Product Manual
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Lucent Technologies
Lineage® 2000
Battery Management System

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

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1 Introduction

General Information

The Lineage® 2000 family name of premier energy monitoring and control products is globally recognized as the right choice for the ultimate in systems performance and reliability. Selecting this product brings the Lucent Technologies commitment to product and service excellence to your telecommunications system. This long-standing Lucent Technologies commitment has been gained from years of worldwide telecommunications experience in the development, manufacturing, engineering, installation and servicing of leading edge energy systems, products and services.

The Lineage® 2000 Battery Management System feature adds continuous battery monitoring and control functions to the Lucent Technologies Lineage® 2000 J85500D ECS battery plant to maintain valve regulated lead-acid batteries at their optimal conditions. When combined with the remote access capabilities of the Lineage® 2000 ECS Controller, the Battery Management System enables the user to have access to important battery parameters without traveling to the site. This manual (167-790-123) describes the features, specifications, installation, applications, and operation of the Battery Management System.

Technical Support

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

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

On a post-sale basis, **during the Product Warranty period,** our Technical Support telephone number 1-800-CAL RTAC (1-800-225-7822) provides coverage during normal business hours. Product Specialists are available to answer your technical

questions and assist in troubleshooting problems. For out-of-hours EMERGENCIES, the 800 number will put you in touch with a Regional Technical Assistance Center Engineer via our 24 hour a day, 7 day per week Help Desk.

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

Central and South America

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

Europe, Middle East, and Africa

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

Asia Pacific Region

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Product Repair and Return

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

Central and South America

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

Europe, Middle East, and Africa

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

Asia Pacific Region

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

Customer Service

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

2 Product Description

Battery Management System (CP5) Specifications

Table 2-A: Battery Management System (CP5) Specifications

Operating Voltage Range	-40.0 to -60.0 Vdc
Input Power	12 watts maximum; In-line 1-1/3A alarmed fuse
Operating Temperature Range	0° - 50°C (32° - 122°F)
Altitude	200 to 13,000 ft. (-61 to 3962 m); For altitudes of 5000 to 13,000 ft. (1524 to 3962 m), reduce the maximum ambient temperature 3.6°F (2°C) for every 1000 ft.
Humidity	10 - 95% noncondensing
Electrostatic Discharge	IEC 801-2 Levels 2 & 4 (14 kV & 15 kV) at 40% relative humidity
Radiated Emission	FCC Level A
Electromagnetic Immunity	10 V/m over a range of 20 to 1000 MHz
Alarm Contacts	Four sets of Form C contacts, one for each system alarm: 500 mA, 60 VDC max
Battery Sensor Set	Accommodates sensor sets for up to two strings on base unit
Temperature Sensor	Two per battery string, with one additional sensor per battery plant to monitor ambient temperature

Table 2-A: Battery Management System (CP5) Specifications

Temperature Compensation Range	68° - 131°F (20° - 55°C)
Temperature Measurement Accuracy	+/-3.6°F (2°C) from 68° - 131°F (20° - 55°C) +/-5.4°F (3°C) from 32° - 158°F (0° - 70°C)
Voltage Sensors	One set per battery string that measures the voltage in two groups
Voltage Measurement Accuracy	+/-0.5%
Current Sensors	One per battery string. Hall-effect device with a gain of 33.3 mV/A
Recharge Current Compensation Settings	12.5A - 100A in 12.5A increments
Current Measurement Accuracy	+/-1.0% full scale accuracy +/-0.6A zero offset accuracy
Analog Outputs:	
Ambient Temperature	10 mV/°F
Highest Battery Temperature	10 mV/°F
Battery String 1 Current	33 mV/A
Battery String 2 Current	33 mV/A
Battery Management Fail Alarm (BMF)	Closure to RG
Minor Voltage Alarm (MNV)	Closure to RG
Minor Temperature Alarm (MNT)	Closure to RG
Major Temperature Alarm (MJT)	Closure to RG

Feature Summary

- Compatible with the Lineage® 2000 ECS Controller Datalogger Board (CP3) and Microprocessor Board (CP2).
- User selectable temperature compensation algorithm customizes the system for each battery plant.
- The system monitors and controls up to two battery strings.
- Flexible design allows the system and its features to grow as the battery plant and needs grow.
- Battery Management System is available in a retrofit kit for upgrading existing J85500D battery plants.

- The Battery Management System is compatible with 23 or 24 cell valve regulated battery strings at any normal float voltage.
- A Hall-effect device is used to measure each battery current, eliminating voltage drop when using a shunt.
- Adjustable recharge current limit lets the user select the proper limit for the capacity of the battery used.
- The system's LCD meter provides a local display of ambient or maximum battery temperature in degrees Fahrenheit or Celsius.
- The system provides local display and remote access of ambient temperature.
- Display LEDs provide local identification of battery strings with abnormal conditions.
- Distinguishable power major and minor alarms may be issued to indicate abnormal battery conditions by user selectable alarm set points.
- The system test feature allows the user to confirm the installation setup and operation of the system.
- All external cables meet or exceed the requirements of UL, NEC and Bellcore for control signal wiring.
- Connectorized sensor package provides maximum flexibility in cable routing and minimizes installation time.

Faceplate Feature Summary

The faceplate of the Battery Management System provides a visual indication of basic system operation (see Figure 2-1).

- The green visual indicator labeled SYSTEM ON lights when the Battery Management System is powered and operational.
- The yellow visual indicator labeled BMF lights when the Battery Management System fails, indicating a minor alarm condition.
- A back-lit LCD meter with 1/2" digits and 6 o'clock viewing angle displays ambient or maximum battery temperature. A switch is used to select battery or ambient temperature for display. Two yellow visual indicators display the units of measurement, Fahrenheit or Celsius.
- A red visual indicator labeled MJT lights when a battery temperature exceeds the selected upper temperature threshold, indicating a major alarm condition.
- A yellow visual indicator labeled MNT lights when a battery temperature exceeds the user selectable lower threshold.

- A yellow visual indicator labeled MNV lights when one or more of the battery strings have a voltage unbalance.
- A yellow visual indicator labeled TEMP CONTROL lights when an abnormally high battery temperature causes the plant voltage to decrease below its nominal value.
- A yellow visual indicator labeled RECHG CUR CONTROL lights if the current limit option is enabled and the charge current into the batteries exceeds the user selectable threshold causing the plant voltage to decrease below its nominal value.
- A group of four yellow visual indicators labeled BATTERY STATUS lights under the following conditions:

    - TEMP BAT 1 lights when the temperature of battery string one is the highest and has exceeded the lower temperature threshold.
    - TEMP BAT 2 lights when the temperature of battery string two is the highest and has exceeded the lower temperature threshold.
    - VOLT BAT 1 lights when the cell voltages of battery string one are unbalanced.
    - VOLT BAT 2 lights when the cell voltages of battery string two are unbalanced.

- A momentary switch labeled TEST simulates system operation based on the user defined parameters.

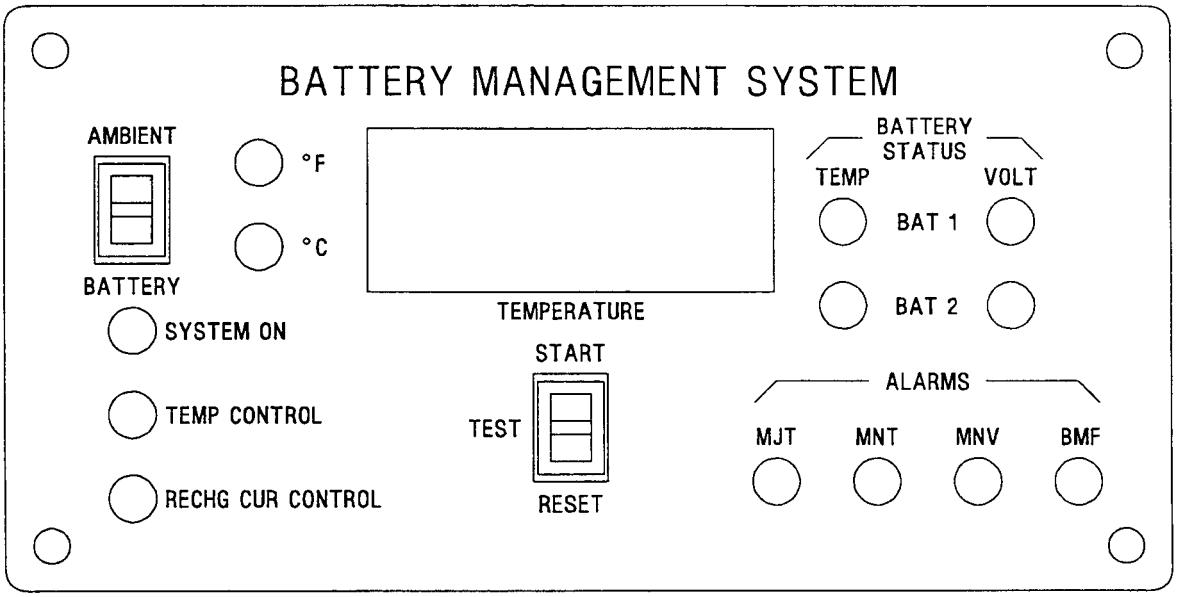


Figure 2-1: Battery Management System Faceplate

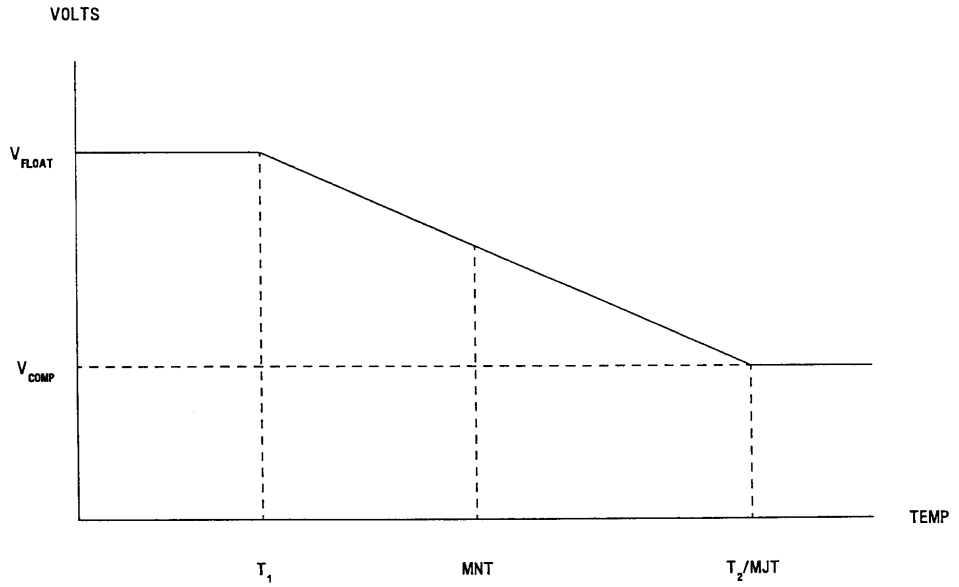


Figure 2-2: Battery Management System Temperature Compensation Function

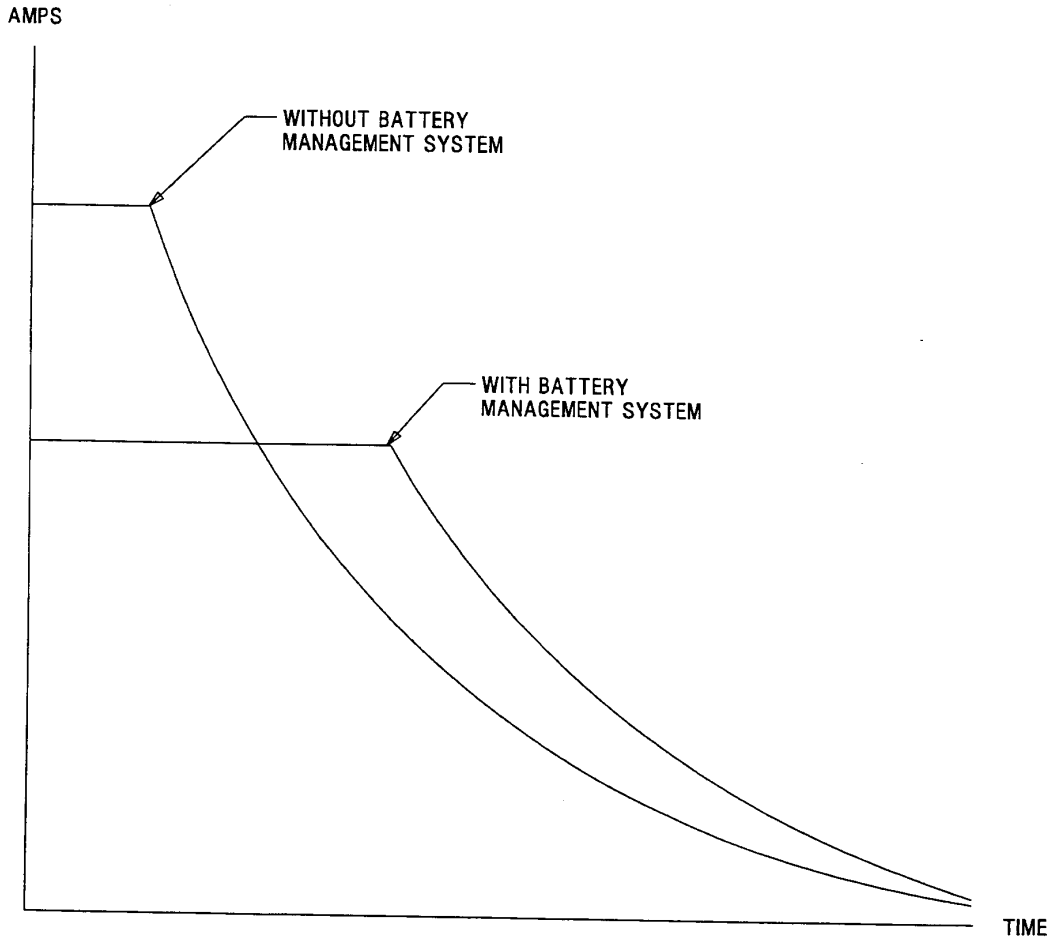


Figure 2-3: Battery Management System Recharge Current Compensation Function

Battery Management System Overview

The Battery Management System combines three functions that offer excellent battery monitoring and control performance. The functions are temperature compensation of float voltage, recharge current compensation of float voltage, and string voltage unbalance detection.

Temperature Compensation

The temperature compensation function automatically adjusts the battery float voltage as a function of the highest monitored battery temperature. This function maintains the batteries at the proper state of charge while ensuring that elevated battery temperatures do not induce catastrophic failures. Figure 2-2 illustrates this control function of the Battery Management System. The parameters in Figure 2-2 are defined as follows:

- V_{float}: Float voltage at 25°C
- V_{comp}: Float voltage after maximum compensation (2.4 volts)
- T1: Compensation start temperature
- T2: Final compensation temperature
- MNT: Minor Temperature Alarm between T1 and T2
- MJT: Major Temperature Alarm at T2
- T1, MNT, and T2/MJT are user selectable levels set via DIP switches on the back of the Battery Management System circuit pack (see Section 3).

Recharge Current Compensation

The recharge current compensation function adjusts battery float voltage as a function of the highest monitored recharge current. This reduces peak charge currents and heat and gas evolution in the battery. Battery plant float voltage is reduced when the highest monitored recharge current exceeds the current limit setpoint, thus limiting the current available for recharge into each battery string. Figure 2-3 illustrates the advantage of limiting the recharge current into the battery string. The full charge capacity is determined by the area under each curve in Figure 2-3, and as illustrated, these areas are approximately equal towards the end of the charging cycle.

String Voltage Unbalance

The string voltage unbalance detection function alerts the user to any change in cell voltages. Cell voltage unbalance detection is an early warning indicator of cell dry-out, end of life, misinstallation, or other abnormal cell conditions. This function is implemented by monitoring the battery string in two halves. The Battery Management System determines the average

per-cell voltage in each half string, thus accommodating 23 or 24 cell plants. The Battery Management System alerts the user with a Minor Voltage Alarm when the difference between the two halves of the string exceeds 0.25 V.

3 Installation

Battery Management System Retrofit Installation

Note

Must be installed or serviced by qualified personnel.

Tools Required

The following tools are required for installation:

- Common electrician's hand tools
- Digital multimeter
- Flat blade screwdriver
- Small Phillips screwdriver
- Socket set

Inspect Contents

Open the shipping container and inspect the contents for damage.

Contents (ED-83241-30 GK1)

- Battery Management System (distribution door, circuit pack, and cover) (Figure 3-1)
- Battery Cable Sets (4) (Figure 3-2)
- CP1 Cable Set (Figure 3-3)
- Cable Ties (7)
- Cable Mounting Bracket (Figure 3-4)
- Temperature Sensor Assemblies (2) (Figure 3-5)
- Hall-effect Current Sensor (Figure 3-6)
- Tape - Velcro (4)
- Drawing Package
- Product Manual
- Label (Figure 3-7)

- E501, E502, E503 Cable Extenders

Contents (ED-83241-30 GK2)

- Battery Cable Sets (4) (Figure 3-2)
- Cable Ties (6)
- Cable Mounting Bracket (Figure 3-4)
- Temperature Sensor Assemblies (2) (Figure 3-5)
- Hall-effect Current Sensor (Figure 3-6)
- Tape - Velcro (4)

Contents (ED-83241-30 GK3)

- Extension Cable (Figure 3-8)

Contents (ED-83241-30 GK4)

- CP3 Cable (Figure 3-9)
- Cable Ties (6)
- Terminals for connection to remote termination unit

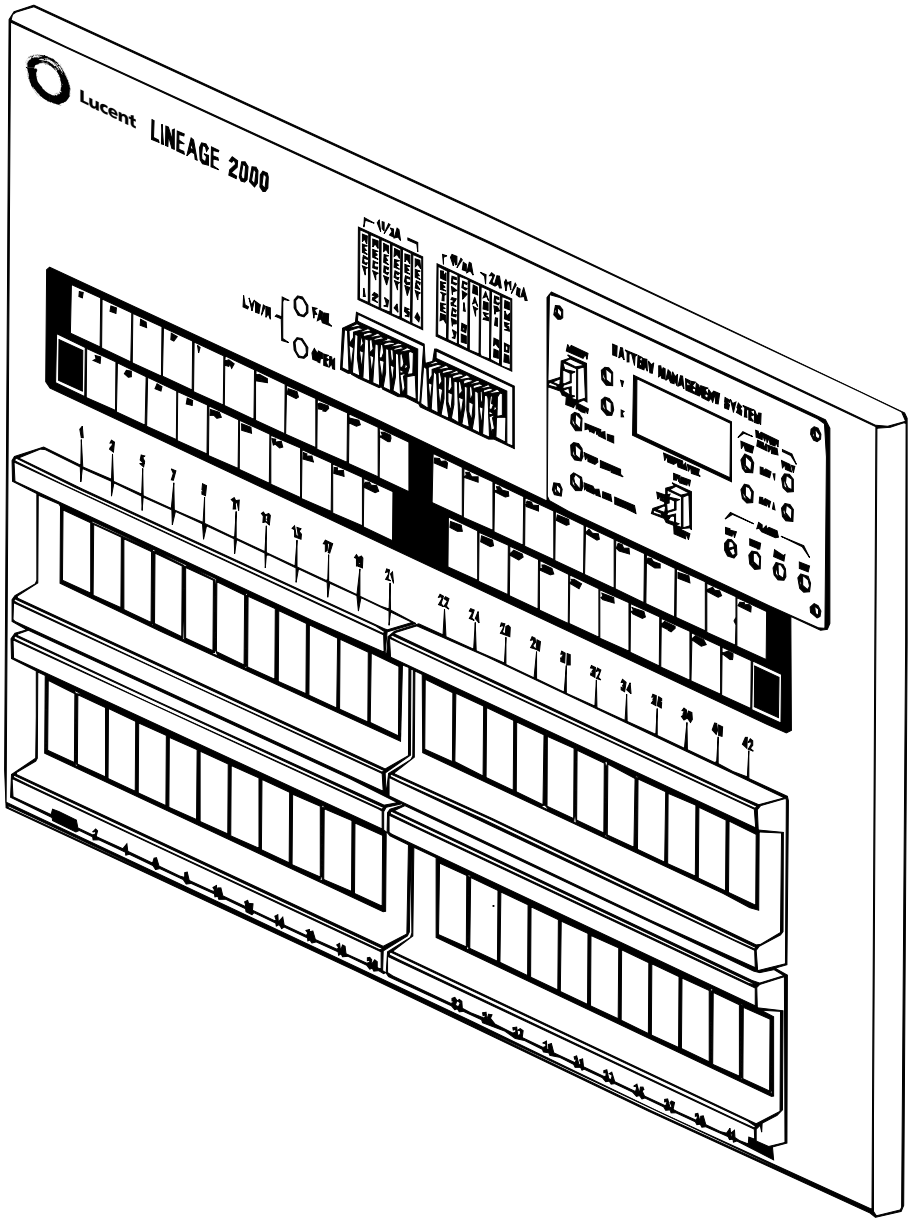


Figure 3-1: Battery Management System

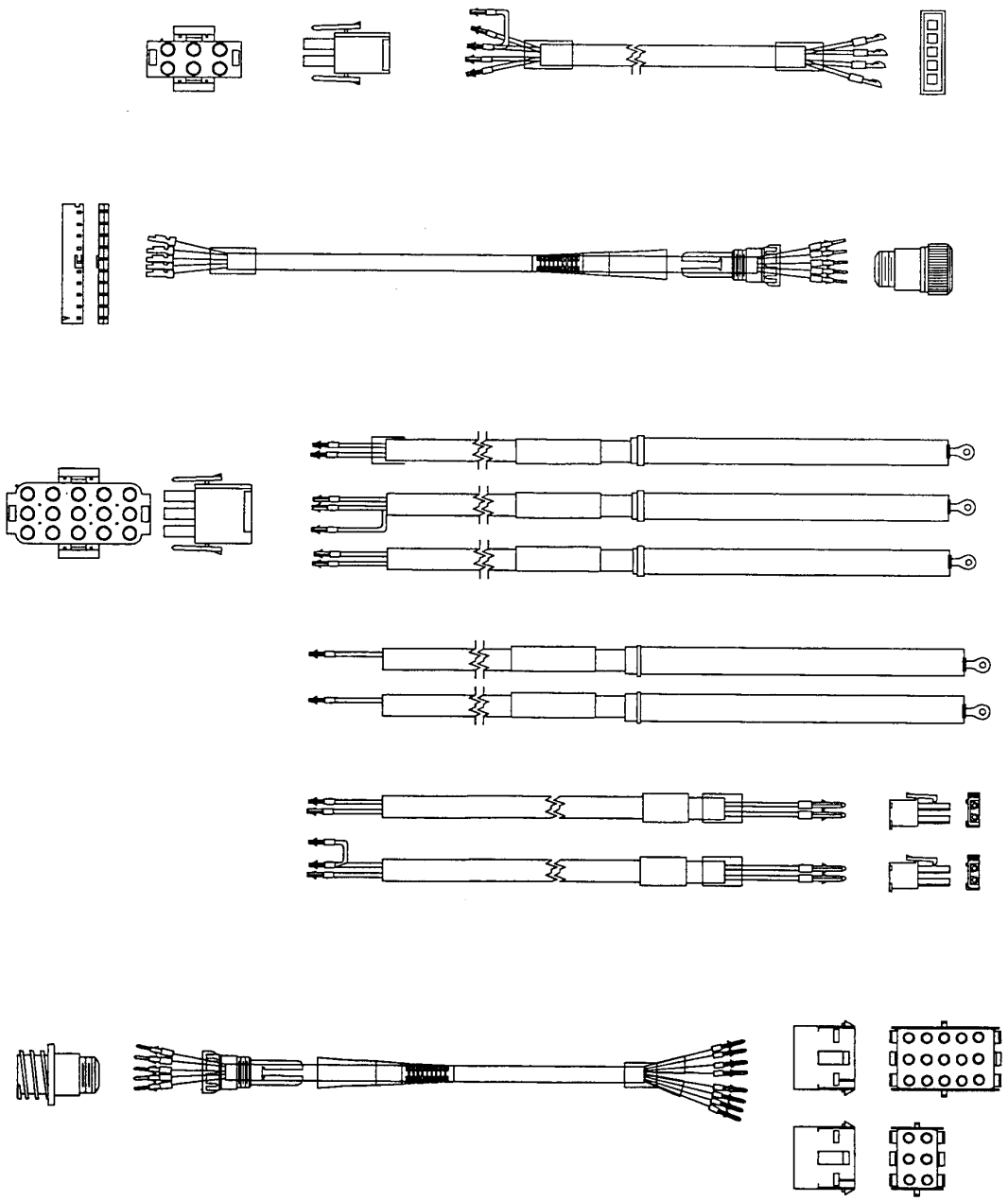


Figure 3-2: Battery Cable Sets

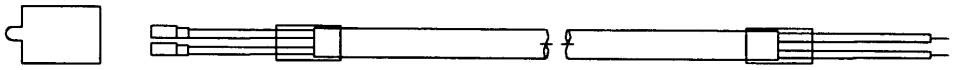


Figure 3-3: CP1 Cable Set

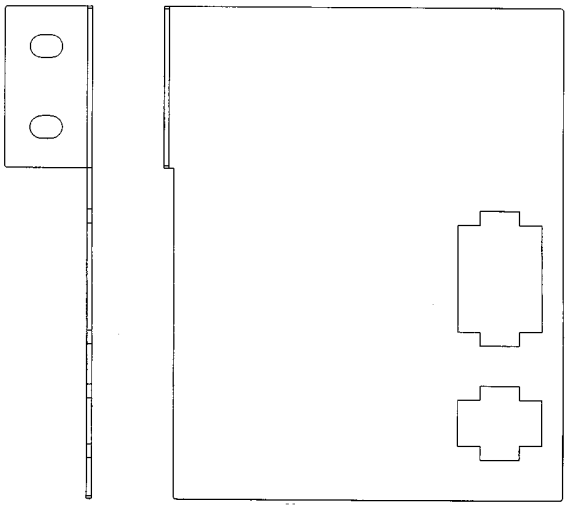


Figure 3-4: Cable Mounting Bracket

Figure 3-5: Temperature Sensor Assemblies

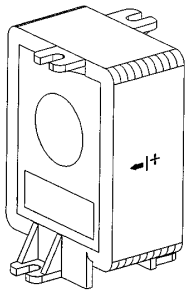


Figure 3-6: Hall-effect Current Sensor

FUSE BOARD (CP5)	
COMCODE	DESCRIPTION
106693245	CP-BDW1 Fuse Board
405673146	1 1/3A Fuse(WP90247 L7)
405181983	2A Fuse (WP90247 L9)

Figure 3-7: Label 846919769

Figure 3-8: Extension Cable 847018314

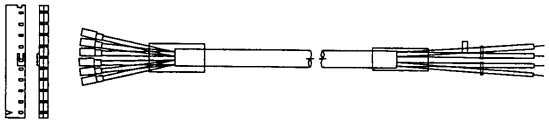


Figure 3-9: CP3 Cable 847018280

Plant Preparation

Note

If any alarms are present, contact the proper personnel. Do not proceed with installation.

1. Verify all rectifiers are on line without any alarms.
2. Verify there are no alarms on the plant controller.
3. Verify all LEDs on distribution door are off.
4. Record plant voltage as shown on the controller front panel.
5. Measure and record individual cell voltages. Readings on 2VR250E or 2VR375E battery cells should be within 0.050 volts of the average or 0.100 volts of the average for the 4VR125E or 4VR125EL battery cells. Any 2VR250E or 2VR375E battery cell reading less than 2.17 volts (4.34 volts for the 4VR125E or 4VR125EL battery cell) is considered to be shorted and must be replaced. Because float readings are affected by discharges and recharges, it is best to take these readings when the battery cells have been on continuous, uninterrupted float for at least one month.
6. Repeat steps 1 - 5 for all battery strings.
7. If controller is equipped with a CP2 Microprocessor Circuit pack, verify the integrity of the lithium battery. Measure voltage across the battery. New cells should be approximately 3.1 to 3.2 volts. Low cell conditions are 2.6 volts +/-0.25 volts. Low battery conditions may result in the loss of CP2's memory configuration during installation.
8. If the plant has a low voltage battery disconnect, the contactor will open when the LVD board (CP5) is disconnected. To prevent disconnecting the batteries, place a strap across the contactor.
9. Disconnect the P790 ribbon cable from each rectifier to return the rectifiers to local sense. This will allow the rectifiers to internally regulate. Load sharing will be disabled. Verify all rectifiers output voltage by measuring the V RECT (+ -) test jacks at each rectifier. Adjust rectifiers if required to proper float voltage.

Remove Original Distribution Door Assembly

1. Cut all cable ties anchoring cables to the distribution assembly door.
2. Disconnect cables to P501, P502, P504 and P506.
3. Remove the three nuts and washers that secure the door assembly to the frame.
4. Remove the door assembly.

Battery Management System Installation

1. If plant is equipped with a contactor place the Battery Management System label above Fail/Open LEDs on front panel, if there is no contactor place this label over these LEDs.
2. Note which circuit breaker positions are being utilized on the original distribution door. Remove the circuit breaker knockouts for the corresponding circuit breaker positions. Or, the old circuit breaker panels can be removed from the original distribution door and installed in place of the panels in the new door.
3. Verify that the ENABLE/DISABLE switch is disabled.
4. Install the Battery Management System assembly on the three studs the original door assembly was installed on, using the original nuts and washers.
5. Reconnect LVD cable sets to P501, P502, P504, and P506 as labeled on the new back cover.
6. Fold extra length of ribbon cable and anchor under plate.
7. Make sure to dress ribbon cable with sufficient slack across hinge to permit full opening of distribution assembly door.
8. The Faston connector located on the discharge return bus and connected to a blue wire requires bending towards the back of the distribution assembly to avoid door interference.

Caution

Verify clearance of circuit breakers to door knockout positions by carefully closing the door.

9. Remove contactor strap from bus if one was used.

10. Reconnect P790 cable to all rectifiers. Rectifiers are now regulating via the remote sense leads. Verify proper float voltage. Adjust if necessary.

11. Verify no alarms are present in the controller and rectifiers.

12. Verify the LEDs on the distribution door are off.

13. Re-label distribution positions on the new door or replace new label with the original.

Installing Battery Cable Sets

1. Bolt cable bracket on top of retainer assembly located second from the top on the left side of the battery stand (see Figure 3-10).

2. Mount bracket cable set in appropriate cutouts on cable bracket (Figure 3-11).

3. Attach board cable set to bracket cable set (Figure 3-11) and route up towards cable tray (Figure 3-10), down through the top of the plant and towards P200 (P201 if installing second battery string).

4. If extension cable is necessary insert between bracket and board cable sets.

5. Repeat Steps 1 through 5 for second battery string, if necessary.

Installing CP1 Cable Set

1. When only CP1 is present in the controller, attach CP1 cable set to P508 on CP5 and route as shown in Figure 3-10. This connection will allow the Battery Management System alarms to cause the appropriate plant alarms. The Battery Management System will generate a Minor Battery Alarm (MNB) if any one of the following Battery Management System alarms are active:

   - Battery Management System Fail (BMF)
   - Minor Temperature Alarm (MNT)
   - Minor Voltage Alarm (MNV)

The Battery Management System will generate a Major Battery Alarm (MJB) if the Major Temperature Alarm (MJT) is active. The MNB and MJB alarms will be connected to the RMN and RMJ alarm inputs, respectively, on CP1.

2. Connect the opposite end of the black wire (MNB) to RMN (TB101-5) and the white wire (MJB) to RMJ (TB101-4) on CP1 (See ECS-6 Controller Product Manual, 167-790-031, Section 3.3.1 for proper connection technique).

Installing CP3 Cable Set

1. If CP3 is present, do not install the CP1 cable set.

2. Place CP3 cable set near P400 on CP5, but do not connect to CP5 at this time. Route as shown in Figure 3-10.

3. Connect the opposite end to unused analog channels on CP3. See Section 3 of ECS Controller Options Product Manual (167-790-109) for proper connection technique. Signals on each pin of P400 are shown in Table 3-A. See Section 5.2.1 through 5.2.4 of this manual for proper datalogger channel configuration.

.

Table 3-A: P400 Connections to CP3 Datalogger Option

Channel Number	Signal Description	Wire Color	CP3	Termination Panel
1	Highest Battery Temperature Return	Black White	TB301-1 TB301-2	TB101-1 TB101-2
2	Ambient Temperature Return	Red Green	TB301-3 TB301-4	TB101-3 TB101-4
3	Battery String One Current Return	Red-White Green-White	TB301-5 TB301-6	TB101-5 TB101-6
4	Battery String Two Current Return	Blue-White Black-Red	TB301-7 TB301-8	TB101-7 TB101-8
5	Battery Management Fail Alarm Return	Orange Blue	TB302-1 TB302-2	TB101-9 TB101-10
6	Minor Voltage Alarm Return	White-Black Red- Black	TB302-3 TB302-4	TB101-11 TB101-12
7	Minor Temperature Alarm Return	Green-Black Orange-Black	TB302-5 TB302-6	TB101-13 TB101-14
8	Major Temperature Alarm Return	Blue-Black Black-White	TB302-7 TB302-8	TB101-15 TB101-16

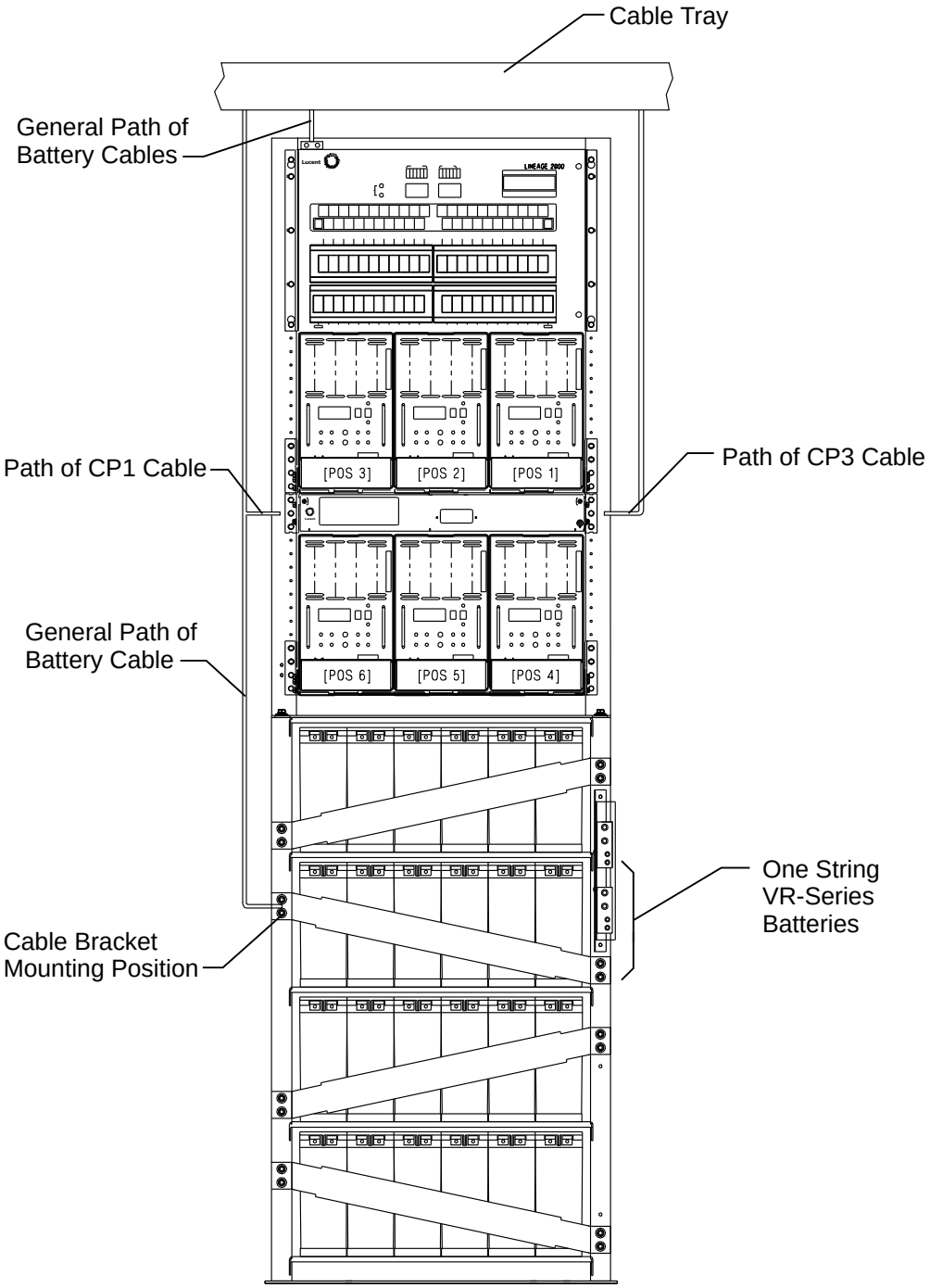


Figure 3-10: Cable Bracket Positioning and Cable Routing

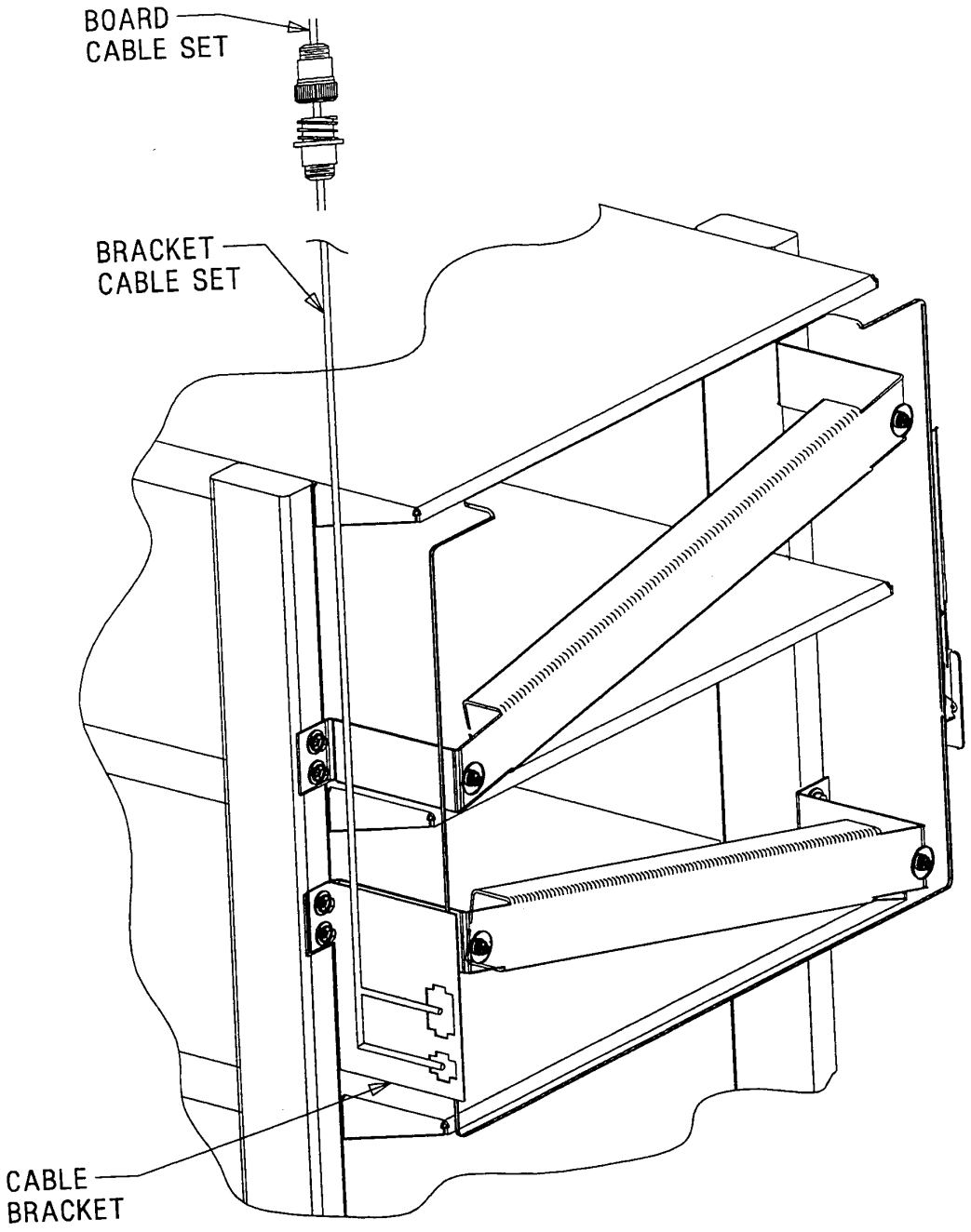


Figure 3-11: Bracket Cable Set Mounting

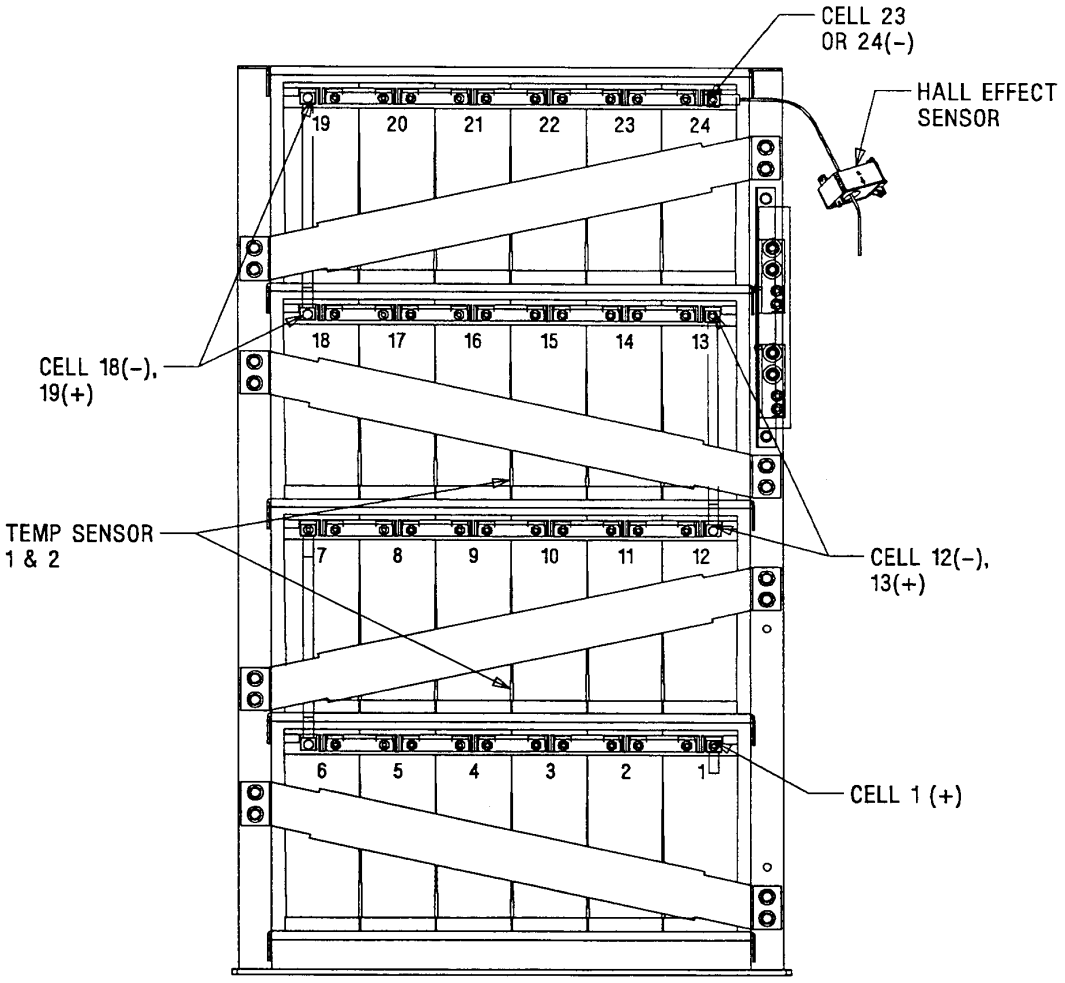
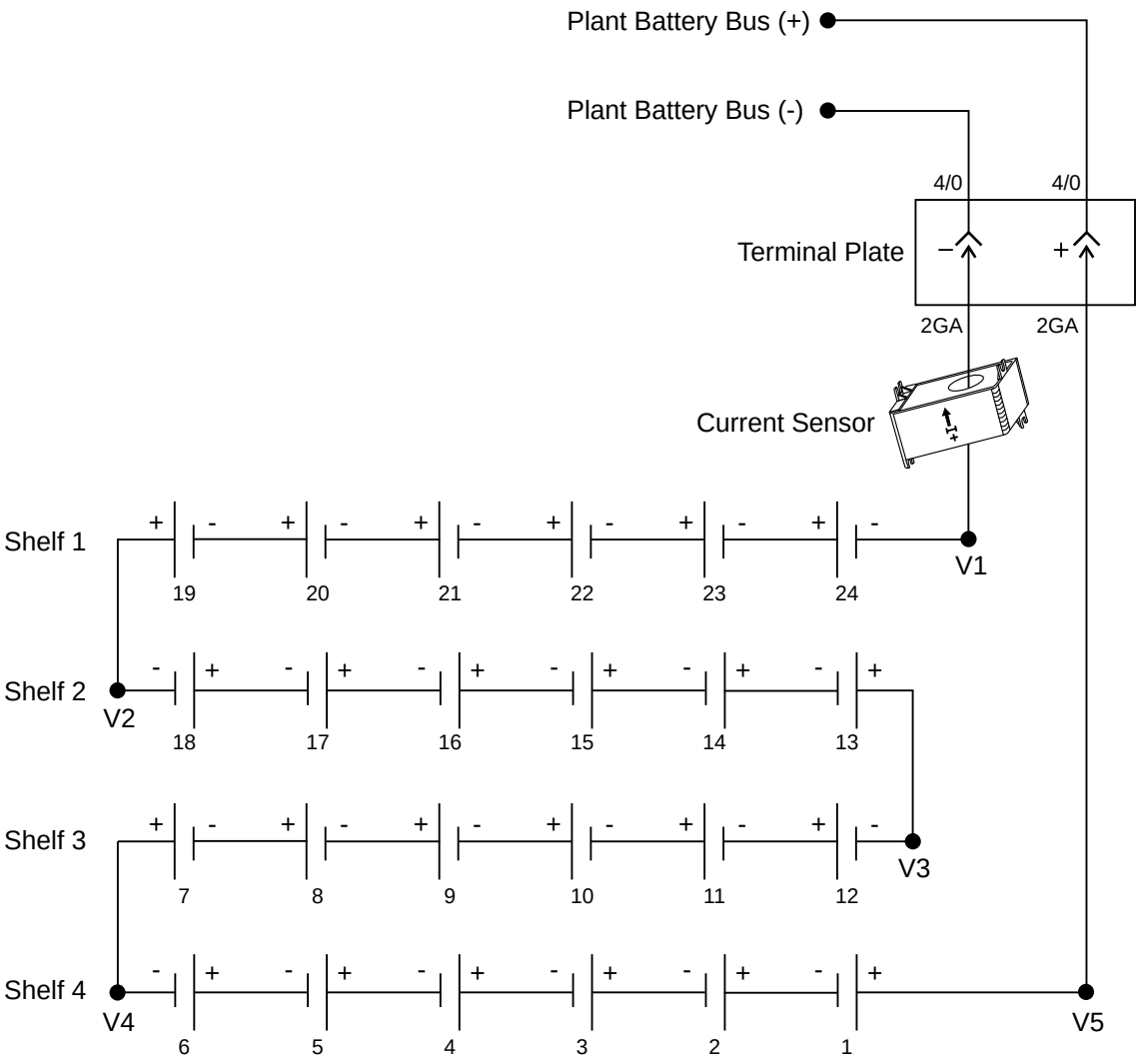


Figure 3-12: Sensor Placement and Wire Routing



V1 = Voltage Probe Attached to Cell 24(-)
V2 = Voltage Probe Attached to Cell 18(-)
V3 = Voltage Probe Attached to Cell 12(-)
V4 = Voltage Probe Attached to Cell 6(-)
V5 = Voltage Probe Attached to Cell 1(+)

Figure 3-13: Voltage Probe and Current Sensor Placement

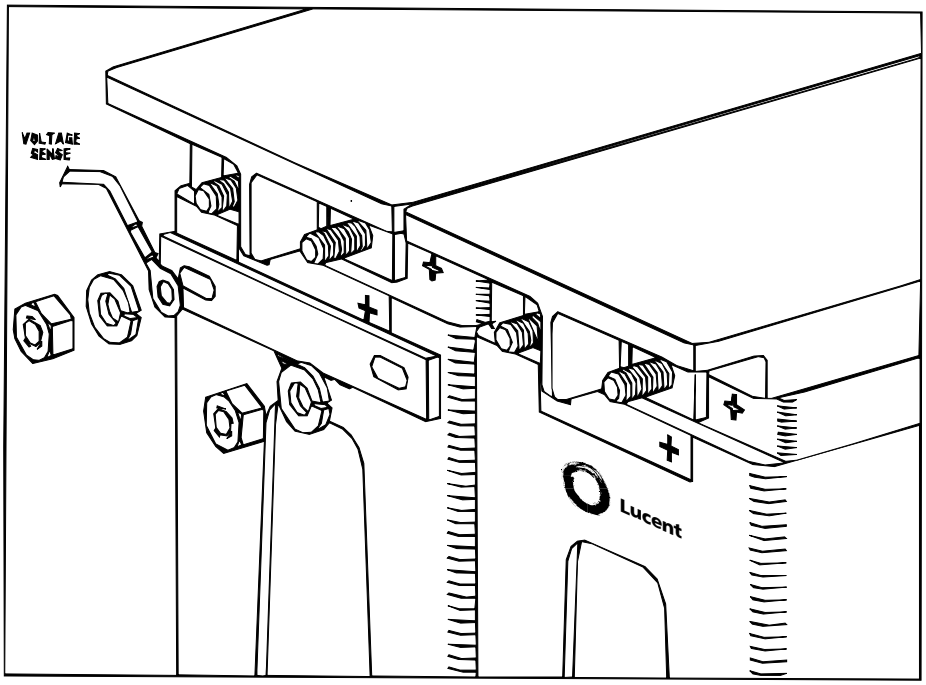


Figure 3-14: Battery Post Connection for Voltage Probe

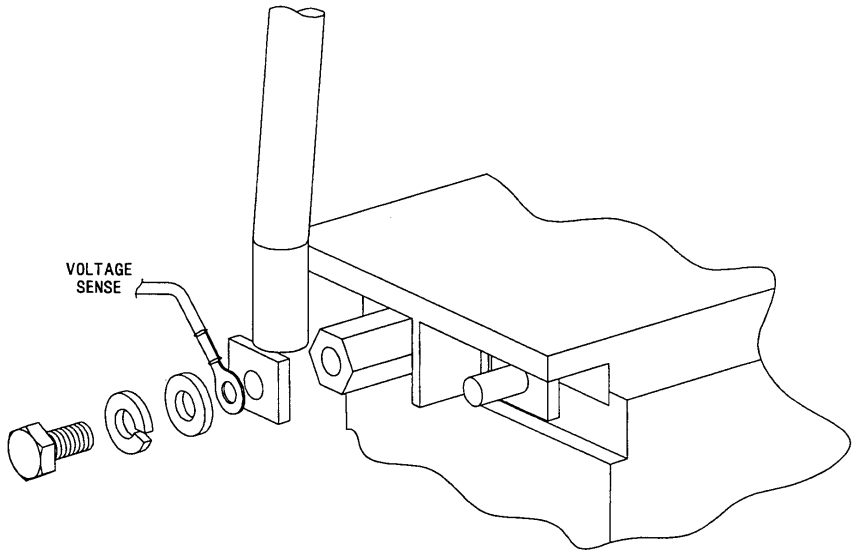


Figure 3-15: Battery Post Connection (Vertical Inter-Cell Strap)

Installing Battery Management System Sensors When Only One Battery String Is Installed

The following procedures, using 12-volt automotive batteries, will maintain battery backup in case of an ac power failure while the Battery Management System sensors are being installed with only one battery string.

Four Batteries Available

If four 12-volt automotive batteries are available, wire them in series to make a 48-volt battery string, then connect it in parallel with the stationary battery string.

1. Pre-charge the automotive battery string to within 0.05 volts of the stationary battery string or lower the plant voltage to within 0.05 volts of the automotive battery string.

2. Connect the automotive battery string across the stationary battery string making the following connections:

   - Automotive battery string (-) to plant battery bus (-)
   - Automotive battery string (+) to plant battery bus (+)

3. Follow the instructions in paragraph "Installing Battery Management System Sensors on a Two Battery String Plant."

One Battery Available

If only one 12-volt automotive battery is available, use it to bypass each shelf of the stationary battery string successively. Install the Battery Management System sensors as follows:

1. Plug volt/temp sensor cable set and current sensor cable set into appropriate connector mounted in cable bracket.

2. Run leads through retainer assemblies toward their appropriate battery posts to avoid catching loose wires. Each cable set is marked with its correct battery post placement (Figure 3-12).

3. For a 24 cell battery string, pre-charge the 12 volt automotive battery to within 0.05 volts of the voltage across Shelf 1, measured between Cell 19 (+) and Cell 24 (-), of the stationary battery string as shown in Figure 3-13. Connect the automotive battery as follows:

- Automotive battery (-) to terminal plate (-)
- Automotive battery (+) to Cell 19 (+)

4. For a 23 cell battery string, pre-charge the 12 volt automotive battery to within 0.05 volts of the voltage across Shelf 1, measured between Cell 18 (+) and Cell 23 (-), of the stationary battery string as shown in Figure 3-13. Connect the automotive battery as follows:

   - Automotive battery (-) to terminal plate (-)
   - Automotive battery (+) to Cell 18 (+)

5. Place ring terminal for voltage probe V1 on Cell 23/24 (-) as shown in Figure 3-13. Place ring terminal under nuts and washers on battery post as shown in Figure 3-14. For connection on battery posts where a vertical inter-cell strap is located, see Figure 3-15.

Note

These cable sets contain current limiting resistors in series with all voltage monitoring points.

6. Slide the Hall-effect current sensor (CS) onto the 2 AWG wire coming off the negative battery post of cell 23 or 24, depending on the configuration. Be sure the arrow marked on the Hall-effect sensor is pointing away from the negative post (Figure 3-16).

Note

If accuracy at very low currents is desired, refer to Section 5 before installing the Hall-effect current sensor.

7. Connect the automotive battery across Shelf 2 as follows:

   - Automotive battery (-) to Cell 19 (+)
   - Automotive battery (+) to Cell 13 (+)

8. Place the ring terminal for voltage probe V2 on Cell 18 (-) as shown in Figure 3-13. Place ring terminal under nuts and washers on battery post as shown in Figure 3-14. For connection on battery posts where a vertical inter-cell strap is located, see Figure 3-15.

9. Connect the automotive battery across Shelf 3 as follows:

- Automotive battery (-) to Cell 13 (+)
- Automotive battery (+) to Cell 7 (+)

10. Place the ring terminal for voltage probe V3 on Cell 12 (-) as shown in Figure 3-13. Place ring terminal under nuts and washers on battery post as shown in Figure 3-14. For connection on battery posts where a vertical inter-cell strap is located, see Figure 3-15.

11. Connect the automotive battery across Shelf 4 as follows:

    - Automotive battery (-) to Cell 7 (+)
    - Automotive battery (+) to terminal plate (+)

12. Place the ring terminal for voltage probe V4 on Cell 6 (-) as shown in Figure 3-13. Place ring terminal under nuts and washers on battery post as shown in Figure 3-14. For connection on battery posts where a vertical inter-cell strap is located, see Figure 3-15.

13. After re-torquing the battery post nuts to 60 in-lb, insert the two temperature sensors between battery cells 15-16 and 9-10. Thermal grease may be used to ease insertion.

14. Attach both the temperature sensors and Hall-effect sensor to their appropriate connectors on the volt/temp sensor cable set and the current sensor cable set, respectively.

Installing Battery Management System Sensors on a Two Battery String Plant

When at least two battery strings are connected to the plant, the Battery Management System sensors may be installed on one battery string at a time to maintain battery backup in case of an ac power failure.

1. Plug volt/temp sensor cable set and current sensor cable set into appropriate connector mounted in cable bracket.

2. Run leads through retainer assemblies toward their appropriate battery posts to avoid catching loose wires. Each cable set is marked with its correct battery post placement (Figure 3-12).

3. Place ring terminals under nuts and washers on battery posts as shown in Figure 3-14. For connection on battery posts where a vertical inter-cell connector is located, see Figure 3-15.

Note

These cable sets contain current limiting resistors in series with all voltage monitoring points.

4. Slide the Hall-effect current sensor (CS) onto the 2 AWG wire coming off the negative battery post of cell 23 or 24, depending on the configuration, to the terminal plate before re-torquing the nut on the terminal. Be sure the arrow marked on the Hall-effect sensor is pointing away from the negative battery post (Figure 3-16).

Note

If accuracy at very low currents is desired, refer to Section 5 before installing the Hall-effect current sensor.

5. After re-torquing the battery post nuts to 60 in-lb, insert the two temperature sensors between battery cells 15-16 and 9-10. Thermal grease may be used to ease insertion.

6. Attach both the temperature sensors and Hall-effect sensor to their appropriate connectors on the volt/temp sensor cable set and the current sensor cable set, respectively.

7. Repeat for second battery string.

DIP Switch Configuration

1. Refer to Section 4 for help in determining proper DIP switch settings for your particular application.

2. Use DIP switch SW100-1,2 to select T1. Use DIP switch SW100-3,4 to select T2/MJT.

Table 3-B: SW100 Settings

T1 Setpoint			**T2/MJT Setpoint**		
°C/°F	1	2	°C/°F	3	4
20/68	1	1	40/104	1	1
25/77	1	0	45/113	1	0
30/86	0	1	50/122	0	1
35/95	0	0	55/131	0	0

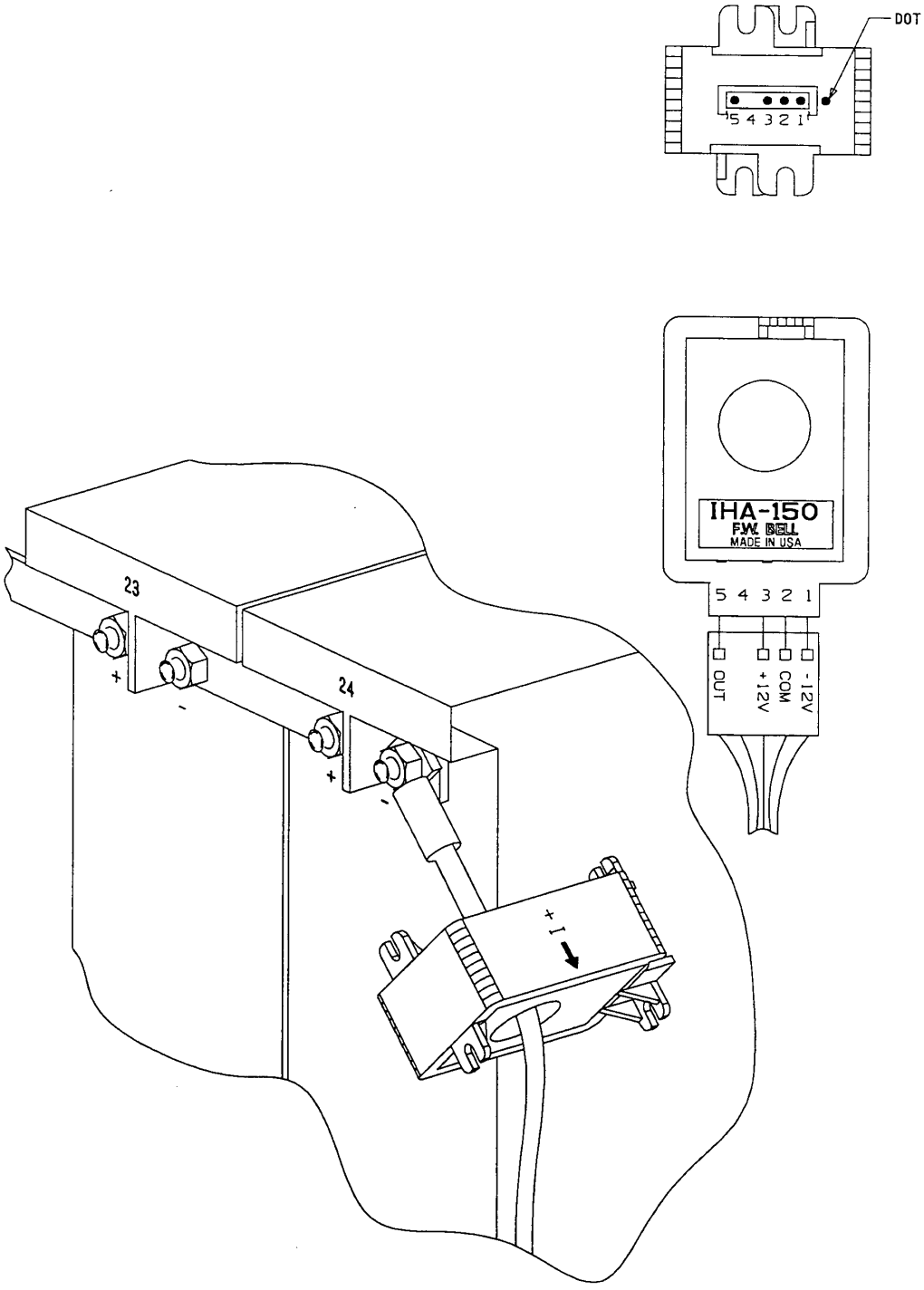


Figure 3-16: Installing Hall-effect Current Sensor

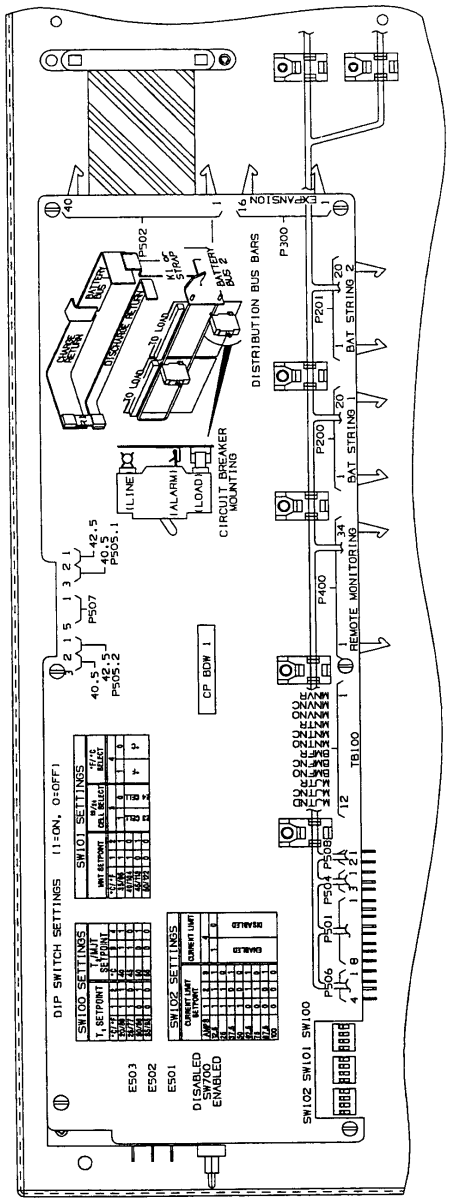


Figure 3-17: BDW1 Circuit Pack Cover

3. Use DIP switch SW101-1,2 to select MNT, DIP switch SW101-3 to select the number of cells, and DIP switch SW101-4 to select the displayed temperature units.

Table 3-C: SW101 Settings

MNT Setpoint			23/24 Cell Select	°F/°C Display Select
°C/°F	**1**	**2**	**3**	**4**
30/86	1	1		
35/95	1	0	1 = 23 Cell	1 = °C
40/104	0	1	0 = 24 Cell	0 = °F
45/113	0	0		

4. Use DIP switch SW102-1,2,3 to select the current compensation limit as needed for the battery size used and DIP switch SW102-4 to select if the current compensation function is Enabled/Disabled.

Table 3-D: SW102 Settings

Current Limit Setpoint				Current Limit
Amps	**1**	**2**	**3**	**4**
12.5	1	1	1	
25	1	1	0	
37.5	1	0	1	
50	1	0	0	1 = Enabled
62.5	0	1	1	0 = Disabled
75	0	1	0	
87.5	0	0	1	
100	0	0	0	

Verify System Operation

1. Connect board cable set(s) to P200, and P201 (if two strings present) on CP5.

2. Connect CP3 cable set to P400 on CP5.

3. Activate Battery Management System by moving switch SW700 to the enable position.

4. Confirm that the green system on LED is illuminated and no alarm conditions exist.

5. Push the system test switch up. Confirm that all LEDs light.

6. Watch temperature display and verify that temperature compensation and alarms occur at the selected temperatures.

7. Once the system is functioning properly and all cable sets have been routed and connected, tie down cables at board as shown in Figure 3-17.

8. Dress cable sets with sufficient slack across hinge to permit full opening of distribution assembly door.

Battery Management System Alarm Relay Wiring

Four sets of Form C alarm relay contacts are provided for customer use. They may be used to control visual or audible alarms. Alarm circuits must be 500 mA and 60 Vdc maximum.

Note

All wiring must comply with National Electric Code and any local codes.

Caution

The alarm relay circuits cannot be fuse protected since an open fuse could prevent an alarm from being sent. Therefore, the current limiting protection for the relays must be designed into the external circuit. Exceeding the maximum ratings specified could result in damage to the unit or fire.

Connections can be made to the four Form C alarm relay contacts via terminal block TB100. The terminal block is a separable connector that accepts the stripped end of a wire in a screw-clamp type connection. Maximum wire size should be 18 AWG wire. Strip ends 3/8 inch. To ease connection, remove the terminal block from the circuit board by pulling down. After making connections, simply plug back onto the board. This is only to ease connections; connections may also be made with the terminal block attached to the board. To connect the wire loosen the screw associated with the desired terminal, insert the stripped end of the wire into its opening, tighten screw, and test the connection by pulling gently on the wire. See Table 3-E for pin assignments on TB100.

The normal state of all alarms is the no-alarm state. For example, if a minor alarm is present, a contact closure will exist between MNVNO and MNVR, and no contact closure will exist between MNVNC and MNVR.

Also note that should power fail to CP5; MNT, MNV and MJT default to their "normal" or no-alarm state, while BMF defaults to the alarm state.

Table 3-E: Alarm Relay Contacts

TB100 Pin No.	Description	Position
1	Minor Voltage Alarm	Center
2	Minor Voltage Alarm	Normally Closed
3	Minor Voltage Alarm	Normally Open
4	Minor Temperature Alarm	Center
5	Minor Temperature Alarm	Normally Closed
6	Minor Temperature Alarm	Normally Open
7	Battery Management Failed Minor Alarm	Center
8	Battery Management Failed Minor Alarm	Normally Closed
9	Battery Management Failed Minor Alarm	Normally Open
10	Major Temperature Alarm	Center
11	Major Temperature Alarm	Normally Closed
12	Major Temperature Alarm	Normally Open

New Installation

Follow this installation procedure when the Battery Management System has been partially installed in the factory before shipment of the battery plant.

Tools Required

The following tools are required for installation:

- Common electrician's hand tools
- Digital multimeter
- Flat blade screwdriver
- Small Phillips screwdriver
- Socket set

Check List

The Battery Management System circuit pack and cover reside on the distribution door which is factory mounted at the top of the battery plant. The following is a list of additional cabling and hardware that should have been shipped with the battery plant in order to properly install the Battery Management System:

- Battery Cable Sets (4) (Figure 3-2)
- CP1 Cable Set (Figure 3-3)
- Cable Ties (7)
- Cable Mounting Bracket (Figure 3-4)
- Temperature Sensor Assemblies (2) (Figure 3-5)
- Hall-effect Current Sensor (Figure 3-6)
- Tape - Velcro (4)
- Product Manual
- Label (Figure 3-7)
- E501, E502, E503 Cable Extenders

Optional Kits

Optional kits include:

- ED-83241-30 GK2 for installation of a second battery string
- ED-83241-30 GK3 to provide extension length for the battery cable sets
- ED-83241-30 GK4 for remote monitoring of battery parameters.

The contents of each of these kits are listed in paragraph "Inspect Contents" at the beginning of Section 3. Open the packaging carefully to verify that the contents are complete and undamaged.

Installing Battery Cable Sets

1. While mounting the batteries in the battery stand be aware that the battery temperature sensors are to be installed between batteries 9-10 and 15-16 as shown in Figure 3-12. Try to leave a small gap between these battery cells in order to ease temperature sensor insertion later.

2. Before installing the retainer bars over the batteries, place the cable bracket on top of retainer bar located second from the top on the left side of the battery stand as shown in Figure 3-10.

3. Mount bracket cable set in appropriate cutouts on cable bracket (Figure 3-11).

4. Attach board cable set to bracket cable set (Figure 3-11) and route up towards cable tray (Figure 3-10), down through the top of the plant and towards P200 (P201 if installing second battery string).

5. If extension cable is necessary, insert between bracket and board cable sets.

6. Plug volt/temp sensor cable set and current sensor cable set into appropriate connector mounted in cable bracket.

7. Run leads through retainer assemblies towards their appropriate battery post to avoid catching loose wires. Each cable set is marked with its correct battery post placement (Figure 3-12).

8. Before inter-cell connectors are torqued, place the ring terminals under nuts and washers on battery posts as in Figure 3-13. For connection on battery posts where a vertical inter-cell strap is located, see Figure 3-14.

9. Slide the Hall-effect sensor onto the 2AWG wire coming off the negative battery post of cell 23 or 24, depending on the configuration (see Figure 3-15). Be sure the arrow marked on the Hall-effect sensor is pointing away from the negative battery post (see Figure 3-16).

Note

If accuracy at very low currents is desired, refer to Section 5, "Battery String Current Channels," before installing the Hall-effect Sensor.

10. After torquing the battery post nuts to 60 in-lb, insert the two temperature sensors between battery cells 9-10 and 15-16. Thermal grease may be used to ease insertion (see Figure 3-12).

11. Attach both the temperature sensors and Hall-effect sensor to their appropriate connectors on the volt/temp sensor cable set and current sensor cable set, respectively.

12. Repeat steps 1-12 for second battery string, if applicable.

13. Continue with remainder of plant installation.

Installing CP1 or CP3 Cable Sets

Follow procedure in previous paragraphs "Installing CP1 Cable Set" and "Installing CP3 Cable Set."

DIP Switch Configuration Follow procedure in previous paragraph "DIP Switch Configuration."

Verify System Operation Follow procedure in previous paragraph "Verify System Operation."

Alarm Relay Wiring Follow procedure in previous paragraph "Battery Management System Alarm Relay Wiring."

4 Setup

DIP Switch Settings

The Lucent Technologies Battery Management System may be customized to meet different applications by selecting the appropriate settings and functions on the DIP switches provided on CP5. The DIP switches used for this purpose are SW100, SW101 and SW102. The location of the switches is shown in Figure 3-17. Tables that show the DIP switch settings are provided on the CP5 cover. The function of each switch is defined below.

SW100

Positions 1 and 2 select the T1 setpoint. The values range from 20°C to 35°C in 5°C increments.

Positions 3 and 4 select the T2 and MJT setpoint. The values range from 40°C to 55°C in 5°C increments.

SW101

Positions 1 and 2 select the (MNT) Minor Temperature Alarm setpoint. The values range from 30°C to 45°C in 5°C increments.

Position 3 provides compatibility with either a 23 cell or 24 cell battery plant.

Position 4 allows the user to select temperature units in degrees Fahrenheit or Celsius for the LCD display.

SW10

Positions 1, 2 and 3 select the current limit setpoint for the recharge current control feature. The current limit ranges from 12.5 Amps to 100 Amps in 12.5 Amp increments.

Position 4 enables or disables the recharge current limit feature.

SW700

This switch enables or disables the Battery Management System control capability. The system continues to provide ambient temperature, maximum battery string temperature and each battery string current to the remote monitoring equipment in either state.

Default DIP Switch Settings

The DIP switches are preset at the factory for a 24-cell battery plant equipped with Lucent Technologies VR Series batteries installed in a controlled environment as shown in Table 4-A. When the system is enabled, these settings provide temperature control of the float voltage beginning at 77°F (25°C)(T1a). The Minor Temperature Alarm will be issued at 95°F (35°C)(MNTa). The float voltage will stop decreasing at 122°F (50°C)(T2a/MJT) and the Major Temperature Alarm will be issued (Figure 4-1). This control algorithm is shown by the curve labeled PRESET in Figure 4-1. The temperature displayed on the LCD meter will read in degrees Fahrenheit.

This temperature control function is recommended for the Lucent Technologies VR Series battery to maximize the battery's life and performance when used in a controlled environment. If the battery plant is being used in a different application, please refer to Section 4.3 for additional information about selection of an appropriate control function.

The preset state for the recharge current compensation feature is in the disabled state. When the feature is enabled, the recharge current will be limited to 37.5 amps per battery string. The recharge limit should be set at a value that is no less than 10% of the ampere-hour capacity at the 10 hour rate.

Table 4-A: DIP Switch Presets

SW100				SW101				SW102			
1	2	3	4	1	2	3	4	1	2	3	4
1	0	0	1	0	1	0	0	1	0	1	0

Other Considerations

The Battery Management System has the flexibility to accommodate a variety of environments. This allows the user to configure the system to maximize battery life and capacity while

protecting against the hazards of high temperatures. The paragraphs below give some suggestions about customizing the system.

When the battery plant is located at an attended site where the temperature is tightly controlled, a more conservative control function may be used to indicate abnormal conditions quickly. This may be accomplished by raising the preset T1 setpoint (T1b) and lowering the preset T2 setpoint (T2b) as shown in Figure 4-1.

If the battery plant is located in an environment where the ambient temperature will exceed the preset T1a setpoint for long periods of time, it may be necessary to raise the T1 setpoint (T1b) to ensure that the battery is maintained in a fully charged state.

In order to reduce the probability of nuisance alarms, the Minor Temperature Alarm level (MNTb) may be raised so that it is above the typical ambient temperature. This will not affect the temperature control of float voltage function, but will make the alarm information more meaningful.

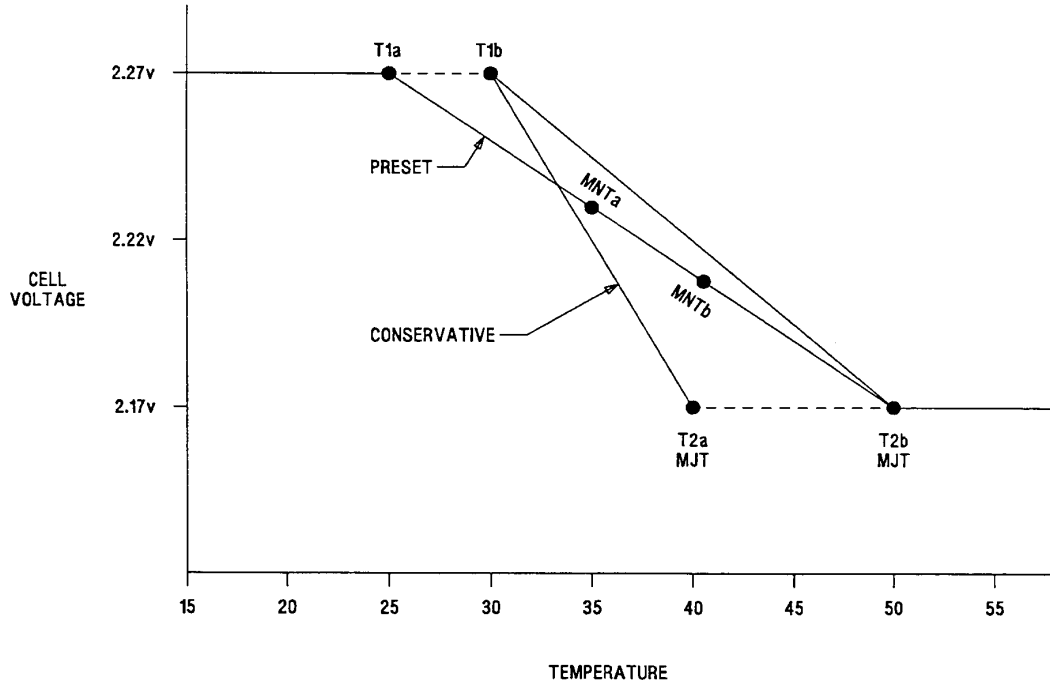
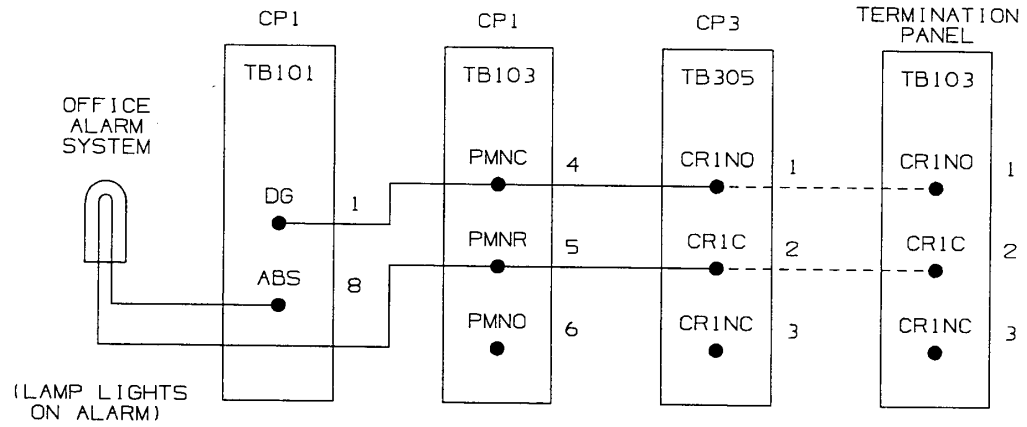
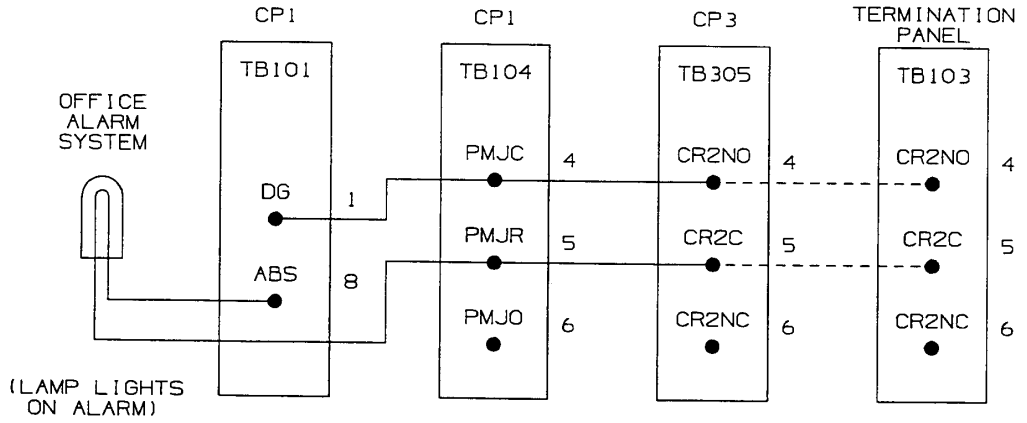


Figure 4-1: Battery Management System Temperature Compensation Function

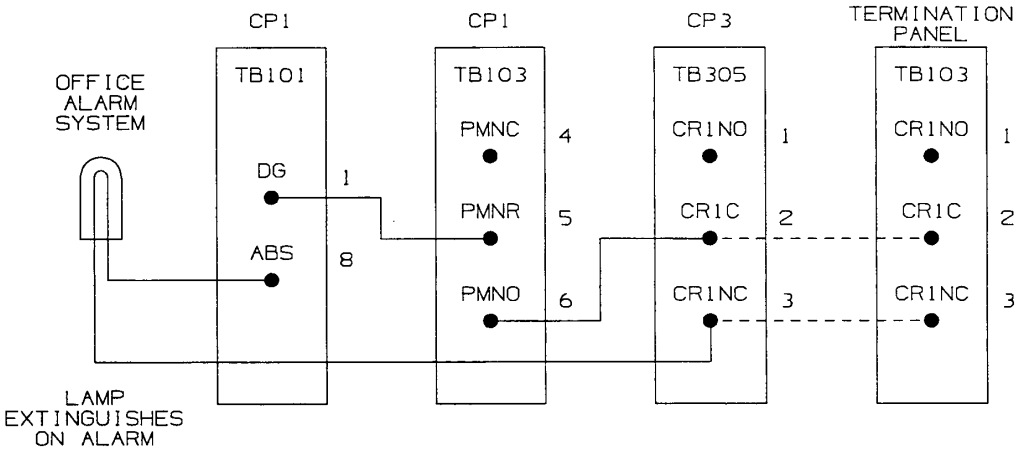


(A) CONTROL RELAY (CR1) REPRESENTING MINOR BATTERY ALARM (BMF OR MNV OR MNT) PARALLELED WITH POWER MINOR VISUAL ALARM FOR CLOSURE-ON-ALARM TYPE SYSTEM

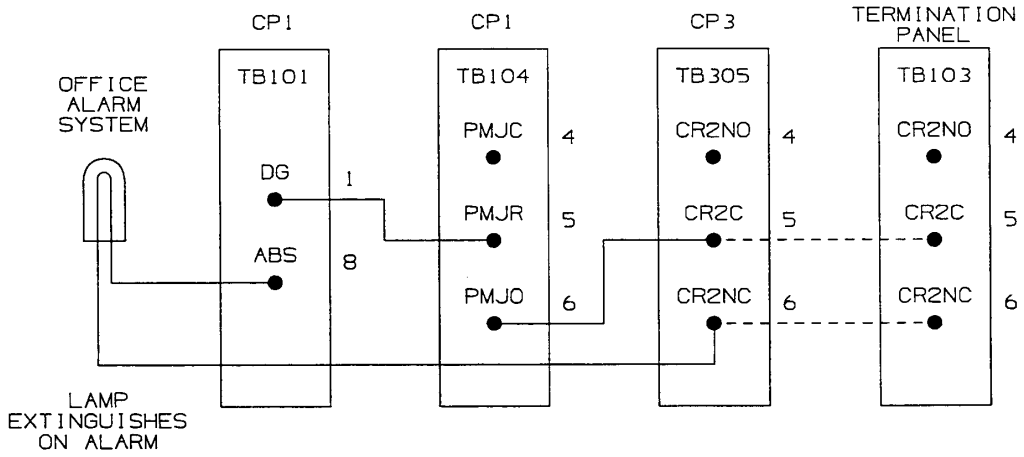


(B) CONTROL RELAY (CR2) REPRESENTING MAJOR BATTERY ALARM (MJT) PARALLELED WITH POWER MAJOR VISUAL ALARM FOR CLOSURE-ON-ALARM TYPE SYSTEM

Figure 4-2: Control Relay Schematics For Closure-On-Alarm Type System



(A) CONTROL RELAY (CR1) REPRESENTING MINOR BATTERY ALARM (BMF OR MNV OR MNT) PARALLELED WITH POWER MINOR VISUAL ALARM FOR OPEN-ON-ALARM TYPE SYSTEM



(B) CONTROL RELAY (CR2) REPRESENTING MAJOR BATTERY ALARM (MJT) PARALLELED WITH POWER MAJOR VISUAL ALARM FOR OPEN-ON-ALARM TYPE SYSTEM

Figure 4-3: Control Relay Schematics For Open-On-Alarm Type System

5 Operations

Remote Access Signals

The Battery Management System provides remote access to four battery parameters and four system alarms if the battery plant is equipped with CP2 and CP3, the microprocessor and datalogger controller circuit packs, respectively. The only equipment necessary to make the connection is a cable set which can be ordered as ED-83241-30 GK4 and installed as described in Section 3.

Battery Parameters

The battery parameters are given below.

Highest Battery Temperature. This signal is the temperature of the hottest battery string as measured by the temperature sensors placed between the individual cells. The signal is buffered and sent out through a 31.6 kΩ resistor. The signal is 0 volts at 0°F and changes at a rate of 10 mV/°F. The front panel Battery Temp Status LEDs indicate which string is the hottest if temperature is above T1 (see Figure 2-1).

Ambient Temperature Signal. This signal is the ambient temperature as measured by a thermistor mounted on the Battery Management System circuit pack. The signal is buffered and sent out through a 31.6 kΩ resistor. The signal is 0 volts at 0°F and changes at a rate of 10 mV/°F. Its value is displayed on the front panel meter when the AMB/BAT paddle switch is in the AMB (ambient) position.

Battery String 1 Current. This signal is the current of battery string 1 as measured by the Hall-effect sensor. The signal is buffered and sent out through a 31.6 kΩ resistor. The signal is 0 volts at 0 amps and changes at a rate of 33.3 mV/A. This signal is always available if the Hall-effect sensor is installed even if the current compensation function is disabled.

Battery String 2 Current. This signal is the current of battery string 2 as measured by the Hall-effect sensor. The signal is buffered and sent out through a 31.6 kΩ resistor. The signal is 0 volts at 0 amps and changes at a rate of 33.3 mV/A. This signal is also available if the Hall-effect sensor is installed even if the current compensation function is disabled.

Alarm Signals The following alarm signals provide closure to RG through a 31.6 kΩ resistor.

Battery Management System Fail. This alarm is issued when any one of the following conditions exist:

1. Low bias-supply power on the Battery Management System circuit pack

2. The system is enabled but there are no temperature probes plugged in.

3. The system is enabled and both temperature probes on the same battery string have failed or are reading an out of range temperature. Also, the Battery Temp status LED corresponding to the battery string with the failed temperature probes will blink at a rate of twice per second.

4. The current compensation function is enabled, but there are no Hall-effect sensors installed.

Minor Voltage Alarm. This alarm is issued if any of the following conditions exist:

1. One or more battery strings are unbalanced.

2. Any battery voltage monitor circuit is not connected. However, if all of the ring terminals are not connected, no alarm is issued.

The front panel battery volt status display indicates which strings are out of balance and causing the alarm.

Minor Temperature Alarm. This alarm is issued when one or more battery strings have reached the user defined temperature threshold as determined by DIP switch SW101-1,2.

Major Temperature Alarm. This alarm is issued when one or more battery strings have reached the upper temperature threshold as determined by DIP switch SW100-3,4.

Datalogger Analog Channel Configuration

Highest Battery Temperature Channel

To display the highest battery temperature in Fahrenheit this channel must be configured as follows:

Channel Description	Highest Battery Temp
Input Type	+DC
Range	6V
Scale Factor	100
Transducer Offset	None
Alarm Threshold	An upper or lower user defined threshold may be set to warn the user if the maximum battery temperature is greater/less than expected. This threshold could be set to a different temperature than the Minor Temperature Alarm. Also, this threshold could be set to the same temperature as T1 to let the user know when the Battery Management System is actively controlling the plant voltage. The number entered is in degrees Fahrenheit.
Units	Degrees Fahrenheit

To display the highest battery temperature in Celsius the channel must be configured as follows:

Channel Description	Highest Battery Temp
Input Type	+DC
Range	6V
Scale Factor	55.556
Transducer Offset	0.32
Alarm Threshold	An upper or lower user defined threshold may be set to warn the user if the maximum battery temperature is greater/less than expected. This threshold could be set to a different temperature than the Minor Temperature Alarm. Also, this threshold could be set to the same temperature as T1 to let the user know when the Battery Management System is actively controlling the plant voltage. The number entered is in degrees Celsius.
Units	Degrees Celsius

Ambient Temperature Channel

To display the ambient temperature in Fahrenheit this channel must be configured as follows:

Channel Description	Ambient Temp
Input Type	+DC
Range	6V
Scale Factor	100
Transducer Offset	None
Alarm Threshold	An upper or lower user defined threshold may be set to warn the user if the ambient temperature near the battery plant is greater/less than expected by taking advantage of the dial-out on alarm capability of the ECS Controller. The number entered is in degrees Fahrenheit.
Units	Degrees Fahrenheit

To display the ambient temperature in Celsius the channel must be configured as follows:

Channel Description	Ambient Temp
Input Type	+DC
Range	6V
Scale Factor	55.556
Transducer Offset	0.32
Alarm Threshold	An upper or lower user defined threshold may be set to warn the user if the ambient temperature near the battery plant is greater/less than expected by taking advantage of the dial-out on alarm capability of the ECS Controller. The number entered is in degrees Celsius.
Units	Degrees Celsius

Battery String Current Channels

To display each battery string current each channel must be configured as follows:

Channel Description	Battery String 1 Current or Battery String 2 Current
Input Type	+DC
Range	6V
Scale Factor	30
Transducer Offset	None. If a higher degree of accuracy is desired at very low currents, the zero offset current error of the Hall-effect sensor can be subtracted. First, connect the Hall-effect sensor to the current sensor cable set and make sure the board cable set is connected to P200 or P201 on CP5, then measure the voltage between pins 2(-) and 5(+) (Figure 3-16) on the current sensor connector while it is plugged into the Hall-effect sensor. The voltage and polarity measured will be the number entered in this field. For example if the voltage measured is -15 mV the number entered will be -0.015.
Alarm Threshold	An upper or lower user defined threshold may be set to monitor the magnitude and polarity of the battery string current, thus detecting if the battery string is discharging.
Units	Amps

Alarm Channels

To display each Battery Management System alarm (BMF, MNV, MNT, MJT) each channel must be configured as follows:

Channel Description	Battery Mgmt System Fail (BMF) Minor Voltage Alarm (MNV) Minor Temp Alarm (MNT) Major Temp Alarm (MJT)
Input Type	CO
Units	Alarm

Control Relay Programming

There are many different ways of monitoring the Battery Management System Alarms. The following is just one common way of accomplishing this. In order to integrate the Battery Management System alarm channels into Plant Minor Alarms or Plant Major Alarms two control relays on CP3 must be programmed, and hard wired to PMN and PMJ. This is accomplished by configuring each control relay Program Line with the following.

Assume the following alarms are hard wired into the following analog channels on CP3 (any available analog channel may be used):

- BMF=A5
- MNV=A6
- MNT=A7
- MJT=A8

If control relay one (CR1) is to be used to trigger a Plant Minor Alarm the following information should be in its Program Line:

Program Line. A5 or A6 or A7

Description. Minor Battery Alarm into PMN

If control relay two (CR2) is to be used to trigger a Plant Major Alarm the following information should be in its Program Line:

Program Line. A8

Description. Major Battery Alarm into PMJ

After programming is complete, these relays should be wired to CP1 using the NO and C contact pair as shown in Figure 4-2 for

closure-on-alarm type systems or using the NC and C contact pair as shown in Figure 4-3 for open-on-alarm type systems.

Battery On Discharge (BD) Alarm Considerations

The BD alarm threshold is commonly set 1 volt below float voltage. However, the Battery Management System has a control range, in the temperature compensation mode, of 0 to -2.4 volts. This could cause a nuisance BD alarm. To alleviate this, set the BD alarm threshold below the nominal control range of the Battery Management System. For a 24-cell battery string floating at -54.48 volts, set the BD alarm at -52.00 volts. For a 23-cell battery string floating at -52.21 volts, set the BD alarm at -49.50 volts.

6 *Product Warranty*

A. Seller warrants to Customer only, that:

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

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

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

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

Warranty Period

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

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

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

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

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

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

associated with returning such Product to Seller shall be borne by Customer. Seller shall pay the cost of transportation of the repair or replacing Product to the destination designated by Customer within the Territory.

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

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

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

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

Appendix A Connector Pin Assignments

Pin assignments on the Battery Management System circuit pack are given in the following tables.

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P200: Battery String One

P200-1	Thermistor 1 Battery String 1 - (4.775V)
P200-2	Thermistor 1 Battery String 1 - (VT)
P200-3	Thermistor 2 Battery String 1 - (4.775V)
P200-4	Thermistor 2 Battery String 1 - (VT)
P200-5	Battery String 1 Terminal (-48V) Cell #23/24 through 31.6K to VRU through P400-14
P200-6	Battery String 1 Terminal (-36V) Cell #18 through 31.6K to VRU through P400-13,16
P200-7	Battery String 1 Terminal (-24V) Cell #12 through 31.6K to VRU through P400-15,18
P200-8	Battery String 1 Terminal (-12V) Cell #6 through 31.6K to VRU through P400-17,20
P200-9	Battery String 1 Terminal (0V) Cell #1 through 31.6K to VRU through P400-19
P200-10	Temperature Probe Present (TPP1) connected to P200-1 when temperature probe plugged in
P200-11	Hall Effect Present (HPP1) (connected to P200-14 (-12V1))when Hall Effect plugged in)
P200-12	Battery String 1 Terminal (-24V-A) through 31.6K Cell #12
P200-13	+12V1 bias for Hall Effect Sensor, Pin 3
P200-14	-12V1 bias for Hall Effect Sensor, Pin 1
P200-15	RTN1 for Hall Effect (CS-), Pin 2
P200-16	Current sense signal from Hall Effect (CS+), Pin 5
P200-17	Battery String 1 Terminal (-48V) through 31.6K Cell #23/24
P200-18	Battery String 1 Terminal (-24V-B) through 31.6K Cell #12
P200-19	Battery String 1 Terminal (0V) through 31.6K Cell #1
P200-20	Frame Ground

P201: Battery String Two

P201-1	Thermistor 1 Battery String 2- (4.775V)
P201-2	Thermistor 1 Battery String 2- (VT)
P201-3	Thermistor 2 Battery String 2- (4.775V)
P201-4	Thermistor 2 Battery String 2- (VT)
P201-5	Battery String 2 Terminal (-48V) Cell #23/24 through 31.6K to VRU through P400-24
P201-6	Battery String 2 Terminal (-36V) Cell #18 through 31.6K to VRU through P400-23,26
P201-7	Battery String 2 Terminal (-24V) Cell #12 through 31.6K to VRU through P400-25,28
P201-8	Battery String 2 Terminal (-12V) Cell #6 through 31.6K to VRU through P400-27,30
P201-9	Battery String 2 Terminal (0V) Cell #1 through 31.6K to VRU through P400-29
P201-10	Temperature Probe Present (TPP2 connected to P201-1 when temperature probe plugged in)
P201-11	Hall Effect Present HPP2 (connected to P200-14 (-12V2)) when Hall Effect plugged in
P201-12	Battery String 2 Terminal (-24V-A) through 31.6K Cell #12
P201-13	+12V2 bias for Hall Effect Sensor, Pin 3
P201-14	-12V2 bias for Hall Effect Sensor, Pin 1
P201-15	RTN2 for Hall Effect (CS-), Pin 2
P201-16	Current sense signal from Hall Effect (CS+), Pin 5
P201-17	Battery Terminal (-48V) through 31.6K Cell #24/23
P201-18	Battery Terminal (-24V-B) through 31.6K Cell #12
P201-19	Battery Terminal (0V) through 31.6K Cell #1
P201-20	Frame Ground

P400: CP3/VRU

P400-1	Highest Battery Temperature signal to CP3/VRU (10mV/°F)
P400-2	Battery Management System Return through 31.6K
P400-3	Ambient Temperature signal to CP3/VRU (10mV/°F)
P400-4	Battery Management System Return through 31.6K
P400-5	Battery Management System Failure Alarm signal to CP3/VRU (Closure to RG through 31.6K)
P400-6	Battery Management System Return through 31.6K
P400-7	Minor Voltage Alarm signal to CP3/VRU (Closure to RG through 31.6K)
P400-8	Battery Management System Return through 31.6K
P400-9	Minor Temperature Alarm signal to CP3/VRU (Closure to RG through 31.6K)
P400-10	Battery Management System Return through 31.6K
P400-11	Major Temperature Alarm signal to CP3/VRU (Closure to RG through 31.6K)
P400-12	Battery Management System Return through 31.6K
P400-13	Battery String 1 Terminal Voltage to VRU (-36V) Cell #18, from P200-6
P400-14	Battery String 1 Terminal Voltage to VRU (-48V) Cell #23/24, from P200-17
P400-15	Battery String 1 Terminal Voltage to VRU (-24V) Cell #12, from P200-7
P400-16	Battery String 1 Terminal Voltage to VRU (-36V) Cell #18, from P200-6
P400-17	Battery String 1 Terminal Voltage to VRU (-12V) Cell #6, from P200-8
P400-18	Battery String 1 Terminal Voltage to VRU (-24V) Cell #12, from P200-7
P400-19	Battery String 1 Terminal Voltage to VRU (0V) Cell #1, from P200-5
P400-20	Battery String 1 Terminal Voltage to VRU (-12V) Cell #6, from P200-8
P400-21	Battery String 1 Current to CP3/VRU (33.3mV/A)
P400-22	Battery Management System Return through 31.6K

P400: CP3/VRU

P400-23	Battery String 2 Terminal Voltage to VRU (-36V) Cell #18, from P201-6
P400-24	Battery String 2 Terminal Voltage to VRU (-48V) Cell #23/24, from P201-6
P400-25	Battery String 2 Terminal Voltage to VRU (-24V) Cell #12, from P201-6
P400-26	Battery String 2 Terminal Voltage to VRU (-36V) Cell #18, from P201-6
P400-27	Battery String 2 Terminal Voltage to VRU (-12V) Cell #6, from P201-6
P400-28	Battery String 2 Terminal Voltage to VRU (-24V) Cell #12, from P201-6
P400-29	Battery String 2 Terminal Voltage to VRU (0V) Cell #1, from P201-6
P400-30	Battery String 2 Terminal Voltage to VRU (-12V) Cell #6, from P201-6
P400-31	Battery String 2 Current to CP3/VRU (33.3mV/A), from P201-6
P400-32	Battery Management System Return through 31.6K
P400-33	No Connection
P400-34	Frame Ground

TB100: Customer Alarms Field Wiring

TB100-1	Minor Voltage Alarm (Center)
TB100-2	Minor Voltage Alarm (Normally Closed Contact)
TB100-3	Minor Voltage Alarm (Normally Open Contact)
TB100-4	Minor Temperature Alarm (Center)
TB100-5	Minor Temperature Alarm (Normally Closed Contact)
TB100-6	Minor Temperature Alarm (Normally Open Contact)
TB100-7	Battery Management Failed Minor Alarm (Center)
TB100-8	Battery Management Failed Minor Alarm (Normally Closed Contact)
TB100-9	Battery Management Failed Minor Alarm (Normally Open Contact)
TB100-10	Major Temperature Alarm (Center)
TB100-11	Major Temperature Alarm (Normally Closed Contact)
TB100-12	Major Temperature Alarm (Normally Open Contact)

Major & Minor Battery Alarms to CP1

P508-1	Minor Battery Alarm (Sent to CP1 as a Ringer Minor Alarm) (Closure to Bat)
P508-2	Major Battery Alarm (Sent to CP1 as a Ringer Major Alarm) (Closure to Bat)

Display LEDs

DS100	Yellow	Minor Temperature Alarm Indicator (MNT)
DS101	Yellow	Celsius Scale Indicator (°C)
DS102	Yellow	Fahrenheit Scale Indicator (°F)
DS103	Yellow	Temperature Control Indicator (TEMP CONT)
DS104	Red	Major Temperature Alarm Indicator (MJT)
DS200	Yellow	Battery String 1 Voltage Unbalance Indicator (BAT 1 VOLT)
DS201	Yellow	Battery String 2 Voltage Unbalance Indicator (BAT 2 VOLT)
DS202	Yellow	Minor Voltage Alarm Indicator (MNV)
DS300	Yellow	Recharge Current Control Indicator (RECHG CUR CONT)
DS450	Yellow	Battery String 1 High Temp Indicator (BAT 1 TEMP)
DS451	Yellow	Battery String 2 High Temp Indicator (BAT 2 TEMP)
DS501	Yellow	LVD Circuit Failure Indicator (FAIL)
DS502	Red	LVD Contactor Open Indicator (OPEN)
DS700	Yellow	Battery Management System Failure Indicator (BMF)
DS701	Green	System On Indicator (SYSTEM ON)