Product Manual
J85500L-1

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Lucent Technologies Lineage® 2000 600 Ampere, -48 Volt Global Power System

Notice:
Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

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1 Introduction

General Information

This product manual (Select Code 167-790-047) describes the Lineage® 2000 J85500L-1 Global Power System (GPS). This battery plant operates from a nominal 208/240-volt ac, 50/60-hertz source. It offers a 600-ampere capacity per cabinet with a nominal -48-volt output.

The J85500L-1 GPS is designed as a compact and complete, totally integrated energy system package. It contains ac distribution, rectifiers, a controller, and dc fuse distribution, which can all be configured in one standard equipment cabinet or expanded into a supplementary distribution cabinet. The plant has a modular front-access design for ease of installation, growth, and maintenance. This modular design architecture allows the system to grow in capacity and functionality to satisfy a broad range of applications around the world.

The J85500L-1 Global Power System was designed for use in the international telecommunications market. The design complies with European Technical Standards Institute (ETSI) standards. The cabinet is 2200 mm high with a footprint of 600 mm wide by 600 mm deep. Metric hardware is used to assemble each system component.

The basic system consists of charge/discharge bus bars with optional low voltage battery disconnect/reconnect; an ECS controller; two rectifier shelf assemblies, each capable of connecting three -48-volt, 50-ampere switchmode rectifiers; ac distribution; and space for installing dc distribution fuse panels, a battery fuse disconnect panel, or two additional rectifier shelves.

The supplemental cabinet provides space for additional dc distribution panels, a battery fuse disconnect panel, and offline-equalize capabilities.

Plant output current is increased by adding -48-volt, 50-ampere rectifiers to the rectifier shelf assemblies. DC distribution is increased by adding fuse panels equipped with DIN fuse bases. Two optional circuit packs are available, one to add microprocessor-based features and another to add a datalogger.

The J85500L-1 GPS is compatible with virtually all flooded and valve-regulated batteries that float within the range of 48 through 58 volts. In addition, the plant is capable of operating in the batteryless mode, making it suitable for those applications where battery backup is not necessary or is achieved through the use of an uninterrupted power supply (UPS).

This manual includes a general product description, basic features and options, ordering information, and engineering and installation information. The main emphasis will be to familiarize the user with each major component in the system and provide step-by-step installation and start-up procedures.

Technical Support

Technical support for Lucent Technologies equipment is available to customers around the world.

USA, Canada, Puerto Rico, and the US Virgin Islands

On a post-sale basis, **during the Product Warranty period,** our Technical Support telephone number 1-800-CAL RTAC (1-800-225-7822) provides coverage during normal business hours. Product Specialists are available to answer your technical questions and assist in troubleshooting problems. For out-of-hours EMERGENCIES, the 800 number will put you in touch with a Regional Technical Assistance Center Engineer via our 24 hour a day, 7 day per week Help Desk.

When Technical Support is required in **the Post-Warranty Period**, the service may be billable unless you hold an extended warranty or contractual agreement.

Central and South America

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

Europe, Middle East, and Africa

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

Asia Pacific Region

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

Product Repair and Return

Repair and return service for Lucent Technologies equipment is available to customers around the world.

USA, Canada, Puerto Rico, and the US Virgin Islands

For information on returning of products for repair, customers may call 1-800-255-1402 for assistance.

Central and South America

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

Europe, Middle East, and Africa

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

Asia Pacific Region

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

Customer Service

For customer service, any other product or service information, or for additional copies of this manual or other Lucent Technologies documents, call 1-800-THE-1PWR (1-800-843-1797). Specify the select code number for manuals, or drawing number for drawings. Contact your regional customer service organization or sales representative for information regarding spare parts.

2 Product Description

Specifications

Electrical

Table 2-A: Electrical Specifications

Nominal Output Voltage	-48 volts dc
Operating Voltage Range (Float or Equalize)	-48 to -58 volts dc
Output Current Rating	0 to 600 amperes
Nominal Input Voltage	380/220Vac, 4 wire + PE 208/240Vac, 3 wire + PE
Input Voltage Range (per phase)	180 to 264 volts ac
Input Frequency Range	47 to 63 Hertz
Input Current (per single rectifier)	15.5 amperes @ 220 volts ac
Efficiency (full load)	86% typical
Power Factor (full load, nominal input)	0.99 typical
Regulation (full output range, full input range)	± 0.5%
AC ripple	250 mV peak-peak
Output Noise	2 mV phosphometric
Active Load Share Accuracy (per rectifier)	± 5 amperes
Electrostatic Discharge	IEC 801-2 Level 5

Physical and Thermal

Table 2-B: Physical and Thermal Specifications

Depth	600 mm
Width	600 mm
Height	2200 mm
Weight (12 rectifiers)	363 kg
Heat Release (54 Volts, 600 amperes)	5750 Watts (19,602 BTU/hr)
Operating Temperature (0 to 1500 m)	0-50° C
Altitude (derate maximum temperature by 0.656º C per 100 meters above 1500 m)	-60 to 4000 meters
Humidity Rating	5-90% noncondensing
Audible Noise (12 rectifiers)	65 dBA (1 meter away)

Features

The following is a list of the many features provided with this product:

- Distributes -48-volt dc power
- Front access capability to all equipment
- Compatible with standards of the European Technical Standards Institute (ETSI)
- AC circuit breaker box prewired to rectifiers
- DC fuse distribution panels with DIN fuse bases
- Individual fuse alarm lights on fuse panels
- Extensive control and alarm monitoring capabilities
- Standard hard-wired form-C office alarm outputs
- Controller includes 4-digit digital meter:
  - Voltmeter, ± 0.05% accuracy
  - Ammeter, ± 0.5% accuracy
- Operates in batteryless mode
- Optional controller microprocessor and datalogger packs
- Battery fuse disconnect panel
- Optional boost/off-line equalize charging for batteries

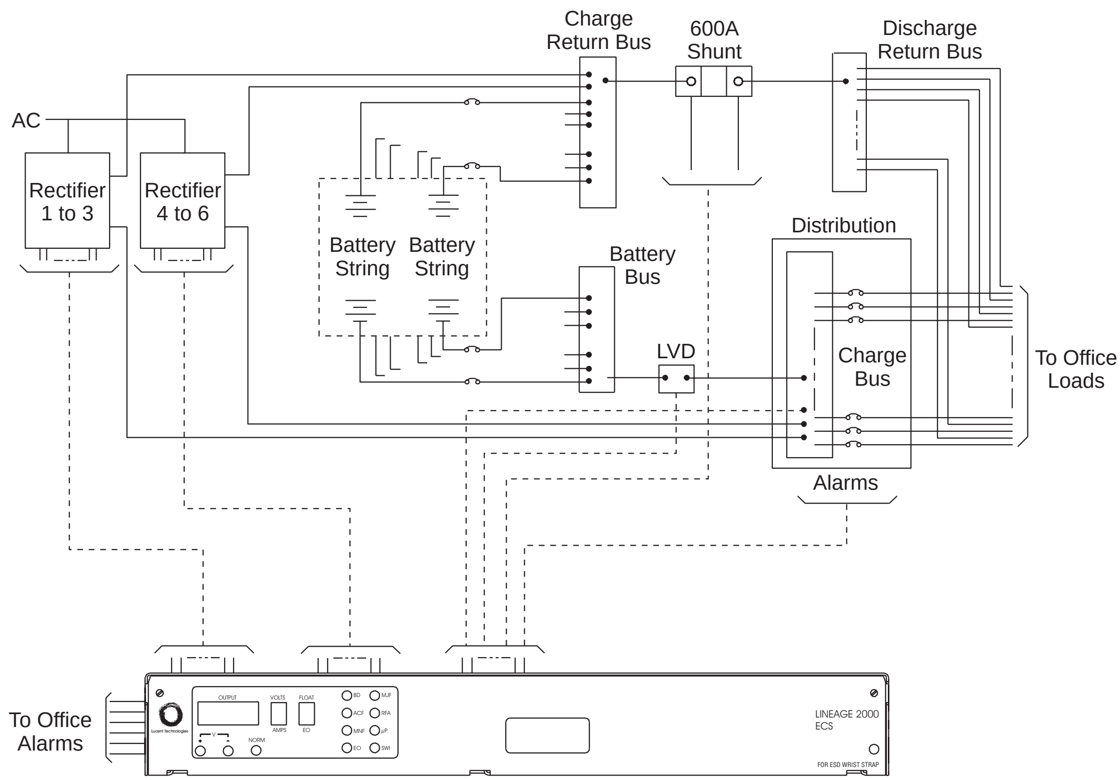


Figure 2-1: Block Diagram of a Typical Battery Plant

Typical Battery Plant Description

A basic block diagram of a typical battery plant is shown in Figure 2-1. The plant accepts alternating current from the commercial utility or a standby ac power source and rectifies it to produce dc power for the using equipment. Control and alarm functions are provided by the plant to interact with the rectifiers and the office. In addition, the plant provides overcurrent protection, charge, discharge, and distribution facilities. Battery reserve automatically provides a source of dc power if the commercial or standby ac fails. This battery reserve is engineered to supply dc power for a specific period of time. In normal practice battery capacity is sized to provide three to eight hours of reserve time.

The subsystems of a typical battery plant are defined as follows:

AC Distribution connects the commercial and/or standby ac power sources to the rectifiers within the plant and provides overcurrent protection.

Rectifiers convert an ac source voltage into the dc voltage level required to charge and float the batteries and to power the using equipment.

Controller provides the local and remote control, monitoring, and diagnostic functions required to administer the battery plant.

Batteries provide energy storage for an uninterrupted power feed to the using equipment during loss of ac input or rectifier failure.

DC Distribution provides overcurrent protection, connection points for the using equipment, and bus bars to interconnect the rectifiers, batteries, plant shunt and dc distribution.

Global Power System Description

The Global Power System Model J85500L-1 rectifier cabinet, shown in Figure 2-2, provides power for the using equipment, as well as float and recharge capability for the battery reserve. The plant operates from a nominal 208/240Vac, 50/60Hz source. Nominal dc output is 48 volts with a 600-ampere total system capacity. The Global Power System's modular design facilitates installation and growth by using a basic building block approach to solving the power needs of telecommunication customers around the world.

Rectifier Cabinet

The rectifier cabinet accommodates up to twelve Lineage® 2000 SR series 48-volt, 50-ampere rectifiers, a Lineage® 2000 ECS controller, dc fuse distribution panels, ac circuit breaker box, battery fuse disconnect panel, and a low voltage disconnect/reconnect feature. The ac circuit breaker box is located at the top of the cabinet, followed by space for three customer selected modules, which might include either additional rectifier shelves, dc distribution panels, or the battery fuse disconnect panel. The ECS controller and two rectifier shelves are located in the bottom portion of the cabinet. Connections to the charge/discharge bus bars are made at the top of the cabinet behind the ac circuit breaker box.

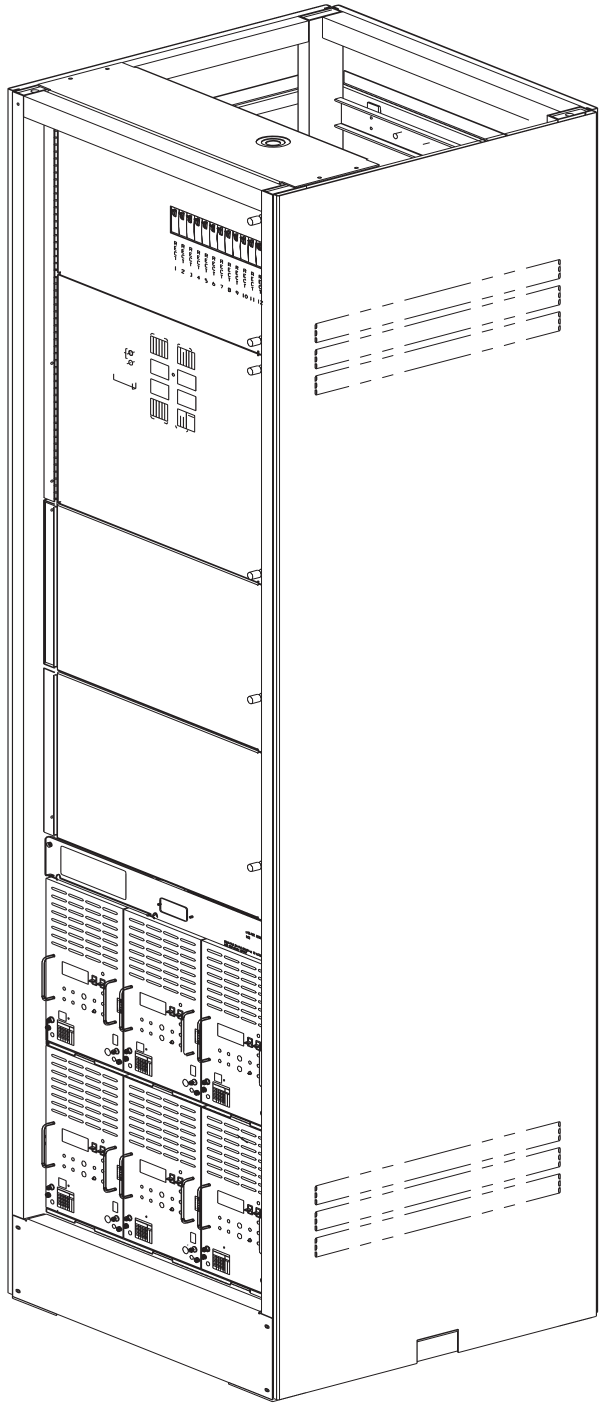


Figure 2-2: Global Power System J85500L-1 Rectifier Cabinet

Supplemental Cabinet

The supplemental distribution cabinet, shown in Figure 2-2A, can accommodate one battery disconnect panel or one off-line equalize panel (which includes one battery disconnect panel, battery contactor switches, switch panel, and one boost/equalize controller), and up to three fuse panels. It is connected to the rectifier cabinet via an internal horizontal bus.

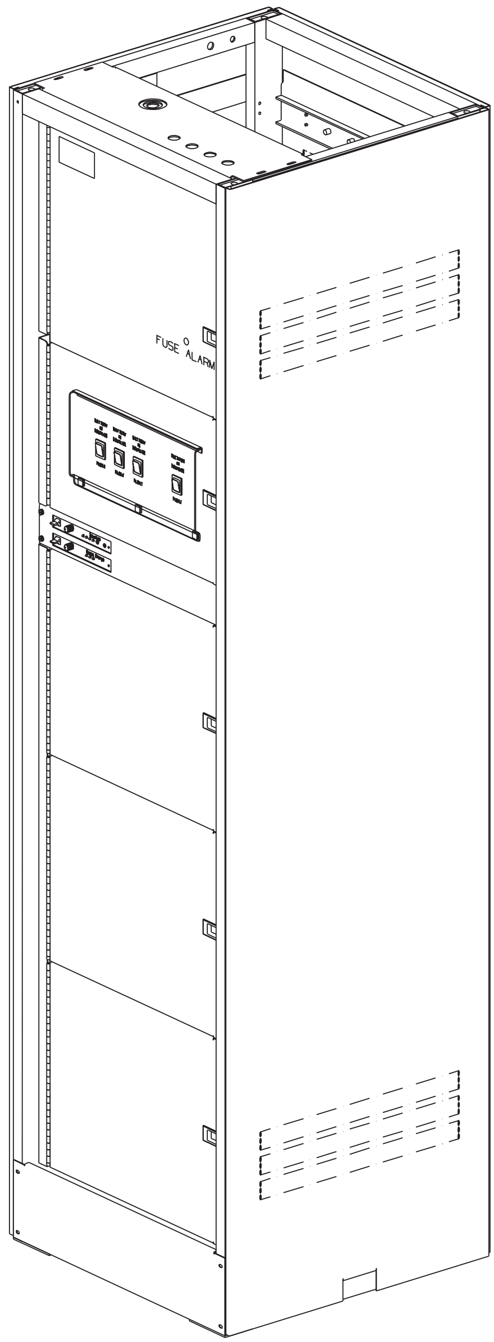


Figure 2-2A: Global Power System J85500L-1 Supplemental Cabinet

Global Power System Modules

The following paragraphs provide descriptions of the Global Power System modules.

Rectifier

The Lineage® 2000 SR series 50-ampere, -48-volt rectifier converts commercial 50/60 Hz ac input power into highly regulated and filtered, low-noise, -48-volt dc output power for telecommunications equipment loads. This rectifier incorporates a 70 kHz switching frequency, advanced technology, and forced-air cooling to achieve high power density and a light weight of 11.3 kilograms.

The rectifiers are plugged into a Rectifier Shelf Assembly (RSA), as shown in Figure 2-3. All interconnections between the rectifier, controller, and distribution are completed through the RSA. The plug-in design of the rectifiers reduces installation time to minutes, permitting easy growth and maintenance without service interruption. Signals from the three rectifiers are routed to the ECS controller via a ribbon cable. The various monitoring and alarm signals generated by the rectifiers are sent to the ECS controller for processing. The controller generates local or remote alarms and/or sends control signals back to the rectifier. See Figure 2-4 for a typical signal flow between a rectifier and the ECS controller. Rectifier and controller interface cables are installed for each of the four potential rectifier shelves in the cabinet. When rectifiers shelves are added in the field, the controller link is ready to go.

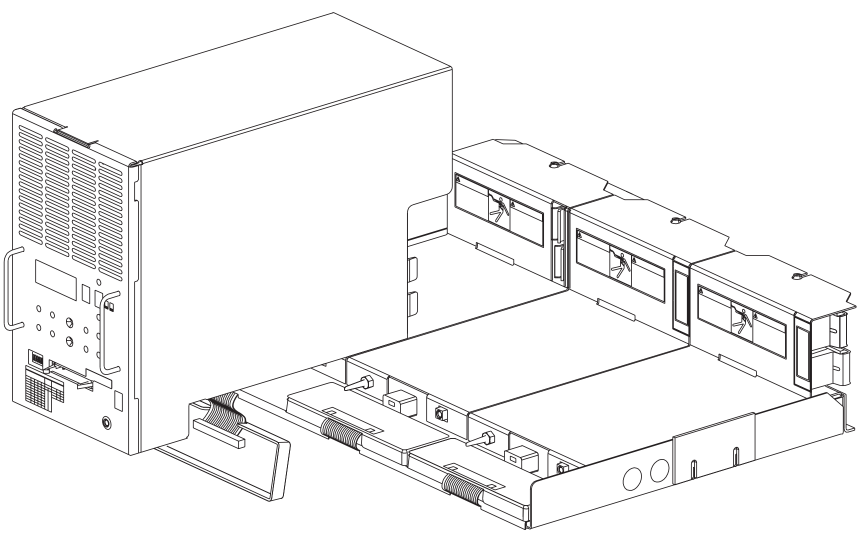


Figure 2-3: Rectifier and Rectifier Shelf Assembly

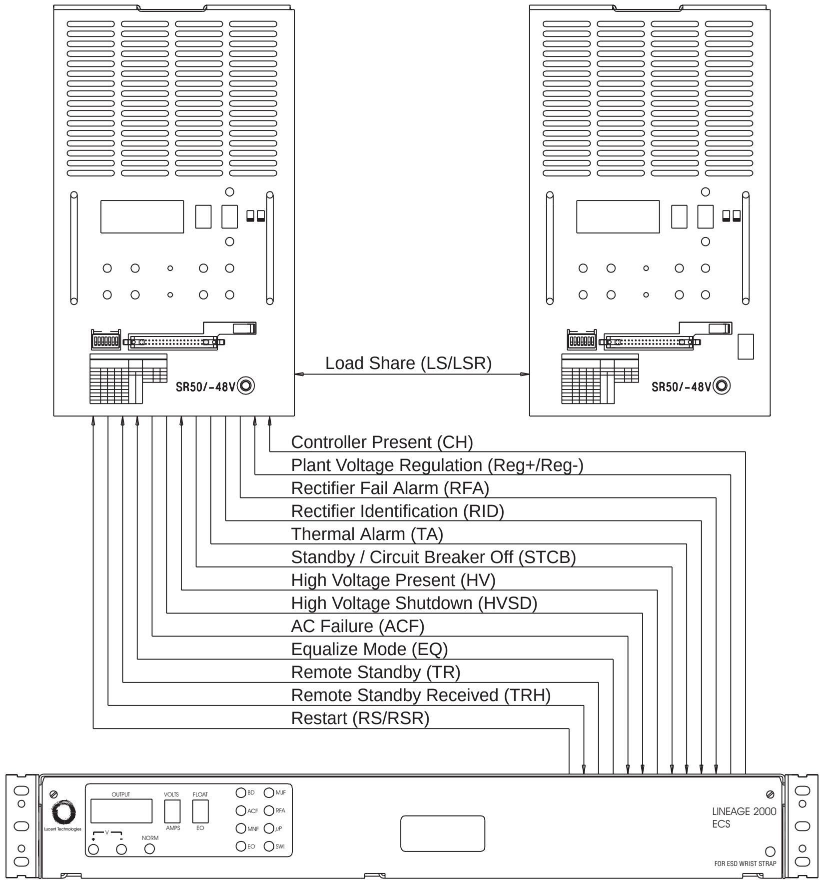


Figure 2-4: Typical Signal Flow Between Rectifiers and Controller

Rectifier Features

Some rectifier features, described in the following paragraphs, require customer interface. Refer to the rectifier product manual for additional information on the shelf and rectifier.

High Voltage Shutdown: If the plant voltage is too high, the controller will signal all of the operating rectifiers that a high voltage is present. The rectifier(s) causing the overvoltage will shut down. The remaining rectifiers will continue operation. This high voltage level is a user-selectable setting on the controller.

The rectifier has two additional high voltage settings of its own that are also user-selectable DIP switch settings on the front of the rectifier. These are Internal Selective High Voltage Shutdown, which is disabled when the ECS controller is present, and Backup High Voltage Shutdown. This fail-safe redundancy should be set higher than the controller setting. This circuit prevents damage to the rectifier and its loads in the event of a high-voltage condition. The rectifier monitors its output voltage and shuts down when this voltage exceeds a user-selected threshold. Figure 2-5 lists DIP switch settings for the rectifier. This information is also silkscreened on the front of each rectifier. The factory setting is 57.0 volts for internal selective high-voltage shutdown and 59.5 volts for backup high-voltage shutdown.

DIP SWITCH SW701 SETTINGS									
INTERNAL SELECT HVSD					LOAD SHARE		BACK-UP HVSD		
VOLTS	1	2	3	4	5		VOLTS	6	7
50.0	1	1	1	1	1	0	54.5	1	1
51.0	1	1	1	0			57.0	1	0
52.0	1	1	0	1	ENABLED	DISABLED	59.5	0	0
53.0	1	1	0	0					
54.0	1	0	1	1					
55.0	1	0	1	0					
56.0	1	0	0	1					
57.0	1	0	0	0					
58.0	0	1	1	1					

Figure 2-5: Rectifier DIP Switch Settings

Load Share: Another DIP switch selectable option enables the rectifier to share the plant load automatically with other rectifiers. The load share circuit is fail-safe using an isolated load share bus between the rectifiers. Upon failure, the failed rectifier is disconnected from the load share bus. The load share feature can be enabled or disabled with the DIP switch on the front of the rectifier. Set it according to Figure 2-5. The factory setting is enabled.

Note

> The CB OFF indicator must be lit and the DC OUTPUT breaker in the OFF position to adjust the output of the rectifiers correctly in the load share mode. (See Figure 2-6.)

Equalize: The rectifier, in conjunction with the ECS controller, can charge batteries at higher voltages than the float voltage. A separate potentiometer allows the equalize voltage to be set independently of the float voltage. A front-panel LED indicates when the rectifier is in equalize mode.

Rectifier Test: A front panel switch is provided for automatically raising or lowering the output voltage of the rectifiers a small amount to test operation.

Lamp Test: This circuit allows the front panel display and LEDs to be tested. When the unit is in STBY and the NL/FL switch is pressed in either direction, all front panel LEDs and meter segments will activate.

RFA (Rectifier Failure Alarm) Indicator: An RFA alarm provides both a local and visual indication of failure and a signal to the controller. An RFA is generated by the following:

- high voltage shutdown
- thermal alarm
- rectifier fuse alarm or circuit breaker overcurrent operation

AC Fail Alarm: An ac input voltage of less than approximately 170 Vrms causes an alarm to be issued to the controller.

Transfer (TR): The rectifier may be placed in the standby mode by an externally generated signal. The rectifier will remain in the standby mode until the removal of that signal.

Thermal Alarm (TA): The rectifier is fan cooled to increase its reliability. High temperatures caused by fan failure or other conditions cause a thermal alarm to be issued.

DC Output Breaker: A circuit breaker is provided to protect the rectifier from malfunction and overcurrent. It may also be used to disconnect the rectifier from the battery.

Test Jacks: Two sets of test jacks are provided. One set measures the plant voltage at the remote regulation sense point. The other set measures the voltage internal to the rectifier before the dc output circuit breaker. When the circuit breaker is open and the rectifier is on but disconnected from the local bus, the rectifier output voltage can be adjusted without affecting the plant voltage.

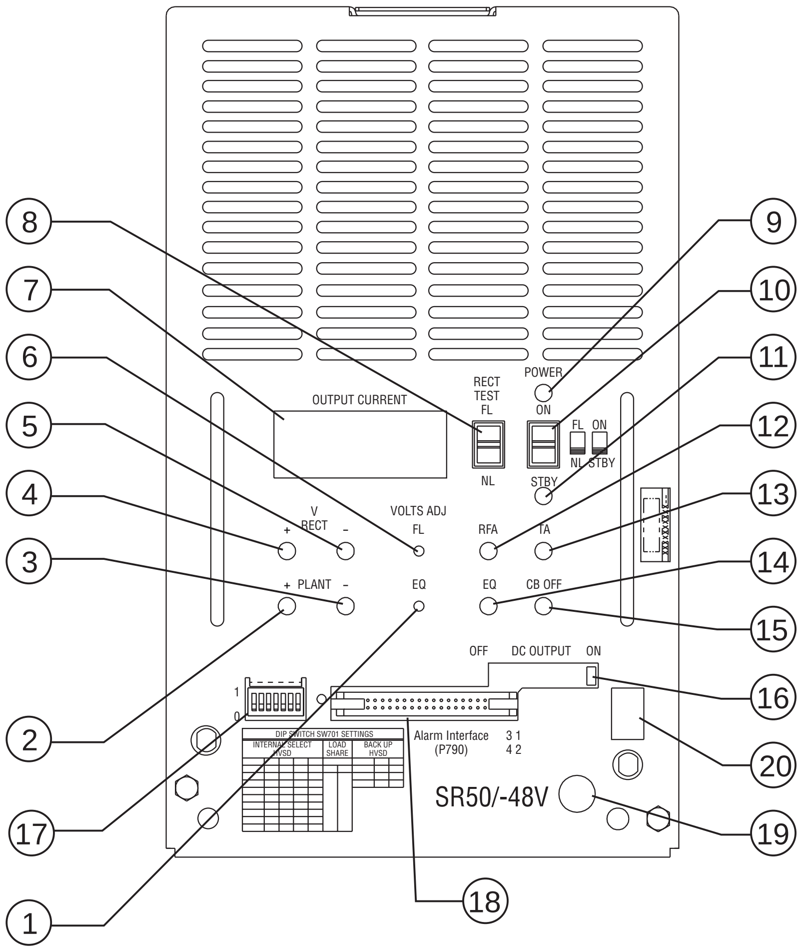


Figure 2-6: Rectifier Front Panel Location of Operating Controls and Displays

Operating Controls and Displays: The rectifier front panel controls, switches, indicators display, and connectors are shown in Figure 2-6. Each item is identified by an index number. The function of each item is described in Table 2-C.

Table 2-C: Rectifier Operating Controls and Displays

1	VOLTS ADJ - EQ	A screwdriver-adjustable recessed potentiometer used during equalize mode to set rectifier output voltage. The range of control is between 50 and 58 volts.
2, 3	V-PLANT Test Jacks	Jacks are used to measure the plant voltage at the remote sense point.
4, 5	V-RECT Test Jacks	Jacks are used to measure the rectifier internal sense point voltage.
6	VOLTS ADJ - FL	A screwdriver-adjustable recessed potentiometer adjustment used during float mode to set rectifier output voltage. The range of control is between 48 and 58 volts.
7	OUTPUT CURRENT	A three-digit, backlit, LCD ammeter used to display the value of current during operation. Its accuracy is ± 0.5%.
8	RECT TEST	This switch provides a manual test of the rectifier regulation by simulating a full load or no load condition on the output (momentary up or down operation of switch selects either FL or NL position). When the switch is in the center position, the rectifier is in the normal operating state. This switch also provides for a lamp test of all front panel LEDs and displays (when the POWER ON/STBY switch is in the STBY position, momentary up or down operation of the switch initiates lamp test).
9	POWER ON	This green LED is lit when the rectifier is operating normally and in the float, equalize, or adjust modes.

Table 2-C: Rectifier Operating Controls and Displays

10	POWER ON/STBY	This switch manually turns the rectifier on or into standby. When the switch is in the STBY position, the rectifier cannot be turned on by the plant controller. When in the ON position, the rectifier may be turned on or off remotely via the OTR leads. The POWER ON LED will be extinguished when the rectifier is turned off manually or remotely.
11	STBY	This yellow LED is lit when the rectifier is in the standby mode. In this mode, ac voltage is present in the rectifier providing power to the rectifier logic; however, it is electronically prevented from producing output power. The rectifier can be put into standby either locally, using the POWER ON/STBY switch, or remotely through the use of a controller.
12	RFA	This red LED provides indication of a rectifier shutdown due to a high output voltage condition, internal fuse, and/or output circuit breaker overcurrent event or inadequate air flow.
13	TA	This red LED lights when the rectifier has shut down due to inadequate air flow, indicating possible blockage, fan failure, or inlet air temperature above 122 degrees Fahrenheit (50 degrees Celsius).
14	EQ	This yellow LED provides a visual indication that the rectifier is in equalize mode.
15	CB OFF	This yellow LED provides a visible indication that the output circuit breaker is open.
16	DC OUTPUT	Circuit breaker used to disconnect the rectifier from the output bus for test purposes. It also protects the plant from rectifier malfunction and overcurrent conditions. When the circuit breaker is in the OFF position, the yellow CB OFF LED indicator is lit and an alarm is sent to the controller.

Table 2-C: Rectifier Operating Controls and Displays

17	DIP Switches	Used to set the rectifier internal selective high voltage shutdown level (Switches 1-4), to enable/disable the load share function (Switch 5), and to set back-up high-voltage shutdown level (Switches 6 and 7).
18	Interface Connector	Thirty-four (34) pin keyed connector provides interface between the rectifier and the controller via an RSA ribbon cable.
19	Mounting Screw	5 mm hex screw used to secure the rectifier to the RSA. An insulated Allen wrench is furnished for rectifier installation. **Note: The screw is accessible only with DC OUTPUT circuit breaker in the OFF position.**
20	Test Connector	A ten-pin keyed factory test connector. **Note: This is a factory test connector and is not used during field maintenance. Improper use of this connector can result in rectifier damage.**

Shipping and Receiving Rectifiers

Rectifiers are ordered separately from the cabinet as J85500L-1 List 4. They are packaged individually and shipped in foam-filled cartons. The carton dimensions are approximately 457 mm by 533 mm by 330 mm. Section 5, "Installing a Rectifier," describes the installation and start-up procedure for a rectifier.

Rectifier Shelf Assemblies (RSAs) are usually factory installed. They may also be field installed by ordering J85500L-1 List 3 as a separate item from the cabinet. Refer to Section 3, *Ordering*. In this case, each RSA is shipped in a separate container with all the mounting hardware needed to install it in the cabinet. Section 5, "Adding an RSA to an Operating Plant," describes the set-up and installation procedures for an RSA.

Controller Basic Configuration and Options

The ECS controller performs the centralized monitoring, control, and reporting functions for the battery plant. The basic ECS controller can monitor and control up to twelve rectifiers. It also provides a single interface point for power alarm and status reporting.

A block diagram of the controller is shown in Figure 2-7. The basic configuration of the controller consists of the 113B analog control unit plugged into a backplane, with expansion slots for the optional microprocessor and datalogger circuit modules. The required fuse board is located outside the controller.

The 113B Control Unit consists of two circuit packs, the control board (CP1) and the display board (CP4). Switch and jumper locations on CP1 are shown in Figure 2-9.

The optional microprocessor board (CP2) is equipped with a powerful 16-bit microprocessor. It adds sophisticated firmware features such as remote communications, alarm history, and statistics. This board is available as List 5 or 7 on J85500L-1. List 7 is the same as List 5, but with the addition of a voice response feature.

The optional datalogger board (CP3) is used in conjunction with the microprocessor option to provide general purpose ac and dc voltage, current and transducer monitoring, and relay control. This board is available as List 8 on J85500L-1.

The required fuse board (CP5) provides fusing for the controller and rectifier sense leads, and also provides a low voltage detection circuit for monitoring the optional low voltage disconnect/reconnect contactor. The CP5 Fuse Board will be discussed in detail in a later paragraph.

Figure 2-8 is a top view of the ECS controller. The chassis is equipped with a rectifier multiplexing circuit pack (BCC1) and the standard analog control unit (113B Control Unit) plugged into a backplane, with expansion slots for two optional circuit packs.

For additional information on the optional microprocessor controller board (CP2), datalogger board (CP3), and voice response option, refer to the ECS Controller Options Product Manual, 167-790-109.

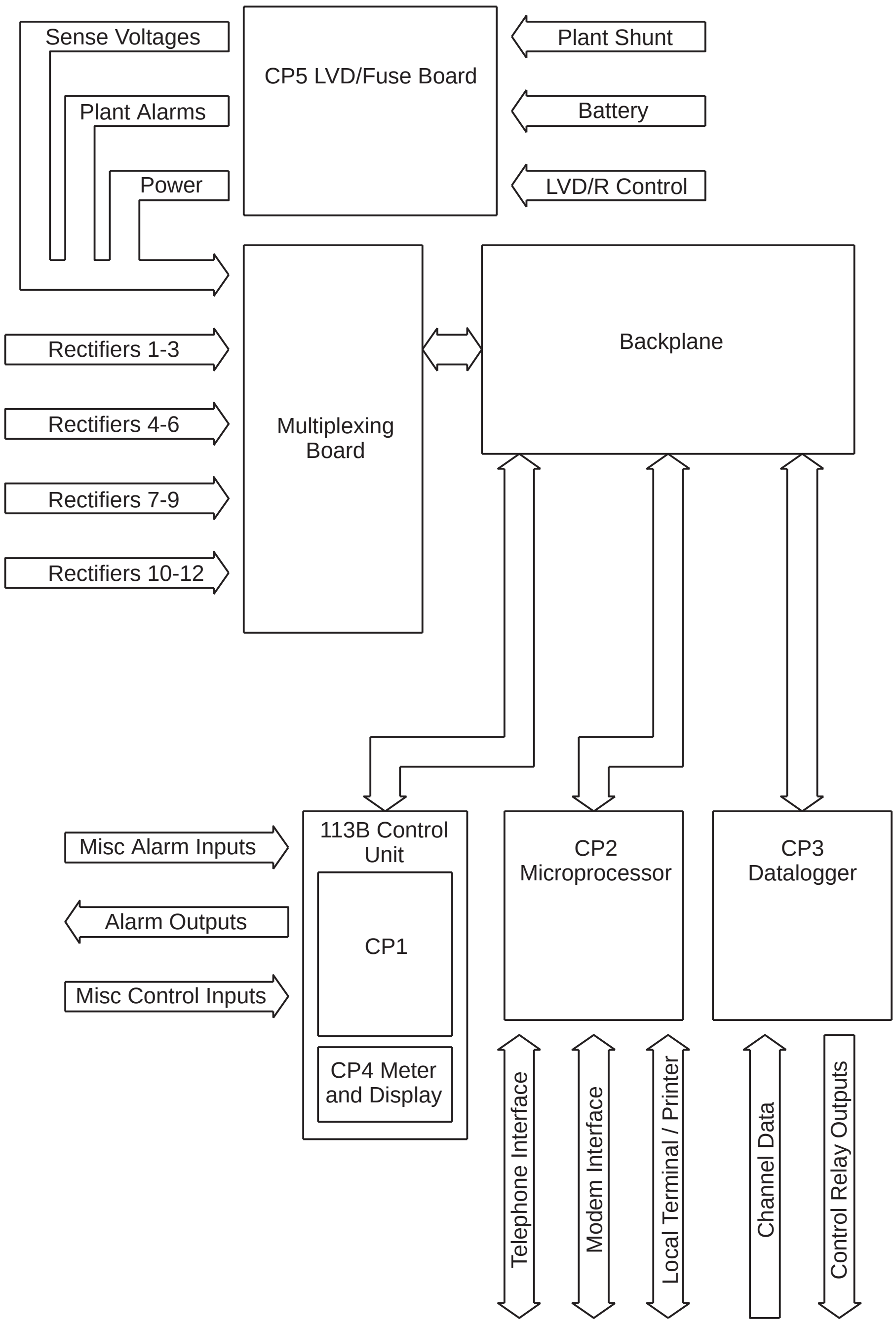


Figure 2-7: ECS Controller Block Diagram

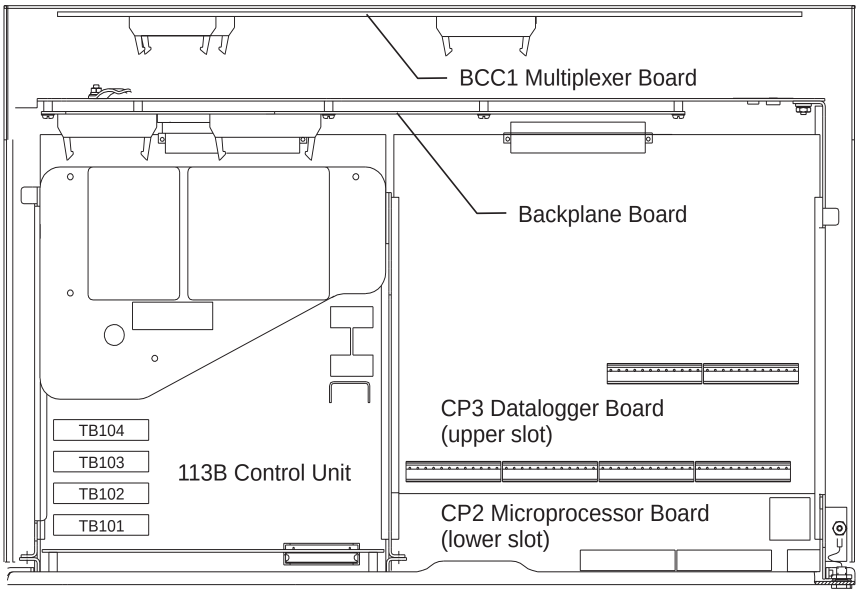


Figure 2-8: Top View of ECS Controller

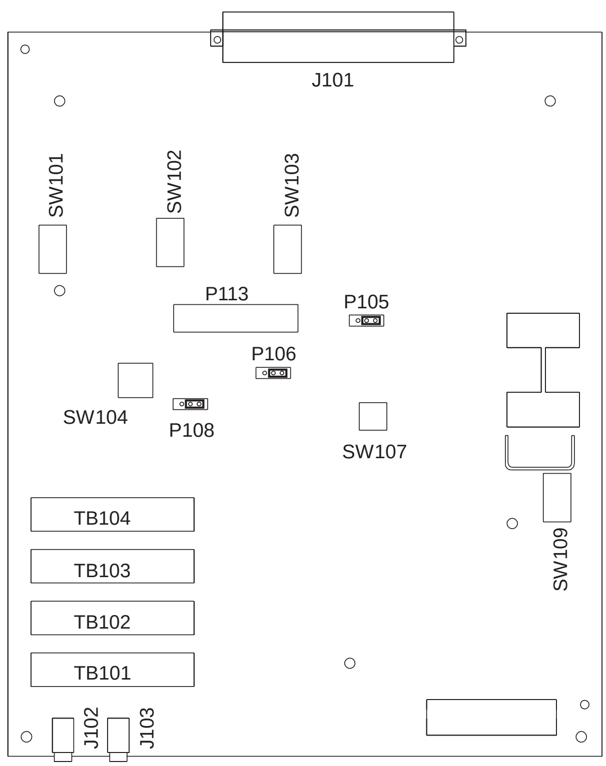


Figure 2-9: CP1 Jumper and Switch Locations

Controller Functions

The controller equipped with the rectifier multiplexing circuit pack and the 113B Control Unit performs the traditional analog control functions described in the paragraphs that follow:

Operating Voltage: The controller is powered by the plant dc voltage and may be used in 24V or 48V plants. It may be powered from either positive ground systems (e.g., -48V) or negative ground systems (e.g., +24V). Movable jumpers located on the backplane are positioned according to the plant voltage. These jumpers are factory set for 48 volts.

Batteryless Operation: The ECS controller is suitable for telecommunications power plants with or without batteries. In batteryless plants, the loss of ac power causes an immediate loss of dc power to the controller. When ac power is restored, the ECS controller, in an unpowered state, allows the rectifiers to automatically restart.

Important

> When the controller loses power, it also loses the ability to detect alarm conditions in the plant. To prevent the danger of unreported alarms, all power major and power minor alarms are automatically issued when the controller is powered down.

Rectifier Sense Leads: Separately fused sense leads run from the external fuse board (CP5) to the rectifiers via the rectifier multiplexing circuit pack (BCC1). These leads are not interrupted when the 113B Control Unit is removed. The rectifiers use the sense leads to maintain the plant bus voltage independent of any load-dependent voltage drop between their output terminals and the bus.

Office Alarm Contacts and Alarm Battery Supply: Alarm contacts are provided on the 113B Control Unit that may be connected to the office alarm system by the installer. Each set of contacts is a Form-C or transfer-type; i.e., a combination of normally open and normally closed contacts with one side of each in common. The normally open contact is referred to as O (other applications may call this the NO contact), the normally closed contact is referred to as C (other applications may call this the NC contact), and the common or return contact is referred to as R (other applications may call this the C contact). Each

Form-C set is isolated. An alarm set is provided for each type of alarm condition, as follows:

– AC Failure (ACF)
– Major Fuse Failure (MJF)
– Minor Fuse Failure (MNF)
– High Voltage (HV)
– Battery on Discharge (low voltage) (BD)
– Low Voltage Battery Disconnect (LV)

In addition, alarms that are classified as Major or Minor cause a group of general-purpose major or minor alarms, as follows:

– Power Major - Visible (PMJV)
– Power Major - Audible (PMJA)
– Power Major - External (PMJE)
– Power Minor - Visible (PMNV)
– Power Minor - Audible (PMNA)
– Power Minor - External (PMNE)

The alarm state is the “normal” state; i.e., when an alarm condition exists, a closure exists between the “C” and “R” poles and an open exists between the “O” and “R” poles.

Each set of contacts can be in the non-alarm state only when the control unit is powered and the corresponding alarm is not present. When an alarm occurs or when the control unit loses power, each closed pair of contacts opens and each open pair of contacts closes. Terminal blocks TB102, TB103, and TB104 are assigned to the various alarm outputs. Refer to Table 5-C for a list of terminal block pin assignments.

Alarm Battery Supply (ABS) and a ground return are available on one of the terminal blocks (TB101). These pins may be wired by the installer to one or more alarms on the terminal blocks to drive alarm lamps, buzzers, or remote relays in the office alarm system. ABS is the same voltage as the plant bus voltage and is separately fused on the external fuse board.

Adjustable Battery on Discharge Alarm: If rectifier output is insufficient to supply the load current for any reason (such as an ac power failure), the battery reserve will provide the necessary current. Such a battery discharge can be detected by a drop in the plant bus voltage. Whenever the plant voltage drops below a preselected threshold, the controller issues a Battery on Discharge alarm (BD) and lights a red LED on the controller front panel. This alarm threshold is typically set to indicate the onset of battery discharge to allow enough time for maintenance personnel to respond before battery reserve is exhausted. When a BD alarm occurs, service is not usually affected immediately. However, since attention is required in a limited time, BD is considered a MAJOR alarm. Therefore, all three Power Major alarm groups are issued to the office alarm system when a BD occurs.

It should be noted here that a BD alarm does not necessarily indicate that rectifier output current has been lost or reduced. A BD alarm can be caused by misadjusted rectifier output voltage during otherwise normal operation. It can also be caused by current overload on normally functioning rectifiers.

The voltage threshold for the BD alarm is selected by the user by setting a group of DIP switches on the 113B Control Unit. The setpoint is typically at least 1 volt below the plant float voltage for nominal 48-volt plant systems. This threshold avoids nuisance alarms due to component tolerances, variations in load, and other transient conditions.

The actual BD threshold settings that may be selected are listed on a label on the controller. Figure 2-10 is a replication of the label. The range of available settings is based on the most common battery float voltage for 24-volt and 48-volt systems.

Adjustable Selective High Voltage Shutdown: The controller is equipped to detect a high voltage condition on the plant bus. Such a high voltage condition is typically caused by lightning-induced transients on the commercial ac power lines. A rectifier failure might, however, cause an individual rectifier to increase its output voltage. To prevent high voltage from damaging the connected telecommunications load, the controller will shut down rectifiers that deliver high voltage power.

When the controller detects an increase in the plant voltage above a preset threshold, it immediately issues an HV alarm to the external alarm system. HV is considered a MAJOR alarm, so all Power Major alarm groups are also issued.

When reporting the alarm, the controller simultaneously sends a shutdown signal to all rectifiers. Since the outputs of all rectifiers are paralleled in the plant, their output voltages are forced to be the same. Their output currents, however, may vary widely. In a high-voltage condition caused by an individual rectifier failure, the failed rectifier will be supplying more current than any other rectifier. When the high voltage shutdown signal is sent by the controller, the rectifier supplying the most current (i.e., the failed rectifier) will shut down, causing the plant voltage to drop to normal and the HV alarm to retire. All other rectifiers will remain on. If a high-voltage condition exists without an individual rectifier failure (e.g., because of an incorrect setting of the HV-threshold DIP switches or lightning-induced high voltage) the rectifier with the highest output current will shut down, but the HV condition will remain. The rectifier with the highest output current of those remaining on will shut down next, but again the HV condition will remain. This will continue until all rectifiers have shut down. **Although it is a sequential shutdown of rectifiers, the timing is very fast and it will appear as if all rectifiers have shut down simultaneously**. The detection of the high-voltage condition and the sending of the shutdown signal are functions of the controller, while the selection of the rectifier with the highest output current for shutdown is a function of the rectifiers.

The high voltage shutdown threshold voltage should be set by the user to a prescribed margin above the plant float voltage. This margin is typically 1.5 volts for nominal 48-volt battery plants. Since voltage fluctuations are greater in batteryless plants, the shutdown margin is typically set at 3 volts above float in 48-volt batteryless plants. The actual threshold voltage is set with a group of DIP switches on the 113B Control Unit. DIP switches provide a visual verification of the shutdown set point at all times.

For plants configured with the float/equalize feature, a separate high voltage shutdown threshold is used when the plant is in equalize mode. A separate group of DIP switches are used to select the HV shutdown threshold for equalize mode. When the plant is switched from float to equalize, the equalize high voltage shutdown threshold becomes effective immediately. When the plant is switched from equalize to float, the equalize high-voltage shutdown threshold remains effective for 2-4 minutes, after which the float high-voltage shutdown threshold becomes effective. This delay is necessary to avoid nuisance HV alarms and shutdowns that would occur if the float threshold became effective while the battery voltage was slowly dropping from the equalize voltage to the float voltage. This feature is basically transparent in normal plant operation, but could be misinterpreted as a failure in the HV detection circuit if not taken into account during acceptance testing or troubleshooting.

The available threshold settings correspond with the range of float and equalize voltages that might be encountered in nominal 24-volt and 48-volt applications. A listing of the actual settings appears in Figure 2-10 and on a label on the controller itself.

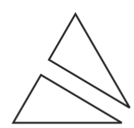
The high voltage alarm contacts can be tested by pressing switch SW104 (see Figure 2-9 for location). When SW104 is pressed, the HV, PMJA, PMJE, and PMJV alarms on the office alarm terminal blocks are activated, the NORMAL LED on the front panel is extinguished, and HV is sent to the CP2 Microprocessor Option Board if the controller is so equipped. The alarm remains as long as the switch is held, and normal operation resumes when the switch is released. This test switch does NOT send an HV signal to the rectifiers, so no rectifiers will be shut down and the rectifier restart signal will NOT be issued.

CP1 DIP SWITCH SETTINGS

VOLTS						SWITCH POSITION (0 = OPEN, 1 = CLOSED)						
SW 101– HV/EQ		SW 102– HV/FL		SW 103– BD		–1	–2	–3	–4	–5	–6	
24V	48V	24V	48V	24V	48V						24V	48V
	51.00		49.00	23.00	46.00	1	1	1	1	1	1	0
	51.50		49.50	23.50	46.50	0	1	1	1	1	1	0
25.75	52.00	24.75	50.00	24.00	47.00	1	0	1	1	1	1	0
26.25	52.50	25.25	50.50	24.50	47.50	0	0	1	1	1	1	0
26.75	53.00	25.75	51.00	25.00	48.00	1	1	0	1	1	1	0
27.25	53.50	26.25	51.50	25.50	48.50	0	1	0	1	1	1	0
27.75	54.00	26.75	52.00	26.00	49.00	1	0	0	1	1	1	0
28.25	54.50	27.25	52.50	26.50	49.50	0	0	0	1	1	1	0
28.75	55.00	27.75	53.00	27.00	50.00	1	1	1	0	1	1	0
29.25	55.50	28.25	53.50	27.50	50.50	0	1	1	0	1	1	0
29.75	56.00	28.75	54.00	28.00	51.00	1	0	1	0	1	1	0
30.25	56.50	29.25	54.50	28.50	51.50	0	0	1	0	1	1	0
30.75	57.00	29.75	55.00		52.00	1	1	0	0	1	1	0
	57.50		55.50		52.50	0	1	0	0	1	1	0
	58.00		56.00		53.00	1	0	0	0	1	1	0
	58.50		56.50		53.50	0	0	0	0	1	1	0
	59.00		57.00		54.00	1	1	1	1	0	1	0
	59.50		57.50		54.50	0	1	1	1	0	1	0
	60.00		58.00		55.00	1	0	1	1	0	1	0
			58.50		55.50	0	0	1	1	0	1	0
			59.00		56.00	1	1	0	1	0	1	0
			59.50		56.50	0	1	0	1	0	1	0
			60.00		57.00	1	0	0	1	0	1	0
					57.50	0	0	0	1	0	1	0

AMPERES			SWITCH POSITION					
SW 109 – METER SHUNT								
25mV	50mV	100mV	–1	–2	–3	–4	–5	–6
150 A	300 A	600 A	1	0	0	0	1	1
300 A	600 A	N/A	1	0	0	0	0	0
600 A	1200 A	2400	0	1	0	0	0	0
1000 A	2000 A	4000 A	0	0	1	0	1	1
1300 A	2600 A	5200 A	0	0	0	1	0	0
2000 A	4000 A	8000 A	0	0	1	0	0	0
3000 A	6000 A	N/A	1	0	0	0	0	0
4000 A	8000 A	N/A	0	0	0	0	0	0

* ECS BATTERY PLANTS USE A 50mV Shunt



CAUTION

THIS PRODUCT CONTAINS ELECTROSTATIC SENSITIVE DEVICES. INSTALLATION AND MAINTENANCE PERSONNEL SHALL USE AN ESD GROUND STRAP TO PREVENT DAMAGE.

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Figure 2-10: Controller DIP Switch Settings

Automatic Rectifier Restart: A high voltage shutdown from the controller is typically followed by an automatic restart signal. When the controller detects that one or more rectifiers have responded to its HV signal by shutting down, there is a 3- to 5-second delay, after which the controller issues a restart signal to all rectifiers. Rectifiers that have shut down may or may not respond to the restart signal, depending on the nature of the failure.

The restart signal consists of two sets of clean contact closures. One set of closures is connected to rectifiers 1, 2, 3, 7, 8, and 9. The other set is connected to rectifiers 4, 5, 6, 10, 11, and 12. In this way, different types of rectifiers with restart circuits that are otherwise incompatible may be combined (in groups of six) in one plant. Different rectifier types may not be mixed within one group of six rectifiers.

After the controller issues the restart closures, they stay in effect for the next 4 to 6 minutes and then they reopen. The controller does not issue a new restart signal in response to any additional high voltage events in that 4- to 6-minute period. The timeout period is intended to prevent multiple shutdown/restart cycles during heavy lightning storms, which would otherwise stress the power equipment.

Rectifiers that have not shut down are not affected by the restart signal from the controller and continue to run normally. Rectifiers that have restarted in response to the signal will resume normal operation unless lightning activity continues or unless they are actually faulty units. In either case, if the plant voltage goes high again during the 4- to 6-minute timeout, the shutdown signal (see previous section) will be reissued but will not be followed by an automatic restart.

The 4- to 6-minute timer may be reset manually before it times out by pressing switch SW107 (see Figure 2-9 for location). This may be desirable during testing of the restart circuit. See also Section 5, “Acceptance Testing.” The timer will also reset and a restart will be issued if the controller loses power for any reason (e.g., if controller fuses are removed).

The automatic restart function may be disabled by the user or installer by moving a jumper strap on the basic controller. (See Section 5, “Hardware Setup,” for this procedure.) This function should be disabled for batteryless plants equipped with only one rectifier. In such an application, the controller loses power if the rectifier is shut down and, in the process, issues a restart. If the one rectifier shuts down again, the cycle will repeat, since the controller will again lose power. To prevent a possibly infinite cycle of shutdown and restart, the automatic restart function should be disabled for batteryless plants with only one rectifier.

Rectifier Fail Alarm: Whenever a rectifier fail signal is received by the controller from any rectifier, the controller issues a rectifier fail alarm (RFA) to the office alarm system and a yellow LED lights on the controller front panel.

A loss of one or more rectifiers is not necessarily an emergency unless the plant voltage starts to drop and the batteries begin to discharge. Rectifier Fail is, therefore, treated as a MINOR alarm by the controller, which issues all three sets of Power Minor office alarms in addition to the separate RFA alarm. If loss of rectifier output causes the plant voltage to drop significantly, a BD alarm is issued, which is a MAJOR alarm condition.

If a failed rectifier is successfully restarted, either manually or automatically, or if it disconnected from the controller interface, the RFA LED will extinguish and the associated alarms will retire.

AC Fail Alarm: The AC Fail Alarm is intended to indicate that ac input power to at least one rectifier has disappeared or has dropped below a minimum voltage. This alarm is provided as an isolated transfer contact for the office alarm systems. An ACF alarm also lights a yellow LED on the front panel of the controller.

Since users may classify the loss of ac power as either a major or a minor alarm condition, ACF does not automatically result in a Power Major or Power Minor alarm. The user or installer may hardwire parallel the ACF alarm to the desired Power Alarm to give loss of ac the proper priority. See Section 5 for alarm wiring details.

Major and Minor Fuse Alarms: The controller monitors all fuse and circuit breaker protection devices in the plant for operation. Each blown fuse or tripped circuit breaker is classified as either a MAJOR or MINOR alarm. MAJOR fuses or circuit breakers protect service-affecting circuits, basic controller circuits, and alarm circuits that report major alarms. Loss of any other circuit protectors are treated as MINOR fuse alarms. Examples of MAJOR fuses include load fuses and the

Alarm Battery Supply (ABS) fuse. Rectifier regulation fuses, on the other hand, are MINOR fuses.

A red MJF LED on the controller front panel lights in the event of a Major Fuse Alarm. Similarly, a yellow MNF LED lights following a Minor Fuse Alarm. Fuse alarms cause the associated Power Major and Power Minor alarms to be issued to the office alarm system. In addition, separate Major Fuse Alarm and Minor Fuse Alarm transfer contacts are provided to the office alarm system. See Section 5 for alarm designations on terminal blocks TB102-TB104.

Open Battery String Protection and Alarm: In a plant equipped with battery string disconnects, the disconnect circuit breakers on each battery string may be wired to the controller to indicate when they are open. The open breaker signal occurs when a battery string breaker is tripped manually or electronically. The Open String alarm (OS) is passed as a separate alarm to CP2 (optional microprocessor controller board).

If the OS signal is wired directly to the controller alarm terminal blocks, it will generate a Minor Fuse Alarm whenever a battery string is open. Alternatively, OS may be hardwired to the auxiliary major fuse alarm input on the external fuse board.

Front Panel Status Indicators: Light-emitting diodes (LEDs) are located on the controller front panel to indicate the alarm status of the battery plant. Yellow LEDs indicate the following conditions, including (but not restricted to) Power MINOR alarms:

- Minor Fuse Alarm (MNF)
- Rectifier Fail (RFA)
- AC Fail (ACF)
- Equalize On (EQ)
- Microprocessor Alarm (See also ECS Controller Options Product Manual, 167-790-109)
- Datalogger Alarm (DLA) (See also ECS Controller Options Product Manual, 167-790-109)

Red LEDs indicate the following Power MAJOR alarms:

- Battery on Discharge (BD)
- Major Fuse Alarm (MJF)

When no alarms are present and the controller is powered, the green NORM LED lights to indicate normal operation. The Equalize LED (EQ) may light when the NORM LED is on, since equalize is not considered an alarm condition. See Section 5 for more information on the Equalize function.

Front Panel Meter: A four-digit, backlit liquid-crystal display is located on the front panel. A switch next to the display selects either the plant voltage or the plant load current to be shown. A calibration potentiometer (R407) is provided inside the controller for fine adjustment of the plant voltmeter. (See Section 5, “Meter Calibration,” for additional details.) When this switch is set in the AMPS position, the display indicates the plant load current in amperes. This current is measured with a calibrated shunt located in the dc distribution return bus.

The load current display has a total of four digits. For plant loads of 999A or less, such as the Global Power System, the jumper (P401) on the CP4 display board is factory set to display a decimal point (xxx.x).

Selectable Ammeter Scale: The controller has a selectable ammeter scale for monitoring the plant shunt of the battery plant. The ammeter scale for a particular plant shunt size is selected by DIP switch SW109 on the 113B Control Unit. Refer to Figure 2-9. The plant shunt in the Global Power System has a full scale rating of 50 millivolts at the maximum plant current rating of 600 amperes. SW109 is set by the factory for this shunt size.

Front Panel Test Jacks: Test points are provided on the front panel so that the plant voltage may be checked with the user's meter. However, the accuracy of the LCD voltmeter on the front panel, at 0.05%, is better than that available with most hand-held meters. The test points are current-limited against accidental short-circuits by test probes.

Rectifier Sequence Control Interface: When the battery plant's ac power is backed up by an engine alternator of limited capacity, it is often necessary to control the number of rectifiers on-line during a commercial ac outage. To avoid stalling the engine during start up or overloading it at steady-state, it may be necessary to turn off rectifiers temporarily until the engine comes up to speed. This operation of turning rectifiers off and back on during engine start up is called Rectifier Sequence Control.

The ECS controller may be connected to the four output signals TR1, TR2, TR3, and TR4 provided by a Rectifier Sequence Controller, such as Lucent Technologies Model J87339A-1. These signals are used to turn off rectifiers or groups of rectifiers.

Sequence control is typically part of the ac engine system rather than part of the dc battery plant system. The Rectifier Sequence Controller is often outside the battery plant and interfaces with the rectifiers through the battery plant controller.

The controller equipped with CP2 is capable of Rectifier Sequence Control without an external sequence controller. (See ECS Controller Options Product Manual, 167-790-109.)

The TR signal input to the controller may also be used for other on/off control of rectifiers by an external control device. (See ECS Controller Options Product Manual, 167-790-109.)

Float/Equalize Control: The rectifiers are capable of battery equalize charging in addition to normal float charging. The equalize feature may be used to recharge flooded-type (i.e., non-sealed) batteries after a discharge more quickly than with conventional float charging. Some battery manufacturers also recommend equalize charging to equalize cell voltages within a string after a discharge.

The controller has several methods of controlling the equalize function in plants that are so equipped.

Hardware Disable: A movable jumper strap on the 113B Control Unit may be used to disable the equalize function and lock the plant in float mode. This is especially important for plants equipped with sealed-type or valve-regulated batteries and for plants powering equipment sensitive to high voltages. Batteryless plants also have no need for the equalize function. The controller is always shipped with equalize disabled by this jumper to prevent accidental misapplication of the equalize feature. See Section 5, “Hardware Setup,” for details.

Local Manual Control: A momentary toggle switch on the controller front panel may be used to switch the rectifiers in the plant from float mode to equalize mode and back again. This control is disabled when equalize is hardware disabled with the jumper described above.

External Timer Panel: The 113B Control Unit may interface with an external equalize control panel. Since the basic controller with CP1 has no built-in on/off timer, CP1 may be connected to a timer panel to automatically terminate equalize without manual intervention (see Section 5). Note that this control method is overridden when equalize is hardware disabled.

Microprocessor Control: CP2 is equipped with a variety of software features for float/equalize control. These features are also disabled by the hardware strap on CP1. (See ECS Controller Options Product Manual, 167-790-109.)

The control methods may be used interchangeably. For example, the front panel switch may be used to initiate equalize, while an external timer may turn it off.

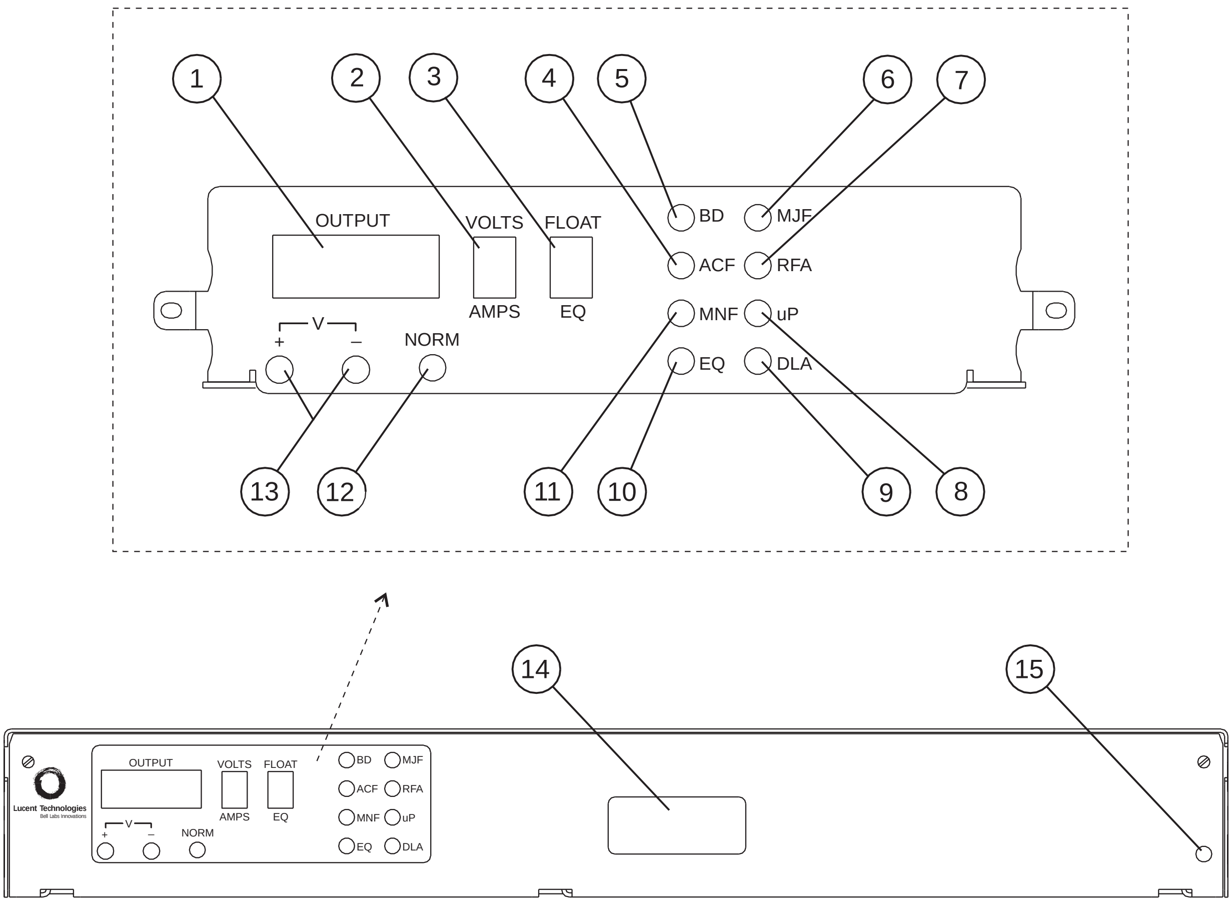


Figure 2-11: Controller Front Panel

Operating Controls and Displays: The controller front panel controls and displays are shown, as numbered and described in Table 2-D, in Figure 2-11.

Table 2-D: Controller Operating Controls and Displays

1	OUTPUT display	Four-digit LCD display shows the plant dc voltage or load dc current. (See 2.)
2	VOLTS AMPS switch	Two-position switch selects either plant dc voltage or load current for display.The switch may be left in either position. (See 1.)
3	FLOAT EQ switch	Three-position, momentary, center-off switch selects either float mode or equalize mode of rectifier operation.
4	ACF indicator	Yellow LED, when lit, indicates one or more rectifiers have reported a loss of AC input power. This may be treated as a major or minor alarm at the user's discretion.
5	BD indicator	Red LED, when lit, indicates the plant voltage is below the preset threshold.This is a MAJOR alarm condition.
6	MJF indicator	Red LED, when lit, indicates an overcurrent protector on a critical circuit has operated. Such protectors include load circuit breakers/fuses, some controller fuses, and may also include auxiliary devices such as battery disconnects. This is a MAJOR alarm condition.
7	RFA indicator	Yellow LED, when lit, indicates one or more rectifiers have failed for reasons other than loss of input ac power. This is a MINOR alarm condition.
8	µP indicator	Yellow LED lights under certain conditions dictated by the CP2 microprocessor board to indicate a microprocessor alarm.

Table 2-D: Controller Operating Controls and Displays

9	DLA indicator	Yellow Datalogger Alarm LED lights as an alarm indication whenever an alarm exists on one of the CP3 data channels.
10	EQ indicator	Yellow LED, when lit, indicates that plant is in equalize charge mode. This is not an alarm condition.
11	MNF indicator	Yellow LED, when lit, indicates that a non-critical overcurrent protector has operated. Such protectors include some controller fuses and may also include battery disconnect circuit breakers. This is a MINOR alarm condition.
12	NORM indicator	Green LED is lit whenever there are no alarms present to indicate normal operation. The only other LED that may be lit when the NORM LED is lit is the EQ indicator.
13	V+ and V- jacks	Test jacks are available for monitoring the plant charge bus voltage with an external meter.
14	Local terminal port	Opening in the front panel reserved for the local terminal port on the CP2 Microcomputer board.
15	ESD connector	Jack provided for electrostatic discharge grounding with a wrist strap. The operator should be grounded to this point before opening the controller front panel

CP5 Fuse Board

The CP5 Fuse Board provides fused power and voltage sense distribution for the ECS controller and rectifiers and low power distribution for customer applications. CP5 produces Major and Minor fuse alarms for the fuses on the board as well as the plant distribution and user selectable applications. It also provides a low voltage detection circuit that controls the optional low voltage battery disconnect/reconnect contactor.

The fuse board, coded A-CP/BCB2, contains six fuses for power and sense voltage distribution in the controller, twelve fuses for battery sense voltage to the regulation leads of the rectifiers, three fuses for user-defined low-power distribution, and three spare fuse holders. A twelve position terminal block is also available for connection to external major and minor fuse alarm inputs and for connection to the three low-power distribution fuses. See Figure 2-12 and Table 5-C for terminal block (TB501) designations.

Power/Sense Voltage Fusing: The LVD/Fuse Board has up to 18 fuses to distribute power and sense voltages. F501-F506 and F513-F518 provide battery sense voltage to the regulation leads of the rectifiers. F507 provides power and plant voltage sensing to the meter circuits of the 113B Control Unit and optional circuit pack CP2. F508 provides power to the optional circuit packs CP2 and CP3. F509 provides power to the rectifier interface circuits on CP1. F510 provides power to the controller interface circuits on the rectifiers. F511 provides power to the ABS leads of the 113B Control Unit. F512 provides power to the circuitry on the 113B Control unit not powered by F507 or F509. The LVD/Fuse Board designations F501 through F524 correspond to fuse positions 1 - 24 as shown in Figure 2-13.

Major/Minor Fuse Alarms: The LVD/Fuse Board provides Major and Minor Fuse Alarms to the controller. A Major Fuse Alarm is generated when F510, F511, F512 or F521-F523 opens, when a plant distribution fuse opens, or when TB501-2 or TB501-4 is tied to the plant voltage. A Minor Fuse Alarm is generated when any one of the fuses F501-F509 or F513-F518 opens, when TB501-3 or TB501-5 is connected to the plant voltage, or when one or both of the low voltage detection circuits attempts to open the LVD contactor (either under normal operation or in a fault situation; see the following paragraph for further details).

Low Voltage Detection for Disconnect/Reconnect Contactor: The LVD/Fuse Board provides sensing of the plant voltage for use in controlling the low voltage disconnect/reconnect contactor in the battery plant. Although the actual contactor is an optional feature of the battery plant, the sensing circuits and associated alarms are standard on all controllers. There are two sense circuits on the LVD/Fuse Board, configured in a redundant fashion so that both circuits must sense a low voltage before opening the contactor. P505.1 and P505.2 provide the user with a choice of two disconnect voltages. Placing jumpers across pins 1 and 2 of P505.1 and P505.2 provides a disconnect voltage of 42.5 volts for 48-volt plants, while placing the jumpers across pins 2 and 3 provides a disconnect voltage of 40.5 volts.

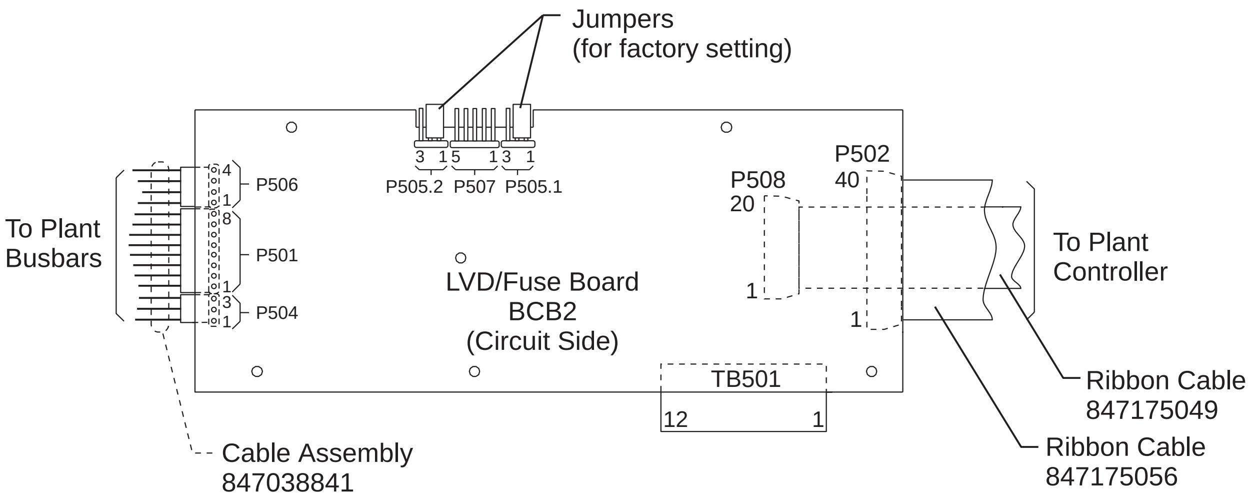


Figure 2-12: LVD/Fuse Board (CP5) Jumper Locations

Fuse Designations	
F1	Reg Lead Rectifier 1
F2	Reg Lead Rectifier 2
F3	Reg Lead Rectifier 3
F4	Reg Lead Rectifier 4
F5	Reg Lead Rectifier 5
F6	Reg Lead Rectifier 6
F7	113B Meter
F8	CP2 and CP3
F9	CP1-Rectifier Interface Power
F10	Rectifier-CP1 Interface Power
F11	Alarm Battery Supply
F12	CP1
F13	Reg Lead Rectifier 7
F14	Reg Lead Rectifier 8
F15	Reg Lead Rectifier 9
F16	Reg Lead Rectifier 10
F17	Reg Lead Rectifier 11
F18	Reg Lead Rectifier 12
F19	Low Power Distribution
F20	Low Power Distribution
F21	Low Power Distribution

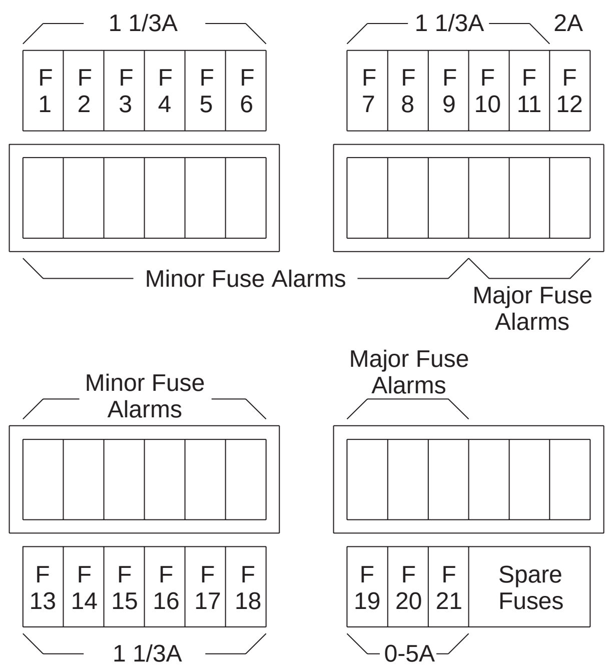


Figure 2-13: Fuse Designation and Function for LVD/Fuse Board (CP5)

Caution

> The two jumpers must be set for the same threshold. Each jumper sets the threshold for one of the two redundant sense circuits. If the jumpers are set for different thresholds, the lower threshold will actually control the contactor since both circuits must sense a low voltage before opening the contactor.

Information on the state of the detection circuits is provided via two LEDs, connections to the controller's Minor Fuse Alarm circuits, and a Form-C contact closure available on the 113B Control Unit. When one or both of the detection circuits senses a low voltage, or if one of the detection circuits fails so that it appears to have detected a low voltage, the yellow LVD/FAIL LED will illuminate and a Minor Fuse Alarm will be sent to the controller. If the battery plant is equipped with the LVD disconnect/reconnect contactor, the red LVD/OPEN LED will illuminate when the contactor is open either during normal operation when a low voltage is detected or in the unlikely event of a contactor failure. A Form-C contact closure available on the 113B Control Unit will also show the status of the contactor. The red LVD/OPEN LED and Form-C contact closure are powered from the battery side of the contactor, while the yellow LVD/FAIL LED is powered from the load side of the contactor. If the rectifiers are powered down and the contactor is open, the red LVD/OPEN LED will be illuminated, the yellow LVD/FAIL LED will not be illuminated, the Form-C contact closure will show the contactor as open, and a Minor Fuse Alarm will be given because the 113B Control Unit sends all alarms when it loses power.

In battery plants without a contactor, the red LVD/OPEN LED will never illuminate and the Form-C contact closure will always show the non-existent contactor as open.

Low Power Distribution: The LVD/Fuse Board may provide low power distribution for customer applications. Plant voltage is supplied to TB501, pins 6, 7, and 8 via fuses F519, F520, and F521 respectively. These three fuses come factory equipped with 5-ampere ratings. Lower ampacity fuses may be used to suit particular applications. Typical applications include remote monitoring systems, alarm indicator panels, temperature transducers, or any other equipment that requires plant voltage at low ampacities. If any of these fuses opens, a Major Fuse Alarm is generated.

Spare Fuses: The LVD/Fuse Board also provides holders for three spare fuses. These fuses are labeled F522, F523, and F524. The holders come equipped from the factory with 1-1/3 ampere rated fuses. These may be replaced with any ampere rating fuses that a customer prefers for a particular application. Note that these fuse holders are not connected to plant power or to the controller's alarm circuitry.

Thermal (Slope/Step) Compensation Feature: The 216A ECS Thermal Compensation Unit, used in conjunction with the BMD1 LVD/R Fuse Board circuit pack, provides reduction in plant voltage for measured temperatures above 77° F (25° C) in a slope plus step manner. See Figure 2-14.

The BMD1 reduces the plant voltage 72mV per degree Celsius for a maximum of 2.0Vdc below the uncompensated voltage. The compensation will stop at approximately 127.4° F (53° C). For temperatures higher than 127.4° F (53° C) but less than 167° F (75° C), a constant voltage drop of 2.0Vdc below the uncompensated voltage will be maintained. For temperatures higher than 167° F (75° C) the plant voltage will be reduced 6 volts below the uncompensated 77° F (25° C) voltage.

The plant voltage will be raised 4.0Vdc when the temperature returns to 149° F (65° C). A green indicator will illuminate to reflect an active module. A yellow indicator will illuminate to reflect temperatures above 127.4° F (53° C) and will blink to reflect temperatures above 167° F (75° C).

The 216A Thermal Compensation Unit also has the ability to increase the plant voltage for sensor temperatures below 77° F (25° C).

The plant voltage will be increased 72mV per degree Celsius to a maximum of 2.0Vdc above the float voltage. The BMD1 will be shipped from the factory with this margining feature disabled.

The 216A Thermal Compensation Unit will accept up to eight thermistors (two per battery string). Up to five 216A modules can be daisy-chained together, which gives the ability to monitor up to 20 battery strings.

There are two types of thermistor kits available for use with the 216A Compensation Unit, paddle-type and ring-type. (See Section 3, *Ordering*.) Use the paddle-type kit with the VR batteries. The kit contains two thermistors that are inserted between the battery cells. Figure 5-12 shows an example of the thermistors inserted into the battery string. Use the ring-type kit when the battery cells are not adjacent to each other (e.g., an air gap is present between cells). The ring terminal is a 1/4-inch diameter ring terminal. Place it on the negative terminal of the battery.

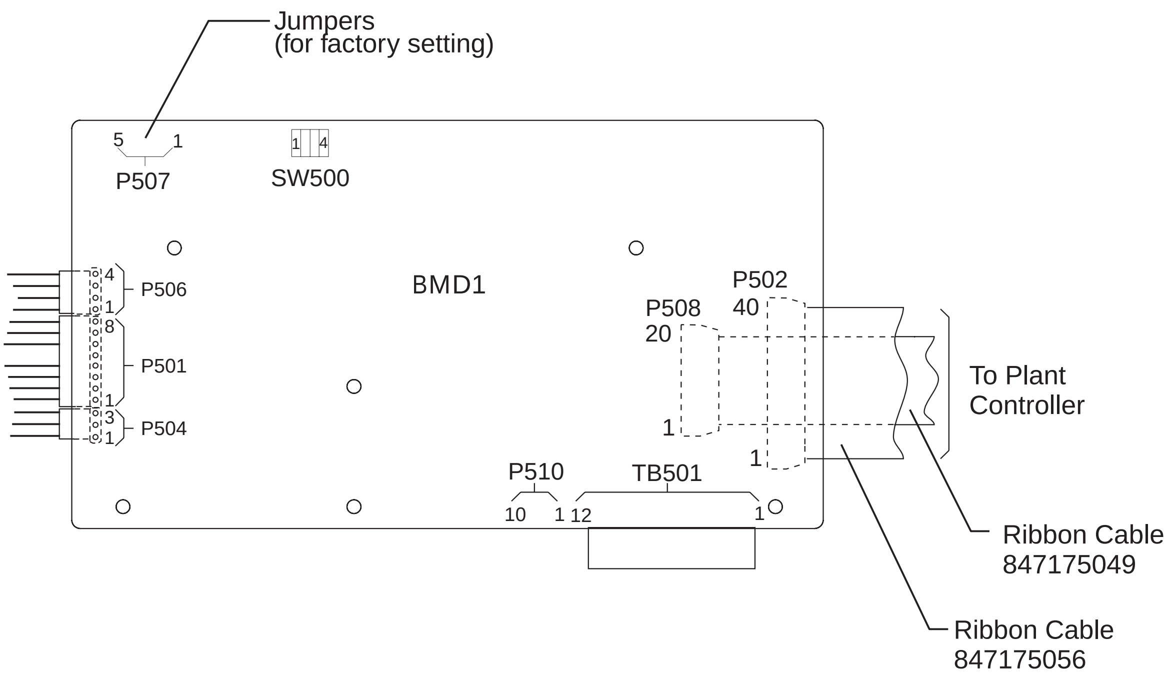


Figure 2-14: LVD/Fuse Board with Thermal Compensation Circuitry (BMD1) Switch Location

Batteries The GPS battery plant is compatible with all flooded and valve regulated batteries that accept float voltages within the range of 48 to 58 volts dc. Battery plant operating voltage is directly related to the recommendations of the battery manufacturer. The nominal cell voltage of lead-acid type batteries is usually defined as 2 volts. The actual recommended float voltage of lead-acid batteries differs slightly among vendors and varies with chemistry. The most common float voltages are 2.17, 2.27, and 2.35 volts per cell. Nominal 48-volt systems typically use

24-cell battery strings for float voltages that range from 52.08 to 56.40 volts per string. The float voltage per string, the minimum string voltage at the end of discharge, and the maximum charging voltage per string must be provided by the battery vendor in order to properly configure the battery plant.

AC Distribution

The ac distribution assembly consists of an ac circuit breaker box prewired to each rectifier in the system, terminations for the commercial ac, and ac voltage and current monitoring devices for monitoring ac status via the ECS controller (L1 only). The ac distribution schemes are shown in Figures 2-15 and 2-15A.

The L1 configuration consists of an ac circuit breaker box located at the top of the cabinet that is equipped with twelve circuit breakers, earth ground, and neutral connection points. AC power is sourced from a 380/220V, 50/60Hz wye derived service (line to neutral, 4-wire + PE). Line 1 feeds breakers 1, 4, 7, 10; Line 2 feeds breakers 2, 5, 8, 11; and Line 3 feeds breakers 3, 6, 9, 12. Each circuit breaker is prewired to one rectifier position on a rectifier shelf.

The L20 configuration consists of an ac circuit breaker box located at the top of the cabinet equipped with earth ground and phase 1(R), 2(S), 3(T) connection points, and a two-pole 30A circuit breaker wired to each rectifier in the cabinet. AC power is sourced from 208/240Vac, 50-60Hz, three-phase, delta plus protective earth ground (3-wire + PE). All ac wiring to the shelves is enclosed in channels that run along both sides of the cabinet. Snap-on covers may be removed to access or install wiring to each of the shelves. Wiring is 10 gauge (2.5mm) and color coded for easy reference as follows:

Earth Ground	Green/Yellow
Neutral	Blue
Line 1	Brown
Line 2	Black
Line 3	Black/White

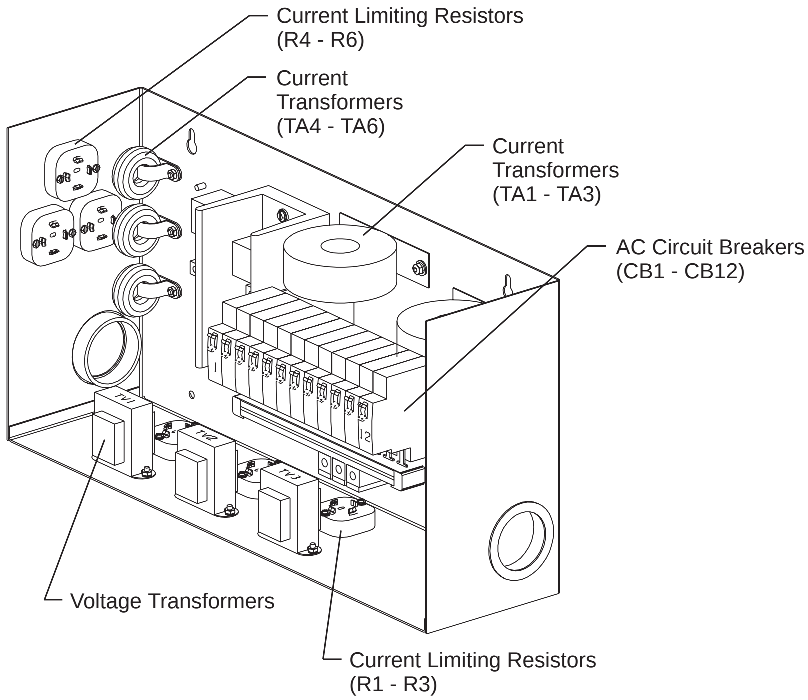


Figure 2-15: AC Distribution Scheme - Wye Configuration (L1)

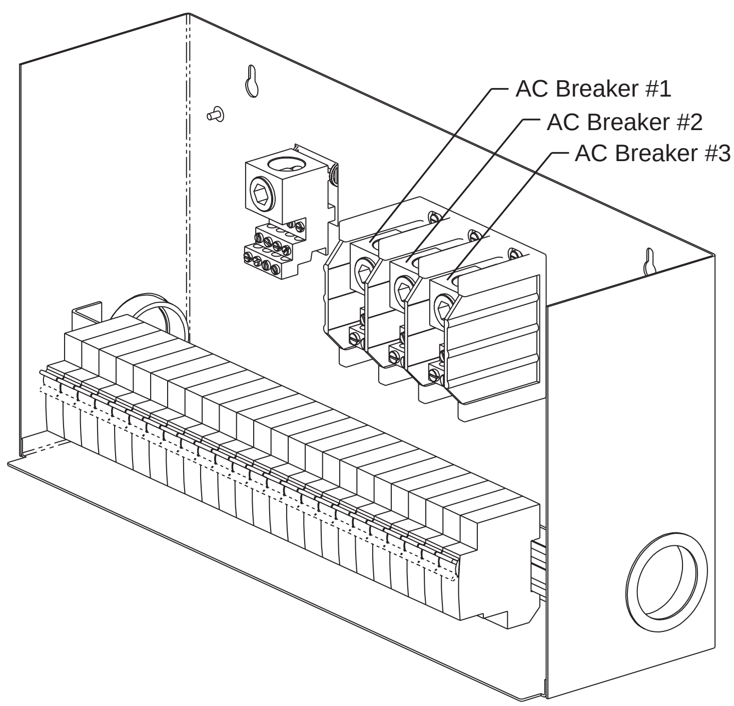


Figure 2-15A: AC Distribution Scheme - Delta Configuration (L20)

AC Phase Connections	
AC Line	Wire Color
L1	Brown
L2	Black
L3	Black/White
N	Blue
ACEG	Green/Yellow

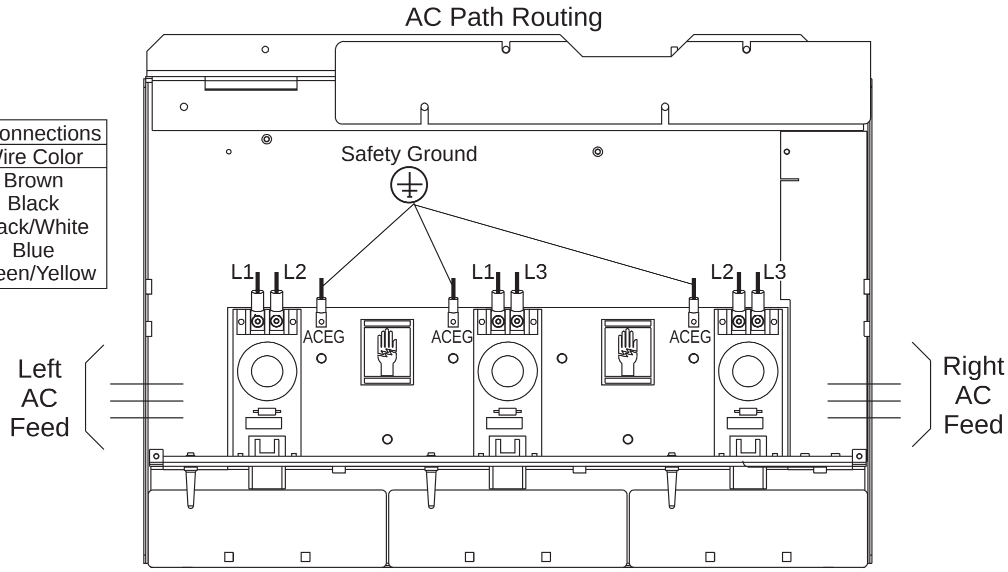


Figure 2-16: AC Wiring to Rectifier Shelves

Figure 2-16 shows the wiring connection points on the rectifier shelf. Each rectifier is wired to a 32-ampere circuit breaker. The circuit breaker protects against an overcurrent condition and provides ac disconnect for each rectifier. Twelve circuit breakers are always furnished with each cabinet regardless of the number of rectifier shelves ordered initially. This simplifies installation of additional rectifier shelves that may be required due to a growth in current requirements. Section 5 of this manual provides a detailed procedure for installing and wiring additional rectifier shelves to an operational plant.

The plant may also be equipped with List 12 to add ac voltage and current monitoring devices to the ac box. Lines 1, 2, and 3 of the ac input are routed through a current transformer before connecting to the circuit breakers. The current transformers reduce the current signal 20 to 1. However, this current is still too large for the controller to measure. A second transformer is used to convert the current signal from each ac line to a voltage signal. These signals are passed through current limiting resistors to the datalogger board (CP3) in the controller. Voltage transformers are wired to each ac line to measure the voltage. These signals are also passed through current limiting resistors to the datalogger board in the controller. The controller must be equipped with the microprocessor board (CP2) and the datalogger board (CP3) to perform ac monitoring. A detailed description of configuring the datalogger board to monitor the ac is provided in Section 5. The ac monitoring option is not available as a field installation kit. It must be ordered with the List 1 cabinet.

DC Distribution

DC distribution consists of the plant charge and discharge bus bars, battery bus bars, plant shunt, low voltage battery disconnect/reconnect contactor with associated circuitry, and fuse distribution panels.

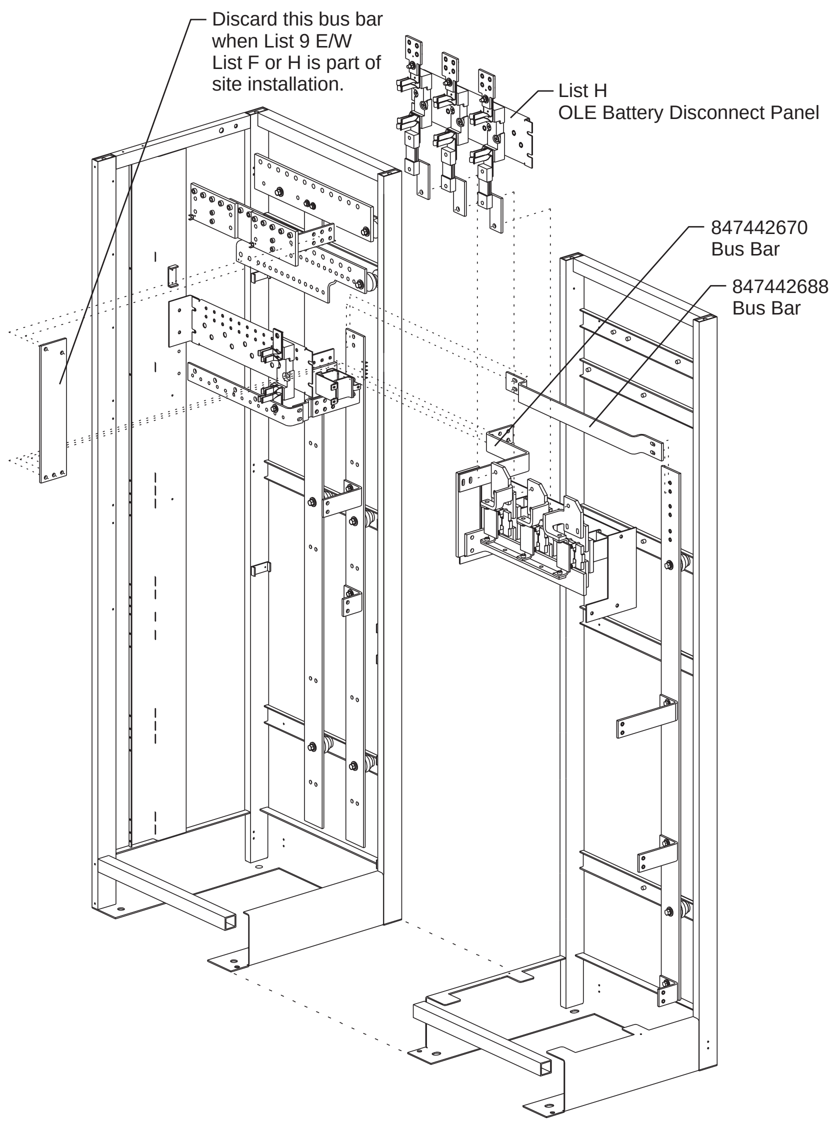


Figure 2-17: Distribution Bus Bar Scheme

Distribution Bus Bars: Figure 2-17 shows the busing scheme for the plant. The copper bus bars (plated with a solder finish) used in the Global Power System are sized to provide a 600-ampere current carrying capacity.

Two sets of bus bars extend vertically along the back of the rectifier cabinet. The charge bus (-48 volt) is on the right side and the charge return bus is on the left. Rectifier shelves and fuse panels connect directly to these buses as shown.

Cabling from batteries is terminated to the battery bus and charge return bus located at the top of the cabinet behind the ac box. The charge return bus is equipped with twelve M10 connection points designed to accommodate single hole copper crimp lug connectors. Battery return cabling (+) is terminated at this bus. The battery bus is equipped with ten M10 connection points. Battery cabling is terminated to this bus.

The discharge return bus is sized to accept the load return cabling from each fuse distribution panel. This bus is located below the charge return bus. There are twenty-eight M8 connection points and twelve M10 connection points on this bus.

The supplemental cabinet, shown in Figure 2-17, has one charge bus extending vertically along the back of the cabinet. It is connected back through to the charge return bus via an interconnecting horizontal bus bar. Fuse panels or battery disconnect panels connect directly to the buses as shown.

The Global Power System offers several additional options for connecting batteries to the system. These include connecting directly to the plant buses as discussed, connecting to the battery fuse-disconnect panel located in the top distribution position, and the use of a low voltage battery disconnect/reconnect contactor. These options are discussed in the following sections.

Plant Shunt: A current shunt is a sensing device that provides a millivolt signal proportional to the current flowing through it. The millivolt-to-ampere ratio of the shunt is the dc resistance of the shunt (in milliohms) that is thermally stable and accurately known.

The current shunt in the J85500L-1 is connected between the charge return bus and the discharge return bus. It is used to measure the total current supplied to the load from the rectifiers and/or batteries. The shunt has a full scale rating of 50 millivolts at the maximum plant current rating of 600 amperes. The shunt millivolt signal is sent, via the CP5 Fuse Board, to the controller where it is translated back to amperes and displayed on the digital meter.

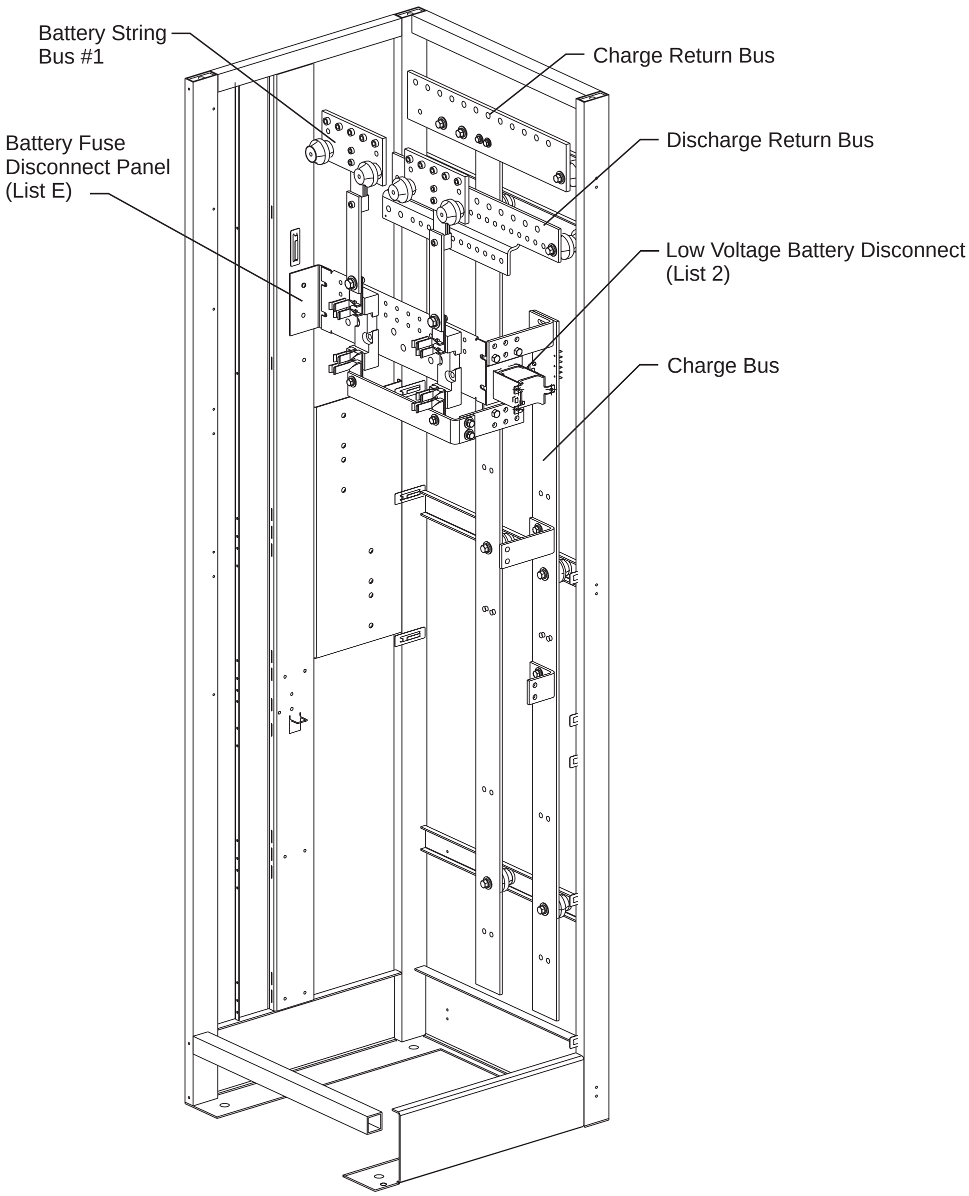


Figure 2-18: LVD Contactor List 2 with Battery Fuse Disconnect Panel List E

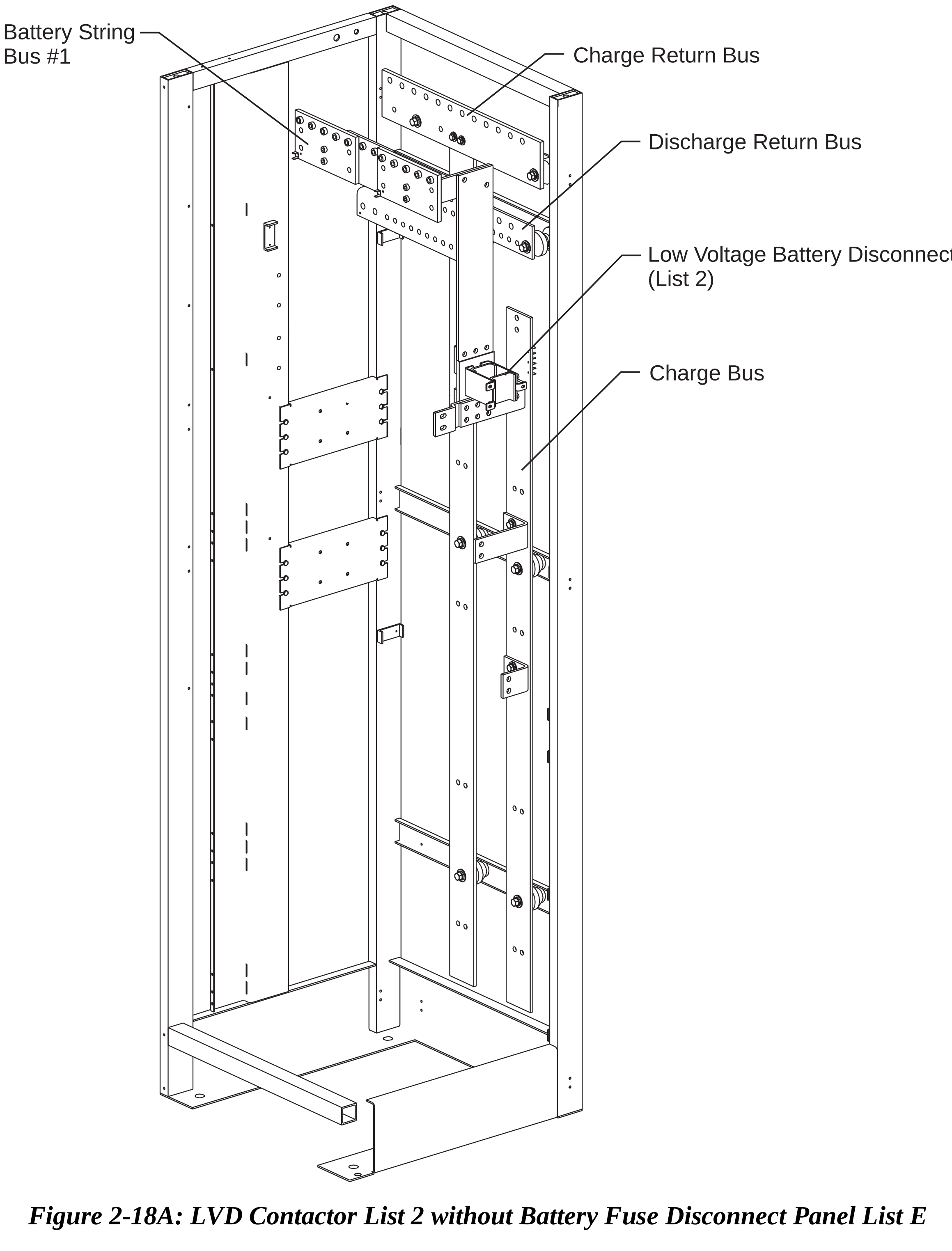


Figure 2-18A: LVD Contactor List 2 without Battery Fuse Disconnect Panel List E

Low Voltage Battery Disconnect/Reconnect (LVD/R) Feature: To prevent costly damage due to deep discharges, the J85500L-1 List 1 may be equipped with an optional automatic battery disconnect feature. The LVD/R contactor is used to either connect or disconnect the charge bus and battery bus. This disconnect is designed to isolate batteries from the load when the plant voltage reaches the lowest usable battery voltage. The disconnect level is below the operating range of most load equipment, in which case service to the load would already have been lost. The disconnect does not separate the load circuits from the rectifiers, enabling the rectifiers to begin powering the load as soon as ac power is restored.

List 2 provides a 600-ampere contactor and interconnection hardware for installing the contactor between the battery bus and the charge bus. There are two methods for installing the contactor. If the battery fuse-disconnect panel is ordered, the contactor is installed as shown in Figure 2-18. If there is no battery fuse-disconnect panel, the contactor is installed as shown in Figure 2-18A.

The LVD/R contactor is controlled by circuitry on the CP5 Fuse Board. The LVD circuit on CP5 monitors the battery bus voltage. When the voltage drops below a preset level, the CP5 Fuse Board senses the low voltage condition and removes power from the contactor. This opens the connection between the charge bus and battery bus, disconnecting the batteries from the rectifiers and the load. The user has the choice of setting the disconnect threshold voltage at either 40.5 volts or 42.5 volts. When the contactor is open and the rectifiers are not delivering power, the controller is unpowered as well. In this state, the controller displays and LEDs are extinguished and various alarms are issued to the alarm reporting center.

The red LVD OPEN and yellow LVD FAIL LEDs are located on the top dc distribution panel door. The red LVD OPEN LED on the CP5 Fuse Board lights whenever the contactor is open, during a normal disconnect or in the unlikely event of a contactor failure. The LVD sensing circuitry on CP5 is redundant. A failure of either voltage detector circuit lights the yellow LVD FAIL LED but the contactor will stay closed. A Fuse Alarm Minor (MNF) is issued when an LVD circuit fails, lighting a yellow LED on the controller front panel and sending Power Minor (PMN) alarms to the reporting center.

Once the contactor opens, it remains open until the voltage again exceeds the set threshold voltage. Voltage does not return until ac power is restored and the rectifiers restart and deliver power. The LVD circuit then restores power to the LVD/R contactor, which reconnects the batteries to the rectifiers and load. The batteries are then free to accept charging current from the rectifiers.

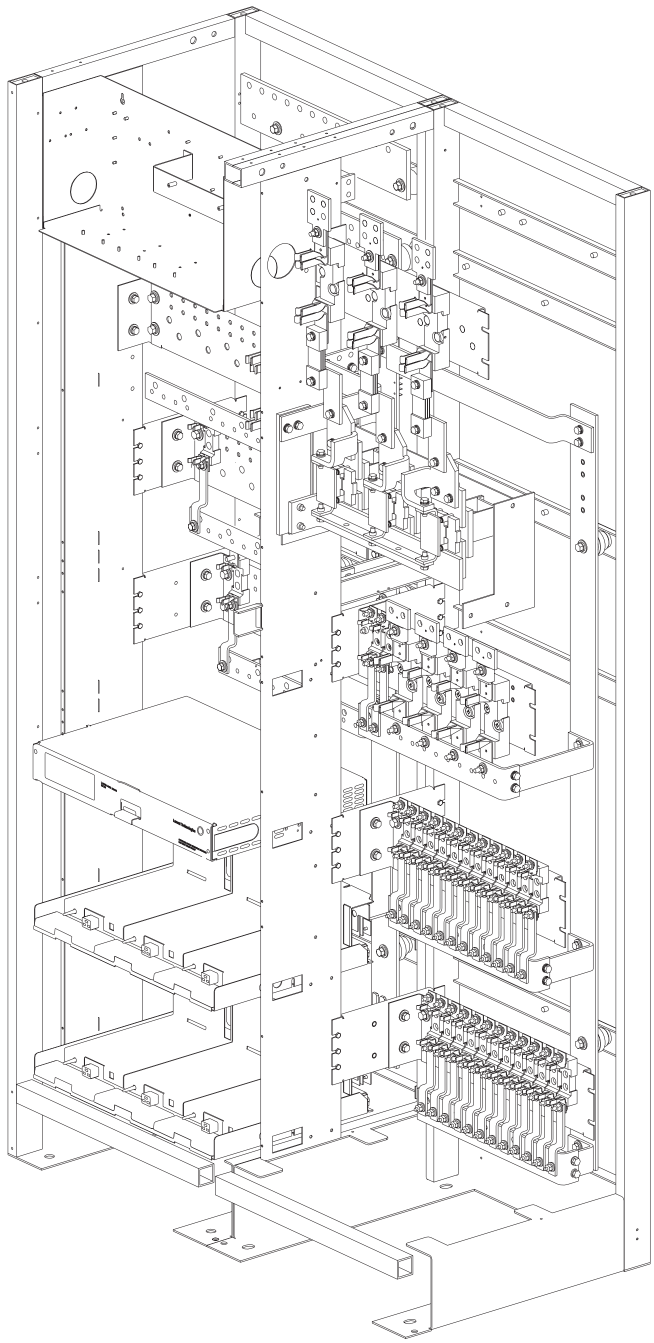


Figure 2-19: Location of DC Distribution Panels

DC Distribution Panels: Fuse and circuit breaker distribution panels may be equipped in three positions in both the rectifier and supplemental distribution cabinets of the J85500L-1. In the rectifier cabinet they are located between the ac box and the controller; in the supplemental distribution cabinet they are located in the bottom three positions. The panels are configured in a tiered arrangement as shown in Figure 2-19. This allows load leads to be cabled directly to each fuse holder or circuit breaker without difficult cable routing or interference with other panels. Distribution panels must always be equipped from the top to the bottom. As you can see, this allows for future growth in either rectifier capacity or distribution capacity without interference with existing equipment.

Two types of fuse panels are available via list numbers on the J85500L-1. The panels can be ordered with the List 1 or List 9 cabinet or ordered separately for existing systems in the field. The panels are shown in Figure 2-19. Two types of fuses holders are available for fuses sized to DIN standard 43620. The fuse holders used are manufactured by Gould as part numbers 41002 and 41502. The smaller fuse holder is rated for 160 amperes of current carrying capacity for size 00 fuses. The larger fuse holder is rated for 400 amperes of current carrying capacity for size 2 fuses.

List A provides a fuse panel equipped with 6 fuse holders, 4 NH2 type and 2 NH00 type. List B provides a fuse panel equipped with 12 NH00 type fuse holders.

List D provides a circuit breaker panel for mounting up to 24 DIN size 35 snap-on circuit breakers.

A hinged panel covers the front of each fuse or circuit breaker panel position and includes mounting positions for the alarm module(s) furnished with each panel, which detects when a fuse or circuit breaker on the panel operates and sends an alarm to the controller.

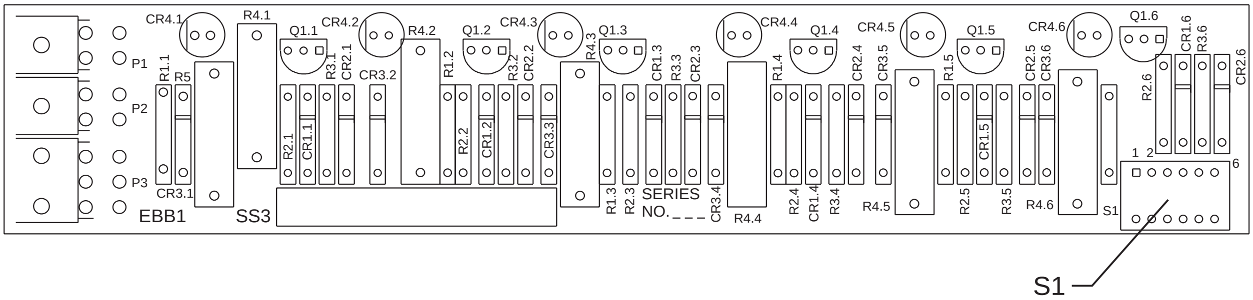


Figure 2-20: EBB1 Alarm Module

Battery Fuse Alarm Board: The J85500L-1 List 9 (Supplemental Cabinet) can be equipped with an A-CP/ECK1 Battery Fuse Alarm Board. The ECK1 will generate a signal that will light a red LED embedded in the cabinet's upper door panel when one or more fuses on the battery fuse-disconnect panel opens. The ECK1 battery fuse alarm board can monitor up to 6 fuses on the J85500L-1 battery fuse-disconnect panels (J85500L-1, Lists F and H). The interconnections between the A-CP/ECK1 circuit pack and the distribution cabinet are shown in Figure 2-21.

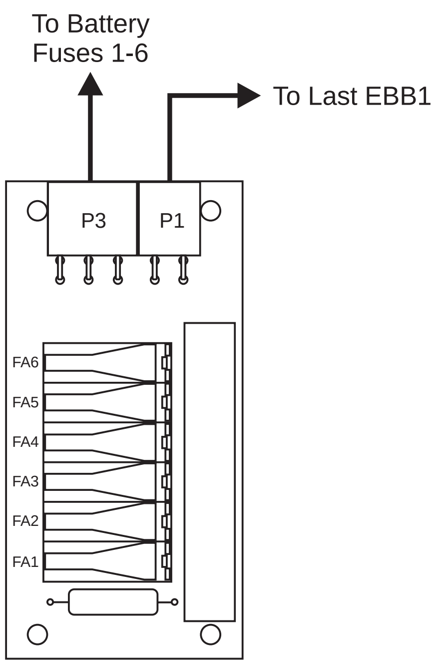


Figure 2-21: ECK1 Battery Fuse Alarm Board

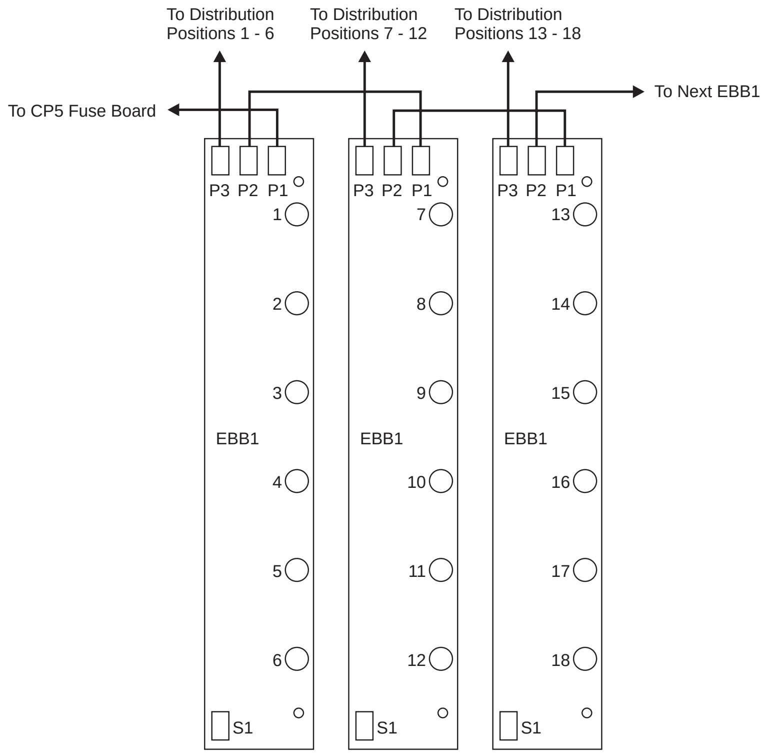


Figure 2-22: Connecting Multiple EBB1 Alarm Modules

Fuse/Circuit Breaker Alarm Module

Fuse and circuit breaker panels are equipped with alarm circuit modules, apparatus code A-CP/EBB1, to provide a visual and remote indication of an alarm for each position.

The EBB1 consists of six alarm circuits. Each circuit has a red LED alarm light that corresponds to one position. When a circuit is open, a major fuse alarm is generated and the red LED lights. The fuse alarms from all panels are paralleled together and connected to the CP5 Fuse Board at terminal TB501-1, Distribution Alarm. CP5 transmits this signal to the ECS controller as a Major Fuse Alarm, MJF.

Power for generating alarms on EBB1 is furnished from CP5 terminal TB501-6, Low Power Distribution via F520 fuse position. A 5-ampere fuse protects the power lead.

A switch is located on each EBB1 to activate a circuit when a fuse or circuit breaker is installed. Positions not utilized should be disconnected from the circuit by setting the associated switch position (S1) to the open position, or open fuse alarm signals will be generated. See Figure 2-20.

The List A fuse panel requires one EBB1 circuit module. The List B requires two; the List D requires four. A six-pin connector on the EBB1 provides the input signal from each holder. The four pin connectors provide ground from the discharge return bus, power from CP5 (TB501-6) to the circuit, and the fuse alarm signal to CP5 (TB501-1). When multiple EBB1s are connected together, they are simply interconnected from one board to the next as shown in Figure 2-22.

Battery Fuse Disconnect Panel

The other option for terminating battery cabling is to a battery fuse-disconnect panel. The panels are furnished with Lists E and F. List E is located in the top distribution panel of the main rectifier cabinet. This panel is designed for terminating two strings of batteries. Each string is connected to a bus bar located at the top of the cabinet behind the ac box. These two bus bars are each equipped with five M10 connection points. The battery is bused across a 600-ampere current monitoring shunt down to a fuse holder on the panel. The fuse holder is manufactured by Gould as part number 41602 and is rated for 630 amperes of current carrying capacity for size 3 fuses.

List F terminates three strings of batteries. The panel is equipped with three Gould 41602 type fuse holders rated at 630 amperes for size 3 fuses and three 600-ampere current monitoring shunts. It is located at the top of the supplemental distribution cabinet.

From the fuse holders, the battery is bused to the vertical charge bus of the main cabinet. The shunts may be wired to the datalogger board (CP3) in the controller. The controller must be equipped with the microprocessor board (CP2) and the datalogger board (CP3) to perform this monitoring. The “Basic Configuration and Options” paragraph describes the procedure for configuring the datalogger board (CP3) to perform shunt monitoring.

Off-Line Equalize Panel

List H terminates three strings of batteries with an off-line equalize feature. The fuse panel and associated equipment are equipped with three Gould 41602 type fuse holders rated at 630 amperes for size 3 fuses, three 600-ampere current monitoring shunts, and three 1200-ampere battery transfer contactor switches. It is also located at the top of the List 9 supplemental distribution cabinet. See Figure 2-19.

Appearance Packages

The Global Power System cabinet is an open framework design, which allows easy access for installation personnel to connect cabling and equipment to the cabinet. Side and rear covers are required to enclose the plant after installation. Both the side and rear covers are ordered as List 10. If both a rectifier and supplemental distribution cabinet are present, only two side covers and two rear covers are required. Plastic clips are attached to the sides of the cabinet. The side cover is then hooked onto the clips. The List 1 and List 9 cabinets have doors covering the ac and dc distribution. Center-opening doors may be ordered as List 11 to provide an aesthetically pleasing look for systems located in high visibility areas. These doors are similar in style and appearance to the doors used on the 5ESS switch system.

Boost Charge Panel

The J85500L-1 Group H includes a boost charge panel (BCP) that is mounted in the supplemental distribution cabinet, as shown in Figure 2-2A and Figure 2-23. Boost charging is a system feature since the load and all batteries receive the boost charge voltage. The BCP activates the boost mode of the rectifiers through the plant controller to reduce battery charging time after a discharge. (The boost mode of the rectifier is indicated with an LED labeled EQ; labels are provided to cover the EQ with BST (see “Boost Charge Panel (BCP) Wiring and Test” in Section 5.)

The BCP may be operated in a manual, timed manual, or automatic mode. In the manual modes, the operator selects the duration of the boost charge and activates the system. When the time period has elapsed, the BCP signals the controller to return the rectifiers to float mode. For the automatic mode, the BCP monitors the plant controller for a battery on discharge (BD) status. The BCP times the BD period and activates the equalize mode depending on the length of the BD. Again, the system returns to the float mode after the specified boost period.

Boost Charge Unit Feature Summary:

- The BCP operates with the Galaxy, CCS, MCS, or ECS family of Lucent Technologies controllers, the 400-ampere ferroresonant rectifier, and all switch mode rectifiers.
- The BCP has the ability to accept a Reserve On-Line signal (RO) from the engine and prevent the rectifiers from operating in the boost mode while the battery plant is on engine.

- The BCP has the ability to accept both the Power Minor (PMN) and Power Major (PMJ) alarms and prevent the rectifiers from operation in the boost mode.
- Failure of the BCP will disable the boost feature. If the unit is in the boost charge mode when it fails, it will force all rectifiers back to “float.”
- Boost charge can be initiated either by automatic or manual means. The operational parameters of the panel can be set on the unit.

Front Panel Indications:

- A yellow LED labeled “Bst” lights whenever the BCP sends the signal for the plant to go into the boost mode.
- A green LED labeled NORMAL lights whenever the BCP is either in the boost mode or the float mode.
- A red LED labeled FAIL lights when the BCP has failed. When the red LED lights, the green LED does not.

Front Panel Switches:

- A three-position, momentary switch that, when operated, will place the plant in either the float or boost mode.
- A twelve-position rotary switch labeled “Boost Time (Hours)” performs the manual and timed boost functions.

Programming Switches:

- A four-position DIP switch, labeled “Option,” is located on the rear of the unit. Positioning the first DIP switch in the ON position disables the auto-boost function. For the auto-boost mode, this switch must be in the OFF position. Positioning the second DIP switch in the ON position allows for +24-volt boost charge operation. The other two positions are not used.
- An eight-position DIP switch labeled “Constant” is located on the rear of the unit. Placing a single switch in the ON position will set “N” to the corresponding number for the following algorithm: e.g., if DIP switch 6 is on, the boost time will be six times as long as the period during which the batteries were on discharge.

BOOST TIME = (BD TIME) x N

where N = 1, 2, 3, 4, 5, 6, 7, or 8

Input Signals and Output Signals:

The BCP has three connectorized, screw-down terminal blocks located in the back of the unit.

- Terminal TB1 is for the input power.
- Terminal TB2 is for the input signals: Battery on Discharge (BD), Power Minor (PMN) and Power Major (PMJ) alarms, and Reserve On-Line (RO) status.
- Terminal TB3 is for the output signals listed below:
  - BCP Fail
  - BCP ON
  - BCP OFF
  - Remote Monitor

Off-Line Equalize Panel

The J85500L-1 Group H also includes an off-line equalize (OLE) panel that is mounted in the supplemental distribution cabinet (refer to Figure 2-2A and Figure 2-23). The OLE monitors the battery switches and a designated off-line charging rectifier switch for off-line indicators. Once the OLE determines that the battery and rectifier are ready, the OLE assumes control of the rectifier and activates the equalize mode. The OLE returns the rectifier to the float mode after the selected time has elapsed. The operator reconnects the battery and the rectifier to the plant bus and the plant controller resumes control of the rectifier. The plant controller still receives any alarms from the rectifier during the process.

Off-line equalize requires communication among the plant controller, the rectifiers, and the supplemental distribution cabinet. To provide off-line equalize, a specially equipped rectifier shelf is required that contains a contactor switch in the left rectifier slot. This contactor switch allows the third rectifier to be switched between the load bus and the OLE bus located in the supplemental distribution cabinet. The batteries must be connected through the battery fuse disconnect panel contained in the List H equipment. This connects the batteries through a 1200-ampere battery transfer contactor that can be switched from the battery bus to the OLE bus. When the rectifier and a battery string are switched to the off-line position, the OLE is activated.

Equalize Panel Features:

- The equalize panel operates with Lucent Technologies ECS controllers and the 364A switchmode rectifiers.
- The equalize function can only be initiated if the battery string and the designated rectifier have been isolated from the load.
- The equalize panel is used to interface the controller to the designated equalize rectifier in the plant. As such, the equalize panel will:
  - Provide the rectifier with a voltage, via the remote sense leads, to allow the rectifier output to increase to the desired equalize voltage.
  - Manage the signal flow between the rectifier and the controller during the equalize period.
  - Time the equalize period.
  - Provide equalize control and status to the field maintenance personnel.

Front Panel Indicators

- A yellow LED labeled BIE (Battery In Equalize) indicates that a battery string has been placed “off line” and is ready for Off-Line Equalization.
- A yellow LED labeled RIE (Rectifier In Equalize) indicates that the designated rectifier of the plant has been taken off line and is available for equalize charging of the battery string in BIE.
- A yellow LED labeled “Eql” indicates that a string of batteries is being equalized via the designated equalize rectifier of the plant.
- A yellow LED labeled ETO indicates that a battery string was placed in the equalize mode for a specific time period and that time period has expired. That battery string can now be placed back on line and another string equalized or the rectifier can be placed back into “normal” service.

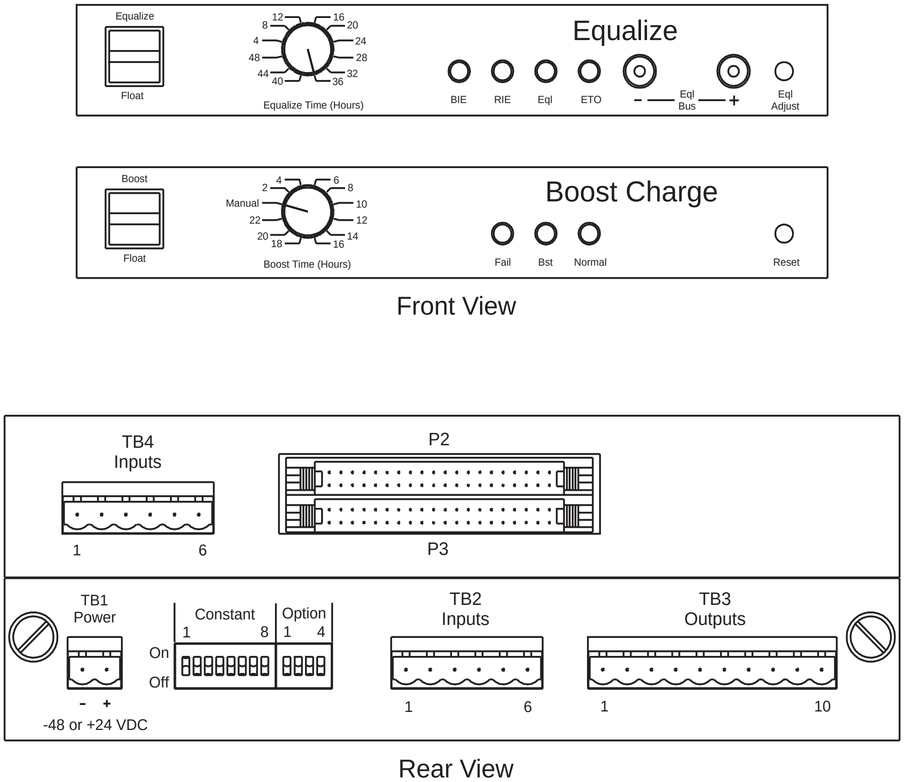


Figure 2-23: Boost Charge and OLE Panel

3 Ordering

Ordering Information

Table 3-A provides a summary of the J85500L-1 List structure. A detailed description of each of the options on the Global Power System is presented in Section 2.

The J85500L-1 is ordered with List (L) numbers. Lists 1 and 20 are the main lists that provide the cabinet equipped with an ECS controller, two rectifier shelves, charge and discharge bus bars, plant shunt, and ac circuit breaker box. List 9 is a main list that provides a supplementary distribution cabinet. The remaining lists are supplementary lists that can be ordered in addition to the main lists to customize the system to meet specific customer requirements. For example, List 2 provides a low voltage battery disconnect/reconnect feature for a List 1 cabinet, List 3 provides an additional rectifier shelf, List 10 provides a side or rear cover for the cabinet, List 11 provides a set of front center opening doors and Lists A, B, and E provide distribution panels. Each of these Lists may be ordered separately or as “Equipped With” (E/W) items. This means that they are ordered in addition to the main list and will be installed at the factory. If these lists are ordered as separate items, they will be shipped to the customer in separate containers for assembly during installation. Some Lists are always ordered separately. Lists 4, 5, 7, 8, K1, K2, and K3 provide equipment that is plugged into a system during installation or as add-on kits to an operational system. List 4 furnishes a rectifier. Lists 5, 7, and 8 provide feature enhancement boards for the controller, Lists K1 and K2 provide kits to modify a fuse panel with additional fuse holders, and List K3 provides a kit to add off-line equalize to a system. As an example, to order a system equipped with delta derived ac input, 10W-voltage disconnect, CP2 controller circuit pack, thermal compensation, one fuse panel with four NH2 fuse holders, and off-line equalize, the following would be ordered:

List 20 equipped with: List 2, List 5, List 21, List A, List G, and List 9 equipped with List H.

In order to mount all necessary equipment, the off-line boost/equalize feature requires both a List 1 or 20 equipped with List G and List 9 equipped with List H.

List 21 provides a thermal (slope/step) compensation feature.

Table 3-A: Ordering Information for the J85500L-1 Global Power System

Description	List
Provides a 2200 x 600 x 600 mm cabinet equipped with two rectifier shelves, ECS controller, charge/discharge bus bars, 600-ampere plant shunt, and an ac circuit breaker box. Three mounting areas/modules are available for distribution and/or additional rectifier shelves.	1
Provides one 600-ampere Low Voltage Disconnect/Reconnect contactor.	2
Provides one rectifier shelf kit consisting of the shelf, ac wiring and mounting hardware (maximum of two per cabinet).	3
Provides one -48-volt, 50-ampere switch mode rectifier.	4
Equipment for ECS controller to provide microprocessor circuit pack (CP2). CP2 provides remote and local monitoring and control functions.	5
Reserved.	6
Same as List 5 (CP2) with voice response feature.	7
Equipment for ECS controller to provide datalogger circuit pack (CP3). CP3 is a data acquisition circuit pack that always requires a List 5 or List 7 microprocessor board.	8
Equipment for one 2200mm x 600mm x 600mm supplemental cabinet. Provides space to mount one List F battery fuse disconnect or one List H OLE panel, and up to three fuse panels per List A, B, or D.	9
Provides one side or rear cover.	10
Provides set of center-opening cabinet doors.	11

Table 3-A: Ordering Information for the J85500L-1 Global Power System

Equipment to add ac monitoring capabilities to a List 1 cabinet.	12
Same as List 1, except with ac circuit breaker box for three phase, delta derived ac input.	20
Optional equipment for List 1 or List 20 to provide thermal (slope/step) compensation feature.	21
One fuse panel equipped with six DIN fuse holders, four size NH2 and two size NH00. Occupies one mounting area.	A
One fuse panel equipped with twelve DIN fuse holders, size NH00. Occupies one mounting area.	B
Reserved.	C
One circuit breaker panel for mounting up to twenty-four DIN Size 35 snap-on circuit breakers.	D
One battery fuse disconnect panel equipped with two DIN fuse holders size NH3 and two 600 ampere current monitoring shunts. Occupies top mounting area.	E
Equipment for List 9 to provide one battery fuse disconnect panel equipped with three NH3 fuse holders and three 600-ampere current monitoring shunts.	F
Equipment for List 1, 20 to provide one specially equipped OLE rectifier shelf, and cabling for interconnection. List 9 equipped with List H must always be ordered with this option for additional equipment to operate the OLE feature.	G
Equipment for List 9 to provide one boost/equalize charge panel, one switch panel, and one battery fuse disconnect panel equipped with three NH3 fuse holders, 1200/50-ampere OLE contactor switches, and 600-ampere current monitoring shunts. List 1 or 20 equipped with List G must always be ordered with this option for additional equipment to operate the OLE feature.	H
Kit to add additional DIN fuse holder, size NH00, to List A or List B fuse panels.	K1
Kit to add additional DIN fuse holder, size NH2, to List A or List B fuse panels.	K2
Kit to add off-line equalize to an installation equipped with both List 1 or List 20 and List 9.	K3

Supplementary Components

Table 3-B: Supplementary Components

Description	Comcode
Thermistor Kit, Paddles	847618048
Thermistor Kit, Rings	847618063

Documentation

This document (Select Code 167-790-047) is part of a set of documentation developed to assist engineering and installation personnel. Additional product information includes the following:

<u>Battery Plant</u>

J85500L-1	Assembly and Ordering Drawing
ED-83130-30	AC Distribution Drawing
ED-83131-30	DC Distribution Drawing
T-83167-30	Wiring Drawing
SD-83167-01	Schematic Drawing

Supplementary information on the ECS controller, Lineage® 2000 SR series rectifier, and Rectifier Shelf Assembly (RSA) is in the following documents.

<u>ECS Controller</u>

J85501D-2	Assembly Drawing
SD-82669-02	Schematic Drawing
167-790-033	Product Manual
167-790-109	Optional Circuit Pack Product Manual

<u>SR Series Rectifiers and Rectifier Shelf Assembly</u>

J85702B-2	Assembly Drawing
J85702F-1	Assembly Drawing
T-82668-30	Wiring Drawing
SD-82668-01	Schematic Drawing
167-790-117	Product Manual

4 Safety

Safety Statements

Please read and follow all safety instructions and warnings before installing, maintaining, or repairing the power system. Reference the individual module product manuals for additional safety statements specific to the modules.

This document is intended to be grounded (earthed) in accordance with all applicable local codes.

Install only in restricted access areas (dedicated equipment rooms, equipment closets, or the like) in accordance with all applicable local codes.

This equipment is to be used in controlled environments (an area where the humidity is maintained at levels that cannot cause condensation on the equipment, the contaminating dust is controlled, and the steady-state ambient temperature is within the range specified).

This equipment must not be installed over combustible surfaces.

For all installations, the appropriate connector is to be applied only to the correct size conductor as specified by the connector manufacturer using only the connector manufacturer's recommended tooling or tooling approved for that connector.

If the proper connector for the country of installation is not provided, obtain appropriate connectors and follow manufacturer's and all local requirements for proper connections. All national and local rules and regulations are to be followed when making field connections.

Torque electrical connections to the values specified on labels or in the product documentation.

Battery input cables must be dressed to avoid damage to the insulation (caused by routing around sharp edges or routed in areas where wires could get pinched) and undue stress on the connectors.

The short circuit current capability of the battery input to the distribution panel must not exceed 10,000 amperes.

AC branch circuits to this equipment must be protected with either fuses or circuit breakers in accordance with local codes. Refer to the equipment ratings to assure rating of equipment will not exceed 80% of the value of the protector chosen.

An accessible ac disconnect/protection device to remove ac power from the equipment in the event of an emergency must be provided. This device must open all poles and be connected together.

When connecting to 3-wire plus neutral supply systems, the neutral is to be reliably earthed at the supply; i.e., this equipment is not intended to be connected to IT supply systems.

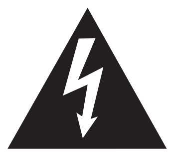
Internal relays have contacts rated at no more than 60Vdc, 0.5 amperes. Any external circuits connected to internal relays must be limited to this rating.

Side and back covers must be installed over open areas after installation or servicing. Front doors and covers must also be kept in place.

Warning Statements And Safety Symbols

This symbol identifies the need to refer to the equipment instructions for important information.

These symbols (or equivalent) are used to identify the presence of hazardous ac mains voltage.



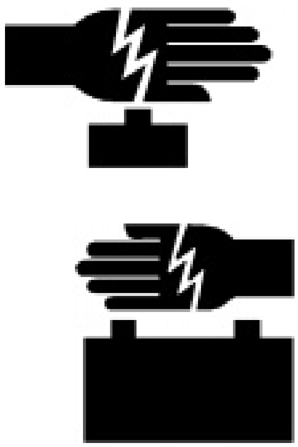
This symbol is used to identify the presence of hazardous ac or dc voltages. It may also be used to warn of hazardous energy levels.

The symbols may sometimes be accompanied by some type of statement; e.g., "Hazardous voltage/energy inside. Risk of injury. This unit must be accessed only by qualified personnel."

When working on or using this type of equipment, the following precautions should be noted:

- This unit must be installed, serviced, and operated only by skilled and qualified personnel who have the necessary knowledge and practical experience with electrical equipment and who understand the hazards that can arise when working on this type of equipment.
- The equipment could be powered by multiple ac inputs. Ensure that the appropriate circuit protection device for each ac input being serviced is disconnected before servicing the equipment.
- For equipment connected to batteries, disconnecting the ac alone will not necessarily remove power to the equipment. Make sure the equipment is not also powered by the batteries or the batteries are not connected to the output of the equipment.
- High leakage currents may be possible on this type of equipment. Make sure the equipment is properly safety earth grounded before connecting power.
- Hazardous energy and voltages are present in the unit and on the interface cables that can shock or cause serious injury. Follow all safety warnings and practices when servicing this equipment. Exercise care when servicing this area.

This symbol is used to identify the need for safety glasses and may sometimes be accompanied by some type of statement, for example: "Fuses can cause arcing and sparks. Risk of eye injury. Always wear safety glasses."

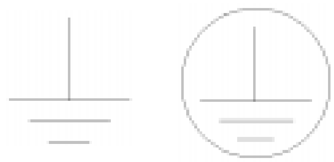


One of these two symbols (or equivalent) may be used to identify the presence of rectifier and battery voltages. The symbol may sometimes be accompanied by some type of statement, for example: "Battery voltage present. Risk of injury due to high current. Avoid contacting conductors with uninsulated metal objects. Follow safety precautions."

When working on or using this type of equipment, the following precautions should always be noted:

- Batteries may be connected in parallel with the output of the rectifiers. Turning off the rectifiers will not necessarily remove power from the bus. Make sure the battery power is also disconnected and/or follow safety procedures while working on any equipment that contains hazardous energy/voltage.
- In addition to proper job training and safety procedures, the following are some basic precautions that should always be used:
    - Use only properly insulated tools.
    - Remove all metallic objects (key chains, glasses, rings, watches, or other jewelry).
    - Wear safety glasses.
    - Test circuits before touching.
    - Lock out and tag circuit breakers/fuses when possible to prevent accidental turn on.

– Be aware of potential hazards before servicing equipment.
– Identify exposed hazardous electrical potentials on connectors, wiring, etc. (note the condition of these circuits, especially wiring).
– Use care when removing or replacing covers; avoid contacting circuits.



These symbols are used to identify the safety earth ground or bonding point for the equipment.

5 Installation

General

This section outlines a sequence for installation of the Global Power System. A suggested test sequence is also provided to check the integrity of the installation effort. Upgrades, retrofits, and replacement of equipment are also discussed.

To improve shipping and handling, the rectifiers and controller circuit packs CP2 and CP3 are packaged separately and must be plugged into the system during the installation process. Though not discussed in this manual, the battery subsystem must also be assembled by the installer and connected to the battery plant.

Installation Tools and Test Equipment

- Material handling equipment to unload cabinet at site, remove from shipping container, and set in final position [Minimum lifting capacity of 800 lb (363 kg)]
- Drill to bore holes for floor anchors (12 mm anchors provided)
- Cable racks and associated hardware
- Input and output cables and terminal lugs
- Common electrician's hand tools, including jeweler's screwdriver, electrical tape, wire cutters, and strippers
- Insulated 5 mm Allen wrench key (provided with cabinet)
- 1/2-inch Allen wrench (provided with cabinet)
- Proper crimping tools and dies for connectors
- Common mechanic's hand tools, including flat blade screwdriver, socket and torque wrenches for 8 mm, 13 mm, 17 mm, and 19 mm bolts, and a crowbar for uncrating
- M8 and M10 bolts, washers, and lockwashers to connect battery leads and load return leads to the plant busbars
- DMM (Digital Multimeter) with at least 0.05% accuracy on the dc scale
- Load Box - 50 amperes at 48 volts

Unpacking, Handling, and Frame Installation

Before opening the packaging, carefully inspect the outside in the presence of shipping personnel for signs of damage. If damaged, follow the shipping carrier’s procedure for filing a damage claim.

Use the equipment weights and dimensions given in Section 2 as a guideline for choosing material handling tools. Carefully open the packaging to verify that the contents are complete and undamaged. If the equipment must be returned, it should be repacked in the original shipping crate.

Figure 5-1 shows the cabinet footprint. The cabinet is 600 mm wide and 600 mm deep. Cabinets are equipped with four 19 mm holes for anchoring the cabinet to concrete floors. The J85500L-1 is shipped with four 12 mm heavy-duty anchors with torque cap bolts and hold-down plates. Figure 5-2 shows the typical floor mounting details for concrete floors. Other types of floor construction may require other mounting methods.

Table 5-A lists the recommended torque settings for the hardware used in the Global Power System.

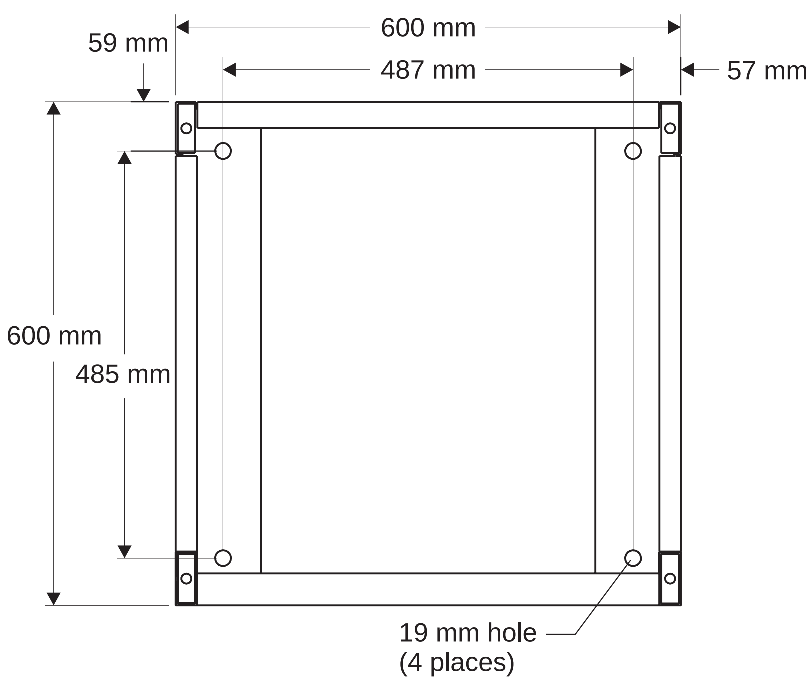


Figure 5-1: J85500L-1 GPS Cabinet Footprint

Table 5-A: Torque Settings for Metric Hardware

Screw Size	Torque (Nm)	Torque (in-lb)
M2	0.24	2
M2.5	0.48	4
M3	0.9	8
M3.5	1.4	12
M4	2	18
M5	4	35
M6	7	62
M8	18	160
M10	34	300
M12	58	513

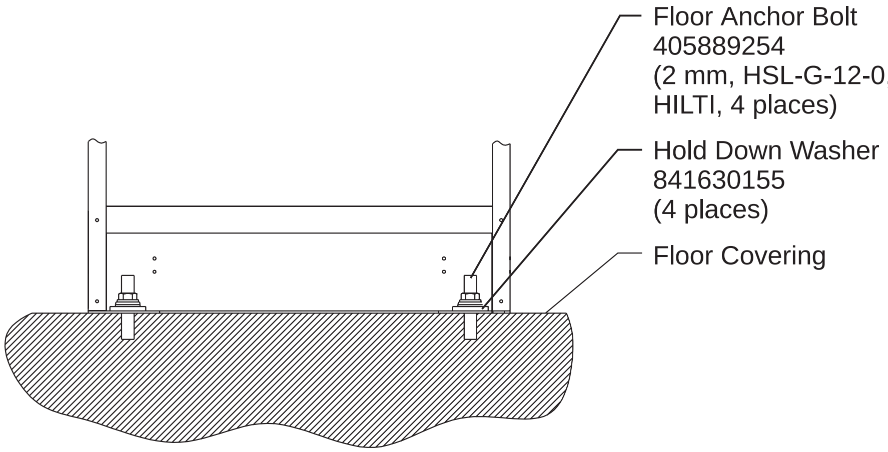


Figure 5-2: Floor-Mounting Details

Cable Routing Strategy

As with any battery plant, cabinet positioning with respect to cable racks, batteries, and ac is very important in order to assure easy installation, proper maintenance, and graceful growth of the system in the future. Figure 5-3 shows a top view of the cabinet. Each corner of the cabinet is equipped with an M12 threaded hole to attach eyebolts for lifting the cabinet or threaded rods for supporting cable racks.

The cabinet is arranged to separate ac from dc leads. All dc leads should be separated from ac leads wherever possible to minimize electrical noise transmitted to the load.

It is recommended that ac cable be run on a cable rack along the front of the cabinet while dc leads be routed to a cable rack along the back of the cabinet. Hang all cable support systems, as well as any auxiliary ground bus bars, as required by the job application drawings.

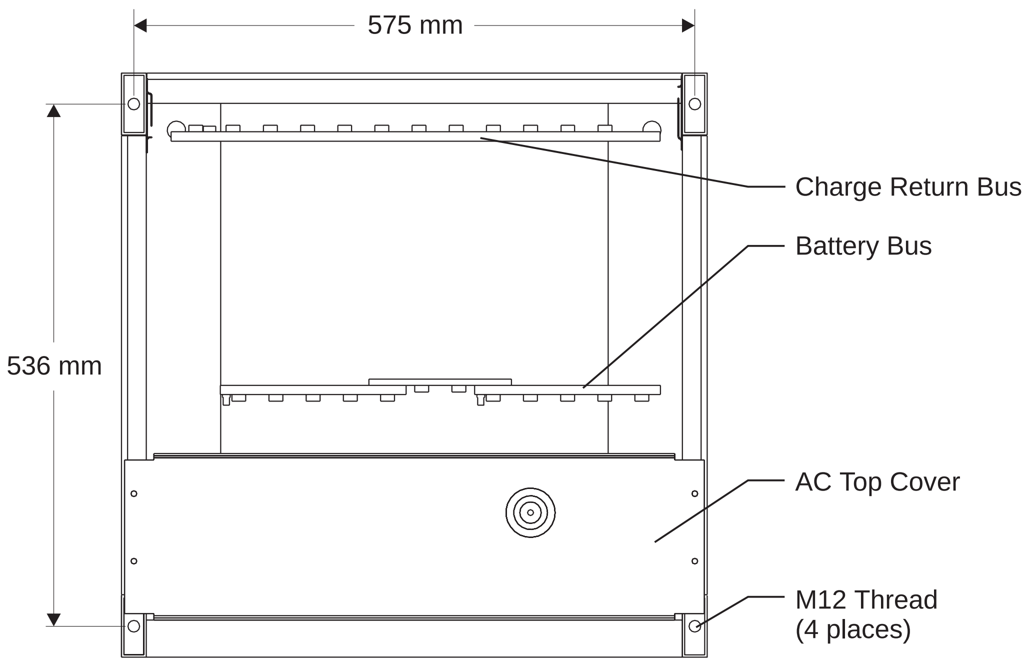


Figure 5-3: Top View of Cabinet

Connecting Main Rectifier Cabinet to Supplemental Distribution Cabinet

When a List 9 Supplemental Distribution Cabinet is ordered, one busbar (847442688) and associated hardware is shipped loose for interconnecting the Main Rectifier Cabinet, List 1, and the Supplemental Distribution Cabinet. This busbar interconnects the charge bus in each cabinet, and is installed as shown in Figure 2-17. When a battery disconnect or OLE panel is installed in the supplemental cabinet, a second busbar (847442670) and associated hardware is shipped loose for interconnecting the battery bus in each cabinet, as shown in Figure 2-17.

Connecting AC to the Global Power System

The procedure for wiring ac to the Global Power System is as follows.

Warning

Hazardous ac voltage. Extreme caution should be exercised when performing this procedure.

1. Open door of ac circuit breaker box located at the top of the cabinet.

2. Install conduit to top of ac circuit breaker box by removing the proper size knockout. Top of box can be removed to ease removal of knockout.

3. Run wires through conduit and into the ac circuit breaker box.

Note

If system is equipped with List 12, AC Monitor Circuit Lines 1, 2, and 3 must be run through transformers TA1, TA2, and TA3, respectively, located behind the circuit breakers. See paragraph “AC Monitoring Setup and Controller Programming.”

4. Terminate Earth Ground and Neutral (wye configuration only) to appropriate distribution blocks using the 1/2-inch Allen wrench furnished with the cabinet.

5. Terminate Lines 1, 2, and 3 to appropriate taps.

6. Check that all rectifier circuit breakers are turned off (down) before applying main ac power.

7. Turn main ac circuit breaker on.

8. Use an ac voltmeter to check that proper ac voltage is present.

9. Close door to ac circuit breaker box.

10. Proceed to paragraph “Installing a Rectifier.”

Installing a Rectifier

The procedure for installation of a rectifier in an operating or new system is as follows:

1. Remove the fuse clip cover from the selected RSA rectifier mounting slot.

2. Set POWER switch on rectifier to be installed to STBY position.

3. Set DC OUTPUT circuit breaker on rectifier to be installed to OFF.

4. Slide the rectifier front cover (part of RSA) out from under the RSA guide pin (Figure 5-4). The cover and attached ribbon cable connectors must be out of the way of the rectifier.

5. Place rectifier at the selected RSA rectifier slot. The rectifier must be horizontal and at the correct height so that it rests on the top of the RSA.

6. Grasp the two front handles and carefully slide the rectifier toward the back panel of the RSA. Push until seated. The front edge of the rectifier (not including cover) should overhang the RSA by approximately 6.5 mm.

7. Use the 5 mm Allen wrench to turn the recessed rectifier locking screw (located in the lower right corner of the rectifier) clockwise until the screw is firmly seated.

8. Mate the ribbon cable from the RSA with the receptacle on the rectifier.

9. Snap the front cover into place on the rectifier.

10. Proceed to paragraph “Initial Start-up and Checkout.”

Disconnecting a Rectifier

Refer to Figure 2-3 and proceed as follows:

1. On the rectifier to be removed, set the DC OUTPUT circuit breaker to OFF and the POWER switch to STBY.

2. Disconnect the ribbon cable plug connector from the receptacle. Remove the rectifier cover by grasping firmly and pulling outward.

3. Insert the 5 mm Allen wrench in the rectifier locking screw opening. Turn the locking screw counterclockwise until the screw turns freely.

4. Grasp the front panel handles and slide/pull rectifier from the RSA.

Note

Due to energy storage in the rectifier, the front panel LEDs will remain lit for approximately one minute after removal of ac voltage. No hazardous voltages exist on the rectifier terminals during this time.

Initial Start-up and Checkout

This paragraph describes the testing procedure for both newly installed or replacement rectifiers. The rectifier installation test must be performed after controller tests have been completed. Occasional references will be made to tables and figures in Section 2.

Electrical Testing for Rectifiers

The following procedures can be used to verify that the rectifiers are working either after initial installation, subsequent addition, or replacement of a rectifier. For troubleshooting and diagnostics, refer to Section 6. Those unfamiliar with the function of rectifier controls and indicators should read Section 2.

DANGER

Before turning on any rectifier, be sure that the associated framework and cable rack are properly grounded per local job instructions and code requirements.

Background Information

Voltage required to operate the indicators on the rectifier, as well as some of the relays, is derived from the ac input voltage. The ac voltage is available to these circuits whenever ac service is available to the rectifier.

Selection of Internal Selective High Voltage Shutdown Level

The rectifier Internal Selective High Voltage Shutdown feature is disabled when a controller is present since the controller provides this feature. However, this voltage level should still be set correctly to avoid false shutdowns in the event the controller is removed for maintenance, repair, or replacement. This level should be set at least 1.5 volts above the normal float voltage to avoid false shutdowns. See Figure 2-6 for location of DIP switches. Set the DIP switches according to the table printed on the face of the rectifier. This table is reproduced in Figure 2-5.

Selection of Backup High Voltage Shutdown Level

The backup high-voltage shutdown circuit protects the rectifier and its loads in the event of a high-voltage condition. The rectifier shuts down when its output voltage exceeds a user-selected threshold programmed by DIP switches in the rectifier. These DIP switches are set in the factory to shut the rectifier down when output voltages reach 59.5 ±0.5 volts, a typical value for telecommunications rectifiers. Two additional DIP switch settings are provided to increase user flexibility. To reduce the HVSD threshold below the value typical of telecommunications rectifiers, set the DIP switches according to Figure 2-5.

Enabling/ Disabling of Load Sharing

The load share feature of the rectifier can be enabled or disabled through DIP switch position 5 located on the front of the rectifier. Set it according to Figure 2-5. The factory setting is enabled.

Initial Power-up and Adjustment

Set the ac supply and rectifier controls as follows:

- Associated ac circuit breaker ON at the ac circuit breaker box at the top of the cabinet

- Rectifier POWER switch to STBY and DC OUTPUT circuit breaker lever to OFF

1. Insure the controller is set for the rectifier to be enabled and in float mode (refer to paragraph “Controller and Low Voltage Disconnect Setup, Wiring, and Test” if necessary).

2. Verify that only the following LEDs are lit on the rectifier: POWER STBY, CB OFF.

3. At the rectifier, set the POWER switch to ON. Verify that only the following LEDs are lit: POWER ON, CB OFF. Check that the OUTPUT CURRENT display reads 00.0.

Note

> If the LED's status is not as specified, refer to Section 6 for troubleshooting help.

4. Connect the DMM to the PLANT (+) and (-) test jacks on the rectifier. If batteries are present or if other rectifiers in the plant are ON and adjusted properly, the meter should read the proper plant voltage. If there are no batteries or other rectifiers ON, the meter should read zero.

5. Connect DMM to the RECT (+) and (-) test jacks. The meter reading represents the rectifier output voltage produced with the DC OUTPUT circuit breaker in the OFF position. (See Notes below.) Using a jeweler's screwdriver, adjust the VOLTS ADJ - FL potentiometer until the desired plant voltage level is obtained. The meter reading should match the value read at the PLANT (+) and (-) test jacks.

Note

> If plant voltage is present, the voltage appearing at the RECT test jacks is never less than 1.5V below the plant voltage, even with the rectifier turned off. When adjusting the rectifier, it may take many turns before the voltage at the rectifier test jacks begins to change. At this time do not close the DC OUTPUT circuit breaker.

6. Repeat Steps 2-5 for all rectifiers to be put on line at this time.

7. If the plant is not to be configured for equalize operation, proceed to Step 16.

8. At the controller, put the rectifier in equalize mode. (Refer to paragraph "Equalize Enable/Disable.")

9. At the rectifier, verify that only the following LEDs are lit: POWER ON, CB OFF, EQ. Check that the OUTPUT CURRENT display reads 00.0.

Note

> If the LED's status is not as specified, refer to Section 6 for troubleshooting help.

10. Connect the DMM to the PLANT (+) and (-) test jacks on the rectifier. If batteries are present or if other rectifiers in the plant are ON and adjusted properly, the meter should read the proper plant voltage. If there are no batteries or other rectifiers ON, the meter should read zero.

11. Connect the DMM to the RECT (+) and (-) test jacks. The meter reading represents the rectifier output voltage produced with the DC OUT circuit breaker in the OFF position. (See Note below.) Adjust the VOLTS ADJ - EQ potentiometer using a jeweler's screwdriver until the desired plant equalize voltage level is obtained. The meter reading should match the value read at the PLANT (+) and (-) test jacks.

Note

> If plant voltage is present, the voltage appearing at the RECT test jacks is never less than 1.5V below the plant voltage, even with the rectifier turned off. When adjusting the rectifier, it may take many turns before the voltage at the rectifier test jacks begins to change. At this time do not close the DC OUTPUT circuit breaker.

12. Repeat Steps 9 through 11 for all rectifiers to be put on line at this time.

13. Set the DC OUTPUT circuit breaker on all rectifiers to be put on line to the ON position. Verify that the CB-OFF LED is extinguished. If the plant is delivering load current, verify that all on-line rectifiers are delivering current (if not, see Note below). In addition, for plants configured for load sharing, verify that the plant load is divided among the rectifiers within specifications (10% of rating) as indicated on the rectifier OUTPUT CURRENT display.

14. Verify that only the EQ and ON LEDs are lit on each rectifier put on line.

Note

- Because of the sharing of the dc bus between rectifiers on an RSA, a rectifier's RECT test points may read higher than the PLANT test points although the rectifier is not producing any current.
- In some operational instances, the OUTPUT CURRENT display on a rectifier may read 00.0 amperes. This in not a malfunction condition. It signifies that another rectifier is taking all the load. Refer to paragraph "Full Load Testing."

Note

If the LED's status is not as specified, refer to Section 6 for troubleshooting help.

15. Return the rectifiers to float mode by setting the appropriate controller switch.

16. Set the DC OUTPUT circuit breaker on all rectifiers to be put on line to the ON position. If the plant is delivering load current, verify that all on-line rectifiers are delivering current. In addition, for plants configured for load sharing, verify that the plant load is divided among the rectifiers within 10 amperes as indicated on the rectifier OUTPUT CURRENT display.

17. Verify that only the ON LED is lit on each rectifier put on line.

Note

If the LED's status is not as specified, refer to Section 6 for troubleshooting help.

Performance Testing

When load sharing is disabled, it is perfectly normal for one rectifier to be fully loaded and another producing no current. However, the following tests can be done to insure that all rectifiers are capable of producing current. These tests may be performed when the plant is in float or equalize mode and with the rectifiers in or out of loadshare mode.

No Load Testing (NL)

This test is typically done on rectifiers that have load share disabled. This test can be performed on a rectifier that is producing any output current.This test should not be performed on a plant consisting of only one rectifier.

1. Press and hold the RECT TEST switch in the NL position.

2. Observe that the reading on the OUTPUT CURRENT display of the rectifier decreases in value and the readings on the other rectifiers increase.

Note

It is normal for rectifiers not in load share to share load very unevenly; it is also possible that the rectifiers are misadjusted. Rectifiers not running in load share mode can be adjusted with the circuit breaker closed. Rectifiers may also be adjusted so that some carry the majority of the load with remaining units functioning as hot spares.

3. If the rectifier's current does not decrease when the RECT TEST switch is in the NL position, turn the applicable potentiometer (FL or EQ) fully counterclockwise. If the rectifier is still producing a disproportionate amount of current, press and hold the RECT TEST switch in the NL position. If the rectifier's current does not decrease, replace the rectifier according to procedures outlined in paragraphs "Installing a Rectifier and "Disconnecting a Rectifier." If the rectifier's current does decrease, readjust its output according to the procedures outlined in paragraph "Initial Start-up and Checkout."

Full Load Testing (FL)

This test can be performed on a rectifier producing no output current although the other rectifiers on line are producing full output current. This test should not be performed on plants consisting of only one rectifier.

1. Press and hold the RECT TEST switch in the FL position.

2. Observe that the reading on the OUTPUT CURRENT display of the rectifier increases in value and the readings on the other rectifiers decrease.

3. If the rectifier's current does not increase when the RECT TEST switch is in the FL position, turn the applicable

potentiometer (FL or EQ) fully clockwise. If the rectifier is still producing no current, press and hold the RECT TEST switch in the FL position. If the rectifier's current does not increase, replace the rectifier according to procedures outlined in paragraphs "Installing a Rectifier" and "Disconnecting a Rectifier." If the rectifier's current does decrease, readjust its output according to the procedures outlined in paragraph "Initial Start-up and Checkout."

Lamp Test The following test may be used to determine if all front panel LEDs and the display are functioning properly.

1. Place the rectifier in the STBY mode.

2. Press the NL/FL switch in either direction.

3. While the NL/FL switch is pressed, all front panel LEDs should be illuminated and the meter should light and display -1888.

Adding an RSA to an Operating Plant

DANGER

Hazardous dc currents are present. These currents may cause serious burns or death. To minimize risk:

1. Only persons trained and experienced in the installation of power equipment should perform this installation.

2. The tasks should be performed only in the sequence given.

3. Use insulated tools. Remove rings, watch, and other jewelry.

4. Before contacting any uninsulated conductor surfaces, always use a voltmeter to ensure that either no voltage or the expected voltage is present.

Before installing a rectifier shelf in the J85500L-1, verify that no distribution panels are installed behind the lowest mounted hinged door. Remove and discard the hinged door and its mounting brackets. Also remove and discard the L-shaped bus bar connected to the right vertical bus bar.

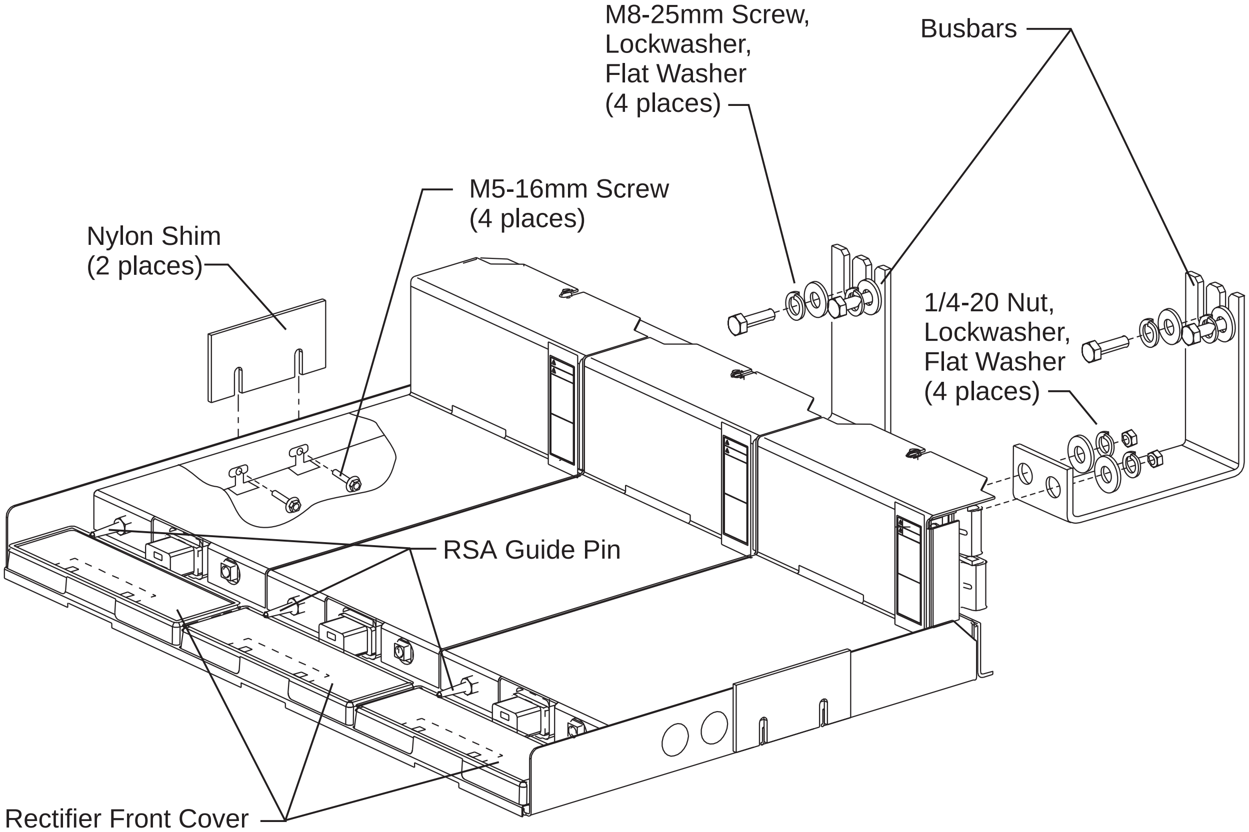


Figure 5-4: Rectifier Shelf Installation

1. Refer to Figure 5-4. Mount the bus bars onto the RSA as shown in the rear view of the RSA. Secure using the 1/4-20 hardware, and torque to 50 in-lb (5.6 Nm).
2. Remove the three black RSA rectifier slot covers.
3. Attach the four M5-16 mm screws and the two nylon shims to the lowest available cabinet position. Do not tighten.
4. Remove the four black plugs from the snap-on covers of the ac wiring channels. Insert the four black snap bushings on the inside of the ac channel into the installed shelf.

5. Place the RSA in the cabinet, above the four mounting screws and lower into position. The shims should be positioned between the rectifier and the cabinet.

6. Push the RSA back so that the RSA bus bars make contact with the cabinet bus bars at the back of the cabinet.

7. Secure the RSA bus bars to the vertical cabinet bus bars using M8-25 mm hardware. Torque to 160 in-lb (18 Nm).

8. Secure the four M5-16 mm screws using a small socket or wrench. Torque to 35 in-lb (4 Nm).

9. The J85500L-1 is factory wired with ribbon cables from the controller to each RSA slot. Locate and connect the cable to the RSA interface connector located on the right rear of the RSA.

10. The rectifier positions should be numbered in the J85500L-1 from right to left and from bottom to top to correspond to the locations assigned to rectifiers by the controller software. See Figure 5-5. Apply the appropriate rectifier labels to the face of the rectifier front cover.

11. Remove the snap-on covers of the left and right ac channels from the installed shelf up to the ac box.

12. Verify that all unused ac circuit breakers are in the open (down) position.

13. The 847001195 cable assembly includes the wiring required to connect ac to the shelf. Wiring is 10 gauge (2.5 mm^2) and color coded for easy reference as follows:

Earth Ground	Green/Yellow
Neutral	Blue
Line 1	Brown
Line 2	Black
Line 3	Black/White

14. Route wiring for rectifier positions 7, 10, and 11 down the right channel and rectifier positions 8, 9, and 12 down the left channel as required. Route ac wiring into rectifier shelves through the black snap bushings and connect to shelf as shown in Figure 2-16. AC wiring should be completed for all rectifier positions on the shelf.

15. Route cable into ac box and cut wires as required to connect Line 1 to ac breaker 7 or 10, Line 2 to ac breaker 8 or 11 and Line 3 to ac breaker 9 or 12. Connect all ground and neutral leads to their respective distribution blocks.

16. Secure the three black RSA covers over the rectifier wiring.

17. Snap on the covers of the ac channels.

18. Close the ac circuit breakers to positions in which a rectifier will be installed.

19. Refer to paragraph “Installing a Rectifier.”

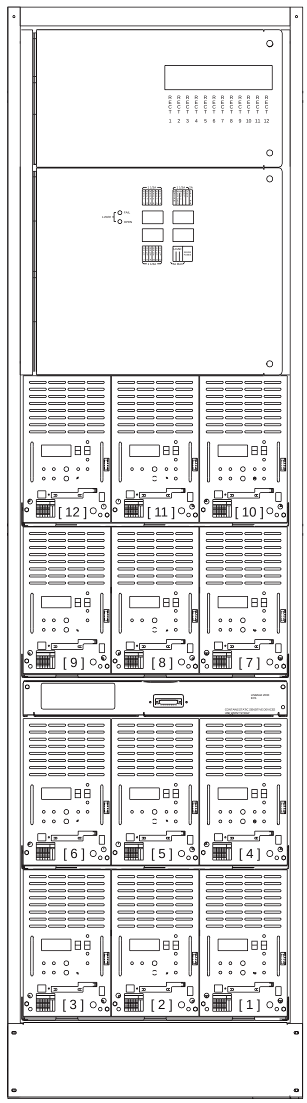


Figure 5-5: Rectifier Locations in J85500L-1

Controller and Low Voltage Disconnect Setup, Wiring, and Test

Hardware Setup

Caution

Circuit packs can be damaged by static electricity. Operators should always wear a grounded wrist strap plugged into the controller front panel when touching or handling circuit packs.

There are jumper straps located on the backplane, the 113B Control Unit (CP1), and the LVD/Fuse Board (CP5) that must be set properly before powering the controller. These jumpers are set at the factory with proper settings for the Global Power System. Please note that all jumpers are numbered from right to left.

Caution

Applying power to the controller when jumper straps are improperly arranged may damage the controller circuit packs.

In addition to the jumpers, several DIP switches should be set before applying power. Incorrect switch settings, however, will not damage the unit. Table 5-B summarizes the factory default settings for user selectable options. Open the controller front panel and pull out the drawer.

Table 5-B: Default Settings for Controller Jumpers and Switches

Board	Header	Jumper Pins	Function
Backplane 846575280	P602.1	2 and 3	-48 volts
	P602.2		
	P602.3		
	P602.4		
CP1	P105	1 and 2	Restart enabled
	P106	1 and 2	Equalize disabled
	P108	1 and 2	For SR series rectifiers
CP4 (113B display)	P401	1 and 2	Shunt size less than 1000A
CP3	P302	2 and 3	-48 volts
CP5	P505.1 P505.2	1 and 2	-42.5 volts low voltage disconnect

SWITCH SETTINGS (0 = Open, 1 = Closed)

Board	Switch	Function	-1	-2	-3	-4	-5	-6
CP1	SW101	HV/EQ Level (-57 volts)	1	1	0	0	1	0
	SW102	HV/FLLevel (-55 volts)	1	1	0	0	1	0
	SW103	BD Level (-53 volts)	1	0	0	0	1	0
	SW109	600A Shunt	1	0	0	0	0	0

Operating Voltage

There are four jumpers, P602-1, 2, 3, 4, for voltage selection on the controller backplane. Verify that all of the jumpers are in the -48V position.

Verify that DIP switch position 6 on SW101, SW102, and SW103 is set for 48 volts (open position). See Figure 2-9.

Equalize Enable/Disable

The equalize jumper, P106, shown in Figure 2-9, is factory set in the DISABLE position (pins 1 and 2). If the plant is equipped with flooded-type batteries, this jumper may be moved to the ENABLE position (pins 2 and 3). When equalize is enabled, the front panel switch and other equalize control methods can be used to initiate equalize charging. If the jumper is removed or misplaced, equalize is DISABLED.

Automatic Restart Enable/Disable

The restart jumper, P105, is factory set in the ENABLE position (pins 1 and 2). See Figure 2-9. This setting allows the controller to attempt to restart rectifiers after a high voltage shutdown. For one rectifier plant without battery reserve, the jumper should be moved to the DISABLE position (pins 2 and 3). Manual intervention will be required to restart the rectifier in such an application.

Caution

If the P105 jumper is removed or lost, the automatic restart function is DISABLED.

Ammeter Scale

DIP switch SW109 is used to select the scale for the plant current meter. The Global Power System is equipped with a 600-ampere plant shunt and the controller preset to the proper ammeter scale. Use the label on the CP1 cover plate or Figure 2-10 to check the DIP switch settings versus the plant shunt rating. Verify that position 1 on SW109 is closed and that positions 2, 3, 4, 5, and 6 are open.

Battery on Discharge Threshold

The voltage threshold for the BD alarms is set with DIP switch SW103. (See Figure 2-9.) Refer to the label on the CP1 cover plate or Figure 2-10 for the DIP switch setting for the desired alarm threshold. The recommended threshold is approximately 1.0 volt below the float voltage for nominal 48-volt plants.

High Voltage Shutdown Thresholds

The controller is equipped with two separate high voltage shutdown thresholds. The first is used during normal float operation. The second threshold is used when the plant is in equalize mode. The float shutdown is set with DIP switch SW102 on CP1. (See Figure 2-9.) The equalize shutdown is controlled by settings on DIP switch SW101 on CP1. The equalize shutdown level does not need to be set if equalize is hardware disabled (see paragraph “Equalize Enable/Disable”). The recommended shutdown levels are approximately 1.0 volts above operating voltage for nominal 48-volt plants. The actual operating voltages in float and equalize modes are determined by the battery manufacturer’s recommendations and by any restrictions imposed by the load equipment. The factory setting is -57 volts.

Rectifier Restart Group Isolation

The Global Power System is equipped with all SR-series rectifiers, and the controller's two restart signals should not be isolated from each other. Jumper P108 should be placed across pins 1 & 2.

Caution

If jumper P108 is removed or lost, the restart signals are isolated. In this configuration all SR-series rectifiers may not self-restart after HV shutdown.

Low Voltage Disconnect Threshold (Optional)

The LVD/Fuse Board (CP5), illustrated in Figure 2-12, provides both controller power fusing and the low voltage battery disconnect/reconnect function. The latter is an optional feature. If the plant is not equipped with an LVD contactor as part of the plant distribution (List 2), the disconnect feature of the LVD/Fuse Board is not relevant. If the plant is equipped with low voltage disconnect/reconnect, the disconnect voltage threshold must be selected by placing jumpers J505.1 and J505.2 across pins 1 and 2 for 42.5 ±0.5 volts or pins 2 and 3 for 40.5 ±0.5 volts. The disconnect voltage is factory set at 42.5 ±0.5 volts.

Basic Controller Wiring (CP1)

Each circuit pack in the controller may require connection to systems outside the power plant or to other parts of the power system. The user must provide these connections. This paragraph addresses the wiring of the CP1 controller circuit pack.

The installer wiring associated with the basic controller is connected to four removable terminal blocks on the 113B Control Unit. The types of signals on these terminal blocks fall into four categories:

- Alarm Outputs (BD, HV, ACF, LV, MJF, MNF, PMJs, and PMNs)
- Alarm Inputs (RMJ, RMN, and OS)
- Control Inputs (TEQ, TEL, TF/ER, and TRs)
- Miscellaneous Outputs (ABS and DG)

Three of the four terminal blocks (TB102, TB103, and TB104) are assigned to the various office alarm outputs from the controller. Terminal block TB101 has the connection points for the remaining three categories of office interfaces. The signal on each terminal is indicated on the label inside the controller front panel. Refer to Table 5-C for a list of terminal block pin assignments.

Table 5-C: CP1 Terminal Block Pin Assignments for 113B Control Unit

Pin No.	Designation	Definition
TB101-1	DC	Discharge Ground
TB101-2	TF/ER	Timer Float/Equalize Return
TB101-3	OS	Open String Alarm
TB101-4	RMJ	Ringer Major Alarm
TB101-5	RMN	Ringer Minor Alarm
TB101-6	TEQ	Timer Equalize
TB101-7	TFL	Timer Float
TB101-8	ABS	Alarm Battery Supply
TB101-9	TR1	Transfer Shutdown from Engine
TB101-10	TR2	Transfer Shutdown from Engine
TB101-11	TR3	Transfer Shutdown from Engine
TB101-12	TR4	Transfer Shutdown from Engine
TB102-1	BDEC	Battery on Discharge External, alarm causes closure
TB102-2	BDER	Battery on Discharge External, return
TB102-3	BDEO	Battery on Discharge External, alarm causes open
TB102-4	HVEC	High Voltage External, alarm causes closure
TB102-5	HVER	High Voltage External, return

Table 5-C: CP1 Terminal Block Pin Assignments for 113B Control Unit

TB102-6	HVEO	High Voltage External, alarm causes open
TB102-7	ACFEC	AC Fail External, alarm causes closure
TB102-8	ACFER	AC Fail External, return
TB102-9	ACFEO	AC Fail External, alarm causes open
TB102-10	LVC	Low Voltage Contactor Closed
TB102-11	LVR	Low Voltage Contactor Return
TB102-12	LVO	Low Voltage Contactor Open
TB103-1	PMNAC	Power Minor Audible, alarm causes closure
TB103-2	PMNAR	Power Minor Audible, return
TB103-3	PMNAO	Power Minor Audible, alarm causes open
TB103-4	PMNEC	Power Minor External, alarm causes closure
TB103-5	PMNER	Power Minor External, return
TB103-6	PMNEO	Power Minor External, alarm causes open
TB103-7	MNFEC	Fuse Alarm Minor, External, alarm causes closure
TB103-8	MNFER	Fuse Alarm Minor, External, return
TB103-9	MNFEO	Fuse Alarm Minor, External, alarm causes open
TB103-10	PMNVC	Power Minor Visual, alarm causes closure
TB103-11	PMNVR	Power Minor Visual, return
TB103-12	PMNVO	Power Minor Visual, alarm causes open

Table 5-C: CP1 Terminal Block Pin Assignments for 113B Control Unit

TB104-1	PMJAC	Power Major Audible, alarm causes closure
TB104-2	PMJAR	Power Major Audible, return
TB104-3	PMJAO	Power Major Audible, alarm causes open
TB104-4	PMJEC	Power Major External, alarm causes closure
TB104-5	PMJER	Power Major External, return
TB104-6	PMJEO	Power Major External, alarm causes open
TB104-7	PMJVC	Power Major Visual, alarm causes closure
TB104-8	PMJVR	Power Major Visual, return
TB104-9	PMJVO	Power Major Visual, alarm causes open
TB104-10	MJFEC	Fuse Alarm Major, External, alarm causes closure
TB104-11	MJFER	Fuse Alarm Major, External, return
TB104-12	MJFEO	Fuse Alarm Major, External, alarm causes open

Alarm Outputs

The alarm outputs (BD, HV, ACF, LV, PMNA, PMNV, PMNE, PMJA, PMJV, PMJE, MNF, and MJF) are clean transfer contacts and are described functionally in Section 2. Most office alarm systems are designed for EITHER closure-on-alarm or open-on-alarm, requiring two wires from each controller alarm that is used.

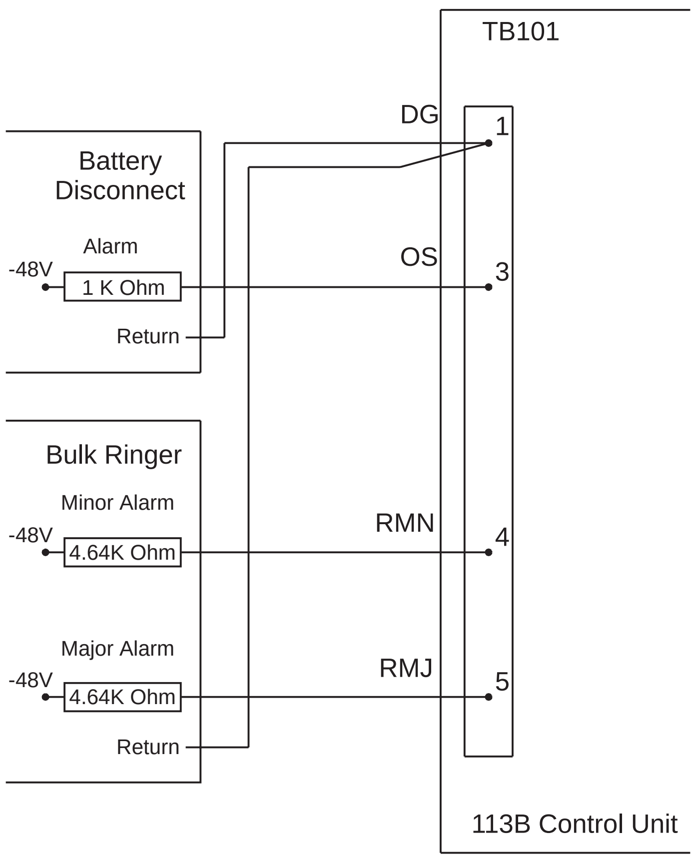
Alarm Inputs

The three alarm inputs (RMJ, RMN, and OS) are compatible with battery voltage on alarm signals, current-limited by resistors. These alarm inputs are general purpose. They can be used to detect alarm conditions from any auxiliary plant equipment, such as ringer, converter, inverter, etc. The subsystems generating those alarms must be powered off the same battery and ground system as the controller (i.e., the dc distribution bus bars). A typical application is shown schematically in Figure 5-6. Note that the resistor value for OS is 1000 ohms and the values for RMN and RMJ are 4,640 ohms.

Control Inputs

The control inputs from an external equalize timer panel (TEQ, TFL, and TF/ER) must be connected to clean contacts with a common return (TF/ER). A momentary closure between TEQ and the common return starts equalize. A momentary closure between TFL and the return stops equalize.

The TR inputs from the external rectifier sequence controller should be contact closures to discharge ground (DG) to turn off rectifier groups.



RMN and RMJ are general purpose alarm inputs that can be used for auxiliary equipment.

Figure 5-6: Typical Alarm Applications

Miscellaneous Outputs

The miscellaneous signals are basically power (ABS) and ground (DG) to drive the office alarm system and some of the control inputs to the controller.

The terminal blocks accept 22- to 24-gauge stranded wire. Wire terminals are not used. The wire ends are stripped and clamped directly in the terminal blocks. Multiconductor 24-gauge jacketed cable or 22-gauge twisted pair wire is recommended.

1. Select the desired alarms and other signals. Determine the total number of wires to be connected to the terminal blocks.

2. Select the configurations of cable and/or twisted pairs based on the number of signals that are to be directed as a group to different locations in the office.

3. Route the total wire bundle for CP1 through the opening on the left side of the chassis.

4. Allow for slack in the cable loop outside of the controller so that the controller drawer will slide out freely to its full extent. Approximately 8 inches (200 mm) of cable will be needed.

5. Strip back the cable jacket(s), if present, approximately eight inches (200 mm) so that the individual wires reach their terminal block positions with no tension on any wire.

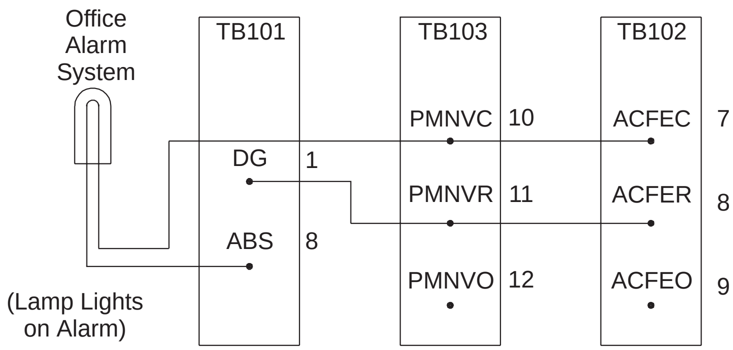
6. Tape the ends of all extra (spare) wires that are not to be connected during the initial installation.

7. Strip the remaining wires approximately 1/4-inch (5 mm), insert in their respective terminal positions, and tighten the terminal block screws. Terminal blocks may be removed from the control unit for this step, if desired. Note that the terminal blocks are each polarized differently and are therefore not interchangeable.

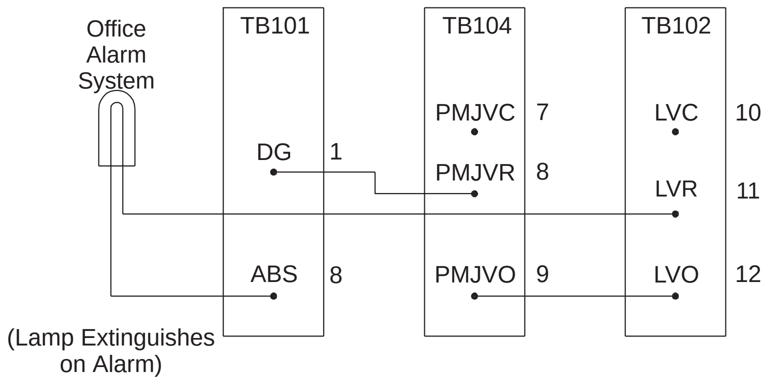
8. Slide the drawer in and out to ensure that the amount of cable slack is adequate. When the desired length is found, tie off the cable bundle with the wire ties and tie anchor points provided with the controller.

9. Connect Alarm Battery Supply and Discharge Ground to alarm contacts as required to power the office alarms.

Alarms, such as ACF, should be combined with other alarms, as required, at this point. If closure-on-alarm contacts are used, alarms should be wired in parallel. If open-on-alarm contacts are used, the alarms should be wired in series. Figure 5-7 shows some examples of typical alarm wiring.



(A) AC Fail Paralleled with Power Minor Visual Alarm for Closure-on-Alarm Type System



(B) Low-Voltage Disconnect Open Alarm in Series with Power Major Visual Alarm for Open-on-Alarm Type System

Figure 5-7: Typical Alarm Wiring

Microprocessor Controller (CP2) and Datalogger Board (CP3) Wiring

See Product Manual 167-790-109, Lineage® 2000 ECS Controller Options, for installation, wiring and use of the optional expansion boards.

Circuit Pack Installation

Caution

Circuit packs can be damaged by static electricity. Operators should always be grounded when handling circuit packs. Connect the grounding wrist strap to the ESD ground plug on the controller front panel.

When replacing a circuit pack or adding a new circuit pack to a controller that is in service, the circuit pack hardware must first be set up according to “Hardware Setup.”

1. To install a circuit pack, simply open the controller front panel, pull out the drawer, and slide the board along its guide rails into the proper slot. Backplane connectors are arranged so that circuit packs cannot be inserted in the wrong slots.

2. If the multiplexing board (BCC1) must be replaced, open the front cover and pull out the drawer. Unplug any field wiring connected to CP1, CP2, or CP3 by lifting the terminal blocks off the board.

3. Lifting the front of the drawer, pull it out of the controller chassis completely and unplug the two ribbon cables at the multiplexing board BCC1 (P705 and P706) and the green ground lead.

4. Unplug the remaining ribbon cable connections to the board, noting the location of each so that they can be reconnected later. The multiplexing board is mounted to the chassis by five screws. The controller chassis can be removed from the frame if necessary for access to the

board. Replace the board and reconnect ribbon cables and ground wire as they were.

Acceptance Testing

The ECS controller is tested as a unit and as a part of a battery plant system in the factory. This part of the manual is provided for those users who wish to repeat some of those test procedures as part of the installation and turn-up process. Most of these tests should not be performed while the plant is powering active loads.

Test procedures:

- Meter calibration
- Battery on Discharge Alarm test*
- Float/Equalize Control test
- High Voltage Shutdown/Restart tests*
- Fuse Alarm tests*
- Remote ON/OFF (TR signal) test*
- Ringer Alarm test*
- Low Voltage Battery Disconnect test*

*These tests are not suitable for plants in service.

Test equipment required:

- Dummy load - 50 amperes at 48 volts
- Multimeter
- Jeweler's screwdriver
- Flat-blade screwdriver
- Blown fuse (Bussman GMT type)
- Resistor, 4.64k ohm, 1 W minimum, 5%
- Short length of 22- to 26-gauge wire [4 inch (100 mm) maximum]
- Power supply, adjustable 0-60 volts dc, 1 ampere, with clip leads.

Unless otherwise indicated in the test procedures, at least one rectifier must be on line in batteryless plants.

Meter Calibration

The controller voltmeter has an accuracy of 0.05% and a resolution of 1 digit. To accurately assess the calibration of the voltmeter, an external meter with better than 0.05% accuracy is needed. If such a meter is not available, only a rough assessment of the controller meter calibration can be achieved. The controller meter is factory calibrated and should not be adjusted in the field unless it is obviously outside the tolerance of the external meter.

If calibration is needed, set the meter select switch to the VOLTS position. Adjust Potentiometer R407 on CP4 meter board.

Battery on Discharge Alarm Test

Note

This test cannot be performed on a live plant powering active loads. If possible, batteries should be disconnected from the plant to allow the plant voltage to be reduced easily.

1. Identify the BD threshold level set on DIP switch SW103.

2. Turn off all rectifiers but one. Verify that the rectifier is delivering power and that only the NORM LED is lit on the controller.

3. Set the controller meter select switch to the VOLTS position and verify that the plant voltage is above the BD threshold.

4. Adjust the dummy load to draw at least 5 amperes.

5. Adjust the rectifier output voltage down until the BD LED on the controller lights. This should occur at the set threshold.

   If Step 5 fails to produce the desired result, recheck the SW103 setting, raise the plant voltage back to normal, and repeat Step 5 by adjusting the rectifier voltage down slowly. Refer to Section 2 for voltage adjustment procedures.

6. With the BD alarm present, check with a multimeter or with the office alarm system (if connected) that the following alarms are present on the controller terminal blocks:

   BDE, PMJE, PMJV, and PMJA

The terminal block positions are listed on a label inside the controller or see Table 5-C.

7. Slowly adjust the rectifier output voltage back up to normal, observing that the BD LED extinguishes at the correct voltage level within the specified tolerance. The green NORM LED should light when the BD LED goes out.

8. Check the office alarms on the CP1 terminal blocks to verify that no alarms are present.

Float/Equalize Control Test

If the equalize function is disabled on CP1 or if the plant is not equipped with equalize-capable rectifiers, skip this test. The dummy load is not required for this test.

1. Use the front panel switch to put the plant in equalize mode. Verify that the equalize LED lights on the controller and that the rectifiers change to their equalize voltage settings. Readjust the equalize voltage of each rectifier, as required. (Refer to Section 2 for voltage adjustment procedures.)

2. Return plant to float mode with the front panel switch. The equalize LED should extinguish.

3. Momentarily short together pins 2 and 6 on TB101 on CP1 with a piece of wire. This simulates an equalize initiation signal from an external timer panel. Verify that the equalize LED lights and the rectifiers change to equalize mode.

4. Momentarily short pins 2 and 7 on TB101 with a piece of wire. This should stop equalize and return the plant to float mode.

High Voltage Shutdown/Restart Test

1. Identify the HV shutdown threshold for float operation on DIP switch SW102. For best results, rectifiers should be set to Non-Load Share mode.

2. Turn on all rectifiers and adjust the dummy load so that each rectifier delivers more than 10% of its full load current.

3. Set the controller meter to read VOLTS, and verify that the green NORM indicator is the only LED that is lit on the controller.

4. At any one rectifier, slowly adjust its output voltage up until it shuts down. This should occur at the specified HV shutdown threshold. Verify that the correct rectifier is shut down.

5. Note that the NORM LED goes out and the yellow RFA LED lights on the controller. If enough rectifier capacity is not still available to maintain the load, the red BD LED may also light.

6. Within ten (10) seconds of rectifier shutdown, the controller should automatically restart all rectifiers. The RFA LED should extinguish and the NORM LED should come on.

7. Since one rectifier is adjusted high, the controller should issue another shutdown signal when the plant voltage again reaches the HV shutdown threshold.

8. After the second shutdown, the controller should NOT automatically attempt to restart rectifiers.

Note

In batteryless plants, if all rectifiers are shut down the controller loses power and will attempt to restart rectifiers more than just once. The user should disable the automatic restart function in batteryless plants with only one rectifier. (See paragraph “Automatic Restart Enable/Disable.”)

9. With the rectifier(s) shut down, check the office alarm terminal blocks to verify that the following alarms are present:

   PMNE, PMNA, and PMNV

   If the BD LED is also lit, the following alarms should also be present on the terminal blocks:

   BDE, PMJE, PMJA, and PMJV

10. Readjust the misadjusted rectifier output voltage back down and restart any failed rectifiers manually (i.e., toggle the on/off switch). Once all rectifiers are back on line, perform the fine adjustment of the rectifier output voltage. (Refer to Section 2 for voltage adjustment procedures.)

11. Verify that only the NORM LED is lit on the controller. Reset the restart timer in the controller by pressing switch SW104, shown in Figure 2-9. This will prevent the controller from ignoring any HV shutdown that might occur in the next four to six minutes.

12. If the Float/Equalize function is disabled on CP1, this test is complete. If Float/Equalize is enabled, proceed with Step 13.

13. Identify the HV shutdown threshold for equalize operation on DIP switch SW101.

14. Use the front panel switch to put the plant in equalize mode and verify that the EQ LED lights. This LED should stay lit through the end of the test. The NORM LED is also lit at this point.

15. Repeat Steps 2 through 11 with the plant in equalize mode.

16. Return the plant to float mode using the front panel switch on the controller.

Fuse Alarm Tests

These tests may be performed with or without load on the plant. Notice that F501-F524 correspond to positions 1-24 as shown in Figure 2-13.

1. Locate the LVD/Fuse Board. Insert a blown fuse in place of F501. The MNF (Minor Fuse Alarm) LED on the controller front panel should light and the NORM LED should go out. With a multimeter, verify that the following office alarms are present on the appropriate terminal blocks on CP1:

   MNFE, PMNE, PMNA, and PMNV

2. Replace the blown fuse with a good fuse. The alarms should retire and the MNF LED extinguish.

3. Repeat Steps 1 and 2 for all minor fuses, including F502 through F509 and F513 through F518, on the LVD/Fuse Board.

4. Replace F510 with a blown fuse. The MJF (Major Fuse Alarm) LED should light, and the NORM LED should go out. Check the terminal blocks for the following major alarms:

   MJFE, PMJE, PMJA, and PMJV

5. Reinsert the good fuse, and note that the alarms retire and that LEDs return to normal.

6. Repeat Steps 4 and 5 for major fuses F511, F512, and F519 through F521.

7. For plants equipped with Battery String Disconnect Breakers Only, the Open String (OS) Alarm is hardwired from the controller terminal blocks to an auxiliary fuse alarm input on the LVD/Fuse Board. If OS is wired into the LVD/Fuse Board, turn one disconnect breaker off to verify that the desired MJF or MNF alarm and associated power alarms are issued. Turn the breaker back on and note that the alarms retire.

8. Repeat Step 7 for each battery string disconnect breaker.

Remote On/Off (TR Signal) Test

1. Attach one end of a piece of wire to Discharge Ground (DG) on pin 1 of TB101 on CP1. This wire will be used to ground the TR input signals to simulate a Rectifier Sequence Controller or other remote on/off device for controlling rectifiers.

2. Touch the free end of the wire, in turn, to each of the TR inputs on the terminal block pins listed below.

   Verify that the listed rectifier or rectifiers turn off. When the wire is removed, the rectifier(s) should restart automatically. Disconnect the lead from both ends when finished.

TB101	Pin #	Rectifier(s)
TR1	9	1, 5, 9
TR2	10	2, 6, 10
TR3	11	3, 7, 11
TR4	12	4, 8, 12

Bulk Ringer Alarm Test

This test involves connecting a lead with plant voltage from one point to another on the controller terminal blocks. Although this voltage is protected by the ABS fuse on the external fuse board, care should be taken to avoid touching and damaging components or printed wiring on CP1.

1. Connect one end of a 4640 ohm resistor to the Ringer Major Alarm input (RMJ) on pin 4 of TB101. Bend the free end clear of any metal parts (e.g., the chassis).

2. Attach one end of a piece of wire to the Alarm Battery Supply (ABS) on pin 8 of TB101.

3. Touch the free end of the wire to the free end of the 4640 ohm resistor. The NORM LED on the controller front panel should go out. With a multimeter or the office alarm system, if connected, verify that the following major alarms are issued:

   PMJE, PMJA, and PMJV

4. Disconnect the lead from the resistor and note that the alarms retire and the NORM LED turns on.

5. Remove the resistor from TB101 pin and connect it to the Ringer Minor Alarm input (RMN) on pin 5 of TB101.

6. Touch the wire to the free end of the resistor. Again, the NORM LED should extinguish and the following power minor alarms should appear on the controller terminal blocks or office alarm system:

   PMNE, PMNA, and PMNV

7. Disconnect the lead and the resistor from both ends when finished. Close the controller front panel.

Low Voltage Battery Disconnect Test

If the plant is not equipped with a low voltage battery disconnect contactor, skip this test.

1. Disconnect all battery strings from the plant bus bars.

2. Turn off all but one of the rectifiers.

3. Check the locations of the jumpers P505.1 and P505.2. Place both jumpers across pins 1 and 2 for a threshold of 42.5 ±0.5V or across pins 2 and 3 for a threshold of 40.5 ±0.5V.

4. Using the front panel VOLTS ADJ FL adjustment of the "on" rectifier, lower the rectifier's output voltage until the contactor opens. By monitoring the voltage shown on the controller's display, verify that the contactor opens in the voltage range selected by jumpers P505.1 and P505.2.

Note

As the power supply voltage decreases and approaches the disconnect threshold, the yellow LVD FAIL LED may light. This is normal and indicates that one part of the LVD circuit has reached its threshold before the other redundant circuit. If the yellow LED lights within the disconnect tolerance and then the contactor opens, also within the tolerance, the low voltage battery disconnect circuit is functioning normally.

5. After the contactor opens, temporarily place a shorting strap from the battery bus to the plant charging bus (i.e., across the contacts of the contactor) and verify that the red LVD/OPEN LED on the LVD/Fuse Board is lit. The strap is required because the red LVD/OPEN LED normally receives its power from the battery. Verify that the BD and MNF LEDs on the controller's front panel are also lit.

6. Adjust the "on" rectifier's output voltage up until the contactor operates. This should occur within 0.5V of where the contact opened. Verify that the MNF LED extinguishes.

7. Reconnect the batteries to the plant bus bars and adjust the "on" rectifier to its proper float voltage. The BD LED should extinguish.

Boost Charge Panel (BCP) Wiring and Test

Traditionally, Lucent Technologies has used the term "equalize" where others, particularly in international markets, have used the term "boost." Therefore, to avoid confusion, when the boost charge feature is ordered, labels (comcode 847542230) are provided to change designations on the rectifiers and ECS controller, as follows:

Unit	From	To
Float/Equalize Switch	**FLT/EQ**	**FLT/Bst**
Potentiometer - Volts Adj	**EQ**	**Bst**
ECS Control Panel LEDs	**EQ**	**Bst**
Rectifier LED	**EQ**	**Bst**

The J85501D-2 ECS-12 Controller's P106 header's jumper must be on pins 2 and 3 to enable the equalize (boost) function. See the J85501D-2 ECS-12 Controller product manual for more detailed information.

Set the boost voltage on each rectifier. Use the "Bst Adj" potentiometer on each rectifier to set the voltage according to plant requirements (normally 2.0 volts above the float voltage.)

Frame Ground

Both the BCP and Off-Line Equalize Panel (OLE, described in next section) are integrated into one panel in the J85500L-1. This integrated panel must be connected to frame ground to function properly.

1. Connect the frame ground by attaching an 18-gauge wire to the #8 stud on the rear of the mounting plate. Use the star lock washer between the lug and the mounting plate.

2. Connect the other end to the frame using a star lock washer between the lug and the frame. Frame ground may be connected at the factory.

All connections between the BCP and the rest of the plant has been prewired at the factory. Refer to Figures 18 and 22 of T83167-30 if performing a retrofit. The only field connection necessary to operate the BCP is the connection between wireset 847892957 and wireset 847911237. Both of these wire sets terminate in a 12-pin Mate-N-Lock connector. Wireset

847911237 originates in the Supplemental Distribution Cabinet, and wireset 847892957 originates in the Main Rectifier Cabinet (T83167-30 Figures 18, 22). The following sections summarize these connections.

PMJ, PMN, and BD Alarms from ECS

The ECS controller requires internal strapping in order for the BCP to register both Power Major (PMJ) and Power Minor (PMN) alarms. These strapping options are shown in the table below:

Alarm	From	To
PMJ	TB104-5	-48V Batt (TB101-1)
PMN	TB103-5	Disch Grd (TB101-8)

PMJ, PMN, and Battery on Discharge (BD) connections between the ECS controller and the BCP are shown in the table below:

Alarm	Lead	ECS	BCP
PMJ	Battery (-)	TB104-4	TB2-4
PMN	RTN (+)	TB103-4	TB2-3
BD	RTN (+)	TB102-1 TB102-2	TB2-1 TB2-2

Output Signals

Relay contacts provide the boost charge output signals for the ECS controllers, as shown in the following table:

Output Signal	BCP	ECS
BCP Fail	TB3-2	TB101-4
Boost Charge Start	TB3-5 and TB3-6	TB101-6 and TB101-2
Boost Charge Stop	TB3-7 and TB3-8	TB101-7 and TB101-2
To Remote Monitor	TB3-9 and TB3-10	To Remote Monitor

The points TB3-9 and TB3-10 on the BCP are used to provide a BCP status signal to an external monitoring system. If the contacts are open, the BCP is in “Float”; if the contacts are closed, the BCP is in “Boost.”

RO Alarm Connections

The following table shows alarm input connections for Reserve On-Line (RO) alarms (if supplied). An engine generates this type of alarm, which prevents the rectifier from operating in the boost charge mode while the battery plant is on engine reserve. The specific alarm connection depends upon the engine being used:

Number of Leads	Lead	BCP
1	Battery (-)	TB2-6
1	RTN (+)	TB2-5
2	Isolated Relay Contacts	TB2-6 TB2-5

Input Power

The BCP/OLE panel does not contain internal fusing. Input power must be provided via a miscellaneous fuse panel. The input fuse should be rated 1.33 amperes, maximum.

Caution

The input power is polarity sensitive. Determine the polarity of the power leads prior to connecting input power to the unit.

BCP Input Power (-48V)

Battery (-)	TB1-1
RTN (+)	TB1-2

BCP Installation Check

Follow the procedure below to verify installation of the BCP:

1. Set the OPTION switch SW1 to OFF, if the CONSTANT switch is to be set.
2. Set the CONSTANT switch to a number between 1 and 8.
3. Ensure that the "Boost Time" switch is in the MANUAL position.
4. Depress the RESET switch. **Wait 10 seconds before continuing.**
5. After 10 seconds, place the "Boost/Float" switch into the "boost" position and release. The following should happen:

   a. The "Boost" (yellow) LED will light.

   b. On the plant controller, the plant voltage reading should increase to the predetermined boost level.

6. Depress the "Boost/Float" switch to the FLOAT position and release. The "Boost" LED should extinguish.

Note: If these things do not happen, review connections.

Off-Line Equalize Panel (OLE) Wiring and Test

The off-line equalize feature for the J85500L-1 requires the following hardware, in addition to the OLE panel, in order to operate correctly:

– J85702F-1 OLE Rectifier Shelf (always occupies the second position from the bottom)
– ED83131-30 G23 Battery Fuse Disconnect Panel
– ED83131-30 G24 Battery Contactor Panel
– ED83131-30 G25 Switch Panel

The J85702F-1 OLE Rectifier Shelf is a specially equipped rectifier shelf that allows the leftmost (position 6) rectifier to be switched between the load bus and the equalize bus when a battery string is being equalized. The G23 Battery Fuse Disconnect Panel provides fused connections for the plant's battery strings, up to three. The G24 Battery Contactor Panel provides three battery contactors that allow each battery string to be switched between the load bus and the equalize bus. The G25 Switch Panel provides the switches that actuate the rectifier and battery contactors. All of this equipment is installed at the factory when a new plant is ordered with the OLE option. Refer to Sheets B6, B10, and B11 of J85500L-1 drawing if performing a retrofit.

All connections between the OLE equipment and the rest of the plant has been prewired at the factory. Refer to Figures 2, 6, 7A, 16A, 16B, 18, 19, 21, and 22 of T83167-30 if performing a retrofit. The only field connections necessary to operate the OLE are:

From	To	Description
Wireset 847846441 (OLE Panel - J8)	**Wireset 847892973 (OLE Rectifier, RTN bus - P8)**	**9 pin Mate-N-Lock connectors between main and supplemental cabinets (T83167-30 Figures 2, 16B, 18, 19, 21).**
Rectifier Cabinet OLE Bus	**Supplemental Cabinet OLE Bus**	**Cable Assembly 847846409, prewired to supplemental cabinet OLE panel (T83167-30 Figures 16A, 19)**
P2 and P3 on OLE panel	**P5 and P6 on OLE rectifier shelf**	**Cable Assembly 847784433, prewired to rectifier shelf (T83167-30, Figures 7A, 18)**

Setting Equalize Voltage

1. The plant float voltage should be set between -48.0V and -58.0V.
2. The equalize rectifier is in the leftmost slot of Rectifier Shelf #2. The DIP switch on the front of this rectifier should be set to all zeroes except for position 5. If loadshare is desired set position 5 to 1. This will enable the rectifier to go to its maximum voltage during equalize, about 61 volts.
3. Switch battery string to the equalize bus. The BIE LED should light.
4. Switch the designated rectifier to the equalize bus. The RIE LED should light.

5. If these two steps are reversed, the BIE and RIE LEDs will flash alternately. Reset the rectifier and battery switches, then restart the procedure.

6. Push the three-position switch toward the Equalize position. The “Eq1” LED should light.

7. Set the digital multimeter (DMM) to the appropriate DC voltage range and insert the probes into the test jacks of the OLE. Observe the voltage on the DMM and set the equalize voltage using a small slotted screw driver to turn the “EQ1 Adjust” screw.

8. Depress the three-position Equalize switch to “Float.” Place the battery and rectifier back to normal operation; all Equalize LEDs should extinguish.

OLE Installation Check Procedure

Follow the procedure below to verify installation of the Off-Line Equalize (OLE) Panel:

1. Start Equalize:

   a. Switch battery string to be equalized to the equalize bus.
   b. Switch rectifier to equalize bus. (BIE and RIE will flash if these two steps are reversed.)
   c. Set Equalize timer to desired position.
   d. Activate Equalize switch.

2. Stop Equalize:

   a. Depress Equalize switch to “Float.”
   b. Monitor string voltage until string voltage is greater than -58Vdc. (Voltages from -48Vdc to -57Vdc are greater than -58Vdc.
   c. Switch rectifier to battery bus.
   d. If BIE and RIE are flashing, the equalization bus is less than -58Vdc.
   e. If BIE and RIE are not flashing, switch battery string to battery bus.

3. Follow this procedure to equalize the remaining battery strings.

Battery Connection

DANGER

> This procedure applies battery power to the battery plant. Before contacting any uninsulated conductor surfaces, always use a voltmeter to insure that no voltage, or the expected voltage, is present.

1. Remove all fuses from CP5 Fuse Board.

2. Confirm that the output circuit breakers of all rectifiers are open.

3. Confirm that no fuses are inserted in the distribution fuse holders.

4. Interconnect the battery strings as instructed by the battery manufacturer's documentation.

5. Run all cables from the battery bus bar (- lead) and the return bus bar (+ lead) to the battery strings by first connecting them to the bus bars at the top of the battery plant behind the ac box. Refer to Figure 2-17.

6. Terminate the cables from the battery plant bus bars at each battery string according to the manufacturer's documentation. Measure the resistance between the two ends of any battery string to verify that the circuit is open. Close the last remaining part of the battery circuit on each string (either intercell connector or disconnect breaker).

7. If the battery plant is equipped with a battery fuse disconnect panel (Lists E, F, H), install an NH3-size fuse in both fuse holders. Fuse size should be determined by engineering based on battery size and rating.

8. Reinsert all fuses in CP5 Fuse Board. Match the fuse ratings and positions as indicated on the front panel.

Note

The white indicators on F1 through F11 and F13 through F18 represent a 1-1/3-ampere rating. The orange indicator on F12 represents a 2-ampere rating, and the green indicators on F19 through F21 represent a 5-ampere rating.

Adding a Load Circuit

DANGER

Battery voltage is present. Remove all jewelry and use only insulated tools.

Caution

Alarms will be issued during the installation process. Notify the alarm reporting center that alarms will be received.

1. Before installing load circuits, open the hinged doors covering the distribution fuse holders. Locate the EBB1 alarm module(s) on the inside of the door and verify that all alarm circuits are deactivated. (All dip switches, S1, are set to the open position.) The six position switch corresponds to the six red lights numbered from top to bottom.

2. Run paired leads (supply and return) to each load from the distribution fuse holder and the discharge return bus. The load supply leads are terminated at the fuse panels. NH2-size fuse holders are equipped with two M10 connection points for single hole connectors. Screws, lockwashers, and washers must be provided. NH00-size fuse holders are equipped with M6 hardware. The load return leads are terminated at the battery plant to the discharge return bus bar located below the charge return bus bar at the top of the cabinet. This bus is equipped with twelve M10 connection points and twenty-eight M8 connection points for single hole connectors. Hardware must be furnished.

3. Activate the alarm circuit for only the fuse position about to be installed by closing the dip switch S1 on the EBB1

Caution

Before applying power to any individual load, follow the powering up instructions as provided in the associated load equipment documentation.

alarm module that corresponds to that fuse position. The red light should be illuminated and an alarm signal generated.

4. Install the required fuse for this position. The red light should extinguish and the alarm retire. If the fuse blows immediately on insertion, this may be due to inrush current and does not necessarily indicate a fault condition. Add another fuse. If the fuse blows again, check the wiring to the load circuit.

5. When all load circuit additions are complete, close the distribution doors and notify the alarm reporting center.

Adding a Distribution Panel

The Global Power System (List 1) is equipped with hinged doors covering each distribution position. When adding a distribution panel, always place the panel in the highest available position. A bus bar connection is present for connecting each distribution panel to the vertical charge bus (-48V). The following components should be furnished with each panel:

2	Mounting brackets
8	M8 x 16mm screws
2	M8 x 25mm screws
10	M8 washers and lockwashers
	EBB1 alarm module(s) as required
4	Nylon standoffs per alarm module

The procedure for installing a distribution panel is as follows:

1. Open hinged door of highest available distribution position.

2. Attach mounting brackets to cabinet using four M8 x 16 mm screws, lockwashers, and washers. Tighten to 18 Nm (160 in-lb).

3. Attach two M8 x 16 mm screws, lockwashers, and washers to left mounting bracket. Do not tighten. Hang distribution panel on left mounting bracket, making sure that the panel bus contacts the plant bus bar on the outside. Attach two M8 x 16 mm screws, lockwashers, and washers to right mounting bracket, securing the panel in place. Do not tighten.

4. Secure panel bus bar to plant bus bar with two M8 x 25 mm screws, lockwashers, and washers. Tighten to 18 Nm (160 in-lb).

5. Secure panel to mounting brackets. Tighten four screws to 18 Nm (160 in-lb).

6. Remove alarm face plate located inside the hinged door.

7. Secure four nylon standoffs to the hinged door starting on the left side. See Figure 5-9.

8. Snap EBB1 alarm module onto standoffs. Make sure all S1 switch positions are set to open position.

9. Repeat Steps 7 and 8 as required.

10. Attach wireset furnished with distribution panel to EBB1 module(s) (six position connectors). Secure to wireset cable tie holders.

11. Alarm modules must be connected as shown in Figure 2-20. Attach the interconnection cable, which has been provided, with the panel from position P1 of alarm module to position P2 of EBB1 alarm module located on the hinged door above. If this is the first distribution panel installed, this cable may be discarded. In this case, attach the connector from CP5 Fuse Board to position P1.

12. If more than one alarm module is provided with a panel, a small interconnection cable should also be provided. Connect this cable from connector P2 of the first EBB1 to connector P1 of the second EBB1.

13. To insure proper operation of alarms, close one of the switch positions on the EBB1 module. A red light should appear on the module and the controller.

14. Secure the alarm faceplate to the hinged door.

15. Proceed to paragraph “Installing a Load Circuit.”

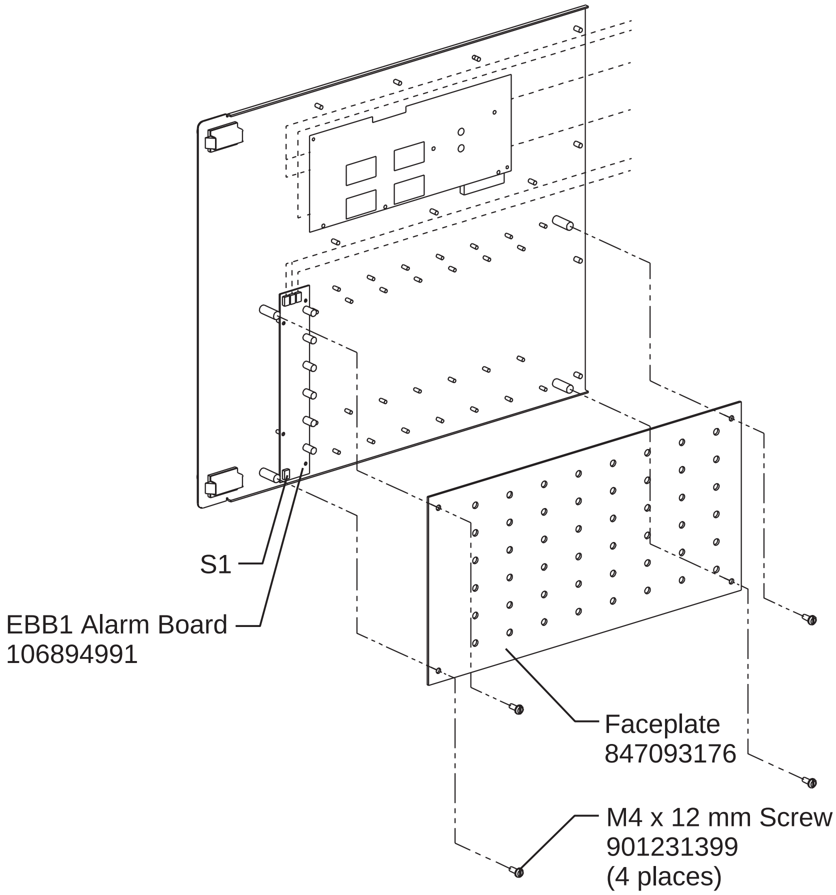


Figure 5-8: Installing the EBB1 Alarm Module

AC Monitoring

Note

Both the Microprocessor (CP2) and the Datalogger Board (CP3) must be installed before the following procedure can be followed.

AC Monitoring Setup

The procedure for setting up the AC Monitor Circuit is as follows:

Warning

Hazardous ac voltage. Extreme caution should be exercised when performing this procedure.

1. Remove the snap-on covers from the right ac channel.
2. Open door to ac circuit breaker box.
3. Open controller door and pull out drawer.
4. Route the ac monitor interface wire set, comcode 847038882, from the ac circuit breaker box down the right channel and into the controller.
5. The wires are color-coded for easy reference and should be terminated as shown on Table 5-D. Wires from the current limiting resistor assemblies (R1-R6) in the ac box are equipped with pink plug-in connectors. The ac monitor interface wire set mates with these connectors. The interface wire set is terminated in the controller to terminal blocks TB301 and TB302 on CP3 datalogger board.
6. Replace all snap-on covers on the right ac channel.
7. Close door to ac circuit breaker box.

Push in controller drawer and close the door.

Table 5-D: AC Monitoring Wire Set Connections

Wire-Set (Color)	AC Circuit Breaker Box (Designation-Color)	Datalogger Board (CP3)
Blue	R1-Red	TB301-1
Blue	R1-Black	TB301-2
Orange	R2-Red	TB301-3
Orange	R2-Black	TB301-4
Brown	R3-Red	TB301-5
Brown	R3-Black	TB301-6
Slate	R4-Red	TB301-7
Slate	R4-Black	TB301-8
White	R5-Red	TB302-1
White	R5-Black	TB302-2
Violet	R6-Red	TB302-3
Violet	R6-Black	TB302-4

Controller Programming for AC Monitoring

The following equipment is required to program the controller for ac monitoring.

- AC voltage meter
- Clamp-on ac current probe
- Small standard screwdriver
- Remote terminal
- RS-232 cable
- Dummy load (50A at 48Vdc)

Warning

Hazardous ac voltage. Extreme caution should be exercised when performing this procedure.

1. System must be on with approximately a 50-ampere load connected to output.

2. Measure and record the following from inside the ac circuit breaker box (Vac = volts ac; A = amperes):

Line 1 to Neutral = __________	Vac	Channel A001
Line 2 to Neutral = __________	Vac	Channel A002
Line 3 to Neutral = __________	Vac	Channel A003
Line 1 current = __________	A	Channel A004
Line 2 current = __________	A	Channel A005
Line 3 current = __________	A	Channel A006

3. Connect remote terminal to the RS-232 connector located on the front of Microprocessor Board (CP2).

4. Log on and go to the Super-User Functions/Configure menu.

5. Go to the Datalogger Configuration menu and configure channels A001-A006 as follows:

Enable/Disable:	Enable
Channel Description:	See Step 6
Type:	AC
Range:	60V
Scale Factor:	1.0000
Transducer offset:	None
Lower Alarm Threshold:	None
Upper Alarm Threshold:	None
Units:	See Step 6

6. Channel Description/Units should be configured as follows:

Channel A001:	Phase 1 voltage/Vac
Channel A002:	Phase 2 voltage/Vac
Channel A003:	Phase 3 voltage/Vac
Channel A004:	Phase 4 current/A
Channel A005:	Phase 5 current/A
Channel A006:	Phase 6 current/A

7. Save the configuration, and go back to the Main Menu.

8. Go to the Dataloggers/Relays, Channels 1 to 8, menu.

9. Record values shown for the following:

   Channel A001 = __________Vac

   Channel A002 = __________Vac

   Channel A003 = __________Vac

   Channel A004 = __________A

   Channel A005 = __________A

   Channel A006 = __________A

10. Divide the value recorded in Step 2 by the value recorded in Step 9 to establish the scale factor for each channel. Example:

    Step 2 (A001) = 220Vac

    Step 9 (A001) = 11 Vac

    Scale Factor (A001) = 220/11 = 20

Note

Scale factors will vary from channel to channel because of tolerance of components.

11. Record scale factors:

    Channel A001 = __________

    Channel A002 = __________

    Channel A003 = __________

    Channel A004 = __________

    Channel A005 = __________

    Channel A006 = __________

12. Go back to the Datalogger Configuration menu and enter the appropriate scale factor for each channel.

13. Results may be checked on the Datalogger/Relay screen at this point.

Shunt Monitoring

Note

Both the Microprocessor (CP2) and the Datalogger Board (CP3) must be installed before the following procedure can be followed.

This procedure is for monitoring the two battery string shunts provided with the List E battery fuse disconnect panel. The shunts have a full scale rating of 50 millivolts at the maximum current rating of 600 amperes. They are located at the top of the cabinet behind the ac box. The left fuse holder and shunt are for battery string 1. The right fuse holder and shunt are for battery string 2.

Shunt Monitoring Setup

1. Route two 18-gauge wires from each shunt down the right side of the cabinet to the controller.

2. Connect a black wire to the screw terminal on the battery bus side of the shunts (top). Connect a red wire to the lower screw terminal of each shunt.

3. Open the controller door and pull out the drawer.

4. Terminate shunt wiring to terminal block TB302 on the CP3 datalogger board as follows:

Shunt	Wire Color	TB302 Pin
1	Black	5
1	Red	6
2	Black	7
2	Red	8

5. Push in the controller drawer and close the door.

Controller Programming for Shunt Monitoring

The following equipment is required to program the controller for shunt monitoring:

- Small standard screwdriver
- Remote terminal
- RS-232 cable

1. Connect remote terminal to the RS-232 connector located on the front of the microprocessor board (CP2).

2. Log on and go to the Super-User Functions/Configure menu.

3. Go to the Datalogger Configuration menu and configure channels A007-A008 as follows:

Enable/Disable:	Enable
Channel Description:	See Step 4
Type:	DC
Range:	50mV
Scale Factor:	12
Transducer offset:	None
Lower Alarm Threshold:	None
Upper Alarm Threshold:	None
Units:	Amperes

4. The channel description should be configured as follows:

Channel A007:	Battery string 1 current
Channel A008:	Battery string 2 current

5. Save the configuration, and go back to the main menu.

6. Results may be checked on the Datalogger/Relay screen at this point.

Installing Side Covers

After installing is complete, the final procedure involves securing the side covers to the cabinet. Three end covers are required to completely enclose the cabinet. Fewer covers are necessary if the equipment is located next to other equipment, a supplemental distribution cabinet, or against a wall. Attach six plastic hanger clips to each side as shown in Figure 5-9. Hook the blue side covers onto the clips.

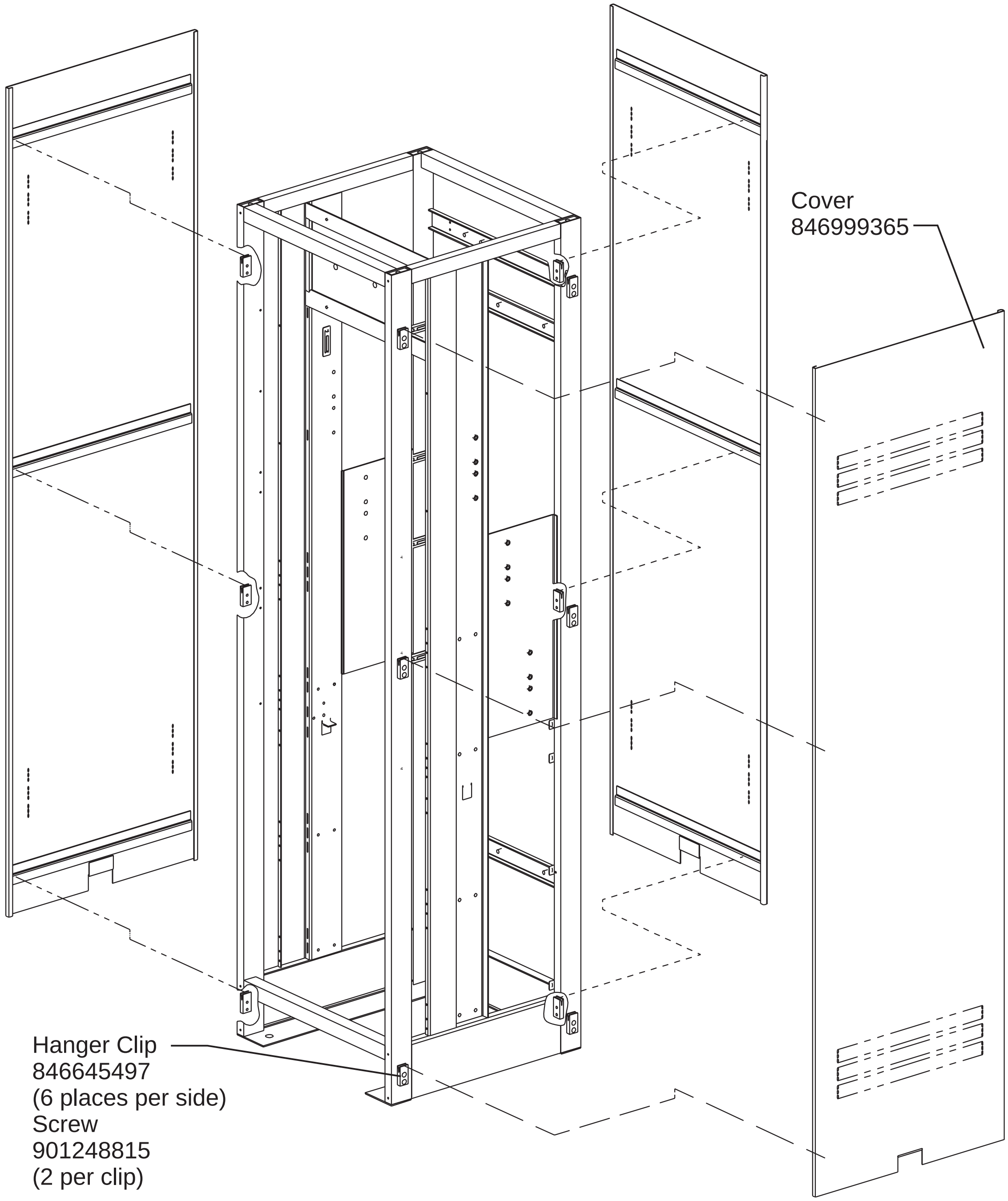


Figure 5-9: Side Covers for Cabinet

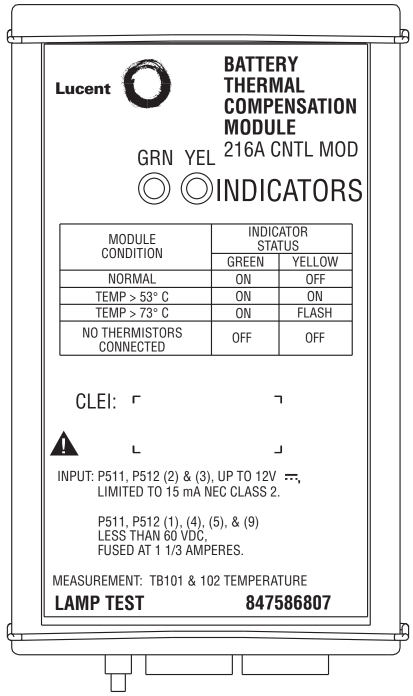


Figure 5-10: Battery Thermal Compensation Control Unit Faceplate

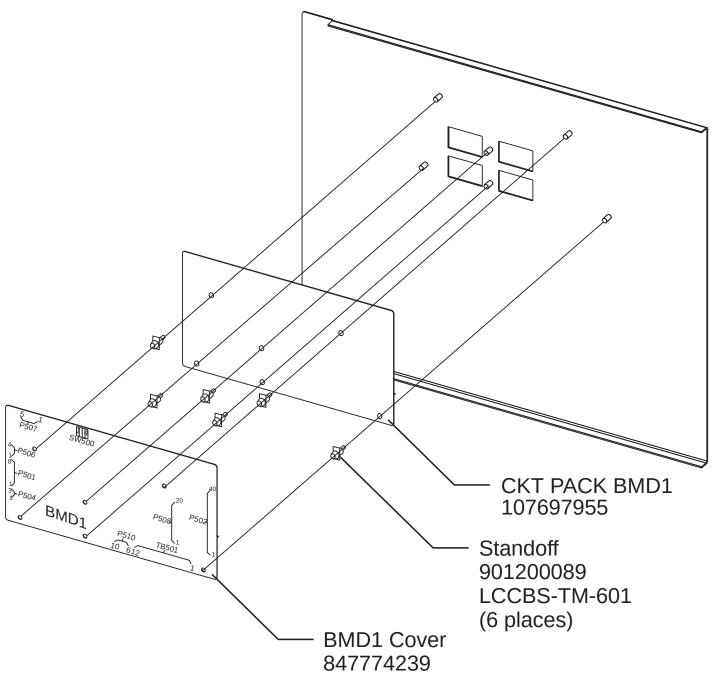


Figure 5-11: Door Assembly

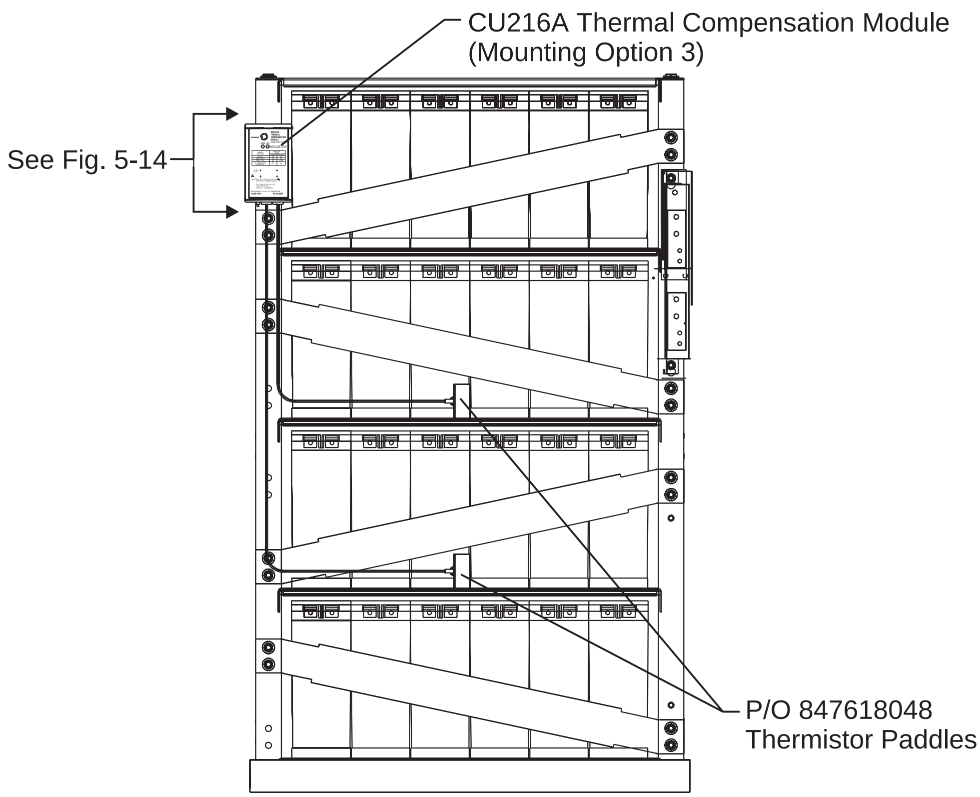


Figure 5-12: Placement of Thermistors in VR Battery Stand

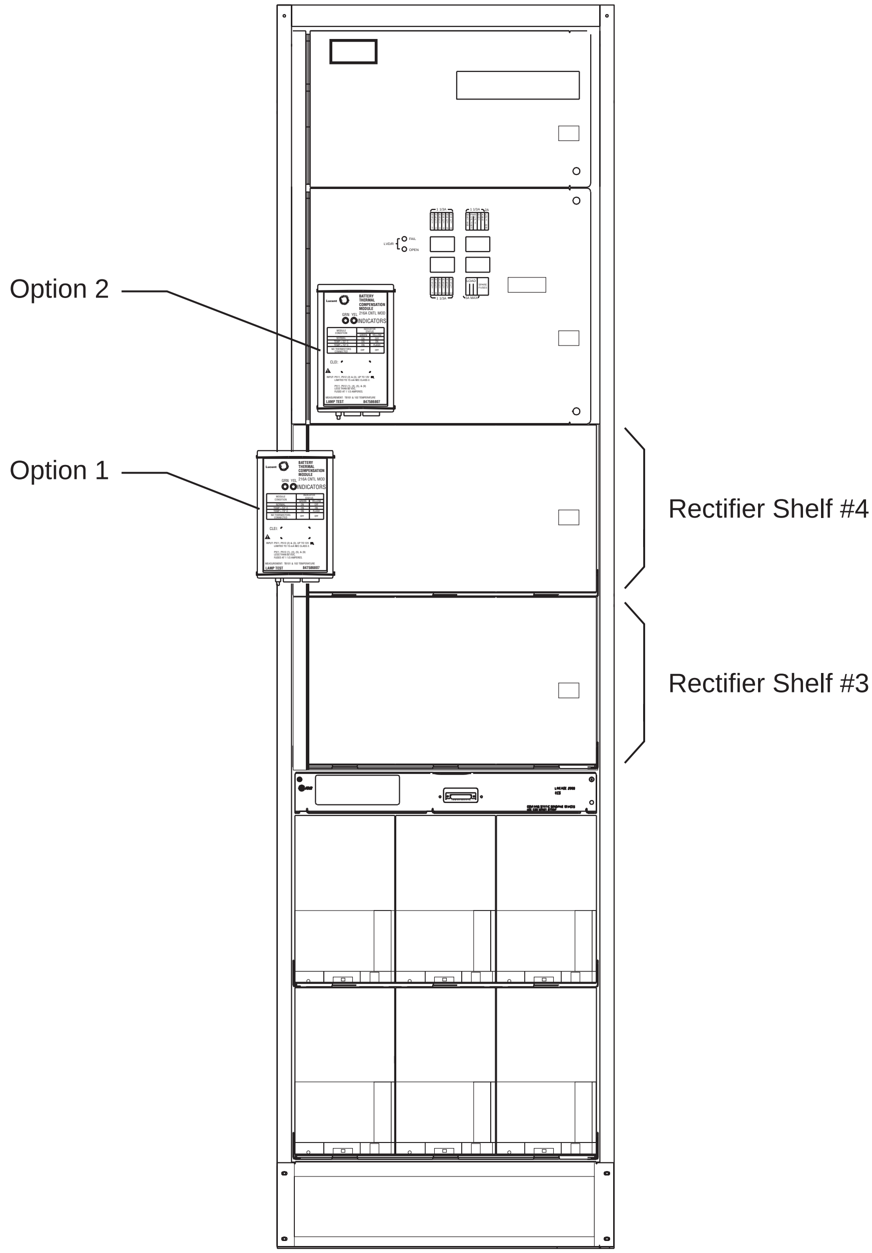


Figure 5-13: Placement of Control Unit in Framework

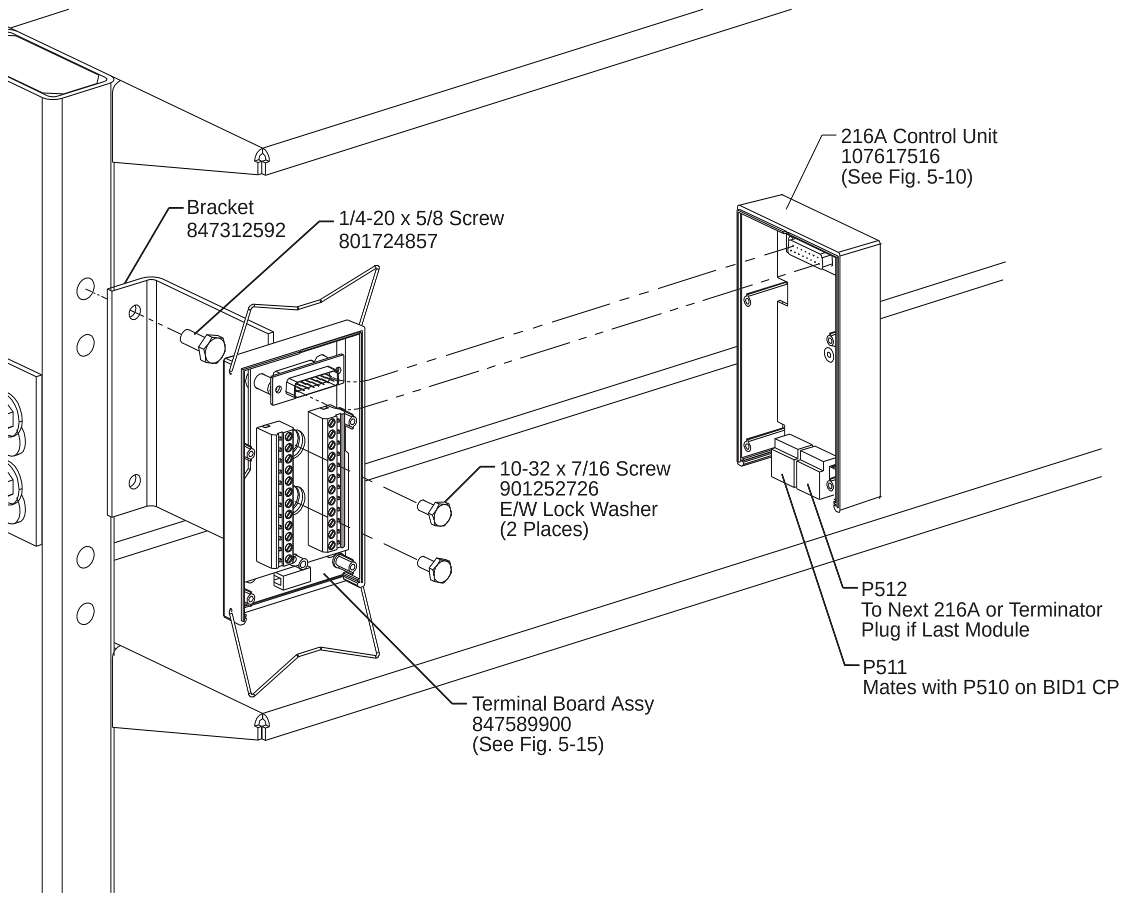


Figure 5-14: 216A Control Unit and Terminal Block Base Assembly

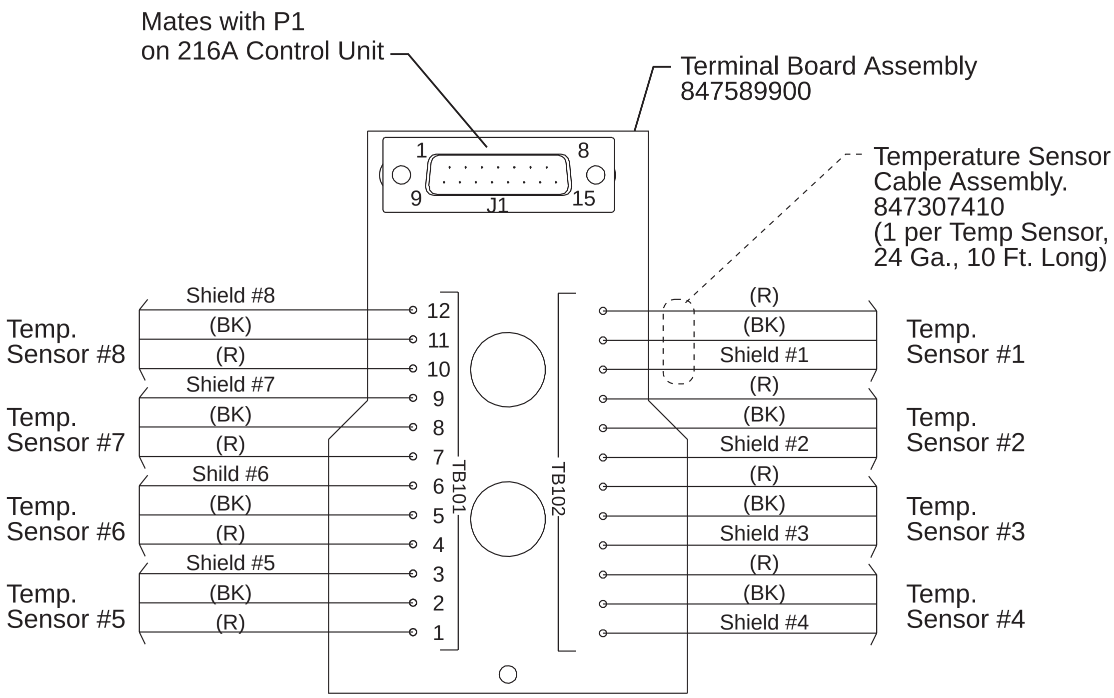


Figure 5-15: Temperature Sensor Connections to Terminal Block Assembly

Installing Thermal Compensation Unit in Existing Plant

The 216A ECS Thermal Compensation Unit described in Section 2 can be retrofitted into a J85500L-1 battery plant. The Kit (Comcode 847774247) contains the circuit packs, wiring, and hardware to monitor one string of batteries. The unit is shown in Figure 5-10. Read the instructions below before beginning, observe all the safety warnings and notes, and follow the instructions step by step.

Tools required:

- 5/16” Nutdriver
- 7/16” Nutdriver
- Jeweler’s Screwdriver
- Wire Strippers (22 AWG)
- Heat Gun

Observe all safety warnings and notes before beginning installation.

Caution

Procedures in this section may cause power alarms to be issued temporarily. Notify the alarm reporting center before starting any replacement procedure to an operating plant.

Installation Procedure

1. For use with Lucent VR Batteries: Mount the VR Module bracket to any one of the available x - 20 Pem-nuts in the battery stand upright. Then attach the Terminal Block Assembly Base to the VR Module bracket with the 10-32 screws provided. (See Figure 5-13.)

   For use with alternate vendor batteries, three options are recommended:

   Option 1: Mount the VR Module bracket to the plant framework (List 1 or List 20) in an unused end rectifier position using the two 10-32 screws that have been provided. Consider further plant growth (rectifier shelves/rectifiers) before choosing this option. (See Option 1 on Figure 5-13.)

   Option 2: Mount the 216A Control Unit on the distribution door panel (lower left corner) using the adhesive backed Velcro strips provided. Make sure the surface of the distribution door is clean before peeling the backing off the

Velcro hooks and affixing to the distribution door. Make sure the back surface of the Terminal Block Assembly is clean before peeling the backing off the Velcro loops and affixing to the Terminal Block Assembly. Mount the Terminal Block Assembly on the distribution door. Consider the protrusion of the 216 Control Unit before choosing this option. (See Option 2 on Figure 5-13.)

Option 3: Mount the 216A Control Unit on the battery stand (not the batteries) in any convenient location using either the VR Module bracket and 1 or 2 10-32 screws or using the Velcro strips. If the Velcro strips are used, affix the Velcro hooks to a clean surface on the battery stand and the Velcro loops to the back of the Terminal Block Assembly (must be cleaned). Consider the distance between the battery plant and the battery stand before choosing this option. (See Option 3 on Figure 5-12.)

2. Temporarily insert the thermistors in the battery locations to be monitored. See Figure 5-12 for suggested locations between the Lucent VR Batteries. Dress the thermistor wire sets from the Terminal Block Assembly to the thermistors and cut to proper length. The thermistors will need to be removed from the battery string during testing so do not secure them into place at this time.

3. Connect all thermistor wire sets (maximum = 8 per 216A) to terminal blocks TB101 and TB102 as shown in 5-15. The ambient temperature of the thermistor must be between 0° C (32° F) and 53° C (127.4° F) when the wire set is connected to the Terminal Block Assembly in order for the proper temperature to be sensed by the 216A Control Unit.

4. Mate the 216A Control Unit to the Terminal Block Base Assembly. See Figure 5-14. Latch the two units together with the clips on the base.

5. Repeat steps 1 through 3 for additional battery strings.

6. Open distribution door.

7. Unplug the following connectors from the BCB2 LVD/Fuse Board. Leave the cables dressed.

Caution

The batteries will be disconnected from the Load Bus during the replacement of the LVD/Fuse Board (Steps 7 through 12). If commercial power fails during this procedure, -48Vdc will be lost to the using equipment. If this causes concern, use a generator.

Note

Step 7 will cause the LVD/R Contactor to OPEN.

- *P502 from J502
- P506 from J506
- P501 from J501
- P504 from J504

  *Slide the ribbon cable removed from P502 so the connector is against the plastic holder. Dress the excess cable into the distribution. Be sure to leave enough cable to allow the door to open completely.

8. Remove the cover over the BCB2 LVD/Fuse Board and then remove the insulated standoffs to free the board.

9. Set SW500 on the BMD1 LVD/Fuse Board for the desired configuration. SW500.2 should be placed in the open position (compensation disabled) at this time. See Table 5-E.

10. Remove Fuses F507, F508, F509, F511, and F512 from the BMD1 LVD/R Fuse Circuit Packs.

11. Mount the BMD1 LVD/Fuse Board to the distribution door assembly as shown in Figure 5-11.Reconnect the following connectors in the order listed below:

    - P502 to J502
    - P506 to J506
    - P501 to J501
    - P504 to J504

12. If you are installing more than one 216A Control Unit, use Cable Assembly 847586815 to interconnect each unit. The 216A Control Units will be daisy-chained from P512 to

P511 up to a maximum of five units. The last unit connected will need Terminator Plug 847631363 inserted into P512.

Note

Step 12 will cause the LVD/R Contactor to CLOSE.

13. Connect the 216A Control Unit Interface Cable Assembly (847586815) to P510 on the BMD1 LVD/Fuse Board and dress the cable out of the distribution and down to the 216A Control Unit connecting to P511.

14. Close all doors and ensure all covers are installed properly.

15. Replace F507, F508, F511, and F512 with their respective fuses into the BMD1 LVD/R Fuse Circuit Pack. Notice that F512 has an orange tab (2 amperes).

16. Place the WARNING label on the controller face close to the output display.

17. Locate the INFORMATION label (Comcode 847754835) approximately as shown in Figure 5-13 to cover the original label.

Table 5-E: SW500 Reference

<table>
<tr><th colspan="2">Conditions</th><th>216A Status</th><th colspan="5">Plant Voltage</th></tr>
<tr><th>Comp. Enable</th><th>Margin Level</th><th>Compensation</th><th colspan="5">Temperature in Degrees Celsius</th></tr>
<tr><th>SW500.2</th><th>SW500.4</th><th></th><th>0-25</th><th>25-53</th><th>53-75</th><th>75+</th><th>From +75 To < 65</th></tr>
<tr><td>1</td><td>0</td><td>Enabled</td><td>V FLT +72mV/C</td><td>V FLT -72mV/C</td><td>V FLT -2.0Vdc</td><td>V FLT -2.0Vdc</td><td>V FLT - 2.0Vdc</td></tr>
<tr><td>1</td><td>1</td><td>Enabled</td><td>No Change</td><td>V FLT -72mV/C</td><td>V FLT -2.0Vdc</td><td>V FLT -2.0Vdc</td><td>V FLT - 2.0Vdc</td></tr>
<tr><td>*0</td><td>*1</td><td>Disabled</td><td colspan="5">No Change</td></tr>
<tr><td>0</td><td>0</td><td>Disabled</td><td colspan="5">No Change</td></tr>
<tr><td colspan="8">“1” represents switch in closed position.
“0” represents switch in open position.
“V FLT” represents uncompensated plant float voltage.
* Indicates factory defaults.</td></tr>
<tr><th colspan="2">SW500.1</th><th colspan="2">SW500.3</th><th colspan="4">Low Voltage Disconnect/Reconnect Voltage Levels</th></tr>
<tr><td colspan="2">*1</td><td colspan="2">*1</td><td colspan="4">-42.5 Vdc</td></tr>
<tr><td colspan="2">0</td><td colspan="2">0</td><td colspan="4">-40.5 Vdc</td></tr>
</table>

Test Procedure

Note

It is recommended to reset the BD alarm on the controller to 3.0 Vdc below the float voltage. The HVSD level should be reset to 3.0 Vdc above the float voltage when the margining feature is enabled. See J85500L-1 assembly drawing for DIP switch settings.

1. Open the distribution door and set SW500.2 on the BMD1 LVD/R Fuse Circuit Pack to the closed position. This will enable the compensation feature. Close the distribution door.

2. Check to see that the green LED on the 216A Control Unit is ON.

3. Verify that there are no alarms being generated on the ECS Controller.

4. Thermistors should be heated with INDIRECT air flow from a heat gun. Heat applied directly to the thermistor could cause damage.

5. The following steps should be observed:

   - A minor fuse alarm (MNF) should be issued at approximately the same time that the yellow LED on the 216A Control Unit is turned on which should correspond to a two-volt drop in the float voltage.
   - A major fuse alarm (MJF) should be issued at the same time as the yellow LED on the 216A Control Unit begins blinking. The six-volt drop will not be seen because the batteries will not discharge that quickly.
   - The thermistors should be allowed to cool and then be inserted and secured into the battery string.
   - Verify there are no alarms present at this time.

6 Spare Parts and Maintenance

Recommended Spare Parts

Table 6-A lists the recommended spare parts for the J85500L-1 Global Power System.

Table 6-A: Recommended Spare Parts

Ordering Code	Description
846835882	DC Rectifier Fan
106394398	CP5 LVD/Fuse Board
106395064	113B Control Unit
107697955	A CP-BMD1 LVD/R Fuse Thermal Compensation (Slope/Step) Board
107617516	CU-216A Thermal Compensation Control Unit
405673147	1-1/3A Fuse
405181983	2A Fuse
406159061	5A Fuse
406526079	Replacement Battery for CP2
107310187	50A Rectifier
847366788	CP2 Microprocessor Board
847366796	CP2 with Voice
846616894	CP3 Datalogger Board
406864926	1/2" Allen Wrench
901181834	5 mm Allen Wrench Key
407211895	OLE Panel

Rectifier and Rectifier Shelf Assembly Field Maintenance

The following paragraphs provide field maintenance information and procedures for the rectifiers and their associated RSAs. Refer to Section 2 for more information on the function of rectifier controls and indicators.

With the exception of fan replacement, the SR 50A/-48V rectifier is designed to be repaired only at a Lucent Technologies factory. The Rectifier Shelf Assembly (RSA) for the SR 50A/-48V rectifier can be repaired in the field. Diagnostics consist of determining whether or not the rectifier needs to be replaced in the event it is not delivering power. Diagnostics also help determine if the problem is in a component other than the rectifier. Use the flowcharts in Figures 6-2.1 through 6-2.4 to isolate the malfunction to the defective replaceable components or assembly.

Fan Maintenance and Replacement

Two approaches can be taken to fan maintenance. Since the expected life of the rectifier fan at 25 degrees Celsius (77 degrees Fahrenheit) is seven years, the first approach is to routinely replace all fans every five years. This insures that the fans do not fail in the field under normal operating conditions. This approach is appropriate when there are no remote alarm facilities at the site. The second approach, assuming there is remote alarm capability, is to wait until the fan fails. The rectifier will safely shut down and issue RFA and TA alarms both locally and to a controller. The fan can then be replaced. Since it is likely that all the rectifiers in that installation are of roughly the same age, all rectifier fans at that site should be replaced at that time. The approach used depends on the convenience of the site as well as the monitoring of alarms used at the site.

Replacing the fan in the field is a simple procedure, requiring only a screwdriver. Since it is mounted on the back of the rectifier, the fan can be replaced without opening the rectifier.

To replace the fan, refer to Figure 6-1 and proceed as follows:

1. Refer to Section 5, “Disconnecting a Rectifier,” to perform the rectifier removal procedure.

2. Remove the two (2) screws holding the fan and fan guard onto the back panel of the chassis.

3. Separate the fan assembly from the chassis back panel.

4. Disconnect the black plug from the terminals of the old fan.

5. Connect the black plug to the terminals of the new fan.

6. Attach the fan assembly to the chassis back panel using two (2) screws.

7. Replace rectifier and restore ac service according to the procedures outlined in Section 5, *Installation*.

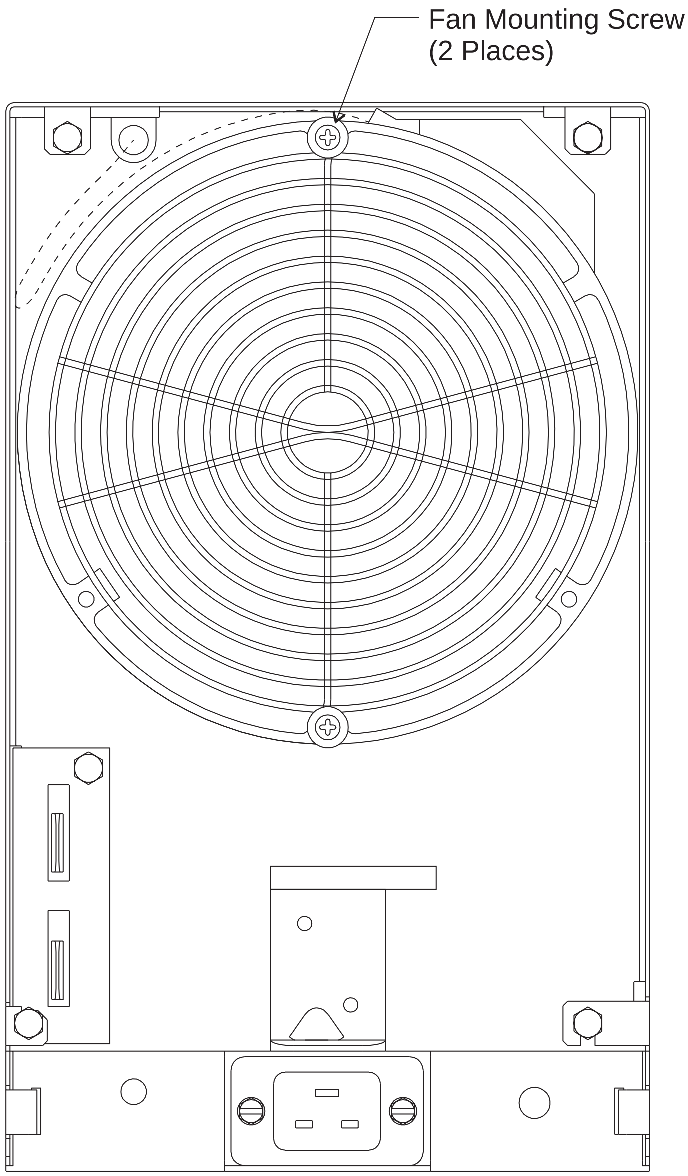


Figure 6-1: Fan Replacement

Required Test Equipment

Depending on the tests to be performed, one or more of the following may be required.

- DMM (Digital Multimeter) Fluke 8060A or equivalent meter having .05% accuracy on dc scale
- Jeweler's Screwdriver for adjusting potentiometer.
- 5mm Allen wrench for replacing rectifiers.

Replacing the Rectifier

In the event the rectifier has to be replaced, follow the steps outlined in Section 5, *Installation*.

Troubleshooting

Rectifier

Figures 6-2.1 through 6-2.2 are flowcharts for troubleshooting the -48-volt, 50-ampere switchmode rectifier.

Controller

This section contains four tables and five flowcharts for the purpose of troubleshooting the ECS-12 Controller, verifying controller alarms, and meter calibration. The flowcharts, which follow the tables, are listed below.

A.	Office Alarms Received	Figure 6-3
B.	113B Control Unit Has Lost Power	Figures 6-4.1 through 6-4.3
C.	Verify Controller Alarms	Figures 6-5.1 through 6-5.5
D.	Display Is Not lit	Figure 6-6
E.	Meter Out of Calibration	Figure 6-7

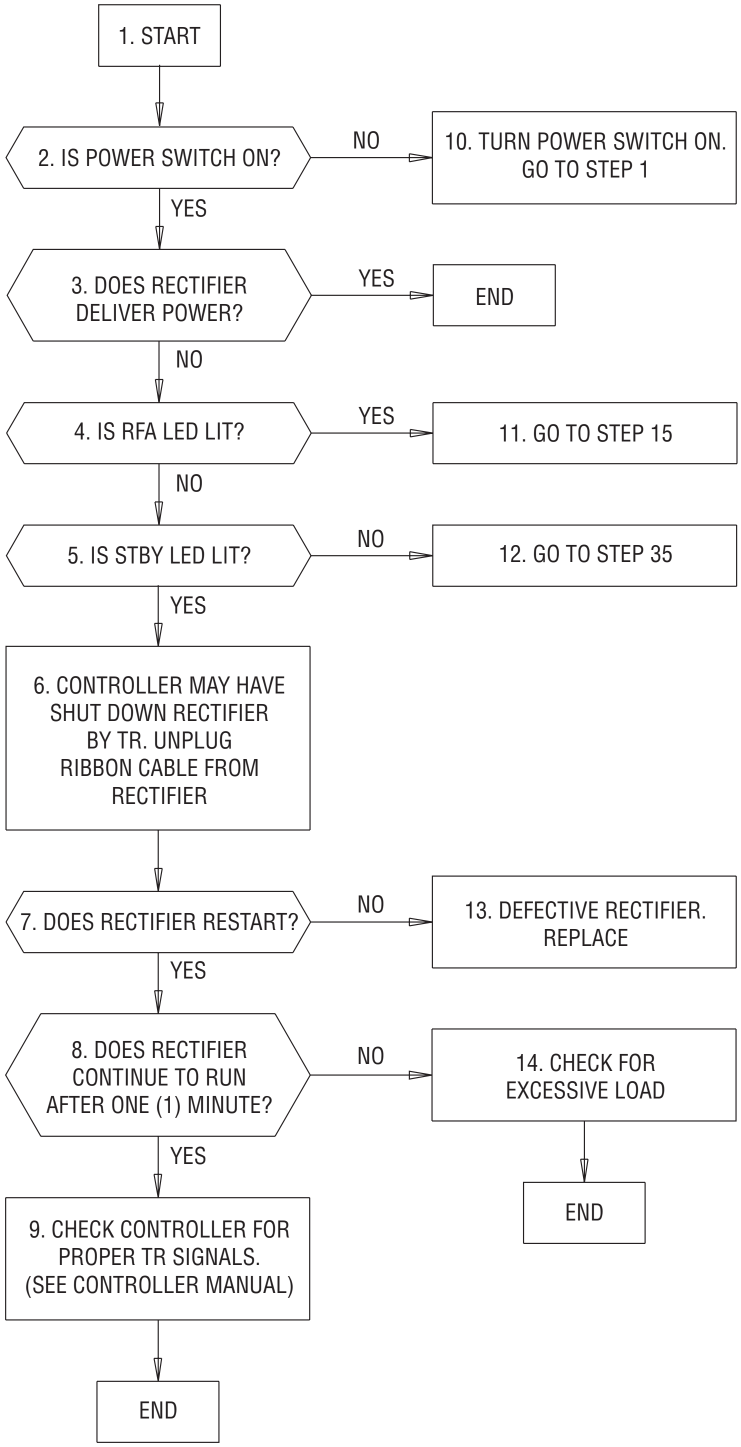


Figure 6-2.1: Rectifier Troubleshooting Flowchart (Sheet 1 of 4)

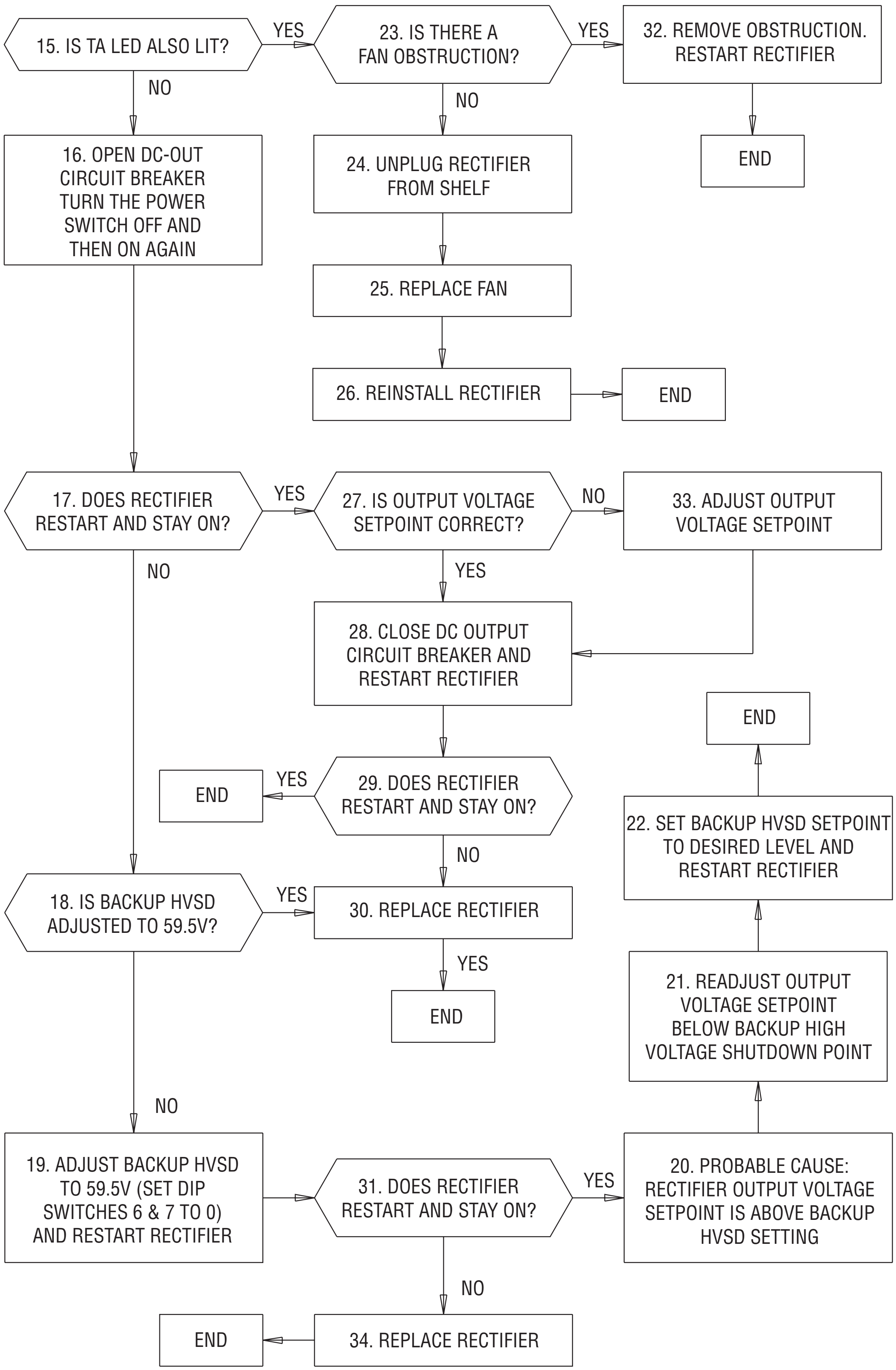


Figure 6-2.2: Rectifier Troubleshooting Flowchart (Sheet 2 of 4)

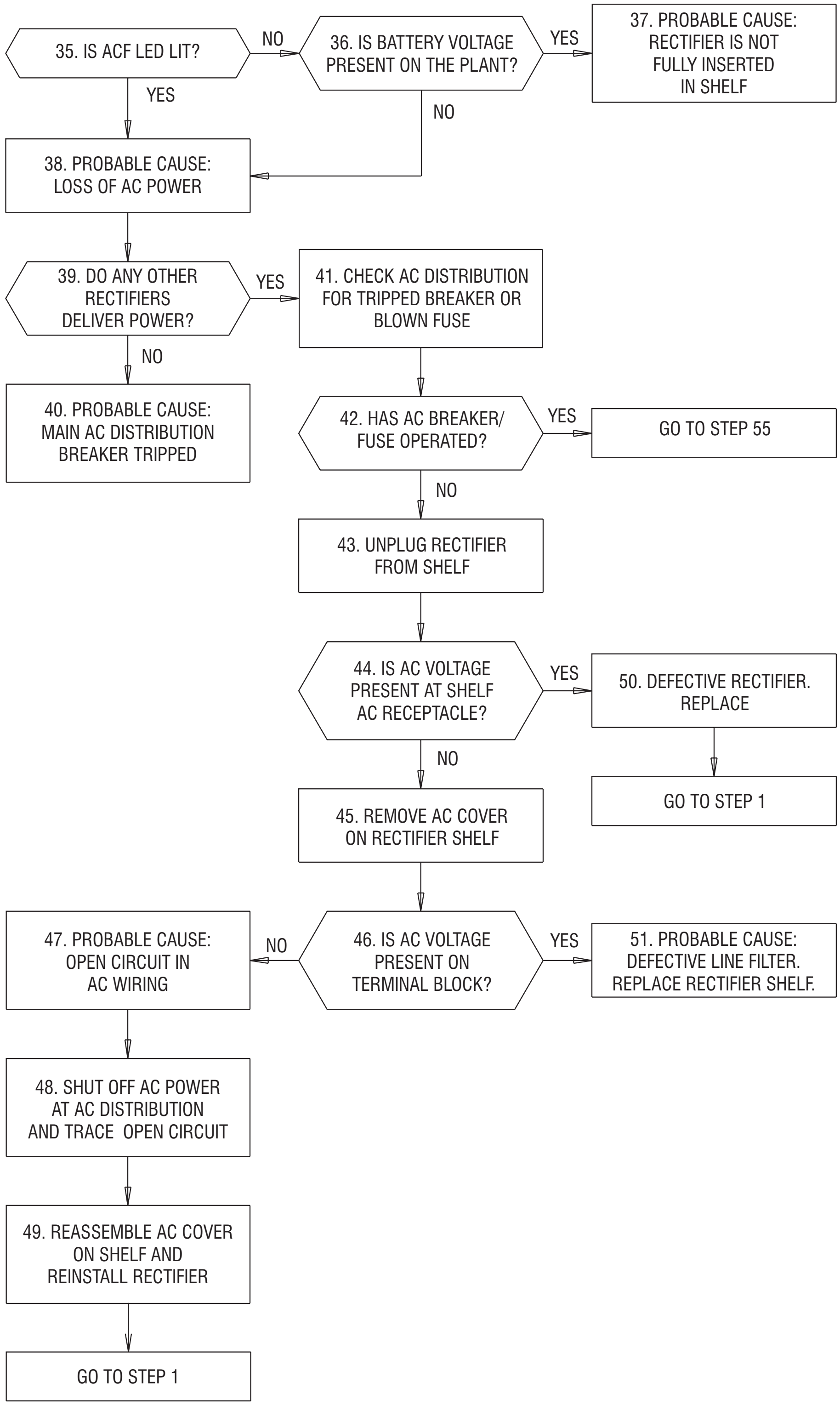


Figure 6-2.3: Rectifier Troubleshooting Flowchart (Sheet 3 of 4)

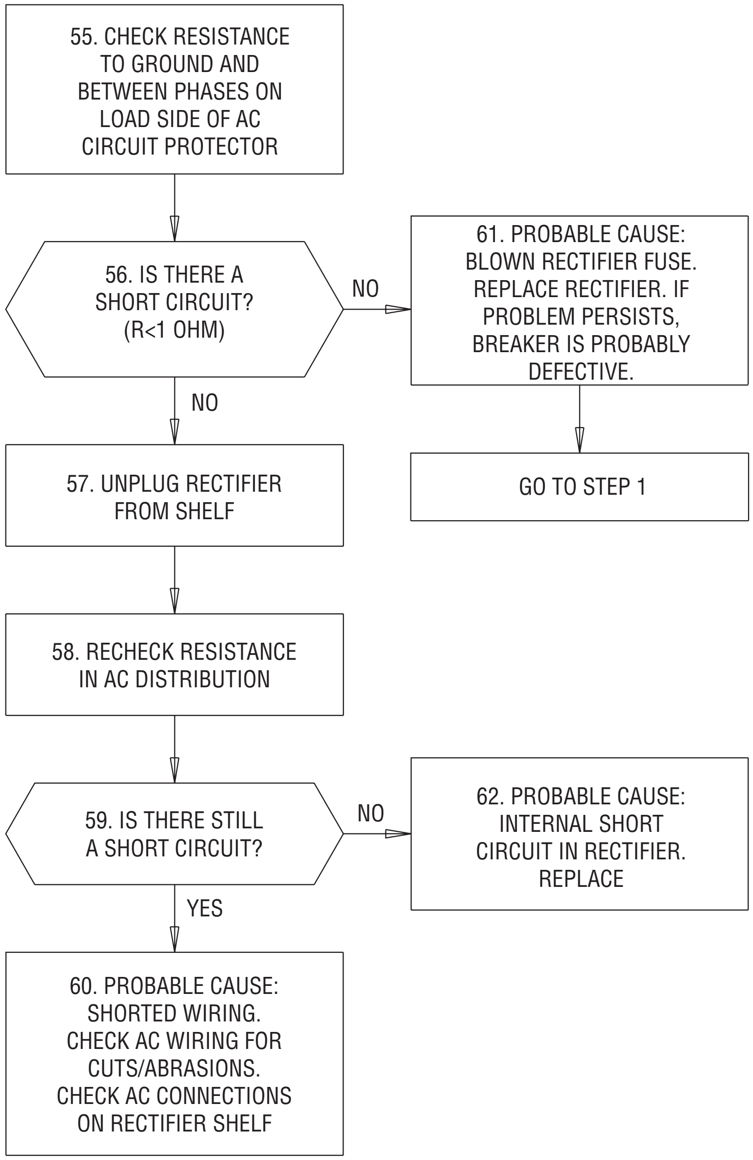


Figure 6-2.4: Rectifier Troubleshooting Flowchart (Sheet 4 of 4)

Table 6-B: Troubleshooting Table, Backplane Connector (P101)

	-48 V Plant -48 volts - nominal*		-24V Plant -24 volts - nominal*		+24V Plant +24 volts - nominal*	
Signal	+	-	+	-	+	-
VS-, VS+	C13	C6	C13	C6, C7		
VS+, VS-					C6, C7	C13
RBMN48, RGM	C4	B15				
RBMN24, RGM			C9	B15		
RBMP, RGM					C17	B15
DB, RTN (DG)	C12	B17	C12	B17	C12	B17
* Voltage is read with volt meter polarity as shown in the “Signal” line.						

Table 6-C: Troubleshooting Table, Ribbon Cable Connector Backplane to BCC1 (P601-1, P706)

	-48 V Plant -48 volts - nominal*		-24V Plant -24 volts - nominal*		+24V Plant +24 volts - nominal*	
Signal	+	-	+	-	+	-
VS-, VS+	4	13	4	13		
VS+, VS-					13	4
RBMN, RGM	10	8	10	8		
RBMP, RGM					32	8
DB, RTN (DG)	12	30	12	30	12	30
∗ Voltage is read with volt meter polarity as shown in the “Signal” line.						

Table 6-D: Troubleshooting Table, Ribbon Cable Connector BCC1 to LVD/Fuse Board (P708, P502)

	-48 V Plant -48 volts - nominal*		-24V Plant -24 volts - nominal*		+24V Plant +24 volts - nominal*	
Signal	+	-	+	-	+	-
VS-, VS+	13	14	13	14		
VS+, VS-					14	13
RBMN, RGM	29	25	29	25		
RBMP, RGM					30	25
DB, RTN (DG)	31	32	31	32	31	32
***** Voltage is read with volt meter polarity as shown in the "Signal" line.						

Table 6-E: Troubleshooting Table, LVD/Fuse Board

	-48 V Plant -48 volts - nominal*		-24V Plant -24 volts - nominal*		+24V Plant +24 volts - nominal*	
Signal	+	-	+	-	+	-
RB, RG	P504-2	P507-2	P504-2	P506-2	P504-2	P506-2
RBM, RG	P504-3	P506-2	P504-3	P506-2	P504-3	P506-2
DB, DG	P504-1	P506-1	P504-1	P506-1	P504-1	P506-1
*Voltage is read with volt meter polarity as shown in the "Signal" line.						

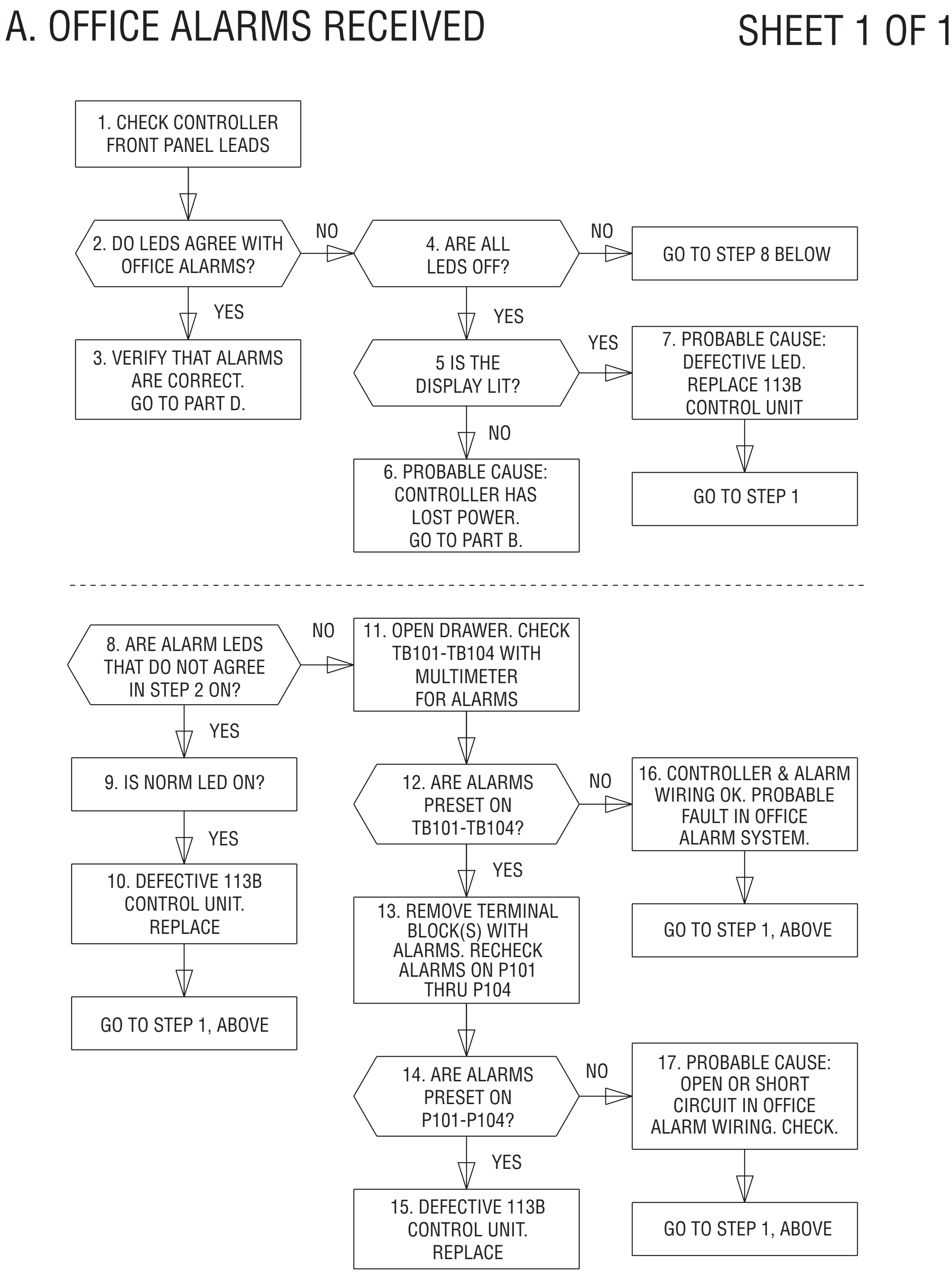


Figure 6-3: Office Alarms Received

B. 113B CONTROL UNIT HAS LOST POWER SHEET 1 OF 3

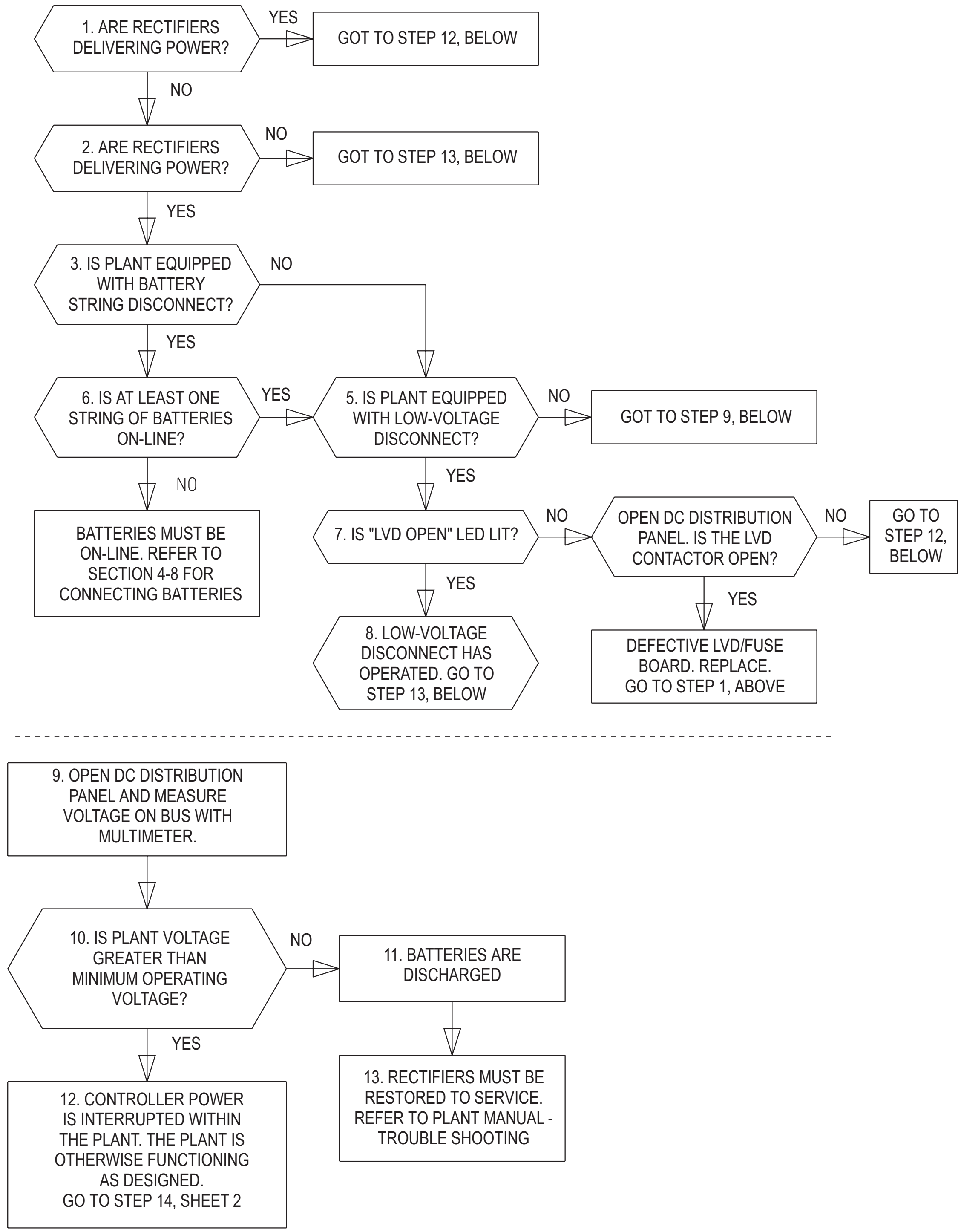


Figure 6-4.1: 113B Control Unit Has Lost Power (Sheet 1 of 3)

B. 113B CONTROL UNIT HAS LOST POWER SHEET 2 OF 3

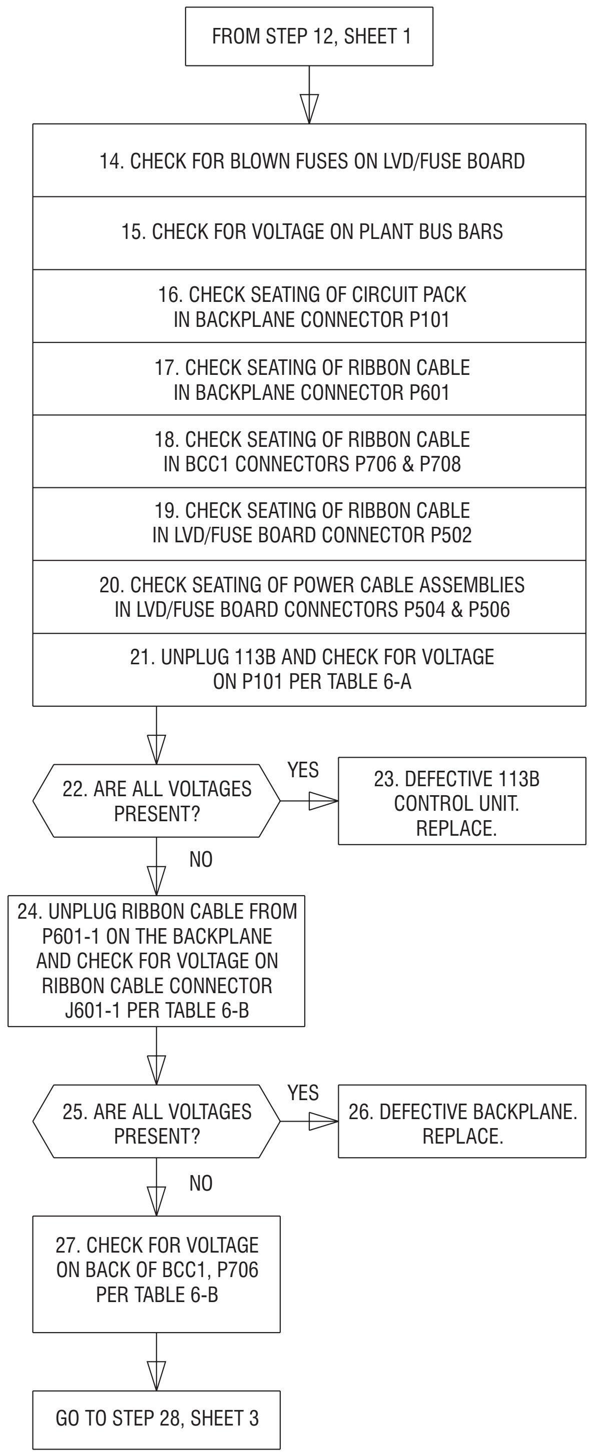


Figure 6-4.2: 113B Control Unit Has Lost Power (Sheet 2 of 3)

B. 113B CONTROL UNIT HAS LOST POWER SHEET 3 OF 3

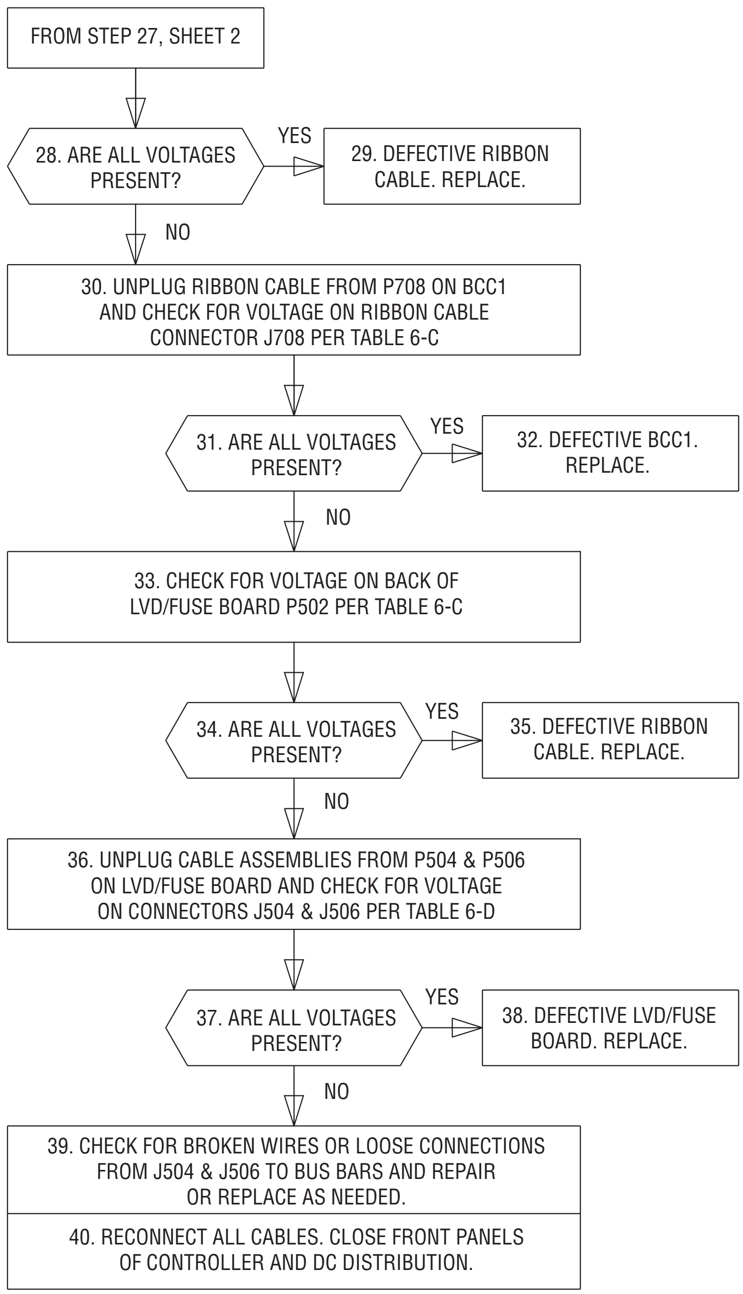


Figure 6-4.3: 113B Control Unit Has Lost Power (Sheet 3 of 3)

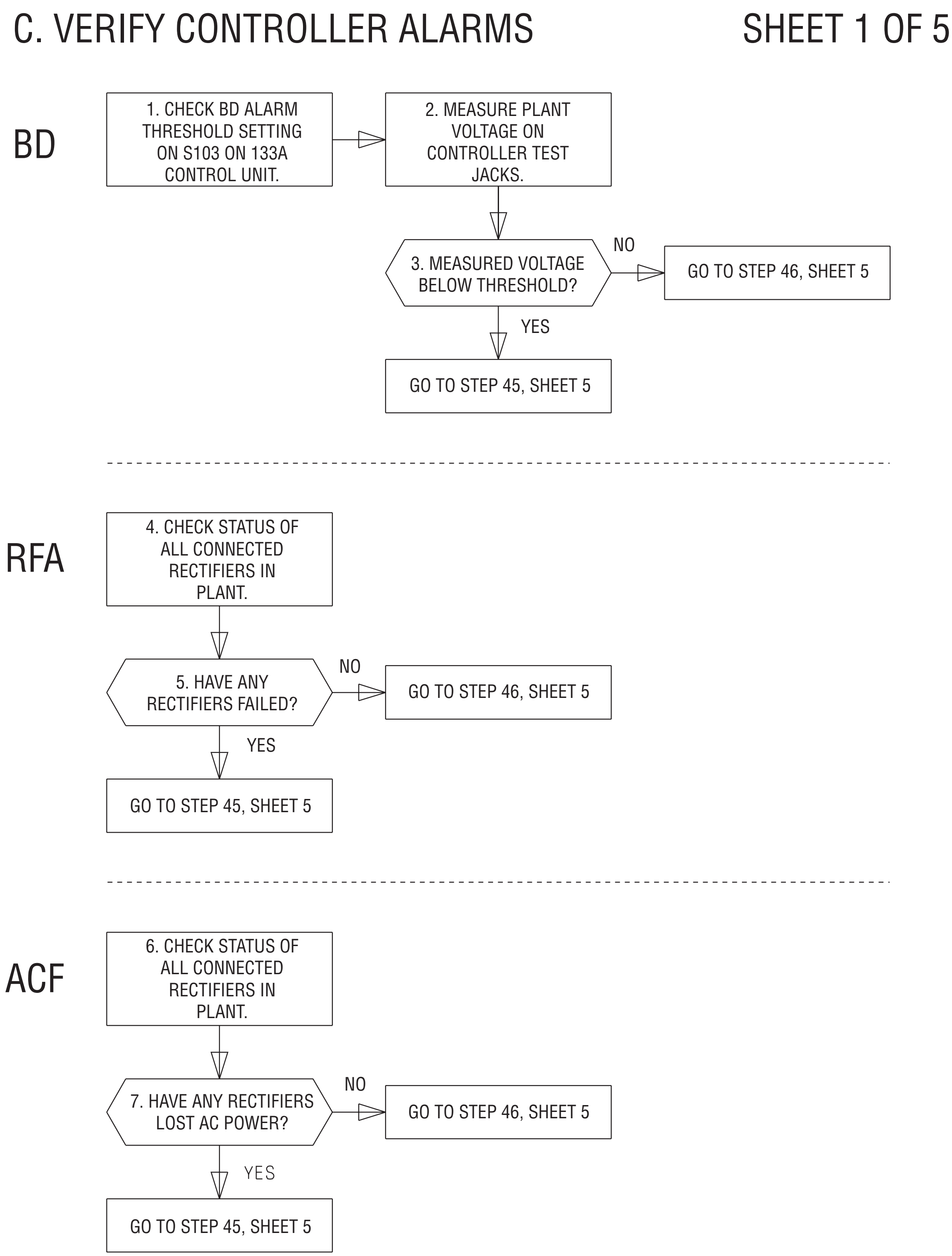


Figure 6-5.1: Verify Controller Alarms (Sheet 1 of 5)

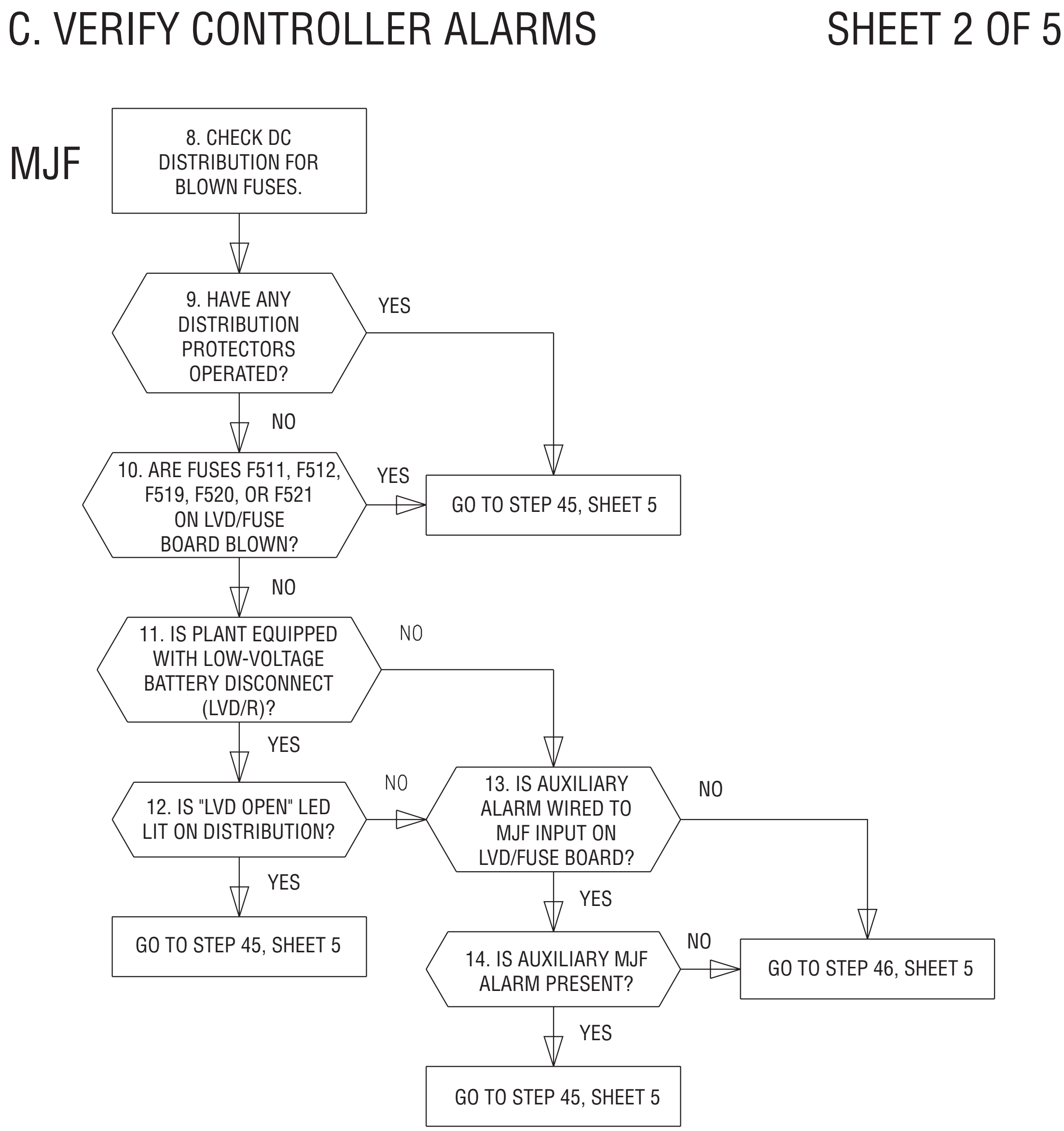


Figure 6-5.2: Verify Controller Alarms (Sheet 2 of 5)

C. VERIFY CONTROLLER ALARMS SHEET 3 OF 5

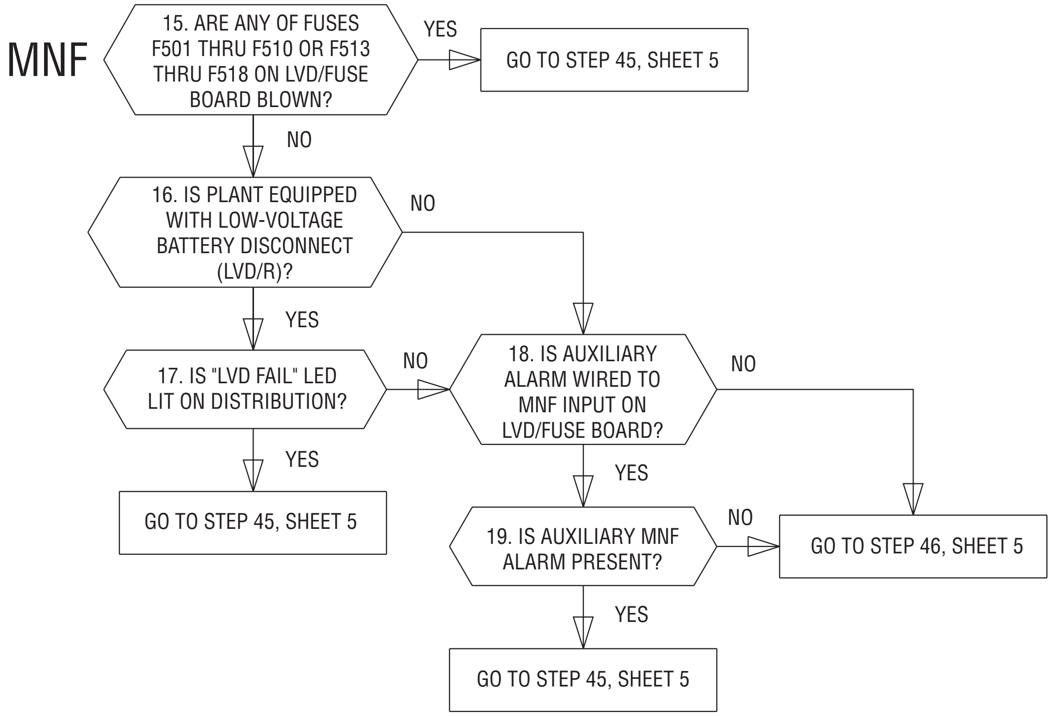


Figure 6-5.3: Verify Controller Alarms (Sheet 3 of 5)

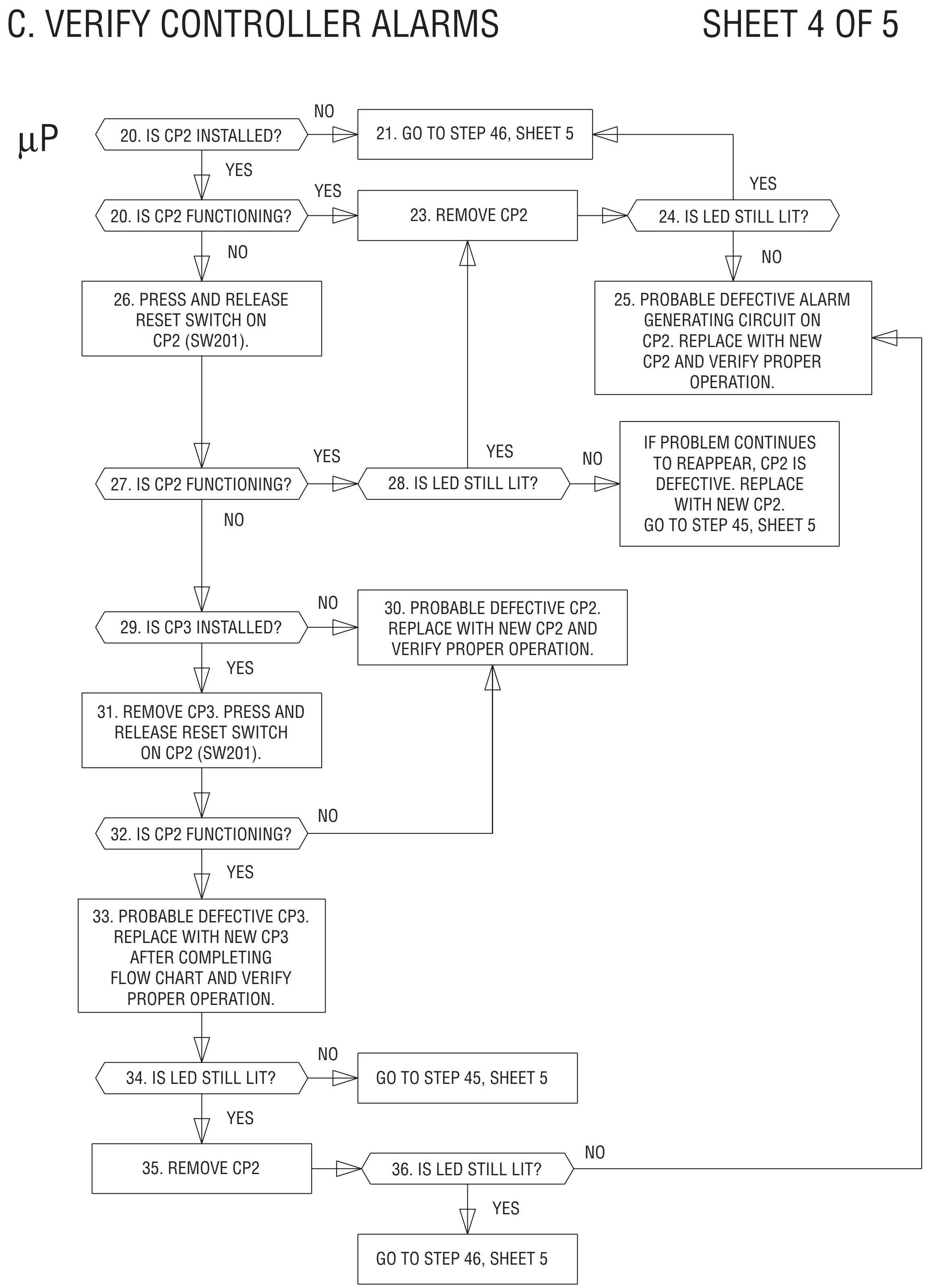


Figure 6-5.4: Verify Controller Alarms (Sheet 4 of 5)

C. VERIFY CONTROLLER ALARMS SHEET 5 OF 5

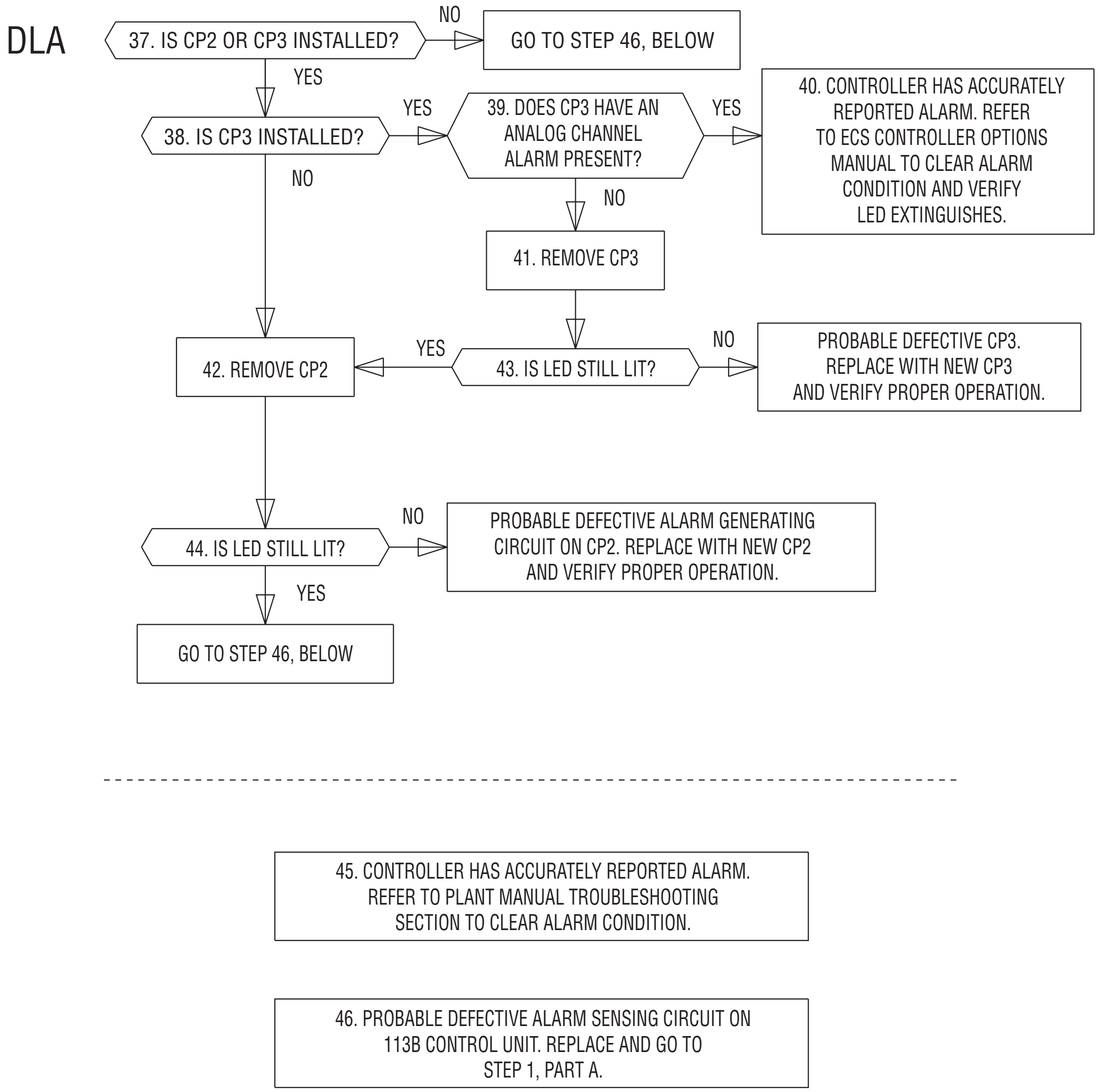


Figure 6-5.5: Verify Controller Alarms (Sheet 5 of 5)

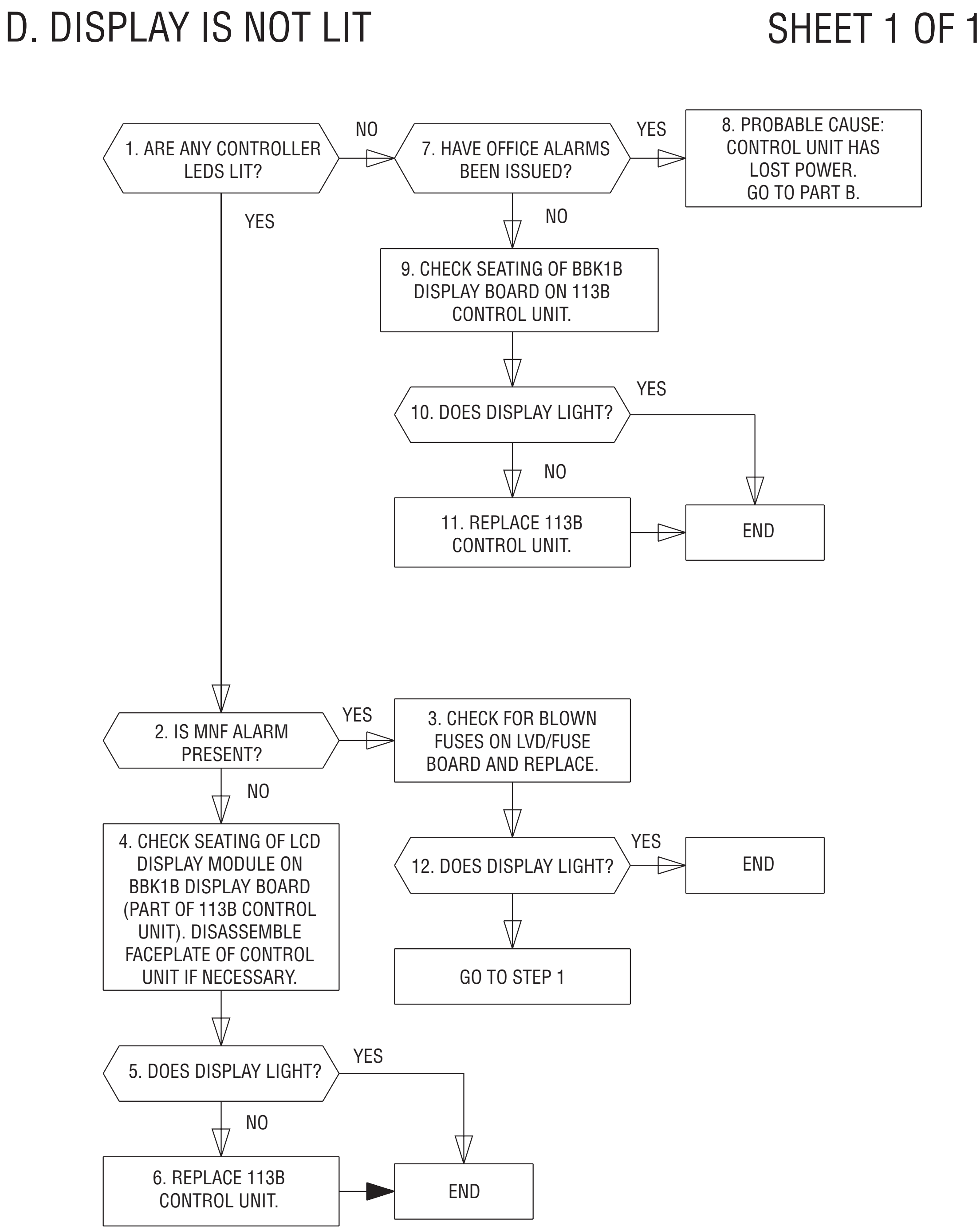


Figure 6-6: Display Is Not Lit

E. METER OUT OF CALIBRATION

SHEET 1 OF 1

ASSUMPTIONS
- DISPLAY IS LIT
- PLANT IS OPERATING NORMALLY WITH NO ALARMS
- VOLTAGE DISPLAY DISAGREES WITH THAT MEASURED AT FRONT PANEL TEST JACKS BY MORE THAN THE COMBINED TOLERANCES OF THE EXTERNAL METER AND 0.05 PERCENT.

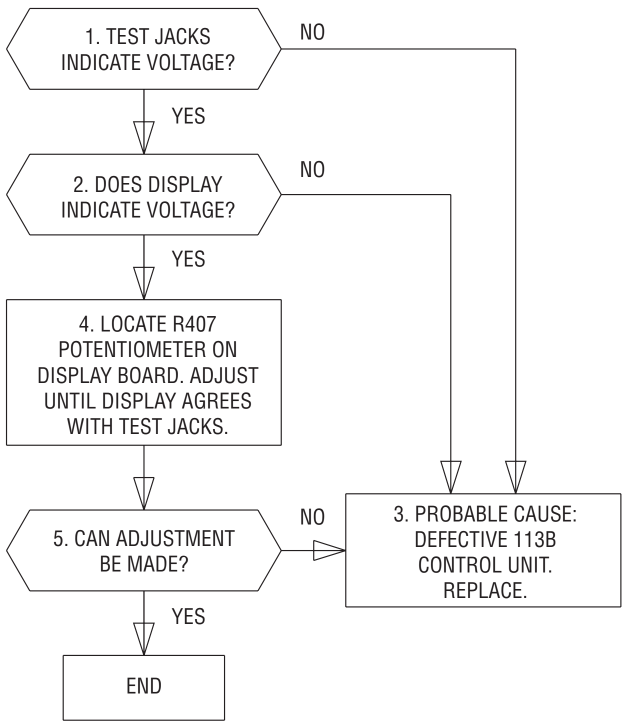


Figure 6-7: Meter Out of Calibration

Low Voltage Disconnect Circuitry

Red LVD OPEN LED Lit

The Red LVD OPEN LED indicates that the LVD Contactor is de-energized, i.e., open. The contactor may be open due to one of four reasons:

1. Plant voltage is below the disconnect threshold.

2. The contactor has failed and must be replaced. See procedure below.

3. There is an open circuit in the wiring that powers the contactor. Check the cable assembly from CP5 to the contactor (see drawing T-83167-30).

4. Both redundant LVD sensing circuits have failed. The CP5 circuit pack must be replaced. Follow "LVD/Fuse Board (CP5) Replacement Procedure."

Yellow LVD FAIL LED Lit

The Yellow LVD FAIL LED indicates that one or both of the LVD circuits has attempted to open the contactor, but the contactor is closed. This may occur in two situations.

1. The plant voltage is right at the disconnect level and is within tolerances of the redundant detector circuits, but only one detector has operated. No action is required.

2. The LVD circuit has partially failed. Follow the "LVD/R Fuse Board (CP5) Fuse Board Replacement" procedure.

LVD/Fuse Board (CP5) Replacement Procedure

A standard screwdriver is required for this procedure. (Refer to Figure 2-13 and T-83167-30 drawing)

1. Open distribution panel.

2. Unplug the following connectors from the LVD/Fuse Board (CP5). Leave the cables dressed.

   – J502 from P502
   – J508 from P508
   – J506 from P506
   – J501 from P501
   – J504 from P504
   – Wires from TB501

3. Remove the 6 mounting screws.

4. Set jumpers J505.1 and J505.2 on replacement LVD/Fuse Board (CP5), in the same positions as on the defective CP5, for the correct disconnect voltage.

5. Mount the replacement board to the distribution panel using the hardware from Step 3.

6. Reconnect the following connectors:

   – J502 to P502
   – J508 to 508
   – J506 to P506
   – J501 to P501
   – J504 to P504
   – Wires to TB501

7. Close distribution panel.

LVD/R Contactor Replacement

Verify the following:

- Contactor coil has failed.
- The contactor is open.
- The rectifiers are carrying the load (off battery) with excess capacity available for charging the batteries.
- Battery string(s) are at a voltage below the rectifier voltage in a state of partial or complete discharge.
- LVD OPEN LED is lit on the distribution front panel.

Required Equipment:

– socket wrench with insulated handle
– M13 socket

Procedure: (Refer to Figure 2-16 and T-83167-30 drawing)

1. Remove rectifier in position directly beneath LVD/R contactor (position 1), if present.

2. Open LVD/fuse panel door and unplug connector P501 from J501 on LVD/Fuse Board (CP5). Leave cable dressed.

3. Disconnect and label the 5 quick connects from the contactor coil and auxiliary switch.

4. Unbolt and remove contactor (6 places).

5. Reconnect quick connect leads to new contactor and then mount new contactor using hardware from Step 4.

6. Plug P501 into J501 on LVD/Fuse Board (CP5) and verify that contactor closes.

7. Replace rectifier and turn on.

8. Close LVD/fuse panel door and verify that LVD FAIL and LVD OPEN lights are not lit.

7 Product Warranty

A. Seller warrants to Customer only, that:

1. As of the date title to Products passes, Seller will have the right to sell, transfer, and assign such Products and the title conveyed by Seller shall be good;

2. Upon shipment, Seller's Manufactured Products will be free from defects in material and workmanship, and will conform to Seller's specifications or any other agreed-upon specification referenced in the order for such Product;

3. With respect to Vendor items, Seller, to the extent permitted, does hereby assign to Customer the warranties given to Seller by its Vendor of such Vendor Items, such assignment to be effective upon Customer's acceptance of such Vendor Items. With respect to Vendor items recommended by Seller in its specifications for which the Vendor's warranty cannot be assigned to Customer, or if assigned, less than Sixty (60) days remain of the Vendor's warranty or warranty period when the Vendor's items are shipped to Customer or when Seller submits its notice of completion of installation if installed by Seller, Seller warrants that such Vendor's items will be free from defects in material and workmanship on the date of shipment to Customer. In such an event, the applicable Warranty Period will be sixty (60) days.

B. The Warranty Period listed below is applicable to Seller's Manufactured Products furnished pursuant to this Agreement, unless otherwise stated:

Warranty Period

Product Type	New Product	Repaired Product or Part*
Central Office Power Equipment**	24 Months	6 Months

* The Warranty Period for a repaired Product or part thereof is as listed or, in the case of Products under Warranty, is the period listed or the unexpired term of the new Product Warranty Period, whichever is longer.

** The Warranty Period for Products ordered for Use in Systems or equipment Manufactured by and furnished by Seller is that of the initial Systems or equipment.

C. If, under normal and proper use during the applicable Warranty Period, a defect or nonconformity is identified in a Product and Customer notifies Seller in writing of such defect or nonconformity promptly after Customer discovers such defect or nonconformity, and follows Seller's instructions regarding return of defective or nonconforming Products, Seller shall, at its option attempt first to repair or replace such Product without charge at its facility or, if not feasible, provide a refund or credit based on the original purchase price and installation charges if installed by Seller. Where Seller has elected to repair a Seller's Manufactured Product (other than Cable and Wire Products) which has been installed by Seller and Seller ascertains that the Product is not readily returnable for repair, Seller will repair the Product at Customer's site.

With respect to Cable and Wire Products manufactured by Seller which Seller elects to repair but which are not readily returnable for repair, whether or not installed by Seller, Seller at its option, may repair the cable and Wire Products at Customer's site.

D. If Seller has elected to repair or replace a defective Product, Customer shall have the option of removing and reinstalling or having Seller remove and reinstall the defective or nonconforming Product. The cost of the removal and the reinstallation shall be borne by Customer. With respect to Cable and Wire Products, Customer has the further responsibility, at its expense, to make the Cable and Wire Products accessible for repair or replacement and to restore the site. Products returned for repair or replacement will be accepted by Seller only in accordance with its instructions and procedures for such returns. The transportation expense associated with returning such Product to Seller shall be borne by Customer. Seller shall pay the cost of transportation of the repair or replacing Product to the destination designated by Customer within the Territory.

E. The defective or nonconforming Products or parts which are replaced shall become Seller's property.

F. If Seller determines that a Product for which warranty service is claimed is not defective or nonconforming, Customer shall pay Seller all costs of handling, inspecting, testing, and transportation and, if applicable, traveling and related expenses.

G. Seller makes no warranty with respect to defective conditions or nonconformities resulting from actions of anyone other than Seller or its subcontractors, caused by any of the following: modifications, misuse, neglect, accident, or abuse; improper wiring, repairing, splicing, alteration, installation, storage, or maintenance; use in a manner not in accordance with Seller’s or Vendor’s specifications or operating instructions, or failure of Customer to apply previously applicable Seller modifications and corrections. In addition, Seller makes no warranty with respect to Products which have had their serial numbers or month and year of manufacture removed, altered, or with respect to expendable items, including, without limitation, fuses, light bulbs, motor brushes, and the like.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER’S SOLE AND EXCLUSIVE REMEDY SHALL BE SELLER’S OBLIGATION TO REPAIR, REPLACE, CREDIT, OR REFUND AS SET FORTH ABOVE IN THIS WARRANTY.