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Description - Contains theory overview for the Compact PDU. Sheet numbers listed at the end of some subsection titles refer to the sheet number within the Compact PDU Block Diagrams.

The compact PDU is a single-bay cabinet and the standard PDU is a two-bay cabinet. Procedures for the compact PDU do not apply to the standard PDU.

1- THEORY

1-1- Introduction

There are four models of Compact PDU: regulated with 480V, 60Hz input; non-regulated with 480V, 60Hz input; regulated with 380/415V, 50/60Hz input; and non-regulated with 380/415V, 50/60Hz input.

The Compact Power Distribution Unit (PDU) serves as the primary interface to facility power. It converts the 3-phase input line voltage to either 208VAC (3-phase) or 120VAC (1-phase) as required by each MR subsystem. In addition, the Compact PDU provides protection against high voltage spikes caused by lightning or switching transients and both transverse mode and common mode high frequency noise. No power line distortion or frequency shift protection is provided. The Regulated Compact PDU provides active power line regulation and protection against power line surges and sags.

Temperature fault detection and power distribution control are also provided by the Compact PDU.

For Regulated Compact PDUs refer to Block Diagram Sheets 1 and 2. For Non-Regulated Compact PDUs refer to Block Diagram Sheets 3 and 4.

1-2- Main Power

1-2-1 Facility Disconnect and Emergency Off

Input power is first routed to the facility disconnect. The disconnect typically utilizes a low voltage low energy (LVLE) transformer to provide power to an under voltage release device. This device is in series with the Emergency Off push buttons. Emergency off is accomplished by actuating any of the customer supplied Emergency Off push buttons.

A temperature monitor circuit within the Compact PDU shunt trips the Main Circuit Breaker (CB1) if the Compact PDU transformer temperature exceeds 160°C or the SCR bank temperature exceeds 105°C. This shuts down the incoming power to the Compact PDU, but does not trip the facility disconnect.

1-2-2 Power Distribution

1-2-2-1 Regulated Compact PDU (46-317099P20/P21) - Sheets 1 and 2

The Regulated Compact PDU operates as a three-phase tapped voltage regulator. It contains an input filter assembly and a multi-tapped transformer with logic control and SCR circuitry and a load center with secondary output breakers. Depending on input voltage, output voltage is regulated by electronically selecting an appropriate transformer tap. There are 6 transformer taps per phase. Taps are spaced at 3% intervals of nominal input voltage. Tap 5 is located at the nominal input voltage. For an input voltage range of +4.5% surge and -13.5% sag, the regulator will maintain the output voltage to within 1.5% of nominal.

The Regulated Compact PDU accepts a 3-phase (delta or wye) 420-500/330-400/360-435 VAC, 60/50 Hz service from the facility input line. The maximum input power is 50 KVA.

The input filter assembly contains an inductor which removes peaks of voltage spikes, reduces rate of rise of voltage (a rapid voltage rate of rise damages SCRs), and removes high frequency noise from line power. The filter assembly is a brute force low pass filter. The filter assembly provides for high-energy surge suppression. Clamped high-energy transients are attenuated to acceptable levels. The filter contains a tuned damping circuit to reduce overshoot. Filter output impedance is designed to minimize voltage waveform distortion due to pulsed loading. The three basic filter components are the surge suppresser, the series inductor, and the shunt module. These components provide attenuation of line noise and high-energy surges.

The surge suppresser is located at the input to the filter. A Tranque llR is used for surge suppression. The surge suppresser limits peak voltage passed on the filter, and subsequently, to the load. When a surge exceeds the suppresser clamping level, the suppresser conducts and diverts surge currents away from the load. Current flow into the surge suppresser limits the surge voltage. Power is dissipated by the suppresser for the duration of the surge. Maximum power absorbed is 12,400 J line-to-line or 6,200 J line-to-neutral (watts X time = joules).

The series inductor blocks high-frequency noise and surge voltages. The frequency at which this blocking occurs, or cutoff frequency, is 2.5 kHz. Beginning at this frequency, output signal decreases as frequency increases. The bode' plot shows the slight filter gain at cutoff. See Illustration L1933A below. Because of this gain, voltage at the filter load side measures from zero to two volts higher than voltage on the filter line side.

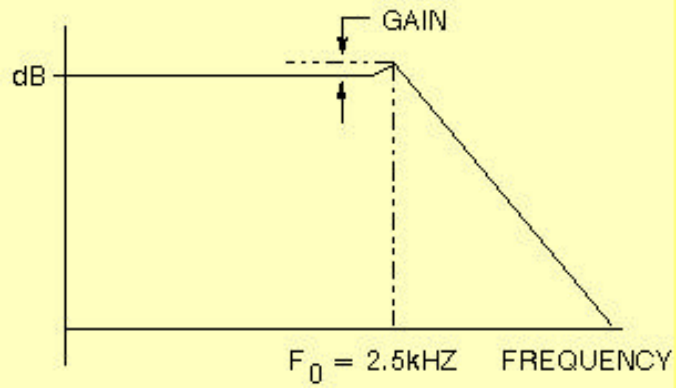


ILLUSTRATION L1933A

TYPICAL BODE' PLOT

The series inductor acts like a variable resistor with frequency. Impedance, or reactance, of the series inductor increases with frequency of a signal. This reactance is responsible for filter roll-off, or increased blocking with frequency. Blocking occurs by energy storage. The shorter the duration of high-frequency noise or surge voltage, the greater the voltage that the inductor can block.

The shunt module has three parts: (1) shunt capacitor, (2) shunt inductor, and (3) damping resistor network. The shunt inductor and damping resistor network are connected in parallel. They are used to tune filter gain at the cutoff frequency. There are two damped shunt capacitors for each undamped shunt capacitors in Model 46-317099P1, and three damped shunt capacitors for each undamped shunt capacitor in Model 46-317099P2.

The shunt capacitor is similar to an inductor in that reactance varies with frequency. Unlike the inductor, however, shunt capacitor reactance decreases as frequency increases. The inductor supports more voltage as time decreases, and the capacitor absorbs more current as voltage rises across it at a higher rate. The difference in function of the inductor and shunt capacitor results in the low-pass phenomenon.

The control logic board current detectors monitor each line current and compare each signal to a preset level in order to activate the regulation circuit. The voltage detector monitors each input line-to-line voltage from T2, T3, and T4. The signal is compared to a reference voltage level. The output of the voltage detector is fed to the comparator network. The comparator network selects the appropriate transformer tap. The output of the comparator network is fed to a voltage flip-flop. The voltage flip-flop transfers the input tap selection information to the output stage through the current flip-flop when a clock signal is received. The clock signal comes from the change detector circuit. The change detector circuit monitors the input and output of the voltage flip-flop once per cycle. When the input of the voltage flip-flop is different from the output, the change detector circuit generates three outputs. One output turns off all SCR drive circuits through the output stage. The conducting SCR will continue to conduct until there is zero current. The second output transfers the tap selection information from the input to the output on the voltage flip-flop. The third output provides a clock signal to the current flip-flop. The output stage on the control logic board acts as an interface to the SCR driver board. The master reset circuit on the control logic board inhibits the output for 6 seconds and is activated by the main input breaker or the undervoltage detection circuit. The undervoltage detection circuit compares the input voltage signal to a preset reference of 3V. When the voltage falls below the reference level, the SCR drive circuit is turned off. The undervoltage shutdown occurs when the line voltage sags by 40% for at least 2 cycles.

The SCR driver board has a 5 KHz oscillator (U3). It provides a push/pull signal to MOSFETS which energizes the pulse transformer primaries. The pulse transformer output is a square wave. This signal is applied to the SCR bank through snubber boards.

There are 6 SCRs per phase mounted on a heat sink. They are fused together by 18-gauge copper bus wire (fuselinks). At any time only one SCR is conducting. If for any reason two or more SCRs begin to conduct, then one or more fuselinks will open. The SCR Sense board monitors fuselink continuity and shunt trips the main circuit breaker if this circuit is open. Additional functions of the SCR Sense board are: providing input, output, and neutral signals to the front panel test points and providing signals for the Power Off and Emer. Stop Reset switches.

The PDU control board allows exterior controls to shunt trip load panel circuit breakers (A5). The signal connection points are J1 (coil), J2 (system cabinet status) and J3 (system cabinet PDU remote). The PDU control board also interfaces the Emer. Stop Reset function. Activation of Emergency Stop from the Magnet Enclosure, Console, or Remote Control Panel located on the System Cabinet, trips the Gradient Amplifier Cabinet, RF Amplifier Cabinet, and Penetration Cabinet load panel circuit breakers. It also trips any option circuit breakers which have shunt trips, such as the Broadband RF Amplifier Cabinet and Resistive Shim Power Supply. The Emer. Stop Reset switch is located on the front panel (A8A5).

Note

Whenever facility power is turned off or lost, the Gradient and RF/Penetration Cabinet circuit breakers will trip if relay K2 and fuse F15 are not installed. With relay K2 and fuse F15 installed, if fuse F1 or F8 opens, the Gradient and RF/Penetration Cabinet circuit breakers will trip. Any option circuit breakers which have shunt trips, such as the Resistive Shim Power Supply will also trip under these conditions.

Power transformer input tap selection is used to obtain the correct output voltages required by the subsystems (120 VAC 1-phase and 208 VAC 3-phase wye). The 3-phase output then is distributed within the 3-phase load center. Note that the neutral and ground buses are tied together.

The Compact PDU has capacitors (A10) across the output line-to-neutral terminals. These capacitors smooth out any waveform distortion that occurs because of tap switching.

The load center contains all feeder circuit breakers. From the load center subsystem power is distributed to each subsystem.

1-2-2-2 Non-Regulated Compact PDU (46-317099P22) - Sheets 3 and 4

The Non-Regulated Compact PDU operates as a three-phase power distribution unit. It contains a multi-tapped transformer and a load center with secondary output breakers. Depending on input voltage, output voltage is regulated by selecting an appropriate transformer tap. There are 6 transformer taps per phase. Taps are spaced at 3% intervals of nominal input voltage. Tap 5 is located at the nominal input voltage.

The Non-Regulated Compact PDU accepts a 3-phase (delta or wye) 456-494/361-418/394-435 VAC, 60/50 Hz service from the facility input line. The maximum input power is 50 KVA.

The SCR Sense board provides signals for the Power Off switch.

The PDU control board allows exterior controls to shunt trip load panel circuit breakers (A5). The signal connection points are J1 (coil), J2 (system cabinet status) and J3 (system cabinet PDU remote). The PDU control board also interfaces the Emer. Stop Reset function. Activation of Emergency Stop from the Magnet Enclosure, Console, or Remote Control Panel located on the System Cabinet, trips the Gradient Amplifier Cabinet, RF Amplifier Cabinet, and Penetration Cabinet load panel circuit breakers. It also trips any option circuit breakers which have shunt trips, such as the Broadband RF Amplifier Cabinet and Resistive Shim Power Supply. The Emer. Stop Reset switch is located on the front panel (A8A5).

Note

Whenever facility power is turned off or lost, the Gradient and RF/Penetration Cabinet circuit breakers will trip if relay K2 and fuse F15 are not installed. With relay K2 and fuse F15 installed, if fuse F1 or F8 opens, the Gradient and RF/Penetration Cabinet circuit breakers will trip. Any option circuit breakers which have shunt trips, such as the Resistive Shim Power Supply will also trip under these conditions.

Power transformer input tap selection is used to obtain the correct output voltages required by the subsystems (120 VAC 1-phase and 208 VAC 3-phase wye). The 3-phase output then is distributed within the 3-phase load center. Note that the neutral and ground buses are tied together.

The Compact PDU has capacitors (A10) across the output line-to-neutral terminals. These capacitors provide some protection from surges in facility power.

The load center contains all feeder circuit breakers. From the load center subsystem power is distributed to each subsystem.

1-3- Modes of Operation

1-3-1 Introduction

There are five operating modes defined for the Regulated Compact PDU: EMERGENCY OFF, OFF, ON-AUTO, ON-MAN, and EMERGENCY STOP. There are four operating modes defined for the Non-Regulated Compact PDU: EMERGENCY OFF, OFF, ON, and EMERGENCY STOP. Mode selection and mode descriptions are provided below.

1-3-2 Mode Selection

The customer-supplied red mushroom buttons located at the exits select the EMERGENCY OFF mode. The Power Off switch is used to trip the Main Circuit Breaker and turn power off to all loads (OFF mode). The Main Circuit Breaker turns Compact PDU power ON and OFF. In the Regulated Compact PDU the Bypass Switch is used to select the AUTO and MAN modes. EMERGENCY STOP mode is normally selected with the Emergency Stop buttons on the Operator Console or the Magnet Enclosure, although it is also selectable from the PDU Remote Control Panel in the System Cabinet. EMERGENCY STOP is automatically activated when facility power is lost or turned off if relay K2 and fuse F15 are not installed. With relay K2 and fuse F15 installed, EMERGENCY STOP is automatically activated only if fuse F1 or F8 opens.

1-3-3 Mode Descriptions

1-3-3-1 Emergency Off

This mode is actuated by pushing one of the red mushroom buttons (customer supplied) located at the exits. All primary power to the PDU is removed in this mode since the facility disconnect will be tripped. System power can be restored only after resetting the facility disconnect. This mode should not be confused with Emergency Stop.

1-3-3-2 Off

Regulated Compact PDU: All subsystems are off while in OFF mode. This mode is automatically enabled when the Main Circuit Breaker is shunt tripped under the following conditions: an overtemperature condition in the Compact PDU or System Cabinet, an SCR failure or blown fuselink, or the Bypass Switch is rotated with power ON. The Main Circuit Breaker will not close if the Bypass Switch is in the AUTO position and the SCR Failure Light is ON.

Non-Regulated Compact PDU: All subsystems are off while in OFF mode. This mode is automatically enabled when the Main Circuit Breaker is shunt tripped as a result of an overtemperature condition in the Compact PDU or System Cabinet. This mode can be selected by pressing the Power Off switch on the Compact PDU.

1-3-3-3 On-Auto

Regulated Compact PDU. With the Bypass Switch in the AUTO position and Main Circuit Breaker ON, line-to-neutral voltages are regulated. This is the mode used for normal operation (i.e. imaging). All subsystems are powered on and regulation circuitry is operational. Turn off input power before switching the Bypass Switch.

1-3-3-4 On-Man

Regulated Compact PDU. With the Bypass Switch in the MAN (manual) position and Main Circuit Breaker ON, regulation logic is bypassed and input power is applied to the load via the transformer without regulation. The MAN position is selected when there is a problem with the regulation logic circuitry (typically indicted by an SCR Failure Light). Turn off input power before switching the Bypass Switch.

1-3-3-5 On

Non-Regulated Compact PDU. This is the mode used for normal operation (i.e. imaging). All subsystems are powered on.

1-3-3-6 Emergency Stop

Emergency Stop is used only under certain emergency situations related to the patient vicinity. When an Emergency Stop button on the Operator Console, the Magnet Enclosure, or PDU Remote Control Panel is pushed, power to most components within the patient vicinity is removed (RF Amplifier Cabinet, Gradient Cabinet, and Penetration Cabinet). This mode also trips any option circuit breakers which have shunt trips, such as the Broadband RF Amplifier Cabinet and Resistive Shim Power Supply. Power to the System Cabinet, Computer Cabinet, computer peripherals, and Operator Console is not removed. Emergency Stop is automatically activated when facility power is lost or turned off if relay K2 and fuse F15 are not installed. With relay K2 and fuse F15 installed, Emergency Stop is automatically activated only if fuse F1 or F8 opens.

1-4- Overtemperature Monitoring

The Compact PDU Power Transformer and SCR bank, the System Cabinet, and the Gradient Coil are monitored for overtemperature conditions. The methods of handling these conditions differ as described below.

1-4-1 Compact PDU Overtemperature Monitoring

The Compact PDU has four thermal switches connected in parallel. An overtemperature condition at any of these thermal switches will generate a Shunt Trip signal to trip the Main Circuit Breaker. One thermal switch is located in the transformer coil, and the other three are located on the heat sinks for the SCR banks. The shunt trip signal trips the Main Circuit Breaker when the Compact PDU transformer temperature exceeds 320°F (160°C) or a heat sink temperature exceeds 221°F (105°C). Power is still present on the input side of the Main Circuit Breaker when it is tripped by the overtemperature shunt.

1-4-2 System Cabinet Overtemperature Monitoring

The System Cabinet (MR2) contains a normally-open sensor that monitors the temperature within the cabinet. The sensor will trip at 94°F (34.4°C), sending a signal to J2 on the PDU Control Board in the Compact PDU. The PDU Control Board generates a Shunt Trip signal to the Main Circuit Breaker. Power is still present on the input side of the Main Circuit Breaker when it is tripped by the overtemperature shunt.

1-4-3 Gradient Coil Overtemperature Monitoring

The gradient coil contains a sensor that monitors the temperature within the coil. The sensor trips when the gradient coil temperature exceeds 248°F (120°C), sending a signal to J1 and J3 on the PDU Control Board in the Compact PDU. This enables the signals to trip the Gradient Cabinet and RF Amplifier Cabinet circuit breakers and lights the PDU Remote Control OVERTEMP light on the System Cabinet to indicate that a gradient coil overtemperature condition has occurred.

2- CONTROL BOARD SET UP

2-1- Introduction

If any of the components in the EMERGENCY STOP loop are missing, a jumper must be substituted in place of the missing component before performing Compact PDU checks. This jumper must be removed and proper cable connected before normal system operation.

PERFORM THIS SECTION PRIOR TO INITIAL POWER UP OF ANY CABINETS. HIGH VOLTAGE HAZARDS MAY EXIST UNTIL THIS SECTION IS PERFORMED.

DANGER!!

FATAL SHOCK HAZARD!! LETHAL VOLTAGES ARE PRESENT WITHIN THE COMPACT PDU EVEN WHEN ALL COMPACT PDU BREAKERS ARE OFF. ENSURE THAT POWER AT MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Turn facility circuit breaker off, lock, and tag with appropriate OSHA procedure. (Refer to CD-ROM *Dir. 2187583-3 [or -2], MR Release Signa 5x/8x Service Methods, Renewal Parts and Service Tools,* Procedure for Safety, Section 6, OSHA LOCKOUT/TAGOUT REQUIREMENTS.)

Note

This section must be performed ONLY if either the Magnet Enclosure, Operator Workspace, System Control Cabinet, Penetration Panel, or any of their interconnecting cables are missing or disconnected. This is the case if powering up a new Signa installation.

2-2- Bypassing E-Stop on Control Board

1. Open outer door of Compact PDU.

2. Open load panel door.

3. Locate the jumper connector in the documentation package inside the load panel door.

4. Remove cable J2 from the PDU Control Board located inside the load panel door.

5. Insert jumper connector into mating connector A14 A1 J2 on the PDU Control Board. See Illustration L2722A1 below.

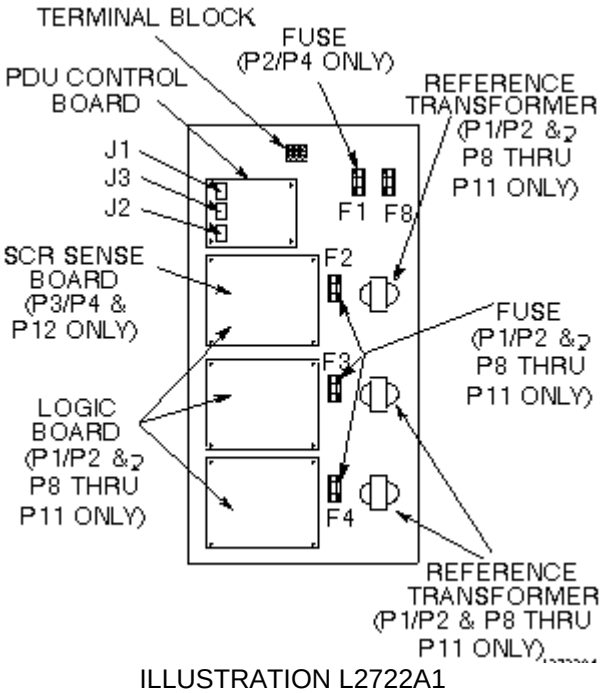


ILLUSTRATION L2722A1

LOAD CENTER BRACKET ASSEMBLY (A14)

2-3- Restoration

When the system is configured for the hardware required, the jumper **must** be removed from the Control Board.

1. Remove jumper connector from the PDU Control Board.

2. Place the jumper connector back into the documentation package inside the load panel door.

3. Connect cable J2 back onto the PDU Control Board

4. Close the load panel door.

5. Close the outer door of the Compact PDU.

6. Remove lock out/tag out devices, and restore current.

3- TRANSFORMER TAPS CONFIGURATION

3-1- Transformer Tap Configuration

3-1-1 Model 46-317099P1

Model 46-317099P1 is shipped factory configured. No configuration change is necessary. Do not change tap connections.

3-1-2 Model 46-317099P2

Model 46-317099P2 is shipped factory configured for 380V nominal input. To change nominal input voltage:

1. Connect the three transformer tap leads as shown in Illustration L2723A below. Refer to Section 3- 2- Change Transformer Tap-Lead Position, below.

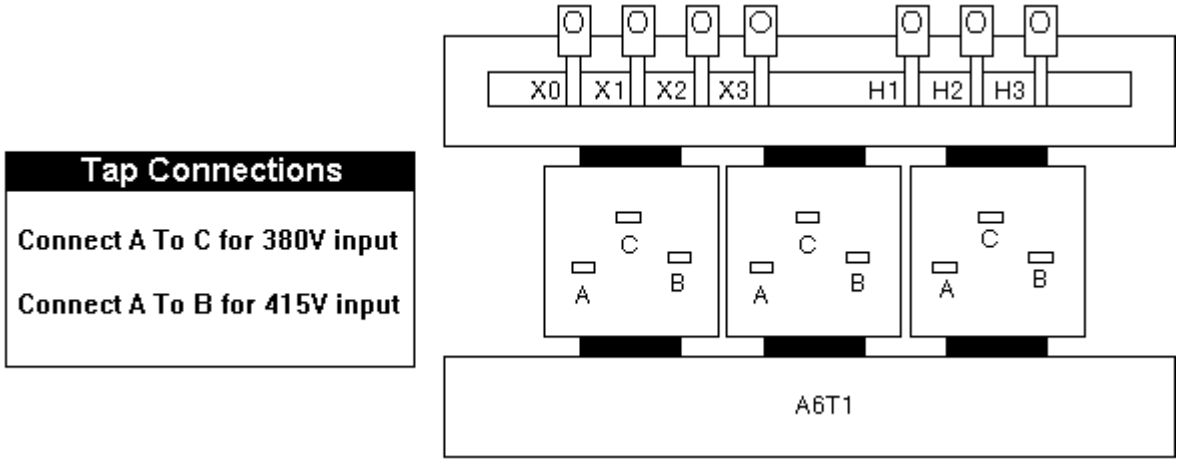


ILLUSTRATION L2723A
TRANSFORMER POWER CONNECTIONS, MODEL 46-317099P2

2. Open outer door.

3. Loosen load panel door with a 90° turn of two assembly screws on right. **Mobile installation:** Remove and keep 1/4-20 screw in center of right-hand edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

DANGER!!

FATAL SHOCK HAZARD!!
LETHAL VOLTAGES EXIST WITHIN COMPACT PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

4. Adjust R39 on logic board for phase A so that line-to-neutral output voltage at the test jack is 1.20 $\pm$ 0.03V. See Illustration L2733A below for location of R39.

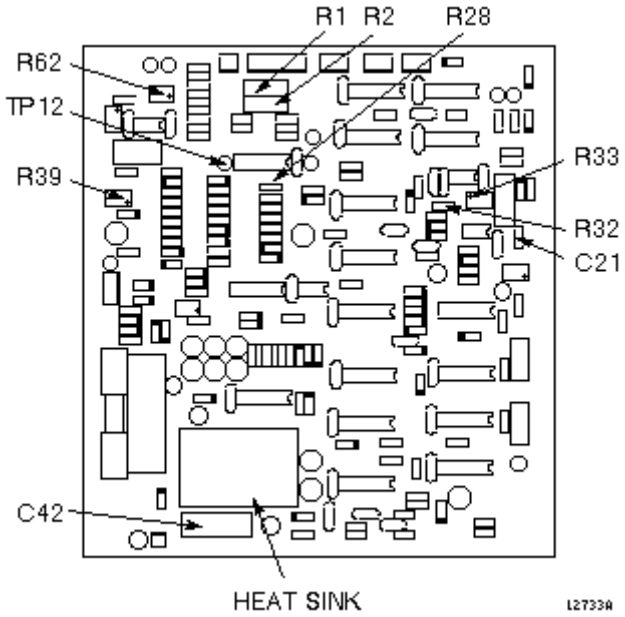


ILLUSTRATION L2733A
LOGIC BOARD

5. Perform step 4 for phase B and phase C.

6. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. **Mobile installation:** Install 1/4-20 screw in center right-hand edge of door.

7. Close outer door.

Note

For a mobile installation, typically leads for both 380 and 415 nominal volts are brought out to a mechanical switch near shore power connector. Depending on facility power at the site, the switch will have to be thrown to the 380 or 415 V position prior to hooking up shore power.

3-1-3 Model 46-317099P3

Note

For input voltages different from those listed in Illustration L2725A, choose taps associated with the closest value (i.e., if input voltage is 488 connect 4 to 6).

Model 46-317099P3 is shipped factory configured for 380V nominal input. For different typical input voltage, connect the three transformer tap leads as shown in Illustration L2725A below. Refer to Section 2- Change Transformer Tap-Lead Position, below.

Tap Connections	
Input Voltage	Connect
504	4 TO 5
492	4 TO 6
480	3 TO 5
468	3 TO 6
456	2 TO 6
444	3 TO 7
432	2 TO 7

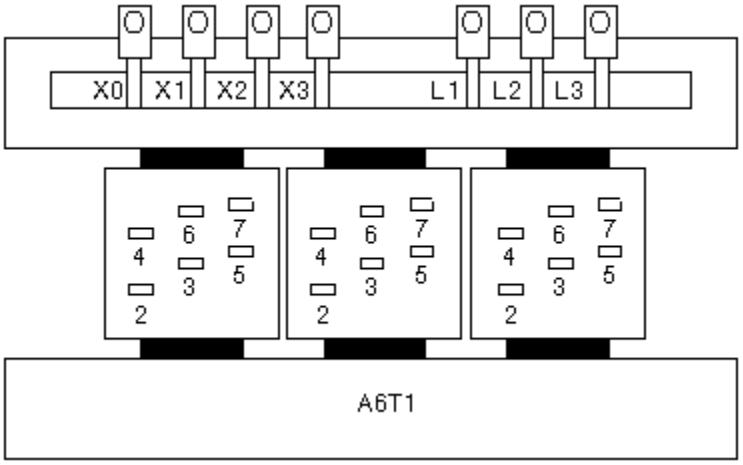


ILLUSTRATION L2725A
TRANSFORMER POWER CONNECTIONS, MODEL 46-317099P3

3-1-4 Model 46-317099P4

Note

For input voltages different from those listed in Illustration L2726A, choose taps associated with the closest value (i.e., if input voltage is 429 connect 4 to 6).

Model 46-317099P4 is shipped factory configured for 415V nominal input. For different typical input voltage, connect the three transformer tap leads as shown in Illustration L2726A below. Refer to Section3-2- Change Transformer Tap-Lead Position, below.

Tap Connections		
Input Voltage	Connect	Connect
436	A TO B	4 TO 5
425	A TO B	4 TO 6
415	A TO B	3 TO 5
405	A TO B	3 TO 6
394	A TO B	2 TO 6
384	A TO B	3 TO 7
374	A TO B	2 TO 7
399	A TO C	4 TO 5
390	A TO C	4 TO 6
380	A TO C	3 TO 5
370	A TO C	3 TO 6
361	A TO C	2 TO 6
351	A TO C	3 TO 7
342	A TO C	2 TO 7

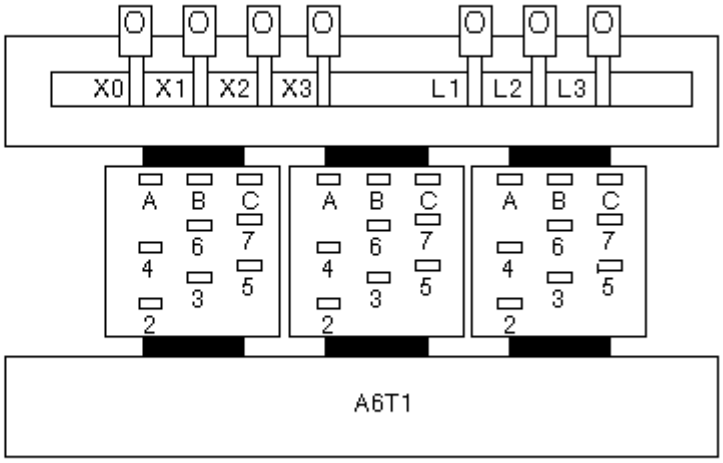


ILLUSTRATION L2726A
TRANSFORMER POWER CONNECTIONS, MODEL 46-317099P4

Note

For a mobile installation, typically leads for both 380 and 415 nominal volts are brought out to a mechanical switch near shore power connector. Depending on facility power at the site, the switch will have to be thrown to the 380 or 415 V position prior to hooking up shore power.

3-1-5 Models 46-317099P8 & P10

Models 46-317099P8 & P10 are shipped factory configured. No configuration change is necessary. Do not change tap connections.

3-1-6 Models 46-317099P9 & P11

Model 46-317099P9 & P11 is shipped factory configured for 380/400/415 Vac, 50 Hz input. For different typical input voltage, connect the three transformer tap leads as shown in Illustration L4792A below. Refer to Section 3-2- Change Transformer Tap-Lead Position, below.

Tap Connections	
Input Voltage	Connect
380	A - D
400	A - C
415	A - B

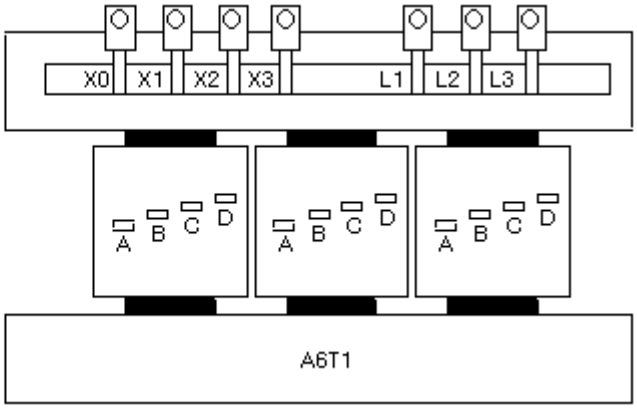


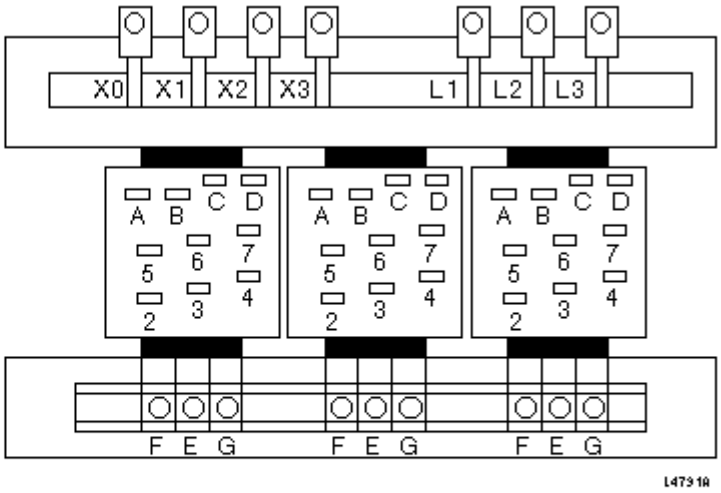
ILLUSTRATION L4792A
TRANSFORMER POWER CONNECTIONS, MODEL 46-317099P9 & P11

3-1-7 Model 46-317099P12

Model 46-317099P12 is shipped factory configured for 380V nominal input. To change nominal in - out voltage:

1. Connect the three transformer tap leads as shown in Illustration L4791A below.
Refer to Section 2- Change Transformer Tap-Lead Position, below.

Tap Connections			
Freq.	Input Voltage	Connect	Connect
50	435	4 to 5	B to C
50	425	4 to 6	B to C
50	415	3 to 5	B to C
50	405	3 to 6	B to C
50	395	2 to 6	B to C
50	385	3 to 7	B to C
50	375	2 to 7	B to C
60	504	4 to 5	B to D
60	492	4 to 6	B to D
60	480	3 to 5	B to D
60	468	3 to 6	B to D
60	456	2 to 6	B to D
60	444	3 to 7	B to D
60	432	2 to 7	B to D
50	400	4 to 5	A to D
50	390	4 to 6	A to D



Secondary Jumpers:
E - F for 60 Hz
E - G for 50 Hz

ILLUSTRATION L4791A
TRANSFORMER POWER CONNECTIONS, MODEL 46-317099P12

3-2- Change Transformer Tap-Lead Position

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!!
LETHAL VOLTAGES ARE PRESENT WITHIN COMPACT PDU EVEN WHEN ALL COMPACT PDU BREAKERS ARE OFF. ENSURE THAT POWER AT MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Turn facility circuit breaker off, lock, and tag. (Refer to CD-ROM *Dir. 2187583-3 [or -2], MR Release Signa 5x/8x Service Methods, Renewal Parts and Service Tools,* Procedure for Safety, Section 6, OSHA LOCKOUT/TAGOUT REQUIREMENTS.)

2. Open outer door of Compact PDU.

3. Loosen load panel door with a 90° turn of two assembly screws on right. **Mobile installation:** Remove and keep 1/4-20 screw in center of right-hand edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

4. Unbolt end of tap lead. See Illustration L2727A below.

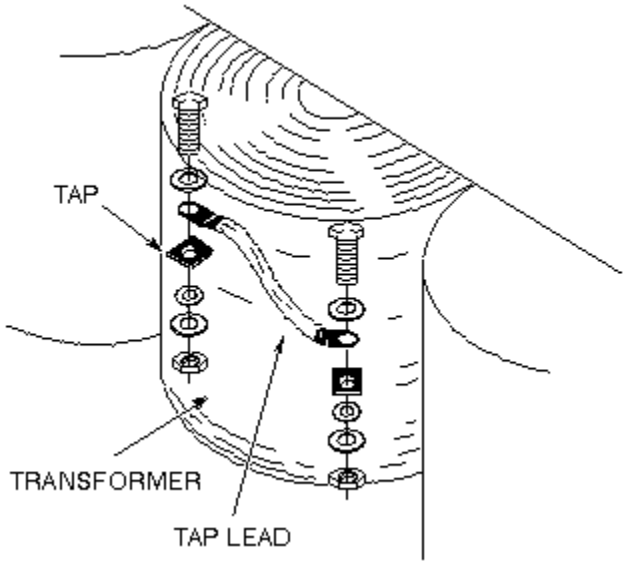


ILLUSTRATION L2727A
TRANSFORMER TAP CONNECTION

5. Move tap lead to desired tap. Refer to Section 1- Transformer Tap Configuration, above.

Note

There must be a flat washer on each side of a terminal lug. This is a UL requirement.

6. Bolt tap lead. Torque to 60 in/lb (68 Nm).

7. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. **Mobile installation:** Install 1/4-20 screw in center right-hand edge of door.

8. Unlock facility circuit breaker and turn on.

9. Turn on main circuit breaker.

Note

On the following step it is necessary to reset circuit breakers only if relay K2 and fuse F15 are not installed.

10. Press Emer. Stop Reset switch, and reset the following circuit breakers:

a. SIGNA HORIZON:
Gradient Amplifier Cabinet #1, Gradient Amplifier Cabinet #2 (for 2-bay cabinet), GRAM Cabinet (if cabinet installed), and RF Amplifier Cabinet.

b. Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

11. Turn on load panel circuit breakers.

12. Close outer door.

13. Remove lock and tag from main disconnect and restore power.

4- VOLTAGE CHECKS

4-1- Compact PDU Voltage Checks

1. Open outer door of Compact PDU.

2. Turn main circuit breaker OFF.

3. Turn all load panel circuit breakers OFF.

4. Turn facility circuit breaker ON.

Note

On the following step, it is necessary to reset circuit breakers only if relay K2 and fuse F15 are not installed.

5. Press Emergency Stop Reset switch, and reset following circuit breakers:

a. Signa Horizon: Gradient Amplifier Cabinet #1, Gradient Amplifier Cabinet #2 (for 2-bay cabinet), GRAM Cabinet (if cabinet installed), and RF Amplifier Cabinet.

b. Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

6. Turn main circuit breaker ON.

7. Loosen load panel door with a 90° turn of two assembly screws on right. Mobile installation: Remove and keep 1/4-20 screw in center right edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

DANGER!!

FATAL SHOCK HAZARD!! USE EXTREME CAUTION FOR STEPS 8 THROUGH 14. LETHAL VOLTAGES EXIST ON LOAD CENTER BRACKET ASSEMBLY (A14), AND ON BOTH SIDES OF COMPACT PDU INTERIOR. ON MODELS 46-317099P1/P2 AND P8 THROUGH P11, LETHAL VOLTAGES EXIST ON FILTER ASSEMBLY AND REGULATION PANEL.

- **USE ONLY ONE HAND.**
- **DO NOT HOLD COMPACT PDU FRAME OR OTHER GROUNDED METAL.**

8. Check that voltage at input terminals matches voltage on nameplate located over load panel.

9. Check that input current is phased in clockwise rotation (phase A, B, C). Use a phase meter. Refer to Table 1 below for phase relationship of input and output voltages.

TABLE 1
PHASE SEQUENCE

PHASE	**1 (L1)**	**2 (L2)**	**3 (L3)**
PHASE METER	A	B	C
WIRE COLOR	BROWN	RED	ORANGE
H	H_1	H_2	H_3
L	L_1	L_2	L_3
X	X_1	X_2	X_3

DANGER!!

FATAL SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN THE PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD RESULT IN SEVERE INJURY OR DEATH.

a. Turn all circuit breakers in Compact PDU to OFF position. Turn main disconnect to OFF position.

b. Connect a Phase Sequence Indicator to secondary of main transformer.

c. Close main disconnect and verify phase sequence is correct. If not correct, open main disconnect and rearrange primary input connections. Close main disconnect and recheck.

d. Open main disconnect and remove Phase Sequence Indicator.

CAUTION

Voltage must be phased in clockwise rotation. Improper phase rotation can damage medical equipment.

e. **Models 46-317099P20/P21.** Check phasing at line side of filter assembly. See Illustration L2728A below.

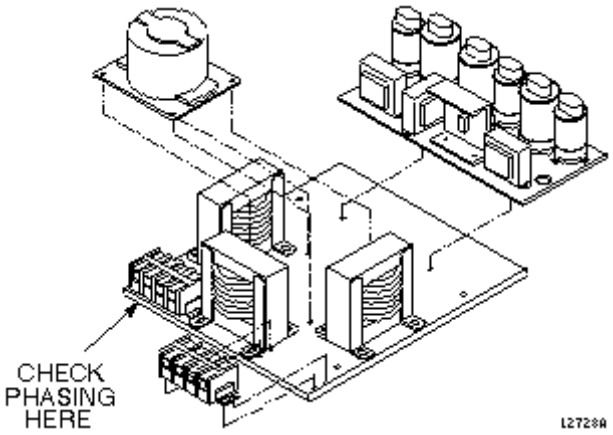


ILLUSTRATION L2728A .
FILTER ASSEMBLY, MODELS 46-317099P1/P2

f. **Models 46-317099P22.** Check phasing at bottom of main circuit breaker.See Illustration L2729A below.

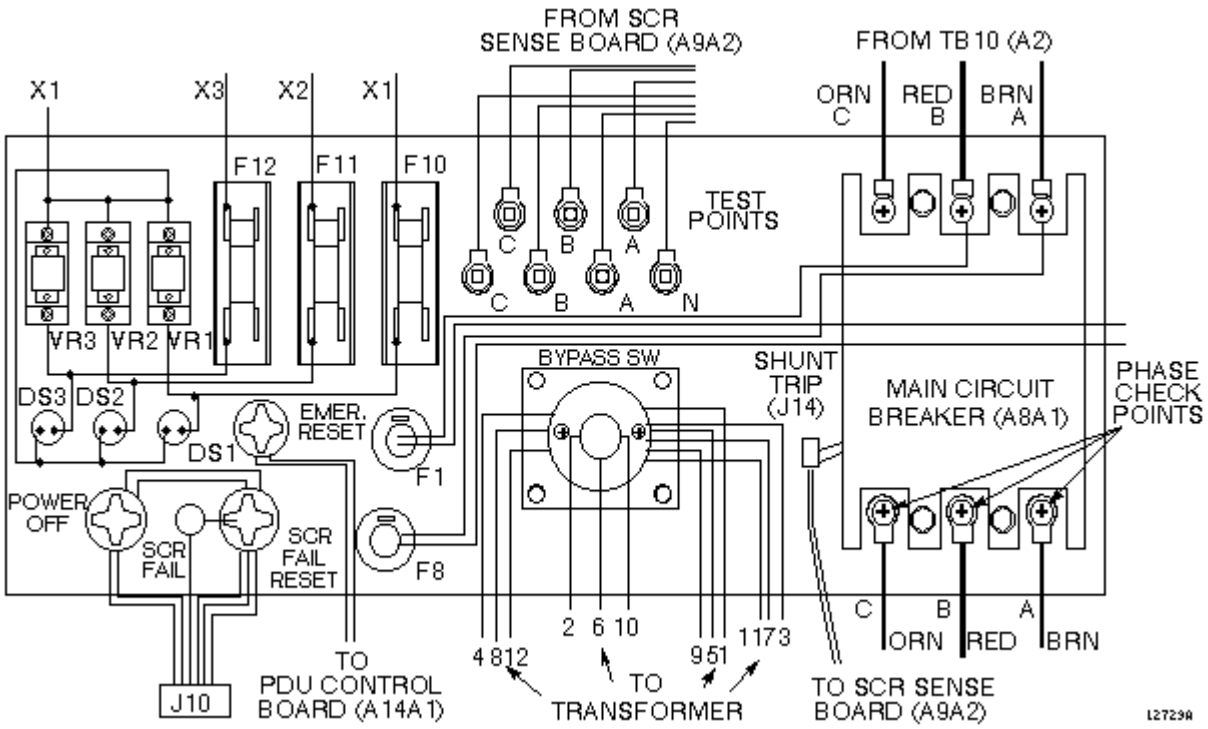


ILLUSTRATION L2729A .
FRONT PANEL, MODEL 46-317099P1 (REAR VIEW)

g. **Models 46-317099P20 through P21.** Check phasing at line side TB1 through TB4 of filter assembly. See Illustration L4793A below.

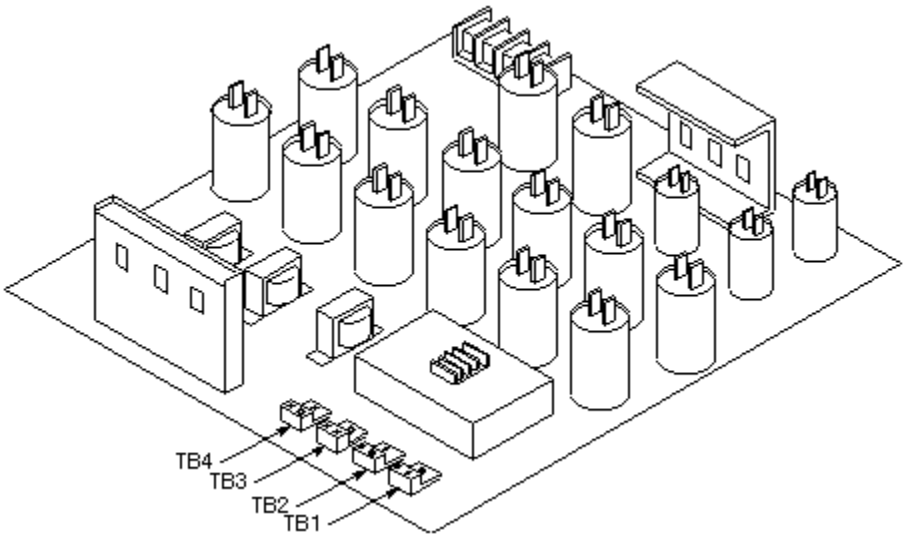


ILLUSTRATION L4793A .
FILTER ASSEMBLY, MODELS 46-317099P8 THROUGH P12

10. Models 46-317099P20/P21 and P22 through P11 only: Measure facility line-to-line voltage at input test points and compare with model voltage specification given in Table 2 below.

TABLE 2
VOLTAGE INPUT BY MODEL

COMPACT PDU

PART NO.	NOMINAL INPUT LINE-TO-LINE	INPUT AT INPUT TEST POINTS
46-317099P20	480 V 60 Hz regulated, filtered	4.8 $\pm$ 0.048 V
46-317099P21	380 V or 415 V 50/60 Hz regulated, filtered	3.8 $\pm$ 0.038 V or 4.15 $\pm$ 0.042 V
46-317099P22	480 V 60 Hz regulated, filtered	4.18 to 5.04 V

Note

There is a 100:1 voltage stepdown at test points. For example, 480 VAC in Compact PDU is measured as 4.8 VAC at test points.

11. Verify voltage of 208 V 3 phase with neutral at magnet and superconducting shim service outlets.

12. Turn load panel circuit breakers ON.

13. If output voltage at front panel test points is within specification, system is ready to run. If not, refer to Section 6 Logic Board Calibration.

14. Verify that voltages on TB10 (A2) match output voltages shown in Table 4 for Signa Horizon.

15. Prepare unit for operation:

    a. Install any side or rear panels removed.

    b. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. Mobile installation: Install 1/4-20 screw in center right edge of door.

    c. Close outer door.

5- START UP CHECKS

5-1- Prestartup Procedure

DANGER!!

FATAL SHOCK HAZARD!! TO PREVENT FATAL ELECTRIC SHOCK, DISCONNECT POWER FROM COMPACT PDU AND LOCK OFF BEFORE YOU PERFORM THE FOLLOWING PROCEDURE.

1. Turn facility circuit breaker off, lock, and tag. (Refer to CD-ROM *Dir. 2187583-3 [or -2], MR Release Signa 5x/8x Service Methods, Renewal Parts and Service Tools,* Procedure for Safety, Section 6, OSHA LOCKOUT/TAGOUT REQUIREMENTS.)

2. Open outer door to Compact PDU.

3. Turn the 80 amp main circuit breaker OFF.

4. Verify that voltage at power input test points is 0 Vac. If 0 volts is not measured, recheck steps 1 and 3.

5. Loosen load panel door with a 90° turn of two assembly screws on right edge of panel door. Mobile installation: Remove and keep 1/4-20 screw in center of right edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing it open, and lock articulated arm.

Note

The following step applies to models 317099P1/P2 and P8 through P12. Adjust all three logic boards (A14A2, A14A3, A14A4). See Illustration L2730A.

6.Models 46-317099P1/P2 only: On each logic control board (A, B, and C), attach ohmmeter from U9 pin 6 to U9 pin 8. The logic control board is oriented as shown in Illustration L2730A below. Adjust R33 for ohmmeter to read 105K ohms.

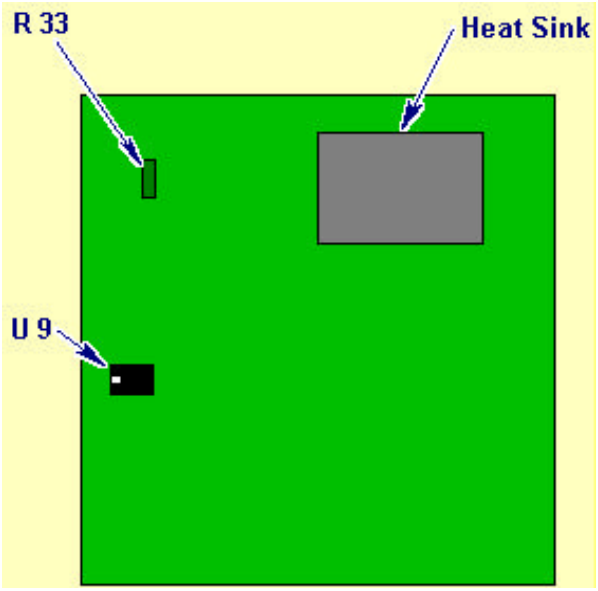


ILLUSTRATION L2730A
LOGIC BOARD

7. Check that all plug connectors on circuit boards are tight.

8. Models 46-317099P1/P2 and P8 through P11 only: Tighten screws on all 18 SCRs (54 screws; 3 per SCR). Torque to 30 lb in (34 Nm). See Illustration L2731A below.

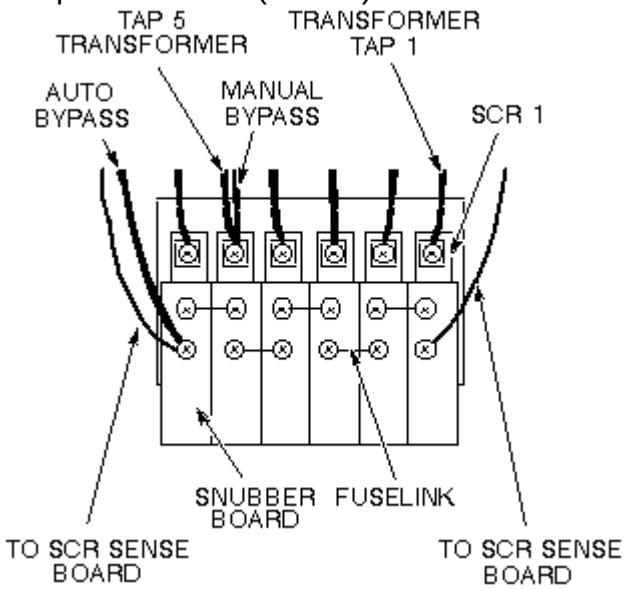


ILLUSTRATION L2731A
SCR BANK

9. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of the the two assembly screws. Mobile installation: Install the 1/4-20 screw in the center right edge of the door.

10. Unlock the facility circuit breaker and turn it ON.

Note

There is a 100:1 voltage stepdown at test points. For example, 480 VAC in Compact PDU is measured as 4.8 VAC at test points.

11. 46-317099P1/P2 and P8 through P11 only: Measure facility line-to-line voltage at input test points. Refer to Table 3 below.

TABLE 3
VOLTAGE INPUT BY MODEL

COMPACT PDU	NOMINAL INPUTLINE-TO-LINE	PART NO. INPUTAT INPUT TEST POINTS
46-317099P1	480 V 60 Hz regulated, filtered	4.8 ± 0.048 V
46-317099P2	380 V or 415 V 50/60 Hz regulated, filtered	3.8 ± 0.038 V or 4.15 ± 0.042 V
46-317099P8 & 46-317099P10	480 V 60 Hz regulated, filtered	4.18 to 5.04 V
46-317099P9 & 46-317099P11	380, 400, or 415 V 50/60 Hz regulated, filtered	3.1 to 3.99 V 3.48 to 4.20V 3.61 to 4.32 V

5-2- Startup Procedure

1. Open outer door of Compact PDU.

2. Turn all load panel circuit breakers OFF.

3. Turn 80 amp main circuit breaker OFF.

4. Turn facility circuit breaker off, lock, and tag. (Refer to CD-ROM *Dir. 2187583-3 [or -2], MR Release Signa 5x/8x Service Methods, Renewal Parts and Service Tools,* Procedure for Safety, Section 6, OSHA LOCKOUT/TAGOUT REQUIREMENTS.)

Verify that voltage at the power input test point is 0 Vac. If 0 Vac is not measured, repeat steps 3-4. On model P12, measure for voltage at filter terminals L1, L2, and L3, located on right front of the filter assembly. See Illustration L4793A in Section 4-1.

6. Loosen load panel door with a 90° turn of two assembly screws on right. Remove 1/4-20 screw in center of right edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing it out, and lock the articulated arm.

7. Check that all accessible power connections are tight: phase A, B, C, neutral, and ground.

8. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of the two assembly screws. Install the 1/4-20 screw in the center of the right edge of the door.

9. Unlock the facility circuit breaker and turn it ON. Mobile units:

   Connect power to trailer. If applicable, press the start button on the PDU START-STOP station.

DANGER!!

FATAL SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN COMPACT PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

10. Check that input power is properly phased at connection to utility. Use a phase meter. Refer to Section 4 - Voltage Checks.

CAUTION

Be sure input power is properly phased. Damage to loads may result if input power is not phased A, B, C (clockwise phase rotation).

11. Verify that there is no obstruction on the top of the Compact PDU that can restrict air flow.

12. Measure voltages at L1, L2, and L3 of TB10 (A2). Verify that voltage is within the voltage range limit. Refer to Table 5 below.

TABLE 5HOTWORDSTYLE=BOOKDEFAULT;
VOLTAGE SPECIFICATIONS

PART NO. 46-317099 >	**P1**	**P2**	**P3**	**P4**			**P12**
NOMINAL INPUT VOLTAGE	480	380/415	480	380/415	480	380/ 400/ 415	380/ 415/ 480
INPUT VOLTAGE RANGE	420-500	330-400 360-435	456-494	361-418 394-435	412-502	329-397 348-420 359-434	327-502
MAXIMUM INPUT VOLTAGE	530	460	504	435	502	434	502
NOMINAL RATED CURRENT (A)	66	80	66	80	66	95	95
MAXIMUM RATED CURRENT (A)	80	80	80	80	80	80	80
FREQUENCY (Hz)	60	50/60	60	50/60	60	50/60	50/60

13. Configure the transformer taps. Refer to Section 3 - Transformer Taps.

Note

On the following step, it is necessary to reset circuit breakers only if relay K2 and fuse F15 are not installed.

14. Press Emer. Stop Reset switch. and reset following circuit breakers:

Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

15. Verify that the two fans are running. Hold a piece of paper in front of each fan in succession. If paper does not stick to fan guard, check fan.

16. Models 46-317099P1/P2 and P8 through P11 only: Measure facility line-to-line voltage at input test points and compare with model voltage specification on nameplate located over load panel inside outer door.

Note

There is a 100:1 voltage step-down at front panel test points. For example, the measure of 480 VAC input voltage is 4.8 VAC at front panel test points.

17. Turn main circuit breaker OFF.

18. Models 46-317099P1/P2 and P8 through P11 only: Turn bypass switch to AUTO position.

19. Turn main circuit breaker ON.

20. Press the power off button. Main circuit breaker will trip.

21. Reset and turn main circuit breaker ON.

22. Verify that three output power status lights on front panel are lit (6 second delay).

23. Models 46-317099P1/P2 and P8 through P11 only: Verify output line-to-neutral voltage at test points of 1.20 $\pm$ 0.03 V. If not, refer to Section 6 - Logic Board Calibration.

24. Press emergency stop reset switch.

25. Turn load panel circuit breakers ON.

26. Check that all loads are operational.

27. Close outer door.

6- LOGIC BOARD CALIBRATION

6-1- Introduction

The purpose of this procedure is to set the output of the regulator to load. The driver board has seven green LEDs. Two LEDs should be lit at all times. LED 7 indicates power on board and is always on. LEDs 1-6 represent tap settings and only one should be on at any time.

If no LED or one LED is lit, or if more than two LEDs are lit, immediately turn off main disconnect. Troubleshoot, diagnose, and repair.

If only one LED (1-6) is lit, perform the following calibration.

6-2- Calibrate Logic Board

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! USE EXTREME CAUTION FOR THIS PROCEDURE. LETHAL VOLTAGES EXIST ON LOAD CENTER BRACKET ASSEMBLY (A14), AND ON BOTH SIDES OF COMPACT PDU INTERIOR. ON MODELS 46-317099P1/P2, LETHAL VOLTAGES EXIST ON FILTER ASSEMBLY AND REGULATION PANEL.

- USE ONLY ONE HAND.
- DO NOT HOLD COMPACT PDU FRAME OR OTHER GROUNDED METAL.

1. Adjust load.
   a. Turn on load and try to achieve 1 KW per phase (8.3 amps).

   b. Verify that all load panel circuit breakers are on. The Compact PDU then provides normal load to all three phases of the regulator.

Note

Potentiometer R62 is a 30-turn pot. It may require several turns before output level changes.

c. Verify that the voltage across C42 on logic board is 8.5 to 9.0Vdc. See Illustration L2733A.

d. If reading is low, adjust R62 to increase reading. If correct reading cannot be obtained, refer to Section 7 - General Checks steps 11-13 to troubleshoot the logic …….board.

e. Repeat step b for phase B and C.

2. Adjust voltage.

a. Locate R39 on phase A logic board.

b. Using a true rms multimeter, verify that the voltage at the output of phase A to neutral is 1.20 ± 0.03V.

Note

Potentiometer R62 is a 30-turn pot. It may require several turns before output level changes.

c. Adjust R39 to obtain correct output voltage for phase A.

d. Repeat step 2 for phase B and phase C.

7- GENERAL CHECKS

7-1- General Checks

1. Unlock facility circuit breaker and turn ON.

2. Turn bypass switch to AUTO position.

3. Turn main circuit breaker ON. Press emer. stop reset switch.

Note

After turning main circuit breaker ON there is a 6-second built-in delay before power is applied to SCRs. Detect an SCR failure by measuring neutral-to-line output voltage of each phase. Test point voltages are in the range 0-5 VAC.

4. Set meter to 2 VAC scale.

Note

After turning main circuit breaker ON there is a 6-second built-in delay before power is applied to SCRs. Detect an SCR failure by measuring neutral-to-line output voltage of each phase. Test point voltages are in the range 0-5 VAC.

a. Verify output at test point A to neutral output voltage of 1.20 ± 0.3 V.

b. Move meter lead to output test point B. Verify output voltage of 1.20 ± 0.3 V.

c. Move meter lead to output test point C. Verify output voltage of 1.20 ± 0.3 V.

Note

On the following step it is only necessary to reset circuit breakers if relay K2 and fuse F15 are not installed.

5. Reset following circuit breakers:
   a. Gradient Amplifier Cabinet #1, GRAM Cabinet (if cabinet installed), and RF Amplifier Cabinet

   b. Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

6. Turn load panel circuit breakers ON.

Note

On the following step it is only necessary to reset circuit breakers if relay K2 and fuse F15 are not installed.

FATAL SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN COMPACT PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

6-2- General Troubleshooting

1. Loosen load panel door with a 90° turn of two assembly screws on right. **Mobile installation:** Remove and keep 1/4-20 screw in center of right edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

2. Check each set of output line-to-neutral voltages at TB10. (On the front of the PDU on the faceplate above the door.) Refer to Table 6 below.

TABLE 6
VOLTAGE INPUT BY MODEL

COMPACT PDUPART NO.	NOMINAL INPUTLINE-TO-LINE	OUTPUT LINE-TO-NEUTRAL
46-317099P1	480 V 60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P2	380 V or 415 V 50/60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P3	480 V 60 Hz unregulated, unfiltered	1.20 + 0.3 V
46-317099P4	380 V or 415 V 50/60 Hz unregulated, unfiltered	1.20 + 0.3 V
46-317099P8	480 V 60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P9	380, 400, or 415 V 50/60 Hz regulated, filtered	1.20 + 0.3 V

46-317099P10	480 V 60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P911	380, 400, or 415 V 50/60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P912	380, 415, or 480 V 50/60 Hz unregulated, filtered	1.20 + 0.3 V
46-317099P20	380, 415, or 480 V 50/60 Hz regulated, filtered	1.20 + 0.3 V
46-317099P21	380, 415, or 480 V 50/60 Hz unregulated, filtered	1.20 + 0.3 V

3. Adjust logic board for phase A as follows. See Illustration L2733A in Section 3-1-2.

a. Measure AC voltage across resistor R1 or R2. Verify that voltage is between 10-100mv.

Note

If voltage is zero, (1) there is no load, or (2) current sensor is defective or disconnected. Logic board does not regulate if voltage is zero.

The following steps are a direct adjustment of the output voltage. You can hear the GRAM fans speed up and slow down while adjusting R39. Do not perform these adjustments with power to the cabinets.

b. Measure DC voltage across C42. Adjust R62 so voltage measures 8.5-9.0 VDC.

c. Adjust R39 clockwise so that LED 6 on driver board is lit.

d. Measure DC voltage across C42. Adjust R62 so voltage measures 8.5-9.0 VDC.

e. Monitor neutral-to-phase-A +/- output voltage. Adjust R39 so output line-to-neutral voltage is 1.20 $\pm$ 0.03 V.

4. Adjust logic boards for phase B and phase C. Refer to Step 3.

5. Verify that voltage at TP12 to ground on each logic board is
10.0 VDC $\pm$ 0.5 VAC. If voltage is not within these limits, replace logic board.

6. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. Mobile installation: Install 1/4-20 screw in center of right edge of door.

7. Close outer door to Compact PDU.

8- REGULATOR CHECKS

8-1- Regulator Check

DANGER!!

FATAL SHOCK HAZARD!! TO PREVENT FATAL ELECTRIC SHOCK, DISCONNECT POWER FROM COMPACT PDU AND LOCK OUT BEFORE YOU PERFORM THIS PROCEDURE.

1. Turn facility circuit breaker off, lock, and tag. (Refer to CD-ROM *Dir. 2187583-3 [or -2], MR Release Signa 5x/8x Service Methods, Renewal Parts and Service Tools,* Procedure for Safety, Section 6, OSHA LOCKOUT/TAGOUT REQUIREMENTS.)

2. Check and replace any fuselinks that are discolored, or that are not continuous.

3. See Illustration L2731A in Section 5-1. For each SCR bank:

Note

SCRs are numbered from right to left. SCR number 6 is on the left when SCRs are oriented as shown in Illustration L2731A.

a. Turn bypass switch to manual position.

b. Verify that resistance between an SCR transformer lead and a snubber board solder pad exceeds 1K ohms. If not, refer to Section 2- SCR Troubleshooting, below.

c. Reconnect transformer lead to snubber board on SCR number six.

4. Check snubber boards for discoloration and rupture of foil.

5. Check that all snubber board plug connections are tight.

6. Check that logic, driver, and SCR sense boards are firmly supported on standoffs.

7. Check that all plug connectors on circuit boards are tight.

8. Check for heat discoloration near heat sink area on logic boards. See Illustration L2733A in Section 3-1-2.

9. Check that all connectors to input/output filter capacitors are tight (A11).

DANGER!!

FATAL SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN COMPACT PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY, OR DEATH.

10. Unlock facility circuit breaker and turn on.

11. Turn main circuit breaker on.

12. Press emergency stop reset switch and reset following circuit breakers:
    a. Gradient Amplifier Cabinet #1, Gradient Amplifier #2 (for 2-bay cabinet), GRAM Cabinet (if cabinet installed), and RF/Pen Cabinet

    b. Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

FATAL SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN COMPACT PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY, OR DEATH.

13. Press power off switch. This shunt trips main circuit breaker.

14. Measure input test points—must measure 0 Vac before you proceed.

15. Remove fuselink from any one SCR bank.

16. Turn main circuit breaker off then on to reset. Main circuit breaker will trip. If it does not trip, replace SCR sense board.

17. Install fuselink. Turn main circuit breaker off then on to reset.

18. Press emergency stop reset switch.

19. Check output line-to-neutral voltage at test points.
Verify that voltage is 1.20V ± 0.03 V. If voltage is out of specification, refer to Section 6 - Logic Board Calibration.

20. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. **Mobile installation:** Install 1/4-20 screw in center right edge of door.

Note

On the following step, it is necessary to reset circuit breakers only if relay K2 and fuse F15 are not installed.

21. Press emergency stop reset switch and reset following circuit breakers:
    a. Gradient Amplifier Cabinet #1, Gradient Amplifier #2 (for 2-bay cabinet), GRAM Cabinet (if cabinet installed), and RF/Pen Cabinet

b. Check any option circuit breakers for tripped condition. Reset tripped option circuit breakers.

22. Turn bypass switch to the Normal position.

23. Turn load panel circuit breakers on.

24. Close outer door.

8-2- SCR Troubleshooting

1. Turn main circuit breaker off.

Note

SCRs are numbered from right to left. SCR number 6 is on the left when SCRs are oriented as shown in Illustration L2731A.

2. Turn bypass switch to the manual position.

3. For SCR number one:

a. Measure resistance between transformer tap connection and solder pad area of snubber board. If reading is greater than 1000 ohms, proceed to step 4. If reading is less than 1000 ohms, continue with this step. Either SCR, snubber board, or driver board is defective. See Illustration L2735A below.

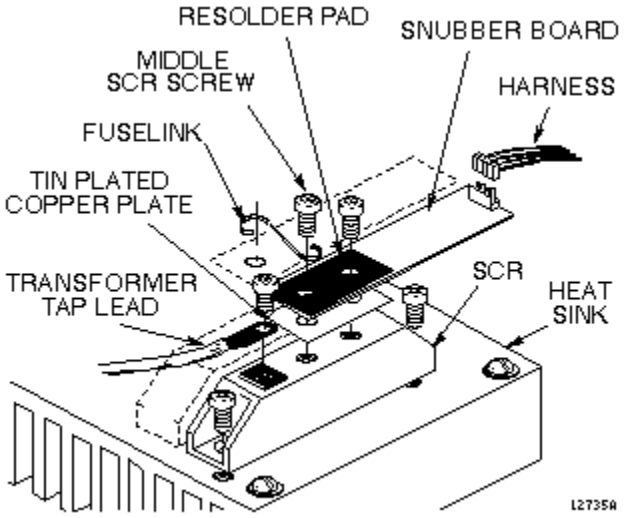


ILLUSTRATION L2735A
SCR ASSEMBLY

b. Disconnect harness between driver board and snubber board. Measure resistance between transformer tap lead and each middle SCR screw.

c. If reading is greater than 1000 ohms, driver board is defective. Replace driver board. Proceed to step 3f. If reading is less than 1000 ohms, either the SCR or snubber board is defective. Continue with step 3d.

d. Disconnect snubber board from SCR. Measure resistance between tap connection and screw in middle of SCR. If resistance is less than 1000 ohms, replace SCR. If resistance is greater than 1000 ohms, replace snubber board.

e. Reconnect snubber board to SCR.

f. Reconnect harness between driver board and snubber board.

4. Repeat step 3 for each remaining SCR in the SCR bank.

5. Reconnect fuselinks between snubber boards. Replace any fuselink that is open or discolored.

6. Replace any snubber board that has cracked or discolored foil pads on either side of board.

7. Repeat steps 3–6 for each remaining SCR bank.

8. Turn bypass switch to Auto position.

9. Measure at output test points (A8) to see if a shorted SCR is doing an instant output voltage.

a. Turn main circuit breaker on.

b. Measure voltage across an SCR between transformer tap connection and foil area of snubber board.

If measurement is > 2 V, perform step 9 for next SCR.
If measurement is <n 2 V, go to step 10.
If all SCRs have voltage measurements > 2 V, go to step 11.

c. Turn main circuit breaker off.

10. SCR or snubber board is defective. Perform this step to determine which board is defective.

a. Disconnect snubber board from SCR.

b. Measure resistance between tap connection and screw in middle of SCR.

c. If resistance is < 1000 ohms, replace SCR. Refer to procedure for Compact PDU Hardware Replacement, Section 2- Replace An SCR.

If resistance is > 1000 ohms, replace snubber board. Refer to procedure for Compact PDU Hardware Replacement, Section 1- Service a Circuit Board.

11. Turn main circuit breaker on.

9- INPUT FILTER CHECKS

9-1- Input Filter Checks Model, 46-317099P1/P2

1. Open outer door of Compact PDU.

2. Turn main circuit breaker off.

3. Turn all load panel circuit breakers off.

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN THE PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

4. Loosen load panel door with a 90° turn of two assembly screws on right. **Mobile installation:** Remove and keep 1/4-20 screw in center of right-hand edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

5. Turn main circuit breaker on. If main circuit breaker shunt trips, go to step 6.

a. Verify that line-to-line voltage at line side of filter is in operating voltage range (360 < V < 520).

Note

Voltage measured at load side is zero to two volts higher than at line side. This is a normal characteristic of filter.

b. Verify that line-to-line voltage on load side of filter is in operating voltage range (208Y/120).

c. Verify that test loop currents are in operating range (11 < A < 16). The three test loops are in wiring above shunt module.

If voltages and currents of step 5 are within specification, filter may be used to power the loads. Go to step 9.

6. Turn off facility power to PDU. Lock out facility power breaker.

7. Check for visible damage to filter. If a surge suppresser fails, there may be soot on the surge suppresser.

a. If a terminal block is damaged, replace it.
Refer to procedure for Compact PDU Hardware Replacement
Section 5 - Replace A Terminal Block (Models 46-317099P1/P2).

b. If surge suppresser is damaged, replace it.
Refer to procedure for Compact PDU Hardware Replacement
Section 6 - Replace Surge Suppresser (Models 46-317099P1/P2).

c. If shunt module is damaged, replace it.
Refer to procedure for Compact PDU Hardware Replacement
Section 7 - Replace Shunt Module (Models 46-317099P1/P2).

8. If there is no visible damage, disconnect wires from line or load side of surge suppresser.

9. Unlock facility breaker. Turn facility power breaker on. Turn main circuit breaker on.

a. If main circuit breaker shunt trips, replace shunt module.
Refer to procedure for Compact PDU Hardware Replacement
Section 8 - Shunt Module (Models 46-317099P1/P2).

b. If main circuit breaker does not trip, replace surge suppresser.
Refer to procedure for Compact PDU Hardware Replacement
Section 6 - Surge Suppresser (Models 46-317099P1/P2).

10. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. **Mobile installation:** Install 1/4-20 screw in center of right-hand edge of door.

11. Turn main circuit breaker on.

12. Turn load panel circuit breakers on.

13. Close outer door.

9-2- Input Filter Checks, Model 46-317099P8–P11

1. Open outer door of Compact PDU.

2. Turn main circuit breaker off.

3. Turn all load panel circuit breakers off.

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN THE PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

4. Loosen load panel door with a 90° turn of two assembly screws on right. **Mobile installation:** Remove and keep 1/4-20 screw in center of right-hand edge of door. Raise load panel slightly to disengage notched guides. Open hinged door, swing out, and lock articulated arm.

5. Turn main circuit breaker on. If main circuit breaker shunt trips, check if Accuvar OK light is on. If fail light is on, replace Accuvar filter.

a. Verify that the green OK light is on.

Note

Voltage measured at line side is nominal input volts to the PDU. These are the terminal lugs at the front of the filter assembly.

b. Verify that line-to-line voltage on secondary side of filter terminal block at rear of the filter assembly is in operating voltage range (208Y/120).
See Illustration L4793A in Section 4-1.

6. Turn off facility power to PDU. Lock out facility power breaker.

7. Check for visible damage to filter.

a. If a terminal block is damaged, replace it.

b. If surge suppresser is damaged, this will be indicated by the red fail light On, located on the Accuvar. Replace Accuvar.
Refer to procedure for Compact PDU Hardware Replacement
Section 7 - Surge Suppresser (Models 46-317099P8 Thru P12).

c. If any capacitors are damaged, replace them.

8. If there is no visible damage, disconnect wires from line and load side of surge suppresser.

9. Unlock facility power breaker. Turn facility breaker on. Turn main circuit breaker on.

a. If main circuit breaker shunt trips, the problem is in the PDU.

b. Turn main circuit breaker off. Turn off facility power toPDI. Lock out facility power breaker.

c. Replace the primary power wires to the line filter.

d. Unlock facility power breaker. Turn facility breaker on. Turn main circuit breaker on. If the main circuit breaker does not trip, the primary filter is okay. If the main circuit breaker does trip, replace the filter.

e. If the primary filter is okay, repeat steps *b, c* and *d* above for the secondary filter. If primary or secondary filter causes circuit breaker to trip, replace filter.

10. Release articulated arm. Close load panel door. Secure load panel door with a 90° turn of two assembly screws. Mobile installation: Install 1/4-20 screw in center of right edge of door.

11. Turn main circuit breaker on.

12. Turn load panel circuit breakers on.

13. Close outer door.

10- MISCELLANEOUS PROBLEMS

Problem # 1:

Main Circuit Breaker Fails to Shunt Trip

Solution #1:

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! LETHAL VOLTAGES EXIST WITHIN THE PDU DURING THIS CHECK. FOLLOW THE STEPS BELOW EXACTLY. FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

1. Disconnect connector on left side of the main circuit breaker.

2. Measure the shunt trip coil resistance with circuit breaker turned ON. It must read <10 ohms. With the circuit breaker OFF, the shunt trip coil must be open. If either condition is not met, replace the circuit breaker.

3. Reconnect the connector behind the main circuit breaker.

4. Turn the main circuit breaker ON.

5. Measure shunt trip coil voltage on the cable side of the unplugged connector J1 with power off switch pressed. If the voltage is 24 to 28 VDC, replace the main circuit breaker. Refer to procedure for Compact PDU Hardware Replacement .

6. If no voltage is present, check the fuses F1 and F8 on A8. If the fuse has failed, replace the fuse.

Problem #2:

Main circuit breaker shunt trips on power up with the bypass switch in the AUTO position.

Solution #2:

1. If the SCR Failure is lighted, replace any open fuselinks, deffective snubber boards, or shorted SCRs. Press the fail reset switch to clear the SCR failure light indicator.

2. Turn the main circuit breaker OFF. Disconnect the SCR Sense board J9. Turn the main circuit breaker back ON. If the circuit breaker does not shunt trip, then replace the SCR Sense board.

Problem #3:

No LED on the Driver board is lit, except for LED 7 (power ok), with the bypass switch in the AUTO position.

Solution #3:

1. Check the connection between the Logic board and the Driver board. The connector is P2 on the Logic Board and P1 on the Driver Board.

2. Check the input power for a clockwise phase rotation.

3. Measure the voltage across the SCR between the transformer tap lead and the snubber solder pad. When the SCR is conducting, the mearured voltage should be less than 1.2 VAC.

4. If none of the SCRs are conducting, replace the Driver board.

5. If the SCRs are still not conducting, replace the Logic board.

6. Check the voltage across R1 or R2 on the Logic board. The voltage is typically 10 - 100 mVACl. If it is zero, the current signal is disabled from the Logic board. Check the current sense transformer connections. Repair any open connections.

Problem # 4:

Alll the LEDs on the Driver board are off.

Solution # 4:

1. Check the interconnect cables to the Driver board.

2. Check LED 1 on the Logic board (Power OK). If LED 1 is not lighted, replace the Logic board.

Problem #5:

No voltage output in AUTO mode.

Solution #5:

1. Check that the main input breaker is ON.

2. Check that the load panel circuit breakers are ON.

3. Check that the facility circuit breaker is ON.

4. Check that the line input power connections are made to H1, H2, and H3 transformer terminal lugs.

Problem #6:

Fuselink opens during powerup.

Solution #6:

1. Check that the primary RC filter is installed and connected.

2. Check that the capacitor connections are tight.

3. Check adjustment for R33 on all 3 Logic boards.

Problem #7:

Audible noise comes from the regulation panel.

Solution #7:

1. Verify that the voltage across the conducting SCR is less than 1.2 VAC.

2. Perform Start Up Checks. See Section 5.

3. Perform the General Checks. See Section 7.

4. Replace the Driver boards if the problem perisists. Refer to procedure for Compact PDU Hardware Replacement .

Problem #8:

Gradient Driver, RF Amplifier, and GRAM Cabinet circuit breakers trip without a power off actuaiton.

Solution #8:

1. Verify that the input voltage is present. The facility input power may have failed.

2. Verify that the main circuit breaker is ON.

3. Press the Emergency Stop reset, and manually reset the circuit breakers.

11- EMERGENCY STOP BUTTON CHECKS

Description - There are four Emergency Stop buttons in the system:

- Two on the Magnet Enclosure (MG2)
- One on the Operator Workspace (OW1)
- One on the system Cabinet (MR2)

The purpose of the Emergency Stop is to remove power in the patient vicinity.

Initial Conditions

Signa Horizon LX software does not have to be up since this is a hardware function. If Signa Horizon LX software is up when Emergency Stop is pressed, then a message at the Operator Workspace will appear indicating the Emergency Stop has been pressed.

Procedure

1. Verify that all cabinets are powered up.

2. Press Emergency Stop button at the Operator Workspace and verify that the breakers trip for the following cabinets:

- RF/Pen Cabinet (MR1)
- Gradient Amplifier Cabinet (MR3)
- GRAM Cabinet
- Shim Power Supply Cabinet (MG4)
- Main Magnet Power Supply Cabinet (MG5)

3. Verify that Emergency Stop button at the System Cabinet and Emergency Stop reset at the PDU are illuminated.
4. Press Emergency Stop reset at the PDU to reset the Control Board Relay K2. Reset the Breakers Mentioned in Step 2.

5. Repeat Steps 1 through 4 for the other four Emergency Stop buttons.

System Restoration

When the test is complete, you must turn the Oxford Shim Power Supply back on by depressing the green Start button on the front of the Shim Power Supply Cabinet, if present.

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	June16, 1998	M. Whitlow	Initial Conversion from Toolbook to Word.