Product Manual
H569-429

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Lucent Technologies 600-Ampere, 140-Volt Galaxy Control and Distribution Bay for 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

H569-429 Control and Distribution Bay

This product manual (Select Code 167-792-120) provides information on the H569-429 Galaxy Control and Distribution Bay. The H569-429 Control and Distribution Bay provides control and distribution capability for the 415B Battery Plant in both new and retrofit applications.

New 4ESS™ Applications

The H569-429 Control and Distribution Bay is a subsystem of the 415B Battery Plant, which offers a 600-ampere total plant capacity with a nominal +140Vdc output in a totally integrated energy system. The 415B Battery Plant uses state-of-the-art technology to achieve dramatic equipment size and weight reduction and to minimize maintenance. These advantages are realized by the application of ferroresonant rectifiers and round cell battery technologies.

The 415B Battery Plant has a modular front/rear access design for ease of installation and maintenance. This power system is ideal for use in confined areas and allows efficient use of valuable floor space.

The Control and Distribution Bay is a compact and complete system that can be configured in one standard equipment bay. It consists of a fuse alarm panel, manual disconnect/reconnect battery switches, a circuit breaker panel with capacitor charge switch, a Galaxy Controller, and 140/48-volt converters. It is compatible with virtually all flooded and valve-regulated batteries that float within the range of 151.9 through 156.0 volts.

The Galaxy Controller requires both front and rear access and a door is provided for the rear of the frame. The Galaxy Controller is configured with circuit packs for the J87132B-2 ferroresonant rectifiers. Optional packs are the modem and data switch boards. All alarms and thresholds are preprogrammed.

Groups 1 and 2 of the Control and Distribution Bay, which are used for new 4ESS™ applications, are shown in Figure 1-1. They are basically the same, except for the distribution breakers. Group 1 provides 60-ampere circuit breakers, and Group 2 provides 100-ampere circuit breakers. The circuit breaker panels, however, do not have the 25mV shunts in this arrangement; the Power Distribution Frames have the Remote Peripheral Modules (RPM) for reading the input bus currents. Growth in output current capacity is achieved by adding up to four 140-volt J87132B-2 ferroresonant rectifiers.

Retrofit Applications

The retrofit battery plant provides power for the using equipment as well as float and recharge capability for the battery reserve. It offers a 600-ampere total plant capacity with a nominal +140Vdc output. It is compatible with virtually all flooded and valve-regulated batteries.

The retrofit battery plant has a modular front/rear design for ease of installation and maintenance. This power system is ideal for replacing the 415A system and allows efficient use of valuable floor space. The retrofit is designed to use the existing ABC (Area Bus Center) distribution and existing batteries. However, when retrofitting a complete battery plant the ac distribution requires one KS-22089 Power Distribution Service Cabinet (PDSC) cabinet with six breakers.

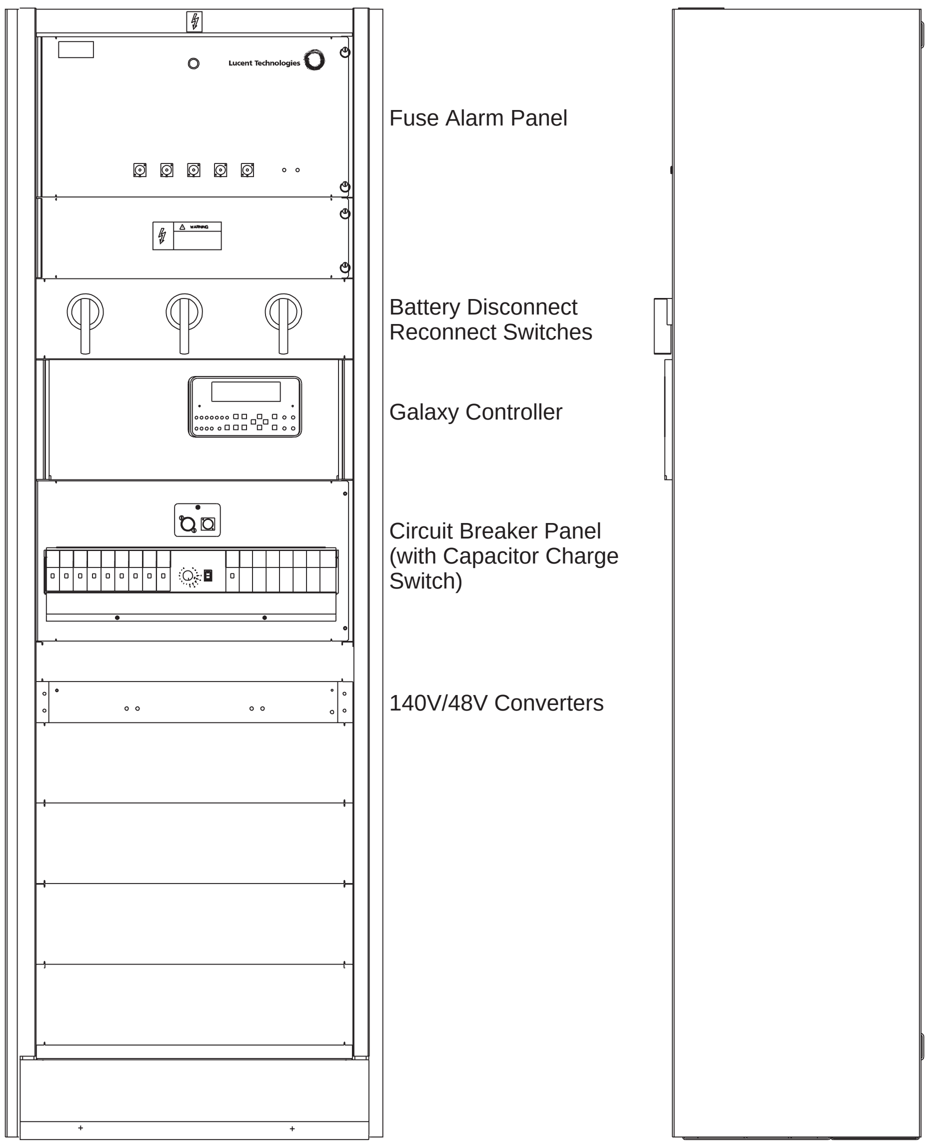
The Control and Distribution Bay for retrofit applications is available as Group 3 or Group 4, which are shown in Figure 1-2.

Group 3 was designed to retrofit “ASCOM WARREN” ferroresonant rectifiers only and is not equipped with a battery switch panel or distribution. Retrofit uses the existing ac from the retired 415A rectifier, and the batteries are still controlled by the PPP (Parallel Plant Protection). Group 3 is also used to add two rectifiers in parallel with the 415A Battery Plant, although the two failed rectifiers have to be in the same 415A module. The Group 3 can also be used to increase the capacity of a module by adding two ferroresonant 140-ampere rectifiers.

Group 4 was designed to replace the 415A system totally, using the same format as the 415B new system layout. The Group 4 distribution uses only 100-ampere breakers and is equipped with

25mV shunts for reading the currents to the Galaxy Controller from the RPM panel mounted below the converters. This system uses only one Power Distribution Service Cabinet (ac distribution) for five rectifiers. The fifth rectifier occupies the position used by the second PDSC in a new 415B system.

Group 5 is the same as Group 4 except the distribution uses 60-ampere breakers.



Group 1 or 2

Figure 1-1: H569-429 Galaxy Control and Distribution Bay Group 1 or 2 (New 4ESS™ Applications Only)

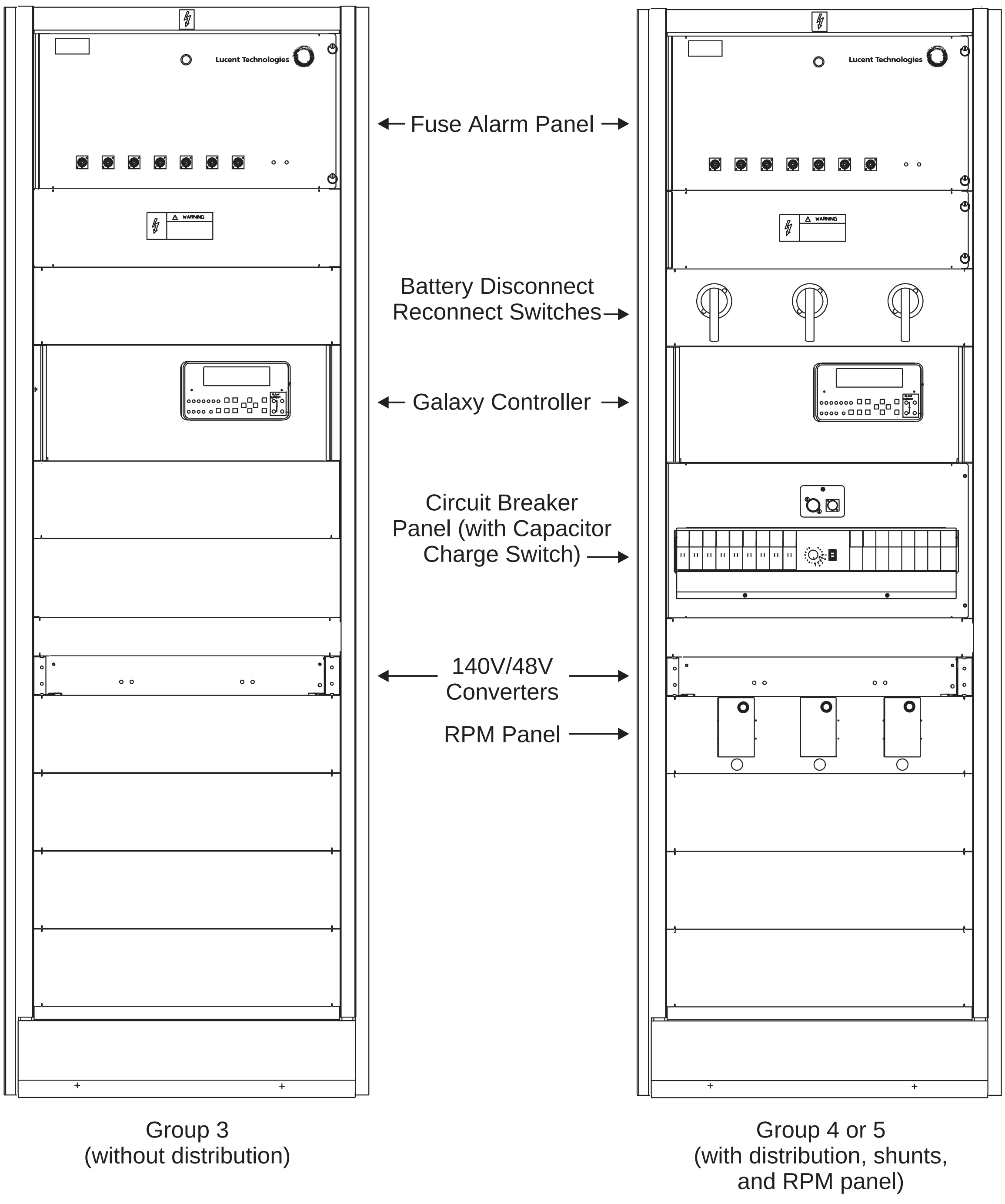


Figure 1-2: H569-429 Galaxy Control and Distribution Bay Groups 3, 4, and 5 (Retrofit Applications Only)

Technical Support

Wherever you are in the world, you can get technical support for all your Lucent equipment.

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

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

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

Central and South America, Europe, Middle East, Africa, and Asia Pacific Region

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

Product Repair and Return

Wherever you are in the world, you can arrange for repair and return of all your Lucent equipment.

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

For information regarding the return of product for repair, both in and out of warranty, customers may call 1-800-255-1402 for assistance.

Central and South America, Europe, Middle East, Africa, and Asia Pacific Region

For information regarding the return for repair of products, your sales representative will be happy to discuss your individual needs with you.

Customer Service

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

2 Product Description

Subsystems for New 4ESS™ Applications

Figure 2-1 is a block diagram of the 415B Battery Plant for new 4ESS™ applications. The Control and Distribution Bay of the 415B Battery Plant will accommodate up to four ferroresonant rectifiers, a Galaxy Controller, distribution panels accepting up to seventeen 60- or 100-ampere circuit breakers, and one capacitor charge panel for the circuit breakers. Stile strips and end covers are provided for appearance. Easy access to the rear of the bay is accomplished by using a rear door with a 1/4-turn latch.

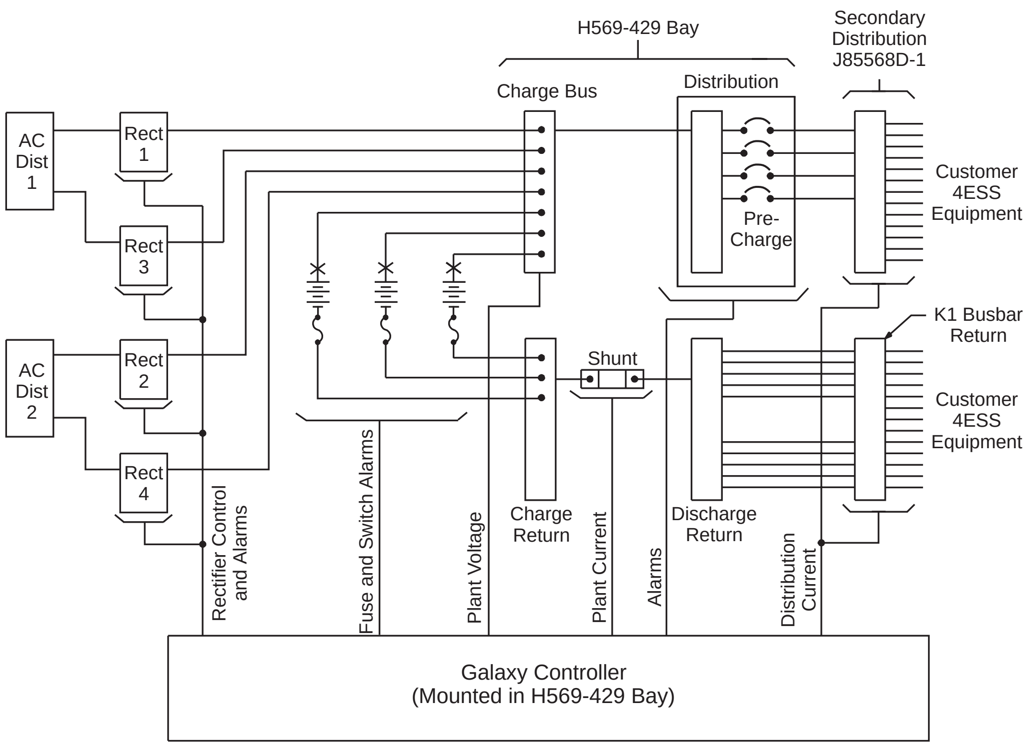


Figure 2-1: 415B Battery Plant Block Diagram (New 4ESS™ Applications)

AC Distribution

The ac distribution connects the commercial and/or standby ac power sources to the rectifiers and provides overcurrent protection. The KS-22089 Floor Mount or Wall Mount Power Distribution Service Cabinet (PDSC) can be purchased through the H569-429 drawing. A maximum of two rectifiers are connected per cabinet.

Rectifiers

The rectifiers convert an ac source voltage into the dc voltage level required to charge and float the batteries and to power the using equipment. The maximum number of rectifiers is four for a 415B plant.

Batteries

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

Galaxy Controller

The Galaxy Controller performs the centralized monitoring, control and reporting functions for the battery plant. The controller is mounted in the Control and Distribution Bay.

Basic Controller

The basic controller provides the basic local control and monitoring functions for the battery plant. User access is by the front-panel controls and display. It provides key battery plant alarms, high voltage shutdown, and plant voltage and current monitoring. The front panel includes an eight-line, 40-character display, LEDs, and switches and jacks for reading current.

Galaxy's basic controller includes a rectifier interface board handling signals from as many as eight rectifiers. The rectifier interface board is provided to work with Lucent Technologies 140V ferroresonant rectifiers.

Intelligent Controller

Plant features include plant alarms and histories, load statistics, and auto boost (sometimes referred to as auto-equalize).

Rectifier features include sequencing, an energy efficiency algorithm, remote rectifier on/standby, and rectifier event histories.

Battery prediction is provided that predicts reserve time for batteries made by Lucent Technologies.

System features include password security, dial-out on alarm, backup and restoration of configuration, and serial system upgrade. Three password security levels are provided: User, with read-only privileges; Super-User, with read/write privileges except for passwords; and Administrator, with read/write privileges including password setting and software updates. The system also provides a warning if passwords have been left at their factory default settings.

Local and remote user access to intelligent features includes the enhanced front panel display, dial-up by modem, and an RS-232 local port for a personal computer or terminal using ANSI T1.317 object-oriented command language. The Galaxy Controller also provides access for computer-to-computer interaction via an RS-485/232 port, using TL1 communications protocol.

Remote peripheral monitoring is provided for measuring feeder currents and reporting these currents to the Galaxy Controller. The RPMs are located in the Power Distribution Frames, one per PDF.

DC Distribution

The dc distribution provides overcurrent protection, connection points for the using equipment, and bus bars for interconnecting the rectifiers, batteries, plant shunt, and dc distribution. The dc distribution is mounted in the Control and Distribution bay. The H569-429 distribution also includes the plant charge and discharge bus bars, plant shunt, three battery disconnects, and a 140/48V converter to power the Galaxy Controller.

Up to 17 circuit breakers for the distribution panel are available with the 415 Battery Plant. The battery plant is supplied with twelve circuit breakers. They are orderable via list numbers from the H569-429 drawing. The panel is shown in Figure 6-1. See Table 3-D for available circuit breakers.

An alarm connection is provided on each panel to indicate an open fuse or tripped circuit breaker. The alarms for all distribution panels in a plant are paralleled and transmitted to the Galaxy Controller as a Major Fuse Alarm, MJF (FAJ).

Termination Points

Termination information for load leads for each distribution panel is listed in Table 3-E. The corresponding return for each load lead is terminated to the Plant Discharge Return Bus.

Circuit Breaker Panel

The circuit breaker panel is shown in Figure 6-1. The specifications are listed in Table 3-D.

The ON/OFF position label is molded into the front of each circuit breaker body. If an overload occurs, the breaker will trip and its handle will automatically move to the mid-trip position. At the same time, a closure signal for the MJF (FAJ) alarm will be provided at the breaker's alarm contacts.

Capacitor Charge Panel

For initial powering of high inrush loads, a charge feature is provided for 17 circuit breakers. In order to provide the Capacitor Charge feature, One Capacitor Charge Panel, List CB (provided with Group 1 and Group 2), is provided for each plant in addition to the charge feature on the circuit breakers.

Load pre-charging is normally required before connecting loads with high inrush current characteristics through circuit breakers to avoid nuisance tripping of the breaker. These instances include start-up, connection after manual disconnect, and connection after circuit breaker electrical trip. See Section 6 for the pre-charging procedure.

Plant Bus Bars

The Plant Bus Bars are mounted in three tiers on insulating standoffs at the top of the plant. These copper bus bars (plated with a solder finish) are designed to accommodate one- or two-hole copper crimp lug connectors in many sizes up to 350MCM. Refer to Table 3-B and Table 3-C for details.

The middle bus bar serves as the Charge Bus for both charge and discharge circuits. The lowermost bus bar serves as the Charge Return Bus, which is connected via the plant shunt to the uppermost Discharge Return Bus Bar.

Fuse Alarm Panel

A hinged panel covers the front of the bus bars and includes mounting space for REG fuses, controller fuses, alarms, remote sense circuitry, and test points to protect the Galaxy Controller from overcurrent in the sense leads.

Plant Shunt

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

The current shunt in the Control and Distribution Bay is connected between the Charge Return Bus and the Discharge Return Bus (see Figure 2-1). It is used to measure the total current supplied to the load from the rectifiers and/or batteries. The shunt has a full scale rating of 50 millivolts at the maximum plant current of 600 amperes. The shunt millivolt signal is sent to the controller, where it is translated back to amperes and displayed on the digital meter.

Battery Disconnect/ Reconnect Switches

The switch panel has three 600-ampere switches that are used to disconnect the batteries for service. The switches can be operated into a loaded condition, although this is not recommended due to the resultant voltage lag to the 4ESS™ system. The switch is designed to operate under extreme conditions, with a circuit-breaking capacity of 1260 amperes at 220Vdc. Mechanical operations are listed at 16,000.

The switch panel has bus bars connecting the three contacts in parallel, which are plated with a solder finish. This eliminates the requirement of using NO-OX-ID for connecting the battery leads. The bus bars are designed to accommodate the two 4/0 cables from the positive output of the batteries. The two 4/0 negative leads from the battery are connected to the charge return bus.

The Battery Switch Open alarm circuit is pre-wired at the factory and will indicate an open string alarm condition with the switch in the **Off** position. Battery Switch Auxiliary contacts for switches two and three are not connected. The blue wire that connects to pin 22 has been left disconnected until the installer needs the alarm signal. When connecting Battery Switches two and three, the installer must connect the blue wire to the mating connector that is connected to pin 22 of the auxiliary switch that is located in front of the battery switch just behind the battery operating handle. Open the battery switch 6-inch panel by turning the two 1/4-turn screws. The auxiliary switch is visible at the front of the battery switch, located on the front right bottom side. After connecting the blue wire, an alarm will be issued at the top of the frame until the battery switch has been placed in the on position. An open string alarm will also be issued by the Galaxy Controller. To avoid an alarm, do not connect the blue wire until the battery switch is in the **On** position**.**

When closing the battery switch, the voltage of the plant should be within 0.5 volts of the batteries. If the voltage difference is more than 10 volts, do not attempt to close the switch.

Warning

Do not operate battery disconnect switch! Removing the battery from the plant is for emergency operation only!

Converters

The converter gets the 140Vdc input from the charge bus and charge return via factory wiring. Two converters provide the 48 volts to the Galaxy Controller. One circuit pack (BAA5) powers the controller, and the second BAA5 is used for redundancy. The converters are used in parallel and are protected by a diode to prevent failure.

The BAA5 boards are hot pluggable and can be easily removed by hand to remove power to the Galaxy Controller. This is easier than removing all the fuses from the fuse board inside the controller. There is no turn-on procedure for the converter. When power is applied to the Control and Distribution Bay, the converter will produce 48 volts instantaneously.

On the front panel there are two LEDs for each converter. The green LED indicates that the converter is operating properly. If the red LED lights, this indicates the converter has failed and should be replaced.

To remove total power from the Galaxy Controller, remove both of the BAA5 converter boards. To restore power, simply plug the BAA5 boards back into the connectors.

Power Distribution Frame or Secondary Distribution

The secondary distribution is usually located remotely from the battery plant. This provides fuses, capacitors, shunts to monitor the feeder current, and a capacitor charge tool.

Subsystems for Retrofit Applications

Figure 2-2 is a block diagram of the 415B Battery Plant for new retrofit applications. The Control and Distribution Bay will accommodate up to five ferroresonant rectifiers, a Galaxy Controller, a distribution panel accepting up to seventeen 60-ampere or 100-ampere circuit breakers with 25mV shunts, an RPM panel, and one capacitor charge panel for the circuit breakers. Stile strips and end covers are provided for appearance. Easy access to the rear of the bay is accomplished by using a rear door with a 1/4-turn latch.

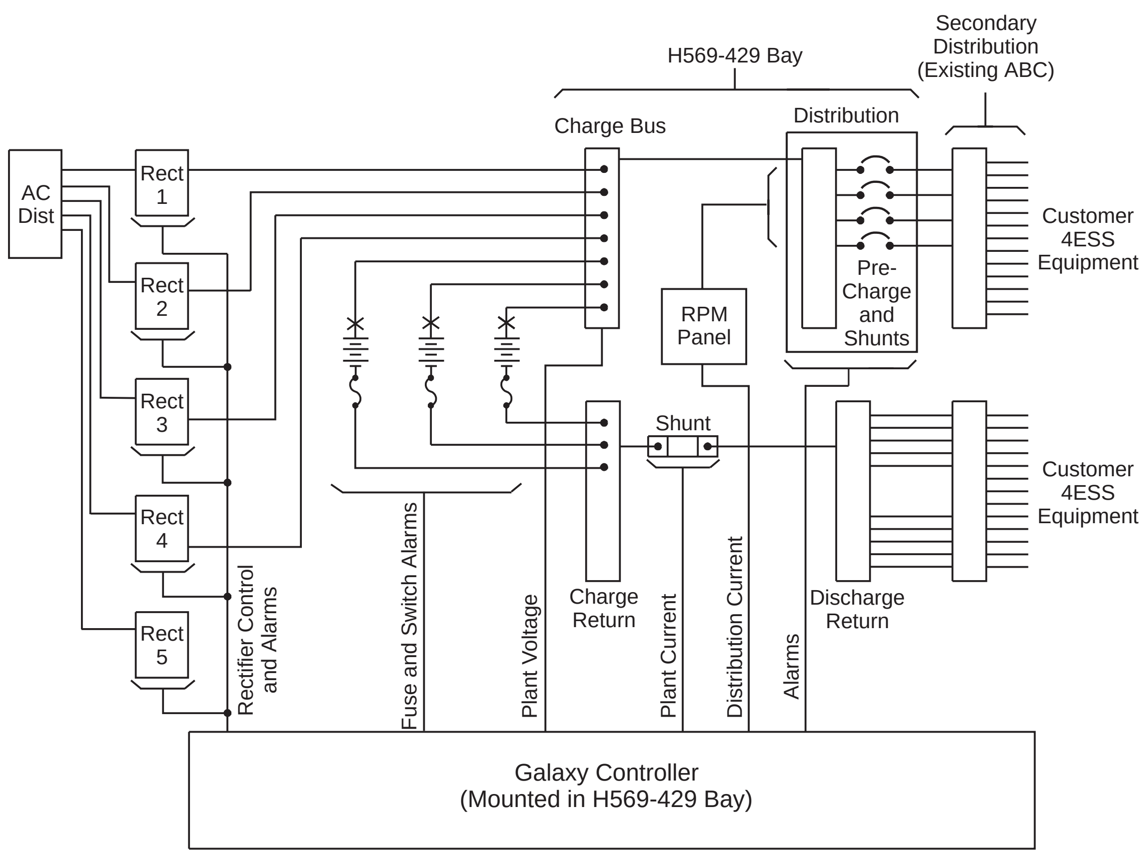


Figure 2-2: 415B Battery Plant Block Diagram (Retrofit)

AC Distribution

The ac distribution connects the commercial and/or standby ac power sources to the rectifiers and provides overcurrent protection. The KS-22089 Floor Mount and Wall Mount are still purchased through the H569-429 drawing. A maximum of five rectifiers are connected for each Power Distribution Service Cabinet (PDSC). The Red and Blue plants now only use one ac cabinet for the layout and still has one breaker for a spare installed in the panel. A maximum of five rectifiers are connected per cabinet.

Rectifiers

The rectifiers convert an ac source voltage into the dc voltage level required to charge and float the batteries and to power the using equipment. For a retrofit 415B Group 4, the maximum number of rectifiers is five.

Batteries

The retrofit will use the existing batteries for the Group 3 or Group 4 retrofit applications.

Galaxy Controller

The Galaxy Controller provides local and remote control and the monitoring and diagnostic functions required to administer the 415B rectifier plant only. The 415A controller will continue to monitor and alarm its own modules. With the complete replacement of the retrofit, however, the Galaxy Controller will provide alarms and monitor and control the battery plant.

The Galaxy Controller performs the centralized monitoring, control, and reporting functions for the Group 4 replacement. However, the Group 3 controls the 415B system only and parallels the alarms with the TB4 of the 415A controller. Alarms are sent from the 415B system and match the 415A alarms, although the controller of the 415A system will not communicate its alarms to the 415B Galaxy Controller.

Basic Controller

The basic controller provides the basic local control and monitoring functions for the battery plant. User access is by front-panel controls and display. It provides key battery plant alarms, high voltage shutdown, and plant voltage and current monitoring. The front panel includes an eight-line, 40-character display, LEDs, and switches and jacks for reading current.

Galaxy's basic controller includes a rectifier interface board that handles signals from as many as eight rectifiers. The rectifier interface board is provided to work with Lucent Technologies 140V ferroresonant rectifiers.

Intelligent Controller

Plant features include plant alarms and histories, load statistics, and auto boost (sometimes referred to as auto-equalize).

Rectifier features include sequencing, an energy efficiency algorithm, remote rectifier on/standby, and rectifier event histories.

Battery prediction is provided that predicts reserve time for batteries made by Lucent Technologies.

System features include password security, dial-out on alarm, back up and restoration of configuration, and serial system upgrade. Three password security levels are provided: User, with read-only privileges; Super-User, with read/write privileges except for passwords; and Administrator, with read/write privileges including password setting and software updates. The system also provides a warning if passwords have been left at their factory default settings.

Local and remote user access to intelligent features includes the enhanced front panel display, dial-up by modem, and an RS-232 local port for a personal computer or terminal using ANSI T1.317 object oriented command language. The Galaxy Controller also provides access for computer-to-computer interaction via an RS-485/232 port, using TL1 communications protocol.

Remote peripheral monitoring is provided for measuring the feeder currents at the 100-ampere circuit breakers. There are three located in the Control and Distribution Bay just below the 140/48Vdc converters. These are prewired at the factory and connected at the Galaxy Controller in manufacturing. There are six channels for each RPM for reading all 17 shunts supplied in the distribution panel.

The energy efficiency algorithm must be disabled for retrofit Group 3.

DC Distribution

Distribution for the Group 3 does not require breakers since the 415A controller and distribution will continue to provide existing service.

Circuit Breaker Panel

The retrofit Group 4 frame will provide a 100-ampere breaker distribution with shunts that are connected to the RPM panel mounted just below the converter unit. The distribution panel is equipped with 25mV/100-ampere shunts that are factory connected in the Group 4 Control and Distribution Bay. There are (17) 100-ampere breakers with 25mV shunts provided with the retrofit distribution panel. The H569-429 Group 4 has this distribution, which provides an ED83119-30 Group 5 distribution panel as well as the ED83119-30 Group 6 RPM panel. Groups 5 and 6 are also orderable for field replacement by ordering the H569-429 Groups 32 and 33. The retrofit Group 5 frame is the same except it uses the 60-ampere ED83119-30 Group 7, and is field orderable as Group 36.

Distribution Shunts

The H569-429 Group 4 provides a 100-ampere distribution with individual shunts for measuring the current supplied from each circuit breaker. Shunts are installed on each circuit breaker of the ED83119-30 Group 5 distribution panel. The 848012456 shunts are mounted on the power side of the circuit breaker connecting the input bus bar to the breaker. Normally, shunts should be mounted on the grounded side of the circuit. However, in this design request the shunt had to be mounted in the powered side. Caution should be exercised when removing or changing the shunt, due to the high voltage. The shunt is rated at 100 amperes @ 25mV, with the millivolt drop of the shunt factory-adjusted to within ±1/4 percent. The design using the 25mV drop at full scale will enhance the durability of the circuit and prolong the life of the shunt accuracy. The H569-429 Group 5 is the same as above except it uses an ED83129-30 Group 7 that provides 60-ampere breakers.

Capacitor Charge Panel

For initial powering of high inrush loads, a charge feature is provided with 17 circuit breakers. In order to provide the Capacitor Charge feature, One Capacitor Charge Panel, List CB (provided with Group 4), is provided for each plant in addition to the charge feature on the circuit breakers. The Capacitor Charge Panel is not provided with Group 3.

Remote Peripheral Monitors

The H569-429 Group 4 also provides the ED83119-30 Group 6 RPM panel that has three 221F Remote Peripheral Monitors with six channels each for communicating the currents to the Galaxy Controller. The retrofit application for a complete replacement of the 415A system requires that the currents be monitored at the Control and Distribution Bay since the ABC (Area Bus Center) distribution will remain in service. This panel is required to communicate the currents to the Galaxy Controller. The 100K current-limiting resistors are located on the rear of the panel and are connected through a plugged-type wireset to the shunts.

Power Distribution Frame or Secondary Distribution

The existing ABC distribution will remain in place. No distribution frame is required for the retrofit applications.

Plant Specifications

Table 2-A: H569-429 Control and Distribution Bay Specifications

Input Voltage	140-156 volts dc.
Operating Voltage	140-156 volts dc (151.9 volts nominal)
Float Voltage	151.9 ± 0.5%
Plant Current Rating	600 amperes
Plant Shunt	600 amperes maximum at 50 millivolts
Controller	Galaxy
Circuit Breakers	Type: Lucent Technologies CF1-Z73-17, 100 ampere CF1-Z73-16, 60 ampere
Fuses	Type: 70G, 100203389 1/2 ampere Fusban 402033930 3 ampere
RPM Resistor Board	100K (847765864)

Table 2-A: H569-429 Control and Distribution Bay Specifications

221F Remote Peripheral Monitor	108040932
PWB Assembly Terminal Block Base for 221F	847635851
Temperature	32-95 degrees Fahrenheit (0-35 degrees Celsius)
Altitude	-200 to 13000 feet (-61 to 3962 meters) For altitudes of 5000 to 13,000 feet, de-rate maximum temperature by 3.6 degrees Fahrenheit per 1000 feet above 5000 feet. For altitudes of 1524 to 3962 meters, de-rate maximum temperature by 0.656 degrees Celsius per 100 feet above 1524 meters.
Framework	Type: 7 foot Central Office Framework (standard 26 inch width) Vertical mounting centers: 1.00 inches (25mm) Horizontal mounting centers: 24.32 inches (618mm)
Dimensions	Height: 84 inches (2134mm) Width: 26 inches (660mm) Depth: 18.5 inches (470mm)
Weight	Initial bay: 530 pounds (240 kilograms)
Earthquake	Zone 4: See ***"Earthquake Bracing"*** in Section 3
Heat dissipation	Full load: 150 watts (512 BTU/hr) (See Note 1) Galaxy, with options: 100 watts
Humidity rating	10% to 95% non-condensing
Electrostatic discharge	IEC 801-2 Level 5 (15 KV) at 40% relative humidity
Electromagnetic immunity	10V/m over the range of 20 to 2000MHz
Note 1: Specified at 140 volts dc, 600 amperes output, and nominal input voltages and frequencies.	

3 Ordering Information

Introduction

Lucent Technologies offers a wide variety of engineering services that range from complete telecommunications installations to custom modifications of in-place equipment. For more information on the type of services that best meet your engineering needs, contact your Lucent Technologies account executive.

Appendix A provides guidance for those customers who wish to engineer their plant completely or partially. It also explains how to order Lucent Technologies equipment from manufacturing, wiring, and schematic drawings.

This section contains tables that provide list information for the H569-429 Control and Distribution Bay, as well as other ordering information.

List Numbers

The H569-429 Control and Distribution Bay is ordered with Group (G) numbers. Table 3-A summarizes the various components of the H569-429 Control and Distribution Bay. Group and Kit items may be combined in an order.

Table 3-A: Ordering Guide for the H569-429 Control and Distribution Bay

Group No	Description of Equipment and Features
1	Framework, assembly, wiring, and equipment for one distribution and control frame for 4ESS™; 600 ampere maximum (plant equipped with a Galaxy Controller, charge/discharge bus bars, fuse/board panel, battery switch panel, 140/48V converter, and one dc breaker distribution panel equipped with twelve 60-ampere CF1-Z73-16 breakers); includes ground fault monitor
2	Same as Group 1, except distribution is equipped with twelve 100-ampere CF1-Z73-17 breakers; includes ground fault monitor
3	Framework, assembly, wiring, and equipment for one distribution and control frame for retrofitting the 415A Battery Plant: 600 ampere maximum (plant equipped with a Galaxy Controller, charge/discharge bus bars, fuse/board panel, 140/48V converter)
4	Framework, assembly, wiring, and equipment for one distribution and control frame for retrofitting the 415A Battery Plant; 600 ampere maximum (plant equipped with a Galaxy Controller, charge/discharge bus bars, fuse/board panel, battery switch panel, 140/48V converter, dc breaker distribution panel equipped with seventeen 100-ampere breakers with 25mV shunts and precharge panel, and RPM panel)
5	Same as Group 4, except distribution is equipped with seventeen 60-ampere CF1-Z73-16 breakers. Includes the RPM panel.
10	Floor mounted ac distribution base cabinet 84"x26"x14" for 480Vac delta 3-phase input (equipped with three 3-phase, 50-ampere breakers, covers, and lockouts)
11	Floor mounted ac distribution base cabinet 84"x26"x14" for 208Vac or 240Vac delta 3-phase input (equipped with three 3-phase, 100-ampere breakers, covers, and lockouts)
12	Wall mounted ac distribution 44X20X5-3/4D for 480Vac delta 3-phase input (equipped with (3) breakers and lockout)
13	Wall mounted ac distribution 44X20X5-3/4D for 208Vac or 240Vac delta 3-phase input (equipped with (3) breakers and lockout)
14	Floor mounted ac distribution base cabinet 84"x26"x14" for 480Vac delta 3-phase input (equipped with six 3-phase 50-ampere breakers, covers and lockouts) for retrofit 415A
15	Floor mounted ac distribution base cabinet 84"x26"x14" for 208Vac or 240Vac delta 3-phase input (equipped with six 3-phase 100-ampere breakers, covers and lockouts) for retrofit 415A
16	Wall mounted ac distribution 44"x20"x5-3/4" for 480Vac delta 3-phase input (equipped with six 50-ampere breakers and lockouts) for retrofit 415A

Table 3-A: Ordering Guide for the H569-429 Control and Distribution Bay

Group No	Description of Equipment and Features
17	Wall mounted ac distribution 44"x20"x5-3/4" for 208Vac or 240Vac delta 3-phase input (equipped with six 100-ampere breakers and lockouts) for retrofit 415A
20	Ferroresonant rectifier used for 208Vac 3-phase input (J87132B2-L1).
21	Ferroresonant rectifier used for 240Vac 3-phase input (J87132B2-L2).
22	Ferroresonant rectifier used for 480Vac 3-phase input (J87132B2-L3).
23	Provides wireset, rack, and hardware for a (8) ferroresonant rectifier installation for the 415B system, Red Plant and Blue Plant.
24	Provides four dc wiresets, for a (2) ferroresonant rectifier installation for retrofit (Red Plant and Blue Plant).
30	Provides framework and assembly for one 6-foot fuse distribution cabinet arranged for top load feed; supports six fuse panels for one to six load buses; for secondary distribution equipped with 1RPM, 150A shunts/meter, and capacitor precharge circuit (J85568D1-L3).
31	Same as List 30 except arranged for bottom feed applications (J85568D1-L3)
32	Provides one circuit breaker panel for field installation; equipped with (17) 100-ampere CF1-Z73-17 breakers, with precharge and 25mV shunts with wireset to connect to RPM panel Group 33 ED83119-30 G6 (ED83119-30 G5, BB, CB).
33	Equipment required in addition to Group 32 or 36 to provide wireset and ED83119-30 G6 RPM panel mounted below the 140/48V converter (ED83119-30 G6).
34	Provides one battery switch panel ED83147-30 G1 for field installation of retrofit application requiring a battery switch.
35	Provides one ED83246-30 G17 (6 rectifier panel).
36	Provides one circuit breaker panel for field installation: equipped with seventeen 60-ampere CF1-Z73-16 breakers, with precharge and 25mV shunts with wireset to connect to RPM panel Group 33 ED83199-30 G6 (ED83119-30 G7, BA, CB).
40	Battery stand parts for a 2-tier, 2-row battery stand, 22 feet six inches long and 2 feet 6 inches wide and connecting equipment for one 70 main cell group per KS-20472-L1S batteries
41	Battery stand parts required in addition to List 40 to provide support for the auxiliary framing and cable rack from the battery stand
42	Provides 1 600-ampere fuse protection for Round Cell Batteries for 70 cells.
43	Provides 70 Round Cell Batteries (402785232) KS-20472-L1S batteries.

Table 3-A: Ordering Guide for the H569-429 Control and Distribution Bay

Group No	Description of Equipment and Features
44	Battery stand parts for a 2-tier, 2-row battery stand occupying space of 22 feet 10-1/2 inches long and 2 feet 10-1/2 inches wide and connecting equipment for one group of 70 main cells per KS-20472, L1S batteries
BA	60-ampere circuit breaker
BB	100-ampere circuit breaker

Table 3-B: Double Hole Terminal Lugs

KS-5482 Wire	KS-20921 Wire	WP-91412 List	Comcode	Bolt Size	Centers	Die
10	10	73	405356171	10	0.625	**R5473-5**
8	8	52	405348178	10	0.625	**Red**
8	8	75	406021626	0.250	0.625	**Red**
6	6	3	405347519	0.250	0.625	**Blue**
4	4	5	405347576	0.250	0.625	**Grey**
2	–	54	405348202	0.250	0.625	**Brown**
–	2	8	405347683	0.250	0.625	**Green**
1/0	–	56	405348228	0.375	1.0	**Pink**
–	1/0	57	405348236	0.375	1.0	**Black**
2/0	–	57	405348236	0.375	1.0	**Black**
–	2/0	77	406021725	0.375	1.0	**Orange**
4/0	–	59	405348251	0.375	1.0	**Purple**
–	4/0	27	405347923	0.375	1.0	**Yellow**
350MCM	–	61	405348277	0.375	1.0	**Red**
–	350MCM	86	406021915	0.375	1.0	**Red**

Table 3-C: Single Hole Terminal Lugs

KS-5482 Wire	KS-20921 Wire	WP-91412 List	Comcode	Bolt Size	Die
10	10	93	406338145	10	R5473-5
8	8	1	405347402	10	Red
8	8	74	405356189	0.250	Red
6	6	2	405347436	0.250	Blue
4	4	4	405347543	0.250	Grey
2	–	53	405348186	0.250	Brown
–	2	7	405347659	0.250	Green
1/0	–	55	405348210	0.375	Pink
–	1/0	10	405477717	0.375	Black
2/0	–	10	405477717	0.375	Black
–	2/0	17	405347790	0.375	Orange
4/0	–	58	405348244	0.375	Purple
–	4/0	78	406021741	0.375	Yellow

Table 3-D: H569-429 Circuit Breaker Panels

List Number	Distribution Type	Maximum Number of Fuses/Breakers	Size (Amps)	Ordering Information
BA	Circuit Breaker*	17	60	Table 3-H
BB			100	
*A capacitor charge feature/panel is supplied with each panel and occupies 4 slots on the breaker panel.				

Table 3-E: Load Lead Termination Points

H569-429	Maximum Wire Size	Output Terminal Information	
		# of Holes	Hardware
1	1 pole: 2/0	1	.375-16

Table 3-F: Circuit Breaker Panel with Capacitor Charge Feature/Panel

Circuit breakers operate and provide an alarm during electrical trip. The panel contains slots for circuit breakers and a capacitor charge feature.* The panel bus bar is sized for 600 ampere capacity.				
Circuit Breaker Specifications				
Capacity (Amps)	**Type**	**Slots Occupied**	**Max. No. Per Panel**	**Ordering Information H569-429**
60 100	Lucent Technologies	1 1	17 17	L-BA L-BB
*The capacitor charge feature occupies 4 slots on the panel and is ordered as L-CB.				

Documentation References

Table 3-G lists the documents that provide the engineering, ordering, and installation information for the Lucent Technologies H569-429 Control and Distribution Bay and its components:

Table 3-G: Documentation References

Battery Plant	
Assembly and Ordering Drawing	H569-429
Wiring Diagram	T-83360-30
Control and Distribution Bay Product Manual	167-792-120
415B Battery Plant Product Manual	167-792-121
8-Load BDFB/PDF Product Manual	157-005-101
Galaxy Controller	
Assembly and Ordering Drawing	J85501F-1
Wiring Diagram	T-83217-30
Schematic Diagram	SD83217-01
Galaxy Controller Product Manual	167-792-122
Remote Peripheral Monitoring System Manual	167-790-063
Round Cell Battery	
Assembly and Ordering Drawing	J87125A-1
Wiring Diagram	J87125A-1 Sheet 2
Schematic Diagram	J87125A-1
Battery Stand Arrangement	ED82563-10
Product Manual	157-629-700

Table 3-G: Documentation References

4ESS™ Grounding	
Equipment Drawing	ED4A081-10
Schematic Drawing	SD82194-01

Spare Parts

Any piece part may be ordered that is identified on the H569-429 drawing. When ordering, please specify the Description and Comcode as shown in the stocklist or spare parts table.

4 Safety

Please read this section carefully before installing, testing, maintaining, or repairing the 415B System or any of its sub-systems.

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 can not 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 35 degrees Celsius.

- AC branch circuits to this equipment must be protected with either fuses or circuit breakers sized as required by the National Electric Code (NEC) and/or local codes. The size of the 480V input overcurrent protector used must not exceed 50A; the size of the 208/240V input overcurrent protector should not exceed 100A. Refer to the equipment ratings to assure rating of equipment will not exceed 80% of the value of the protector chosen. (See 140V Rectifier product manual.)

- An accessible ac disconnect/protection device to remove ac power from the equipment in the event of an emergency must be provided.
- For installations in the United States, UL Listed compression connectors should be used to terminate UL Listed field-wired conductors where required. For all installations, the appropriate connector should be applied only to the correct size conductor as specified by the connector manufacturer using only the connector manufacturer's recommended tooling or tooling approved for that connector.
- For electrical connections requiring crimp-on lugs, make sure the proper crimping tools and dies are used.

Precautions

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

- This unit must be installed, serviced, and operated only by skilled and qualified personnel who have the necessary knowledge and practical experience with electrical equipment and who understand the hazards that can arise when working on this type of equipment.
- 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 to the rectifier.
- For equipment connected to batteries, disconnecting the ac alone will not necessarily remove power to the equipment. Make sure the equipment is not also powered by the batteries or the batteries are not connected to the output of the equipment.
- AC voltage may be present in the unit even when the Power switch is in the **Off** position.

- Hazardous dc energy (from batteries and rectifier output) and voltages up to 140 volts are present in the rectifier. 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 busbars.

- 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 still contain 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 have bleeder resistors and will discharge after power has been disconnected from the rectifier. Always check all of the dc capacitor terminals with a voltmeter before performing this 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.

- Batteries may be connected in parallel with the output of the rectifiers. Turning off the rectifiers will not necessarily remove power from the bus. Battery voltage may still be present on one side of the output dc circuit breaker 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.

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 rectifier. 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.

Personal Safety

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

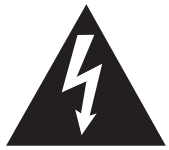
- Use only properly insulated tools.
- Remove all metallic objects (key chains, glasses, rings, watches, or any other jewelry).
- Wear safety glasses.
- Test circuits before touching.
- Lock out and tag any circuit breakers/fuses when possible to prevent accidental turn on.
- Be aware of potential hazards in the area 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

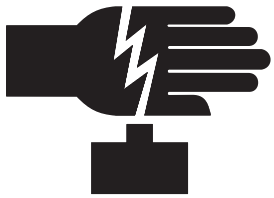
The symbols may sometimes be accompanied by some type of statement. For example, "Hazardous voltage/energy inside. Risk of injury. This unit must be accessed only by qualified personnel."

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

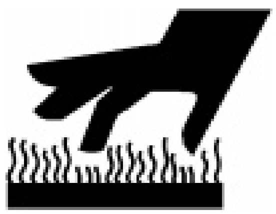
This symbol (or equivalent) is used to identify the presence of hazardous ac mains voltage.



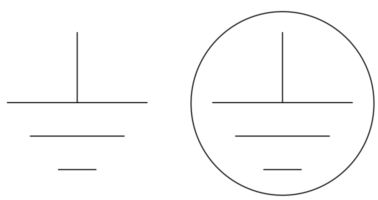
This symbol is used to identify the presence of hazardous ac or dc voltages. It may also be used to warn of hazardous energy levels.



This symbol identifies the presence of rectifier and battery voltages. The symbol may sometimes be accompanied by some type of statement. For example, “Battery voltage present. Risk of injury due to high current. Avoid contacting conductors with uninsulated metal objects. Follow safety precautions.”



This symbol is used to identify the presence of a hot surface. It may also be accompanied by a statement explaining the hazard. A symbol like this with a lightning bolt through the hand also means that the part is or could be at hazardous voltage levels.



These symbols (and/or the word “gnd”, “ground”, or the equivalent) are used to identify the safety earth ground or bonding point for the equipment. Make sure the associated framework and cable rack are properly grounded, per local job instructions, before turning on any rectifier.

5 Installation

Introduction

Lucent Technologies offers complete engineering and installation service that results in "turn-key" plant operation. Contact your Lucent Technologies Account Executive for further information on the complete range of installation services available from Lucent. Customers may, however, choose to make their own arrangements to fully or partially install the components of the 415B Battery Plant.

This section outlines an efficient sequence of installation steps for installing the Control and Distribution Bay that minimizes the installer's exposure to live circuits. Upgrades, retrofits, and replacement of equipment in the controller, rectifier, and battery subsystems are covered in their respective manuals. The 415B Battery Plant manual provides operation, maintenance, installation and testing requirements for the complete 415B system.

The framework, rectifier, controller, and dc distribution subsystems of the H569-429 Control and Distribution Bay are factory tested. The controller and distribution subsystems are shipped assembled to the framework, ready for use. The battery subsystem must be assembled by the installer. The installation sequence that follows refers to the rectifier, controller, and battery product manuals for details of those subsystems. Read this section and the referenced sections in other subsystem manuals completely before starting any work.

Tools and Test Equipment

The following tools and test equipment are required for installing and testing the H569-429 Control and Distribution Bay:

- Equipment to handle shipping containers, remove framework from shipping containers, and erect framework into final position
(minimum lifting capacity: 550 lbs.)
- 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 0.05% accuracy on the dc scale

Guidelines

1. Typical routing of dc and control cabling is shown on the plant assembly drawing, H569-429. Connection points and wire types are indicated on the plant wiring diagram, T-83360-30.
2. Wherever possible, all dc leads should be separated from ac leads to minimize electrical noise transmitted to the load.
3. Pair the battery potential lead with the associated return lead of a given circuit for as much of the run as possible.
4. All control leads and other small gauge wiring should be separated from the ac and dc power leads to prevent physical damage. (Routing of control leads within the controller is described in the Galaxy Controller manual.)
5. All bolts used for electrical connections should be torqued to the values in Table 5-A; all bolts used for mechanical connections should be torqued to values in Table 5-B.

Procedures

Table 5-D lists the drawings, manuals, and other documentation that are necessary to complete the following sequence of tasks.

Unpacking, Handling, and Frame Installation

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

2. To ensure personnel safety and equipment protection, use appropriate equipment during handling of crates and uncrated equipment. Use the equipment weights and dimensions, given in Section 2, as a guideline for choosing material handling tools. Move crated equipment to an area with adequate space and tools for unpacking and handling.

3. Carefully open the packaging to verify that the contents are complete and undamaged. If the equipment must be returned, repack it in the original shipping crate.

4. Locate, shim, and anchor the framework. Figure 5-1 shows typical floor mounting details for concrete floors. Other types of floor construction may require other mounting methods. Holes can be located using Figure 5-2. Note that primary mounting locations are at the outermost corners of each set of four holes (four anchoring devices per bay). Select alternate locations if primary locations would interfere with floor reinforcing bars. For multi-bay plants and for plants in aisle line-ups with compatible framework, frames may be tied together for extra rigidity.

Table 5-A: Minimum Torque for All Electrical Connections (e.g., Bus Bars)

Screw Size	**Torques in lb-in or (lb-ft)**	
	Wire Connectors	**Mechanical Connectors**
8-32	15	19
10-24	21	27
1/4-20	50	65
5/16-18	100	135
3/8-16	180	240
7/16-14	280	385
1/2-13	(42)	(49)
5/8-11	(71)	(97)
3/4-10	(125)	(172)

Table 5-A Notes:

1. Slotted machine screws should be pan-head type.

2. Slotted machine and hex cap screws should be SAE Grade 2 steel or equivalent.

3. Socket cap screws should have a minimum tensile strength of 100,000 psi.

4. Steel flat washers should be furnished under heads of socket cap screws.

5. Ferrous screws and washers should have a corrosion protective finish.

6. Locking means is required only for connections subject to vibration. Belleville-type washers or jam nuts are the preferred means.

7. For less than 1/4-inch thick tapped copper bars, use No. 8, No. 10, or 1/4-inch machine screws to minimize applicable torque. When larger size screws are required, provide captive-type steel nuts or reduce torque.

8. Torque recommendations are also suitable for all non-ferrous fasteners, except aluminum.

9. Where the application permits, hex cap screws should be used.

Table 5-B: Torque for All Non-Electrical Connections (e.g., Floor Anchors)

Cap Screw Diameter	Torque (ft-lb) UNRC
1/4	6
3/16	12
3/8	22
7/16	35
1/2	54
9/16	77
5/8	107
3/4	190
1	290
1-1/4	580
1-1/2	1010

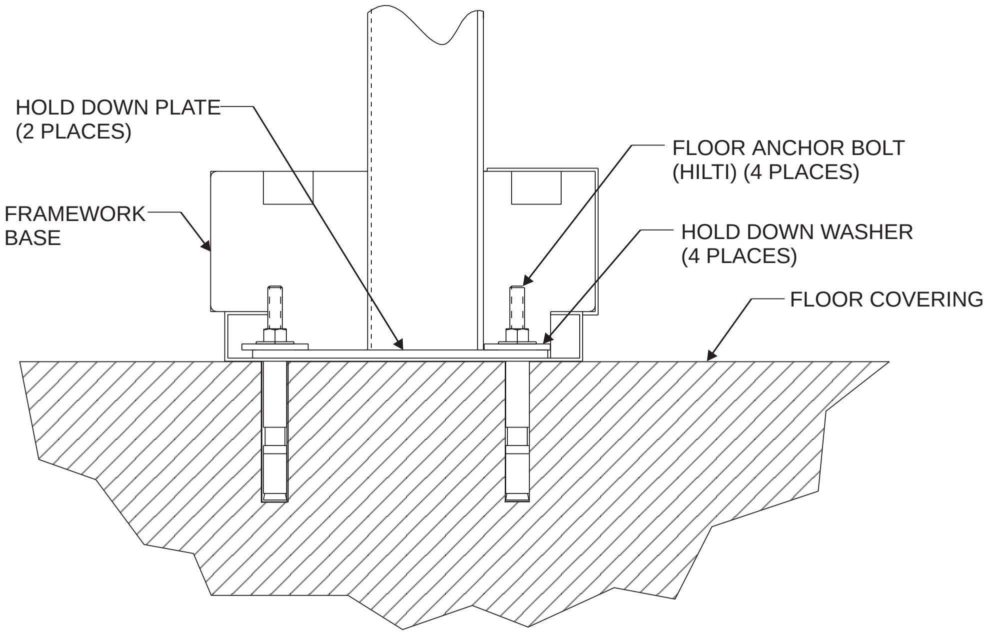
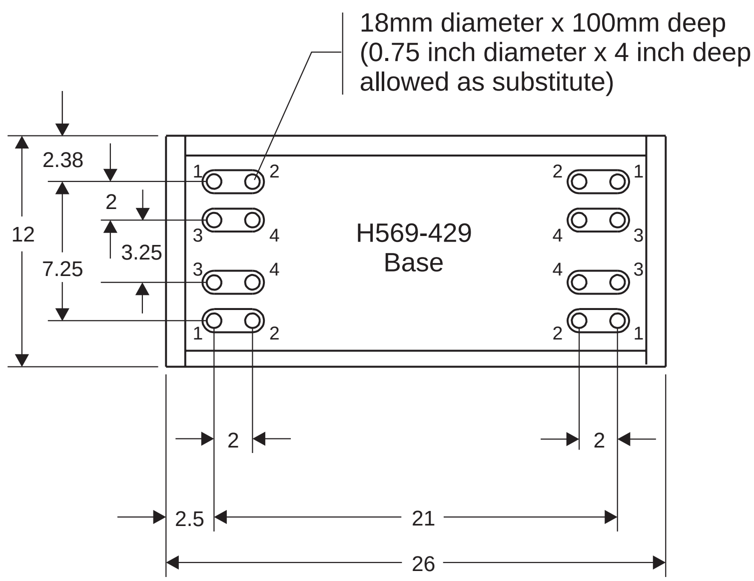


Figure 5-1: Typical Floor Mounting Detail



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 5-2: Floor Mounting Template (Dimensions in Inches)

Batteries

Warning

Do not connect batteries to the system at this time.

1. Assemble battery stands or shelves as instructed in the Lucent Technologies battery product manual or other manufacturer's documentation.

2. Install the batteries onto the stands or into the shelves.

Initial Charge

Batteries may undergo initial charging at this time, according to the manufacturer's recommendations. One of the rectifiers may be used for initial charging. Refer to the procedure given in the rectifier manual.

Cable Support and Ground System

Hang all cable support systems, as well as any auxiliary ground bus bars, as dictated by the job application drawings. Make the frame ground connection between the frame and the nearest Central Office ground bar, as shown in Figure 5-3. Make a No. 0 AWG ground reference from the plant discharge ground to the Central Office Ground bar that is nearest to the +140V distribution bays being served. Refer to drawings ED4A081-10 and SD82194-01 for details regarding 4ESS™ grounding requirements.

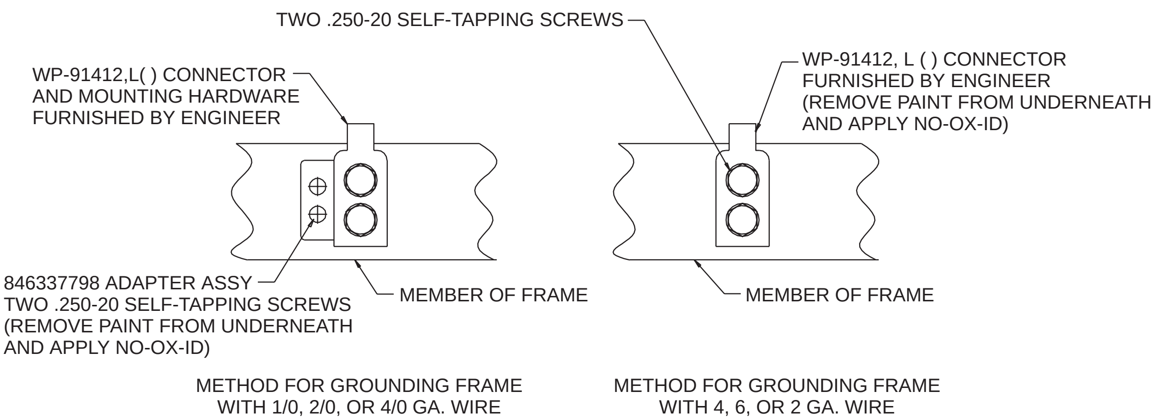


Figure 5-3: Frame Ground Adapter Assembly

Galaxy Controller

1. Set BD alarm level.
2. Run office alarm wiring.
3. Run other controller wiring.
4. Set-up other optional circuit packs.

Table 5-C shows the pre-set Galaxy Controller alarm settings.

Table 5-C: Galaxy Controller Alarm Settings

Software Alarm	Setting
HVSD	156.5V
$HVSD_{boost}$	160.0V
HFV	155.5V
HFV_{boost}	159.0V
BOOST	156.0V
FLOAT	152.0V
BD	149.0V
BD_{boost}	149.0V
VLV	133.0V
ROT	130.0V
BUHVSD (hardware alarm)	156.9V

AC Wiring, Rectifier Installation, and Test

Refer to the installation and start-up procedure in the rectifier manual for the following steps:

- Wire AC
- Set up
- Test

Load Wiring

1. Before proceeding, verify that all rectifier output circuit breakers are in the **Off** position.

2. Open the dc distribution cover panel by turning the two 1/4-turn fasteners located on the front of the panel.

DANGER

Verify that no voltage is present on the dc distribution bus bars and that all dc circuit breakers are off before connecting any load leads.

3. Run paired leads (supply and return) to each load from a dc distribution circuit breaker and from the discharge return bus. The load supply leads are terminated at the circuit breaker panels (directly to the breaker terminal end). The load return leads are terminated at the Control and Distribution Bay end on the discharge return bus, located at the top front of the bus bar arrangement.

   Recommendations for routing and dressing of load leads as they leave the Control and Distribution Bay and enter the cable rack system are shown on the plant assembly drawing, H569-429. Consult the job application drawings for the routing of these leads to the load equipment.

Battery Connections, Installation, and Test

1. Before proceeding, verify that all load circuit breakers are in the **Off** position.

2. For a Galaxy Controller, remove all controller REG fuses, which are located on the distribution door. Confirm that the output circuit breakers of all rectifiers and all distribution breakers are open.

DANGER

The next step in this procedure will apply battery power to the Control and Distribution Bay. Before contacting any uninsulated conductor surfaces, always use a voltmeter to insure that no voltage, or the expected voltage, is present.

3. Interconnect the battery strings as instructed by the battery manual or other manufacturer’s documentation.

4. Two 4/0 cables are required for each positive and the returns. Run all cables from the battery and return bus bars

to the battery strings by first connecting them to the bus bars in the dc distribution subsystem. For suggested cable routing within the dc distribution, see the H569-429 drawing or Figure 5-4. Replace the dc distribution cover panel on the plant framework after all connections have been made at the plant bus bars.

5. Terminate the cables from the dc distribution at each battery string according to the manufacturer's documentation. Measure the resistance between the two ends of any battery string to verify that the circuit is open.

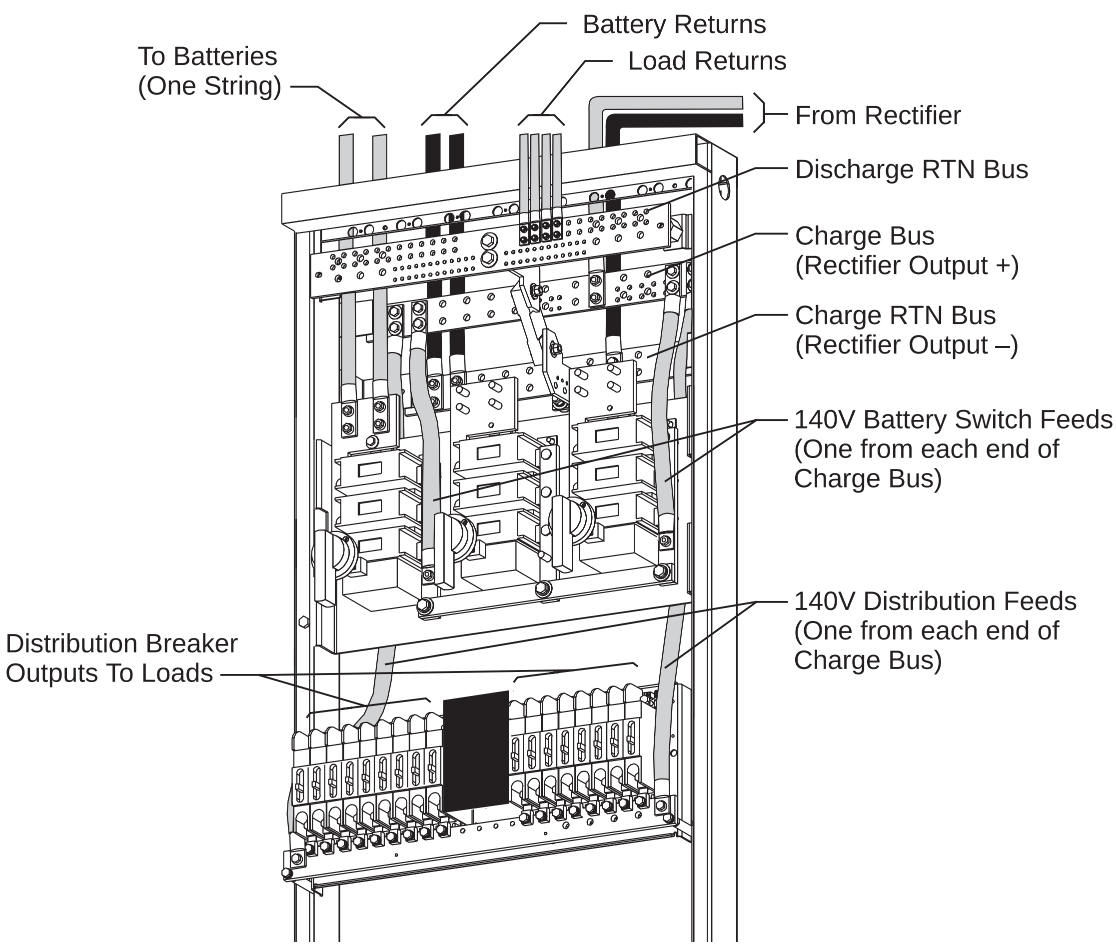


Figure 5-4: Cabling Arrangement

Controller Test

Follow the controller test procedure given in the Galaxy Controller product manual to complete these steps:

- Test enable/disable boost charge feature
- Test enable/disable rectifier restart feature
- Test HV shutdown level(s)
- Test BD alarm levels
- Test other optional circuit packs

Load Turn-up

Turn on and adjust all rectifiers for normal operation according to the rectifier product manual.

Warning

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

Installation Procedures for Plant Growth

As your power needs evolve, equipment may be readily added to the Control and Distribution Bay to provide any of the following:

- Expanded controller features
- Additional rectifier capacity
  (maximum of four for the 415B plant)
- Increased battery capacity
  (associated with additional rectifier capacity)
- Additional load circuits

Procedures for adding controller features, rectifiers, and batteries to an operating plant are described in the installation sections of the associated subsystem manuals. The procedure to add load circuits, since they are part of the dc distribution subsystem, is described below.

Adding a Load Circuit

The following procedure provides the steps to add a new load circuit to an operating Control and Distribution Bay. See Section 3 for details on sizing additional circuit breakers.

DANGER

Battery voltage is present behind the distribution cover panel. Remove all jewelry before working in this area. Use insulated tools only.

Caution

Procedures in this section may cause power alarms to be issued temporarily. Notify the alarm reporting center before starting any installation procedure on an operating Control and Distribution Bay.

Accidentally or intentionally turning a circuit breaker off may affect service to load equipment. Take care not to disturb load-carrying circuits.

1. Locate the intended new breaker. Remove blank panels, some of which can be reused to cover empty spaces after installation. Ensure that the breakers are switched to the **Off** position or that fuses are not loaded.

2. Install the load leads by following the procedure in "Load Wiring."

3. Mark the new circuit on the distribution cover panel label.

4. For safety, mount the dc distribution front cover before proceeding to the next step.

Warning

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

5. When all work on the dc distribution is complete, close the distribution cover and notify the alarm reporting center.

System Turn-Up

Refer to the 415B Battery Plant product manual for turn-up procedures.

Table 5-D: Installation Reference Documents

Step	Procedure	Reference Document
A	Unpacking, handling and frame installation	H569-429 drawing and manual
B	Battery stand assembly	Battery manual
C	Initial battery charge	Battery manual Rectifier manual
D	Cable support and ground system	Job application drawings
E	Controller setup	Controller manual
F	Rectifier installation and rectifier test	J87132B2 rectifier Manual
G	Load wiring	H569-429 drawing, T-83360-30 drawing, and 415B Battery Plant manual
H	Battery connections, disconnect installation, and test	Battery manual
I	Controller test	Controller manual
J	Load turn-up	Load equipment documentation

6 Maintenance

Controls and Indicators

Operating controls and indicators on the Control and Distribution Bay are listed below:

- Controller LEDs (see Galaxy Controller product manual)
- Major Failure red LED at the top of the Control and Distribution Bay
- Converter LEDs (see Section 2, *Product Description*, in this manual)
- Visual fuse alarm indications from the alarm panel
- Battery switch position indication

DC Circuit Breakers/Fuses

Any circuit breaker mounted in the panel is **On** (or closed) when the handle is in the Up position, and **Off** (or open) in the Down position. A circuit breaker that is supplying a load may be turned off manually, but this may affect service to the load. All fuse blocks have indicating fuses that allow a red element to pop out when a fuse blows (opens). If a breaker has tripped off or a fuse blows, the overcurrent problem should be cleared before restoring power to the load by resetting the breaker or replacing the fuse.

Open Distribution Breaker or Fuse

A distribution breaker or fuse that should be closed may be in the open position for one of three reasons:

- A distribution breaker may have been inadvertently turned off manually. If this is the case, follow the proper procedure to restore power to the load equipment. If a distribution breaker is no longer needed, it may be unplugged from the panel or left in the **Off** position.

- A distribution breaker or fuse may be tripped due to a short circuit in the load equipment or wiring. The fault must be cleared before resetting the breaker, except when the open is suspected to be caused by inrush current during equipment start up.
- A circuit breaker may fail and cannot be reset. Replace a failed distribution breaker. A failed fuse must always be replaced. See procedure in "Load Circuit Breaker or Fuse Replacement."

Repair and Replacement

Note

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

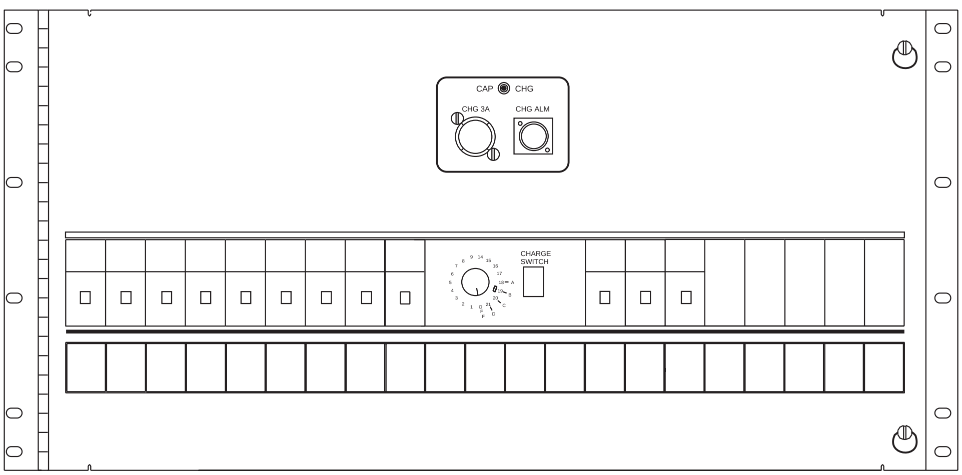


Figure 6-1: Circuit Breaker Panel

Load Circuit Breaker or Fuse Replacement

Procedure (refer to Figure 6-1 and H569-429 drawing):

1. Obtain a replacement circuit breaker. See the H569-429 drawing for spare parts.
2. Verify that the faulty breaker is in the **Off** position or that a blown fuse is actually in the fuse block.

3. Unscrew the panel cover.

4. Measure the voltage at the load connection associated with the faulty breaker or fuse to verify that the breaker or fuse is truly open. The voltage relative to the battery bus bars or distribution panel bus bar should be approximately the float voltage of the plant. With a blown fuse, the indicating fuse can be replaced to verify that the fuse is truly open. If the faulty breaker or fuse is, in fact, still closed, the load equipment that it powers must be shut down so that no current flows through the breaker/fuse arrangement during the following replacement steps.

DANGER

Do not attempt to unplug a circuit breaker that may be carrying current. Arcing may result in personnel injury and equipment damage.

5. Disassemble the faulty breaker from the panel or remove the load fuse and indicating fuse from the fuse block.

6. Switch the new circuit breaker, if applicable, to the **Off** position before plugging it in.

7. Assemble the new breaker or fuse, ensuring that line, load and alarm connectors are properly mated.

Warning

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

8. Follow the Capacitor Charge Procedure:

    a. Verify that the affected equipment is ready to accept dc power.

    b. Locate the rotary slot selector and charge switch in the middle of the circuit breaker distribution panel. Circuit breakers are numbered from left to right and correspond to the rotary selector.

c. Select the circuit breaker with the rotary switch.

Caution

Do not attempt to turn the rotary switch while holding the charge button depressed. Damage to the rotary switch may result.

d. Press the charge button and observe that the **CAP CHG** LED on the Capacitor Charge Panel lights. If the LED does not light, the connected load may already be pre-charged or the circuit breaker may not be wired to the capacitor charge circuit.

e. The LED will dim as the pre-charge current diminishes. When the LED no longer changes in intensity, turn the associated breaker and then release the charge button. Typically, the LED is only lit for less than one second.

9. Note that Fuse Alarm Major, FAJ (MJF), and its associated alarms retire.

7 Product Warranty

A. Seller warrants to Customer only, that:

1. As of the date title to Products passes, Seller will have the right to sell, transfer, and assign such Products and the title conveyed by Seller shall be good;
2. Upon shipment, Seller’s Manufactured Products will be free from defects in material and workmanship, and will conform to Seller’s specifications or any other agreed-upon specification referenced in the order for such Product;
3. With respect to Vendor items, Seller, to the extent permitted, does hereby assign to Customer the warranties given to Seller by its vendor of such Vendor Items, such assignment to be effective upon Customer's acceptance of such Vendor Items. With respect to Vendor items recommended by Seller in its specifications for which the vendor's warranty cannot be assigned to Customer, or if assigned, less than Sixty (60) days remain of the vendor's warranty or warranty period when the Vendor's items are shipped to Customer or when Seller submits its notice of completion of installation if installed by Seller, Seller warrants that such Vendor's Items will be free from defects in material and workmanship on the date of shipment to Customer. In such an event, the applicable Warranty Period will be sixty (60) days.

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

WARRANTY PERIOD

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

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

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

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

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

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

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

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

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

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

Appendix A Engineering and Reference Material

Engineering Process

The detailed process of engineering a battery plant is described as it progresses through four stages. This process is essentially the same for the field modification of an existing battery plant as it is for a new installation.

The four stages are:

1. Characterizing the basic power requirements
2. Determining the power equipment that satisfies those needs
3. Determining the impact on the various building systems
4. Preparing the order using the information in this manual or the engineering drawings

Engineering Calculations

The using system, also referred to as the **load equipment**, determines many characteristics of the power equipment. Service and maintenance strategies also affect the selection of power equipment. This section describes, through the following topics, the types of basic power specifications and how they may be determined.

- Load Equipment Voltage
- Battery Voltage
- Load Drain And Growth
- Reserve Capacity

- Charge Capacity and Recharge Time
- Battery String Balancing
- Voltage Drop Calculations
- Conductor Sizing
- Overcurrent Protection

Load Equipment Voltage

Determine the recommended operating voltage range of the using equipment. If the battery plant is used to power different types of equipment, it must meet the requirements of each. Fill in the load voltage information below. The answers to these questions will be used in engineering calculations and equipment selection in the following sections.

1. Recommended operating voltage: ______ volts
2. Minimum steady-state voltage: ______ volts
3. Maximum steady-state voltage: _____ volts
4. Maximum high voltage transient: ______ volts

Battery Voltage

Battery plant operating voltage is directly related to the recommendations of the battery manufacturer. These recommendations must include:

- The steady-state voltage for maximum life or **float voltage**
- The **end voltage** after complete discharge
- The maximum **recharging** voltage
- The **initial charging** method

Equalize or **boost** charging is recharge capacity greater than the float voltage.

Rectifier and load equipment voltage ranges are associated with typical battery voltage ranges.

A **battery string** consists of a number of battery cells connected in series to provide the desired plant operating voltage. Although virtually any plant voltage is possible by varying the number of cells per string, this manual deals specifically with **nominal 140-volt** systems.

The **nominal cell voltage** of lead-acid-type batteries is usually defined as 2 volts. The actual **recommended float voltage** of lead-acid batteries differs slightly among vendors and varies with chemistry. The most common float voltages are 2.17 and 2.27 volts per cell.

Nominal 140-volt systems typically use 70 cell battery strings for float voltages that range from 140.0 to 156.0 volts per string. Lucent Technologies KS-type flooded lead-acid batteries float at 2.17 volts per cell (151.9 volts per string).

Customers should select a battery type and vendor based on their maintenance and replacement strategies, weighing initial cost, expected life, service requirements, and replacement cost against each other. Once the battery is chosen, the following information is needed for the battery plant engineering process.

5. Float voltage per cell: ____ volts
6. Minimum cell voltage at end of discharge: ____ volts
7. Is boost or equalize charging recommended? ____ (Yes or no; boost or equalize charging is not recommended for the Lucent Technologies VR Series battery.)

   If "yes", the maximum recharging voltage per cell: ____ volts
8. Maximum initial charging voltage per cell: ____ volts
9. Number of cells per string: ____

Multiply the number of cells per string (10) by the voltages (6), (7) and (8) to find the values for (11), (12) and (13), respectively.

10. Float voltage per string: _____ volts
11. Minimum string voltage at end of discharge: ____ volts
12. Maximum charging voltage per string: ____ volts

Compare these three calculated voltages (11, 12, and 13) against the steady-state load equipment voltages (1, 2, and 3).

Load Drain and Growth

Under normal conditions with a constant load, battery plant voltage to the load equipment is essentially constant. During an ac power outage, however, as the batteries deliver power, the voltage drops steadily. Most types of load equipment do not draw a constant current over their input voltage range; the current drain on the plant may change as the batteries discharge.

Some types of load equipment are purely resistive, i.e., their current drain decreases as the plant voltage decreases. Other types of loads are characterized as constant power equipment, i.e., the current increases as the plant voltage drops. Load equipment may have a combination of resistive and constant power characteristics.

In the telecommunications industry, List 1 and List 2 are the designations of the load current drains that have historically been used to size various elements of the battery plant. These values are normally provided for each load circuit or group of load circuits through engineering of the load equipment, a topic not covered in this manual. These terms may be briefly defined as follows:

LIST 1 drain: the average “busy-hour” current during normal plant operation (i.e., at float voltage). This value is used to size batteries and rectifiers.

LIST 2 drain: the peak current under worst case conditions of voltage, traffic, etc. This current is used to size load feeder cables, plant discharge capacity, and overcurrent protectors.

The summations of List 1 and List 2 drains for all individual load circuits provide the List 1 and List 2 drains, respectively, for the entire battery plant.

Initial List 1 drains are used to size initial rectifiers and batteries since these components may be added relatively easily to operating plants. To determine the initial rectifier and battery needs, use Table A-1 to list the current drain information for all load circuits in the initial installation. Use additional sheets, as needed.

As the customer’s power needs evolve, however, load circuits may need to be added and traffic on existing circuits may increase. Ultimate List 2 drain should be used to select the initial sizes of load feeder cables and plant discharge capacity, since these cannot be readily increased once the plant is installed. In

Table A-2, fill in the anticipated future drains for the circuits listed in Table A-1. Also include in Table A-2 any additional circuits that may be added and their drains. Recalculate the total battery plant drains.

Reserve Capacity

The customer's service and maintenance strategy are important in determining reserve time. The availability of back-up ac power and accessibility of the site are usually the determining factors in battery sizing. The risk and acceptability of loss of service is another factor that will vary from application to application.

Table A-3 lists reserve time practices that have been used in some telecommunications applications where maintaining power to the load is critical. The figures are not intended to be guidelines except in the absence of any specified customer practices.

The noise and transient filtering capability of batteries may also be considered in selecting the minimum battery capacity. Many using systems specify the maximum allowable input noise. Applications such as UPS-supplied ac power that do not require batteries for dc reserve purposes, may require batteries or some other means for noise filtering. Compare the input noise requirements of the using system to the specifications in Table 2-A.

Table A-1: Initial Load Drain Information

Load Circuit	List 1 (Amps)	List 2 (Amps)
1		
Battery Plant Total		

Table A-2: Anticipated Future Load Drain Information

Load Circuit	List 1 (Amps)	List 2 (Amps)	NC, C or A*
1			
Battery Plant Total			

*NC = No Change, C = Changed, A = Added

Table A-3: Reserve Capacity

Back-up Source	Typical Reserve Time	
	Attended Location	**Unattended Location**
Stationary Engine (automatic start)	3 hours	3 hours + travel time
Stationary Engine (manual start)	4 hours	4 hours + travel time
Portable Engine	4 hours + travel time	
Uninterruptible Power Supply	0 hours	

Fill in the minimum reserve time below.

13. Minimum battery reserve time: ____ hours

Battery capacity is usually specified in terms of **ampere hours**, which is essentially a measure of energy. The ampere-hour rating is the product of a constant discharge current and the time to discharge a fully charged battery to a specified end voltage. For comparison purposes, most vendors of telecommunications batteries specify ampere-hour ratings at the **8-hour rate** of discharge to an end voltage of 1.75 volts per cell. Many battery vendors also supply ratings at other discharge rates, such as 3-, 5-, and 24-hour rates.

Although ampere-hour ratings are useful for rough estimates of battery size, actual battery selection should be based on curves or tables of discharge current versus time.

Charge Capacity and Recharge Time

For all but batteryless applications, rectifier capacity must be provided specifically for the recharging of batteries. This rectifier capacity must be engineered into the plant in addition to that required to power the load under normal or float conditions. The sum of the normal and the recharge rectifier capacities is called the **plant charge capacity**.

The recharge current is a function of the recharge time and voltage. For example, increasing the plant voltage will, within limitations, decrease the necessary recharge time, but this calls for more current. Increasing the plant voltage after a discharge is also recommended by some battery vendors to assure that all cells charge equally for maximum life. Although these two charging methods are essentially the same, they are usually called by different names. The former process is usually called **boost charging**, while the latter is called **equalize charging**. For the purposes of this manual, the term “Equalize” is used to indicate boost or equalize charging. Refer to the battery manufacturer’s recommendations on equalize charging.

The recharging requirement is determined by customer practices and is usually specified as a maximum time to reach a minimum percent of full capacity, e.g., at least 90% capacity in no more than 24 hours.

14. Maximum recharge time: ____ hours

15. Percent of full capacity after recharge time: ____ %

Refer to the Battery manual or other documentation to calculate the required recharge current to meet the requirements of (15) and (16). The recharge voltage (13) will be needed for this calculation.

16. Minimum recharge current: ____ amperes

Recharge factor is a term that is sometimes used to describe available recharge capacity. The recharge factor is the total charge current divided by the List 1 drain. Typical recharge factors range from 1.20 to 1.50.

17. Minimum recharge factor: ____

The minimum initial rectifier requirement for float operation is derived from the Plant List 1 Drains calculated in Table A-1.

Customer practices may dictate any combination of the following rectifier engineering conventions:

- At least one on-line spare rectifier must be included in the plant for increased reliability.
- Any on-line spares must be the same size as the largest rectifier in the plant.
- At least 20 percent additional capacity must be included in the plant to provide recharge capacity and spares.

See "*Engineering Specifics, Rectifier Sizing,*" for specifics on sizes and quantities of rectifiers for the battery plant.

Battery String Voltage Drop and Balancing

The rectifiers, while recharging or floating the batteries, maintain a constant voltage at the battery plant bus bars. When batteries are accepting recharge current after a discharge, there is a finite voltage drop from the charge bus bars inside the bay to the battery string terminals. This voltage drop is, of course, proportional to the magnitude of the recharge current. Any voltage drop from the battery plant bus bars to the terminals of each battery string will tend to slow the rate of battery recharge and delay their readiness for future discharges. The same cable resistance responsible for voltage during recharge creates a voltage drop during discharge as well. Voltage drop during discharge can limit the effectiveness of the batteries in supplying the necessary reserve. For these reasons, the engineer should minimize the voltage drop between bus bars and batteries by interconnecting them with the largest practical wire size.

In battery plants with multiple, parallel strings of batteries, the cable lengths from the dc distribution subsystem to each string will be different. It is as important to "balance" the strings as it is to minimize voltage drop. Multiple strings are balanced by sizing cables for equal resistance (and, therefore, equal voltage drop) between terminals and bus bars. If battery strings are unbalanced, the string with the least voltage drop to the dc distribution provides more than its share of current during each discharge. A battery string that undergoes excessive discharges may fail unexpectedly before its predicted end of life.

To both minimize and equalize voltage drops to parallel strings, the largest practical wire size should be selected for the most distant battery string. The cable sizes for the strings nearer to the dc distribution are then selected so that the drop in each is roughly the same as that for the most distant string.

Some using systems, such as electronic switching systems or transmission systems, dictate maximum allowable voltage drops. A common rule-of-thumb is a maximum drop of 4 volts in the leads from battery string terminals to the dc distribution. Voltage drop calculation methods are described in “*Calculating Voltage Drop*.” For the calculation, use the plant List 2 drain divided by the number of parallel battery strings.

For extraordinarily long runs between batteries and dc distribution, wire gauges may be called for that cannot be conveniently terminated at the equipment at either end. In such cases, the necessary larger cables may usually be tapped down to smaller ones to make the actual connections to the bus bars and battery terminals.

Battery Size Versus Voltage Drop

The critical requirement for a battery plant is that the input voltage to the load equipment remain within the proper operating range for the prescribed reserve time. Constants imposed by the typical 140-volt battery system are the normal battery float voltage and the minimum battery end voltage.

Note

> Engineering of plants with end cell or counter-emf cell battery arrangements is not included in this discussion.

The variables that may be adjusted to ensure service for the specified time period are battery capacity and voltage drop from batteries to the load. If the system is engineered with a relatively small voltage drop, large gauge cabling is required, but battery capacity can be minimized. If a large voltage drop exists between batteries and load, the minimum load voltage may be reached before the batteries reach their end voltage, so that their rated capacity is only partially used. In this second case, additional battery capacity is required.

The trade-off between battery size and wire size is an economic one. For systems with long cabling runs, the cost of large quantities of heavy wire should be balanced against the cost of additional batteries. Finding the exact optimum combination of cabling and batteries involves complex iterative calculations that are beyond the scope of this discussion. Some using systems, such as electronic switching systems or transmission systems, dictate maximum allowable voltage drops, which simplifies the calculations. Lucent Technologies offers a computerized service to optimize the selection of cable sizes and battery capacity for any application. Contact your Lucent Technologies Account Executive for details on this service.

Alternatively, various rules-of-thumb are used to specify maximum voltage drops. During discharge, the critical voltage drop is the total drop from the battery terminals to the load equipment. Increasing the voltage drop from dc distribution to load can potentially be compensated for by decreasing the voltage drop from batteries to dc distribution.

The voltage drop from the batteries to the distribution (4 volts) has been covered in *"Battery String Voltage Drop and Balancing."* One rule-of-thumb specifies a maximum voltage drop of 4 volts in the feeder loop from the dc distribution to the load and back again, using the List 2 drain for that circuit as listed in Table A-2. Voltage drop calculation methods are described in the next section, *"Calculating Voltage Drop."*

Fill in the selected or calculated system voltage drops below.

18. Maximum drop (batteries to dc distribution): ____ volts
19. Maximum drop (dc distribution to load): ____ volts
20. Maximum drop (batteries to load): (19) + (20) = ____ volts

After the total drop from the batteries to the load is determined, the actual end voltage of the batteries can be derived from the minimum input voltage to the load (2).

21. Actual battery string end voltage: ____ volts
22. Actual battery cell end voltage: ____ volts

Since most battery vendors provide capacity information as a function of end voltage, Step 23 is important in the selection of a specific battery. If Step 23 is below the manufacturer's recommended discharge voltage, low-voltage battery disconnect/reconnect may be helpful in preventing battery damage from deep discharge. In attended locations with back-up ac power, low-voltage disconnect/reconnect may not be necessary.

Calculating Voltage Drop

A useful formula to relate voltage drop, cable length, and cable size is:

VD = (K x I x L) / CM, or CM = (K x I x L) / VD

where:

VD = allowable voltage drop, in volts

CM = conductor size in circular mils

K = 11.1 for copper at 78°F (25.5°C)

I = appropriate current drain, in amperes

L = conductor length, in feet

The formula may be applied to one-way conductors or to loop circuits (i.e., paired power and return conductors). The value of K in the above expression increases with increasing conductor temperature.

Conductor Ampacity

Two criteria are used to select the actual wire gauge of a given conductor: **ampacity** and **voltage drop**. Ampacity is the current that may be carried safely without overheating. In relatively low voltage/high current systems, such as dc distribution, voltage drop limitations are often the determining factors in sizing conductors. In systems, such as ac distribution, with relatively high voltage and low current, ampacity usually determines minimum conductor size. All conductors, however, must be large enough to safely carry the intended current.

Allowable ampacity is provided in Article 310 of the NEC (National Electrical Code), and it is a function of the following:

- Wire size
- Ambient temperature
- Type of insulation
- Proximity to other conductors

The ampacity tables are given in the National Electrical Code (NEC), starting with Table 310-16. These tables, together with the appropriate notes, determine the current that will result in the maximum allowable operating temperature for each wiring method. For instance, the maximum temperature for Type RHW wire is 75°C (167°F). The current that will result in that temperature (i.e., the ampacity) is less when the ambient air temperature is higher and also when conductors are bundled or side-by-side.

Overcurrent Protection

The rating of an overcurrent protection device (fuse or circuit breaker) should not exceed the ampacity of the conductor it is intended to protect. The absolute maximum rating permitted by the NEC for an overcurrent protector is the next larger standard rating above the ampacity.

Overcurrent protectors may be sized smaller than this maximum rating. In general, however, protectors should be rated as high as allowable to avoid nuisance tripping due to high load conditions or inrush during start-up.

The peak current drain (List 2) is used to size the circuit protection for each individual load. The fuse or circuit breaker must also protect the wire connecting to it in accordance with NEC and local code regulations.

Fuses

Load fuses are not provided with the fuse panels that are supplied with the power plant. The individual fuse size should be 150% of the List 2 current drain for the load that the fuse is protecting.

Circuit Breakers

All circuit breakers supplied with the power plant can be loaded up to 100% of their rating only if the job engineer can determine that the user load has no short term peaks greater than 150% of its rating and does not exceed 10 milliseconds in duration. If the characteristics of the load cannot be determined, apply a factor of 125% instead of 100%.

Engineering Specifics

The methods used in *"General Engineering Calculations"* are appropriate for the engineering of any battery plant. The same methods are used in this section to select the specific types and quantities of equipment available with the H569-429 Control and Distribution Bay.

The following topics are covered in this section:

- Rectifier sizing
- Battery sizing
- Number of bays
- Cable and load breaker sizing
- Emergency shutdown/disconnect
- Controller options
- Alarm system interface
- Earthquake bracing

Rectifier Sizing

The Lucent Technologies 140-ampere, 140-volt ferroresonant rectifier is currently available with the H569-429 Battery Plant. The maximum number of rectifiers per plant is 4. In the absence of specific customer practices, the following procedure is RECOMMENDED.

23. Determine the smallest whole number of rectifiers that will provide the normal (List 1) plant drain in Table A-1: ____
24. Determine the smallest whole number of rectifiers that will provide the normal plus recharge current from Table A-1 and Step 17: ____
25. provide the GREATER of Step 23 +1 or Step 24 rectifiers: ____

Some battery plants include batteries in the same bay as the rectifiers and controller. Others, like the H569-429, locate the batteries elsewhere.

Battery Sizing

Many vendors offer families of batteries that cover a wide range of ampere-hour capacities. Ampere-hour capacities of parallel battery strings are added to provide the total reserve capacity of the battery plant. To supply the necessary reserve, several strings of small capacity batteries or one or two strings of large capacity batteries may be connected in parallel.

Here are several important considerations in the choice of battery size versus number of strings:

- cost
- weight and space efficiency
- anticipated growth
- system reliability

Cost: In general, for one vendor's family of batteries, the cost per ampere-hour decreases with increased cell capacity. In other words, a battery that is twice as large costs less than twice as many batteries. On the basis of initial material cost, the number of strings should be minimized.

Weight and Space Efficiency: Weight density and space efficiency increase, in general, as battery capacity increases. There can be significant differences in space efficiency, however, between different vendors of the same capacity battery. Floor loading restrictions may limit the potential compactness of the battery arrangement. Such limitations of the building structure must be clearly understood before selecting a battery arrangement.

See **Floor Plan Data** under ***"Planning"*** for more information on floor loading. Applications with space restrictions such as standard aisle depths may dictate the use of more strings of smaller batteries.

Anticipated Growth: To simplify expansion, the growth pattern for the battery plant may dictate the battery size. It is usually easier to engineer and install additional strings of the same battery type and capacity as those already in place. The growth in battery capacity is tied to the growth in rectifier capacity, since both must increase with increasing load current. It is typically most economical to match an increase in charge capacity with an increase in battery capacity, which can back up the load supported by the additional rectifiers. Since a fraction of any added rectifier capacity is needed for recharging added batteries, the matching incremental change in battery capacity depends on the desired recharge factor. Since the charge capacity of the battery plant grows in 150 ampere increments with the ferroresonant rectifiers, the optimum battery capacity increment may be approximated as follows.

A-hr increment = (150 A) x (reserve time in hours) / (minimum recharge factor)

System Reliability: In most battery plants it is possible to have an open circuit in the battery subsystem that could remain undetected until ac power is lost and battery power is required. For applications where service reliability is critical, it is a good practice to select a battery size that requires at least two strings. Multiple strings allow for easier maintenance on the battery system without jeopardizing service to the load equipment.

Initial Bays

All subsystems of the battery plant can occupy one framework, which is called the main distribution. Up to four rectifiers, controller, capacitor charge panel, a breaker panel, and bus bars, along with a Galaxy Controller, will fit in this space.

Cable And Load Breaker Sizing

In this section, power cabling for the dc distribution and battery subsystems is covered, including the following subtopics:

- Maximum and minimum wire gauges
- Wire type
- Crimp lugs
- Circuit breaker selection

To determine actual wire sizes, equipment locations, cable rack and routing systems at the site must be known. Since the battery plant shares the cabling system with other building systems, cabling engineering is not completely defined by this section of the product manual. In this section, the basics are derived for the dc power cabling that will be required as part of a complete cable engineering process. Lucent Technologies offers cabling engineering services that are separate from battery plant engineering. Contact your Lucent Technologies Account Executive for more information on available services.

Use wire type RHW or RHH for dc power wiring. This type of wire is commonly available in American Wire Gauge (AWG) stranded (e.g., KS-5482) and in a finer stranded “welding” type (e.g., KS-20921). Flexible or welding wire is slightly larger than AWG stranded wire of the same gauge, which may affect the selection of crimp lugs. For example, different crimp lugs are required for AWG and welding wire of the same gauge for 1/0 gauge and larger. Use flexible power wire (e.g., KS-20921) for sizes 1/0 and larger in applications requiring tight bends, such as small battery plants in confined locations.

The terminal lugs that may readily be attached at the dc distribution subsystem are listed in Tables 3-B and 3-C.

Record Wire and Breaker/Fuse Sizes

Determine the lengths of all load and battery conductors before proceeding with this section. Use the following steps to record the wire and breaker sizes for each load feeder in Table A-4. Use additional sheets as needed.

1. Copy List 2 drains for each load feeder from Table A-2 to Table A-4.

2. Calculate the minimum wire size that meets the ampacity requirement based on the List 2 drain for each load feeder.

3. List the wire sizes based on ampacity in Table A-5.

4. Calculate the minimum wire size for each load feeder in Table A-2 to meet the voltage drop requirements outlined under *“Calculating Voltage Drop.”*

5. List the sizes based on voltage drop in Table A-4.

6. Indicate the larger size for each load feeder in the “Selected Wire Gauge” column.

7. Fill in the circuit breaker or fuse rating (e.g., 10, 20 or 30 amperes) in Table A-4 for each feeder.

8. Record in Table A-5 the wire sizes for each battery feeder.

9. Calculate the minimum wire size that meets the ampacity requirement based on the total plant List 1 drain divided by the number of parallel battery strings.
10. Enter that wire size on the first line in Table A-5.
11. Calculate the minimum wire size for each battery feeder in Table A-2 to meet the voltage drop requirements outlined under *"Battery Size Versus Voltage Drop and Calculating Voltage Drop."*
12. List the sizes based on voltage drop in Table A-5.
13. Indicate the larger size for each load feeder in the "Selected Wire Gauge" column.

Table A-4: Load Feeder Wire and Fuse/Breaker Size

Circuit Number	List 2 Drain	Minimum Wire Gauge		Selected Wire Gauge	Fuse/breaker Rating
		(Ampacity)	(Voltage Drop)		
1					

Table A-5: Minimum Wire Gauge (Ampacity) - All Strings

String Number	Minimum Wire Gauge	Selected Wire Gauge
1		
2		
3		
4		
5		
6		

Controller Options

The engineering of the controller features involves orderable circuit packs and field-movable jumper straps or DIP switches.

Circuit Packs: Circuit pack options for the Galaxy Controller are listed on the Galaxy Controller drawing J85501F-1 and in the Galaxy Controller product manual.

DIP Switches and Jumper Straps: Certain controller features must be set during the installation process if requirements differ from the standard factory settings. The engineering process must provide the necessary instructions to the installer for the controller set-up. Refer to the J85501F-1 controller drawing and the Galaxy Controller product manual for details.

Alarm System Interface

The standard Galaxy Controller is equipped with connection points for a variety of battery plant alarms, but the wiring from the controller alarm points to the local and remote reporting alarm systems is NOT provided with the battery plant. Such wiring must be compatible in gauge and type with the terminal blocks provided on the controller circuit packs, as detailed in the Galaxy Controller product manual.

Earthquake Bracing

The earthquake rating for the standard battery plant is Zone 4, upper floors, per NEBS TR-EOP-00063

Planning

The equipment specified in the previous section will affect various other systems within the building that serve more than just the battery plant. Some of these common systems are ac distribution, cabling, air conditioning and ventilation, and the building structure itself. For example, the ac distribution system for a building or room is not completely defined by the power equipment needs alone, but clearly the number and type of rectifiers have a direct impact.

The following topics are covered in this section:

- Floor plan data: floor space, floor load, heat load, ac service
- Cable rack and routing
- Grounding
- Growth

Floor Plan Data

There are several types of information that are collectively called Floor Plan Data. This information is sometimes published on Floor Plan Data Sheets. Floor Plan Data for the battery plant are given in Figure A-1. This battery plant information must be combined with the corresponding data for all other equipment in the office to engineer the appropriate aspects of the building.

The four categories of floor plan data relevant to battery plants are listed below:

- **Floor Space:** Space must be adequate for the battery plant footprint and for aisles.
- **Floor Load:** The building structure must support the intended weight per unit floor area, and equipment must be spaced out to distribute the load, as necessary.
- **Heat Load:** The air conditioning and ventilation systems are sized to maintain the environment based on the heat dissipation of the equipment.
- **AC Service:** The ac distribution system is sized to accommodate the current requirements of the powered equipment.

Cable Rack and Routing

To help plan for the routing and support of battery plant cabling, a typical arrangement is shown in Figure 5-4.

Grounding

The battery plant is designed for compatibility with most grounding systems. The standard dc discharge return bus is located in the initial bay. Alternatively, the battery plant return bus system may be mounted in the overhead cable rack.

When the discharge return bus is in the initial bay, a connection point is provided on it specifically for grounding. This point may be used to tie the battery plant to the building grounding electrode. Two holes for 0.250-20 self-tap screws are provided at the rear of the top crossmember of the bay uniframe to accommodate a two-hole cable lug on 0.62" centers. If the frame ground lead is calculated to be larger than 2 AWG, the corresponding lug has 3/8" diameter holes on 1" centers. In this case, the adapter that is always provided with the bay should be used. Refer to Figure 5-3.

Growth Building systems should be designed for ultimate growth. Cable rack support and ac distribution cabinets should be sized for the maximum anticipated battery plant capacity. Floor space and weight capacity should also account for any increase in battery reserve.

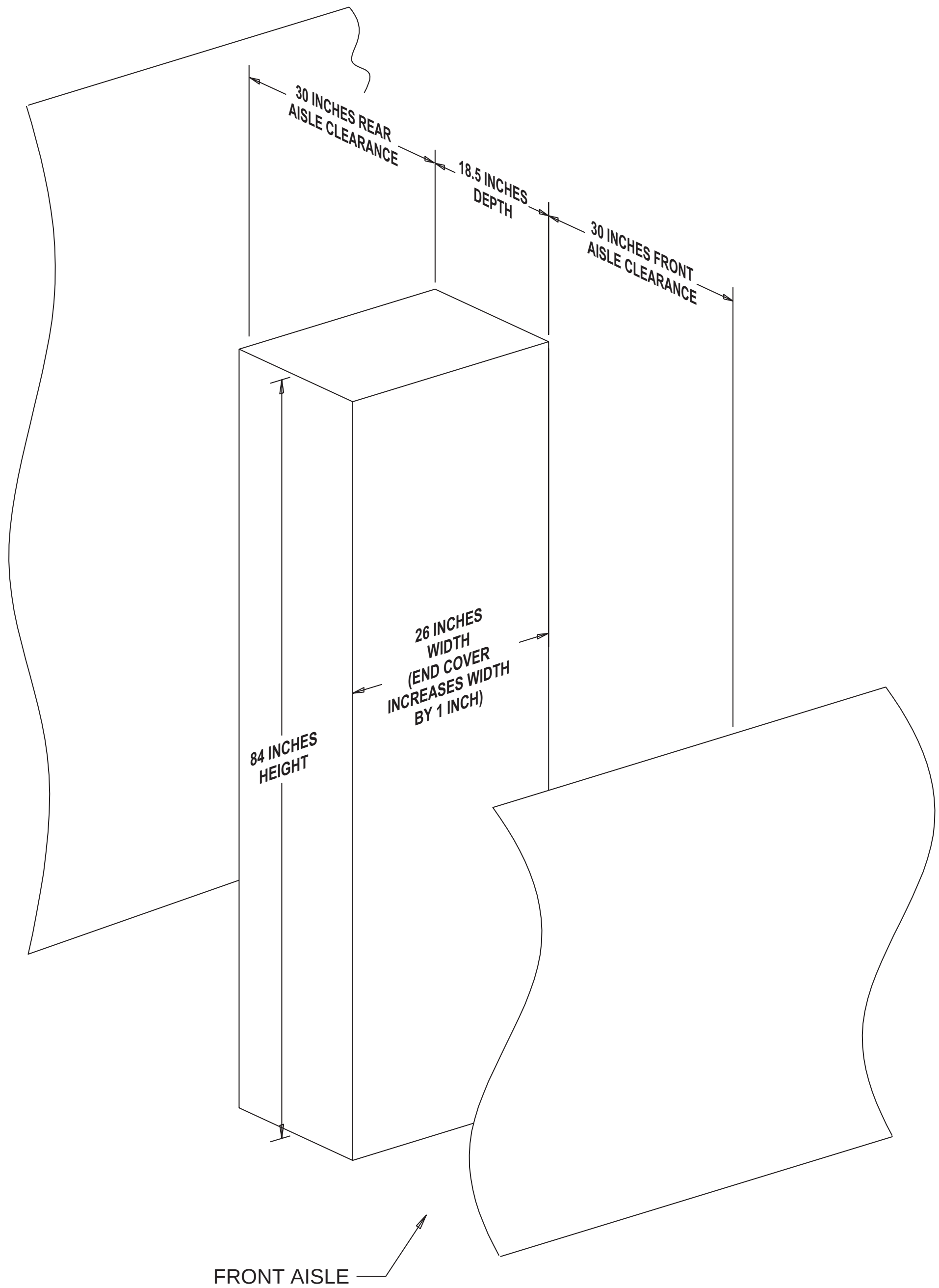


Figure A-1: Control and Distribution Bay Dimensions and Clearances

Product Drawings

This manual contains all the needed planning and ordering information for the H569-429 battery plant. Some customers may prefer to prepare plans and orders from manufacturing, wiring, and schematic drawings. Read the following sections to learn how to order Lucent Technologies equipment from these drawings.

Coding and Terminology

The two main categories of Lucent Technologies hardware are called **apparatus** and **equipment**. The battery plant ordering process primarily involves **equipment** for the system and **apparatus** for components and replacements.

An apparatus code identifies one specific arrangement of hardware. The product is available in one form only. Lucent Technologies coded apparatus is always specified by the code followed by the descriptor. For example:

- BAA5 Circuit Pack
- Power Unit
- Control Unit

The vintage or version of coded apparatus is controlled by a **series number**. The series number may be appended to the apparatus code for a complete description of the product, but is not necessary because only the latest vintage is orderable at any given time. Apparatus-coded components for a battery plant are, typically, replacement parts and spares. (See H569-429 drawing.)

Equipment-coded hardware is available in different configurations with combinations of optional features. The total number of combinations and permutations of the optional features on a given product may be in the hundreds or thousands. For this reason, a unique code is not assigned to each combination of options. Instead, a **main code** is specified, which is followed by a list of identifiably separate options with the quantities for each option.

The main code number falls into one of three categories:

- J-code
- ED-code
- H-code

J-codes take the form JxxxxxA-y and are used to specify main assemblies, stand-alone products, and units that may have multiple applications.

ED-coding, of the form ED-xxxxx-yy, identifies subassemblies that are components of main equipment assemblies. For example, an ED-coded distribution panel assembly may be a component of a J-coded battery plant.

H-coding takes the form H-xxx-xxx and is used for a variety of special applications such as field installation kits, pre-assembled cables, or custom configurations of options for a J-coded product.

The “xxxxx” part of an equipment code is called the **base number**. The “y” or “yy”, called the **dash number**, is used to identify the vintage of the base number or to indicate a close relationship to products with the same base number.

A J-, ED-, or H-coded piece of equipment is controlled by a standard drawing of the same number. This drawing contains the descriptions of the optional configurations, manufacturing assembly information, and any additional details for engineering or field installation.

An equipment option is identified by a number or letter called a **List** or a **Group**. J- and H-coded equipment use Lists, while ED-coded products are equipped with Groups. For simplicity, the discussion that follows deals specifically with J-coded equipment. ED- and H-coded equipment, however, may be treated similarly.

The standard drawings for Lucent Technologies battery plants and their components are **J-**, **T-** and **SD-drawings**. Together these drawings provide the necessary details for engineering, planning, ordering, record-keeping, installation and repair. A thorough understanding of the construction and content of the standard drawings is required for proper, error-free engineering and ordering of the battery plant. The drawings associated with this battery plant should be reviewed completely before preparing an order.

The generic features of J-, T- and SD-drawings are described in the following sections.

J-drawings A J-drawing consists of the following parts:

- Cover Sheet(s), containing ordering, engineering, and issue information, as well as notes for manufacturing and installation;
- Assembly views, showing details of shop and field assembly; and
- Stocklist, listing the quantity and complete ordering code for each component part used in the assembly.

The cover sheets of a J-drawing contain a wide variety of important engineering and ordering information. The important parts of the cover sheet are described below. Item numbers refer to those on the typical one page cover sheet, shown in Figure A-2.

(1) Title Block: This contains the official drawing title, including the input and output, if any. The title is **not** required for ordering purposes. Also included in the title block are the **J-code** and the **issue number**.

(2) J-code: This number must be included in the order exactly as shown on the drawing. It is always followed by at least one List Number when describing an orderable piece of equipment. On its own, the J-code refers to either the drawing itself or, in generic terms only, the product.

(3) Issue number: Each sheet of a drawing has its own issue number, which changes whenever anything is changed on that sheet. The issue number of the first cover sheet changes whenever any sheet in the J-drawing is changed. The issue number of the cover sheet is called the **drawing issue**.

The drawing issue number is one mechanism used to distinguish between vintages of the same product. Ordering information may or may not change when a J-drawing is reissued. The drawing issue must agree with the vintage of product available from Lucent Technologies. Reissued drawings are sometimes released prior to actual factory availability to provide time for engineering and order preparation. Consult your Lucent Technologies Account Executive for assistance with issue number coordination.

(4) Sheet index: The index lists the numbers of all sheets in the drawing and their respective issue numbers. Some drawings have sheets numbered 1, 2, 3, etc. Many, including the example shown, are divided into A-, B-, C-, and D-sheets. The A-sheets are the cover sheets and are numbered A1, A2, A3, etc. The B-sheets contain the main assembly views and are numbered similarly (B1,B2,...). C-sheets are used to show assembly details and any other relevant graphical information. The stocklist is included on D-sheets.

(5) Table A: Table A is the single most important entity on a J-drawing for engineering and ordering. It contains a description of each orderable feature, its ordering code, its availability and a cross-reference to the wiring diagram.

(5A) List numbers: The ordering codes for product features are called Lists. They may be numbers, letters or combinations thereof. A list describes a collection of parts that are: (1) assembled and packaged per the assembly views and stocklist of the J-drawing, and (2) wired per the referenced figures of the T-drawing.

(5A-1) Main lists: The list number for a basic configuration of equipment is called a Main List. A Main List describes a set of features, which is a lowest common denominator or a typical arrangement. There may be several Main Lists on a given J-drawing that share, perhaps, common components or Supplementary Lists (see below). Only one Main List number is specified for one equipment assembly, and the quantity specified for that List is one.

(5A-2) Supplementary Lists: Features are added to or omitted from Main Lists by specifying Supplementary Lists. A Supplementary List is not orderable by itself but must be specified in addition to a main list. Different supplementary lists and multiples of individual supplementary lists may be specified for one main list. Restrictions on possible combinations of main and supplementary lists are described in the feature descriptions in Table A and/or in Engineering Notes (see below).

(5B) Ratings: The availability for ordering of each List is controlled by the Rating, listed in Table A. Currently there are two Rating classifications: Available ("AVAIL" or no marking) and Discontinued Availability ("DA"). The conditions on discontinued availability, such as factory repair policy, vary from product to product and from List to List. Contact your Lucent Technologies Account Executive for information on specific products.

(5C) Circuit Figures: There is often a Wiring Diagram (T-drawing) that is separate from the assembly drawing for equipment that incorporates factory wiring. If a List contains wiring, the associated figure number of the T-drawing is indicated in Table A of the J-drawing. A quantity indicates the number of multiples of the wiring in the specified figure that are required for a List. When a T-drawing figure is not listed in parentheses, everything in the figure that is not indicated as optional is provided. (See below for a detailed discussion of T-drawing options.) When a T-drawing figure is listed in parentheses, only the indicated wiring or apparatus options are provided from that figure.

(5D) Wiring Options: If portions of the wiring are connected differently among the Lists, those differences are indicated by T-drawing Wiring Options.

(5E) Apparatus Options: When circuit components differ from one List to another, these differences are indicated by Apparatus Options on the T-drawing.

(6) Table C: This table cross-references the schematic (SD) and wiring diagram (T).

(7) Table D: This table provides a list of all associated drawings, such as other J-, ED-, or H-coded equipment that must be ordered separately. Drawings that are required for engineering or manufacturing but are not necessary for installation are indicated by an equals-sign (=).

(8) Manufacturing Notes and Symbols: Notes that apply to factory and/or field assembly are listed as Manufacturing Notes and are numbered from 1 to 50. The first several notes define standard symbols used on the assembly views and in the stocklist to indicate stamping and factory packaging methods. Additional manufacturing notes are specific to each J-drawing. All manufacturing notes should be read and understood by engineering, as well as installation, since they may include important installation details that the engineer must include in planning.

(9) Engineering Notes: For engineering, the second most important part of the J-drawing, after Table A, is the Engineering Notes section. These notes, starting at Note 51, provide such information as:

Restrictions on List combinations,

Additional job-specific hardware that must be ordered,

Product manual references, and

Numbering conventions for panel positions.

(10) Other tables: Other nonstandard tables may appear on the J-drawing to provide additional engineering, manufacturing, and/or installation information. Each table should be referenced from an engineering or manufacturing note on the drawing.

(11) Change Notes: Change or Revision Notes chronicle, in very abbreviated form, the history of drawing reissues and the associated changes, such as additional Lists, modifications to assembly views, clerical error corrections, and part number changes. The Issue number and date always follow the list of changes.

T-drawings

T-drawings are used to show wiring details, such as wire colors, gauges, and routing, which cannot be conveniently shown in assembly views of the J-drawing. T-drawings are similar in format to J-drawings, with cover sheets and assembly sheets. There is no stocklist or Table A, however, on a T-drawing. The following T-drawing cover sheet features are essentially the same as those for J-drawings:

- Title Block
- Issue Number
- Sheet Index
- Manufacturing Notes and Symbols

- Engineering Notes
- Change Notes

As with the J-drawing, read all the notes on the T-drawing completely when engineering a job. Other important features of the T-drawing cover sheet are Tables B, C, and D. Table B of the T-drawing gives a historical record of the addition and elimination of options. This table corresponds to the Record of Change Table on the SD-drawing. (See below.)

As noted earlier, there is usually a close correspondence between options defined on the SD and those shown on the T-drawing. The exact correlation of options and figure numbers between the two drawings is given in Table C.

Table D gives an index to the locations of T-drawing options on the various sheets of the drawing. There is a similar Option Index on the SD. (See below.)

The wiring information is shown graphically two ways: Shop Figures and Installer Figures. Shop figures are numbered 1, 2, 3, etc. for main figures and A, B, C, etc. for details. Installer figures are similarly numbered but with the prefix “H”. All connections and circuit components in a given figure, which are not indicated as optional, are provided when that figure is specified by the J-drawing. Options are indicated on the figures by a letter or letters inside a double circle.

An option is defined when alternative connections or circuit components are possible. T-drawing options are called Wiring options for connection alternatives and Apparatus options for component differences. Where possible, T-drawing options are derived directly from those defined on the SD-drawing, using the same lettering scheme (see below). Options that are found on the T-drawing, but not on the SD, always include the prefix “H”. Optional wiring and hardware is provided only when the associated options are specifically called for by Table A of the J-drawing.

SD-drawings

The SD-drawing is the source for the circuit information that describes a product. The connectivity and options shown on the T-drawing are based on the SD. The parts on the J-drawing stocklist that are circuit components are documented on the SD.

Mechanical parts, wire colors, wire routing, and cable harnesses are not necessarily shown on the SD.

The SD-drawing package is usually sectionalized, similar to the J-drawing, as follows:

- **A-sheets** are cover sheets including Title Block, Supporting Information, Sheet Index, Option Index. All of this information is similar in format to that on T- and J-drawings.
- **B-sheets** contain the Functional Schematics (FSs).
- **C-sheets** list the Apparatus Figures (APP FIGs) (i.e., circuit component lists).
- **D-sheets** contain drawing notes categorized as Circuit Notes (numbered 101 to 200), Equipment Notes (numbered 201 to 300) and Information Notes (301 to 400). Certain standard notes of particular interest are:
- **Note 102:** Feature and Option Table that describes each option letter, is often duplicated in the T-drawing engineering notes.
- **Note 103:** The Record of Change Table traces when options are added and discontinued on various drawing issues, as in Table C of the T-drawing.
- **SD notes** often contain important details on applications of circuit features and options, so all notes should be read before completing the engineering process.
- **G-sheets** show Cabling Diagrams (CADs), define terminal designations and wiring for installer connections. This information is duplicated in the Installer Figures of the T-drawing.
- **H-sheets** are included in some SD-drawings to provide Block Diagrams (BDs) that are helpful in understanding complex circuits.
- **J-sheets** are used for Circuit Pack Schematics (CPSs), if any are included in the SD. Most circuit packs, however, are documented on separate schematic drawings, some of which are proprietary and are not generally accessible.

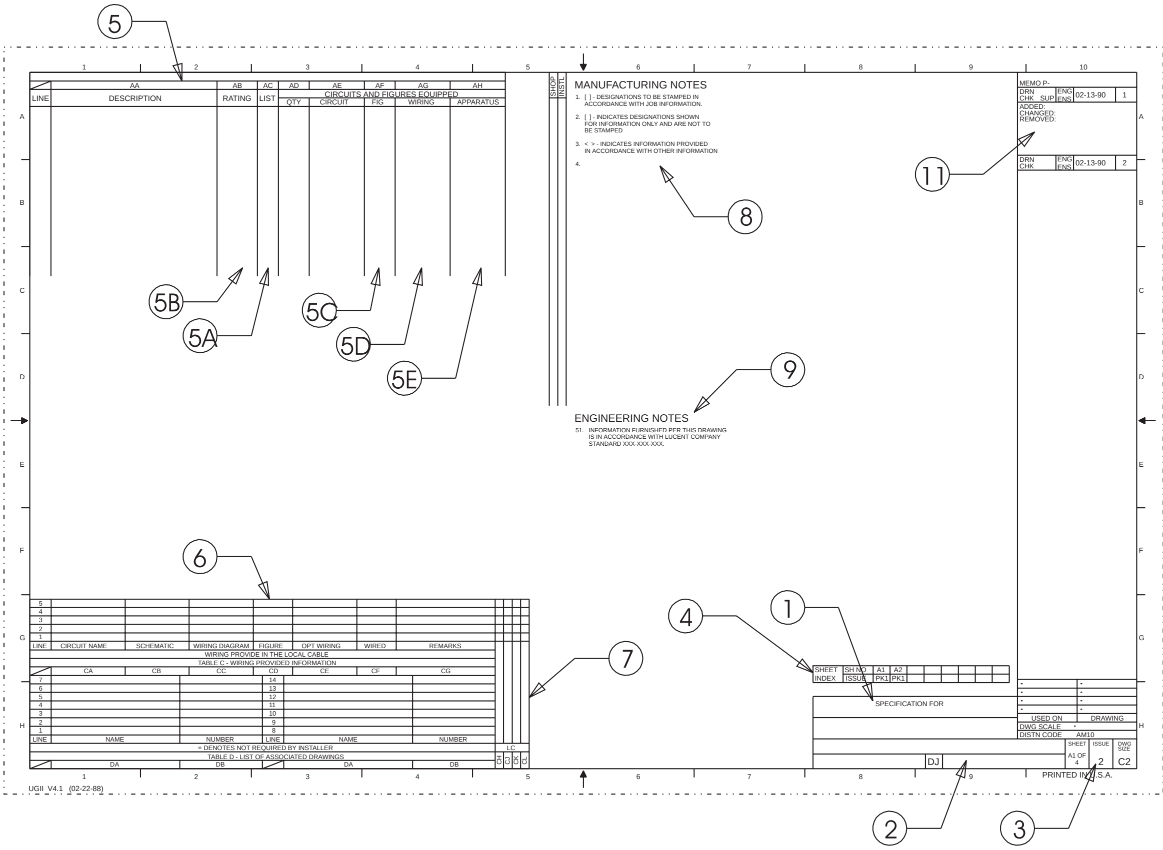


Figure A-2: Typical H-Drawing A-Sheet