

**Lucent Technologies**  
Bell Labs Innovations



***Operation, Maintenance,  
Installation, and Testing  
Requirements for the  
415B Battery Plant  
(New and Retrofit 4ESS<sup>TM</sup>  
Applications)***

Product Manual  
Select Code 167-792-121  
Comcode 107972754  
Issue 6  
September 1999  
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Operation, Maintenance, Installation, and  
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415B Battery Plant  
(New and Retrofit 4ESS™ Applications)***

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***

## ***Product Manual***

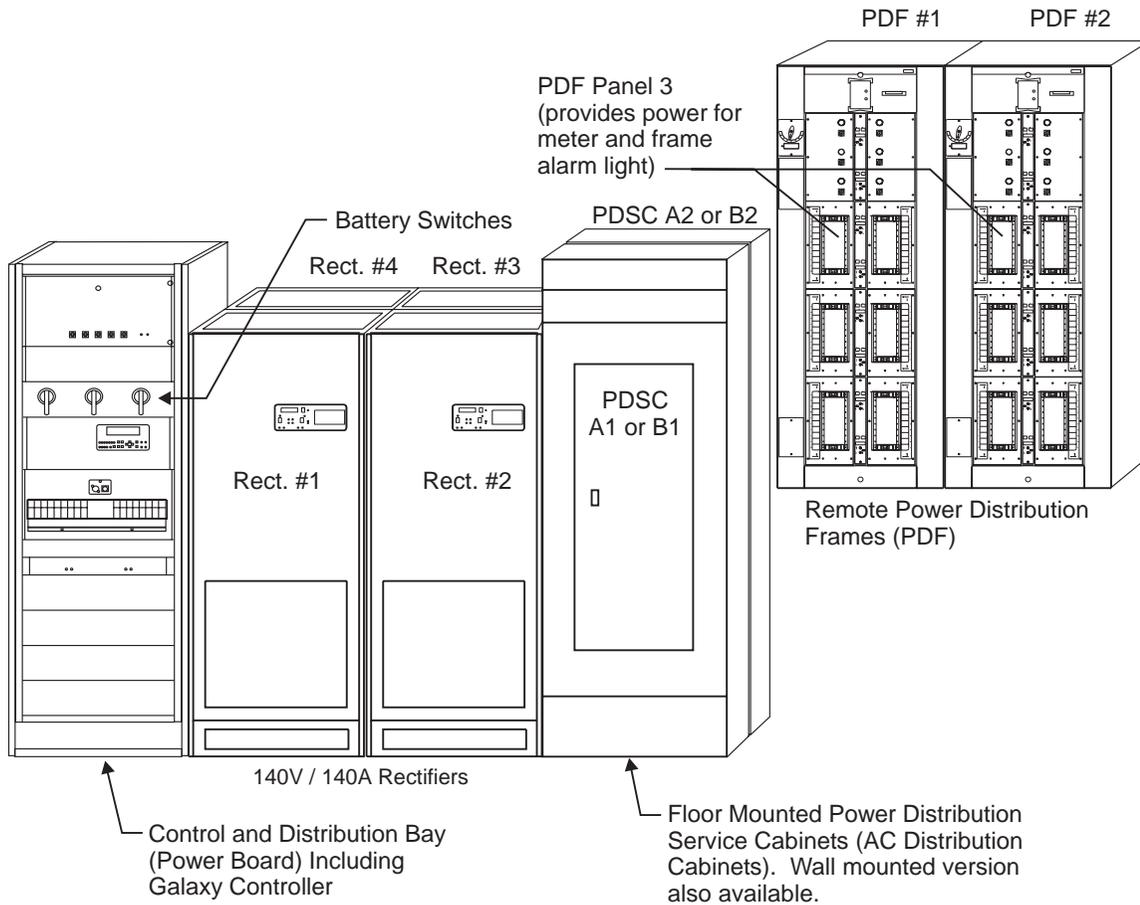
This product manual (Select Code 167-792-121) describes the installation, testing, operating, and maintenance instructions for the 415B Battery Plant, which is shown in Figure 1-1. The following list provides a reference key to the contents of this product manual:

Section 1	Introduction
Section 2	System Description
Section 3	Safety
Section 4	System Installation
Section 5	System Testing
Section 6	Connecting Telecommunications Loads to the Power Distribution Frame
Section 7	Retrofit of 415A Battery Plant
Section 8	Maintenance and Operation
Section 9	Glossary

## ***415B Battery Plant***

The 415B Battery Plant contains the following subsystems:

- KS-22089 AC Distribution Panel or Cabinet, two required; also referred to as a Power Distribution Service Cabinet (PDSC)
- H569-429 Control and Distribution Bay; also referred to as a Power Board
- J87132B-2 140Vdc, 140A, 60Hz Ferroresonant Rectifier, two to four required
- J85501F-1 Galaxy Controller
- J85568D-1 Power Distribution Frame (PDF), two required
- KS-20472 Round Cell Batteries, 70 cells/string, up to three strings
- NE00305-45, G1 Enhanced Ground Current Monitor



- Note: 1. Two identical battery plants, similar to that in the figure, are required. One is called the A plant and one the B plant.  
 2. A maximum of three battery strings (not shown) connect to the C&D Bay.  
 3. Also not shown, an Enhanced Ground Current Monitor (EGCM) that monitors the ground current in the central office ground conductor. There are separate EGCMs for the A plant and the B plant.

**Figure 1-1: 415B Battery Plant**

**Applications** The 415B Battery Plant is usually used to power a 4ESS™ switch, but it can be used for any high power, 140-volt plant. Two complete plants are required.

**Installation and Testing** Refer to the appropriate sections in the product manuals for installation procedures for the H569-429 Control and Distribution Bay, the Galaxy Controller, the J87132B-2 Ferroresonant Rectifier, and the J85568D-1 Power Distribution Frame (PDF). These manuals, along with other documentation, are listed in the “Documentation References” portion of Section 2.

## ***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***

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

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

***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.”

## 2 *System Description*

### ***415B Battery Plant Overview***

Two 4ESS™ switches are powered by two independent 415B Battery Plants. Each 415B Battery Plant consists of two Power Distribution Service Cabinets (PDSC), a Control and Distribution Bay, up to four rectifiers, three battery strings, two Power Distribution Frames, an Enhanced Ground Current Monitor, and a Galaxy Controller.

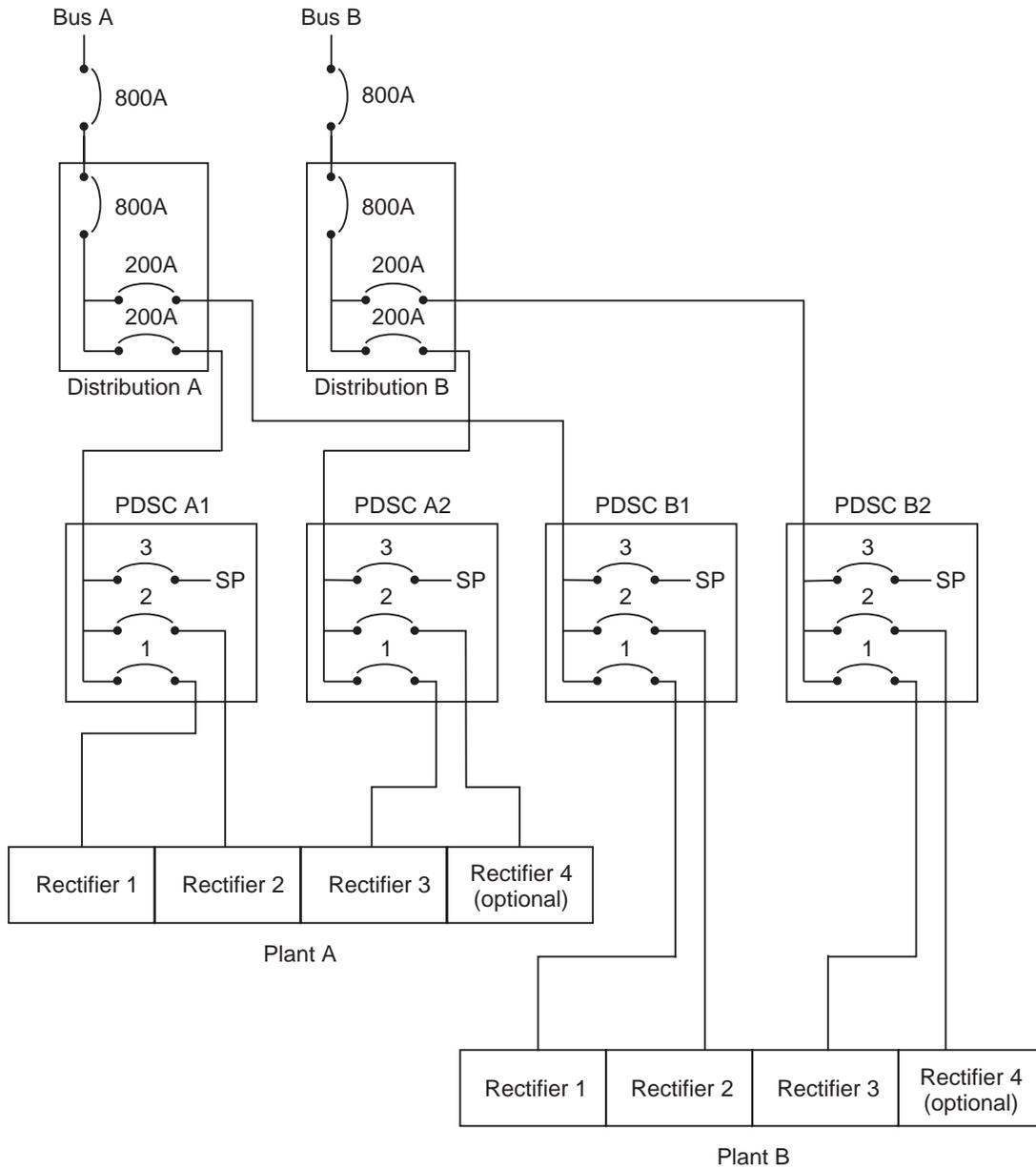
**The two independent plants are labeled Battery Plant “A” and Battery Plant “B”. The dc output cables between the Control and Distribution Bay and the Power Distribution Frames of each plant are different colors for clarification purposes. The cables are colored as follows:**

- Battery Plant “A” - Red and Red with Black tracer
- Battery Plant “B” - Blue and Blue with Black tracer

### ***Power Distribution Service Cabinet (PDSC)***

Commercial ac is brought into two ac distribution panels and sent to each rectifier in the plant. Each ac distribution panel is fed from a separate input circuit breaker, ideally from a different power station. There are two ac distribution panels per battery plant that can either be free standing or wall mounted. One of three ac input voltage levels may be utilized for the rectifiers in the plant: 208V, 240V, or 480V at 60 hertz. Three-phase power is required.

There are a maximum of four rectifiers in the plant, each having its own circuit breaker located in one of the ac distribution panels. The circuit breakers are the type that may be tagged and locked out for safety. Normally, each ac distribution panel feeds two rectifiers. Refer to Figure 2-1.



**Figure 2-1: Typical 415B Battery Plant AC Feeds**

## ***Control and Distribution Bay***

The Control and Distribution Bay distributes power for the using equipment, as well as for float and recharge capability for the batteries, the alarm panel, the plant shunt, Galaxy Controller, dc/dc converters, battery disconnect/reconnect switches, and distribution breakers.

### ***Alarm Panel***

The alarm panel is located on the top of the Control and Distribution Bay. It provides alarms, remote sensing, test points, fuses, and power to operate the lamp. The circuit board is the BNF2, which uses the plant voltage to supply sense voltage to the Galaxy Controller. Alarms are generated by isolated contacts from the individual panels.

### ***Plant Shunt***

The plant shunt, which is used to measure the total plant load, is mounted in the Control and Distribution Bay. It has a full scale rating of 600 amperes at 50 millivolts.

### ***Galaxy Controller***

The Galaxy Controller is an intelligent controller that is mounted in the Control and Distribution Bay. It is powered by redundant dc/dc converters that convert the nominal battery voltage (+140 volts) to +48 volts, permitting the standard +48-volt Galaxy Controller to be used. The Galaxy Controller J85501F-1 List 4 is specifically programmed for the 415B System. (See Product Manual 167-792-122 for all features.)

### ***DC/DC Converters***

The dc/dc converters are mounted in the Control and Distribution Bay, and their outputs are diode ORed to provide power to the Galaxy Controller if one of the converters fails.

### ***Battery Disconnect/Reconnect Switches***

The switch panel has three 600-ampere switches, one per string, that are used to disconnect individual strings of batteries from service. Each switch has an Auxiliary Contact to signal an alarm if the switch is placed in the **Off** position. Switch one is factory connected and will alarm if placed in the **Off** position. When installing a second or third battery string, the second or third battery auxiliary switch must have the blue wires connected in order to activate the alarm when switch two or three is placed in the **Off** position. The location of the wires is at the auxiliary switch.

***Distribution  
Breakers***

There are 12 circuit breakers in the Control and Distribution Bay that supply power to a secondary dc distribution system, which consists of two Power Distribution Frame (PDF) bays. Six circuit breakers feed PDF #1 and the other six breakers feed PDF #2. The current through the circuit breakers is monitored by shunts located in the PDF bays, and this information is sent to the Galaxy Controller via Remote Peripheral Monitoring (RPM) modules.

***Rectifiers***

Each rectifier is rated at 152 volts, 140 amperes. The maximum plant load is 560 amperes. The plant always has a redundant rectifier.

The rectifiers are connected in parallel with up to three strings of batteries that float at 151.9 volts. The output of all rectifiers is combined in the Control and Distribution Bay.

The rectifiers contain a 50mV, 175-ampere shunt. Their output circuit breakers are also sized at 175 amperes.

***Battery Equalize/  
Boost Feature***

You will see the terms “Equalize” and “Boost” used throughout the documentation associated with the 415B Battery Plant. **In this manual, the terms are interchangeable and mean exactly the same thing.**

The rectifiers, in association with the Galaxy Controller, allow the batteries to be charged at a higher voltage (**Boost**) than float voltage to **Equalize** the individual voltages of the cells in the string. The **Equalize/Boost** voltage is factory set to 2.23 volts per cell, or 156.1 volts total.

***Power  
Distribution  
Frame (PDF)***

The Power Distribution Frame (PDF) bay is the secondary distribution point for the 415B Battery Plant. There are two PDF bays per plant, and each bay contains six panels of secondary distribution fuses to power the loads. Each panel is fed from a circuit breaker located in the Control and Distribution Bay.

Each PDF bay contains load fuses, capacitors, a load capacitor charge tool, shunts to monitor the feeders from the Control and Distribution Bay, a manually switchable ammeter, and a Remote Peripheral Monitoring (RPM) module.

**Capacitors** Capacitors are located in the PDF bay to add extra energy storage either to help maintain the bus voltage or to aid in the clearing of fuses depending on where a fault condition occurs.

**Load Capacitor Charge Tool** A load capacitor charge tool is located at the top of the PDF bay. This device is used to precharge capacitive-type loads to prevent operating a load fuse upon insertion.

**Shunts** Six shunts are mounted in each PDF bay to monitor feeders from the Control and Distribution Bay.

**Remote Peripheral Monitoring Unit** The Remote Peripheral Monitoring (RPM) Unit, mounted on the front of each PDF bay, monitors the six shunts in the PDF bay and sends load-monitoring serial data to the Galaxy Controller. A manually-switchable ammeter is also used to locally monitor these shunts.

**MOV Assembly for PDF Frames** A Metal Oxide Varistor (MOV) is mounted from frame ground to the K1 bus bar of each PDF frame. Mounting is made using connectors from the return K1 Bus Bar, either at the top for a Top Feed application or at the bottom for a Bottom Feed (BE) application. This device prevents transients from becoming a problem when a fuse clears in the PDF frame. This protection is required when connected to a 4ESS™ system. Installation is covered by Sheet F3 of the H569-429 only.

**Battery Strings** Each battery string consists of 70 flooded cells, floated at 2.17 volts per cell, giving a float voltage of 151.9 volts. The 415B Battery Plant can accommodate up to three strings of batteries. Each battery string is fused and contains a pilot fuse for alarming purposes that sends an open string alarm to the Galaxy Controller.

Each battery string has a battery disconnect switch. These switches are located in the Control and Distribution Bay and are accessible from the front of the bay. They have lock-in and lock-out capability. They also have auxiliary contacts that will send a major alarm and an open string alarm to the Galaxy Controller.

## ***Enhanced Ground Current Monitor***

The Enhanced Ground Current Monitor (EGCM) is designed to measure and display current present in the 1/0 AWG ground cable of the 415B Battery Plant. The EGCM will give an alarm when user-set current limits are exceeded. The input to the EGCM is protected with a half (1/2) ampere fuse.

### ***Current Display***

The EGCM is capable of measuring current in the range of -5.0A to +5.0A, with an accuracy better than 50mA over full scale. The LCD display reads to two decimal places. The maximum reading is 9.99A, but no damage will occur to the monitor if current exceeds 9.99A.

### ***Performance Verification***

Proper operation and calibration of the EGCM can be confirmed with a hand-held Digital Multimeter (DMM). No additional equipment is required to check performance.

### ***Alarm Contacts and Alarm Indication Light***

Adjustable low and high current alarm settings activate four isolated Form-C contact closures and illuminate the light on the display when current in the ground lead exceeds alarm set points. A built-in alarm test circuit verifies the set point operation by lighting the red test lamp and triggering the alarm when test current exceeds the set point.

### ***Design***

The EGCM's modular design allows for one-time sensor installation and easy removal of the control unit. If calibration or repair is ever required, unplug the control unit from the sensor and leave the sensor attached to the ground lead.

### ***Power Requirements***

The EGCM requires an input voltage in the range of -40Vdc to -60Vdc. The EGCM must be fused at 0.5 amperes.

## ***Documentation References***

The following documents provide engineering, ordering, and installation information for the 415B Battery Plant and its subsystems:

### **H569-429 Galaxy Control and Distribution Bay**

Assembly Drawing	H569-429
Wiring and Schematic Diagram	T-83360-30
Product Manual Select Code	167-792-120

**J87132B-2 140Vdc, 140A, 60Hz Ferroresonant Rectifier**

Assembly Drawing	J87132B-2
Wiring Diagram	T-83325-30
Schematic Drawing	SD-83325-01
Product Manual Select Code	169-792-100

**J85501F-1 Galaxy Controller**

Assembly Drawing	J85501F-1
Wiring Diagram	T-83217-30
Schematic Drawing	SD-83217-01
Product Manual Select Code	167-792-122

**Power Distribution Frame**

Assembly and Ordering Drawing	J85568D-1
Wiring Diagram	T-83170-30
Schematic Drawing	SD-83170-01
Product Manual Select Code	157-005-101
Capacitor Charge Tool	ED-83127-30, G22

**KS-20472 Round Cell Battery**

Wiring Diagram	J87125A-1 Sh. 2
Schematic Drawing	J87125A-1
Battery Stand Arrangement	ED-82563-10
Product Manual Select Code	157-629-700

**Remote Peripheral Monitoring System**

Assembly and Ordering Drawing	J85501G-1
Wiring Diagram	T-83275-30
Schematic Drawing	SD-83275-01
Product Manual Select Code	167-790-063

**Enhanced Ground Current Monitor\***

Assembly and Ordering Drawing	NE00305-45, G1
Product Manual Select Code	100-517-100
<p><b>*The product manual for the Enhanced Ground Current Monitor must be ordered through the Lucent Technologies Customer Information Center at 1-888-582-3688.</b></p>	



## 3 *Safety*

### *Information*

Please read this section carefully before installing, testing, maintaining, or repairing the 415B Battery Plant or any of its subsystems. Also refer to the product manuals of the subsystems for additional safety information.

### *Rubber Gloves*

**Whenever operations require working inside a rectifier or anywhere near the plant output bus or the ac input, RUBBER GLOVES must be worn. Hazardous voltages exist.**

### *Admonishments*

Always take precautions to protect personal safety as well as the equipment when working on power systems. Throughout this manual, admonishments relating to personal safety are labeled **DANGER** or **Warning**. Those relating to equipment damage are labeled **Caution**. Please read all admonishments carefully and follow safety instructions and warnings.

### *Safety Statements*

- For use only in restricted access areas (dedicated equipment rooms, equipment closets, or the like) in accordance with articles 110-16, 110-17, and 110-18 of the U.S. National Electric Code (NEC), ANSI/NFPA No. 70, and pursuant to applicable local codes.
- This equipment is to be used in controlled environments (an area where the humidity is maintained at levels that cannot cause condensation on the equipment, the contaminating dust is controlled, and the steady-state ambient temperature is within the range specified).

- This equipment has been evaluated for use in a continuous ambient temperature of up to 95 degrees Fahrenheit (35 degrees Celsius).

## ***Precautions***

When working on or using this type of equipment, follow these precautions:

- The 415B Battery Plant and its subsystems must be installed, serviced, and operated only by skilled and qualified personnel who have the necessary knowledge and practical experience with electrical equipment and who understand the hazards that can arise when working on this type of equipment.
- Because of the hazardous voltages supplied to and within the equipment, make sure the equipment, all associated framework, and the cable rack are properly grounded per local job instructions before turning on any power.
- For equipment connected to batteries, disconnecting the ac alone will not necessarily remove power to the equipment. Batteries may be connected in parallel with the output of the rectifiers and at the input side of the distribution frames. Turning off the rectifiers will not necessarily remove power from the bus. Also, battery voltage may still be present on one side of the output dc circuit breaker within the rectifier even with the circuit breaker off. Make sure the battery power is also disconnected and/or follow safety procedures while working on any equipment that contains hazardous energy/voltage.
- Wear rubber gloves while working on live equipment.
- AC voltage is present in the rectifier when the Power switch is in the **Off** position, and ac is still supplied to the input of the rectifier.
- Hazardous dc energy (from batteries and rectifier output) and voltages up to 140 volts are present in the rectifier and power distribution frames. Use a voltmeter to insure no voltage, or the expected voltage, is present before contacting any uninsulated conductor surface. Follow the procedures in the order given to minimize dangerous encounters with these voltages. Exercise extreme caution when working near the battery bus bars.

- When servicing the rectifier, disconnect the ac service and the dc battery buses. Use extreme caution when handling the battery bus cables since these cables may transmit hazardous currents from the batteries. The disconnected charge battery and charge ground connectors (cables) must be taped adequately to prevent them from contacting each other or any other metal surface. (Refer to 140V Rectifier product manual.)
- DC capacitors in the rectifier and distribution have bleeder resistors and will discharge after power has been disconnected. Always check all of the dc capacitor terminals with a voltmeter before performing any procedure. Wait at least five minutes after shutting down ac and circuit breaker of the rectifier (CB1) before working on capacitors or associated bus work.
- Circuit breakers in the rectifier and distribution frames are referenced to the non-grounded side of the 140Vdc. Therefore, some of these circuits may contain hazardous voltages with respect to ground (earth ground and equipment frame). Test circuits before touching and disconnect all connectors (even before removing protective covers). Make sure all protective covers are put back in place.

### ***Personal Safety***

Always observe these precautions when working on or using this type of equipment.

- Wear rubber gloves while working on live equipment.
- Use only properly insulated tools.
- Remove all metallic objects (key chains, glasses, rings, watches, or other jewelry).
- Wear safety glasses.
- Test circuits before touching.
- Lock out and tag any circuit breakers/fuses, when possible, to prevent accidental turn on.
- Be aware of potential hazards in the area in which you are working before entering the equipment.
- Identify exposed hazardous electrical potentials on connectors, wiring, etc. (note the condition of these circuits, especially any wiring).

- Use care when removing or replacing any covers. Avoid contacting any circuits.
- Use gloves when handling thermally hot components inside the rectifier. Transformers are very hot after sustained operation.

## **Warning Statements and Safety Symbols**

Safety symbols may sometimes be accompanied by some type of statement. For example, “Hazardous voltage/energy inside. Risk of injury or death. This unit must be accessed only by qualified personnel.”



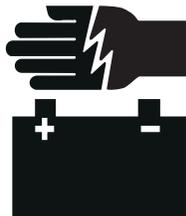
This symbol identifies the need to refer to the equipment instructions for important information.



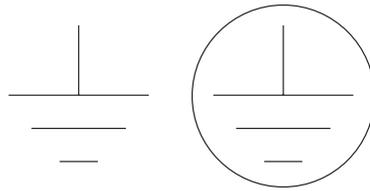
These symbols (or equivalent) are used to identify the presence of hazardous ac mains voltage, which can cause severe injury or death.



This symbol is used to identify the presence of hazardous ac or dc voltages. It may also be used to warn of hazardous energy levels. In the 415B Battery Plant the hazardous dc voltage can cause injury or death.



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



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

### ***Electrostatic Discharge (ESD)***

- Assume all circuit packs containing electronic (solid-state) components can be damaged by ESD.
- When handling circuit packs (storing, inserting, removing, etc.) or when working on the backplane, always use the appropriate grounding procedure: either a wrist strap connected to ground or, when standing, a heel strap with a grounded dissipative floor mat.
- A grounded person must never hand an unprotected circuit pack to an ungrounded person. A static discharge from the ungrounded person through the circuit pack to the grounded person could cause an electrostatic discharge failure. All persons and equipment at a work location must be at the same common ground potential to be static safe.
- Handle all circuit packs by the faceplate or latch and by the top and bottom outermost edges. Never touch the components, conductors, or connector pins.
- Do not rub or wipe circuit packs to clean them unless you and the circuit pack are at the same ground potential.
- Observe warning labels on bags and cartons. Whenever possible, do not remove circuit packs from antistatic bags or cartons until ready to insert into the equipment. Otherwise, open all circuit packs at a static-safe work position with wrist straps and dissipative table mats.
- Upon removal of any circuit pack, immediately put circuit packs into antistatic packages. Always store and transport circuit packs in antistatic packaging. Shielding is not required unless specified.
- Keep all static-generating materials away from all circuit packs. These materials include common plastics such as food wrappers, clear plastic bags, styrofoam containers, packing material, drinking cups, notebooks, and

nonconductive plastic solder suckers. The insulation on small hand tools does not represent a static hazard.

- Keep adhesive tape (Scotch, masking, etc.) away from static-sensitive devices.
- When soldering static-sensitive semiconductor devices, the soldering iron must be grounded to the work table, which must also be earth grounded.
- Whenever possible, maintain relative humidity above the 20-percent level to minimize electrostatic discharge when handling circuit modules.

## 4 *System Installation*

### *Safety*

Please read Section 3, *Safety*, carefully before installing, testing, maintaining, or repairing the 415B Battery Plant or any of its subsystems.

#### **DANGER**

The voltage in this plant can cause serious injury. 140 volts is considered to be a hazardous voltage. Be sure qualified personnel are present when working with live circuits. **Wear RUBBER GLOVES as required.**

### *Unpacking Equipment*

Contact the shipping carrier if there is damage to the equipment. Follow the shipping carrier's procedure for filing a damage claim, if necessary.

### *Required Tools*

The following equipment is required to handle the shipping containers, remove framework from the shipping containers, and erect framework into final position. **The minimum lifting capacity is 1500 pounds.**

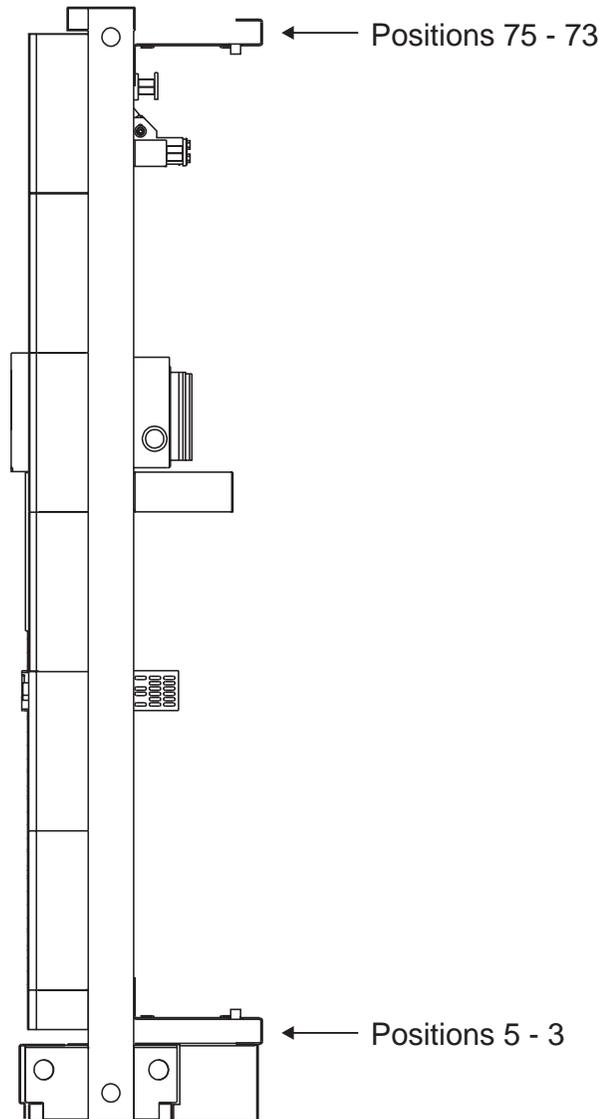
- common electrician's hand tools
- proper crimping tools and dies for connectors used
- common mechanic's hand tools
- 18mm or 3/4-inch drill to bore holes for floor anchors
- DMM (Digital Multimeter) with at least .05% accuracy on the dc scale (Fluke 8060A or equivalent)
- rubber gloves

## General Installation

### Note

Install top and bottom door mounting brackets before running the cables to the Control and Distribution Bay bus bars.

**Mounting Brackets on Control and Distribution Bay** Mount the top bracket in Positions 75-73. Mount the bottom in Positions 5-3. See Figure 4-1.

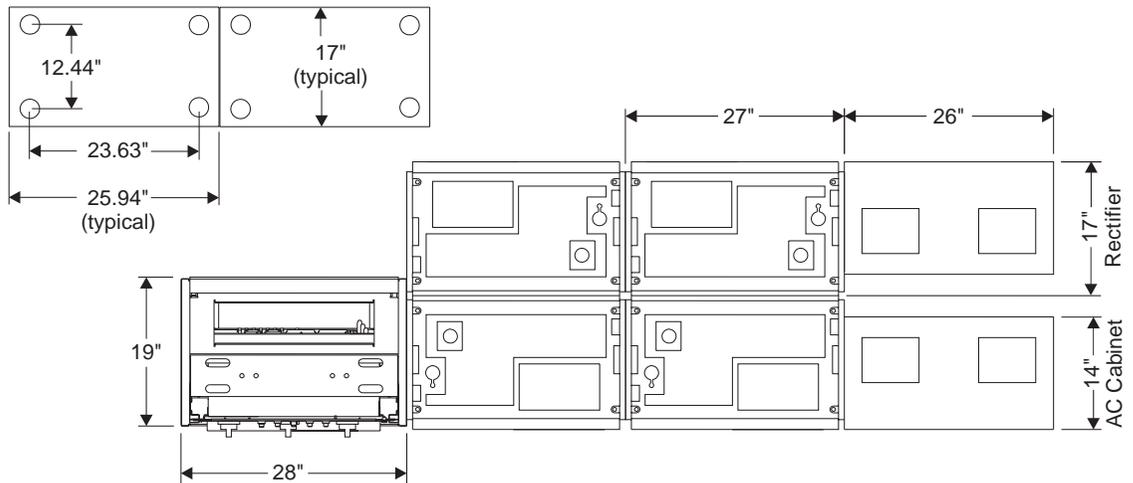


**Figure 4-1: Bracket Mounting Locations**

**4ESS™  
Configurations**

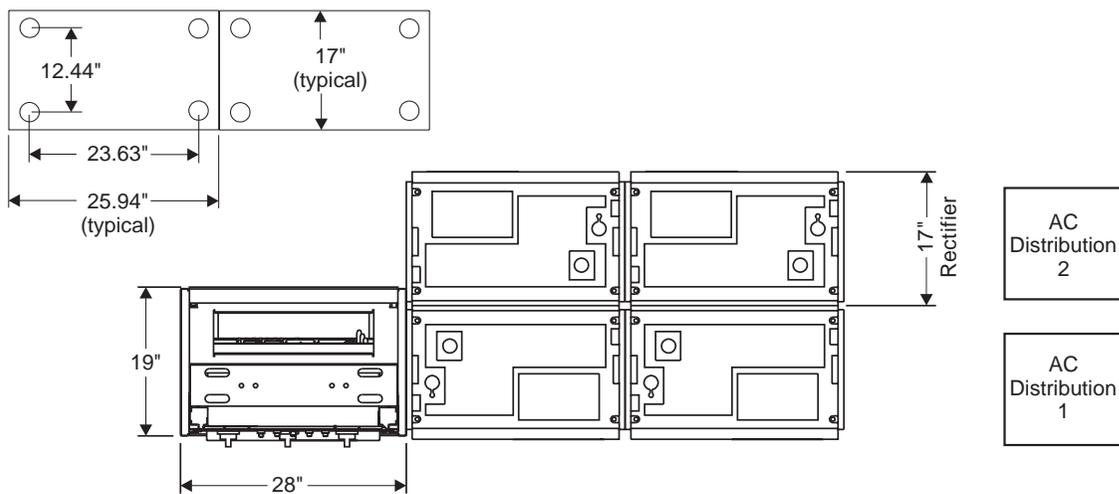
The ac distribution for the 4ESS™ can be either floor-mounted or wall-mounted. Figure 4-2 (A and B) shows both configurations. Choose the appropriate configuration from the D1 sheet of the T-83360-30 drawing, and locate rectifiers and ac distribution as shown.

PDF Frames (remote)



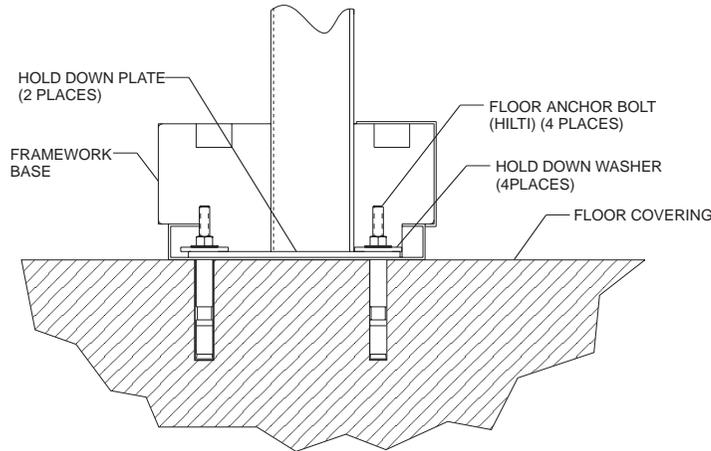
**Figure 4-2A: AC Distribution Floor Mounting Configuration**

PDF Frames (remote)

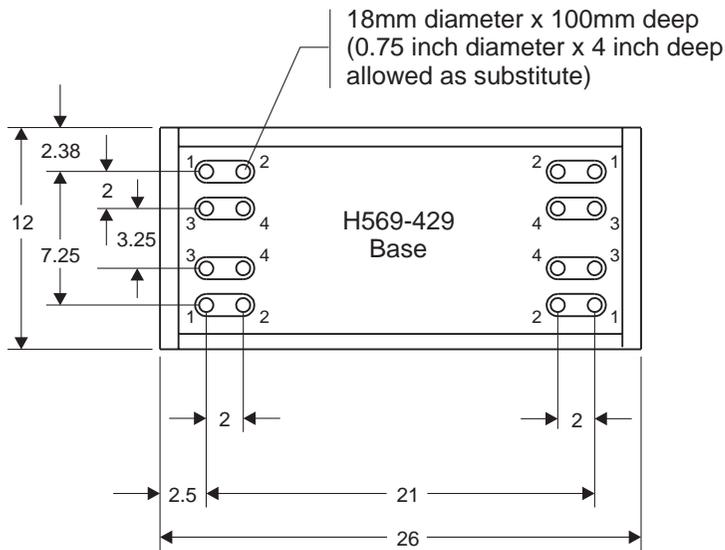


**Figure 4-2B: AC Distribution Wall Mounting Configuration**

**Bolting Hardware** The Control and Distribution Bay contains the bolting hardware for mounting both the ac cabinet and Control and Distribution Bay to the floor. Figure 4-3 shows a typical floor mounting detail. Figure 4-4 is a floor-mounting template.



**Figure 4-3: Typical Floor Mounting Detail**



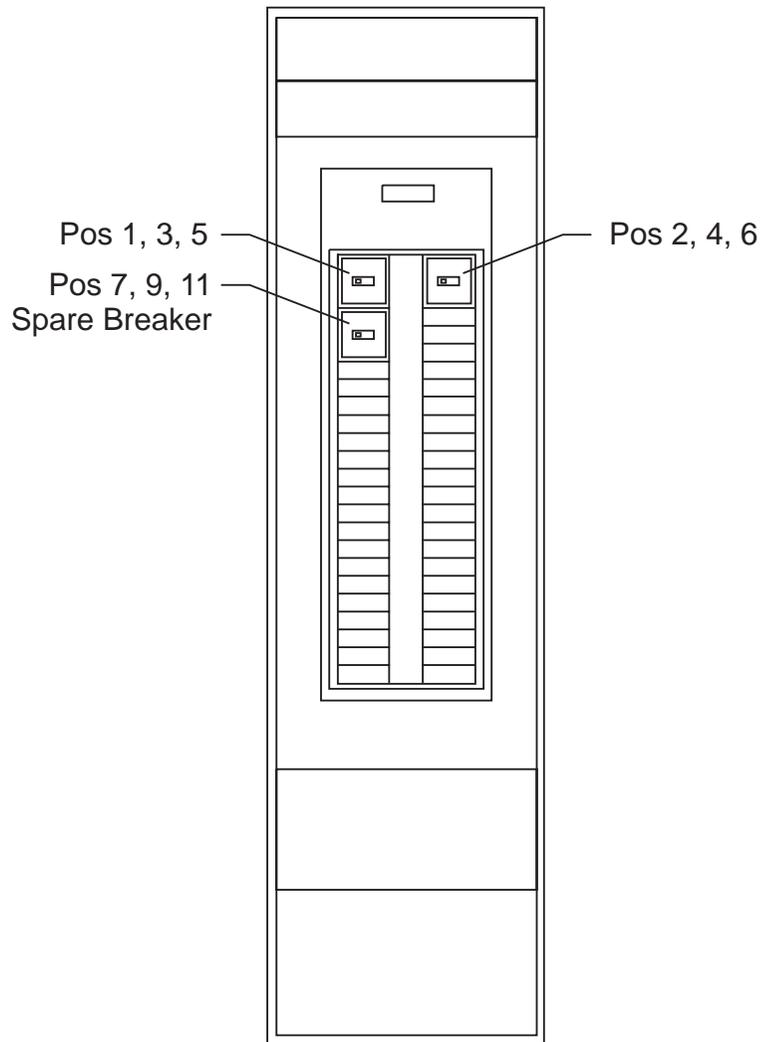
- 1 Concrete edge to hole center distance to be at least 2.5 inches.
- 2 Drill 4 holes, position 1. If interference in reinforced concrete occurs, use position 2, 3, or 4 in that order.

**Figure 4-4: Floor Mounting Template for Control and Distribution Bay**

All hardware for making electrical connections to the KS-22089 ac cabinets can be found inside the cabinet. The input ac lugs are not provided and must be furnished by the line engineer.

Follow local codes and NEC codes and requirements for connecting the service for the ac cabinets. (Service should be 100 amperes for 480 volts input and 200 amperes for 208 and 240 volts input.)

Three breakers are provided for each cabinet, and Position 7, 9, 11 is a spare in case of a failure. See Figure 4-5.

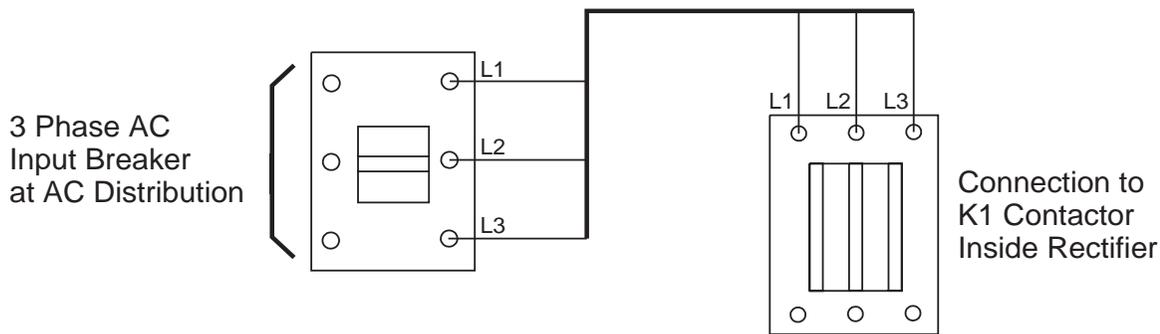


**Figure 4-5: AC Breaker Locations with Spare**

**Rectifier and AC Connections**

Connections between the ac cabinet and the rectifiers are 6-gauge for 480Vac service. The connections for the 208 or 240 Vac are 4-gauge. The installer must follow all local municipal codes and NEC codes and requirements. Figure 4-6 shows the connection of the ac to the rectifier.

Connect the appropriate gauge wire to the rectifier from the ac cabinet, per job specifications. Lugs for connecting to the rectifier are located in the hardware kits. (Refer to T-83360-30, Sheet D2 for appropriate connectors.)



**Figure 4-6: Connecting the AC to the Rectifier (K1 Contactor)**

**Rectifier Output Connections**

Use two 4/0 cables for the output of the rectifier to the Control and Distribution Bay, one for the + output, and one for the return. When Group 23 is ordered, the 4/0 cable is supplied with the ladder rack for each rectifier.

**Caution**

Be sure the rectifier's output breaker is **Off**. Be sure no control cables are connected to the rectifier.

Refer to sheet D3 of the H569-429 drawing for connections in the Control and Distribution Bay. Each bus bar is marked as Charge Bus, Charge Return, or Discharge Return Bus.

**Alarms**

All rectifier alarms are prewired at the factory. Office alarms should be connected to the rear of the Galaxy Controller. Form C contacts are provided from the Galaxy Controller with Normally Closed (NC) or Normally Open (NO) contacts. Refer

to the Galaxy Controller product manual for alarm connections to the customer's panel.

***Control and  
Distribution Bay  
Connections***

Output from the Control and Distribution Bay uses KS-24194, L13 Red with trace ("A" Plant), and Blue with trace ("B" Plant) braided 2-gauge wire.

Circuit breakers in the Control and Distribution Bay should be left in the **Off** position. For circuit breaker operation, use the precharge circuit. Refer to paragraph "PDF Precharge Procedure" in the *System Testing* section.

The List K1 Return Bus Bar Kit is to be mounted either on a ladder rack or on top of the PDF Bay. Refer to the PDF Bay product manual. The filter panels and precharge circuits are prewired in the factory. Only their ground connections are required to be wired in the field. Follow normal procedures for installing the PDF Bay.

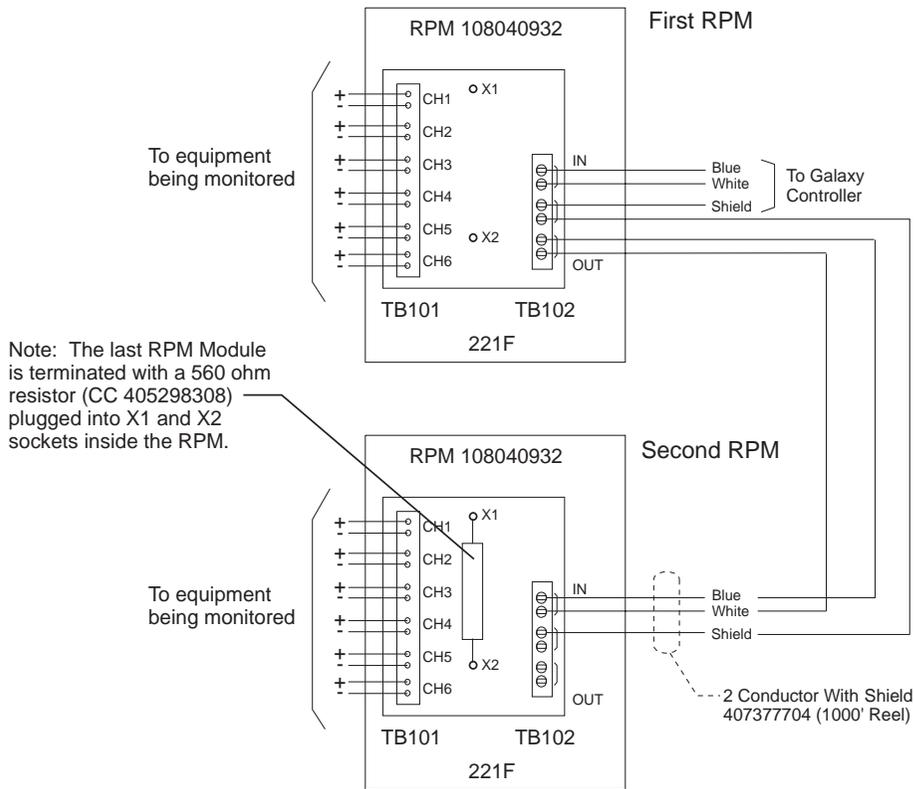
Connect the grounds from the filter panels to the K1 Return bus Bar Kit and one ground to the Modutec Ammeter, pin 2. See Sheet D4 of the T-83360-30 drawing.

Connect the 4ESS loads to the PDF Bay according to SD4A008-02 instructions.

***RPM Connection***

Connect to the RPMs using the 407377704 shielded cable. (See sheet D6 of the T83360-30 drawing for connections to the Galaxy Controller 847264348 circuit board.) The Blue and White wires are connected to the input (See Figure 4-7). Connect the shield to the first input shield return. Add the 560 ohm resistors to the last RPM. (Resistors are provided in the documentation package shipped with the product.)

Connect the RPM of the first PDF bay by placing the first cable from the Galaxy Controller to TB102, labeled IN. The second cable to the next PDF is connected to the bottom of TB102, labeled OUT. Inside the RPM there are two switches, SW1 and SW2. For the first PDF, set SW1 to "0" and SW2 to "1" (address 01). For the second PDF, set SW1 to "0" and SW2 to "2" (address 02). The second, or last, RPM requires the 560-ohm terminating resistor that is connected by plugging the leads into X1 and X2 pins (see Figure 4-7). For further information, see the Galaxy Controller product manual.



**Figure 4-7: Connections for the RPM**

**Battery String Protection Module Alarm Connections**

Make connections to the ED83146-30 G1 battery string protection module alarm by connecting the 202A terminal of the battery string protection module alarm to one of the terminals marked E1, E2, and E3 on the BNF2 board located in the top panel of the Control and Distribution Bay. E1 should be connected to string 1, etc. The return is connected to the battery return and is jumpered from the battery return to the alarm terminal of the fuse. The E1 through E3 terminals are 0.25" spade, quick-connect terminals. Stranded 22 AWG wire is recommended for the connection. The 202A terminal is accessed by removing the two screws and cover from the ED83146-30 G1 module.

The battery string protection module has a 600-ampere fuse in parallel with a 70G-type fuse. When the 70G operates, the alarm contact is closed. When closed, one side of the alarm contact is connected to battery return, the other is in series with an LED and is connected to +48 volts through a resistor. This completes a circuit that causes the LED to light and an alarm to be issued.

**Battery String  
Alarm  
Connections**

The Battery String Protection Fuse Alarm connection was designed for ease of installation. Use 22-gauge stranded wire to connect the alarm from the BNF2 board to the ED83146-30 G1 protection fuse with a single wire connection.

The connections at the BNF2 alarm board at the top of the H569-429 Control and Distribution Bay have quick connect, wire crimp, push-ons for ease of installation. The connection is current limited by the R10 resistor on the circuit board. The connection at the battery protection fuse has a 202A terminal for terminating the connection. It is easily accessed by removing the two screws and removing the cover from the ED83146-30 G1. The Battery Fuse Alarm connections at the BNF2 board are marked E1, E2, or E3. Each connection is for one battery string. The connections are common on the circuit board so that if any negative return is applied to any E1, E2, or E3, it will issue an MJF alarm and an Open String alarm.

The Battery String Protection Module has a 600-ampere fuse with an LED and a 70G-type fuse indicator that is used to indicate a blown fuse. The module is mounted to the battery stand with Kit 847936192 and mounted on the negative side of the battery return.

**Miscellaneous  
Connections**

Connect the rectifier sense cable (847821907) to the Control and Distribution Bay BNF2 alarm board located inside the top panel of the Bay. Refer to Sheet D5 of the T-83360-30 drawing for connections.

**Rectifiers**

Refer to the rectifier product manual for power up of the rectifiers.

**Enhanced  
Ground Current  
Monitor**

Follow this procedure to install the Enhanced Ground Current Monitor (EGCM).

1. Identify the ground lead between the Plant Discharge Return Bus Bar and the CO Ground. This should be a 1/0 cable.
2. With a dc clamp-on ammeter, verify that the cable identified in Step 1 is carrying less than 500mA. If a current flow greater than 500mA is detected, it must be eliminated before proceeding.

3. Prepare an appropriate length of 1/0, stranded, green-color cable and half-tap this cable to the ground cable in proximity to the EGCM.
4. Install the EGCM on the cable rack above the Control and Distribution Bay in a location where the display can be easily observed.
5. Pass the 1/0, stranded, green cable through the sensor opening and connect it to the plant discharge return bus bar.
6. Verify that continuity exists in the half-tapped cable from the half-tap to ground.
7. Use the KS-21652 L3 Cover to cover the half-tap.
8. The ground fault monitor is connected to the Galaxy BJT1 board. Connections are from TB3 of Galaxy to TB1 of the EGCM. This supplies the 48 volts needed to power the EGCM. Connect the red wire from Pin 46 of the TB3 terminal block of the Galaxy to the EGCM terminal labeled “-48V RTN”. Connect the black wire from the discharge return bus to the “-48VDC” terminal on TB1 of the EGCM. This connection is made to a 0.25" spade, quick-connect terminal located on the discharge return bus.

**Notes:**

- a. **The ABS2 circuit must be protected by a 1-1/3 ampere fuse in the BJF4 fuse board.**
  - b. **A red, 20 AWG wire is used to connect +48 volts to the EGCM from the Galaxy, and a black 20 AWG is used to connect the -48Vdc return to the EGCM from the discharge return bus.**
9. Four independent sets of alarm contacts are provided at Terminal Strip TB2 on the EGCM. These must be connected to alarm points as specified by the engineer and/or the customer.
  10. Allow fifteen minutes warm-up time, then verify the display reading by comparison with a digital clamp-on ammeter reading of the ground current. Adjust the offset control multi-turn potentiometer on the front of the control

unit until the display matches the clamp-on ammeter reading. See Step 2 of this section.

11. The EGCM has its own scan point, OAOO, in the 4ESS™ office alarm system.



## 5 *System Testing*

### ***Test Equipment Required***

The following equipment is required to test the 415B Battery Plant:

- 300 watt test load – 2 amperes @ 150 volts
- 90 kilowatt load box – 600 amperes @ 150 volts  
[(3) ITE – 5317 load boxes may be used]
- DMM (digital multimeter) with 4-1/2 digit display and 0.05% accuracy or better
- Calibrated clamp-on DC current meter (0.1 ADC sensitivity)
- Battery Plant Simulator Test Set (ITE-7102)
- Standard installation tools, screwdrivers, etc.
- J87132B-2 Rectifier product manual
- Galaxy Controller for 415B Battery Plant product manual
- Rubber gloves
- Windows-based personal computer (PC) with EasyView software installed
- Cable to connect PC communication port to local port of the controller

### ***Power Up of 415B Battery Plant***

1. Perform the following verification checklist:
  - The frames of all cabinets are properly grounded.
  - The ground from return to CO Ground through the Enhanced Ground Current Monitor is installed correctly.

- The ac equipment ground is properly connected to each rectifier.
- The correct ground cable gauge has been used (minimum #6 for rectifier, #2 for Control and Distribution Bay).
- The Enhanced Ground Current Monitor has been properly connected and its alarm contacts have been connected.
- Each 415B PDSC cabinet is fed from a circuit breaker, separated both physically and electrically for diversity (refer to Figure 2-1). Check that both PDSC ac cabinets are wired for the correct voltage.

- The PDSC ac cabinet has two lists, one to accommodate 208/240 Vac and one to accommodate 480Vac:

208/240	Floor mounted	KS-22089, L4003
208/240	Wall mounted	KS-22089, L4183
480	Floor mounted	KS-22089, L4013
480	Wall mounted	KS-22089, L5183

- The rectifier list number must match the ac input voltage provided by the ac distribution panels:

List 1 - 208Vac, L310 breaker  
List 2 - 240Vac, L310 breaker  
List 3 - 480Vac, L606 breaker

- At both PDSC ac cabinets, check that the neutral conductor of ac input is not connected to the ground conductor.
- Examine each PDSC and rectifier for loose power connections and check that correctly-sized cables have been installed as specified in the job specifications.
- Examine each bay for sharp corners and burrs, and modify as appropriate.
- Check for conductor clearance within each bay. Pay special attention inside the rectifier, especially clearance associated with the high power or high voltage

components, i.e., transformers, inductors, capacitors, etc.

- On both Power Distribution Frames, check that RPMs have been properly installed and that dip switches have been properly set and wired.
- Check that all fuses have been removed at both Power Distribution Frames.
- Refer to the switch setting table inside the rectifier door and check that the DIP switches on the 208G circuit module have been set correctly. The switch settings are set during manufacture to the default values shown in Table 5-A.

**Table 5-A: DIP Switch Default Settings for 208G Circuit Module**

Switch	Function	Setting	Description
S203.1, .2, .3, .4	BUHVSD	All OFF	163V default setting
S205.1, .2	ISHVSD	Both ON	160V default setting
S205.3	Local Equalize Disable	ON	Used to set equalize output voltage
S205.4	Meter	ON	Meter off with unit off
S205.5	Meter Calibrate	OFF	Allows calibration of front panel meter
S205.6, .7, .8	Meter Calibrate	All OFF	Off -- used for factory test only

- Verify that the ac input POWER switch on each rectifier is **Off**.
  - Assure that the rectifier output breaker is **Off** on all rectifiers.
2. Remove REG fuses for all rectifiers. They are located at the top of the Control and Distribution Bay.

3. Verify that all alarm cables J202 are *disconnected* at the 208G boards inside all rectifiers. The other end is still *connected* at the back of the Galaxy Controller.
4. Verify that all the remote sense cables J208 are still connected at both the Galaxy Controller and at all 208G boards in the rectifier.
5. Check that Battery Disconnect Switches (on Control and Distribution Bay) are **Off**.
6. Make sure load boxes are turned off and at no load, then connect the load boxes between the Charge and Discharge Return buses.
7. Verify that the battery voltage and polarity at the top of the Control and Distribution Bay is correct, i.e., “+” on the switch bus bars and “-” on the Charge Return bus.
8. Operate battery disconnect switch(es) to the **On** position, which connects power to the Control and Distribution Bay. Result: the converters in the Control and Distribution Bay should power up the Galaxy display, and, after a short delay, the display will indicate battery voltage. The Galaxy will also indicate any alarms that are present.

**Note: Ignore alarms at this time.**

9. At each ac cabinet, turn on the ac circuit breakers, then test them by pushing the trip button to verify proper operation. After testing, turn on the breaker by turning to full **Off** position, then back to **On**.
10. Turn on the rectifier power switch of Rectifier #1. Adjust rectifier output voltage to 151.9 volts.
11. Close the dc output circuit breaker of rectifier #1 following the procedure outlined on the label above the breaker.
12. Turn off rectifier. (Use the Power ON/OFF switch at rectifier.)
13. Install REG fuse.
14. Repeat Steps 10 through 15 for all rectifiers.

15. Verify that all rectifiers are off before proceeding.
16. Reconnect ALL alarm cables J202 at the 208G boards for all rectifiers.
17. Place a 20-ampere load on the battery plant; turn the ac power switch on rectifier to **On** and adjust its output to 151.9 volts.
18. Turn off rectifier and load.
19. Repeat Steps 19 and 20 for all rectifiers.
20. Turn all rectifiers on with 20 amperes still applied. Wait until batteries are charged and draw less than 5 amperes at the rectifier displays.
21. At PDSC A1 (or B1), open ac circuit breaker #1. Verify that power has been removed from the appropriate rectifier (refer to Figure 2-1).
22. Operate breaker to **On** after test.
23. Repeat Steps 23 and 24 for all assigned circuit breakers in both ac cabinets associated with the plant PDSC A1 or B1.

### ***Control and Distribution Bay Precharge Procedure***

Precharge each capacitor of the Power Distribution Frames by following these steps:

1. Turn the rotary switch on the Control and Distribution Bay distribution panel to the first position.
2. Press and hold the precharge button on the distribution panel. Notice that the red LED will be on momentarily.
3. Close Circuit Breaker #1, then release the precharge button.
4. Repeat Steps 1 through 3 until all circuit breakers have been operated to the **On** position.
5. Verify that all the green LEDs on the Power Distribution Frames are lit.

**Note**

Circuit Breaker #1 also provides power for the alarm circuit.

***Pre-test Setup***

These system test procedures are based on the assumption that all installation work has been completed, battery strings have been initially charged, and no working loads have been connected to the battery plant.

Plant loads will be simulated through the use of a test load box. Verify that spare fuses for each of the components of the battery plant are available and accessible. Do not overlook the fuses associated with the battery strings.

***Rectifier Tests***

Before performing the system test procedures, complete individual rectifier tests by following procedures in the rectifier product manual,

**Note**

At this point all rectifiers are on and the plant is connected to the battery and to the Power Distribution Frames. The test load is connected.

***System Test Procedures***

**Warnings**

A limited recharge alarm may occur at the Galaxy Controller during these tests.

Whenever rectifiers have been turned on, their output filter capacitors stay charged for several minutes. Do not place hands inside a rectifier until these capacitors have discharged to a safe level (below 50 volts).

Remember that this is a 140V (nominal) battery plant. Personal safety must be considered at all times while working on this plant. The batteries will be floating at 151.9 volts.

When power is removed from the rectifier, the display may stay lit until the dc output voltage is less than 30 volts.

***Rectifier Walk-in***

1. With only one rectifier turned on, adjust the battery plant load to be 130-140 amperes. The rectifier assumes full load.
2. Turn the rectifier off via the POWER switch; wait 5 seconds, then turn it back on. The rectifier walks in and assumes full load within 10 seconds.
3. Turn the POWER switch to **Off**.
4. Repeat Steps 1 through 3 for all rectifiers (one rectifier on line at a time).

**Note**

Always open the load between tests to keep batteries from discharging.

**Note**

Alarms may be present in the Galaxy Controller. Overlook them during this test.

***Current Limit Adjustment***

1. With two rectifiers turned on and on line, set plant load to be 170-180 amperes.
2. Set both rectifier voltage outputs to be 151.9 volts so that they share the load as much as possible.
3. Operate the rectifier NL/FL switch to FL (Full Load) on one of the rectifiers. The rectifier should assume a  $140 \pm 2$  ampere load. If it does not, adjust R488 (counter-clockwise to lower, clockwise to raise) on the 208G circuit pack until it does.
4. Operate the rectifier NL/FL to NL (No Load). The rectifier sheds most of its load and the other rectifier picks up most of the load.
5. Repeat Steps 1 through 4 for all rectifiers, always having two rectifiers on line, until all current limit set points are verified to be  $140 \pm 2$  amperes.
6. Turn off load box. (Reduce load to zero amperes.)

***Output Voltage  
Adjustment  
Range***

Before making the Output Voltage Adjustment, follow these preliminary steps:

- Turn off all rectifiers.
- Operate Battery Disconnect Switches to **Off**.
- Disconnect the control cable J202 at each 208G board on each rectifier.
- Remove the REG fuse for all rectifiers from alarm panel on Control and Distribution Bay.
- Make sure there is no load on the rectifier.

To make the Output Voltage Adjustment, follow these steps:

1. With one rectifier on line, set the load at 20-30 amperes.
2. Adjust the output of the rectifier up and down and observe that the output voltage is adjusted smoothly in less than 0.1-volt steps.
3. The rectifier should be capable of being adjusted between 140 and 158 volts.
4. Return the rectifier to float voltage (151.9 volts).
5. Turn the rectifier off.
6. Repeat Steps 1 through 5 for all rectifiers.

***Rectifier Alarms  
and High Voltage  
Shutdown***

This test verifies that each rectifier shuts down and issues a Rectifier Fail Alarm (RFA) for each of the following conditions:

- When a rectifier fuse clears on the 329B fuse board
- Backup high voltage shutdown (BUHVSD) operates
- Internal selective high voltage shutdown (ISHVSD) operates

Perform the following procedures before continuing test:

- Turn all rectifiers to the **Off** position via the ON/OFF power switch at the rectifier.
- Remove all control (J202) and REG (J208) cables at the 208G board in all rectifiers.
- Turn all battery switches to the **Off** position at the Control and Distribution Bay.

**FA Test**

1. Replace a fuse on the 329B (CM1) board with a blown fuse. Turn on the rectifier via the ON/OFF power switch. The rectifier shuts down immediately and the RFA and FA LEDs should light on front of the rectifier.
2. Turn off the rectifier via the ON/OFF power switch.
3. Repeat Steps 1 and 2 until all five fuse positions on the 329B have been tested and verified.
4. Turn off the rectifier via the ON/OFF power switch. Replace the blown fuse with a good fuse.

**BUHVSD**

5. Set load to 10-20 amperes.
6. Turn on the rectifier via the ON/OFF power switch, and record the voltage on the display. This recorded voltage will be used to reset the rectifier in Step 11.
7. Set the load to 2 amperes and adjust to 161.5 volts. Observe that the rectifier remains operational.
8. Increase the voltage by depressing the **RAISE VOLTAGE** pushbutton to 164.5 volts. Within 20 seconds the rectifier will shut down and the red RFA led will light.
9. Turn off the rectifier and lower the voltage via the **LOWER VOLTAGE** pushbutton by depressing the switch for approximately five seconds.

**ISHVSD**

10. Set load to 15 amperes (minimum) and adjust the output voltage to 158.5. (Wait 30 seconds). The rectifier should not shut down. Increase the voltage to 161.5 volts. Within

20 seconds, the rectifier will shut down and issue an RFA. Shut the rectifier off via the ON/OFF power switch, and lower the voltage by depressing the **LOWER VOLTAGE** pushbutton for approximately five seconds.

11. Turn the rectifier back on via the ON/OFF power switch. Set the load to 10-20 amperes and adjust the output voltage to the recorded voltage made in Step 6. Turn off the rectifier via the ON/OFF power switch.
12. Repeat test procedure steps 1 through 11 for all the rectifiers.

After completing these test procedures, follow these final steps:

- Remove all load.
- Reconnect the control (J202) and REG (J208) cables to the 208G board of each rectifier. Reinstall the REG fuses.
- Turn on all rectifiers and wait 10-20 seconds.
- Operate the battery disconnect switch to **On** for each position that has a battery string connected to it.

***Rectifier Equalize  
Adjustment (on  
Battery)***

1. Set the plant load to zero.
2. Turn off all rectifiers via their POWER switches.
3. Remove control cable J202 ONLY from each rectifier at the 208G board.
4. On the 208G circuit pack of each rectifier, operate DIP switch S205.3 to **Off**. This will enable local equalize in each rectifier.
5. Turn one rectifier **On** via the POWER switch.
6. Set the plant load to 10 - 20 amperes.
7. Operate the Float/Equalize switch on the front of the rectifier to EQUALIZE. Adjust the rectifier output voltage to 156 volts.
8. Operate the Float/Equalize switch to Float.

9. Turn the rectifier **Off** via the POWER switch.
10. Disable local equalize by operating DIP switch S205.3 to **On**.
11. Repeat Steps 5 through 10 for all rectifiers.
12. Remove load. Reconnect control cables J202 to each rectifier at 208G board.

Upon completion of this procedure, turn all rectifiers **On** with the POWER switch.

***AC Failure Test***

The purpose of this test is to assure that no Rectifier Fail Alarm (RFA) is generated under the most stringent ac failure circumstances.

This test is performed with all rectifiers on line and a set load on the battery plant. Set load according to Table 5-B for test depending on how many rectifiers are present.

**Table 5-B: Load Settings for AC Failure Test**

<b>Number of Rectifiers in Plant</b>	<b>Load Not Less Than</b>
2	100
3	200
4	300

1. Open the ac circuit breaker feeding the PDSC that is powering the rectifier under test. The rectifier will shut off.
2. Verify that no rectifier failure alarm (RFA) is initiated.
3. Close the circuit breaker previously opened.
4. The rectifier returns to normal.
5. All alarms clear.
6. Repeat Steps 1 through 5 with less than 50 amperes load for all rectifiers in plants. A momentary PHA may occur,

then an ACF, when power is first removed. Observe that the ACF LEDs on the rectifiers light while ac is failed.

7. Restore the system to normal by closing all breakers previously opened.

## ***Galaxy Controller***

The Galaxy Controller for the 415B Battery Plant is ordered as J85501F-1, L4. Table 5-C lists the circuit packs furnished with the controller.

**Table 5-C: Circuit Packs/Kit Furnished with the Galaxy Controller**

Power Supply	BJJ1
Independent Controller	BJB2
Intelligent Controller	BJH3
Remote Peripheral Monitor (RPM) Interface	BJM1
Fuse Board	BJF4
Terminal Board	BJT1
Display	BJG1
Alarm Board	BJE1
Rectifier Interface	BJC1
Basic Power Board	BJA1
Battery Reserve Time Prediction Kit	K1

Table 5-D lists the optional circuit packs/kits.

**Table 5-D: Optional Circuit Packs for the Galaxy Controller**

Modem	BJL2
Data Switch	BJK1

The Galaxy Controller is configured at the factory. Refer to the section on *Configuration* in the Galaxy Controller product manual (Select Code 167-792-122).

The following list gives some of the more important Galaxy information that is needed in order to check the configuration.

Rectifier	J87132B-2
Plant Shunt	600 amperes @ 50 mV
High Voltage Shutdown	156.5V
Boost High Voltage Shutdown	160V
Backup High Voltage Shutdown	156.9V
High Float Warning	155.5V
Rectifier on Threshold (ROT)	130V
High Float Warning (Boost)	159V
Battery on Discharge (BD)	149V
Battery on Discharge (BD Boost)	149V
Very Low Voltage (VLV)	133V
Power Distribution Frame Shunts	150 amperes @ 50 mV
Float Voltage	151.9V
Boost Voltage	156V

**Note**

The "Boost" voltage level is equal to 2.23 volts per cell, or 156 volts.
--

After configuration has been checked and values confirmed as indicated above, proceed to the next section.

***Galaxy Readouts***

1. Using the digital multimeter, read the plant voltage at the test jacks, which are located at the top of the Control and Distribution Bay. Compare this voltage with the Galaxy Controller voltage on the front panel readout. If the readouts do not agree to within  $\pm 0.1$  volt, adjust the Galaxy to agree, utilizing the ADJ PLV function under the CONFIGURE and PLANT menus. Return the display to normal by pressing the MENU button.
2. Connect the digital multimeter across the plant shunt at the top of the Control and Distribution Bay. Place a 240-260 ampere load on the plant. Remember that each millivolt read across the shunt equates to 12 amperes load ( $\pm 2\%$ ).
3. Compare the shunt load reading with the Galaxy front panel load reading. If they do not agree to within  $\pm 1$

ampere, adjust Galaxy to agree with the shunt readings, utilizing the ADJ PLI function under the CONFIGURE and PLANT menus. Restore the plant to normal via the MENU key.

4. Remove load.

***DC/DC  
Converters***

Mounted below the Galaxy are two (redundant) converters that supply its power. They convert the 140Vdc battery voltage to 48Vdc. The converters are located behind the front panel.

1. Remove converter #1 circuit pack and observe that Galaxy does not lose power. Also observe that CONV 1 FAIL LED (red) lights and extinguishes as circuit pack is removed. Check that a minor alarm is received at Galaxy. Replace the converter #1 circuit pack.
2. Repeat Step 1 for converter #2.

***Galaxy and  
Rectifier  
Interface Leads***

For this series of tests, set the load to 10 to 20 amperes. The batteries should be connected to the load.

***Rectifier Fail  
Alarm (RFA)  
Leads***

1. Turn off rectifier. Replace fuse on the 329B board with a blown fuse. Turn on the rectifier. Verify that the rectifier shuts down and that there is an RFA and a Minor alarm indication at Galaxy. Also verify that Galaxy sends a Power Minor (PMN) alarm, i.e., that the alarm is remotod.
2. Restore the rectifier to normal.
3. Repeat Steps 1 and 2 for all rectifiers.

***AC Fail (ACF)  
Leads***

1. Remove ac from rectifier #1 by opening its ac input circuit breaker at the PDSC. Verify that there is a minor alarm at Galaxy and that a PMN alarm is sent from Galaxy.
2. Restore ac to rectifier #1.
3. Repeat Steps 1 and 2 for all rectifiers.

**PH Leads** This test is done with the battery connected to the Control and Distribution Bay and with 10 - 20 amperes of plant load with all rectifiers on.

**Warning**

Extra care should be taken while performing the following test. It requires removing a phase of the incoming ac. Before performing any operation, use a DMM to verify the circuit is not live.

**Wear rubber gloves.**

1. Open ac breaker at PDSC for rectifier #1.
2. At a convenient location, e.g., at the rectifier input, remove one ac phase powering rectifier #1.
3. Insulate the open lead at the side coming from the PDSC.
4. Turn on the breaker at the PDSC.
5. Verify that the rectifier has an alarm and does not cause an RFA, the PH LED lights at the rectifier, and that minor, rectifier, and ac alarms are present at Galaxy.
6. Open the ac circuit breaker at the PDSC for the rectifier under test.
7. Remove insulation installed in Step 3 and restore the ac phase removed in Step 2.
8. Close ac breaker at PDSC that powers the rectifier under test.
9. The rectifier restarts and all alarms clear.
10. Repeat this procedure for all rectifiers.

**CB Leads**

1. Turn off rectifier #1 and open the output dc circuit breaker on the rectifier.
2. Remove the REG fuse to the rectifier at the Control and Distribution Bay.

3. Open the ac breaker to the rectifier at the PDSC.
4. Verify that the voltage on the output capacitors is less than 50 volts. If not, wait until the voltage is less than 50 volts.
5. At the rear of the output circuit breaker, remove the pair of small gauge wires. These wires are used to send a trip signal from the breaker to the Galaxy.
6. Restore the ac to the rectifier, turn the rectifier on and short the two wires that were disconnected in Step 5.
7. Verify that a MIN alarm is displayed at the Galaxy, a PMN is sent from the Galaxy, and the rectifier turns off.
8. Turn the rectifier off, remove ac to the rectifier at the PDSC, wait until the voltage on the capacitors is less than 50 volts, and restore the wires previously disconnected from the rear of the breaker.
9. Restore the ac at the PDSC; turn on the rectifier output breaker using the procedure specified on the label above the breaker.
10. Repeat this procedure for each rectifier.

***MAN Leads***

This test is done with the battery connected to the Control and Distribution Bay, 10 - 20 amperes load, and all rectifiers on.

1. Turn off one of the rectifiers.
2. Verify that MIN and RECT alarms are displayed on the Galaxy and that a PMN is remoted.
3. Turn the rectifier on; the alarm should clear.
4. Repeat Steps 1 through 3 for all rectifiers.

***VI and VP Leads***

Refer to Section 7, *Glossary*, for the definitions of VI and VP.

1. Before adjusting the VI signal, locate the BJB board inside the Galaxy controller.

2. Verify that SW202 position #8 is at the “1” or “closed” position.

3. Configure the controller for rectifiers. You can configure the rectifiers from the front panel of the Galaxy by doing the following:

Press MENU→CONFIG→RECT DEF

Press ENTER; the display will now show:

RECT DEF

G01 (flashing)

Note: G01 represents rectifier one and you will see it flashing off and on.

Press ENTER; the display will now show

RECT 01

TYPE: UNCONFIGURED (flashing)

SHUNT mV: 50.00

MAN SW: NONE

Press ADJUST + or - to scroll through menu until J87132B-2 appears in TYPE.

Press ENTER to store information selected.

Press ESCAPE to return to RECT DEF and select G02 for rectifier two.

Configure rectifier number two the same as above and continue for all rectifiers.

Press ESCAPE to return screen back to main display.

After all rectifiers are configured, proceed to Step 4.

4. On the front of the Galaxy, follow the path  
MENU →MEAS→RECT

Press ENTER and all configured rectifiers will display their currents, i.e., G01 = 5, G02 = 7, etc.

5. Press ENTER to store and save the information.

**Note: Pressing ESCAPE returns the screen one level.**

6. With only rectifier #1 on line and carrying a load of approximately 70 amperes, measure the voltage at test points E101 and E102 of the 329B fuse board. Calculate the actual load on rectifier as follows:

The rectifier test points (shunt) will read 50 millivolts at 175 amperes. Each millivolt read on the meter is equal to 3.5 amperes of load. Calculate the load current from this reading. For example:

$$20\text{mV} \times 3.5 \text{ amperes per millivolt} = 70 \text{ amperes}$$

Compare the calculated load current with the current reading at Galaxy. The shunt reading should agree with the Galaxy reading. If not, proceed to Step 7. If the two readings agree, skip to Step 8.

7. Adjust R435 on CM2 of the rectifier to bring the reading on the Galaxy within tolerance.
8. Repeat procedure for all rectifiers.

### ***HV and RS Leads***

The following HV tests should only be performed with a test load and on battery.

1. With all rectifiers on line and a plant load of approximately 20-40 amperes, adjust output of rectifier #1 up until it assumes the total plant load from the other rectifiers. Continue raising its output voltage until the plant HFV (155.5 volts) alarm activates (RECT and MIN LEDs light).
2. Continue raising the output voltage until the rectifier exceeds the HV threshold of the Galaxy (156.5 volts). At this point rectifier #1 will shut down, allowing the plant voltage to drop back to float, and the remaining rectifiers will assume the load. After five seconds the rectifier under test will restart, assume the load once more, and shut down again from high voltage. This time the test rectifier stays shut down and an RFA alarm is present.
3. Reduce the output voltage of rectifier #1 and restart it from the Galaxy utilizing the path MENU→RECT RST.
4. Repeat the procedure for all rectifiers.

5. Adjust all rectifiers to a float voltage of 151.9 volts at the battery terminals.

***TR and TRH  
Leads***

1. At TB3, located at the rear of the Galaxy, short terminals 8 and 24 (TR1 and return). Rectifiers #1 and #2 will shut down while leads are shorted. Observe that Galaxy indicates that rectifiers #1 and #2 have been externally shut down. The path is MENU→ALARM. Remove the short and verify that the rectifiers restart.
2. Short terminals 9 and 24 (TR2 and return). Rectifiers 3 and 4 (if provided) shut down while leads are shorted. Observe that Galaxy indicates that rectifiers #3 and #4 have been externally shut down. The path is MENU→ALARM. Remove the short and verify that the rectifiers restart.

***Equalize/Boost  
Leads***

1. Apply a 20 - 30 amperes test load.
2. From front panel of Galaxy, activate Boost command. The path is MENU → MODE→ ENTER. Verify that each rectifier raises its output voltage to 156V.
3. Deactivate the boost command via the Galaxy. The path is MENU → MODE→ ENTER.
4. Verify that the rectifiers return to the correct float voltage.

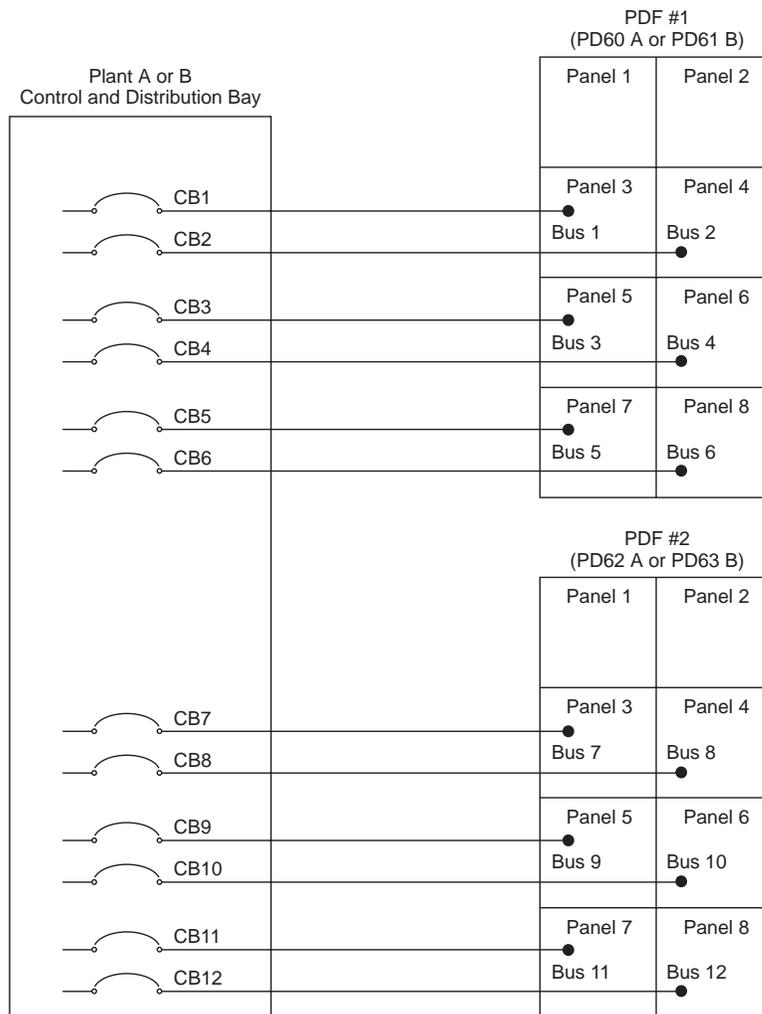
***Control and  
Distribution  
Bay***

***Circuit Breaker  
Panel***

There are two Power Distribution Frames for each Control and Distribution Bay. The first six circuit breakers feed Power Distribution Frame #1 and circuit breakers 7 - 12 feed Power Distribution Frame #2. See Figure 5-1. Each circuit has a 150 amp, 50mV shunt associated with it that is located in the Power Distribution Frame.

1. Precharge the Power Distribution Frame buses as follows:
  - a. Rotate the CAP/CHG rotary switch to circuit #1.

- b. Depress the CAP/CHG pushbutton switch; the red LED lights, then extinguishes.
  - c. With the CAP/CHG pushbutton switch depressed, operate circuit breaker #1 to the **On** position.
  - d. Release the pushbutton switch.
2. Check that the appropriate bus is powered at the Power Distribution Frame. A green LED on the front of the Power Distribution Frame will light, indicating the bus that has been energized. Refer to Figure 5-1.
  3. Repeat Steps 1 and 2 for all circuit breakers that are electrically connected to the Power Distribution Frames.



**Figure 5-1: Circuit Breaker Feeds to Power Distribution Frames**

## **Miscellaneous Alarms**

### ***BD and VLV Alarms***

1. With all rectifiers off, apply a 100-ampere test load to the plant. Observe the plant voltage on the front panel of the Galaxy. Verify that the BD alarm is generated at  $149 \pm 1$  Vdc. The Battery on Discharge (BD) and a MAJ alarm will be displayed at Galaxy and a PMJ alarm remotod.

**Note: It may be necessary to use less than 100 amperes in order to accurately determine the BD alarm level.**

2. Turn all rectifiers on; set plant load to 400 amperes. Change the VLV setting on the Galaxy to  $143+1/-0$  volts using the path MENU→CONFIG→THRESHOLD.
3. Turn rectifiers off.
4. Allow batteries to discharge to threshold of Very Low Voltage (VLV). Verify that a VLV alarm is activated along with PMJ and critical at  $143 \pm 1$  volts.

**Note: It may be necessary to increase or decrease the load to verify the alarm level.**

5. Return rectifiers on line. Decrease load to 100 amperes. Verify that the alarms are retired after the voltage increases above  $143 \pm 1$  volts.
6. Using the path MENU→CONFIG→THRESHOLD, restore the VLV setting to 133 volts.

### ***Battery String Fuse***

1. With batteries connected and a 50 to 100-ampere load, insert or simulate a blown alarm fuse at battery string #1. The LED lights at the battery string fuse holder. External fuse major and OS MAJ alarms are generated, and BATT, DIST, and MAJ LEDs light on the Galaxy front panel. Verify that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center.
2. Repeat procedure for all battery strings.

**Battery String  
Disconnect**

This test is done with all rectifiers on and at no load.

1. At the Control and Distribution Bay, operate battery disconnect switch #1 to **Off**. OS and MAJOR alarms are initiated and displayed at Galaxy. A red lamp lights at the top of the Control and Distribution Bay. Verify that the Open String alarm is initiated and that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center. Press MENU→ALARMS at the Galaxy front panel.

**Note: Be sure to return the battery switch to On after completing the test.**

2. Repeat the procedure for each battery switch connected to a battery string.

**Note: Battery Switch One is factory connected. When installing a 2nd or 3rd battery string, the 2nd or 3rd battery Auxiliary switch must have the blue wires connected to activate the alarm when switch two or three is placed in the Off position.**

3. Verify that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center.

**Control and  
Distribution Bay  
Fuse Alarms**

This test is done with all rectifiers **On** and a 10 - 20 amperes load. REG fuses are located on the top panel of the Control and Distribution Bay. There are four REG fuses (Minor) and one controller fuse (Major).

1. Place a blown fuse in all REG fuse locations (one at a time) on the Control and Distribution Bay. Observe and verify that rectifiers #1 through #4 issue a DIST and MIN alarms.
2. Verify that a local RFA alarm is issued, visual and audible Local Office alarms are initiated, and a remote alarm has been received at the Alarm Center.
3. Place a blown fuse in the CONTROLLER fuse position. Observe and verify that Galaxy LEDs BD, BATT, DIST, CRIT, and MAJ light.

4. Verify that local MJF and RFA alarms are issued, visual and audible Local Office alarms are initiated, and a remote alarm has been received at the Alarm Center.

***Power  
Distribution  
Frame Fuse  
Alarms***

Power Distribution Frame alarms are not sent to Galaxy. A red lamp will light at the top of the Power Distribution Frame and alarms sent to the local alarm circuit. Alarms may be monitored at terminal blocks beneath the stile strip at the front of the Power Distribution Frame or by the local alarm circuit if it is wired.

1. Verify that the ABS power of PDF #1 is furnished from PDF #2. This connection is located at the top of the Power Distribution Frame, labeled Terminal E4.
2. Verify that the ABS power of PDF #2 is furnished from PDF #1. This connection is located at the top of the Power Distribution Frame, labeled Terminal E4.
3. Place or simulate a blown fuse in each active fuse position.
4. Verify that the local alarm is generated.

**Note**

The Power Distribution Frame alarms are not wired to the Galaxy, but are wired directly to the 4ESS™ scan points.
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***Battery Plant  
Overall  
Operation Tests***

**Note: For this procedure, full load is 240 amperes if three rectifiers are installed and 360 amperes if four rectifiers are installed.**

***Energy  
Management  
(Efficiency)  
Algorithm***

1. Before testing the energy management algorithm, locate the BJH board inside the Galaxy controller, and:
  - a. Enable SW204 position #1 to the “1” or “closed” position.
  - b. On the front of the Galaxy, follow the path: MENU→CONFIG→RECT CTR→EFFIC and then enable the energy management algorithm by pushing the (+) button.
  - c. Press ENTER to store and save the information.

**Note: Pressing ESCAPE returns the screen one level.**

2. Place all rectifiers on line at float voltage and apply full load. Record plant voltage. In ten minutes a rectifier will turn off. Record plant voltage.
3. Decrease the load to 90% of two rectifiers or 240 amperes. In ten minutes another rectifier will turn off. Record plant voltage. (Skip this step if there are three rectifiers in the plant.)
4. Decrease the load to 90% of one rectifier, about 120 amperes. In ten minutes another rectifier will turn off. Record plant voltage.

**Note: One rectifier remains on at this point.**

5. Increase the load to 160 amperes. A second rectifier turns on immediately. Record plant voltage.
6. Increase the load to 300 amperes. A third rectifier turns on immediately. Record plant voltage.
7. Decrease load to 120 amperes. Wait until only one rectifier is on. Record plant voltage.
8. Apply 80% of rectifier capacity to the plant. All rectifiers turn on. Record plant voltage. Remove load. Record plant voltage.
9. Review all of the plant voltage readings taken in this section. All readings should be within  $\pm 0.7$  volts of 151.9 volts.

***Power  
Distribution  
Frame Shunt  
Monitors***

Before performing these tests:

- Be sure that no telecommunication loads are being powered from the Power Distribution Frame.
  - Using EasyView, configure the RPMs that are connected.
  - Have access to 1-ampere and 20-ampere test loads.
1. Verify that the RPMs are flashing, indicating that the Galaxy is communicating with the RPMs. If the RPMs are not flashing, check the connection to the Galaxy and the wiring from the RPMs to the Galaxy.

2. Apply a 1-ampere test load to the output of a fuse position on the Power Distribution Frame.
3. Insert the Power Distribution Frame load charge probe into the slot of the alarm fuse associated with the fuse position. The charge probe is keyed and must be inserted only one way.
4. Depress the CHG/CAP button and verify that the red LED on the charge probe is on.
5. Continue to hold the CHG/CAP button until the yellow FAIL LED lights.
6. The yellow FAIL LED lights between 8 and 15 seconds.
7. Release the CHG/CAP button, remove the charge probe, and return it to its holder on the Power Distribution Frame.
8. Reduce the test load to zero; install a 20-ampere fuse in the main fuse holder of the position under test.
9. Increase to 20 amperes the test load connected to the output of the fuse position under test.
10. Measure the shunt voltage. Multiply the shunt voltage by 3 and record this value of current. The reading on the ammeter of the Power Distribution Frame and the Galaxy reading of the Remote Peripheral Monitoring device should agree within  $\pm 5\%$  of the current recorded above.
11. Repeats Steps 8 through 10 for one fuse position on each fuse panel of both Power Distribution Frames, a total of 12 fuse positions.
12. Remove the load box.
13. Remove all fuses from the Power Distribution Frame.

### ***Battery Reserve Time Prediction Option***

Refer to Section 3, *Installation*, in the Galaxy Controller product manual and verify that the thermistor has been installed properly at the battery. Also, program the Galaxy Controller using EasyView, and set the end volts per cell to 1.8 volts.

1. Place a load of approximately 50 amperes on the plant. Turn off all rectifiers and verify that a BD alarm occurs. Allow the BD alarm to exist for a minimum of 15 minutes.
2. Referring again to the Galaxy Controller product manual, verify at the Galaxy front panel that a Battery Reserve Time Prediction has been made. Record the predicted reserve time.
3. Turn rectifiers back on and verify that the BD alarm is retired.
4. After the BD alarm has been retired, verify that another (higher) prediction has been made. Record the predicted reserve time.
5. Provide the customer's technician with the recorded data.

### ***Enhanced Ground Current Monitor (EGCM)***

Once installed and powered, the Enhanced Ground Current Monitor (EGCM) will display the current flowing through the ground cable. If the ground current exceeds the upper or lower alarm set points, an alarm will be initiated and the red alarm light on the display will be illuminated. Alarms are not latching; if the current drops below alarm limits, the alarm condition will clear. There is a 250 msec time delay; transient conditions may trigger alarms.

#### ***Checking and Setting the EGCM's Offset Control***

Required tools:

- Calibrated clamp-on dc current probe
  - Small slotted straight blade screwdriver (1/8")
1. Use the calibrated clamp-on current probe to measure the current flow in the ground lead.
  2. Verify that the polarity of the current reading on both the sensor and the clamp-on probe are the same.
  3. Adjust the multi-turn offset control on the EGCM so that the display and the current probe read the same current. The offset control potentiometer is located on the front of the control unit.

4. If the offset cannot be adjusted properly, refer to the calibration and/or repair procedure in the product manual that is shipped with the EGCM.

***Checking High  
and Low Alarm  
Set Points***

Alarm set points can be checked by pressing the POSITIVE and NEGATIVE alarm test buttons located on the display unit. Holding the test button down will change the current reading at a fast rate. Tapping the button will change the value slowly.

1. Hold the POSITIVE test button down until the current increases.
2. Eventually the high alarm set point is exceeded.
3. Verify that when the set point is exceeded, the red alarm is lit and an alarm is issued.
4. Verify the integrity of the alarm to the 4ESS™ scan point.
5. Hold the NEGATIVE test button down until the reading is below the low alarm set point.
6. Verify that when the set point is exceeded, the red alarm is lit and an alarm is issued.
7. After the test button is released, the display current will gradually return to the actual current reading.

***Life Test***

**Note: This test will take at least 16 hours.**

1. Be sure to follow the safety practices recommended in this document.
2. Upon completion of all of the above tests, connect a test load set to 0 amperes to the plant.
3. Turn on all rectifiers and verify that the plant voltage is set to 151.9 volts.
4. Set the load to 140 amperes per rectifier.
5. Record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.

6. Allow the plant to run at this load for at least 16 hours.
7. At the end of the allotted time, record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.
8. Reduce the load to 0 amperes and record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.
9. Remove the load. The plant is now ready to be connected to the office load.

### ***Heat Scan***

After one hour into the 16-hour full Load Test, perform a heat scan on the following connections using an Exergen or equivalent device:

1. Scan rectifier connections made in each power distribution service cabinet (PDSC) during the installation process.
2. Scan ac and dc connections in each rectifier made during the installation process.

# 6 *Connecting Telecommunication Loads to the Power Distribution Frame*

## *Capacitor Charging from the Power Distribution Frame*

**Note: This procedure is used when connecting the actual telecommunication load to the plant.**

Included as part of the Power Distribution Frame is a Capacitor Charge Tool that is used to precharge a capacitive load before installing the load fuse. The capacitor charge tool is mounted at the top of the Power Distribution Frame and is protected with a 2-ampere 70-type fuse.

The probe is attached to the end of a 7-foot retractable cable. When in use the probe is inserted into the alarm fuse location of the load circuit being charged. A Charge button is then depressed and a red LED (labeled **CAP CHG/TEST**) lights, indicating the circuit is being charged. When fully charged, the LED extinguishes, indicating that the circuit is ready for the load fuse to be installed. This prevents the operation of the fuse at the time of insertion due to the capacitive charging of the load. The LED is typically on for less than one second.

A second yellow LED (labeled **LOAD FAULT**) is also on the front panel. It is used to indicate to the operator that a load fault condition exists and should be investigated. Charging should normally take a very short time; this LED will also light if the **CHARGE** pushbutton is held operated for more than 5 seconds.

For safety reasons, voltage appears only at the tip of the probe while the **CHARGE** pushbutton switch is operated. **Never touch the tip of the charge probe.**

Perform the following tests to verify proper operation of the Capacitor Charge Unit:

1. Insert the charge probe into an alarm fuse position that has a load connected to it. The charge probe is keyed and can only be inserted in the correct position.
2. Operate the **CAP CHG/TEST** pushbutton. The red LED lights, then extinguishes, indicating the load capacitor has been charged. Release the button at this time. If the yellow **LOAD FAULT** LED lights, operate the pushbutton a second time. If the **LOAD FAULT** LED lights a second time, investigate the problem. There is probably a fault at the load.

**Note: If the pushbutton is held for more than five seconds, the charge tool circuit will remove its output and light the FAULT LED.**

3. When the red LED extinguishes, indicating the load capacitor has been charged, remove the charge probe and insert load fuse. **This should be done immediately after the red LED extinguishes.**
4. Insert alarm fuse.
5. Repeat Steps 1 through 4 for the remaining active fuse positions.

# 7 *Retrofit of 415A Battery Plant*

## ***Retrofit Configurations***

This section describes the installation, testing, operation, and maintenance instructions for retrofitting the 415A battery plant. Three retrofit configurations are shown in Figure 7-1 and are defined in the following paragraphs:

Configurations 1 and 2 use the H569-429 Group 3 frame for paralleling the alarms to the 415A plant. The Group 3 frame is equipped with a six-rectifier alarm panel, a 415B Galaxy Controller, and a 140/48-volt converter for powering the controller. The 415B Galaxy Controller controls the J87132B-2 ferroresonant rectifiers and communicates the alarms to the 415A controller. However, the controller from the 415A plant will not communicate its alarms to the 415B Galaxy Controller. Configurations 1 and 2 have the same setup, except that the second configuration uses two rectifiers instead of one.

Configuration 1 can also be used to increase the capacity of the 415A module by 140 amperes by using one rectifier. Using Configuration 2 that adds two rectifiers can increase the power capacity by 280 amperes. The connections are identical for installation and testing; however, the bus bar provided in the H569-429 hardware kit would be installed in the 415A distribution rectifier 3 position. The two 4/0 cables provided in H569-429 Group 24 would be connected from the rectifiers to the 415B distribution and the 350MCM would be used to connect to the 3rd rectifier fuse position of the 415A distribution.

### **Note**

<p>The 415A distribution cabinet must have a position three rectifier module to connect the 350MCM for increasing the capacity.</p>
---

Configuration 3 uses the H569-429 Group 4 frame, which is equipped with a six-rectifier alarm panel, battery disconnect/reconnect switches, a Galaxy Controller, seventeen 100-ampere distribution breakers with precharge and 100 ampere/25mV shunts, 140/48-volt converter, and a Remote Peripheral Monitor Panel with three 221F modules for reading the currents from the main distribution panel. The Group 5 is the same except the distribution has 60-ampere circuit breakers.

**Restrictions** Retrofit of the 415A system using Configuration 1 or 2 to parallel the 415B system has two qualifying factors:

1. The 415A rectifier must be manufactured by “ASCOM WARREN”. This is the only rectifier that has been verified by the design requirements.
2. When adding the second rectifier, the failed unit must be in the same module. If this is not the case, the entire 415A should be replaced with the 415B Group 4 with the five-rectifier application.

**Configuration 1  
(Adding One  
Rectifier)** Configuration 1 is the installation of one Control and Distribution Bay (H569-429) with one rectifier. The rectifier is directly connected to the Control and Distribution Bay.

Requires:

- (1) H569-429 Group 3 with no distribution
- (1) J87132B-2 ferroresonant rectifier
- (2) Bus bars (supplied) for replacement of fuse in 415A distribution
- (1) H569-429 Group 24 (wireset for 2 red and red with trace and 2 blue and blue with trace for connecting the rectifier)

**Configuration 2  
(Adding Two  
Rectifiers)** Configuration 2 is the installation of one Control and Distribution Bay with two rectifiers. Both rectifiers are directly connected to the Control and Distribution Bay; the Control and Distribution Bay is directly connected to the 415A distribution.

Requires:

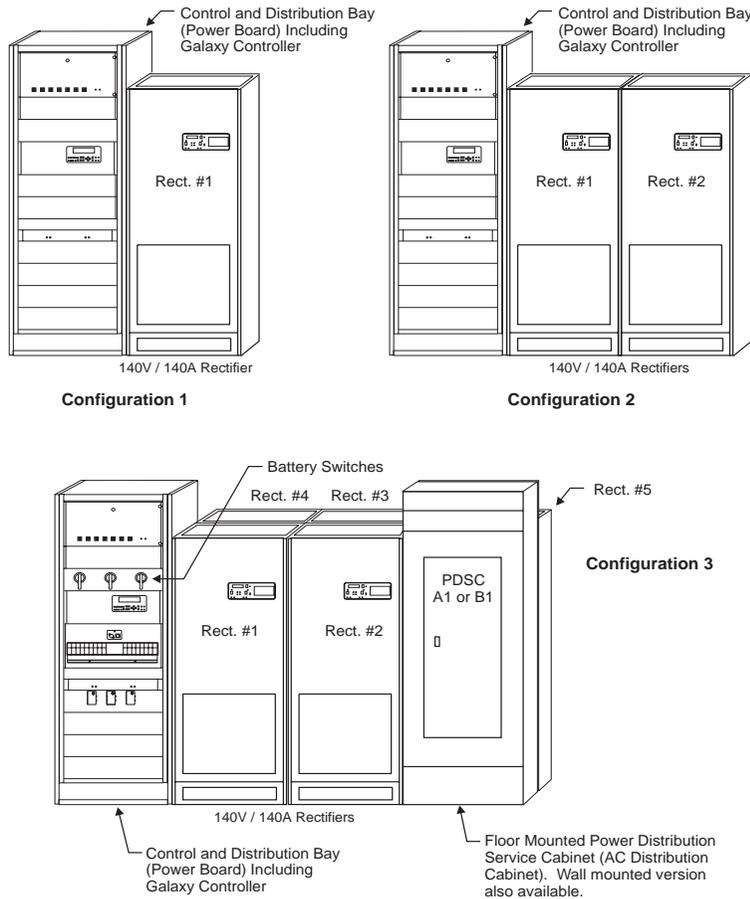
- (1) H569-429 Group 3 with no distribution
- (2) J87132B-2 ferroresonant rectifiers
- (2) Bus bars (supplied) for replacement of fuse in 415A distribution

(1) H569-429 Group 24 (wireset for 2 red and red with trace and 2 blue and blue with trace for connecting the rectifier)

**Configuration 3  
(Adding a  
5-Rectifier Plant)**

Configuration 3 is the installation of up to five rectifiers. It is used in replacing both the A Plant and the B Plant for 4ESS™.

- Requires:
- (1) H569-429 Group 4
  - Up to (5) J87132B-2 ferroresonant rectifiers
  - (1) KS-22089 PDSC (ac distribution cabinet, equipped with 5 breakers)
  - (1) Group 23 wireset and ladder rack
  - (1) Group 24 wireset for 5th rectifier



- Note:
1. Two identical battery plants, similar to that in the figure, are required. One is called the A plant and one the B plant.
  2. A maximum of three battery strings (not shown) connect to the C&D Bay.
  3. Also not shown, an Enhanced Ground Current Monitor (EGCM) that monitors the ground current in the central office ground conductor. There are separate EGCMs for the A plant and the B plant.

**Figure 7-1: Three Configurations of the 415B Battery Plant**

## ***Control and Distribution Bay***

The Control and Distribution Bay distributes power for the using equipment, as well as for float and recharge capability for the batteries, the alarm panel, plant shunt, Galaxy Controller, dc/dc converters, battery disconnect/reconnect switches, RPM panel, and distribution breakers with the 60- or 100-ampere/25mV shunts.

The circuit board is the BNF2, which uses the plant voltage to supply sense voltage to the Galaxy Controller and generates alarms using isolated contacts to the controller.

### **Alarm Panel**

The alarm panel is located at the top of the Control and Distribution Bay. It provides alarms, remote sensing, test points, fuses, and power to operate the frame alarm lamp. The circuit board is the BNF2, which uses the plant voltage to supply sense voltage to the Galaxy Controller. Alarms are generated by isolated contacts from the individual panels.

### **Plant Shunt**

The plant shunt, which is used to measure the total plant load, is mounted in the Control and Distribution Bay. It has a full scale rating of 600 amperes at 50 millivolts.

### **Distribution Shunts**

The distribution shunts, which are used to measure the individual currents for each circuit, are mounted in the Distribution Panel just below the breakers. They have a full scale rating of 100 amperes at 25 millivolts.

### **Galaxy Controller**

The Galaxy Controller is an intelligent controller that is mounted in the Control and Distribution Bay. It is powered by redundant dc/dc converters that convert the nominal battery voltage (+140 volts) to +48 volts, permitting the standard +48 volt Galaxy Controller to be used. The Galaxy Controller J85501F-1 List 4 is specifically programmed for the 415B System. (See Product Manual 167-792-122 for all features).

## **DC/DC Converters**

The dc/dc converters are mounted in the Control and Distribution Bay, and their outputs are diode OR'd to provide power to the Galaxy Controller if one of the converters fails.

## **Battery Disconnect/Reconnect Switches**

The switch panel has three 600-ampere switches, one per string, that are used to disconnect individual strings of batteries from service. Each switch has an Auxiliary Contact to signal an alarm if the switch is placed in the **Off** position. Switch one is factory connected and will alarm if placed in the **Off** position. When installing a second or third battery string, the second or third battery auxiliary switch must have the blue wires connected in order to activate the alarm when switch two or three is placed in the **Off** position. The location of the wires is at the auxiliary switch.

## **Distribution Breakers**

There are 17 circuit breakers in the Control and Distribution Bay that supply power to a secondary dc distribution system. These can be connected to the existing ABC (Area Bus Center) distribution bays or can be connected to two Power Distribution Frames (PDF). Six circuit breakers feed PDF #1 and the other six breakers feed PDF #2. When connecting the Power Distribution Frames, the unused circuit breaker shunts of the distribution panel can be hidden from the RPM (Remote Peripheral Monitor) reporting the currents to the Galaxy Controller by placing a \* in front of the named channel using EasyView software from a laptop computer. The PDF currents are reported back to the Galaxy Controller on Bus 1. The Control and Distribution RPMs report their currents to Galaxy using Bus 2.

## **Rectifiers**

Each rectifier is rated at 152 volts, 140 amperes. The maximum plant load is 560 amperes, with the plant always having a redundant rectifier. The rectifiers are connected in parallel with up to three strings of batteries that float at 151.9 volts. The output of all rectifiers is combined in the Control and Distribution Bay.

The rectifiers contain a 50mV, 175-ampere shunt. Their output circuit breakers are sized at 170 amperes.

## Battery Equalize/ Boost Feature

You will see the terms “Equalize” and “Boost” used throughout the documentation associated with the 415B Battery Plant. **In this manual, the terms are interchangeable and mean exactly the same thing.**

The rectifiers, in association with the Galaxy Controller, allow the batteries to be charged at a higher voltage (**Boost**) than float voltage to **Equalize** the individual voltages of the cells in the string. The **Equalize/Boost** Voltage is factory set to 2.23 volts per cell, or 156.1 volts total.

## Battery Strings, Enhanced Ground Current Monitor, and Documentation References

See the *System Description* section for information about the battery strings and the EGCM, as well as a list of documentation that provides engineering, ordering, and installation information for the 415B Battery Plant and its subsystems.

## Power Distribution Frames (PDF)

If the PDFs are used to replace the distribution, refer to the *System Description* section for information. The retrofit requires use of the existing **Area Bus Centers (ABC) Bays**.

### **Group 3 (Configurations 1 and 2, Adding 1 or 2 Rectifiers)**

The H569-429 Group 3 was developed for retrofitting or increasing capacity with up to two J87132B-2 ferroresonant rectifiers in parallel with a 415A module. The Group 3 contains an alarm panel, 140/48-volt converter, and a Galaxy Controller. The battery disconnect switches and the distribution panel are not required with this application. The Group 3 provides alarms and control for the 415B rectifier only. The alarms are paralleled with the 415A Control and Distribution Bay. The Control and Distribution Bay is installed next to the 415A lineup, and the rectifier is connected to the Control and Distribution Bay using Group 24 wireset. The Control and Distribution Bay is then connected to the 415A distribution, with the positive connection made to the unused fuse position or the fuse that is connected to the failed 415A rectifier. The 415B rectifier has its own circuit breaker, which requires the installer to replace the fuse in the 415A distribution with one of the supplied bus bars found in the prepack hardware. All alarms from the 415B are wired in parallel with the 415A alarms at TB4 of the 415A terminal block

(see T-drawing T83360-30, sheet D12). The Galaxy Controller will control the 415B rectifier and monitor any alarms from the 415B battery plant.

H569-429 Group 3 is shown in Figure 7-2.

**Note**

Only two rectifiers are to be used with the Group 3, and the failed rectifier must be in the same module. If more than two rectifiers have failed, the 415A system should be replaced. The Group 3 can be updated to the Group 4 frame by adding the distribution panel, a battery switch panel, and an RPM panel.
--

***Group 4 or 5  
(Configuration 3,  
Adding a  
5-Rectifier Plant)***

This application uses the H569-429 Group 4 frame and is similar to the 415B new system, except that it uses five rectifiers and 100-ampere breakers. H569-429 Group 5 is the same as Group 4 except it uses 60-ampere circuit breakers. The currents are read from the Control and Distribution Frame instead of the secondary frames at the PDF. It offers a 600-ampere total plant capacity with a nominal 140-volt dc output distribution in a totally integrated energy system. The plant consists of charge and discharge bus bars with three manually-operated battery disconnect switches, a Galaxy Controller, a dc distribution panel with 100-ampere breakers equipped with 25mV shunts, a six-rectifier fuse panel with a remote peripheral monitor panel, and a 140/48-volt converter.

The Group 4 design is unique to the 415A system and is required for a total replacement of the 415A Battery Plant. The retrofit requires one ac cabinet (PDSC) that contains six circuit breakers, which is five plus one for a spare. Growth in plant output capacity is achieved by adding up to five 140-volt ferroresonant rectifiers for the 415B Battery Plant. The fifth rectifier is installed in the floor layout where the previous ac (PDSC) cabinet number two was located in the 415B system. The Galaxy Controller requires both front and rear access and a door is provided for the rear of the frame. The battery plant is compatible with virtually all flooded and valve regulated batteries that float within the range of 151.90 through 156.00 volts.

H569-429 Group 4 is shown in Figure 7-2.

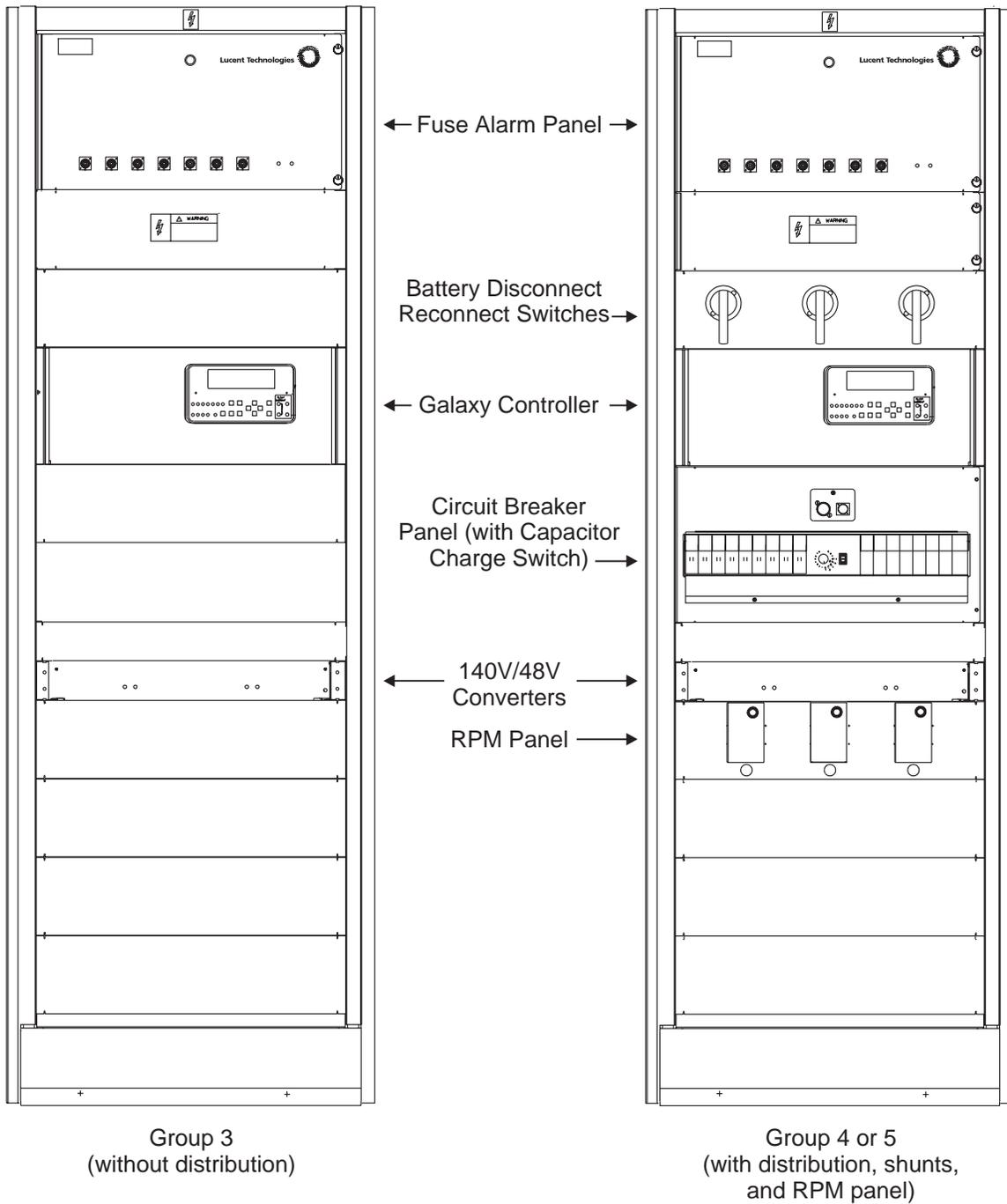


Figure 7-2: H569-429 Groups 3, 4, or 5

Two 4ESS™ switches are powered by two independent 415B Retrofit Battery Plants. Each 415B Retrofit Battery Plant consists of one Power Distribution Service Cabinet (PDSC), a Control and Distribution Bay, up to five rectifiers, up to three battery strings, and a Galaxy Controller.

The secondary distribution will continue to use the existing ABC (Area Bus Center) bays that will remain in place, along with the existing battery strings and Enhanced Ground Current Monitor. However, depending on the condition of the ABC distribution, the new Power Distribution Bays could be installed.

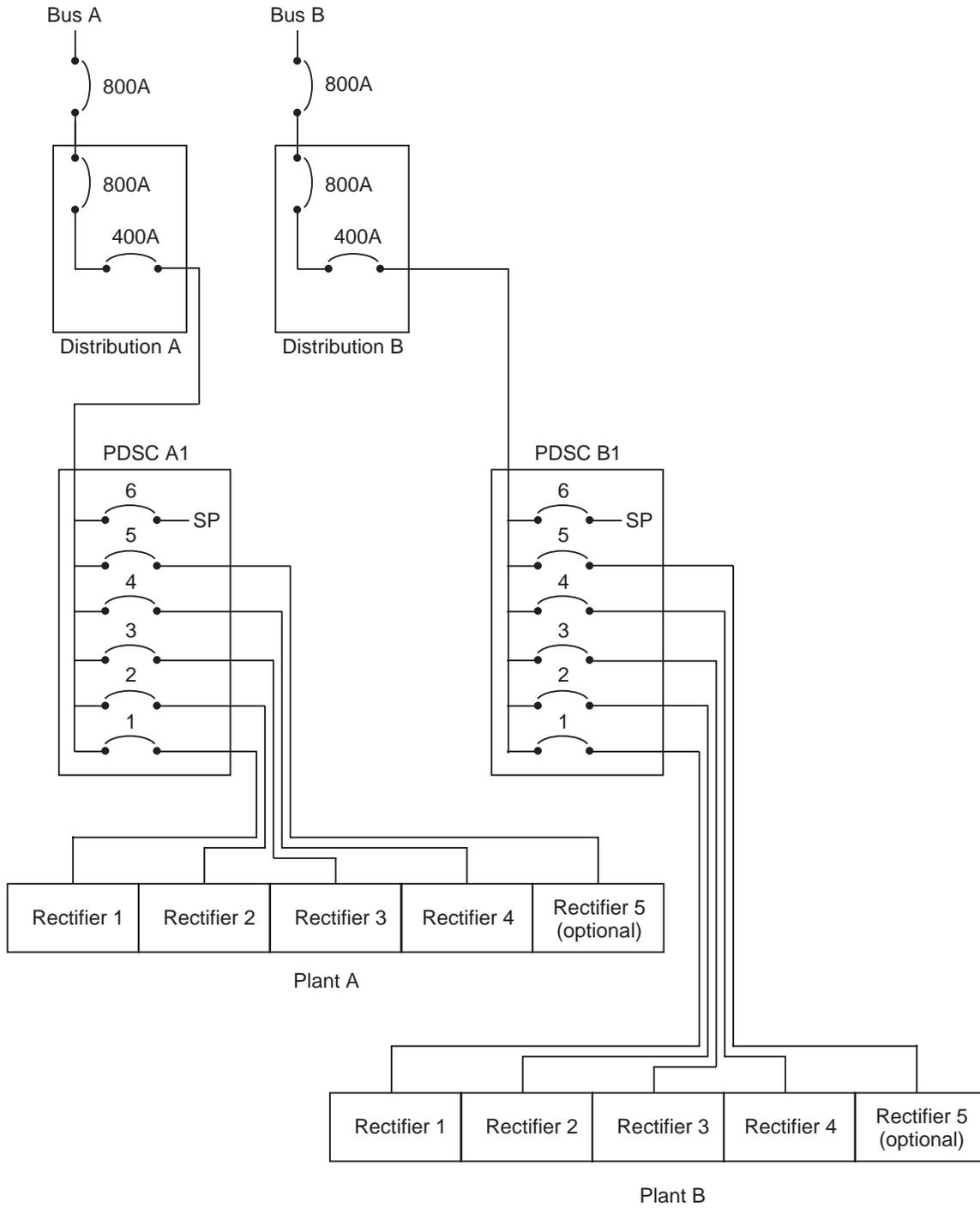
#### **Note**

The two independent plants are labeled Battery Plant “A” and Battery Plant “B”. The dc output cables between the rectifiers and the Control and Distribution Bay of each plant are different colors for clarification purpose. The cables are colored as follows:

- Battery Plant “A” - Red and Red with Black Tracer
- Battery Plant “B” - Blue and Blue with Black Tracer

Commercial ac is brought into two ac distribution panels and sent to each rectifier in the plant. Each ac distribution panel is fed from a separate input circuit breaker, ideally from a different power station. There is only one ac distribution panel per battery plant, which can either be free standing or wall mounted. One of three ac input voltage levels may be utilized for the rectifiers in the plant: 208V, 240V, or 480V at 60 hertz. Three-phase power is required.

There are a maximum of five rectifiers in the plant, each having its own circuit breaker located in one of the ac distribution panels. The circuit breakers are the type that may be tagged and locked out for safety. Normally, each ac distribution panel feeds five rectifiers. Refer to Figure 7-3.



**Figure 7-3: Typical 415B Retrofit Battery Plant  
AC Feeds for Total Replacement**

## ***Retrofit System Installation and Testing for One or Two Rectifiers***

Please read Section 3, *Safety*, carefully before installing, testing, maintaining, or repairing the 415A Battery Plant or any of its subsystems.

### **DANGER**

**The voltage in this plant can cause serious injury.** 140 volts is considered to be a hazardous voltage. Be sure qualified personnel are present when working with live circuits. **Wear rubber gloves as required.**

### ***Unpacking Equipment***

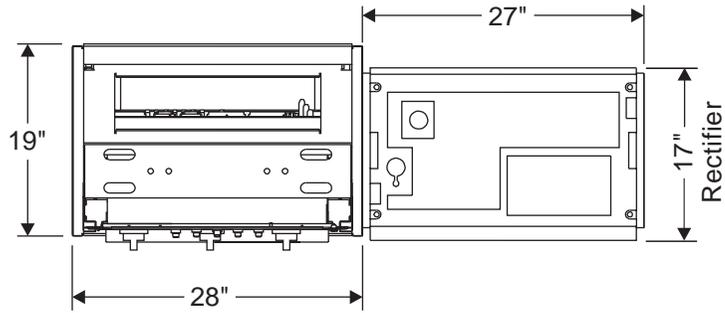
Contact the shipping carrier if there is damage to the equipment. Follow the shipping carrier's procedure for filing a damage claim, if necessary.

### ***Required Tools***

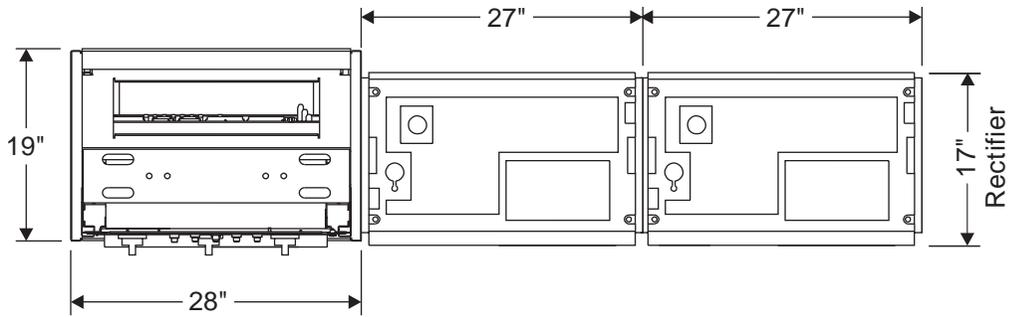
The following equipment is required to handle the shipping containers, remove framework from the shipping containers, and erect framework into final position. The minimum lifting capacity is 1500 pounds.

- Common electrician's hand tools
- Proper crimping tools and dies for connectors used
- Common mechanic's hand tools
- 18mm or 3/4-inch drill to bore holes for floor anchors
- DMM (Digital Multimeter) with at least .05% accuracy on the dc scale (Fluke 8060A or equivalent)
- Rubber gloves

Choose the appropriate configuration from Figure 7-4 (also shown on the D8 sheet of the T83360-30 drawing). Group 3 uses one or two rectifiers. Locate rectifiers and the Control and Distribution Bay as shown in Figure 7-4.



**Configuration 1**

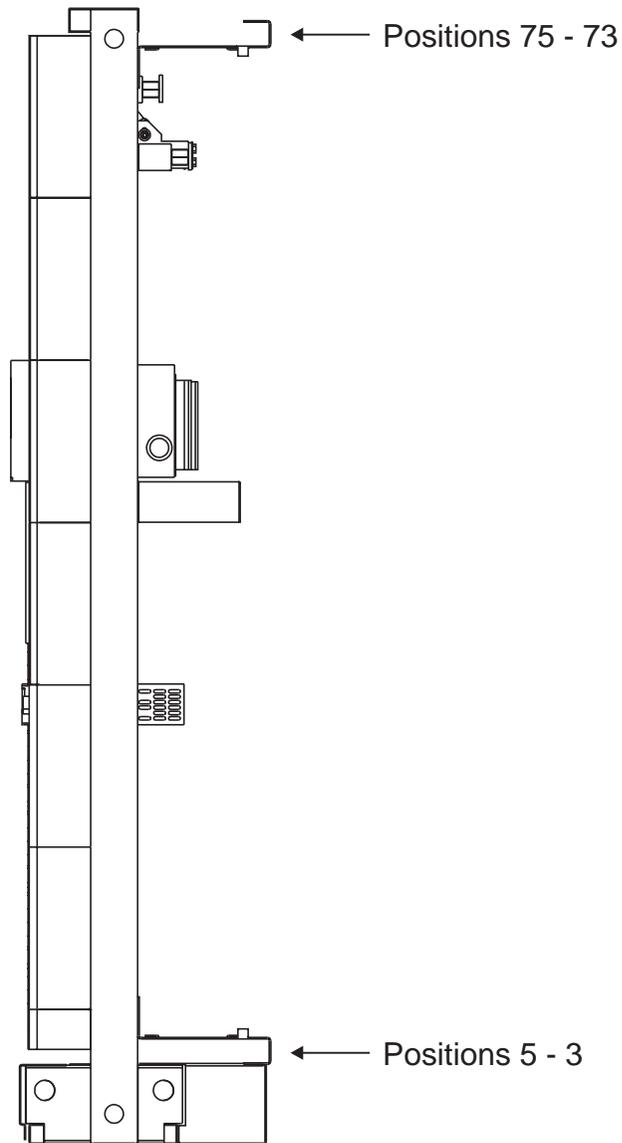


**Configuration 2**

**Figure 7-4: Retrofit with One or Two Rectifiers**

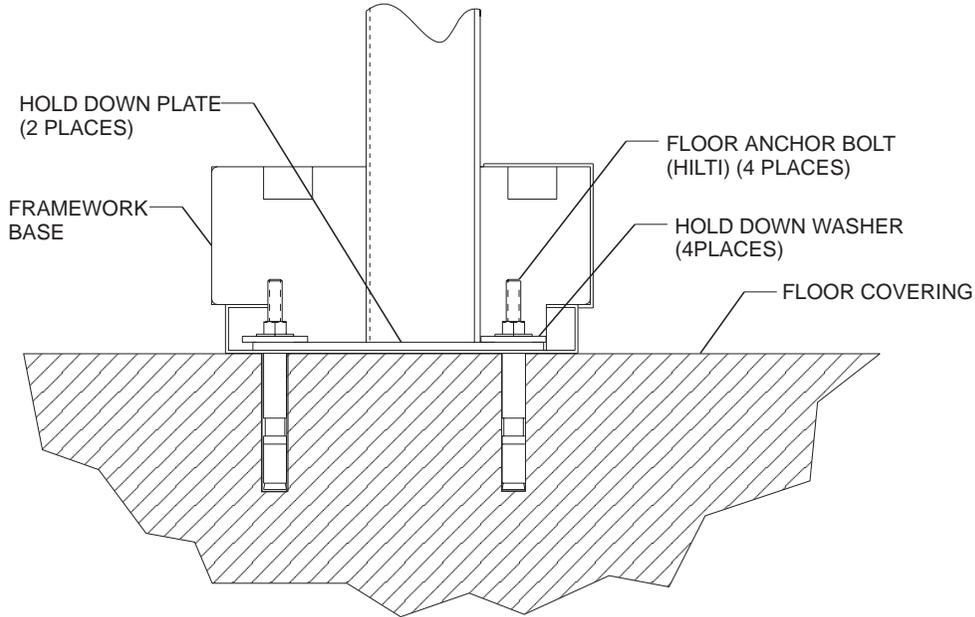
***Mounting  
Brackets on  
Control and  
Distribution Bay***

1. Install top and bottom door mounting brackets before running the cables to the Control and Distribution Bay bus bars.
2. Mount the top bracket in positions 75-73. Mount the bottom bracket in positions 5-3. See Figure 7-5.

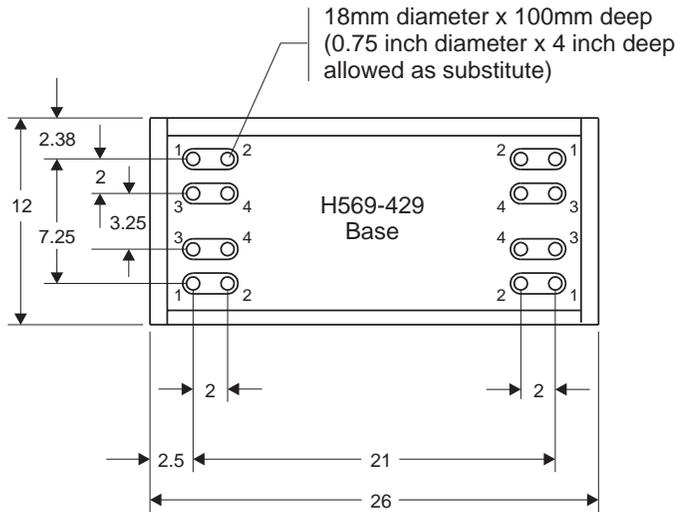


***Figure 7-5: Bracket Mounting Locations***

**Bolting Hardware** The Control and Distribution Bay contains the bolting hardware for mounting the frame to the floor. Figure 7-6 shows a typical floor mounting detail. Figure 7-7 is a floor mounting template.



**Figure 7-6: Typical Floor Mounting Detail**



- 1 Concrete edge to hole center distance to be at least 2.5 inches.
- 2 Drill 4 holes, position 1. If interference in reinforced concrete occurs, use position 2, 3, or 4 in that order.

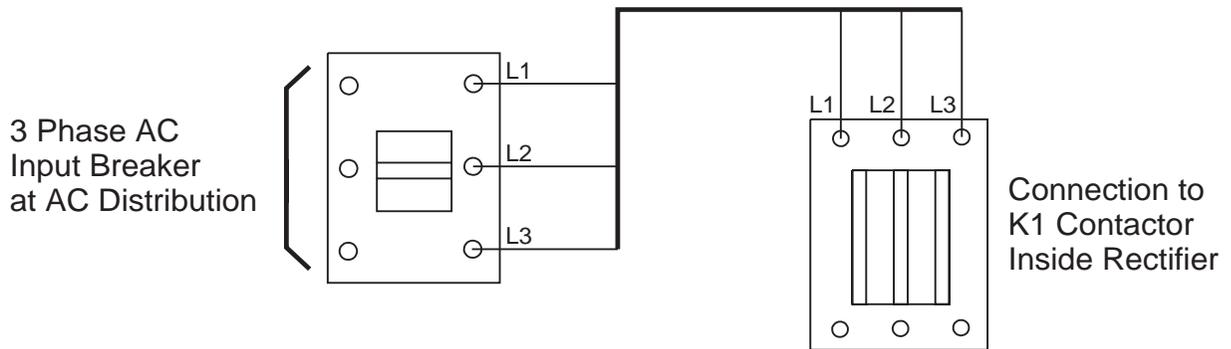
**Figure 7-7: Floor Mounting Template for Control and Distribution Bay**

**Rectifier and AC Connections**

Make ac connections from the failed rectifier of the 415A system. Engineering provides the necessary ac from the existing service. Follow local codes and NEC codes and requirements for connecting the service for the rectifiers. (Service should be 50 amperes for 480-volt rectifier and 100 amperes for the 208/240-volt rectifier). The input lugs and conduit are not provided and must be furnished by the line engineer.

Use existing ac service for retrofit ac connections. The engineer must provide the ac conduit or sealtight and knockouts with connectors from the PDSC to the rectifiers. AC for the 480Vac service must be 6 gauge. The wire size for the 208Vac or 240Vac is 4 gauge. The installer must follow all local municipal codes and NEC code requirements. Figure 7-8 shows the connection of the ac to the rectifier.

Connect the appropriate gauge wire to the rectifier from the ac cabinet according to job specifications. The hardware kits contain lugs for connecting the wire to the rectifier. (Refer to T-83360-30, sheet D13 for appropriate connections.)



**Figure 7-8: Connecting AC to the Rectifiers (K1 Contactor)**

***Retrofit  
Connections for  
the Group 3 to  
the 415A  
System (Adding  
One or Two  
Rectifiers)***

**Notes**

Remove 415B charge fuse and replace with bus bar provided. Do not install until the test informs you to.

Add a label printed in red to the rectifier fuse head, to read as follows:

DO NOT REMOVE  
415B POWER  
NO FUSE

Remove all the REG fuses from the 415B fuse panel and unplug the BAA5 circuit boards from the converter.

***Rectifier Output  
Connections for  
One Rectifier***

1. Connect rectifier BAT and RTN leads to the Control and Distribution Bay's Charge and Charge Return bus bars. (See T83360-30, sheet D9.)
  - a. Connect the 4/0 cable (+) from the charge bus of the 415B Control and Distribution Bay to the rectifier's +V bus bar.
  - b. Connect the (-) from the Charge Return of the 415B Control and Distribution Bay to the rectifier's -V bus bar.
  - c. Connect the 350MCM cable from the Control and Distribution Bay bus bars to the 415A module.

***Second Rectifier  
Addition***

1. Connect the 4/0 cable (+) from the charge bus of the 415B Control and Distribution Bay to the rectifier's +V bus bar.
2. Connect the (-) from the Charge Return of the 415B Control and Distribution Bay to the rectifier's -V bus bar.

***Shunt  
Connections***

See sheet D12 of the T83360-30.

### Notes

Final alarm connections to the 415A should not be made until the 415B test is completed.

The resistor block is not used on the 415A distribution shunt of the module being monitored by the shunt (+) and (-) terminals of the Galaxy Controller. The resistor blocks must be installed on the shunts that are connected to the RPM module.

1. In the 415B Control and Distribution Bay, remove the leads going to the shunt (+) and shunt (-) terminals of the Galaxy Controller and insulate. Run a shielded, twisted pair (comcode 405400847) from the shunt + and shunt - terminals of the Galaxy Controller to the shunt in the 415A Control and Distribution Bay. (When facing the 415A Control and Distribution Bay, (+) is on the left and (-) is on the right of the shunt.)
2. Ground the shield of the cable to the chassis using the spade provided in the prepack of the 415B Control and Distribution Bay.

### *Sense Voltage Connections*

1. In the 415B Control and Distribution Bay, remove the red wire from the Charge Bus and the blue wire from the Charge Return.
2. Using the connectors provided and wire (comcode 405400847), make the connections as follows:
  - a. Connect the red to red in the 415B and black to the blue wire in the 415B.
  - b. Connect the red wire to TB4 Terminal 27 (+) and the black wire to terminal TB4 terminal 29 in the 415A Control and Distribution Bay.
  - c. Ground the shield of the cable to the chassis in the 415A Control and Distribution Bay.

**Alarm Connections** The alarm connections from the 415B to the 415A Control and Distribution Bays are wired in parallel using 807A 16/26 SWBD (comcode 105412480).

**Note**

Connection of the alarms should be made after the test is complete. If connected prior to testing, alarms will be issued to the alarms centers.

Table 7-A shows the connections required between the 415A and 415B frames.

**Table 7-A: BJT1 Connections**

Alarm	415B		415A			
	Color	Pin	Color	Pin		
HV	R/G	1	TB3	R/G	11	TB4
	G/R	17		G/R	13	
PMJA	W/O	4	TB2	W/O	9	
	O/W	20		O/W	10	
PMJV	W/S	5		W/S	26	
	S/W	21		S/W	25	
PMNA	W/BR	7		W/BR	4	
	BR/W	23		BR/W	5	
PMNV	R/BL	8		R/BL	28	
	BL/R	24		BL/R	30	
DISCHG FA	W/G	11		W/G	6	
	G/W	27		G/W	8	
FA	W/BL	12		W/BL	1	
	BL/W	28		BL/W	3	
BD	R/O	13		R/O	16	
	O/R	29		O/R	18	
ACF	R/BR	14		R/BR	14	
	BR/R	30		BR/R	15	
VLV	R/S	16	R/S	21		
	S/R	32	S/R	23		
RFA	BL/BK	15	BL/BK	12	TB1	
	BK/BL	31	BK/BL	13		

## ***Testing for Group 3 (One or Two Rectifiers)***

### ***Required Test Equipment***

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

- DMM (Digital Multimeter) Fluke® 8060A or equivalent meter having  $\pm 0.02$  percent accuracy on the dc scale
- Battery Plant Simulator Test Set, customer constructed, or equivalent (see **Note** below)
- DC Dummy Load Bank, 150-volt, with adjustment to provide a load of at least 10 to 12 percent of the rectifier's rating (see specific test procedure to determine ampere setting required)
- Jeweler's screwdriver for adjusting potentiometer

### **Note**

The Battery Plant Simulator Test Set, listed above, is a convenient tool used to isolate communication troubles between the plant controller and the rectifier. It simulates the plant controller relative to receiving signals from, and sending signals to, the rectifier. If the rectifier works properly with the test set, the problem is either at the controller or in the interface wiring (plant cable). This tool can be ordered from ITE (ITE-7102).

## ***Simulated Plant-Rectifier Interface Tests Using Test Set (ITE 7102)***

The following tests will verify that the rectifier responds properly to plant controller commands and outputs proper signals in return. It may be helpful to refer to the Schematic Drawing (SD-83325-01) during performance of the procedures.

### **DANGER**

Voltages in excess of 600 volts are present in the rectifier. Extreme care should be exercised to avoid contact with exposed terminals or bus bars.

**DANGER**

AC voltage is present even when the **Power** switch is in the **Off** position.

**DANGER**

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

**Warning**

Do not operate the **DC Output** circuit breaker to **On** (or turn an external charge circuit breaker on, or install an external charge fuse) until told to do so.

**Warning**

The rectifier output filter capacitors stay charged for several minutes. Check that they have discharged adequately before contacting any exposed terminals inside the rectifier. Do not work on the rectifier until capacitors have discharged below 50Vdc.

***Preparation***

The following information covers initial settings of equipment and meter, and the test connections necessary before beginning the test.

**Warning**

Be sure that connections to circuit packs are not made or removed with voltages present. Before disconnecting a cable from a circuit pack, operate the **Power** switch to **Off**. If the control cable is connected, remove the associated REG fuse from the plant control panel and then disconnect the control cable. If complete plant connections are to be restored, operate the **Power** switch to **Off**, reconnect the control cable, and then install the associated REG fuse.

### Warning

For safety, the measurements for current shall be made on CM1 at E101 and E102 at the shunt (+) and (-) test points. (See Figure 7-10).

1. Set the ac supply and rectifier controls as follows:

Controls	Position/Status
Associated ac circuit breaker or fuse at the ac service cabinet	<b>Off</b> or fuse is removed
Rectifier <b>Power</b> switch	<b>Off</b>
Rectifier <b>DC Output</b> circuit breaker	<b>Off</b>
<b>Output Volts Adjust</b>	Fully down
Plant control connector ( <b>J202</b> ) and remote sense connector ( <b>J208</b> ) mounted on inside of front panel door on <b>CM2</b>	Disconnected
Regulation (REG) fuses in Control and Distribution Bay	Removed
BAA5 Converter	Disconnected

2. Connect dummy load (+) to rectifier Test Load connection below **CB1** of the rectifier. Connect dummy load (-) to the connection just above the (-**V**) output of the rectifier.
3. Using the digital multimeter on the dc volts scale, make the following checks:
  - a. Install the rectifier fuse head with the bus bar in the 415A.
  - b. Verify that the battery voltage between the rectifier charge terminal and ground has the correct polarity.
  - c. With the associated REG fuse in the plant installed, check for battery voltage between terminals of the REG connector of 208G circuit pack (J208). Check that Pin 3 is positive with respect to Pin 2. Remove REG fuse.

**Connections** Secure the Battery Plant Simulator Test Set (ITE-7102) and support it at a convenient location near the rectifier. Make the connections as detailed in Table 7-B. Note that Table 7-B contains references to Figure 7-9.

**Table 7-B: Test Set Connections**

Step	Test Clip	Connection	See Figure
1	Red	E13 on <b>CM2</b> (Positive side of capacitor C201)	7-9
2	Black	E22 on <b>CM2</b> (Negative side of capacitor C202)	7-9

Connect **J202** from the test set to connector **P202** on the **CM2** control board (mounted on the inside of the front door).

- Startup**
1. Turn on the ac supply to the rectifier. Measure voltage at banana jacks TP3 and TP4 on test set. The voltage should be approximately 54V at TP3 (red) with respect to TP4 (black).
  2. Set the digital multimeter to the 200-volts range, and connect it to the **Rect** jacks on the rectifier control panel.
  3. Adjust the test load so that when the rectifier is turned on it will deliver between 14-38 amperes of full load.
  4. Operate the power switch to **On**. The rectifier should start. The digital meter should indicate between 135 and 150 volts. The **MAN LED** on the test box should light and remain lit as long as the rectifier is turned on.

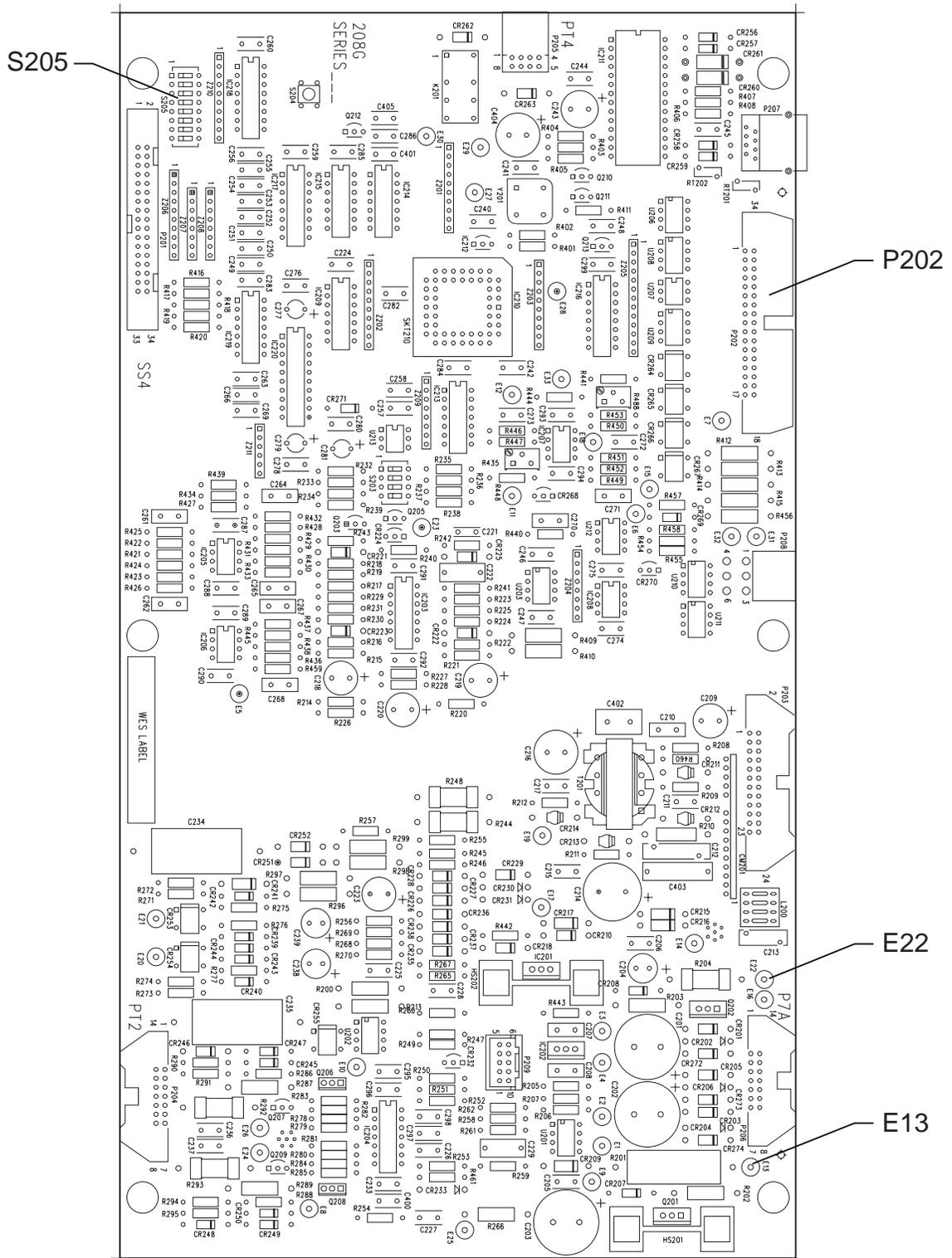
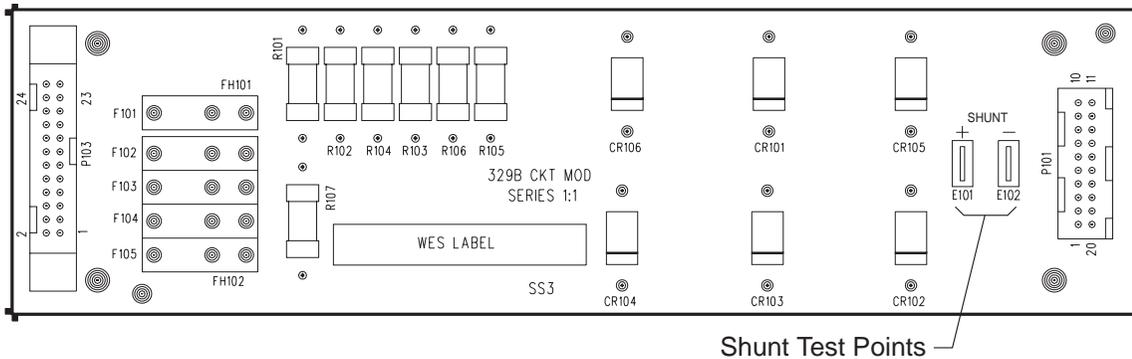


Figure 7-9: Partial Sketch of CM2 (208G) Control Board



**Figure 7-10: CM1 (329B) Fuse Board**

**Internal Tests**

1. Disable the internal selective high voltage shutdown by opening **S205.1** and **S205.2** on **CM2** (see Figure 7-9). Then adjust the **Output Volts Adjust** until the rectifier shuts down.

**Note**

When the rectifier shuts down, the **RFA LED** on the front panel should light and the rectifier should shut down at  $163 \pm 2$  volts. When this step is completed, restore the original conditions of **S205.1** and **S205.2**.

2. Adjust the **Output Volts Adjust** down, restart the rectifier, and adjust the voltage to 151.9 volts. The **RFA Alarm LED** on the rectifier and the **RFA LED** on the test box should go out. Restore internal selective high voltage shutdown to 160V (**S205.1** and **S205.2**).
3. Connect the test meter to the rectifier input conductor to **CB1** and **DC OUTPUT RETURN**. On the rectifier, hold the **Rect V - Amps - Plt V** switch in the **Rect V** position. The digital display should agree with the digital test meter within  $\pm 0.1$  volt. Release the switch.
4. Hold the same switch in the **Plt V** position. The digital display should agree with the digital test meter within  $\pm 0.1$  volt. If not, refer to the paragraph “Check Calibration of CM3 Digital Meter” in this section.
5. Hold the **Rect V - Amps - Plt V** switch in the **Rect V** position. Watch the digital test meter and operate the **Rect**

**Test** switch to **NL**. The voltage should drop between 0.3 and 0.6 volt.

6. Repeat Step 5 with the **Rect Test** switch in the **FL** position. The voltage should increase between 0.1 and 0.46 volt.
7. Turn off rectifier. Replace fuse on 329B fuse board with blown fuse. Turn on rectifier. Rectifier should shut down immediately and the **RFA** alarm, **FA** (fuse alarm), and the **RFA** LED on test set should light. (See Figure 7-10.) Turn off rectifier and replace blown fuse.
8. Restart the rectifier.
9. Repeat Steps 7 and 8 for the **F101**, **F103**, **F104**, and **F105** alarm fuses located on **CM1**.

#### ***Control Test***

1. Press and hold the **TR** switch on the test box for 5 seconds. The rectifier should shut down and the **TRH** LED on the test box should light.
2. Release the switch. The rectifier should restart and the **TRH** LED should go out.
3. Reduce the load to zero.
4. Press the **HV** switch on the test box. The rectifier should continue to operate. Turn off **HV** switch.

#### ***HV Shutdown and Restart***

1. Adjust the test load so that the rectifier delivers a minimum of 10 percent of its rated amperage (28 amperes).
2. Turn on the **HV** switch on the test box. After approximately 5 seconds, the rectifier should shut down and the **RFA Alarm** LED on the rectifier and the **RFA** LED on the test box should light. Turn off **HV** switch.
3. Momentarily press the **RS** switch on the test box. The rectifier should restart and both **RFA** LEDs should go out.

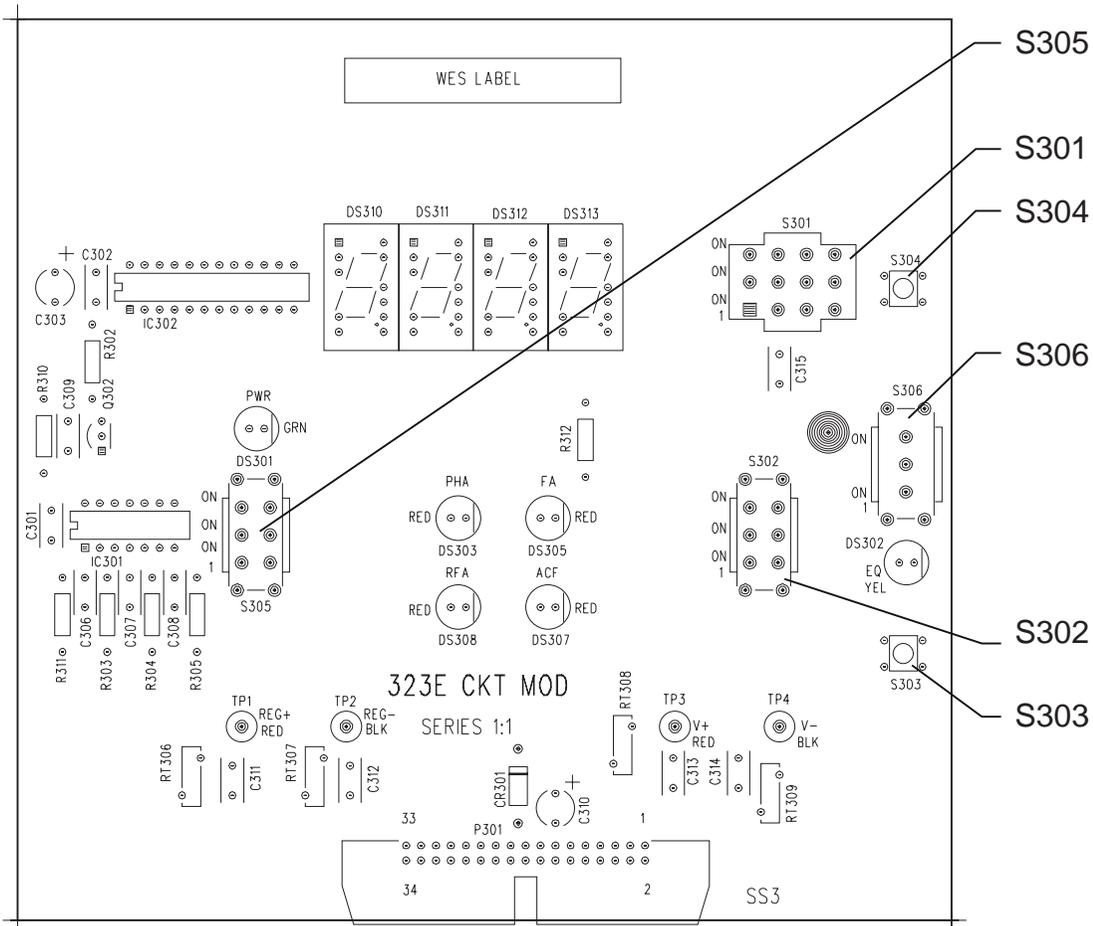


Figure 7-11: Partial Sketch of CM3 Digital Meter Board

**Phase Failure Test**

1. Increase the load to 30-42 amperes.
2. With the **Power** switch still in the **On** position, turn off the ac service and note that the rectifier has shut down and that the **MAN** LED on the test box is off.
3. Verify that no ac voltages are present on the input leads of the ac input contactor.
4. Disconnect one of the colored leads (blue, red, or white) on the input side of the contactor.

**Note: Both blue wires have to be removed.**

5. Turn on the ac. The rectifier should not restart. The display and alarm outputs to the test box may blink.

6. Turn off the ac and reconnect the ac input lead.
7. Turn on the ac. The rectifier should restart. On the test box only the **PWR** and **MAN** LEDs should light.
8. Repeat Steps 4 through 8 for the other two phases.
9. Reduce the load to zero.
10. Operate the **Power** switch to **Off**.
11. Disconnect and remove the Battery Plant Simulator Test Set, the DMM (Digital Multimeter), and the dummy load.

**Note: Repeat all tests for the second rectifier, if equipped, from “Simulated Plant-Rectifier Interface Tests Using Test Set (ITE 7102).”**

12. Remove rectifier fuse head from 415A.
13. Reconnect the dummy load to the Control and Distribution Bay charge and charge return bus bars.

**Note: The dummy load does not have to be connected if the 415A has a load greater than 160 amperes. The plant load will be sufficient without it.**

14. Replace rectifier fuse head in 415A.

***Completion of  
Test***

1. Verify all REG fuses are removed from the Control and Distribution Bay. Connect J202 and J208 on each rectifier.
2. Install the BAA5 converter packs (verify Galaxy Controller is on line). **Note: Ignore all alarms.**
3. Install controller REG fuse.
4. Close the dc output circuit breaker of rectifier #1 following the procedure outlined on the label above the breaker.
5. Turn off rectifier. (Use the Power ON/OFF switch at rectifier.)
6. Install rectifier REG fuse.

7. Repeat Steps 4 through 6 for other rectifier.
8. Verify that the rectifiers are off before proceeding.

**Current Limit  
Adjustment**

1. Turn on a rectifier.
2. Set load to 160 amperes and on line. Adjust dummy load if the 415A plant is less than 160 amperes.
3. Operate the Rect NL/FL switch to FL (full load). The rectifier should assume a 140A  $\pm$ 2A load. If it does not, adjust R488 (counter-clockwise to lower, clockwise to raise) on the 208G circuit pack until it does assume a 140A  $\pm$ 2A load.
4. Operate the Rect NL/FL switch to NL (no load). The rectifier sheds most of the load and the other rectifiers pick up most of the load. Adjust the rectifier to 151.9V to match the 415A System.
5. For a dual module replacement, repeat Steps 1 through 4 for the second rectifier.

**VI and VP Test  
Leads**

Refer to Section 7, *Glossary*, for the definitions of VI and VP.

1. Before adjusting the VI signal, locate the BJB board inside the Galaxy controller.
2. Verify that SW202 position #8 is at the “1” or “closed” position.
3. Configure the controller for rectifiers. You can configure the rectifiers from the front panel of the Galaxy by doing the following:

Press MENU→CONFIG→RECT DEF

Press ENTER; the display will now show:

RECT DEF

G01 (flashing)

Note: G01 represents rectifier one and you will see it flashing off and on.

Press ENTER; the display will now show

RECT 01  
TYPE: UNCONFIGURED (flashing)  
SHUNT mV: 50.00  
MAN SW: NONE

Press ADJUST + or - to scroll through menu until J87132B-2 appears in TYPE.

Press ENTER to store information selected.

Press ESCAPE to return to RECT DEF and select G02 for rectifier two.

Configure rectifier number two the same as above and continue for all rectifiers.

Press ESCAPE to return screen back to main display.

After all rectifiers are configured, proceed to Step 4.

4. On the front of the Galaxy, follow the path  
MENU → MEAS → RECT

Press ENTER and all configured rectifiers will display their currents, i.e., G01 = 5, G02 = 7, etc.

5. Press ENTER to store and save the information.

**Note: Pressing ESCAPE returns the screen one level.**

6. Remove insulator from battery of BJH3 circuit pack.
7. With only rectifier #1 on line and carrying a load of at least 70 amperes, measure the voltage at test points E101 and E102 of the 329B fuse board. Calculate the actual load on rectifier as follows:

The rectifier test points (shunt) will read 50 millivolts at 175 amperes. Each millivolt read on the meter is equal to 3.5 amperes of load. Calculate the load current from this reading. For example:

$$20\text{mV} \times 3.5 \text{ amperes per millivolt} = 70 \text{ amperes}$$

Compare the calculated load current with the current reading at Galaxy. The shunt reading should agree with the Galaxy reading. If not, proceed to Step 7. If the two readings agree, skip to Step 8.

8. Adjust R435 on CM2 of the rectifier to bring the reading on the Galaxy within tolerance.
9. Repeat procedure for all rectifiers.

***Final Connections***

1. Verify the Galaxy controller is reporting NORMAL status. Make final alarm connections to Galaxy's terminal block BJT1 as shown in Table 7-A.
2. After one hour, perform a heat scan of the ac and dc connections made in each rectifier during the installation process.

***Alarm Lamp***

With this configuration the red lamp at the top of the 415B Control and Distribution Bay does not illuminate.

***Laptop Computer Settings***

Connect your laptop computer and, using EasyView software, configure as follows:

Login to the Galaxy Controller.

Select Configure→DC Plant→Software Configure→Enter.

Change Shunt Current to "500A" and Shunt Voltage mVolts to "50". Click OK→OK.

Select Configure→Monitoring→Derived Channels. Enter.

Click OK. Select Add. Click OK.

Select Modify. In Description, type "415A & 415B Total Current".

Select Program Line Editor. In Measurements, select Shunt Monitor Channel→Chan 1→Add Selected Item. Select + from Menu. Select Chan 2→Add Selected Item. Select + from Menu. Select Chan 3→Add Selected Item. Select + from Menu. Type "DC1 ADC". Click OK→OK→OK→Close

Select Options→Config Monitor Channels. Under T1 Command, type "MET DR01". In Description type "415A & 415B Total Current". In Object to Find, select VAL. In Monitoring, select Enable. Click OK.

Display will now show the total current for the 415A and 415B on the laptop.

**Note: To read total current from the front panel of the Galaxy Controller, follow Menu, Meas, Drv Chan. Press Enter. This is the total current from all modules and the 415B Galaxy Controller current.**

Current readings on the Galaxy display are from the 415A module connected to the Galaxy shunt input terminals, pins 1 and 2.

Select Configure, Monitoring, Shunt Channels, Modify.  
Change Shunt Current to “500A” and Shunt Voltage mVolts to “50”. Click OK, OK.  
Select Modify. Click Copy. Select and highlight all channels.  
Click OK, OK, OK, OK, Close.

Verify amperage and alarms.

***System  
Installation and  
Testing for  
Retrofit  
Group 4 (5  
Rectifier Plant)***

Please read Section 3, *Safety*, carefully before installing, testing, maintaining, or repairing the 415A Battery Plant or any of its subsystems.

**DANGER**

**The voltage in this plant can cause serious injury.** 140 volts is considered to a hazardous voltage. Be sure qualified personnel are present when working with live circuits. Wear rubber gloves as required.

***Unpacking  
Equipment***

Contact the shipping carrier if there is damage to the equipment. Follow the shipping carrier's procedure for filing a damage claim, if necessary.

***Required Tools***

The following equipment is required to handle the shipping containers, remove framework from the shipping containers, and erect framework into final position. The minimum lifting capacity is 1500 pounds.

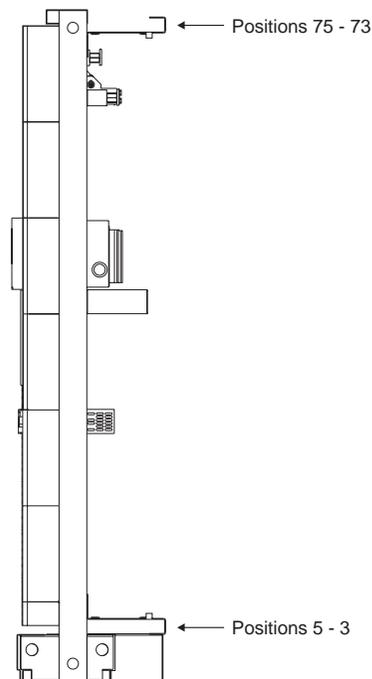
- Common electrician's hand tools
- Proper crimping tools and dies for connectors used
- Common mechanic's hand tools
- 18mm or 3/4-inch drill to bore holes for floor anchors
- DMM (Digital Multimeter) with at least .05% accuracy on the dc scale (Fluke 8060A or equivalent)
- Rubber gloves

**Note**

Install top and bottom door mounting brackets before running the cables to the Control and Distribution Bay bus bars.

***Mounting  
Brackets on  
Control and  
Distribution Bay***

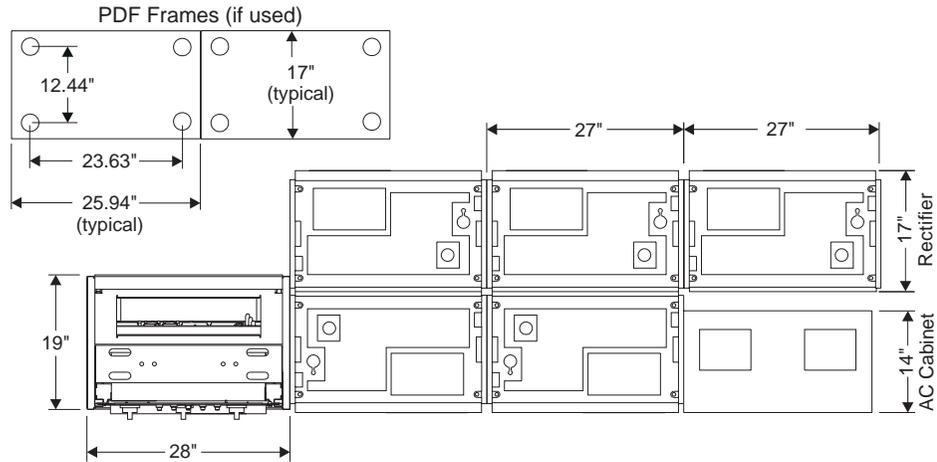
Mount the top bracket in Positions 75-73. Mount the bottom in Positions 5-3. See Figure 7-12.



***Figure 7-12: Bracket Mounting Locations***

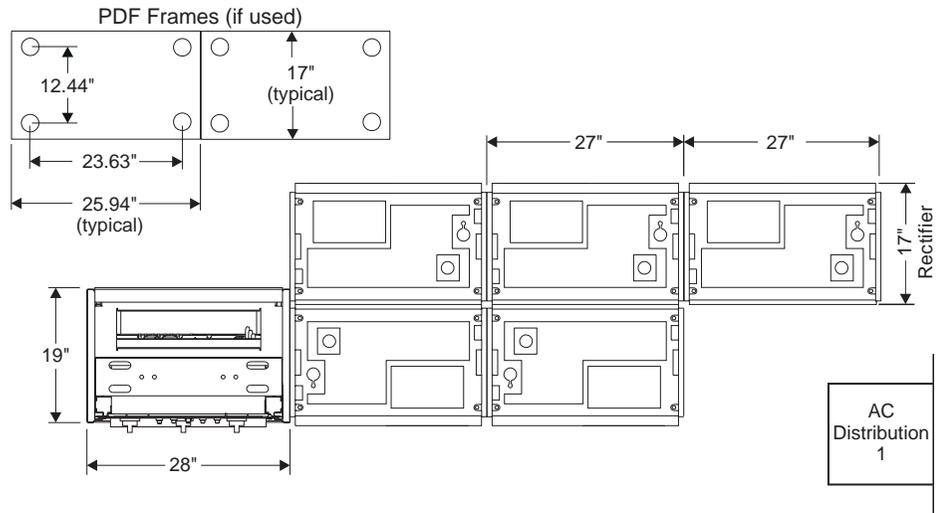
**4ESS™  
Configurations**

The ac distribution for the 4ESS™ can be either floor-mounted or wall-mounted. Figures 7-13A and 7-13B show both configurations. Choose the appropriate configuration from the D8 sheet of the T-83360-30 drawing, and locate rectifiers and ac distribution as shown.



Configuration 3 (with PDSC)

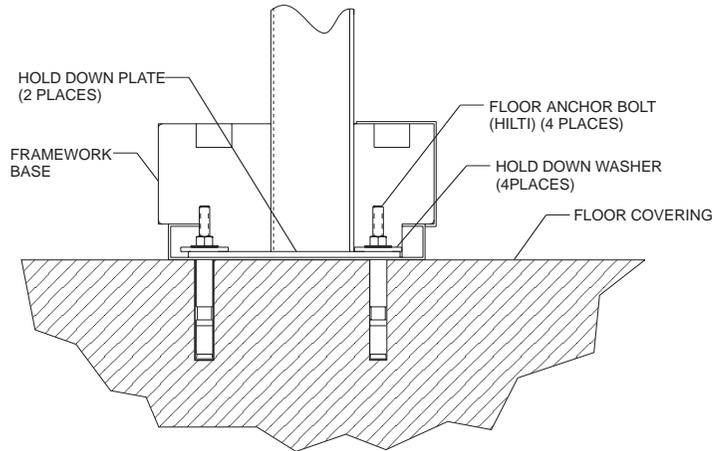
**Figure 7-13A: AC Distribution Floor Mounting Configuration**



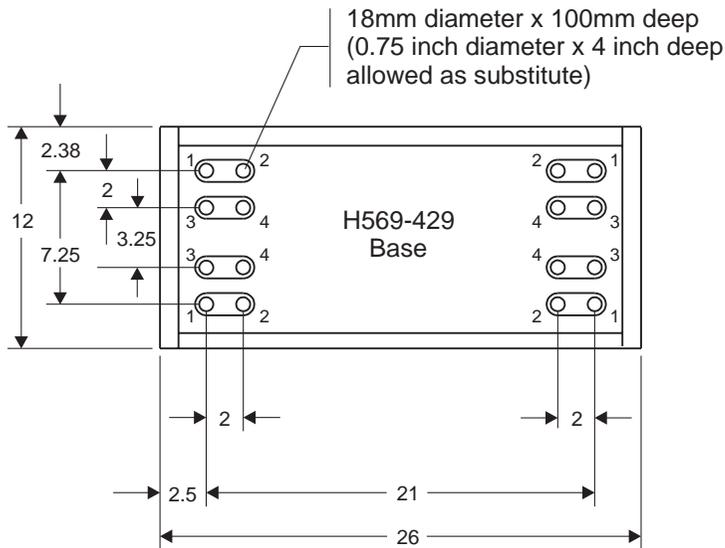
Configuration 3 (with wall mounted ac distribution cabinet)

**Figure 7-13B: AC Distribution Wall Mounting Configuration**

**Bolting Hardware** The Control and Distribution Bay contains the bolting hardware for mounting both the ac cabinet and Control and Distribution Bay to the floor. Figure 7-14 shows a typical floor mounting detail. Figure 7-15 is a floor-mounting template.



**Figure 7-14: Typical Floor Mounting Detail**



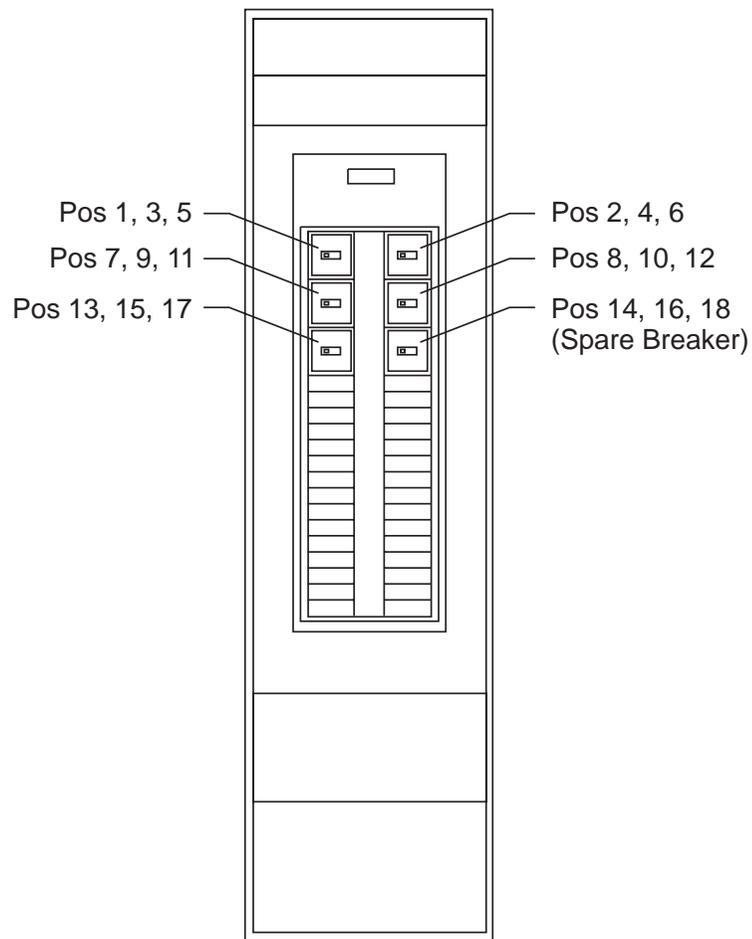
- 1 Concrete edge to hole center distance to be at least 2.5 inches.
- 2 Drill 4 holes, position 1. If interference in reinforced concrete occurs, use position 2, 3, or 4 in that order.

**Figure 7-15: Floor Mounting Template for Control and Distribution Bay**

All hardware for making electrical connections to the KS-22089 ac cabinets can be found inside the cabinet. The input ac lugs are not provided and must be furnished by the line engineer.

Follow local codes and NEC codes and requirements for connecting the service for the ac cabinets. (Service should be 100 amperes for 480-volts input and 200 amperes for 208 and 240 volts input.)

Six breakers are provided for each cabinet, and Position 14, 16, 18 is a spare in case of a failure. See Figure 7-16.

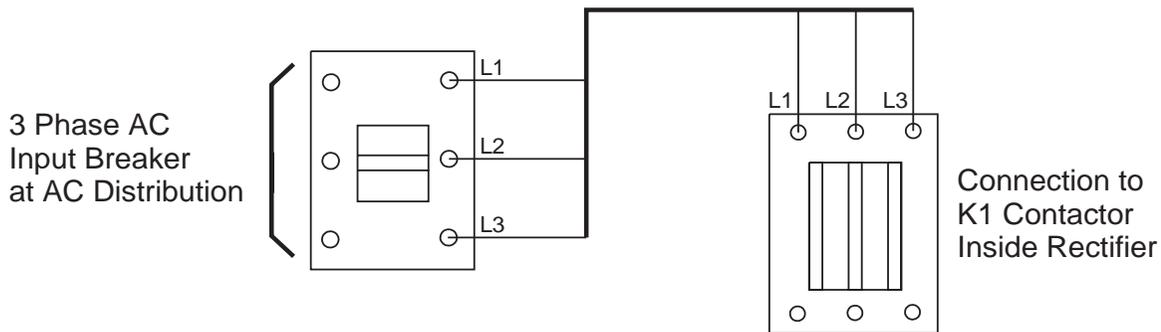


**Figure 7-16: AC Breaker Locations with Spare**

**Rectifier and AC Connections**

Connections between the ac cabinet and the rectifiers are 6-gauge for 480Vac service. The connections for the 208 or 240 Vac are 4-gauge. The installer must follow all local municipal codes and NEC codes and requirements. Figure 7-17 shows the connection of the ac to the rectifier.

Connect the appropriate gauge wire to the rectifier from the ac cabinet, per job specifications. Lugs for connecting to the rectifier are located in the hardware kits. (Refer to T-83360-30, Sheet D13 for appropriate connectors.)



**Figure 7-17: Connecting the AC to the Rectifier (K1 Contactor)**

**Rectifier Output Connections**

Use two 4/0 cables for the output of the rectifier to the Control and Distribution Bay, one for the (+) output, and one for the return. When Group 23 is ordered, the 4/0 cable is supplied with the ladder rack for each rectifier.

**Caution**

Be sure the rectifier's output breaker is **off**. Be sure no control cables are connected to the rectifier.

Refer to sheet D9 of the H569-429 drawing for connections in the Control and Distribution Bay. Each bus bar is marked as Charge Bus, Charge Return, or Discharge Return Bus.

**Alarms**

All rectifier alarms are prewired at the factory. Office alarms should be connected to the rear of the Galaxy Controller. Form C contacts are provided from the Galaxy Controller with Normally Closed (NC) or Normally Open (NO) contacts. Refer to the Galaxy Controller product manual for alarm connections to the customer's panel.

***Control and  
Distribution Bay  
Connections***

Output from the Control and Distribution Bay uses KS-24194, L13 Red with trace (“A” Plant), and Blue with trace (“B” Plant) braided 2-gauge wire.

Circuit breakers in the Control and Distribution Bay should be left in the **Off** position. For circuit breaker operation, use the precharge circuit. Refer to paragraph “Control and Distribution Bay Precharge Procedure” in this section.

***Return Bus Bar  
Kit (Using New  
PDF)***

The List K1 Return Bus Bar Kit is to be mounted either on a ladder rack or on top of the Power Distribution Frame. Refer to the Power Distribution Frame product manual. The filter panels and precharge circuits are prewired in the factory. Only their ground connections are required to be wired in the field. Follow normal procedures for installing the Power Distribution Frame.

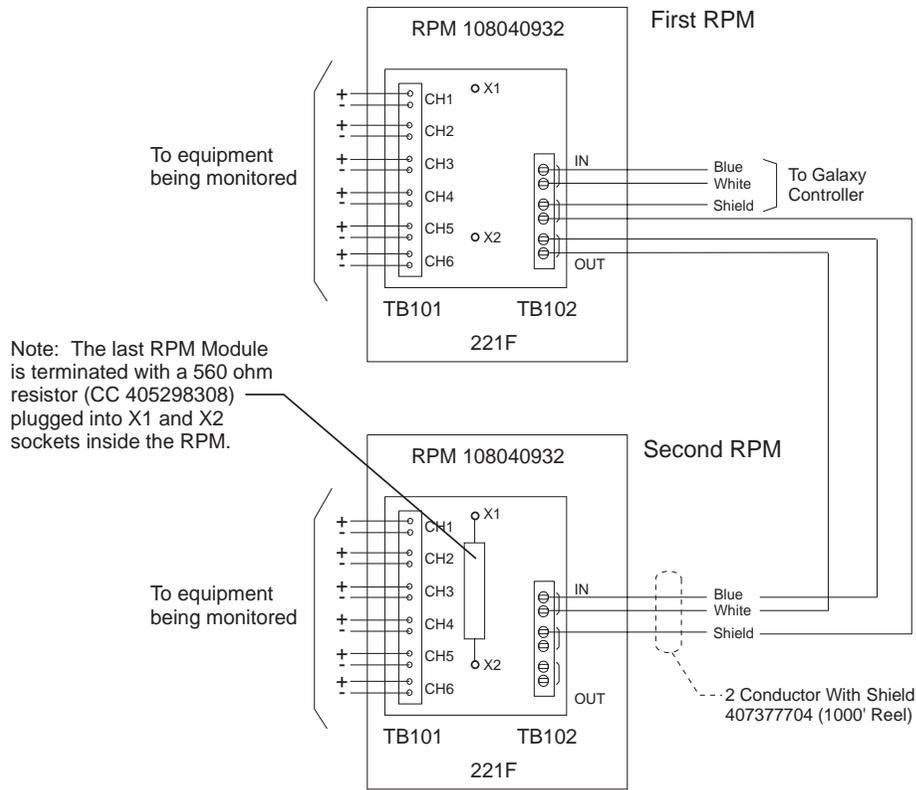
Connect the grounds from the filter panels to the K1 Return Bus Bar Kit and one ground to the Modutec Ammeter, pin 2. See Sheet D4 of the T-83360-30 drawing.

Connect the 4ESS™ loads to the Power Distribution Frame according to SD4A008-02 instructions.

***RPM Connection***

Connect to the RPMs using the 407377704 shielded cable. (See sheet D11 of the T83360-30 drawing for connections to the Galaxy Controller 847264348 circuit board.) The Blue and White wires are connected to the input (See Figure 7-18). The shield is to be connected to the first input shield return. Add the 560-ohm resistors to the last RPM. (Resistors are provided in the documentation package shipped with the product.)

Connect the RPM of the first Power Distribution Frame by placing the first cable from the Galaxy Controller to TB102, labeled IN. The second cable to the next PDF is connected to the bottom of TB102, labeled OUT. Inside the RPM there are two switches, SW1 and SW2. For the first PDF, set SW1 to “0” and SW2 to “A” (address 0A). For the second PDF, set SW1 to “0” and SW2 to “B” (address 0B). The second, or last, RPM requires the 560-ohm terminating resistor that is connected by plugging the leads into X1 and X2 pins (see Figure 7-18). For further information, see the Galaxy Controller product manual.



**Figure 7-18: Connections for the RPM**

**Battery String Protection Module Alarm Connections**

Connections to the ED83146-30 G1 battery string protection module alarm are made by connecting the 202A terminal of the battery string protection module alarm to one of the terminals marked E1, E2, and E3 on the BNF2 board, which is located in the top panel of the Control and Distribution Bay. E1 should be connected to string 1, etc. The return is connected to the battery return and is jumpered from the battery return to the alarm terminal of the fuse. The E1 through E3 terminals are 0.25" spade quick connect terminals. Stranded 22-AWG wire is recommended for the connection. The 202A terminal is accessed by removing the two screws and cover from the ED83146-30 G1 module.

The battery string protection module has a 600-ampere fuse in parallel with a 70G-type fuse. When the 70G operates, the alarm contact is closed. When closed, one side of the alarm contact is connected to battery return, the other is in series with an LED and is connected to +48 volts through a resistor. This completes a circuit that causes the LED to light and an alarm to be issued.

**Battery String  
Alarm  
Connections**

The Battery String Protection Fuse Alarm connection was designed for ease of installation. Use 22-gauge stranded wire to connect the alarm from the BNF2 board to the ED83146-30 G1 protection fuse with a single wire connection.

The connections at the BNF2 alarm board at the top of the H569-429 Control and Distribution Bay have quick connect, wire crimp push-ons for ease of installation. The connection is current limited by the R10 resistor on the circuit board. The connection at the battery protection fuse has a 202A terminal for terminating the connection. It is easily accessed by removing the two screws and removing the cover from the ED83146-30 G1. The Battery Fuse Alarm connections at the BNF2 board are marked E1, E2, or E3. Each connection is for one battery string. The connections are common on the circuit board so that if any negative return is applied to any E1, E2, or E3, it will issue an MJF alarm and an Open String alarm.

The Battery String Protection Module has a 600-ampere fuse with an LED and a 70G-type fuse indicator that is used to indicate a blown fuse. The module is mounted to the battery stand with Kit 847936192 and mounted on the negative side of the battery return.

**Miscellaneous  
Connections**

Connect the rectifier sense cable (847821907) to the Control and Distribution Bay BNF2 alarm board located inside the top panel of the Bay. Refer to Sheet D5 of the T-83360-30 drawing for connections.

**Rectifiers**

Refer to the rectifier product manual for power up of the rectifiers.

**Enhanced  
Ground Current  
Monitor**

Follow this procedure to install the Enhanced Ground Current Monitor (EGCM).

1. Identify the ground lead between the Plant Discharge Return Bus Bar and the CO Ground. This should be a 1/0 cable.
2. With a dc clamp-on ammeter, verify that the cable identified in Step 1 is carrying less than 500mA. If a current flow greater than 500mA is detected, it must be eliminated before proceeding.

3. Prepare an appropriate length of 1/0, stranded, green-color cable and half-tap this cable to the ground cable in proximity to the EGCM.
4. Install the EGCM on the cable rack above the Control and Distribution Bay in a location where the display can be easily observed.
5. Pass the 1/0, stranded, green cable through the sensor opening and connect it to the plant discharge return bus bar.
6. Verify that continuity exists in the half-tapped cable from the half-tap to ground.
7. Use the KS-21652 L3 Cover to cover the half-tap.
8. The ground fault monitor is connected to the Galaxy BJT1 board. Connections are from TB3 of Galaxy to TB1 of the EGCM. This supplies the 48 volts needed to power the EGCM. Connect the red wire from Pin 46 of the TB3 terminal block of the Galaxy, to the EGCM terminal labeled “-48V RTN”. Connect the black wire from the discharge return bus to the “-48VDC” terminal on TB1 of the EGCM. This connection is made to a 0.25" quick connect spade terminal located on the discharge return bus.

**Notes:**

- a. **The ABS2 circuit must be protected by a 1-1/3 ampere fuse in the BJF4 fuse board.**
  - b. **A red, 20-AWG wire is used to connect +48 volts to the EGCM from the Galaxy, and a black 20-AWG is used to connect the -48Vdc return to the EGCM from the discharge return bus.**
9. Four independent sets of alarm contacts are provided at Terminal Strip TB2 on the EGCM. These must be connected to alarm points as specified by the engineer and/or the customer.
  10. Allow fifteen minutes warm-up time, then verify the display reading by comparison with a digital clamp-on ammeter reading of the ground current. Adjust the offset control multi-turn potentiometer on the front of the control

unit until the display matches the clamp-on ammeter reading. See Step 2 of this section.

11. The EGCM has its own scan point, OAOO, in the 4ESS™ office alarm system.

### ***Test Equipment Required***

The following equipment is required to test the 415B Battery Plant:

- 300 watt test load – 2 amperes @ 150 volts
- 90 kilowatt load box – 600 amperes @ 150 volts [(3) ITE – 5317 load boxes may be used]
- DMM (digital multimeter) with 4-1/2 digit display and 0.05% accuracy or better
- Battery Plant Simulator Test Set (ITE-7102)
- Calibrated clamp-on dc current meter (0.1 ADC sensitivity)
- Standard installation tools, screwdrivers, etc.
- J87132B-2 rectifier product manual
- Galaxy Controller product manual for 415B Battery Plant
- Rubber gloves
- Windows-based personal computer (PC) with EasyView software installed
- Cable to connect PC communication port to local port of the controller

### ***Power Up of 415B Battery Plant***

1. Perform the following verification checklist:
  - The frames of all cabinets are properly grounded.
  - The ground from return to CO Ground through the Enhanced Ground Current Monitor is installed correctly.
  - The ac equipment ground is properly connected to each rectifier.

- The correct ground cable gauge has been used (minimum #6 for rectifier, #2 for Control and Distribution Bay).
- The Enhanced Ground Current Monitor has been properly connected and its alarm contacts have been connected.
- Each 415B PDSC cabinet is fed from a circuit breaker, separated both physically and electrically for diversity (refer to Figure 2-1). Check that both PDSC ac cabinets are wired for the correct voltage.
- The PDSC ac cabinet has two lists, one to accommodate 208/240Vac and one to accommodate 480Vac:

208/240	Floor mounted	KS-22089, L4003
208/240	Wall mounted	KS-22089, L4183
480	Floor mounted	KS-22089, L4013
480	Wall mounted	KS-22089, L5183

- The rectifier list number must match the ac input voltage provided by the ac distribution panels:
  - List 1 - 208Vac, L310 breaker
  - List 2 - 240Vac, L310 breaker
  - List 3 - 480Vac, L606 breaker
- At both PDSC ac cabinets, check that the neutral conductor of ac input is not connected to the ground conductor.
- Examine each PDSC and rectifier for loose power connections and check that correctly-sized cables have been installed as specified in the job specifications.
- Examine each bay for sharp corners and burrs, and modify as appropriate.
- Check for conductor clearance within each bay. Pay special attention inside the rectifier, especially clearance associated with the high power or high voltage components, i.e., transformers, inductors, capacitors, etc.

- If not using the Area Bus Center: on both Power Distribution Frames, check that RPMs have been properly installed and that dip switches have been properly set and wired. PDF #1 should be set at 0A and PDF #2 to 0B.
- If not using the Area Bus Center, check that all fuses have been removed at both Power Distribution Frames.
- Refer to the switch setting table inside the rectifier door and check that the DIP switches on the 208G circuit module have been set correctly. The switch settings are set during manufacture to the default values shown in Table 7-C.

**Table 7-C: DIP Switch Default Settings  
for 208G Circuit Module**

Switch	Function	Setting	Description
S203.1, .2, .3, .4	BUHVSD	All Off	163V default setting
S205.1, .2	ISHVSD	Both On	160V default setting
S205.3	Local Equalize Disable	On	Used to set equalize output voltage
S205.4	Meter	On	Meter off with unit off
S205.5	Meter Calibrate	Off	Allows calibration of front panel meter
S205.6, .7, .8	Factory Test	All Off	Off -- used for factory test only

2. Verify that the ac input POWER switch on each rectifier is **Off**.
3. Assure that the rectifier output breaker is **Off** on all rectifiers.
4. Remove REG fuses for all rectifiers. They are located at the top of the Control and Distribution Bay.

5. Verify that all alarm cables J202 are *disconnected* at the 208G boards inside all rectifiers. The other end is still *connected* at the back of the Galaxy Controller.
6. Verify that all the remote sense cables J208 are still connected at both the Galaxy Controller and at all 208G boards in the rectifier.
7. Check that Battery Disconnect Switches (on Control and Distribution Bay) are **Off**.
8. Make sure load boxes are turned off and at no load, then connect the load boxes between the Charge and Discharge Return buses.
9. Verify that the battery voltage and polarity at the top of the Control and Distribution Bay is correct, i.e., (+) on the switch bus bars and (-) on the Charge Return bus.
10. Operate battery disconnect switch(es) to the **On** position, which connects power to the Control and Distribution Bay. Result: the converters in the Control and Distribution Bay should power up the Galaxy display, and, after a short delay, the display will indicate battery voltage. The Galaxy will also indicate any alarms that are present.

**Note: Ignore alarms at this time.**

11. At each ac cabinet turn on the ac circuit breakers, then test them by pushing the trip button to verify proper operation. After testing, turn on the breaker by turning to full **Off** position, then back to **On**.
12. Turn on the rectifier power switch of Rectifier #1. Adjust rectifier output voltage to 151.9 volts.
13. Close the dc output circuit breaker of rectifier #1 following the procedure outlined on the label above the breaker.
14. Turn off rectifier. (Use the Power ON/OFF switch at rectifier.)
15. Install REG fuse.
16. Repeat Steps 12 through 15 for all rectifiers.

17. Verify that all rectifiers are off before proceeding.
18. Reconnect ALL alarm cables J202 at the 208G boards for all rectifiers.
19. Place a 20-ampere load on the battery plant; turn the ac power switch on rectifier to **On** and adjust its output to 151.9 volts.
20. Turn off rectifier and load.
21. Repeat Steps 19 and 20 for all rectifiers.
22. Turn all rectifiers on with 20 amperes still applied. Wait until batteries are charged and draw less than 5 amperes at the rectifier displays.
23. At PDSC A1 (or B1), open ac circuit breaker #1. Verify that power has been removed from the appropriate rectifier (refer to Figure 2-1).
24. Operate breaker to **On** after test.
25. Repeat Steps 23 and 24 for all assigned circuit breakers in both ac cabinets associated with the plant PDSC A1 or B1.

### ***Control and Distribution Bay Precharge Procedure***

Precharge each capacitor of the Power Distribution Frames by following these steps:

1. Turn the rotary switch on the Control and Distribution Bay distribution panel to the first position.
2. Press and hold the precharge button on the distribution panel. Notice that the red LED will be on momentarily.
3. Close Circuit Breaker #1, then release the precharge button.
4. Repeat Steps 1 through 3 until all circuit breakers have been operated to the **On** position.

5. Verify that all the green LEDs on the Power Distribution Frames are lit.

**Note**

Circuit Breaker #1 also provides power for the alarm circuit.

***Pre-test Setup***

These system test procedures are based on the assumption that all installation work has been completed, battery strings have been initially charged, and no working loads have been connected to the battery plant.

Plant loads will be simulated through the use of a test load box. Verify that spare fuses for each of the components of the battery plant are available and accessible. Do not overlook the fuses associated with the battery strings.

Complete individual rectifier tests, following procedures in the rectifier product manual, before performing these system test procedures.

**Note**

At this point all rectifiers are on and the plant is connected to the battery and to the Power Distribution Frames. The test load is connected.

## ***System Test Procedures***

### **Warnings**

A limited recharge alarm may occur at the Galaxy Controller during these tests.

Whenever rectifiers have been turned on, their output filter capacitors stay charged for several minutes. Do not place hands inside a rectifier until these capacitors have discharged to a safe level (below 50 volts).

Remember that this is a 140V (nominal) battery plant. Personal safety must be considered at all times while working on this plant. The batteries will be floating at 151.9 volts.

When power is removed from the rectifier, the display may stay lit until the dc output voltage is less than 30 volts.

### ***Rectifier Walk-in***

1. With only one rectifier turned on, adjust the battery plant load to be 130-140 amperes. The rectifier assumes full load.
2. Turn the rectifier off via the POWER switch; wait 5 seconds, then turn it back on. The rectifier walks in and assumes full load within 10 seconds.
3. Turn the POWER switch to **Off**.
4. Repeat Steps 1 through 3 for all rectifiers (one rectifier on line at a time).

### **Note**

Always open the load between tests to keep batteries from discharging.

### **Note**

Alarms may be present in the Galaxy Controller. Overlook them during this test.

***Current Limit  
Adjustment***

1. With two rectifiers turned on and on line, set plant load to be 170-180 amperes.
2. Set both rectifier voltage outputs to be 151.9 volts so that they share the load as much as possible.
3. Operate the rectifier NL/FL switch to FL (Full Load) on one of the rectifiers. The rectifier should assume a  $140 \pm 2$  ampere load. If it does not, adjust R488 (counter-clockwise to lower, clockwise to raise) on the 208G circuit pack until it does.
4. Operate the rectifier NL/FL to NL (No Load). The rectifier sheds most of its load and the other rectifier picks up most of the load.
5. Repeat Steps 1 through 4 for all rectifiers, always having two rectifiers on line, until all current limit set points are verified to be  $140 \pm 2$  amperes.
6. Turn off load box. (Reduce load to zero amperes.)

***Output Voltage  
Adjustment  
Range***

Before making the Output Voltage Adjustment, follow these preliminary steps:

- Turn off all rectifiers.
- Operate Battery Disconnect Switches to **Off**.
- Disconnect the control cable J202 at each 208G board on each rectifier.
- Remove the REG fuse for all rectifiers from alarm panel on the Control and Distribution Bay.
- Make sure there is no load on the rectifier.

To make the Output Voltage Adjustment, follow these steps:

1. With one rectifier on line, set the load at 20-30 amperes.
2. Adjust the output of the rectifier up and down and observe that the output voltage is adjusted smoothly in less than 0.1-volt steps.
3. The rectifier should be capable of being adjusted between 140 and 158 volts.

4. Return the rectifier to float voltage (151.9 volts).
5. Turn the rectifier off.
6. Repeat Steps 1 through 5 for all rectifiers.

***Rectifier Alarms  
and High Voltage  
Shutdown***

This test verifies that each rectifier shuts down and issues a Rectifier Fail Alarm (RFA) for each of the following conditions:

- When a rectifier fuse clears on the 329B fuse board
- Backup high voltage shutdown (BUHVSD) operates
- Internal selective high voltage shutdown (ISHVSD) operates

Perform the following procedures before continuing test:

- Turn all rectifiers to the **Off** position via the ON/OFF power switch at the rectifier.
- Remove all control (J202) and REG (J208) cables at the 208G board in all rectifiers.
- Turn all battery switches to the **Off** position at the Control and Distribution Bay.

***FA Test***

1. Replace a fuse on the 329B (CM1) board with a blown fuse. Turn on the rectifier via the ON/OFF power switch. The rectifier shuts down immediately and the RFA and FA LEDs should light on front of the rectifier.
2. Turn off the rectifier via the ON/OFF power switch.
3. Repeat Steps 1 and 2 until all five fuse positions on the 329B have been tested and verified.
4. Turn off the rectifier via the ON/OFF power switch. Replace the blown fuse with a good fuse.

***BUHVSD***

5. Set load to 10-20 amperes.

6. Turn on the rectifier via the ON/OFF power switch, and record the voltage on the display; This recorded voltage will be used to reset the rectifier in Step 11.
7. Set the load to 2 amperes and adjust to 161.5 volts and observe the rectifier remains operational.
8. Increase the voltage by depressing the **RAISE VOLTAGE** pushbutton to 164.5 volts and within 20 seconds the rectifier will shut down and the red RFA led will light.
9. Turn off the rectifier and lower the voltage via the **LOWER VOLTAGE** pushbutton by depressing the switch for approximately five seconds.

- ISHVSD**
10. Set load to 15 amperes (minimum) and adjust the output voltage to 158.5. (Wait 30 seconds). The rectifier should not shut down. Increase the voltage to 161.5 volts. Within 20 seconds, the rectifier will shut down and issue an RFA. Shut the rectifier off via the ON/OFF power switch, and lower the voltage by depressing the **LOWER VOLTAGE** pushbutton for approximately five seconds.
  11. Turn the rectifier back on via the ON/OFF power switch. Set the load to 10-20 amperes and adjust the output voltage to the recorded voltage made in Step 6. Turn off the rectifier via the ON/OFF power switch.
  12. Repeat test procedure steps 1 through 11 for all the rectifiers.

After completing these test procedures, follow these final steps:

- Remove all load.
- Reconnect the control (J202) and REG (J208) cables to the 208G board of each rectifier. Reinstall the REG fuses.
- Turn on all rectifiers and wait 10-20 seconds.
- Operate the battery disconnect switch to **On** for each position that has a battery string connected to it.

After completing these test procedures, follow these final steps:

- Remove all load.
- Reconnect the control (J202) and REG (J208) cables to the 208G board of each rectifier. Reinstall the REG fuses.
- Turn on all rectifiers and wait 10-20 seconds.
- Operate the battery disconnect switch to **On** for each position that has a battery string connected to it.

***Rectifier Equalize  
Adjustment (on  
Battery)***

1. Set the plant load to zero.
2. Turn off all rectifiers via their POWER switches.
3. Remove control cable J202 ONLY from each rectifier at the 208G board.
4. On the 208G circuit pack of each rectifier, operate DIP switch S205.3 to **Off**. This will enable local equalize in each rectifier.
5. Turn one rectifier On via the POWER switch.
6. Set the plant load to 10 - 20 amperes.
7. Operate the Float/Equalize switch on the front of the rectifier to EQUALIZE. Adjust the rectifier output voltage to 156 volts.
8. Operate the Float/Equalize switch to Float.
9. Turn the rectifier off via the POWER switch.
10. Disable local equalize by operating DIP switch S205.3 to **On**.
11. Repeat Steps 5 through 10 for all rectifiers.
12. Remove load. Reconnect control cables J202 to each rectifier at 208G board.

Upon completion of this procedure, turn all rectifiers **On** with the POWER switch.

**AC Failure Test** The purpose of this test is to assure that no Rectifier Fail Alarm (RFA) is generated under the most stringent ac failure circumstances.

This test is performed with all rectifiers on line and a set load on the battery plant. Set load per Table 7-D for test depending on how many rectifiers are present.

**Table 7-D: Load Settings for AC Failure Test**

<b>Number of Rectifiers in Plant</b>	<b>Load Not Less Than</b>
2	100
3	200
4	300
5	400

1. Open the ac circuit breaker feeding the PDSC that is powering the rectifier under test. The rectifier will shut off.
2. Verify that no rectifier failure alarm (RFA) is initiated.
3. Close the circuit breaker previously opened.
4. The rectifier returns to normal.
5. All alarms clear.
6. Repeat Steps 1 through 5 with less than 50 amperes load for all rectifiers in plants. A momentary PHA may occur, then an ACF, when power is first removed. Observe that the ACF LEDs on the rectifiers light while ac is failed.
7. Restore the system to normal by closing all breakers previously opened.

**Galaxy  
Controller**

The Galaxy Controller for the 415B Battery Plant is ordered as J85501F-1, L4. Table 7-E lists the circuit packs furnished with the controller.

**Table 7-E: Circuit Packs/Kit Furnished with the Galaxy Controller**

Power Supply	BJJ1
Independent Controller	BJB2
Intelligent Controller	BJH3
Remote Peripheral Monitor (RPM) Interface	BJM1
Fuse Board	BJF4
Terminal Board	BJT1
Display	BJG1
Alarm Board	BJE1
Rectifier Interface	BJC1
Basic Power Board	BJA1
Battery Reserve Time Prediction Kit	K1

Table 7-F lists the optional circuit packs/kits.

**Table 7-F: Optional Circuit Packs for the Galaxy Controller**

Modem	BJL2
Data Switch	BJK1

The Galaxy Controller is configured at the factory. Refer to the section on *Configuration* in the Galaxy Controller product manual (Select Code 167-792-122).

The following list gives some of the more important Galaxy information that is needed in order to check the configuration.

Rectifier	J87132B-2
Plant Shunt	600 amperes @ 50 mV
High Voltage Shutdown	156.5V
Boost High Voltage Shutdown	160V
Backup High Voltage Shutdown	156.9V
High Float Warning	155.5V
Rectifier on Threshold (ROT)	130V
High Float Warning (Boost)	159V
Battery on Discharge (BD)	149V
Battery on Discharge (BD Boost)	149V
Very Low Voltage (VLV)	133V
Power Distribution Frame Shunts	150 amperes @ 50 mV
Float Voltage	151.9V
Boost Voltage	156V

### Note

The “Boost” voltage level is equal to 2.23 volts per cell, or 156 volts.

After configuration has been checked and values confirmed as indicated above, proceed to the next section.

### *Galaxy Readouts*

1. Using the digital multimeter, read the voltage across the output buses [Charge (+), Charge Return (-)] at the top of the Control and Distribution Bay. Compare this voltage with the Galaxy Controller voltage on the front panel readout. If the readouts do not agree to within  $\pm 0.1$  volt, adjust the Galaxy to agree, utilizing the ADJ PLV function under the CONFIGURE and PLANT menus. Return the display to normal by pressing the MENU button.
2. Connect the digital multimeter across the plant shunt at the top of the Control and Distribution Bay. Place a 240-260 ampere load on the plant. Remember that each millivolt read across the shunt equates to 12 amperes load ( $\pm 2\%$ ).
3. Compare the shunt load reading with the Galaxy front panel load reading. If they do not agree to within  $\pm 1$  ampere, adjust Galaxy to agree with the shunt readings, utilizing the ADJ PLI function under the CONFIGURE and PLANT menus. Restore the plant to normal via the MENU key.
4. Remove load.

### *DC/DC Converters*

Mounted below the Galaxy are two (redundant) converters that supply its power. They convert the 140Vdc battery voltage to 48Vdc. The converters are located behind the front panel.

1. Remove converter #1 circuit pack and observe that Galaxy does not lose power. Also observe that CONV 1 FAIL LED (red) lights and extinguishes as circuit pack is removed. Check that a minor alarm is received at Galaxy. Replace the converter #1 circuit pack.
2. Repeat Step 1 for converter #2.

## ***Galaxy and Rectifier Interface Leads***

For this series of tests, set the load to 10 to 20 amperes. The batteries should be connected to the load.

### ***Rectifier Fail Alarm (RFA) Leads***

1. Turn off rectifier. Replace fuse on the 329B board with a blown fuse. Turn on the rectifier. Verify that the rectifier shuts down and that there is an RFA and a Minor alarm indication at Galaxy. Also verify that Galaxy sends a Power Minor (PMN) alarm, i.e., that the alarm is remotod.
2. Restore the rectifier to normal.
3. Repeat Steps 1 and 2 for all rectifiers.

### ***AC Fail (ACF) Leads***

1. Remove ac from rectifier #1 by opening its ac input circuit breaker at the PDSC. Verify that there is a minor alarm at Galaxy and that a PMN alarm is sent from Galaxy.
2. Restore ac to rectifier #1. Repeat tests for all rectifiers.

### ***PH Leads***

This test is done with the battery connected to the Control and Distribution Bay and with 10 - 20 amperes of plant load with all rectifiers on.

### **Warning**

Extra care should be taken while performing the following test. It requires removing a phase of the incoming ac. Before performing any operation, use a DMM to verify the circuit is not live.

**Wear rubber gloves.**

1. Open ac breaker at PDSC for rectifier #1.
2. At a convenient location, e.g., at the rectifier input, remove one ac phase powering rectifier #1.
3. Insulate the open lead at the side coming from the PDSC.
4. Turn on the breaker at the PDSC.

5. Verify that the rectifier has an alarm and does not cause an RFA, the PH LED lights at the rectifier, and that minor, rectifier, and ac alarms are present at Galaxy.
6. Open the ac circuit breaker at the PDSC for the rectifier under test.
7. Remove insulation installed in Step 3 and restore the ac phase removed in Step 2.
8. Close ac breaker at PDSC that powers the rectifier under test.
9. The rectifier restarts and all alarms clear.
10. Repeat this procedure for all rectifiers.

***CB Leads***

1. Turn off rectifier #1 and open the output dc circuit breaker on the rectifier. Remove the REG fuse to the rectifier at the Control and Distribution Bay.
2. Open the ac breaker to the rectifier at the PDSC.
3. Verify that the voltage on the output capacitors is less than 50 volts. If not, wait until the voltage is less than 50 volts.
4. At the rear of the output circuit breaker, remove the pair of small gauge wires. These wires are used to send a trip signal from the breaker to the Galaxy.
5. Restore the ac to the rectifier, turn the rectifier on and short the two wires that were disconnected in Step 5.
6. Verify that a MIN alarm is displayed at the Galaxy, a PMN is sent from the Galaxy, and the rectifier turns off.
7. Turn the rectifier off, remove ac to the rectifier at the PDSC, wait until the voltage on the capacitors is less than 50 volts, and restore the wires previously disconnected from the rear of the breaker.
8. Restore the ac at the PDSC; turn on the rectifier output breaker using the procedure specified on the label above the breaker.

9. Repeat this procedure for each rectifier.

**MAN Leads**

This test is done with the battery connected to the Control and Distribution Bay, 10 - 20 amperes load, and all rectifiers on.

1. Turn off one of the rectifiers.
2. Verify that MIN and RECT alarms are displayed on the Galaxy and that a PMN is remoted.
3. Turn the rectifier on; the alarm should clear.
4. Repeat Steps 1 through 3 for all rectifiers.

**VI and VP Leads**

Refer to Section 7, *Glossary*, for the definitions of VI and VP.

1. Before adjusting the VI signal, locate the BJB board inside the Galaxy controller.
2. Verify that SW202 position #8 is at the "1" or "closed" position.
3. Configure the controller for rectifiers. You can configure the rectifiers from the front panel of the Galaxy by doing the following:

Press MENU→CONFIG→RECT DEF

Press ENTER; the display will now show:

RECT DEF  
G01 (flashing)

Note: G01 represents rectifier one and you will see it flashing off and on.

Press ENTER; the display will now show

RECT 01  
TYPE: UNCONFIGURED (flashing)  
SHUNT mV: 50.00  
MAN SW: NONE

Press ADJUST + or - to scroll through menu until J87132B-2 appears in TYPE:

Press ENTER to store information selected.

Press ESCAPE to return to RECT DEF and select G02 for rectifier two.

Configure rectifier number two the same as above and continue for all rectifiers.

Press ESCAPE to return screen back to main display.

After all rectifiers are configured, proceed to Step 4.

4. On the front of the Galaxy, follow the path:  
MENU →MEAS→RECT

Press ENTER and all configured rectifiers will display their currents, i.e., G01 = 5, G02 = 7, etc.

5. Press ENTER to store and save the information.

**Note: Pressing ESCAPE returns the screen one level.**

6. With only rectifier #1 on line and carrying a load of approximately 70 amperes, measure the voltage at test points E101 and E102 of the 329B fuse board. Calculate the actual load on rectifier as follows:

The rectifier test points (shunt) will read 50 millivolts at 175 amperes. Each millivolt read on the meter is equal to 3.5 amperes of load. Calculate the load current from this reading. For example:

$$20\text{mV} \times 3.5 \text{ amperes per millivolt} = 70 \text{ amperes}$$

Compare the calculated load current with the current reading at Galaxy. The shunt reading should agree with the Galaxy reading. If not, proceed to Step 7. If the two readings agree, skip to Step 8.

7. Adjust R435 on CM2 of the rectifier to bring the reading on the Galaxy within tolerance.
8. Repeat procedure for all rectifiers.

***HV and RS Leads***

The following HV tests should only be performed with a test load and on battery.

1. With all rectifiers on line and a plant load of approximately 20-40 amperes, adjust output of rectifier #1 up until it assumes the total plant load from the other rectifiers. Continue raising its output voltage until the plant HFV (155.5 volts) alarm activates (RECT and MIN LEDs light).
2. Continue raising the output voltage until the rectifier exceeds the HV threshold of the Galaxy (156.5 volts). At this point rectifier #1 will shut down, allowing the plant voltage to drop back to float, and the remaining rectifiers will assume the load. After five seconds the rectifier under test will restart, assume the load once more, and shut down again from high voltage. This time the test rectifier stays shut down and an RFA alarm is present.
3. Reduce the output voltage of rectifier #1 and restart it from the Galaxy utilizing the path MENU→RECT RST.
4. Repeat the procedure for all rectifiers.
5. Adjust all rectifiers to a float voltage of 151.9 volts at the battery terminals.

***TR and TRH Leads***

1. At TB3, located at the rear of the Galaxy, short terminals 8 and 24 (TR1 and return). Rectifiers #1 and #2 will shut down while leads are shorted. Observe that Galaxy indicates that rectifiers #1 and #2 have been externally shut down. The path is MENU→ALARM. Remove the short and verify that the rectifiers restart.
2. Short terminals 9 and 24 (TR2 and return). Rectifiers 3 and 4 (if provided) shut down while leads are shorted. Observe that Galaxy indicates that rectifiers #3 and #4 have been externally shut down. The path is MENU→ALARM. Remove the short and verify that the rectifiers restart.

***Equalize/Boost Leads***

1. Apply a 20 - 30 amperes test load.
2. From front panel of Galaxy, activate Boost command. The path is MENU → MODE→ ENTER. Verify that each rectifier raises its output voltage to 156V.

3. Deactivate the boost command via the Galaxy. The path is MENU → MODE → ENTER.
4. Verify that the rectifiers return to the correct float voltage.

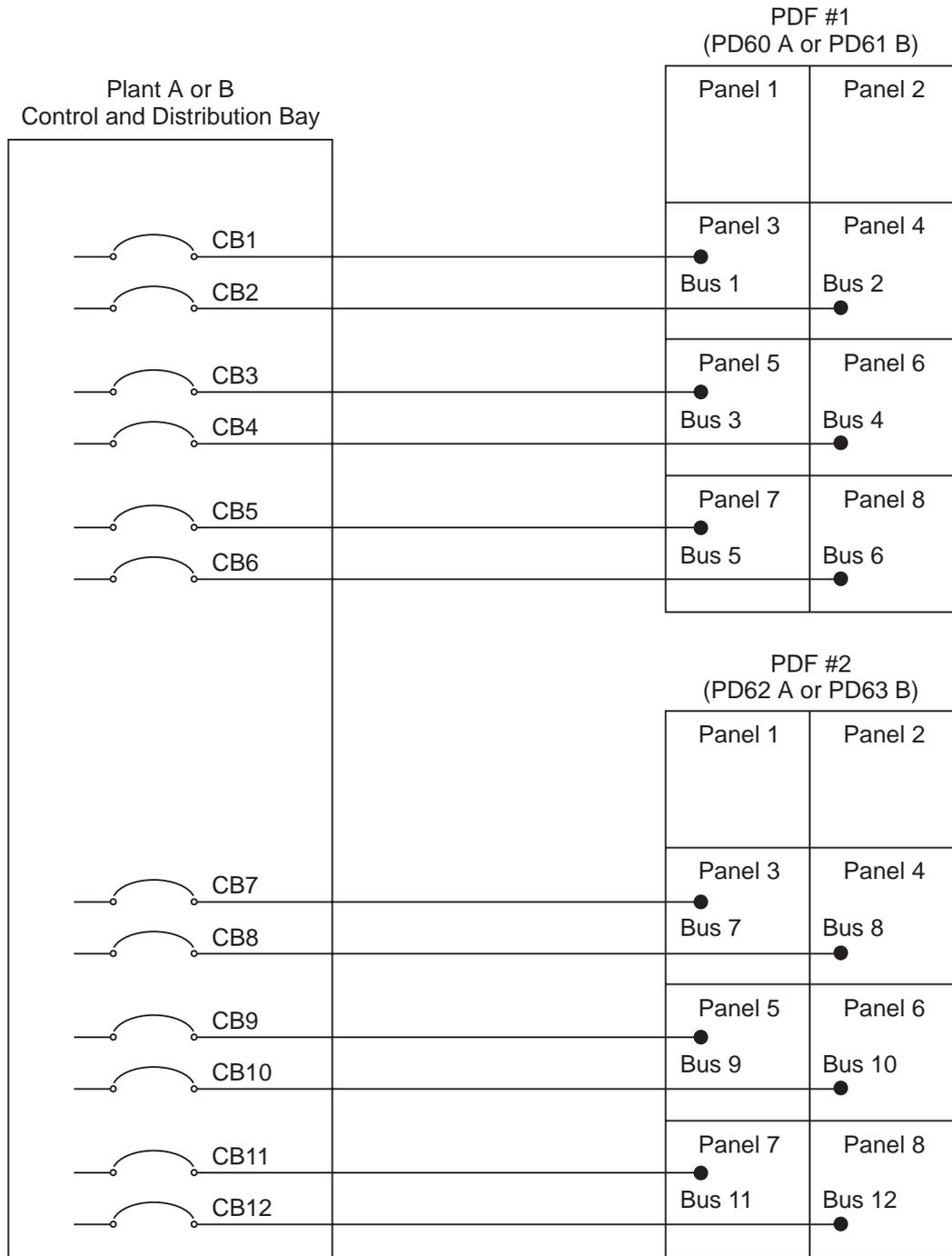
## ***Control and Distribution Bay***

**Note: Skip this section if using the Area Bus Center (ABC).**

### ***Circuit Breaker Panel***

There are two Power Distribution Frames for each Control and Distribution Bay. The first six circuit breakers feed Power Distribution Frame #1 and circuit breakers 7 - 12 feed Power Distribution Frame #2. See Figure 7-19. Each circuit has a 150 amp, 50mV shunt associated with it that is located in the Power Distribution Frame.

1. Precharge the Power Distribution Frame buses as follows:
  - a. Rotate the CAP/CHG rotary switch to circuit #1.
  - b. Depress the CAP/CHG pushbutton switch; the red LED lights, then extinguishes.
  - c. With the CAP/CHG pushbutton switch depressed, operate circuit breaker #1 to the **On** position.
  - d. Release the pushbutton switch.
2. Check that the appropriate bus is powered at the Power Distribution Frame. A green LED on the front of the Power Distribution Frame will light, indicating the bus that has been energized. Refer to Figure 7-19.
3. Repeat Steps 1 and 2 for all circuit breakers that are electrically connected to the Power Distribution Frames.



**Figure 7-19: Circuit Breaker Feeds to Power Distribution Frames**

## **Miscellaneous Alarms**

### ***BD and VLV Alarms***

1. With all rectifiers off, apply a 100-ampere test load to the plant. Observe the plant voltage on the front panel of the Galaxy. Verify that the BD alarm is generated at  $149\pm 1$  Vdc. The Battery on Discharge (BD) and a MAJ alarm will be displayed at Galaxy and a PMJ alarm remotod.

**Note: It may be necessary to use less than 100 amperes in order to accurately determine the BD alarm level.**

2. Turn all rectifiers on; set plant load to 400 amperes. Change the VLV setting on the Galaxy to  $143+1/-0$  volts using the path MENU→CONFIG→THRESHOLD.
3. Turn rectifiers off.
4. Allow batteries to discharge to threshold of Very Low Voltage (VLV). Verify that a VLV alarm is activated along with PMJ and critical at  $143\pm 1$  volts.

**Note: It may be necessary to increase or decrease the load to verify the alarm level.**

5. Return rectifiers on line. Decrease load to 100 amperes. Verify that the alarms are retired after the voltage increases above  $143\pm 1$  volts.
6. Using the path MENU→CONFIG→THRESHOLD, restore the VLV setting to 133 volts.

### ***Battery String Fuse***

1. With batteries connected and a 50 to 100-ampere load, insert or simulate a blown alarm fuse at battery string #1. The LED lights at the battery string fuse holder. External fuse major and OS MAJ alarms are generated, and BATT, DIST, and MAJ LEDs light on the Galaxy front panel. Verify that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center.
2. Repeat procedure for all battery strings.

**Battery String  
Disconnect**

This test is done with all rectifiers on and at no load.

1. At the Control and Distribution Bay, operate battery disconnect switch #1 to **Off**. OS and MAJOR alarms are initiated and displayed at Galaxy. A RED lamp lights at the top of the Control and Distribution Bay. Verify that the Open String alarm is initiated and that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center. Press MENU→ALARMS at the Galaxy front panel.

**Note: Be sure to return the battery switch to On after completing the test.**

2. Repeat the procedure for each battery switch connected to a battery string.

**Note: Battery Switch One is factory connected. When installing a 2nd or 3rd battery string, the 2nd or 3rd battery Auxiliary switch must have the blue wires connected to activate the alarm when switch two or three is placed in the Off position.**

3. Verify that visual and audible Local Office alarms are initiated and that a remote alarm has been received at the Alarm Center.

**Control and  
Distribution Bay  
Fuse Alarms**

This test is done with all rectifiers **On** and a 10 - 20 amperes load. REG fuses are located on the top panel of the Control and Distribution Bay. There are four REG fuses (Minor) and one controller fuse (Major).

1. Place a blown fuse in all REG fuse locations (one at a time) on the Control and Distribution Bay. Observe and verify that rectifiers #1 through #4 issue a DIST and MIN alarms.
2. Verify that a local RFA alarm is issued, visual and audible Local Office alarms are initiated, and a remote alarm has been received at the Alarm Center.
3. Place a blown fuse in the CONTROLLER fuse position. Observe and verify that Galaxy LEDs BD, BATT, DIST, CRIT, and MAJ light.

4. Verify that local MJF and RFA alarms are issued, visual and audible Local Office alarms are initiated, and a remote alarm has been received at the Alarm Center.

***Power  
Distribution  
Frame Fuse  
Alarms***

**Note: Skip this procedure if using the existing ABC bays.**

Power Distribution Frame alarms are not sent to Galaxy. A red lamp will light at the top of the Power Distribution Frame and alarms sent to the local alarm circuit. Alarms may be monitored at terminal blocks beneath the stile strip at the front of the Power Distribution Frame or by the local alarm circuit if it is wired.

1. Verify that the ABS power of PDF #1 is furnished from PDF #2. This connection is located at the top of the Power Distribution Frame, labeled Terminal E4.
2. Verify that the ABS power of PDF #2 is furnished from PDF #1. This connection is located at the top of the Power Distribution Frame, labeled Terminal E4.
3. Place or simulate a blown fuse in each active fuse position.
4. Verify that the local alarm is generated.

**Note: The Power Distribution Frame alarms are not wired to the Galaxy, but are wired directly to the 4ESS™ scan points.**

***Battery Plant  
Overall  
Operation Tests***

**Note: For this procedure, full load is 240 amperes if three rectifiers are installed and 360 amperes if four rectifiers are installed.**

***Energy  
Management  
(Efficiency)  
Algorithm***

1. Before testing the energy management algorithm, locate the BJH board inside the Galaxy controller, and:
  - a. Enable SW204 position #1 to the “1” or “closed” position.
  - b. On the front of the Galaxy, follow the path: MENU→CONFIG→RECT CTR→EFFIC and then enable the energy management algorithm by pushing the (+) button.

c. Press ENTER to store and save the information.

**Note: Pressing ESCAPE returns the screen one level.**

2. Place all rectifiers on line at float voltage and apply full load. Record plant voltage. In ten minutes a rectifier will turn off. Record plant voltage.
3. Decrease the load to 90% of two rectifiers or 240 amperes. In ten minutes another rectifier will turn off. Record plant voltage. (Skip this step if there are three rectifiers in the plant.)
4. Decrease the load to 90% of one rectifier, about 120 amperes. In ten minutes another rectifier will turn off. Record plant voltage.

**Note: One rectifier remains on at this point.**

5. Increase the load to 160 amperes. A second rectifier turns on immediately. Record plant voltage.
6. Increase the load to 300 amperes. A third rectifier turns on immediately. Record plant voltage.
7. Decrease load to 120 amperes. Wait until only one rectifier is on. Record plant voltage.
8. Apply 80% of rectifier capacity to the plant. All rectifiers turn on. Record plant voltage. Remove load. Record plant voltage.
9. Review all of the plant voltage readings taken in this section. All readings should be within  $\pm 0.7$  volts of 151.9 volts.

***Power  
Distribution  
Frame Shunt  
Monitors***

**Note: Skip this test if using existing ABCs.**

Before performing these tests:

- Be sure that no telecommunication loads are being powered from the Power Distribution Frame.
- Using EasyView, configure the RPMs that are connected.
- Have access to 1-ampere and 20-ampere test loads.

- If using PDFs, set RPM address on PDFs to OA and OB for second RPM. Retrofit Control and Distribution Bay RPMs are preset to 01, 02, and 03. OA and OB currents read at Galaxy will be secondary currents.
1. Verify that the RPMs are flashing, indicating that the Galaxy is communicating with the RPMs. If the RPMs are not flashing, check the connection to the Galaxy and the wiring from the RPMs to the Galaxy.
  2. Apply a 1-ampere test load to the output of a fuse position on the Power Distribution Frame.
  3. Insert the Power Distribution Frame load charge probe into the slot of the alarm fuse associated with the fuse position. The charge probe is keyed and must be inserted only one way.
  4. Depress the CHG/CAP button and verify that the red LED on the charge probe is on.
  5. Continue to hold the CHG/CAP button until the yellow FAIL LED lights.
  6. The yellow FAIL LED lights between 8 and 15 seconds.
  7. Release the CHG/CAP button, remove the charge probe, and return it to its holder on the Power Distribution Frame.
  8. Reduce the test load to zero; install a 20-ampere fuse in the main fuse holder of the position under test.
  9. Increase to 20 amperes the test load connected to the output of the fuse position under test.
  10. Measure the shunt voltage. Multiply the shunt voltage by 3 and record this value of current. The reading on the ammeter of the Power Distribution Frame and the Galaxy reading of the Remote Peripheral Monitoring device should agree within  $\pm 5\%$  of the current recorded above.
  11. Repeats Steps 8 through 10 for one fuse position on each fuse panel of both Power Distribution Frames, a total of 12 fuse positions.
  12. Remove the load box.

13. Remove all fuses from the Power Distribution Frame.

### ***Battery Reserve Time Prediction Option***

Refer to Section 3, *Installation*, in the Galaxy Controller product manual and verify that the thermistor has been installed properly at the battery. Also, program the Galaxy Controller using EasyView, and set the end volts per cell to 1.8 volts.

1. Place a load of approximately 50 amperes on the plant. Turn off all rectifiers and verify that a BD alarm occurs. Allow the BD alarm to exist for a minimum of 15 minutes.
2. Referring again to the Galaxy Controller product manual, verify at the Galaxy front panel that a Battery Reserve Time Prediction has been made. Record the predicted reserve time.
3. Turn rectifiers back on and verify that the BD alarm is retired.
4. After the BD alarm has been retired, verify that another (higher) prediction has been made. Record the predicted reserve time.
5. Provide the customer's technician with the recorded data.

### ***Enhanced Ground Current Monitor (EGCM)***

Once installed and powered, the Enhanced Ground Current Monitor (EGCM) will display the current flowing through the ground cable. If the ground current exceeds the upper or lower alarm set points, an alarm will be initiated and the red alarm light on the display will be illuminated. Alarms are not latching; if the current drops below alarm limits, the alarm condition will clear. There is a 250 msec time delay; transient conditions may trigger alarms.

#### ***Checking and Setting the EGCM's Offset Control***

Required tools:

- Calibrated clamp-on dc current probe
  - Small slotted straight blade screwdriver (1/8")
1. Use the calibrated clamp-on current probe to measure the current flow in the ground lead.

2. Verify that the polarity of the current reading on both the sensor and the clamp-on probe are the same.
3. Adjust the multi-turn offset control on the EGCM so that the display and the current probe read the same current. The offset control potentiometer is located on the front of the control unit.
4. If the offset cannot be adjusted properly, refer to the calibration and/or repair procedure in the product manual that is shipped with the EGCM.

***Checking High  
and Low Alarm  
Set Points***

Alarm set points can be checked by pressing the POSITIVE and NEGATIVE alarm test buttons located on the display unit. Holding the test button down will change the current reading at a fast rate. Tapping the button will change the value slowly.

1. Hold the POSITIVE test button down until the current increases.
2. Eventually the high alarm set point is exceeded.
3. Verify that when the set point is exceeded, the red alarm is lit and an alarm is issued.
4. Verify the integrity of the alarm to the 4ESS™ scan point.
5. Hold the NEGATIVE test button down until the reading is below the low alarm set point.
6. Verify that when the set point is exceeded, the red alarm is lit and an alarm is issued.
7. After the test button is released, the display current will gradually return to the actual current reading.

***Life Test***

**Note: This test will take at least 16 hours.**

1. Be sure to follow the safety practices recommended in this document.
2. Upon completion of all of the above tests, connect a test load set to 0 amperes to the plant.

3. Turn on all rectifiers and verify that the plant voltage is set to 151.9 volts.
4. Set the load to 140 amperes per rectifier.
5. Record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.
6. Allow the plant to run at this load for at least 16 hours.
7. At the end of the allotted time, record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.
8. Reduce the load to 0 amperes and record the plant voltage. Verify that it is within 0.7 volts of the setting in Step 3.
9. Remove the load. The plant is now ready to be connected to the office load.

### ***Heat Scan***

After one hour into the 16-hour full Load Test, perform a heat scan on the following connections using an Exergen or equivalent device:

1. Scan rectifier connections made in each power distribution service cabinet (PDSC) during the installation process.
2. Scan ac and dc connections in each rectifier made during the installation process.



## 8 *Maintenance and Operation*

### ***Reference Documentation***

Table 8-A provides reference documentation for installation, maintenance, and alarm wiring for the 415 Battery Plant.

**Table 8-A: Reference Documentation**

<b>Description</b>	<b>Product Manual</b>	<b>Select Code</b>
Maintenance for the Control and Distribution Bay	H569-429	167-792-120
Installation and Alarm Wiring for Power Distribution Frame	J85568D-1	157-005-101
Maintenance for the Rectifier	J87132B-2	169-792-100



## 9 *Glossary*

ABS	Alarm Battery Supply
AC	Alternating Current
ACF	AC Failure
ADJ PLI	Adjust Plant Current
ADJ PLV	Adjust Plant Voltage
BD	Battery on Discharge
BD Boost	Battery Discharge during Boost
BUHVSD	Backup High Voltage Shutdown
C&D	Control and Distribution
C. O.	Central Office
CAP	Capacitor
CHG	Charge
CONV	Converter
DC	Direct Current
DIP	Dual Inline Package

EG	Equipment Ground
EGCM	Enhanced Ground Current Monitor
ESD	Electrostatic Discharge
ESS	Electronic Switching System
FL	Full Load
HFV	High Float Voltage
ISHVSD	Internal Selective High Voltage Shutdown
LED	Light Emitting Diode
MAJ	Major Alarm
MIN	Minor Alarm
NC	Normally Closed (state when energized)
NEC	National Electric Code
NL	No Load
NO	Normally Open (state when unenergized)
OS	Open String
PDF	Power Distribution Frame
PDSC	Power Distribution Service Cabinet
PH	Phase Alarm
PMJ	Power Major Alarm
PMN	Power Minor Alarm

Rect Rst	Rectifier Restart
REG	Regulation
RFA	Rectifier Fail Alarm
ROT	Rectifier on Threshold
RPM	Remote Peripheral Monitor
TB	Terminal Block
TR	Remote Transfer, or Transfer
VI	a 2 to 10 volt signal from the rectifier, where 2 volts = 0 amperes from the rectifier and 10 volts = 125% of full load from the rectifier. The signal is linear at intermediate voltages
VLV	Very Low Voltage
VP	A dc voltage sent to the rectifier from the controller that is used to provide power for the VI signal. The voltage is isolated from the rectifier.

