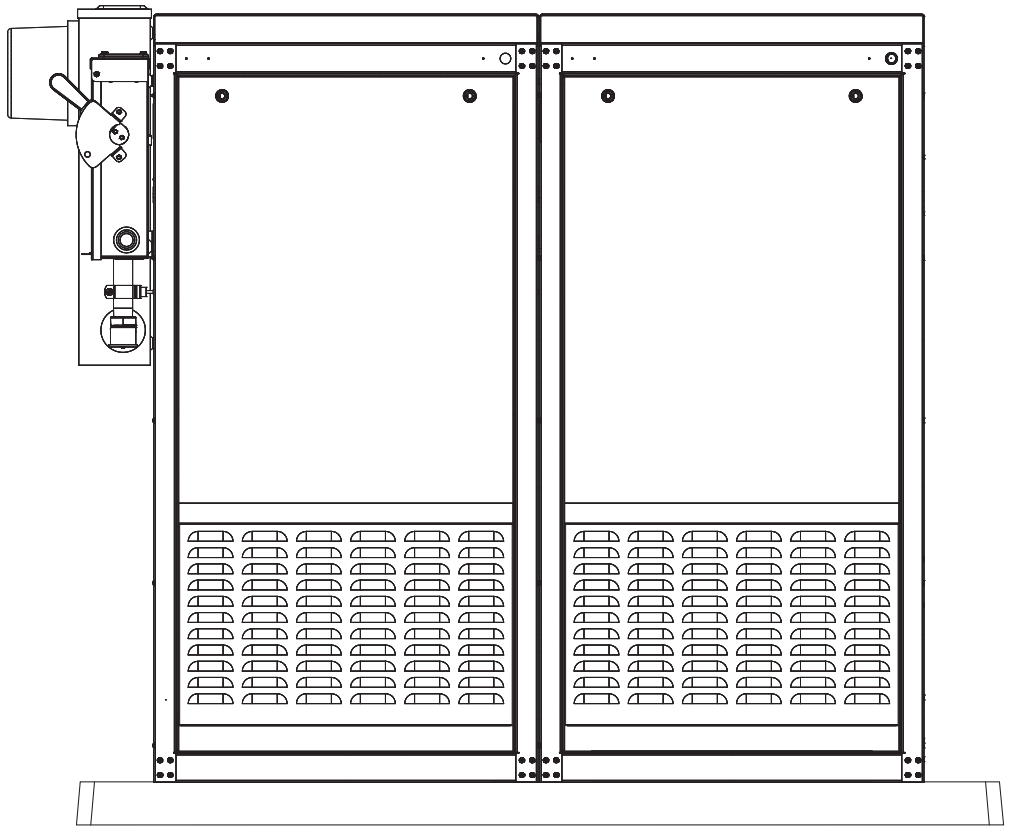
an EnerSys® company

Alpha® XRT-Li Extended Runtime Power System Technical Manual

Effective: March 2025



Safety Notes

Review the information contained in this manual before proceeding. If there are any questions regarding the safe installation or operation of the system, contact Alpha Technologies Services, Inc., an EnerSys company, or the nearest Alpha® product sales representative. Save this document for future reference.

To reduce the risk of injury or death and to ensure the continued safe operation of this product, the following symbols have been placed throughout this manual. Where these symbols appear, use extra care and attention.

WARNING! CALIFORNIA PROPOSITION 65

This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

WARNING! GENERAL HAZARD

GENERAL HAZARD WARNING provides safety information to PREVENT INJURY OR DEATH to the technician or user.

WARNING! ELECTRICAL HAZARD

ELECTRICAL HAZARD WARNING provides electrical safety information to PREVENT INJURY OR DEATH to the technician or user.

WARNING! FUMES HAZARD

FUMES HAZARD WARNING provides fumes safety information to PREVENT INJURY OR DEATH to the technician or user.

WARNING! FIRE HAZARD

FIRE HAZARD WARNING provides flammability safety information to PREVENT INJURY OR DEATH to the technician or user.

There may be multiple warnings associated with the call out. Example:

WARNING! ELECTRICAL & FIRE HAZARD

This WARNING provides safety information for both Electrical AND Fire Hazards.

CAUTION!

CAUTION provides safety information intended to PREVENT DAMAGE to material or equipment.

NOTICE:

NOTICE provides additional information to help complete a specific task or procedure.

ATTENTION:

ATTENTION provides specific regulatory/code requirements that may affect the placement of equipment and /or installation procedures.

Alpha® XRT-Li Extended Runtime Power System

Technical Manual

031-00019-B0-001, Rev. B

Effective Date: March 2025

Disclaimer

Images contained in this manual are for illustrative purposes only. These images may not match your installation.

Alpha shall not be held liable for any damage or injury involving its enclosures, power supplies, generators, batteries or other hardware if used or operated in any manner or subject to any condition not consistent with its intended purpose or is installed or operated in an unapproved manner or improperly maintained.

Notice of FCC Compliance

Per FCC 47 CFR 15.21:
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Per FCC 47 CFR 15.105:
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

Contact Information

Sales information and customer service in USA (7AM to 5PM, Pacific Time):	+1 800-322-5742
Complete technical support in USA (7AM to 5PM, Pacific Time or 24/7 emergency support):	+1 800-863-3364
Sales information and technical support in Canada:	+1 888-462-7487
Website:	www.alpha.com www.enersys.com

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0.0 Important Notes About Installation

- The system must be installed only by qualified service personnel.
- Always consult local codes for mounting pad requirements.
- Consult local utility codes for additional cabinet grounding and utility requirements.
- Consult the local power company for correct meter type and riser location.
- Not intended for mounting directly in a flood zone. Contact the local Authority Having Jurisdiction (AHJ) for options on mounting above the flood zone such as raised ground or other platforms.
- Precast mounting pads may either be purchased from Alpha® or poured in place. The pad must be capable of holding 1,750 lbs (minimum) for a single enclosure. A double wide pad must be capable of holding 2,400 lbs of equipment (minimum) on a 52" × 24" footprint. Rebar may be placed in a crosshatch pattern for pad reinforcement, as needed.
- If the pad is to be located in an area with a deep frost line or unstable soil, concrete pylon footings (4" diameter × 4' deep, or 1' deeper than the regional frost line) can be placed below the concrete pad, in front of and below the four (4) mounting features.
- The top of the pad must be above grade to reduce the buildup of debris around the base of the cabinet.
- Adequate space must be allowed for cable TV input/output conduit; plant grounding electrode conductor(s); RF cable entrance via (1) 4", (2) 3" or (3) 2½" rigid conduit sweep(s) with 2' bend radius (minimum); and fiber optic cable entrance (refer to fiber manufacturer's specification for minimum bend radius requirements).
- Prior to pouring concrete, any wire running through the pad must have a thermal expansion jacket (i.e., PVC) to prevent cracking of the concrete during lightning strikes.
- Alpha Technologies Services, Inc. is not responsible for broken welds or other damage to the cabinet caused by improper installation.
- A 25+ year vapor barrier must be used between the concrete pad and the base of the enclosure to further inhibit the ingress of moisture. Alpha Technologies Services, Inc. is not responsible for water damage or moisture damage resulting from improper installation.
- Concrete filled, 6" diameter steel posts (or equivalent) can be placed at the corners of the pad to reduce exposure to accidental traffic damage.
- This system has been certified to UL® 9540A standard for Performance Unit Test Level (Outdoor Ground Mounted Units) with 3 feet clearance to exposures. Refer to CSA® report 80132092 dated 16 Feb. 2023.
- The electrical and electronic controls in the battery subsystem critical to safety have evaluated for functional safety to ISO 13849-1 and -2 (minimum performance level (PL)) "c".
- For further information regarding this installation, contact Alpha Technologies Services, Inc. or your nearest Alpha® product sales representative.

0.1 Unpacking and Inspection

To ensure operator safety:

- Enclosures must be installed only by qualified personnel and in accordance with all applicable electrical codes.
- Use eye and hand protection whenever working with batteries.

Unpacking and Inspection:

Carefully remove the enclosure from the shipping container. Verify that:

- The correct unit was shipped.

Ordered options have been included. (Refer to packing label details located on wooden pallet. See **Fig. 0-2**.)

NOTICE:

Batteries are shipped separately.

Inspect the contents. If items are damaged or missing, contact Alpha Technologies Services, Inc. and the shipping company immediately. Most shipping companies have only a short claim period.

Fig. 0-1, Enclosure as it Arrives from Alpha

Fig. 0-2, Packing Label Location

1.0 Introduction

The Alpha® XRT-Li extended runtime power system offers extended runtime for XM3.1-HP™ power supply cable TV powering applications and solutions based on power supply loading that can be supported using up to 50 Battery Power Modules (BPM) and one to three Battery Control Modules (BCM) confined in one to two cabinets (PN-4LI and PN-4LIB). This manual briefly describes the XRT-Li power system and provides procedures with regard to the installation of the power supply, BPMs, BCMs, and initial start-up. The XM3.1-HP power supply requires specific firmware to operate this system (see **Section 2.3.2 Power Supply Firmware Requirements on page 28**). Additional XRT-Li power system documentation is available at www.alpha.com.

Specifications			
	PN-4LI	**PN-4LIB22**	**PN-4LIB28**
Dimensions (W × H × D)	26" × 52" × 24" (660.4 mm × 1320.8 mm × 609.6 mm)		
Total System Dimensions (W × H × D) (includes meter and cabinet overhangs)	62" × 52" × 28" (1574.8 mm × 1320.8 mm × 711.2 mm)		
Power Supply Capacity	One power supply (XM3.1-HP) (2kW)	N/A	
Battery Capacity	Up to 22 Battery Power Modules (BPM)	Up to 22 Battery Power Modules (BPM)	Up 28 Battery Power Modules (BPM)
Battery Control Modules	1		Up to 2
Cabinet Weight	248 lb (112.5 kg)	203 lb (92.1 kg)	238 lb (107.9 kg)
Material	Aluminum and steel (doors), 0.080 - 0.125" (2 - 3.175 mm)		

Table 1-1, PN-4LI and LIB Enclosure Specifications

NOTICE:

For a site to comply with the 72-hour runtime required by the California Public Utilities Commission (CPUC), the maximum site load shall not exceed the values in the table below:

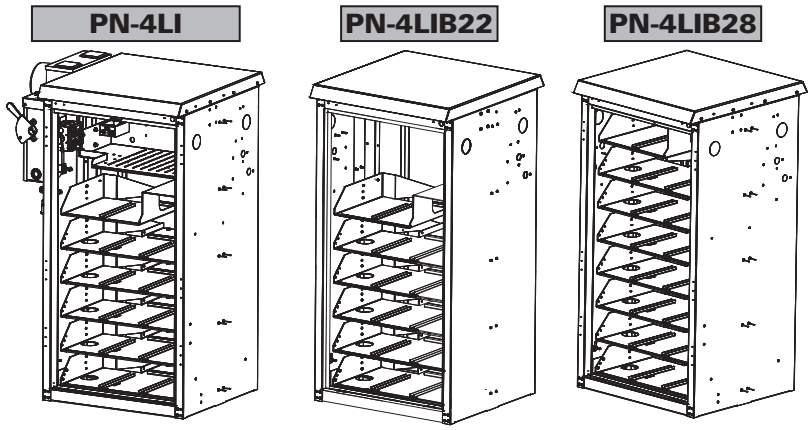


Fig. 1-1, PN-4 Enclosures

Battery Configurations			
Recommended PN-4 Enclosures	**BPMs**	**BCMs**	**P/S Output Current (Site Load)**
Single PN-4LIB28	23	2	4.1 - 4.8 A
	24		4.1 - 5 A
	28		5.1 - 6 A
PN-4LI and PN-4LIB28 or PN-4LI22 and PN-4LIB28	31	2	6.1 - 7 A
	35		7.1 - 8 A
	39		8.1 - 9 A
	42		9.1 - 10 A
	46	3	10.1 - 11 A
	50		11.1 - 12 A

Table 1-2, Battery Configurations

2.0 Power System

The XRT-Li power system has the following electrical ratings and temperature range for optimal operation:

System Operation	
Normal Operating Temperature [1]	32°F to 113°F (0°C to 45°C)
Safe Functioning Temperature Range [2]	5°F to 131°F (-15°C to 55°C)
Non-destructive Temperature Range [3]	-40°F to 167°F (-40°C to 75°C)
Abnormal Temperature Range [4]	Less than -40°F (-40°C) and greater than 167°F (75°C)
Charge/Discharge Temperature (Upper Limit)	131°F (55°C)
Charge/Discharge Temperature (Lower Limit)	-9.4°F (-23°C)
Charge/Discharge Rating	40.7V @ 44A
The following values are based on cell manufacturer specifications at 1C discharge rate at 25°C:	
System (fully populated w/ 3 BCMs and 50 BPMs) Rated Usable Energy Capacity	81.3 kWh (@ 40.7V maximum)
Battery String (1 BCM and 22 BPMs) Rated Energy Capacity	35.8 kWh (@ 40.7V maximum)
Battery Power Module (BPM) Rated Energy Capacity	1.6 kWh (@ 40.7V maximum)
Battery Electrical Ratings	
Battery Voltage	30.0VDC to 40.7VDC
Battery Current	39A limit (BCM is based on the fuse)
Power Supply (XM3.1-918-HP) Electrical Ratings - Fine Mode Parameters	
Nominal AC Input Voltage	120VAC (factory ordered)
Nominal Input Frequency	60Hz
Input Frequency Tolerance	±3%
Input Voltage Operating Range Tolerance	–25% to +15%
Input Voltage Range	90VAC to 138VAC
Output Voltage	63/89VAC
Output Voltage Regulation (Based on Nominal Input Voltage at 50% Load, 25°C)	–2.5 to +1%
Maximum Rated Output Current [5]	18A
Maximum Output Power [5]	1620VA
Fine Mode Parameters [5]	Maximum rated output current
Line Mode Efficiency	Up to 94%
Standby Efficiency	Up to 91%
Output Waveform	Quasi-square wave
Short Circuit Protection	<150% of max current rating
Transfer Characteristics	Uninterrupted output
Battery Voltage (Nominal)	36VDC

[1] The battery system shall be fully functional in this temperature range.

[2] The battery system shall be fully functional in this temperature range, but performance or capacity may be reduced. This performance reduction is due to cell limitations given that internal cell temperatures may differ from ambient environmental temperatures.

[3] Outside the limits of the Safely Functioning temperature range, the battery system is not guaranteed to be fully functional, and therefore, performance may degrade in an unspecified manner. The battery system shall, in all situations, fulfill legal requirements and not become hazardous to people.

[4] The battery system is internally protected against thermal overload during operation in abnormal temperatures. If the thermal protection device is activated, the battery system output voltage will shut down. The battery system monitors the temperature and will automatically initiate a reconnection procedure when the temperature is within normal operation temperature range, defined in definitions and references tab.

[5] The power supply output parameters are electronically limited to 12A and 1080VA when used in the XRT-Li power system application.

Table 2-1, Power System Specifications

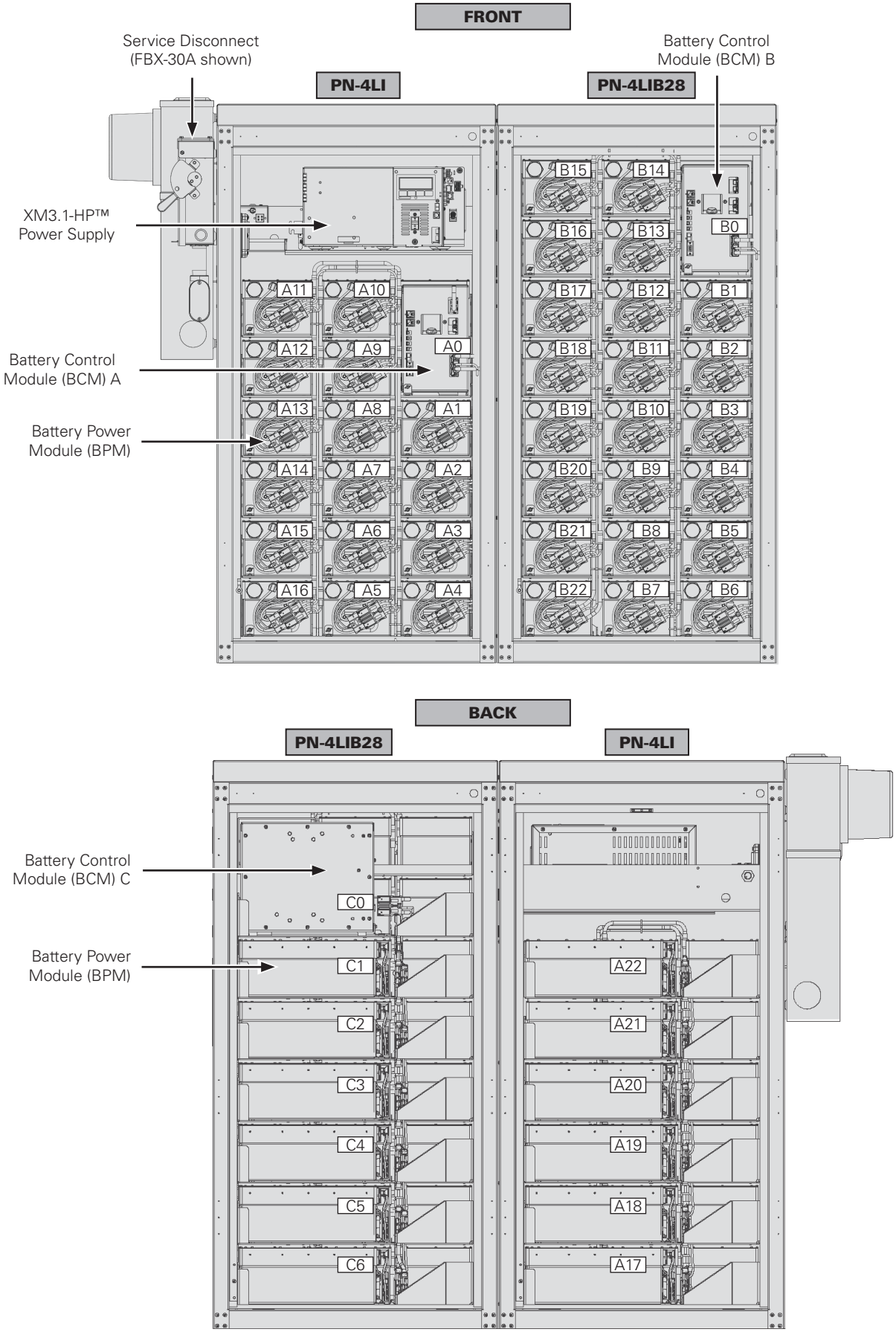


Fig. 2-1, Full System Installation (PN-4LI with PN-4LIB28) Example

2.1 Battery System

2.1.1 Battery Power Module (BPM)

The Battery Power Module (BPM, also known as a PowerSafe® iON 36-1800 lithium battery, model PSI-36-1800) is a single, field replaceable, high density, lithium-ion battery engineered to maximize battery capacity in a compact form factor. The BPM provides superior energy density and performance ideal for cable broadband outside plant applications. The integrated Battery Management System (BMS) is optimized for performance with the Alpha® XM3.1-HP™ Intelligent Broadband Uninterruptible Power Supply (UPS), ensuring proper charging and integration with a remote management system.

The BPM provides high energy density for extended runtimes. The system manages charge and discharge flows of energy, while reporting operating parameters and status remotely. Low self-discharge and fast recharge rates make the modules both storage and deployment friendly. The BMS provides additional levels of protection - overvoltage, undervoltage, and overcurrent – while managing cell balancing and temperatures to help maintain the BPM's overall State of Health (SoH).

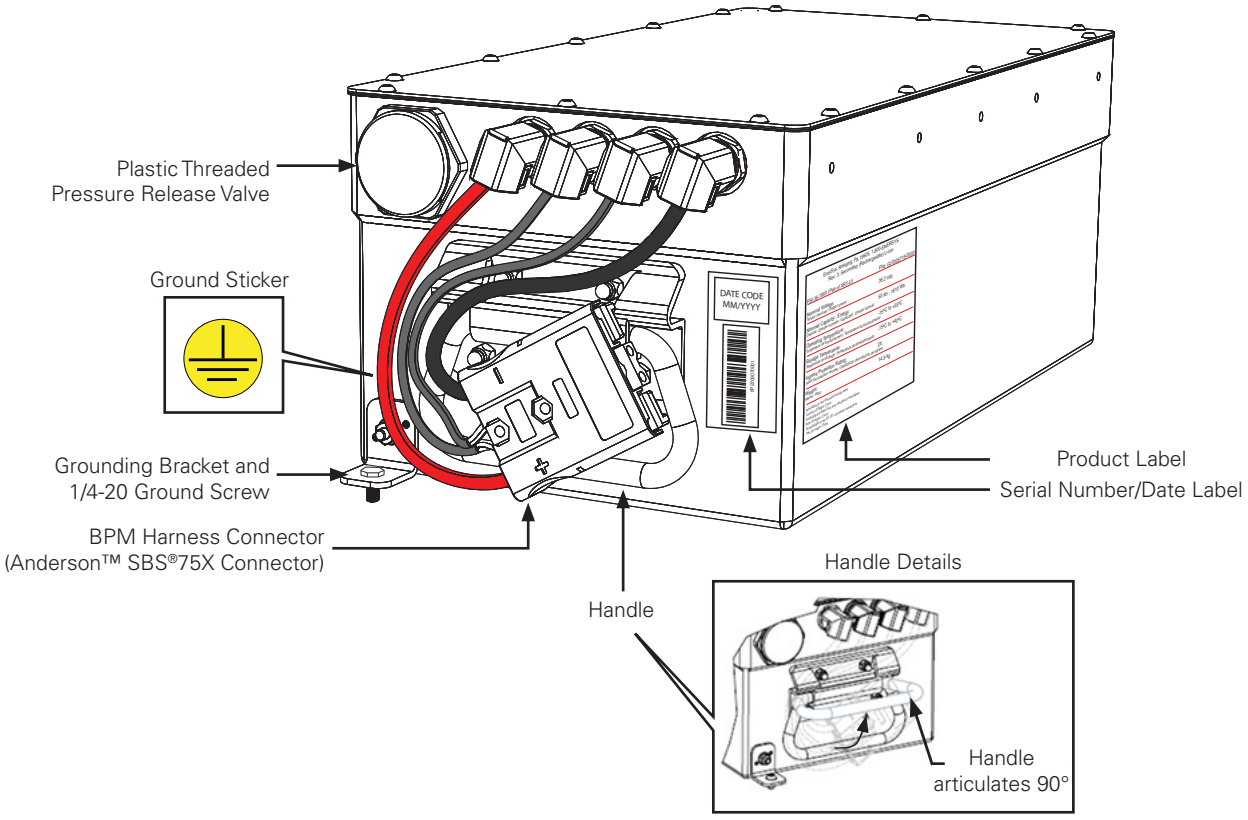


Fig. 2-2, Battery Power Module (BPM)

2.1.1.1 BPM Features and Specifications

Battery Power Module (BPM) Specifications	
Nominal Voltage	36V
Operating Voltage Range	30.0V to 40.7V
Maximum Discharge Current	30A
Maximum Charge Current	30A
Capacity	50Ah
Energy	1810Wh
Operating Temperature	5°F to 131°F (-15°C to +55°C)
Optimal Storage Temperature	5°F to 104°F (-15°C to +40°C)
Ingress Protection Rating	2X
Weight	32.8 lb (14.9 kg)
Dimensions (H × L × W)	5.27" × 13.54" × 6.57" (134 mm × 317 mm ×167 mm)
Self-discharge	Retention ≥ 85%, Recovery ≥ 90%, 28 days at 20 °C or 7 days at 55 °C at ambient module temperature
Terminal Type	Anderson™ SBS®75X Connector
Lifting Handle	Folding pull handle
Certifications	Compliant with UN 38.3, CSA/UL® 1973:2018

Table 2-2, Battery Power Module (BPM) Specifications

2.1.2 Battery Control Module (BCM)

The Battery Control Module (BCM, also known as a PowerSafe® iON battery management system, model PSI-36-BMS) manages and monitors a series of BPMs, and coordinates with the XM3.1-HP™ power supply.

2.1.2.1 BCM Features and Specifications

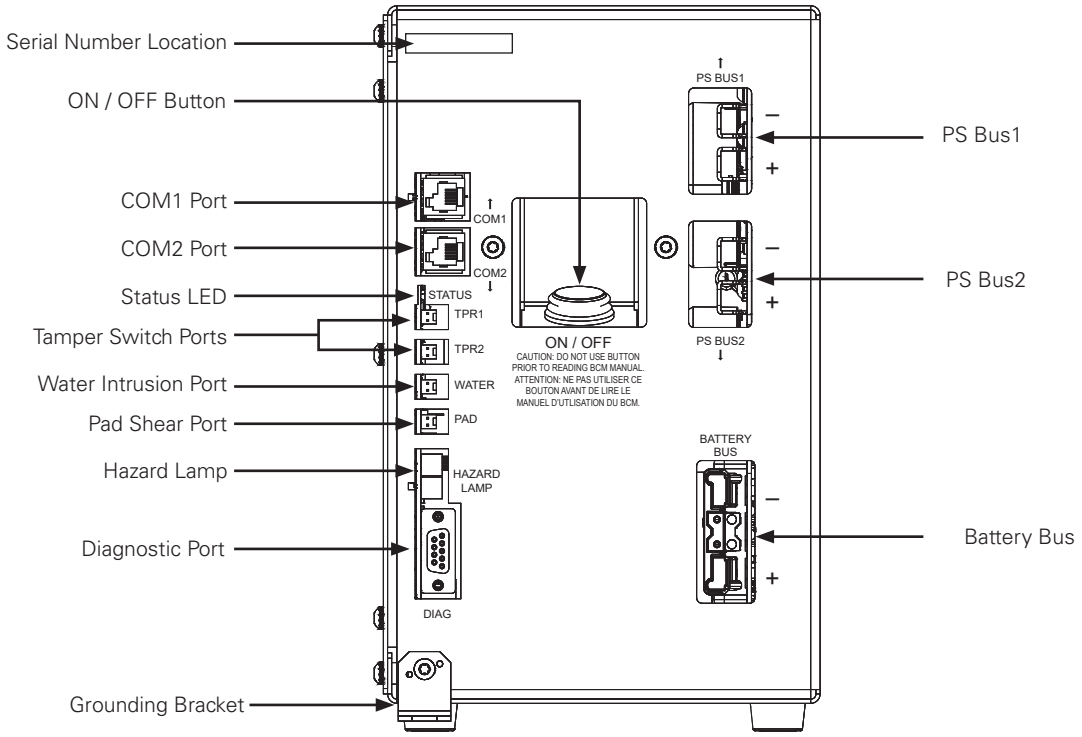


Fig. 2-3, Battery Control Module (BCM)

Battery Control Module (BCM) Features	
ON / OFF Button	Direct control of BCM power. Short press (one second) requests the Link-Up process, described in **Section 5.6.2, Link-Up**. Long press (three seconds) turns the BCM off.
COM1 Port	Communications link to the power supply, or to the upstream BCM. The LED adjacent to this connector indicates whether the port is receiving power from the power supply.
COM2 Port	Communications link to the next BCM. A termination plug *(p/n ATL7400644-001)* shall be installed in the last BCM.
Status LED	A pair of LEDs (green and red) indicating the status of the BCM, as described in **Section 2.1.2.2, Status LED**.
Tamper Switch Ports	Connections for door switches, to indicate if the cabinet is being accessed. TPR1 is for the front door, and TPR2 is for the rear door of the cabinet it is inserted in.
Water Intrusion Port	Connection for optional water intrusion switch; normally unused.
Pad Shear Port	Connection for optional pad shear detection switch; normally unused.
Hazard Lamp	Connection for optional external indicator lamp indicating a potential safety hazard in approaching the cabinet. The LED adjacent to this connector also indicates the possible hazard condition.
Diagnostic Port	Connection for service access to the BCM. This connector is reserved for use by trained Alpha/EnerSys personnel only.
Grounding Bracket	Earth ground connection between the BCM and the cabinet shelf.
PS Bus1	Power cable link to the power supply, or to the upstream BCM.
PS Bus2	Power cable link to the next BCM. This opening should remain covered for the last BCM, to avoid accidental contact with the power terminals.
Battery Bus	Combined power and communications cable to the string of Battery Power Modules (BPMs).

Table 2-3, Battery Control Module (BCM) Features

Battery Control Module (BCM) Specifications	
Nominal DC Input Voltage	36.2V
Operating Voltage Range	30.0V to 40.7V
Maximum Continuous Discharge Current	39A
Maximum Continuous Charge Current	39A
Maximum Voltage	40.7V
Module Operating Temperature	-4 to 185°F (-20 to 85°C) (Note: Derating occurs before or up to extremes.)
Weight	16.5 lbs (7.5 kg)
Dimensions (H × L × W)	10.38" × 6.39" × 13.15" (264 mm × 162 mm × 334 mm)
Connectors	
To Battery Pack	6 Position SBS®75X Connector
To Inverter / Parallel BCM	2 Position Anderson™ PP75 Connector
Communication Protocol	Alpha® RS-485; CAN 2.0
Safety Certification	Compliant with CSA/UL® 1973:2018, EN ISO® 13849-1:2015, EN ISO® 13849-2:2012

Table 2-4, Battery Control Module (BCM) Specifications

2.1.2.2 Status LED

The red/green pair status LED is the primary indicator of the BCM's status, showing whether the BCM is powered, the batteries are online for backup use, and whether the BCM is communicating with the power supply as follows:

Status	BCM powered?	Batteries online?	Communicating with XM3.1-HP™ power supply?
Off	No	No	Not specified
Solid green	Yes	Yes	Yes
Blinking green	Yes	Yes	No
Blinking red	Yes	No	Yes
Blinking green and red	Yes	No	No

Table 2-5, Status LED Functions

The COM LED, next to the COM1 connector, is lit green when there is a communications voltage from the power supply. Communications is not possible if this LED is not lit.

The Hazard LED, next to the Hazard Lamp connector, blinks red when there is a potential safety concern in approaching the cabinet. This occurs when the temperature within the battery modules is critically high.

2.1.2.3 ON / OFF Button

The push-button on the front of the BCM turns the BCM(s) on or off. To turn the BCM on, press the button for one second and then release it. The status LED should blink for several seconds before turning back off again. If the BCM is communicating with an XM3.1-HP™ power supply, the power supply will detect the BCM startup, and automatically perform a "Link-Up" operation (as described in **Section 5.6.3 Link-Up on page 72**) to bring the BCM batteries online.

To turn the BCM off, verify that the system is not actively being charged or discharged. Press the ON/OFF button for three seconds and then release it. If the batteries were online (solid green status LED), the status LED will begin blinking red, and after a short pause there is an audible sound as the contactors open. After a few seconds, the BCM should turn off and the status LED goes dark.

2.1.2.4 Battery Control Module Block Diagram

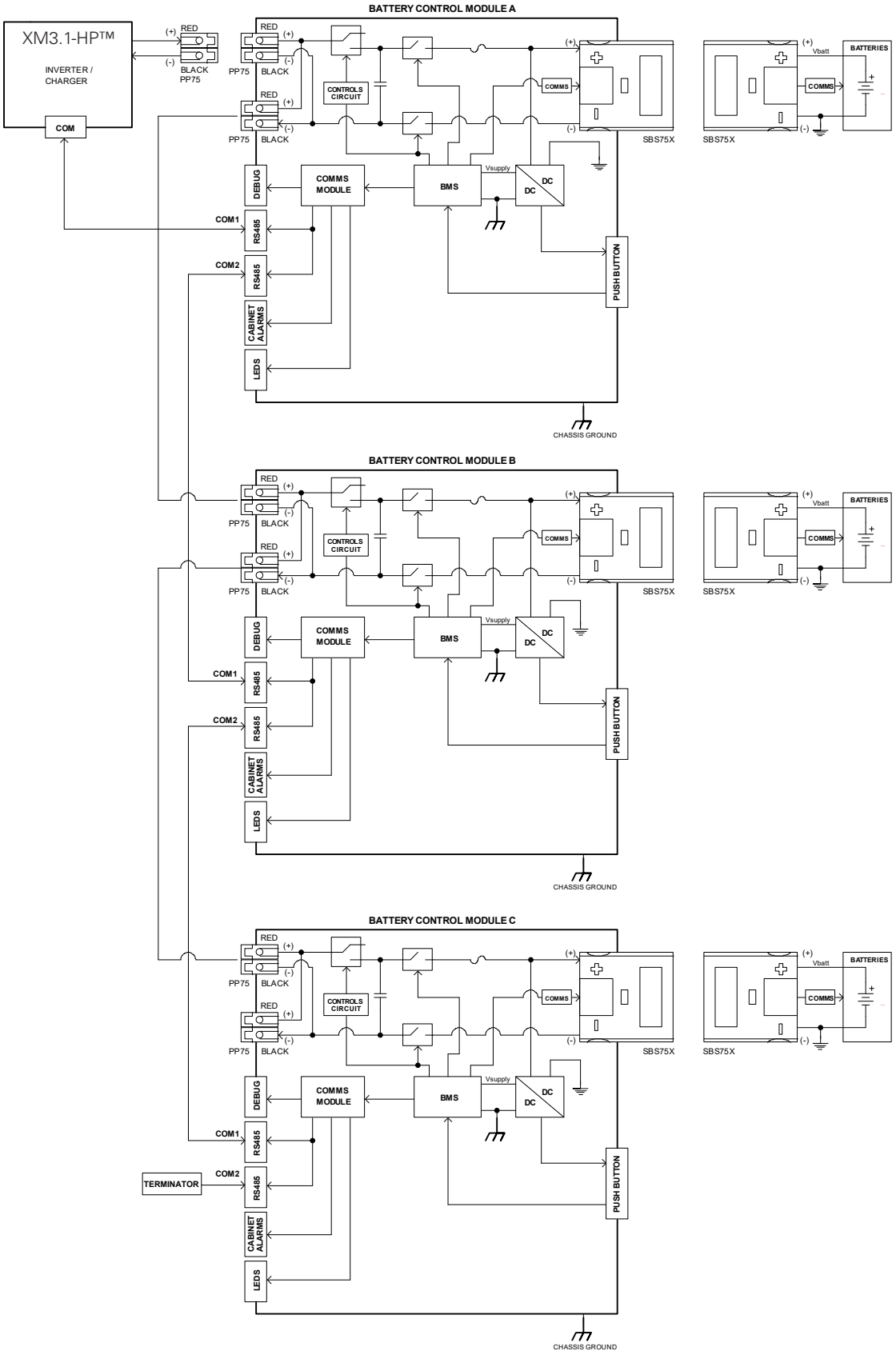


Fig. 2-4, Battery Control Module Block Diagram

2.1.3 BPM and BCM Safety

Each battery string is comprised of a BCM and multiple BPMs. An active Battery Management System (BMS) is incorporated within each BCM string to provide protection against overcurrent, overvoltage, over-discharge, and over-temperature conditions. The BCM and BPMs incorporate passive overcurrent protection in the form of fuses. The BMS communicates operating limits to the connected XM3.1-HP™ power supply via CAN communications. The BMS self-protects in case these limits are violated.

WARNING! EXPLOSION, ELECTROCUTION OR FIRE HAZARD

- Only use Alpha® approved charging sources.
- A battery can present a risk of electric shock, burns from high short-circuit current, fire, or explosion. Observe proper precautions.
- Ensure the cables are properly sized.
- Ensure clearance requirements are strictly enforced around the batteries.
- Ensure the area around the batteries is well ventilated and clean of debris.
- Never allow a spark or flame near the batteries.
- Always use insulated tools. Avoid dropping tools onto batteries or other electrical parts.
- Do not charge battery below -9.4°F (-23°C).
- Follow the appropriate listed procedure for removing/replacing battery modules within this system.
- Do not stick fingers or tools in BCM.
- Remove jewelry before accessing the system.
- Do not use BPMs or BCMs with external signs of damage.

CAUTION! EQUIPMENT DAMAGE

- Failure to install or use this product as instructed can result in damage to the product that may not be covered under the limited warranty.
- Do not break into or tear apart BPMs.
- This product has no user-replaceable parts, including fuses. It is only serviceable by qualified personnel. An open fuse should be returned to Alpha® for evaluation.
- Only install BPMs and BCMs per the procedure. Do not connect them together in any other manner, or to other batteries.
- Wear an electrostatic discharge (ESD) wrist strap when handling BCMs and plugging in the BPMs.

WARNING! FUMES & ELECTROLYTE HAZARD

- Any gelled or liquid emission from a battery is an electrolyte, which is harmful to the skin and eyes. In the event of an electrolyte leak, do not come in contact with the electrolyte. Immediately disconnect the battery and properly dispose of it.
- If electrolyte contacts the skin, wash immediately and thoroughly with water. If electrolyte enters the eyes, wash thoroughly for 10 minutes with clean water or a special neutralizing eye wash solution and seek immediate medical attention.
- If the battery material is released, remove operators from area until the battery cools and fumes dissipate. Provide maximum ventilation to clear out hazardous gases. Avoid skin and eye contact or inhalation of vapors. Remove spilled liquid with absorbent cloth and dispose of according to local codes.

ATTENTION:

- See **Fig. 2-2, Battery Power Module (BPM)** and **Fig. 2-3, Battery Control Module (BCM)** for silkscreen and sticker labels.
- Install this product in accordance with local electrical, building, fire, and other codes or utility requirements.
- Use with copper conductors rated 75°C minimum.
- If installed in the United States, all wiring methods shall be in accordance with the National Electrical Code® (NEC®) (NFPA 70), National Electrical Safety Code® (NESC®) and California General Order Codes.
- If installed in Canada, all wiring methods shall be in accordance with the Canadian Electrical Code, C22.1, Current Edition.
- Wear complete eye and clothing protection when working with batteries.
- Do not expose to rain or spray.
- Fire suppression equipment must be available in case of fire. The minimum required equipment for this installation is a type ABC fire extinguisher.

WARNING! CALIFORNIA PROPOSITION 65

This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

2.1.3.1 BPM and BCM Disposal and Recycling

WARNING! EXPLOSION & FIRE HAZARD

Do not dispose of the BPM or BCM by fire. Disposal or recycling of this battery shall be managed in accordance with approved local, state, and federal requirements. Consult state environmental agencies and/or the federal Environmental Protection Agency (EPA).

Do not dismantle, incinerate, or crush batteries.

In case of irreparable failure or end of life, the battery must be taken out of operation in a controlled manner (contact Alpha® for more details). The battery should not be dismantled by the customer. Specialized handling and recycling are required for damaged products. Do not dispose of waste batteries as unsorted municipal waste.

Alpha®, in line with government regulations, will accept the XRT-Li power system batteries at specific facilities for disposal. Contact your local Alpha® product sales representative for specific recycling instructions per region.

2.1.4 System Safety and Certifications

The XRT-Li power system has been certified to the following standards:

System Safety and Certifications		
Certification	**Edition**	**Type**
CSA/UL/IEC 62368:2019	3	Audio/video, information and communication technology equipment; Telecommunication products: network infrastructure equipment
CSA/UL® 9540:2020	2	Energy Storage System (ESS) Requirements
CSA/UL® 9540a:2019	4	Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
CSA/UL® 1973:2018	2	Batteries for Use in Light Electric Rail (LER) and Stationary Applications
UN 38.3		Transportation Testing for Lithium Batteries and Cells
EN ISO® 13849-1:2015	3	Safety of Machinery - Safety-related Parts of Control Systems - Part 1
EN ISO® 13849-2:2012	2	Safety of Machinery - Safety-related Parts of Control Systems - Part 2

Table 2-6, System Safety and Certifications

2.1.4.1 System Identification and Labels

The battery serial numbers are located in two places on the battery case. The first is on the front of the battery. The manufacturing date is also located on this label below the serial number. The second is on the positive terminal side towards the rear of the battery (see. **Fig. 2-2, Battery Power Module (BPM)**). The BCM serial number label can be found on the front face of the unit in the upper left corner (see **Fig. 2-3, Battery Control Module (BCM)**).

The BPM and BCM have the following labels and identification:

BCM and BPM Identification and Labels	
Label/Symbol	**Indication**
	Indicates a hazard.
	Indicates high voltage.
	Read/refer to manual.
	Recycle electrical equipment according to WEEE (Waste Electrical and Electronic Equipment) directive.
	Recycle and dispose of battery according to Hazardous Material Regulations for Class 9 Miscellaneous.
	Lithium-ion battery can be recycled. Follow local regulations for recycling.
	Grounding
	DC Voltage

Table 2-7, BCM and BPM Identification and Labels

2.0 Power System, continued

The following labels are located on the outside of the PN-4LI, PN-4LIB22, and PN-4LIB28 enclosures:

Enclosure Labels

PN-4LI

POWER SUPPLY EQUIPMENT
ENERGY STORAGE SYSTEM - ESS

INPUT 120 VAC 50/60 HZ 20 A. MAX 2040 VA MAX
OUTPUT 89/63 VAC 60 HZ 12 A. MAX 1068 VA MAX
DC CHARGER 36 VDC NOM. 39 A. MAX
DC INVERTER 36 VDC NOM. 39 A. MAX
MAX SYSTEM DC SCCR: 1250A @ 15ms
ENERGY OUTPUT THIS UNIT AS INSTALLED ____ KWH 39.8 KWH MAX
ENERGY OUTPUT SYSTEM AS INSTALLED ____ KWH 90.5 KWH MAX
MODEL PN-4LI DATE CODE ____ FACTORY CODE ____
CONFIGURATION ____
S/N ____

RAINPROOF TYPE 3R ENCLOSURE C US 161172

To be installed by qualified service personnel only, in accordance with applicable local and/or state electrical codes, including consideration of a dedicated grounding rod.

D'être installé par une personne qualifiée suivant les codes électrique locaux et/ou nationaux applicable prenant en considération d'une tige de mise à la terre.

950-00040-19-001 A

PN4-LIB22

POWER SUPPLY EQUIPMENT
ENERGY STORAGE SYSTEM - SUBASSEMBLY

INPUT ____ VAC ____ HZ ____ A. MAX ____ VA MAX
OUTPUT ____ VAC ____ HZ ____ A. MAX ____ VA MAX
DC CHARGER 36 VDC NOM. 39 A. MAX
DC INVERTER 36 VDC NOM. 39 A. MAX
MAX SYSTEM DC SCCR: 1250A @ 15ms
ENERGY OUTPUT THIS UNIT AS INSTALLED ____ KWH 39.8 KWH MAX
ENERGY OUTPUT SYSTEM AS INSTALLED ____ KWH 90.5 KWH MAX
MODEL PN-4LIB22 DATE CODE ____ FACTORY CODE ____
CONFIGURATION ____
S/N ____

RAINPROOF TYPE 3R ENCLOSURE C US 161172

To be installed by qualified service personnel only, in accordance with applicable local and/or state electrical codes, including consideration of a dedicated grounding rod.

D'être installé par une personne qualifiée suivant les codes électrique locaux et/ou nationaux applicable prenant en considération d'une tige de mise à la terre.

950-00040-19-001 A

PN4-LIB28

POWER SUPPLY EQUIPMENT
ENERGY STORAGE SYSTEM - SUBASSEMBLY

INPUT ____ VAC ____ HZ ____ A. MAX ____ VA MAX
OUTPUT ____ VAC ____ HZ ____ A. MAX ____ VA MAX
DC CHARGER 36 VDC NOM. 39 A. MAX
DC INVERTER 36 VDC NOM. 39 A. MAX
MAX SYSTEM DC SCCR: 1250A @ 15ms
ENERGY OUTPUT THIS UNIT AS INSTALLED ____ KWH 50.7 KWH MAX
ENERGY OUTPUT SYSTEM AS INSTALLED ____ KWH 90.5 KWH MAX
MODEL PN-4LIB28 DATE CODE ____ FACTORY CODE ____
CONFIGURATION ____
S/N ____

RAINPROOF TYPE 3R ENCLOSURE C US 161172

To be installed by qualified service personnel only, in accordance with applicable local and/or state electrical codes, including consideration of a dedicated grounding rod.

D'être installé par une personne qualifiée suivant les codes électrique locaux et/ou nationaux applicable prenant en considération d'une tige de mise à la terre.

950-00040-19-001 A

The following label is applied to all enclosures:

CAUTION: To reduce the risk of electric shock and fire, a circuit breaker/service disconnect switch must be installed ahead of this equipment on the enclosure when the equipment is not provided with a service entrance. Refer to installation instructionsfor details.

ATTENTION: Un disjoncteur/sectionneur de branchement doit être installé sur le cabinet devant l'équipement pour réduire le risque de choc électrique et d'incendie lorsque l'appareil ne dispose pas d'une entrée de service. Lisez les instructions d'installation pour plus de détails.

CAUTION: This unit has more than one power supply connection point. To reduce risk of electric shock, before servicing disconnect both the AC input breaker and the battery circuit switching device.

ATTENTION: Ce cabinet a plus d'un point de connexion d'alimentation. Pour réduire le risque de choc électrique, déconnecter la fois l'entrée du disjoncteur AC et le dispositif de commutation de circuit de la batterie.

WARNING: Hazardous voltage circuits. Risk of electric shock. Hazardous live parts inside this unit are energized from the battery supply even when the input AC power is disconnected.

AVERTISSEMENT: Circuits à tension élevée. Risque de choc électrique. Pièces sous tension dangereuses à l'intérieur de cet appariel sont alimentés à partir de l'a limentation de la batterie même lorsque l'alimentation secteur d'entrée est débranché.

WARNING: To reduce the risk of injury, read all instructions.

AVERTISSEMENT: Veuillez lire toutes les instructions pour réduire le risque de blessures.

Ambient temperature range / Plage de température ambiante: +45C to -15C.

Weight / Poids: 1,200 lbs / 544 kg MAX.

Technology utilized in ESS is Li-ion.
La technologie utilisée dans l'ESS est le Li-ion.

For use with CATV equipment.
À utiliser avec l'équipement CATV.

This enclosure is designed to be used with Alpha Technologies power supply modules.
Ce cabinet est désigné pour être utilisée avec les modules d'alimentation de Alpha Technologies.

This equipment meets the unit level performance criteria of UL 9540A.
Cet équipement répond aux critères de performance au niveau le appariel de UL 9540A.

Technical Support / Assistance technique: 1-800-863-3364 950-00045-19-001 A

The following label is applied to PN-4LI and PN-4LIB22 enclosures:

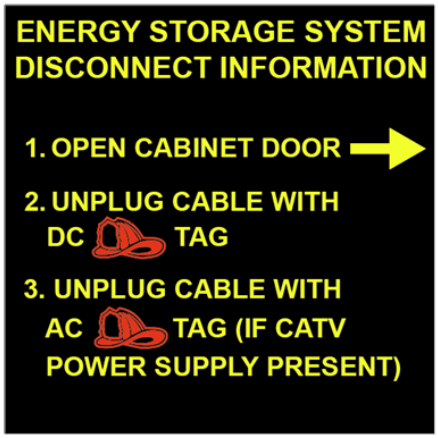


Table 2-8, Enclosure Labels

ATTENTION:

Additional sticker labels specific to your configuration will need to be added on-site. See **Section 5.6.5 Installation Wrap Up on page 76** for details.

2.1.5 Battery Reconciliation Device (BRD)

The Battery Reconciliation Device (BRD) *(p/n 018-00003-xx-xxx)* is the recommended tool used to balance each BPM to the common BPM Bus prior to it being independently connected to it. The BRD comes as a kit *(p/n 746-00055-20-xxx),* which includes a BRD, carrying case with a foam padded interior, and a wire harness extension *(p/n 876-00119-20-xxx)*.

The BRD uses "buzzer logic"; when the BRD has finished reconciling and is inactive, an audible buzz will notify the technician. This buzzing will start at five minutes of inactivity. Another audible buzz will happen after four minutes of inactivity, then at three minutes, two minutes, and then every minute it is inactive, beeping only once per interval.

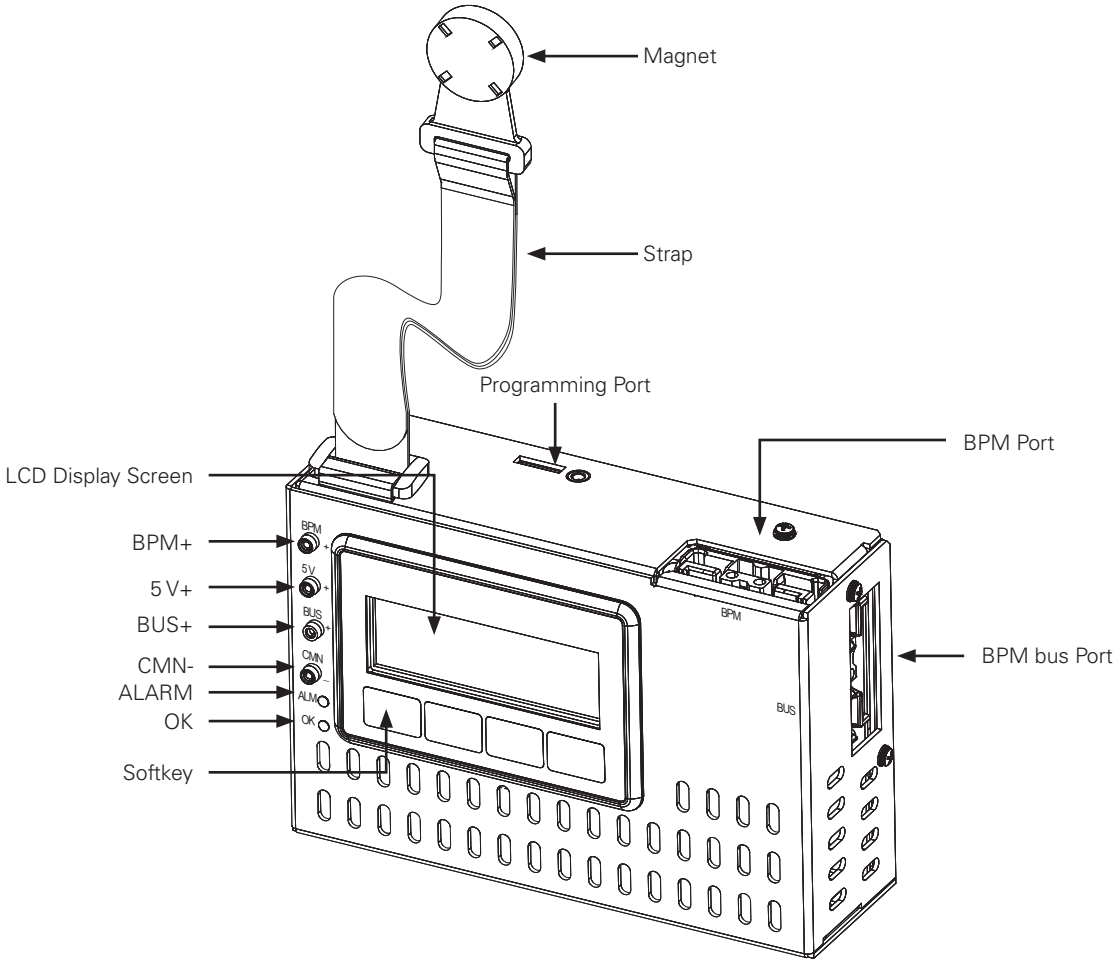


Fig. 2-5, Battery Reconciliation Device (BRD)

Battery Reconciliation Device (BRD) Features	
LCD Display Screen	Non-touch screen. Displays diagnostic and commissioning information.
BPM+	Meter test point for easy measuring of the BPM positive voltage.
5 V+	Verify meter reference voltage.
BUS+	Meter test point for easy measuring of the BPM bus positive voltage.
CMN-	Common negative of all the measurement points, including the BPM, BPM bus, and 5 V+.
ALARM LED	Indicates alarm condition.
OK LED	Indicates reconciliation is complete. BPM is adequately balanced with the battery string.
Softkey	Four softkeys are used for input and setting selections on the BRD display screen.
Programming Port	Pin header reserved for Alpha use.
Strap and Magnet	Allows BRD to be hung on battery handle.
BPM Port	Connection to BPM to be reconciled.
BPM bus Port	System battery bus.

Table 2-9, Battery Reconciliation Device Features

2.1.5.1 BRD LEDs

The BRD has two front-facing LEDs, a red alarm (ALM) LED and a green OK LED. The following table lists out the LED functions when the BRD is powered and in use:

Status	Function
Off	Idle
Solid green OK LED	Reconciliation is successfully completed.
Blinking green	Reconciliation in progress.
Solid red ALM	Reconciliation fault, LCD will display fault or alarm

Table 2-10, Battery Reconciliation Device LED Status

2.2 Theory of Operation

The battery subsystem is comprised of one or more strings (A, B, and C) of Battery Power Modules (BPM) connected in parallel. Each string is monitored and controlled by a Battery Control Module (BCM). Strings A and B may contain 3 to 22 power modules each, and String C may contain 6 power modules as described in **Table 5-1, Cabinet Configuration Examples**.

Each BPM has maximum continuous charge and discharge limits based on the cell manufacturer limitations and an internal BPM fuse. Cell limits are determined based on temperature and state of charge (SoC). The limit for the BPM is established by the value that is smaller between the cell limit and the fuse limit.

Each BCM has maximum continuous charge and discharge limits based on an internal fuse. In the event that the maximum BCM charge or discharge limit exceeds the combined BPMs' limits due to configuration or operating conditions (e.g. only one BPM is connected to the string, cold temperatures, etc.), the BCM will act to disconnect to protect itself and the BPMs.

The maximum charging and discharging limit for the battery subsystem is based on the combined current limits of the number of connected BCM strings.

2.2.1 Charging

CAUTION!

The Battery Management System (BMS) tracks the battery's condition and automatically assesses the best charging parameters based on present conditions. These parameters can be communicated to the inverter/charger using the CANBUS connection. There is no "typical" BMS charging cycle due to the adaptive nature for each unique situation.

2.2.1.1 Battery Power Module (BPM)

Battery Power Module Continuous Charge Limits (Amps), as a Function of Temperature and User SoC																					
SoC (%)/ Temp. (°C)	**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**	**85%**	**90%**	**95%**	**100%**
-30°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-20°C	2.0	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.4	2.2	2.0	1.8	1.8	1.7	1.5	1.4	1.2	1.0	0.9	0.7
-10°C	7.0	7.0	7.3	7.6	7.9	8.2	8.5	8.9	8.9	8.2	7.5	6.8	6.5	6.1	5.8	5.3	4.8	4.2	3.6	3.0	2.4
0°C	18.2	18.2	18.0	17.7	17.5	17.3	17.0	16.8	16.6	16.6	16.7	16.7	16.0	15.1	14.2	13.3	12.3	11.2	10.2	9.2	8.2
10°C	29.3	29.3	28.6	27.8	27.1	26.3	25.5	24.7	24.2	25.0	25.8	26.6	25.5	24.1	22.7	21.2	19.8	18.3	16.8	15.4	13.9
25°C	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	27.0	23.0
45°C	15.0	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1	16.3	16.4	16.6	16.6	16.5	16.4	16.6	16.8	17.1	17.4	17.6	17.9
50°C	9.8	9.8	9.9	10.0	10.1	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.7	10.7	10.7	10.9	11.1	11.3	11.5	11.7	11.9
55°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2-11, Battery Power Module Continuous Charge Limits as a Function of Temperature and User SoC

2.2.1.2 System and Battery String Level

System Level Maximum Continuous Charge Limits (Amps), Scalable for User SoC																					
SoC (%)/ Temp. (°C)	**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**	**85%**	**90%**	**95%**	**100%**
-30°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-20°C	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1
-10°C	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.7	1.5	1.4	1.3	1.2	1.2	1.1	0.9	0.8	0.7	0.6	0.4
0°C	3.7	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.2	3.0	2.9	2.7	2.5	2.2	2.0	1.8	1.4
10°C	6.0	6.0	5.8	5.7	5.5	5.3	5.2	5.0	4.9	5.1	5.3	5.4	5.1	4.8	4.6	4.3	4.0	3.7	3.4	3.0	2.4
25°C	10.0	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	10.4	9.8	9.3	8.5	7.7	6.9	6.1	5.2	4.0
45°C	3.1	3.1	3.1	3.1	31.	3.2	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.3	3.4	3.4	3.5	3.5	3.6	3.1
50°C	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.1
55°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2-12, System Level Maximum Continuous Charge Limits Scalable for User SoC

For total BPMs of 3 to 50, limits are equal to the lesser of 39A or the value in the scalable table above multiplied by the total number of battery power modules in system.

NOTICE:

The same values above also applies to the battery string level of maximum continuous charge limits that are scalable for user SoC. Limits are equal to the lesser of 39A or value in scalable table multiplied by the total number of battery power modules in the string.

2.2.1.3 Battery Control Module (BCM)

The maximum continuous charging current for BCM is 39A. In the event that the connected BPMs have an aggregated lower charging limit, the BCM will disconnect when the lower limits has been exceeded for protection.

2.2.1.4 Battery Subsystem

The maximum continuous charging current limits for the battery subsystem take into account imbalance factors to ensure reliable operation and may be less than the summation of max limits for all the connected BCM strings.

2.2.2 Discharging

2.2.2.1 Battery Power Module (BPM)

Battery Power Module Continuous Discharge Limits (Amps), as a Function of Temperature and User SoC																					
SoC (%)/ Temp. (°C)	**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**	**85%**	**90%**	**95%**	**100%**
-30°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-20°C	0.0	2.4	4.2	5.9	7.5	9.2	10.9	12.6	13.8	13.3	12.8	12.3	12.1	11.8	11.6	11.5	11.5	11.5	11.5	11.5	11.5
-10°C	0.0	8.5	14.7	20.5	26.4	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
0°C	0.0	15.6	23.1	29.5	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
10°C	0.0	22.7	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
25°C	0.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
45°C	0.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
50°C	0.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
55°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2-13, Battery Power Module Continuous Discharge Limits as a Function of Temperature and User SoC

2.2.2.2 System and Battery String Level

System Level Maximum Continuous Discharge Limits (Amps), Scalable for User SoC																					
SoC (%)/ Temp. (°C)	**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**	**85%**	**90%**	**95%**	**100%**
-30°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-20°C	0.0	0.5	0.9	1.2	1.5	1.9	2.2	2.6	2.8	2.7	2.6	2.5	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3
-10°C	0.0	1.7	3.0	4.2	5.4	6.6	7.8	9.0	9.8	9.4	9.0	8.7	8.6	8.4	8.3	8.2	8.2	8.2	8.2	8.2	8.2
0°C	0.0	3.2	4.7	6.0	7.3	8.6	9.9	11.2	12.2	12.0	11.8	11.7	11.6	11.5	11.4	114.	11.4	11.4	11.4	11.4	11.4
10°C	0.0	4.6	6.4	7.8	9.2	10.7	12.1	13.5	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
25°C	0.0	8.9	10.5	11.2	11.9	12.6	13.3	14.1	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
45°C	0.0	9.6	10.8	10.8	10.9	10.9	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
50°C	0.0	6.1	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
55°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2-14, System Level Maximum Continuous Discharge Limits Scalable for User SoC

For total BPMs of 3 to 50, limits are equal to the lesser of 39A or the value in the scalable table above multiplied by the total number of battery power modules in system.

NOTICE:

The same values above also applies to the battery string level of maximum continuous discharge limits that are scalable for user SoC. Limits are equal to the lesser of 39A or value in scalable table multiplied by the total number of battery power modules in the string.

2.2.2.3 Battery Control Module (BCM)

The maximum continuous discharging current for BCM is 39A. In the event that the connected BPMs have an aggregated lower discharging limit, the BCM will disconnect when the lower limits has been exceeded for protection.

2.2.2.4 Battery Subsystem

The maximum continuous discharging current limits for the battery subsystem take into account imbalance factors to ensure reliable operation and may be less than the summation of max limits for all the connected BCM strings.

2.3 XM3.1-HP™ Power Supply

For detailed information on the operation of the XM3.1-HP™ power supply, refer to the XM3.1-HP Power Supply Technical Manual *(Alpha p/n 017-950-B0-001)* on Alpha's website (www.alpha.com). Below are some unique features specific for the extended runtime (XRT) configuration.

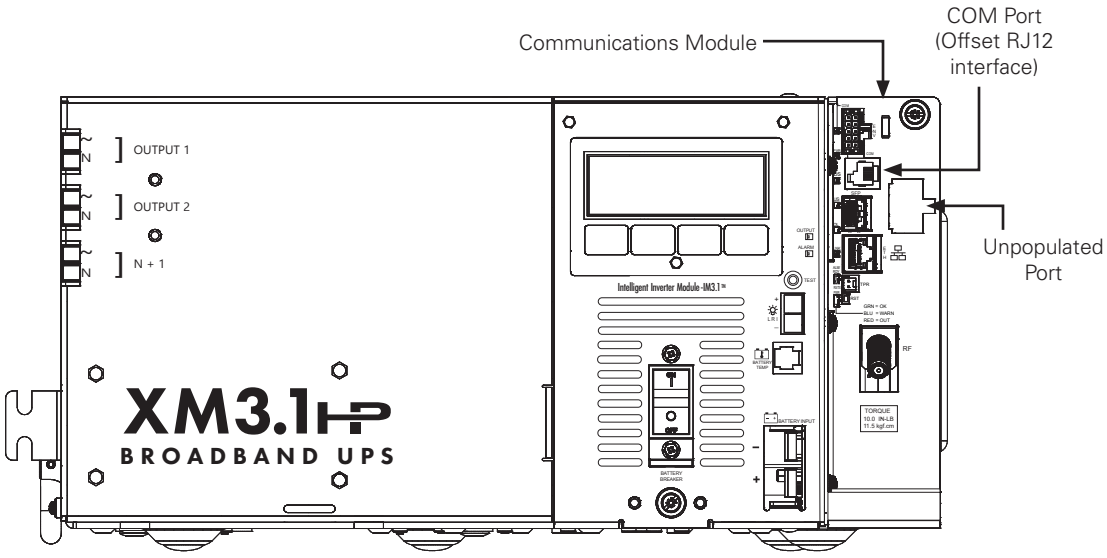


Fig. 2-6, XM3.1-HP™ Power Supply

2.3.1 Power Supply General Requirements

The Communications Module contains an embedded Cable Modem Module (CMM) which enables status monitoring and communications. The CMM Embedded DOCSIS® Status Monitoring enables monitoring of Alpha® power supplies through existing cable network infrastructure. Advanced networking services provide quick reporting and access to critical powering information.

The CMM utilizes Simple Network Management Protocol (SNMP) and standard SCTE-HMS and Alpha Management Information Bases (MIBs) to provide network status monitoring and diagnostics. A web interface enables authorized personnel direct access to advanced diagnostics using a common web browser.

The CMM can use an optical link instead of a DOCSIS® RF cable for communicating status monitor information. This is accomplished using a small form-factor pluggable (SFP) optical module into the SFP socket on the CMM.

SFP Module Recommendations:

- Industrial-rated SFP form factor modules only.

This Battery System COM interface is provided using an offset RJ12 interface on the front of the power supply, which is then interfaced to each BCM connected in the chain providing battery status and battery system control. This RS485 communications bus must be terminated *(p/n: ATL7400644-001)* after the last connected battery system interface.

2.3.2 Power Supply Firmware Requirements

In order for the XM3.1-HP power supply to use the XRT mode, the minimum firmware requirements are as follows (note that the PCM and EMM version depends on the version of its associated hardware):

- PCM: v1.06.0 / v2.06.0
- EMM: v1.06.0 / v2.06.0
- Cable modem firmware: PS3.1 01.07.00

For details on how to update the firmware to the latest version, refer to the XM3.1-HP Power Supply Technical Manual *(Alpha p/n 017-950-B0-001)*.

3.0 Enclosure Pre-Installation

3.1 Site Preparation

Site location and enclosure orientation must conform to local codes and permits. Each site may have unique requirements that need to be met and evaluated on an individual basis.

The site must be planned so that the enclosure will receive good air flow. If possible, in areas of extreme heat, it is best to position the enclosure so that it will be shaded from the afternoon sun. In areas of prevailing winds, it is best that the enclosure be located so that the sides of the cabinet face the winds instead of the doors. This will greatly reduce the buildup of sand or snow against the enclosure's air vents.

In areas of potential flooding, the geographical site and concrete pad must be located above the floodplain. Pedestals can be used to raise the enclosures above expected snow and water levels.

The enclosure must be placed where it will be free of obstructions, allowing easy access to the doors for service or equipment access. For ventilation and maintenance, allow a minimum space of 36 inches in the front and 36 inches in the rear, between the enclosure and other solid structures.

Place the enclosure well away from ground level sources of forced water, such as underground sprinkler systems and direct roadway splash.

Refer to the concrete pad drawings in this section, which contains all of the required mounting details, including electrical service and cable plant entrances.

Precast mounting pads may either be purchased from Alpha® or poured in place. The pad must be capable of holding 1,750 lbs (minimum) for a single enclosure. A double wide pad must be capable of holding 2,400 lbs of equipment (minimum) on a 52" × 24" footprint. Rebar may be placed in a crosshatch pattern for pad reinforcement, as needed.

The vapor barrier material (such as 30 lb felt, neoprene pond liner, or heavy grade tar paper) must initially extend at least 6" in all directions around the base perimeter of the enclosure and be trimmed closer to the enclosure, using the appropriate utility knife or cutting tool.

ATTENTION:

- Unit described in this manual is not to be installed inside habitable living spaces or residential buildings, and also not intended for indoor installation.
- Always consult local codes for mounting pad requirements.
- Consult local utility codes for additional cabinet grounding and utility requirements.

CAUTION!

Never transport the enclosure with batteries installed. Batteries must ONLY be installed after the enclosure is transported to the site and secured to the pad. Transporting the enclosure with batteries installed may cause a short circuit, fire, explosion, and/or damage to the battery pack, enclosure and installed equipment. Damage caused by improper shipping or transporting an enclosure with batteries installed is not covered under warranty.

3.2 Concrete Pad Preparation

NOTICE:

Items marked DO NOT USE in the following diagrams cannot be used due to the entrances being blocked by shelves. Only use the recommended openings located in back left corner of the cabinets.

Pads can either be poured on site, or precast by Alpha Technologies Services, Inc. Available concrete pad configurations and part numbers can be found in **Section 3.2.1 Precast Concrete Pads on page 31**.

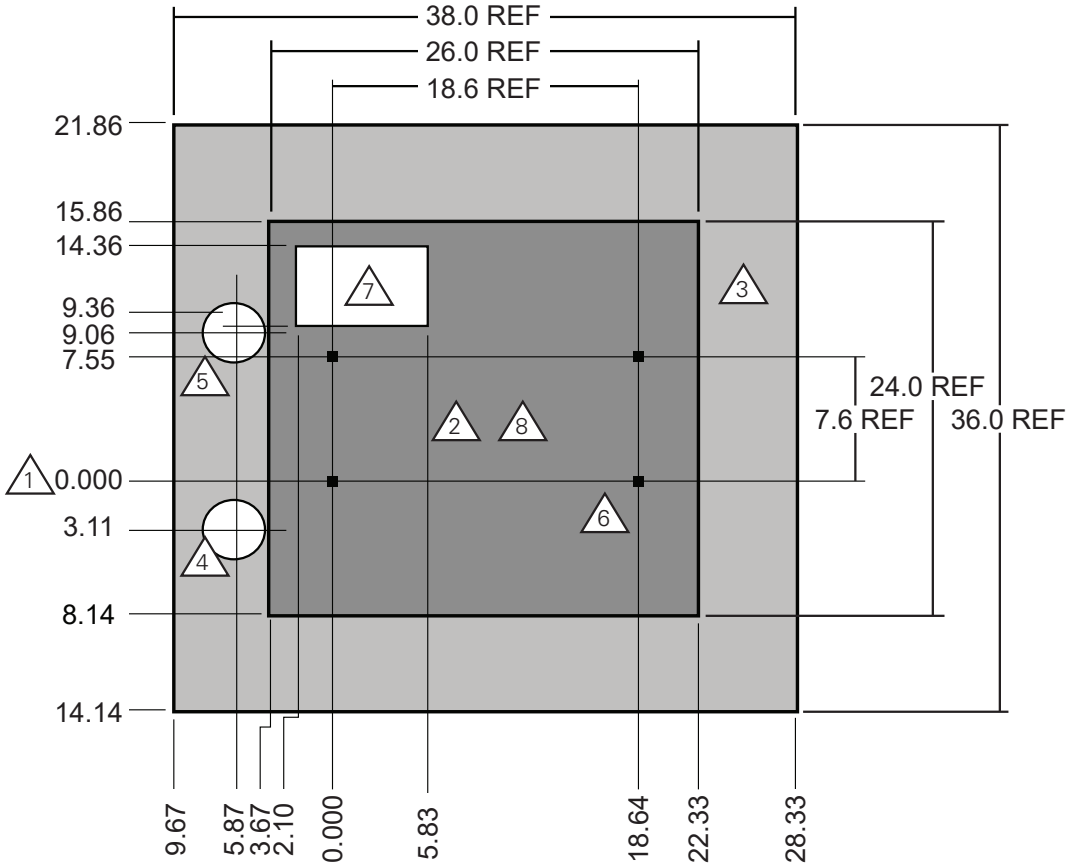


Fig. 3-1, Single-Wide Concrete Pad for PN-4LI or PN-4LIB22

1. All dimensions shown in inches. Mounting holes and sweeps indexed from this position.
2. Indicates PN-4LI pedestal enclosure mating surface.
3. Alpha® standard; recommended distance (6" minimum) between edge of pad and cabinet.
4. Four inch diameter hole for AC power IN (non-metered installation).
5. Four inch diameter opening for AC power IN (meter installation).
6. All mounting hardware must be stainless, galvanized, or better to prevent corrosion.
7. 5" × 8" rectangular cutout, open area for all internal connections including coax cable conduit sweeps.
8. A 25+ year continuous vapor barrier must be used between the enclosure and the pad to prevent moisture ingress and possible corrosion caused by metal to concrete contact. The vapor barrier material (such as 30 lb felt, neoprene pond liner, or heavy grade tar paper) must be initially extended at least 6" in all directions around the base perimeter of the enclosure. After the enclosure is secured to the pad, the material can be cut closer to the enclosure, using the appropriate knife or cutting tool.

3.2.1 Precast Concrete Pads

Alpha® offers a precast concrete pad for the PN Series Enclosures. Contact your nearest Alpha product sales representative for additional information.

Part Number:

PCO-3: 649-00002-10-001 (Precast pad)

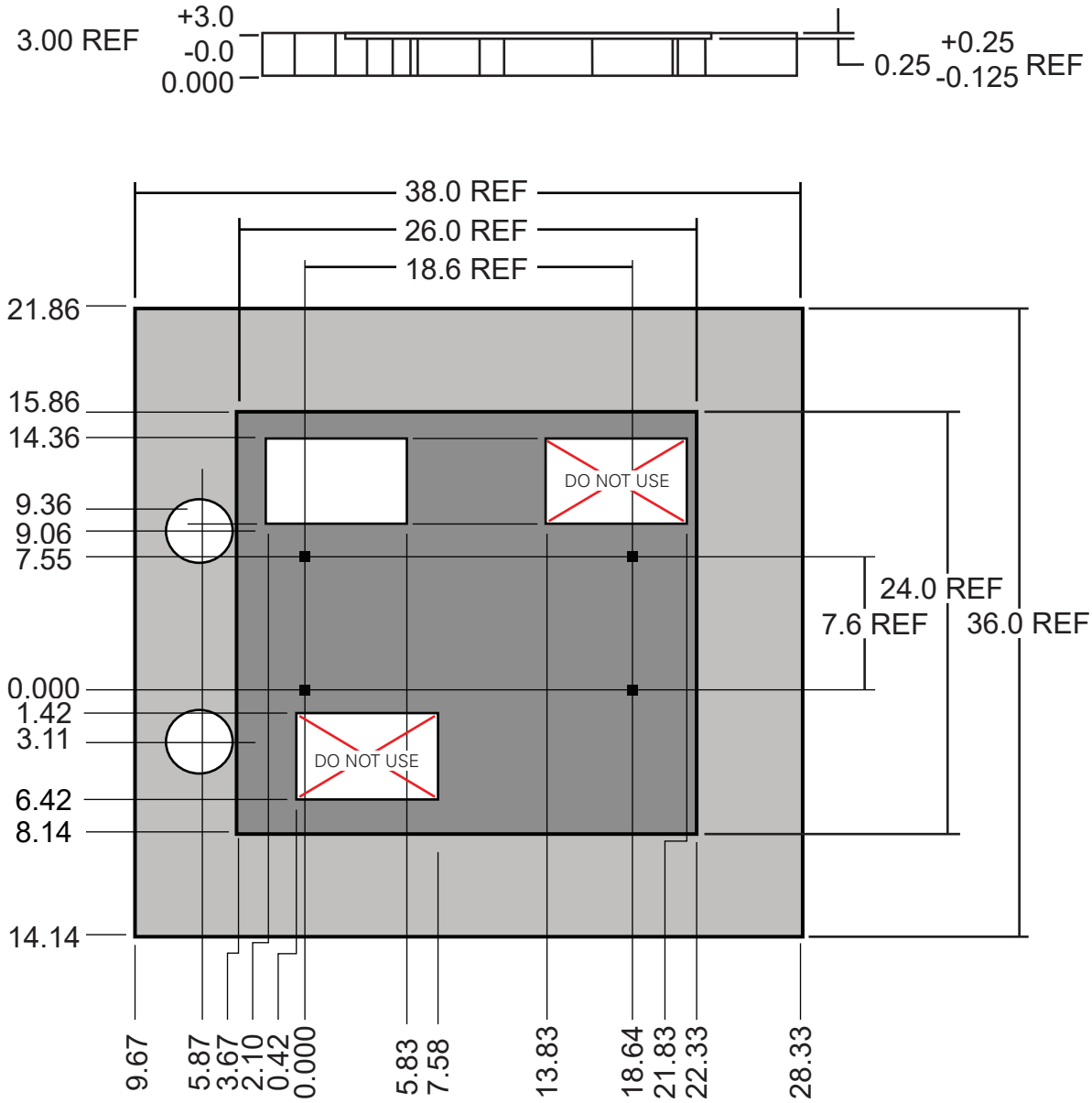


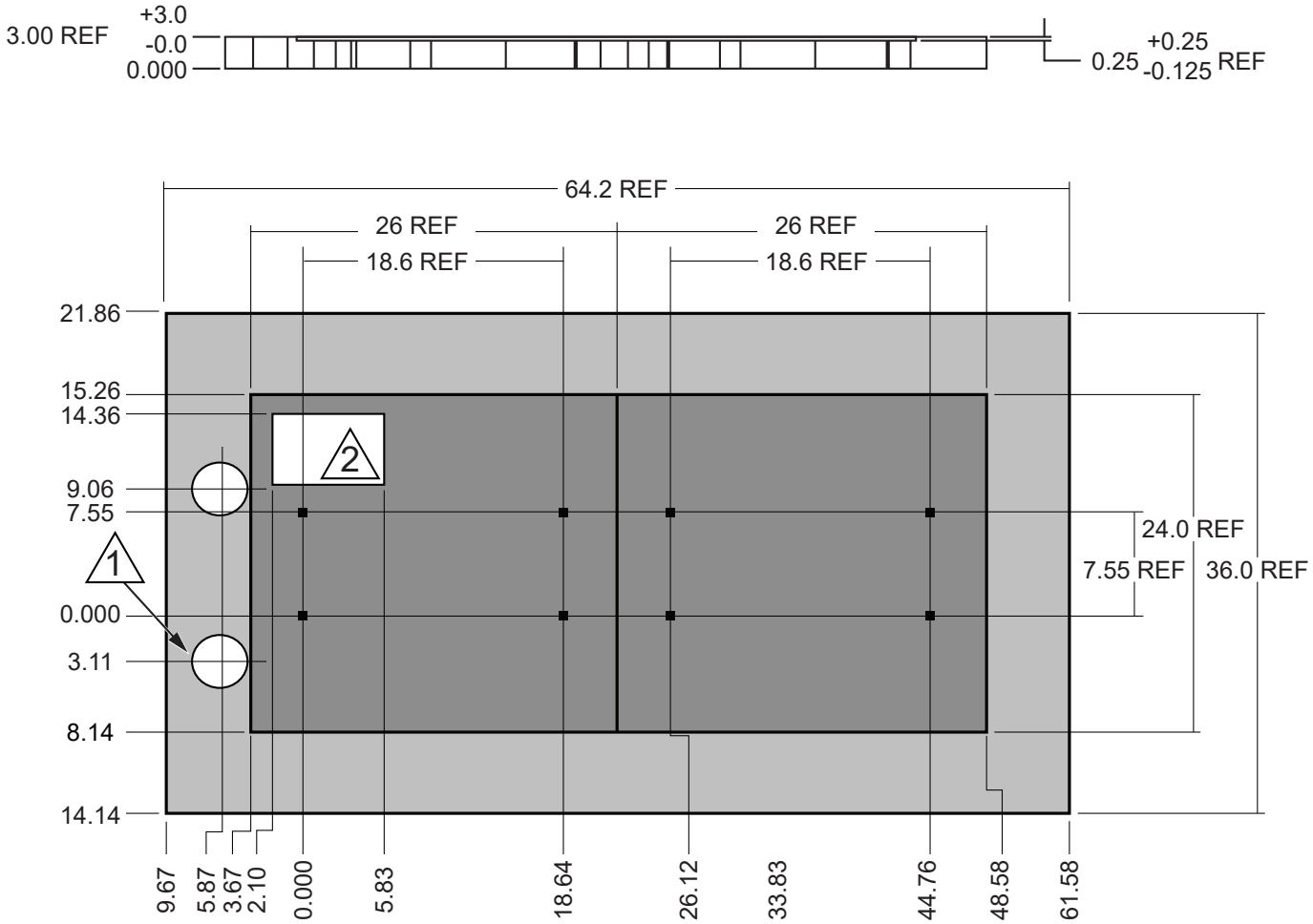
Fig. 3-2, Single-Wide Precast Concrete Pad for PN-4LI or PN-4LIB22

NOTICE:

Precast double-wide pads are not available for order. The layout below provides dimensions for double-wide concrete pour in pads.

NOTICE:

In this configuration, the PN-4LI or PN-4LIB22 is on the left while the PN-4LIB28 is on the right.



1 4" diameter opening (2 places)

2 5" × 8" opening

Fig. 3-3, Double-Wide Pour in Place Pad for PN-4LI or PN-4LIB22 and PN-4LIB28

3.3 Enclosure Grounding

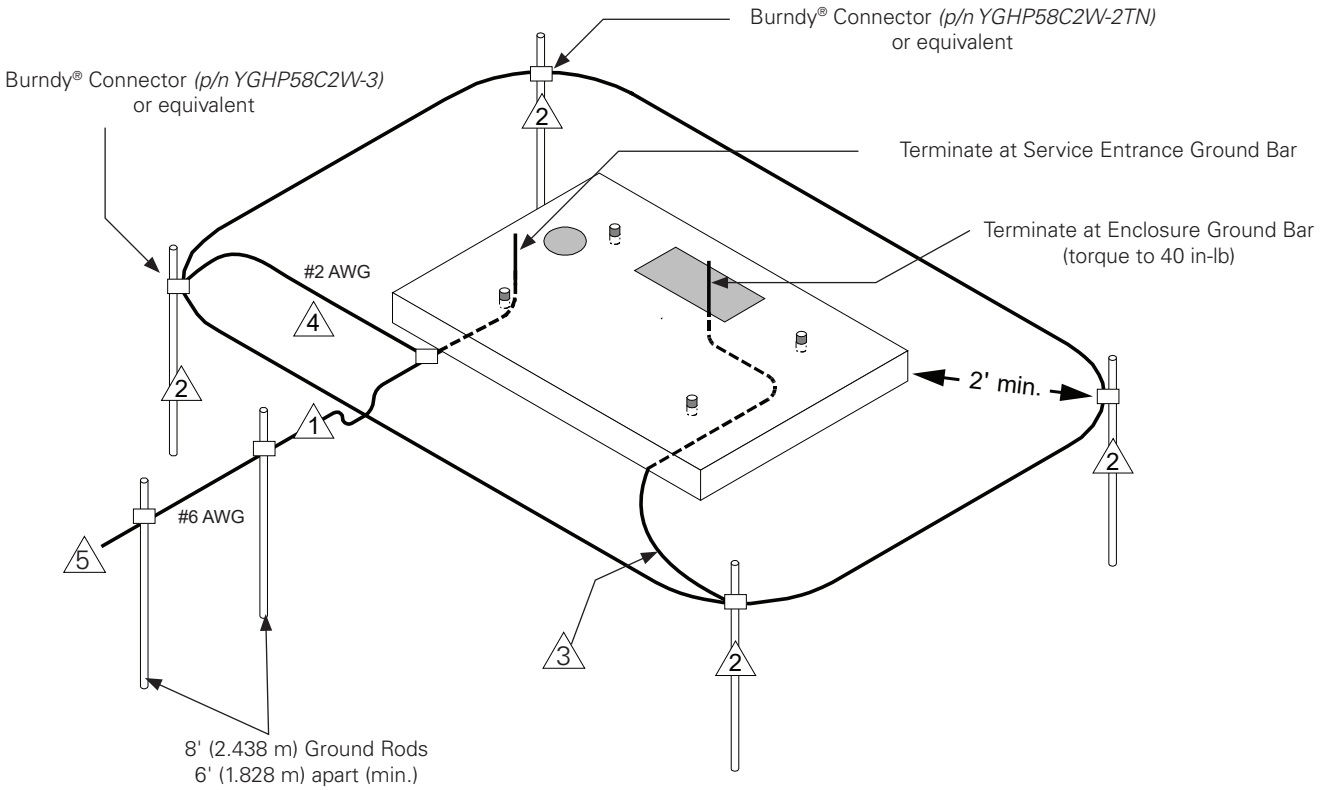


Fig. 3-4, Suggested Grounding, PN-4LI

Lightning Protection (optional)

1. 1/2" × 8' copper ground rod, four places, located about 2 feet (typical) from the corners of the pad.
2. #2 bare copper wire loop terminated to each ground rod and buried below grade 2 to 12 inches. Corrosion-proof connections (25+ year life-span) and hardware suitable for direct burial MUST be used.
3. #2 bare copper wire from loop to enclosure.
4. When the electrical supply is a primary service (not a secondary or feeder service), a #2 bare copper wire must bond the lightning protection loop to the Grounding Electrode Conductor where they are closest.

Service Grounding (required)

5. #6 bare copper wire from Service Neutral / Ground Bar with two ground rods located 6 feet apart.

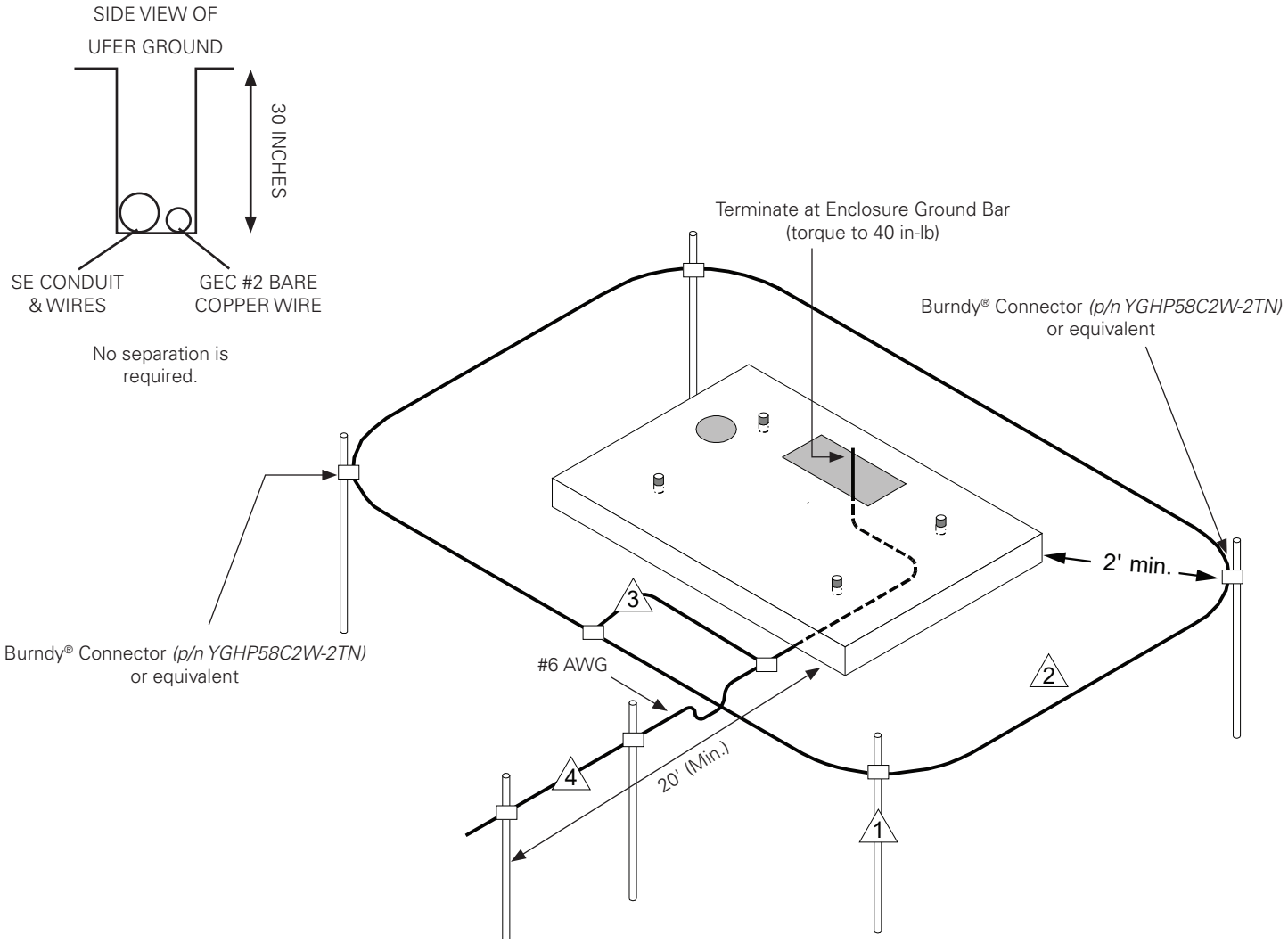


Fig. 3-5, Alternate Grounding, PN-4LI/LIB

Lightning Protection (optional)

1 1/2" × 8' copper ground rod, four places, located about 2 feet (typical) from the corners of the pad.

2 #2 bare copper wire loop terminated to each ground rod and buried below grade 2 to 12 inches. Corrosion-proof connections (25+ year life-span) and hardware suitable for direct burial MUST be used.

3 When the electrical supply is a primary service (not a secondary or feeder service), a #2 bare copper wire must bond the lightning protection loop to the Grounding Electrode Conductor where they are closest.

Service Grounding (required)

4 #6 bare copper wire from Service Neutral / Ground Bar down 30 inches and out 20 feet beyond the pad edge. This is often called a Ufer ground or Ground Ring in the NEC®.

4.0 Enclosure Installation

4.1 Transportation and Lifting

The PN-4 cabinet as shipped weighs approximately 250 lbs. A safe means of transportation to the site and a safe procedure for unloading the enclosure is necessary. Do not transport or lift with a device that may not be able to bear the unit's weight, and do not place the unit upon a surface that will not be able to fully support it. Optional lifting ears are available for the PN-4LIB enclosure (see **Section 9.2 PN-4LI/LIB Spare Part List on page 106**).

NOTICE:

Enclosure must always remain in the upright position during the shipping, storage and installation process. Damage may result from enclosure being shipped or stored on its side.

NOTICE:

Electronic modules, batteries or other components must not be installed until the enclosure is securely set in place at its permanent location.

4.2 Enclosure Mounting Procedure

ATTENTION:

Seismic rated anchors MUST be used when securing the enclosure to the pad, and there must be at least 3 feet between the co-located PN-4LI cabinets and other structures. Alpha® recommends using seismic rated anchors such as the HILTI® HSL4/HSL4-G (or equivalent). Contact your Alpha product sales representative for more information.

The enclosure bolts directly to the concrete pad. Mounting holes are provided in the base of the internal enclosure rack to accommodate the pad's 3/8" stainless or galvanized anchor bolts.

1. If installing two cabinets, place a Poron gasket *(Alpha p/n 648-023-10-001)* around the 2" knockout on the front of the PN-4LIB28 before attaching cabinets. See figure below.
2. Place vapor barrier material on pad and make cutouts for anchoring hardware and other openings as necessary. A 25+ year vapor barrier MUST be used between the concrete and enclosure base to inhibit moisture ingress and to prevent corrosion caused by concrete-to-metal contact.
3. With no less than two field personnel lifting the enclosure, position it above the concrete pad and slowly lower it into position over the pad's 3/8" anchor bolts.
4. Secure the enclosure using stainless, galvanized (or better) flat washers, lock washers and 3/8" nuts at each mounting bolt.

NOTICE:

Enclosures must be mounted flush with a smooth surface. If the concrete pad is uneven or has bumps, cracks or other imperfections, the installer is responsible for correcting these defects prior to installing the enclosure.

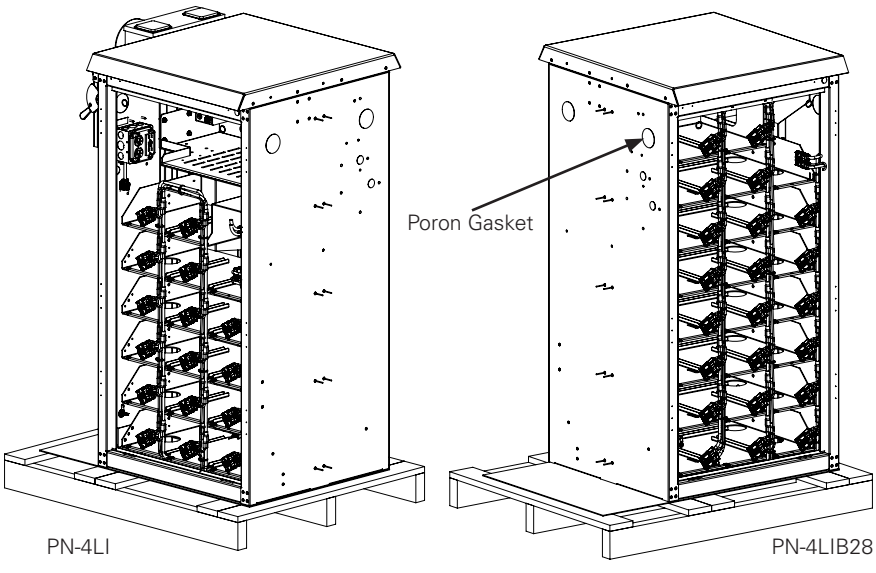


Fig. 4-1, Poron Gasket Location

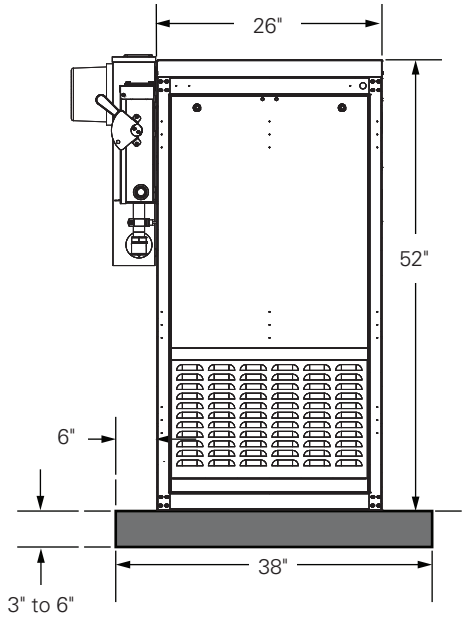


Fig. 4-2, PN-4LI Mounted to Prepared Pad

4.3 Utility Powering

The XM3.1-HP™ power supplies are powered by 120VAC, attached to an external service entrance. The size of the service conductors must be based upon the actual size of the utility service and be in accordance with applicable electrical code requirements.

The utility conduit may be placed in one of two locations, depending upon the utility service entrance requirements. Note the optional conduit location for use with meter base and the standard location for entry directly to the load center.

Proper grounding is critical. The enclosure MUST have a hard-wired ground to the service entrance. A qualified electrician will need to verify that grounding is in compliance with applicable electrical codes. (Refer to **Section 3.3 Enclosure Grounding on page 33**.)

NOTICE:

All applicable codes must be adhered to when installing a system, pouring concrete, or placing a preformed pad. These codes supersede any procedures outlined in this document.

NOTICE:

All mounting hardware must be stainless or galvanized, depending on local environmental conditions. Use of improper hardware may cause corrosion, which is not covered under warranty.

NOTICE:

Soil conditions vary and may affect the integrity of the pad. Alpha Technologies Services, Inc. recommends that proper steps be taken to ensure that the soil supporting the pad is stable. Improper installation of the pad may cause uneven settling or cracking, which is not covered under warranty.

WARNING! ELECTRICAL HAZARD

The following utility powering procedures must be performed only by qualified service personnel and in compliance with local electrical codes.

Verify electrical codes prior to installation. Codes may vary and contain specific conduit and wire sizes for connection to the service entrance.

Connection to utility power must be approved by the local utility before installing the power supply.

The enclosure is equipped with a Square D, rainproof rated suitable for use service entrance (SUSE). The service entrance is equipped with a circuit breaker for a 120/240VAC, split phase, 3-wire w/GND source.

4.3.1 Service Disconnects

The PN-4LI is equipped with a fused safety switch disconnect box (FBX-60A), which is for applications with high Ampere Interrupting Capacity (AIC) rating requirements. A 30A option (FBX-30A) is also available.

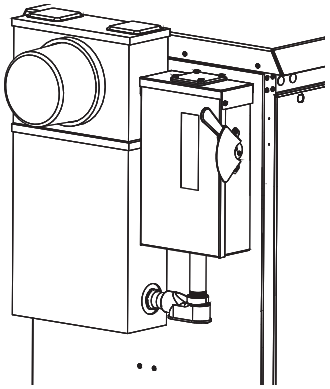


Fig. 4-3, FBX-60A on PN-4LI

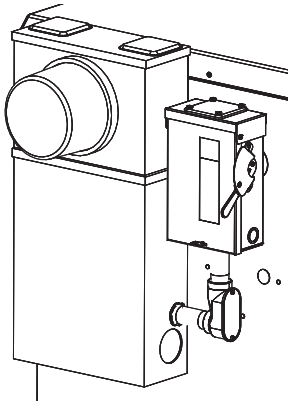


Fig. 4-4, FBX-30A on PN-4LI

4.3.2 Sample Input Power Panel

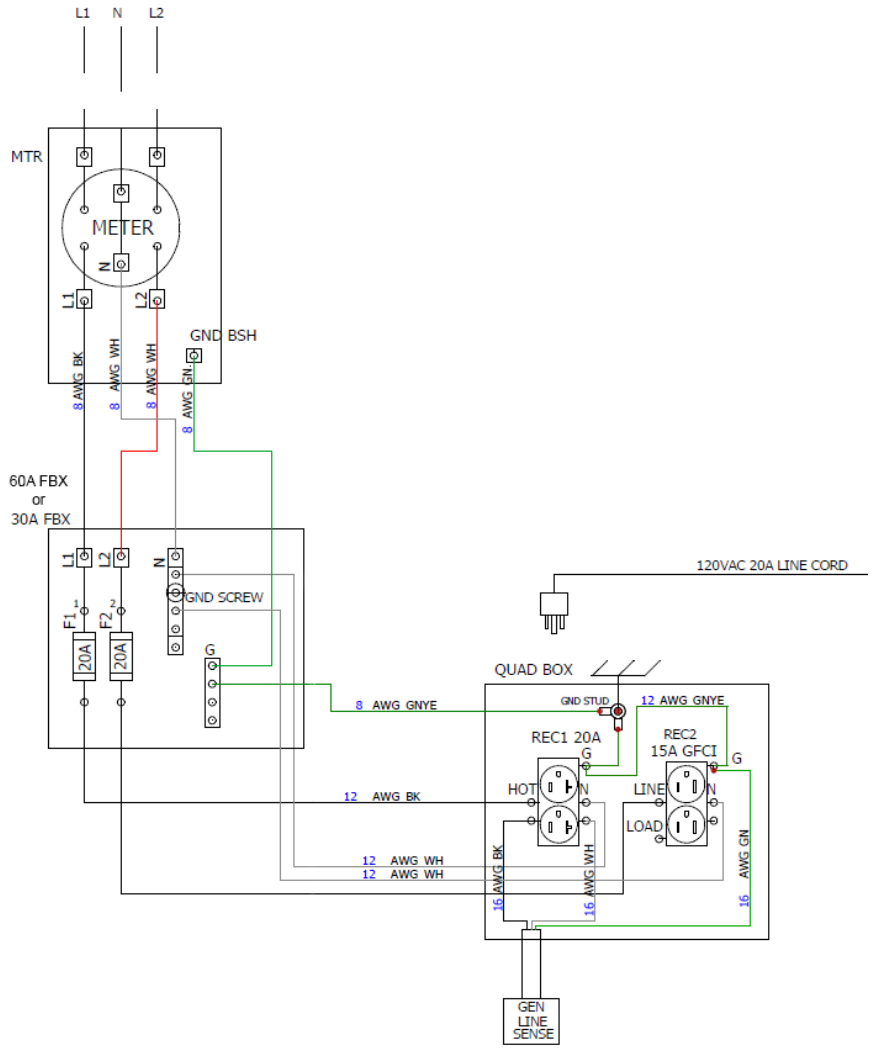


Fig. 4-5, Schematic: Secondary Service FBX-60A or 30A with IPP-120-1

4.4 Coaxial Cable to Service Power Inserter (SPI) Installation

In most cases, the SPI will already be installed in the cabinet. If it is, skip to **Section 4.4.2 Conduit Placement on page 39**. If it is not, refer to **Section 4.4.1 SPI to Ground Bar Connection Procedure on page 39**. For further detailed installation instructions for an SPI unit, refer to the SPI-20, SPI-25 & SPI-RF Installation Manual *(Alpha p/n 745-997-C0-001)* on www.alpha.com.

4.4.1 SPI to Ground Bar Connection Procedure

Tools List:

- 1" socket (3/8" drive)
- 3/8" ratchet
- #2 Phillips screwdriver

Procedure:

1. Install SPI by tightening the attached coaxial connector to the equipment tray.
2. Secure SPI ground wire to the SPI with attached screw located on the top of the SPI behind the seizure screw insulator, and connect to enclosure ground bar.
3. Terminate stripped end of wire at enclosure ground bar.

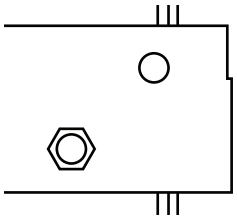


Fig. 4-6, Connector Fitting in Rear of Equipment Tray

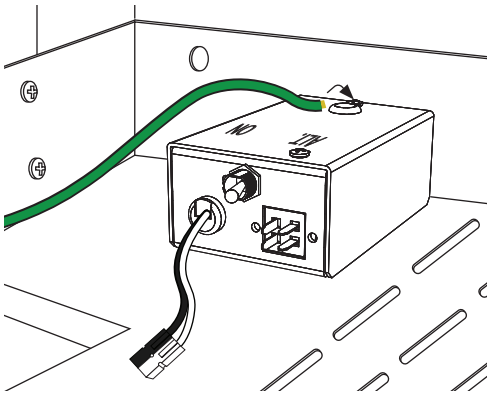


Fig. 4-7, Location of SPI in Equipment Tray

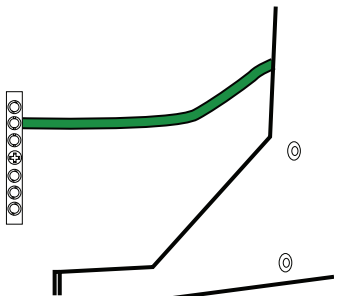


Fig. 4-8, SPI Ground Wire Connected to Enclosure Ground Bar

4.4.2 Conduit Placement

Conduit location is in the back of the enclosure, on the right side. (Location is specified on concrete pad.)

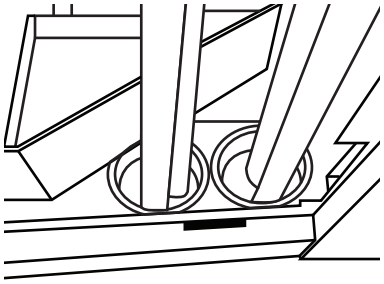


Fig. 4-9, Conduit Location

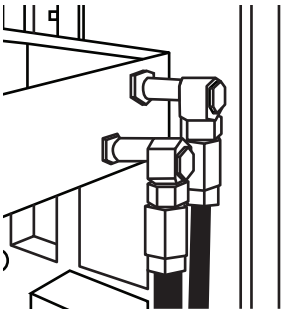


Fig. 4-10, Coaxial Connectors

4.5 Enclosure Pass-Through and Conduit Installation

Required Tools:

- Conduit pass-through kit *(Alpha p/n 744-793-26-xxx)*
- Disposable gloves
- Firestop putty (to be used after system wire installation)

Procedure:

1. If using a side-by-side PN-4 configuration, install conduit pass-through kit after positioning the enclosures next to each other. Use 2" conduit knockout on the top front sides of the cabinets as seen in figure below. Remember to insert the Poron gasket between the two cabinets to ensure rain tight installation.
2. Insert the conduit parts and hand tighten until snug.

NOTICE:

A firestop putty MUST be installed in the conduit pass-through AFTER all wiring is complete between the enclosures. Alpha recommends using 3M® Fire Barrier Moldable Putty Stix MP+ *(Alpha p/n 973-00004-10)* and HILTI® 618 Firestop Putty Stick *(Alpha p/n 973-00005-19)*, or equivalent. Refer to manufacturer's user instructions when applying between enclosures.

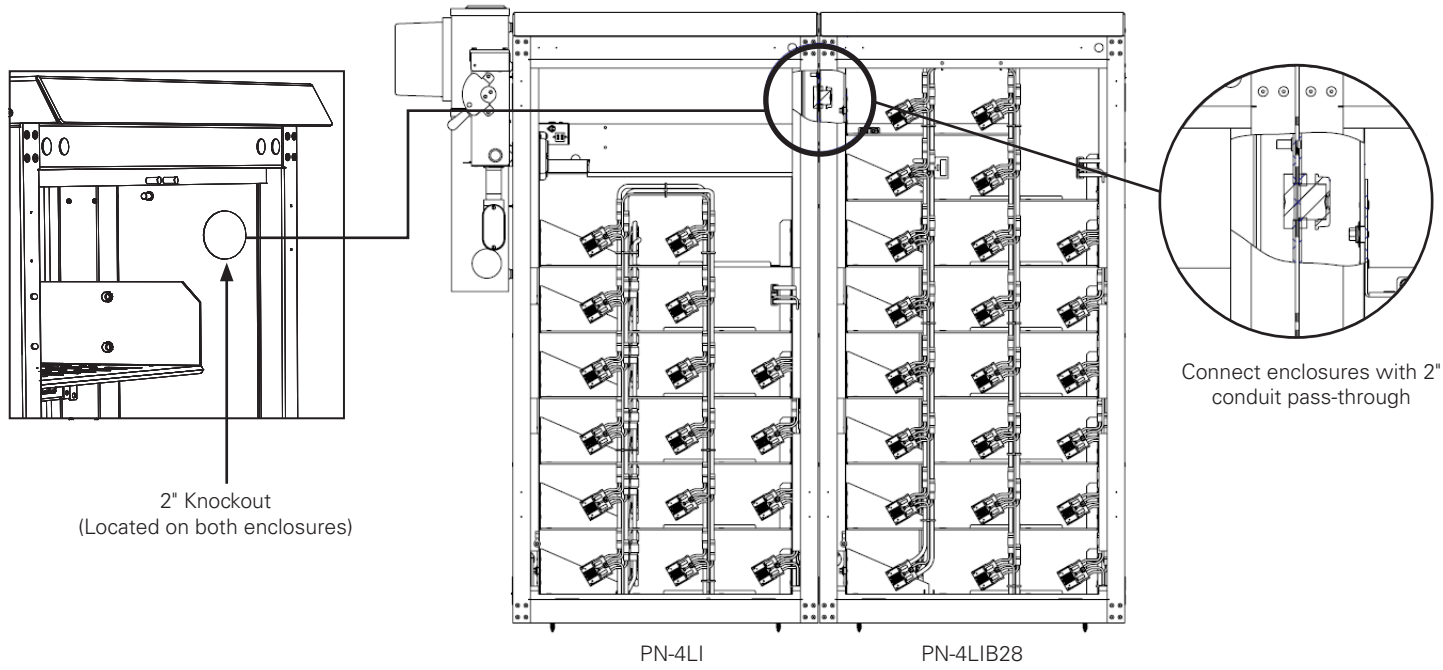


Fig. 4-11, Conduit Pass-Through

4.5.1 External Power Supply Conduit

1. If integrating an existing ground mounted UPE or PWE cabinet to house an XM3.1-HP™ power supply, install metallic conduit run from the PN-4LIB to existing enclosure (see **Fig. 4-13, Routing Conduit Underground Examples**). Use the cable access area in rear left side of enclosure to route wires. The rectangle entry through pad should be used to route wires from underground. The enclosures must be ground bonded.

NOTICE:

If the conduit is above ground, a metallic conduit must be used. If it is below ground, a non-metallic conduit may be used.

2. If integrating a pole mounted enclosure, remove existing PWE cabinet batteries and slide trays so conduit can enter the bottom of the enclosure. Excess wire can be looped in the bottom of the PWE.
3. Install grouped BIU/BCM extension, #6 AWG battery and COM cables in conduit run. Remove 75A Anderson™ connector housing on the end to be pulled through the conduit. Use appropriate wire pulling grip techniques to protect Anderson terminals and RS485 COM cable connector. When in place, BCM extension wires must be long enough to route from XM3.1-HP™ power supply to BCM A connectors after batteries are installed. Re-install 75A Anderson connector housing on battery cables and check contacts are seated correctly before use (note polarity and orientation).

Anderson™ PP75 connector housing orientation and polarity:

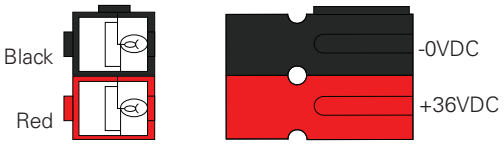


Fig. 4-12, Anderson™ PP75 Connector

NOTICE:

Use maximum 50 feet long, #6 AWG battery cable kit extension provided by Alpha®. Consult with Alpha applications engineering for other permissible larger gauge wire and connector kit for longer distances (see **Section 4.5.2 Battery Cable Extension Kit for PN4-LIB22 Cabinet (p/n 876-00116-20-xxx) on page 42** for details. Total resistance not to exceed 41.5 mΩ at 20˚C.

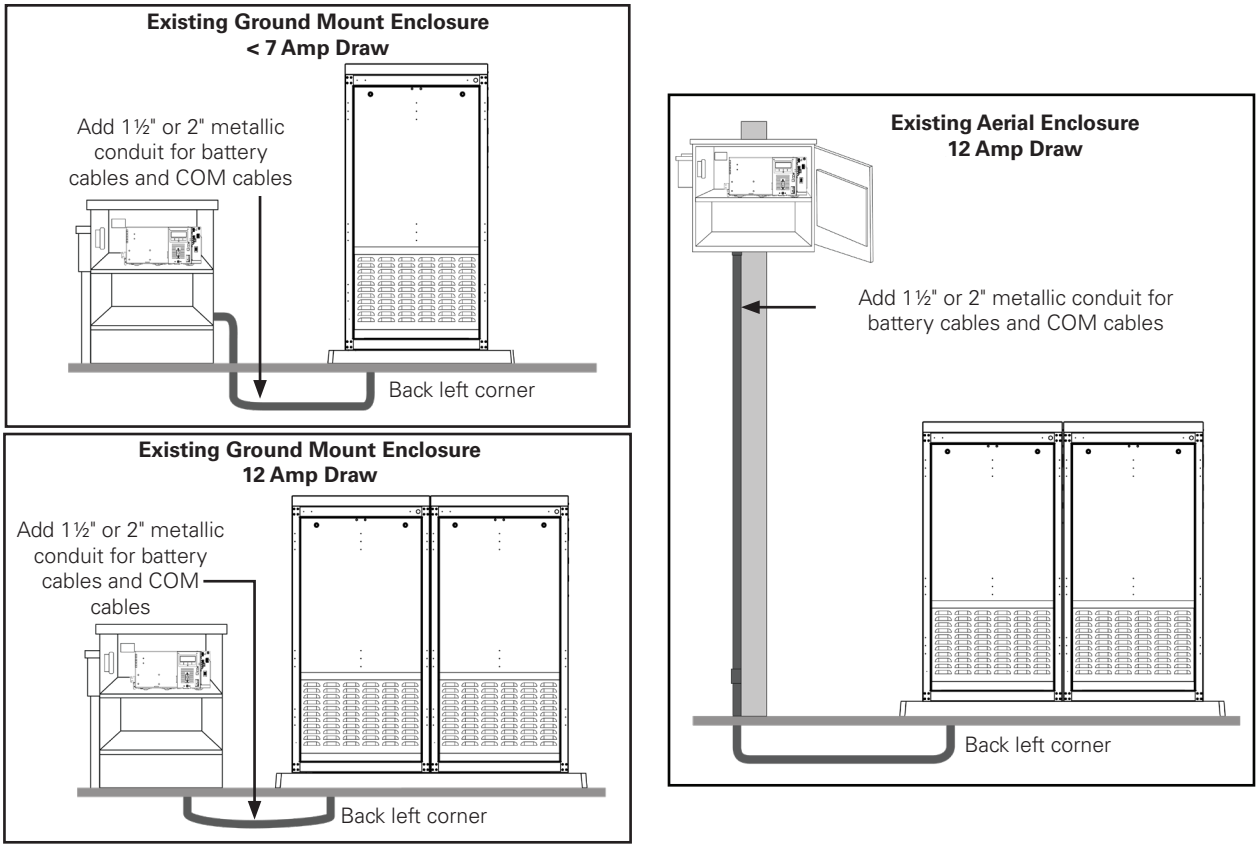


Fig. 4-13, Routing Conduit Underground Examples

4.5.2 Battery Cable Extension Kit for PN4-LIB22 Cabinet (p/n 876-00116-20-xxx)

This wire kit *(p/n 876-00116-20-xxx)* is used to extend the #6 AWG DC power wires for a PN-4LIB22 cabinet equipped with a battery control module (BCM A) to a PWE cabinet with an XM3.1-HP™ power supply that requires run lengths beyond 50 feet. In most cases, this kit is used for pole mounted configurations as shown in **Fig. 4-13, Routing Conduit Underground Examples**. While much of the installation process is similar to that in the previous section, there are a few key differences when installing this extension kit such as creating a custom RS485 COM cable. See the table below for recommended wire gauge for the appropriate length of your setup:

Site HFC Plant Load	DC Cable Run Length	DC Cable Gauge	Cable Vdrop @ 38A
Up to 12A	Up to 50 ft	#6 AWG	1.577 V
	50 to 65 ft	#4 AWG*	1.516 V
	65 to 105 ft	#2 AWG*	1.535 V
	105 to 130 ft	#1 AWG*	1.511 V
	130 to 172 ft	#1/0 AWG*	1.573 V
* Must use connector kit *(p/n 876-00116-20-xxx,* CONNECTOR KIT,BAT,6AWG-1/0 AWG, FOR PN-4LI*)*. Kit requires use of THHN/THWN heavy gauge battery cable provided separately. 1.577 Vdrop max allowed. (This is based on total run resistance not to exceed 41.5 mΩ at 20˚C.)			

The kit includes the following:
- #6-1/0 AWG Polaris® connector tap (×4) *(p/n 546-00104-19)*
- Anderson™ connector leads to tap, 2.5' long to connect to XM3.1-HP power supply in PWE cabinet (×1)
- Anderson connector leads to tap, 4' long to connect to BCM A in PN-4LIB22 cabinet (×1)
- Wire ties for strain relief (×8)

The following items are needed, but not included in the kit:
- Black electrical tape (to hold cap over (–) tap set screw)
- Red electrical tape (to hold cap over (+) tap set screw and mark red THHN/THWN heavy gauge battery cable)
- THHN/THWN heavy gauge battery cable (round trip of run length)
- Offset connectors for RS485 COM cable (×2) *(p/n 545-275-19)*
- #26 AWG, 6 conductor flat cable for length of run *(p/n 858-042-19)*
- Stewart Connector® hand crimper tool for modular connectors, no die *(p/n 2940231-01)*
- Stewart Connector® tool die set for modular RJ11/12 (6p6c) offset *(p/n 2905009-01)*

Procedure:

1. To create a custom length RS485 COM cable, use the hand crimper and die set, and refer to the figure below as a guide for constructing a cable with a maximum length up to 200 ft:

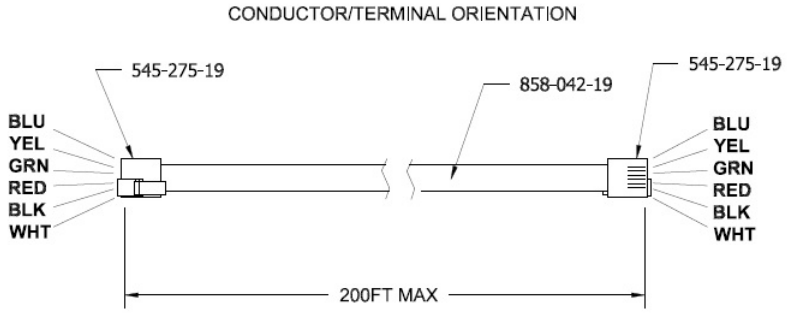


Fig. 4-14, Custom length RS485 COM Cable

2. Group THHN/THWN heavy gauge battery cable and COM cables in conduit run. Use appropriate wire pulling grip techniques to protect RS485 COM cable connector. When in place, Anderson™ connector taps must be long enough to route from XM3.1-HP™ power supply to BCM A connectors after batteries are installed.
3. Make Polaris® connector tap splices using the Anderson™ connector leads provided: 2.5′ long for the XM3.1-HP™ power supply, and 4′ long for BCM A.
4. Follow Polaris® wire gauge strip length and torque specifications provided in the kit.
5. Use red (+) and black (–) electrical tape to hold caps and mark polarity. See figures below.
6. Use wire ties to strain relief and tie off THHN/THWN heavy gauge battery cables to the BPM shelf in PN4-LIB28 cabinet.

Fig. 4-15, Tying THHN/THWN Heavy Gauge Battery Cables

7. Check contacts are seated correctly on 75A Anderson™ connector before use (note polarity and orientation, see **Fig. 4-12**). Connect to power supply.

Fig. 4-16, Connecting 75A Anderson™ Connector

4.6 Cabinet Ground Wire Installation

Procedure:

Route the ground wire from the PN-4LI cabinet, through the slot in the rail, to the front of the cabinet, and under the bottom tray. Continue routing it up the right side, through the conduit pass-through and down the left side of the second cabinet (either a PN-4LIB22 or PN-4LIB28), then through the slot in the rail, heading toward the rear, to the ground bar.

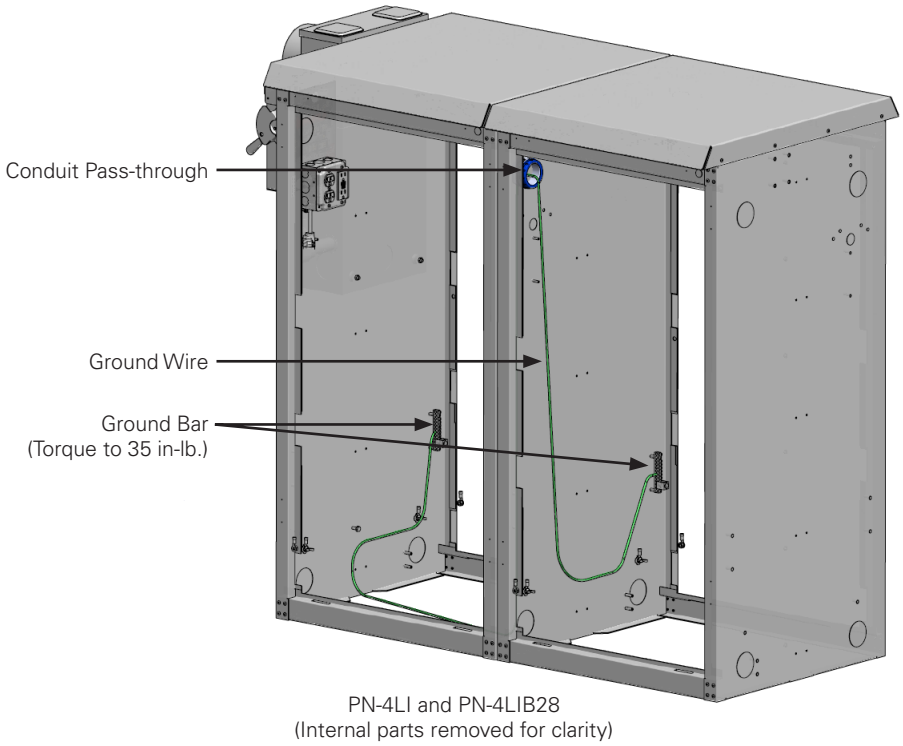


Fig. 4-17, Routing Ground Wire in Cabinets

5.0 System Installation

NOTICE:

Before going on-site, ensure tablet contains the latest XRT-Li power system support software.

WARNING! ELECTRICAL & FIRE HAZARD

- Installer must wear the correct PPE when installing batteries. Failure to do so may result in injury or death.
- Failure to install and/or use this equipment as instructed in the system documents can result in a hazard to personnel or damage to the equipment. This system is only serviceable by qualified personnel.

CAUTION!

Do not install, charge, or reconcile battery below 0°C. Failure to follow this will damage equipment.

WARNING! ELECTRICAL HAZARD

When working with any electrical equipment, use an electrostatic discharge (ESD) wrist strap. Failure to do so will cause equipment damage or personal injury.

5.1 Recommended Tools and Equipment

The following tools and equipment are recommended for installation as well as maintenance for the system.

- Insulated tools - socket wrenches, screwdrivers, and box end wrenches (size and setting based on battery manufacturer torque specification)
- Insulated calibrated torque wrenches
- Safety glasses or face shield
- Rubber gloves
- Disposable gloves
- Chest shield
- Hard hat
- Infrared temperature probe
- Infrared imager
- Steel-toed boots with metatarsal protection
- Fire extinguisher
- Paper towels and/or rags
- Plastic soft bristle brush
- Portable eye wash
- True RMS digital multimeter (DMM) (DC Amp clamp recommended, 4½ or greater digit required)
- Electrostatic discharge (ESD) wrist strap with 1 Megohm (MΩ) resistance built-in to cord and alligator clip
- Battery Reconciliation Device (BRD) *(p/n 018-00003-xx-xxx)* (up to 3)
- Android™ tablet with Spotlight360™ app and XRT-Li Utility app installed
- WiFi router w/ power source and cables
- Barcode scanner
- Lawicel CANUSB interface and cable adapter, connected to the USB port on the tablet, for low-level communications with the BCM
- Tools for troubleshooting and repairing isoSPI communication wires on BPM wire harness:
  - Anderson™ SBS®75X auxiliary contact insertion tool: ***PM1002G1***
  - Anderson™ SBS®75X auxiliary contact extraction tool: ***PM1003G1***
  - Anderson™ SBS®75X auxiliary contact insertion inspection tool: ***PM1003GX***
    - ◊ Bushing spacers for PM1003GX inspection tool:
      - 7.7 pin *(p/n 581-00018-10-001)*
      - 9.3 pin *(p/n 581-00018-11-001)*
      - Socket (*p/n 581-00018-12-001)*
- 3M® Fire Barrier Moldable Putty Stix MP+ *(Alpha p/n 973-00004-10)* or HILTI® 618 Firestop Putty Stick *(Alpha p/n 973-00005-19)*
- Anti-tamper paint
- Box or bag for storing cables and hardware while out in the field
- APP service power supply

5.2 System Wiring Diagrams

NOTICE:

Review the system wire diagrams before proceeding with installation.

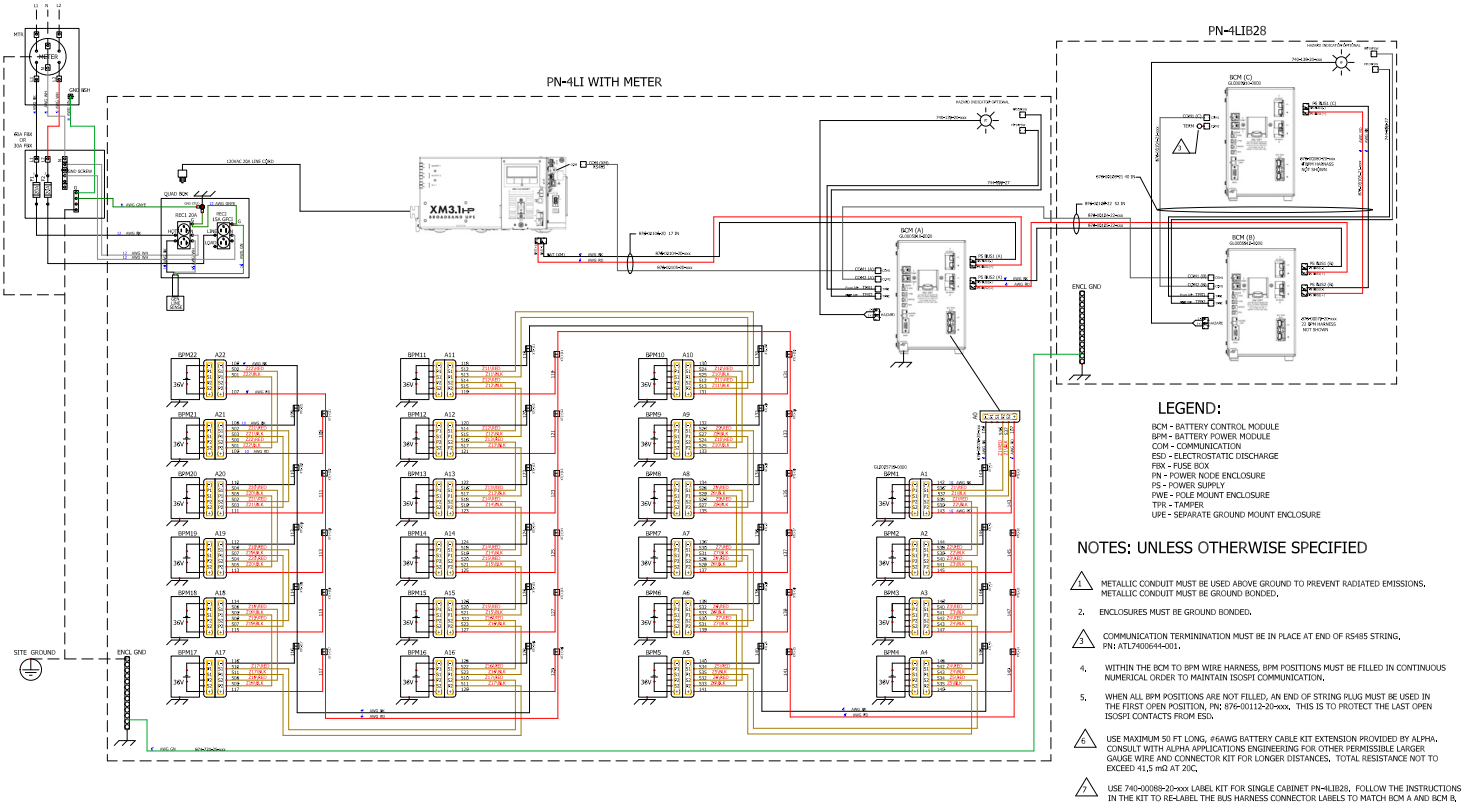


Fig. 5-1, PN-4LI with Meter and PN-4LIB28 Full System Installation

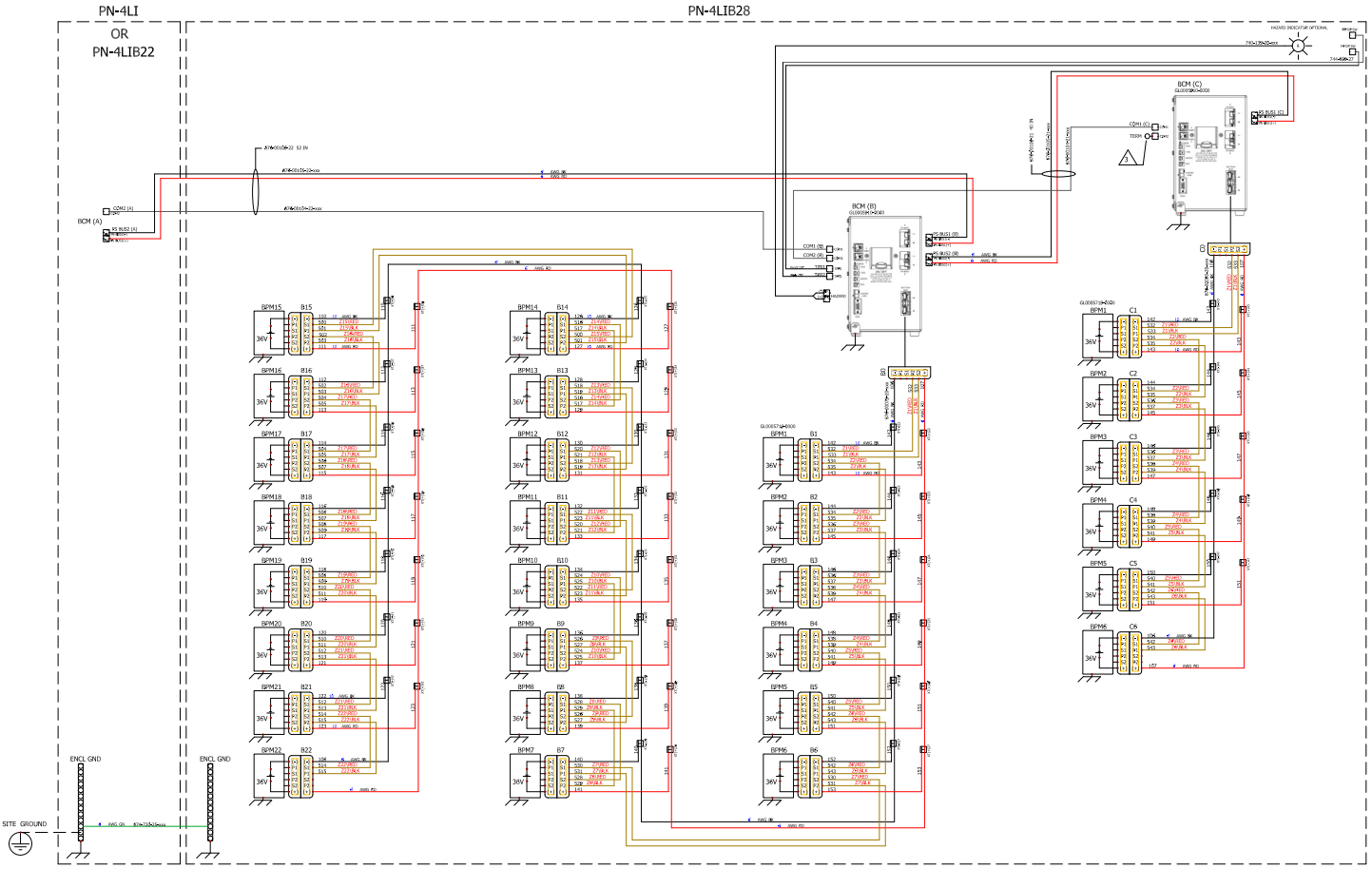


Fig. 5-2, PN-4LI or PN-4LIB22 Cabinet with PN-4LIB28 Cabinet Full System Installation

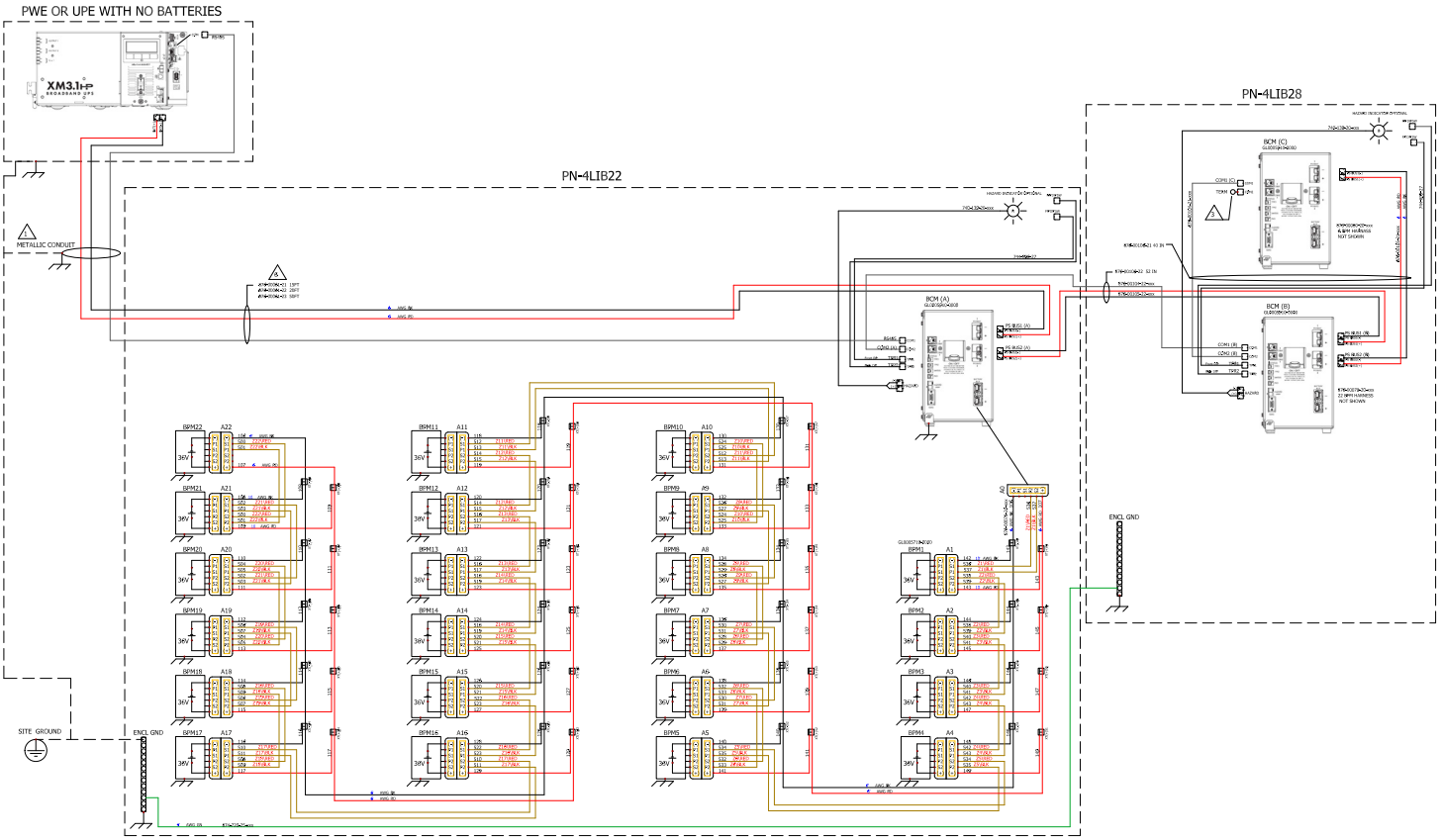


Fig. 5-3, PN-4LIB22 and PN-4LIB28 Cabinets with PWE or UPE Enclosure Full System Installation

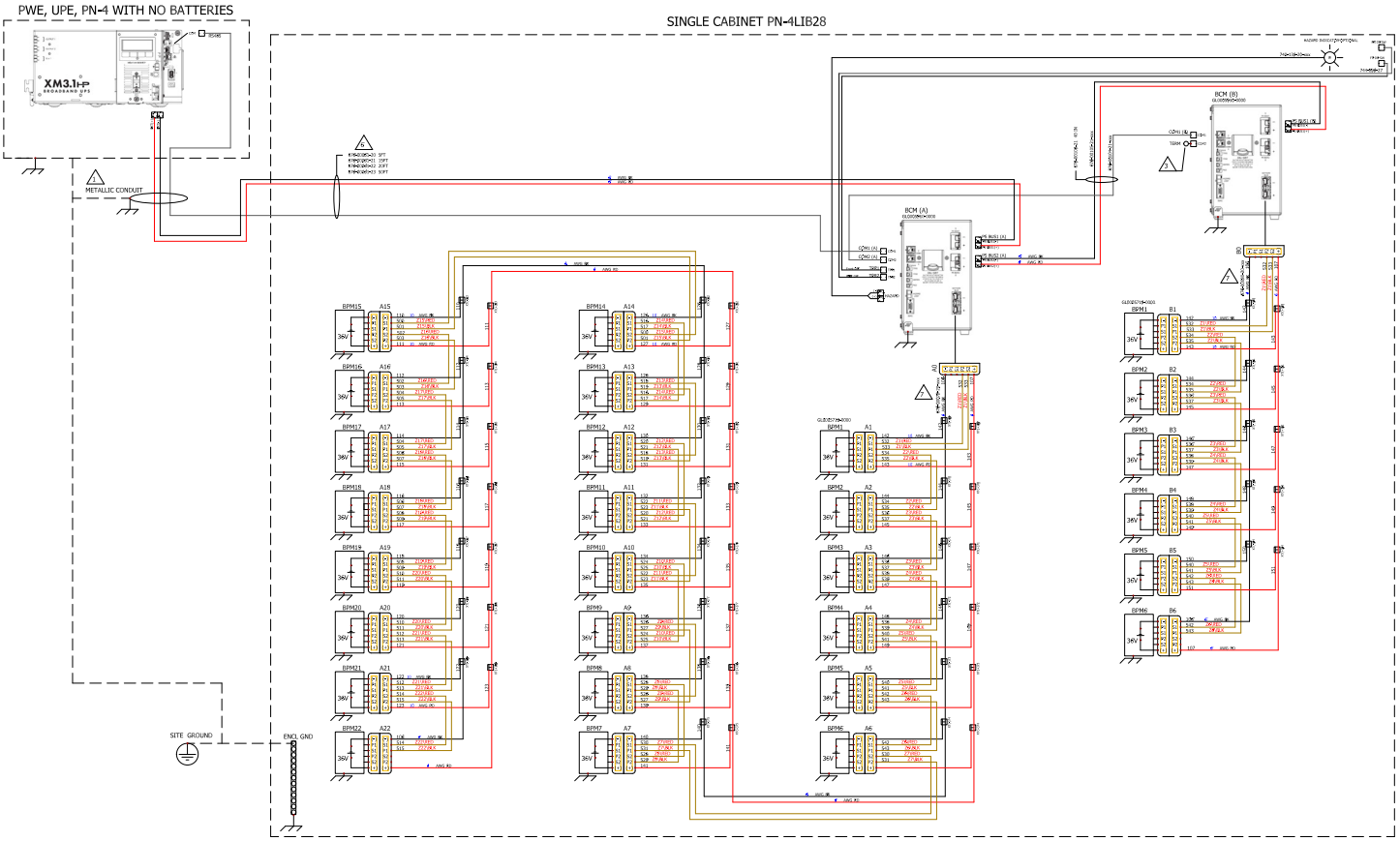


Fig. 5-4, Single PN-4LIB28 Cabinet with PWE or UPE Enclosure Full System Installation

5.3 BCM Installation Procedure

1. Place BCM A in its designated spot in the PN-4LIB22 or PN-4LI, which is the left cabinet in a two cabinet installation. If the configuration calls for BCM B and/or BCM C, place those in the right cabinet, a PN-4LIB28, depending on the configuration.
2. Secure BCMs to the enclosure(s) via the ground securing screw. Torque to 68 in-lb (7.7 Nm). Do not connect the Battery Bus connector, but confirm all DC wiring is accessible.
3. Optional: Apply torque marking, anti-tamper paint to ground securing screw.
4. If the Spotlight360™ app is not available or being used, scan each BCM serial number, located in the upper left hand corner of the face plate, to add them to the system population information.

5.3.1 Inter-Cabinet Cable Connections

1. For power systems with more than one BCM, route and connect Anderson™ PP75 DC battery cables:
   - From BCM A PS BUS2 to BCM B PS BUS1 *(p/n 876-00105-22-xxx)*
   - From BCM B PS BUS2 to BCM C PS BUS1 *(p/n 876-00105-21-xxx)*

   Ensure cables are routed so they don't interfere with the removal of any BPM or ability to close the door. Note that some cables will be routed through the conduit between the cabinets.
2. For power systems with more than one BCM, route and connect gray system COM cables:
   - From BCM A COM2 to BCM B COM1 *(p/n 876-00104-22-xxx)*
   - From BCM B COM2 to BCM C COM1 *(p/n 876-00104-21-xxx)*
3. When the final connection is made, place the RS485 Communication Termination *(p/n ATL7400644-001)* in the last connected BCM COM2 port.
4. Install tamper cables. The front door should be connected to TPR1 and the back door to TPR2 ports. They are not polarity dependent, but the connector is polarized. Note that it is easy to connect the tamper cables incorrectly. Verify the connector is centered prior to pushing them in.
5. Do not connect a tamper cable to the second BCM in a cabinet. The tamper cable on the second BCM should be disabled before completing the installation, as described in **Section 5.6.1 Battery Management System Configuration/Firmware Installation on page 63.**
6. If optional pad shear and water intrusion sensors are included with this installation, connect the cables to the appropriate ports on the BCM.

NOTICE:

The TPR (tamper) port and battery temperature sensor port on the XM3.1-HP™ power supply are not used in a PN-4LI cabinet. However, if the power supply is housed in a remote pole mounted cabinet, the TPR port on the XM3.1-HP power supply is used.

5.4 BPM Installation Procedure

NOTICE:

An ESD wrist strap shall be worn when handling the BPMs, specifically when removing ESD bags, and plugging the BPMs into the BRD, BPM Bus, or the harness into the BCM.

NOTICE:

Do not carry the BPM via the harness. Only use the handle located on the front when transporting.

NOTICE:

Before installing the BPMs, refer to Table 5-1 for BPM configurations under BCMs. BPMs must be placed in their appropriate slots under their corresponding BCM (ex: BPM A1 must go into the slot designated for BPM A1.) Do not skip the order. Skipping modules will cause operational issues.

1. Install all the Battery Power Modules (BPMs) by lifting via the handle and sliding into position (see figure below). Refer to work order for system configuration and BPM placement. Ensure the battery harness is out of the way when installing the BPMs. DO NOT remove the electrostatic discharge (ESD) bags over BPM connectors at this time.
2. Secure all BPMs in place in the enclosure with the ground securing screw. Torque to 68 in-lb (7.7 Nm).
3. Optional: Apply torque marking, anti-tamper paint to ground securing screw.
4. If the Spotlight360™ app is not available or being used, scan each BPM serial number, located on the front, to add them to the system population information.

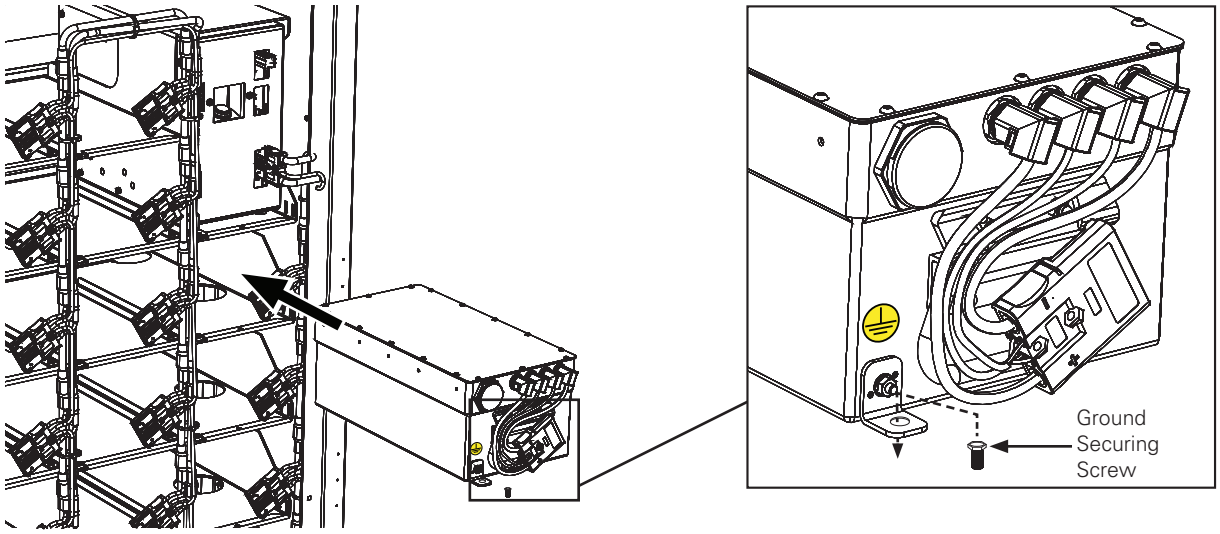


Fig. 5-5, Installing BPM

The following table describes the required varying configurations and the number of BPMs under BCM A, BCM B and BCM C, and optimized configuration for load balancing. Note that the higher number of BPMs fall under BCM A, and that BCM C, if present, will always contain six BPMs in a string.

Total BPMs	Cabinets	BCM A	BCM B
3	1	3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23	2	12	11
24		12	12
25		13	12
26		13	13
27		14	13
28		14	14
29		15	14
30		15	15
31		16	15
32		16	16
33		17	16
34		17	17
35		18	17
36		18	18
37		19	18
38		19	19
39		20	19
40		20	20
41		21	20
42		21	21
43		22	21
44		22	22

Total BPMs	Cabinets	BCM A	BCM B	BCM C
45	2	20	19	6
46		20	20	6
47		21	20	6
48		21	21	6
49		22	21	6
50		22	22	6

Single PN4-28LIB Cabinet

Total BPMs	Cabinets	BCM A	BCM B
23	1	17	6
24		18	6
25		19	6
26		20	6
27		21	6
28		22	6

NOTICE:

When a single PN-4LIB28 cabinet is used, a label kit *(p/n 740-00088-20-xxx)* is needed. Follow the instructions in the kit to relabel the bus harness to match BCM A and BCM B.

Table 5-1, Cabinet Configuration Examples

5.4.1 Verifying Ground Integrity

In order to ensure UL® compliance for the field installation, all modules must be grounded. Following this process will confirm the modules are grounded correctly.

1. Set digital multimeter (DMM) to continuity or Ohm testing.
2. Attach the common (-) lead to a ground reference point such as the ground on the cabinet door.
3. Use the test lead and touch each BCM front screw on the faceplate next to the ON / OFF button. The reading on the DMM should be less than 2 Ohms.
4. Use the test lead, touch each BPM metal handle. The reading on the DMM should be less than 2 Ohms.

5.4.2 End of String Plug Installation

1. Install the end of string plug *(p/n 876-00112-20-xxx)* if needed. If not used, leave in the enclosure on top of the BCM for future use.

NOTICE:

When all BPM positions are not filled, an end of string plug must be used in the first open position. This is to protect the BPMs from electrostatic discharge (ESD).

NOTICE:

Wear an ESD wrist strap when handling BPM connectors. Attach wrist strap alligator clip to BPM ground tab or screw, cabinet grounding bus, or outlet ground.

2. Remove ESD bag from BPM connectors. Collect the bags and attachment items and properly dispose them.

5.4.3 Reconciliation and BPM Connections

NOTICE:

The following instructions utilize the Battery Reconciliation Device (BRD) during the reconciliation process. If using a digital multimeter (DMM) in place of a BRD, see **Section 5.4.4 Manual Reconciliation and BPM Connections with a Digital Multimeter on page 58**.

NOTICE:

When not in use, it is recommended that the BRD remain in the carrying case it was shipped in *(Alpha p/n 960-00023-10)* to reduce the risk of damage to the unit.

NOTICE:

Wear an ESD wrist strap when handling BPM connectors. Attach wrist strap alligator clip to BPM ground tab or screw.

After the ground integrity has been verified, the BPMs must be reconciled in order to bring their states of charge to a common level. This reconciliation process must be performed in the recommended temperature range for normal operation (0°C - 45°C) of the XRT-Li power system, as noted in **Table 2-1, Power System Specifications**.

To give a basic overview of BPM connection process, the cabinet wire harness must be connected to the last BPM in the string (ex: If there are sixteen batteries in string A, connect only BPM A16.) Working backwards from the last BPM, test the unconnected BPM to ensure it is safe to connect to the BPM(s) already attached to the wire harness. Once verified, the BPM can be connected to the harness and the technician can move on to the next unconnected BPM. Repeat this process until all the BPMs in the string are checked and connected.

WARNING! ELECTRICAL HAZARD

BPMs must be reconciled before installing/attaching to Bus. Failure to do so will result in equipment damage such as a blown fuse.

1. Ensure the battery bus cable is NOT plugged into a BCM. As indicated on **Table 5-1, Cabinet Configuration Examples**, based on the count shown for this string (A, B or C), connect cabinet-integrated BPM harness connector (BPM bus) to the highest numbered BPM connector shown in that table.
2. Remove BRD from protective carrying case.
3. To ensure proper state of charge (SoC) levels, a reconciliation of these components must be performed. Connect the Battery Reconciliation Device (BRD) starting from the next to last BPM. Place the cabinet's Anderson™ SBS®75X connector into the BRD's BPM bus port.
4. Place the next to last BPM's harness connector into BRD's BPM port.
5. Check BRD display to verify that two BPMs are detected. (See **Fig. 5-6**) This should reflect the BPM connected to the BRD BPM port and subsequent BMPs in the string.

NOTICE:

There are three important voltages in this process: the voltage of the BPM under test, the voltage of the BPM string, and the delta voltage between them. The steps included in this section identify the correct way to measure and understand these voltages to allow a non-destructive direct connection.

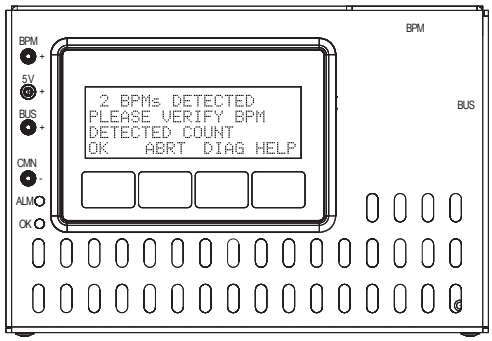


Fig. 5-6, BPM Detection Screen on BRD

CAUTION!

The BRD may become hot to the touch when in use.

NOTICE:

The BRD uses "buzzer logic"; when the BRD has finished reconciling and is inactive, an audible buzz will notify the technician. This buzzing will start at five minutes of inactivity then four minutes, three minutes, two minutes, and then every minute it is inactive, beeping once per interval.

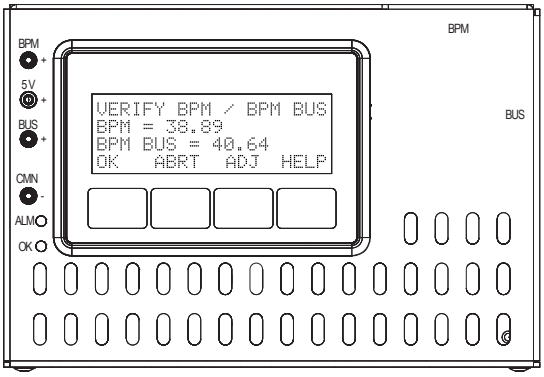


Fig. 5-7, Verifying BPM / BPM BUS

NOTICE:

If a few BPMs are widely different in voltage, spare BPMs can be substituted to speed up provisioning.

6. On-site verify the meter's operation and calibration: Turn on the digital multimeter (DMM), set mode to DC volts, automatic or manual range above 42VDC. With the BRD connected to the BPMs, place meter's common lead in the CMN- (common negative) test point on the BRD, place the meter's positive lead in the 5VDC+ test point, and verify the meter displays 5.0VDC ±0.2V. Remove meter leads from test point.
7. Use the previously on-site calibrated DMM to verify BPM voltage. Place meter's common lead in the CMN- test point on the BRD, place the meter's positive lead in the BPM+ test point, and verify the meter displays between 30 and 41VDC. Verify the BRD displayed value. If the difference between the DMM and BRD readings are greater than 0.03VDC, press the **ADJ** softkey on the BRD to adjust the voltage closer to what the DMM measures. Use the arrow softkeys to adjust the displayed values. If the difference is within spec, press the **OK** button. (See **Fig. 5-7** to **Fig. 5-9** for reference.)

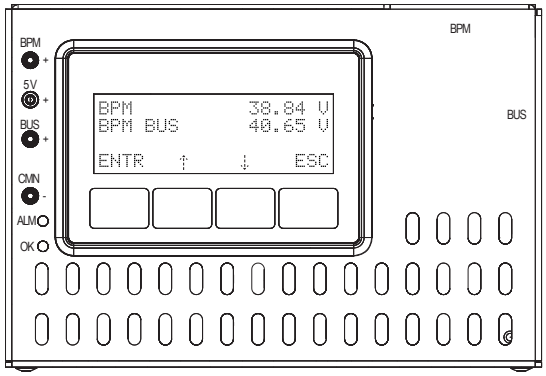


Fig. 5-8, BRD Screen - BPM and BPM BUS Voltage Readings

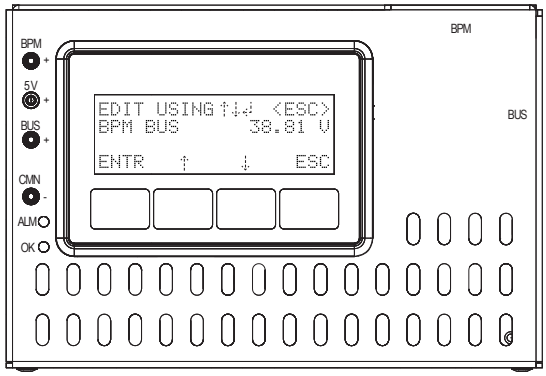


Fig. 5-9, BRD Screen - Voltage Adjustment

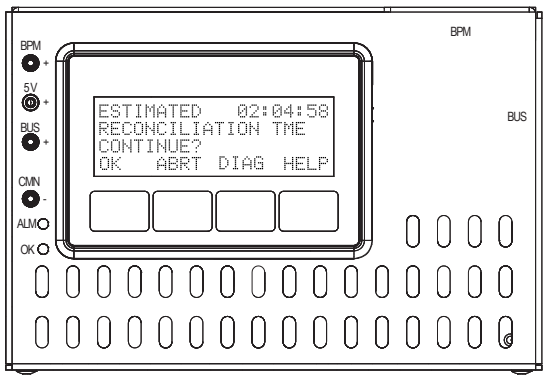


Fig. 5-10, BRD Screen - Reconciliation Estimated Time

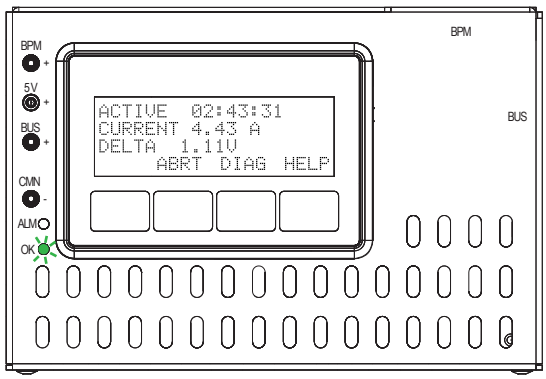


Fig. 5-11, BRD Screen - Reconciliation in Process

8. Use the previously on-site calibrated DMM to verify BPM BUS+ voltage. Place meter's common lead in the CMN- test point on the BRD, place the meter's positive lead in the BUS+ test point, and verify your meter displays between 30 and 41VDC. Verify the BRD displayed value. If the difference between the DMM and BRD readings are greater than 0.03VDC, press the **ADJ** softkey on the BRD to adjust the voltage closer to what the DMM measures. If the difference is within spec, press the **OK** button.

NOTICE:

The Abort (**ABRT**) function is always available on the display screen of the BRD. If there is an emergency or if any issue arises during the reconciliation process, press the **ABRT** softkey to stop reconciliation.

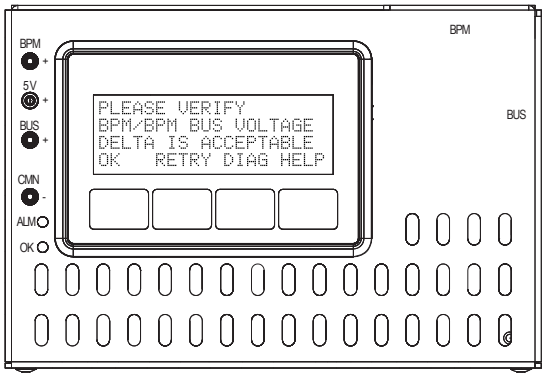


Fig. 5-12, BRD Screen - Verifying BPM/BPM Bus Voltage

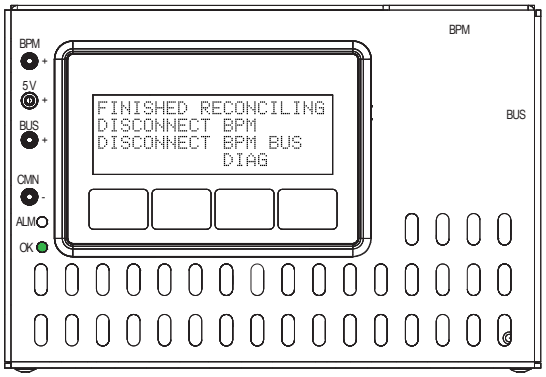


Fig. 5-13, BRD Screen - Reconciliation Complete

9. Reconciliation will start - the green LED will blink during this process (**Fig. 5-11**). The top line on the BRD display will show an estimated time (**Fig. 5-10**). Ordinarily this is a rapid process unless the BPMs are not already balanced to a common charge level. During this process, the BRD may become warm to the touch. Reconciliation is done when the BRD's OK green LED lights up solid (**Fig. 5-13**).

NOTICE:

While the reconciliation time may vary, do not leave the site unattended while the BRD is reconciling.

10. Check the voltage by placing one of the DMM probes in the BPM+ jack on the BRD and the other probe in the BUS+ jack. Verify the voltage delta is less than 0.10VDC. If it is, press the **OK** softkey on the BRD. If it is not less than 0.10VDC, press the **RTRY** softkey to retry balancing.

11. Disconnect the BRD. Connect the BPM to the BPM Bus.
12. Continue with the next lower numbered BPM in the chain (example: BPM 14 and BPM BUS string connector 14). Connect BPM BUS cabinet-integrated connector to the previously on-site calibrated BRD BUS port, and connect the BPM to the BPM port on the BRD.
13. Use the previously on-site calibrated DMM to verify delta voltage displayed on the BRD. If the difference is within 11.0VDC, press the **OK** softkey twice. **Note:** If the BPMs are within 0.1V of each other, there's no need to reconcile and they may be installed. If the BPMs are within 11.0V of each other AND NOT within 0.1V, then they must be reconciled. If the delta is greater than 11.0V, then new BPMs are needed.
14. Reconciliation will start - the green LED will blink during this process (**Fig. 5-11**). The top line on the BRD display will show an estimated time (**Fig. 5-10**). Ordinarily this is a rapid process unless the BPMs are not already balanced to a common charge level. (Displayed on BRD.) During this process, the BRD may become warm to the touch. Reconciliation is done when the BRD's OK green LED lights up solid.
15. Check the voltage on the DMM. Verify the voltage delta is less than 0.100VDC. If it is, press the **OK** softkey on the BRD. If it is not less than 0.100VDC, press the **RTRY** softkey to retry balancing.
16. Disconnect the BRD. Connect the BPM to the BPM Bus.
17. Repeat steps 10 to 15 for the remainder of the BPMs in the string, ending with BPM1.
18. With the BRD connected to the BPM and BPM Bus in the first location, verify BPM count displayed on BRD matches the count expected on this string. If this matches, continue to next step.
19. Connect the BPM string battery wire harness, connector A0, B0 or C0, into its corresponding BCM.

NOTICE:

BPM reconciliation can occur on different BPM strings simultaneously if required. More than one reconciliation device in a single string is not allowed.

20. After reconciling all the BPMs behind BCM A, repeat this process for BCM B and BCM C, where applicable.
21. Place BRD back in its protective carrying case when not in use.
22. Proceed to **Section 5.5 XM3.1-HP™ Power Supply Installation Procedure on page 60**.

5.4.4 Manual Reconciliation and BPM Connections with a Digital Multimeter

This reconciliation process must be performed in the recommended temperature range for normal operation (0°C - 45°C) of the XRT-Li power system, as noted in **Table 2-1, Power System Specifications**.

BPMs have an operational range and the BPM DC terminal voltages must be within a tolerable voltage range before connection, to limit the amount of instantaneous current across the connections between the BPM and the other BPMs on the DC BPM bus. Connections outside the tolerable voltage range will result in equipment damage. Confirming the voltage delta is a simple process of measuring the terminals of each connector.

This process proceeds from the highest numbered BPM applicable to the string to BPM1.

CAUTION: EQUIPMENT DAMAGE!

Wear an ESD wrist strap when handling BPM connectors. Attach wrist strap alligator clip to BPM ground tab or screw.

1. Ensure the BPM bus cable is NOT plugged into the BCM. Set digital multimeter (DMM) to DC volts in a sub 50VDC range or automatic.
2. Using a known calibration source, confirm meter is reading accurately.
3. Check each BPM you are planning to connect to the system. (All BPMs).
   - Place the Common, or negative lead of the DMM to the negative "-" terminal of the Anderson™ SBS®75X connector on the BPM you plan to connect.
   - Place the Positive (V+) lead of the DMM to the positive "+" terminal of the Anderson™ SBS®75X connector on the BPM you plan to connect.
   - When a good connection is indicated, check the voltage indicated on the DMM.
     - Record the voltage using an appropriate method.
       - Is the voltage below 30VDC?
         - Check connections.
         - If connections are good, the BPM is suspect; return to depot for evaluation.
       - Is the voltage above 42VDC?
         - Check your DMM against a known source.
         - Reconciliation may be problematic as this voltage is outside of the normal operating range. Note serial number and voltage reading, and proceed with reconciliation.
   - If a few BPMs are widely different in voltage, spare BPMs can be substituted to speed up reconciliation.
4. After confirming the highest numbered BPM displays a voltage above 25 and below 42 VDC, connect it to its BPM bus connector.
5. Check the BPM bus voltage you are planning to connect to the system. (2nd and remaining).
   - Place the Common, or negative lead of the DMM to the negative "-" terminal of the Anderson™ SBS®75X connector on the BPM bus you plan to connect to.
   - Place the Positive (V+) lead of the DMM to the positive "+" terminal of the Anderson™ SBS®75X connector on the BPM bus terminal you plan to connect the BPM to.
   - Visually inspect the voltage, it should be between 25 and 42 VDC.
     - Follow recommendations in step 3 if voltages are outside of this range.
     - Record the voltage using an appropriate method.
6. Compare the recorded reading to the next lowest numbered BPM.
   - If the difference in voltage is less than 100mVDC (0.100VDC), connect the BPM module to the BPM BUS.
   - If the voltage of the BPM is more than 100mV below the BPM BUS, charge the BPM with an approved charging source until it is within 100mV of the BPM bus.

- If the voltage of the BPM is 100mV above the BPM bus, discharge the BPM using an approved method until it is within 100mV of the BPM bus.
- When the voltage difference is <100mV between the BPM and BPM bus connect the BPM module to the BPM bus using the corresponding connector.

7. Follow steps 5 and 6 for the remaining BPMs on this BPM bus.
8. Follow this process for the remaining BPM / BCM strings in the system.
9. Proceed to next section for the remaining system connections. The ESD wrist strap may now be removed.

5.5 XM3.1-HP™ Power Supply Installation Procedure

There are several options available for a power supply installation. Please understand the nuances of this deployment as some items may vary.

NOTICE:

To allow adequate ventilation, ensure the power supply is placed approximately 2" from the front edge of the shelf.

NOTICE:

Ensure the XM3.1-HP power supply contains the latest XRT-Li power system firmware before starting this process.

5.5.1 Alternate Power Source

If the XRT-Li power system is replacing or upgrading an existing power system, follow your company's policy of providing an alternate power source to the cable plant during this procedure. The process used in this installation will create an interruption of the existing power source. Alpha® recommends using a service power supply such as the APP-9015S. If this is an entirely new power system installation, proceed to **Section 5.5.2 New Power Supply Installation on page 61.**

1. Verify that the APP service power supply (SPS) has the appropriate line cord, that the input voltage selector switch is set to 120V, and that the output selector dial is set to 90V.
2. Locate the service power inserter (SPI) in or around the existing power supply enclosure. Plug the APP SPS Jones connector into the SPI AUX Jones connector.
3. Plug the APP SPS power cord into the convenience outlet in the existing power supply enclosure. Switch the APP SPS power switch to ON, and verify that the output power indicator is lit.
4. Toggle the SPI ALT/ON switch to ALT. This transfers output power from the original power supply to the APP SPS. **Note:** Toggle the switch quickly to prevent a drop in the plant power.
5. Switch the battery breaker on the existing power supply to OFF.
6. Unplug power supply from the AC power. Wait approximately one minute for the power supply capacitors to full discharge.
7. Carefully remove all cables from the power supply and batteries.
8. Remove the power supply and the associated batteries.

5.5.2 New Power Supply Installation

In an existing HFC powering location, the XM3.1-HP™ power supply is typically installed in a different cabinet than the BPMs. This "remote power supply cabinet" is often reused from a previous power system. Some of the installation instructions are different when the XM3.1-HP power supply is installed in the PN-4LI cabinet with the BPMs. Where these differences are called out, be sure to follow the steps specific to your installation.

1. Ensure the cabinets are completely installed, including being bolted to the pad and enclosure grounding before proceeding.
2. If the cabinet containing the power supply is a new installation:
   - Turn the disconnect or main breaker ON. Test the AC mains voltage at the outlets.
   - Install the SPI or SPI-RF in the back of the cabinet. Connect the HFC hardline to the SPI. Leave the AUX/MAIN switch in the AUX position.
   - Mount LAP surge suppressor. If the center screw is installed in the left side outlet, remove and discard it. Insert the LAP into the lower left outlet and install the longer supplied screw through the LAP and into the outlet to secure it.
   - Mount the RF surge suppressor and ground it appropriately. Connect the plant RF cable to the input of the surge suppressor. Connect a short RF jumper cable to the output of the RF surge suppressor. (Do not connect this to the power supply at this time.) Tighten the RF cable on the power supply and the surge suppressor connectors to a torque setting of 10in-lb ± 1in-lb.
3. Place the XM3.1-HP power supply in the cabinet (remote cabinet, or PN-4LI, as appropriate).
4. If the Spotlight360™ app is not available or being used, record the XM3.1-HP power supply serial number. Even with the existing sites, the serial number must be recorded.
5. If the XM3.1-HP power supply is installed in a different cabinet from the BPMs, connect the tamper switch for the power supply cabinet to the TPR input on the XM3.1-HP power supply.
6. Optional: Connect the XM3.1-HP power supply to ground wire to the enclosure. Torque to 10in-lb ± 1in-lb.
7. Open the breaker on the XM3.1-HP power supply.
8. Connect the black and white SPI PP30 cable to OUTPUT 1 of the XM3.1-HP power supply.
9. Plug in the short IEC power cord into the XM3.1-HP power supply's AC power input. Zip tie the power cord to the bracket on the power supply.

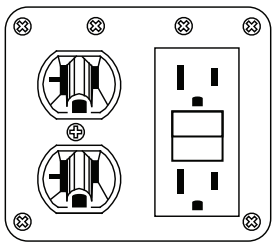


Fig. 5-14, Input Power Panel

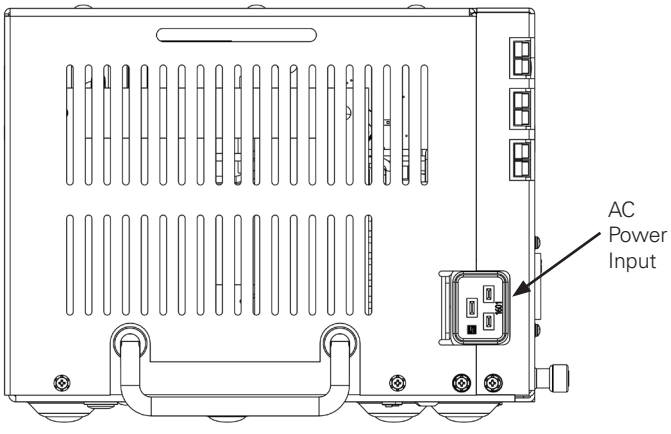


Fig. 5-15, XM3.1-HP™ AC Power Input Location (Side View)

10. Plug the XM3.1-HP™ power supply into the outlet. Note that the XM3.1-HP power supply turns on and shows an input voltage and current. (**Fig. 5-16**)

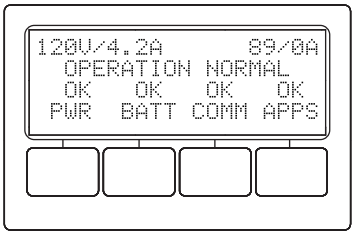


Fig. 5-16, XM3.1-HP™ Power Supply Smart Display

11. If an APP SPS is being used, toggle the SPI ALT/ON switch to ON. This transfers output power from the APP SPS to the new power supply. Confirm the output voltage and current on the XM3.1-HP power supply Smart Display. Turn off the APP SPS, unplug and remove it.

5.5.3 Additional Power Supply Connections

1. Turn on the WiFi router and connect the Ethernet cable to the ETH port on the XM3.1-HP power supply.
2. On the tablet with the Spotlight360™ app, connect to the WiFi router. If the tablet displays an alert about not being able to reach the Internet, tap OK.
3. Install Anderson™ PP75 DC battery cables between the power supply battery input port and the PS BUS1 port on BCM A. If the XM3.1-HP power supply is located in a remote cabinet, the battery cable and gray COM cable were installed in the conduit between cabinets as part of **Section 4.5.1 External Power Supply Conduit on page 40**.
4. Install the gray system COM cable between the XM3.-HP power supply COM port and the COM1 port on BCM A.
5. Close the circuit breaker on the XM3.1-HP power supply.
6. Leave the RF cable disconnected.

5.6 System Connections and Final Checks

1. Confirm previous wiring connections are in place.
2. Verify each BCM has a green LED lit next to COM1 connector.
3. On the Lithium page in the Spotlight360™ application on the tablet (**Fig. 5-17**), swipe to the "BCM Connections" display, and check whether the displayed "Devices" count matches the number of BCMs. If not, check the communications cables, then use the "Device Count" button to update the count. Alternatively, on the XM3.1-HP™ power supply Smart Display (**Fig. 5-18**), in the **BATT** menu, confirm that the **SYS DEVICE CNT** matches the number of BCMs. (If not, check the communications cables, then use the **RESET SYS COMMS** function to update the count.)

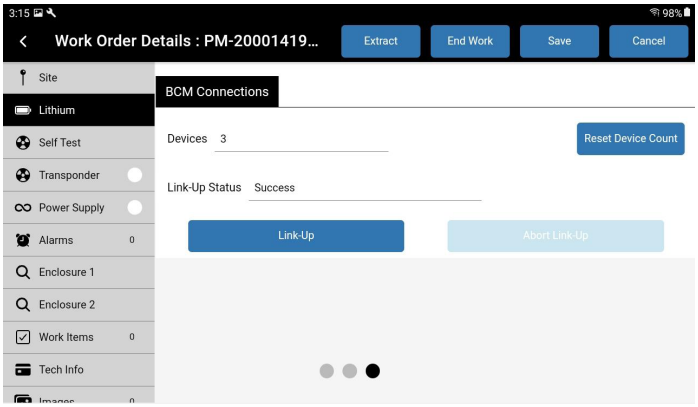


Fig. 5-17, Spotlight360™ App - BCM Connections

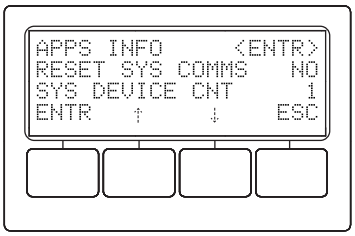


Fig. 5-18, Smart Display - System Device Count

5.6.1 Battery Management System Configuration/Firmware Installation

NOTICE:

Ensure tablet contains the latest XRT-Li power system support software before starting this process.

After placing all the BCMs and BPMs in the enclosures, the BCMs must be updated with the correct firmware that corresponds with the system configuration for the appropriate number of BPMs.

1. Connect the blue CANUSB programming adapter between the tablet (USB) and the BCM ("DIAG" port).

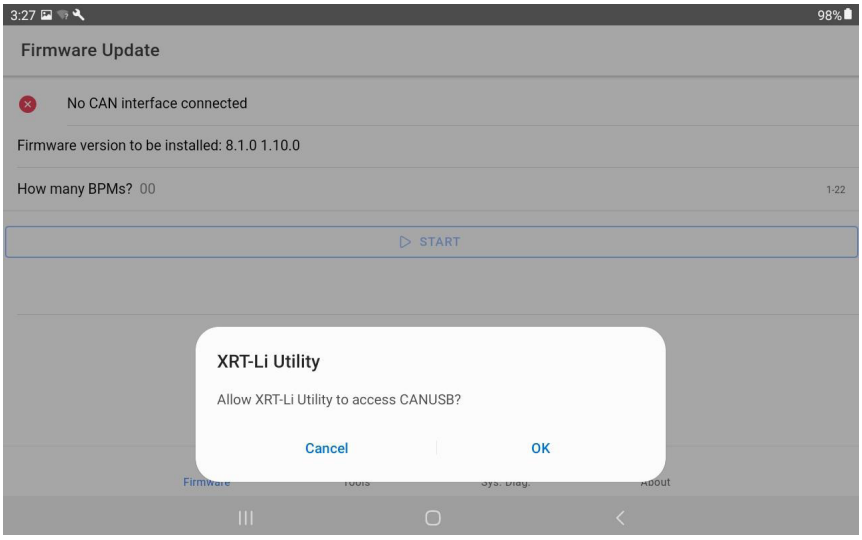


Fig. 5-19, XRT-Li Utility App Popup

2. On the tablet, start the XRT-Li Utility app (if it isn't already running), and select the Firmware Update tab at the bottom of the screen. When prompted to allow access to CANUSB, tap the OK button.
3. Verify that the status at the top of the screen indicates a "public CAN link" connection. If not, check your connections, and ensure the XM3.1-HP™ power supply is on with battery breaker "on."

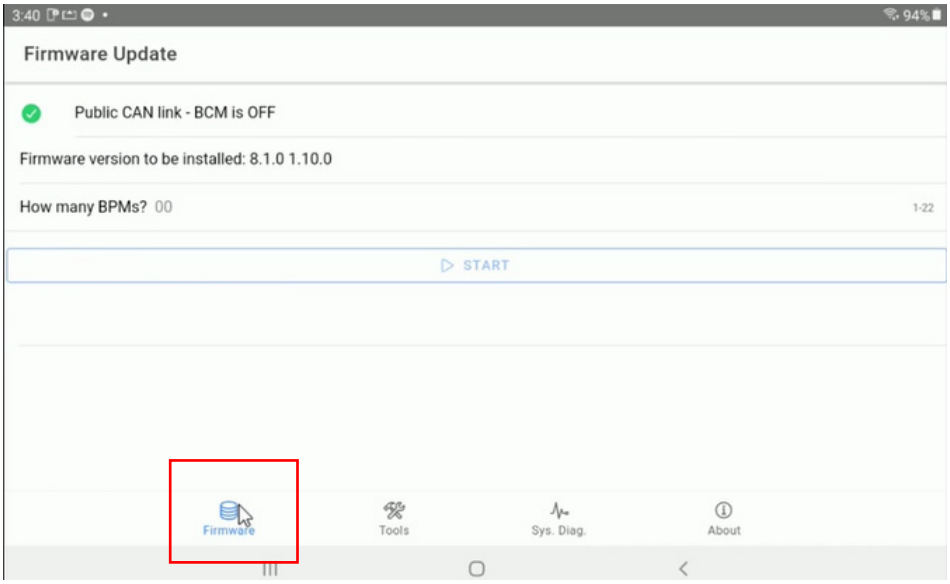


Fig. 5-20, XRT-Li Utility App Firmware Update

4. Enter the count of BPMs for this BCM and sign off on this work order (**Fig. 5-21**).
5. Tap the START button on the tablet to begin the firmware update.

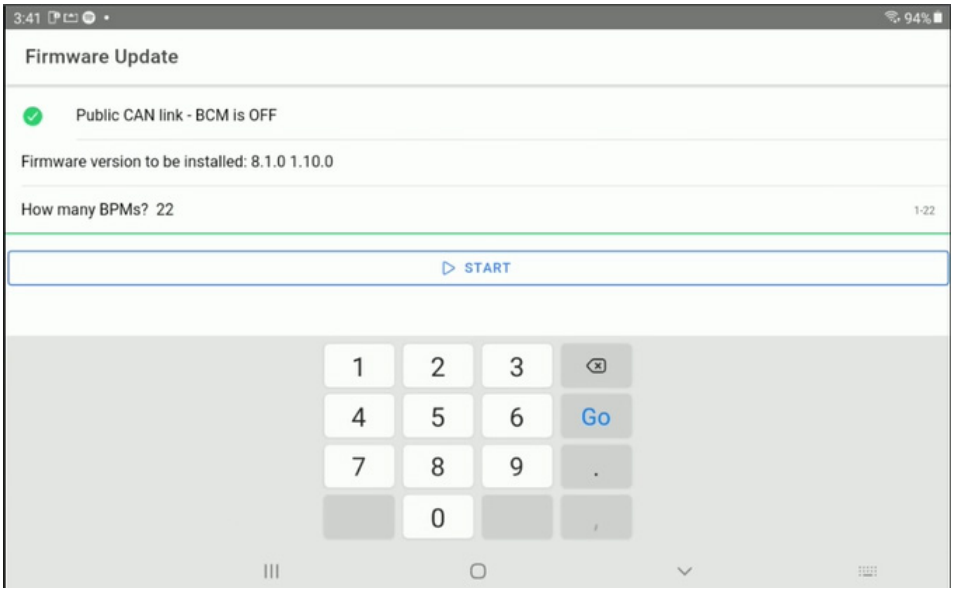


Fig. 5-21, XRT-Li Utility App - BPM Count and Start Button

6. The firmware update proceeds automatically, and takes several minutes to complete. The XRT-Li Utility app automatically turns off the BCM when the update is completed. The app reports the success or failure of the operation. In the case of a failure, this sequence must be restarted.

Fig. 5-22, XRT-Li Utility App - Firmware Update Complete

7. If there are multiple BCMs at a site, update each one according to the above sequence with the appropriate BPM count for each.
8. If the system includes three BCMs, the tamper inputs on BCM C must be disabled. In the XRT-Li Utility app, choose "Sensor Inputs" on the Tools tab to disable these inputs. If a single PN-4LIB28 cabinet with two BCMs installed, BCM B tamper 2 must be disabled.

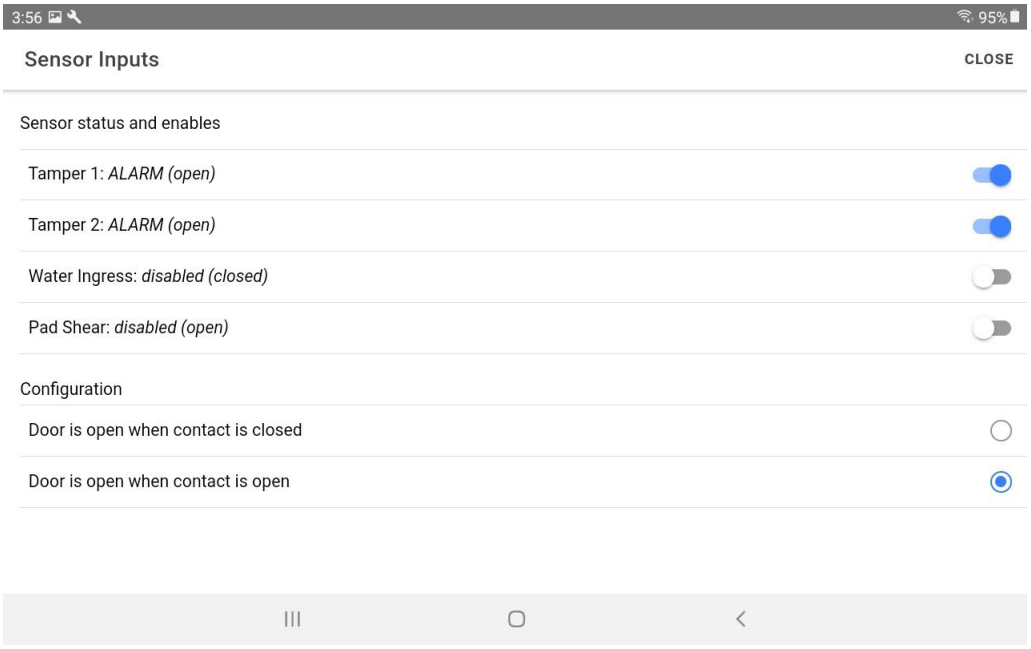


Fig. 5-23, XRT-Li Utility App - Sensor Inputs

9. Verify and sign off that the firmware update tool reported success. Continue to next section for on-site verification checks.

5.6.2 IsoSPI Wire Manipulation Test

Overview of verification process:

This verification process ensures the Anderson™ SBS®75X data connections are secure by using a mechanical manipulation called a "shake test," and by securing the BPM and BUS connectors to the front of the BPM with a zip tie through the BPM handle and around the connectors.

- Identify any interruptions in the isoSPI communications using the tablet EnerSys tool connected to the BCM associated with the tested connections.
- Relieve any stressed isoSPI wires to ensure they do not pull on the terminals of the connections.
- If any isoSPI failures are detected during the processes, the Anderson™ SBS®75X connectors contributing to the failure have to be tested and repaired to ensure proper operation.

Required Parts:

- Additional SBS®75X connector housings to replace any isoSPI data connections (pins or sockets) that may have ejected from their placement
- Spare BPM bus data cables to replace any where the pins are bent
- 8" zip ties, enough to allow for one per BPM in the cabinets of the sites
- 4" zip ties to allow for the removal and reattachment of any isoSPI data connections that the tension cannot be released another way
- Tags for any cable assemblies or BPMs that have to be replaced

Required Tools:

For required tools to perform this task, refer to **Section 5.1 Recommended Tools and Equipment on page 45.** The tools listed below are also needed, and numbers shown are per testing session. Up to three sessions can be concurrently executed, one for each BCM.

- One Handheld diagonal cutters to cut the wire ties and ends of the wire ties used on the cable harnesses
- One set of Anderson™ SBS®75X tools with bushing spacers (7.7P for BPM pin, 9.3P for BPM bus, and S for socket)
- Anderson™ power pin removal tool (or a small flat blade screw driver or tool) to remove the DC bus wires from the connections. (These tools should be insulated to avoid shoring the power.)
- A knife or small object to remove the label from the BUS harness SBS®75X housing shells you may have to replace to facilitate re-use on the replacement connector
- A qualified wrist strap. Connected to ground when SBS®75x repair and assembly is required
- One BRD (a 2nd BRD just in case any BPM cables are damaged or identified as intermittent internal to the BPM)
- Appropriate PPE (see **Section 5.1 Recommended Tools and Equipment on page 45**)
- 4-digit DVM with leads to configure and verify BRD readings
- A Bluetooth® HID hand scanner, paired to the computer or tablet, to record information

5.6.2.1 Preparing the Shake Test on a New System

'Shake test' is a term for manually manipulating the BPM wire harness in such a way as to identify an intermittent connection on the tablet screen. Where problems are identified, they can be corrected in the field. While manipulating the wires, pay attention to the CANUSB attached to the tablet running the EnerSys CANUSB tool to look for communication failures identified by the alarms as seen on the tablet screen. The next step is to identify the loose connections using the Anderson™ inspection tool with bushing spacer. Use the 7.7P for BPM pin, 9.3P for BPM bus and S for socket (see **Fig. 5-24, Anderson™ SBS®75X Tools**).

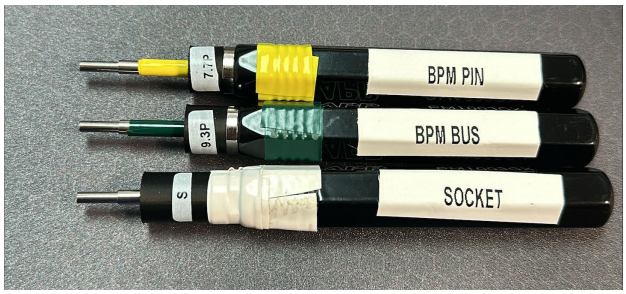


Fig. 5-24, Anderson™ SBS®75X Tools

Procedure:

1. Connect the tablet with the EnerSys XRT-Li Utility app, with the CANUSB adapter, to the BCM whose harness you intend to test.
2. Launch the EnerSys XRT-Li Utility app on the tablet.
3. Click OK on the "Allow XRT-Li Utility to access the CANUSB" popup window.
4. Select the "Tools" tab (bottom of the tablet screen). If the "POWER ON" section is highlighted, tap it to allow the BCM to turn on.
5. Click the confirmation that the BCM power is on (if not previously accessible, the BCM information, error list and lockout recovery is now available.)
6. Click the "ERRORS LIST" button and the current list of errors should be displayed.
7. The tablet is now set up to view any errors that appear during the shake test.

5.6.2.2 Performing the Shake Test

1. Begin with the bus wires leading to the connector for the first BPM. (The connectors are labeled 'A1' for BCM A, 'B1' for BCM B, or 'C1' for BCM C.) Hold and move the wires in all directions around the axis of the wires (left, right, up, down), applying about one to two pounds of force. Check the Errors List display on the tablet.

Grab wires and move them up, down, left, right, and pull away.

Fig. 5-25, Shake Test Example

2. Using about the same amount of force, gently pull the smaller data wires away from each connector. Repeat the movements a few times in succession lasting about five seconds total. Watch the tablet Errors List display for an additional five seconds to ensure that any errors are seen. If any additional alarms appear in the Errors List during this operation, note the specific failure (such as, bus failure at A1), and address the issue:
   a. Press the power button on the BCM you are performing this test on for five seconds to turn the BCM off - this is indicated by the BCM status light turning off.
   b. Disconnect the Anderson connectors on both sides of the section of the harness you shook. Use the Anderson™ PM1003GX pin inspection tool with bushing spacer to test all the pins and sockets on both sides of the disconnected connectors. If any pins are loose, you will need to proceed to **Section 5.6.2.4 BPM Connector Repair on page 69**. If a repair was performed, you must go back to the Tools menu and turn the BCM power back on before proceeding to the next set of wires that need a shake test.
3. If no alarms were found during the shake test of the bus wires, then check the wires from the BPM to its connector. Follow the same five second shake test and five second pause for error reporting as described in Step 2. If the tablet reports errors, follow the mitigation instructions in steps a and b above.
4. After testing both sides of each BPM connector, move on to the next BPM and continue the shake tests. After completing all the BPMs in the chain, also perform the shake test on the wires leading into the BCM connector. Continue this operation until all the connectors have been tested, verified, and repaired as required in the BCM A group. Once complete, move onto BCM B and C and continue to test, verify, and repair on those BCMs.
5. As you are performing the steps, address any isoSPI wires that seem excessively tight by pulling on the Anderson™ SBS®75X data connectors to deflection. Free the tension by gently pulling on the affected wires to slide them through the attached wire ties or cut the wire ties to allow free movement, then secure them back to the bundle using a wire tie.

Once this is complete, continue to **Section 5.6.2.3 Securing the BPM Harness Connectors on page 68**.

5.6.2.3 Securing the BPM Harness Connectors

Secure the BPM and BPM bus connector to the front of the BPM using an 8" or greater wire tie through the BPM's handle and wrapping it around the connector and pulling it tight as seen in the figure below. Ensure you do not dislodge the connection during this process.

Fig. 5-26, Securing BPM Harness Connector

The tablet should still be showing the Errors List display during this process as well. Any isoSPI alarms generated will require cutting the new wire tie off, checking the connector with the Anderson™ PM1003GX tool, and repairing the connections. Follow the repair process in **Section 5.6.2.4 BPM Connector Repair on page 69**.

Place the connectors upright on the BPM shelf and tighten the wire tie sufficiently to minimize future movement of the connection and wires. Cut off the tail of the wire tie when complete. The direction or position of the finished wire tie is not important, but consistency will improve the appearance of the installation.

If there aren't any connector repairs that need to be made, continue to **Section 5.6.2.5 Final Checks on page 71**

5.6.2.4 BPM Connector Repair

WARNING! ELECTRICAL HAZARD

During this operation it is possible that an Anderson™ SBS®75X connector shell will have to be replaced. This exposes the DC wiring of the BPM or bus. The BPM and connected BPM bus cables have a very high capacity for instantaneous current delivery (>100A on the BPMs and > 1000A on the BPM bus). **DO NOT** allow any DC pins to come into contact with the ground or the other power pins of that system. Additionally, DC power pole polarity must be maintained to ensure there are no excessive current events. Catastrophic failure of the system will result if a ground or reverse polarity condition occurs. If such a connection is created, BPM internal fuses or the BCM fuse could blow, and BPM bus wiring could be irreparably damaged. If such an event occurs, replacement of all affected items is advisable. A single DC wire transfer method is recommended to minimize any possible shorting, and a polarity check before connection is advisable.

Safe Grounding

Before repairing a BPM or BPM bus Anderson™ SBS®75X connector, attach your static wrist-strap to the XRT-Li power system ground or BPM handle. Place the anti-static wrist-strap on your wrist orienting it correctly and assuring it is secure and in good contact with your skin.

Anderson™ SBS®75X Repair Process

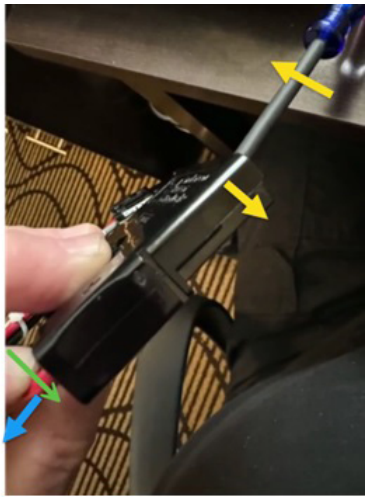
The pins or sockets of the Anderson™ SBS®75X connector can be reseated by using the PM1002G1 tool. It should be noted that the plastic housing may be damaged by forced removal by displacement of the pins or socket. It's advisable to replace the affected plastic housing to create a more secure environment for the pins. This requires removing all the DC and data pairs from the connector. Only the housing where the pin or socket was pushed out must be replaced, whereas its mate should be fine unless there are loose pins or sockets in it, which would also require a replacement. The best way to do this is to remove the DC wires one at a time.

Procedure:

1. Remove the positive wire from the affected housing using an insulated removal tool (or an insulated flat blade screwdriver) by pushing down the spring clip on either side of the face of the positive connector. At the same time, lift the connector away from the spring and pull it out of the back.
2. Once the positive wire is removed, insert it into the new housing following the orientation and the marked "+" on the connector. The face of the connection should have the forward divot toward the base where the spring is located.
3. Push the "+" contact forward until an audible click is heard. Repeat for the "-" negative DC terminal, again noting polarity and assuring it does not touch and other contacts.
4. The isoSPI data lines must be done in pairs; note the wire's position and pin and socket orientation. Using the Anderson™ PM1003G1 removal tool, insert the tool and apply pressure on the handle and click the release button. You will feel the pins and socket release from the housing.
5. Noting the orientation and which side the wires occupy (are they closer to the positive or negative wire), insert them into the same location in the new connector shell by using the Anderson™ PM1002G1 insertion tool. Ride up the wires and push them into the housing, listening for the audible click.
6. Test the newly finished connector and its potential mate's isoSPI data connections using the Anderson™ PM1003GX inspection tool with bushing spacer. Use 7.7P for BPM pin, 9.3P for BPM bus, and S for socket (see **Fig. 5-24, Anderson™ SBS®75X Tools**).
7. If the bus harness SBS®75X housing has to be replaced, the bus connector tag must be moved to the new housing. Use a knife edge or other sharp instrument to lift the edge of the label and move it to the new housing, placing it in the same location on the harness as the one it was removed from. Press the label down to ensure good adhesion.
8. If all data connections pass this test, verify that the positive and negative connections are in their proper marked slot and verify by visually inspecting how the connectors will go together to their mate (red to red and black to black).
9. Carefully insert the repaired BPM and bus connections together until they click. Then execute the shake test again to verify there are no intermittent connections.
10. Attach the connectors to the front of the BPM as highlighted in **Section 5.6.2.3 Securing the BPM Harness Connectors on page 68**.

Yellow arrow: retention spring
Green arrow: DC contact

Use an insulated flathead screwdriver, push down on DC terminal spring and use leverage.



Leverage the spring with the insulated screwdriver, push gently down on the wire and pull the wire and connector out.

Fig. 5-27, Repairing Anderson™ SBS®75X Connector

5.6.2.5 Final Checks

1. In the XRT-Li Utility app, go to the BCM Information tool (only available if the BCM is connected and powered on). Check to see whether the "BCM Part Number" field displays the same part number and revision as the label on the front panel of the BCM. If these are missing or incorrect, please enter the part number plus the revision (for example, 'GL0005910-0000+16') in that field.
2. Check to see whether the "BCM Serial Number" field displays the same serial number as the label on the front panel of the BCM. If this is missing or incorrect, please enter the serial number (or scan it using your wireless barcode scanner). If you have updated the part number and/or serial number, click 'Save Changes' on the BCM Information screen.
3. Disconnect from that BCM and connect to the next BCM and perform the same operation. Do this for the 3rd BCM if installed. When finished, click "Close" to return to the main screen of the Tools page of the XRT-Li Utility app.
4. When all these operations are complete, continue to **Section 5.6.3 Link-Up on page 72**.

5.6.3 Link-Up

The next step in the installation is to turn on the BCMs, to make the batteries (BPMs) associated with the BCMs available for backup. The process described in this section equally applies after installation, whenever a BCM is off for any reason and needs to be turned back on.

The XRT-Li power system can have multiple BCMs, but they need to be at acceptably similar levels of charge to be online at the same time. The XM3.1-HP™ power supply manages the process of bringing the BCMs online in an orderly manner. This process is called "Link-Up". If the BCM is powered using its On/Off button, the BCM will not come online, but will signal the XM3.1-HP power supply to attempt a Link-Up.

During installation, the XM3.1-HP power supply should attempt a Link-Up automatically once the BCMs have been configured, and any time the XM3.1-HP power supply powers up.

Before turning on the BCMs, verify:

- The BCM battery connectors (BATTERY BUS, PS BUS1, PS BUS2 if used) should all be in place.
- The green LED next to the COM1 port should be lit, indicating proper communications cabling to the XM3.1-HP power supply.
- The battery breaker on the XM3.1-HP power supply should be in the “On” (closed) position.

NOTICE:

System will show "0 BATT" (zero batteries).

To start the link-up from the Spotlight360™ application:

1. On the Lithium tab, swipe to the "BCM Connections" display, then tap the "Link-Up" button located below the displayed BCM count.
2. The "Link-Up Status" display will show the progress of the link-up operation.

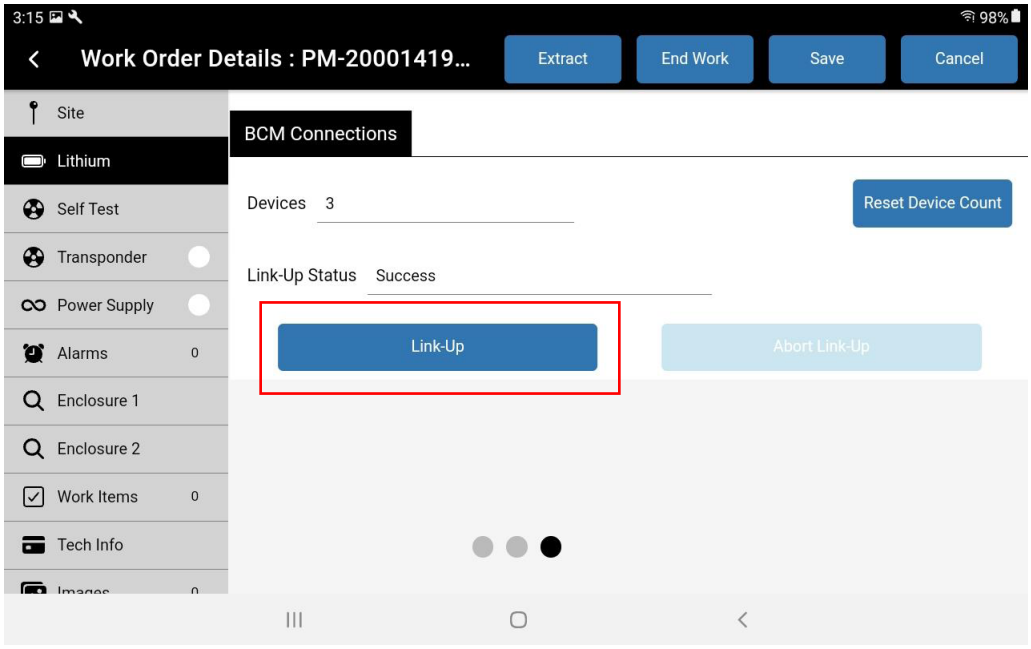


Fig. 5-28, Spotlight360™ App - Link-Up

To start the link-up from the XM3.1-HP™ power supply Smart Display:

1. From the **BATT** menu, go to the **LINK UP CMD** line. Note that before the link-up, the **BATT** menu will almost certainly be showing errors because the BCMs are not powered or online. Scroll through the errors to get to **BATT INFO** to see the regular **BATT** menu options. The **LINK UP CMD** line is below the **SYS DEVICE CNT** line, which should show the correct count of BCMs in your system. (**Fig. 5-29**)
2. When the **LINK UP CMD** line is highest on the LCD (**Fig. 5-30**), press the **ENTR** softkey to make a change. Use the up or down arrow softkeys to change the value on the right to "Start." (**Fig. 5-31**) Press the **ENTR** softkey.
3. When the display says "New data accepted," press the **OK** softkey. (**Fig. 5-32**)

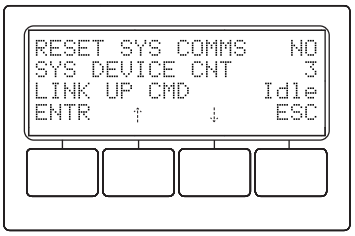


Fig. 5-29, Smart Display - BATT Menu

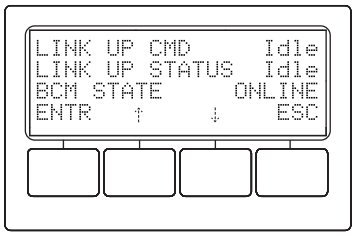


Fig. 5-30, Smart Display - Link-Up Command

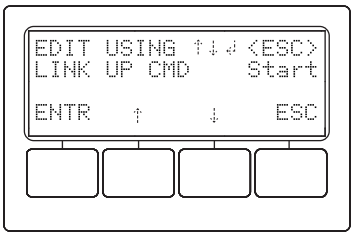


Fig. 5-31, Smart Display - Link-Up Command "Start"

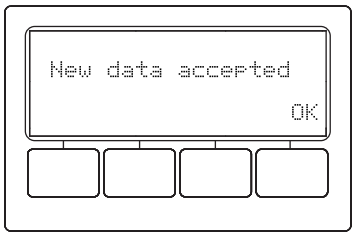


Fig. 5-32, Smart Display - New Data Accepted

4. The LINK UP STATUS line on the LCD will show the progress of the link-up operation.

NOTICE:

If the power supply is performing a Link-Up, or if Link-Up is in process, the Self Test function is disabled on both the web page and from the front panel of the XM3.1-HP™ power supply. There is no indication of a failure, it just will not start. Understanding this operational function will help reduce any confusion. If a Self Test must be issued, first disable the Link-Up and then issue the Self Test (remember to restart the Link-Up when the self test completes). If the XM3.1-HP power supply is performing a Link-Up and the AC input is interrupted, the system will continue to operate on the connected set of BPMs until AC power is returned or they are exhausted. The other strings that are not engaged during the Link-Up will remain offline until power is restored and the Link-Up process allows for their safe re-connection. Note that in both these examples the runtime of the XRT-Li is greatly reduced as this is an exception to normal operation.

To start the link-up from the web page:

1. Connect a laptop computer or tablet to the web user interface using a local Ethernet cable. (See the "Web Interface" section of the XM3.1-HP™ Intelligent Broadband UPS Technical Manual for details. If using a tablet, the wireless connection is described in the next section.)
2. Log in to the user interface using the administrative credentials. These credentials may vary by site, although the power supply ships with default credentials described in the XM3.1-HP Intelligent Broadband UPS Technical Manual.
3. Navigate to the Hardware > Batteries page.
4. In the "Batteries" summary section at the top of the page, from the "BMS Control" drop-down list, choose "Begin link-up." At the bottom of the page, click "Save Changes" to perform this action.
5. The "Link-Up Status" line will show the progress of the link-up operation.

NOTICE:

A link-up can also start automatically from the XM3.1-HP power supply startup, or by using a BCM On/Off button to turn it on. However, the Spotlight360™ app, the Smart Display or web page should be used to observe the current status during this operation.

The link-up process begins by collecting information. There will be audible clicks from the BCM(s) that are off as the system checks the status of each BCM by very briefly turning them on in a controlled manner. If using the web page, the displayed information for each BCM will reflect the newly captured data. If one of the BCMs is reporting a problem, the link-up will abort with an error message, less than a minute after starting; that BCM will remain off-line until the specific problem is resolved.

The link-up process could complete very quickly if the BCM strings are all at similar charge levels, or it could take hours to charge the BCM strings to the point where they should be online together. However, if the link-up has been running for more than a minute without errors, this means there are no obvious problems blocking the system from coming fully online when ready.

Possible Troubleshooting

For the link-up to get underway, the safety-critical core of the BCM has verified that its firmware is internally consistent and that the connected hardware is consistent with the firmware expectations (this includes a correct BPM count), a separate communications processor within the BCM has verified that the BCM is reporting firmware version and configuration information that is known to be good, and the BCM is not reporting any faults that prevent it from joining the power system.

One possible failure is a BCM reporting a lock-out condition, based on having previously detected a mismatch in the hardware consistency. This is to be expected if the BCM was previously powered on and running a firmware version expecting a different count of BPMs from what was connected at the time. (This should be avoided by having the BCM off whenever adding or removing BPMs.) In this specific failure scenario, if the technician has verified that the reported information is now otherwise correct, the technician connects the CAN interface to the complaining BCM to clear the lock-out condition, using the "Lock-out Recover" tool in the tablet XRT-Li Utility app. The technician should always report such unlock operations in the service record for the site visit. The power system "black box" log for the site will also record that a lock-out condition was detected and then cleared.

As problems are resolved, the technician can again restart the link-up process on the power supply user interface. As stated above, any problems blocking the link-up process should be identified within the first minute of operation. A technician may choose to leave the site while the link-up is still underway, where needed for a heavily imbalanced power system.

5.6.4 On-site Verification and Data Collection

Once the power system is running, and link-up has started successfully (if not already finished), use the Spotlight360™ app to collect and record the power system information. (If you previously used the tablet for the Configuration/Firmware Installation process described earlier, the connection to the DIAG port is no longer needed.) Refer to the Spotlight360™ software documentation for instructions on how to collect the information from this installation.

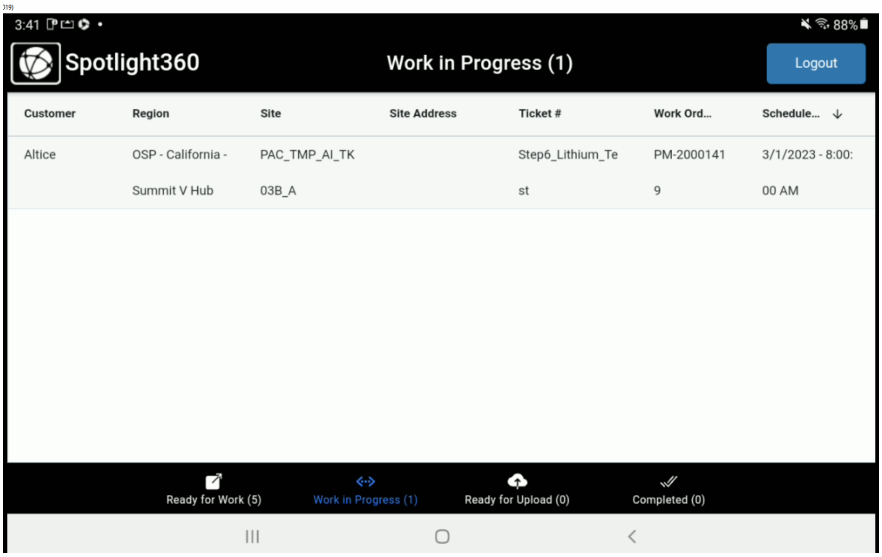


Fig. 5-33, Spotlight360™ App - Work Order Selection

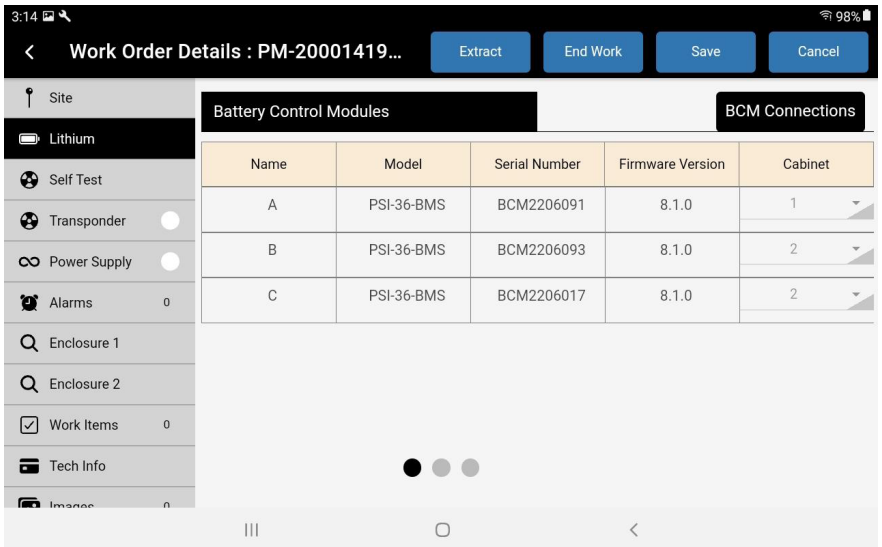


Fig. 5-34, Spotlight360™ App - Lithium Battery Page

5.6.5 Installation Wrap Up

The final steps for installing the XRT-Li power system include installing a firestop putty and verifying operation before leaving the site.

NOTICE:

A firestop putty MUST be installed in the conduit pass-through AFTER all wiring is complete between the enclosures. Alpha recommends using 3M® Fire Barrier Moldable Putty Stix MP+ *(Alpha p/n 973-00004-10)* and HILTI® 618 Firestop Putty Stick *(Alpha p/n 973-00005-19)*, or equivalent. Refer to manufacturer's user instructions when applying between enclosures.

1. If two cabinets are used, install firestop putty. See **Section 4.5 Enclosure Pass-Through and Conduit Installation on page 40** for location. Use approximately 1/3 of the tube of firestop putty. Roll into a ball and pack around the inside of the 2" conduit and around the wires to form an air tight seal between the enclosures.
2. Attach the RF cable and verify transponder operation and level.
3. Ensure the SPI unit is switched back to MAIN (or ON) from AUX to allow the XM3.1-HP power supply to power the HFC plant.
4. If a service power supply was used, it is now safe to remove it.
5. Check to ensure there are no error conditions indicated on the BCMs or XM3.1-HP power supply.
6. Add configured site energy stickers based on your work order and population to the appropriate labels on the outside of the enclosures.
7. Add UNPLUG AC and UNPLUG DC labels to their corresponding cables (**Fig. 5-35**).
8. Reconnect door grounds if removed.
9. Close the enclosure door(s).
10. Call the network operations center (NOC), confirm communications and alarm status is cleared.
11. Clean up site and follow appropriate processes related to boxes and equipment.
12. Leave the site.

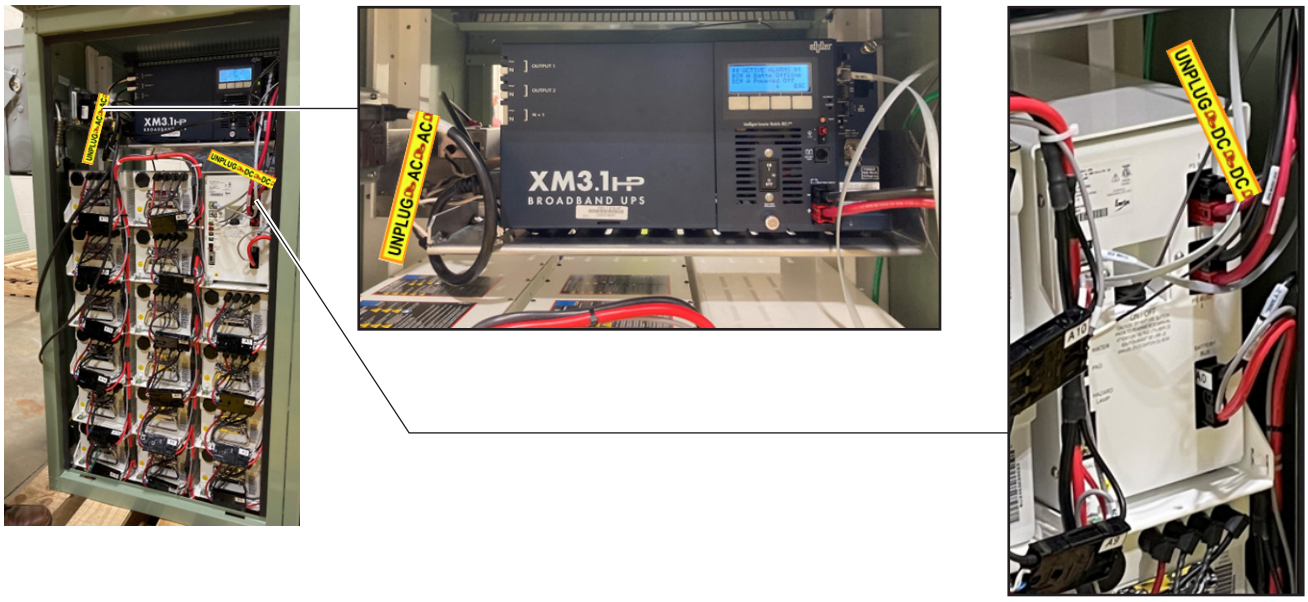


Fig. 5-35, Unplug AC and Unplug DC Label Locations

6.0 Operations

6.1 Preventative Maintenance

Physical Inspection of Cabinet System

Recommended Frequency:

It is recommended that each XM3.1-HP™ power supply location be visited at least once a year for preventative maintenance.

Recommended Tools and Equipment:

Prior to beginning the maintenance, ensure that all recommended tools, equipment, and personal protective equipment (PPE) is functional and available. See **Section 5.1 Recommended Tools and Equipment on page 45** for a list of recommended equipment.

ATTENTION:

- Follow your cable operator's recommended PPE and safety procedures for the work site. Drop cones and implement other safety procedures as required.
- Notify the cable systems network operations center (NOC) of your intention to work on this outside plant powering system.

Inspection of Cabinet Site:

Conduct a visual inspection of the cabinet at the site. The inspection should include vents, door panels, locks, indicator lights, and overall condition of the system.

- Inspect the security and condition of the power supply cabinet.
- Check physical integrity of the cabinet (securely mounted, conduit integrity, service meter integrity, etc.).
- Check for any signs of corrosion through visual inspection.
- Check for signs of impact or abuse.
- Inspect door panel locks.
- Remove any overgrowth of brush surrounding the enclosure.
- Clear any dust or debris from external vents.
- Check for the integrity of parking bollards or other impacted related items if installed.

Pad Undermining:

- Inspect the surrounding soil of the cabinet for any indications of erosion. Verify that the cabinet is still level, and any soil erosion has not caused the cabinet to lean.
- Report any observed issues to the supervisor.

Ground Integrity:

- Verify the ground/bond wire of the door is intact and wire lugs are secure.
- Inspect ground brackets on each BPM and BCM to ensure they are still secure.
- Inspect each bolt/screw used in each ground connection is secure and free of any corrosion.
- Additional ground tests, using impedance testing equipment, are beneficial but not required.

Surge Suppression (LAP) and SPI Alt Box:

- If installed in the system, inspect the surge suppressor (LAP). If the LED indicator is not illuminated on the LAP, the LAP will need to be replaced.
- Ensure that the power supply is not plugged into the LAP.
- Verify that all connections for the SPI are tight (coaxial connection and ground connection of coax sheath).
- Make sure the SPI/alt box is properly secured to the coax cable.
- Visually inspect all SPI/alt box wires and connections are in good working condition (includes wires, lugs, and Anderson™ connectors).

XM3.1-918-HP Power Supply:

- The Inverter requires almost no regular maintenance. However, Alpha® recommends the following items:
- Vacuum or clean all vents on a regular basis.
- Check all electrical connections periodically for tightness using the torque values listed in the XM3.1-HP™ Intelligent Broadband UPS Technical Manual. Turn off all circuit breakers before making these checks.
- For more maintenance information on the XM3.1-918-HP power supply, please refer to section 4.0 of the XM3.1-HP Intelligent Broadband UPS Technical Manual.

Battery Maintenance:

CAUTION: EQUIPMENT DAMAGE!

Do not perform any form of equalization with the Battery Power Modules (BPMs).

The BPM (PowerSafe® iON 36-1800 lithium battery) requires almost no regular maintenance. However, Alpha® recommends the following items:

- Check all connections of Anderson™ connectors are properly installed
- Check the indicators of all the BCMs to ensure they are operating properly.
- Check the alarm display of the XM3.1-HP power supply to ensure no BPM or BCM related alarms are indicated. (There may be a Tamper Alarm from the front door of the XM3.1-HP power supply cabinet, this is normal during the testing phase and can be ignored.)
- Please refer to component replacement section regarding removing/replacing BCMs or BPMs.

Other Maintenance Checks:

- Inspect all wiring within the cabinet.
- Check the Anderson™ PP75 connections of the power supply and the BCMs to ensure they are in place and tightened.
- Check the Anderson™ SBS®75X connectors on the BPMs and BCMs to ensure they are tight and making good connection.
- Check all cable securing elements to ensure they are in place and tightened appropriately.
- Check all wiring for damage or abrasion, and follow recommended practices for determining if replacement is necessary.
- Check the integrity and operation of tamper switches.
- Check external hazard indicator wiring if installed.
- Check the door gaskets to ensure it is not damaged or missing. Replace as required.
- Remove all dirt, dust, and debris from the cabinet.

Final Maintenance Checks:

- Check the remote management communications wiring to ensure it is operating.
- Check enclosure for any loose tools or supplies.
- Close all cabinet doors.
- After the service is complete, contact the associated cable system NOC to assure the site is operational and no alarms are displayed. Notify them when you leave the site.

Additional Maintenance References:

For additional information not referenced here regarding maintenance, please refer to SCTE 205 – 2014 for further guidance.

6.1.1 Outlier Conditions Beyond Certified Parameters

In the event of water ingress or high water, or external physical damage (such as dents, bullet holes, and vehicle impacts) to the cabinet or a visible thermal event, contact Alpha Technical Services. The site must be inspected by trained personnel before performing any service.

6.2 Monitoring

The Alpha® XRT-Li extended runtime power system is remotely monitored over its network connection (DOCSIS® RF, or optical) through the communications module in the XM3.1-HP™ power supply.

6.2.1 Simple Network Monitoring Protocol (SNMP)

The primary monitoring is via Simple Network Monitoring Protocol (SNMP), which supports querying the power system status, issuing unsolicited notifications ("traps"), and limited control capabilities. The use of SNMP monitoring is described in the XM3.1-HP Intelligent Broadband UPS Technical Manual. Information specific to the XRT-Li power system is described in ATI-DEV-BATTERIES-MIB, which has been expanded for extended runtime power systems.

The expanded sections include:

- batteryManagementSystemTable (1.3.6.1.4.1.926.1.5.2.5) - high-level battery system information. For the XRT-Li power system, there is a single row in this table describing the full battery system.
- batteryManagerTable (1.3.6.1.4.1.926.1.5.2.6) - more detailed information about the battery system. For the XRT-Li power system, there is a row in this table for each BCM.
- batteryManagerFaultTable (1.3.6.1.4.1.926.1.5.2.7) - a table reporting any active faults associated with the battery system.
- batteryManagerPowerModuleTable (1.3.6.1.4.1.926.1.5.2.8) - inventory and error status information for the power modules attached to the battery system. For the XRT-Li power system, there is a row in this table for each BPM.
- batLanguageStrings (1.3.6.1.4.1.926.1.5.2.9) - this section contains supporting tables that offer textual strings accompanying the tables listed above, in English and other languages supported by the power supply.
- batlogManagerEventsTable (1.3.6.1.4.1.926.1.5.2.10.1) - a table recording recent battery system events, including faults that have occurred.

6.2.2 Web Interface

The power system may also be accessed using a web browser (HTTP or HTTPS) for viewing the power system status. General information about the web user interface is described in the XM3.1-HP Intelligent Broadband UPS Technical Manual.

Real-time status information specific to the XRT-Li power system is found on the Hardware > Batteries page. The page is divided into five sections:

- **Batteries:** summary information at the top of the page includes the general status of the overall battery system.
- **Battery Charging:** describes the power supply charging (or discharging) activity.
- **Battery Management System (BMS):** shows a more detailed status, with each BCM in a separate column.
- **Battery Management System Faults:** reports any active errors/alarms in the battery system. This section is not shown if there are no active errors or alarms.
- **Battery Power Modules:** a table of each BPM, where the serial number and installation date are recorded. If there is an active error or alarm for a specific BPM, it is shown in this table (as well as in the Battery Management System Faults section).

The XRT-Li power system presents a log of battery system events on the History > BMS Events page. This log includes a record of faults that have occurred.

Apart from the changes to the Batteries page, and the addition of the BMS Events page, the web interface for an XRT-Li power system is the same as for any other Alpha® XM3.1-HP power supply.

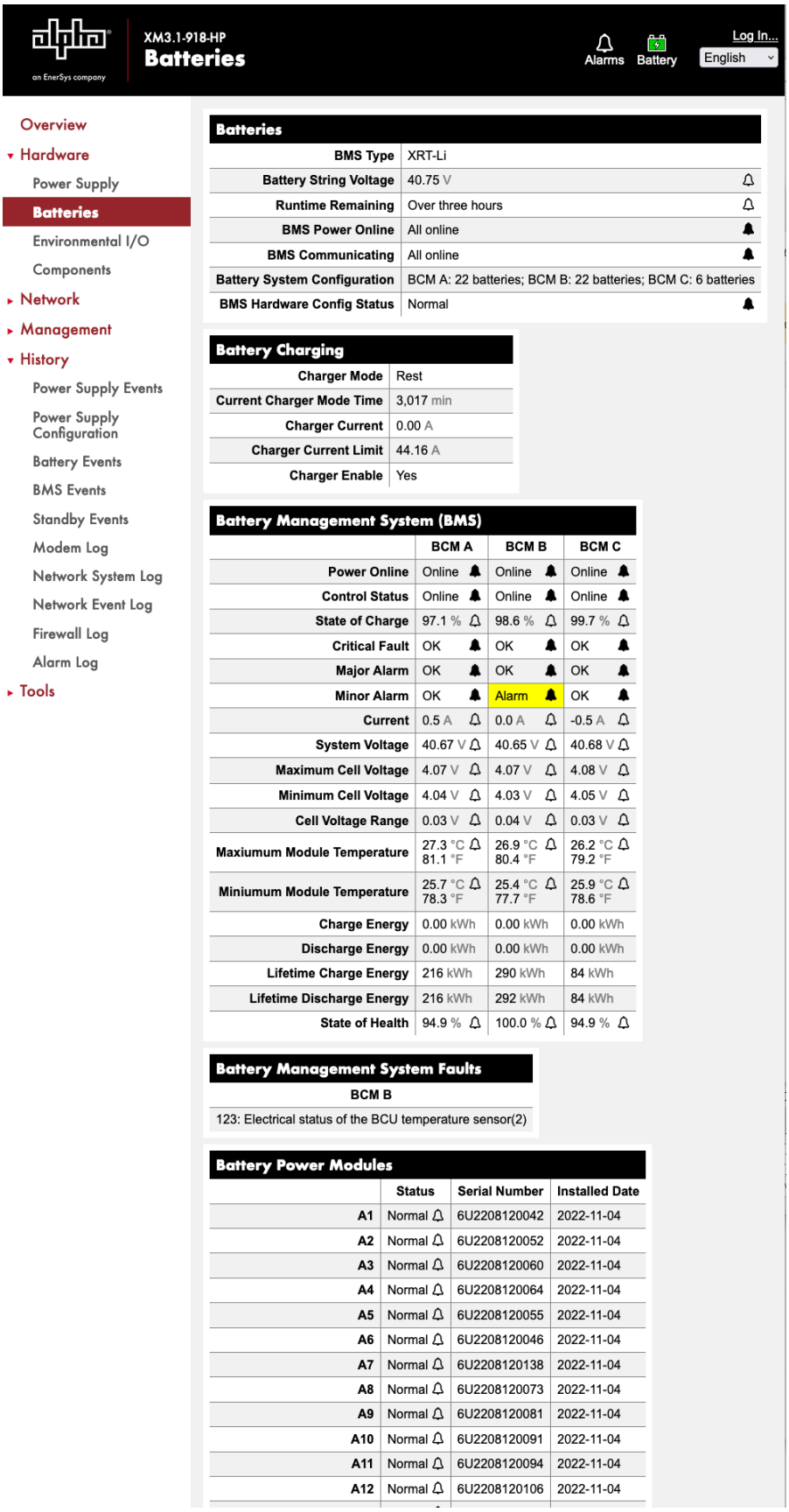


Fig. 6-1, Batteries Web Page

6.3 Field Replacement of Spare Components

6.3.1 Replacing BPM (p/n GL0005719-0000)

CAUTION: EQUIPMENT DAMAGE!

Before any disconnection and reconnection occurs, an ESD wrist strap must be worn and connected to a ground.

A BPM can be replaced using the following process:

1. Prior to replacing BPM, ensure the BCM is powered off.
2. Disconnect the battery harness from the BPM that is to be replaced.
3. Disconnect the battery harness from the BPM in the first position (A1, B1, or C1, depending on the location.)
4. Remove the ground securing screw from both BPMs and save them for reuse.
5. Disconnect and remove the faulty BPM from its location using the handle, not the harness.
6. Remove the BPM from the first position using the handle, not the harness, and place it where the faulty BPM used to be.
7. Remove defective BPM serial number from the system population information.
8. Insert BPM connector into the BPM Bus harness at the location of where the BPM was installed.
9. Install a new BPM in the first position by lifting via the handle and sliding into position. Ensure the battery harness is out of the way. Do not connect to the BPM harness at this time.
10. Scan the new BPM into the system population information.
11. Secure both BPMs to the enclosure via the ground securing screw by torquing it to 75 in-lb (8.5 Nm).
12. Verify the ground integrity by following the applicable portion of **Section 5.4.1 Verifying Ground Integrity on page 53**.
13. To ensure proper state of charge (SoC) levels a reconciliation of these components must be performed. Connect the Battery Reconciliation Device (BRD) to the BPM in the first position. Place the cabinet's Anderson™ SBS®75X connector into the BRD's BPM bus port.
14. Place the BPM's Anderson™ SBS®75X connector into the BRD's BPM port.
15. Verify BPM count displayed on BRD matches the count expected on this string. If this matches, continue to next step.
16. On-site verify the meter's operation and calibration:
    a. Turn on your digital multimeter (DMM).
    b. Set the mode to DC volts.
    c. Set the range to automatic or manual range above 42VDC.
    d. Place the DMM's common lead into the BRD's COM test point.
    e. Place the DMM's positive lead in the 5VDC test point.
    f. Verify the DMM displays 5.0VDC ±0.2V.
    g. Remove the positive DMM lead from the test point.
17. Using the previously on-site verified DMM, verify the BPM voltage by placing the DMM's positive lead into the BPM+ test point.
    a. If the difference between the DMM and BRD readings are greater than 0.03VDC, press the **ADJ** softkey on the BRD to adjust the voltage closer to what the DMM measures.
    b. If the difference is within spec, press the **OK** button.
18. Using the previously on-site verified DMM, verify the BPM voltage by placing the DMM's positive lead into the BPM bus+ test point.

a. If the difference between the DMM and BRD readings are greater than 0.03VDC, press the **ADJ** softkey on the BRD to adjust the voltage closer to what the DMM measures.

b. If the difference is within spec, press the **OK** button.

19. Reconciliation will now begin. Ordinarily this is a rapid process unless the BPMs are not already balanced to a common charge level. (Displayed on BRD.) During this process, the BRD may become warm to the touch. Reconciliation is done when the BRD's OK green LED lights up.
20. Check the voltage by placing one of the DMM probes in the BPM jack on the BRD and the other probe in the BPM bus jack. Verify the voltage delta is less than 0.1VDC.
    a. If it is, press the **OK** softkey on the BRD.
    b. If it is not less than 0.1VDC, press the **RTRY** softkey to retry balancing.
21. Disconnect the BRD. Connect the BPM to the BPM bus.
22. Run Link-Up procedure. Refer to **Section 5.6.3 Link-Up on page 72** for details.

6.3.2 Replacing BCM (p/n GL0005910-0000)

CAUTION: EQUIPMENT DAMAGE!

Before any disconnection and reconnection occurs, an ESD wrist strap must be worn and connected to a ground.

A BCM can be replaced using the following process:

1. Prior to replacing a BCM, ensure it is powered off. Scan the serial number located on the top left front face and remove this number from the system population information.
2. Disconnect the Battery Bus connector from the BCM.
3. Disconnect the upstream grey phone cable from the BCM's COM1 port. Disconnect the downstream grey phone cable, or terminator plug, from the COM2 port.
4. Disconnect the tamper cables from the BCM's TRP1 and TPR2 ports (if present).
5. Remove the ground securing screw and save it for reuse.
6. Remove the BCM from the enclosure.
7. Place replacement BCM in its designated spot. Scan the new serial number located on the top left front face into the system population information.
8. Secure the BCM to the enclosure via the ground securing screw by torquing it to 75 in-lb (8.5 Nm).
9. Verify the ground integrity by following the applicable portion of the paragraph in **Section 5.4.1 Verifying Ground Integrity on page 53**.
10. Reconnect the upstream grey phone cable to the BCM's COM1 port. Reconnect the downstream grey phone cable, or terminator plug, to the COM2 port.
11. Reconnect the tamper cables to the BCM's TRP1 and TPR2 ports (if present).
12. Reconnect the Battery Bus connector to the BCM.
13. Before running the Link-Up procedure, the BCM must be updated with the correct firmware for the number of BPMs. See **Section 5.6.1 Battery Management System Configuration/Firmware Installation on page 63** for details.
14. Run Link-Up procedure. Refer to **Section 5.6.3 Link-Up on page 72** for details.

6.3.3 Enclosure BPM Bus Harness Replacement

CAUTION: EQUIPMENT DAMAGE!

Before any disconnection and reconnection occurs, an ESD wrist strap must be worn and connected to a ground.

Tools and parts:

- Side Cutters
- 8" wire ties (Qty. 24 depending on harness) *(p/n 651-002-19)*
- Replacement enclosure BPM bus wire harness (See replacement parts list.)

Procedure:

1. Identify the BPM bus harnesses needed for replacement. The part number is located on the black wire near the A0, B0 or C0 connector. Candidates for replacement would be damaged power wires or connectors. If the problem is with the isoSPI communication, troubleshoot with Ohm meter by checking for continuity and proper connector insertion.
2. The BCM should be off and BPM Bus Harness connector should be unplugged from BCM. If replacing A0 or B0 harness, the BPMs on the right side will need to be removed to access the wire ties. If removing A0 BPM Bus harness BPM 16 and 17 will need to be removed to access the wire tie holding the wires going from front to back.
3. Cut wire ties holding harness to shelves. Note the location of the ties and placement of the harness. Installation of the new harness will require replacing wire ties and securing the harness in the same locations.
4. When installing new harness start with the A0, B0 or C0 connector. Place harness in enclosure on the right side next to the top shelf and secure with two wire ties as shown.

Fig. 6-2, Replacement Wire Harness

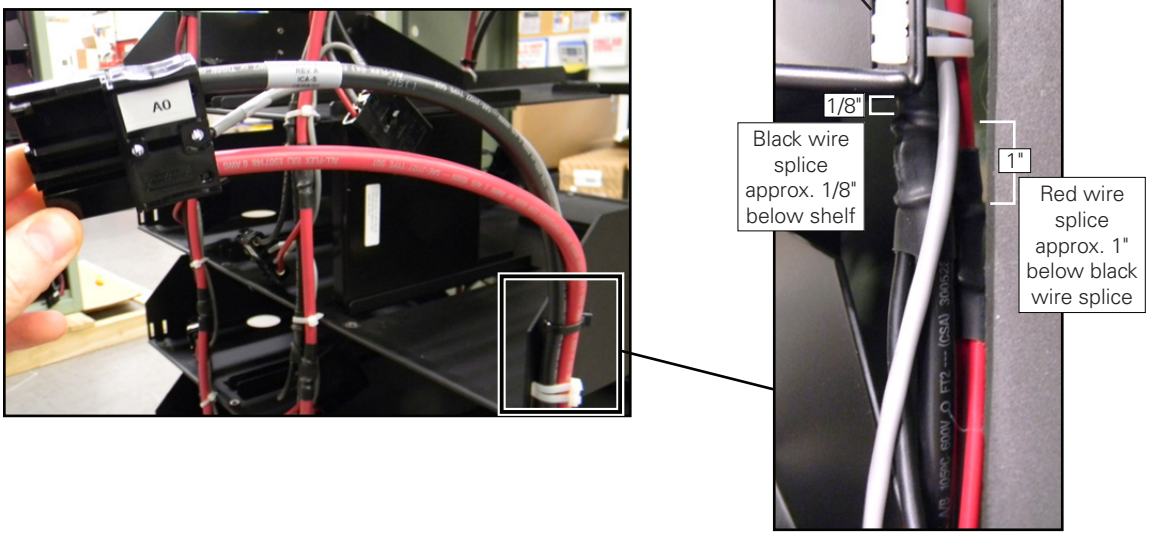


Fig. 6-3, Wire Tie Placement

5. Route wires around bends at the bottom, top and to the back shelves as needed. Secure harness with wire ties on the 2nd from the bottom shelf and top shelves only at first to get connectors in the appropriate positions, then go back and fill in the appropriate tie off positions. Wires will need to be formed in a square loop and wire ties added as shown to accommodate the BPM sliding under the harness.
6. After harness is secured to shelves, replace BPMs in their appropriate positions with appropriate grounding and ground checks. All BPMs must undergo reconciliation procedure as noted in **Section 5.4.3 Reconciliation and BPM Connections on page 54** before connecting to the BPM Bus harness.

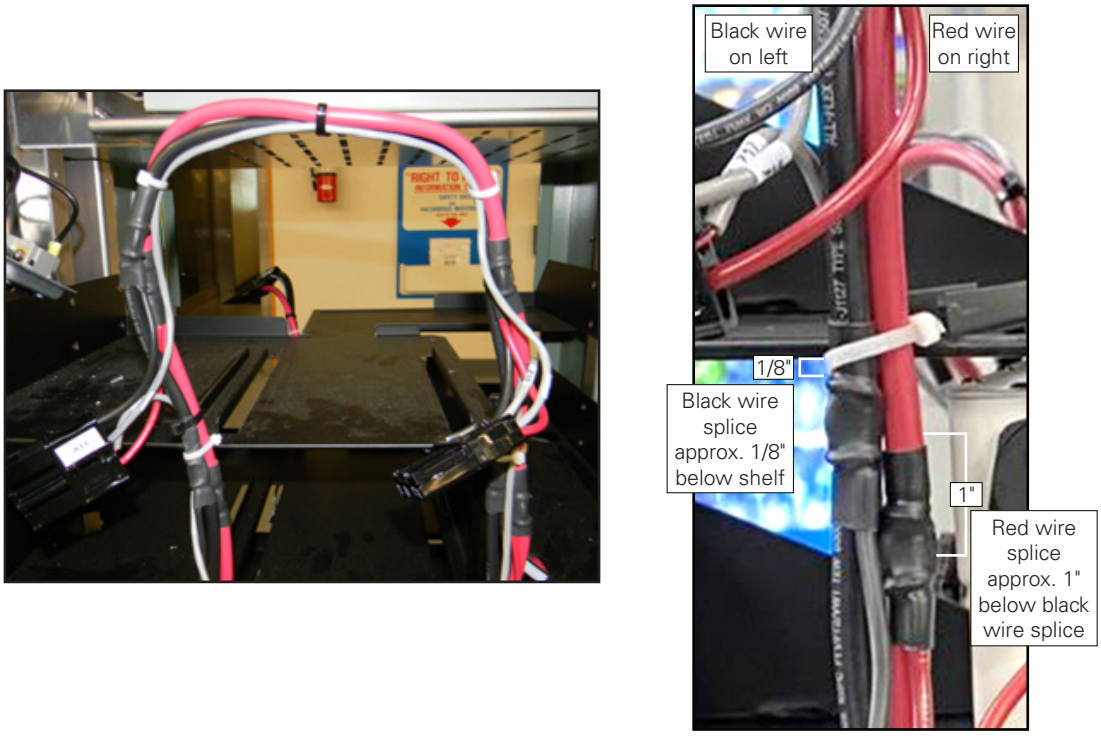


Fig. 6-4, Securing BPM Bus Harness

6.3.4 Relabeling BCMs for PN4-LIB28 Cabinet (p/n 740-00088-20-xxx)

The label kit *(p/n 740-00088-20-xxx)* is for use on a PN-4LIB28 enclosure with two battery control modules (BCMs) when it is installed as a single cabinet for battery back up of an XM3.1-HP™ power supply that is housed in another cabinet that does not have any other batteries. The existing battery power module (BPM) bus wire harness connectors need to be relabeled to indicate that the first BCM connected to the XM3.1-HP power supply is BCM A and the second BCM connected is BCM B. Refer to "740-00088-20-xxx Label Kit for Single PN-4LIB Cabinet with 28 BPMs, XRT-Li Extended Runtime Power System Installation Instructions" *(p/n 031-00019-C0-001).*

6.4 Decommissioning

CAUTION!

Decommissioning **MUST** be performed by trained personnel. Failure to follow the procedures could result in equipment damage or personal injury.

ATTENTION:

Refer to **Section 2.1.3 BPM and BCM Safety on page 18** for more information and safety guidelines.

6.4.1 Overview

The decommissioning process is comprised of five major components:

1. An approved concrete support structure for ground mount cabinets.
2. Utility and HFC components and conduits.
3. One or more painted aluminum cabinet(s) with steel doors and battery support structure inside.
4. A utility connected HFC compatible inverter/charger that may be contained within a battery or pole cabinet. The voltages of this device include a utility provided 120VAC input, an HFC 89VAC NESC® compliant low voltage output to the cable plant or devices and a nominal 36VDC battery string voltage.
5. A 36VDC high density Li-ion battery system sharing the same cabinet with the inverter/charger or be distributed between multiple cabinets. The system sizes range from just a few kWh of available storage to 81kWh of storage. The battery systems are comprised of one to three sets of 3 to 22 Battery Power Modules (BPMs) connected to a Battery Control Module (BCM) resulting in a complete end to end Battery Management System (BMS).

Depending on the type of decommissioning, each type requires a different approach.

- Decommissioning for redeployment of the system or components
  - Decommissioning of the entire system
  - Decommissioning of components
  - Repurposing of the site
  - Decommissioning a defective or damaged system
- Decommissioning of Lithium-ion BPMs or BCMs
  - Decommissioning of the BCMs
  - Decommissioning for routine disposal of BPMs
  - Decommissioning of exhausted modules
  - Decommissioning of defective or damaged modules
  - Replacement and recommissioning items.

Carriage of High Density Lithium-ion Battery Power Modules:

In the above definitions there are 2 types of BPM handling: routine and defective. Routine handling can leverage normal lithium-ion carriage; defective modules must be carried in an EnerSys® approved high density Li-ion carrier and in accordance with said methods.

6.4.2 Decommissioning System with a Normal or Exhausted Battery System

NOTICE:

The process used in this procedure will create an interruption of the existing power source. Alpha® recommends using a service power supply such as the APP-9015S.

Procedure:

1. Visit the site, deploy appropriate safety systems, unlock, and open the on-site cabinets. It is important that the technician determines the state of charge (SoC) of the system, which can be easily obtained from the XM3.1-HP™ power supply's Smart Display, if operational.
2. Open the XM3.1-HP power supply battery breaker, open the AC disconnect and remove the AC utility plug from the receptacle inside the cabinet. Remove the other electrical connections from the HFC inverter/charger, including the Anderson™ PP30 output connector, the Anderson™ PP75 battery connector, the RF or fiber communications cables, and all other connecting cables.
3. Remove the XM3.1-HP power supply from the cabinet and dispose of it in an appropriate manner.
4. Disconnect the battery system. Remove each of the (1 to 3) BPMs' DC interconnection cables by pulling and removing the PP75 connected #6 AWG cables from each BCM. Remove the communications cable, tamper, and other smaller cables connected to each BCM.
5. Remove each of the BCM's BPM 0 bus connectors from the front of those units by pulling the Anderson™ SBS®75X connectors from the front of the BCMs. Remove the ground screws that attach each BCM to the cabinet. Remove each of the BCMs and dispose of them using an approved method.
6. Gather and collect loose wiring.
7. If not completed earlier, determine the SoC of the BPMs; this can be accomplished using a DVM and measuring the bus voltage at the removed SBS®75X connector terminals:
   - DC voltage >42VDC (>91%SoC) modules may be in an overcharge condition – use appropriate ground shipping.
   - DC voltage less than 42VDC but over 32VDC (91%>SoC>30%), batteries in a good or low state of charge – use typical battery containers and ground transportation.
   - DC voltage less than 32VDC, batteries in a good or exhausted condition – use typical battery containers and ground or air transportation.
8. Once the SoC has been determined, continue to disconnect each of the BPMs from its BPM BUS connection by separating the Anderson™ SBS®75X connectors.
9. When all the BPM connectors are disconnected, remove the ground screw from each BPM, and use the handle to remove the module from the cabinet and place it in an appropriate container. Dispose of it properly by using the methods related to the BPMs reported SoC.
10. Populate the containers with the approved count of BPMs and note the total nameplate power being loaded in a cargo vehicle. Note not to exceed the cargo vehicles total rating for both weight and power capacity when loading. Ensure that loads are secure and loaded in such a way that their weight is distributed as required by the vehicle for safe operation.
11. Any BPM with a known electrical, physical, or thermal event related damage must be placed in an approved EnerSys® Lithium containment system and shipped to the factory for disposition. These containers will be designated for a particular population - do not exceed that population. Ship according to the EnerSys® approved method for that battery condition and count. These containers must be labeled as required. Follow the above rules for battery container loading and securing as well as assuring the shipping method follows the directions outlined for suspect lithium battery transportation.
12. Remove the remainder of the HFC components from the cabinet including the SPI, hardline, RF and optical cables from the cabinet. If not recommissioning, the battery harnesses may be removed from the cabinet. Gather components and wire and dispose of these items appropriately.
13. Have the utility disconnect the AC service from the cabinet and remove the meter and decommission the service.
14. Remove the cabinet securing bolts from poles and the concrete pad. Remove the cabinet and dispose of them using appropriate means.

15. Remove concrete pad and conduit if required.
16. Entire system decommissioning complete.

NOTICE:

If the system is to be recommissioned, move the equipment to the new site and recommission as outlined in **Section 5.0 System Installation on page 45**.

NOTICE:

Repurposing the decommissioned site to handle VRLA or VRLA with generators will require the removal of all BPMs, BCMs, and cabinets as shown in the procedure above to allow a properly outfitted VRLA cabinet to be put in its place. The concrete pad, electrical service, HFC cabling, and conduit can be left in place and reused.

6.4.3 Suspect Module Decommissioning

The following subsections describe the removal of a single or multiple suspect items on the site.

Procedure for removing/replacing XM3.1-HP™ power supply powering the site:

NOTICE:

The process used in this procedure will create an interruption of the existing power source. Alpha® recommends using a service power supply such as the APP-9015S.

1. Visit the site, deploy appropriate safety systems, unlock, and open the on-site cabinets. It is important that the technician determines the state of charge (SoC) of the system, which can be easily obtained from the XM3.1-HP power supply's Smart Display, if operational.
2. Open the XM3.1-HP power supply battery breaker, open the AC disconnect and remove the AC utility plug from the receptacle inside the cabinet. Remove the other electrical connections from the HFC inverter/charger, including the Anderson™ PP30 output connector, the Anderson™ PP75 battery connector, the RF or fiber communications cables, and all other connecting cables.
3. Remove the XM3.1-HP power supply from the cabinet and dispose of it in an appropriate manner.
4. Replace the XM3.1-HP power supply following the installation manual, if required.

Procedure for removing/replacing one or more BCMs:

1. Visit the site, deploy appropriate safety systems, unlock, and open the on-site cabinets. It is important that the technician determines the state of charge (SoC) of the system, which can be easily obtained from the XM3.1-HP power supply's Smart Display, if operational.
2. Open the XM3.1-HP power supply battery breaker.
3. On the BCM to be removed, depress the BCM ON/OFF button for 3 seconds. The BCM should shut down and Status LED will turn off. Note that all the BCMs will likely be shut down from the event. Carefully remove the wires from the front of the BCM – the Anderson™ PP75 DC interconnect cables, the Comms cables, the tamper cable, and other sense cables. Remove the Anderson™ SBS®75X BPM bus cable from the front of the BCM. Remove the ground screw and remove the BCM.
4. If the BCM is to be replaced, see **Section 6.3.2 Replacing BCM (p/n GL0005910-0000) on page 83** to install the replacement BCMs.
5. If the BCM is not to be replaced, the BPMs will also have to be decommissioned. The cables may have to be re-routed as required to ensure connections to additional BCM and BPM chains.
6. Place the defective BCM in an appropriate container and dispose of according to local codes.

Procedure for decommissioning one or more BPMs, but the system will still be operational:

CAUTION: EQUIPMENT DAMAGE!

Before any disconnection and reconnection occurs, an ESD wrist strap must be worn and connected to a ground.

1. Visit the site, deploy appropriate safety systems, unlock, and open the on-site cabinets. It is important that the technician determines the state of charge (SoC) of the system, which can be easily obtained from the XM3.1-HP™ power supply's Smart Display, if operational.
2. Open the XM3.1-HP power supply battery breaker.
3. On the BCM hosting the BPM to be removed, depress the BCM ON/OFF button for 3 seconds. The BCM should shut down and Status LED will turn off. Note that all the BCMs will likely be shut down from the event. Remove the Anderson™ SBS®75X BPM bus cable from the front of the BPM connector to be removed. Remove the ground screw from the decommissioned BPM and remove the BPM from the enclosure.
4. Place the removed BPM in the appropriate container (based on the systems SoC) as shown in the system BPM decommissioning section.

Procedure for replacing defective BPM in the chain:

Refer to **Section 6.3.1 Replacing BPM (p/n GL0005719-0000) on page 82** for the replacement procedure.

Procedure for removing a decommissioned BPM without replacement – creating a smaller string with one less BPM:

CAUTION: EQUIPMENT DAMAGE!

Before any disconnection and reconnection occurs, an ESD wrist strap must be worn and connected to a ground.

1. Shutdown and disconnect the Anderson™ SBS®75X cables in the above section.
2. Remove the BPM as indicated in the above section.
3. Take the last BPM in the chain and place it in the removed BPM slot (unless it is in the last BPM chain location) following the above reconciliation and documentation steps.
4. Place the Anderson™ SBS®75X end cap to the connector of the removed BPM.
5. Reinsert the Anderson™ SBS®75X BPM #0 connector in the front of the BCM.
6. The BCM will have to be reprogrammed with the new lower count of BPMs on the bus; see **Section 5.6.1 Battery Management System Configuration/Firmware Installation on page 63**.
7. Dispose of the BPM in the manner shown in the first section depending on its SoC.
8. Perform a Link-up procedure. See **Section 5.6.3 Link-Up on page 72**.

7.0 Powernode (PN) Series Enclosure Options

7.1 Flat Security Bars (PN-4LI and PN-4LIB Enclosures Only)

This section covers the installation of flat security bars in the enclosure. See **Section 9.0 Alpha Part Numbers on page 105** for part number series options shown in this section.

CAUTION!

Metal shavings will enter the enclosure during installation. Before proceeding, verify power supply, C/B box, service entrance box and batteries are disconnected or adequately protected. If the batteries are being handled, an ESD wrist strap attached to a ground must be worn.

CAUTION!

Remove or protect any equipment in the enclosure before performing the installation. DO NOT install the security bar over any ventilation louvers. This will hamper enclosure ventilation. Failure to follow these precautions may result in equipment damage that is not covered under warranty.

Parts/Materials (Qty):

- Drill hole template/instructions
- Security bar (2)
- Side bracket (4)
- Center bracket (2)
- Carriage bolt 1/4"-20 × 1" (8)
- Flat washer 1/4" (8)
- Hex nut 1/4"-20 (8)

Required Tools (Qty):

- Center punch
- Drill
- 19/64" Drill bit
- Drill-stop collar for 19/64" drill bit
- 3/8" Drill bit
- Drill-stop collar for 3/8" drill bit
- 7/16" Socket or hex driver
- Torque wrench
- Alpha® security screw (5)*
- Security screw key (1)*

*Customers may supply their own security screws; see dimension specifications below for more detail.

Security Screw Dimensions:

5/16"-18 × 1"

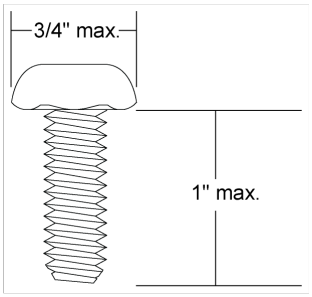


Fig. 7-1, Security Screw Dimensions

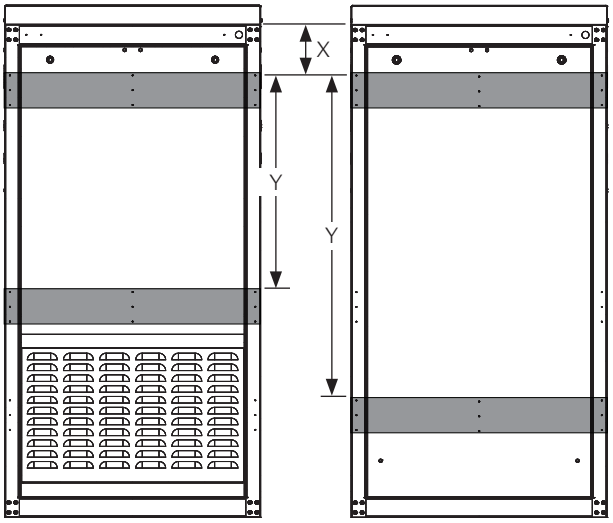
Procedure:

1. Position and tape the template to the enclosure at the desired height for installing the security bar (see **Fig. 7-2** and **Fig. 7-3**).

CAUTION!

Ensure the template is placed at a desired height where the security bar won't interfere with the shelving or the batteries. Failure to do so may result in damage to the enclosure or batteries.

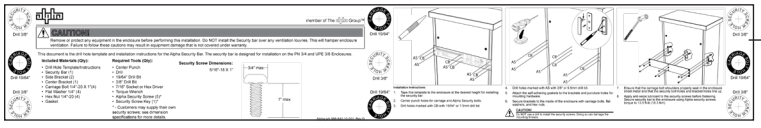
2. Using a center punch, mark the nine drill holes on each template for carriage and Alpha® security bolts. (Note that these locations are specific to PN-4LI and PN-4LIB enclosures.) Remove doors after using the center punch.



Enclosure Door	X Measured from top of door to top of upper template	Y Measured from top of upper template to top of lower template
Front door	2-1/2"	22"
Back door	2-1/2"	33"

Fig. 7-2, Security Bar Locations

Template



Template is for PN-3/4 and UPE3/6. UPE 3/6 is shown throughout.

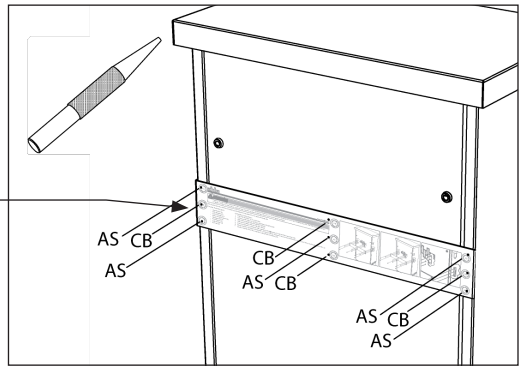


Fig. 7-3, Template Placement on Enclosure

3. Attach Drill-Stop collar to 19/64" drill bit 1/4" or 6mm from tip.
4. Drill holes marked with CB with 19/64" or 8mm drill bit.
5. Attach Drill-Stop collar to 3/8" drill bit 1/4" or 6mm from tip.
6. Drill holes marked with AS with 3/8" or 10mm drill bit.
7. Attach the self-adhering gaskets to the brackets and puncture holes for mounting hardware.
8. Secure brackets to the inside of the enclosure with carriage bolts, flat washers, and hex nuts.

CAUTION!

DO NOT use a drill to install the security screws. Doing so can damage the mounting threads.

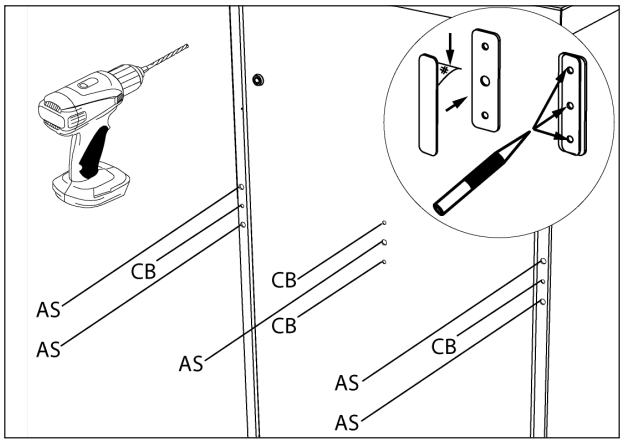


Fig. 7-4, Installing Brackets

9. Ensure that the carriage bolt shoulders properly seat in the enclosure sheet metal and that the security bolt holes and bracket holes line up.
10. Apply anti-seize lubricant to the security screws before fastening. Secure security bar to the enclosure using Alpha® security screws, torque to 13.5 ft-lb (18.3 Nm).

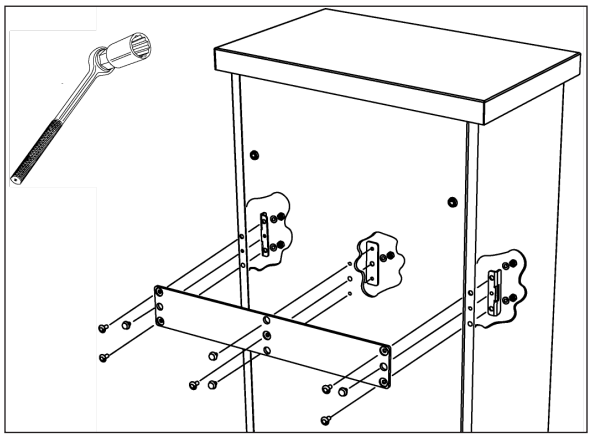


Fig. 7-5, Installing Security Bar

7.2 Input Power Panel (IPP)

There is one basic configuration of the IPP: 120V. Units are pre-wired with two 20A class R rated fuses; one fuse is designated to the power supply, and the other fuse is designated for the GFCI outlet. **Note:** Do not plug the XM3.1-HP™ power supply into the GFCI outlet.

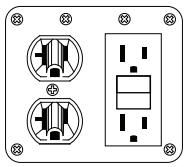


Fig. 7-6, IPP for One Power Supply

7.3 Lightning Arrester

The LA-P-120T lightning arrester is available in 120VAC, and installed by plugging into an IPP. The unit is operating properly when the green LED is lit. **Note:** Do not plug in the XM3.1-HP power supply into the LA-P-120T.

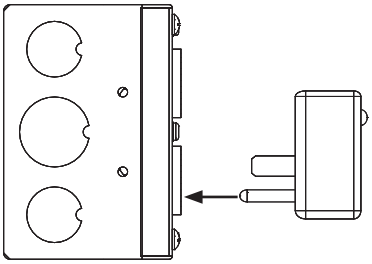


Fig. 7-7, LA-P-120T Installed in an IPP

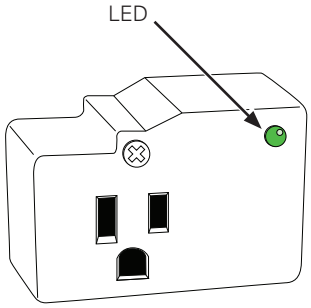


Fig. 7-8, Location of LED on LA-P-120T

7.4 Hazard Indicator

The hazard indicator is typically known as the LRI on PN-4 cabinets. Each cabinet will have indicators attached to each BCM hazard port.

NOTICE:

The LRI connector on the power supply is not used for this system configuration.

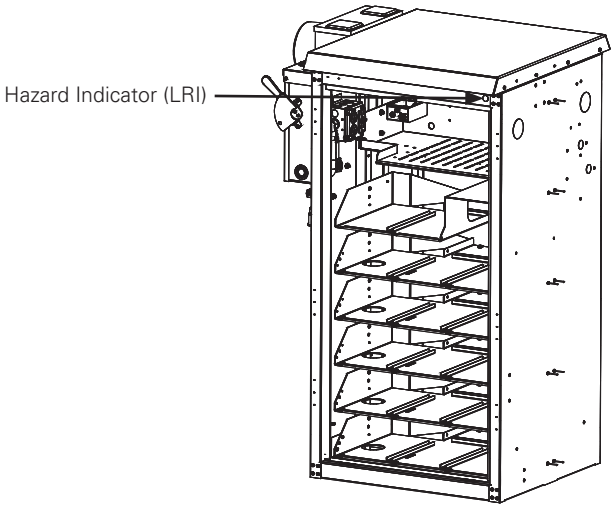


Fig. 7-9, Location of Hazard Indicator (LRI)

8.0 XRT-Li Power System Troubleshooting

This section is related to XRT-Li power system issues. For troubleshooting the XM3.1-HP™ power supply and other elements of this system, please refer to the appropriate documentation on **www.alpha.com**.

8.1 Battery Alarms

The XM3.1-HP power supply detects battery alarms and displays the type of active alarm on the Smart Display screen and the severity of the alarm (Major/Minor) by means of the Inverter Module LED indicators. Alarms are listed in the XM3.1-HP Series Power Supply Technical Manual, but there are additional possible alarms that may be displayed under the **BATT** menu in the XRT-Li power system as listed below.

Active Alarm	Alarm Type	Probable Cause of Alarm	Corrective Action	Batteries Offline
BCM A External Flash	Minor	Hardware failure within the BCM	1. Replace the BCM	NO
BCM A Precharge Fail	Minor	Excessive heat within the BCM	1. Check enclosure ventilation 2. Check ambient temperature	NO
BMC A Disconnect Pending	Minor	An error condition requires taking the batteries offline or normal shutdown	1. Check error log 2. When error condition is resolved, perform Link-Up	PENDING
BCM A CAN 1	Minor	Internal communications failure	1. Replace the BCM	NO
BCM A CAN 2	Minor	Internal communications failure	1. Replace the BCM	NO
BCM A Batts Offline	Minor	Batteries are offline	1. Check error log 2. When error condition is resolved, perform Link-Up	YES
BCM A No Bus Power	Minor	No voltage on PS BUS connectors	1. Check XM3.1-HP power supply breaker 2. Check PS BUS cables	YES
BCM A Powered Off	Minor	The BCM is turned off	1. Perform Link-Up	YES
BCM A Environ Input	Minor	Water ingress or pad dislocation	1. Check cabinet for indicated condition 2. Check environmental sensor configuration 3. Check sensor wiring	NO
BCM A Hazard	Major	System temperature readings indicate a potential risk of battery system fire	1. Approach cabinet with caution 2. Contact Alpha/EnerSys service	YES
BCM A Misconfigured	Major	Problem with installation or damage to the system	1. Contact Alpha/EnerSys service	YES
BCM A COMM Status	Major	XM3.1-HP power supply can't communicate with the BCM	1. Check the COM cable between the XM3.1-HP power supply and BCM 2. Check PS BUS cables 3. Reset SYS COMMS on Smart Display 4. Replace BCM	NO

Table 8-1, Battery Alarms

8.2 Battery Harness Issues

In most cases, if there is a problem with the XRT-Li battery system, the affected BCM reports errors (as listed in **Section 8.3 BCM Errors on page 96**) indicating the problem. However, if there is a problem with the battery harness linking the BPMs to the BCM, the BCM reports a flood of errors. If the vast majority of the errors list "temperature sensors" or "MCU," it is likely there is an issue with the battery harness.

The easiest way to diagnose this issue is to look on the Batteries web page, at the Battery Power Modules section at the bottom (below the list of active errors). If some of the BPMs are reporting temperature sensor errors, look for the first BPM with this complaint; it represents the first BPM that is not communicating with the BCM.

There are a few reasons as to why this issue occurs:

- A BPM is removed while the BCM is running: The removed BPM, and all BPMs behind it, would be reporting the errors.
- Cabling within the cabinet is damaged: Check the connectors of the first BPM with the error messages, and at the BPM immediately preceding the problem. The smaller inside wires on the connectors are how the communications flow from the BCM to each BPM; if those connections are loose or damaged, the long list of errors will result.

  Anderson™, the maker of the connectors used in the BPM harness, provides a pin insertion tool that can be used to ensure the signal pins are properly seated and making good contact. (Anderson also provides a pin removal tool if the cable needs to be repaired.)

  The following Anderson™ tools can be used for troubleshooting isoSPI communication wires on BPM wire harness:

  - SBS®75X auxiliary contact insertion tool: *PM1002G1*
  - SBS®75X auxiliary contact extraction tool: *PM1003G1*
  - SBS®75X auxiliary contact insertion inspection tool: *PM1003GX*

After resolving any battery harness issues, attempt a Link-Up from the XM3.1-HP™ Smart Display screen or web page. Although this will still show an error because the BCM has entered a "lock down" state as a result of the previous connection issue, review the information displayed in the "BMS Hardware Config Status" field on the "Batteries" web page. The long list of errors should no longer be displayed as the connection issue should be fixed. If the long list of errors is still displayed, the problem has not been resolved.

Once the problem is cleared, the on-site technician can clear the lock down state using Alpha® provided tools.

8.3 BCM Errors

Each BCM in the XRT-Li power system reports errors (including warnings and informational messages) to the power supply. Active errors are reported in SNMP and on the Batteries web page, and the BMS Events Log records past errors when they occur and when they clear.

8.3.1 Error Levels

In the XRT-Li power system, each error has a level of severity, from the following list:

Level	Level Description	System Reaction	Possible Corrective Action	Notification Type
0	Diagnostic information	N/A	N/A	BMS event log only
1	Diagnostic information	N/A	N/A	batmgrMinorAlarm
2	Warning	N/A	N/A	batmgrMinorAlarm
3	Warning (limited capacity)	Reduced capacity	N/A	batmgrMinorAlarm
4	Error	Batteries offline	Link-Up	batmgrMajorAlarm
5	Critical error	Batteries offline	Link-Up	batmgrCriticalFault
6	Temporary lock down	Batteries offline	Contact EnerSys/Alpha	batmgrCriticalFault
7	Lock down	Batteries offline	Contact EnerSys/Alpha	batmgrCriticalFault

Table 8-2, BCM Error Levels

NOTICE:

Any active error with a level of 4 or higher causes the batteries in that BCM to be offline (unavailable for backup power).

NOTICE:

Error levels 4 and 5 can be recovered with a Link-Up command via the XM3.1-HP™ power supply after the condition has been corrected.

Level 0 Diagnostic Information

Informational messages, only for data collection. A level 0 message is not reported as an error, and only appears in the BMS Events Log.

Level 1 Diagnostic Information

Informational messages for temporary conditions. When the condition clears—typically on its own—the message is removed.

Level 2 Warning

Warning messages for conditions which do not impact system functionality. When the condition clears, the message is removed.

Level 3 Warning

Warning messages for conditions which may necessitate reductions in system capabilities such as reduced charge current or discharge current. When the condition clears, the message is removed.

Level 4 Error

Error conditions that take the battery system offline. A level 4 error starts a shutdown counter that runs for several seconds, during which time the BCM indicates a "disconnect pending." Once the batteries are offline, if the error condition is cleared, the batteries remain offline. Once the issue is resolved, a Link-Up operation is necessary to bring the batteries back online.

Level 5 Critical Error

Urgent error conditions that immediately take the battery system offline. There is no pending disconnect period. Once the batteries are offline, even when the error condition is cleared, the batteries remain offline. Once the issue is resolved, a Link-Up operation is necessary to bring the batteries back online.

Level 6 Temporary Lock Down

In certain rare circumstances, the BCM can promote the error severity level of a persistent error condition to level 6, thus inhibiting the BCM temporarily from use in any way. Each failed battery system recovery (unsuccessful attempt of going from the "offline" state to the "online" state) increments an internal error severity level 6 counter. If this counter reaches its limit of five consecutive failures, the BCM enters a temporary lock down condition where the battery system will not come online. This condition can only be cleared by an Alpha/EnerSys certified service technician.

Level 7 Lock Down

Urgent error conditions where the battery system has passed a "point of no return" for safe operation. The BCM enters a lock down condition where the battery system will not come online. This condition requires service before any further operation, and can only be cleared by an Alpha/EnerSys certified service technician.

NOTICE:

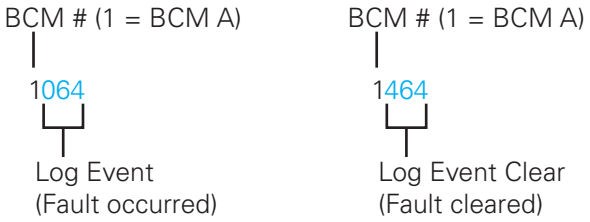
Lock down conditions (error level 6 or 7) cannot be remotely reset and will require on-site correction from an Alpha/EnerSys certified service technician.

8.3.2 Error IDs

Each error has an ID. For active alarms, refer to the "Fault ID" column (decimal values) in Table 8-3 below. In SNMP, this ID is reported in the batmgrfaultId column of batteryManagerFaultTable; in the Batteries web page, this is the start of any active error message.

For the BMS Events Log web page, refer to the "Log Event" column (hexadecimal values). Each log entry is a four digit hexadecimal number, such as "1064," where the first digit indicates which BCM reported the event (1=BCM A, 2=BCM B, 3=BCM C). For an entry when a **fault occurred**, the last three digits range from 000-3FF, and are from the "Log Event" column in the table. For an entry where a **fault was cleared**, the last three digits range from 400-7FF, and are from the "Log Event" column with a "4" added to the first digit. (For example, when fault "064" occurs on BCM A, there is a log entry with ID 1064. When that fault clears, there is a log entry with ID 1464.) A log entry with the last three digits higher than 7FF is not associated with a BCM error.

EXAMPLE:



Fault ID	Log Event	Level	Description
1	001	5	Maximum precharge duration exceeded
2	002	5	Maximum main connect duration exceeded
3	003	5	Maximum shutoff duration exceeded
4	004	5	Maximum disconnect duration exceeded
5	005	5	Maximum emergency disconnect duration exceeded
6	006	5	Maximum precharge current limit exceeded
7	007	5	Maximum main connect current limit exceeded
8	008	4	Negative HV contactor stuck open
9	009	5	Negative HV contactor stuck closed
10	00A	4	Positive HV contactor stuck open
11	00B	5	Positive HV contactor stuck closed
12	00C	4	Precharge HV contactor stuck open
13	00D	5	Precharge HV contactor stuck closed
14	00E	5	Load circuit voltage maximum limit exceeded
15	00F	5	Maximum service mode current limit exceeded
28	01C	2	Positive HV contactor deterioration warning
29	01D	4	Positive HV contactor deterioration error
30	01E	2	Negative HV contactor deterioration warning
31	01F	4	Negative HV contactor deterioration error
32	020	2	Precharge HV contactor deterioration warning
33	021	4	Precharge HV contactor deterioration error
34	022	2	Precharge resistor overheat warning

Table 8-3, BCM Errors

Fault ID	Log Event	Level	Description
35	023	5	Precharge plausibility check maximum voltage exceeded
36	024	5	Precharge plausibility check minimum voltage exceeded
37	025	5	Precharge energy limit exceeded
38	026	5	Charge current limit critically exceeded
39	027	5	Discharge current limit critically exceeded
40	028	1	Charge current limit exceeded (warning)
41	029	1	Discharge current limit exceeded (warning)
42	02A	0	Current sensor amperage limit exceeded
43	02B	0	Voltage drop error (rapid load circuit voltage drop without reason)
44	02C	4	Maximum cell voltage limit critically exceeded
45	02D	4	Minimum cell voltage limit critically exceeded
46	02E	1	Maximum cell voltage limit exceeded (warning)
47	02F	1	Minimum cell voltage limit exceeded (warning)
48	030	4	Maximum pack voltage limit critically exceeded
49	031	4	Minimum pack voltage limit critically exceeded
50	032	2	Maximum pack voltage limit exceeded (warning)
51	033	2	Minimum pack voltage limit exceeded (warning)
52	034	4	Voltage acquisition 1 plausibility check error
53	035	4	Voltage acquisition 2 plausibility check error
54	036	4	Voltage acquisition 3 plausibility check error
55	037	4	Voltage acquisition 5 plausibility check error
56	038	4	Module voltage acquisition plausibility check error
57	039	4	Cell voltage acquisition plausibility check error
58	03A	4	Load circuit voltage acquisition plausibility check error
59	03B	2	Maximum pack resistance limit exceeded
62	03E	3	Current sensor 1 plausibility check error
63	03F	3	Current sensor 2 plausibility check error
64	040	2	Load circuit voltage did not decrease in time for contactor diagnosis
65	041	4	Maximum cell temperature limit critically exceeded
66	042	4	Minimum cell temperature limit critically exceeded
67	043	3	Maximum cell temperature limit exceeded (warning)
68	044	3	Minimum cell temperature limit exceeded (warning)
69	045	4	Maximum pack state of charge limit critically exceeded
70	046	4	Minimum pack state of charge limit critically exceeded
71	047	2	Maximum pack state of charge limit exceeded (warning)
72	048	3	Minimum pack state of charge limit exceeded (warning)
73	049	2	Isolation measurement timeout
74	04A	5	HV interlock error
75	04B	5	HV fuse error
76	04C	2	Pack state of health low (warning)
77	04D	3	Pack state of health low
78	04E	4	Pack state of health critically low

Table 8-3, BCM Errors, continued

Fault ID	Log Event	Level	Description
79	04F	0	MCU Diagnostic register check error - SM12
80	050	4	Pack low voltage power supply out of nominal range
81	051	5	External emergency shutdown activation detected
82	052	4	BCU low voltage power supply out of nominal range
84	054	3	High deviation between minimum and maximum cell SoC
85	055	0	Crash detected
90	05A	0	Temperature of auxiliary temperature sensor 1 is too high
91	05B	0	Temperature of auxiliary temperature sensor 2 is too high
92, 124-138, 248-253	07C-08A, 0F8-0FD	3	Electrical status of the module controller temperature sensor XX
93, 139-153, 330-335	08B-099, 14A-14F	3	Electrical status of the cell temperature sensors in module XX
94, 154-168, 403-408	09A-0A8, 193-198	4	Critical electrical status of the cell temperature sensors in module XX
95, 170-184, 419-424	0AA-0B8, 1A3-1A8	3	Plausibility error of temperature sensors in module XX
96	060	3	MCU temperature too high
97	061	4	MCU auxiliary sinc filter check error - SM13
98	062	4	MCU State Timeout Error
99	063	4	MCU cell result range check error - SM18
100-121	064-079	0	Low cell SoC module XX
123	07B	2	Electrical status of the BCU temperature sensor
169	0A9	4	Low pack SoC warning for charging need
185	0B9	3	MCU Send bad CRC error - SM19
186	0BA	4	MCU thermistor measurement range check error - SM20
187	0BB	4	MCU GPIO open wire error - SM21
188	0BC	4	MCU Die temperature measurement error - SM22
189	0BD	3	MCU Diagnostic test on digital redundancy error - SM26
190	0BE	3	MCU Discharge verification algorithm error - SM27
191	0BF	4	MCU Verify that open wire currents not stuck on or off during cell measurements error - SM29
192	0C0	4	MCU GPIO adjacent short verification error - SM30
193	0C1	4	MCU Cell overvoltage detection error
194	0C2	4	MCU Cell undervoltage detection error
195-210, 232-237	0C3-0D2, 0E8-0ED	0	MCU Error of device XX
211	0D3	0	MCU Verify that open wire currents not stuck on or off during GPIO measurements error - SM31
212	0D4	5	CAN communication error of current sensor 1
213	0D5	0	CAN communication error of current sensor 2
214	0D6	0	Generic device error of CAN current sensor 1
215	0D7	0	Generic device error of CAN current sensor 2
220	0DC	2	Charge HV contactor deterioration warning
221	0DD	4	Charge HV contactor deterioration error

Table 8-3, BCM Errors, continued

Fault ID	Log Event	Level	Description
222	0DE	4	Charge HV contactor stuck open
223	0DF	5	Charge HV contactor stuck closed
224	0E0	3	Isolation error in closed contactor state
225	0E1	3	Isolation error in open contactor state
226	0E2	0	Error Memory: Write command out of range
227	0E3	0	Error Memory: Read command out of range
228	0E4	1	Non volatile memory initialization failed
230	0E6	0	CAN current sensors reported a short circuit state
231	0E7	4	MCU cell sinc filter check error - SM5
267	10B	0	Temperature of auxiliary temperature sensor 3 is too high
268	10C	0	Temperature of auxiliary temperature sensor 4 is too high
269	10D	0	Coulomb counter message of current sensor is missing
270-291	10E-123	3	High cell resistance module XX
292-313	124-139	0	Large resistance change of module XX
346	15A	0	Invalid checksum or alive counter value within message BatRecData1
349	15D	2	Isolation resistance warning (closed)
350	15E	2	Isolation resistance warning (open)
352-373	160-175	0	Large difference between predicted and measured voltage of module XX
383	17F	3	Current sensor 1 electrical error
384	180	3	Current sensor 2 electrical error
385	181	1	Manual error entry: Level 1
386	182	2	Manual error entry: Level 2
387	183	3	Manual error entry: Level 3
388	184	4	Manual error entry: Level 4
389	185	5	Manual error entry: Level 5
390	186	6	Manual error entry: Level 6
391	187	7	Manual error entry: Level 7
392	188	2	Capacity test mode activated
393	189	2	Total discharge mode activated
397	18D	4	Generic charge error
401	191	7	Cell deep discharge error
402	192	4	Voltage deviation error between cells
435	1B3	0	Temperature of auxiliary temperature sensor 1 is too high Warning
436	1B4	0	Temperature of auxiliary temperature sensor 2 is too high Warning
437	1B5	0	Temperature of auxiliary temperature sensor 3 is too high Warning
438	1B6	0	Temperature of auxiliary temperature sensor 4 is too high Warning
439	1B7	2	Temperature of IVT current sensor is too high Warning
441	1B9	4	Temperature of IVT current sensor is too high Error
442	1BA	1	Early warning signal (INT) error
443	1BB	1	Shock sensor error
444	1BC	0	Fan speed error
445	1BD	4	BCU high voltage power supply out of nominal range

Table 8-3, BCM Errors, continued

Fault ID	Log Event	Level	Description
448	1C0	4	L2 error: Main positive or precharge contactor is stuck closed
449	1C1	1	CAN BUS Off error
450	1C2	3	MCU multiplexer failure - SM1
451	1C3	3	MCU wrong second reference voltage - SM2
452	1C4	3	MCU wrong sum of cells - SM23
453	1C5	4	MCU open wire detected on any cell from specific module - SM4
454	1C6	4	MCU error during cell measurement - SM32 - Cell
455	1C7	4	MCU cell self test error - SM7
456	1C8	3	MCU wrong analog or digital power supply voltage - SM3
457	1C9	3	MCU wrong checksum received from LTC6813 - SM16
458	1CA	2	MCU ADC measurement inaccuracy error - SM8
459	1CB	3	MCU error during GPIO measurement - SM32 - GPIO
460	1CC	3	MCU GPIO self test error - SM11
461	1CD	3	MCU error during GPIO measurement 2 - SM9
462	1CE	5	MCU Clear cell results error - SM6
463	1CF	3	MCU wrong number of connected modules in daisy chain
464	1D0	3	MCU wrong number of connected cells per module
465	1D1	4	MCU SPI communication error
468	1D4	4	L2 error: CAN-based shunt sensor
469	1D5	4	L2 error: Cell temperature hard limit
470	1D6	4	L2 error: Cell temperature implausibility
471	1D7	4	L2 error: Cell temperature soft limit
472	1D8	4	L2 error: EE Unit temperature invalidity
473	1D9	4	L2 error: LTC safety mechanism fault
474	1DA	4	L2 error: EE Unit Maximum temperature fault
475	1DB	4	L2 error: Cell voltage difference
476	1DC	4	L2 error: Cell overvoltage fault
477	1DD	4	L2 error: Cell deep undervoltage fault
478	1DE	4	L2 error: Cell voltage soft limit fault
479	1DF	4	L2 error: Pack current short circuit fault
480	1E0	4	L2 error: current sensor implausibility
481	1E1	4	L2 error: pack current charging/discharging limit fault
482	1E2	4	L2 error: Hall sensor invalidity
483	1E3	4	L2 error: ADC-based shunt invalidity
484	1E4	4	L2 error: Incorrect configuration of modules or cells
485	1E5	4	L2 error: Incorrect number of modules-in-series
486	1E6	5	Safe state request: Temporary deactivation
487	1E7	7	Safe state request: Permanent shutdown
488	1E8	5	L2 Contactor opening based on Error Level 4
489	1E9	5	L2 Contactor opening
490-511	1EA-1FF	0	Large Capacitance Change of Module XX
512-533	200-215	0	SoC initialization error of module XX

Table 8-3, BCM Errors, continued

8.3.3 BCM Error 11: Positive HV Contactor Stuck Closed

One of the most commonly reported alarm error types, BCM error 11 is typically shown in the Recent errors as "11: Positive HV contactor stuck closed (5)." After an engineering review, this event has been confirmed to be a nuisance alarm with no impact on the system operation. The alarm is generated as the battery system is going down for another event. Although it is displayed as a level 5 alarm (noted as (5) after the alarm name), it is a passive event.

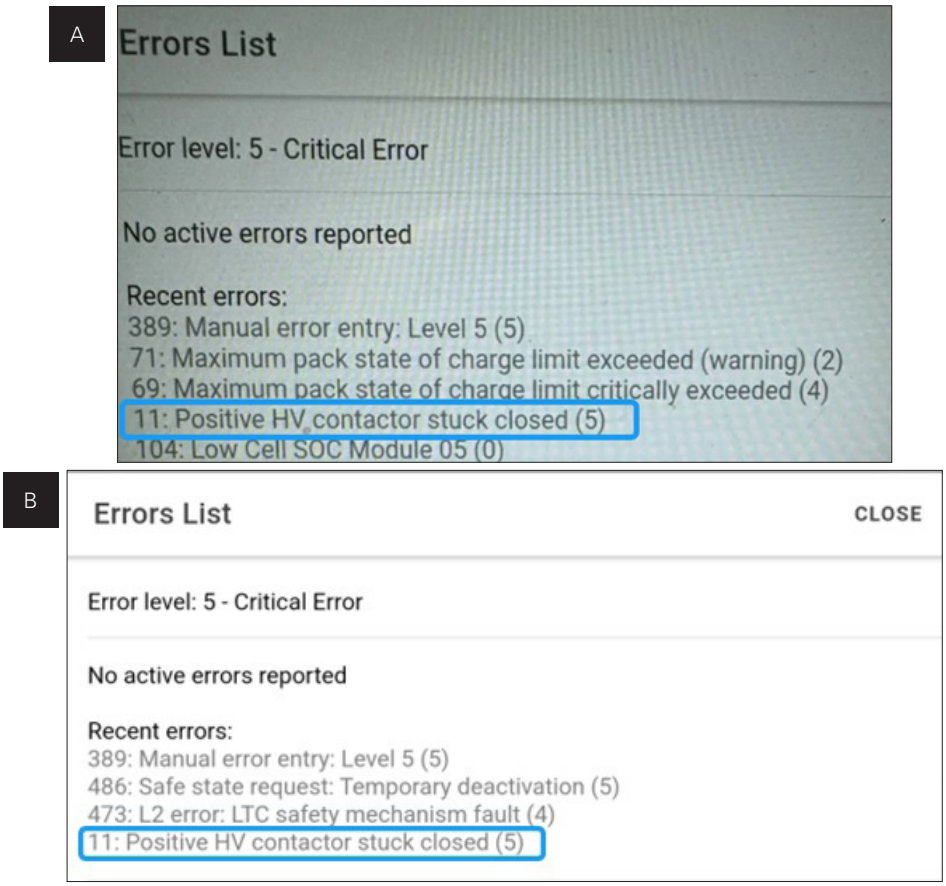


Fig. 8-1, BCM Error 11: Positive HV Contactor Stuck Closed (5) Alarm

When the "11" alarm is displayed, you can note it, but the real event that created the BCM to open contactors will be elsewhere in the list (in **Fig. 8-1**, the event in example A is the 69: SOC alarm, and in example B it's the 473: L2 error alarm). This is true for any log or diagnostic reporting interface.

Suggested mitigation:

When a shutdown condition is identified, note all the alerts but ignore the "11: Positive HV contactor stuck closed". Review other alarms in the list with a severity of 4 (4) or greater, perform repair operations on those alarms, and attempt a link-up or lockout recovery as required. When the alarms are cleared, the "11: Positive HV contactor stuck closed" will also be cleared and is not returned.

If a condition requires a BCM replacement, there is no need to report the "11: Positive HV contactor stuck closed" alarm in the issue report, just annotate the other events.

8.4 Portable Generator

In the event of a prolonged power outage, an NRTL listed, Alpha® approved portable AC generator can be used to feed the AC input of the XM3.1-HP™ power supply.

CAUTION!

Under no circumstances should a portable DC generator be used on the lithium battery bus.

9.0 Alpha Part Numbers

9.1 Part Number Series Options

NOTICE:

Alpha® part numbers are correct at the time of printing. As part numbers are subject to change, please contact your Alpha® product sales representative prior to ordering to ensure that numbers are correct.

Item	Part Number
Security Key	647-089-10
Service Disconnects	
FBX-30A	740-00074-20
FBX-60A	744-534-21
Replacement Fuse for FBX-60A or FBX-30A (FU, 9/16×2 20A 250V CURRENT LIMITING, Class R)	460-192-10
Lightning Arrester	
LA-P-120T 120V (L-N, L-G, N-G)	162-046-10
Service Power Inserter (SPI) 20A	
ASSY, SPI, W/GND WR, PN SER	744-279-22

Table 9-1, Part Number Series Options

9.2 PN-4LI/LIB Spare Part List

Item	Part Number
Power Supply	
XM3.1-918-HP	017-950-21 (Configuration X6C-H2-0BA0-0001)
Battery Power Module (BPM)	
PSI-36-1800	GL0005719-0000
Battery Control Module (BCM)	
PSI-36-BMS	GL0005910-0000
XM3.1-HP™ Power Supply to BCM A Extension Cable Kit with COM	
BCM-EXT,17 IN,6AWG,W/COM,PN-4LI	876-00106-20
BIU-EXT,15',6AWG,W/COM,PN4FT	876-00061-21
BIU-EXT,20',6AWG,W/COM,PN4FT	876-00061-22
BIU-EXT,50',6AWG,W/COM,PN4FT	876-00061-23
BCM A TO BCM B Extension Cable Kit with COM	
BCM-EXT,52 IN,6AWG,W/COM,PN-4LI	876-00106-22
BCM B TO BCM C Extension Cable Kit with COM	
BCM-EXT,40 IN,6AWG,W/COM,PN-4LIB	876-00106-21
System COM Cables	
WR KT,SYS,COM,RS485,CBL,24 IN,PN-4LI	876-00104-20-xxx
WR KT,SYS,COM,RS485,CBL,48 IN,PN-4LI	876-00104-21-xxx
WR KT,SYS,COM,RS485,CBL,56 IN,PN-4LI	876-00104-22-xxx
WR KT,SYS COMM,PLZD ALPHA BUS CBL,18'	875-190-22-xxx
WR KT,SYS COMM,PLZD,ALPHA BUS CBL,50'	875-190-24-xxx
WR KT,SYS COMM,PLZD ALPHA BUS CBL,25'	875-190-27-xxx
RS485 Communication Termination	
TERM,120OHM,OFFSET,6P6C	ATL7400644-001
Alpha Bus Communication Cable Components	
CONN,TEL,MDLR,6POSN/6CNTCT LN PLG,OFS	545-275-19
CBL,TEL,6C FLAT,#26 AWG STD,GRA VNYL	858-042-19
Battery Cable Kit Extensions	
BCK-EXT,6AWG,15',PN4FT	876-00060-21-xxx
BCK-EXT,6AWG,20',PN4FT	876-00060-22-xxx
BCK-EXT,6AWG,50',PN4FT	876-00060-23-xxx
BCK-EXT,6AWG,17 IN,PN-4LI	876-00105-20-xxx
BCK-EXT,6AWG,40 IN,PN-4LI	876-00105-21-xxx
BCK-EXT,6AWG,52 IN,PN-4LI	876-00105-22-xxx
CONNECTOR,KIT,BATTERY,6AWG-1/0AWG,FORPN-4LI	876-00116-20-xxx

Table 9-2, PN-4LI/LIB Spare Part List

BPM Enclosure Wire Harness PN-4LI & PN-4LIB	
WR HRNSS,BPM,16FR,6BK,10 to 6AWG,PN-4LI	876-00078-20-xxx
WR HRNSS,BPM,22FR,10 to 6AWG,PN-4LIB	876-00079-20-xxx
WR HRNSS,BPM,6BK,10 to 6AWG,PN-4LIB	876-00080-20-xxx
WR HRNSS,BPM,SBS75X,END,PLUG	876-00112-20-xxx
TIE,CBL,8"L,NYL	651-002-19
KIT, LABEL, SINGLE CABINET, WITH 28BPM, FOR PN-4LIB	740-00088-20-xxx
Conduit Pass-through Kit (Includes #6 AWG GND Wire and Poron gasket, but not fire putty)	
ASSY,.CND,PN-4LI TO PN-4LIB (Poron Gasket: GSKT, SL, FOR 2" CND, PORON	744-793-26 (648-023-10-001)
3M® Fire Barrier Moldable Putty Stix MP+	973-00004-10
HILTI® 618 Firestop Putty Stick	973-00005-19
Lifting Ears for PN-4	
KT,LFT,5K GEN,SFG	744-941-27
Hazard Indicator	
ASSY,LRI,LONG-LIFE,XM SER	740-139-20

Table 9-2, PN-4LI/LIB Spare Part List, continued

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