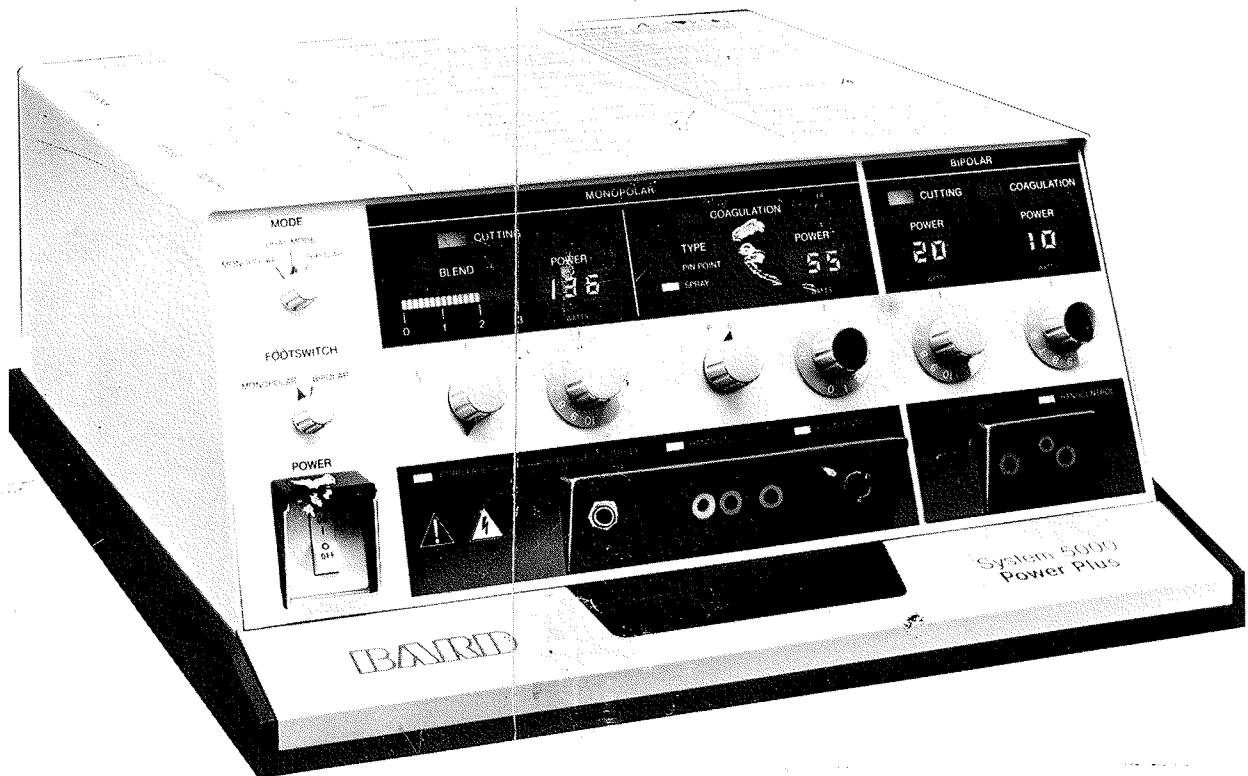


Bard Electro Medical Systems System 5000 Power Plus

Technical Manual



BARD

System 5000 Power Plus **Electrosurgical Generator**

Preface

The System 5000 **Power Plus** is a multi-purpose electrosurgical generator for use in the modern operating room. It features both monopolar and bipolar functions to satisfy all of your surgical demands with safety, flexibility, reliability and convenience.

The System 5000 **Power Plus** offers two levels of coagulation, pinpoint and spray. Pinpoint coagulation provides precise control of bleeding in localized areas. Spray coagulation provides greater control of bleeding in highly vascular tissues over broad surface areas. This unit also offers infinitely variable blend that allows you to set the exact power desired for pure cut or cutting with hemostasis.

For your convenience, the power output of the System 5000 **Power Plus** is calibrated in watts with large, illuminated digital displays. For your safety this unit has totally separate bipolar controls, discrete output, cord fault alarm and isolated R.F. output.

Bard Electro Medical Systems

System 5000

Power Plus

Technical Manual



BAIRD

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Specifications

System 5000 Power Plus Specifications

Performance

Output Waveform:

Pure Cut:	500 KHz Sinusoid (Independent of load)
Blend:	Pulse modulated variable duration 500 KHz Sinusoid (500 Ohm Load) Pulse duration variable from 47 ± 2 usec to 14usec Period 50usec
Bipolar Cut:	500 KHz Sinusoid (Independent of load).
Bipolar Coag:	Pulse modulated 500 KHz Sinusoid (125 Ohm Load) Pulse duration 7usec nominally Period 50usec
Pinpoint Coag:	Pulse modulated 500 KHz Sinusoid (500 ohm load) Pulse duration 7usec nominally Period 50 usec Open circuit: Waveform is damped sinusoid.
Spray Coag:	Pulse modulated 500 KHz damped sinusoid (open circuit). Pulse duration 4usec nominally (500 ohm load) Period 32usec. Open circuit: Waveform is damped sinusoid.

Specifications

System 5000 Power Plus Specifications

Output characteristics (maximum control settings)

Frequency all modes 500KHz

<u>Mode</u>	<u>Power</u> (Typical)	<u>P/P Voltage</u> (Maximum open circuit)
Cut	350 W	2000 V
Cut Blend 1.5	320 W	3600 V
Coag Pinpoint	130 W	4000 V
Coag Spray	75 W	8000 V
Cut Bipolar	50 W	550 V
Coag Bipolar	50 W	1280 V

-- 500 ohm

125 ohm

Input Characteristics (Typical)

Maximum control setting into 500 ohm load

Model 132030, 132036

Models 132031, 132033, 132034, 132035

115 VAC 60 Hz

220/240 VAC 50 Hz

Idle: 0.6 A

Idle: 0.3 A

Cut: 12 A

Cut: 6 A

Coag: 6 A

Coag: 3 A

A = Amps
 Hz = Hertz
 V = Volts
 W = Watts

System 5000 Power Plus Specifications

Risk Currents (Typical)

R.F. High Frequency (Per IEC 601-2-2 Sec 19.101)
AAMI 1982 Draft for Electrosurgery (200 ohm load)

	<u>Patient to Ground</u>	<u>Active to Ground</u>
Cut Pure	100 ma	100 ma
Coag Pinpoint	70 ma	70 ma
Coag Spray	125 ma	120 ma
Coag Bipolar	105 ma	95 ma
Coag Bipolar	95 ma	90 ma

General

Classification: Class I

Type:

CF



Spillage Protection:

Drip Proof



Internal Design: Solid State

Output Configuration: RF Floating (Isolated)

Cooling: Convection (No Fan)

Dimensions: 8 H x 18 W x 19 D Inches
20 x 4 x 46 W x 49 D Centimeters

Weight: 43 lbs. (19 KG)

Approvals: BS5724, SPRIMA, TNO (220/240V)

UL544, CSA22.2 No. 125 (115V), AS. 3200, 3202

ma = milliamp

CF = Cardiac Floating (See Glossary)

System 5000 Power Plus Specifications

Risk Currents (Typical)

Low Frequency (Per IEC 601-1 Sec 19)

Earth Leakage (Ground)	.042 ma (N.C.), 0.0003 ma (S.F.C.)
Enclosure Leakage	.042 ma (N.C.), 0.080 ma (S.F.C.)
Patient Leakage (Type CF)	0.0004 ma (N.C.), 0.0004 ma (S.F.C.)
Mains Voltage on AP (Type CF)	0.001 ma
Patient Auxiliary (Type CF)	.0001 ma (N.C.), .0001 ma (S.F.C.)

Risk Currents (Typical)

Low Frequency (Per U.L. 544 Sec 27)

Chassis to Neutral

Line Polarity Normal (Ground Open)	18.0 uA
Line Polarity Reversed (Ground Open)	24.0 uA

Patient Lead (All - RF Active or Neutral)

Line Polarity Normal - Ground Closed	0.4 uA
Line Polarity Reversed - Ground Closed	0.5 uA
Line Polarity Normal - (Ground Open)	1.5 uA
Line Polarity Reversed - (Ground Open)	2.5 uA

AP Applied Part
CF Cardiac Floating
ma Milliamp
N.C. Normal Condition
S.F.C. = Single Fault Condition
uA Microamp

Visual Indicators:

Coag	Blue
Cut	Yellow
Bipolar Coag	Blue
Bipolar Cut	Yellow
Cord Fault	Red
Footswitch Select	Green
Mode Select	Green

Audio Indicators:

Cord Fault	1KHz Modulated Tone
Monopolar Cut Mode	1K Hz
Monopolar Coag Mode	500 Hz
Bipolar Cut	250 Hz
Bipolar Coag	125 Hz

Rear adjustment for Cut and Coag tone (Audio Tone cannot be silenced). Cord fault alarm is not adjustable.

Electrical:

Line Regulation:

Output power is unaffected by line voltage variation of $\pm 10\%$.

Table 1-1

TYPICAL AC INPUT VOLTAGE VS OUTPUT POWER

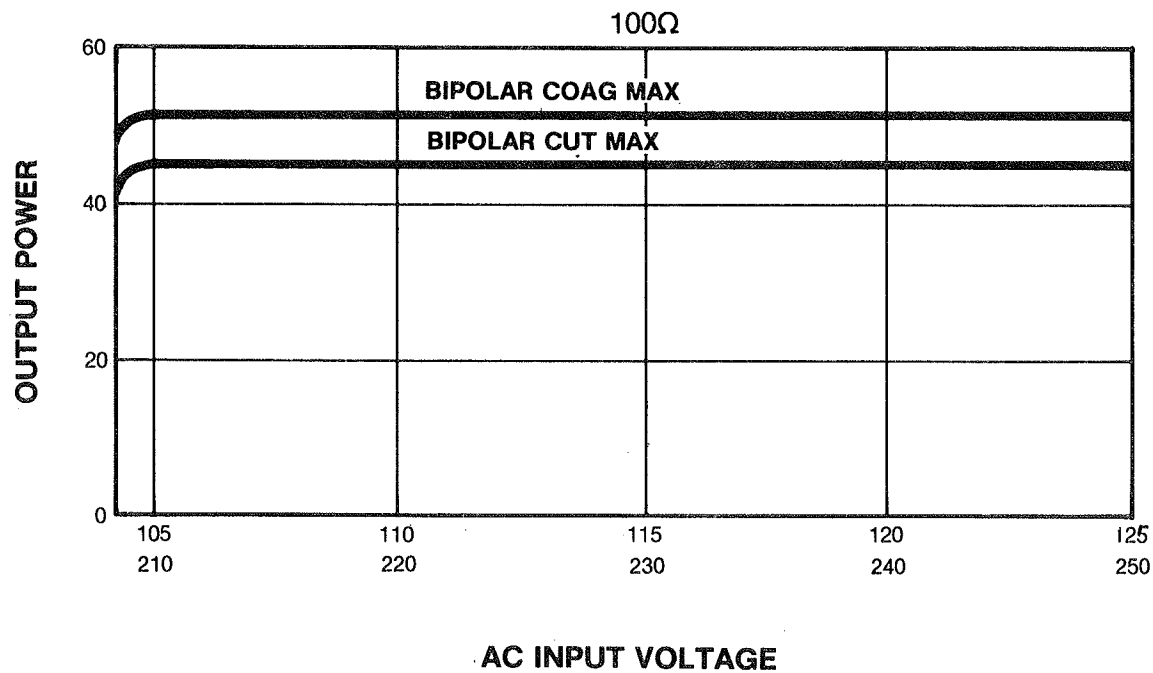
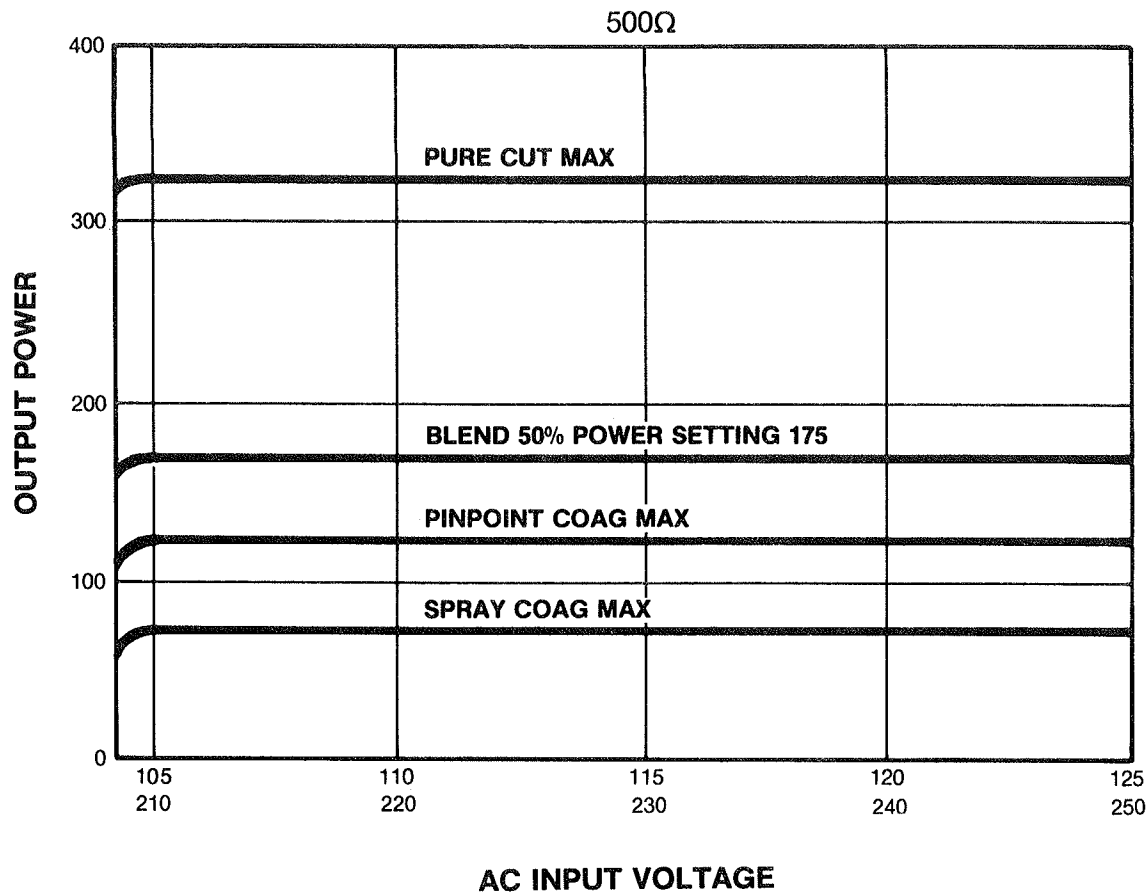
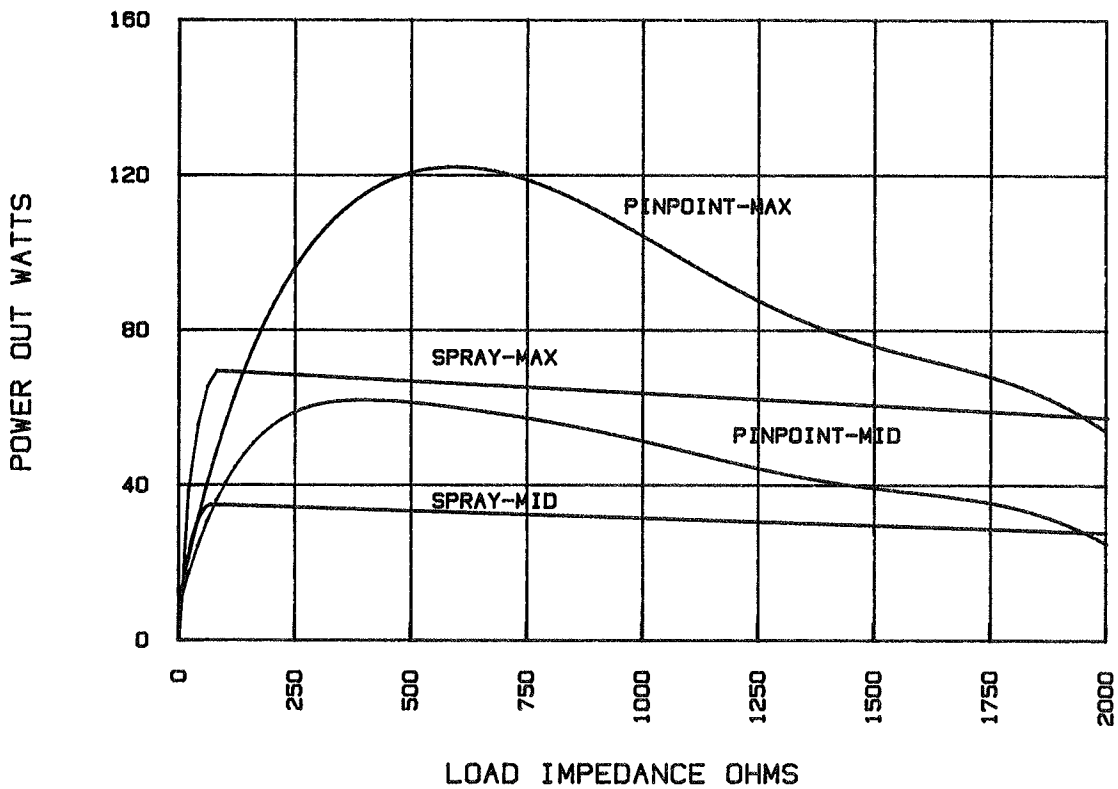
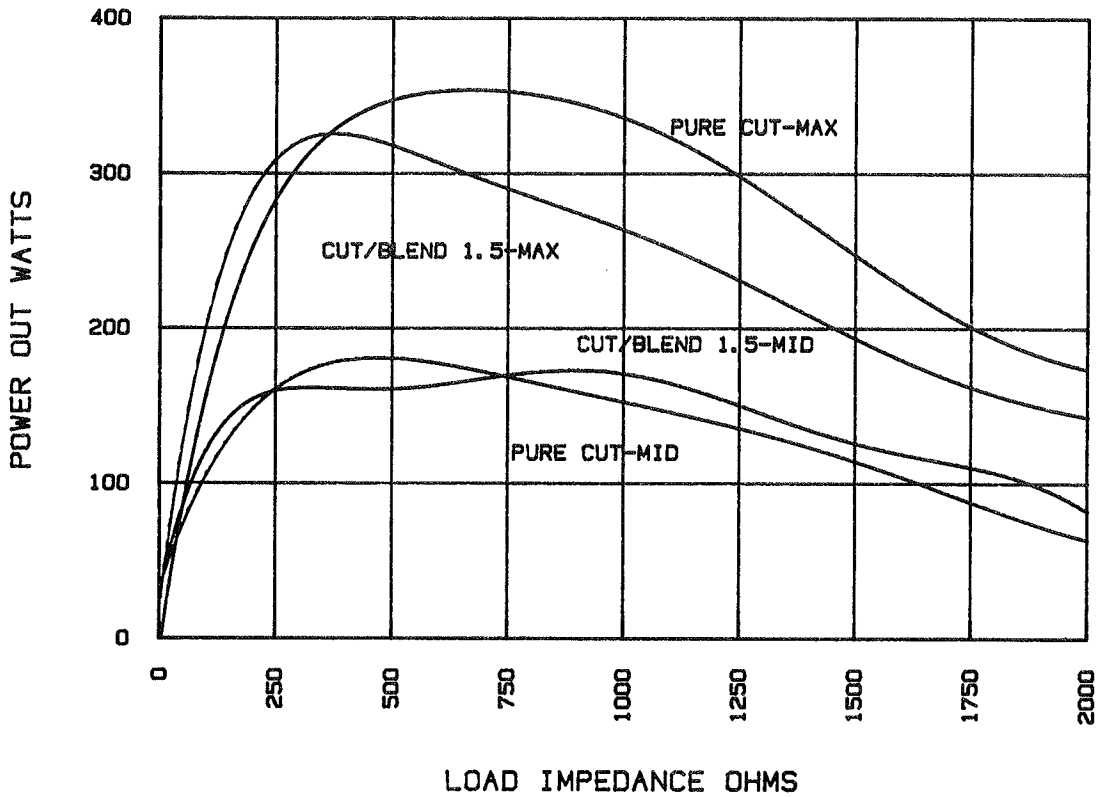


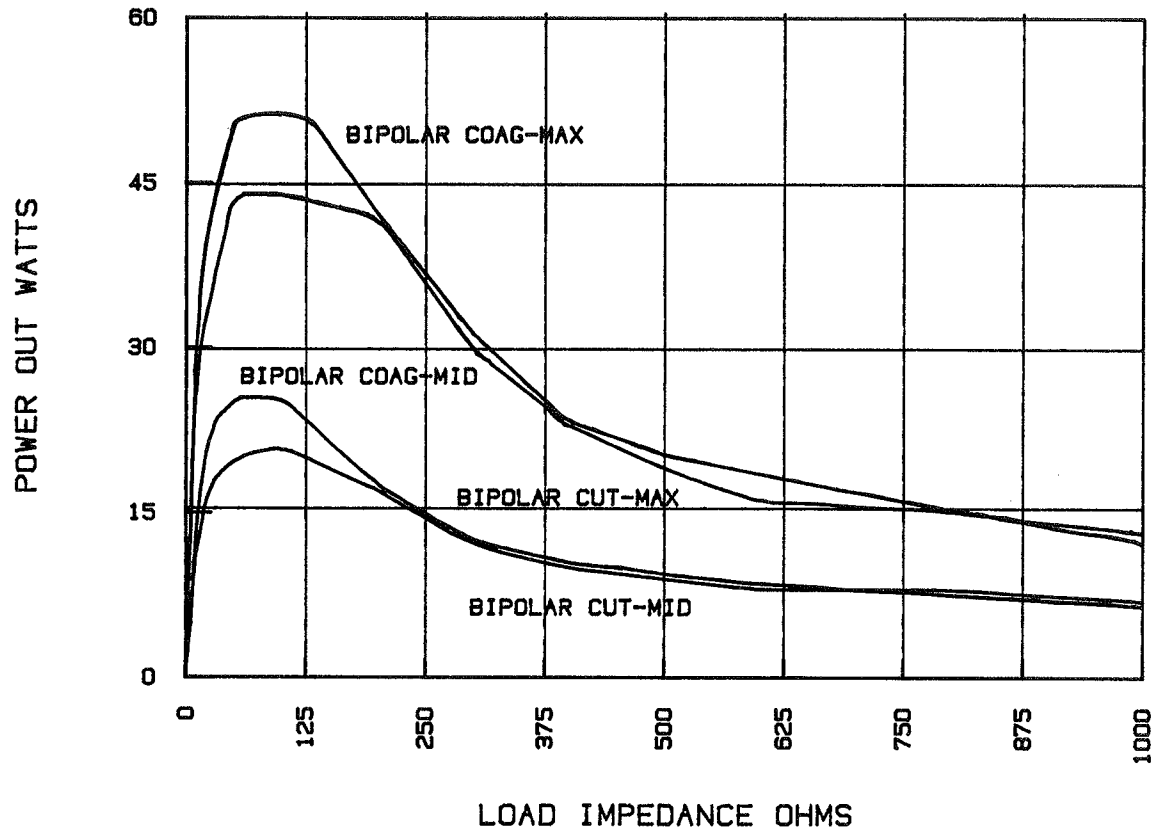
TABLE 1-1

**Typical Power Output vs Load Impedance
At Maximum And Mid Positions**

Monopolor



**Typical Power Output vs Load Impedance
At Maximum And Mid Positions
Bipolar**



TYPICAL POWER SETTINGS VS POWER OUTPUT

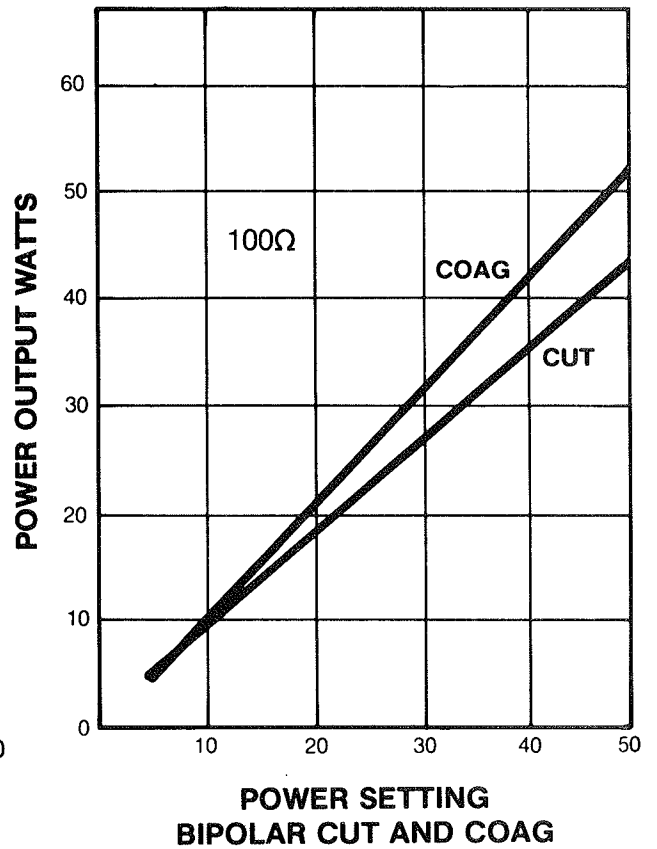
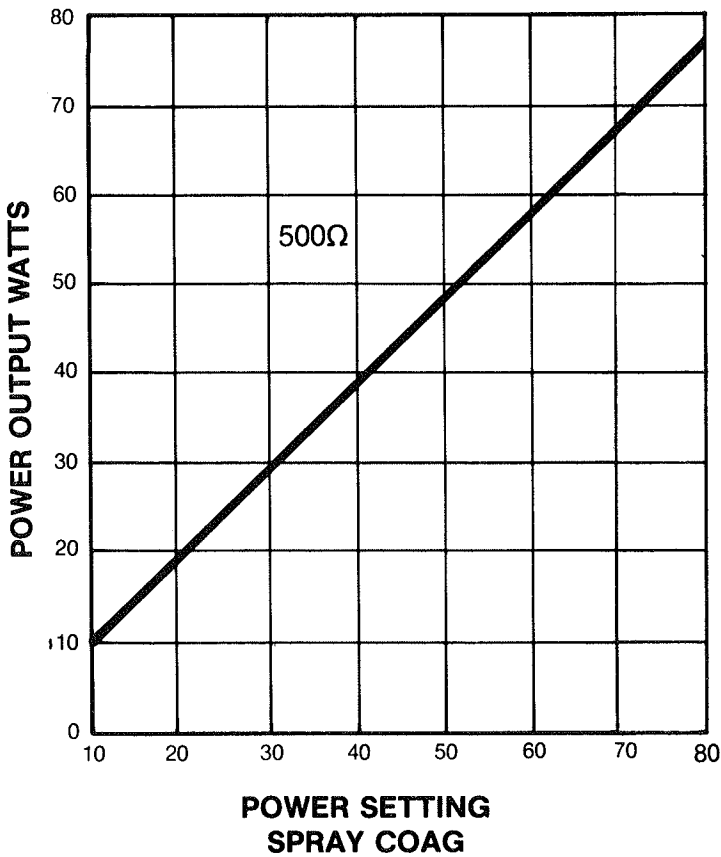
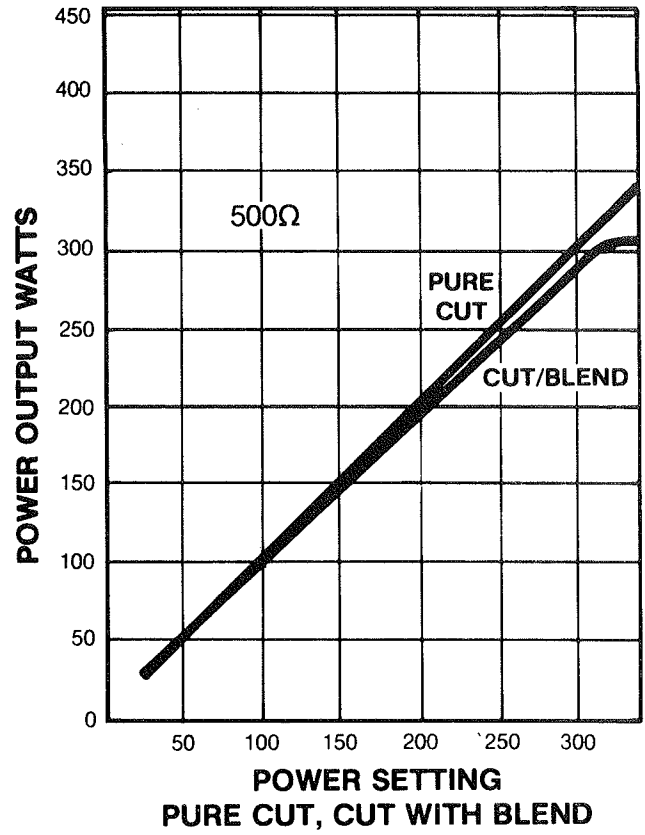
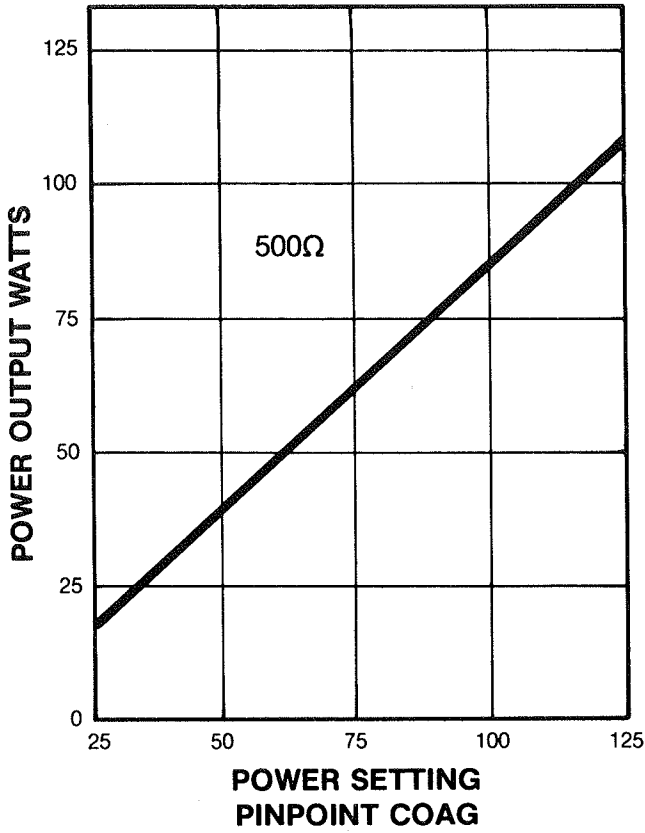


TABLE 1-1

TYPICAL POWER SETTING VS OPEN CKT PEAK VOLTAGE

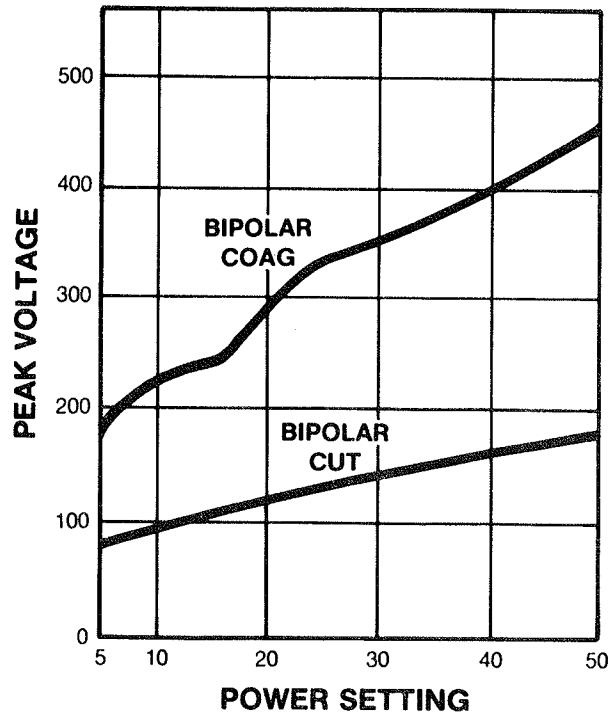
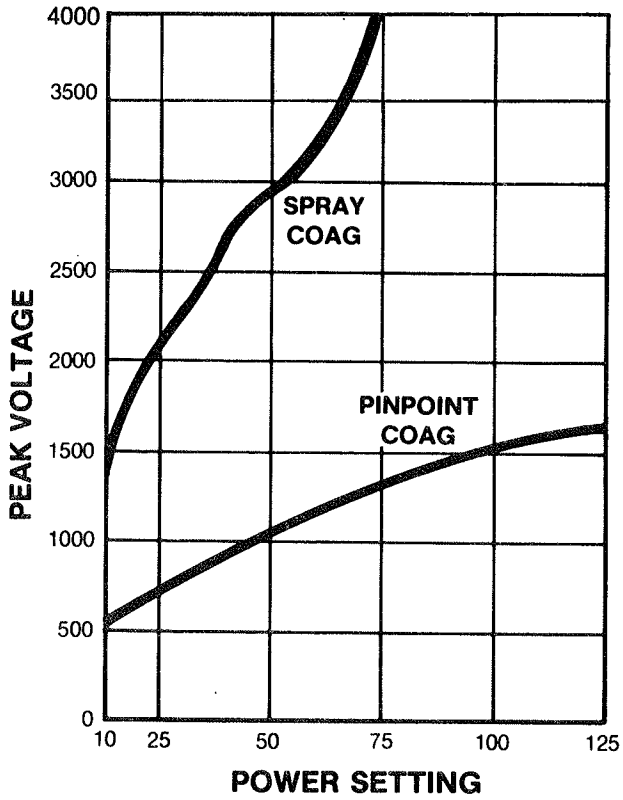
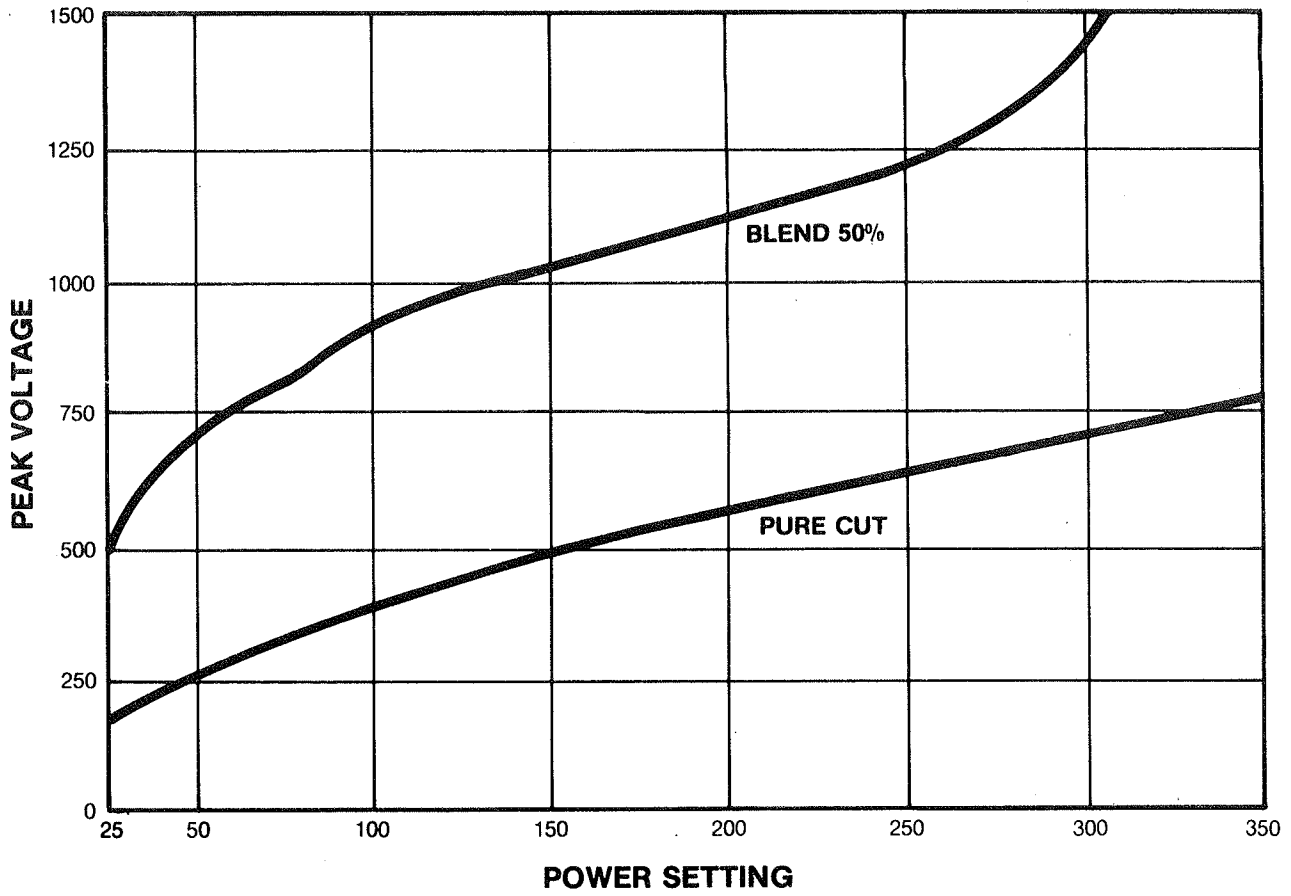


TABLE 1-1

Foreword

All Bard Electro Medical Systems electrosurgical products are warranted against defects in workmanship and materials as described in the warranty (see below). The Warranty Registration Card enclosed with the generator should be completed and returned promptly to Bard Electro Medical Systems to ensure registration of your new generator. If a warranty card was not enclosed with your new generator, please call the Field Services Department 1-303-790-1117 for assistance. If additional information or assistance is required within the United States, contact the Marketing Services Department, Bard Electro Medical Systems, Englewood, Colorado (1-303-790-1117) and request the additional information or assistance that you feel is required. If any information in this manual is found to be in error, or if there are any additions or deletions that you feel will improve the manual, please forward your comments to the Technical Services Department, Bard Electro Medical Systems. Note

Note:

Do Not attempt to assemble, install, operate, or service this equipment until all contents of this manual are thoroughly understood.

Bard Electro Medical Systems reserves the right to make changes to its products without incurring any obligation to make similar changes on equipment previously built or sold.

Limited Warranty

The electrosurgical power unit and/or footswitch is warranted to the original purchaser to be free

from defects in material and workmanship for a period of two (2) years from the date of purchase. If the Power Unit and/or Footswitch proves to be so defective, Purchaser may return same to Bard Electro Medical Systems for repair or replacement, as Bard Electro Medical Systems deems appropriate. The liability of Bard Electro Medical Systems under this limited warranty does not extend to any Power Unit and/or Footswitch which has been abused, misused or serviced by anyone other than an authorized Bard Electro Medical Systems representative.

While the unit is within the stated warranty period, no unauthorized service repairs or modifications on this equipment other than that described in the Maintenance Section of the Technical Manual should be attempted. Any unauthorized repairs will immediately void the remainder of the warranty. If a local Bard Electro Medical Systems representative is not available, service assistance is available by calling 1-303-790-1117.

This limited warranty is in lieu of all other warranties, whether expressed or implied (including any warranty of merchantability, suitability or fitness for a particular purpose) respecting the power unit and/or footswitch, or any other component and the liability and remedy stated in this limited warranty will be the sole liability of Bard Electro Medical Systems and remedy available to purchaser for said products whether in contact tort (including negligence or otherwise). Bard Electro Medical Systems will not be liable to purchaser for any incidental or consequential damages

arising out of or incident to the handling, use, maintenance or servicing or disposition of the same.

I. General Information

This Technical Manual contains operating and maintenance information concerning the Bard Electro Medical Systems System 5000 Power Plus. This manual is designed principally for the Bioengineer or other technical personnel concerned with periodic evaluation of system performance and maintenance. A separate document, the Operator's Reference Manual, is provided by Bard Electro Medical Systems to satisfy the needs of surgical personnel who are concerned with daily checkout and operation of the system. The operation section of this technical manual is equivalent in format and content to the Operator's Reference Manual. If you are performing an incoming inspection on a System 5000 Power Plus, your attention is directed to the Installation, Operation and Maintenance sections of this manual, which should be reviewed prior to applying power to the generator.

A. System

The System 5000 Power Plus' basic operating kit consists of a Generator, an Operator's Reference Manual and the Technical Manual. The generator's front and rear views are depicted in Figure 1-1.

B. Accessories

A complete line of compatible reusable and disposable electrosurgical accessories are available from Bard Electro Medical Systems. The following Bard accessories are recommended for use: footswitches, patient

plates, conductive gel, mobile carts, safety cup holders, switchable handcontrols, disposable and reusable pencils and handles (monopolar and bipolar), suction tubes, cords and adapters. See the "Operation" section for connection of accessories.

Specifications for the System 5000 Power Plus generator are presented in the front of the manual, Table 1-1. Consult the "Maintenance" section of the manual for instructions on Testing and Calibration of the generator.

II. Use Safety Precautions

Do Not's

- A. Do Not: Operate equipment before reading the Operator's Reference Manual.
- B. Do Not: Operate equipment in the presence of flammable anesthetics or cleaning agents, etc. (Possible explosion hazard.)
- C. Do Not: Actuate the foot pedal, handcontrol or forceps above 50% duty cycle (allow more time "Off" than "On").
- D. Do Not: (Under test condition) operate equipment with no load at full power output for greater than 30 seconds.
- E. Do Not: Test electrosurgical unit output by sparking the active electrode to the patient plate or grounded metal objects.
- F. Do Not: Connect patient plate to ground and defeat generator's isolated configuration.
- G. Do Not: Use power plug adapters or "cheaters".
- H. Do Not: Attempt measurement or servicing of any type before reading Technical Manual.

Do's

- A. Do: Read the Operator's Reference Manual and Technical Manual before applying power to generator.
- B. Do: Set power control dials counter clockwise (C.C.W.) before applying power.
- C. Do: Observe Danger and Warning notes on the cover of the generator.
- D. Do: Be aware that the generator delivers power on a "first come first served" activation (first activated device controls the output).
- E. Do: Know that Coag overrides Cut in Monopolar and Bipolar, if both modes are activated at the same time using the footswitch.
- F. Do: Know that Pinpoint and Spray are mutually exclusive modes. "Type" switch on control panel must be positioned to desired mode for correct output.
- G. Do: Know that changing front panel control switches (i.e., mode, footswitch or coag select) when activated will momentarily shut down the output until reset to new mode.
- H. Do: Know that Blend power may have to be increased when switching from Pure Cut to Cut with Blend at very high settings.
- I. Do: Observe manufacturer's area requirements for dispersive electrodes (patient plates).
- J. Do: Perform periodic inspection of equipment and accessories.
- K. Do: Request the troubleshooting cassette tape film from Bard Electro Medical Systems, Inc. or your local Bard Electro Medical Systems, Inc. distributor.

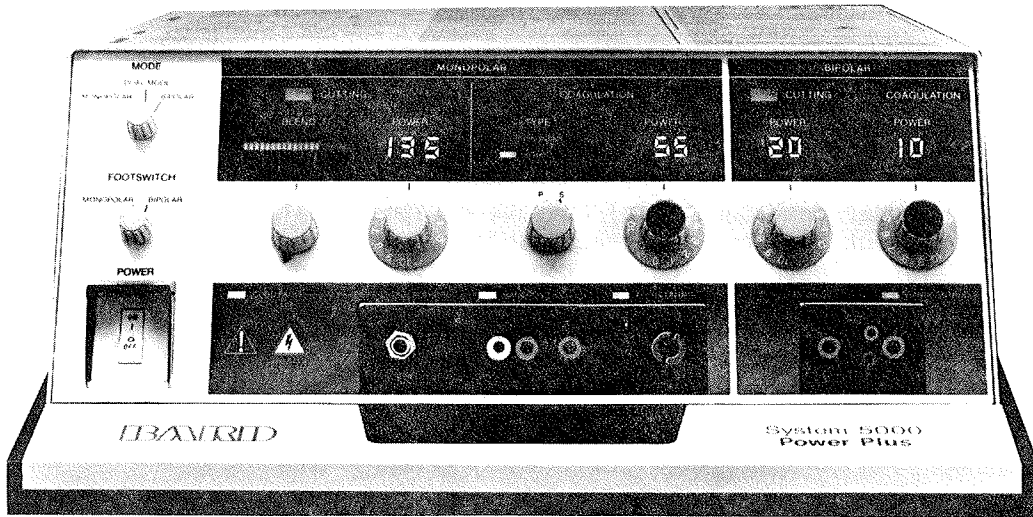


FIGURE 1-1
FRONT VIEW

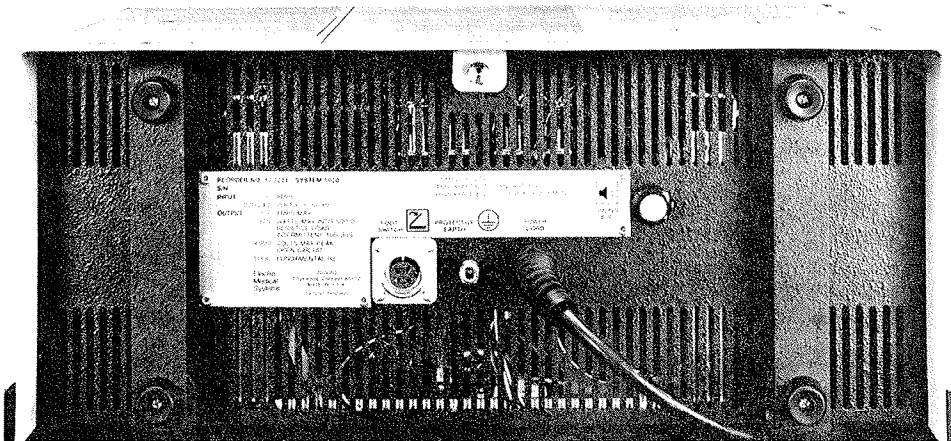


FIGURE 1-2
BACK VIEW

System 5000 Power Plus

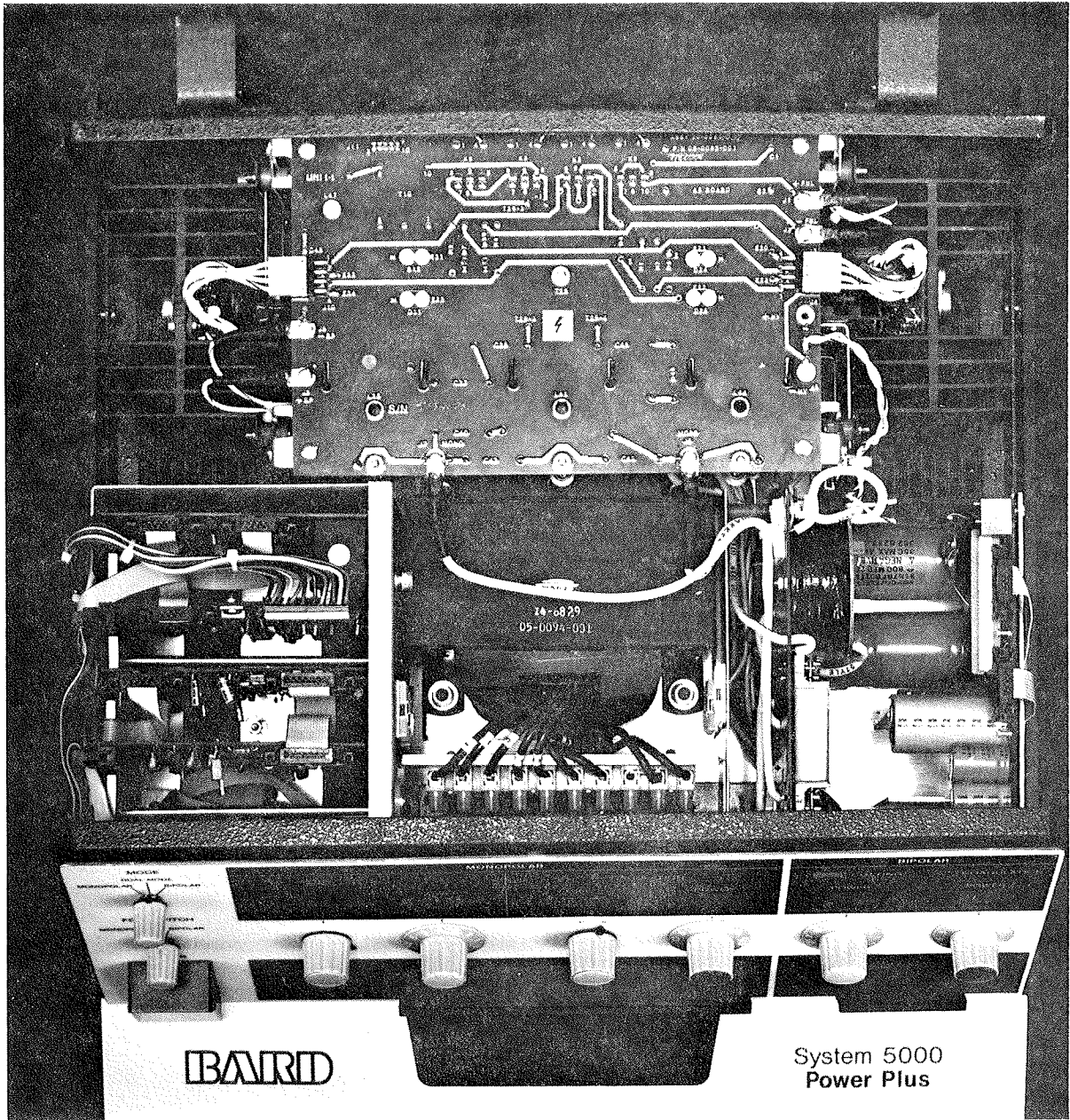


Figure 1-3
Top View - Cover Off

Description

General

This section contains information concerning the general Description and Functional operation of the System 5000 Power Plus electro-surgical Generator. The 5000 generator is an extremely versatile unit that provides monopolar output power to meet the requirements of conventional surgery and Bipolar output power to meet the requirements of more delicate surgery.

The System 5000 Power Plus incorporates the latest state-of-the-Art electronic devices. Modular design enables easy removal and replacement of Sub-assemblies. The front panel power controls are color coded, as well as the mode indicators and output receptacles. In addition, Functional lamps illuminate when selector switches are positioned to the desired modes of operation, or when the cord fault monitor activates.

The System 5000 Power Plus generator is an isolated system (patient return Not referenced to chassis ground). The generator is designed with discrete output, "first come first served" meaning only one accessory will be activated at a time. A cord fault monitor circuit senses the dispersive electrode (patient plate) integrity sounding an alarm in the event of a disconnection or malfunction. Mode tones of different frequencies are used (as are the mode lights) to clearly distinguish the activations of the cutting and coagulation (monopolar or bipolar) modes of operation. The audio circuits cannot be silenced completely, so that in the event of an accidental activation of the generator, the audio circuits will emit a tone alerting personnel of generator activation.

Modes

The System 5000 Power Plus generator provides four (4) basic modes of monopolar operation and two (2) modes of bipolar operation.

A. Monopolar

1. Pure Cutting: Provides an incision with minimal hemostasis. Generates a continuous 500KHz, sinusoid. (Independent of load.)
2. Blend: Provides cutting with hemostasis. Generates a variable duration pulse modulated 500KHz, sinusoid; (500 ohm load) variable from 47 + 2usec to 14 usec. Period 50usec.
3. Pin Point Coagulation: Provides hemostasis (dessication). Generates fixed duration pulse modulated 500KHz, damped sinusoid (open circuit) (500 ohm load). Pulse duration 7usec. Period 50usec.
4. Spray Coagulation: Used where fulguration, i.e., sparking to tissue is required. Generates pulse modulated 500KHz damped sinusoid (open circuit) period 32usec.

B. Bipolar

1. Bipolar Coagulation: Provides reduced coagulation power to bipolar accessories. Generates pulse modulated 500KHz sinusoid (125 ohm load). Pulse duration 7usec. Period 50usec.

2. Bipolar Cutting: Provides cutting power to bipolar accessories. Generates a continuous 500KHz sinusoid. (Independent of load).

II. Functional

A complete description and purpose of each front and rear panel control, indicator and accessory connectors is shown in the 'Operations' section of this manual page 3-12.

The function of the front panel mode, footswitch, pin point/spray selectors and blend control are described as follows:

A. Mode Switch

1. Monopolar Position

- a. Monopolar LED digital displays illuminate.
- b. Cord fault lamp illuminates and the sound circuit emits a warning tone until a dispersive electrode (patient plate) is connected to the dispersive receptacle.
- c. Monopolar RF current flows through an isolated loop from the selected monopolar active receptacles through the active accessory, through the patient, and returns to the generator via the dispersive electrode.
- d. Discrete output: first monopolar activated accessory and mode will provide power to its accompanying output receptacle.
- e. Pure cutting, blend, pin point and spray modes are available

subject to mode selector switch positions.

- f. Method of activating modes depends on the footswitch selector position.

2. Bipolar Position

- a. Bipolar LED digital display illuminates.
- b. Cord fault lamp and warning tone turn Off. (Dispersive electrode not required for bipolar operation.)
- c. Bipolar RF current is restricted to tissue grasped between the bipolar forceps' jaws. The bipolar RF current flows through an isolated loop from the generator's bipolar active receptacle to the active accessory forceps jaw through the patient tissue grasped by the forceps, back to the generator via the return forcep jaw and output receptacle.
- d. Discrete output: first activated bipolar accessory will provide power to the bipolar receptacles.
- e. Both bipolar cutting and coagulation modes are available. Method of activating depends on the footswitch selector position.

3. Dual Mode Position

- a. Both monopolar and bipolar LED digital displays illuminate.
- b. Cord fault lamp illuminates and the sound circuit emits a

warning tone until a dispersive electrode (patient plate) is connected to the dispersive receptacle. (Monopolar RF current available, hence, return path required.)

- c. Monopolar and bipolar RF current are both available. Monopolar current flow is identical to that described for the monopolar mode switch position. Bipolar current flow is identical to that described for the bipolar mode switch position.
- d. Discrete output: first accessory activated (whether it be monopolar or bipolar cutting or coagulating), activated by footswitch, handcontrol or handswitchable forceps, provides the power to its accompanying active output receptacle.
- e. Any of the six (6) modes of operation, pure cutting, blend, pin point coagulation, spray coagulation, bipolar cutting or bipolar coagulation, can be used with proper switch selection.

B. Footswitch Selector

1. Provides choice of footswitch activation for either the monopolar or bipolar output receptacles.
2. Illuminates the green functional lamps above the active output receptacles, indicating which type of accessories (handcontrolled or footcontrolled) are

available for activation and delivery of power.

C. Blend Control

1. When in the fully counter-clockwise detent position (CCW), the generator is in the pure cutting mode.
2. To activate the blend mode of operation, rotate the blend control clockwise (CW) out of its detent position (should hear a click). Further clockwise rotation of the blend control will progressively illuminate the LED bar graph above the blend control knob. This action controls the variable pulse width in the blend mode. The more illuminated the blend bar graph, the more hemostasis effect and less cutting effect. The cutting power control adjusts the power of the blend output and the blend control adjusts the pulse width.

D. Coagulation Type Selector

1. When positioned to "P", pin point type coagulation is available. The green mode lamp marked pinpoint above the P/S selector switch will illuminate.
2. When positioned to "S", spray type coagulation is available. The green mode lamp marked spray above the P/S selector switch will illuminate.
3. The pin point/spray coagulation positions have no effect in the pure cutting, blend or bipolar modes. Switch design

separates the circuits.

4. When switching coagulation type selector (P/S), LED digital readout will change.

E. Safety Features

1. Discrete Output: Only one active accessory at any time.
2. Cord Fault: Alerts personnel in case of a disconnection of the dispersive electrode (patient plate) and also inhibits output power until the fault is corrected. This action occurs in all four monopolar modes (pure cutting, blend, pin point and spray).
3. Coag Override: Mode logic circuits permits only coagulation circuits to be activated, should accidental simultaneous activation of the footswitch occur. The footswitch is also designed with coag override lock-out feature.
4. Isolated: Return RF current restricted to generator active and dispersive electrode loop.

F. Operational Mode Considerations

1. In the following discussion of functional modes, only the differences of each mode will be explained. There are many similarities in selector switch positions, controls, indicators, output receptacles and overall circuit configurations. Reiteration will be

repeated only when considered significant.

2. Power delivered to loads will vary as described in the power curves shown in the front of the manual and Table 1-1.
3. Color code for cutting, yellow; coagulation, blue; active, red and functional lamps are green.
4. While the System 5000 Power Plus generator is designed with wide safety margins, it is not intended for continuous operation. Activation of an accessory in the monopolar mode should generally be limited to one minute "on" followed by an "off" time of equal or longer duration.
5. Low voltage triacs are triggered in the cutting modes. High voltage triacs are triggered in the coagulation modes. (Coagulation type signals require higher peak voltage applied to the RF output amplifiers to obtain the desired RF output peak-to-peak voltage.)
6. Dispersive electrodes (patient plates) must be used for all monopolar modes.

III. Operational Modes

A. Monopolar

1. Pure Cutting Operation:

Blend control must be in detent (full CCW). A request for pure cutting power by means of the

handcontrol or footswitch results in the following action:

- a. The cut sound circuit emits a tone of 1KHz.
- b. The front panel, yellow monopolar lamp illuminates.
- c. The low voltage triac triggers and provides a variable 20-125 DC voltage to the output RF amplifiers. This voltage is controlled in pure cut by adjusting the monopolar cutting power control dial. The output power can be controlled from 0-350 watts.
- d. The RF logic circuit generates a continuous 500KHz squarewave. This squarewave drives the RF driver. The driver amplifier activates a fullwave type bridge amplifier which is configured by conventional relays that are driven by the mode determining circuits. The RF signal is further amplified by this amplifier and delivered to the monopolar output transformer, A5T29. The signal is then filtered to eliminate undesirable low and high frequency energy. RF power is then routed to the selected monopolar output receptacle via balance transformer A12T1 by means of high voltage relays controlled by the mode logic circuits.

2. Blend Operation

Operationally, blend (cutting with hemostasis) is nearly identical to pure cutting. The blend control must be out of detent to enter the mode and any further clockwise (CW) rotation increases the hemostasis and decreases the cutting effect, as can be monitored on the LED bar graph.

A request for blend cutting power is acquired by the same means as was pure cutting: footswitch or handcontrol. The cut sound circuit, mode indicator lamp, and low voltage triac are all the same. However, in the blend mode, the output power is controlled from 0-230 watts.

The RF logic circuit is different in blend, in that a "pulsed" waveform is generated at 500KHz instead of a continuous waveform. The RF driver, fullwave bridge amplifier configuration, output transformer, filter, balanced transformer high voltage relays and output receptacles are common to the pure cutting mode. Additional circuits in the front panel and RF logic are required to create the blend waveform. (Detailed circuit analysis will be covered in Section V, Theory of Operation.

3. Pin Point Coagulation Operation

The coagulation "type" selector switch must be in

"p" (pinpoint). A request for pinpoint coagulation power by means of hand-control, footswitch or handswitchable monopolar forceps results in the following actions.

- a. The coag sound circuit emits a tone of 500Hz.
- b. The front panel, blue monopolar lamp illuminates.
- c. The high voltage triac triggers and provides a variable 20-200 DC voltage to the RF amplifiers. This voltage is controlled in pinpoint coagulation by adjusting the monopolar coagulation power control dial. The output power can be controlled from 0-130 watts.
- d. The RF logic circuit generates a "pulsed" 500KHz squarewave. Its pulse width is fixed at 6usec at a period of 50usec.

From the RF logic circuit forward, pinpoint coagulation utilizes the same RF driver, amplifier configuration and monopolar output circuitry as was used for the pure cutting and blend modes.

4. Spray Coagulation Operation

Spray coagulation differs from pinpoint coagulation in the following ways:

- a. The coagulation "type" selector is positioned to "S" (spray).
- b. The RF logic circuit generates "pulsed" squarewaves of 1.8usec

pulse duration at a 32usec period.

- c. The previous fullwave bridge type amplifier is now converted to a stacked, single-ended amplifier configuration by means of logic and conventional relays which also transfer the single-ended amplifier output to the monopolar spray (fulgeration) output transformer, A2T2. This type RF output configuration generates the necessary peak-to-peak voltage to produce the fulgeration (sparkling to tissue) hemostasis effect that is then routed through the balance transformer to the selected monopolar receptacle via the high voltage fulgeration relay.
- d. The output power in spray ranges from 0-75 watts as indicated on power readout digital display controlled by the monopolar coagulation power control dial. Note: Power readout display changes as coagulation type selector switched.

B. Bipolar

1. Bipolar Coagulation Operation

The mode selector switch must be positioned to either bipolar or dual mode. Dual mode will require a dispersive electrode.

A request for bipolar coagulation is obtained by means of the footswitch or

handswitching bipolar forceps resulting in the following actions:

- a. The coag sound circuit emits a tone at 125Hz.
- b. The front panel bipolar blue coagulation lamp illuminates.
- c. The high voltage triac triggers as in the pinpoint and spray modes. The bipolar output power can be adjusted from 0-50 watts by the bipolar coagulation power control dial.
- d. The RF logic circuits generate a "pulsed" 500 KHz squarewave. Its pulse width is 6usec and period is 50usec. The RF driver and output amplifier are the same configuration as in pinpoint cogulation. The logic circuits set up the conventional relays to connect the bipolar transformer, A5T10. The signal then is routed through the bipolar filter to the bipolar output receptacles.

2. Bipolar Cutting Operation

The bipolar cutting mode differs from bipolar coagulation in the following ways:

- a. The cutting sound emits a tone of 250Hz.
- b. The front panel bipolar yellow cutting lamp illuminates.
- c. The low voltage triac triggers as in cutting and blend modes. The bipolar output can be adjusted from 0-50

watts by the bipolar cutting power control dial.

- d. The RF logic circuit generates a "continuous" 500KHz squarewave.

The amplifier configuration and output circuitry is the same for bipolar cutting as it was for bipolar coagulation.

Installation

I. Unpacking

Upon receipt of the System 5000 Power Plus in its shipping carton, carefully examine the exterior of the carton for visible damage. If damage is evident, have the carrier's representative remain with you while you open the carton and examine the contents.

Note

Treat the contents of this carton with care. The System 5000 Power Plus is a durable medical instrument, but rough handling can damage it.

The System 5000 Power Plus is packed in one carton, unpack the generator as follows: (See Figure 6-2).

- A. Open the carton containing the System 5000 Power Plus.
- B. Remove the foam packing.
- C. Remove the Operator's Reference Manual and the Technical Manual.
- D. Lift out the generator.
- E. Inspect the unpackaged equipment for visible damage or missing components. If the equipment is damaged, determine if the damage was sustained during shipment. If so, contact the carrier and advise them so that a report can be made and settlement determined.

Save the packing carton and material until the unit is operational. If for any reason the unit must be returned, the original carton will help protect the unit from shipping damage. If the carton is not available, pack the unit carefully, since damage caused by negligence can void the

warranty.

Note

Record and retain the serial and model numbers of the generator. These numbers should always be referred to in any correspondence regarding the 5000 Electrosurgical Generator.

II. Assembly

The System 5000 Power Plus requires no additional assembly prior to use. When setting up the System 5000 Power Plus for use, the generator should be placed on the specially designed Mobile Cart or any stable cart or table. Caution should be exercised when placing the generator on a cart or table so as not to obstruct the vents on the bottom or rear of the generator.

Cautions

This generator was properly Grounded at the factory by connecting the ground wire in the power cable to the generator chassis. This reduces the possibility of electrical shocks that could result from internal electrical shorts to the generator cabinet.

The Users' Responsibility is to insure proper grounding of the AC power outlets that provide power to the generator.

Generators are normally shipped with a standard hospital grade 3 prong connector, which meets requirement standards for Safe Grounding.

Note:

Refer to the Operation section of this manual or the Operator's

Reference Manual for detailed operating instructions.

III. Environmental Requirements

Danger

Use of this device in flammable, combustible, or oxidizing atmospheres is not recommended. An explosion hazard may exist due to possible spark emissions.

Unit should be operated at air temperatures from 10°C to 38°C (50° to 100°F) and within a relative humidity range of 0 to 97%.

Note:

Avoid storing the unit at temperatures exceeding 60°C (140°F).

IV. Operational Set-Up

- A. Refer to the System 5000 Power Plus Operator's Reference manual or the Operation section of this manual for instructions pertaining to preliminary adjustments and control functions.
- B. Place the System 5000 Power Plus generator on a clean, flat surface and allow ample room so as not to obstruct the vents on the bottom of the generator.

Bard Electro Medical Systems System 5000 Power Plus

Operator's Reference Manual



BARD

System 5000 Power Plus

Electrosurgical Generator

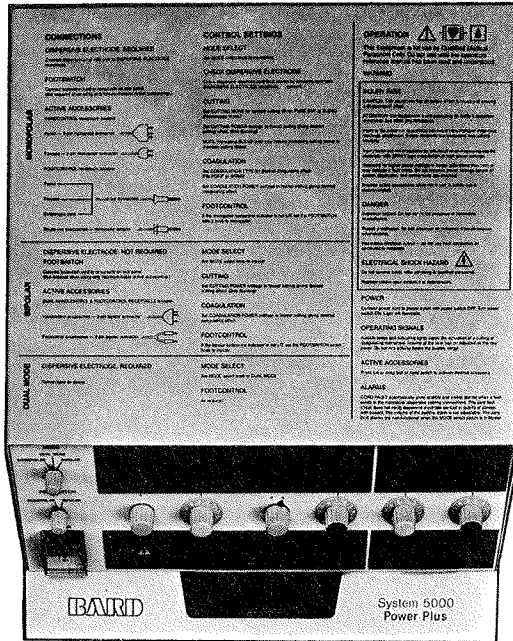
Preface

The System 5000 **Power Plus** is a multi-purpose electrosurgical generator for use in the modern operating room. It features both monopolar and bipolar functions to satisfy all of your surgical demands with safety, flexibility, reliability and convenience.

The System 5000 **Power Plus** offers two levels of coagulation, pinpoint and spray. Pinpoint coagulation provides precise control of bleeding in localized areas. Spray coagulation provides greater control of bleeding in highly vascular tissues over broad surface areas. This unit also offers infinitely variable blend that allows you to set the exact power desired for pure cut or cutting with hemostasis.

For your convenience, the power output of the System 5000 **Power Plus** is calibrated in watts with large, illuminated digital displays. For your safety this unit has totally separate bipolar controls, discrete output, cord fault alarm and isolated R.F. output.

See the contents of this Operator's Manual for further details.



Top Cover Instructions

Connections

Dispersive Electrode: Required


Connect dispersive electrode cord to DISPERSIVE ELECTRODE receptacle.


Footswitch

Connect footswitch cord to receptacle on rear panel. (Not required when using only handswitchable active accessories.)

Active Accessories



HANDCONTROL receptacle accepts:

Pencil — 3-pin monopolar connector 

Forceps — 2-pin monopolar connector 

FOOTCONTROL receptacle accepts:

Pencil  

Forceps  

Endoscopic cord  

Single-use accessories — monopolar adapter 


Dispersive Electrode: Not Required


Footswitch

Connect footswitch cord to receptacle on rear panel. (Not required when using only handswitchable active accessories.)

Active Accessories

Dual HANDCONTROL & FOOTCONTROL RECEPTACLE accepts:

Handcontrol accessories — 3-pin bipolar connector 

Footcontrol accessories — 2-pin bipolar connector 

Dispersive Electrode: Required

Connections as above.

Control Settings

Mode Select

Set MODE select knob to monopolar.

Check Dispersive Electrode

Check dispersive electrode cord fault alarms by removing cord from DISPERSIVE ELECTRODE receptacle . . . reinsert.

Cutting

Set BLEND CUTTING control for desired cutting effect. LED bar display off for pure cutting, fully illuminated for maximum blend (Hemostasis in cut).

Set CUTTING POWER wattage to lowest setting giving desired cutting effect. (See Warning)

Note: increasing BLEND level may require increasing CUTTING POWER to maintain cutting speed.

Coagulation

Set COAGULATION TYPE for desired coagulating effect; PIN POINT or SPRAY.

Set COAGULATION POWER wattage to lowest setting giving desired coagulating effect.

Footcontrol

If the MONOPOLAR FOOTCONTROL indicator is not lit, set the FOOTSWITCH select knob to MONOPOLAR.

Mode Select

Set MODE select knob to BIPOLAR.

Cutting

Set CUTTING POWER wattage to lowest setting giving desired cutting effect. (See Warning)

Coagulation

Set COAGULATION POWER wattage to lowest setting giving desired coagulating effect.

Footcontrol

If the BIPOLAR FOOTCONTROL indicator is not lit, set the FOOTSWITCH select knob to BIPOLAR.

Mode Select

Set MODE select knob to DUAL MODE.

Footcontrol

As required

Operation



This equipment is for use by qualified medical personnel only. Do not use until the operators reference manual has been read and understood.

Warning

Injury Risk

Caution: This equipment has an output which is capable of causing a physiological effect.

Attention: Cet équipement a une puissance de sortie susceptible d'entraîner des effets physiologiques.

Injury to the patient or operator(s) can result from improper dispersive electrode attachment. Follow electrode manufacturers instructions carefully.

Injury to the patient or operator(s) can result when employing needle electrode at high power settings.

Requests for higher power settings or longer activations than normal may indicate a fault exists. Do not increase power settings before all cables, electrodes, and connections are checked.

Insulate active accessories when not in use. A safety cup is recommended.

Danger

Explosion hazard. Do not use in the presence of flammable anaesthetics.

Risque d'explosion. Ne pas employer en présence d'anesthésiques inflammables.

Hazardous electrical output — do not use near conductive or combustible materials.

Electrical Shock Hazard



Do not remove cover, refer servicing to qualified personnel.

Replace cables upon evidence of deterioration.

Power

Connect power cord to proper outlet with power switch off (O). Turn power switch on (I). Light will illuminate.

Operating Signals

Audible tones and indicating lights signal the activation of a cutting or coagulating instrument. Volume of the tone can be adjusted on the rear panel. Do not turn volume below the audible range.

Active Accessories

Press cut or coag foot or hand switch to activate desired accessory.

Alarms

CORD FAULT automatically gives audible and visible alarms when a fault exists in the monopolar dispersive cabling connections. The cord fault circuit does not verify dispersive electrode contact or quality of contact with patient. The volume of the audible alarm is not adjustable. The cord fault alarms are non-functional when the MODE select switch is in BIPOLAR.

MONOPOLAR

BIPOLAR

DUAL MODE

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Foreword

General

Electrosurgical safety is a combination of good equipment design and safe surgical practices. The Bard System 5000*, as part of this combination, represents state-of-the-art designs using the most modern solid-state components. As a pioneer in solid-state electrosurgery, Bard continues to design automatic safety systems into it's equipment. The cord fault alarm, audible tones, discrete outputs and isolated output circuitry are examples of the safety circuitry built into the Bard System 5000 Electrosurgical Generator. The other, and equally important, part of this safety combination, is an operating team trained and knowledgeable in the use of electrosurgical equipment.

Operational Considerations

- An operating room is a complex electrical environment. Understanding each piece of equipment and following the recommended operating procedure is an absolute requirement. Interaction between different pieces of equipment is not always predictable. Unusual performance by any surgical equipment is a warning to check the entire set up and confirm that an unsafe condition does not exist. If the safety or performance of a piece of equipment is in doubt, remove it from service for evaluation by a trained specialist.

- Solid-state electrosurgical devices are not designed for continuous operation (activation of handcontrol or footswitch). Observe duty cycles. Allow as much "OFF" time as "ON" time.
- The System 5000 can be operated in any of three different modes. If the monopolar mode is selected, a patient plate is required and bipolar mode is inactive. If the bipolar mode is selected, a patient plate is not required and monopolar mode is inactive. If the dual mode is selected, a patient plate is required and either a monopolar or bipolar output may be selected on a "first come, first served" basis.
- The "first come, first served" design of the System 5000 enhances safety by allowing only one output to be activated at a given time. This feature assures that only the device you first activate will be an active device. Secondary commands will not override the first command. As an example: While the monopolar footcontrolled output is activated, all handswitching capability is inactive, as well as the bipolar footswitch capability.
- The monopolar cutting speed and degree of hemostasis is controlled by the monopolar blend control. When the control is full counterclockwise, the blend indicator bar is extinguished and a pure cutting output with no hemostasis will be obtained. As the control is

advanced in a clockwise direction, the blend indicator bar begins to illuminate. As the illumination advances from left to right, the degree of hemostasis will increase and cutting speed may decrease. The cutting power may have to be increased to maintain cutting speed as blend is increased.

- Two types of monopolar coagulation are available, Pinpoint and Spray. Each type of coagulation has it's uses. These are discussed below.
- Pinpoint: Use with forceps, blade or needle electrodes, and endoscopic devices. The technique employed is to activate the generator just prior to contact with the tissue. After desired effect is achieved, remove from tissue, then deactivate. Pinpoint coagulation is intended for use on a small defined area.
- Spray: Use with all types of pencil electrodes, endoscopic devices and clamps. The technique employed is to activate the generator without contacting tissue. The area can then be repeatedly sprayed until desired hemostasis is established. Spray coagulation can be used on all types of tissue whenever it is desirable to coagulate a larger area.

Whenever greater depth of penetration is desired, the spray mode is the mode of choice. The technique employed is to activate the generator

just prior to contact with tissue. After desired effect is achieved, remove from tissue, then deactivate.

Whenever a clamp is employed, touch a non-crusted portion of the electrode to the clamp, then activate. When desired effect is achieved, deactivate before breaking contact with the clamp.

- Exercise great care when using needle electrodes with any mode. Fine needle electrodes may overheat and fail at high wattage settings.

General Safety Precautions

General Safety Precautions When Using The Bard System 5000

Do not use in the presence of flammable anesthesia agents, flammable disinfecting agents, or other combustable materials.

Common items, such as dry sponges, lubricants, and endotracheal tubes, can become combustable in the presence of oxygen. Therefore, insure draping technique does not allow pockets of methane, hydrogen, oxygen or any gas to form around patients' body.

- During electrosurgical procedures utilizing insufflation, such as laparoscopic tubal ligation or polypectomy, - take care to insufflate only with a gas that is not combustable. Carbon dioxide is recommended for this purpose.
- During electrosurgical procedures involving small bowel or colon, take care that the bowel/colon is properly protected to reduce the possibility of explosive methane gas being present within these structures.
- Avoid skin to skin contact by separating body extremities from body trunk with dry towels or drape material.
- Do not allow solutions to pool underneath or around patient.

Fluid pooling underneath patient can provide an "alternate pathway" for electrosurgical current to return to the

generator through the grounded¹ operating table.

Iodine based prep solutions pooling under the patient can create severe chemical burns to the patients' tissues.

- Do not use the generator as a shelf or temporary storage point for liquids. While the Bard System 5000 is of "drip-proof" design to minimize fluid entry, any electrosurgical² generator can become a serious hazard to the patient and personnel if conductive or flammable liquid enters the generator.
- Utilize minimum power to provide the desired surgical effect. Excessive power delivered to the patient results in increased tissue destruction and can increase the risk of accidental patient burns.

The Bard System 5000 delivers consistent, repeatable power into varying load impedences, therefore greatly reducing the need for changing the power setting to obtain desired surgical effect.

- Do not loop active accessory/instrument cables around towel clips or other instruments to attach or secure these cables to the surgical drapes.

Electrosurgical generators utilize radio frequency current similar to a radio transmitter. A certain amount of electrosurgical current leaks out through the insulated cables. If active

¹Ground¹ = Earth

Electrosurgical² = Surgical Diathermy

the insulated cables. If active cables are looped around a metal instrument, this leakage current can energize the instrument. If it touches the patient's skin on the patient side of the surgical drape a burn can occur to the patient at that point of contact.

Automatic Safety Systems With The Bard System 5000

In regard to understanding why Automatic Safety Systems within the Bard System 5000 or any electro-surgical unit are necessary, it is important to understand that burns, either intentional or accidental, can occur to the operator or patient: as a result of Current Density or Current Concentration.

- High frequency, electro-surgical current is applied to the patient's body by means of electrodes. If both electrodes have a relatively large surface area in contact with the patient, the current flow is evenly distributed throughout the tissue in contact with the electrodes. As a result, the heating effect is spread out. The patient will experience only sensation of warmth. However, when one of these two electrodes has a very small contact area with the patient, the current flow is very concentrated in the immediate vicinity of that electrode and a burn occurs at that site. As long as the

dispersive electrode has a large contact area with the patient, the heating effect at that site is minimal, this is the intended situation. When electro-surgical current is applied to the patient via an active electrode with small patient contact area, the current concentration, or current density is quite high in the immediate vicinity of contact, hence heating is maximized and localized and thus an intentional burn occurs - producing the surgical effect at the operative site.

- Operators should be aware that this principle of Current Density/Current Concentration applies to all electro-surgical burns - intentional (at the surgical site) or accidental, whether to the operator or to the patient.

Isolated⁴ Output vs Ground Referenced Output

The preferred pathway for electro-surgical current during electro-surgical procedures is from the generator through the active accessory and cable, through the patient and returning to the generator via the dispersive electrode³ (neutral) and cable.

There are two types of electro-surgical systems, those that utilize ground referenced power output and those utilizing isolated⁴ power output.

Dispersive Electrode³ = Neutral Electrode
Isolated⁴ = Floating Output

- The Bard System 5000 utilizes isolated (floating) output.

Aspects of ground referenced power output electrosurgical systems:

Everything in a typical Operating Room⁵ is grounded. This includes operators and equipment. The common ground point is the conductive operating room floor. Ground referenced electrosurgical generators have their power output circuits, the one producing electrosurgical current, referenced to the grounded operating room floor. Thus, in some cases, the floor itself can serve as an alternate pathway for the electrosurgical current to return to the generator. Consequently, anyone or anything in contact with the patient and the grounded operating room floor can become an alternate pathway for significant amounts of electrosurgical current to return to the generator.

When this situation occurs, the potential for an "alternate path burn" to the operator or patient greatly increases.

Examples And Explanation Of Typical "Alternate Path Burns"

To The Doctor:

- The surgeon can burn his hand while holding a hemostat or similar clamp if his glove has

Operating Room⁵ - theatre

a pinhole or tear in it. The burn can occur when electrosurgical current is applied to the hemostat. What happens is the surgeon becomes an alternate pathway for the current to return to the generator via the pinhole or tear. The pinhole or tear has a small surface area and can allow sufficient current density or concentration to produce a serious burn, also a burn can occur to the hand or fingers while an urologist is holding an endoscopic instrument such as a resectoscope. Again, the surgeon becomes the pathway for the current to return to the generator. Urologists have also reported burns to the face and eye area. Non-conductive resectoscope eyepieces are a recommended device to be used with electrosurgical equipment.

To The Patient:

- Burns at ECG monitoring electrode site - the electrode, via the cable and monitor unit can become an alternate pathway for the electrosurgical current to return to the generator. Eliminate the use of ECG monitoring needle electrodes in favor of those with larger surface areas and place them as far away as possible from the operative and dispersive electrode sites can help to minimize this potential hazard.
- Burns at temperature probe site - such probes can also become alternate pathways for electrosurgical current.

Battery operated temperature probes can help to minimize the potential for this occurrence.

Burns caused by current taking an alternate path can be avoided by conducting preoperative inspections. Insure that the patient is sufficiently insulated from grounded points. These points could occur where the patient is in direct contact with the metal operating table or other grounded components like metal retractors, or neurosurgical headframes connected to the operating table.

Aspects Of The Bard System 5000 Isolated Power Output

- Unlike ground referenced electrosurgical generators, the power output circuit of the Bard System 5000 is not referenced to the grounded operating room floor. The Bard System 5000 is isolated from ground points.
- This isolated output design helps to insure that the electrosurgical current travels only in the preferred pathway, and minimizes the risk of accidental burns to the operator and patient through electrosurgical current taking "alternate pathways" to return to the generator.
- Unlike ground referenced electrosurgical generators, the

Bard System 5000 will not deliver usable surgical current if the patient is not in contact with the dispersive electrode. The one exception is if the dispersive electrode via the attached cable is plugged into the generator and not in contact with the patient, but in direct contact with a grounded object such as the operating room floor, a metal instrument table, or on top of the generator. In such a position the power output circuit of the generator would then be referenced to ground. Surgical current output would be reduced yet the generator would still operate. The system would then function as a ground referenced generator. Care should be taken to avoid this.

Cord Fault Alarm Feature

- The Bard System 5000 is equipped with an automatic alarm system to deactivate the generator and alert the staff if there is interruption in the continuity of the dispersive electrode (patient plate) circuit.
- An audible alarm will sound and the generator will automatically become disabled when the following conditions occur:

Dispersive electrode cable not plugged securely into generator.

Dispersive electrode cable damaged or broken.

Cable/cord connection at dispersive electrode site is defective, damaged or not connected to dispersive electrode.

The cord fault alarm only measures the continuity of the dispersive electrode circuit and does not measure proper patient and dispersive electrode contact.

Discrete Output (First Come-First Served)

The "first come, first served" design of the System 5000 enhances safety by allowing only one output to be activated at a given time.

This feature assures that only the device you first activate will be an active device. Secondary commands will not override the first command. As an example: While the monopolar footcontrolled output is activated, all handswitching capability is inactive, as well as the bipolar footswitch capability and vice versa.

- While this safety feature allows only one accessory to be active at a time, electrosurgical instruments, when not in use, should be kept away from the patient in an insulated safety cup holder.

Dispersive Electrode Safety With The Bard System 5000

To maximize patient safety, it is very important to maintain uniform dispersive electrode and patient contact throughout surgical procedures utilizing monopolar electrosurgical current with the Bard System 5000 or any electrosurgical generator.

Warning

- Inadequate/poor patient and dispersive electrode contact can create an accidental patient burn at the dispersive electrode site. Please read the discussion of "Current Density/Current Concentration" located in the operator's manual in the Safety Systems section.

Follow the manufacturer's instructions regarding application of dispersive electrodes.

Guidelines For Proper Dispersive Electrode Location:

- Dispersive electrode site should have good blood supply.

While a properly applied dispersive electrode results in minimal tissue heating beneath the electrode, a good blood supply helps carry heat away from the site.

- Dispersive electrode site chosen should be primarily muscle tissue.

Buttocks, thighs and biceps are common sites, muscle tissue generally has a good blood supply and a relatively low resistance to electrosurgical current flow.

- Dispersive electrode - patient application site should be as close as possible to operative site.

This will minimize the distance the electrosurgical current has to flow through the patient. The further the dispersive (neutral) electrode is from the operative site, the greater number of alternate paths that will be available before the current reaches the dispersive electrode. This is especially important with ground referenced electrosurgical systems. In addition, a dispersive electrode far from the surgical site can result in more power required to produce the desired surgical effect.

- When reusable, metal dispersive electrodes or rigid disposable cardboard and foil types are utilized, the only suitable patient application site is under the patient's buttocks.

An appropriate amount of conductive gel should be applied to the dispersive electrode. The gel should be designed for use with electrosurgical equipment only.

Other gels, ECG paste or lubricants should not be used. Such gels or lubricants can dry

out during surgical procedures and become insulators rather than conductors, thus increasing the potential for an accidental burn to the patient.

Utilization Of Flexible Type Disposable Dispersive Electrodes

Patient Application Sites To Avoid:

- Avoid application under the patient's buttocks.

While this is a suitable application site for reusable type dispersive electrodes, disposable dispersive electrodes usually have a connector attaching the electrode to the cable. Depending upon the location of the connector on the dispersive electrode, the connector site could become a pressure point thus increasing the potential for the current to concentrate at that point and produce an accidental burn. This pressure point can also increase the potential for damage to the patient's tissue from a pressure lesion.

- Avoid application over scar tissue:

Scar tissue generally has poor blood supply and higher resistance to electrosurgical current flow than normal tissue.

- Avoid application over metal implants (prostheses):

The electrosurgical current may tend to concentrate at the metal implant site producing areas of high current density. The effects of such current concentration to the acrylic cement/bone interface are not known.

- Hairy areas should be shaved.
- Avoid application to areas of the patient affected by a tourniquet.

Due to compromised blood supply, the dispersive electrode should not be placed below a tourniquet.

- Avoid application sites in close proximity to monitoring electrodes. Especially with ground referenced electrosurgical generators. The monitor via the electrode and cable can provide an "alternate path" for the electrosurgical current to return to the generator. Thus, the potential for an accidental patient burn at the electrode site is increased.

Leakage current from the dispersive electrode can also increase interference with monitoring equipment.

(For more information regarding interference to monitoring equipment, please read the chapter in this manual entitled "Minimizing Interference With Monitoring Equipment").

- When utilizing electrosurgical current in the presence of cardiac pacemakers, place the

dispersive electrode at right angles (90°) to the pacemaker. *(For more information regarding pacemakers and electrosurgical current, see the chapter in this manual entitled "Precautions For Utilization Of System 5000 In The Presence Of Cardiac Pacemakers").

- Avoid application to areas that are wet or likely to become wet.

Dispersive electrodes which have adhesive, to affix them to the patients skin, can become loose or dislodged if they become wet.

- Avoid application over bony prominences (such as over the patient's spine or shoulder blade).

Application over bony prominences can create pressure points resulting high current concentration at that site, thus increasing the potential for an accidental patient burn.

General Safety Precautions Regarding Dispersive (Neutral) Electrodes

- Do not alter the shape or size of the dispersive electrode.
- Metal, reusable dispersive electrodes which have become scratched, dented, bent or otherwise altered, should not be used. Electrosurgical current will tend to "concentrate" at these defects thus producing high current density at the defect location and increase the

potential for an accidental patient burn at that site.

- When utilizing pre-gelled type disposable dispersive electrodes, inspect the gelled area on the electrode before application to the patient to insure:

The gel is not discolored

Has not dried out during storage

Is evenly distributed within the conductive area.

If there is a failure of any or all of the above items, do not use the disposable dispersive electrode.

- During the surgical procedure, take care that tension is not applied to the dispersive electrode cable.

This can cause the electrode to become dislodged and thus not maintain proper patient contact and may result in an accidental burn to the patient.

- During the surgical procedure, inspect the dispersive electrode application site:

If tension has been placed on the cable (as discussed above).

If the patient has been moved to another position, the dispersive electrode may have become dislodged.

If it is a long procedure (over 4 hours) - the gel could have

dried out in the disposable/adhesive type. (A reusable electrode or disposable, non-adhesive type requiring gel should be inspected for dry-out after 2 1/2 hours).

If the surgeon requires more power than usual to produce the desired surgical effect - one of the first signs of insufficient electrode and patient contact is a reduction of power delivered from the electro-surgical generator.

Utilization Of The Bard System 5000 For Bipolar Electro-surgical Procedures

Bipolar Current and Instrument Utilization

- A surgical procedure wherein only bipolar current will be utilized with the Bard System 5000 does not require a dispersive electrode be applied to the patient and connected to the generator. However, a dispersive electrode applied pre-operative to the patient but not connected to the generator may be of benefit, if during the procedure, the surgeon requires monopolar current (which does require a dispersive electrode) the electrode will already be applied to the patient and is easy to connect to the generator. This technique can be beneficial as it can prevent delay during the procedure. It also helps to insure that the drape material does not accidentally become lodged

between the electrode and the patient.

- Bipolar forceps care and use:

If forceps are the insulated type, check insulation for chips, cracks or other defects before use, cables should also be inspected for damage and discarded if not free of defects.

Tips of bipolar forceps should be kept clean and free of coagulum build-up during bipolar procedures.

Tissue should always be contained between or within the forcep jaws before activation. If the forceps tips touch, without tissue between them, no usable surgical current will be delivered.

- Keep the bipolar cutting power control in the "0"/OFF position if cutting current is not desired.
- Utilizing bipolar current with the Bard System 5000 for coagulation during pediatric or neonate surgical procedures is most preferable. The Bard System 5000 has sufficient bipolar coagulation power to produce the desired surgical effect in such cases and provides the following benefits:

Helps eliminate hazards associated with dispersive electrodes and placement/application difficulties on small patients.

Helps eliminate potential hazards of current taking alternate pathways.

Allows for precise coagulation with minimal tissue destruction.

Precautions Regarding The Use Of Electrosurgical Accessories/ Instruments With The Bard System 5000

- Only accessories and instruments which, by design, conform to the manufacturers specifications should be utilized with the Bard System 5000.
- Accessories/Instruments and all cables should be inspected for defects such as broken cable insulation, or chipped, nicked or cracked insulation on forceps before use. Defective accessories, instruments or cables should not be used.
- Do not try to temporarily repair defects in accessories, instruments or cables with tape. Defective or damaged items should be replaced or professionally repaired.
- Electrosurgical handcontrols, (finger controlled handles) which by design, offer no protection from the ingress of liquids should be avoided whenever possible.
- Electrosurgical accessories or instruments, when not in use, should be kept away from the patient in an insulated safety cup holder.

Minimizing Electrosurgical Interference With Monitoring Equipment

All electrosurgical generators, when activated, create certain levels of monitor interference. Generator design, such as the isolated output design of the Bard System 5000, can help to reduce this by allowing the monitor to return to normal sooner than ground referenced generators generally allow.

The following actions can be taken to help reduce this interference:

- Contact the manufacturer of the monitor for suggestions to reduce interference.
- Utilize a monitoring electrode cable which incorporates a "RF CHOKE" (filter) connected between the monitoring electrode and the monitor.
- Keep electrosurgical cables (active and dispersive) separated from and not in direct contact with monitor cables.
- Place the dispersive electrode as far away as possible from the monitoring electrodes (this also helps to reduce the potential for "alternate path burns" at the monitoring electrode site).
- Keep active and dispersive electrodes from lying on the operating room floor. When active or dispersive cables

contact the operating room floor, RF leakage and thus the potential for interference is increased.

Precautions For Utilization Of The Bard System 5000 In The Presence Of Cardiac Pacemakers

- Although cardiac pacemakers manufactured within the past several years do have shielding which helps to protect the pacemaker from electrosurgical interference - careful attention should be given to the following safety precautions:

Consult the manufacturer of the cardiac pacemaker per recommendations regarding the use of electrosurgical current in the presence of the pacemakers. Some manufacturers may feel the use of any electrosurgical equipment in the presence of a pacemaker is contraindicated.

If the Bard System 5000 is utilized, place the dispersive electrode at right angles (90°) to the pacemaker to minimize the possibility of current traveling through the pacemaker.

Take care not to touch any leads connected to the pacemaker or the pacemaker unit with an active accessory/instrument.

Take care to insure the operator does not activate the generator at a rate that approximates the patients pulse rate as this can

create inhibition of the pacemaker.

To avoid most pacemaker interference utilize bipolar current for coagulation. The power level of bipolar in the Bard System 5000 is sufficient to provide, in most instances, satisfactory coagulation effect. Utilization of bipolar electro-surgical current for coagulation also eliminates the need for a dispersive electrode and thus the potential hazards of accidental burns at the dispersive electrode site as well as "alternate path burns".

Pacemakers And Electrosurgery

The Problem:

A patient with a pacemaker may be sensitive to such high frequency devices as electrosurgical generators. This is usually most prevalent in "demand" pacemakers where the pacemaker will activate only when the heart needs to be stimulated. A potential problem may exist when high frequency currents create interference with the pacemaker which might cause shutdown.

What Should Be Done?

Surgeon's Considerations:

- If possible, limit the ESU use

to Bipolar.

- Always consult the pacemaker manufacturer before using the ESU - have the name of the pacemaker and ESU's frequency available for the manufacturer. Follow the manufacturer's suggestions.
- Use an isolated generator to minimize the potential problem of current division when some current may be seeking an alternate ground source through the pacemaker.
- If you must introduce electrosurgical current near the pacemaker leads, do so at right angles to reduce the chance of tissue destruction by the leads.
- Do NOT activate the ESU at such a rapid rate that it may mimic the pulse rate.
- Always have qualified personnel taking the pulse as a cross-check when the ESU is being activated.

Nurse's Considerations:

- Place the dispersive electrode (patient plate) as close as possible to the surgery site.
- Carefully place the dispersive electrode (patient plate) distal to the pacemaker site, so that current will be less likely to go through the pacemaker.
- If the case is performed under local anesthesia, the circulating nurse should monitor

the pulse, especially when the ESU is being activated.

- Have a defibrillator and an external pacemaker available.

Keep in mind that the newer pacemakers have significant amounts of shielding to minimize the effects of high frequency interference. Following these precautions should optimize the safety for the patient with a pacemaker.

Specifications

System 5000 Power Plus Specifications

Output characteristics (maximum control settings)

Frequency all modes 500KHz

<u>Mode</u>	<u>Power</u> (Typical)	<u>P/P Voltage</u> (Maximum open circuit)
Cut	350 W	2000 V
Cut Blend 1.5	320 W	3600 V
Coag Pinpoint	130 W	4000 V
Coag Spray	75 W	8000 V
Cut Bipolar	50 W	550 V
Coag Bipolar	50 W	1280 V

-- 500 ohm

125 ohm

Input Characteristics (Typical)

Maximum control setting into 500 ohm load

Model 132030, 132036

Models 132031, 132033, 132034, 132035

115 VAC 60 Hz

220/240 VAC 50 Hz

Idle: 0.6 A

Idle: 0.3 A

Cut: 12 A

Cut: 6 A

Coag: 6 A

Coag: 3 A

A = Amps
 Hz = Hertz
 V = Volts
 W = Watts

System 5000 Power Plus Specifications

Risk Currents (Typical)

R.F. High Frequency (Per IEC 601-2-2 Sec 19.101)
 AAMI 1982 Draft for Electrosurgery (200 ohm load)

	<u>Patient to Ground</u>	<u>Active to Ground</u>
Cut Pure	100 ma	100 ma
Coag Pinpoint	70 ma	70 ma
Coag Spray	125 ma	120 ma
Coag Bipolar	105 ma	95 ma
Coag Bipolar	95 ma	90 ma

General

Classification: Class I

Type:



Spillage Protection: Drip Proof



Internal Design: Solid State

Output Configuration: RF Floating (Isolated)

Cooling: Convection (No Fan)

Dimensions: 8 H x 18 W x 19 D Inches

20 x 4 x 46 W x 49 D Centimeters

Weight: 43 lbs. (19 KG)

Approvals: BS5724, SPRIMA, TNO (220/240V)

UL544, CSA22.2 No. 125 (115V), AS. 3200, 3202

ma = milliamp

CF = Cardiac Floating (See Glossary)

System 5000 Power Plus Specifications

Risk Currents (Typical)

Low Frequency (Per IEC 601-1 Sec 19)

Earth Leakage (Ground)	.042 ma (N.C.), 0.0003 ma (S.F.C.)
Enclosure Leakage	.042 ma (N.C.), 0.080 ma (S.F.C.)
Patient Leakage (Type CF)	0.0004 ma (N.C.), 0.0004 ma (S.F.C.)
Mains Voltage on AP (Type CF)	0.001 ma
Patient Auxiliary (Type CF)	.0001 ma (N.C.), .0001 ma (S.F.C.)

Risk Currents (Typical)

Low Frequency (Per U.L. 544 Sec 27)

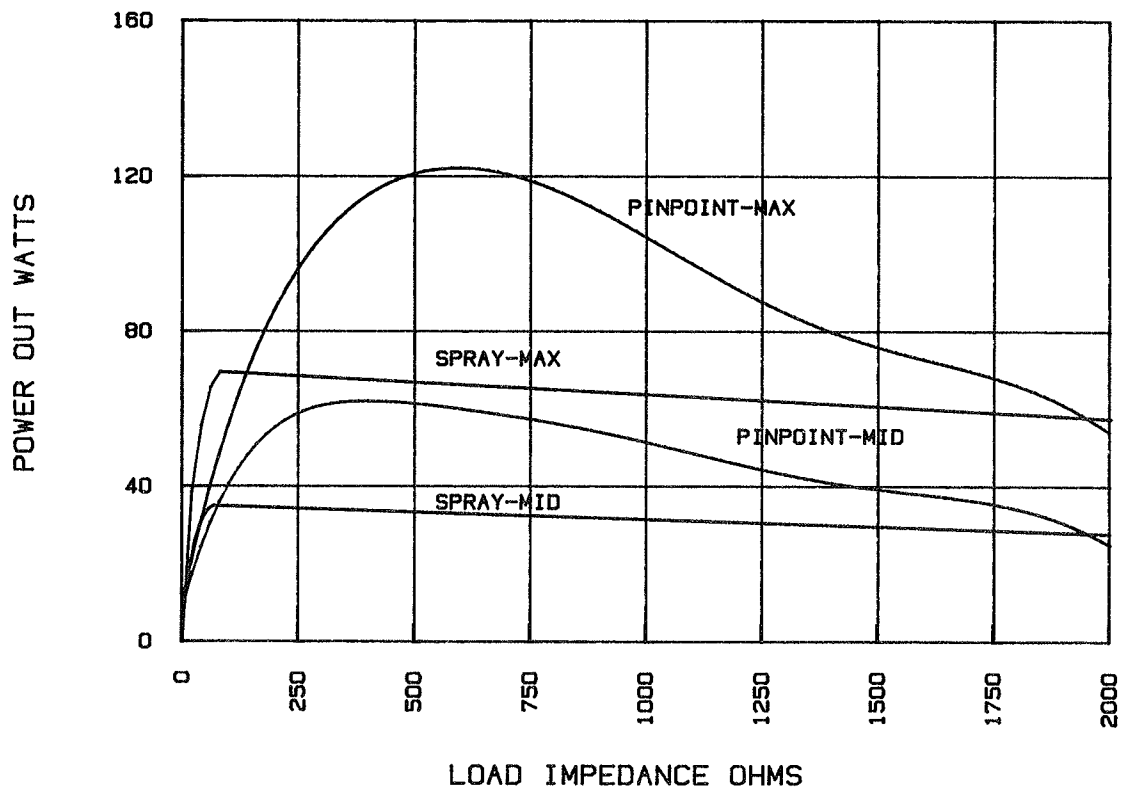
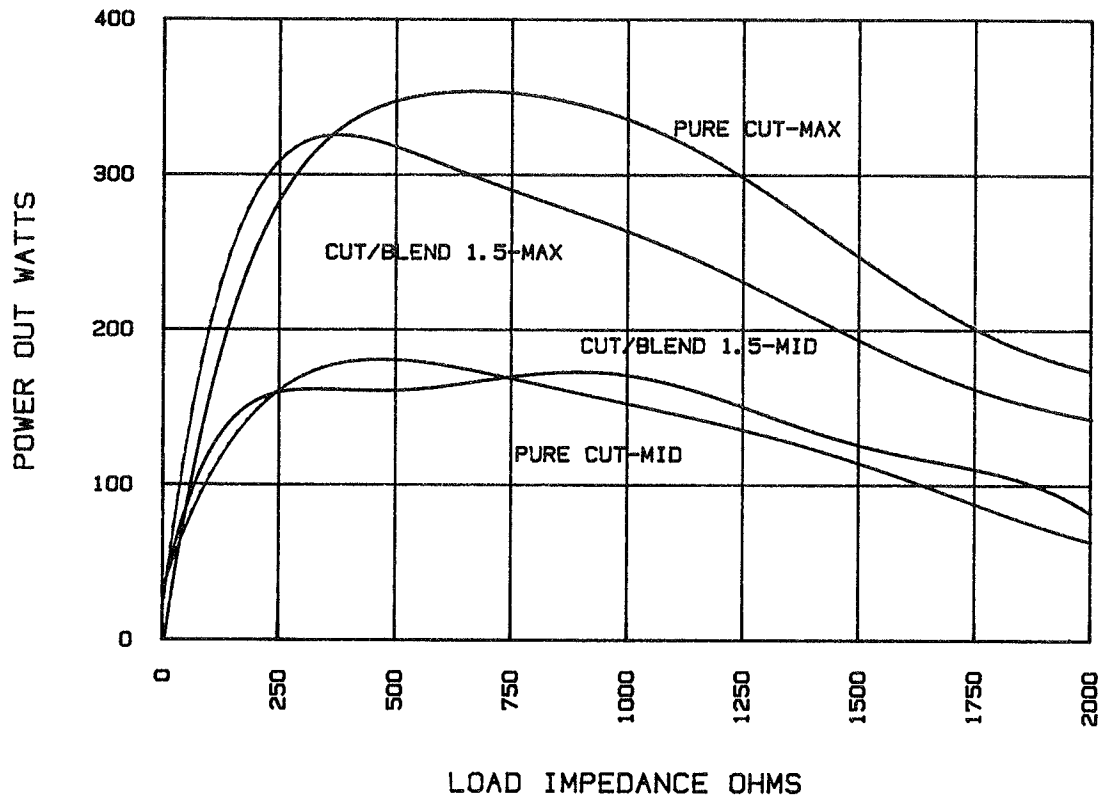
Chassis to Neutral

Line Polarity Normal (Ground Open)	18.0 uA
Line Polarity Reversed (Ground Open)	24.0 uA
Patient Lead (All - RF Active or Neutral)	
Line Polarity Normal - Ground Closed	0.4 uA
Line Polarity Reversed - Ground Closed	0.5 uA
Line Polarity Normal - (Ground Open)	1.5 uA
Line Polarity Reversed - (Ground Open)	2.5 uA

AP Applied Part
CF Cardiac Floating
ma Milliamp
N.C. Normal Condition
S.F.C. = Single Fault Condition
uA Microamp

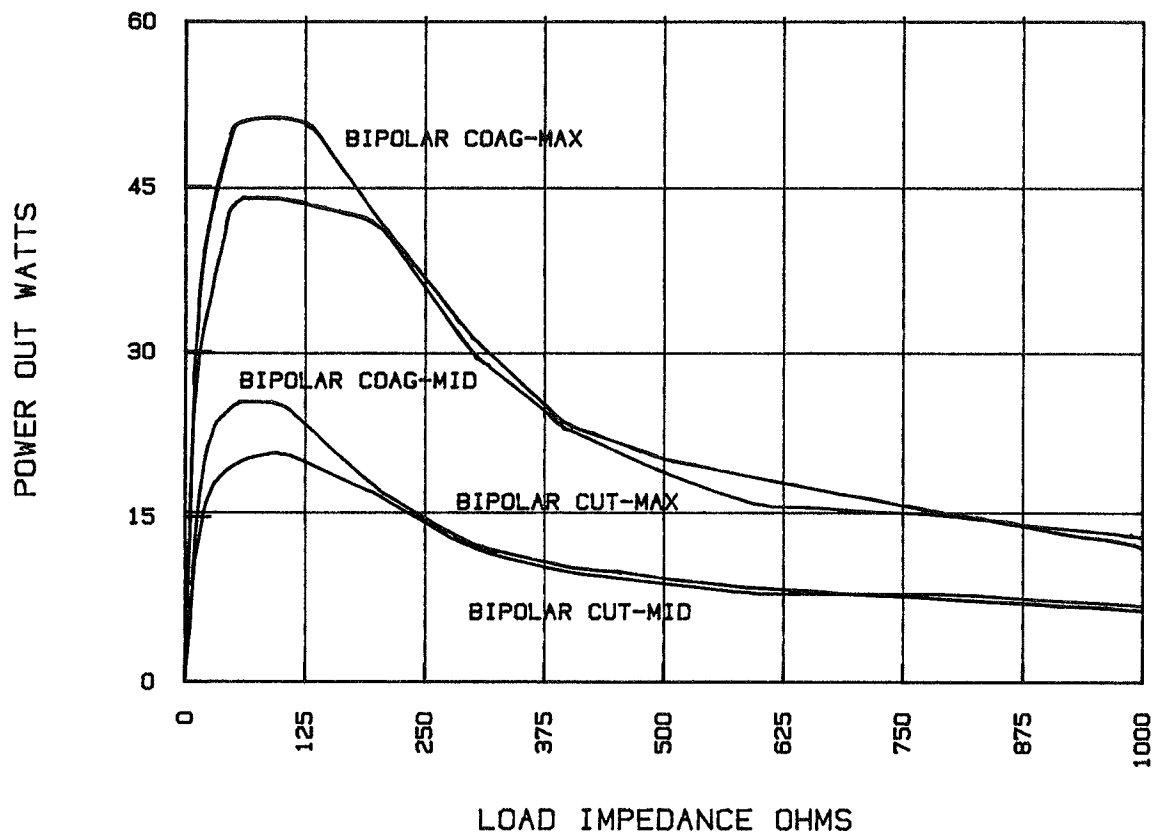
**Typical Power Output vs Load Impedance
At Maximum And Mid Positions**

Monopolor



Typical Power Output vs Load Impedance At Maximum And Mid Positions

Bipolar



**OPERATIONAL
CHECK LIST**

Operational Checkout

1

The following checklist will guide you through a users operational check. Perform the pre-operational control settings in Section 2 first. Then perform the operational check steps in Section 3. Generator and accessory actions are listed in the left hand column. Generator expected outcomes are listed in the right hand column.

NOTE

2

The parentheses after the name of the control or connector contains the reference number. Refer to Page 20 to use the reference number to locate the item.

Connect a serviceable footswitch to the FOOTSWITCH Connector (22) on the rear panel.

Connect a serviceable 3-Wire Handcontrol to the Monopolar Handcontrol receptacle (16).

If the generator fails any of the following tests, DO NOT USE. Refer to qualified service personnel.

PRE-OPERATIONAL CONTROL SETTINGS

CONTROL	SETTING
POWER (1)	OFF
FOOTSWITCH (12)	BIPOLAR
MODE (4)	BIPOLAR
MONOPOLAR BLEND Control (3)	Full CCW
MONOPOLAR CUTTING POWER Control (6)	Zero (0) Full CCW
MONOPOLAR COAGULATION Type (13)	PINPOINT (P)
MONOPOLAR COAGULATION POWER Control (8)	Zero (0) Full CCW
BIPOLAR CUTTING POWER Control (12)	Zero (0) Full CCW
BIPOLAR COAGULATION POWER Control (11)	Zero (0) Full CCW
SOUND LEVEL (19)	Mid Range

After completion of pre-operation control settings, plug the generator into a directly grounded power outlet.

DO NOT use adapters or extension cords between the generators power cord and the directly grounded power outlet because said utilization may cause increased risk currents.

Operational Checkout

3

Action	Expected Outcome
1. Turn the POWER switch (1) ON.	1. BIPOLAR CUTTING and COAGULATION POWER displays are lit and read zero. The BIPOLAR FOOTCONTROL and HANDCONTROL green indicators are lit. All monopolar function indicators are OFF. CORD FAULT light and audible warning are OFF.
2. Depress the CUT treadle of the footswitch (24).	2. BIPOLAR CUTTING indicator light is lit. An audible tone is heard. (Tone volume is adjusted with a control on the rear panel.)
3. Depress the COAG treadle of the footswitch (24).	3. BIPOLAR COAGULATION light is lit. An audible tone is heard. (This tone is lower in pitch than the cut tone.)
4. Depress both the CUT and COAG treadles of the footswitch (24).	4. BIPOLAR COAGULATION light is lit. An audible tone is heard.
5. Set the FOOTSWITCH control (2) to MONOPOLAR.	5. The BIPOLAR FOOTCONTROL light is out.
6. Depress the CUT and then the COAG treadles of the footswitch (24).	6. No event occurs.
7. Set the MODE control (4) to MONOPOLAR.	7. The CORD FAULT light is lit. An audible alarm is heard. Both MONOPOLAR HANDCONTROL and FOOTCONTROL indicators are lit. All bipolar function indicators are Off. The MONOPOLAR CUTTING and COAGULATION POWER displays are lit and read zero.
8. Connect a patient plate to the DISPERSIVE ELECTRODE receptacle (17).	8. The CORD FAULT light is out. The audible alarm is OFF.
9. Depress the CUT treadle of the footswitch (24).	9. MONOPOLAR CUTTING indicator is lit. An audible tone is heard.
10. Depress the COAG treadle of the footswitch (24).	10. MONOPOLAR COAGULATION indicator is lit. An audible tone is heard. (This tone is lower in pitch than the cut tone.)
11. Set the footswitch control (2) to BIPOLAR.	11. The MONOPOLAR FOOTCONTROL light is out.

Action**Expected Outcome**

- | | |
|---|--|
| 12. Depress the CUT and then the COAG treadles of the footswitch (24). | 12. No event occurs. |
| 13. Activate the CUT control on the handcontrol. | 13. MONOPOLAR CUTTING indicator is lit. An audible tone is heard. |
| 14. Activate the COAG control on the handcontrol. | 14. MONOPOLAR COAGULATION indicator is lit. An audible tone is heard. |
| 15. Set the MODE Control (4) to DUAL. | 15. Both MONOPOLAR CUTTING and COAGULATION and BIPOLAR CUTTING and COAGULATION POWER displays are lit and read zero. |
| 16. Remove the patient plate from the DISPERSIVE ELECTRODE receptacle (17). | 16. The CORD FAULT light is lit. An audible alarm is heard. |
| 17. Activate the handcontrol in CUT. | 17. No event occurs. |
| 18. Reconnect the patient plate. | 18. The CORD FAULT light is out. The audible alarm is OFF. |
| 19. Depress the CUT treadle of the footswitch (24). | 19. The BIPOLAR CUTTING light is lit. An audible tone is heard. |
| 20. Depress and hold the COAG control of the handcontrol. Then depress the CUT treadle of the footswitch. | 20. The MONOPOLAR COAGULATION light is lit. An audible tone is heard. |
| 21. Set MONOPOLAR COAGULATION POWER (8) to 65 watts. Then set the MONOPOLAR COAGULATION TYPE (13) to SPRAY. | 21. MONOPOLAR COAGULATION POWER now reads 35 ± 5 watts. |
| 22. Set MONOPOLAR CUTTING POWER (6) to 260 watts. Then turn the MONOPOLAR BLEND Control (3) full clockwise so that the entire blend indicator bar is lit. | 22. The MONOPOLAR CUTTING power display now reads 230 ± 5 watts. |
| 23. This completes the operational check. | |

Return controls to pre-operational settings per Section 2.

Service Support

Preventive Maintenance

The System 5000 Technical Manual spells out a recommended preventive maintenance program for your Engineering Department. Following this program will increase equipment life and help provide for the safe, consistent performance of your Bard equipment. For accessories, see packaged instructions.

Service

Should your System 5000 require service beyond the recommended preventive maintenance, contact the Bard Electro Medical Systems Field Service Department (1-303-790-1117) to arrange for prompt professional service.

International customers, please contact your local sales representative.

Limited Warranty

The Electrosurgical Power Unit and/or Footswitch is warranted to the original purchaser to be free from defects in material and workmanship for a period of two (2) years from the date of purchase. If the Power Unit and/or Footswitch proves to be so defective, Purchaser may return same to Bard Electro Medical Systems, for repair, or replacement, as Bard deems appropriate. The liability of Bard under this limited warranty does not extend to any Power Unit and/or Footswitch which has been abused misused or serviced by anyone other than an authorized Bard representative.

While the unit is within the stated warranty period, no unauthorized service repairs or modifications on this equipment other than that described in the 'Maintenance' Section of the Technical Manual should be attempted. Any unauthorized repairs will immediately void the remainder of the warranty. If a local Bard representative is not available, service assistance is available by calling 1-303-790-1117.

This limited warranty is in lieu of all other warranties, whether expressed or implied (including any warranty of merchantability, suitability or fitness for a particular purpose) respecting the power unit and/or footswitch or any other component, and the liability and remedy stated in this limited warranty will be the sole liability of Bard Electro Medical Systems, and remedy available to purchaser for said products, whether in contract tort (including negligence) or otherwise, and Bard will not be liable to purchaser for any incidental or consequential damages arising out of or incident to the handling, use, maintenance or servicing or disposition of same.

Inservice

Your sales representative is thoroughly trained to provide inservice Programs for your hospital's surgical personnel. Should you have questions on the use of your System 5000, contact your local representative.

Glossary of Terms

ACTIVE CABLE - The conductor between the electrosurgical generator and the active electrode, including any connectors and/or handle.

AC CURRENT - Abbreviated AC. A flow of electricity which reaches maximum in one direction, decreases to zero, then reverses itself and reaches maximum in the opposite direction. The cycle is repeated continuously.

ACTIVE ELECTRODE - The electrode or electrode assembly at which the electrosurgical effect is intended. It usually has a small contact surface area and provides a high current density to achieve the desired surgical effect. A bipolar instrument is to be considered an active electrode.

AMPS - Abbreviation for ampere which is a unit of electrical current or rate of flow of electrons. One volt across 1 ohm of resistance causes a current flow of 1 ampere (unit of measured current).

BIPOLAR INSTRUMENT - A forceps or other electrosurgical accessory having two electrodes, both of which are intended to be applied to the tissue undergoing electrosurgical treatment and energized by the electrosurgical generator so that the current passes between the electrodes and by design produces a surgical effect at both electrodes. It is intended that the electrosurgical current is restricted to tissue between the electrodes.

BIPOLAR TECHNIQUE - Electrosurgical effect takes place between paired electrodes placed across the tissue to be treated. It is intended that the electrosurgical current is confined to the tissue between the electrodes. Because the current passes between the paired electrodes no patient electrode (dispersive electrode) is required.

BLEND - A cut waveform with intermittent bursts of coagulation to allow cutting with hemostasis.

BREAKDOWN (Dielectric) - The failure of insulation under the stress of a voltage characterized by marked increase in conductivity and/or disruptive discharge.

CAPACITOR - A device consisting of two conducting surfaces separated by an insulating material or dielectric. Capacitors can store electrical energy in DC circuits and conduct radio frequency current.

CF = CARDIAC FLOATING - A class of protection against electrical shock providing a high degree of protection regarding leakage currents utilizing an isolated (floating) applied part (AP). The type CF equipment has sufficiently low risk current limits to permit usage in operations in which there are electrical connections with direct cardiac applications.

COAGULUM - The greyish-white substance resulting from the destruction of living tissue by the passage of coagulation current. It normally separates from the underlying living tissue in several hours to several days. A semi-solidified mass, as of blood or lymph; clot.

CONVECTION COOLING - (No Fan) Heat removal by natural vertical air flow from hot to cool areas.

CURRENT (measured in AMPERES) - The movement or flow of electric charges (electrons) through a conductor. Direct current (DC) flows in only one direction through the circuit (from "negative" to "positive" terminals). Alternating current (AC) reverses the direction of its flow at regular intervals. Alternating AC current can produce a wave-form that is sinusoidal (i.e., producing a sine wave), like the supply mains or the high frequency output of an ESU. AC can vary according to the heights of the peaks (maximum or peak voltage, also called the amplitude), or by the number of complete cycles per unit time (frequency).

CURRENT DENSITY - The quotient of the current flowing across a given area divided by that area, expressed as amperes per square meter.

DESICCATE - (A form of coagulation) The dehydration and necrosis of tissue caused by passing a radio frequency electric current through the tissue. In desiccation, the electrode must be in good electrical contact with the tissue. The current heats the tissue by dissipating power in the electrical resistance of the tissue. Desiccation differs from fulguration in that there is no sparking between the electrode (s) and the tissue. See: fulguration/spray.

DESICCATION (pinpoint or spray) - A procedure wherein a small amount of tissue on the surface is dried out by placing the active electrode in contact with the tissue.

DIATHERMY - The generation of heat in the body tissues due to the resistance offered by the tissues to the passage of high frequency electric currents. The therapeutic heating of the body tissues or parts without necrosis by means of an oscillating electric current of high frequency.

DISCRETE OUTPUT - Only one output active at any time.

DISPERSIVE ELECTRODE - The electrode at which no electrosurgical effect is intended. It is usually large in area in order to provide a low current density so that no electrosurgical effect occurs at that site. It is also known as a patient plate, plate electrode, return electrode, neutral electrode, inactive electrode, etc. It is sometimes (inaccurately) referred to as a ground plate.

DISPERSIVE ELECTRODE CABLE - The conductor between the electrosurgical generator and the dispersive electrode, together with any attached connector.

DISPOSABLE ACCESSORY - An electrosurgical accessory, such as active electrodes, handles, dispersive electrodes, etc., which is not intended to be used more than once.

DUTY CYCLE - The proportion of time (expressed in percentage) that a current or device is "on" versus off. Duty cycle may be used when referring to current wave forms which are repetitive. Thus high frequency current would be "on" using a shorter period of time than a low frequency current. Duty cycle is also used in reference to electrical components or equipment. For example, some equipment is designed to be used continuously, that is, with a duty cycle rating of 100%, while other equipment may be rated for intermittent use, that is, less than 100% duty cycle. Most ESU's are designed to be used intermittently. Typically they are rated for 50% duty cycles from 25% to 50%. Use of any equipment beyond its duty cycle rating may result in premature failure.

ELECTROCAUTERY - The searing or destruction of tissue by heat delivered to the tissue from a conductor brought to a high temperature by the passage of an electric current through the conductor. Current does not pass through the patient.

ELECTROSURGERY - (Surgical Diathermy) - the generation and delivery of a radio frequency current between an active electrode and a dispersive electrode or through a bipolar instrument for the purposes of dehydration of tissue. Electrosurgery also includes the cutting or vaporising (tissue explosion). In contrast to electrocautery, the electric current actually passes through the tissue.

ELECTROSURGICAL ACCESSORY - Equipment used in conjunction with the electrosurgical generator to accomplish electrosurgery. These include, but are not limited to footswitch, cable, dispersive electrode, and active electrode.

ELECTROSURGICAL COAGULATION CURRENT - An electrosurgical current, which, when applied with an appropriate electrode and magnitude, to a tissue surface where there are several blood vessels, causes clotting of those vessels with necrotizing of the tissues. It is used primarily to control bleeding (hemostasis).

ELECTROSURGICAL CURRENT - An alternating electrical current of sufficiently high frequency for the performance of electrosurgery without neuro-muscular stimulation.

ELECTROSURGICAL CUTTING CURRENT - An electrosurgical current, which, when applied to tissue with an appropriate electrode and magnitude, divides tissue cleanly with a result similar to that achieved mechanically by a knife (scalpel).

ELECTROSURGICAL UNIT (SURGICAL DIATHERMY) - The electrosurgical generator together with its accessories intended for use to accomplish electrosurgery.

ESCHAR - Slough produced by thermal burn.

E.S.U. - Electrosurgical Unit.

FIRST COME, FIRST SERVED - First activation command maintains control without override on both mode and output receptacle until released by operator.

FREQUENCY (expressed as cycles/second or Hertz) - The rate at which an alternating or oscillating current repeats itself in each second. Typical supply current has a frequency of 50 or 60 cycles/second (or Hertz). Generally, currents with frequencies of over about 20,000 cycles/second (20 kilo Hertz) are considered radio frequency (RF) currents.

FULGURATE (Technique or spray technique) - Coagulating tissue or blood by means of radio frequency electric sparks. In contrast to desiccation, the active electrode is not in good electrical contact with the tissue and sparks jump from the electrode to the tissue.

GROUND (Earth) - Wires and conductors connected to the earth. Grounded conductors all have the same voltage so no currents can flow between the two grounded objects.

GROUNDING GENERATOR OUTPUT - An electrosurgical generator output which has the patient electrode grounded to the metal chassis of the generator. This means that current will flow from the active electrode when it touches any grounded object in the room.

HEMOSTASIS (electrosurgical) - The desired therapeutic effects of electrosurgical current, which is used to stop bleeding of cut vessels. A relatively slow (compared to cutting) evaporation of fluid which results in the formation of a "plug" or coagulated tissue in the cut vessel. The property of stopping blood flow.

HEMOSTAT (artery forcep) - A scissors-like clamp for occluding a blood vessel and stopping flow of blood.

IMPEDANCE (Measured in Ohms) - Total opposition, both resistive and reactive, a circuit offers to the flow of alternating current at a given frequency.

ISOLATED POWER SYSTEM - A large transformer assembly commonly found in operating rooms that converts conventional 120/220 volts A.C. ground-referenced power to isolated power with no voltage reference to ground.

LEAKAGE CURRENT - The non-functional currents (milliampere, microampere) that can "leak" or pass through the insulation of cables, cords, connectors and other electrical circuit components.

LINE ISOLATION MONITOR - A safety system used in conjunction with operating room power systems which monitors the supply leakage current flowing to ground through the power system ground wiring. The monitor sounds an alarm if the current exceeds preset limits.

LOAD - An impedance or resistance placed across a voltage source which draws current from that source. For example, the electrical resistance of the tissue grasped in the jaws of bipolar forceps is the load on the output of the electrosurgical generator.

LOW FREQUENCY LEAKAGE CURRENT - Any supply current (50 or 60 Hz), including capacitively-coupled currents, which may be conveyed from accessible parts of the electrosurgical generator or accessories to ground, or through the patient to ground.

MEDICAL DIATHERMY - The application of a high-frequency current, electromagnetic field or ultrasonic mechanical energy to attain diffuse heating of body tissues, usually at some distance from the energy coupling electrodes or other applicator. In contrast to electrosurgery, tissue temperature rises are maintained well below that which would cause tissue destruction. Sometimes also called therapeutic diathermy.

MICRO - Abbreviated μ , prefix meaning one millionth ($\frac{1}{1,000,000}$ or 10^{-6}).

MICROBIPOLAR - A Bipolar mode with low power output designed to allow fine contact in critical areas.

MILLI - Abbreviated m , prefix meaning one-thousandth ($\frac{1}{1,000}$ or 10^{-3}).

MODE (Operating) - Each of the distinct ways in which the electrosurgical unit can be operated with electrosurgical output, e.g., monopolar cutting, monopolar coagulation, monopolar blended, monopolar spray (fulguration), bipolar coagulation, bipolar cutting.

MODULE - A combination of components which are contained in a package to perform a complete function. The several modules in an ESU facilitate fault isolation to a given functional module for quick replacement.

MONOPOLAR - The traditional form of electrosurgery which uses an active electrode to apply the therapeutic current to the surgical site, and a dispersive electrode (patient plate) to return the current to the ESU.

MONOPOLAR TECHNIQUE - The electrosurgical effect that takes place at the active electrode only. At the dispersive electrode, no electrosurgical effect is intended or desired.

NECROSIS - Localized tissue death that occurs in groups of cells.

OHM - Unit of resistance. One ohm is the value of resistance through which a potential difference of one volt will maintain a current of one ampere. In AC currents the resistance is called impedance.

OPEN CIRCUIT - No load or resistance connected to a voltage source. For example, if the generator is activated and the active electrode is not touching any tissue, the output of the generator is said to be open circuit.

OPEN CIRCUIT PEAK VOLTAGE - For the purpose of this standard, the maximum instantaneous output voltage of the electrosurgical waveform under the condition of no intentional load.

OPERATING ROOM - Hospital surgical area, also known as O.R., O.R. Suite, Operating theatre, etc.

OPERATIONAL CHECKOUT - Any examination, such as visual or auditory, without the use of special laboratory test equipment.

OUTPUT POWER - The rate of delivery of electrosurgical energy as determined by the measurement of the RMS current in a non-reactive load resistance and/or the RMS voltage across the load resistance.

OUTPUT TERMINALS (Electrosurgical) - The terminals on the electrosurgical generator to which are connected the cables and electrodes through which electrosurgical current pass to accomplish electrosurgery.

PATIENT CIRCUIT SAFETY MONITOR - Any circuit in an electrosurgical unit designed to detect an unsafe condition in the output circuit and give a warning or disable the generator.

PIN POINT COAGULATION - A procedure where in a small amount of tissue on the surface is dried out by placing the active electrode in contact with the tissue.

POWER - The rate at which energy is produced or consumed. Power is equal to voltage times current or resistance times current squared. The unit of measure of power is the watt.

RESISTANCE (measured in OHMS) - The opposition that a device or material presents to the flow of current independent of frequency. When current actually flows through a resistance, heat is produced.

R.F. - Radio Frequency. A high frequency alternating current usually greater than 100,000 Hz or that coherent electromagnetic radiation of energy is possible.

R.F. CHOKE - A small value inductor whose low frequency impedance is small but offers very high impedance to R.F.

R.F. ISOLATED (Floating) - The patient terminals have no intentional conductive path to ground (earth).

SHORT CIRCUIT - A zero impedance load connected across a voltage source. For example, if the generator touches the metal active electrode directly to the patient plate, the resistance to current flow in the cables will be essentially zero and the generator is said to be operating short circuit.

SOLID STATE - Electronic circuitry which is entirely transistorized and does not use vacuum tubes, spark gaps, or other such active circuit elements. The word "solid" refers to the structure of transistors which perform their electric function inside solid crystals, rather than in a vacuum, air gaps or rarified gases.

SPARK - An electric discharge across an air gap. In electrosurgery it is the discharge seen at the end of an electrode when cutting or fulgurating.

SPRAY COAGULATION - Coagulating tissue by means of radio frequency sparks. In contrast to Pin Point, the active electrode is not in contact with the tissue and sparks are to the tissue. When the active electrode is touched using the spray mode, the depth of desiccation is deeper.

STERILIZATION - Destruction of micro-organisms using heat, water chemicals, or gases.

SURGICAL DIATHERMY - An alternative term for electrosurgery.

TRANSFORMER - A circuit device which couples the electrical energy from one circuit to another by electromagnetic induction on a common magnetic path (core).

TRANSISTOR, BIPOLAR - A three terminal, current controlled device made of semi-conducting material (like silicon or germanium). The base current controls the amount of current in the collector emitter circuit, and is used in many applications. However, in power amplifiers, their speed and amplification capabilities can become limiting factors.

TRANSISTOR, (POWER MOS) - A three terminal voltage controlled device, made of semi-conducting material (generally silicon). The gate voltage controls the amount of current in the drain source circuit. Generally, used as a power amplifier due to its excellent speed and amplification capabilities.

VOLT - Abbreviation for voltage. It is equivalent to the force required to produce a current of 1 ampere through a resistance of 1 ohm. (The unit of measured voltage.)

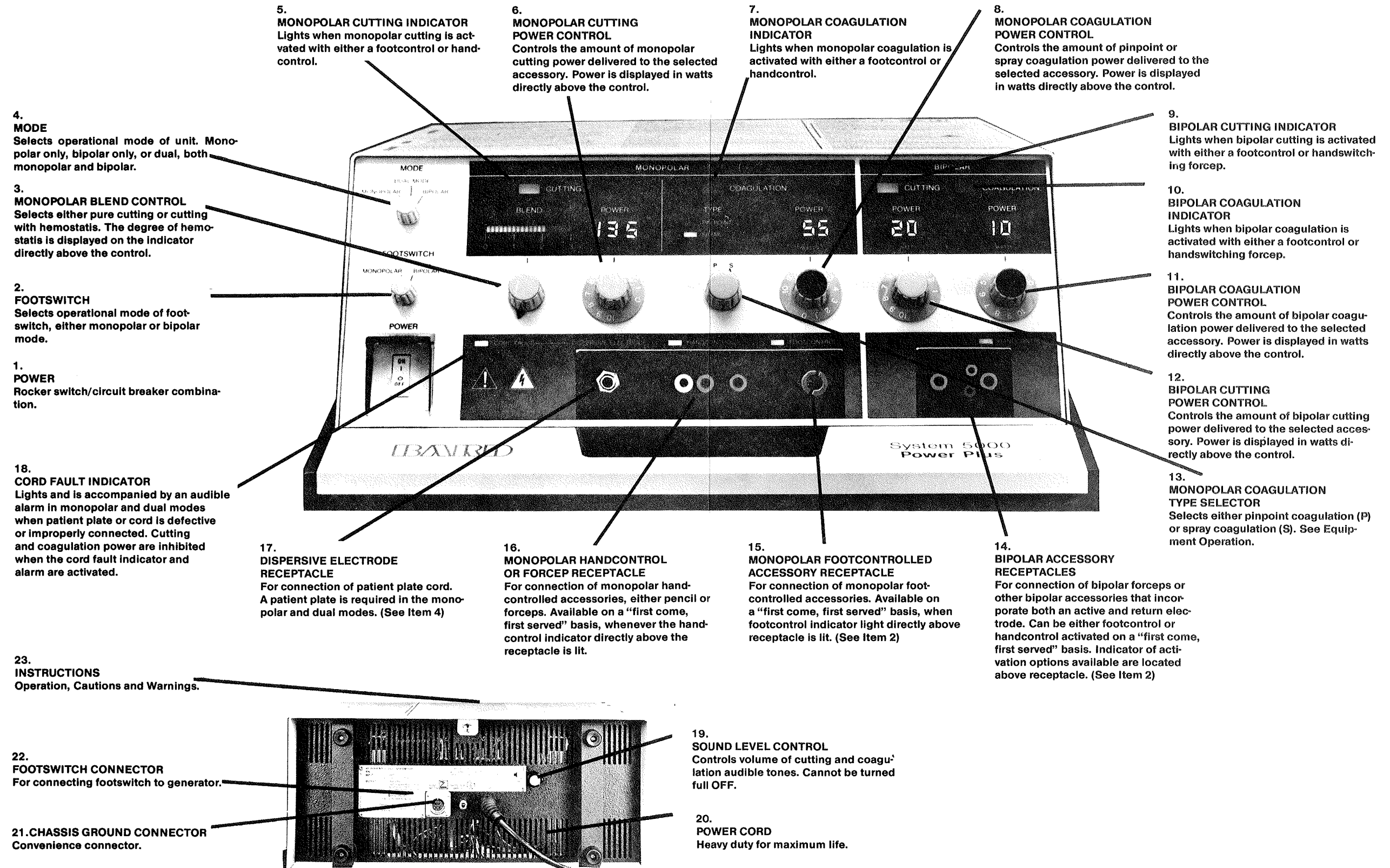
VOLTAGE - The force, or pressure that drives electrons (electric current) through a circuit, wires, etc. In electrosurgery voltage is the force that drives electrons across an air gap to tissue to make an electric spark.

WATT - Abbreviated W. A unit of the electric power required to do work at the rate of 1 joule per second. In an alternating current the true power in watts is effectively volt-amperes multiplied by the circuit power factor.

WATTMETER - A meter for measuring power. An RF wattmeter usually consists of an RMS ampere meter in series with a large power resistor. The meter is calibrated in the watts of power dissipated in the resistor.

System 5000 Power Plus

Controls, Indicators and Accessory Connectors





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Maintenance

I. Introduction

This section of the manual contains information concerning routine maintenance and service. General maintenance, such as access, cleaning and preventive maintenance is discussed as well as detailed information concerning functional checks, performance checks, test equipment, calibration, troubleshooting and repair.

Note

The Field service information provided in this manual is for Bard Electro Medical Systems trained and qualified personnel only. Bard Electro Medical Systems assumes no responsibilities for the results of any servicing attempted or performed by any personnel not factory trained.

II. Field Repairs And Warranty Considerations

The System 5000 Power Plus generator is designed for field repair. Repair should only be attempted by qualified service personnel.

The service technician should consider the following factors before repairs are started:

- A. The extent of the repairs required.
- B. The availability of proper tools and test equipment for calibration and repair.
- C. The availability of replacement module boards, sub-assemblies, parts, etc.
- D. The possible hazards involved with servicing electrosurgical equipment.

- E. The availability of technical assistance from the factory at 1-303-790-1117.

Note

If the generator is under warranty, refer to the warranty information in the Foreword section of the manual.

The following procedures may be performed by qualified personnel without invalidating the warranty:

1. Cleaning
2. Calibration
3. Preventive Maintenance

III. General Maintenance

A. Access: Top Cover Removal

Use the following procedure to gain access to the interior of the generator:

1. Insure the Power is off.
2. Unscrew the spring loaded screw at the rear of the chassis.
3. Remove the 4 screws near the front of the cover. (Prior units - no screws.)
4. Slide the cover straight back, approximately 3/4", and lift off the cover.

B. Cleaning:

The System 5000 Power Plus generator should be cleaned as required by wiping the exterior with a clean, damp cloth using a mild detergent. Avoid abrasive or harsh cleansers which can damage the exterior finish and operating instructions on the generator cover.

Note: If instructions on the top cover are illegible, they are also printed on the first page of the operator's manual in Section 3.

IV. Functional Check:

To perform a functional check of the System 5000 Power Plus generator, refer to the detailed checkout procedure in the Operations section of the manual, page 3-21.

The purpose of the functional checkout is to quickly determine if the generator is operating properly. This checkout procedure can also serve to identify possible defective foot and handcontrol accessories.

V. Performance Checks:

Performance values can be compared with the measurement standard in the Specification Table 1-1 in the front of the manual. (See Fig. 4-5 through 4-12, Page 4-19 for photos of output waveforms.)

If the generator requires adjustment, refer to the calibration procedures in Item VI.

Test equipment required to properly perform a performance check, calibrate and troubleshoot the System 5000 Power Plus generator:

- A. Oscilloscope (10MHz bandwidth minimum.) (Photos in manual with 60MHz BW).
- B. X100 Tektronix P6009 probe or equivalent.
- C. X1000 Tektronix P6015 probe or equivalent. (Required for "optional" Spray Coagulation open circuit test.)

- D. Electrosurgical Analyzer EMS Model 1200, Neurodyne-Dempsey, Model 443 or equivalent.
- E. DMM Fluke Model 8010 or equivalent.
- F. Frequency Counter Fluke Model 1900A or equivalent (100MHz bandwidth).
- G. Patient Shorting Plug.
- H. RF ammeter with 200 ohm non-inductive resistance (I.E.C. leakage).
- I. Proper hand tools and repair facilities to handle static-sensitive CMOS integrated circuits. (See Page 4-17.)

VI. Calibration

A. Introduction

The purpose of the calibration procedure is to align the System 5000 Power Plus RF output power to the specifications outlined in Table 1-1, Page i and ii (front of the manual).

This calibration procedure may also be used as part of an incoming Quality Control Inspection, periodic operation check or to verify operation after repairs or adjustments.

B. Information to consider before performing calibration:

1. If the measured readings fall within 10% of the specifications outlined in Table 1-1 or agree with the specifications recorded on the System 5000 Power Plus Data Summary Sheet shipped with the generator, calibration should not be necessary.

2. Common sense should be exercised when removing connectors and module cards. Even though most connectors are keyed, it is still possible to reconnect them to the wrong receptacle or to connect them in the wrong orientation, thus creating malfunctions and causing damage to other generator components.

When removing and placing a module card on top of the card cage, isolate the card with an insulator so that it does not short to the chassis.

Removal of module cards is sometimes necessary when making voltage measurements and calibrating the adjustment pots. When reinstalling the cards, insure proper fit into the stabilizing tracks.

3. Do Not attempt to calibrate "open circuit" Spray coagulation (fulgeration) with less than a X1000 high voltage signal probe. (This is an optional check in "open circuit" condition).

Use discretion when using X100 probe on other high peak "open circuit" voltages. Check probe specification since X100 probes vary with manufacturer and will withstand high peak voltages for different time durations.

Measure outputs under load except when and where specified to be measured in open circuit.

4. Protect the generator by turning off power when moving meter leads, signal probes, etc.

Damage to circuit components could occur since circuit traces are close to each other and the possibility of shorting to "live" circuits exist with power on.

C. Preliminaries

1. Refer to the operations checkout on Page 3-21 for a complete functional check of the generator.
2. Refer to Table 1-1 (in front of the manual) or to the System 5000 Power Plus Data Summary Sheet shipped with the generator and compare these specifications with the actual measured generator RF power outputs.
3. (See photos of output waveforms in Fig. 4-5 through 4-12, Page 4-19.)
4. Use recommended test equipment in Item V Page 4-2 (performance checks).
5. perform the calibration procedure outlined in Item "D" if adjustments are required. Note: Waveform amplitude effected by scope bandwidth.)

D. System 5000 Power Plus Calibration Procedure

1. The preliminary checkout in Item C, above should be confirmed before attempting calibration.
2. The following calibration

procedures direct the technician step-by-step through the complete System 5000 Power Plus alignment.

The alignment starts with calibration of the Front Panel (A3) digital display adjustment pots, and proceeds to the PS translator (A10), PS control (A9) and RF logic (A8) adjustment pots on the module cards.

Note:

Do Not attempt adjustment of L41 and L26 on the RF Output card (A5). These are factory calibrations.

3. Figure 6-1, Page 6-3, shows the location of module cards and sub-assemblies within the generator chassis. Refer to this pictorial diagram when card or sub-assembly PCB's need to be located.

4. Front Panel Calibration

Front Panel (A3) LED Digital Display Calibration

Test equipment required:

Non-conductive adjustment device with flat blade.

- a. Remove top cover (see III. A. Page 4-1).
- b. Turn all power control dials fully counter clockwise (CCW) to zero (0).
- c. Set mode switch to Dual Mode.
- d. Turn the blend control knob fully CCW. A click should be heard (pure cut position).
- e. Switch footswitch to monopolar.

- f. Insert a patient plate or shorting plug into the dispersive electrode receptacle.
- g. Turn on power - all power LED digital displays should read zeros (000 or 00) and the LED blend bar graph should be fully extinguished.

Note

Do Not key generator while calibrating the digital display adjustment pots.

Note

LED digital display adjustment pots are located behind the front panel on the A3 PCB - see Fig. 6-17 page 6-19

Pure Cut Display Adjustment (R243)

- a. Turn the monopolar cutting power control dial fully clockwise (CW).
- b. Adjust R243 pot for 350 + 2 counts on the cutting digital display.

Spray Coag Display Adjustment (R224)

- a. Switch the coagulation type selector to spray (S).
- b. Turn the monopolar coagulation power control dial fully clockwise (CW).
- c. Adjust R224 Pot for 75 + 2 counts on the coagulation digital display.

Note

Machines prior to Power Plus 70 + 2 counts).

Pin Point Coag Display Adjust
(R221)

- a. Switch the coagulation type selector to pin point (P).
- b. Adjust R221 pot for 130 + 2 counts on the monopolar coagulation digital display.

Bipolar Cut Display Adjustment
(R144)

- a. Turn the bipolar cutting power control dial fully clockwise (CW).
- b. Adjust R144 pot for 50 + 2 counts on the bipolar cutting digital display.

Bipolar Coag Display Adjustment
(R149)

- a. Turn the bipolar coagulation power control dial fully clockwise (CW).
- b. Adjust R149 pot for 50 + 2 counts on the bipolar coagulation digital display.

Blend Display Check

- a. Insure the monopolar power control dial is at 350 counts (fully clockwise).
- b. Turn the blend control just out of detent (should hear a click). The first bar in the graph display should illuminate.
- c. Turn the blend control slowly clockwise (CW) and observe the monopolar cutting digital display. The count should decrease from 350 to 230 + 4

counts at full blend. The bar graph should be fully illuminated as the blend control reaches the end of its rotation.

Mode Switch Check

- a. Rotate mode switch and insure it locks out proper modes.
- b. Turn off power.

This completes the Front Panel LED digital display calibration.

Continue on to System 5000 Power Output Alignment - next page.

5. System 5000 Power Output Alignment.

Test equipment required:

- a. Oscilloscope
- *b. Digital Voltmeter
- c. Electrosurgical Analyzer (Dempsey 443 or equivalent capability).
- d. Miscellaneous: patient plate or shorting plug, IC clip, clip leads, non-conductive adjustment device with flat blade, footswitch and handcontrol.

* Use of 2 digital voltmeters prevents having to shift the meter from one point to another throughout the procedure since it is necessary to monitor some voltages simultaneously while adjusting pots.

The system's power calibrations consist of adjustments to the following sub-assemblies:

- a. PS Translator A10 (5 adjustment pots). (Earlier models 7 adjustment pots.)
- b. PS Control A9 (2 adjustment pots).
- c. RF Logic A8 (3 adjustment pots).

Alignment may not require adjustment of all the pots in that some may be within their specified tolerance. However, these tolerances must be strictly adhered to. If not, the generator's outputs may not meet designed specifications and repeated adjustments may be necessary.

System 5000 Power Calibration

- a. Insure power is off.
- b. Locate the translator card A10. (See page 6-3 for card locations.)
- c. Disconnect the translator connectors from J1 and J2.
- d. Loosen the knob on the side of the module card cage and lift the arm that secures the cards in place.
- e. Slide the translator card out.
- f. Reconnect the extended ribbon cables to the translator card and position it on top of the generator.

Caution: Isolate the translator card from the generator by use of an insulating material, such as cardboard, etc.

Confirm an RF Power output from the analyzer.

(This insures proper operation before continuing calibration.)

- a. Connect the analyzer patient lead to the generator front panel dispersive receptacle and connect the analyzer active electrode to the front panel footcontrol receptacle.
- b. Set the generator for the dual mode of operation.
- c. Set the footswitch selector to monopolar.
- d. Increase power controls to mid-position.

- e. Turn power on.
- f. Test the generator for RF output power.

This completes the "Ramp" Time Base Adjustment.

Ramp Time Base Adjustment
(R118, R122)

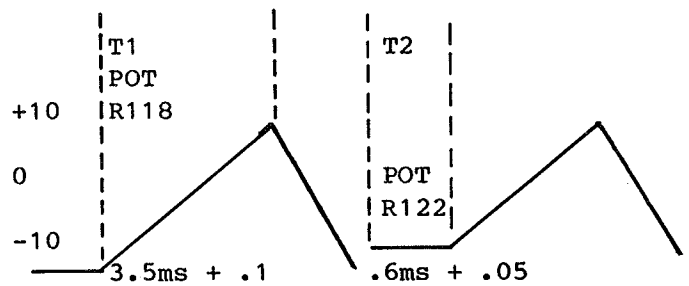
Ramp calibration pots on the translation card A10.

- a. Turn power off.
- b. Disconnect the two mox connectors J3 and J10 on the RF output card A5 (horizontal card to rear of generator). This disconnects the RF amplifier.
- c. Connect the oscilloscope signal probe to the post terminal adjacent J1. (Marked "ramp" on back side of the translator card.)
- d. Connect the scope probe ground clip to the metal case of Q5 voltage regulator. (Do not use Q10 voltage regulator case as ground point!)
- e. Turn power on.
- f. Set scope time base to 1ms and adjust scope amplitude as necessary.
- g. Stabilize the ramp signal. (Synch to line if feature is on scope and insure AC low frequency reject is off.)
- h. If necessary, adjust pots R118 and R122 on the translator card to replicate the signal shown in Fig. 1.
- i. Turn power off.
- j. Remove scope from PS translator card.

Caution:

Switch scope off "Line Setting" if line setting was used.

Simplified diagram indicating T1 and T2 for 60Hz generators. (See T1 and T2 for 50Hz generators below.)



Caution:
50Hz generators
T1 = 4.2ms
T2 = .72ms

R118 and R122 adjustment pots are interactive. Adjust both pots until the signal agree with Figure 4-1.

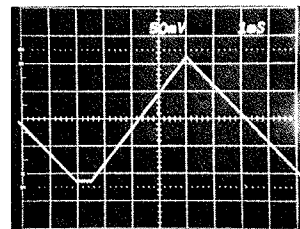


Figure 4-1

VVO Ratio Adjustment

Coag power control dial and R1

- a. Connect a digital voltmeter to ground and VSEN on the PS output card A6 (both locations are marked on the backside of the card) negative to ground clip to post.
- b. Set voltmeter to read >200VDC.
- c. Connect the analyzer active lead to +HV (J4) and the analyzer patient plate lead to the -HV (J5) on the RF output card A5. (This step places the analyzer load across the output power supply A6.)

Caution: When connecting to J4 and J5, do not allow method of connection to short the high voltage power output supply A6. Some A5 cards have clips to connect leads to and some have screw receptables - use discretion!

- d. Set the analyzer for a 500 ohm load.
- e. Use patient plate or shorting plug to silence cord fault alarm.
- f. Set coagulation type to spray (s).
- g. Set the coagulation power control dial to zero.
- h. Connect the other digital voltmeter to the PS translator card A10. Negative lead to "ground" (metal case of A5) and positive lead to R70 (end adjacent to U44).

- i. Set digital voltmeter to read 20Vdc.
- j. Turn power on.
- k. Key the generator in "spray coagulation" and adjust the coagulation power control dial until the voltage across R70 (VVO) reads 9 volts + .1 Vdc.
- l. The VSense PS output A6 should measure 180Vdc + 2Vdc.

If not,

- m. Adjust the R1 pot on the PS translator card until 180 Vdc occurs at VSense.
- n. Recheck that 9Vdc still exists across R70. To attain these two voltages simultaneously, readjustment between R1 (180 Vdc) and the coagulation power dial (9Vdc) may be necessary.

A ratio of 20:1 should exist between VSense and VVO (180Vdc divided by 9Vdc = 20).

VIO Ratio Adjustment

(Cut power control dial and R56)

- a. Move the volt meter + lead from R70 to the junction of R67 and R43 adjacent U44 on the translator card A10. Negative should still be on ground Q5 case.
- b. Set the analyzer for 125 ohm load (heavy load).
- c. Blend control should still be to maximum hemo, fully clockwise

- (CW) (bar graph fully illuminated).
- d. Key cut and adjust the cutting power control dial until the VSense measures 150Vdc \pm 2Vdc. VIO should measure 1.2 volts \pm .05. If the voltages are in tolerance, proceed to VPO voltage adjustment.

If the voltages are not in tolerance, and if the translator has 5 adjustment pots, proceed to e.

If the translator has 7 adjustment pots, proceed to "d1" and zero the input op amp U57.

- d1. Procedure for 7 pot translator (R55 adjustment)

Turn off power.

Short R50 (end closest to C51) to ground (metal case Q5). This provides a means to zero the input to OP Amp U57. Do Not key generator.

Turn on power.

Adjust R55 until VIO = 0 to 4mv.

Turn off power.

Caution:

Remove short from R50.

Turn on power.

- e. Key Cut, (blend still fully clockwise, bar graph fully illuminated) and adjust

the cutting power control dial for 150 volts VSense.

- f. Adjust R56 until VIO = 1.2V \pm 5 -0mv. Fine tuning between the cutting power control dial and R56 may be necessary to attain 150Vdc VSense and 1.2 volts VIO simultaneously.

Analyzer should read approximately 1.2 amps.

Note: Double analyzer reading when in heavy load (125 ohms) $.6a \times 2 = 1.2$ amps.

$$I = \frac{E}{R} \quad 1.2 \text{ amps} = \frac{150 \text{ volts}}{125 \text{ ohms}}$$

thus, VIO = 1.2 volts.

VPO Voltage Adjustment

(Power Control Dial and R74)

- a. Turn power off.
 b. Move the + lead from the junction of R67 and R43 to U69 (pin 6) on the translator. (If not using an IC stand-off, or if it will not fit, carefully clip the voltmeter lead to the inside lead of C72 or C73 adjacent U69.)

Note:

If the translator has 5 adjustment pots, proceed to c.

If the translator has 7 adjustment pots proceed to "b1" and zero the input to op amp U69.

b1. Procedure For 7 Adjustment Pot Translator (R68)

Short R20 (end farthest from the connector J1) to ground (Q5 case).

Turn on power. Do Not key generator.

Adjust R68 on the translator for $0 \pm 5\text{mv.}$

Set voltmeter for next highest range.

Turn off power.

Caution: Remove short from R20.

- c. Set the cutting power control dial to zero and maintain blend fully clockwise (CW).
- d. Turn power on.
- e. Key cut and adjust the cutting power control dial until VPO U69 (pin 6) measure $1.2 \pm .02\text{V.}$
- f. Adjust R74 until VSense reads 93.5 VDC.

Fine tuning of cutting power control and R74 may be necessary to achieve precise voltages.

- g. Turn off power.

Set-Up for Voltage and Power Limit Adjustments

- a. Disconnect voltmeter from translator card A10.
- b. Replace the translator into the card cage and reconnect J1 and J2.
- c. Reconnect the analyzer to the generator front panel: active lead to the monopolar

footcontrol receptacle and analyzer patient plate lead to the dispersive electrode receptacle.

- d. Set the analyzer for a 500 ohm load (normal).

Voltage Limit Adjustment (R114)

PS Control Card A9

- a. Insure a digital voltmeter is connected between ground and VSense on the PS output card A6.
- b. Turn power on.
- c. Key spray coagulation and increase the coagulation power control dial to 10 (fully clockwise) should measure $205 \pm 3 \text{ Vdc.}$

If correct, proceed to Power Limit Adjustment.

If not,

- d. Adjust R114 (bottom pot) on the PS control card A9 for $205 \pm 3 \text{ volts.}$ (See Fig. 6-6, Page 6-8.

R114 can be reached by either removing the PS control card or slipping an adjustment device between the front panel and card cage. (Be careful of the ribbon harnesses and card components.)

- e. Disconnect digital voltmeter from PS output card A6 (VSense).
- f. Turn off power.

Power Limit Adjustment (R105)

PS Control Card A9

- a. Insure power is off.
- b. Disconnect digital voltmeter from PS output card A6, if not already disconnected from previous step.
- c. Reconnect J3 and J10 on the RF output card A5.
- d. Turn on power.
- e. Return the blend control knob to pure cut (fully counter clockwise) (CCW) bar graph fully extinguished.
- f. Set cut power control dial to 10 (fully clockwise), display should read 350 ± 2 .
- g. Key cut, analyzer should measure 345 ± 2 watts. (Optimum value is 350 watts.)

If correct, proceed to pin point coag power check.

If not,

- h. Adjust R105 on the PS control card A9 (top pot on the card) for 345 ± 20 watts measured on the analyzer. (Optimum value is 350 watts.) See Fig. 6-6 page 6-8.

Pin Point Coag Power Check

- a. Set coagulation type to pin point (P).
- b. Set coagulation digital display to 100 counts.
- c. Key pin point coag and observe output on the analyzer, should measure 100 ± 10 .

Blend Pulse Adjustment (R89)

RF Logic card A8

- a. Turn power off.
- b. Remove the RF logic card (A8) from the card cage and reconnect it to gain access to the adjustment pots. (Adj. pots may be accessible depending on model and cut away on card cage.)

Caution: It is possible to reverse the top two connectors on this card (A8).

- c. Turn power on.
- d. Connect the oscilloscope to the analyzer or generator output (same point electrically). Use X100 probe.
- e. Set time base to 10usec and set scope amplitude to appropriate level (see Fig. 2).
- f. Set cutting power digital display to 40 counts.
- g. Set blend control to full clockwise position. Bar graph fully illuminated.
- h. Key cut and observe the blend pulses. There should be 7 sine wave pulses as depicted in Fig. 4-2.

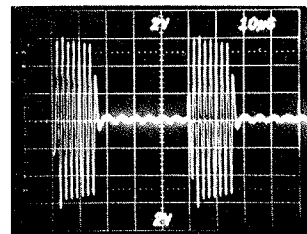


Figure 4-2

- k. Key bipolar cutting and observe the waveform. (Adjust scope amplitude as necessary.) Correct waveform appears in Fig. 4-3.

Incorrect waveform appears in Fig. 4-4).

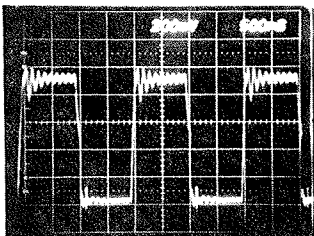


Fig. 4-3

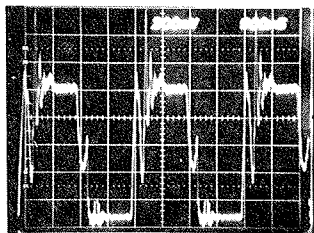


Fig. 4-4

If correct, no adjustment is required.

If not,

1. Key bipolar cutting and adjust R35 pot on the RF logic card A8 for minimum noise or spiking on the waveform (bottom adjustment pot).

Adjust for smooth waveform as in Fig. 4-3.

- m. Turn off power.

This completes the calibration procedure.

- Remove scope leads from J10 on RF output card A5.
- Replace RF logic card if removed.
- Recheck specifications.

Note:

If checking specs in the bipolar mode first, analyzer leads and correct load (125 ohms) is already set.

If going back to monopolar to check specs, return analyzer to 500 ohm load (normal) and switch high sense on analyzer back to normal. And, of course, set mode switch and footswitch to proper settings, and return analyzer leads to dispersive electrode and footcontrol receptacles.

VII. Troubleshooting

A. Introduction

The service technician must be familiar with the contents of this manual before attempting servicing, troubleshooting or repair. Troubleshooting analysis outlined in this section of the manual systematically guides the technician to the most likely sub-assembly PCB or module card causing the particular malfunction. A PC board exchange program is available through Electro Medical Systems service department. Call 1-303-790-1117 for information. If the customer is owner of the equipment and the generator is out of warranty, it is the customer's option to troubleshoot and field repair module cards to component level. Warranty generators are to be repaired at module card level. The exception being socket type devices, such as LED digital display indicators, lamps, switches, relays, power transistors and electro-mechanical hardware, such as control dials, receptacles, etc.

B. Information To Consider Prior To Troubleshooting

1. Observe all cautions, notes and special instructions associated with the troubleshooting procedures to prevent unnecessary damage to test equipment or generator components.
2. Read through the complete troubleshooting procedure before starting any test for measurements. Consider the type leads and best method to make

measurements.

3. If the troubleshooting signal guide does not lead to the particular malfunction, use all available technical information: Theory of Operation, simplified diagrams, schematics and test equipment to further analyze the problem and arrive at a solution.
4. Due to differences in test equipment, some variations may occur in the indicated readings. Prior to testing, insure test equipment is set up and calibrated properly. Calibrate probes before measuring waveforms.
5. Do Not measure coagulation spray open circuit with less than a X1000:1 signal probe. Spray open circuit is an optional check only. Spray coagulation can be measured under load with a X100 probe. (Check manufacturers specifications for recommendation on scope probes.)
6. Aids for troubleshooting and repair.
 - a. Table 1-1 specifications.
 - b. Table 4-1 troubleshooting signal guide.
 - c. Photos of output signals Fig. 4-5 through 4-12.
 - d. Preventive maintenance procedures.
 - e. Calibration procedures.
 - f. Mnemonics list, table 5-1.
 - g. Illustrated parts list

- and detail component location diagrams.
- h. Remove and replace module card and sub-assembly tips.

7. Secure as many accessories as possible that were used with the generator when it malfunctioned. The accessories - handcontrols, forceps, footswitch, dispersive electrode (patient plate) - are often the cause of the problem and not the generator. Many accessories are the disposable type and are discarded after use; hence, a technician may not be able to reproduce a reported malfunction. Reusable accessories may also cause a problem. When reusable accessories are not returned with the generator for examination, there is a possibility the accessory will be put back into service and cause the same malfunction again.

8. To eliminate the possibility of shipping damage, pack generators per Fig. 6-2, Page 6-4.

C. Troubleshooting Methods

Visual and Functional Operation

1. Visually check for signs of damage or loose hardware outside and inside the generator.
2. Perform the visual inspection and power off resistance checks outlined in the Preventive Maintenance section, item IX, Page 4-29.

3. Functionally check the generator for correct operation as outlined on Page 3-21. This checkout procedure will reveal clues to defective indicators, such as LED displays, function and mode lamps, cord fault, audible circuits, control dials, selectors and switches.

Further analysis of selector switch positions and activation of the generator in its operational modes will provide more clues as to its proper or improper operation.

Activating the footswitch and handcontrol devices can identify defective accessories, as well as reveal information about the modes control operation.

In addition to observing visual indications of generator operation, one can listen for audio indications (tones). Each keyed mode of operation emits a different audio tone.

Also, one can listen for predictable relay action that might provide clues to improper mode operation. For instance:

- a. When spray coagulation is keyed, the output amplifier configuration relays K3, K5 and k8 should energize. A (click) sound at the relay should be heard when either the foot-control or handcontrol is activated in coag.

- b. When keying bipolar in the dual mode, listen for the bipolar relay K9 to energize (if footswitch in bipolar, key either footswitch, or active bipolar handcontrol).
- c. When the mode selector is switched to bipolar, listen to the bipolar relay K9 to energize immediately. When the bipolar mode is now keyed, there is no relay sound since the relay is already energized.

It can readily be seen that visual and audible observations of the generator functional checks can reveal important clues to malfunction analysis information.

The next important method to consider in troubleshooting analysis is RF power checks and wave form observations.

D. Troubleshooting Methods

RF Output (Power and Waveforms)

The functional checkout may not reveal malfunctions that produce improper RF outputs. Analysis of proper RF outputs can only be made by using additional test equipment. This method makes use of an electrosurgical analyzer and oscilloscope to analyze RF output problems. Perform the following electrical test to verify the presence of RF output power.

Analyzer Check

1. Connect an electrosurgical

analyzer to the generator. The active lead can be connected to the monopolar footcontrol receptacle or to the monopolar handcontrol pencil. The patient plate lead should be connected to the dispersive electrode receptacle. Recall that keying the footcontrol results in only RF output power to the footcontrol receptacle and keying the handcontrol result in only RF output power to the handcontrol receptacle (discrete output).

Power Checks

2. Check the performance specifications in Table 1-1 (front of the manual) or System 5000 Power Plus Data Summary Sheet shipped with the generator.

Test the generator for monopolar and bipolar output power. (Specifications give measured values and resistive loads.)

For bipolar power checks move the analyzer patient plate lead and active lead to both red active bipolar receptacles.

Observation of the analyzer measured power in monopolar and bipolar may reveal a deficiency in power requiring calibration or further troubleshooting.

Scope Check

3. Connect an oscilloscope to the analyzer output (generator output). Compare the measurements with the specifications in

Table 1-1 and waveforms as depicted in Fig. 4-5 through 4-12, Page 4-19. Observation of the waveforms and measured signals may reveal that a problem exists or that calibration is required.

If an RF output power problem exists in any mode of operation, then the next stage of troubleshooting and malfunction analysis should be followed up.

E. Troubleshooting Methods

Voltage Measurements and Signal Tracing

The following information should be considered before using the troubleshooting signal guide table 4-1 or starting measurement analysis.

1. The waveforms depicted in the photos illustrated in Table 4-1 were photographed in the pin point coagulation mode (Step 3 Forward).
2. To check other mode waveforms, key selected mode. (Some measurements may require moving the scope probes to a different test location or component, refer to Schematic diagrams where necessary.) The Functional Block diagram, Figure 5-1, and Interconnect Diagram, Figure 5-2 are helpful in revealing clues to conversion and diversion signal flow.
3. Waveforms were measured with 60MHz bandwidth scope and photographed with X100:1 probe at a 50 watt

setting of the coag power control dial. Scopes with BW less than 60MHz will result in decreased signal amplitude. If powre on the analyzer is correct, this is a good indication that the signal amplitude is probably correct.

4. Do Not attempt to measure spray coagulation (fulgurate) open circuit with less than X1000:1 probe. (Optional check.)
5. Spray coagulation can be measured under load - see Table 1-1.
6. Isolate module cards from chassis when removing for troubleshooting. Also observe connectors and orientation of connectors when reconnecting. Even though most connectors are keyed, errors can occur, damaging other generator components.
7. Observe special notes on each page of the troubleshooting signal guide, Table 4-1.
8. The System 5000 Power Plus is an isolated generator. The chassis is not a test point reference gound for measuring circuit voltages. Use circuit return grounds - see schematics.
9. Do Not short the active lead to the dispersive electrode (patient plate) or chassis to confirm presence of RF power - use test equipment.
10. Observe 50% duty cycle. Allow the same duration of "Off" time as "On" time

when testing signals and calibrating the generator.

F. Application Of Table 4-1

Analysis of malfunctions may begin with Step 1 and 2 (power supply voltage measurements) and proceed forward to the output receptacles, or analysis can be started at the output receptacles and proceed backwards to the power supplies. Table 4-1 is designed to allow the technician to start where desired. Technical knowledge and experience will also be a factor as to where signal tracing need be started on the Troubleshooting Signal Guide, Table 4-1.

Technicians often use the "divide and conquer" technique by starting in the middle of a unit. An effective starting point on Table 4-1 is Step 3 on the RF output card A5 at J10 or J3. If the proper signal exists at these points, then move forward toward the output receptacles via high voltage relays A12. If no signal occurs at J10 or J3, move backwards through the RF Logic Card A8, Mode Logic A7 and Power Supplies (see Table 4-1).

Pin point coag has been traced in Table 4-1; however, the same or similar troubleshooting techniques of signal tracing would be used for the other modes of operation. Table 4-1 is designed to give the technician a pattern or technique for troubleshooting. The technician should assimilate the pinpoint coag signal tracing technique to other modes of operation and malfunction analysis.

Table 4-1 will not reveal all malfunctions, but attempts to isolate the area, stage, module card or sub-assembly where the problem is occurring. A technician, with the aid of proper test equipment and theoretical knowledge provided in the technical manual, should have generator malfunctions corrected in the minimum of time.

Review the complete troubleshooting signal guide (Table 4-1) and pay particular attention to the special notes before using it.

Caution

G. Protect CMOS Integrated Circuits

CMOS IC are static-sensitive.

1. Handling: IC's are packed in conductive foam. Remove when ready for installation.
2. Handle in static-free area.
3. Do Not hand CMOS IC to another person without anti-static protection.
4. Do Not wear nylon or synthetic materials.
5. Pick up CMOS IC's by the body. Do Not handle the leads (unless properly grounded) or slide the chip over surfaces.
6. Personnel should be grounded with a wrist strap while handling CMOS IC chip.
7. Soldering iron should be grounded to a common ground.

H. SYSTEM 5000 RF OUTPUT WAVEFORMS (X100:1 PROBES DIFFERENTIAL)

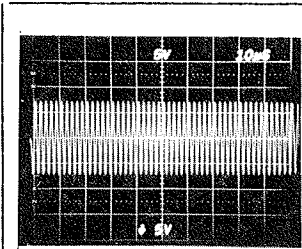


FIGURE 4-5
PURE CUT
175 WATTS
500 OHM LOAD

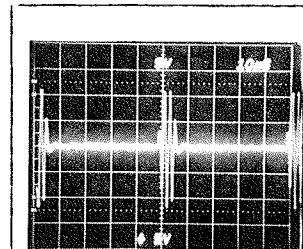


FIGURE 4-9
PIN POINT COAG
50 WATTS
500 OHM LOAD

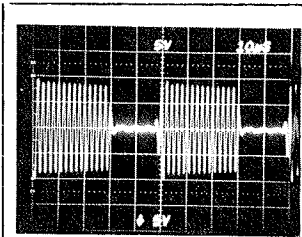


FIGURE 4-6
BLEND (1.5 MID
HEMO)
175 WATTS
500 OHM LOAD

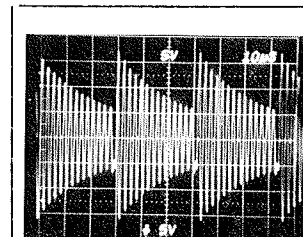


FIGURE 4-10
*SPRAY COAG
35 WATTS
OPEN CIRCUIT

*NOTE:
USE X1000:1
PROBE

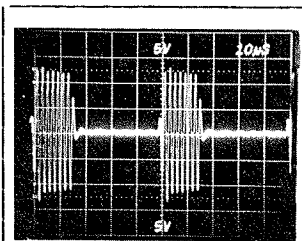


FIGURE 4-7
BLEND (3 MAX HEMO)
175 WATTS
500 OHM LOAD

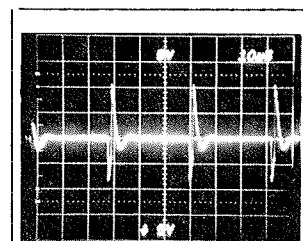


FIGURE 4-11
SPRAY COAG
35 WATTS
500 OHM LOAD

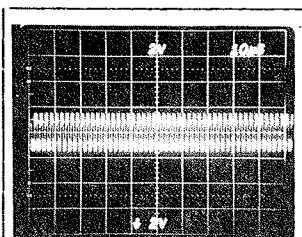


FIGURE 4-8
**BIPOLAR CUT
25 WATTS
125 OHM LOAD

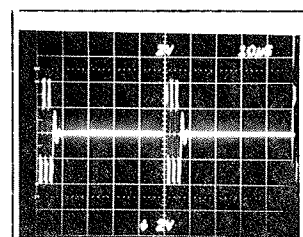


FIGURE 4-12
**BIPOLAR COAG
25 WATTS
125 OHM LOAD

*OPTIONAL CHECK - USE X1000:1 PROBE IF MEASURING OPEN CIRCUIT.
**OUTPUT RESISTIVE LOAD AND AMPLITUDE SCALE CHANGED IN BIPOLAR MODES.

TABLE 4-1

TABLE 4-1

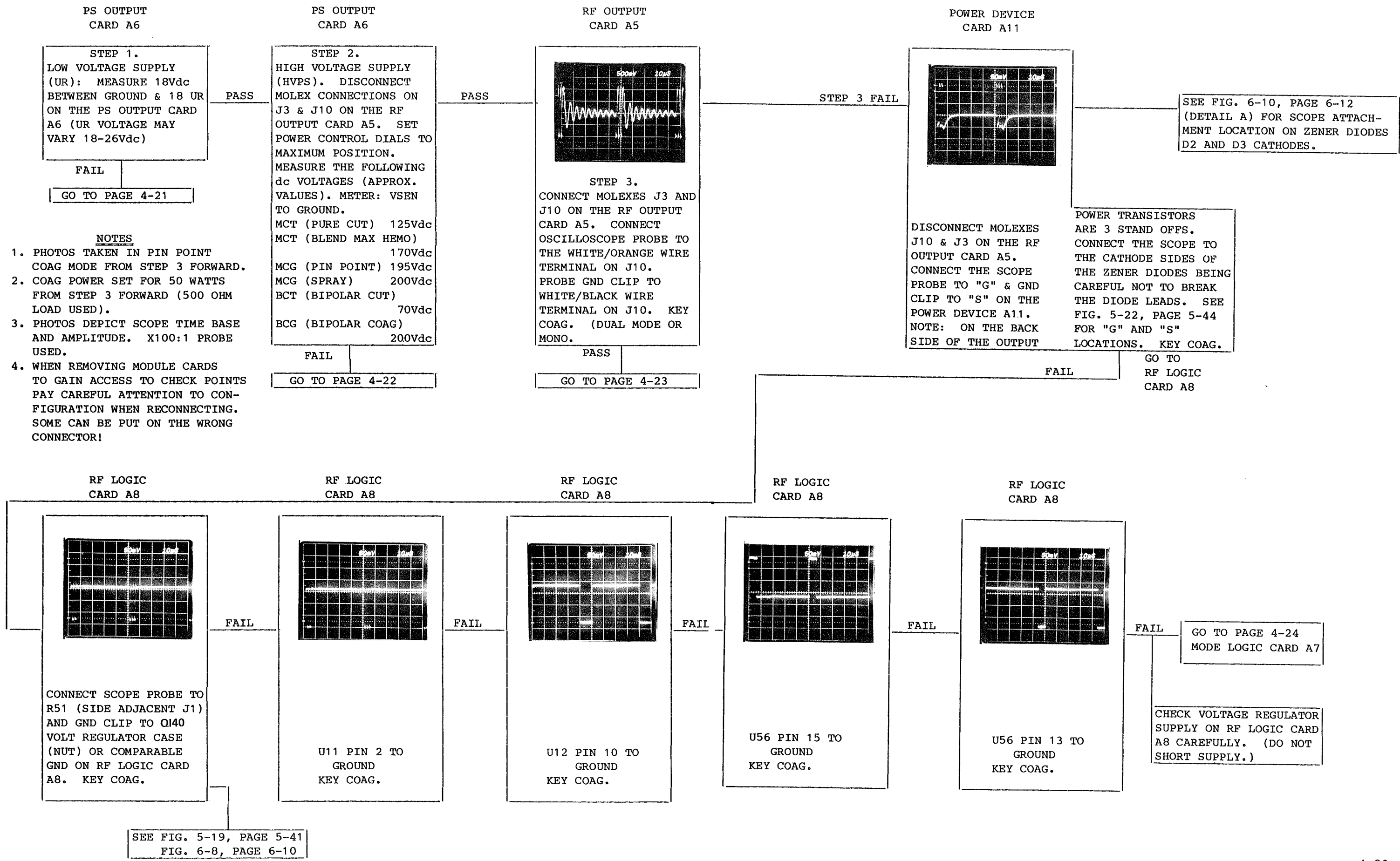


TABLE 4-1

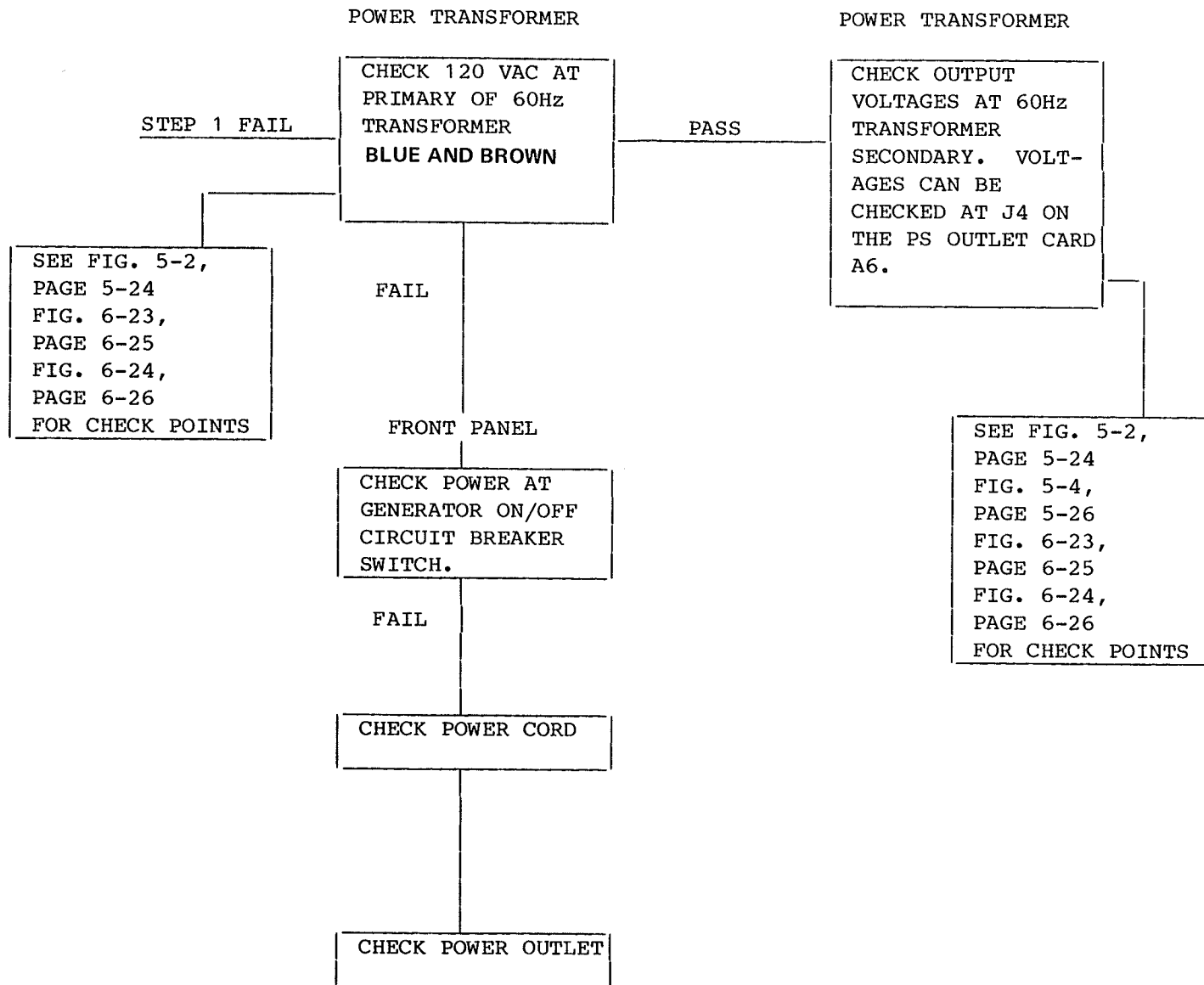


TABLE 4-1

NOTES

1. GROUND FOR THE TRANSLATOR CARD IS THE METAL CASE ON THE VOLTAGE REGULATOR Q5 (ADJACENT J1).
2. DO NOT USE Q10 VOLTAGE REGULATOR AS GROUND REFERENCE POINT.
3. PHOTOS DEPICT SCOPE TIME BASE AND AMPLITUDE (X100:1 PROBE USED).
4. IF ALL STEPS FAIL, CHECK CARD VOLTAGE REGULATOR VOLTAGES (CARE SHOULD BE TAKEN TO NOT SHORT OUT THE VOLTAGE REGULATOR WHEN MAKING MEASUREMENT).

SEE FIG. 5-7, PAGE 5-29
FIG. 6-5, PAGE 6-7

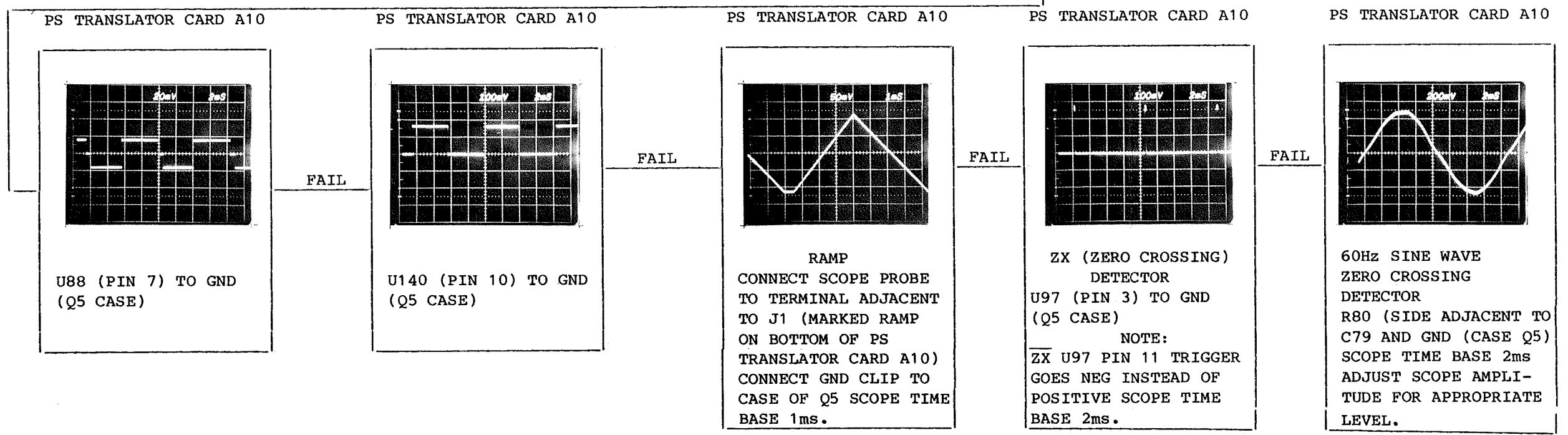
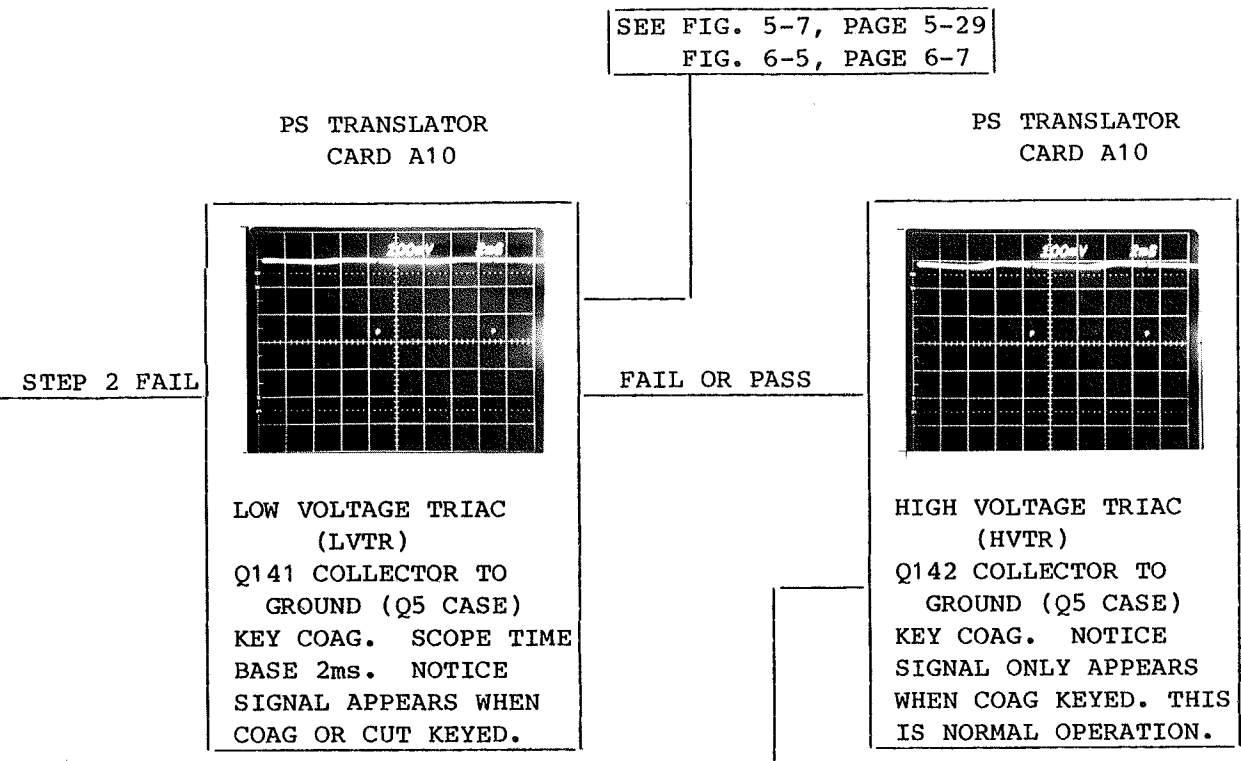
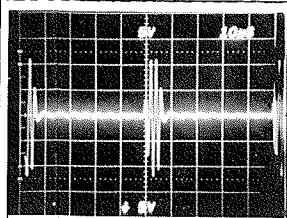
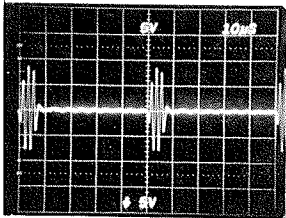


TABLE 4-1

RF OUTPUT
CARD A5

FRONT PANEL
OUTPUT RECEPTACLE



STEP 3 PASS

PASS

PASS

STEP 4.
CONNECT SCOPE PROBE
TO MONO AND GROUND
CLIP TO MOPP ON THE
RF OUTPUT CARD A5.
KEY COAG. (INSURE
MOLEX CONNECTORS J3
& J10 ARE CONNECTED)

STEP 5.
CONNECT SCOPE PROBE
TO ACTIVE OUTPUT
RECEPTACLE, FOOT-
CONTROL OR HANDCON-
TROL AND CONNECT
SCOPE GND CLIP TO
DISPERSIVE ELECT-
TRODE (ANALYZER
OUTPUT). KEY COAG

STEP 6.
GENERATOR PIN POINT
COAG OUTPUT POWER
CHECKS GOOD. CHECK
AGAINST SPECIFICA-
TION IN TABLE 1-1.
IF OUT OF SPEC,
REFER TO CALIBRA-
TION PROCEDURE.

SEE FIG. 5-26,
PAGE 5-48 &
FIG. 6-13, PAGE
6-15

FAIL

FAIL

HIGH VOLTAGE RELAY
CARD A12

CHECK HIGH VOLTAGE
RELAYS. INSURE
MOPP K6, MONO K2
AND FOOT K4 OR HAND
K3 CLOSE UPON ACTI-
VATION. OBSERVE
DISCRETE OUTPUT.

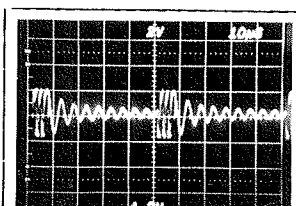
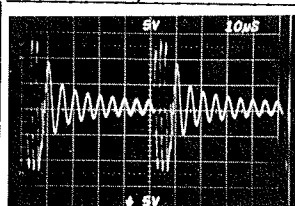
INSURE DISCRETE
OUTPUT BEING
OBSERVED. FOOTCON-
TROL ONLY PROVIDES
POWER TO FOOTCON-
TROL OUTPUT RECEPTACLE,
HANDCONTROL TO HANDCONTROL
OUTPUT RECEPTACLE.

PASS

SEE FIG. 5-25
PAGE 5-47
FIG. 5-28
PAGE 5-50
FIG. 6-15
PAGE 6-17

RF OUTPUT
CARD A5

RF OUTPUT
CARD A5



FAIL

FAIL

T29 MONOPOLAR
TRANSFORMER SECOND-
ARY SCOPE PROBE PIN
3 GND CLIP PIN 4.
USE 100:1 PROBE.
KEY COAG.

T29 MONOPOLAR
TRANSFORMER PRIMARY
SCOPE PROBE PIN 1
GND CLIP PIN 2
KEY COAG.

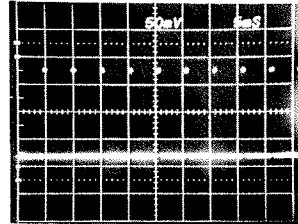
CHECK DIODES,
RESISTORS, ETC. AND
ASSOCIATED COMPONENTS
AND CIRCUITRY.

OUTPUT POWER TRAN-
SISTORS CAN BE CHECKED
FOR FORWARD & REVERSE
BIAS AT J10 & J3
WHITE/ORANGE TO WHITE/
BLACK AND WHITE/RED TO
WHITE/BROWN (ANALOG
METER).

1. RF SIGNALS IN PHOTOS THIS PAGE TAKEN DIFFERENTIALLY (TWO X100:1 PROBES) SINGLE PROBE AND SCOPE GND CLIP MAY BE USED.
2. IF COMPARING SIGNAL AT OUTPUT RECEPTACLE WITH TABLE 1-1, READJUST POWER SETTING TO THAT OUTLINED IN THE TABLE.

MODE LOGIC CARD A7

RF LOGIC
U56 PIN 13
FAIL



FAIL

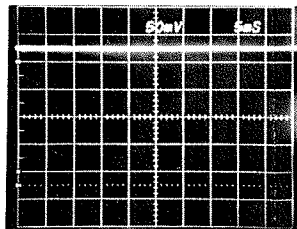
GO TO PAGE 4-25

CHECK MODE SCANNING
U40 PIN 6 TO GROUND
METAL CASE OF Q72
VOLT REG) CHANGE
SCOPE TIME BASE
5ms AND SCOPE
AMPLITUDE TO dc
VOLTS.

SEE FIG. 5-12, PAGE 5-34
FIG. 6-7, PAGE 6-9

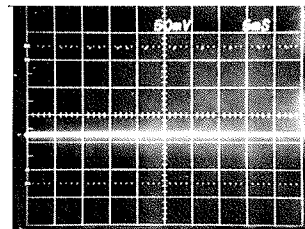
PASS

MODE LOGIC CARD A7



FAIL

SCOPE, SAME CONNECTIONS
AS ABOVE (U40 PIN 6 AND
GROUND)
KEY FOOTCONTROL COAG.
LOGIC SIGNAL SHOULD GO
HIGH AS DEPICTED IN
PHOTO. (DISCRETE OUT-
PUT)



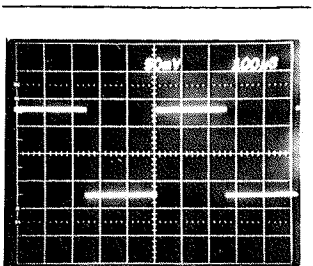
SCOPE SAME CONNECTION
AS ABOVE (U40 PIN 6
AND GROUND)
KEY ALL OTHER MODES.
LOGIC SIGNALS SHOULD
REMAIN LOW AS DEPICTED
IN PHOTO.

IF MODE LOGIC
SIGNAL DID NOT
GO HIGH CHECK
SCOPE AMPLITUDE,
SHOULD BE ON dc
NOT ac.

TABLE 4-1

MODE LOGIC CARD A7

MODE LOGIC
U40 PIN 6 FAIL

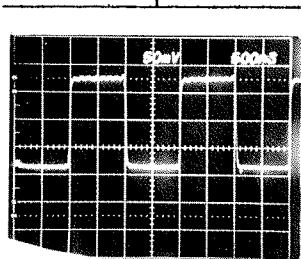


U40 (PIN 14 TO GROUND)
2KHz INPUT SIGNAL
SCOPE TIME BASE
100us.

FAIL

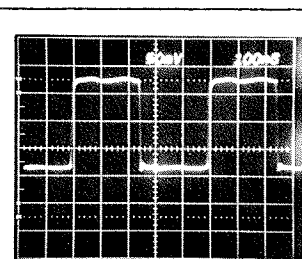
SEE FIG. 5-12, PAGE 5-34
FIG. 6-7, PAGE 6-9

MODE LOGIC CARD A7



U41 (PIN 2 TO GROUND)
SCOPE TIME BASE
500ns
500KHz \bar{Q} OUTPUT

MODE LOGIC CARD A7



U60 (PIN 2 TO GROUND)
MASTER CRYSTAL
OSCILLATOR INPUT
SCOPE TIME BASE
100ns.

VIII. Remove and Replace Module Cards and Sub-Assemblies

Rarely will the System 5000 Power Plus have to be completely disassembled. However, in the event that it does, module cards, sub-assemblies, power transformer, on/off circuit breaker switch, card cage and sub-chassis can be removed easily. In most instances, only partial removal is necessary to gain access to components. For example, to change a lamp or LED display indicator on the front panel card or a relay on the high voltage relay card, the module card does not have to be removed completely. Generally, it will only be necessary to remove the four (4) module cards from within the card cage. The reason for removing the cards is to gain access to the adjustment pots and test points for calibration, signal tracing and for performing voltage measurements.

Quick disconnect wiring harnesses, terminal leads and use of nut plates, enables the generator to be field stripped easily.

Disconnecting wiring harnesses and/or connectors and removing two or three screws is generally all that is required to remove most sub-assemblies.

Some wiring harnesses may use a tie wrap to keep them secured and out of the path of RF voltages. Replace if removed.

Brief comment on each assembly:

A. Module cards:

1. A9 - PS Control
2. A10 - PS Translator
3. A7 - Mode Logic
4. A8 - RF Logic

Disconnect the module wiring

harnesses observing orientation "mark them". It is best to only remove the card being tested, leave others in place. Loosen the knob on the side of the card cage and lift up on the arm that holds the cards in place. Remove cards. When replacing the cards, insure they fit into the slide tracks (grooves). This will prevent them from shorting out to the card cage chassis. Connect wiring harnesses correctly. Drop arm in place and tighten the knob that secures the cards in place.

B. Heat sink assembly - A13 incorporates:

1. A4 - RF Driver
2. A11 Power Devices

Remove RF card A5 first (see item C). Loosen the two screws that secures the latches that holds the heat sinks in place. Flip the latches back and pull up on the heat sink until the open portion of the bottom grooves mesh. Remove the heat sink slightly and disconnect J2 on the RF Driver card A4. A harness clip secures the wiring harness. It can be slipped out to extend the range the heat sink can be pulled away from the generator for troubleshooting, etc. When reinstalling, insure the harness is secured to the clip provided and that connector J2 is connected to the RF Driver. J10 and J3 should also be connected to the RF output card A5. Secure the two latches that hold the heat sinks in place.

Caution

If J11 on the RF output card has been disconnected, insure

that it is not mixed up with J2 on the A4 card. Both will fit. J11 is the wider wiring harness.

C. RF Output Card A5

Disconnect J1 through J3 and J6 through J10. Remove the four screws that secure the RF card to the subassembly chassis. Carefully pull up on the card and reach under the card and disconnect J11. When reinstalling, reverse the process. (If complete removal is desired, cut the tie wrap and disconnect high voltage leads from output power supply (A6).)

Caution

If the heat sinks have been removed or J2 on the RF driver A4 has been removed, be careful in connecting the two wiring harnesses. J2 and J11 are adjacent to each other. J11 is the wider wiring harness.

D. Fulguration (spray) Card A2

Remove the RF output card A5 first. Remove quick disconnects. Remove the three screws that secure the fulguration card to the subchassis. Lift card assembly out. Reinstall: reverse process. (If complete removal is desired, cut tie wrap.)

E. PS Output Card A6

Disconnect J1 and J1, mark connectors and jack headers, and +HV and -HV terminal leads, these two can be reversed. Remove three screws securing card to the sub-chassis. Slide card to the side to gain access to J4. Remove J4 connector.

Remove card. Reinstall: reverse process. (If complete removal is desired, cut tie wrap on connector going to the front panel.) Insure J1 and J2 are connected correctly.

F. High Voltage Relay Card A12

Easiest method to work on A12 card is to remove A5 and A6 cards and drop the front panel. Disconnect high voltage leads that are accessible and unsolder necessary HV leads. Remove three screws securing card to sub-chassis.

Note:

Experience will guide you in changing the different high voltage relays.

To replace or check relays, it is only necessary to partially remove the card. Reverse process for installation.

G. Front Panel A3

To gain access to the front panel card, remove the two elongated hex nuts on the top sides of the card and the one at the top, middle position. Tilt the front panel forward.

If the front panel is to be completely removed, remove the clamps that secure the monopolar and bipolar receptacles in place and slide them free of the front panel. Also, remove quick disconnect footcontrol receptacle on some models to free monopolar receptacle. Disconnect J1 through J3. (Cut tie wrap.) Slide the front panel free of the main chassis.

If access to the inside of the

front panel card is required (to change an LED, lamp or for troubleshooting purposes), then remove the seven screws securing the card to the front panel frame. The module card can now be disengaged and turned a full 90° angle from the front panel providing full access.

Caution:

Protect the front panel screen from scratches, etc.

Reinstallation - reverse process. Note - when putting the front panel back together, insure wiring harnesses are not pinched and that the panel fits flush to the main chassis without binding.

H. Sensor Board A1

Disconnect J3 from the front panel. Note J1 on the sensor board card A1 is permanently secured. Do Not try to disconnect it.

Push in on the protruding snaps that secure the sensor card to the sub-chassis. Once all are free, lift card up. If complete removal is necessary, unsolder leads E1 through E6 and remove sensor board card.

Reinstall - reverse process. Insure stand off snap into place.

I. Power Transformer

Disconnect J4 from the PS output card A6. Drop front panel and disconnect primary leads from terminal strip. Remove four screws securing the transformer to the sub-chassis. Lift power transformer out. Reinstall - reverse process.

J. Remove Power (On/Off) Circuit Breaker

Disconnect the four leads at the rear of the switch.

Push in on the plastic holders that secure the switch in place to the front panel. Remove switch. Be careful of switch cover. Installation: reverse the process.

K. Speaker

Remove A5 RF output power card. Remove two screws that secures the speaker to the chassis. Unsolder two leads on the speaker. Installation: reverse the process.

L. Sub-Chassis A14

Disconnect ground lead from sub-chassis. remove card cage from sub-chassis (three screws). Remove 12 nuts and washers that secure sub-chassis to the main chassis. Lift out sub-chassis from main chassis. With the sub-chassis out, complete wiring harness access is revealed.

Installation: reverse process.

Caution

Be careful with wiring harness.

IX. Preventive Maintenance

To maintain an efficient, safe and operational generator, it is recommended that periodic inspection and electrical test be performed at least semi-annually. The hospital environment may necessitate more frequent periodic inspections.

Establishing a preventive maintenance program may ultimately save money by decreasing the amount of time a generator would normally be out of service. It also saves labor costs due to unexpected breakdown as data can be accumulated on each generator, and its condition be effectively evaluated. When a generator can be confirmed as losing its electrical integrity, it can be removed from service for recalibration, repair or replacement before it malfunctions or becomes a health hazard. Thorough records indicating the safety performance of each generator may alert and protect your facility from possible adverse situations associated with electrical incidents. Reliable and proper test equipment will effectively pay for itself by saving valuable time and effort.

The following guide is recommended for performing preventive maintenance on the System 5000 Power Plus generator. Table 1-1 or the System 5000 Power Plus data summary sheet shipped with the generator may also be used as a guide to verify generator specifications. Refer to the calibration procedure if generator alignment is required. Power output waveforms can be seen in Figures 4-5 through 4-12, Page 4-19.

A. Visual Inspection

1. Remove the top cover by unscrewing the springloaded screw at the rear of the chassis and removing the 4 screws near the front cover. Four cover screws not on all models. Slide the cover straight back approximately 3/4" and lift the cover off.

2. Clean out dust, lint and foreign particles using dry pressurized air.
3. Visually check power cord, wires, harnesses, electrical leads, connectors and receptacles.
4. Check printed circuit boards for damage; components, loose contacts, security of connections, corrosion, etc.

B. Electrical Evaluation

1. Power Off Checks

Resistance check:

- a. Chassis to third wire ground on power cord less than 0.2 ohms.
- b. Chassis to high voltage circuit ground greater than 20 MEG ohms.
- c. Chassis to dispersive electrode (patient plate) receptacle greater than 20 MEG ohms.
- d. Chassis to handcontrol active receptacle greater than 20 MEG ohms.
- e. Chassis to footswitch active receptacle greater than 20 MEG ohms.
- f. Chassis to bipolar receptacles greater than 20 MEG ohms.

2. Power On Checks

Refer to Operational Check-Out on page 3-21.

Indicators, Switches, Controls, and Receptacles

- a. Power switch/circuit breaker.

- b. LED digital displays, including blend bar graph.
- c. Functional mode lamps (green) selector switch position.
- d. Cutting and coagulation lamps monopolar and bipolar with footswitch and handcontrol also check audio tone and volume control.
- e. Cord fault lamp and audio alarm.

3. Power Output

Refer to Table 1-1 in the front of the manual for specifications.

Surgical Analyzer:

- a. Pure cutting.
- b. Blend (cutting with hemostasis).
- c. Pin Point coagulation.
- d. Spray coagulation (if monitoring with oscilloscope, must use X1000:1 probe in open circuit condition (optional check). Probe damage may occur if X100:1 probe used.)
- e. Bipolar cut.
- f. Bipolar coag.

Frequency measurement period and pulse width:

- g. Cut-frequency.
- h. Blend-pulse width, period.
- i. Pin Point-pulse width, period.
- j. Spray-pulse width, period.
- l. Bipolar cut-frequency.
- m. Bipolar coag-pulse width, period.

Checks per I.E.C. and UL-544: Table 1-1

- n. RF leakage active output to chassis ground.
- o. RF leakage - dispersive electrode (P/P) to chassis ground.

Test Method:

Set up - place the ESU on a non-conductive table that is one meter above the floor. Attach handcontrol and patient plate and extend them forward to full length at one meter above the floor and one half meter apart. Connect an RF ammeter in series with a 200 ohm (non-inductive) load and measure RF current from patient plate to chassis ground and active to chassis ground while the unit is operating in open circuit full output power setting.

Maximum allowable current is 150mA in any mode of operation with either patient plate to ground or active to ground.

- p. Line leakage:
 1. Chassis to neutral.
 2. Dispersive electrode (P/P) to neutral.
 3. Active lead to neutral.
 4. Bipolar lead to neutral.
- q. Low frequency energy test (0-70KHz).
- r. Power Decrease.

MNEMONIC LIST - SYSTEM 5000

TABLE 5-1

ACK	Power Supply Acknowledge of Power Req. and Ready to Supply	MCT	Monopolar Cut Logic Level
<u>ACK</u>	Inverted ACK	MCTS	Monopolar Cut Handcontrol Sense
ACL	Audio Control Leg	MEN	Monopolar Enable from Control Panel
ACW	Audio Control Wiper	MHCG	Monopolar Handcontrol Coag Enable
BCG	Bipolar Coag Logic Level	MHCT	Monopolar Handcontrol Cut Enable
BCGS	Bipolar Coag Hand Sense	HONO	Monopolar Activation of Cut, Cut w/Blend, or Pinpoint Coag
BCT	Bipolar Cut Logic Level	MOPP	Monopolar Patient Plate
BCTS	Bipolar Cut Hand Sense	PCC	Proper Connector Connection
BEN	Bipolar Enable from Control Panel	<u>PCT</u>	Pure Cut (No Hemo)
BHCG	Bipolar Hand Control Coag	PPS	Patient Plate Sense
BHCT	Bipolar Hand Control Cut	PP	Patient Plate Output Jack
+BP	Bipolar Output Jack	REQ	Mode Logic Level Requesting HVPS Output
-BP	Bipolar Output Jack	SIG	Signal Ground
BPR	Energizes Bipolar Relay	SP+	Speaker (+)
<u>CF</u>	Cord Fault Enable from Front Panel	SP-	Speaker (-)
CG	Coag, Monopolar or Bipolar	VBCG	Voltage Representing Bipolar Coag Power Setting
CGEN	Coag Enable Logic Level for RF Logic	VBCT	Voltage Representing Bipolar Cut Power Setting
<u>COAG</u>	Footswitch Coag	VC	Power Supply Control Voltage
COM	20 Volt Common	VHMO	Hemostasis Voltage Proportional to Dial
CTEN	Cut Enable Logic Level for RF Logic	VHPW	Voltage Proportional to Hemostasis Pulse Width (Duty Cycle)
<u>CUT</u>	Footswitch Cut	VIO	Voltage Proportional to HVPS Output Current
DRBP	Relay Drive, Bipolar	VMCG	Voltage Representing Monopolar Coag Power Setting
		VMCT	Voltage Representing Monopolar Cut Power Setting
FGR	Drive for Fulgurate Mode Relay Driver	VPO	Voltage Proportioned to DC Power
FLPP	Fulgurate Patient Plate	VSEN	Positive HVPS Voltage Sense
FS	Active Lead, Footcontrol	VVO	Voltage Proportional to HVPS Output $V_o = VVO \frac{20}{20}$
FSG	Footswitch Ground	ZX	Zero Crossing Pulses of AC Line
FSSL	Footswitch Select Logic Line	ϕ	RF Drive Pulse with Pulse Width and Repetition Rate Conditioned by Mode
FULG	Generator Has Been Keyed in Spray	$\bar{\phi}$	RF Drive Pulse to Reset Magnetics
+FULG	Positive Side of the Primary of Fulg. Transformer	10VR	Precision 10V Referenced Signal
-FULG	Negative Side of the Primary of Fulg. Transformer	6VUR	Unregulated + 6V DC
<u>FULG</u>	Fulg. Enable Logic Level for RF Logic	+15	15V Regulated $\pm 5\%$
<u>GCF</u>	Gated Cord Fault Signal	+15L	15V Regulated $\pm 5\%$ Low Current to the RF Driver P.C.B.
GND	Low Voltage Ground	18UR	Unregulated +18 VDC
HC	Active Lead, Handcontrol	-18U	Unregulated -18VDC
-HV	High Voltage Common	20CT	20 Volts RMS AC Centertapped
+HV	High Voltage DC	36CT	36 Volts RMS AC Centertapped
HVAC	High Voltage AC Common	100V	100 VAC Tap for Line Transformer
HVFG	High Voltage Relay Coil Fulgurate Transformer	186V	186 VAC Tap for Line Transformer
HVFS	High Voltage Relay Coil FS Output Jack	125	125 Hz Clock Synchronized to Master 2 MHz Clock
HVHC	High Voltage Relay Coil Handcontrol Output Jack	250	250 Hz Clock Synchronized to Master 2 MHz Clock
HVMO	High Voltage Relay Coil Monopolar Transformer	20K	20 KHz Clock Synchronized to Master 2 MHz Clock
HVTR	High Voltage (Triac) Trigger	125K	125 KHz Clock Synchronized to Master 2 MHz Clock
ISEN	Voltage Developed Across the DC Current Sense Resistor	250K	250 KHz Clock Synchronized to Master 2 MHz Clock
IPS1	Positive Current Peak	500K	500 KHz Clock Synchronized to Master 2 MHz Clock
IPS2	Negative Current Peak	1M	1 MHz Clock Synchronized to Master 2 MHz Clock
<u>KHV</u>	Pulse to Energize HV Cap Dump Transistor		
<u>KHV</u>	Inverted KHV		
LVS	18 VAC Unreg. w.r.t. ground		
LVTR	Low Voltage (Triac) Trigger		
MCG	Monopolar Coag Logic Level		
MCGS	Monopolar Coag Handcontrol Sense		

Theory of Operation

I. INTRODUCTION

This section of the manual examines the System 5000 Power Plus generator Theory of Operation. Two diagrams are particularly helpful in visualizing and understanding the overall system. The Interconnect diagram Figure 5-2 page 5-24 and the functional block diagram Figure 5-23 page 5-23. The Interconnect diagram is a wiring diagram of the major sub-assemblies shown joined together. The functional block diagram shows in detail how the circuits within the major sub-assemblies marry together as an operational system. Study of these two diagrams plus an in-depth circuit analysis of each major sub-assembly will provide a comprehensive understanding of the entire system.

II. Functional Block Diagram (Figure 5-1)

The following explanation is a brief description of the functional block diagram. Notice the circuits in the functional block diagram have been separated to show the inter-relationships and signal flow interlacing. Periodic referral to the Interconnect diagram will be helpful in that it consolidates the smaller sections to one major group.

The AC main power is routed to the AC power transformer via the power switch/circuit breaker. One section of the power transformer steps down the AC input voltage and transfers it to the fixed low voltage power supplies (A6), where it is rectified and routed to other sub-assemblies. These sub-assemblies incorporate regulators that provide the necessary low voltage regulation for operation of logic circuits, lamps, relays, switches and sound circuits. Another section of the AC power transformer

transfers voltages to the high voltage bridge rectifiers and triacs (A6). The triacs, through a power regulation network, provide a variable DC voltage to the RF output transistors (A13) within the RF amplifier.

Note:

"A" numbers are card identifiers. For instance: "A7" is the mode logic sub-assembly card; however, there are several functioning sub-circuits within a major sub-assembly. They are identified throughout the functional block diagram as a part of the major sub-assembly (i.e., 2MHz crystal oscillator and divider A7 is a small functional circuit within the mode logic card).

The interconnect diagram, Figure 5-2, identifies the major sub-assembly. Use both to more easily understand and follow the flow as the functional block diagram is explained.

The front panel control switches and indicators (A3) are selected by the operator to give both control and indication of the many modes available with the System 5000 Power Plus. The operator also sets the output power available in each mode using the front panel power controls by reading the digital power displays (A3). For example, with the generator at idle, the operator may select the "dual mode" with "pure cut" at 100 watts (requires a dispersive electrode, and blend control fully [CCW] counter clockwise), "pin point coagulation" at 75 watts, "bipolar cut" at 0 watts (no output), "bipolar coagulation" at 35 watts and select the "footswitch" for use in the "bipolar mode", thus allowing for "handcontrol" use in

the "monopolar mode". (Note that either a handswitchable or footcontrolled bipolar forceps could be used in the bipolar mode.) Activation of the "footswitch" or "handswitch" now provides the operator with the mode output and power selected. Operation of the front panel power control and appropriate digital power display from the functional block diagram is described as follows:

Position of the front panel power control (A3) is represented by a voltage which is routed through the power control buffers and blend scaling (A3), to the analog to digital converter (A3) RF pulse train generator (A8) and HVPS mode select and scaling (A9). The analog to digital converter (A3) also receives clock signals from the crystal oscillator and dividers (A7) to synchronize the conversion rate and sequence the digital IC's to the four digital power displays at a rate of 125 Hz (A3). This digital power display (A3) then represents the power available in the selected modes. Various control sections of the generator work together to maintain the output power to within approximately five percent (5%) of the represented power at prescribed load ranges (see Load Curves, and Table 1-1 in the front of the manual).

An analysis of one mode of operation traced from an activated accessory to the output receptacle, provides insight into understanding the other modes of operation. Common circuitry is employed throughout the system in all modes of operation. Therefore, study of the signal diversions on the functional block diagram will be useful to understand the other

modes of operation.

When the generator is set up for the pure cutting mode and a request for cutting power is made by activating a handcontrol accessory, the following action results:

The hand sense detector (A1) acknowledges the request and routes the request through the mode control scanner which responds to mode requests on a "first come first served" basis (A7). (Notice also, connection of the dispersive electrode [patient plate] causes the cord fault circuitry to deactivate via the cord fault sense detector [A1], permitting monopolar operation.)

The "first come first served" mode control scanner (A7) detects the cutting request and routes a logic signal to the tone generator (A7) where it merges with the input signal from the 2MHz crystal oscillator divider (A7). The combined action generates a 1KHz tone at the speaker (A14), giving an audible confirmation to the original request for cut mode power.

The "first come, first served" mode scanner generator (A7) also routes a cut logic signal back to the front panel (A3), illuminating the monopolar cutting lamp, giving visual confirmation of the cut request. In addition, the "first come first served" mode scanner generator (A7) routes logic signals to the H.V. relay drivers (A7), causing the appropriate high voltage relays (A12) to energize.

The mode scanner generator output (A7) is also routed to the HVPS mode select and scaling (A9), which selects the power control buffer output (A3) for the pure cutting mode and prescales the high voltage

power supply output (A9). This scaled value is routed to the power, voltage and current limit circuits (A9) for the HVPS output. These limit circuits are part of a closed loop control network to regulate the output power of the variable high voltage power supply. With fixed losses in the System compensated for by the HVPS output power limit circuits the RF output power is in turn regulated. The scaled pure cutting power control (A3) setting is combined in the limit circuits (A9) with the power signal from the PS output scaling and power calculation circuits (A10). The limit circuit output (A9) is routed to the error integrator and control voltage generator (A9), which synchronizes changes in the control voltage to the input AC line. This control voltage is routed to the phase control pulse generator for triacs (A10). The phase controlled pulse sets the firing angle for pure cutting on the low voltage triac (A6). The firing angle of the triac determines the energy removed from the AC power transformer. This energy charges the HVPS filter (A6) to the appropriate voltage to deliver sufficient current to the RF output transistors and configuration relays (A5, A13) at the preset power level. The HVPS filter with voltage and current sense (A6) levels are routed into the PS output scaling and power calculation (A10), thus closing the power supply control loop.

The "first come first served" mode scanner generator (A7) also energizes the pure cutting RF start up and mode enable circuits (A7, A8). These logic levels are then routed to the configuration relay drivers (A8), which in turn selects the cut, cut/blend, pin point, transformer (A5) and also sets up the RF amplifier into a full bridge configuration for the output

transistors (A5). The logic levels (A7, A8) are also routed to the RF pulse train generator (A8).

The RF pulse train generator (A8) receives a clock input and develops a continuous 500KHz squarewave for monopolar cut. This signal is processed through the RF drive synchronization circuit (A8) and the RF drivers which turn "on" the output transistors (A13). The pure cutting RF signal is then routed to the monopolar cut (cut/blend-pin point) output transformer and filter (A5). The pure cutting 500KHz sinewave is then routed to the output monopolar receptacles via the balance transformer and high voltage relays (A12).

The pure cutting request has now been traced from the handcontrol accessory to the output receptacles.

The functional block diagram reveals the hand sense detector (A1) is by-passed if the footswitch accessory is activated first.

The footswitch request (A14) is routed directly to the "first come first served" mode scanner generator (A7) via the footswitch coag override circuit (A7). The remainder of the circuit follows the same signal route as previously described for the handcontrol activation in pure cutting, except only the HV relay for the footcontrolled jack is activated. Thus, power will not be delivered to a monopolar handcontrol accessory if a footswitch accessory has been activated. When blend operation is requested, the front panel blend pot and bar display (A3) route signals into the power control buffer and scaling circuits and also the RF pulse train generator (A8). This produces variable "pulsed" 500KHz width

squarewaves instead of continuous squarewaves as generated in pure cutting. The remainder of the circuits are common to the pure cutting mode previously described.

A request for pin point coagulation from a handcontrol accessory or footswitch is accomplished in the same manner as cutting. Observation of the functional block diagram reveals the same blocks (circuits) and signals used for pin point coagulation are common to the cutting mode. However, a difference occurs in the RF pulse train generator (A8). Instead of continuous 500KHz as in cutting, fixed pulse width 500KHz squarewaves are generated. The other blocks (circuits) are common to the previous two monopolar modes.

In the spray operational mode, the output transistors (A13) are routed directly to the spray output transformer and filter (A2) via the configuration relays (A5). This is accomplished by means of the RF logic input signals (A8) to the configuration relay drivers (A8).

The configuration relay drivers (A8) reconfigure the full bridge RF amplifier (A5, A13) network to a single-ended stacked output RF amplifier. The RF signal is then routed to the monopolar output receptacles via the high voltage fulguration (spray) relays and balance transformer (A12). The high voltage fulguration relays (A12) are energized from the mode logic circuits via the high voltage relay drivers (A7). Again, a difference occurs in the RF pulse train generator (A8). Instead of a continuous 500Hz squarewave as in cutting, a pulse train with a pulse of approximately 1.8usec duration at a 31.25KHz rate is generated to drive the single-ended amplifier.

The functional block diagram shows that the bipolar modes of operation are common to the pure cut, blend and pin point (circuitry). The RF pulse train generator (A8) output is the same for bipolar coagulation (pulsed 500KHz squarewaves) as it is for pin point coagulation. Bipolar cutting is identical to pure cutting (continuous 500KHz squarewave). Bipolar differs, in that the full bridge RF amplifier network is routed directly to the bipolar output transformer and filter (A5) via the bipolar relay driver (A8). The RF bipolar output is then routed directly to its own bipolar output receptacles.

Notice on the functional block diagram that the bipolar accessory output receptacles are separate from the monopolar output receptacles. Also, a dispersive electrode (patient plate) is not required for bipolar mode of operation. (Required only in dual mode and monopolar to permit return path for monopolar current.)

Other differences occur at the front panel: lights, different tones for different modes of operation, orientation of digital display LED's and control dials, etc.

In summary, the functional block diagram and interconnect diagrams provides a good background for entering the Theory of Operation of each major sub-assembly, the next subject to be discussed in detail.

III. Sub-Assembly Circuit Description

Introduction

Analysis of major sub-assemblies are contained in this section of Theory. Simplified diagrams and schematics are provided throughout

the Theory text and may be referred to by Figure number. Referral to the functional block diagram and interconnect diagram may be helpful in maintaining systems perspective as each major sub-assembly is examined.

A. P.S. Output (A6)
(DWG 50-0074) Fig. 5-4

The power supply (PS) output sub-assembly rectifies and filters AC voltages from the power transformer to provide unregulated low voltages. In addition, the variable high voltage DC required for the RF amplifier is developed here.

The low voltage supplies are continuous output capacitor input types, and are depicted in Figure 5-4. Diodes D9-D12 and capacitors C6 and C8 rectify and filter the 36 VAC C.T. (center tapped) input voltage, providing +18 Vdc and -18 Vdc. Diodes D13, D14 and C7 rectify and filter the 20 VAC C.T. input voltage providing +10 Vdc. The interconnect diagram shows which sub-assemblies receives these unregulated voltages.

The adjustable high voltage is developed by the proper firing of one of two triacs. These triacs are fired only upon request from the operator and are held off in the idle mode.

The input voltage to the low voltage triac is 100VAC and 186 VAC for the high voltage triac. Triac Q31 is connected to the low voltage power transformer tap and when fired provides 20-125 volts DC.

The triacs switch the incoming AC voltage to the diode bridge at the proper moment in time.

The two triacs and two bridges are arranged in order to select either the low voltage triac for the 20-125VDC operation or both the low voltage and high voltage triacs for the 20-200VDC operation by the choice of trigger lines. Note that the low voltage triac cannot conduct current due to the reverse bias condition on the diode bridge when the high voltage triac is conducting. The cutting request triggers triac Q31, 20-125Vdc and a coagulation request triggers the triac Q49, 20-200 Vdc. This method of triggering enables either of two transformer taps to be selected without use of a mechanical relay increasing system efficiency.

Removal of the operation request generates a high voltage kill drive signal on the mode logic (A7). This signal is then routed through the PS control (A9) to the PS translator driver transistor Q14 (A10). This signal provides a drive pulse turning on transistor Q32. The high voltage filter capacitors, C40 and C41, are discharged through resistors R33 and transistor Q32 to allow for fast mode changes to occur (approximately .25 seconds between modes).

B. P.S. Translator, (A10)
(DWG 50-0070) Fig. 5-7

The PS translator provides two basic functions. (1) Monitors DC voltage and current delivered to the RF amplifiers establishing voltage, current and power limits, and regulation. (2) Generates a pulse whose position with respect to 60Hz/50Hz zero crossings is a linear function

of an incoming control voltage (Vc).

In normal operation, the output of the high voltage supply (PS output A6) is a triangular ripple waveform at 120Hz/100Hz with a DC level. The ramp up of the ripple component coincides with the triac conduction period so that the lowest voltage occurs at the triac trigger point and the highest voltage occurs just when the triac has turned off. The voltage and current at these two points in time are stored in the four (4) sample and hold circuits, U35, U63 and capacitors C34, C36, C62 and C64. The approximate average value is provided at the resistor junctions R37 and R38 for voltage and R65 and R66 for current. The capacitors C20 and C25 serve as RF bypass components. This circuit network provides a virtually ripple-free sample of voltage and current without the usual response delay of low pass filtering. U44 and U69 form a precision four (4) quadrant analog multiplier.

The following component description should be helpful prior to analyzing the translator logic ramping circuitry. Not all component pins are identified. Important pins will be explained while describing each operational situation.

1. U131 Pins (1,2,3)
Integrator: Generates the ramp signal.

U131 Pins (8,9,10)
Comparator: Senses when the integrator output reaches +10V.

U131 Pins (12,13,14)
Comparator: Senses when the integrator reaches -10V.

U131 Pins (5,6,7)
Comparator: Compares the integrator waveform to the control voltage VC and signals when the ramp intersects the incoming control voltage (VC).

2. U140 Pins (1 through 6)
Set-Reset flip flop:
Provides +1.5V to the integrator for ramp down.

U139 Pins (8 through 13)
Set-Reset flip flop:
Provides -1.5V to the integrator for ramp up.

3. U100 Pins (4,5,6)
U139 Pins (4,5,6)

Gate the transition of the -10V comparator to signal the limits of the integrator insuring the waveform generator will not get out of sequence if a zero crossing pulse occurs before the ramp has reached -10V.

(The circuit enclosed in the dashed lines, Figure 5-7, is the zero crossing detector.)

4. U88 Pins (1,2,3)
Senses line polarity.
5. U97 Pins (4,5,6)
Converts the op amp output to CMOS levels.

U97 Pins (1,2,3)
Produce a pulse at each transition of U88.

Now operation of the ramp generator will be explained.

6. R118 (potentiometer)

Adjusts the period of the triangle waveform which essentially sets hold time and determines the minimum phase angle at which the triac may be fired.

7. R122 (potentiometer)

Controls the symmetry of the triangle waveform which sets the maximum phase angle for triac firing.

8. Q121

Removes the offset introduced by R118 during hold time to make hold time and symmetry adjustments less interactive.

Adjustments of items "6" and "7" along with the logic in the translator, permits the triac to be fired not less than the minimum phase angle set by the hold time (R118) nor at greater than the maximum phase angle set by the symmetry of the triangle R122.

Further analysis (assume the circuit is in the hold state) reveals that when a zero crossing pulse occurs, the hold flip flop, U139 (output pin 10) is reset turning on Q121. The output of flip flop U140 (pin 3) is set low and simultaneously routed through U140 and applied to U88 (pins 5 and 6). The output of U88 (pin 7) is applied to integrator U131 (pin 1), causing it to ramp up from -10V. When the integrator reaches +10V. When the integrator reaches +10V, the output of comparator U131 (pin 10) resets flip flop U140 to reverse the input to the integrator making it ramp down.

When the integrator reaches -10V, the hold flip flop U139 is set and the flip flop U140 is reset. In the hold mode, ramping of the integrator is disabled because U140 (pins 10, 11) outputs are held low, making U88's output (pin 7) zero. Q121 is then turned off removing the effect of R118.

When the ramp intersects the incoming control voltage at U131 (pins 5,6), the output of U131 (pin 7) triggers the one shot logic U107 (pin 13) via U139, U107 and U97 to generate a nominal .2 usec pulse for routing to the appropriate triac triggering circuits Q141 or Q142 via U107 and U100. U131 (pins 5,6) compares the integrator waveform to the control voltage input. The logic between U131's output (pin 7) and Q141 or Q142 generates the transfer function shown in Figure 5-6.

The HVPS acknowledge input allows for the triac triggering to be enabled or disabled by control from the acknowledge logic in the PC control circuit (A9).

C. P.S. Control - A9
(DWG 50-0097) Fig. 5-9

The P.S. control converts front panel dial voltages into a single control signal which adjusts the high voltage supply up or down. The control voltage (VC) establishes the phase angle firing point of a triac switch in the high voltage supply (A6).

The P.S. control also provides automatic deactivation of the output RF power in the event of a large voltage disparity between the high voltage output

and equivalent dial setting.

The P.S. control performs as a multiple scaled DC feedback amplifier with voltage, current and power limit. Analog switches, as a function of mode, select the appropriate incoming dial voltage, and after non-linear scaling, a voltage proportional to the selected input is compared with the high voltage power supply output (Vvo). Any difference (error) is amplified by an AC compensated op amp whose output controls the phase angle of the previously detailed triac firing circuit. This same control level (Vc) will drop down if any power limit, voltage or current is exceeded. Assume a request and activation of one of the four (4) mode lines (MCT, MCG, BCT or BCG) from the mode logic sub-assembly (A7). The output voltage at op amp U213 (pin 14) is proportional to the difference of the chosen front panel dial setting and the power (Vpo) signal coming from a multiplier in the sense section of the PS translator (A10). This difference signal is presented to a summing amplifier, U110 (pin 13). The summing amplifier output would cause maximum power supply voltage under no load condition if it were not for the voltage limit circuit. The voltage limit is derived from the same signal (mode select front dial) which establishes the voltage limit. U213 (pins 1,2,3) processes this upper voltage limit level by taking a squareroot approximation. After inversion by U213 (pins 8,9,10) scaling by the appropriate analog switch (U37) and op amp U94 (pins 8,9,10), U94 (pins

12,13,14) takes the difference between this conditioned voltage and the actual high voltage power supply (Vvo). U94 (pins 12,13,14) also amplifies this error term and op amp U110 (pins 1,2,3) performs a simple inversion with diode blocking (D70).

In summary, whenever the power supply (Vvo) exceeds its voltage limit, test link TL160 will measure negative, otherwise it idles within 0.1 volt of ground.

The P.S. control circuit will fall into automatic current limit when V_{10} exceeds the reference level selected by analog switches, one of five set point resistors, a 10 volt reference and U94 (pin 1,2,3). Any difference is amplified by U94 (pins 5,6,7) and inverted and rectified by U110 (pins 5,6,7). Resistors R73, R74, R77 and R78 combine the three error terms of power, voltage and current in such a way that the high voltage supply performs simply as a well regulated voltage amplifier with automatic power and current limit. Op amp output, U110 (pin 14), is the composite error term which, after inversion and amplification by U106 (pins 8,9,10) leaves the board as Vc.

The P.S. control also provides over voltage and zero dial deactivation. The level at the input of U94 (pin 12) is the difference between the desired output voltage and the actual voltage itself. This difference is compared with a reference level by U213 (pins 5,6,7) so that "ACK" is dropped whenever the high voltage output exceeds the dial

selected equivalent by approximately 20 volts. "ACK" (and hence RF generation) is permitted only if there are: Request (from operator), no over voltage and selected dial setting greater than 2.5%. Op amp U110 (pins 8,9,10) generates the latter by sensing whenever the selected front panel level is close to zero. The delay network of resistors R144, diode D145 and capacitor C104 allows the supply to enter momentary excursions into over-voltage. U53 (pin 8) keeps error amp U106 "reset" during idle. See Figure 5-8, simplified diagram.

D. Mode Logic - A7
(DWG. 50-0073) Fig. 5-12

The mode logic sub-assembly serves as the "nerve center" for the generator. It services requests from several other sub-assemblies (refer to functional block diagram, figure 5-1, and interconnect diagram, figure 5-2) and generates proper output logic signals for performance of the selected mode. These logic signals energize relays, activate switching, sound and indicator circuits as well as provides logic signals to the P.S. control and R.F. logic circuits. In addition, the mode logic circuit contains a 2MHz crystal oscillator that clocks the tone generator, R.F. pulse generator and front panel digital circuits.

When no request has been made, the generator is in the "idle" mode. At this time, the counter-decoder, U40, scans all eight (8) possible generator states. When a request does occur, OR-gate U25 discharges

capacitor C47 and "freezes" the counter via the output of Schmit trigger U55 (pin 3). This circuit network honors requests on a "first come first served" basis.

Generation of this request also enables the relay driver sections, U30, U65, U64, transistors Q84, Q88, Q80, Q92 and also the tone selector U57. This request triggers one shot U41 through U26. Its Q output inhibits any RF generation for approximately 40 ms, allowing setting of the relay contacts and power supply. RF activation (CTEN or CGEN) will cease if incoming "ACK" goes high.

The shutdown sequence begins with the output of U25 (pin 13) returning to a logic high. Immediately, request to the power supply, U23 (pin 9), relays and RF enable (cut and coag) are dropped, and capacitor C47 begins charging. At a given threshold inside U55 (Pin 3) stretched request will drop some 180-220 ms after the end of raw request. During this extended interval, (stretch) the KHV line turns on Q14 in the translator (A10) which turns on the kill transistor Q32 in the output power supply (A6) which dumps the high voltage power supply capacitor by going low for the 180-220 msec interval. At the end of this period, counter-scanner U40 is unlocked and begins looking for the next user request.

Various clock frequencies for RF and tone generation are driven from a nominal 2 MHz crystal clock, U61. Decade counter, U60, divides the fundamental by 100 and counter

U62 provides a binary sequence of frequencies down to 125 Hz, four of which are used for tone generation. After gating by the tone generator U57 the selected tone drives speaker current source Q98, through a potentiometer external to the board.

Since user mode changes during activation are potentially harmful to the RF amplifier, changes in the position of the front panel switches are sensed by U10. Should change occur, U10, Pin 11, sends a nominal 1ms pulse which fires one shot U41, thereby deactivating RF. Also, capacitor C52 is discharged by transistor Q53, generating a nominal half-second system reset. Capacitor C52 performs this same function during initial power up.

E. Front Panel - A3
(DWG 50-0077) Fig. 5-15

The front panel enables the operator to select the desired modes for generator operation. He can also control power output and visually monitor generator activity. The front panel monopolar output receptacle block permits use of a variety of footcontrolled and handcontrolled accessories, as well as providing for the dispersive electrode (patient plate) receptacle. The front panel bipolar output receptacle block permits use of either footcontrolled or handcontrolled accessories.

Mode, footswitch and coagulation type selector positions determine which LED displays and functional lamps illuminate. The blend control position will determine how

much of the LED bar graph illuminates. Activation of cutting or coagulation footcontrol or handcontrol accessories will illuminate the desired monopolar or bipolar cutting and coagulation mode lamps.

The power control dials provide five (5) lines of analog information via five potentiometers R301 through R305. 0 to 10 volts is derived from these potentiometers, which are driven from a 10 volt reference chip, U3. These potentiometers are buffered by sections of five (5) respective voltage followers, U112 and U114, for delivery of dial voltage to other circuits within the front panel, P.S. control circuits and RF pulse train via the mode logic sub-assembly.

Analog preconditioning:

Op amp, U114 (pins 12,13,14) clips the maximum level of MCT as a function of the degree of blend (hemostasis). At maximum blend, the maximum MCT power displayed is 230 watts instead of the 350 watts displayed for cutting. Each monopolar coagulating mode (pin point or spray) requires its own individual scaling for power readout on the LED digital display. Two sections of the analog switch, U116, select the appropriate calibration potentiometer, R221 or R224, in an adjustable voltage divider network.

Multiplexed four channel A/D (analog to digital) converter:

Single slope conversion is employed with a maximum conversion of 0.7 milliseconds. After conversion, a channel's digits are held for 4 ms minus the 0.7 ms conversion time.

The falling edge of the 250 Hz clock begins a conversion by generating a 60 usec system reset pulse from the digital 1-shot formed by U136 (pins 10,14,15) and the output of U172 (pin 4). The positive going reset pulse does three things (1) turns on transistor Q73 to discharge the ramp capacitor, C71; (2) turns off all "contacts: inside the analog switch, U158 (this blanks all displays during the short reset interval) and (3) disconnects the comparator, U157 (pins 4,5,2) from any of the four possible inputs so that it is reset in time for the beginning of the counting interval. Resistor R138 helps accomplish this.

The return of the system's reset line to zero (0) permits several things. (1) Decode counters U170, and U136 are enabled for counting; (2) the clamp, Q73, is removed to allow capacitor C71 to charge linearly from the constant current source formed by transistors Q13, Q11 and the precision 10 volt reference regulator U3; (3) the "gated" 1-shot U159 (Pins 2,3,4) is also enabled. During counting, it generates an approximate .5 usec pulse beginning on the rise of the incoming

the rise of the incoming 500KHz clock. Assuming gate U172 is enabled by the comparator circuitry (U157), the clock edge strobes a zero (0) onto the Q of U159. U172 will now send a reset pulse to flip-flop U159, but delayed by approximately .5 usec because of resistor R247 and capacitor C161.

During the counting interval, analog switch U158 selects an incoming dial level to be digitized and also energizes the corresponding LED display. When the voltage ramp on capacitor C71 reaches the selected analog level, the comparator's output, U157 (Pin 2) changes to low, the output of U172 (Pin 10) then goes high, turning on the proper digital display and also inhibiting count pulses via U172 (Pin 12).

Until the next negative transition of the 250Hz line, nothing happens and the count is held on one of the four (4) displays. When this 250 Hz transition next occurs, all of the above repeats, excepts that the next analog level is converted instead. The 125 Hz line and divider U159 form a simple counter having four (4) states, each state corresponding to one of the channels U158. In this way, one A/D converter handles all four channels. The three (3) decades of "BCD" (binary coded decimal) information are sent from counters U170 and U136 to special 7-segment decoders, U81, U82 and U69. The outputs

of the decoders are fixed 25ma current sources which drive the cathodes of all LED segments. All the anodes of a particular display are connected to 6 volts via the Darlington transistors Q65, Q74, Q35 and Q174. Schmidt trigger U208 provides buffering of the incoming clock frequencies. Resistors connected to its inputs provide conventional handling-static protection. Resistors connected from its outputs permit 15 volts U208 to level shift to the five volt circuitry of the A/D converter. The outputs of comparator U157 (Pins 1 and 14) function internally as open collector switches to ground. The LED's of the bar graph are thus enabled when the resistors R17 and R20 are switched to ground.

In the lamp driver section, notice that some transistors are Darlington MPSA13; others are conventional NPNS, depending upon gain and current requirements. Q215, provides the gated cord fault signal. In bipolar, current from resistor R209 prevents a disconnected dispersive electrode (patient plate) from activating the cord fault alarm and turning on the cord fault warning lamp. The voltage level from the blend potentiometer (Hemo) R301 is actually the inverse of the RF waveform duty cycle, and op amp U112 (Pins 1,2,3) is used for inversion, offsetting and scaling. Thus, at maximum hemo (blend control at maximum), the 10 volt pot level is inverted to approximately 2.8 volts at U112, Pin 2. In pure cut, V

hemo is zero but U112 now delivers approximately 10V (100% duty cycle).

F. R.F. Logic - A8
(DWG 50.0072) Fig. 5-19

The RF logic sub-assembly incorporates a three (3) section pulse generator. Its purpose is to initiate and develop the cut/hemo, coag, and spray (fulguration) signals. In addition, a two (2) phase RF logic circuit is employed to further develop the logic pulses, and drive the RF amplifiers. (To assure selected modes receive the proper signal amplification and is routed to the proper output transformer, a relay drive circuit is incorporated for bipolar and fulguration.)

An explanation follows of how the cut/hemo, coag and spray (fulguration) signals are generated.

Before explaining specific mode operation, notice U12 (Pins 10,11,12,13) on the RF logic schematic, Figure 5-19 page 5-41. U12 (Pin 10, output) is a common point that can be observed to reveal which pulse train has been selected. U12 (Pin 11) receives the fulgurate signal, (Pin 12) the coag signal and (Pin 13) the cut/hemo signal.

1a. Cut (monopolar or bipolar mode)

Pure cut begins with activation of CTEN and PCT. All other input lines, except the continuous clock frequencies, remain in their rest state.

CTEN enables the one-shot formed by U67 (Pin 2) and U76 (Pins 13 and 12). This logic action, in turn, sets the flip-flop U67 (pin 9). U67 (Pin 14) then sends a logic low through inverter U40 (Pins 9 and 8) and OR-gate U12 (pin 10), which enables the 2-phase RF generator via U40 (Pins 11 and 10) for 100% duty cycle operation. Removal of CTEN permits the deactivation of the hemo pulse train by first unclamping comparator U78 (Pins 11 and 13) via diode D74 and U34 (Pins 11,12,13). A high logic level at U67 (Pin 11) permits reset to occur on the next 1MHz clock pulse.

- 1b. Hemo (blend) pulses vary from approximately 28% to 95% duty cycle and period of 50 usec (rep rate 20KHz) are produced using the ground referenced sawtooth waveform generator. It consists of a constant current source made up of transistor Q83, resistors R80, R85, R86 and R88. The ramp on capacitor C79 charges toward the source when transistor Q82 is 'off'. The charging time is proportional to VHPW, and reaches approximately 100% when VHPW equals 10 volts. When the ramp level intersects the DC level of VHPW, comparator U78 (pins 11 and 13) resets U67 via (pin 11) its 'K' input. When U67 resets, Q82 turns 'on' via U64 (pin 11) and U76 (pin 10) pulling the voltage on C79 to ground creating the sawtooth. The duty cycle of the hemo pulse train coming off from U40 (pin 10) is

proportional to VHPW and reaches approximately 100% when VHPW equals 10 volts. This is the signal that enables the 2-phase RF generator in blend (cut/hemo).

2. Coag (pin point) pulse widths of 6 usec and 50 usec period (rep rate 20KHz) begin with enabling the JK flip-flop, U56 (pin 10) via U75 (pin 4 and 5) and U78 (pin 2 and 4). On the next falling edge of the 20KHz clock, (connector J3, pin 8), U56 (pin 13) is set. The binary counter, U63, begins to count up at a 1MHz rate. Eventually, a count of 6 from binary lines 2 and 4 is detected by gate U64 (pin 6 and 5). Its output pin 4 resets flip-flop U56 (pin 12), hence ending the main coag event. The next rising edge of the 20KHz resets counter U63 (pin 11) via gate U64 (pin 2 and 3) starting the next coag cycle.
3. Fulgurate (spray coag) pulse width of approximately 1.8 usec and period of approximately 32 usec (rep rate 31.25 KHz) begin when CGEN and FULG disable flip-flop U56 (pin 10) via U75 (pins 4 and 6) and U76 (pins 1 and 2) and enable U56 (pin 6) via U75 (pin 3 and 1) and connector (J3, pin 3). No reset is applied to counter U63, which allows continuous generation of a 31.25 KHz squarewave for setting U56 (pin 3). The binary '1' line from U63 (pin 9) resets U56 (pin 4) via U64 (pin 8-10) producing the

basic 1 usec pulse at U56 (pin 1) 'Q'. Network resistors R57, R59 and R58, diode D60, capacitor C61 and comparator U78 (pins 1, 6 and 7) stretch the fulgurate pulse to 1-2 usec. Final adjustment depends on the product specifications. Note: The pulse observed at the RF output will be typically 4 usec under a 500 ohm load. As the load varies, the spray output pulse width will vary due to frequency shifts in the output transformer tank.

Two Phase RF Logic

The 2-phase RF logic driver receives the selected RF signal from the 3-sectioned pulse generator to develop the logic pulses that drive the RF amplifiers. The 2-phase logic is developed by the JK flip-flop U11 and sections of U39. Section "B" of U11 generates phase 1 ($\phi 1$) and section "A" generates phase 2 ($\phi 2$). These phases alternately drive a "full bridge" RF amplifier when the operator selects any mode of operation except spray coagulation. When spray coagulation is selected, the configuration relays switch the full bridge RF amplifier into a single ended stacked configuration. This configuration requires $\phi 1$ and $\phi 2$ be turned on at the same time. Synchronous turn on is accomplished via the set and reset inputs of the JK flip-flop, U11.

For cut, cutting with hemostasis (blend), pin point coag, bipolar cutting and bipolar coagulation, the 3-section pulse generator

determines the amount of 'on' time that $\phi 1$ and $\phi 2$ will operate. The 'on' pulse is fed to U39 (pin 4). This pulse, along with the input from the \bar{Q} of section B of U11, allows U11 (pin 6) to go high. On the next positive edge of the 1MHz clock, U11 (pin 3), the Q output of 1 section B will go high and \bar{Q} will go low. U39 (pin 5) is connected to the \bar{Q} output, forcing U39 (pin 6) to go low. Since U11 (pin 6) is low, on the next positive edge of the 1MHz clock, U11 (pin 3), Q and \bar{Q} will go low and high respectively. U39 (pin 5) is now high, which enables U11 (pin 6) to go high and on the next positive edge of the 1MHz clock output Q and \bar{Q} will toggle once again high and low respectively. This toggling continues as long as a high signal remains on U39 (pin 4). As soon as U39 (pin 4) goes low, then U11 (pin 6) is low and on the next positive edge of the 1MHz clock Q becomes low and \bar{Q} becomes high. These levels will remain until U39 (pin 4) goes high causing the cycle to start all over again.

Section A of U11 provides the $\phi 2$ signals. The relationship between the two phase is that section B ($\phi 1$) is master and section A ($\phi 2$) is slave. This means that whatever the master flip-flop ($\phi 1$) does, ($\phi 2$) will always follow, except that it occurs on the following positive edge of the 1MHz clock.

If Q of section B goes high, then the J input U11 (pin 10) goes high, which sets section A up to force its Q to go high on the next positive edge of the 1MHz clock U11 (pin 13). At the same time, U39 (pin 6) goes

low, which sets section B's Q to go low on the next positive edge of the clock U11 (pin 3). When the next positive edge of the clock does occur, both section B and section A will toggle. After the transition occurs, both J inputs of sections B and A changes their state to a high and a low respectively, which sets the next state of Ø1 and Ø2. The toggling of Ø1 depends on the amount of 'on' time applied to U39 (pin 4). Ø2 will always follow Ø1, but its transition occurs 1 usec later ($\frac{1}{F} = T$, therefore $\frac{1}{1\text{MHz}} = 1 \text{ usec}$ until U39 (pin 4) goes low.

Both Ø1 and Ø2 operate with 1 usec on pulses, which will drive the RF amplifier at 500KHz rate. The 500KHz rate is determined since Ø1 drives the amplifier in one direction and Ø2 drives the amplifier in the other direction. The total cycle occurs in 2 usec (1usec for Ø1, and 1 usec for Ø2) which determines 500KHz.

The output of section B and section A are obtained from their \bar{Q} outputs which are fed to U9 (pin 8) and U9 (pin 13), respectively. Since both Ø1 and Ø2 circuits after this point operate in the same manner, only the circuit operation of Ø1 will be described. The input on U9 (pin 9) is from the pulse width adjust (PW adjust) and will be described later. For now, assume U9 (pin 9) is always low.

During the off state, U9 (pin 8) is always high which produces a low on U9 (pin 10). This is then inverted by U8 and its high is applied to the

output J1 (pin 1) via 2 non-inverting buffers and a non-inverting 'totem pole'. As soon as section B \bar{Q} goes low, the output at J1 (pin 1) goes low. This turns on the Ø1 output transistors of the RF amplifier. In the same manner, Ø2 output transistors are turned on by a low on U9 (pin 13). Because the rising and falling edges of the drive pulses at the gate of the output transistors are not as fast as the logic's rising and falling edges, the output transistor can overlap. In other words, Ø1 and Ø2 output transistors can be on at the same time. To insure that an overlap of Ø1 and Ø2 does not occur, a PW adjust circuit is used to reduce the on time of both Ø1 and Ø2, adjusted by R35. The 1MHz clock is applied to a RC time constant made up of resistor R35 and capacitor C38 from U39 (pin 10). Depending on the resistance of R35, the rate of increase in voltage applied to U8 (pin 13) will vary. If the RC time constant is long enough, the voltage at U8 (pin 13) will never reach the threshold level, thus never causing U8 (pin 12) to go low. U34 (pin 9) is always high. As a result, U34 (pin 8 and 10) act as an inverter. This then takes the high signal from U8 (pin 12) and applies a low signal at U9 (pin 9). At the end of the 1MHz positive cycle, the voltage that has been built up on capacitor C38 is discharged quickly through diode D37. If the RF time constant is short enough, the voltage across C38 will cross the threshold level and cause U8 (pin 12) to low. This, in turn, causes a high to be applied to U9 (pin 9) which

shortens the pulse at U9 (pin 10). The amount that the pulse at U9 (pin 10) can be varied is between .5 usec to 1 usec on time depending on the value on the RC time constant.

The $\bar{\theta}1$ signal on J1 (pin 2) is used to reset the drive transformer on A4 (RF driver PCB). When θ at J1 (pin 1) is low then U10 (pin 1) is also low via U8 (pin 4). This forces U10 (pin 3) to go high. Since U10 (pin 5 and 6) are high, then U10 (pin 4) goes low. This low is then applied to U9 (pin 6) and U10 (pin 2). The low signal at U10 (pin 2) ensures that U10 (pin 3) stays high until a change occurs at J1 (pin 1) θ output. The low signal on U9 (pin 6) enables U9 (pin 4) to go high as soon as the drive signal is turned off. As soon as the drive pulse is turned off, U9 (pin 5) goes low. This causes U9 (pin 4) to go high and because of inverter U8 (pin 6) goes low the low signal applied to $\bar{\theta}$ J1 (pin 2) resets the driver transformer on A4. As soon as J1 (pin 2) goes low, input U10 (pin 6) will also go low, which causes U10 (pin 4) to go high. This will cause J1 (pin 2) to go back high, which will turn off the reset pulse. Since the propagation delay of the logic is used to determine the time that the reset pulse is on only a narrow pulse (typically 100-150 nsec) is used to reset the driver transformer.

The above description occurs for all modes of operation: cut, cutting with hemostasis, pin point coag, bipolar cut and bipolar coag; except spray coag. For spray coag, all of the 2 phase RF logic driver circuit operates the same

except for two differences. Both $\theta1$ and $\theta2$ sections are activated at the same time, and the PW adjust is inoperative.

During spray coag, U75 (pin 3) is high. This high, along with a high spray pulse delivered from the 3-section pulse generation circuit on U39 (pin 8), enables U39 (pin 9) to go high. Also, the high on U75 (pin 3) produces a low at U40 (pin 4). This disables the PW adjust circuit via U39 (pin 11), and enables u12 (pin 6) to go high when a low is delivered from the 3-section pulse generation circuit on U12 (pin 5). With a high on U12 (pin 8), U12 (pin 1 and 2) are normally low, a high is produced on both U11 (pin 4 and 12). With a high applied to U39 (pin 2) and applied to U39 (pin 8) pulse from the 3-section pulse generation circuit a high is applied to U11 (pins 7 and 9) and a low is applied to U11 (pins 4 and 12). This will turn on (low signal) both $\theta1$ and $\theta2$ at J1 (pin 1 and 15) respectively. When a low pulse is delivered from the 3-section pulse generation circuit, a high is applied to U11 (pins 4 and 12) and a low is applied to U11 (pins 7 and 9). This will turn off (high signal) both $\theta1$ and $\theta2$ at J1 (pin 1 and 15) respectively. At the end of the on pulse, $\theta1$ and $\theta2$ will deliver a 100-150 nsec pulse to reset the driver transformer (A4) in the same manner as described above.

To ensure that the connector hooked to A5J11 (RF output PCB) is properly mated, a connection between J11 (pin 1 and 2) on A5 is made. If the connector is in properly, then J1 (pin 7) is connected to ground via J1 (pin

7), A5J11 (pin 1), A5J11 (pin 2) J1 (pin 8) and then to ground. This will apply a low at U12 (pin 1), which will allow ϕ_1 and ϕ_2 to operate properly in all modes as described above. If the connector is not properly installed, J1 (pin 7) is not connected to ground and is pulled high through resistor R71. This will apply a high to U12 pin 1), forcing ϕ_1 and ϕ_2 to not operate in any modes until the connector is installed properly

Configuration Relays

Transistor Q113 and Q110 provide drive for the configuration relays which selects the proper RF amplifier configuration and output transformer. When spray coagulation is selected, Q113, provides drive to relays K3, K5 and K8 on the RF output PCB, A5. When these relay coils are energized, their contact points set up the RF amplifier to a single-ended stacked configuration and selects the monopolar fulguration transformer. When in any other mode, the configuration relays (K3, K5 and K8) contact points are set for the full bridge amplifier configuration. Should the operator select bipolar cutting or coagulation, transistor Q110 will engage relay K9, hence, select the bipolar output transformer.

G. RF Driver - A4 (DWG 50-0076) Fig. 5-21

The RF driver consists of a low power push-pull amplifier used to drive the power MOS-FET's in the RF amplifier. Since the RF amplifier operates identically with the ϕ_1 and ϕ_2 system, only one half of the RF driver (ϕ_1) will be described. (Because

ϕ_1 and ϕ_2 are duplicated circuits in the system, inputs are designated by ϕ and $\bar{\phi}$.) Also duplicated are the inverting totem-pole sections of the RF driver, thus only the 0 operation will be described.

In the rest state, ϕ input on J2 (pin 1) is high. This high causes Q44 to turn on and Q45 to turn off. This applies zero volts (less than .5V) between the gate (G) and the source (S) of Q46, keeping Q46 off. When the RF logic calls for a ϕ_1 to turn on the signal on J2 (pin 1) goes low. This low turns Q44 off and Q45 on. This applies approximately +11V between the gate and the source of Q46, turning it on into its saturation region, thus allowing current to flow through primary winding of T55. This will produce a positive voltage between each pair of output leads, causing all of the ϕ_1 output transistors to turn on.

At the end of the on cycle, the signal at J2 (pin 1) goes high, turning Q44 on, Q45 off and Q46 off. This stops current flow through the primary winding of T55 connected to Q46, allowing the output voltage applied to the output transistor of the RF amplifier to go negative turning the output transistors off. To reset T55, the driver transformer, J2 (pin 2) input goes low immediately after J2 (pin 1) goes high for approximately 100-150 nano seconds. In the same manner as ϕ , Q40 turns on causing current to flow through the primary winding of T55 in the opposite direction when Q46 turned on. This short $\bar{\phi}$ pulse is required to force the negative going edge that is driving the output

transistors to go quickly to its negative value. If the $\bar{\theta}$ pulse is too short (less than 50 nano seconds), or does not occur, then the effect can be seen in coag (worst case). The negative edge of drive waveform at the gate, with reference to the source, of the output transistor will look like the waveform shown in Figure 5-20A page 5-42. Since the negative going edge is very slow, then severe overlapping of $\theta 1$ and $\theta 2$ output transistor can occur, causing damage to the output transistors. If the $\theta 1$ pulse is too long (greater than 250 nano seconds), a resultant coag waveform is shown in figure 5-20B. (Note: A similar effect can be seen if there is a gap between the two legs of the drive transformer, T55.) In this case, too much flux is produced in the transformer during the $\bar{\theta}$ on time, causing the voltage to go positive after the three pulses are delivered to the output transistors. If the voltage above ground is greater than +2 volts, both $\theta 1$ and $\theta 2$ output transistors can turn on at the same time, causing damage to the output transistor.

For comparison, figure 5-20C shows a typical coag drive waveform applied to the gate of the output transistors.

H. RF Amplifier (DGW 50-0068) Fig. 5-25

The RF amplifier incorporates the high power output transistors and transformers to provide the final stage of amplification in the generator. The power transistors can be connected in two distinct RF amplifier configurations:

1. Full bridge configuration used in monopolar cutting, blend (cut/hemo), pin point coagulation, bipolar cutting and bipolar coagulation.
2. Single-ended stacked configuration used in spray coagulation.

Both amplifier configurations use common drive circuits and DC source voltage.

To gain a more comprehensive understanding of the RF amplifier, its input and output circuitry is illustrated in a composite schematic diagram in Figure 5-25 page 5-47.

Included are sub-assemblies sections previously discussed A4, A6, A7 and A8, that control the RF amplifier as well as the sub-assemblies to be discussed: A2, A5, A11 and A12 (refer to Interconnect Diagram for A sub-assembly numbers) page 5-24. The composite schematic also depicts the output transformers, filters, configuration relays, high voltage relays and output receptacles in a manner that makes it easy to visualize their operation in the circuit.

With the generator operating in monopolar cut, cut/blend or pin point coag and bipolar modes, the amplifier is configured in the full bridge which requires a $\theta 1$ and $\theta 2$ mode of operation. The $\theta 1$ and the $\theta 2$ sections of the RF amplifier are duplicate circuits, thus all reference designators are the same. To separate which is $\theta 1$ and which is $\theta 2$ (looking from the front of the unit), $\theta 1$ is the circuit mounted on the left heat sink, and $\theta 2$ is the circuit mounted on the right heat sink. On the schematic,

Ø1 is designated by 'L' and Ø2 is designated by 'R'.

At the beginning of the cycle, Ø1 driver will produce a positive voltage on pin 5 with respect to pin 4 and pin 6 with respect to pin 3 of the transformer A4T55L. This positive voltage will turn on their associated output transistors. The actual operation of all four legs of the amplifier are identical, thus only the operation of the upper leg of Ø1 will be described.

Since the power MOS-FET's operate in a voltage mode, a positive voltage applied between gate and source of Q1L and Q6L will turn both transistors on into their saturation region (assuming a positive voltage of over 10V is applied). Zener diodes A11D2L and A11D3L, 11DK7L and A11D8L provide over voltage protection for the gate and source junctions of the output transistors (refer to Figure 5-22 page 5-44, Power Device for gate and source locations). Ferrite Beads A11L4L and A11L9L are used to dampen any high frequency oscillation in the drive, which may occur in a parallel MOS-FET configuration. A11D5L is a 275 volt "Trans Zorb" (a very fast zener diode) used to clamp any voltage spikes that might damage the transistors during the off time of the power MOS-FET's. Diode A5D12 and A5D7 are used to force any 'fly back' current caused by the output transformer or the output filter to route around the power MOS-FET's.

Since the generator is operating in the monopolar

mode, Ø1 output transistors are turned on first, causing current to flow in the following manner: A6 +HV, A5J4, through relay A5K3, A5J10-1, A11P1-1L, through both Q1L and Q6L, A11P1-2L, A5J10-2, A5D12, through relays A5K8 through primary of transformer A5T29 and A5K8, A5J10-3, A11P1-3L, transistors Q10L and Q15L, A11P1-4L, A5J10-4, diode A5D11 and back to -H.V. via A5J5 and A6 -H.V. Current will continue to flow as long as the voltage applied to all of the Ø1 output transistors stays above their threshold level. As soon as Ø1 turns off, Ø2 will turn on causing current to flow in the same manner as Ø1 except through the Ø2 path (designated by 'R' at the end of the reference designators). The only difference between Ø1 and Ø2 is that the Ø2 current will flow through the primary of transformer A5T29 in the opposite direction as it did with Ø1. Since the output transistors operate as a class 'D' amplifier (transistors switched into their saturated region), the voltage across the primary of transformer A5T29 is a squarewave with a peak value of 2 times the DC power supply voltage.

This squarewave voltage is coupled through transformer A5T29 and is applied to the 500KHz bandpass filter. The filter converts the squarewave voltage to a sinewave voltage, thus rejecting harmonic current that can produce high amounts of R.F. leakage. After the filter, the sinewave is delivered to P.C. board, A12, via connections between A5J7 and A12 MONO, and J5J6 and A12 MOPP. Since the unit is being operated in the monopolar mode,

2 relays, A12K2 and A12K6, are closed allowing the sinewave voltage to be applied through the balance transformer A12T1 to the front panel output jack. The operator chooses the monopolar output mode by keying the handcontrol or the footswitch. If the operator keys the monopolar mode with the footswitch, then a low signal is provided at A7J4-7 (HVMO) and A7J4-10 (HVFS). This action closes the high voltage relays, A12K2, A12K4 and A12K6, allowing the 500KHz sinewave voltage to be applied to the output of the generator at jacks FS and P/P.

Because of the action of the high voltage relays, only the jack that is being called for will be hot (output power available). The balance transformer A12T1 maintains a constant difference ratio between active and return current to greatly reduce the RF leakage through alternate paths.

In the case that either bipolar cut or coag is being activated, a low signal is applied to A8J1-13, causing relay A5K9 to close (opens contacts between A5K9, (pins 5 and 6) and closes contacts between A5K9 (pins 6 and 7). All other portions of the amplifier remain the same, thus instead of the squarewave voltage being applied to the primary of monopolar output transformer A5T29, the voltage is applied to the primary of bipolar output transformer A5T10. This voltage is coupled through transformer A5T10 and applied to secondary of A5T10.

Since bipolar has only a series bandpass filter, the 'Q' of the

filter is dependent on the load that the bipolar is operating into. If the impedance between the two bipolar output jacks (both designated by BP) is very low (10 ohm or less) the voltage becomes sinusoidal. As the impedance becomes higher and higher, the 'Q' of the filter goes down, thus causing the voltage applied to the output jacks to become a squarewave voltage.

In the case that the generator is activated in monopolar coag with the spray type coag selected, the amplifier changes its configuration from a full bridge to a single-ended type amplifier. (Configuration reverts back to a full bridge when spray coagulation is deactivated). When spray coag is keyed, a low is applied to A8J1-14, causing relays A5K3, A5K5 and A5K8 to close. By closing these relays, the output transistors are configured so that the four legs of the full bridge amplifier are now electrically on top of each other, forming the transistors into a four high, two deep type single-ended amplifier. With the amplifier operating in a single-ended mode, both O1 and O2 occur simultaneously. (This is achieved by the R.F. logic circuit, A8, not shown.) In this case, both $\phi 1$ and $\phi 2$ output transistors are turned on at the same time causing current to flow in the following manner: A6 +H.V., A5J4 through relay A5K3, A5J1, A2J7, diodes A2D4 and A2D5, through primary of fulguration transformer A2T2, A2J8, A5J2, through relay A5K3, A5J10-1, A11P1-1L, through both transistors Q1L and Q6L, A11P1-2L, A5J10-2, A5D12,

A5J3-3, A11P1-3R, through both transistors Q10R and Q15R, A11P1-4R, A5J3-4, diode A5D24, through both sections of relay A5K5, A5J3-1, A11P1-1R, through both transistors Q1R and Q6R, A11P1-2R, A5J3-2, diode A5D25, A5J10-3, A11P1-3L, through both transistors Q10L and Q15L, A11P1-4L, A5J10-4, diode A5D11 and back to -H.V. via A5J5 to A5 -H.V. Current continues to flow as long as both Ø1 and Ø2 drivers remain high. During this on time, the current causes a field to be produced in the primary of monopolar fulguration transformer A2T2. When the power MOS-FET's turn off, the field in the primary, A2T2, collapses and the resultant current charges capacitors A2C6, A2C7 and A2C8. The primary of transformer A2T2 and the capacitors A2C6, A2C7 and A2C8, form a parallel resonant tank, which results in an exponentially decaying sinewave, oscillating at approximately 400KHz, which is coupled through transformer A2T2 to its secondary. As the load on the output of the generator becomes heavier, more of the energy is dumped into the load, thus reducing the 'Q' of the parallel tank. From the secondary of A2T2 the voltage is applied to A12 via capacitors A2C1 and A2C3, A2-6 and A2-5, A12 FLPP, and A12 FULG, respectively. The R.F. current automatically flows to the proper front panel jacks, when the operator chooses monopolar spray operation with the handcontrol or footcontrol. If spray is activated by the footswitch, a low is applied to A7J4-10 and A7J4-5 closing relays A12K1, A12K4 and A12K5. Keying the handcontrol activates A12K3 via A7J4-9.

I. Sensor Board - A1 (DWG 50-0079) Fig. 5-29

The sensor board provides five (5) independent channels of isolated contact sensing. Four (4) are incorporated for generator handcontrol activating accessories. The fifth is used for the dispersive electrode (patient plate) return and cord fault monitor circuit.

The input sensing signal is referenced to the RF voltages produced by the generator due to the nature of 3-wire handcontrols. Upon activation, the sensing circuits produce conventional 15 volt CMOS logic output voltages. These levels are routed to the mode logic circuits, processed and further routed to circuits that eventually activate the generator in the selected mode: BCG, BCT, MCG OR MCT. The four (4) handwitching channels are identical. When no contact closure is sensed from the handcontrol accessory, the transistor oscillator produces a 20KHz signal that charges the 0.1µfd capacitor to 15 volts through a diode and resistor. This capacitor level is switched by the inverter buffer U34, and delivered as a logic low. Activating the handcontrol accessory (contact closure), will inhibit the transistor oscillator and discharge the previously charged 0.1µfd capacitor through its 100K resistor. At a low threshold, the inverter buffer, U34, will switch to its high state signaling a request.

The dispersive electrode (patient plate) sense circuit is designed to insure detection of resistance paths of 150 ohm

or less. During cord fault conditions, the output from the transistor oscillator, Q15, is sensed and squared up by a separate section of the inverter buffer, U34 (pin 1 and 2), which alternately charges capacitor C35 through a short time constant network, but also discharges it through a long time constant network. Correction of the cord fault turns the transistor oscillator, Q15, off, causing the collector to rest at a 15 volt level. The two inversions by U34 (pin 1-4) present the no fault level as a normally high cord fault signal. This signal inputs the mode logic circuit which in turn generates logic signals that turn off the cord fault tone generator, cord fault lamp and deactivates other cord fault monitor circuits permitting use of monopolar modes of operation.

Examination of the interconnect diagram, figure 5-2 page 5-24, shows that the sensor board receives its regulated +15V and ground from the front panel. The four handswitching logic levels are fed back through the front panel to the mode logic for processing. The cord fault (\overline{CF}) signal is gated with the bipolar mode switch on the front panel to become GCF, then routed to the mode logic.

SYSTEM 5000 FUNCTIONAL BLOCK DIAGRAM

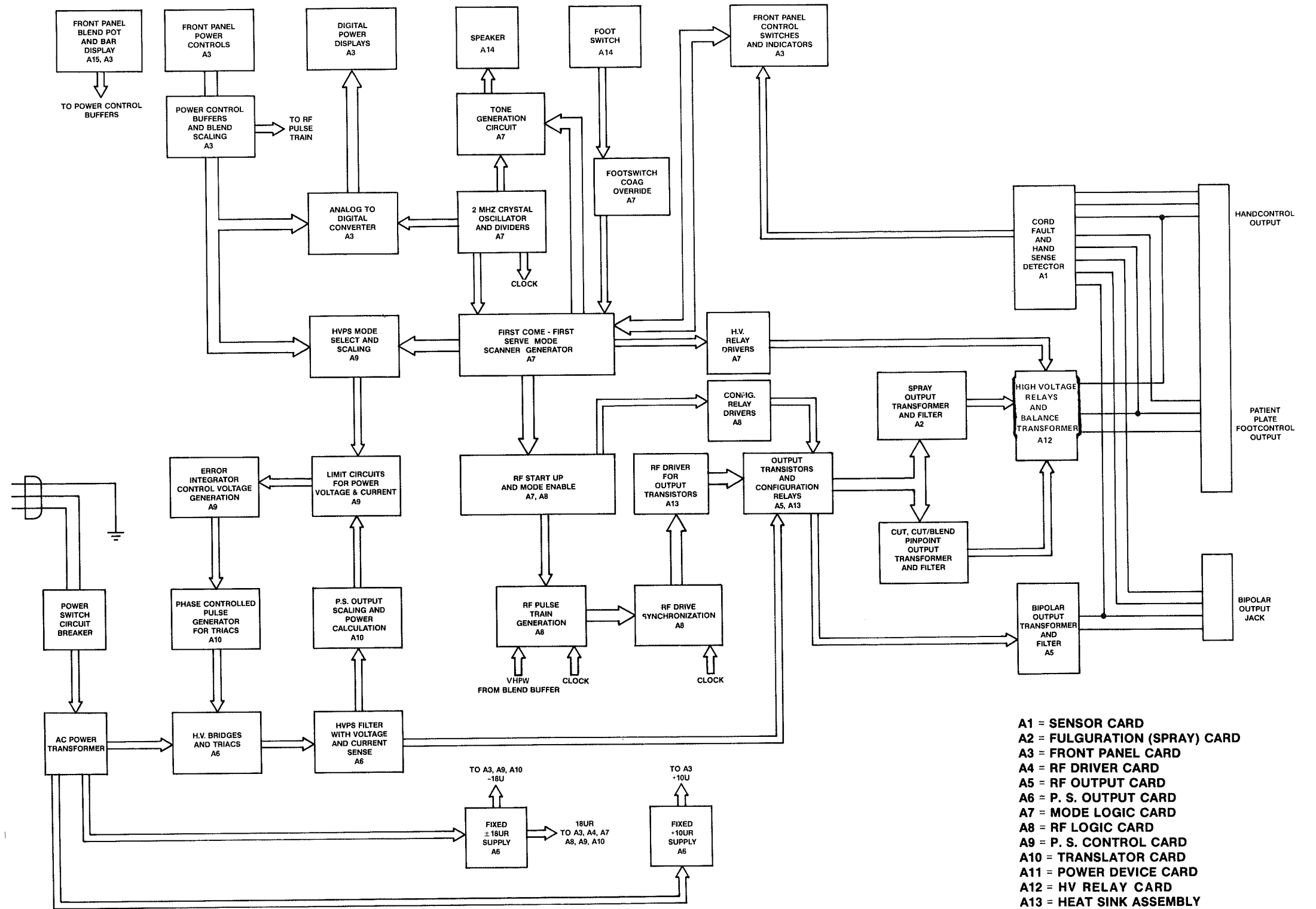


Figure 5-1
System 5000 Power Plus
Functional Block Diagram

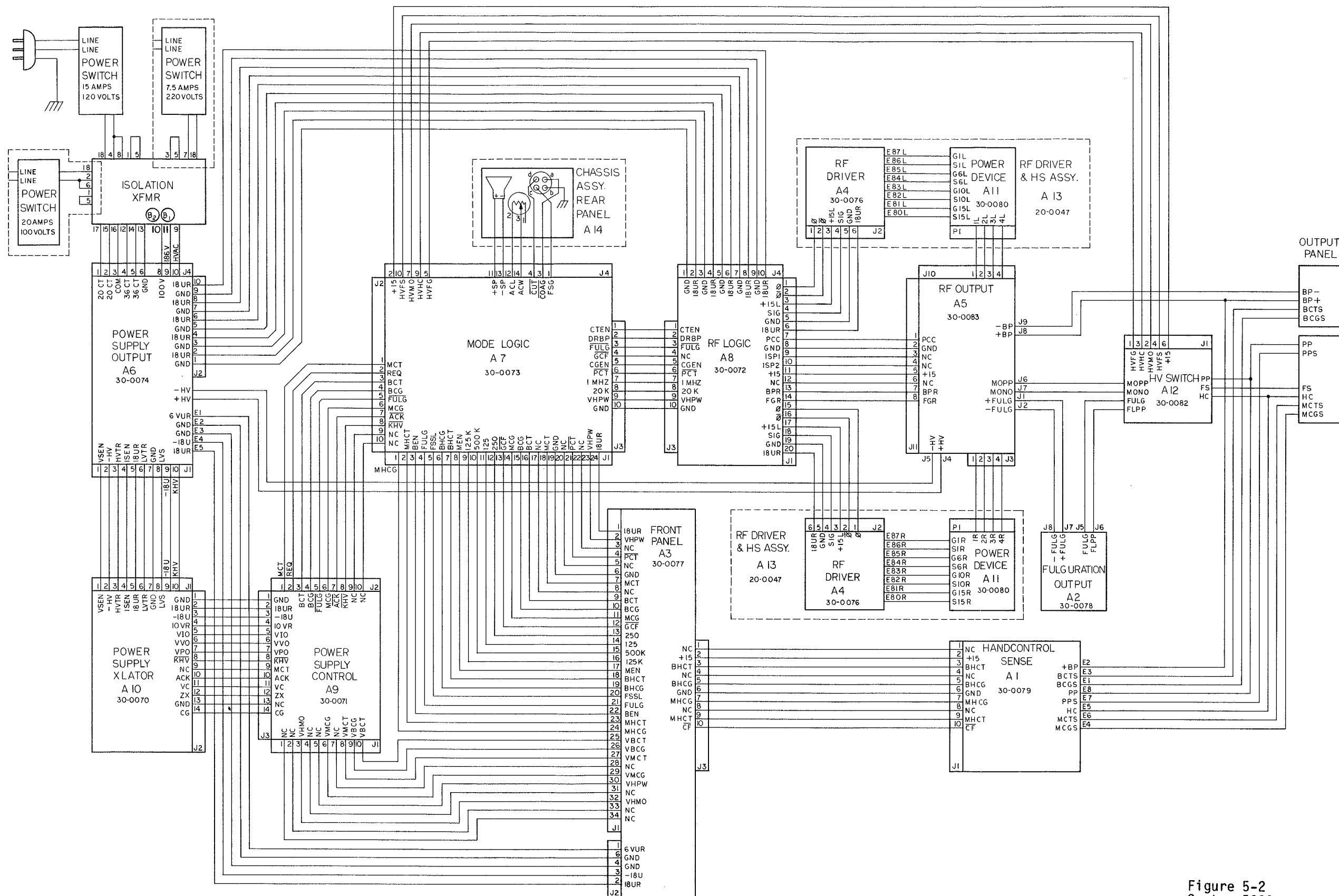


Figure 5-2
System 5000
Interconnect Diagram
DWG. No. 50-0069

SYSTEM 5000 SUB-ASSEMBLY PICTORIAL DIAGRAM

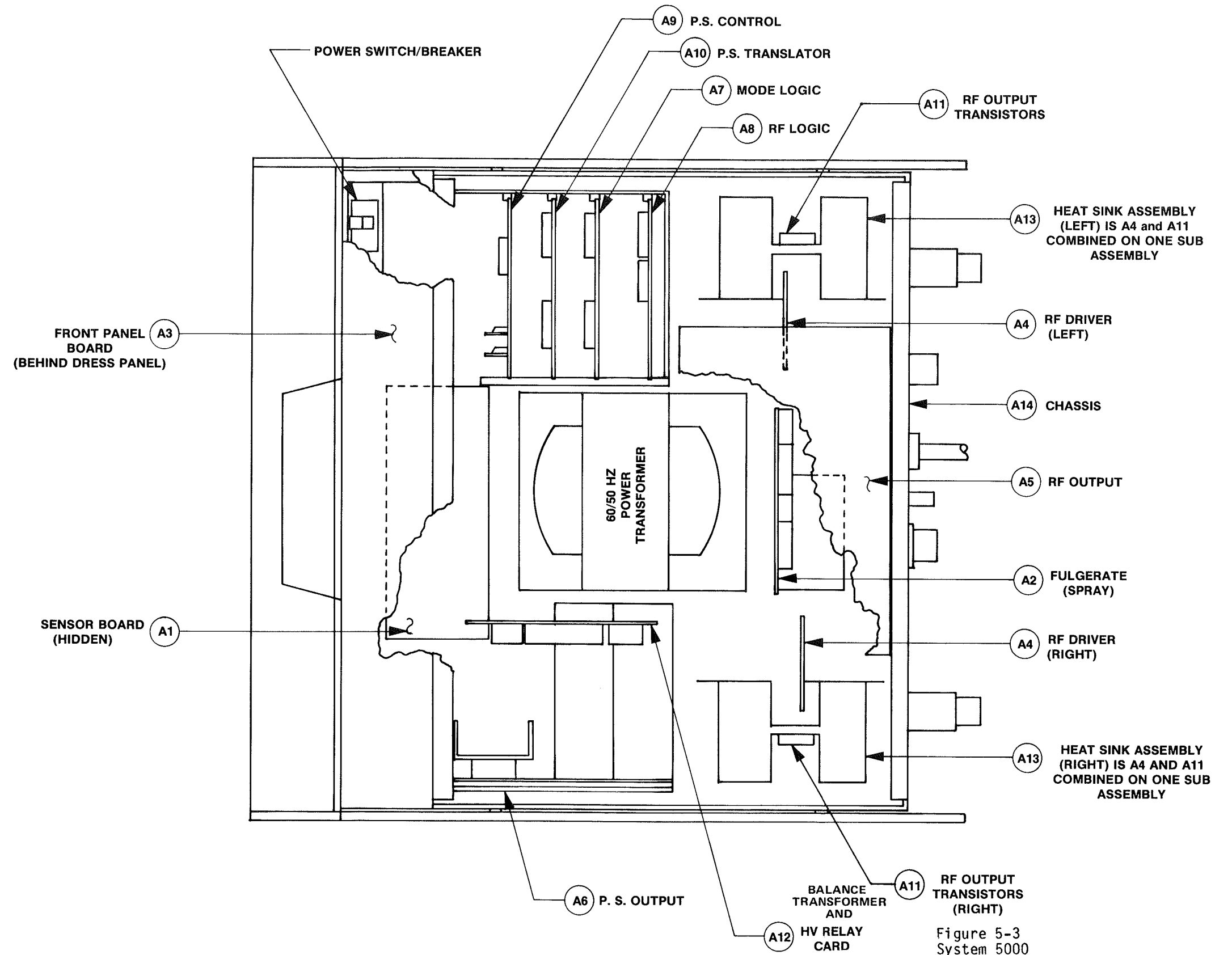


Figure 5-3
System 5000
Sub-Assembly Pictorial Diagram
0 Balance Transformer

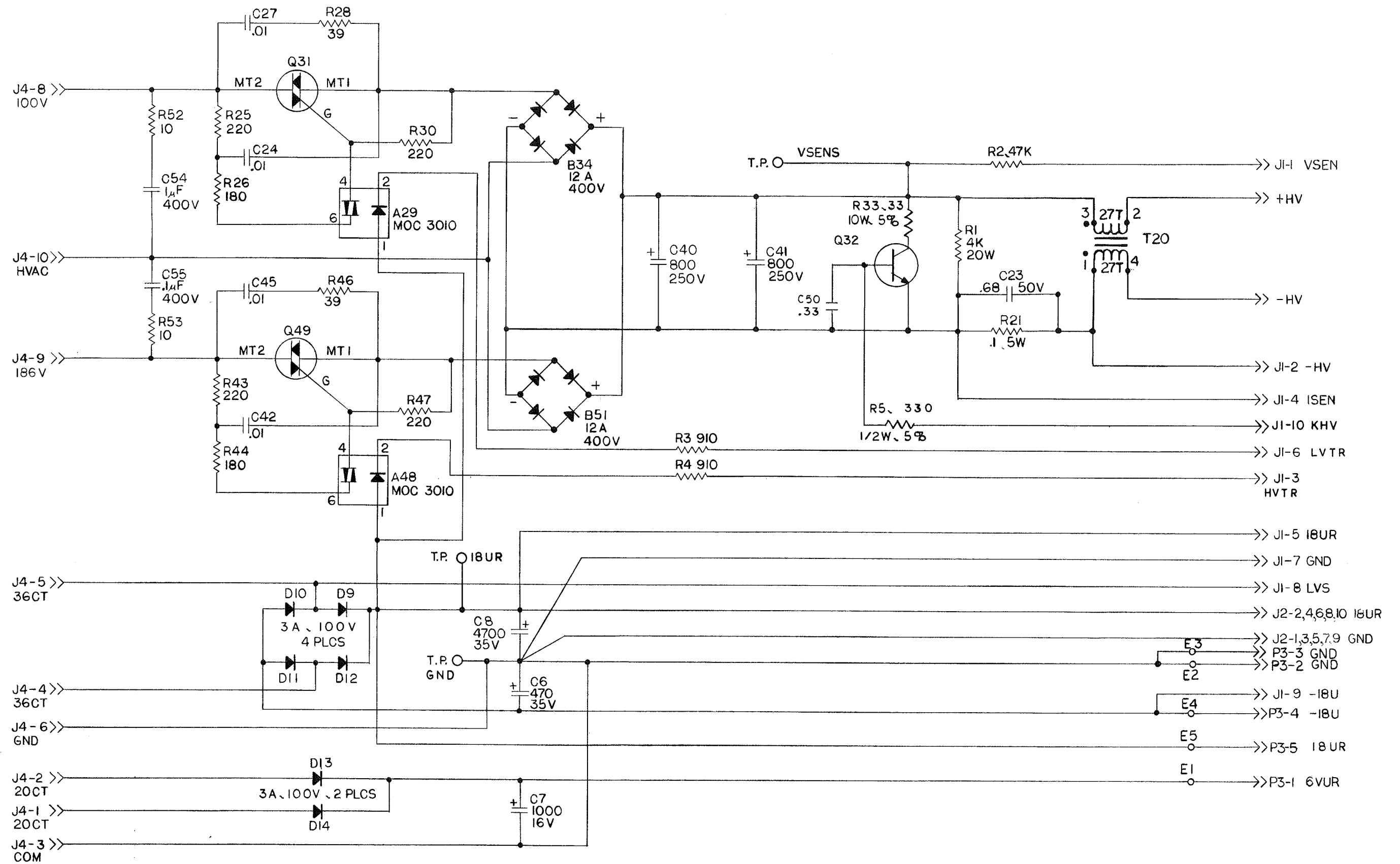


Figure 5-4
Schematic
P.S. Output A6
DWG. No. 50-0074-005

NOTES
1. PORTIONS OF THIS SCHEMATIC IS ALSO CONTROLLED ON THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.

TRANSLATOR BLOCK DIAGRAM 50-0070

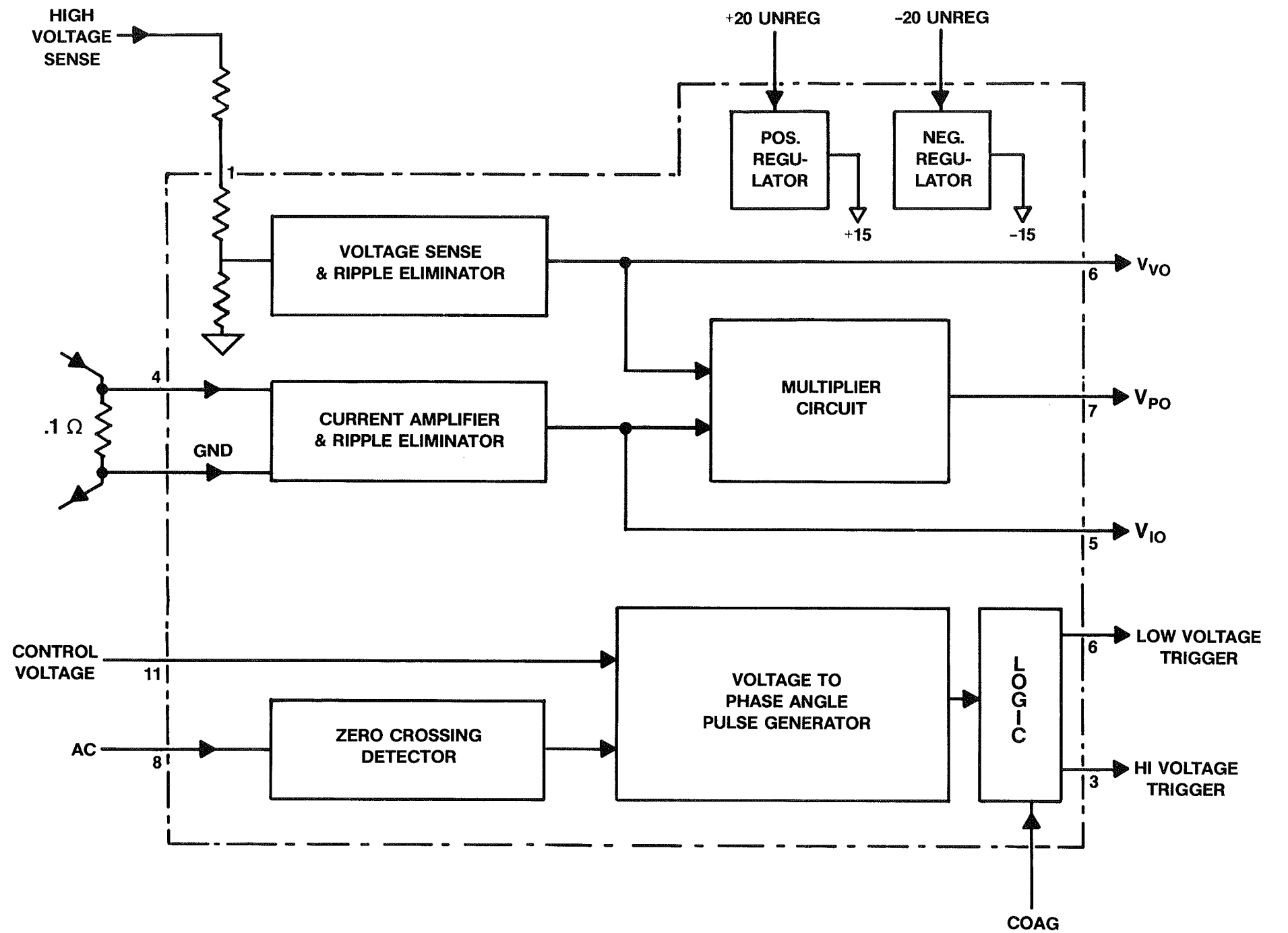


Figure 5-5
Simplified Diagram
P.S. Translator A10

TRANSLATOR TIMING DIAGRAM

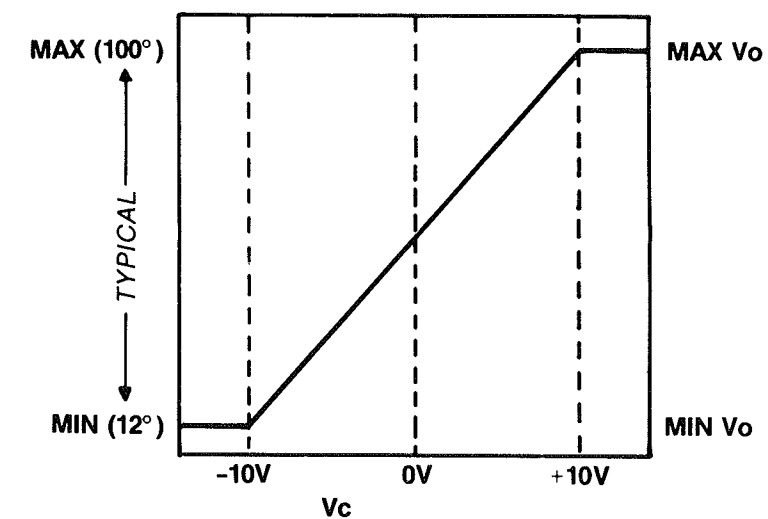
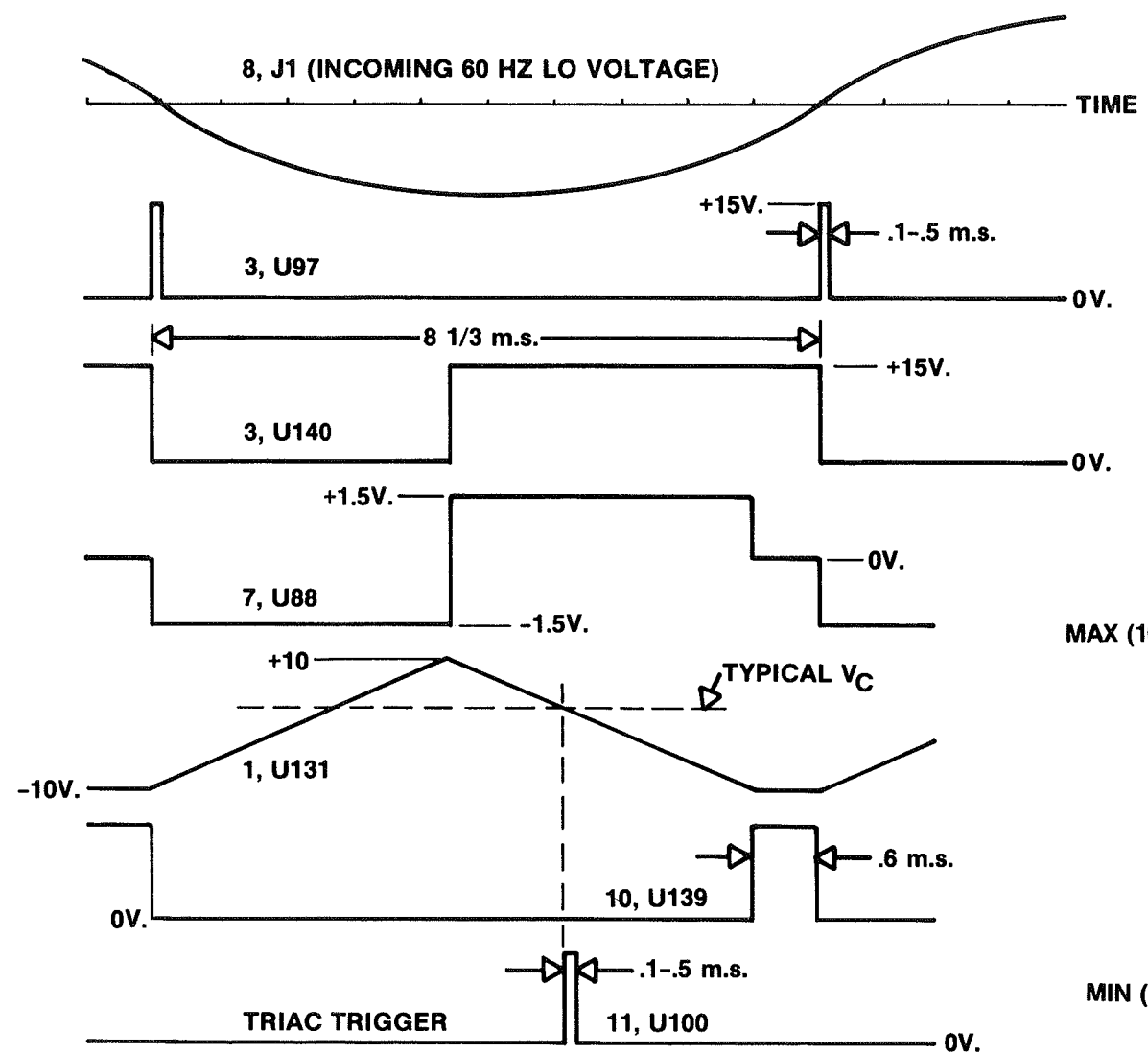


Figure 5-6
Timing Diagram
P.S. Translator A10

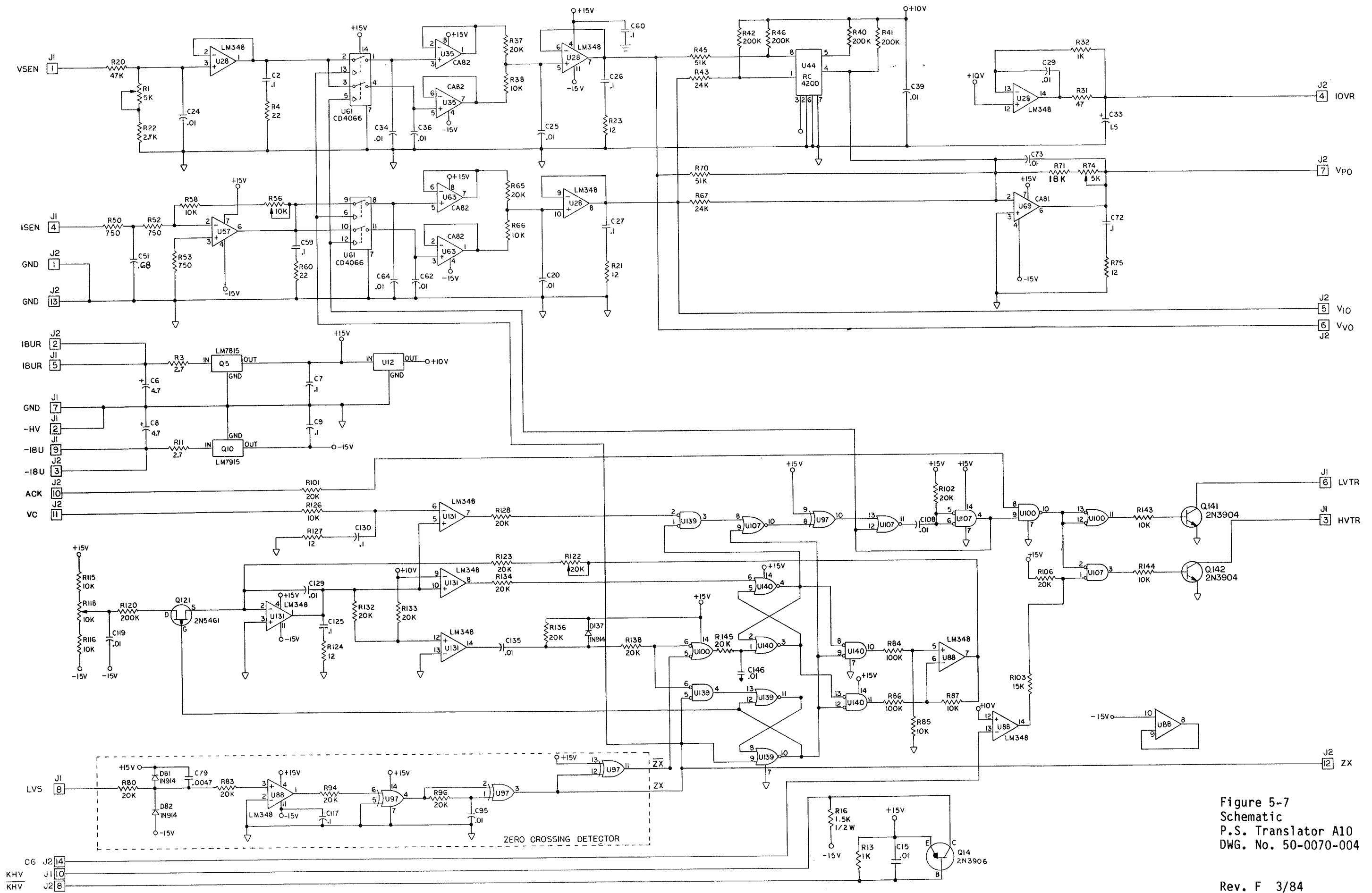


Figure 5-7
Schematic
P.S. Translator A10
DWG. No. 50-0070-004

Rev. F 3/84

CONTROL CARD SIMPLIFIED BLOCK DIAGRAM

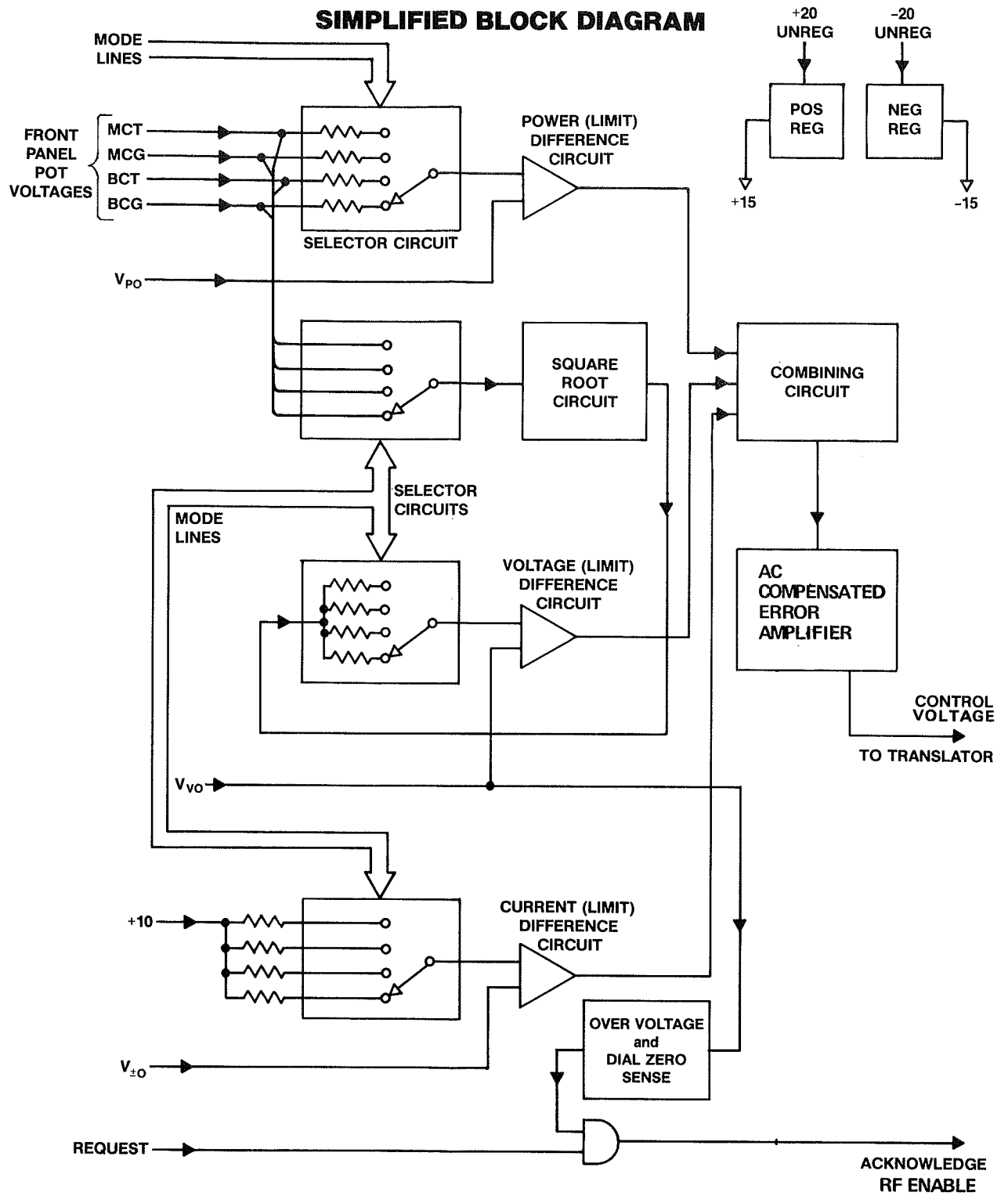
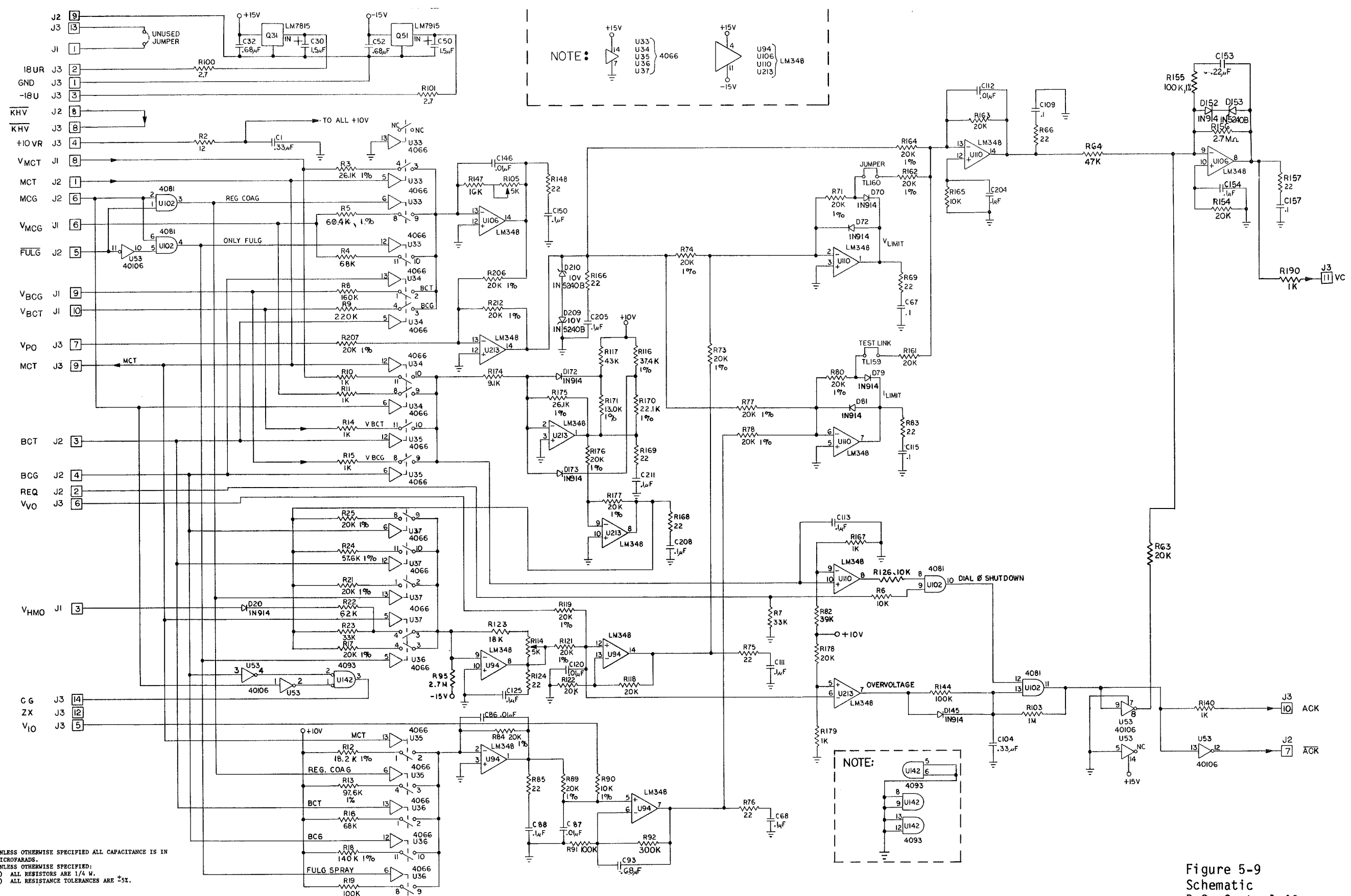


Figure 5-8
Simplified Diagram
P.S. Control A9



2. UNLESS OTHERWISE SPECIFIED ALL CAPACITANCE IS IN MICROFARADS.
 1. UNLESS OTHERWISE SPECIFIED:
 A) ALL RESISTORS ARE 1/4 W.
 B) ALL RESISTANCE TOLERANCES ARE ±5%.

Figure 5-9
 Schematic
 P.S. Control A9
 DWG. No. 50-0097-002

MODE LOGIC BLOCK DIAGRAM

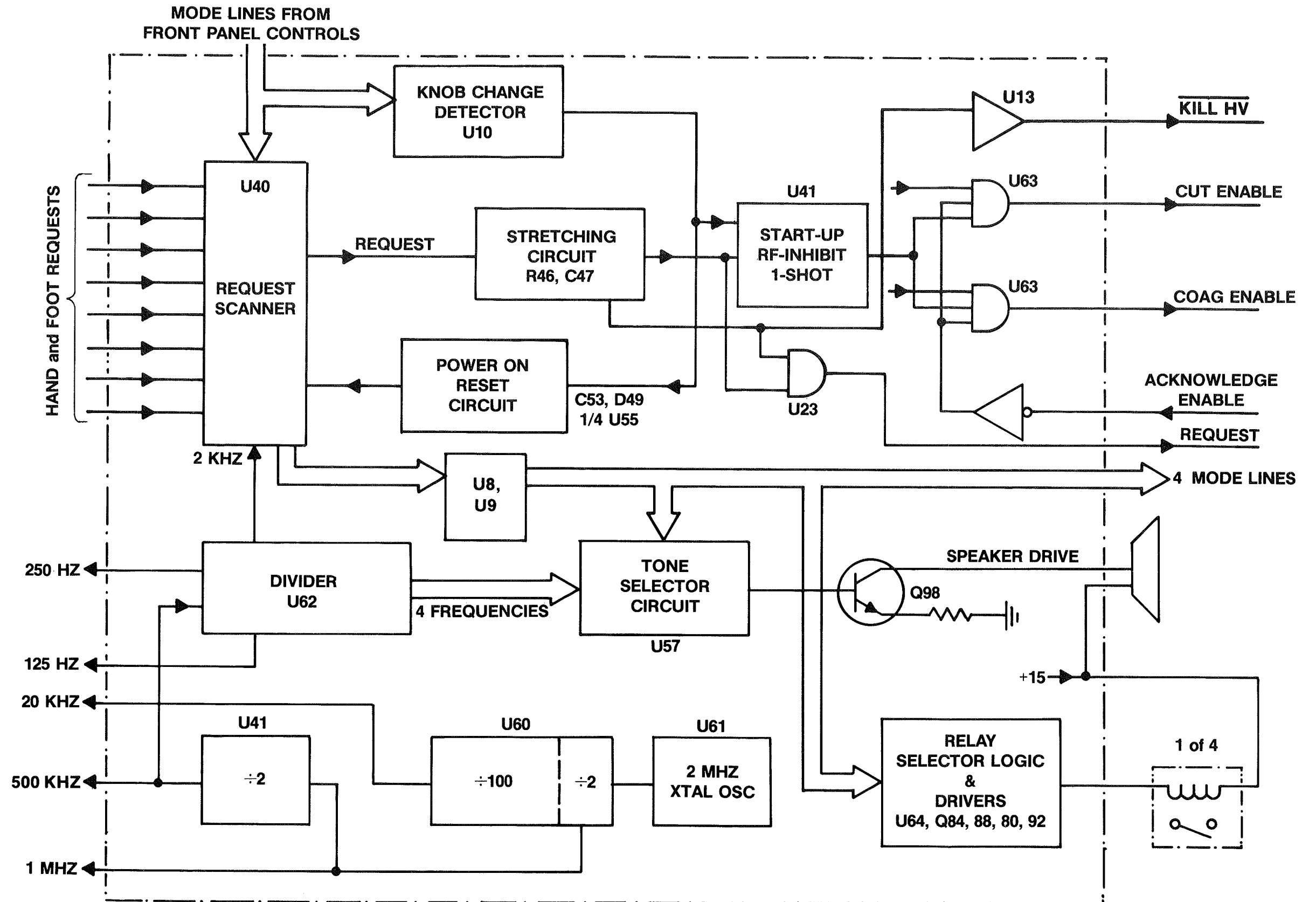


Figure 5-10
Simplified Diagram Mode
Logic A7

TIMING RELATIONSHIPS — MODE LOGIC

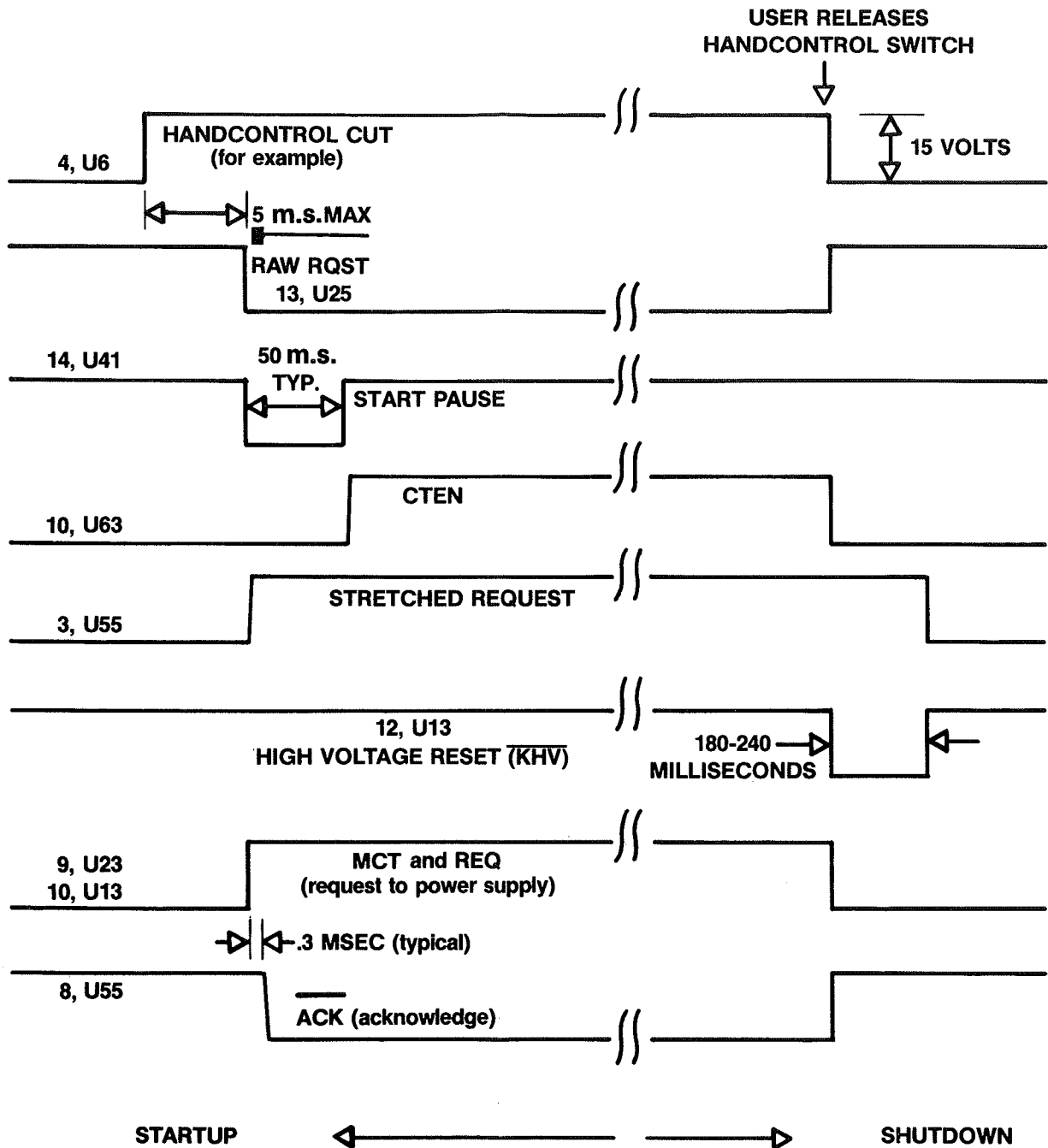


Figure 5-11
Timing Diagram
Mode Logic A7

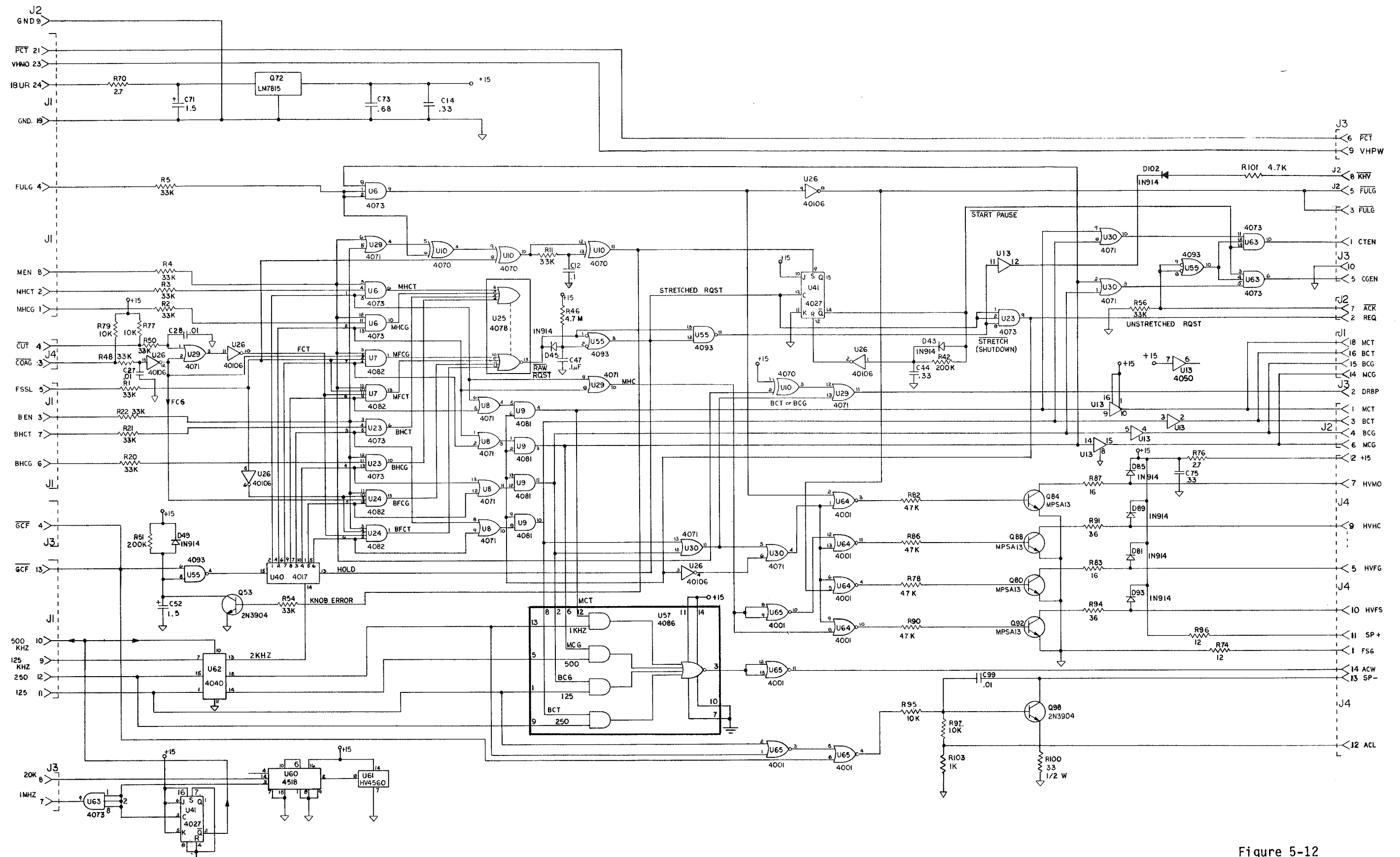


Figure 5-12
 Schematic
 Mode Logic A7
 DWG. No. 50-0073-005
 Rev. F 3/84

FRONT PANEL SIMPLIFIED SCHEMATIC

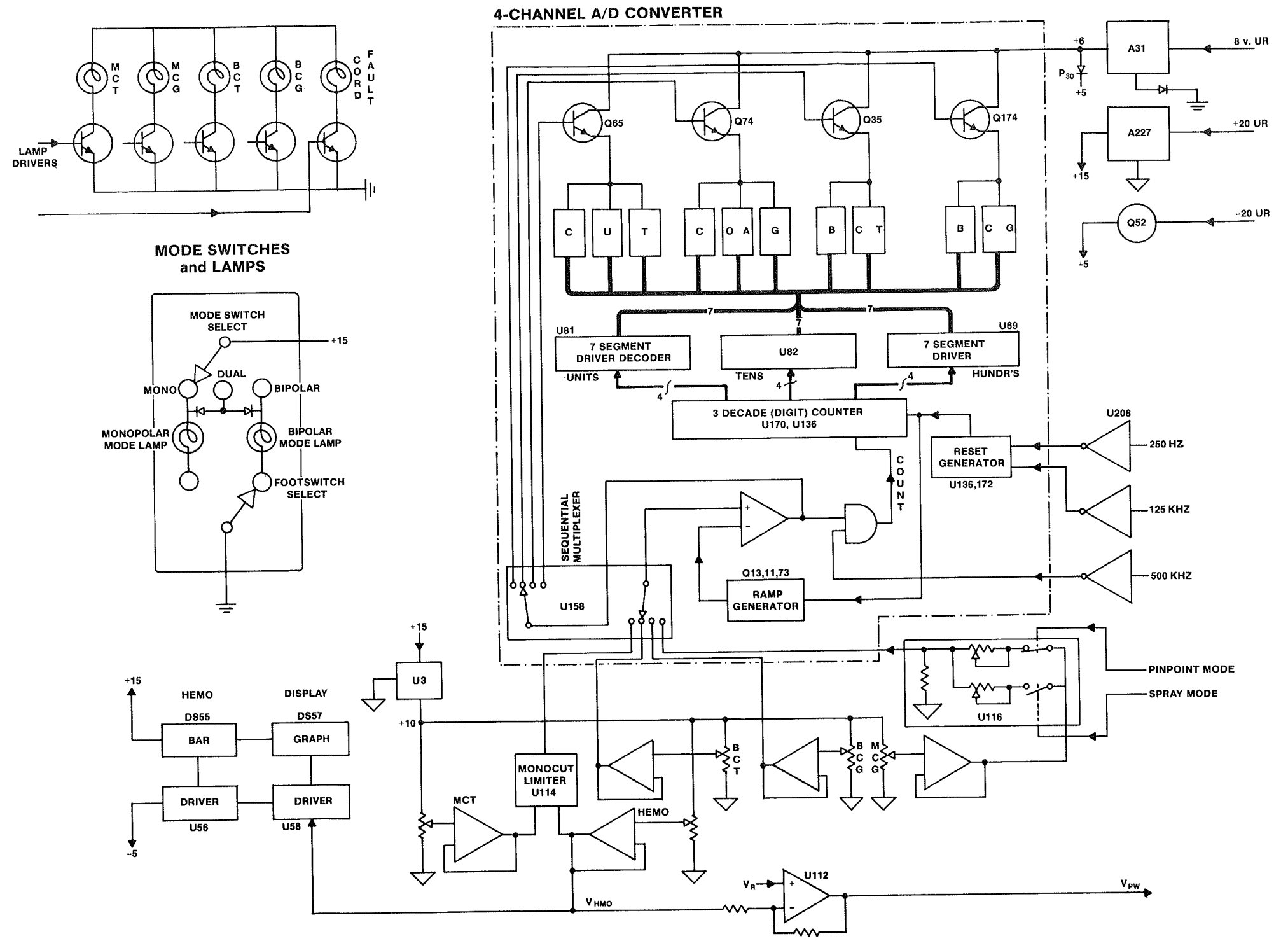
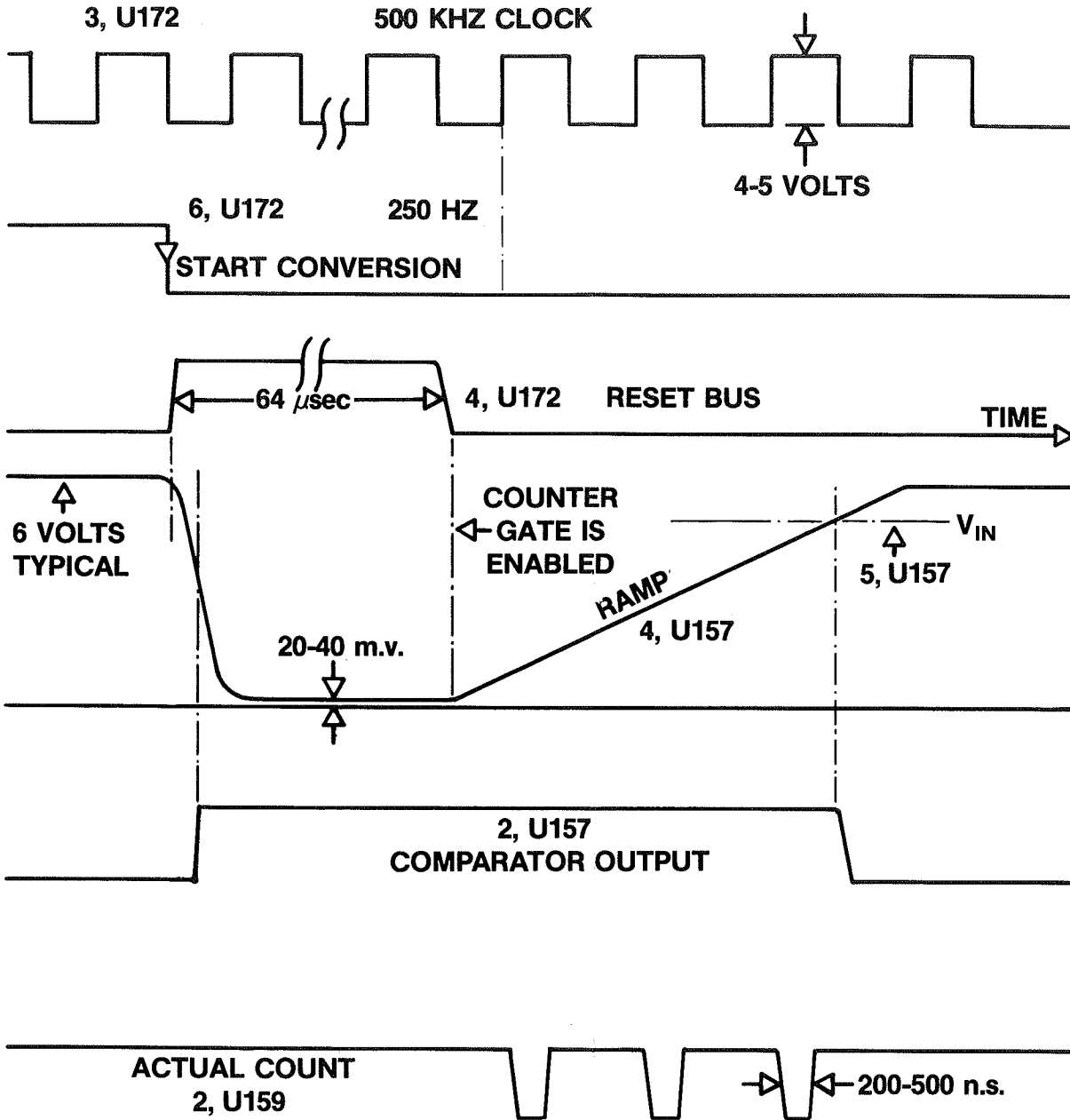


Figure 5-13
Simplified Diagram
Front Panel A3

Rev. B 3/84

FRONT PANEL A/D CONVERTER TIMING RELATIONSHIPS



EXAMPLE SHOWS A CONVERSION FOR A SELECTED INPUT CHANNEL WHOSE VOLTAGE LEVEL PRODUCED A TOTAL COUNT OF THREE.

Figure 5-14
Timing Diagram
Front Panel A3

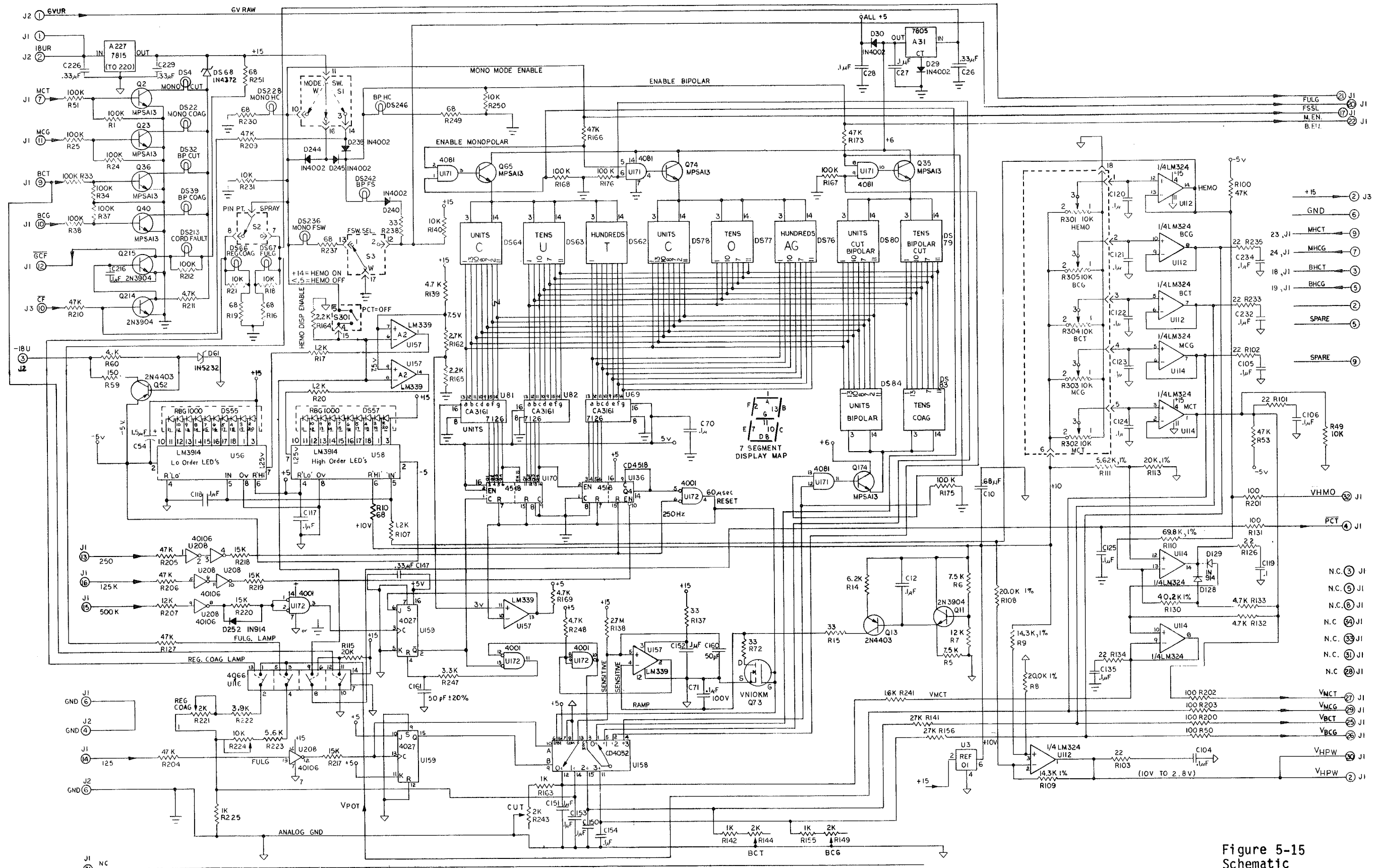


Figure 5-15
Schematic
Front Panel A3
DWG. No. 50-0077-005

BLEND PULSE GENERATION

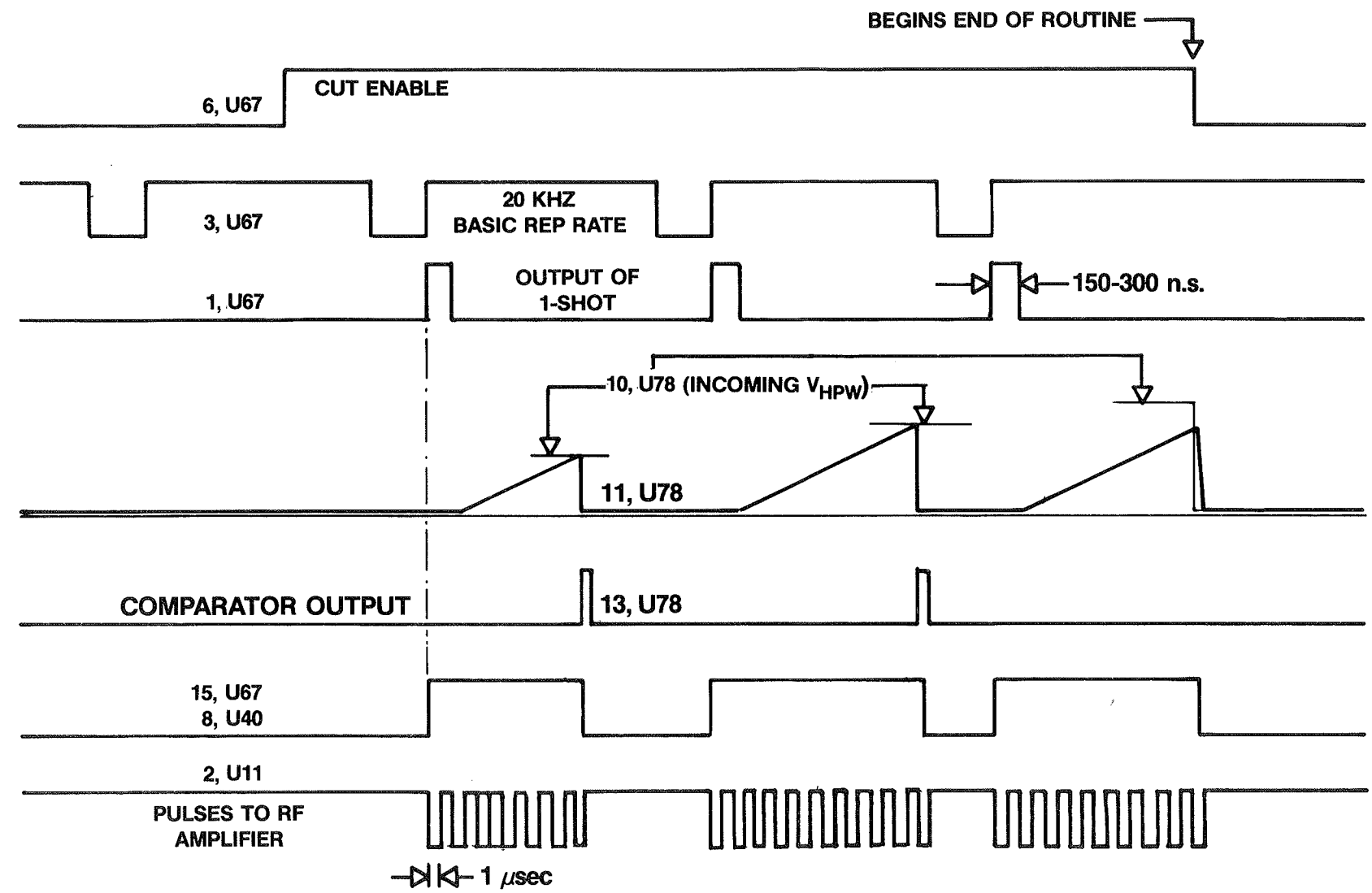
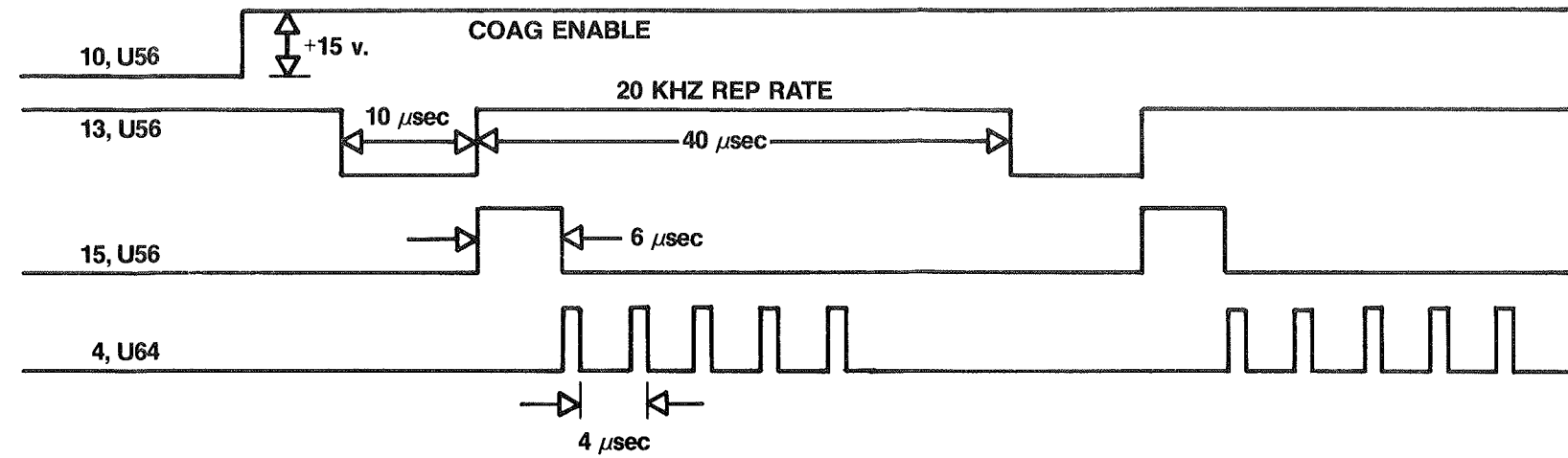


Figure 5-16
Timing Diagram
R.F. Logic A8
Blend Pulse Generation

Rev. B 3/84

COAG PULSE GENERATION



FULGERATE (SPRAY) GENERATION

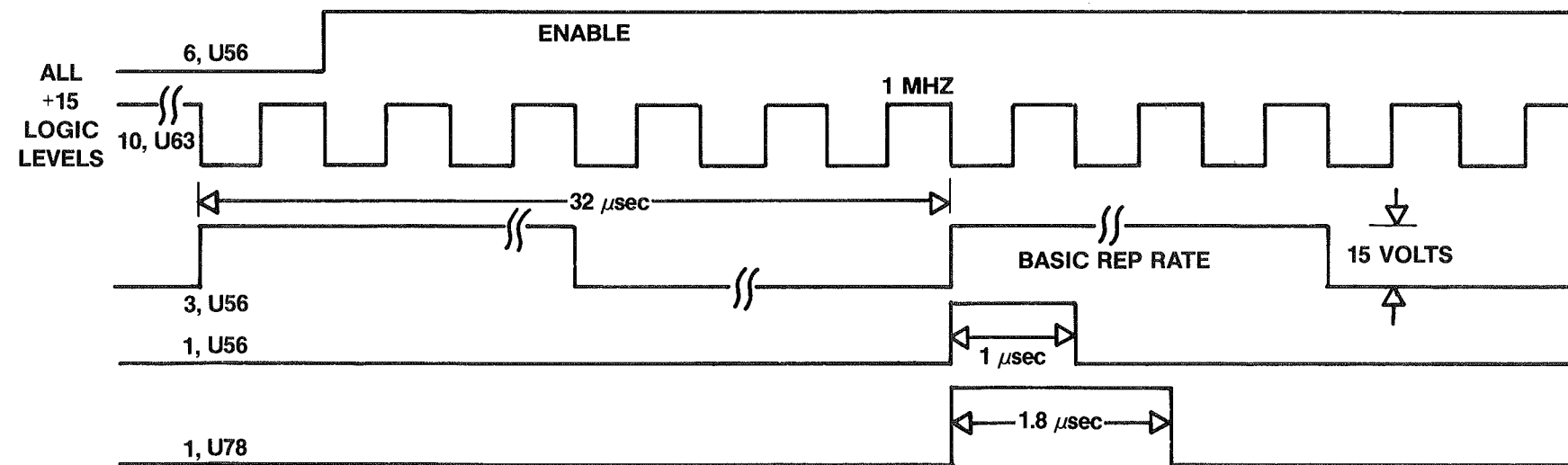


Figure 5-17
Timing Diagram
R.F. Logic A8
Coagulation Pulse Generation
and Fulguration (Spray Generation)

RF LOGIC TIMING PULSES

- Line A) Fulguration output drive pulse on the output of JK Flip-Flop U56 (Pin 1) before pulse stretcher.
- Line B) Output of comparator U78 (Pin 1) for fulguration after pulse stretcher.
- Line C) 6 Microsecond pulses feeding JK Flip-Flop Reset U56 (Pin 12)
- Line D) 6 Microsecond pulse at 20K Hertz rate for COAG out of JK Flip-Flop U56 (Pin 15)
- Line E) $\phi 1$ of \bar{Q} , first Flip-Flop in COAG mode U11 (Pin 2)
- Line F) $\phi 2$ of \bar{Q} , second Flip-Flop in COAG mode U11 (Pin 14)
- Line G) Small pulses of output JK Flip-Flop U67 (Pin 1) to reset cutting with Hemo Flip-Flop.
- Line H) Pure cut waveform out of JK Flip Flop U11 (Pin 2) $\bar{\phi 1}$.
- Line I) Hemo ramp U78 (Pin 11)(50% secondary modulation).
- Line J) Hemo output of JK \bar{Q} U67 (Pin 14) (50% secondary modulation).
- Line K) Hemo output of $\phi 1$ U11 (Pin 2) (50% secondary modulation).

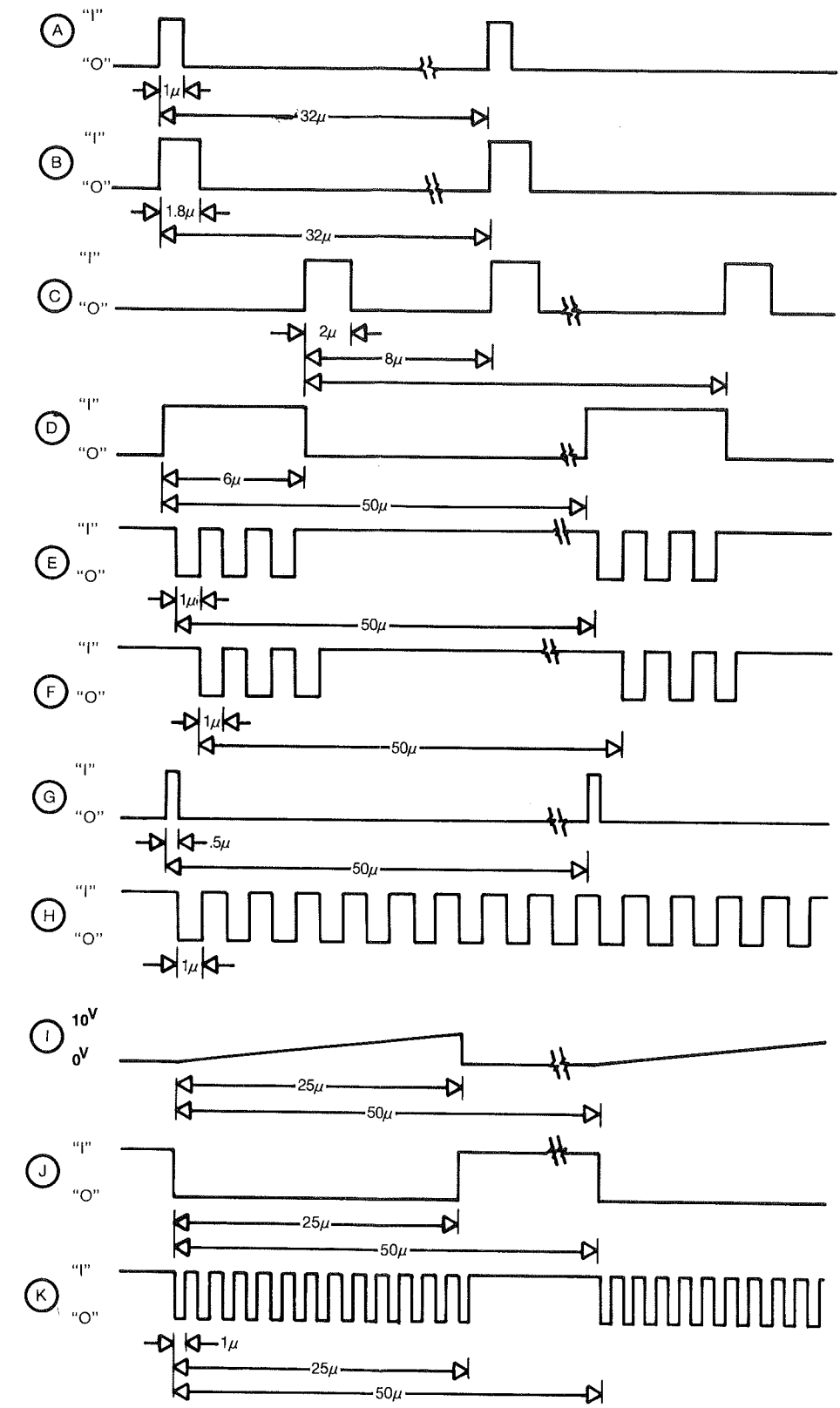
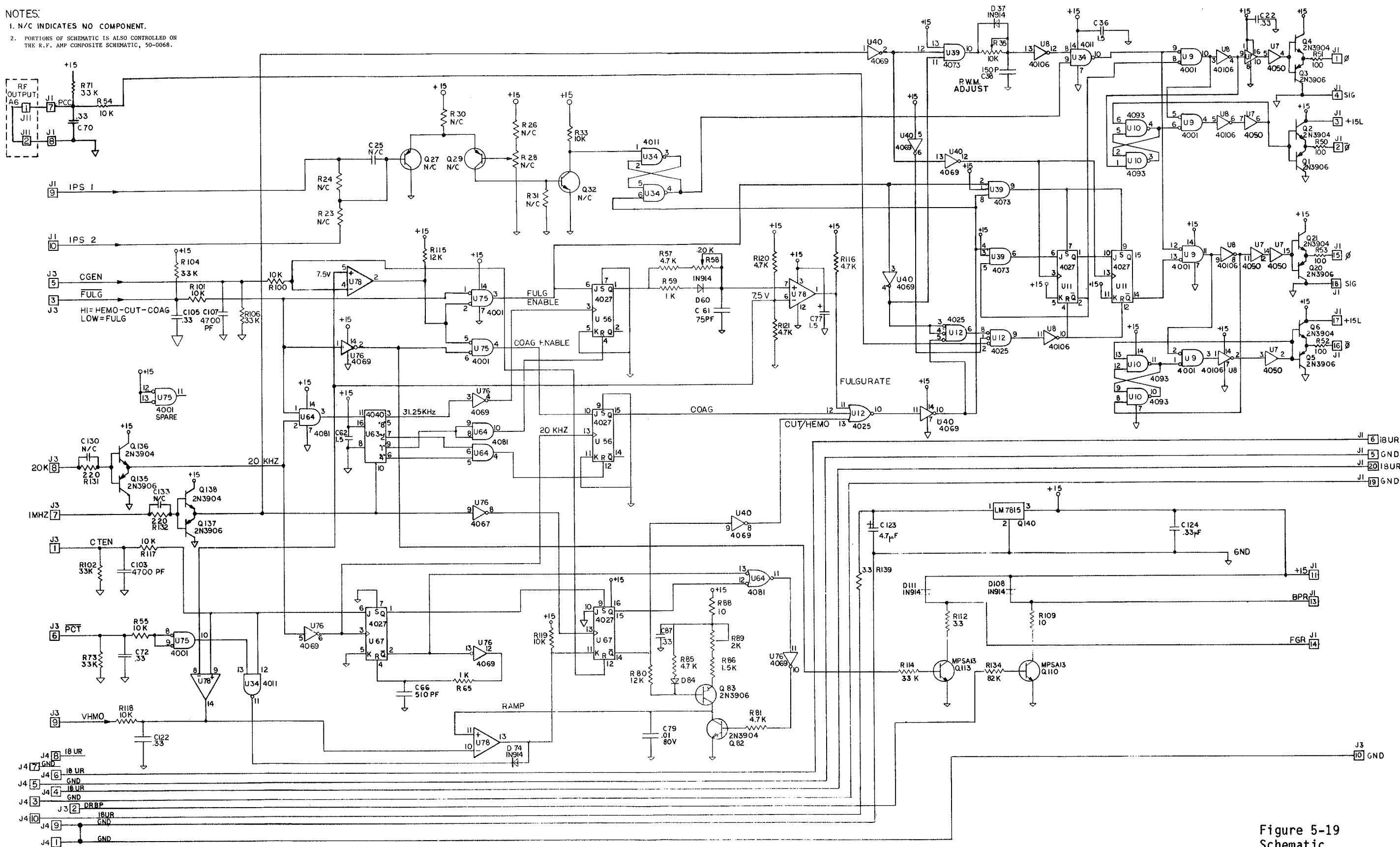


Figure 5-18
Timing Diagram
R.F. Logic A8
Timing Pulses

NOTES:

1. N/C INDICATES NO COMPONENT.
2. PORTIONS OF SCHEMATIC IS ALSO CONTROLLED ON THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.



NOTES

1. N/C INDICATES NO COMPONENT.
2. PORTIONS OF SCHEMATIC IS ALSO CONTROLLED ON THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.

Figure 5-19
Schematic
R.F. Logic A8
DWG. No. 50-0072-004

Rev. F 3/84

COAGULATION PINPOINT DRIVE SIGNALS



FIGURE A

PROBLEM: $\bar{\theta}$ is too short or not working

VERT 5 v/div

HORZ 1 usec/div

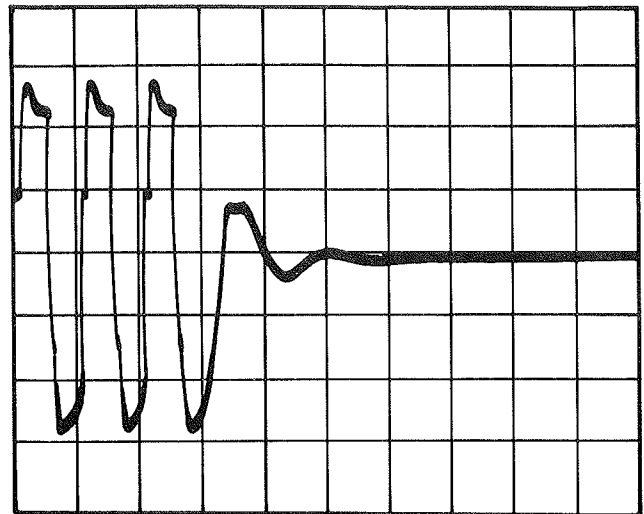


FIGURE B

PROBLEM: $\bar{\theta}$ is too long

VERT 5 v/div

HORZ 2 usec/div



FIGURE C

TYPICAL PINPOINT DRIVE

VERT 5 v/div

HORZ 2 usec/div

Figure 5-20
Timing Diagram
Pin Point Coagulation Drive
R.F. Drive A4

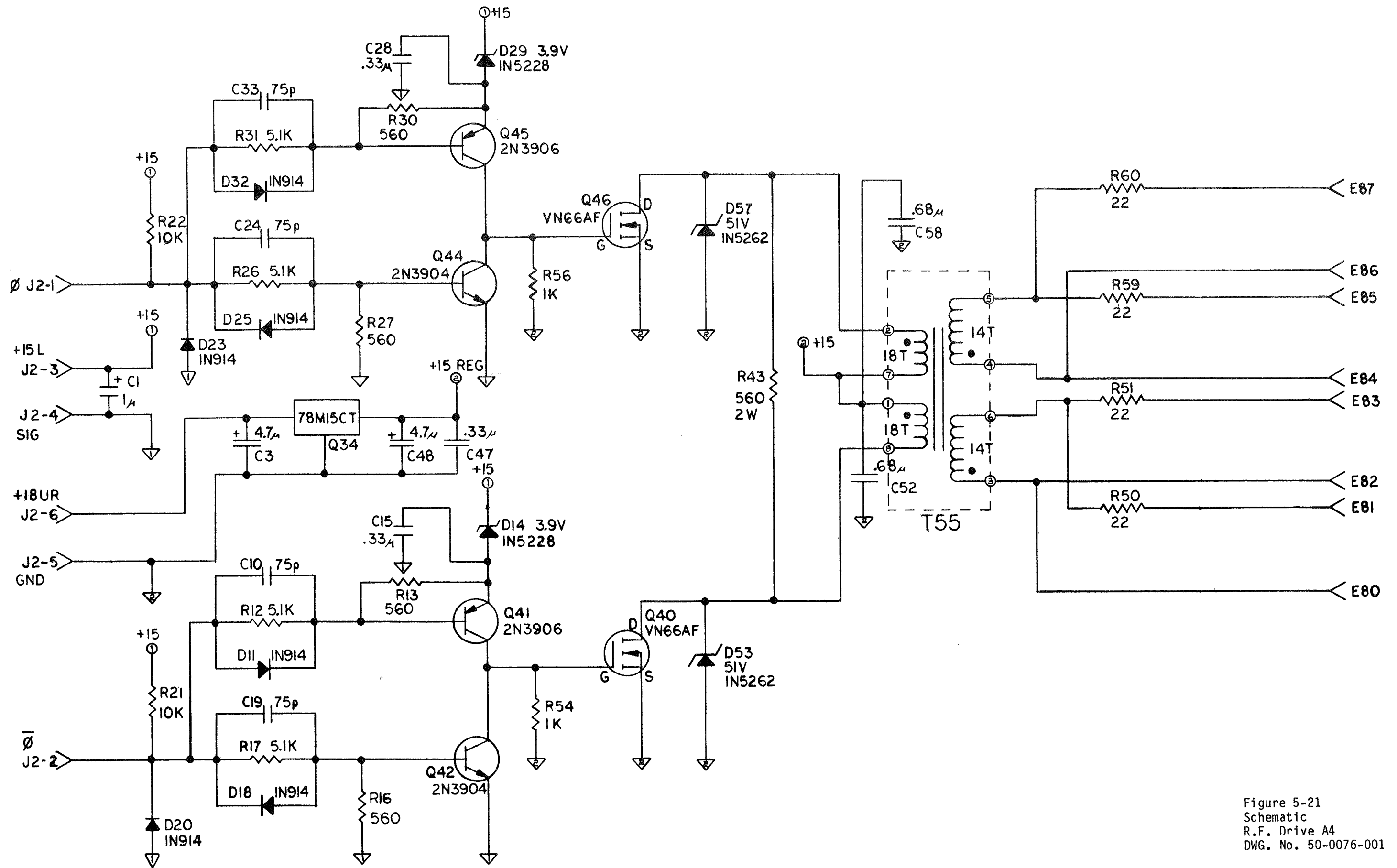
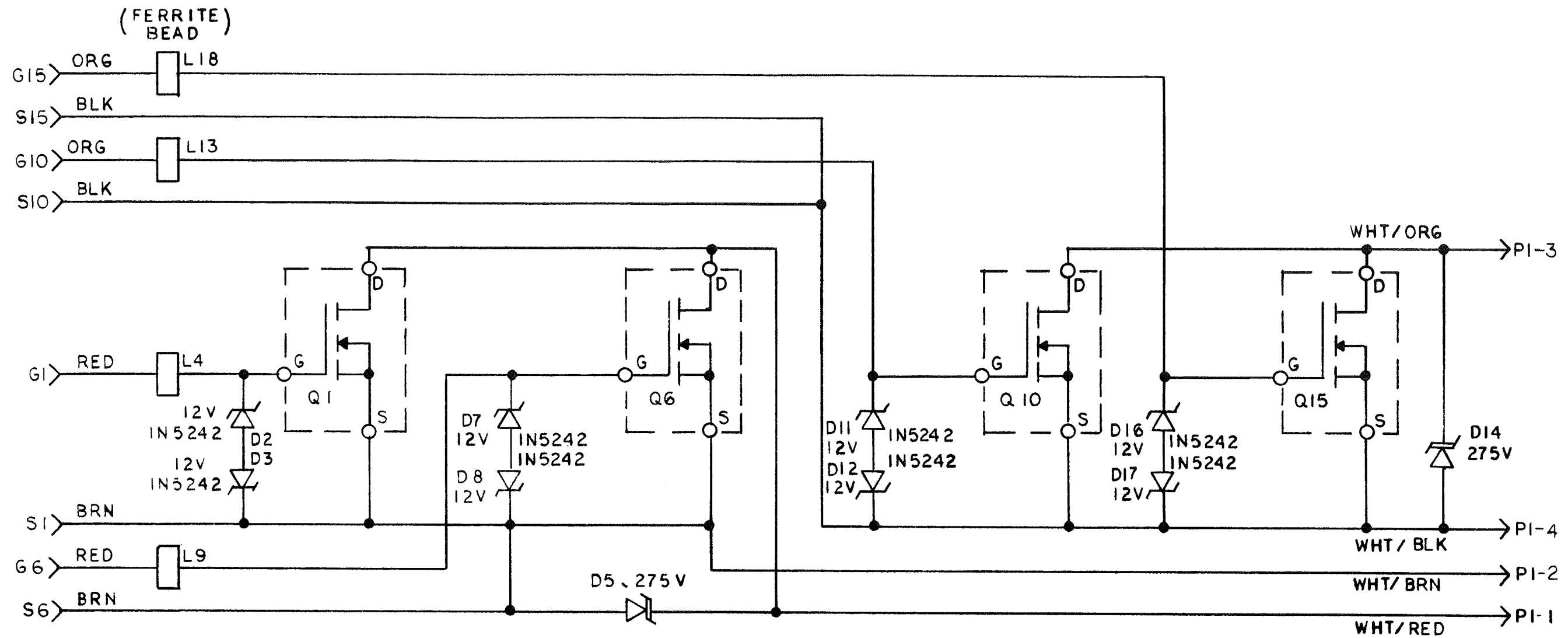


Figure 5-21
Schematic
R.F. Drive A4
DWG. No. 50-0076-001

Rev. B 3/84

NOTES
1. PORTIONS OF THIS SCHEMATIC IS ALSO CONTROLLED
ON THE R. F. COMPOSITE SCHEMATIC, 50-0068.

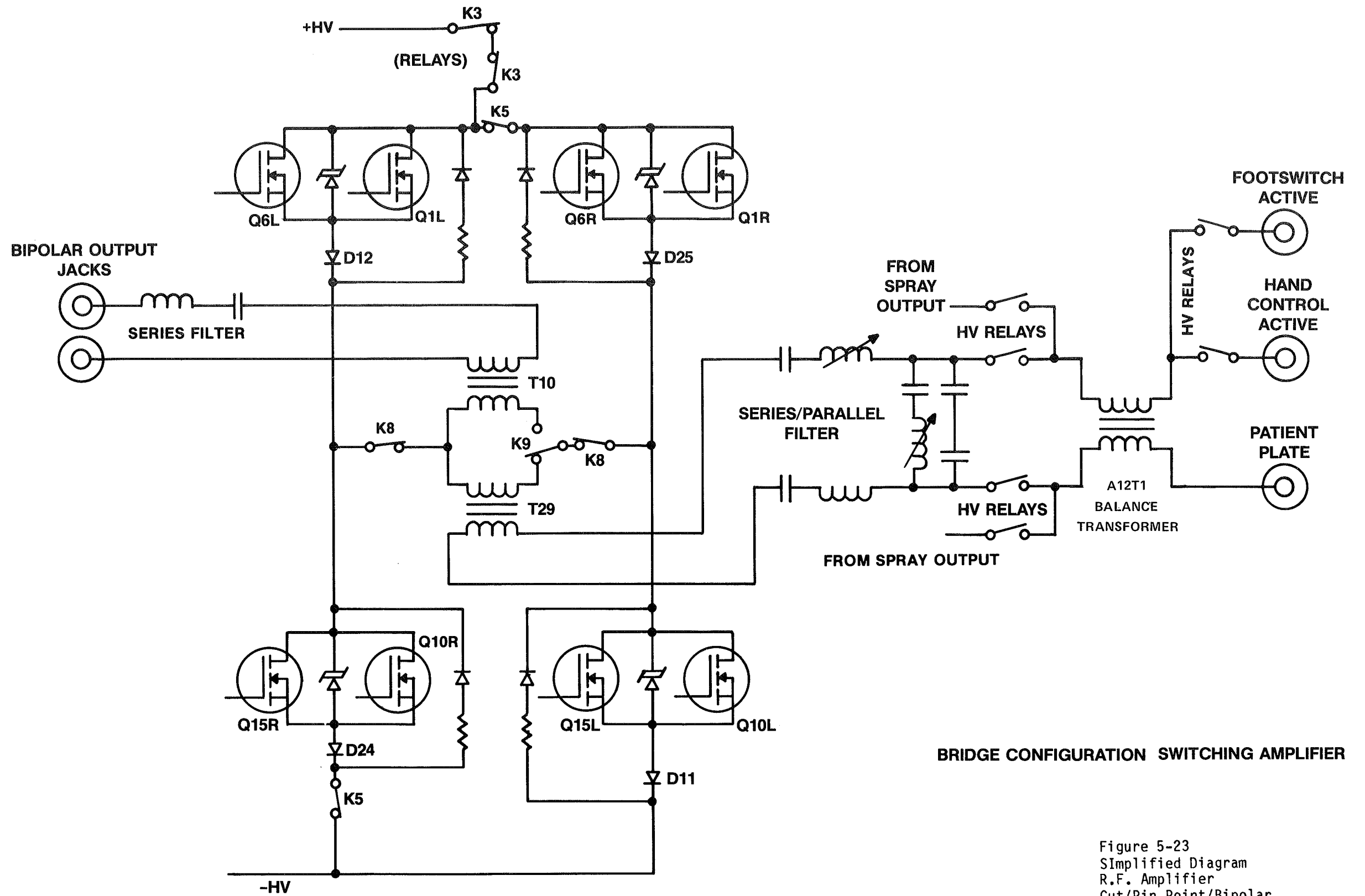


NOTES: 1. THIS SCHEMATIC IS ALSO CONTROLLED ON THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.

Figure 5-22
Schematic
Power Device A11
DWG. No. 50-0080-001

Rev. B 3/84

RF AMPLIFIER — CUT/PIN-POINT



BRIDGE CONFIGURATION SWITCHING AMPLIFIER

Figure 5-23
Simplified Diagram
R.F. Amplifier
Cut/Pin Point/Bipolar
Coagulation Configuration

Rev. B 3/84

RF AMPLIFIER – SPRAY CONFIGURATION

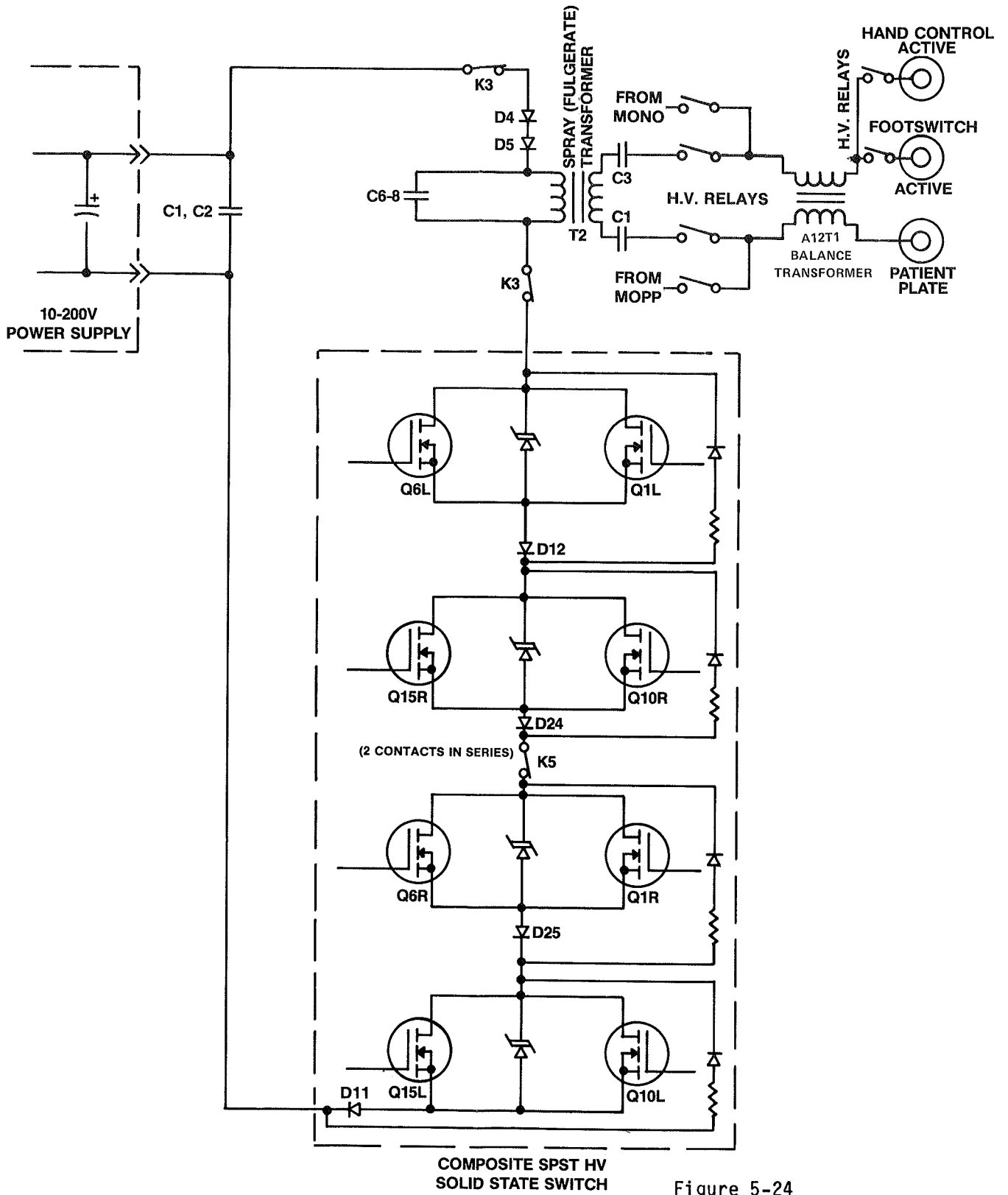
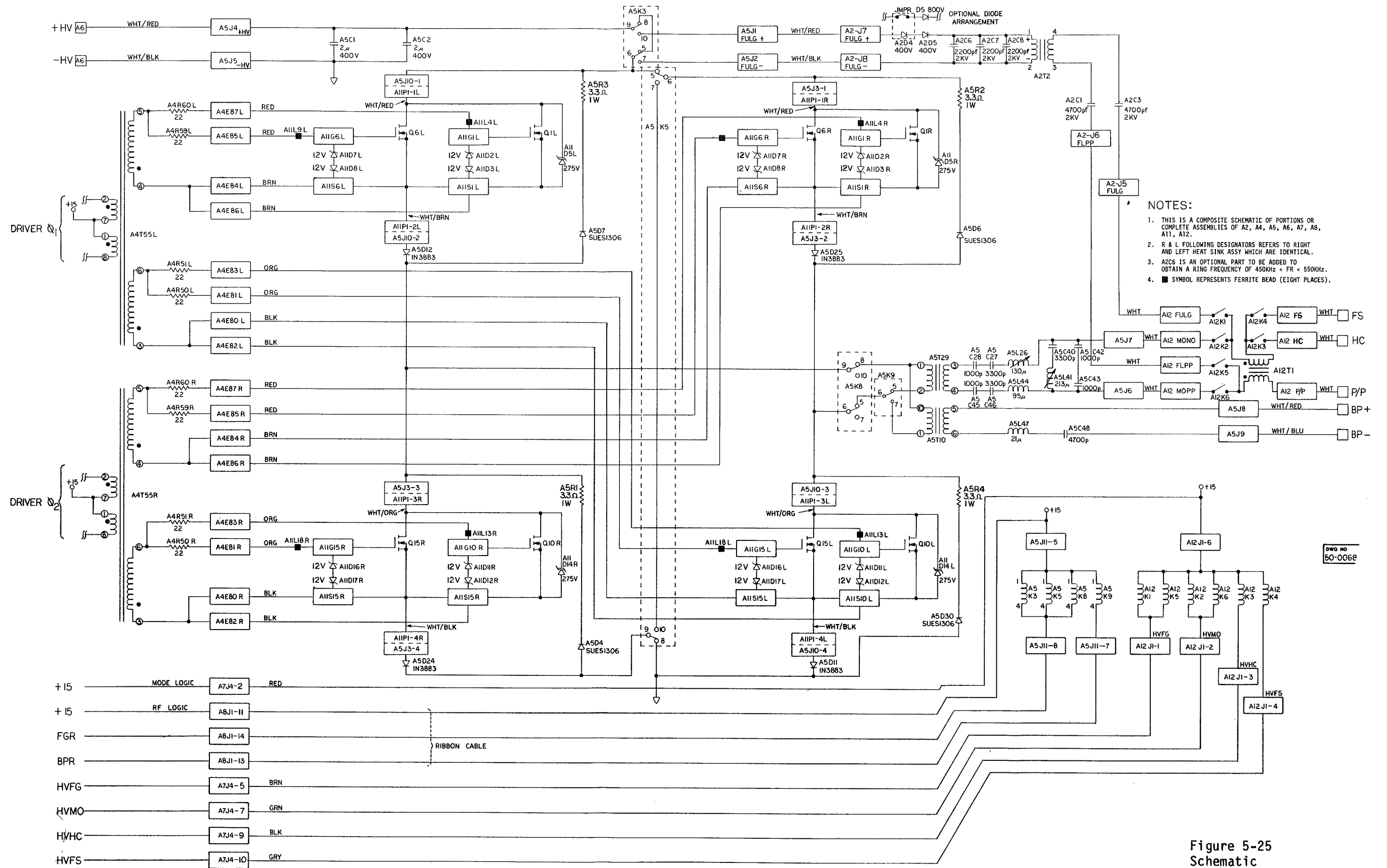


Figure 5-24
Simplified Diagram
R.F. Amplifier
Spray (Fulguration)
Coagulation Configuration

Rev. B 3/84



- NOTES:
1. THIS IS A COMPOSITE SCHEMATIC OF PORTIONS OR COMPLETE ASSEMBLIES OF A2, A4, A5, A6, A7, A8, A11, A12.
 2. R & L FOLLOWING DESIGNATORS REFERS TO RIGHT AND LEFT HEAT SINK ASSY WHICH ARE IDENTICAL.
 3. A2C6 IS AN OPTIONAL PART TO BE ADDED TO OBTAIN A RING FREQUENCY OF 450KHZ < FR < 550KHZ.
 4. ■ SYMBOL REPRESENTS FERRITE BEAD (EIGHT PLACES).

DWG NO 50-0068

Figure 5-25
Schematic
Composite R.F. Amplifier
DWG. No. 50-0068

Rev. A 3/84

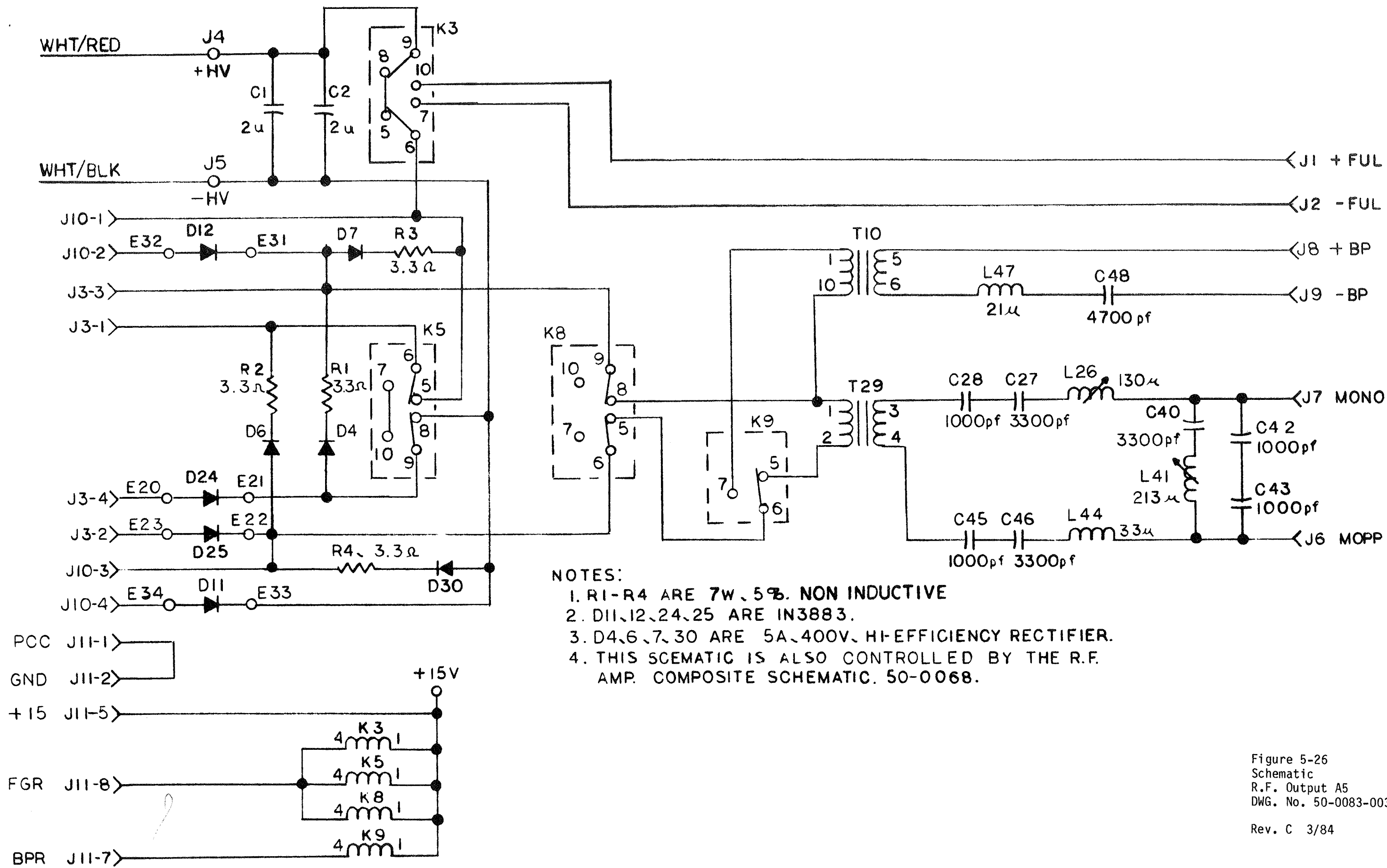
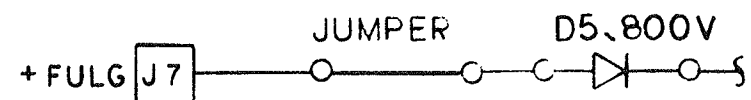
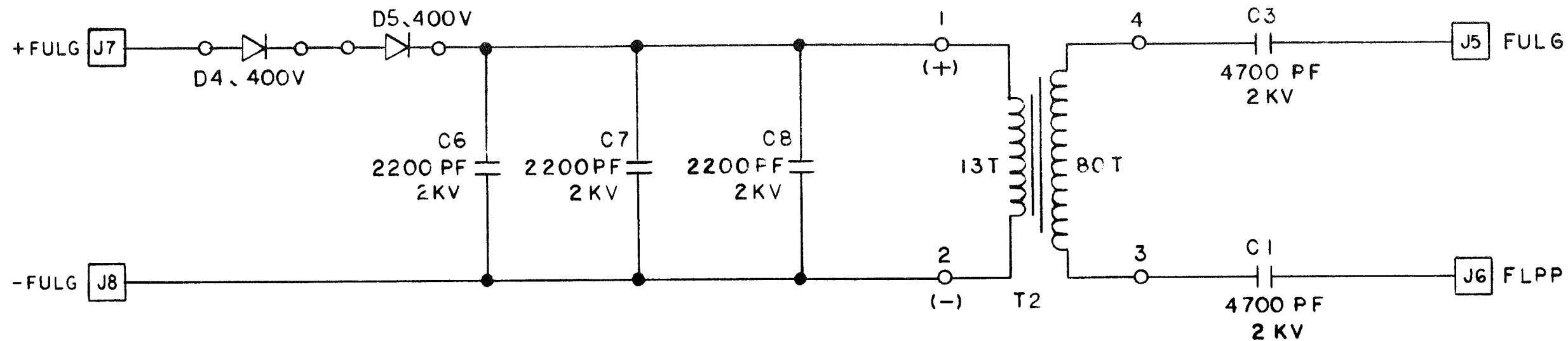


Figure 5-26
Schematic
R.F. Output A5
DWG. No. 50-0083-003
Rev. C 3/84



(OPTIONAL DIODE ARRANGEMENT)

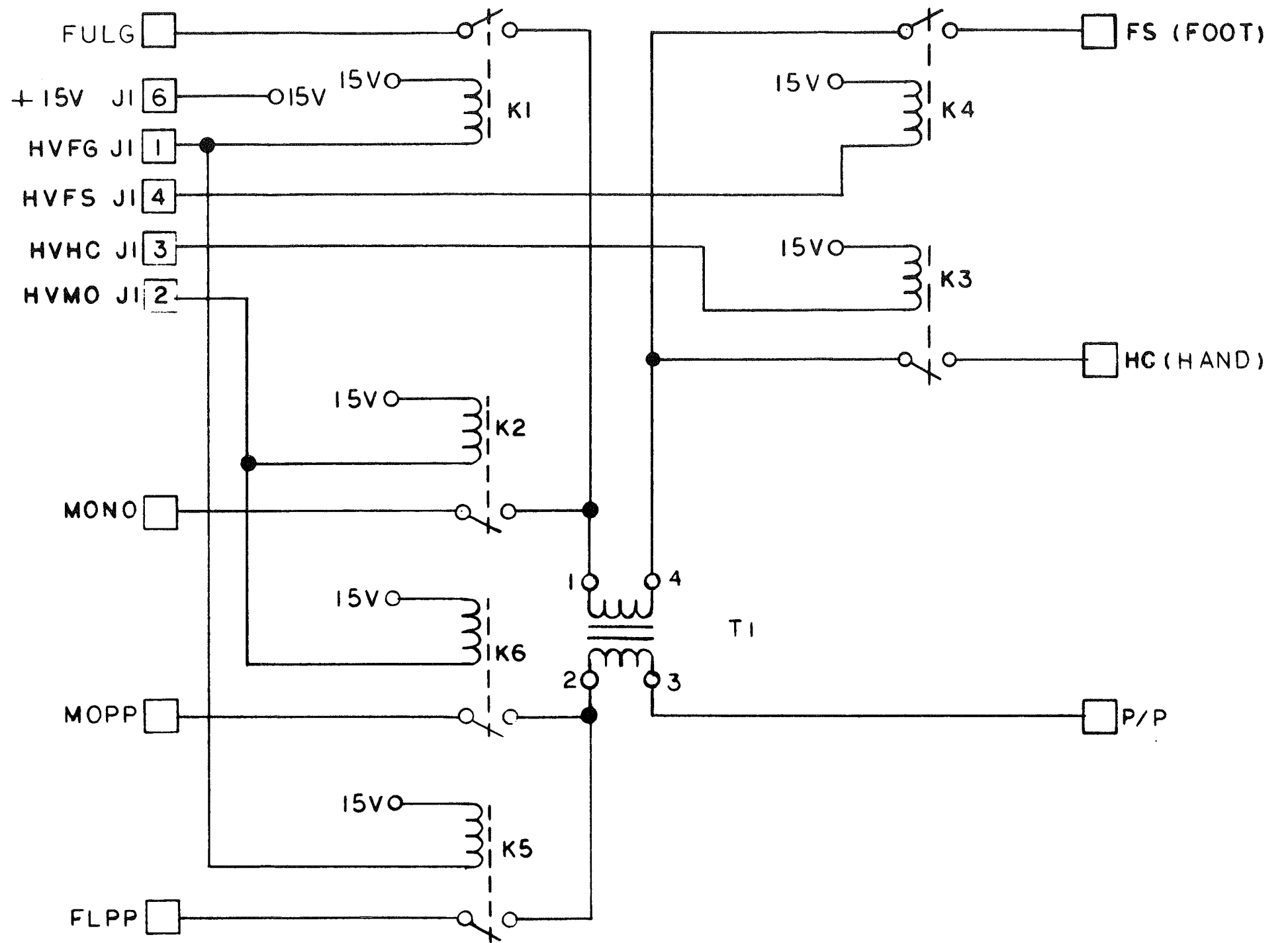


- I. THIS SCHEMATIC IS ALSO CONTROLLED BY THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.

NOTES:

Figure 5-27
Schematic
Fulguration (Spray) Output A2
DWG. No. 50-0078-002

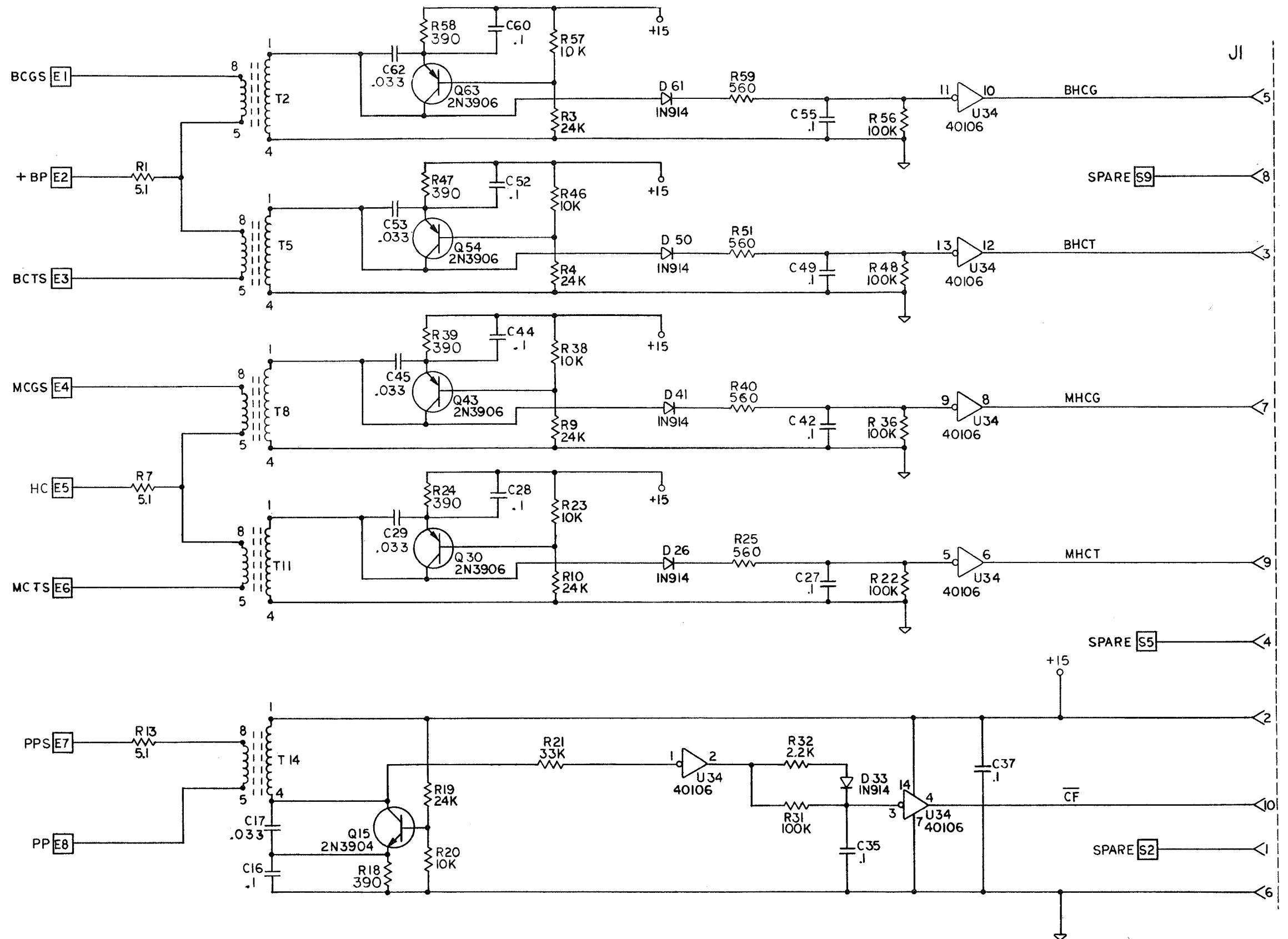
Rev. B 3/84



1. THIS SCHEMATIC IS ALSO CONTROLLED BY THE R.F. AMP COMPOSITE SCHEMATIC, 50-0068.

Figure 5-28
Schematic
High Voltage Relay A12
DWG. No. 50-0082

Rev. A 3/84



2. UNLESS OTHERWISE SPECIFIED ALL CAPACITANCE IS IN MICROFARADS.
 1. UNLESS OTHERWISE SPECIFIED:
 A) ALL RESISTORS ARE 1/4W.
 B) ALL RESISTANCE TOLERANCES ARE $\pm 5\%$.

NOTES

Figure 5-29
 Schematic
 Sensor Board A1
 DWG. No. 50-0079-001

Rev. D 3/84

Diagrams/Parts Lists

ILLUSTRATED PARTS BREAKDOWN

This section contains information for ordering replacement parts. The organization of the parts list is accomplished in the following manner.

- a) Item Number
- b) Part Number
- c) Description
- d) Quantity Required
- e) Reference Designator
- f) Manufacturer's Code
- g) Manufacturer's Part Number

Also, the assembly and drawing numbers are provided for further clarification.

ORDERING INFORMATION

To obtain replacement parts, phone 1-303-790-1117. The address from which to order parts is:

Bard Electro Medical Systems, Inc.
14 Inverness Drive East, Bldg. C, Suite 120
Englewood, Colorado 80112

Please provide the following information when placing your parts order:

- a) Generator Model Number
- b) Serial Number
- c) Assembly number 20-0050-xxx

This information is located on the back panel of the generator printed on the identification label.

Component Manufacturers List

Code	Manufacturer	Code	Manufacturer	Code	Manufacturer
102	Mallory/Disbr. Prdts.	163	Keystone Electronics	194	Fugitsu
103	Sprague Electric Co.	164	Molex	195	Siliconix
104	Motorola Semiconductor	165	Duncan Electronics	196	M.P.I.
105	J.W. Miller Company	166	Weckesser	197	Thermoly
106	Fairchild Semiconductor	167	Plastiglide	198	Hytec
110	Dale Electronics Co.	170	Seastrom	199	AMP
111	Ohmite Mfg. Co.	171	Panduit	200	Litronix
113	Potter-Brumfield	172	ARROWMAT	201	Hewlett Packard
114	Electro Medical Systems	173	Bourns	202	Hamlin
116	Switchcraft, Inc.	174	Nylomatic	203	Mepco
119	Littlefuse, Inc.	175	Dow Corning	204	Penn Keystone
120	Semtech Corp.	176	Guardin Elect. Co.	205	Aries
122	H.H. Smith, Inc.	177	Micro Plastics	207	Frako
127	Cutler-Hammer	178	Heyco	208	Pacific Resistor
128	Delco Electronics	179	Cambion	209	Illinois
129	Stackpole	180	Electrol	210	RIFA
131	TRW Semiconductor	181	Int. Rect.	211	Spectrol
133	Texas Instruments	182	Unicorp	212	Graphic
136	G.E. Electronics	183	Ledco	213	Fastex
138	Alco Electronic Products	184	Veritron	214	Beldon
140	Pomona Electronics	185	Loctite	215	Alpha
141	Solitron Devices	186	Gen. Inst.	216	GC Electronics
146	CTS Corporation	187	Interlock	217	Bar-Lok
148	TRW Capacitors	188	Etc.	218	General Semi
154	ARCO/STM	189	Howard, Inc.	219	Woodhead
155	Amphenol	190	National	220	Dennison
158	Airpax Electronics	191	Rohm	221	Electrovert
159	Truarc Retainer Rings Div.	192	RCA	222	Heyman
161	Centralab, Electronics Div.	193	Raytheon	223	ERO

SYSTEM 5000 SUB-ASSEMBLY PICTORIAL DIAGRAM

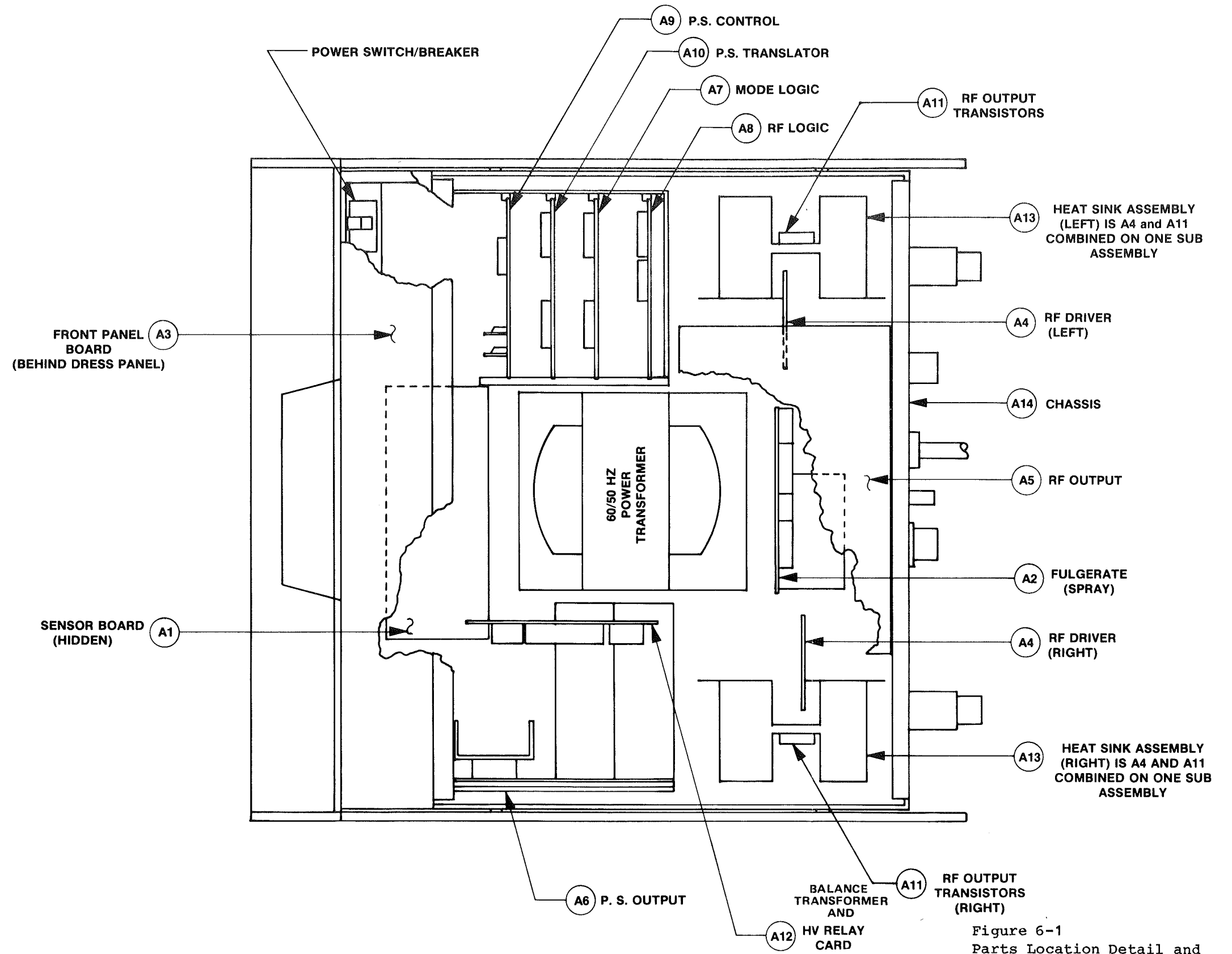


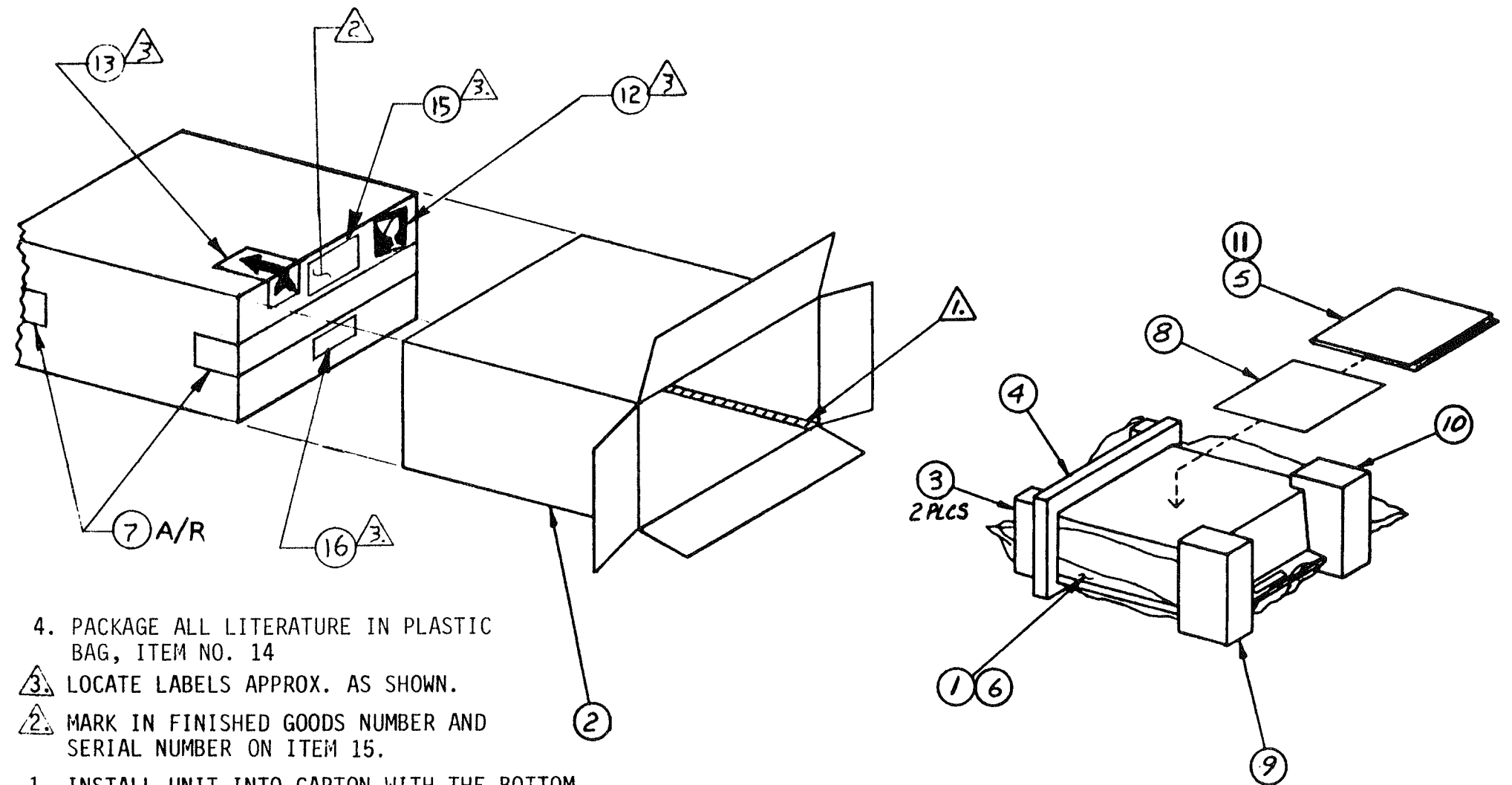
Figure 6-1
 Parts Location Detail and
 Parts List
 System 5000 Power Plus Sub-
 Assembly
 Pictorial Diagram

System 5000 Power Plus - Packaging Assembly 13-2030 Through 13-2036
 13-2030 Rev R 13-2032 Rev N 13-2031, 13-2033 through 13-2036 Rev M

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1	20-0069-011	TOP ASSY, 5000 110VAC ENGLISH	1		114	
	20-0069-012	TOP ASSY, 5000 220VAC ENGLISH	1		114	
	20-0069-013	TOP ASSY, 5000 100VAC JAPANESE	1		114	
	20-0069-014	TOP ASSY, 5000 220VAC ITALIAN	1		114	
	20-0069-015	TOP ASSY, 5000 220VAC FRENCH	1		114	
	20-0069-016	TOP ASSY, 5000 220VAC SPANISH	1		114	
	20-0069-017	TOP ASSY, 5000 110VAC SPANISH	1		114	
2	14-0151-002	CARTON	1		114	
3	14-0148-001	PACKING FOAM	2		114	
4	14-0149-002	PACKING FOAM	1		114	
5	13-0220-000	OPERATOR MANUAL, 5000	1		114	
6	09-0113-010	PLASTIC BAG 25"X30"X.007	1		114	
7	14-0022-002	TAPE, 3", WHITE	A/R		114	
** 8	90-0006-003	WARRANTY CARD	1		114	
9	14-0150-003	LEFT PACKING FOAM	1		114	
10	14-0150-004	RIGHT PACKING FOAM	1		114	
** 11	13-0221	TECH. MANUAL, 5000 POWER PLUS	1		114	
12	10-0147-001	LABEL, FRAGILE SYMBOL	1		114	
13	10-0148-001	LABEL, THIS SIDE UP	1		114	
14	09-0113-019	PLASTIC BAG, 12 X 16	1		114	
15	10-0159-001	LABEL, SHIPPING 5000	1		114	
16	10-0160-001	LABEL, RETAIN PACKAGING	1		114	

** (8) Warranty Card packaged with 13-2030 model only. Also instruction conversion 50/60 Hz 80-0031-001 Japanese generators.

** (10) Technical manual not packaged with 13-2032 model.



4. PACKAGE ALL LITERATURE IN PLASTIC BAG, ITEM NO. 14
- ③ LOCATE LABELS APPROX. AS SHOWN.
- ② MARK IN FINISHED GOODS NUMBER AND SERIAL NUMBER ON ITEM 15.
1. INSTALL UNIT INTO CARTON WITH THE BOTTOM OF THE MACHINE TOWARDS THE GLUED SEAM OF THE CARTON.

NOTES:

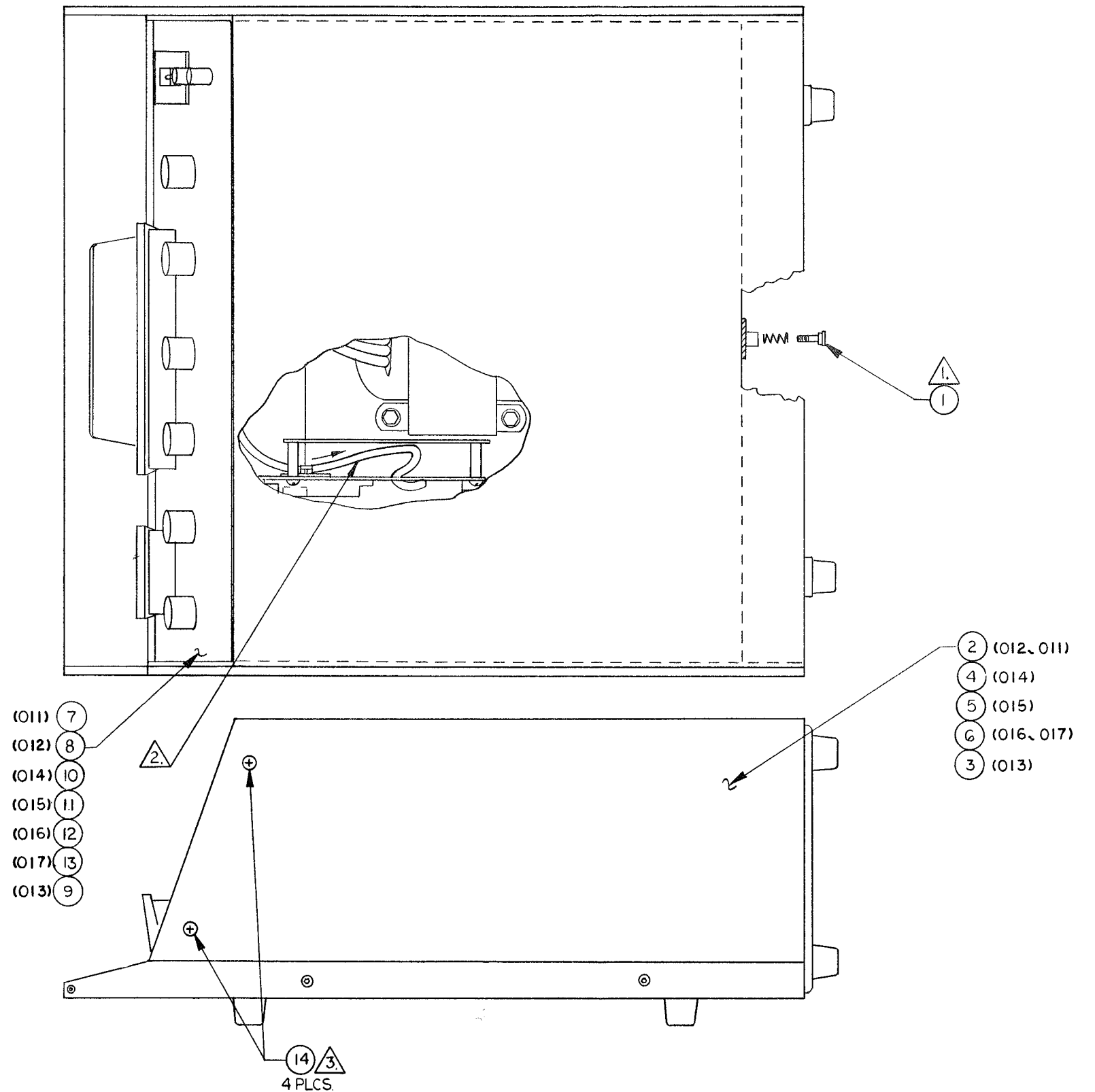
Figure 6-2
 Parts Location Detail and
 Parts List
 System 5000 Power Plus
 Packaging Pictorial Diagram
 13-2030 through 13-2036

Rev. M-R (See Above) 3/84

Top Assembly 20-0069

20-0069-(011, 012 English) (013 Japanese) (014 Italian) (015 French) (016, 017 Spanish)

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1	03-0300-001	SCREW, SHOULDER,8-32 HEX HD	1		114	
2	04-0223-016	COVER, 5000	1	ENGLISH	114	
3	04-0223-020	COVER, 5000	1	BLANK, JAPAN	114	
4	04-0223-023	COVER, 5000	1	ITALIAN	114	
5	04-0223-024	COVER, 5000	1	FRENCH	114	
6	04-0223-025	COVER, 5000	1	SPANISH	114	
7	20-0068-031	FINAL ASSEMBLY	1	ENGLISH (100V)	114	
8	20-0068-032	FINAL ASSEMBLY	1	ENGLISH (220V)	114	
9	20-0068-033	FINAL ASSEMBLY	1	JAPANESE	114	
10	20-0068-034	FINAL ASSEMBLY	1	ITALIAN	114	
11	20-0068-035	FINAL ASSEMBLY	1	FRENCH	114	
12	20-0068-036	FINAL ASSEMBLY	1	SPANISH (220V)	114	
13	20-0068-037	FINAL ASSEMBLY	1	SPANISH (110)	114	
14	03-0320-203	SCREW, CAP, SOCKET, BUTTON HD, 8-32 X 1/4 L	4		114	
15	09-0081-000	LOCTITE 242	A/R			
16	50-0069-001	INTERCONNECT DIAGRAM SYSTEM 5000	REF		114	
17	70-0015-015	POWER UNIT SPEC.SYS.5000	REF	(110V)	114	
18		NOT USED				
19		NOT USED				
20	90-0008-001	TEST DATA SUMMARY FIELD	1		114	
21	14-0014-000	DATA ENVELOPE	1		114	
22	90-0010-002	FORM, CUSTOMER DATA SUMMARY, Q.A.	1		114	



- 3 APPLY LOCTITE 242, ITEM (15), TO THREADS BEFORE INSTALLING.
 2 AFTER TESTING, PULL SLACK OUT OF P/P WIRE TOWARD RELAY BOARD. THIS IS TO KEEP WIRE AWAY FROM THE U34 IC ON HANDSENSE BOARD.
 1 REMOVE EXISTING SCREW FROM CLINCH NUT AND REPLACE WITH HEX SCREW, ITEM (1), (REASSEMBLE WITH SPRING.)
- NOTES**

Figure 6-3
 Parts Location Detail
 and Parts List
 Top Assembly Pictorial
 Diagram
 20-0069
 (See dash number above)

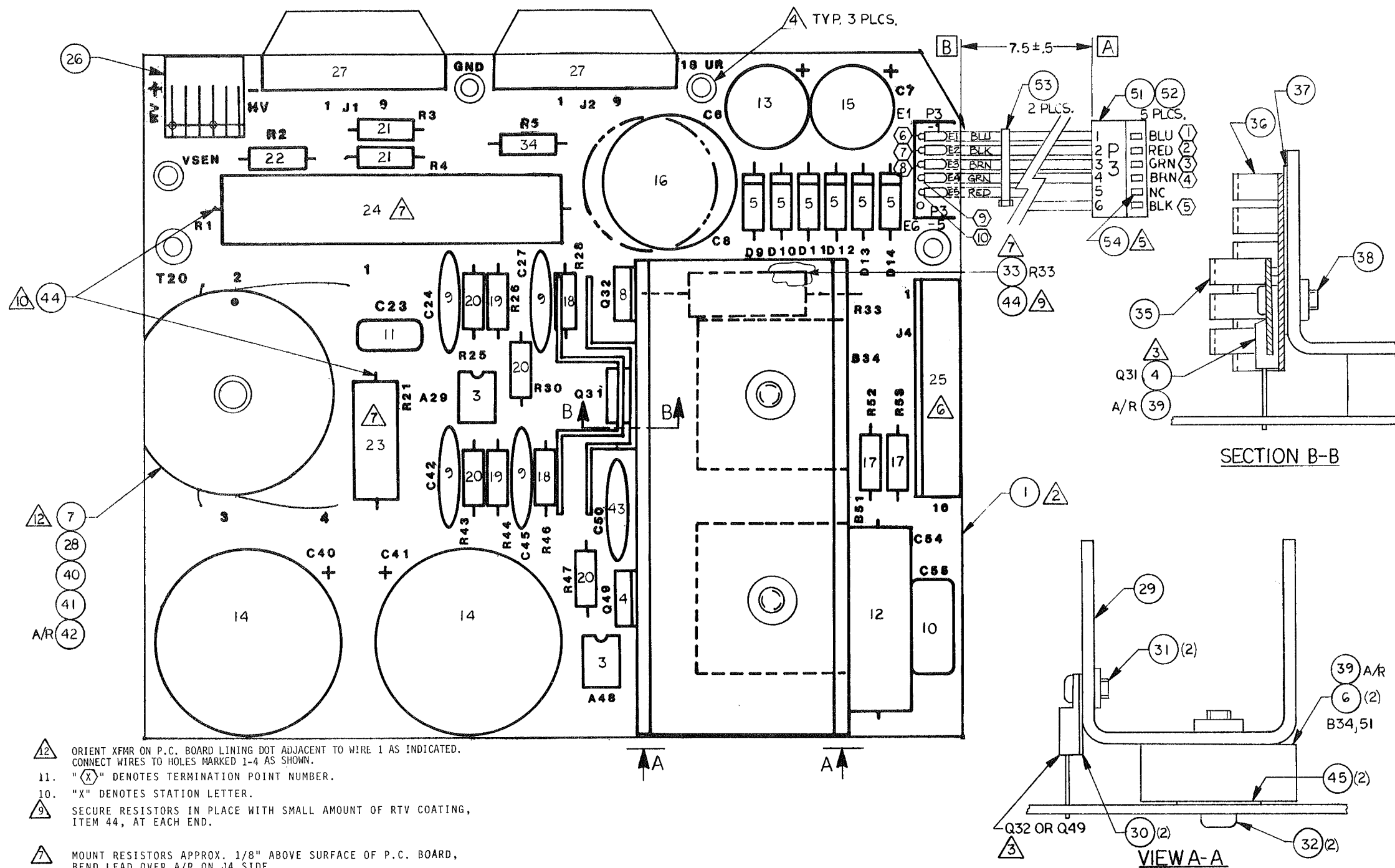
Rev. F 3/84

* OUTPUT (A6) PCB ASSEMBLY 30-0074-006

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0074-005	SCHEMATIC PS OUTPUT A-6	REF		114	
3	01-0278-000	MOC 3010 TRIAC DRIVER	2	A29,A48	104	
4	01-0277-000	TRIAC 400V 15A	2	Q31,Q49	104	MAC 15A6
5	01-0312-000	DIODE RECTIFIER 3A	6	D9 THRU D14	104	MR501
6	01-0321-000	BRIDGE 12A 400V PC	2	B34,B51	186	KBDCW12-04
7	05-0090-002	XFMR, COMMON MODE	1	T20	206	RL1256-4-390
8	01-0333-000	TRANSISTOR, 6A, 250V	1	Q32	104	MJE5740
9	01-0203-000	CAP 1KV CERAMIC DISC. .01ufd	4	C24,C27,C42,C45	103	5GA-S10
10	01-0063-000	CAP 400V POLYESTER .1ufd	1	C55	131	601-PE
11	01-0262-684	CAP 50V CERAMIC MONO .68ufd	1	C23	161	CZ15C684M
12	01-0267-105	CAP 400V POLYESTER 1ufd	1	C54	131	TRWX663FR-1-400
13	01-0257-477	CAP 35V RADIAL ELECT 470ufd	1	C6	103	503D477F-035QE
14	01-0437-821	CAP, AL EL, 250V, 820ufd	2	C40,C41	203	3187BF801T250CD
15	01-0258-108	CAP 16V RADIAL ELECT 1000ufd	1	C7	103	503D108F162E
16	01-0257-478	CAP 35V RADIAL ELECT 470ufd	1	C8	207	47004D
17	01-0166-100	RESISTOR 1/4W 5% 10 OHM	2	R52,R53	191	
18	01-0166-390	RESISTOR 1/4W 5% 39 OHM	2	R25	191	
19	01-0166-181	RESISTOR 1/4W 5% 180 OHM	2	R25	191	
20	01-0166-221	RESISTOR 1/4W 5% 220 OHM	4	R25	191	
21	01-0166-911	RESISTOR 1/4W 5% 910 OHM	2	R3,R4	191	
22	01-0166-473	RESISTOR 1/4W 5% 47K OHM	1	R2	191	
23	01-0331-001	RESISTOR 5W 10% .1 OHM	1	R21	110	CP-5
24	01-0193-000	RESISTOR 20W 10%4K OHM	1	R1	110	CP-20-4K
25	02-0144-010	HEADER ST LOCKING 10 PIN	1	J4	171	HLSS156-10
26	02-0224-001	TERMINAL STRIP, 2 POLE	1		114	
27	02-0181-101	HEADER RT ANGLE 1.x.1 10 PIN	2	J1,J2	199	102160-1
28	03-0192-000	SPACER, PHENOLIC, .171x.5x.687Lg	1			
29	04-0235-001	HEAT SINK - BRIDGE	1		114	
30	03-0286-001	INSULATOR PAD T0-220	2			
31	03-0285-103	SCREW-NYLON P.H. 6-32x1/4	2			
32	03-0252-209	SCREW-B.H. 8-32x3/4	2			
** 33	01-0338-330	RESISTOR, 10W, 5% 33 OHM	1	R33	208	CP5
34	01-0167-331	RESISTOR, 1/2W 5% 330 OHM	1	R5	191	
35	03-0299-003	HEAT SINK T0-220 PK	1		114	
36	03-0299-002	HEAT SINK T0-220 PK	1		114	
37	03-0298-001	INSULATOR PAD T0-220 PK	1		114	
38	03-0285-105	SCREW NYLON P.H. 6-32 3/8	1			
39	09-0001-000	HEAT SINK COMPOUND	A/R			
40	03-0178-000	WASHER, NYLON, 188x1.5x.04.	1			
41	03-0284-110	SCREW, RH, CR, 6-32 X 7/8	1			
42	09-0081-000	LOCTITE, 242	A/R			
43	01-0262-334	CAP, CM 50V, .33ufd	1	C50	161	CZ30C334M
44	09-0052-000	RTV COATING, 732	A/R			
45	03-0313-023	WASHER, FLAT, MICA .625x.187	2			
46	08-0442-000	WIRE, 22 AWG. BLK	.7 FT			
47	08-0442-001	WIRE, 22 AWG. BRN	.7 FT			
48	08-0442-002	WIRE, 22 AWG. RED	.7 FT			
49	08-0442-005	WIRE, 22 AWG. GRN	.7 FT			
50	08-0442-006	WIRE, 22 AWG. BLU	.7 FT			
51	02-0190-006	HOUSING, 100. 6 POS.	1		114	
52	02-0184-001	TERMINAL CRIMP, .100	5		164	08-50-0113
53	07-0133-000	TIE WRAP	2			
54	02-0164-001	KEY, POLARIZING	1		171	PK 156-C

** ITEM 33 MAY BE REPLACED WITH A35 OHM RESISTOR PN 01-0338-350, PENDING ITEM 33 AVAILABILITY.

* COMPLETE P.S. OUTPUT (A6) PCB ASSEMBLY WITH ELECTRONIC COMPONENTS INSTALLED. ORDER 30-0074-0006 ASSEMBLY



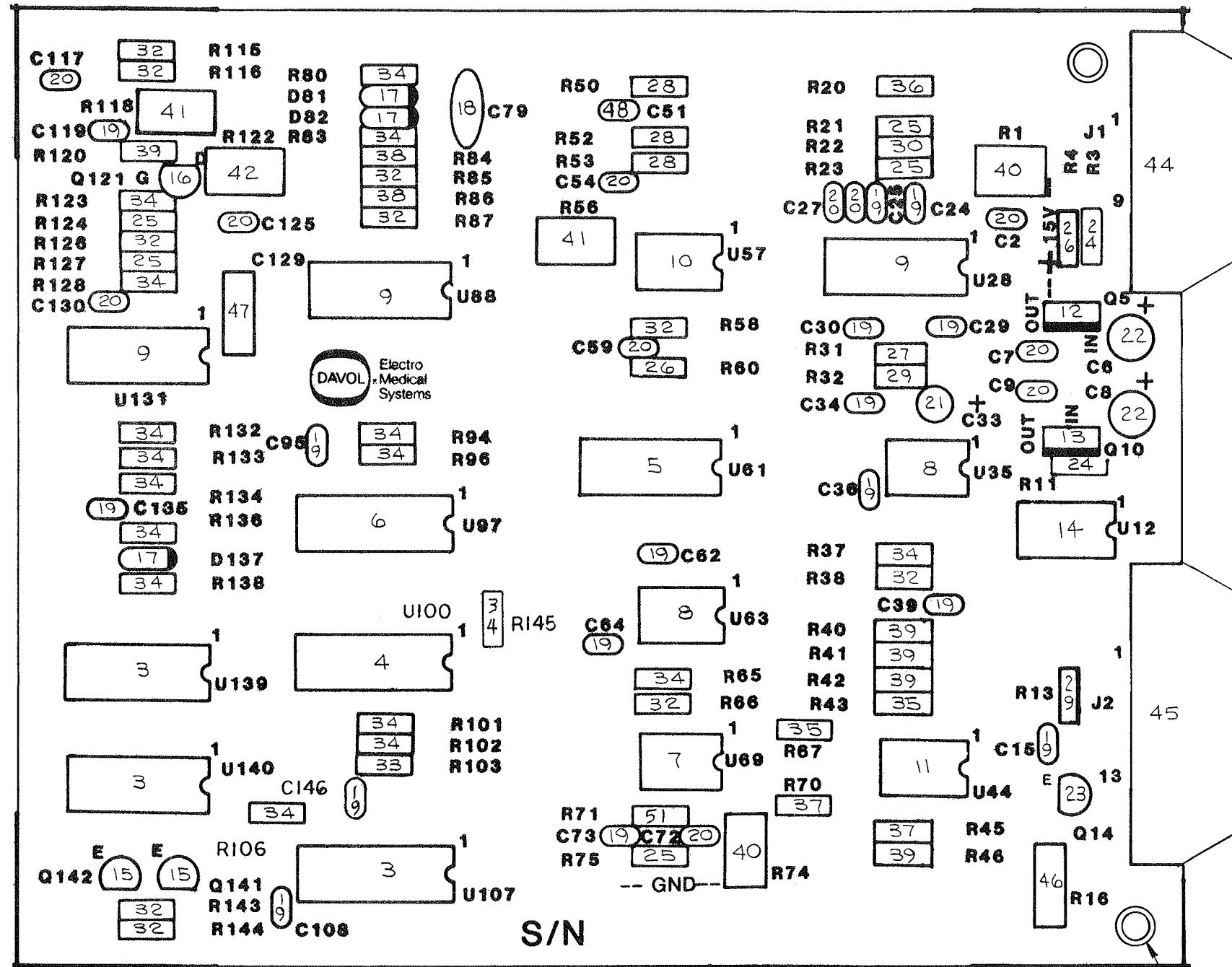
12. ORIENT XFMR ON P.C. BOARD LINING DOT ADJACENT TO WIRE 1 AS INDICATED. CONNECT WIRES TO HOLES MARKED 1-4 AS SHOWN.
11. "X" DENOTES TERMINATION POINT NUMBER.
10. "X" DENOTES STATION LETTER.
9. SECURE RESISTORS IN PLACE WITH SMALL AMOUNT OF RTV COATING, ITEM 44, AT EACH END.
7. MOUNT RESISTORS APPROX. 1/8" ABOVE SURFACE OF P.C. BOARD, BEND LEAD OVER A/R ON J4 SIDE.
6. REMOVE PIN 7 FROM CONNECTOR PRIOR TO ASSEMBLY.
5. INSERT KEY INTO TERMINAL OPENING SPECIFIED.
4. SOLDER TURRET TERMINALS IN PLACE.
3. ASSEMBLE TRANSISTORS TO THE MAIN HEATSINK AND MOUNT ON BOARD OVER THE BRIDGES, THEN SOLDER THE TRANSISTORS AND BRIDGES IN PLACE.
2. MFG. IS TO PERMANENTLY MARK IN THE ASSEMBLY DASH NUMBER OF UNIT BEING BUILT AND SERIALIZE EACH BOARD.
1. NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES REPRESENT THE ITEM NUMBERS ON THE BILL OF MATERIALS.

Figure 6-4
Parts Location Detail and
Parts List
P.S. Output A6 PCB Assy
30-0074-006

* P.S. TRANSLATOR (A10) PCB (CARD) ASSEMBLY 30-0070-005

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2		NOT USED				
3	01-0200-000	4001 QUAD 2 INPUT NOR	3	U107,U139,U140	190	CD4001BCN
4	01-0201-000	4011 QUAD 2 INPUT NAND	1	U100	190	CD4011BCN
5	01-0295-000	CD4066 QUAD BILATERAL SW	1	U61	106	4066BPC
6	01-0296-000	4070 QUAD EXCLUSIVE - OR	1	U97	106	4070BPC
7	01-0275-000	CA81E OP AMP BI FET	1	U69	192	CA81E
8	01-0276-000	CA82E OP AMP DUAL BI FET	2	U35,U63	192	CA82E
9	01-0282-000	LM348 QUAD OP AMP	3	U28,U88,U131	190	LM348N
10	01-0283-000	LF355 OP AMP BI FET	1	U57	190	LF355N
11	01-0303-000	RC4200 MULTIPLIER	1	U44	193	RC4200ANB
12	01-0079-000	LM7815 CT +15V REG	1	Q5	104	LM7815CT
13	01-0289-000	LM7915 CT -15V REG	1	Q10	190	LM7915CT
14	01-0288-000	VOLTAGE REFERENCE +10V	1	U12	104	MC1404U10
15	01-0152-000	2N3904 NPN	2	Q141,Q142	104	
16	01-0310-000	2N5461 PCHAN FET	1	Q121	104	
17	01-0029-000	1N914 DIODE	3	D81,D82,D137	133	
18	01-0208-000	CAP 500V CERAMIC DISC .0047ufd	1	C79	103	5HKD47
19	01-0262-103	CAP,CER,25U,50V,20%,.01uF	16	C24,C25,C29,C30,C34,C36,C39,C62,C64,C73,C95,C108,C119,C135,C146,C15,C2,C7,C9,C26,C27,C54,C59,C72,C117,C125,C130	161	CZ15C103M
20	01-0262-104	CAP 50V CERAMIC MONO .1ufd	11		161	CZ20C104K
21	01-0259-015	CAP 25V RADIAL TANT 1.5ufd	1	C33	103	119D155X0025AB1
22	01-0257-475	CAP 35V RADIAL ELECT 4.7ufd	2	C6,C8	103	503D475F035KA
23	01-0213-000	TRANSISTOR, PNP, 2N3906	1	Q14	104	
24	01-0167-027	RESISTOR 1/2W 5% 2.7 OHM	2	R3,R11	191	R50
25	01-0166-120	RESISTOR 1/4W 5% 12 OHM	5	R21,R23,R75,R124,R127	191	R25
26	01-0166-220	RESISTOR 1/4W 5% 22 OHM	2	R4,R60	191	R25
27	01-0166-470	RESISTOR 1/4W 5% 47 OHM	1	R31	191	R25
28	01-0166-751	RESISTOR 1/4W 5% 750 OHM	3	R50,R52,R53	191	R25
29	01-0166-102	RESISTOR 1/4W 5% 1K OHM	2	R32,R13	191	R25
30	01-0166-272	RESISTOR 1/4W 5% 2.7K OHM	1	R22	191	R25
31		NOT USED				
32	01-0166-103	RESISTOR 1/4W 5% 10K OHM	10	R38,R58,R66,R85,R87,R115,R116,R126,R143,R144	191	R25
33	01-0166-153	RESISTOR 1/4W 5% 15K OHM	1	R103	191	R25
34	01-0166-203	RESISTOR 1/4W 5% 20K OHM	17	R37,R65,R80,R83,R94,R96,R101,R102,R106,R123,R128,R132,R133,R134,R136,R138,R145	191	R25
35	01-0166-243	RESISTOR 1/4W 5% 24K	2	R43,R67	191	R25
36	01-0166-473	RESISTOR 1/4W 5% 47K	1	R20	191	R25
37	01-0166-513	RESISTOR 1/4W 5% 51K OHM	2	R45,R70	191	R25
38	01-0166-104	RESISTOR 1/4W 5% 100K OHM	2	R84,R86	191	R25
39	01-0166-204	RESISTOR 1/4W 5% 200K OHM	5	R40,R41,R42,R46,R120	191	R25
40	02-0186-502	RESISTOR TRIM 1T 5K OHM	2	R1,R74	173	3386H
41	02-0186-103	RESISTOR TRIM 1T 10K OHM	2	R56,R118	173	3386H
42	02-0186-203	RESISTOR TRIM 1T 20K OHM	1	R122	173	3386H
43		NOT USED				
44	02-0181-101	HEADER RT ANGLE .1x.1 10 PIN	1	J1	199	102160-1
45	02-0181-104	HEADER RT ANGLE .1x.1 14 PIN	1	J2	199	102160-2
46	01-0167-152	RESISTOR 1/2W 5% 1.5K	1	R16	191	R50
47	01-0074-000	CAP 80V FILM .01uF	1	C129	103	192P1039R8
48	01-0262-684	CAP, CER, 25U,50V,20%,.68MFD	1	C51	161	CZ15C684M
49		NOT USED				
50	50-0070-004	SCHEMATIC PS TRANSLATOR A10	REF		114	
51	01-0166-183	RES, 1/4W, 5%, 18K	1	R71	191	R25

* COMPLETE P.S. TRANSLATOR (A10) CARD WITH ELECTRONIC COMPONENTS INSTALLED ORDER 30-0070-005 PCB ASSEMBLY



SOLDER TURRET TERMINALS IN PLACE, 2 PLCS

- △ MFG. IS TO PERMANENTLY MARK IN THE ASSY DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
- NUMBERS INSIDE BALLOONS OF INSIDE COMPONENT OUTLINES REPRESENT THE ITEM NUMBERS ON THE BILL OF MATERIALS.

NOTES

Figure 6-5
Parts Location Detail and
Parts List
P.S. Translator A10 PCB Assy
30-0070-005

* P.S. CONTROL (A9) PCB (CARD) ASSEMBLY 30-0097-002

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
01		NOT USED				
02	50-0097-002	SCHEMATIC PS CONTROL A9	REF		114	
03	01-0295-000	CD4066 QUAD BILATERAL SW	5	U33 THROUGH U37	106	4066BPC
04	01-0199-000	4081 QUAD 2 INPUT AND	1	U102	192	CD4081RE
05	01-0302-000	4093 QUAD 2 INPUT NAND SCHM.	1	U142	190	CD4093BCN
06	01-0231-000	40106 HEX INVERTER, SCHMIDT	1	U53	192	CD40106BE
07	01-0282-000	LM348 QUAD 741 OP AMP	4	R94,R106,R110,R213	190	LM348N
08	01-0079-000	LM7815 CT +15V REG	1	Q31	104	LM7815CT
09	01-0289-000	LM7915 CT -15V REG	1	Q51	190	LM7915CT
10	01-0029-000	IN914 DIODE 75V 10ma	9	D20,D70,D72,D79,D81,D152, D145,D172,D173	133	
11	01-0343-000	1N5240B 10V ZENER	2	D209,C210	104	
12	01-0262-103	CAP 50V CERAMIC MONO.01u	5	C86,C87,C112,C120,C146	161	CZ15C103A
13	01-0262-104	CAP 50V CERAMIC MONO.1uFd	15	C208,C67,C109,C111,C113, C115,C88,C125,C150,C154, C157,C205,C204,C211,C68	161	CZ20C104M
14	01-0262-334	CAP 50V CERAMIC MONO .33 uFd	2	C1,C104	161	CZ30C334M
15	01-0262-684	CAP 50V CERAMIC MONO .68 UFD	3	C32,C52,C93	161	CZ30C684M
16	01-0257-475	CAP 25V RADIAL TANT 1.5 uFd	2	C30,C50	103	199D155X0025AB1
17	01-0166-104	RES 1/4W 5%, 100K OHM	1	R91	191	R25
18	01-0167-027	RESISTOR 1/2W 5%, 2.7 OHM	2	R100,R101	191	R25
19	01-0166-120	RESISTOR 1/4W 5%, 12 OHM	1	R2	191	R25
20	01-0166-220	RESISTOR 1/4W, 5%, 22 OHM	12	R66,R69,R75,R76,R83,R85,R124, R148,R166,R168,R169,R157,R179 R179,R10,R11,R14,R15, R140,R167,R199	191	R25
21	01-0166-102	RESISTOR 1/4W, 5%, 1K OHM	8	R174	191	R25
22	01-0166-912	RESISTOR 1/4W, 5% 9.1K OHM	1	R6,R165,R126	191	R25
23	01-0166-103	RESISTOR 1/4W, 5% 10K OHM	3	R171	191	R25
24	01-0316-312	RESISTOR 1/8W, 1% 13.0K OHM	1	R123	191	R25
25	01-0166-183	RESISTOR 1/4W, 5% 18K OHM	1	R63,R118,R122,R154,R161, R163,R178	191	R25
26	01-0166-204	RESISTOR 1/4W, 5% 20K OHM	7	R170	191	R25
27	01-0316-334	RESISTOR 1/8W, 1% 22.1K OHM	1	R7,R23	191	R25
28	01-0166-333	RESISTOR 1/4W, 5% 33K OHM	2	R82	191	R25
29	01-0166-393	RESISTOR 1/4W, 5% 39K OHM	1	R117	191	R25
30	01-0166-433	RESISTOR 1/4W, 5% 43K OHM	1	R22	191	R25
31	01-0166-623	RESISTOR 1/4W, 5% 62K OHM	1	R16,R4	191	R25
32	01-0166-683	RESISTOR 1/4W, 5% 68K OHM	2	R19,R144	191	R25
33	01-0166-104	RESISTOR 1/4W, 5% 100K OHM	2	R64	191	R25
34	01-0166-473	RESISTOR 1/4W, 5% 47K OHM	1	R8	191	R25
35	01-0166-164	RESISTOR 1/4W, 5% 160K OHM	1	R9	191	R25
36	01-0166-224	RESISTOR 1/4W, 5% 220K OHM	1	R103	191	R25
37	01-0166-105	RESISTOR 1/4W, 5% 1M OHM	1	R147	191	R25
38	01-0166-163	RESISTOR 1/4W, 5% 16K OHM	1	R90	191	R25
39	01-0316-301	RESISTOR 1/8W, 5% 10K OHM	1	R12	191	R25
40	01-0316-326	RESISTOR 1/8W, 5% 18.2K OHM	1	R17,R21,R25,R71,R73,R74,R77, R78,R80,R84,R89,R119,R121, R162,R164,R176,R177,R206, R207,R212	191	R25
41	01-0316-330	RESISTOR 1/8W, 1% 20.0K OHM	20	R3,R175	191	R25
42	01-0316-341	RESISTOR 1/8W, 1% 26.1K OHM	2	R116	191	R25
43	01-0316-356	RESISTOR 1/8W, 1% 37.4K OHM	1	R24	191	R25
44	01-0316-374	RESISTOR 1/8W, 1% 57.6K OHM	1	R18	191	R25
45	01-0316-415	RESISTOR 1/8W, 1% 140K OHM	1	R105,R114	173	3386H502
46	02-0186-502	POT TRIM IT 3/8SQ. 5K OHM	2	R5	191	R25
47	01-0316-376	RESISTOR 1/8W 1% 60.4K OHM	1	J1,J2	199	102160-1
48	02-0181-101	HEADER RT. ANGLE .1X.1 10 PIN	2	J3	199	102160-2
49	02-0181-104	HEADER RT. ANGLE.1X.1 14 PIN	1	R95,R156	191	R25
50	01-0166-275	RESISTOR 1/4W 5% 2.7M OHM	2			
51		NOT USED				
52	01-0166-304	RESISTOR 1/4W 5% 300K OHM	1	R92	191	R25
53	01-0316-401	RESISTOR 1/8W 1% 100K OHM	1	R155	191	
54	01-0355-224	CAP 50V .22uF	1	C153	161	CW30C224K
55		NOT USED				
56	01-0343-000	DIODE ZENER 1N5240B	1	D153	104	
57	01-0316-396	RESISTOR, 1/8W, 1% 97.6K OHM	1	R13	191	

* COMPLETE P.S. CONTROL (A9) CARD WITH ELECTRONIC COMPONENTS INSTALLED.
ORDER 30-0097-002

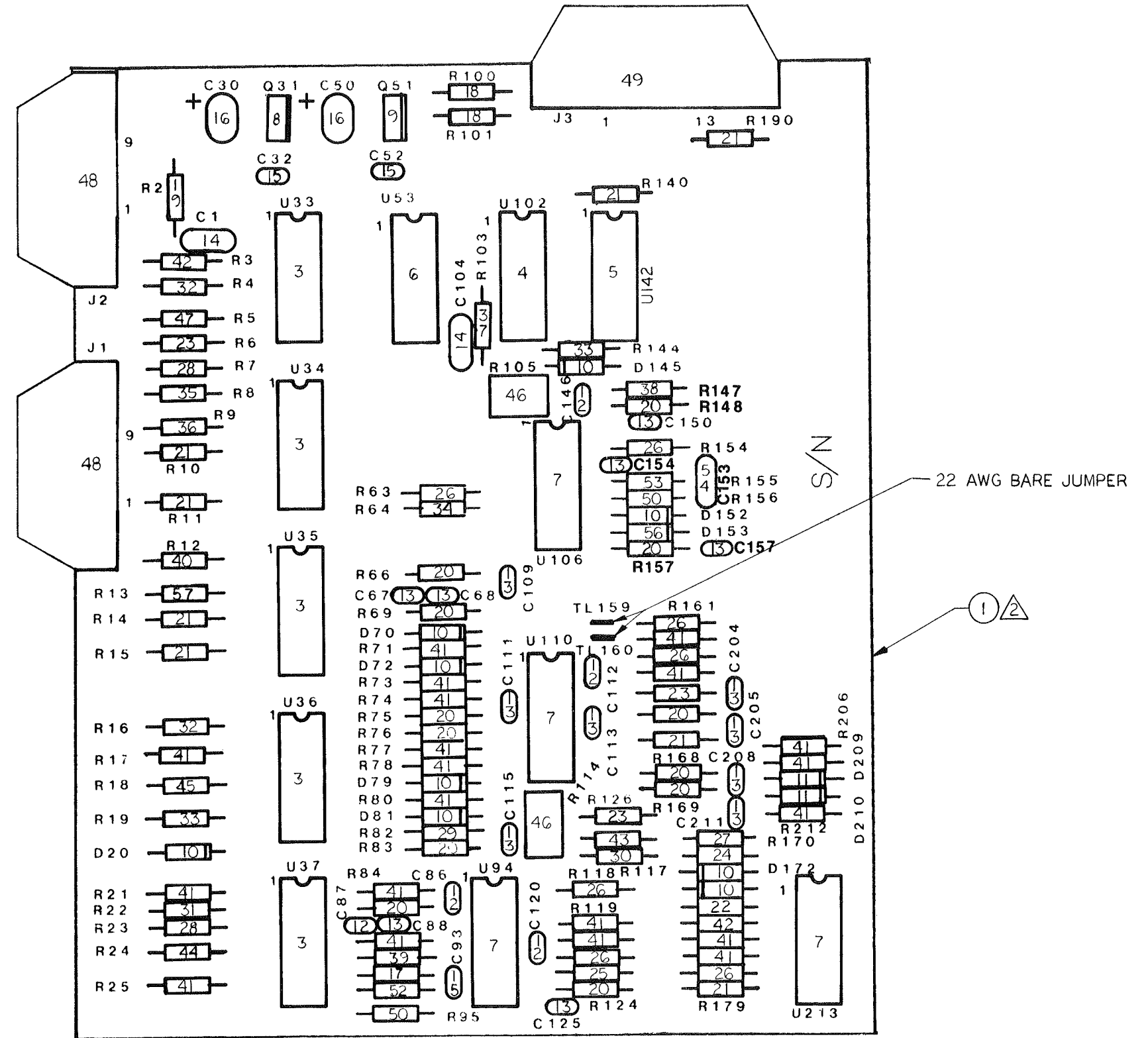


Figure 6-6
Parts Location Detail and
Parts List
P.S. Control A9 PCB Assy
30-0097-002

Rev. C 3/84

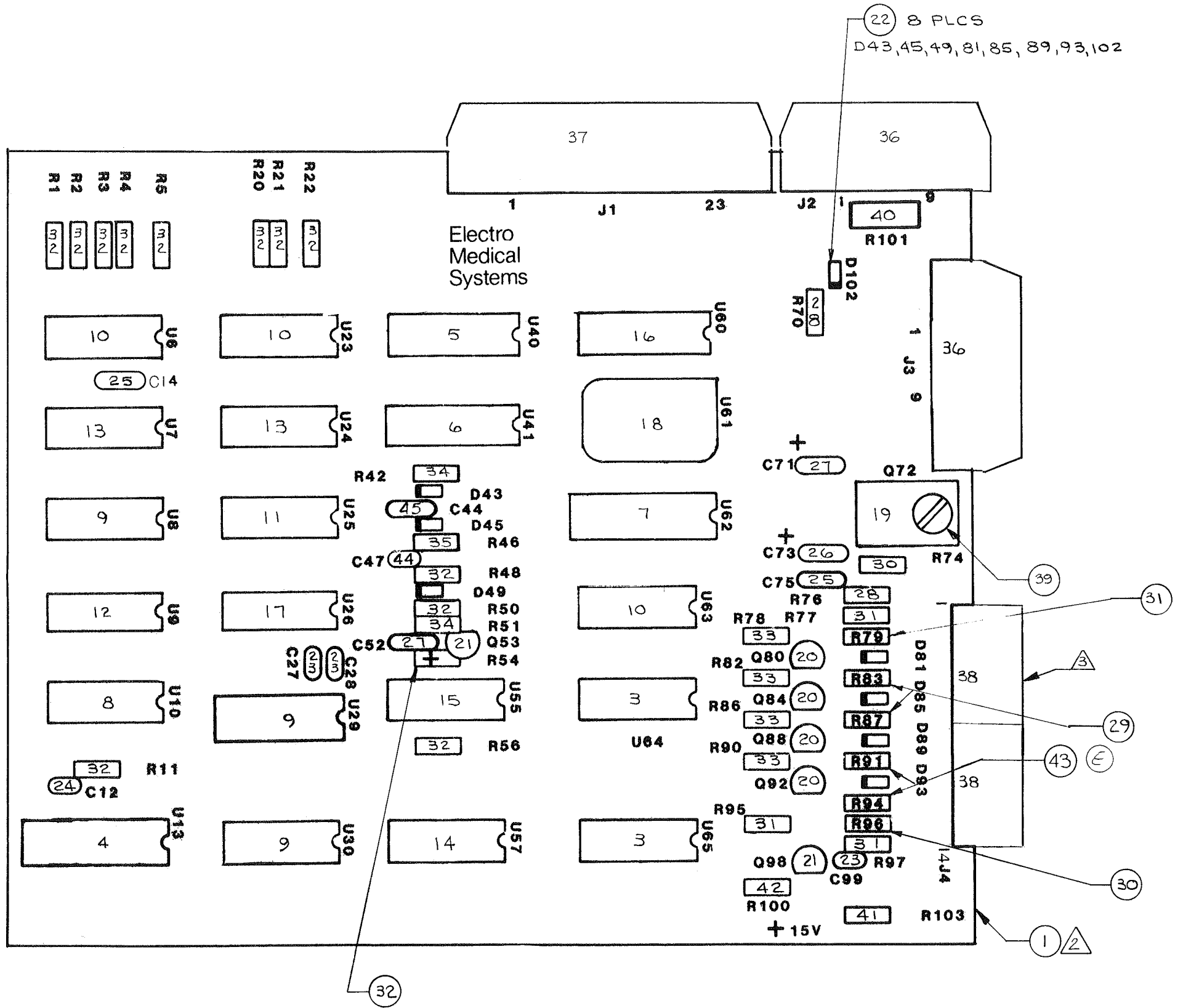
NOTES

2. MFG. IS TO PERMANENTLY MARK IN THE ASSY. DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
1. NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES ON THE P.C. BOARD REPRESENT ITEM NUMBERS ON THE MATERIAL LIST.

* MODE LOGIC (A7) PCB (CARD) ASSEMBLY 30-0073-006

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED	REF		114	
2	50-0073-005	SCHEMATIC MODE LOGIC A7	1		190	CD4001BCN
3	01-0200-000	4001 QUAD 2 INPUT NOR	2	U64,U65	104	MC14050B
4	01-0317-000	IC NON INVERT HEX BUFFER 4050	1	U13	106	4017BPC
5	01-0291-000	4017 COUNTER 5-STAGE	1	U40	106	4027BPC
6	01-0202-000	4027 DUAL J-K F-F	1	U62	104	MC14040BCP
7	01-0230-000	4040 BINARY COUNTER 5-STAGE	1	U10	106	4070BPC
8	01-0296-000	4070 QUAD EXCLUSIVE OR	1	U10	106	4071BPC
9	01-0198-000	4071 QUAD 2 INPUT OR	3	U8,U29,U30	106	4073BPC
10	01-0298-000	4073 TRIPLE 3 INPUT AND	3	U6,U23,U63	106	CD4078BCN
11	01-0323-000	4078 8 INPUT OR/NOR	1	U25	192	CD4081BE
12	01-0199-000	4081 QUAD 2 INPUT AND	1	U9	106	4082BPC
13	01-0300-000	4082 DUAL 4 INPUT AND	2	U7,U24	106	4086BPC
14	01-0301-000	4086 AND OR INVERT	1	U57	190	CD4093BCN
15	01-0302-000	4093 QUAD 2 INPUT NAND SCHMIDT	1	U55	106	CD4518BCN
16	01-0304-000	4518 DUAL 4 BIT DECADE COUNTER	1	U60	190	CD40106BCN
17	01-0231-000	40106 HEX SCHMIDT	1	U26	198	HY4560
18	01-0305-000	2MHz OSC	1	U61	104	MC7815CT
19	01-0079-000	REGULATOR 15V, 7815	1	Q72	190	
20	01-0210-000	MPS A13 DARLINGTON NPN	4	Q80,Q84,Q88,Q92	104	
21	01-0152-000	2N3904 NPN	2	Q53,Q98	104	
22	01-0029-000	1N914 DIODE	8	D43,D45,D49,D81,D85, D89,D93,D102	133	
23	01-0262-103	CAP 50V CERAMIC MONO .01ufd	3	C27,C28,C99	161	CZ5C103A
24	01-0262-104	CAP,CER,Z5U,50V,20%,.1ufdd	1	C12	161	CW20C104K
25	01-0262-334	CAP,CER,Z5U,50V,20%,.33.ufd	2	C14,C75	161	CZ30C334M
26	01-0262-684	CAP 50V CERAMIC MONO .68ufd	1	C73	161	CZ15C684M
27	01-0259-015	CAP 25V TANT 1.5ufd	2	C52,C71	103	199D155X0025AB1
28	01-0167-027	RESISTOR 1/2W 5% 2.7 OHM	2	R70,R76	191	R25
29	01-0166-160	RESISTOR 1/4W 5% 16 OHM	2	R83,R87	191	R25
30	01-0166-120	RESISTOR 1/4W 5% 12 OHM	2	R74,R96	191	R25
31	01-0166-103	RESISTOR 1/4W 5% 10K OHM	4	R77,R79,R95,R97	191	R25
32	01-0166-333	RESISTOR 1/4W 5% 33K OHM	13	R1 THRU R5,R20 THRU R22, R48,R50,R54,R56,R11	191	R25
33	01-0166-473	RESISTOR 1/4W 5% 47K OHM	4	R78,R82,R86,R90	191	R25
34	01-0166-204	RESISTOR 1/4W 5% 200K OHM	2	R42,R51	191	R25
35	01-0166-475	RESISTOR 1/4W 5% 4.7M	1	R46	191	R25
36	02-0181-101	HEADER RT ANGLE .1x1 10 PIN	2	J2,J3	199	102160-1
37	02-0181-113	HEADER RT ANGLE .1x1 24 PIN	1	J1	199	10216-5
38	02-0192-007 1	HEADER RT ANGLE 7 PIN .100	2	J4	199	640457-7
39	03-0012-000	SCREW B.H. 6-32x1/4"	1		191	R25
40	01-0166-472	RESISTOR, 1/4W 5% 4.7K OHM	1	R101	191	R25
41	01-0166-102	RESISTOR 1/4W 5% 1K	1	R103	191	R25
42	01-0167-330	RESISTOR 1/2W 5% 33 OHM	1	R100	191	R25
43	01-0166-360	RESISTOR 1/4W 5% 36 OHM	2	R91,R94	191	R25
44	01-0355-104	CAP, CER X7R, 50V,10%,.1ufd	1	C47	161	CW20C104K
45	01-0355-334	CAP,CER,X7R,50V,10%,.33ufd	1	C44	161	CW30C334K

* COMPLETE MODE LOGIC (A7) CARD WITH ELECTRONIC COMPONENTS INSTALLED.
ORDER 30-0073-006

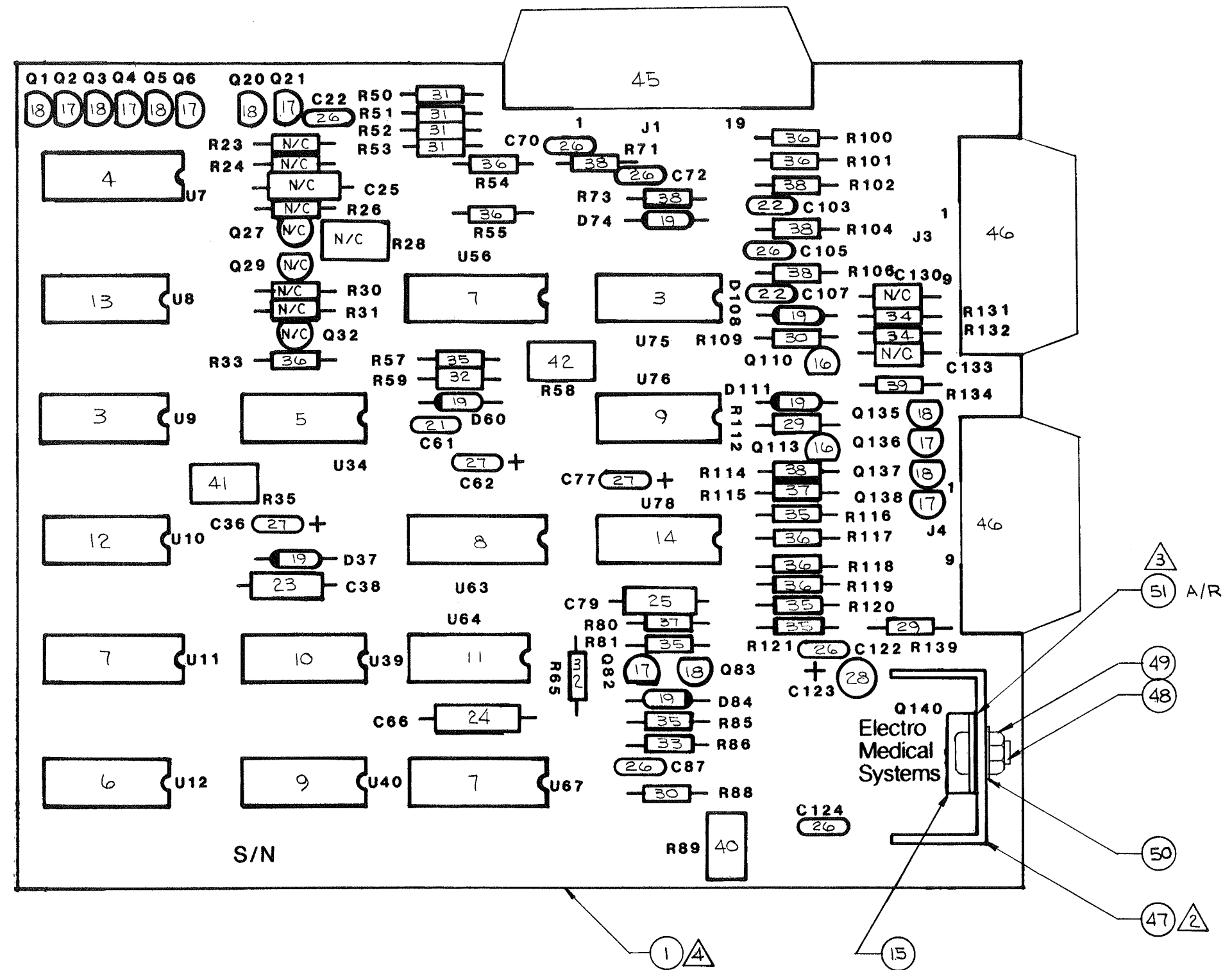


- ⚠ REMOVE PIN 6 FROM THE J4 HEADER
- ⚠ MFG. IS TO PERMANENTLY MARK IN THE ASSEMBLY DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
- I. NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES REPRESENT THE NOTES ITEM NUMBERS ON THE BILL OF MATERIALS.

Figure 6-7
Parts Location Detail and
Parts List
Mode Logic A7 PCB Assy
30-0073-006

* RF LOGIC (A8) PCB (CARD) ASSEMBLY 30-0072-005

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0072-004	SCHEMATIC RF LOGIC A8	REF	A8	114	
3	01-0200-000	4001 QUAD 2-INPUT NOR	2	U9,U75	190	CD4001BCN
4	01-0317-000	4050 BUFFER, HEX, NON-INVERT	1	U7	104	MC14050B
5	01-0201-000	4011 QUAD 2-INPUT NAND	1	U34	190	CD4011BCN
6	01-0293-000	4025 TRIPLE 3-INPUT NOR	1	U12	190	CD4052BCP
7	01-0202-000	4027 DUAL J-K F-F	3	U11,U56,U67	106	4027BPC
8	01-0230-000	4040 BINARY COUNTER 12 STAGE	1	U63	104	MC14040BPC
9	01-0195-000	4069 HEX INVERTER	2	U40,U76	106	MC4069UBPC
10	01-0298-000	4073 TRIPLE 3-INPUT AND	1	U39	106	4073BPC
11	01-0199-000	4081 QUAD 2-INPUT AND	1	U64	192	CD4081BE
12	01-0302-000	4093 QUAD 2-INPUT NAND SCHM	1	U10	190	CD4093BCN
13	01-0231-000	40106 HEX INVERTER SCHMIDT	1	U8	190	CD40106BCN
14	01-0281-000	LM339 QUAD VOLT COMPARATOR	1	U78	190	LM339N
15	01-0079-000	LM7815 CT + 15V REG	1	Q140	104	LM7815CT
16	01-0210-000	MPS A13 DARLINGTON NPN	2	Q110,Q113	190	
17	01-0152-000	2N3904 NPN	7	Q2,Q4,Q6,Q21,Q82,Q136,Q138	104	
18	01-0213-000	2N3906 PNP	7	Q1,Q3,Q5,Q20,Q83,Q135,Q137	104	
19	01-0029-000	1N914 DIODE 75V 10MA	6	D37,D60,D74,D84,D108,D111	133	
20		NOT USED				
21	01-0260-750	CAP 630V POLYSTYRM 75pfd	1	C61	102	SX475
22	01-0208-000	CAP 1KV DISC CERAMIC 4700pfd	2	C103,C107	103	5GAD47
23	01-0260-151	CAP 630V POLYSTYRENE 150pfd	1	C38	102	SX315
24	01-0260-511	CAP 630V POLYSTYRENE 510pfd	1	C66	102	SX 282
25	01-0074-000	CAP 80V FILM .01ufd	1	C79	103	192P1039R8
26	01-0262-334	CAP 50V CERAMIC MONO .33ufd	7	C22,C70,C72,C87,C105,C122,C124	161	CZ30C334M
27	01-0259-015	CAP 25V RADIAL TANT 1.5ufd	3	C36,C62,C77	103	199D155X0025AB1
28	01-0257-475	CAP 35V RADIAL ELECT 4.7u	1	C123	103	503D475F035KA
29	01-0167-033	RESISTOR 1/2W 5%	3.3	R112,R139	191	R25
30	01-0166-100	RESISTOR 1/4W 5%	10	R88,R109	191	R25
31	01-0166-101	RESISTOR 1/4W 5%	100	R50 THROUGH 53	191	R25
32	01-0166-102	RESISTOR 1/4W 5%	1K	R59,R65	191	R25
33	01-0166-152	RESISTOR 1/4W 5%	1.5K	R86	191	R25
34	01-0166-221	RESISTOR 1/4W 5%	220	R131,R132	191	R25
35	01-0166-472	RESISTOR 1/4W 5%	4.7K	R57,R1,85,116,120	191	R25
36	01-0166-103	RESISTOR 1/4W 5%	10K	121	191	R25
37	01-0166-123	RESISTOR 1/4W 5%	12K	R33,54,55,100,101	191	R25
38	01-0166-333	RESISTOR 1/4W 5%	33K	117,118,119	191	R25
39	01-0166-823	RESISTOR 1/4W 5%	82K	114	191	R25
40	02-0186-202	RESISTOR, TRIM 1T 3/8SQ.2K	1	R134	173	3386H202
41	02-0186-103	RESISTOR, TRIM 1T 3/8 SQ. 10K	1	R89	173	3386H103
42	02-0186-203	RESISTOR, TRIM 1T 3/8 SQ. 20K	1	R35	173	3386H203
43		NOT USED				
44		NOT USED				
45	02-0181-110	HEADER, RT ANGLE.1X.1 20 PIN	1	J1	199	102160-4
46	02-0181-101	HEADER, RT ANGLE.1X.1 10PIN	2	J3,4	199	102160-1
47	04-0234-000	HEATSINK TO220 150 C/W	1		197	62308
48	03-0251-003	SCREW 4-40 X 1/4L BH	1			
49	03-0016-000	NUT 4-40	1			
50	03-0288-115	WASHER FLAT 4-40	1			
51	09-0001-000	HEATSINK COMPOUND	A/R			



* COMPLETE RF LOGIC (A8) CARD WITH ELECTRONIC COMPONENTS INSTALLED.
ORDER 30-0072-005

5. N/C INDICATES THAT THERE IS NOT A COMPONENT INSTALLED.

4 MFG. IS TO PERMANENTLY MARK IN THE ASSY. DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.

3 PLACE HEATSINK COMPOUND ON BACK OF METAL TAB BEFORE MOUNTING TO HEATSINK.

2 BEND HEATSINK MTG. TABS OUTWARD TO SECURE HEATSINK TO PCB.

1 NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES ON THE P.C. BOARD REPRESENT ITEM NUMBERS ON THE MATERIAL LIST.

NOTES

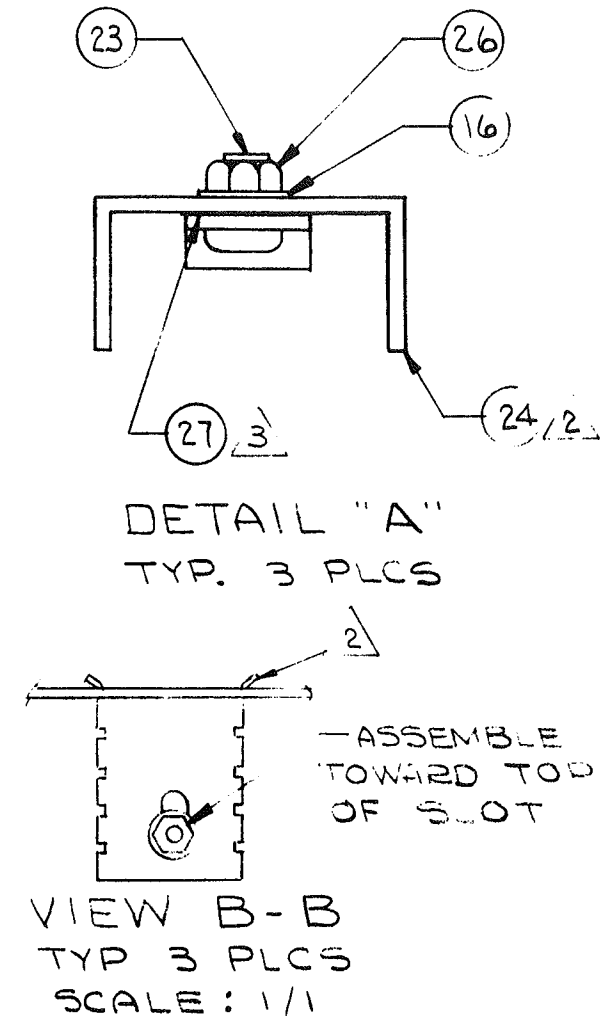
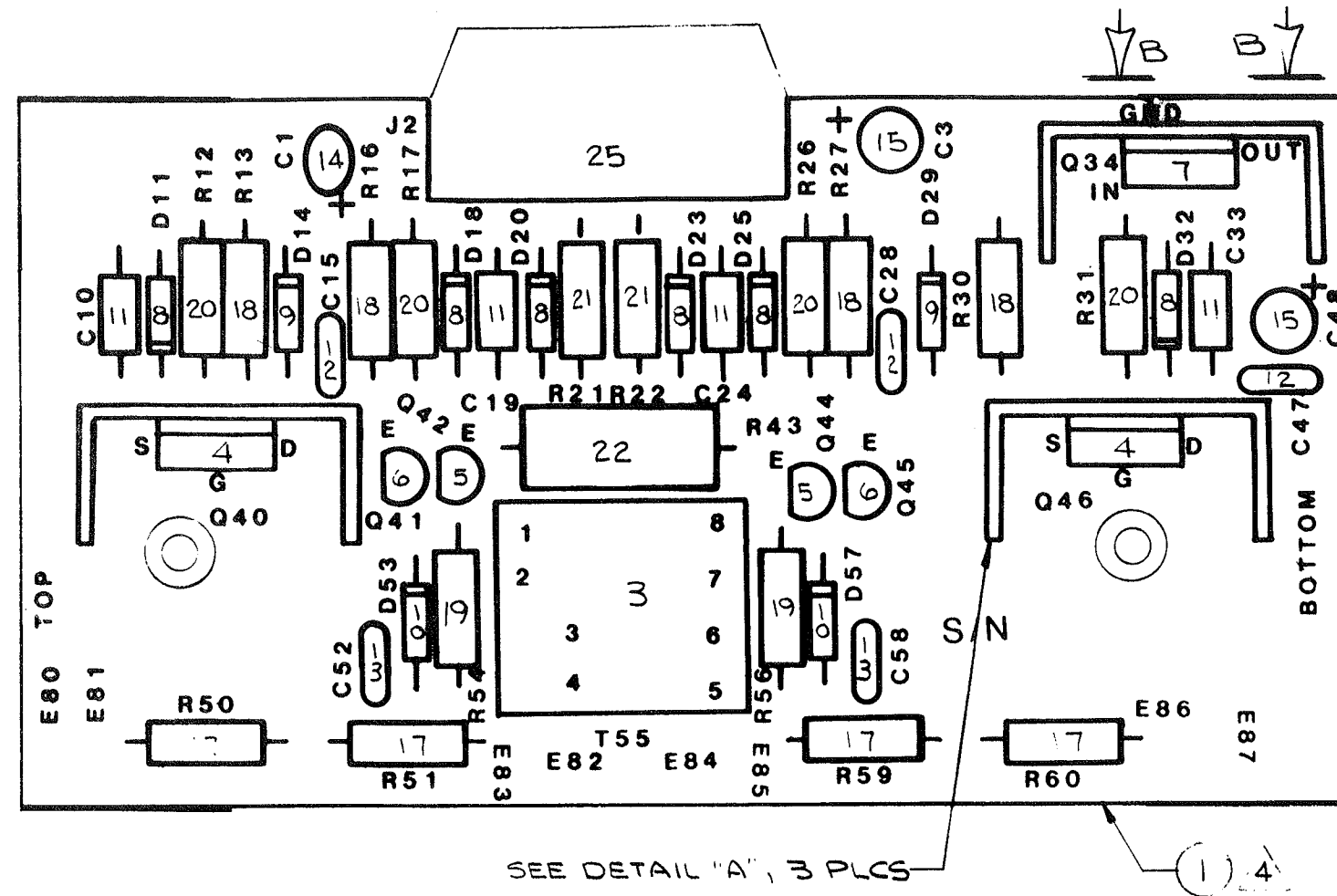
Figure 6-8
Parts Location Detail and
Parts List
R.F. Logic A8 PCB Assy
30-0072-005

*** RF DRIVER (A4) PCB SUB-ASSEMBLY 30-0076-002

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0076-001	SCHEMATIC RF DRIVER A4	REF			
3	05-0074-001	TRANSFORMER, DRIVER	1	T55	114	114
4	01-0211-000	VN66AF FET	2	Q40,Q46	195	
5	01-0152-000	2N3904 NPN	2	Q42,Q44	104	
6	01-0213-000	2N3906 PNP	2	Q41,Q45	104	
7	01-0320-000	LM340A5 + 15V REG + 2%	1	Q34	190	LM340AT-15
8	01-0029-000	1N914 DIODE	6	D11,D18,D20,D23,D25,D32	133	
9	01-0103-000	DIODE 1N5228 ZENER 3.9V	2	D14,D29	104	
10	01-0315-000	DIODE 1N5262 ZENER 51V	2	D53,D57	196	1N5262B
11	01-0260-750	CAP 630V POLYSTYRENE 75pfd	4	C10,C19,C24,C33	102	SX475
12	01-0262-334	CAP 50V CERAMIC MONO .33ufd	3	C15,C28,C47	161	CZ30C334M
13	01-0262-684	CAP 50V CERAMIC MONO .68ufd	2	C52,C58	161	CZ30C684M
14	01-0259-015	CAP 25V TANT 1.5ufd	1	C1	103	199D155X0025AB1
15	01-0257-475	CAP 35V RADIAL ELECT 4.7ufd	2	C3,C48	103	503D475F035KA
16	03-0288-115	WASHER, FLAT #4	3			
17	01-0166-220	RESISTOR, 1/4W 5% 22 OHM	4	R50,R51,R59,R60	191	R25
18	01-0166-561	RESISTOR, 1/4W 5% 560 OHM	4	R13,R16,R27,R30	191	R25
19	01-0166-102	RESISTOR, 1/4W 5% 1K OHM	2	R54,R56	191	R25
20	01-0166-512	RESISTOR, 1/4W 5% 5.1K OHM	4	R12,R17,R26,R31	191	R25
21	01-0166-103	RESISTOR, 1/4W 5% 10K OHM	2	R21,R22	191	R25
22	01-0169-561	RESISTOR, 2W 5% 560 OHM	1	R43	129	RC2 RCR42
23	03-0251-003	SCREW, 4-4x1/4" L B.H.	3			
24	04-0234-000	HEAT SINK 50-220 15°C/W	3		197	623CB
25	02-0181-101	HEADER, RT ANGLE .1x1	1	J2	199	102160-1
26	03-0016-000	NUT 4-40	3			
27	09-0001-000	HEAT SINK COMPOUND	A/R			

*** DO NOT ORDER - ASSEMBLY IS PART OF HEAT SINK A13, SEE PAGE 6-13,14
SEE DISASSEMBLY INSTRUCTIONS MAINTENANCE SECTION
COMPLETE QUICK DISCONNECT ASSEMBLY

* ORDER RF DRIVER AND HEATSINK ASSEMBLY A13 20-0047-002



- 4 MFG. IS TO PERMANENTLY MARK IN THE ASSY. DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
- 3 PLACE HEATSINK COMPOUND ON BACK OF METAL TAB BEFORE MOUNTING TO HEATSINK.
- 2 BEND HEATSINK MTG. TABS OUTWARD TO SECURE HEATSINK TO PCB.
- 1 NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES ON THE P.C. BOARD REPRESENT ITEM NUMBERS ON THE MATERIAL LIST.

NOTES

Figure 6-9
Parts Location Detail and
Parts List
R.F. Driver A4 PCB Assy
30-0076-002

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*** POWER DEVICE (A11) PCB SUB-ASSEMBLY 30-0080-001

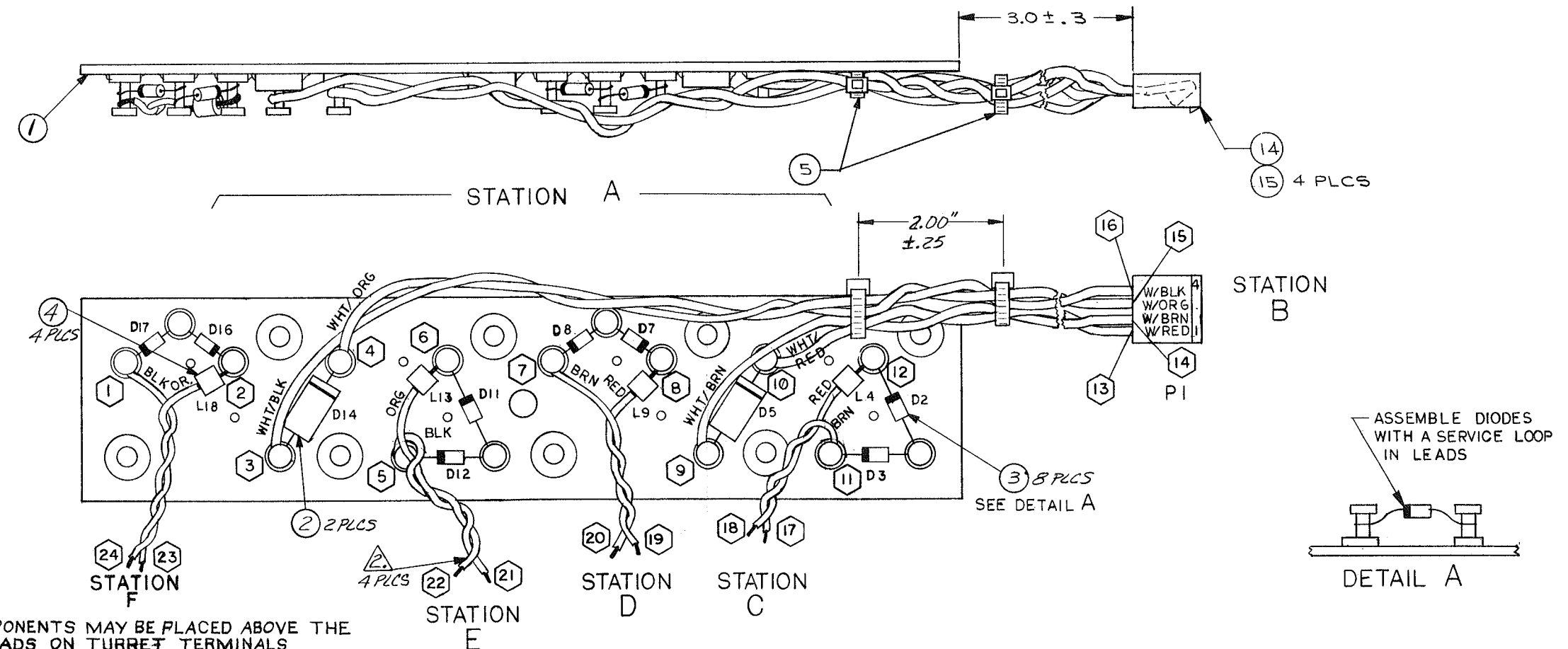
Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	01-0318-001	TRANSORB 275 V	2	D5,D14	218	KE250
3	01-0327-000	DIODE ZENER 1/2W 1N5242B 12V	8	D2,D3,D7,D8,D11, D12,D16,D17	196	1N5242B
4	05-0079-000	FERRITE BEADS	4	L4,L9,L13,L18		
5	07-0133-000	WIRE TIE	2		114	
6	08-0440-090	WIRE INSULATED 18AWG WHT/BLK	.7		114	
7	08-0440-091	WIRE INSULATED 18AWG WHT/BRN	.5		114	
8	08-0440-092	WIRE INSULATED 18AWG WHT/RED	.5		114	
9	08-0440-093	WIRE INSULATED 18AWG WHT/OR	.7		114	
10	08-0442-000	WIRE INSULATED 22AWG BLK	.5		114	
11	08-0442-001	WIRE INSULATED 22AWG BRN	.5		114	
12	08-0442-002	WIRE INSULATED 22AWG RED	.5		114	
13	08-0442-003	WIRE INSULATED 22AWG OR	.5		114	
14	02-0165-004	HOUSING CONNECTOR .156 4 PIN	1	P1	164	09-50-3041
15	02-0097-001	CRIMP TERMINAL	4		164	08-55-0104
16	50-0080-001	SCHEMATIC, POWER DEVICE, A11	REF			

*** DO NOT ORDER - ASSEMBLY IS PART OF HEATSINK A13, SEE PAGE 6-13,14

* ORDER RF DRIVER AND HEATSINK ASSEMBLY (A13) 20-0047-002
"COMPLETE QUICK DISCONNECT ASSEMBLY" SEE DISASSEMBLY INSTRUCTIONS MAINTENANCE SECTION

TERMINATION/WIRE LIST

WIRE NO.	ITEM NO.	WIRE COLOR	IN. WIRE LENGTH	TERMINATION FROM			TERMINATION TO				
				STATION	POINT	WITH	STATION	POINT	WITH	COMMENT	
1	7	WHT/BRN	7	A	9			B	14		PIN 2
2	6	WHT/BLK	9-1/8	A	3			B	16		PIN 4
3	9	WHT/ORG	8-3/8	A	4			B	15		PIN 3
4	8	WHT/RED	6-1/2	A	10			B	13		PIN 1
5	11	BRN	3	A	11			C	18		
6	11	BRN	3	A	7			D	19		
7	10	BLK	3	A	1			F	24		
8	10	BLK	3	A	5			E	22		
9	13	ORG	2-3/4	A	2			F	23		
10	13	ORG	2-3/4	A	6			E	21		
11	12	RED	2-3/4	A	8			D	20		
12	12	RED	2-3/4	A	12			C	17		



7. ALL COMPONENTS MAY BE PLACED ABOVE THE WIRE LEADS ON TURRET TERMINALS.
6. STRIP WIRES 1/8" ± 1/16" FOR CRIMP TERMINALS.
5. STRIP WIRES 1/4" ± 1/8".
4. ROUTE ALL WIRES APPROX. AS SHOWN.
3. STRIP WIRE 1/2" ± 1/16", AND SLIP FERRITE BEAD OVER EXPOSED LEAD. SOLDER REMAINING LEAD TO TERMINAL
2. TWIST WIRE PAIRS 5 FULL TWISTS.
1. SOLDER ALL TURRET TERMINALS AND PEM-NUTS TO CIRCUIT BOARD.

NOTES

Figure 6-10
Parts Location Detail and
Parts List
Power Device A11 PCB Assy
30-0080-001

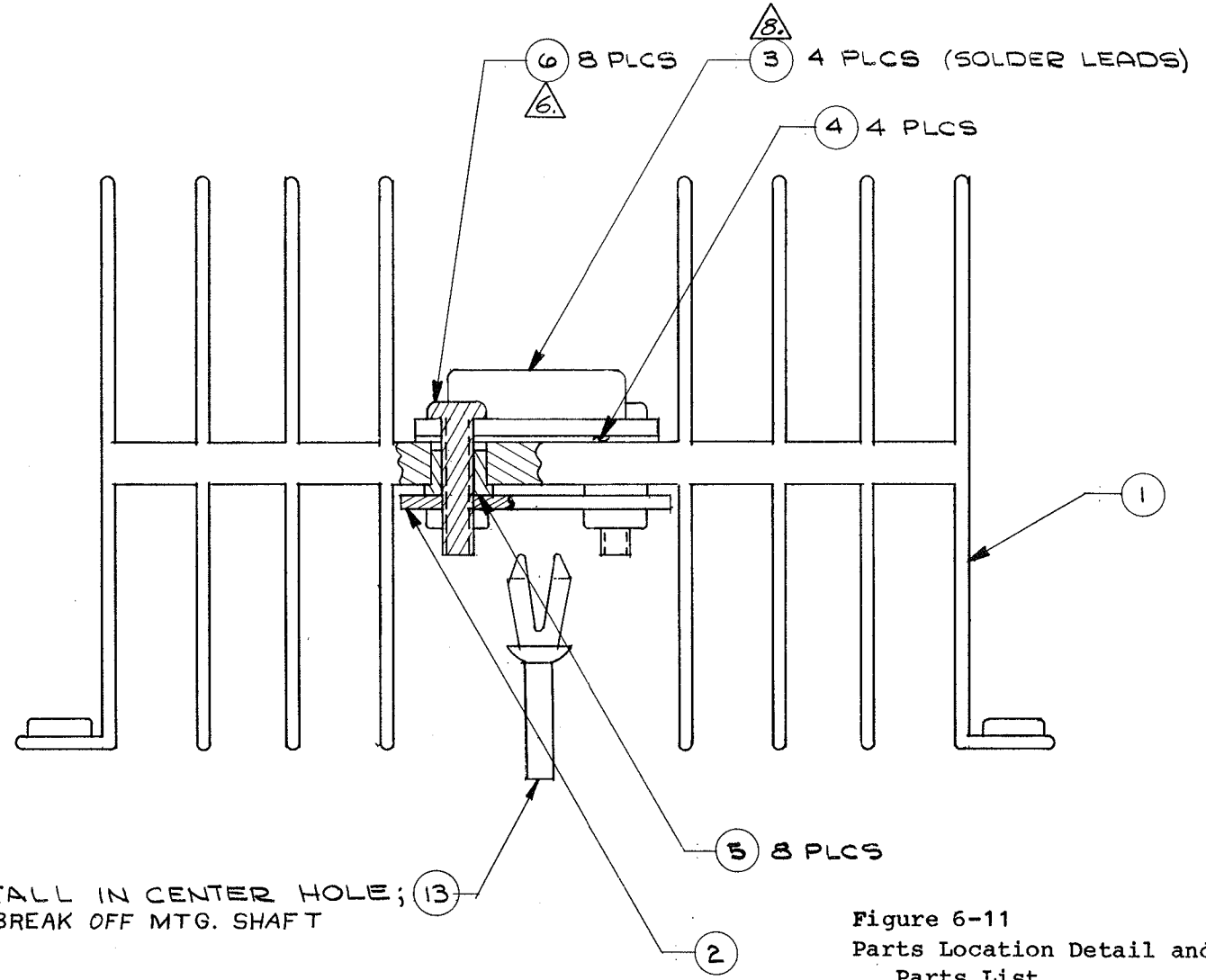
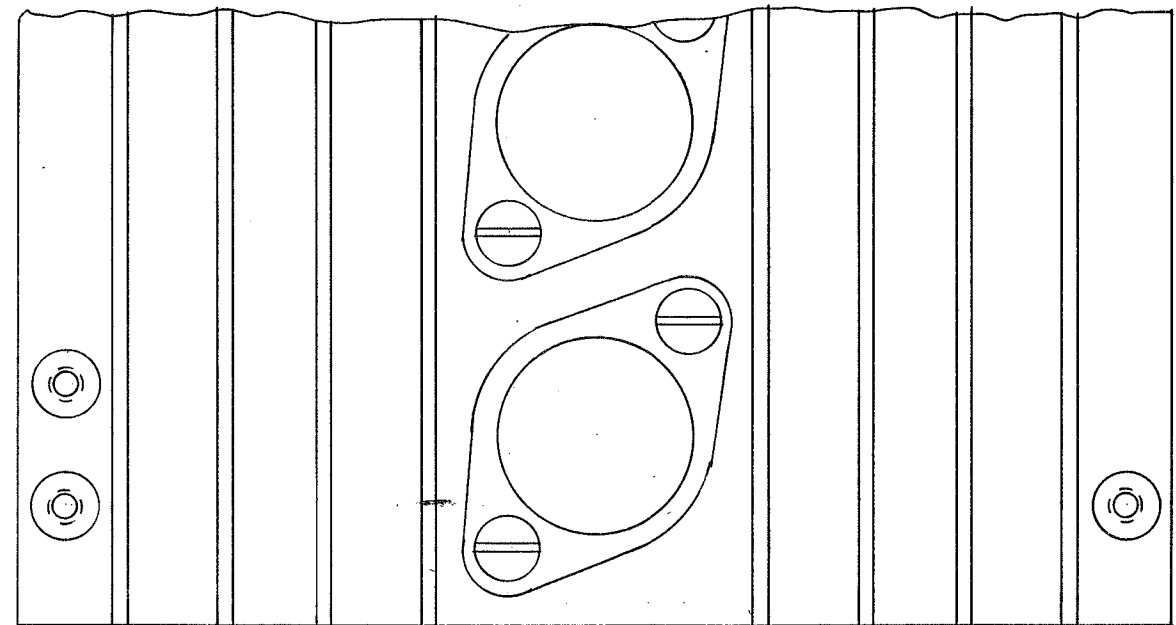
* RF DRIVER & HEATSINK ASSY (A13) - ASSEMBLY 20-0047-002 (2 EACH)

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1	04-0229-001	HEAT SINK	1		114	
*** 2	30-0080-001	PCB ASSY, PWR DEVICE A11	1		114	
** 3	01-0311-001	TRANSISTOR, PWR 7	4	Q1,Q6,Q10,Q15 (L/R)	**	SEE **
4	03-0279-001	INSULATOR, TO-3	4			
5	03-0291-028	WASHER, SHOULDER, TFE	8			
6	03-0251-107	SCREW, B.H. SLOT, 6-32x1/2"	8*			
*** 7	30-0076-002	PCB ASSY, RF DRIVER A4	1		114	
8	03-0269-001	BRACKET, HEAT SINK	2			
9	03-0282-001	STANDOFF, PHENOLIC	4			
10	03-0251-103	SCREW, B.H. 6-32x1/4L	4			
11	03-0251-109	SCREW, B.H. 6-32x3/4L	4			
12	09-0081-000	LOCTITE, 242	A/R			
13	07-0185-003	RIVET, NYLON	1			
14	03-0311-008	CABLE CLIP	1			

** INTERNATIONAL RECTIFIER IRF 332
 MOTOROLA MTM5N40
 HITACHI 2SK2985P
 ACTUAL * K298SP
 INTERSIL IVN6200KNS

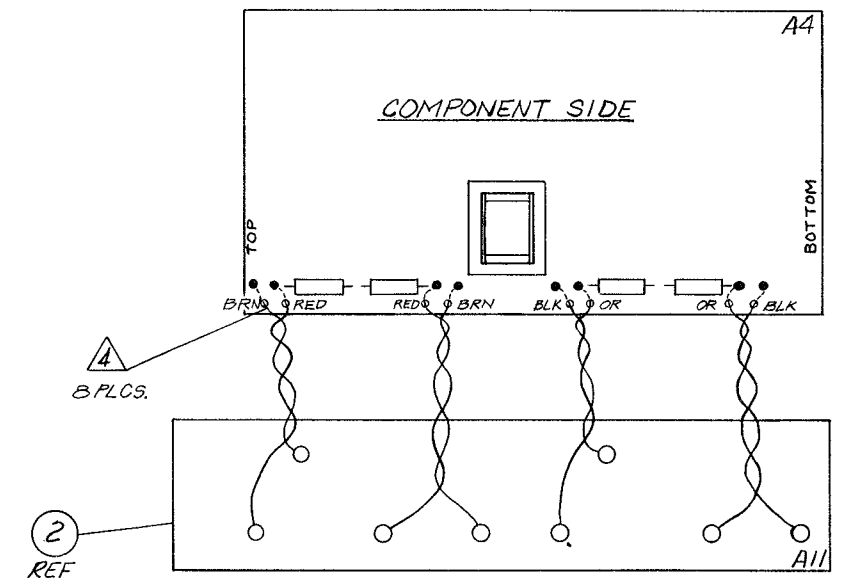
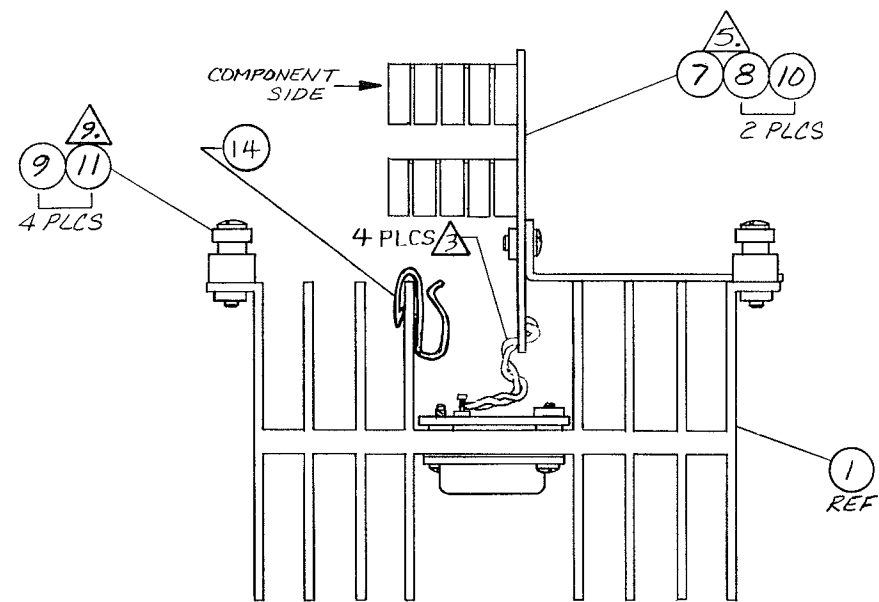
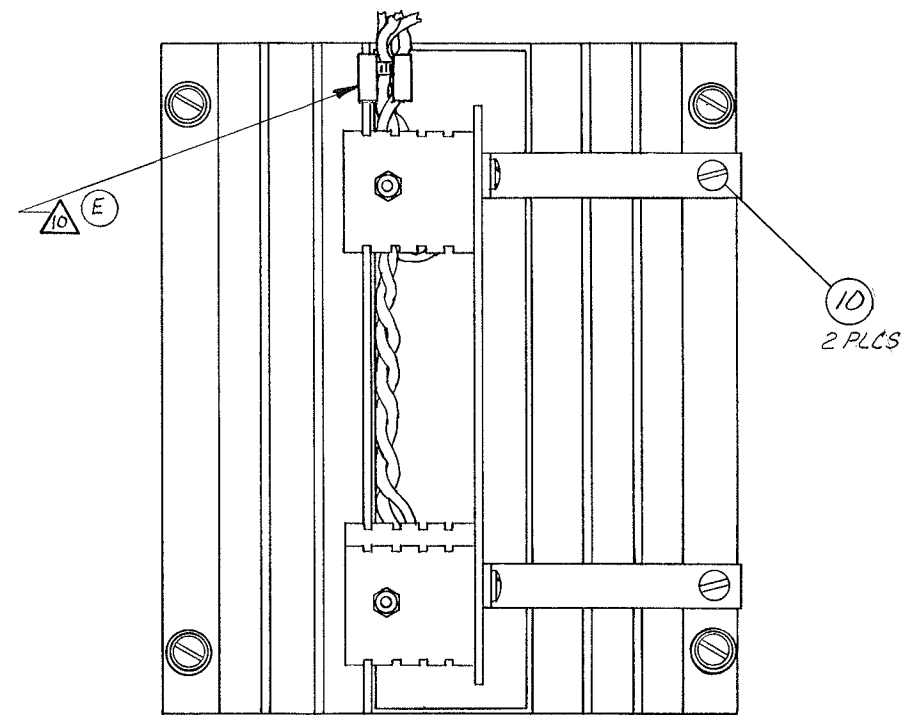
*** DO NOT ORDER - PART OF COMPLETE HEAT SINK ASSEMBLY

* ORDER COMPLETE RF DRIVER AND HEATSINK ASSEMBLY
 (A13) 20-0047-002 (BOTH HEAT SINK ASSEMBLIES ARE INTERCHANGEABLE)
 "COMPLETE QUICK DISCONNECT ASSEMBLY", SEE DISASSEMBLY INSTRUCTIONS MAINTENANCE SECTION



INSTALL IN CENTER HOLE; (13)
 AND, BREAK OFF MTG. SHAFT

Figure 6-11
 Parts Location Detail and
 Parts List
 R.F. Driver & Heat Sink
 Assy A13
 20-0047-002



- (E)
- ⑩ LOCATE CABLE CLIP APPROX. AS SHOWN.
 - ② APPLY LOCTITE 242, ITEM ⑫, TO THREADS, AS REQ'D.
 - ⑧ ALL TRANSISTORS TO BE FROM SAME MFG. FOR EACH ASSY.
 - ⑦ (SEE SHT. 1)
 - ⑥ TORQUE INDICATED SCREWS TO 6 IN-LBS. APPLY LOCTITE, ITEM ⑫.
 - ⑤ ASSEMBLE R.F. DRIVER BD A4, ITEM ⑦, AND BRACKETS, ITEM ⑧, BEFORE ASSEMBLY TO HEATSINK, ITEM ①.
 - ④ SLIP WIRES INTO FEED THRU HOLES AS SHOWN BEFORE SOLDERING; MIN. STRAIN RELIEF REQ'D.
 - ③ BEND TWISTED PAIRS AS SHOWN BEFORE ASSEMBLY OF BRACKETS TO HEATSINK.
 - 2. ORIENT PC BOARDS AS SHOWN BEFORE SOLDERING.
 - 1. ROUTE WIRES AS SHOWN.

NOTES

WIRE INTERCONNECT SCHEME

Figure 6-12
Parts Location Detail and
Parts List
R.F. Driver & Heat Sink
Assy A13
20-0047-002

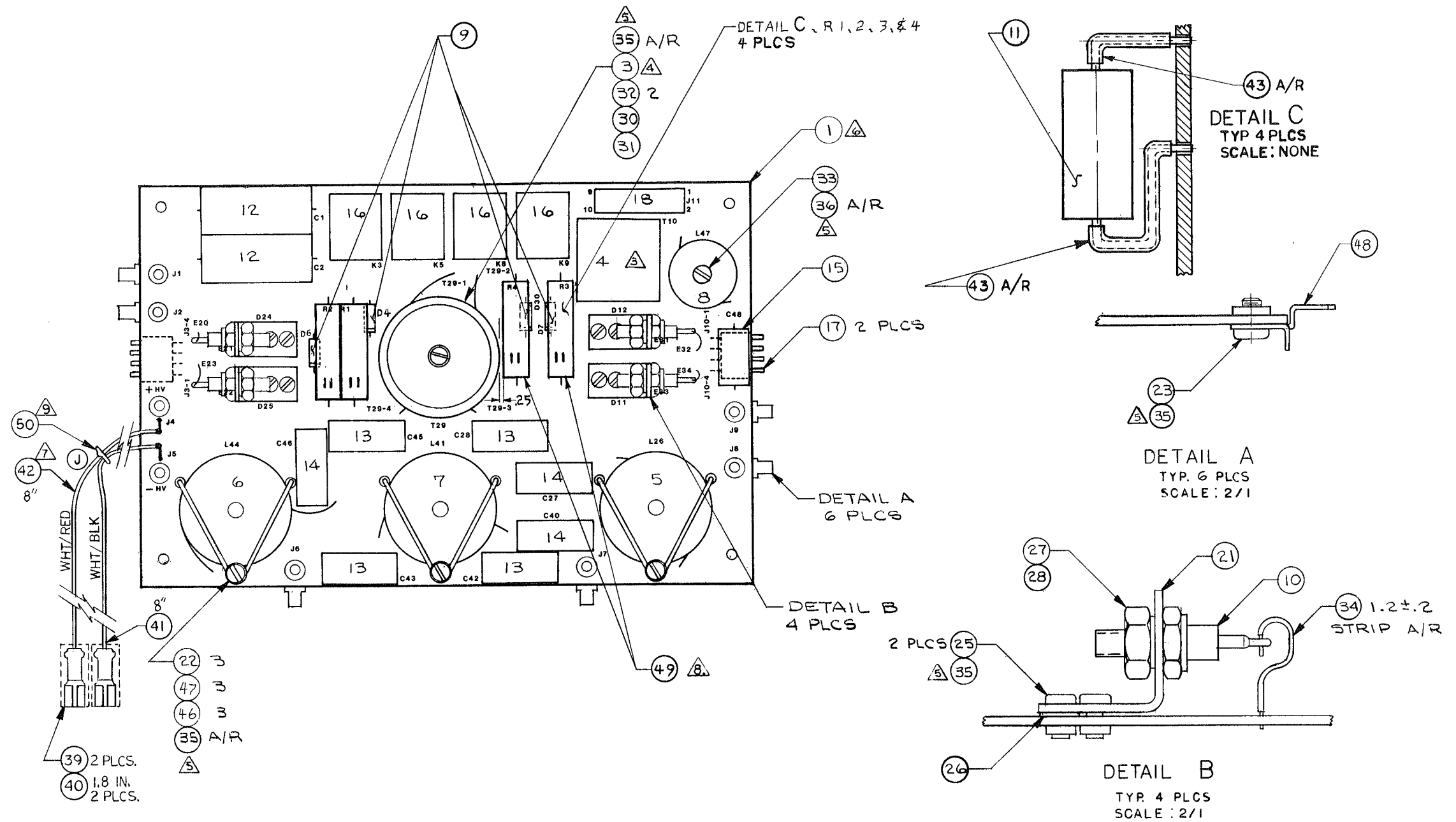
Rev. F 3/84

SHEET 2 OF 2

* RF OUTPUT (A5) PCB ASSEMBLY 30-0083-005

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0083-003	SCHEMATIC, R.F. LOGIC A5	REF		114	
3	05-0068-001	TRANSFORMER ASSY, MONO	1	T29	114	
4	05-0069-001	TRANSFORMER ASSY, BI-POL	1	T10	114	
5	05-0075-001	INDUCTOR, POT CORE, ADJ.	1	L26	114	
6	05-0075-004	INDUCTOR, POT CORE	1	L44	114	
7	05-0075-003	INDUCTOR, POT CORE, ADJ.	1	L41	114	
8	05-0077-001	INDUCTOR, POT CORE	1	L47	114	
9	01-0328-000	RECTIFIER, 5A, HI-EFF	4	D4, D6, D7, D30	131	DSR 5400X
10	01-0187-000	DIODE, FAST RECOVERY	4	D11, D12, D24, D25	136	IN 3883
11	01-0397-033	RESISTOR, WW, N/IND, 7W, 5%, 3.3	4	R1, R2, R3, R4	191	
12	01-0267-205 1	CAP, POLYESTER, 400V 2MFD	2	C1, C2	209	MWR20RM 400V 10%
13	01-0261-102	CAP, POLYPROP, 2KV, 1000pfd	4	C28, C42, C43, C45	210	PHE421SD410J
14	01-0261-332	CAP, POLYPROP, 2KV, 3300pfd	3	C27, C40, C46	210	PHE421SD433J
15	01-0260-472	CAP, POLYSTYRENE, 630V, 4700pfd	1	K48	102	SX247
16	02-0174-000	RELAY, 10A, 12V, DPDT	4	R3, K5, K8, K9	211	R10-E2-W2V185 V185-12V DC
17	02-0145-004	CONN, R.A., .156, 4 PIN	2	J3, J10	171	HPAS156-4
18	02-0187-102	HEADER, ST, .10X10, 10PIN	1	J11	199	102156-1 AV/A
19		NOT USED				
20		NOT USED				
21	04-0239-002	BRKT, DIODE	4		114	
22	40-0021-001	BRKT ASSY, FERRITE	3		114	
23	03-0252-103	SCREW, PH, SL, 6-32 X 1/4	6			
24		NOT USED				
25	03-0252-003	SCREW, PH, SL, 4-40 X 1/4	8			
26	03-0289-102	WASHER, LK, I.T., #4, ST.	4			
27	03-0287-016	NUT, HEX, 10-32, ST.	4			
28	03-0289-105	WASHER, LK, I.T., #10, ST.	4			
29		NOT USED				
30	02-0288-121	WASHER, ST, .156X.438X.040	1			
31	03-0252-112	SCREW, PH, SL, 6-32 X 1-1/4	1			
32	03-0178-000	WASHER, NYL, .199X1.50X.04	2			
33	03-0285-111	SCREW, PH, SL, 6-32X1, NYL.	1			
34	08-0334-000	WIRE, 22 AWG, SOLID, WHT/BLK	.5 FT.			
35	09-0081-000	LOCTITE, 242	A/R			
36	09-0109-000	LOCTITE 430	A/R			
37	01-0267-225	CAP, POLYESTER, 400V, 2.2MFD	REF		223	MKT1813
38	10-0105-001	DECAL HI-VOLTAGE	1		114	
39	03-0117-000	TERMINAL, .250 O.D., 22/18 GA	2			
40	11-0028-006	TUBING, H.S. 1/4" O.D., BLK	.3 FT.			
41	08-0440-090	WIRE, INS, 18AWG, WHT/BLK	.75 FT.			
42	08-0440-092	WIRE, INS, 18AWG, WHT/RED	.75 FT.			
43	11-0012-000	TUBING, NO. 17, TFT	.6 FT.			
44	09-0048-000	SOLDER, 63/37, TIN/LEAD, .031	3			
45	09-0048-001	SOLDER, 63/37, TIN/LEAD, .020	3			
46	03-0070-000	WASHER, NYLON, .142 X .312 X .031	3			
47	03-0252-113	SCREW, PH, SL, 6-32 X 1-1/2	3			
48	04-0281-001	TERMINAL, O.D., .187 SPECIAL	6	J1, 2, 6, 7, 8, 9		
49	09-0079-000	ADHESIVE/SEALANT, RTV 108	A/R			
50	07-0133-000	TIE WRAP	1			

* COMPLETE RF OUTPUT (A5) PCB ASSEMBLY WITH ELECTRONIC COMPONENTS INSTALLED
ORDER 30-0083-005 ASSEMBLY



- △ ITEM 50 TO BE POSITIONED 3.0±.5 FROM TERMINALS; (ITEMS 40 AND 41).
- △ USING ITEM 49, RTV, BOND R4 TO R3 WHEN THE ASSEMBLY IS COMPLETE, A MINIMUM SPACE OF 1/4" IS REQUIRED BETWEEN R4 AND T29.
- △ LOOP WIRES THRU HOLES AND SOLDER ON CIRCUIT SIDE. TWIST WIRES TOGETHER APPROX. 3 TURNS PER INCH.
- △ APPLY HI-VOLTAGE DECAL, ITEM 38, TO FAR SIDE OF BOARD (CIRCUIT SIDE) JUST BELOW T29 REF. DESIGNATOR.
- △ APPLY LOCTITE TO SCREW THREADS A/R.
- △ WHITE DOT DENOTES PRIMARY SIDE OF TRANSFORMER (T29-1 & T29-2).
- △ SOLDER TRANSFORMER LEADS FROM BOTH SIDES.
2. MFG. IS TO PERMANENTLY MARK IN THE ASSY DASH NO. OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
1. NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES REPRESENT ITEM NUMBERS ON THE BILL OF MATERIALS.

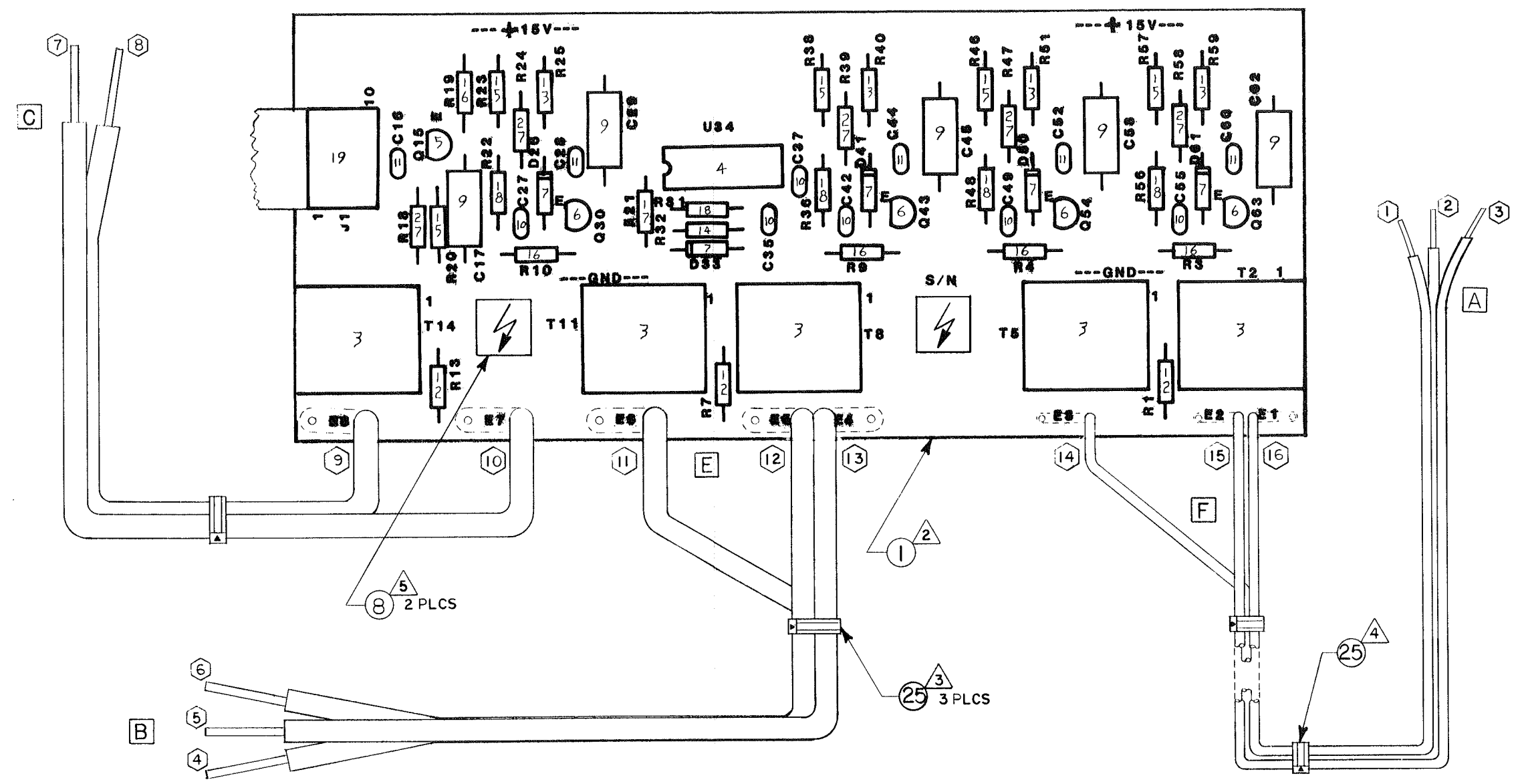
NOTES

Figure 6-13
Parts Location Detail and
Parts List
R.F. Output A5 PCB Assy
30-0083-005

* SENSOR BOARD (A1) PCB ASSEMBLY 30-0079-002

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0079-001	SCHEMATIC HANDCONTROL SENSE A-1	REF		114	
3	05-0073-002	TRANSFORMER	5	T2,T5,T8,T11,T14	114	
4	01-0231-000	40106 HEX SCHMIDT	1	U34	190	CD40106 BCN
5	01-0152-000	TRANSISTOR NPN 2N3904	1	Q15	104	
6	01-0213-000	TRANSISTOR PNP 2N3906	4	Q30,Q43,Q54,Q63	104	
7	01-0029-000	DIODE 1N914	5	D26,D33,D41,D50,D61	133	
8	10-0105-001	DECAL, HIGH VOLTAGE	2		114	
9	01-0073-000	CAP 80V FILM .033UFD	5	C17,C29,C45,C53,C62	103	192P3339R8
10	01-0262-104	CAP,CER,Z5U,50V,20%,.1ufd	6	C27,C35,C37,C42,C49,C55,	161	CZ20C104M
11	01-0355-104	CAP,CER,X7R,50V,10%,.1ufd	5	C16,C28,C44,C52,C60	161	CZ20C104K
12	01-0166-051	RESISTOR 1/4W, 5%, 5.1 OHM	3	R1,R7,R13	191	R25
13	01-0166-561	RESISTOR 1/4W, 5%, 560 OHM	4	R25,R40,R51,R59	191	R25
14	01-0166-222	RESISTOR 1/4W, 5%, 2.2K OHM	1	R32	191	R25
15	01-0166-103	RESISTOR 1/4W, 5%, 10K OHM	5	R20,R23,R38,R46,R57	191	R25
16	01-0166-243	RESISTOR 1/4W, 5%, 24K OHM	5	R3,R4,R9,R10,R19	191	R25
17	01-0166-333	RESISTOR 1/4W, 5%, 33K OHM	1	R21	191	R25
18	01-0166-104	RESISTOR 1/4W, 5%, 100K OHM	5	R22,R31,R36,R48,R56	191	R25
19	60-0036-001	HARNES SENSOR INTERCONNECT	1	J1	114	
20		NOT USED				
21	08-0442-006	WIRE, INSULATED, 22AWG, BLUE	.67			
22	08-0442-000	WIRE, INSULATED, 22AWG, BLK	.67			
23	08-0442-004	WIRE, INSULATED, 22AWG, YELLOW	.67			
24	08-0453-001	WIRE, SILICONE, 20AWG, WHT	2.83			
25	07-0133-000	CABLE TIE	4			
26						
27	01-0166-391	RESISTOR 1/4W, 5% 390 OHM	5	R18,R24,R39,R47,R58	191	R25

* COMPLETE SENSOR BOARD (A1) PCB ASSEMBLY WITH ELECTRONIC COMPONENTS INSTALLED.
ORDER 300079-002 PCB ASSEMBLY



5. LOCATE APPROX. AS SHOWN; SURFACE TO BE FREE OF GREASE, DIRT AND OTHER DEBRIS BEFORE INSTALLATION.
4. FASTEN CABLE TIE 2.00±.25 FROM EXISTING CABLE TIE.
3. FASTEN CABLE TIE 1.00±.25 ABOVE TOP SURFACE OF CIRCUIT BOARD.
2. MANUFACTURER IS TO PERMANENTLY MARK IN THE ASSEMBLY DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
1. NUMBERS INSIDE BALLOONS OR INSIDE THE COMPONENT OUTLINES REPRESENT THE ITEM NUMBERS ON THE BILL OF MATERIAL.
- NOTES**

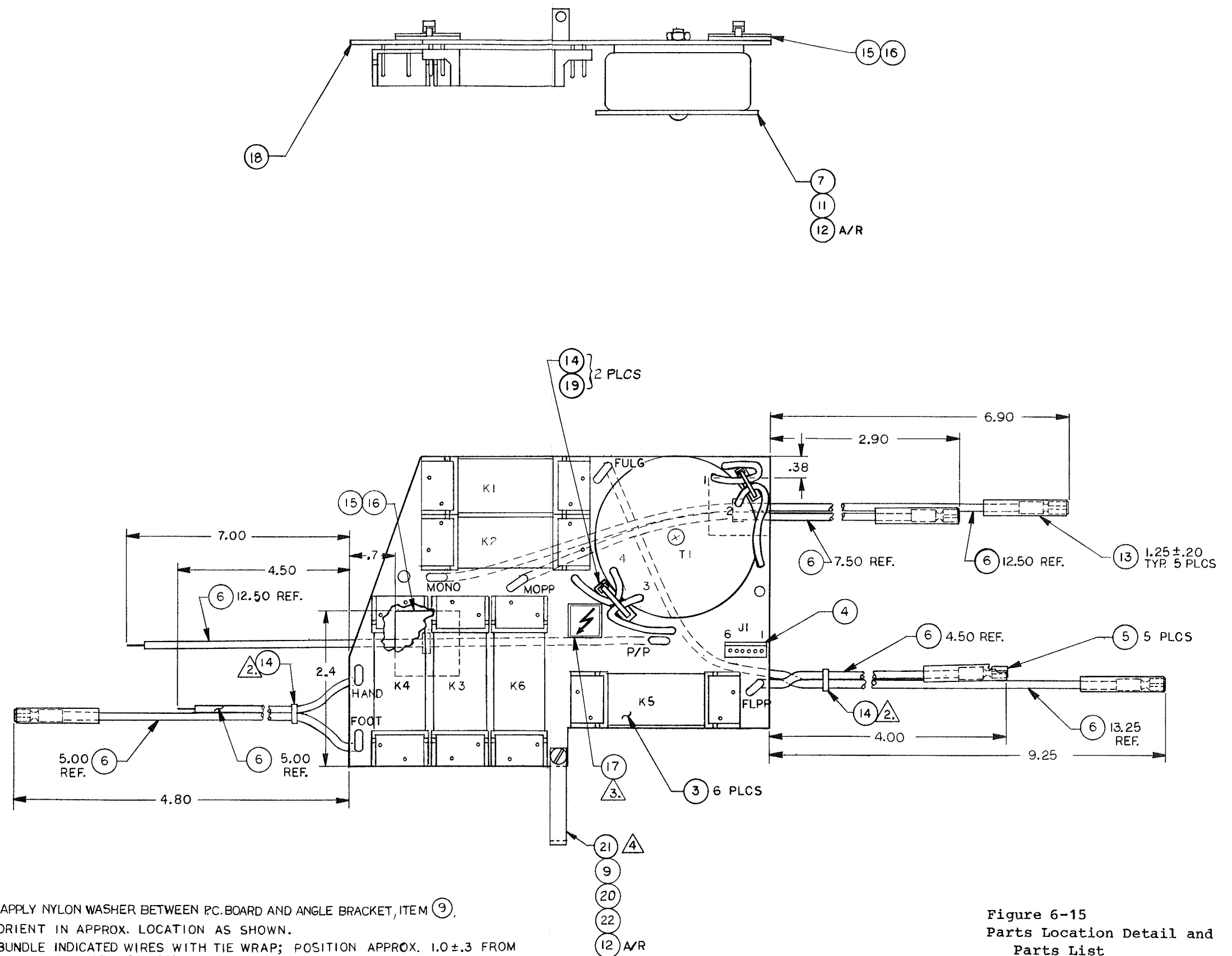
Figure 6-14
Parts Location Detail and
Parts List
Sensor Board A1 PCB Assy
30-0079-002

Rev. K 3/84

*** HIGH VOLTAGE RELAY (A12) PCB ASSEMBLY 30-0082-004

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0082-001	SCHEMATIC, HI VOLT RELAY A12	REF		114	
* 3	02-0169-000	RELAY, HI VOLTAGE	6	K1,K2,K3,K4,K5,K6	202	HE551A5054
4	02-0188-006	CONN.,ST.,.100,6 PIN	1	J1	164	22-29-2061
5	03-0242-000	TERMINAL, QD .187, 22 AWG	5			
6	08-0453-001	WIRE, H.V., 30KV, 20 AWG	5FT.			
* 7	05-0088-002	DIFFERENTIAL TRANSFORMER	1		114	
8		NOT USED				
9	04-0250-001	BRACKET, ANGLE	1		114	
10	03-0252-105	SCREW, PH, SLOT, 6-32 X 3/8	-			
11	03-0287-013	NUT, HEX, 6-32	2			
12	09-0081-000	LOCTITE, 242	A/R			
13	11-0002-000	HEATSHRINK	.43			
14	07-0133-000	TIE WRAP	4			
15	07-0165-000	TIE BLOCK	2			
16	07-0014-005	TIE WRAP	2			
17	10-0105-001	DECAL, HIGH VOLTAGE	1		114	
18		NOT USED				
19	03-0310-001	CABLE TIE HOLDER	2			
20	03-0285-107	SCREW, PH, NYLON SLOTTED 6-32 X 1/2	1			
21	03-0070-000	WASHER, NYLON.142X.312.X.031	1			
22	03-0287-023	NUT, HEX, NYLON 6-32	1			

*** DO NOT ORDER ASSEMBLY UNLESS CARD TRACES ARE DAMAGED
* ORDER RELAYS OR TRANSFORMER AS INDIVIDUAL COMPONENTS.



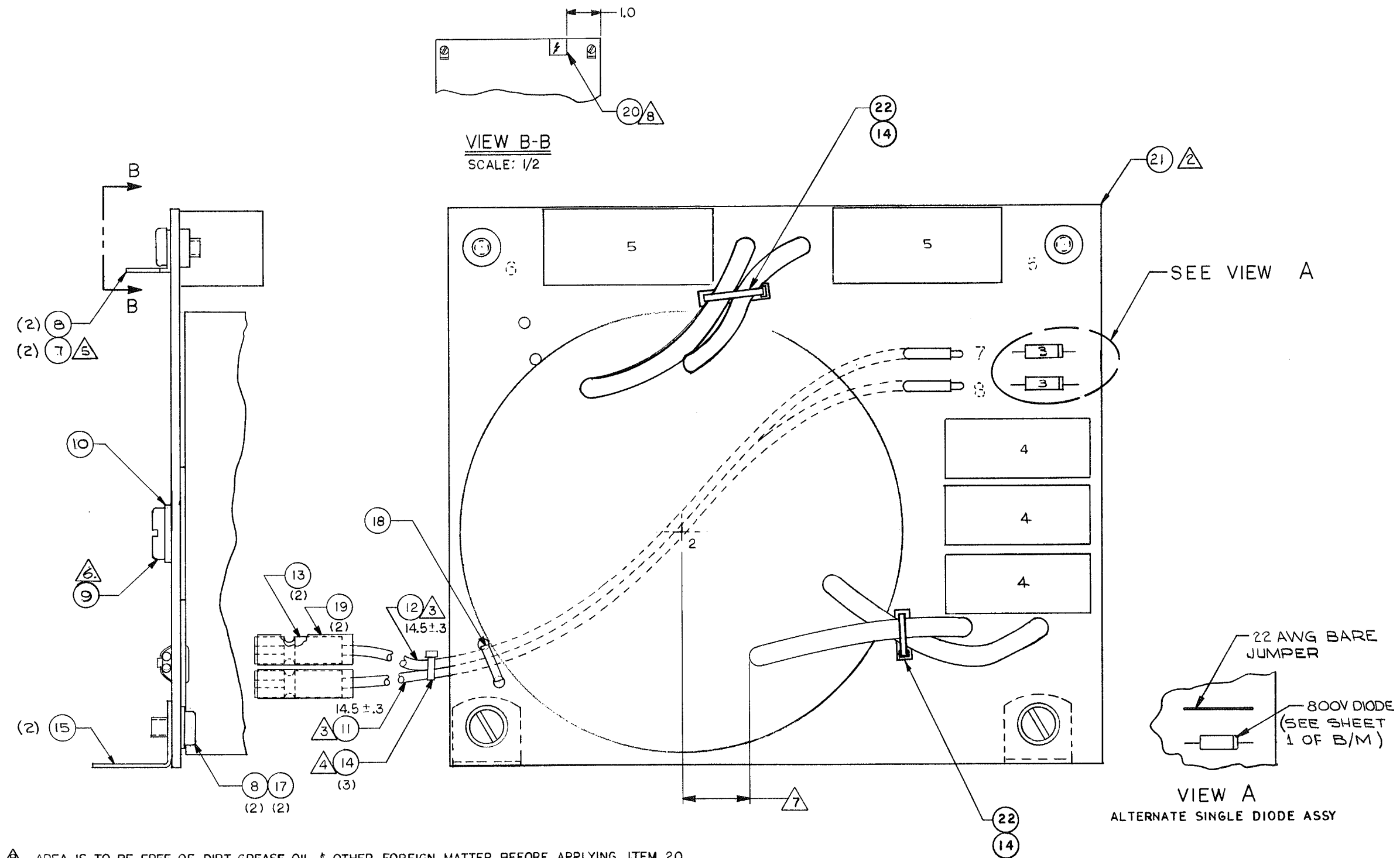
- ④ APPLY NYLON WASHER BETWEEN PC BOARD AND ANGLE BRACKET, ITEM ⑨.
 - ③ ORIENT IN APPROX. LOCATION AS SHOWN.
 - ② BUNDLE INDICATED WIRES WITH TIE WRAP; POSITION APPROX. 1.0 ± .3 FROM PC BOARD EDGE, (2 PLCS).
- NOTES
1. STRIP BACK ENDS OF ALL UNFINISHED LEADS .30 ± .06 PRIOR TO SOLDERING OR CRIMPING.

Figure 6-15
Parts Location Detail and
Parts List
High Voltage Relay A12
PCB Assy
30-0082-004

*** FULGURATION OUTPUT (A2) PCB ASSEMBLY 30-0078-003

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
* 2	05-0071-002	TRANSFORMER, FULGURATE	1	T2	114	
* 3	01-0328-000	DIODE, 3A, 400V	2	D4,D5	148	DSR5400
* 4	01-0261-222	CAP,2KV, POLYPROPYLENE, 2.2NF	3	C6,C7,C8	210	PHE421SF-422J
* 5	01-0261-472	CAP, 2KV, POLYPROPYLENE, 4.7NF	2	C1,C3	210	PHE421SF4475J
6	09-0081-000	LOCTITE 242	A/R	A/R		
7	03-0243-003	TERMINAL, QUICK DISCONNECT	2	P/P, ACT		
8	03-0251-103	SCREW, B.H., #6-32X1/4	4			
9	03-0252-307	SCREW, P.H., #10-24X1/2	1			
10	03-0289-105	WASHER, LOCK, #10	1			
11	08-0440-090	WIRE, INSULATED, 18AWG, WH/BK	1.2	(-)	114	
12	08-0440-091	WIRE, INSULATED, 18AWG, WH/RD	1.2	(+)	114	
13	07-0102-000	TERMINAL, .187 Q.D., 22-18GA.	2			
14	07-0133-000	CABLE TIE	5		212	6005-0350 NAT.
15	03-0025-000	BRACKET, RIGHT ANGLE	2		114	
16	50-0078-002	SCHEMATIC, FULGURATION A2 OUTPUT	REF		114	
17	03-0288-120	WASHER, FLAT, .312X.156X.032	2		*	
18	07-0014-005	TIE WRAP	1			
19	11-0028-006	HEATSHRINK 3/16 OD	.2 FT.			
20	10-0105-001	DECAL, HIGH VOLTAGE	1		114	
21		NOT USED				
22	03-0310-001	CABLE TIE HOLDER	2			

* ONE DIODE P/N 01-0319-000, MAY BE SUBSTITUTED FOR THE TWO DIODES (D4 AND5) CALLED OUT AS ITEM 3.
 * ORDER THE RELAYS, DIODES OR TRANSFORMER AS INDIVIDUAL COMPONENTS
 *** DO NOT ORDER ASSEMBLY UNLESS CARD TRACES ARE DAMAGED



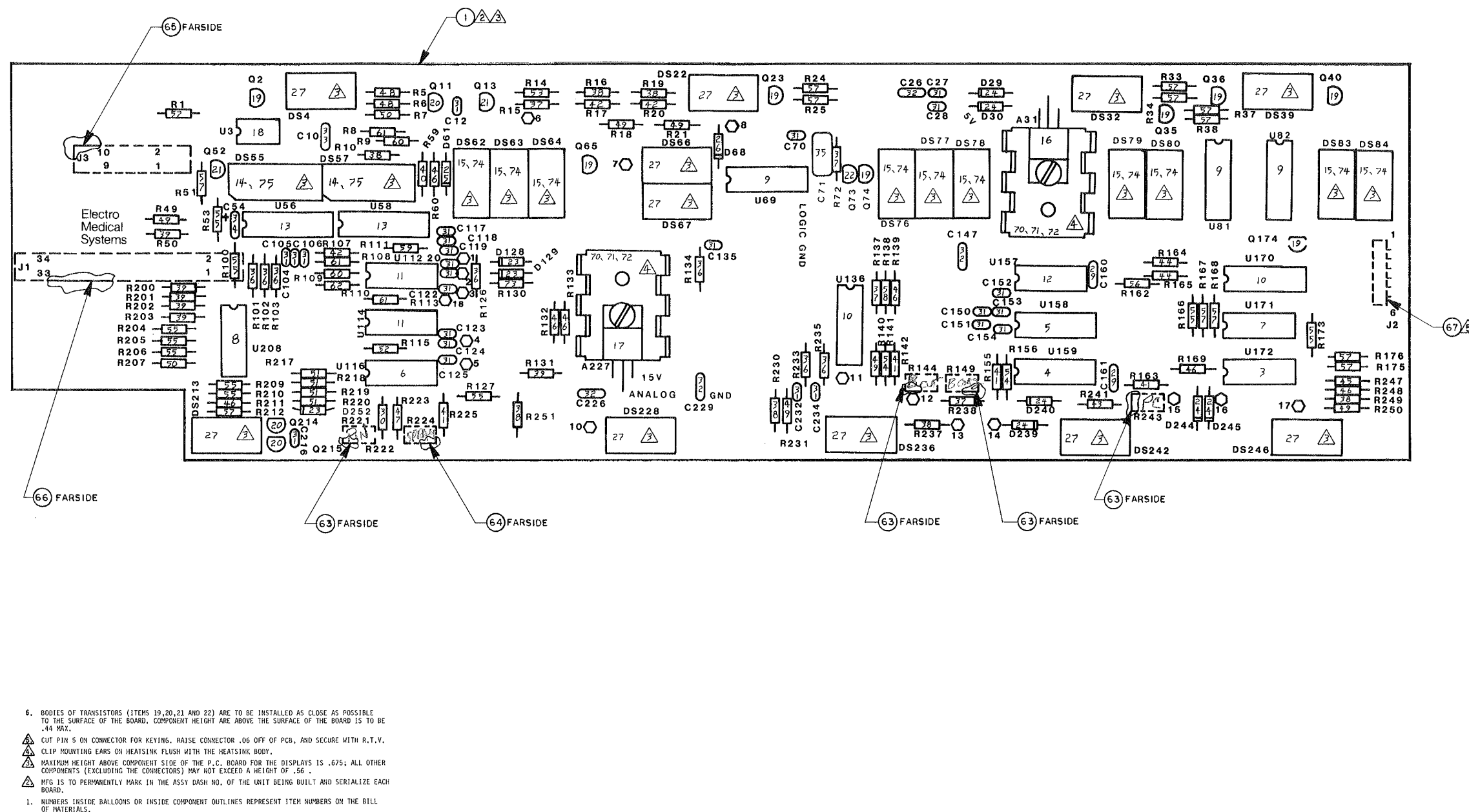
- ⊗ AREA IS TO BE FREE OF DIRT, GREASE, OIL, & OTHER FOREIGN MATTER BEFORE APPLYING ITEM 20.
 - ⊗ ALIGN XFMR ASSY, ITEM (2), .50 ± .25 IN. FROM CENTER LINE AS SHOWN.
 - ⊗ USE LOCTITE 242, ITEM (6), ON THREADS.
 - ⊗ SOLDER TERMINAL TO BOARD.
 - ⊗ TWIST WIRES TOGETHER 10 FULL TIMES, MINIMUM. SPACE CABLE TIES APPROX. EQUALLY OVER TWISTED LEADS. THE END TIES ARE TO BE APPROX. 1.00 FROM BOARD AND TERMINALS.
 - ⊗ STRIP BOTH ENDS OF WIRE .25 ± .05. TIN END OF WIRE THAT IS INSERTED INTO THE BOARD.
 - ⊗ MFG. IS TO PERMANENTLY MARK IN THE ASSY DASH NUMBER OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
1. NUMBERS INSIDE BALLOONS OR INSIDE THE COMPONENT OUTLINES ON THE P.C. BOARD REPRESENT ITEM NUMBERS ON THE BILL OF MATERIALS.

NOTES

Figure 6-16
 Parts Location Detail and
 Parts List
 Fulguration Output (Spray) A2
 PCB Assy
 30-0078-003

*** FRONT PANEL (A3) PCB SUB-ASSEMBLY 30-0077-007

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	50-0077-005	SCHEMATIC FRONT PANEL A3	REF			114
3	01-0200-000	4001 QUAD INPUT NOR	1	U-172		190
4	01-0202-000	4027 DUAL J-K F-F	1	U-159		106
5	01-0294-000	4052 DUAL 4 CHAN MUX	1	U-158		106
6	01-0295-000	4066 QUAD BILATERAL SW	1	U-116		106
7	01-0199-000	4081 QUAD INPUT AND	1	U-171		192
8	01-0231-000	40106 HEX SCHMIDT	1	U-208		190
9	01-0284-000	CA3161 BCD TO 7 SEGMENT	3	U-69,U-81,U-82		192
10	01-0304-000	4518 DUAL DECADE COUNTER	2	U-136,U-170		106
11	01-0280-000	LM324 QUAD 741 OP AMP	2	U-112,U-114		190
12	01-0291-000	LM339 VOLT COMPARATOR	1	U-157		190
13	01-0285-000	LM3914 LED BAR DRIVER	2	U-56,U-58		190
14	01-0341-001	LED BAR GRAPH	2	DS55,DS57		186
15	01-0306-000	DISPLAY - 7 SEG .3 IN LED	10	DS-62,63,64,DS-76,77, DS-78,79,80,83,84		201
16	01-0297-000	LM7805CT +5V REG	1	A-31		190
17	01-0079-000	LM7815CT +15V REG	1	A-27		104
18	01-0288-000	VOLTAGE REF +10V DC	1	U-3		104
19	01-0210-000	MPSA13 DARLINGTON NPN	8	Q-2,Q23,Q35,Q36,Q40, Q65,Q74,Q174		190
20	01-0152-000	2N3904 NPN	3	Q-11,Q214,Q215		104
21	01-0309-000	2N4403 PNP	2	Q13,Q52		104
22	01-0307-000	TRANSISTOR FET VN10KM	1	Q73		195
23	01-0029-000	DIODE 1N914 75V 10MA	3	D128,D129,D252		133
24	01-0028-000	DIODE 1N4002	6	D29,D30,D239,D240,D244,D245		104
25	01-0031-000	DIODE ZENER 1N5232 5.6V	1	D-61		104
26	01-0324-000	DIODE ZENER 1N4372 3.0V 1/2W	1	D-68		104
27	02-0176-003	LAMP, PANEL, WHT. 12.0V	11	DS-4,DS22,DS32,DS39,DS66, DS67,DS213,DS228,DS236, DS242,DS246		204
28		NOT USED				
29	01-0204-000	CAP 1KV CERAMIC DISC 50pfd	2	C160, C161		103
30	01-0166-392	RES. 1/4 W 5% 3.9K OHM	1	R222		129
31	01-0262-104	CAP 50V CERAMIC MONO .1uFd	25	C12,C27,C28,C70,C104, C106,C117,C125,C135, C150,C154,C216,C232, C234		161
32	01-0262-334	CAP 50V CERAMIC MONO .33uFd	4	C26,C147,C226,C229		161
33	01-0262-684	CAP 50V CERAMIC MONO .68uFd	1	C10		161
34	01-0259-015	CAP 25V RADIAL TANT 1.5uFd	1	C54		103
35	01-0337-104	CAP. POLYCARB., 1uF, 100V	1	C71		203
36	01-0166-220	RESISTOR, 1/4W 5%, 22 OHM	7	R101,R102,R103,R126, R134,R233,R235		191
37	01-0166-330	RESISTOR 1/4W 5% 33 OHM	4	R15,R137,R72,R238		191
38	01-0166-680	RESISTOR 1/4W 5% 68 OHM	7	R10,R16,R19,R230,R237,R249, R251		191
39	01-0166-101	RESISTOR 1/4W 5% 100 OHM	6	R50,R131,R200 THROUGH 203		191
40	01-0166-151	RESISTOR 1/4W 5% 150 OHM	1	R59		191
41	01-0166-102	RESISTOR 1/4W 5% 1K OHM	4	R142,R155,R163,R225		191
42	01-0166-122	RESISTOR 1/4W 5% 1.2K OHM	3	R17,R20,R107		191
43	01-0166-162	RESISTOR 1/4W 5% 1.6K OHM	1	R241		191
44	01-0166-222	RESISTOR 1/4W 5% 2.2K OHM	2	R164,R165		191
45	01-0166-332	RESISTOR 1/4W 5% 3.3K	1	R247		191
46	01-0166-472	RESISTOR 1/4W 5% 4.7K OHM	7	R60,R132,R133,R139,R169, R248,R211		191
47	01-0166-562	RESISTOR 1/4W 5% 5.6K OHM	1	R223		191
48	01-0166-752	RESISTOR 1/4W 5% 7.5K OHM	2	R5,R6		191
49	01-0166-103	RESISTOR 1/4W 5% 10K OHM	6	R18,R21,R49,R140,R231,R250		191
50	01-0166-123	RESISTOR 1/4W 5% 12K OHM	2	R7,R207		191
51	01-0166-153	RESISTOR 1/4W 5% 15K OHM	4	R217 THRU R220		191
52	01-0166-203	RESISTOR 1/4W 5% 20K OHM	1	R115		191
53	01-0166-622	RESISTOR 1/4W 5% 6.2K	1	R14		191
54	01-0166-273	RESISTOR 1/4W 5% 27K OHM	2	R141,R156		191
55	01-0166-473	RESISTOR 1/4W 5% 47K OHM	10	R53,R100,R127,R166,R173, R204 THRU 206,R209		191
56	01-0166-272	RESISTOR 1/4W 5% 2.7K	1	R162		191
57	01-0166-104	RESISTOR 1/4W 5% 100K OHM	13	R1,R24,R25,R33,R34,R37, R38,R51,R167,R168,R175, R176,R212		191
58	01-0166-275	RESISTOR 1/4W 5% 2.7m OHM	1	R138		191
59	01-0316-273	RESISTOR 1/8 1% 5.62K OHM	1	R111		191
60	01-0316-316	RESISTOR 1/8 1% 14.3K OHM	2	R9,R109		191
61	01-0316-330	RESISTOR 1/8 1% 20.0K OHM	3	R8,R108,R113		191
62	01-0316-382	RESISTOR 1/8 1% 69.8K OHM	1	R110		203
63	02-0186-202	RES TRIM 3/8 SQ 2K OHM	4	R144,R149,R221,R243		173
64	02-0186-103	RES TRIM 3/8 SQ 10K	1	R224		173
65	02-0187-102	HEADER, STRAIGHT 1x.1 10 PIN	1	J3		199
66	02-0187-122	HEADER, STRAIGHT 1x.1 34 PIN	1	J1		199
67	02-0189-006	HEADER, RT. ANGLE 1.00 6 PIN	1	J2		164
68		NOT USED				
69		NOT USED				
70	04-0234-000	HEAT SINK T0220 15°C/W	2			114
71	03-0012-000	SCREW B.H. 6-32x1/4"	2			
72	09-0001-000	HEAT SINK COMPOUND	A/R			
73	01-0316-359	RESISTOR 1/8W 1% 40.2K OHM	1	R130		191
74	02-0249-001	SOCKET, DIP, WIRE WRAP 14 PIN	10	DS62,63,64,76,77,78,79, 80,83,84		205
75	02-0232-001	SOCKET, STRIP LINE, ELEVATOR 20 PIN	2			.355 HI



NOTES

6. BODIES OF TRANSISTORS (ITEMS 19,20,21 AND 22) ARE TO BE INSTALLED AS CLOSE AS POSSIBLE TO THE SURFACE OF THE BOARD. COMPONENT HEIGHT ARE ABOVE THE SURFACE OF THE BOARD IS TO BE .44 MAX.
- CUT PIN 5 ON CONNECTOR FOR KEYING. RAISE CONNECTOR .06 OFF OF PCB, AND SECURE WITH R.T.V.
- CLIP MOUNTING EARS ON HEATSINK FLUSH WITH THE HEATSINK BODY.
- MAXIMUM HEIGHT ABOVE COMPONENT SIDE OF THE P.C. BOARD FOR THE DISPLAYS IS .675. ALL OTHER COMPONENTS (EXCLUDING THE CONNECTORS) MAY NOT EXCEED A HEIGHT OF .56.
- REF IS TO PERMANENTLY MARK IN THE ASSY DASH NO. OF THE UNIT BEING BUILT AND SERIALIZE EACH BOARD.
- NUMBERS INSIDE BALLOONS OR INSIDE COMPONENT OUTLINES REPRESENT ITEM NUMBERS ON THE BILL OF MATERIALS.

*** DO NOT ORDER PCB ASSEMBLY 30-0077-007/
 * ORDER COMPLETE FRONT PANEL ASSEMBLY 20-0048- (SEE PAGE 6-21)

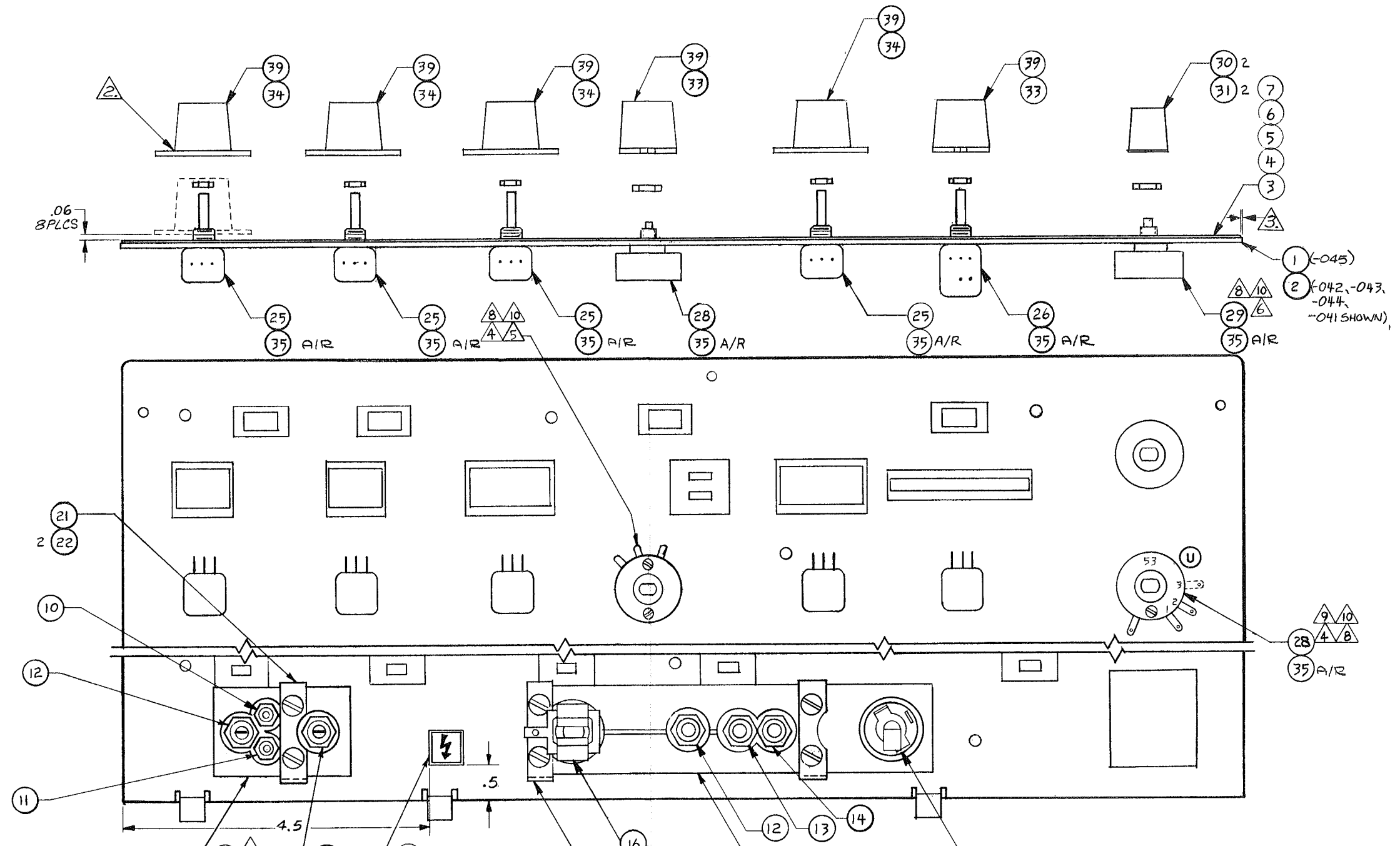
Figure 6-17
 Parts Location Detail and
 Parts List
 Front Panel A3 PCB Assy
 30-0077-007

Rev. M 3/84

*** FRONT PANEL SUB-ASSY MECHANICAL - 20-0044
 DWG 20-0044- (-041 ENGLISH) (-042 FRENCH) (-043 SPANISH) (-044 ITALIAN) (-045 JAPANESE)

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1	04-0228-004	FRONT PANEL	1	-045	114	
2	04-0228-005	FRONT PANEL	1	041,042,043,044	114	
3	10-0093-061	OVERLAY, ENGLISH	1		114	
4	10-0093-062	OVERLAY, FRENCH	1		114	
5	10-0093-063	OVERLAY, SPANISH	1		114	
6	10-0093-064	OVERLAY, ITALIAN	1		114	
7	10-0093-055	OVERLAY, JAPANESE	1		114	
8	09-0052-000	RTV 732	3			
9	40-0022-001	RECPT. BAR MONO	6		114	
10	07-0047-001	BANANA JACK, MIN., BLUE	1		140	2142-6
11	07-0047-002	BANANA JACK, MIN., BLACK	1		140	2142
12	07-0007-000	BANANA JACK, RED	3		122	1509-102
13	07-0009-000	BANANA JACK, BLUE	1		122	1509-105
14	07-0010-000	BANANA JACK, YELLOW	1		122	1509-107
15		NOT USED				
16	04-0280-001	BUSHING, ACTIVE JACK	1		114	
17	04-0072-002	ELECTRODE RETAINER	1		114	
18	03-0129-000	NUT, HEX 15/32-32	1			
19	02-0033-000	PHONE JACK	1		116	
20		NOT USED				
21	04-0230-004	BRKT RECPT BAR	3		114	
22	03-0251-105	SCREW, B.H., SLOT 6-32X3/8	6			
23		NOT USED				
24	40-0022-002	RECPT. BAR, BIPOLAR	1			
25	02-0227-103	POT, 1W, 10%, 10K, .45 SHAFT	4		211	SERIES 149
26	02-0252-103	POT, 1W, 10%, 10K, W/SWITCH .45 SHAFT	1		211	SERIES 149
27		NOT USED				
28	02-0170-004	SWITCH, 2 POSITION	2		146	5P12125 W/ADJ STOPS
29	02-0170-005	SWITCH, 3 POSITION	1		146	5P12125 W/ADJ STOPS
30	07-0173-018	KNOB, 14.5 MM, GRAY	2		114	
31	07-0175-002	POINTER, 14.5 MM, BLACK	2		114	
32		NOT USED				
33	07-0178-001	POINTER, 21 MM, BLACK	2		114	
34	07-0170-002	SKIRT, DIAL, 21 MM, BLACK	4			
35	09-0081-000	LOCTITE, 242	A/R			
36	10-0105-001	DECAL, HIGH VOLTAGE	1			
37	09-0105-000	LOCTITE 414	A/R			
38		NOT USED				
39	07-0176-018	KNOB, 21 MM, GRAY, 1/8	6		114	

*** DO NOT ORDER FRONT PANEL ASSEMBLY MECHANICAL 20-0044
 * ORDER COMPLETE FRONT PANEL ASSEMBLY 20-0048 (SEE PAGE 6-21)



- ▲ APPLY SMALL BEAD OF RTV, ITEM 8, ACCROSS TOP AND DOWN SIDES OF BOTH RECEPTACLE BARS, ITEMS 9 & 24.
- ▲ INSTALL LOCKWASHER, (I.T.) SUPPLIED WITH SWITCH BETWEEN SWITCH AND FRONT PANEL.
- ▲ ITEM 28, REMOVE TAB IN POSITION 3 (53 ONLY).
- ▲ FLATTEN TERMINATIONS. TIGHTEN KNOB COLLET SCREW TO 8 IN-LB ±1/2 IN-LB. (V)
- ▲ INSTALL SWITCH STOP RING WITH THE LOCKING TAB CLIPPED OFF.
- ▲ CUT OFF ALL TERMINATIONS, EXCEPT AS SHOWN.
- ▲ POSITION INDEXING TAB OF SWITCH, ITEM 28, PRIOR TO INSTALLATION SO THAT SWITCH WILL OPERATE 2 POSITIONS ONLY.
- ▲ ITEMS 3, 4, 5, 6, OR 7 OVERLAY TO BE CENTERED EQUALLY OVER SURFACE OF ITEM NO. 1 OVERLAY CANNOT PROTRUDE OVER EDGES OF SHEET METAL.
- ▲ APPLY LOCTITE 414, ITEM 37, A/R BETWEEN SKIRT AND KNOB AND POINTER AND KNOB, (TYP 8 PLCS).
1. DISCARD ALL LK. WASHERS WHICH ARE SUPPLIED WITH COMPONENTS, EXCEPT AS NOTED IN 10.
- NOTES**

Figure 6-18
 Parts Location Detail and
 Parts List
 Front Panel Mechanical
 Assy
 20-0044
 (See dash number above)

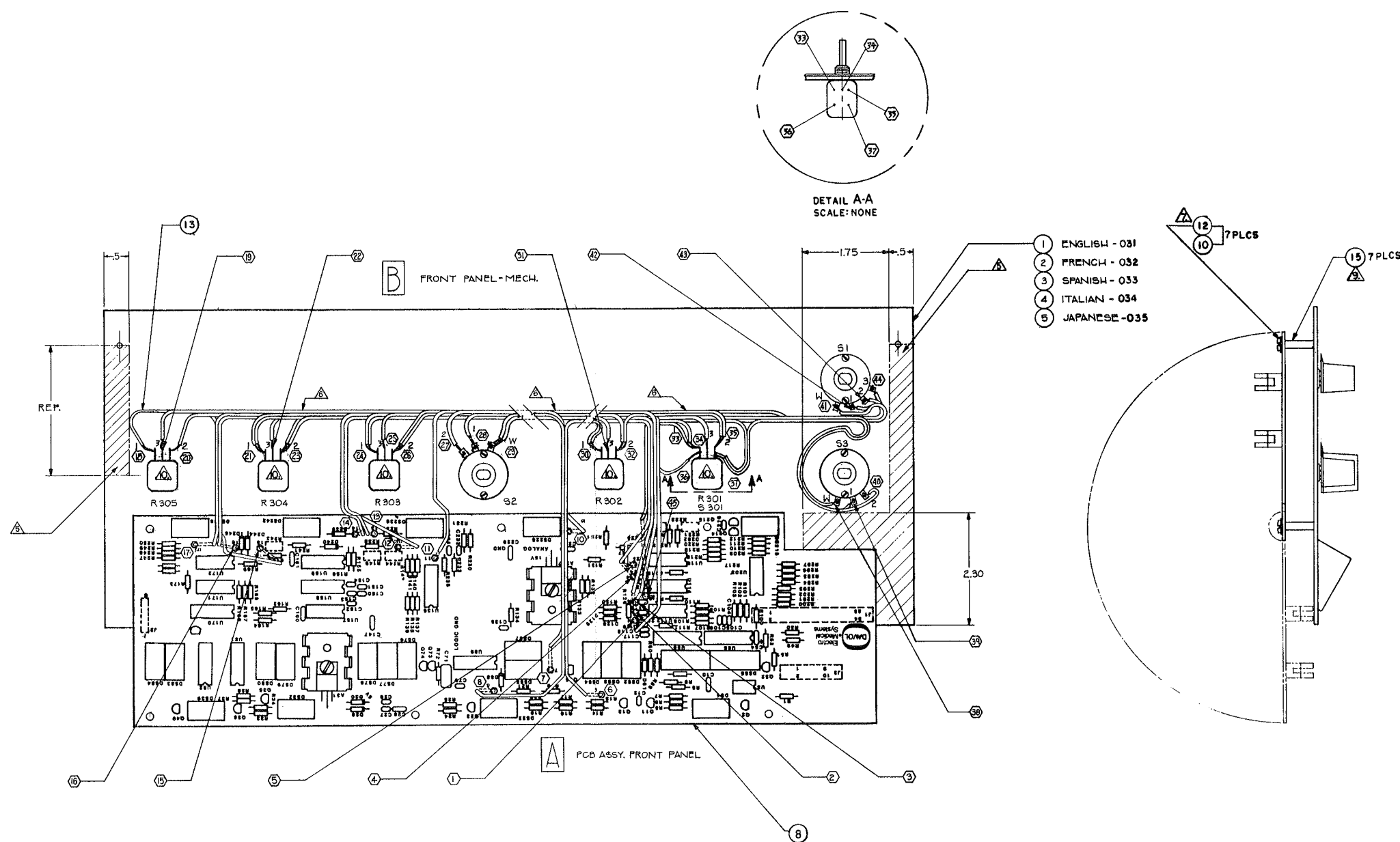
* FRONT PANEL ASSY - ELECTRICAL - ASSEMBLY 20-0048
 DWG 20-0048- (-031 ENGLISH) (-032 FRENCH) (-033 SPANISH) (-034 ITALIAN) (-035 JAPANESE)

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
*** 1	20-0044-041	FRONT PANEL ASSY-MECH	1	ENGLISH (-031)	114	
*** 2	20-0044-042	FRONT PANEL ASSY-MECH	1	FRENCH (-032)	114	
*** 3	20-0044-043	FRONT PANEL ASSY-MECH	1	SPANISH (-033)	114	
*** 4	20-0044-044	FRONT PANEL ASSY-MECH	1	ITALIAN (-034)	114	
*** 5	20-0044-045	FRONT PANEL ASSY-MECH	1	JAPANESE (-035)	114	
6	11-0028-003	TUBING, H.S.	A/R			
7		NOT USED				
*** 8	30-0077-007	PCB ASSY. FRONT PANEL	1		114	
9		NOT USED				
10	03-0252-105	SCREW, P.H. 6-32 X 3/8	7			
11		NOT USED				
12	03-0070-000	WASHER, FLAT, NYLON, #6	7			
13	60-0044-002	FRONT PANEL HARNESS ASSY.	1		114	
14	09-0081-000	LOCTITE 242	A/R			
15	03-0307-010	SPACER, PHEN 6-32X.250DX.635L	7			

*** DO NOT ORDER FRONT PANEL ASSY-MECH. 20-0044

*** DO NOT ORDER PCB ASSEMBLY 30-0077-007.

* ORDER COMPLETE FRONT PANEL ASSEMBLY 20-0048 (SEE DASH NUMBERS ABOVE).



① APPLY TUBING, H.S., ITEM 6 A/R TO ALL TERMINALS. ⑤
 ② APPLY LOCTITE 242, ITEM 14 TO THREADS ON PANEL STUDS. SCREW PEHNOLIC SPACERS, ITEM 15 ONTO THREADED STUDS, PRIOR TO INSTALLING PCB, ITEM 8.
 B. CUT EXCESS WIRE FROM SOLDER JOINTS ON ALL 'E' TERMINATIONS TO PCB; MAX HEIGHT .05 IN.

③ APPLY LOCTITE 242, ITEM ④, TO THREADS, AS REQ'D.
 ④ CABLING AND WIRES TO BE CLEAR OF ELECTRONIC COMPONENTS WHEN ASSEMBLING ITEM ⑦, ⑧, PCB, AND ITEM ①, THROUGH ⑥ FRONT PANEL.
 ⑥ DO NOT ALLOW WIRES TO PROTRUDE INTO SHADED AREA AFTER ASSEMBLY.
 ④ SOLDER ALL WIRES TO SWITCHES AND POTS OF FRONT PANEL, BEFORE SOLDERING WIRES TO PC BOARD.
 ③ * ③ DENOTES TERMINATION POINT NUMBER.
 ② * ② DENOTES STATION LETTER.
 ① * ① DENOTES ITEM NUMBER.

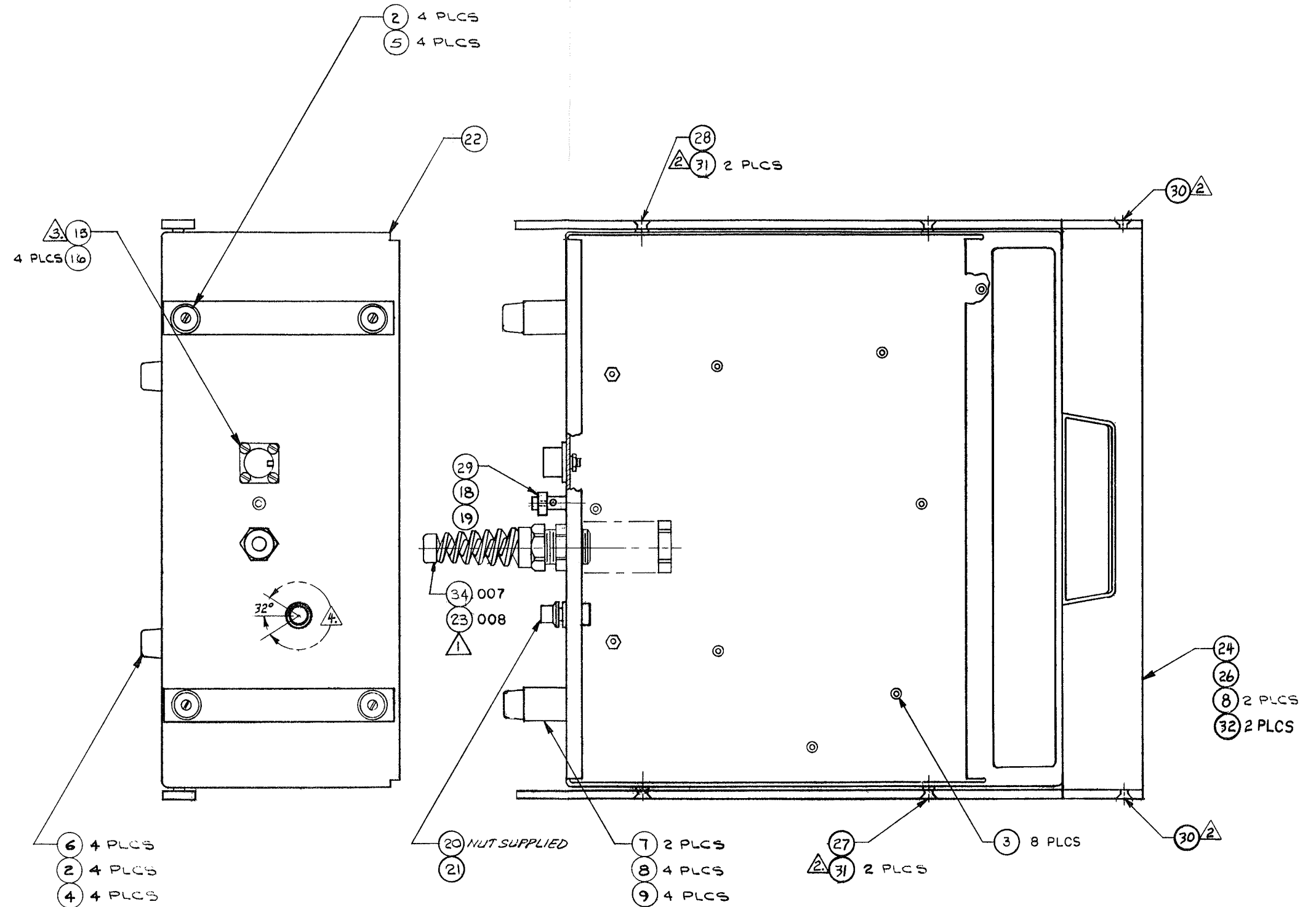
NOTES

Figure 6-19
 Parts Location Detail and
 Parts List
 Front Panel Electrical Assy
 20-0048
 (See dash number above)

Rev. S 3/84

CHASSIS ASSY, 5000 - ASSEMBLY 20-0045-007,-008

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1		NOT USED				
2	03-0004-000	BUMPER, RUBBER	8		114	
3	03-0317-104	STANDOFF, THD. 6-32 X .312	8			
4	03-0284-211	SCREW, R.H., SLOT #8-32x1	4			
5	03-0284-205	SCREW, R.H., SLOT #8-32x5/16	4			
6	03-0281-103	STANDOFF, THD. 8-32x312	4			
7	04-0209-002	BRKT. CORD WRAP	2		114	
8	03-0289-004	WASHER, LK. I.T. #8	6			
9	03-0287-014	NUT, HEX #8-32	4			
10		NOT USED			114	
11		NOT USED			114	
12		NOT USED				
13		NOT USED				
14		NOT USED				
15	02-0110-000	RECEPTACLE, FOOT CONTROL	1		155	MS3102-A-
16	03-0251-004	SCREW, B.H., SLOT #4-40x5/16	4			
17		NOT USED				
18	03-0289-103	WASHER, LK. I.T. #6	1			
19	03-0251-103	SCREW, B.H., SLOT, #6-32x1/4	1			
20	02-0227-103	POT, 1W, 10%, 10K, .45 SHAFT	1		146	WK04842 TYPE 550
21	03-0170-001	KNOB, W/SKIRT, 1/8DIA SHAFT	1		114	
22	04-0213-007	CHASSIS, 5000	1		114	
23	03-0312-003	STRAIN RELIEF	1	-007BSI	222	3213
24	07-0184-003	HANDLE INSERT	1		114	
25		NOT USED				
26	04-0219-004	EXTRUSION, HANDLE	1		114	
27	04-0220-003	RAIL, LEFT SIDE	1		114	
28	04-0220-004	RAIL, RIGHT SIDE	1		114	
29	03-0011-001	GROUNDING POST	1			
30	03-0344-104	SCREW C/SNK SOCKT HD6-32X3/8LG	2			
31	03-0344-204	SCREW, 82° C'SINK SOCKET HD, 8-32X3/8 LG	4			
32	03-0253-205	SCREW,CAP,SOCKT HD,8-32X3/8LG	2			
33	09-0158-001	ADHESIVE/SEALANT,#222,LOW	A/R			
34	07-0191-003	STRAIN RELIEF	1	-008UL	178	3243



- ⚠️ ASSEMBLE KNOB, ITEM (21), WITH 295° ROTATIONAL DEFLECTION OF KNOB MARK, APPROX. AS SHOWN.
 ⚠️ ALIGN ITEM (15) WITH KEYWAY SLOT TOWARDS TOP OF CHASSIS AS SHOWN.
 ⚠️ APPLY LOCTITE, ITEM 33, TO THREADS BEFORE INSTALLING.
 ⚠️ ASSEMBLE CORD STRAIN RELIEF NUT BUT DO NOT TORQUE DOWN. (NOTE: -007 ASSY SHOWN.)

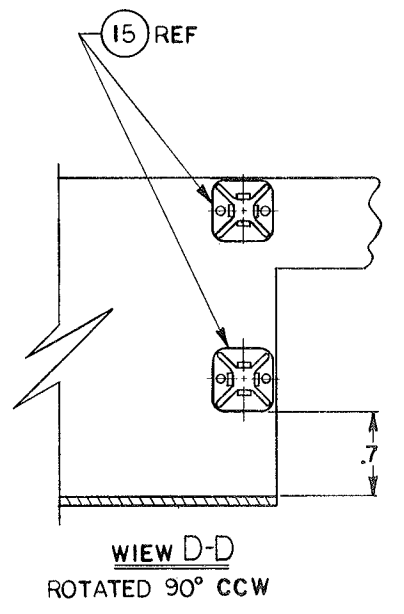
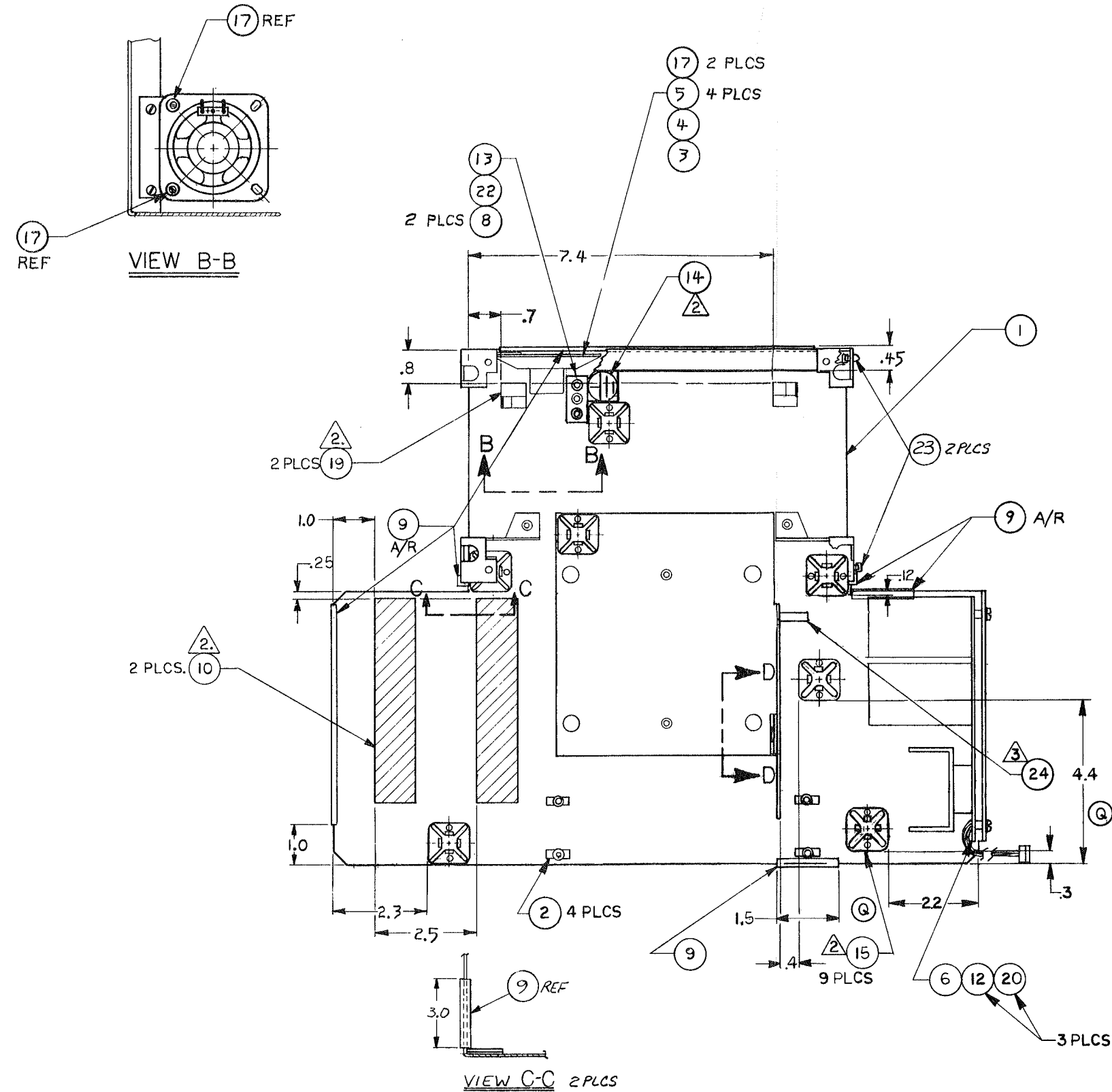
NOTES

Figure 6-20
Parts Location Detail and
Parts List
Chassis Assy
20-0045

Rev. W 3/84

SUB-CHASSIS ASSY, 5000 - ASSEMBLY 20-0046-007

Item No	Bard EMS Part No.	Description	Qty	Reference Designator	MFG'R Code	MFG'R P/N
1	40-0020-005	SUB CHASSIS&TRANSFORMER PLATE	1		114	
2	07-0180-000	SUPPORTS, CIRCUIT BOARD	4		102	
3	01-0140-001	SPEAKER, 100 OHM, 3W	1		216	LCBS3R
4	40-0019-001	INSULATOR BOARD, ASSY	1		114	S-2-206-2-1/2"
5	03-0251-003	SCREW 4-40 x 1/4L B.H.	4			
6	30-0074-006	P.S. OUTPUT, PCB ASSY	1	A6	114	
7		NOT USED				
8	03-0252-008	SCREW P.H. 4-40 X 5/8L	2			
9	09-0129-002	GROMMET STRIP	1.5FT		114	
10	09-0116-019	FOAM TAPE-NEO.5L,1/4 THK 1 WIDE	2		114	
11		NOT USED				
12	03-0252-003	SCREW, P.H. 4-40 x 1/4L	3			
13	04-0278-002	INSULATOR, TERMINAL BLOCK	1			
14	10-0106-001	DECAL, GND, EARTH	1		114	
15	07-0165-000	MOUNTING PLATFORM, CABLE TIE	9		171	ABM25-A
16		NOT USED				
17	03-0288-120	WASHER, FLAT,.156X.312 X .036	2			
18		NOT USED				
19	07-0181-001	RIBBON CABLE CLIP	2	8511-56-00-9909	213	274-000010-00 1788
20	03-0289-102	LOCK WASHER, I.T. #4	3			
21	09-0081-000	LOCTITE 242	A/R			
22	02-0196-003	TERMINAL BLOCK	1		221	10E/3 OS
23	03-0310-001	CABLE TIE HOLDER	2			
24	03-0307-014	SPACER, PHENOLIC	1			



- ③ APPLY LOCTITE 242, ITEM ②①, TO THREADS, AS REQ'D.
- ② CLEAN AREA OF ALL DIRT, GREASE, OIL, OR OTHER FOREIGN MATTER BEFORE APPLYING PART TO SUB-CHASSIS.

NOTES

Figure 6-21
Parts Location Detail and
Parts List
Sub-Chassis Assy
20-0046-007

Rev. Q 3/84

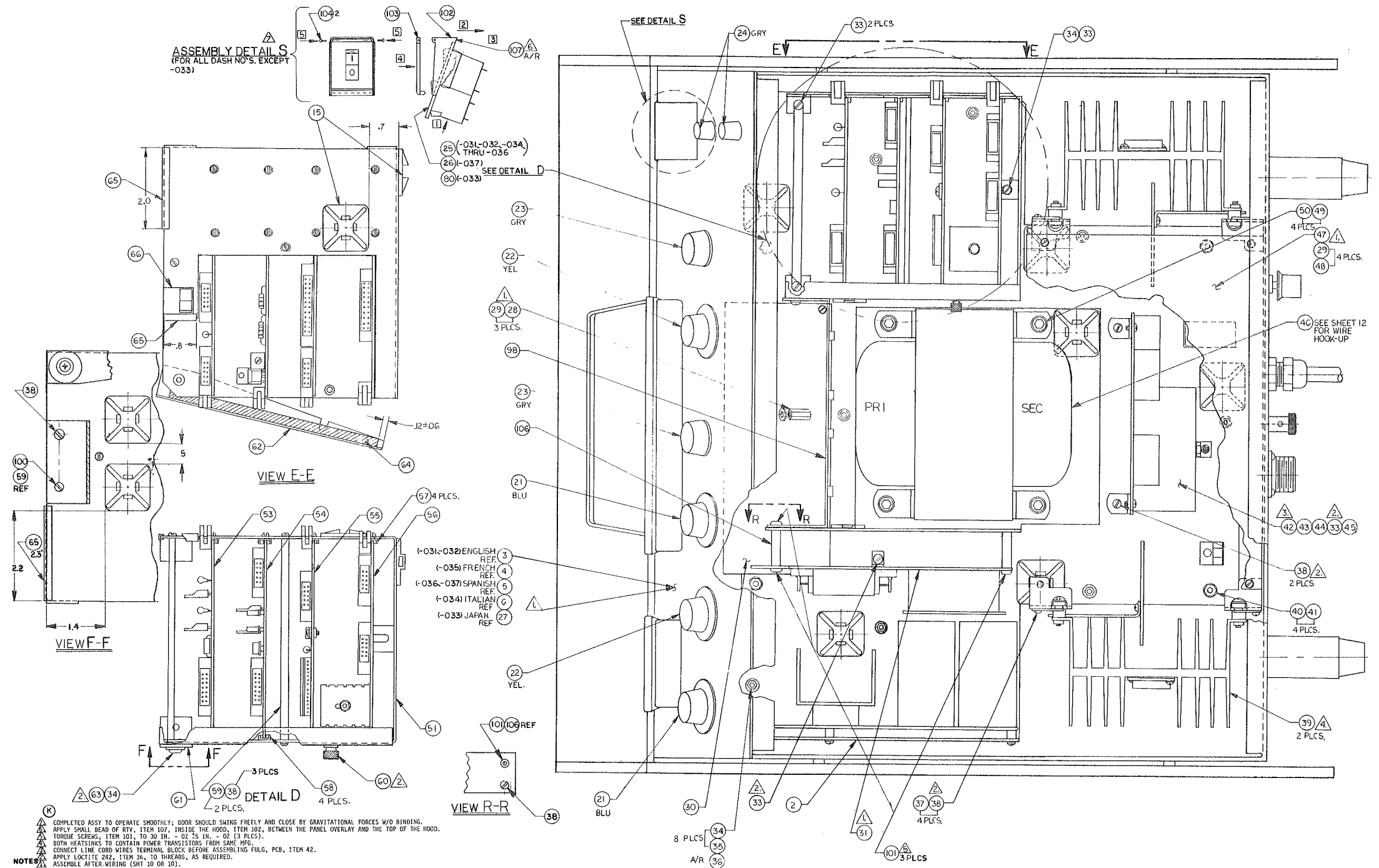
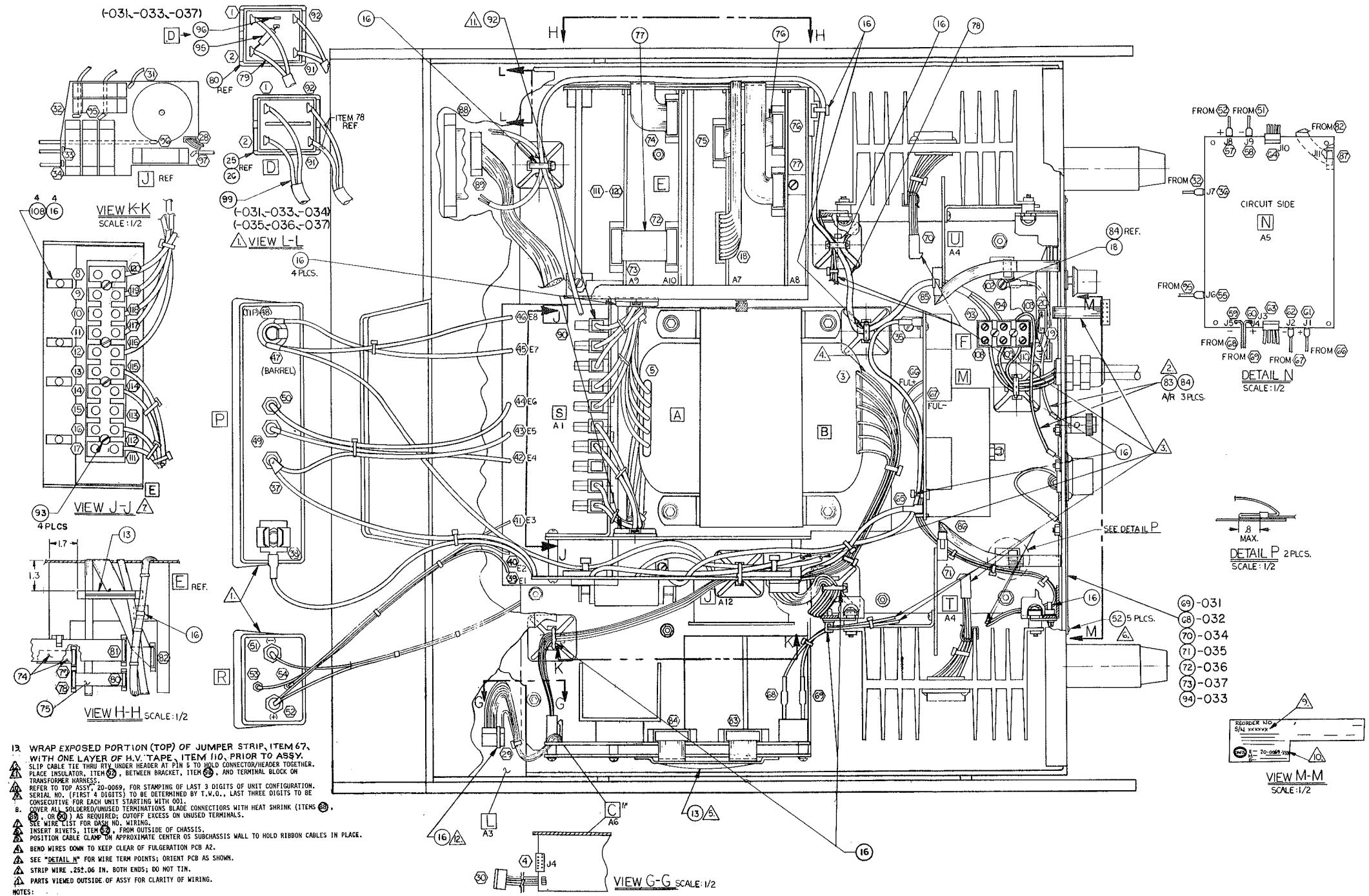


Figure 6-23
Parts Location Detail and
Parts List
Final Assy
20-0068
(See dash number above)



13. WRAP EXPOSED PORTION (TOP) OF JUMPER STRIP, ITEM 67, WITH ONE LAYER OF H.V. TAPE, ITEM 110, PRIOR TO ASSY. SLIP CABLE TIE THRU RTV UNDER HEADER AT PIN 5 TO HOLD CONNECTOR/HEADER TOGETHER. PLACE INSULATOR, ITEM 68, BETWEEN BRACKET, ITEM 69, AND TERMINAL BLOCK ON TRANSFORMER HARNESS. REFER TO TOP ASSY, 20-0069, FOR STAMPING OF LAST 3 DIGITS OF UNIT CONFIGURATION SERIAL NO. (FIRST 4 DIGITS) TO BE DETERMINED BY T.W.O.. LAST THREE DIGITS TO BE CONSECUTIVE FOR EACH UNIT STARTING WITH 001. B. COVER ALL SOLDERED/UNUSED TERMINATIONS BLADE CONNECTORS WITH HEAT SHRINK (ITEMS 69, 70, OR 71) AS REQUIRED; CUTOFF EXCESS ON UNUSED TERMINALS. SEE WIRE LIST FOR DASH NO. WIRING. INSERT RIVETS, ITEM 62, FROM OUTSIDE OF CHASSIS. POSITION CABLE CLAMP ON APPROXIMATE CENTER OF SUBCHASSIS WALL TO HOLD RIBBON CABLES IN PLACE. BEND WIRES DOWN TO KEEP CLEAR OF FULGERATION PCB A2. SEE "DETAIL N" FOR WIRE TERM POINTS; ORIENT PCB AS SHOWN. STRIP WIRE .282,06 IN. BOTH ENDS; DO NOT TIN. PARTS VIEWED OUTSIDE OF ASSY FOR CLARITY OF WIRING.

NOTES:

Figure 6-24
 Parts Location Detail and
 Parts List
 Final Assy
 20-0068
 (See dash number above)



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