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Preface

Warranty

GTR® LABS, llc warrants that this product will be free from defects in materials and workmanship for a period of twelve (12) months from the date of installation at the first end user's site; If any such product proves defective during this warranty period, **GTR®**, at it's option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify **GTR®** of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by **GTR®** with shipping charges prepaid. **GTR® shall** pay for the return of the product to Customer if the shipment is to a location within the country in which the **GTR®** designated service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure, or damage caused by improper or inadequate maintenance and care. **GTR®** shall not be obligated to furnish service under this warranty 1) to repair damage resulting from attempts by personnel other than **GTR®** representatives to install, repair, or service this product; 2) to repair damage resulting from improper use or connection to incompatible equipment or power source; or 3) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

Further, **GTR® LABS**, llc warrants that the product is in compliance with U.S.A. DHHS regulations which may be in force and effect at the time of shipment of the product.

The following is not covered by the warranty: General maintenance and simple adjustments mentioned in the manuals delivered with the material.

THIS WARRANTY IS GIVEN BY GTR® WITH RESPECT TO THIS PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. GTR® AND IT'S VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. GTR®'S RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. GTR® AND IT'S VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER GTR® OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

There are no warranties which extend beyond the description mentioned in this document.

Presentation

This manual contains information on the installation of the **V-RAD generators.**

Notation

NOTE: This is an example of a NOTE. NOTES are areas that need additional attention.

CAUTION: This is an example of a CAUTION. CAUTIONS are procedures that the operator must heed in order to avoid damage to the equipment.

NOTES:

NOTES:

WARNING: This is an example of a WARNING. WARNINGS are procedures that the operator must heed in order to avoid bodily harm or injury.

Applicability

This manual is applicable to the **"V" Series, Single Tube RAD** generators.

V-10	10 kW
V-20	20 kW
V-30	30 kW
V-40	40 kW
V-50	50 kW

This manual is shipped with generator Model # _____, Serial #_____, with Software Version _____.

Safety

Mechanical-Electrical Warning

All of the electronic assemblies and parts of this equipment should be operated with care and routinely inspected in accordance with the manufacturer's recommendations.

Only properly trained and qualified personnel should be permitted access to any internal parts. Live electrical terminals are **LETHAL**. Be sure line disconnect switches are opened and other appropriate precautions are taken before removing covers or attaching accessories.

Do not remove the flexible high tension cables from the x-ray tube housing or high tension generator, and/or the access covers from the generator until the main and auxiliary power supplies have been disconnected.

WARNING: **Failure to comply with the foregoing safeguards may result in serious or fatal bodily injuries to the operator or those in the area.**

NOTES:

Electrical Grounding Instructions

WARNING: The equipment must be grounded to an earth ground by a separate #8 conductor. The neutral side of the line is not to be considered the earth ground.

Environment

This equipment is designed to work within a temperature range of 20^0C to 30^0C, with a relative humidity (non-condensing) less than 40%.

CAUTION: Provide adequate filtration if the generator is installed in a high dust or particulate matter environment.

Radiation Warning

WARNING: X-rays are dangerous to operator unless established safe exposure procedures are observed.

The useful and scattered beams can produce serious or fatal bodily injuries to any persons in the immediate or surrounding area. Adequate precautions should be taken to avoid exposure to the central beam or to scattered radiation.

Persons authorized to operate the equipment should be familiar with the established safe exposure factors and procedures.

NOTES:

Chapter 1: Specifications

Ratings

CAUTION: For proper operation on a Single Phase or Three Phase Line, it is recommended that you have 187/250 VAC.

V-10 10 kW

187/250 VAC, 1 Phase, 5A Standby, 35A Momentary

V-20 20 kW

187/250 VAC, 1 Phase, 5A Standby, 50A Momentary

V-30 30 kW

187/250 VAC, 1 Phase, 5A Standby, 65A Momentary

V-40 40 kW

187/250 VAC, 3 Phase, 5A Standby, 75A Momentary

V-50 50 kW

187/250 VAC, 3 Phase, 5A Standby, 100A Momentary

NOTE: Refer to the sections on "Line Limits" and "Line Voltage and Current" at the end of this chapter for a review of the power requirements.

kVp (In steps of 1 kVp)	**40 to 125 V-10/20/30 40 to 150 V-40/50**
mA	**V-10 25 to 200 mA V-20 25 to 300 mA V-30 25 to 400 mA V-40 25 to 500 mA V-50 25 to 600mA**
Time	**2ms to 6 seconds**

Table 1-1 Technique Ranges

mA	2ms to .5 sec.	.6	.7	.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
25														
50														
75														
100														
150														
200														

Table 1-1A Maximum Technique Selections (V-10)

mA	2ms to .5 sec.	.6	.7	.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
25														
50														
75														
100														
150														
200														
250														
300														

Table 1-1B Maximum Technique Selections (V-20)

mA	2ms to .5 sec.	.6	.7	.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
25														
50														
75														
100														
150														
200														
250														
300														
400	.1sec													

Table 1-1C Maximum Technique Selections (V-30)

NOTES:

NOTES:

mA	2ms to .5 sec.	.6	.7	.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
25														
50														
75														
100														
150														
200														
250														
300														
400														
500	.1 sec													

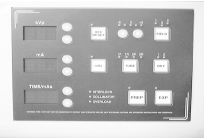
Table 1-1D Maximum Technique Selections (V-40)

mA	2ms to .5 sec.	.6	.7	.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
25														
50														
75														
100														
150														
200														
250														
300														
400														
500	.1 sec													
600	.1 sec													

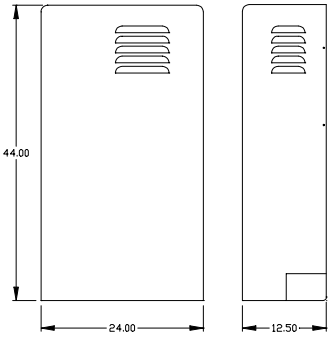
Table 1-1E Maximum Technique Selections (V-50)

Size and Weight

NOTES:



Operator's Console



Cabinet

Height	**44.0"**
Depth	**12.5"**
Width	**24.0"**
Weight	**70lbs (32kgs)**

Table 1-2 Cabinet

Height	**11.0"**
Depth	**16.0"**
Width	**12.0"**
Weight	**85lbs (38.5kgs)**

Table 1-3 HVT

Height	**8"**
Depth	**2.50"**
Width	**10"**
Weight	**1.0lbs (.5kgs)**

Table 1-4 Operator's Console

NOTES:

Configuration

Operator's Consol

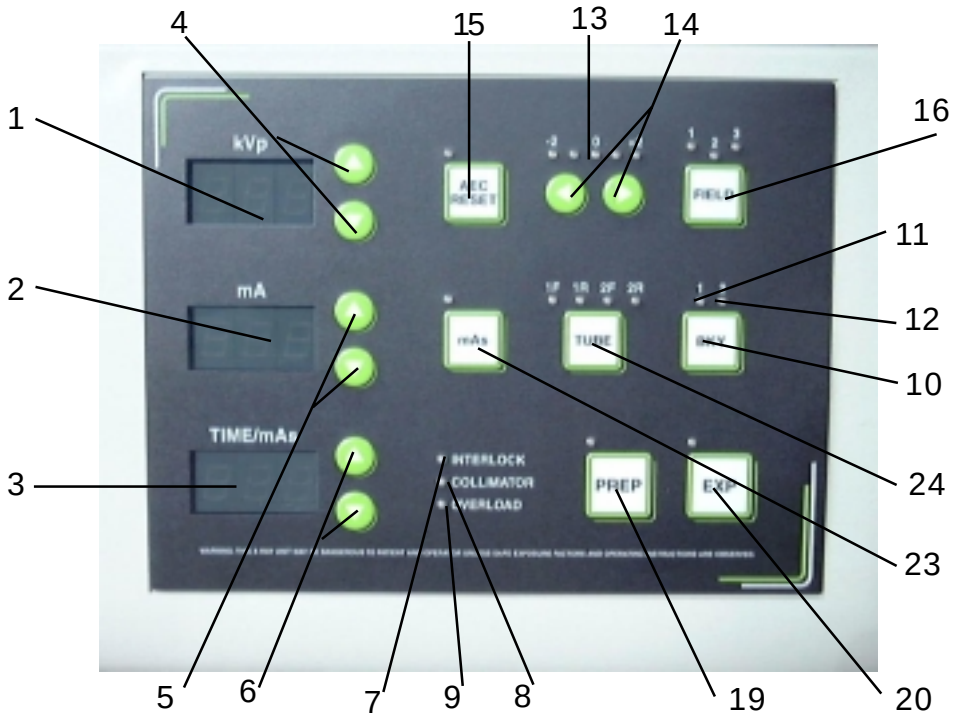


Figure 1-1A Operator's Console (Front View)

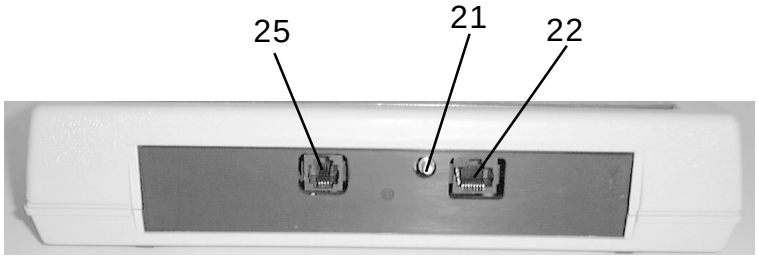


Figure 1-1B Operator's Console (Rear View)

1. kVp Display
2. mA Display
3. Time Display
4. kVp Up/Down
5. mA Up/Down
6. Time Up/Down
7. Interlock LED
8. Collimator LED
9. Overload LED
10. BKY Select
11. BKY 1 LED
12. BKY 2 LED
13. AEC Density LEDs
14. AEC Density Up/Down
15. AEC reset
16. AEC Field Select
19. PREP
20. EXP
21. On/Off
22. Connector
23. mAs Select
24. Tube Select
25. Hand Switch

Revision:
Date:

NOTES:

1. kVp Display

The kVp Display displays the selected kVp. Additional functions include:

- **Displays Error Codes in Self-Diagnostics**

2. mA Display

The mA Display displays the selected mA. Additional functions include:

- **Displays Calibration and Set Up Data in SERVICE Mode**

3. Time Display

The Time Display displays the selected Time. Additional functions include:

- **Displays Pre-Set # in SERVICE Mode**

4. kVp Up/Down

The kVp Up/Down push-buttons raise and lower the selected kVp. Additional functions include:

- **Select functions/data in calibration mode**

5. mA Up/Down

The mA Up/Down push-buttons raise and lower the mA. Additional functions include:

- **Toggle values for Pre-Set #s in SERVICE Mode**

6. Time Up/Down

The Time Up/Down push-buttons raise and lower the Exposure Time. Additional functions include:

- **Toggle Pre-Set #s in SERVICE Mode**

7. Interlock LED

The Interlock LED illuminates when an operational interlock is open. One or more interlocks can be connected in series to this function. Exposure is inhibited when this LED is illuminated.

8. Collimator LED

The Collimator LED illuminates when the collimator logic is not satisfied. Exposure is inhibited when this LED is illuminated.

NOTES:

NOTE: Bucky's and AEC are active only if the options are installed.

9. Overload LED

The Overload LED illuminates when the safe exposure factors for the selected x-ray tube are exceeded. Exposure is inhibited when this LED is illuminated.

10. BKY Select

The BKY Select Switch toggles between BKY 1, BKY 2, and No Bucky. (The condition of No Bucky is indicated when BKY 1 and BKY 2 LEDs are not illuminated.)

11. BKY 1 LED

BKY 1 LED illuminates when Bucky 1 is selected. If an ion chamber is installed and enbaled in the Bucky 1 position, it is selected as well.

12. BKY 2 LED

BKY 2 LED illuminates when Bucky 2 is selected. If an ion chamber is installed and enabled in the Bucky 2 position, it is selected as well.

13. Density LEDs

Density LEDs indicate user selectable AEC Density.

14. Density Up/Down

The Density Up/Down push-buttons increase and decrease the AEC Density.

15. AEC Reset

Pressing the AEC Reset will reset the Bucky Motion Error (E03).

A blinking AEC Reset LED indicates that Backup Time has terminated an AEC exposure or the 600 MAS limit has been reached. Pressing this switch resets the AEC function and another exposure may be initiated.

16. FIELD

FIELD toggles between the three fields of a 3 field ion chamber

NOTES:

19. PREP

When pressed, PREP initiates the Prep Sequence. The ready condition is indicated when the green LED is illuminated.

20. EXP

When pressed, with a green LED showing in PREP, EXP initiates an Exposure Sequence. “X-ray On” is indicated when the red LED is illuminated.

21. On/Off

This momentary pushbutton switch turns the generator on and off.

22. Connector

This is the serial interface connector. It connects the Operator’s Console to the GCU using the Interconnecting Cable supplied with the generator.

23. mAs Select

Toggles TIME/mAs Display [3] between TIME indication in seconds and mAs indication. If the LED associated with [23] illuminated then the TIME/mAs Display [3] indicates mAs.

24. Tube Select

On a single tube system this push button has no effect when pressed. On a multiple tube system this push button will toggle between the x-ray tubes. The LEDs will indicate the programmed function for each tube.24. (6046) Tube Select

25. Hand Switch

This is the Hand Switch connector. Connect the optional Hand Switch to this connector.

NOTES:

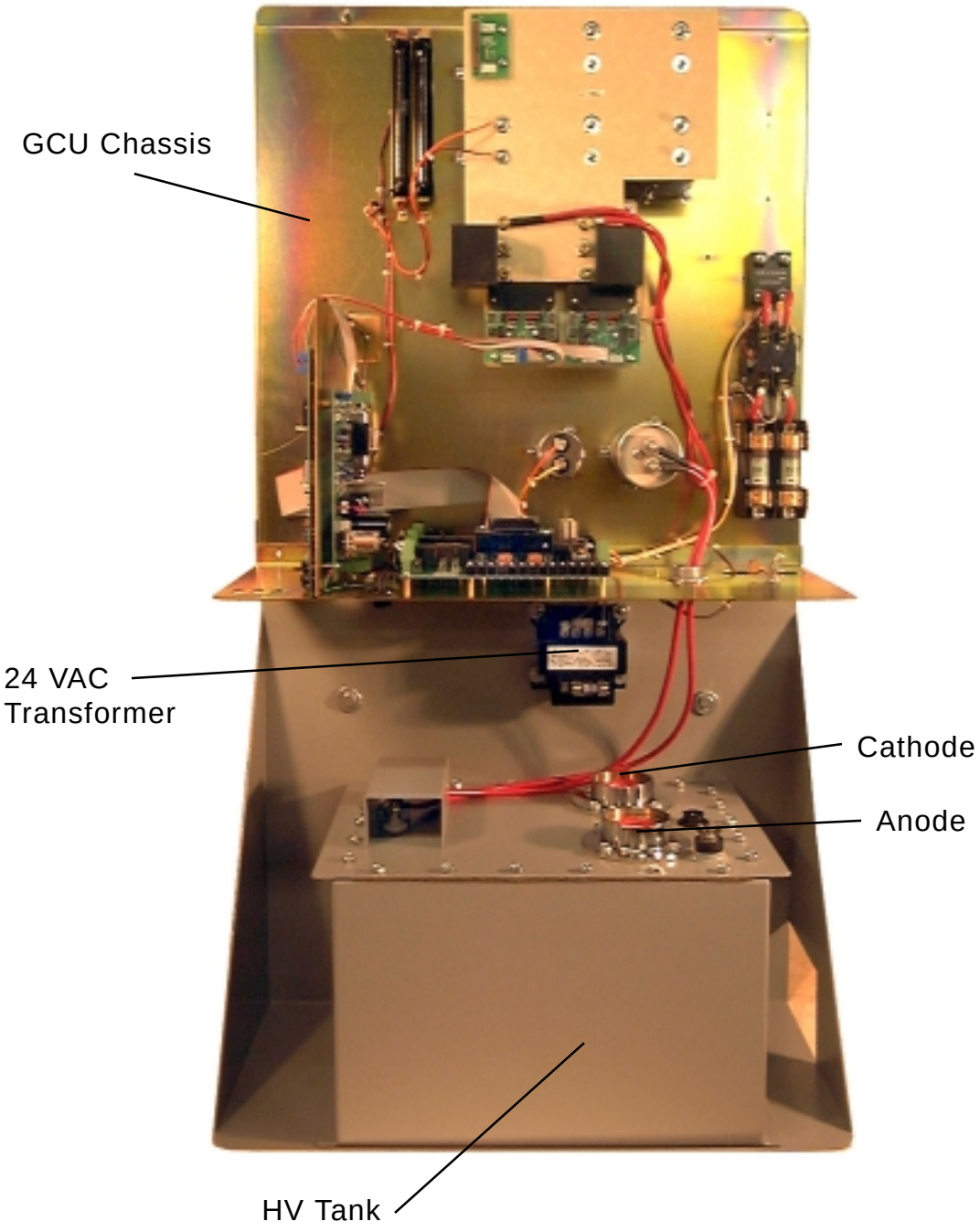


Figure 1-2 Cabinet (Front View)

GCU (Generator Control Unit)

NOTES:

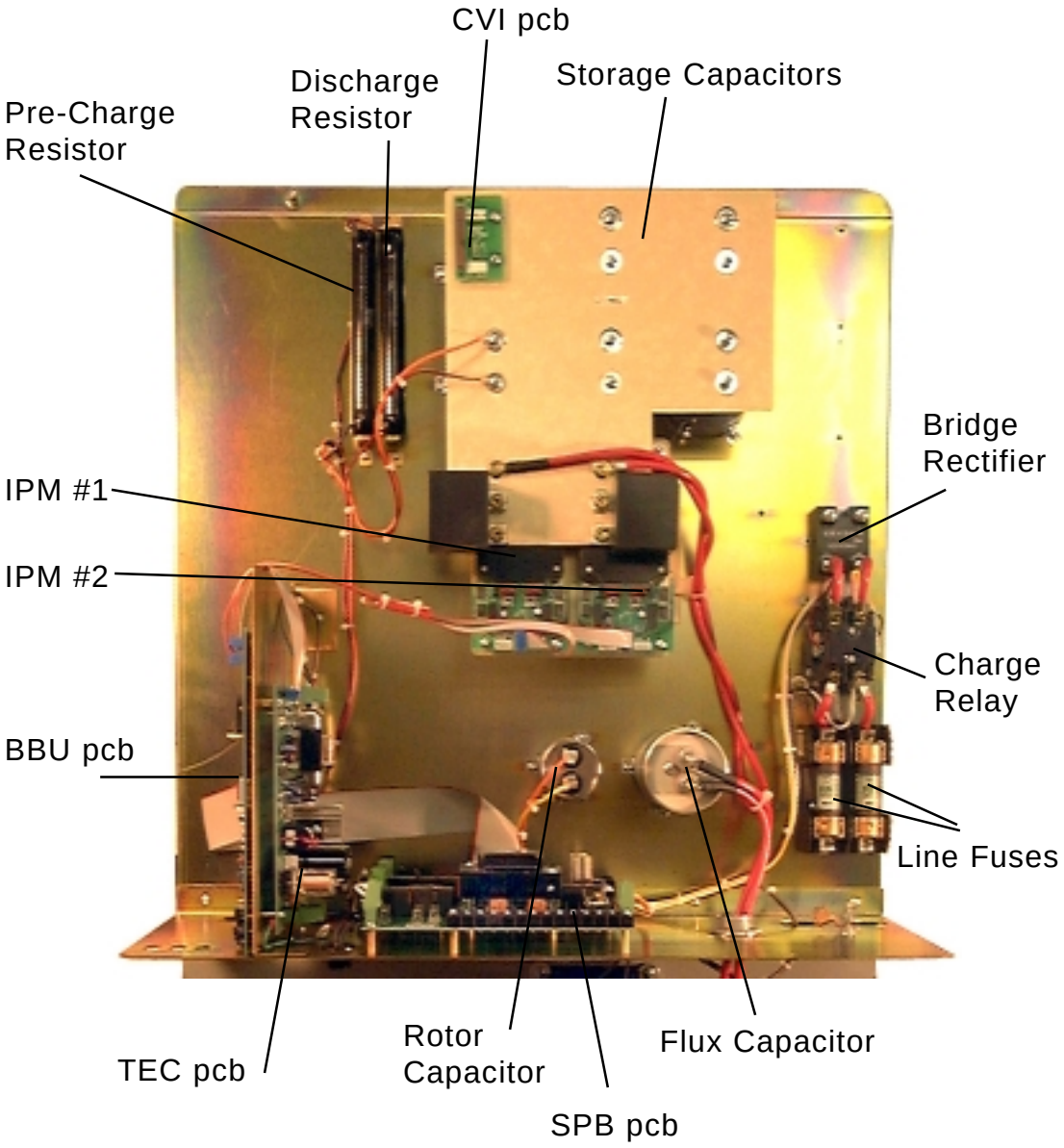


Figure 1-3 Chassis (Front View)

NOTES:

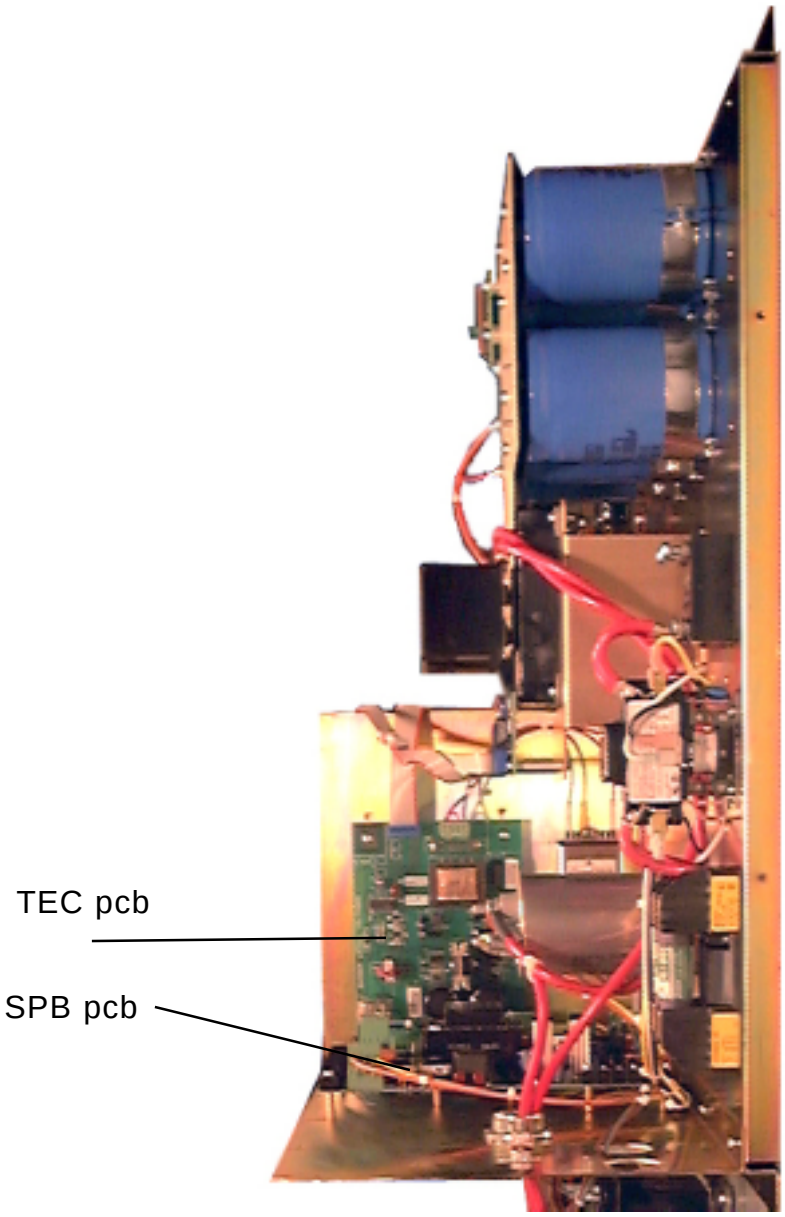


Figure 1-4 Chassis (Right Side)

NOTES:

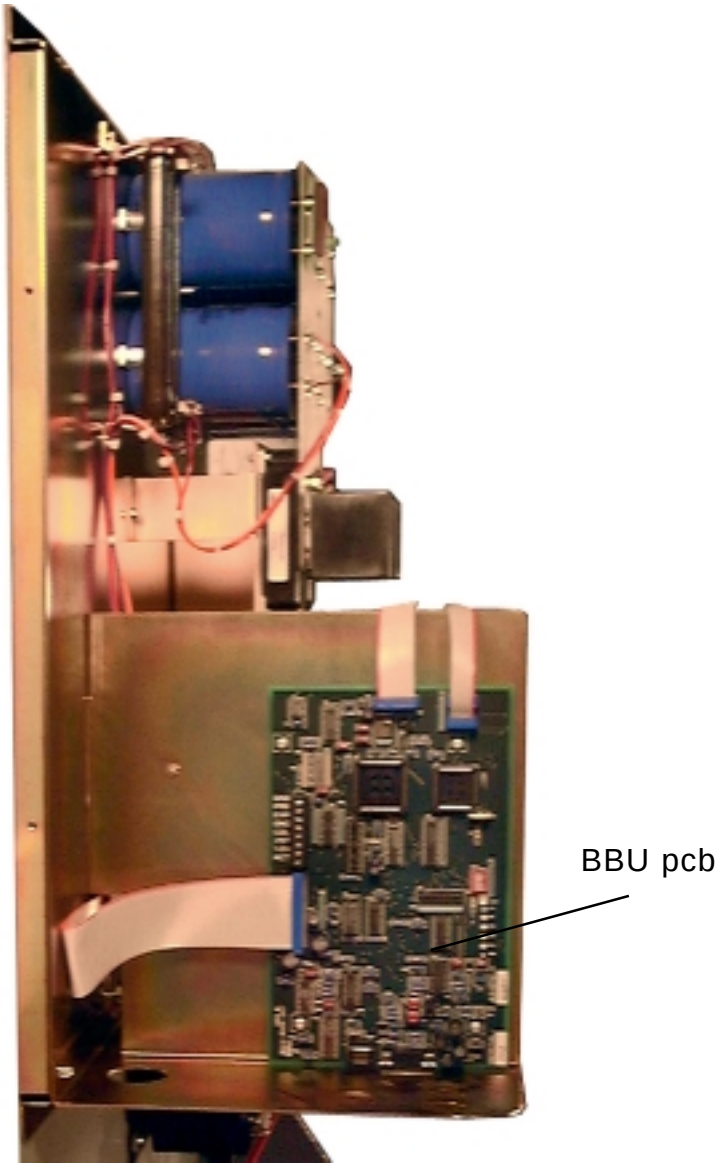


Figure 1-5 Chassis (Left Side)

NOTES:

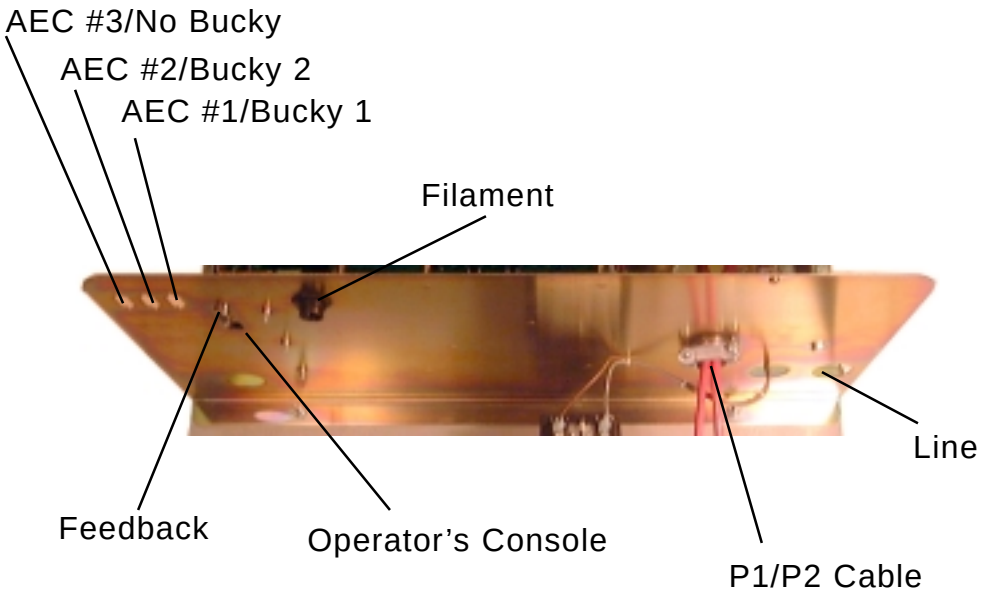


Figure 1-6 Chassis (Bottom View)

NOTES:

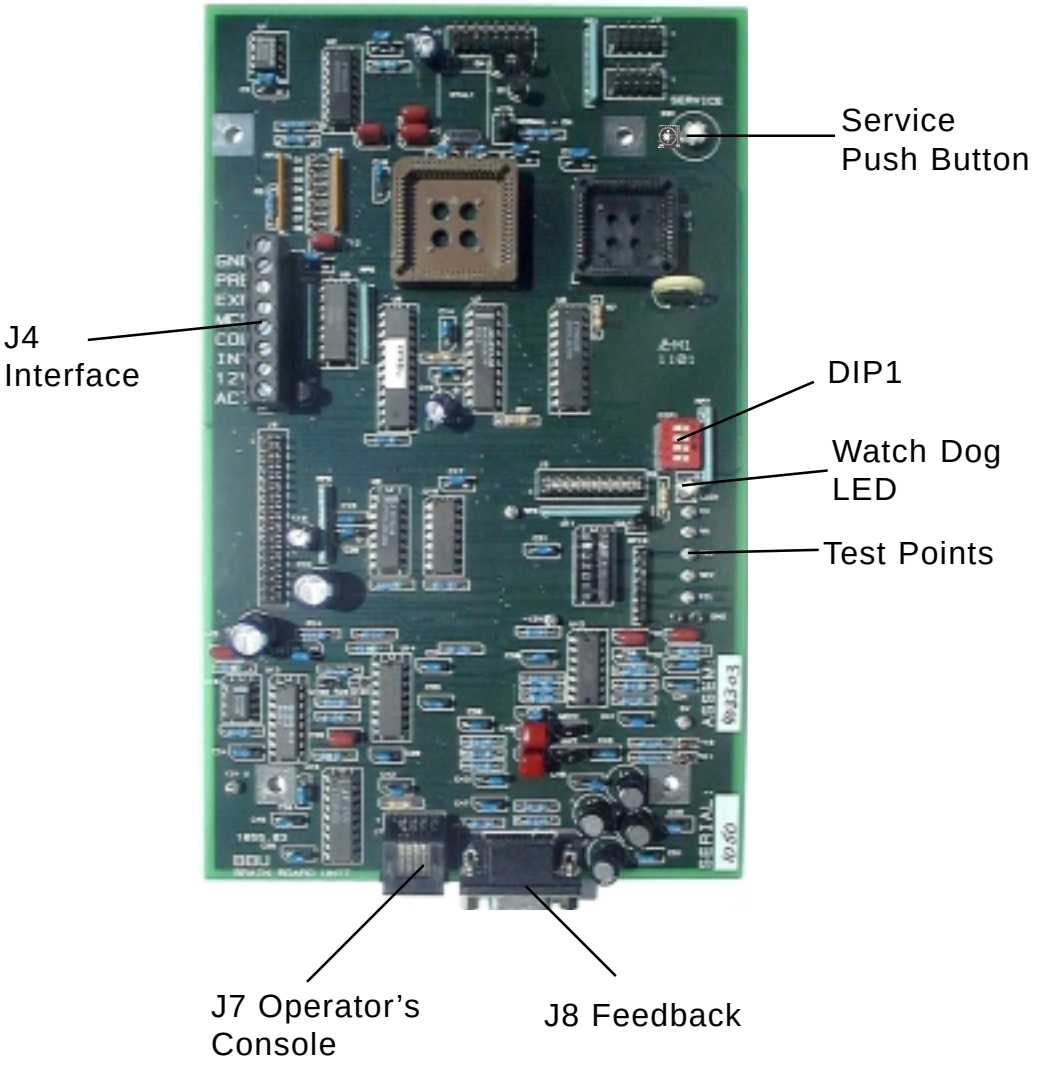


Figure 1-7 Brain Board (BBU)

NOTES:

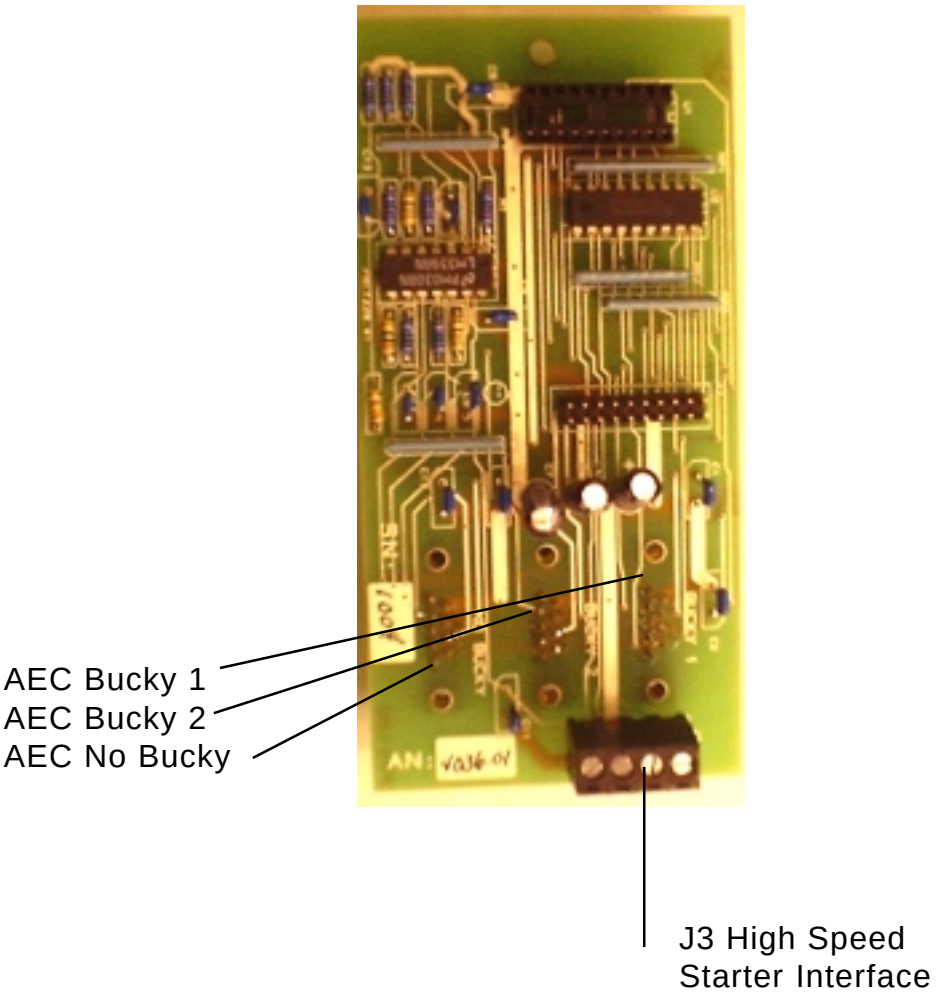


Figure 1-8 AEC/HSS pcb

NOTES:

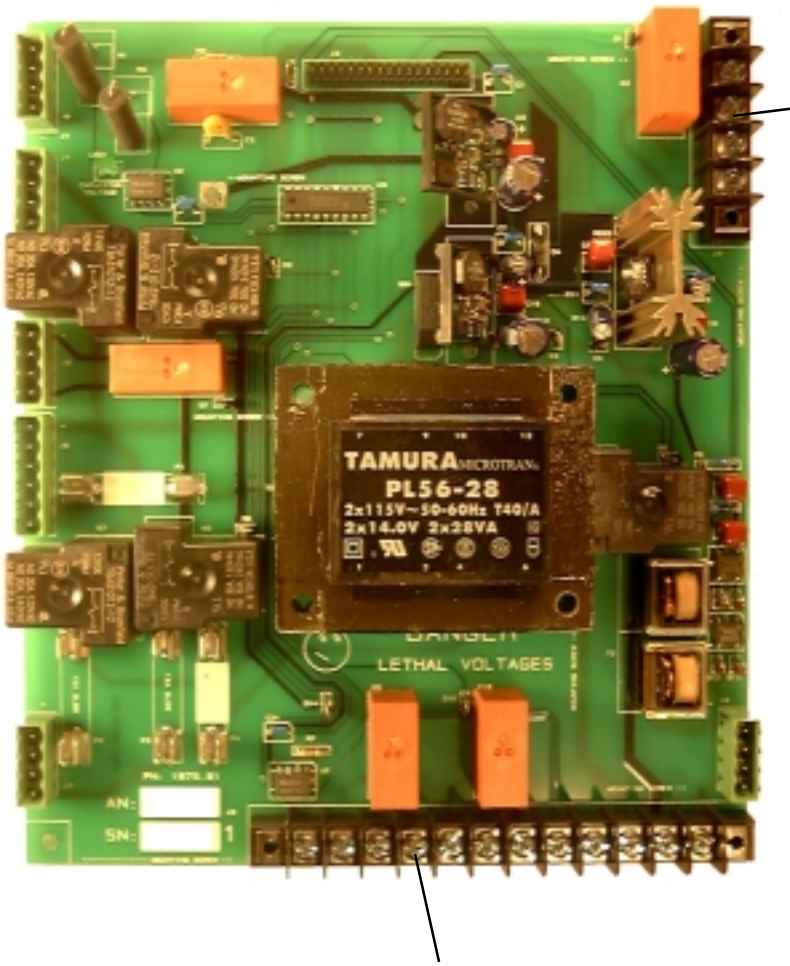


Figure 1-9 System Power Board

NOTES:

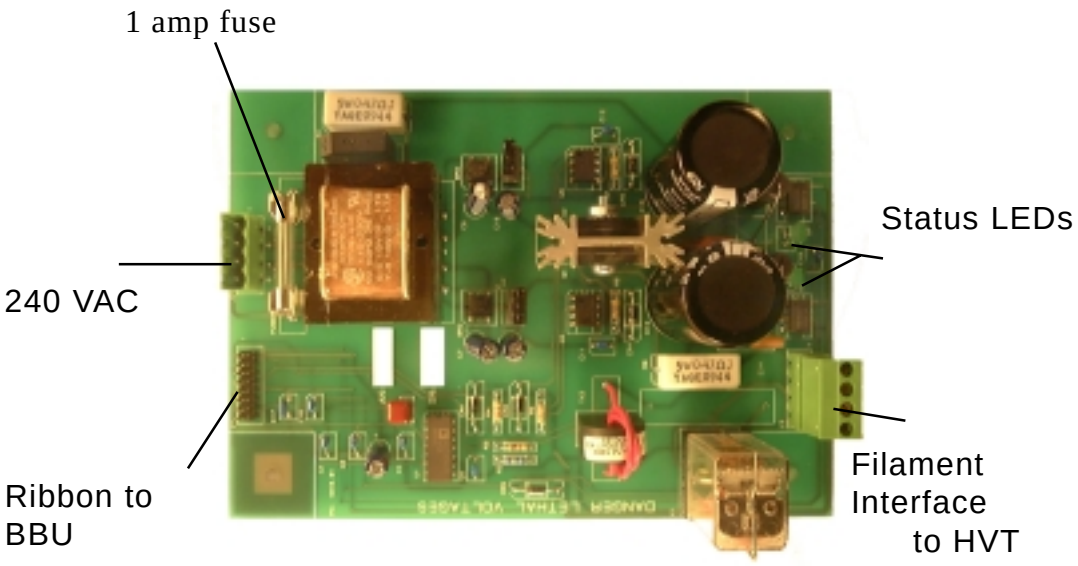


Figure 1-10 TEC (Thermionic Emission Controller)

NOTES:

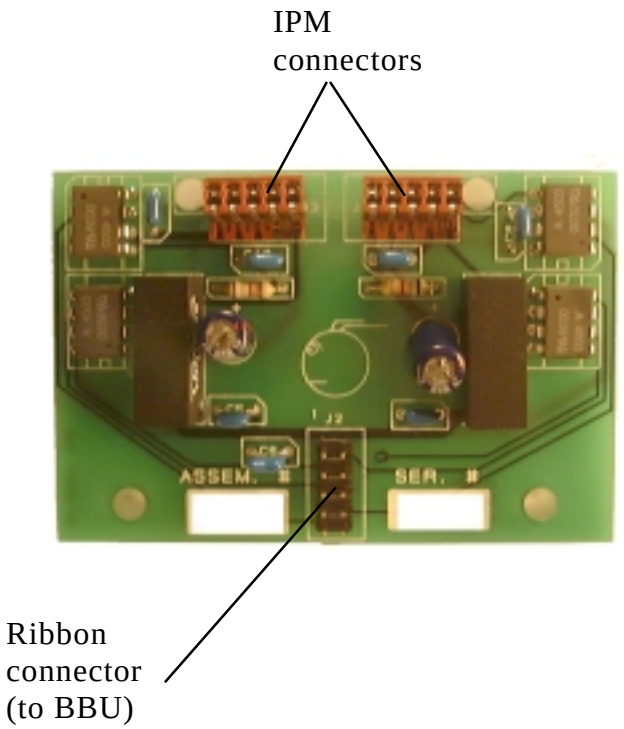


Figure 1-11 IPM Driver

NOTES:

HV Tank

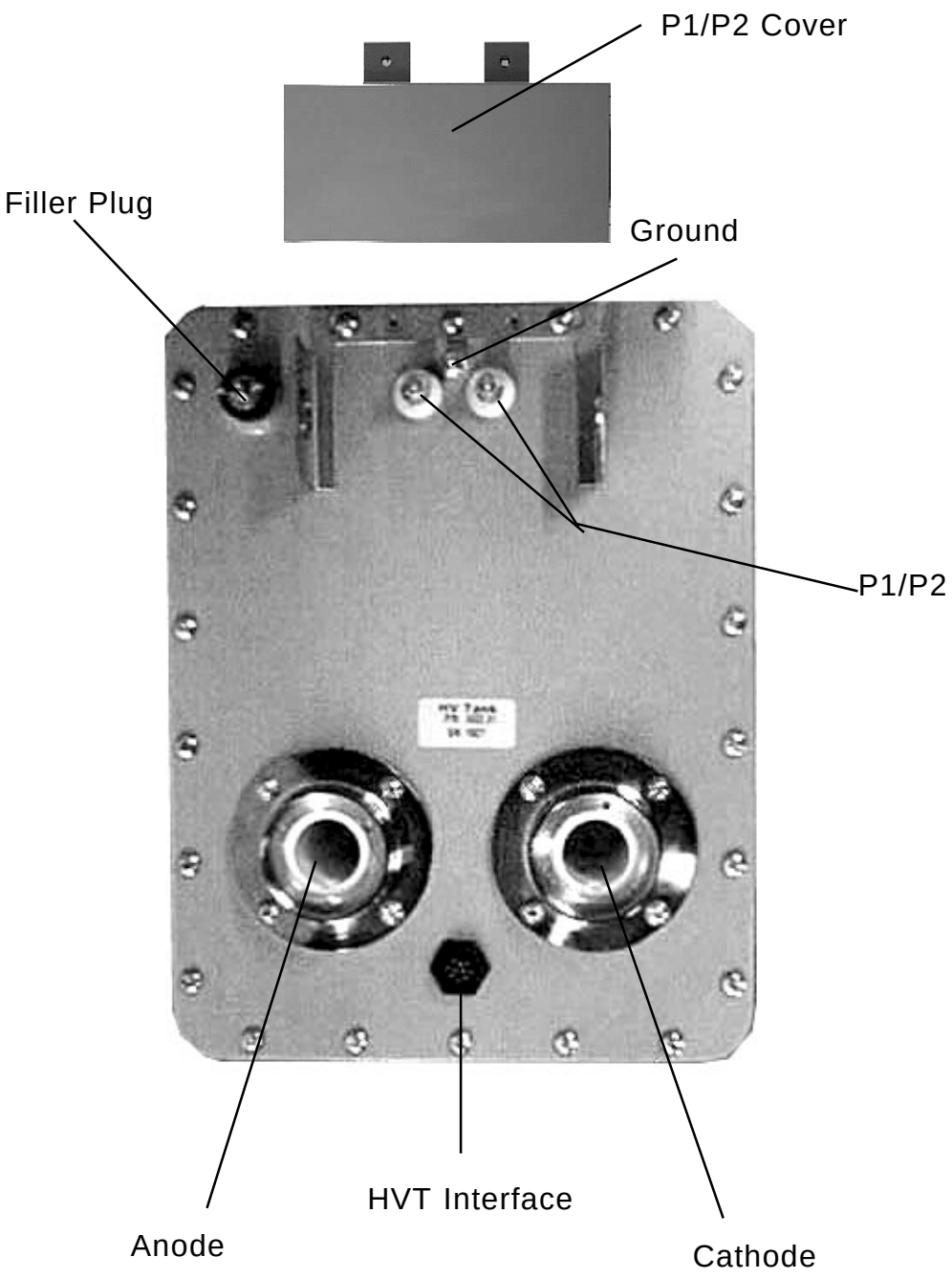


Figure 1-12 HV Tank (Top View)

NOTES:

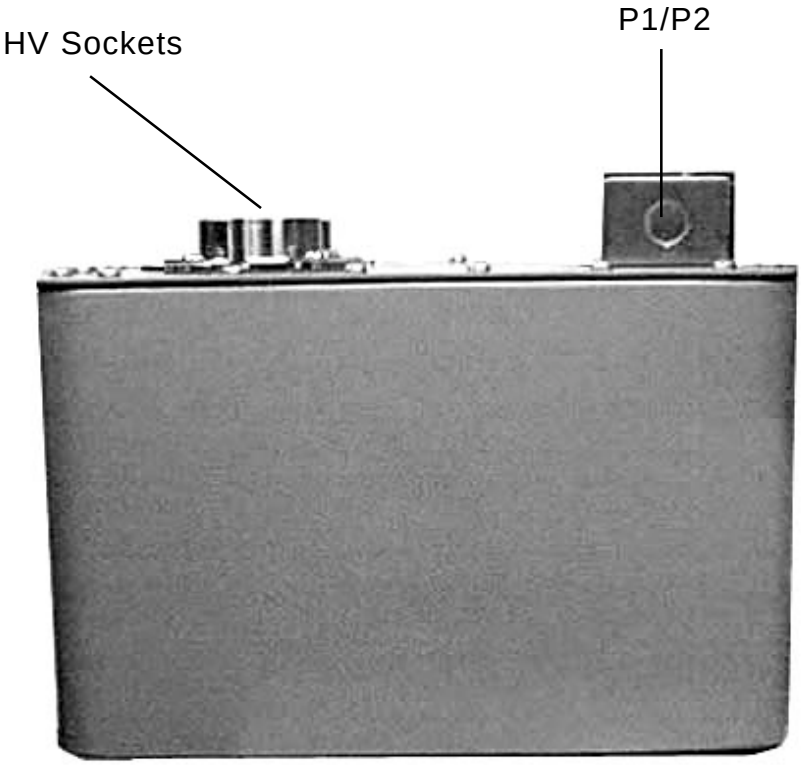


Figure 1-13 HV Tank (Side View)

NOTES:

Line Limits

Determination of Line Limits for use in generator installations.

Vs = 240 voltage at the source “ideal” (volts)

Rc = .1 the resistance of the line (ohms)

Pg = 37500 power used by the generator (watts)

$$Vg = Vs - \frac{Pg}{Vg} \cdot Rc$$

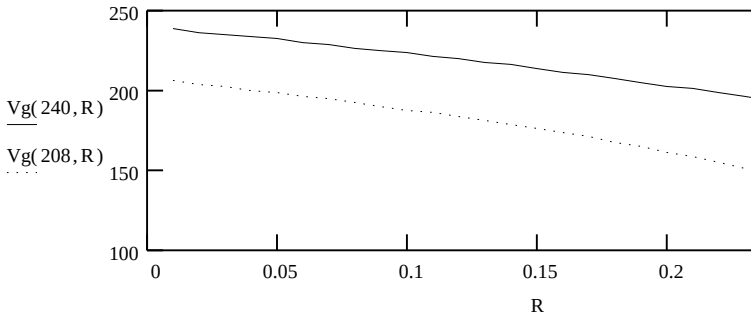
Solving for Vg is then:

$$\begin{bmatrix} \frac{1}{2} \cdot Vs + \frac{1}{2} \cdot \sqrt{Vs^2 - 4 \cdot Rc \cdot Pg} \\ \frac{1}{2} \cdot Vs - \frac{1}{2} \cdot \sqrt{Vs^2 - 4 \cdot Rc \cdot Pg} \end{bmatrix}$$

Choosing the appropriate solution as a function of the source voltage and line resistance:

$$Vg(Vs, Rc) := \frac{1}{2} \cdot Vs + \frac{1}{2} \cdot \sqrt{Vs^2 - 4 \cdot Rc \cdot Pg}$$

$$R := .01, .02 .. .25$$



Now if the source voltage is only 208, as can be seen by this graph, a resistance greater than .05 ohms creates less than 200 volts at the generator.

NOTES:

The resistance used in this model includes the supply transformer resistance and reactance, the wiring to the disconnect resistance and reactance as well as the source impedance to the supply transformer.

This indicates that a 240 VAC supply has much more margin for line losses than a 208 VAC supply.

A small change in line resistance at 208 VAC has a greater effect on the energy supplied to the generator than at 240 VAC.

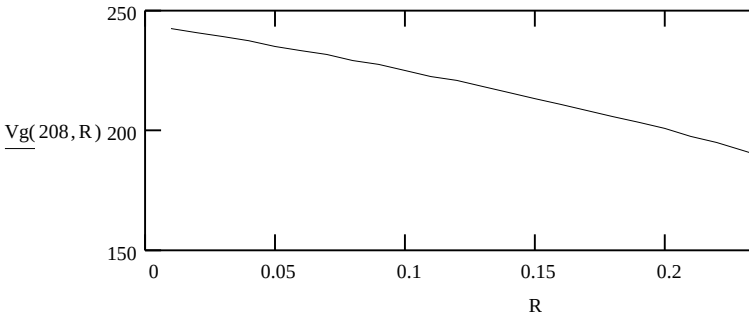
A boost transformer at the generator can increase the voltage but actually increases the source resistance thus limiting the power received by the generator.

A 15 % boost transformer configuration is equivalent to:

$$Vg = Vs - \frac{Pg}{Vg} \cdot Rc + .15 \cdot Vg$$

Solving for Vg is then:

$$Vg(Vs, Rc) := .588\,Vs + .263\sqrt{5. \cdot Vs^2 - 17. \cdot Rc \cdot Pg}$$



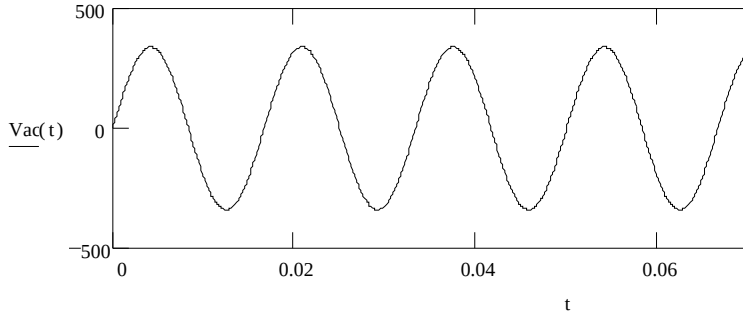
Now with a 208 VAC source, the voltage at the generator would be below 200 VAC with a line resistance greater than .2 ohms. So then if the boost transformer adds more than .15 ohms resistance the source will look the same from the generator's view point.

NOTES:

Line Voltage and Current

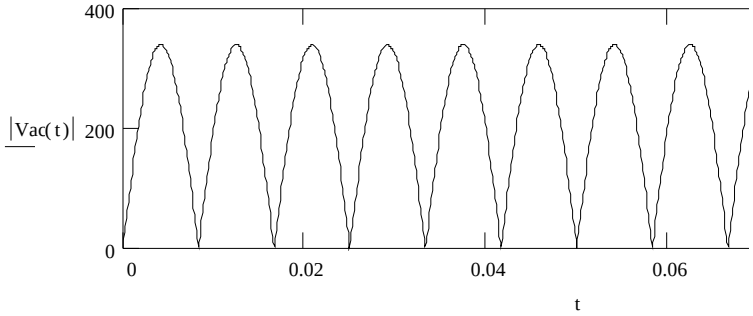
Generator Line voltage and Current Relationships

$$Vac(t) := \sqrt{2} \cdot 240 \sin(t \cdot 2 \cdot \pi \cdot 60) \qquad t := 0, .0001 .. 1$$



The "sine wave"

After full wave rectification, the output looks like:

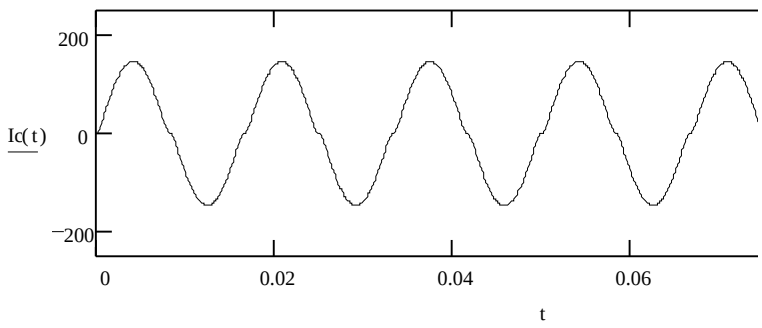


Full Wave

In a conventional full wave, single phase generator the line current closely follows the input voltage:

$$Ic(t) := e^{-\frac{1}{\frac{|Vac(t)|}{50} + .0001}} \cdot Vac(t) \cdot .5$$

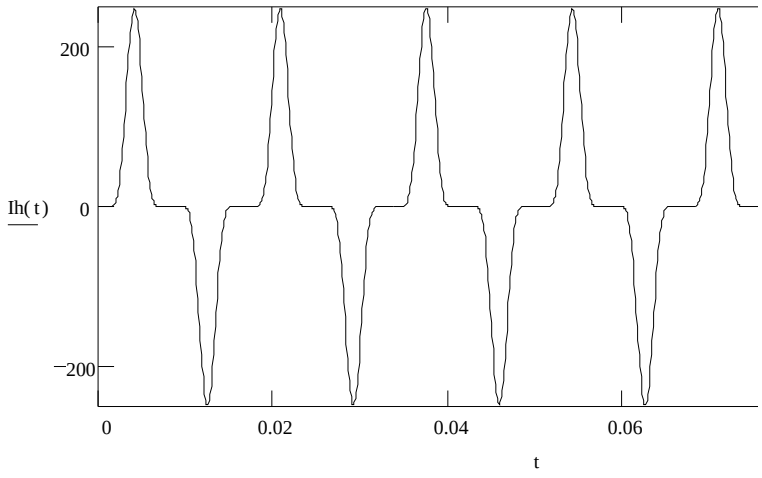
NOTES:



Typical Conventional Line Current

In a high frequency generator, the line is directly connected to a bridge rectifier. The output of the bridge rectifier is connected to a storage capacitor bank. The line current into the bridge rectifier is dependent upon the voltage the capacitors are charged to and the total capacitance. The more capacitance and the lower the voltage, the more current will flow from the line. The typical line current waveform is more “extreme” than that for a conventional generator.

$$Ih(t) := e^{-\frac{1}{\frac{|Vac(t)|}{2500}+.0001}} \cdot Vac(t) \cdot 1150$$

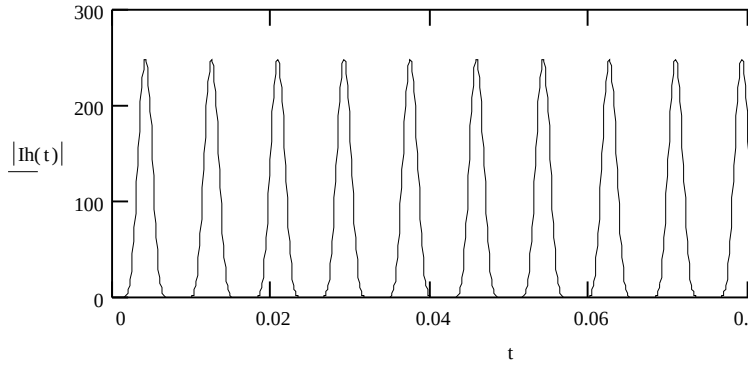


Typical High Frequency Generator Line Current

More energy is drawn from the peaks of the incoming line voltage. This waveform has many high frequency harmonics. The reactance of the line is much higher at these higher frequencies making it more difficult to get the energy from the line into the generator.

NOTES:

The current into the capacitors would look like this:

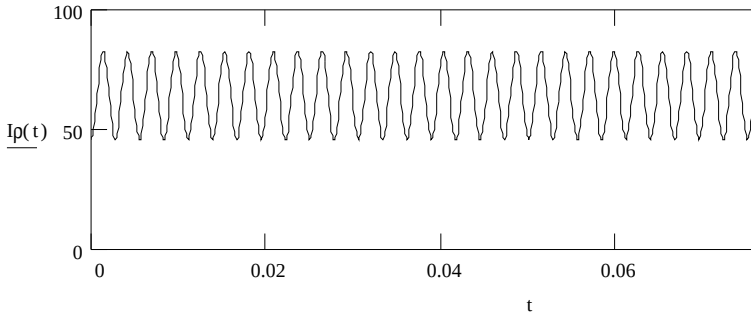


Typical Charging Current

The line current must increase if the line voltage decreases for the same power demand.

For a 3 Phase line the current into the capacitors looks more like:

$$I\rho(t) := \frac{|Ih(t)| + \left|Ih\left(t + \frac{1}{60 \cdot 3}\right)\right| + \left|Ih\left(t + \frac{2}{60 \cdot 3}\right)\right|}{3}$$



Typical Three Phase Capacitor Charging Current

There is a much “smoother” flow and lower peak currents for 3 Phase.

For this reason, 3 Phase power is preferred.

Chapter 2: Installation

NOTES:

Site Preparation

The following factors should be considered when selecting a site for installation of the Cabint:

Environment:

This equipment is designed to work within a temperature range of 20°C to 30°C, with a relative humidity (non-condensing) of less than 40%.

Proximity to Mains Disconnect:

L1/L2/L3 connections should be as short as possible in order to minimize line drop during an exposure.

NOTE: If less than 15' use #6 stranded wire from Mains Disconnect to F1/F2/F3. If greater than 15' use #4 stranded wire. Consult Local Electrical Code for the proper wire size between Mains Disconnect and Source.

WARNING: For proper operation of the generator you may not increase the length of the Interface Cable or the P1/P2 Cable.

NOTES:

Unpacking

The **g**enerator is shipped in two cartons. The HV Tank is in one carton and the Cabinet is in the other.

Carefully inspect the exterior of both cartons for external damage. Report any damage immediately to the carrier. Damage due to mishandling during shipping or transportation is specifically not covered by the manufacturer's warranty.

NOTE: Damage due to mishandling during shipping or transportation is specifically not covered by the manufacturer's warranty.

HV Tank

Remove the HV Tank from the carton. Open the plastic bag and inspect for an oil leak. Some seepage is normal due to pressure changes in shipping.

NOTE: Due to pressure changes in shipping and transportation, residual amounts of oil may leak from the HVT and be evident on the carton or packing materials.

Release the seal on the HV Tank (with the HV Tank in it's normal, upright position) by turning the wing nut on top of the filler plug counterclockwise several times until it is loose.

Cabinet

Remove the Cabinet from the carton. Open the plastic bag and inspect for damage to the cover.

Inspection

NOTES:

WARNING: It is critical that you conduct a complete visual inspection of the components of the generator after unpacking.

Every precaution is taken during the final test and packing procedures to ensure that all screws and fasteners are secured tightly and that all circuit boards are seated properly.

However, it is the responsibility of the installer to inspect carefully prior to the first application of power.

Failure to follow this step could result in damage to the generator as well as injury to personnel.

HV Tank

The High Voltage cable wells are covered by red plastic plugs. Remove the plugs and ensure that the wells are clean and free of any contaminant.

Inspect the sides of the tank. They should be smooth and without indentations.

Inspect the pins on the Interface Connector. Remove any residue that may have accumulated during shipping. Ensure that all the pins are straight.

Remove the cover protecting P1/P2 and inspect the brass studs. Note the presence of the proper mounting hardware.

NOTES:

Cabinet

Inspect the cover of the Cabinet. It should be smooth without any indentations other than the air vents.

Remove the four (4) 6.32 screws (two on each side) that secure the cover to the main chassis. Lift off the cover. Inside you should find the following:

Wall Mount Bracket

GCU (Generator Control Unit)

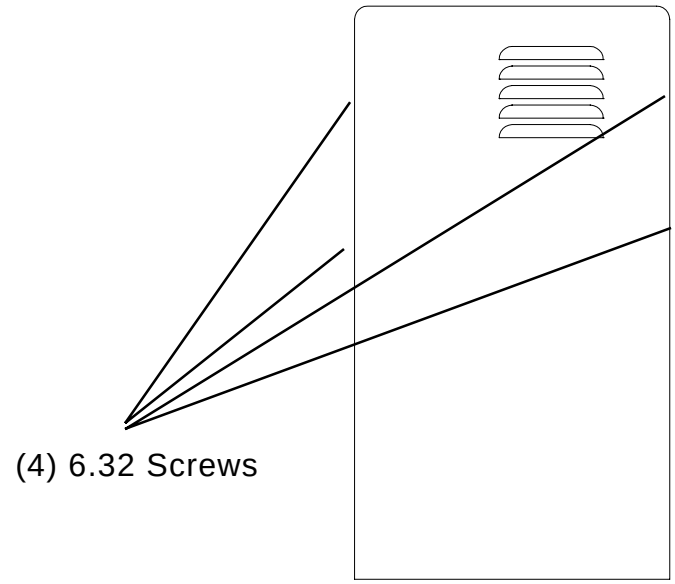
Interface Cable (GCU to HVT)

Operator's Console

Interconnecting Cable for Operator's Console

1 set of Manuals (Operator's and Technical)

Check the security of all components. Refer to the illustrations in Chapter 1. The unit was not shipped with extra hardware inside. Any loose screws, washers, etc. have a proper place in the Cabinet. If you find loose hardware, it is not normal.



(4) 6.32 Screws

Operator's Console

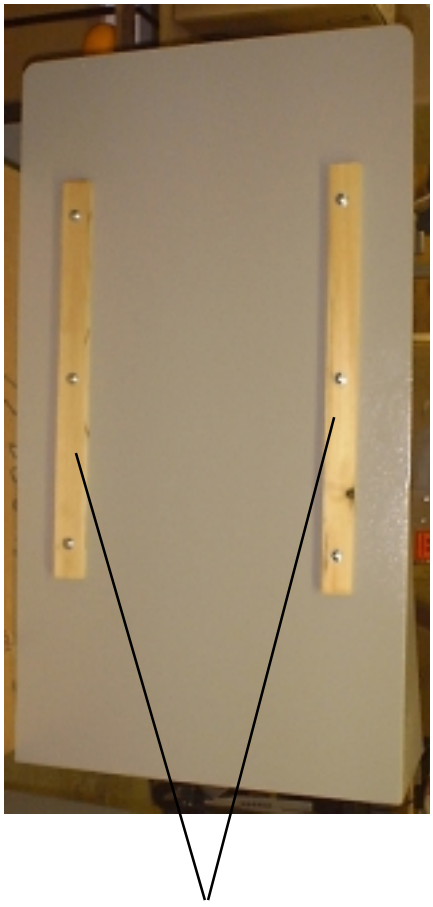
NOTES:

Unwrap and inspect the Operator's Console. The plastic case should be solid and without cracks or scratches.

The membrane switch panel should be without blemish and you should be able to see each of the 7 segment LED displays through the green filters on the display windows.

The rear panel should be intact with the connector for the Interconnecting Cable, the Hand Switch and On/Off Push-button visible and unobstructed.

Rear View of Wall Mount Bracket



Wooden Shipping Braces

NOTES:

Mechanical Installation

Wall Mount Bracket

WARNING: The Cabinet is not free-standing. If sited so that the bottom shelf is flush with the floor you must use the two top mounting holes to secure the Wall Mount Bracket to the wall to prevent the Cabinet from falling over.

Remove the 4 1/4-20 nuts which secure the GCU chassis to the Wall Mount Bracket. Refer to Figure 2-2. Remove the GCU chassis from the Wall Mount Bracket.

Remove the 1”x2”x24” wooden shipping braces from the rear of the Wall Mount Bracket.

The Wall Mount Bracket can be sited flush with the floor or suspended on the wall. (See Warning above.)

If you install the Wall Mount Bracket flush with the floor you must use the two top mounting holes to secure theWall Mount Bracket to the wall to prevent the Cabinet from falling over.

If you install theWall Mount Bracket suspended on the wall you must use all 6 mounting holes to secure the Wall Mount Bracket.

Refer to Figure 2-1 for the dimensions of theWall Mount Bracket and the location of the mounting holes.

Once the Wall Mount Bracket has been secured to wall using one of the above methods, you may mount the HV Tank and GCU chassis.

Cable Access is through the bottom right corner of the Wall Mount Bracket. Refer to Figure 2-3.

NOTES:

HV Tank

The HV Tank weighs approximately 85 lbs (38 kgs) and must be mounted in an upright position on the bottom shelf of the Wall Mount Bracket. Refer to Figure 2-2.

If the local building code requires that the HVT be secured mechanically to a mounting surface, you may drill holes in the bottom shelf of the Wall Mount Bracket.

GCU

The GCU chassis weighs approximately 35 lbs (16 kgs). Secure the Chassis to the Wall Mount Bracket using the 4 1/4-20 studs provided. Refer to Figure 2-2.

Cable access to the GCU is through the bottom panel. Refer to Figure 1-6 in Chapter 1.

Operator's Console

The Operator's Console is designed to mount on a shelf or desk top in the Control Booth. The 25' (7.5 meter) Interconnecting Cable connects between the rear of the Operator's Console and the bottom panel of the GCU.

NOTES:

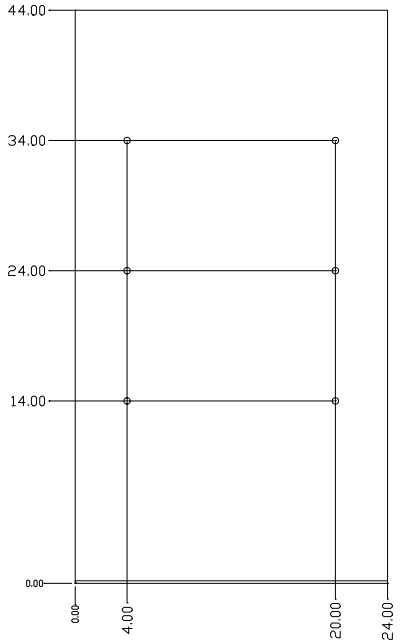


Figure 2-1 Wall Mount Bracket Mounting Holes

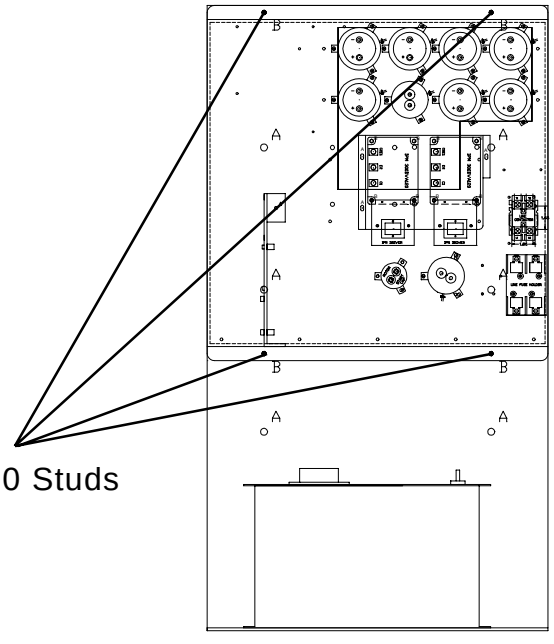


Figure 2-2 GCU Mounting Studs

NOTES:

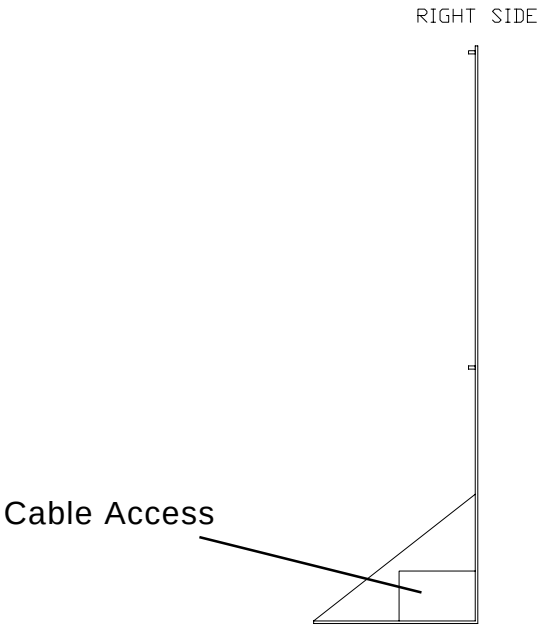


Figure 2-3 Wall Mount Bracket Cable Access

NOTES:

Interconnection

Interconnection of the **g**enerator consists of three cables supplied with the generator.

P1/P2 Cable

This consists of 2 #8 Red Wires and a #8 Green/Yellow Ground Wire with one end already attached inside the GCU. It is packed coiled against the bottom panel of the GCU.

#6 round terminals are attached to the open end of the cable for connection to the P1/P2 and Ground studs on the HV Tank.

The ground wire attaches to the Ground stud. Connect the other two wires to P1 and P2. The order is not critical.

CAUTION: P1/P2 connections are brass studs. It is possible to strip the threads on these studs or break them if you over tighten the locknuts. Do not use excessive force when tightening these connections.

Interface Cable

The Interface Cable connects the HV Tank to the GCU. It consists of a 30” (80 cm) cable with a single connector on the HV Tank end and two (2) connectors on the GCU end. (Refer to Figure 2-4)

Connect the single connector to the HV Tank.

At the GCU connect the 4 conductor round connector to the Filament connector on the Bottom Panel.

Connect the 9 pin D-Sub connector to the Feedback connector on the Bottom Panel.

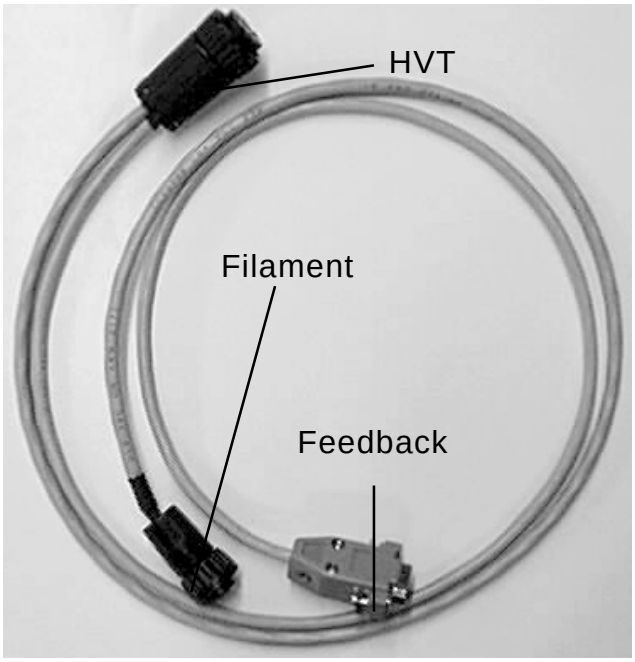


Figure 2-4 Interface Cable

Interconnecting Cable

Route the 25’ (7.5 meter) Interconnecting Cable from the Bottom Panel of the GCU through conduit or trough to the Control Booth.

One end connects to the rear panel of the Operator’s Console and the other end connects to the Bottom Panel of the GCU.

NOTES:

NOTES:

NOTE: Hand Switch is optional.

Figure 2-5 Hand Switch

Hand Switch

If your generator includes an optional Hand Switch, connect it to the rear of the Operator's Console (refer to Fig. 1-1B {25}).

This is a two position Hand Switch. The first position is PREP and the second position is EXP. These switches are in parallel with the PREP and EXP push buttons on the Operator's Console.

Chapter 3: Interface

NOTES:

Mains

Single Phase (V-10/20/30)

Connect 187/250 VAC, 1 Phase to F1/F2 in the GCU from Mains Disconnect. Refer to Figure 3-1A.

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

NOTE: If less than 15' use #6 stranded wire from Mains Disconnect to F1/F2. If greater than 15' use #4 stranded wire.

WARNING: The equipment must be grounded to an earth ground by a separate #8 conductor. The neutral side of the line is <u>not</u> to be considered the earth ground.

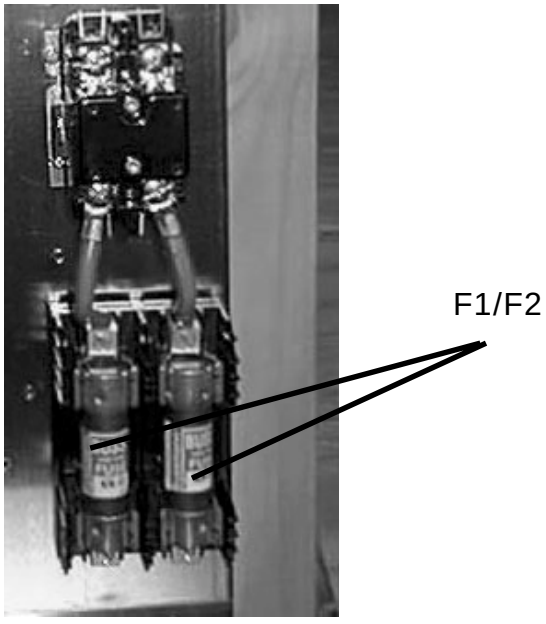


Figure 3-1A F1/F2 Location

NOTES:

3 Phase (V-40/50)

Connect 187/250 VAC, 3 Phase to F1/F2/F3 in the GCU from Mains Disconnect. Refer to Figure 3-2A.

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

NOTE: If less than 15' use #6 stranded wire from Mains Disconnect to F1/F2. If greater than 15' use #4 stranded wire.

WARNING: The equipment must be grounded to an earth ground by a separate #8 conductor. The neutral side of the line is not to be considered the earth ground.

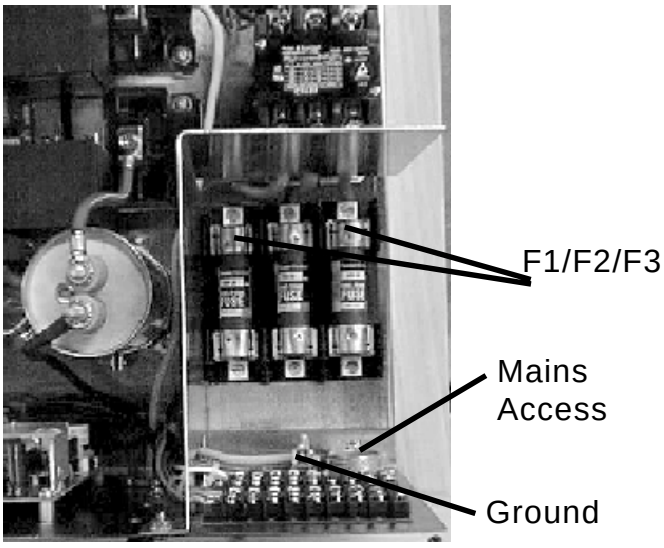


Figure 3-1B F1/F2/F3 Location

Buckys

Connect Bucky (or Buckys) to J9 Termnial Block on the SPB pcb. (Refer to Figure 3-2.)

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

WARNING: The Bucky Motion Inputs must be a “dry contact” to ground (NO VOLTAGE!). Any voltage on this input will result in damage to the equipment.

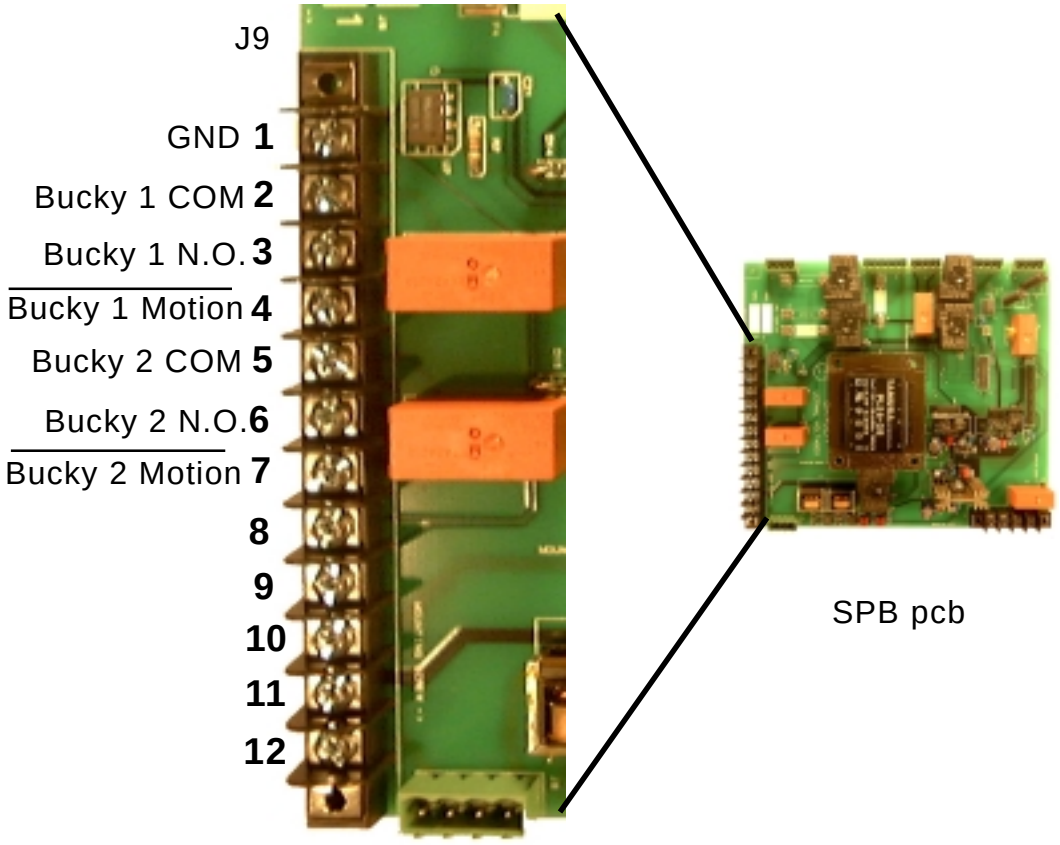


Figure 3-2 Bucky Connections

NOTES:

NOTE: V-10/20/30: Buckys are active only if the specific option is installed.

NOTES:

Liebel Bucky

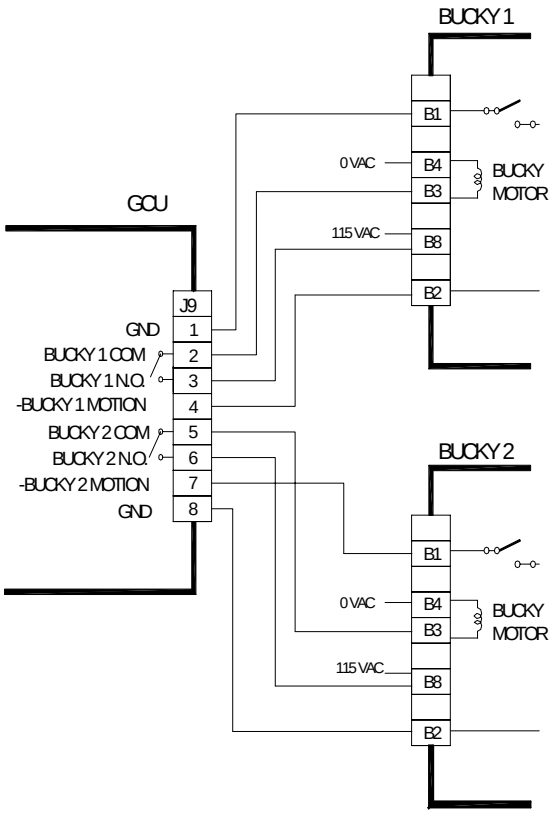


Figure 3-3 Liebel Bucky Typical Configuration

NOTES:

Midwest Bucky

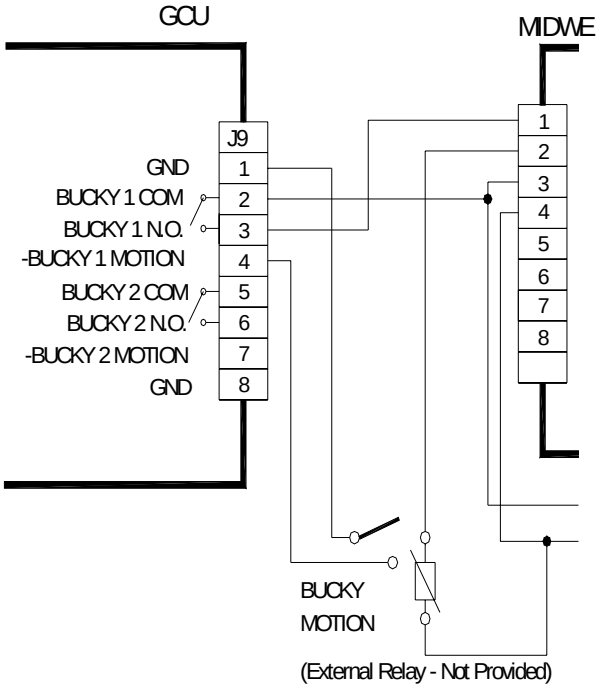


Figure 3-4 Midwest Bucky Typical Configuration

NOTE: V-10/20/30: Buckys are active only if the specific option is installed.

NOTE: The Midwest Bucky requires an external relay with a set of normally open contacts for the Bucky Motion input to the generator. This relay is not provided.

NOTES:

Rotor

Connect the Rotor to J9 Terminal Block on the SPB pcb. (Refer to Figure 3-5).

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

WARNING: The Common terminal for the Rotor(Rotor COM) is connected to one side of the AC Line at all times. <u>DO NOT CONNECT AN X-RAY TUBE WITH A GROUNDED ROTOR TO THIS SYSTEM !</u> Failure to heed this WARNING will result in catastrophic failure of the x-ray tube in a very short time.

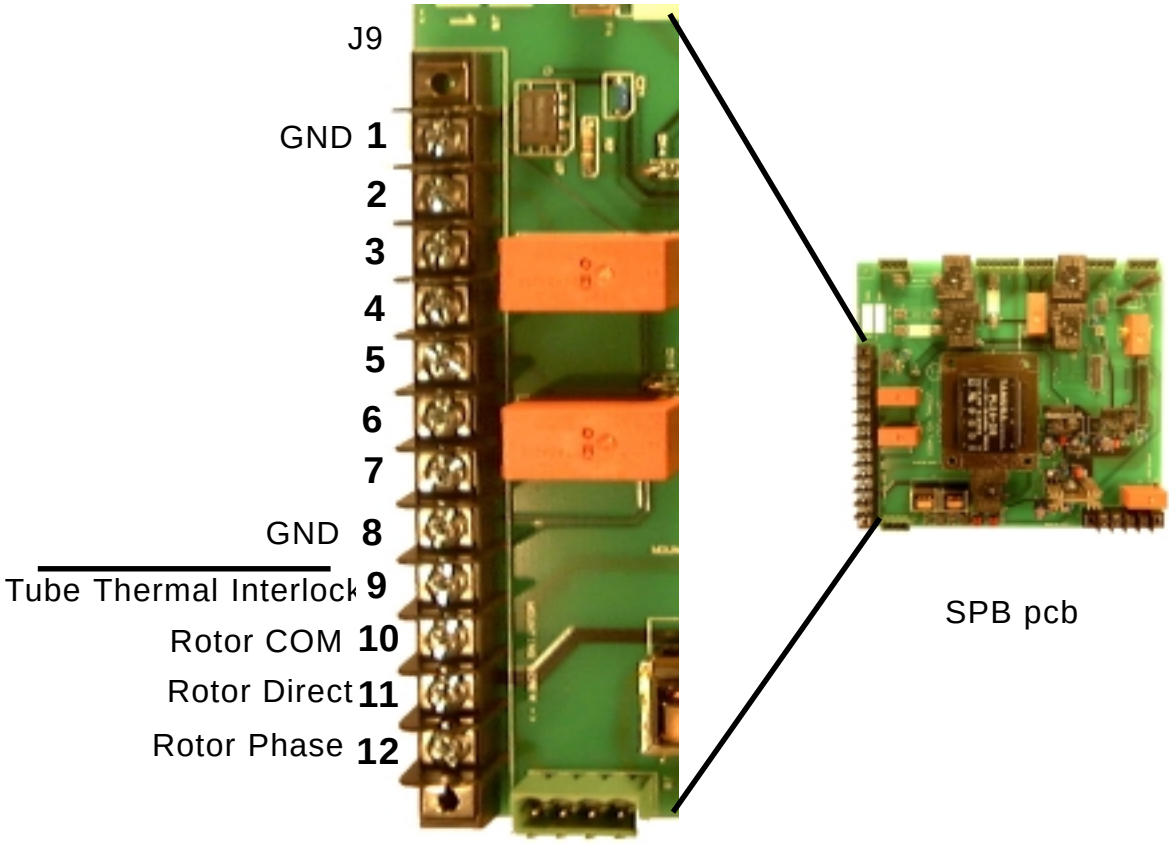


Figure 3-5 Rotor Connections

Revision:
Date:

External Handswitch/Footswitch

NOTES:

Connect an External Handswitch/Footswitch to the J4 Terminal Block on the BBU. Refer to Figure 3-6.

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

All connections must be a “dry contact” (No Voltage!) to ground.

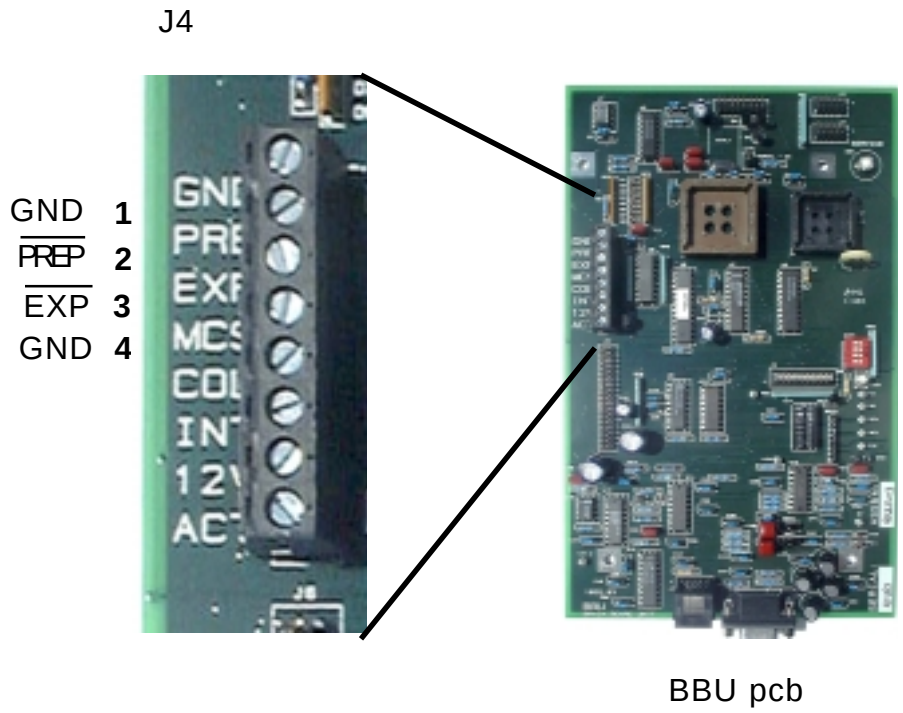


Figure 3-6 Handswitch/Footswitch Connections

NOTES:

Interlocks

Connect Door and Collimator Interlocks to the J4 Terminal Block on the BBU pcb. Refer to Figure 3-7.

Input to the GCU is through the access hole on the Bottom Panel. Refer to Figure 1-6 in Chapter 1.

All connections must be a “dry contact” (No Voltage!) to ground.

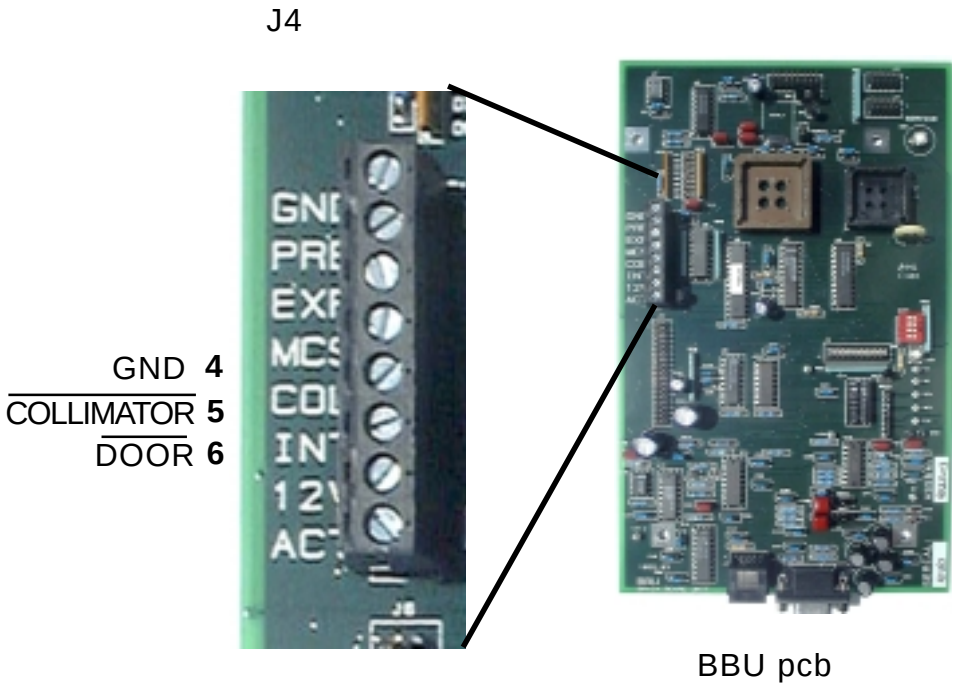


Figure 3-7 Interlock Connections

NOTES:

AEC

Connect Ion Chambers to input connectors on Bottom Panel of GCU. Refer to Figure 3-8.

NOTE: Ion Chamber selection is based upon configuration programming in Chapter 4: Setup.

NOTE: V-10/20/30: AEC is active only if the specific option is installed.

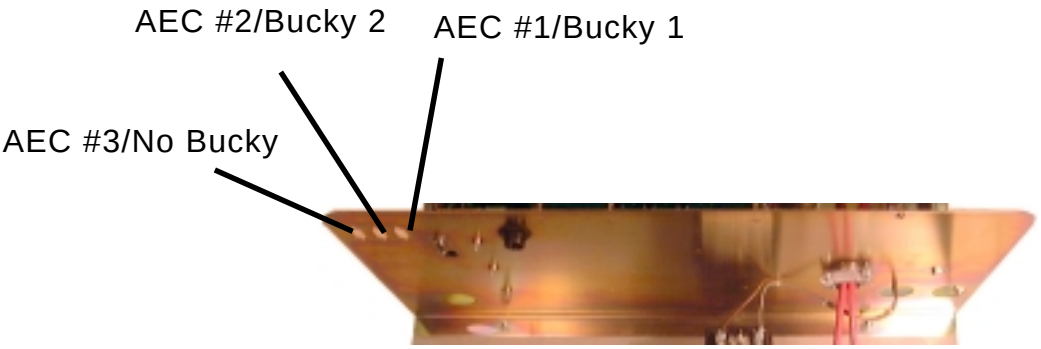


Figure 3-8 AEC Ion Chamber Connections

NOTE: The AEC circuitry is compatible with positive slope Ion Chambers only.

NOTES:

Auxillary Relay

An Auxillary Relay is provided on the SPB pcb. This relay may be used to switch on power to other devices in the x-ray room (ie. table, tube stand, etc.).

Two sets of normally open contacts are provided at J3 on the SPB pcb (refer to Figure 3-9). These contacts close after a normal power up sequence.

NOTE: The maximum rating for the relay contacts is 8 Amps @ 250 VAC.

WARNING: For safety, you must provide fuse protection for any voltage switched by this Auxillary Relay.

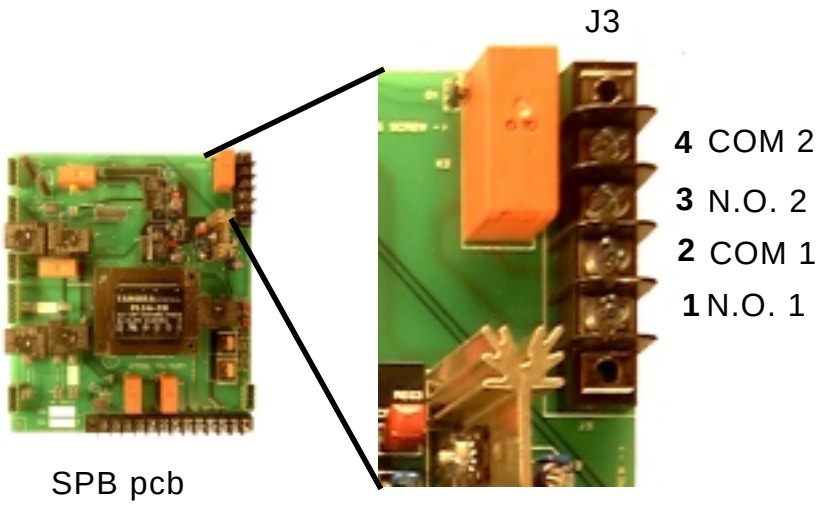


Figure 3-9 J3 Auxillary Relay Connections

24 VAC Collimator Lamp Power

NOTES:

A step-down transformer is supplied, mounted to the Wall Mount Bracket, for 24 VAC Collimator Lamp Power. (Refer to Figure 3-10).

Input power for this transformer comes from the SPB pcb and is present after a normal power up sequence.

Output power is 24 VAC @ 8 Amps.

NOTE: The primary connections for the transformer are not connected during shipping. They must be connected after the wall mount bracket has been mounted to the wall and the GCU Chassis has been re-installed.

NOTE: To gain access to the F1 output terminal of the transformer you must remove the 8 Amp fuse.

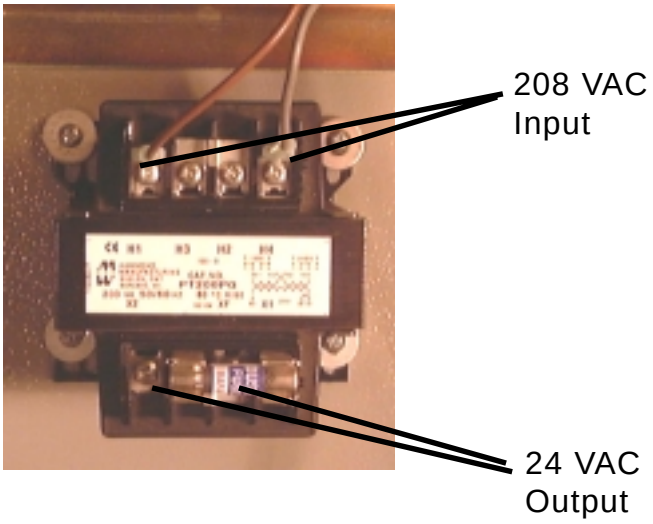


Figure 3-10 24VAC Transformer

NOTES:

External Exposure Indication

An open collector output is provided at J4-8 on the BBU pcb for an external exposure indication. Refer to Figure 3-11.

The output is active low and is present during an exposure sequence.

The output has a minimum on time of 75 milliseconds.

WARNING: The maximum rating for this open collector output is 30 VDC @ 100 mA. If the device you attach requires a higher rating, use this output to energize a relay.

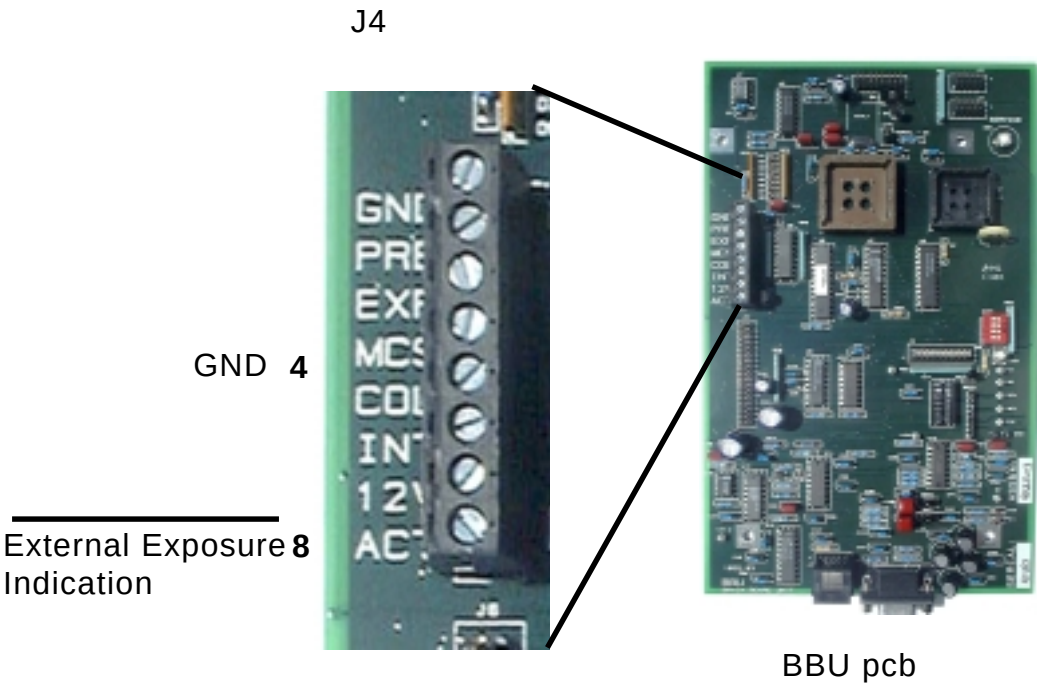


Figure 3-11 External Exposure Indication

High Speed Starter Interface (V-40/50)

NOTES:

A High Speed Starter Interface is provided in the V-40 and V-50 generators.

NOTE: If a High Speed Starter is connected to the generator, do not connect the Rotor to TB-1. Connect the Rotor as indicated in the High Speed Starter Technical Manual.

NOTE: If you select an x-ray tube in Pre-Set # [≡00] that does not have High Speed Rotor capability, you will not be able to select a 1 for Pre-Set # [≡22].

The interface for the High Speed Starter in on connector J3 of the AEC/HSS pcb. Refer to Figure 3-12.

The signals and their descriptions are according to Table 3-1.

NOTES:

SIGNAL	CONNECTION	DESCRIPTION
HSSGO	J3 pin 1	Open Collector Output Pulled low on PREP if Pre-Set # 22 set to 180
HSSHI	J3 pin 2	Open Collector Output High Speed Requested Pulled low on PREP if Pre-Set # 22 set to 180
GND	J3 pin 3	Ground Connection
HS NT	J3 pin 4	Opto-Coupled Input Pulled low for Rotor Interlock

Table 3-1 High Speed Starter Connections

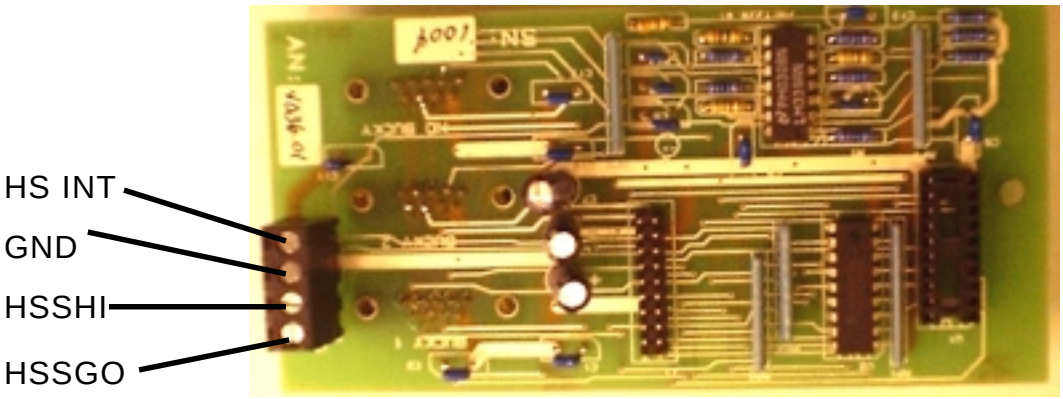


Figure 3-12 AEC/HSS pcb High Speed Starter Connections

Chapter 4: Setup

Overview

This chapter covers the initial Power On Test, selecting the mA Stations, initializing all preset variables and testing the Filament.

CAUTION: The generator is shipped with DIP1-1 on the BBU pcb in the OFF position. This disables the drive to the TEC pcb as well as the Pre-Charge and Charge relays. Do not move this switch to the ON position until directed to do so in this manual.

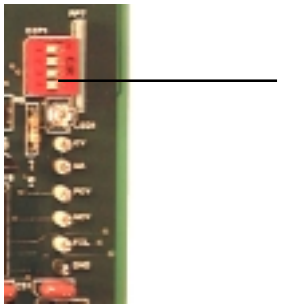


Figure 4-1 BBU pcb

In addition to the Self-Diagnostic functions built into the generator, there are several additional safety features. One of these is the Diagnostic Interlock. This Diagnostic Interlock allows the microprocessors to detect if the HV Tank feedback cable is disconnected.

On Power Up if the HV Tank feedback cable is disconnected you will have an Error Code E01 displayed on the kVp Display of the Operator's Console.

CAUTION: Do not operate the generator with any of the circuit boards, the HVT, or the Operator's Console disconnected.

NOTES:

NOTE: Bucky's and AEC are active only if the Feature Package option is installed.

NOTES:

Power On Test

NOTE: This test presumes you have performed the Inspection and Interconnection steps detailed in Chapter 2 of this manual. If you have not performed these steps please return to Chapter 2 and complete them at this time.

Blue Watch Dog LED

The Blue Watch Dog LED on the BBU pcb provides additional information. When the Line Disconnect is first turned on the LED will illuminate for approximately 2 to 4 seconds. During this time the processor is initializing and you cannot turn on the Operator's Console. At the end of this initialization period, the Blue Watch Dog LED will go out.

When you press the On/Off Pushbutton on the Operator's Console the Blue Watch Dog LED will illuminate and stay on as long as the Console is on and there are no errors. If an error occurs, in addition to the Error Code being displayed in the kVp Display of the Operator's Console, the Blue Watch Dog LED will blink the number of times corresponding to the Error Code.

Power On

Switch on the wall disconnect. The Blue Watch Dog LED should illuminate steady for approximately 2 to 4 seconds and then go out. This indicates a normal power up sequence for the processor.

WARNING: DANGER: When the wall disconnect is switched on, 220 VAC standby power is present on the SPB pcb even if the Operator's Console is switched off. Lethal voltages are present on the pcb and care should be taken to avoid electrical shock.

NOTES:

Figure 4-2 Operator's Console (Rear View)

Momentarily press the On/Off push-button switch on the rear of the Operator's Console. **Do not hold the switch down**. Press and release.

There will be a slight delay during which the microprocessors are initializing. Then you will hear an audible tone and the displays on the Operator's Console will illuminate. The Blue Watch Dog LED on the BBU pcb will illuminate and stay on. This indicates a normal Power Up sequence.

If this does not occur, read the Error Code on the kVp Display of the Operator's Console and refer to Chapter 7, Diagnostics.

During a normal Power Up sequence the generator initializes the microprocessors and checks the following data:

Battery Backup RAM

Communications

Diagnostic Interlock

+/- 12 VDC Regulated

If you have no Error Codes showing on the Operator's Console and the Blue Watch Dog LED is illuminated, the generator has executed a normal Power Up sequence and is ready to proceed with the initialization process.

NOTES:

NOTE: You must return DIP1-1 to the ON position and initiate a Power On sequence before proceeding.

You must initiate a Power On sequence in order to reset the generator's microprocessors. Momentarily press the On/Off Pushbutton on the rear of the Operator's Console. This will turn the generator off.

Move DIP1-1 on the BBU pcb to the ON position and momentarily press the On/Off push-button on the rear of the Operator's Console. This will initiate a Power On Sequence.

Pre-Set #s

This section covers the following steps:

Select the X-Ray Tube

Select Small mA Stations

Select Large mA Stations

Select Filament Standby Number for Small Filament

Select Filament Standby Number for Large Filament

Select the Rotor Boost Time

Select Buckys and AEC (if option installed)

Select Interlocks

Select High Voltage Cable Length

Select Maximum kVp

Refer to Table 4-1 for the Pre-Set # adjustments and their order of appearance. Space is provided in the Table for you to note the settings you make during this sequence for future reference.

NOTES:

Pre-Set #	Description	Factory Setting	Notes
≡ 0 0	X-Ray Tube Selection	0	
≡ 0 1	1st mA Station, 25mA	1 (10_50)	
≡ 0 2	2nd mA Station, 50mA	1 (10_50)	
≡ 0 3	3rd mA Station, 75mA	1 (10_50)	
≡ 0 4	4th mA Station, 100mA	1 (10_50)	
≡ 0 5	5th mA Station, 150mA	1 (10_50)	
≡ 0 6	6th mA Station, 200mA	2 (10_50)	
≡ 0 7	7th mA Station, 250mA	2 (20_50)	
≡ 0 8	8th mA Station, 300mA	2 (20_50)	
≡ 0 9	9th mA Station, 400mA	2 (30_50)	
≡ 1 0	10th mA Station, 500mA	2 (40_50)	
≡ 1 1	11th mA Station, 600mA	2 (50)	
≡ 1 2	FIL Standby # (Small)	200	
≡ 1 3	FIL Standby # (Large)	200	
≡ 1 4	HV Cable Length	15	
≡ 1 5	Bucky 1 Select	0 *	

Table 4-1a Pre-Set Number Selection

NOTES:

Pre-Set #	Description	Factory Setting	Notes
≡ 1 6	Bucky 2 Select	0 *	
≡ 1 7	AEC - No Bucky Select	0 *	
≡ 1 8	AEC - Bucky 1 Select	0 *	
≡ 1 9	AEC - Bucky 2 Select	0 *	
≡ 2 1	Maximum kVp	**	
≡ 2 2	Rotor Speed	50/60/180	
≡ 2 3	Low Speed Boost Time	1.7	
≡ 2 4	Tube Thermal Interlock	0	
≡ 2 5	Collimator Interlock	0	
≡ 2 6	Door Interlock	0	
≡ 2 7	Software Version		
≡ 3 2	kVp Feedback Test		

Table 4-1b Pre-Set Number Selection

* Only available on the V-10/20/30 if the option is installed. If the option is not installed, these numbers will not move.

** 125 kVp for the V-10/20/30. 150 kVp for the V-40/50.

NOTES:

With the generator on and no Error Codes showing on the Operator's Console, momentarily press the Service Push Button. Refer to Figure 4-5.

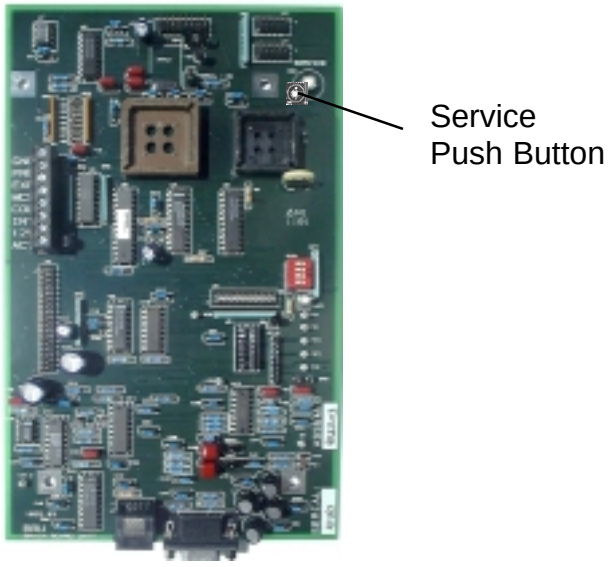


Figure 4-5 Location of SERVICE Push Button

This puts the generator in the Set Up mode. The Time Display on the Operator's Console becomes the Pre-Set # Display. The first character will display this symbol **[≡]**. Refer to Figure 4-6.

Pressing the Up/Down push-buttons associated with the Time Display allows you to scroll forward and reverse through the Pre-Set # selections.

The selection values associated with each individual Pre-Set # are displayed on the mA Display. Pressing the Up/Down push-buttons associated with the mA Display allows you to change the value in memory for that Pre-Set #.

CAUTION: The value displayed on the mA Display is the value in memory for that Pre-Set #. Take care not to accidently change any of the values.

NOTES:

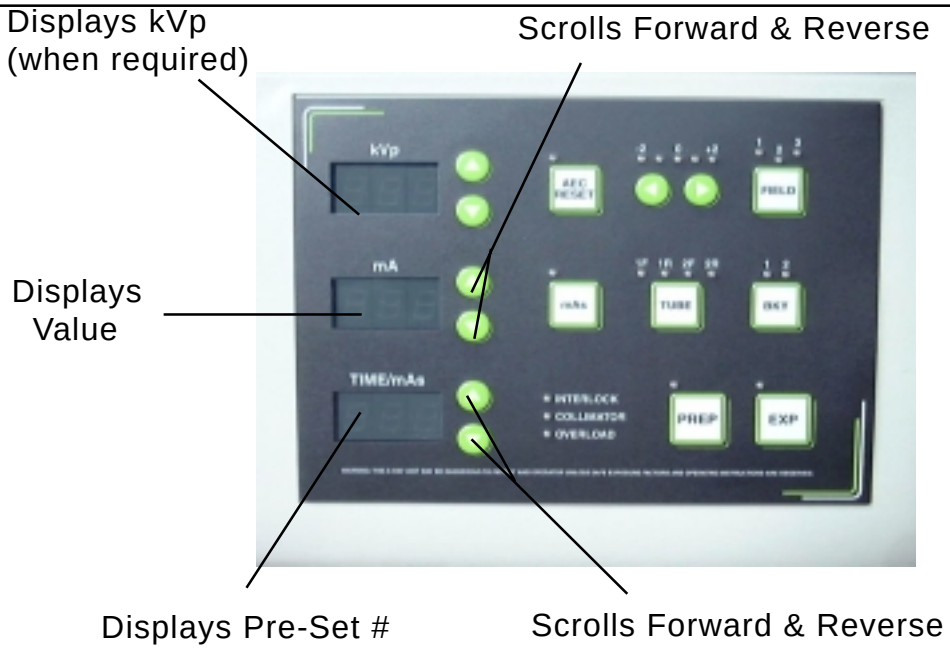


Figure 4-6 Operator's Console SERVICE Configuration

X-Ray Tube Selection

When you enter the SERVICE Mode, the first Pre-Set # which appears in the Time Display is the X-Ray Tube Selection # **[≡00]**. The Factory Setting for this value (as displayed in the mA Display) is [0]. With a [0] showing in the mA Display you have the default x-ray tube selected. This tube is a generic tube used for testing and shipping.

Do not leave this setting at [0]. Select the x-ray tube you are using from Table 4-2. If your tube is not listed on the table, select a tube with similar filament characteristics.

WARNING: If the x-ray tube you are using is not listed in Table 4-2 and there is no tube in the table with similar filament characteristics, do not proceed. Tube protection is only available with the tubes listed in Table 4-2 or tubes with similar filament characteristics. Failure to heed this WARNING may result in catastrophic failure of the x-ray tube.

Tube #	Description	Focal Spot	50Hz	60Hz	180Hz
0 0	Eureka RAD 44	1.0/2.0	X	X	X
0 1	Eureka RAD 8	1.0/2.0	X	X	
0 2	Eureka RAD 9	0.6/1.5	X	X	
0 3	Eureka RAD 13	1.0/2.0		X	X
0 4	Eureka RAD 14	0.6/1.2	X	X	X
0 5	Eureka RAD 14	0.6/1.5	X	X	X
0 6	Eureka RAD 16	1,0/2.0	X	X	X
0 7	Eureka RAD 20	0.6/1.2		X	X
0 8	Eureka RAD 21b	0.6/1.2	X	X	X
0 9	Eureka RAD 40b	0.6/1.0		X	X
1 0	Eureka RAD 40c	0.6/1.2		X	X
1 1	Eureka RAD 40d	0.6/1.5		X	X
1 2	Eureka RAD 44	1.0/2.0	X	X	X
1 3	Eureka RAD 55a	0.6/1.2		X	X
1 4	Eureka RAD 55b	0.6/1.5		X	X
1 5	Eureka RAD 56	0.6/1.0		X	X
1 6	EIMAC A256	0.6/1.0	X	X	X
1 7	EIMAC A292	0.6/1.2	X	X	X
1 8	EIMAC A416	1.0/2.0		X	X

Table 4-2a X-Ray Tube Selection

NOTE: 50 Hz data is not available for some x-ray tubes. If you have selected (50) for Setup location [≡22], you cannot select an x-ray tube unless an "X" appears in the 50Hz column.

NOTES:

NOTES:

Tube #	Description	Focal Spot	50Hz	60Hz	180Hz
1 9	EIMAC A492	0.6/1.2		X	X
2 0	EIMAC A102	1.0/2.0	X	X	X
2 1	EIMAC A132	0.6/1.2	X	X	X
2 2	EIMAC 192	0.6/1.2	X	X	X
2 3	Toshiba E7239	1.0/2.0	X	X	X
2 4	GE Maxiray 100 - 12.5°	0.6/1.25	X	X	X
2 5	GE Maxiray 100 - 12.5°	0.6/1.5	X	X	X
2 6	GE Maxiray 100 - 12.5°	0.6/1.0	X	X	X
2 7	Eureka RAD 74	0.6/1.5	X	X	X
2 8	Toshiba E7242	0.6/1.5	X	X	
2 9	EIMAC G292	0.6/1.2		X	X
*3 0	C.E.I. OX/105-4	2,6	X	X	
3 1	COMET DI9-30/50-150		X	X	
3 2	GENDEX UX-42	0.6/1.5	X	X	
3 3	BEL DRA1	1.2/2.0	X		
3 4	Toshiba E7240	0.6/1.2	X	X	
3 5	Toshiba E7252	0.6/1.2	X	X	X
3 6	RAD 68	0.6/1.2	X	X	
3 7	RAD 68	1.0/2.0	X	X	

Table 4-2b X-Ray Tube Selection

***NOTE: This tube has a fixed anode and is rated at 5 kW. Selecting this tube automatically disables the rotor circuit and sets 5 kW as maximum output (100 kVp @ 50 mA).**

NOTES:

Use the Up/Down push-buttons for the mA Display to scroll forward and reverse through the available X-Ray Tube numbers.

When you have the X-Ray Tube you want selected, use the Up/Down push-buttons for the Time Display to proceed to the next Pre-Set #.

The tube number will be stored automatically.

mA Station Selection

You have a maximum of 11 mA Stations which you can program on the V-50 generator, 10 on the V-40, 9 on the V-30, 8 on the V-20 and 7 on the V-10.

You may use any combination between the large and the small filaments.

NOTE: In the mA Display there are three (3) numbers which will be displayed.

0	**Not Programmed or Not Available**
1	**Progammed on Small Filament**
2	**Programmed on Large Filament**

NOTES:

Small mA Station Selection

Review the factory settings in Table 4-1. If the settings are ok no further action is required.

If you wish to make a change in any of the selections use the following procedure.

With the Setup Location for the mA station showing in the TIME display, select the desired programming in the mA display.

Your options are:

0 Not Programmed or Not Available

1 Progammed on Small Filament

2 Programmed on Large Filament

NOTES:

Large mA Station Selection

Review the factory settings in Table 4-1. If the settings are ok no further action is required.

If you wish to make a change in any of the selections use the following procedure.

With the Setup Location for the mA station showing in the TIME display, select the desired programming in the mA display.

Your options are:

0 Not Programmed or Not Available

1 Progammed on Small Filament

2 Programmed on Large Filament

NOTES:

Filament Standby Number

The generator has the capability of adjusting the standby current through the large and small filaments independently of each other.

The filament standby current is adjusted by increasing or decreasing the number displayed on the mA Display of the Operator's Console during Set Up.

This number does not directly correlate to an actual amount of filament current. It is subjective and the adjustment procedure is augmented by visually inspecting each filament and monitoring the FIL I test point on the BBU pcb as you make the adjustment.

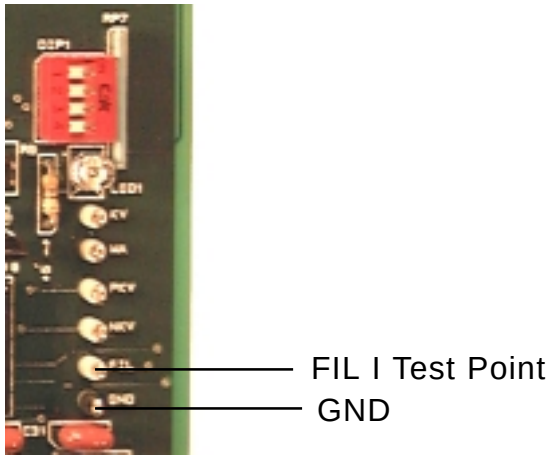


Figure 4-7 FIL I Test Point

NOTE: The range of filament numbers for Standby is [0] to [230]. The Factory Setting is [200]. Since filament characteristics vary from x-ray tube to x-ray tube it is strongly recommended that you return this value to [200] when replacing an x-ray tube.

CAUTION: Monitor the FIL I test point on the BBU pcb during Filament Standby Number adjustment. Do not exceed the maximum allowable filament current for the focal spot you are adjusting. At the FIL I test point, 1 VDC = 0.88 Amp Filament Current. (Refer to Table 4-3)

NOTES:

Small Filament Standby Number

Using the Up/Down push-buttons for the Time Display, scroll through the Pre-Set #s until you have **[≡12]** displayed on the Time Display. Monitor the FIL I test point on the BBU pcb (refer to Figure 4-7) with a Digital Voltmeter or an oscilloscope. 1 VDC = 1.3 Amp (refer to Table 4-3).

Using the Up/Down push-buttons for the mA Display, increase the Filament Number until the filament begins to illuminate. Determine that you are adjusting the Small Filament by visual inspection.

Continue adjusting the number until is bright enough.In no case should the FIL I exceed 2.75 Amps. Record this value in Table 4-1 for future reference.

VDC @ FIL I Test Point	FIL Current	VDC @ FIL I Test Point	FIL Current
2.00	1.76	3.50	3.08
2.25	1.98	3.75	3.30
2.50	2.20	4.00	3.52
2.75	2.42	4.25	3.74
3.00	2.64	4.50	3.96
3.25	2.86		

Table 4-3 Conversion Table for FIL I Test Point on BBU pcb

NOTES:

Large Filament Standby Number

Using the Up/Down push-buttons for the Time Display, scroll through the Pre-Set #s until you have **[≡13]** displayed on the Time Display.

Monitor the FIL I test point on the BBU pcb (refer to Figure 4-7) with a Digital Voltmeter or an oscilloscope. 1 VDC = 1.3 Amp.

Using the Up/Down push-buttons for the mA Display, increase the Filament Number until the filament begins to illuminate.

Determine that you are adjusting the Large Filament by visual inspection.

Continue adjusting the number until you reach a maximum of 2.75 Amps or the Large Filament is bright enough.

Record this value in Table 4-1 for future reference.

HV Cable Length

The length of the HV Cables is a factor in the shape of the kVp waveform.

This effect is non-linear and more pronounced at the lower kW levels.

The generator compensates for this effect automatically.

With Pre-Set # **[≡14]** showing in the Time Display, select the approximate length of the HV Cables connected to the generator using the Up/Down push-buttons for the mA Display. The length is displayed in increments of 5 feet.

NOTE: For cable length not divisible in 5 feet increments, select the next lowest setting on the mA Display. For instance: for a cable length of 17 feet, select the setting of 15 feet on the mA Display.

Buckys and AEC Selection

The generator will operate 2 Buckys and 3 Ion Chambers for AEC if the options are installed. Each of these functions can be programmed independently.

NOTE: For Pre-Set #s [≡15] and [≡16] you have three choices on the mA Display; [0], [1] and [2]. [0] = disabled, [1] = enabled (bucky) and [2] enabled (tomo).

NOTE: For Pre-Set #s [≡17] through [≡19] you have two choices on the mA Display; [0] or [1]. [0] = disabled, [1] = enabled.

Bucky 1 Select

If you have connected a Bucky to the Bucky 1 position of J9 select a [1] for Pre-Set # **[≡15]**. For Tomo select a [2]. If none select a [0].

Bucky 2 Select

If you have connected a Bucky to the Bucky 2 position of J9 select a [1] for Pre-Set # **[≡16]**. For Tomo select a [2]. If none select a [0].

AEC - No Bucky Select

The generator has the capability of operating an Ion Chamber without the selection of a Bucky for table top, stretcher or wheel chair use.

This condition is selected by having both BKY 1 and BKY 2 LEDs not illuminated on the Operator's Console.

The interconnection point for this Ion Chamber is AEC #3 on the Bottom Panel of the GCU (refer to Figure 1-6)

If you have connected an Ion Chamber to AEC #3 select a [1] for Pre-Set # **[≡17]**. If not select a [0].

NOTES:

NOTE: Bucky's and AEC are active only if the specific option is installed.

NOTES:

AEC - Bucky 1 Select

If you have connected an Ion Chamber to AEC #1 and it is installed in Bucky 1 select a [1] for Pre-Set # **[≡18]**. If not select a [0].

AEC - Bucky 2 Select

If you have connected an Ion Chamber to AEC #2 and it is installed in Bucky 2 select a [1] for Pre-Set # **[≡19]**. If not select a [0].

Maximum kVp

The Maximum kVp selectable by the Operator can be programmed during Setup.

With Pre-Set # **[≡21]** showing in the Time Display, select the Maximum kVp. The choices are 99 kVp, 125 kVp (V-10/20/30) and 150 kVp (V-40/50). This selection represents the Maximum kVp the Operator will be permitted to select on the Operator's Console during normal operation.

Rotor Speed

NOTES:

You must select the Rotor Speed.

By selecting (50) for **Pre-Set # [≡22]** you configure the generator for 50Hz, Low Speed operation. In this configuration **Pre-Set # [≡23]** becomes a display of Rotor Boost Time.

By selecting (60) for **Pre-Set # [≡22]** you configure the generator for 60Hz, Low Speed operation. In this configuration **Pre-Set # [≡23]** becomes a display of Rotor Boost Time.

By selecting (180) for **Pre-Set # [≡22]** you configure the generator for High Speed operation. In this configuration **Pre-Set # [≡23]** has no function.

CAUTION: If you select (180) for Pre-Set# [≡22] you must have an External High Speed Starter connected to the AEC/HSS option pcb and the rotor connections must terminate in the External High Speed Starter, not on J9 of the SPB pcb.

NOTES:

Low Speed Boost Time

When you press the PREP push-button there is a delay before the green PREP LED illuminates.

This delay is the Rotor Boost Time.

During this time the rotor is accelerated to approximately 3600 RPM, the filament is boosted to the correct temperature, all the interlocks are checked (including the rotor interlock) and the Pre-Charge and Charge sequences are initiated.

If you have selected (50) or (60) for Pre-Set# **[≡22],** you may select a Rotor Boost Time.

Using the Up/Down push-buttons for the Time Display, scroll through the Pre-Set #s until you have **[≡23]** displayed on the Time Display.

The Factory Setting for this Pre-Set # is [1.7] sec.

Select a value for Rotor Boost Time.

NOTE: The minimum value is [1.7] sec. This is the minimum time necessary for the filament temperature to stabalize when changing from Standby to the mA Station selected for exposure.

NOTES:

Interlock Selection

The generator provides for two independent interlocks with LED Displays on the Operator's Console.

They are Collimator Interlock and Door Interlock. In addition, there is a Thermal Interlock for the X-Ray Tube.

NOTE: For Tube Thermal Interlock, Collimator Interlock, and Door Interlock you have two choices on the mA Display; [0] or [1]. [0] = disabled, [1] = enabled.

Tube Thermal Interlock

If you have connected a Thermal Interlock for the X-Ray Tube to J9, pin 9 on the SPB pcb (refer to Figure 3-5) select a [1] for Pre-Set # **[≡24]**. If not select a [0].

Collimator Interlock

If you have connected a Collimator Interlock to J4, pin 5 on the BBU pcb (refer to Figure 3-7) select a [1] for Pre-Set # **[≡25]**. If not select a [0].

Door Interlock

If you have connected a Door Interlock to J4, pin 6 on the BBU pcb (refer to Figure 3-7) select a [1] for Pre-Set # **[≡26]**. If not select a [0].

Software Version

Pre-Set # **[≡27]** will indicate the Software Version of the generator.

NOTES:

NOTE: This completes the Setup section of the Technical Manual. Advance the Pre-Set # showing in the Time Display to [≡32] and turn to Chapter 5: Calibration.

Chapter 5: Calibration

NOTES:

WARNING: The procedures detailed in this chapter will produce tube current. Do not proceed unless you have completed the steps outlined in Chapter 4: Setup. Failure to heed this WARNING may result in catastrophic failure of the X-Ray Tube, serious damage to the generator and possible injury.

NOTE: You should be in the SERVICE Mode with Pre-Set # [≡32] showing in the Time Display on the Operator's Console.

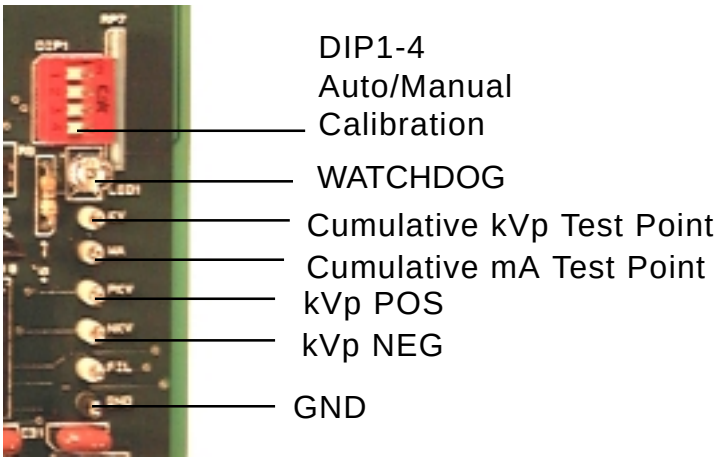


Figure 5-1 kVp, mA Test Points

kVp Cumulative	**1 V = 32 kVp**
kVp Anode	**1 V = 28 kVp**
kVp Cathode	**1 V = 28 kVp**
mA Cumulative	**1 V = 133 mA**

NOTES:

Monitor the kVp POS and kVp NEG test points with a dual trace, storage oscilloscope for these procedures (refer to Figure 5-1). Select 1 V/division and 10 ms.

kVp Feedback Test

The first step in the Calibration Procedure is to ensure that the kVp Feedback loop is connected correctly and working properly.

WARNING: Do not omit this procedure when initiating a Calibration Sequence. Catastrophic damage to the High Voltage components of the generator could occur.

Connect a voltmeter to the positive and negative connections on the storage capacitors. Monitor this voltage during the following procedure.

CAUTION: The maximum voltage can exceed 360 VDC.

NOTE: The technique factors for the following series of exposures are automatically adjusted by the software.

WARNING: DANGER: When the wall disconnect is switched on, 220 VAC standby power is present on the SPB pcb even if the Operator's Console is switched off. Lethal voltages are present on the pcb and care should be taken to avoid electrical shock.

NOTES:

During this test the mA Display will indicate the DC Voltage charge on the Storage Capacitors and the kVp Display will show the test kVp. With Pre-Set # **[≡32]** showing on the Time Display of the Operator's Console, the capacitor voltage level **[100]** will be showing on the mA Display. The kVp Display will show the kVp value for the test (50 kVp).

With Pre-Set # **[≡32]** showing on the Time Display of the Operator's Console, press and hold the PREP push-button.

The following sequence of events will be initiated:

The Discharge Relay will be disabled.

The Pre-Charge Relay will be energized momentarily until approximately 100 VDC is indicated on the storage capacitors.

The Charge Relay will be disabled.

The Rotor will boost and begin to run.

The green Ready LED in the PREP push-button will illuminate.

Press the EXP push-button and monitor the kVp waveforms on the oscilloscope. The kVp POS should be 25 kVp +/- 5 kVp and the kVp NEG should be 25 kVp +/- 5 kVp.

NOTE: Only make one exposure. If you must make another exposure for any reason, release the PREP and EXP push-buttons momentarily and start the sequence again.

NOTE: During this test there is no tube current. The kVp waveforms will have a long "tail" on them due to slow cable discharge. This is normal.

NOTES:

WARNING: If the kVp is not within the limits specified, or if you get an Error Code on the kVp Display of the Operator's Console, do not proceed. This indicates a problem in the kVp Feedback circuitry and must be corrected before any further exposures are made.

Release the PREP and EXP push-buttons.

If the kVp waveforms are within the limits specified, proceed to Calibration.

Calibration

NOTES:

NOTE: During the Calibration Procedure each selected mA station is adjusted at different kVp Set Points. This procedure establishes mA linearity. During calibration, exposures for the higher mA stations will be made at kVp Set Points including 100 kVp, 120 kVp and 140 kVp (V-40/50) regardless of the generator power rating. These exposures are limited to 10 milliseconds and have no relationship to the maximum kW output of the generator.

The generator has two calibration modes: Manual Calibration and **AUTOCAL**.

In the Manual Calibration mode the Service Engineer selects each programmed mA station and each kVp set point manually. At each of these points he can make exposures and adjust the Filament Number manually.

In the **AUTOCAL** mode the Service Engineer selects each programmed mA station manually and the generator operating system makes exposures and adjusts the Filament Number automatically for each kVp set point.

The generator is shipped in the Manual Calibration mode. DIP1-4 on the BBU pcb is in the OFF position (refer to Figure 5-1).

To select the **AUTOCAL** mode, move DIP1-4 to the ON position.

You may switch between Manual Calibration and **AUTOCAL** at any time during the Calibration procedure.

NOTES:

NOTE: You should monitor the Cumulative kVp and mA test points during the calibration sequence. Take note of any irregularities in either waveform and note the values indicated.

CAUTION: If you encounter any difficulty during the calibration sequence, refer to Chapter 7: Diagnostics for assistance.

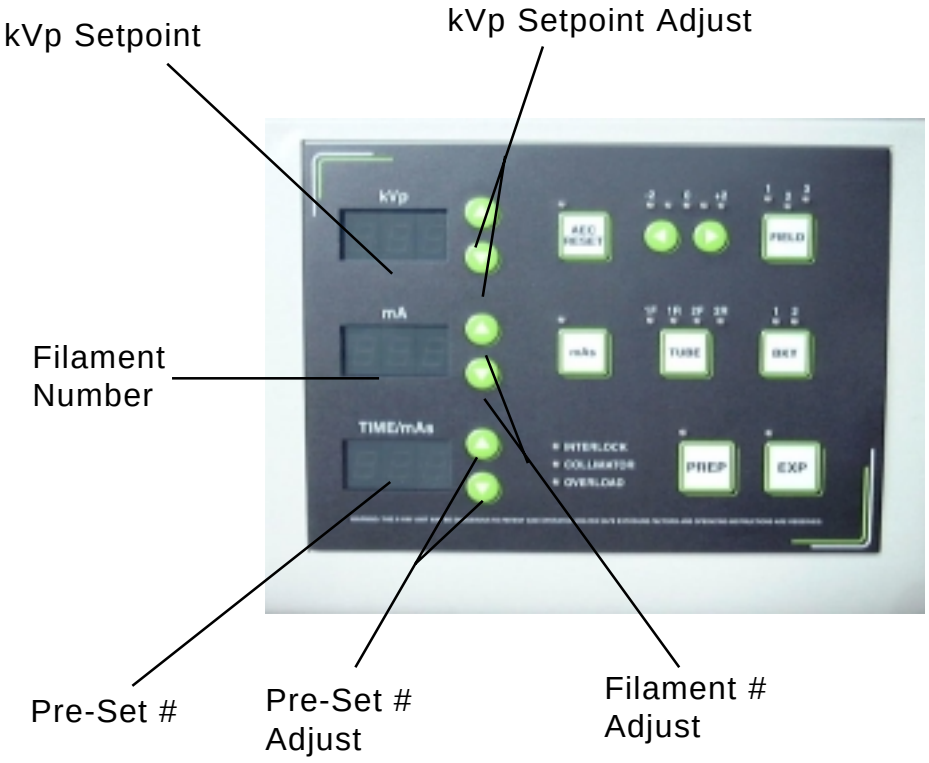


Figure 5-2 Operator's Console Calibration Configuration

NOTES:

Pre-Set #	Description	40 kVp	50 kVp	70 kVp	100 kVp	120 kVp	140 kVp
≡ 3 3	25 mA Station						
≡ 3 4	50 mA Station						
≡ 3 5	75 mA Station						
≡ 3 6	100 mA Station						
≡ 3 7	150 mA Station						
≡ 3 8	200 mA Station						
≡ 3 9	250 mA Station						
≡ 4 0	300 mA Station						
≡ 4 1	400 mA Station						
≡ 4 2	500 mA Station						
≡ 4 3	600 mA Station						

Table 5-1 Calibration Pre-Set #s

NOTE: The filament numbers in all the kVp Set Point locations for the mA stations were entered during Final Test at the factory. Your numbers will be different for the x-ray tube you are calibrating.

NOTES:

mA Station	mA Test Point Voltage	mA Station	mA Test Point Voltage
25 mA	0.19	250 mA	1.88
50 mA	0.38	300 mA	2.25
75 mA	0.56	400 mA	3.00
100 mA	0.75	500 mA	3.75
150 mA	1.13	600 mA	4.50
200 mA	1.50		

Table 5-2 Voltage Readings at mA Composite Test Point on DIB for each mA Station

Manual Calibration

NOTES:

The Manual Calibration mode provides for manual selection of each mA station and kVp set point and manual adjustment of the Filament Numbers for each programmed mA station to produce the correct mA.

Tube Protection is automatic and is based upon the selection of the x-ray tube in Pre-Set # **[≡00]**.

Using the Up/Down push-buttons for the Time Display, advance the Pre-Set # until you have the first programmed mA station displayed on the Time Display. (Refer to Table 5-1.)

The mA Display will show the Filament Number.

NOTE: The range of Filament Numbers is 0 to 999, depending upon the size of the filament,

The kVp Display will show the first kVp set point (refer to Figure 5-2).

Press and hold the PREP push-button. When the green READY LED is illuminated make an exposure by pressing the EXP push-button.

Adjust the Filament Number (up or down as required) and make another exposure and read the mA.

Continue until you have completed calibration for this mA station on all the kVp set points.

Using the Up/Down push-buttons for the Time Display advance to the next Pre-Set # corresponding to the next programmed mA station. (Refer to Table 5-1).

Adjust the Filament Number for each kVp set point in turn until you have completed calibration for this mA station.

Continue until you have adjusted the correct mA for each mA station and each kVp set point programmed.

NOTES:

AUTOCAL

The **AUTOCAL** mode provides for manual selection of each programmed mA station and automatic adjustment of the Filament Numbers at each kVp set point to produce the correct mA.

The generator is shipped in the Manual Calibration mode. DIP1-4 on the BBU pcb is in the OFF position (refer to Figure 5-1).

To select the **AUTOCAL** mode, move DIP1-4 to the ON position.

Tube Protection is automatic and is based upon the selection of the x-ray tube in Pre-Set # **[≡00]**.

Using the Up/Down push-buttons for the Time Display, advance the Pre-Set # until you have the first programmed mA station displayed on the Time Display. (Refer to Table 5-1.)

The mA Display will show the Filament Number.

NOTE: The range of Filament Numbers is 0 to 999, depending upon the size of the filament,

The kVp Display will show the first kVp set point (refer to Figure 5-2).

Press and hold the PREP push-button. When the green READY LED is illuminated, press and hold the EXP push-button.

The generator will begin a series of exposures controlled by the operating system. The mA value will be sampled and the Filament Number will be adjusted up or down as required.

This process will continue until the correct mA level is reached for the selected kVp set point.

The generator will then select the next kVp set point and continue the process.

This will continue (as long as the PREP and EXP push-buttons are pressed) until the mA value at the last kVp set point is correct.

The generator will stop making exposures.

Release the PREP and EXP push-buttons and select the next programmed mA station by using the Up/Down push-buttons for the TIME Display.

Press and hold the PREP and EXP push-buttons to begin the **AUTOCAL** sequence for the selected mA station.

Continue this process until you have completed the **AUTOCAL** sequence for each programmed mA station.

WARNING: During the calibration procedure (Manual or AUTOCAL) the generator is monitoring % Heat Units in the anode of the x-ray tube. When the % Heat Units reaches 85% a pulsed tone will sound continuously. Exposures are prohibited while this tone is sounding. Should you reach 85% Heat Units during the calibration procedure for the particular x-ray tube you are using, take a 15 minute time-out to allow the anode to dissipate the accumulated heat.

NOTES:

NOTES:

NOTE: AEC is active only if the specific option is installed.

AEC Density Adjust

Each Ion Chamber connected to generator can be adjusted independently for density and skew.

There are 6 Pre-Set #s associated with the AEC Density Adjust procedure, 2 for each Ion Chamber. (Refer to Table 5-3.)

NOTE: The Pre-Set #s indicated in Table 5-3 will not be active unless you selected a [1] for Pre-Set#s [≡17], [≡18], [≡19] in Chapter 4: Setup.

The following procedure applies to each Ion Chamber connected to the generator.

Select 80 kVp, and a Back-Up Time. Select an mA station appropriate for the density phantom you use.

Select 0 Density on the Operator's Console and Bucky 1, Bucky 2 or No Bucky as appropriate.

Make an exposure and read the density of the film.

NOTE: You cannot make an exposure in the Service Mode with one of the AEC Pre-Set #s showing on the Time Display. You must exit the Service Mode to make the exposure and re-enter the Service Mode to make density and skew adjustments.

Select the Service Mode and the Pre-Set # associated with the Ion Chamber you are adjusting. The Density Number will be displayed on the mA Display of the Operator's Console.

Adjust the number up or down using the Up/Down push-buttons for the mA Display.

Exit the Service Mode and make another exposure.

Continue this procedure until you have the correct density for the Ion Chamber selected.

Adjust the Skew Number up or down using the Up/Down push-buttons for the mA Display.

Select 50 kVp and make an exposure and read the density of the film.

NOTE: The Skew Number cannot be less than the Offset Number nor more than twice the Offset Number.

Exit the Service Mode and make another exposure.

Continue this procedure until you have the correct skew for the Ion Chamber selected.

NOTE: The maximum number for Skew is 250.

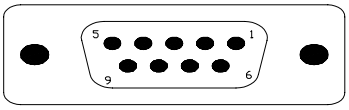
NOTES:

NOTES:

Pre-Set #	Description	Factory Setting	Notes
≡ 4 4	No Bucky AEC Offset	100	
≡ 4 5	No Bucky AEC Skew	100	
≡ 4 6	Bucky 1 AEC Offset	100	
≡ 4 7	Bucky 1 AEC Skew	100	
≡ 4 8	Bucky 2 AEC Offset	100	
≡ 4 9	Bucky 2 AEC Skew	100	

Table 5-3 AEC Pre-Set #s

NOTE: For Use With Positive Slope ION Chambers Only



Female DB-9 AEC connector
on bottom of GCU

pin	signal	I/O
1	N.U.	
2	'Field 3 Select	Output from generator
3	'Field 2 Select	Output from generator
4	'START	Supplied from generator
5	OUTPUT	Output from ion chamber
6	'Field 1 Select	Supplied from generator
7	-12V DC	Output from generator
8	+12V DC	Ouput from generator
9	GND	Common

(') indicates an active low signal

Figure 5-3 Pinout for AEC Connectors

NOTES:

Chapter 6: Compliance Testing

Overview

The generator meets the requirements for DHHS Radiation performance standards for high voltage generators as detailed in Title 21 CFR, Chapter 1, Sub Chapter J, Section 1020 in effect as of the date of manufacture.

This chapter details the procedures necessary to ensure compliance with the performance standard.

The tests and inspections in this chapter should be performed:

Upon initial installation

Once a year as part of a preventive maintenance inspection

Any time a major component is replaced

CAUTION: The generator is a sophisticated electronic device. All components are chosen for performance, quality and safety. Replacement should be confined to printed circuit boards or major components. Replacement of components other than those mounted in a socket (i.e. fuse, relay,) on a printed circuit board is not authorized as this may affect safety as well as performance standard compliance.

NOTES:

Operator's Console

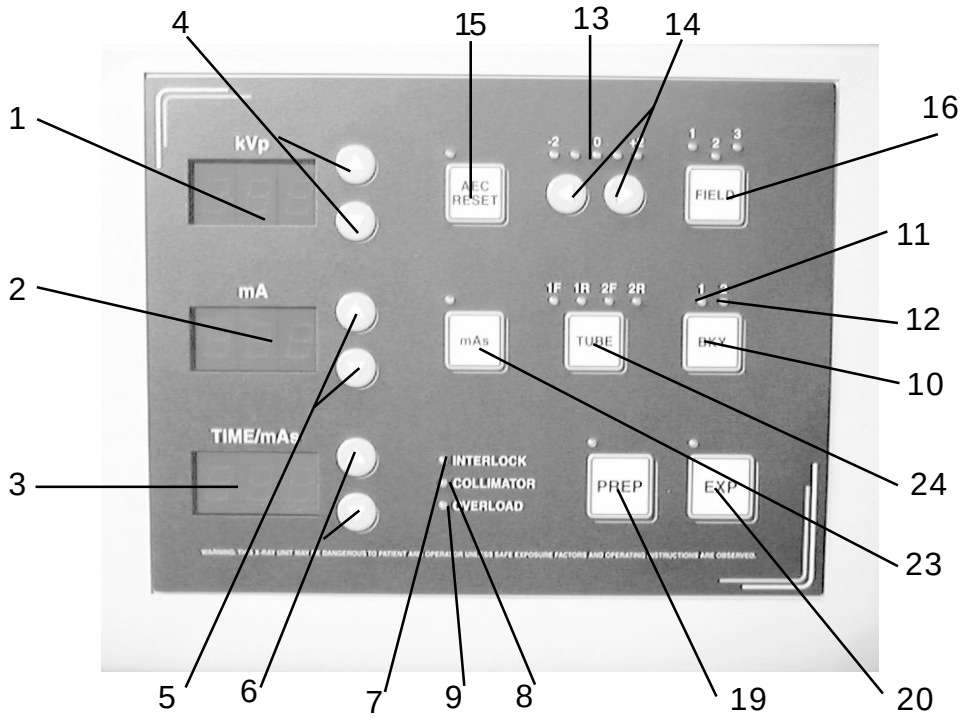


Figure 6-1A Operator's Console (Front View)

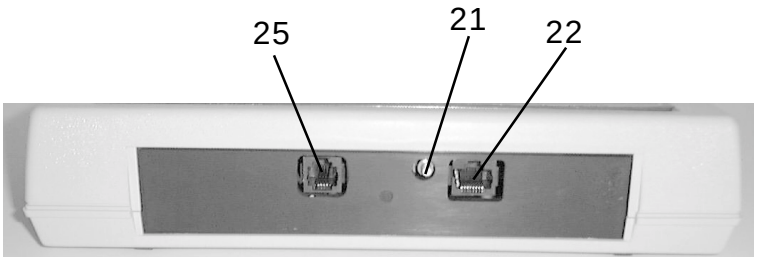


Figure 6-1B Operator's Console (Rear View)

1. kVp Display
2. mA Display
3. Time Display
4. kVp Up/Down
5. mA Up/Down
6. Time Up/Down
7. Interlock LED
8. Collimator LED
9. Overload LED
10. BKY Select
11. BKY 1 LED
12. BKY 2 LED
13. AEC Density LEDs
14. AEC Density Up/Down
15. AEC reset
16. AEC Field Select
19. PREP
20. EXP
21. On/Off
22. Connector
23. mAs Select
24. Tube Select
25. Hand Switch

NOTES:

NOTE: Based upon selections made in Chapter 4: Setup, some of the following tests may not be applicable.

Refer to Figure 6-1A&B for the following tests.

On/Off

Press and release the On/Off push-button [21] on the Operator's Console .

The system should come on and all LEDs in the three displays should illuminate and the Beep should sound.

There should not be an Error Code displayed in the kVp Display.

kVp Display and Up/Down

There should be a value between 40 and 125 displayed on the kVp Display [1].

Press kVp Up and kVp Down [4]. The display should increase and decrease.

mA Display and Up/Down

There should be an mA value showing on the mA Display [2].

Press mA Up and mA Down [5]. The display should increase and decrease. The decimal point in the lower right of the display will illuminate to indicate Large Focal Spot.

Time Display and Up/Down

There should be a Time value showing on the Time Display [3].

Press Time Up and Time Down [6]. The display should increase and decrease. The decimal point will change to indicate milliseconds, tenths and whole seconds.

NOTES:

Interlock LED

Open the external interlock connected to Pin 1 of J14 on the IOP pcb.

The Interlock LED [7] should be illuminated and PREP should be inhibited.

Close the Interlock.

The Interlock LED [7] should not be illuminated and PREP should be functional.

Collimator LED

Open the collimator interlock connected to Pin 2 of J14 on the IOP pcb.

The Collimator LED [8] should be illuminated and PREP should be inhibited.

Close the Interlock

The Collimator LED [7] should not be illuminated and PREP should be functional.

Overload LED

Increase the kVp, mA and Time to the maximum indications for each display.

Observe the Overload LED [9].

If the exposure factors selected exceed the maximum ratings for the x-ray tube selected, this LED should be illuminated and PREP should be inhibited.

NOTES:

PREP

Press and hold PREP [19].

The rotor should turn and after the programmed Rotor Boost Time, the green PREP LED should illuminate indicating an exposure is possible.

EXP

Select 50 kVp, the smallest mA programmed and 1.0 sec Time.

Press and hold PREP [19].

When the green PREP LED illuminates, press and hold EXP [20].

The red EXP LED should illuminate and an audible tone should sound to indicate an exposure in progress.

Release EXP before the selected time expires.

The exposure should stop, the red EXP LED should extinguish and the audible tone should stop.

Press and hold EXP again.

Another exposure should begin.

At the end of the selected time the exposure should stop.

Release PREP and EXP.

Press and hold EXP only.

There should be no indication and no exposure.

NOTES:

NOTE: Bucky and AEC are active only if the specific options are installed.

BKY

Bky 1

Press the BKY switch [10] until the Bky 1 LED [11] is illuminated.

Select 50 kVp, the smallest mA station programmed and .25 secs on the Time Display.

Make an exposure and observe the Bucky connected to Bky 1.

The Bucky should oscillate and the exposure should occur normally.

Bucky 2

Press the BKY switch [10] until the Bky 2 LED [12] is illuminated.

Select 50 kVp, the smallest mA station programmed and .25 secs on the Time Display.

Make an exposure and observe the Bucky connected to Bky 2.

The Bucky should oscillate and the exposure should occur normally.

No Bucky

Press the BKY switch [10] until the Bky 1 and Bky 2 LEDs are not illuminated.

Select 50 kVp, the smallest mA station programmed and .25 secs on the Time Display.

Make an exposure and observe the Buckys connected to the generator.

The Buckys should not oscillate and the exposure should occur normally.

NOTES:

AEC Density

One of the LEDs in the AEC Density Display [13] should be illuminated.

Press AEC Density Up and AEC Density Down [14].

The LEDs should indicate a full range between -2 to +2 Density.

AEC Reset/600 MAS Limit

Select 50 kVp, the maximum mA programmed and a backup Time to exceed 600 MAS. (i.e. if 300 mA then 2.5 sec)

NOTE: If your x-ray tube will not allow a technique that will exceed 600 MAS, ignore this step.

Close the collimator.

Make an exposure and observe that the AEC Reset LED [15] illuminates and flashes.

While flashing, PREP and EXP are inhibited.

Press the AEC Reset push-button and the LED ceases to flash and is extinguished.

AEC Field Select

Press and release FIELD (16) 4 times in succession. The LEDs should sequence in the following manner: all three LEDs off; 1 & 3 on; 1 on; 3 on; 2 on.

Pressing FIELD (16) one more time should return all LEDs to off.

NOTES:

Exposure Factor Tests

kVp/mA

The following tests will determine the accuracy of the three factors involved in an x-ray exposure; kVp, mA and Time.

Monitor the kVp and mA Test Points with a dual trace, storage oscilloscope for the following tests (refer to Figure 6-2).

Select 1 V/division and 10 ms. Monitor the kVp with Channel 1 and the mA with Channel 2. Trigger on Channel 1.

kVp Cumulative	**1 V = 32 kVp**
kVp Anode	**1 V = 28 kVp**
kVp Cathode	**1 V = 28 kVp**
mA Cumulative	**1 V = 133 mA**

NOTE: The oscilloscope must have a current calibration sticker attached.

Figure 6-2 kVp and mA Test Points

NOTES:

Insert the mA stations selected for this installation in Table 6-1.

mA Station	60 kvp	90 kVp	110 kVp	130 kVp (V-40/50)
25				
50				
75				
100				
150				
200				
250				
300				
400				X
500			X	X
600		X	X	X

Table 6-1 kVp/mA Measurements

NOTES:

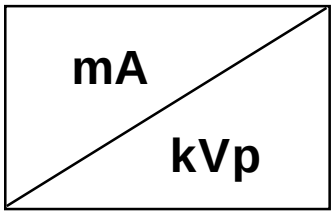
Select the lowest mA station the generator has been programmed for during Setup.

Select 60 kVp.

Select a time which will allow you to capture the exposure length on the oscilloscope.

Make an exposure and record the mA and kVp in Table 6-1.

Use the following convention:



Select 90 kVp.

Make an exposure and record the mA and kVp in Table 6-1.

Select 110 kVp.

Make an exposure and record the mA and kVp in Table 6-1.

Repeat this procedure for each mA station listed in Table 6-1.

NOTE: You may have to change the scale on the oscilloscope at the higher mA values. Take care to read the mA correctly.

Compare the values you have recorded in Table 6-1 with the following specifications for mA and kVp accuracy.

mA accuracy	**+/- 8%**	**+/- 5 mA**
kVp accuracy	**+/- 8%**	**+/- 2 kVp**

Time

NOTES:

Exposure Time is a function of measuring two corresponding points on the kVp waveform.

The exposure time begins at the 75% point on the leading edge of the kVp waveform and ends at the 75% point on the trailing edge of the kVp waveform.

Time Displayed	Time Measured	Time Displayed	Time Measured
.002		.400	
.005		.500	
.008		.600	
.010		.700	
.015		.800	
.020		1.00	
.025		1.50	
.035		2.00	
.050		2.50	
.075		3.00	
.100		3.50	
.125		4.00	
.150		4.50	
.200		5.00	
.250		6.00	
.300			

Table 6-2 Time Measurements

NOTES:

Select 70 kVp, 100 mA , and 2 milliseconds on the Time Display (.002).

Make an exposure and measure the length of the kVp waveform on the oscilloscope.

Record that value in the corresponding box in Table 6-2.

Advance to the next Time station and repeat the procedure.

Continue until you have entered a value for each Time Station in Table 6-2.

NOTE: As you advance in time you will have to change the time base on the oscilloscope to present the entire kVp waveform on the oscilloscope display.

Compare the values you have recorded in Table 6-2 with the following specification for Time accuracy.

Time accuracy:

0.002 Sec. to 0.010 Sec.	**+/- 0.5 ms**
0.015 Sec. to 0.035 Sec.	**+/- 1.5 ms**
0.050 Sec. to 0.100 Sec	**+/- 3.0 ms**
0.125 Sec. to 6.0 Sec.	**+/- 3%**

Reporting

Report any difficulties you encounter during Compliance Testing to the manufacturer.

Chapter 7: Diagnostics

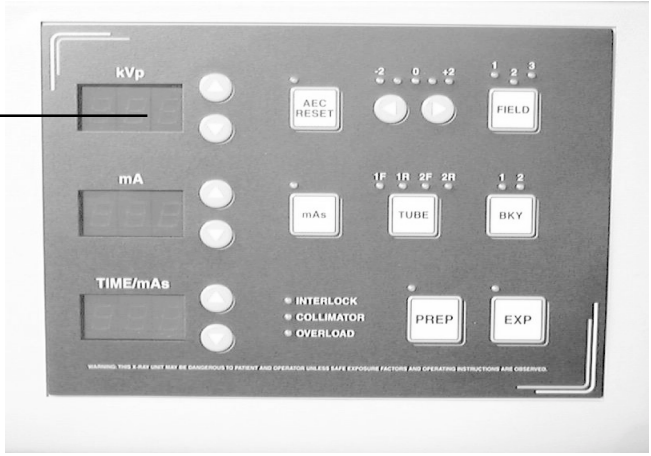
NOTES:

Overview

The Self-Diagnostic System of the generator provides accurate, detailed information about the functions of the generator and attached peripheral equipment.

This information is presented in the form of numerical Error Codes.

For the Operator and the Service Engineer, these Error Codes are presented on the kVp Display of the Operator's Console. A table in the Operator's Manual as well as the Technical Manual lists the Error Codes which can be displayed and describes the possible cause of the fault and the action the Operator should take.



NOTES:

Refer to Table 7-1 for the Error Codes presented on the kVp Display on the Operator's Console.

If any of the Error Codes listed in Table 7-1 are showing on the display, refer to the following information for possible causes and suggested corrective action.

NOTES:

Console kVp Display	Description
No Display	Internal GCU Error
E01	Interface Cable
E02	Tube Thermal Interlock
No Display	Communications Error
E03	Bucky Timeout
E04	Rotor Boost Timeout
E05	Rotor Current w/o PREP
E06	Filament Boost Timeout
E07	Bad FIL Current
E08	FIL Current Too High
E09	Cathode kVp Fault (kVp too high)
E10	Anode mA Fault (mA too high)
E11	Anode kVp Fault (kVp too high)
E12	Cathode mA Fault (mA too high)
E13	TEC Fault
E14	IPM #1 Fault
E15	IPM #2 Fault

Table 7-1a Error Codes

NOTES:

Console kVp Display	Description
E16	Setup/Calibration Data Fault
E17	Voltage Monitor Fault
E18	GPU not responding to Console
E19	kVp Drop during exposure
E20	Voltage on capacitors in Standby
E31	% HU over 85%
E32	Sync Missing or Incorrect

Table 7-1b Error Codes

NOTES:

NOTE: In this section on Error Codes the following abbreviation is used: OPC = kVp Display on the Operator's Console

Error Codes

Error Code: OPC = No Display

Description: Internal GCU Error (No reset)

System Indication:

Complete lockup of all system functions
No Operator's Console
No "Watch Dog" indication

Possible Causes:

+/- 12 VDC Regulated incorrect or missing
Interconnection Ribbon Cables missing or disconnected
RAM error on Power Up
Ribbon Cable Error

Corrective Action:

Check voltage test points on BBU pcb
Check fuses on SPB
Replace BBU
Check Ribbon Cables

NOTES:

Error Code: OPC = E01
Description: Interface Cable Error (Resets on Power Up Sequence)

System Indication:

No PREP function
No “Watch Dog” indication
Displayed until corrective action taken

Possible Causes:

Disconnected or defective Interface Cable (GCU/HVT)

Corrective Action:

Connect or repair Interface Cable (GCU/HVT)

Error Code: OPC = E02
Description: Tube Thermal Interlock Error (Resets when Tube cools)

System Indication:

No PREP function
No “Watch Dog” indication
Displayed until corrective action taken

Possible Causes:

X-Ray Tube overheated

Corrective Action:

Wait until X-Ray Tube Cools

NOTES:

Error Code: OPC = No Display
Description: Communications Error (No Reset)

System Indications:

Complete lockup of all system functions
Possible no Operator's Console
No "Watch Dog" indication

Possible Causes:

Failure of Operator's Console
Disconnected or defective Interconnecting Cable (GCU/ Operator's Console)

Corrective Action:

Replace Operator's Console
Connect or replace Interconnecting Cable (GCU/ Operator's Console)

Error Code: OPC = E03
Description :No Bucky Motion/Tomo Error (Resets with AEC Reset pressed)

System Indications:

Error Displayed until corrective action taken
No EXP function
No "Watch Dog" indication

Possible Causes:

No Bucky Motion Signal
No Tomo Expose Signal

Corrective Action:

Restore Bucky Motion Signal
Restore Tomo Expose Signal
Deselect Bucky

NOTES:

Error Code: OPC = E04
Description: Rotor Boost Time-out Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Stop PREP sequence in progress
Disconnects 208 VAC Switched on SPB

Possible Causes:

No Rotor current after time-out

Corrective Action:

Restore Rotor current

Error Code: OPC = E05
Description: Rotor Current without PREP Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

Failure in Rotor Boost circuit
Rotor Relay stuck

Corrective Action:

Restore normal Rotor function
Replace SPB pcb

Error Code: OPC = E06

Description: Filament Boost Time-out Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Stops PREP Sequence in progress
Disconnects 208 VAC Switched on SPB

Possible Causes:

Failure in Filament circuit
X-Ray Tube
Incorrect or missing Calibration numbers for selected mA

Corrective Action:

Restore Filament Current
Check Calibration numbers. Recalibrate if necessary.

NOTES:

NOTES:

Error Code: OPC = E07
Description: No FIL I Error (Reset when FIL I restored)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

BBU pcb failure
TEC pcb failure
Open High Voltage Cable (Cathode)
Open Filament Transformer (HVT)
Open Filament in X-Ray Tube
Disconnected or defective Filament Cable (GCU/HVT)

Corrective Action:

Replace BBU pcb
Replace TEC pcb
Inspect High Voltage Cable (Cathode)
Measure resistance of Filament Transformer (HVT)
Inspect Filament in X-Ray Tube
Reconnect or repair Filament Cable (GCU/HVT)

NOTES:

Error Code: OPC = E08

Description: FIL I Too High Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Stop PREP sequence in progress
Disconnects 208 VAC Switched on SPB

Possible Causes:

BBU pcb failure
TEC pcb failure

Corrective Action:

Replace BBU pcb
Replace TEC pcb

Error Code: OPC = E09

Description: Cathode Fault (kVp Too High) (Resets on Power Up Sequence)

System Indication:

Stop EXP in progress
Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

High Voltage Arc on Anode side
Defective X-Ray Tube
Defective High Voltage Cable
Failure in HVT

Corrective Action:

Inspect for visual evidence of High Voltage Arc
Inspect/Replace X-Ray Tube
Inspect/Replace High Voltage Cables
Inspect/Replace HVT

NOTES:

Error Code: OPC = E10

Description: Anode Fault (mA Too High) (Resets on Power Up Sequence)

System Indication:

Stop EXP in progress
Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

High Voltage Arc on Cathode side
Defective X-Ray Tube
Defective High Voltage Cable
Failure in HVT

Corrective Action:

Inspect for visual evidence of High Voltage Arc
Inspect/Replace X-Ray Tube
Inspect/Replace High Voltage Cables
Inspect/Replace HVT

NOTES:

Error Code: OPC = E11
Description: Anode Fault (kVp Too High) (Resets on Power Up Sequence)

System Indication:

Stop EXP in progress
Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

High Voltage Arc on Cathode side
Defective X-Ray Tube
Defective High Voltage Cable
Failure in HVT

Corrective Action:

Inspect for visual evidence of High Voltage Arc
Inspect/Replace X-Ray Tube
Inspect/Replace High Voltage Cables
Inspect/Replace HVT

NOTES:

Error Code: OPC = E12

Description: Cathode Fault (mA Too High) (Resets on Power Up Sequence)

System Indication:

Stop EXP in progress
Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

High Voltage Arc on Anode side
Defective X-Ray Tube
Defective High Voltage Cable
Failure in HVT

Corrective Action:

Inspect for visual evidence of High Voltage Arc
Inspect/Replace X-Ray Tube
Inspect/Replace High Voltage Cables
Inspect/Replace HVT

NOTES:

Error Code: OPC = E13

Description: TEC pcb Fault Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

BBU pcb failure
TEC pcb failure
Open High Voltage Cable (Cathode)
Open Filament Transformer (HVT)
Open Filament in X-Ray Tube
Disconnected or defective Filament Cable (GCU/HVT)

Corrective Action:

Replace BBU pcb
Replace TEC pcb
Inspect High Voltage Cable (Cathode)
Measure resistance of Filament Transformer (HVT)
Inspect Filament in X-Ray Tube
Reconnect or repair Filament Cable (GCU/HVT)

NOTES:

Error Code: OPC = E14
Description: IPM 1 Fault Error (Resets on Power Up Sequence) Ensure Ribbon Cable for IPM 1 to J6 on IOP pcb.

System Indication:

Stops EXP in progress
Disconnects 208 VAC Switched on SPB
Complete lock up of Operator's Console functions
No "Watch Dog" indication

Possible Causes:

AC Line weak or collapsed (below 187 VAC)
Excessive current through IPM 1
Failure of IPM Driver pcb
Failure of HVT
Loose or corroded connections for P1/P2
Defective X-Ray Tube
Defective High Voltage Cable

Corrective Action:

Check IPM 1 for short circuit (Replace both IPM 1 and the IPM Driver pcb)
Inspect X-Ray Tube
Inspect High Voltage Cables
Inspect P1/P2 connections on HVT

Error Code: OPC = E15

Description: IPM 2 Fault Error (Resets on Power Up Sequence) Ensure Ribbon Cable for IPM 2 to J5 on IOP pcb.

NOTES:

System Indication:

Stops EXP in progress
Disconnects 208 VAC Switched on SPB
Complete lock up of Operator's Console functions
No "Watch Dog" indication

Possible Causes:

AC Line weak or collapsed (below 187 VAC)
Excessive current through IPM 2
Failure of IPM Driver pcb
Failure of HVT
Loose or corroded connections for P1/P2
Defective X-Ray Tube
Defective High Voltage Cable

Corrective Action:

Check IPM 2 for short circuit (Replace both IPM 2 and the IPM Driver pcb)
Inspect X-Ray Tube
Inspect High Voltage Cables
Inspect P1/P2 connections on HVT

NOTES:

Error Code: E16

Description: Setup/Calibration Data Incorrect (Will not reset)

System Indication:

Checked on Power Up Sequence only
Complete lockup of Operator's Console
No "Watch Dog" indication

Possible Causes:

Setup/Calibration Data Missing or corrupted
Defective BBU pcb

Corrective Action:

Follow detailed procedure listed below
If the problem recurs, replace BBU pcb

NOTE: If you have this Error Code showing on the Operator's Console, the generator is disabled until you perform the following procedure. With this Error Code, the SERVICE switch on the BBU pcb will not function.

If Error Code E16 appears on Start Up;

1. Turn off the generator

2. Turn off the Wall Disconnect

3. Press and hold the Service Push Button on the BBU pcb and turn on the Wall Disconnect

4. Hold the Service Push Button for approximately 2 seconds then release.

5. When the Blue Watch Dog LED goes out, turn on the genertor.

WARNING: At this point you will have returned all of the Setup Locations to their factory default settings including calibration. Do not attempt to make an exposure until you have completed the steps detailed in Chapter 4 and Chapter 5. Failure to follow this WARNING may result in damage to the equipment and/ or failure of the x-ray tube.

NOTES:

6. Press the Service Push Button on the BBU pcb. You will now be in the SERVICE Mode. All of the Setup Locations will be reset to Factory Default values. You must complete all of the steps in Chapter 4, Setup and calibrate the generator according to instructions in Chapter 5, Calibration.

7. Exit the SERVICE Mode bypressing the Service Push Button on the BBU pcb. The generator should return to normal operation with no error codes displayed on the Operator's Console.

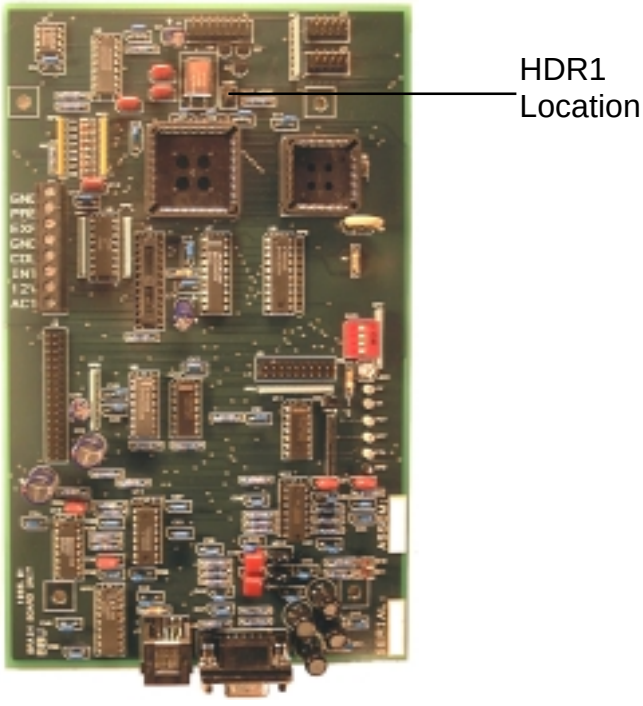


Figure 7-1 HDR1 Location on BBU pcb

NOTES:

Error Code: OPC = E17

Description: Voltage Monitor Fault Error (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Disconnects 208 VAC Switched on SPB

Possible Causes:

Failure in Pre-Charge circuit
Failure in Charge circuit
Low or weak 208 VAC Line
Bad Storage Capacitor

Corrective Action:

Replace SPB pcb
Check 208 VAC Line
De-Rate generator kW
Replace defective capacitor

Error Code: OPC = E18

Description: GPU Not Responding Error (Will not reset)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication

Possible Causes:

BBU pcb Failure
+/- 12 VDC Regulated incorrect or missing
+ 5 VDC Regulated incorrect or missing

Corrective Action:

Replace BBU pcb
Check voltage test points on BBU pcb
Check fuses on SPB
Replace SPB pcb

NOTES:

Error Code: OPC = E19

Description: kVp Drop During Exposure (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication

Possible Causes:

Flux Capacitor Failure

Corrective Action:

Replace Flux Capacitor

Error Code: OPC = E20

Description: Voltage on Capacitors in Stand By (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Prohibit Exposure Sequence

Possible Causes:

Defective SPB pcb

Corrective Action:

Replace SPB pcb

NOTES:

Error Code: OPC = E31
Description: % HU over 85% (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Prohibit Exposure Sequence

Possible Causes:

X-Ray Tube Anode overheated

Corrective Action:

Wait for X-Ray Tube Anode to Cool

Error Code: OPC = E32
Description: Sync Missing or Incorrect (Resets on Power Up Sequence)

System Indication:

Complete lock up of Operator's Console functions
No "Watch Dog" indication
Prohibit Exposure Sequence

Possible Causes:

Defective SPB pcb

Corrective Action:

Replace SPB pcb

Trouble-Shooting Tips

NOTES:

This section contains information to assist the service technician in trouble-shooting the generator.

The information presented is in order of descending importance. The most likely cause is first and the next likely cause is second, etc.

NOTE: The "Possible Causes" and "Corrective Actions" mentioned in this section DO NOT represent all of the factors that may apply to any given situation presented here.

System will not come on when On/Off pushbutton on the Operator's Console is pressed.

Possible Causes:

Incorrect or missing 208 VAC applied to GCU
Blown Fuses 208 VAC on SPB pcb
Incorrect or missing +12 VDC from SPB pcb
Blown Fuse +12 VDC from SPB pcb
Incorrect or missing +5 VDC Regulated from SPB pcb
Blown Fuse + 5 VDC Regulated on SPB pcb
Interconnecting cable missing or defective (GCU/ Operator's Console)
Defective BBU pcb
Defective Operator's Console

IPM Fault occurs at higher KW settings only.

Possible Causes:

Low 208 VAC Line Voltage
AC Line Collapse during exposure

NOTES:

Parts List

PART NUMBER	DESCRIPTION
4001	TEC pcb
4034	IPM Driver pcb
4032	SPB pcb
	Option pcb
4033	Brain Board pcb
6002	HV TANK (V-10/20/30/40)
6046	Operator's Console
6048	HV Tank (V-50)
8610	Pre-Charge Resistor
8612	Discharge Resistor
10520	3900mfd (V-10/20/30)
10521	4700mfd Capacitor (V-40/50)
10950	Flux Capacitor
10951	Rotor Capacitor
11002	IPM Snubber
12020	3 Phase Bridge (V-40/50)
12025	1 Phase Bridge (V-10/20/30)
18164	400A IPM (V-10/20/30)
18165	600A IPM (V-40/50)
23600	3 Phase Charge Relay (V-40/50)
23610	1 Phase Charge Relay (V-10/20/30)
31120	Line Fuse

Figure S-1 Parts List

Schematics

NOTES:

This section contains the main system schematic, signal flow diagrams for each printed circuit board and a chart detailing the acronyms used in this manual.

BB	**Brain Board**	**DSP Processing**
GCU	**Generator Control Unit**	**The chassis housing the electronics for the generator**
HVT	**High Voltage Transformer**	**Source of High Voltage and Filament Supply for the x-ray tube**
IPM	**Intelligent Power Module**	**High Frequency Switching Module which includes the IPM Driver pcb**
SPB	**System Power Board**	**Provides interface for 208 VAC, Charge and Discharge and Rotor**
TEC	**Thermionic Emission Controller**	**Source of supply for x-ray tube filament**

Figure S-2 Acronym Chart