# EGUANA Commercial AC BATTERY™

Model/Series
ACB15-480/208

## ❖ Installation & Start-up Guide

For use only with battery model
- LG Chem EM048126P3S7

# IMPORTANT SAFETY INSTRUCTIONS

## SAVE THESE INSTRUCTIONS

This manual contains important instructions for the Eguana Commercial AC Battery™ Energy Storage System. The Eguana Commercial AC Battery™ components described by this manual are intended to be used as part of an Energy Storage system and installed per all local building codes and regulations in addition to the National Electrical Code, ANSI/NFPA 70 (for US) and Canadian Electrical Code (for Canada).

**CAUTION! Hazardous Voltages! This inverter contains hazardous voltage and energy that may be lethal**. It may only be installed by qualified personnel who have read this manual and are familiar with its operation and hazards. The following safety procedures should be followed:

**CAUTION! Equipment powered by two sources of power.** Disconnect all power sources and wait 5 minutes before servicing.

1 Only connect the PCS cabinet to a compatible electrical service as defined in the model specifications. The PCS must be connected to a dedicated branch circuit in the main electrical panel.

2 An external disconnect switch shall be provided in the end installation by others for the AC Grid output circuit.

**CAUTION! This equipment contains high energy lithium batteries.** Qualified and trained personnel should wear protective clothing and equipment when working inside the battery cabinet and/or with battery modules.

**3 The PCS is compatible with the LG Chem battery model EM048126P3S7 only.**

**CAUTION! The batteries provided with this system must be charged only by the PCS included as part of the energy storage system.** Do not attempt to charge batteries with any other charger device or connect any devices directly to the DC battery bus.

4 Ensure proper electrical grounding in accordance with code requirements.

5 Ensure proper airflow path for active cooling.

6 Never operate system in a manner not described by this manual.

7 Only qualified personnel should service this product.

8 Ensure all covers are securely fastened after installation is complete.

9 This product must be stored indoors in an environmentally conditioned location prior to installation, protected from rain and exposure to any hazardous chemicals.

10 Do not attempt to operate this product if there is any physical evidence of damage to any of the cabinets or internal components.

**CAUTION! This equipment is heavy.** Mechanical lifts are recommended for safe installation.

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# 1 Safety

This manual contains important instructions for the Eguana Commercial AC Battery™ Energy Storage System. The Eguana Commercial AC Battery™ components described by this manual are intended to be used as part of an Energy Storage system and installed per all local building codes and regulations in addition to the National Electrical Code, ANSI/NFPA 70 (for US) and Canadian Electrical Code (for Canada).

Throughout this manual, the following symbols will be used to highlight important information and procedures:

| Symbol | Definition | Symbol | Definition |
|---|---|---|---|
|  | ***WARNING! A dangerous voltage or other condition exists. Use extreme caution when performing these tasks.*** |  | Meter measurement required. |
|  | ***CAUTION!*** *This information is critical to the safe installation and or operation of the inverter. Follow these instructions closely.* |  | Torque rating critical to operation. |
|  | ***NOTE:*** *This statement is important. Follow instructions closely.* |   | Login to the remote monitoring system for operating status |

## 1.1 In case of emergency

**In all cases:**

- If safe to do so, switch off the AC breakers (external to the system) .
- Contact the fire department or other required emergency response team.
- Evacuate the area, and if applicable, follow your emergency evacuation plan if others are in proximity to the installed location.

**In case of fire:**

- When safe, use a fire extinguisher suitable for use; including A, B, and C dry chemical fire extinguishers or carbon dioxide extinguishers.

**In case of flooding**:

- Stay out of water if any part of the system or wiring is submerged.
- Do not attempt to operate batteries that have been submerged in water even after they have been dried.

**In case of unusual noise, smell or smoke:**

- If safe to do so, ventilate the area.

## 1.2 Battery module safety precautions

This product is integrated with LG Chem EM048126P3S7 series battery modules. Refer to the LG Chem product manual LG Chem P3S series 48V Standalone Battery Module Installation Manual, for complete safety instructions regarding handling of battery modules.

## 1.3 General safety precautions

**Important!** Installation, service, and operating personnel must read this document in its entirety, and observe all safety and installation procedures as described in this manual. Never operate system in a manner not described by this manual.

Only qualified personnel should service this product.

Ensure all covers are securely fastened after installation is complete.

Personal Protective Equipment (PPE) in compliance with local work place safety standards must be worn when working inside the cabinet.

| Risks of Fire |
|---|
| Do not expose the system to temperatures exceeding 60 degrees Celsius. |
| Avoid installation in direct sunlight. |
| Do not store objects on top of the cabinet. |
| Do not obstruct the airflow paths of the HVAC cooling system. |
| Do not obstruct the intake or exhaust of the forced airflow system. |
| Do not store combustible objects and corrosive chemicals directly adjacent to the system. |
| **Risks of Shock** |
| **WARNING! Hazardous Voltages. The Inverter contains hazardous voltage and energy that may be lethal**. It may only be installed by qualified personnel who have read this manual and are familiar with its operation and hazards. |
| Only connect the PCS cabinet to a compatible electrical service as defined in the model specifications. The PCS must be connected to a dedicated branch circuit in the main electrical panel. |
| Ensure proper electrical grounding in accordance with code requirements. |
| **CAUTION! Both AC and DC voltage sources are terminated inside this equipment. Each circuit must be individually disconnected before servicing** |
| **Risks of Damage** |
| **The PCS is compatible with the LG Chem battery model EM048126P3S7 only.** Do not attempt to connect any other battery to the system. |
| Do not connect any other loads directly to the battery power bus. |
| Do not drop, tip, or puncture the cabinet during transport and installation. Visible damage to the cabinet and/or internal components should be reported to the manufacturer immediately. |
| Do not store this system for periods longer than six months without a battery maintenance charge. This may result in permanent damage to the batteries. |

## 1.4 Environmental Protection

Do not dispose of the system or any of the components within the cabinet. Batteries, electronics, cables, and metal parts are recyclable. Consult your municipal waste management authority to determine required methods of component recycling.

# 2 Introduction

## 2.1 About this Manual – Target Audience

This manual is intended to be used by qualified service and installation personnel for the purposes of product installation. This manual contains instructions for the installation and start up sequence of the Eguana Commercial AC Battery energy storage system. This product is permanently wired to the electrical service, and must be installed by a licensed electrician only.

This system requires an externally supplied energy management system to operate and manage the battery system. The energy management system must be qualified and approved for use by Eguana Technologies to be compliant with the manufacturer warranty. Consult the manufacturer for a list of approved energy management systems prior to installation of this product.

## 2.2 Glossary

| Term | Definition | Term | Definition |
|---|---|---|---|
| AC | Alternating Current | NC | Normally Closed |
| ARC | Auto Recovery Circuit | NEC | National Electrical Code |
| CPU | Central Processing Unit | NO | Normally Open |
| DC | Direct Current | PCS | Power Control System (Inverter) |
| EMS | Energy Management System | PE | Protective Earth |
| ESD | Electrostatic Discharge | PV | Photo-Voltaic |
| ESS | Energy Storage System | RF | Radio Frequency |
| GND | Ground | SOC | State Of Charge (Battery) |
| LED | Light Emitting Diode | SOH | State of Health (Battery) |

## 2.3 Initial Inspection of Material List

In addition to the battery system, the following additional components are supplied with your Eguana Commercial AC Battery™ Energy Storage system. Each component should be inspected visually for any damage that may have been caused by shipment. If damage is present, please contact your local distributor.

- Cabinet canopy
- Hardware kit
- Installation and Startup Guide
- Antenna (optional)

## 2.4 Installation materials not included

The following materials should be readily available to install the system:

- CAT 5e communication cable of appropriate length and gauge (non-integrated EMS)
- RJ-45 connectors (EMS communication)
- Mounting hardware for pad mounting of cabinet – up to ½" hardware supported.

## 2.5 Special Tools

In addition to standard tools required for cabinet mounting, the following tools should be readily available to interconnect the battery and PCS cabinets.

- RJ-45 crimp tool (EMS to PCS communication cable).

# 3 Installation Site Preparation

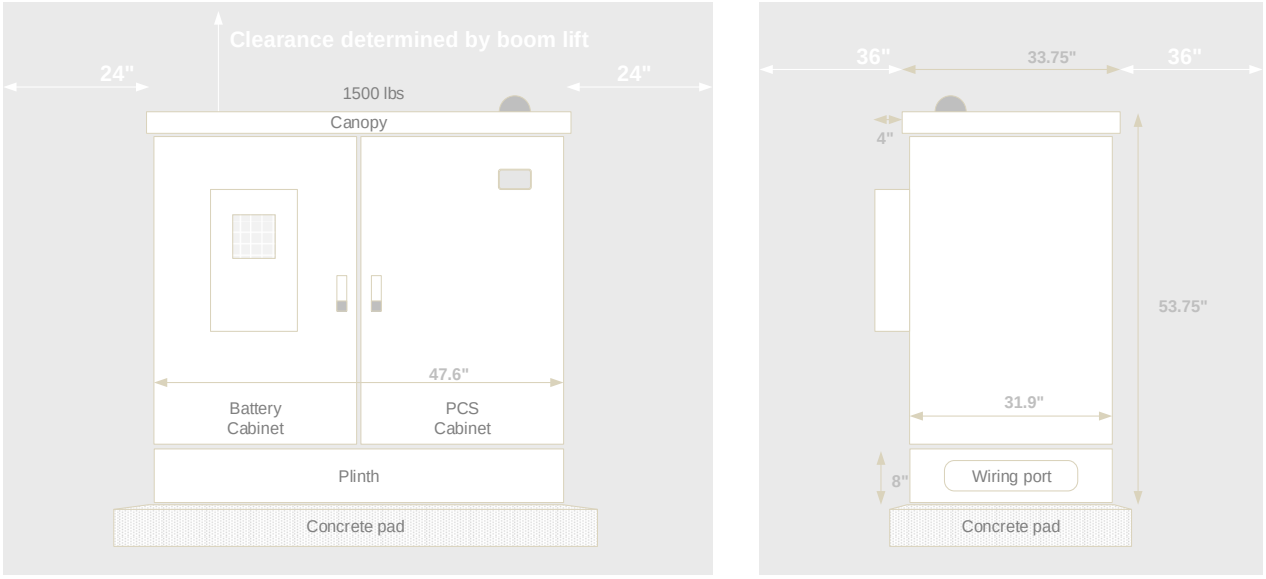
Before installing the system, read all instructions and warnings in this manual.

***CAUTION! All electrical and civil installation work should be performed in accordance with local building and electrical codes.***

## 3.1 Installation Planning

***CAUTION! The cabinet weighs approximately 1500 lbs. Handle with care. All six lift points must be used to lift the cabinet into its fixed position, and equal tension at all six lift points is required to prevent damage to the interconnected cabinets. Ensure equipment and lift straps used are rated to safely install the system.***

***CAUTION! Avoid installation in direct sunlight. Battery performance is dependent upon operating ambient temperature.*** *Radiant heat absorbed in direct sunlight will greatly reduce the performance of the batteries and will prematurely cause degradation of the display indicator panel on the front of the cabinet. The HVAC option will be required where direct sunlight installation is the only option. Refer to Section 12 for more details.*




Front View Side (Right) View

*Figure 1: Mounting installation plan – minimum clearances required for installation and service access to the battery system.*

## 3.2 Cabinet Plinth Pad-mount Dimensions

The following diagram illustrates the pad-mount footprint dimensions for the cabinet plinth, with relative position of the field wiring ports near the front-right corner of the cabinet plinth. Anchoring of the cabinet is supported by four mounting holes rated up to ½" (13 mm) anchor bolts.

***CAUTION! Concrete pad or floor must be level to ensure proper weight distribution of rack-mount components within the cabinet. All civil work should be performed in accordance with local building codes.***

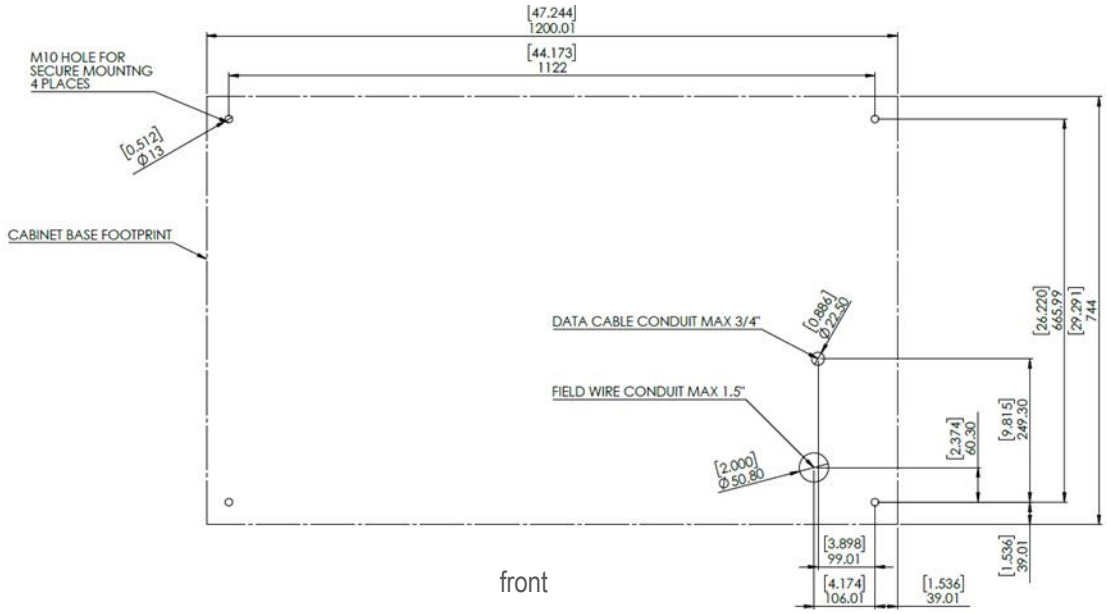



*Figure 2: Cabinet Plinth Pad-mount dimensions.*

## 3.3 Cabinet lift method

The following diagram illustrates the lift points. The two cabinets are interconnected at the base plinth and the top center lift hardware. Note that the product is shipped without the canopy installed, such that it is ready for direct lift off of the shipping pallet.

***CAUTION! The cabinet weighs approximately 1500 lbs. Handle with care. All six lift points must be used to lift the cabinet into its fixed position, and equal tension at all six lift points is required to prevent damage to the interconnected cabinets. Ensure equipment and lift straps used are rated to safely install the system.***

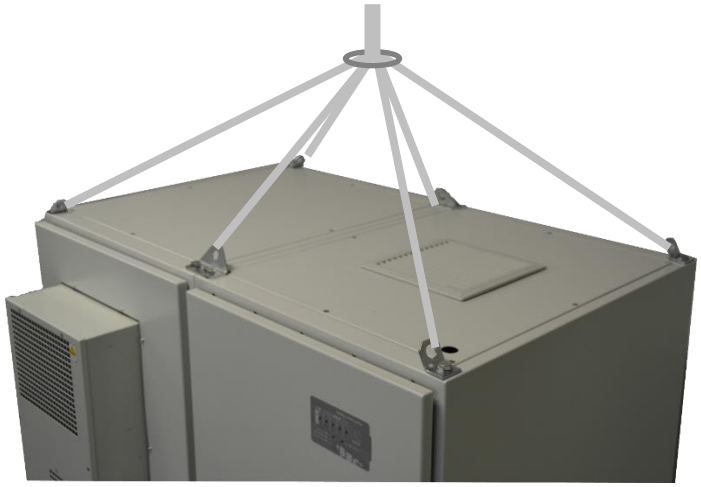
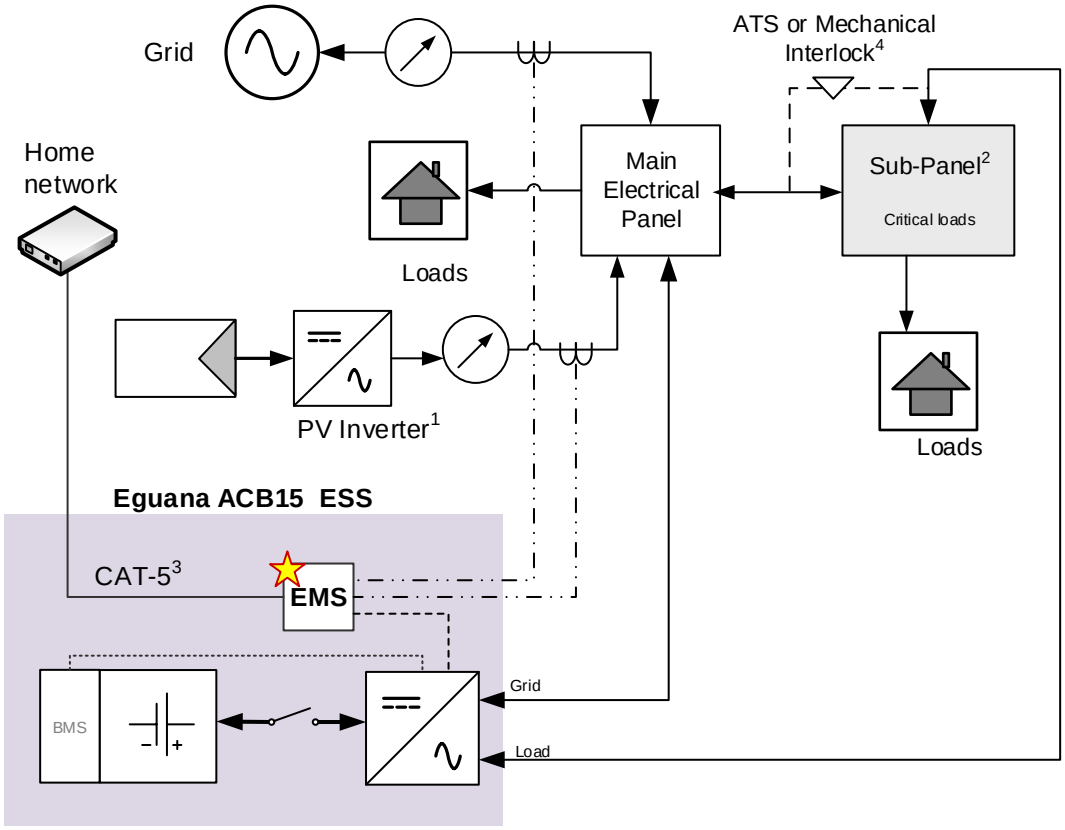


*Figure 3: Lift points on the battery system.*

## 3.4 SLD - AC Coupled PV System with Back-up Power Operation

The following block diagram is representative of an AC coupled solar plus storage system with backup power operation (480V model only).




***Important:*** *The above diagram is a single line representation of a utility interactive battery system with AC coupled PV to a critical load panel, based on the electrical ratings of the Eguana AC battery. Please consult your National and local electrical codes for full compliance in an actual installation.*

1 – PV Inverter should not exceed rating of base load plus battery inverter rating for optimal self-consumption and/or where PV export to grid is not permitted.
2 – Sub-panel is grounded directly from the main panel.
3 – Refer to EMS/gateway specs for communication cabling requirements.
4 – An Automatic Transfer Relay (ATS) or Mechanical interlock is recommended in case of system service. This will power critical loads directly from the grid.

*Figure 4: Single Line Diagram: Typical AC coupled PV system.*

# 4 Cabinet Installation Instructions

1. Lower the cabinet onto the concrete pad/floor, positioning the cabinet over the mounting points. Remove the lift straps.

2. Secure the cabinet to the floor at the four corner mounting points on the base of the plinth.

*Figure 5: Wiring Port and Plinth mounting access.*

3. Lower the canopy cover onto the cabinets.

   Note: Wi-Fi / Cellular antenna option; if your system was delivered with an optional antenna kit, mount the antenna to the canopy by adhering the gasket against the top of the canopy and tightening the nut against the bottom side of the canopy. Then lower the canopy onto the cabinets and route the antenna cables through the cabinet port immediately below the antenna. Propping the front of the canopy upward towards the front will make cable routing easier.

4. Terminate the antenna cables at the EMS antenna inputs on the inside of the PCS cabinet door. See the EMS installation documentation for installation details.

*Figure 6: Lowering canopy onto cabinet - antenna kit option shown.*

5. Fasten the canopy to the cabinets using the 20 Phillips screws and washers in the supplied hardware kit; 10 at the front, and 10 at the rear of the cabinet.

*Figure 7: Fastening the canopy to the cabinet.*

# 5 Internal Product Layout


*Figure 8: System Internal Layout.*

| Ref | Definition | Ref | Definition |
|---|---|---|---|
| 1 | Air conditioner | 9 | Cabinet Plinth |
| 2 | Master Battery Module | 10 | Antenna |
| 3 | Battery Disconnect | 11 | AC Field Wiring Terminals |
| 4 | Canopy | 12 | EMS Control Panel (not included) |
| 5 | PCS Cabinet Exhaust Fan + Filter | 13 | Air Inlet + Filter |
| 6 | PCS Master – Phase A | 14 | (side) AC Wiring Port Access Panel |
| 7 | PCS Slave – Phase B | | |
| 8 | PCS Slave – Phase C | | |

# 6 System Electrical Wiring

**Note:** This product is capable of providing utility interactive and islanded back up power and can be AC coupled to a utility interactive photovoltaic inverter through the grid-coupled circuit. Wiring methods must be in accordance with local electrical codes. The installer is responsible for ensuring that over-current protection is installed and sized appropriately for the AC grid and off-grid output circuits, in accordance with the National Electrical Code, ANSI/NFPA 70, Canadian Electrical Code and local codes.

## 6.1 AC Grid and AC Load Wiring

CAUTION! To reduce the risk of fire, connect only to a dedicated circuit provided with appropriate branch circuit over-current protection in accordance with local electrical codes.

Refer to Figures 9 and 10 below for connection of AC Grid and AC load circuits. The AC wiring size for the AC grid and AC Load is to be determined based on the AC over-current protection installed, and not to exceed ratings as provided in table 2.

1. Route the AC Grid wiring (3 wire) from the main electrical panel to the [AC Grid] terminal block of the AC Battery.
2. 480V model only: If applicable, route the AC Load wiring (3 wire) from the critical load panel to the [AC Load] terminal block of the AC Battery.

***WARNING! Improper connection of the wiring panel may result in equipment damage and cause personal injury. Disconnect all AC and DC Sources prior to installation.***

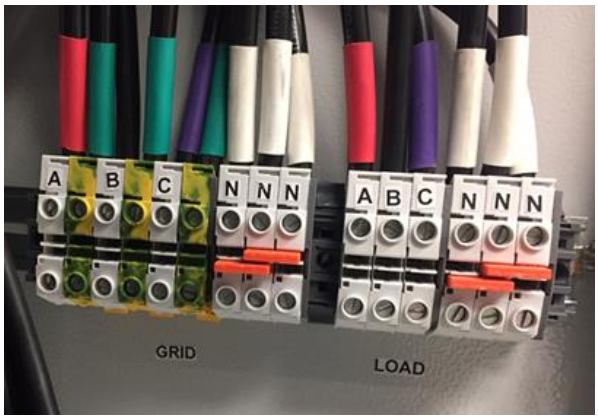



*Figure 10: PCS AC Grid and Load Wiring Terminals – 480 V Wye model shown.*

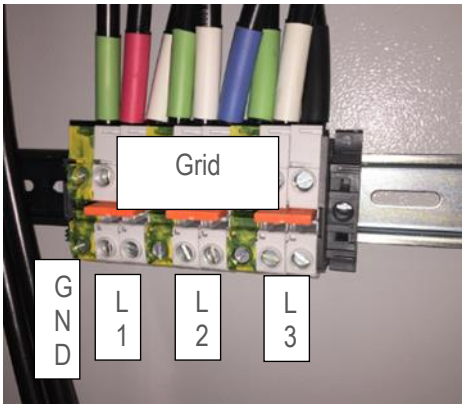



*Figure 9: PCS AC Grid Wiring Terminals – 208 V Delta model shown.*

## 6.2 Chassis Grounding

In this section, “Chassis Ground” is referred to as “ground” or “grounding” unless otherwise mentioned.
The AC and DC grounding are intended to provide a low impedance signal path at all frequencies.

DC Ground Wiring Installation: The default setting for DC grounding is set for DC negative to ground. This is to indicate that the DC negative terminal of the inverter is grounded within the PCS system.

AC Ground Wiring Installation: The AC power grounding is achieved through the ground terminal blocks which are connected to the PE ground terminals on the AC Filter Boards  If a neutral connection is present (ACB15-480), it is not bonded to the AC power grounding within the unit.  Refer to table 2 for wire ratings.

**Note: The field ground wire rating applies to the AC circuit only**.  The DC source loop is internal to the battery cabinet, and is rated accordingly.

Lightning Grounding: The inverter has built-in lightning protection. In order for the lightning protection to be effective, the grounding for lightning currents must be provided via low impedance path from AC Filter Board to System Ground and further to the building Ground/Earthing point.

## 6.3 EMS to PCS Communication Wiring & RJ45 Pin-out

The PCS provides the user with a communications link to an EMS controller via RS-485.

1. Connect the communication cable to the [EMS In] port (RJ-45) of the master PCS module (ref: fig 8, item 6). Refer to the PCS pinout table below for terminating the PCS end. Refer to the EMS instruction manual for communication wiring to the EMS.  .


| EMS | PCS | PCS: RJ-45 Pin |
|---|---|---|
| G+shield | G | 3 |
| A | A | 4 |
| B | B | 5 |

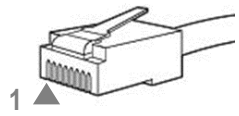



*Figure 11: EMS to PCS wiring.*

## 6.4 Auxiliary Actuator Relays

The AC Battery contains two actuators which can be used by the EMS to provide external alarm/control based on different operating states or modes of service, referenced as shown (P10, P11 reference).

EMS

Refer to the EMS operator’s manual for implementation details.

# 7 Start-up Sequence

**CAUTION! Powering the energy storage system requires a specific start-up procedure. Please follow the steps below.**

**CAUTION! If the battery disconnect has been placed in the OFF position at any time during operation, wait one minute before returning to the ON position. Rapid cycling (less than one minute) of the battery disconnect can cause damage to the pre-charge circuits of the PCS modules.**

**CAUTION! During the first start-up sequence after installation, the battery modules may require a battery maintenance cycle to balance the SOC.** This maintenance cycle requires a grid connection so that the PCS can be commanded to charge the batteries. The PCS battery SOC alarm light will flash yellow if maintenance and/or other battery faults are present. This procedure may take from a few minutes to a few hours, depending on the difference in battery module SOC. Please refer to the PCS Service Manual for more information.

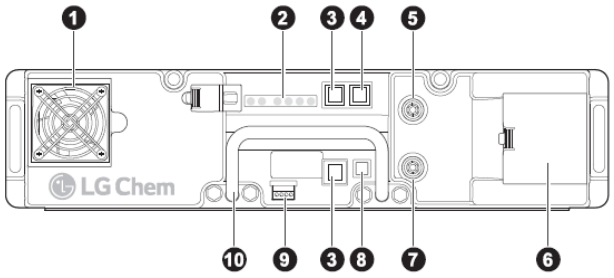



*Figure 12: Battery BMS interface.*

1. Fan
2. Status indicators
3. RJ48 port for intra-rack communication cable
4. RJ48 port for higher-level communication cable
5. Positive connector (+)
6. Power terminal compartment
7. Negative connector (–)
8. On/Off button
9. Dry contact
10. Handle

1. Remove the front cover from the battery cabinet adjacent to the PCS cabinet.

2. Press the [Power] button (see above, label #8) on the master battery module. The master battery module has communication wired from the battery BMS port (label #3) to the PCS [BMS in] port.

**WARNING! When the batteries are turned ON, the battery voltage will be present at the power panel assembly busbar where the battery modules are terminated.**

3. *This step may take up to one minute.*

   Verify that the indicators are as shown in "Normal Operation" as shown below.

## Battery Power Button Operation

**Turn Batteries ON:** Press and Release the power button on the module designated as the Master module (this is the top module within the battery cabinet)
(PCS connected com cable).

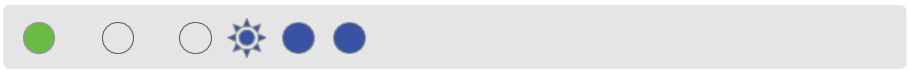
**Turn Batteries OFF:** Press and hold 5 seconds the power button of any module designated as a Slave Module. If all modules do not shut off, repeat individually for each module.

| | |
|---|---|
| | Normal |
| | SOC ≥ 75% |
| | SOC ≥ 50% |
| | SOC ≥ 25% |
| | SOC < 25% |
| | Voltage imbalance |
| | Warning |
| | Fault 1 |
| | Fault 2 |

**Green indicator**: The left indicator indicates normal operation.

**Blue indicators (SOC)**: In normal operation, the four indicators on the right show the module's state of charge (SOC). Each indicator represents 25% of a full charge. If the SOC value is 50%, the three rightmost indicators are on solid ***BLUE***. The blue indicators of the slave modules look as below.

Whereas, the leftmost blue indicator on the master module flashes.



4. Also, verify that the module with the left-most flashing blue SOC indicator corresponds to the module which has communication wired from the BMS to the PCS [BMS in] port.

**Caution!** If the battery module other than the module designated as a master has a flashing SOC light at startup, shut down all battery modules by holding the [Power] button for 5 seconds. In this state, it may be necessary to shut down battery modules individually. After all modules are OFF. Repeat steps 2 and 3.

5. Turn ON the Battery disconnect switch inside the battery cabinet (see Figure 13).

6. The PCS module will initialize, indicated by a brief flash of all LEDs on the display panel, followed by a status of the battery and PCS. Refer to table 5 for indicator status of the PCS.

7. Turn ON the AC breaker at the main electrical panel to the PCS.

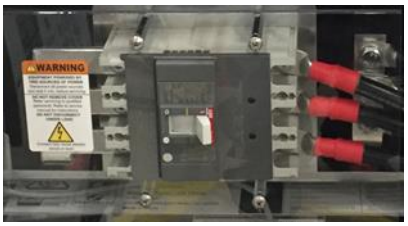



*Figure 13: Battery breaker disconnect turned ON.*

## 8 Operation

EMS

This product does not operate without a 3rd party supplied energy management system. Please consult the EMS manual for operation of this system.

# 9 PCS Display Panel

## 9.1 LED Display Indicators

The PCS cabinet is equipped with a display panel that provides indication of the following:

- Battery Operating State
- PCS Operating State
- (out of) Service Indicator

Refer to section 9.2 for a complete definition of indicator states.

To conserve energy, the LEDs will turn off after 5 minutes from being activated. They can be re-activated by pressing the service button.

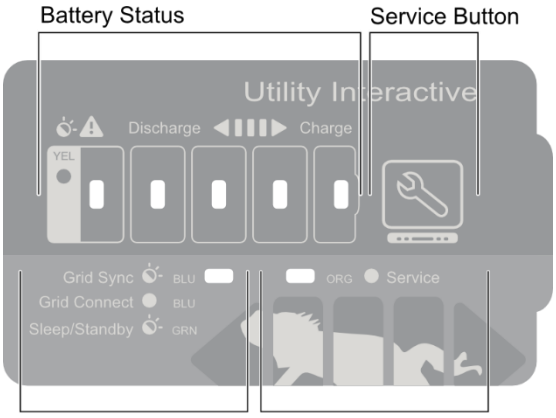
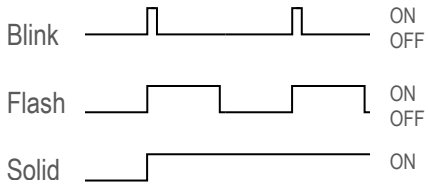



*Figure 14: PCS display panel.*

## 9.2 PCS display panel indicator summary.

The LEDs on the PCS identify operating states by both display mode and color.
The display mode patterns (shown right) are defined as:

- Blink: short ON, long OFF
- Flash: equal ON/OFF
- Solid: steady ON




| Indicator | Status | Display mode | Display Color |
|---|---|---|---|
| Battery Status | State of charge | (L-R): 5 LEDs, 20% SOC per LED | Green >20%, Yellow <20% |
| | Initialized | One time blink | Multi |
| | Charging | Flashing pattern - right | Green |
| | Discharging | Flashing pattern - left | Green (Yellow <20%) |
| PCS Status | Sleep/Standby | Blinking pattern | Green |
| | Pre grid-connect notification | Flashing pattern | Blue |
| | Grid connected | ON | Blue |
| | Off-grid mode | ON or Blinking pattern | Green/Yellow |
| Service Status | Service | ON | Orange |
| | Programming mode | ON | Green |
| | Active sleep | Blinking pattern | Green |
| | Pre-charge | Blinking pattern | Green |
| | DC Ground Fault | Blinking pattern | Yellow |
| Auto-Recovery | All lights rapid blinking – See section 11 for more details. | | |

### 9.3 Service Button

The service button can be used to wake the LED display, and either place the system into or out of service mode, as well as cycle through various operating modes. If the system has gone into service mode, the user can attempt to bring the system back into normal operation using the service button. Note that on the Commercial AC Battery the service button is only accessible from the inside of the PCS cabinet (on the LED circuit board, mounted on the door).

| Observed state | Action | Service button command |
|---|---|---|
| All panel lights off | Wake panel display | Press and release |
| Service light on | Exit service mode | Press and hold 5 seconds |

Refer to *section 11 – Troubleshooting* if the service button does not perform the action requested.

## 10 Maintenance

The energy storage system requires very little maintenance; annual inspections of the airflow path, and replacement of the air intake and exhaust filters are all that is required. For models including the air conditioner, annual maintenance is also required. Consult the Envicool manual included with the system for more details. There are two filters to inspect and replace, if necessary (see- section 5, figure 8 for location of filters):

1. Exhaust fan filter – Inside the PCS cabinet, top-center.
2. Air inlet filter – Inside the front door of the PCS cabinet.

## 11 Troubleshooting

System faults are reported and logged in the monitoring system. All fault logs are also accessible remotely by your installer.

**IMPORTANT!** Contact your system installer as recommended below if any of the following conditions are present on the front display of the inverter panel.

| PCS indicator status | Definition/Action |
|---|---|
| Service light ON | System is prevented from normal operation due to an internal fault. Upon first power up of the system, the PCS can also go into service mode if the PCS is powered by the battery but there is no valid AC source. Check the AC breaker for the ESS at the main panel. Log into the EMS via web browser to retrieve the service code before attempting to clear the service code. |
| All panel lights flashing | The PCS has a valid AC power input, but does not detect a battery voltage, and the system is attempting battery recovery. Check the battery disconnect. Check the communication cable from the master battery module to the PCS's BMS port (Appendix A – ref: A1). Notify service personnel if this condition persists more than 30 minutes. |
| All panel lights OFF after service button wake command | This indicates loss of both AC And DC sources to the PCS. Check AC and DC circuit breakers and disconnects. |
| Sleep/standby mode engaged | This is a normal operating mode initiated by the EMS when the battery SOC reaches the maximum or minimum SOC. Loss of EMS communication will also engage the PCS into sleep/standby mode. If on initial power up of the system, the PCS does not exit sleep/ standby mode, and one to four battery SOC lights are ON, inspect the EMS to PCS communication cable , and verify that the EMS is powered. |

# 12 Specifications

*Table 1: PCS Electrical / Mechanical Ratings*

| Model | ACB15 | |
|---|---|---|
| AC Grid Specifications | -208 | -480 |
| Nominal AC Voltage | 208 V (L-L), 3 Phase Delta | 480 V (L-L), 3 Phase Wye |
| AC Voltage Range (default) | -12% to +10% of nominal AC voltage | |
| Nominal AC Frequency | 60 Hz | |
| Frequency Range (default) | 59.3 to 60.5 Hz | |
| Rated AC Current | 41.6 A (Line) | 18.1 A (Line) |
| Continuous AC Power | 15000 VA | |
| Power Factor | > 0.99 (fixed) / 0.8 leading to 0.8 lagging (adjustable) | |
| Harmonic Distortion | < 5% | |
| Efficiency (PCS only) | 96% Peak | |
| Maximum Output Overcurrent Protection | 60 A | |
| Maximum AC Short-circuit Current | 99 $A_{pk-pk}$, 2.1 $A_{rms}$ (50 ms) | |
| Maximum Synchronization In-rush Current | 32 $A_{pk-pk}$, 2.0 $A_{rms}$ (50 ms) | |
| Galvanic Isolation | Integrated transformer | |
| Protective Class (I, II, or III) | Class I | |
| Over-Voltage Category (OVC I, II, III, or IV) | OVC III | |
| Pollution Degree | 3 | |
| Lightning Protection | IEEE 62.41.2, location category C, low exposure | |
| Active Anti-islanding Method | Sandia frequency shift | |
| Grid Monitoring | Active in all states | |
| Configurable Grid Management Functions | Watt Reduction, VAR Control, VRT/FRT Control | |
| Power Ramp Rate | 0.1% to 100% / sec, programmable | |
| Energy Storage Specifications | -39 | |
| Rated AC Energy | 39.1 kWh | |
| Rated Charge / Discharge Current | 300 Adc / 375 Adc | |
| Nominal DC Voltage | 48 Vdc | |
| Operating DC Range | 40 to 65 Vdc | |
| DC Overcurrent Protection | 525 Adc | |
| Mechanical | Base Model | -H (HVAC option) |
| Max Humidity | < 95% (non-condensing) | |
| Enclosure Type | Type 3R outdoor | |
| Cooling - PCS Cabinet | Fans | Fans |
| Cooling - Battery Cabinet | Natural convection | Air conditioned |
| Enclosure Dimensions (WxHxD)<br>(excluding antenna) | 1245 x 1365 x 857 mm<br>49" x 53.75" x 33.75" | 1245 x 1365 x 959 mm<br>49" x 53.75" x 37.75" |
| Antenna Height | 82 mm<br>3.2” | |
| Enclosure Weight | 653 kg<br>1437 lbs | 674 kg<br>1483 lbs |
| Operating Temperature | -10 to +45 C | -15 to +50 C |
| Full Load Operating Temperature | 0 to +40 C | -5 to +45 C |
| Air Conditioner, Base Load Power | - | 300 Watt |
| General Specifications | | |
| External Communication | Modbus RTU (RS-485) | |
| Display | LED indication | |
| Self-consumption Power (without HVAC) | < 300 W (operating), 15 W (sleep) | |
| Ground Fault Monitoring | DC grounded system configuration | |
| Auxiliary Dry Contacts (programmable, x2) | 240V, 10A rated | |

| Standards & Certifications | |
|---|---|
| EMC | FCC, part 15-B |
| Utility Interface and Safety | UL1741 SA, IEEE 1547, CSA C22.2 No. 107.1 |
| Battery System Safety | UL 9540, UL1973 |

| AC Voltage / Frequency Trip Limits: UL1741 (IEEE 1547.1) | | | |
|---|---|---|---|
| | Model | -208 | -480 |
| Low Volt Trip (adj), AC voltage | Default | 183.0 V (L-L) | 243.8 V (L-N) |
| | Min/Max | 104.0 - 183.0 V (L-L) | 138.5 - 243.8 V (L-N) |
| Low Volt Trip Time (adj.) | Default | 117 cycles (1.95 sec) | |
| | Min/Max | 0 - 3600 cycles (60.0 sec) | |
| High Volt Trip (adj.), AC voltage | Default | 228.8 V (L-L) | 304.7 V (L-N) |
| | Min/Max | 228.8 - 249.6 V (L-L) | 304.7 - 332.4 V (L-N) |
| High Volt Trip Time (adj.), | Default | 57 cycles (0.95 sec) | |
| | Min/Max | 0 - 3600 cycles (60.0 sec) | |
| Undervoltage: (Very Low) Trip Limit, AC voltage | | < 104.0 V (L-L) | < 138.5 V (L-N) |
| Undervoltage: (Very Low) Trip Time | | < 10 cycles (0.16 sec) | |
| Overvoltage: (Very High) Trip Limit, AC voltage | | > 249.6 V (L-L) | 332.4 V (L-N) |
| Overvoltage: (Very High) Trip Time | | < 10 cycles (0.16 sec) | |
| Underfrequency Trip (adj), frequency | Default | 59.3 Hz | |
| | Min/Max | 55.0 - 59.3 Hz | |
| Underfrequency Trip Time (adj) | Default | < 10 cycles (0.16 sec) | |
| | Min/Max | 0 - 3600 cycles (60.0 sec) | |
| Overfrequency Trip (adj), frequency | Default | 60.5 Hz | |
| | Min/Max | 60.5 - 65.0 Hz | |
| Overfrequency Trip Time (adj) | Default | < 10 cycles (0.16 sec) | |
| | Min/Max | 0 - 3600 cycles (60.0 sec) | |
| Frequency Trip Limit Accuracy | | 0.01 Hz | |
| Frequency Trip Time Accuracy | | 0.05 sec | |
| AC Voltage Trip Limit Accuracy | | 1% of nominal | |
| AC Voltage Trip Time Accuracy | | 0.05 sec | |

*Table 2: PCS Field Wiring Ratings – AWG / Torque*

| **Field Wiring** | **Use Copper Wire Only, 90°C or higher rated** | | |
|---|---|---|---|
| **Terminal** | **Minimum Wire Size mm² (AWG)** | **Maximum Wire Size mm² (AWG)** | **Tightening Torque, Nm (in. lbs)** |
| Ground Lug | 16 mm² (6 AWG) | 16 mm² (6 AWG) | 1.7 (15.0) |
| AC Grid Terminals* | 6 mm² (10 AWG) | 16 mm² (6 AWG) | 1.7 (15.0) |
| AC Load Terminals* | 6 mm² (10 AWG) | 16 mm² (6 AWG) | 1.7 (15.0) |

*Note: See rated AC current in table 1 for nominal phase currents. Wire ratings are based on product terminal ratings.

## 12.1 UL 1741 SA Grid Support Utility Interactive Inverter Specifications

The PCS within the Commercial AC Battery complies with the UL 1741SA standard for grid support utility interactive inverters. These functions are intended to be either enabled or disabled in accordance with local utility interconnection requirements. The UL 1741 SA testing was conducted in accordance with both Rule 21 and Rule 14H (V1.1) as source requirements documents (SRD), which are applicable in jurisdictions within California and Hawaii, respectively. The corresponding default settings and specifications are listed below.

*Table 3: UL1741 SA grid support functions.*

| Grid Support Function Tested | Test Standard |
|---|---|
| Anti-Islanding protection – unintentional islanding with grid support functions enabled | UL 1741 SA 8 |
| Low/high voltage ride through | UL 1741 SA 9 |
| Low/high frequency ride through | UL 1741 SA 10 |
| Ramp rates | UL 1741 SA 11 |
| Reconnect by "Soft Start" | UL 1741 SA 11 |
| Specified power factor | UL 1741 SA 12 |
| Dynamic Volt/VAR operations | UL 1741 SA 13 |
| Frequency-Watt | UL 1741 SA 14 |
| Volt-Watt | UL 1741 SA 15 |

*Table 4: Low and high voltage ride through settings.*

| SA9 Low and High Voltage Ride Through - Rule 21 | | | | |
|---|---|---|---|---|
| **Region** | **Voltage Range [%Vnom]** | **Ride Through Duration [s]** | **Maximum Trip Time [s]** | **Operating Mode During Ride Through** |
| High Voltage 2 (HV2) | V > 120% | N/A | 0.16 | N/A |
| High Voltage 1 (HV1) | 110% < V ≤ 120% | 12 | 13 | Momentary Cessation (zero power) |
| Near Nominal (NN) | 88% ≤ V ≤ 110% | Indefinite | N/A | Continuous Operation |
| Low Voltage 1 (LV1) | 70% ≤ V < 88% | 20 | 21 | Mandatory Operation |
| Low Voltage 2 (LV2) | 50% ≤ V < 70% | 10 | 11 | Mandatory Operation |
| Low Voltage 3 (LV3) | V < 50% | 1 | 1.5 | Momentary Cessation (zero power) |
| **SA9 Low and High Voltage Ride Through - Rule 14H** | | | | |
| **Region** | **Voltage Range [%Vnom]** | **Ride Through Duration [s]** | **Maximum Trip Time [s]** | **Operating Mode During Ride Through** |
| Over Voltage 2 (OV2) | V > 120% | N/A | 0.16 | Cease to Energize |
| Over Voltage 1 (OV1) | 110% < V ≤ 120% | 0.92 | 1 | Mandatory Operation (VW) |
| Continuous Operation (CO) | 88% ≤ V ≤ 110% | N/A | N/A | Continuous Operation (VW) |
| Under Voltage 1 (UV1) | 70% ≤ V < 88% | 20 | 21 | Mandatory Operation |
| Under Voltage 2 (UV2) | 50% ≤ V < 70% | 10 | 11 | Mandatory Operation |
| Under Voltage 3 (UV3) | V < 50% | 1 | 1.5 | Momentary Cessation (zero power) |

| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
|---|---|---|---|
| Nominal AC voltage [V] | Vnom | 208 or 277 | |
| AC voltage accuracy [%Vnom or V] | MSA-vac | 1% | |
| Voltage trip time accuracy [s] | MSA-ttv | 0.05 | |
| Voltage range of adjustability [%Vnom] | Vvrtmin-Vvrtmax | 0.0% - 120.0% | |
| Trip time range of adjustability [s] | Tvrtmin-Tvrtmax | 0.0 - 50.0 | |
| Default function status | | Enabled | Enabled |

*Table 5: Low and high frequency ride through settings.*

| SA10 Low and High Frequency Ride Through - Rule 21 | | | | |
|---|---|---|---|---|
| **Region** | **Frequency Range [Hz]** | **Ride Through Duration [s]** | **Maximum Trip Time [s]** | **Operating Mode During Ride Through** |
| High Frequency 2 (HF2) | f > 62.0 | N/A | 0.16 | N/A |
| High Frequency 1 (HF1) | 60.5 < f ≤ 62.0 | 299 | 300 | Mandatory Operation (FW) |
| Near Nominal (NN) | 58.5 ≤ f ≤ 60.5 | Indefinite | Indefinite | Continuous Operation |
| Low Frequency 1 (LF1) | 57.0 ≤ f < 58.5 | 299 | 300 | Mandatory Operation |
| Low Frequency 2 (LF2) | f < 57.0 | N/A | 0.16 | N/A |
| **SA10 Low and High Frequency Ride Through - Rule 14H: Oaho, Maui, Hawaii** | | | | |
| **Region** | **Frequency Range [Hz]** | **Ride Through Duration [s]** | **Maximum Trip Time [s]** | **Operating Mode During Ride Through** |
| Over Frequency 2 (OF2) | f > 64.0 | N/A | 0.16 | N/A |
| Over Frequency 1 (OF1) | 63.0 < f ≤ 64.0 | 20 | 21 | Mandatory Operation (FW) |
| Continuous Operation (CO) | 57.0 ≤ f ≤ 63.0 | Indefinite | Indefinite | Continuous Operation (FW) |
| Under Frequency 1 (UF1) | 56.0 ≤ f < 57.0 | 20 | 21 | Mandatory Operation |
| Under Frequency 2 (UF2) | f < 56.0 | N/A | 0.16 | N/A |
| **SA10 Low and High Frequency Ride Through - Rule 14H: Lanai, Molokai** | | | | |
| **Region** | **Frequency Range [Hz]** | **Ride Through Duration [s]** | **Maximum Trip Time [s]** | **Operating Mode During Ride Through** |
| Over Frequency 2 (OF2) | f > 65.0 | N/A | 0.16 | N/A |
| Over Frequency 1 (OF1) | 63.0 < f ≤ 65.0 | 20 | 21 | Mandatory Operation (FW) |
| Continuous Operation (CO) | 57.0 ≤ f ≤ 63.0 | Indefinite | Indefinite | Continuous Operation (FW) |
| Under Frequency 1 (UF1) | 50.0 ≤ f < 57.0 | 20 | 21 | Mandatory Operation |
| Under Frequency 2 (UF2) | f < 50.0 | N/A | 0.16 | N/A |

| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
|---|---|---|---|
| Nominal frequency [V] | fnom | 60 | |
| AC frequency measurement accuracy [Hz] | MSA-f | 0.02 | |
| Frequency trip time accuracy [s] | MSA-ttf | 0.05 | |
| Frequency range of adjustability [Hz] | ffrtmin-ffrtmax | 50.0 - 66.0 | |
| Trip time range of adjustability [s] | Tfrtmin-Tfrtmax | 0.0 - 1000.0 | |
| Default function status | | Enabled | Enabled |

*Table 6: Ramp rate settings.*

| SA11 Ramp Rates | | | |
|---|---|---|---|
| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
| Output current rating [A] | Irated | 41.6 A (208 V Delta), 18.1 A (480 V Wye) | |
| Minimum normal ramp up rate [%Irated/sec] | RRnorm_min | 1.0% | |
| Maximum normal ramp up rate [%Irated/sec] | RRnorm_max | 100.0% | |
| Minimum output current [A] | Ilow | 0 | |
| Ramp Rate Accuracy [%Irated/sec] | MSA-rr | N/A | |
| Minimum soft start ramp up rate [%Irated/sec] | RRss_min | 0.1% | |
| Maximum soft start ramp up rate [%Irated/sec] | RRss_max | 100.0% | |
| Default normal ramp up rate [%Irated/sec] | RRnorm | 100.0% | 100.0% |
| Default soft start ramp function status | | Enabled | Enabled |
| Default soft start ramp up rate [%Irated/sec] | RRss | 2.0% | 0.33% |

*Table 7: Specified power factor settings.*

| SA12 Specified Power Factor | | | |
|---|---|---|---|
| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
| Apparent power rating [VA] | Srated | 15000 | |
| Output power rating [W] | Prated | 15000 | |
| DC input voltage range with function enabled [V] | Vdcmin-Vdcmax | 40.0 - 80.0 | |
| Nominal AC voltage [V] | Vnom | 208 (L-L, Delta) or 277 (L-N, Wye) | |
| AC voltage range with function enabled [%Vnom] | Vmin-Vmax | 88.0% - 110.0% | |
| AC voltage accuracy [%Vnom or V] | MSA-vac | 1% | |
| DC voltage measurement accuracy [V] | MSA-vdc | 0.05 | |
| Active power range of function [W] | Plow, Prated | 3000 - 15000 | 750 - 15000 |
| Power Factor Accuracy | MSA-pf | 0.01 | |
| Power Factor settling time [sec] | Ts-pf | 5 | |
| Minimum inductive power factor | PF min,ind | -0.8 | |
| Minimum capacitive power factor | PF min,cap | 0.8 | |
| Mid inductive power factor | PF mid,ind | -0.9 | |
| Mid capacitive power factor | PF mid,cap | 0.9 | |
| Default function status | | Disabled | Disabled |
| Power factor default | PF | -0.95 | -0.95 |

*Table 8: Volt- VAr settings.*

| SA13 Volt-VAr Mode | | | |
|---|---|---|---|
| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
| Apparent power rating [VA] | Srated | 15000 | |
| Output power rating [W] | Prated | 15000 | |
| EUT input voltage range with function enabled [V] | Vdcmin-Vdcmax | 40.0 - 80.0 | |
| Nominal AC EPS voltage [V] | Vnom | 208 (L-L, Delta) or 277 (L-N, Wye) | |

| | | | |
|---|---|---|---|
| AC EPS voltage range with function enabled [V] | Vmin-Vmax | 96.0 - 144.0 | |
| Reactive power accuracy [%Srated, VAr] | MSA-q | 5%, 250VAr | |
| Maximum ramp rate [VAr/s] | RRvar | 500 | |
| Maximum rated reactive power production (capacitive, overexcited) [VAr] | Qmax,cap | 6600 | |
| Maximum rated reactive power production (inducitive. underexcited) [VAr] | Qmax,ind | -6600 | |
| Minimum rated reactive power production (capacitive, overexcited) [VAr] | Qmin,cap | 750 | |
| Minimum rated reactive power production (inducitive. underexcited) [VAr] | Qmin,ind | -750 | |
| Maximum slope [VAr/V] | KVARmax | 1587 | |
| Deadband range [%Vnom] | Deadmand_min | 0.0 - 20.0 | |
| | Deadband_max | | |
| Time accuracy [s], related Tr-vv | MSA-t | 2 | |
| Settling time [s] | Ts-vv | 3 | |
| Default function status | | Enabled | Enabled |
| Default response time, ramp to Qmax,ind [s] | Tr-vv | 10 | 10 |
| Default power prioritization | P/Q Priority | Q | Q |
| Default Voltage at Q1 [%Vnom] | V1 | 94.3% | 94.0% |
| Default max reactive power production setting [VAr] | Q1 | 4500 | 6600 |
| Default voltage at Q2 [%Vnom] | V2 | 98.0% | 97.0% |
| Default reactive power setting at lower voltage deadband limit [VAr] | Q2 | 0 | 0 |
| Default voltage at Q3 [%Vnom] | V3 | 102.0% | 103.0% |
| Default reactive power setting at upper voltage deadband limit [VAr] | Q3 | 0 | 0 |
| Default voltage at Q4 [%Vnom] | V4 | 105.7% | 106.0% |
| Default max reactive power absorption setting [VAr] | Q4 | -4500 | -6600 |

* Volt-VAr mode can function with active or reactive power priority. When an inverter is set in Volt-VAr mode with reactive power priority and the inverter's apparent power kVA limit is reached, active power is reduced to maintain reactive power production. When an inverter is set in Volt-VAr mode with active power priority and the inverter's apparent power kVA limit is reached, the reactive power is reduced to maximize active power production.

*Table 9: Frequency-watt Settings*

| SA14 Frequency Watt | | | |
|---|---|---|---|
| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
| Output Power Rating [W] | Prated | 15000 | |
| AC frequency range with function enabled [Hz] | fmin, fmax | 60.0 - 65.0 | |
| AC frequency measurement accuracy [Hz] | MSA-f | 0.02 | |
| P(f) accuracy [%Prated or W] | MSA-p(f) | 2%, 300W | |
| Settling time [sec] | Ts-fw | 3 | |
| Adjustment range of response time [s] | Tr-fw | 0.5 - 3.0 | |

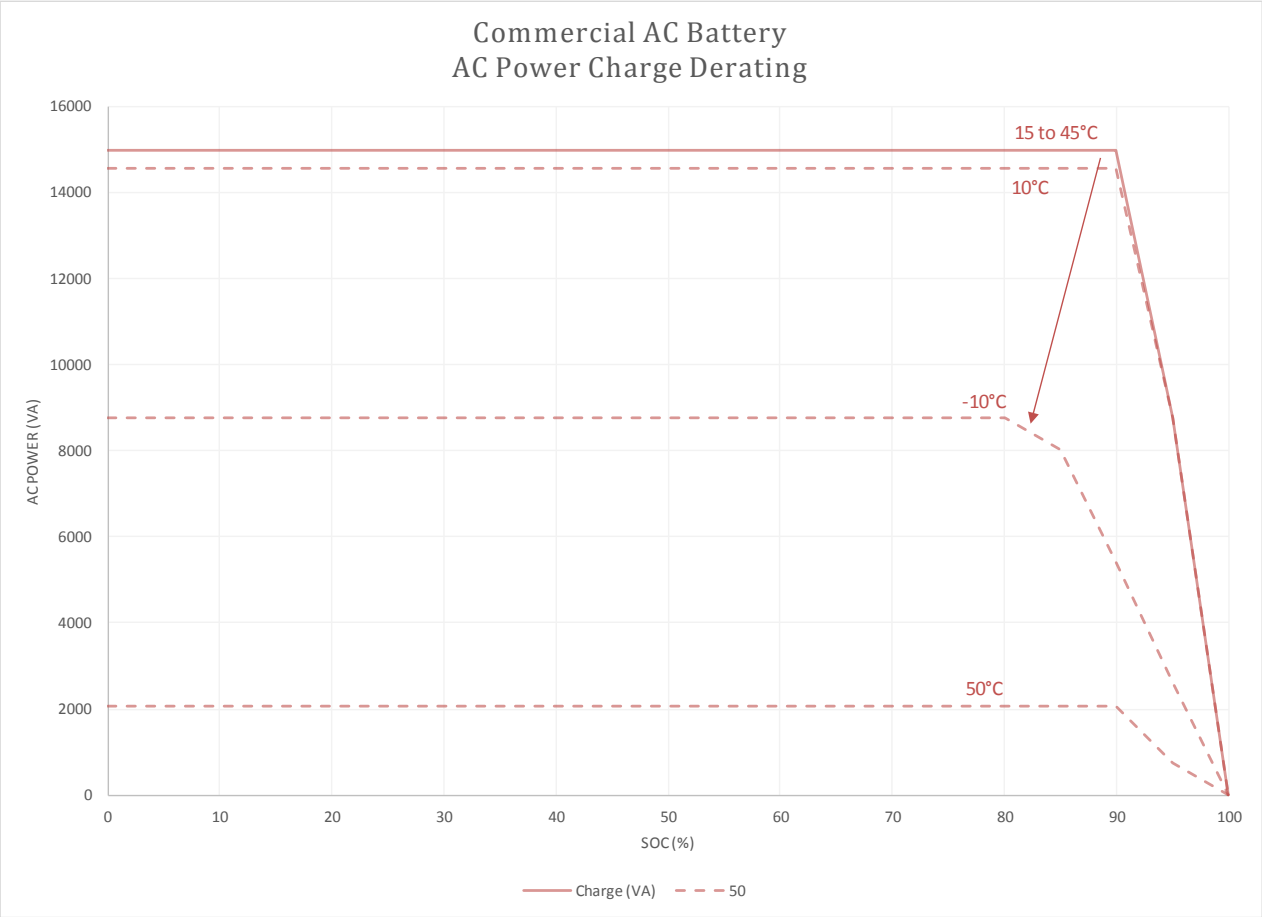
| | | | |
|---|---|---|---|
| Adjustment range of the start of frequency droop [Hz] | fstart_min, fstart_max | 60.017 - 63.0 | |
| Maximum slope of frequency droop [%Prated/Hz] | Kpower-freq_max | 100.0% | |
| Minimum slope of frequency droop [%Prated/Hz] | Kpower-freq_min | 23.8% | |
| Default function status | | Enabled | Enabled |
| Default response time, ramp to 10% Prated [s] | Tr-fw | 0.5 | 0.5 |
| Default start frequency [Hz] | fstart | 60.1 | 60.036 |
| Default slope of frequency droop [%Prated/Hz] | Kpower-freq | 50.0% | 41.7% |
| Default use of hysteresis (symmetric recovery) | | Enabled | Enabled |

*Table 10: Voltage-watt Settings*

| SA15 Voltage Watt | | | |
|---|---|---|---|
| **Parameter** | **Abbreviation** | **Value for Rule 21** | **Value for Rule 14H** |
| Output power rating [W] | Prated | 15000 | |
| AC voltage range with function enabled [%Vnom] | Vmin-Vmax | 1.00 - 1.12 | |
| Nominal AC voltage [V] | Vnom | 208 (L-L, Delta) or 277 (L-N, Wye) | |
| AC voltage accuracy [%Vnom or V] | MSA-vac | 1% | |
| Output power accuracy [%Prated or W] | MSA-watts | 2%, 300W | |
| Time accuracy [s], related to treturn_min, treturn_max, Tr-vw | MSA-t | 2 | |
| Setting time [sec] | Ts-vw | 3 | |
| Adjustment range of the start of active power reduction [%Vnom] | Vstart_min, Vstart_max | 102.0% - 106.0% | |
| Adjustment range of the stop of the curtailment function [V] | Vstop_min.,Vstop_ max | 101.0% - 105.0% | |
| Maximum Slope of active power reduction [%Prated/V] | Kpower-volt_max | 36.1% | |
| Minimum slope of active power reduction [%Prated/V] | Kpower-volt_min | 4.5% | |
| Range of adjustment of a delay before return to normal operation [sec] | treturn_min, treturn_max | 1.0 - 60.0 | |
| Adjustment range of the rate of return to normal operation [%Prated/sec] | Kpower_rate_min. Kpower_rate_max | 10.0 - 100.0% | |
| Default function status | | Disabled | Disabled |
| Power duration reference | | Pre-disturbance | Rated |
| Default response time, ramp to 10% Prated [s] | Tr-vw | 1 | 10 |
| Default start voltage [%Vnom] | Vstart | 106.0% | 106.0% |
| Default stop voltage [%Vnom] | Vstop | 105.0% | 106.0% |
| Default active power slope [%Prated/V] | Kpower_volt | 20.8% | 20.8% |
| Default use of hysteresis (symmetric recovery) | | Disabled | Enabled |
| Default delay before return to normal operation [s] | treturn | 1 | N/A |
| Default active power rate of return to normal operation [%Prated/s] | Kpower_rate | 100 | N/A |

### *12.2 Thermal Performance of PCS and Battery Modules*

The following charts indicate the power performance of the PCS and batteries based on the outside ambient operating temperature. Note that direct sunlight can significantly raise the internal temperature of the batteries. Avoiding installation in direct sunlight is critical to the long term performance and operation of the battery.



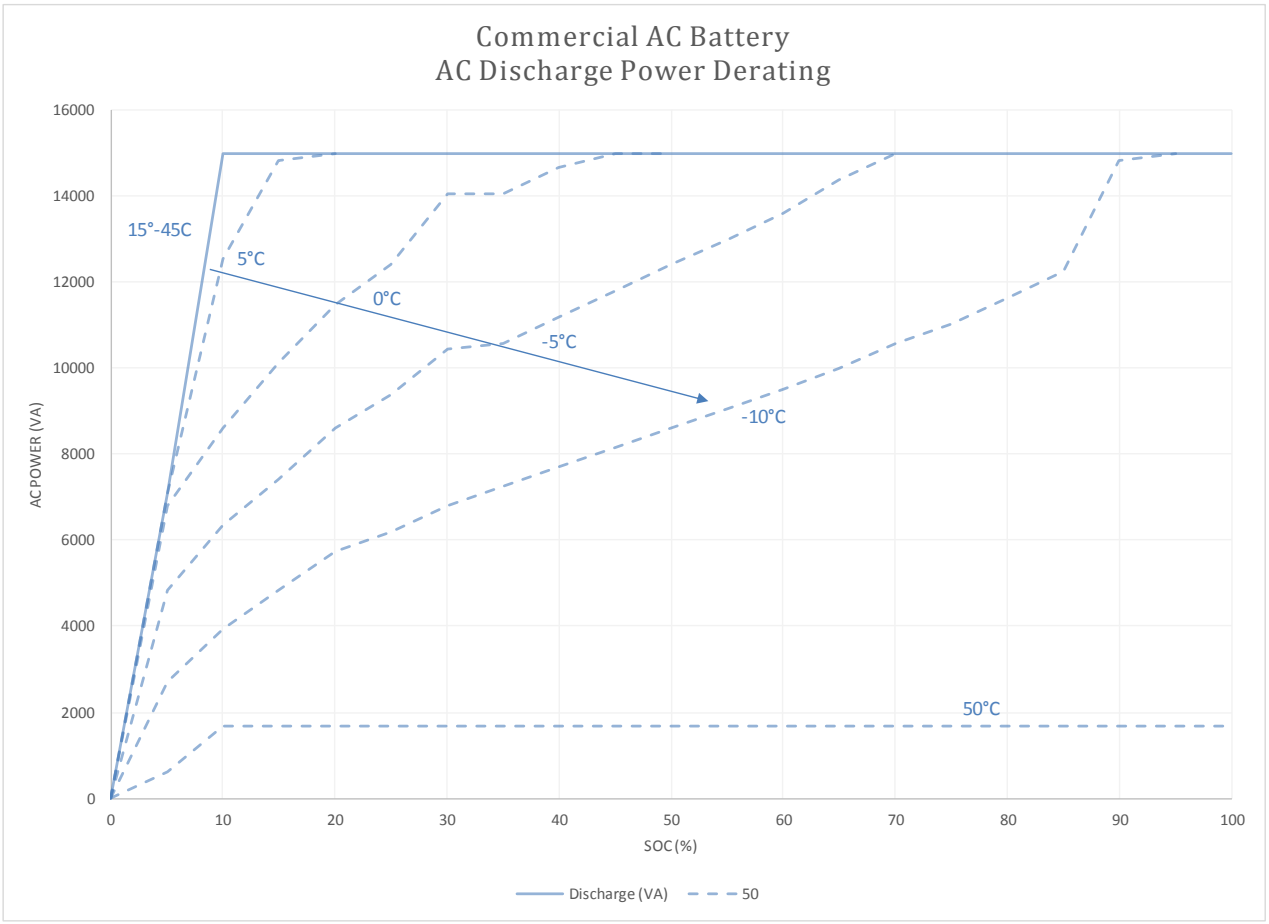
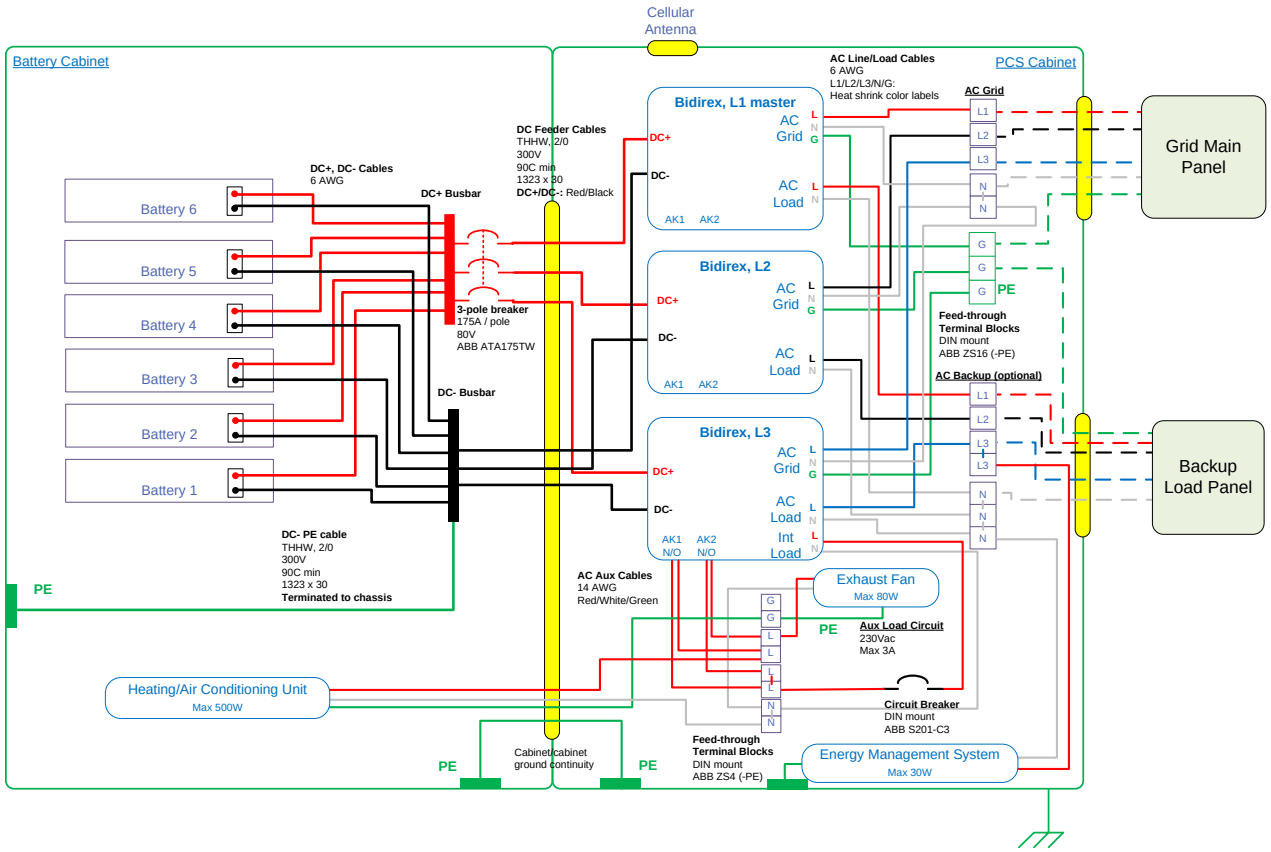


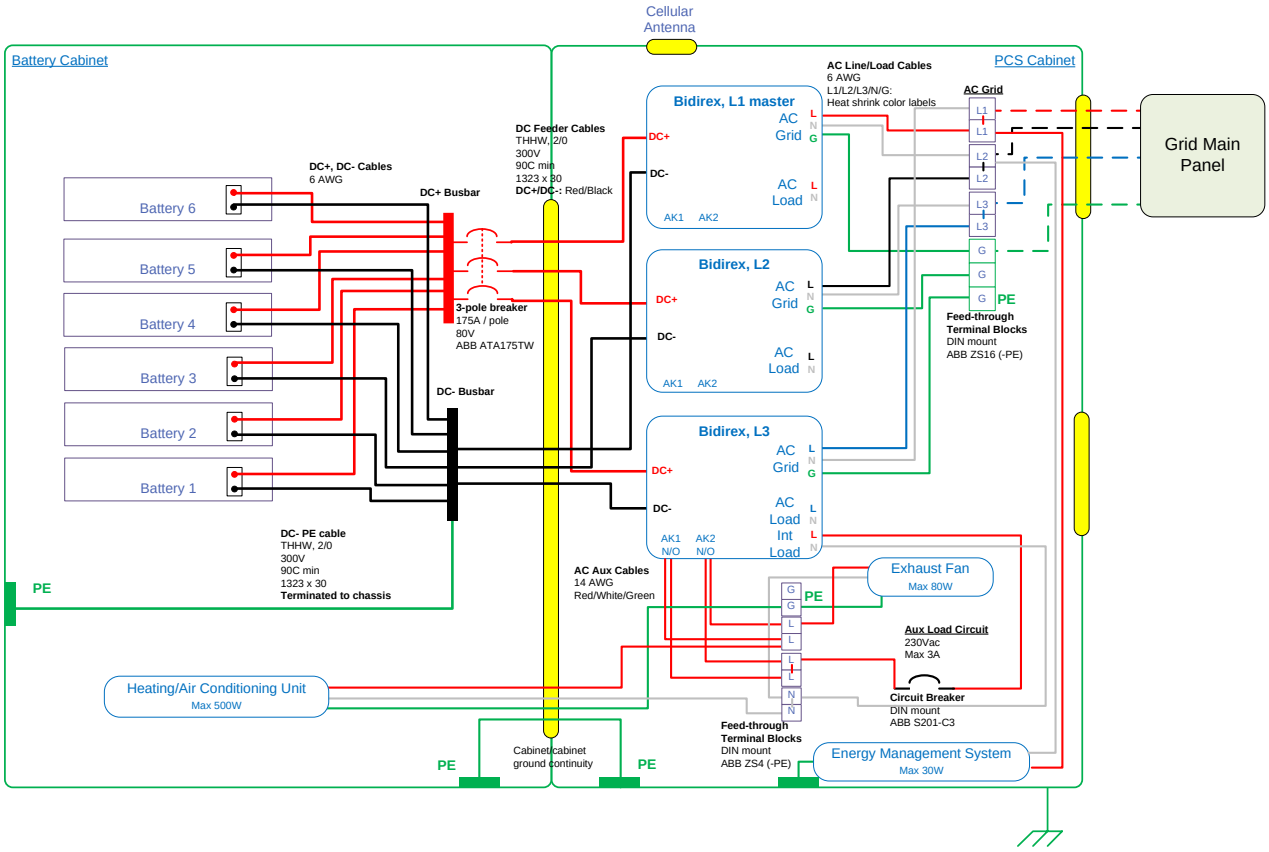

*Figure 15: Thermal operating range of PCS and Battery.*

# Appendix A: ACB-15 Series Electrical Block Diagrams

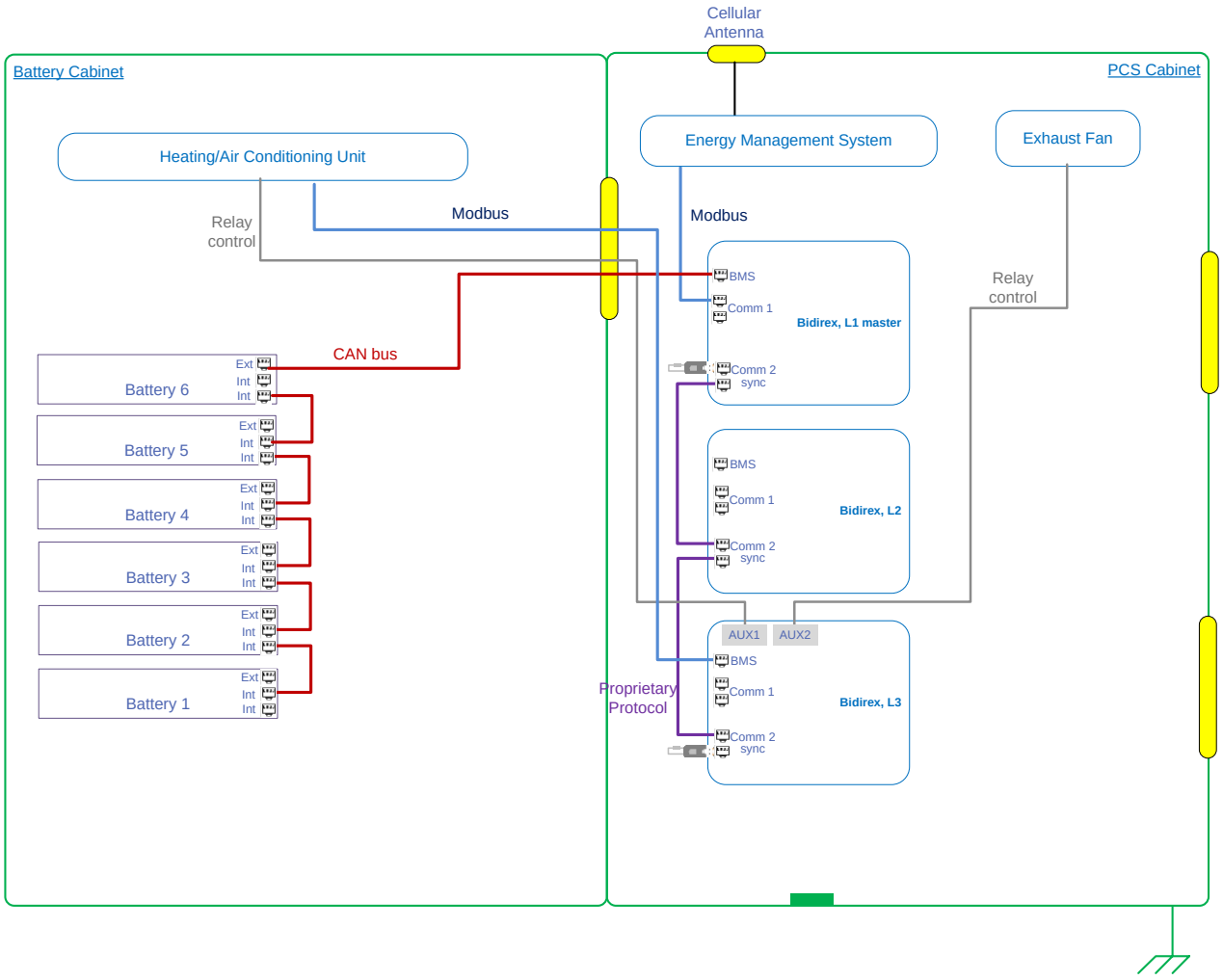
## A.1: Three Phase 480 V Wye



# A.2: Three Phase 208 V Delta



## A.3 Communication



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