
U206, Pin 13
Horizontal = 5uS/cm
Vertical = 5V/cm

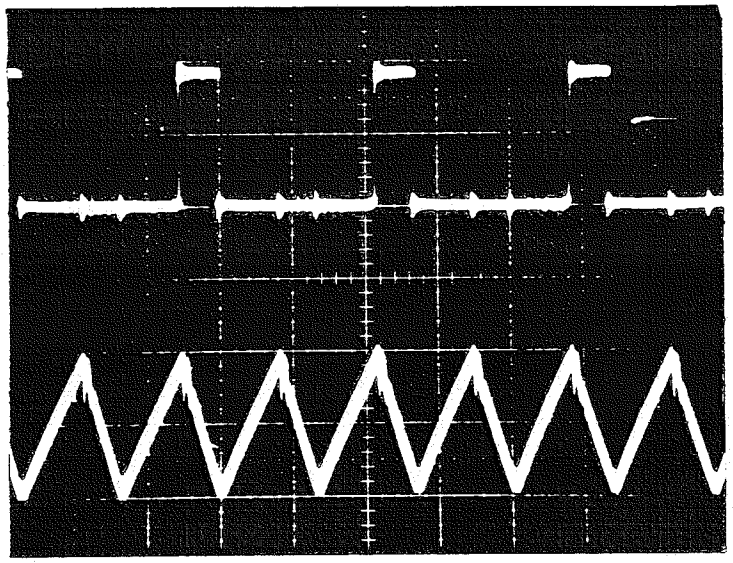
FIGURE 7

RF OUTPUT GATE DRIVE WAVEFORMS

Power Supply Current Limit
R_{Load} = 1 ohm
Horizontal = 10uS/cm

Top Trace
U302, Pin 16 (OUT B)
Vertical = 5V/cm

Bottom Trace
I L302
Vertical = 5A/cm



RF Output Current Limit
R_{Load} = 0 ohms
Horizontal = .5uS/cm

Top Trace
E_G Q207 - Q210
Vertical = 10V/cm

Bottom Trace
U303, Pin 7
Vertical = 10V/cm

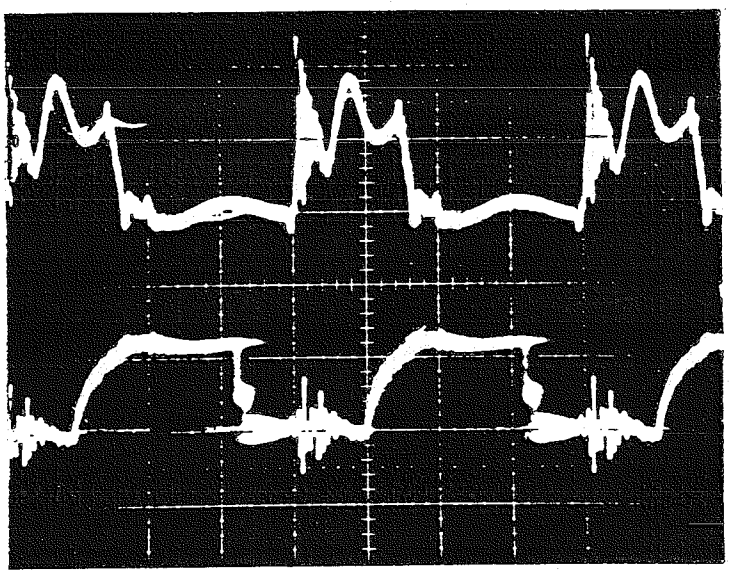


FIGURE 8

POWER SUPPLY AND RF CURRENT LIMIT WAVEFORMS

SECTION 7

ASSEMBLIES AND SCHEMATICS

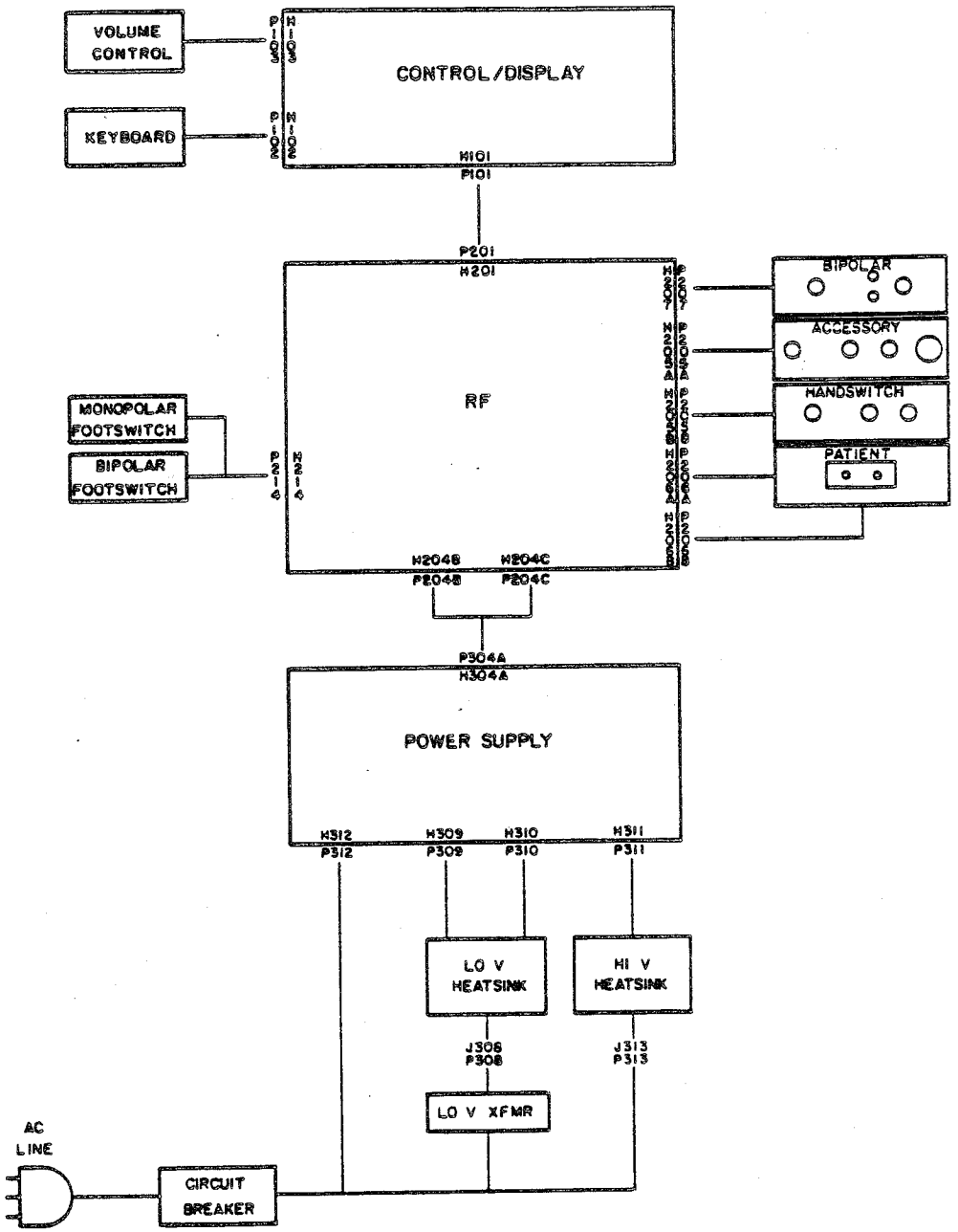


FIGURE 9

INTERCONNECT DIAGRAM/LISTING

CONNECTOR	J101 P101 J201 P201
PIN NUMBER	DESCRIPTION
01	ECON
02	ICON
03	RFSEN
04	EREM
05	COGEN
06	FSCOG
07	REMSW
08	N.C.
09	ACCOG
10	HSCOG
11	CUTRLY
12	CUTEN
13	FSCUT
14	HSCUT
15	ASWRLY
16	BIPPEN
17	ACCUT
18	BIPSW
19	HSWRLY
20	BIPRLY
21	TON
22	N.C.
23	GND
24	GND
25	GND
26	GND
27	+12V
28	+12V
29	+5V
30	+5V

CONNECTOR	J102 P102
PIN NUMBER	DESCRIPTION
01	SHIELD
02	BNK02
03	BNK01
04	MUX02
05	MUX03
06	MUX04
07	MUX05
08	MUX07
09	MUX06
10	MUX01

CONNECTOR	J103 P103
PIN NUMBER	DESCRIPTION
01	+12V
02	N.C.
03	VOL

CONNECTOR	J304A P304A
PIN NUMBER	DESCRIPTION
01	ECONV
02	+12V
03	+5V
04	A GND
05	D GND
06	HV RTN
07	DC HV

CONNECTOR	J204B P204B
PIN NUMBER	DESCRIPTION
01	ECONV
02	+12V
03	+5V
04	A GND
05	D GND

CONNECTOR	J204C P204C
PIN NUMBER	DESCRIPTION
01	HV RTN
02	DC HV

CONNECTOR	J205A P205A
PIN NUMBER	DESCRIPTION
01	HSWACT
02	HSWCOG
03	HSWCUT

CONNECTOR	J205B P205B
PIN NUMBER	DESCRIPTION
01	ACCACT
02	ACCCOG
03	ACCCUT

CONNECTOR	J206A P206A
PIN NUMBER	DESCRIPTION
01	MNRET1
02	MNRET2

CONNECTOR	J206B P206B
PIN NUMBER	DESCRIPTION
01	REMSW1
02	REMSW2

CONNECTOR	J207 P207
PIN NUMBER	DESCRIPTION
01	BIPRF1
02	BIPHSW
03	N.C.
04	BIPRF2

CONNECTOR	P308 J308
PIN NUMBER	DESCRIPTION
01	17VAC1
02	17VAC2
03	09VAC1
04	09VAC2

CONNECTOR	J309 P309
PIN NUMBER	DESCRIPTION
01	+5VFIL
02	12VFIL
03	LVRETN
04	12VREG
05	+5VREG

CONNECTOR	J310 P310
PIN NUMBER	DESCRIPTION
01	HVAC2
02	SEC. SNUBBER
03	HVAC1
04	-HVDC
05	+HVDC

CONNECTOR	J311 P311
PIN NUMBER	DESCRIPTION
01	AC HI
02	AC COM
03	PRI. SNUBBER
04	N.C.
05	PRI. SNUBBER
06	N.C.

CONNECTOR	P312 J312
PIN NUMBER	DESCRIPTION
01	AC LOW
02	N.C.

CONNECTOR	J313 P313
PIN NUMBER	DESCRIPTION
01	AC NEUTRAL
02	N.C.
03	230VAC

CONNECTOR	J214 P214
PIN NUMBER	DESCRIPTION
01	BIPFSW
02	BFSCOM
03	BFSGND
04	MFSGND
05	MFSCOM
06	MFSCUT
07	MFSCOG

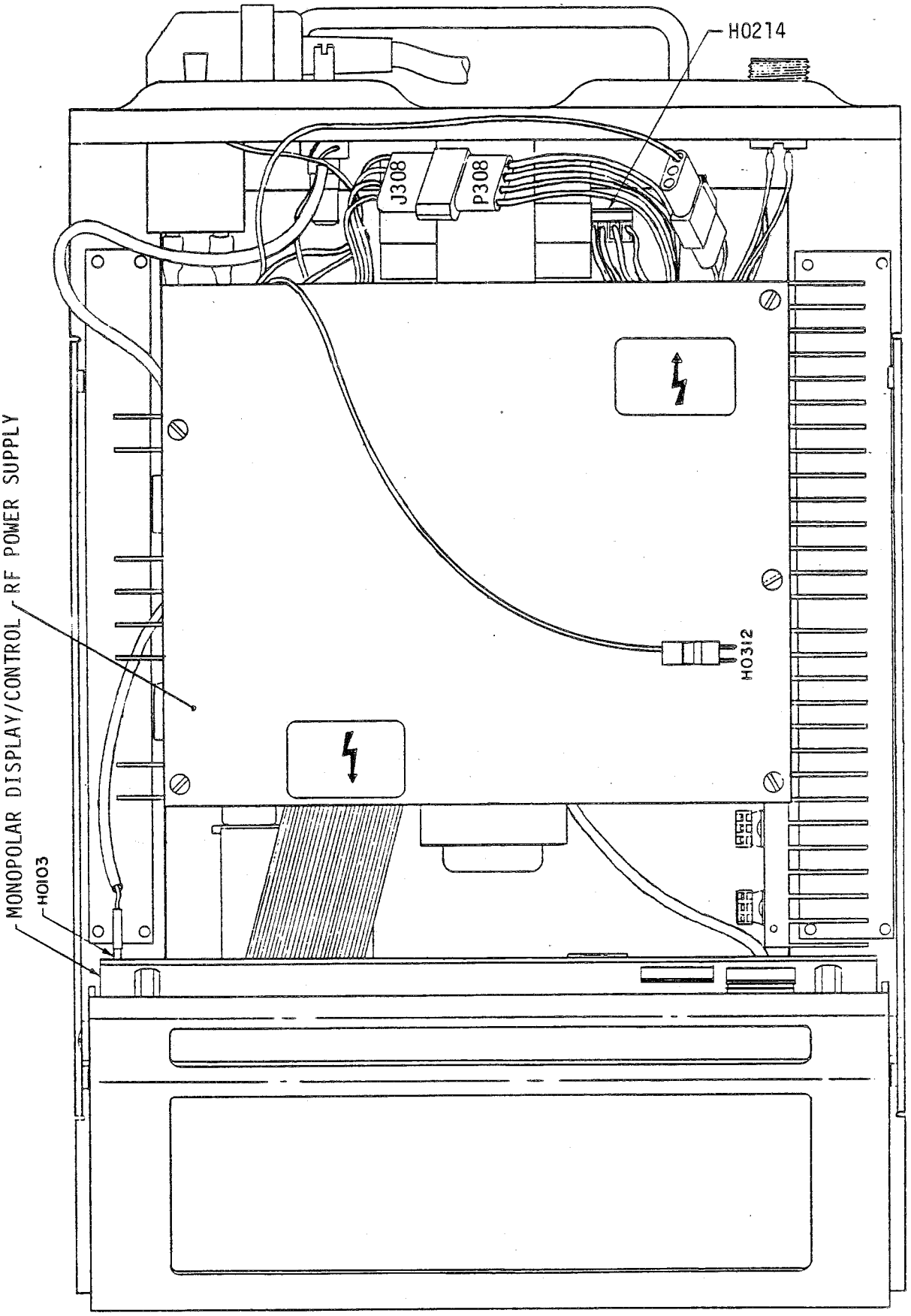
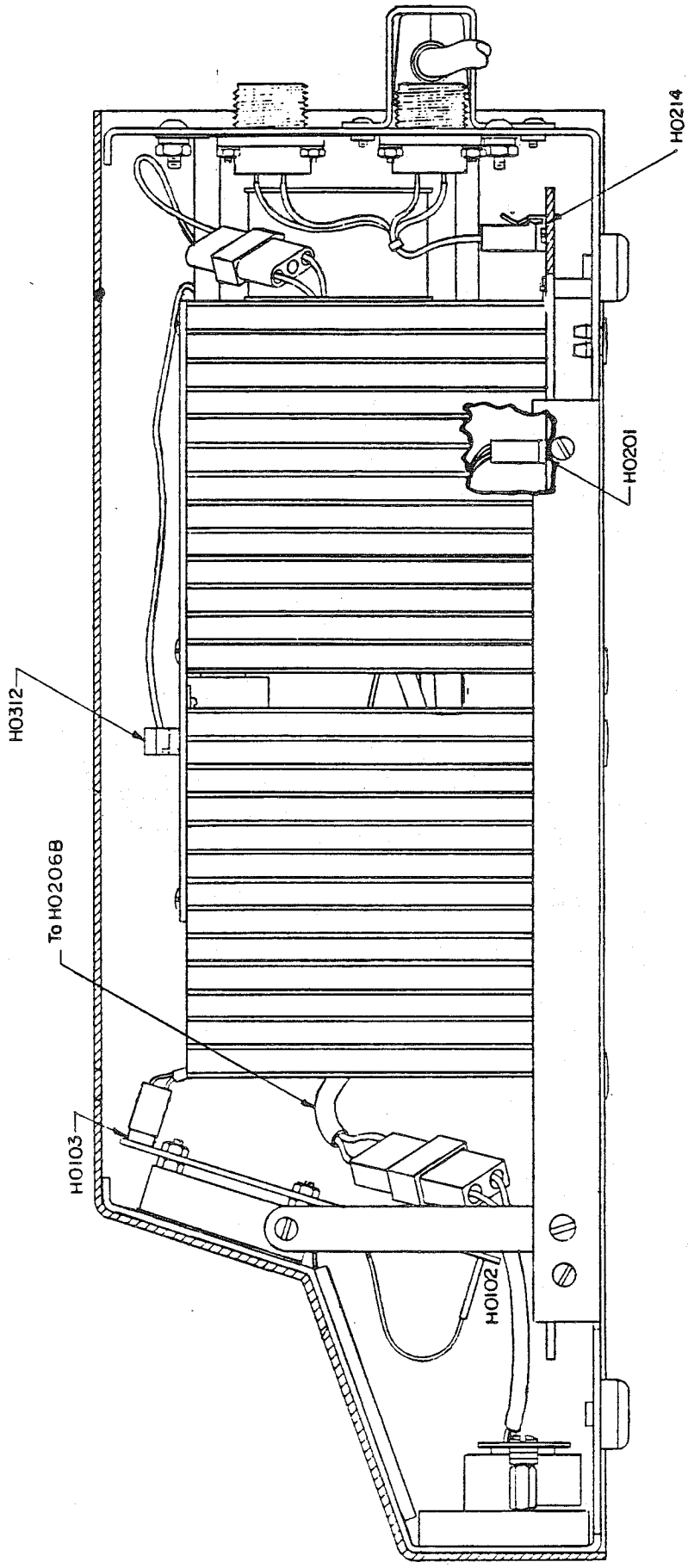
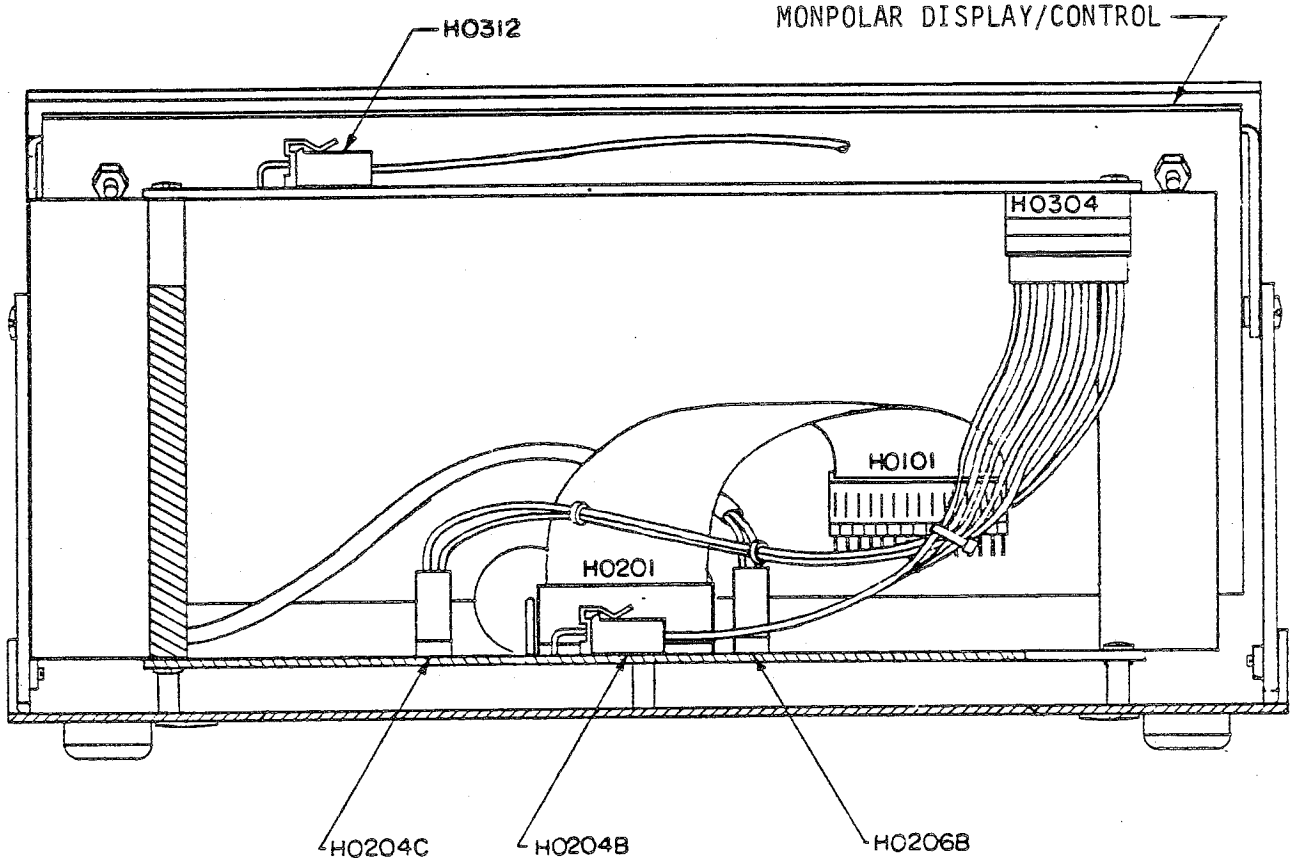
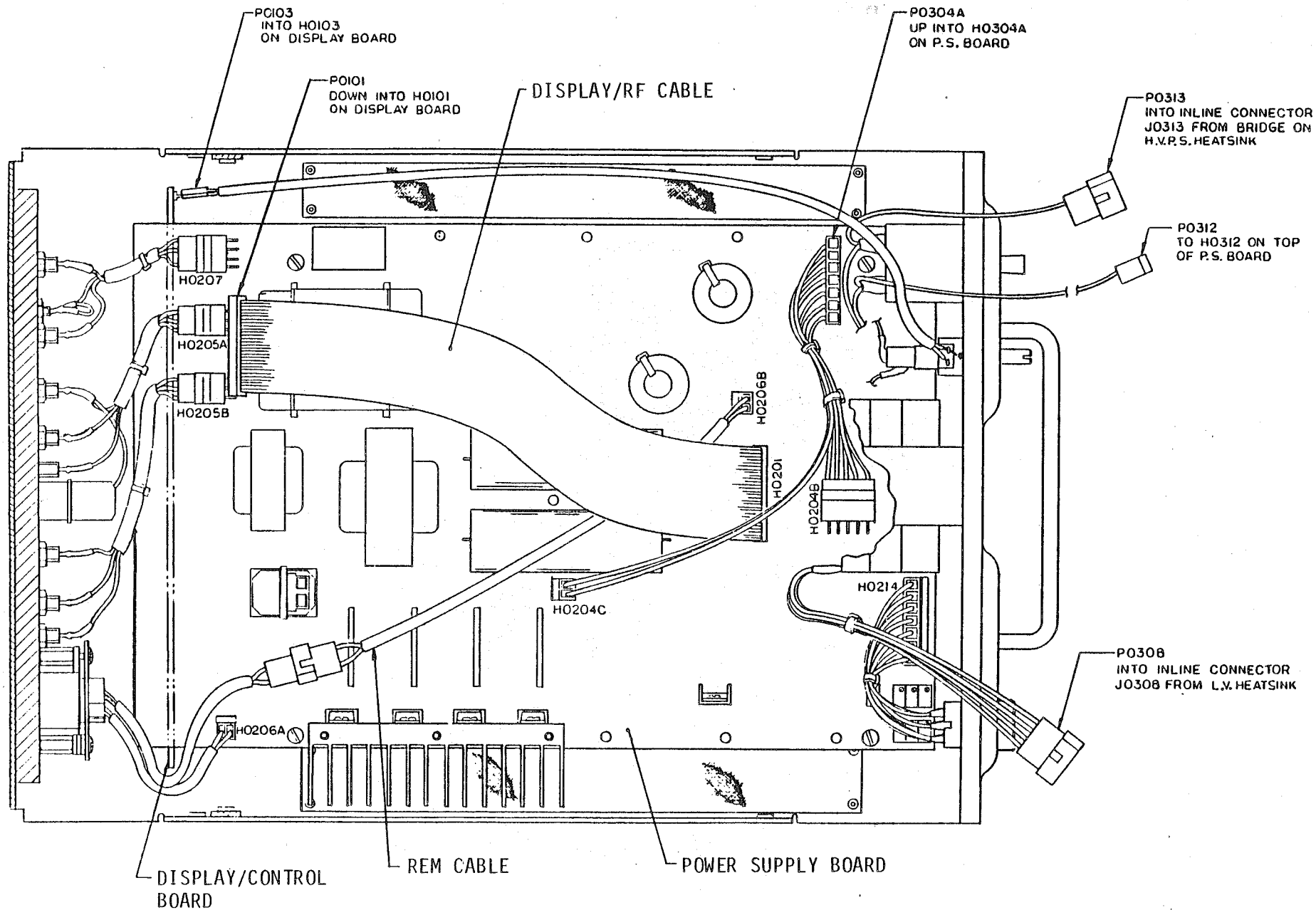


FIGURE 10

FORCE 1B COMPONENT/CONNECTOR LOCATIONS


H0214
H0201
H0312
To H0206B
H0103
H0102


H0312
MONPOLAR DISPLAY/CONTROL
H0304
H0101
H0201
H0204C
H0204B
H0206B


P0103
INTO H0103
ON DISPLAY BOARD
P0101
DOWN INTO H0101
ON DISPLAY BOARD
DISPLAY/RF CABLE
P0304A
UP INTO H0304A
ON P.S. BOARD
P0313
INTO INLINE CONNECTOR
J0313 FROM BRIDGE ON
H.V.P.S. HEATSINK
P0312
TO H0312 ON TOP
OF P.S. BOARD
H0207
H0205A
H0205B
H0206B
H0201
H0204B
H0214
H0204C
P0308
INTO INLINE CONNECTOR
J0308 FROM L.V. HEATSINK
H0206A
DISPLAY/CONTROL
BOARD
REM CABLE
POWER SUPPLY BOARD

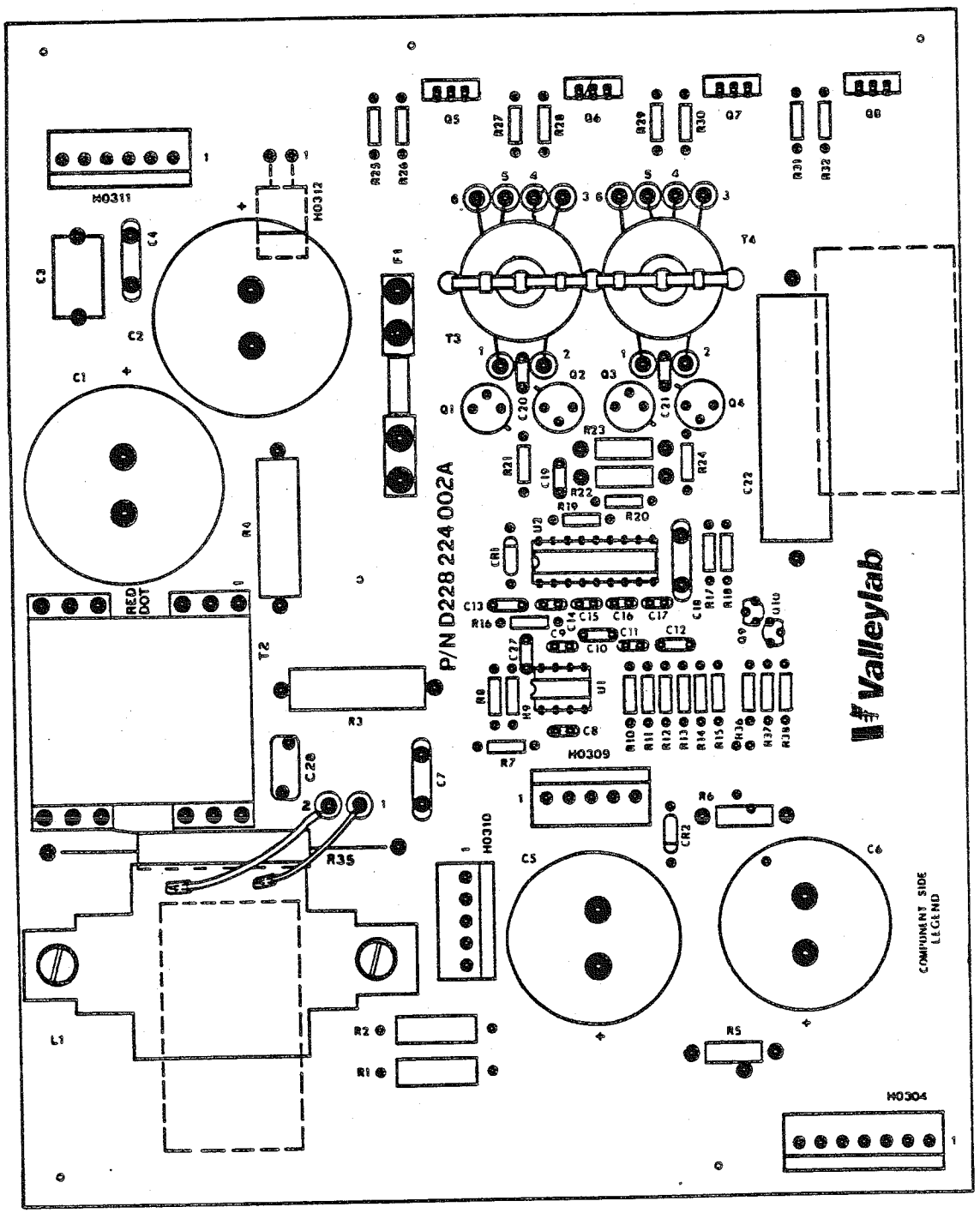
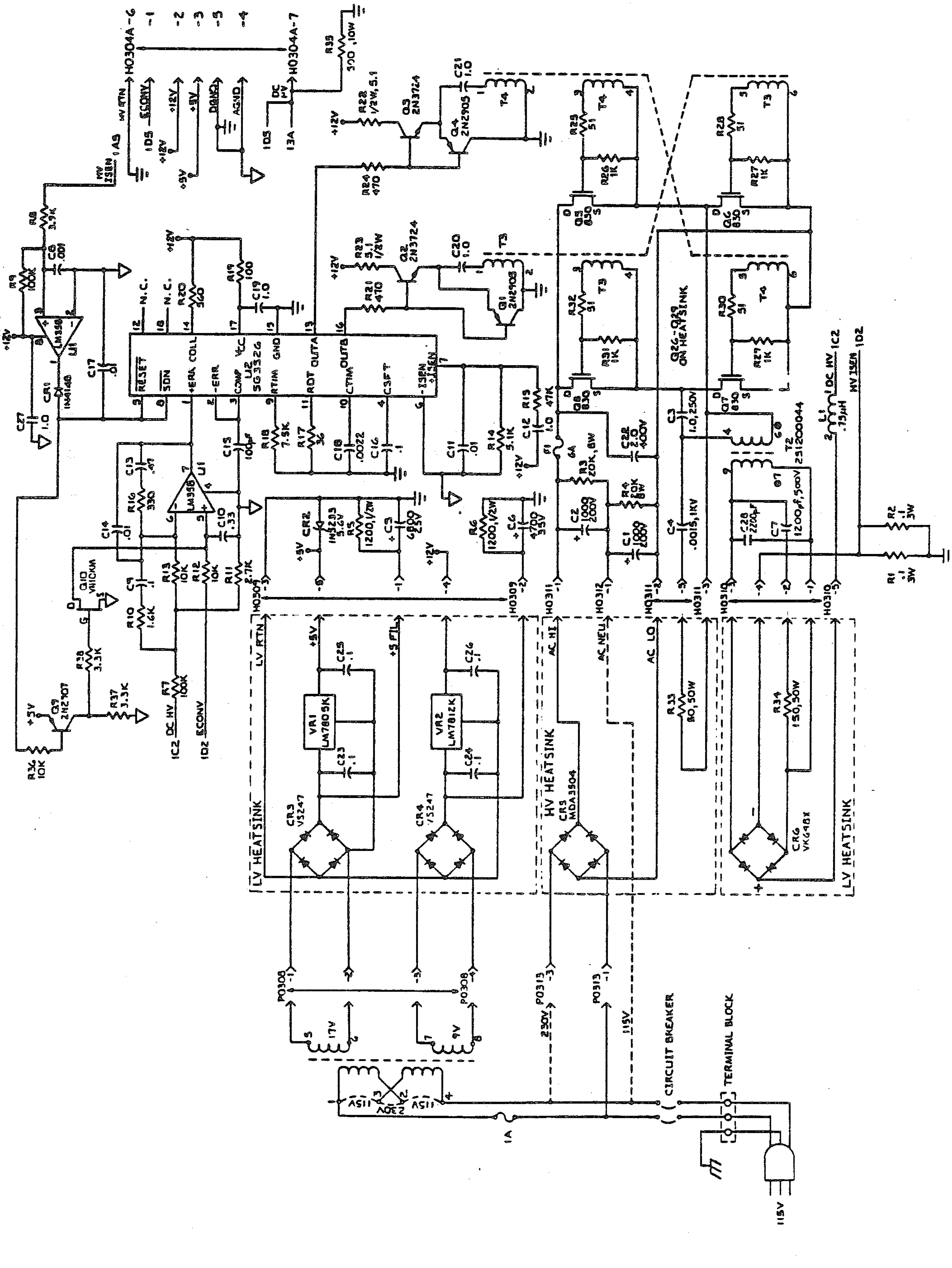


FIGURE 11

POWER SUPPLY BOARD/SCHEMATIC


LV HEATSINK
HV HEATSINK
CIRCUIT BREAKER
TERMINAL BLOCK
115V
230V
Q26-Q29 ON HEATSINK
U2 SG3526
VR1 LM7805K
VR2 LM7812K
CR3 VS247
CR4 VS247
CR5 MDA3504
CR6 VK648X
HO304A-6
HO304A-7
LM358
17V
9V
1A

PAGE INTENTIONALLY LEFT BLANK

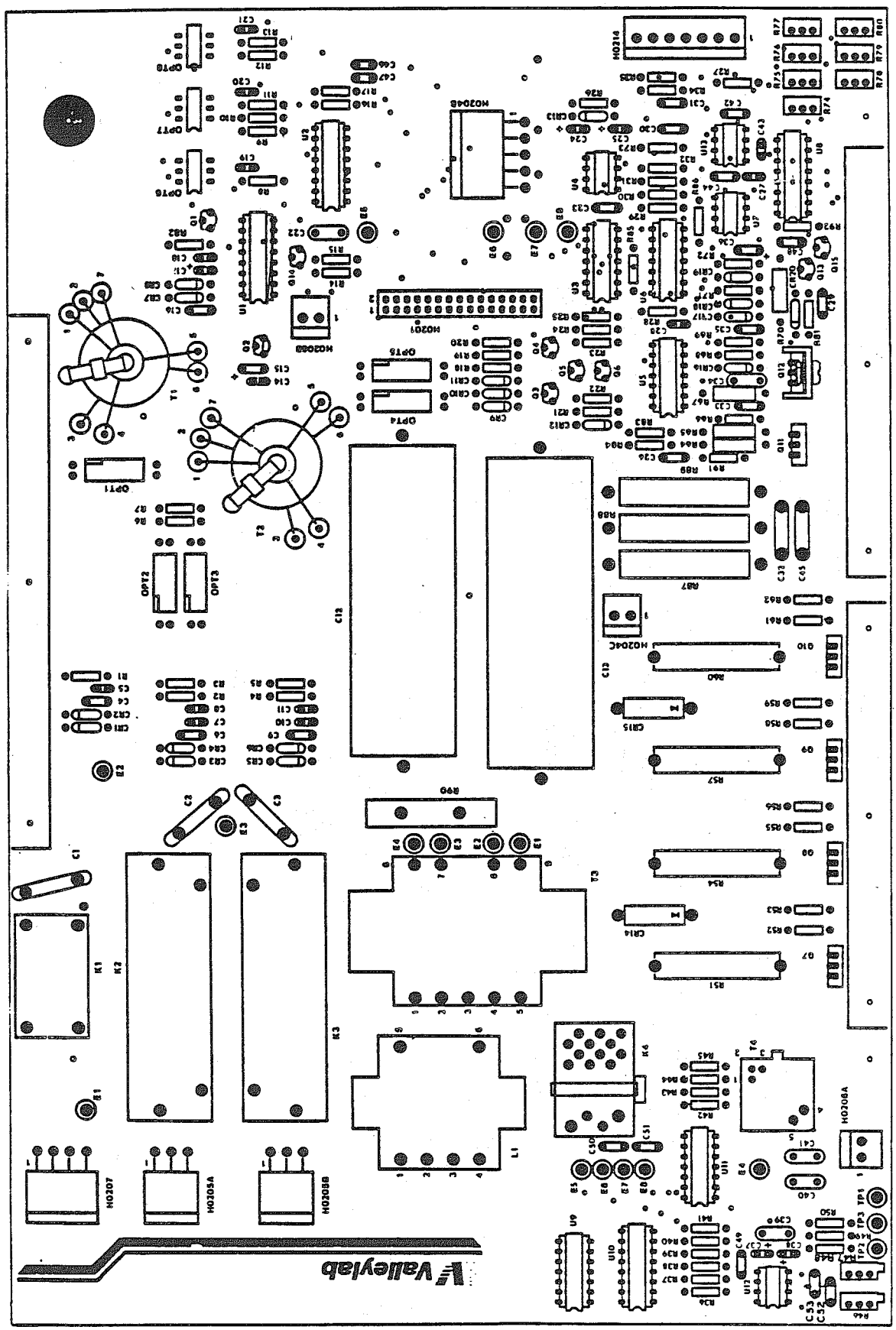
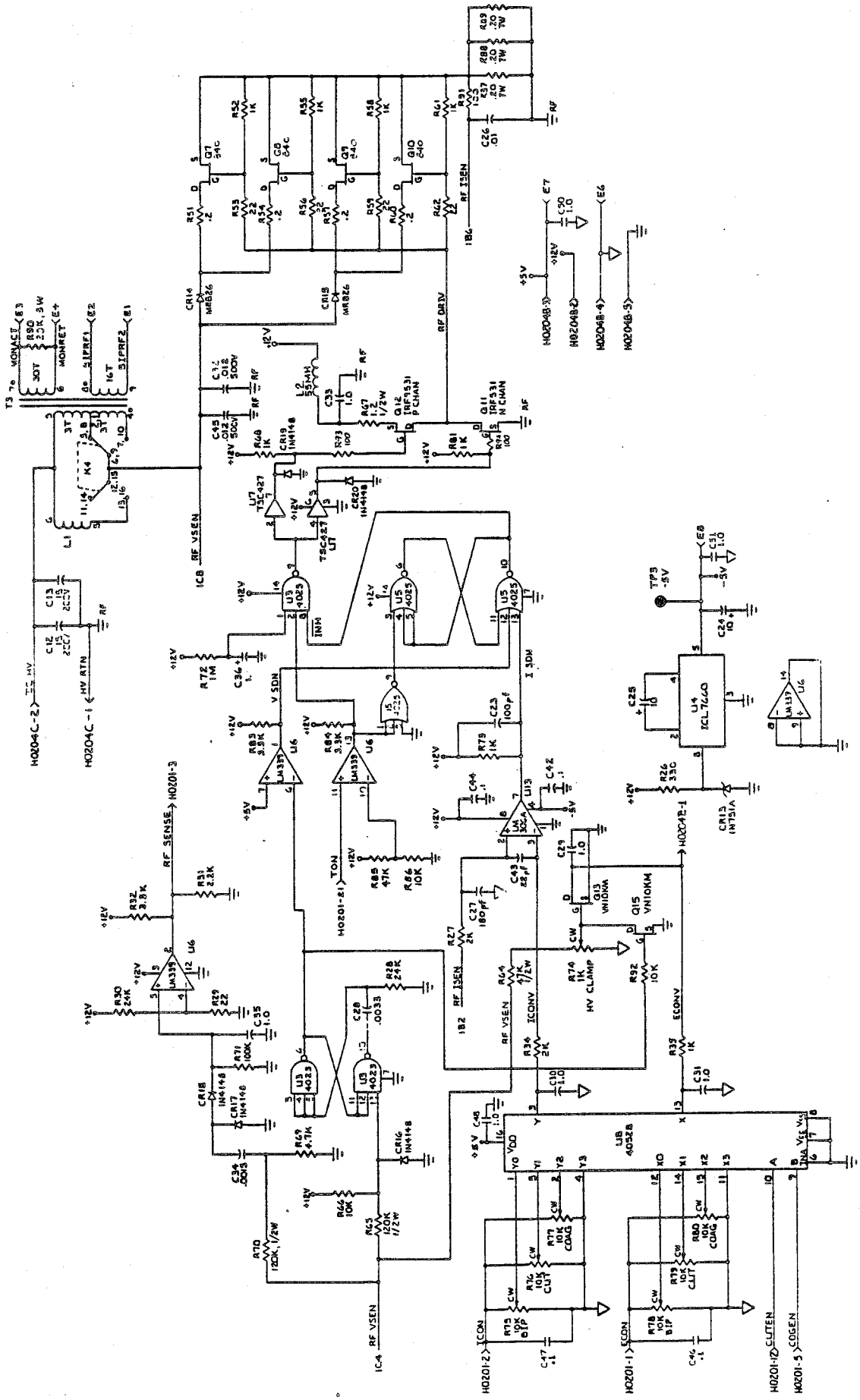
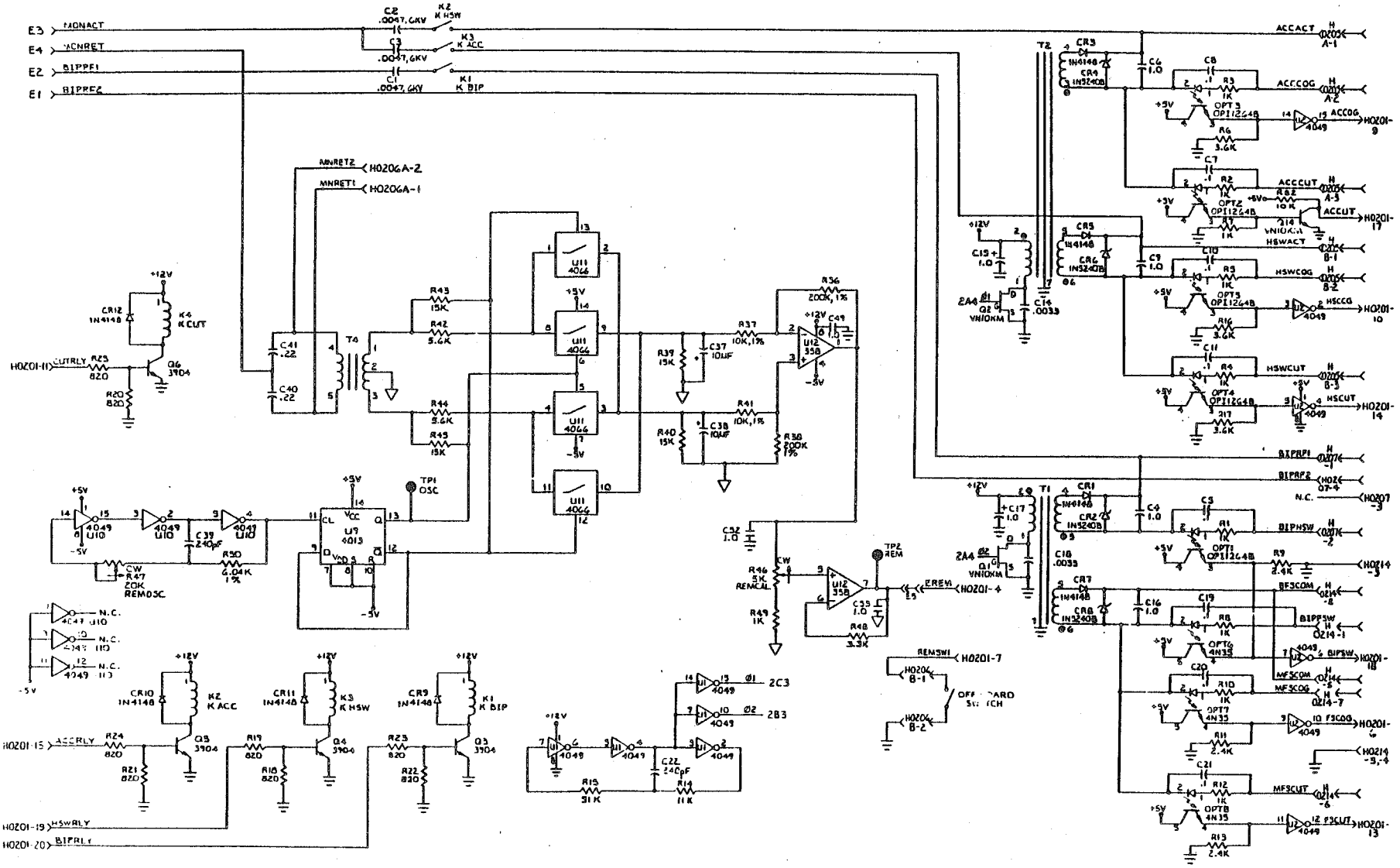


FIGURE 12

RF OUTPUT BOARD/SCHEMATIC




E3 ANACT
E4 ANRET
E2 BIPPE1
E1 BIPRE2
C2 .0047, 6KV
K2 K HSW
C3 .0047, 6KV
K3 K ACC
C1 .0047, 6KV
K1 K BIP
ANRETZ H0206A-2
ANRETI H0206A-1
U11 4066
R43 15K
R42 5.6K
R44 5.6K
R45 15K
T4
C41 .22
C40 .22
CR12 IN4148
K4 K CUT
Q6 3904
HOZOI-11 CUTRLY
R23 820
R20 820
U10 4049
C39 240pF
R50 4.04K 1%
R47 20K REMOSC
U9 4013
TP1 OSC
R37 10K, 1%
R39 15K
C37 10uF
R36 200K, 1%
R41 10K, 1%
R40 15K
C38 10uF
U12 358
C49 1.0
C32 1.0
R46 5K REMCAL
R49 1K
C35 1.0
R48 3.3K
TP2 REM
EREM HOZOI-4
REMSWI HOZOI-7
H0204 B-1
H0204 B-2
OFF BOARD SWITCH
N.C. U10
N.C. U10
N.C. U10
CR10 IN4148
K2 K ACC
CR11 IN4148
K3 K HSW
CR9 IN4148
K1 K BIP
HOZOI-15 ACCRLY
R24 820
R21 820
Q5 3904
R19 820
R18 820
Q4 3904
R23 820
R22 820
Q3 3904
HOZOI-19 HSWRLY
HOZOI-20 BIPRLY
Ø1 2C3
Ø2 2B3
R15 31K
C22 24CpF
R14 11K
T2
T1
CR3 IN4148
CR4 IN5240B
CR5 IN4148
CR6 IN5240B
CR1 IN4148
CR2 IN5240B
CR7 IN4148
CR8 IN5240B
C4 1.0
C5 1.0
C6 1.0
C7 1.0
C8 1.0
C9 1.0
C10 1.0
C11 1.0
C16 1.0
C17 1.0
C18 .0033
C19 1.0
C14 .0033
C15 1.0
2A6 Q2 VN10KM
2A4 Q1 VN10KM
OPT1 OPI12648
OPT2 OPI12648
OPT3 OPI12648
OPT4 OPI12648
OPT6 4N35
OPT7 4N35
OPT8 4N35
ACCACT H 0205 A-1
ACCCOG H 0205 A-2
ACCCUT H 0205 A-3
ACCUT HOZOI-17
HSWACT H 0205 B-1
HSWCOG H 0205 B-2
HSCCG HOZOI-10
HSWCUT H 0205 B-3
HSCUT HOZOI-14
BIPRP1 H 0214 -1
BIPRP2 H 0214 -7
N.C. HOZ07 -3
BIPHSW H 0214 -2
HOZ14 -3
BFSCOM H 0214 -8
BIPPSW H 0214-1
HOZOI-18
MFSCOM H 0214 -5
MFSCOG H 0214-7
10 FSCOG HOZOI-9
HOZ14 -5,-4
MFSCUT H 0214 -6
12 FSCUT HOZOI-13

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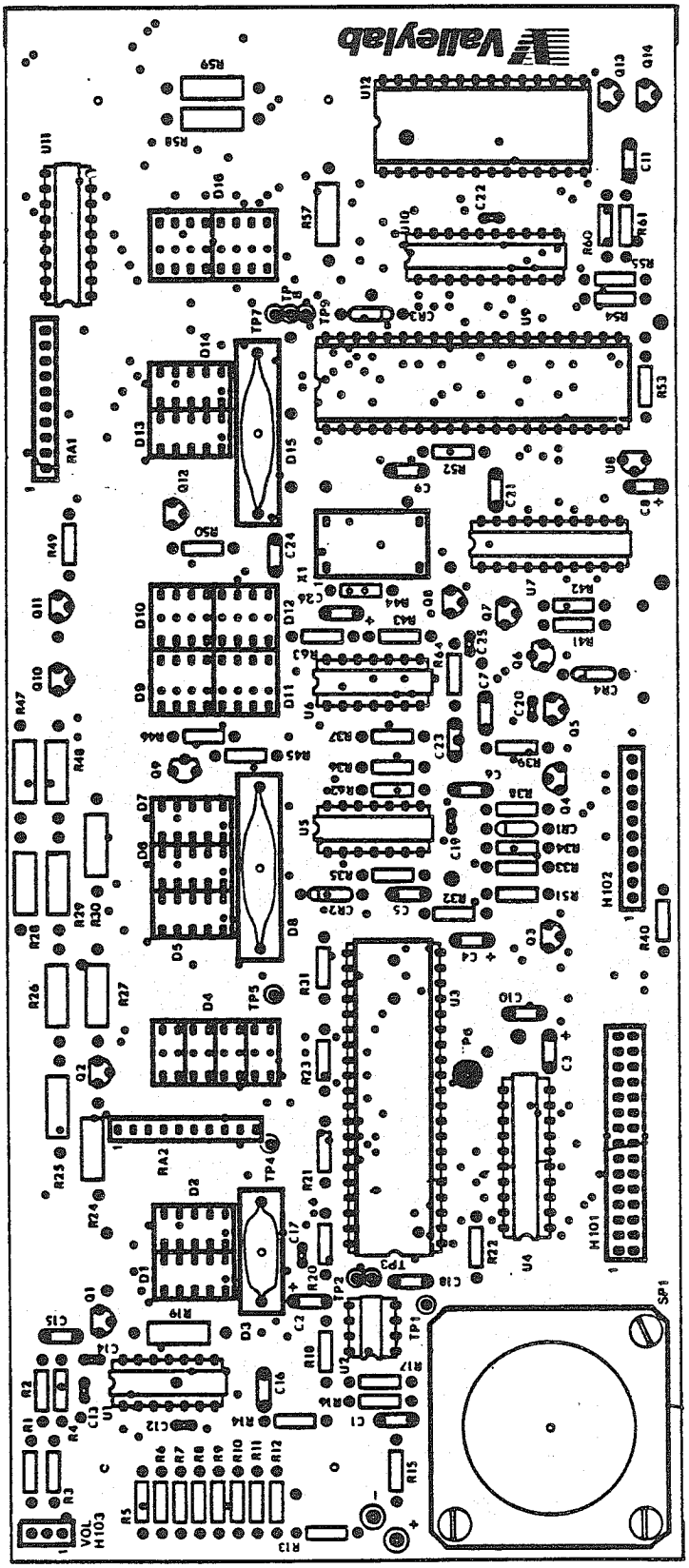
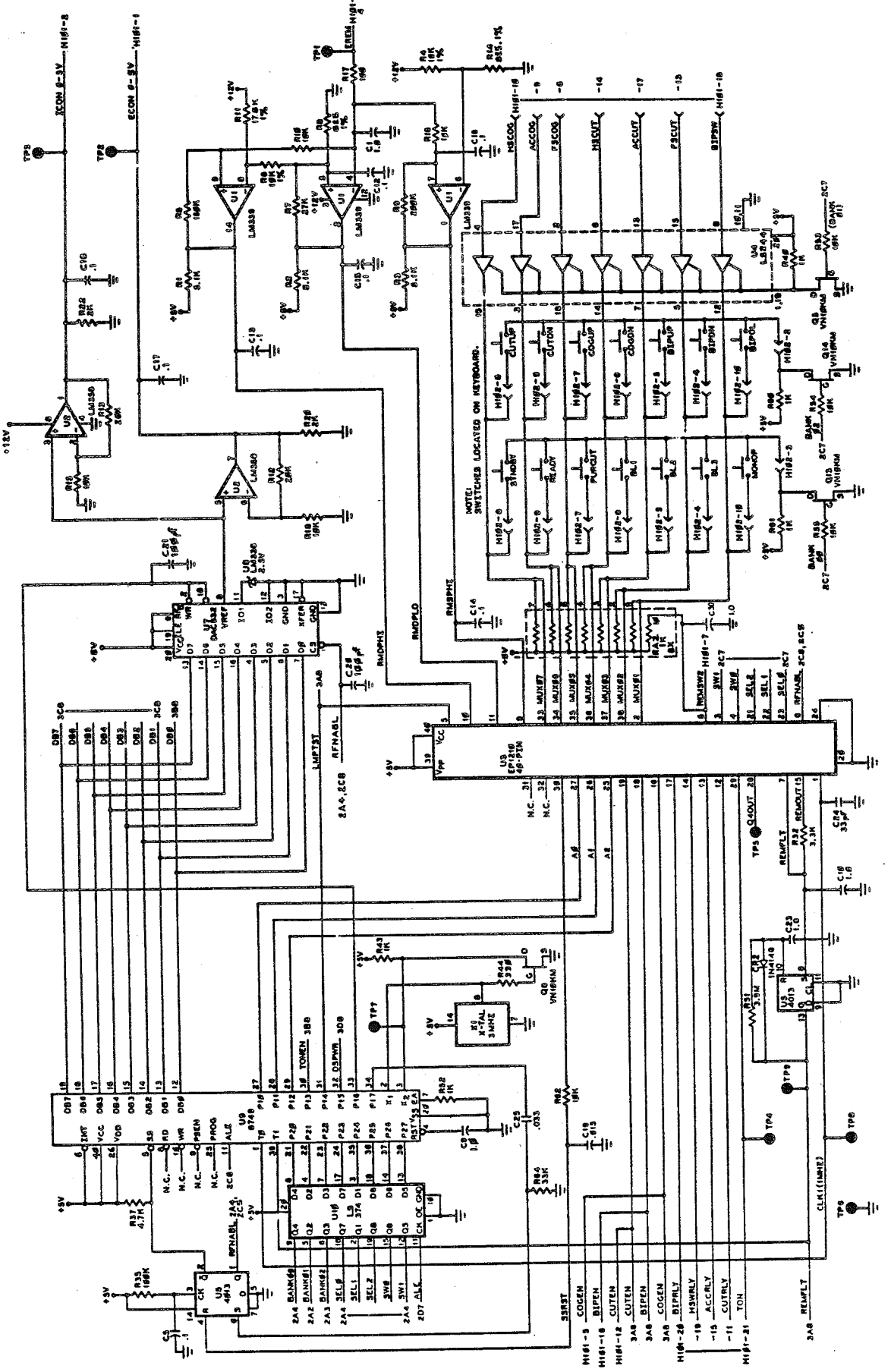
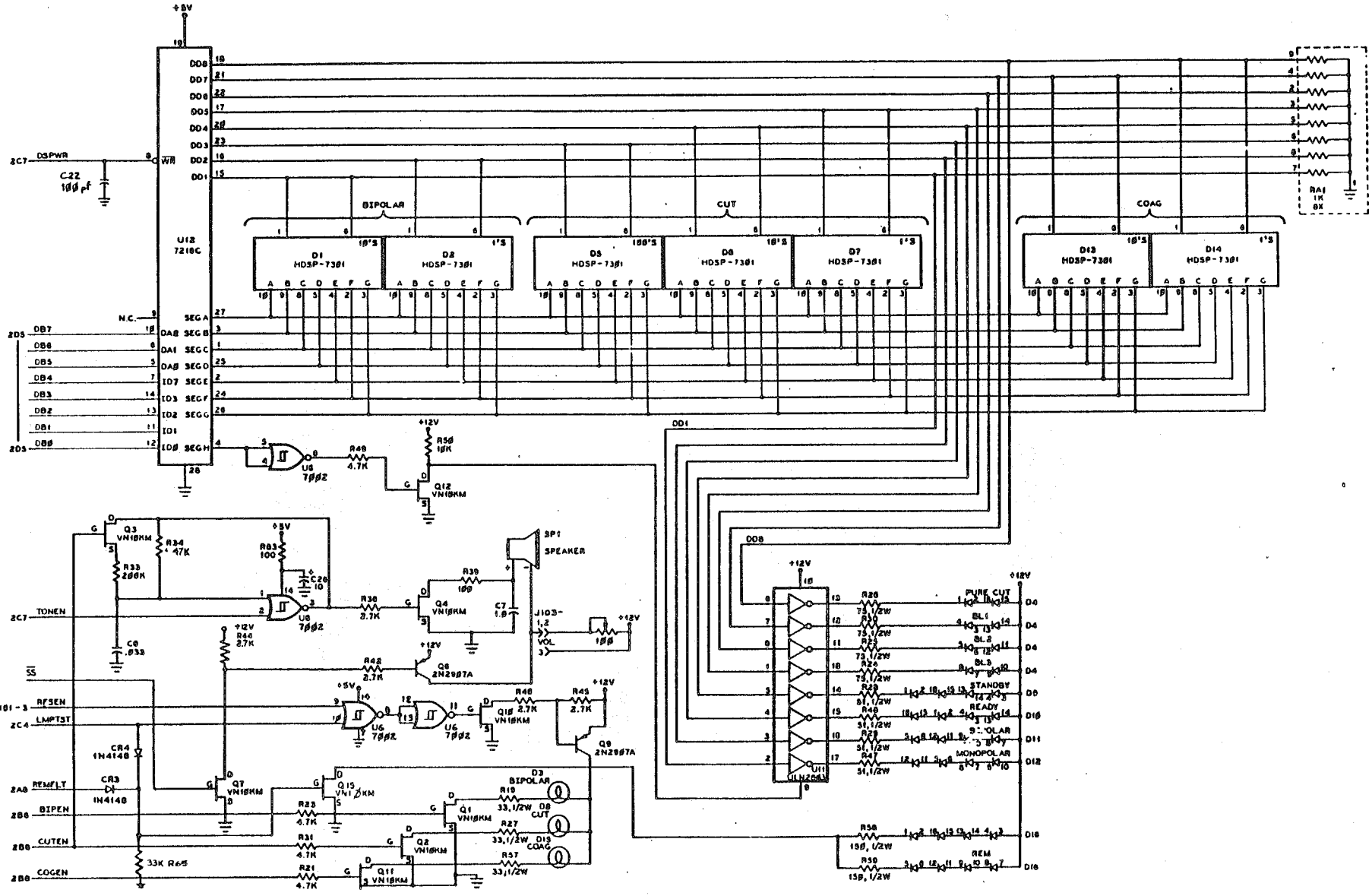


FIGURE 13

DISPLAY-CONTROL BOARD/SCHEMATIC




+5V
DSPWR
C22
100 pf
U12
7218C
BIPOLAR
CUT
COAG
D1 HDSP-7301
D2 HDSP-7301
D5 HDSP-7301
D6 HDSP-7301
D7 HDSP-7301
D13 HDSP-7301
D14 HDSP-7301
RA1
1K
8X
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
U8
7400
R49
4.7K
R50
10K
Q12
VN10KM
+12V
DD1
DD8
SP1
SPEAKER
Q3
VN10KM
R34
47K
R33
200K
R03
100
C26
10
TONEN
R38
2.7K
R39
100
Q4
VN10KM
C7
1.0
J103-
1,2
VOL
3
100
C0
.033
R44
2.7K
R42
2.7K
Q6
2N2907A
SS
J101-3
RESEN
LMPTST
ZC4
U6
7400
R46
2.7K
Q10
VN10KM
R45
2.7K
Q9
2N2907A
CR4
1N4148
CR3
IN4148
REMFLT
BIPEN
CUTEN
COGEN
33K R65
Q7
VN10KM
Q15
VN10KM
R23
4.7K
R31
4.7K
R21
4.7K
Q11
VN10KM
Q1
VN10KM
Q2
VN10KM
D3
BIPOLAR
R19
33,1/2W
D8
CUT
R27
33,1/2W
D13
COAG
R57
33,1/2W
U11
ULN2543
R26
75,1/2W
R25
75,1/2W
R24
75,1/2W
R29
51,1/2W
R28
51,1/2W
R47
51,1/2W
PURE CUT
BL1
BL2
BL3
STANDBY
READY
BIPOLAR
MONOPOLAR
R58
150, 1/2W
R59
150, 1/2W
REM
D4
D8
D10
D11
D12
D16

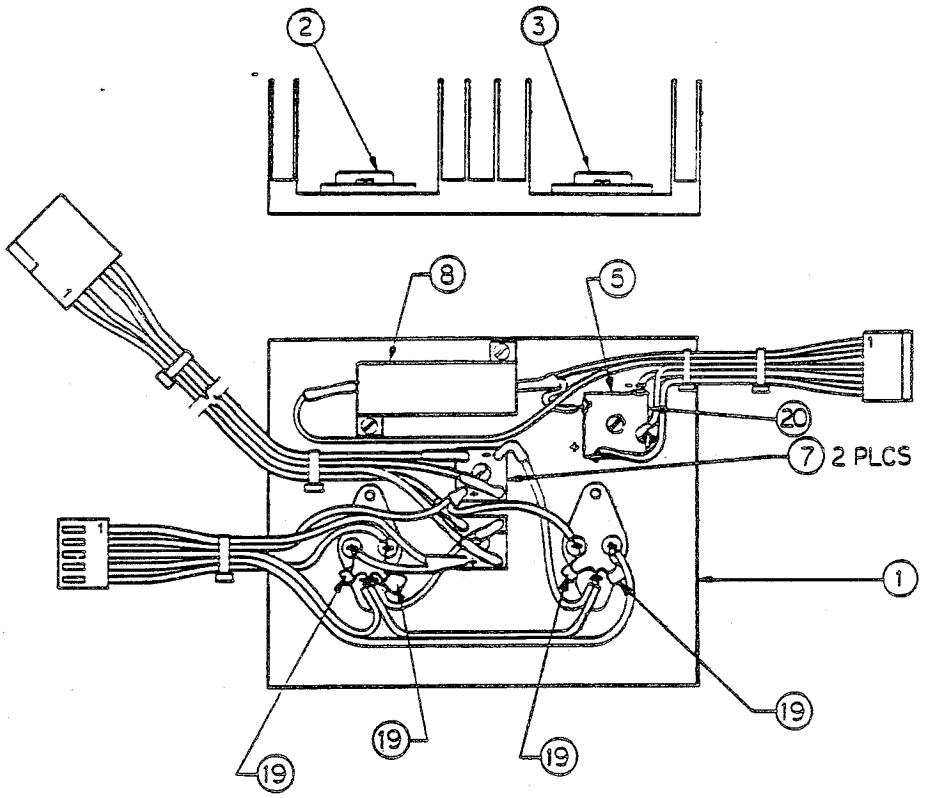


FIGURE 14

HEATSINK ASSY, LVPS

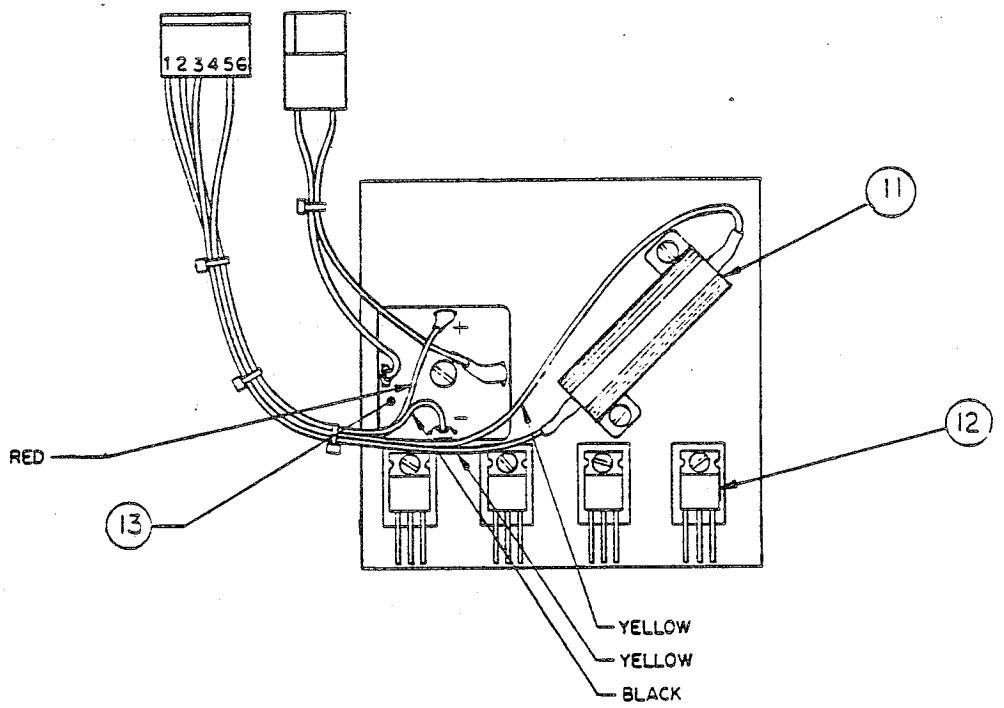


FIGURE 15

HEATSINK ASSY, HVPS

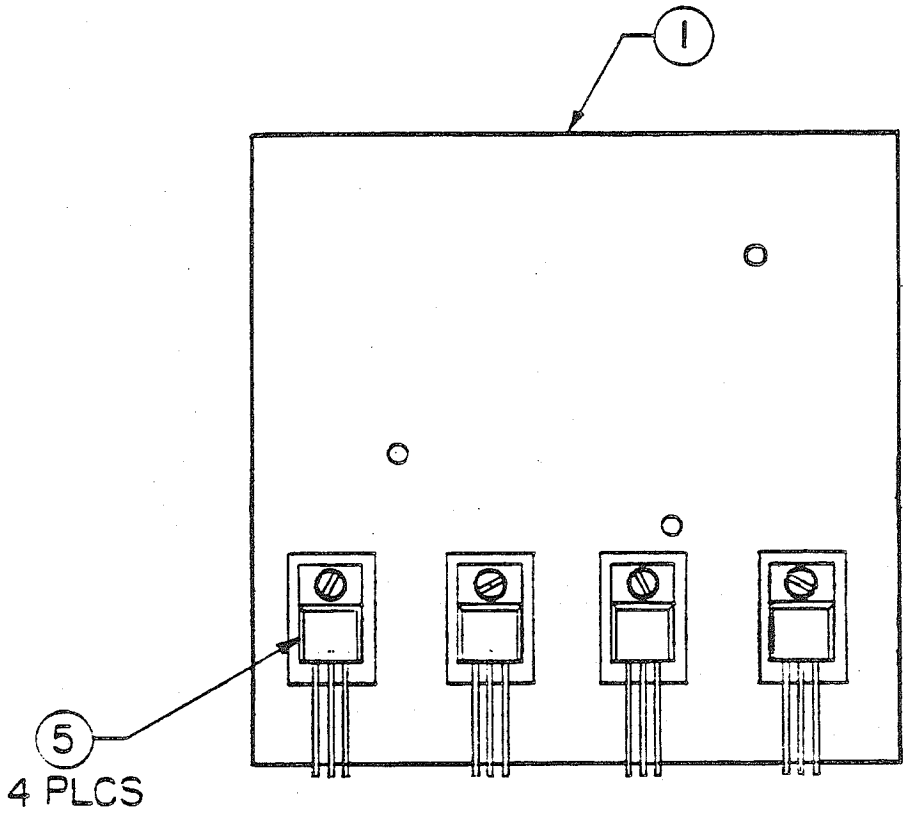


FIGURE 16

HEATSINK ASSY, RF OUTPUT

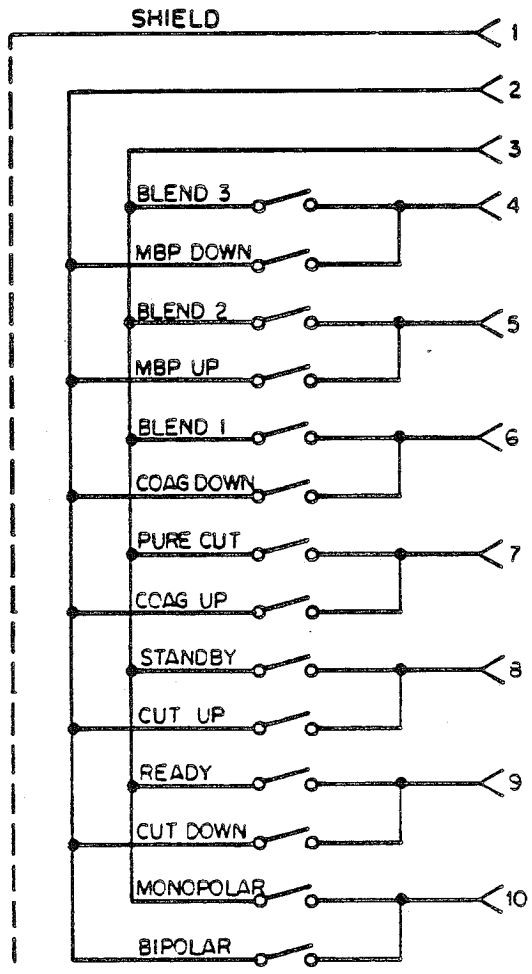


FIGURE 17

KEYBOARD SCHEMATIC

SECTION 8

PARTS LIST

PCB ASSEMBLY, DISPLAY/CONTROL 201 255 002 D

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1-3	5.1K ohm ± 5%, 1/4W	234 024 080
R4, 6	10K ohm ± 1%, 1/8W	234 201 385
R5	160K ohm ± 5%, 1/4W	234 024 116
R7	27K ohm ± 5%, 1/4W	234 024 097
R8, 14	825 ohm ± 1%, 1/8W	234 201 281
R9, 33, 38	200K ohm ± 5%, 1/4W	234 024 118
R10, 15, 16, 18, 50, 53, 54, 55	10K ohm ± 5%, 1/4W	234 024 087
R11	17.8K ohm ± 1%, 1/8W	234 201 409
R12, 13	20K ohm ± 5%, 1/4W	234 024 094
R17, 39, 63	100 ohm ± 5%, 1/4W	234 024 039
R19, 27, 57	33 ohm ± 5%, 1/2W	234 014 078
R20, 22	2K ohm ± 5%, 1/4W	234 024 070
R21, 23, 31, 36, 37, 49	4.7K ohm ± 5%, 1/4W	234 024 079
R24, 25, 26, 30	75 ohm ± 5%, 1/2W	234 014 086
R28, 29, 47, 48	51 ohm ± 5%, 1/2W	234 014 083
R32	3.3K ohm ± 5%, 1/4W	234 024 075
R34	330K ohm ± 5%, 1/4W	234 024 123
R35	100K ohm ± 5%, 1/4W	234 024 111
R40, 43, 52, 60 - 62	1K ohm ± 5%, 1/4W	234 024 063
R41, 42, 45, 46	2.7K ohm ± 5%, 1/4W	234 024 073
R44	330 ohm ± 5%, 1/4W	234 024 051
R51	3.9M ohm ± 5%, 1/4W	234 024 148
R58, 59	150 ohm ± 5%, 1/2W	234 014 021
R64, 65	33K ohm ± 5%, 1/4W	234 024 099
RA1, 2	RESISTOR ARRAY, 1K SIP	234 100 134
CAPACITORS		
C1, 7, 9, 10, 23, 27	1.0uf ± 20%, 50V	204 118 014
C2, 3, 4, 8	1.0uf ± 10%, 35V	204 104 001
C5, 11-18	0.1uf ± 20%, 50V	204 118 007
C6, 25	.033uf ± 20%, 50V	204 118 004
C19	.015mf ± 20%, 50V	204 118 002
C20, 21, 22	100pf ± 15%, 100V	204 200 013
C24	33pf	204 200 007
C26	10uf, 35V	204 104 048

PCB ASSEMBLY, DISPLAY/CONTROL (CONT'D) 201 255 002 D

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
INTEGRATED CIRCUITS		
U1	LM339AN	210 300 015
U2	LM358AN	210 300 013
U3	EPLD 1210	210 700 003
U4	74LS244	210 520 244
U5	4013B	210 027 001
U6	7002	210 250 095
U7	DAC 0832	210 750 002
U8	LM336	210 300 016
U9	8749H-3	210 760 012
U10	74LS374	210 520 374
U11	2803A	210 800 002
U12	ICM7218	210 700 001
TRANSISTORS		
Q1-5, 7, 8, 10-15	VN10KM	239 200 012
Q6, 9	2N2907A	239 100 012
DIODES		
CR1-4	1N4148	239 014 000
L.E.D.'S		
D1, 2, 5, 6, 7, 13, 14	7 SEG RED	239 750 029
D3	PTL 6/12	215 200 071
D4	HLMP2720	239 750 022
D8, 15	PTL 20D/12	215 200 070
D9, 11, 12	HLMP2755	239 750 033
D10	HLMP2855	239 750 039
D16	HLMP2685	239 750 024
MISCELLANEOUS		
SP1	SPEAKER, #707	241 030 000
X1	XTAL OSCILLATOR 3.0 HHz	250 010 013

PCB ASSEMBLY, POWER SUPPLY 201 224 002 A

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1, 2	.1 ohm ± 3%, 3W	234 028 001
R3, 4	20K ohm ± 5%, 8W	234 000 017
R5, 6	1.2K ohm ± 5%, 1/2W	234 014 041
R7, 9	100K ohm ± 5%, 1/4W	234 024 111
R8	3.9K ohm ± 5%, 1/4W	234 024 077
R10	1.6K ohm ± 5%, 1/4W	234 024 068
R11	2.7K ohm ± 5%, 1/4W	234 024 073
R12, 13, 36	10K ohm ± 5%, 1/4W	234 024 087
R14	5.1K ohm ± 5%, 1/4W	234 024 080
R15	47K ohm ± 5%, 1/4W	234 024 103
R16	330 ohm ± 5%, 1/4W	234 024 051
R17	36 ohm ± 5%, 1/4W	234 024 028
R18	7.5K ohm ± 5%, 1/4W	234 024 084
R19	100 ohm ± 5%, 1/4W	234 024 039
R20	560 ohm ± 5%, 1/4W	234 024 057
R21, 24	470 ohm ± 5%, 1/4W	234 024 055
R22, 23	5.1 ohm ± 5%, 1/2W	234 014 061
R25, 28, 30, 32	51 ohm ± 5%, 1/4W	234 024 032
R26, 27, 29, 31	1K ohm ± 5%, 1/4W	234 024 063
R35	500 ohm, 10W	234 030 221
R37, 38	3.3K ohm ± 5%, 1/4W	234 024 075
CAPACITORS		
C1, 2	1000uf	204 500 103
C3	1uf, 250V	204 400 138
C4	.0015uf ± 10%, 1000V	204 079 059
C5	6800uf	204 500 106
C6	4700uf	204 500 105
C7	1200pf ± 5%, 500V	204 105 028
C8	1000pf ± 15%, 100V	204 200 025
C9, 16	0.1uf ± 20%, 50V	204 118 007
C10	.33uf, ± 20%, 50V	204 118 011
C11, 14, 17	.01uf ± 20%, 50V	204 118 001
C12, 19, 20, 21, 27	1.0uf ± 20%, 50V	204 118 014
C13	.47uf ± 20%, 50V	204 118 012
C15	100pf ± 15%, 100V	204 200 013
C18	2200pf ± 5%, 500V	204 105 034
C22	2uf, 400V	204 400 001
C28	.0022uf, 6KV	204 025 044

PCB ASSEMBLY, POWER SUPPLY (CONT'D) 201 224 002 A

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
INTEGRATED CIRCUITS		
U1	LM358AN	210 300 013
U2	SG 3526	210 300 062
TRANSISTORS		
Q1, 4	2N2905A	239 019 000
Q2, 3	MM3724	239 052 000
Q9	2N2907	239 100 012
Q10	VN10KM	239 200 012
DIODES		
CR1	1N4148	239 014 000
CR2	1N5223B	239 600 000
TRANSFORMERS		
T2	SWITCHING TRANSFORMER	251 200 044
T3, 4	PULSE TRANSFORMER	251 200 043
MISCELLANEOUS		
F1	FUSE, 6 Amps	215 005 039
L1	INDUCTOR 0.75 MH T-0403	251 039 000

PCB ASSEMBLY, RF — 201 256 001 C

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1-5, 7, 8, 10, 12, 34, 35, 49, 52, 55, 58, 61, 68, 73, 81	1K ohm ± 5%, 1/4W	234 024 063
R6, 16, 17	3.6K ohm ± 5%, 1/4W	234 024 076
R9, 11, 13	2.4K ohm ± 5%, 1/4W	234 024 072
R14	11K ohm ± 5%, 1/4W	234 024 088
R15	51K ohm ± 5%, 1/4W	234 024 104
R18-25	820 ohm ± 5%, 1/4W	234 024 061
R26	330 ohm ± 5%, 1/4W	234 024 051
R27, 34	2K ohm ± 5%, 1/4W	234 024 070
R28, 30	24K ohm ± 5%, 1/4W	234 024 096
R29, 53, 56, 59, 62	22 ohm ± 5%, 1/4W	234 024 023
R31	2.2K ohm ± 5%, 1/4W	234 024 071
R32, 48, 83, 84	3.3K ohm ± 5%, 1/4W	234 024 075
R36, 38	200K ohm ± 1%, 1/8W	234 201 510
R37, 41	10K ohm ± 1%, 1/8W	234 201 385
R39, 43, 45	15K ohm ± 5%, 1/4W	234 024 091
R40, 66, 82, 86, 92	10K ohm ± 5%, 1/4W	234 024 087
R42, 44	5.6K ohm ± 5%, 1/4W	234 024 081
R46	TRIMPOT 5.0K ohm #3299X	236 010 006
R47	TRIMPOT 20K ohm	236 010 008
R50	6.04K ohm ± 1%, 1/8W	234 201 364
R51, 54, 57, 60	RESISTOR ASSY, .2 ohm	203 077 001
R64	47K ohm ± 5%, 1/2W	234 014 115
R65, 70	120K ohm ± 5%, 1/2W	234 014 124
R67	1.2 ohm ± 5%, 1/2W	234 014 048
R69	4.7K ohm ± 5%, 1/4W	234 024 079
R71	100K ohm ± 5%, 1/4W	234 024 111
R72	1 Meg ± 5%, 1/4W	234 024 135
R74	TRIMPOT 1K ohm	236 200 076
R75-80	TRIMPOT 10K ohm	236 200 079
R85	47K ohm ± 5%, 1/4W	234 024 103
R87, 88, 89	0.2 ohm ± 5%, 7W	234 300 060
R90	20.0K ohm ± 5%, 8W	234 000 017
R91	100 ohm ± 5%, 1/4W	234 024 039
R93, 94	100 ohm ± 5%, 1/2W	234 014 088
CAPACITORS		
C1, 2, 3	.0047uf ± 20%, 6KV	204 025 050
C4, 6, 9, 16, 29, 30, 31, 33, 35, 48-51	1.0uf ± 20%, 50V	204 118 014
C5, 7, 8, 10, 11, 19, 20, 21, 42, 44, 46, 47	0.1uf ± 20%, 50V	204 118 007
C12, 13	15uf ± 10%, 220V	204 400 130
C14, 18, 28	.0033uf ± 10%, 100V	204 121 095
C15, 17, 36	1.0uf ± 10%, 35V	204 104 001
C22, 39	240pf ± 5%, 500V	204 105 011

PCB ASSEMBLY, RF (CONT'D) 201 256 001 C

REFERNCE DESIGNATOR	DESCRIPTION	VALLEYLAB PART NUMBER
C23	100pf ± 15%, 100V	204 200 013
C24, 25, 37, 38	10uf ± 10%, 20V	204 055 002
C26	.01uf ± 20%, 50V	204 118 001
C27	180pf ± 15%, 100V	204 200 016
C32, 45	.012uf ± 5%, 500V	204 085 010
C34	.0015uf ± 10%, 1000V	204 079 059
C40, 41	.22uf ± 15%, 50V	204 200 115
C43	22pf ± 15%, 100V	204 200 005
INTEGRATED CIRCUITS		
U1, 2, 10	4049B	210 210 049
U3	4023B	210 210 023
U4	ICL7660CPA	210 300 072
U5	4025B	210 210 025
U6	LM339AN	210 300 015
U7	TSC427	210 800 011
U8	4052	210 210 052
U9	4013B	210 027 000
U11	4066	210 200 022
U12	LM358AN	210 300 013
U13	LM306	210 016 002
TRANSISTORS		
Q11	IRF531	239 200 014
Q12	IRF9531	239 200 015
Q3-6	2N3904	239 015 000
Q1, 2, 13, 14, 15	VN10KM	239 200 012
DIODES		
CR14, 15	MR826	239 066 005
CR1, 3, 5, 7, 9, 10-12, 16-20	1N4148	239 014 000
CR13	1N751A	239 600 011
CR2, 4, 6, 8	1N5240B	239 600 001
MISCELLANEOUS		
K1	RELAY, HI VOLTAGE	230 007 006
K2, 3	RELAY, HI VOLTAGE	230 006 018
K4	RELAY, 4 POLE	230 007 002
OPT1-5	PHOTOISOLATOR 1264B	239 750 019
OPT6-8	OPTOISOLATOR 4N35	239 750 002
L1	INDUCTOR	251 100 077
L2	RF CHOKE, 55uH	251 100 098
T1, 2	TOROID ASSY	202 224 000
T3	TRANSFORMER, RF OUTPUT	251 200 030
T4	TRANSFORMER, RF INPUT	202 900 017

HEATSINK ASSY, RF — 202 701 323 B

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
1	HEATSINK	223 400 476
5	PWR FET	239 200 022

HEATSINK ASSY, LVPS — 202 701 322 B

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
1	HEATSINK	223 400 410
2	VOLTAGE REG. LM340K-5.0	210 300 073
3	VOLTAGE REG. LM340K-12	210 300 074
5	RECTIFIER VK648X	239 700 034
7	RECTIFIER VS247	239 006 000
8	RES. 150 ohm ± 3%, 50W	234 003 005
19	CAP 0.1uf ± 20%, 50V	204 118 007

HEATSINK ASSY, HVPS — 202 701 321 A

REFERENCE DESIGNATOR	DESCRIPTION	VALLEYLAB PART NUMBER
1	HEATSINK	223 400 476
11	RES. 50 ohm ± 5%, 50W	234 003 007
12	POWER FET	239 200 016
13	RECTIFIER MDA 3504	239 700 003

GENERATOR CHASSIS ASSEMBLY — 202 701 268 A

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
	CIRCUIT BREAKER ASSY	202 701 324
	FUSE, 1 Amp	215 005 032
	VOLUME CONTROL ASSY	202 701 325
	TRANSFORMER ASSY	202 900 033

SECTION 9

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	One Year
Mounting Fixtures (all models)	One Year
Footswitches (all models)	One Year
Return Electrodes	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 Manfuacturer'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, Inc., its dealers and representatives, reserve the right to make changes in equipment built and/or sold by them at anytime without incurring any obligation to make the same or similar changes on equipment previously built and/or sold by them.