

Lucent Technologies
Bell Labs Innovations



Galaxy Power System 4848/100
(GPS 4848/100)
H569-434

User's Guide
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Issue 5
June 2000
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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

GPS 4848/100

Overview

Lucent Technologies developed the Galaxy Power System (GPS) 4848/100 to support -48 volt telecommunications powering solutions in worldwide markets. The GPS 4848/100 combines 200-ampere, fan-cooled, switchmode rectifiers, microprocessor control technologies, battery and load disconnect/reconnect options, and a comprehensive line of fuse and circuit breaker dc distribution options in a modular front-access design. This modularity ensures easy access, simplified installation and maintenance, and allows the system to expand in capacity and features as power needs grow.

With 10,000-ampere maximum capacity, distribution flexibility, and universal ac input capability, the GPS 4848/100 supports switching, transmission, and wireless applications in central office locations and environmentally controlled remote sites (huts or vaults). For centralized architecture, bus bars are available to 5,200A.

Safety/Standards Compliance

Safety

- UL¹ Listed (US and Canada): UL Subject 1801 with applicable sections of UL1950/CSA² 950)
- VDE Licensed to VDE 0805/IEC950/EN60950

Electromagnetic Compliance

- Emission:
 - FCC Part 15 Class B
 - EN55022 (CISPR 22) Radiated/Conducted Emission, Class B
- Immunity
 - IEC/EN 61000-4-2 ESD level 3 and 4
 - IEC/EN 61000-4-3 Radiated Immunity, 10V/m
 - IEC/EN 61000-4-4 Electrical Fast transients/Burst, level 4
 - IEC/EN 61000-4-5 Lightning Surge, level 4

CE Marking

- CE marked per European Union Council Directives:
 - Low-Voltage Directive (73/23/EEC) and
 - EMC Directive (89/336/EEC) as amended by CE Marking Directive (93/68/EEC)

Telcordia

- GR-63 and GR-1089 NEBS (including Level 3 testing)
- Report by an independent test house

1.UL is a registered trademark of Underwriters Laboratories, Inc.
2.CSA is a registered trademark of Canadian Standards Association.

Illustrations

Figure 1-1 is an isometric view of the GPS 4848/100 with an SCF Controller.

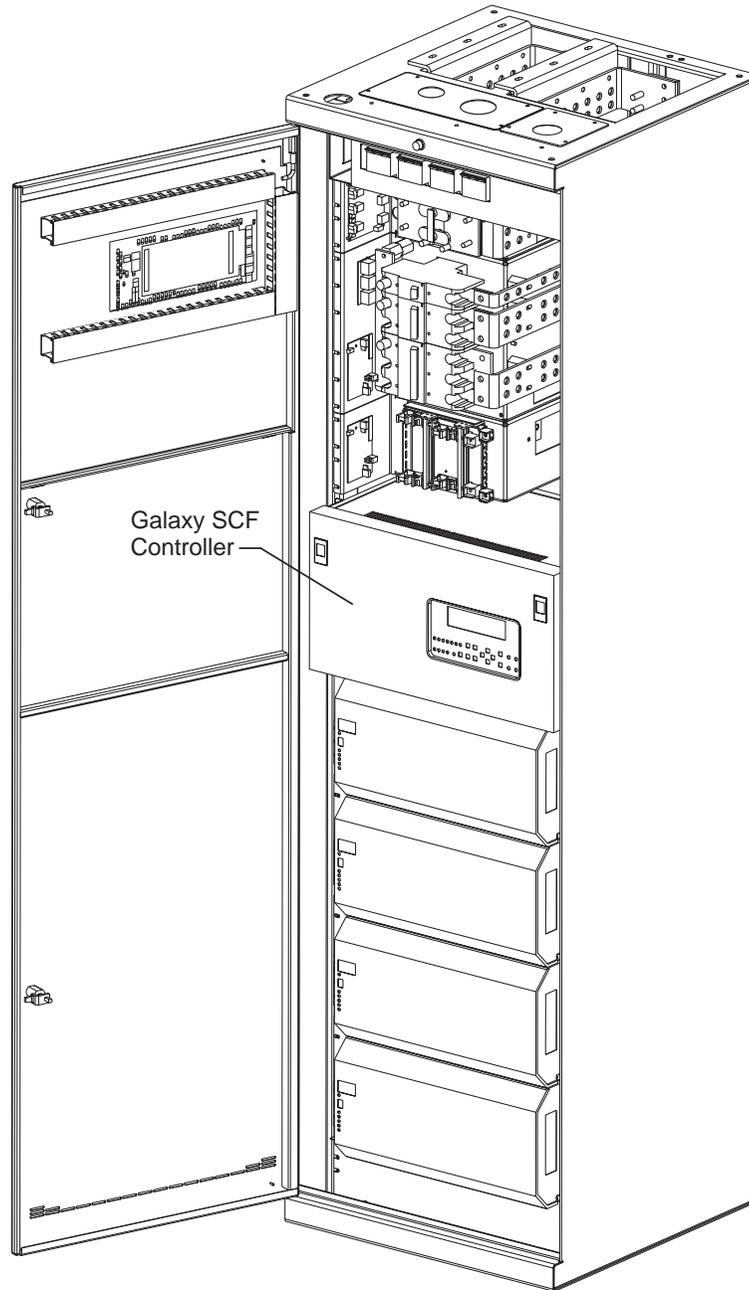


Figure 1-1: GPS 4848/100 With SCF Controller

Illustrations, continued

Figure 1-2 is an isometric view of the GPS 4848/100 with a Millennium Controller.

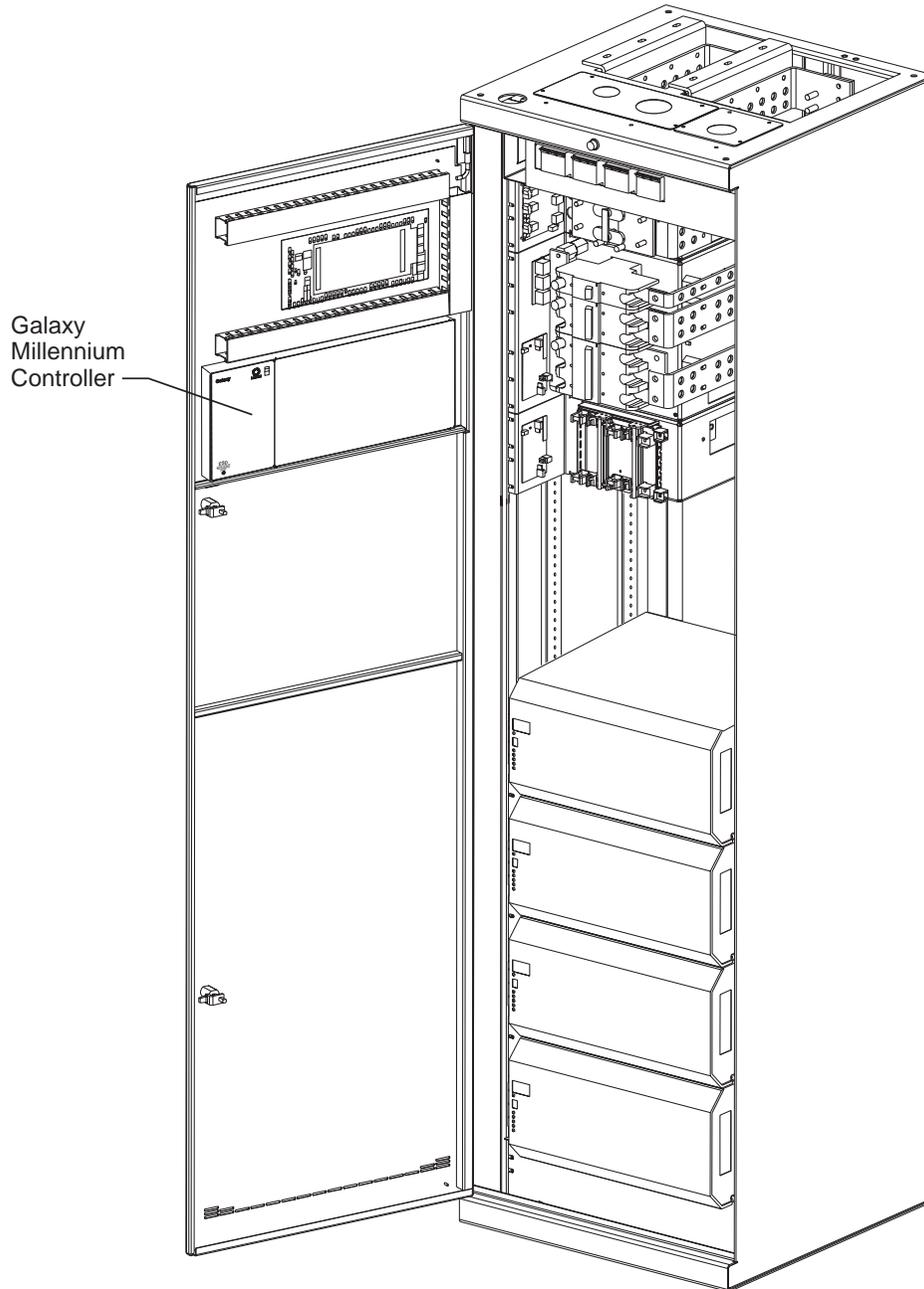


Figure 1-2: GPS 4848/100 With Millennium Controller

Customer Assistance Contacts

Customer Training Lucent Technologies offers customer training on many Power Systems products. For information call 1-972-284-2163. This number is answered from 8:00 a.m. until 4:30 p.m., Central Time Zone (Zone 6), Monday through Friday.

Customer Service For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-THE-1PWR (1-800-843-1797). Services provided through this contact include initiating the spare parts procurement process for out of service emergencies, ordering Lucent Technologies documents, and providing other product and service information.

For other customers worldwide, call 001-972-840-0382. This number is answered from 8:00 a.m. until 4:30 p.m., Central Time Zone (Zone 6), Monday through Friday.

Technical Support Technical support for Lucent Technologies customers is available around the world during the normal product warranty period and also while specific contractual agreements extend this service.

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-CAL-RTAC (1-800-225-7822) to contact a product specialist to answer your technical questions and assist in troubleshooting problems.

For other customers worldwide, contact your local field support center or your sales representative to discuss your specific needs.

Product Repair and Return Repair and return service is provided for Lucent Technologies customers around the world.

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-255-1402 for information on returning of products for repair.

For other customers worldwide, contact your sales representative to discuss your particular circumstances.

Customer Assistance Contacts, continued

Warranty Service

For domestic warranty service, contact your Warranty Service Manager (WSM). For international warranty service, contact your sales representative.

On-Line Power Systems Product Manuals

For Lucent Technologies users logging in from inside the corporate firewall, the address of the “Power Systems On-Line Product Manuals” page is <http://www.cic.lucent.com/lineage.html>.

For customers logging in from outside the firewall, the address is <http://www.lucent8.com/lineage.html>. The annual subscription fee for access to this site is \$25. To obtain a password, follow the instructions on-line or call 1-888-Lucent8 (1-888-582-3688). When prompted for an order number, enter or say “167-790-010.”

On-Line Power Systems Software Upgrades

EasyView software upgrades are on-line at <http://www.lucent.com/networks/power/software.html>.

2 System Description

Overview

Block Diagram

Figure 2-1 shows a basic block diagram of the Galaxy Power System 4848/100. It illustrates the arrangement and interconnections of the system components from the ac input to the dc output.

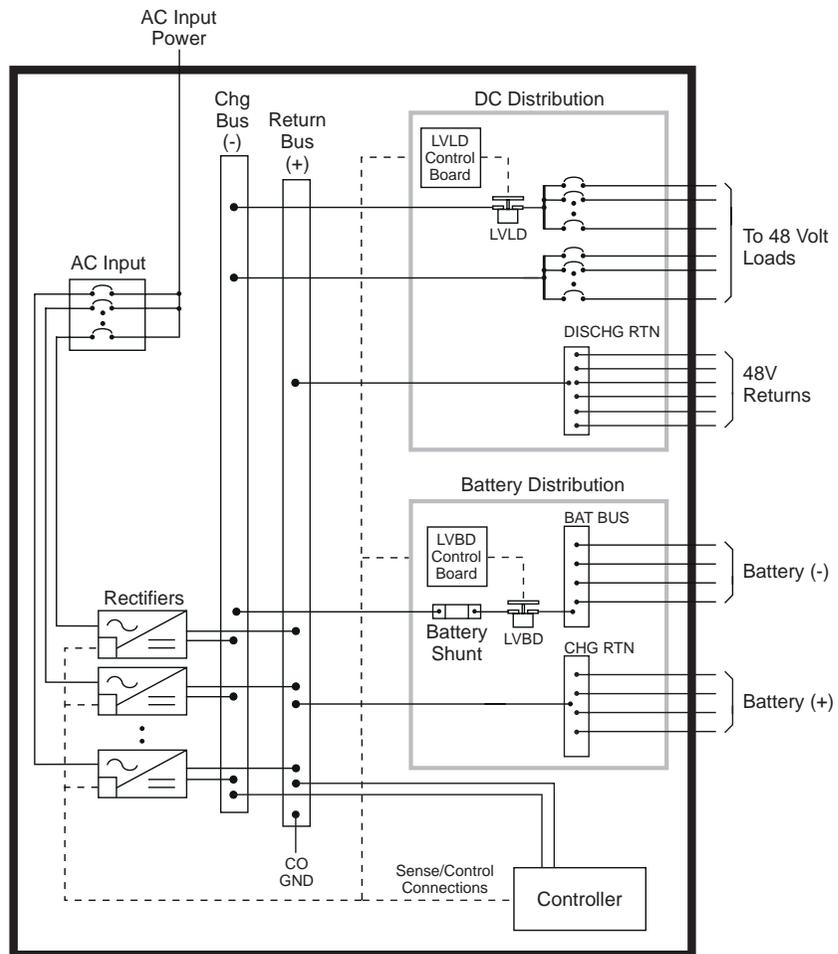


Figure 2-1: Block Diagram of the GPS 4848/100

Overview, continued

System Components

The power system accepts alternating current from the commercial utility or a standby ac power source and rectifies it to produce dc power for the using equipment. The system's control and alarm functions interact with the rectifiers and the office. In addition, the system provides overcurrent protection and charge, discharge, and distribution facilities. Battery reserve automatically provides a source of dc power if the commercial or standby ac fails. Battery reserve can be engineered to supply dc power for a specific period of time. In normal practice, battery capacity is sized to provide 3 to 8 hours of reserve time.

AC Input connects the commercial and/or standby ac power sources to the rectifiers within the system and provides overcurrent protection. In some applications the ac service is wired directly to the rectifiers and overcurrent protection is provided at the service panel.

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 power system.

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

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

Battery Connection Panel provides connection points for the battery strings through battery disconnect fuse, contactors, current monitoring shunts, and equalize converters.

Architecture

Introduction

For the GPS 4848/100 system, the basic system components, i.e., ac input panels, battery connection panels, dc distribution panels, rectifiers, and controller, can be configured to form two distinct system architectures: a distributed architecture or a centralized architecture.

Distributed

In this system each cabinet contains ac distribution, dc distribution panels, battery connection panels, rectifiers, termination points for load circuits, and a battery shunt. The initial cabinet also contains the system controller and, as such, it can function as a stand-alone system. The rectifier output buses are interconnected to permit cabinets to share current and ensure common voltage references for all system rectifiers. Because each cabinet is basically a self-contained system, the overall system capacity can be increased by simply adding cabinet/battery entities. However, growing the system requires a distinct, dedicated floor plan.

During normal operation, the readings from the battery shunts are summed and subtracted from the rectifier current to obtain the system current. While the batteries are providing the system load power, the individual shunt may be monitored to determine the status of the individual battery sections. If required, the cabinets can be equipped with load and/or battery disconnect/reconnect facilities to prevent battery damage during deep discharges.

Figure 2-2 shows an example of GPS 4848/100 components configured in a distributed architecture; Figure 2-3 gives a front view of the distributed initial and growth cabinets.

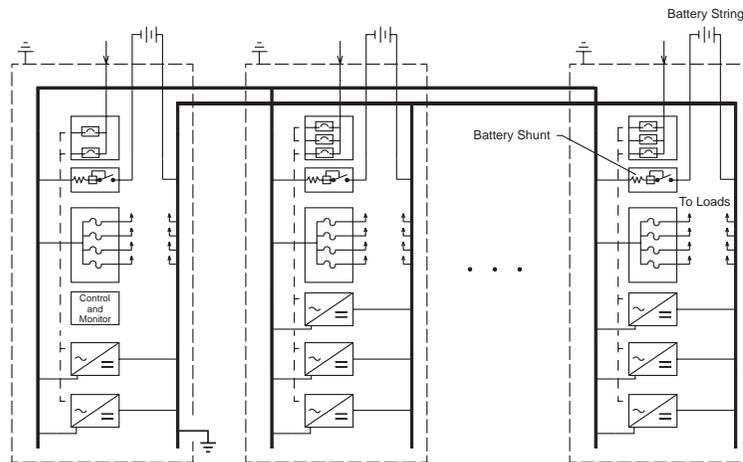


Figure 2-2: Distributed Architecture

Architecture, continued

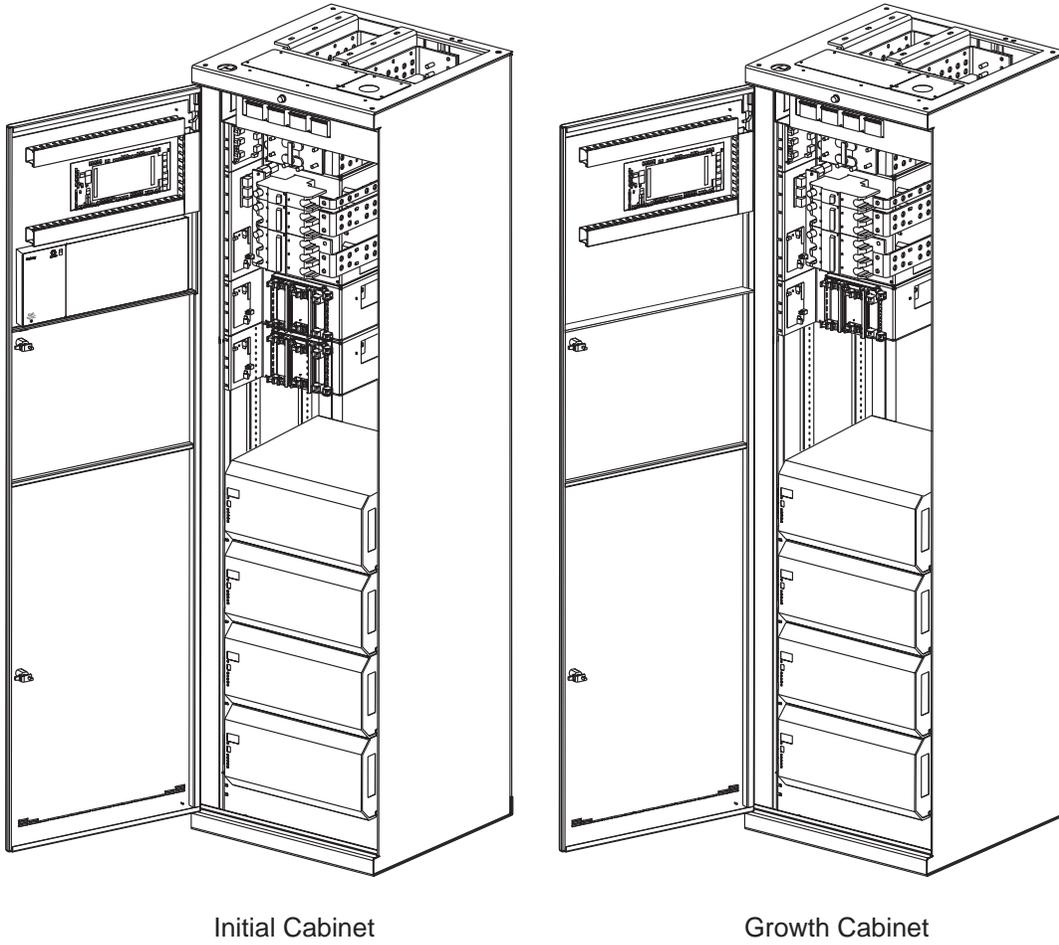


Figure 2-3: Distributed Architecture Initial and Growth Cabinets

Architecture, continued

Centralized

Figure 2-4 shows GPS 4848/100 components configured in a centralized architecture; Figure 2-5 provides a view of the centralized architecture initial and growth cabinets. Rectifiers, dc distribution panels, and batteries are cabled to external busbars where a single system shunt is provided to measure total system current. The initial cabinet contains ac distribution, rectifiers, the controller, and termination points for the system interconnect cables. Growth cabinets contain ac distribution, rectifiers, and cable termination points. A separate cabinet provides load distribution and protection facilities and may include a load disconnect/reconnect feature.

This architecture requires extensive up-front planning to determine the ultimate system capacity and engineering to size the external busbars appropriately; however, the system plan is not constrained to dedicated layouts as required for distributed architecture systems.

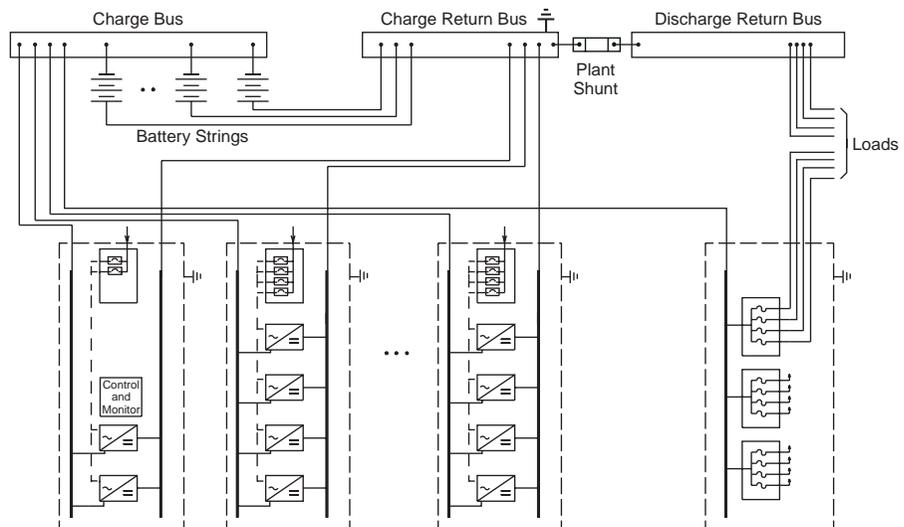


Figure 2-4: Centralized Architecture

Architecture, continued

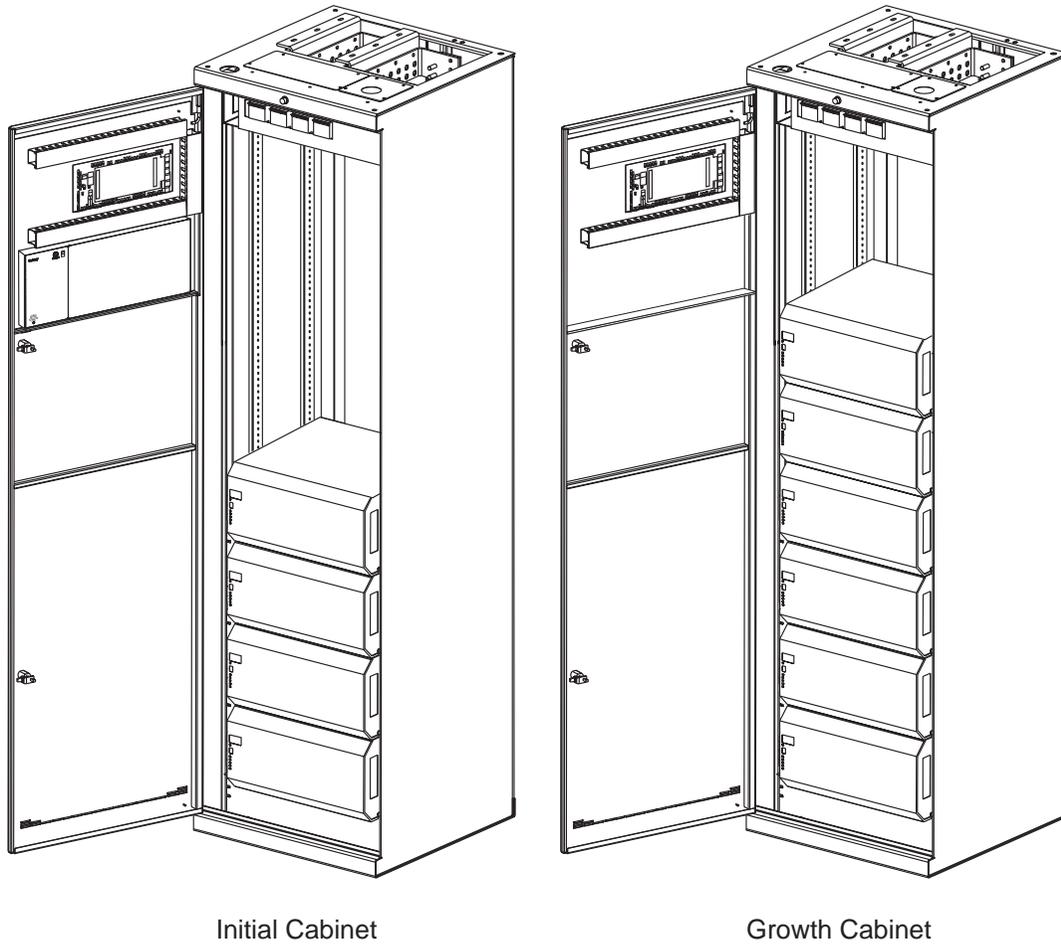


Figure 2-5: Centralized Architecture Initial and Growth Cabinets

3 ***Galaxy Controllers***

Overview

Introduction

There are two controllers available with the GPS 4848/100: the Galaxy SCF and the Galaxy Millennium. The SCF mounts inside the cabinet and has front access. The Millennium mounts inside the front door with the display viewed from the outside.

Both controllers are equipped with a Basic control board for basic operations and an optional Intelligent control board that provides advanced local and remote monitoring and data acquisition features. These control boards monitor each other's status and issue appropriate alarms in the event a failure occurs.

Galaxy SCF Controller

The Galaxy SCF Controller has two shelves. The lower shelf contains plug-in circuit packs. Circuit packs on the right perform the Basic functions; circuit packs on the left provide the Intelligent functions. The upper shelf contains a user interface circuit pack that provides system interconnect facilities. Fuses protecting controller circuit packs are on a printed circuit board located to the right of the lower shelf.

Galaxy Millennium Controller

The Galaxy Millennium Controller's circuit packs are accessed by opening the hinged cover from the left side.

User Interface and Display

Front Panels

The control panel displays alarm and status indicators and provides test jacks to monitor the system output. Keys are provided for interacting with various menus that configure and monitor the system. The controller menus can be viewed in either English or Spanish.

The user's primary interface with the controller is a panel that includes a backlit LCD front panel display, two rows of LEDs, test jacks, and an array of simple pushbutton controls. See Figures 3-1 and 3-2.

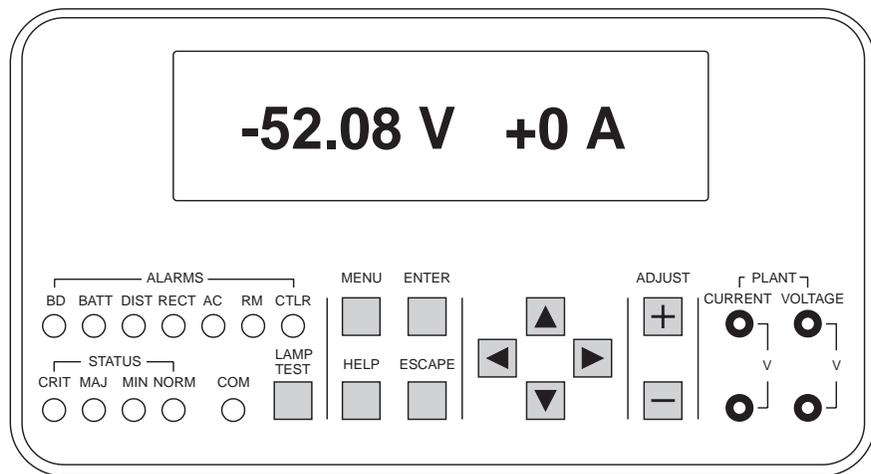


Figure 3-1: Galaxy SCF Controller Front Panel

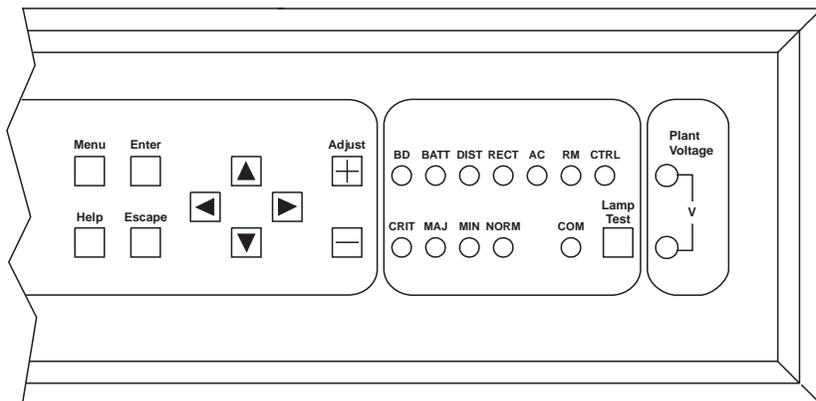


Figure 3-2: Galaxy Millennium Controller Front Panel

User Interface and Display, continued

Default Display

The default display shows basic plant status. The controller returns to this display three minutes after the last time a key is pressed. The default screen display is similar to the following: The first line shows the number of alarms (0) and warnings (0) present in the system, the date and time. The next two lines show the plant voltage and the plant load. The last line shows the plant mode, which can be FLOAT, BOOST, STC (Slope Thermal Compensation), or BTP (Battery Thermal Protection, a boost mode that offers protection against thermal runaway). The Millennium also has a BATT TEST mode.

The information on the screen is updated automatically approximately every two seconds.

LEDs

Two rows of LEDs show the source and severity of various alarms.

An alarm may light two LEDs: one alarm LED and one status LED. More than one alarm LED may be on at the same time. In this case, the status LED will be that of the most severe active alarm.

The first row of seven LEDs indicates the source of the alarm (BD, battery on discharge; BATT, battery; DIST, distribution; RECT, rectifier; AC, ac power supply; RM, remote monitoring; and CTRLR (SCF) or CTRL (Millennium), controller).

The second row includes five LEDs. The first four LEDs indicate the severity of the reported alarms (CRIT, critical; MAJ, major; MIN, minor; and NORM, normal). Another LED, labeled COM, will be illuminated when the internal modem is in use. A pushbutton labeled LAMP TEST is provided to test the controller's circuit pack LEDs and front panel LEDs. It will also test the indicators of serially connected rectifiers.

User Interface and Display, continued

Pushbutton Controls

A group of pushbutton keys beneath the backlit LCD display provides the primary user interface with the controller. These keys are used singly or in combination to navigate through the controller's menus. The following is the general description of these keys.

- Up arrow key: Use to navigate the menu; press the key to move the cursor up one line.
- Down arrow key: Use to navigate the menu; press the key to move the cursor down one line.
- Left arrow key: Use to navigate the menu; press the key to move the cursor left one field.
- Right arrow key: Use to navigate the menu; press the key to move the cursor right one field.
- MENU key: Press this key any time to view the MAIN menu.
- HELP key: Press this key to display limited on-line help information.
- ENTER key: Use this key to select a menu item.
- ESCAPE key: Use this key to return to the immediately higher level menu.

Test Jacks

Two sets of test jacks on the Galaxy SCF Controller allow direct measurement of the plant voltage and current monitored by the controller.

A pair of test jacks on the Galaxy Millennium Controller allows direct measurement of the dc bus sense voltage being monitored.

Reference Material

Controller Product Manuals

A controller product manual is furnished with every GPS 4848/100. Refer to the manual for information regarding configuration and operation.

- Galaxy SCF Controller, Select Code 167-792-110
- Galaxy Millennium Controller, Select Code 167-792-180

RPM System Product Manual

Refer to the Galaxy Remote Peripheral Monitoring System product manual (Select Code 167-790-063) for additional information regarding module operation.

4 *Rectifiers*

595 Series

Overview

Two 200-ampere rectifiers are available for the GPS 4848/100 system: 595A2 and 595B2. The 595A2 operates from 3-phase ac service with a phase-to-phase voltage within the range of 320-530Vac. The 595B2 operates from 3-phase ac service with a phase-to-phase voltage within the range of 170-260Vac.

The rectifiers are shipped separately from the cabinets for quick and straightforward installation into rectifier shelves at the site. Interconnections to ac input, dc output, and control signals occur automatically during insertion. The rectifiers are keyed to prevent installation of a rectifier with incompatible ac input. No operational settings or adjustments to potentiometers are necessary. The installer must set the rectifier's ID using the ON/STBY switch to allow the controller to learn the rectifier's physical location for alarm reporting.

Front Panel Display

Power Switch

This three-position switch has two active states:

- It controls the on/standby state of the rectifier.
- It is used to set the rectifier ID.

Status Indicators

In addition to the ON and STBY LEDs, four other LEDs on the rectifier's faceplate indicate the rectifier's condition.

- The **ALM** LED is red and lights when communication to the controller is lost, a thermal alarm occurs, or a rectifier fails.
- The **LIM** LED is yellow and lights when the unit is in current limit.
- The **FAN ALM** LED is red and lights when the fan inside the rectifier is not functioning properly.
- The **EQL** LED is yellow and lights when the rectifier is in equalize mode.

Current Display

This display indicates the current of the rectifier. Upon specific no-power conditions, the 3-digit display will show informative messages.

Lamp Test

To test the LEDs on the rectifier front panel, press the Lamp Test button on the controller.

Front Panel Display, continued

Illustration

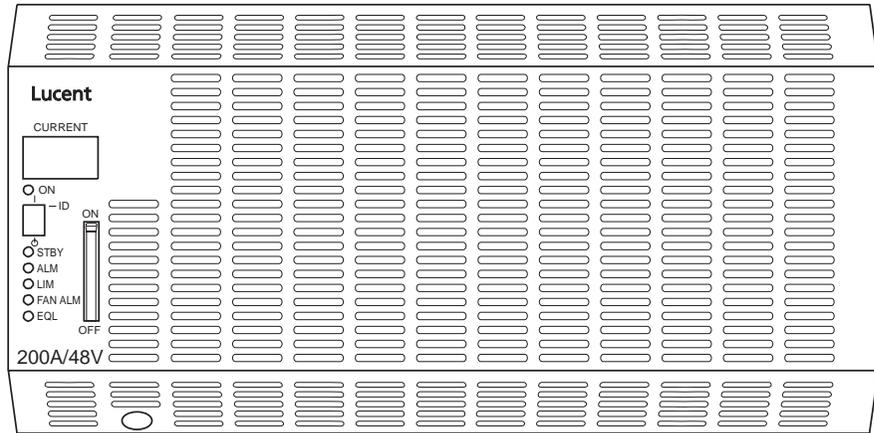


Figure 4-1: Rectifier Front Panel

Features

Output Voltage Adjustment

This feature allows the rectifier output voltage to be set through the controller. See Table 9-B.

Output Current “Walk-in”

This circuit controls the time (up to eight seconds) required for the rectifier to reach normal operating conditions after it is turned on. This feature minimizes the starting surge on the customer's power source.

Electronic Current Limit

When the output current tends to increase above the current limit set point (10% to 110% of rated output), the current limit circuit overrides the voltage regulating signal and safely limits the output current of the rectifier, thus preventing damage to itself, the battery, or the load.

Selective High Voltage Shutdown (SHVSD)

This feature allows the rectifier to respond and shut down at the output high voltage threshold set through the Galaxy controller. See Table 9-B.

Backup High Voltage Shutdown (BHVSD)

This is a hardwired feature independent of the rectifier's microcontroller. This feature will operate even if the rectifier microcontroller fails or communication with the Galaxy controller is lost. See Table 9-B.

Restart

Upon shutdown, the rectifier will attempt to restart. The rectifier will try to restart three times before issuing a rectifier fail alarm to the controller. The rectifier will also accept a restart command from the controller for a remote restart.

Output Circuit Breaker

The output circuit breaker located on the front panel protects the power system from rectifier malfunction and may be used to disconnect the rectifier from the system output bus.

Fan Alarm and Control

The rectifier contains two cooling fans whose speed is based on ambient temperature and output power level. The fan's speed is lowered during low-load and low-temperature conditions to minimize audible noise and maximize fan life.

Features, continued

Thermal Alarm

The rectifier senses the internal operating temperature and will issue a thermal alarm if the internal temperature exceeds a safe operating level. Ambient temperatures above the maximum rating will result in a rectifier shutdown and the issuing of a thermal alarm (TA). See Table 9-B.

Controller Communications Alarm

When communications between the rectifier and controller are interrupted, the rectifier continues to operate and the red **ALM** LED on the rectifier blinks.

Autonomous Operation of the Rectifier

If communication with the Galaxy controller is lost, the rectifier will continue to operate by raising and lowering its output according to load needs by watching the system voltage. As voltage rises, the system load drops; when voltage falls, the system load increases.

Connectorized

The rectifiers provide the controller with a full complement of status and alarm messages. The rectifier status and alarm signals, ac input, and dc output are all connectorized for easy installation and maintenance. All connections automatically occur as the rectifier is physically mated to its shelf.

“Forced” Load Sharing

The controller forces rectifiers to load share by sending messages to them. In the event communication to the controller is lost or the controller malfunctions, load share balance is maintained while ac or dc power is applied to the rectifiers.

5 ***AC Input Panels***

Overview

AC Service

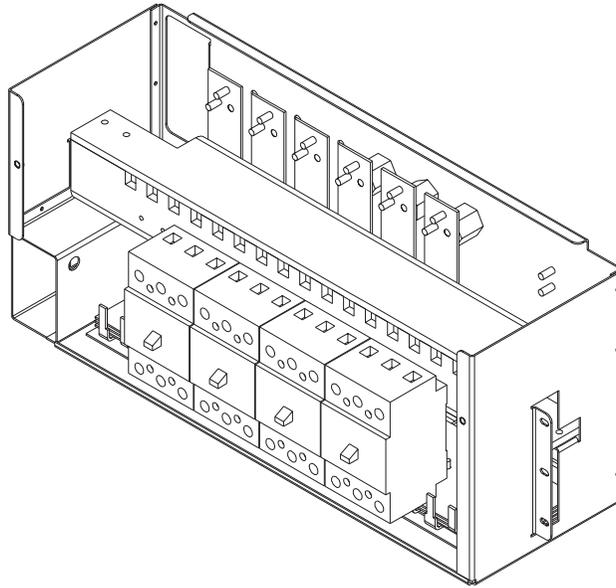
The ac input panel provides the facility to terminate the 3-phase ac service to the GPS 4848/100. Depending upon the option ordered, the panel will connect 3-wire delta or 3-wire wye service to provide the phase-to-phase ac voltage required for the rectifiers.

In some systems, circuit breakers are provided in the AC Input Panel to protect the conductors providing ac service to the individual rectifiers. In other systems, the circuit breakers protecting these conductors are located in the building's ac service panel. In either case, conductors to each rectifier are protected by a dedicated circuit breaker.

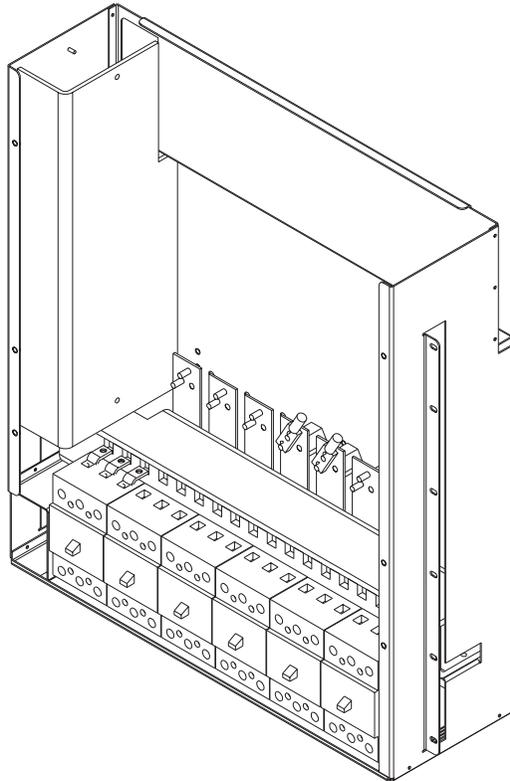
Note: All wire sizes were based on the US National Electric Code.

Illustrations

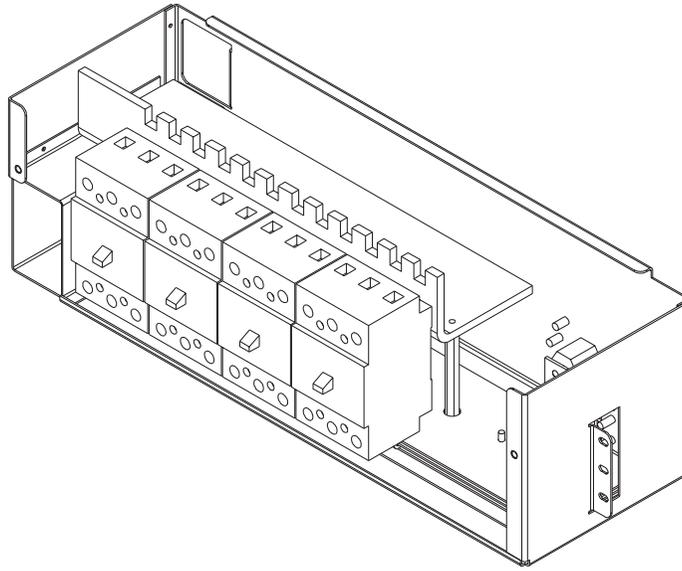
Circuit breaker panels are shown in Figures 5-1 through 5-3; the terminal strip panel is shown in Figure 5-4.



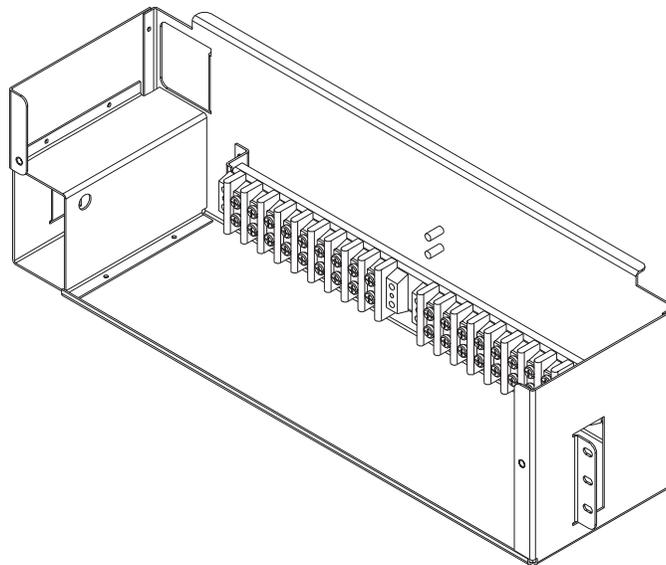
**Figure 5-1: H569-434 G20 (ED83142-30 G3)
208/240V AC Input Circuit Breaker Panel**



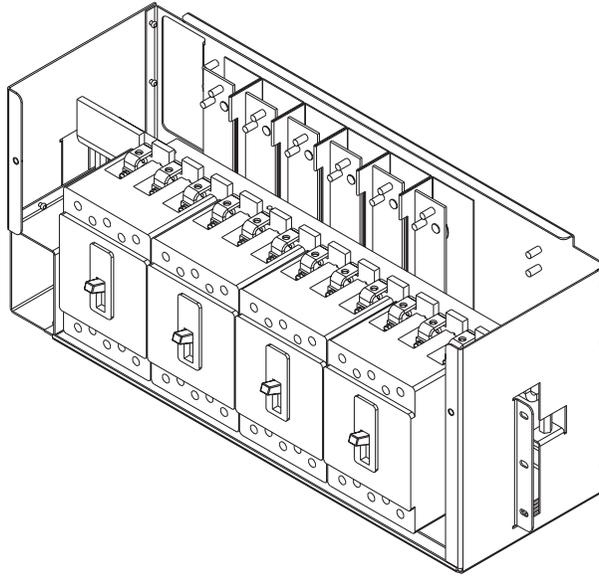
**Figure 5-2: H569-434 G21/23 (ED83142-30 G4)
208/240/480V AC Input Circuit Breaker Panel**



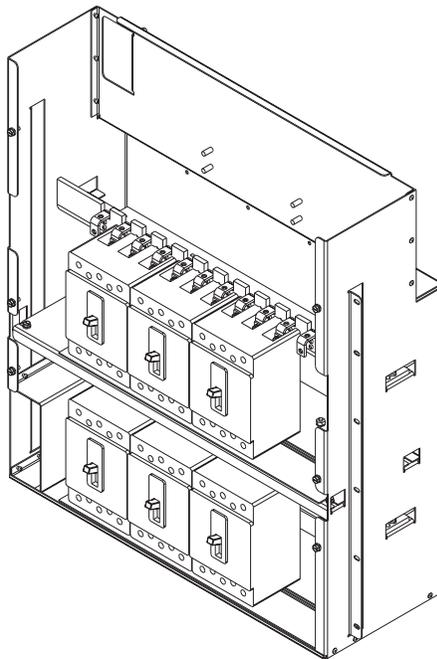
**Figure 5-3: H569-434 G22 (ED83142-30 G2)
480V AC Input Circuit Breaker Panel**



**Figure 5-4: H569-434 G24/25/26/27 (ED83142-30 G5)
208/240/480V AC Input Terminal Strip Panel**



**Figure 5-5: H569-434 G70 (ED83142-30 G10)
480V 65kAIC AC Input Terminal Strip Panel**



**Figure 5-6: H569-434 G71 (ED83142-30 G11)
480V 65kAIC AC Input Terminal Strip Panel**

6 *Battery Connection Panels*

Overview

Introduction

Batteries are connected to the GPS 4848/100 cabinets based on the system architecture.

Distributed Architecture

For distributed power architecture, the batteries are terminated on battery connection panels located in the cabinet directly below the ac input panel. As options, the panels may include fuses or low battery voltage disconnect/reconnect (LVBD/R) contactors. When equipped with contactors, a contactor control card provides local/manual control of the contactors.

Off Line Equalize (OLE) battery connection panels additionally provide means to manually equalize single battery sections. A plug-in dc to dc converter provides up to 65V to fully charge battery section cells, equalizing cell float voltages. This restores fully charged cell capacity to each cell in the section. A timer terminates the manually initiated equalize operation.

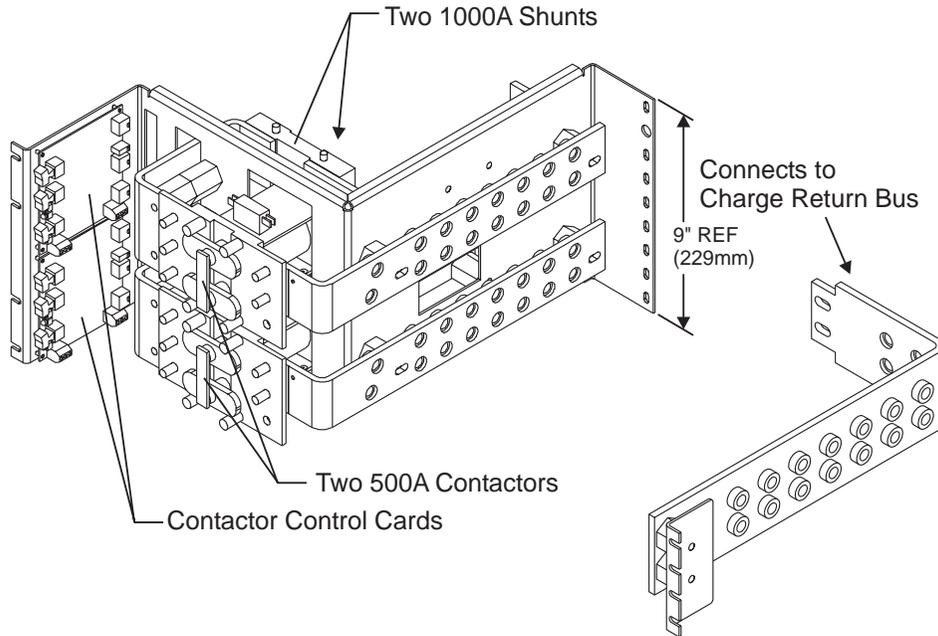
Centralized Architecture

For systems with centralized architecture, the batteries are connected between the system charge and charge return buses. In turn, these buses are connected to rectifier termination buses located behind the ac input panel.

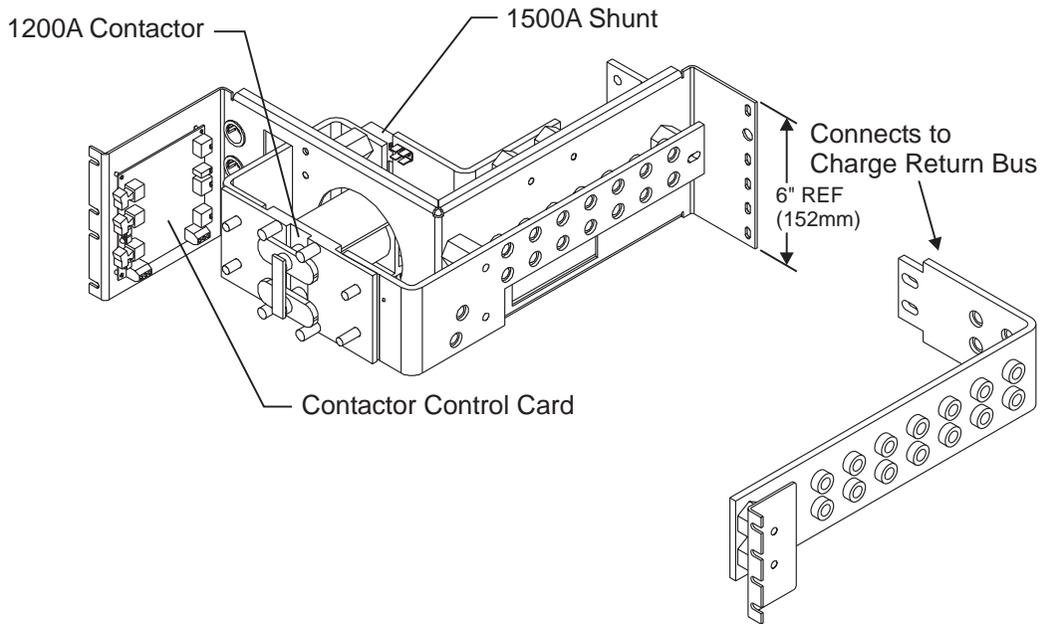
Illustrations

The battery connection panels are illustrated in Figures 6-1 through 6-6.

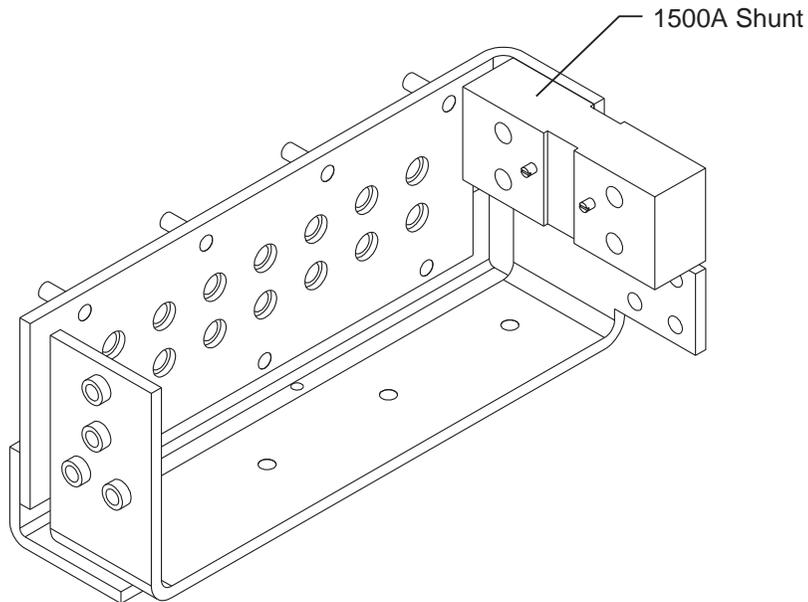
Note: Battery connection panels are blue; dc distribution panels are white.



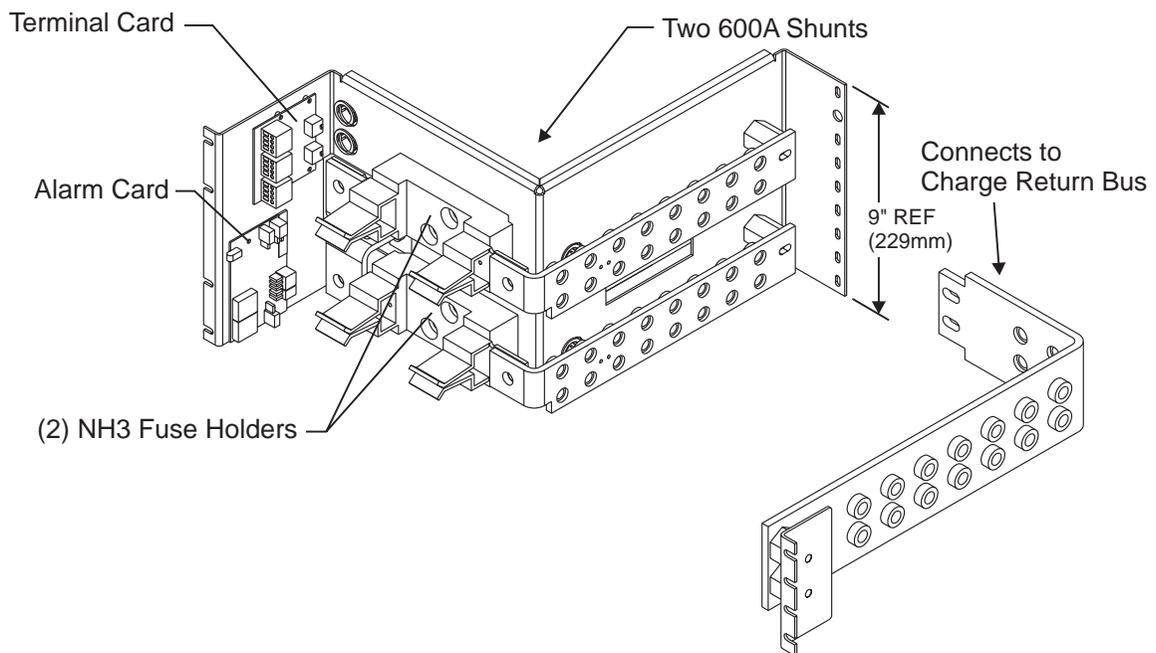
**Figure 6-1: H569-434 G30 (ED83143-30 G32)
Battery Connection Panel**



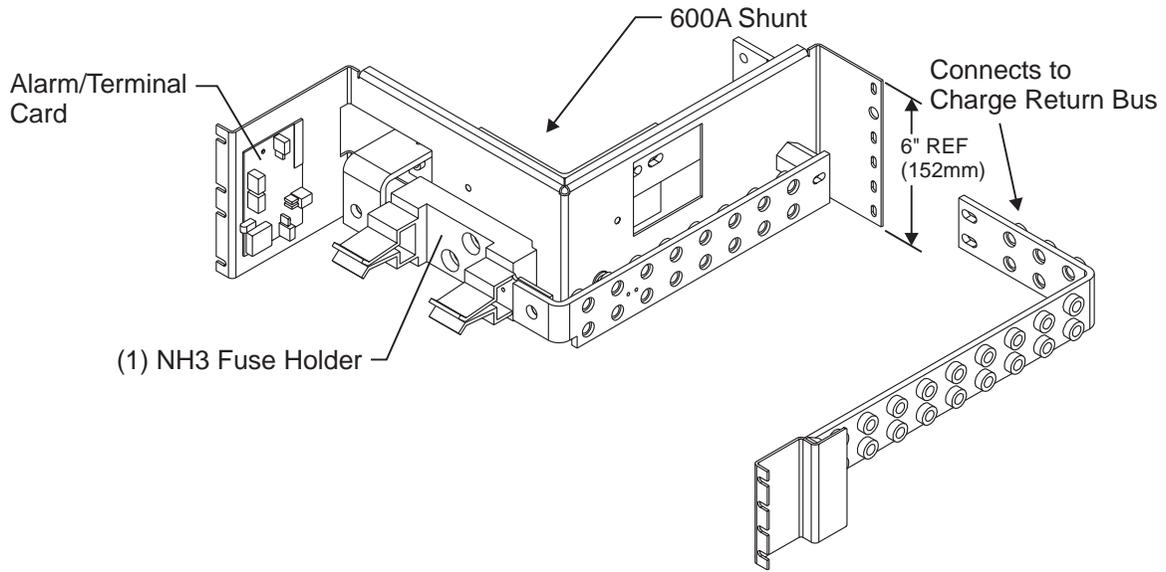
**Figure 6-2: H569-434 G31 (ED83143-30 G31)
Battery Connection Panel**



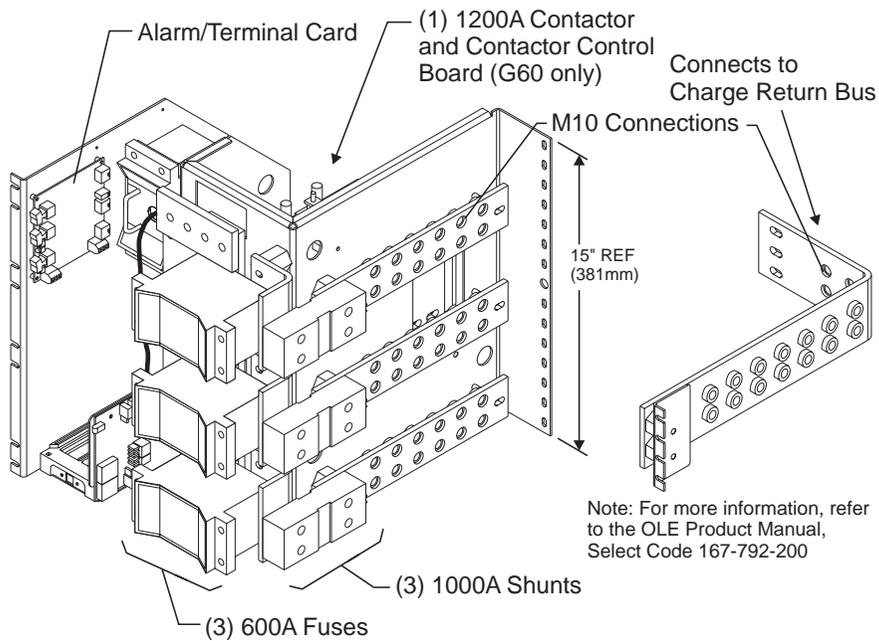
**Figure 6-3: H569-434 G32 (ED83143-30 Group 30)
Battery Connection Panel**



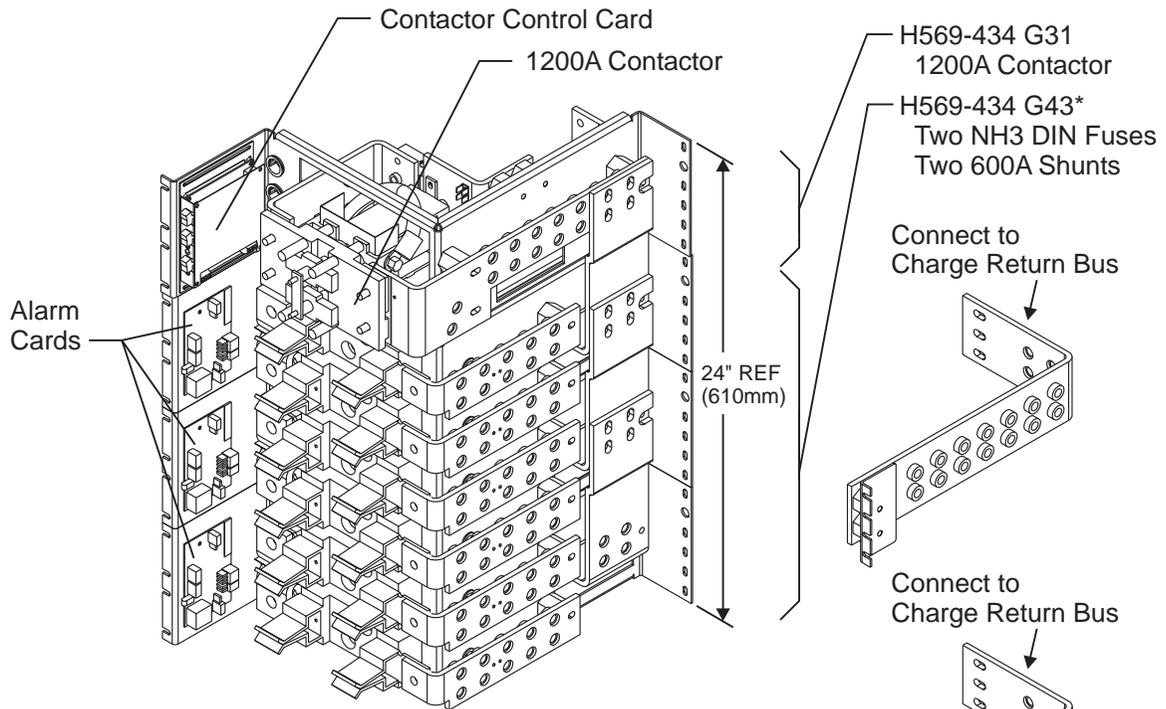
**Figure 6-4: H569-434 G34 (ED83143-30 Group 41)
Battery Connection Panel**



**Figure 6-5: H569-434 G35 (ED83143-30 Group 42)
Battery Connection Panel**



**Figure 6-6: H569-434 G37/38 (ED83143-30 Group 60/61)
Battery (OLE) Connection Panel**



*H569-434 Battery Module

Group #	Includes:
G80	1 G31 1 G43
G81	1 G31 2 G43
G82	1 G31 3 G43 (shown)

**Figure 6-7: H569-434 G80/81/82 (ED83143-30 G31/43)
Battery Connection Panel**

7 *DC Distribution Panels*

Overview

Function

A variety of dc distribution panels are available featuring large or small fuses and circuit breakers of both domestic and European design. All panels are equipped with an alarm card. When a fuse operates or a circuit breaker trips, a red LED on the alarm card lights, the cabinet alarm lights, and the alarm is transmitted to the controller. Replacement fuses and plug-in circuit breakers are listed in the *Replacement Parts* section.

Illustrations

The dc distribution panels are illustrated in Figures 7-1 through 7-14.

Note: DC distribution panels are white; battery connection panels are blue.

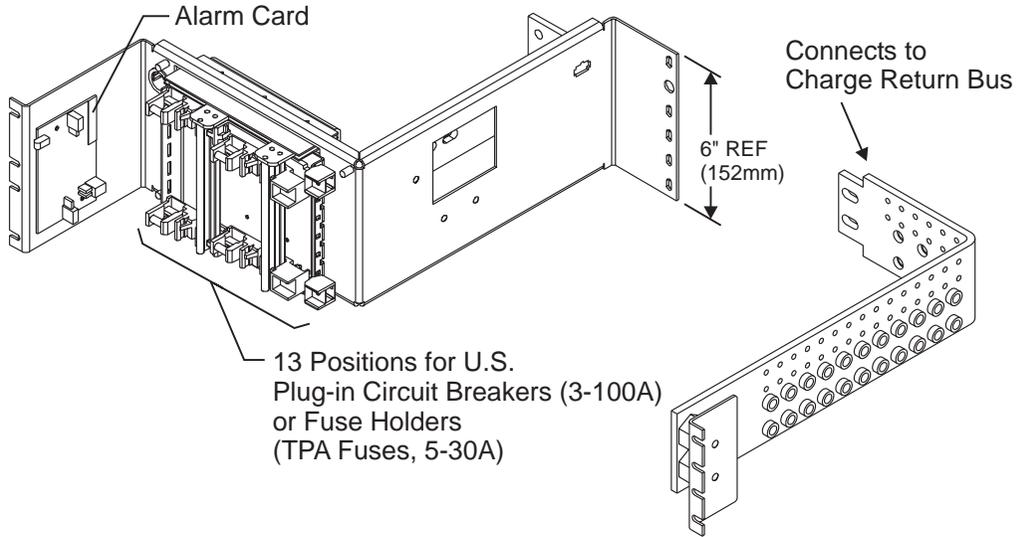


Figure 7-1: H569-434 G40/45/50/55 (ED83143-30 G11/13) 400A DC Distribution Panel

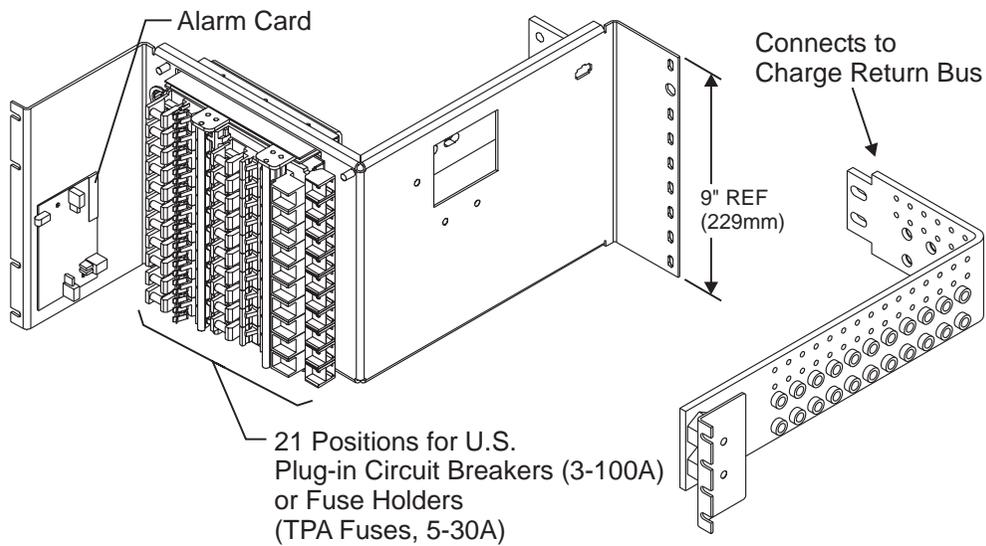
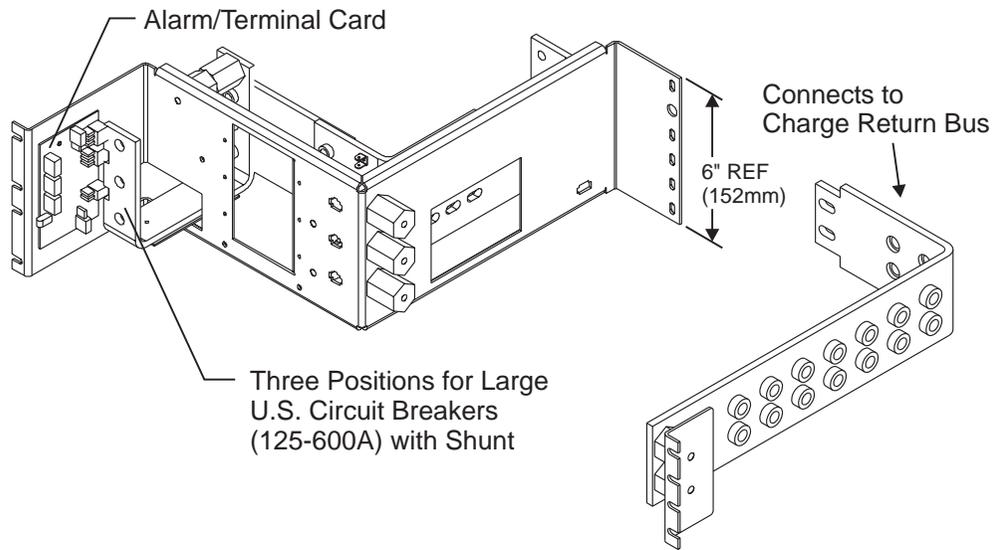
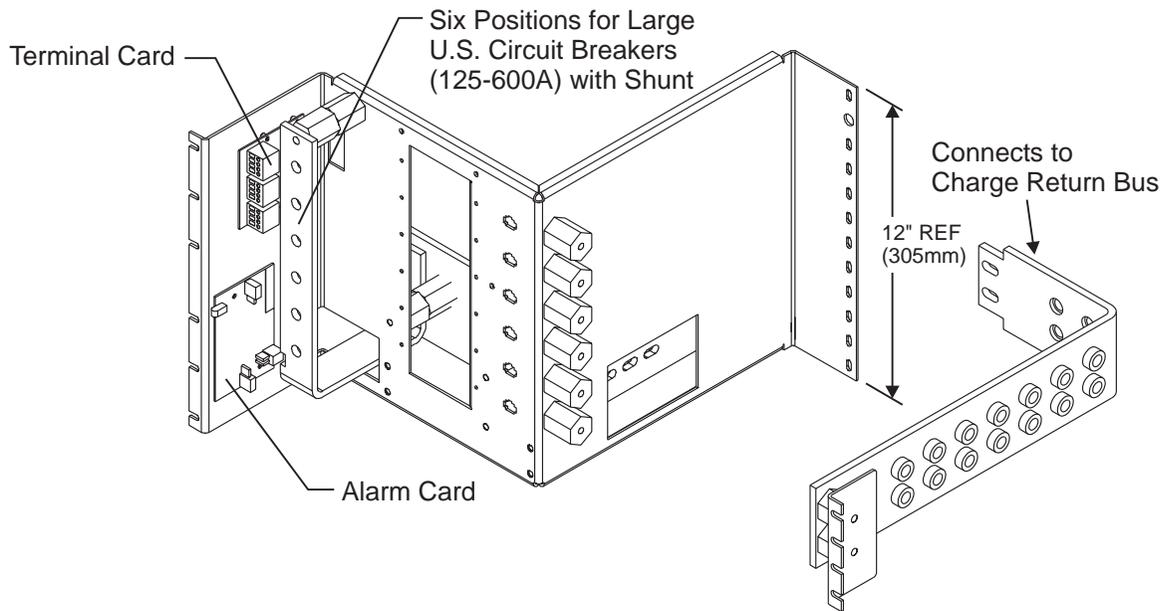


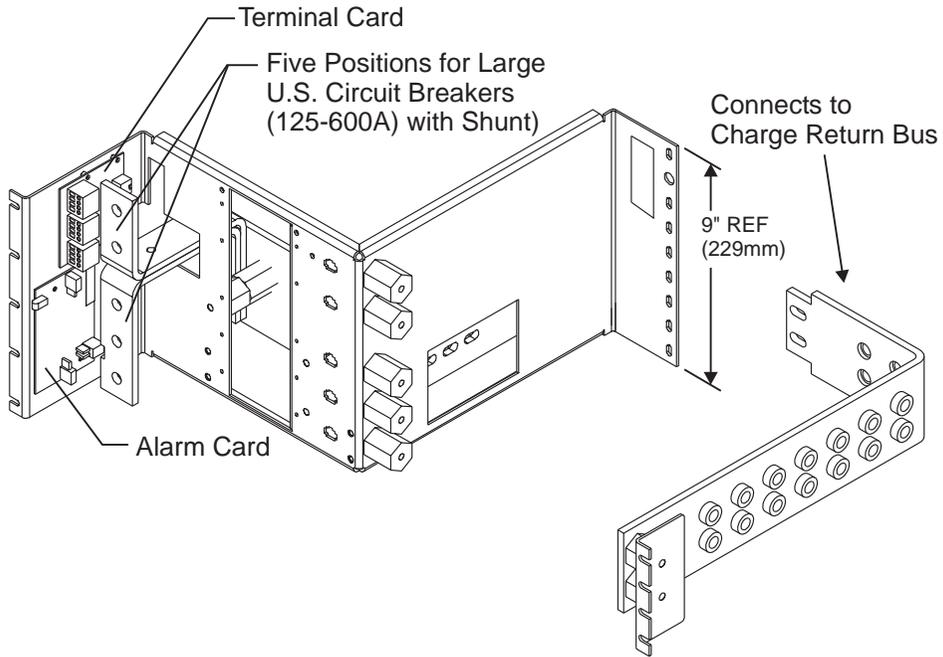
Figure 7-2: H569-434 G41/46/51/56 (ED83143-30 G12/14) 400A DC Distribution Panel



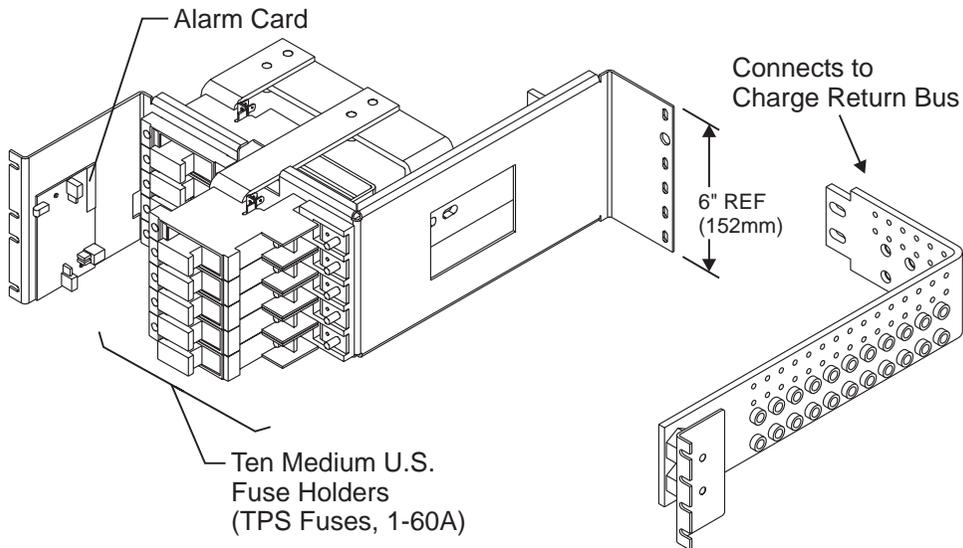
**Figure 7-3: H569-434 G42/47 (ED83143-30 G2/3)
600A DC Distribution Panel**



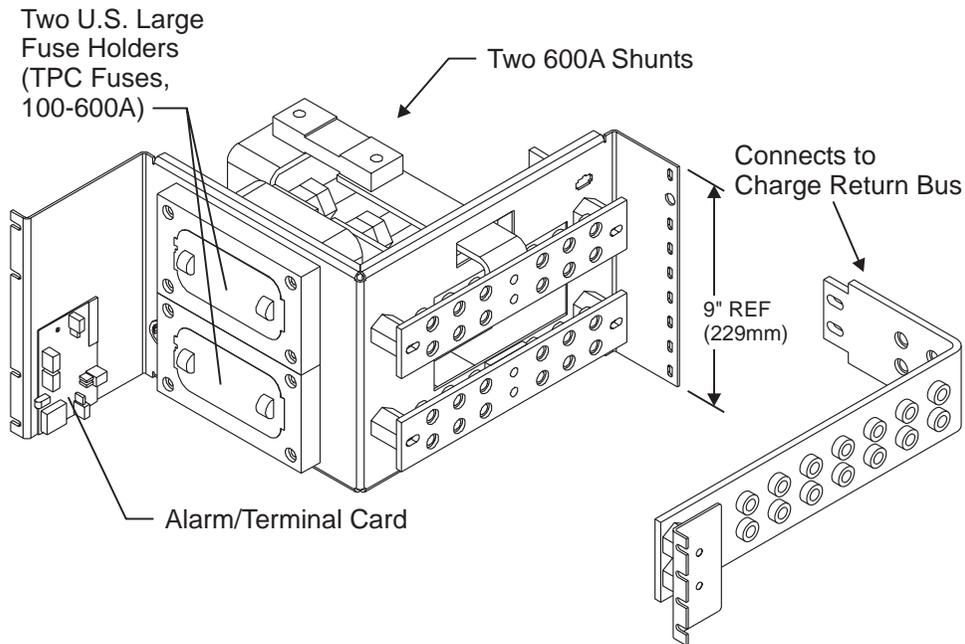
**Figure 7-4: H569-434 G43 (ED83143-30 G1/4)
1200A DC Distribution Panel**



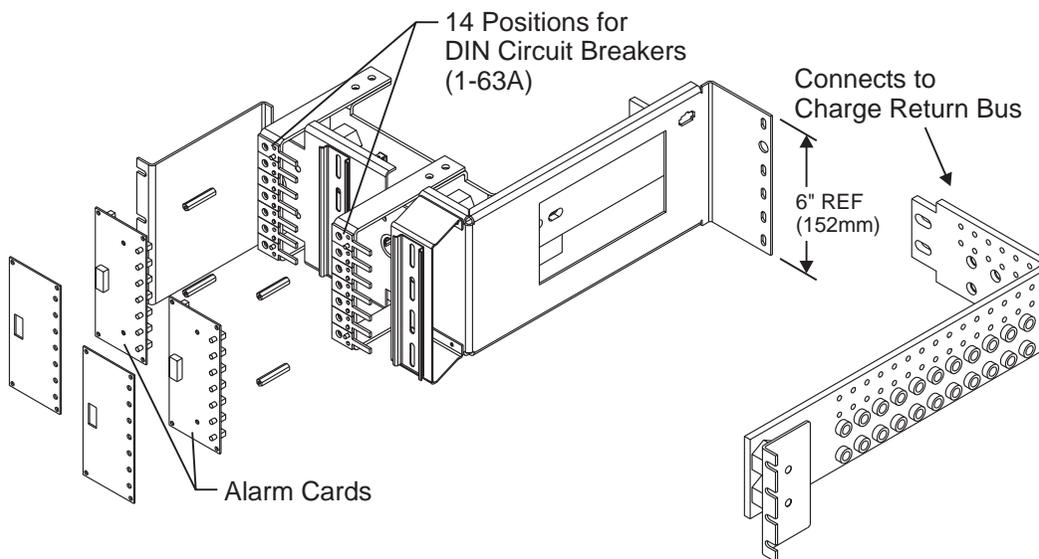
**Figure 7-5: H569-434 G48 (ED83143-30 G5/6)
1000A DC Distribution Panel**



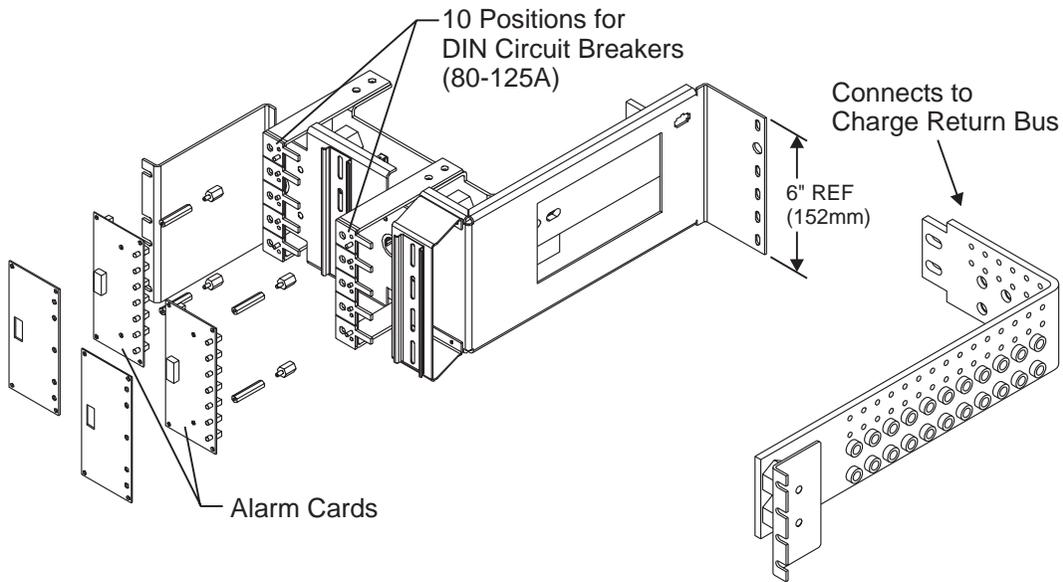
**Figure 7-6: H569-434 G52 (ED83143-30 G53)
600A DC Distribution Panel**



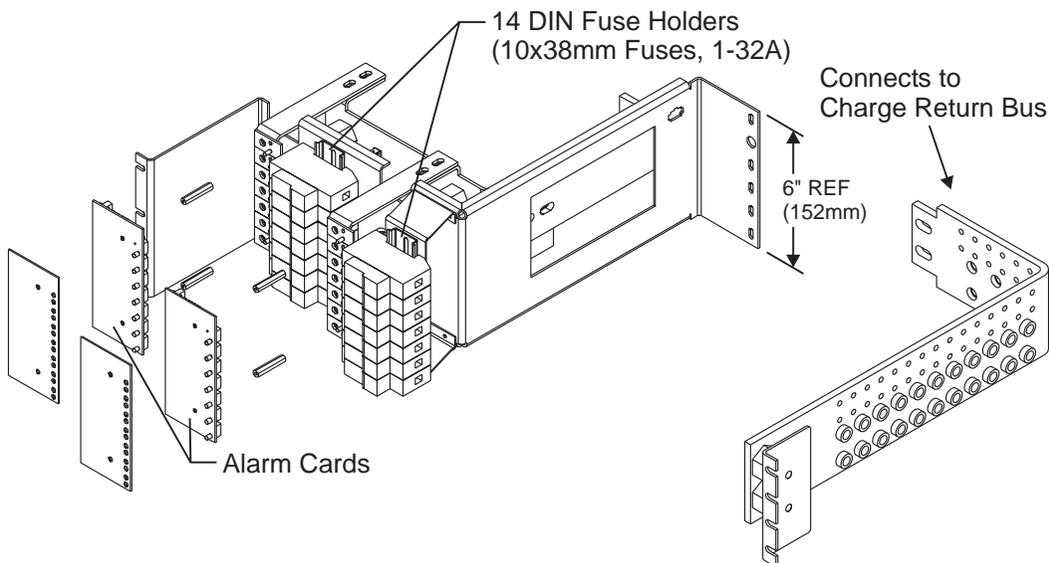
**Figure 7-7: H569-434 G53/57 (ED83143-30 G51/52)
1000A DC Distribution Panel**



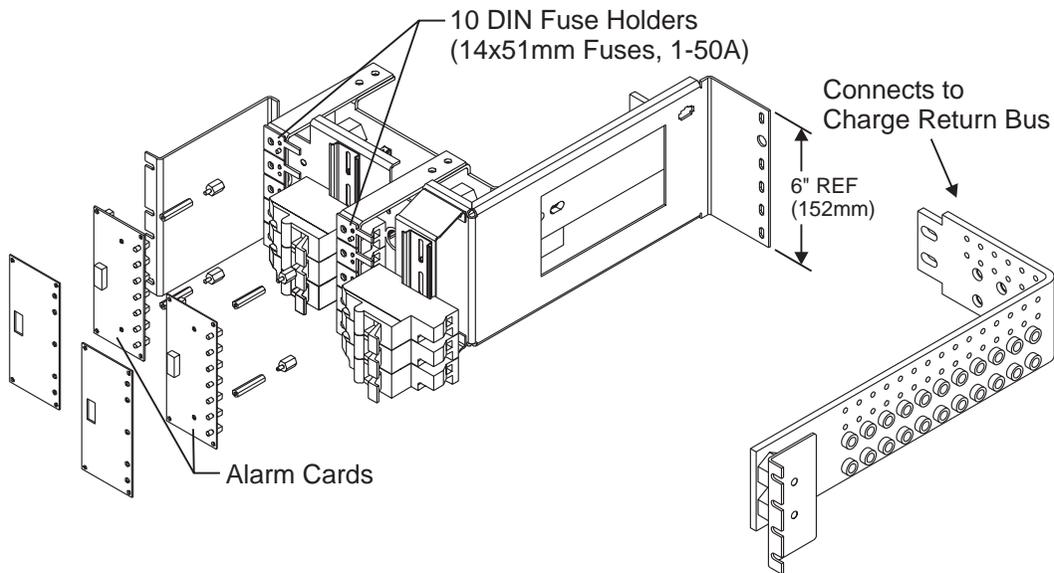
**Figure 7-8: H569-434 G60 (ED83143-30 G20/26)
600A DC Distribution Panel**



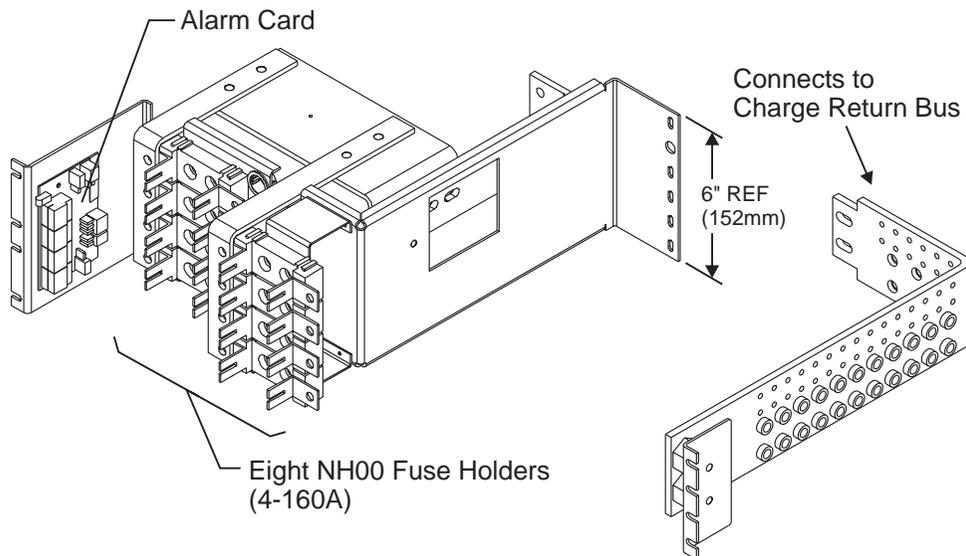
**Figure 7-9: H569-434 G61 (ED83143-30 G25/29)
600A DC Distribution Panel**



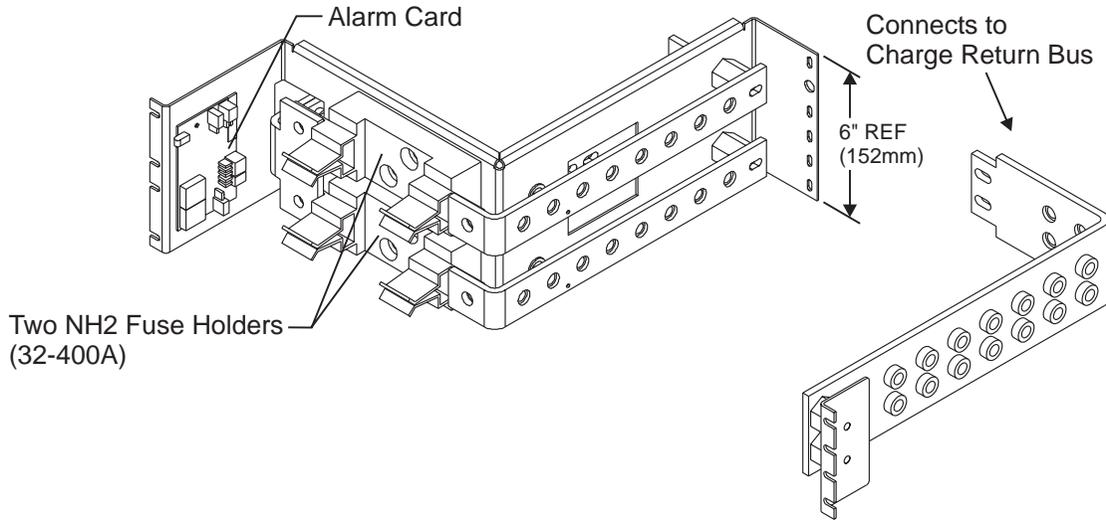
**Figure 7-10: H569-434 G65 (ED83143-30 G24/28)
600A DC Distribution Panel**



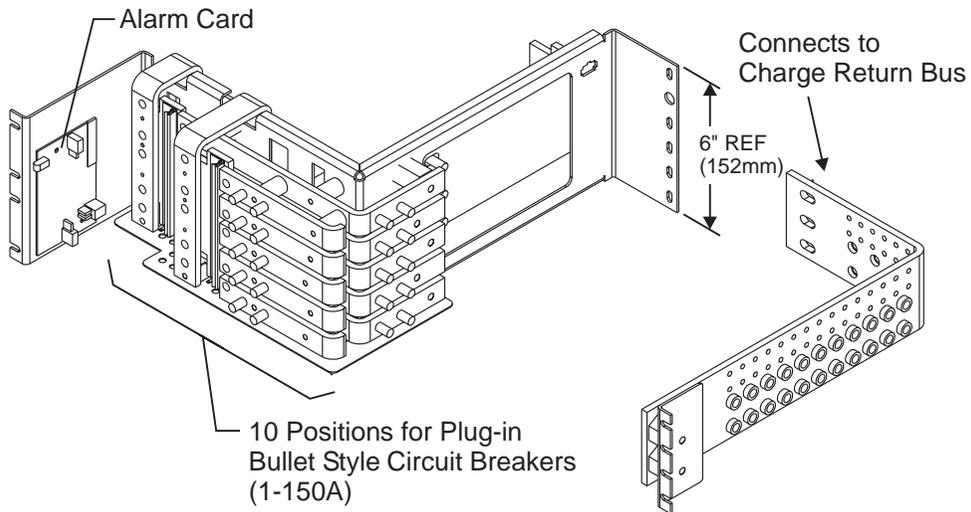
**Figure 7-11: H569-434 G66 (ED83143-30 G23/27)
600A DC Distribution Panel**



**Figure 7-12: H569-434 G67 (ED83143-30 G22)
600A DC Distribution Panel**



**Figure 7-13: H569-434 G68 (ED83143-30 G21)
1200A DC Distribution Panel**



**Figure 7-14: H569-434 G95 (ED83143-30 G15)
510A DC Distribution Panel**

8 *Circuit Boards*

Overview

Function

Circuit boards (sometimes referred to as “cards” or “circuit packs”) are included in bays, battery connection panels, and dc distribution panels to provide data required by the controller and to control devices such as contactors and lamps.

Terminal Boards

Terminal boards are used to provide shunt voltage data to the controller, where it is used to calculate current. Data from the terminal boards located on the battery connection panels provide data that is used to calculate battery current; data from terminal boards located on the dc distribution panels are used to calculate load currents.

Alarm Boards

Alarm boards perform two functions:

- monitor panel functions and activate local indicators when faults occur on the panel;
- provide alarm data to the controller.

Alarm/Terminal Boards

Alarm/terminal boards combine the functions of alarm boards and terminal boards.

BLJ Terminal Board

The BLJ terminal board is located inside the cabinet door. The BLJ is the termination point for all signal cables in each cabinet and between cabinets.

Overview, continued

Bay Interface Card Each cabinet has a Bay Interface Card (BIC) that attaches to the cabinet's terminal board (BLJ). The BIC provides controller access to alarm monitoring, battery voltages, battery currents, and temperature probes in the cabinet through the serial rectifier bus. The BIC also provides connection of the system serial rectifier bus to the bay rectifiers. See Figure 8-1.

Contactor Control Board Contactor control boards provide four functions:

- Monitor and report shunt voltage to the controller
- Monitor and report contactor status to the controller
- Operate the contactor based on controller commands
- Operate or block the contactor based on maintenance switch settings

9 Specifications

GPS 4848/100

Table 9-A: Galaxy Power System 4848/100 Specifications

Electrical	
Nominal output voltage	-48Vdc
Operating Voltage Range (Float or Boost)	-44Vdc to -58Vdc
Output Current (System Maximum)	10,000A ¹ ¹ Centralized bus bars available to 5,200A
Nominal Input Voltage (595A2 Rectifier)	380-480Vac, 3-wire plus ground
Nominal Input Voltage (595B2 Rectifier)	200-240Vac, 3-wire plus ground
Input Voltage Range per phase (595A2 Rectifier)	320Vac - 530Vac
Input Voltage Range per phase (595B2 Rectifier)	176Vac - 254Vac
Input Frequency Range	47 Hz - 63 Hz
System Efficiency (including ac and dc cables)	>88%
Regulation (line and load range with controller)	± 0.5%
AC Ripple	<100mVrms
Output Noise	<2mV psophometric
Electromagnetic Immunity	10V/meter over 20 MHz - 2000 MHz

Table 9-A: Galaxy Power System 4848/100 Specifications

Physical	
Width, Depth	600 mm, 600 mm (23.6 in. x 23.6 in.)
Weight (approximate, per cabinet)	250 kg (551 lbs.)
Height (cabinet only)	2134 mm (84.0 in.)
Height (cabinet with link bus bar)	2274 mm (89.5 in.)
Environmental	
Maximum Input Current, per cabinet	120 amperes per phase, 3-wire
Heat Release, per cabinet 4 rectifiers @ 1068W each ² 5 rectifiers @ 1068W each ² 6 rectifiers @ 1068W each ² ² 54Vdc, 200A output, per rectifier	4272W [14,583 BTU/hr] 5340W [18,228 BTU/hr] 6408W [21,874 BTU/hr]
Operating Temperature	0°C to 40°C
Operating Release Humidity	5% - 95%
Units Per Initial Cabinet	
Rectifiers	0 - 6
Controller	1
Battery Disconnect Modules	1 - 3
DC Distribution	1 - 6 (maximum of 5 with battery disconnect)
Units Per Growth Cabinet	
Rectifiers	0 - 6
Battery Disconnect Modules	0 - 1
DC Distribution	1 - 6 (maximum of 5 with battery disconnect)

Table 9-A: Galaxy Power System 4848/100 Specifications

Standards Compliance	
Safety	<ul style="list-style-type: none"> • UL³ Listed (US and Canada): UL Subject 1801 with applicable sections of UL1950/CSA⁴950) • VDE Licensed to VDE 0805/IEC950/EN60950 <p>³UL is a registered trademark of Underwriters Laboratories, Inc.</p> <p>⁴CSA is a registered trademark of Canadian Standards Association.</p>
Electromagnetic Compliance	<ul style="list-style-type: none"> • Emission: <ul style="list-style-type: none"> – FCC Part 15 Class B – EN55022 (CISPR 22) Radiated/Conducted Emission, Class B • Immunity <ul style="list-style-type: none"> – IEC/EN 61000-4-2 ESD levels 3 and 4 – IEC/EN 61000-4-3 Radiated Immunity, 10V/m – IEC/EN 61000-4-4 Electrical Fast Transients/Burst, level 4 – IEC/EN 61000-4-5 Lightning Surge, level 4
CE Marking	<ul style="list-style-type: none"> • CE marked per European Union Council Directives: <ul style="list-style-type: none"> – Low-Voltage Directive (73/23/EEC) – EMC Directive (89/336/EEC) as amended by CE Marking Directive (93/68/EEC)
Telcordia	<ul style="list-style-type: none"> • GR-63 and GR-1089 NEBS (including Level 3 testing) • Report by an independent test house

Rectifiers

Table 9-B: 595 Series Rectifier Specifications

Electrical	
Output Voltage	52Vdc typical
Equalize Voltage	65Vdc typical
Output Voltage Adjustment	44-58Vdc float/boost 58-65Vdc equalize mode
Regulation (with controller)	±.5%
High Voltage Shutdown (selected by controller)	Float/boost 44-60Vdc (56Vdc default) Equalize 44-67Vdc (65Vdc default)
Backup High Voltage Shutdown	Float/boost 59-60Vdc (59.5Vdc nominal) Equalize 65.5-66.5Vdc (66Vdc nominal)
Thermal Alarm	595A2 65°C (63-67°C range ¹) 595B2 60°C (58-63°C range ¹) ¹ Actual range due to tolerance in component and circuit
Ripple	100mVrms
Noise	<2mV psophometric
Permanent Overload	220A dc
Current Limit Set Point	60A dc - 220A dc (60A dc - 100A dc in equalize)
Nominal Input Voltage 595A2 Rectifier	380-480Vac, 3-wire plus ground
Nominal Input Voltage 595B2 Rectifier	200-240Vac, 3-wire plus ground
Input Voltage Range per phase 595A2 Rectifier	320Vac - 530Vac
Input Voltage Range per phase 595B2 Rectifier	176Vac - 254Vac
Input Current 595A2 Rectifier	20A ac @ 480Vac 25A ac @ 380Vac
Input Current 595B2 Rectifier	40A ac @ 208Vac 35A ac @ 240Vac
Frequency Range	47 - 63 Hz
Power Factor	>0.92 @ 50% to 100% load
Total Harmonic Distortion	<34% @ 50% to 100% load

Table 9-B: 595 Series Rectifier Specifications

Rated Service Entrance Surge Protector: It is important that the service entrance surge protector (if provided) be coordinated with the internal surge protection and that it clamps at a lower voltage than the internal protection. The internal protection voltage and current characteristics of the 595A2 and 595B2 are as follows:	
595A2	
Phase to Phase	MOV Conduction
<u>Voltage</u>	<u>Current</u>
625 Vac (RMS)	0 A
940 Vpeak	1 mA
1650 Vpeak	100 A
595B2	
Phase to Phase	MOV Conduction
<u>Voltage</u>	<u>Current</u>
320 Vac (RMS)	0 A
462 Vpeak	1 mA
810 Vpeak	100 A
Physical	
Width	445 mm (17.5 in) rear of unit
Height	210 mm (8.25 in) rear of unit
Depth	470 mm (18.2 in) overall, less connector
Weight	29 kg (<65 lbs)
Environmental	
Efficiency	> 90% @ 100Adc - 200Adc output current
Operating Temperature	0°C - 40°C
Operating Relative Humidity	5% - 90% non-condensing
Storage Temperature	-40°C - +85°C
Storage Relative Humidity	5% - 90%
Altitude	-50 to 4000 meters (Note: For altitudes above 1500 meters, derate the temperature by .656° Celsius per 100 meters.)
Audible Noise	< 60dBA at room temperature, mounted in cabinet
Heat Release:	Per Rectifier
54Vdc, 160A	854W [2915 BTU/hr]
54Vdc, 200A	1068W [3645.7 BTU/hr]

Table 9-B: 595 Series Rectifier Specifications

Standards Compliance	
Safety	<ul style="list-style-type: none">• UL Recognized (US and Canada) and VDE• UL1950, EN60950/IEC950, and CSA 234/950 (tested for SELV output)
Electromagnetic Compliance: Emission and Immunity	<ul style="list-style-type: none">• EN55022 (CISPR22) Radiated/ conducted emission, Class B meets FCC Part 15 Class B• IEC/EN 61000-4-2 ESD levels 3 and 4• IEC/EN61000-4-3 Radiated Immunity, 10Vm• IEC/EN61000-4-4 Electrical Fast Transients/Burst, level 4• IEC/EN 61000-4-5 Lightning Surge, level 4
CE Marking	CE marked per European Union Council directives: Low-voltage Directive (73/23/EEC) as amended by CE Marking Directive (93/68/EEC)

AC Input Panels

Table 9-C: AC Panels

Description	H569-434 Group No.	ED83142-30 Group No.
AC Input Circuit Breaker Panel	G20	G3
AC Input Circuit Breaker Panel	G21 or G23	G4
AC Input Circuit Breaker Panel	G22	G2
AC Input Terminal Strip Panel	G24, G25, G26, or G27	G5
AC Input Circuit Breaker Panel	G70	G10
AC Input Circuit Breaker Panel	G71	G11

Battery Connection Panels

Table 9-D: Battery Connection Panels

Description	H569-434 Group No.	ED83143-30 Group No.
LVBD: (2) 500A contactors with 1000A shunts	G30	G32
LVBD: 1200A contactor with 1500A shunt	G31	G31
1500A shunt	G32	G30
2 fuse holders for 315-630A NH3 DIN fuses with 600A shunts	G34	G41
Fuse holder for 315-630A NH3 DIN fuse with 600A shunt	G35	G42
Off-Line Equalize (OLE) with (3) 600A fuse holders (US style), (3) 1000A shunts, and (1) 1200A contactor	G37	G60
Off-Line Equalize (OLE) with (3) 600A fuse holders (US style) and (3) 1000A shunts	G38	G61
LVBD: 1200A contactor, (2) NH3 DIN fuses and (2) 600A shunts	G80	G31 (1) G43 (1)
LVBD: 1200A contactor, (4) NH3 DIN fuses and (4) 600A shunts	G81	G31 (1) G43 (2)
LVBD: 1200A contactor, (6) NH3 DIN fuses and (6) 600A shunts	G82	G31 (1) G43 (3)

DC Distribution Panels

Table 9-E: DC Distribution Panels

Description	Shunt	H569-434 Group No.	ED83143-30 Group No.
13 positions for 3-100A plug-in fuse holders or circuit breakers	--	G40, G45, G50, G55	G11, G13
21 positions for 3-100A plug-in fuse holders or circuit breakers	--	G41, G46, G51, G56	G12, G14
3 positions for 125-600A circuit breakers	CB, 25mV	G42, G47	G2, G3
6 positions for 125-600A circuit breakers	CB, 25mV	G43	G1, G4
5 positions for 125-600A circuit breakers	CB, 25mV	G48	G5, G6
10 fuse holders for 3-70A fuses	--	G52	G53
2 fuse holders for 100-600A fuses	600A, 50mV	G53, G57	G51, G52
14 positions for 1-63A DIN circuit breakers	--	G60	G20, G26
10 positions for 80-125A DIN circuit breakers	--	G61	G25, G29
14 fuse holders for 1-32A DIN fuses	--	G65	G24, G28
10 fuse holders for 1-50A DIN fuses	--	G66	G23, G27
8 fuse holders for 4-160A DIN NH00 fuses	--	G67	G22
2 fuse holders for 32-400A DIN NH2 fuses	--	G68	G21
10 positions for 3-150A plug-in (bullet style) circuit breakers	--	G95	G15

10 ***Safety***

Please read and follow all safety instructions and warnings before servicing the Galaxy Power System. Reference the GPS Installation Guide and individual module product manuals for additional safety statements specific to the modules.

11 Maintenance and Replacement

Requirements

System

With the exception of the battery, periodic maintenance specific to the power system is not required. The ac service for the building must be maintained with ANSI specified limits. The temperature and humidity within the power room must be maintained within the limits specified in Section 9 of this product manual.

Refer to Table 11-A for system replacement parts.

Batteries

The batteries must be maintained as directed by the battery manufacturer's requirements.

Controller

For replacement circuit packs, refer to:

- Table 11-B for Galaxy SCF Controller
- Table 11-C for the Galaxy Millennium Controller

Requirements, continued

Rectifier

With the exception of a fan failure, rectifiers are repaired by replacement.

Refer to “Installing or Replacing a Rectifier” and “Removing a Rectifier” in this section.

Rectifier Fan Assembly

The expected life of the rectifier fans at 25 °C (77°F) is approximately seven years. The fans in the rectifiers may be replaced in the field.

Two approaches can be taken to fan maintenance:

- The first approach is to replace the two fans on a routine basis every six to seven years; this ensures 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 one has remote alarm capability, is to wait until the fans fail. The rectifier will safely shut down and issue both a fail alarm and a thermal alarm. The two fans 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.

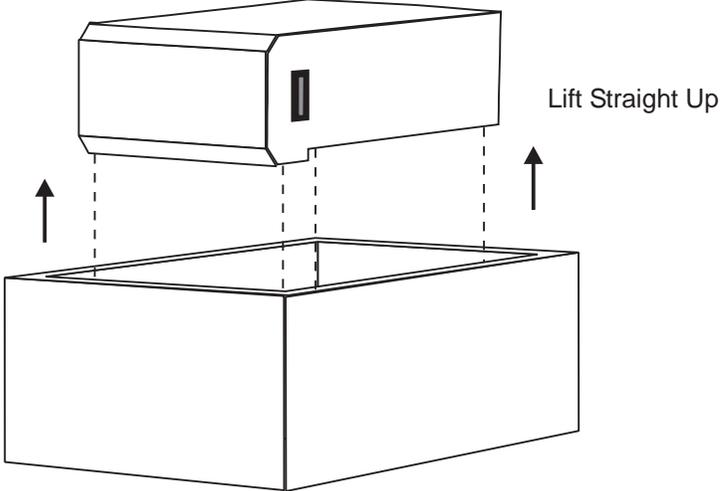
The approach used depends on the location and manning of the site as well as the monitoring of alarms used at the site.

Refer to “Replacing the Rectifier Fan Assemblies” in this section.

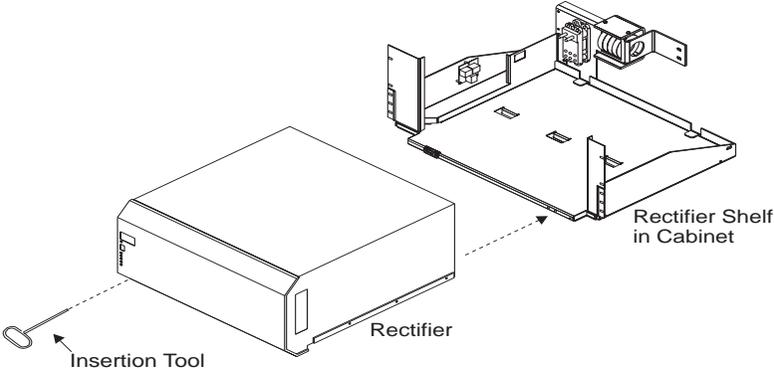
Replacement Procedures

⚠ Installing or Replacing a Rectifier

Stop! ⚠ Be sure ac breakers on cabinet are OFF!

Installing or Replacing a Rectifier	
Step	Action
1	Unpack the rectifier from shipping container. ⚠ Caution Rectifier is heavy (65 pounds). Use two people to lift and move rectifiers.
2	Remove rectifier by lifting the unit in a vertical direction from the packing container. See figure below. ⚠ Caution Do not rest rectifier on faceplate or rear chassis; damage to faceplate and/or rear busbars will occur, rendering the unit unusable.
	
<i>Continued on next page.</i>	

Replacement Procedures, continued

Installing or Replacing a Rectifier, continued	
Step	Action
3	Turn ac circuit breaker OFF.
4	Place rectifier power switch in STBY.
5	<p>Install the rectifier. See Figure 11-1.</p> <p>a.  Verify that the output circuit breaker is OFF and that the rectifier power switch is in the “Standby” position.</p> <p>b. Slide the unit slowly onto the shelf until it contacts the rear connector.</p> <p>Note: Install rectifiers, starting at the bottom position and working upward.</p> <p>c. Remove the label over the locking screw access window. Using a 5mm (3/16") Allen-head “T” wrench, turn the locking screw clockwise to secure the rectifier to the shelf.</p> <p style="text-align: center;"> Caution</p> <p>Verify that the rectifier chassis slides rearward evenly on the left and right sides as the locking screw is turned. DO NOT USE EXCESSIVE FORCE DURING THIS PROCEDURE! If the rectifier-to-shelf mating process appears to bind, back the unit out and start over. Avoid stripping the threads of the locking screw by stopping when the rearward progress of the rectifier ceases.</p>
	
<p>Figure 11-1: Installing a Rectifier in a Rectifier Shelf</p> <p style="text-align: right;"><i>Continued on next page.</i></p>	

Replacement Procedures, continued

Installing or Replacing a Rectifier, continued	
Step	Action
6	Turn ON output circuit breaker.
7	Turn ON ac circuit breaker.
8	Turn rectifier power switch to ON position.
9	Verify: <ul style="list-style-type: none"> • Green LED is illuminated. • No alarms are illuminated.
10	<p>Set rectifier slot ID number:</p> <ol style="list-style-type: none"> a. Depress rectifier power switch in UP position; rectifier ID is displayed. b. Hold rectifier power switch in UP position for 5 seconds; the display number will begin to blink. c. Release the switch. d. Depress and hold the switch for 3 seconds to rapidly advance the ID. e. Depress and release repeatedly until the desired ID is reached. f. Leave switch un-pressed for 10 seconds to save the ID number. <p>For early rectifiers, use the following procedure:</p> <ol style="list-style-type: none"> a. Depress and hold rectifier power switch in UP position for 5 seconds; the displayed number will begin to blink. b. Depress and release switch until desired number is reached. c. When the desired number is reached, continue to hold switch until display stops blinking. The new ID number is now set. <p>Note: Abandoning this process before the display stops blinking will default the rectifier to the last number set.</p>
<i>Continued on next page.</i>	

Replacement Procedures, continued

Installing or Replacing a Rectifier, continued	
Step	Action
11	Follow Steps 3-5 to install remaining rectifiers. Follow Steps 6-10 to set remaining ID numbers.
12	Verify that the system voltage reads 52.08V or desired float voltage.
13	Test replaced rectifiers using the “Testing Additional Alarms After Replacement of Rectifiers” procedure in this section.

Replacement Procedures, continued

 **Removing a Rectifier**

Removing a Rectifier	
Step	Action
1	Turn OFF power switch on rectifier.
2	Turn OFF ac circuit breakers.
3	Turn OFF output circuit breaker on rectifier.
4	 Wait 5 minutes to allow capacitors to discharge.
5	Using a 5mm Allen-head "T" wrench, slowly turn the locking screw counterclockwise to release the rectifier from the shelf.
6	<p>Slowly slide rectifier from shelf.</p> <p style="text-align: center;"> Caution</p> <p>Rectifier is heavy (65 pounds). Use two people to lift and move rectifiers.</p> <p>Do not rest rectifier on faceplate or rear chassis; damage to faceplate and/or rear busbars will occur, rendering the unit unusable.</p>

Replacement Procedures, continued

⚠ Replacing the Rectifier Fan Assemblies

Replacing the Rectifier Fan Assemblies	
Step	Action
1	Follow instructions in the “Removing a Rectifier” procedure in this section. Refer to Figure 11-1.
2	Place rectifier on a flat surface at a comfortable working height.
3	<p>Loosen the front cover (white) by removing 14 screws (5 top, 5 bottom, 2 on each side). Before fully removing the cover, disconnect the ribbon cable from the display circuit pack.</p> <p style="text-align: center;">⚠ Caution</p> <p>Allow the front end of the rectifier to <i>overhang</i> the working surface. To remove bottom screws, turn the rectifier on its side, or work below the table surface.</p> <p><i>Never tilt the front of the unit to gain access to the bottom screws. This will result in damage to the rear connector.</i></p>

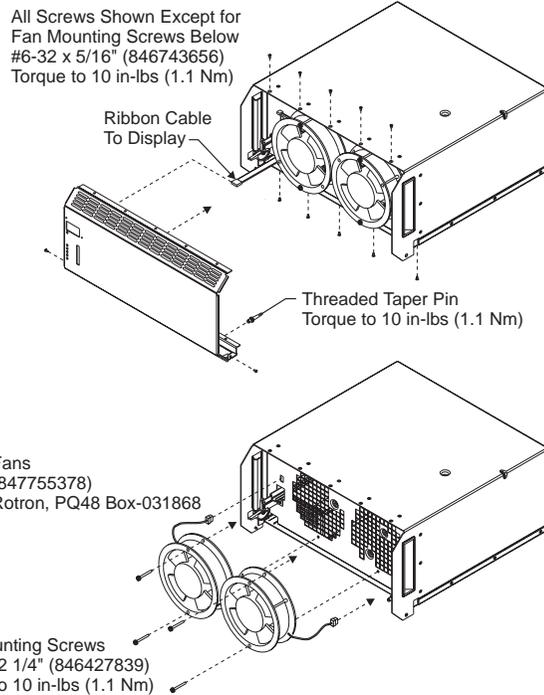


Figure 11-2: Replacing a Rectifier Fan Assembly

Continued on next page.

Replacement Procedures, continued

Replacing the Rectifier Fan Assemblies, continued	
Step	Action
4	Remove the screws attaching the old fans to the chassis and carefully unplug the fan connector. The fan connector is keyed and can be loosened by inserting a screwdriver into the slotted side of the connector and gently prying the fan-side connector loose.
5	Place the new fans in position. Torque fasteners to 10 in-lbs.
6	Replace the ribbon cable removed in Step 3.
7	Replace the front cover.
8	Install the rectifier, following the “Installing or Replacing a Rectifier” procedure in this section.
9	Test replaced rectifiers using the “Testing Additional Alarms After Replacement of Rectifiers” procedure in this section.

Testing

Note: Consult the Installation Guide for Galaxy Power Systems (Select Code 167-792-157) for complete testing guidelines for new installations.

Testing Additional Alarms After Replacing Rectifiers

Alarm operation may be verified while the system operates at float voltage.

Testing Additional Alarms After Replacing Rectifiers	
Step	Action
1	Turn OFF the ac circuit breaker of replaced rectifier. Verify that the AC and MIN alarm LEDs illuminate, the rectifier displays ACF, and the controller alarms screen indicates RECTIFIER FAIL : Gmm (SCF and Millennium controllers).
2	Turn ON the ac circuit breaker of the replaced rectifier. Verify that the rectifier starts and the alarms retire.
3	OPTIONAL: Simulate a load circuit breaker alarm by shorting the alarm contacts on the circuit breakers or inserting an operated alarm fuse. For ED83143-30 G1-6 (101-106), add a jumper from the hot bus to the FAJ input signal on the associated BNL1 (P4-1) or BNL7 (P5-6) alarm card. Verify that the DIST and MAJ alarm LEDs illuminate and the controller alarms screen indicates EXTERNAL FUSE MAJOR (SCF and Millennium controllers).

Testing Rectifiers and Load Share in Bay Expansions

Testing Rectifiers and Load Share in Bay Extensions	
Step	Action
1	Turn all rectifiers to STBY.
2	Connect a resistive load box (proper voltage) to the system's positive and negative bus bars.
3	Verify that the system load is less than 50 amperes.
4	Increase the system load to 200 amperes.
5	Turn ON all the rectifiers; after approximately 60 seconds, verify that the load is divided equally among all the rectifiers (within 2 amperes).
6	Reduce the system load. Verify that the rectifiers continue to share the load.
7	Remove system load.

Replacement Parts

System

Table 11-A provides a list of replacement parts for GPS 4848/100.

Table 11-A: GPS 4848/100 Replacement Parts

Ordering Comcode	Description
Cabinet	
406204230	3 ampere alarm fuse
402328926	.18 ampere alarm fuse
406530725	1-1/3 ampere alarm fuse
405673161	1/2 ampere panel alarm fuse (WP90247 L3)
406420273	GMT fuse puller tool
848262622	BLJ3 terminal board
408229318	Wire insertion tool
108588625	BIC8 bay interface card
107900169	EBV2 load disconnect board
107604076	BJN1 battery disconnect board
407226786	Lens cover, red
407227172	Cabinet alarm lamp, 48V
Rectifier and Rectifier Shelf	
108680018	595A2, 200 ampere rectifier
108680026	595B2, 200 ampere rectifier
847755378	Rotron fan, PQ48 Box-031868
901181834	Insulated Allen-head wrench
Distribution	
405673161	1/2 ampere alarm fuse
Controller (both SCF and Millennium)	
406530725	1-1/3 ampere fuse (GMT)
406204230	3 ampere fuse (GMT)
Galaxy SCF Controller	
406203976	5 ampere fuse (GMT)
406526079	Battery BR2032 for BJH
Galaxy Millennium Controller	
406677880	Battery TL5101 for BSJ

Replacement Parts, continued

SCF Controller Circuit Boards

Table 11-B lists the spare parts available for the Galaxy SCF Controller (Front Access).

Table 11-B: Galaxy SCF Controller Circuit Boards

Ordering Comcode	Description
107199374	Display board (BJG)
107748444	Alarm board (BJE2)
107583072	Front access interface board (BLG1)
107561284	Rectifier interface board (BJC3)
107172355	Basic control board (BJB)
107172348	Basic controller power board 48V (BJA1)
107381915	Intelligent control board with TL1 (BJH2)
107172397	Intelligent control board (BJH1)
107243834	Intelligent controller power board 48V (BJJ1)
107284499	Modem board (BJL2)
107243867	Peripheral monitor board (BJM1)
107243842	Data switch board (BJK1)
406918425	RS485/232 converter
107243826	Gateway board (BJD1)
847367661	LCD module assembly

Replacement Parts, continued

Millennium Controller Circuit Boards

Table 11-C lists the spare parts of the Galaxy Millennium Controller.

Table 11-C: Galaxy Millennium Controller Circuit Boards

Ordering Comcode	Description
108029679	Display board (BSK1)
108029687	Alarm wire wrap board (BSL1)
848194551	Insulation displacement alarm board (BSL2)
108029653	Basic control board (BSH1)
847950912	LCD module assembly display board
108029661	Intelligent control board (BSJ1)
108029695	Modem board (BSM1)
108163601	Data switch board (BSW1)
108340100	Gateway board (EBW1)

Additional Ordering Information

Documentation

Table 11-D lists documentation associated with the GPS 4848/100.

Table 11-D: Product Documentation

Document Number	Description
H569-434	GPS 4848/100 Ordering Guide
167-792-157	GPS Installation Guide
167-792-110	Galaxy SCF Controller Product Manual
167-792-180	Galaxy Millennium Controller Product Manual
167-790-063	Remote Peripheral Monitoring System Product Manual

Software

EasyView software is a Windows-compatible communications package designed specifically for use with Galaxy controllers. Download EasyView software from <http://www.lucent.com/networks/power/software.html>.

12 *Troubleshooting Preparations*

Preliminary

Introduction

This section provides information needed in preparation for locating and interpreting visual indicators to help identify problems.

When replacing a part does not correct the problem or visual indicators do not identify a defective part, notify the local Regional Technical Assistance Center (RTAC) at 1-800-CAL-RTAC (1-800-225-7822).



Review all safety instructions and warnings in Section 10 before troubleshooting the GPS 4848/100.



Hazardous ac and dc voltages and/or energy are present. Caution should be exercised. Tools must be insulated to help prevent accidental contact with live surfaces.

Coordinate all troubleshooting activities with other personnel that may be working on the system.

Tools

The following tools are necessary in order to troubleshoot the GPS 4848/100:

- 3/16-inch (5 mm) Allen-head wrench
- Insulated hand tools
- Calibrated digital voltmeter (DVM) (0.05% accuracy on dc scale)
- ESD wrist strap

Troubleshooting Procedure

Purpose

The troubleshooting procedure described below is used when a trouble condition has been identified and a technician has been dispatched to the system location as a first and fundamental step in diagnosing and correcting the problem.

For all trouble conditions, proceed as follows:

Cabinet Alarm

1. Locate the system controller. The controller is typically located in the cabinet identified as BAY ONE. Because a trouble condition exists, the red alarm on the top of the cabinet will be illuminated. See Figure 12-1.).

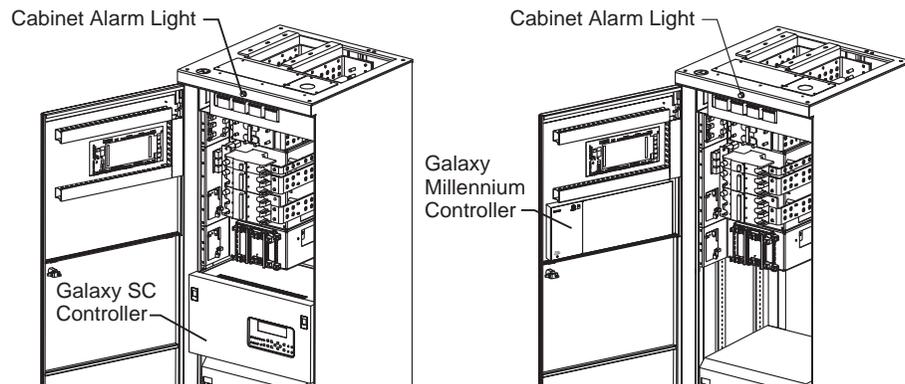


Figure 12-1: Location of Cabinet Alarm Light and Controller

Troubleshooting Procedure, continued

System Status

2. Determine the system status. For most problems, one or more alarm and status LEDs will be illuminated. The controller default screen indicates system voltage and current, the system mode (i.e., FLOAT or EQUALIZE), and the number of alarms and/or warnings present.

If the screen is blank, but alarm and status LEDs are illuminated, call your RTAC representative.

If the entire panel is blank, check the controller fuse (the active fuse for the BJA board for the SCF (Figure 12-3); F3 basic power for the Millennium (Figure 12-5). Verify that the controller is getting power. If not, replace fuse or the BJA board on the SCF. If the display is still blank, call your RTAC representative.

Alarms Menu

3. If the default screen appears normal, press the MENU button. The main menu appears with "Alarms" blinking. Press ENTER to obtain the Alarms menu. Additional data appears that will help to identify the problem.

Troubleshooting Tables

4. Based on the information presented by the alarm LEDs, select the appropriate table from the list below:

Section 13, Troubleshooting SCF Systems	
Alarm LED	Table
AC	13-A, AC Alarms
BATT	13-B, Battery Alarms
BD	13-F, Miscellaneous Alarms
CTRL	13-C, Controller Alarms
DIST	13-D, Distribution Alarms
RECT	13-E, Rectifier Related Alarms
No LED*	13-F, Miscellaneous Alarms
*If an alarm condition exists, but no alarm LED is lit, refer to Table 13-F.	

Troubleshooting Procedure, continued

Troubleshooting Tables, continued

Section 14, Troubleshooting Millennium Systems	
Alarm LED	Table
AC	14-A, AC Alarms
BATT	14-B, Battery Alarms
BD	14-F, Miscellaneous Alarms
CTRL	14-C, Controller Alarms
DIST	14-D, Distribution Alarms
RECT	14-E, Rectifier Related Alarms
No LED*	14-F, Miscellaneous Alarms
*If an alarm condition exists, but no alarm LED is lit, refer to Table 14-F.	

Identifying Problems

5. Once the appropriate table is identified, use the status LEDs and the alarm menu data to identify the specific problem that is causing the alarm.

Reference Figures

Figure Numbers and Titles

The following figures are provided for reference while performing the troubleshooting procedure:

Figure No.	Title
12-1	Location of Cabinet Alarm Light and Controller
12-2	Galaxy SCF Controller Display
12-3	Galaxy SCF Controller Fuses and Circuit Boards
12-4	Millennium Controller Display
12-5	Millennium Controller Fuses and Circuit Boards
12-6	Rectifier Display
12-7	Low Voltage Battery Disconnect Contactor Control Switches
12-8	AC Input Panel and Rectifier Connection
12-9	DC Distribution Panel
12-10	Low Voltage Load Disconnect Contactor Control Switches

Reference Figures, continued

SCF Controller

Basic Controller

BJA (power board): If no problem exists, the green LED is lit.

BJB (microprocessor board): After power up, or after a reset, the green and amber LEDs will both be lit while self diagnostics are in progress (which will take about 10 seconds). If all diagnostics pass, the amber LED will extinguish and the green LED will remain lit. If failures are detected during diagnostics the green LED will extinguish, and the amber LED will remain lit. During normal operation if a failure occurs the green LED will extinguish and the amber LED will light.

Other Basic Boards: The basic controller boards (rectifier interface, alarm relay/display, and power) are diagnosed by the basic controller's microprocessor. During normal operation, each board's green LED is lit. Note that if the basic controller microprocessor board fails, both the green and amber LEDs on the other basic controller boards will be lit.

Intelligent Controller

BJJ (power board): If no problem exists, the green LED is lit.

BJH (microprocessor board): After power up, or after a reset, the green and amber LEDs will both be lit while self diagnostics are in progress (which will take about 30 seconds). If all diagnostics pass, the amber LED will extinguish and the green LED will remain lit. If failures are detected during diagnostics the green LED will extinguish, and the amber LED will remain lit.

Intelligent Option Boards: The intelligent option boards (modem, data switch, and peripheral monitor) are diagnosed by the microprocessor. During normal operation, each board's green LED is lit.

Reference Figures, continued

SCF Controller, continued

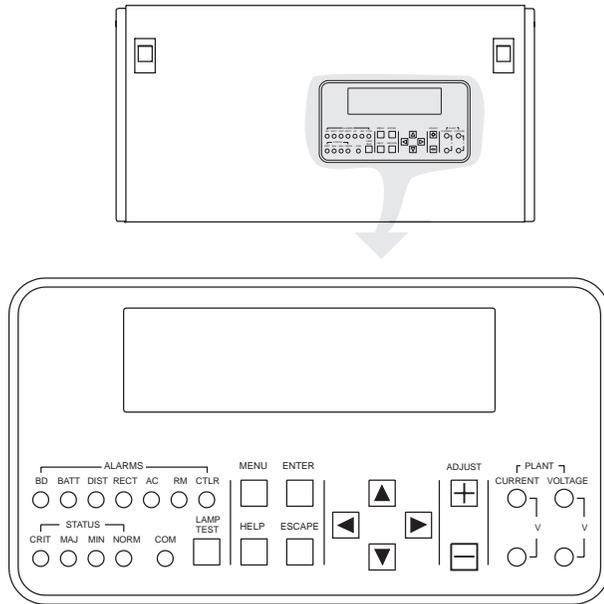


Figure 12-2: Galaxy SCF Controller Display

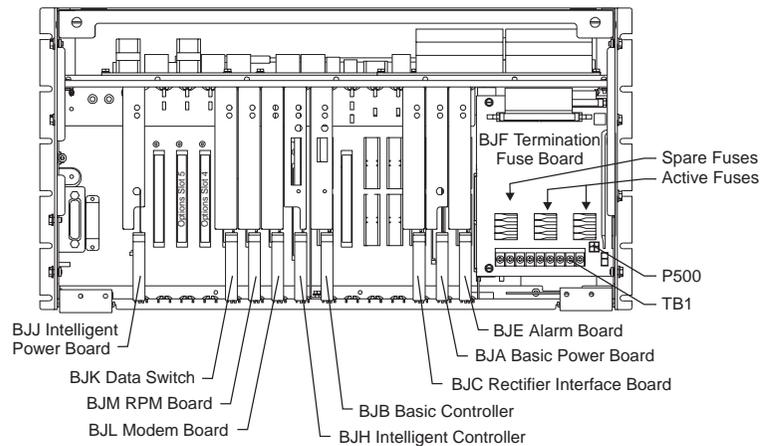


Figure 12-3: Galaxy SCF Controller Fuses and Circuit Boards

Reference Figures, continued

Millennium Controller

Basic Controller

BSH (microprocessor board): After power up, or after a reset, the green and yellow LEDs will both be lit while self diagnostics are in progress (which will take about 10 seconds). If all diagnostics pass, the yellow LED will extinguish and the green LED will remain lit. If a failure is detected during diagnostics, the green LED will extinguish and the yellow LED will remain lit.

If a failure occurs during normal operation, the green LED will extinguish and the yellow LED will light.

Intelligent Controller

BSJ (microprocessor board): After power up, or after a reset, the green and yellow LEDs will both be lit while self diagnostics are in progress (which will take about 30 seconds). If all diagnostics pass, the yellow LED will extinguish and the green LED will remain lit. If a failure is detected during diagnostics, the green LED will extinguish and the yellow LED will remain lit. If a terminal is attached to the local port during diagnostics, the diagnostic messages will show which test failed.

If a failure occurs during normal operation, the green LED will extinguish and the yellow LED will light.

Reference Figures, continued

Millennium Controller, continued

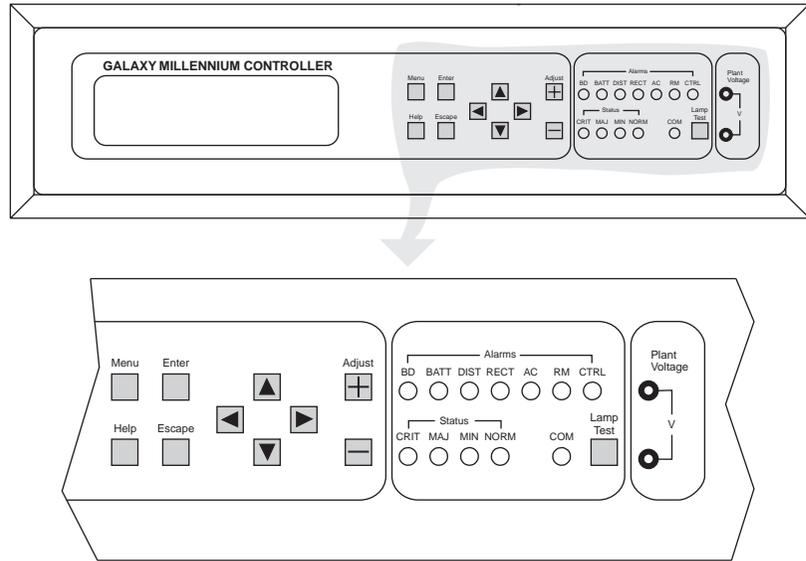


Figure 12-4: Millennium Controller Display

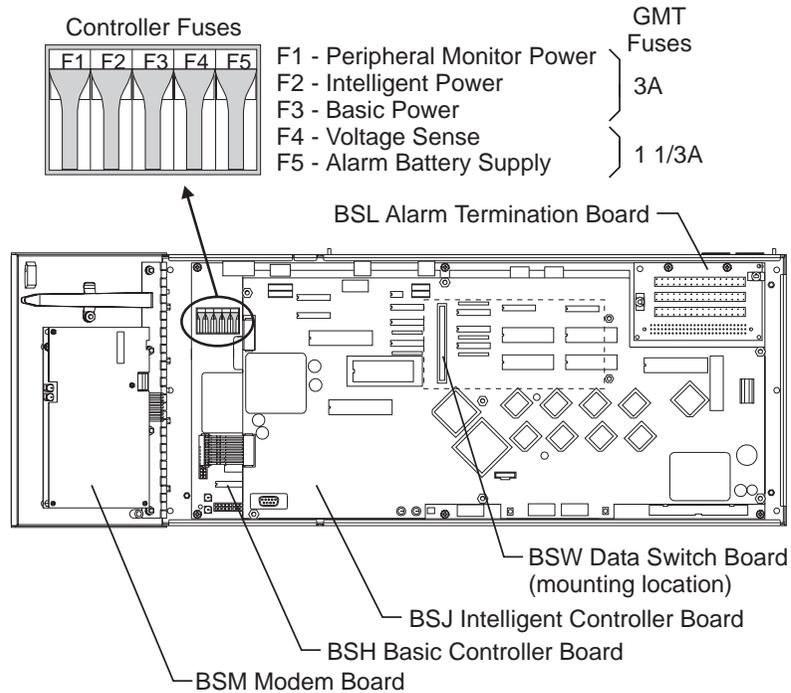


Figure 12-5: Millennium Controller Fuses and Circuit Boards

Reference Figures, continued

Rectifier

During normal operation, the rectifier's green ON LED will be lit and the display will show the rectifier's output current.

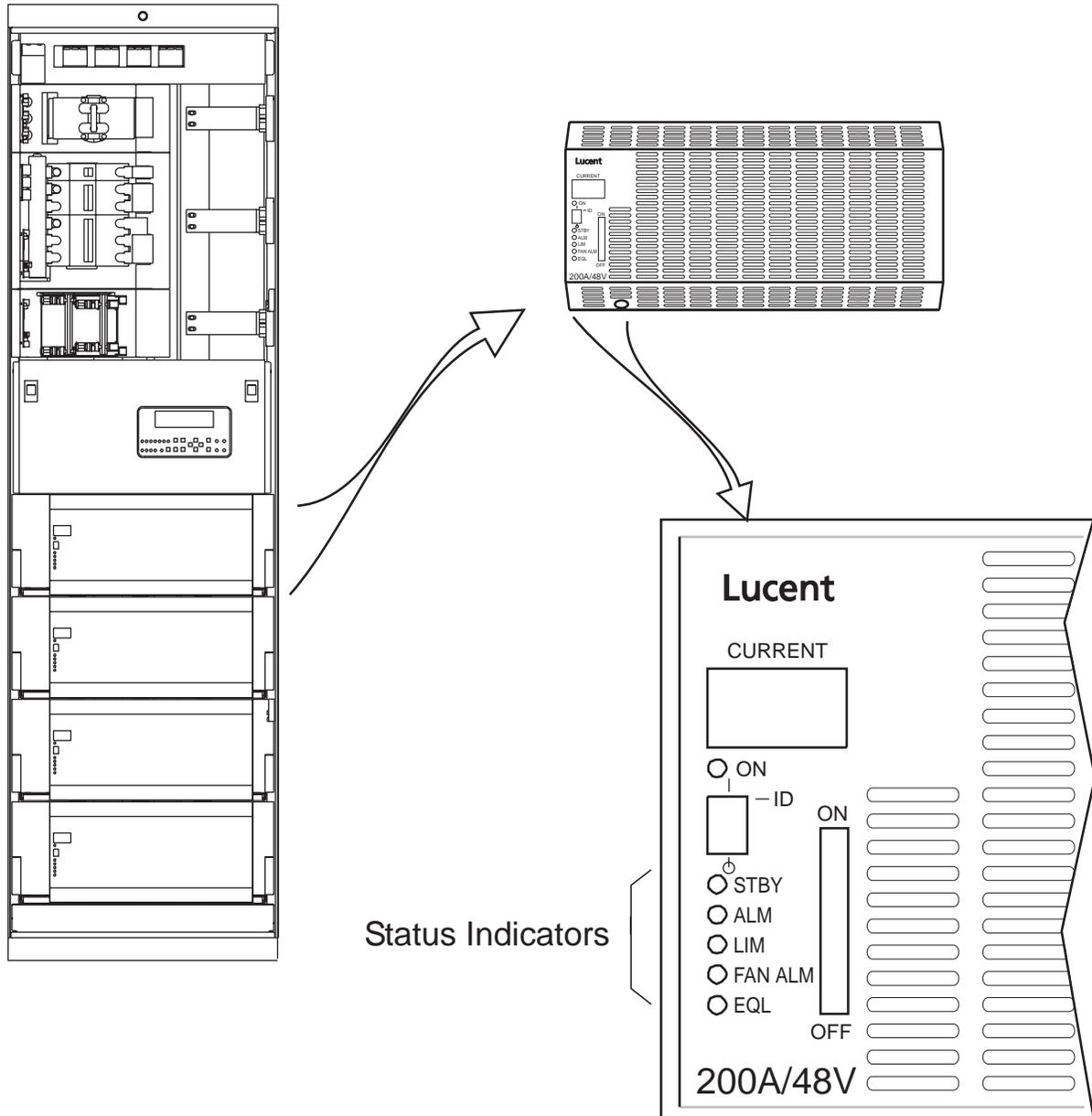
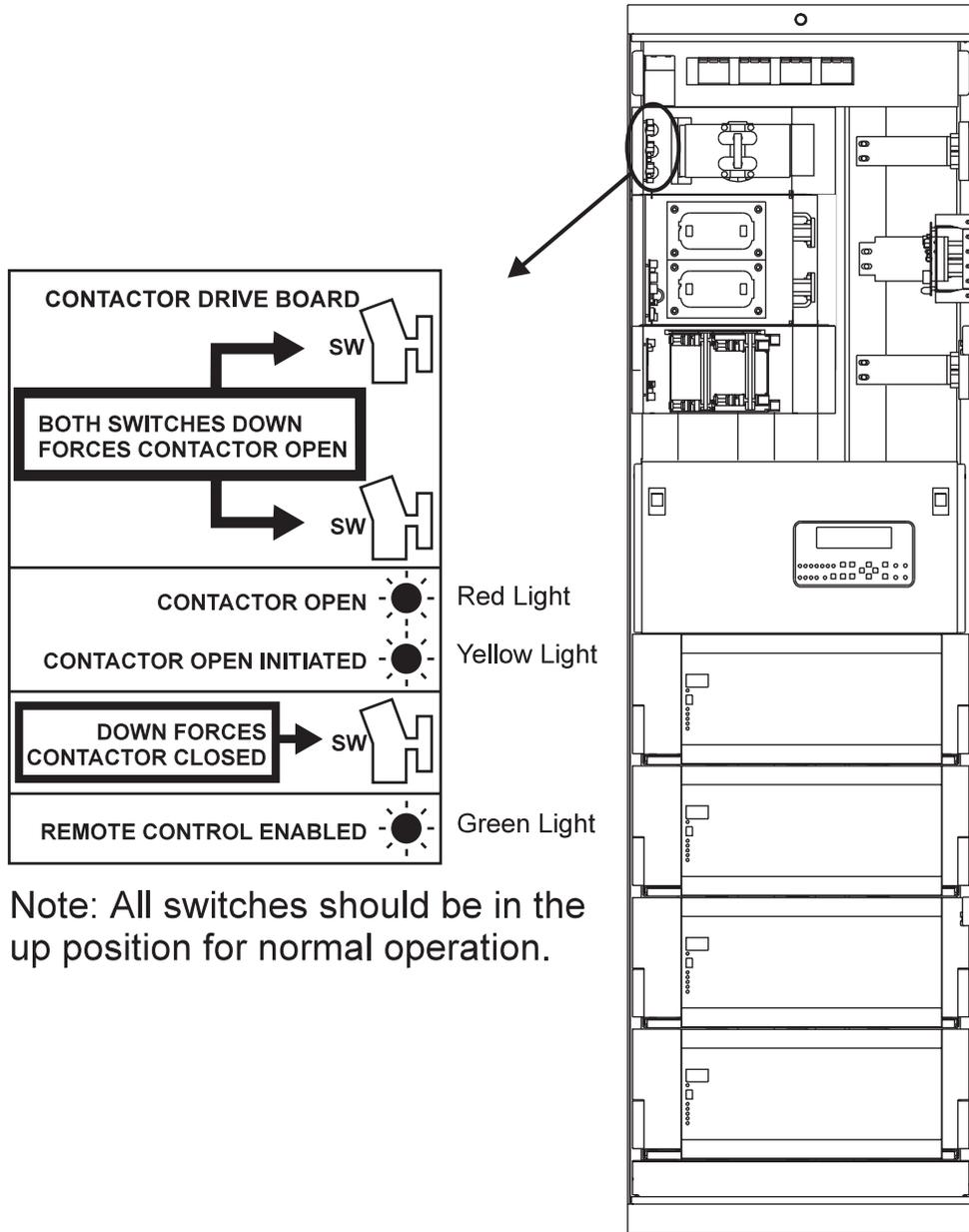


Figure 12-6: Rectifier Display

Reference Figures, continued

Low Voltage Battery Disconnect

The low voltage battery disconnect (LVBD) feature consists of a contactor, circuitry on the BJN board, and associated wiring. Control of the contactor is dictated by the BJN contactor control board and the controller.



Note: All switches should be in the up position for normal operation.

Figure 12-7: Low Voltage Battery Disconnect Contactor Control Switches

Reference Figures, continued

AC Input

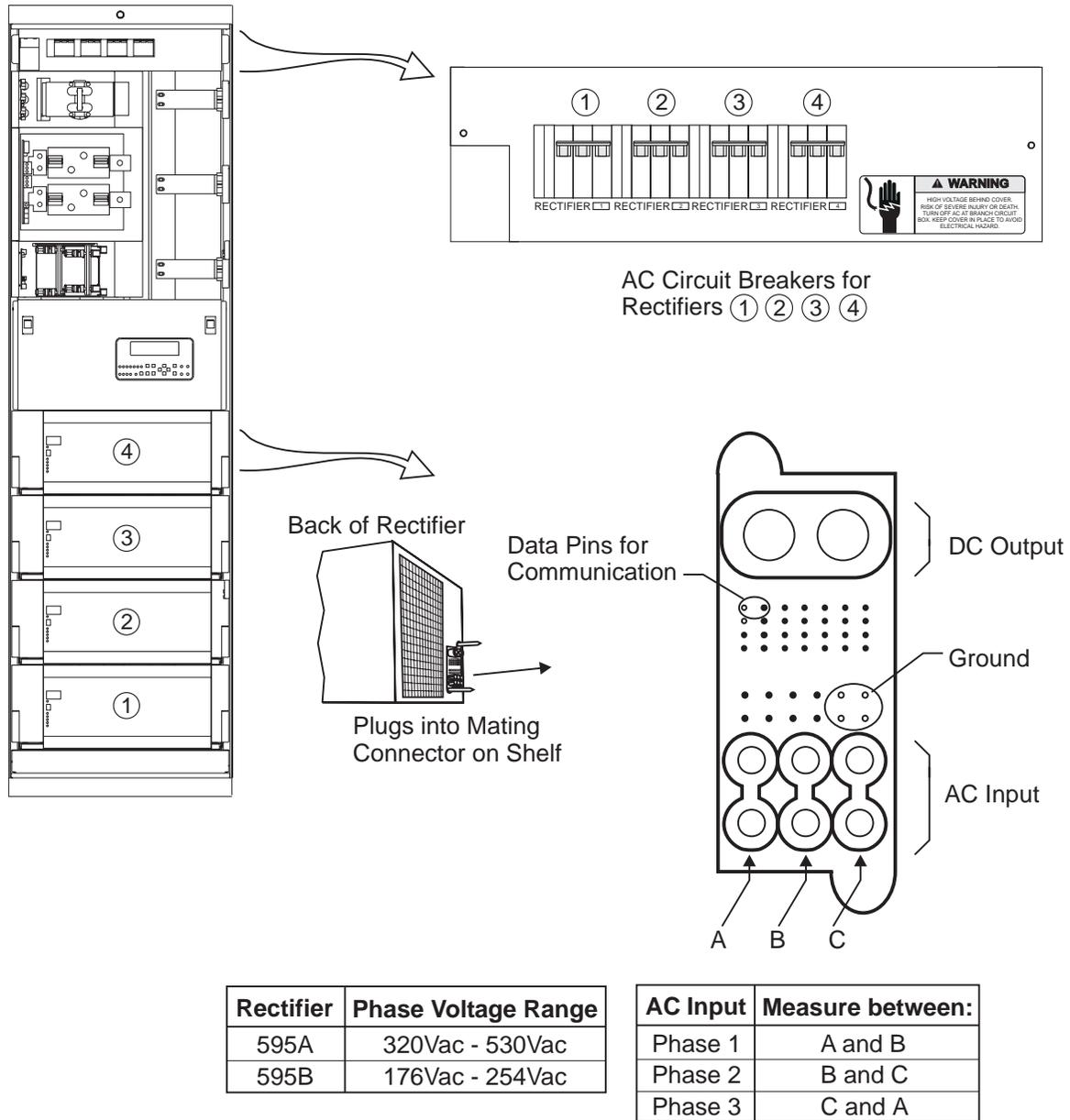


Figure 12-8: AC Input Panel and Rectifier Connection

Reference Figures, continued

DC Distribution

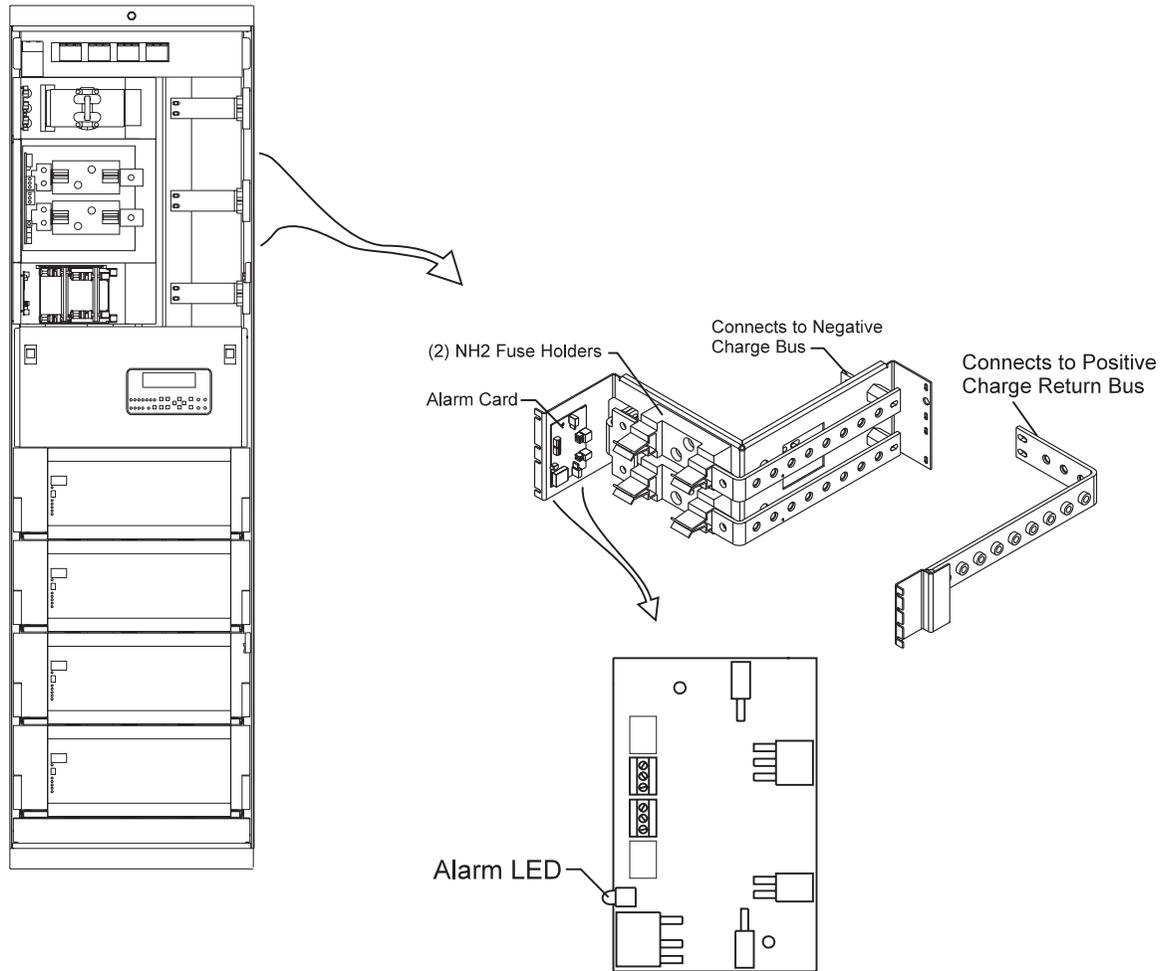


Figure 12-9: DC Distribution Panel

Reference Figures, continued

Low Voltage Load Disconnect

The EBV low voltage load disconnect (LVLD) contactor control board is mounted on the right side of the cabinet, as shown in Figure 12-10.

The manual contactor control switch (SW300) is not meant to be used to permanently override the LVLD function. It is only to be used temporarily while servicing or testing the equipment.

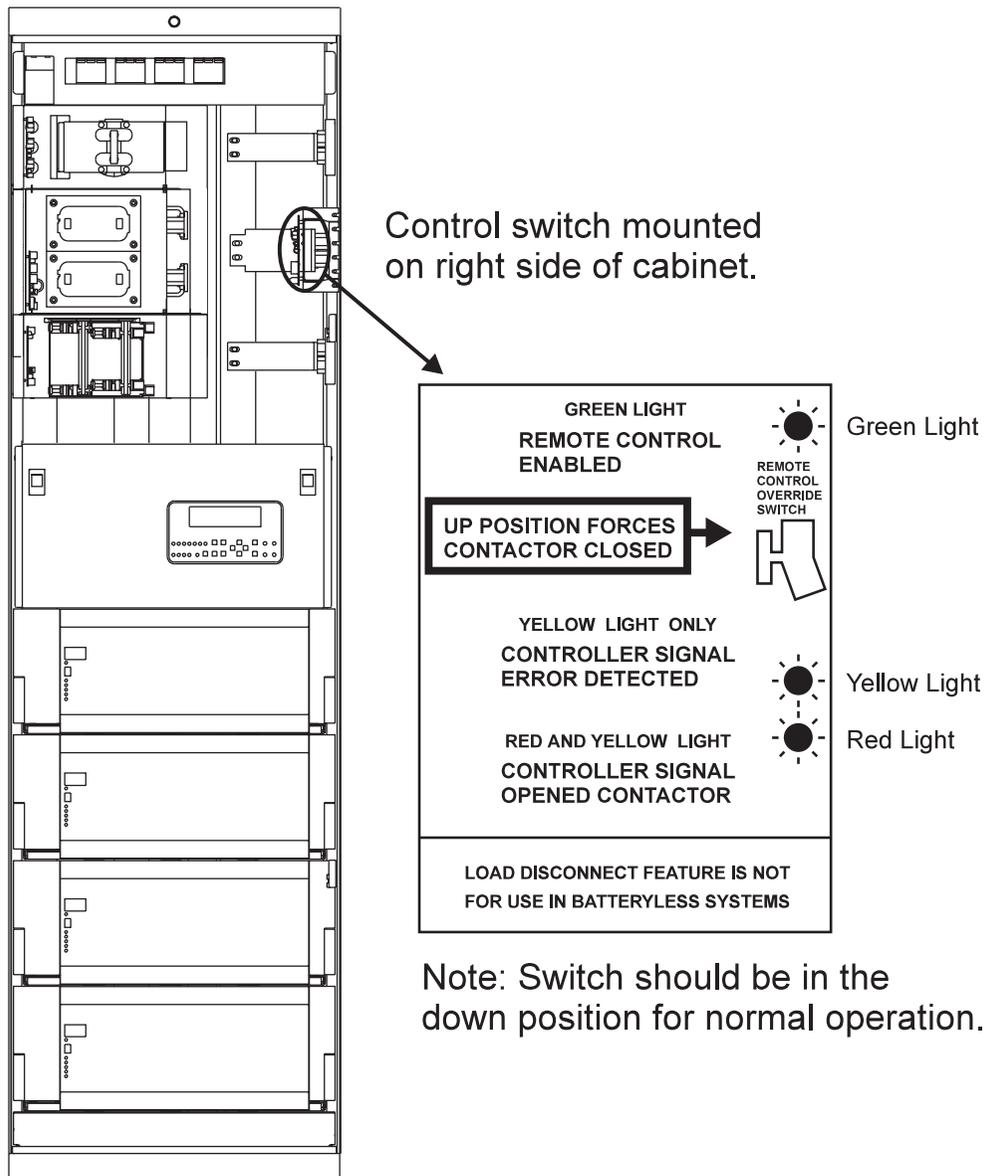


Figure 12-10: Low Voltage Load Disconnect Contactor Control Switches

13 ***Troubleshooting SCF Systems***

Introduction

In This Section This section provides information for locating and interpreting visual indicators to help identify problems.

Preparation Read Section 12, *Troubleshooting Preparations*, thoroughly before proceeding.

Technical Assistance When visual indicators do not identify a defective part, notify the local Regional Technical Assistance Center (RTAC) at 1-800-CAL-RTAC (1-800-225-7822).

Troubleshooting Tables

Organization

The tables in this section are organized alphabetically by Alarm LED, then grouped according to the status of the alarm: Critical (CRIT), Major (MAJ), or Minor (MIN).

Table Reference

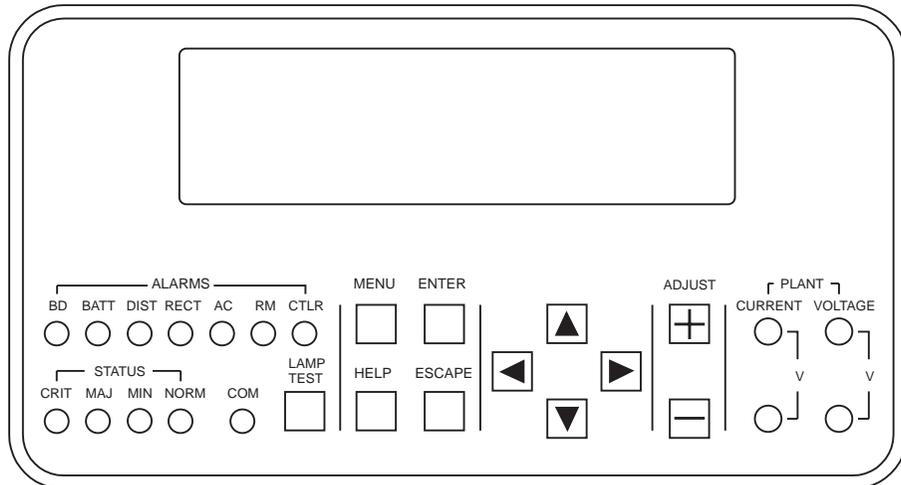
Use the reference below to locate the Alarm LED and corresponding table.

Alarm LED	Table
AC	13-A, AC Alarms
BATT	13-B, Battery Alarms
BD	13-F, Miscellaneous Alarms
CTLR	13-C, Controller Alarms
DIST	13-D, Distribution Alarms
RECT	13-E, Rectifier Related Alarms
RM	13-F, Miscellaneous Alarms
No LED*	13-F, Miscellaneous Alarms

*If an alarm condition exists, but no alarm LED is lit, refer to Table 13-F.

SCF Controller Display

The SCF display is illustrated below.



AC Alarm LED

Table 13-A: AC Alarms
(See Figure 12-8)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
AC	MIN	AC Fail	ACF on rectifiers	Rectifier is not receiving ac power: <ul style="list-style-type: none"> •AC input circuit breaker has operated. •AC input voltage is out of range. •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify that ac circuit breaker is closed; close circuit breaker if operated. 2. If the problem is not corrected, replace the rectifier.
AC	MIN	Engine Transfer Timeout	Engine may have alarm.	Remote engine or connection to engine has failed.	Call your local RTAC representative.
AC	MIN	Phase Alarm	PF on rectifier display	Phase failure: <ul style="list-style-type: none"> •Rectifier high voltage shutdown •External phase imbalance or failure •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

BATT Alarm LED

Table 13-B: Battery Alarms
(See Figure 12-7)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
BATT	CRIT	Very Low Voltage	--	Occurs in an operating system following an extended commercial ac power outage, during which the batteries are providing power for the system and the system voltage is approaching the user-defined low limit.	<ol style="list-style-type: none"> 1. If commercial ac power is present but the system voltage remains low, call your local RTAC representative. 2. Investigate other alarms that may be present (rectifier-related alarms and the AC Fail alarm may also occur during the fault condition).
BATT* *Alarm must be configured to turn on the BATT LED; not a factory default.	MAJ	Contactora 1 Open	Red LED on contactora drive board is lit.	Contactora is open: •Open has been initiated by controller. •Open has been initiated manually.	<ol style="list-style-type: none"> 1. Follow instructions on the label adjacent to the contactora drive board (see Figure 12-7). 2. If the problem is not corrected, call your local RTAC representative.
BATT* *Alarm must be configured to turn on the BATT LED; not a factory default	MAJ	Contactora 1 Fail	--	Contactora or drive board has failed.	Call your local RTAC representative.
BATT	MAJ	Battery Thermal Major	Alarm on 210E unit, if equipped	Batteries have exceeded temperature threshold.	Call your local RTAC representative.

Table 13-B: Battery Alarms
(See Figure 12-7)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
BATT	MIN	Battery Thermal Minor	Alarm on 210A or 210E unit, if equipped	Batteries have exceeded temperature threshold.	Call your local RTAC representative.
BATT	MIN	Open String	Alarm LED on battery fuse panel is lit.	Battery fuse has operated or bat string switch has opened.	Replace the operated fuse.
BATT	MIN	Low Reserve Time	--	Controller has calculated that reserve time is below alarm threshold level.	Call your local RTAC representative.

CTLR Alarm LED

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure→ •BJB failure •BJC rectifier interface board failure •Display failure •BJJ failure •BJH failure •Intelligent option board failure 	<p>Check BJA power board to see if the green and yellow LEDs are lit. If so, one of the supply voltages is out of range; perform the following steps:</p> <ol style="list-style-type: none"> 1. Use the test jacks on the front of the BJA board to verify the following voltage levels: +5V: 4.75V-5.25V +15V: 14.25V-15.75V -15V: 14.25V-15.75V 2. If any voltage is too high, replace the BJA board. 3. If any voltage is too low, either the power board is faulty or one of the other basic controller boards is overloading the power supply. Remove the other basic controller boards one at a time; if the voltage rises back into range, replace the faulty board. If the voltage remains low, replace the power board. 4. If the problem remains, call your local RTAC representative.

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure→ •BJC rectifier interface board failure •Display failure •BJJ failure •BJH failure •Intelligent option board failure 	<p>Check the BJB board to see if the green LED is extinguished and the yellow LED is lit. (Note that if the BJB has indeed failed, the green and yellow LEDs on the other basic boards will also be lit.) If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Press the reset switch on the front of the BJB circuit pack. If all diagnostics pass, it is possible that some type of one-time abnormality occurred to cause the failure (such as hot-insertion of option boards, shorting backplane pins when installing optional equipment, etc.) 2. If the diagnostics did not pass, or if the problem recurs, replace the BJB circuit board. 3. If the problem remains, put the original BJB circuit pack back in the controller. Remove all BJC rectifier interface boards and the BJE alarm relay/display board. Press the reset switch on the BJB. If the problem is still present, replace the BJA power board. If the problem is resolved, insert all boards that were removed, reset the controller, and verify proper operation. 4. If the problem remains, put the original BJA back in the controller. Insert all boards that were removed, resetting the controller after each board is installed and looking for improper operation. Replace the board that causes the failure, insert the remaining option boards, and verify proper operation. 5. If the problem remains, call your local RTAC representative.

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure •BJC rectifier interface board failure→ •Display failure •BJJ failure •BJH failure •Intelligent option board failure 	<p>Check the BJC circuit pack to see if the green LED is extinguished and the yellow LED is lit. If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Reset the BJB microprocessor board and see if the problem is resolved. 2. If the problem recurs, replace the BJC board. 3. If the problem remains, call your local RTAC representative.
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure •BJC rectifier interface board failure •Display failure→ •BJJ failure •BJH failure •Intelligent option board failure 	<p>If the front panel LCD module, LEDs, or switches fail, perform the following steps:</p> <ol style="list-style-type: none"> 1. Verify that the ribbon cable from the backplane to the display is not cut, abraded, or otherwise mangled. Replace the cable if damaged. 2. Reset the BJB microprocessor board after replacing the cable but before retesting. 3. If the problem remains, replace the BJE alarm relay/display board. 4. If the LCD module is still not functioning, but LEDs and switches are working, replace the LCD module; if the switches and LEDs are still not operating, replace the BJG board.

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure •BJC rectifier interface board failure •Display failure •BJJ failure→ •BJH failure •Intelligent option board failure 	<p>Check the BJJ power board to see if the green and yellow LEDs are lit. If so, one of the supply voltages is out of range. Perform the following test:</p> <ol style="list-style-type: none"> 1. Verify that the ribbon cable from the backplane to the display is not cut, abraded, or otherwise mangled. Replace the cable if damaged. 2. Use the test jacks on the front of the BJJ board to verify the following voltage levels: +5V: 4.75V-5.25V +12V: 12.43V-12.85V VPP: 12.08V-12.12V 3. If any voltage is too high, replace the BJJ board. 4. If any voltage is too low, either the power board is faulty or one of the other intelligent controller boards is overloading the power supply. Remove the other intelligent controller boards one at a time; if the voltage rises back into range, replace the faulty board. If the voltage remains low, replace the power board. 5. If the problem remains, call your local RTAC representative.

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure •BJC rectifier interface board failure •Display failure •BJJ failure •BJH failure→ •Intelligent option board failure 	<p>Check BJH to see if the green LED is extinguished and the yellow LED is lit. If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Press the reset switch on the front of the BJH circuit pack. If all the diagnostics pass, it is possible that some type of one-time abnormality occurred to cause the failure (such as hot-insertion of option boards, shorting backplane pins when installing optional equipment, etc.). 2. If the diagnostics did not pass or the problem recurs, replace the BJH circuit pack. 3. If the problem remains, put the original BJH circuit pack back in the controller. Remove all the intelligent option boards and press the reset switch on the BJH. If the problem is still present, replace the BJJ power board. If the problem is resolved, insert all boards that were removed, reset the controller, and verify proper operation. 4. If the problem remains, put the original BJJ circuit pack back in the controller. Insert all boards that were removed, resetting the controller after each board is installed and looking for improper operation. Replace the board that causes the failure, insert the remaining option boards, and verify proper operation. 5. If the problem remains, call your local RTAC.

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BJA failure •BJB failure •BJC rectifier interface board failure •Display failure •BJJ failure •BJH failure •Intelligent option board failure→ 	<p>Check the modem, data switch, and peripheral monitoring boards to see if the green LED is extinguished and the yellow LED is lit on one of them. If so, perform the following steps.</p> <ol style="list-style-type: none"> 1. Reset the BJH microprocessor board and see if the problem is resolved. 2. If the problem recurs, replace the option board. 3. If the problem remains, call your local RTAC representative.
CTLR	MAJ	Circuit Pack Fail	--	See "Controller Fail".	See "Controller Fail".
CTLR	MAJ	Controller Fuse	--	Fuse has operated.	Replace the controller fuse on BJF board labeled INTEL (intelligent power).
CTLR	MAJ	Alarm Battery Supply Fuse	--	Fuse has operated.	Replace the controller fuse on BJF board labeled ABS (alarm battery supply).
CTLR	MAJ	Remote Peripheral Fuse	--	Fuse has operated.	Replace the controller fuse on BJF board labeled PER (option power).
CTLR	MAJ	Sense/Control Fuse	--	Fuse has operated.	Replace the controller fuse on BJF board labeled SENSE (voltage sense).
CTLR	MAJ	Battery Thermal Fuse	--	Fuse has operated.	Replace the controller fuse on BJF board labeled BTP (battery thermal power).
CTLR	MAJ	Battery Power Fuse	--	Fuse has operated.	Replace the controller fuse labeled BAT (battery power).

Table 13-C: Controller Alarms
(See Figures 12-2 and 12-3)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTLR	MAJ	Major Communications Fail Alarm	Blinking ALM LED on Rectifier	Loss of communication with controller: <ul style="list-style-type: none"> •Defective interface from BIC or multiple rectifiers to controller •Internal failure of controller, BIC, or multiple rectifiers 	<ol style="list-style-type: none"> 1. Verify that the controller is powered and operating correctly. 2. If there are no controller alarms, replace the piece of equipment that has lost communication. 3. If the problem is not solved, call your local RTAC representative.
CTLR	MAJ	Bay Interface ID Conflict	--	Two or more bay interface cards (BICs) have the same ID number.	Following instructions printed on the label over the BIC, adjust the DIP switches to change the ID number.
CTLR	MIN	PC Power Fuse	--	Fuse has operated.	Replace the controller fuse on BJB board labeled PCPWR (PC power).
CTLR	MIN	Self Fail Test	--	See "Controller Fail".	See "Controller Fail".
CTLR	MIN	Thermal Probe Failure	--	Battery thermal probe has failed.	Call your local RTAC representative.
CTLR	MIN	Minor Communications Fail Alarm	Blinking ALM LED on Rectifier	Loss of communication with controller: <ul style="list-style-type: none"> •Defective interface from single rectifier to controller •Internal controller or rectifier failure 	<ol style="list-style-type: none"> 1. Verify that the controller is powered and operating correctly. 2. If there are no controller alarms, replace the piece of equipment that has lost communication. 3. If the problem is not solved, call your local RTAC representative.

DIST Alarm LED

Table 13-D: Distribution Alarms
(See Figures 12-9 and 12-10)

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
DIST	MAJ	External Fuse Major	Alarm LED on dc distribution panel is lit.	DC load fuse or circuit breaker has operated.	Replace fuse or reset circuit breaker.
DIST* *Alarm must be configured to turn on the DIST LED; not a factory default.	MAJ	Contactors 2 (or 3) Open	Red LED on contactor drive board is lit.	Contactors are open: •Open has been initiated by controller. •Open has been initiated manually.	1. Follow instructions on the label adjacent to the contactor drive board (see Figure 12-10). 2. If the problem is not corrected, call your local RTAC representative.
DIST* *Alarm must be configured to turn on the DIST LED; not a factory default.	MAJ	Contactors 2 (or 3) Fail	--	Contactors or drive board has failed.	Call your local RTAC representative.

RECT Alarm LED

Table 13-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	SCF Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MAJ	ID Not Configured	None	None	Rectifier ID number has not been set.	<ol style="list-style-type: none"> 1. Press ON/STBY switch up and hold for five seconds until display starts blinking "0". 2. Release switch; display should continue to blink. 3. Depress switch and release. Display will increment up one number on each release of the switch, but will remain flashing. 4. Once the desired ID number appears, depress and hold the switch for five seconds. The display will cease to blink, and then revert to the rectifier current.
RECT	MAJ	ID Conflict	None	None	Two or more rectifiers have the same ID number.	See alarms listed above.
RECT	MAJ	Multiple Rectifier Fail	ALM	None	More than one rectifier has an ALM LED lit.	See alarms listed above.
RECT	MAJ	High Voltage Alarm	Possibly ALM	Possibly HO	<ul style="list-style-type: none"> •Lightning has struck system. •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

Table 13-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	SCF Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	Rectifier Fail	ALM	HO	High output voltage: <ul style="list-style-type: none"> •Rectifier high voltage shutdown •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify the configurable HV thresholds in the controller. 2. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 3. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	TA	Thermal alarm: <ul style="list-style-type: none"> •Excessive ambient temperature •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify that there is no obstruction of the fan inlet. 2. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 3. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	CB	Circuit breaker alarm: <ul style="list-style-type: none"> •DC output circuit breaker open •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position; toggle the DC output circuit breaker into the OFF position and then into the ON position. Return the ON/STBY switch to the ON position. 2. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	LO	Low output voltage: <ul style="list-style-type: none"> •Excessive output current •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

Table 13-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	SCF Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	Rectifier Fail	ALM	ICS IP5 IP6 IP7	Internal rectifier failure	<ol style="list-style-type: none"> 1. Place the ac circuit breaker for the rectifier in the OFF position. 2. Remove the rectifier from the shelf. 3. Wait for 30 seconds or until all front panel display LEDs have extinguished. 4. Replace the rectifier. 5. Return the ac breaker to the ON position. 6. Place the rectifier ON/STBY switch into the ON position. 7. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	SEN	Thermal sensor failure: •Internal rectifier failure	<ol style="list-style-type: none"> 1. Place the ac circuit breaker for the rectifier in the OFF position. 2. Remove the rectifier from the shelf. 3. Wait for 30 seconds or until all front panel display LEDs have extinguished. 4. Replace the rectifier. 5. Return the ac breaker to the ON position. 6. Place the rectifier ON/STBY switch into the ON position. 7. If the problem is not corrected, replace the rectifier with a new one.
RECT	MIN	Rectifier Fail	FAN ALM	None	Fan failure	Replace the fans in the rectifier.
RECT	MIN	Manual Off	STBY	Blank	Rectifier has been manually turned off.	Turn rectifier on.

Table 13-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	SCF Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	High Float Voltage	None	None	Configuration problem	Call your local RTAC representative.
RECT	MIN	Excess Rectifier Drain	None	None	Internal rectifier fault	Replace rectifier.
RECT	MIN	Excess System Drain	None	None	System load exceeds shunt rating.	Call your local RTAC representative.
RECT	MIN	Limited Recharge	None	None	Rectifier capacity has been exceeded.	Install more rectifiers.
RECT	MIN	External Transfer Shutdown	STBY	TR	System is operating on external engine.	No action required.
RECT	MIN	Rectifier Fail	ALM	FSE	Fuse alarm: •DC fuse open •Internal rectifier failure	1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

BD and RM Alarm LEDs, or No LED

Table 13-F: Miscellaneous Alarms

Controller LED	Controller Alarm Status	SCF Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
BD	MAJ	Battery on Discharge	Rectifiers may say ACF.	Temporary condition that may be associated with other alarms	Call your local RTAC representative.
RM	MIN	Module Failure	Green LED on RPM will not blink.	Remote Peripheral Module has failed.	Call your local RTAC representative.
RM	MIN	Measurement Out of Range	--	<ul style="list-style-type: none"> •Data being sensed exceeds remote peripheral module's capability. •Remote peripheral module has failed. 	Call your local RTAC representative.
None	MAJ	Auxiliary Major	Auxiliary equipment may have alarm.	Problem with operation of auxiliary equipment	Call your local RTAC representative.
None	MIN	Auxiliary Minor	Auxiliary equipment may have alarm.	Problem with operation of auxiliary equipment	Call your local RTAC representative.
None	None	None	<ul style="list-style-type: none"> •STBY LED on rectifier is lit. •TR on rectifier display 	Remote standby: <ul style="list-style-type: none"> •Rectifier is in STBY. 	Remove the remote standby command issued by the controller.
None	None	None	Red LED is lit on some battery contactor drive boards, while green LED is lit on others.	If a green LED is lit despite a contactor open command issued by the controller, the drive card or the contactor has failed.	Call your local RTAC representative.

14 ***Troubleshooting Millennium Systems***

Introduction

In This Section This section provides information for locating and interpreting visual indicators to help identify problems.

Preparation Read Section 12, *Troubleshooting Preparations*, thoroughly before proceeding.

Technical Assistance When visual indicators do not identify a defective part, notify the local Regional Technical Assistance Center (RTAC) at 1-800-CAL-RTAC (1-800-225-7822)

Troubleshooting Tables

Organization

The tables in this section are organized alphabetically by Alarm LED, then grouped according to the status of the alarm: Critical (CRIT), Major (MAJ), or Minor (MIN).

Table Reference

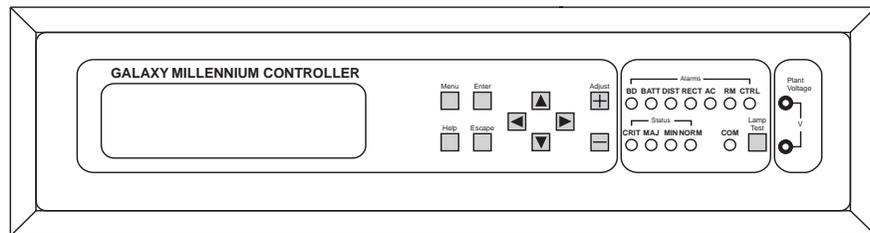
Use the reference below to locate the Alarm LED and corresponding table.

Alarm LED	Table
AC	14-A, AC Alarms
BATT	14-B, Battery Alarms
BD	14-F, Miscellaneous Alarms
CTRL	14-C, Controller Alarms
DIST	14-D, Distribution Alarms
RECT	14-E, Rectifier Related Alarms
RM	14-F, Miscellaneous Alarms
No LED*	14-F, Miscellaneous Alarms

*If an alarm condition exists, but no alarm LED is lit, refer to Table 14-F.

Millennium Controller Display

The Millennium display is illustrated below.



AC Alarm LED

Table 14-A: AC Alarms
(See Figure 12-8)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
AC	MIN	AC Fail	ACF on rectifier display	Rectifier is not receiving ac power: <ul style="list-style-type: none"> •AC input circuit breaker has operated. •AC input voltage is out of range. •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify that ac circuit breaker is closed; close circuit breaker if operated. 2. If the problem is not corrected, replace the rectifier.
AC	MIN	Engine Transfer Timeout	Engine may have alarm.	Remote engine or connection to engine has failed.	Call your local RTAC representative.
AC	MIN	Phase Alarm	PF on rectifier display	Phase failure: <ul style="list-style-type: none"> •Rectifier high voltage shutdown •External phase imbalance or failure •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

BATT Alarm LED

Table 14-B: Battery Alarms
(See Figure 12-7)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
BATT	CRIT	Very Low Voltage	--	Occurs in an operating system following an extended commercial ac power outage, during which the batteries are providing power for the system and the system voltage is approaching the user-defined low limit.	<ol style="list-style-type: none"> 1. If commercial ac power is present but the system voltage remains low, call your local RTAC representative. 2. Investigate other alarms that may be present (rectifier-related alarms and the AC Fail alarm may also occur during the fault condition).
BATT* *Alarm must be configured to turn on the BATT LED; not a factory default.	MAJ	Contactor 1 Open	Red LED on contactor drive board is lit.	Contactor is open: <ul style="list-style-type: none"> •Open has been initiated by controller. •Open has been initiated manually. 	<ol style="list-style-type: none"> 1. Follow instructions on the label adjacent to the contactor drive board (see Figure 12-7). 2. If the problem is not corrected, call your local RTAC representative.
BATT* *Alarm must be configured to turn on the BATT LED; not a factory default.	MAJ	Contactor 1 Fail	--	Contactor or drive board has failed.	Call your local RTAC representative.
BATT	MIN	Open String	Alarm LED on battery fuse panel is lit.	Battery fuse has operated.	Replace the operated fuse.
BATT	MIN	Low Reserve Time	--	Controller has calculated that batteries are low.	Call your local RTAC representative.

CTRL Alarm LED

Table 14-C: Controller Alarms
(See Figures 12-4 and 12-5)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTRL	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BSH failure→ •BSJ failure •Option board failure •Display failure •BIC failure 	<p>Check the BSH board to see if the green LED is extinguished and the yellow LED is lit. If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Press the SW200 reset switch on the top of the BSH board. If all diagnostics pass, it is possible that some type of “one time” abnormality occurred to cause the failure. 2. If the diagnostics did not pass, or if the problem recurs, unplug all the optional circuit board cables, then press the reset switch on the top of the BSH board again. If all the diagnostics pass, install optional circuit board cables one at a time, verifying operation after each. 3. If the diagnostics did not pass, replace the BSH board and verify the failure is resolved. If so, reinstall the optional circuit boards and cables one at a time. 4. If the problem is not corrected, call your local RTAC representative.

Table 14-C: Controller Alarms
(See Figures 12-4 and 12-5)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTRL	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BSH failure •BSJ failure→ •Option board failure •Display failure •BIC failure 	<p>Check the BSJ board to see if the green LED is extinguished and the yellow LED is lit. If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Press the SW201 reset switch on the top of the BSJ board. (This circuit has an automatic restart, which will try three times to restart the microprocessor.) 2. If the diagnostics did not pass, or if the problem recurs, remove all the optional circuit board cables, then press the reset switch on the top of the BSJ board again. If all the diagnostics pass, install optional circuit board cables one at a time, verifying operation after each. 3. If the diagnostics did not pass, replace the BSJ board and verify the failure is resolved. If so, reinstall the optional circuit boards and cables one at a time. 4. If the problem is not corrected, call your local RTAC representative.

Table 14-C: Controller Alarms
(See Figures 12-4 and 12-5)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTRL	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BSH failure •BSJ failure •Option board failure→ •Display failure •BIC failure 	<p>Check the option boards (modem and data switch) to see if the green LED is extinguished and the yellow LED is lit. If so, perform the following steps:</p> <ol style="list-style-type: none"> 1. Press the SW201 reset switch on the top of the BSJ board. (This circuit has an automatic restart, which will try three times to restart the microprocessor.) If the BSJ is not present, press the reset switch on the top of the BSH board. 2. If the diagnostics did not pass, or if the problem recurs, replace the failed option board.
CTRL	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BSH failure •BSJ failure •Option board failure •Display failure→ •BIC failure 	<p>If the front panel LCD module, LEDs, or switches fail, perform the following steps:</p> <ol style="list-style-type: none"> 1. Verify that the ribbon cable from the BSH board to the display is not cut, abraded, or otherwise mangled. Replace the cable if damaged. 2. Press SW200 to reset the BSH board. 3. If the LCD module is still not operating, replace the LCD module; if the switches and LEDs are still not operating, replace the BSH board.

Table 14-C: Controller Alarms
(See Figures 12-4 and 12-5)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTRL	MAJ	Controller Fail	--	<ul style="list-style-type: none"> •BSH failure •BSJ failure •Option board failure •Display failure •BIC failure→ 	<ol style="list-style-type: none"> 1. Strap K1, K2, K3 on BLJ from “C” to “R” prior to replacing BIC. See Figure 8-2. 2. Replace BIC.
CTRL	MAJ	Circuit Pack Fail	--	See “Controller Fail”.	See “Controller Fail”.
CTRL	MAJ	Controller Fuse	--	Fuse has operated.	Replace the controller fuse labeled F2 (intelligent power).
CTRL	MAJ	Alarm Battery Supply Fuse	--	Fuse has operated.	Replace the controller fuse labeled F5 (alarm battery supply).
CTRL	MAJ	Remote Peripheral Fuse	--	Fuse has operated.	Replace the controller fuse labeled F1 (option power).
CTRL	MAJ	Sense/Control Fuse	--	Fuse has operated.	Replace the controller fuse labeled F4 (voltage sense).
CTRL	MAJ	Bay Interface ID Conflict	--	Two or more bay interface cards (BICs) have the same ID number.	Following instructions printed on the label over the BIC, adjust the DIP switches to change the ID number.
CTRL	MAJ	Major Communication Fail Alarm	Blinking ALM LED on rectifiers or red LED on BIC	Loss of communication with controller: <ul style="list-style-type: none"> •Defective interface from BIC or multiple rectifiers to controller •Internal failure of controller, BIC, or multiple rectifiers 	<ol style="list-style-type: none"> 1. Verify that the controller is powered and operating correctly. 2. If there are no controller alarms, replace the equipment that has lost communication. 3. If the problem is not corrected, call your local RTAC representative.

Table 14-C: Controller Alarms
(See Figures 12-4 and 12-5)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
CTRL	MIN	Minor Communication Fail Alarm	Blinking ALM LED on rectifier	Loss of communication with controller: <ul style="list-style-type: none"> •Defective interface from rectifier to controller •Internal controller or rectifier failure 	<ol style="list-style-type: none"> 1. Verify that the controller is powered and operating correctly. 2. If there are no controller alarms, replace the equipment that has lost communication. 3. If the problem is not corrected, call your local RTAC representative.
CTRL	MIN	Self Fail Test	--	See "Controller Fail".	See "Controller Fail".
CTRL	MIN	Thermal Probe Failure	--	Battery thermal probe has failed.	Call your local RTAC representative.

DIST Alarm LED

Table 14-D: Distribution Alarms
(See Figures 12-9 and 12-10)

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
DIST	MAJ	External Fuse Major	Alarm LED on dc distribution panel is lit.	DC load fuse or circuit breaker has operated.	Replace fuse or reset circuit breaker.
DIST* *Alarm must be configured to turn on the DIST LED; not a factory default.	MAJ	Contactor 2 (or 3) Open	Red LED on contactor drive board is lit.	Contactor is open: •Open has been initiated by controller. •Open has been initiated manually.	1. Follow instructions on the label adjacent to the contactor drive board (see Figure 12-10). 2. If the problem is not corrected, call your local RTAC representative.
DIST* *Alarm must be configured to turn on the DIST LED; not a factory default.	MAJ	Contactor 2 (or 3) Fail	--	Contactor or drive board has failed.	Call your local RTAC representative.

RECT Alarm LED

Table 14-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	Millennium Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MAJ	ID Not Configured	None	None	Rectifier ID number has not been set.	<ol style="list-style-type: none"> 1. Press ON/STBY switch up and hold for five seconds until display starts blinking "0". 2. Release switch; display should continue to blink. 3. Depress switch and release. Display will increment up one number on each release of the switch, but will remain flashing. 4. Once the desired ID number appears, depress and hold the switch for five seconds. The display will cease to blink, and then revert to the rectifier current.
RECT	MAJ	ID Conflict	None	None	Two or more rectifiers have the same ID number.	See above.
RECT	MAJ	Multiple Rectifier Fail	ALM	None	More than one rectifier has an ALM LED lit.	See alarms listed below.
RECT	MAJ	High Voltage Alarm	ALM	HO	<ul style="list-style-type: none"> •Lightning has struck system. •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

Table 14-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	Millennium Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	Rectifier Fail	ALM	HO	High output voltage: <ul style="list-style-type: none"> •Rectifier high voltage shutdown •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify the configurable HV thresholds in the controller. 2. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 3. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	TA	Thermal alarm: <ul style="list-style-type: none"> •Excessive ambient temperature •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Verify that there is no obstruction of the fan inlet. 2. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 3. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	CB	Circuit breaker alarm: <ul style="list-style-type: none"> •DC output circuit breaker open •Internal rectifier failure 	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position; toggle the DC output circuit breaker into the OFF position and then into the ON position. Return the ON/STBY switch to the ON position. 2. If the problem is not corrected, replace the rectifier.

Table 14-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	Millennium Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	Rectifier Fail	ALM	ICS IP5 IP6 IP7	Internal rectifier failure	<ol style="list-style-type: none"> 1. Place the ac circuit breaker for the rectifier in the OFF position. 2. Remove the rectifier from the shelf. 3. Wait for 30 seconds or until all front panel display LEDs have extinguished. 4. Replace the rectifier. 5. Return the ac breaker to the ON position. 6. Place the rectifier ON/STBY switch into the ON position. 7. If the problem is not corrected, replace the rectifier.
RECT	MIN	Rectifier Fail	ALM	LO	Low output voltage: •Excessive output current •Internal rectifier failure	<ol style="list-style-type: none"> 1. Toggle the ON/STBY switch into the STBY position and then back into the ON position. 2. If the problem is not corrected, replace the rectifier.

Table 14-E: Rectifier Related Alarms
(See Figures 12-6 and 12-8)

Controller LED	Controller Alarm Status	Millennium Controller Display	Rectifier LED	Rectifier Display	Possible Problem(s)	Possible Solution(s)
RECT	MIN	Rectifier Fail	ALM	SEN	Thermal sensor failure: •Internal rectifier failure	<ol style="list-style-type: none"> 1. Place the ac circuit breaker for the rectifier in the OFF position. 2. Remove the rectifier from the shelf. 3. Wait for 30 seconds or until all front panel display LEDs have extinguished. 4. Replace the rectifier. 5. Return the ac breaker to the ON position. 6. Place the rectifier ON/STBY switch into the ON position. 7. If the problem is not corrected, replace the rectifier with a new one.
RECT	MIN	Rectifier Fail	FAN ALM	None	Fan failure	Replace the fan in the rectifier.
RECT	MIN	Manual Off	STBY	Blank	Rectifier has been manually turned off.	Turn rectifier on.
RECT	MIN	External Transfer Shutdown	STBY	TR	System is operating on external engine.	No action required.
RECT	MIN	High Float Voltage	None	None	Configuration problem	Call your local RTAC representative.
RECT	MIN	Excess Rectifier Drain	None	None	Internal rectifier fault	Replace rectifier.
RECT	MIN	Excess System Drain	None	None	System load exceeds shunt rating.	Call your local RTAC representative.
RECT	MIN	Limited Recharge	None	None	Rectifier capacity has been exceeded.	Install more rectifiers.

BD and RM Alarm LEDs, or No LED

Table 14-F: Miscellaneous Alarms

Controller LED	Controller Alarm Status	Millennium Controller Display	Other Indication(s)	Possible Problem(s)	Possible Solution(s)
BD	MAJ	Battery on Discharge	Rectifiers may say ACF.	Temporary condition that may be associated with other alarms	Call your local RTAC representative.
RM	MIN	Module Failure	Green LED on RPM will not blink.	Remote Peripheral Module has failed.	Call your local RTAC representative.
RM	MIN	Measurement Out of Range	--	<ul style="list-style-type: none"> •Data being sensed exceeds remote peripheral module's capability. •Remote peripheral module has failed. 	Call your local RTAC representative.
None	MAJ	Auxiliary Major	Auxiliary equipment may have alarm.	Problem with operation of auxiliary equipment	Call your local RTAC representative.
None	MIN	Auxiliary Minor	Auxiliary equipment may have alarm.	Problem with operation of auxiliary equipment	Call your local RTAC representative.
None	None	None	<ul style="list-style-type: none"> •STBY LED on rectifier is lit. •TR on rectifier display 	Remote transfer: <ul style="list-style-type: none"> •Rectifier is in STBY. 	Remove the remote standby command issued by the controller.
None	None	None	Red LED is lit on some battery contactor drive boards, while green LED is lit on others.	If a green LED is lit despite a contactor open command issued by the controller, the drive card or the contactor has failed.	Call your local RTAC representative.

15 *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.

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